Manaaki
Taha Moana

An Annotated Bibliography: Health of Te Awanui Tauranga Harbour

Manaaki Taha Moana: Enhancing Coastal Ecosystems for Iwi
Monograph Series - No. 8

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EXECUTIVE SUMMARY

This report provides an annotated bibliography of research publications and scientific/technical reports in relation to the ecological health of Tauranga Harbour - Health of Te Awanui Tauranga Harbour (Sinner et al., 2011). Other selected reports with relevance to environmental research have also been included. The bibliography is intended to be a starting point for people working on environmental research within Tauranga Harbour and its catchments and a guide to what reports and other information exist about the state of coastal ecosystems in the case study region.

Manaaki Taha Moana (MTM) is a six-year programme, running from October 2009 to September 2015, with research being conducted primarily in two areas: Tauranga Moana and the coastal rohe of Ngati Raukawa on the Horowhenua coast. The wider research project aims to restore and enhance coastal ecosystems and their services of importance to iwi/hapu, by working with iwi to improve knowledge of these ecosystems and the degradation processes that affect them.

This report is not a comprehensive listing of all environmental research publications during the period, but some guidance is provided as to other bibliographic references and publication sources.

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1 INTRODUCTION

1.1 Background

This report is one in a series of reports and other outputs from the research programme "Enhancing Coastal Ecosystems for Iwi: Manaaki Taha Moana" (MAUX0907), funded by the Ministry of Business, Innovation and Employment (previously the Ministry for Science and Innovation, and before that the Foundation for Research Science and Technology, and the Ministry of Research, Science and Technology).

1.2 Manaaki Taha Moana (MTM) Project & Team

Manaaki Taha Moana (MTM) is a six-year programme, running from October 2009 to September 2015. Research is conducted primarily in two areas: Tauranga Moana and the Horowhenua coast. This programme builds upon "Ecosystem Services Benefits in Terrestrial Ecosystems for Iwi" (MAUX0502), Massey University's previous research with Ngati Raukawa in the lower North Island.

Professor Murray Patterson of Massey University is the Science leader of MTM. A number of different organisations are contracted to deliver the research: Waka Taiao Limited with support of Te Manaaki Awanui (previously, Te Manaaki Taiao Trust) in the Tauranga Moana case study; Te Reo o Taiao Ngati Raukawa Environmental Resource Unit (Taiao Raukawa) and Dr Huhana Smith in the Horowhenua coast case study; Waka Digital; Cawthron Institute; and Massey University. The research team endeavours to engage extensively with local communities and end users through a variety of means. More about the research programme can be found on the MTM programme website http://www.mtm.ac.nz.

1.3 Objectives of the MTM Project

The central research question is: — how can we best enhance and restore the value and resilience of coastal ecosystems and their services, so that this makes a positive contribution to iwi identity, survival and welfare in the case study regions? Accordingly, our research aims to restore and enhance coastal ecosystems and their services of importance to iwi/hapū, through a better knowledge of these ecosystems and the degradation processes that affect them.

The MTM teams utilize both western science and mātauranga Māori knowledge to assist iwi/hapū to evaluate and define preferred options for enhancing/restoring coastal ecosystems. This evaluation of options will also be assisted by the development of innovative Information Technology and decision support tools.

The research team works closely with iwi/hapū in the case study regions to develop tools and approaches to facilitate the uptake of this knowledge and its practical

implementation. Mechanisms will also be put in place to facilitate uptake amongst other iwi throughout New Zealand. The key features of this research are that it is: cross-cultural, interdisciplinary, applied/problem solving, technologically innovative, and integrates the ecological, environmental, cultural and social factors associated with coastal restoration.

Manaaki Taha Moana has three specific research objectives:

Objective 1: Develop a Knowledge Base of Coastal Ecosystems and their Services in the two case study regions.

This objective is focused on determining the extent of critical coastal ecosystems and their services in both of our case study regions (Tauranga Moana and the Horowhenua coast). The relevant research questions are: What are they? Where do they occur? How can they be measured in biophysical, cultural and other terms? How culturally significant are they? How much are they worth or valued?

Objective 2: Determine how to Enhance and Restore Specified Coastal Ecosystems and their Services in the case study regions.

We are working directly with Te Manaaki Te Awanui, Taiao Raukawa and other agencies in the local communities to harness and build on the knowledge from Objective 1 to answer the central research question of: how can we best enhance and restore the value and resilience of coastal ecosystems and their services, so that this makes a positive contribution to iwi identity, survival and welfare in the case study regions? This will be achieved through detailed case studies in both regions, on topics of most importance to local iwi and hapū, in ascertaining how to go about restoring coastal ecosystems and their services. We will work with other groups and local councils who may also be undertaking complementary-focused research.

Objective 3: Implementation and Benefit Transfer to other Iwi.

A condition of involvement, of both Tauranga Moana iwi and Ngāti Raukawa, in this research program is that the research be implemented to bring about real change in the state of coastal ecosystems within their rohe. Both Tauranga Moana iwi and Ngāti Raukawa have catalogued the poor state of many coastal ecosystems within their rohe - recalling, for example, accounts from tribal elders of the abundant kaimoana found 40 to 50 years, but not today. Both iwi groups are committed to arresting these trends and keen, through this research program, to put in place Action Plans and other mechanisms to improve the quality of the coastal environment. Further, the tools and frameworks developed in this project will be made available to iwi and other end user groups nationally, through information and communication technology and other means.

1.4 Objective of the Annotated Bibliography

The following annotated bibliography is aimed at providing aknowledgeplatform of referenced literature that relates to research, temporal monitoring and ecologyof the Horowhenua coast and Te Awanui, Tauranga Harbour. The broad range of literature within this bibliography encompasses environmental reponses to pollution, contamination and anthropogenic stressors, across a variety of ecosystems and at the national and international level. Along with this, the collection of information presented here forms a strong basis for integrating research-based knowledge withindeginous and community based knowledge, falling in form with Objectives 2 and 3 (*see above*) of the MTM project. Utilizing the vast amount of research and litretature available allows for an understanding of the mechanisms which lead to degradation of resources, this being directly applicable to marine and freshwater ecosystems under threat within the case study regions.This document creates a broad baseline of knowledge, which is integral to laying the foundations for future monitoring and management of the Horowhenua coast, Tauranga Harbour and its catchments, which fits into objective 1 of the MTM project (*see* “1.3 Objectives of the MTM Project”, *of this report*).

2 METHODOLOGY

The following annotated bibliography is an extension of the Manaaki Taha Moana Report “Health of Te Awanui, Tauranga Harbour, MTM Report 1” (Sinner *et al*., 2011). The referenced citations used to construct report 1 have been collated to make thefollowing report.The following annotated bibliography is listed by author in alphabetical order.

Analoged lists for each citation are as follows:

- Title
- Date
- Author
- Publisher
- Spatial Information
- Key words
- Summary

It should be noted that some of the reports may still be confidential. The incorporation of a report title and/or abstract in this publication should not be taken to imply that they are available. There are also unresolved problems to wide access to these reports, as many are not listed as being available in the records of inter-loan libraries.

3. ANNOTATED BIBLIOGRAPHY& ALPHABETICAL CITATIONS

3.1. A

Assessment of heavy metal enrichment factors and the degree of contamination in marine sediments from Tamaki Estuary, Auckland, New Zealand (January 2008)
Abrahim, G. M. S.; Parker, R. J.
Environmental Monitoring and Assessment

Spatial Information: Elsewhere in New Zealand: Tamaki Estuary, Auckland
Key words: sedimentation; heavy metals, enrichment factor, degree of contamination, sediments pollution, Tamaki Estuary, Auckland, New Zealand

Summary: Eight sediment cores recovered from Tamaki Estuary were analysed for Cu, Pb, Zn, and Cd using downward cored sub-samples. The results indicate significant concentrationsof heavy metals in the upper sediment layers, with the highest concentrations found between 0-10 cm of the sediment. Assessment of heavy metal pollution in marine sediments requires knowledge of pre-anthropogenic metal concentrations, to act as a reference against which measured values can be compared. Pristine values for the cored sediments were determined from flat "base-line" metal trends evident in lower core samples. Various methods for calculating metal concentration and contamination factors are reviewed in detail and a modified and more robust version of the procedure for calculating the degree of contamination is proposed. The revised procedure allows the incorporation of a flexible range of pollutants, including various organic species, and the degree of contamination is expressed as an average ratio rather than an absolute summation number. Comparative data for normalized concentration factors and the modified degree of contamination show that Tamaki Estuary sediments have suffered significant systematic heavy metal contamination following catchment urbanization. Compared to baseline values the uppermost sediment layers show a four-fold increase in contamination, averaged across eight cores and four analysed metals.

Distribution and assessment of sediment toxicity in Tamaki Estuary, Auckland, New Zealand (2007)
Abrahim, G. M. S.; Parker, R. J.; Nichol, S. L.
Environmental Geology

Spatial Information: Elsewhere in New Zealand: Tamaki Estuary, Auckland
Key words: sedimentation, heavy metals, contamination, sediment quality guidelines, and geomorphology, Tamaki Estuary Auckland, New Zealand

Summary: Heavy metal levels in surface sediments from Tamaki Estuary demonstrate significant upper estuary increases in Cu, Pb, Zn, Cd and mud concentrations. Increased metal levels towards the head of the estuary are linked to local catchment sources reflecting the historical development, industrialisation and urbanisation of catchment areas surrounding the upper estuary. The relatively narrow constriction in the middle estuary (Panmure area), makes it susceptible to accumulation of upper estuary pollutants, since the constriction reduces circulation and extends the time required for fine waterborne sediments in the upper estuary to exchange with fresh coastal water. As a result fine fraction sediments trapped in the upper estuary facilitate capture and retention of pollutants at the head of the estuary.

The increase in sandy mud poor sediments towards the mouth of the estuary is associated with generally low metal concentrations. The estuary's geomorphic shape; with a mid estuary constriction, sediment texture, mineralogy and catchment history are significant factors in understanding the overall spatial distribution of contaminants in the estuary. Bulk concentration values for Cu, Pb, Zn, and Cd in all the studied surface samples occur below ANZECC ISQG-H toxicity values. Cd and Cu concentrations are also below the ISQG-L toxicity levels for these elements. However, Pb and Zn concentrations do exceed the ISQG-L values in some of the surface bulk samples, in the upper estuary, proximal to long established sources of catchment pollution.

The spread of marine non-indigenous species via recreational boating: A conceptual model for risk assessment based on fault tree analysis (2009)
Acosta, H.; Forrest, B. M.
Ecological Modelling

Spatial Information: Elsewhere in New Zealand: Port Nelson
Key words: invasive species, marine invasion, non-indigenous species, recreational boating, conceptual model, invasion risk modelling

Summary: Recreational vessel movements are increasingly recognised as an important pathway for the spread of non-indigenous species (NIS) in marine environments. Research on risks posed by recreational vessels has focused on external hull fouling, yet a number of studies reveal the potential for NIS to also be transferred by a range of other vessel components. This paper uses fault tree analysis as a framework for incorporating input from a panel of international experts, to elucidate the consecutive steps that must occur for NIS to be introduced from different components of recreational boats. Our conceptual model reveals the complexity of the invasion process even when only the 'release' phase is considered (i.e. the release of NIS from an infected vessel into a new area). The model highlights that, in addition to external fouling of the 'hull'(hull, rudder and propeller), important vessel components may also include fouling, sediment or water released from the deck, internal spaces, anchors and fishing/diving gear. The extent to which these components are important is situation-specific, and depends on attributes of the vessel, location and NIS present. Hence, the comprehensive model described here could be modified or simplified to reflect the attributes that are relevant to particular circumstances. We demonstrate this principle using examples of three NIS: the colonial tunicate *Didemnum vexillum* and the Asian kelp *Undaria pinnatifida* that both have established in Port Nelson New Zealand after vessel-mediated spread, and the clubbed tunicate *Styela clava* that was detected on a vessel hull in the port but is not known to have established. Although the modelling and assessment of some of the events identified in the fault trees would be difficult or unrealistic, it is important to acknowledge them in order to provide a comprehensive risk assessment tool. Even where risks are largely unknown, difficult to quantify, or reflect stochastic events, this does not necessarily preclude management intervention.

Why "indigenous" knowledge? (2009)
Agrawal, A.
Journal of the Royal Society of New Zealand

Spatial Information: No spatial context
Key words: indigenous knowledge, scientific knowledge, terminology

Summary: Discussion on research of indigenous knowledge and reasons for interest in it; comparison with "scientific knowledge" and the use of these terms.

Loss, status and trends for coastal marine habitats of Europe (2007)
Airoldi, L.; Beck, M. W.
Oceanography and Marine Biology: An Annual Review; Taylor & Francis

Spatial Information: Overseas: Europe
Key words:macroalgae; marine ecosystem, coastal development, Europe, wetland, sea grass, fishing methods, coastal management, fragmentation, habitat loss

Summary: Over the centuries, land reclamation, coastal development; overfishing and pollution have nearly eliminated European wetlands, seagrass meadows, shellfish beds, biogenic reefs and other productive and diverse coastal habitats. It is estimated that every day between 1960 and 1995, a kilometre of European coastline was developed. Most countries have estimated losses of coastal wetlands and seagrasses exceeding 50% of the original area with peaks above 80% for many regions. Conspicuous declines, to virtual local disappearance of kelps and other complex macroalgae, have been observed in several countries. A few dominant threats have led to these losses over time. The greatest impacts to wetlands have consistently been land claim and coastal development. The greatest impacts to seagrasses and macroalgae are presently associated with degraded water quality while in the past there have been more effects from destructive fishing and diseases. Coastal development remains an important threat to seagrasses. For biogenic habitats, such as oyster reefs and maerls, some of the greatest impacts have been from destructive fishing and overexploitation with additional impacts of disease, particularly to native oysters. Coastal development and defence have had the greatest known impacts on soft-sediment habitats with a high likelihood that trawling has affected vast areas. The concept of 'shifting baselines', which has been applied mostly to the inadequate historical perspective of fishery losses, is extremely relevant for habitat loss more generally. Most habitat loss estimates refer to a relatively short time span primarily within the last century. However, in some regions, most estuarine and near-shore coastal habitats were already severely degraded or driven to virtual extinction well before 1900. Native oyster reefs were ecologically extinct by the 1950s along most European coastlines and in many bays well before that. These shellfish reefs are among the most endangered coastal habitats, but they receive some of the least protection. Nowadays less than 15% of the European coastline is considered in 'good' condition. Those fragments of native habitats that remain are under continued threat, and their management is not generally informed by adequate knowledge of their distribution and status. There are many policies and directives aimed at reducing and reversing these losses but their overall positive benefits have been low. Further neglecting this long history of habitat loss and transformation may ultimately compromise the successful management and future sustainability of those few fragments of native and semi-native coastal habitats that remain in Europe.

Benthic macro-invertebrate community composition within a mangrove/seagrass estuary in northern New Zealand (2006)
Alfaro, A.
Estuarine, Coastal and Shelf Science

Spatial Information: Elsewhere in NZ: Matapouri Estuary, Northland

Keywords: benthic fauna, estuarine habitats, mangroves, sand flats, biodiversity, plants, sea grass, *Zostera*, *Avicennia marina*

Summary: In the tropics and sub-tropics, estuarine environments with mangrove and seagrass habitats provide important structures and resources for diverse communities of benthic organisms. However, temperate estuarine habitats, especially in mangrove areas, may differ significantly in their community associations and interactions. The community composition of benthic macro-fauna was investigated within temperate Matapouri Estuary, northern New Zealand. The density and distribution of fauna were sampled within six distinctive habitats (mangrove stands, pneumatophore zones, Zostera beds, channels, banks, and sand flats), within four sampling events between December 2002 and September 2003. Each type of habitat was replicated seven times within different locations in the estuary. Counts of all infauna and epifauna within four replicate cores were recorded from each habitat and location. Multidimensional scaling plots were used to identify differences in structure and composition of assemblages among habitats and locations within each sampling event. Results from these benthic samples indicate that Matapouri Estuary has a high overall biodiversity, with distinctive faunal assemblages found within different habitats, and some seasonal variations also apparent. In terms of both number of individuals and taxa per unit area, seagrass beds had the highest numbers and mangrove areas had the lowest numbers, with all other habitats in between. Some locations were found to support a high diversity of organisms across habitats, while other locations had high densities of a few species only. Several physical and biological differences between tropical/sub-tropical and New Zealand's temperate mangrove habitats are put forth as potential reasons for the lower density and diversity of the benthic component observed herein. Further ongoing studies aim to elucidate the structure and interactions within food webs in this estuarine ecosystem.

Conservation status of New Zealand freshwater fish, 2009 (2010)

Allibone, R., David, B., Hitchmough, R., Jellyman, D., Ling, N., Ravenscroft, P., Waters, J.

New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand Wide
Key words:threatened fish; endangered fish; uncommon fish; extinct fish; conservation status; New Zealand; threat classification

Summary: The threat status of 74 freshwater and estuarine fish present in New Zealand was determined. Fifty-one native taxa were ranked of which 67% were considered Threatened or At Risk. A single species was classified as Extinct, the New Zealand grayling, which has not been observed since the 1920s. Four taxa were classified in the highest threat category, Nationally Critical, and a further 10 taxa as Threatened (Nationally Endangered or Nationally Vulnerable). Twenty taxa were ranked in the At Risk group with the majority ranked as Declining. Endemic galaxiids (Galaxiidae) dominated the Threatened and At Risk taxa. The majority (68%) belonged to the Galaxias genus, comprising 81% of recognised taxa in this genus and all five species in the genus Neochanna were also ranked as Threatened or At Risk. In addition to 51 native taxa, a further three fish species were considered colonists and 20 introduced species were classified as naturalised, although two of these are considered rare. The majority of the Threatened species occur in the Canterbury and Otago regions where a suite of rare non-migratory galaxiids exist. Threat mechanisms that were identified as causal in the decline of freshwater fish

species were the impact of introduced fish species, declining water quality, effects of water abstraction, loss of habitat via land-use change and land-use activities, and river modifications.

The effects of sewage and natural seasonal disturbances on benthic macrofaunal communities in Fitzroy Bay, Wellington, New Zealand (1992)
Anderlini, V.C., Wear, R.G.
Marine Pollution Bulletin

Spatial Information: Elsewhere in NZ: Fitzroy Bay, Wellington
Keywords: benthic fauna, Fitzroy Bay, New Zealand, macrofauna, sewage, effluent, ocean outfall, Abundance/Biomass Comparison (ABC) analysis, cluster, multi-dimensional scaling

Summary: Benthic macrofauna were sampled on 6 occasions over a 14 month period from Fitzroy Bay, Wellington, New Zealand to assess the effects of an existing sewage effluent discharge on these organisms and to determine natural seasonal fluctuations in community structure within the vicinity of a proposed new ocean outfall. Results of Abundance/Biomass Comparison (ABC), Cluster, and Multi-Dimensional Scaling analysis indicated that only benthic communities within a 500m radius of the present sewage outfall were affected by the discharge. However, seasonal data indicated that most sites within Fitzroy Bay were disturbed on at least one occasion during the sampling period. The data suggests that ABC analysis should be conducted over several seasons to provide a more accurate assessment of pollution-induced and/or natural physical and biological disturbance.

Harmful Algal Blooms and Eutrophication: Nutrient Sources, Composition and Consequences (August2002)
Anderson, D.M.; Gilbert, P.M.; Burkholder, J.M.
Estuaries and Coasts

Spatial Information: No specific spatial area - is a review/discussion of many (overseas) studies.
Keywords: harmful algal blooms, nutrients, toxic, eutrophication, algae, phosphorous, nitrogen, red tides

Summary: Although algal blooms, including those considered toxic or harmful, can be a natural phenomena, the nature of the global problem of harmful algal blooms (HABs) has expanded in both extent and its public perception over the last several decades. Of concern, especially for resource managers, is the potential relationship between HABs and the accelerated eutrophication of coastal waters from human activities. We address current insights into the relationships between HABs and eutrophication, focusing on sources of nutrients, known effects of nutrient loading and reduction, new understanding of pathways of nutrient acquisition among HAB species, and relationships between nutrients and toxic algae. Through specific, regional, and global examples of these various relationships, we offer both an assessment of the state of understanding, and the uncertainties that require future research efforts. The sources of nutrients potentially stimulating algal blooms include sewage, atmospheric deposition, groundwater flow, as well as agricultural and aquaculture runoff and discharge. On a global basis, strong correlations have been demonstrated between total phosphorus inputs and phytoplankton production in freshwaters, and between total nitrogen input and phytoplankton production in

estuarine and marine waters. There are also numerous examples in geographic regions ranging from the largest and second largest U.S. mainland estuaries (Chesapeake Bay and tile Albemarle-Panllico Estuarine System), to the Inland Sea of Japan, the Black Sea, and Chinese coastal waters. Within these regions, increases in nutrient loading have been linked with the development of large biomass blooms, leading to anoxia and toxic or harmful impacts on fisheries resources, ecosystems, and human health or recreation. Many of these regions have witnessed reductions in phytoplankton biomass (as chlorophyll a) or HAB incidence when nutrient controls were put in place. Shifts in species composition have often been attributed to changes in nutrient supply ratios, primarily N:P or N:Si. Recently this concept has been extended to include organic forms of nutrients, and an elevation in the ratio of dissolved organic carbon to dissolved organic nitrogen (DOC:DON) has been observed during several recent blooms. The physiological strategies by which different groups of species acquire their nutrients have become better understood, and alternate modes of nutrition such as heterotrophy and in mixotrophy are now recognized as common among HAB species. Despite our increased understanding of the pathways by which nutrients are delivered to ecosystems and the pathways by which they are assimilated differentially by different groups of species, the relationships between nutrient delivery and the development of blooms and their potential toxicity or harmfulness, remain poorly understood. Many factors such as algal species presence/ abundance, degree of flushing or water exchange, weather conditions, and presence and abundance of grazers contribute to the success of a given species at a given point in time. Similar nutrient loads do not have the same impact in different environments or in the same environment at different points in time. Eutrophication is one of several mechanisms by which harmful algae appear to be increasing in extent and duration in many locations. Although important, it is not the only explanation for blooms or toxic outbreaks. Nutrient enrichment has been strongly linked to stimulation of some harmful species, but for others it has not been an apparent contributing factor. The overall effect of nutrient over enrichment on harmful algal species is clearly species specific.

Regional Models of Benthic Ecosystem Health: Predicting Pollutant Gradients from Biological Data (November 2006)

Anderson, M.J.; Hewitt, J.E.; Ford, R.B.; Thrush, S.F.
NIWA and the Department of Statistics & Leigh Marine Laboratory (University of Auckland)

Spatial Information: Elsewhere in NZ: Auckland region
Key words:model, benthic ecosystem health, pollution gradients, intertidal habitats, estuary, Auckland, New Zealand

Summary: The purpose of this work was to develop new regional models of benthic ecosystem health for sheltered intertidal soft-sediment habitats, on the basis of new and existing biological, chemical and physical data. More particularly, we wished to obtain a model whereby biological data from a new or monitored site could be used to classify that site in terms of its relative health. Data assembled from sites across the Auckland Region included mean abundances of 102 taxa from 84 sites, some of which were sampled in multiple years (from 2002-2005), yielding 95 samples. Models were developed using 81samples, with 14 samples being reserved to provide independent model validation. Physical data included grain size fractions and measures of furthest and closest wind exposure. Chemical data consisted of measures of concentrations (mg/kg) of copper, lead and zinc from the total sediment sample (< 500 µm) and also from weak acid extraction of the mud fraction (< 63 µm).

The latter is generally considered a measure of bioavailable metals. Metal concentrations showed very high correlations with one another, so a single measure of the degree of pollution along a gradient across all samples was obtained using principal components analysis (PCA). This was done separately for the total sediment measures (PC1.500) and for the mud fraction measures (PC1.63), explaining 94% and 95% of the variation in metal concentrations, respectively. If metal concentrations are sampled at a site, the degree of pollution can be determined directly by calculating the position of that new site, given these values, along each of these gradients. Clusters of 5 groups were identified along each gradient (in rank order from 1 = healthy to 5 = polluted). Groups 4 and 5 along the gradients corresponded well with existing "amber" and "red" sediment quality guidelines of the Environmental Response Criteria ("ERC") (ARC 2004). However, the PC axes developed here gave greater resolution and discrimination among healthier sites (groups 1-3). Ecological assemblages generally reflected pollution gradients very well, all along their range. The present study identified clear methods for modelling the pollution gradient axes using ecological data. Canonical analysis of principal coordinates (CAP) was used to develop models, using biotic dissimilarities among sites to predict their relative position along each of the pollution gradients (PC axes). The best models of benthic ecosystem health were those which obtained high canonical correlations with the pollution gradient(s) and which had a low level of error when new sites were tested (validation).The best overall ecological models were obtained using all sites together, regardless of their physical characteristics. The biotic assemblages had the strongest relationships with metal concentrations in the total sediment sample (PC1.500), rather than in the mud fraction (PC1.63), indicating that the biota do respond to all metals present in the sediments. Some of the models which used only subsets of taxa (a biologically derived "sensitivity" subset of 22 variables and a statistically derived "BVSTEP" subset of 16 variables) performed virtually as well as the models which used all 102 taxa. Although we do not feel that models using subsets can replace those which use all taxa, they may be used with fairly high confidence if the data for all taxa, for some reason, is lacking. The physical characteristics at each site (grain size fractions and exposure indices) were used to identify two physical groups of sites: those having coarser sediments and greater exposure (group C) and those having finer sediments and lesser exposure (group F). These two physical groupings correspond roughly to the Outer Zone and Settling Zone, respectively. Although no advantage was obtained by relating sites in group F alone to total metal concentrations (PC1.500), an excellent model was obtained by considering sites in group C alone and relating these to metal concentrations in the mud fraction (PC1.63). This supports previous studies suggesting that heavy metals are potentially more bioavailable in the mud fraction in Outer Zones.We recommend that the models we have developed here be used for monitoring and management purposes, as follows:

- First, using all taxa, the position of a new site (or a monitored site) may be obtained along PC1.500 (and therefore into a group of relative pollution from 1-5) on the basis of the biotic dissimilarities between it and each of the existing sites, which we will call "the first classification".

- Second, if the site has relatively coarse sediments and greater relative exposure (i.e. if it occurs in group C based on its physical characteristics, or is in the Outer Zone), then its biotic dissimilarity with all other group C sites will yield its position along PC1.63 (and therefore, once again, into a group of relative pollution from 1-5), which we will call "the second classification".

- For sites in group C, the more cautious (i.e. the higher value) of the first and second classifications can be used as the assessment of the benthic health of the site. For sites in group F, the first classification can be used.

- If metal concentration data from the site is available, then validation of the positioning of the site on each of PC1.63 and PC1.500 achieved by using biotic data can be obtained. The ERC criteria can also be examined and considered when metal data are available.

A multivariate computer software package, PRIMER v6, with the add-on PERMANOVA+ (Anderson and Gorley –released in 2007), will be provided so that ARC managers can implement this strategy of modelling directly. These models rely on the high degree of correlation in the levels of the three metal concentrations co-occurring in sediments across the region. It is anticipated that, even though zinc and lead, in particular, are currently highly correlated (r = 0.95), these associations may change with contaminant control measures. For example, lead levels are expected to decrease across the region, due to the elimination of leaded petrol. Zinc levels may decrease over time with controls on metal cladding and roofing. Thus, we further recommend that, from time to time, the degree of correlation among the three metal variables (copper, lead and zinc) be checked. If these correlations begin to decrease, then a re-development of the overall model which separates and distinguishes the three individual metals may be appropriate.

A review of public attitudes towards marine issues within and beyond New Zealand (2004)
Arnold, A.
Department of Conservation New Zealand

Spatial Information: No specific spatial area - is a review/discussion of New Zealand and overseas studies.
Keywords: Marine, public attitudes, research, New Zealand.

Summary: This paper reviews current research on public attitudes towards marine issues and considers the New Zealand Department of Conservation's future research priorities in this area. The paper is based on a review of previous research undertaken by the Department and other local and central government agencies within and beyond New Zealand, along with discussions on research priorities with Department staff. For each study the key research findings and research methodologies are discussed. Possible research priorities for the Department and recommendations for further research on public attitudes towards marine issues are then outlined.

Bay of Plenty Primary Production Modelling: Aquaculture Management Areas - Mussel Farm Impacts - 25 m, 15 m and Surface Water Depth (n.d.)
ASR Ltd
ASR Ltd

Spatial Information: Elsewhere in NZ – Coastal waters off eastern Bay of Plenty

Keywords: aquaculture, marine farming, Bay of Plenty, mussel, *Perna canaliculus*, 25 m, 15m, surface water, data

Summary: Encompasses three documents, each is a series of figures displaying models of the effects of potential mussel farm(s) in eastern Bay of Plenty waters; one at a depth of 25m, another at 15 m and the last examining effects at the surface waters. The different models compare scenarios, and measure the differences in phytoplankton chlorphyll-*a* (mg/m3).

Natural Hazards: cyclones (2009)
Auckland Regional Council
Auckland Regional Council

Spatial Information: Auckland (specifically mentions tropical cyclones that have passed within 220 km of Auckland City in the past); otherwise not spatially specific.
Keywords:natural hazards, storms, cyclones, Auckland

Summary: This web page is part of Auckland Regional Council's civil defence emergency management information. Specifically, it lists the main hazards associated with tropical cyclones, consequences of a severe cyclone event, and how tropical cyclones are formed.

Australian and New Zealand (ANZECC) Guidelines for Fresh and Marine Water Quality (2000)
Australian and New Zealand Environment and Conservation Council (ANZECC)
Australian and New Zealand Environment and Conservation Council; Agriculture and Resource Management Council of Australia and New Zealand.

Spatial Information: New Zealand and Australia
Keywords: water quality, guidelines, Australia, New Zealand

Summary: (including information from the introductory booklet that comes with the guidelines). The introductory booklet summarises the main features of the ANZECC Guidelines to help readers understand and use the documents. The main objective of the guidelines is to “provide an authoritative guide for setting water quality objectives required to sustain current, or likely future, environmental values (uses) for natural and semi-natural water resources in Australia and New Zealand”. The guidelines provide government and the general community (particularly catchment/water managers, regulators, industry, consultants and community groups) with a sound set of tools for assessing and managing ambient water quality in natural and semi-natural water resources. They are not meant to be applied directly to recycled water quality, contaminant levels in discharges from industry, mixing zones, or storm water quality, unless storm water systems are regarded as having conservation value. Local and regional jurisdictions are encouraged to use these national guidelines to formulate their own regional guidelines or specific water quality objectives. The guidelines are not mandatory. The ANZECC guidelines have seven chapters. The first two introduce the guidelines and give a framework on how to apply them. Chapters three through six are specific to different types of water quality management, namely aquatic ecosystems, primary industries, recreational water

quality and aesthetics and drinking water, respectively. The last chapter is entitled Monitoring and Assessment. It gives advice on collecting and analysing data for the different indicators, over a range of scenarios and makes recommendations on the number and mix of indicator types that should be considered. These chapters are followed by references, appendices and an index. All chapters can be applied to Tauranga Harbour and its catchments.

3.2. B

Aquacultural development: social dimensions of an emerging industry (1996)
Bailey, C.; Jentoft, S.; Sinclair, P.R.;
Westview Press

Spatial Information: No specific spatial area; looking at aquaculture as an industry worldwide
Keywords: Aquaculture industry, environmental impacts, social impacts, sustainable development

Summary: In this volume, an international group of contributors explores the newly emerging aquaculture industry. Focusing on the social and environmental dimensions of aquacultural development, in both industrialized and non-industrialized nations, they examine issues of social equity, user-group conflict, environmental impacts of production, and mediating role of the state. They also discuss aquaculture's role in development activity - especially in sustainable development, where it can enhance community viability, coherence, and solidarity. Asserting the need for careful planning and recognizing impending political and moral choices, the contributors assess the decision making process for public authorities and development agencies and consider the social consequences of these decisions. Policymakers that are responsible for promoting and managing this growing industry will find this volume invaluable as they begin to research and design appropriate institutional structures. In addition, scholars interested in the overall adoption and diffusion of new technologies will find here a rich source of information about a system that shares attributes with, but also differs significantly from agricultural and fisheries production systems.

Conservation status of New Zealand marine mammals (suborders Cetacea and Pinnipedia), (2010)
Baker,C.S.; Chilvers,B.L.; Constantine, R.; DuFresne,S.; Mattlin,R.H.; Helden,A.; Hitchmough, R.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand-wide
Keywords: dolphins, whales, sea lions, New Zealand, threatened marine mammals, pinniped, cetacean, conservation status

Summary: This study re evaluated the conservation status of NZ marine mammals using the 2008 version of the NZ Threat Classification System, based on several data sources including those used for the previous listing, public submissions and expert opinion. It considered all marine mammal taxa recorded from the NZ Exclusive Economic Zone (EEZ) since 1800. Compared to previous listing, no species was considered to have an improved status and the threat status of two species

worsened: the NZ sea lion was up-listed to Nationally Critical, and the bottlenose dolphin to Nationally Endangered.

Aspects of the ecology of Tauranga Harbour, Volume 1 (1976)
Barker, M.F.; Larcombe, M.F.
Bioresearches Ltd. Prepared for Bay of Plenty Catchment Commission and Regional Water Board.

Spatial Information: Tauranga Harbour, New Zealand
Key words: Tauranga Harbour, Te Awanui, ecology, habitat, biodiversity, mangroves, marshes,flora, fauna

Summary: This report is one of series describing the ecology of harbours, estuaries, and the lower sections of major rivers in the Bay of Plenty. Previous reports dealing with the ecology of Tauranga Harbour are: 'A preliminary assessment of some aspects of the ecology of Tauranga Harbour' (Bioresearches Ltd, April 1974) and sections of the reports 'Ecological Monitoring survey of the lower reaches of the major Bay of Plenty rivers, the Ohau Channel, and parts of Tauranga Harbour' (Separate reports for Winter 1974, summer 1974/75 and Winter 1975 conditions).
This report deals with the entire Tauranga Harbour area, and in an attempt to collate information previously obtained, and present a clear description of the ecological condition of the Harbour, a baseline classification of major habitats within the Harbour was made. The habitats were plotted on aerial photograph overlays to show their distribution and abundance within the Harbour, and each habitat was described and discussed separately.
Following the description of major Harbour habitats, various aspects of the ecology of the Harbour arediscussed, the ecological value of the Harbour assessed, and the effects of reclamation and pollution briefly described.
The aerial photographs and overlays showing major Harbour habitats are included in Volume 2.
The overall findings were that the Harbour was in excellent condition, with the only obvious pollution occurring in the Rereatukahia Inlet near Katikati, where organic material and nutrients had resulted in enrichment and deterioration of the soft sediments of the intertidal industrial area. Other points discussed:

- The expected increase in pressure on the capacity of the Harbour, to deal with increased inputs from land uses and development within the watershed, and controlling of land use in the future;

- The importance of marshes and mangroves and their capacity to retain fine sediments and nutrients and prevent these from being carried further into the Harbour.

Aspects of the ecology of Tauranga Harbour: Volume 2 - Aerial photographs and overlays (1976)
Barker, M.F.; Larcombe, M.F.
Bioresearches Ltd. Prepared for Bay of Plenty Catchment Commission and Regional Water Board.

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, aerial photographs, habitat type, ecology, flora, fauna

Summary: The major Tauranga Harbour habitats as outlined in Volume 1 (immediately previous reference) are plotted on aerial photograph overlays to show their distribution and abundance within the Harbour.

Aquaculture: biology and ecology of cultured species (1994)
Barnabé, G.
E. Horwood, New York; London

Spatial Information: No specific spatial area
Keywords: aquaculture management,marine farming, aquaculture diseases, history of aquaculture

Summary: This book covers the history of modern aquaculture, the aquatic environment and the physical factors that need to be considering in successful management of aquaculture; mollusc culture; crustacean farming; and aquacultural diseases.

Collaboration in community action: a successful partnership between indigenous communities and researchers (2000)
Barnes, H. M.
Health Promotion International

Spatial Information: Elsewhere in NZ: Auckland
Keywords: Maori, western science, indigenous knowledge, alcohol, community programme, researched-based knowledge, community knowledge

Summary: New Zealand Maori, in common with the indigenous peoples of many countries, face considerable alcohol-related problems. Although a number of initiatives have been implemented to deal with alcohol issues, these have often had limited involvement from Maori and consequently have been more effective for non-Maori. This paper examines a collaborative project between researchers at the Alcohol & Public Health Research Unit and two Maori organizations, Te Whanau o Waipareira Trust in West Auckland and the Huakina Development Trust in South Auckland. The 3-year project evaluated two community action programmes which aimed to prevent alcohol-related traffic crashes amongst Maori. The programmes were run by the Trusts and were able to integrate research-based knowledge with community knowledge, resulting in a richness of strategies and a level of success that would not have been likely in an imposed project.

Tauranga Harbour study: a report for the Bay of Plenty Harbour Board (1984)
Barnett, A. G.; Healy, T.R.; Black, K.P.;Bay of Plenty Harbour Board; Ministry of Works and Development; University of Waikato; Dansk hydraulisk institut.
New Zealand Ministry of Works and Development

Spatial Information: Tauranga Harbour, New Zealand

Keywords: Tauranga Harbour, Te Awanui, hydrodynamics, sediment transport, marine sediments, estuarine sediments, environmental aspects, mathematical models

Summary: This was a major joint study undertaken by the Ministry of Works and Development, the Danish Hydraulics Institute, and the University of Waikato (with Dr. K.P. Black) to provide a physical background for a long term management strategy for the harbour. Chapters include:
Part I. Overview /ed. A.G. Barnett
Part II. Field data collection programme / T.R. Healy
Part III. Hydrodynamics / ed. A.G. Barnett
Part IV. Sediment transport: text / K.P. Black
Part IV. Sediment transport: figures and tables / K.P. Black
Part V. Morphology study / T.R. Healy

Aspects of Nitrogen Metabolism in the Green Alga *Ulva*; Developing an Indicator of Seawater Nitrogen Loading (2007)
Barr, Neill. G.
Thesis for Doctorate of Philosophy in Environmental and Marine Science, Environmental and Marine Sciences Department, University of Auckland

Spatial Information: New Zealand-wide
Keywords: plants, sea lettuce, *Ulva*, nitrogen, water quality, nutrients, New Zealand

Summary: This is a comprehensive document on the utilisation of nitrogen by macroalgae and specifically looks at sea lettuce (*ulva)*. There are 5 chapters:

- Chapter 1 - General introduction of nitrogen use by macroalgae, marine eutrophication, the biology of *ulva* and aim of the thesis.
- Chapter 2 - Geographical variation in nitrogen status of NZ *Ulva*.
- Chapter 3 - Experimental assessment of biochemical responses to nitrogen concentration in *Ulva*.
- Chapter 4 - Developing *Ulva* as a multi-purpose environmental test-organism.
- Chapter 5 - General discussion on difference in *Ulva* tissue-N indices and *Ulva* as an integrator of nitrogen loading nitrogen isotopic source pool.

Changes in invertebrate and macroalgal populations in Tasmanian marine reserves in the decade following protection (2009)
Barrett, N. S.; Buxton, C. D.; Edgar, G. J.
Journal of Experimental Marine Biology and Ecology

Spatial Information: Overseas – Tasmania, Australia.
Keywords: plants, macroalgae, abalone, effects of fishing, marine protected area, reserve size, rock lobster, sea urchin, Tasmania, population densities

Summary: Densities of macrobenthic invertebrates and macro-algae in four Tasmanian 'no-take' marine protected areas (MPAs) were monitored annually for 10 years following MPA establishment, with changes compared to those at external (fished) reference locations. Fishing influenced the population characteristics of many speciessubstantially, altering the mean size and abundance of rock lobsters and the abundance of prey species, such as urchins and abalone. Strong declines in abundances of purple urchins and abalone, within the largest MPA at Maria

Island,indicate likely indirect effects related to protection of predators from fishing. The two smallest MPAs (ca. 1 km coastal span) generated few detectable changes. Our results affirm the importance of long-term monitoring and the value of MPAs, when sufficiently large, as reference areas for determining and understanding ecosystem effects of fishing in the absence of historical baseline data.

Mapping the values of New Zealand's coastal waters. 2. Economic values (2009)
Batstone, C.; Elmetri, I.; Taylor, M.; Sinner, J.; Clarke, S.
Ministry of Agriculture and Forestry Biosecurity New Zealand

Spatial Information: New Zealand wide, but no specific spatial area
Key words: New Zealand, coastal waters, map, introduced species, threat, biosecurity

Summary: Introduced species are recognised as one of the greatest threats to natural environments worldwide. New Zealand's ability to assess and manage these risks is significantly hampered by a lack of detailed information on the resources that should be protected: Which species are of greatest concern? What values are at risk? Where should surveillance monies be concentrated? Which incursion can or should be responded to?
To help address these questions and thereby improve risk management in the marine environment, MAF Biosecurity New Zealand (MAFBNZ) commissioned research to map the economic, environmental, social and cultural values associated with New Zealand's coastal and marine environments.

Baseline Survey of Waimapu Estuary, Tauranga, New Zealand (1993)
Baxter, A.
Marine Studies Department, Bay of Plenty Polytechnic.

Spatial Information: Waimapu Estuary, Tauranga Harbour.
Keywords: estuary, Waimapu Estuary, Bay of Plenty, Tauranga Harbour, Te Awanui, baseline survey, resource management

Summary: Waimapu Estuary, an inlet of Tauranga Harbour situated alongside State Highway 2, is a biologically productive ecosystem, incorporating estuarine plants, shellfish and finfish,as well asbird species. A comprehensive baseline survey of this estuary was undertaken to allow future monitoring of human impacts. Results of this initial survey indicate that the estuary sustains varied flora and fauna and contains water which is of reasonable quality.

A World-Class Aquaculture Region: A Growth Plan for the Bay of Plenty (2009)
Bay of Plenty Connections
Bay of Plenty Connections

Spatial Information: Bay of Plenty, New Zealand
Keywords: Bay of Plenty, aquaculture, strategy, economic

Summary: This report is written by a Regional Governance Group consisting of three business leaders, three representatives from each of the sub-regional Economic Development Agencies (EDAs), a local/central government representative, and the

Group Manager of Strategic Development, Bay of Plenty Regional Council, whose role is overseeing the economic development of the region. This report outlines this group's strategic plan for "growing a world-class, integrated and sustainable aquaculture industry in the Bay of Plenty with export sales of $250 million by 2025".

Bay of Plenty Aquaculture Strategy - A Product of the Bay of Connections Economic Strategy (2009)
Bay of Plenty Connections
Bay of Plenty Connections

Spatial Information: Bay of Plenty, New Zealand
Keywords: Bay of Plenty, aquaculture, strategy, economic

Summary: Four regional aquaculture forums have been held since 2006, involving stakeholders from industry, research and science, iwi, training and education providers and local and central government. In November 2008 a forum was held to get initial comments and input for the proposed Aquaculture strategy. During mid-2009 an Aquaculture Advisory Group was established to guide the development of this strategy. This group is composed of representatives from industry, local, regional and central government agencies and research institutes.Aquaculture is one of 13 key focus areas for the region's growth and development under the region's economic development strategy.

This plan is guided by Aquaculture New Zealand's national aquaculture strategy and accordingly, the basis of this action plan is Aquaculture New Zealand's ten point plan (see Burrell, M.; Meehan, L. (LECG Ltd); 2006; The New Zealand Aquaculture Strategy).

The aim of the strategy is "to grow an integrated and sustainable aquaculture industry in the Bay of Plenty with export sales of $250 million by 2025". Nine key opportunities (the authors believe) aquaculture in BOP will bring are listed. The report states that BOP is well positioned to play a key role in aquaculture growth, both nationally and internationally. A geographic and demographic overview is given and discusses how aquaculture has the potential to boost the economy of the region. Indicative economic potential estimates are given, along with a brief description of the two largest aquaculture sites in the region (and country); a 3 800ha mussel farm off the coast of Opotiki and a 4 009 ha site in Otamarakau. Once these are both fully operational (they weren't at the time of publishing of this strategy), the total of aquaculture space in BOP will equate to around one third of the total aquaculture space in New Zealand. The significant amounts of work already done by stakeholders to investigate the potential of the region for aquaculture are listed. This includes processing consent applications and regional forums, aquaculture-specific research and investment in teaching and research resources. The BOP Regional Council's research findings indicate that BOP's waters are among the most productive in New Zealand and opportunities exist for large-scale offshore mussel farms. Furthermore, other aquaculture activities using the waterways and lakes such as eel farming are noted.

Port of Tauranga: Port information (1986)
Bay of Plenty Harbour Board
Bay of Plenty Harbour Board

Spatial Information: Tauranga Harbour, Tauranga, New Zealand

Key words: Port of Tauranga, history, development

Summary: The report provides general information about the Port of Tauranga, location, administration, history, community, and future development.

Introducing Tauranga Moana (The Tauranga Harbour) (1997)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, Tauranga, New Zealand
Keywords: Tauranga Harbour, Te Awanui, management, water quality, history, catchment, recreation, pest, plan, Environment Bay of Plenty

Summary: The aim of this booklet is to help readers increase their knowledge and understanding of the harbour by discussing the current (1997) issues affecting the harbour and how they are addressed by the Bay of Plenty Regional Council and other organisations, who help manage the harbour. The chapters include:

- Tauranga Harbour and its Catchment;
- Settlement History;
- The Changing Face of the Land;
- A Harbour with Two Faces (entrances);
- A Natural, Healthy and Stable Ecology;
- A Recreational Paradise;
- The Issues (covering ecology, water quality, natural character, recreation, reclamations and structures, pests and residential development)
- Sustainable Management of the Harbour;
- Coastal Management in the Tauranga Harbour and Who Does What;
- Resource Consents and Coastal Permits;
- What is Being Done?

Bay of Plenty Regional Coastal Environment Plan Volume 1(2003)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords: Environment Bay of Plenty, coastal management, discharges, sustainable management, resources, damming, diversion, reclamation, recreation, noise pollution, pests, hazards, cultural heritage, coastal permits

Summary: This plan incorporates the Regional Coastal Plan (as required by the RMA (1991), to be prepared by regional councils) as well as issues pertaining to the landward part of the coastal environment. Section 2.1 defines the geographic coverage of this plan. The purpose of this plan is to enable Environment Bay of Plenty to promote the sustainable management of the natural and physical resources of the Bay of Plenty coastal environment.

Farm Dairy Fact Sheet no. 2: Land Based Systems (2003)
Bay of Plenty Regional Council
Bay of Plenty Regional Council,

Spatial Information: No specific spatial area

Keywords: effluent, disposal, farm*, management, dairy, land, pond soakage, land soakage, pasture irrigation, Bay of Plenty, Environment Bay of Plenty

Summary: This is a factsheet that discusses land-based effluent disposal options for (dairy) farms, including pond soakage, land soakage and pasture irrigation. It also gives guidelines for managing these systems.

Bay of Plenty Regional Navigation and Safety Bylaws (2004)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords: Environment Bay of Plenty, navigation, safety, bylaw, Bay of Plenty, estuary, harbour, river, lake, coastal waters

Summary: These navigation and safety bylaws were created to ensure safe use of the harbours, rivers, lakes and coastal waters of the Bay of Plenty.

Bay of Plenty Regional Navigation and Safety Bylaws (2010)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords: Environment Bay of Plenty, navigation, safety, bylaw*, Bay of Plenty, estuary, harbour, river, lake, coastal waters

Summary: These navigation and safety bylaws were created to ensure safe use of the harbours, rivers, lakes and coastal waters of the Bay of Plenty (2010 update).

Bay of Plenty Regional Air Plan (2006)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords:plants, sea lettuce, *Ulva*, Bay of Plenty, Environment Bay of Plenty

Summary: This report provides for the sustainable management of discharges of contaminants into the air in the whole of the Bay of Plenty Region. Within this plan is mentioned the public's concern of the odours released by sea lettuce in the Tauranga region.

Bay of Plenty AMA Remote Sensing Report (2006)
Bay of Plenty Regional Council
Bay of Plenty Regional Council; NIWA; ASR Ltd

Spatial Information: BOP wide - data collected from Tauranga, Pukehina, Whakatane, Opotiki
Keywords: Environment Bay of Plenty, aquaculture, aquaculture management areas, Bay of Plenty, water quality, sustainability, coastal waters

Summary:A study of the Bay of Plenty's coastal shelf waters was undertaken, to collect data for the support of modelling, and estimating the sustainability and carrying capacity of aquaculture. The study included physical and chemical analysis of the waters, quantification of phytoplankton communities, current measurements and temperature profiling of the water column and the use of remote sensing, to provide a synopsis of seasonal and spatial patterns of sea surface temperature and chlorophyll-a concentrations. This report presents results gained from development and processing of remote sensing data.

Bathing Suitability Report (2007)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords: Environment Bay of Plenty, water quality, bathing water quality, *E. coli*, Enterococci, shellfish monitoring, Bay of Plenty,

Summary: Environment Bay of Plenty annually undertakes a water quality survey of popular recreational waters over the warmer months. The survey serves to monitor and identify the risk to public health from faecal contamination within waterways popular for recreational activities. Monitoring information can then be used by public health services, territorial authorities and the public to assess the risk of using these waters, as well as providing information on the potential or existing risk. Agencies involved in the monitoring and reporting on recreational waters are the regional council, territorial authorities and District Health Boards and Medical Officer of Health. The survey monitors aspects of the water quality of water bodies, in line with the Regional Policy Strategy, the Regional Coastal Plan, Regional Water and Land Plan, and Ten Year Plan. It also provides a basis to assess the effects of discrete discharges and diffuse run-off from various land-uses. The main objective of this report is to examine and report on the suitability of the 27 freshwater, 30 lake and 46 marine sites in the Bay of Plenty region for contact recreation. Shellfish monitoring results over the past few years is also reported.

Water Quality Classification (Map)(2008)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords:sedimentation, map, Environment Bay of Plenty, Bay of Plenty, water quality

Summary:A 1:50 000 Sheet U14 of Tauranga water quality classification.

Operative Bay of Plenty Regional Water and Land Plan (2008)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords:sedimentation, land use, water use, water allocation, Bay of Plenty, Environment Bay of Plenty, land management, water management, discharge, geothermal resources, sustainable, kaitiakitanga, wetlands

Summary:*Extracts taken from the introduction section (chapter 1):*
Spatial Coverage:
The regional plan covers all the area within the Bay of Plenty Regional Council boundary, as seen in Map 1, excluding the Coastal Marine Area. The Bay of Plenty Regional Coastal Environment Plan has defined the boundary between the Coastal Marine Area and the land/freshwater zone. This boundary often extends upstream into the mouths of rivers.
Resource Coverage:
The regional plan covers the following natural and physical resources in the Bay of Plenty:

a) Land (including soil);
b) Water (including rivers, streams, lakes, wetlands, modified watercourses and groundwater);
c) Geothermal resources in the Bay of Plenty, excluding geothermal resources covered by the Rotorua Geothermal Regional Plan2; and
d) Physical resources associated with the use of water resources (e.g. structures in, on, under or over the bed of a river, stream or lake).

The purpose of this regional plan is to achieve the following;

(a) Promote the sustainable management of land, water and geothermal resources.
(b) Achieve the integrated management of land, water and geothermal resources.
(c) Maintain or improve environmental quality in the Bay of Plenty region.
(d) Protect existing high quality environments and resources.
(e) Protect sensitive receiving environments.
(f) Sustain the life-supporting capacity of soil, water and ecosystems.
(g) Maintain or enhance the ecological, Maori cultural, recreational, natural character and landscape values of land, water and geothermal resources.
(h) Establish appropriate environmental standards to achieve (c) to (f). This includes ensuring instream minimum flow requirements are maintained in rivers and streams.
(i) Address the adverse environmental effects of the use and development of land, water and geothermal resources.
(j) Allow for the use and development of land, water and geothermal resources where it is consistent with (a) to (g).
(k) Enable people and communities to provide for their social, economic and cultural wellbeing, while achieving (a) to (i).
(l) Work with communities to promote community participation and interest in the management of natural and physical resources in the Bay of Plenty region.

Sea lettuce: Tauranga Harbour fact sheet (2009)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand

Keywords:sea lettuce, Tauranga Harbour, Te Awanui, algae, sea lettuce blooms, *Ulva*

Summary: This is a two page factsheet outlining what sea lettuce is, why it is a problem in Tauranga Harbour, why it grows here, monitoring of sea lettuce blooms and mitigation actions being taken by the regional and district councils towards sea lettuce blooms in Tauranga Harbour.

Tauranga Harbour our special place Te ora o te iwi (2009)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Environment Bay of Plenty, Tauranga Harbour, Te Awanui, dolphins, whales, shellfish, fish, birds, ecosystem, seagrass, land use, sedimentation, land management, pests, harbour management, heritage, history, Port of Tauranga, mangroves, water quality, threats,

Summary: This booklet provides a general description of Tauranga Harbour. It covered a wide range of topics including the marine life in the harbour, the economic importance of the Tauranga Harbour and the importance of Tauranga Harbour as a place for recreation. The booklet described the harbour as a home to thousands of plants, shellfish, birds and fish. It documented that estuarine areas of the harbour were important nursery and spawning grounds for many marine and freshwater species, and that the health of the shellfish in the harbour depended on the quality of the water. Through presenting facts, and general knowledge, it increased local people's awareness of human impacts on the harbour. For example, the booklet presented a story of declining seagrass beds within the harbour, which was associated with the subdivision of land and clearance of bush in the harbour catchment. The booklet identified responsibilities of government agencies for the care of the harbour, including Bay of Plenty Regional Council, Western Bay of Plenty District Council, Ministry of Fisheries and the Department of Conservation,as well as providingtheir contact details.

The Chairman and Councillors; Regulation Monitoring & Operations Committee (2009)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Tauranga, New Zealand
Keywords:plants, sea lettuce. *Ulva*, hydrogen sulphide, Tauranga Harbour, Te Awanui

Summary: This is a report from the Regulation Monitoring and Operations Committee of the Bay of Plenty Regional Council. Within it is the results of the recent monitoring of the levels of hydrogen sulphide gas at 2 locations within Tauranga where sea lettuce has accumulated (Ongare & Ngakautuakina Point) (pgs 13-20)

Annual Report and Consolidated Financial Statements for the Year Ended 30 June 2009 (2009)
Bay of Plenty Regional Council

Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords:plants, mangroves, *Avicennia marina*, mānawa, Environment Bay of Plenty

Summary: This is the Bay of Plenty Regional Council's Annual Report for the year ended 30 June 2009. It highlights projects the Regional Council has been involved in for the year including trials to mechanically remove mangroves from Tauranga Harbour.

Proposed Bay of Plenty Regional Policy Statement (2010)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords: Regional Policy Statement, Environment Bay of Plenty, Bay of Plenty

Summary: This is the proposed Regional Councils RPS 2010. The Proposed Bay of Plenty Regional Policy Statement ('the Statement') promotes the sustainable management of the Bay of Plenty region's natural and physical resources. This is the second such statement prepared for the Bay of Plenty region under the Resource Management Act 1991 ('the Act'). Since the commencement of the Act, a lot has been learned about what is effective resource management and what is not. This experience is reflected in the significantly revised format and the more targeted and directive approach of this Statement. The outcomes, the objectives and the monitoring indicators, found within in part four of the document, are the measures against which the success of this framework will be measured.

The Statement is in five parts. Part one contains introductory and explanatory material about the structure and purpose of the Statement, in relation to the purpose of the Act. It also addresses the philosophy behind the Statement and discussion of the concept 'sustainable region'. Each chapter in Part two presents background information on the chapter topic and outlines the significant issues associated with each topic. The issues are followed by a summary table of the objectives, policies for the issues and objectives, and methods to implement the policies. Part three is divided into two sections. The first contains the policies and the second sets out the methods of implementation. The policies section is grouped according to the topic under which the policy was originally drafted (e.g., coastal environment). Within these topic groups' policies are divided into four types which includes; those that provide broad direction to regional and district plans, those that give specific direction for consideration in plans and consents processes, policies that allocate responsibilities and those that provide guidance. A brief explanation of each policy is also presented. The methods section is divided into two main groups,which fall under directive or guiding methods. Part four sets out the procedures for monitoring the efficiency and effectiveness of the policies and methods of the Statement. It also gives the environmental results anticipated from implementation of all policies and methods. Part five presents the principal reasons for adopting the objectives, policies and methods set out in the Statement.

Tauranga Harbour Restoration - Sediment Action Plan DRAFT (2010)
Bay of Plenty Regional Council

Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Environment Bay of Plenty, Tauranga Harbour, Te Awanui, Bay of Plenty, sedimentation, biodiversity protection, harbour catchments, sea lettuce management, mangrove removal, estuary care groups, erosion

Summary: This draft Sediment Action Plan sets out existing and planned policy, and operational work, to address sedimentation issues within Tauranga Harbour. It also looks at related matters around protecting biodiversity and natural character values within the harbour and its catchments. It presents current and planned operational work being undertaken by Bay of Plenty Regional Council in an integrated manner. This draft plan does not address water quality, recreation/access and marine flora and fauna issues for the harbour.

Environment Bay of Plenty's Ten Year Plan 2009-2019 (2009)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, New Zealand
Keywords: Bay of Plenty, ten year plan, 2009-2019, Environment Bay of Plenty

Summary: The Ten Year Plan describes what the Bay of Plenty Regional Council (BOPRC) proposes to do over the next ten years and is reviewed every three years. As a result, it sets out in detail what BOPRC plans to do over the next three years in detail, while the following seven years activities are outlined. It is grouped into the following categories/chapters: introduction, community outcomes, groups of activities, regional leadership, natural environment, sustainable development and infrastructure, corporate services, financial overview and summary, financial and non financial policies and funding impact statement.

Media Release 'New way of managing mangrove mulch' (2011)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Waikareao Estuary, Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, mangroves, mechanical mangrove removal, *Avicennia marina*, mānawa, Environment Bay of Plenty, resource consent, mulch removal, anoxic,

Summary: Media release about a trial of a new way to manage mulch after the mechanical removal of mangroves at Waikareao Estuary. The trial involved the purpose-built mechanical mangrove mulcher being followed by a beach groomer. The beach groomer collects the mulch, which is then taken off-site as green waste to be composted. The purpose of the removal of the mulch after mechanical mangrove removal is to help lessen the anoxic conditions that result from mechanical mangrove removal. This release does not mention anything about the impact that the beach groomer itself has on the estuary bed.

Concrete Information Sheet (n.d.)

Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Not spatially specific
Keywords:inorganic pollutants, Environment Bay of Plenty, water quality, toxins, runoff, cement, concrete

Summary: This fact sheet identifies that the lime in cement is an inorganic pollutant which alters the pH of waterways and is toxic to aquatic life. The lime in cement dissolves into water making that water alkaline (pH 11-13). This can burn fish and kill other aquatic organisms. Lime from cement can enter the waterways through concrete work. Operations that will cause pollution if the runoff enters the waterways are: concrete cutting, spills, washing equipment, disposing of unwanted concrete, and concrete dust. It should be noted that diluting concrete slurry is not a solution as this only increases the size of the problem as more water becomes contaminated. Procedures should be used to ensure that concrete, dust and waste water do not enter the storm water drains or directly run off into a stream.

Biosecurity: Pests in and around Tauranga Harbour, fact sheet 5 (n.d.)
Bay of Plenty Regional Council
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords:invasive species, marine invasion, non-indigenous species, Asian date mussel, undaria, Asian kelp, possums, *Styela clava*, sea squirt, Environment Bay of Plenty, Tauranga Harbour, Te Awanui

Summary: This is a factsheet outlining the invasive species in and around the Tauranga Harbour, and also outlines what the Regional Council, DOC and Biosecurity NZ are currently doing to protect the harbour. It also gives some tips on what individuals can do to prevent pest invasion of the harbour, or if one wishes to report any suspicious findings.

Sea Lettuce and its Effect on our Harbours (1992)
Bay of Plenty Regional Council and Tauranga District Council
Bay of Plenty Regional Council and Tauranga District Council

Spatial Information: Bay of Plenty, New Zealand
Keywords: ulvales, New Zealand, Tauranga Harbour, Te Awanui, water quality, aquatic ecology, plants, sea lettuce, *Ulva*

Summary: This is a four page document that attempts to inform the public on five topic areas about sea lettuce. These topics include describing: what is sea lettuce?, the sea lettuce life cycle, sea lettuce in nz - its distribution, its impact in the Bay of Plenty and noting what is being done about it. The pamphlet informs that studies are being undertaken jointly by the Bay of Plenty Regional Council, the Tauranga District Council, the University of Auckland and the Water Quality Centre, Ecosystems Division, National Institute of Water and Atmospheric Research (NIWA). The impacts fall into four broad categories: water quality and ecological changes, loss of aesthetic and recreational values, chronic and intermittent health hazards and impact on commercial port activities and shipping.

Shellfish Ban Continues (2010)
Bay of Plenty Times
Bay of Plenty Times

Spatial Information: Whiritoa, Waihi Beach, Tauranga Harbour (all in BOP, NZ)
Keywords: Tauranga Harbour, shellfish, toxin, Bay of Plenty, health warning, bi-valve

Summary: Short article stating that the shellfish ban (all bi-valves, as well as cat's eyes and kina) continues across the Bay of Plenty coastline, including the Tauranga Harbour.

Wetland restoration guide (2007)
Bay of Plenty Wetlands Forum
Bay of Plenty Regional Council, Department of Conservation and Fish and Game

Spatial Information: Not spatially specific, but targeted at the BOP area
Keywords: wetland, restoration, Bay of Plenty, guide

Summary: This guide provides a description of different types of wetland and a step-by-step guide to starting, running and maintaining a wetlands restoration project. It also has a list of links (BOP specific) where you can get further information on or relating to wetlands.

Tauranga Ecological District Phase 1 Protected Natural Areas Programme Report (2005)
Beadel, S.; Harfoot, R.; Shaw, W.B.; Bawden, R.
Wildland Consultants Ltd

Spatial Information: Tauranga Ecological District, New Zealand
Keywords: Tauranga Ecological District, biodiversity, map, landscape, estuary, Tauranga Harbour, Te Awanui

Summary: The Protected Natural Areas Programme (PNAP) was established in 1983 to address Section 3(1)(b) of the Reserves Act 1977:This report presents a summary of existing information on the physical nature of the Tauranga Ecological District and identifies what is needed to complete a protected natural areas programme survey of the ecological district.

Ecological Restoration and Enhancement of Waikaraka Estuary, Tauranga Harbour (2003)
Beadel, S.; Maseyk, F.; Garrick, A.; Pierce, R.; Bawden, R.; Honey, M.
Wildland Consultants Ltd

Spatial Information: Waikaraka Estuary, Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, Waikaraka Estuary, plants, mangroves, mānawa, mangrove management

Summary: The Waikara Estuary is situated in the southern basin of Tauranga Harbour, southeast of Te Puna Estuary, near Te Puna. This is a low-energy estuary and is fed by the Oturu Creek. Rapid changes in estuary morphology have occurred in recent history. This has been attributed to surrounding land use, particularly horticultural development. The Waikaraka Estuary Managers Group comprises a group of residents and landowners adjoining the estuary. The group has forged strong links with local government agencies (BOPRC & WBOPDC), the Landcare Trust and a crown research institute (NIWA). NIWA are also publishing a case study on managing estuaries and mangrove habitat. Manipulation of mangrove distribution is already underway in Waikaraka Estuary; a Master of Science thesis has also been conducted on sediment dynamics (Hope, 2002). The Waikaraka Estuary Managers would like to undertake ecological restoration of the Waikaraka Estuary margins and require the preparation of a restoration plan to identify opportunities for enhancing the natural values of the project area and actions required to restore the estuary margins. This report includes vegetation and habitat descriptions and a landform map. The future management is assessed in the context of the historical background of the site. Restoration options, a work plan and a comprehensive management plan, including monitoring methods are provided. A list of flora and fauna species is also included.

Natural areas in Tauranga Ecological District (2008)
Beadel, S.; Renner, M.; Stephen, M.; Bawden, R.; Collins, L.; Honey, M.
Wildland Consultants Ltd

Spatial Information: Tauranga Ecological District, New Zealand
Keywords: Tauranga Ecological District, biodiversity, map, landscape, estuary, Tauranga Harbour, Te Awanui

Summary: TheTauranga Ecological District includes the harbours and estuaries (Tauranga, Maketu, Little Waihi), a long strip of dunelands, Matakana Island, coastal plains between Otamarakau and Tauranga, and low rounded hills and valleys in the vicinity of Tauranga Harbour. There are very few protected areas, and most are small. The total area of the ecological district is about 102,000 hectares and of this only 1.12% has some formal protection for nature conservation. If Tauranga Harbour is excluded, only 1.5% of the terrestrial and freshwater part of the ecological district has some formal protection. All wetlands of natural origins and examples of vegetation with a high proportion of indigenous species are probably worthy of protection. Many are small, weed infested, and in need of fencing and other active restoration management.

Mapping the Values of New Zealand's Coastal Waters: 1. Environmental Values (2008)
Beaumont, J.; Oliver, M.; MacDiarmid, A.
Biosecurity New Zealand

Spatial Information: New Zealand coastal waters
Keywords: invasive species; coastal waters; New Zealand; measures of environmental value; spatially-explicit database; coastal, shelf and estuarine habitats; diversity indices; habitat distributions

Summary: An estimated 65,000 marine species and associated ecosystems around New Zealand deliver a wide range of environmental services that sustain

considerable fishing, aquaculture and tourism industries as well as driving major biogeochemical processes. However, New Zealand's marine ecosystems are increasingly at risk of, or are already experiencing, threat from anthropogenic impacts. One of the greatest threats beingthe introduction of non-indigenous species.

Sewage Disposal Facilities for Welcome Bay (1977)
Beca Carter Hollings & Ferner Ltd
Beca Carter Hollings & Ferner Ltd

Spatial Information: Tauranga District, New Zealand
Keywords:sewage, disposal facility, Tauranga, Welcome Bay, Tauranga Harbour, Te Awanui, wastewater, treatment plant

Summary: This report was commissioned to investigate and detail the main features of the trunk sewage system which will be required to service Welcome Bay. Because the ultimate system has a high capital cost and a much greater capacity than required by the present (1977) stage of residential development, and will in turn create practical operating problems during the initial years of operation of the scheme, the report also suggests ways in which the long term scheme may be constructed in stages.

Port of Tauranga Model Study: Deepened Shipping Channel Proposal (1991)
Bell, R.
Water Quality Centre, DSIR Consultancy Report No. 6127/1

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga, Tauranga Harbour, shipping channel, dredging

Summary: The Water Quality Centre (DSIR Marine and Freshwater) were approached on 15 October 1990 by the Port of Tauranga Limited (Engineering Division) to carry out further hydrodynamic model runs to determine the effects of a deepened shipping channel on current patterns and velocities in Tauranga Harbour and the entrance area. Essentially the proposal is to deepen and widen the Port channels and approach channels to achieve an all-tide (i.e. at both Low and High tides) draft of at least 11.7 metres.

Port of Tauranga Model Study: Sulphur Point Wharf Extensions (1994)
Bell, R.
NIWA Consultancy Report No. POT 002/1

Spatial Information: Stella Passage and Otumoetai Channel**,** Sulphur Point,Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, wharf, hydrodynamics, dredging, port, shipping channels

Summary: In July 1994 NIWA were commissioned by the Port of Tauranga Limited to carry out additional runs of the Tauranga Harbour hydrodynamic model. The main purpose was to predict the effects of an extension of the Sulphur Point wharf, and its associated dredged shipping channel, on the current patterns and velocities within Tauranga Harbour. Changes in the hydrodynamics were also analysed to infer sediment transport pathways.Essentially the proposal is to extend the existing 600 m

Sulphur Point Wharf by 170 m and 250 m at the north and south ends respectively. This will require a dredged area (5.9 ha) of 12.9 m draft at the southern end extending a further 250 m southwards along Stella Passage from the terminus of the existing shipping channel dredged in 1992. A separate model simulation was also carried out for possible future dredging of the lower Otumoetai Channel.The calibrated hydrodynamic models set up during the 1983-85 Tauranga Harbour Study (Barnett, 1985) and the 1990-91 Shipping Channel Study (Bell, 1991) were used as the starting point for the additional model runs discussed in this report.Possible effects on sedimentation and sediment transport due to the additional dredging are concurrently being investigated by Prof. Terry Healy (Dept. of Earth Sciences, University of Waikato).

Impact of climate change on the coastal margins of the Bay of Plenty (2006)
Bell, R.; Goring, D.; Gorman, R.; Hicks, M.; Hurran, H.; Ramsay, D.
National Institute of Water & Atmospheric Research Ltd (NIWA)

Spatial Information: Bay of Plenty coastline, New Zealand
Keywords:climate change, Environment Bay of Plenty, Bay of Plenty coastline, coastal processes, coastal hazards, sea levels, storm surges, longshore drift, fluvial sediment supply, inundation, coastal erosion

Summary: Environment Bay of Plenty have commissioned NIWA to assess potential climate change impacts on the drivers of coastal hazards that may affect the coastal margin of the Bay of Plenty region over the coming 50 to 100 years. This is the second phase of a climate change impact study and builds on the first phase study report: *The Climate of the Bay of Plenty: Past and Future?* (Griffiths *et al.*, 2003) prepared for Environment Bay of Plenty. The primary focus of the study is to assess changes and trends in the "drivers" of coastal physical processes and hazards, and assess the potential impacts these changes or trends may have on the coastal margin of the Bay of Plenty region.

Marine landscapes and faunal recruitment: A field test with seagrasses and copepods (1991)
Bell, S.; Hicks, G.
Marine Ecology Progress Series

Spatial Information: Elsewhere is NZ - Pauatahanui Inlet, near Wellington, New Zealand
Keywords:meiobenthic copepods, habitat complexity, vertical migration, meiofauna, beds, hydrodynamics, behaviour, meadows, ecology, blades, plants, seagrass, eelgrass, *Zostera*

Summary: The influence of plant landscapes on recruitment of meiofaunal copepods was investigated in a New Zealand seagrass bed (Pauatahanui Inlet, near Wellington). Artificial plant mimics were placed into sediments at levels equivalent to natural blade densities (100 units per 0.5 x 0.25 m plot) in a variety of experimental treatments and retrieved 3 or 5 d later. To assess the effect of plant arrangement on faunal recruitment, plots were established within a seagrass bed in areas clipped of vegetation with (1) natural vegetation immediately surrounding the experimental plot; (2) natural vegetation clipped up to 0.5 m from plot edges; and (3) vegetation clipped up to 1 m from plot edges. Outside the natural seagrass bed plots were established in unvegetated sediments 0.5 m from the edge of the bed. Additionally, mimics were

placed into plots 0.5 m from the edge of the bed which had sediment surfaces covered by plastic sheeting to determine whether recruitment onto plant mimics was from underlying sediments or from outside plots. Density of total copepods was highest on plant mimics with vegetation immediately adjacent to clipped areas inside the natural seagrass bed after 5 d. Densities of total copepods on mimics placed outside the bed were 5x higher than those inside the bed and the covering of sediment significantly reduced recruitment. The dominant copepod species, *Bulbamphiascus sp*., recruited to mimics irrespective of sediment border and probably invaded mimics from underlying sediments, although this was not true for other common species. While plant arrangement may influence recruitment of some copepod species, altering access to a source pool had a much greater effect on copepod densities on plant mimics.

The ERS oil-spill research project in New Zealand: demonstrations to the commercial market. (2000)
Belliss, S. E.; McNeill, S. J.
Landcare Research

Spatial Information: 5 New Zealand harbours - Whangarei, Tauranga, New Plymouth, Wellington, Lyttelton
Keywords:C-band SAR data, ERS-oil spill, New Zealand harbours, port, shipping lanes, oil-spill detection, ENVISAT data, Tauranga Harbour

Summary: In New Zealand, the best way to show the potential advantages of satellite-based mapping and monitoring is first to carry out application-oriented research on the problems, thus demonstrating the advantages to the stakeholders. Current research concerns the practicality of using C-band SAR data to map and monitor discharge events, especially oil discharges, in selected New Zealand harbours and shipping lanes. An important feature from the market's perspective has been the possibility of investigating and prosecuting those responsible for illegal discharges. If successful, and once widely known, this monitoring capability could act as a strong disincentive to vessels contemplating discharge within New Zealand waters.

Rehabilitation of Coastal Foredunes in New Zealand Using Indigenous Sand-binding Species (1999)
Bergin, D.O.; Kimberly, M.O.
Department of Conservation New Zealand

Spatial Information: NZ beach trial sites: Nuhiti Beach (east coast, Nth Is.), Whiritoa Beach (Coromandel Peninsula), Waikawau Bay (Coromandel Peninsula), Port Waikato, South Brighton Beach (near Chch), Brighton Spit (near Chch), Taylor's Mistake (near Chch).
Keywords:sand dunes, restoration, planting, *Desmoschoenus spiralis*, *Spinifex sericeus*, *Austrofestuca littoralis*, foredunes, New Zealand, spinifex, pingao, sand tussock

Summary: Techniques for revegetation of foredunes in New Zealand were investigated using three indigenous sand-binding species: pingao, spinifex and sand tussock. Emphasis was placed on the development of guidelines from research trials designed to investigate the rehabilitation of dunes by planting nursery-raised seedlings. The aim was to promote successful techniques that will be of use to

coastal managers and community-based interest groups such as Beach Care and Coast Care.

Indigenous ways of knowing and the study of environmental change (2009)
Berkes, F.
Journal of the Royal Society of New Zealand

Spatial Information: Review discussing studies from Canada, NZ, and South America.
Keywords:traditional knowledge; indigenous knowledge, matauranga Maori, environment, ecology, climate change, conservation, sustainability, tītī, muttonbird, sooty shearwater, *Puffinus griseus*

Summary: Paradox of traditional knowledge.
We start with a paradox. Many of the applications of traditional ecological knowledge (indigenous knowledge; matauranga Māori) are in the context of global environmental change. Traditional knowledge has been used to help understand such issues as climate change, and in this case, the conservation of tītī (*Puffinus griseus* or sooty shearwater), a species with a long migration route from New Zealand to the North Pacific and back. What could traditional knowledge possibly have to say about the sustainability of tītī populations, knowing that traditional knowledge does not (directly) track overall population numbers, migration routes, mortality at different life stages, fledgling success, and the various population parameters that biologists study to assess the status of a population? For that matter, what could traditional knowledge possibly have to say about climate change, given that indigenous elders have not previously experienced climate change, and that the changes being observed now are beyond the range of experience of traditional groups?

Ecology, management and history of the forests of the Mamaku Plateau, New Zealand: An annotated bibliography (2009)
Beveridge, A. E.; Christensen, B. R.; Smale, M. C.; Bergin, D. O.
Department of Conservation New Zealand

Spatial Information: Elsewhere in NZ - Mamaku (or Patetere) Plateau, North Island, New Zealand
Keywords:bibliography, Mamaku Plateau, Patetere Plateau, ecology, forest history

Summary: The forests of the Mamaku (or Patetere) Plateau, North Island, New Zealand, have a history of numerous land uses, and now exist as key enclaves for indigenous biota within the Bay of Plenty. Conservation focus is moving from single-species protection to a more comprehensive management approach, targeting multiple pests at key sites. This annotated bibliography covers a timeframe from the late 19th century onwards. It includes research and survey work on the forests, flora and fauna, with some information on soils, geology and hydrology. It also covers the history of logging and conversion of logged indigenous forest to pine plantations on land leased to forestry companies. Podocarp restoration trials following cutover operations are outlined. This is the third compilation of annotated bibliographic information on the ecology and management of indigenous forest of the central North Island Volcanic Plateau, following publications on the Pureora Forest Park and Whirinaki Conservation Park. The bibliography is an ongoing project and its authors welcome updates, corrections or details of relevant articles.

Tuapiro Inlet water quality, 1974-1977 (1977)
Bioresearches Ltd
Unpublished report to the BOP Catchment Commission

Spatial Information: Tuapiro Inlet, Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, Tuapiro Inlet, water quality

Summary: Aspects of the water quality of the Tuapiro Inlet, northern Tauranga Harbour, were monitored over a full tidal cycle to enable comparison with results obtained by Steven and Fitzmaurice in a survey undertaken in June 1974 and reported in 'Tauranga Harbour water quality survey. A Report prepared for the Bay of Plenty Catchment Commission and Regional Water Board' (Steven and Fitzmaurice). Since the 1974 investigation the Regional Water Board has implemented a policy of preventing the discharge of dairy shed and piggery wastes into watercourses leading to the Harbour, with the aim of reducing bacterial and general pollution of the freshwater courses and the shallow Harbour areas receiving the freshwater flows.
For this survey a station at the entrance to the Tuapiro Inlet was sampled at approximately 2 hourly intervals throughout the tidal cycle, and various stations within the inlet were sampled at different stages of the tide. The major freshwater inflows, the Tuapiro River and the Kauri Point Stream were both sampled twice. Samples of cockles were taken from three areas and analysed for coliform bacteria concentration.

It was deduced that:
-There has been a major improvement in the quality of freshwater flow from the Kauri Point Stream. It is noted, however, that flow in the stream was very low during the 1977 survey, and it considered that the quality of waters in the stream could vary markedly with varying flow.
-A general improvement in the bacterial quality of the tidal waters of the inlet is evident. Results from 9.2.77 show that the waters have very low bacterial concentrations for a long period of the tidal cycle, with moderate concentrations occurring for a relatively brief period about the time of low tide when the freshwater flow from the catchment extends through the low tidal channels of the estuary. Considerable variation in bacterial quality of the inlet waters is still to be expected with varying freshwater flow.
-Inflow from the Kauri Point Stream contains high nutrient concentrations.
-Generally water quality within the inlet is considered to be good. Although coliform bacterial concentrations were low during the 9.2.77 survey, increased concentrentrations are still to be expected during wet periods with increased land runoff, and freshwater flow from the watershed.

The effects of septic tank inflow on the quality of Tauranga Harbour waters (1977)
Bioresearches Ltd
Unpublished report prepared for the BOPCC.

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, water quality

Summary: The Bay of Plenty Catchment Board requested Bioresearches to investigate stormwater discharges around urban Tauranga to determine if septic tank infiltration of stormwater drains was occurring. Harbour water was sampled at 10

locations a minimum of five times over a thirty day period. Freshwater inflows were sampled three times over the same period. Harbour waters were found to be of excellent quality, although local increases in bacterial concentrations were detected near shore at high tide at some sites and in the low tidal channel as a result of input from freshwater inflows

Tauranga Harbour Bridge ecological assessment (1984)
Bioresearches Ltd
Bioresearches Ltd

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, bridge, ecological effects, dredging, environmental impact assessment

Summary: This report presents an assessment of the natural environment implications of the construction of a bridge across Tauranga Harbour between Tauranga City and Mount Maunganui, and forms part of an Environmental Impact Assessment required by the Ministry of Transport.

The following biological aspects are discussed: distribution, abundance and size of edible shellfish, with data on cockles/tuangi (*Chione stutchburyi)* and wedge shells (*Tellina liliana)*; biology of areas to be reclaimed for the Eastern Approach Causeway, biology of the area to be dredged, bird use and fish habitats. Additionally the use of the area for the following resources: shellfish gathering fishing swimming and boating. Finally the construction effects of the proposal are discussed.

Tauranga Harbour Bridge; resurvey of the cockle resource near the eastern causeway (1988)
Bioresearches Ltd
Bioresearches Ltd.

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, bridge, cockles (Tuangi)

Summary:A study of the edible shellfish resources of the area to be reclaimed for the Tauranga Harbour bridge approach causeway was carried out as part of the Impact Assessment undertaken in 1984, prior to final consent being granted for bridge construction. That study found that cockles were the major edible seafood resource in the proposed causeway area, and defined the abundance and size of cockles, and the extent of beds of cockles of attractive edible size.

Factors influencing the growth of the sea lettuce, *Ulva* in the south-eastern Tauranga Harbour (1989)
Bioresearches Ltd
Bioresearches Ltd

Spatial Information: South-eastern Tauranga Harbour, New Zealand
Keywords:plants, sea lettuce, *Ulva*, Tauranga Harbour, Te Awanui, monitor, green algae, distribution, abundance, sewage effluent discharge, growth, algal growth management, nutrients, nitrogen, run off,

Summary: This report presents the results of the annual algal monitoring study, together with the results of a wider investigation of the distribution and abundance of green algae in south-eastern Tauranga Harbour, which was undertaken in response to public concerns about accumulations of algae on beaches in the Matua area. The aims of the wider study were: to document the distribution and abundance of green algae in the Tauranga area; to identify, if possible, the factors responsible for the observed distribution and abundance; to evaluate the importance of the Tauranga sewage effluent discharge as a factor influencing algal distribution and abundance and to comment on possible future trends and possible methods of algae control.

The growth of the sea lettuce, *Ulva* in south-eastern Tauranga Harbour (1991)
Bioresearches Ltd
Bioresearches Ltd

Spatial Information: South-eastern Tauranga Harbour, New Zealand
Keywords:plants, sea lettuce, *Ulva*, Tauranga Harbour, Te Awanui, monitor, green algae, distribution, abundance, sewage effluent discharge, growth, algal growth management, nutrients, nitrogen, run off

Summary: This report presents the results of the annual algal monitoring study, together with the results of an investigation of the distribution and abundance of green algae in south-eastern Tauranga Harbour, which was a follow-up to the first such study undertaken in December 1989.

The aims of the wider study were: to document the distribution and abundance of green algae in the Tauranga area and comment on differences between 1989 and 1990; to discuss the factors responsible for the observed distribution and abundance; to comment on possible future trends. The overall abundance of *Ulva* was less than that recorded in 1989. The Wairoa River was considered to be a major influence on algal growth between Tilby Point and Sulphur Point. The masses of *Ulva* present in 1988/89 have mostly disappeared 1990.

Possible biological significance of contaminated sediments in Port Jackson, Sydney, Australia (2002)
Birch, G.; Taylor, S.
Environmental Monitoring and Assessment

Spatial Information: Overseas – Port Jackson, Sydney, Australia.
Keywords:organic pollutants, inorganic pollutants, biological effects, contaminants, estuary, estuarine management, sediment quality guidelines, Sydney, Australia, Port Jackson, metal, toxic

Summary:A comprehensive investigation of estuaries in central New South Wales has identified Port Jackson as the most contaminated waterway on the eastern seaboard of Australia. Extensive areas of the estuary are mantled in sediment containing high concentrations of a large range of metallic and organic contaminants. Although extensive, this database does not provide an effective basis for determining the potential adverse effects of chemicals on living resources. In the absence of any ecotoxicological information, the recently published (1999) draft Australian and New Zealand Environmental and Conservation Council (ANZECC) sediment quality guidelines have been used to assess possible adverse biological effects of these toxicants. The ANZECC guidelines use the lower effects range of the widely used U.

S. National Oceanic and Atmospheric Administration (NOAA) scheme to identify potentially contaminated sediment and as a threshold to trigger for additional investigative work. This guideline level has been used in the current study to assess possible toxicity of contaminated sediments in Port Jackson. It is estimated that sediments in approximately 26% of the estuary, mainly the upper parts of the harbour and much of the central harbour, have a 67% probability of being toxic. Sediments in the central harbour and a major tributary, the Middle Harbour, comprising about 40% of the estuary, have a 13 to 25% probability of toxicity. All sediments in the harbour, except at the mouth of the estuary, would require additional environmental assessment based on the proposed draft ANZECC sediment quality guidelines.

The nature and causes of coastal landsliding on the Maungatapu Peninsula, Tauranga, New Zealand (1981)
Bird, G.A.
University of Waikato; M.Sc. Earth Sciences thesis

Spatial Information: Maungatapu Peninsula, Tauranga, New Zealand
Keywords:sedimentation, landslides, subsidence (earth movements), coast changes, Tauranga, Maungatapu

Summary: Maungatapu Peninsula is a northeast trending peninsula located within the Tauranga Basin covering an area of 1.6km2. Maungatapu is underlain by a sequence of volcanic tephras, ashes and fluvial deposits derived both locally and from the Taupo Volcanic Zone. Over the last 40 years the city of Tauranga has progressively increased in size due to its mild climate and central location within the North Island. This growth has led to many of the productive agricultural areas, such as the Maungatapu Peninsula, being rezoned for residential development. Since the late 1960's major housing development has occurred on Maungatapu Peninsula, gradually infilling the area and resulting in houses being constructed closer to the cliff edge to obtain a picturesque view of Tauranga Harbour. The vegetation along Maungatapu Peninsula cliff faces has been highly modified by both human and natural processes. As tree and shrub cover has been disturbed by slipping, weed species have revegetated the cliff face. In other areas man has replanted using more ornamental species.

Aquaculture in Action Fact Sheets (n.d.)
Biswell, S. F.
New Zealand Government

Spatial Information: Throughout NZ; not spatially specific
Keywords:aquaculture, teaching resources, New Zealand, fact sheet,

Summary: Seven fact sheets aimed at Year 7 and 8 level to give them an opportunity to learn more about aquaculture and in particular, marine farming. They cover: what aquaculture is, New Zealand's mussels, oysters and salmon, aquaculture and the environment, aquaculture and the economy and about balancing coastal uses.

Bay of Plenty Current and Temperature Measurements: Aquaculture Management Areas (2005)
Black, K.; Beamsley, B.; Longdill, P. ; Moores, A

ASR Marine Consulting and Research Ltd; Coastal Marine Group, University of Waikato

Spatial Information: Bay of Plenty coastal waters – off the coast of Opotiki, Pukehina/Otamarakau and Whakatane.
Keywords:aquaculture, aquaculture management area, Bay of Plenty, Whakatane, Pukehina, Otamarakau, Opotiki, marine farm, mussel, current, water temperature, Environment Bay of Plenty

Summary: Temperature and current measurements were made in the eastern BOP to record the 3-dimensional structure of the Bay. The report includes short period transect deployment data collection atboth of the proposed mussel farm sites mentioned above (off the coast of Opotiki and Pukehina/Otamarakau) as well as off the coast of Whakatane; no measurements taken in or around the Tauranga Harbour. The data covers the period September 2003-January 2005 and is fully summarised in Figure 2.4.

Bay of Plenty Primary Production Modelling: Influence of Climatic Variation and Change (2006)
Black, K.; Haggitt, T.; Mead, S.; Longdill, P.; Prasetya, G.; Bosserelle, C.,
ASR Marine Consulting and Research Ltd; Coastal Marine Group, University of Waikato; Coastal and Aquatic Systems

Spatial Information: Bay of Plenty coastal waters – off the coast of Opotiki, Pukehina/Otamarakau and Whakatane.
Keywords:aquaculture, Bay of Plenty, Opotiki, Pukehina, Otamarakau, mussel, marine farm, aquaculture management area, primary production modelling, climate, weather, La Nina, El Nino, phytoplankton, Environment Bay of Plenty

Summary: Altered wind patterns have consequences for up/down welling of ocean bottom waters that provide an important source of nutrients for phytoplankton and zooplankton. In addition, the dispersal of land-sourced nutrients from the rivers throughout the Bay of Plenty will vary as the weather patterns change.
The present report deals with the effects of climate on primary production in the Bay of Plenty. The numerical modelling examined changes to phytoplankton productivity during La Nina, El Nino and a more extreme westerly wind pattern (described here as “Diablo” El Nino). The latter is predicted to occur in the Bay of Plenty in response to global climate change.

Sediment Transport.Tauranga Harbour Study: Part IV (1984)
Black, K. P.
Bay of Plenty Harbour Board

Spatial Information: Tauranga Harbour, New Zealand
Keywords:sedimentation, Tauranga Harbour, Te Awanui.

Summary: After determining to establish a joint project to study Tauranga Harbour, the Bay of Plenty Harbour Board requested sediment transport model studies from this consultant. A consulting agreement was signed on 17 June 1983 with the Ministry of Works and Development, to undertake the sediment transport modelling, while they would undertake the water flow modelling.

Sediment dynamics in the lower section of a mixed sand and shell-lagged tidal estuary, New Zealand (1989)
Black, K. P.; Healy, T. R.; Hunter, M. G.
Journal of Coastal Research

Spatial Information: Elsewhere in NZ - Whangarei Harbour, New Zealand
Keywords:sedimentation, Whangarei Harbour, sediment dynamics, tidal inlet, tidal deltas, numerical modelling, velocity residuals

Summary:A series of field investigations and a numerical hydrodynamic model were applied to determine the sediment transport characteristics in the lower section of a large, tidally-dominated estuary at Whangarei Harbour, northeast New Zealand. The results show a consistent pattern in this unusual case where shell lag and shell/sand mixes have a dominant influence on the net sediment transport even though the estuary is subjected to a wide range of competent flows well above the sandy sediment threshold. A description of the estuary's sediment transport capacity, the influence of lagged beds, the relationship of morphology and sediments to tidal dynamics, especially tidal-cycle velocity residuals, and the implications for a proposed marine terminal in the study region are presented and discussed.

Te Awa O Waitao Restoration Project Social Survey 2007: Part A Interview Data (2008)
Blackett, P.
Ag Research and New Zealand Landcare Trust (as part of the Waitao Restoration Project) for NIWA

Spatial Information: Waitao catchment, Tauranga Harbour catchment, New Zealand
Keywords: Tauranga Harbour, Te Awanui, water quality, farm management, riparian, Waitao Valley, Waitao Stream, social impacts, erosion, Kaiate Falls, Te Awa O Waitao Restoration Project, Maori knowledge, matauranga Maori

Summary: Overall a shift in awareness of stream management issues has occurred within the Waitao Valley section of the catchment. This is probably a result of three key factors;

- Efforts of the Te Awa O Waitao Restoration Project Joint Steering committee;
- Collective submission in opposition to a proposed landfill site in the old pumice quarry; and
- Formation and activities of the Waitao-Kaiate Environment Group.

Te Awa O Waitao Social Survey 2007:Part B Survey Data (2008)
Blackett, P.; Wilson, J.
Ag Research and New Zealand Landcare Trust (as part of the Waitao Restoration Project) for NIWA

Spatial Information: Waitao catchment, Tauranga Harbour catchment, New Zealand
Keywords: Tauranga Harbour, Te Awanui, water quality, farm management, riparian, Waitao Valley, Waitao Stream, social impacts, erosion, Kaiate Falls, Te Awa O Waitao Restoration Project, Maori knowledge, matauranga Maori

Summary: The 43 respondents generally supported the water and habitat quality improvement goals of both Te Awa O Waitao Restoration project and the Waitao-Kaiate Environment Group. They tended to be long term residents of primarily lifestyle properties within the Waitao Valley section of the catchment.

Review of New Zealand Environmental Farm Plans (2003)
Blaschke.P.; Ngapo, N.
New Zealand Ministry for the Environment (MfE)

Spatial Information: Not spatially specific, but NZ targeted document
Keywords:sustainable, farm, management, New Zealand, dairy, water quality, run off, effluent, nutrients, fertiliser, biodiversity protection, riparian management

Summary: This report, commissioned by the Ministry for the Environment as part of its work into Agricultural Impacts, provides a background on current environmental farm plan and other farm planning practice in New Zealand and their potential linkages with industry-led environmental management initiatives.

Results of baseline and first post-dredging surveys of the biological monitoring programme (1993)
Blom, W.; Grace, R.; Cooper, B.
Port of Tauranga

Spatial Information: Tauranga Harbour and off Motuotau (Rabbit) Island, New Zealand
Keywords: Tauranga Harbour, Te Awanui, dredging

Summary: This report examined the effect of the Port's activity on sea life in Tauranga Harbour and surrounding waters, mainly focussing on the environmental impacts of dredging and inner shelf disposal.A dredging programme, completed in July 1992 has allowed an increase in Port draught to 13.0m high water and 11.7m low water. The largest vessel to enter the Port to date had Length Overall (LOA) of 264m. Vessels up to LOA 290m can now be handled. Within the port, there is on-going maintenance dredging as required. This usually occurs every 18 months, with the removal of approximately 200,000 m3. The majority of spoil is deposited in various consented off-shore spoil sites (not marked on nautical charts), although up to 50,000 m3 of clean sand spoil is deposited on-shore at Sulphur Point for use in beach renourishment

Tauranga Harbour Mangroves: Ecological Issues and Values (2003)
Boffa Miskell
Boffa Miskell

Spatial Information: Southern Tauranga Harbour - Waimapu Estuary, Welcome Bay, Waikareao Estuary, Matua Estuary -, New Zealand.
Keywords: Tauranga Harbour, Te Awanui, sediment*, mangroves, manawa, mangrove removal, *Avicannia marina*, resource consent

Summary: Over the past 50 years there has been a 117% increase in the area of mangroves within the Tauranga Harbour. Mangrove expansion has occurred

throughout the harbour, but most noticeably within the inner harbour and estuarine areas. The formation of mangrove populations can be the beginning of a natural remediation process and is a response to a range of changing environmental variables, not the least of which is substrate change and climate change. While not always the case, mangrove expansion often occurs where the land based loss of silt and sediment is continuous and relatively large. This build up of sediments, and the resulting changes in water flow, nutrient and substrate type all favour mangroves, giving the species a competitive advantage over other existing communities and habitats. A loss in habitat diversity within estuarine areas can result.Mangroves also contribute positive values to the harbour environment. In this respect, they provide coastal edge protection from erosion and cause land discharged sediment entrapment, thus protecting wider water quality and habitats outside of the mangroves. Mangroves also have ecological values associated with them acting as a habitat for wildlife and fish species.

Biological nitrogen fixation for sustainable agriculture: A perspective (1992)
Bohlool, B.B.; Ladha, J.K.; Garrity, D.P.; George, T.
Plant and Soil Journal

Spatial Information: Not spatially specific
Keywords:chemical fertilizer, crop production, developing countries, environment, inoculation, legume, pollution, biological nitrogen fixation

Summary: The economic and environmental costs of the heavy use of chemical N fertilizers in agriculture are a global concern. Sustainability considerations mandate that alternatives to N fertilizers must be urgently sought. Biological nitrogen fixation (BNF), a microbiological process which converts atmospheric nitrogen into a plant-usable form, offers this alternative. Nitrogen-fixing systems offer an economically attractive and ecologically sound means of reducing external inputs and improving internal resources. Symbiotic systems such as that of legumes and Rhizobium can be a major source of N in most cropping systems and that of Azolla and Anabaena can be of particular value to flooded rice crop. Nitrogen fixation by associative and free-living microorganisms can also be important. However, scientific and socio-cultural constraints limit the utilization of BNF systems in agriculture. While several environmental factors that affect BNF have been studied, uncertainties still remain on how organisms respond to a given situation. In the case of legumes, ecological models that predict the likelihood and the magnitude of response to rhizobial inoculation are now becoming available. Molecular biology has made it possible to introduce choice attributes into nitrogen-fixing organisms but limited knowledge on how they interact with the environment makes it difficult to tailor organisms to order. The difficulty in detecting introduced organisms in the field is still a major obstacle to assessing the success or failure of inoculation. Production-level problems and socio-cultural factors also limit the integration of BNF systems into actual farming situations. Maximum benefit can be realized only through analysis and resolution of major constraints to BNF performance in the field and adoption and use of the technology by farmers.

The trade and hinterland of the Port of Tauranga (1971)
Bowers, M.
Department of Geography, University of Auckland

Spatial Information: Tauranga Harbour, New Zealand

Keywords: Port of Tauranga, history, growth, development, export

Summary: The development of the Port of Tauranga from a small coastal import port in the 1920, 30s, 40s, to a major overseas export port from the 1950s has been of vital importance to the Bay of Plenty region. The report investigates the relationship between the Port and the volcanic plateau region as a result of rapid overseas exports.

Baseline Survey of the Welcome Bay Catchment and Estuary, Tauranga, Bay of Plenty, New Zealand (1993)

Boyd, G.
BOP Polytechnic Marine Studies report

Spatial Information: Tauranga Harbour – Welcome Bay Estuary, New Zealand
Keywords: Welcome Bay Estuary, Tauranga Harbour, Otumanga Stream, water quality, mangroves, Inanga, jointed rush, sediment

Summary: Six locations were selected on streams feeding the Welcome Bay estuary, to test the water quality as measured by pH, conductivity, turbidity and dissolved oxygen. Water samples were collected to determine suspended sediment quantities. Analysis of data indicated that the streams had relatively high water quality. Sediment, macrobiota and shellfish quantity and diversity surveys were conducted along the coastal margins. Shellfish were present in low numbers and in a juvenile state. Macrobiota consisted mainly of noxious exotic plants, mangroves are prolific around the foreshore, especially the streams that enter the estuary. The Otumanga Stream is bounded on one side by an area of jointed rush (L*eptocarpus similis*). Salinity levels were measured in the 3 streams at spring high tide to locate the upper position of the salt wedge and thus determining the likely spawning sites of Inanga (*Galaxis maculatus*).

1999/2000 National Marine Recreational Fishing Survey: harvest estimates. Draft New Zealand Fisheries Assessment Report (2002)

Boyd, R. O.; Reilly, J. L.
Kingett Mitchell Ltd; Statistical Insights Ltd

Spatial Information: Whole of New Zealand
Keywords:recreational fishing, fisheries, fish, shellfish, harvest.

Summary: Recreational harvest estimates for 1999-2000 (1 December 1999 to 30 November 2000) are presented for a wide range of fish and shellfish species. The estimates are based on a similar, but enhanced, survey methodology that has been adopted for estimating recreational harvests in previous surveys. The survey methodology involves combining results from three separate but related surveys. An estimate of fisher prevalence derived from a nation-wide face to face survey is combined with detailed diary data of recreational harvests recorded by a nation-wide sample of recreational fishers recruited by telephone, to estimate recreational harvests in numbers of fish or shellfish. Estimated harvests in numbers of fish or shellfish were converted to total harvest weight using the results of a boat ramp survey to estimate the mean weight of recreationally harvested fish and shellfish. Key enhancements over previous surveys included the use of a face to face survey for measuring fisher prevalence, improved methods for weighting up diarists' harvests using extensive demographic data and a more appropriate method for estimating

coefficients of variation. Estimates for the 1999-2000 national marine recreational fishing survey are much higher than the estimates from previous surveys. The harvest estimate for SNA1 which has a c.v. of 11% is in excess of 6.9 million fish and 6 200 tonnes. Very few of the harvest estimates have c.v.s of less than 20%. Most of the fish stock recreational harvest estimates presented in the report is higher than previous estimates by a factor of two to three times. Coefficients of variation (c.v.s) for the harvest estimates are much larger than estimated for previous surveys but are more reflective of the complex nature of the survey design and the highly skewed nature of diarists' harvests. These factors were not taken into account in the method used for estimates of c.v.s in previous surveys. Some of the 1999-2000 harvest estimates, particularly the estimates for a number of key fish stocks in QMA2 appear to be implausibly high. While the reasons for this are not known, the small sample size for this area may have resulted in a biased sample of diarists. Results from pilot surveys undertaken as part of the 1999-2000 survey together with a review of the available literature strongly suggest that previous harvest estimates from the 1996 national survey and earlier regional surveys are highly unreliable and probably much too low. Therefore, caution should be exercised in comparing the estimates presented here with the estimates from previous surveys as such comparisons are likely to be misleading. The improved survey methodology and estimation procedures adopted for the 1999- 2000 national marine recreational fishing survey mean that the reported harvest estimates should be more accurate than the estimates from prior surveys. The much higher recreational harvest estimates have significant fisheries sustainability and management consequences. Future surveys to estimate recreational harvests will need to focus on making further improvements to the survey methodology and improving the precision of estimates.

Potential suitability of maintenance dredged sediments for beach renourishment of Pilot Bay (2006)

Braddock, H.
University of Waikato

Spatial Information: Pilot Bay, Tauranga Harbour – New Zealand
Keywords: beach nourishment, dredging spoil, shore protection, Tauranga Harbour, Te Awanui

Summary: Beach nourishment refers to the strategic placement of large quantities of beach quality sand on an existing beach to provide a source of nourishment for littoral movement or restoration of a recreational beach. Generally, beach nourishment projects are carried out along a beach where a moderate and persistent erosional trend exists. Sediment with physical characteristics similar to the native beach material used is mechanically or hydraulically placed. Beneficial use of dredged material for shoreline stabilization includes the creation of berms or embankments at an orientation to the shoreline that will either modify the local wave climate in order to improve shoreline stability, or alter the wave direction to modify the rate or direction of local sediment transport. Berms may be constructed of a wide variety of dredged material, including rock or coarse gravel, sands, and clays. Stabilization and enhancement of eroding shorelines with dredged materials may also help reduce the volume and frequency of future maintenance dredging. Shoreline stabilization has the potential to improve recreational opportunities for surfing, swimming, sailing, and other activities.

Distribution of reactive phosphorus and plankton in relation to upwelling and surface circulation around NZ (1978)
Bradford, J.M.; Roberts, P.E.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand coastal waters
Keywords: New Zealand, water quality, upwelling, nutrients, parameters, phosphorus, chlorophyll a, zooplankton

Summary: For the New Zealand region, the distributions of reactive phosphorus, chlorophyll a, surface primary productivity, integrated primary productivity, and zooplankton biomass are collated, mainly from previously published data. The hydrology of the New Zealand region intimately affects the amount of reactive phosphorus available for phytoplankton growth. Winter cooling of surface waters is important in promoting nutrient recycling. Also, the New Zealand land mass and its submarine plateau disturb the general eastward flow of water, causing nutrient renewal, especially in summer, by upwelling associated with topographic features. In some upwelling areas (Three Kings Islands, Mernoo Gap, and Challenger Plateau) high reactive phosphorus concentrations are found in conjunction with maxima in chlorophyll a, primary productivity, and zooplankton biomass.

Change in Geomorphology, Hydrodynamics and Surficial Sediment of the Tauranga Entrance Tidal Delta System (MSc thesis) (2009)
Brannigan, A.M.
Earth and Ocean Sciences Department, University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords:hydrodynamics, residual distance plot, Van Veen grab sampler, bedforms, accretion, deposition, sediment transport pathways, Tauranga Harbour, Te Awanui

Summary: Historical change in the geomorphology, hydrodynamics, and surficial sediment of the tidal delta system of Tauranga Harbour are investigated with the general aim of analysing. The general aims of this thesis are: firstly to analyse historical changes to the inlet delta's system geomorphology using historical hydrographic charts, secondly, to conduct hydrodynamic numerical modelling using historical bathymetries to access changes in peak spring flow and potential net tidal sediment transport, and thirdly, to analyse historical changes in surficial sediment and bedforms. Geomorphic change was investigated through plotting difference in bathymetry graphs and conducting cross sections taken from digitised bathymetries obtained from historical hydrographic charts from 1852, 1879, 1901, 1927, 1954 and a modern bathymetry from 2006. Two-dimensional hydrodynamic numerical modelling was conducted to investigate the changes in peak tidal current flow and potential net sediment transport between 1852 and 2006. Changes in surficial sediment patterns were determined through completing a side scan sonar survey with associated sediment samples for ground truthing of grain size and underwater videography to gather surficial shell coverage information. This was used to produce a surficial sediment coverage map which was compared to historical studies. Major geomorphological findings include that the shipping channel appears to have induced minor change in the geomorphology of the FTD but such changes are similar to those identified in the historical bathymetries of 1852, 1879, 1901, 1927, 1954 prior to dredging. Significant changes have occurred on the ETD, with the majority of the ETD showing scour of 1 m while the terminal lobe has extended seawards. This is

associated with historical (since 1852) narrowing of the inlet from Panepane Point to Mt Maunganui by ~ 900 m. Hydrodynamic numerical modelling has shown a significant increase in potential net tidal sediment transport in the Cutter Channel due to dredging, while the Maunganui Roads Channel shows a reduction of net potential tidal sediment transport that is associated with the dredging of this channel. The area surrounding Panepane Point undergoes significant increases and decreases in net potential tidal sediment transport both before and after dredging Investigation of the surficial sediment patterns over the FTD and ETD from sidescan sonar and bottom samples show that between 1983 and 2007 there has been a northwards extension of the area of major shell (greater than 50 %) converge in the main ebb channel as well as reduction in major shell converge in flood tidal delta ebb shield region. The Maunganui Roads Channel changes from silty sands to medium and fine sands.

How do quota management systems work in rock lobster fisheries? A comparative analysis of the experience in New Zealand, Tasmania and South (2006)

Bray,T.; Gill,S.; Edwards,R.
Department of Fisheries, Perth WA

Spatial Information: New Zealand and Australia.
Keywords: macroinvertebrates, southern rock lobster, *Jasus edwardsii*, quota management system, fisheries management, total allowable commercial catch (TACC), strategic management options

Summary: Quota management systems are now in place for the New Zealand, Tasmanian and South Australian rock lobster fisheries. New Zealand was the first to move to QMS (1989), followed by the Southern Zone of South Australia (1993), Tasmania (1998) and Northern Zone South Australia (2001).Throughout the world of fisheries management, there are a number of assumptions made about quota management systems. Most common are that under a QMS the fleet size falls, the ownership of commercial fishing access rights will concentrate and there will be vertical integration through the catching and processing sectors. These assumed effects are made because the economic theory is that there are strong incentives for fishing fleets to restructure in order to become more efficient and focus on maximising the value of their catch as opposed to investing in inputs to maximise their catch.

Evaluating the State of New Zealand's Coastal Management: Application of Integrated Coastal Management Indicators at the National and Local Scale (2009)

Bremer, S.
New Zealand Centre for Ecological Economics, Massey University

Spatial Information: New Zealand Coastline
Keywords: New Zealand Coastal management, indicators

Summary: This monograph seeks to provide a broad evaluation of current coastal management in New Zealand. It uses indicators taken from Integrated Coastal Management (ICM) research, and applies them at both a national scale, through a desktop study, and at a regional scale, through semi-structured interviews with planning and policy representatives from all regional authorities. While the monograph is coloured by a 'planning' bias, it has strived to illuminate all the issues

facing the New Zealand coastal management institutional framework.While some key coastal management duties such as writing and reviewing the New Zealand Coastal Policy Statement are led within central government, the coastal management framework devolves significant responsibility to local government. In practice, the majority of coastal management occurs in the regions and districts through Resource Management Act 1991 (RMA) policy and plans, administered in concert with local Department of Conservation conservancy offices. This highlights the importance of regional variation; both in the pressures exerted on a regions coastline, and in their capacity to respond to these pressures. Indeed most regions felt their coastline was one of the resources least under pressure within their region, meaning they managed the coastline with a commensurate level of resources and commitment.The coastal management framework remains fundamentally fragmented across the RMA, the Conservation Act 1987, and the Fisheries Act 1996. For many practitioners, this lack of a single coastal vision or strategy, and poor communication between central government and local government were sources of vertical fragmentation. Meanwhile, the jurisdictional boundary at high tide, and poor coordination between government agencies, remain significant sources of horizontal fragmentation. Moreover, the current management framework places too much emphasis on regulatory mechanisms, which are being implemented in a combative and litigious arena. This makes the policy process laborious and non-responsive to issues, and it is for this reason that almost no regions have introduced economic tools. Finally, the lack of knowledge of New Zealand's coastal environment, and the lack of capacity in local government to improve this knowledge, poses one of the greatest barriers to making informed decisions.The significant devolution of power to local government allows significant latitude for creative initiatives, particularly of a non-statutory nature. All regions recognised a network of interested stakeholders that reconfigured and mobilised around different coastal issues, and which had an open and honest relationship with the council. Relationships were at times nurtured through forums of varying formality and frequency, or more often through the preparation of policy. Almost all regions augmented their RMA First Schedule policy process with other non-statutory tools, and many planned to include more local knowledge in the preparation of their second generation policy. Perhaps the most significant opportunity was seen in non-statutory policy initiatives; with 17 forms of these documents detailed across nine councils. Even statutory policies were evolving in their form and sophistication, with all existing, and other planned, second-generation policy documents taking a more integrated approach. This noted, many regions felt their autonomy also hindered them in the resources they needed to expend litigating policy documents. There was a strong desire for central government to write, and defend, policy that could be slotted directly into local government documents.

Compliance report: Bay of Plenty Fertiliser Limited, report no 98/10 (1998)
Brian, K. G.
Bay of Plenty Regional Council

Spatial Information: Tauranga, New Zealand
Keywords: Bay of Plenty Fertiliser Limited, Fertilizer industry Waste disposal New Zealand Mount Maunganui, Water quality New Zealand Tauranga Harbour, Water rights New Zealand Mount Maunganui, Environment Bay of Plenty

Summary: Bay of Plenty Fertiliser Limited operates a nine hectare manufacturing site at Mount Maunganui, adjacent to the Tauranga Harbour Bridge Toll Plaza. Fertiliser and raw products have been stored, blended and manufactured on this site since 1955. BOP Fertiliser holds a number of resource consents for the discharge of

contamination and the taking of sea and ground waters. This report deals with consent number 02 4155: the discharge of site stormwater.

Minimising visitor impacts on threatened shorebirds and their habitats (2000)
Bridson, L.
Department of Conservation New Zealand

Spatial Information: Waipu and Ruakaka wildlife refuges, Northland, New Zealand
Keywords:visitor impacts, threatened birds, shorebirds, wildlife refuges, Northland, Waipu, Ruakaka

Summary: The Waipu and Ruakaka Wildlife Refuges in Northland are recognised as habitats of international importance as they provide regular breeding sites for the endangered New Zealand fairy tern and the threatened New Zealand dotterel. Despite management initiatives, the level of human related disturbance upon these shorebirds is increasing.This study was conducted with the aims of identifying: the current levels and patterns of visitor use; visitors' level of awareness about shorebirds and the impacts upon them; and the compatibility of visitors' activities with the needs of shorebirds.An on-site questionnaire was used at both Waipu and Ruakaka to enable this information to be collected. The results show that the average visitor utilising the Wildlife Refuges was aged between 33-45 and from Auckland. They usually visited once a year, but for a considerable number it was their first visit. Most stayed locally and used the refuge for swimming, fishing and surfing. An important difference between the two sites was that more local residents appeared to utilise the Waipu Wildlife Refuge than the Ruakaka Refuge.

^{40}Ar/^{39}Ar ages of silicic volcanic rocks in the Tauranga-Kaimai area, New Zealand: dating the transition between volcanism in the Coromandel Arc and the Taupo Volcanic Zone (2005)
Briggs, R. M.; Houghton, B. F.; McWilliams, M.; Wilson, C. J. N.
New Zealand Journal of Geology and Geophysics

Spatial Information: Tauranga and Kaimai volcanic centres, New Zealand
Keywords: 40Ar/39Ar; silicic volcanism; Tauranga Volcanic Centre; Kaimai Volcanic Centre; Pliocene; Pleistocene; Aongatete Ignimbrites; Waitеariki Ignimbrite; Papamoa ignimbrites; Hauraki Fault

Summary: Subduction-related volcanism in the northern part of the North Island of New Zealand shifted abruptly during the late Pliocene. This study focuses on the transition, in time and space, from the NNW-oriented Miocene–Pliocene Coromandel Volcanic Zone to the northeast-oriented active Taupo Volcanic Zone. The volcanic rocks marking this transition are exposed in the Tauranga Basin and adjacent Kaimai Range, and associated here with the recently defined Tauranga and Kaimai Volcanic Centres, respectively. New 40Ar/39Ar age determinations indicate that the transition occurred between 1.90 and 1.55 Ma, which is between the youngest age of silicic volcanism in the Tauranga-Kaimai area, and the age of the oldest silicic volcanism in the Taupo Volcanic Zone. This interpretation is generally consistent with recent plate models and with the initiation of the Kermadec Arc within the last 2 m.y.

Tauranga Harbour Recreation Strategy (2008)
Britton, R.; Lee, B.; Lawrie, A.; Whale, J.; Watson, P.; Rauputu, J.; Larking, C.

Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Environment Bay of Plenty, Tauranga Harbour, Te Awanui, recreation, strategy, management, harbour margins, navigation safety, boating facilities, ecology, access

Summary: This strategy explores the issues for recreation on Tauranga Harbour and sets out a series of actions to improve recreation opportunities and reduce conflict, while maintaining the quality of the environment. It is a joint strategy between Environment Bay of Plenty, Tauranga City Council and Western Bay of Plenty District Council. The need for the strategy arose from SmartGrowth and the Tauranga Harbour Integrated Management Strategy. They identified the impacts of recreation are not well understood, we need better planning for recreational activities, and planning needs to be a joint effort between the community and the three councils. The vision for the strategy is: “Recreation on Tauranga Harbour is, enjoyable, safe, sustainable, and accessible to all: A set of goals and principles set out how the vision is to be achieved and a framework for decision making.

Ecological sustainability assessment for Firth of Thames shellfish aquaculture: Tasks 2-4 - Biological modelling (2004)
Broekhuizen, N.; Ren, J.; Zeldis, J.; Stevens, S.
NIWA; Auckland Regional Council; Environment Waikato, Regional Council;

Spatial Information: Firth of Themes, New Zealand
Keywords: shellfish culture, New Zealand, Thames, Firth of., environmental aspects, aquaculture, mussel farming, biophysical modelling, hydrodynamics, snapper larvae, phytoplankton, zooplankton,

Summary:NIWA were engaged by the Auckland Regional Council, Environment Waikato and the Western Firth Mussel Consortium to make quantitative predictions of the degree to which large-scale mussel farming in the western Firth would influence snapper egg / larval survival and plankton abundance and spatial distribution.

Verification of plankton depletion models against the Wilson Bay synoptic survey data (2005)
Broekhuizen, N.; Oldman, J.W.; Image, K.; Gall, M.; Zeldis, J.
NIWA; Auckland Regional Council; Environment Waikato, Regional Council

Spatial Information: Wilson Bay, Firth of Themes, New Zealand.
Keywords: phytoplankton, New Zealand, Firth of Thames, shellfish culture, aquaculture, Wilson Bay, mussel farm, biological models, aquaculture management area

Summary: This report presents the results of a verification exercise applied to the models NIWA utilised to assess the ecological sustainability of the Firth of Thames shellfish aquaculture: the 'original biophysical model', the 'revised biophysical model' the 'logistic plankton model', and the 'hydrodynamic model' which drives transport in the biological models.

Compliance Report: Tauranga District Council Discharge of Tauranga and Mount Maunganui Sewage Consent Numbers 02 3803 and 02 3540 (1999)
Bruce, A. C.
Bay of Plenty Regional Council

Spatial Information: Tauranga/Mt Maunganui, New Zealand
Keywords: wastewater, monitor, sewage, consent, compliance, Tauranga, Mount Maunganui, Te Maunga, Tauranga Harbour, Te Awanui, treatment plant, Chapel Street, Environment Bay of Plenty

Summary: This report gives a brief outline of the wastewater treatment facilities in the Tauranga District (at the time) and how it is processed and discharged into the Pacific Ocean. It also provides background information on the history of wastewater treatment in the district.

Port of Tauranga the central port of the North Island of New Zealand - strategic port plan 1975-2000 (1975)
Brueton, L.H.
Bay of Plenty Harbour Board

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga, strategic plan

Summary: Bay of Plenty Harbour Board strategic plan from 1975 for the next 25 years.

BOP Fertiliser compliance report (2000)
Buckley, M. T.
Bay of Plenty Regional Council

Spatial Information: Mount Maunganui, Tauranga, New Zealand
Keywords: Bay of Plenty Fertiliser Limited, Fertilizer industry Waste disposal New Zealand Mount Maunganui, water quality New Zealand Tauranga Harbour, water rights New Zealand Mount Maunganui, Environment Bay of Plenty

Summary: Bay of Plenty Limited operates a nine hectare manufacturing site at Mt Maunganui adjacent to the Tauranga Harbour Toll Plaza. Fertiliser and raw products have been stored, blended and manufactured on this site since 1955. BOP Fertiliser holds a number of resource consents for the discharge of contaminants and the taking of sea and groundwaters.This report deals with consent numbers 02 4155: the discharge of site stormwater and 04 0056: the discharge of wastewater. The period of consent covered in this report is May 1998 to June 2000.

Foraging Ecology of Common Dolphins (*Delphinus sp.*) in the Hauraki Gulf, New Zealand (MSc thesis) (2006)
Burgess, E.A.
Massey University (Albany)

Spatial Information: Hauraki Gulf Marine Park, off the east coast of Auckland, NZ
Keywords: foodweb, common dolphins, *Delphinus sp.*, Hauraki Gulf, New Zealand, ecosystem, foraging habits

Summary: This is a comprehensive study of the foraging ecology of common dolphins in the Hauraki Gulf Maine Park, off the east coast of Auckland. The study was based on field work conducted between January and April 2006 during which a total of 59 focal groups were followed and observed. Data collected during the observation include predominant behaviours, state of the group, foraging phase, foraging strategy, group dispersion, group formation, swimming style, group heading, calf presence and associated species. Many findings were obtained from the data. For example, common dolphins on average spent 14% of the time on feeding, with larger groups spending more time foraging than smaller groups. Herding accounted for a large part of the foraging behaviour of common dolphins. Nonetheless, the results from this study indicate that the benefits of coordinated team hunts implemented by common dolphins in the Hauraki Gulf are a key factor in their foraging ecology. Their cooperative foraging skills appear to not only benefit the common dolphin individual, but other species as well. Ultimately, their role as a social hunter and an abundant, apex predator in the ocean, suggests that the common dolphin is a strongly interacting species which may facilitate population viability of other species in the Hauraki Gulf ecosystem.

A study of chemical pollutants in the Tauranga Harbour (MSc thesis) (1993)
Burggraaf, S.
University of Waikato, New Zealand

Spatial Information: Tauranga Harbour, New Zealand
Keywords:water pollution, New Zealand, Tauranga Harbour, water quality, water analysis, organochlorine compounds analysis, Te Awanui, chemical pollutant, organic pollutant

Summary: Organochlorine compounds (OCCs) are a major class of organic environmental contaminants which are routinely detected in almost all environmental compartments. Their toxicity, environmental persistence and bioaccumulation potential are the major factors warranting their study in the environment. DDTs and polychlorinated biphenyls (PCBs) are the OCCs over which most controversy has arisen. These compounds are the OCCs which are most widely distributed both globally, in New Zealand (NZ) and in this study of the Tauranga Harbour. Preliminary work in Tauranga Harbour was directed toward locating sites in the harbour where further research was warranted. While at most of the sites surveyed the levels of extractable OCCs were low, site 3 (Waikareao Estuary) showed elevated levels of OCCs in comparison to the other sites surveyed. Results obtained by combined gas chromatography/mass spectrometry presented definitive evidence for PCBs and the metabolites of DDT in the sediment and biological samples collected from the Waikareao Estuary. A detailed sediment and biological survey of the estuary revealed that the OCC residues detected appeared to have entered the estuary through similar means, namely storm water drains and the Kopurererua Stream which enters the estuary at the southern end. Organochlorine residue profiles were indicative of the historical entry of PCBs and DDTs into the environment.

Organochlorine contaminants in sediments of the Tauranga Harbour, New Zealand (1994)
Burggraaf, S.; Langdon, A.G.; Wilkins, A.L.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Waikareao Estuary, Tauranga Harbour, New Zealand
Keywords: organic pollutants, water pollution, New Zealand, Tauranga Harbour, water quality, water analysis, Te Awanui, chemical pollutant, dichlorodiphenyltrichloroethane (DDT), DDE, DDD, polychlorinated biphenyls (PCBs), organochlorine compounds (OCCs), Waikareao Estuary, Kopurererua Stream, gas chromatography

Summary:DDT, PCBs, and dieldrin in Tauranga Harbour sediments.
After identifying levels of dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) at elevated levels in a Waikareao Estuary sample, Burggraaf, Langdon and Wilkins (1994) further tested eastern shore Waikareao Estuary sediments for these and other organochlorine chemical pollutants. Organochlorine compounds (OCCs) are water pollutants that are highly persistent in the environment in that they don't readily degrade, they are toxic, and they are bio-accumulative. Bioaccumulation refers to the tendency for these toxins to accumulate in the food chain. Species accumulate the toxins by eating contaminated plants and animals and this poisoning can be passed along the food chain and accumulate to dangerous levels in the top end consumers.

Organochlorine Compounds in Three Species of from Waikareao Estuary, Tauranga Harbour, New Zealand (1996)
Burggraaf, S.; Wilkins, A. L.; Langdon, A. G.; Wilcock, R. J.
Bulletin of Environmental Contamination and Toxicology

Spatial Information: Waikareao Estuary, Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, Waikareao Estuary, water quality, polychlorinated biphenyls (PCBs), *Macomona liliana*, wedge shell, *Saccostrea glomerata*, New Zealand rock oyster, *Amphibola crenata*, mud snail, sediments, p.p'-DDT, p.p'-DDD, p.p'-DDE, technical chlordane, dieldrin

Summary: We have previously reported the levels of some organochlorine compounds (OCCs) in sediments from the Waikareao Estuary (Figure I), a small inlet of Tauranga Harbour, New Zealand (37°39'S, 176°ll'E). The detection of significant levels of OCCs in Waikareao Estuary sediments prompted us to investigate the levels of nine PCB congeners, p,p'-DDT, p,p'-DDD, p,p'-DDE, technical chlordane, and dieldrin in three species of shellfish gathered from eleven sites in the estuary.

Heavy metals and organic hydrocarbons in sediments from the Waikareao Estuary, Tauranga Harbour, New Zealand (1997)
Burggraaf, S.; Wilkins, A. L.; Langdon, A. G.; Kim, N. D.
Bulletin of Environmental Contamination and Toxicology

Spatial Information: Waikareao Estuary and Kopurererua Stream, Tauranga Harbour, New Zealand
Keywords: organic pollutants, inorganic pollutants, heavy metals, Cu, Pb, Zn, Cd, hydocarbons, polyaromatic hydrocarbons (PAHs), n-alkanes, hopane triterpenes, sediments, Tauranga Harbour, Te Awanui, Waikareao Estuary, Kopurererua Stream, water pollution, water quality

Summary: Organic pollutants in Tauranga Harbour sediments: PAHs, n-alkanes and hopane triterpenes. Burggraaf *et al.* (1997) investigated the levels of three groups of organic hydrocarbons, PAHs, n-alkanes and hopane triterpenes in eleven sites in the

Waikareao Estuary. PAHs (polycyclic aromatic hydrocarbons) are highly toxic, and thought to be teratogenic (cause abnormalities in birth and developmental stages), carcinogenic (exacerbate and increase cancer through disruption of cellular metabolic process), and mutagenic (cause changes to genetic material). Results found elevated levels of PAHs in sites adjacent to storm water drains and a lesser concentrations at a site adjacent to the Kopurererua Stream mouth. The PAH levels found were less than the levels considered harmful to aquatic organisms. PAH levels varied with sediment type, with sediments that hadshell fragments, pumice and stones having low levels of PAH in comparison to sediments rich in organic matter, which had higher levels.The n-alkanes identified were generally two types, the shorter chained n-C15 to n-C22 petroleum hydrocarbons and the n-C23 to n-C33 plant waxes. The higher chains are solids and more likely to be retained in sediment for a longer time than the more volatile shorter chains (n-C17) which are liquid. Some hopane triterpenes were found, indicating the presence of petroleum contamination.

The New Zealand Aquaculture Strategy (2006)
Burrell, M.; Meehan, L.
Creative Design Advertising Ltd

Spatial Information: Not spatially specific- whole of NZ
Keywords: aquaculture, New Zealand, strategy, economic development, sustainable

Summary: This strategy sets out how regional and local government and economic development agencies can work in partnership with industry, government, iwi, science and training providers and communities, to promote environmentally sustainable aquaculture in New Zealand. Furthermore, it highlights the importance of innovation in accelerating the growth rate of the sector. This includes production and process innovations for current products, as well as innovations in new species and products, underpinned by sound market knowledge.

Impacts of inter-tidal macroalgal mats on benthic communities (1999)
Busing, P.
University of Waikato, New Zealand

Spatial Information: Adjacent to Te Puna boat ramp, Tauranga Harbour, New Zealand.
Keywords: Tauranga Harbour, Te Awanui, benthic communities, inter-tidal macroalgal mats, *Ulva* blooms, sea lettuce, green algae, Te Puna

Summary: Problems associated with algal mats have increased in frequency and intensity over the last 30 years. In recent years, blooms of *Ulva* spp. reached unprecedented levels within Tauranga Harbour. The presence of algal mats has been identified as being responsible forchanges in the benthic macrofaunal communities. The impact of inter-tidal algal mats on benthic macrofauna was studied using two manipulative experiments in conjunction with monitoring natural mat communities. Both full and empty mesh bags were attached to the benthic substrate. The mesh bags and controls were sampled 3,7,14,28 and 42 days after they were developed. Within 7 days large numbers of the amphipod *Polycheria obtusa* were present in the algal mats. After 14 days the herbivorous gastropod *Zeacumantis subcarinatus* and the crab *Hemigrapsus edwardsi* appeared in significantly higher numbers. Mounding of sediment under the 42-day-old empty mesh bags were found

to cause an increase in number of the polychaete, *Perineresis camiquinoides*.Once the mats had been removed from the study site, the areas affected by the mat were resampled in order to monitor the recovery of the sites over time. The sites were resampled 3, 7, 14, 28 and 42 days after the mats had been removed. Due to the spatial scale of the experiment, the recovery from the effects of algal mats was nearly complete after 3 days. Post-settlement processes were responsible for the quick recovery. Only the polychaete*, Perinereis camiquinoides* showed any lasting effects from the experiment, being found 14 days after the 42 day mesh bags were removed.

Possible Impacts of Marine Farming of Mussels (*Perna canaliculus*) on King Shags (*Leucocarbo carunculatus*) (2003)

Butler, D.J.
Department of Conservation New Zealand

Spatial Information: Marlborough Sounds, New Zealand (but applicable to all NZ).
Keywords: king shag, *Leucocarbo carunculatus*, vulnerable species, mussel farms, environmental impacts, sediment deposition, sea currents, mussel, *Perna canaliculus*, marine farms, aquaculture

Summary: The king shag (*Leucocarbo carunculatus*) is an endemic species classed as Vulnerable; its total population of c. 650 individuals is confined to the Marlborough Sounds, New Zealand. Possible effects of mussel farms are of increasing concern, as some licence applications cover the deeper water favoured by the birds. The birds forage within c. 24 km from nest colonies and are deep divers, feeding on fish typically in areas with depths of 20–40 m. Mussel farms could have wide impacts on marine ecology, which may in turn affect king shags. Minor changes in current flows have been recorded, but more significant impacts are on bottom sediments and the water column through deposition of fine sediments (faeces and pseudofaeces) and shell litter in certain currents at a site. Currents and the amount of stratification at a site also determine how large an effect a farm has on the water column, through removal of phytoplankton, inputs of nitrogen, and the creation of habitat for 'fouling' organisms. However, the flow-on effects of changes of sediments and the water column to the wider marine ecology, particularly the fish on which king shags depend, are poorly understood. Modelling research is examining cumulative effects of farms to estimate the carrying capacity of an area. There are risks of transferring unwanted organisms or diseases associated with farms. Proposals are made for monitoring the king shags and their diet and feeding ecology, and determining what impacts, negative or positive, mussel farms have on them.

Benthic communities of the Stella Passage region, Tauranga Harbour, New Zealand (MSc thesis) (1999)

Butler, R. J.
School of Biological Sciences, University of Waikato

Spatial Information: Stella Passage, Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, Stella Passage region, benthic communities, *Nucula hartvigiana*, *Pectinaria australis, Helice crassa, Tawera spissa*, *Paguridae sp*., *Micrelenchus huttoni, Maoricolpus roseus*, *Armandia maculata*, *Ulva sp*., dredging, species composition, species abundance, current velocity

Summary: Benthic communities in the Stella Passage region of Tauranga harbour were investigated from September 1997 to December 1998. The first research aim

was to describe spatial and temporal variation in species composition and abundance. The second aim was to describe the immediate changes in community composition following maintenance dredging of Stella Passage, a major shipping channel within Tauranga Harbour. It was intended that obtained data would provide baseline information regarding variation in benthic community composition against which future ecological investigations may be compared. Four surveys of the benthic communities were conducted in the Stella Passage region, September 1997, January, April and June of 1998. Species composition was spatially variable and four distinct community groups, which correlated with physical characteristics, were identified. *Nucula hartvigiana*, *Pectinaria australis* and *Helice crassa* were associated with fine black silt sediments and low current velocities (< 0.5 ms-1), *Tawera spissa* and *Paguridae sp*., with low stability coarse sand in areas of high current velocity ($>$ 0.5 ms-1). *Paphies australis* and *Micrelenchus huttoni* were characteristic species of areas with substantial amounts of seabed shell material, *Maoricolpus roseus* and *Armandia maculata* of areas with patches of macroalgae (*Ulva sp.*). Temporal community variation occurred at a lesser degree, although areas subjected to frequent natural disturbances exhibited variable community composition.From November 5th to December 4th 1998, a smaller scale survey was performed 2 days before and 2, 11, and 18 days after maintenance dredging. After dredging, community composition was significantly different and the abundance and number of taxa at dredged sites had significantly decreased. The disproportionate dominance of polychaete fauna temporarily declined as did species diversity. Three small robust crustacean taxa were principally responsible for the significant difference between dredged and non-dredged communities. Eighteen days after dredging, most taxonomic groups had reached original levels of abundance while community composition remained distinct from the non-dredged localities.

3.3. C

Aquaculture Reform: Further Proposals and Report on Progress (Minutes of Decision paper #2) (2010)
Cabinet Office New Zealand
Ministry of Fisheries New Zealand

Spatial Information: New Zealand coastal waters
Keywords: aquaculture, 2010 reform, aquaculture management areas (AMAs), resource consent

Summary: These are the minutes of the Cabinet decision on the aquaculture reform (2010) about further proposals and reports on progress. Decisions made are to do with: transition of existing farms; outstanding applications and interim Aquaculture Management Areas (AMAs) under the new law; achieving the reform objectives through regional coastal plans; relevant RMA amendments; amendments to the Aquaculture Legislation Amendment Bill (No. 2), July 2008; notes on report back on planning and consenting and the allocation tools for managing high and/or competing demand; notes on streamlined re-consenting process and default 'restricted discretionary' status.

Guidelines for Water Reuse (2004)
Camp Dresser & McKee Inc. under a Cooperative Research and Development Agreement with the U.S. Environmental Protection Agency
U.S. Agency for International Development

Spatial Information: Overseas: U.S.A
Keywords: wastewater, water reuse, guidelines, USA, management, wastewater treatment technologies

Summary: The 2004 Guidelines for Water Reuse examines opportunities for substituting reclaimed water for potable water supplies where potable water quality is not required. It presents and summarizes recommended water reuse guidelines, along with supporting information, as guidance for the benefit of the water and wastewater utilities and regulatory agencies, particularly in the U.S. The document updates the 1992 Guidelines document by incorporating information on water reuse that has been developed since the 1992 document was issued. This revised edition also expands coverage of water reuse issues and practices in other countries. It includes many new and updated case studies, expanded coverage of indirect potable reuse and industrial reuse issues, new information on treatment and disinfection technologies, emerging chemicals and pathogens of concern, economics,user rates and funding alternatives, public involvement and acceptance (both successes and failures), research activities and results, and sources of further information. It also includes as an updated matrix of state regulations and guidelines, and a list of state contacts. This information should be useful to states in developing water reuse standards, and revising or expanding existing regulations. It should also be useful to planners, consulting engineers and others actively involved in the evaluation, planning, design, operation or maintenance of water reclamation and reuse facilities.

Benthic foraminifera associated with the invasive ascidian, *Didemnum* sp A (2007)
Carman, M. R.
Journal of Experimental Marine Biology and Ecology

Spatial Information: Sample locations include: New England coastline and California, U.S.A; Zeeland, the Netherlands; and Shakespeare Bay, Picton Harbour, New Zealand.
Keywords: invasive species, Ascidian; biodiversity; Detritus; Epibiota; Foraminifera;

Summary: The invasive ascidian, *Didemnum* sp. A, first appeared in New England bays and harbours in the early 1990s, and in the waters around Cape Cod in 1993. While ship traffic was the likely vector introducing the species, its origin and precise date and location of its introduction are presently unknown. On first inspection, colony surfaces of *Didemnum* sp. A appear very clean and unfavourablefor epibiota settlement, but closer inspection revealed the presence of benthic foraminifera. During 2003 and 2004, 52 samples of *Didemnum* sp. A and other ascidians were collected to determine whether or not the foraminiferal assemblages might also be non-native and thus provide a potential clue to the place of origin of *Didemnum* sp. A. Sample locations included the New England coast from Connecticut to Maine (with a concentration in the Cape Cod area), northern California, Zeeland, The Netherlands, and Shakespeare Bay, New Zealand. From New England samples, 18 species of benthic foraminifera were identified. The most common species represented were *Cornuspira involvens, C. planorbis, Elphidium galvestonense, E. margaritaceum, Glabratellina lauriei, Miliolinella subrotunda, Quinqueloculina bicornis*, and *Rosalina floridana*. Foraminiferal assemblages on *Didemnum* sp. A from other regions sampled were composed of the same cosmopolitan species found in New England, plus other species which were indigenous to each region. Because no exotic foraminifera species were found it is concluded that *Didemnum* sp. A likely did not

introduce non-native foraminifera originating from their native habitats into the New England region.

Comparative Analysis of New Zealand and US Approaches for Agricultural Nonpoint Source Pollution Management (2000)
Caruso, B.S.
Environmental Management

Spatial Information: New Zealand and U.S.A
Keywords: agriculture, nonpoint source pollution, water quality management, New Zealand, U.S.A

Summary: The role of the central government in New Zealand is generally limited to research and policy development, and regional councils are responsible for most monitoring and management of the problem. The role of the federal government in the United States includes research and monitoring, policy development and regulation. States also have a significant management role. Both countries rely on voluntary approaches for NPS pollution management. Very few national water quality standards exist in New Zealand, whereas standards are widely used in the United States. Loading estimates and modelling are often used in the United States, but not in New Zealand. A wide range of best management practices (BMPs) are used in the United States, including buffer strips and constructed/engineered wetlands. Buffer strips and riparian management have been emphasized and used widely in New Zealand. Many approaches are common to both countries, but management of the problem has only been partly successful. The primary barriers are the inadequacy of the voluntary approach and the lack of scientific tools that are useful to decision-makers. More work needs to be performed on the evaluation of approaches developed in both countries that could be applied in other countries. In addition, more cooperation and information/technology transfer between the two countries should be encouraged in the future.

Maori, whales and "whaling" an ongoing relationship; in Conservation Advisory Science Notes (no. 308) (2000)
Cawthron,M.W.
Department of Conservation New Zealand

Spatial Information: New Zealand (in general)
Keywords: whales, dolphins, whaling, history, Polynesian navigation, Maori philosophy, Maori history, cetacean

Summary: This report covers Polynesian navigation, Maori respect for whales, the arrival of European whalers, NZ shore whaling stations, the decline of whales, whaling from off-shore islands, and the significance of whaling in NZ .

Immunofluorescent detection of a PSP-producing dinoflagellate, *Alexandrium minutum,* from Bay of Plenty, New Zealand (1999)
Chang, F.H.; Garthwaite,I.; Anderson,D.M.; Towers,N.; Stewart,R.; Mackenzie,L.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Samples taken from Tauranga Harbour and Ohope during the 1993 toxic outbreaks of the dinoflagellate *Alexandrium minutum*Halim, were used to

raise antibodies against for the fluorescence tool. These were then used to measure samples taken from the 3 localities in NZ for this study - Bay of Plenty (article is not more specific than this), Anakoha Bay (Marlborough Sounds), and Crosilles Bay (near Tasman Bay), as well as the Australian sample.
Keywords: phytoplankton, immunofluorescence staining; antibody; toxic dinoflagellate; *Alexandrium minutum*; Bay of Plenty, shellfish poisoning

Summary: This study investigated immunofluorescent detection of a PSP-producing dinoflagellate, *Alexandrium minutum*, from Bay of Plenty, New Zealand. The cross-reactivity of an antibody raised against cell surface antigens of *Alexandrium minutum* Halim, a dinoflagellate isolated from the Bay of Plenty during the 1993 toxic shellfish outbreaks, was tested on other strains of the same species isolated from a variety of locations, as well as a wide range of unrelated phytoplankton using an indirect immunofluorescence staining technique. The antibody showed positive reactions to all four isolates of *A. minutum* from different localities in New Zealand and one from South Australia. The antibody also showed a positive, but weaker, reaction to *A. ostenfeldii* (two isolates) from New Zealand but no reaction with *A. lusitanicum*, a species which is morphologically similar to *A. minutum*. No cross-reactivity was observed with 51 species or strains from 10 different algal classes tested. The antibody bound to cells of *A. minutum* preserved with either 2.5% glutaraldehyde or 3.5% formaldehyde. Recognition of cells in stationary growth phase, including the encysted form, however, was generally weaker than for cells growing exponentially. The cell surface location of the antigen was confirmed using confocal laser scanning microscopy.

Seasonal and spatial variation of phytoplankton assemblages, biomass and cell size from spring to summer across the north-eastern New Zealand continental shelf (2003)
Chang,F.H.; Zeldis, J.; Gall, M.; Hall, J.
Journal of Plankton Research

Spatial Information: Hauraki Gulf and adjacent shelf of north-eastern NZ
Keywords: phytoplankton, Hauraki Gulf, New Zealand, biomass, spatial variation, season, diatom, dinoflagellate, nutrients, bloom

Summary: This article investigated the composition, biomass and cell size of phytoplankton taxonomic groups in the Hauraki Gulf and adjacent shelf of north-eastern New Zealand. On the inner shelf, over-winter mixing and upwelling supported a bloom dominated by large, chain-forming diatoms in a moderately turbulent water column in early spring. The bloom declined in late spring because of nutrient limitation, and the assemblage evolved initially toward small diatoms, and eventually to co-occurrence of dinoflagellates, small nanoflagellates and picophytoplankton in early and late summer. Mid- to outer shelf biomass was much lower than inshore, and was dominated by small or motile taxa which were probably limited by grazing and light. In early summer, strong upwelling displaced inner shelf phytoplankton to beyond the shelf edge, whilst enriching the shelf with nutrients. However, shelf phytoplankton biomass increased only after the relaxation of upwelling. The Hauraki Gulf was strongly stratified from early spring through late summer. The flora were seasonally less variable than on the shelf, with a thecate dinoflagellate-dominated flora in early spring, replaced post-bloom by the co-occurrence of presumably low-nutrient-adapted autotrophic and/or heterotrophic dinoflagellates (most of which were non-thecate, and some toxic), nanoflagellates and picophytoplankton. The succession in floristics was consistent with a change from an autotrophic toward a

heterotrophic ecosystem from spring to summer. Implications for secondary production, and vertical and lateral organic carbon export on the shelf, are discussed.

A triad study of sediment quality associated with a major, relatively untreated marine sewage discharge (1996)
Chapman, Peter M.; Paine, Michael D.; Arthur, Allan D.; Taylor, Laura A.
Marine Pollution Bulletin

Spatial Information: Macaulay Point and Clover Point, Capital Regional District, Victoria, BC, Canada.
Keywords: benthic fauna, sediment chemistry, toxic, benthic community, wastewater, sewage, outfall, environmental effects, sewage treatment management

Summary: Sediment chemistry, toxicity and benthic community structure were used individually and together (i.e. the sediment quality triad) to assess the effects of screened but otherwise untreated sewage from a major city, discharged to the marine environment via an offshore, deep water outfall. Only two chemicals related to the outfall, mercury (probably primarily from hospitals and dental offices) and 1,4-dichlorobenzene (probably primarily from urinal deodorizers) were found in the sediments at concentrations of possible concern, up to 100 m away from the outfall terminus. Sediment toxicity tests indicated that survival was not a major problem, even at the outfall terminus; however, growth and development were reduced up to 100 m away from the outfall terminus. Benthic community structure followed the Pearson-Rosenberg model for organic enrichment, with stations 100 m away from the outfall terminus typical of moderately polluted conditions. Such minimal, highly localized impacts to the receiving environment are not unexpected, since the receiving environment is well flushed and mixed, and the city is not highly industrialized. The results of this study raise questions concerning generic decisions about sewage treatment where site- and situation-specific conditions do not indicate a major problem, and source control is a reasonable option.

Ecosystem Approach to Fisheries: From indicators to theorical simulation; towards a model coupling ecology and economics applied to Finistere (France) (2005)
Chassot, E.; Gascuel, D.
Unknown Publisher

Spatial Information: Overseas – France
Keywords: fisheries, fisheries management, ecosystems, France

Summary: The overfishing of many fish stocks at the global scale associated with the degradation of marine ecosystems have progressively put into relief the limits of current fisheries management. The Ecosystem Approach to Fisheries (EAF), particularly recommended by FAO, calls for modifying the perception of fisheries management in order to include ecosystem considerations. By improving our understanding of population and ecosystem dynamics, and by quantifying the effects of fishing, EAF thus aims to reconcile sustainable exploitation of fisheries resources and conservation. The PhD thesis is part of a European project (PECHDEV QLRT-2000-02277), aiming to define a link between the state of the ecosystem, the dynamics of marine exploited populations, and the economic sectors of the production region. The case study is the department of Finistere (France), characterized by a high degree of dependence on fishing.

Bottom-up control regulates fisheries production at the scale of eco-regions in European seas (2007)
Chassot, E.; Melin, F.; Le Pape, O.; Gascuel, D.
Marine Ecology Progress Series

Spatial Information: Productivity of eco-regions in the northeast Atlantic, Mediterranean, Black and Baltic Seas, vs production in European seas.
Keywords: bottom-up control, fisheries production, primary productivity, ocean-colour remote sensing

Summary: We used primary productivity data derived from remote sensing images and catch data for the period 1998 to 2004 to characterize the productivity of eco-regions in the northeast Atlantic, Mediterranean, Black and Baltic Seas, and then analysed the strength of the trophic linkage between primary productivity and marine fisheries production in European seas. Mean annual primary production (PP) derived from an ocean-colour based model was highly contrasted among eco-regions, exceeding 500 g C m(-2) yr(-1) in the Marmara and North Seas but being less than 150 g C m(-2) yr(-1) in the Faroes, Adriatic-Ionian and Aegean-Levantine Seas. Fisheries production expressed in mean annual yield and primary production required to support catches (PPR) varied greatly among eco-regions, from 0.02 t km(-2) and 0.7 g C m(-2) yr(-1) for the oceanic northeast Atlantic eco-region to 6 t km(-2) and 130 g C m(-2) yr(-1) in the Marmara Sea respectively. Linear regression models showed significant positive relationships between PP and yield as well as between PP and PPR, suggesting a strong linkage between marine productivity and fisheries production in European seas. Moreover, this bottom-up control appeared consistent over time: recent mean annual yield for the period 1998 to 2004 reflected the long-term yield averaged over the last 3 decades. We argue that such large-scale coupling is due to energy transfer along the food web (from phytoplankton to predators) through predation processes, primary productivity driving the production of living marine resources and their exploitation at the scale of eco-regions. Our findings have an important bearing for ecosystem approaches to fisheries, particularly for the estimation of the capacity of eco-regions with regard to sustainable exploitation. This is further relevant in a context of climate change, because variations in PP linked to global warming could strongly modify fisheries production in the future.

Global marine primary production constrains fisheries catches (2010)
Chassot, E.; Bonhommeau,S.; Dulvy,N.; Melin, F.; Watson,R.; Gascuel, D; Pape, O.L.
Ecology Letters

Spatial Information: World-wide
Keywords: foodweb, bottom-up; Large Marine Ecosystem; quantile regression; sustainable fishing

Summary: This study examined constrains of global marine primary production on fisheries catches. It shows that phytoplanktonic primary production, estimated from an ocean-colour satellite (SeaWiFS), is related to global fisheries catches at the scale of Large Marine Ecosystems, while accounting for temperature and ecological factors such as ecosystem size and type, species richness, animal body size, and the degree and nature of fisheries exploitation. The study demonstrates that global fishery catches since 1950 have been increasingly constrained by the amount of primary production. The primary production appropriated by current global fisheries is

17–112% higher than that appropriated by sustainable fisheries. Global primary production appears to be declining, in some part due to climate variability and change, with consequences for the near future fisheries catches.

Cetacean research in New Zealand 2001; in *DOC Internal Science Series 87*(2001)
Childerhouse, S.
Department of Conservation New Zealand

Spatial Information: New Zealand wide
Keywords: dolphins, whales, cetacean, New Zealand, research

Summary: This report summarises cetacean (i.e. whales and dolphins) research undertaken in New Zealand over the period April 2001 to March 2002 with statistical information for the 2001 calendar year. It covers cetacean research by a wide range of researchers including Government, University and non-governmental agencies and individuals. Information is presented on species studied, strandings, research projects undertake, samples collected and references to the publications resulting from research. Data of 18 species, from 8 different institutions/agencies and 47 researchers are included. Although the report is comprehensive for work reported to Government in 2001, it does not include all cetacean research currently carried out in New Zealand.

***Megaptera novaeangliae* (*Oceania subpopulation*).List of Threatened Species.Version 2011.1. (2008)**
Childerhouse, S.; Jackson, J.; Bakers, C.S.; Gales, N. Clapham, P.J. Brownell Jr, R.L.
International Union for Conservation and Nature (IUCN)

Spatial Information: World-wide
Keywords: whales, *Megaptera novaeangliae* (Oceania subpopulation), humpback whale*, endangered species, paikea

Summary: The IUCN Red List of Threatened Species™ is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species.

Monitoring changes in wetland extent: an environmental performance indicator for wetlands Final report - project phase one (1999)
Clarkson, B. D.; Clarkson, B. R.; Denyer, K.; Gerbeaux, P.; Harmsworth, G.; Johnson, P.N.; Partridge, T.R.; Richmond, C.; Smith, S.; Wilde, R.H.
Lincoln Environmental, Lincoln University

Spatial Information: New Zealand wide
Keywords: wetlands, New Zealand, environmental performance indicators, monitor*, map*, wetland type*

Summary: This report documents Phase One of the Coordinated Monitoring of New Zealand Wetlands (SMF) project, which is aimed at developing a nationally consistent methodology for mapping and monitoring New Zealand's wetlands.

Handbook for monitoring wetland condition (2003)
Clarkson, B. R.; Sorrell, B. K.; Reeves, P. N.; Chapman, P. D.; Patridge, T. R.; Clarkson, B. D.
Landcare Research

Spatial Information: Not spatially specific – target of all wetlands in NZ
Keywords: wetlands, New Zealand, environmental performance indicators, monitor*, wetland type*

Summary: To assist with New Zealand's obligations as a signatory to two international conventions - the Convention on Biological Diversity, and the Ramsar Convention on Wetlands - this handbook describes a set of science-based indicators that have been developed to monitor the condition of New Zealand estuarine and palustrine wetlands. It has been designed for managers, landowners, community groups and anyone else with a need to monitor the condition of wetlands.

A Spatial Analysis of Indigenous Cover patterns and Implications for Ecological Restoration in Urban Centres, NZ (2007)
Clarkson, B.D. ; Wehi, P.M. ; Brabyn, L.K.
Urban Ecosystems

Spatial Information: The 20 largest cities in NZ were studied - so this includes both Tauranga and Palmerston North.
Keywords: biodiversity, urban, periurban, restoration, New Zealand, Tauranga

Summary: High levels of endemism, the sensitivity of species that have evolved without humans, and the invasion of exotic species have all contributed to severe depletion of indigenous biodiversity in New Zealand. We considered the contribution that urban restoration can make to maximising biodiversity by analysing land cover patterns from two national databases along an urban–rural gradient. Thirteen of 20 land environments in New Zealand are represented in cities, and nearly three-quarters of all acutely threatened land environments are represented within 20 km of city cores nationally. Despite this, remaining indigenous land cover is low within urban cores, with less than 2% on average, but increasing to more than 10% on average in the periurban zone. Threatened lowland environments are most commonly represented within cities, and least represented within protected natural areas. Restoration of existing urban habitat is insufficient to halt biodiversity loss. Ecosystem reconstruction is required to achieve a target of 10% indigenous cover within cities. A co-ordinated national urban biodiversity plan to address issues beyond a local and regional focus is needed. Analysis of national patterns of urban land environments, indigenous cover and remnant ecosystems will support action at a regional and local level while enhancing national and global biodiversity goals.

Marine Mammals within Gisborne District Coastal Waters (2010)
Clement, D
Cawthron Institute

Spatial Information: Gisborne District Council coastal waters
Keywords: dolphins, whales, porpoises, cetaceans, pinnipeds, seals, sea lions, Gisborne, Regional Coastal Environmental Plan, marine mammals, species sighting

maps, habitat, migration routes, aihe, patu paraoa, upokohue, tuupoupou, oioi, kekeno, rāpoka

Summary: The Gisborne District Council (GDC) is in the process of reviewing provisions regarding natural heritage for their Regional Coastal Environment Plan, one of which is to identify the presence of any valuable indigenous marine mammal populations. GDC contracted Cawthron Institute to collate and review all available records of marine mammal species that might reside or migrate along the North Island's central and southern coastal waters, specifically focusing on GDC's territorial waters. These records were used to create species sighting maps and identify any potentially important habitat regions and/or migration routes.

The relative importance of light and nutrient limitation of phytoplankton growth: a simple index of coastal ecosystem sensitivity to nutrient enrichment (1999)
Cloern, J.E.
Aquatic Ecology

Spatial Information: Overseas - case study sites include 3 Californian estuaries and 2 Dutch estuaries.
Keywords: phytoplankton, estuaries, eutrophication, resource management, nutrients, ecosystem processes, coastal zone, light energy

Summary: Anthropogenic nutrient enrichment of the coastal zone is now a well-established fact. However, there is still uncertainty about the mechanisms through which nutrient enrichment can disrupt biological communities and ecosystem processes in the coastal zone. For example, while some estuaries exhibit classic symptoms of acute eutrophication, including enhanced production of algal biomass, other nutrient-rich estuaries maintain low algal biomass and primary production. This implies that large differences exist among coastal ecosystems in the rates and patterns of nutrient assimilation and cycling. Part of this variability comes from differences among ecosystems in the other resource that can limit algal growth and production – the light energy required for photosynthesis. Complete understanding of the eutrophication process requires consideration of the interacting effects of light and nutrients, including the role of light availability as a regulator of the expression of eutrophication. A simple index of the relative strength of light and nutrient limitation of algal growth can be derived from models that describe growth rate as a function of these resources. This index can then be used as one diagnostic to classify the sensitivity of coastal ecosystems to the harmful effects of eutrophication.

Ecosystem services: Thinking about nature's benefits - Presentation for the Land Use Futures Board (2009)
Clothier, B.; Mackay, A.
Plant & Food Research; AgriSearch

Spatial Information: Not spatially specific
Keywords: ecosystem services, New Zealand, soil, land use management, ecosystem management

Summary: This is a power point presentation explaining and describing the importance of using ecosystem services in sustainable land management practises, and taking it a step further to use ecosystem services data as measurables in

environmental policy. It also gives a glimpse on how other countries around the world are starting to do this. The emphasis of this power point is the significance of soil - for example, all of the 17 ecosystem services listed in Costanza et al 1997 involve soil. Many research papers are referred to, including P.Hawken et al 1999 (Natural Capitalism), Costanza et al 1997 (17 ecosystem services across 16 biomes), the Millennium Ecosystem Assessment 2005, and more.

Results and conclusions of the project "Ecosystem approaches for fisheries management in the Benguela Current large marine ecosystem" (2007)
Cochrane, K. L.; Augustyn, C. J.; Bianchi, G.; de Barros, P.; Fairweather, T.; Iitembu, J.; Japp, D.; Kanandjembo, A.; Kilongo, K.,; Moroff, N.; Nel, D.; Roux, J. P.; Shannon, L. J.; van Zyl, B. ; Vaz Velho, F.
Food and Agriculture Organization of the United Nations

Spatial Information: Overseas - Benguela Current Large Marine Ecosystem which extends from east of Port Elizabeth, South Africa, to Angola's Cabinda province in the north.
Keywords: marine ecosystem management, Benguela Current Region, aquatic resources, Benguela Current Region management, sustainable fisheries, sustainable aquaculture, fishery management

Summary: This report provides the final results and conclusions of the Benguela Current Large Marine Ecosystem (BCLME) project LMR/EAF/03/01 “Ecosystem approaches for fisheries management in the BCLME”. The project set out to examine the feasibility of implementing an ecosystem approach to fisheries (EAF) in the Benguela Current Large Marine Ecosystem which extends from east of Port Elizabeth, South Africa, to Angola's Cabinda province in the north. The project, a cooperative effort by BCLME, the management agencies of the three countries and FAO, started in January 2004 and ended in December 2006. The main objective of the project has been to investigate the feasibility of EAF management in the BCLME region through examining the existing issues, problems and needs related to EAF, and considering different management options to achieve sustainable management of the resources at an ecosystem level. The approach followed was to focus on ten of the major fisheries in the three countries. The project used a structured and participatory approach, attempting to engage the range of stakeholders in the countries, in order to identify and prioritize the gaps in the existing, largely conventional, approaches to fisheries management and to describe potential management actions necessary to address those gaps. In a similarly participatory approach, preliminary estimates of the costs and benefits (positive and negative impacts) of those actions specifically related to implementation of EAF have been made. The costs and benefits were evaluated for each of the broad objectives identified for each fishery. The detailed results, including potential management actions and their costs and benefits, are still preliminary but the issues and the broad management needs and possible actions that have been identified are highly informative. The process that has been developed provides a valuable framework for future refinement and implementation of EAF. The project also considered the applicability of a number of tools and activities that would be important for effective progress in implementation of EAF, in particular methods for improved decision making, incentives to encourage implementation, institutional requirements and research needs.

Wairoa River and coastal environment issues and options paper: prepared for Ngati Kahu resource development and management (1995)
Coffin, A
Bay of Plenty Polytechnic

Spatial Information: Wairoa River, Tauranga, Bay of Plenty, New Zealand
Keywords: estuaries, New Zealand, Wairoa River, Bay of Plenty, coastal environmental management, natural resources, conservation

Summary: This document sets out the issues and options for Ngāti Kahu hapū with regard to environmental management in the coastal river environment. Whilst the focus of the plan is the Wairoa River, there are specific references to freshwater quality and quantity and artesian waters. Strategies are included in the document that provides methods of implementation. These include preparation of hapū policy statements, access to monitoring information, assessment of effects of flow changes to river, no cost to hapū extracting artesian water, prohibiting commercial and inappropriate activities and improved access to water.

Distributional relationships among subtidal algae, sea urchins and reef fish innorth-eastern New Zealand (PhD thesis) (1993)
Cole, R.G.
School of Biological Sciences, University of Auckland

Spatial Information: Elsewhere in NZ: Main study site: The Cape Rodney to Okakari Point Marine Reserve, north-easternNew Zealand.
Keywords: plants, macroalgal assemblages, sea urchin*, brown macroalgae, *Carpophyllum flexuosum, Ecklonia radiata, E. chloroticus*, Okakari Point Marine Reserve, Leigh Marine Reserve, Cape Rodney, Hauraki Gulf, New Zealand, reef fish

Summary: Interactions among large brown macroalgae, sea urchins, and fish were investigated in north-eastern New Zealand during the period 1988 - 1993. The Cape Rodney to Okakari Point Marine Reserve was the site of many of these investigations. The patterns of abundance of large brown macroalgae and urchins down depth gradients over a wide geographic range were compared with those reported from earlier studies, and 3 major trends were identified. First, the fucoid alga *Carpophyllum flexuosum* now occurs at many sites which are exposed to wave action, in contrast to earlier studies. This alga occurred most abundantly on urchin-grazed coralline flat areas. Second, at four sites in the Marine Reserve, the densities of the echinometrid urchin *Evechinus chloroticus* decreased with increasing depth, rather than reaching maximal densities at mid-depths, as had previously been described. Finally, at sites of decreased exposure to wave action, the coralline flats habitat did not occur at all, and dense stands of. *C. flexuosum* occurred, in conjunction with the ubiquitous laminarian alga, *Ecklonia radiata*.

Port of Tauranga biological monitoring report 93/2. Results of the baseline and first post-dredging surveys of the biological monitoring programme (1993)
Cole, R. G.; Foster, D.; Grace, R.
Publisher unknown

Spatial Information: Tauranga Harbour sediment designated dump ground(reef of Rabbit Is), North Island, New Zealand

Keywords: Port of Tauranga, biological monitoring, baseline survey, dredging, impact, Tauranga Harbour, Te Awanui, Amphipoda, Bivalvia, Brachyura, Gastropoda

Summary: This report presents data concerning the diversity and densities of four major groups of organisms: *Amphipoda*, *Bivalvia*, *Brachyura* (crabs), and *Gastropoda*. These comprise a major portion of the total fauna identified. Data for other taxa will be presented in a subsequent report.

Port of Tauranga dredge spoil disposal monitoring programme (1994, 1995)
Cole, R. G.; Foster, D. M.; Grace, R.
Publisher unknown

Spatial Information: Tauranga Harbour sediment designated dump ground(reef of Rabbit Is), North Island, New Zealand
Keywords: Port of Tauranga, biological monitoring, baseline survey, dredging, impact, Tauranga Harbour, Te Awanui, Amphipoda, Bivalvia, Brachyura, Gastropoda

Summary: Two reports (1994 and 1995) present the final results from an extensive benthic ecology monitoring programme relating to capital dredging and spoil dumping undertaken by Port of Tauranga Limited in 1992. Dredging was from the shipping channels and material was dumped on the inner shelf in 22-28 m water depth during January - June 1992.

Assemblage structure, spatial patterns, recruitment, and post-settlement mortality of subtidal bivalve molluscs in a large harbour in north-eastern New Zealand (2000)
Cole, R.G.; Hull, P.J.; Healy, T.R.
New Zealand Journal of Marine and Fresh water Research

Spatial Information: Flood tidal delta, Tauranga Harbour, NZ
Keywords: shellfish, clams, infauna, population dynamics, species autocorrelation analysis, Tauranga Harbour, Te Awanui, *Paphies australis*, *Tawera spissa*, *Ruditapes largillierti*

Summary: Based on a 6-month period survey, this study evaluated the infaunal bivalve molluscs on the flood tidal delta of Tauranga Harbour, North-eastern New Zealand. The objective of the study was to understand the shellfish resources, to assess the magnitudes of temporal and spatial variability in abundances, and to identify potentially important processes. A total of 31 bivalve taxa were identified from 27 sites surveyed. The study found that the species richness per site varied significantly with time and space, ranging from 0 to 9. Density of several abundant species also varied greatly in time. The study also found that the abundances of the three species that dominated the fauna (*Paphies australis*, *Tawera spissa*, and *Ruditapes largillierti*) had characteristic spatial scales on the order of 200 m. Comparisons of size frequency distributions for individual sites suggested that mortality or emigration in the first year of benthic life was high. Substantial populations of bivalves occur on Centre Bank, and the most abundant of these are greatly influenced by events early in their lives.

Water Quality Indicators and the Risk of Illness at Beaches with Nonpoint Sources of Faecal Contamination (2007)
Colford, J.M.; Wade, T.J.; Schiff, K.C.; Wright, C.C.; Griffith, J.F.; Sandhu, S.K.; Burns, S.; Sobsey, M.; Lovelance, G.; Weisberg, S.B.
Epidemiology

Spatial Information: Mission Bay, California, USA.
Keywords: water quality, indicator bacteria, non point pollution, faecal contamination, health risk

Summary: Background: Indicator bacteria are a good predictor of illness at marine beaches that have point sources of pollution with human faecal content. Few studies have addressed the utility of indicator bacteria where nonpoint sources are the dominant faecal input. Extrapolating current water-quality thresholds to such locations is uncertain.Methods: In a cohort of 8797 beachgoers at Mission Bay, California, we measured baseline health at the time of exposure and 2 weeks later. Water samples were analysed for bacterial indicators (enterococcus, faecal coliforms, total coliforms) using both traditional and non-traditional methods, i.e., chromogenic substrate or quantitative polymerase chain reaction. A novel bacterial indicator (Bacteroides) and viruses (coliphage, adenovirus, norovirus) were also measured. Associations of 14 health outcomes with both water exposure and water quality indicators were assessed.

Best management practices to mitigate faecal contamination by livestock of New Zealand waters (2007)
Collins, R.; McLeod, M.; Donnison, A.; Close, M.; Hanly, J.; Horne, D.; Ross, C.; Davies-Colley, R.; Bagshaw, C.; Matthews, L.
New Zealand Journal of Agricultural Research

Spatial Information: New Zealand wide
Keywords: agriculture, best management practices, faecal contamination, mitigation, New Zealand

Summary: This paper summarises findings from the Pathogen Transmission Routes Research Programme, describing pathogen pathways from farm animals to water bodies and measures that can reduce or prevent this transfer. Significant faecal contamination arises through the deposition of faeces by grazing animals directly into waterways in New Zealand. Bridging of streams intersected by farm raceways is an appropriate mitigation measure to prevent direct deposition during herd crossings, whilst fencing stream banks will prevent access from pasture into waterways by cattle that are characteristically attracted to water. Riparian buffer strips not only prevent cattle access to waterways, they also entrap microbes from cattle and other animals being washed down-slope towards the stream in surface runoff. Microbial water quality improvements can be realised by fencing stock from ephemeral streams, wetlands, seeps, and riparian paddocks that are prone to saturation. Soil type is a key factor in the transfer of faecal microbes to waterways. The avoidance of, or a reduction in, grazing and irrigation upon poorly drained soils characterised by high bypass flow and/or the generation of surface runoff, are expected to improve microbial water quality. Dairy shed wastewater should be irrigated onto land only when the water storage capacity of the soil will not be exceeded. This “deferred irrigation” can markedly reduce pollutant transfer to waterways, particularly via subsurface drains and groundwater. Advanced pond systems provide excellent effluent quality and have particular application where soil type and/or climate are

unfavourable for irrigation. Research needs are indicated to reduce faecal contamination of waters by livestock.

New Zealand wetlands management policy (1986)
Commission for the Environment
Department of Conservation New Zealand

Spatial Information: New Zealand wide
Keywords: wetlands, New Zealand, conservation, preservation, definition, wetland management

Summary: This policy is designed to 'show the way', rather than to specify particular actions. It starts by defining a wetland in the context of this policy, followed by a brief history of wetlands and their modification in New Zealand. It then goes on to state that wetland management must consider causes and consequences beyond the wetland boundary. Government must act as an advocate for wetland preservation, and play its role in wetland management by promoting research and fostering awareness of wetland values, as well as acknowledge its responsibility to future generations to preserve possible future benefits that may not be recognised at the present moment. Accordingly, this statement sets out Government policy as a guide to all agencies and individuals who manage and make decisions in relation to the use of wetlands throughout New Zealand. The provisions of this policy are to be reflected in local, regional and national policies and legislation that relate to wetlands and their management.

Integrating ecology with biogeography using landscape characteristics: a case study of subtidal habitat across continental Australia (2008)
Connell, S. D.; Irving, A. D.
Journal of Biogeography

Spatial Information: Overseas - The subtidal rocky coast of continental Australia, with longitudinal comparisons spanning > 4000 km of southern coast (115 degrees 03' E-153 degrees 60' E) between latitudes of 33 degrees 05' S and 35 degrees 36' S, and latitudinal comparisons across 26 degrees 40' S to 37 degrees 08' S of eastern Australia.
Keywords: plants, macroalgae, biogeography; habitat (ecology); landscapes; macroecology; ecology; Australia

Summary: This report aims to redress a current limitation of local ecological studies (i.e. piecemeal information on specific taxa) by integrating existing ecological knowledge with quantifiable patterns in primary habitat (i.e. composition, distribution and cover) from local to continental scales. By achieving this aim, we sought to provide a bio-geographical framework for the interpretation of variation in the ecology of, and threats to, subtidal rocky landscapes.
Location: The subtidal rocky coast of continental Australia, with longitudinal comparisons spanning > 4000 km of southern coast (115 degrees 03' E-153 degrees 60' E) between latitudes of 33 degrees 05' S and 35 degrees 36' S, and latitudinal comparisons across 26 degrees 40' S to 37 degrees 08' S of eastern Australia.
Methods: The frequency and size of patches of major benthic habitat were quantified to indicate contemporary function (ecology) and to establish patterns that may result from contrasting regional-scale processes (biogeography). This was achieved by quantifying the composition and patchiness of key subtidal habitats across the

continent and relating them to the known ecology of subsets of locations in each region. A nested design of several spatial scales (1000s, 100s, 10-1 km) was adopted to distinguish patterns at local through to bio-geographical scales.

The direct effects of increasing CO2 and temperature on non-calcifying organisms: increasing the potential for phase shifts in kelp forests (2010)
Connell, S. D.; Russell, B. D.
Proceedings of the Royal Society B - Biological Sciences

Spatial Information: Overseas: Fleurieu Peninsula, South Australia; Victor Harbour, South Australia (35.571268 S,138.612218 E) at 2–4 m depth.
Keywords: climate change, plants, macroalgae, carbon dioxide, habitat resilience, phase shift, turf-forming algae, Australia

Summary: Predictions about the ecological consequences of oceanic uptake of CO2 have been preoccupied with the effects of ocean acidification on calcifying organisms, particularly those critical to the formation of habitats (e.g. coral reefs) or their maintenance (e.g. grazing echinoderms). This focus overlooks the direct effects of CO2 on non-calcareous taxa, particularly those that play critical roles in ecosystem shifts. We used two experiments to investigate whether increased CO2 could exacerbate kelp loss by facilitating non-calcareous algae that, we hypothesized, (i) inhibit the recovery of kelp forests on an urbanized coast, and (ii) form more extensive covers and greater biomass under moderate future CO2 and associated temperature increases. Our experimental removal of turfs from a phase-shifted system (i.e. kelp- to turf-dominated) revealed that the number of kelp recruits increased, thereby indicating that turfs can inhibit kelp recruitment. Future CO2 and temperature interacted synergistically to have a positive effect on the abundance of algal turfs, whereby they had twice the biomass and occupied over four times more available space than under current conditions. We suggest that the current preoccupation with the negative effects of ocean acidification on marine calcifiers overlooks potentially profound effects of increasing CO2 and temperature on non-calcifying organisms.

Monitoring the commercial swim-with-dolphin operations in the Bay of Islands (1997)
Constantine, R.; Baker, C.S.
Department of Conservation, New Zealand

Spatial Information: Elsewhere in NZ : Bay of Islands, New Zealand
Keywords: dolphins, tourism, New Zealand, Bay of Islands, bottlenose dolphin, *Tursiops truncatus*, common dolphin, *Delphinus delphis*, swim with dolphins, aihe

Summary: Bottlenose (*Tursiops truncatus*) and common dolphins (*Delphinus delphis*) were observed and photographed during their encounters with swim-with-dolphin operations in the Bay of Islands from March, 1994 to March, 1995. From observation of 156 commercial trips, lasting an average of 3.1 hours, there was an 86% success rate in encountering one or both species of dolphins. Bottlenose dolphins changed their behaviour on 32% of approaches by the operator's boat, and common dolphins changed their behaviour on 52% of approaches. Of all groups of dolphins encountered, 37% were exposed to at least one swim attempt. A total of 163 swim attempts were observed, including multiple attempts with the same pod. Bottlenose dolphins had a sustained interaction with swimmers on 25% (n = 33) of encounters

involving swims, and common dolphins had a sustained interaction on 21% (n = 6). The remaining swims resulted in neutral or avoidance behaviour. Dolphin responses to swimmers were dependent to some degree on swimmer placement, with in-line placement eliciting the highest risk of avoidance. A total of 265 bottlenose dolphins were individually identified by photographs of nicks and scars on their dorsal fins. The majority (76%) were re-sighted on more than one occasion, but the Bay of Islands does not seem to be the exclusive home range of any individuals. Future research should attempt to determine the dolphins' home range, habitat use, and the impact of changes in their environment. In the long-term, it is possible that dolphins will become familiar with the boats and swimmers and increase their approaches or, conversely, develop a cumulative aversion towards them.

Effects of tourism on marine mammals in New Zealand (1999)
Constantine, R.
Department of Conservation, New Zealand

Spatial Information: New Zealand wide
Keywords: dolphins, whales, marine mammals, tourism, New Zealand, sea lions, toothed cetaceans, pinnipeds, seals,

Summary: There has been a rapid growth in marine mammal based tourism around the world, because marine mammals have a wide appeal for many people and are readily found around many coastal areas and are therefore readily accessible.
Marine mammal based tourism in New Zealand is a wide-ranging, species-diverse industry with an increasing demand for permits from land, boat and air-based platforms. A total of 74 permits at 26 sites have been issued from Maunganui to Stewart Island. The region with the most concentrated effort is Kaikoura. Past and current research projects in New Zealand evaluating the effects of tourism on marine mammals are reviewed. The only current ones deal with the New Zealand sea lions of the Catlins, and Northland's bottlenose dolphin population. In New Zealand, toothed cetaceans and pinnipeds form the basis of the marine mammal based tourism industry. We are one of few countries which permit swimming with dolphins and seals.

Effects of tourism on behavioural ecology of bottlenose dolphins of north-eastern New Zealand (2003)
Constantine, R.; Brunton, D.H.; Baker, S.C.
Department of Conservation New Zealand

Spatial Information: Elsewhere in NZ: Bay of Islands, Northland, New Zealand
Keywords: dolphins, Human-dolphin interaction, bottlenose dolphins, *Tursiops truncatus*, tourism, Bay of Islands, human impact, boat impacts, swim-with-dolphins, habitat use, New Zealand.

Summary: This is a study of the tourism effects on the behaviour of bottlenose dolphin in the Bay of Islands. Through field observation by following on dolphin focal groups using independent research boat during the period of 1996 to 2000, the study found that permitted dolphin-watching boats have the most effect on the behaviour of dolphin in the region. More specifically, resting behaviour decreased and milling behaviour increased when the permitted boats were present. Though threshold on the number of permits cannot be recommended, the study suggested that, to minimise the effects of the permitted boats on dolphin, no further permits should be

issued. A likely wide home range was also suggested based on individuals that were photographed between Doubtless Bay in the north and Tauranga in the south.

Photo-identification of humpback whales (*Megaptera novaeangliae*) in New Zealand waters and their migratory connections to breeding grounds of Oceania (2007)
Constantine, R; Russell,K.; Gibbs,N.; Childerhouse, S.; Baker, C.S
Marine Mammal Science

Spatial Information: Elsewhere is NZ: Tory Channel entrance to Cook Strait; Bay of Islands; Kaikoura; Hauraki Gulf (all NZ). Also in other pacific nations.
Keywords: whales, humpback whales, *Megaptera novaeangliae*, New Zealand, migration, sightings

Summary: Humpback whales pass along the coast of New Zealand as they migrate between summer feeding grounds in Antarctic waters and winter breeding grounds in the tropical waters of the South Pacific. the Oceania (South Pacific) region (Garrigue et al. 2000). Humpback whales in New Zealand waters were individually identified from photographs of marks and coloration on the ventral surface of the fluke (Katona et al. 1979). Data was collected opportunistically from 1994 to 2004 and during a dedicated survey in the Tory Channel entrance to Cook Strait in June 2004 (Gibbs and Childerhouse 2004). During these dedicated surveys boat-based researchers were (when weather conditions permitted) directed by land-based observers to whales for the purposes of photographing the whales and collecting tissue samples. All good quality photographs have been compiled in a catalogue of New Zealand humpback whale flukes and matched by at least three independent observers for any resightings within or between years. A total of thirty-four whales have been photographed in New Zealand waters on fifteen independent occasions over the eleven years of data collection. The majority of whales (20 individuals) were photo-identified during the 2004 dedicated survey in Cook Strait (Gibbs and Childerhouse 2004). Of the thirty-four whales, four have been resighted: two individuals in New Caledonia (Garrigue et al. 2000), one individual in New Zealand, and one in Vava'u, Tonga.

Te Awa O Waitao Stream Restoration Project Annual Report 1st July 2007 to 30th June 2008 (2008)
Cooper; H.; Quinn, J. M.; Morrison, D.
Te Awa O Waitao Stream Restoration Project Steering Group

Spatial Information: Welcome Bay, Tauranga
Keywords: Te Awa O Waitao Stream Restoration Project

Summary: Te Awa O Waitao Stream Restoration Project is happening in Welcome Bay and is a FRST-funded joint NIWA, Tangata Whenua and NZ Landcare Trust project. The aim is to restore the locally significant Waitao Stream and wider catchment by using a combination of western science and traditional Māori knowledge.The project spans the entire Waitao from the Otawa Ranges to the mouth of the River (te Kopu a Parera) and was initiated by Nga Papaka O Rangataua. The project is managed by a Joint Steering Group made up of Hinenui Cooper (Nga Papaka O Rangataua, John Quinn (NIWA) and Robyn Skelton (NZ Landcare Trust). The project Kaitiaki is Tom Cooper.This is the third formal annual report for the project. It summaries activity of the period 1 July 2007 to 30 June 2008.

The value of the world's ecosystem services and natural capital (1997)
Costanza, R.; d'Arge, R.; de Groots, R.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem. S.; O'Neill, R. V.; Paruelo, J.; Raskins, R. G.; Sutton, P.; van den Belt, M.
Nature

Spatial Information: Not spatially specific
Keywords: biotic communities; environmental economics

Summary: Estimates values for ecosystem services for ecologists, economists, policy makers and the general public. A comparison between the estimated rate of change of value and changes in ecosystem services; Ecosystem functions; Natural capital; Valuation methods; Ecosystem values, markets, and gross national product; Global land use; Methodology.

Accidents and interruptions in the cycle of marine erosion (1951)
Cotton, C. A.
Geographical Journal

Spatial Information: New Zealand wide
Keywords: sedimentation, coastal processes, New Zealand, progradation, longshore drift, retrogradation, Flandrian transgression

Summary: Discusses coastal processes common to New Zealand coastlines for example progradation, longshore drift, retrogradation, Flandrian transgression, and interruptions to these processes. Areas specifically discussed include Breaker Bay, near Wellington; North Auckland peninsula (Waitakere Ranges right up to the Hokianga Harbour); Bay of Plenty coastline (Tauranga Harbour to Opotiki).

Development and application of tools for incursion response: Lessons learned from the management of the fouling pest *Didemnum vexillum*(2007)
Coutts, A. D. M.; Forrest, B. M.
Journal of Experimental Marine Biology and Ecology

Spatial Information: New Zealand wide
Keywords: invasive species, anthropogenic spread, *Didemnum vexillum,* incursion response, marine bio-invasion, New Zealand, pest management, slow-moving vessels, Tauranga Harbour, Te Awanui

Summary:*Didemnum vexillum* is type of sea squirt. Sea squirts have a mobile larval life stage but then adhere to hard surface where they spend the adult stage of their lifespan. They are a marine invertebrate which pump seawater through their bodies, hence the name 'squirt.' When this species was identified in New Zealand for the first time in 2001, there was confusion as to whether this was a native or invasive species (Coutts & Forrest, 2007). It is "crypotogenic spp." or origins unknown. It has been established that the barge vessel the Steel Mariner was most likely a vector for the introduction and spread of this sea squirt around New Zealand (Coutts & Forrest, 2007). The Steel Mariner was in the Tauranga Harbour in May 1992 and late June 2000 (Coutts & Forrest, 2007). The sea squirt is invasive, has the potential to out compete other species and the potential to smother mussels. The confusion surrounding its origins slowed efforts to control this species in the Picton Harbour

(Coutts & Forrest, 2001). This sea squirt is established in the Tauranga Harbour (BOPRC, n.d.). This paper provides a chronology of events surrounding the initial detection and spread of the ascidian, and describes the development of incursion response tools for the different substrata that were infected. The treatments included smothering soft-sediment habitats with uncontaminated dredge spoil, wrapping wharf piles with plastic, smothering rip-rap habitats using a geotextile fabric, and various other approaches based on water blasting, air drying or chlorine dosing. While many of the response methods were completely effective at eliminating *D. vexillum* from different substrata, the programme overall failed to eradicate the organism from the region. The reasons for this failure are documented, and the important lessons learned are highlighted, as a contribution to the successful management of invasive species in the future.

Maori and Science: three case studies (2002)
Cram, F.
Auckland UniServices Limited, University of Auckland

Spatial Information: Case study areas: Ngati Kere Rohe (coast of central Hawkes Bay); various planting sites of pa harakeke throughout NZ; Otaraua Hapu Rohe (Taranaki).
Keywords: matauranga Maori, Kaupapa Maori,Tangata Whenua and the Scientific Community interactions, case study*, collaboration guidelines

Summary: In March of 2002 Dr Fiona Cram, IRI, was approached by the Royal Society of New Zealand about a small piece of research that they wanted to commission about Maori views of science and technology. The result was Dr Cram's proposal to the Royal Society that the research focus on three case studies of Maori communities/groups who had had reasonably positive interactions with scientists. The findings of the present research should go some way toward facilitating better interactions between Tangata Whenua and the Scientific Community. Three case studies were therefore conducted with three Maori groups that have problem-solved an issue by the engagement with science/technology and matauranga Maori (indigenous knowledge). From this research Good Practice Guidelines were developed.

Ecology and environmental impact of *Musculista senhousia* (Mollusca: Bivalvia: Mytilidae) in Tamaki Estuary, Auckland, New Zealand (1997)
Creese, R.; Hooker, S.; de Luca, S.; Wharton, Y.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Elsewhere in NZ: Tamaki Estuary, Auckland, New Zealand
Keywords: invasive species, Asian date mussel, *Musculista senhousia*, environmental impact, ecology, distribution, New Zealand

Summary: The introduced, mytilid bivalve *Musculista senhousia* (Asian date mussel) occurs on the east coast of New Zealand and Auckland region. Eighteen sites were searched within the Tamaki Estuary: six had extensive mats of mussels and three contained small, isolated clumps. Core samples were taken monthly during 1994/95 from two of the mat-forming populations. Densities reached 16 000 m^{-2} at Bucklands Beach and 5000 m^{-2} at Farm Cove. Both populations were dominated by a single cohort of mussels. Mussels grew to about 20 mm in 12 months, after which growth virtually ceased. Recruitment was sporadic into existing mats, but occurred adjacent

to the monitored mat at Bucklands Beach in April 1995. The area occupied by the initial mussel bed at this site decreased by 60% over 1 year. Further core sampling revealed significantly fewer macrofaunal invertebrates under mussel mats compared to control samples taken from areas of beach without mussels. Infaunal bivalves were most adversely affected by *M. senhousia*, showing an 8-fold decrease in abundance within mats compared to cores in the control area. Our results reveal that *M. senhousia* in the Auckland area has similar life history features to those reported from populations outside New Zealand. We suggest that any adverse environmental effects caused by *M. senhousia* are likely to be local and short-lived.

Mangroves in New Zealand: trees in the tide (1990)
Crisp, P.; Daniel, L.; Tortell, P.
GP Books

Spatial Information: New Zealand estuaries, coastlines – Whakatane northwards
Keywords: mangrove ecology, mangrove swamps, Manawa, *Avicennia marina*, New Zealand

Summary: This bookinforms in a simple and easy understanding way generally about mangroves, about mangroves in New Zealand, about their distribution and values as well as about protecting mangroves and how mangroves influence the food chain. Contains many illustrations and pictures.

Mangrove Review (2007)
Croad, B.
Catalyst Management Services Ltd

Spatial Information: Tauranga Harbour, New Zealand
Keywords: plants, mangroves, New Zealand, *Avicennia marina*, Manawa, Tauranga Harbour, Te Awanui, estuary, estuary care group, Environment Bay of Plenty

Summary: The purpose of this report is to provide the findings of the mangrove review report and advice on implementation of the recommendations so as to improve relationships with the Tauranga Estuary Care Groups.

A directory of wetlands in New Zealand (1995)
Cromarty, P.; Scott, D. A. (eds)
Department of Conservation New Zealand

Spatial Information: New Zealand wide. Includes geographical co-ordinates and general location of all wetland sites.
Keywords: wetlands, New Zealand, directory

Summary: The Directory describes 73 wetlands and wetland complexes that meet the criteria for international importance (it is not a comprehensive listing of ALL wetlands in New Zealand). The wetlands have been selected on the basis of criteria developed in relation to the Ramsar Convention. Although special attention is paid to the importance of the wetlands for wildlife, all wetland values including water storage, flood control, coastal protection and fisheries production have been taken into consideration.

Macrobenthic communities of the Matakana Banks and Inner Shelf (2001)
Crozier, J. J.
University of Waikato

Spatial Information: Matakana (Island) banks & the inner shelf of the southern entrance of Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, macrobenthic communities, Matakana, spatial variation, temporal variation, harbour entrance

Summary: To date there have been a limited number of studies describing New Zealand's coastal soft sediment benthic communities. These systems are however affected by anthropogenic disturbances (e.g. disposal of dredge spoil, trawling) and in order to identify potential impacts, the natural variation in community structure must be known. The aim of this study was to characterise the spatial and temporal variation in benthic community composition on the ebb tidal delta (Matakana Banks) and the inner shelf around the southern entrance channel of Tauranga Harbour, New Zealand. This study was undertaken in two parts the first of which involved the sampling of 30 sites on the Matakana Banks during summer (8 – 10 February, 20-21 March 2000) and winter (20-21 September 2000). The objective of these surveys was to examine the spatial variability in macrofauna, and relate community composition to various sediment properties (organic content, chlorophyll *a*, pheophytin pigment and depth). Five surveys of seven sites were also undertaken between February and October 2000 in order to investigate the temporal variability between sites.

Northland and Coromandel scallop stock assessment for 2001 (2002)
Cryer, M.
Ministry of Fisheries; NIWA

Spatial Information: Northland and Coromandel scallop fisheries (Ahipara to Cape Rodney and Cape Rodney to Town Point, respectively).
Keywords: fishery, New Zealand, Northland, Coromandel, scallop, *Pecten novaezelandiae*, biomass

Summary: The Northland and Coromandel scallop fisheries were surveyed by dredge in April-May 2001 to predict start-of-season recruited biomass. Areas thought unlikely to support commercial fishing in the 2001 season were not surveyed. Dredge efficiency was not estimated directly, but assumed based on precautionary treatment of historical estimates in each fishery. For the Northland fishery, start-of-season biomass (scallops 100 mm or more shell length) was estimated at 871 t greenweight with a C.V. of 27%, or 118 t meatweight at an assumed average recovery rate of 13.5% (meat). For the Coromandel fishery, start-of-season biomass (scallops 90 mm or more shell length) was estimated at 577 t greenweight with a C.V. of 27%, or 78 t meatweight at an assumed average recovery rate of 13.5%. For comparison with historical surveys, start-of-season biomass (scallops 100 mm or more shell length) was estimated at 195 t with a C.V. of 29%. Estimates of recruited biomass in 2001 are among the lowest on record for both fisheries, although slightly better than the most recent surveys in both fisheries (1998 in the Northland fishery and 1999 in the Coromandel fishery). Using estimates of Fo.1 h m stochastic yield-per-recruit models as reference rates of fishing mortality, yield for the Northland fishery was estimated as CAY = 45 t (meatweight), and yield for the Coromandel fishery was estimated as CAY = 28 t. Provisional Yield (F'Y) for the Coromandel fishery was estimated (for

historical comparison) as PY = 11 t (meatweight). Estimates of biomass and yield for both fisheries are sensitive to assumptions about dredge efficiency in 2001, to exclusion of areas of low scallops density (where it is assumed uneconomic to fish), and to the selection of a reference rate of fishing mortality. The gazetted conversion factor of 8 (equivalent to a recovery of 12.5%) also leads to lower estimates of yield in meatweight than the estimated recovery rate of 13.5%.

The influence of the pinnid bivalve *Atrina zelandica* (Gray) on benthic macroinvertebrate communities in soft-sediment habitats (1998)
Cummings, V. J.; Thrush, S. F.; Hewwitt, J. E.; Turner, S. J.
Journal of Experimental Marine Biology and Ecology

Spatial Information: 'muddy' site - Te Kapa Inlet, inside Mahurangi Harbour (368 309 S, 1748 449 E), east coast, North Island, NZ; 'sandy' site - outside Mahurangi Harbour in Martins Bay (368 279 S,1748 469 E), east coast, North Island, NZ.
Keywords:*Atrina zelandica*; horse mussel, kukuroa, community structure; macroinvertebrates; marine; New Zealand; Pinnid bivalves; soft-sediment, Mahurangi Harbour

Summary: The pinnid bivalve *Atrina zelandica* (Gray) is found in muddy to sandy soft-sediment habitats around the coast of New Zealand. Because of their size and their often dense and patchy distribution, *Atrina* can add complex physical structure to soft-sediment habitats. We compare diversity and structure of benthic macroinvertebrate assemblages inside and outside of natural patches of *Atrina*, at two different sites in north eastern New Zealand: a muddy harbour site and a sandy open coast site. Clear differences between macrofaunal assemblages in and out of *Atrina* patches were noted at both sites, with stronger effects apparent at the sandy site. Further studies incorporating the effects of suspension feeders on both macrofaunal communities and local hydrodynamic conditions simultaneously are needed to help our understanding of how they modify their local habitat. Our results also illustrate the importance of identifying differences in relationships with location so that habitat variation features can be encompassed in the design of experiments investigating the influence of key species on benthic communities.

Variable effect of a large suspension-feeding bivalve on infauna: experimenting in a complex system (2001)
Cummings, V.; Thrush, S. F.; Hewitt, J.; Funnell, G.
Marine Ecology Progress Series

Spatial Information: Mahurangi Harbour, east coast, North Island, New Zealand.
Keywords: habitat modification, *Atrina zelandica*, horse mussel, kukuroa, benthic communities, density manipulation experiment, soft-sediments, Mahurangi Harbour

Summary: In soft-sediment habitats there are many examples of species that modify their habitat and thus can be expected to have an important influence on macrobenthic community structure. The large, suspension-feeding pinnid bivalve *Atrina zelandica* adds complexity to soft-sediment habitats by protruding into the water column and altering boundary-flow conditions and by providing predation refuges and substrates for epifaunal settlement. To investigate effects of *A. zelandica* density on macrobenthic community composition, we conducted a density manipulation experiment in 4 different habitat types in and around Mahurangi Estuary, New Zealand. Our experiment incorporated a comparatively large spatial

and temporal scale: each habitat was separated by at least 1.75 km, and was sampled 3 times over 16 mo. Based on previous work, we predicted that macrofaunal community responses would differ between sites and would be stronger at sandy sites than muddy sites, and that variability in site hydrodynamic and sediment characteristics would help explain differences in benthic community responses to the density manipulation. While these predictions were supported, there was considerable temporal variation in the response. We also made predictions of the response of different aggregate macrofaunal groups to the *A. zelandica* manipulation (i.e. total numbers of individuals and taxa, suspension feeders, deposit feeders, top 2 cm dwellers, and mobile, short and long-lived species). Whether these predictions were supported varied spatially as well as temporally. To be able to generalise results, larger scale experiments, conducted at more than 1 site and at more than 1 time, are generally considered preferable. Although our *A. zelandica* manipulation experiment has these attributes, the results have demonstrated that the influence of this large suspension feeder on the associated macrofaunal community is not simple (except perhaps in sandy, relatively non-tidal environments), and illustrates our limited success in 'reducing' the complexity of this system using a field experiment. However, we were able to demonstrate that interactions between *A. zelandica*, site hydrodynamic conditions and sediment characteristics were all important in influencing macrofauna, rather than there being a simple *A. zelandica* density–macrofauna relationship. Thus, where multi-species interactions, indirect effects, non-linear biotic/abiotic interactions and threshold effects play an important role, specific experiments may not always lead to generalisable results, simply because the system is too complex.

3.4. D

A study of dredge spoil dispersion off the entrance to Tauranga Harbour (1980)
Dahm, J.; Healy, T.R.
University of Waikato, Dept. of Earth Sciences

Spatial Information: Tauranga Harbour, New Zealand
Keywords: sediments, Tauranga Harbour, Te Awanui, dredge spoil dumping, dredging

Summary: Nearshore and shelf sediments near the entrance to Tauranga Harbour were studied in relation to the nature and character of sediment dispersing from dredge spoil dumping grounds.

The geomorphic development, bathymetric stability and sediment dynamics of Tauranga Harbour (1983)
Dahm, J.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: estuary sediments, estuarine oceanography, geomorphology, Tauranga Harbour, Te Awanui

Summary: This thesis looks at the physiography of Tauranga Harbour and the evolution of the Tauranga-Katikati estuarine lagoon complex.

Community based dune management for the mitigation of coastal hazards and climate change effects: A guide for local authorities (2005)
Dahm, J.; Jenks, G.; Bergin, D.
Bay of Plenty Regional Council

Spatial Information: Not spatially specific, but has been written specifically for the NZ coastline. Case study regions include BOP, Waikato and New Plymouth.
Keywords: climate change, dune systems, coastal processes, coastal management, case study, coast care.

Summary: This report covers the following matters:

Section 2: A brief outline of the challenge posed by coastal hazards, including climate change (see further detail in MfE, 2004)
Section 3: The importance of dunes in the mitigation of coastal hazards and in the protection of natural coastal processes and values
Section 4: Guidelines for the development of dune management plans and outline of the key elements commonly involved with dune restoration
Section 5: Use of community-based partnerships for dune management, including key issues involved in establishing and operating such partnerships
Section 6: Example case studies illustrating community-based dune restoration and management programmes operated by local authorities (including BOP Coast Care). This section also highlights advantages of dune restoration over traditional engineering approaches.
Section 7: Short summary.

This report is exclusively concerned with shore parallel dunes formed along the landward edge of a beach, where windblown sand is trapped by vegetation. These dunes are known as foredunes, with the most seaward generally called the frontal or active foredune (sometimes with a small incipient dune further seaward) and those further landward as relict foredunes (Hesp, 2000) or back dunes.

A new geodetic estimate of deformation in the central volcanic region of the North Island, New Zealand (1991)
Darby, D. J.; Williams, R. O.
New Zealand Journal of Geology and Geophysics

Spatial Information: Immediately north of Lake Taupo in the Central Volcanic Region of the North Island, New Zealand.
Keywords: natural hazards, storms, Central Volcanic Region; deformation; geodesy; shear; strain; extension, New Zealand

Summary: Deformation immediately north of Lake Taupo in the Central Volcanic Region of the North Island, New Zealand, is shown from repeated geodetic surveys to vary in both orientation and magnitude. While the relatively extensional direction is nearly east-west in the west of the region, the northeast-southwest dextral shear component increases eastward, so that the relatively extensional direction becomes nearly north-south in the east of the region. The magnitude of maximum engineering shear strain varies spatially between 0.4 and 1.0 x 10(-6)/yr. Previous geodetic analyses have not had sufficient spatial resolution to study this type of variation. Under an assumption of no length change parallel to the trend of faulting, the extension rate across a 40 km zone north of Lake Taupo is estimated to be 18 +/- 5 (1 s.e.) mm/yr. This is consistent with an upper bound of 20-30 mm/yr for the last 4

Ma, from the age distribution of low-potash and esites, and is significantly greater than previous geodetic estimates. The deformation is generally consistent with geological inferences, but not necessarily with seismological data from earthquakes below magnitude 5, which are themselves difficult to interpret consistently.

Marine brown algae introduced to New Zealand waters: first record of *Asperococcus ensiformis* (Phaeophyta, Ectocarpales, Chordariaceae) (2006)
D'Archino, R.; Nelson, W. A.
New Zealand Journal of Marine & Freshwater Research

Spatial Information: Specimens collected by SCUBA at 13m depth on the deck of the wreck F69/HMS *Wellington* (41°21.270′S 174°46.770′E), a vessel recently deliberately sunk off Island Bay in Cook Strait, Wellington, NZ in November 2005.
Keywords: invasive species, *Asperococcus ensiformis*; introduced macroalgae; Ectocarpales; New Zealand, brown algae, marine plants, plant morphology

Summary: The article presents baseline information of the brown alga *Asperococcus ensiformis* from New Zealand waters. This alga species is considered an introduced species which is closely related to*A. bullosus*. The thalli of this alga are membranous, flattened and ribbon-like, which grow in clumps up to 60 centimetre high and 8-20 millimetre wide. Furthermore, it can be distinguished from similar native species by a combination of anatomical and morphological characters.

Some field techniques used in a study of Tauranga Harbour (1976)
Davies-Colley, R.
Proceedings of the New Zealand Ecological Society

Spatial Information: Tauranga Harbour, New Zealand
Keywords: sediment, Tauranga Harbour, Te Awanui, dredge sampling, field methods, Port of Tauranga

Summary:A summary of the main field methods of research used in a sedimentological study of part of Tauranga Harbour is presented. The research concentrated on the tidal inlet which is the entrance to the Port of Tauranga. SCUBA divers have carried out direct observations of the sea bed and installed various monitoring devices. Sediment sampling programmes posed problems which were largely overcome by using a dredge-type sampler. Tidal currents in the boundary layer were measured one metre above the harbour floor at a number of monitoring stations. Direct measurements of sediment discharge have been made with various devices which trap mobile sediment. Studies of tidal bedforms of both ripple and megaripple scale have been carried out. These investigations have provided a picture of sediment transport processes and patterns near the entrance to the Port of Tauranga.

Sediment Dynamics of Tauranga Harbour (1976)
Davies-Colley, R. J.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: sediment transport, estuarine sediment, Tauranga Harbour, Te Awanui

Summary:A sedimentological study of part of Tauranga Harbour was carried out during 1974-75. The aim of the reseach was to study the hydrodynamics and sediment characteristics of the harbour and thus determine what sediment transport processes are occuring in the study area. Quantitative rates of sediment transport near the Tauranga Inlet were also estimated. The study programme involved underwater observations and mapping by divers, sediment sampling, direct monitoring of tidal currents and sediment movement and study of the harbour bedforms.

Sediment and hydrodynamics of the Tauranga Entrance to Tauranga Harbour (1978)
Davies-Colley, R.J.; Healy, T.R.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, sediments, hydrodynamics, Port of Tauranga

Summary: To relate the textural characteristics of the bottom sediments of a tidal inlet to hydrodynamics, 45 sediment samples from the Tauranga Entrance to Tauranga Harbour were analysed for textural parameters, and tidal currents and waves were monitored. Tidal currents dominate sediment transport processes near the Tauranga Entrance although swell waves are significant on the ebb tidal delta, and wind waves may influence intertidal sediments within the harbour. The bulk of the sediment is probably derived from marine sand from the Bay of Plenty continental shelf, but tidal currents and waves have changed its textural character. In areas of swift tidal currents, particularly in the inlet channel itself, sediment is coarser, more poorly sorted, and more coarsely skewed than that in areas of slower currents.

Sediment transport near the Tauranga entrance to Tauranga Harbour (1978)
Davies-Colley, R.J.; Healy, T.R.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Tauranga Harbour, New Zealand
Keywords: sediment, Tauranga Harbour, Te Awanui, Port of Tauranga, sediment transport, hydrodynamics, wave action,

Summary: Davies-Colley and Healy investigated how tidal movements impact the transport of sediment both along the bottom and through suspension in the water column, in the Tauranga Harbour entrance. This research was conducted in 1978, therefore rates of transport may be different today, due to changes in the landforms and changes ininput of land derived sediments. Davies-Colley and Healy do not estimate the amount of sediment in the harbour in 1978 but rather looked at the erosion and deposition action of the waves on sediment movement. At the sediment-water interface, sediment is moved along the sea bed by the waves, forming patterns of dunes and smaller ripples on the bed. Sediment is also entrained in the water and is transported as suspended sediment. Sediment transported out of the harbour tends to move south-eastward along the coast of Matakana Island and potentially back into the inlet. Bars of deposited sediment develop due to decreases in the amount of sediment transported by wave action away from the inlet and the position of those bars is due to the power and direction of the waves. More sediment tends to be moved in the channel areas due to acceleration of tidal water and faster currents,

while sediment in the bar areas tends to be less mobile. Future studies on sediment in the Tauranga Harbour may utilize this information to assess changes in sediment transport over time.

Holocene coastal depositional sequences on a tectonically active setting: south-eastern Tauranga Harbour, New Zealand (1993)
Davis, R.A.; Healy, T.R.
Sedimentary Geology

Spatial Information: South-eastern Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, sediment, hydrodynamics, Port of Tauranga, seismic data, coastal deposition, lithofacies

Summary: More than 70 cores, a high-resolution seismic survey, and SCUBA observations provide the basis for the interpretation of depositional environments during the Quaternary in the south-eastern Tauranga Harbour area of the North Island, New Zealand. Three lithofacies comprise this sequence; in ascending order they are pumiceous sand and gravel, shelly mud and shelly sand. The pumiceous sand is interpreted as fluvial and fan deposits of Pleistocene to early Holocene age with a radiometric date of 9420 ± 100 yr BP near the top of the unit. The shelly mud represents low-energy estuarine deposition of essentially normal marine salinity in a valley-like setting. This unit dates at 8100 ± 80 yr BP. The extensive overlying shelly sand thickens seaward and represents wave-dominated shoreface conditions much like the present nearshore environment. Radiometric dating of samples within the present harbour are all between 6000 and 7000 yr BP and those seaward of the spit to Mt. Maunganui are less than 3370 ± 100 yr BP. The barrier spit that has attached to the volcanic headland began accumulating about 4000-5000 years ago.

The Migrations of Humpback Whales which Pass the New Zealand Coast (1956)
Dawbin, W.H.
Transactions of the Royal Society of New Zealand

Spatial Information: New Zealand coastline
Keywords: whales, humpback whale, *Megaptera novaeangliae*, paikea, migration, New Zealand, baleen whale, cetacean

Summary: The migration route of humpback whales in New Zealand waters as indicated by approximately 9,000 sightings is described. North-bound humpbacks pass mainly along the eastern coastlines of New Zealand. Along with this, one group passes through Cook Strait to the western side of the North Island and another passes the western side of Stewart Island and round the south-west corner of the South Island, before leaving the coast. South-bound humpbacks pass mainly along the western coast of New Zealand, forming a large aggregation near the south-west corner of the South Island, while others follow the east coast of the North Island as far as East Cape, but few occur elsewhere along the eastern coastlines or pass through Cook Strait. Seasonal variation in commencing dates, duration of migration, tune of peak and the periods taken by equivalent proportions of the humpback groups are described for 36 seasons in Cook Strait, three at Whangamumu and four at Centre Island. The rate of migration, times of arrival, peak concentration and latitudinal spread of the migrating stock, at phases of the passage from Antarctic to tropical waters and return, are calculated and discussed.

The New Zealand Whale and Dolphin Digest: the official Project Jonah guidebook (1985)
Dawson, S. M.
Brick Row Publishing Co.

Spatial Information: New Zealand wide
Keywords: New Zealand Whales and Dolphins

Summary: The information in this book is condensed from a wide variety of sources, including the author's own observations and research. The first section is on the biology of whales and dolphins and an introduction to what makes these fascinating animals "tick". The second section is about strandings, how you can help, and what to do to rescue the animals. The third section is a comprehensive guide to the 34 species recorded in New Zealand waters.

Wave climate and sediment transport within Tauranga Harbour, in the vicinity of Pilot Bay (1988)
de Lange, W. P.
University of Waikato, Department of Earth Sciences

Spatial Information: Pilot Bay,Tauranga Harbour, New Zealand
Keywords: sediment transport, estuarine sediments, ocean waves, Tauranga Harbour, Te Awanui

Summary: This thesis looks at the effect of waves on sediment transport and deposition in the southern part of the Harbour, particularly in the vicinity of the Port. The study looks at tides, sedimentation, wind and pressure in Pilot Bay. A profile of the sediments of the area is also provided.

Wave Spectra for a shallow Meso-tidal Estuarine Lagoon: Bay of Plenty, New Zealand (1990)
de Lange, W.P.; Healy, T.R.
Journal of Coastal Research

Spatial Information: Tauranga Harbour, New Zealand
Keywords:sedimentation, ONSWAP, Rayleigh distribution, seiches, wave climate, Weibull distribution, Tauranga Harbour, Te Awanui

Summary: The wave climate of Tauranga Harbour, a shallow meso-tidal estuarine lagoon in the Bay of Plenty, New Zealand, was investigated between 1984 and 1987. Two main groups of waves were identified, viz., high frequency waves, f>0.0714 Hz (period < 14 s), and low frequency waves, f<0.0714 Hz, excluding the semi-diurnal tidal oscillations. The low frequency waves were analysed by spectral techniques only. The high frequency component of the wave climate is dominated by wave energy transmitted through the harbour entrance, with -70% of the energy in the average harbour spectrum attributable to this source. The harbour entrance filters the wave energy passing through it, restricting most of the energy to a relatively narrow frequency band. Wind-waves generated within the harbour also contribute a significant proportion of the wave energy within the average spectrum. A spectral relationship, based on the JONSWAP spectral form, was derived and this is presented. Seiches occur frequently within the harbour, usually in association with

wind speeds exceeding 9.5 m.s over the harbour, but also in response to external forcing by tsunamis and large external swell waves. The seiche frequencies are not controlled by the harbour channels or dredged shipping basins. The largest oscillations within the harbour are caused by tsunamis and storm surges.

Renourishment of a flood-tidal delta adjacent beach, Tauranga Harbour, New Zealand (1990)
de Lange, W. P.; Healy, T. R.
Journal of Coastal Research

Spatial Information: Pilot Bay, Tauranga Harbour, New Zealand
Keywords: sedimentation, sediment transport, sediment texture, beach renourishment, artificial beach, dredging, beach sediment, Tauranga Harbour, Te Awanui, Pilot Bay

Summary: Pilot Bay Beach, a flood-tidal delta adjacent beach in Tauranga Harbour, has demonstrated a history of continual erosion. During a maintenance dredging programme in early 1984, the Bay of Plenty Harbour Board renourished the south-eastern end of the beach with 2.1 x 104 m³ of dredge spoil. The bay had been included in the Tauranga Harbour Study, which provided baseline data for a study of the behaviour of the renourished beach. Tidal currents in Pilot Bay are affected by a flood-tidal eddy, which results in a dominant ebb-directed flow for most of each tidal cycle. However, this flow rarely exceeds the sediment entrainment velocity. Additional energy for the entrainment of sediment is provided by waves, particularly on the beach. Sediment used for renourishment was very similar in composition and texture to the original beach sediment, except for a change in the dominant shell species, and the presence of pumice. The pumiceous clasts within the dredge spoil, being of very low density, were rapidly transported away from the renourished beach. The sediment transport direction predicted by the dominant tidal flow direction, and by the spatial distribution of sediment texture, was confirmed by observed beach profile changes. Sediment moved from the renourished end of the beach, towards the north-western end, where long term accretion may occur. During the period April 1984 to October 1987, the average rate of erosion of the renourished beach was 2.52 $m^3 day^{-1}$, giving an expected life of less than 13 years.

Wave climate for No. 1 Reach, Port of Tauranga, Tauranga Harbour (1991)
de Lange, W. P.
Department of Earth Sciences, University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, Port of Tauranga

Summary: The wave climate of Tauranga Harbour, a shallow meso-tidal estuarine lagoon in the Bay of Plenty, New Zealand, was investigated between 1984 and 1987. Two main groups of waves were identified, viz., high frequency waves, f>0.0714 Hz (period < 14 s), and low frequency waves, f<0.0714 Hz, excluding the semi-diurnal tidal oscillations. The low frequency waves were analysed by spectral techniques only. The high frequency component of the wave climate is dominated by wave energy transmitted through the harbour entrance, with -70% of the energy in the average harbour spectrum attributable to this source.

Extremal significant wave analysis: entrance to Tauranga Harbour (1993)
de Lange, W. P.
Department of Earth Sciences, University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: ocean waves, Tauranga Harbour, Te Awanui

Summary: In 1992 the entrance channel through the tidal inlet to Tauranga Harbour, which is located along the Bay of Plenty littoral drift system, was deepened from 10 m to 14 m. The deepened channel has become a sediment trap for littoral drift bypassing and tidal current driven sediment transport through the inlet. Since 1992, there has been an increase in maintenance dredging requirements at the inlet, because of sand accumulation along the southeastern border of the entrance channel. Previous studies have identified an ebb tide–induced eddy operating on the eastern side of the ebb-jet as it exits the tidal gorge. In this article, the eddy system has been simulated with a validated two-dimensional hydrodynamic model, detailing time-varying current patterns over the ebb-tidal delta. Particular emphasis is placed on defining the trajectory of the eddy and evaluating its influence on the observed sedimentation patterns. The model results indicate the formation of opposing eddies on either side of the entrance channel, both of which are transient in nature. The centre of the eastern eddy propagates seaward along the downdrift margin of the entrance channel as the ebb-jet lengthens.

An appraisal of factors controlling the latitudinal distribution of mangrove (*Avicennia marina var. resinifera*) in New Zealand (1994)
de Lange, W. P.; de Lange, P. J.
Journal of Coastal Research

Spatial Information: Elsewhere in New Zealand: study sites - Hobsonville, Houhora Harbour, Kaipara Harbour, Mangere, Miranda, Ohiwa Harbour, Pollen Island, Tuff Island, Whangarei Harbour, Whangaroa Harbour.
Keywords: plants, mangroves, *Avicennia marina*, manawa, climate, dispersal, littoral drift, tidal currents, wind drift.

Summary: The latitudinal distribution of mangroves (*Avicennia marina* var. *resinifera*) in New Zealand has traditionally been considered to be controlled by climatic stress, particularly air temperature. This paper reviews the influence of climate factors, particularly frost, and the dispersal of mangrove propagules on the present-day mangrove distribution. There is no strong evidence to show that the southern limit of mangroves in New Zealand is a function of climatic conditions, or that the present mangrove distribution is in equilibrium with climatic conditions. It is probable that coastal processes affecting propagule dispersal are more important controls on the mangrove distribution within New Zealand than climatic factors. In particular, tidal asymmetry inhibits mixing of east and west coast mangrove populations around northern-most New Zealand, and low coastal current velocities and large distances between suitable habitats makes natural establishment south of present limits unlikely.

Assessing the stability of inner shelf dredge spoil mounds using spreadsheet applications on personal computers (1994)
de Lange, W. P.; Healy, T. R.
Journal of Coastal Research

Spatial Information: Mount Maunganui coastal zone
Keywords: sedimentation, dredging, sediment transport, threshold of sediment motion, Hands and Allison (1991) method, Tauranga Harbour, Te Awanui, Mount Maunganui coastal zone

Summary: Three methods, 1) *viz.* the Hands and Allison (1991) method, 2) predictions of sediment threshold, and 3) predictions of sediment transport rate, are used to assess the long term stability of dredge spoil mounds on the inner shelf and compared with available observations of their behaviour. These methods are chosen for simplicity and ease of implementation with a spreadsheet application on a personal computer.
Three main approaches were followed: an evaluation of the annual, and daily limits, of onshore-offshore sediment movement near the spoil mound; a comparison between the theoretical thresholds of sediment motion and the annual wave height and period joint distribution; and an evaluation of sediment transport rates and directions using semi-empirical relationships. The Hands and Allison (1991) method had the smallest data requirements: mean and standard deviation of the annual significant wave height distribution; and the median grain-size at the mid-point of the shoal zone. Analysis of sediment threshold and comparison with wave climate required data concerning the annual joint wave height and period probability distribution, and sediment textural characteristics. Sediment transport rate calculations required the most detailed information about the site: annual joint wave height and period probability distribution; sediment textural characteristics; and mean unidirectional current velocity. Using a spreadsheet, it is relatively easy to simulate a range of values (that span the likely conditions) with all three methods, if the necessary data are not available. All the methods produced predictions consistent with available observations, and all were straightforward to implement within a spreadsheet application. The choice of method depends on the information required, with each method needing different data and providing contrasting but complementary outputs.

Seasonal, inter-annual, and decadal variability of storm surges at Tauranga, New Zealand (2000)
de Lange, W. P.; Gibb, J. G.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: South-eastern Tauranga Harbour: study sites = Harbour entrance (Mauao side at North West Rock), Pilot Bay, Sulphur Point, Slipway (Te Awanui Drive), Tauranga Town (between Te Awanui Drive/ Hewletts Rd and the Matapihi Bridge on the town side).
Keywords: natural hazards, storms, storm surge, sea level, climate change, wind storms, El Nino-Southern Oscillation, Interdecadal Pacific Oscillation, Tauranga Harbour, Te Awanui

Summary:A database of storm surge events was constructed for two sites in south-eastern Tauranga Harbour, New Zealand, for the period 1960-mid 1998. Storm surge events were defined as occasions when the residual level between the predicted high tide level and recorded water level exceeded 10 cm. The residual was determined at high tide only (every 12.4 h), with 954 storm surge events found over the 38.4-year period analysed. The magnitude and frequency of storm surge events varied considerably between 1960 and 1997, with a marked shift evident c. 1976. The period from 1976 to 1997 corresponded to a reduced storm surge frequency and

magnitude, compared to the period 1960-76. Wavelet analysis of 125 years of wind storm annual frequencies showed strong fluctuations at inter-decadal periods. Therefore, it is suggested that the frequency of storm surges varies in response to a coherent inter-decadal oscillation in surface temperature over the Pacific Ocean, known as the Inter-decadal Pacific Oscillation (IPO), that reversed phase c. 1976. The El Nino Southern Oscillation (ENSO) also affected the number of days exceeding the storm surge threshold per year, with La Nina events being associated with more storm surge: days. The presence of significant decadal variations indicates that annual exceedance probability distributions may misrepresent the storm surge hazard. The available data indicates that there are extended periods when the IPO increases the hazard and others when the hazard is decreased. Existing analyses of storm surge hazard for the Bay of Plenty have largely been based on data obtained during a period of reduced hazard. Conditions that were associated with larger and more frequent storm surges during 1960-76 may be expected to prevail again over the next few decades.

Coastal hazards of the Bay of Plenty (2007)
de Lange, W. P.; *Cochran, U. & Cervelli, A. (ed.)*
Geological Society of New Zealand

Spatial Information: (coastal) Bay of Plenty, New Zealand – sites visited: Bryans Beach, Ohiwa Spit, Ohope Spit, Thornton, Matata, Maketu, Papamoa, Omanu and Mount Maunganui.
Keywords: sedimentation, coastal processes, coastal hazard zone, coastal management, morphodynamics, storm surge, storm tide, sea level rise, climate change, tectonic effects, Bay of Plenty, New Zealand

Summary: This is the handout that accompanied one of the field trips for this conference. The trip examined the advances in our understanding of coastal processes and hazards in the context of coastal development in the Bay of Plenty. This handout outlines the development of Coastal Hazard Zones (CHZs) in New Zealand, and accordingly the current understanding of coastal processes and how to mitigate coastal hazards in terms of coastal management. Aspects of coastal hazards covered in this field trip were:

- Beach responses to wave forcing (morphodynamics);
- Beach response to water level changes, particularly due to storm surge and storm tide, and sea level rise;
- Climatic variability and its influence on the coast; and
- Tectonic effects.

Planned site visits included Bryans Beach, Ohiwa Spit, Ohope Spit, Thornton, Matata, Maketu, Papamoa, Omanu and Mount Maunganui.

Monitoring the effects of mangrove removal in Tauranga Harbour (n.d.)
de Luca-Abbott, S.; O'Shea, S.
Boffa Miskell; Auckland University of Technology; Tauranga City Council

Spatial Information: Southern Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, sediment, mangroves, manawa, mangrove removal, *Avicennia marina*, resource consent

Summary: This is a power point presentation giving an overview on the removal of mangroves in Tauranga Harbour. No date given. TCC applied to BOPRC for

resource consent to remove mangroves seaward of the Mangrove Management Boundary. Consent was given, but monitoring of environmental effects was required as part of the consent. This presentation summarises the data after one year of monitoring. Conclusions indicate that there is little evidence of adverse ecological effects related to mangrove removal, however, ongoing monitoring is required to confirm this.

Chemical fractionation of lead in intertidal sediments from Manukau Harbour, Auckland, New Zealand (1990)
De Mora, S.J.; Demeke, G.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Manukau Harbour, Auckland, New Zealand
Keywords: sedimentation, lead, sediments, speciation, diagenesis, partitioning, Manukau Harbour, New Zealand

Summary: Four cores were collected from intertidal sites in the Manukau Harbour, Auckland, New Zealand. Cores were sub-sectioned under nitrogen; total lead was determined following an acid digestion. Pb was also determined in each of six chemical phases resolved by differential extraction procedures. Total Pb concentrations in surficial sediments varied in the range 3.5-98 mg kg^{-1}, with the highest level observed at Little Huia. Although background Pb concentrations are difficult to define, it is apparent that discharges from the northern effluent outfall at the New Zealand Steel Works, Glenbrook, have approximately doubled sedimentary Pb concentrations in the immediate vicinity. Analyses of Pb partitioning indicate that no diagenetic processes are operating to remove Pb from the sediments. At Little Huia, Pb preservation within the sedimentary record is accompanied by transformations from iron/ manganese oxide to organic/sulfide phases.

Subtidal *Ulva* status within Tauranga Harbour(1996)
de Winton, M.D; Clayton, J.S.; Hawes, I.
NIWA

Spatial Information: Tauranga Harbour, New Zealand
Keywords: plants, sea lettuce, *Ulva*, nutrients, Tauranga Harbour, Te Awanui, subtidal, Environment Bay of Plenty

Summary: The extent of Ulva development within the subtidal reaches of Tauranga Harbour has not previously been documented, despite probable links between submerged growth and nuisance strandings. To address the gap in the ecological information on this problem seaweed, two approaches were recommended. Firstly a systematic survey of the distribution and abundance of the submerged Ulva population was proposed, and secondly, laboratory experimentation to gain relevant physiological information.

Sea lettuce dynamics and ecophysiology in Tauranga Harbour, Bay of Plenty (1998)
de Winton, M.D; Clayton, J.S.; Hawes, I.
NIWA

Spatial Information: Tauranga Harbour, New Zealand

Keywords: plants, sea lettuce, *Ulva*, nutrients, Tauranga Harbour, Te Awanui, subtidal, Environment Bay of Plenty

Summary: This report presents the results of studies on sea lettuce in Tauranga Harbour, undertaken for Environment B.O.P, Tauranga District Council and Western Tauranga District Council between 1994 and 1998. It also includes relevant information from a Government funded research programme

The Grey-faced Petrel and the Predator (2001)
Dee, M.D.
Bay of Plenty Polytechnic

Spatial Information: Mauao, Tauranga, New Zealand
Keywords: gray-faced petrel, *Pterodroma macroptera gouldi*, North island muttonbird, Oi, Mauao, Mount Maunganui, predator

Summary: The aim of this research was to band, weigh and measure the wing length of as many grey-faced petrels at Mauao during the breeding season. This took place during the months of July- October. This report was written and was given to the Department of Conservation (DOC), who now looks after the grey-faced petrels on Mauao, inherited from the Ornithological Society of New Zealand (OSNZ), Waikato region.The objective of the research was to look at the effect that predators have had on the grey-faced petrels at Mauao, who those predators were and how they got there. It also looked at the predator control programme that is in effect on Mauao. The results were then collated to see if this programme has had an effect on the grey-faced petrel population. The method for this research was to go out at dusk and either call in the grey-faced petrel by using the war whoop method or look for them on the ground near borrows. The birds were then weighed, banded if they were not already, and then their wing length was measured. In 1995, Hugh Clifford from OSNZ, Waikato region, with the help of the Tauranga DOC, Tauranga District Council and Environment Bay of Plenty developed a predator control programme based at Mauao. The results showed that in the banding season the predator control programme was implemented, the amount of chicks caught and banded rose considerably, with an average of 3.8 chicks being banded five years previous to the programme, and an average of 30.5 chicks being banded in the following five years.

New Zealand Coastal Policy Statement 1994 (1994)
Department of Conservation
Department of Conservation

Spatial Information: New Zealand's coastline
Keywords: coastal management, policy, Resource Management Act 1991, RMA

Summary: The Resource Management Act 1991 established a new coastal management regime based on a partnership between the Crown and the community through their regional and local authorities. The Act (Section 56) requires that at all times there shall be a New Zealand Coastal Policy Statement. The Policy Statement will guide local authorities in their day-to-day management of the coastal environment. In 1992, after consultation with interested parties, the Minister of Conservation released a draft New Zealand Coastal Policy Statement for submissions/ consultation. This report is the outcome of that process.

Proposed New Zealand Coastal Policy Statement 2008 (2008)
Department of Conservation
Department of Conservation

Spatial Information: New Zealand coastline
Keywords: coastal management, policy, Resource Management Act 1991, RMA

Summary: Under the Resource Management Act, most decision-making about what happens on the coast is devolved from central to local government. The NZCPS is the key statement of national policy that guides planning and resource consent decisions for the coastal environment. Fourteen years ago the first NZCPS came into force. It has done good service, providing sound guidance on important matters such as public access to the coast, the preservation of natural character, and the discharge of sewage to the sea.In fourteen years, however, much has changed and much has been learned. Coastal development has accelerated and shows no sign of slowing down. It is time to take advantage of experience, look ahead, and see how we can improve on existing policy and strike the right balance between use, development and protection of our precious coastal environment.

Rare visitor marks start of seal season (2009)
Department of Conservation
Infonews

Spatial Information: Waimapu Estuary, Tauranga Harbour, New Zealand
Keywords: Leopard seal, *Hydrurga leptonyx*, popoiangore, seal sightings, New Zealand fur seal, *Arctocephalus forsteri*, kekeno, oioi, Tauranga

Summary:A press release about a Leopard seal sited on the edge of the Waipu Estuary, near Tauranga Airport, August 2009. The article also gives some information about the last reported sighting of a leopard seal in Tauranga (2006 - so relatively uncommon), as well as general information about their habitat and diet; it then goes on to talk about the New Zealand fur seal, which is more common to Tauranga.

New Zealand Coastal Policy Statement 2010 (2010)
Department of Conservation
Department of Conservation

Spatial Information: New Zealand coastline
Keywords: coastal management, policy, Resource Management Act 1991, RMA

Summary: The purpose of the New Zealand Coastal Policy Statement (NZCPS) is to state policies in order to achieve the purpose of the Resource Management Act in relation to the coastal environment of New Zealand.

Department of Conservation Central Database: Cetacean sightings in the Tauranga Area (2010)
Department of Conservation
Department of Conservation

Spatial Information: Tauranga Area
Keywords: Tauranga Area, Cetacean sightings

Summary: This is a national catalogue of biodiversity inventory and monitoring projects, administered by the Department of Conservation. It includes research projects managed by various organisations, institutions and the community, not just DOC projects. A typical project report contains information about what species were monitored, what methods were used and who to contact - it does not contain detailed monitoring results.

East Coast Bay of Plenty Pesticide Summary (2011)
Department of Conservation
Department of Conservation

Spatial Information: East Coast and BOP (Rotorua Lakes, Tauranga, Gisbourne, Whakatane and Te Urewera Whirinaki areas and some off shore islands), NZ.
Keywords: pesticide*, Bay of Plenty, East Coast, poison, bait station, Rotorua, Tauranga, Gisborne, Whakatane,Te Urewera Whirinaki

Summary: Pesticide summaries are regularly updated lists of animal pest operations using vertebrate pesticides that occur on lands managed or administered by DOC. Each Conservancy (region) issues a pesticide summary every four months. They tell hunters, and other people, where pesticides are being used in the Conservancy. The public can then choose, based on clear information, where to go, and which areas to avoid. Some Conservancies also issue pesticide summaries that concentrate on specific areas that are heavily used by the public, like Forest Parks and National Parks.Pesticides are categorised into HAVE BEEN LAID and WILL BE LAID, give the location and total area of application, what poison is used, dates of application, and the expected time to warning sign removal.

NOBANIS Invasive Alien species fact sheet - *Teredo navalis*(2007)
Didziulis, V.
NOBANIS (European Network on Invasive Alien Species)

Spatial Information: Europe
Keywords: invasive species, alien species, *Teredo navalis*, naval shipworm, bivalve

Summary: This is a factsheet listed on the NOBANIS (European Network on Invasive Alien Species) website about the species *Teredo navalis*, commonly known as naval shipworm. This species is very destructive to any wooden constructions in the marine environment. The factsheet gives information on taxonomy, native range, alien distribution (focused around Europe only), ecology (habitat, reproduction and life cycle, dispersal and spread), its impact on indigenous organisms, economic and societal effects, and management approaches.

Personal communication with Rob Donald, Science Manager Bay of Plenty Regional Council (2011)
Donald, R.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: mangrove removal, resource consent, estuary care groups, Tauranga Harbour, Environment Bay of Plenty, manawa, *Avicennia marina*

Summary: This is the personal communication that occurred between one of our researches and Rob Donald, Science Manager, from the Bay of Plenty Regional Council. The discourse is focused around clarifying past and future mangrove removal in Tauranga Harbour (resource consents, specific areas and total area of mangrove removal).

Animal and human faecal pollution in New Zealand rivers (1999)
Donnison, A.M., Ross, C.M.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Does not specifically name sites (i.e. their geographic locations), just categorises them by type - non-polluted forest; treated meat-processing waste water; non-point inputs form dairy farms; treated sewage.
Keywords:*Salmonella*; *Campylobacter*; *Yersinia enterocolitica*; *Hydridella menziesi*; sentinel mussels; fresh waters; faecal pollution; animal faecal wastes; sewage; meat-processing waste water; dairy farms

Summary: Sentinel freshwater mussels (*Hydridella menziesi*) were immersed in rivers at sites impacted by faecal pollution. The indicator bacterium, was recovered from all mussels including those at a forest control site, but concentrations were highest at sites impacted by either treated sewage or treated meat-processing waste water, or by inputs from dairy farms. The three pathogens sought were recovered from mussels, except those at the forest (control) site: and *Campylobactercoli* at treated sewage sites; *Salmonella typhimurium* and *C. jejuni* at treated meat-processing waste water sites; and *C. jejuni* and *Yersinia enterocolitica* at sites impacted only by dairy farms. The FRNA bacteriophage concentration was high in mussels impacted by sewage or sheep-processing waste water but was low when the input was only from dairy farms. Mussels up to 23 km from a sewage discharge contained a high concentration of FRNA suggesting that there could be a health risk due to viruses, although the water did not exceed recommended guidelines. Pathogens were also sought in untreated waste waters. C. jejuni and C. coli were recovered from both sheep-processing and beef-processing waste waters and the only sewage isolate identified was confirmed as. *Salmonella* spp. were recovered from all waste waters, with *S. typhimurium* phage type 135, isolated from a sample of meat-processing waste water, and from mussels immersed 1 and 5 km downstream of that plant's discharge. *Y. enterocolitica* was recovered from most samples of animal waste water. It appears that pathogens are introduced into New Zealand rivers by all major sources of faecal contamination.

Ecological monitoring survey of the lower reaches of the major Bay of Plenty Rivers, the Ohau Channel, and Parts of Tauranga Harbour (Winter 1974)
Donovan, W.F.; Hatton, C.; Barker, M.F.; Larcombe, M.F.
Bioresearches Ltd

Spatial Information: Bay of Plenty Rivers, the Ohau Channel (Rotorua) and parts of Tauranga Harbour

Keywords: Tauranga Harbour, Te Awanui, Rereatukahia Inlet, Wairoa Estuary, Waikareao Inlet, Waimapu Inlet, Welcome Bay, ecological monitoring, sample, water quality, algae, seagrass, eel grass, *Zostera*, shellfish, bivalve

Summary: This report gives the results of initial sampling of this ecological monitoring survey. Other reports give the results of later sampling done in the summer and the winter of 1975. Survey sites in the Tauranga Harbour include the Rereatukahia Inlet, Wairoa Estuary, Waikareao Inlet, Waimapu Inlet and Welcome Bay. Fauna recorded include members of mollusca (bivalves), gastropods, crustacea, polychaetes, coelenterate, chiton and nemertean.

Ecological monitoring survey of the lower reaches of the major Bay of Plenty rivers, the Ohau Channel, and parts of Tauranga Harbour (Summer 1975)
Donavon, W.F.;Hatton, C.;Barker, M.F.; Larcombe, M.F.;
Bioresearches Ltd

Spatial Information: Bay of Plenty rivers, Ohau Channel, Tauranga Harbour – New Zealand
Keywords: Tauranga Harbour, Te Awanui, Rereatukahia Inlet, Wairoa Estuary, Waikareao Inlet, Waimapu Inlet, Welcome Bay, ecological monitoring, sample*, water quality, algae, seagrass, eel grass, *Zostera*, shellfish, bivalve*, gastropod, flora, fauna, macrofanua,

Summary: This report contains the results of the second sampling of stations in the Tauranga Harbour and Whakatane River Estuary as part of a continuing monitoring programme. Initial sampling was undertaken in the winter of 1974, and the results are contained in the report 'Ecological monitoring survey of the lower reaches of the major Bay of Plenty Rivers, the Ohau Channel, and parts of the Tauranga Harbour (Winter 1974) (Bioresearches Ltd).This second sampling of the selected stations, undertaken during January 1975, is intended to illustrate seasonal ecological changes on the study areas by comparison with the Winter 1974 data. Long term, or non-seasonal changes are also identified where possible. The selection of the stations sampled is discussed in the Winter 1974 report. Sample sites located in the Tauranga Harbour include Rereatukahia Inlet, Wairoa Estuary, Waikareao Inlet, Waimapu Inlet and Welcome Bay. This survey measured changes in faunal distribution and abundance, density of algae and sediment B.O.D.5 levels (a useful parameter for identification of the 'condition' of a soft sediment habitat with respect to organic content of the sediment).
Findings for marine areas:

- Most of the changes in faunal distribution and abundance since the Winter 1974 survey are considered to be a result of natural variation, whether part of a long term fluctuation, or spatial variation in abundance.
- The density of algae, particularly *Gracilaria secundata*, has shown considerable seasonal variation in several harbour areas. Areas recommended for algal growth are Welcome Bay, the Rereatukahia Inlet and Waikareao Inlet.
- In areas with very high sediment B.O.D.5 level, there is obvious deterioration of the sediment environment, but the test is considered to be of most potential use in identifying those areas which would be sensitive to increased organic loading, and in monitoring long term change in the surface sediment.

Seagrass in bloom (2008)
Dos Santos, V.; Matheson, F. E.; Pilditch, C. A.
Water & Atmosphere

Spatial Information: Tauranga Harbour, New Zealand
Keywords: plants, seagrass, eel grass, *Zostera muelleri*, Tauranga Harbour, flower cluster, sexual reproduction

Summary: Rare discovery - seagrass flowering in Tauranga Harbour. Flowers of *Zostera muelleri*, an indigenous marine plant discovered from a dense, exposed, intertidal seagrass patch on estuarine sandflats near the centre of the Tauranga Harbour. Discovered by Virginie Dos Santos while she was collecting information for her doctorate research investigating damage to seagrass meadows caused by black swan grazing and pollution. The seagrass flower cluster (or inflorescence) is small and inconspicuous, so flowering may be more common than realised. Further research will continue into understanding the flowering of seagrass in NZ.

Habitat networks of indigenous shorebirds in New Zealand (2006)
Dowding, J.E., Moore, S.J.
Department of Conservation (New Zealand)

Spatial Information: New Zealand wide
Keywords: New Zealand, shorebirds, waders, habitat, estuaries, wetlands, breeding sites, migration, movements, wintering sites

Summary: This report reviews current knowledge and collates information on the important regions, habitats and sites used by seven endemic shorebird species in New Zealand: New Zealand pied oystercatcher (*Haematopus finschi*),variable oystercatcher (*Haematopus unicolor*), pied stilt (*Himantopus himantopus leucocephalus*), black stilt (*Himantopus novaezelandiae*), New Zealand dotterel (*Charadrius obscurus*), banded dotterel (*Charadrius bicinctus*) and wrybill (*Anarhynchus frontalis*). For each taxon, status, range, numbers, important breeding and non-breeding sites are described. We summarise information on movement patterns and links between breeding and non-breeding areas. We also identify sites where there is significant overlap between these endemic species and Arctic-breeding migrant waders. Many of the wintering sites are important to several of these taxa. Nineteen sites (mostly well-defined harbours or estuaries) are identified as having national significance to endemic shorebirds, and 15 of these have been previously identified as wetlands of national significance. Key regions for breeding or wintering shorebirds were northern North Island east-coast beaches and estuaries; large northern North Island harbours (particularly Kaipara, Manukau and Firth of Thames); northern South Island estuaries, particularly Farewell Spit and Tasman Bay; smaller estuaries and lagoons on the east coast of the South Island; and large braided riverbeds in the central South Island. Shorebird flocks are often highly mobile. Little is known about the important feeding areas for many taxa, and little attention has been given to potential threats in non-breeding areas. All significant populations of all indigenous shorebird species come into contact with Arctic-breeding migrant waders to some degree.

New Zealand dotterel (*Charadrius obscurus*) recovery plan, 2004-14 (2007)
Dowding, J.E., Davis, A.M.

Department of Conservation (New Zealand)

Spatial Information: New Zealand dotterel breeding areas (coastal areas of the North Island, north of a line between Taranaki and northern Hawke's Bay, although it is most common on the east coast of Northland, Auckland, Coromandel and Bay of Plenty; also breeds in Gisbourne area; South Island - breeding is now confined to Stewart Island/ Rakiura, but there is a post-breeding flock site at Awarua Bay, Southland).
Keywords: New Zealand dotterel, *Charadrius obscurus*, shorebird, threatened species, recovery programme, conservation management, New Zealand, birds, avifauna, Tauranga Harbour, Matakana Island, endangered.

Summary: The New Zealand dotterel (*Charadrius obscurus*) is a threatened endemic shorebird that is classified internationally as Endangered. There are two widely separated subspecies. The northern subspecies (*C. o. aquilonius*) breeds on or near the coast of the North Island (mainly north of 39°S) and numbered c. 1700 individuals in October 2004. It is classified in New Zealand as Nationally Vulnerable. The southern subspecies (*C. o. obscurus*) was once widespread in the South Island, but now breeds only inland on Stewart Island/Rakiura. In April 2005, it numbered c. 250 individuals, and it is classified in New Zealand as Nationally Critical. The present plan replaces the first recovery plan for the species, which was published in 1993. This new plan expires in 2014. Summaries are provided of the ecology of the species, past and present distributions, threats to the subspecies, and the history of management and research. Long-term and short-term goals for both subspecies are given. Proposed objectives for the northern subspecies include continuing existing protection programmes, expanding protection to new sites, and increasing community involvement and other-agency partnerships in management. There is also a need to identify and protect important breeding, roosting and feeding habitat from degradation using advocacy and statutory protection. Proposed objectives for the southern subspecies include continuing current management on Stewart Island/Rakiura, maintaining the mustelid free status of the island, and investigating more cost-effective methods of cat (*Felis catus*) control. A review of the first recovery plan, details of management techniques used at North Island sites and a timeline for the actions proposed in this plan are included in appendices.

Nutrients in Agroecosystems: Rethinking the Management Paradigm (2007)
Drinkwater, L.E., Snapp, S.S.
Advances in Agronomy

Spatial Information: Not spatially specific
Keywords: agroecosystems, nutrient cycling, coupled biogeochemical processes, plant species functions, microbial community structure and function

Summary: Agricultural intensification has greatly increased the productive capacity of agroecosystems, but has had unintended environmental consequences, including degradation of soil and water resources, and alteration of biogeochemical cycles. Current nutrient management strategies aim to deliver soluble inorganic nutrients directly to crops and have uncoupled carbon, nitrogen, and phosphorus cycles in space and time. As a result, agricultural ecosystems are maintained in a state of nutrient saturation and are inherently leaky because chronic surplus additions of nitrogen and phosphorus are required to meet yield goals. Significant reductions of nutrient surpluses can only be achieved by managing a variety of intrinsic ecosystem processes at multiple scales to recouple elemental cycles. Rather than focusing

solely on soluble, inorganic plant-available pools, an ecosystem-based approach would seek to optimize organic and mineral reservoirs with longer mean residence times that can be accessed through microbially and plant-mediated processes. Strategic use of varied nutrient sources, including inorganic fertilizers, combined with increases in plant diversity aimed at expanding the functional roles of plants in agroecosystems will help restore desired agroecosystem functions. To develop crops that can thrive in this environment, selection of cultivars and their associated microorganisms that are able to access a range of nutrient pools will be critical. Integrated management of biogeochemical processes that regulate the cycling of nutrients and carbon combined with increased reservoirs more readily retained in the soil will greatly reduce the need for surplus nutrient additions in agriculture.

Factors affecting cetacean bycatch in a New Zealand trawl fishery (2007)
Du Fresne,S.P.; Grant, A.R.; Norden, W.S.; Pierre, J.P.
Department of Conservation (New Zealand)

Spatial Information: Data collected from eight Fisheries Management Areas (FMAs) in New Zealand waters (which cover NZ's entire coastline).
Keywords: classification tree analysis, common dolphin, *Delphinus delphis*, aihe, bycatch, trawl, jack mackerel, *Trachurus novaezelandiae*, observer data, New Zealand

Summary: Incidental catch of cetaceans in commercial fisheries is a global phenomenon, occurring across a range of fishery types and affecting numerous species. In some cases such interactions have led to population declines, and may threaten viability of cetacean populations or species. In New Zealand, common dolphin (*Delphinus delphis*) bycatch often occurs during trawling for the commercial fish species jack mackerel (*Trachurus novaezelandiae*). Data gathered by New Zealand fisheries observers between the 2001/2002 and 2004/2005 fishing years (i.e. 01 October 2001 to 30 September 2005) were collated and examined to identify risk factors contributing to common dolphin bycatch in the jack mackerel trawl fishery. Exploratory analysis suggested that geographical area (represented by Fisheries Management Areas) had the most influence on dolphin bycatch. All observed bycatch events occurred in three out of eight Fisheries Management Areas. Using classification tree analysis, fishing depth emerged as an important predictorvariable for dolphin bycatch during trawl tows for jack mackerel. Other potentially important predictors were total winch time and light conditions. Because of a large amount of missing data, extreme caution must be taken in generalising these results, but recommendations are made for future observer programmes and data management.

Evaluation of the impacts of finfish farming on marine mammals in the Firth of Thames (2008)
Du Fresne, S.P.
Environment Waikato

Spatial Information: Firth of Thames, Waikato, New Zealand
Keywords: marine mammals, dolphin*, whale*, cetacean*, aihe, patu paraoa, entanglement risk, habitat exclusion, vessel disturbance, New Zealand, Thames-Coromandel District, aquaculture, marine farming, aquaculture management areas, finfish aquaculture, environmental impact,

Summary: Aquaculture in New Zealand is dominated by the Greenshell™ mussel, however it is expected that finfish aquaculture will expand in coming years. Environmental Waikato is scoping a plan change that would allow finfish aquaculture to be developed within existing aquaculture management areas (AMA) currently used for mussel farming. This report seeks to identify those marine mammal species most likely to be at risk from such activities. Impacts, associated risks, and ecological consequences are identified and discussed. The marine mammal species most likely to be encountered in the Firth of Thames include: short-beaked common dolphins (*Delphinus delphis*); bottlenose dolphins (*Tursiopstruncates*); killer whales (orca; *Orcinus orca*); Bryde's whales (*Balaenopteraedeni/bry dei*); and various species of beaked whales. Additionally, the neighbouringHauraki Gulf contains a high diversity of marine mammals, including those already listed, as well as: humpback whales (*Megaptera novaeangliae*); southern right whale (*Eubalena australis*); pilot whales (*Globicephala* sp.); and minke whales (*Balaenoptera acutorostrata/bonaerensis*). Three possible effects of finfish aquaculture on marine mammals were identified: entanglement; habitat exclusion; and vessel disturbance. Entanglement will be a greater risk for small cetaceans such as short-beaked common dolphins and bottlenose dolphins. Entanglement risk is currently well-managed by the aquaculture industry in areas of New Zealand where salmon farms exist, and there have been only three known cases of dolphin fatalities after becoming entangled in predator nets in over 25 years. Operational practices and net designs have improved such that entanglement should be a minor risk, however this will need to be monitored. Habitat exclusion and vessel disturbance are potential risks for many marine mammals that utilise the Firth. A paucity of data makes assessment difficult; however clear mitigation strategies exist should future surveys and monitoring determine these risks to be significant.

The future of seagrass meadows (2002)
Duarte, C. M.
Environmental Conservation

Spatial Information: Review on seagrass (in general) world wide
Keywords: seagrass, *Zostera* , eel grass, conservation, status, perspectives, global change

Summary: Seagrasses cover about 0.1–0.2% of the global ocean, and develop highly productive ecosystems which fulfil a key role in the coastal ecosystem. Widespread seagrass loss results from direct human impacts, including mechanical damage (by dredging, fishing, and anchoring), eutrophication, aquaculture, siltation, effects of coastal constructions, and food web alterations; and indirect human impacts, including negative effects of climate change (erosion by rising sea level, increased storms, increased ultraviolet irradiance), as well as from natural causes, such as cyclones and floods. The present review summarizes such threats and trends and considers likely changes to the 2025 time horizon. Present losses are expected to accelerate, particularly in South-east Asia and the Caribbean, as human pressure on the coastal zone grows. Positive human effects include increased legislation to protect seagrass, increased protection of coastal ecosystems, and enhanced efforts to monitor and restore the marine ecosystem. However, these positive effects are unlikely to balance the negative impacts, which are expected to be particularly prominent in developing tropical regions, where the capacity to implement conservation policies is limited. Uncertainties as to the present loss rate, derived from the paucity of coherent monitoring programmes, and the present inability to formulate reliable predictions as to the future rate of loss, represent a

major barrier to the formulation of global conservation policies. Three key actions are needed to ensure the effective conservation of seagrass ecosystems: (1) the development of a coherent worldwide monitoring network, (2) the development of quantitative models predicting the responses of seagrasses to disturbance, and (3) the education of the public on the functions of seagrass meadows and the impacts of human activity.

Influence of light intensity and nutrient source on delta C-13 and delta N-15 signatures in *Ulva pertusa*(2010)
Dudley, B. D.; Barr, N. G.; Shima, J. S.
Aquatic Biology

Spatial Information: Experiments conducted at Leigh Marine Laboratory, New Zealand
Keywords: plants, sea lettuce, *Ulva pertusa*, nutrient enrichment, trophic linkages, nitrogen, phosphorus, light availability, algae, New Zealand, Leigh Marine Laboratory

Summary: Stable isotopes are increasingly used to infer sources of nutrient enrichment and trophic linkages in coastal marine systems, although the utility of these tools often depends upon a predictable expression of delta N-15 and delta C-13 signatures by primary producers. Accordingly, we examined how tissue delta N-15 and delta C-13 values change in the common coastal marine alga *Ulva pertusa* Kjellman under contrasting light and nutrient treatments. In Expt 1, we manipulated nitrogen and phosphorus enrichment and light availability in a factorial design and found that: (1) delta C-13 values in the tissue of *U. pertusa* depended upon interactions between light and nutrient availability, and there was no clear, overarching relationship between tissue delta C-13 values and growth rate; and (2) these effects yielded a substantial (11.6 parts per thousand) range of variation in delta C-13 values. In Expt 2, we manipulated natural light (shaded versus unshaded) and nitrogen form (nitrate versus ammonium) in a factorial design and found that (3) delta N-15 of *U. pertusa* tissue was closely tied to delta N-15 of source nitrogen under all treatments and (4) delta N-15 differences between high and low light treatments were largest when *U. pertusa* was supplied with ammonium (3.7 parts per thousand), relative to nitrate (0.8 parts per thousand). The variation in delta C-13 values has implications for studies that use stable isotopes to infer trophic relationships in coastal marine environments, where gradients in nutrient concentration and light availability are common. The comparatively small range of delta N-15 values expressed in *U. pertusa* supplied with nitrate confirms that this species represents a good proxy for delta N-15 of biologically available nitrogen in nitrate-dominated coastal seawater.

Algal and invertebrate bio-indicators detect sewage effluent along the coast of Titahi Bay, Wellington, New Zealand (2010)
Dudley, B.D.; Shima, J.S.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Elsewhere in New Zealand: Titahi Bay, Wellington.
Keywords: plants, sea lettuce, Ulva, Wellington, New Zealand, sewage treatment plant*, bioindicator*, food web, *Carpophyllum maschalocarpum, Amphoroidea media*, *Petrolisthes elongates*, carbon ratios, isotope*, nutrients

Summary: The article presents a study on the use of *Carpophyllum maschalocarpum, Amphoroidea media*, and *Petrolisthes elongates* as bioindicators at Titahi Bay wastewater treatment plant (TWTP) in Wellington, New Zealand. The study uses δ^{15}N andδ^{13}C ratios to examine the bioindicators. It reveals the importance of multiple-isotope and multi-species bioindicator approaches in sewage dispersal patterns and integration of sewage-derived nutrients into food webs.

3.5. E

Short term monitoring of biotic change in Tasmanian marine reserves (1997) Edgar, G. J.; Barrett, N. S.
Journal of Experimental Marine Biology and Ecology

Spatial Information: Off the eastern Tasmanian coast, Australia.
Keywords: plants, macroalgae, fish; invertebrates; marine reserve; Tasmania; temperate reef; visual census, ANOVA design

Summary: Fishes, large invertebrates and macroalgae inside four marine reserves and at associated external reference sites off the eastern Tasmanian coast were censused between 1992 and 1993 shortly after the declaration of the reserves. Changes in several population parameters during the first year of protection in the largest Maria Island Marine Reserve were examined using two different ANOVA designs. The densities of rock lobsters and sea urchins and the mean sizes of wrasse, leatherjackets, abalone and rock lobsters all increased within the reserve relative to outside over the first year; however, only the increases in density of sea urchins and mean abalone size were statistically significant at the 5% level. The census methodology and statistical techniques nevertheless were considered sufficiently sensitive to reveal any long term change following future censuses. A doubling in population numbers of most large fishes and invertebrates, or a 10% increase in the mean size of animals, is required to indicate that significant change has occurred.

The Letters and Journals of Samuel Marsden 1765-1838 *senior chaplain in the colony of New South Wales and superintendent of the mission of the Church missionary society in New Zealand*(1932)
Elder, J.R. (Ed.)
Coulls, Somerville, Wilkie and A. H. Reed for the Otago University Council

Spatial Information: New Zealand
Keywords: Church Missionary Society, missions New Zealand, New Zealand colonial history, Māori

Summary: Rev. Samuel Marsden was a chaplain, magistrate, agriculturalist, and missionary who founded the Christian mission in New Zealand. Reaching New Zealand nearly half a century after Cook's first visit, Marsden arrived with the definite intention of giving Maori knowledge of the religion and industrial arts of Western Europe. Marsden's journals, so far as New Zealand is concerned, cover the period from 1814 when the Mission was first established at the Bay of Islands to 1838 when he died. The transcripts were used by Elder for his book 'The Letters and Journals of Samuel Marsden 1765-1838' published in Dunedin in 1932. Dr T.M. Hocken spent years of his life collecting Marsden material, as he intended to write a book dealing with the journals and life of Marsden. The collection includes transcripts of Marsden

journals and correspondence, as well as biographical papers, publications and illustrations.

Simplified Tool for Estuary Erosion/Deposition Risk Assessment (2007)
Elliott, A. H.; Green, M. O.; Altenberger, A.; Basher, L.
Modelling and Simulation Society of Australia and New Zealand

Spatial Information: Model 'testbed' is Raglan Harbour (New Zealand) and its catchment
Keywords: erosion, catchment, estuary, sedimentation, model, decision support system, New Zealand

Summary: Increased sediment runoff from the land poses serious threats to estuaries in New Zealand that need to be managed to enhance and protect estuarine ecosystems. In the past, sediment risks have been assessed using detailed physically based erosion and deposition models. However, a recent survey found that resource managers have a need for relatively simple and accessible tools for conducting risk assessment associated with sediments (at both the long-term and event timescales) as a function of land-use and potential mitigation measures. To satisfy this need we have developed a prototype decision support tool for application by resource managers. The tool allows for capturing the summary properties of more detailed models, or the expert-based assessment of system component behaviour, within a desktop based tool. The tool enables the land manager to rapidly identify changes in risk and costs associated with modifications to proposed land-uses and mitigation scenarios. In this paper, we summarise the findings from the user needs survey, outline the design of the decision support framework, and present the features of a prototype model.

A guide for assessing effects of urbanisation on flow-related stream habitat (2004)
Elliott, S.; Jowett, I.G.; Suren, A.M.; Richardson, J.
NIWA

Spatial Information: Not spatially specific
Keywords: stream, New Zealand, urban, effect, impact, model, benthic ecosystem, stream flow, guide

Summary: Urban streams in New Zealand are becoming increasingly valued, not only for their recreational amenity value but also for their intrinsic biological value. Consequently, there is increasing interest in methods for assessing and predicting the effects of urbanisation on stream biota and in measures to mitigate the detrimental effects of urbanisation on aquatic ecosystems. This guide describes how urbanisation affects stream flows, and how such changes in flow affect stream habitat and stream biological communities. It provides a process and techniques to quantify the effect of urbanisation on flows (baseflow and storm flow) and the stream channel (channel width and bed mobilisation), and methods for assessing the effects of these habitat changes on stream communities. Methods to mitigate the effects of urbanisation on flow-related aspects of stream habitat are also summarised.

Tauranga Harbour sediment study: catchment model results (2010)
Elliott, S.; Parshotam, A.; Wadhwa, S.

NIWA

Spatial Information: Southern Tauranga Harbour - Matahui Point to Rangataua Bay.
Keywords: sedimentation, Environment Bay of Plenty, Tauranga Harbour, Te Awanui, benthic communities, species richness, biodiversity, climate change, catchment model

Summary: In order to better understand sediment sources and the fate of sediment entering Tauranga Harbour, Environment Bay of Plenty contracted NIWA to conduct the Tauranga Harbour Sediment Study. The outcome of the study will be to appropriately manage growth and development now and in the future. This knowledge will assist in adapting and prioritising management rules and practices for the catchment and harbour with a full understanding of likely sedimentation effects for changes expected in land-use and the anticipated effects of climate change by 2051.

Determining effects of suspended sediment on condition of a suspension feeding bivalve (*Atrina zelandica*): results of a survey, a laboratory experiment and a field transplant experiment (2002)
Ellis, J.; Cummings, V.; Hewitt, J.; Thrush, S. F.; Norkko, A.
Journal of Experimental Marine Biology and Ecology

Spatial Information: Elsewhere in New Zealand: Big Bay, near Mahurangi Estuary, North Island.
Keywords: horse mussel, *Atrina zelandica* (Gray), kukuroa, suspended sediment flux; condition; transplant experiment; field survey; suspension feeding bivalve; turbidity; physiological condition; estuary; New Zealand; storms

Summary: The horse mussel *Atrina zelandica* (Gray) is a large, suspension feeding pinnid bivalve, common in coastal and estuarine areas of northern New Zealand. As a suspension feeder, *Atrina* is likely to be influenced by suspended sediment loads. We conducted a laboratory experiment to determine the effect of short-term elevations in turbidity levels, such as those commonly recorded during storms, on the physiological condition and clearance rates of *Atrina*. We also conducted a field survey and a 3-month transplant experiment at multiple sites along a gradient of increasing suspended sediment load in a New Zealand estuary. Laboratory clearance rates of *Atrina* declined above a threshold suspended sediment concentration, and *Atrina* physiological condition at the end of this experiment was lower in high cf. low turbidity treatments. Decreases in *Atrina* condition were detected after exposure to elevated levels for only 3 days. The field survey and transplant experiment provided empirical evidence of a strong, negative effect of increasing suspended sediment flux on the physiological condition of *Atrina*. We suggest that relationships between the physiological condition of suspension feeders and sediment settling flux could provide a link between sediment inputs, which commonly occur as a result of catchment runoff during rainfall events, and the ecological health of estuarine and shallow coastal areas. Our study also demonstrated that *Atrina* have a natural distribution limit controlled by suspended sediment load. Thus, there is potential for larger-scale functional and structural effects on benthic communities in estuarine and coastal areas with high rates of sedimentation.

Effects of terrigenous sedimentation on mangrove physiology and associated macrobenthic communities (2004)
Ellis, J.; Nicholls, P.; Craggs, R.; Hofstra, D.; Hewitt, J.
Marine Ecology Progress Series

Spatial Information: Elsewhere in New Zealand: Mangemangeroa Estuary and Waikopua Estuary, Auckland, North Island.
Keywords: mangrove, *Avicennia marina*, manawa, benthic community composition, sedimentation, growth, physiological condition, estuary, New Zealand

Summary: In New Zealand, one species of mangrove, *Avicennia marina* var. *australasica*, forms a characteristic and often extensive feature of the tidal mudflats of harbours and estuaries. Within their natural range, mangroves have generally increased in abundance in New Zealand over the last 100 years in response to increased sedimentation associated with concurrent changes in catchment land use. However, little information is available about the ecological consequences of changes in the extent of mangrove habitats under varying sedimentation regimes. We therefore conducted a study to determine the effects of high sedimentation rates on mangrove plant communities and associated benthic community composition. We selected an estuary that is experiencing high rates of sedimentation (as high as 23 mm yr–1) and associated increases in mangrove area. We recorded clear differences in both plant and benthic communities along a gradient of decreasing sedimentation. Mangrove architecture (such as height and density of plants) and health (as measured by chlorophyll a fluorescence) were linked to high mud content of the sediment and elevated sedimentation patterns. Mangrove plants at the upper landward sites, characterised by a high percentage of mud and high total nutrients (total phosphorus [TP] and total nitrogen [TN]) and organic content, were taller than those at the seaward sites and had a larger number of pneumatophores as well as the greatest number of new seedlings. However, benthic macrofaunal diversity and abundance within the mangrove habitats were lower than expected, and clear functional differences were found between habitats with differing sedimentation patterns. Sites with high sedimentation rates had lower numbers of suspension feeders, low macrobenthic diversity, and were dominated by deposit-feeding polychaetes and oligochaetes. The diversity and density of benthic macrofaunal communities was, however, lower than that of sandflat communities for both mangrove habitats and adjacent intertidal mudflats in these sheltered areas, suggesting a response to the increased silt/clay from sedimentation rather than to the mangroves themselves. Our study demonstrates the potential for functional and structural effects on benthic communities on a larger spatial scale in estuarine areas experiencing high rates of sedimentation.

Te Awanui Tauranga Harbour Iwi Management Plan (2008)
Ellis, K; Ngatai, K; Piahana, T; Dickson, B; Palmer, H; Smallman, R; Bennett, P; Kuka, N; Coffin, A; Cooper, H; Kaiawha, D
Te Rūnanga o Ngāi Te Rangi

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, iwi management plan, fishery, customary fisheries, shellfish, macroinvertebrate, Matauranga Māori, kaitiaki, rangatira, environmental management, indigenous rights, shellfish, kaimoana, water quality,

sewerage discharge, stormwater, sedimentation, erosion, reclamation, urban development, recreation activities

Summary: The Te Awanui, Tauranga Harbour, Iwi Management Plan was commissioned by the Tauranga Moana iwi, being a statement of Ngāi Te Rangi, Ngāti Ranginui and Ngāti Pūkenga values and perspectives with regard to harbour management. This document is prescribed as an indigenous tool created by tangata whenua to carry out their function as kaitiaki and rangatira over their ancestral waters, Te Awanui (Tauranga Harbour). Te Rūnanga o Ngaiterangi Iwi Trust is the tribal iwi authority for the hapū of Ngāi Te Rangi. Te Rūnanga o Ngāti Ranginui is the tribal iwi authority for the hapū of Ngāti Ranginui and Ngāti Pūkenga ki Tauranga Trust is the tribal iwi authority for the hapū of Ngāti Pūkenga. This plan has been produced by members of the three iwi in conjunction with the whānau, hapū and iwi of Tauranga Moana as an Iwi Management Plan for Te Awanui. Te Awanui is a traditional name for the Tauranga Harbour, given by the whāänau, hapū and iwi of Ngāi Te Rangi, Ngāti Ranginui and Ngāti Pūkenga for the Tauranga Harbour. Hence, the revival of the name, Te Awanui is given in title for this document. This is the beginning of a series of kōrero, meetings with other stakeholders to implement the objectives, policies and actions within. The Tauranga Moana Iwi reserve the right to re submit an annual review of this document as required.

Impacts of Sediment Burial on Mangroves (1999)
Ellison, J.C.
Marine Pollution Bulletin

Spatial Information: Review of worldwide mangrove deaths due to rapid sedimentation.
Keywords: mangrove species, sediment, burial, death, rehabilitation, *Avicennia*, *Rhizophora*, *Laguncularia*, *Sonneratia*

Summary: Aerial roots are a common adaptation of mangrove trees to their saline wetland habitat, allowing root respiration in the anaerobic substrate. While mangroves flourish on sedimentary shorelines, it is shown here that excess input of sediment to mangroves can cause death of trees owing to root smothering. Descriptions of 26 cases were found in the literature or described here, where mangroves have been adversely affected by sediment burial of roots. The impacts ranged from reduced vigour to death, depending on the amount and type of sedimentation, and the species involved. There isinsufficient data to establish specific tolerances. For rehabilitation, where the disturbance was a past event, the elevation change must be assessed in selection of species for replanting, and field trials are required in areas where rapid accretion is an ongoing problem.

Two new species of the marine genus *Limnodriloides* and a record of *Tubificoides fraseri* Brinkhurst (Oligochaeta: Tubibicidae) from New Zealand (1989)
Erseus, C.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Otago Harbour, Manukau Harbour and Tauranga Harbour, New Zealand.
Keywords: Invasive species, Oligochaeta; Tubificidae; *Limnodriloides thrushi*; *L. insolitus*; new species; *Tubificoides fraseri*; taxonomy; New Zealand

Summary:*Limnodriloides thrushi* n. sp., from subtidal muddy sands in Otago Harbour, South Island, New Zealand, and *L. insolitus* n. sp., from a mudflat in Tauranga Harbour, North Island, New Zealand, are described. The first species has both (grooved) spermathecal and (bifid) penial setae, and bears its maleporesonapair of bulbous protuberances in segment XI. The latter has a pair of styliforrn penes, of a kind unique for the genus. The estuarine, parthenogenetic (self-fertilising), species *Tubificoides fraseri* Brinkhurst, 1986, previously known from North America and Australia, is also reported from Manukau Harbour, Auckland, New Zealand.

3.6. F

Polychlorinated biphenyls: human health aspects (draft) (2003)
Faroon, O.M.; Keith, L.S.; Smith-Simon, C.; De Rosa, C.T.
World Health Organisation

Spatial Information: Not spatially specific.
Keywords:organic pollutants, polychlorinated biphenyls, PCBs, toxic, adverse affects, risk assessment, environmental exposure, health,

Summary: The Agency for Toxic Substances and Disease Registry, Division of Toxicology, prepared this CICAD on polychlorinated biphenyls (PCBs) based on the updated Toxicological profile for polychlorinated biphenyls (PCBs) (ATSDR, 2000). In addition, several articles based on the source document can be consulted for details on each of several health end-points considered important in this CICAD (Faroon et al., 2000, 2001a,b). Information on the nature of the peer review and the availability of the source document is presented in Appendix 1. Information on the peer review of this CICAD is presented in Appendix 2. This CICAD was approved as an international assessment at a meeting of the Final Review Board, held in Ottawa, Canada, from 29 October to 1 November 2001. Participants at the Final Review Board meeting are listed in Appendix 3. The International Chemical Safety Card (ICSC 0939) for polychlorinated biphenyl (Aroclor 1254), produced by the International Programme on Chemical Safety (IPCS, 2000), has also been reproduced in this document. PCBs are synthetic chlorinated hydrocarbon compounds that consist of two benzene rings linked by a single carbon-carbon bond, with from 1 to all 10 of the hydrogen atoms replaced with chlorines. PCBs have been produced commercially since 1929. They have been used in plasticizers, surface coatings, inks, adhesives, flame retardants, pesticide extenders, paints, and microencapsulation of dyes for carbonless duplicating paper.

Aspects of hopper washings disposal and storm runoff water quality from the log handling areas at the Port of Tauranga (1993)
Fengming, T.
University of Waikato

Spatial Information: southernTauranga Harbour, New Zealand
Keywords:water quality, logging, environmental aspects, runoff, stormwater, port, cargo holding, Tauranga Harbour, Te Awanui

Summary: This thesis looks at aspects of hopper washing disposal and storm runoff water quality from the log handling areas at the Port of Tauranga. Port of Tauranga is a very large site with a complex array of industrial activities and processes.

Environmental aspects of storm runoff discharge from a timber port, Tauranga, New Zealand (1997)
Fengming, T.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: runoff, environmental aspects, logging, water quality, Tauranga Harbour, Te Awanui, port, stormwater, discharge

Summary: Regional Council and Port staff meet regularly to discuss compliance issues. Council staff have noted significant improvements to Port processes in recent years, including the establishment of an ongoing mechanical sweeping programme.Within this sweeping programme more than 90 percent of Port sweepings (things like bark and wood chips, salt, palm kernel, and stock feed) are collected and taken off-site for disposal, keeping it entirely free of the drains. Other actions at the Port include:

- Storm water 'catch pits' that collect waste headed for the stormwater drain; like the sweepings, this waste is collected and taken off-site for disposal
- Sealing of all wharf and port operational areas
- Slot drains and eight-screen chambers used for stormwater treatment in higher-risk areas
- Shade cloth installed to reduce dust beyond the boundary of the Port.

Relationships between indicators, pathogens and water quality in an estuarine system (1996)
Ferguson, C. M.; Coote, B. G.; Ashbolt, N. J.; Stevenson, I. M.
Water Research

Spatial Information: Sydney, Australia.
Keywords:indicators, pathogen, water quality, enteric virus, *Giardia*, *Cryptosporidium*, *Clostridium perfringens*, *Cryptosporidium* oocysts, *Escherichia coli*, coliphages, viruses, sediment, survival, marine, Australia

Summary: This study examined water and sediment samples for a range of indicator and pathogenic microorganisms from six sites in an urban estuary, Sydney, Australia. Water quality was affected by rainfall and sewage overflows which were associated with significant increases in the concentration of faecal coliforms, faecal streptococci, *Clostridium perfringens* spores, F-RNA bacteriophage, *Aeromonas* spp., *Giardia*and *Cryptosporidium* spp. However, in sediments, only faecal coliform concentrations were significantly increased by rainfall, although sewage overflow again resulted in increased concentrations of faecal coliforms, faecal *streptococci*, *C. perfringens* spores and *Aeromonas*. Isolation of *Salmonella* appeared to coincide with wet weather events and occasionally identical serotypes were detected in sediments at several locations within the estuary. However, isolations of enteric virus were sporadic and did not appear to be exclusively related to wet weather events. *C.*

perfringens was identified as the most useful indicator of faecal pollution and was the only indicator significantly correlated to the presence of pathogenic *Giardia* ($r = 0.41$, $p < 0.05$) and the opportunistic bacterial genus *Aeromonas* ($r = 0.39$, $p < 0.05$). F-RNA bacteriophage was not significantly correlated with any of the pathogens examined.

Eastern Region – Hunting Regulations (2011)
Fish and Game New Zealand
Fish and Game New Zealand

Spatial Information: Bay of Plenty, New Zealand
Keywords: Fish and Game Eastern Region, game bird species, A1 area definition

Summary: This is a web page from Fish & Game New Zealand displaying (map) the Eastern Fish & Game bird hunting areas (A1, A2, B1, B2). It also gives a written description of these areas, along with species that may be hunted or killed for the duration of the season in a particular area and allowable shooting hours.
http://www.fishandgame.org.nz/Site/Regions/Eastern_HawkesBay/huntingRegulations.aspx

The issues concerning the use, control and management of Tauranga Harbour and its estuaries: a combined report (*Wai 215*) (1997)
Fisher, A.; Piahana, T.; Black, T. A.; Ohia, R.
Waitangi Tribunal

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, Treaty of Waitangi, Wai 215, Ngai Te Rangi, Ngati Ranginui, Ngati Pukenga, estuary management

Summary: The Tauranga Harbour is an extensive estuarine and deep water harbour in the Western Bay of Plenty which is bounded on its landwards side by approximately 280 kilometres of shoreline extending from Mauao at the eastern end, around to Bowentown at the western end. With the exception of a narrow entrance at each end, the Harbour is fully enclosed and is protected from the open coast by Matakana Island which runs parallel to the shoreline from Mauao to Bowentown. Although Ngai Te Rangi, Ngati Ranginui and Ngati Pükenga exist as separate economic, political and social entities, they are bound together through whakapapa, proximity to and intermarriage with each other, a common relationship with the Harbour and the effects of the alienation of their resources by the Crown and its agents.

Grey-Faced Petrel Project 2001, Marine Studies report no. 116 (2001)
Fitzgibbon, J.
Bay of Plenty Polytechnic

Spatial Information: Mauao and Motuotau (Rabbit) Island, Tauranga, Bay of Plenty, NZ
Keywords: seabirds, grey-faced petrel, *Pterodroma macroptera gouldi*, North island muttonbird, Oi, Mauao, Mount Maunganui, Motuotau Island, Rabbit Island, habitat, behaviour

Summary: As a requirement of the Diploma in Marine Studies course 2001, the following students, with the help of Hugh Clifford of the Ornithological Society of New Zealand (OSNZ), studied and banded a species of bird, the Grey-faced Petrel, at Mauao (Mount Maunganui) and Motuotau Island: Joshua Fitzgibbon, Henry Vaughton, Charl Naude, Wayne Goodchild and Meghann Dara-Dee.
This report is only a section of the overall report, with the focus on the Motuotau (Rabbit) Island colony site, with references to the Mauao colony site.
The aim of this report is to provide a detailed background on the Grey-faced petrel's biology and history of conservation. The focus is on the factors that affect the population of breeding colonies and the methods used to band and process petrels. This report describes the Motuotau Island colony site and draws comparisons with the Mauao colony site.The results show a larger population density at Motuotau Island than at Mauao, although actual figures on this were not obtained. Site comparisons show a similarity in vegetation species that occupy Motuotau Island and Mauao. Differences in the growth of this vegetation relate to the burrow descriptions and population numbers of the respective sites.

The state of world fisheries and aquaculture(2000)
Food and Agriculture Organization of the United Nations (Fisheries and Aquaculture Department)
Food and Agriculture Organization of the United Nations

Spatial Information: Worldwide
Keywords: fisheries, aquaculture, marine farming

Summary: This is the third issue of The State of World Fisheries and Aquaculture. It follows the pattern set by the previous issues, published in 1996 and 1998. The purpose continues to be to provide policy-makers, civil society and those who derive their livelihood from the sector a comprehensive, objective and global view of capture fisheries and aquaculture, including associated policy issues.

The World's Mangroves 1980-2005: A Thematic Study prepared in the framework of the Global Forest Resources Assessment 2005 (2007)
Food and Agriculture Organisation of the United Nations
Food and Agriculture Organisation of the United Nations

Spatial Information: Worldwide
Keywords: plants, mangroves, manawa, habitat, population, resource, threats, conservation, management, *Avicennia marina*, *Rhizophoraceae, Avicenniaceae, Combretaceae, Bruguiera, Camptostemon, Ceriops, Conocarpus, Cynometra, Aegiceras, Acrostichum, Acanthus, Excoecaria, Heritiera, Kandelia, Laguncularia, Lumnitzera, Nypa, Osbornia, Osbornia, Pelliciera, Pemphis, Scyphiphora, Sonneratia, Xylocarpus*

Summary: High population pressure in coastal areas has led to the conversion of many mangrove areas to other uses and numerous case studies describe these mangrove losses over time. Nevertheless, information on the current status and trends in the extent of mangroves at the global level arescarce.With the preparation of the present report, FAO aims to facilitate access to comprehensive information on the current and past extent of mangroves in all countries and areas in which they exist. The information provided in this report, as well as the gaps in information that it

highlights, will serve as tools for mangrove managers and for policy- and decision-makers worldwide.

Environmental impacts of recent dredging and inner shelf spoil disposal at Tauranga (1992)
Foster, D.M.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand – Mt Maunganui Beach, Motuotau & Moturiki Islands
Keywords: Sedimentation, Dredging, Mt Maunganui Beach, Benthic community, Molluscs, Moturiki, Motuotau, Leisure Island, Rabbit Island, Marine ecology

Summary: This thesis looks at the area where dumping of dredge material occurs off Mount Maunganui. The study includes a survey of the extent to which biological recolonisation of the dump ground occurred. Some species including pipi that survived the dredge were found to be living on the inner shelf. The study also looked at the effect of the dredge dumping on the rocky reef surrounding islands such as Motuotau and Moturiki. The study includes information about the ecology and biology of the inner shelf area off Mount Maunganui as well as the rocky reef environments of Moturiki and Motuotau.

Environmental impacts of a recent dredge spoil dumping operation off Tauranga, New Zealand (1991)
Foster, D.M.;Healy, T.R.;Warren, S.K.
Coastal Engineering: Climate for Change; Proceedings of the 10th Australasian conference on Coastal and Ocean Engineering.

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Plants, macroalgae, dredging spoil, sedimentation and deposition, Waste disposal in the ocean

Summary: The environmental impacts of a recent dredge spoil dumping episode are discussed. Techniques used to determine firstly the extent of spoil dispersal, and secondly the environmental impacts of spoil dispersal are outlined. The results are then presented. It is concluded that in the six months since dumping finished, spoil dispersal from the dump ground has been minimal, and that the greatest environmental impact resulted from burial of benthic organisms where most of the spoil dumping was concentrated.

Environmental impacts of a recent dredge spoil dumping operation off Tauranga, New Zealand (n.d.)
Foster, D.M.;Healy, T.R.;Warren, S.K.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Benthic Fauna, Benthic organisms,dredge spoil dumping

Summary: Foster, Healy and Warren (n.d.) reported on the environmental impact of the dredge spoil dumping off the coast from Mt. Maunganui. The benthic organisms were sampled 3 months after the dumping was completed. The study concluded that

the diversity of the organisms in the site had reduced by around 60% in and around the dumping zone. The most common organisms in the dump ground were worms such as *Epigonichthys hectori* and also hermit crabs. The major differences between the spoil and unspoiled sites were in the number of species of molluscs. The unspoiled sites had greater diversity of molluscs. The accumulation of sediment in the dump ground included a single species of pipi *Paphies australis* which was present in large numbers. This pipi is not normally found in this environment and is thought to have survived the dredging operation and colonised from the dredge spoil removed from inside the harbour. The main conclusion of the report was that organisms can cope with small increases in sediment levels.

Beach nourishment from a near-shore dredge spoil dump at Mount Maunganui beach (1991)
Foster, G.A.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand – Mount Maunganui Beach
Keywords: Mount Maunganui Beach; Sediment; Benthic community; Molluscs

Summary: This study looks at the sediments of the near shore zone off Mount Maunganui Beach prior to dumping of dredged materials. Investigations were also made into the benthic community prior to, during and after the dumping of dredge spoil. It was found that the zone was repopulated quickly after dumping. The study includes information about near shore sediment patterns, sea floor characteristics and a benthic survey.

Sediment budget equilibrium beach profiles applied to re-nourishment of an ebb tidal delta adjacent beach, Mt. Maunganui, New Zealand (1994)
Foster, G.A., Healy, T.R., & de Lange, W.P.
Journal of Coastal Research

Spatial Information: Tauranga Harbour, New Zealand – Mount Maunganui Beach
Keywords: Dean's Equilibrium Beach Profile model, Tauranga Harbour, Mount Maunganui Beach, beach nourishment, volume analysis, dredging

Summary: An ebb tidal delta adjacent beach was nourished by placement of dredged material in water depths of 4-7 m below Chart Datum. The beach and nearshore were subsequently monitored with accurate integrated beach-nearshore surveys along 7 transects. All the nourishment material could be accounted for by onshore movement resulting in 89 m^3 of accretion within 15 months of placement. Application of the Dean's Equilibrium Beach Profile model, before, during and after disposal, indicated that before nourishment the beach-nearshore profiles exhibited a deficit of sediment throughout their length. After nourishment, the profiles adjusted towards the equilibrium profile predicted by the model.

Predictive models of small fish presence and abundance in northern New Zealand harbours (2005)
Francis, M.P., Morrison, M.A.,Leathwick, J., Walsh,C. and Middleton, C.
Estuarine, Coastal and Shelf Science

Spatial Information: Elsewhere in New Zealand – Northern New Zealand Harbours

Keywords: Fishery, fish, estuaries, Sea grass, harbours, GAM, environment, predictions, modelling, New Zealand

Summary: A broad-scale, small-fish survey was carried out in northern New Zealand inshore waters using beach seines. The survey covered 30 estuaries spanning ca 1000 km of coastline and three degrees of latitude. Correspondence analysis and cluster analysis were used to identify assemblages, and Generalized Additive Models (GAMs) were used to model the abundance and occurrence of individual species. We aimed to assess the utility of these models for making predictions. The results were mixed. Descriptive models of fish abundance performed well for four out of 12 species; for most other species, and species richness, the models described the data well but performed moderately to poorly, under cross validation. Predictive models of fish abundance usually performed worse than descriptive models, but appeared reasonable for four species. Presence-absence models performed better overall than abundance models: descriptive models showed good performance for all 12 species, and predictive models performed well for eight species. For an independent data set, the models successfully predicted occurrence for five species. Water clarity, salinity and the amount of freshwater inflow were important predictor variables. Despite the limitations of our GAMs, they should be useful for planning intensive process-based research, and for guiding the management of human activities that impinge on coastal marine environments.

Invasion of the Asian goby, *Acentrogobius pflaumii*, into New Zealand, with new locality records of the introduced bridled goby, *Arenigobius bifrenatus* (2003)

Francis, M.P.; Walsh, C.; Morrison, M.A.; Middleton, C.

New Zealand Journal of Marine and Freshwater Research

Spatial Information: Elsewhere in New Zealand – East coast of the North Island, Waitemata and Whangapoua Harbours

Keywords: Invasive species, *Acentrogobius pflaumii, Arenigobius bifrenatus*, goby, invasion, ballast water, bio-security

Summary: The Asian goby, *Acentrogobius pflaumii* (Bleeker, 1853), is reported from New Zealand waters for the first time. It was collected by beach seine in 2001-02 from muddy substrata in the upper reaches of the Waitemata and Whangapoua Harbours. We suggest that *A. pflaumii* has been introduced to New Zealand, probably in ship ballast water. It may have arrived directly from its native range in the north-west Pacific Ocean, or indirectly via Australia, which it invaded before 1996. The Australian bridled goby, *Arenigobius bifrenatus* (Kner, 1865), which is also thought to have invaded New Zealand via ballast water, is here recorded from three new locations, extending its known New Zealand range to five different harbours spanning c. 150 km of coastline. This species is more widespread than previously thought and appears well established. Both gobies have been found only on the east coast of the North Island.

Blooms of ulvoids in Puget Sound (2000)

Frankenstein, Gretchen.

Puget Sound Water Quality Action Team

Spatial Information: Overseas: Puget Sound – Drayton Harbour near the Canadian border to Eld Inlet near Olympia

Keywords: Plants, sea grass, sea lettuce

Summary: This report assesses the sea lettuce distribution and associated environmental conditions at a range of sites within the Puget Sounds. This is an attempt to identify the next step in investigating macroalgal blooms in Puget Sound. A model on sea lettuce blooms is also given which explores causal factors.

An investigation of eelgrass (*Zostera marina*) transplanting in San Francisco Bay, CA (1985)
Fredette, T.J.;Fonseca, M. S.;Kenworthy, W.J.;Wyllie-Echeverria, S.
U.S. Army Corp. of Engineers

Spatial Information: Overseas – San Francisco Bay, California
Keywords: Seagrass; Transplant; Photosynthesis; Carbon budget; *Zostera marina*

Summary: Survival, metabolism and growth of *Zostera marina L*. transplants were examined along depth gradients in Keil Cove and Paradise Cove in the extremely turbid San Francisco Bay estuary. Water transparency was unusually high throughout 1989–1990 for San Francisco Bay. Transplant survival was strongly depth-dependent at Paradise Cove but not at Keil Cove. All transplants were lost below − 1.0 m depth within 1 year at Paradise Cove, but survived to depths of − 1.5 m at Keil Cove. Half the transplants growing in shallow water survived the first year at both sites. Shoot photosynthesis, respiration, growth, and sugar content did not differ between sites. Daily periods of irradiance-saturated photosynthesis (Hsat) were over 6 h all year. Seasonal photosynthetic acclimation to light availability maintained long Hsat periods and high ratios of daily whole-plant production to respiration through the winter, indicating a potential for net carbon gain throughout the year. Winter growth was 50% of the summer rate. Despite high initial losses, surviving transplants have persisted at both sites through 1994. Although eelgrass transplants can succeed in San Francisco Bay given sufficient light availability, the role of carbon reserves and transplant timing may influence transplant survival.

Bloom dynamics in a seasonally forced phytoplankton-zooplankton model: Trigger mechanisms and timing effects (2006)
Freund,J.A.;Mieruch,S.;Scholze,B.;Wiltshire,K.; Feudel,U.
Ecological Complexity
Spatial Information: No Spatial context
Keywords: phytoplankton

Summary: The study developed an extension of the phytoplankton-zooplankton model used by Truscott and Brindley (1994) to describe the annually recurring phytoplankton blooms. The extension is a seasonal forcing of the phytoplankton growth rate driven by an oscillating temperature via a Q10 law. The authors observe bi-stable long-term behaviour of the ecological system, i.e. a bloom and non-bloom mode, the importance of timing, and noise-induced switchings between the bloom and non-bloom mode. We link the model results to existing Helgoland Roads long-term data series by analysing the latter using the novel method of bloom-triggered averaging, a tool borrowed from signal analysis of neurophysiological recordings. The study found that, on average, blooms are correlated with rapid upward temperature fluctuations and speculates on their possible role as trigger mechanisms.

Aquaculture - Join the Discussion: Summary of Submissions Received (2001)
Froude, V.
Ministry of Fisheries and Ministry for the Environment

Spatial Information: No spatial context
Keywords: aquaculture, marine farm, reform proposals (2005)

Summary: This report summarises submissions made on the public discussion document entitled "Aquaculture-Join the Discussion" released by the Minister of Fisheries, Hon. Pete Hodgson, in August 2000. The purpose of the discussion paper was to provide people with an opportunity to comment on proposals for the future management of aquaculture. At the end of June 2001 Pacific Eco-Logic Ltd. was asked to complete previous submissions analysis work and prepare a report for public distribution. A total of 242 submissions were received on the discussion paper.

Impact of Septic Tank Contamination at Te Puna (2003)
Futter, Paul
Environment Bay of Plenty

Spatial Information: Tauranga Harbour – Te Puna, New Zealand
Keywords: septic tank, contamination, monitoring, Bay of Plenty, Te Puna, on-site wastewater treatment system, effluent, sewage,

Summary: The On-Site Effluent Treatment Regional Plan became Operative in December 1996. Within the Plan, policies were developed to give guidance for the use of on-site effluent treatment systems.
The policies addressed:

a) The issue of contamination through poor maintenance and servicing of systems;
b) The lack of knowledge of what lay below the ground at each household;
c) The need for a maintenance programme to be developed; and
d) The need for continued environmental monitoring.

In December 2002 the Te Puna community agreed to join the maintenance programme of regular cleaning and inspection of their systems. The area covered by the programme incorporates 136 properties, including seven empty sections. Some sections may have more than one dwelling on them.This report discusses the results of the monitoring programme at Te Puna between 8 May 2002 and 26 May 2003, and the results of monitoring of septic tank systems up to June 2003. About 55% of systems reported so far have failed. As expected there is a predominance of failures around the Waitui Reserve but not an absence of failures elsewhere.

3.7. G

Beyond hard protection? An anthropological perspective on emerging coastal flood risk management practices in New Zealand (2010)
Gesing, F
International Research Training Group Intercoast: University of Bremen (Germany) and University of Waikato (New Zealand)

Spatial Information: New Zealand
Keywords: Coastal Flood, Risk Management

Summary: Currently, there are several processes of change that interact and impact upon coastal protection strategies in New Zealand: so-called coastal change (changes in settlement patterns, gentrification, increased development and subdivision of coastal areas), climate change (sea-level rise and increased coastal hazard) as well as changing paradigms in coastal protection practices and policies. Policy makers and planners in New Zealand, along withother industrialized countries,are becoming increasingly aware that,in the long run,it is not technically feasible to protect the shore through coastal armouring alone. Hard protection structures require very high investment, along with follow up costs and have negative environmental and social impacts. Ongoing erosive processes in front of seawalls induce coastal squeeze and preclude public use of the beach. The preservation of the natural coastline in the interest of the wider public is now measured against the demand for protective structures by beachfront property owners. This renunciation of so-called hard protection measures will be a starting point for a multi-local and multi-method ethnography of emerging coastal flood risk management practices in New Zealand.

The anthropological research project concentrates on how coastal protection is negotiated by different acting participants in the field. The main focus will be on discursive understandings and practices about nature as they are important for understanding different coastal protection strategies and technologies. The study will combine the main body of data gathered from extensive participant observation and semi-structured interviews with additional material, like newspaper articles, grey literature/brochures and policy documents, including submissions and protocols from the ongoing review process of the main regulative framework in the area, the New Zealand Coastal Policy Statement (NZCPS). Main objective is to investigate how coastal protection is negotiated, decided upon and carried out on a concrete, practical level. The focus of this study does not lie on an abstract, institutional level, but on every-day practices, informal processes of communication, networking and decision-making. Why are certain practices successful in claiming to be “state of the art” in coastal protection? What kind of discourses – especially those relying on certain understandings of nature, natural features and the natural character of the coast – back up certain techniques and policies to protect the coast? What role does “nature” as a concept play in defining the need for coastal protection measures in the first place? What role does the idea of managed retreat play as the ultimate opposite of altering the coast for the benefit of human use? How do coastal engineers, dune planting volunteers, scientists and other interested parties negotiate their perceptions of nature, coast, and protection.

Regional estuary monitoring programme: sediment monitoring (2003)
Gibberd, B.; Carter, N.
Environment Waikato Technical Report

Spatial Information: Elsewhere in New Zealand – Firth of Thames, Whaingaroa (Raglan) Harbour
Keywords: intertidal sediments, benthic macro-fauna communities.

Summary: In April 2001 Environment Waikato initiated the Regional Estuary Monitoring Programme (REMP) at permanent monitoring sites in the southern Firth of

Thames and Whaingaroa (Raglan) Harbour. The programme focuses on intertidal sediments and their benthic macro-fauna communities as "indicators" of the health of the Region's estuaries. The objective is to determine the current status of and monitor the temporal changes in benthic macro-fauna communities that may occur as a direct or indirect consequence of catchment activity and/or estuary development. Details of the rationale and design of the programme are provided in full in Turner (2000 and 2001).

Benthic nutrient fluxes along an estuarine gradient: influence of the pinnid bivalve *Atrina zelandica* in summer (2005)
Gibbs, M.; Funnell, G.;Pickmere, S.;Norkko, A.;Hewitt, J.
Marine Ecology Progress Series

Spatial Information: Mahurangi Harbour, New Zealand
Keywords: pinnid bivalve *Atrina zelandica,*Benthic nutrient fluxes, food web

Summary: Benthic nutrient fluxes (BNF) can supply 30 to 100% of the nutrient requirements of benthic and pelagic algae in an estuary, and can, thus, potentially sustain benthic and pelagic primary production within the estuarine food web. While BNF can be influenced by microbial processes, epibenthic suspension-feeding bivalves have the potential to alter fluxes by their influence on the community composition of surrounding macrofauna and benthic boundary conditions, and their feeding activities. In Mahurangi Harbour, New Zealand, the large suspension feeding pinnid *Atrina zelandica* (hereafter referred to as *Atrina*) occupies large areas of the harbour floor. Consequently, Atrina have the potential to substantially influence the BNF and, thus, primary production, and the food supply to the filter feeding community within the harbour, including the rack-farmed Pacific oyster aquaculture industry. Mahurangi Harbour is almost always isohaline, but exhibits a strong gradient in suspended sediment concentration, which declines from head to mouth. As *Atrina* increase their rate of pseudofaeces production with increases in suspended sediment concentration, we conducted in situ light and dark paired benthic chamber experiments with and without *Atrina* at 4 stations along this turbidity gradient, to determine their effect on BNF. Our results showed substantially greater BNF from *Atrina* beds than bare sediments. We also found greater net BNF (difference between *Atrina* beds and bare sediment) in the less turbid water under dark conditions, but enhanced water column nutrient supply in the more turbid water in light, due to Atrina excretion of ammoniacal nitrogen (NH4-N). Within the marine environment, we estimate that BNF from *Atrina* beds may account for up to 80% of the nutrient supply for pelagic primary production and, thus, are of major importance to the sustainability of aquaculture in this harbour.

Identifying Source Soils in Contemporary Estuarine Sediments: A New Compound-Specific Isotope Method (2008)
Gibbs, M.M
Estuaries and Coasts Journal

Spatial Information: No Spatial context
Keywords: Compound-specific isotope analysis - FAME - Estuarine sediment - Land use soil sources - Identification and apportionment method - IsoSource - Management tool

Summary: A new method is proposed for the identification and apportionment of contemporary source soils contributing to estuarine sediments. The method uses compound-specific isotopic analysis of naturally occurring biomarkers (fatty acids) derived from plants to link source soils to land use within a single catchment. For identification and apportionment of source soils in the estuarine samples, the method uses the isotopic mixing model, IsoSource. The feasible proportions obtained from IsoSource are then scaled to allow for the percent organic carbon in the source soils. With this approach, the estimation of each source soil contribution to a location in the estuary is independent of any degradation of the biomarkers through microbial or biogeochemical processes. Identification relies on the evaluation of the sediment sample relative to a "library" of reference source soils from different land use within the catchment. Selection of potential sources is geographically constrained by the requirement for a natural linkage between each source soil and the sediment site sampled. A case study, using this method, mapped the distribution of three main land use source soils (pasture, native forest, and pine forest) across the river delta in a small estuary fringed with mangroves. Rather than being uniformly distributed, the results indicated that the source soil contributions varied markedly across the delta, raising concerns about the validity of taking single cores to characterize the sediments of an estuary. Coupling the source apportionment results with land use data indicated that the mean percent contribution of pine forest soil in the river delta sediments was almost three times greater than the percent land use area of pine forest in the catchment. Furthermore, isotopic signatures indicated that most of the pine forest soil came from the much smaller areas exposed to erosion by clear cut harvesting and that the soil contribution from recently harvested areas of pine forest could be as much as 20 times greater than that land use area in this catchment. This is the first method that can identify and apportion, by land use on a catchment scale, the sources of soil contributing to the sediment at a location of an estuary. The results are given as a "best estimate", within definable limits, of the proportional contribution of each potential source soil. Information obtained using this method will allow development of management strategies to alter land use practices to reduce the sediment load to rivers, and thus, the impact on the aquatic ecosystem downstream in estuaries.

Application of a Bayesian network model and a complex systems model to investigate risks of a proposed aquaculture development on the carrying capacity of shorebirds at the Miranda Ramsar wetland (2006)

Gibbs, Mark T.
Environment Waikato Regional Council, Auckland Regional Council and Ministry for the Environment

Spatial Information: Firth of Thames - New Zealand
Keywords: Aquaculture Environmental aspects New Zealand Firth of Thames Mathematical models. Shore birds Effect of habitat modification on New Zealand Firth of Thames Mathematical models. Wetland, ecology, New Zealand Firth of Thames

Summary: This study was commissioned as a result of stakeholder's concerns over possible effects of the proposed Western Firth aquaculture developments on the Ramsar wetland at the southern Firth of Thames. The study involved the development of a hazard assessment, and then investigating risk pathways through the use of a Bayesian network model, and a complex systems model. The results of the study may be summarised as follows: The hazard assessment identified multiple pathways through which the proposed farms may interact with the wetland habitat;

including through changes to primary productivity, detrital pathways and sediment dynamics. Both the Bayesian network model and complex systems model suggest that the ability of the habitat to support shorebirds is non-linearly dependent upon both the habitat size, and quality. Cultured mussels feed on seston (suspended particulate matter), therefore there is the potential for the proposed farms to influence the standing stock/production rates of plankton at the shorebird habitat. However, the network model suggests that the habitat quality is not strongly dependent on primary production rates in the water-column. Therefore, this result, along with the low predicted phytoplankton depletion resulting from the farms, suggests that phytoplankton drawdown will not have more than a minor influence over the ability of the habitat to support shorebirds. Mussel farms can become reservoirs for numerous species of fouling organisms, including non-indigenous invasive species, although a major vector (vessel traffic) is low in the region at present. If new mussel farm service vessels were to dock in the region of the Ramsar habitat, then biosecurity management codes of practice will be required in order to minimise risks of invasive species colonising the habitat as the introduction of pests may present risks. There is a risk that in the future some pest species may colonise the farms, then jump, through natural dispersion, onto hard structures in the Ramsar habitat, or increased recreational traffic may become a new vector.

Once again it will be the responsibility of farmers and regulators to develop management plans to ensure that any unwanted pest species that establish on the farms are managed effectively.Considerable volumes of sediment entering the southern Firth of Thames end up on the mudflat habitats where the shorebirds forage. Changes to the sediment dynamics resulting from the establishment of the farms could play a role in changing both the shorebird habitat quantity, and quality. However, present best estimates of the influence of the proposed farms on sediment transport processes also suggest that this interaction will be minor. By far the greatest influence on the shorebird habitat appears to be from terrestrial drivers, including the generation and delivery of sediments, organic material and nutrients. The recent dramatic expansion of the mangrove forests demonstrates the dynamic nature of this habitat, and despite the observed increase in utilisation of the habitat by Oystercatchers, these changes to a Ramsar-designated wetland are cause for concern.The complex systems model also alluded to another possible cause for concern that should be highlighted. As noted above, there has been a substantial increase in the number of New Zealand migratory Pied Oystercatchers using the site. It remains to be seen whether this increase in utilisation has been at a cost to other birds, particularly the more celebrated Arctic migratory waders. Although beyond the scope of this study, the model hints at the possibility that this may be occurring as a small change in the foraging behaviour of the Oystercatchers, which may lead to an out-competing of the smaller bird species considered.

Humpback whales around New Zealand (2000)
Gibbs,N.;Childerhouse, S.
Department of Conservation

Spatial Information: New Zealand Coast
Keywords: dolphins and whales

Summary: Through detailed literature searches of published and unpublished work and contacting people, sighting information on humpback whales were collated and analysed to determine location, date and seasonality, composition of sightings, and

common behaviour states. The analysis found that the number of humpback sightings and abundance had a slow increase during the 1990s, particularly in the late 1990s. The study confirmed that the northern migration occurs between May and August whilst the southern occurs between September and December. No evidence of change was found in the migration patterns past New Zealand coast.

Māori methods and indicators for marine protection: A process to identify tohu (marine indicators) to measure the health of the rohe moana of Ngāti Konohi (2005)
Gibson, P
Ngāti Konohi, Department of Conservation and Ministry for the Environment

Spatial Information: Elsewhere in New Zealand – Waihau Bay to Tatapouri heads
Keywords: Ngati Konohi, Maori methods & indicators, Marine protection

Summary: This report focuses on the environmental tohu identified by Ngāti Konohi as indicators of the health of the marine environment in the rohe moana of Ngāti Konohi (Waihau Bay in the north, to Tatapouri heads in the south). It has been developed with several purposes in mind:

- To provide a more complete total picture of the elements that have a bearing on the health of the marine environment, when used in conjunction with western scientific method. That is, environmental tohu, while important in their own right, should also be seen as complementing western scientific methods, for a fuller, more holistic view of the environment.
- To provide a specific c focus and to outline possible directions for future marine management for Ngati Konohi.
- To be of use to other hapu/iwi nationwide: its findings can be adapted, adjusted and modified to suit other marine environments in different locations throughout the motu.

Microbial Activity in Natural and Organically Enriched Intertidal Sediments near Nelson, NZ (1990)
Gillespie, P.A.;MacKenzie, A.L.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Nelson, New Zealand
Keywords: estuarine sediments, microbial activity, microalgal production, New Zealand, eutrophication, pollution, nutrients

Summary: Two measures of microbial activity were used to characterise a variety of sediment habitats in three intertidal inlets in the Nelson region, South Island, New Zealand. Rates of microbial mineralisation potential and epibenthic microalgal production were compared with sediment textures, concentrations of photosynthetic pigments, ATP concentrations, and organic and inorganic nutrients. Baseline ranges for these parameters were established for relatively undisturbed estuarine sites for assessing future environmental deterioration and for comparison with sites affected by organic enrichment. Sediment mineralisation rates were increased more than 1000-fold by enrichment from a fruit processing plant and microalgal production was enhanced by more than 50-fold at a site exposed to slaughterhouse wastes. The remaining variables, although often strongly correlated with activity measurements,

were not as sensitive as measures of enrichment. Sediment microbial activity measurements are proposed as a means of detecting changes in nutrient status of estuarine environments.

The proceedings of a workshop on current issues and potential management strategies conducted Feb 13-14 2004 (2005)
Godwin, L.S.
Hawaii Coral Reef Initiative - Research program

Spatial Information: No Spatial context
Keywords: Invasive species

Summary: Mechanisms for introducing alien marine species. Ships and sea going vessels can be thought of as biological islands. These vessels provide a mechanism for alien species to be transported to new localities around the globe. Species can be transported in ballast water, hull fouling, and in the recesses and enclosed spaces of ships. As ships take in and exchange ballast water, they also take in the substances that are in the water. The organisms are generally those found in intertidal and subtidal areas in ports. They can be small crustaceans, unicellular algae and bacteria, zooplankton, and also adult species of fish and crabs. Typical hull fouling species include arthropods (barnacles, amphipods, and crabs), molluscs (mussels, clams, and sea slugs), sponges, bryozoans (moss animals), cnidarians (hydroids and anemones), protozoans, annelids (marine worms) and chordates (sea squirts and fish) as well as seaweeds. Godwin (2004) notes that bacteria transported in ballast water were thought to be responsible for a major outbreak of cholera bacteria in shellfish in the early 1990's in the U.S.A. The bacteria was traced back to South America were the strain caused 10,000 deaths. Particulate matter such as organic and inorganic detritus can also be suspended in the water column and accumulate in ballast tanks, these can provide a temporary habitat for organisms.

Revealing the unseen threat tsunami sources in the Bay of Plenty (2007)
Goff, J., & Walters, R.
Water & Atmosphere Journal

Spatial Information: Bay of Plenty, New Zealand
Keywords: Bay of Plenty, Tsunami sources

Summary: Tsunami sources in the Bay of Plenty. The region is exposed to tsunami risks. A tsunami is a 'wall' of water which travels through the ocean after it is displaced suddenly, usually triggered by an earthquake or an underwater landslide. When this water hits the offshore shelves and coastal areas, it is pushed up and can cause destruction to coastal areas. Scientists can locate evidence of tsunamis in the sediment layers in some coastal sites. Goff and Walters (2007) undertook a study that investigated the sources of tsunamis in the Bay of Plenty. They found that 'local faults' where one side of the seabed slips downward would produce small tsunamis of around 2m. The collapse of seamounts or submarine volcanoes offshore would produce small tsunamis of 1.5m. Earthquakes in the offshore subduction zone in the Tonga-Kermadec Trench, which is just north of East Cape, would produce tsunamis of more catastrophic height. Two waves are produced, one moves onshore and the other moves offshore away from the coast. The tsunami crests at 2-3m in the southeast and increased towards 5-7m in the northwest Bay of Plenty. Goff and Walters (2007) tested this with a model and matched it with evidence in the coastal

sediment record. They concluded that the Tonga-Kermadec Trench is the most likely source of historical catastrophic tsunamis in the Bay of Plenty.

Regional connectivity and coastal expansion: differentiating pre-border and post-border vectors for the invasive tunicate *Styela clava* (2010)
Goldstien, S. J.;Schiel, D. R.;Gemmell, N. J.
Molecular Ecology

Spatial Information: Worldwide
Keywords: invasive species, marine phylogeography, phylogeography, *Styela clava*, Genetic Diversity, Undaria-pinnatifida, Ciona-intestinalis, Incursion, Response, Computer-program, Allelic richness, Recent migration, Bayesian method, New Zealand, DNA

Summary: The dramatic increase in marine bio-invasions, particularly of non-indigenous ascidians, has highlighted the vulnerability of marine ecosystems and the productive sectors that rely on them. A critical issue in managing invasive species is determining the relative roles of ongoing introductions, versus the local movement of propagules from established source populations. *Styela clava* (Herdman, 1882), the Asian clubbed tunicate, once restricted to the Pacific shores of Asia and Russia, is now abundant throughout the northern and southern hemispheres and has had significant economic impact in at least one site of incursion. In 2005 *S. clava* was identified in New Zealand. The recent introduction of this species, coupled with its restricted distribution, provided an ideal model to compare and contrast the introduction and expansion process. In this study, the mitochondrial DNA cytochrome oxidase subunit I gene (COI) gene and 11 microsatellite markers were used to test the regional genetic structure and diversity of 318 *S. clava* individuals from 10 populations within New Zealand. Both markers showed significant differentiation between the northern and southern populations, indicative of minimal pre- or post-border connectivity. Additional statistics further support pre and post-border differentiation among Port and Harbour populations (i.e. marinas and aquaculture farms). We conclude that New Zealand receives multiple introductions, and that the primary vector for pre-border incursions and post-border spread is most likely the extensive influx of recreational vessels that enter northern marinas independent of the Port. This is a timely reminder of the potential for hull-fouling organisms to expand their range as climates change and open new pathways.

Statistical analysis of the grey-faced petrel colony on Mount Maunganui 1999-2001 (2001)
Goodchild, W.
Bay of Plenty Polytechnic

Spatial Information: Mount Maunganui, New Zealand
Keywords: Grey-faced Petrel, Mauao, Mount Maunganui, sea bids

Summary: The aim of this report was to continue research on the grey-faced petrel breeding colony on Mount Maunganui. The research began in 1991 and has been carried out by the Ornithological Society of New Zealand (OSNZ) Waikato Branch, up until this year. It was also done as part of the Diploma in Marine Studies programme at the Bay of Plenty Polytechnic. Five students, who each wrote a report focusing on a different aspect of the colony, carried out the research. This report shows the data collected during night time excursions around the Mount, where birds were caught,

banded and recorded, weighed, wing measurements taken, marked and then released. The results, compared to previous years, showed that not many birds were caught this year, which may have been related to the number of trips made. They also showed that the birds weight did not fluctuate enormously over the years, and more specifically in a selected month each year. It was found that there may be a linear relationship between the birds weight and wing length, but it is not yet certain. The number of recaptured birds versus new bandings shows that the number of new bandings has been dropping consistently for the last few years, but the number of recaptures, although fluctuating, seems to be remaining relatively stable over the same time period. The main conclusion gathered from this report is that there has not been a great deal of change to the petrel colony over the last ten years. There is however plenty of work that can still be done to allow a more precise analysis of the current situation, any changes that occurred in the past, and any changes that may occur in the future.

Hull fouling as a mechanism for marine invasive species introductions (2005)
Goodwin, L.S (Ed.)
Proceedings of a 2003 workshop on current issues and potential management strategies

Spatial Information: Throughout New Zealand
Keywords: aquaticinvasive species, hull fouling

Summary:A workshop was conducted February 12 and 13, 2003 focusing on hull fouling as a mechanism for alien species transport and potential management strategies. This was accomplished with two invited speakers from New Zealand:
Dr. Oliver Floerl, Marine Biosecurity Researcher, National Institute of Water and Atmospheric Research (NIWA), and Ashley Coutts, Marine Biosecurity Division, Cawthron Institute.This workshop presented current research and knowledge concerning hull fouling introductions and began a process of developing information that can be integrated into the overall alien aquatic species management plan through specific efforts,concentrating on mechanisms associated with maritime vessel activity. The papers in this volume are a product of this workshop.The first paper by Godwin is an introduction to the issue of aquatic invasive species transport by marine vessel activity. A final paper by Godwin summarizes the efforts to develop an information framework for management strategies for minimizing aquatic alien species introductions through hull fouling.A comprehensive paper on the factors influencing the development of hull fouling on maritime vessels is presented by Floerl. The Floerl and Inglis paper specifically focuses on the hull fouling of private yachts as an aquatic invasive species transport mechanism. Floerl *et al.*provide an overview of current research activitiesundertaken by NIWA in New Zealand, which deal with aquatic invasive species.Coutts and Taylor provide a paper that covers the issue of hull fouling transport of aquatic invasive species by merchant vessels in New Zealand. Coutts is the sole author on a paper that documents the introduction and spread of a tunicate species in New Zealand that is associated with hull fouling community. Another paper by Coutts presents a research perspective on efforts to minimize aquatic invasive species by resource management agencies.

Recovering sub-tidal forests in human-dominated landscapes (2009)
Gorman, D.;Connell, S. D.
Journal of Applied Ecology

Spatial Information: No Spatial context
Keywords: Plants, macroalgae

Summary: Policy initiatives that seek to recover lost habitats require the capacity to anticipate and suppress the mechanisms that drive loss. The replacement of forested landscapes by simple landscapes comprising of opportunistic or 'weedy' species represents an increasingly common phenomenon across human-dominated systems. The failure of subtidal forests to recover from natural and human disturbance and their ultimate replacement by degraded habitats is recognized globally. The current lack of knowledge on whether such shifts can be reversed jeopardizes considerations of restoration policy within increasingly human-dominated landscapes. We critically assessed the model that recovery of canopies within remnant kelp forests in degraded landscapes (i.e. turf-forming algae that carpet space) is slower than in adjacent forested landscapes, but may be increased by removing turfs. After generating experimental disturbance, canopies recovered to their former state within forested landscapes, but not in remnant forests in degraded landscapes. Removal of turfs from spaces between remnant forests, however, enabled canopies to recruit and subsequently develop covers that matched those in remnant forests. Whilst the supply of canopy-forming propagules to degraded landscapes is likely to decline with gap expansion, we show that improvements to forest resilience and restoration are possible via policies that result in a reduction of turf covers. These results also support the model that regime-shifts need not be a product of synchronized loss, but can occur as a result of reduced rates of canopy-recruitment over broad areas and many years. Indeed, patterns of canopy-loss over several decades redouble attention to the human-mediated conditions that enable turfs to retain space (i.e. elevated nutrient and sediment loads via coastal runoff). We demonstrate that future restoration is a possible outcome of polices that promote ecosystem recovery. In doing so, we reduce uncertainty about policy initiatives that aim to upgrade the recycling potential of wastewater treatment plants (e.g. nearly 45% of South Australia's metropolitan wastewater) to improve the quality of water needed to restore subtidal forests. Uncertainty about resilience-building and restoration management are redressed by demonstrating that the feedbacks maintaining regime-shifted landscapes are not necessarily permanent.

The population dynamics and production of *Paphies australis* (pipi) in the southern basin, Tauranga Harbour, New Zealand (2001)
Gouk, S. G.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour; Bivalvia ecology; Marine ecology; Estuarine ecology; Pipis; Fish; Invertebrates, *Paphies australis*

Summary: This thesis looks at pipi (*Paphies australis*) population dynamics and production at three sub tidal sites in the Southern Basin of Tauranga Harbour. The study looks at seasonal and tidal variations at the sites as well as population dynamics and production of pipi at these locations. The ecology of the area and pipi are also described.

Statement of evidence of Roger Vernon Grace for resource consent applications by Port of Tauranga (n.d.)
Grace, R.V.

Spatial Information: Tauranga Harbour, New Zealand
Keywords: intertidal & sub-tidal ecology, dredging, dredge spoil disposal, Port of Tauranga, Te Paritaha

Summary: Dr Grace is a specialist in intertidal and sub tidal ecology, long-tem monitoring of marine life in coastal and shallow benthic areas, and effects of dredging and dredge spoil and off-shore sand extraction. He has carried out biological investigations into the ecological effects of dredging in Harbour channels within the Tauranga Harbour, as well as the impacts of dredge spoil disposal offshore for over 20 years. Dr Grace, like Professor Healy, produced comprehensive and detailed evidence relating to the matters set out above. The submitters did not contest this evidence, and this combined with Dr Grace's long professional association with and experience in the Tauranga Harbour, gave the Panel considerable confidence that his evidence was thorough, robust and could be relied upon in respect of physical effects on ecological resources. Dr Grace discussed the impacts of the proposed dredging and disposal on the biological ecology of the area. This was particularly significant to Hapu and Iwi with respect to the effects on the natural environment, but also as the Harbour is a significant source of kaimoana. In this respect, one of the more significant issues was the impact of the dredging proposal on the pipi beds at Te Paritaha – part of which would be destroyed by the dredging operation.

Monitoring of submerged reef biota off Motuotau Island in relation to dredge spoil dumping by Port of Tauranga Ltd (1997)
Grace, R.V.
Port of Tauranga Ltd

Spatial Information: Tauranga Harbour/ Inner Shelf off Mount Maunganui, New Zealand
Keywords: Port of Tauranga, dredge spoil dumping, Motuatau Island, Mount Maunganui, sedimentation, reef, biota, monitoring

Summary: Dredge spoil resulting from the development and maintenance of the Port of Tauranga has for over a quarter of a century been dumped in a series of zones on the inner shelf off Mount Maunganui.A major channel deepening and widening programme was undertaken in 1992, resulting in the dumping of 4.5 million cubic metres of spoil on a new dump ground in 25 to 30 metres of water.A monitoring programme was designed to determine if the dumped sediment was impacting on the reef biological communities around Motuotau Island inshore from the dump ground. A control site and two test sites were established in May 1990 on submerged reefs near the island.Photographic monitoring of approximately 3 metre long permanent transects close to the rock/sand boundary followed changes in rocky bottom biota and in sediment loading on the biota, as well as movement of sediment at the rock/sand interface.Metal stakes driven into the sandy seabed near the rocks enabled measurement of changes in the level of sediments.Maximum measured fluctuation in sediment level at the control was 16 cm, most occurring before major dumping. Sites 1 and 2 showed only 5 cm level rise. The level changes were probably within the range of natural change.No major changes in biota occurred at any site. Small changes appeared to be well within the normal range of variability expected in this shallow rocky habitat close to sand.Small quantities of fine sediment dusting the rocky bottom biota appeared to be derived from localised turbidity during rough weather. Some marine organisms can temporarily stabilise this material during periods of calm.It is concluded that minor sediment level changes, occasional

dustings of fine sediment, and minor changes on rocky bottom biota were not related to dumping or dredge spoil. There was no evidence found of any harmful effects on rocky reef ecology attributable to the major dredge spoil dumping event of January to July 1992.

Intertidal benthos near the airport drain outlet carrying storm-water from Port of Tauranga's Hewletts Road log storage area (1998)
Grace, R.V.
Port of Tauranga Ltd

Spatial Information: Tauranga Harbour, New Zealand
Keywords: stormwater, Port of Tauranga, intertidal benthos

Summary: During 1994 Port of Tauranga Ltd established a log handling facility on about 11 hectares of flat land at Hewletts Road. Stormwater from the area is treated with alum and settled in a pond before intermittent discharge into a public stormwater drain which in turn discharges on the foreshore, where there are beds of seagrass and shellfish.

Preliminary results of the baseline and first post-dredging surveys of biological monitoring programme (1992)
Grace, R.V.;Blom, W.
Port of Tauranga Ltd

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, post-dredging surveys, Port of Tauranga

Summary: Early in 1992 the Port of Tauranga Ltd commenced a capital dredging programme in order to deepen and widen the shipping channels in Tauranga Harbour. Since then up to 6 million cubic metres of dredge spoil have been removed from the Harbour shipping lanes and dumped on a specified dump ground 2km offshore from Mount Maunganui.

White Island Notes (1975)
Grace, R.V.
Unpublished report

Spatial Information: Tauranga, New Zealand – White Island
Keywords: Macroalgae, volcanic activity on marine life, sea surface temperatures

Summary: Observations of various marine aspects of White Island were made during a week-long visit in May 1974. Sea water temperatures between White Island and Tauranga show an abrupt discontinuity, probably associated with a change from coastal to oceanic water. Volcanic activity at White Island includes subtidal hot springs and gas vents. Marine life is reduced close to the outfall of an acid stream, and high tidal limpets are severely eroded by acid from the volcano. Zonation of marine organisms on the Volkner Rocks has some features apparently peculiar to the White Island region. 55 species of marine fishes were observed, several species with strong subtropical affinities. A number of species of marine organisms that could be expected at White Island were apparently absent.

Tanea reef investigation (1991)
Graeme, B.;Graeme, A
Port of Tauranga Ltd

Spatial Information: Tauranga Harbour – Tanea Reef, New Zealand
Keywords: Tanea reef, Port of Tauranga, channel widening, Mt Maunganui, Panepane, Pilot Bay, Tauranga Harbour

Summary: The report details the biological community at the Tanea reef, significance of the Tanea reef within the Tauranga ecological district, and options for relocation of Tanea boulders and their recolonisation. To assist larger ships entering the Harbour, the Port of Tauranga proposed a channel widening programme to cut into the channel edge close to the foot of Mount Maunganui. The conclusion of the Tanea Reef Investigation was that the reef could be successfully relocated to facilitate channel widening. Conditions at Panepane and Pilot Bay were considered optimal for recolonisation with diversity and abundance. In practical terms, this indicated Pilot Bay was the best relocation site, with North to North-west rock being a reasonable alternative.

Re-colonisation of a relocated boulder reef in Tauranga Harbour, New Zealand (1995)
Graeme, M.
University of Otago

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tanea Shelf, sub-tidal boulder reef, Port of Tauranga

Summary: Tanea Shelf at the base of Mount Maunganui (Bay of Plenty, New Zealand), is a sub-tidal boulder reef that supports a diverse marine community. To allow for expansion of the Port of Tauranga, 3.2 ha of this reef was dredged up and relocated less than 0.5 km away in Pilot Bay. Colonisation of the relocated boulders was assessed every three months from May 1993 to May 1994 and with a final survey in January 1995. Random photo-quadrats were taken on marked and random boulders, and a random dot method was used to estimate percent cover and species diversity. Monitoring of the relocated reef and the original Tanea Shelf documented the initial colonisation of the Pilot Bay boulders and demonstrated the increasing species diversity of the newly formed community with time. By the end of the study the boulders at the west end of Pilot Bay reef had gained species diversity similar to that found on remaining Tanea Shelf boulders

World Atlas of Sea grasses (2003)
Green, Edmund P.;Short, Frederick T
University of California Press

Spatial Information: Overseas & New Zealand Harbours including Tauranga Harbour
Keywords: Plants, Sea grass

Summary: Looks at the distribution of sea grass throughout the world including New Zealand. The report states the sea grass status of many NZ harbours, including Tauranga. Also covers the threats and management of sea grasses in NZ. There is

also mention of a 'limpet' that specialises in sea grass, however, no research exists on this endemic species.

Prediction of Contaminant Accumulation in Auckland Estuaries (2001)
Green, M.;Williamson, B.;Bull, D.;Oldman, J.;MacDonald, I.;Mills, G.
NIWA

Spatial Information: Elsewhere in New Zealand – Auckland Estuaries
Keywords: Estuary, contaminant accumulation, model, water quality, storm-water,

Summary: This report was written by NIWA for Auckland Regional Council (ARC) to develop a way to predict contaminant accumulation over the long term (decades and longer) in sandy estuaries in the Auckland region. The intent was to build on the Urban Stormwater Contaminant (USC) model, which has been used to predict long-term accumulation of contaminants in muddy estuaries. This model was chosen through an international literature review of realistic model(s) to describe sediment mixing. The authors show how mixing can be incorporated into the primary deposition area (PDA) and secondary deposition area (SDA) prediction schemes but concludes that improvements in the actual mixing model will have to await better local data.Although this report is aimed specifically at Auckland estuaries, much of it is applicable to Tauranga Harbour. For example, it explains the processes of contaminant accumulation in estuaries, specifically those from stormwater.

Tauranga Harbour sediment study: implementation and calibration of the USC-3 Model (2009)
Green, M. O.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation, USC-3 model, southern Tauranga Harbour

Summary: This report describes the implementation and calibration of the USC-3 model in southern Tauranga Harbour. The model predicts estuarine sedimentation on the planning timescale, which is decades and greater. The model is physically based, and is intended to support decision-making by predicting various changes in the harbour bed sediments that are associated with catchment development scenarios and associated changes in sediment runoff from the catchment.

Tauranga Harbour sediment study: predictions of Harbour sedimentation under future scenarios (2010)
Green, M.O
NIWA for Environment Bay of Plenty

Spatial Information: Tauranga Harbour – New Zealand
Keywords: Sedimentation

Summary: Technical Report E2 is one of a series of reports published in the progress of the Tauranga Harbour Sediment Study and modelling developments by NIWA for EBOP. This project is intended to predict sedimentation in the southern Tauranga Harbour under current and future scenarios.One of the goals for this report

was to help understand how changes in sediment runoff from the land via the river catchments prompt changes to sedimentation in the harbour. The model predicted that climate change will increase the net sediment runoff from every sub-catchment by 8% to 26%. Land use change predictions are variable, with increases in sediment runoff in some areas and decreases in others. This report also addresses the net sediment loss from the estuarine system to the ocean and estimates figures of fine sediment loss to the ocean for each sub-catchment. The reported figures range from 15% net loss to 95% loss. Wairoa river has the greatest freshwater and fine sediment contribuition of the rivers to the area, but of the discharges from the river, it has the highest percentage of fine sediment lost to the ocean (95%).

The amount of sediment loss to the ocean depends on the location of the river mouth, where effective loss is driven by distance from the estuary mouth or position of discharge into the middle reaches, as well as the amount of freshwater discharged from the river. Sub-catchments with low freshwater in put, along with locations of in putsbeing in the far reaches of the estuary, have less fine sediment loss to the ocean and greater deposition. In comparison to fine sediment,smaller amounts of coarse sediment is lost to the ocean, as the heavier grain size is less easily entrained and moved by the waves and currents.The model allows links to be drawn between sub-catchments and the sub-estuaries and describes the behaviours of sediment deposition. Sediment that is deposited in the nearby sub-estuary is not necessarily from the nearest catchment source. Notably the increase in sedimentation rates is greater than the increase in sediment discharged from the primary catchment source creating a “positive imbalance.” This imbalance results from mixing of sediment from other sub-catchments in the estuary and where the harbour sediment removal processes are overwhelmed.Finally a description of the potential changes in the mud percentage of the seabed under climate change predictions is presented. Most land bordering sub-estuaries were flagged as ecologically at risk due to predicted changes in the fine sediment deposition. The ecology of those parts of the harbour is likely to be adversely impacted as the changes in sediment runoff occur in the next decades, moving towards 2050.

For and against mangrove control (2003)
Green, M. O.;Ellis, J. I.;Schwarz, A. M.;Lind, D.;Bluck, B.
NIWA Information Series No. 31

Spatial Information: Elsewhere in New Zealand – Upper North Island
Keywords: Mangroves

Summary: Residents ofthe upper North Island are increasingly voicing concerns about the spread of mangroves in their local harbours. They perceive a decrease in amenity values because of mangrove spread – reduced access, smelly mud, loss of water views, poorer fishing and shellfish gathering, decreased property values – and they want to know what to do about it. An earnest and urgent debate is developing at the local community level. On one side are residents who want to reclaim their waterways by cutting and removing mangroves; on the other, are residents who want to let nature be. Occupying the middle ground are residents who want to draw a line in the sand and contain mangroves at present levels.

Birds of Waikaraka Estuary and Tauranga Harbour (2006)
Sally Greenway;Rosalie Smith;Brian Chudleigh;Paul Cuming
Environment Bay of Plenty

Spatial Information: Waikaraka Estuary – Tauranga Harbour, New Zealand
Keywords: Birds, Waikaraka Estuary, Tauranga Harbour

Summary: This booklet gives:

- Information about the birds that inhabit the Waikaraka Estuary Inlet and the Tauranga Harbour;
- Help for deciding what to plant to provide food and shelter for birds;
- Information on how you can contribute to predator control and so increase bird numbers and diversity;
- Information on what you can do so there are fewer threats to birds; and
- Reference material providing in-depth information about birds and native planting.

Use of Classification and Regression Tree (CART) Analysis with Faecal Indicators to Determine Sources of Contamination (2002)
Gregor, J.; Garrett, N.; Gilpin, B.; Randall, C.; Saunders, D
New Zealand Journal of Marine and Freshwater Research

Spatial Information: No Spatial context
Keywords: chemical indicators, faecal effluent, classification and regression tree analysis, faecal stanols, fluorescent whitening agents

Summary: Both human and non-human faecal contamination of environmental waters pose a risk to human health that can be reduced if the source can be identified and responsibility for mitigation accepted. Traditional microbiological indicators are rarely adequate for source identification but some chemical indicators offer promise. In this work, the similarities and differences of selected chemical profiles of different faecal effluent types have been modelled using classification and regression tree (CART) analysis. Human effluents can be distinguished from non-human effluents by the presence of fluorescent whitening agents, and the concentrations or ratios of concentrations of the faecal stanols coprostanol and 24-ethylcoprostanol can distinguish most of the non-human effluent types considered. To allow for the effect of variable dilution when effluents enter environmental waters, ratios of concentrations will be required to establish a model, and a model more complex than CART will be required to apportion multiple effluent-type contamination.

Grazers of Estuarine *Ulva* in Tauranga Harbour (1995)
Gregor, K.
University of Auckland

Spatial Information: Tauranga Harbour – New Zealand
Keywords: Plants, Sea lettuce, Ulva

Summary: There was a demand after the 1991 *Ulva* (sea lettuce) blooms in the Tauranga harbour to better understand the biology and ecology of the life history of *Ulva*.This study is one of 2 Auckland university (Masters') thesis to investigate *Ulva* (Snow, 1995 was the other student). This thesis investigates the role of grazers in the removal of *Ulva* from soft sediment habitat. The study concluded that intertidal

gastropod molluscs were unable to effectively control periodic blooms. The most effective grazers were the Parore (*Girella tricuspidata*) and the black slug (*Scutus breviculus*). Although, biological agencies can reduce *Ulva* biomass, the influence of currents and winds remain the major factors affecting the removal of *Ulva* from the Tauranga harbour.

Accumulation and distribution of virgin plastic granules on New Zealand beaches (1978)
Gregory, M. R.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand beaches
Keywords: Organic Pollutants

Summary: Numbers of pellets are greatest near Auckland, Wellington, and Christchurch, which are the important source areas. However, pellets are also found on beaches remote from these cities, and some may have come from eastern Australia. Because they degrade slowly, plastics can be a significant contributor to coastal pollution, but the environmental hazards of their accumulation are uncertain.
Between 1972-76 Gregory (1978) surveyed over 300 New Zealand beaches in order to determine the distribution of small (<0.01-<0.08g) plastic granules and pellets in the foreshore environment. Specifically, this study looked at virgin plastic granules, which are those used by the plastics industry to manufacture products. This study did not investigate the abundance of other types of plastic litter. Virgin plastic granules are thought to enter the environment through spillage and loss during transport. This study identified that the plastics virgin polyethylene and polypropylene were common, while polystyrene and polyvinyl chloride were rare, on New Zealand beaches at the time of measurement. Pellets tended to accumulate on beaches with fine sediment sizes and were seldom recorded on gravel and boulder beaches. These particles can be hazardous to marine life and can accumulate in the stomachs of fish and sea birds. High pellet concentrations were recorded around Auckland often exceeding 10,000 per metre. Gregory gives a conservative estimate that there were over 1000 t of pellets in the New Zealand foreshore environment at the time of measurement. This amount was much less than figures reported for locations around the North Atlantic. These particles are not readily degradable and are likely to remain in the environment for some time.

Spatial and temporal variability in suspended sediment yields of North Island basins, New Zealand (2007)
Griffiths, G. A.
JAWRA Journal of the American Water Resources Association

Spatial Information: Elsewhere in New Zealand – North Island
Keywords: Sedimentation, suspended sediment, precipitation, regression, climate

Summary: Specific annual suspended sediment yields and their standard deviations are presented for 47 basins of North Island, New Zealand. Most of the variance in yields is explained by catchment mean rainfall. Rivers with similar flow range have similar suspended sediment concentration ratings, independent of differing watershed lithology and regolith, except for six basins having an abundance of soft

fine sediments. Prediction equations for yield and its standard deviation are derived for four essentially arbitrary regions. AU feature rainfall as the independent variable. Differences between regions may be due to variations in intensity, frequency, and duration patterns of storms and, in one area, to bed material size as well. The temporal distribution of annual yields from a basin is modelled by a two-parameter lognormal function: the prediction equations above may be used to evaluate this function at a site for which suspended sediment data are unavailable.

Sediment macrobenthos of upper Otago Harbour, New Zealand (1999)
Grove, S.L.,Probert, P.K.,
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Elsewhere in New Zealand – Otago Harbour
Keywords: macrobenthos; Otago Harbour; New Zealand; sediments; contaminants; chromium, heavy metals, benthic community structure,

Summary: Sediment macrobenthos of the Upper Otago Harbour, south-eastern New Zealand, was surveyed in 1993. Replicate samples (0.1 m^2 sieved on 1-mm mesh) were taken using a diver-operated suction sampler from 15 stations, including some suspected to be contaminated. Multivariate analysis of abundance data was used to examine patterns of benthic community structure and their relationship to environmental variables: sediment grain size, organic content, heavy metal concentration (V, Cr, Mn, Co, Ni, Cu, Zn, Cd, Pb), sea-floor temperature, dissolved oxygen concentration, water depth, and macro-algal content. Samples from Sawyers Bay, an area previously identified as impacted by sewage and industrial waste, were set apart from all other stations. A combination of percent sand, macro-algal content, water depth, and chromium concentration correlated best with the observed community structure.

Effects of consumers and enrichment on abundance and diversity of benthic algae in a rocky intertidal community (2009)
Guerry, AD.;Menge, BA.;Dunmore, R. A.
Journal of Experimental Marine Biology and Ecology

Spatial Information: Elsewhere in New Zealand – South Island
Keywords: Grazing, Limpet, Species richness, benthic algae

Summary: Human alteration of nutrient cycling and the densities of important consumers have intensified the importance of understanding how nutrients and consumers influence the structure of ecological systems. We examined the effects of both grazing and nutrient enrichment on algal abundance and diversity in a high-intertidal limpet-macro-algal community on the South Island of New Zealand, a relatively nutrient-poor environment. We used a fully factorial design with three levels each for grazing (manipulations of limpet and snail densities) and nutrients (nutrient-diffusers attached to the rock). Top-down control by grazers appears to be the driving organizing mechanisms for algal communities in this system, with strong negative effects of grazing on algal diversity and abundance across all levels of nutrient enrichment. However, in contrast to the conclusions drawn from the analysis of the whole algal community, there was an interactive effect of grazing and enrichment on foliose algae, an important component of the algal system. When herbivory was reduced to very low levels, enrichment generated increases in the abundance and biomass of foliose algae. As expected, top-down control was the primary determinant

of algal community structure in this system, controlling abundance and diversity of macrophytes on the upper shore. Contrary to expectations, however, increased nutrients had no community-wide effects, although foliose algal abundance increases were greatest with high nutrients and reduced grazing. It seems likely that most of the corticated algal species have limited capacity to respond to nutrient pulses in this nutrient-poor environment.

Comparison of two methods for quality assessment of macroalgae assemblages, under different pollution types (2008)
Guinda, X.;Juanes, J. A.;Puente, A.;Revilla, J. A.
Ecological Indicators

Spatial Information: Overseas – North East Atlantic, North coast of Spain (Bay of Biscay)
Keywords: Plants, macroalgae

Summary: The selection of adequate methodologies for the assessment of different biological quality elements is urgently needed for the application of the water framework directive (WFD 2000/60/EEC). In the case of macroalgae in coastal waters of the North East Atlantic, two methodologies have been proposed: the reduced species list (RSL) index and the quality of rocky bottoms (CFR) index. Both methods use multimetric approaches to evaluate the quality of macroalgae assemblages, which are based on community characteristics (species/populations richness, cover, percentage of opportunistic species, ecological state groups ratio, etc.). In this paper the results of applying both indices on three different types of pollution gradients in the North coast of Spain (bay of Biscay) are presented, in order to test their usefulness and intercalibration possibilities. In general terms, the CFR index responded more accurately than the RSL index to the pollution gradients under study. With respect to the indicators used in the current evaluation, richness, opportunistic species and cover seemed to be the most accurate for quality assessment of macroalgal communities. While the first two indicators are taken into account in both indices, the latter (cover) is only considered in the CFR index, even though the abundance of macroalgae is one of the aspects to be included in the evaluation of this biological element, according to the WFD.

Soil Quality in the Bay of Plenty (2009)
Guino, D.,
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: soil quality, Bay of Plenty, land use, topsoil, parameters, nutrients, land management, dairy, maize, anaerobically mineralisable nitrogen, Olsen phosphorus, Tauranga, farm, monitoring,

Summary: Temporal changes in topsoil qualities of dairy pasture and maize cropping sites were monitored periodically over a 10-year period. Results indicate that for both land uses, many of the topsoil quality parameters were being maintained and these are within the provisional target values set by Landcare Research New Zealand for production and/or environmental criterion. However, the steady increase in the levels of anaerobically mineralisable N and Olsen P in dairy sites is a concern.

High values of anaerobically mineralisable N could potentially lead to increased nitrate leaching while high values of Olsen P could lead to P-rich sediments polluting water bodies. Dairy farmers should therefore exercise judicious use of N and P fertilisers through periodic soil testing and farm nutrient budgeting. Six new maize sites were established and sampled for topsoil qualities as well. With the exception of low aggregate stability values of most soils, mean soil quality values were within the desirable provisional target ranges established by Landcare Research. The soil quality monitoring programme is invaluable in informing land managers of changes in soil quality on their properties over time, particularly when there are clear trends in declining soil health, so that remedial actions can be promptly undertaken. Soil quality monitoring should therefore continue well into the future with a view towards expansion into areas that are undergoing land use intensification (e.g. recent forest to dairy farm conversions); inclusion of trace elements in the regular monitoring as opposed to when the need arises only (e.g. as part of Ministry for the Environment's (MfE's) requirements in State of the Environment reporting); and inclusion of more biological measures of soil quality such as soil microbial biodiversity (earthworms, microbiological activity, etc.), respiration, microbial biomass, soil enzyme activity, etc. as an indication of soil well-being.

3.8. H

Toxicity of estuarine sediments using a full life-cycle bioassay with the marine copepod *Robertsonia propinqua* (2008)
Hack, L. A.;Tremblay, L. A.;Wratten, S. D.;Forrester, G.;Keesing, V.
Ecotoxicology and Environmental Safety

Spatial Information: Bay of Plenty region – New Zealand
Keywords: Sedimentation, Pollutants

Summary: Estuarine sediment contamination is a growing significant ecological issue in New Zealand. Methods of assessing toxicity and ecological impacts in a cost effective way are currently limited. Further to that is a need to develop bioassays that generate data quickly and cost effectively and have ecological relevance to the wider community. A chronic full life-cycle bioassay to assess the toxicity of New Zealand estuarine sediments using the marine harpacticoid copepod *Robertsonia propinqua* has been investigated. Sediment samples were collected from the Bay of Plenty region and included two polluted and one reference site. Sources of pollutants in the contaminated field sites originated from a variety of sources and generally include nutrients, pesticides and herbicides and the pollutants zinc, copper, lead and polycyclic aromatic hydrocarbons (PAHs). Conversely, the reference site was exposed to low levels of contaminants due to the relatively undeveloped catchment. Adult male and female copepods were exposed to field collected sediments for 24 days under flow-through conditions at 21 degrees C and 12 h L:D cycles. Five endpoints were recorded: male and female survival, fecundity (number of gravid females per replicate at the end of the test), clutch size per female, number of eggs per sample and juvenile survival (number of nauplii and copepodites per replicate at the end of the test). Adult mortality was observed in all sediment samples but the number of males, gravid females, clutch size per female and number of eggs produced were not affected by either the contaminated or reference sediment samples. However, the contaminated sediments did reduce reproductive output (i.e. nauplii and copepodite production). Therefore, we conclude that reproductive endpoints provide a good measure of sediment-associated contaminant effects compared with adult *R. propinqua* survivorship. It may be that a change in focus from

chemical thresholds without ecological relevance or lethal dose threshold methods, to more subtle but ecologically significant elements of faunal life, such as reproductive success, are a more sensitive and a long term ecologically informative method.

Benthic meiofauna community composition at polluted and non-polluted sites in New Zealand intertidal environments (2007)
Hack, L. A.;Tremblay, L. A.;Wratten, S. D.;Lister, A.;Keesing, V.
Marine Pollution Bulletin

Spatial Information: Auckland & Bay of Plenty regions, New Zealand
Keywords: Organic Pollutants

Summary: Meiofauna composition was investigated for six field sites, including polluted and non-polluted sites, within two regions (Auckland and Bay of Plenty) during winter (July-August 2004) in the North Island of New Zealand. Physico-chemical parameters were measured during the sampling period and meiofauna distribution and abundance were compared with these measured parameters. Analysis of meiofauna abundance indicated that foraminiferans, nematodes and ostracods were the taxa that contributed to the variability between field sites within the Auckland region. However, no clear taxa dominance was seen in the Bay of Plenty region. Comparison of meiofauna abundance and physico-chemical parameters was done using multivariate analysis (PRIMER). However, no clear relationships between the parameters were observed in any field site in either region. The Shannon-Weiner index of diversity did not show any clear differentiation between polluted and non-polluted field sites. Therefore, from the present study, the taxa or physico-chemical parameters used could not effectively characterise pollution at the investigated field sites.

Physical disturbance and marine benthic communities: life in unconsolidated sediments (1994)
Hall,S.J.
Oceanography and Marine Biology Annual Review

Spatial Information: No Spatial context
Keywords: shellfish, Benthos, bioturbation, bottom trawls, cohesionless sediments, current forces, dredging, ecosystem disturbance, intertidal environment, littoral zone, man-induced effects, sediment mixing, sediment sorting, wave forces

Summary: This review examines the physical and biological processes which move marine intertidal and subtidal sediments and considers available information on the consequences of physical disturbance for benthic communities. The agents examined include waves and currents, bioturbation, fishing and dredging and the intensities and scales upon which the various processes operate is considered. The inter-relationships between the various disturbance processes are also examined.

Stakeholder views about the marine environment and its protection (2005)
Hallas, S.
Department of Conservation

Spatial Information: Elsewhere in New Zealand – Whangarei, Auckland, Nelson

Keywords: Fishery, public understanding, marine environment, protection strategies and mechanisms

Summary: This report presents the findings of some explorative research carried out by the Centre for Research, Evaluation and Social Assessment (CRESA), to support the implementation of the Department of Conservation's (DOC's) 'Building Community Support for Marine Protection' strategy. The research investigated aspects of public understanding of, support for, and involvement in the marine environment and marine protection issues. Fourteen focus-group meetings were held with a range of stakeholders in Whangarei, Auckland and Nelson, New Zealand. The research describes focus-group meeting participants' marine experiences, their perspectives on marine health and observed changes to the marine environment, and their aspirations for the future. It also describes their views about the value of, and threats to, a healthy marine environment, as well as current and possible future protection strategies and mechanisms. We discuss how these results, and participants' views about effective approaches to education and advocacy, have implications for DOC's implementation of the strategy.

How will habitat change affect intertidal animals in estuaries (2004)
Halliday, J.;Thrush, S.;Hewitt, J.;Funnell, G.
NIWA

Spatial Information: North Island estuaries, harbours & embayments including Tauranga Harbour – New Zealand
Keywords: sediment, estuaries, intertidal zone, estuarine communities, sediment type, invertebrate, occurrence model, maximum density model,

Summary: Discusses how the authors have developed several statistical models that will allow researchers to forecast changes in the distribution and abundance of several important intertidal species as sediment mud content changes. For the particular study, 19 sites in 18 North Island estuaries, harbours and embayments were surveyed, including Tauranga Harbour. Two models were used - an occurrence model and a maximum density model. The results of the modelling of the above survey indicated that most of the (modelled) species have habitat preferences either for sand, mud or mixed sediment.

Tauranga Harbour sediment study: harbour bed sediments (2009)
Hancock, N.;Hume, T.;Swales, A.
NIWA for Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation, Tauranga Harbour

Summary: This report was conducted by NIWA for EBOP with the purpose of assessing the sediment sources, sediment characteristics and the dispersal and deposition of sediments in the southern Tauranga Harbour. Technical Report C1 is a report on the progress for developing the modelling component of the Tauranga Harbour Sediment Study. The location of this report is the southern Tauranga Harbour, which is divided into 26 sub-estuaries for the purposes of the study. Technical Report C1 specifically covers the sediment grain size statistics, composition and patterns of accumulation rates.Data from previous studies of the Harbour was used to identify grain size statistics and gain information on the

sediment composition gravel/sand/mud percentage, and sorting parameters for the sub-estuaries. Percentage mud composition for the sub-estuaries ranged from 0.7% to 48.10% mud. The information gained was used to categorise the sub-estuaries into 11 types. These category types identify areas of similar sediment types, geomorphology and similar environments of sediment transport, deposition and wave/tidal intensities.Sediment accumulation rates on tidal flats in the sub-estuaries ranged from 0.75 to 1.57mm yr-1 over the previous 23 to 90 years. Findings suggest that there are low net accumulation rates of fine sediments on the intertidal flats over the last 50 to 100 years. These rates are low in comparison to the rates reports for other North Island estuaries. Auckland averaged an intertidal flat accumulation of 4.7mm yr-1, Central Waitemata Harbour averaged 3.2mm yr-1, and the Firth of Thames averaged a high rate of around 25mm yr-1 since the 1930s with a 3-5 fold increase in the sediment accumulation rate following mangrove colonisation in the Firth of Thames. Findings from sediment cores undertaken for this study found relatively deep surface mixing (indicated by deep 7Be data) and shallow 210PB concentrations in comparison to other North Island estuaries. This implies low accumulation rates of fine sediments on the intertidal flats due to reworking of wave action and burrowing organisms. The evidence of deep mixing in surface sediments indicated that large areas of wave-exposed intertidal flats are not long term sinks for fine sediments.

History of Tauranga Harbour and Port (1997)
Hansen, N.
Port of Tauranga

Spatial Information: Tauranga Harbour -Port of Tauranga, New Zealand
Keywords: Tauranga Harbour, Port of Tauranga, New Zealand

Summary: The first European ships started arriving in the Tauranga Harbour in 1826. Cargo was initially ferried to shore by smaller boats, until wharfs and jetties were established. It appears that the Tauranga Borough and Tauranga City Council administered the town wharf and collected fees. In 1912 the Tauranga Harbour Board was constituted under the Tauranga Harbour Act. The role of the Harbour Board was to administer harbour assets - wharfs, sheds, and landings. In 1988 the Port of Tauranga Limited was formed. Between 1953 and 1994, cargo tonnage increased from 55,000 tons to 7,000,000 tons. Work on the Mount wharf started in 1952. The report is about the history of the Tauranga Harbour and Port activities. The author discusses the early history of harbour activities prior to 1826 through to 1997 and the development and expansion of Port and Harbour activities. The administrative bodies are discussed in detail. The report provides some detail on the changes to the harbour environment and harbour works and reclamations.

Dredge spoil dispersion from an inner shelf dump mound (1989)
Harms, C.
University of Waikato

Spatial Information: Tauranga Harbour and Mount Maunganui, New Zealand
Keywords: Tauranga Harbour, Port of Tauranga, dredging

Summary:A study was undertaken to ascertain whether material to be dredged from the shipping channel through a large ebb tidal delta at the entrance to Tauranga Harbour, New Zealand, could be dumped in shallow water (5-8m below Mean Sea

Level) off the downdrift Mt. Maunganui Beach and induce beach nourishment. Investigations included comparison of sedimentological texture of the material to be dredged, the dump site on the beach; a fluorescent sediment tracing experiment; application of standard Shore Protection Manual “fill” and “renourishment” factors; and application of the new techniques. Results illustrated textural similarity between the sediments to be dredged and the natural beach and dump zone, while the sediment tracing experiment indicated predominantly onshore movement.

Pilot Bay reclamation (1982)
Harrison and Grierson and Partners
Mount Maunganui Borough Council and Tauranga Harbour Board

Spatial Information: Tauranga Harbour – Pilot Bay, New Zealand
Keywords: Pilot Bay, Reclamation, Tauranga Harbour, Te Awanui

Summary: Mount Maunganui Borough Council and the Bay of Plenty Harbour Board jointly propose a reclamation of approximately 1.6350 ha in the inner Pilot Bay area at Mount Maunganui. The proposal is more fully described in Section 2 of this report and in accompanying plans. The proposed reclamation will be developed to provide a large, all-tide landing ramp, several small shallow ramps and parking for cars, boats and trailers. The Mount Maunganui Borough Council is completing the proposed development as the local authority adjoining the harbour area, with the assistance of the Bay of Plenty Harbour Board on both construction and technical matters.

Differences in coverage between the PDE and New Zealand local earthquake catalogues (1999)
Harte, D.; Vere-Jones, D.
New Zealand Journal of Geology and Geophysics

Spatial Information: New Zealand
Keywords: PDE catalogue, New Zealand catalogue, location errors, magnitude, scales, earthquake swarm

Summary: This paper examines systematic differences between the coverage of New Zealand earthquakes in the New Zealand local catalogue and the PDE catalogue put out by the United States National Earthquake Information Centre (NEIC). Only events with local magnitudes M-L greater than or equal to 5 in the New Zealand catalogue, and with body-wave magnitude m(b) greater than or equal to 4.5 in the PDE catalogue, are considered in the study, which covers the period 1965-93, and a series of four quadrats covering the landmass of New Zealand and extending between latitudes 33-49 degrees S, and longitudes 165-183 degrees E. The main differences found are: (1) before 1983, the PDE catalogue misses many events (mainly of intermediate depths) with M-L greater than or equal to 5 listed in the New Zealand catalogue; after 1983 most of the New Zealand shallow events are recorded, but some intermediate events are still missing; (2) the New Zealand catalogue misses many events with m(b) greater than or equal to 4.5 listed in the PDE catalogue as occurring to the northeast of New Zealand, and a few listed as occurring to its southwest; otherwise, virtually all events with m(b) greater than or equal to 4.5 listed in the PDE catalogue are also found in the New Zealand catalogue; (3) the epicentres of events to the northeast of New Zealand are systematically displaced to the east in the New Zealand catalogue, relative to the PDE catalogue; many such events listed as having intermediate depths in the New

Zealand catalogue are classified as shallow events in the PDE catalogue; (4) this region aside, for shallow events in the given magnitude ranges, there seems to be no systematic difference between the PDE body-wave magnitude m(b) and the New Zealand local magnitude M-L; however, magnitudes of individual events may differ by up to one unit in either direction; (5) for intermediate depth events there is a small but systematic tendency for m(b) to be less than M-L for the same event; the effect appears to increase with depth down the descending plate; (6) an extremely large swarm occurred in Bay of Plenty in 1984, some 9 months after the Edgecumbe earthquake, and marked the start of an unusually active period in the northeast of the region covered by the New Zealand catalogue; the swarm was followed 11 years later by a magnitude 7 event off East Cape, which itself initiated an exceptionally large aftershock sequence; (7) both catalogues indicate a modest increase in activity, mainly at intermediate depths, in the northern and central regions of New Zealand, in the last few years of the study (1992-95).

Seagrasses: transplant experiments, productivity and consumer ecology (1974)
Hartog, C.D.
Aquaculture

Spatial Information: No spatial context
Keywords: Seagrass, aquaculture

Summary: Seagrass transplantation is gaining wide acceptance as a solution to the impairment of seagrass meadows. Evidence demonstrates that seagrasses form an ecosystem that has both physical and biological ramifications: (1) the system is as productive as any natural ecosystem on earth; (2) it has great value in stabilizing and protecting coastlines from erosion; and (3) the presence of seagrasses is essential to the occurrence and growth of many species of marine life. There are two forms of seagrass that may be used in transplantation, i.e. vegetative material or seeds. Vegetative material appears to be the most logical choice since it is present throughout the year, while seed production is seasonal, abundance and germination are unpredictable, and survival of seedlings in the field is low.

Mangrove planning and management in New Zealand and South East Australia - A reflection on approaches (2009)
Harty, Chris
Ocean & Coastal Management

Spatial Information: Elsewhere in New Zealand – North Island; Overseas: Australia - New South Wales, Victoria, South Australia
Keywords: Plants, Mangroves

Summary: The mangrove *Avicennia marina var. australasica* occurs on the temperate coastlines of New Zealand's North Island and New South Wales, Victoria and South Australia in South East Australia. Mangroves are increasing in area with seaward expansion in New Zealand and landward expansion in temperate Australia. Their expansion has been viewed as unnatural. With pressure from residential and coastal development, planning and management authorities in both countries are being exerted to allow for the removal and destruction of mangroves, partly for protecting and re-instating other impacted habitats such as saltmarsh and mudflats

and partly to maintain recreational and amenity values of coastal communities. Estuary management planning is a useful tool that can integrate and balance policy directions for mangroves and other estuarine habitats in a strategic manner. Mangroves should not be considered as `bad' in isolation but viewed as part of the mosaic of tidal habitats important for estuary function and health.

Ecological monitoring survey of the lower reaches of the major Bay of Plenty rivers, the Ohau Channel, and parts of Tauranga Harbour (Winter 1975)
Hatton, C.;Thomson, M.; Donovan, W.F.;Larcombe, M.F.
Bioresearches Ltd

Spatial Information: Bay of Plenty rivers, Ohau Channel, Tauranga Harbour – New Zealand
Keywords: Tauranga Harbour, Te Awanui, Rereatukahia Inlet, Waikareao Inlet, ecological monitoring, sample, water quality, algae, seagrass, eel grass, *Zostera*, shellfish, bivalve, *Gracilaria secundata*,

Summary: This report presents the results of the third in a series of ecological surveys carried out for the BOP Catchment Commission and Regional Water Board. This survey was carried out in winter conditions on August 1975. The results of the earlier surveys are presented in two reports “Ecological monitoring survey of the lower reaches of the major Bay of Plenty Rivers, the Ohau Channel, and parts of the Tauranga Harbour “ (Winter 1974) and (Summer 1975) by Bioresearches Ltd. The aim of this survey was to determine whether the change observed in earlier surveys (Winter 1974; Summer 1975) were seasonal or long term in nature. An ecological survey was carried out of all the ‘permanent’ river stations established in the Winter 1974 survey. At the same time a brief explanation was made of two Tauranga Harbour transects – Rereatukahia and Waikareao- in order to obtain further information on the nature of algal growth in these areas.Sampling methods used are described in the Winter 1974 and Summer 1975 reports.As mentioned above, the only two Tauranga Harbour sites monitored in this survey were the – Rereatukahia and Waikareao Inlets/Estuaries. The results of this survey compared with the results of previous surveys suggest that although there have been some marked changes in both density of algae and grazing gastropods since the Summer 1975 Survey, it appears that the grazing gastropods are effectively controlling the algal growth and maintaining a relatively stable ecological situation.

Research Directed Towards the Management of Sea Lettuce in Bay of Plenty Coastal Water (1992)
Hawes, I.
NIWA

Spatial Information: Bay of Plenty, New Zealand
Keywords: Plants, Sea lettuce

Summary: The processes which need to be studied in order to effectively manage sea lettuce populations in Bay of Plenty coastal waters are identified in this report. Each process is reviewed in terms of existing knowledge and required information and recommendations for research programmes are given and prioritised in the summary section.

The dispersal of sporophytes of *Undaria pinnatifida* by coastal shipping in New Zealand, and implications for further dispersal of Undaria in France (1990)
Hay, C.H.
British Psychological Journal

Spatial Information: New Zealand and Tasmanian waters
Keywords: Asian kelp,*Undaria pinnatifida*, New Zealand and Tasmanian waters, sporophytes

Summary: Sporophytes of the adventive Asian kelp *Undaria pinnatifida*, recently discovered growing in New Zealand and Tasmanian waters, are apparently spread by coastal shipping. Mature sporophytes, up to 1 m long and growing just below the waterline on the sides of ships, can be transported intact over hundreds of kilometres between New Zealand ports. The hulls of vessels can also be seeded with *Undaria* spores, and the gametophytes or the microscopic sporophytes transported to other harbours where the sporophytes mature. Commercial vessels, laid up pending sale and thus immobile for long periods, are especially prone to spread the plant because their waterline is at a constant depth. Such conditions permit the development of a fringing band of *Undaria* sporophytes along the ship's hull. In France *Undaria* was accidentally introduced to the Mediterranean coast near Sete before 1971, and intentionally planted on the coast of Brittany in 1983. The likely further dispersal of the kelp in this region is discussed in the light of these observations from New Zealand.

Evaluation of species with potential for aquaculture in New Zealand: a draft discussion document (1988)
Hayden, B. J.
Fisheries Research Centre, Ministry of Fisheries

Spatial Information: New Zealand
Keywords: aquaculture, New Zealand,

Summary: This paper contains brief notes on a selection of potential candidate species for aquaculture. It has been compiled to illustrate the wide range of marine and freshwater species that could be cultured in New Zealand, some of the factors which need to be considered when evaluating the potential of these, and the diversity of culture methods possible. Species have been selected to give a range of examples of marine and freshwater, exotic and indigenous, fish and shellfish. Inclusion of a species in this paper does not necessarily indicate that MAFFish considers that culture of the species will be successful. The list is not comprehensive as there are a large number of species which could be grown. For instance it does not include the culture of feed species such as brine shrimps and rotifers, but these species should not be overlooked as candidates for aquaculture ventures.

Micropalaeontological evidence for the Holocene earthquake history of the eastern Bay of Plenty, New Zealand, and a new index for determining the land elevation record (2004)
Hayward, B. W.;Cochran, U.;Southall, K.;Wiggins, E.;Grenfell, H. R.;Sabaa, A.;Shane, P. R.;Gehrels, R.
Quaternary Science Reviews

Spatial Information: Ohiwa Harbour – eastern Bay of Plenty, New Zealand
Keywords: Natural Hazards/Storms

Summary: Fossil foraminifera and diatoms are used to identify sudden, probably earthquake-related, elevational changes in three Holocene sedimentary sequences from the high-tidal fringes of Ohiwa Harbour, eastern Bay of Plenty, New Zealand. Modern analogue calibration sets of faunal and floral census data are used to estimate palaeosalinities and palaeotidal elevations that help quantify seismic-related, vertical displacements. Age models for the three vibracored sequences are built on a combination of tephrostratigraphy and radiocarbon dating. A new index, the land elevation record (LER), is introduced to graphically portray earthquake-related vertical land displacements on a time-depth diagram. Also plotted are elements used to calculate LER, such as the indicative depth estimated from microfossils, inferred sediment compaction, and the New Zealand Holocene palaeo-sea-level curve. All three Ohiwa cores, spread over 3 km of coast, contain both freshwater and intertidal sediments. A prominent erosional contact between freshwater peat or soil and overlying intertidal mud, records a major Subsidence event in each core of c. 2m, dated at ca 2600 cal years BP. The deepest core (7.4 m) indicates that this is the only substantial vertical displacement event to have occurred in the last 8 ka. A small subsidence event (ca 0.3-0.7 m) is indicated close to the top of one core, but is not present in the other two sites. This may be the result of a local land subsidence during the poorly known Taneatua Earthquake of 1866. There is no historic human record of earthquake displacements around Ohiwa, but mid-Pleistocene, interglacial, marine sediments have been uplifted 10-60 m in several identified fault blocks. Our study provides conclusive evidence of at least 2 that are earthquake-related.

Channel dredging, dredge spoil migration and downdrift (1994)
Healy, T.
New Zealand Geographer

Spatial Information: Tauranga Harbour – Port of Tauranga, New Zealand
Keywords: Port of Tauranga, channel dredging, dredge spoil migration

Summary: A major dredging programme to deepen the shipping channels at the Port of Tauranga has seen some 5 million m³ of mainly sandy sediment dredged from the shipping channels and dumped on the adjacent inner shelf. An Environmental Impact Assessment has identified major concerns and consent granting authorities have proposed a monitoring programme.

Review of capital dredging impacts for the Port of Tauranga Ltd 1992 major channel deepening and widening programme (1996)
Healy, T.
Port of Tauranga Ltd

Spatial Information: Tauranga Harbour – Port of Tauranga, New Zealand
Keywords: Tauranga Harbour, Port of Tauranga, dredging

Summary: The purpose of this report is to summarise the results of the monitoring programme implemented as a condition of the consents granted to permit Port of Tauranga Ltd to undertake its 1991 major channel deepening and widening programme. The programme involved dredging some 5 million m^3 from the entrance and harbour channels. In the final event, the dredging of the lower Otumoetai Channel, allowed for in the consents and potentially involving some 450,000 m^3, was not carried out in the major dredging episode.

Chapter Fourteen Muddy coasts of mid-latitude oceanic islands on an active plate margin-New Zealand (2002)
Healy, Terry
Proceedings in Marine Science - Elsevier

Spatial Information: New Zealand – Firth of Thames, Poverty Bay, Hawkes Bay
Keywords: muddy coast, erosion, firth of Thames

Summary: The oceanic islands comprising New Zealand lie astride the boundary between the Australian-Indian and the Pacific Plate. As such, these large islands are subjected to the geological processes of an active subduction zone, including volcanism, seismic instability, and rapid tectonic uplift of the plate marginal on-lapping soft Tertiary deposits. This hilly-to-mountainous unstable setting is a pre-condition for remarkable regolith instability, allowing exceptional erosion rates of the resulting steepland catchments. New Zealand possesses an extensive and often indented coastline exceeding some 10,000km in length. This long coastline is a reflection partly of the essentially drowned character of the hilly-to-mountainous island structure, and partly of the landscape forming processes. Two examples are the vigorous fluvial downcutting active over much of the country, and Pleistocene alpine valley glaciations which has created deep re-entrant fjords in south Westland. Sections of the New Zealand coastline exhibiting muddy coast characteristics, include the inner parts of harbours and estuaries, especially around the North Island coast. The thickest and most laterally extensive mud deposits occur in the structural graben named as the 'Firth' of Thames where Holocene mud deposits are known to be 10s of meters thick (Middleton 1989; Naish 1990; Chick 1999). However in some areas of high mud supply from adjacent catchments, even the shallow shelf may be very muddy, despite the high energy ocean conditions, for example the broad embayments of Poverty and Hawkes Bay of the East Coast region. The aim of this chapter is to prevent the various morphodynamic types of muddy coast in New Zealand, the processes leading to their formation, and the characteristics of the sedimentation regime.

Physical and chemical characteristics of material to be dredged and dumped as spoil (1990)
Healy, T.; McCabe, B.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Port of Tauranga, dredging

Summary: Sediment that had accumulated on the western bank of the Cutter channel was to be maintenance dredged and dumped at sea during the 1990/91 dredging programme which was to take place in October 1990. This report, in accordance with the requirements of Water Right No.2192, describes the physical and chemical characteristics of these sediments and comments on their suitability for marine disposal in the approved dump ground.

Analysis of bottom sediment samples from the Stella Passage (1997)
Healy, T.; Roberts, S.
Port of Tauranga Ltd

Spatial Information: Tauranga Harbour – Stella Passage, New Zealand
Keywords: Tauranga Harbour, Port of Tauranga, sediments

Summary: This report presents the findings of an investigation to ascertain (i) the baseline (1996) chemical concentrations for heavy metals of the Stella Passage and (ii) attempt to determine the origin of the black organic-rich matter in the surface of the Stella Passage.

Progradation at the Entrance, Tauranga Harbour, Bay of Plenty (1977)
Healy, T.R.
New Zealand Geographer

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour

Summary: This paper reports shoreline changes in and around Tauranga Harbour in the northern Bay of Plenty. Throughout the Holocene the Bay of Plenty coastline has exhibited a prograding sandy barrier and dune ridge shoreline. Material for the substantial progradation originated partly from input into the littoral system from rivers draining the active volcanic zone in the hinterland of the Bay of Plenty, and partly from onshore movement of sands swept up with the post-glacial rise in sea level. There have been numerous well documented and dated eruptions throughout the Holocene which have continued through to historical times culminating in the Tarawera eruption of 1886. The main ejecta materials from these eruptions have been rhyolitic pumice flows and ashes which are readily susceptible to erosion and transportation by numerous rivers draining from the volcanic plateau to the Bay of Plenty. Subsequent transport in the littoral zone and deposition has resulted in a prograding sandy barrier and dune ridge shoreline for most of the Bay of Plenty coastline from Opotiki to Waihi.

Channel Dredging, Dredge Spoil Migration and Downdrift: Impacts at a large tidal inlet, Tauranga Harbour, New Zealand (1994)
Healy, T.R.
New Zealand Geographer

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour

Summary: A major dredging programme to deepen the shipping channels at the Port of Tauranga has seen some 5 million m³ of mainly sandy sediment dredged from the shipping channels and dumped on the adjacent inner shelf. An Environmental Impact Assessment has identified major concerns and consent granting authorities have proposed a monitoring programme.

Environmental assessment programme for Tauranga Harbour dredging and inner shelf spoil dumping (1988)
Healy, T. R.; McCabe, B.; Grace, R.; Harms, C.
Bay of Plenty Harbour Board

Spatial Information: Tauranga Harbour, New Zealand

Keywords: Tauranga Harbour, dredging

Summary: The report is an assessment of environmental issues of sediments, biology and chemistry, and coastal environment and marine resource use to support an application to dispose of dredged material at sea. According to the report, the disposal of dredged spoil is unlikely to have any serious effects on the ecology of the islands and emergent reefs inshore of the dump zone. Similarly, the analysis of surface sediments is likely to be conservative and pollution effects are most likely to occur in the top centimetre of harbour sediments. The report notes that recreational use around dumping grounds is the least popular recreational use area.

Port of Tauranga Limited Channel Deepening and Widening Dredge Programme 1991-92 Environmental Impact Assessment, Part 1 (1991)
Healy, T. R.; McCabe, B.; Thompson, G.
Port of Tauranga Limited

Spatial Information: Tauranga Harbour – Port of Tauranga, New Zealand
Keywords: Port of Tauranga, channel deepening & widening, dredging

Summary: The Port of Tauranga has limitations on the vessel length and draft and the ability of the Port to service larger vessels. In order to provide cost effective port services required by the region, it is necessary that the Port have the ability to accommodate larger ships servicing New Zealand. Therefore, channel improvements are necessary to accommodate vessels. The channel requires an excavation of 6 million m^3 of sediment. The cost of the works is estimated to be $23M, for which there is a predicted return of $31M to the region and a net revenue impact of $300M by the end of the century (year 2000). The operational impacts are considered minimal. Impacts on Tangata Whenua are not expected to affect traditional Maori fisheries or cultural activities in any great level. Monitoring to date has shown no discernible effects on recreational fishing and diving outside the dump zones. This is expected to apply for this disposal programme.

Assessment of environmental effects for Port of Tauranga Ltd, maintenance dredging and disposal (1998)
Healy, T. R.; Thompson, G.; Mathew, J.; Pilditch, C.; Tian, F.
Port of Tauranga

Spatial Information: Tauranga Harbour – Port of Tauranga, New Zealand
Keywords: Maintenance dredging, Port of Tauranga, Tauranga Harbour

Summary: Maintenance dredging has been required since the establishment of the dredged navigational channels through the tidal inlet and delta system in 1968. With the deepening of the channels for larger draught vessels the maintenance dredging requirement has increased and remains a requirement of the port for the long-term future. The purpose of this report is to support an application for a resource consent application to undertake and dispose of maintenance dredging associated with the operation of the Port of Tauranga. The maintenance has typically been undertaken by a trailer suction dredge. The justification for the maintenance programme is seen in the increase in trade. Public and Tangata Whenua consultation and associated issues are addressed in the Assessment of Environmental Effects. Other options for disposal were considered, however, were found inappropriate for the type of dredged material. Impacts on benthic communities from dredged dumping material showed

that at the end of a 3 year survey there was no evidence for large irreversible change in the benthic macrofauna which could be attributed to the dredging programme. Impacts on disposal of dredged material are expected to be minimal.

Extractives from a Coniferous Bark Dump in Coastal Estuarine Sediments (1997)
Healy, T. R.; Wilkins, A. L.; Leipe, T.
Coastal Education & Research Foundation, Inc

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Organic Pollutants

Summary: An investigation was made of intertidal sediments in the vicinity of bark dumps adjacent to the shoreline created in the 1960's as bark waste from a log export port at Tauranga Harbour, New Zealand. Samples collected in a drainage ditch and intertidal sediments near the bark dumps were analysed by GC-FID and by total ion and selected ion mode GC/MS for concentration of log and bark sourced resin acids such as dehydroabietic acid, abietic acid and pimaric acid. Only low concentrations of resin acids (mainly dehydroabietic acid and pimaric acid), together with a series of fatty acids (mainly 16:0 to 30:0 fatty acids) and hydrocarbons (mainly C22 to C23 n-alkanes) were detected in the sediments of the intertidal flats. Chemical analyses indicated the sediments to be generally toxic.

Broad classification of New Zealand inlets with emphasis on residence times (1976)
Heath,R.A.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand coastal inlets - Moutere, Waimea, Aotea, Whanganui, Avon-Heathcote, Tauranga, Parengarenga, Porirua-Pauatahanui, Kawhia, Nelson, Rangaunu, Raglan, Whangarei, Bluff, Otago, Hokianga, Manukau, and Whangaruru
Keywords: hydrodynamics, Moutere, Waimea, Aotea, Whanganui, Avon-Heathcote, Tauranga, Parengarenga, Porirua-Pauatahanui, Kawhia, Nelson, Rangaunu, Raglan, Whangarei, Bluff, Otago, Hokianga, Manukau, Whangaruru.

Summary: The study investigated the circulation patterns and residence time of thirty two New Zealand coastal inlets. Based on ratios of their physical parameters, the study classified them into seven groups with probable similar circulation patterns. Among the coastal inlets, 18 of them have predominant tidal flow, including Moutere, Waimea, Aotea, Whanganui, Avon-Heathcote, Tauranga, Parengarenga, Porirua-Pauatahanui, Kawhia, Nelson, Rangaunu, Raglan, Whangarei, Bluff, Otago, Hokianga, Manukau, and Whangaruru. The other fourteen range from long narrow sounds with probable strong vertical circulation (e.g., Pelorus Sound) to large bays with strong mean horizontal circulations (e.g., Tasman and Hawke Bays). The study also estimated the residence time of those inlets with a ratio of tidal compartment to total volume greater than 4. For example, a residence time of 1-3 months was estimated for Tasman Bay, while for Pelorus sound, the estimate was about 20 days.

The Field Guide to the Birds of New Zealand Vol. 1 (2005)
Heather, B. D.; Robertson, H. A.
Penguin Books

Spatial Information: New Zealand
Keywords: New Zealand wild birds, bird population, distribution, conservation, breeding, feeding habits.

Summary: The *Field Guide to the Birds of New Zealand* is astonishingly comprehensive, covering the identification, status, and distribution of wild birds seen anywhere in the New Zealand region. Up to date and featuring the latest research, this handy volume represents every bird species of New Zealand in seventy-four stunning, original, colour paintings by a leading New Zealand bird artist, including rare and recently extinct species. Renowned New Zealand bird experts Barrie Heather and Hugh Robertson have written a brief and informative identification guide which provides the reader with a summary of what is known about the birds of New Zealand. Each page contains a colour plate and accompanying distribution map on the facing page. The maps provide sufficient plumage and behavioural details that should help identify the species, sex and/or age of the bird in the field as well as where species breeding in New Zealand may be found in suitable habitat. An additional handbook section provides details on distribution, populations, conservation, breeding, behaviour, and feeding habitats of each species. Maps for vagrants, stragglers, and non-native seabirds, and for migratory waders (which can turn up in any estuary around the coast) are also included in this section.

***Ulva*, *Umbraulva* and *Gemina*: Genetic survey of New Zealand taxa reveals diversity and introduced species (2009)**
Heesch, S.;Broom, J. E. S.; Neill, K. F.; Farr, T. J.; Dalen, J. L.; Nelson, W. A.
European Journal of Phycology

Spatial Information: New Zealand
Keywords: *Gemina*, New record, New Zealand region, Pacific, rbcL, Southern Hemisphere, Species introductions, *Ulva, Umbraulva*, genetic variation, geographical distribution, green alga, introduced species, new taxon, sampling, New Zealand Algae, *Ulva armoricana, Ulva californica, Ulva flexuosa, Ulva lactuca, Umbraulva olivascens*

Summary: The genetic diversity of the green algal genus *Ulva sensu lato* in the New Zealand region was surveyed, examining rbcL sequences of 581 samples from a wide geographical range. Twenty-four genetically distinct taxa were discovered in New Zealand waters, belonging to three genera-*Ulva* (19 species), *Umbraulva* (four species) and *Gemina* (one species). Of the 19 species of *Ulva* reported here, 13 could be identified to the species level based on morphological and genetic data. The remaining six species cannot currently be assigned to known species groups due to a lack of close homology with sequences in GenBank. These species may include undescribed endemic taxa, recognised taxa for which rbcL sequences are not yet available, or may represent cryptogenic species. The genus *Umbraulva* is recorded for the first time for the New Zealand region and for the Southern Hemisphere. Of the four species distinguished, one is considered to be introduced to the region and the other three are undescribed indigenous taxa. Subantarctic samples provide the first evidence of the genus *Gemina* since its description in 1952: sequence data confirmed that *Gemina* is distinct from *Ulva* and *Umbraulva*. A number of the species identified in this study can be distinguished through a combination of growth form,

morphological, ecological and distributional characters. However there remain considerable problems in distinguishing a number of other species by morphological characters alone. Based on information such as distribution in New Zealand (percentage of samples occurring in highly modified environments and/or areas with frequent vessel traffic), as well as the genetic similarity of New Zealand samples to material from overseas, we have concluded that at least five species have been introduced to the New Zealand region: *Ulva armoricana, U. californica, U. flexuosa, U. lactuca and Umbraulva olivascens.*

Eutrophication and harmful algal blooms: A scientific consensus (2008)
Heisler, J.; Gilbert, P.M.; Burkholder, J.M.; Anderson, D.M.; Cochlan, W.P.; Dennison, W.C.; Dortch, Q.; Gobler, C.J.; Heil, C.A.; Humphries, E.; Lewitus, A.; Magnien, R.; Marshall, H.G.; Sellner, K.; Stockwell, D.A.; Stoecker, D.K.; Suddleson, M.
Harmful Algae

Spatial Information: No spatial context
Keywords: Eutrophication, Harmful algal blooms, HABs, Management of nutrients, Nutrient loading, Nutrient composition, Nutrient pollution, US EPA, Water quality

Summary: In January 2003, the US Environmental Protection Agency sponsored a ‘‘roundtable discussion’’ to develop a consensus on the relationship between eutrophication and harmful algal blooms (HABs), specifically targeting those relationships for which management actions may be appropriate. Academic, federal, and state agency representatives were in attendance. The following seven statements were unanimously adopted by attendees based on review and analysis of current as well as pertinent previous data:

(1) Degraded water quality from increased nutrient pollution promotes the development and persistence of many HABs and is one of the reasons for their expansion in the U.S. and other nations;
(2) The composition, not just the total quantity, of the nutrient pool impacts HABs;
(3) High-biomass blooms must have exogenous nutrients to be sustained;
(4) Both chronic and episodic nutrient delivery promote HAB development;
(5) Recently developed tools and techniques are already improving the detection of some HABs, and emerging technologies are rapidly advancing toward operational status for the prediction of HABs and their toxins;
(6) Experimental studies are critical to further the understanding about the role of nutrients in HABs expression, and will strengthen prediction and mitigation of HABs; and
(7) Management of nutrient inputs to the watershed can lead to significant reduction in HABs.

Seagrass Ecology (2000)
Hemminga, M.A.; Duarte, Carlos M.
Cambridge University Press

Spatial Information: Worldwide
Keywords: Seagrass, ell grass, *Zostera*

Summary: Sea grasses occur in coastal zones throughout the world in the areas of marine habitats that are most heavily influenced by humans. Despite a growing awareness of the importance of these plants, a full appreciation of their role in coastal ecosystems has yet to be reached. This book provides an entry point for those wishing to learn about sea grass ecology and provides a broad overview of the present state of knowledge. The volume discusses the recent progress in research and current research foci, complemented by extensive literature references to guide the reader to more detailed studies. This book will be valuable to students of marine biology wishing to specialize in this area and to established researchers wanting to enter the field. In addition, it will provide an excellent reference for those involved in the management and conservation of coastal areas that harbour sea grasses.

"Koe wai hoki koe?!", or "Who are you?!":Issues of trust in cross-cultural collaborative research (2007)
Hepi, M; Foote, J; Marino, M; Rogers, M; Taimona, H
New Zealand Journal of Social Sciences Online

Spatial Information: Northland, New Zealand
Keywords: Cross-cultural research designs, social and environmental issues

Summary: Cross-cultural research designs are increasingly employed in the New Zealand context to investigate a range of complex social and environmental issues. However, there is little guidance for researchers who work for mainstream organisations and hapū (subtribe(s)) and iwi (tribe(s)) on how to undertake cross-cultural collaborative research. Trust is a key issue that makes cross-cultural research possible and it is surprising that issues relating to trust have not featured widely in the literature. In this paper, we reflect on our experiences working cross-culturally and collaboratively with a hapū in Northland, New Zealand. We discuss how a mainstream research organisation worked with a community health trust and developed a working relationship with a hapū, forming the basis of a community-driven collaborative evaluation of a central government-funded project. Key findings were the establishment of a tuākana-tēina relationship (where teacher and learner are interchangeable) between the members of the collaborative research team and the employment of appropriate research methods to develop a research agenda that ensured everyone would benefit from the research.

Updated: Residents stunned as freak hail storm, tornadoes hit BOP (2009)
NZ Herald
NZ Herald

Spatial Information: Bay of Plenty, New Zealand
Keywords: Natural Hazards/Storms, hail, storm,

Summary: A violent thunder and hailstorm has brought chaos to the Western Bay of Plenty, with hailstones half the size of golf balls leaving parts of the region whitened. Wattie Newtown says he watched five waterspouts offshore from his home at Town Point. "One about two or three kilometres off the Mount that would have been 500 metres across, it was huge. There was about three touch downs of those, one lasted for probably five to 10 minutes," Mr Newtown said. Mr Newton says the winds that accompanied the spouts were horrendous. He says the hailstorm that followed left the beach looking as though it is coated in snow. The hail was 10 centimetres deep

in places. Another resident told the Herald the hail storm hit the beachside suburb of Papamoa around 11:40am, bringing marble size hail stones with "some twice as large". Senior Sergeant Ian Campion says fallen hail is lying about four inches thick in some places. He says driving is also hazardous on State Highway 2, east of Te Maunga, due to surface flooding and hail.

Does seagrass contribute to marine biodiversity? (2007)
Hewitt, J.; van Houte-Howes, K; Pilditch, C. A.
NIWA

Spatial Information: No spatial context
Keywords: plants, seagrass, eel grass, *Zostera*, habitat, biodiversity

Summary: This article answers a series of questions using recent research:Does sea grass contribute to marine biodiversity?
Benthic communities in seagrass are not necessarily more diverse than surrounding non-vegetated areas. Seagrass is still important because it contributes to habitat diversity.A range of habitats provides the necessary variety of 'services' – such as food, shelter, and nursery grounds.

Environmental history and physiological state influence feeding responses of *Atrina zelandica* to suspended sediment concentrations (2004)
Hewitt, J. E.; Pilditch, C. A.
Journal of Experimental Marine Biology and Ecology

Spatial Information: No spatial context
Keywords: Sedimentation, suspended sediment, Feeding behaviour, increased seston concentrations, stress responses, suspension feeders.

Summary: Epifaunal suspension-feeding bivalves can play important roles in marine ecosystems affecting macrobenthic communities, benthic boundary layers and benthic-pelagic coupling, not just by their presence but also by any changes in feeding behaviour. While seston quality has consistently been found to be an important influence on the feeding rates of suspension-feeding bivalves, factors causing stress to individuals are also likely to be important, as they may affect energy-dependent thresholds of response. We postulated that (1) history of seston quantity would affect how suspension feeders deal with increases in total suspended particulates, and (2) high-seston concentrations would affect rates more in individuals whose energy reserves were low after spawning. Three sites were selected for short-term (1 day) feeding experiments on the pinnid bivalve, *Atrina zelandica*. At one site, the experiment was run pre- and post spawning. *Atrina* exhibited high rejection of filtered particles (mostly 75% to 100%) and high organic absorption efficiencies (0.9 - 1) at all seston levels. Strong differences in the response of feeding behaviour to increased seston concentrations were observed between *A. zelandica* from different sites, with lesser differences observed between times. The site-specific feeding responses to seston concentrations observed are likely to affect our ability to model responses of *A. zelandica* to sediment loading and to influence the importance of *A. zelandica* to benthic-pelagic coupling

Mahanga Bay (Wellington): The Life History of an Aquaculture Research Centre (2009)

Hickman, R.W,
NIWA

Spatial Information: Elsewhere in New Zealand - Mahanga Bay ,Wellington
Keywords: aquaculture, marine farming, New Zealand, Mahanga Bay, history, Wellington, research,

Summary: Mahanga Bay (Wellington): The Life History of an Aquaculture Research Centre. This report documents the history of the Mahanga Bay aquaculture research centre. It covers everything from its initial conception and operation, different species researched over time and improving technologies, to staff who have worked there and collaborations with other NIWA centres.

Applications for two coastal permits by Ports of Tauranga Limited (2010)
Hill, G.; Payne, V.; Heerdegen, R.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: sedimentation, dredging, port, Tauranga Harbour, Te Awanui

Summary: Applications for two coastal permits by Ports of Tauranga Limited to dredge the main shipping channels in the Tauranga Harbour (Te Awanui) (up to 15 million cubic metres); depositing that material at identified sites within the coastal marine area; and also removing dredged material from the coastal marine area (up to 10 million cubic metres).

Inventory of New Zealand's Active Dunelands (2000)
Hilton, M.; Macauley, U.; Henderson, R.
Department of Conservation

Spatial Information: New Zealand
Keywords: sand dunes, dunelands, map, geographic information system (GIS), impacts, degradation, urbanisation, agriculture, New Zealand,

Summary: An inventory of active dunelands in New Zealand, those dunelands that owe their physical, landscape and ecological character to the ongoing or very recent movement of sand by wind, is presented. Maps of active dunelands for the 1950s, 1970s and 1980s for each region were derived from published topographic maps and other historic sources. Maps showing the extent of active duneland in the 1990s were derived from the most recent aerial photographs held by local authorities. The boundaries of active dunelands were digitised at the map or photo scale and stored as a geographic information system database using ARC-INFO software. ARC-INFO was used to calculate the area of each active duneland, sum the areas of active duneland in each region and produce A4 format maps of active duneland cover in the 1950s, 1970s, 1980s and 1990s for each region and for subdivisions of each region. Maps were circulated to Department of Conservation and local authority offices and corrections made where necessary.

New Zealand Threat Classification System Lists – 2005 (2007)
Hitchmough, R.; Bull, L.; Cromarty, P.

Department of Conservation

Spatial Information: New Zealand
Keywords: Threatened species

Summary: New Zealand's threatened and potentially threatened species of animals (marine mammals, bats, birds, reptiles, amphibians, freshwater and marine fish, and terrestrial, freshwater and marine invertebrates) and non-vascular plants (bryophytes and macroalgae) were assessed or reassessed for risk of extinction using the New Zealand Threat Classification System. Lists of threatened vascular plants were taken from previous publication. Threatened fungi were not reassessed. The number of species listed as threatened increased from 2372 to 2788, and the number listed as Data Deficient increased from 2047 to 3031. These changes were mostly as a result of improved knowledge and the assessment of species that had not been considered previously, but a small number of species changed category as a result of genuinely improved or deteriorated status. Each of these changes is discussed, and complete lists of threatened and Data Deficient species are provided.

Environment and livelihoods in tropical coastal zones: managing agriculture-fishery-aquaculture conflicts (2006)
Hoanh, C.T., (Edited by); Tuong, T.P., (Edited by); Gowing, J.W., (Edited by); Hardy, B., (Edited by),
CABI Publishing, International Rice Research Institute (IRRI) and the International Water Management Institute (IWWI)

Spatial Information: No spatial context
Keywords: aquaculture, tropics, congresses, agriculture, fisheries, coastal zone management, environmental aspects, marine ecosystems, open-access resources, resource management,

Summary: The focus of the book is around the challenges people face in managing crops, aquaculture, fisheries and related ecosystems in inland areas of coastal zones in the tropics. A priority issue that emerges from the case studies presented here is the impact of change on poor people whose livelihoods depend upon open-access resources. Any development decision that aims at enhancing production from aquaculture and/or agriculture is likely to adversely affect access to and the productivity of these resources. Conflicts arise between different stakeholders and in this book we discuss the nature of these conflicts and identify what is known and not known about how to manage them. The book will therefore help planners, resource managers and donors to make better-informed investment decisions in connection with development of the coastal zone.The chapters in this book were selected from papers presented at the International Conference on Environment and Livelihoods in Coastal Zones: Managing Agriculture–Fishery–Aquaculture Conflicts, organized in Bac Lieu, Vietnam, on 1–3 March 2005.

Persistent organochlorine residues in estuarine and marine sediments from Ha Long Bay, Hai Phong Bay, and Ba Lat Estuary, Vietnam (2008)
Hong, S. H.; Yim, U. H.; Shim, W. J.; Oh, J. R.; Viet, P. H.; Park, P. S.
Chemosphere Journal

Spatial Information: Overseas - Ha Long Bay, Hai Phong Bay, and Ba Lat Estuary, Vietnam

Keywords: Organic Pollutants

Summary: To assess the organochlorine contamination in the northeast coastal environment of Vietnam, a total of 41 surface sediments were collected from Ha Long Bay, Hai Phong Bay, and Ba Lat estuary, and analysed for their organochlorine content. Organochlorine compounds (OCs) were widely distributed in the Vietnamese coastal environment. Among the OCs measured, DDT compounds predominated with concentrations ranging from 0.31 to 274 ng g(-1). The overall contamination level of DDTs in coastal sediments from northern Vietnam is comparable with those from other Asian countries. However, concentrations exceeding 100 ng g-1 are comparable with high concentrations reported from India and China, the largest DDT consumers in the world. The overall concentrations of PCBs, HCHs, and chlordanes in surface sediments were in the ranges of 0.04-18.71 ng g-', not detected (n.d.) - 1.00 ng g-1, and n.d. - 0.75 ng g-', respectively. Ha Long Bay and Hai Phong Bay were relatively more contaminated with DDTs and PCBs than other regions, respectively. In contrast, the distribution of HCHs was relatively homogeneous. OCs contamination in the coastal environment of Vietnam is closely related to shipping and industrial activities. The levels of DDT compounds in harbours and industrial areas exceeded their sediment quality guideline values suggested by Environment Canada [CCME (Canadian Council of Ministers of the Environment), 2002.

Nutrient and Vegetation Changes in a Retired Pasture Stream (1999)

Howard-Williams, C.; Pickmere, S
Department of Conservation

Spatial Information: Elsewhere in New Zealand - Whangamata Stream, Lake Taupo
Keywords: Whangamata Stream, Lake Taupo, New Zealand, freshwater quality, riparian, farm management, stream rehabilitation, nutrients, nitrogen, phosphorus, monitor, suspended solids, biodiversity, sediment

Summary: This report records water quality and vegetation changes in the Whangamata Stream, Lake Taupo catchment from 1995 to 1998. The data represents the latest three years of a 24-year study on changes to this pasture stream since riparian strips were established in 1976, to retire the margins of the stream from pastoral farming. This data set is unique in New Zealand for its continuity and allows a quantitative assessment of the extent and time scales of change in rehabilitation programmes of this nature. The process of rehabilitation of the stream was assisted by some plantings of native species among the pasture-grassed banks. During this three-year study period, the number of vascular plant species recorded in the stream and along the banks increased from 119 to 148. Native plants made up 41% of the total. Woody species hadinvaded the flax-dominated stream banks. The reaches of the stream which had the original plantings (c. 1976) were found to have the highest number of species. The old pasture proved very resistant to invasion and in many areas where assisted plantings have not occurred, extensive areas of rank grass comprising the original pasture species were still intact.

The ability of the stream bank and channel flora to remove nutrients from the stream has been reduced over this three-year monitoring period, with nitrate and dissolved reactive phosphorus uptake in mid-summer found to be less than 15% of the mass flow of these nutrients. This compares with c. 90% removal in the mid-1980s. Total suspended solids showed a strongly seasonal pattern, with values increasing in winter and decreasing to low values (<5 g m–3) in summer. A similar pattern was

recorded in the late 1970s and early 1980s. The winter maximum TSS concentration in 1996 was very high (c. 70 g m–3) coinciding with the Ruapehu eruption which blanketed much of the catchment in ash. The stream channel was essentially clear of the plant blockages which were a feature of the 1980s and early 1990s. The water flowed unimpeded below a dense cover of flax and toetoe, allowing easy access for spawning trout to the upper reaches of the stream. Fernbird, fantails, bellbird, pukeko were observed. The stream is now an increasingly important wildlife area. The role of the protected riparian strips has therefore changed over the years from a sediment and nutrient trapping mechanism to sediment control, with greatly enhanced wildlife values.

Management of the Esplanade Reserve Alongside the Kopurererua Stream, Tauranga (1995)
Howells, R.
Bay of Plenty Polytechnic Report no. 19

Spatial Information: Kopurererua Stream, Tauranga
Keywords: Kopurererua Stream, Waikareao Estuary, esplanade reserve, water quality, industrial encroachment, runoff from urban & pastoral areas, riparian zone management, invasive species.

Summary: There are a number of problems associated with the Kopurererua Stream. The main one is inadequate management of the esplanade reserve adjacent to the stream which has lead to the loss of natural values; deterioration of water quality and the problem of industrial encroachment. The stream has been dramatically modified over the years from its natural state which has, as a result, contributed to the above problems. Degraded water quality of the Kopurererua Stream is mainly caused by runoff from both urban and pastoral areas. As a result the stream has high nitrogen, phosphorus and suspended solid loads. This not only affects the stream but also the Waikareao Estuary which is an important food source for the Maori of the area. The vegetation of the stream banks lacks diversity due to invasive plants. The remainder of the stream bank vegetation is being affected by industrial encroachment which has lead to some areas being quite bare. The answer to this problem is riparian zone management, which can help to enhance the area. The Kopurererua Stream has the potential to be a real asset as a amenity resource. The stream could also act as a good link to already existing amenities of the area.

An Assessment of Potential Whitebait Spawning Grounds in the Kopurererua, Waimapu and Waitao Streams, Tauranga (1994)
Howells, R.; Lovell, D.
Bay of Plenty Polytechnic Report no. 21

Spatial Information: Kopurererua, Waimapu and Waitao Streams, Tauranga
Keywords: Kopurererua, Waimapu and Waitao Streams, Whitebait spawning grounds

Summary: This report consists of locating the probable spawning grounds for whitebait in three streams in the Tauranga area, the Kopurererua, Waimapu and Waitao streams and investigating ways in which these spawning areas can be enhanced. The saltwater wedge was identified for each stream and bank conditions in that area were evaluated. We found the Kopurererua stream to be very undesirable as a whitebait spawning ground due to the encroachment onto the

Esplanade Reserve by the adjacent properties. The Waimapu is more suited as a whitebait spawning ground and is well protected by surrounding reserves. There is, however, a problem with adjacent land owners modifying the bank system in a stretch of the saltwater zone. The saltwater wedge zone of the Waitao stream has been grazed to the water's edge on the true right bank. This has left bare patches and poor vegetation. The true left bank is in better condition with only a small amount of blackberry to be removed. Recommendations for the immediate future of the streams have been made. These centre largely around the clearing of undesirable plant species from the banks in the areas of the saltwater wedge and replacing them with more suitable species.

Draft Ohiwa Harbour and Catchment scoping report (2002)
Hughes, B.N.
Environment Bay of Plenty

Spatial Information: Ohiwa Harbour, Tauranga
Keywords: Sedimentation, Coastal zone management, Harbours, Ohiwa Harbours (N.Z), watershed management

Summary: This is the Draft Ohiwa Harbour and Catchment Scoping Report prepared for the Strategic Policy Committee of the Bay of Plenty Regional Council (Environment B·O·P). The Scoping Report is designed to help Environment B·O·P decide whether to proceed to fund the development of an integrated management strategy for the Ohiwa Harbour and its catchment. This Scoping Report is based on research of reports prepared for Environment B·O·P and other stakeholder organisations. An intensive consultative process involving statutory and iwi and hapu stakeholder group's was undertaken prior to the preparation of this report. In all cases staff and elected representatives of each organisation indicated their willingness to participate in the Scoping Report process and any subsequent strategy that might arise out of it. For this reason it is recommended that further consultation should follow this report, regardless of the outcome. Planning terms such as 'integrated management' and 'strategy' are explained in the report and identify the focus of the Scoping Report. The report recognises that integrated management is a goal and that arriving at integrated management requires communication which is, in itself, a strategic device that has potential to benefit all stakeholder participants. Developing a strategy that focuses on integrated management offers management agencies the potential to:

- Reduce duplication of services and spending,
- Provide greater clarity and certainty about roles and responsibilities,
- Design processes to help resource consent applicants plan application timelines,
- Enhance relationships between stakeholder groups, including the community,
- Provide opportunities for stakeholder groups to participate in activities aimed at achieving a common vision, while sustainably managing resources that are being appropriately used and developed.

This report asserts that such objectives are best met when stakeholder groups come together to strategise how they might integrate their resource management with other stakeholders.

Perceptions of conservation and the Department of Conservation: interim findings from the 2008 Environmental Perceptions Survey. Land Environment and People research report; no. 1 (2008)

Hughy, K.F.D.; Kerr, G.N.; Cullen, R.; Cook, A.J.
Lincoln University, Environment Society and Design Division

Spatial Information: New Zealand.
Keywords: land use, New Zealand, environmental protection, environmental policy, natural resources New Zealand management, Tourism New Zealand, fisheries, aquaculture, conservation

Summary: A conservation case study was included as a component of the 2008 biennial environmental perceptions survey. The survey drew on a random sample of 2000 people aged 18 and over from the electoral roll, and achieved an effective response rate of 40%. The conservation case study had five major themes. First, the study of national park visitation rates indicated that 44% of respondents made at least one visit to a national park in 2007. Second, the Natural Areas Value Scores enabled a clustering of respondents into five groups – these value groups are directly comparable to similar research from Australia, and comparable to more recent New Zealand research. The value group clusters were used to further analyse responses to other conservation questions. Third, respondents recognise a wide range of meanings for the term 'conservation' and conservation is very important to them as individuals. Given the above it should not be surprising that respondents, fourthly, were very supportive of additional government expenditure for conservation. Finally, it was surprisingly how low the rates of awareness are of how DoC's activities contribute to a range of ecosystem services. But, even given this response there is very high overall support for the importance of the work done by DoC, with over half the respondents considering the Department's performance to be 'good' or 'very good'. The patterns of responses and overall conclusions are similar to those that were drawn from a similar phone-based survey in 2007. Overall, therefore, this postal survey has proven to be both cost-effective and timely in terms of providing the sorts of information required by DoC. Ongoing biennial surveys of this sort would allow the Department to monitor people's perceptions of its performance and related issues over time.

The ecology of bivalves on Centre Bank, Tauranga Harbour (1996)

Hull, P. J.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour; Bivalvia ecology; Marine ecology; Estuarine ecology; Molluscs; Invertebrates

Summary: An investigation into the ecology of bivalve molluscs on Centre Bank, the flood tidal delta of Tauranga Harbour was undertaken over the period December 1994 – March 1996. The primary purpose of which was to gather quantitative data on bivalve diversity, spatial patterns of distribution, abundance, and population size structure of bivalves present on Centre Bank. Experiments were conducted to assess the burrowing behaviour of the bivalve Paphies australis. A focus of the investigation was to gather information regarding changes in the ecology of Centre Bank.

Finding safe harbour involving communities in coastal hazard mitigation (2007)

Hume, T.; Blackett, P.; Dahm, J.
Water & Atmosphere

Spatial Information: No spatial context
Keywords: Natural Hazards/Storms

Summary: Does involving local people in reducing coastal hazards lead to better environmental outcomes? Terry Hume, Paula Blackett, and Jim Dahm surveyed seven community groups to find out. Community groups are playing a growing role in coastal hazards mitigation as policy agencies increasingly focus on community participation, inclusion, and consultation, and put more emphasis on voluntary environmental actions. This community involvement is thought to have many benefits: it can improve the quality of decisions and overall environmental results, build community relationships, and increase local capacity to understand and manage environmental issues. At the same time, there has been a shift away from hard engineering and a 'humans against nature' approach, and increased emphasis on managing humans rather than nature.

How estuaries grow old (2003)
Hume, T.; Swales, A.
Water & Atmosphere

Spatial Information: New Zealand
Keywords: Sedimentation, estuaries

Summary: Have you ever wondered how estuaries have formed and if they will eventually fill up with sediment and die? Estuaries in New Zealand have not always looked like they do today. These semi-enclosed coastal water bodies, where land drainage mixes with the sea, began life about 6500 years ago, when climatic warming caused sea level to rise some 150 m to its present level. The sea level rise drowned an ancient and varied landscape. So, in the Auckland region, the seabed of present-day Hauraki Gulf was once a broad alluvial plain with meandering river channels incised into it and the coast was out beyond Great Barrier Island. In south-west New Zealand, the landscape was dominated by deep U-shaped valleys cut by glaciers. The “proto-estuaries” that formed as sea-level rose were very different from those we see today because since that time they have filled with sediment and grown old.

Coastal oceanography and sedimentology in New Zealand, 1967-91(1992)
Hume, Terry M.; Bell, Robert G.; de Lange, Willem P.; Healy, Terry R.; Hicks, D. Murray; Kirk, R. M.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand
Keywords: Sedimentation

Summary: This paper reviews research that has taken place on physical oceanography and sedimentology on New Zealand's estuaries and the inner shelf since c. 1967. It includes estuarine sedimentation, tidal inlets, beach morphodynamics, nearshore and inner shelf sedimentation, tides and coastal currents, numerical modelling, short-period waves, tsunamis, and storm surges. An extensive reference list covering both published and unpublished material is

included. Formal teaching and research programmes dealing with coastal landforms and the processes that shape them were only introduced to New Zealand universities in 1964; the history of the New Zealand Journal of Marine and Freshwater Research parallels and chronicles the development of physical coastal science in New Zealand, most of which has been accomplished in last 25 years.

Tauranga Harbour Sediment Study: Assessment of predictions for management (2009)
Hume, T. M.; Green, M. O.; Elliott, S.
NIWA

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Sedimentation

Summary: Technical Report F1 provides a summary of the previous technical reports from the NIWA Tauranga Harbour Sediment Study. In addition, Technical Report F1 provides a model of how the harbour works to address how changes in sediment runoff from the catchment translate into changes in sediment in the harbour. Sediment-transport patterns emerged, in that sub-estuaries deposit sediment from more than the adjacent sub-catchment, as sediment mixing occurs in the estuary. Under current land use and climate scenarios, about 42% of the net sediment runoff from the sub-catchments is lost to the ocean.The report then addresses three questions: (1) Which catchments are more important as priority areas for focusing resources to reduce sedimentation in the harbour? (2) What are the likely effects of existing and future urban development on the harbour? (3) How can the appropriate regulatory agencies (EBOP, WBPDC and TCC) most effectively address sedimentation issues, and what management intervention could be appropriate? (4) Are there any reversal methods, such as mangrove control and channel dredging that may be effective in managing sedimentation?

(1) The sediment load to the estuary generally increases with the size of the catchment; subsequently 42.4% of the sediment enters the southern harbour from the Wairau sub-catchment.
(2) Urbanisation is predicted to lower the sediment load to the harbour slightly by the year 2051, as urban land use has lower rates of sediment run off than pasture. Other land use changes were not assessed. The controls on earth works were predicted to reduce the sediment load contributed by these activities substantially.
(3) Strategies for intervention include: retiring steep pasture land to established plantations; enhancing the potential for sediment to be deposited on floodplains within the catchment in particular for Waitao and Waimapu sub-catchments; riparian planting; improved forestry controls; and to maintain and enhance the existing controls on earth works.
(4) Mitigation of sediment runoff as a preventive measure for managing sedimentation is preferred over reactive dredging and mangrove removal.

Factors controlling tidal inlet characteristics on low drift coasts (1992)
Hume, T. M.; Herdendorf, C. E.
Journal of Coastal Research

Spatial Information: New Zealand - northeast coast
Keywords: Sedimentation

Summary: New Zealand's northeast coast is characterised by low littoral drift and the numerous barrier enclosed estuaries along the shore present an excellent opportunity to examine tidal inlet processes under low littoral drift conditions. The estuaries range in area from c.l to 98 km^2, are micro-mesotidal and have tidal prisms ranging from c.0.8 x 106 to 155 x 106 m^3. Tidal inlets mostly occur where Holocene sand barriers have built out towards rock headlands. The inlets generally have positional stability as a result of shelter from wave energy in the lee of rock headlands, however, morphological instability is common and temporal. Ebb tidal delta platform is controlled by the tidal discharge, degree of headland shelter and littoral supply. In situations where a rock headland provides shelter from waves, the ebb tidal delta comprises an elongate or triangular swash platform built normal to the shore in the lee of the headland. Where there is little headland shelter and the littoral drift is very low, the ebb tidal delta is poorly developed and comprises an extension of the beach bar system across the mouth of the inlet. In comparison where there is little headland shelter but the littoral drift and tidal prism are greater, a large and more classical shaped ebb tidal delta bulges out from the coast. In general the inlets can be considered as geometrically stable (i.e. have the ability to return to their initial configuration after a disturbance) because: (1) the generally low width to depth ratio (average 44) indicates that the inlet throat channels are hydraulically efficient, (2) the strong relationship between throat area and tidal prism/discharge indicates that there is a balance between inlet geometry and tidal flow through the gorge, (3) of the similarity of their throat area/tidal prism relationships and width/depth ratios to those inlets stabilized with 2 jetties on the Pacific and particularly the Atlantic coast of the USA, and (4) the high tidal prism/ littoral drift ratios indicate that entrance conditions are good and that the tidal current is the main mechanism for transporting sediment through the entrance. The rock headlands at the northeast coast inlets appear to act in a similar manner to jetties in directing the ebb tide jet and so forcing tidal dominance of sediment transport, creating an efficient throat profile and a geometrically stable entrance.

On the use of empirical stability relationships for characterising estuaries (1993)
Hume, T. M.; Herdendorf, C. E.
Journal of Coastal Research

Spatial Information: New Zealand and overseas
Keywords: sedimentation, estuaries

Summary: Data from New Zealand and overseas studies are used to support the hypothesis that area-prism (A-Q) relationships, like those used to characterise the entrance throat stability of barrier enclosed tidal inlets on exposed sandy coasts, hold for a wide variety of estuary types ranging from lagoon to river mouth situations to large coastal embayments. The relationships indicate that both the bay size and the amount of littoral drift are important in determining the geometry of estuary mouths. The empirical relationships can be used to characterise and classify estuaries.

Tauranga Harbour Investigation. Report on first stage (1963)
Hydraulics Research Station,
Hydraulics Research Station

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour

Summary: Until 1940 the needs of the community surrounding the Bay of Plenty were adequately served by the 330-ft long Railway Wharf at Tauranga. During the years that followed, the development of the timber industry, based on the products of the forests in the Rotorua area, necessitated the construction of further dock facilities. In 1949 the Ministry of Works gave their support to plans to provide wharfage at Maunganui in preference to the alternative proposition for development at Whakatane, some 50 miles to the south-east. It was considered that the Maunganui site would best serve the needs, not only of the pulp and paper industry to be established somewhere between Tauranga and Whakatane, but also of the whole Bay of Plenty. In addition it was felt that, providing entrance depths could be improved to allow passage at high water vessels drawing at least 30ft, trade in the primary products of meat and butter could be developed.

Tauranga Harbour Investigation. Report on the second stage (1968)
Hydraulics Research Station,
Hydraulics Research Station

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour

Summary: In May, 1959 the Hydraulics Research Station, Wallingford, England was asked by the Tauranga Harbour Board to make a study of the hydraulic conditions obtaining in Tauranga harbour and to examine by means of a scale model the relative merits of various schemes proposed for the future development of the port's facilities. The 2 major problems confronting the Harbour Board were: 1. How to improve and maintain depths in the entrance to the harbour and in the Maunganui Channel so that ships drawing at least 30ft would be able to navigate as far as the Maunganui wharves at high water, and 2. How to plan future port development, particularly with regard to the provision of additional wharfage, so that existing assets would in no way be jeopardized.

3.9. I

The Health Significance of Viruses in Water (1983)
IAWPRC Study Group on Water Virology,
Water Research

Spatial Information: No spatial context
Keywords: viruses, water quality, indicator organisms, water disinfection, epidemiology, viral analysis, health risk, water-borne diseases, infectious dose, water reuse

Summary: There is no question that water may transmit pathogenic viruses. In fact, epidemiological data on the incidence of water-borne viral diseases probably fail to reflect the true extent of the hazard. However, it is equally clear that the technology to produce virologically safe water is available, but often not applied. Viral infections could always be traced to inefficient treatment, break-down of equipment, or secondary pollution in distribution systems. In addition, the efficiency of treatment processes can reliably be assessed by means of microbiological indicator systems. This information should now be used in research on the improvement of water treatment and surveillance systems in terms of cost, efficiency and reliability in order

to ensure more safe water for more people throughout the world. The role of water in the overall incidence of microbial diseases and the optimum utilization of financial resources for the benefit of public health, in general, should be a major consideration in these endeavours. Monitoring procedures must include operational and chemical control as well as practical microbiological assays to detect treatment deficiencies. It should be possible to perform the microbiological tests economically and at high frequency in conventional laboratories, and reliable results should be available in a short time. Evidence has been presented that currently available virological tests, which do not meet these requirements, may be eliminated from routine monitoring. However, the optimization of water treatment and surveillance for the many different uses and users of water, requires more information on the incidence and behaviour of viruses in water, the relation of pathogenic viruses to indicators, the virucidal efficiency and mechanism of action of treatment processes, and the epidemiology of waterborne viral diseases. Success in these efforts will heavily depend upon a multi-disciplinary approach and close co-operation among fields of expertise such as engineering, microbiology, chemistry, public health, epidemiology, economics, statistics and education.

The seagrasses of New Zealand (2003)
Inglis, G
University of California Press

Spatial Information: NZ harbours including Tauranga
Keywords: Plants, Sea grass

Summary: Looks at the distribution of sea grass throughout New Zealand (Aotearoa). Includes the sea grass status of many NZ harbours including Tauranga. Also covers the threats and management of sea grasses in NZ. There also mentions a sea grass 'limpet' that specialises in sea grass. However, no research exists on this endemic species.

Port of Tauranga: Baseline survey for non-indigenous marine species (2006)
Inglis, G.; Gust, N.; Fitridge, I.; Floerl, O.; Woods, C.; Hayden, B.; Fenwick, G
Ministry of Agriculture & Forestry and Biosecurity New Zealand

Spatial Information: Port of Tauranga, New Zealand
Keywords: Plants, Sea grass, Sea lettuce

Summary: This report describes the results of a March 2002 survey to provide a baseline inventory of native, non-indigenous and cryptogenic marine species within the Port of Tauranga. The survey is part of a nationwide investigation of native and non-native marine biodiversity in 13 international shipping ports and three marinas of first entry for yachts entering New Zealand from overseas.Sampling methods used in these surveys were based on protocols developed by the Australian Centre for Research on Introduced Marine Pests (CRIMP) for baseline surveys of non-indigenous species in ports. Modifications were made to the CRIMP protocols for use in New Zealand port conditions. A wide range of sampling techniques was used to collect marine organisms from a range of habitats within the Port of Tauranga. Fouling assemblages were scraped from hard substrata by divers, benthic assemblages were sampled using a sled and benthic grabs, and a gravity corer was used to sample for dinoflagellate cysts. Mobile predators and scavengers were sampled using baited fish, crab, starfish and shrimp traps.

Port of Tauranga: Second Baseline Survey for Non-Indigenous Marine Species (2008)

Inglis, G.; Gust, N.; Fitridge, I.; Floerl, O.; Woods, C.; Kospartov, M.; Hayden, B.; Fenwick, G
NIWA

Spatial Information: Port of Tauranga, New Zealand
Keywords: Plants, Sea grass, Sea lettuce

Summary: This report describes the results of a repeat port baseline survey of the Port of Tauranga undertaken in April 2005. The survey provides a second inventory of native, non indigenous and cryptogenic marine species within the port and compares the biota with the results of an earlier port baseline survey of the Port of Tauranga undertaken in March 2002. The survey is part of a nationwide investigation of native and non-native marine biodiversity in 13 international shipping ports and three marinas of first entry for yachts entering New Zealand from overseas. To allow a direct comparison between the initial baseline survey and the resurvey of the Port of Tauranga, the survey used the same methodologies, occurred in the same season, and sampled the same sites used in the initial baseline survey. To improve the description of the biota of the port, some additional survey sites were added during the repeat survey. Sampling methods used in both surveys were based on protocols developed by the Australian Centre for Research on Introduced Marine Pests (CRIMP) for baseline surveys of non-indigenous species (NIS) in ports. Modifications were made to the CRIMP protocols for use in New Zealand port conditions. These are described in more detail in the body of the report. A wide range of sampling techniques was used to collect marine organisms from habitats within the Port of Tauranga. Fouling assemblages were scraped from hard substrata by divers, benthic assemblages were sampled using a sled and benthic grabs, and a gravity corer was used to sample for dinoflagellate cysts. Mobile predators and scavengers were sampled using baited fish, crab, starfish and shrimp traps. Sampling effort was distributed in the Port of Tauranga according to priorities identified in the CRIMP protocols, which are designed to maximise the chances of detecting on indigenous species. Most effort was concentrated on high-risk locations and habitats where non-indigenous species were most likely to be found. Organisms collected during the survey were sent to local and international taxonomic experts for identification.
A total of 304 species or higher taxa were identified in the first survey of the Port of Tauranga in March 2002. They consisted of 202 native species, 10 non-indigenous species, 51 cryptogenic species (those whose geographic origins are uncertain) and 41 species indeterminata (taxa for which there is insufficient taxonomic or systematic information available to allow identification to species level). During the repeat survey, 264 species or higher taxa were recorded, including 177 native species, 9 non-indigenous species, 43 cryptogenic species and 35 species indeterminata. Many species were common to both surveys. Around 41% the native species, 44% of non-indigenous species, and 50% of cryptogenic species recorded during the repeat survey were also found in the earlier survey.The 9 non-indigenous organisms found in the repeat survey of the Port of Tauranga included representatives of 3 major taxonomic groups. The non-indigenous species detected were: *Bugula flabellata, Bugula neritina, Electra tenella, Watersipora subtorquata, Amathia distans, Zoobotryon verticillatum* (Bryozoa); *Monotheca pulchella, Sertularia marginata* (Cnidaria); *Cliona celata* (Porifera). Five of these species – *Electra tenella, Amathia distans, Zoobotryon verticillatum, Monotheca pulchella, Sertularia marginata* – were not recorded in the earlier baseline survey of the Port of Tauranga. In addition, 5 non-

indigenous species that were present in the first survey – *Polydora hoplura, Clytia ?linearis, Eudendrium capillare, Apocorophium acutum, Monocorophium acherusicum* – were not found during the repeat survey. Twenty three species recorded in the repeat survey had not previously been described from New Zealand waters. This included 19 species of sponge that not correspond with existing descriptions from New Zealand or overseas and may be new to science. None of the species recorded from the Port of Tauranga is on the New Zealand register of unwanted organisms. Most non-indigenous species located in the Port are likely to have been introduced to New Zealand accidentally by international shipping or spread from other locations in New Zealand (including translocation by shipping). Approximately 44 % (4 of 9 species) of NIS in the Port of Tauranga are likely to have been introduced in hull fouling assemblages, 44 % (4 species) by hull fouling or ballast water, and 1 species (12 %) via fouling on flotsam vectors. The predominance of hull fouling species in the introduced biota of the Port of Tauranga (as opposed to ballast water introductions) is consistent with findings from similar port baseline studies overseas.

Climate Change 2007 - Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007)
IPCC
Cambridge University Press

Spatial Information: Africa, Asia, Australia/New Zealand, Europe, Latin America, North America, polar regions and small islands
Keywords: Climate change, Sea-level Rise, Water Resources, Agriculture, Food Security, Coastal Regions

Summary: Climate change 2007 - Impacts, Adaption and Vulnerability provides the most comprehensive and up-to-date scientific assessment of the impacts of climate change, the vulnerability of natural and human environments, and the potential for response through adaptation. The report:

- evaluates evidence that recent observed changes in climate have already affected a variety of physical and biological systems and concludes that these effects can be contributed to global warming;
- makes a detailed assessment of the impacts of future climate change and sea-level rise on ecosystems, water resources, agriculture and food security, human health, coastal and low-lying regions and industry and settlements;
- provides a complete new assessment of the impacts of climate change on major regions of the world (Africa, Asia, Australia/New Zealand, Europe, Latin America, North America, polar regions and small islands);
- considers responses through adaptation;
- explores the synergies and trade-offs between adaptation and mitigation;
- evaluates the key vulnerabilities to climate change, and assesses aggregate damage levels and the role of multiple stresses.

NERMN Beach Profile Monitoring (2007)
Iremonger, S.

Bay of Plenty Regional Council

Spatial Information: Bay of Plenty coastline
Keywords: Environment Bay of Plenty, NERMN, beach profile, monitoring, Bay of Plenty, Tauranga Harbour, Te Awanui, Mount Maunganui

Summary: This is the second report detailing the results of the coastal monitoring network initiated by Environment Bay of Plenty in 1990 as part of its Natural Environment Regional Monitoring Network (NERMN) programme. A total of 53 sites are profiled on an annual basis within the current coastal monitoring programme. Some selected sites are monitored quarterly; others are monitored as necessary, i.e. after storm events or where a beach is considered to be of significant concern to the public due to impacts on private property. Over the course of a year along the Bay of Plenty coastline, changes in the beach morphology result from "cut and fill" processes. The movement of sediment from this process is dependent on wind and wave action as well as sediment properties. These seasonal changes are superimposed on short and long term processes which act to produce periods (tens of years) of erosion, accretion and dynamic equilibrium. Wave action is the dominant forcing process causing changes in erosion and accretion patterns along the Bay of Plenty coastline. Wave conditions in the Bay of Plenty are moderately influenced by the El Niño Southern Oscillation. More stormy conditions than average tend to occur during La Niña periods, which are associated with an increase in north-easterlies in the New Zealand region. During El Niño years, where a higher occurrence of south-westerlies occurs, wave conditions in the Bay of Plenty are somewhat reduced although episodic extra-tropical cyclones still occur. Given that since 1998 we have entered a negative phase of the Interdecadal Pacific Oscillation where neutral or La Niña conditions may be more likely to occur, it is possible that the Bay of Plenty region may experience increased rates of erosion over the next 20 to 30 years, similar to that experienced in the late 1960s and early to mid 1970s (Bell et. al., 2006). Over the period of the physical coastal NERMN (typically 16 years of data to date), 53 sites have been monitored to access changes in beach profile position and beach volume. The overall beach state (Table 1) generally shows common patterns per reported beach system. This is not unexpected as typically these beach systems are affected by sources of localised sediment influx from fluvial sources or are separated by a number of natural obstructions, such as:

- hard-rock coastline north of Waihi Beach
- northern Tauranga Harbour entrance
- southern Tauranga Harbour entrance
- Mount Maunganui
- Town Point, Maketu
- Kohi Point headland, Whakatane
- Ohiwa Harbour entrance

These features punctuate the general direction of littoral drift in the Bay of Plenty of north-west to south east flux, though there are areas where the direction of net sediment movement has been modelled to be orientated towards the North West (Bell et. al., 2006; Phizacklea 1993). Littoral drift is the main mechanism by which sediment is supplied to a beach; it is also a value that is difficult to measure directly. Results from this report show that the following beaches are showing trends of erosion for the period 1990-2006:

- Ohope Beach
- Pukehina Beach
- Southern area of Waihi Beach
- Central section of Hikuwai Beach

A continuation of this NERMN is important in the management regime of this coastal area. There are increasing pressures (development and recreational) in this coastal environment. The profile monitoring provides a baseline dataset for determining the physical state of these beach systems. Additional increasing pressures such as sea level rise further enforce the requirement for this monitoring to continue. A future monitoring schedule has been outlined in Chapter 6 of this report which will allow for timely and representative information to be collected and analysed.

Eutrophication-related changes in macrovegetation and foraging of young cod (*Gadus morhua* L.): a mesocosm experiment (1994)
Isaksson, I.; Pihl, L.; van Montfrans, J.
Journal of Experimental Marine Biology and Ecology

Spatial Information: No spatial context
Keywords: Decapod, Eutrophication, Filamentous algae, *Gadus morhua,*Predation, Skagerrak

Summary: Predation by 1-year-old cod *(Gadus morhua)* on three decapod crustacean prey (*Crangon crangon, Caninus maenas* and *Palaemon adspersus*) was examined in outdoor flow-through mesocosms. Experimental treatments included varying percent cover (70-80; 30-40 and 0 or 10%, respectively) of filamentous algae (*Enteromorpha prolifera, E. intestinalis or Cladophora spp.*) on bare sand and on patches of *Zostera marina.* Foraging efficiency of cod on *Crangon crangon* and *Carcinus maenas* was greatest in unvegetated treatments. Survival of *Crangon crangon* and *Carcinus maenas* was significantly enhanced by the addition of moderate (30-40%) levels of filamentous algal cover to sand substrates, while further increased habitat complexity (70-80% cover) didn't significantly increase the survival of these two species. This suggests a threshold effect in the influence of habitat structure where only small changes in macrovegetation are needed to dramatically decrease foraging efficiency of cod on *Crangon crangon* and *Carcinus maenas.* In contrast, no significant difference in predation-induced mortality of *P. adspersus* was observed between experimental treatments, indicating that *P. adspersus* is equally susceptible to predation in all habitat types tested. Our studies emphasize the potential effects of habitat alteration from barren sandy embayments providing optimal foraging areas for cod, to progressively more algal-covered habitats in which cod are less successful foragers. During the past decade, shallow coastal areas along the Swedish west coast have been subjected to increasing eutrophication and a general proliferation of filamentous algae. By affecting predator-prey relationships, eutrophication-related structural changes in macrovegetation might cause considerable alterations in trophic relationships in shallow coastal waters.

3.10. J

Cross-cultural approaches to environmental research and management: a response to the dualisms inherent in Western science? (2009)

Jacobson, C.; Stephens, A.
Journal of the Royal Society of New Zealand

Spatial Information: No spatial context
Keywords: western science, Mātauranga Māori, local knowledge, indigenous knowledge, dualism, cross-cultural environmental research

Summary: This forum attempts to deepen the reflection and discussion on the linkages between indigenous and non-indigenous research and how they need to embrace and learn from one another. It focuses on the need for science to genuinely embrace and respect local knowledge by considering the value of the different epistemologies.

Understanding the conservation expectations of Aucklanders (2001)
James, B.
Department of Conservation New Zealand

Spatial Information: Auckland, New Zealand
Keywords: community relations, public perceptions, conservation expectations, focus groups, Auckland

Summary: This report contributes to the development of a community relations strategy for the Auckland Conservancy of the Department of Conservation (DOC). Information was collected from nine focus groups: four of DOC stakeholders (agencies, iwi, NGOs, and supporters) and five general public groups (older people, young people, parents, urban Maori and Pacific peoples). It presents results on people's identification of conservation issues facing Auckland, their awareness and view of DOC and involvement in conservation. Conservation issues were identified in four main areas: pollution, urban sustainability, parks and reserves, and threatened species and habitats. Factors inhibiting conservation outcomes were also identified. The views expressed about DOC were generally positive or neutral. All groups identified education and information dissemination as key roles of DOC. Participants were involved in a range of conservation activities. They stressed personal, social and cultural motivations, not simply desired environmental outcomes, as reasons for involvement in conservation. The community relations strategy needs to address: DOC's low profile, Aucklanders' conservation concerns, conservation education and information, clarification of DOC's role, consultation and communication, and community involvement. The results of this Auckland study raise wider issues for DOC's community relations.

Sea Urchin Opportunities and Lessons (2010)
James, P.
VIP Publications Ltd

Spatial Information: New Zealand
Keywords: aquaculture, sea urchin, New Zealand, kina, Tripneustes gratilla

Summary: What has no brain, thousands of feet and could be the basis of a multi-million dollar aquaculture industry in New Zealand? If you guessed sea urchins you answered correctly. The value of high quality sea urchin roe, together with increasing demand in Asia and Europe, has caused overfishing of many sea urchin populations around the world. Subsequently, wild catches have steadily decreased and there has

been increasing interest in the aquaculture of a range of sea urchin species. There are two approaches to sea urchin aquaculture. The first is roe enhancement. This involves catching mature wild animals, holding and feeding them in either land or sea-based systems for a limited period of normally 10 to 12 weeks and increasing the quantity and quality of the roe. The second option is closed-cycle culture, which involves conditioning and spawning broodstock, fertilisation and hatching eggs, rearing the larvae through to settlement and on-growing juveniles through to market-size animals. The latter is the basis for most finfish and invertebrate (such as paua) aquaculture. In New Zealand there has been a substantial amount of research into roe enhancement of wild-caught sea urchins, or kina (*Evechinus chloroticus*) over the past 10 years (see NZ Aquaculture, issue 05, 2005) with the primary aim being to utilise kina found in barrens (areas with very high density of kina and little or no food) around New Zealand. These kina are normally easy to find and harvest but have a very small amount of poor quality roe and are not of any economic value unless they are enhanced.

Little Blue Penguin (*Eudyptula minor*) on Mauao (2000)
Jervis, K.; Davies, K.
Bay of Plenty Polytechnic Report no. 101

Spatial Information: Mt Maunganui (Mauao), New Zealand
Keywords: Little Blue Penguin (*Eudyptula minor*), Mauao, Mt Maunganui

Summary: This project investigates the Little Blue Penguin (Eudyptula minor) population on Mauao, Mt Maunganui, in the Bay of Plenty, New Zealand. It is a project which is ongoing in nature and the preliminary findings are shown here. Twenty-eight artificial nesting boxes were installed on Mauao to enhance the nesting habitat of the Little Blue Penguin population. To date these artificial nesting sites have not been utilised. It is expected that further weathering of the nesting boxes will make them more attractive to the penguins. Tagging training was undertaken with Roderick Cossee (DOC Manager National Banding Scheme). Fifty-two penguins have so far been tagged and tagging will continue over the following years. A total of 18 burrows have so far been located within the study area. There are many more particularly to the north of the study area, although their numbers have not been determined. At the time this report was compiled no chicks were present, although some adults were incubating eggs. Two dead birds were found during tagging excursions but did not show signs of predation and appeared to have died of natural causes. One cat, two rats and a mustelid were observed in the study area.

A Research Project Investigating *Eudyptula minor* on Mauao (2001)
Jervis, K.; Davies, K.
Bay of Plenty Polytechnic Report no. 121

Spatial Information: Mt Maunganui (Mauao), New Zealand
Keywords: Little Blue Penguin (*Eudyptula minor*), Mauao, Mt Maunganui

Summary: The aim of this research was to investigate the *Eudyptula minor* population on Mauao (Mt Maunganui). The research objectives were; to band all *Eudyptula minor* encountered on Mauao; to take and record morphometric measurements in an effort to determine any differences between sexes in *Eudyptula minor*; to enhance the nesting habitat of *Eudyptula minor* by installing and monitoring artificial nesting boxes; to locate and monitor natural burrows; and to determine the

timing of lifecycle stages (breeding, moulting etc) of *Eudyptula minor* on Mauao. Over the duration of the research a total of 106 penguins were banded. There was a recapture rate of 29.84%. The recapture rate is an indicator of a healthy population size. The most productive months were from August-December.

Wetland Types in New Zealand (2004)
Johnson, P. N.; Gerbeaux, P.
Department of Conservation

Spatial Information: New Zealand
Keywords: Wetlands, bogs and marshes, swamps

Summary: Wetlands are diverse for many reasons, and New Zealand has many types. They include bogs and marshes, swamps and seepages, and the edges of lakes, rivers and estuaries. Wetlands are important for biodiversity, birds, fish, plants and people. This book describes a recently-devised system for classifying and naming New Zealand wetland types, and provides an understanding of how wetlands work.

Adapting farming to climate variability (2009)
Jones, C.,
Amazing Carbon

Spatial Information: Australia
Keywords: agriculture, soil, organic carbon, carbon dioxide, carbon cycle, biofuels, biofertiliser, livestock, methane, mycorrhizal fungi, humus, ecosystem, pasture, farm, land management, nitrogen, phosphorus,

Summary: This article is aimed at agriculturalists in Australia, but is still applicable to New Zealand farmers. This paper discusses the use of fertilisers on conventional farms and links the effects and impacts of fertilisers on the health of the soil, people and the surrounding ecosystems.
Introduction: The financial viability of the agricultural sector, as well as the health and social wellbeing of individuals, families and businesses in both rural and urban communities, are inexorably linked to the functioning of the land.There is widespread agreement that the health of vegetation, soils and waterways in many parts of the Australian landscape have become seriously impaired, resulting in reduced resilience in the face of increasingly challenging climate variability. Agriculture is the sector most strongly impacted by these changes. It is also the sector with the greatest potential for fundamental redesign. The Australian nation has the opportunity to be a world leader in the implementation of innovative technologies centred on adaptation to our variable climate.In addition to enabling the farming community to more effectively deal with warmer, drier conditions, the restoration of landscape function will result in the active drawdown of excess CO^2 from the atmosphere via stable biosequestration in soils.

Soil Carbon -Can It Save Agriculture's Bacon? (2010)
Jones, C.
Agriculture & Greenhouse Emissions Conference

Spatial Information: Australia

Keywords: Agriculture, Australia, Soil Carbon, Soil Nitrogen

Summary: This paper discusses the state of agriculture in Australia (but is still relevant to New Zealand), soil carbon and soil nitrogen, historical levels of soil carbon compared to present day and changing the face of agriculture.
Introduction: The number of farmers in Australia has fallen 30 per cent in the last 20 years, with more than 10,000 farming families leaving the agricultural sector in the last five years alone. This decline is ongoing. There is also a reluctance on the part of young people to return to the land, indicative of the poor image and low income-earning potential of current farming practices. Agricultural debt in Australia has increased from just over $10 billion in 1994 to close to $60 billion in 2009. The increased debt is not linked to interest rates, which have generally declined over the same period. The financial viability of the agricultural sector, as well as the health and social wellbeing of individuals, families and businesses in both rural and urban communities, is inexorably linked to the functioning of the land.There is widespread agreement that the integrity and function of soils, vegetation and waterways in many parts of the Australian landscape have become seriously impaired, resulting in reduced resilience in the face of increasingly challenging climate variability.Agriculture is the sector most strongly impacted by these changes. It is also the sector with the greatest potential for fundamental redesign. The most meaningful indicator for the health of the land, and the long-term wealth of a nation, is whether soil is being formed or lost. If soil is being lost, so too is the economic and ecological foundation on which production and conservation are based.

Coastal sedimentation: what we know and the information gaps (2008)
Jones, H.
Environment Waikato Technical Report 2008/12

Spatial Information: New Zealand
Keywords: Coastal sedimentation, estuaries

Summary: This report aims to bring together available information on coastal sedimentation, summarising what is known and identifying what is not known about the sources and the effects of coastal sedimentation. Sedimentation in estuaries is a natural process that can be accelerated by changes in land use or land management within the catchment or by development of structures within the estuary. Estuaries are under increasing pressure from coastal development or catchment activities and development, such as farming, subdivision and vegetation clearance. Estuaries on the east coast of the Coromandel Peninsula are at high risk of infilling because of the erosion nature of their catchments (steep topography and frequent high intensity rainfall events) and the physical nature of the estuaries (sandbars or barriers narrow the harbour entrances). In addition, major land use changes have occurred to pasture (early to mid 20th century), with exotic production forestry becoming established from the 1950s until present.

Genetic variability of New Zealand seagrass *(Zostera muelleri)* assessed at multiple spatial scales (2008)
Jones, Tracey C.; Gemmill, Chrissen E. C.; Pilditch, Conrad A.
Aquatic Botany

Spatial Information: New Zealand

Keywords: RAPDs, Multiple spatial scales, Conservation, Restoration, Plants, Sea grass

Summary: We conducted RAPD analyses at multiple spatial scales to contribute to the conservation and future restoration of New Zealand's seagrass, *Zostera muelleri Irmisch ex Asch.* (*Zosteraceae*). Initially we focused on fine-scale genetic variation within two estuaries on the North Island, one on the East coast the other on the West coast. Within each estuary individuals were genetically similar, however, there was clear genetic separation between the two sites (genetic distance D = 0.2965). Genetic variation within a sampling location (m scale) was similar to that observed among sampling locations (km scale) within a site (21% and 28%, respectively) and smaller than that observed between sites (51%). We then expanded our sampling to include a further six populations distributed across almost the entire latitudinal (ca. 15°) gradient of the North and South Islands. At this scale genetic differences were closely correlated with coastal currents. There was a clear separation between North Island and South Island populations and further separation between the East and West coast populations of each Island. Sites located along the same section of coastline were more genetically similar than those from the opposite coast and other Island. Genetic similarity was highest within each of the sites, indicating a low degree of gene flow between populations. We recommend that any future restoration and conservation projects use only locally eco-sourced materials for population augmentations.

Bleached kraft pulp mill sourced organic chemicals in sediments from a New Zealand River. Part II: Tarawera River (1996)
Judd, M. C.; Stuthridge, T. R.; McFarlane, P. N.; Anderson, S. M.; Bergman, I.
ChemosphereJournal

Spatial Information: Tarawera river, New Zealand
Keywords: Organic Pollutants, River Sediments; Resin Acids; Chlorophenolic Compounds; Bleached Kraft Mill Effluent; Sulphonated Chemithermomechanical Mill Effluent

Summary: The concentrations of resin acids, chlorophenolic compounds and resin acid derived neutral compounds (fichtelite, dehydroabietin, tetrahydroretene and retene) were measured in river sediments above and below the effluent discharges of two New Zealand pulp and paper mills. The two mills, a sulphonated chemithermomechanical pulp (CTMP) and tissue mill, and an integrated kraft and mechanical pulp and paper mill, discharge secondary treated effluent into the Tarawera River in New Zealand. No significant concentrations of pulp and paper mill sourced organic compounds were found at background sites. Below the CTMP mill slight increases in the concentrations of the resin acids and resin acid derived neutral compounds were measured. Elevated concentrations of all three compound classes were observed downstream of the second pulp and paper mill. Total concentrations of chlorophenolic compounds and resin acids in the river sediments from below the second mill effluent discharge reached to 17.0 ng g−1 and 23.1 µg g−1 dry weight respectively. Still higher concentrations of chlorophenolic compounds and resin acids, 58.7 ng g−1 and 94.5 µg g−1 respectively, were present in sediments from a downstream estuarine lagoon which was previously part of the river system. The organic carbon content in sediments was a principle constituent governing the concentrations of pulp and paper mill derived compounds in the New Zealand receiving water systems.

Philippine coastal resources under stress (1995)
Juinio-Meñez, Marie Antonette; Newkirk, G. F.; Coastal Resources Research Network.; University of the Philippines. Marine Science Institute.
Coastal Resources Research Network, Dalhousie University

Spatial Information: Overseas - Philippines
Keywords: Fisheries Philippines Congresses.; Aquaculture Philippines Congresses.; Coastal zone management Philippines Congresses.

Summary: Coastal ecosystems in the Philippines and all over Southeast Asia are under severe stress from the combined impacts of human overexploitation, physical disturbance, pollution, sedimentation and general neglect. Although this region is the tropical marine and coastal biodiversity centre of the world, the decline of coral reef, seagrass, mangrove and estuarine quality and productivity is disturbing. Surveys in the 1980s and 1990s have shown that more than 75% of the coral reefs in the country have been degraded from human activities.

3.11. K

Feeding and burrowing in a North Island New Zealand population of the estuarine mud crab, *Helice crassa* (2000)
Kalayarasi, S
University of Auckland

Spatial Information: North Island, New Zealand
Keywords: Mud Crab (*Helice crassa*), North Island, New Zealand, Bioturbation

Summary: Benthic organisms interact with and modify the sediment in which they live by their feeding and burrowing activities. These two activities result in bioturbation, a major ecological process in soft sediment habitats. Bioturbators themselves can be affected if they live in polluted estuaries, as their feeding and burrowing may result in accumulation of contaminants in their tissues, which might ultimately affect their behaviour or physiology. This thesis documents aspects of the feeding and burrowing of the mud crab *Helice crassa*, a common inhabitant of intertidal sediments throughout New Zealand, that relate to these two processes: bioturbation of the sediment and effects of any contaminants in that sediment. The field component of study was carried out in the mud flats of Whangateau Harbour, and represents the first comprehensive account of the behaviour of a North Island population of this crab. The temporal activity pattern of *H. crassa* was investigated in both field and laboratory situations. *H. crassa* exhibited temporal organisation for different activities according to different tides and times of the day. It is postulated that *H. crassa* has tidal and circadian endogenous clocks that may enable it to anticipate and prepare the sense organs for the changes that occur on its home beach. However, much of a crab's activities appear to be a response to immediate and exogenous stimuli. Of particular relevance was the finding that they were most active during daytime low tides. Fine structures of mouthparts were analysed using scanning electron microscopy to determine whether *H. crassa*'s distribution on the shore could be explained by its ability to feed on different substrata. With the exception of a lack of setae on the inner surface of the chelae, *H. crassa* is well adapted to feeding on a wide range of material. It possesses the full array of setae that were identified as necessary to feed on muddy and sandy substrata at both low

and high water. Foraging pattern in terms of the size and shape of home ranges was quantified with respect to different densities of crabs and different sizes of individuals. Home range size increased with crab size. The radius of the foraging area decreased with an increase in crab density. The position and size of any neighbouring crabs influenced the directions of feeding excursions; the majority of feeding excursions took place away from neighbouring crabs. The findings indicated that the shape and size of individual feeding areas of *H. crassa* results from intra-specific interactions and that the population has a 'despotic' distribution (i.e. they are not “free” to move). This aspect was further tested by examining the spatial dispersion of burrows. Organic and water content of the surficial sediment samples were also analysed to determine the relationship with crab density. Dispersion patterns are also likely to be density dependent; at higher crab densities, dispersion was uniform but this changed to random, at lower densities. There was no consistent relationship found either between crab density and organic content of surface sediments or crab density and water content of the sediments. The factors which determine the burrowing activity were examined, as the depth of burrows may influence the rate of bioturbation by burrowing. While the depth of burrows increased with the size of the crabs, not all burrows reached down to the water table. In addition, *H. crassa* possesses well-developed setae to suck up interstitial water and crabs are likely to depend on this interstitial water particularly in sandy substrata. In order to quantify the rate of bioturbation, burrow characteristics such as burrow: crab ratio, residence time in burrows, longevity of burrows and burrow architecture were investigated for all four seasons, and sediment turnover rates were then estimated. The bioturbational activity by burrowing is likely to be greatest in summer-spring (a sediment turnover rate of 126-l35%) than in autumn-winter (a sediment turnover rate 48-91 %). The seasonal values were then converted to annual estimates on both a "per crab" basis and a "per unit area" basis. These estimates of sediment turnover rate, and consequently the total amount of new surface area exposed per unit time were greater compared to published studies that have estimated the bioturbational activity of other crab species. The responses of *H. crassa* in terms of accumulation in the tissues and changes to burrowing activity as a result of exposure to different levels of copper, zinc and lead contaminated sediments were examined. The results indicated that *H. crassa* is a robust species that can regulate to a wide range of ambient zinc and copper bioavailabilities at an approximately constant level. Therefore, *H. crassa* is not likely to be an effective bioindicator for the generally low levels of zinc (< 300 µg Zn g-1) and copper (< 500 µg Cu g-1) that are found currently in New Zealand, estuarine sediments. However, *H. crassa* could be used as an indicator for higher levels of lead pollution in estuarine sediment, because they accumulated lead in proportion to the concentration of lead in the sediment. The resilient behaviour that *H. crassa* showed for the metal contaminated sediments suggests that *H. crassa* would turbate the contaminated sediments and may increase the bioavailability of the contaminants in polluted estuaries. Overall, *H. crassa* is an efficient bioturbator and can be considered as a pivotal species in the natural functioning of estuaries in New Zealand.

Make Money and Save the Eel (2010)
Kaspar, H.,
VIP Publications Ltd

Spatial Information: No spatial context
Keywords: aquaculture, eels, tuna, glass eels

Summary: World-wide, eel populations are dwindling and eel fisheries are collapsing. The most commercially important European, Japanese and North American eels are threatened with extinction. Yet there is still a big eel farming industry, mainly in East Asia. This is possible because wild glass eels (similar to whitebait and equally delicious!) are caught along the shores of Europe (legally and otherwise) and then sold live, mainly to China, for on-growing in farms. It's good to know that eel farming is technologically feasible, but I believe this industry is doomed as long as it is based on wild glass eels for seed. Our own 2 major eel species may not yet be immediately threatened with extinction, but nobody will argue that their populations have also been declining. There are many reasons for this, including habitat destruction, obstruction of migration by dams and culverts, pollution and fishing.

Monitoring of submerged reef biota off Motuotau Island in relation to dredge spoil dumping by Port of Tauranga Ltd (1998)

Keeley, N.; Pilditch, C.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga, dredge spoil dumping, Motuatau Island, Mount Maunganui, sedimentation, reef, biota, monitoring

Summary:
Background:

- Dredge spoil resulting from the development and maintenance of the Port of Tauranga has for over a quarter century been dumped in a series of zones on the inner shelf off Mount Maunganui.
- A major channel deepening and widening programme was undertaken in 1992, resulting in the dumping of 4.5 million cubic metres of spoil on a new dump ground in 25 to 30 metres of water.
- A monitoring programme was designed to determine if the dumped sediment was impacting on the reef biological communities around Motuotau Island inshore from the dump ground. A control site and two test sites were established in May 1990 on submerged reefs near the island.
- Photographic monitoring of approximately 3m long permanent transects close to the rock/sand boundary followed changes in rocky bottom biota.
- Metal stakes driven into the sandy seabed near the rocks enabled measurement of changes in the level of sediments.
- To date, monitoring has taken place three times in 1990, three times in 1991, once in 1993 and 1995 and most recently in 1998. This report presents the results from the 1998 survey, in comparison with and additional to that of Grace (1997).

Findings:

- In general terms the reefs around Motuotau Island seem to be healthy and in a state typical of reefs of similar depth, aspect and exposure found elsewhere on neighbouring coastline.

- In concurrence with Grace (1997), the 1998 survey found no evidence to indicate any significant recent sediment induced modifications of the rocky reef communities on the designate monitoring sites.
- During the course of this survey changes in sediment cover were noted. However, as with the 1990-1995 surveys, it is accepted that these occur naturally and are well within fluctuations that could be expected on shallow, relatively exposed sand surrounded reefs such as these.
- The findings of this recent survey are also in agreement with Grace (1997) that: “Small quantities of the fine sediment dusting the rocky bottom biota appeared to be derived from localised turbidity during rough weather. Some marine organisms can temporarily stabilise this material during periods of calm.”
- Missing pins at some sites prohibited the comparison of individual flora noted in previous years with the 1998 survey. However, the new transects are all within a few metres of the original transects and encompass the same animal community types, which means assessment is possible.
- Between 1990 and 1995, fluctuations in sediments levels were established from the stake measurements. The observed fluctuations were considered to be within the range of natural change. In 1998 no measurements could be made dues to absence and/or severe corrosion of all of the measuring stakes. These have since been re-established.
- As a result of the extensive re-marking and re-establishment of sites required to repeat this survey, this exercise has also served to re-align the structures and further refine the protocols for future monitoring.

Tauranga Harbour Mangroves - ecological issues and values (2003)
Keesing, V.
Boffa Miskell

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Mangroves, Manawa

Summary: In a report prepared for the Tauranga District Council, "Tauranga Harbour Mangroves - Ecological Issues and Values", four areas have been identified within the harbour as sites where the community has concerns about the spread of mangroves and a desire to manage that spread. On behalf of the Tauranga District Council, Boffa Miskell has drafted a discussion document relating to the Council's proposal to develop and implement a community led mangrove management project. A 117% increase in the area of mangroves within Tauranga Harbour has been documented to have occurred over the past 50 years. The report indicates that the communities concern appears to focus on the five following precepts:

1. Mangroves are obstructing access to, and recreational enjoyment of the harbour
2. Mangroves are changing pleasant 'sandy beaches' to unpleasant mud flats with visual and cultural impacts

3. Mangroves can obscure views from nearby properties and public reserves. As houses were constructed to take advantage of the views present, there is some concern mangroves will result in a loss of property values.
4. Mangrove colonisation is resulting in the loss of mahinga kai (food sources for Tangata Whenua)
5. The mangroves colonisation is causing the loss of the harbour's significant salt marsh communities/habitats ecological diversity.

Cliffed coasts of New Zealand: perspectives and future directions (2007)
Kennedy, D. M.; Dickson, M. E.
Journal of the Royal Society of New Zealand

Spatial Information: New Zealand shoreline
Keywords: Erosion, New Zealand

Summary: About one-quarter of New Zealand's shoreline is composed of cliffs. In some areas erosion rates are sufficiently rapid to be of concern to planners, whereas other cliffs have eroded imperceptibly slowly over human timescales. This paper reviews work conducted on New Zealand's cliffed coasts, from the pioneering studies of Sir Charles Cotton, who used Davisian theoretical methods to elucidate the evolution of hard-rock coasts, to Jeremy Gibb's nationwide benchmark measurements of historical erosion rates. This review is augmented with a description of state-of-the art methods in use globally for investigating processes of cliff evolution. Key methods identified include detailed measurements using the micro-erosion meter as well as novel geophysical methods of studying cliff movement under wave loading. Such process-based studies build on previous research that has been largely confined to explanatory description and observation. It is recognised that the combined impact of such studies has been relatively muted, owing particularly to the difficulty of unravelling ambiguous process-form interactions. However, the increasingly widespread availability of terrestrial and aerial remote laser scanning systems now provides an opportunity to re-invigorate such studies by extending the scale from local to regional. The paper concludes by outlining prospects within New Zealand for further research. In particular, the development and use of numerical models is seen as an important avenue both for clarifying some basic behaviours observed on cliffed coasts, and for studying the likely response of eroding cliffs to future climate change.

Biotic effects of climate change in the Bay of Plenty (2006)
Kenny, G
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: climate change

Summary: This report is based on an unequivocal view that climate change is happening. Thus, consideration of impacts and adaptation responses do not simply relate to sometime in the future. Biotic changes are happening now, with a currently unknown influence from climate change. Fundamental questions for Environment Bay of Plenty relate to what and how much needs to be known to develop and implement appropriate adaptation responses and over what time frames. The approach taken has been to work through a stepwise process of identifying key

issues, assessing effects, evaluating risk, and considering adaptation options and further steps. Existing knowledge and expertise within Environment Bay of Plenty has been used as much as possible.

Re-Starting Aquaculture: Report of the Aquaculture Technical Advisory Group (2009)
Kidd, D.; Burrell, M.; Bush-King, D.; Farnsworth, M.; Gibbs, N.; Volkerling, K.; Woods, K.
Aquaculture Technical Advisory Group

Spatial Information: No spatial context
Keywords: aquaculture, 2010 reform, TAG, Technical Advisory Group, New Zealand,

Summary: A Technical Advisory Group (TAG) was established to provide the government with a report with recommendations to enable the development of sustainable aquaculture in New Zealand after the 2004 aquaculture reforms severely restricted research and development. Furthermore, no new space has been created under this reform. This report identifies the issues and gives recommendations to "re-start New Zealand's aquaculture industry".

Problems and potentials of recycling wastes for aquaculture (1974)
Kildow, Judith T.; Huguenin, John E.; Baram, Michael S.
United States. National Oceanic and Atmospheric Administration, Massachusetts Institute of Technology, Sea Grant Program

Spatial Information: No spatial context
Keywords: Aquaculture; Sewage as fertilizer; Thermal pollution of rivers, lakes, etc.; Fish-culture.

Summary: The potentialities and problems of using thermal effluents and/or secondary sewage as inputs to a marine aquaculture system is the main focus of this study. The demand on coastal zones for both waste disposal and food production is complimented by the rising feed cost for raising fish and farm animals. In examining the advantages of a waste-food recycle system current and foreseeable problems, especially including those dealing with biological, social, political and legal matters become more recognizable and obtainable in deriving solutions. Economic planning, institutions of concern, consumer acceptance of waste-grown seafoods and marketing strategies are discussed. The state-of-the-art and potential development involving the use of thermal effluents in marine aquaculture, include the problems of thermal waste, aquaculture potential, and technical, biological and chemical problems. The use of domestic sewage and metal contamination are also major factors.

Port of Tauranga: investigation of sediments to be dredged in the lower Town Reach-Upper Stella Passage and disposed of at an inner shelf dump ground (1998)
Klaus, M.
Port of Tauranga

Spatial Information: Port of Tauranga, New Zealand

Keywords: Sedimentation, Dredging

Summary: For the 1992 major “Channel Deepening and Widening Programme” of the Tauranga Port Company Ltd. Extensive investigations, involving vibrocores and subbottom profiling, established that the channel bottom sediment in Tauranga Harbour consists predominantly of marine sand. A band of puggy estuarine silt was identified only in the Stella Passage, in the area to be dredged, upstream from the present Sulphur Point wharves for the Sulphur Point Wharf Extension South.

Seals - strange visitors and sad endings (2009)
Knill, K.
Department of Conservation (blog)

Spatial Information: Waipu Estuary, Tauranga Harbour – New Zealand
Keywords: Leopard seal, Waimapu Estuary, Tauranga Harbour

Summary: We had a rare visitor this week – an immature Leopard seal was found snoozing on the edge of the Waipu Estuary, near Tauranga Airport. Usually inhabiting Antarctic and Sub-Antarctic seas, these are the most ferocious of the seal species. Regardless of rarity – our approach to this seal was much the same as when the more common NZ fur seal turns up on Tauranga beaches – a regular occurrence, especially during spring. We left him alone to rest, in the knowledge that he’ll eventually move on – although we did put up some warning signs in case an unwary member of the public got too close to those powerful jaws. I had to explain our minimal intervention policy to a member of the public today – she had reported an unwell NZ fur seal pup and was disappointed that we’d done nothing to save it. Letting nature take its course can sometimes be the hardest thing to do and it felt wrong to her that no-one would help – I can see the double-standard when our messages are usually about getting involved and making a difference. The Department’s minimum intervention policy is in place due to the high human health risks involved in working with seals, low rehabilitation success rates and a focus on species conservation. Seals carry diseases such as TB, seal finger and salmonella that are very easily transmitted to humans whom come into contact with them – there have been several examples of people becoming hospitalised following attempts to care for seals. For that reason, we discourage public contact with them. Fur seals are breeding locally and come ashore to rest especially after heavy seas. Pups are leaving the rookery and can appear thin whilst they learn to find food for themselves. Pups that are unable to fend for themselves can become emaciated and die of starvation or other disease. Seals often look like they are crying or weeping which people often mistake as a sign of illness or unhappiness, it is in fact the way that they excrete excess salt from their bodies.Unless a seal is being harassed, is entangled in marine debris, is severely injured, or it presents a danger to the public, DOC leaves its management to the original expert, nature.Seals with obvious injuries, in hazardous locations i.e. roads or being harassed, should be reported to the local DOC office. Conservation emergencies can be reported to a 24 hour hotline 0800 DOC HOT (0800 362 468). Project Jonah runs marine mammal medic training and volunteer programmes that are focused on whales and dolphins and suggest ways that people can assist in the protection of whales, dolphins and seals.

The ecology of the Avon-Heathcote Estuary (1973)
Knox, G. A.; Kilner, A. R.

Christchurch Drainage Board

Spatial Information: Avon-Heathcote Estuary, Canterbury – New Zealand
Keywords: Avon-Heathcote Estuary, Ecology

Summary: The Avon Heathcote Estuary is the largest semi-enclosed shallow estuary in Canterbury and remains one of New Zealand's most important coastal wetlands. It is well known as an internationally important habitat for migratory birds, and it is an important recreational playground and educational resource. It was once highly valued for *mahinga kai.* The estuary has an area of 8 km^2, is shallow (the mean at high water of ordinary spring tides (HWOST) is 1.4 m), and predominantly intertidal, as only about 15% of the area lies below low water of ordinary spring tides (LWOST).

A complex didemnid ascidian from Whangamata, New Zealand (2002)
Kott, P.
Journal of the Marine Biological Association of the United Kingdom

Spatial Information: Whangamata Harbour, Coromandel Peninsula – New Zealand
Keywords: Invasive species

Summary: An undescribed species of the genus *Didemnum* (*Didemnidae*) reported from installations in Whangamata Harbour (Coromandel Peninsula) has a unique and conspicuous three-dimensional growth form (possibly associated with vertical and under surfaces it occupies). It is also distinguished by a combination of the few characters available to define these small, simplified, convergent organisms. Its stellate spicules are sparse except for a patchy layer in the surface test, primary common cloacal canals are the full depth of the zooids, nine *vas deferens* coils surround the testis, the gut is long forming a double loop, and larvae have six pairs of ectodermal ampullae. Eleven species said to belong to this genus have previously been reported from New Zealand, but only six are valid *Didemnum* spp., and they all are distinguished readily from the present species. Nevertheless, there is no evidence that the new species is introduced, and the simplest explanation of it occurrence is that it is part of the little known indigenous didemnid fauna of New Zealand.

Environmental drivers in mangrove establishment and early development: A review (2008)
Krauss, K. W.; Lovelock, C. E.; McKee, K. L.; Lopez-Hoffman, L.; Ewe, S. M. L.; Sousa, W. P.
Aquatic Botany

Spatial Information: No spatial context
Keywords: biotic effect; CO2; ecophysiology; flooding; global climate change; growth; light; nutrient; salinity; sea-level rise; temperature; marina forsk vierh; rhizophora mangle l.; water-use efficiency; sea-level rise; gas-exchange characteristics; indian river lagoon; of-mexico coast; avicennia-marina; red mangrove; bruguiera-gymnorrhiza; Plants; Mangroves

Summary: Mangroves have a global distribution within coastal tropical and subtropical climates, and have even expanded to some temperate locales. Where they do occur, mangroves provide a plethora of goods and services, ranging from coastal protection from storms and erosion to direct income for human societies. The

mangrove literature has become rather voluminous, prompting many subdisciplines within a field that earlier in the 20th century received little focus. Much of this research has become diffuse by sheer numbers, requiring detailed syntheses to make research results widely available to resource managers. In this review, we take all inclusive approach in focusing on eco-physiological and growth constraints to the establishment and early development of mangrove seedlings in the intertidal zone. This is a critical life stage for mangroves, i.e., the period between dispersal and recruitment to the sapling stage. We begin with some of the research that has set the precedent for seedling-level eco-physiological research in mangroves, and then we focus oil recent advances (circa. 1995 to present) in our understanding of temperature, carbon dioxide, salinity, light, nutrient, flooding, and specific biotic influences on seedling survival and growth. As Such, we take a new approach in describing seedling response to global factors (e.g., temperature) along with site-specific factors (e.g., salinity). All variables will strongly influence the future of seedling dynamics in ways perhaps not yet documented in mature forests. Furthermore, understanding how different mangrove species respond to global factors and regional influences is useful for diagnosing observed mortality within mangrove wetlands, managed or natural. This review provides an updated eco-physiological knowledge base for future research and reforestation activity, and for understanding important links among climate change, local physico-chemical condition, and establishment and early growth of mangrove seedlings.

Sedimentation at the entrance channel of Tauranga Harbour, New Zealand (1999)

Krüger, J. C.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: sedimentation, Tauranga Harbour, Te Awanui

Summary: This study investigated the sedimentation at the Entrance Channel of Tauranga Harbour. Textural (e.g. grain size patterns), hydrodynamic, sediment flux, and morphologic studies were undertaken to assess the sediment transport and physical processes leading to shoaling at specific areas in the Entrance Channel.
The basic issue addressed by this study concerns the causes for the deposition zones along the Entrance Channel, i.e. the hydrodynamics associated with conditions of sediment transport and deposition at the dredged Entrance Channel. From the investigation it can be concluded that the depositional patterns in the Entrance Channel are controlled by hydrodynamic and morphodynamic processes that are systemic to sediment transport at a stable tide-dominated, mixed energy, inlet. However, the complicated morphology of the ebb tidal delta, in conjunction with the dredged Entrance Channel, creates an environment that leads to strong velocity production primarily by differential bottom friction. It is suggested that, a tide-induced transient eddy exerts spatial control on sediment transport and deposition, leading to enhanced sedimentation along the eastern margin of the Entrance Channel. The shoaling is congruent with the pathway of the tide-induced transient eddy, and accounted for more than 50% (~70000m^3) of the volume dredged from the Entrance Channel in 1998.

Mapping the morphology of a dredged ebb tidal delta, Tauranga Harbour, New Zealand (2006)

Krüger, J. C.; Healy, T. R.
Coastal Education & Research Foundation, Inc

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Dredging

Summary: The morphological units of an ebb tidal delta were mapped and results used to evaluate the relationship between morphology and hydrodynamics, as part of an investigation into the sedimentation at the Entrance Channel at Tauranga Harbour, New Zealand. Four end-member map units (shell lag, coarse sand, medium sand, and fine sand) were identified from the sidescan sonar imagery, which was verified using seabed sediment samples and SCUBA diver observations. These four units were used in a classification scheme that consisted of 10 composite map units. The use of standardized map units helped to reduce the subjectivity involved in sidescan sonar image interpretation. The mapping scheme was used to assist in the understanding of the impact of capital dredging on the morphological evolution of an ebb tidal delta. Observed morphological changes over the ebb tidal delta were attributed to possible changes in the asymmetry of the vertical tide and residual eddy currents.

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The New Zealand Mangrove; Monoculture vs. Mangal; Sustainable Management of the New Zealand Mangrove (2003)

La Bonte, Andre, W.; La Bonte, Robin, R; Farnsworth, Mark, C
Landcare Research

Spatial Information: New Zealand
Keywords: Plants; Mangroves

Summary: This is an unpublished paper from Landcare Research on the sustainable management of New Zealand mangroves. This paper denotes the value of mangroves of New Zealand and suggests they should not be compared as being as valuable as the mangroves of tropical climates.

A preliminary assessment of some aspects of the ecology of Tauranga Harbour (1974)

Larcombe, M.F.;Donovon, W.F.
Bioresearches Ltd

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, ecology, flora, fauna, macrofauna, shellfish, *Amphibola crenata*, mud snail, *Amphidesma australe,* pipi, *Chione stutchburyl*, cockle, *Perna canaliculus,* green mussel, *Pecten novaezelandiae,* scallop, salt marsh, sea grass, *Zoestera*, mangroves, mānawa, *Avicennia marina*, fish, birds, algae, plants, estuary

Summary: The preliminary ecological study of the Tauranga Harbour has several aims:
General:

1. To make a preliminary assessment of the ecology of the Harbour by studying areas that are representative of the range of ecological variation within the Harbour.
2. To identify areas in which ecological problems, or potential ecological problems occur; to discuss such problems, and make proposals for further investigation.
3. To make recommendations as to the nature of further ecological study of the Harbour with the aim of providing information of use in managing the natural resources of the Harbour

Specific:

1. To study the ecology of the Welcome Bay region – with particular reference to the area S.A.6.of the waters classification.
2. To study the ecology of an area on Rereatukahia Estuary, in which known pollution is occurring from waste discharge from the Katikati Dairy Factory.
3. To examine populations of edible shellfish form different parts of the Harbour with a view of using such populations as indicators of general ecological conditions.

Specific monitoring sites are: Welcome Bay (several sites); Reretukahia Estuary; around Motuhoa Island; Mount Maunganui town beach; Mount Maunganui wharf area; Park Rd; Katikati; Kauri Point; Tuapiro Inlet; Katikati Harbour.

Findings
The intertidal ecology of Tauranga Harbour is generally natural, healthy and stable. There is considerable ecological variation within the Harbour (expected).The extensive *Zostera* beds, salt marsh and mangrove marsh at high intertidal levels, are highlighted for being very ecologically important for their key role in providing habitat for invertebrates, juvenile fish and other fauna, which in turn are food sources for higher organisms such as other fish and birds. Their role in deposition of fine sediments is also highlighted. Specifically, the importance of the salt marsh and mangrove marsh areas as a habitat for the edible mud snail (*Amphibola crenata*), an important food source for local Maori, is observed; this is where the larvae first settle due to the shelter these habitats provide, as well as the adequate food available. Monitoring results of populations of key edible shellfish species are provided. These include: *Amphibola crenata* – mud snail, *Amphidesma australe* – pipi, *Chione stutchburyl* – cockle, *Perna canaliculus* – green mussel, *Pecten novaezelandiae* – scallop.

Factors causing ecological change in small regions (only) of the harbour are identified. The two major causes are:

1. Contribution of fine sediment from land runoff causing reductions in water quality, and changing the nature of sediment environment in areas where deposition occurs.
2. Enrichment by organic pollutants.

Recommendations of the report include:

- Broad scale classification and continuation of the general ecological investigation;
- Careful investigation of the particularly important salt marsh and mangrove marsh of the upper intertidal region and their ecological function(s);
- Monitoring and assessment of areas where adverse ecological changes are apparent, and in some cases extending this investigation to the incoming freshwater sources;
- Continued investigation of the edible shellfish populations, including the determination of distribution, density, basic population parameters, and the effects of human exploitation;
- The establishment of a regular monitoring programme to determine seasonal variations of ecological change across the Harbour;
- Investigation into fish species that require the Harbour resources for spawning or growth of juveniles, as well as the effects of present fishing practises on fish populations; and
- Examine the use of the Harbour by bird populations, particularly identification of areas of importance for feeding, roosting and nesting.

Tauranga Harbour Integrated Management Strategy (2006)
Lawrie, A.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Te Awanui, Bay of Plenty, sedimentation, management, monitoring, stormwater, water quality, recreation, estuary, legislation, strategies, discharge, nutrients, large game birds, mangroves, sea lettuce, ulva, sea grass, zostera marina,

Summary: This report arises from the Environment Bay of Plenty Long Term Council Community Plan 2004-2014. In accordance with the Council direction it details the issues, gaps and overlaps in the management of Tauranga Harbour and provides recommended actions to address gaps. Considerable effort has been made to objectively evaluate each issue raised. While the report has been produced by Environment Bay of Plenty there has been significant input from the Western Bay of Plenty District Council (WBOPDC) and Tauranga City Council (TCC). Sedimentation has been identified as the issue of most concern to both the community and to Council staff involved in environmental management. As a result, a detailed review of the available science, the management mechanisms and the projected effects of the SmartGrowth strategy is proposed. Similarly, population growth poses a management challenge for the recreational use of Tauranga Harbour. A strategy to deal with recreation in an integrated way is in preparation. Environment Bay of Plenty has approved the commencement of a series of changes to the Regional Coastal Environment Plan. A number of issues identified in this report can be dealt with as part of those changes, likely to be notified in the 2007 financial year. Additional efforts in monitoring Tauranga Harbour are needed in respect of wetland extent and condition and the effects of stormwater near outfalls. A number of other monitoring recommendations are made. A number of groups involved in the preparation of this report appeared to have a lack of knowledge about investigations carried out by Environment Bay of Plenty. Many of the issues raised in this report can be dealt with

by improving the links between the community and the Council. Action needs to be taken to make science and experts more accessible to the public. Likewise, formalising the Estuary Care Groups will assist with this issue. A number of difficulties arise across spatial and functional boundaries. Both regional and district councils need to be mindful of these boundaries and actively work to minimise the integration difficulties caused by legislation.

Networks of power and influence: the role of mycorrhizal mycelium in controlling plant communities and agroecosystem functioning (2004)
Leake, J.;Johnson, D.;Donnelly, D.;Muckle, G.;Boddy, L.;Read, D.,
Canadian Journal of Botany

Spatial Information: No spatial context
Keywords: arbuscular mycorrhiza, ectomycorrhiza, extraradical mycelium, hyphal networks, soil, nutrients,

Summary: Extra-radical mycelia of mycorrhizal fungi are normally the “hidden half” of the symbiosis, but they are powerful underground influences upon biogeochemical cycling, the composition of plant communities, and agro-ecosystem functioning. Mycorrhizal mycelial networks are the most dynamic and functionally diverse components of the symbiosis, and recent estimates suggest they are empowered by receiving as much as 10% or more of the net photosynthate of their host plants. They often constitute 20%–30% of total soil microbial biomass yet are undetected by standard measures of biomass used by soil scientists and agromomists. Mycorrhizal mycelia provide extensive pathways for carbon and nutrient fluxes through soil, often exceeding tens of metres per gram of soil. We consider the amounts of photosynthate “power” allocated to these mycelial networks and how this is used in fungal respiration, biomass, and growth and in influencing soil, plant, and ecosystem processes. The costs and functional “benefits” to plants linking to these networks are fungal specific and, because of variations in physiology and host specificity, are not shared equally; some plants even depend exclusively on these networks for carbon. We briefly assess the potential contribution of extra-radical mycorrhizal mycelium to sustainable agriculture and maintenance of biodiversity and highlight technologies that promise new vistas and improved fine-scale resolution of the dynamic spatial and temporal functioning of these networks in soil.

Migration of offshore mound constructed by dredged materials (1998)
Lee, C. E.
KSCE Journal of Civil Engineering

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation, Dredging

Summary: A numerical model to predict the migration rate of submerged mound constructed by dredged materials due to waves is developed in this paper. The model is based on Bailard's sediment transport rate formula, Stokes' second-order wave theory, and the sediment balance equation. Particularly, the suspended load is included into the present numerical model, so that it may be possible to estimate the migration of mound composed of the mixture sediment accurately. The numerical model is satisfactorily verified by comparison of the numerical results with the field data measured both at Silver Strand mound and at Tauranga mound. The convection-dispersion processes, by which the crest of mound is flatted and moved

shoreward at the same time, are generated by the present numerical model very well. In addition, it is found that the migration of mound depends directly on the wave height, the sediment size and the wave period through the analyses on the characteristics of mound migration. The dependence of mound migration on the wave height and the sediment size is relatively stronger than that on the wave period.

Effects of deposit-feeding bivalve (*Macomona liliana*) density on intertidal sediment stability (2004)
Lelieveld, S.D.; Pilditch, C.A.; Green, M.O.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Tuapiro sand-flat in Tauranga Harbour, New Zealand
Keywords: Sedimentation

Summary: This study investigated the effects of macrofaunal feeding and bioturbation on intertidal sediment stability. By manipulating density of the facultative deposit-feeding wedge shell (*Macomona liliana*) on the Tuapiro sandflat in Tauranga Harbour, it was found that sediment stability increased up to 200% with decreasing *M. liliana* density and this was correlated with greater sediment microalgal biomass and mucilage content. The change in stability occurred despite homogeneity of grain size amongst experimental treatments, highlighting the importance of macrofaunal-microbial relationships in determining estuarine sediment erodibility.

Systematics of seagrasses (*Zosteraceae*) in Australia and New Zealand (2002)
Les, D.H.; Moody, M.L.; Jacobs, S.W.L.; Bayer, R.J.
Journal of Systematic Botany

Spatial Information: Australia and New Zealand
Keywords: Seagrass, Eel Grass, *Zostera, Zosteraceae*

Summary: Previous taxonomic treatments of the family *Zosteraceae* in Australia/New Zealand have recognized *Heterozostera tasmanica* (monotypic) and four *Zostera* species all belonging to subgenus *Zosterella: Z. capricorni, Z. muelleri, Z. mucronata, Z. novazelandica. Zostera* has always been taxonomically problematic in Australia, where researchers have expressed difficulty with species recognition due to vague or inconsistent morphological characters. There also has been a lack of agreement on generic (notably the distinctness of *Heterozostera*) and subgeneric delimitation. Recent anatomical, developmental, and molecular studies urge a reevaluation of relationships in the family. To clarify the taxonomy of *Zosteraceae*, we investigated interspecific phylogenetic relationships focusing on Australian species of subgenus *Zosterella*. We examined material comprising all genera of *Zosteraceae* (*Heterozostera, Nanozostera, Phyllospadix, Zostera*), six/seven species of *Zostera* subgenus *Zosterella* (including all Australian/New Zealand species), and one of four species of *Zostera* subgenus *Zostera*. We conducted phylogenetic analyses of morphological data and DNA sequences from nuclear (ITS) and plastid (trnK intron, rbcL) genomes. Our results indicate two major clades (highly divergent at both morphological and molecular levels) and two subclades (with low morphological and molecular divergence) within *Zosteraceae*. Little morphological and molecular variation was observed among representatives within the clade of Australian/New Zealand members of subgenus *Zosterella*, and none provided cladistic support for taxa recognized formerly as separate species. We recommend that *Zosteraceae*

comprise two genera (*Phyllospadix, Zostera*) with the latter subdivided into three subgenera (*Zostera, Zosterella, Heterozostera*).
Furthermore, Australian/New Zealand representatives of *Zostera* subgenus *Zosterella* should be merged within a single species (*Z. capricorni*) to reflect the inability of morphological or molecular data to effectively delimit additional species in this group.

Improving flowering of kiwifruit in climatically marginal areas using hydrogen cyanamide (1989)
Linsleynoakes, G. C.
Scientia Horticulturae

Spatial Information: Western Cape, South Africa.
Keywords: Organic Pollutants**,** *Actinidia deliciosa*, delayed foliation, dormancy, flowering, hydrogen cyanamide

Summary: Application of hydrogen cyanamide (H2NC N; Dormex ®) more than doubled the average flowering intensity when applied to 8 kiwifruit (*Actinidia deliciosa* (A. Chev.) C.F. Laing and A.R. Ferguson) orchards in the Western Cape. All pollinated flowers set fruit and this represented a potential doubling of production. There appeared to be some interaction between concentration and application time. Concentration had a much greater influence than application time. Three and 4% hydrogen cyanamide gave the highest flowering intensities. Application 5, 4 or 3 weeks before natural bud break gave equally good results, however, the vines showed increasing sensitivity to hydrogen cyanamide with decreasing time to bud break.The increased flowering intensity was brought about mainly by a more compact bud break period, which increased the proportion of flower-bearing (reproductive) shoots, as well as by an increase in the number of flowers on individual shoots. Overall bud break percentages were increased as well, but this had a smaller influence than the altered flower development pattern. The low chilling cultivar 'Abbott' was more sensitive to the chemical than cultivar 'Hayward' and showed phytotoxicity at the higher concentration (4%). The mature vines were naturally more productive, but showed a lower response to hydrogen cyanamide than the young vines. Mature vines generally had higher average flower numbers per reproductive shoot. The response to hydrogen cyanamide appeared to be greater in the orchards that received higher winter chilling accumulation.

Potential Effects of Mussel Farming on New Zealand's Marine Mammals and Seabirds: A Discussion Paper (2003)
Lloyd, B.D.
Department of Conservation

Spatial Information: New Zealand.
Keywords: environmental effects, green-lipped mussel, Perna canaliculus, sustainable aquaculture, threatened species.

Summary: Mussel farming is an important and expanding industry in New Zealand. In the year 2000, there were nearly 3000 ha of mussel farms, with proposals for a further 39 000 ha including offshore farms of up to 4000 ha each. There have been no concerted attempts to investigate the effects of mussel farms on marine mammals and seabirds. However, there is growing evidence of adverse effects as these animals are in direct competition for space in the most productive coastal waters.

Mussel farms deplete phytoplankton and zooplankton; modify the benthic environment, species assemblages, and local hydrodynamics; increase marine litter; and facilitate the spread of unwanted organisms. Thus, the establishment of mussel farms may lead to loss and degradation of wildlife habitat, either by exclusion or as a consequence of changes to the ecosystem. Thus far, the only adverse effects reported within New Zealand are the exclusion of dusky dolphins from mussel farms areas, and the entanglement and deaths of two Bryde's whales in mussel spat-catching lines. Because of the limited extent of mussel farms to date, effects on wildlife were dismissed as inconsequential. However, the proposed increase in the area used for mussel farming changes the scale of effects and prompts concern. The construction of large offshore farms across the seasonal migration routes of large whales is particularly worrying. An ecologically sustainable mussel farming industry requires a programme to monitor the industry's effects on wildlife and other forms of marine biodiversity. This report provides a resource to assist the mussel farming industry, coastal planners and researchers in the development of an ecologically sustainable industry.

Terrestrially derived sediment: response of marine macrobenthic communities to thin terrigenous deposits (2004)
Lohrer, A. M.; Thrush, S. F.; Hewitt, J. E.; Berkenbusch, K.; Ahrens, M.; Cummings, V.
Marine Ecology Progress Series

Spatial Information: Elsewhere in New Zealand - Whitford embayment, North Island
Keywords: Land-use · Sediment impacts · Terrigenous sediment deposition · Marine benthos · Sandflat · Low intensity · High-frequency disturbance · Self-organized criticality

Summary: Coastal marine habitats adjacent to catchments with encroaching human development are likely to experience increased sediment loadings in ensuing decades. Thus, sedimentary disturbance regimes in which coastal marine benthic communities have evolved may be shifting, as depositional events exceeding critical thresholds become more frequent. To understand the threat posed by terrigenous sedimentation in an embayment with increasing urban development, we determined the thickness and frequency at which terrigenous sediment deposits begin to affect the benthos. We performed manipulative experiments involving layers of terrigenous sediment <1 cm thick in a variety of intertidal habitats in the Whitford embayment, North Island, New Zealand. Results of 3 separate experiments performed at 5 sites were largely consistent. While experimental plots were never completely defaunated, as little as 3 mm of the terrigenous material was sufficient to significantly alter macrobenthic community structure (measured after 10 d, relative to 0 mm controls). The direction of change was predominantly negative; the number of individuals and taxa declined as a result of sediment application, as did the densities of nearly every common species. Large bivalves were less affected than smaller ones, and deeper-dwelling species were less affected than ones at the sediment surface. With repeated applications of thin terrigenous layers (3 mm thickness, monthly over a 6 mo period), the sandflat sediments gradually became finer (clay volume % increased), and macrofaunal community composition progressively diverged from controls. To summarise, macrofauna were negatively affected by extremely small amounts of terrigenous sediment, and repeated depositional events did more damage than single ones. With increasing defoliation and excavation of catchment hillsides, the frequency of depositional events of a given intensity is likely to quicken, indicating an enhanced likelihood of macrofaunal disturbance and degradation in estuarine tidal

flats. Management decisions that protect coastal catchments may partially ameliorate the threat to the benthos in coastal receiving waters.

Environmentally sustainable aquaculture: an eco-physical perspective (2008)
Longdill, P.
University of Waikato

Spatial Information: Bay of Plenty, New Zealand
Keywords: Bay of Plenty, Aquaculture, sustainable,mussel, greenshell, aquaculture management area

Summary: The New Zealand aquaculture industry during the late 1990s and early 2000s experienced a significant and sustained period of growth. Greenshell mussels (*Perna canaliculus*) are proving to be a popular and valuable cultured species, with large domestic and international markets. Traditionally, these bivalves have been farmed within enclosed embayments and on relatively small scales (~3 Ha). The recent expansion of the industry coupled with the near saturation of existing 'traditional' sites and new culture technologies has led the industry toward alternate environments, notably exposed offshore sites. Initial proposals within the Bay of Plenty have included multiple farms of ~4500 Ha each. This novel approach to shellfish culture created uncertainty with respect to potential environmental impacts, cumulative effects, and sustainable carrying capacities within these exposed open-coast locations. In zoning for Aquaculture Management Areas (AMAs), environmental managers must be informed of each of these aspects to ensure the rational and sustainable use of the coastal-marine space. The overall goal of this study is to determine the potential for environmentally sustainable large-scale offshore mussel culture within the Bay of Plenty marine environment. The long term sustainability of aquaculture development on an open coast is a function of many influences which can vary in both time and space. The benthic environments of the Bay of Plenty exhibit great variability in their ability to assimilate waste inputs from suspended mussel culture; a direct function of the variability in sedimentary environments and benthic habitats within the region. Specifically, silty sediments with low natural organic contents, generally found between 40 and 100 m depths are the most suitable locations for sustainable mussel aquaculture from an environmental impact perspective. Both observations and model predictions indicate productivity potential within the region to be greatest within neritic zones of the western Bay of Plenty. Local wind forcing is the predominant mechanism forcing local shelf currents. Current meter data and numerical modelling tests from this study indicate that local winds explain the majority of water current variability on the shelf, generate the delivery of new nutrients to the shelf through upwelling, and hence create the variability in productivity potential. Complicating the AMA zoning process for environmental managers, however, are existing uses of, and societal values toward, the coastal-marine environment. GIS planning tools have been shown to be effective at minimising conflicts and maximising sustainability potential through informed site selection. Within the Bay of Plenty, these preferential sites are located on the mid-shelf (60-80 m depths) offshore from Pukehina, Matata, and Whakatane. This study shows that the simulated cumulative lower trophic-level depletion impacts of two large (~5000 Ha) proposed offshore mussel farms vary seasonally as a result of subtle changes in ecosystem dynamics and mussel feeding patterns. At proposed stocking densities, largest relative impacts are expected during autumn and winter, when relative phytoplankton biomass is low and growth rates slow. During spring, while absolute impacts are greater than those during autumn/winter, greater phytoplankton-zooplankton biomass and faster growth rates result in quicker

recovery times and reduced 'depletion halo' extents. Year-long predicted impacts are below those applied as 'acceptable limits of change', both within New Zealand and internationally, indicative of the ecological carrying capacity.

Numerical Hydrodynamic Modelling: Aquaculture Management Areas (2006)
Longdill, P.; Black, K.
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: Aquaculture Management Areas, Aquaculture Industry, New Zealand

Summary: Numerical hydrodynamic modelling of the Bay of Plenty was undertaken to be informed about offshore oceanographic and ecological systems for the selection of open coast Aquaculture Management Areas. These areas will sustain the environment, kaimoana and the aquaculture industry in the Bay of Plenty. The broad study involved:

- Establishing monitoring stations and undertaking regular surveys of water properties, currents and waves
- Undertaking numerical modelling of circulation and physical dynamics
- Undertaking numerical modelling of the food chain (food dynamics modelling), with particular focus on green mussels
- Developing recommendations about the carrying capacity of sites around the Bay of Plenty

The present report deals with the numerical modelling of hydrodynamics for the subsequent primary production modelling and the impacts of large scale green-lipped mussel farming within the Bay of Plenty. The goal of the current stage of the project was to calibrate the hydrodynamic model 3DD from the “3DD Suite”, which were:

- 2D – 2-dimensional circulation predicting the depth averaged currents.
- 3DHomo (barotropic) – 3-dimensional circulation models predicting the currents in several levels through the water column.
- 3DStrat (baroclinic) – 3-dimensional circulation models predicting the currents under salinity and temperature stratified conditions.

The third model is highly complex, as the inputs to the model are multiple and time-varying over a large spatial scale. Challenges included establishment of initial conditions at the start of the model run (throughout the grid in each layer) and the determination of boundary conditions that specify sea levels, temperatures and salinities in the open boundary cells of the model. After consideration and testing of several options, satellite observations were highly utilised, including the development of a novel temperature “nudging scheme”. This involved assimilation of satellite-sensed sea surface temperatures in the upper two layers of the model, and applied every 3 days. By using the measured satellite temperatures, the model incorporates the elevated temperatures associated with the warm East Auckland current that penetrates into Bay of Plenty and the highly variable temperatures associated with shallow water heating/cooling and the upwelling that is common around East Cape. The satellite images reveal the complexity of the temperature structure in the Bay

which is captured by assimilating the satellite data directly into the model. This novel method was developed for the study and has not been used in New Zealand modelling previously. In addition, satellite observations were used for determination of boundary conditions and river temperatures. Finally, the wind fields were also taken from satellite measurements at 14 sites across the model domain. For the sea levels on the open boundaries, a "Coriolis Boundary" condition (uniquely provided by model 3DD) was adopted to enable accurate reproduction of the cross-shore geostrophically-balanced sea gradients that occur under winds on the continental shelf.

We found that the model was effectively reproducing the dynamics of the Bay of Plenty, including both the longshore and cross-shore currents throughout the water column. The salinities and temperatures were closely matching the field measurements. Given the complexity of the environment, the good results are attributed to the quality of the field measurements, the intensity of the calibration and the capacity of the model to treat a broad range of processes simultaneously. The novel and extensive use of satellite observations also assisted greatly. We conclude that the model is able to reproduce the essential dynamics of Bay of Plenty and can be applied to the determination of the potential environmental effects of the Aquaculture farms. In the next stage, the hydrodynamic model is used to drive the Primary Production model 3DDLife, which considers impacts of the farms on the nutrients, phytoplankton and zooplankton in the Bay of Plenty due to mussel feeding. Future hydrodynamic modelling would involve further comparisons with the very broad field dataset, including modelling over longer time periods, with detailed consideration of continental shelf waves and the East Auckland current. Incorporation of these two phenomena would be expected to lead to further improvements in the model calibration.

Bay of Plenty Primary Production Modelling: Aquaculture Management Areas; Primary Production Modelling, and Assessment of Large Scale Impacts of Aquaculture Management Areas on the Productivity within Bay of Plenty (2006)
Longdill, P.; Black, K.; Haggitt, T.; Mead, S.,
Environment Bay of Plenty

Spatial Information: Central Bay of Plenty – Opotiki &Pukehina, New Zealand
Keywords: aquaculture, Bay of Plenty, Opotiki, Pukehina,Otamarakau, mussel, marine farm, aquaculture management areas, primary production modelling, impact

Summary: The potential effects of several large aquaculture (mussel) farms within the Bay of Plenty have been simulated with a calibrated ecological model. The depletion of phytoplankton and zooplankton are determined for scenarios of two and four large mussel farms (approximately 5000 Ha each) with different relative positions on the inner shelf of the central Bay of Plenty. When averaged over a year, the proposed farms (Opotiki and Pukehina) reduce the phytoplankton in a region some 40 km by 20 km by approximately 1% in the surface waters of the Bay (0-5 m depth). This depletion represents a decrease of ~ 0.04 mg/m^3 chlorophyll-α from a typical average value of ~ 4.5 mg/m^3. The mussel farms increase the local ammonia concentration by approximately 0.001 g/m^3, and deplete the local dissolved oxygen concentration by approximately 0.002 g/m^3, from background values of typically 0.05 g/m^3 and 8 g/m^3 respectively. More severe impacts are evident at the depth layer in the water column where the mussels are located (15-25 m), with phytoplankton abundance reductions of 4-8% being predicted when averaged over the full year. The higher impacts at depth occur over a region some 12 x 6 km, i.e. they are mostly

restricted to the environs of the farm and the adjacent coast. Of course, the zone where phytoplankton abundance is reduced is proportional to the total area and mussel density of the farms. To specify carrying capacity of the Bay, the issue to address is whether these reductions to phytoplankton and zooplankton are biologically significant. In particular, while the abundances may be reduced by 4-8% when averaged over the year, the percentage reductions are higher in seasons when natural phytoplankton abundance is lower. Thus, there are both annual and seasonal effects, which will potentially impact on the broader eco-system, which is equally subject to seasonal dynamics. It is unlikely that the production carrying capacity of the Bay of Plenty system will be adversely affected by the level of aquaculture modelled in this study, as even maximum depletion rates resulted in chlorophyll-α levels well above published threshold production carrying capacity levels identified for mussel farming in other parts of New Zealand, e.g., ~ 1 µg L-1. Given the physical and biological characteristics of the Bay of Plenty area, relative to the predicted levels of impact presented here, it is also unlikely that the ecosystem carrying capacity will be adversely affected. Further model simulations are currently underway to consider the influence of climatic factors such as El Nino/La Nina events. Further assessments of the ecosystem carrying capacity can be achieved by additional modelling and investigating present knowledge gaps, particularly the variation in phytoplankton species composition through space and time within the Bay of Plenty and impacts on the zooplankton community. Other factors that also impact on ecosystem health and warrant investigation are the significance of zooplankton mortality due to marine farms with respect to recruitment of other water-borne marine organisms and the potential impacts of mussel spat colonisation to new locations outside the marine farms (resulting to a decreased of marine biodiversity and/or community change).

Bay of Plenty Sediment Characteristics: Aquaculture Management Areas - sediment grab samples, analysis and determination of grain size distributions of the Bay of Plenty sub-tidal area 10-100 metres depth (2005)
Longdill, P.;Black, K.; Healy, T.; Mead, S.; Beamsley, B.,
Environment Bay of Plenty

Spatial Information: Eastern Bay of Plenty- Pukehina to Ruakokore, New Zealand
Keywords: aquaculture, aquaculture management areas, Bay of Plenty, sediment, benthic, Whakatane, Pukehina, marine farm, mussel,

Summary: Numerous sediment samples were obtained from the seabed in depths ranging from 10 m to 100 m depth within eastern Bay of Plenty in December 2004. The survey sites were also sampled for a separate Biological Survey, within the eastern Bay of Plenty (Pukehina to Ruakokore). To classify and analyse the sediments of the eastern Bay of Plenty, over 120 sediment samples were obtained using a specially designed grab sampler. In addition, video camera images were obtained to qualitatively assess the seafloor habitat and environment. Samples were analysed for organic content, shell content, and grain size distribution using either a laser-sizer (111 samples) or mechanical sieving.These data represent a significant advancement in the knowledge of the benthic environment of the eastern Bay of Plenty relative to the limited and sparse prior data set of the New Zealand Oceanographic Institute (1979). Coarser sediments dominate the inshore areas of the study region, reflecting the wave energies reaching the seabed. Eastwards of Whakatane, offshore (60 m - 100 m) sediments are dominated by silt-sized fractions typical of 'quiet water depositional environments'. Immediately offshore from Whakatane, however sediments are coarse relative to those at similar depths to the

east and west. This trend peaks at between 90 m and 100 m depths where the sediments off Whakatane are much coarser than others at similar depths within the study area. This area is adjacent to the White Island Canyon, which may accelerate shore-normal flows as they move down-slope. Further research utilising 3D models of water movements will provide further insights to this pattern.Sediments between 40 and 100 m to the west of Whakatane exhibit two strong peaks in their size distribution, one of sandy-sized material and another of silt-sized material. This pattern is predicted to be a result of the transport of silt-sized material from the more eastern areas of the Bay of Plenty. The figures in this document give excellent visual information. Furthermore, the appendices show graphs of the grain size distribution curves for each transect and the grain size statistics (raw data).

An Integrated GIS Approach for Sustainable Aquaculture Management Area Site Selection (2008)
Longdill, P.; Black, K.; Healy, T.R.,
Ocean & Coastal Management

Spatial Information: New Zealand wide
Keywords: aquaculture, marine farming, Bay of Plenty, Geographic Information System, GIS, New Zealand, mussel, *Perna canaliculus*, location, sustainable, aquaculture management areas, AMA

Summary: Within New Zealand, growth in the aquaculture industry has led to the diversification of aquaculture sites from more sheltered bays and harbours toward open coast locations. Coastal zone managers, along with the aquaculture industry, aim to ensure the long-term sustainability of any 'new' sites selected. Through targeted data collection programmes and the subsequent implementation of Geographic Information System (GIS) based models, the most suitable and sustainable locations for Aquaculture Management Areas (AMAs) can be identified. This approach is applied within the Bay of Plenty, New Zealand, with specific reference to suspended mussel (Perna canaliculus) aquaculture. Within the region, areas where maximum sustainability may be achieved make up 18% of the total area considered, with conflicting uses and other constraints accounting for 46%. Whilst further site and development specific studies are required to determine explicit carrying capacities, the effort required has been considerably reduced by eliminating unsuitable locations and identifying those where sustainability can be maximised.

Bay of Plenty Shelf Water Properties Data Report 2003-2004: Aquaculture Management Areas - Initial data analysis of shelf CTD and water sample data to determine temporal and spatial patterns in the physical and chemical aspects of the water column (2005)
Longdill, P.; Park, S.G.; Black, K.,
Environment Bay of Plenty

Spatial Information: Bay of Plenty - Pukehina, Whakatane, Tauranga and Opotiki, New Zealand
Keywords: aquaculture, Bay of Plenty, aquaculture management areas, water column, Pukehina, Whakatane, Opotiki, marine farm, mussel

Summary: The goal of this report was to provide a summary of the large amount of cross-section data recorded on the shelf in the eastern end of the Bay of Plenty as part of the AMA project. This report focuses on the water column characteristics

during transect surveys. The field sampling builds upon a previous survey of coastal shelf waters undertaken in 1996/97 by Park. Sampling for this study was taken from the same sites, but only the Pukehina, Whakatane and Opotiki sites (and NOT the Tauranga site). Parameters measured were: suspended solids, total organic carbon, dissolved carbon, dissolved reactive silica, dissolved iron, total nitrogen, ammonium nitrogen, total phosphorus, dissolved reactive phosphorus and phytoplankton. The methods used to measure these parameters are listed in Table 1 of the report. The raw data from both the CTD (data at each metre down the water column) and also from the water samples (data more sparse at discrete intervals) were plotted using Golden Software's Surfer software (graphs for each parameter are displayed as distance from shore in metres (x) versus depth in metres (y)). No written results or discussion is provided.

Sediment dynamics surrounding a flood tidal delta adjacent to reclamation and a dredged turning basin (2007)
Longdill, P. C.; Healy, T. R.
Journal of Coastal Research

Spatial Information: Whangarei Harbour, New Zealand
Keywords: Sedimentation, Dredging, Reclamation, Tidal inlet, velocity residual, Whangarei Harbour

Summary: Field measurements of tidal current velocities are used to infer sediment transport characteristics in the lower section of a large, tidally dominated estuarine system at Whangarei Harbour, New Zealand. Recent (2002) developments at the harbour entrance included a 32.6 ha intertidal reclamation and a 31.8 ha dredged turning basin. Residual distance vectors indicate that the post development, large-scale pattern of sediment transport dynamics remains consistent. Minor, localised modification of transport potentials has been observed immediately adjacent to the developments, however. These modifications include a slight realignment of current flows near the reclamation wall and some leakage from a previously identified transport loop near the dredged basin. The potential for scour is identified along the eastern margin of the dredged basin, which could act to remove material moving downslope into the basin from its western edge. This data is consistent with numerical model results that predicted minimal consequences resulting from the developments. Lower harbour sediment dynamics are consistent with established patterns for tide-dominated inlets, with separation of the channel into areas of ebb and flood dominance, and typical transport patterns over the flood tidal delta. Broad-scale inlet geomorphology has been maintained, which is consistent with other dredged tide-dominated inlets.

Background Levels of Agrichemical Residues in Bay of Plenty Soils: A Preliminary Technical Investigation (2005)
Love, B.; Gaw, S.
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: soil quality, Bay of Plenty, land use, land management, dairy, maize, Tauranga, farm, monitoring, horticulture, pesticide, kiwifruit, market gardens, orchard, trace metals, DDT, organochlorine, organophosphorus, organonitrogen, measurements, contamina

Summary: SEM New Zealand Limited (SEMNZ) was engaged by Environment Bay of Plenty (EBOP) (the Regional Council) to carry out an assessment of the levels of agrichemical residues in the Bay of Plenty. The objective of this investigation was to assess the general risk posed to the environment and to human health by any remnant agrichemical residues in soils associated with a range of horticultural and agricultural land uses. Soil samples were collected from 128 sites in the Bay of Plenty region. These 128 sites comprised seven land use categories; kiwifruit (26 sites), glass houses/market gardens (14), other orchards (16), maize (14), horticulture (10), pasture (23), and control sites (25).The sampling locations were selected to avoid areas that were likely to contain any potential hotspots such as spray mixing, storage, equipment wash down areas or old sheep dip sites. Such areas have been identified in previous studies (Gaw 2002) to contain concentrations of over 100 times those found on produce growth areas. A total of ten sub-samples were collected from the representative area at each site, and composited for laboratory testing. The representative area at each site was approximately 1 hectare in size and located within areas where produce was grown (e.g. between rows of fruit trees or vines). Soil samples were analysed for a selection of contaminants associated with agrichemical application throughout the region. All of the sites were analysed for seven trace metals (Cadmium, Arsenic, Nickel, Copper, Lead, Zinc, and Chromium) and 24 organochlorine pesticides (including DDT and its break down products). Control and maize site samples were also analysed for 72 Organonitrogen and Organophosphorus compounds (including Simazine and Atrazine). The analyses were carried out by Hill Laboratories, an IANZ accredited laboratory. The results were compared to both residential and agricultural land use guidelines (trigger levels) as a method of identifying soil contamination levels that may pose either ecological or human health risks. It should be noted that guideline values for human health are significantly higher than those where ecological protection is considered. Therefore, should the results of this investigation be compared to guidelines for human health only, there would be a considerable reduction in the number of sites exceeding land use values. For the purposes of this report SEMNZ have used the more conservative "50% produce consumption" values from the MfE/MoH, Health and Environmental Guidelines for selected Timber Treatment Chemicals. While SEMNZ is not aware of any studies to determine home grown produce consumption rates in New Zealand, it is likely that the majority of residential occupants consume a much lower percentage of home grown produce. In addition, the MfE is currently revising human health only guidelines for various contaminants such as copper, arsenic and DDT. These revisions, when completed, will likely result in an increase of guideline values for some contaminants.

Further information on agrichemical toxicity can be found in the references listed in section 7 and by accessing the websites of the Ministry for the Environment at http://www.mfe.govt.nz/ and the United States Environmental Protection Agency at http://www.epa.gov/. Copper, arsenic and total DDT were the analytes that most frequently exceeded the trigger level (exceedances). Copper had the highest exceedance rate, with 13 % of samples. Cadmium, chromium, nickel, dieldrin and total endosulphan did not exceed residential trigger levels for any sample analysed. However, two sites did exceed the cadmium agricultural trigger level (1.4 mg/kg). Orchards had the highest level of exceedances with 59 % of samples exceeding a trigger level. Samples from glass houses/market gardens exceeded respective trigger levels in 43% of samples, followed by kiwifruit at 38%. Table I summaries the significant results from horticultural and grazing land use sites from the region.
Control sites (25) have not been included in this data set due to their effect on median and mean values. These results have been considered separately to determine background concentrations for each contaminant.

Mangrove growth in New Zealand estuaries: the role of nutrient enrichment at sites with contrasting rates of sedimentation (2007)
Lovelock, C. E.;Feller, I. C.; Ellis, J.; Schwarz, A. M.; Hancock, N.; Nichols, P.; Sorrell, B.
Oecologia Journal

Spatial Information: New Zealand wide
Keywords: *Avicenna marina*, leaf area index, nutrient resorption efficiency, photosynthesis, soil respiration, Waikopua, Whangapoua, rhizophora-mangle, plant-growth, carbon, phosphorus, nitrogen, performance, limitation, deposition, herbivory, ecosystem, Plants, Mangroves

Summary: Mangrove forest coverage is increasing in the estuaries of the North Island of New Zealand, causing changes in estuarine ecosystem structure and function. Sedimentation and associated nutrient enrichment have been proposed to be factors leading to increases in mangrove cover, but the relative importance of each of these factors is unknown. We conducted a fertilization study in estuaries with different sedimentation histories in order to determine the role of nutrient enrichment in stimulating mangrove growth and forest development. We expected that if mangroves were nutrient-limited, nutrient enrichment would lead to increases in mangrove growth and forest structure and that nutrient enrichment of trees in our site with low sedimentation, would give rise to trees and sediments that converged in terms of functional characteristics on control sites in our high sedimentation site. The effects of fertilizing with nitrogen (N) varied among sites and across the intertidal zone, with enhancements in growth, photosynthetic carbon gain, N resorption prior to leaf senescence and the leaf area index of canopies being significantly greater at the high sedimentation sites than at the low sedimentation sites, and in landward dwarf trees compared to seaward fringing trees. Sediment respiration (CO_2 efflux) was higher at the high sedimentation site than at the low one sedimentation site, but it was not significantly affected by fertilization, suggesting that the high sedimentation site supported greater bacterial mineralization of sediment carbon. Nutrient enrichment of the coastal zone has a role in facilitating the expansion of mangroves in estuaries of the North Island of New Zealand, but this effect is secondary to that of sedimentation, which increases habitat area and stimulates growth. In estuaries with high sediment loads, enrichment with N will cause greater mangrove growth and further changes in ecosystem function.

Tauranga harbour water quality survey: a report (1974)
Lowe, F J.;Abboy, J. M.; Steven & Fitzmaurice.; Bay of Plenty Catchment Commission
Steven & Fitzmaurice

Spatial Information: Tauranga harbour, New Zealand
Keywords: Water quality, New Zealand, Tauranga Harbour.

Summary: Despite its popular image overseas as an unspoiled land, New Zealand has clearly changed a lot since humans arrived here. One of the most obvious, and significant, impacts of humans on the landscape has been the clearance of huge areas of native vegetation for farming, habitation and extraction of timber. This has had a major effect on rivers, lakes, estuaries and the coast because they represent the receiving environment for the sediment that is eroded and transported from these

disturbed areas by rainwater runoff. Most of today's estuaries began to form around 15,000 years ago, as rising sea levels flooded river valleys until, about 6,000 years ago, sea level stabilised at its present height. The fate of most estuaries since then has been to fill up with sediments. Marine sands typically accumulate near the mouth as sandbanks and delta deposits, under the influence of waves and tides. Finer sediments, derived from erosion of soils in the river catchments, accumulate in more sheltered regions of the upper estuary. After an initial, rapid phase of infilling, the process slows down and eventually, the estuary will fill up to the extent that the river flows across a depositional plain and disgorges its sediment load directly into the sea over a submarine delta. In the final stages of infilling, channels are shoaled, turbidity increases throughout the estuary and sediment collects in backswamps, intertidal flats and marshes, as these features spread down the estuary. This might suggest that if human activity increases the rate of delivery of sediments to estuaries, it is simply hastening an inevitable process and that, therefore, we should not be too concerned about it. This is not necessarily so, for the following reason. We can conceive of a "healthy ageing" of an estuary, in which changes in the estuarine ecosystem keep pace with the changes in patterns of sedimentation that accompany the infilling of the estuary. Conversely, "unhealthy" or "premature" ageing may be brought on by changes in the timing, rate or nature of sediment entering the estuary, such that the ecosystem may not be able to keep pace with changes in the physical environment. Consequences of this might include degradation of water quality (in turn affecting primary producers), decreased biodiversity, dominance of invasive or otherwise undesirable species, premature disappearance of species and reduction of human amenity values. Many, if not all, of these considerations involve human perceptions of what is desirable in an estuarine environment. Some of these perceptions relate directly to our own use of estuaries, so that we might, for example, wish to prevent the loss of commercially, recreationally or culturally important species of fish, areas used for recreation, or deterioration of the aesthetic quality of the estuary, such as decreased water clarity. We do not, however, need to stop at these human interests. Accelerated rates of evolution of estuaries are an inevitable consequence of the growth of human populations and we are left with no choice but to manage this evolution since to do nothing is itself, in effect, a management decision. With improved understanding of how estuarine ecosystems function, we can start to make decisions aimed at restoring more natural rates of change. Two examples drawn from recent work by NIWA (the National Institute of Water and Atmospheric Research) illustrate this point. The first concerns predicting the effects of catchment development on sediment runoff to an estuary and estimating the associated risk of impacts on populations of animals inhabiting the intertidal flats. The second concerns longer-term changes caused by enhanced sedimentation, in the form of the spread of mangroves within estuaries and the consequent loss of other habitats.

Co-managing environmental research: lessons from two cross-cultural research partnerships in New Zealand (2005)
Lyver, P. O. B.
Environmental Conservation

Spatial Information: New Zealand wide
Keywords: Cross-cultural Environmental Research, New Zealand

Summary: Few cross-cultural environmental research partnerships exist in New Zealand where Maori have been given the autonomy or resources to govern the decision-making process. Maori representatives and scientists from two collaborative

research partnerships in New Zealand were interviewed to determine conditions required for successful partnerships, the costs and benefits involved and the roles of kaitiakitanga (environmental guardianship by Maori) and matauranga (Maori traditional knowledge). Ninety per cent of Maori participants reported that a collaborative partnership should be defined by equitable power sharing and decision-making responsibility, however all the scientists perceived the term to be ambiguous and was represented in New Zealand by a continuum of weak to strong power-sharing relationships. Developing trust, distilling and communicating scientific concepts and results, facilitating access to traditional knowledge and building scientific capability within a community can be fundamental to the success of a strong collaborative partnership, but demands a large time commitment, and at times a re-evaluation of priorities, from scientists. Kaitiakitanga and matauranga can be key to directing and guiding research, but may require scientists to adapt and work within unfamiliar cultural systems. Strong collaborative research has a role to play initiating dialogue and partnership-building, demonstrating environmental, justice, economic and social outcomes, and indirectly building a consciousness in society about problem definition and potential solutions that could lead naturally to co-management of the environment by maori communities and local or central governments.

3.13. M

Wave climate of the Western Bay of Plenty, New Zealand 1991-93 (1995)
Macky, G. H.;Latimer, G. J.;Smith, R. K.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Western Bay of Plenty, New Zealand
Keywords: Natural Hazards/Storms

Summary: Wave measurements were made for 3 years from a buoy moored in 34 m water depth off the Katikati inlet in the western Bay of Plenty, New Zealand. The significant wave heights were less than 1 m for 70% of the time, with a mean of 0.8 m, and a maximum of 4.3 m. The peak in the spectral density occurred each year at 0.09-0.10 Hz (10-11 s period). Wave steepness suggests that many of the measured waves originated close to the buoy. The year-to-year uniformity in averaged spectral density masks considerable short-term variability although there is some evidence of higher wave energy in winter. Most wave energy arrived from the north-east to east sector. Calculations of the longshore wave energy flux factor suggest that the direction of littoral drift fluctuates frequently, but during the 3 years studied there was a small nett drift in a north-west direction. Significantly less wave energy was measured at Katikati than in previous studies at Great Barrier Island and Hicks Bay. Our Katikati wave data may not be typical of the long-term climate, because they were obtained in El Nino conditions when fewer storms occur.

Mangroves: Current Research Activities and New Zealand Bibliography; A Summary Document Prepared on Behalf of the Mangrove Steering Group (2006)
Mangrove Steering Group
Mangrove Steering Group

Spatial Information: New Zealand wide
Keywords: plants; mangroves, manawa, *Avicennia marina* subspecies *australasica*

Summary: A summary document prepared on behalf of the Mangrove Steering Group. This report looks at current and recent research activities around New Zealand on mangroves, including works from Auckland University of Technology, Waikato University, NIWA, Environment Waikato, Northland Regional Council and Environment Bay of Plenty.

Comparative Assessment of Water Quality at Durban Beaches According to Local and International Guidelines (2004)
Mardon, D.;Stretch, D.
Water SAJournal

Spatial Information: No spatial context
Keywords: pathogenic pollution, water quality guidelines, indicator micro-organisms, *E. coli*, enterococci

Summary: The pathogenic pollution of Durban's beaches is reviewed on the basis of local and international guidelines by analysing concentrations of indicator micro-organisms (*E. coli* and enterococci). The average water quality is generally acceptable according to South African guidelines, but assessments based on international guidelines indicate poor water quality at many beaches during some seasons (especially summer). The reason for this inconsistency is the absence of any enterococcus criteria in the SA guidelines, which was found to be particularly significant when the pollution loadings are relatively low. This result confirms epidemiological studies that have shown enterococcus to be a more sensitive indicator of pathogenic pollution in marine environments. South African guidelines should therefore be updated to incorporate enterococcus as the preferred indicator for marine waters.

Guidelines for aquaculture management areas and marine farms (2005)
Maritime New Zealand
Maritime New Zealand

Spatial Information: New Zealand wide
Keywords: Aquaculture New Zealand Safety measures; Aquaculture industry New Zealand

Summary: The purpose of these guidelines is to provide support for the appropriate authorities while they develop their AMAs and to give guidance to marine-farm applicants on areas of concern for Maritime New Zealand with respect to navigational safety.The introduction of this document gives a brief overview of the change in legislation around aquaculture in New Zealand and a definition of 'Aquaculture Management Areas' (AMAs).Maritime New Zealand's interest in the development of AMAs is limited to matters of navigational safety and lies in the four spheres of location, marketing and lighting, safety management and control and compliance. Chapter's three and four relate to legislation and Maritime New Zealand's role and requirements for consultation. Some key statutory requirements when developing AMAs are:

- The Minister for Transport is in charge of prescribing standards and requirements for navigational aids relevant to applications for coastal permits in respect to the construction of structures, thus regional councils need to

consult Maritime New Zealand when developing/changing Regional Coastal Plans in respect to AMAs;

- Maritime New Zealand or (if delegated) the Harbour Master must approve any changes to aids to navigation;
- Once a coastal permit is granted, the applicant and regional council must inform the location and size of the marine farm to the Hydrographer of Land Information New Zealand.

Chapter five focuses on location factors when creating AMAs, while chapter six concentrates on marking and lighting requirements; chapter seven on safety management and chapter eight on control and compliance. The first appendix gives a list of useful definitions while appendix number II provides a checklist of AMA considerations for council authorities.

Effects of macroalgal mats and hypoxia on burrowing depth of the New Zealand cockle (*Austrovenus stutchburyi*) (2009)
Marsden, Islay D.;Bressington, Melanie J.
Estuarine, Coastal and Shelf Science Journal

Spatial Information: New Zealand wide
Keywords: *Austrovenus stutchburyi*; *Ulva* spp; *Gracilaria chilensis*; burial depth; hypoxia; macroalgal mat; Plants; Sea lettuce; Tuangi

Summary: Macroalgal mats commonly occur in estuaries and sheltered embayments where they are thought to affect the oxygen conditions in the sediment, influence the geochemical process and influence the burrowing activity of bivalves. Laboratory experiments evaluated the effects of sediment hypoxia and algal mats on the burrowing ability and survival of the New Zealand cockle *Austrovenus stutchburyi* at 15 °C. Both dissolved oxygen concentration and time affected the burial depth of the cockles over the 12 days of the experiment. In hypoxic conditions (<2 mg L-1), cockles migrated to the sediment surface after 3.5 days and mortality occurred after 11 days. Bivalves exposed to oxygen concentrations of 2-3 mg L-1 buried closer to the sediment surface than those in the other treatments. Using a simulated tidal regime, in a mesocosm, burrowing behaviour of the cockle and pore-water oxygen conditions in the sediment were measured on exposure to experimental mats of *Gracilaria chilensis* and *Ulva* spp. for over 6 days. Algal mats on the surface of the sediment significantly lowered the dissolved oxygen concentration of the sediment pore-water and this effect was greater for the *Ulva* spp. treatment than the *G. chilensis* treatment. Cockles were buried more deeply in the control treatment without algae than in either of the two algal treatments. It is concluded that reduced oxygen conditions (<3.5 mg L-1) develop under macroalgal mats and that this reduces the burial depth of cockles. The potential harmful effects of the mats can depend on the species forming the mat and these effects are likely to be greater in the field than they are in controlled laboratory conditions.

Short-term study testing the resilience of an estuarine bivalve to macroalgal mats (2010)
Marsden, I. D.; Maclaren, S. R.
HydrobiologiaJournal

Spatial Information: Avon-Heathcote Estuary, Christchurch, New Zealand
Keywords: *Austrovenus stutchburyi*; Macroalgal mats; Soft sediment macrobenthos; Algal mat; Community composition; Long-term effects; New Zealand; Red algae; Sea lettuce; Sediment characteristic; Short-term exposure; Estuaries

Summary: Macroalgal mats occur seasonally in many estuaries worldwide but there is little information on their short- or long-term effects on the abundance or resilience of macrofauna. Within a small estuary, with a history of exposure to algal mats (Avon-Heathcote Estuary, Christchurch, New Zealand), we quantified the relationship between macroalgal mats and community composition. There was a high degree of species overlap between sites, and community analysis did not separate out areas that had been previously exposed to mats. Density of the cockle *Austrovenus stutchburyi* was negatively correlated with current abundances of sea lettuce *Ulva* and the red alga *Gracilaria chilensis*. A caging experiment at three sites with different sediment characteristics investigated the survival of the cockle (*A. stutchburyi*) to short-term exposure to mats of *Ulva* sp. and *G. chilensis*. Neither low nor high algal biomass had any effect on cockle mortality, macroinvertebrate diversity or the sediment characteristics. Although the population structure of cockles differed amongst sites, bivalves followed normal seasonal development, regardless of the experimental treatment. The results confirm that the cockle has the ability to survive short-term exposure to algal mats

Seagrass restoration in Whangarei Harbour: results of a small scale transplantation trial (2008)
Matheson, F.;Reed, J.;Dos Santos, V.;Cummings, V.;MacKay, G.;Jordan, M.
Northland Regional Council

Spatial Information: Elsewhere in New Zealand - Whangarei Harbour
Keywords: Sea Grass Restoration, Eel Grass, Zostera

Summary: Seagrass beds once covered large areas of the outer Whangarei Harbour, covering an estimated 14 square kilometres before the early 1960s. Human activities in the upper-mid part of the harbour resulted in the almost complete loss of this important undersea habitat. Since the 1970s, small pockets of seagrass have struggled for survival on the southern shores of Whangarei Harbour. In recent years, there have been encouraging signs that improving water quality is enabling the slow expansion of these pockets.

Seagrass in the Eastern Bay of Islands: past, present abundance, threats and management options (2010)
Matheson, F.;Wadhwa, S.; Taumoepeau, A.; Smith, J.
NIWA

Spatial Information: Elsewhere in New Zealand - Eastern Bay of Islands
Keywords: Seagrass, eel grass, *Zostera*, Eastern Bay of Islands

Summary: This report describes an investigation into the loss of seagrass meadows from the Eastern Bay of Islands area. The project aimed to quantify the loss of seagrass in this area by comparison of historical and recent aerial images, identify factors that may have contributed to seagrass decline and recommend options to protect remaining seagrass and rehabilitate denuded areas.

Growth responses of *Zostera capricorni* to estuarine sediment conditions (2007)
Matheson, F. E.;Schwarz, A. M.
Aquatic Botany

Spatial Information: New Zealand harbours
Keywords: Sedimentation, Nitrogen, Organic content, Phosphorus, seagrass, sulphide

Summary: This study comprised (1) a field survey of intertidal seagrass (*Zostera capricorni*) biomass, cover and photosynthetic potential and sediment characteristics at a range of contrasting sites in three New Zealand harbours, and (2) a microcosm experiment comparing plant responses to sediments from extant versus historical seagrass sites. The field survey showed that the sediment physico-chemical characteristics were generally consistent with the limited previous reports for *Zostera* environments, although the total P concentration range was higher (0.08-0.72 mg P g -1). Overall, 52% of variation in seagrass cover was explained by sediment water content (R= 0.54) and organic content (R= -0.56). Twenty-two percent of variation in seagrass biomass was explained by sediment total P and redox potential (both R= -0.35). Intra-harbour seagrass-sediment relationships were more significant (explaining up to 82% of plant variation) but harbour-specific. In the microcosm experiment, threefold higher *Z. capricorni* biomass was maintained on extant thyan historical sediments but not conclusively linked to measure sediment characteristics. Overall, the results of this study demonstrate that significant relations can exist between estuarine sediment conditions and *Z. capricorni* growth responses, and suggest that detrimental change in sediment conditions may be a contributing factor in seagrass decline.

Morphological changes of tidal deltas and an inner shelf dump ground from large scale dredging and dumping, Tauranga, New Zealand (1997)
Matthew, J.
University of Waikato

Spatial Information: Tauranga, New Zealand
Keywords: Tauranga Harbour, dredging

Summary: The Port of Tauranga is located within a tidal inlet estuarine system that has been dredged to improve navigation for shipping since 1968. During a major capital dredging programme in 1991-92 the shipping channels were deepened by removing about 5 million m^3 of sediment. A number of conditions were imposed by the consent granting authorities before the Port Company was permitted to undertake the dredging and dumping. As one of the conditions, a detailed monitoring programme was instituted to identify any adverse effects on the flood and ebb-tidal deltas due to dredging and on the inner shelf due to the disposal of dredged material.

Ebb-tidal delta response to shipping channel dredging, Tauranga, New Zealand (1997)
Mathew, J.;Healy, T. R.;De Lange, W. P.;Immenga, D.
Pacific Coasts and Ports '97. Proceedings Volume 2, Centre for Advanced Engineering, University of Canterbury

Spatial Information: Tauranga, New Zealand
Keywords: Sedimentation, Dredging

Summary: The effects on ebb-tidal delta morphodynamics resulting from deepening and widening of a shipping channel through the ebb-tidal delta are examined using detailed annual bathymetric survey data. The data show the post-dredging geomorphic configuration of the ebb-tidal delta has remained broadly stable but significant localised changes occurred. The net volume change over the ebb-tidal delta was negligible for the comparison period relative to the measurement and calculation errors. However, the sedimentation in the navigation channel through the delta seems to have increased after the dredging from a long-term average of 70,000 to about 130,000 m^3 per year. Near-bottom current measurements show ebb tidal dominance offshore of the proximal ebb channel, but flood currents dominate for about 80% of the tidal cycle in the adjacent more-sheltered regions. The adjacent regions are evidently influenced by an eddy operating during most of the ebb phase.

Current situation and future challenges facing the production and marketing of organic fruit in Oceania (2004)
McArtney, S. J.; Walker, J. T. S.
International Society Horticultural Science

Spatial Information: Australia & New Zealand
Keywords: Organic Pollutants

Summary: Australia has almost half of the global area in managed organic production, much of it low productivity land for cattle production. Organic food accounts for 1 percent of the total food market in Australia, however the demand still exceeds production, so little organic food is exported. Major supermarkets in Australia tend not to have developed organic products as part of their marketing strategic position, so that demand for organic food remains outside the mainstream food industry. Nevertheless beef, carrots, citrus, wheat and wine are considered target products for priority development in organic production systems within Australia. New Zealand produces organic food on 46 000 hectares, much of it grown for export. Fresh fruit accounts for 71 percent of all organic exports with kiwifruit (Actinidia deliciosa cv. Hayward) and apple (Malus x domestica) making up the bulk of this category. Production systems for kiwifruit and apples in New Zealand have moved from conventional to either Integrated Fruit Production (IFP) or organic production systems over the last decade in response to market signals rather than to government subsidies. Organic apple and kiwifruit production systems typically yield less than conventional or IFP systems. Market premiums for organic fruit have until recently compensated for reduced yield. Declining premiums can quickly erode the profitability of current substitutional organic production systems. For kiwifruit, organically acceptable alternatives to hydrogen cyanamide are needed to enhance bud break and flowering and to fumigation for a key quarantine-actionable pest. For apple, the lack of alternatives to sulphur-based fungicides, and of acceptable thinning technology, limit profitability. Continued expansion of organic apple production will be dependent on development of orchard systems that integrate resistant cultivars; and ground cover management systems that optimise nutrient and water status of trees, and that enhance bio-control and bio-diversity.

Health Effects of Marine Bathing in New Zealand (1998)

McBride, G.B; Salmond, C.E; Bandaranayake, D.R; Turner, S.J; Lewis, G.D; Till, D.G.
International Journal of Environmental Health Research

Spatial Information: New Zealand wide
Keywords: Epidemiology; Swimming; Paddling; Respiratory Illness; Faecal Contamination; Enterococci

Summary: Prospective epidemiological studies on the possible health effects from sea bathing were carried out at seven popular New Zealand bathing beaches over the 1995 summer. The association of gastrointestinal/ respiratory symptoms or other infections with human or animal faecal contamination of the beach water were examined. Beach users were interviewed at the beach and then followed up within 5 days to ascertain any illness symptoms. On each of the 107 interview days multiple samples of the beach water were examined for three faecal indicators (faecal coliforms, *E. coli* , enterococci). Of the usable responses, 2307 users did not enter the water; 1577 did. Log-linear modelling showed that enterococci was most strongly and consistently associated with illness risk for the exposed groups, particularly for respiratory illness among paddlers and long-duration swimmers. Crude risk differences for these two groups were 7 and 33 per 1000 individuals, rising to 62 and 87 per 1000 individuals for the highest enterococci quartile. No substantial differences in illness risks were found between the human and animal waste impacted beaches, though both were markedly different from the control beaches. The results are being used to develop recommendations for sampling design and use of single-sample maxima in new bathing-water guidelines.

Toxic Metals in Sewage Sludge-amended soils: Has Promotion of Beneficial Use Discounted the Risks? (2003)
McBride, M.B.
Advances in Environmental Research

Spatial Information: No spatial context
Keywords: Heavy metals; Sewage sludge; Biosolids; US EPA; Risk assessment; Toxicity; Agricultural crops; Regulation; Land application

Summary: Land application of contaminated waste products has been defended as beneficial use by some scientists and regulators, based on the premise that the behaviour of any toxins accumulated in soils from this practice is reasonably well understood and will not have detrimental agronomic or environmental impacts into the foreseeable future. In this review, I use the case of toxic metals in sewage sludges applied to agricultural land to illustrate that metal behaviour in soils and plant uptake is difficult to generalize because it is strongly dependent on the nature of the metal, sludge, soil properties and crop. Nevertheless, permitted agricultural loadings of toxic metals from sewage sludges are typically regulated using the sole criterion of total metal loading or concentrations in soils. Several critical generalizing assumptions about the behaviour of sludge-borne metals in soil-crop systems, built into the US EPA risk assessment for metals, have tended to underestimate risks and are shown not to be well justified by published research. It is argued that, in the absence of a basic understanding of metal behaviour in each specific situation, a more precautionary approach to toxic metal additions to soils is warranted.

National overview of biological monitoring in New Zealand's Marine Protected Areas (2001)

McCrone, A.
Department of Conservation

Spatial Information: New Zealand wide
Keywords: Biological monitoring, Marine Protected Areas and Applications (MPAAs), Marine Reserves (MR), Sugar Loaf Islands Marine Park (SLIMPA)

Summary: This report provides a national overview of biological monitoring that has been undertaken or is in progress for 25 Marine Protected Areas and Applications (MPAAs) in New Zealand - 16 marine reserves (MR) and the Sugar Loaf Islands Marine Park (SLIMPA) and 8 marine reserve applications (MRA). MPAAs have been established since 1975, however, most MPAAs (22) have only been established or the applications lodged in the last 10 years. There have been a total of 41 baseline surveys and monitoring programmes undertaken in 19 of the 25 MPAAs since 1975. About half the MPAAs (15) in NZ have had a baseline survey conducted near to the establishment of the MR or the application of a MRA. Many of these baseline surveys were not used to establish monitoring programmes. Most of the baseline surveys included habitat surveys. Generally habitat monitoring has not been continued. Eighteen MPAAs have had monitoring programmes undertaken. There are 9 programmes currently running that are formally planned to continue beyond June 2000. Most monitoring programmes that have been undertaken or are currently underway focus on examining changes in population abundance and size structures of selected key species especially reef fish species, rock lobster, paua and kina. A total of 52 monitoring reports have been produced to date, with a further 9 in the process of being produced. The overview has shown that marine survey and monitoring work has not been well co-ordinated in the past. It is recommended that biological monitoring should be nationally co-ordinated. Benefits arising from this would include assistance with obtaining funding and other necessary resources, assessment and standardisation of baseline surveys and monitoring programmes centralised storage of data and reports, and the development of protocols of what and how to monitor. However, much of this work is currently underway with the development of a Standard Operating Procedure for survey and monitoring in marine reserves.

Visitor impacts on marine protected areas in New Zealand (2001)

McCrone, A.
Department of Conservation

Spatial Information: New Zealand wide
Keywords: Impacts on marine protected areas, visitor impacts

Summary: The establishment of marine protected areas in New Zealand has accelerated in recent times. The first marine protected area was established in 1975. Four more were established during the 1980s and 15 in the 1990s. Public interest and hence visitor numbers have grown to a point where serious concerns are being expressed about potential negative impacts of visitors on the conservation values within these areas. A survey of New Zealand and international literature was made to identify negative impacts associated with visitors, plus any useful lessons from international research that would be relevant to the New Zealand situation. Most studies looked at visitor impacts on the coastal area in general than on marine protected areas specifically; and compared with international literature, visitor

impacts on marine protected areas have been little studied in New Zealand. The review showed that there are some significant problems associated with visitors to marine reserves in New Zealand. These include damage to intertidal and subtidal reefs and changes to fish behaviour through interactions with visitors feeding them. Managers of each marine protected area need to identify and assess visitor impacts in their area, and monitor the situation in order to adopt timely management responses. They also need to monitor the success or otherwise of the visitor management techniques they employ. It is suggested that further research is required to assess the biological significance of visitor impacts on marine protected areas in New Zealand. There is also a need to instigate and maintain long-term research to assess the impacts of various visitor activities and hence their sustainability.

Water and sediment quality of Tauranga Harbour (1994)
McIntosh, J.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Water quality, sediment, Tauranga Harbour

Summary: This volume is part of a four volume series describing investigations regarding the environmental resources of Tauranga Harbour. Extensive fieldwork was carried out between July 1990 and June 1991. Water quality of the harbour inflows, harbour water and sediment chemistry are described in this report.

Shellfish Quality Assessment (1999)
McIntosh, J.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: water quality, monitor, Bay of Plenty, Tauranga Harbour, Te Awanui, shellfish, NERMN, indicator bacteria, faecal coliform, enterococci, polycyclic aromatic hydrocarbons, heavy metals, pipi, mussel, oyster, cockle, tuatua, *Mactra*, Environment Bay of Plenty

Summary: This report looks at shellfish quality in Bay of Plenty waters. Bacterial, pollutant, metal, tin and other contaminants are investigated.

NERMN Estuarine Water Quality (2003)
McIntosh, J.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: estuary, water quality, monitor, Bay of Plenty, Tauranga Harbour, Te Awanui, recreation, bathing, guideline, agriculture, industry, impact, effect,

Summary: As part of Environment Bay of Plenty's Natural Environment Regional Monitoring Network (NERMN), the water quality of estuarine sites around the Bay of Plenty is monitored. This data combines with estuarine ecological monitoring to build up a picture of the state of the estuaries and the trends in environmental changes. This report collates the water quality data since 1990. In the period of monitoring

some changes have taken place in the sampling strategy with some new sites being added and some sites changed to another adjacent location. The objective of the monitoring programme is to determine the quality of estuarine waters of the Bay of Plenty and trends in their quality, compliance of the water with appropriate objectives in the regional coastal Environment Plan. Generally the estuaries of the Bay of Plenty are of high to good quality. However, this is most likely assisted by dilution with coastal waters. The sites with minor excursions from the bathing guidelines have greater freshwater influences. In these catchments, agricultural, industrial and urban sources contribute bacteria to the waterways. Matata Lagoon has the poorest quality, probably due to the large waterfowl population. Monitoring at 2 monthly intervals will continue at the 21 estuarine sites.

Kiwifruit and Dairying Effects on Shallow Groundwater (2009)
McIntosh, J
Bay of Plenty Regional Council

Spatial Information: Kelly Road – Maketu, New Zealand
Keywords: nutrients, nitrogen, phosphorus, dairy, kiwifruit, orchard, land use, rural, groundwater, horticulture, Environment Bay of Plenty

Summary: This study was initiated to examine how the development of kiwifruit orchards affects nutrient levels (particularly nitrate) in shallow groundwater in comparison to dairying. The study was incorporated as 'in-kind' support with a Sustainable Farming Fund (SFF) project which was examining nitrogen and water use in Hort16A (gold) kiwifruit.The study sites were at Kelly Road, Maketu, and included a kiwifruit orchard and a dairy farm about to be converted to a kiwifruit orchard. At each site five bores were drilled to around 6 metres and the water quality was monitored for three years.The key finding of the study is that nutrient exports are considerably less from kiwifruit than from dairying as summarised in the table below.

Urban stormwater (2001)
McIntosh, J.; Deely, J.
Bay of Plenty Regional Council

Spatial Information: Tauranga/Mt Maunganui, Rotorua and Whakatane, New Zealand
Keywords: Urban stormwater, sediment sampling, Environment Bay of Plenty, stormwater, discharge, monitoring, contaminant

Summary: EBOP staff carried out a project to examine the effects of stormwater discharge on the environment of the Bay of Plenty. Because of the difficulties involved in sampling stormwater, simultaneously, over extended areas of the Bay of Plenty a method of sediment sampling was employed. A matrix of sites was set up in three urban centres, Tauranga/Mt Maunganui, Rotorua and Whakatane, with 5 replicate sites in selected residential, commercial and industrial areas. A surface sample from freshly deposited sediment was sampled in stormwater catchments after storm events. Contaminants levels in the sediment were determined. Contaminant levels in urban stormwater are elevated above background levels coming from rural environments. Industrial and commercial land use generates the greatest quantity of contaminants. Even in a small community such as Whakatane, the commercial and industrial sector had considerable effect on contaminant levels in the environment.

Bathing Suitability Investigations Summer 2000/01 (2001)
McIntosh, J. ;Gibbons-Davies, J.G.
Bay of Plenty Regional Council

Spatial Information: Bay of Plenty, Waimapu Stream and Waihi Beach stream, Little Waihi Estuary, Waiteti Stream, New Zealand
Keywords: water quality, monitor, bathing, Bay of Plenty, Tauranga Harbour, Te Awanui, Environment Bay of Plenty

Summary: Over the summer of 2000/01, Environment B.O.P staff sampled bathing waters in the Bay of Plenty in accordance with The Ministry for the Environment and the Ministry of Health Recreational Water Quality Guidelines (1999). The new guidelines promote annual surveys of bathing beaches. Consequently an annual programme has been implemented to complement the three yearly Bay of Plenty bathing suitability survey. Marine, estuarine, stream and lake sites selected included the most popular tourist bathing beaches, sites based on risk assessment of previous years data, and those based on local issues raised by the liaison group. Environment B.O.P staff undertook the majority of the sampling and analysis. The results show that marine, estuarine and lake sites were safe for bathing for the complete period of monitoring. The Waimapu Stream and Waihi Beach stream sites, however, were found to have very poor water quality for all of the summer and signs were erected to warn the public against bathing in these waters. Little Waihi Estuary and the Waiteti Stream were in alert mode for much, or all, of the sampling period. As a result of a record of poor bathing water quality at Whakarewarewa in the past, a catchment survey of the Puarenga Stream and its tributaries was undertaken prior to the summer sampling programme. There was communication with resource consent holders in the catchment prior to and during the survey so that they would be aware of the current findings. Despite high bacteria levels being found in some of the tributaries, the site at Whakarewarewa remained suitable for bathing over the summer of 2000/2001. Publicity over contamination problems was effective in reducing contamination at Pilot Bay although the exact cause of the contamination was not found. The approach taken over the Puarenga Stream catchment will be followed in future years with other catchments where bacterial contamination has been consistently high. Next summer, the Waimapu Stream and its tributary the Waiorahi Stream will be surveyed. A combination of publicity and catchment sampling will be used to find the source(s) of contamination and draw people's attention to the types of activities that result in bacterial discharges.

Points to note:

- Sites monitored in the Tauranga Harbour and its tributaries were: Omokoroa, Anzac Bay, Pilot Bay (estuarine) and Waimapu Stream and two of its tributaries (freshwater).
- Marine waters were analysed for enterococci (only) using the USEPA Method 1600, with the results checked against APHA Method 9230C. Freshwaters were analysed for *Escherichia coli* using the APHA Method 9213D, which is also known as USEPA Method 1103.1 1985.
- Anzac Bay and Omokoroa were safe for bathing over the summer period of 2000/2001 (i.e. there were no exceedances above an enterococci running medium of 35/100mL). Monitoring of septic tank seepage at Omokoroa has shown that contaminated discharges are occurring to open waters. However,

at a depth of sampling (500 mm) for bathing quality, sufficient dilution occurred to render the contamination to 'safe' levels.

- Pilot Bay only had a single 'alert' exceedance (enterococci level of 147/100mL) on 22/11/00.
- The Waimapu Stream site at Greerton Park was found to exceed the bathing guidelines continually, with the highest single exceedances being 3700/100mL *E.coli*, with an average running medium of 435/100mL *E.coli* (alert level is >126/100mL *E.coli*). Upstream sampling showed that the Waiorohi tributary was the primary source of contamination.

A Recreational Geography of the Avon-Heathcote Estuary, Christchurch (1979)
McKenna, A.P.
University of Canterbury

Spatial Information: Elsewhere in New Zealand - Avon-Heathcote Estuary, Christchurch
Keywords: plants; sea lettuce,*Ulva*, Avon-Heathcote Estuary

Summary: This thesis has a brief description of the impacts of sea lettuce blooms to the Avon-Heathcote Estuary.This thesis examines the recreational use of a multi-functional resource, the Avon-Heathcote Estuary. The nature of resources suitable for outdoor recreation in the Christchurch area and the present use made of them are explored through a demand-supply framework. Although exploratory, the research into recreational use of an estuarine environment advocates the need for a greater understanding of resource capabilities and use requirements. To this end, a framework which examines both user and resource is described. Recreation resources within the study area are identified and examined with respect to quantity, quality and distribution. Recreational demand is analysed in terms of measures of recreationalists' attitudes preferences and activities. The diversity of functions provided by the Avon-Heathcote Estuary means that recreation must be considered in relation to other uses. In view of the expected growth in recreational use of the Estuary the notion of carrying capacity is introduced. The capacity concept is discussed within the wider context of maintaining user satisfaction and conserving the estuarine environment.

Shifts in flood and low-flow regimes in New Zealand due to interdecadal climate variations (2003)
McKerchar, A. I.; Henderson, R. D.
Hydrological Sciences Journal

Spatial Information: New Zealand wide
Keywords: Interdecadal Pacific Oscillation, Flood

Summary: Thirty-one of the longest available stream-flow records for New Zealand were analysed to see whether shifts in flood and low-flow regime occurred in 1977/1978 corresponding to a shift in phase of the Interdecadal Pacific Oscillation. Annual peak flows, and annual minimum flows averaged over 28 days, for two periods, 1947-1977 and 1978-1999, were compared using box plots and statistical tests. The plots and the tests show that a decrease of flood size has occurred since

1978 in the Bay of Plenty region of the North Island, and that increases in flood size and low-flow magnitude have occurred in the South Island for most rivers with headwaters draining from the main divide of the Southern Alps and Southland. For much of the North Island apart from the Bay of Plenty, and the north of the South Island, no consistent pattern of shifts was identified.

Stormflow dynamics and loads of *Escherichia coli* in a large mixed land use catchment (2009)
McKergow L.A., Davies-Colley R.J.
Hydrological Processes

Spatial Information: Motueka River, New Zealand
Keywords: diffuse pollution, faecal indicator bacteria, faecal microbes, turbidity

Summary: Storm events are major transporters of faecal microbial contaminants, but few studies have reported storm loads or concentration dynamics in relation to discharge or other pollutants, notably fine sediment. Episodically, high loads of faecal contamination during storm flows impact downstream uses of water bodies, particularly contact recreation and shellfish harvesting. We examined the storm dynamics of *Escherichia coli*, turbidity and discharge in the mixed land use Motueka catchment (2047 km2; 60% forest and 19% pasture) to gain insights into *E. coli* sources and transport. We also explored different approaches for calculating *E. coli* loads. Discharge and field turbidity were recorded continuously, and *E. coli* concentrations were sampled during events, over a 13-month period near the mouth of the Motueka River. *E. coli* loads were estimated by interpolation, averaging estimators and by using linear regression with smearing correction of the log-transformed variables: discharge, turbidity, and both turbidity and discharge. The annual *E. coli* load was dominated (98%) by export during events. Comparison of monthly monitoring with the intensive storm monitoring campaign suggests that simple stratification of the sampling into storm and baseflow would greatly improve export estimates. *E. coli* peak concentrations always preceded discharge and turbidity peaks (which had similar timing). Turbidity can be a useful surrogate for faecal microbes in smaller catchments, but in the Motueka, turbidity was no better for predicting *E. coli* concentration than discharge. Runoff from grazed pasture and direct deposition from livestock are probably the ultimate *E. coli* sources in the Motueka catchment. However, in-channel stores seem to dominate *E. coli* dynamics during events and account for the typical feature of bacterial concentrations peaking ahead of discharge and turbidity. This study demonstrates the importance of storm events to faecal microbial loads and shows that *E. coli* concentration dynamics may contrast with those of turbidity.

Vertical distribution of New Zealand shipworms (Bivalvia: Teredinidae) (1981)
McKoy, J.L
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Tauranga Harbour, Wellington Harbour - New Zealand
Keywords: Invasive species, Teredinidae, shipworms, Bay of Islands, Tauranga Harbour, Wellington Harbour, vertical distribution, intertidal environment, mangroves

Summary: In Tauranga Harbour, *Lyrodus medilobatus* was found ingreatest numbers on test blocks placed near the bottom, while *Bankia australis, B. neztalia,* and *Nototeredo edax* had a more uniform vertical distribution. Shipworms occurred in

the intertidal zone up to about mean sea level. In Wellington Harbour, *B. neztalia* was found in test blocks up to mean sea level, but was most abundant in blocks near the bottom. In the Bay of Islands, shipworms settled in the intertidal on test blocks as high as 30 cm below mean sea level. *B. australis* was the most abundant species in mangrove wood in northern New Zealand, and *L. medilobatus* occurred occasionally. No evidence was found for shipworms settling on living mangrove wood, although they frequently tunnelled from dead wood into living wood

Mud Snail (1966)
McLintock, A. H.
An Encyclopaedia of New Zealand 1966

Spatial Information: New Zealand
Keywords: macroinvertebrates, mud snail, titiko, *Amphibola crenata*

Summary: *Amphibola crenata*: About the size of a garden snail, this is the shellfishseen scattered in thousands over upper tidal mud flats. It feeds by sifting organic particles from the mud. The species is remarkable in that it breathes by means of a primitive lung, not gills. It is the only air-breathing marine snail possessing an operculum. The Māori esteemed this shellfish as an important food source and called it titiko.

Mangroves and Estuarine Ecologies. A Report in Five Parts Based on Studies of Mangroves and Settlements in the Kaipara Harbour (2005)
McShane, O.
Centre for Resource Management Studies

Spatial Information: Kaipara Harbour, New Zealand
Keywords: Kaipara Harbour; Plants; mangroves, manawa, *Avicennia marina* subspecies *australasica*

Summary: Owen McShane is the Director of the Centre for Resource Management Studies which is a small executive office in the Northland of New Zealand. Present trustees of the Centre include Don Brash, Noel Lane, Sir Roger Douglas, Dick Quax, Alan Gibbs and Owen McShane. This report is produced by this Centre on the mangroves in the Kaipara Harbour.

A multipurpose, artificial reef at Mount Maunganui Beach, New Zealand (1999)
Mead, S.; Black, K.
Coastal Management

Spatial Information: Mount Maunganui Beach, New Zealand
Keywords: sedimentation, dredging, artificial reef

Summary: A multipurpose, artificial, offshore reef has been designed for construction at Mount Maunganui Beach, New Zealand. The proposed reef will form the basis for research into coastal protection, amenity enhancement (particularly surfing, but also diving, fishing, and beach recreation), biological response, and social and economic impacts. In order to proceed with reef construction, a five-year resource permit is being sought from the regulatory authority, and this application required an assessment of the likely environmental impacts of the proposed reef. The

studies undertaken for the assessment included the examination of physical, biological, social, and economic impacts. A comprehensive design process was undertaken to incorporate the amenity of surfing into a submerged reef shape. Programs to monitor physical and biological responses, as well as social and economic impacts, were also established. These studies support the use of multipurpose, artificial, offshore reefs as an environmentally friendly solution to coastal protection. The reefs also cater to the growing demand for more coastal-amenity development

Bay of Plenty Biological Survey: Aquaculture Management Areas (2005)
Mead, S.; Longdill, P.; Moores, A.; Beamsley, B.; Black, K.
ASR and University of Waikato

Spatial Information: Eastern Bay of Plenty (Pukehina to Ruakokore), New Zealand
Keywords: aquaculture, Bay of Plenty, biological survey, sediment, infaunal organisms, epifaunal organisms, seabed, polychaete, amphipod, bivalve, benthic, marine farm, mussel

Summary: Sediment samples and dredge tow samples obtained from the seabed in depths ranging from 10 m to 100 m depth within the eastern Bay of Plenty (Pukehina to Ruakokore) in December 2004 have been analysed for both infaunal and epifaunal organisms. In addition over 200 video camera images have been obtained over the same area to classify the variability of the seabed habitat and environment. These data provide base-line information on the variety of organisms that inhabit the Bay of Plenty seabed and insight into the relative abundance and distribution of these organisms and their association with different physical seabed characteristics in the survey area. A total of 3257 individuals (124 species from 14 groups) were identified in the grab and dredge-tow samples. Polychaetes and amphipods are the dominant fauna in the area, however, large variations in species and abundance were found, demonstrating the patchy distribution of benthic organisms. Some associations with respect to sediment type were evident. For example, amphipods dominate shallower (<50 m) mud/silt areas, while polychaetes dominate sandy areas, with high organic content. A wide variety of bivalves are spread throughout region, although some patterns are present, i.e. larger numbers of deposit-feeding bivalves are present in the in the muddy areas compared to the sandy areas.

Institutional design for the co-management of an urban harbour in New Zealand (1998)
Memon, P.A.; Selsky, J.W.,
Society & Natural Resources

Spatial Information: Otago Harbour, New Zealand
Keywords: co management, common pool resources, CPRs, Dunedin, New Zealand, NIMBY, ports,

Summary: What factors affect the design of an institutional framework for stakeholder management to promote sustainable outcomes for ports in urban settings? In examining this research question, we characterize urban harbours as complex common property resource systems (CPRs). Complex CPRs differ from simple CPRs in several ways that highlight the need for, but also the difficulties of, integrated management that promotes sustainable outcomes. We review the literature on locational conflicts, corporate social responsibility, and co management

for insights that bear on this problem. We then examine the port on the Otago Harbour as a case study in shifting institutional arrangements in a complex CPR, focusing on long-standing conflicts between the port company and the local community. Finally, we draw implications for the design of effective co management arrangements for ports located in dynamic and diverse communities.

Land use impacts on nitrogen and phosphorus loss and management options for intervention (2004)

Menneer, J.C.;Ledgrad, S.F.;Gillingham, A.G.;
AgResearch

Spatial Information: New Zealand wide
Keywords: nutrients, nitrogen, phosphorus, land management, leaching, sustainable farming, New Zealand, agricultural land uses

Summary: The amounts of N and P loss from different agricultural land uses are summarised and the main sources of losses are reviewed for the New Zealand scene using literature published up until 2003. Also presented is a summary of the main land management options known to reduce N and P losses. Of the land use systems considered in this report, the potential for causing nitrate leaching typically follow the order: forestry < sheep/beef/deer farming < arable/mixed cropping < dairy farming < vegetable cropping. Insufficient information is available to establish the order of orcharding and organic farming within this framework. The lowest nitrate leaching losses are in forestry systems which average about 3 kg N ha^{-1} yr^{-1}, whereas the greatest losses are in intensively managed vegetable cropping systems at an average of 177 kg N ha^{-1} yr^{-1}. In typical dairy farm systems, nitrate leaching losses average approximately 40 kg N ha^{-1} yr^{-1}. The majority of the N leaching occurs during winter when soil drainage is greatest. In grazing systems, the main source of leached nitrate is from patches of deposited urine, which can have high N concentrations equivalent to between 500 and 1000 kg N ha^{-1} depending on the animal type (e.g. sheep versus cattle). Direct leaching of fertiliser N has only a marginal effect on nitrate leaching under grazing and only when N applications are excessive (>400 kg N ha^{-1} yr^{-1}) or untimely (e.g. ³ 50 kg N ha^{-1} in winter). In contrast, in cropping systems, the main sources of leached nitrate are from fertiliser N and crop residues that remain in the soil following harvest. In addition, the amount of nitrate leached is greatly influenced by the length of the fallow period following crop harvest and the subsequent timing of cultivation.To reduce nitrate leaching from these sources, a range of management options are available. These options relate to making improvements to various components of individual land use types, such as: grazing management, cultivation practices, winter crop management and fertiliser N management.

In grazing systems, the most significant gains in reducing nitrate leaching from animal urine are achieved by minimising the time animals spend on pasture during winter to reduce urine N inputs. In a dairy system, grazing cows over winter or the use of a feed-pad during winter can reduce nitrate leaching by up to 60%. Other more novel approaches (e.g. low feed N supplements and nitrification inhibitors) show potential but their role in reducing nitrate leaching has yet to be quantified. In arable cropping systems, the timing of cultivation and the presence of a winter cover crop are management strategies which can markedly reduce nitrate leaching. By cultivating soon after harvest (e.g. late summer) and planting a winter cover crop to utilise released N, nitrate leaching losses can be reduced by up to 80%. Under vegetable cropping, matching the rate of applied N fertiliser to crop requirements in

conjunction with splitting, placement and timing of fertiliser N applications are the best strategies for reducing nitrate leaching. Using this type of tactical fertiliser management can decrease nitrate leaching losses by between 24% and 45% depending on the technique of N application. Compared to N losses, P losses from agricultural systems are generally much less (e.g. 21-177 versus 0.11-1.60 kg ha^{-1} yr^{-1}, respectively), but can still have a critical impact on the eutrophication of surface waters. The main mechanism leading to increased P in waterways is through elevated P concentrations in surface run-off. In contrast, N run-off is minor relative to leaching losses on most soils.The amount of P in run-off from different land uses has been less researched than N losses. Nonetheless, in general, forestry seems to contribute the least amount of P to waterways, followed by hill country sheep farming. The P losses from forestry systems range from 0.07-0.10 kg P ha^{-1} yr^{-1}, whereas in hill country sheep farms, P transfer to waterways is in the range of 0.11-0.75 kg P ha^{-1} yr^{-1}. When cattle are a component of the grazing system (e.g. sheep and cattle systems), P losses can be up to 1.60 kg P ha^{-1} yr^{-1}. However, a recent study showed extreme losses of 10 kg P ha^{-1} yr^{-1} from a dairy catchment in an extremely high rainfall area of Westland. Unfortunately, there is only limited information on the amount of P lost from typical dairy and cropping systems (e.g. vegetable cropping). P losses from these more intensive land uses are likely to vary dramatically with differences in animal stocking rate, soil type, topography, cultivation, fallow periods, cover crop and P fertiliser management. Further research is required in intensively managed New Zealand agricultural systems to determine their importance in contributing P to surface waters.

High risk periods for P loss are generally during late winter and early spring when high rainfall and soil moisture often coincide leading to the potential for run-off and P transport. In general, the majority of P (up to 80%) in run-off is in the form of particle bound P (e.g. bound to sediment or organic material) while less than 20% is present as dissolved P. The main factors affecting the amount and type of P in run-off from different land uses are a mix of edaphic features and farm management practices, and jointly include: topography, soil type, soil P status, animal treading, and fertiliser management. To reduce P losses from agricultural systems appropriate management options are required to minimise the impact of these factors. Five key areas of system management should be targeted: (1) P fertiliser management (2) grazing management (3) riparian management (4) post-harvest crop management (5) whole-system management. For example, in grazing systems animal treading damage should be minimised so the risk of increased sediment in run-off and increased P in waterways is reduced. This could be achieved by winter and spring grazing management strategies that incorporate a stand-off pad (in a non-critical area) to restrict grazing-time on pasture. In cropping systems, where harvesting removes the protective vegetation cover (e.g. forestry, vegetable cropping, and mixed/arable cropping), post-harvest management strategies should be utilised to reduce the potential for surface run-off and erosion during storm events (e.g. zero tillage, cover crops, timing of cultivation). Many of these management strategies serve a dual purpose in terms of reducing both N and P losses from agricultural systems suggesting that a more holistic approach is worthwhile. At the whole system level, more complete approaches include farm nutrient budgeting and precision farming to integrate the different components of individual agricultural systems. Whole system nutrient budget models can predict the amount of nitrate leaching and P run-off loss based on N and P inputs and outputs while considering the different management strategies of the land use involved. This enables management decisions to be made that will minimise N and P losses to the environment. Similarly, precision farming can assist in minimising N and P losses by considering the spatial and temporal variability of soil attributes and crop characteristics within a farm/field

and assist in the decision making process for selecting and adopting appropriate site-specific levels of management (e.g. critical source areas).

Stomach contents of common dolphin (*Delphinus* sp.) from New Zealand waters (2008)
Meynier,L.; Stockin, K. A.; Bando, M. K. H.; Duignan, P. J.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand wide
Keywords: dolphins and whales, foodweb

Summary: This paper investigated the stomach contents of the common dolphin from New Zealand waters. The study was based on stomach content of 53 animals (42 stranded and 11 by-caught) collected from the North Island of New Zealand between 1997 and 2006. It was found that the diet of the common dolphin comprised of a diverse range of fish and cephalopod species, dominated by arrow squid, jack mackerel and anchovy. Examination of the diet content of stranded dolphins from coastal waters, and dolphins by-caught within neritic waters, suggests that dolphins move between inshore/offshore on a diel basis.

Managed aquatic ecosystems (1987)
Michael,R. G.
Elsevier

Spatial Information: Worldwide
Keywords: Aquaculture; Fish ponds.

Summary: A collection of papers on fish and shellfish environment management is presented, covering carp ponds, fresh-water ponds worldwide and in Europe, man-made reservoirs in India, microalgae culture and oyster culture in Japan.

Port of Tauranga investigation of sediments to be dredged in the lower town reach-upper Stella passage and disposal of at an inner shelf dump ground (1998)
Michels, K.; Healy, T. R.
Port of Tauranga

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga, Tauranga Harbour, Te Awanui, sediment, dredge, shipping lane, dump ground

Summary: The report investigates, the composition of sediments to be dredged from southerly wharf extension in the inner Stella Passage upstream from the present Sulphur Point wharves; and identify a suitable disposal ground on the inner shelf for the substantially muddy sediments expected in the area to be dredged in the future, together with any other dredged materials with a significant silt and clay content which do not comply for dumping in the present Port of Tauranga ocean disposal site. The report provides the scientific basis for an application by the Port of Tauranga to Environment Bay of Plenty for a resource consent to dredge the Tauranga harbour. The report concludes that dredged sediments contain considerable amounts of silt and clay and may cause high turbidity in the water column when dredged. Therefore, rather than using a trailer-suction dredge it was

thought to use a bucket. A new disposal area is also suggested in 32 meters of water. The disposal zone is situated well away from popular diving areas.

Evaluation of an inner shelf site off Tauranga Harbour, New Zealand, for disposal of muddy-sandy dredged sediments (1999)
Michels, Klaus H.; Healy, Terry R.
Coastal Education & Research Foundation, Inc

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga, Dredging, Tauranga Harbour

Summary: A planned extension of the Port of Tauranga requires capital dredging of material containing significant amounts of silt and clay. The existing disposal ground located about 4 km offshore in water depths of 15 to 25 m, is unsuitable as it was designed for slow migration of predominantly sandy materials onshore to nourish the adjacent beaches. Investigation for a new disposal site involved consideration of alternatives, but the "best practical option" selected was offshore of the existing ground in water depths of 28-33 m. Site research included side scan sonar imagery of the sea floor, sediment sampling by SCUBA diving, and deployment of a current meter for several weeks during the spring season to obtain background hydrodynamic data. Analysis of the data indicated that motion of medium to coarse sands occurs during periods of high swell conditions. Calculations of potential transport of discrete mud "clasts" suggest that small units may move under large waves but larger mud "clasts" would be stable. It is expected that the existing high disposal mound immediately shoreward of the proposed new disposal ground would hinder onshore migration of muddy clasts.

An early Holocene occurrence of the mangrove *Avicennia marina* in Poverty Bay, North Island, New Zealand: its climatic and geological implications (1987)
Mildenhall, D. C.; Brown, L. J.
New Zealand Journal of Botany

Spatial Information: Poverty Bay, North Island, New Zealand
Keywords: Avicennia marina var. resinifera, Avicenniaceae, pollen analysis, pollen morphology, Quaternary, postglacial, paleclimate, paleoenvironments, sea level, climatic optimum, coastal geomorphology, radiocarbon dates, Poverty Bay, East Cape

Summary: Pollen evidence indicates that the mangrove *Avicennia marina var. resinifera* (Forst. f.) Bakh.*(Avincenniaceae)* once occurred in Poverty Bay, and its presence is used as evidence for warm climate following the last glaciation. Radiocarbon dates indicate a maximum of 9840 ± 190 years B. P. (NZ 6309B)* for this warm climate event, coinciding with the Holocene climatic optimum. The mangrove is currently found c. 1° further north in the Bay of Plenty.
The climatic implications of the pollen data when considered with macrofaunal determinations, sediment lithologies, depositional environments, and radiocarbon associated with the postglacial rise in sealevel, local tectonic activity, and the concomitant change in coastal geomorphology. A full description of the pollen of extant *Avicennia marina var. resinifera* is presented.

Ecosystems and Human Well-being: A Framework for Assessment (2003)
Millennium Assessment
Island Press

Spatial Information: No spatial context
Keywords: Ecosystems, Human well-being

Summary: Ecosystems and Human Well-Being is the first product of the Millennium Ecosystem Assessment, a four-year international work program designed to meet the needs of decision-makers for scientific information on the links between ecosystem change and human well-being. The book offers an overview of the project, describing the conceptual framework that is being used, defining its scope, and providing a baseline of understanding that all participants need to move forward.The Millennium Assessment focuses on how humans have altered ecosystems, and how changes in ecosystem services have affected human well-being, how ecosystem changes may affect people in future decades, and what types of responses can be adopted at local, national, or global scales to improve ecosystem management and thereby contribute to human well-being and poverty alleviation. The program was launched by United Nations Secretary-General Kofi Annan in June 2001, and the primary assessment reports will be released by Island Press in 2005. Leading scientists from more than 100 nations are conducting the assessment, which can aid countries, regions, or companies by:

- providing a clear, scientific picture of the current state of Earth's ecosystems at multiple scales
- deepening our understanding of the relationship and linkages between ecosystems and human well-being, including economic, social and cultural aspirations
- demonstrating the potential of ecosystems to contribute to poverty reduction and enhanced well-being
- offering scenarios of our future human and ecological well-being
- identifying and evaluating policy and management options for sustaining ecosystem services and harmonizing them with human needs

The Millennium Assessment is an invaluable new resource for professionals and policy-makers concerned with international development, environmental science, environmental policy, and related fields. It will help both in choosing among existing options and in identifying new approaches for achieving integrated management of land, water, and living resources while strengthening regional, national, and local capacities. It will also improve policy and decision-making at all levels through improved collaboration between natural and social scientists, and between scientists and policy-makers. Ecosystems and Human Well-Being is an essential introduction to the project.

Seagrass *(Zostera muelleri)* patch size and spatial location influence infaunal macroinvertebrate assemblages (2009)
Mills, V. Sadie; Berkenbusch, Katrin
Estuarine, Coastal and Shelf Science

Spatial Information: South-eastern New Zealand

Keywords: macrofauna; Plants; sea grass; environmental factors; grain size; New Zealand; Papanui Inlet; Otago Harbour, eel grass, *Zostera*

Summary: Seagrass landscapes are coastal environments that support diverse and abundant faunal communities. This study investigated infaunal assemblage patterns in fragmented and continuous *Zostera muelleri* habitat in south-eastern New Zealand. Intertidal macroinvertebrate assemblages were examined in fragmented seagrass habitat (containing discrete patches varying in size from 1 to 200 m^2) and continuous meadows (>1000 m^2), in a small and a large tidal inlet. Community indices differed between seagrass habitat types and the total number of taxa was significantly lower at fragmented seagrass sites in one of the inlets. The total number of individuals and diversity were significantly different between fragmented and continuous seagrass habitat in both inlets, but diversity values showed inconsistent patterns between inlets. Multivariate analysis confirmed that different seagrass habitat types support distinct macrofaunal assemblages in each inlet and position on the shore was identified as the single most important variable explaining dissimilarities in assemblage compositions. These findings confirm the influence of seagrass habitat size on infaunal assemblages and also highlight the importance of spatial position of seagrass habitat in intertidal areas.

The state of New Zealand's environment (1997)
Ministry for the Environment
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: deforestation, wetland drainage, introduction of pests and weeds, pollution, soil erosion, flooding, soil and water contamination, air pollution

Summary: This report to the nation describes New Zealand's natural environment, what we have done to it, and what we are doing now. It is written in the hope that, confronted by the available evidence, we can learn both from our successes and from our failures. In the short time that humans have been in New Zealand, we have dramatically changed the environment through such activities as harvesting, deforestation, wetland drainage, the introduction of pests and weeds, and the generation of pollution. The changes have generally led to economic improvement, but have been devastating for many indigenous species. In some cases, they have also had an economic backlash (e.g. through soil erosion, flooding, soil and water contamination and air pollution). It has to be said at the outset that much of this had to happen. Humans simply could not have survived here without making changes. Most of the indigenous plants were of limited use for food and fibre and most of the large edible animals were too slow breeding to be sustainably harvested. It is a tribute to the ingenuity and tenacity of classical Maori society that people survived here at all, and it is a tribute to the European settlers who came later that a prosperous and stable economy was built in such an apparently hostile environment. Today's New Zealand stands largely on the achievements of those vanished generations.

Environmental indicators for the sustainable management of freshwater (1997)
Ministry for the Environment
Ministry for the Environment

Spatial Information: No spatial context

Keywords: Environmental indicators, freshwater

Summary: The Ministry for the Environment is developing a core set of nationally standardised environmental indicators that will help to assess the state of the environment and help to monitor the effectiveness and suitability of regional and national environmental policy and legislation including the Resource Management Act (RMA) 1991 and the Government's Environment 2010 Strategy (MfE, 1995). Indicators will also help to monitor the effectiveness and suitability of regional policies and resource management methods. The purpose of this report is to suggest an approach to, and some examples of, indicators for the sustainable management of freshwater.

Summary of Proposed Indicators for the Marine Environment (1998)
Ministry for the Environment
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: Marine resources conservation New Zealand, Coastal zone management New Zealand, Environmental indicators New Zealand, Environmental policy New Zealand, New Zealand, Environmental Performance Indicators Programme, Plant, Sea grass, eel grass, *Zostera*

Summary: The overall purpose of the EPI Programme is to develop and use indicators to measure and report how well we are looking after our (marine) environment.

The Government's objectives for the EPI Programme are:

- To systematically measure the performance of its environmental policies and legislation
- To better prioritise policy and improve decision making
- To systematically report on the State of New Zealand's environmental assets.

Sea grasses are an important environmental indicator.

Environmental Performance Indicators: Marine Environment Potential Indicators for Physical and Chemical Processes, and Human Uses and Values (1998)
Ministry for the Environment
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: New Zealand. Environmental Performance Indicators Programme. Marine resources conservation New Zealand, Coastal zone management New Zealand, Environmental indicators New Zealand, Environmental policy New Zealand, Plants; Sea grass, eel grass, *Zostera*

Summary: The Ministry for the Environment is currently developing a comprehensive suite of indicators for assessing the state of our environment and measuring progress towards implementing the government's strategy on the environment (Environment

2010). This report provides technical information on potential indicators for the marine environment specific to:

- Physical and chemical processes; and
- Human uses and values.

The report covers those indicators that were proposed by working groups and recommended to the Minister of Environment at the end of June 1998, as being worthy of further development. There was further analysis of these potential indicators before publication of the discussion document Environmental Performance Indicators: Proposals for the marine environment. Consequently there are some differences between the potential indicators described in this document and those proposed in the discussion document.

Environmental Performance Indicators: Confirmed Indicators for the Marine Environment (2001)
Ministry for the Environment
Ministry for the Environment

Spatial Information: New Zealand
Keywords: New Zealand. Environmental Performance Indicators Programme.; Marine resources conservation New Zealand.; Coastal zone management New Zealand.; Environmental policy New Zealand.; Plants; Sea grass

Summary: This report confirms the environmental performance indicators (EPIs) for the marine environment. It explains how indicators were modified following submissions received to the draft discussion document (Environmental Performance Indicators: Proposals for the marine environment, MfE 1998a), identifies roles for each EPI, and provides detailed monitoring and reporting requirements. Finally, it canvasses the steps involved in implementing the indicators. The key audience for this report will be those implementing and reporting on these indicators, including regional councils, territorial local authorities, industry/commercial operators and, some central government departments.

Managing Waterways on Farms - A Guide to Sustainable Water and Riparian Management in Rural New Zealand (2001)
Ministry for the Environment,
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: water quality, rural land use effects, management, erosion, riparian, run off, sedimentation

Summary: This document is primarily a reference manual for those who advise farmers and foresters in how they manage their land. However, it is also strongly recommended that landowners themselves read it in order to understand how forestry and farming has profound effects on our land and water resources. It does this by providing background information about the sources, causes and processes involved with the deterioration of streams in farmed catchments and the consequences of that deterioration.Riparian areas are those which adjoin water bodies, such as streams, rivers and lakes. Riparian vegetation shades and feeds the

stream, protects its banks and filters water passing through it: “the valley rules the stream”. Appropriate riparian management is vital to maintaining the quality and biodiversity of our water bodies. Those not benefiting from such management exhibit degraded biodiversity and water quality unsuitable for many desired uses such as swimming, water supplies and, in some case, even for stock watering.The authors recognise that the focus of land management should be on how one directly crops, however many of the ‘inevitable’ impacts of farming and forestry can be buffered by effective riparian management.

Coastal hazards and Climate Change: A guidance manual for local government in New Zealand (2004)
Ministry for the Environment
Ministry for the Environment

Spatial Information: New Zealand
Keywords: Climate change, coastal hazards, sea level, erosion, tsunami

Summary: Climate change will not introduce any new types of coastal hazards, but it will affect existing hazards. Coastal hazards in many areas are expected to increase as a result of the effects of climate change. As development of coastal areas and property values increase, the potential impacts of coastal hazards increase. There is increasing confidence in the predictions of the effects of climate change. Sea level has risen in New Zealand by about 0.25 m since the mid-1800s (historical sea-level rise has been approximately 0.16 m per century), and this rise is expected to accelerate. Under the most likely mid-range projections, sea level is projected to rise a further 0.14 - 0.18 m by 2050, and 0.31 - 0.49 m by 2100. In developing scenarios, it is recommended that at least the most likely mid-range scenario for sea-level rise is used: it is recommended that council staff use a figure of 0.2 m by 2050 and 0.5 m by 2100 when considering sea-level rise in projects or plans. Sea-level rise and other climate change effects, such as increased intensity of storms and changes in sediment supply to coastlines, are expected to modify coastal hazards in many areas around New Zealand. Because climate change effects are very gradual, land-use planning decisions must have long-term horizons to accommodate the lifetimes of structures. It is vital that planning occurs now for climate change effects, particularly where decisions are being made on issues and developments that have planning horizons and life expectancies of 50 years or more. This Guidance Manual is intended to help local authorities manage coastal hazards by: providing information on the effects of climate change on coastal hazards; presenting a decision-making framework to assess the associated risks; providing guidance on appropriate response options. Three main types of coastal hazard are addressed: coastal erosion caused by storms and/or long-term processes; coastal inundation caused by storms or gradual inundation from sea-level rise and coastal inundation caused by tsunami.

A Beginner's Guide to the 2004 Aquaculture Law Reforms (2005)
Ministry for the Environment
Ministry for the Environment

Spatial Information: Marlborough Sounds, Northland and Coromandel Peninsula - NZ
Keywords: aquaculture, 2004 reform, guide

Summary: Before the 1990s, marine farming was a reasonably small industry in New Zealand, with small farms dotted around the coast, mostly in the Marlborough Sounds, Northland and around the Coromandel Peninsula. Over the next 10 years, marine farming took off and demand for water space increased five-fold. The clean and nutrient-rich waters of New Zealand were rightly recognised as a great place to grow quality seafood. By 2000, it had become clear that the existing ways of managing marine farming could not cope with this demand. There were two main complaints: marine farmers wanting new space were unhappy because of the delays and the costs in processing their resource consent applications; and communities were raising concerns that the possible effects of marine farming were not being fully recognised and managed. So, changes began, ending up with the Aquaculture Law Reform, which came into effect on 1 January 2005. The changes aim to get a balance between four things: (1) enabling economic development, (2) looking after the environment, (3) settling the Crown's Treaty obligations to Maori, and (4) responding to community concerns.

Aquaculture Reform 2004 - Settling Maori Claims (2005)
Ministry for the Environment
Ministry for the Environment

Spatial Information: No spatial context
Keywords: aquaculture, 2004 reform, Maori claims

Summary: This document is an information sheet that explains the Maori Commercial Aquaculture Claims Settlement Act 2004. The Maori Commercial Aquaculture Claims Settlement Acts 2004 provides a full and final settlement of Maori commercial aquaculture interests since 21 September 1992. It allows the marine farming industry to continue to grow without risk of litigation relating to contemporary Treaty grievances, and ensures iwi access to coastal marine space to develop their marine farming interests.There are two sets of obligations to the settlement:

- The Crown must provide the Maori Commercial Aquaculture Settlement Trust with the equivalent of 20 percent of 'existing' aquaculture space in the coastal marine area, issued on or after 21 September 1992. These provisions will be made on a region-by-region basis except on those harbours identified by the Second Schedule of the Maori Commercial Aquaculture Claims Settlement Act 2004 (which includes Tauranga Harbour). The allocation of these harbours is calculated and provided separately.
- The Crown can provide this space using one of three methods:

    1. Using up to 20 percent of any new AMA space
    2. Buying the required additional aquaculture space on a willing-buyer/willing-seller basis
    3. Financial equivalent

- 20 percent of all new aquaculture space identified in the coastal marine area is required to be transferred to iwi, via the Maori Commercial Aquaculture Settlement Trust.
- The space provided should be representative of:
    1. Each farming type covered by the rules on the AMA's plan, and
    2. The overall productive capacity of the new space.

It should also be of economic size. The Maori Commercial Aquaculture Settlement Trust then distributes space to iwi. If any party is unhappy with a council's identification of the space in the AMA set aside for iwi, they can appeal this to the Environment Court. The process of iwi to apply for coastal permits, and the permits themselves (as for any other marine farm developer) are subject to general Resource Management Act 1991 requirements. Maori will also be able to make claims for non-commercial marine farming customary use rights under the foreshore and seabed legislation.

Allocation to Iwi: Before the trustee can distribute the aquaculture rights (or financial equivalent), iwi must establish aquaculture organisations to receive these settlement assets. These will be the same mandated iwi organisations established under the Maori Fisheries Act to receive fisheries assets under the 1992 Fisheries Settlement, but they must also have been authorised by their iwi members to receive aquaculture assets under the aquaculture settlement. Iwi then have twelve months to reach written agreement over how their region's aquaculture settlement assets will be divided. If an agreement cannot be reached, the assets will be allocated on the basis of iwi claims to coastline length in the relevant region or, in specified harbours in the Act, based on agreement among iwi whose rohe abuts the harbour. The final topic area of this document discusses the specific tasks of the Ministry of Fisheries in this settlement.

Aquaculture Reform 2004: The Rules of the Game - Creating Aquaculture Management Areas (2005)
Ministry for the Environment
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: aquaculture, 2004 reform, aquaculture managementareas, AMA, rules, New Zealand

Summary: This document is an information sheet explaining the aquaculture planning provisions introduced by the aquaculture reform in the Resource Management Amendment Act (No. 4) 2004. The reform introduces Aquaculture Management Areas (AMAs) as a planning tool in regional coastal plans. AMAs are defined as 'coastal management tools to address the cumulative effects of aquaculture'. From January 2005, new marine farms are only able to occur within an AMA. All new and existing marine farms are to be managed under this regime. During the transitional period (moratorium) into this new regime, certain existing marine farm leases and licences, RMA permits, RMA regional coastal plans and some existing applications were deemed as AMAs or 'Interim AMAs'. (For more information about this period see the MfE information sheet entitled Aquaculture Reform 2004 – From the Old to the New – Moving to the New Regime). More specific topic areas covered in this information sheet are:

- What are AMAs and why do we have them?
- What will AMAs look like?
- The AMA process including testing the effects on fishing and the Minister of Conservation's approval
- Private plan changes
- The role of territorial authorities
- Allocating space in AMAs

Some relevant key points are:

- In preparing AMAs, councils are required to address the effects of aquaculture on the environment, fisheries resources and other uses of the coastal marine area, and to consider their effects on commercial, customary and recreational fishing.
- Not all councils need to identify new AMAs in their regional coastal plan, for example, if marine farming is not viable and/or appropriate in the region.
- Councils may remove or modify existing AMAs though a plan change. An activity authorised by a consent can continue until the end of the fixed term for that particular consent, regardless of what happens to the AMA. The AMA only matters when a marine farmer wants to renew the consent or change it.
- Councils cannot notify their coastal regional plan of an AMA until the Ministry of Fisheries has performed an 'Undue Adverse Effects test' on fishing within the proposed area. The test primarily looks at the extent and type of fishing at the site, and what alternative sites are available if the proposed AMA goes ahead.
- Councils apply to the Minister of Conservation to have their proposed regional coastal plans, including new AMAs, approved. Only when they get this approval does the plan become operative. Once this happens, they can start receiving applications for coastal permits within the new AMA(s).
- The private plan change is an alternate route to create new AMAs. It gives individuals and/or industry the option to identify potentially suitable aquaculture areas when doing so is not a priority for a regional or unitary council at the time. A council can specify where it will accept Private Plan Change applications, and identify maximum sizes for an AMA. The flow diagram on page four sums up the AMAs establishment process well.

Environment New Zealand (2007)
Ministry for the Environment
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: New Zealand land, water, air, plants and animals; Impacts of transport, energy, waste.

Summary: This report is the second national-level state of New Zealand's environment report. It takes the pulse of the physical well-being of New Zealand's land, water, air, plants and animals and measures the impact of transport, energy, waste, and our consumption on the environment. It identifies trends in and selected pressures on our natural resources. It introduces benchmark environmental indicators as well as 80 specific measures, to capture hard data which will be used to build up a clear picture of trends and pressures over time.

A Quick Guide to Establishing and Operating a Marine Farm in New Zealand (2009)
Ministry for the Environment

Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: aquaculture, 2004 reform, marine farm, aquaculture management areas, AMA,

Summary: This guide has been developed by the New Zealand government to help marine farmers know where to go for information regarding the setting up and operating of a marine farm and key contact information. The opening chapter refers to how one goes about applying for a marine farm. It covers the AMA process, the resource consent process and fish farmer registration. Key points are:

- AMAs are provided for under a regional coastal plan and any person wishing to establish a marine farm must apply and obtain a resource consent within the AMA and register your marine farm with the Ministry of Fisheries' Fish Farming Register.
- The Ministry for the Environment's website (www.mfe.govt.nz) has information about the Resource Management Act 1991 and the Aquaculture Reform 2004: The Rules of the Game – Creating Aquaculture Management Areas which provide more in depth information about setting up a marine farm.
- Previous leases and licences granted under the Marine Farming Act have been grandfathered into the RMA and are valid until 31 December 2024.
- An application for registration or a variation of a fish farmer's registration can be obtained at FishServe www.fishserve.co.nz or (04) 460 9555.

The next chapter outlines the role of the Maori Commercial Aquaculture Settlement Act 2004 plays in establishing marine farms. Key points are:

- The settlement requires the government to provide Iwi Aquaculture Organisations (IAOs) with 20 percent of all new aquaculture space (within the AMAs). This space is provided to IAO through the Maori Commercial Aquaculture Settlement Trust (the Takutai Trust) which is managed by the Te Ohu Kaimoana Trustee Limited.
- Allocation is done on a region-by-region basis and is centred around the jurisdictions of regional councils and unitary authorities as well as by the harbours that have been identified by the second schedule of the Maori Commercial Aquaculture Claims Settlement Act.

Chapter three discusses the codes and regulations that one needs to comply with when building new structures or modifying structures on their marine farm. The two main directives are:

- The Maritime New Zealand Guidelines for Aquaculture Management Areas and Marine Farms. These guidelines are in relation to navigation-related matters. They can be found on Maritime New Zealand's website: www.maritimenz.govt.nz .
- The Building Act 2004. Aside from onshore facilities, for example warehouses and processing plants, there are also some structures in the water that may need to comply with the Building Act and the Building Code. More information

can be found on the Department of Building and Housing's website: www.dbh.govt.nz .

Chapter four relates to food safety regulations on aquaculture products. These are managed by the New Zealand Food Safety Authority (NZFSA) with the cooperation of their public health agents in district health boards and the shellfish industry.

There are separate standards for shellfish and finfish. This is because shellfish commonly farmed are filter feeders, meaning they may accumulate concentrations of any microbial, chemical or marine biotoxin contaminant present in the water. Furthermore, many shellfish are often eaten raw without removal of the gut, thus food safety regulations require that they are harvested from clean and safe waters. New Zealand's mandatory shellfish food safety programme is based on international best practise. They include regular monitoring requirements, measuring levels of microbial, chemical, phytoplankton and marine biotoxin levels in the water and the shellfish. For full details of this programme refer to Animal Products (Regulated Control Scheme – Bivalve Molluscan Shellfish) Regulations 2006 and the Animal Products (Specifications for Bivalve Molluscan Shellfish) Notice 2006. These are both available on the NZFTA website: www.nzfta.govt.nz . Furthermore, the processing of commercially harvested seafood must be done in a processing environment that meets the NZFSA's strict hygiene standards.

Chapter five discusses concerns about external sources of water pollution to marine farms, including discharges from vessels and marine oil spills. Chapter six examines biosecurity issues and refers to the Biosecurity Act 1993. More information about this can be found on www.biosecurity.govt.nz . There is also a note about levies and additional fees pertaining to marine farmers, such as water quality levies, port charges and council administration fees. Under the Commodity Levies Act, all commercial growers of mussels, oyster and salmon pay a levy per tonne of product harvested. The User's Guide to the Commodities Levies Act and the Seafood Industry Council site provides additional information. Chapter seven talks about the roles of related national industry organisations in New Zealand, such as Aquaculture New Zealand Ltd (AQNZ) and the New Zealand Seafood Industry Council Ltd as well as industry codes of practice.Finally, a list of key contacts for each regional council in New Zealand, as well as central government and industry contacts.

Aquaculture Reform Regulatory Impact Statement (2010)
Ministry for the Environment; Ministry of Fisheries; Ministry of Economic Development
Ministry of Fisheries

Spatial Information: No spatial context
Keywords: aquaculture, 2010 reform,

Summary: The aquaculture industry has potential to contribute significantly to New Zealand's future economic growth. The aquaculture legislation creates significant barriers to this potential, and this paper assesses options for reform. The 2004 aquaculture reforms, and prior moratoria, were a response to high and scattered demand for aquaculture space. The 2004 reforms prohibited aquaculture outside Aquaculture Management Areas (AMA) - a new tool that combined RMA planning zones, an aquaculture settlement and an assessment of the effects of new aquaculture on existing fishing (the UAE test). The rationale for this model was that upfront planning for aquaculture would focus development in a manageable way. The

legislation has overcorrected beyond what is needed to manage high demand and has placed significant barriers to new aquaculture. The legislation is extremely complicated, and the incentives lie in the wrong place, as industry in most cases need to wait for councils to initiate aquaculture planning before they can apply for consents.The objectives of this aquaculture reform are:

1. Reduce cost, delays and uncertainty with the aquaculture regulatory process
2. Promote investment in aquaculture development
3. Integrate decision making

Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (2003)
Ministry for the Environment, Ministry of Health
Ministry for the Environment and the Ministry of Health (New Zealand)

Spatial Information: New Zealand wide
Keywords: water quality, New Zealand, guidelines, microbiological, marine, freshwater, recreation,

Summary: The guidelines are a risk-based approach for councils to monitoring water quality promoted by the WHO and with consultation with regional councils, territorial local authorities and public health agencies. Main sections include: Introduction, framework for monitoring and guidelines for recreational water quality in: a) marine b) freshwater c) shellfish-gathering waters. All are applicable to Tauranga Harbour and its contributories (i.e. rivers and streams in the Tauranga Harbour catchment). The guidelines for assessing the public health risk of using recreational waters use a combination of qualitative risk grading of the catchment, supported by the direct measurement of appropriate faecal indicators (which indirectly tell us about the level of pathogens). In addition, alert and action guideline levels are used for surveillance throughout the bathing season (generally Nov 1- March 31). The preferred indicator pathogen measured in freshwater systems is *Escherichia coli,* while enterococci are preferred in marine waters. Thus, in estuarine waters BOTH are measured. If the primary source of contamination in marine water body is from a waste stabilisation pond (WSP), *E. Coli* rather than enterococci should be used as an indicator as enterococci are damaged in WSPs, are inactivated in receiving water faster and are less sunlight resistant. Additionally, it is noted that enterococci may be derived from other sources than faecal ones, such as sub-tropical temperatures, the influence of mangrove swamps and freshwater run-off from dense vegetation.

From the combination of the catchment risk grading and faecal indicator monitoring, Suitability for Recreation Beach Grade (SFRG) is reported. The risk of becoming sick from swimming at a beach increases as the beach grades shift from Very Good to Very Poor. The SRFG is applicable for up to five years, provided there are no significant changes within the catchment that may affect water quality. Conditions affecting water quality vary for the middle range beaches (Good, Fair and Poor). For example, ‘Good’ beaches usually comply with the guidelines, but events such as high rainfall increases the risk of contamination levels from run-off. It is advised that weekly monitoring should be carried out during the bathing season for the above middle-range beaches. This monitoring is categorised via a three-tier traffic light system. For beaches graded Very Good, the guidelines state that ongoing monitoring may not be required because of the low risk identified. [What happens if a ‘significant change’ occurs within the water bodies catchment and contamination goes by for a

period of time undetected; which could have been prevented?] Similarly, beaches graded Very Poor may not require ongoing monitoring as they will generally be unsuitable for recreational use.

The public is to be informed when swimming is not recommended. For marine guidelines, when two consecutive samples taken from the beach exceed the action level of the microbiological water quality guidelines; for freshwater, when one sample exceeds the action level. This is because the dilution factor is likely to be less for freshwaters than marine, resulting in more extreme exceedances. Secondly, potentially higher concentrations and a greater range of pathogens may be present in freshwaters.

Biosecurity Magazine, 89 (2009)
Ministry of Agriculture and Forestry; Biosecurity NZ
Ministry of Agriculture and Forestry, Biosecurity NZ

Spatial Information: New Zealand wide
Keywords: invasive species

Summary: Biosecurity is published six-weekly by MAF Biosecurity New Zealand. It is of special interest to all those with a stake in the protection of New Zealand's economic, environmental and social assets from the dangers posed by pests and diseases. Animal welfare issues are also covered. The articles in this magazine do not necessarily reflect government policy.

New Technologies and approaches to biosecurity; New Zealand Biosecurity summit (2008)
Ministry of Agriculture and Forestry; Biosecurity NZ
Ministry of Agriculture and Forestry

Spatial Information: New Zealand wide
Keywords: Biosecurity

Summary: Since 2003, Biosecurity New Zealand has convened a Biosecurity Summit for all biosecurity stakeholders each year in November. These include about 250 representatives from Central, Regional, and Local Government, importers and exporters, industry, tertiary institutes, the science community, pest management companies, community groups, and more. 'New Technologies & Approaches to Biosecurity' is the theme for the Sixth New Zealand Biosecurity Summit which is to be held from the 4th to the 5th November 2008 in Christchurch. This summit will look at new approaches to biosecurity and technologies that deliver efficiencies to the supply chain whilst improving biosecurity. Key note speakers from the United States will share an international perspective on the latest technologies and explore New Zealand's ability to deliver not only biosecurity but also importers, exporters and growers. Presentations include a look at how social and cultural change impacts on biosecurity; new approaches to pest detection, management, and control; and a review of progress with implementation of the Biosecurity Strategy.

Aquaculture: proposed policy and legislation (1989)

Ministry of Agriculture and Forestry; Ministry of Fisheries
Ministry of Agriculture and Forestry and Ministry of Fisheries

Spatial Information: New Zealand wide
Keywords: Aquaculture Law and legislation New Zealand, Aquaculture Government policy New Zealand.

Summary: The government supports well-planned and sustainable aquaculture growth in New Zealand and is committed to enabling industry to achieve its goal of $1 billion in annual sales by 2025. An essential part of this commitment is to ensure aquaculture growth takes place within acceptable environmental limits and respects other uses and values of our waterways and marine environment. Also to provide advice on policy development to promote new frameworks aimed at enabling New Zealanders to get the best value from the sustainable and efficient use of fisheries and to ensure the Crown delivers on its obligations to Maori with respect to fisheries.

Our blue horizon He pae kikorangi: the government's commitment to aquaculture (2007)
Ministry of Economic Development
Ministry of Economic Development

Spatial Information: New Zealand wide
Keywords: Aquaculture Government policy New Zealand.; Aquaculture industry Economic aspects New Zealand.

Summary: The New Zealand Aquaculture Industry is currently (2007) worth over $300 million to our economy, with an aim of being a sustainable billion dollar industry by 2025. The focus of this growth is to be on sustainable, high value, innovative products that meet the needs of increasingly sophisticated world markets. The purpose of this report is to explain how the government and the New Zealand aquaculture industry aims to do this.
The government’s commitment to aquaculture is built on five key objectives:

1. Building the confidence to invest
2. Improving public support
3. Promoting Maori success
4. Capitalising on research and innovation
5. Increasing market revenues

Within each of these objectives the government has identified a number of targeted initiatives which were their initial commitments for aquaculture 2007-2010.

Details of the Maori commercial aquaculture claims settlement (2006)
Ministry of Fisheries
Ministry of Fisheries

Spatial Information: New Zealand wide
Keywords: New Zealand.; Aquaculture Law and legislation New Zealand.; Maori Claims.; Aquaculture industry New Zealand.; Taunga ika.; Ika.; Kaimoana; Ture.

Summary: The Maori Commercial Aquaculture Claims Settlement Act 2004 provides a "full and final settlement" of all Maori claims (current and future) over commercial marine farming in the coastal marine are, from 21 September 1992 onwards.
The Act contains the framework for providing aquaculture settlement assets to iwi.
In 2007, the Minister of Fisheries will begin reviewing the Crown's progress towards completing its settlement obligations, and consult with iwi over how further progress will be made. Any claims relating to marine farming space created before September 1992, and/or omissions of the Crown should be addressed through the Treaty of Waitangi historical claims settlement process.

Fisheries Plan, North-East Shellfish (2007)
Ministry of Fisheries
Ministry of Fisheries

Spatial Information: New Zealand's North-East coast
Keywords: shellfish fisheries, Fisheries Management Area, Maximum Sustainable Yield, biological diversity, Marine Protected Area

Summary: This plan considered the fisheries management issues relating to the shellfish fisheries of New Zealand's North-East coast. It attempted to identify the values tangata whenua and stakeholders place on the shellfish resources of the North-East coast and then, through a collaborative process, determining how to balance these different interest so that the value of the fisheries can be maximised. The major purpose of the plan was to set objectives that reflect these values and then put in place process and procedures to achieve them. Geographically, the plan covered Fisheries Management Area 1 (FMA 1) of North-East coast. It included a wide range of species, with a focus on a small number of key species such as cockle, green-lipped mussel, scallop, kina, pipi and tuatua. The plan provided a brief overview of the current status of the species biology, their habitat and fisheries, and discussed future management issues in terms of Maximum Sustainable Yield (MSY), Total Allowable Catch (TAC), biological diversity, Marine Protected Area and impacts of catchment activities.

Mount Maunganui and Tauranga Harbour Mataitai (2008)
Ministry of Fisheries
Ministry of Fisheries

Spatial Information: Mount Maunganui and Tauranga Harbour, New Zealand
Keywords: Mataitai Reserve, Mount Maunganui, Tauranga Harbour, Bay of Plenty, Kaimoana Customary Fishing Regulations, traditional Maori fishing grounds, customary food gathering, Tauranga Moana, Ngai Te Rangi, Ngati Ranginui, Ngati Pukenga

Summary: A mataitai reserve over waters surrounding Mt Maunganui and part of Tauranga Harbour in Bay of Plenty is to be established, Fisheries Minister Jim Anderton said today (2008). Mataitai Reserves are authorised under the Kaimoana Customary Fishing Regulations and recognise traditional Maori fishing grounds that are important for customary food gathering. They also allow the local Tauranga Moana iwi– Ngai Te Rangi, Ngati Ranginui and Ngati Pukenga, to advise the Minister of Fisheries directly on how best to manage fishing in the local area. Jim Anderton said this Mataitai reserve would allow the Tauranga Moana iwi to more effectively manage customary fishing in important traditional fishing grounds. "The reserve

recognises the strong and enduring connection the hapu has with this area." Commercial fishing will be banned within the six km^2 Mataitai reserve but recreational and customary fishing will still be allowed. Recreational fishing will not require a permit from local Maori. Jim Anderton said the Mt Maunganui Mataitai reserve would have no effect on the local community's ability to go fishing or gather shellfish under the existing recreational allowances. However, the current temporary closure to the take of green-lipped mussels between Moturiki and Motuotau Islands would remain in place until it expires on 6 December 2009. In the future, the Tangata Tiaki/Kaitiaki (guardians) for the Mataitai reserve may recommend bylaws to the Minister of Fisheries that could impose some restrictions within the boundaries of the mataitai reserve. Any such restrictions would apply equally to everyone fishing within the Mataitai reserve. Customary seafood gathering for Maori cultural purposes would be governed by authorisations issued by appointed guardians (rather than recreational regulations), as is currently the case for customary fishing around many areas of the North Island. Jim Anderton said that as Minister, he was ultimately responsible for all New Zealand's fisheries, and must carefully consider any fishing restriction recommended by the guardians and must approve them before they come into effect. "I carefully considered the effect the Mataitai reserve would have on commercial fishers. I recognise that the Mataitai reserve will affect some, but overall, I do not believe those effects will prevent them from taking their catch entitlements." The Mataitai reserve will come into effect on the 25th September 2008. The proposal for this mataitai reserve was extensively consulted on with the local community including two separate calls for written submissions, two public meetings and direct discussions with local Maori.

Auckland and Kermadec Fishery Management Area Recreational fishing rules (includes Northland, Waikato and the Bay of Plenty) (2009)
Ministry of Fisheries
Ministry of Fisheries

Spatial Information: Northland, Waikato, Auckland and the Bay of Plenty – New Zealand
Keywords: macroinvertebrates

Summary: Fishing is one of New Zealand's most popular recreational activities. Every year a large number of finfish, rock lobster and shellfish are taken by recreational fishers. This can seriously affect local fisheries. This means it is important for all fishers to act responsible and help conserve the resource.
Know the limits: Commercial fishers must have a current fishing permit and are subject to strict quotas or limits on how much they can catch, along with many other controls. The restrictions on recreational fishers are relatively simple. The three main things to remember are:

- Don't take more than the daily limit.
- Don't take undersized fish
- Don't sell or trade your catch

Only those people physically involved in taking finfish, rock lobster, or shellfish are entitled to claim a catch within the daily limit. You should also be aware of the restrictions on the fishing gear and methods you can use

Report for the Fisheries Assessment Plenary, May 2010: Stock assessments and yield estimates (2010)
Ministry of Fisheries
Ministry of Fisheries

Spatial Information: New Zealand wide
Keywords: macroinvertebrates

Summary: This is part of the report for the fisheries assessment plenary, May 2010: Stock assessments and yield estimates, which describe fisheries status of commercially exploited species in New Zealand. This part of the report provides information of the fisheries status, general biology of Kina. Data on the commercial fisheries, such as the historical catch statistics and the corresponding TACC are presented by Quota Management Areas. There are generally no reliable estimates of recreational catches except for that of SUR 2. There is an important customary non-commercial harvest of kina by Maori for food. Where data are available, only small catches of kina have been reported under the customary non-commercial harvest provisions of the Fisheries Act 1996. In SUR 3, 5, and 7, all catches were less than 1 t per year. However, these catch estimates are probably under-estimates as an unknown proportion of the kina harvested by Maori is caught outside of taiapure or mataitai and not recorded as customary non-commercial harvest. No data are available for other regions of New Zealand.

Aquaculture Reform Questions and Answers (Paper 2) (2010)
Ministry of Fisheries
Ministry of Fisheries

Spatial Information: Tasman and Waikato region, New Zealand
Keywords: aquaculture, 2010 reform,

Summary: The July 2010 decisions focus on transitioning existing marine farms and applications to the new regulatory regime, including how to achieve the reform objectives through regional coastal plans. Key matters covered include:

- The transition to the new law of existing marine farms, the outstanding applications lodged under previous law and the interim Aquaculture Management Areas in Tasman and Waikato
- Amendments to the Tasman and Waikato regional coastal plans to enable applications to be made for finfish farming
- New funding for Resource Management Act plan changes and related activities to support sustainable aquaculture development
- Future progression of the Aquaculture Legislation Amendment Bill (No 2)
- Planning and consenting issues, including allocation tools, and streamlined re-consenting processes.

Aquaculture Reform Questions and Answers (Paper 1) (2010)
Ministry of Fisheries
Ministry of Fisheries

Spatial Information: New Zealand wide
Keywords: aquaculture, 2010 reform

Summary: Why is the government reforming the aquaculture regime?
There are significant opportunities for the sustainable development of New Zealand's aquaculture industry. The government is committed, as part of its Economic Growth Agenda, to enabling that growth. It fully supports the aquaculture industry's goal of generating annual sales of $1 billion by 2025, a three-fold increase on the current sales level. This is about building the economy, creating more jobs and getting more people into work, particularly in the regions. No new aquaculture space has been created since the current regime came into effect five years ago. There is a lack of incentives for local government to plan for aquaculture space and for industry to invest. What is the aim of the reforms?

- Reduce costs, delays and uncertainty with the regulatory process for aquaculture by providing an efficient regulatory framework that enables the sustainable development of aquaculture;
- Promote investment in aquaculture development; and
- Enable integrated decision-making that balances aquaculture with other marine interests.

What are the main proposals?

- A more active role for central government which clearly signals the government's interest in and objectives for aquaculture. Initiatives include:
- identifying a Minister with overall responsibility for aquaculture (the Minister of Fisheries and Aquaculture, Hon Phil Heatley);
- establishing an aquaculture business unit within the Ministry of Fisheries to be the government's principal advisor on aquaculture and lead implementation of the reforms;
- more effective use of current mechanisms including "call in" powers;
- new measures to support sustainable aquaculture development including a power enabling the Minister to amend regional coastal plans in exceptional circumstances where it is in significant regional or national interest (this measure was initially agreed "in principle" and was confirmed in July 2010).
- Reform of Resource Management Act planning and consenting processes for aquaculture to reduce costs, shorten timeframes, create certainty and build investment confidence, and enable councils to more readily adopt a strategic approach to managing demand for aquaculture space.
- A streamlined approach to the test that examines the effects of aquaculture proposals on existing wild-catch fishing to reduce costs ("Undue Adverse Effects on Fishing Test" or UAE), shorten timeframes and help the transition from commercial fishing to aquaculture if appropriate, while continuing to protect the interest of commercial, customary and recreational fishers.

Aquaculture in New Zealand (2008)
Ministry of Fisheries Aquaculture Team
Ministry of Fisheries

Spatial Information: New Zealand wide
Keywords: sustainable, aquaculture, New Zealand.

Summary: This document is written by the government with the intention of informing the public about New Zealand aquaculture and the ways in which the government is supporting the development of an environmentally friendly industry.

Aquaculture, join the discussion: public consultation on the future management of aquaculture (2000)
Ministry of Fisheries; Ministry for the Environment
Ministry of Fisheries

Spatial Information: New Zealand wide
Keywords: Marine resources Government policy New Zealand.; Fishery law and legislation New Zealand.; Aquaculture Government policy New Zealand.

Summary: Key points:

- The key message in this discussion paper is that aquaculture could make a greater contribution to the economy if the legislative framework under which this activity operates was updated.
- The challenge therefore is to develop a legislative framework for aquaculture that can provide certainty to all participants, including administrators. This framework should enable the greatest benefit to be obtained from the use of coastal space, without undermining the rights of fishers or allowing undue adverse impacts on the aquatic environment.
- This paper sets out four key proposals to do that: Proposal One, that a single form of aquaculture harvesting right be provided, under which all existing and future aquaculture harvesting activity would operate. Proposal Two, that only one agency should have the responsibility to manage effects that aquaculture activities have on aquatic fauna, habitat and the sustainability of fisheries. Proposal Three, that mechanisms are developed to improve the planning process and to encourage area-use or trade agreements to be entered into between new marine farm applicants, fishers and other stakeholders. Proposal Four, that the management of land-based aquaculture activity be streamlined by removing redundant or overlapping regulatory regimes.
- Having outlined the key proposals, this paper then goes on to explore two legislative approaches that might be available to implement the proposals. Approach One is to continue to manage aquaculture under a dual Resource Management Act (RMA) and Fisheries Act (FA) regime, but with improved linkages between the two Acts. Approach Two is to roll the management of aquaculture into the RMA.
- The first approach would represent a modification of the current split whereby marine farmers require approval under both the RMA and the FA before they engage in aquaculture activity.
- The second approach would provide for all marine farming activity to be approved under a single resource consent system. Marine farmers would no longer require a second approval under the fisheries legislation, as fisheries matters would be dealt with by regional councils as part of the resource consent process.

- The initiatives outlined in this paper are not final. They are presented in order to generate discussion.
- Submissions are invited on the initiatives identified in this paper and on any possible alternatives that might be available to improve the management of aquaculture.
- Information on how to make a submission is provided at the end of this paper.

Microbiological reference criteria for food (1995)
Ministry of Health
Ministry of Health

Spatial Information: New Zealand wide
Keywords: Microbiological Standards, Microbiological Reference Criteria, Food safety

Summary: These reference criteria are formulated as a guide for regulators to assess when foods can be considered unacceptable or unsafe. They apply until the end of the given shelf life of a particular food. The Ministry of Health recommends industry strive for more stringent specifications. Microbiological knowledge is expanding rapidly. Therefore regardless of what is printed here no food provided for public consumption should contain any microorganisms or biotoxin at a level identified as capable of causing foodborne disease.There are 2 criteria referred to in this document, standards and reference criteria. Microbiological Standards are part of the New Zealand Food Regulations 1984 which clearly establishes a microbiological content or level that it is unlawful to exceed. They are legislative and mandatory. As such they are identified separately to reference criteria. Microbiological Reference Criteria are not part of a New Zealand law. They are to be used where no standard exists in law to monitor the microbiological safety of a manufacturing process or the safety of a food. They may be used as supplements to existing standards where public health concerns dictate. The Microbiological Reference Criteria can be of prime importance in deciding if a food is unsound or in reinforcing other observations and providing reasons to suspect that a food may not meet sound public health practices. If the bacteriological quality is outside these reference criteria, an audit of the company's food safety programme will almost inevitably reveal unsatisfactory practices.

A guide to aquaculture development for Maori (1996)
Ministry of Maori Development
Ministry of Maori Development

Spatial Information: New Zealand wide
Keywords: Aquaculture industry New Zealand.; Joint ventures New Zealand.; Aquaculture New Zealand.; Maori Fishing.

Summary: Chapters include: 1. Aquaculture, is it a viable option for you? 2. Planning for the development of your farm. 3. How to obtain commercial lending. 4. Processing and exporting. 5. Co-operation/co-ordination, what are the advantages? 6. Who can help? There is also a list of organisations and an outline of services they offer.

Aquaculture development in New Zealand: Ahumoana ahutangata : scientific and technical information to inform Maori (2009)
Ministry of Maori Development (Te Puni Kokiri),NIWA
Te Puni Kokiri and NIWA

Spatial Information: New Zealand wide
Keywords: Aquaculture industry New Zealand

Summary: Provides Maori with technical information on aquaculture species and technologies, the economics and business of marine farming, and the regulatory environment following the introduction of the aquaculture law reforms.

Aquaculture information sheet series (2007)
Ministry of Maori Development
Ministry of Maori Development

Spatial Information: New Zealand wide
Keywords: Aquaculture industry New Zealand.; Aquaculture Government policy New Zealand.; Maori Fishing.; ika.; Taunga ika.; Kaitiakitanga.; Umanga.

Summary: Topics covered include: Te whakauru atu ki te Ahumahi Ahumoana = Getting into the aquaculture industry -- 1. Te Ahumahi Ahumoana = The aquaculture industry -- 2. Nga Turanga Mahi me nga Mana Whakahaere Ahumoana = Roles and responsibilities in aquaculture -- 3. Ratonga Pakihi mo te Ahumoana = Business services for aquaculture -- 4. Kaiwhakawhiwhi putaiao Ahumoana = Aquaculture science providers -- 5. Te Whakataunga Ahumoana = The aquaculture settlement -- 6. Whakamahere mo te Ahumoana = Planning for aquaculture.

Baseline Survey of Waikareao Estuary, Tauranga, New Zealand (1993)
Minkhorst, R.
Bay of Plenty Polytechnic Report no. 17

Spatial Information: Waikareao Estuary, Tauranga, New Zealand
Keywords: Waikareao Estuary, cultural health index

Summary: A baseline survey of Waikareao estuary was conducted to investigate social, cultural and historical aspects and assess the condition of water quality, flora and fauna of the estuary and surrounding area. The human activity around the estuary has caused a considerable amount of impact as a result of the estuary providing a venue for a number of recreational and cultural activities, and the increasing residential and industrial developments. However, some adjacent land has been allocated for parks and reserves. The water is of acceptable quality and sustains diverse marine life. There are numerous different shellfish species, most of which are edible, but no commercial shell fishing has been established, Flounder are commercially fished in the estuary, but the majority of fishing is recreational with some good catches being made. There is a large bird population in the area, centred upon the areas of productive maritime marsh which provide the rich food sources for the birds and a number of good roosting areas.

Conservation status of New Zealand birds(2008)
Miskelly, C. M.; Dowding, J. E.; Elliott, G. P.; Hitchmough, R. A.; Powlesland, R. G.; Robertson, H. A.; Sagar, P. M.; Taylor, G. A.
Notornis

Spatial Information: New Zealand wide
Keywords: threatened birds; endangered birds; uncommon birds; extinct birds; conservation status; threat classification; New Zealand

Summary: An appraisal of the conservation status of the post-1800 New Zealand avifauna is presented. The list comprises 428 taxa in the following categories: 'Extinct' 20, 'Threatened' 77 (comprising 24 'Nationally Critical', 15 'Nationally Endangered', 38 'Nationally Vulnerable'), 'At Risk' 93 (comprising 18 'Declining', 10 'Recovering', 17 'Relict', 48 'Naturally Uncommon'), 'Not Threatened' (native and resident) 36, 'Coloniser' 8, 'Migrant' 27, 'Vagrant' 130, and 'Introduced and Naturalised' 36. One species was assessed as 'Data Deficient'. The list uses the New Zealand Threat Classification System, which provides greater resolution of naturally uncommon taxa typical of insular environments than the IUCN threat ranking system. New Zealand taxa are here ranked at subspecies level, and in some cases population level, when populations are judged to be potentially taxonomically distinct on the basis of genetic data or morphological observations. In contrast, IUCN and BirdLife International bird threat rankings are assigned only at species level. This paper represents the first time that the entire modern New Zealand avifauna has been assessed from a conservation perspective. A brief analysis of patterns of extinction, threat, and rarity exhibited by the taxa listed, is presented.

Mangroves. Coastal Ecosystem Series (Volume 2) (2008)
Miththapala, S.
Ecosystems and Livelihoods Group Asia (IUCN)

Spatial Information: No spatial context
Keywords: Plants; Mangroves

Summary: This report is produced by IUCN on the importance of mangroves to their parts of the world.

Matauranga Maori, science and seabirds in New Zealand Foreword (2009)
Moller, H.
New Zealand Journal of Zoology

Spatial Information: Rakiura (Stewart Island), New Zealand
Keywords: Titi (sooty shearwater), Muttonbird, Matauranga Maori

Summary: This Matauranga Maori, Science and Seabirds special issue reports mainly research on one species, the titi (sooty shearwater), and one 14-year research project called *Kia Mau Te Titi Mo Ake Tonu Atu* ("Keep the Titi Forever"). Sooty shearwaters are medium-sized petrels, commonly referred to as the most numerous seabird in the Southern Hemisphere. Efficient flight and investment in magnificent feathers enable trans-equatorial migration to feed in cool temperate waters in the northern Pacific during the austral winter months, returning in September and October to New Zealand breeding colonies. A single egg is laid within a burrow in late November, and hatched in late January. The chicks start to

emerge from burrows from about 20 April to shed down and harden muscles in preparation for fledging in the coming 2-4 weeks. Muttonbirding and Matauranga Maori study of sooty shearwaters is not just ecologically important, it is also culturally important. "Muttonbirding", the harvesting of sooty shearwater chicks, is the last remaining widespread customary bird harvest that remains almost entirely within the control of Maori. Currently around 435 Rakiura Maori "muttonbirders" (people with legal rights to harvest the Titi from 36 Titi Islands around Rakiura (Stewart Island) take a total of 320,000 - 400,000 near fledging chicks.

Combining science and traditional ecological knowledge: Monitoring Populations for co-management (2004)
Moller, H.; Berkes, F.; Lyver, P. O.; Kislalioglu, M.
Ecology and Society

Spatial Information: Canada and New Zealand
Keywords: Customary Wildlife Harvests, Traditional Ecological Knowledge, Co-Management

Summary: Using a combination of traditional ecological knowledge and science to monitor populations can greatly assist co-management for sustainable customary wildlife harvests by indigenous peoples. Case studies from Canada and New Zealand emphasize that, although traditional monitoring methods may often be imprecise and qualitative, they are nevertheless valuable because they are based on observations over long time periods, incorporate large sample sizes, are inexpensive, invite the participation of harvesters as researchers, and sometimes incorporate subtle multivariate cross checks for environmental change. A few simple rules suggested by traditional knowledge may produce good management outcomes consistent with fuzzy logic thinking. Science can sometimes offer better tests of potential causes of population change by research on larger spatial scales, precise quantification, and evaluation of population change where no harvest occurs. However, science is expensive and may not always be trusted or welcomed by customary users of wildlife. Short scientific studies in which traditional monitoring methods are calibrated against population abundance could make it possible to mesh traditional ecological knowledge with scientific inferences of prey population dynamics. This paper analyses the traditional monitoring techniques of catch per unit effort and body condition. Combining scientific and traditional monitoring methods can not only build partnership and community consensus, but also, and more importantly, allow indigenous wildlife users to critically evaluate scientific predictions on their own terms and test sustainability using their own forms of adaptive management.

Knowing by doing: learning for sustainable muttonbird harvesting (2009)
Moller, H.; Kitson, J. C.; Downs, T. M.
New Zealand Journal of Zoology

Spatial Information: Rakiura (Stewart Island), New Zealand
Keywords: Titi, Mutton Bird, Rakiura

Summary: In a fast-changing world, successful communication of traditional cultural principles and practices of guardianship and stewardship across generations is more important than ever before. This study investigates knowledge and learning in relation to the last large-scale customary harvest of a seabird in New Zealand, the titi

(*Puffinus griseus*), by Rakiura Maori. Semi-directed interviews were conducted with 20 titi-harvesting elders. We sought firstly to identify the key knowledge-holders and mechanisms for the transmission of ecological knowledge, as well as the cultural and spiritual beliefs interwoven with harvest practice. Secondly, we sought to identify modern challenges to traditional pathways of learning, and the changing roles of knowledge holders in the harvesting community. Traditional approaches, including observation, hands-on experience, and storytelling, continue as the main mechanisms for knowledge transmission. Awareness of ancestors (tupuna) and taboo improve compliance of accepted harvesting practices, reinforcing the connection of Rakiura Maori to the harvesting islands and fostering a strong conservation ethic. However, modern needs and pressures appear to threaten the transmission of knowledge between successive generations. The effects, both positive and negative, of the adoption of modern processing, transport and communication techniques within the traditional harvest are considered. Learning and social mechanisms for the titi harvest are based on the foundation of tikanga (protocol) and kaitiakitanga (environmental guardianship), but are demonstrably adaptive, building the resilience and social-ecological sustainability of this culturally-fundamental harvest.

Guidelines for cross-cultural Participatory Action Research partnerships: a case study of a customary seabird harvest in New Zealand (2009)
Moller, H.; Lyver, P. O.; Bragg, C.; Newman, J.; Clucas, R.; Fletcher, D.; Kitson, J.; McKechnie, S.; Scott, D.; Rakiura Titi Island Administering.;
New Zealand Journal of Zoology

Spatial Information: Rakiura (Stewart Island), New Zealand
Keywords: Titi, Mutton Bird, Rakiura

Summary: Adaptive co-management and Participatory Action Research (PAR) promotes social ecological resilience by simultaneously protecting wildlife and its habitat and promoting capacity and motivation for sustainable harvest management by communities. We report here on a case study of learning through a partnership (1994-2009) between science and Traditional Ecological Knowledge (TEK) to determine the sustainability of titi (sooty shearwater, *Puffinus griseus*) harvests by Rakiura Maori in southern New Zealand. Testimony of Maori elders and titi harvesters (birders), members of the Rakiura Titi Islands Administering Body, researchers and participants in workshops and meetings were recorded throughout the 14-year research project to identify critical determinants of success of the partnership. A large majority of participants supported the research, mainly because it expanded their knowledge by investigating the reasons for declining bird numbers and the means of ensuring the continuation of their muttonbirding heritage. Initial concerns about the research included fear that prohibition or quota would be imposed through political pressure from external groups; the intrusion of strangers on the islands; the misconception that the research was being promulgated by government regulatory agencies; and scepticism about research findings. Research also precipitated conflict and division within the Rakiura community, and some birders feared that science might displace matauranga Maori (TEK) of the Rakiura people for guiding harvest management. Core conditions for community engagement included trust between parties, effective communication of the science, equitable decision-making responsibility, and building scientific capability and monetary support to enable meaningful participation. The most fundamental requirement is mutual respect for each party's knowledge. Attention to this inclusive, equitable, slow and prolonged process makes it more likely that the community will uptake results to

improve sustainability of harvesting. The research has heightened awareness within the harvesting community of conservation issues facing the titi and of potential options to mitigate them. Eradication or control of weka (*Gallirallus australis*), and reducing titi harvest levels from around a quarter of the manu (family birding territories), are the main practical ways of increasing sustainability, but the magnitude and direction of climate change impacts on the shearwater population remains uncertain.

Mangroves: are they a problem or an asset? (2003)
Mom, B.
Coastal News

Spatial Information: Northern New Zealand, including the Tauranga region
Keywords: Mangroves, mangrove management, catchment management, eutrophication

Summary: With great interest have I been following the progress of the "mangrove issue" in a series of areas in northern New Zealand, including the Tauranga Region. Among a number of other councils, Tauranga District Council has provided a range of options in managing the mangroves in a number of estuaries, and considers the status quo option most appropriate. My interest in this particular area comes via my PhD thesis, which deals with the ecology, management and restoration of mangrove communities in New Zealand. One of the projects was the assessment of the restoration potential of a cleared area in the Welcome Bay estuary after the removal of mangroves to facilitate the installation of a new sewage pipeline. During one of my visits to the Welcome Bay area, I met up with members of the Welcome Bay Catchment Care Group, and was impressed by their holistic approach when dealing with the issue of mangrove encroachment. Unlike a number of residents who had taken it upon themselves to randomly remove mangroves (and consequently destroy a number of my sampling plots), this group was gathering relevant information (including catchment use and sedimentation levels) in an attempt to assess the potential causes of the spread of mangroves and come up with a sustainable management scheme. One of the main conclusions of my thesis was that catchment management could be identified as a predominant factor explaining major changes in mangrove coverage. Several of the studied sites showed major increases in coverage, while in two other sites changes were minor to non-existent. Changes in land use were the common denominator in all sites with major changes, while the other two sites with minor changes were both marine reserves, which included implementing proper catchment management. The main changes over time that were identified have been forest clearing, housing and roading (e.g. increases in impervious surfaces), removal of non-native stabilizing plants along riverbanks (such as *Salix* spp), use of fertilizers, changes in cattle management practises and the introduction of other species (*Spartina alterniflora*). Combined with the New Zealand topography, erratic precipitation patterns and soil texture, these have resulted in an increased influx of fine and coarser sediment types in estuaries in which mangroves are an integral part. I would, therefore, like to emphasize that any mangrove management proposal should include issues such as catchment management, eutrophication and other anthropogenic activities. If councils do decide to start removing mangroves without addressing these issues, they will definitely not solve the problem. Hence, prior to labelling mangroves in a particular estuary as "problem" or "asset", local government bodies need to assess all relevant factors within each catchment prior to making a decision on the appropriate type of management.

Nutrient Management in New Zealand Pastures - Recent Developments and Future Issues (2007)
Monaghan, R.M.; Headley, M.J.; Di, H.J.; McDowell, R.W.; Cameron, K.C.; Ledgard, S.F.
New Zealand Journal of Agricultural Research

Spatial Information: New Zealand wide
Keywords: adoption; farm dairy effluent; grazed pastures; mitigation; nitrogen; nutrient budgets; phosphorus; water quality

Summary: In this publication we review recent research and understandings of nutrient flows and losses, and management practices on grazed pastoral farms in New Zealand. Developments in nutrient management principles in recent years have seen a much greater focus on practices and technologies that minimise the leakage of nutrients, especially nitrogen (N) and phosphorus (P), from farms to the wider environment. This has seen farm nutrient management planning shift from a relatively small set of procedures designed to optimise fertiliser application rates for pasture and animal production to a comprehensive whole-farm nutrient management approach that considers a range of issues to ensure both farm productivity and environmental outcomes are achieved. These include consideration of factors such as multiple sources of nutrient imports to farms, the optimal re-use and re-distribution of nutrient sources generated within the farm (such as farm dairy effluent), identification of the risks associated with applying various nutrient forms to contrasting land management units, and an econometric evaluation of farm fertilisation practices. The development of nutrient budgeting and econometric decision support tools has greatly aided putting these more complex whole-farm nutrient management systems into practice. Research has also identified a suite of mitigation systems and technological measures that appear to be able to deliver substantial reductions in nutrient losses from pastoral farms. However, issues of cost, complexity, compatibility with the current farm system, and a perceived uncertainty of actual environmental benefits are identified as key barriers to adoption of some of these technologies. Farmers accordingly identified that their main requirement for improved nutrient management planning systems was flexibility in how they would meet their environmental targets. The provision of readily discernible information and tools defining the economic and environmental implications of a range of proven management or mitigation practices is a key requirement to achieve this.

Post-disposal behaviour of sandy dredged material at an open-water, inner shelf disposal site (1994)
Moon, Vicki; Lange, Willem de; Warren, Sue; Healy, Terry
Coastal Education & Research Foundation, Inc

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sediment Transport, Dredging, Tauranga Harbour

Summary: Geotechnical properties of dredged material placed in an open-water disposal site were monitored over a six-month period immediately following disposal to determine the consolidation behaviour of the spoil mound and the impact of dredged material on sediment transport behaviour. The dredged material consisted largely (> 90%) of fine to medium sand, with a significant proportion of gravel-sized pumice and shell fragments (1-10%), and minimal (< 0.5%) mud. This distribution was compatible with the natural sediment at the dump ground. Immediately after

placement, mean grain size and settling velocity of surficial sediments increased compared with pre-disposal values, and sorting reduced. Dredged material bulk density and static friction angle were lower than those of pre-existing dump ground sediments, yet moisture content was comparable. These changes are attributed to the dredging and injection processes. Due to the low mud content, the dredged material consolidated immediately upon deposition, attaining normal consolidation with respect to ambient stresses within a short period. Reduced static friction angles resulted in an enhancement of the potential for bedload transport relative to pre-disposal rates. Increased settling velocities resulted in decreased potential suspended sediment transport. Lower shear strength of the dredged material resulted in larger bedforms on the dump ground compared with surrounding areas. With time, properties of the materials reverted towards pre-disposal conditions as a result of increased sorting and packing of grains. However, after six months, the properties had not completely returned to previous conditions.

Distribution patterns in New Zealand seaweeds. Tuatara: Volume 9 (1961)
Moore, L.B
Central Govt; Botany Division, Dept of Scientific and Industrial Research

Spatial Information: New Zealand wide
Keywords: Plants, macroalgae

Summary: Of certain categories of red seaweeds, R. M. Laing wrote in 1939: 'Our ignorance of distribution is such that in most cases we are quite unable to give the exact range of any particular species.' Though this is still all too true, an attempt was made in 1947 to delimit marine algal provinces and a map showing suggested boundaries was published (Moore, 1949). Only a brief text accompanied the map and little of the evidence on which it was based was presented for possible alternative interpretation. Since 1947 there has been much activity in all fields related to New Zealand marine biology, including spectacular advances in physical oceanography which should ultimately contribute towards the understanding of patterns of distribution. Nevertheless there remain many miles of coastline, for example from Cape Runaway to Cape Palliser, where only the most sketchy sort of sampling has been made. The maps show how rewarding closer investigation of certain critical areas could be.

Tauranga Wastewater Treatment Plants Compliance Report (2006)
Morris, J.
Environment Bay of Plenty

Spatial Information: Tauranga, Bay of Plenty, New Zealand
Keywords: wastewater, treatment plant, Tauranga, Tauranga Harbour, effluent, Omanu ocean outfall, contamination, compliance, sewage, Chapel Street Treatment Plant, Te Maunga Treatment Plant, consent,

Summary: Tauranga City Council operates two wastewater treatments plants to treat all wastewater within the greater Tauranga area. Sewage from Tauranga, Greerton, Bethlehem and surrounding areas is treated via the Chapel Street wastewater treatment plant. Installation of the Western Bay of Plenty District Council reticulation sewer line, is at present (in 2006) under construction and all wastewater from the Omokoroa area will be treated at the Chapel Street wastewater treatment plant. Treated wastewater from Chapel Street is either piped directly to the wetland area at

Te Maunga for further treatment, or discharged by irrigation to different locations within the Tauranga city area. Wastewater from Mount Maunganui, Bayfair and Papamoa is treated via the Te Maunga wastewater treatment plant. Once wastewater has passed through the wetland area at Te Maunga, it is then discharged via the Omanu ocean outfall to the Pacific Ocean. The previous report on the Tauranga City Council wastewater treatment plants was presented in December 2001 and covered consents 02 3540 and 02 3803. Since then, both these consents have expired. Tauranga City Council now hold nine new consents covering both treatment sites. This report covers the compliance levels of the expired consents leading up to their expiration and the latest compliance levels of all the current Tauranga City Council Wastewater Treatment Plant consents. A draft of this report has been reviewed by Tauranga City Council.

Healthy estuaries (2000)
Morrisey, D.; Green, M.
New Zealand Science Monthly - February

Spatial Information: New Zealand wide
Keywords: Estuaries, infilling, Sedimentation, mangroves,

Summary: Website about the natural progression and infilling of estuaries in New Zealand. Discusses the anthropogenic factors that can increase the infilling of an estuary. Discusses mangrove growth and why mangrove cover has increased in recent years.

The New Zealand Mangrove: Review of the Current State of Knowledge (2007)
Morrisey, D. J.; Beard, C. M.; Morrison, M. A.; Craggs, Rupert.;Lowe, Meredith.
NIWA Client Report

Spatial Information: New Zealand wide
Keywords: plants; mangroves

Summary: The Auckland Regional Council (ARC) is proposing to amend the Auckland Regional Plan: Coastal, to introduce objectives and policies relating to mangrove management. To support this proposed change, ARC has commissioned NIWA to: "Produce a balanced, impartial, but technically robust and reputable report. The report is to provide a review of the current state of knowledge, and where possible to include an update on the latest research being undertaken."

Differences in benthic fauna and sediment among mangrove (*Avicennia marina var. australasica*) stands of different ages in New Zealand (2003)
Morrisey, D. J.; Skilleter, G. A.; Ellis, J. I.; Burns, B. R.; Kemp, C. E.; Burt, K.
Estuarine Coastal and Shelf Science

Spatial Information: New Zealand wide
Keywords: mangrove; benthic fauna; sediments; progradation and prograding coasts; management; New Zealand; crab *Helice crassa*; litter production; var resinifera; tuff crater; assemblages; forests; boardwalks; estuaries; growth; river; plants; *Avicennia marina var. australasica*

Summary: Management of coastal environments requires understanding of ecological relationships among different habitats and their biotas. Changes in

abundance and distribution of mangroves, like those of other coastal habitats, have generally been interpreted in terms of changes in biodiversity or fisheries resources within individual stands. In several parts of their range, anthropogenically increased inputs of sediment to estuaries have led to the spread of mangroves. There is, however, little information on the relative ecological properties, or conservational values, of stands of different ages. The faunal, floral and sedimentological properties of mangrove (*Avicennia marina var. australasica*) stands of two different ages in New Zealand has been compared. Older (>60 years) and younger (3-12 years) stands showed clear separation on the basis of environmental characteristics and benthic macrofauna. Numbers of faunal taxa were generally larger at younger sites, and numbers of individuals of several taxa were also larger at these sites. The total number of individuals was not different between the two age-classes, largely due to the presence of large numbers of the surface-living gastropod *Potamopyrgus antipodarum* at the older sites. It is hypothesized that as mangrove stands mature, the focus of faunal diversity may shift from the benthos to animals living on the mangrove plants themselves, such as insects and spiders, though these were not included in the present study. Differences in the faunas coincided with differences in the nature of the sediment. Sediments in older stands were more compacted and contained more organic matter and leaf litter. Measurement of leaf chemistry suggested that mangrove plants in the younger stands were able to take up more N and P than those in the older stands.

The ecology and management of temperate mangroves (2010)
Morrisey, D. J.; Swales, A.; Dittmann, S.; Morrison, M. A.; Lovelock, C. E.; Beard, C. M.
Crc Press-Taylor & Francis Group

Spatial Information: New Zealand
Keywords: New South Wales; sea level rise; marina forsk vierh; Hunter River estuary; northern New Zealand*; Lepsiella vinosa*; gastropoda; tidal marsh sedimentation; long-term retrospection; multiple stable-isotope; large-scale patterns; plants; mangroves

Summary: Previous reviews of mangrove biology focused on the more extensive and diverse tropical examples, with those of temperate regions generally relegated to a footnote. Temperate mangroves are distinctive in several ways, most obviously by the lower diversity of tree species. Their occurrence in relatively developed countries has created different issues for mangrove management from those in the tropics. Mangroves in several temperate areas are currently expanding, due to changes in river catchments, in contrast to their worldwide decline. Information derived from the greater body of research from tropical regions has sometimes been applied uncritically to the management of temperate mangroves. The growing body of information on the ecology of temperate mangroves is reviewed, with emphasis on productivity, response to anthropogenically enhanced rates of sediment accumulation, and potential effects of climate change. There is no unique marine or estuarine fauna in temperate mangroves, but the poorly known terrestrial fauna includes mangrove-dependent species. Although productivity generally declines with increasing latitude, there is overlap in the range of reported values between temperate and tropical regions and considerable within-region variation. This, and variation in other ecologically important factors, makes it advisable to consider management of temperate mangroves on a case-by-case basis, for example, when responding to expansion of mangroves at a particular location.

Biogenic habitats and their value to New Zealand fisheries (2008)
Morrison, M.; Consalvey, M.; Berkenbusch, K.; Jones, E.
NIWA

Spatial Information: New Zealand wide
Keywords: Plants; Sea grass

Summary: This article looks at the biogenic habitats that support NZ fisheries. Preserving productive fisheries:

- Biogenic habitats – those formed by plants (including sea grass) and animals – are essential for different life stages of commercial fish species.
- Many biogenic habitats are threatened by the effects of land development, pollution, and certain fishing practices.
- Research programmes are extending our understanding of how these habitats support commercial fisheries.

Fish Survey: Update on NIWA survey of fish communities in mangroves and seagrass meadows (2005)
Morrison, M.; Francis, M.
NIWA

Spatial Information: New Zealand wide
Keywords: Plants; Sea grass

Summary: This article gives a glimpse into a recent survey conducted within estuaries of the North Island on mangroves and sea grasses. Niwa will receive funding from Ministry of Fisheries Biodiversity Fund to advance our understanding and management of biodiversity of seagrass habitats throughout New Zealand, including their role as invertebrate and fish nurseries, input into foodwebs, and overall contribution to maintaining ecosystem biodiversity.

Surveying fish in the mangrove and seagrass wilds of Northland (2005)
Morrison, M.; Francis, M.
NIWA

Spatial Information: Elsewhere in New Zealand – Rangaunu Harbour, Northland
Keywords: Plants; Sea grass

Summary: This article acknowledges the evidence in the importance of sea grass to marine nurseries. Further studies will be conducted in Rangaunu Harbour.

Comparing seagrass meadows across New Zealand (2007)
Morrison, M.; Lowe, M.; Spong, K.; Rush, N.
NIWA

Spatial Information: New Zealand
Keywords: Plants; Sea grass

Summary: Seagrass meadows are found in coastal areas throughout New Zealand. Scientists are using a sampling survey to assess the importance of seagrass for biodiversity, shelter, and food for fish and invertebrates. Results will be shared with coastal resource managers through a workshop and a comprehensive report.

Snapper's eye view of the inner Hauraki Gulf (2008)
Morrison, M.; Shanker, U.; Parsons, D.; Carbines, G.; Hartill, B.
NIWA

Spatial Information: Elsewhere in New Zealand – inner Hauraki Gulf
Keywords: Plants; Sea grass

Summary: Recreational fishing and other human activities are putting increasing pressure on coastal ecosystems.

- NIWA scientists are using a range of tools and techniques to study the interactions between snapper, recreational fishing, and seafloor habitats (including sea grasses).
- Our findings about snapper in the Gulf will help in moving towards ecosystem-based fisheries management.

A Review of Land Based Effects on Coastal Fisheries and Supporting Biodiversity in New Zealand (2009)
Morrison, M.A. ; Lowe, M.L. ; Parsons, D.M. ; Usmar N.R. ; McLeod, I.M.
NIWA

Spatial Information: New Zealand
Keywords: Coastal Fisheries, Suspended Sediments, Pastrol Livestock Farming, Dairying, Exotic Forestry

Summary: Land-based effects on coastal fisheries may occur through a diversity of mechanisms. Changing inputs from the land have included large volumes of suspended sediments and nutrients into the coastal zone, following large-scale clearances of New Zealand's forests, and the expansion of land-based industries such as pastoral livestock farming, dairying, and exotic plantation forestry. More localised effects from urbanisation have included elevations of heavy metal concentrations and pollution from sewage. Impacts from such activities have continued into the present day. Commercial coastal fisheries have been established over the same time period, with initial periods of heavy utilisation leading to over-fishing of many stocks, and subsequent catch reductions to more sustainable levels. Most fisheries are now managed under the Quota Management System which generally applies Maximum Sustainable Yield (MSY) targets, under which stocks are fished down to a level where productivity is thought to be highest. This inevitably leads to large reductions in overall (meta-) population size, and fishing down of the larger and older size/age classes. One assumption inherent in most stock assessment models used to provide advice on changes to catch limits (and of the generally stable catch limits for stocks for which there is no stock assessment model) is that fished populations will move back towards their original size following any reduction in fishing pressure. It is also assumed that environmental influences on the stock and the carrying capacity of the system remain constant over time or fluctuate without much trend. However, substantial changes in estuarine and coastal habitats

and ecosystems are known to have occurred over the last 100 or more years, and to still be occurring. These environmental impacts have happened over the same time frame as that of the establishment, and subsequent over-fishing of, coastal fisheries, and have driven population trends in the same direction, i.e., in a negative direction, for most species (but not all). Such impacts are currently poorly understood, with most fisheries research having been directed at the fished species themselves, in terms of factors such as how many there are, growth rates, age structures, and fishing removals, and the integration of these variables into numerical single species population models. The possible effects of environmental and habitat degradation on these fished populations have been largely ignored.

The New Zealand Sea Shore (2nd edition) (1973)
Morton, J.; Miller, M.
Collins

Spatial Information: New Zealand wide
Keywords: New Zealand Coastline, marine life

Summary: The New Zealand Coastline is a very long one. It varies in climate from warm to cold, and in structure from sandy beaches and dunes to rocky storm-bound shores, from muddy creeks and inlets to exposed and windswept islets. The plants and animals of these shores are of a corresponding variety, not yet familiar to science, and this general introduction to their study has long been needed. This book is a comprehensive and fully illustrated guide to NZ marine life. The treatment is habitat by habitat, so that the reader may know what plants and animals to expect in any one type of locality, where to look for them, and how and why they live there.

Recent advances in aquaculture (1982)
Muir, J. F.; Roberts, Ronald J.
Croom Helm ; Westview Press

Spatial Information: No spatial context
Keywords: Aquaculture Collected works.

Summary: An international perspective on the developing field of aquaculture is presented with an emphasis on some of the wider issues underlying aquaculture, particularly water resources and socioeconomic aspects. The chapters are: Fish production from engineered water systems in Developing countries; Azolla in aquaculture – past, present and future; The nutrition of prawns and shrimp in aquaculture – a review of recent research; Epizootic ulcerative syndrome of farmed and wild fishes; Aquaculture in Africa – socioeconomic dimensions; and Future directions.

Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand. 2nd Edition (2008)
B Mullan; D Wratt;S Dean;M Hollis;S Allan;T Williams; G Kenny; Ministry for the Environment
Ministry for the Environment

Spatial Information: New Zealand
Keywords: Climate Change

Summary: This Guidance Manual was prepared by David Wratt, Brett Mullan and Jim Salinger (NIWA), Sylvia Allen and Tania Morgan (MWH New Zealand Ltd), and Gavin Kenny (Earthwise Consulting), in consultation with a range of people from local government organisations. It follows a specification prepared by the Climate Change Office of the Ministry for the Environment. As explained in the report, developing projections of future climate changes is still subject to significant uncertainty. The authors have used the best available information in preparing this report, and have interpreted this information exercising all reasonable skill and care. Nevertheless none of the organisations involved in its preparation accept any liability, whether direct, indirect or consequential, arising out of the provision of information in this report.

Fish response to modified flow regimes in regulated rivers: research methods, effects and opportunities (2008)
Murchie, K. J.; Hair, K. P. E.; Pullen, C. E.; Redpath T. D.; Stephens, H. R.; Cooke, S. J.
River Research and Applications

Spatial Information: No spatial context
Keywords: river regulation; meta-analysis; management; biological impacts; sampling design; hydroelectric; synthesis; flow modification

Summary: Globally, rivers are increasingly being subjected to various levels of physical alteration and river regulation to provide humans with services such as hydropower, freshwater, flood control, irrigation and recreation. Although river regulation plays an important role in modern society, there are potential consequences which may negatively affect fish and fish habitat. While much effort has been expended examining the response of fish to fluctuating flow regimes in different systems, there has been little in the way of a comprehensive synthesis. In an effort to better understand the effects of river regulation on fish and fish habitat, we conducted a systematic review of available literature with three goals: (1) summarize the various research methodologies used by regulated river researchers, (2) summarize the effects found on fish and fish habitat and (3) identify opportunities for future research. The results of the synthesis indicate that a wide variety of methodologies are being employed to study regulated river science, yet there is a gap in incorporating methodologies that examine effects on fish at a cellular level or those techniques that are interdisciplinary (e.g. behaviour and physiology). There is a clear consensus that modified flow regimes in regulated rivers are affecting fish and fish habitat, but the severity and direction of the response varies widely. Future study designs should include methods that target all biological levels of fish response, and in which detailed statistical analyses can be performed. There is also a need for more rigorous study designs including the use of appropriate controls and replicates. Data on physical variables that co-vary with flow should be collected and examined to add explanatory power to the results. Increased multi-stakeholder collaborations provide the greatest promise of balancing ecological concerns with economic needs.

Ecology and geomorphology of Maketu Estuary, Bay of Plenty (1978)
Murray, K. N.
University of Waikato

Spatial Information: Maketu Estuary, Bay of Plenty, New Zealand

Keywords: estuary; sediments; tidal inlets; beaches; coastal erosion; inner shelf; tides; currents; waves; tsunamis; storm surge; numerical modelling

Summary: This paper reviews research that has taken place on physical oceanography and sedimentology on New Zealand's estuaries and the inner shelf since c. 1967. It includes estuarine sedimentation, tidal inlets, beach morphodynamics, nearshore and inner shelf sedimentation, tides and coastal currents, numerical modelling, short-period waves, tsunamis, and storm surges. An extensive reference list covering both published and unpublished material is included. Formal teaching and research programmes dealing with coastal landforms and the processes that shape them were only introduced to New Zealand.

Photosynthesis of *Ulva lactuca* at different tidal levels during submergence and emergence (1987)
Murthy, M. S.; Naresh, J.; Faldu, P. J.; Rao, Y. N.
British Ecological Society

Spatial Information: No spatial context
Keywords: Plants; Sea lettuce

Summary: The relative photosynthetic rates of fronds of *Ulva lactuca Linn.* (Ulvales, *Chlorophyceae*) sampled from upper, middle and lower littoral zones, were measured when submerged and at different levels of desiccation under laboratory conditions. The upper and middle littoral fronds showed increased rates of photosynthesis under exposure to air but the lower littoral ones showed maximal rates under submergence and registered lower rates under exposure. The rates of the upper littoral fronds were significantly higher than those of lower ones, under desiccated conditions. The upper ones had higher moisture content than the middle and lower littoral fronds during submergence but they were fast to lose their moisture under desiccation. The moisture levels at which the photosynthetic rates began to fall were 45%, 72% and 100%, in the upper, middle and lower littoral fronds, respectively. It is inferred from this study that the upper littoral fronds of the species, which are subjected to longer periods of exposure and consequently more desiccation during emergence in nature, are better adapted to emerged conditions than the lower ones. The results further suggest that the three types of fronds could be locally adapted ecads or ecotypes, the differences being the outcome of their responses to the physical conditions operating along the intertidal belt.

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Aquaculture sector planning and management (1995)
Nash,C. E.
Fishing News Books

Spatial Information: No spatial context
Keywords: Aquaculture industry Management; Aquaculture industry Government policy.

Summary: The Primary purpose for producing this book on Aquaculture Sector Planning and Management is to fill the great void for fundamental information needed by planners and administrators in government charged with the responsibilities of organising and managing the relatively new and important food-producing sub-sector, now widely called aquaculture. Secondly, it is intended to be a useful

guideline on planning and management processes for anyone in the public or private sectors who has some responsibility for planning and implementing aquaculture development programmes or projects. Finally, it is a different type of textbook for undergraduate students, including those in the closely related fields of agriculture and environmental sciences on the many issues underlying the development of aquaculture, or that of any other similar field.

Science and its role in the National Marine Fisheries Service (2002)
National Research Council (U.S.). Ocean Sciences Board.,
ebrary Inc.,
National Academy Press

Spatial Information: No spatial context
Keywords: United States. National Marine Fisheries Service; Aquaculture United States.; Aquaculture Research United States.; Fisheries United States.; Electronic books.

Summary: The mission of the National Marine Fisheries Service (NMFS) is to manage the marine fisheries of the United States to serve the nation now and to benefit future generations. The physical domain that NMFS manages is the largest exclusive economic zone (EEZ) in the world, with an area of 3.4 million square nautical miles (11 million square kilometres). This area spans arctic to tropical ecosystems and is home to 905 identified stocks of fish and invertebrates, and over 100 species of marine mammals and sea turtles. Of the marine mammals, 44 populations are strategic, that is, they are either listed as threatened, endangered, or they are declining populations that are at risk. As NMFS manages marine fisheries, it operates under a complex set of laws. The centrepiece of fisheries legislation is the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), an act that had its origins in 1976 when the United States extended federal management to fisheries within the Fisheries Conservation Zone (now named the Exclusive Economic Zone or EEZ) that had been established the year before, from 3 to 200 miles offshore. Under the MSFCMA, eight regional fishery management councils work with NMFS in developing fishery management plans (FMPs). With the enactment of this law, the fishing industry, through its membership on the regional fishery management councils (FMCs), had a far greater voice in marine-fish management.

Report and Study of Grey-faced Petrels (*Pterodroma macroptera gouldi*) on Mount Maunganui, in conjunction with OSNZ and DoC (2001)
Naude, C.
Bay of Plenty Polytechnic Report no. 115

Spatial Information: Mount Maunganui (Mauao), Tauranga Harbour
Keywords: Mount Maunganui (Mauao), Grey-faced Petrels (*Pterodroma macroptera gouldi*)

Summary: The purpose of this study was to continue the study of Grey-faced Petrels (*Pterodroma macroptera gouldi*) on Mount Maunganui on behalf of Hugh J Clifford, and in conjunction with DoC and OSNZ. The primary objective of the study was to locate, capture, measure, band, and record as many Grey-faced Petrels on Mount Maunganui that could be found, and then to collate the data obtained. It was found that 135 Grey-faced Petrels were captured, measured, and recorded, of which 64

were new birds, and thus banded, and 71 were birds that had previously been recorded.

Using Cellular Technology to Capture Amateur Catch Estimate Data (2010)
NBR
Ministry of Fisheries

Spatial Information: No spatial context
Keywords: Fishery

Summary: A study involving 529 fishers was conducted to determine the feasibility and efficacy of using the cell phone SMS/text system to report fishing activity over a 10 week period. The selected sample included a mix of fishers by area, fishing method, age and texting ability. Study participants were randomly assigned to one of four treatment groups: weekly reporters, weekly reporters with reminders, twice weekly reporters, twice weekly reporters with reminders. Texting management software was used to broadcast routine SMS requests to the participants and to receive replies. Participants reported whether they went fishing or not, and if they did, the number of trips, areas fished and the number of each species personally caught and kept. On average, 69% of the sample responded with a text. Weekly reporters with reminders had the highest response out of the four treatment groups, with 77.6% replying. Of those that sent texts, 67.4% were coded as correct and 23.6% 'fixable' when considering other information, such as previously sent texts and message receipt time. Over a 10 week period, participants reported an average of 2.9 fishing trips per head and 4.9 fin fish caught and kept per trip. A telephone feedback survey revealed considerable information about how the fishers responded to the survey, including reasons for not replying and not texting correctly. This information, together with other learning's resulting from the trial, can be used to improve any further surveys using the SMS reporting method. This study demonstrates that reporting of harvest via text is indeed feasible, albeit with certain constraints, such as the character limits of the cell phone technology.

Marine Algae of the West Coast, South Island, New Zealand (1998)
Neale, D; Nelson, W
Te Papa Museum of NZ

Spatial Information: Elsewhere in New Zealand – West Coast, South Island
Keywords: Plants, macroalgae, Marine algae, West Coast South Island New Zealand, biogeography

Summary: The West Coast of New Zealand's South Island is a windward shore that transects a westerly temperate ocean current system. The coastline structure is very much dominated by its history of glaciation and tectonic uplift, and it's high sediment loading, which combines to give the marine region a distinctive ecological character. Within the region, three ecological districts (Buller, Westland and South Westland) can be distinguished. Although the biomass of seaweeds on the West Coast's rocky shores and estuaries is often reduced by heavy sediment abrasion and other influences, over 175 taxa are recorded from historic and recent collections in the region. Significant features of the region's algal flora are hard to discern on the basis of existing knowledge, but include the virtual absence of some common New Zealand species, and extensions to the known distributions of others.

Ecological and physiological controls of species composition in green macroalgal blooms (2008)
Nelson, T. A.; Haberlin, K.; Nelson, A. V.; Ribarich, H.; Hotchkiss, R.; Van Alstyne, K. L.; Buckingham, L.; Simunds, D. J.; Fredrickson, K.
Ecology Journal

Spatial Information: No spatial context
Keywords: Plants, macroalgae

Summary: Green macroalgal blooms have substantially altered marine community structure and function, specifically by smothering seagrasses and other primary producers that are critical to commercial fisheries and by creating anoxic conditions in enclosed embayments. Bottom-up factors are viewed as the primary drivers of these blooms, but increasing attention has been paid to biotic controls of species composition. In Washington State, USA, blooms are often dominated by *Ulva* spp. intertidally and *Ulvaria obscura* subtidally. Factors that could cause this spatial difference were examined, including competition, grazer preferences, salinity, photoacclimation, nutrient requirements, and responses to nutrient enrichment. *Ova* specimens grew faster than *Ulvaria* in intertidal chambers but not significantly faster in subtidal chambers. *Ulva* was better able to acclimate to a high-light environment and was more tolerant of low salinity than *Ulvaria*. *Ulvaria* had higher tissue N content, chlorophyll, chlorophyll b: chlorophyll a, and protein content than *Ulva*. These differences suggest that nitrogen availability could affect species composition. A suite of five grazers preferred *Ulva* to *Ulvaria* in choice experiments. Thus, bottom-up factors allow *Ulva* to dominate the intertidal zone while resistance to grazers appears to allow *Ulvaria* to dominate the subtidal zone. While ulvoid algae are in the same functional-form group, they are not functionally redundant.

A revised checklist of marine algae naturalised in New Zealand (1999)
Nelson, W. A.
New Zealand Journal of Botany

Spatial Information: New Zealand wide
Keywords: marine algae

Summary: Twenty species of marine algae are listed as probable introductions to New Zealand. Thirty percent of these are new records, recognised in the fifteen years since the first list of naturalised algae recorded from New Zealand was prepared.

Calcified macroalgae - critical to coastal ecosystems and vulnerable to change: a review (2009)
Nelson, W. A.
Marine and Freshwater Research Journal

Spatial Information: No spatial context
Keywords: Plants, macroalgae

Summary: Calcified macroalgae are distributed in marine habitats from polar to tropical latitudes and from intertidal shores to the deepest reaches of the euphotic zone. These algae play critical ecological roles including being key to a range of invertebrate recruitment processes, functioning as autogenic ecosystem engineers

through provision of three-dimensional habitat structure, as well as contributing critical structural strength in coral reef ecosystems. Calcified macroalgae contribute significantly to the deposition of carbonates in coastal environments. These organisms are vulnerable to human-induced changes resulting from land and coastal development, such as altered patterns of sedimentation, nutrient enrichment through sewage and agricultural run-off, and are affected by coastal dredging and aquaculture. The consequences of increasing sea surface temperatures and fundamental changes in the carbon chemistry of seawater due to CO^2 emissions from anthropogenic activities will have serious impacts on calcifying macroalgae. It is not yet understood how interactions between a range of variables acting at local and global scales will influence the viability of calcifying macroalgae and associated ecosystems. Research is urgently needed on all aspects of the taxonomy, biology and functional ecology of calcifying macroalgae. Without an understanding of the species present, measurement of change and understanding species-specific responses will not be possible.

Seasonal movements of short-beaked common dolphins *(Delphinus delphis)* in the north-western Bay of Plenty, New Zealand: influence of sea surface temperature and El Niño/La Niña (2001)
Neumann, D. R.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: North western Bay of Plenty, New Zealand
Keywords: dolphins and whales, common dolphins, *Delphinus delphis*, sea surface temperature, distribution, El Nino, La Nina

Summary: Movement patterns of small cetaceans are influenced by a great number of variables including prey availability, sea floor profile, thermocline, oxygen minimum layer, and sea surface temperature (SST). Presented here are data on short-beaked common dolphins *(Delphinus delphis* L.) in New Zealand, showing a seasonal offshore-shift in their distribution, which appears to be correlated with SST. *D. delphis* moved from a mean distance of 9.2 km (SD = 4.42) from shore in spring and summer to a mean distance of 20.2 km (SD = 3.86) from shore in autumn. During warmer La Nina conditions their mean distance from shore was further reduced to only 6.2 km (SD = 2.56), and offshore movement was delayed by a month. Worldwide, *D. delphis* can be found throughout a wide range of sea temperatures, and it is therefore unlikely that SST is the primary factor influencing their distribution. It is hypothesised, that SST influences the distribution of *D. delphis* prey, which in turn affects their seasonal movements.

The Activity budget of free-ranging common dolphins (*Delphinus delphis*) in the north-western Bay of Plenty, New Zealand (2001)
Neumann, D. R.
Aquatic Mammals Journal

Spatial Information: North western Bay of Plenty, New Zealand
Keywords: dolphins and whales, common dolphin, *Delphinus delphis*, behaviour, activity budget, distribution, travelling, feeding, group formation

Summary: This study presents findings on seasonal and diurnal behavioural patterns of short beaked common dolphins (*Delphinus delphis*) off the east coast of New Zealand's North Island. Data on the activity state of focal groups were collected

by instantaneous scan-sampling at 3 min intervals from a 5.5 m rigid-hull inflatable boat. Predominant group activity was classified as one of 5 categories. The overall proportion of time spent in these activities was 54.8% travelling, 20.5% milling, 17% feeding. 7.3% socializing, and 0.4% resting. Comparisons with activity budgets of bottlenose dolphins indicated a roughly similar pattern. Time-of-day and time of low tide appeared to influence diurnal common dolphin behaviour. Seasonal fluctuations in activity budget did not show a consistent trend. The role of sea surface temperature and prey availability in affecting common dolphin movements is discussed. Mean group size peaked in late summer at 140 individuals. Overall, the average number of individuals in a group was 55.1. Group composition appeared to be rather fluid, because fission and fusion of groups were observed frequently. Low photo-identification resighting rates suggested a large, possibly transient population. The present activity budget provides valuable information on the behaviour of free-ranging common dolphins, which could be useful in the conservation and management of this species.

Photo-identification of short-beaked common dolphins *(Delphinus delphis)* in north-east New Zealand: a photo-catalogue of recognisable individuals (2002)
Neumann, D. R.; Leitenberger,A.; Orams,M.B.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Elsewhere in New Zealand –Whakatane, Mercury Bay and the Hauraki Gulf
Keywords: dolphins and whales

Summary: This study applied photo-identification to common dolphins and discussed the methods for distinguishing between individual dolphins. The study was based on two studies that were conducted concurrently in Mercury Bay and the Hauraki Gulf on the north-east of New Zealand's North Island. Collection of photographic data lasted from the period of 1998 to 2001. Sighting records of recognisable individuals suggested that some common dolphins move between Mercury Bay and the Haruaki Gulf, as well as between Mercury Bay and Whakatane. This work provides a photo-catalogue of distinct individuals for future studies.

Behaviour and ecology of common dolphins (*Delphinus delphis*) and the impact of tourism in Mercury Bay, North Island, New Zealand (2005)
Neumann, D. R.; Orams, M. B.
Science for Conservation

Spatial Information: Elsewhere in New Zealand - Mercury Bay, North Island
Keywords: dolphins and whales, Common dolphins, *Delphinus delphis*, Mercury Bay, behaviour, ecology, activity budget, dolphin-human interactions, tourism, boating.

Summary: This report provides insights into the behavioural ecology of short-beaked common dolphins (*Delphinus delphis*) in Mercury Bay, on the east coast of the Coromandel Peninsula, North Island, New Zealand. The report also includes a preliminary assessment of the influence of tourism activity on common dolphins in the area. From 1998 to 2001 (excluding the austral winter months May to September) we conducted 166 boat-based surveys, resulting in 102 'focal group follows', with 118.2 hours spent observing common dolphins. In Mercury Bay common dolphins showed a geographical movement associated with seasonal changes. The dolphins

were found further inshore in spring and increasingly offshore through summer and during autumn. Anecdotal reports suggest continued offshore movement over winter. However, re-sightings of identifiable dolphins indicate movement of individuals between Mercury Bay and the Hauraki Gulf to the north and west (by sea) and between Mercury Bay and the waters off Whakatane to the south. Data revealed that common dolphins spent 57% of their daylight time travelling, 21.5% milling, 13% feeding, 8% socialising, and 0.5% resting. Common dolphins were observed to prey on at least six different species of fish. Boat traffic altered the behaviour of some dolphin groups, especially those containing few individuals; however, low-level commercial tourism appeared to have little impact on the dolphins. Few attempts at swimming with common dolphins resulted in a sustained interaction. This information about Mercury Bay common dolphins will be useful for comparative purposes as recreational and tourism activity increases in the future.

Ahu moana: the aquaculture and marine farming report: Wai 953 (2002)
New Zealand Waitangi Tribunal.
Legislation Direct

Spatial Information: New Zealand wide
Keywords: Aquaculture New Zealand.; Mariculture New Zealand.; Aquaculture industry New Zealand.; Maori Claims.

Summary: The marine farming and aquaculture claims relate to the proposed legislative reforms of the regime regulating aquaculture, including marine farming, in Aotearoa. The claimants primarily say that they have not been adequately consulted regarding the reforms and that the reforms do not provide adequately for their interests in aquaculture. The Crown initiatives to reform the regime regulating aquaculture date back to February 1998, when an independent review of the Fisheries Act 1996 was agreed to. That review was reported back in September 1998 and concluded that the legislative matrix regulating aquaculture was fragmented. After some public consultation, policies relating to the reforms were developed over the period 2000 to 2001. On 28 November 2001, a public announcement was made about proposed legislation which would bring into effect significant reforms to aquaculture, including that regional councils would both be given the responsibility of setting aside aquaculture marine areas (AMAs) within which marine farming would be confined and be delegated to tender the coastal marine space to determine competing applications within the AMAs. In addition, the announcement revealed that a two-year moratorium on the granting of resource consents for new aquaculture developments was also to be effected through the legislation and that the moratorium was to have retrospective effect. It was the pending imposition of the moratorium and the wider issue of the impact of the proposed reforms on Maori interests in marine farming that gave rise to the claims currently before this Tribunal for inquiry.

Ranking pesticides by environmental impact new models combine human health, ecosystem impact, and natural resource data to identify the most hazardous agricultural pesticides (1995)
Newman, A.
Environmental Science & Technology Journal

Spatial Information: No spatial context
Keywords: Organic Pollutants

Summary: Two research groups recently have proposed mathematical models for determining the most environmentally hazardous agricultural pesticides. Although the models have different goals – influencing policy decisions versus influencing agricultural practices – they both rank pesticides by combining different types of data on human health, ecosystem impact, and groundwater and soil contamination. The model falls short of a formal quantitative risk assessment, but they can be used to rate the relative hazard of many pesticides using data that are available today.

NZFSA Animal Products (Specifications for Bivalve Molluscan Shellfish) Notice (2006)
NFSA
New Zealand Food Safety Authority

Spatial Information: New Zealand wide
Keywords: bivalve molluscan shellfish, regulated control scheme, NZFSA Animal Products

Summary: Under section 40 and 167(1)(g) of the Animal Products Act 1999, Tim Knox – Director New Zealand Standards issued this Notice for the purpose of setting specifications that:

- are specified, or contemplated by, or necessary, or desirable to give effect to the regulated control scheme for bivalve molluscan shellfish; and
- are necessary or desirable to amplify the manner in which the requirements of that scheme are to be met.

Maori methods and indicators for marine protection: Ngati Konohi interests and expectations for the rohe moana (2005)
Ngati Konohi,;DOC; MfE
Ngati Konohi, Department of Conservation and Ministry for the Environment

Spatial Information: Ngati Konohi of Whangara, East Coast, New Zealand
Keywords: Maori methods and indicators, marine protection, Ngati Konohi

Summary: This report from the Ngati Konohi, Department of Conservation (DOC) and Ministry for the Environment (MfE) community research team aims to explore how different marine management systems are able to meet the goals and aspirations of Ngati Konohi in their rohe moana/coastal area and also meet wider conservation objectives. The marine management systems referred to in this project include marine reserves, taiapure/locally managed sea area, mataitai/reserved sea area for marae use and tangata kaitiaki/ caretakers of a given area. The purpose of this report is to identify:

- Ngati Konohi's future goals and aspirations for the rohe moana
- The key species of importance to Ngati Konohi in the rohe moana
- How Ngati Konohi would like to use the different marine management systems in the rohe moana
- The tohu/signs or indicators that have traditionally been used or that are currently used by Ngati Konohi to tell them whether the rohe moana is healthy.

The report also contributes towards the second stage of the community research project which involves developing, monitoring and reporting on Ngati Konohi's tohu for the rohe moana.

Estuarine and Coastal Ecosystems: Fringing habitats in estuaries; the sediment-mangrove connection (2002)
Nicholls, Pip; Ellis, Joanne
NIWA

Spatial Information: Elsewhere in New Zealand - Whitford embayment, Auckland: Mangemangeroa and Waikopua Creek
Keywords: Plants; Mangroves

Summary: Fringing plant communities, such as salt marshes and mangroves, play an important role in our estuaries and coastal ecosystems. These fringing habitats are a key source of organic material and nutrients, which help to fuel the estuarine food web. To understand how estuaries respond to long-term increasing sediment inputs, they studied two estuary systems in the Whitford embayment, Auckland: Mangemangeroa and Waikopua Creek.

Coastal Ecosystems: Nutrient enrichment in mangrove ecosystems: a growing concern (2004)
Nicholls, Pip; Schwarz, A. M.; Hancock, N.
NIWA

Spatial Information: Elsewhere in New Zealand - Waikopua Creek
Keywords: Plants; Mangroves

Summary: This article discusses the findings of a NIWA driven project in the Waikopua Creek on mangrove distribution due to nitrogen availability. New Zealand is one of the few places in the world where the area covered by mangroves is expanding seaward.

Study revealed 166 offshore earthquake sources in the Bay of Plenty (2006)
NIWA
NIWA

Spatial Information: Bay of Plenty, New Zealand
Keywords: Natural Hazards/Storms

Summary: The number of known offshore earthquake sources in the Bay of Plenty has been drastically revised. In a report to Environment Bay of Plenty, NIWA has identified 166 offshore earthquake sources in the region. A national 'probabilistic seismic hazard assessment' published in 2000 incorporated just 14 offshore earthquake sources for the bay.

Pathogen pathways - best management practise (2006)
NIWA
Ministry of Agriculture and Forestry

Spatial Information: No spatial context
Keywords: pathogen, water quality, guidelines, faecal contamination, run-off, management, agriculture, dairy, riparian,

Summary: This report describes the key pathways by which faecal microbes are transferred from farm animals to waterways, which were identified in the Pathogen Transmission Routes Research Program (and related studies). Additionally, Best Management Practice (BMP) guidelines are presented with which to reduce the faecal contamination of waterbodies. The key findings are summarised as follows:

- Faecal contamination of freshwaters can arise through the deposition of faeces by grazing animals directly into waterways. This 'direct' deposition can occur when dairy cows cross streams as a herd to or from the milking shed, and through sporadic incursions by grazing cattle into unfenced waterways adjoining pasture. Indirect pathways whereby microbes are ultimately transferred to waterways via the flow of water over the surface of the land (surface runoff) or down through the soil horizons (subsurface flow) are also important.
- Direct deposition associated with herd crossings is a major pathogen transmission route and hence bridging streams intersected by farm raceways should markedly improve stream water quality.

Invasive Sea Squirt (*Styela clava*) Fact Sheet (2008)
NIWA
NIWA

Spatial Information: New Zealand
Keywords: Invasive species

Summary: The invasive sea squirt, *Styela clava*, has been found in New Zealand. This Fact Sheet outlines: Key features of sea squirts in general and Key features of *Styela clava* in particular.

Restoration of seagrass beds in Whangarei Harbour (2010)
NIWA
NIWA

Spatial Information: Elsewhere in New Zealand – Whangarei Harbour
Keywords: seagrass, Whangarei Harbour

Summary: Seagrass beds form an important undersea habitat for small fish, seahorses and shellfish in New Zealand. A large amount of New Zealand's seagrass habitat has been lost as a result of human activities, with only small pockets remaining in some harbours. NIWA is leading a small-scale transplantation trial in Whangarei Harbour to determine whether transplanted seagrass can survive, and hopefully thrive, at a former site.

Strategic Assessment of Near Coastal Waters, Chapter 3 (1988)
NOAA; EPA
NOAA

Spatial Information: No spatial context
Keywords: Estuaries; Pollution Sources; Agricultural Wastes; Coastal Regions; Coastal Waters; Ecological Concentration; Forecasting; Hydrology; Nitrogen; Nutrients; Phosphorus; Runoff; Waste Water; Water Pollution; Elements; Environmental Transport; Hydrogen Compounds; Liquid Wastes; Mass Transfer; Non Metals; Organic Wastes; Oxygen Compounds; Pollution; Surface Waters; Wastes;

Summary: The study is an assessment of the susceptibility and status of 17 Northeast estuaries to nutrient-related pollution problems. It is the final version of one of seven chapters in the Case Study and one of two chapters that will be completed. It first presents background information on the problems of nutrient over-enrichment in estuaries followed by a screening analysis of the susceptibility and status of estuaries to nutrient discharges and sections on nutrient sources and discharge estimation methods. The final section is an overview of the region, based on simple comparisons of discharge estimates across estuaries in the region. Appendix A contains one-page summaries for each estuary that include information on significant physical and hydrologic features, susceptibility and pollutant status, nutrient discharge estimates, and a narrative to assist the reader interpret the data. Summary estimates of particular interest are the changes in nitrogen and phosphorus inputs that would significantly alter the pollutant status of each estuary. Four additional appendices contain more detailed breakdowns of nutrient discharges by season and by source, an evaluation of the quality of the discharge estimates, and the method for determining an estuary's nutrient concentration status and susceptibility to nutrient-related pollution problems.

Effects of increased sedimentation on the physiology of two estuarine soft-sediment bivalves, *Austrovenus stutchburyi* and *Paphies australis*(2006)
Norkko, J.; Hewitt, J. E.; Thrush, S. F.
Journal of Experimental Marine Biology and Ecology

Spatial Information: No spatial context
Keywords: *Austrovenus stutchburyi*; Impact assessment; Nucleicacid ratios; *Paphies australis*; RNA; Sedimentation

Summary: In a combination of laboratory, transplant and manipulative field experiments covering a range of temporal scales, the effects of different aspects of increased sedimentation on two suspension-feeding bivalves were investigated under the main hypothesis that increased sedimentation negatively affects the physiology of bivalves. Nucleic acid ratios (RNA : DNA, RNA : protein or total RNA content) have been successfully used as indirect measures of short-term growth in a range of marine organisms. This is the first study to utilise nucleic acid ratios to directly assess the influence of increased sedimentation on bivalves. As bivalves show considerable physiological and behavioural plasticity in relation to varying seston quantities and qualities, increased sedimentation is not immediately translated into decreased growth potential: The results indicate that although no significant differences in RNA were detected over the short term in response to either increased suspended sediment concentrations (laboratory experiment, 14 days) or deposition of thin layers of terrigenous clay (field experiment, 10 days), over the longer term

changes in both suspended material and deposition affected bivalves (transplant and field experiments, 3–5 months). The findings of this combination of experiments emphasise that physiological investigations need to consider several different time scales, in addition to considering a range of habitats and environmental conditions, and that matching the temporal dynamics of the response variable with the dynamics of the stressor is imperative

Marine Biology: an ecological approach (2005)
Nybakken, J.W.;Bertness, M.D.;
Benjamin Cummings

Spatial Information: No spatial context
Keywords: Marine Environments, Plankton Communities, Oceanic Nekton, Deep-Sea Biology, Shallow-Water Subtidal Benthic Associations, Intertidal Ecology, Meiofauna, Estuaries and Salt Marches, Tropical Communities, Symbiotic Relationships, Human Impact on the Sea

Summary: Approaches the subject of marine biology by emphasizing the ecological principles that govern marine life throughout all ocean environments and by acknowledging the differences between marine and terrestrial ecosystems. This unique approach adds real-world relevance by exploring how organisms interact within their individual ecosystems while also focusing on the significance of human impact on the sea.

NZ Statistics Fish monetary stock account 1996-2006 (2007)
NZ Statistics,
NZ Statistics

Spatial Information: New Zealand wide
Keywords: fish monetary stock, commercial fish resource

Summary: The fish monetary stock account presents a time series asset value of New Zealand's commercial fish resource, based on quota values. Asset values in this report are derived from the quota and annual catch entitlement (ACE) values of the commercial fish resource as managed under the QMS. The time series show trends in the total asset value of New Zealand's commercial fish resource and trends in the asset values of selected species, which can be utilised for analysis by government and the wider community. The report also presents technical notes and a description of how fish stocks are valued.

Western Bay of Plenty Catchment Management. Newsletter of the New Zealand Association of Resource Management (2009)
NZARM Broadsheet,
NIWA

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, Kaimai Mamaku Ranges, sedimentation, Tauranga Harbour Integrated Management Strategy

Summary: The Tauranga Harbour is a significant cultural, social, ecological and economic asset to the western region of the Bay of Plenty. There are 17 sub-

catchments that feed into the harbour from the Kaimai Mamaku Ranges. The Tauranga Harbour Integrated Management Strategy (2006) identified sedimentation from these catchments to the harbour as the largest environmental management issue for the western region. In response to this strategy, Council undertook a three-year sediment study of the Tauranga Harbour and its sub-catchments. The results of this study, conducted by the National Institute of Water and Atmospheric Research (NIWA) to guide land management policy and decision-making for the western region. The study was expected to be completed before December 2009. This report briefly summarises the past approach to land management and outlines the catchment management approach currently being developed for the western region.

3.15. O

Consequences of habitat disturbance and recovery to recruitment and the abundance of kelp forest fishes (2010)
O'Connor, K. C.; Anderson, T. W.
Journal of Experimental Marine Biology and Ecology

Spatial Information: No spatialcontext
Keywords: Plants, macroalgae

Summary: The complete or partial removal of kelp forests due to disturbance can alter species composition and cause large reductions in the abundance of fishes in temperate zones. The effects of a gradient in disturbance that results in the thinning of kelp, however, have not been explored. We conducted manipulations corresponding to 0%, 33%, 66%, and 100% removal of Macrocystis pyrifera (L) C. Ag at three sites along Santa Catalina Island, California. Surveys of fishes conducted 1-3 months after the removal of *M. pyrifera* revealed differences in recruitment for *Brachyistius frenatus* (Gill). Additionally, a trend was seen for *Oxyjulis californica* (Gunther) showing an increase in recruit fish densities in treatments with higher amounts of *M. pyrifera.* For older life stages, there also were differences among treatments in the numerical densities of *Chromis punctipinnis* (Cooper). *Paralabrax clathratus* (Girard), and *B. frenatus* and in the biomass densities of *P. clathratus* and *B. frenatus*. Algae surveys conducted annually in the 2 years following disturbance showed the stipe densities of *M. pyrifera* among all treatments were at least as high as at the initiation of the experiment, indicating that treatments of *M. pyrifera* removal had recovered quickly to pre-disturbance levels. With one exception, there were no differences in recruitment or in the numerical or biomass densities of older juvenile and adult fishes among treatments in either of the two years following the initial disturbance. *M. pyrifera* in mature vs. recovering forests differs in its distribution and morphology, which might influence recruitment of kelp-associated fishes. To investigate these differences we conducted an experiment manipulating the distribution of adult and juvenile fronds of *M. pyrifera*. Recruitment of fishes was significantly higher on adult *M. pyrifera* and bundled fronds of juvenile *M. pyrifera* than on a dispersed distribution of juvenile *M. pyrifera*, indicating that the distribution of fronds primarily influences recruitment of kelp-associated fishes. Our results indicate that a gradient in disturbance and variation in the density of fronds of *M. pyrifera* influences recruitment and the distribution of older life stages of fishes, revealing some patterns at intermediate levels of removal that would not be observed by the simple presence or absence of this habitat. Although recovery of *M. pyrifera* to pre-manipulation levels was achieved over a relatively short period time in this study, variation in recruitment and the abundance of kelp forest fishes as a result of

disturbance will depend on the intensity of the disturbance, the conditions that promote or delay habitat recovery, and the life history characteristics of individual species.

Aquaculture Reform Cabinet Paper 1 (2010)
Office of the Minister for the Environment,Office of the Minister of Fisheries,Office of the Minister for Economic Development,
Minister for the Environment

Spatial Information: No spatial context
Keywords: aquaculture, 2010 reform,

Summary: This paper set outs problems with aquaculture legislation. Summarises the policy development context including the contribution of the Aquaculture Technical Advisory Group (TAG) and key themes in stakeholder submissions on the Group's October 2009 report *Re-Starting Aquaculture* (the TAG report). This paper seeks agreement to a suite of legislative and non-legislative changes to reform the aquaculture regime, along with seeking agreement to draft an aquaculture amendment bill.

Inhibition of larval settlement to a soft bottom benthic community by drifting algal mats: An experimental test (1988)
Olafsson, EB
Marine Biology Journal

Spatial Information: No spatial context
Keywords: drifting red algal mats, planktonic larvae, benthic community

Summary: The hypothesis that drifting red algal mats inhibit settlement of planktonic larvae was tested in a field experiment in 1986. Substratum free of algae (caged boxes) was compared with substratum covered with algae (natural substratum and open boxes). Settling densities of 1500 to 5500 ind. m-2 of the bivalves *Macoma balthica, Cardium glaucum* and *Mya arenaria* were observed in sediment without algal cover, whereas no recruits of the same species were found beneath the algae during the period of peak settlement (June to July). The same difference was observed for the polychaete *Nereis diversicolor*, although in this case occasional individuals were found beneath the algae. The results demonstrate that algae mats may be efficient inhibitors of larval settlement to benthic soft-substratum communities. It is concluded that algae act as a larval filter.

Verification of Firth of Thames hydrological model (2007)
Oldman, J. W.
Auckland Regional Council and NIWA

Spatial Information: Firth of Thames, New Zealand
Keywords: Tidal currents New Zealand Thames, Firth of Thames Computer simulation; Harbours New Zealand Thames, Aquaculture New Zealand Thames, Firth of.

Summary: In 2003 the Auckland Regional Council contracted NIWA to undertake an ecological sustainability assessment for aquaculture in the Firth of Thames. The work

was undertaken using a hydrodynamic model to simulate physical conditions in the Firth (Stephens 2003), and this was coupled with a biological model (Broekhuizen et al.2004). To verify the hydrodynamic model it was re-run and compared with field data collected near Waimangu Point during April 2001 (Zeldis et al. 2001). This work complements another verification against data gathered at Wilson Bay in the eastern Firth (Broekhuizen et al. 2005).

Marsh Birds of the Waikareao and Waimapu Estuaries: An Impact Assessment (1994)
O'Neill, S.M.
Bay of Plenty Polytechnic Report no. 13

Spatial Information: Tauranga Harbour, New Zealand – Waikareao & Waimapu Estuaries
Keywords: Marsh Birds, Waikareao Estuary, Waimapu Estuary

Summary: A survey was carried out at four sites at the Waikareao and Waimapu Estuaries to compare bird numbers in a wetland with a walkway that is used extensively by the public and a wetland that is in a relatively natural state. Of the five different species looked for, only two were sighted, they were the Banded Rail and the North Island Fernbird. Although the Marsh Crake, the Spotless Crake and the Australasian Bittern were not seen, they still may be present. To ensure the well being of the birdlife, dog owners should be made aware of the harm their dogs can do to the bird life of a wetland when they are allowed to run freely. People must also be kept off the wetland area if the vegetation is to survive.

Classification and evolution of the genus *Phymatophaea* Pascoe from New Zealand and New Caledonia (Coleoptera: Cleridae: Enopliinae) (2009)
Opitz, W.
Journal of the Royal Society of New Zealand

Spatial Information: New Zealand and New Caledonia

Summary: The genus *Phymatophaea* Pascoe is revised here for the first time. It consists of 22 species, 21 from New Zealand and one from New Caledonia. Ten species are described as new: *P. aquila, P. auripila, P. caledonia, P. deirolinea, P. enodis, P. earlyi, P. insula, P. maorias, P. tracheloglaba*, and *P. watti*. Of the 25 nominal species listed in Corporaal's world catalogue 12 are considered valid species: *P. atrata* Broun, *P. breviclava* Broun, *P. guttigera* (Waterhouse*), P. fuscitarsis* Broun, *P. hudsoni* Broun, *P. longula* Sharp, *P. lugubris* Broun, *P. oconnori* Broun, *P. opacula* Broun*, P. opilioides* (Pascoe), *P. pustulifera* (Westwood), and P. testacea Broun. Lectotypes are designated for all valid previously published species except: P*. breviclava* Broun, *P. fuscitarsis* Broun, *and P. opacula* Broun, whose primary types are based on holotypes. Twelve new synonymies are proposed, which are as follows: the junior synonym of *P. atrata* Broun is *P. griseipennis* Broun; of *P. guttigera* are *P. brevicollis* Broun, *P. dorsalis* Broun, *P. formosa* Broun, *P. ignea* Broun, *P. nigricornis* Broun, *P. picta* Broun, and *P. viridans* Broun; *of P. hudsoni* Broun is *P. fulvipalpis* Brown; of *P. opacula* Broun is *P. sculptipennis* Broun; of *P. opilioides* (Pascoe) is *P. apicalis* Broun; and of *P. pustulifera* (Westwood) is *P. abnormis* Broun. Phymatophaea species are classified into seven species groups (see Table 1) which are considerably different morphologically. The North Island is apparently more speciose than the South Island although it is acknowledged that this

may reflect collecting bias. Intraspecific variation in colour is prominent in the genus, particularly in the guttigera group. Phymatophaea are thought to be predators of lignicolous insects with several species apparently members of mimetic complexes. Five synapotypies distinguish *Phymatophaea:* antennal club sex dimorphic, 9th antennomere subtrapezoidal, profemora robust, one pair of mesodermal male accessory glands, and tegminal plates slender. The substantial morphologic diversity among the species groups is interpreted as a manifestation of extensive evolution, antiquity of the groups, considerable extinctions, and a paleohistory that may date back to Gondwana.

A global crisis for seagrass ecosystems (2006)
Orth, Robert J.; Carruthers, Tim J. B.; Dennison, William C.; Duarte, Carlos M.; Fourqurean, James W.; Heck, Kenneth L.; Hughes, A. Randall; Kendrick, Gary A.; Kenworthy, Judson. W; Olyarnik, Suzanne; Short, Frederick T.; Waycott, Michelle; Williams, Susan L.
University of California Press on behalf of the American Institute of Biological Sciences

Spatial Information: Worldwide
Keywords: Plants; Sea grass

Summary: Seagrasses, marine flowering plants, have a long evolutionary history but are now challenged with rapid environmental changes as a result of coastal human population pressures. Seagrasses provide key ecological services, including organic carbon production and export, nutrient cycling, sediment stabilization, enhanced biodiversity, and trophic transfers to adjacent habitats in tropical and temperate regions. They also serve as "coastal canaries," global biological sentinels of increasing anthropogenic influences in coastal ecosystems, with large-scale losses reported worldwide. Multiple stressors, including sediment and nutrient runoff, physical disturbance, invasive species, disease, commercial fishing practices, aquaculture, overgrazing, algal blooms, and global warming, cause seagrass declines at scales of square meters to hundreds of square kilometres. Reported seagrass losses have led to increased awareness of the need for seagrass protection, monitoring, management, and restoration. However, seagrass science, which has rapidly grown, is disconnected from public awareness of seagrasses, which has lagged behind awareness of other coastal ecosystems. There is a critical need for a targeted global conservation effort that includes a reduction of watershed nutrient and sediment inputs to seagrass habitats and a targeted educational program informing regulators and the public of the value of seagrass meadows.

Capture-based aquaculture: the fattening of eels, groupers, tunas and yellowtails (2004)
Ottolenghi, Francesca, Food and Agriculture Organization of the United Nations.
Food and Agriculture Organization of the United Nations

Spatial Information: No spatial context
Keywords: Fish culture.; Cage aquaculture.; Eels.; Groupers.; Tuna.; Yellowtail.; Eels Feeding and feeds.; Groupers Feeding and feeds.; Tuna Feeding and feeds.; Yellowtail Feeding and feeds.

Summary: Defines and reviews certain practices that are shared between aquaculture and capture fisheries. Specifically considers the on-growing or fattening

of four species groups - eels, groupers, tunas and yellowtails - which is based on the use of wild-caught "seed". Begins with an introduction on the overlap between aquaculture and fisheries and their global trends. Chapters on the four species groups follow and include information on species identification, fishery trends, the supply and transfer of "seed" for stocking purposes, aquaculture trends, culture systems, feeds and feeding regimes, fish health, harvesting and marketing. Further chapters examine the environmental and socio-economic impacts of capture-based aquaculture, together with the relevant fisheries and aquaculture management issues, and food safety issues.

Distribution and conservation of shorebirds in the Bay of Plenty, New Zealand, 1984-2003 (2006)
Owen, K. L.; Wilson, T. D.; Latham, P. M.; Young, K. D.
Department of Conservation Technical report series 26

Spatial Information: Bay of Plenty, New Zealand
Keywords: Shorebirds (Order Charadriiformes), Bay of Plenty, RAMSAR Conservation criteria

Summary: Shorebirds (Order Charadriiformes) have been counted at high tide roosts on harbours, estuaries and beaches in the Bay of Plenty since 1970. Twice yearly (summer and winter) counts started in 1984 and continue today. This report is an analysis of numbers and distribution of shorebirds in the Bay of Plenty from 1984 to 2003. It considers the contribution Bay of Plenty's shorebirds make to national shorebird populations and whether these achieve the RAMSAR Conservation criteria for wetlands of international importance. The location and properties of shorebird roost sites are described and some outcomes from conservation management programmes in the Bay of Plenty discussed.

3.16. P

Natural environmental regional monitoring network river and stream channel monitoring programme - 2000/2001 and 2001/2002 (2003) - 2002/03, 2003/04, 2004/05 and 2005/06 (2006)

Pak, I.
Environment Bay of Plenty

Spatial Information: Bay of Plenty region, New Zealand
Keywords: Sedimentation

Summary: The Environment Bay of Plenty Natural Environmental Regional Monitoring Network (NERMN) River and Stream Channel Monitoring was included as part of the network for the first time in 1993/94. The River and Stream Channel Monitoring Programme provides Environment Bay of Plenty with:

- Reliable data to identify the quantity of gravel available for extraction and the present extraction rates in the Bay of Plenty region.
- Data to allow setting maximum annual extraction rates available based on river control and river maintenance criteria.

- Data with which Environment Bay of Plenty can meet its statutory obligations under the Resource Management Act, and more effectively manage the region's resources.

Stormwater discharge AEE and management plan for the Mount Maunganui wharves at the Port of Tauranga (1998)
Palmer, J.; Fengming, T.; Healy, T.; Thompson, G.

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga, Stormwater discharge, Mt Maunganui wharves

Summary: The prime purpose of this report is to provide an AEE and Management Plan to support an application for a long-term resource consent to discharge storm runoff from the Mount Maunganui port area. This report sets quality objectives for the stormwater discharge. It recognises that these quality objectives cannot be achieved immediately but will require a planned programme of work.

Placing well-being: A Maori case study of cultural and environmental specificity (2007)
Panelli, R.; Tipa, G.
EcohealthJournal

Spatial Information: New Zealand
Keywords: well-being; Culture; place; Maori; Environment; New Zealand; IndigenousKnowledge

Summary: Studies of well-being have been dominated by perspectives that stem from Western, health-science notions of individual's health and psychological development. In recent times, however, there has been a developing sensitivity to the cultural and place-specific contexts affecting the health and well-being of contrasting populations in different environments. Drawing on these advances, this article explores the potential in conceptualizing a place-based notion of well-being that recognizes the cultural and environmental specificity of well-being for specific populations in a given setting. We argue that a geographical approach to well-being enables the linking of culture and environment for future indigenous research into both ecosystems and human health. Taking the case of an indigenous population, we identify the contexts that affect Maori well-being and we argue that key sociocultural and environmental dimensions need to be integrated for a culturally appropriate approach to Maori well-being.

Sea lettuce monitoring in the Tauranga Harbour 1991-2007 (2007)
Park, S.
Environment Bay of Plenty Environmental Publication 2007/20

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour, sea lettuce

Summary: This report presents the results of Environment Bay of Plenty's sea lettuce (*Ulva* spp.) monitoring programme. This programme was set up in 1991 in response to the extensive blooms that were occurring in Tauranga Harbour at that

time. In addition Environment Bay of Plenty set up a sea lettuce technical committee and funded a number of earlier research projects. The long period of data recorded allows various aspects of sea lettuce dynamics in Tauranga Harbour to be clearly seen. Current levels of abundance (early to mid 2007) are low to moderate in comparison to the longer term record. Seasonal patterns with high spring growth are very apparent at all sites. Abundance can change rapidly in a very short time due to the effect of wind and tides which introduces high random variability. This can lead to some sites having high abundance while others have very little. Despite the variability some factors influencing abundance are still clearly detectable. Abundance has a highly significant relationship with the Southern Oscillation Index (SOI) with more sea lettuce being present during El Nino events and less during La Nina.

Bay of Plenty Marine Sediment contaminants survey 2008 (2009)
Park, S.
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: Organic Pollutants, Inorganic Pollutants, Sedimentation

Summary: This report presents the results of the annual sediment contaminant monitoring in the Bay of Plenty region harbours and a one off recording of stormwater outfall in the industrial areas around Tauranga city. The contaminant levels were compared to the levels given in the Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 guidelines which are the interim sediment quality guidelines. A low value in these guidelines is a level of a contaminant where there may be sub-lethal effects on species. High levels indicate potential toxicity. Park (2008) concluded that the results from samples of sediment around stormwater outlets showed low to moderate contamination overall. There were areas of high contamination when values were standardised to the mud fraction with the drain for Te Maire Rd industrial area exceeding at least the low guidelines for every metal except mercury. Te Maire Rd exceeded the high guideline value for As, Cr, Cu, Pb, Ni and Zn. Exceptionally high readings were recorded for Zinc. These were 4851 and 3321 mg/kg where the high value guideline is 410 mg/kg. Copper levels were also high in this area with recorded values of 522 and 368 mg/kg where the high value guideline is 270 mg/kg. This indicates that Te Maire Rd is an area of high contamination. Zinc levels exceeded at least the low guideline value for all sites except Welcome Bay 50 m. High levels were recorded for: Te Maire Rd as listed above, Grace Rd 0-10 m (635 mg/kg), Maxwell Rd 0-10 m (646 mg/kg), Harbour Dr 50 m (742 mg/kg), Fraser Rd 0-10 m (547 mg/kg), Fraser Rd 50 m (525 mg/kg), Welcome Rd 0-10 m (1179 mg/kg). A potential source for zinc is from roofing materials. Park notes that similar pattern of contamination have been found for Auckland drains from industrial sites. The conclusion of this report is that industrial areas contribute high levels of contaminants and that ongoing monitoring of contaminates should occur and strategies to reduce levels investigated.

Environment Bay of Plenty Tauranga Harbour regional plan environmental investigations: ecology of Tauranga Harbour (1994)
Park, S.; Donald, R.
Environment Bay of Plenty Report No. 94/8

Spatial Information: Tauranga Harbour, New Zealand

Keywords: Tauranga Harbour, sea lettuce, Neptune's necklace, Gracilaria secundata, pink coralline turf algae (*Corallina officinialis*), *Gelidium caula cantheum*, and *Ceramium species*

Summary: A survey of Tauranga Harbour in 1994, identified sea lettuce (*Ulva* sp.), Neptune's necklace, *Gracilaria secundata*, pink coralline turf algae (*Corallina officinialis*), *Gelidium caula cantheum*, and *Ceramium* species as very abundant within soft shore areas. They noted that most other algal species identified were rarely encountered.

Sea Lettuce Monitoring in the Bay of Plenty : Changes in Abundance, Nutrients and Environmental Influences for the period July 1992 - June 1996 (1996)
Park, S.
Environment Bay of Plenty Environmental Report 96/23

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Ulvales New Zealand Tauranga Harbour.; Aquatic ecology New Zealand Tauranga Harbour.; Environmental monitoring New Zealand Bay of Plenty (Region); Plants; Sea lettuce

Summary: This report presents monitoring results from Environment BOP's four *Ulva* monitoring sites located in Tauranga and Ohiwa Harbours for the period July 1992 to June 1996. This monitoring programme consists of baseline monitoring undertaken as part of the Coastal and Estuarine Ecology - Natural Regional Monitoring Network. Monitoring is conducted every second month to gain data on sea lettuce biomass, nutrient status, environmental influences and sediment water interactions in relation to growth and the development of nuisance blooms in Tauranga Harbour.

An increased understanding of sea lettuce dynamics in Tauranga Harbour is now emerging which will help in setting any possible management objectives. Ongoing baseline monitoring will help determine factors which lead to nuisance sea lettuce blooms.

Bay of Plenty Coastal Water Quality 1996 - 1997 (1998)
Park, S.G.
Bay of Plenty Regional Council Environmental Report 98/5

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Water quality, Bay of Plenty, Whakatane, Tauranga Moana

Summary: This report presents results from the first series of comprehensive coastal water quality surveys conducted within the Bay of Plenty from August 1996 through May 1997. Surveys were conducted at sites along two transects extending out to the edge of the continental shelf off Tauranga and Whakatane on each of four occasions. It is intended to repeat the surveys once every third year until an adequate baseline data set is established. Objectives of the programme included the assessment of nutrient status of the shelf waters and the relative contribution from terrestrial/anthropogenic inputs versus those from the open ocean. Surveys were structured to maximise data acquisition that would improve the understanding of the ecosystems/physical dynamics. Information gained from the study will assist in the future reviews and monitoring of Environment BOP coastal plan.

Changes in Abundance of Seagrass *(Zostera spp.)* in Tauranga Harbour from 1959-96 (1999)
Park, S. G.
Bay of Plenty Regional Council Environmental Report

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Plants; Sea grass

Summary: This report presents the results of mapping and assessing changes in abundance of seagrass throughout the whole of Tauranga Harbour between 1959 and 1996. Seagrass beds have high ecological values and contribute to the harbour ecosystem in terms of:

- stabilising the sea bed and preventing erosion,
- provide food and shelter for a range of small animals,
- increase productivity
- increased habitat complexity and hence species diversity.

Seagrass beds are particularly sensitive to human induced impacts that result in a decrease in the levels of light reaching the seabed. Overseas the main impacts are usually caused by increased suspended sediment and nutrients from land runoff and stormwater. Overall the loss of seagrass beds between 1959 and 1996 has been assessed at 34% for the whole of Tauranga Harbour. Seagrass beds in the shallow subtidal and sub-estuary areas with larger catchments have suffered the most. Losses for the estuaries along the western fringe of the harbour average 69%. Subtidal areas have suffered the highest loss at 90% for the whole harbour. The areas near the harbour entrance with little land runoff or influence from other catchments have shown the smallest decline in seagrass abundance.

Benthic Macrofauna Monitoring (2000)
Park, S.G.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: water quality, monitoring, benthic macrofauna, Tauranga Harbour, Te Awanui, species richness, Bay of Plenty, estuary, coastal ecosystems, pollutant, accumulate, eutrophication, sediment

Summary: The Coastal & Estuarine Ecology (CEE) benthic macrofauna-monitoring programme includes over fifty established sites throughout the harbours and coastal environment of the Bay of Plenty. Currently only 21 sites are being surveyed on an annual basis. The majority of these are in the harbours and estuaries where water quality impacts are more likely to cause a decline in ecological health. Over the ten-year period of monitoring, no major decline in species richness of benthic macrofauna has been detected at these sites.

Bay of Plenty Maritime Wetlands Database (2000)
Park, S. G.
Environment Bay of Plenty Environmental Report 2000/21

Spatial Information: Tauranga Harbour and Ohiwa Harbour, New Zealand
Keywords: Wetland, Tauranga and Ohiwa Harbours, weed infestation, mangroves, Regional Coastal Environment Plan

Summary: Wetland vegetation surveys, digital mapping, database design and data capture have now been completed for nearly all the maritime wetland within the Bay of Plenty region. In addition an estimation of historical wetland from aerial photography has been mapped for Tauranga and Ohiwa Harbours at a 1:10,000 scale. The information and database form an important tool for mapping and assessing these ecosystems. In particular the surveys and data can provide both spatial and quality assessments for areas of special importance with formal protection in the Regional Coastal Environment Plan. It can also provide baseline data allowing assessment of ecosystem impacts and change in general that may link to the success or otherwise of environmental plans and management.

Marine Sediment and Contaminants Survey (2001-03) of Tauranga Harbour (2003)
Park, S.G.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: sediment, contaminant, Tauranga Harbour, Te Awanui, metal, polycyclic aromatic hydocarbons, polychlorinated biphenyls, estuary, pesticide, stormwater

Summary: An extensive sediment survey covering the whole of Tauranga Harbour was undertaken from 2001-03 to provide information on sediment particle size (392 sites), nutrients and total organic content (TOC) (135 sites), metals (32 sites), total petroleum hydrocarbons (29 sites), pesticides (18 sites), polycyclic aromatic hydrocarbons (PAH's) (19 sites) and polychlorinated biphenyls (PCB's) (8 sites). The sampling of sites was weighted towards the sheltered sub-estuaries around the harbour, particularly for the contaminants sampling which targeted settlement areas. Results for sediment particle size were used to produce maps of mud (silt and clay) content. These muddy areas define the sensitive settlement zones around the harbour. The muddy areas can also be used as an accurate indicator of where sediment nutrient and TOC levels are high as these parameters are highly correlated. As might be expected the muddiest areas of the harbour are the small estuaries along the western harbour margin from Katikati to Te Puna Estuary.

Aspects of Mangrove Distribution and Abundance in Tauranga Harbour (2004)
Park, S.G.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Mangroves New Zealand Tauranga Harbour.; Aquatic ecology New Zealand Tauranga Harbour.; Environmental monitoring New Zealand Bay of Plenty (Region); Plants; Mangroves, Environment Bay of Plenty

Summary: This report presents results on the distribution of mangroves in the Tauranga Harbour and also looks into factors relating to the increase. A number of sites were selected around Tauranga Harbour for mapping of mangrove extent from 1943 up to 2001. All sites show a pattern of exponential increase. The rate of increase appears to reflect the overall abundance of mangroves in a particular area.

Blue Gum Bay for instance has one of the lowest proportions of mangrove cover relative to estuary size and also has the lowest rate of increase. A number of variables were looked at with respect to mangrove extent. Results showed that there is a good correlation between the average mud content of an estuary and the proportion of mangrove cover, although it would not be the only environmental factor to influence extent. Those estuaries around Tauranga Harbour with higher mud content also tend to be on the western margin with larger catchments. Areas that have cleaner sands near the entrances or in open exposed areas generally have fewer mangroves. It is clear that higher rates of sediment input to sheltered estuarine environments will enhance the rate of mangrove spread.

Bay of Plenty Coastal Water Quality 2003 – 2004 (2005)
Park, S.G.
Environment Bay of Plenty Regional Council

Spatial Information: Bay of Plenty Coast - Pukehina, Whakatane and Opotiki, New Zealand
Keywords: aquaculture, water quality, quantification of phytoplankton communities, current measurements, temperature profiling of the water column.

Summary: A study of the Central Bay of Plenty's coastal shelf waters was undertaken to collect data for the support of modelling and estimating the sustainability and carrying capacity of aquaculture. The study included physical and chemical analysis of the waters, quantification of phytoplankton communities, current measurements and temperature profiling of the water column and the use of remote sensing to provide a synopsis of seasonal and spatial patterns of sea surface temperature and chlorophyll-a concentrations. In this report data gained from physical, chemical and phytoplankton analysis of the water column is presented. Field work to collect physical, chemical and phytoplankton data was conducted along three transects spanning the coastal shelf out to a depth of 200 m at Pukehina, Whakatane and Opotiki.

Bay of Plenty Marine Sediment Contaminant Survey 2008 (2009)
Park, S.G.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: contaminant, heavy metals, organics, Tauranga Harbour, monitoring, estuarine, sediment, benthic, macrofauna, stormwater, land use, polycyclic aromatic hydrocarbons, copper, zinc, lead, toxic

Summary: This report presents sediment contaminant results (metals and organics) from the following surveys:

- Tauranga Harbour and Ohiwa Harbour baseline monitoring (2006) – this is undertaken every three years.
- Coastal and estuarine ecology survey (2006 to 2008) – sediment sampling of harbours and estuaries for metals is undertaken annually in conjunction with the benthic macrofauna sampling.
- Stormwater outlet survey (2008) - a one-off survey of sediment contaminants associated with stormwater outfalls and industrial areas around Tauranga City.

Dissolved oxygen monitoring over mulched mangrove areas (2011)
Park, S.G.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Mangroves

Summary: Dissolved oxygen (DO) measurements were taken in the water overlying mulched mangrove areas between the 7th and 9th December 2010. Two mulch sites (Waikareao and Omokoroa – Lynley Park) were monitored along with one control site of untouched mature mangroves (upper Te Puna estuary). The two mulch sites were chosen as they are both very large and therefore represent the worst case in terms of the potential for DO depletion. The Omokoroa site is a relatively old site being mulched on 10 February 2010 while work ceased in the Waikareao on 31 August 2010. They therefore have the potential to show differing rates of decomposition and associated impacts on oxygen levels.

Synopsis of SST and Chl-a in Bay of Plenty (2006)
Park, S.G.; Longdill, P.
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: Ocean temperature New Zealand Bay of Plenty (Bay) Measurement.; Chlorophyll New Zealand Bay of Plenty (Bay) Measurement.; Ocean temperature New Zealand Bay of Plenty (Bay) Remote sensing.; Chlorophyll New Zealand Bay of Plenty (Bay) Remote sensing.; Bay of Plenty (N.Z. : Bay) Environmental conditions.

Summary: A study of the Bay of Plenty's coastal shelf waters was undertaken to collect data for the support of modelling and estimating the sustainability and carrying capacity of aquaculture. The study included physical and chemical analysis of the waters, quantification of phytoplankton communities, current measurements and temperature profiling of the water column and the use of remote sensing to provide a synopsis of seasonal and spatial patterns of sea surface temperature and chlorophyll-α concentrations. This report presents results gained from development and processing of remote sensing data provided by NIWA (see Remote Sensing Survey of the Bay of Plenty: Report on Sea Surface Temperature and Ocean Colour Product Generation for Environment Bay of Plenty). This work was part of the Aquaculture Management Areas (AMA) science project which has also included collection of physical and biological data (Oct 2003 – May 2004) to support assessment of the productivity and sustainability of coastal shelf waters within the Bay of Plenty.

Tauranga Harbour sediment study: specification of scenarios (2008)
Parshotam, A., Hume, T., Elliot, S., Green, M., & Wadhwa, S.
NIWA

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation

Summary: This report defines scenarios that are to be modelled in the Tauranga Harbour Sediment Study, including the way the scenarios were derived and the assumptions that were used. Three scenarios are to be modelled, which will differ in terms of landuse, which includes earthworks associated with any development, and weather. Each scenario covers 50 years into the future from the present day, which is defined as 2001. Scenario 1 has present-day (2001) landuse with 2007 earthworks associated with development, and present-day weather. This scenario is intended as a baseline against which comparisons can be made. Scenario 2, for the period 2001 to 2051, has landuse as provided for in SmartGrowth and Change No.2 (Growth Management) to the Regional Policy Statement Change in the Western Bay of Plenty sub-region, and present-day weather. Scenario 3, for the period 2001 to 2051, has the same landuse as scenario 2, but with weather incorporating anticipated effects of climate change.

Tauranga harbour sediment study: sediment load model implementation and validation (2009)
Parshotam, A., Wadhwa, S., & Mullan, B.
NIWA

Spatial Information: Tauranga Harbour - Waimapa, Kopurererua and Waimapu Streams, New Zealand
Keywords: sedimentation

Summary: This report describes the implementation and validation of the GLEAMS model for simulating sediment generation in the rural and urban areas of the catchment surrounding the Tauranga Harbour. The model developed and implemented is called the "GLEAMS-TAU" model. The input data requirements of the study are detailed as well as the assumptions for creating climate and land use scenarios established by Parshotam et al. (2008). A validation of the GLEAMS-TAU model is performed using monitoring data. The predictions of the combined GLEAMS-TAU sediment load model and sediment stream network routing procedure were compared with sediment load estimates derived from monitoring data at Waimapa, Kopurererua and Waimapu Streams. The modelled loads compare well with these data, giving confidence in the application of the sediment load model for providing predictions of long-term average sediment loads for a range of catchment conditions.

Status of the introduced brown seaweed *Undaria* in New Zealand (1995)
Parsons, M.J
Department of Conservation Advisory Science Notes No.112

Spatial Information: Elsewhere in New Zealand - harbours of Wellington, Lyttelton, Timaru, Oamaru, Picton, Porirua, Otago, and Port Chalmers
Keywords: brown seaweed *Undaria, U. pinnatifida,* harbours of Wellington, Lyttelton, Timaru, Oamaru, Picton, Porirua, Otago, and Port Chalmers

Summary: *Undaria pinnatifida* (Phaeophyceae, Laminariales) was accidentally introduced into New Zealand waters from Japan sometime before 1987. To date it has been found in the harbours of Wellington, Lyttelton, Timaru, Oamaru, Picton, Porirua, Otago, and Port Chalmers, apparently spread by shipping. A description of *U. pinnatifida* and details of its life history are given. Information is provided on the size of the plants in New Zealand and their seasonality, which differs somewhat from

that seen in Asia. Substrate preferences and the depth of growth are summarised. Temperature is the most important environmental factor influencing the spread of *Undaria* in New Zealand waters. In time this seaweed will probably become established in most New Zealand ports, having been spread by coastal shipping. It is believed that *Undaria* will integrate into the natural community of marine organisms and not displace any other species completely. It is not possible to control the spread of *Undaria* in the marine environment. Care should be taken not to introduce any other new species or strains of species of marine algae into New Zealand waters.

Estimation of the value of ecosystem services in the Waikato region (1999)
Patterson, M.; Cole, A.
Environment Waikato Internal Series

Spatial Information: Waikato region, New Zealand
Keywords: Non-market valuation, New Zealand, Consumer surplus, Resource Management Act

Summary: Non-market valuation (NMV) is recognized as an essential tool in policy decision making worldwide. In this paper, we investigate the history of NMV, specifically in relation to New Zealand (NZ), by compiling and analysing all available published studies. Results show a significant increase in the number of studies, specifically those requested by government agencies, following the passage of the NZ Resource Management Act of 1991. Studies were found to be concentrated in three major areas: outdoor recreation, environmental conservation/management, and travel time savings. These three areas covered eight environmental commodities, the value of which totalled NZ$72 billion, or 50% of NZ GDP, with the highest valued commodity being biodiversity services. While our analysis yielded many positive results, we did discover, however, a severe lack of studies in many areas including pest control, water resources and outdoor recreation.

Primary production required to sustain global fisheries (1995)
Pauly,D.; Christensen,V.
Nature Journal

Spatial Information: No spatial context
Keywords: Foodweb

Summary: The mean of reported annual world fisheries catches for 1988-1991 (94.3 million t) was split into 39 species groups, to which fractional trophic levels, ranging from 1.0 (edible algae) to 4.2 (tunas), were assigned, based on 48 published trophic models, providing a global coverage of six major aquatic ecosystem types. The primary production required to sustain each group of species was then computed based on a mean energy transfer efficiency between trophic levels of 10%, a value that was re-estimated rather than assumed. The primary production required to sustain the reported catches, plus 27 million t of discarded bycatch, amounted to 8.0% of global aquatic primary production, nearly four times the previous estimate. By ecosystem type, the requirements were only 2% for open ocean systems, but ranged from 24 to 35% in fresh water, upwelling and shelf systems, justifying current concerns for sustainability and biodiversity.

Sediment transport on intertidal flats, in a tide-dominated environment, Wairoa Estuary, Tauranga, New Zealand (2000)
Perano, K.M.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand - Wairoa Estuary
Keywords: Sedimentation

Summary: This thesis looks at sediment transport on intertidal flats, in a tide-dominated environment – Wairoa Estuary, Tauranga. The Wairoa River intermittently carries very high volumes of floodwater, sediment and debris of numerous forms, and as a consequence the low-lying floodplains downstream are susceptible to flooding. EBOP has undertaken assessments of the sources of sediment in the Wairoa River. EBOP considers that because the Wairoa River is almost completely diverted through the Ruahihi power scheme, under normal flow conditions, sediments in the water are low at the Ruahihi site because of settling in the hydro-lakes. From the Ruahihi site to the harbour, the Wairoa River has a small gradient and is relatively wide, hence little riverbank erosion is caused by the slow flow. This alters dramatically at times of high flood and when agitation is increased by wind action of speeding powerboats. The bulk of sediments in the river are thought to originate through some of the main tributaries.

New learnings from Old Understandings. Conducting Qualitative Research with Maori (2009)
Pere, L; Barnes, A
Qualitative Social WorkJournal

Spatial Information: New Zealand
Keywords: cultural frameworks; Empowerment; ethics; Maori research programmes; worldviews

Summary: The article demonstrates the absolute place of tikanga in research with Maori; tikanga being those ways of doing what is right for a given context centred in Maori values, beliefs, traditions and customs. A qualitative study involving Maori participants exposed large gaps in understanding of this importance beyond rhetoric. Western research processes surrounding consultation, consent and ownership of data were challenged by Maori philosophies and principles governed by tapu and noa. Adherence to understanding of 'kanohi ki te kanohi', 'he kanohi kitea', manaakitanga, 'tangata mauri', 'powhiri, mihimihi and karakia ensured informed and consensual participation. The rights and responsibilities of iwi to conduct research in keeping with local kawa also ensured this participation was safe and respectful. This acknowledgements of 'tino rangatiratanga' was poorly understood, highlighting the significance of undertaking research with Maori in a way that takes for granted the validity and legitimacy of Maori in a context where Maori worldviews are centred.

Ground water resources of the Tauranga group sediments in the Hamilton Basin, North Island, New Zealand (1988)
Petch, R. A.; Marshall, T. W.
Journal of Hydrology New Zealand

Spatial Information: Hamilton Basin, North Island, New Zealand
Keywords: Sedimentation

Summary: The Tauranga Group sediments contain the most important and widely distributed aquifers in the Hamilton Basin. Among these sediments the most productive aquifers are well-sorted, coarse sand and gravel deposits. However, poor hydraulic characteristics are common because the sediments are often poorly sorted, and high-yielding zones are interspersed with lenses of less permeable silts, clays and peats. The spatial variation of the regional piezometric surface and the patterns of ground-water flow closely follow the surface topography in the Basin. The depth to the piezometric surface varies, from a few metres below the undissected lowland plains, to a 30 m adjacent to incised stream channels. Vertical piezometric gradients and isotopic analyses suggest most ground water flow is restricted to the upper 30 m of the Tauranga Group sediments. Recharge occurs from rainfall infiltration over the undissected lowland plains: ground-water discharge is by effluent flow to the incised stream networks. The net variation in aquifer storage observed during this study (9 ram) suggests recharge to the Tauranga Group sediments equals discharge from them and implies no subterranean leakage from the Basin. The implied equilibrium between aquifer recharge and discharge means use of ground water will be associated with a reduction in stream flow. Thus, the availability of water resources in the Tauranga Group sediments depends on the joint management of ground water and surface water resources.

Wetland Restoration, a handbook for New Zealand freshwater systems (2010)
Peters, M.; Clarkson, B
Manaaki Whenua Press, Landcare Research

Spatial Information: New Zealand wide
Keywords: Wetland Restoration

Summary: Wetland Restoration: A Handbook for New Zealand Freshwater Systems brings together expertise from specialists and groups actively engaged in restoring wetlands throughout the country. The Handbook builds on regionally based restoration guides and provides a detailed, comprehensive ecosystem approach towards understanding, protecting and enhancing our remaining wetlands. It is targeted at those who plan to, and those who already are making a difference to improving wetlands, and is written in a way that can easily be understood and, importantly, acted on. The results, showcased using a diverse range of case studies, speak for themselves. The numbers of individual landowners, interest and conservation groups now restoring wetlands to capitalise on their natural attributes and applying more sustainable landuse practices are increasing. Now that we understand what we have lost, and what we can gain, perhaps New Zealand can become a world leader in wetland restoration. What is being achieved speaks well not only for the future of wetlands but also for the whole country as international pressures associated with climate change, reducing green house gases and conserving indigenous biodiversity, drive change towards environmental improvement.

The dynamics of a bivalve nursery system: an investigation of the coupling dynamics between outdoor phytoplankton ponds and a pumped upweller nursery system used for on-growing bivalve spat (2003)
Pilcher, Olin
University of Waikato

Spatial Information: Elsewhere in New Zealand - Nelson
Keywords: Aquaculture New Zealand Nelson.; Freshwater phytoplankton New Zealand Nelson.; Water quality New Zealand Nelson.; Freshwater biology New Zealand Nelson.

Summary: Spawning of *P.canaliculus* broodstock and rearing of all larvae was completed in accordance with the standard methods used by the industry. Spawning of mussels was via thermal shock and gametes collected from mussels of the same site were mixed to provide 'site-pure' F1 larvae. Several full-sib crosses from individual male-female pairings were created in this way. Juveniles were reared to sexual maturity under identical conditions in the Cawthron Institute's shellfish nursery, receiving seawater at ambient temperature (18.1±0.6°C mean ± s.d.) from eutrophic algae ponds, allowing *ad libitum* feeding.

Supporting information, consent application for the dredging and disposal of silty materials (n.d.)
Port of Tauranga,
Port of Tauranga

Spatial Information: Tauranga Port
Keywords: Port of Tauranga

Summary: The report describes the processes for dredging activity in the Tauranga Harbour and the associated disposal. The principal methods used by the Port of Tauranga are - trailer-suction dredging, and bucket excavators. The primary adverse effect of dredging is the resulting suspended solids and turbidity. The trailer-suction dredge operates via a long suction pipe with a draghead attached which trails alongside the vessel, similar to a vacuum cleaner. The bucket works similar to operations on land. The disposal site for the dredged material is located 16 km from the harbour entrance.

Environmental impact assessment, Sulphur Point wharf extension No 2 – north (1994)
Port of Tauranga
Port of Tauranga

Spatial Information: Tauranga, New Zealand
Keywords: Port of Tauranga,

Summary: The Port of Tauranga has announced plans to construct a further 170 m of new wharf at Sulphur Point Tauranga, together with associated reclamation, storage areas and services. This development is required to further the promotion and marketing of the Port and to attract new shipping services and trades. According to the report, the wharf and reclamation is heavily modified with very little ecological value. The wharf piles and extended rock walls will provide a richer habitat than that which currently exists. There will be no detectable impacts on current flows or sediment transport regimes. There is also no link between this development and beach erosion issues at Whareroa and Sulphur Point.

Take a Look at Our Future, New Zealand's Port for the Future (2009)
Port of Tauranga
Port of Tauranga

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga

Summary: This report consists of plans and photographs of future planned expansion of the Port of Tauranga and applications to deepen the channel from 11.7 metres to 14.5 metres at low water.

Environmental Policy (n.d.)
Port of Tauranga
Port of Tauranga

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga

Summary: The Port's operations are guided by our Environmental Policy and - under the Resource Management Act 1991 - are governed by resource consents protecting the harbour and neighbouring environment. These cover the Port's activities such as dredging, spoil disposal, discharges and wharf construction. All consents have monitoring conditions to ensure the quality of our community's environment is maintained. The Environmental Policy: Port of Tauranga Limited will:

- Seek continual improvement to environmental and social outcomes by ensuring that these are considered as part of the day-to-day management of all business units;
- Seek to minimise the use of resources by implementation of new technologies, processes and practices;
- Identify and take into account community aspirations and needs;
- Comply with all relevant environmental legislation;
- Establish procedures for setting, reviewing and achieving environmental objectives; and
- Communicate policy and procedures, as required and appropriate, to all stakeholders including employees, other port users, government, iwi and other community interest groups

Compliance/impact monitoring report, Bay of Plenty Fertiliser Limited, consent no. 2031/2 (1990)
Power, Fergus M.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Bay of Plenty Fertiliser Limited, Effluent quality, New Zealand, Tauranga Harbour, Water quality, Waste disposal in the ocean, Environmental aspects

Summary: On the 3rd of December 1987, the Bay of Plenty Regional Water Board granted Bay of Plenty Fertiliser Limited a consent to discharge up to 2500 m^3/day of cooling water and wastewater into Tauranga Harbour. This consent expired on 31

May 1992. The current consent application relates to the discharge of cooling and wastewaters arising from the manufacture of superphosphate.

Compliance/impact monitoring report, Chemical Cleaning Limited, permit no. 2027 (1991)
Power, Fergus M.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Chemical Cleaning Limited.; Effluent quality New Zealand Tauranga Harbour.; Water quality New Zealand Tauranga Harbour.; Waste disposal in the ocean Environmental aspects New Zealand Tauranga Harbour.

Summary: On the 28th of March 1988, the Bay of Plenty Regional Water Board granted Chemical Cleaning Limited a right to discharge up to 300 m^3/day of stormwater and wastewater into Tauranga Harbour. This right has the same expiry date as that of the nearby discharge permit for the Bay of Plenty Fertiliser Company Limited, being 31 March 1992. The right relates to the discharge of stormwater and wastewater arising from the activities associated with the importation, storage, formulation and distribution of bulk liquid industrial chemicals.

Compliance/impact monitoring report, Bay of Plenty Fertiliser Limited, consent no. 2031/2 (1991)
Power, Fergus M.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Bay of Plenty Fertiliser Limited.; Effluent quality New Zealand Tauranga Harbour; ; Water quality New Zealand Tauranga Harbour.; Waste disposal in the ocean Environmental aspects New Zealand Tauranga Harbour.

Summary: The Bay of Plenty Regional Water Board granted Bay of Plenty Fertiliser Limited a consent to discharge up to 2500 m^3/day of cooling water and wastewater into Tauranga Harbour on 03 December 1987. This consent expired on 31 May 1992. The current consent application relates to the discharge of cooling and wastewaters arising from the manufacture of superphosphate.

Marine Pollution and Water Quality of Tauranga Harbour, New Zealand (1991)
Power, F. M.; McIntosh, J. J.; O'Shaughnessy, B. W.; Park, S. G.
Water Quality Centre, DSIR Marine and Freshwater

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Pollutants, Water Quality

Summary: Coastal Engineering - Climate for Change is the 10th Australasian Conference on Coastal and Ocean Engineering held in Auckland, New Zealand from December 2-6, 1991. It was the tenth in the biennial series of conferences held in either Australia or New Zealand and follows the ninth conference held in Adelaide in 1989. The conference theme not only focused on the effect of climate change and its implications for coastal management but also the increasing requirement to move to a multi-disciplinary approach, involving engineering, scientific, planning and resource

management disciplines, when addressing coastal zone problems. The peer-reviewed papers in this publication cover a wide spectrum from biological and microbiological monitoring of the marine environment through to the design and construction of coastal structures. The authors represent a well balanced mix of professionals from government, resource management agencies, academic institutions and private industry.

Compliance/impact monitoring report, Tauranga District Council, wastewater treatment plant consent no. 2461(1992)
Power, Fergus M.; O'Shaughnessy, Brett
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Effluent quality, New Zealand, Tauranga Harbour, Water quality, Waste disposal in the ocean, Environmental monitoring, Sewage Purification, Sewage disposal plants

Summary: The Bay of Plenty Regional Council granted the Tauranga District Council consent to discharge treated effluent into Tauranga Harbour on 08 November 1990. This consent expired on 30 September 1991. The consent relates to the discharge of domestic and industrial wastes from the Tauranga environs.

Aquaculture in New Zealand market intelligence report (2006)
PricewaterhouseCoopers
Investment New Zealand

Spatial Information: New Zealand wide
Keywords: Aquaculture industry New Zealand.; Aquaculture New Zealand.

Summary: New Zealand has thousands of kilometres of pristine, unpolluted coastline situated in the vast South Pacific Ocean in the path of nutrient rich currents. Its isolated position, far removed from intensive human activity, and many sheltered harbours and bays make New Zealand one of the world's best locations for growing a diverse array of shellfish, finfish, seaweed and other aquatic and marine organisms.
New Zealand's aquaculture sector has grown at a rapid rate since the late 1980s but remains in the early stages of its development. It is an industry that, like many others in New Zealand, is based on natural competitive advantages and supported by a sound knowledge base, excellent research capability and spirit of innovation.
Aquaculture in New Zealand has traditionally been dominated by the Greenshell™ mussel, with a smaller-scale industry in pacific oysters. The Greenshell™ mussel continues to lead the way for the industry in terms of volume and export earnings, but since the mid1990s the high-value king salmon industry has become an emerging force in the sector.

Nutrient assimilation and growth of some seaweeds in mixtures of sea water and secondary sewage treatment effluents (1974)
Prince, J.S.
AquacultureJournal

Spatial Information: No spatial context
Keywords: Plants, Sea lettuce

Summary: Preliminary experiments with several economically important seaweeds studied their utilization of the major inorganic nutrients contained in secondary sewage effluent. Optimal growth occurred in a sewage--sea-water mixture upon addition of trace elements. Growth was similar whether nitrogen was mainly in the form of ammonia or nitrate. The assimilation of nitrogen and phosphorus was in a ratio, by atoms, which was considerably higher than that commonly found for phytoplankton. Phosphorus remained after nitrogen had been depleted from the medium. Methods for the restriction of both phytoplankton blooms and the growth of epiphytic algal species in large continuous flow cultures are discussed.

Tauranga Harbour sediment study: hydrodynamic and sediment transport modelling (2009)
Pritchard, M.; Gorman, R.; Hume, T.
NIWA Client Report

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation

Summary: The report is Technical Report D1 of the Tauranga Harbour Sediment study. The study uses several models, including an estuarine hydrodynamic model, a wave model, and a sediment transport model to evaluate the dispersal of contaminants and sediments by physical processes such as tidal currents and waves. It is found that the calibrated hydrodynamic model provided good predictions of water surface elevations and semi-diurnal tidal currents inside the harbour and the effects of wind driven currents in the harbour were negligible in scale as compared to the tide. The modelled salinity was consistent with observed CTD data where the water column was well mixed and of lower salinity than the ocean. Simulations of the sediment dynamics in the harbour found that the suspended sediment concentrations (SSC) and deposition were strongly correlated to source outflow rates and the tide.

Ecology of the invertebrate predatory fauna across Centre Bank, Tauranga Harbour (MSc Thesis) (1996)
Putt, F. G.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga Harbour; Starfishes ecology; Buccinidae ecology; Estuarine ecology; Invertebrates

Summary: This thesis looks at the distribution, abundance, population size structure and behaviour of three common invertebrate predators on the Central Bank in Tauranga Harbour. Surveys of *Patriella regularis, Coscinasterias calamaria* and *Cominella adspersa* (Cushion stars, Spiny stars and Speckled whelks) were conducted. The ecology of the area and biology of the species are also described.

3.17. Q

Water Quality and Sediment and Nutrient Export from NZ hill-land catchments of contrasting land use (2002)
Quinn, J M; Stroud, M J
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand wide
Keywords: agriculture; plantation forestry; native forest; phosphorus; nitrate; nitrogen; dissolved organic carbon; pH; alkalinity; erosion; sediment; stream flow; temperature

Summary: Measurements were made of suspended sediment (SS), volatile suspended solids, dissolved organic carbon (DOC), nitrogen (N) and phosphorus (P) concentrations, turbidity, black disk visibility, pH, alkalinity, and temperature, at monthly intervals for 2-5 years on nine streams draining catchments with pasture, pine plantation, and native forest land uses. Stream flow and flow-weighted concentrations of SS, N, and P were also measured for up to 2 years from pasture, native forest, and mixed land-use catchments enabling calculation of export (kg ha-1 yr-1). During 1996-97, export from the pasture stream was 2.5 to 7 fold higher for SS (988), total P (1.50), total Kjeldahl N (5.65), nitrate N (4.37), and ammoniacal N (0.34) than from the stream draining native forest. In contrast, export of DOC (25.5) and dissolved reactive P (DRP) (0.25) from the pasture stream were within 20% of the native stream's values. Export of SS and nutrients (except DRP) from the pasture catchment was 4 to 15 fold higher during the winters of 1995 and 1996 than winter 1997, when rainfall was half the normal level. Streams draining native forest had lower temperature, sediment, and nutrient concentrations (except DRP), and higher water clarity, than those draining pine forest and pasture. A pine/scrub stream had the highest SS and turbidity and lowest DRP, pH, and alkalinity. Pasture streams had the highest concentrations of all N species (geometric means 2-to 4-fold > native), total P, and DOC, and also showed the greatest variation in water quality attributes in relation to season and flow. The influences of land use were attributable to differences in both source materials of sediment and nutrients available for transport and changes in rates of in-stream processing.

3.18. R

Biomonitoring of heavy metal availability in the marine environment (1995)
Rainbow, P.S.
Marine Pollution BulletinJournal

Spatial Information: World wide
Keywords: Plants; Sea lettuce

Summary: Biomonitors can be used to establish geographical and/or temporal variations in the bioavailabilities of heavy metals in the marine environment, offering time-integrated measures of those portions of the total ambient metal load that are of direct ecotoxicological relevance. Heavy metal biomonitors need to conform to certain required characteristics, not least being metal accumulators. Use of a suite of biomonitors allows recognition of the presence and relative magnitude of different metal sources. For example, a macrophytic alga responds essentially to dissolved metal sources only, a suspension feeder like a mussel responds to metal sources in dissolved and suspended phases, and a deposit feeder responds to metal available in the sediment. Examples are given of suitable heavy metal biomonitors in the

coastal waters of Europe, New Zealand, Hong Kong and China. It is not valid to compare absolute accumulated metal concentrations in biomonitors interspecifically, although interspecific comparisions of rank orders do allow cross correlations of relative bioavailabilities of heavy metals to different biomonitors at the same sites. There is a need to identify widespread cosmopolitan biomonitors to allow intra-specific comparisons of bioavailabilities between geographical areas. Such cosmopolitan biomonitors may include the alga *Ulva lactuca*, mussels of the genera *Mytilus* and *Perna*, the oysters *Ostrea* and *Crassostrea*, barnacles like *Balanus amphitrite* and *Tetraclita squamosa*, and the talitrid amphipod *Platorchestia platensis*. A major caveat in the use of such cosmopolitan biomonitors remains the need for reliable, specific taxonomic identification.

Patch dynamics and response to disturbance of the seagrass *Zostera novazelandica* on intertidal platforms in southern New Zealand (1999)
Ramage, D. L.; Schiel, D. R.
Marine Ecology-Progress SeriesJournal

Spatial Information: southern New Zealand
Keywords: Plants; sea grass; patch dynamics; disturbance; *Zostera novazelandica*; Intertidal; New Zealand; Eelgrass

Summary: We examined the patch dynamics of the intertidal seagrass *Zostera novazelandica* and 2 reef platforms in order to understand the processes governing the establishment, maintenance and mortality of patches. The size distribution of patches at 3 tidal heights (low, mid and high shore) was assessed. Eighty patches, ranging in initial size from 0.1 to 2.4 m^2 surface area, were tagged and video image analysis was used bi-monthly for 14 mo to calculate rates of expansion and contraction of these patches. Permanently marked 150 m^2 areas of reef were monitored monthly to record patch recruitment and mortality. Initially, 75% of patches were <0.5 m^2. All patches decreased in size during winter, probably due to increased wave action, and expanded during spring and summer. The proportional expansion and contraction of patches was independent of initial patch size. At the end of the study the size distribution of patches was similar to the initial distribution. Patch mortality was restricted to those <0.4 m^2, of which 60% disappeared during the study. Larger patches suffered partial mortality through fragmentation. No large patches were formed through the amalgamation of smaller patches. Seedlings recruited into small sediment pockets in tide pools during spring, but few survived through summer because of removal by wave action. Experimental perturbation of patches resulted in increased erosion followed by decreased growth rates and, in many small patches mortality. Removing only seagrass blades, however, resulted in increased production of new shoots relative to controls. Overall, seagrass patches are susceptible to disturbance, successful recruitment by seedlings may be rare or at least episodic, and populations are probably long-lived and depend on slow vegetative growth for maintenance and expansion.

Satellite Sees Ocean Plants Increase, Coasts Greening (2005)
Ramanujan,K.
NASA News

Spatial Information: World wide
Keywords: phytoplankton

Summary: This article investigated the trend of chlorophyll over 6 years from 1998 to 2003 using NASA satellite data. It documented that phytoplankton abundance had declined globally by 6% over the period between the 1980s and 1990s, while the present data showed that phytoplankton amounts had increased globally by more than 4% from 1998 to 2003 and this increase had mostly occurred along the coasts. Although no significant changes were seen in phytoplankton concentrations within the global open oceans, phytoplankton levels declined in areas near the centre of the oceans, the mid-ocean gyres. It also described the roles that phytoplankton play in the ocean and on the globe. For example, the article documented that phytoplankton generated half of the total oxygen on earth and reduced the impacts of climate change by absorbing carbon dioxide. In addition, phytoplankton served as the base of the ocean food chain.

Wetland Ecosystem Services (2009)
Ramsar Convention on Wetlands
Ramsar

Spatial Information: World wide
Keywords: Wetlands

Summary: The Convention on Wetlands is an intergovernmental treaty adopted on the 2nd February 1971 in the Iranian city of Ramsar, on the southern shore of the Caspian Sea. Thus, though nowadays the name of the Convention is usually written "Convention on Wetlands (Ramsar, Iran, 1971)", it has come to be known popularly as the "Ramsar Convention". Ramsar is the first of the modern global intergovernmental treaties on the conservation and sustainable use of natural resources, but, compared with more recent ones, its provisions are relatively straightforward and general. Over the years, the Conference of the Contracting Parties has further developed and interpreted the basic tenets of the treaty text and succeeded in keeping the work of the Convention abreast of changing world perceptions, priorities, and trends in environmental thinking.

Algal macronutrients and food selection by the omnivorous marine fish *Girella tricuspidata* (2005)
Raubenheimer, D.; Zemke-White, W. L.; Phillips, R. J.; Clements, K. D.
Ecology Journal

Spatial Information: New Zealand
Keywords: Plants; Sea lettuce; Fish

Summary: We used combined field and laboratory studies to investigate the relationships among foraging, food selection, and macronutrient intake and retention by the New Zealand marine reef fish, *Girella tricuspidata* (*E Girellidae*). Gut analyses of field-caught fish revealed a diet comprising significant proportions both of algal and non-algal (copepods, hydroids, and organic detritus) foods, with the relative proportions of algal and non-algal food items varying from 65% of non-algal foods in the winter to 34% in autumn. Observations of the diurnal feeding pattern of free-ranging wild fish showed an increase in bite rate from sunrise to late afternoon, followed by a decrease toward sunset. In laboratory studies we recorded (a) gut throughput rates, (b) macronutrient intake, and (c) macronutrient assimilation by captive *G. tricuspidata* fed one of three algal species. The algae *were Enteromorpha intestinalis* and *Ulva lactuca*, both of which are preferred foods of *G. tricuspidata*, and

Gracilaria chilensis, which has not been recorded in the stomach contents of the fish despite its co-occurrence in some habitats. The two species of preferred algae were found to have a higher starch and lower protein content than the non-dietary *G. chilensis*. The fish regulated their intake and utilization of the algae such that similar amounts of protein were ingested and assimilated from all three species, but less starch was ingested and assimilated from the non-dietary *G. chilensis* than from the preferred species. Gut throughput times correlated positively with starch availability in the algae but were lower for all treatments than previous studies would suggest are associated with fermentative digestion. The data suggest that omnivory in *G. tricuspidata* is likely based on complimentarily, rather than substitutability of algal and animal foods.

New Zealand Municipal Wastewater Monitoring Guidelines (2002)
Ray, D.E.; Dolan, L.; Berminham, G.; Potts, R.; Simith, S.; Barter, P.; Robertson, B.; Baines, J.; Gough, J.; Couch, D.; Bell, R.; Hickey, C.; McBride, G.; Kennedy, P.; Gadd, J.; Forrest, B.; Ryan, L.; Fullerton, R.; Yeats, S.; Stumbles, C.; Docherty, R.; Turner, B.,
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: wastewater, monitor, guidelines, New Zealand, sewage, discharge,

Summary: This document provides guidance to developing monitoring programmes for municipal wastewater discharges. The Guidelines use a risk-based approach. The guiding principle is that the higher the risk to the environment from the discharge, the greater the required scale of monitoring. Although the principles of these Guidelines can be applied to many types of monitoring programmes (e.g., investigative monitoring for consent applications), the primary focus is monitoring required for resource consent conditions.

Invasive marine and estuarine animals of Hawai'i and other Pacific Islands (2005)
Ray, G.L.
Aquatic Nuisance species research program

Spatial Information: Hawai'i and other Pacific Islands
Keywords: Invasive species

Summary: Non-native species of estuarine and marine animals are inadvertently or intentionally introduced into the waters of the United States every year. Variously referred to as introduced, non-indigenous (NIS), alien, non-native, or exotic species, most pose little or no threat; however, a few have the potential to disrupt local ecosystems, fisheries, and human infrastructure. Such invasions can directly impact the mission of the U.S. Army Corps of Engineers (USACE) through its responsibilities for construction and maintenance of harbours, ports and waterways, erosion control, management of water resources, and wetland and coastal habitat restoration. The general biology and ecology of invasive estuarine and marine animals have been described in previous works (Carlton 2001, Ray 2005). This report is part of a series describing known invasive estuarine and marine animals in the major geographic regions of the United States. Invasive animals of Hawaii and other Pacific islands are described and examples of species posing a specific threat to USACE activities are identified.

Microbial biotechnology in agriculture and aquaculture (2005)
Ray, R.C.
Science Publishers

Spatial Information: No spatial context
Keywords: Microbial biotechnology.; Agricultural biotechnology.; Aquaculture.; Electronic books.

Summary: Plant genetic engineering has revolutionized our ability to produce genetically improved plant varieties. A large portion of our major crops have undergone genetic improvement through the use of recombinant DNA techniques in which microorganisms play a vital role. The cross-kingdom transfer of genes to incorporate novel phenotypes into plants has utilized microbes at every step - from cloning and characterization of a gene to the production of a genetically engineered plant. This book covers the important aspects of Microbial Biotechnology in Agriculture and Aquaculture with and aim to improve crop yield.

Feasibility study to investigate the replenishment/reinstatement of Seagrass Beds in Whangarei Harbour - Phase 1 (2004)
Reed, J.; Schwarz, A. M.; Gosai, A.; Morrison, M.
NIWA Client Report

Spatial Information: Whangarei Harbour, New Zealand
Keywords: Plants; Sea grass

Summary: This report has been prepared for the Northland Regional Council and is Phase 1 of a larger project which has the aim of determining the feasibility of restoring seagrass beds in Whangarei Harbour and, if so, to ascertain the best practicable option and method/s for doing so. The purpose of this report is to assess the current and historical distribution of seagrass in the harbour, to review the environmental conditions that influence the distribution, growth, and resilience of seagrass beds, and to identify the factors potentially affecting these conditions at specific sites. Seagrass beds in Whangarei Harbour are estimated to have covered ~1400 ha (14km²) prior to the 1960s. This extensive area included both intertidal and subtidal beds. Studies elsewhere in New Zealand and local knowledge suggests that these beds had significant ecological importance as habitat for marine invertebrates, nursery for juvenile fish (e.g. snapper, trevally) and for bird foraging. Today, only small pockets of seagrass are evident in the intertidal zone. Hence restoration of even a modest proportion of the historical beds may well be of significant ecological value to both the harbour ecosystem, and the broader marine environment. Potential factors that contributed to the loss of seagrass in Whangarei Harbour are an increased rate and degree of sedimentation, accumulation or erosion / removal of sediment at specific sites, increased suspended sediment levels (especially of fine material), changes in sediment texture, and changes to local bathymetry. The potential environmental effects from these factors are likely to have included higher turbidity levels, lower water clarity, exposure to anoxic sediments, and burial of plants, resulting in reduced photosynthesis and growth of seagrasses. Other environmental stressors include contaminant discharges to the Hatea River (from Town Basin to the Port of Whangarei), such as treated (sewage) effluent, industrial spills, leachates from refuse tips, discharges from industrial processes, oil spills and

stormwater runoff. The key environmental parameters to target for habitat restoration are water clarity, water quality and sediment condition. We suggest ways that such improvements might be achieved including catchment initiatives involving riparian planting, waste water treatment wetlands and erosion control measures. Identification of appropriate sites for seagrass restoration within Whangarei Harbour will require collection of baseline information on environmental conditions. Feasibility Study to Investigate the Replenishment of Seagrass Beds in Whangarei Harbour 1.

Feasibility Study to Investigate the Replenishment/reinstatement of Seagrass Beds in Whangarei Harbour - Phase 2 (2005)
Reed, J.; Schwarz, A. M.; Morrison, M.
NIWA Client Report

Spatial Information: Whangarei Harbour, New Zealand
Keywords: Plants; Sea grass

Summary: This report has been prepared for the Northland Regional Council and is Phase 2 of a larger project which aims to assess the feasibility of restoring seagrass beds in Whangarei Harbour and determine the best practicable option and method/s for doing so. The purpose of this report is to quantify the environmental conditions (i.e. water clarity and sediment quality) that are likely to influence current seagrass growth and health in the harbour and to identify the potential of sites for consideration for restoration. To achieve this goal, existing Northland Regional Council data was analysed and additional sampling was conducted in November 2004 at three sites within the harbour. The sites were (1) where seagrass exists as stable beds, (2) where seagrass grows as patches (or transitional beds) and (3) where seagrass no longer exists but was present in the mid-1940s. At each of these sites, sampling was conducted at low tide along a 50 m transect. Each transect was located between the high and low tide level (i.e. shore to sea) and at regular intervals sediment cores were collected for analysis of particle size, total organic carbon (TOC) and metal concentrations (total zinc, copper and lead). Where it was present, seagrass was sampled to determine percent cover and above and below ground biomass. In addition, sampling of the water column was conducted at high tide at each of the study sites plus two additional sites where seagrasses have historically been reported. Measurements of water clarity (using a secchi disk) and attenuation of photosynthetically available radiation (using an underwater light meter) were made. Water samples were taken for analysis of nutrients (nitrogen and phosphorus) and total suspended sediment load. At the sites where seagrasses currently grow, both water and sediment quality were within published ranges for seagrass growth although plant nutrient concentrations and organic carbon contents were both at the lower end of those ranges. Metal concentrations in sediments were below ANZECC–low guideline. Water clarity was, however, variable and given the importance of water clarity to seagrass growth we recommend regular monitoring. Sediments were mostly a combination of fine sand and coarse silt, except at site 3 (One Tree Point East), where sediments had a higher proportion of coarse sand. At site 3, the absence of seagrass was consistent with the sandiest substrate and lowest organic content of all three sites. The vicinity of two sites where seagrasses currently grow will be considered further (Task 3 to 5 of SMF project 2209) for implementing seagrass restoration trials.

Ecosystems and Human Well-Being (2005)
Reid, W.; Mooney, H.A.; Cropper, A.
Millennium Ecosystem Assessment

Spatial Information: No spatial context
Keywords: Ecosystems

Summary: It is becoming increasingly clear that population growth and economic development are leading to rapid changes in our global ecosystems. In recognition of this, the United Nations' Secretary-General Kofi Annan, in a 2000 report to the General Assembly entitled: "We the Peoples: The Role of the United Nations in the 21st Century," called for the Millennium Ecosystem Assessment to be undertaken. Since 2001, the Millennium Ecosystem Assessment has worked to assess the consequences of ecosystem change for human well-being, and establish the scientific basis for actions needed to enhance the conservation and sustainable use of those systems, so that they can continue to supply the services that underpin all aspects of human life. The assessment exercise has involved more than 1300 experts worldwide. The findings provide the strongest evidence so far of the impact of our actions on the natural world. They show, for example, that over the past 50 years, humans have changed natural ecosystems more rapidly and extensively than in any comparable period in human history. This transformation of the planet has contributed to substantial net gains in human well-being and economic development. But not all regions and groups of people have benefited from this process, and many have been harmed. Moreover, the full costs associated with these gains are only now becoming apparent. Approximately 60% of the ecosystem "services" examined, from regulation of air quality to purification of water, are being degraded or used unsustainably. Nature's goods and services are the ultimate foundations of life and health, even though in modern societies this fundamental dependency may be indirect, displaced in space and time, and therefore poorly recognized. These more distant and complex links mean that we now need to look at environmental health through a broader lens. Health risks are no longer merely a result of localized exposures to "traditional" forms of pollution – although these still certainly exist. They are also a result of broader pressures on ecosystems, from depletion and degradation of freshwater resources, to the impacts of global climate change on natural disasters and agricultural production. Like more traditional risks, the harmful effects of the degradation of ecosystem services are being borne disproportionately by the poor. However, unlike these more traditional hazards, the potential for unpleasant surprises, such as emergence and spread of new infectious diseases, is much greater. This report represents a call to the health sector, not only to cure the diseases that result from environmental degradation, but also to ensure that the benefits that the natural environment provides to human health and well-being are preserved for future generations.

White HDPE Bottles as Source of Serious Contamination of Water Samples with Ba and Zn (2007)
Reimann, C.; Grimstvedt, A. ; Frengstad, B. ; Fine, T.E.
Science of the Total Environment Journal

Spatial Information: No spatial context
Keywords: Surface water; Plastic bottles; Sample contamination; HDPE

Summary: During a recent study of surface water quality factory, new white high-density polyethylene (HDPE) bottles were used for collecting the water samples.

According to the established field protocol of the Geological Survey of Norway the bottles were twice carefully rinsed with water in the field prior to sampling. Several blank samples using milli-Q (ELGA) water (N18.2MΩ) were also prepared. On checking the analytical results the blanks returned values of Ag, Ba, Sr, V, Zn and Zr. For Ba and Zn, the values (c. 300 µg/l and 95 µg/l) were about 10 times above the concentrations that can be expected in natural waters. A laboratory test of the bottles demonstrated that the bottles contaminate the samples with significant amounts of Ba and Zn and some Sr. Simple acid washing of the bottles prior to use did not solve the contamination problem for Ba and Zn. The results suggest that there may exist "clean" and "dirty" HDPE depending onmanufacturer/ production process. When collecting water samples it is mandatory to check bottles regularly as a possible source of contamination.

African inland fisheries, aquaculture and the environment (1997)
Remane, K.
Food and Agriculture Organization of the United Nations, Fishing News Books

Spatial Information: Africa
Keywords: Fisheries, Environmental aspects, Africa Congresses, Aquaculture, Environmental management

Summary: The environmental degradation of African inland waters is increasing, thought still not as severe as in industrial countries. This will become a serious problem within the next decade if no preventative management actions are taken. Nevertheless, there is still potential for increased production which can be realized by improving the management of existing stocks, utilizing unexploited stocks and increasing the exploitation of reservoirs. In addition, the promotion of aquaculture, which is mainly extensive or semi-intensive in Africa, will require determined action to prevent uncontrolled and unsustainable development.

New Zealand Mariculture: Unfairly Challenged? (2006)
Rennie, H.G.
Routlegde

Spatial Information: New Zealand
Keywords: aquaculture, marine farm*, mariculture, policy, New Zealand

Summary: This begins with an overview of the significant political changes in New Zealand over the past thirty years, followed by an overview of the development of aquaculture and an outline of the legal and policy frameworks governing New Zealand marine farming since the 1970s. The piece concludes with a discussion of the industry response, the moritatorium (2005) and government proposals, and Maori responses to these reforms.

Aquaculture management areas - an example of why we should not rush to ditch the RMA's effected-based approach? (2009)
Rennie, H.G.;
Planning Quarterly Journal

Spatial Information: No spatial context

Keywords: aquaculture, marine farm, New Zealand, aquaculture management areas, 2005 reform.

Summary: The author summaries and highlights the failure of the 2005 Resource Management Act amendments (in regards to aquaculture) and its activities-based planning approach in the hope that those seeking a return to the "good, old days" of activity-based planning will think again.

Two GIS-based approaches to aquaculture planning? (2009)
Rennie, H.G.
The Grower Journal

Spatial Information: No spatial context
Keywords: aquaculture, GIS, geographic information systems, aquaculture management areas,

Summary: This article compares the two different approaches from two different universities in New Zealand (Waikato University and Lincoln University) used in applying Geographic Information Systems (GIS) to aid aquaculture planning for aquaculture management areas.

Developing a Conceptual Model of Marine Farming in New Zealand (2009)
Rennie, H.G.; White, R.; Brabyn, L.
Marine Policy Journal

Spatial Information: New Zealand wide
Keywords: Marine farming, aquaculture, agent-based modelling, New Zealand, ICZM, DSS

Summary: Survey and Geographic Information System (GIS) data analysis describes the relative influence of biophysical and human variables on site choices made by marine farmers in New Zealand. Community conflicts have grown in importance in determining farm location and different government planning strategies leave distinct signature patterns. Recent legislation empowers local governments to choose among three strategies for future regional aquaculture development. This paper suggests each strategy could result in different spatial outcomes. Simulation modelling of the type described here can provide a better understanding of farmer responses to management approaches and the range of futures that could result from planning choices made today.

Morphology and growth characteristics of *Chrysochromulina* species (Haptophyceae = Prymnesiophyceae) isolated from New Zealand coastal waters (1996)
Rhodes,L.; Burke,B.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand coastal waters
Keywords: phytoplankton, *Chrysochromulina;* Haptophyceae; Prymnesiophyceae; growth; electron microscopy

Summary: *Chrysochromulina acantha, C. hirta, C. pachycylindra,* and *C.* cf. *polylepis* (Haptophyceae = Prymnesiophyceae) are new records, based on transmission electron microscopy, for New Zealand coastal waters. The morphology and growth characteristics of *C. acanthi* and *C. hirta,* and of *C. simplex* and *C. ericina* (also New Zealand isolates), are described. *C. ericina* of the present study has a shorter haptonema (12-24 urn; noncoiling), larger plate and spine scales, and fewer spine scales (with broader bases), than northern hemisphere isolates. Scales of *C. simplex* fit the emended type description, whereas the large spine scales of *C. hirta* are shorter (< 11 um) than the type description (20—30 um). *C. ericina* and *C. Hirta* fall into a temperate (15—20°C), and *C. Acantha* and *C. simplex* into a sub-tropical (20—25°C), temperature group. All species tested grew well in brackish salinities (c. 23 through to 36); *C. Hirta* grew optimally at a salinity of 23. All tolerated 25— 150 umol n r 2 s"1 photon flux and pH of 7.5 to c. 8.4. *C. acantha* had significantly faster growth rates (doublings d~') with nitrate than with urea or ammonium chloride as nitrogen source, and *C. Hirta* with urea and ammonium chloride rather than with nitrate; none required selenium. None of the species tested was toxic to *Artemia salina*. *C. ericina* and *C. acantha* were phagotrophic. Calcofluor assisted in the identification of *C. quadrikonta* from other spine-bearing species and FITC-conjugated wheat germ lectin aided differentiation of the *Chrysochromulina* species from *Prymnesium parvum* and *P. patelliferum*.

The Influence of Bivalve Suspension-Feeders on Phytoplankton and Inorganic Nutrient Cycling (2001)

Rice, M.
Ecology and Field Biology, Environmental Change in the Coastal Environment

Spatial Information: No spatial context
Keywords: shellfish, phytoplankton, bivalves

Summary: Suspension-feeding bivalves serve to couple pelagic and benthic processes because they filter suspended particles from the water column and the undigested remains, ejected as mucus-bound faeces and pseudofeces, sink to the sediment surface. This biodeposition can be extremely important in regulating water column processes where bivalves are abundant in coastal waters and in seasons when water temperatures are warm enough to promote active feeding. Bivalves under these conditions can exert "top-down" grazer control on phytoplankton and in the process reduce turbidity, thereby increasing the amount of light reaching the sediment surface. This has the effect of reducing the dominance of phytoplankton production and extending the depth to which ecologically important benthic plants, such as seagrass and benthic microalgae, can grow. Nitrogen and phosphorus, excreted by the bivalves and regenerated from their biodeposits, are recycled back to the water column and support further phytoplankton production.

Remote Sensing Survey of the Bay of Plenty: Report on Sea Surface Temperature and Ocean Colour Product Generation for Environment Bay of Plenty (2005)

Richardson, K.M; Pinkerton, M.H; Uddstrom, M.J; Hill, P.
NIWA

Spatial Information: Bay of Plenty, New Zealand

Keywords: aquaculture, aquaculture management area, Bay of Plenty, Whakatane, Pukehina, marine farm, mussel, sea surface temperature, surface chlorophyll a, bio-physical numerical modelling,

Summary: (note copyrights pg 13). This document was written by NIWA to deliver a range of remotely sensed Sea Surface Temperature (SST) and surface chlorophyll α (Ca) products to inform bio-physical numerical modelling efforts relevant to its Aquaculture Management Areas (AMA) project. Bio-optical measurements in the Bay of Plenty were carried out to calibrate the NOWA IOP algorithm and hence enable the generation of case 2 products. This report summarises the process of product generation, and provides a qualitative comparison of case 1 and case 2 Ca retrievals for the Bay of Plenty. It also provides an account of the BoP bio-optical research voyage and subsequent calibration of the IOP algorithm. Appendix two is a paper entitled Bio-optics Research Voyage EBoP0604 Supporting Ocean Colour Remote Sensing of the Bay of Plenty. It explains and justifies how it came up with the data for the algorithms specific to the Bay of Plenty region for this paper.

Effects of urban development and discharges on water quality: Tauranga Harbour and Little Waihi (1989)

Roan, P.
Tauranga County Council

Spatial Information: Tauranga Harbour and Little Waihi, New Zealand
Keywords: Water quality, Tauranga Harbour and Little Waihi

Summary: Principal water pollution sources from urban areas include:

- treated effluents discharged from sewage treatment plants and untreated effluents that bypass sewage treatment plants;
- treated and untreated storm water runoff;
- combined sewer overflows that carry a mixture of untreated sewage and storm water;
- air emissions from incidental and accidental releases and mobile sources; and
- groundwater discharges to adjacent receiving waters.

Diversity and biogeography of coastal fishes of the East Cape Region of New Zealand (2006)

Roberts, C.D.; Stewart, A.L.
Department of Conservation

Spatial Information: Elsewhere in New Zealand - East Cape Region
Keywords: Fishery, coastal fishes, rotenone sampling, specimen collections, species diversity, rare species, new species, biogeography, East Cape, New Zealand

Summary: A fish survey was carried out along 300 km of coast in the East Cape Region (ECR), North Island, between Whakatane (Bay of Plenty) and Gisborne (Poverty Bay) New Zealand during 1992–1999. Sampling, using mainly rotenone ichthyocide and handspear, was carried out at 0–21 m depth by teams of 4–7 divers who spent c. 200 hrs underwater collecting fish specimens and recorded

identification and habitat data. A total of 148 fish species (114 genera; 65 families) were recorded in inventory lists supported by voucher specimens. Of these, 107 shallow reef fish species were analysed to compare diversity and composition in four ECR subareas: East Coast, coastal Bay of Plenty (BOP), inshore BOP islands, and offshore BOP islands. No significant difference was found between the East Coast and the coastal BOP stations, and between the BOP inshore and offshore island stations; but there was a significant difference between all coastal stations (East Coast and BOP) and all island stations (inshore and offshore) using ANOVA and Tukey *post hoc* comparisons. Complementary results were obtained with Jaccard's pair-wise comparison between composition of reef fish faunas, which indicated that offshore BOP islands were the least similar to coastal BOP and the East Coast (46% species shared respectively); and the East Coast and coastal BOP were the most similar (79% species shared). Most reef fishes in the ECR (78%) were widespread New Zealand species; and there was a moderate northern component (20%) and small southern component (2%). There were progressive changes in composition moving from west to east and from offshore to inshore, with a reciprocal decrease in northern species and increase in widespread species, and a small increase in southern species. Northern species reached their limit of distribution variously at White Island, coastal BOP, East Cape, and East Coast; southern species reached their limits at East Cape. All these results provide strong support for a wide biogeographic transition throughout the ECR, and refute a narrow biogeographic boundary.

The Bay of Plenty earthquakes of July 1989 - comparison with foreshock activity of the 1987 Edgecumbe earthquake (1990)
Robinson, R.
New Zealand Journal of Geology and Geophysics

Spatial Information: Bay of Plenty, New Zealand
Keywords: Earthquakes; Bay of Plenty; Edgecumbe; New Zealand; California;

Summary: Observations of the July 1989 Bay of Plenty earthquake sequence, using both portable and permanent seismograph stations, allow location of the aftershocks and comparison of the sequence with the foreshocks of the 1987 Edgecumbe earthquake. The two mainshocks (M (L) 4.6 and 4.7) and the aftershocks fall within a 6 x 2 km zone, elongated in the northeast-southwest direction, centred 20 km northwest of Whakatane. This is within the zone of foreshocks of the 1987 shock. Calculated depths ranged from 4.7 to 10.5 km. The time history of the sequence, which began abruptly, is typical of a mainshock-aftershock sequence, and the b-value (1.37 +/- 0.11) is similar to the regional value. In contrast, the 1987 foreshocks had a low b-value (0.86 +/- 0.15) and an irregular time history. Coda durations, for a given amplitude magnitude, were longer for the 1987 foreshocks than for the 1989 aftershocks. This can be explained by the backscattering theory of coda formation if the scattering coefficient of the crust at the time of the foreshocks was higher than in 1989. However, an explanation in terms of event depths is possible if, as suggested by felt reports, the 1987 foreshocks were very shallow.

Effects of sewage contamination on macro-algae and shellfish at Moa Point, New Zealand, using stable carbon and nitrogen isotopes (1999)
Rogers, K.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Moa Point, New Zealand
Keywords: sewage contamination; carbon and nitrogen isotopes; *Ulva lactula*; *Cellana denticulata*; *Mytilus galloprovinialis*; sea lettuce, blue mussels, mussels, limpets, shellfish, EA-IRMS, Lyall Bay, New Zealand

Summary: Stable carbon and nitrogen isotopes have been used to characterise sewage discharge and effects on seaweed (*Ulva lactuca* L.), blue mussels (*Mytilus galloprovinialis*), and limpets (*Cellana denticulata*) from Moa Point Bay, New Zealand. The nitrogen (15N/14N) ratio is shown to be a good tracer of sewage pollution in *Ulva lactuca* and associated grazers (*Cellana denticulata*) as a result of the increased contribution of urea and ammonia to the surrounding marine environment from the sewage outfall. The carbon (13C/12C) ratio is suggested as a more appropriate sewage tracer for mussels (*Mytilus galloprovinialis*), which filter feed the particulate organic matter from the effluent. Lower carbon:nitrogen ratios were found in *U. lactuca* sampled from the outfall region, compared to uncontaminated control sites, however carbon:nitrogen ratios do not vary significantly amongst shellfish species.

Stable carbon and nitrogen isotope signatures indicate recovery of marine biota from sewage pollution at Moa Point, New Zealand (2003)
Rogers, Karyne M.
Marine Pollution Bulletin

Spatial Information: Moa Point, New Zealand
Keywords: Sewage; Carbon isotopes; Nitrogen isotopes; EA-IRMS; New Zealand; Bioremediation; Plants; Sea lettuce

Summary: Stable carbon and nitrogen isotopes have been used to assess sewage contamination of a sewage outfall, discharging milli-screened effluent into Moa Point Bay, New Zealand, and monitor the recovery of flora and fauna after the outfall's closure. An initial study characterising the extent of the discharge and the effects on seaweed (*Ulva lactuca* L.), blue mussels (*Mytilus galloprovincialis*) and limpets (*Cellana denticulata*) from the area, showed effects of the sewage discharge on flora and fauna were localised within in the bay. The immediate area surrounding the discharge area was found to contain limited biodiversity, with an abundance of *Ulva lactuca*, a bright green lettuce-like seaweed, typically found in areas with high nutrient input, limpets and small blue mussels. The nitrogen isotopic signature ([delta]15N) is shown to be a good tracer of sewage pollution in seaweed and associated grazers (i.e. limpets) as a result of the increased contribution of urea and ammonia to seawater nitrogen derived from the effluent. The carbon isotopic signature ([delta]13C) is suggested as a more appropriate sewage tracer for mussels, which filter feed the effluent's particulate organic matter from the water. Lower carbon:nitrogen ratios were found in *Ulva lactuca* sampled from around the outfall region compared to uncontaminated control sites. However carbon:nitrogen ratios do not vary significantly amongst shellfish species. After closure, monitoring continued for 9 months and showed that the carbon and nitrogen isotopic signatures of algae (*Ulva lactuca* L.) returned to similar control site levels within 3 months. Limpet and blue mussels (*Cellana denticulata* and *Mytilus galloprovincialis*) showed slower recovery times than the Ulva lactuca, with detectable levels of the sewage-derived carbon and nitrogen remaining in the animal's tissue for up to 9 months.

Benthos Associated With an Estuarine Outfall, Tauranga Harbour, New Zealand (1990)
Roper, D.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Tauranga Harbour, New Zealand
Keywords: benthos; Outfall; pollution; sediments; sewage effluent; Tauranga Harbour, Te Awanui, Bay of Plenty, estuary*,

Summary: Benthos near a sewage outfall discharging 69 000 m^3 d"1 of municipal sewage into Tauranga Harbour was studied to determine the nature and extent of the impact caused by a small organic input. Sediment samples were collected about the outfall and analysed for particle size, sorting, mud content, readily oxidisable carbon (ROC), total Kjeldahl nitrogen (TKN), total phosphorus (TP), "oil and grease" (OG), and macroinvertebrates. It is concluded that observed patterns of physical sediment characteristics are mainly natural. Levels of ROC, TKN, TP, and OG were all highest at or nearby the outfall. However, chemical changes in the sediment related to the discharge seemed to be limited to within less than 50 m distance of the outfall. The distributions of ROC, TKN, and TP in the sediments were closely related to natural changes in mud content. The outfall had little effect on the distribution of total numbers of taxa or individuals, or the composition of macro-invertebrate assemblages. Rather, these were most closely related to the (probably natural) variability in sediment particle size and sorting. Analysis of the distributions of common species showed that several were responding to the discharge, but such responses were limited to within 10 m of the outfall. The absence of extensive impact on benthos from the outfall probably related to high water velocities (up to 0.5 m s"1 on a mean tide) over the outfall diffuser, which would ensure that any drop in sediment oxygen levels is small.

Monitoring of submerged reef biota off Motuotau Island in relation to dredge spoil dumping by Port of Tauranga Ltd (2006)
Ross, P.; Pilditch, C.
Port of Tauranga Ltd

Spatial Information: Port of Tauranga, Tauranga Harbour
Keywords: Port of Tauranga, Tauranga Harbour, dredging

Summary: Dredge spoil resulting from the development and maintenance of the Port of Tauranga has for over a quarter century been dumped in a series of zones on the inner shelf off Mount Maunganui. A major channel deepening and widening programme was undertaken in 1992, resulting in the dumping of 4.5 million cubic metres of spoil on a new dump ground in 25 to 30 metres of water. A monitoring programme was designed to determine if the dumped sediment was impacting on the reef biological communities around Motuotau Island inshore from the dump ground. A control site and two test sites were established in May 1990 on submerged reefs near the island.

Seasonal and hydrological control of phytoplankton nutrient limitation in the lower Neuse River Estuary, North Carolina (1991)
Rudek,J.; Paerl,H.W.; Mallin,M.A.; Bates,P.W.
Marine Ecology Progress Series

Spatial Information: Neuse River Estuary, North Carolina, USA
Keywords: phytoplankton

Summary: This study investigated the nutrient limitation of phytoplankton production from 1987 to 1990 in the lower Neuse River Estuary, North Carolina, USA. The study found that the lower estuary experienced a general state of nitrogen limitation, particularly during summer months, a period of high phytoplankton productivity. Algal productivity with the addition of both nitrogen and phosphorus was significantly greater than that with addition of nitrogen alone. The study identified seasonal patterns in ambient nutrient concentrations, with nitrogen maxima associated with spring, fall, and winter runoff events, with summer minima. The study found that hydrologically driven nitrogen loading exerted a strong, year-round influence on primary production and nutrient limitation characteristics. The phytoplankton community responded to increased flow and concomitant nutrient loadings by increasing production and biomass levels, often very rapidly. In this regard, hydrologic factors influencing nitrogen loading are key determinants of the trophic state of this estuary.

An investigation into the commercial feasibility of *Jasus edwardsii* aquaculture in New Zealand (2000)
Ruru, I. H.
University of Waikato

Spatial Information: New Zealand
Keywords: *Jasus edwardsii*.; Lobster culture New Zealand.; Aquaculture Economic aspects New Zealand.

Summary: In 1996 New Zealand introduced legislation to allow *Jasus edwardsii* pueruli to be collected as "seedstock" and ongrown in a commercial aquaculture trial. The aim of this thesis was to investigate the commercial feasibility of *J. Edwardsii* aquaculture in New Zealand by working with an organisation involved in the trial. The methodology involved a combination of experiments in the field, in laboratories, and within an ongrowing facility. This thesis examined five key areas and found the following:1. Data obtained in the research indicates that New Zealand will continue to rely on harvesting pueruli from the wild since significant technical obstacles remain in the development of commercial scale pueruli hatcheries. Forecast data, obtained using the delphi technique and information about current research on larval rearing, indicates that commercial scale supply of pueruli from hatcheries may occur between 2017 and 2021. 2. Harvesting trials collected a low number of pueruli with the lowest unit cost for collection being $1.80. A greater collection rate could be achieved with a better understanding of seasonal and local settlement patterns. 3. Survival rates in pueruli transporting experiments were significantly affected by stocking density, time and temperature. The safest transit conditions were achieved with 15 pueruli per litre for less than 6 hours at 14°C.

A novel interaction between nutrients and grazers alters relative dominance of marine habitats (2005)
Russell, B. D.; Connell, S. D.
Marine Ecology Progress Series

Spatial Information: No spatial context
Keywords: Plants, macroalgae

Summary: Strong top-down control by grazers is considered a moderating influence on the negative effects of elevated nutrients on marine algae. Little experimental work has been done in a system that has weak grazing pressure (weak top-down control), which is also subjected to elevated nutrients. We experimentally elevated nutrient concentration to test (1) the effects of nutrient enrichment on algal assemblages in the presence and absence of canopies (*Ecklonia radiata*) and (2) the interactive effects of nutrients and molluscan grazers (meso-grazers) on algal assemblages in the absence of canopies. We established that the loss of canopy-forming algae is likely to be a key precursor to nutrient-driven changes of assemblages of benthic algae, because nutrients had no effects on algal assemblages in the presence of canopy-forming algae. In the absence of canopy-forming algae, space was monopolised by filamentous, turf-forming algae, and it was only in the presence of grazers that nutrients caused a change to the relative covers of algal habitat that monopolise canopy-free space. When grazers were present at natural densities, elevated nutrients reduced the monopoly of turf-forming algae in favour of foliose algae. These results demonstrate a novel interaction between nutrients (bottom-up control) and grazing pressure (top-down control), which are fundamental to predictions about management of human activities that continue to reduce densities of herbivores and increase nutrient availability on temperate coasts.

Effects of Biologically Active Discharges into Aquatic Ecosystems: Review of Treatment Systems and Standards (1998)

Ryan, P.A
Department of Conservation

Spatial Information: No spatial context
Keywords: water quality, wetlands management, treatment standards

Summary: Over the last ten years there has been an increasing awareness of the impacts of uncontrolled biological waste discharge into the receiving waters. The types of impacts such discharges produce in the receiving waters are discussed. Early standards were based on overseas research but there is now a substantial body of New Zealand based work. Initial research concentrated on dairy shed discharges and domestic sewage pond discharges but has broadened to include piggeries wastes, meat industry wastes and various others. In the main this work has shown that traditional oxidation pond systems do not treat the water to a high enough standard. Currently many discharges are high in suspended solids, biochemical oxygen demand, nitrogen (often in the form of ammonia), phosphorus and faecal coliforms.

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Microalgal populations of three New Zealand coastal locations: forcing functions and benthic-pelagic links (2003)
Safi, K.A.
Marine Ecology Progress Series

Spatial Information: east coast of the North Island of New Zealand
Keywords: phytoplankton dynamics

Summary: This study investigated spatial and temporal variability in benthic and pelagic (phytoplankton) microalgal assemblages in 2 harbours and a coastal embayment off the east coast of the North Island of New Zealand in late spring, summer and autumn. A total of 97 species/taxa were identified, with diatoms being the dominate category, followed by dinoflagellates. The study found that around 1% to 23% of the biomass about 10 cm above the sediment was benthic in origin; hence it appears that pelagic phytoplankton is the dominant food source for filter feeders in the region. The study also found that current speed was associated with the percentage of benthic microalgae found in suspension and accounted for 87% of the variation observed. The phytoplankton populations in Tauranga Harbour were temporally diverse, with an average Bray-Curtis similarity of only 9% between seasons. Tauranga harbour also appeared to be typical to other North Island sites studied (3 sites located in or near Mahurangi Harbour), with an average Bray Curtis similarity of over 40% between all sites studied.

Shallow *Cystoseira* (Fucales: *Ochrophyta*) assemblages thriving in sheltered areas from Menorca (NW Mediterranean): Relationships with environmental factors and anthropogenic pressures (2009)
Sales, M.; Ballesteros, E.
Estuarine Coastal and Shelf Science

Spatial Information: island of Menorca - Balearic Islands, NW Mediterranean
Keywords: Plants, macroalgae

Summary: The distribution of *Cystoseira* species was studied at 103 coves in the island of Menorca (Balearic Islands, NW Mediterranean). Both geomorphological parameters and anthropogenic pressures were considered in order to investigate which were the main environmental factors explaining their distribution. Several factors contributed to explain the composition of *Cystoseira* assemblages in the sampled coves, being coastal morphology, bottom nature, nutrient concentration in seawater and urbanization level of the coast the most important. The relatively high number of *Cystoseira* species found in Menorca suggested a general high quality of the environment. However, in southern coves the number and abundance of *Cystoseira* spp. was reduced compared to the northern ones. This pattern seems to be related both to a higher anthropogenic pressure and to a less favourable geomorphology at southern coves. When strong anthropogenic disturbances were present (proximity to harbour areas), coves were completely devoid of *Cystoseira* specimens. As historical data is available for some of these sites, we can document the disappearance of some *Cystoseira* species at these coves, which seems to be related to increased pollution levels. However, as the absence of *Cystoseira* assemblages can also respond to a lack of a suitable geomorphology, their use as bioindicators; of water quality needs of a definition of proper reference sites.

The collaborative innovation of commercially viable marine-based nutraceuticals (2006)
Sankaran, J.K.
Department of Information Systems & Operations Management, University of Auckland

Spatial Information: No spatial context
Keywords: Aquaculture Technological innovations, New Zealand, Economic aspects, Functional foods, Marine biotechnology.

Summary: Biotechnology is turning a traditionally low-tech industry (food) into a high-tech industry (functional food/nutraceuticals). There is a real need to enhance managerial understanding by clarifying the nature of innovation processes in the functional food industry, including the role of R&D and collaboration. The present investigation focuses on a particular segment of the functional food industry, viz. marine-based nutraceuticals. We find that various hurdles thwart the fullest realization of the business potential of marine bio-actives in the pharmaceutical space. However, the innovation of commercially viable marine-based nutraceuticals/ cosmeceuticals is yet possible if the extraction route for supply is a feasible fallback option, should industrial-scale synthesis prove elusive. Effectiveness in innovation is facilitated by the collaboration of various disciplines including epidemiology, traditional/folkloric medicine, aquaculture/ fermentation, natural products chemistry, and relevant strands of medical, pharmacological, and clinical research. In this regard, the inter-disciplinary field of ethno-pharmacology rises to prominence. Universities and government research institutes may be well-positioned to drive such collaboration and reap the benefits from problem definition in addition to problem solving. Towards this end, the findings from the present study are integrated into a phased approach towards the innovation of commercially viable marine-based nutraceuticals that is targeted at entrepreneurs in this field.

Transition from pasture to native forest land-use along stream continua: effects on stream ecosystems and implications for restoration (1999)
Scarsbrook, M.R.,;Halliday, N.J.,
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Waikato, New Zealand
Keywords: stream habitat; forest remnants; channel morphology; water quality; benthic macroinvertebrates; riparian restoration; New Zealand, Waikato,

Summary: Three first-order, hill country, pasture streams in Waikato, New Zealand, were chosen to investigate the effects of patches of late-succession indigenous riparian forest on water quality, epilithon, stream morphology, and aquatic macro-invertebrates. Sites were situated in open pasture and at two distances (c. 50 and 300 m) into a forest remnant on each stream. Shade, channel width, and epilithon biomass were restored to conditions similar to a native forest control site within 300 m of the streams entering the native forest remnants, whereas water chemistry and levels of surficial fine sediment changed more slowly. Invertebrate community composition showed shifts towards the native forest condition just 50 m into the forest remnants, and full recovery had occurred within 300 m. Results from this study suggest that discontinuous restoration of riparian margins could mitigate some changes associated with pastoral land use, but sediment and water quality problems may not be solved.

Introduced macroalgae - a growing concern (2006)
Schaffelke, Britta; Smith, Jennifer.E;Hewitt, Chad. L
Journal of Applied Phycology

Spatial Information: No spatial context
Keywords: Plants; Sea lettuce; Invasive macroalgae

Summary: Introductions of non-indigenous species to new ecosystems are one of the major threats to biodiversity, ecosystem functions and services. Globally, species introductions may lead to biotic homogenisation, in synergy with other anthropogenic disturbances such as climate change and coastal pollution. Successful marine introductions depend on (1) presence of a transport vector, uptake of propagules and journey survival of the species; (2) suitable environmental conditions in the receiving habitat; and (3) biological traits of the invader to facilitate establishment. Knowledge has improved of the distribution, biology and ecology of high profile seaweed invaders, e.g. *Caulerpa taxifolia*, *Codium fragile ssp. tomentosoides*, *Sargassum muticum*, and *Undaria pinnatifida*. Limited, regional information is available for less conspicuous species. The mechanisms of seaweed introductions are little understood as research on introduced seaweeds has been mostly reactive, following discoveries of introductions. Sources of introductions mostly cannot be determined with certainty apart from those directly associated with aquaculture activities and few studies have addressed the sometimes serious ecological and economic impacts of seaweed introductions. Future research needs to elucidate the invasion process, interactions between invaders, and impacts of introductions to support prevention and management of seaweed introductions.

The adverse effects of hydrogen cyanamide on human health: an evaluation of inquiries to the New Zealand National Poisons Centre (2009)
Schep, L.; Temple, W.; Beasley, M.
Clinical Toxicology Journal

Spatial Information: New Zealand
Keywords: Organic Pollutants

Summary: Hydrogen cyanamide is used in New Zealand to induce bud break in kiwifruit vines. The aim of this investigation was to evaluate the calls received by the New Zealand National Poisons Centre (NZNPC) attributed to acute hydrogen cyanamide exposure, and to ascertain the clinical effects of such exposures. Call data from the NZNPC telephone collection databases regarding human hydrogen cyanamide exposures were analysed retrospectively for the years 1990-2006. There were 68 human exposures, 69% were male and 22% female; 88% were adults and there were no suicide attempts. Common exposure routes were inhalation (56%) and skin contact (28%). The workplace accounted for 45% of calls. The predominant toxic effects were nausea and vomiting (29%), headache (22%), contact dermatitis (19%), and erythema (18%). Reported symptoms and signs were consistent with the expected effects of hydrogen cyanamide exposure. Other reports of similar exposures describe higher degrees of illnesses among workers using hydrogen cyanamide, which might have been because of lack of training, inadequate access to personal protective equipment, and the absence of engineering controls. Based on the calls received by the NZNPC, acute exposure to hydrogen cyanamide in the workplace or acute exposure to those living within the vicinity of its use may not pose a significant immediate threat to human health.

Macroalgal assemblages in New Zealand: structure, interactions and demography (1990)
Schiel, D. R.
Hydrobiologia Journal

Spatial Information: Northern and southern main islands of New Zealand as well as the Chatham Islands and the sub-antarctic Auckland Islands.
Keywords: New Zealand, fucalean algae, laminarian algae, sea urchin, grazing, population structure

Summary: Quantitative description of macroalgal distributions from low intertidal regions to a sublittoral depth of 20 m is presented for rocky reefs from several localities ranging over 16° latitude, in New Zealand. These include the northern and southern main islands as well as the Chatham Islands and the sub-antarctic Auckland Islands. Fucalean algae are dominant in the shallow sublittoral regions throughout NZ. Laminarian species are rare and generally reach their greatest abundances at 7-17 m depth. The colder waters in central and southern NZ tend to have different dominant species from those in northern NZ. Sea urchins from a characteristic zone devoid of kelp at 5-8 m in the north, but tend to occur only in patches on reefs in southern localities. Summaries of experiments in the north show that strong inter-specific effects occur among algal species, particularly due to canopy shading, and between sea urchins and algae. Much of the patchiness in algal assemblages, however, is not accounted for by these effects. A knowledge of the demographic processes of individual species is necessary to understand assemblage organisation; life histories, phenology and biogeography significantly affect distributions and interactions.

Sediment on rocky intertidal reefs: Effects on early post-settlement stages of habitat-forming seaweeds (2006)
Schiel, D. R.; Wood, S. A.; Dunmore, R. A.; Taylor, D. I.
Journal of Experimental Marine Biology and Ecology

Spatial Information: Kaikoura Peninsula in southern New Zealand
Keywords: Plants, macroalgae

Summary: Modification of the coastal environment by human activities often leads to an increase in sedimentation of nearshore waters, with potential impacts on benthic marine assemblages. Here we assess the relationships between the levels of sedimentation, wave exposure and benthic organisms on rocky intertidal platforms around the Kaikoura Peninsula in southern New Zealand. We designed and tested five sediment traps to provide a tool for measuring the relative abundance of sediment across sites. Using field- and laboratory-based experiments, we tested hypotheses concerning whether different levels of sedimentation affected algal germling survival and algal zygote attachment, and whether the interactions of grazers and sediments affected germling survival. Levels of sediment and exposure were inversely related across seven sites. The fucoid alga *Hormosira banksii* characterized the more sedimented wave-sheltered and intermediately wave-exposed sites, with up to 80% cover in the lower mid-tidal zone, while the bull kelp *Durvillaea antarctica* characterized the three most wave-exposed sites. Grazing molluscs were found across all sites but species abundances varied by sediment and exposure levels. We did two 11-day trials testing the effects of different levels of

sediment and different species of molluscan grazers on the survival of 1-week-old *Hormosira* germlings. Generally, there was no significant treatment effect of grazers, but mortality varied considerably among sites. In particular, one site had very high levels of sediment, which resulted in 100% mortality of germlings across all grazer treatments. Removing sediment at 1-week, 2-week and 4-week intervals made no difference to the survival of *Hormosira* germlings. In laboratory-based experiments, a light dusting of sediment reduced the percentage of zygotes of *Hormosira* by 34% and *Durvillaea* by 71% that attached to primary substratum, and a complete cover of sediment prevented attachment altogether. Overall, the effects of sediments and its interaction with molluscan grazing were highly variable but often large, particularly on the attachment of zygotes to primary substratum.

NERMN Estuarine Water Quality (2005)
Scholes, P.
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: water quality , estuary, Tauranga Harbour, Te Awanui, Bay of Plenty, NERMN, nutrients, sediments, indicator bacteria, *E. coli*, Enterococci, faecal coliforms, toxin, nitrogen, phosphorus, trend, monitor

Summary: The monitoring of water quality within the Bay of Plenty Estuaries is part of Environment Bay of Plenty's Natural Environmental Regional Monitoring Programme (NERMN). Water quality data is collated and analysed to detect for changes in water quality. Monitoring is used to observe trends in water clarity, nutrient levels, suspended sediments, pathogens, and phytoplankton. Nine estuaries with twenty-one sites are monitored in the NERMN programme with changes in sites having occurred since monitoring began in 1990.

Onsite Effluent Disposal in the Bay of Plenty 2006 (2007)
Scholes, P.
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: septic tank, contamination, monitoring, on-site wastewater treatment, wastewater, groundwater, effluent, Tauranga Harbour, stormwater, water quality, indicator bacteria, impact, shellfish, nitrate, ammonium, recreation, bathing, Tanners point, Ongare Po

Summary: Many of the Bay of Plenty's unsewered communities are located on coastal fringes, estuarine shorelines and lake edges. These communities often have high amenity and cultural values but when problems arise with on-site wastewater treatment systems the values can be negatively impacted. Many of these communities have been investigated with regards to potential discharges to the receiving environment. Targeted monitoring of stormwater discharges, seepages and groundwater in specific unsewered communities is used to investigate potential impacts of septic discharges and to ascertain if the policies and objectives of the On-site Effluent Treatment Regional Plan are being met. Results are used to chart the progress of initiatives to reduce septic tank contamination in communities and to investigate new or re-occurring problems. Data will be used to help communities meet environmental outcomes and plan for the future.

Effluent Discharge Receiving Water Impact Report (2008)
Scholes, P.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Effluent, discharge, Bay of Plenty, Tauranga Harbour, marine effluent outfalls, monitoring, stormwater, indicator bacteria, shellfish, heavy metals, sediment, water quality, compliance, impact, industry, port, nutrients,

Summary: Major industrial and municipal effluent discharges in the Bay of Plenty have the potential to degrade the receiving environment through a number of mechanisms. Water quality and consent monitoring has helped determine if discharge activities are impacting on the environment.

Bathing Surveillance Grading Report (2008)
Scholes, P.
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: bathing water quality, Bay of Plenty, Tauranga Harbour, estuarine, Sanitary Inspection Index, Microbiological Assessment Category, Suitability of Recreation Grade, indicator bacteria, *E. coli*, Enterococci, faecal coliforms, monitoring, recreation, shell

Summary: Environment Bay of Plenty staff sampled bathing water in the Bay of Plenty in accordance with the Ministry for the Environment (MfE) and Ministry of Health (MoH) 'Microbiological Water Quality Guidelines for Marine and Freshwaters, 2003'. The MfE/MoH Guidelines have a system for grading beaches used for contact recreational activities based on indicator bacteria results and a catchment survey of potential microbiological hazards. This risk-based approach to monitoring water quality has the end result of a 'grade' that community and water managers alike can easily identify with to assess the risk of using recreational waters. The purpose of this monitoring is for 'state of the environment' information and to assist Toi Te Ora Public Health and District Councils in health protection of the community. The objective of this report is to provide information for recreational water managers and users which can be used to assess the risks of using those waters. The report does this by giving a 'grade' based on the MfE/MoH Guidelines for many of the Bay of Plenty's most popular and higher risk recreational waters.

Bathing and shellfish surveillance report 2009-2010 (2010)
Scholes, P.
Bay of Plenty Regional Council

Spatial Information: Tauranga Harbour
Keywords: Shellfish, Water Quality

Summary: Bay of Plenty Regional Council undertakes annual quality surveys of popular recreational (bathing) waters and shellfish beds over the warmer months (October to March). The surveys serve to monitor and identify the risk to public health from faecal contamination within waterways popular for recreational activities in the context of national monitoring protocols. Monitoring information can then be used by

public health services, local authorities and the public to assess the risk of using these waters, as well as providing information on the potential or existing risk. Agencies involved in the monitoring and reporting of recreational waters are regional councils, district councils, district health boards and the medical officer of health. The surveys monitor aspects of the water quality of water bodies in line with the Regional Policy Statement, the Regional Coastal Environment Plan, the Regional Water and Land Plan and the Ten Year Plan. They also provide a basis to assess the effects of discrete discharges and diffuse run-off from land-use activities. The main objective of this report is to report on the bathing suitability of approximately 80 river, lake and marine sites in the Bay of Plenty over the 2009-2010 bathing season.

Microbiological Quality of Shellfish in Estuarine Areas 2009: Joint Agency Research Report (2009)
Scholes, P.; Greening, G.; Campbell, D.; Sim, J.; Gibbons-Davies, J.; Dohnt, G.; Hill, K.; Kruis, I.; Shoemack, P.; Davis, A.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, Bay of Plenty,
Keywords: microbiological, shellfish, estuarine, indicator bacteria, *E. coli*, Enterococci, faecal coliforms, virus, contamination, effluent discharge, overflow, monitoring, toxic, stormwater, sewage, pollution, Tauranga Harbour, Bay of Plenty,

Summary: Towards the end of 2006 recreational shellfish monitoring showed an increase in elevated bacterial levels in shellfish beds within Tauranga harbour adjacent to the city of Tauranga. Recreational water quality monitoring also identified contamination events which could result in pathogenic bacteria and viruses being present at harmful levels in shellfish. Environment Bay of Plenty (EnvBOP), Tauranga City Council, Western Bay of Plenty District Council and Toi Te Ora – Public Health (TTO) agreed it was necessary to obtain better information on the pathogen levels in shellfish stocks so the public could be better informed on the risks of eating shellfish from local beds. Two estuarine areas were sampled in this study, Tauranga Harbour and Waihi Estuary. Monthly shellfish and water sampling was carried out over a 12 month period to obtain information on the usual microbiological and viral quality of shellfish. Comprehensive sampling was also carried out after two significant pollution events. This study found that enteric virus contamination of shellfish is occurring in the Tauranga Harbour and Waihi Estuary. Shellfish from a few sites - namely Tilby Point and Pilot Bay were found to be regularly contaminated with viruses. These two sites are closest to the urban area and main cities of Tauranga and Mount Maunganui. Over the study period, norovirus levels were generally low in shellfish except following the significant sewage spill.

Water Quality of Bay of Plenty Rivers 1989-2008 (2009)
Scholes, P.; McIntosh, J.,
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: water quality , rivers , streams, Bay of Plenty, freshwater, Tauranga Harbour catchment, dissolved oxygen, temperature, colour, pH, suspended solids, turbidity, visual clarity, indicator bacteria, nutrients, total nitrogen, oxides of nitrogen, dissolved

Summary: Rivers and streams in the Bay of Plenty provide a range of economic benefits and have important ecological, recreational, aesthetic and cultural values. Uses of rivers and streams in the region include municipal and industrial water supply, waste disposal, irrigation, frost protection and hydro-generation. These uses and values can be adversely affected by degradation of water quality. Management of the environmental quality of rivers and streams in the Bay of Plenty is guided primarily by the Regional Water and Land Plan (RWLP). Objectives, methods and policies in this plan, and in the Regional Plan for the Tarawera River Catchment, are intended to provide for the maintenance and enhancement of water quality and quantity. Water classifications are included in regional plans as a guide for issuing resource consents for activities that might impact on waterways. Over 40 river and stream sites are included in the Bay of Plenty's Natural Environment Regional Monitoring Network (NERMN) water quality module and an additional seven sites are monitored by NIWA. The sampling sites are representative of a range of land uses and catchment land cover and include most of the region's major rivers and streams. The purpose of this report is to summarise the results of trend analysis for water quality in the regions' rivers and streams. NERMN data from 1989 to 2008 has been used to examine trends in a number of parameters; dissolved oxygen, temperature, colour, pH, suspended solids, turbidity, visual clarity, five forms of nutrients and three forms of indicator bacteria. While there are a number of significant improving trends, the key finding of the report is that the water quality of many rivers and streams is deteriorating. The main indicators of this are nutrients, bacteria and suspended solids/turbidity.

The role of nutrients in contributing to mangrove expansion (2002)
Schwarz, A. M.
NIWA Client Report

Spatial Information: Tauranga Harbour
Keywords: Mangrove, Tauranga Harbour, Estuaries

Summary: In New Zealand, an increase in the extent and distribution of mangroves is commonly attributed to increased sedimentation following changes in land use. This study was jointly commissioned by Environment Waikato (EW) and Department of Conservation (DOC) with the aim of establishing the role of nutrients in contributing to mangrove expansion. The dataset was considerably enhanced by contributions from Environment Bay of Plenty (EBOP). This study aimed to establish the role of nutrients in contributing to mangrove expansion in different estuaries as well as in specific areas within each of those estuaries. The approach was to determine if there were within and/or between estuary differences in sediment composition and nutrient content that could be related to structural characteristics of mangrove forests and to rates of spread in different parts of the estuaries. To help interpret cause and effect in any observed relationships, the nutrient content of leaves was used as an integrator of the nutrient status of the plant. Case study estuaries were Whangamata (EW), Whangapoua (DOC) and Tauranga (EBOP) with the inclusion of additional information from a previous study by NIWA for the Auckland Regional Council (ARC) in the Whitford embayment.

Guidelines for Community- Focused Ecological Monitoring of Mangrove Habitats in Estuaries (2004)
Schwarz, A. M.; Burns, B. R.; Alfaro, A. C.
NIWA

Spatial Information: No spatial context
Keywords: Plants; Mangroves

Summary: This document (mangrove guidelines) was prepared after the Mangrove Steering Group identified a need to develop standard methods for monitoring changes in estuaries, with emphasis on mangrove habitats. The objective of the mangrove guidelines is to provide some guidance on techniques that individuals, or groups with an interest in mangroves can employ to investigate environmental questions within their local estuaries. The document describes and provides methodological detail for a recommended minimum set of techniques to address each of these questions.

The role of sediment in keeping seagrass beds healthy (2004)
Schwarz, A. M.; Matheson, F. E.; Mathieson, T.
NIWA

Spatial Information: New Zealand
Keywords: Plants; Sea grass

Summary: As part of FRST-funded research, and in collaboration with various management agencies, NIWA scientists are studying the conditions that promote healthy seagrass beds in New Zealand. One aspect we have considered is the relationship between sediment conditions, growth, and seagrass health.

Estuary monitoring by communities; Mangrove habitats a case study (2005)
Schwarz, A. M.; Parker, S.; Grose, M.
NIWA and Waikaraka Estuary Managers

Spatial Information: New Zealand
Keywords: Plants; Mangroves

Summary: This report was produced by NIWA in conjunction with the Waikaraka Estuary Managers. These guidelines outline a recommended minimum set of methods (step by step) for a community group interested in following habitat changes in an estuary. They have been developed in relation to mangroves but the principles can be applied to a number of aspects of estuarine ecology in general.

Decision making document (2005)
Schwarz, A. M.; Reed, J.; Morrison, M.
NIWA

Spatial Information: Whangarei, New Zealand
Keywords: Sea Grass, Zostera

Summary: Seagrass beds in Whangarei Harbour have been demonstrated to have declined in a real extent since the 1960's and now local communities are interested in exploring ways of reversing that decline. This report fulfils tasks 3 and 4 of SMF project 2209, which has the overall aim of assessing the feasibility and techniques for restoration of seagrasses in Whangarei Harbour. In this document we draw on overseas experiences as well as local knowledge about New Zealand's seagrass

biology, to provide advice on the best practicable options for designing a seagrass restoration trial in Whangarei Harbour. There is evidence to suggest that adverse environmental conditions, such as low water clarity, which were possible causes of seagrass loss in Whangarei Harbour in the past, have improved sufficiently as to provide a rationale for continuing with preparations for a restoration trial. Restoration of seagrass beds has received considerable attention elsewhere in the world; however, with the exception of NIWA trials in Manukau Harbour; we are not aware of structured trials here in New Zealand. As New Zealand has only one species of seagrass, which is predominantly intertidal, and probably primarily reproduces vegetatively, not all overseas experiences are relevant for consideration. The document includes three decision making trees (presented at the end), which outline a series of actions required by managers in attempting seagrass restoration. Flow Chart I deals with identifying a restoration site and requirements for environmental enhancement. Considerations include ensuring sufficient light, moderate nutrient loads, and protecting plantings from disturbance. Flow Chart II outlines the steps required to conduct a trial, and links with Flow Chart III, which details requirements for monitoring the success of the trial. Successful restoration of seagrass beds will be a long process (years) and there will be lessons about the local environment to learn as the process proceeds. We recommend that monitoring of seagrass bed extent and water clarity in the harbour be undertaken as a matter of course to provide background information for future restoration attempts. This would be in addition to specific monitoring of restoration trials.

Organochlorines in New Zealand: ambient concentrations of selected organochlorines in estuaries (1999)
Scobie, S.; Buckland, S. J.; Ellis, H. K.; Salter, R. T.
Ministry for the Environment

Spatial Information: New Zealand
Keywords: Organochlorines, Shellfish

Summary: This study is one component of the Ministry for the Environment's Organochlorines Programme, which also includes a nation-wide survey to determine the background concentrations of organochlorines in soils, rivers, and in ambient air. This report presents data on the concentrations of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), organochlorine pesticides and chlorophenols measured in New Zealand estuarine sediments and shellfish. A total of 26 composite sediment samples and 26 composite shellfish samples were collected from 12 estuaries throughout New Zealand. The land uses within the catchments of these estuaries range from highly urbanised to relatively remote from anthropogenic influences. The results from this survey demonstrate that concentrations of PCDDs, PCDFs, PCBs, organochlorine pesticides and chlorophenols in New Zealand estuaries are low, and in most cases markedly lower than concentrations reported for estuaries in other countries. Concentrations of PCDDs and PCDFs (including half LOD values for non-detectable congeners) were in the range 0.081 - 2.71 ng I-TEQ kg-1 DW for sediments, and 0.015 - 0.26 ng I-TEQ kg-1 WW for shellfish. Exclusion of LOD values resulted in lower TEQ concentrations, in the range 0 -1.38 ng I-TEQ kg-1 DW for sediments and 0 - 0.23 ng I-TEQ kg-1 WW for shellfish. The higher chlorinated congeners were most abundant and most frequently detected in sediments and shellfish. PCBs were detected more frequently in shellfish (18 samples) than in sediments (9 samples). The sum of 25 congeners was in the range 0.12 - 8.80 µg kg-1 DW for sediments and 0.11 - 12.9 µg kg-1 WW for shellfish (including half LOD values). The most

frequently detected congeners in both sediments and shellfish were PCB #153 and 138. Of the non *ortho*- congeners, PCB #77 was quantified in two sediments samples and four shellfish samples. PCB #126 was only quantified in one shellfish sample. Aldrin, α- and β-HCH were not detected in either the shellfish or sediments. The most frequently detected pesticides were: dieldrin, <0.05 - 0.38 µg kg-1 DW for sediment, <0.02 - 0.56 µg kg-1 WW for shellfish; and DDT and its degradation products, with pp'-DDE the most abundant, <0.01 - 3.29 µg kg-1 DW in sediments and <0.01 - 2.77 µg kg-1 WW in shellfish. The only location where dieldrin and DDT (and its degradation products) were not detected was Parengarenga Harbour, a site chosen for its distance from large urban areas and agricultural activity. However, lindane (γ-HCH) was quantified in both shellfish samples taken from this site. Heptachlor and heptachlor epoxide were not detected in any shellfish samples and were measured in only one sediment sample. No tri- or tetrachlorophenol were detected in any samples. Pentachlorophenol was quantified in two sediment and two shellfish samples at concentrations close to the limits of detection. Concentrations ranged from <0.03 - 0.4 µg kg-1 DW in sediments and from <0.1 - 0.25 µg kg-1 WW in shellfish. The contaminant concentration data sets for PCDDs, PCDFs, PCBs, organochlorine pesticides and chlorophenols in all samples analysed are detailed in full in Appendices D to G and in the Organochlorines Programme Environmental Survey database available from the Ministry's website (http://www.mfe.govt.nz/issues/waste/organo.htm). A summary of comparative international data is provided in Appendices H to K. Appendix A provides information on the status of organochlorine pesticides in New Zealand. Appendices B and C contain detailed information on the sampling and analytical programmes, including the results from the analysis of field and laboratory quality control samples. The survey has demonstrated that New Zealand's estuarine environments are relatively free of organochlorine contaminants, although concentrations in some estuaries are approaching those reported for urbanised estuaries overseas

Ohiwa Harbour Sediment and Mangrove Management Plan (2009)
Senior, T.; Hougton, M.; Donald, M.; Douglas, J.
Environment Bay of Plenty

Spatial Information: Ohiwa Harbour, New Zealand
Keywords: Plants; Mangroves

Summary: This report has been prepared on behalf of the Ohiwa Strategy Co-ordination Group to give effect to some of the actions proposed in the Ohiwa Harbour Strategy concerning increasing sedimentation and mangrove spread in the harbour. Part 1 includes an assessment of the land resources of the Ohiwa Harbour catchment and their uses. Part 2 provides some background to the spread of mangroves in the Ohiwa harbour and provides a rationale and a recommended process to manage their spread subject to the wishes of the community.

Indigenous Biodiversity of Tauranga District - Selection of Indicators for State of the Environment Monitoring and Reporting (2000)
Shaw, W.; Biddy, J.; Hosking, M.; Beadel, S.
Wildland Consultants Ltd

Spatial Information: Tauranga, New Zealand
Keywords: Indigenous, biodiversity, state of the environment, indicators, monitoring, Tauranga

Summary: This report provides detailed vegetation maps, a review of Special Ecological Sites, a review of potential restoration sites and corridors, and analysis of eight biodiversity indicators (area of indigenous vegetation removed; habitat fragmentation and isolation; land use and development; biodiversity condition and trend; number and distribution of threatened species; area legally protected; and location, area, and type of pest and weed control).

State of the Environment Assessment for the Catchments of the Kaimai Range and Northern Mamaku Plateau (2010)

Shaw, W.;Renner, M.; Gillies, R.; van Meeuwen-Dijkgraaf, A.; Mazzieri, F.; Rossouw, M.; Thomas, S.
Wildland Consultants Ltd

Spatial Information: Kaimai Range and Northern Mamaku Plateau, New Zealand
Keywords: State of the Environment, Kaimai, Mamaku, Tauranga Harbour Catchments, Bay of Plenty, land cover, land use, flora, fauna, management, ecosystem,

Summary: The Department of Conservation, Environment Bay of Plenty, and Environment Waikato have formed a working party to cooperatively explore options for a joint planning and management approach for the Kaimai-Mamaku Ranges, in order to protect and enhance the significant catchment, conservation, and recreational values that this area provides. The objective for this project was to provide a comprehensive report on the environmental state of the Kaimai Range, including all stream catchments that flow from the Kaimai-Mamaku Ranges into Tauranga Harbour and the Waihou River, also encompassing the northern catchments of the Otanewainuku-Otawa Range that extend north-east from the Mamaku Plateau.The project area encompasses a distinctive suite of prominent landforms and the Kaimai Range, in particular, is very prominent from the Waikato and the Bay of Plenty, and is highly valued by the people of both regions. With the exception of the plains and downlands on the western and eastern sides of the range and plateaus, these landforms are largely of volcanic origins, with fault uplift resulting in the large western scarp rising above the Waikato Basin. North-south, the project area spans almost 90 km, and c.40 km west-east at its widest point, encompassing more than 240,000 ha, in 15 sub-catchments. Five of these sub-catchments - Waihi, Paeroa, Te Aroha, Middle Waihou, Upper Waihou - flow into the Waihou River and drain the northern part of the Kaimai Range, the steep western flanks of the range, and the western parts of the northern Mamaku Plateau. The other ten - Waiau, Tuapiro, Uretara, Rereatukahia, Aongatete, Te Puna, Wairoa, Omanawa, Waimapu, and Otawa - drain from the northern hill country near Waihi Beach, the eastern flanks of the Kaimai Range, the Whakamarama Plateau, the north-eastern parts of the northern Mamaku Plateau, and the Otawa-Otanewainuku hills to the Tauranga Harbour. The Tauranga Harbour sub-catchments (122,340 ha) are mainly individual catchments originating in the Kaimai-Mamaku ranges, with single discharge points into the harbour, while the Waihou sub-catchments (118,426 ha) are groups of smaller tributary catchments with similar characteristics (stream type, geology, topography) that discharge into the Waihou and Ohinemuri Rivers.

Ecological assessment of potential mangrove clearance scenarios at Whangamata (2009)
Shaw, W.B.
Wildland Consultants Ltd

Spatial Information: Whangamata, New Zealand
Keywords: Sedimentation, Mangroves

Summary: The purpose of this assessment is to provide input on the effects on benthic and aquatic ecology and water quality likely to be associated with the clearing of 38 ha of existing mangroves in Whangamata Harbour. It addresses the following matters: (a)The ecosystem services provided by mangroves. (b) The potential impacts of mangrove removals on benthic communities and aquatic ecology. (c) Monitoring to detect and respond to unanticipated impacts of mangrove removals.

Continuing trophic cascade effects after 25 years of no-take marine reserve protection (2003)
Shears, N. T.; Babcock, R. C.
Marine Ecology Progress Series

Spatial Information: No spatial context
Keywords: Benthic Communities, Kina, *Evechinus chloroticus*

Summary: Between 1978 and 1996 benthic communities in the Leigh Marine Reserve shifted from being dominated by sea urchins to being dominated by macroalgae. This was a result of a trophic cascade thought to be an indirect effect of increased predator abundance. We assessed further changes in communities from 1996 to 2000, differences in benthic communities between reserve and adjacent unprotected sites, and the stability of these patterns from 1999 to 2001. Since 1996, densities of sea urchins *Evechinus chloroticus* have continued to decline in shallow areas of the reserve (< 8 m), and all sites classified as urchin barrens in 1978 are now dominated by large brown algae. Comparisons between reserve and non-reserve sites revealed differences consistent with a trophic cascade at reserve sites. The greatest differences in algal communities between reserve and non-reserve sites occurred at depths where *E. chloroticus* was most abundant (4 to 6 m). Reserve sites had lower urchin densities and reduced extent of urchin barrens habitat with higher biomass of the 2 dominant algal species (*Ecklonia radiata* and *Caipophyllum maschalocarpum*). At reserve sites densities of exposed *E. chloroticus* (openly grazing the substratum) declined so that urchin barrens were completely absent by 2001. Lower density of the limpet *Cellana stellifera* and higher densities of the turbinid gastropod *Cookia sulcata* at reserve sites are thought to be responses to changes in habitat structure, representing additional indirect effects of increased predators. The overall difference in community types between reserve and non-reserve sites remained stab le between 1999 and 2001. Localised urchin mortality events due to an unknown agent were recorded at some sites adjacent to the marine reserve. Only at 1 of these sites did exposed urchins decline below the critical density of 1 m (-2), which resulted in the total replacement of urchin barrens with macroalgae-dominated habitats. At other sites urchin barrens have remained stable. Declines in the limpet *C. stellifera* occurred across all sites between 1999 and 2001 and may be indirectly associated with urchin declines. Long-term changes in benthic communities in the Leigh reserve and the stability of differences between reserve and non-reserve sites over time are consistent with gradual declines in urchin

densities due to increased predation on urchins, thus providing further evidence for a trophic cascade in this system. The rapid declines in urchin numbers at some unprotected sites, however, demonstrate how short-term disturbances, such as disease, may result in shifts in community types over much shorter time frames.

Validation of qualitative habitat descriptors commonly used to classify subtidal reef assemblages in north-eastern New Zealand (2004)
Shears, N. T.; Babcock, R. C.; Duffy, C. A. J.; Walker, J. W.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: north-eastern New Zealand
Keywords: Plants, macroalgae

Summary: On shallow temperate subtidal reefs, habitat types are usually defined subjectively by the dominance or presence of major macroalgal species. Many of these habitat types (e.g., urchin barrens, kelp forest) are frequently used in the literature but little attempt has been made to quantitatively define these habitats. A survey of shallow subtidal reefs in north-eastern New Zealand identified a number of commonly occurring "habitat types". In this paper the abundances of habitat-forming species within each of these habitats are quantified and the validity of the subjective classification system is tested. In addition to previously-described reef habitats from north-eastern New Zealand a number of other habitat types were encountered and described in this study (e.g., "mixed algae", "red foliose algae", and "Caulerpa mats"). The algal communities within each habitat were biologically distinct and there was strong concordance between the grouping of samples from cluster analysis and the subjective habitat type assigned to each. The habitat classification system was reliable and canonical analysis of principal coordinates revealed an overall classification success of 81%. This provides strong evidence that the habitat classifications used in this study are biologically meaningful based on the abundances of habitat-forming algal groups. Furthermore, this demonstrates that these habitat types can be reliably categorised visually, which has important applications in classification and mapping of the marine environment.

Chlordane residues in marine biota and sediment from an intertidal sandbank in Manukau Harbour, New Zealand (1996)
Simpson, C. D.; Wilkins, A. L.; Langdon, A. G.; Wilcock, R. J.
Marine Pollution Bulletin

Spatial Information: Manukau Harbour, New Zealand
Keywords: Organic Pollutants

Summary: Low levels of chlordane residues were determined in several species of mollusc and polychaetes and in a shallow sediment core from an intertidal sandbank. Chlordane levels were lowest in surface sediments and increased with increasing sediment depth. Total chlordane levels were similar in all molluscs (91-117 ng (g lipid)-1), but were twice as high in the polychaetes (202 ng (g lipid)-1).

Draft Whangamata Harbour plan: looking forward to a healthier harbour (2007)
Singleton, P.
Environment Waikato Internal Report 2007/14

Spatial Information: Whangamata Harbour, New Zealand
Keywords: Water quality, Catchments, Sedimentation, Recreation, Harbour

Summary: The Draft Whangamata Harbour Plan is a non-statutory document developed in cooperation with the Department of Conservation (DOC), Forest & Bird, iwi and Thames-Coromandel District Council. It also draws on work by other groups such as Whangamata Harbour Care. This document gives an overview of the issues facing the harbour, what could be done to address them and how we could work together to ensure the community's vision for the harbour is achieved. The possible actions outlined in this plan have been prioritised to help guide work programmes and funding applications. The plan also recognises that the harbour is affected by what is happening in its 'catchment' (the land surrounding the harbour) and that both need to be managed together. Given this, Environment Waikato has also prepared a Draft Whangamata Catchment Management Plan 20071 which sets out the priority works we propose to carry out to address the sedimentation and flooding issues identified in the harbour plan. The key concerns and risks to the harbour covered in this plan are grouped into four core issues; Water quality, Habitat, Sedimentation and flooding, recreation, boating, access and views. A major issue affecting the long-term health of the harbour concerns sedimentation. This is caused by soil settling into the harbour and waterways as mud after being washed down from surrounding land by rainfall. Although sedimentation and erosion are essentially natural processes, people's land use activities (for example, through urban development and agricultural activities like forestry and farming) can increase how much soil is moved in this way. Contaminants from the land and invasive weeds and pests also need attention. Mangroves have spread by growing in the mud in the harbour and its waterways. Controlling further mangrove expansion and limited removal of mature mangroves are part of the harbour plan. The mangrove management issue has remained unresolved throughout consultation and development of the harbour plan. Additional reports have been prepared to help resolve this issue.

A proposed pest management strategy for the Asian Kelp *Undaria* (2000)
Sinner, J.; Forrest, B.; Taylor, M.
Ministry of Fisheries

Spatial Information: No spatial context
Keywords: Asian Kelp *Undaria,* pest management

Summary: Because of the actual and potential threat from *Undaria* to "natural character," commercial fisheries, customary and conservation values the Government directed the Ministry of Fisheries (Mfish) to prepare a proposal for a national pest management strategy (NPMS) for *Undaria*. MFish engaged Jim Sinner and the Cawthron Institute to prepare a draft strategy for the management of *Undaria* (the Sinner/Cawthron report). Following consideration of the Sinner/Cawthron report, and the additional tools that became available when *Undaria* was declared unwanted, MFish developed a proposed framework for managing *Undaria*.
The proposed management for *Undaria* included:
• A national pest management strategy (NPMS) developed for *Undaria*;
• Management effort focussed on protecting selected High Value Areas (HVAs);
• Management of HVAs including surveillance, response, education, enforcement, research, restriction on deliberate cultivation/transfer, and a combination of mandatory and voluntary vector controls;

• Options for government to bear the cost of surveillance, response, education and enforcement in HVAs, while private individuals and enterprises bear thecost of vector control; and
• A framework under the Biosecurity Act 1993 that could be used by local authorities to manage Undaria in areas of importance to local communities.

Faecal *Streptococci* as Faecal Pollution Indicators: a review. Part I: Taxonomy and Enumeration (1993)
Sinton, L.W.; Donnison, A.M.; Hastie, C.M.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: No spatial context
Keywords: faecal streptococci; Enterococci; taxonomy; enumeration; review

Summary: The faecal *streptococci* are the most commonly used alternative or adjunct to coliform bacteria as faecal pollution indicators. They are a group of coccoid bacteria, naturally inhabiting the gut of warm-blooded animals and humans. Their potential as faecal pollution indicators was recognised in the 1890s, but it was 50 years before the accumulated knowledge of their taxonomy and sanitary significance, together with the development of isolation and enumeration methods, allowed their practical application in water pollution research and management. There is still much disagreement over the classification of the group. Many workers now place some species in a separate genus, Enterococcus, and it is likely that this revised nomenclature will be incorporated into the next edition of Bergey's Manual. Of the enumeration methods available (plate count,MPN, and membrane filtration), the mE-EIA membrane filtration method, which recover senterococci (a subset of faecal streptococci) is probably the most important, because it is the basis of current United States Environmental Protection Agency recommendations on bathing water standards. However, there appears to be no universally accepted "best method" for the isolation of faecal streptococci from natural waters. Biochemical and serological identification methods are commercially available, and research has begun into the use of DNA-based techniques for identifying faecal streptococcal strains and faecal sources.

Distinguishing Human from Animal Faecal Contamination in Water: A Review (1998)
Sinton, L.W.; Finlay, R.K.; Hannah, D.J.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand wide
Keywords: faecal source identifiers; faecal streptococci; bifidobacteria; Bacteroides fragilis; Bacteriophages; Rhodococcus coprophilus; faecal sterols; fluorescent whitening agents; sodium; tripolyphosphate; linear alkyl benzenes

Summary: Management of faecal contamination of water would be improved if sources could be accurately identified through water analysis. Human faeces are generally perceived as constituting a greater human health risk than animal faeces, but reliable epidemiological evidence is lacking. United States waterborne disease data suggest that human-specific enteric viruses account for over half the documented outbreaks. However, in New Zealand, where there is a high grazing animal: human ratio (increasing the relative importance of water-transmissible zoonoses), it seems prudent to assume that human and animal faecal pollution both

constitute a risk to human health. Irrespective of the relative risks, the ability to identify sources would assist in overall management of microbial water quality. Faecal streptococci do not appear to provide reliable faecal source identification. Human and animal sources, respectively, maybe distinguishable by two tests on Bifidobacterium spp.—growth at 45°C in trypticase phytone yeast broth and sorbitol fermentation. Different species of Bacteroides tend to be present in humans and animals, but poor survival in water is a problem. Phages of the Bacteroides fragilis strain HSP40 appear to be human specific, but low counts in effluent in some countries, including New Zealand, may limit their usefulness. Different F-RNA phage subgroups appear to be associated with human and animal faecal sources. The actinomycete Rhodococcus coprophilus has potential as a grazing animal indicator but it is persistent, and existing culturing techniques are time consuming. The development of DNA-based techniques, such as polymerase chain reaction (PCR), may assist in the assay of some microbial faecal source indicators. Various faecal sterol isomers offer the possibility of distinguishing between human and animal sources, and even between different animals. Washing powder constituents such as fluorescent whitening agents, sodium tripolyphosphate and linear alkyl benzenes, offer useful human source identifiers. It is unlikely that any single determinant will be useful in all situations, but statistical analysis of appropriate “baskets” of microbial and chemical determinants offers the possibility of identifying and apportioning human and animal faecal inputs to natural waters.

Port of Tauranga 1993 economic impact study (1993)
Smith, Mark. I. A; Hughes, Warren. R.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: TaurangaPort economy, Industry

Summary: The purpose of the study is to investigate and quantify the magnitude and distribution of economic benefits, in terms of revenue, payroll and employment within the Bay of Plenty, surrounding districts and New Zealand economy. The study uses data provided by the Port company, users and industry groups. A limitation of the study is that the research is reliant on information and knowledge of port related activities and port dependent firms to estimate impacts. In order to obtain information effectively, the researchers elected to use qualitative and quantitative research methods. The study illustrated that the economic influence of the Port of Tauranga is not merely confined to its exporters and importers and to the local port industry, but has flow-on effects to many other sectors of the community and economy.

The Population Ecology of Intertidal *Ulva* in the Bay of Plenty (1995)
Snow, J.
University of Auckland

Spatial Information: Bay of Plenty, New Zealand
Keywords: Plants; Sea lettuce; Ulva

Summary: There was a demand after the 1991 *Ulva* (sea lettuce) blooms in the Tauranga harbour to better understand the biology and ecology of the life history of *Ulva*. This study is one of 2 Auckland university (Masters') thesis to investigate *Ulva* (Gregor, 1995 was the other student). This thesis investigates 3 aspects of the life history of *Ulva* in the Tauranga and Ohiwa harbours. These aspects were swarmer

release, growth of individual plants, populations, and recruitment. The report notes that there was a rapid decline in the populations of *Ulva* in the Tauranga harbour in 1994 and that this affected the studies. In particular, Ohiwa harbour showed the most growth in *Ulva.*

A comparison of eelgrass, sea lettuce macroalgae, and marsh creeks as habitats for epibenthic fishes and decapods (1991)
Sogard, S. M.; Able, K. W.
Estuarine, Coastal and Shelf Science

Spatial Information: No spatial context
Keywords: Habitat quality; Estuaries; Zostera marina; *Ulva lactuca*; Recruitment; New Jersey; Plants; Sea grass; Sea lettuce

Summary: Densities of epibenthic fishes and decapod crustaceans (excluding xanthids and pagurids) were quantified with daytime throw trap sampling in shallow water habitats of New Jersey estuaries. We compared eelgrass (*Zostera marina*), sea lettuce macroalgae (*Ulva lactuca*), unvegetated sand/mud substrates adjacent to these vegetation types, and saltmarsh creeks. The highest total density of fishes occurred in marsh creeks, due primarily to high abundances of *Menidia menidia*. The highest total decapod density was also in a marsh creek, but only slightly surpassed the density in *Zostera*. Results of apriori comparisons tests for individual species demonstrated that vegetation (either *Zostera* or *Ulva*) was superior in quality (based on fish and decapod densities) to adjacent unvegetated substrates. Sites with *Zostera* as the dominant vegetation had higher densities of most fish species than sites with Ulva as the dominant vegetation, but only one decapod, *Hippolyte pleuracanthus*, was more abundant at eelgrass sites. *Ulva lactuca*, therefore, was an important habitat in areas lacking *Zostera marina*; for the decapods the two vegetation types were comparable in habitat quality, but for fishes *Ulva* did not provide an equivalent substitute for *Zostera*. Marsh creeks supported very high densities, but only for a few species that were also common in other habitats. Comparison of recruitment patterns suggested many species do not begin exploiting these estuarine habitats until relatively late in the summer, perhaps as result of peak spawning in mid-summer.

Estimated Human Health Risks from Exposure to Recreational Waters Impacted by Human and Non-human Sources of Faecal Contamination (2010)
Soller, J.A.; Schoen, M.E.;Bartrand, T.;Ravenscroft, J.E.;Ashbolt, N.J.,
Water Research Journal

Spatial Information: No spatial context
Keywords: Recreational water; Quantitative microbial risk assessment; Non-point source contamination

Summary: This work was conducted to determine whether estimated risks following exposure to recreational waters impacted by gull, chicken, pig, or cattle faecal contamination are substantially different than those associated with waters impacted by human sources such as treated wastewater. Previously published Quantitative Microbial Risk Assessment (QMRA) methods were employed and extended to meet these objectives. Health outcomes used in the analyses were infection from reference waterborne pathogens via ingestion during recreation and subsequent gastrointestinal (GI) illness. Illness risks from these pathogens were calculated for

exposure to faecally contaminated recreational water at the U.S. regulatory limits of 35 cfu 100 mL−1 enterococci and 126 cfu 100 mL−1 *Escherichia coli*. The probabilities of GI illness were calculated using pathogen dose-response relationships from the literature and Monte Carlo simulations. Three scenarios were simulated, representing a range of feasible interpretations of the available data. The primary findings are that: 1) GI illness risks associated with exposure to recreational waters impacted by fresh cattle faeces may not be substantially different from waters impacted by human sources; and 2) the risks associated with exposure to recreational waters impacted by fresh gull, chicken, or pig faeces appear substantially lower than waters impacted by human sources. These results suggest that careful consideration may be needed in the future for the management of recreational waters not impacted by human sources.

World atlas of mangroves (2010)
Spalding, M.; Kainuma, M.; Collins, L.
Earthscan

Spatial Information: World wide
Keywords: Mangrove forests Maps; Mangrove swamps Maps; Mangrove plants Maps; Plants; Mangroves

Summary: This atlas provides the first truly global assessment of the state of the world's mangroves. Written by a leading expert on mangroves with support from the top international researchers and conservation organizations, this full colour atlas contains 60 full-page maps, hundreds of photographs and illustrations and a comprehensive country-by-country assessment of mangroves. Mangroves are considered both ecologically and from a human perspective. Initial chapters provide a global view, with information on distribution, biogeography, productivity and wider ecology, as well as on human uses, economic values, threats, and approaches for mangrove management. These themes are revisited throughout the regional chapters, where the maps provide a spatial context or starting point for further exploration. The book also presents statistics on biodiversity, habitat area, loss and economic value which provide a unique record of mangroves against which future threats and changes can be evaluated. Case-studies, written by regional experts provide insights into regional mangrove issues, including primary and potential productivity, biodiversity, and information on present and traditional uses and values and sustainable management.

Continued beach renourishment of dredge spoil disposal (2005)
Spiers, K.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga, Tauranga Harbour, dredging

Summary: After dredging the shipping channel through the ebb-tidal delta entrance to Tauranga Harbour, the Port of Tauranga Ltd are able to use the coarse sand dredge spoil to renourish adjacent beaches. During 2004, maintenance dredging was carried out using the trailer suction dredge Pelican, which deposited 112,000 m^3 of sandy material in 5-15 m water depth off the adjacent down-drift ocean beach. This project was undertaken to monitor the renourishment program. An aspect of this study was to identify and characterize the deposited dredge spoil and monitor its

subsequent dispersal in the outer part of the active beach profile. Seafloor characterization was carried out using sidescan sonar and sediment textural analysis. Methods used to monitor changes to the dump ground bathymetry included a combination of single beam and shallow water multiband surveys. Preliminary findings confirm that the dredged sediments have been deposited in a shore parallel line across the dump ground in 5-8 m water depth and in a smaller area in 10-14 m water depth. Side-scan sonograph comparisons show the formation of coarse grained ripples, corresponding to spoil disposal sites in 10 m-14 m water depth. Other results indicate active erosion of the main spoil mounds with some shoreward movement of sediment in the western side of the dump ground. Volumetric comparisons suggest that most of sediment eroded from the spoil mounds is likely to have been redistributed within the dump ground area and has not (to date) reached the sub-aerial beach.

Ebb-jet dynamics and transient eddy formation at Tauranga Harbour: implications for entrance channel shoaling (2009)
Spiers, K.C., Healy, T.R., Winter, C.
Journal of Coastal Research

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation

Summary: In 1992 the entrance channel through the tidal inlet to Tauranga Harbour, which is located along the Bay of Plenty littoral drift system, was deepened from 10 m to 14 m. The deepened channel has become a sediment trap for littoral drift bypassing and tidal current driven sediment transport through the inlet. Since 1992, there has been an increase in maintenance dredging requirements at the inlet, because of sand accumulation along the south-eastern border of the entrance channel. Previous studies have identified an ebb tide–induced eddy operating on the eastern side of the ebb-jet as it exits the tidal gorge. In this article, the eddy system has been simulated with a validated two-dimensional hydrodynamic model, detailing time-varying current patterns over the ebb-tidal delta. Particular emphasis is placed on defining the trajectory of the eddy and evaluating its influence on the observed sedimentation patterns. The model results indicate the formation of opposing eddies on either side of the entrance channel, both of which are transient in nature. The centre of the eastern eddy propagates seaward along the downdrift margin of the entrance channel as the ebb-jet lengthens. Bathymetric survey residuals between 2004 and 2006 confirm significant accumulations of sediment along this downdrift margin. The evidence is consistent that the eddy system exerts a directional control over transport of sediments entrained by waves over the ebb-tidal delta.

Hydrodynamic modelling of harbour circulation patterns and the influence of entrance channel topography on hydraulic efficiency (2009)
Spiers, K. C.
University of Waikato

Spatial Information: No spatial context
Keywords: Hydrodynamics

Summary: A harbour is a sheltered part of a body of water deep enough to provide anchorage for ships or a place of shelter and refuge. The purpose of a harbour is to provide safety for boats and ships at mooring or anchor and to provide a place where

upland activities can interface with waterborne activities. Harbours range in complexity from the basic harbour of refuge, consisting of minimal or no upland support and only moderate protective anchorage from storm waves to the most complex, consisting of commercial port facilities, recreational marinas, and fuel docks linked to the sea through extensive navigation channels and protective navigation structures. Key features of all harbours include shelter from both long- and short-period open ocean waves, easy and safe access to the ocean in all types of weather, adequate depth and manoeuvring room within the harbour, shelter from storm winds, and minimal navigation channel dredging.

Investigation of sorted bedforms, Tauranga Harbour, New Zealand (2007)
Spiers, K.C.; Healy, T.
Coastal Education & Research Foundation, Inc

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Dredging, Tauranga Harbour, Port of Tauranga

Summary: Geotechnical properties of dredged material placed in an open-water disposal site were monitored over a six-month period immediately following disposal, to determine the consolidation behaviour of the spoil mound and the impact of dredged material on sediment transport behaviour. The dredged material consisted largely (> 90%) of fine to medium sand, with a significant proportion of gravel-sized pumice and shell fragments (1-10%), and minimal (< 0.5%) mud. This distribution was compatible with the natural sediment at the dump ground. Immediately after placement, mean grain size and settling velocity of surficial sediments increased compared with pre-disposal values, and sorting reduced. Dredged material bulk density and static friction angle were lower than those of pre-existing dump ground sediments, yet moisture content was comparable. These changes are attributed to the dredging and injection processes. Due to the low mud content, the dredged material consolidated immediately upon deposition, attaining normal consolidation with respect to ambient stresses within a short period. Reduced static friction angles resulted in an enhancement of the potential for bedload transport relative to pre-disposal rates. Increased settling velocities resulted in decreased potential suspended sediment transport. Lower shear strength of the dredged material resulted in larger bedforms on the dump ground compared with surrounding areas. With time, properties of the materials reverted towards pre-disposal conditions as a result of increased sorting and packing of grains. However, after six months, the properties had not completely returned to previous conditions.

Wave Focusing in Response to a Dredged Sediment Mound (2009)
Spiers, K. C.; Healy, T. R.
Journal of Coastal Research

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation, Dredging, Dredge disposal, tidal inlet, wave focusing

Summary: Dredged sediments from the navigation channel to Tauranga Harbour (New Zealand) have historically been deposited in approved dump grounds, located some 3-5 km off Mt Maunganui Beach. The refraction of approaching waves around the resultant spoil mounds focuses wave energy onto the adjacent beaches and, depending upon the angle of wave approach, the Entrance Channel through the ebb tidal delta. At the present time there is a proposal to significantly deepen and widen

the shipping channels, with the dredged sediments likely to be deposited offshore. To simulate the influence of a deposited dredged sediment mound on local wave focusing patterns, a hypothetical spoil mound has been added to existing bathymetry (between ~20-31 m water depth adjacent to the Mt Maunganui beaches) in two alternate scenarios. Modifications to local wave patterns, induced by the addition of either hypothetical spoil mound, are assessed through applications of a wave refraction model and compared to the present conditions. Model predictions indicate that in each scenario inshore wave heights are likely to be altered by the addition of a disposal mound at these water depths (between 20-31 m). Wave refraction is enhanced along both sides of the mound, leading to varying levels of wave height amplification in the lee, depending on the specific mound design and wave event simulated. This coincides with wave height reduction on either side of this zone of convergent wave energy.

Hydrological Approaches to the Delineation of Critical-Source Areas of Run-Off (2007)
Srinivasan, M.S.; McDowell, R.W.
New Zealand Journal of Agricultural Research

Spatial Information: Silverstream and Glenomaru in Otago, New Zealand
Keywords: critical-source areas; Hydrology; modelling; rainfall-runoff processes

Summary: Five hydrological approaches, ranging from empirical to physically based, were applied in two headwater catchments (Silverstream and Glenomaru) in Otago, New Zealand, to delineate the critical-source areas (CSAs) of runoff, the areas that are directly linked to contaminant transport to surface waterways. Comparison of observed and simulated flows for selected rainfall events indicated that in one catchment (Glenomaru) the empirical approaches performed better than physically-based approaches, while the converse was true in the other catchment (Silverstream). However, spatial mapping of simulated CSAs indicated that the approaches failed to recognise areas where subsurface flows can potentially emerge to the surface as seeps and springs on steep hillsides bordering the valleys. The approaches were also evaluated based on the availability and processing times of input data, representation of hydrological processes, reliability of simulations, likely economic impact, and the ease of implementing alternative management on the CSAs identified. Due to minimal input data needs, minimal likely economic impact, and ease of CSA management, empirical approaches may prove to be the most useable approaches. Process-based approaches simulated unconnected and poorly manageable CSAs that if managed would have a negative economic impact. Economic analysis based on CSAs simulated using the empirical approaches indicated that by managing CSAs to mitigate phosphorus losses, significant decreases in phosphorus losses on a catchment scale can be achieved without any loss in profitability, or even a gain. However, we concluded that these approaches should be examined further and the simulated CSAs validated to allow a better linkage of sources of contaminants and runoff at a catchment scale.

Efficient Fertiliser Use (2004)
Stace, C.
Environment Bay of Plenty

Spatial Information: No spatial context
Keywords: fertiliser, land management, farm, requirements, application, guidelines

Summary: This is a factsheet aimed at farmers to help them with efficient fertiliser use. It gives indicators of poor soil quality, discusses fertiliser requirements how conventional fertilisers work, additionally, it gives some general guidelines for application of these fertilisers and other helpful tips.

A Study of the Matakana Island Sand Dunes and Coastal Vegetation (2004)
Stannard, C.
Bay of Plenty Polytechnic Report no. 136

Spatial Information: Matakana Island, Bay of Plenty, New Zealand
Keywords: Matakana Island, sand dunes, coastal vegetation

Summary: A project was carried out on Matakana Island to assess the health of the foredune area. 20 beach profiles were completed at one-kilometre intervals along the beachfront and the results from each profile were used to classify each area of dune. Australian Coastal Tea tree (*Leptospermum lavigatum*) was found to be growing in dense plots in the south-eastern and north-western extremities of the island. These areas also showed high levels of instability and erosion. *L. lavigatum* growing in the active dune area had a direct negative effect on the stability of the foredune. Information on this report could also be used as a baseline for comparison with future studies.

Rock lobster catch and effort data: summaries and CPUE standardisations, 1979–80 to 2007–08 (1998)
Starr, P.J.
New Zealand Fisheries Assessment Report 2009/38

Spatial Information: New Zealand wide
Keywords: macroinvertebrates

Summary: The report characterizes the rock lobster fisheries of New Zealand using commercial catch and effort data provided by the Ministry of Fisheries. The analysis was done by quota management areas (QMAs) and covered the period of 1978/80 to 2007/08 fishing year. Standardised catch per unit effort analysis (CPUE) was conducted to develop annual indices of relative abundance, in an attempt to track the rock lobster stocks. Findings from this analysis are an important information source for stock assessments of rock lobster.

The effect of nutrient enrichment and temperature on the growth in culture of *Ulva lactuca*(1976)
Steffensen, D. A.
Aquatic Botany Journal

Spatial Information: Avon-Heathcote Estuary (Christchurch, New Zealand)
Keywords: Plants; Sea lettuce

Summary: The growth response of *Ulva lactuca* L. to different combinations of phosphorus and nitrogen was followed using discs cut from the expanded region of mature plants. Addition of either NO3 -N or PO4 -P stimulated growth, optimum levels being 0.6 g/m3 for both nutrients. Below the optimum, N and P interacted in

their effect on growth; above the optimum, increasing N concentration decreased growth while no change occurred with increasing P. These results are similar to those of Waite and Mitchell (1972), but their suggestion that the results fit a limiting factor equation was found to be true for only part of the P/N response surface. The growth response of *U. lactuca* to temperatures between 6 and 25° C was tested on plants from two localities which differed in water temperature. The plants from the locality with the higher mean monthly temperature had the higher temperature optimum in the experiments. The results support findings from field data which suggested that the high standing crop (up to 130 g/m2 dry weight) of *U. lactuca* in the Avon-Heathcote Estuary (Christchurch, New Zealand) is related to eutrophic water conditions and that temperature is an important factor in controlling seasonal and annual fluctuations in growth.

Baseline Data on the Biodiversity of Sub-Tidal Species Found in the Sea off Mount Maunganui between North Rock & Banks Avenue Including: Leisure Island, North Rock to Main Beach and Rabbit Island & its Outer-lying Reefs (2000)
Stephens, B.; Letcher, R.; Hawkings, S.; Simpson, E.; Shaw, M.; Uchinda, A.
Bay of Plenty Polytechnic Report no. 93

Spatial Information: Mount Maunganui between North Rock & Banks Avenue Including: Leisure Island, North Rock to Main Beach and Rabbit Island & its Outer-lying Reefs, New Zealand
Keywords: Biodiversity of Sub-Tidal Species, Mount Maunganui

Summary: Our objective was to obtain baseline data on the biodiversity of subtidal species found in the sea off Mt Maunganui from North Rock to Banks Ave, including Leisure Island, North Rock to Main Beach, and Rabbit Island, and it's outer-lying reefs. Thirty eight 50 metre transect lines were laid from shore to sea in the specified area, recording four main categories; substrates, fish, invertebrates and seaweed species. The thirty eight transect sites spaced approximately 100-200 metres apart, evenly covered all the rocky coastal area afore-mentioned. When the 4 categories of data were combined, a clear indication of each transect sites habitat was profiled showing the biodiversity of species in their environment. Each transect site surveyed was profiled on A2 laminate boards displaying a virtual 2D picture of what lay beneath the sea.

Indigenous perspectives on ecosystem sustainability and health (2007)
Stephens, C.; Parkes, M. W.; Chang, H.
Ecohealth Journal

Spatial Information: World wide
Keywords: ecosystem sustainability, ecosystem health

Summary: Indigenous peoples have been guardians of our global environment and its medicines for millennia—built on a communal view of humanity and its links to the ecosystem. Yet as the new millennium rolls out, Indigenous peoples are among those most marginalized within many nation states, they have the worst health indicators, and their knowledge continues to be threatened as the land and resources they depend on are appropriated, developed, degraded, or destroyed. This edition of EcoHealth has been put together with explicit interest in (re)integrating indigenous perspectives on ecosystem sustainability and health. It is timely that the issue was

finalized the same week that the United Nations General Assembly adopted the Declaration on the Rights of Indigenous People, after almost 13 years since the draft declaration was proposed in 1994 (United Nations, 2007). In this edition of EcoHealth you will find perspectives from Alaska, Australia, Burma, Cambodia, Canada, Guatemala, Kenya, Laos, Namibia, New Zealand, and Peru. Beyond their diversity, indigenous cultures converge toward a multifaceted view of human health that includes the health of the ecosystem in which humans live. These perspectives are grounded in ancient wisdom that is both timely and prescient when considering our present struggle to understand and respond to the intricate interrelationships between ecology and health.

Ecological sustainability assessment for Firth of Thames shellfish aquaculture. Task 1, Hydrodynamic modelling (2005)

Stephens, S.
Auckland Regional Council and Environment Waikato

Spatial Information: Firth of Thames, New Zealand
Keywords: Shellfish culture, New Zealand, Firth of Thames, Environmental aspects, Aquaculture

Summary: Auckland Regional Council, Environment Waikato and the Western Firth Consortium contracted NIWA to undertake an ecological sustainability assessment for aquaculture in the Firth of Thames. This report addresses hydrodynamic modelling of the Firth of Thames to produce a series of spatially resolved time series of velocity vectors, temperature and salinity as inputs to biological modelling. The three-dimensional numerical model MIKE3 was used to simulate hydrodynamics in the Firth of Thames. The model included temperature and salinity, and was forced by tides, winds solar radiation and river inputs. The model was calibrated against available environmental data measured during September 1999 and March 2000, during a La Nina period. No environmental data was available to calibrate for El Nino conditions. Tides dominated the instantaneous flow field in the Firth of Thames, with strongest flows in the outer Firth reaching 0.2 and 0.4 ms-1 during neap and spring tides, respectively. Tidal flows were less than 0.05 m s-1 in the shallow southern Firth. Flood tides are stronger on the eastern side of the Firth near Wilson Bay, and ebb tides stronger on the western side. Wind was of secondary importance to the instantaneous currents, but had a dominant influence on time-averaged currents, which show cumulative flow features. When winds approached from the ENE, surface currents were pushed SW, with a time-averaged clockwise circulation in the lower Firth, and deep currents returned toward the north. When winds approached from the WSW, surface currents were pushed NE, with a time-averaged anticlockwise circulation in the lower Firth, and deep currents returned towards the SW. The effects of stratification on de-coupling vertical water 'layers' means that particles near the water surface are likely to remain there and be transported faster by wind-driven flows during summer than in winter.

Vehicle impacts on the biota of sandy beaches and coastal dunes: A review from a New Zealand perspective (1999)

Stephenson, G
Department of Conservation

Spatial Information: New Zealand wide

Keywords: Vehicle impacts, coastal dunes, sandy beaches, New Zealand

Summary: Previous research into vehicle impacts on the biota of sandy beaches and coastal dunes in other countries is summarised, and is examined for its relevance to the management of these resources in New Zealand. Vehicle impacts on the biota of the backshore of sandy beaches and on the biota of coastal dunes have been demonstrated to be severe and these areas are considered to have a nil 'carrying capacity' with respect to vehicle use. A similar situation can be expected for the backshore of sandy beaches and for coastal dunes in New Zealand. Vehicle impacts on the biota of the foreshore (intertidal) of sandy beaches have appeared to be minimal, at least when the vehicle use occurred during the day, but very few elements of the foreshore biota have been examined. The situation regarding vehicle impacts on the biota of the foreshore of sandy beaches in New Zealand remains uncertain. Although previous research provides a guide for management strategies with respect to vehicle use of sandy beaches and coastal dunes in New Zealand at a general level, some local research is considered desirable. Future research into vehicle impacts on the biota of sandy beaches and coastal dunes in New Zealand should include fundamental research to further underpin decision-making processes, and applied research to address problems and monitor the results of management at specific sites.

Forum: foreword and analysis Cross-cultural environmental research and management: challenges and progress (2009)
Stephenson, J.; Moller, H.
Journal of the Royal Society of New Zealand

Spatial Information: New Zealand wide
Keywords: Cross-cultural environmental research, Mātauranga Māori

Summary: The Royal Society of New Zealand encouraged this Forum on cross-cultural environmental research and management following the publication of a special issue of the New Zealand Journal of Zoology in September 2009 called "Mātauranga Māori, science and seabirds" (Moller 2009). Mātauranga Māori (Māori knowledge) is concerned with all aspects of Te Ao Māori (the Māori world view), including their version of what overseas scholars have variously termed Traditional Ecological Knowledge (TEK), Traditional Knowledge, Local Knowledge, Ethnoscience or Ethnobiology. The most widely used definition of TEK is "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and the environment". Mātauranga Māori, and especially its interface with science, is a particularly important issue for New Zealand because of its colonial history, the partnership principles derived from the Treaty of Waitangi, and the government's vision for Mātauranga to 'unlock the innovation potential of Māori Knowledge, Resources and People'. This Forum demonstrates both the value of local journals and their international contribution, and also illustrates the tension between place-based studies and more generic meta-analyses. Once dislocated from its place of origin, who is the TEK inquiry for, and how can TEK can be kept safe and true to its cultural and place-based roots? TEK's immense contribution to combating local and global environmental threats by the application of locally-informed, small-scale, bottom-up and wonderfully inclusive local environmental management interventions is self evident. But might non-indigenous societies have failed to adequately listen to and apply valuable generic TEK principles to combat more general environmental

challenges? For example, traditional mātauranga teaching is to leave breeding stocks alone and take only immature animals (Bird et al. 2009; Moller & Lyver in press). Application of this fundamental principle could greatly increase the sustainable take of fish and pāua (abalone, *Haliotis iris*) by commercial and customary fishers which are currently managed by fisheries scientists that set minimum rather than maximum legal sizes for catch.

Sewage Collection and Disposal Borough of Mount Maunganui Preliminary Report (1969)
Steven, L.; Fitzmaurice, J.R,
Steven & Fitzmaurice Consulting Civil and Sanitary Engineers

Spatial Information: Tauranga, New Zealand
Keywords: sewage collection, sewage disposal, wastewater treatment plant, Tauranga, Mount Maunganui, Te Maunga, Tauranga Harbour, Te Awanui,

Summary: This report expands on the preliminary report, with a comparative cost-benefit study for the preferred disposal methods of an ocean outfall, oxidations ponds and a combination of an oxidation pond and a sea outfall. It is noted that the Pollution Advisory Council expressed the opinion that a raw sewage outfall would not be acceptable for this location unless sufficient evidence could be produced to support this proposal. The authors then go on to comment: “For a discharge which is comminuted and has fat and floatables removed, suitable conditions will exist on the beach if an adequate length of out fall is provided. Such conditions exist at Gisborne even without fat removal. If, as the population increased, the bacterial quality of beach waters should deteriorate to an unacceptable level, chlorination of the effluent could be adopted. This would be satisfactory, even if costly, but less expensive than the implied alternative of a full treatment in addition to an outfall.” [Clearly, the options for disposal were primarily based on cost, with little or no consideration of the potential environmental effects this could pose. For example, the effects on marine life, especially those which we consume and the habitats of those organisms.] The cost benefit analysis section states that it will be more economic to establish a regional scheme to service the area east of the harbour independently of the City’s present system (as opposed to extending the reticulation system of the City’s system or having expensive local treatment facilities for each area of development). Six differing schemes have been costed and (estimated) total expenditure over a 45 year period computed for comparison. Of these, the most attractive alternatives (for the authors) are those which minimise the initial costs and have reasonable long term expenditure. This limits the choice to ponds for 6 or 10 years and then an outfall; or permanent ponds with an outfall after six years (schemes C, D and F). All provide a regional service. The key difference between these schemes is the length of the outfall; a longer outfall means that the sewage will be discharged raw, where as a shorter outfall will require the sewage to be treated first.

Borough of Mount Maunganui Sewage Disposal Extension Report (1969)
Steven, L.; Fitzmaurice, J.R.,
Steven & Fitzmaurice Consulting Civil and Sanitary Engineers

Spatial Information: Tauranga Harbour, New Zealand
Keywords: sewage disposal, wastewater treatment plant, Mount Maunganui, Tauranga, Tauranga Harbour, Te Awanui, Te Maunga,

Summary: This report was written at the request of the Mayor and Councillors of the time. It discusses and examines the various possible methods which may be used for the collection, treatment and disposal of sewage and trade wastes of the 'Borough'. It presents a recommended programme of initial development which:

- is within the financial resources of the Borough;
- provides sufficient service to warrant adoption; and
- provides a system to which additional sewer reticulation can easily be added.

In this proposal, sewage disposals have taken into account the (population) conditions for the next 40 years, i.e. until the year 2015, and has estimated the total population of Tauranga to be 140 000 at this time. The water quality requirements of the time stated that 'the effect of the discharge of waste should not be noticeable to eye or nose, and that bacteriological conditions of the water should be suitable for the type of use specified. Possible Disposal Methods looked at were:

1. Disposal to Tauranga City Treatment Plant
2. Building of a new treatment plant for Mount Maunganui, with either conventional treatment or electrolytic treatment.
3. An ocean outfall (requiring no treatment) but relying on the dilution factor. A twin outfall option was also discussed, as well as oxidation ponds and the various possible sites for these.

Based on the above recommended programme, the authors believe that only two of the above disposal types merit consideration – oxidation ponds and ocean outfalls. As oxidation ponds were the more economical choice, an oxidation pond at Te Maunga (opposite the railway station - a map is attached to the report), with probable future disposal through ocean outfall (type yet to be determined). Discharge from the ponds would be to the upper harbour estuary on only the most suitable portion of the tide cycle. Disposal to the Tauranga City Treatment Plant was ruled out for two reasons, firstly cost, and secondly, its unsuitability for handling the seasonal peak loads (the pollution potential of a substantially increased discharge into the enclosed harbour waters). The report then goes on to recommend the stages of the work required to build this, provision for keeping land available for this and a more accurate monitoring of visitor numbers over the summer and their general geographic location.

The *corophiid* amphipods of Tauranga Harbour, New Zealand: evidence of an Australian crustacean invader (2002)
Stevens, M. I.; Hogg, I.D.; Chapman, M. A.
Springer Netherlands

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Invasive species

Summary: Using morphological and molecular techniques we examined the *corophiid* amphipods in the Waimapu Estuary, Tauranga Harbour in the North Island of New Zealand. Based on morphology we identified two New Zealand endemic species, *Paracorophium lucasi* and *P. excavatum*, as well as *P. brisbanensis*, previously recorded only from the eastern coast of Australia and Corophium sp. which has not been previously recorded from New Zealand. Allozyme analyses confirmed the morphological diagnoses of three distinct species within

Paracorophium and of the single *Corophium* species. The presence of reproductive females and juvenile *P. brisbanensis* suggests a viable, breeding population in Tauranga Harbour. We conclude that the species is likely to have been introduced to New Zealand waters via shipping activities (e.g., ballast water). The possibility that *P. brisbanensis* may now spread to other New Zealand ports as well as the consequences of this introduction for other New Zealand taxa need to be urgently examined.

Principles of warm water aquaculture (1979)
Stickney, R. R.
Wiley

Spatial Information: No spatial context
Keywords: Aquaculture.; Channel catfish.

Summary: Provides the basic concepts and techniques required to rear warm water animals in both fresh and marine environments and under controlled or semi-controlled conditions. Utilizes examples from various species to demonstrate how specific general principles can be applied throughout the field. Focuses on commercially important species that are being or can be reared in the United States. The concepts can also be applied to animals reared for laboratory use. Includes a comprehensive bibliography to the literature.

Tourism affects the behavioural budget of the common dolphin *Delphinus* sp. in the Hauraki Gulf, New Zealand (2008)
Stockin, K. A.; Lusseau,D.; Binedell, V.; Wiseman, N.; Orams, M. B.
Marine Ecology Progress Series

Spatial Information: Hauraki Gulf, New Zealand
Keywords: dolphins and whales

Summary: During the period of Feb 2003 to Jan 2005, non-systematic surveys were conducted in the Hauraki Gulf using an independent research boat to collect data variables such as their movement, rest, forage and social behaviour. Markov chains models were used to assess the impact of tourism activities on the behavioural state of common dolphins. The study found that foraging and resting bouts were affected by boat interactions, with significant reduction of both the duration of bouts and the overall time spent in these 2 behavioural states. The study also found that it took significantly longer time for the foraging dolphins to return to their initial behavioural state in the presence of tour boats.

The status of common dolphins (*Delphinus delphis*) within New Zealand waters (2009)
Stockin, K. A.; Orams, M. B.
Journal of Cetacean Research

Spatial Information: New Zealand wide
Keywords: Dolphins and Whales

Summary: New Zealand common dolphins (*Delphinus delphis*) are subject to a range of human-induced threats including fisheries bycatch and tourism impacts.

Common dolphins are incidentally captured in the trawl fishery for jack mackerel (*Trachurus* spp) and appear susceptible to entanglement within coastal set nets. Pollutant burdens and tourism impacts reported for the New Zealand population appear in line with those previously reported for coastal conspecifics such as the bottlenose dolphin (*Tursiops truncatus*). Despite this, common dolphins remain the most poorly understood delphinid within New Zealand waters. Until recently, majority of the information relating to their identity, abundance and ecology had relied upon untested assumptions. This lack of empirical data has historically resulted in the inadequate recognition of this species. To date, common dolphins remain the only resident cetacean within New Zealand to lack a species-specific Marine Mammal Action Plan. This is of concern, since fundamental data necessary to assess their status and stability remain unknown for the New Zealand population. Limited insights offered by strandings and opportunistic sightings data suggest the coastal distribution of New Zealand *Delphinus* may, at least in part, offer some explanation as to why common dolphins within these waters appear vulnerable to human-induced impacts. Furthermore, small pod sizes reported during vessel and aerial surveys indicate that the New Zealand population may not be as large or robust as previously assumed.

Factors Affecting the Occurrence and Demographics of Common Dolphins (*Delphinus* sp.) in the Hauraki Gulf, New Zealand (2008)
Stockin, K. A.; Pierce,G.J.; Binedell,V.; Wiseman,N.; Orams, M. B.
Aquatic Mammals

Spatial Information: Hauraki Gulf, New Zealand
Keywords: dolphins and whales, common dolphin, *Delphinus*, occurrence, demographics, prey, calving, nursery, predation, Hauraki Gulf, New Zealand

Summary: The common dolphin (*Delphinus* sp.) is the most frequently observed cetacean species in the Hauraki Gulf, a large shallow body of water on the north-eastern coastline of North Island, New Zealand. Herein, we present the first data relating to the occurrence and distribution of common dolphins in this region and assess the possible effects of abiotic parameters on the demographics of this population. The presence of associated marine species is quantified, and differences in the occurrence and demographics of single and multi-species groups are examined. Sightings data were collected between February 2002 and January 2005 during boat-based surveys. We recorded 719 independent encounters with common dolphins, involving 1 to > 300 animals. Dolphin presence was significantly affected by month, latitude and depth. Group size varied significantly by month, season, depth, sea surface temperature (SST) and latitude, and was highly skewed towards smaller groups made up of < 50 animals. Larger aggregations were most frequent during the austral winter when nutrient upwelling typically leads to increased prey availability within the region. Over 70% of groups encountered contained immature animals and 25% of groups included neonates. Calves were observed throughout the year but were most prevalent in the austral summer months of December and January. Month, season, depth, and SST significantly affected group composition. Common dolphins were observed in association with four cetacean and eight avian species, most frequently with the Australasian gannet (*Morus serrator*) and the Bryde's whale (*Balaenoptera brydei*). The distribution of dolphin-only groups differed significantly from that of dolphin-whale groups, with mono-specific groups found on average in waters that were 3.6 m shallower and 3.1º C warmer. The year-round occurrence and social organisation of common dolphins in Hauraki Gulf waters suggest this region is important both as a calving and nursery ground.

Expansion dynamics of monospecific, temperate mangroves and sedimentation in two embayments of a barrier-enclosed lagoon, Tauranga Harbour, New Zealand (2010)
Stokes, D.J., Healy, T.R., & Cooke, P.J.
Journal of Coastal Research

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation, Mangroves

Summary: This study relates sedimentation and mangrove expansion processes. The purpose of the study is to investigate how mangroves are evolving and the relationship this has with sedimentation. Stokes, Healy and Cooke (2010) studied the Waikareao Estuary and Welcome Bay in the Tauranga Harbour. Mangrove expansion was identified from aerial photographs from 1943, 1982, 1996 and 2003. Stokes, Healy and Cooke (2010) noted that the processes of sedimentation and mangrove expansion are linked. Land use changes leads to increased sediment in the estuaries. This increased sediment budget allows mangrove expansion to take place as more habitat area is deposited. The extensive root networks of the mangroves further accelerate sedimentation by trapping fine muddy sediment around the plants leading to further sedimentation and this process speeds up landscape evolution. Mangroves tended to be successful at trapping and holding muddy sediments while sandy deposition was found to occur in the bare tidal flats in front of the mangrove vegetation. The main conclusion for sedimentation in this study is that mangroves are not the only driver of changes in elevation at the sites; the availability and type of sediments also play a role.

The benthic ecology of expanding mangrove habitat, Tauranga Harbour, New Zealand (2009)
Stokes, D. J.; Healy, T.; Mason, N.
Coasts and Ports Conference

Spatial Information: Tauranga Harbour, New Zealand
Keywords: mangroves

Summary: Over the last 40-50 years, mono-specific mangrove stands in New Zealand have expanded, and generally this expansion has been across previously un-vegetated intertidal flats. In response to an increasing perception that mangroves present a negative ecological and aesthetic coastal change, coastal managers are sometimes opting to have some portion of them removed. The removal of this vegetation and the impacts on the macro-invertebrate community within these areas is largely unknown given that there have been relatively few studies of macro-invertebrate community structure undertaken in New Zealand's temperate mangrove habitats. To address these key questions and broaden our knowledge of New Zealand intertidal ecology, macro-invertebrates were collected within 3 sub-estuaries of Tauranga Harbour. Cores were collected from 3 transects within each estuary, each passing through mangrove habitat and un-vegetated intertidal flats. Surface sediment grain size and organic content were also assessed. All sites monitored in this study were located in the upper half of the estuaries where surface sediments were either dominated by mud (all mangrove sites and some bare sites closest to the head of the estuary) or fine sand (mid-estuary). Species richness and species abundance were low at all sites, partly due to the exclusion of smaller organisms (e.g. oligochaetes). Abundance was generally greater in the bare flat habitat, being

approximately < 6 individuals per core. Multivariate analyses indicate a significant difference in species richness between mangrove and bare intertidal habitats; however, within the overall suite of species identified, no species were exclusive to either habitat. These results suggest that catchment-based fine sediments entering the study sites are influencing benthic community composition more so than the presence of mangroves.

Surface Elevation Changes and Sediment Characteristics of Intertidal Surfaces Undergoing Mangrove Expansion and Mangrove Removal, Waikaraka Estuary, Tauranga Harbour, New Zealand (2009)

Stokes, D.J.; Healy, T.R.; Cooke, P.J.
University of Waikato

Spatial Information: Waikaraka Estuary, Tauranga Harbour, New Zealand
Keywords: New Zealand, Waikaraka Estuary, Tauranga Harbour, surface; elevation changes; plants; mangroves

Summary: Since the 1940s mangroves have expanded their areal coverage in many estuaries in the northern half of the North Island of New Zealand. The extent of mangrove colonization in Waikaraka Estuary, Tauranga Harbour, has been documented using photogrammetric analysis, and the impacts of subsequent mangrove removal are analysed. Surface elevation changes in response to mangrove removal are measured using RSETs (Rod Surface Elevation Table) and erosion pins, and sediment accumulation rates were calculated from sediment trap results. Temporal changes to surface sediment texture are analysed. Mangrove physiognomy is described from analysis of mean plant height, plant density and pneumatophore density. Plant heights reflect the shrubby growth form of mangroves growing toward their southern climatic limit, with mean plant heights under 1.5 m. Mangrove coverage has increased from approximately 16,000 m^2 in 1943 to 115,000 m^2 in 2003. Since May 2005, 9,600 m^2 of mangrove vegetation has been removed from the estuary. For the monitoring period of March 2006 to March 2007, rates of surface elevation change in cleared areas ranged from - 9 mm to - 38 mm yr (mean - 14 mm yr). Conversely, surface elevation under mangrove forest varied between sites, ranging from -5 mm to 14 mm yr (mean 3 mm yr). Results from RSETs and erosion pins and a coarsening of surface sediment texture at the cleared sites, is consistent with sediment release after mangrove removal.

Department of Conservation Marine Mammal Action Plan for 2005–2010 (2004)

Suisted,R.; Neale,D.
Department of Conservation

Spatial Information: New Zealand wide
Keywords: dolphins and whales

Summary: This Marine Mammal Action Plan (MMAP) 2005-2010 provides a guide for conservation management of New Zealand's marine mammals by the Department of Conservation over the next five years, and represents an active interpretation of priorities across a broad work area using key strategic documents and directive government policies. The Department's work takes two general approaches: firstly to protect species, and secondly to manage human interactions and use. These are undertaken with careful regard to the Crown's interests, safety and welfare, understanding and co-operation and quality performance. Both of the general

approaches may be further divided into a range of topics (species and issues) that are arranged in a broad order of priority. For each topic, the Department's key objectives and their necessary actions are listed, and the responsibilities and priority levels are specified for each action.

Methyl Bromide Hearing Environment Bay of Plenty (2010)
Summerhays, K.; Weiss, S., & Iremonger, S.
Environment B.O.P

Spatial Information: Port of Tauranga, New Zealand
Keywords: Organic Pollutants

Summary: Methyl bromide is a chemical used to fumigate export timber at the Port of Tauranga. This chemical is a good fumigant; however is it also very toxic. This report by Environment Bay of Plenty provides recommendations for the use of methyl bromide at the port. Currently whole containers are fumigated and logs are fumigated under a tarpaulin which is then vented to the air. This is concern about the possible environment and health problems arising from this process. At the time of this report there was very little monitoring of the methyl bromide fumigation processes. This report recommends that the methyl bromide used at the Port be used with a stenching agent such as LPG in order to give the gas a detectable odour to limit the possibility of accidents with staff, emergency personnel, and bystanders. The report recommends that signage be put up in order to inform people about the potential for exposure to this chemical. Signs would comply with the NZS 8409: Code of Practise for the Management of Agrichemicals. The report also recommends that buffer distances be established with distances of 100 m for fumigation of logs under tarpaulins and also for the fumigation of ship holds. It is unclear what is meant by buffer distances and whether buffer distances means to restrict access to the area while the activity is carried out. The report recommends that all properties within 150 m of large fumigation activities be notified of the fumigation and further that sensitive areas (e.g. schools) within 200 m of the fumigation be notified. Currently no fumigation activities occur within 200 m of cruise ships. A fumigation management plan is recommended. This plan would detail how monitoring will occur for: the occupational health and environment impacts of methyl bromide including air monitoring, record keeping, regulation compliance, and the effectiveness of the fumigation.

Tauranga Harbour sediment source survey (1999)
Surman, M., Clarke, R., Carter, M.
Environment Bay of Plenty

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation

Summary: Environment B·O·P has undertaken a field survey of 23 of the major streams flowing into Tauranga Harbour. The work was undertaken as a component of general investigations of the natural environment of Tauranga Harbour. The work was done predominantly during the university vacations of 1995/6, 1996/7 and 1997/8. The report provides an order of magnitude estimate of sediment transported from stream bank erosion into Tauranga Harbour from the harbour catchments. The report describes and costs possible stream improvement works and estimates the reduction of sediment yields such works may achieve.

Mangrove-Habitat Expansion in the Southern Firth of Thames: Sedimentation Processes and Coastal-Hazards Mitigation (2007)
Swales, A.; Bell, R; Ovenden, R.; Hart, C.; Horrocks, M.; Hermanspahn, N.; Smith, R. K.
NIWA

Spatial Information: Southern Firth of Thames, Piako and Waitakaruru Rivers, New Zealand
Keywords: Mangrove-Habitat Expansion

Summary: Grey mangrove (*Avicennia marina* subsp *australasica*) or Manawa has rapidly colonised intertidal areas of the southern Firth of Thames during the last 50 years or so. Today, mangrove habitat occupies some 7 km^2 of former intertidal flat between the Piako and Waitakaruru Rivers and 11 km^2 in the southern Firth as a whole (section 1). Grey-mangrove seedlings can colonise intertidal areas down to about mean sea level (MSL), where they are submerged for < six hours per tide. Mangrove-habitat expansion has occurred in many North Island estuaries in recent decades as sediments delivered by rivers has built intertidal habitat suitable for mangrove colonisation. The Firth of Thames is an 800 km^2 meso-tidal estuarine embayment. Currents, sea level and waves within the Firth are strongly linked to oceanographic and meteorological processes occurring within the wider Hauraki Gulf (section 2). The low-lying coast of the southern Firth is potentially exposed to erosion and inundation due to sea and swell waves, storm surge and tsunami. Environment Waikato commissioned NIWA to undertake a study of mangrove-habitat expansion and sedimentation processes in the southern Firth. The main objectives of the study are to:

- Reconstruct the historical sequence mangrove-habitat expansion based on historical aerial photography (1944–2005) and dated sediment cores.
- Quantify sediment accumulation rates (SAR) and changes in SAR resulting from mangrove colonisation and habitat expansion.
- Determine the role of mangrove habitat in mitigating coastal erosion and inundation hazards in the southern Firth.

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Co-management of New-Zealand's conservation estate by Maori and Pakeha: a review (1997)
Taiepa, T.; Lyver, P.; Horsley, P.; Davis, J.; Bragg, M.; Moller, H.
Environmental Conservation

Spatial Information: New Zealand
Keywords: Co-Management, Department of Conservation, Policies, Treaty of Waitangi

Summary: Despite direction by the Conservation Act (1987) to give effect to the principles of the Treaty of Waitangi, New Zealand's Department of Conservation has few formal collaborative management arrangements with Maori. Obstacles to establishing agreements that involve Maori in equitable conservation decision-making roles include divergent philosophies (preservation versus conservation for

future use), institutional inertia, a lack of concrete models of co-management to evaluate success or otherwise to promote conservation, a lack of resources and opportunities for capacity building and scientific research amongst Maori, opposition and a lack of trust from conservation non-governmental organizations that are predominantly euro-centric in approach and membership, and a fundamental reluctance of some to share power with Maori. Recent examples of work towards co-management emphasize the need for innovative methods to build trust and explore common ground and differences. Meetings on marae (traditional Maori gathering places) have established guiding principles, lengthy dialogue, and a collective symbol as a metaphor for co-management. These were valuable steps towards building trust and understanding required for the restoration of coastal lakes and a river, and the potential joint management of two national parks on the west coast of the North Island.

Establishment of a research project to assess the sustainability of a traditional harvest of a sea-bird (*Puffinus griseus*) by Rakiura Maori was facilitated by drawing up a 'cultural safety' contract. This contract underscored the role of Maori as directors of the research, protected their intellectual property rights to their traditional environmental knowledge, guaranteed continuity of the collaborative research project and regulated how results were to be communicated. The scientific ethics of a university ecological research team were safeguarded by the contract, which ensured that they could publish their inferences without erasure or interference. The New Zealand experience shows that even when legislation signals from the top down that the doorway is open for co-management with indigenous people, this by itself is unlikely to make it happen. Active facilitation by innovative middle-level agreements and the creation of new administrative structures are needed to govern co-management of a broad spectrum of resource issues. Bottom-up initiatives involving single, or very localized, resource uses may also trigger co-management. Models for successful co-management involving indigenous peoples must focus more strongly on issues of equity or power sharing, and therefore may be very different from models directed at a single conservation outcome.

Valuation of agricultural impacts on rivers and streams using choice modelling: A New Zealand case study (2011)
Tait, P.;Baskaran, R.;Cullen, R.;Bicknell, K.;
New Zealand Journal of Agricultural Research

Spatial Information: New Zealand
Keywords: non-market valuation, agricultural environmental externalities, choice experiment, agri-environmental policy analysis, Canterbury

Summary: Increasing substitution of dry land pastoral and arable farming for water-intensive practices is placing pressure on water resources in Canterbury. Although there is a large body of scientific data documenting environmental change, there is a general lack of information on the economic values of agricultural impacts on rivers and streams. This paper applies an economic non-market valuation method to help address this issue. Three impacts are considered: health risks of pathogens from animal waste; ecological effects of excess nutrients; and low-flow impacts of irrigation. This study provides a valuation of outcomes for public agri-environmental policy implemented in Canterbury such as The Dairy and Clean Streams Accord, Living Streams and The Restorative Programme for Lowland Streams. Modelling results indicate that the 5-year economic value for improvements to rivers and

streams in Canterbury provided by agri-environmental policy is estimated to be about $186 million.

Customary and traditional fisheries practices, Tauranga Moana (2006)
Tata, T.; Ellis, K.
Tauranga Moana Iwi Customary Fisheries Management Committee

Spatial Information: Tauranga, New Zealand
Keywords: Tauranga Moana Iwi Customary Fisheries Management Committee, Customary and traditional fisheries practices

Summary: An alarming amount of interviewees believed that current management practices are incapable of protecting the once pristine environment of Tauranga Moana and many people have observed the accelerated demise of the fishery. Many supported the view of having more contribution from Maori and the use of the old ways of conservation such as, seasonal fishing and revised regulations on fishing. During the interview process Tangata Whenua all expressed the desire to manage their own fisheries of their own individual rohe moana.

Mount Maunganui reserves management plans (1998)
Tauranga City Council
Tauranga City Council

Spatial Information: Tauranga, Mt Maunganui, New Zealand
Keywords: Mauao, Reserves, Management Plans, Moturiki

Summary: The reserves considered in this Management Plan are key natural, cultural and recreation resources in the Tauranga District. Mauao is a conical, rocky feature at a height of 232 metres and is the remnant of an eroded volcanic table with its slower slopes at an easy gradient. On the north western side of the peninsula are the sheltered waters of the harbour and Pilot Bay. The "Main Beach" fronts the coast with Moturiki and Hopukiore, being key landscape and recreation features. All of these reserves are part of an integrated system which includes a natural setting and a built environment. The system also depends on the intimacy of a narrow tombolo, with different character beaches on either side. It depends on the enclosure provided by Moturiki and Hopukiore and also on the range of opportunities for recreation, from intense human activity on the Main Beach to the quiet retreat of Hopukiore. The Management Plans for these reserves are therefore inextricably linked. Each Reserve has its own particular qualities and management issues, but they are each part of a system. Each reserve is managed to enhance "the Mount" as a whole. Many of the management issues for Mauao - Mount Maunganui, Main Beach, Moturiki - Leisure Island, Hopukiore - Mount Drury and Pilot Bay are about balancing the community's recreation needs and protection of the area's natural and cultural characteristics. The priority and funding for works within the scope of the Management plan will be to be considered through the Annual Plan process.

Harbour reserves management plan (2007)
Tauranga City Council
Tauranga City Council

Spatial Information: Tauranga Harbour, New Zealand

Keywords: Reserves, Tauranga Harbour, Management Plans

Summary: The Harbour Reserves Management Plan has been prepared for the harbour reserves which border onto the tidal margins of the Tauranga Harbour. These include recreation, local purpose and esplanade reserves which collectively make up the network of harbour reserves that are included in this comprehensive reserve management plan. The harbour reserves network begins in the Matua Wetlands character area (which includes York Park and the Matua Saltmarsh), stretching along the foreshore around each peninsula and estuary to Tye Park in Welcome Bay. Other landlocked reserve areas in Rangataua Bay and Matapihi are also included in this reserve management plan. The type and size of the harbour reserves varies along the inner harbour, from large premier recreational boating access reserves (such as Marine Park), City Parks (such as Kulim Park), through to smaller esplanade reserves which range in width from less than a metre to 20 metres wide. The larger parks are well defined in their use with many needing only enhancement work.

There are a significant proportion of remaining reserves that are generally undeveloped but have very high existing and potential ecological, natural character and landscape values as well as recreational, cultural and historical values. Harbour reserves are part of a dynamic and sensitive landscape which forms an integral part of the wider Tauranga Harbour and surrounding environment. The harbour edge has come under increased pressure from urban expansion and recreation demands in the past, and this will continue into the future (given population growth and demands through development and recreational desires). In order to protect the natural character and environmental qualities of the harbour (and harbour edges), including public access opportunities, clear directions for its future use and management have been developed based upon an holistic management approach. The development of a collective reserve management plan for these reserves allows the management and development to be undertaken in an integrated manner. This management plan addresses and resolves a number of issues inherent within the harbour reserves and outlines a comprehensive approach to the management of the harbour reserves network while recognising the diverse characteristics of individual reserves. The plan outlines the general intentions for use, development, maintenance, protection and preservation of the reserves. It provides a vision, clear set of goals and management statements to assist in the effective long term planning and day-to-day management for the harbour reserves.

Section 8: Groups of Activities (2): Wastewater (2009)
Tauranga City Council
Tauranga City Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Tauranga City Council, ten year plan, 2009-2019, wastewater, LTCCP, treatment plant, Te Maunga, Chapel Street, outfall, financial report, water supply

Summary: This is a chapter out of Tauranga City Council's Ten Year Plan or LTCCP, which focuses on wastewater, water supply, stormwater, solid waste, libraries, venues and events, Baypark and Arts and Heritage. In relation to wastewater, it gives a 2009 snapshot of the wastewater plants at Te Maunga and Chapel Street, future plans for wastewater management in Tauranga and its growing population. It also gives a budget overview for this over the next 10 years.

Statistical Information Report Tauranga City (2009)
Tauranga City Council
Tauranga City Council

Spatial Information: Tauranga City, New Zealand
Keywords: Tauranga Statistics

Summary: This report has statistical information on Tauranga which include: Total population, Tauranga's standing nationally, population projections, population migration, new dwellings created, new dwelling projections, subdivision and new sections created, community age structure, travel to work, household car ownership, income of Tauranga residents, employment status, business employment & type etc.

Tauranga Harbour Sea Lettuce Report: Summary (1990)
Tauranga District Council
Tauranga District Council

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Plants; Sea lettuce

Summary: This is a report to the Tauranga City Council summarising the causes to the excessive *ulva* growth. Bioresearches Limited (Auckland) was commissioned to investigate *ulva* growth. Input of nutrients into the harbour appears to be one of the key factors. Testing showed that nutrient levels in the harbour were well below the set levels of concentration. However, during heavy rainfall nitrogen levels would markedly increase. The report then looks into where the extra nitrogen comes from and says that the sewage discharged contributed to about 20% of the input (which was minor) and that the majority more than likely came from land use practices.

Port of Tauranga gateway to the central North Island New Zealand (1968)
Tauranga Harbour Board
Tauranga Harbour Board

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Port of Tauranga

Summary: Report discusses the activities of the Port of Tauranga, tourism potential, facilities, and financial reporting.

A Survey of the Tauranga Sulphur Point Marina (2000)
Taylor, D.; Brown, G.
Bay of Plenty Polytechnic Report no. 125

Spatial Information: Tauranga Sulphur Point Marina, New Zealand
Keywords: Tauranga Sulphur Point Marina, *Turbo smaragdus* (Cats eye), *Patiriella regularis* (Cushion Star).

Summary: This report provides the basis of, and a proposal for, an ongoing ecological monitoring program to be set up and carried out yearly in the Tauranga Sulphur Point Marina. It does not list and identify any decreased species found, only

those live specimens observed. The data recorded provides a baseline from which future surveys can be compared to. This report shows the marina ecosystem appears to be healthy with large numbers of some species, both adults and juveniles, notably *Turbo smaragdus* (Cats eye) and *Patiriella regularis* (Cushion Star). The pollution of the marina bottom is minimal, with both plants and animals having made extensive use of discarded rubbish. Further study is needed to fully understand the unique ecosystem and the effects of chemical and water pollution.

A Bloom of the Planktonic Diatom, *Cerataulina pelagica*, off the Coast of North-eastern New Zealand in 1983, and its Contribution to an Associated Mortality of Fish and Benthic Fauna (2007)
Taylor,F.J.; Taylor,N.J.; Walsby,J.R.
International Review of Hydrobiology A journal Covering all Aspects of Limnology and Marine Biology

Spatial Information: North-eastern New Zealand
Keywords: phytoplankton

Summary: A bloom of *Cerataulina pelagica* dominated the sea area off the north-east coast of New Zealand for three months in the summer of 1982–83, and has been related to unusually calm conditions associated with an unusually low Southern Oscillation Index. Deaths of benthic shellfish during the bloom were attributed to anoxia induced by the bacterial decay of the diatom cells. Death of bony fish caught on long-lines was attributed to anoxia and the clogging of the gills with mucilage produced by the diatoms.

Terrestrial Indigenous Biodiversity Monitoring in the Bay of Plenty Discussion Document (2002)
Taylor, J
Environment Bay of Plenty Environmental Publication 2002/09

Spatial Information: Tauranga, New Zealand
Keywords: indigenous biodiversity

Summary: New Zealand continues to experience a nationwide loss of indigenous biodiversity. The Bay of Plenty has lost vast areas of indigenous habitats, and those that remain continue to be under threat from degradation (particularly by animal pests and weeds) and local disturbance and clearance. This report provides information on the Bay of Plenty's terrestrial ecosystems and habitats and update on Project BIODiversity, which was initiated to scope the contents of the terrestrial biodiversity monitoring module. The report closes with an outline of the pilot monitoring of key terrestrial ecosystems to be undertaken over the remainder of the 2002-03 financial year.

Natural Environment Regional Monitoring Network: Bay of Plenty Rivers water quality (1989-2000) (2001)
Taylor, J.R.;Park, S.G.
Environmental Report 2001/12

Spatial Information: Bay of Plenty, New Zealand
Keywords: water quality, Bay of Plenty, Water Quality Score

Summary: This report presents 1989/2000 water quality (physico-chemical and bacteriological) data of the rivers of the Bay of plenty region. The rivers' data for 44 sites throughout the region has been assessed with a focus on Council's aquatic ecosystem protection function to:

- Summarise the representative water quality of the region
- Identify regional water quality extremes and issues
- Determine if receiving water quality standards are being met; and
- Detect if there are any significant long term trends in water quality that may be of concern.
- Data for each site have been summarised into a Water Quality Score (WQS) based on 7 key parameters (clarity, suspended solids, dissolved oxygen, pH, NA, -N and *E.coli*).

Mangroves of East Africa (2003)
Taylor, M.; Ravilious, C.; Green, E.P.
UNEP-WCMC

Spatial Information: East Africa
Keywords: Plant; mangroves

Summary: Living in two worlds at once, mangroves protect coastlines from wave energy and protect offshore ecosystems from terrestrial sediments flowing downstream. Throughout the tropics mangroves exist in intertidal areas and are utilised as a habitat by thousands of animal species and as fuel, medicine, food and timber by human coastal populations

Normal fault growth and linkage in the Whakatane Graben, New Zealand, during the last 1.3 Myr (2004)
Taylor, S. K.; Bull, J. M.; Lamarche, G.; Barnes, P. M.
Journal of Geophysical Research-Solid Earth

Spatial Information: Whakatane Graben, New Zealand
Keywords: neotectonics; normal faulting; fault growth; Taupo Volcanic Zone; 1987 Edgecumbe Earthquake;

Summary: Determination of fault growth rates and fault network evolution at timescales from 104 to 106 years has been hampered by a lack of a well-constrained stratigraphic succession that provides a high-fidelity record of fault development over these time periods. Here we show how seismic reflection data of different spatial resolutions can be used to constrain the linkage history and displacement rate variations of a single major fault. We present data collected in the offshore Whakatane Graben, Bay of Plenty, New Zealand, where intense normal faulting occurs as a result of active back extension. The focus of our study is the Rangitaiki Fault, a linked segmented normal fault which is the dominant active structure in the graben. The total linked fault length is similar to 20 km and has a displacement of up to 830 +/- 130 m in the top 1.5 km of sediments. The fault has been actively growing for the last 1.34 +/- 0.51 Myr and has developed from isolated fault segments to a fully linked fault system. Initially, the dominant process of fault growth was tip propagation, with an average and maximum displacement rates of 0.52 +/- 0.18 and

0.72 +/- 0.23 mm yr(-1), respectively. Interaction and linkage became more significant as the fault segments grew toward each other, resulting in the fault network becoming fully linked between 300 and 18 ka. Following fault segment linkages, the average displacement rate of the fault network increased by almost threefold to 1.41 +/- 0.31 mm yr(-1), while the maximum displacement rate increased to 3.4 +/- 0.2 mm yr(-1). This is the first time that the growth rate of unlinked fault segments has been resolved and has been shown to be slower than in the subsequent linked fault system.

Te Awa O Waitao Stream Restoration Project Annual Report 1st July 2005 to 30th June 2006 (2006)
Te Awa O Waitao Stream Restoration Project
Te Awa O Waitao Stream Restoration Project

Spatial Information: Tauranga Harbour – Waitao Stream, Welcome Bay, Tauranga
Keywords: Te Awa o Waitao, Tauranga Harbour, water quality, Rangataua Bay (Welcome Bay)

Summary: Te Awa o Waitao restoration project was initiated in 2004, as a result of growing concern among local Hapu about water and habitat quality issues in the Waitao Catchment. Of particular concern was increasing sedimentation, declining water and habitat quality, erosion, catchment deforestation, spread of pest plants, undervaluation of Maori knowledge, resources and rongoa, and dumping of rubbish. The project aims to improve water and habitat quality in the stream and the Rangataua Bay branch of the Tauranga Harbour (south-eastern end of the Tauranga Harbour, Welcome Bay, and Tauranga.) It also aims to achieve its goals by merging Maori traditional knowledge with Western science, in a meaningful way.

Te Awa O Waitao Stream Restoration Project Annual Report 1st July 2006 to 30th June 2007 (2007)
Te Awa O Waitao Stream Restoration Project
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Te Ohu Kaimoana Annual Report (2008)
Te Ohu Kai Moana (Maori Fisheries) Trust & Group
Te Ohu Kai Moana

Spatial Information: New Zealand wide
Keywords: aquaculture, fisheries

Summary: This report discusses the allocation and transfer to iwi of fisheries, aquaculture and the Takutai Trust, protecting Maori fisheries assets, government proposals affecting Maori fisheries, developmental fisheries and customary rights. Additionally, it describes the governance of the Te Ohu Kaimoana Group, gives their financial report and reports against their annual plan. Furthermore, it discusses the strategies and future developments for Aotearoa Fisheries Ltd, Te Putea Whakatupu Trust and Te Wai Maori Trust.

The effects of turbidity on suspension feeding bivalves (1999)
Teaioro, I.
University of Waikato

Spatial Information: No spatial context
Keywords: Suspended sediment concentration, scallops and pipis

Summary: This thesis aimed to describe the relationship between suspended sediment concentration stimulating the turbidity caused by natural events or human activities, and the feeding behaviour and energetic of scallops and pipis. A wide range of suspended sediment concentration with different organic content was used.

A Worldwide Perspective on the Population Structure and Genetic Diversity of Bottlenose Dolphins (*Tursiops truncatus*) in New Zealand (2007)
Tezanos-Pinto,G.; Baker, C.S; Russell, K.; Martien,K.; Baird,R.W.; Hutt,A.; Stone,G.; Mignucci-Giannoni,A.A.; Caballero,S.; Endo,T.; Lavery,S.; Oremus,M.; Olavarria,C.; Garrigue,C.
Journal of Heredity

Spatial Information: New Zealand
Keywords: dolphins and whales

Summary: Using samples collected from coastal habitats around New Zealand, Pacific Ocean Dataset, and Atlantic Ocean Dataset, the study examined the phylogeography, genetic diversity and female migration rates among New Zealand populations, and explored the phylogeographic relationship of New Zealand bottlenose dolphins to other populations in the world. Analysis of the molecular variance from mitochondrial DNA (mtDNA) control region sequences showed a considerable differentiation among the 3 populations of New Zealand (Northland, Marlborough Sounds, and Fiordland). All 3 populations showed higher mtDNA diversity than expected given their small population sizes and isolation. A comparison of New Zealand haplotypes with haplotypes worldwide found that, regardless of population habitat use, all haplotypes in the Pacific are more divergent from populations described asinshore ecotype in the Western North Atlantic than from populations described as offshore ecotype. Gene flow analysis indicated a long-distance dispersal among coastal and pelagic populations worldwide, meaning that these populations are probably interconnected on an evolutionary timescale.

Farmers fed up with seal's love (1987)
The World,
The World News

Spatial Information: Coromandel Peninsula, New Zealand
Keywords: elephant seal

Summary: A newspaper article about Humphrey, a 3-ton male elephant seal lumbering ashore at a dairy farm on New Zealand's northeast coast and falling in love with a herd of milk cows. The huge, blubbery mammal, which refused to leave the farm, has flattened barbed wire fences and farm gates in repeated but unsuccessful attempts to woo the cows, which are so frightened they had stopped giving milk. Humphrey also apparently tried to make love to a 10,000 gallon water tank, which sprang a leak and became the sea elephant's personal shower. Allan and Helen Bridson, owners of the farm on Coromandel Peninsula some 70 miles northeast of Auckland, decided enough was enough. They called the federal Conservation Department, which earlier sent out veterinarians to tranquilize the love-struck mammal and return it to the chilly Pacific.

Methyl bromide: effective pest management tool and environmental threat (1996)
Thomas, W.B.
Supplement to Journal of Nematology

Spatial Information: No spatial context
Keywords: Organic Pollutants

Summary: Methyl bromide is used extensively on a global basis as a pesticide against nematodes, weeds, insects, fungi, bacteria, and rodents. As a soil fumigant, it is used in significant quantities in the production of strawberry and tomato, as well as other agriculture commodities. Grain, fresh fruit, forestry products, and other materials are fumigated with methyl bromide to control pest infestations during transport and storage. Structures are also treated with this chemical to control wood-destroying insects and rodents. However, methyl bromide has been identified as a significant ozone-depleting substance, resulting in regulatory actions being taken by the U.S. Environmental Protection Agency and the United Nations Environment Program (Montreal Protocol). The science linking methyl bromide to ozone depletion is strong and was reinforced by the 1994 UNEP Montreal Protocol Science Assessment on Ozone Depletion, which states, "Methyl bromide continues to be viewed as a significant ozone-depleting compound". Identifying efficacious and viable alternatives in the near term is critical.

A bibliography of the major ports and harbours of New Zealand (marine geology, physical oceanography and related topics) (1981)
Thompson,R.M.
New Zealand Oceanographic Institute Misc

Spatial Information: New Zealand wide
Keywords: hydrodynamics

Summary: A bibliography of the major ports and harbours of New Zealand - marine geology, physical oceanography and related topics.

The sublittoral macrobenthic community structure of an Irish sea-lough: Effect of decomposing accumulations of seaweed (1986)
Thrush, S. F.
Journal of Experimental Marine Biology and Ecology

Spatial Information: No spatial context
Keywords: polychaetes, *Capitella* spp. and *Malacoceros fudiginosus* (Claparède), Seaweed decay

Summary: The deposition and decay of seaweed has been identified as producing localized changes in sublittoral macrobenthic community structure on the basin floor of a small sea-lough. Surveys of the abundance of seaweed accumulations revealed ≈7 accumulations 100 m^2, of which many were of sufficient size and stability to cause anoxic patches. A manipulative field experiment was conducted to assess changes in sediment conditions and community structure in areas covered with seaweed, adjacent areas, and clear areas. Sediment pH and Eh were reduced in smothered areas. Differences in the macrobenthic community between the three treatments indicated a rapid increase in the abundance of two polychaetes, *Capitella* spp. and *Malacoceros fudiginosus* (Claparède), and a loss of rare species in disturbed areas. Sixty nine days after the initiation of the experiment a similar number of species were found in each treatment, although areas under seaweed were still numerically dominated by *Capitella* spp. These results indicate that patches of decomposing seaweed have an important role in determining the pattern of species distribution and benthic community structure.

Muddy waters: Elevating sediment input to coastal and estuarine habitats (2004)
Thrush, S. F.; Hewitt, J. E.; Cummings, V.; Ellis, J.; Hatton, C.; Lohrer, A. M.; Norkko, A.
Frontiers in Ecology and the Environment

Spatial Information: No spatial context
Keywords: Sedimentation, Benthic Sampling, Biodiversity

Summary: Changes in land use and the development of coastal regions around the world have markedly increased rates of sediment input into estuarine and coastal habitats. Field studies looking at the consequences of terrestrial sediment deposition, water-borne sediment, and long-term changes in habitats indicate that increasing rates of sediment loading adversely affect the biodiversity and ecological value of estuarine and coastal ecosystems. Managing this threat requires means with which to convey the magnitude of the problem, forecast long-term trends, and assess the risks associated with changes in land use. Here we focus on approaches for assessing the risks of changes in land use, which include combining biological effect studies with catchment and hydrodynamic modelling, using statistical models that forecast the distribution and abundance of species relative to changes in habitat type, and using sensitive species that play important ecological roles as indicators of change.

Habitat change in estuaries: predicting broad-scale responses of intertidal macrofauna to sediment mud content (2003)

Thrush, S. F.; Hewitt, J. E.; Norkko, A.; Nicholls, P. E.; Funnell, G. A.; Ellis, J. I.
Marine Ecology Progress Series

Spatial Information: No spatial context
Keywords: Sedimentation

Summary: There is a growing threat of habitat change in estuarine and coastal regions, yet there are few models that enable ecologists and resource managers to forecast the response of macrofaunal species to long-term changes in sediment type. This study details a novel strategy that enabled us to rapidly collect data on macrofaunal densities and sediment characteristics by sampling mud-to-sand transition zones in 19 estuaries. Species-specific models that predict probability of occurrence relative to sediment mud content were developed for 13 common macrofaunal species. However, the roles played by many macrofaunal species are influenced by density, not just occurrence. Over broad spatial scales, the constraint an environmental variable places on density can be represented by the upper (or lower) limit on density. Thus, the distribution of maximum density along the gradient from mud to sand was modelled as another indicator of a species' preference. Both the maximum and minimum values for number of taxa, number of individuals, Shannon-Wiener diversity and taxonomic distinctness were also modelled. For most variables, good models (r2 > 0.6) were developed. The models developed for the different species exhibited a wide variety of functional forms, highlighting the potential variation in response to habitat change even for closely related species with similar natural history characteristics. Probability-of-occurrence models and maximum-density models for a specific species also varied in functional form, emphasising that changes in both occurrence and density need to be considered when predicting likely responses to changes in habitat.

Light absorption by yellow substance in storm runoff from log handling areas at a timber export port, Tauranga, New Zealand (1994)
Tian, F.; Healy, T. R.; Davies-Colley, R. J.
Journal of Coastal Research

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Organic Pollutants

Summary: Spectral values of light absorption by yellow substance at near ultraviolet to visible wavelengths were measured in 22 storm runoff samples from the wharf log handling areas at the Port of Tauranga, New Zealand, to ascertain the feasibility of measuring light absorption for monitoring yellow substance in storm runoff. As in previous research on natural marine and inland waters, the spectral shapes of yellow substance absorption in storm runoff from the wharf log handling areas fitted an exponential model. The spectral slope varied only slightly, though the suspended solid concentration of the samples varies from 9.2 to 1,100 mg/1. The overall mean was 85 and 160-1,280 times that of natural marine waters in the Tauranga Harbour and around the South Island of New Zealand. The method appears feasible for rapid monitoring of yellow substance in storm runoff from log handling areas and provides a basis for tracing dispersion of the storm effluent in the receiving tidal waters.

Accumulation of resin acids in sediments adjacent to a log handling area, Tauranga Harbour, New Zealand (1998)
Tian, F.; Wilkins, A.L.; Healy, T.R.

Bulletin of Environmental Contamination and Toxicology

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Organic Pollutants

Summary: After previous studies, on the same site, found resin acids were accumulating on the sea floor around storm water discharge areas, this study by Tian, Wilkins and Healy (1998) investigated the accumulation of resin acids in the estuarine sediments adjacent to a log handling area at the Port of Tauranga. Samples of the sea bed sediment were taken from ten sites at locations of increasing distance from the log handling area and adjacent storm water discharge points. This study does not provide explanation of resin acids, however drawing from an additional source: resin acids are diterpenoid carboxylic acids which are present in wood species and can accumulate in sediment, being potentially toxic to fish and aquatic species (Liss, Bicho, & Saddler, 1997). Ten sites were sampled, opposite the northern and southern drain systems as well as two control samples in recently dredged areas of the harbour, which were used as control sites. The dominant resin acids found were: primaric acid, sandaracopimaric acid, abietic acid, dehydroabietic acid (DHAA), dehydrodehydro-abietic acid, and 7-hydroxydehydro-abietic acid. The site 1m from the northern drain had high levels of bark residue (34.7% loss on ignition of the sample) and had high resin acid concentration (874,000 ppb). The other sediment samples ranged from 820 ppb to 3900 ppb. These are substantially lower than levels identified adjacent to the bark dumping ground which was 31-84 ppm (Healy et al, 1997). The control samples were collected after 36-44 months following the recent dredging of the area, these readings led to the conclusion that there is approximately 300 ppb/year (southern drain outfall) and 370 ppb/yr (northern drain outfall) of resin acids accumulating in the shipping channel at distances of 100-300 m from Sulphur Point wharf. This is assuming a linear rate of accumulation. Dredging removed previous accumulation and left sediments with negligible levels of contamination. In conclusion, the highest rates of resin acid contamination occur in surface sediments close to the drain source adjacent to the log handling area. The levels of contamination decrease away from the source.

Estimates of the Damage Costs of Climate Change. Part 1: Benchmark Estimates (2002)
Tol, R.S.J.
Springer Netherlands

Spatial Information: No spatial context
Keywords: Business and Economics

Summary: A selection of the potential impacts of climate change – on agriculture, forestry, unmanaged ecosystems, sea level rise, human mortality, energy consumption, and water resources – are estimated and valued in monetary terms. Estimates are derived from globally comprehensive, internally consistent studies using GCM based scenarios. An underestimate of the uncertainty is given. New impact studies can be included following themeta-analytical methods described here. A 1 °C increase in the global mean surface air temperature would have, on balance, a positive effect on the OECD, China, and the Middle East, and a negative effect on other countries. Confidence intervals of regionally aggregated impacts, however, include both positive and negative impacts for all regions. Global estimates depend on the aggregation rule. Using a simple sum, world impact of a1 °C warming would be a positive 2% of GDP, with a standard deviation of 1%. Using globally averaged

values, world impact would be a negative 3% (standard deviation: 1%). Using equity weighting, world impact would amount to 0% (standard deviation: 1%).

Review of Bay of Plenty Regional Coastal Environment Plan. Environment Bay of Plenty - Bay of Plenty Regional Council (2009)
Totman, D; Le Meur, A
Environment Bay of Plenty

Spatial Information: Bay of Plenty, New Zealand
Keywords: Plants, macroalgae

Summary: This report describes the approach and findings of a restricted review of the effectiveness, efficiency and appropriateness of the Bay of Plenty Regional Coastal Environment Plan. Environment Bay of Plenty (EBOP) commissioned the review towards the end of 2008 in order to fulfil its statutory obligations under Section 35 of the Resource Management Act (2003) to compile and make available to the public a review of the efficiency and effectiveness of the policies, rules and methods of the Bay of Plenty Regional Coastal Environment Plan.
The purpose of the review was to:

- Ensure the Bay of Plenty Regional Coastal Environment Plan remains relevant, lawful and appropriate;
- Identify any issues pertaining to the clarity and effectiveness of the regional rules in the Bay of Plenty Regional Coastal Environment Plan and whether there are any disputes over the interpretation of those rules;
- Identify any issues regarding efficiency of the Bay of Plenty Regional Coastal Environment Plan and;
- On the basis of the above, identify whether changes to the Bay of Plenty Regional Coastal Environment Plan are required immediately or following the 10-year review due in 2013.

In accordance with the terms of reference for the project, the review incorporated a literature overview of existing relevant documents as well as consultation with key staff of Environment Bay of Plenty and the four coastal district councils, Western Bay of Plenty District Council, Tauranga City Council, Whakatane District Council and Opotiki District Council that work with the Bay of Plenty Regional Coastal Environment Plan.

Effects of Ivermectin in Dairy Discharges on Terrestrial and Aquatic Invertebrates (2002)
Tremblay, L.A.; Wratten, S.D.
Department of Conservation Science Internal Series 67

Spatial Information: No spatial context
Keywords: dairy discharges, pollution, antiparasitic drugs, chemical residues, ivermectin, avermectins, endocrine-disrupting chemicals, invertebrates, freshwater systems.

Summary: Ivermectin (22, 23-dihydroavermectin B1) is a broad-spectrum antiparasitic drug that was introduced for the control of parasitic worms and lice in sheep and cattle. This review summarises what is known about the impact of ivermectin in pastures and catchments and also on freshwater systems. Differing

results have been obtained for the effects on decomposition of dung from ivermectin-treated cattle, although other experiments have shown adverse effects on growth of earthworms. There were likely to be risks to sediment-dwelling invertebrates where farmed salmon had been treated with ivermectin to control sea lice. In laboratory tests, freshwater fish appeared to have low sensitivity to ivermectin. In view of the lack of published information about environmental effects of use of avermectins and about endocrine-disrupting chemicals in detergents used in dairy operations, it is recommended that monitoring of dairy discharges for residues of such chemicals should be undertaken.

Establishment of the green alga *Codium fragile* ssp. *tomentosoides* on New Zealand rocky shores: current distribution and invertebrate grazers (1995)
Trowbridge, C.D
Journal of Ecology

Spatial Information: New Zealand wide
Keywords: Plants, macroalgae

Summary: The green alga *Codium fragile* ssp. tomentosoides has recently become established on New Zealand rocky shores in spite of a diverse and abundant assemblage of invertebrate herbivores, many of which consume native species of Codium. The alga was initially reported from the port of Auckland in 1973; it now occurs on many wave-protected, east-coast shores of the North Island but not at wave-exposed, west coast beaches or in the south at Wellington Harbour or Cook Strait. Of 11 common species of grazers tested in laboratory feeding trials, four gastropods and two echinoids consumed the introduced *C. fragile* ssp. tomentosoides. In the field, the major intertidal grazers on this alga were the snail *Turbo smaragdus* (a generalist herbivore) and the ascoglossan (= sacoglossan) sea slugs *Placida dendritica* and *Elysia maoria* (specialist herbivores). In laboratory experiments, herbivores were offered pairwise choices of the invasive alga *C. fragile* ssp. tomentosoides and the sympatric, native, encrusting congener *C. convolutum*. The generalist snail *Cookia sulcata* and sea urchin *Evechinus chloroticus* preferred the invasive alga whereas one of the ascoglossan sea slugs (*P. dendritica*) preferred the native species but the other had no preference. When grazers were offered pairwise choices of the invasive *C. fragile* ssp. tomentosoides and the native ssp. *novae-zelandiae*, *T. smaragdus* and *P. dendritica* preferred the introduced alga whereas other grazers preferred the native subspecies or exhibited no preference. Feeding preferences were not related to herbivore size, diet breadth, life history, or geographical range, and differences in algal structural morphology were not clearly related to herbivore choice. Field observations and an algal transplant experiment indicated that intertidal herbivores exerted little grazing pressure on *C. fragile* ssp. tomentosoides. Results of this study suggest that the introduced alga will eventually successfully invade most of the protected to semi exposed shores of New Zealand despite the diverse herbivore fauna.

Estuarine Sedimentation and Vegetation: Management Issues and Monitoring Priorities (2001)
Turner, S.; Riddle, B.
Environment Waikato Technical Report 2001/05

Spatial Information: New Zealand – 12 estuaries on the Coromandel Peninsula & 4 estuaries on the West Coast

Keywords: Sedimentation, monitoring, estuaries, Coromandel Peninsula, West Coast

Summary: Estuaries have been identified as one of the coastal areas within the region most at risk from human activities. Many different types of communities are found in and around estuaries, including coastal forest, salt meadows and saltmarshes, mangroves, seagrass beds, sand and mud flats, rocky reefs and shallow open water areas. Protecting the diversity of habitats provided by these plant communities is an important factor in maintaining the diverse roles of the region's estuarine ecosystems. The Waikato Regional Council has developed a Regional Estuary Monitoring Programme to provide a more comprehensive understanding of the region's estuarine environments and the threats they face. Monitoring changes in extent, distribution and type of intertidal estuarine habitats is an aspect of this programme. Waikato Regional Council uses this information to identify policy responses and make consent decisions so that we can avoid or remedy adverse affects on estuarine environments. Find out about the Waikato Regional Council's policies relating to natural character, habitat and coastal processes in the section 3 of the Regional Coastal Plan.

Growth and productivity of intertidal *Zostera capricorni* in New Zealand estuaries (2007)
Turner, S. J.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: New Zealand wide
Keywords: leaf growth rates; leaf productivity; rhizome growth rates; environmental stress; emersion, Sea grass

Summary: In situ leaf and rhizome growth and productivity rates were determined for intertidal populations of *Zostera capricorni* in three New Zealand estuaries on four occasions in summer and winter 2000 and 2001. Leaf growth and productivity, leaf plastochrone interval, leaf life-spans and turnover rates were found to vary depending on site, bed position, season, and year. Absolute leaf growth (2.1 +/- 0.8mm leaf (-1) day (-1)) and productivity (0.4 +/- 0.2 mg shoot (-1) day (-1)) were generally lowest, relative growth (0.2 +/- 0.6mm leaf-l day-1) and productivity (0.4 +/- 0.4 mg shoot (-1) day (-1)) highest, and the leaf and shoot plastochrone intervals shorter at the site exposed to greater desiccation stress and photoinhibitory high irradiances. Rhizome growth rates, the production of new branches and shoots, as well as rhizome and shoot plastochrone intervals were also found to vary depending on site, season, and year. The results indicate that *Z. capricorni* is able to maintain high productivity and growth rates in intertidal estuarine environments which signify a high degree of environmental stress for marine plants.

Management and Conservation of Seagrass in New Zealand: An Introduction (2006)
Turner, S. J.; Schwarz, A. M.
Department of Conservation Science for Conservation Report 264

Spatial Information: New Zealand wide
Keywords: Plants; Sea grass, *Zostera capricorni*, ecology, threats, monitoring, indicator species, ecosystem health

Summary: Globally, seagrass management and conservation have received increased attention over the last decade. To date, however, there has been a paucity of available information specific to New Zealand about seagrass beds as an ecosystem component and which could be used to assist resource managers in decision making. This report has been prepared primarily for coastal resource managers, to assist in the management and conservation of seagrass. It provides a review of the current state of knowledge in New Zealand, within the context of international seagrass research. There are some key characteristics that set New Zealand seagrass habitat apart from many temperate and tropical systems. In New Zealand, the seagrass flora is represented by one genus, *Zostera*, in the family *Zosteraceae*. Seagrass occurs predominantly intertidally in New Zealand, although it may extend into the shallow subtidal areas of sheltered estuaries, and permanently submerged beds of seagrass have been recorded around a small number of offshore islands. While a lot is known about seagrasses in other regions, the role that these plants play and just how important they are in estuarine and coastal ecosystems in New Zealand is less well understood and to date has been the subject of limited study. The relative importance or magnitude of the multiple ecosystem functions of seagrass beds may vary considerably within and between different estuarine and coastal systems. For successful management, a specific understanding of seagrass ecology within New Zealand is required, preferably at the regional or estuary scale, rather than relying on international paradigms.

Biomass development and photosynthetic potential of intertidal *Zostera capricorni* in New Zealand estuaries (2006)

Turner, S. J.; Schwarz, A. M.

Aquatic Botany Journal

Spatial Information: New Zealand wide
Keywords: Seagrass; Shoot density; Rhizome morphometrics; Environmental stress; Emersion

Summary: A 2-year study of structural (biomass, shoot density), morphological (rhizome morphometrics) and dynamic (photosynthetic potential, tissue nutrient content) characteristics of the seagrass *Zostera capricorni* Asch. on intertidal estuarine sand-flats was undertaken at four sites on the Coromandel Peninsula, New Zealand. Spatial (position within the bed, within and among estuaries), summer-winter and between year variations in almost all measured characteristics were observed, suggesting responses to varying environmental conditions at different scales. Mean above-ground biomass ranged from 46 to 81 g DW m^2 and mean below-ground biomass ranged from 133 to 542 g DW m^2, varying significantly among the four sites. The site with the lowest biomass also had the lowest and most variable photosynthetic potential, measured using the pulse amplitude modulated fluorescence parameter (Fv/Fm), ranging from an average of 0.35 to 0.78. Despite the differences in biomass, there was much greater similarity in shoot density (mean summer densities: 2700-3800 m^2) among the sites. At all sites, above- and below-ground biomass, shoot density and rhizome morphometrics differed between the edge of the beds and within the beds. While biomass was generally higher within the beds, the incidence of rhizome branching was higher and primary rhizome internode lengths were longer at the edge than within the beds. Differences in biomass and shoot density between summer and winter were similar at all the sites, consistent with high growth rates in spring-summer reported elsewhere for temperate intertidal seagrass. At some sites, the lengths of the primary rhizome internodes, the

frequency of rhizome branching and leaf lengths at the edge of the bed were longer in winter than summer, and plants exhibited high Fv/Fm values in winter 2001. Despite lower ambient temperatures than in summer, winter may still be an important period for growth in the temperate North Island New Zealand climate.

3.21. U

Intercoast Research Plan (n.d.)
University of Waikato and University of Bremen
University of Waikato

Spatial Information: Bay of Plenty-Coromandel in New Zealand and of the North Sea in Germany
Keywords: harbour development and ship traffic, coastal land use conversion for housing and industry, fisheries and aquaculture industries, tourism

Summary: The International Research Training Group INTERCOAST will investigate questions of societal relevance relating to the coastal and shelf regions of the Bay of Plenty-Coromandel in New Zealand and of the North Sea in Germany. The research programme focuses on coasts and shelves in both areas, as they have similar coastal problems, despite their wide geographic location disparity. Both coastal and shelf zones have much in common, including existing and expanding settlement, intensifying harbour development and ship traffic, coastal land use conversion for housing and industry, fisheries and aquaculture industries, tourism and, particularly important for the future – energy production from the marine realm and wind parks. These activities and their impacts necessitate environmental intervention: dredging for shipping channels and wharves, land reclamation, and infrastructure development for homes, factories, and population mobility, sewage treatment, etc. Overriding such intensifying development, global change exerts strong impacts on both the German North Sea and the Bay of Plenty regions. In both areas this rapid population increase, commercial development, and recreational usage require long-term and careful planning, paying special attention to the principles of sustainable and precautionary, environmentally sound, and conservation-oriented economic practices.

3.22. V

Mangrove Forests: One of the World's Threatened Major Tropical Environments (2001)
Valiela, Ivan; Bowen, Jennifer L.; York, Joanna K.
University of California Press on behalf of the American Institute of Biological Sciences

Spatial Information: World wide
Keywords: Plants; Mangroves

Summary: This article writes about the distribution and loses of mangrove forests across the world.

The impact of human activities on sediments of San Francisco Bay, California: an overview (2002)

van Geen, A.; Luoma, S. N.
Marine Chemistry Journal

Spatial Information: Overseas - San Francisco Bay, California, USA
Keywords: Organic Pollutants, Inorganic Pollutants

Summary: This note introduces a set of eight papers devoted to a detailed study of two sediment cores from San Francisco Bay with an overview of the region and a chronology of human activities. Data used in this study to constrain the range of sediment ages at different depths include Th-234, Pb-210, Cs-137, Pu-239, Pu-240 and Be-10 concentrations in the sediment and the C-14 age of shell fragments. In order of first detectable appearance in the record, the indicators of contamination that were analysed include PAHs > Hg > Ag, Cu, Pb, Zn > DDT, PCB > foraminiferal Cd/Ca. This study also documents a large memory effect for estuarine contamination caused by sediment mixing and re-suspension. Once an estuary such as San Francisco Bay has been contaminated, decades must pass before contaminant levels in surface sediment will return to background levels, even if external contaminant inputs have been entirely eliminated.

Ecosystem services of protected areas and ecological corridors within Kaimai-Tauranga catchments (2010)
Van Meeuwen-Dijkgraaf, A.; Shaw, W; Mazzieri, F.
Wildland Consultants Ltd

Spatial Information: Kaimai- Tauranga Catchment, Tauranga Harbour, New Zealand
Keywords: Kaimai- Tauranga Catchment, ecosystem services, Tauranga Harbour, protected areas

Summary: This report on the Ecosystems of Services of DOC land parcels and corridors within the Kaimai- Tauranga Catchment aims to identify priority sites for protection within the Kaimai- Tauranga Catchment. The study area includes all catchments that flow into Tauranga Harbour. In this report actual and potential ecological corridors were identified and ecological services and benefits within the proposed corridors were identified.

Aquaculture law and policy: towards principled access and operations (2006)
Vander Zwaag, David L.; Chao, Gloria
Routledge

Spatial Information: No spatial context
Keywords: Aquaculture industry Law and legislation

Summary: The aquaculture industry is fast expanding around the globe and causing major environmental and social disruptions. The volume is about getting a 'good governance' grip on this important industry. The book highlights the numerous law and policy issues that must be addressed in the search for effective regulation of aquaculture. Those issues include among others: the equitable and fair assignment of property rights; the design of effective dispute resolution mechanisms; clarification of what maritime laws apply to aquaculture; adoption of a proper taxation system for aquaculture; resolution of aboriginal offshore title and rights claims; recognition of international trade law restrictions such as labelling limitations and food safety

requirements; and determination of whether genetically modified fish should be allowed and if so under what controls.

Size-fractionated phytoplankton biomass and photosynthesis in Manukau Harbour, New Zealand (1996)
Vant,W.N.; Safi, K.A.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Elsewhere in New Zealand - Manukau Harbour
Keywords: phytoplankton dynamics

Summary: This article studied the seasonal variation in phytoplankton biomass and photosynthesis in three size classes at four contrasting sites in Manukau Harbour during 1993-94. Low levels occurred during winter, when the < 5 µm class dominated. The 5-22 µm class dominated during early summer, whereas the > 22 µm class dominated during a late summer bloom of *Odontella sinensis* and other large diatoms, particularly at the inner harbour sites. Values of the photosynthetic parameter for the different size classes were similar. Values of Ik for the > 22 µm class were higher than those for both the smaller classes. The ratio of photosynthesis to biomass in the euphotic zone—a simple index of potential growth rate—varied seasonally; but at any given time values for all three size classes were similar. Despite this, during summer the biomass of the smaller size classes increased much less than that of the > 22 µm class, implying the smaller cells was lost at a greater rate then.

An Assessment of Grey-Faced Petrel (*Pterodroma macroptera goldi*) nesting sites on Mount Maunganui (Mauao) (2001)
Vaughton, H.
Bay of Plenty Polytechnic Report no. 108

Spatial Information: Mt Maunganui (Mauao), New Zealand
Keywords: Grey-Faced Petrel (*Pterodroma macroptera goldi*), Mt Maunganui (Mauao)

Summary: The aim of the group was to collect as much data for an ongoing Ornithological Society of New Zealand report. The aim of this project was to establish how the different nest sites around Mauao affected the number of Petrels caught at each site. The objectives of the group project were to band as many adult petrels as possible during the breeding season. The wing lengths and weights of each bird were also recorded. Over 100 petrels were processed in 2001 and the number of birds processed varied hugely between sites. Fewer new branding were processed than recaptures and more birds were captured in areas with mature Pohutukawa forest than any other types of vegetation. The majority of the burrows were excavated amongst the roots of these mature trees. Larger nest sites with higher numbers of burrows did not always supply larger numbers of birds. The birds seemed to prefer nesting in areas under a canopy of trees without much ground covering vegetation.

ADCP Measurements of Momentum Balance and Dynamic Topography in a Constricted Tidal Channel (2006)
Vennell, R.

Journal of Physical Oceanography

Spatial Information: No spatial context
Keywords: hydrodynamics

Summary: The dynamics of tidal flow through inlets are not fully understood; observations are scarce due to the small spatial scales over which the flow varies. This paper gives the first detailed measurements of the 2D structure of tidal currents and the dynamical terms of the momentum equation within a tidal inlet, leading to an improved understanding of the physics of tidal inlets. In the 180 cm/s peak flow the near steady state momentum balance is dominated by horizontal advection and pressure gradient, with bottom friction playing a secondary role. At slack water there is a balance between local acceleration and pressure gradient. Numerical integration of the ADCP measured terms in the momentum equation yields 60 m resolution dynamic topography which shows a 7 cm variation at peak flood consistent with Bernoulli's equation. The surface topography due to friction forms a linear ramp with a peak irreversible head loss of 2 cm over 600 m. Tidal velocities were extracted from the ADCP measurements by extending an existing spline analysis technique. This technique is known to be sensitive to the number and location of the nodes where weights are applied to the spline. Simulations with artificial data representative of the tidally varying ADCP measurements show that, provided there are sufficient nodes to resolve the smallest spatial scale of interest, velocities predicted by the spline technique are insensitive to the number or locations of the nodes.

Benthic foraging on stingrays by killer whales (*Orcinus orca*) in New Zealand waters (1999)
Visser, I.
Marine Mammal Science Journal

Spatial Information: North Island of New Zealand
Keywords: killer whales (*Orcinus orca*), New Zealand

Summary: One method of foraging not previously reported for the killer whale is benthic foraging. This paper describes frequent feeding by killer whales on rays in shallow water off the North Island of New Zealand. Few accounts of killer whale predation on elasmobranchs (sharks, skates, and rays) have been reported worldwide (Fertl et al. 1996). However, rays may be important prey for killer whales in New Zealand.

A summary of interactions between orca (*Orcinus orca*) and other cetaceans in New Zealand waters (1999)
Visser, I.
New Zealand Journal of Natural Science

Spatial Information: New Zealand waters
Keywords: food webs, *Orcinus orca, Delphinus delphis, Tursiops truncates, Lagenorhynchus obscures, Physeter macrocephalus*, New Zealand, attack, interactions

Summary: Interactions between orca *(Orcinus orca)* and other species of cetaceans in New Zealand waters are presented, involving six species, over a 36 year period. Forty four published (n = 15) and previously unpublished (n = 29) accounts are

reviewed. The first Southern hemisphere accounts of orca attacking common dolphins *(Delphinus delphis)* are presented. Details are given of a dead sperm whale *(Physeter macrocephalus)* which had been attacked by orca.

Killer whale (*Orcinus orca*) interactions with longline fisheries in New Zealand waters (2000)
Visser, I.N
Aquatic Mammals Journal

Spatial Information: New Zealand waters
Keywords: food webs, Killer whale, *Orcinus orca*, longline predation, fishery interactions, school shark, *Galeorhinus galeus*, bluenose, *Hyperoglyphe antarchia*

Summary: Killer whales (*Orcinus orca*) interact with longline fisheries around the world; however they have not previously been reported taking fish off longlines in New Zealand waters. Two new killer whale prey species (school shark, *Galeorhinus galeus* and bluenose, *Hyperoglyphe antarchia*) have been recorded. A great deal of effort has been applied, worldwide, to reduce killer whale-fishery interactions, but few methods are successful. Fishers in New Zealand have used 'tuna bombs' and shooting.

Orca (*Orcinus orca*) in New Zealand waters (2000)
Visser, I.N.
University of Auckland

Spatial Information: New Zealand waters
Keywords: dolphins and whales

Summary: The focus of this study is to determine baseline information on New Zealand orca and to provide recommendations for future management and conservation. The study documented that the New Zealand orca population appears to be made up of at least three sub-populations based on geographic distribution (North-Island-only, South- Island-only and North+South-Island sub-populations). Using photo identification, the study estimated that the total New Zealand populations is small, ranging from 65 to 167 individuals, with 115 calculated alive in 1997. The study also provided other information, such as their social behaviour, feeding behaviour and reproduction. Bioaccumulation of toxic chemicals, oil spills, boat strikes and shootings were identified as potential threats to orca, which was recommended to be considered for conservation and future management.

Killer whale (*Orcinus orca*) predation on a shortfin mako shark (*Isurus oxyrinchus*), in New Zealand waters (2000)
Visser, I.N.; Fertl,D.; Berghan,J.; van Meurs,R.
Aquatic Mammals Journal

Spatial Information: New Zealand waters
Keywords: dolphins and whales, foodweb

Summary: This study investigated predation of the killer whale on a shortfin mako shark in New Zealand waters. It was based on observations on a group of seven

killer whales in New Zealand waters capturing a shortfin mako shark, a species previously not reported as prey of killer whales. This finding supports the previous suggestion that elasmobranches are the principal prey of killer whales.

Maori me te whanaketanga ahumoana Maori and aquaculture development (2007)
Volkerling, Keir
Ministry for the Environment and Ministry for Maori Development

Spatial Information: New Zealand wide
Keywords: Aquaculture industry New Zealand.; Aquaculture Planning.; Aquaculture Government policy.; Maori Fishing.; H*i ika.; Taunga ika.; Kaitiakitanga.; Umanga

Summary: The paper discusses how tangata whenua can engage with the planning processes for aquaculture development, develop relationships with the aquaculture industry and implement arrangements for the allocation of aquaculture assets. The aim is to provide tangata whenua with sufficient information and access to the relevant tools to enable effective participation in the planning and development processes.

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Shellfish toxins continue to be detected along the Coromandel and Bay of Plenty coastline (2011)
Waikato District Health Board
Waikato District Health Board

Spatial Information: Coromandel and Bay of Plenty coastline
Keywords: Shellfish toxins, Coromandel, Bay of Plenty, health warning, bi-valve shellfish, pipi, tuatua, mussels, cockles, oysters, scallops, catseyes, kina, paua, crayfish, crab

Summary: The health warning, first issued back in December 2009, advising against the collection and consumption of shellfish along part of the Coromandel and Bay of Plenty coastline remains in place. The affected area is unchanged and includes the entire coastline from Tairua (including Tairua Harbour) south, including Opoutere, Onemana, Whangamata, and Whiritoa, east along the Bay of Plenty coastline from Waihi Beach, including Tauranga Harbour to the mouth of the Whakatane River in the Eastern Bay of Plenty. Included are all inshore islands within the above area. The coastline eastward from Ohope beach remains unaffected. The health warning applies to all bi-valve shellfish including mussels, pipi, tuatua, cockles, oysters, scallops as well as catseyes and kina (sea urchin). Paua, crayfish and crabs can still be taken but as always, the gut should be removed before cooking.

Maori methods and indicators for marine protection: A process to identify tohu (marine indicators) to measure the health of the rohe moana of Ngati Kere (2007)
Wakefield, A; Walker, L; Tichinin, P; Wakefield, M; Tipene, M; McGregor, M
Ministry for the Environment & Department of Conservation

Spatial Information: Elsewhere in New Zealand - Central Hawke's Bay
Keywords: Ngati Kere, Central Hawke's Bay, marine indicators/tohu

Summary: This report documents a process for the development of marine tohu/indicators relevant to Ngati Kere for monitoring the health of their rohe moana/coastal and marine area. It has been produced from an Ngati Kere perspective, and aims to be useful to iwi and hapu organisations and others involved in the monitoring of marine health. NGATI KERE hapu - Ngati Kere is a recognised hapu within Central Hawke's Bay, whose traditional coastal boundaries range from Ouepoto Stream in the north to Akitio River in the south. Porangahau (population 255) is the main township where descendants of Keretipiwhakairo (Kere) still reside.

Maori methods and indicators for marine protection: Ngati Kere interests and expectations for the rohe moana (2005)
Wakefield, A.T; Walker, L
Department of Conservation and Ministry for the Environment

Spatial Information: Elsewhere in New Zealand - Central Hawke's Bay
Keywords: Ngati Kere, Central Hawke's Bay, Maori methods and indicators, marine protection

Summary: This report asks for our opinion on modern management systems in the rohe moana/ coastal area, by identifying visions and values, species of importance and indicators relevant to Ngati Kere. We have produced it purely from an Ngati Kere perspective which can be easily read while still addressing the research questions. We would like to acknowledge the Department of Conservation and the Ministry for the Environment for providing Ngati Kere with the opportunity to share our practices with all people of Aotearoa/New Zealand; that these practices may prove relevant to a combined management system that works within the Ngati Kere rohe moana.

Iwi Estuarine Indicators for Nelson (2009)
Walker, D.
Nelson City Council. Tiakina te Taiao occasional report

Spatial Information: Elsewhere in New Zealand – Nelson, South Island
Keywords: Iwi Estuarine Indicators

Summary: Nelson City Council (NCC) approached Landcare Research Manaaki Whenua and Tiakina Te Taiao Ltd. (Tiakina) to provide technical advice and professional expertise on cultural monitoring tools for estuarine areas within the NCC administrative area. The 4 estuaries within the administrative area of NCC are Kokorua Inlet, Delaware (Wakapuaka) Inlet, The Haven (Paruroa) and the eastern edge of the Waimea Inlet. Wakapuka Inlet was chosen as a case study in which to trial and establish monitoring sites. This report contains the following;

1. A brief review of iwi/cultural literature and knowledge (matauranga) on monitoring tools and indicators/indices applicable to coastal and estuarine environments.
2. A monitoring form for the collection and analysis of cultural health data gathered from estuaries across the rohe of Tiakina te Taiao.

3. A guide for the use of the monitoring form above.
4. Recommendations on a set of methods and iwi indicators that can be used in the NCC area for estuarine and sub-tidal environments along with a suggested monitoring programme.

A rapid transcriptional activation is induced by the dormancy-breaking chemical hydrogen cyanamide in kiwifruit (*Actinidia deliciosa*) buds (2009)
Walton, E. F.; Wu, R. M.; Richardson, A. C.; Davy, M.; Hellens, R. P.; Thodey, K.; Janssen, B. J.; Gleave, A. P.; Rae, G. M.; Wood, M.; Schaffer, R. J.
Journal of Experimental Botany

Spatial Information: No spatial context
Keywords: Organic Pollutants

Summary: Budbreak in kiwifruit (*Actinidia deliciosa*) can be poor in locations that have warm winters with insufficient winter chilling. Kiwifruit vines are often treated with the dormancy-breaking chemical hydrogen cyanamide (HC) to increase and synchronize budbreak. This treatment also offers a tool to understand the processes involved in budbreak. A genomics approach is presented here to increase our understanding of budbreak in kiwifruit. Most genes identified following HC application appear to be associated with responses to stress, but a number of genes appear to be associated with the reactivation of growth. Three patterns of gene expression were identified: Profile 1, an HC-induced transient activation; Profile 2, an HC-induced transient activation followed by a growth-related activation; and Profile 3, HC- and growth-repressed. One group of genes that was rapidly up-regulated in response to HC was the glutathione S-transferase (GST) class of genes, which have been associated with stress and signalling. Previous budbreak studies, in three other species, also report up-regulated GST expression. Phylogenetic analysis of these GSTs showed that they clustered into two sub-clades, suggesting a strong correlation between their expression and budbreak across species.

Monitoring and Indicators of the Coastal and Estuarine Environment: A Literature Review (1997)
Ward, Jonet C.
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: New Zealand. Environmental Performance Indicators Programme.; Coastal zone management.; Environmental indicators.; Environmental monitoring.; Plants; Sea grass

Summary: This literature review of monitoring and indicators of the coastal and estuarine environment are part of the Ministry for the Environment's National Environmental Indicators Programme. The coastal and estuarine environment is monitored at several levels in most countries, from the local authorities, NGOs and interest groups to state and/or regional government and national government. International agencies such as the IUCN and OECD also undertake monitoring, usually by assessing the data and information provided by individual nations.

Environmental Performance Indicators; Potential Coastal and Estuarine Indicators: A Review of Current Research and Data (1997)
Ward, Jonet C.; Snelder, Ton
Ministry for the Environment

Spatial Information: New Zealand wide
Keywords: Coastal zone management New Zealand.; Estuarine ecology New Zealand.; Indicators (Biology) New Zealand.

Summary: The Ministry for the Environment's Environmental Performance Indicator Program (EPIP) is developing a core set of national environmental indicators for New Zealand's coasts and estuaries. As a first step in developing these indicators the Ministry needed to consult with New Zealand's coastal and estuarine scientists to identify potential indicators from the existing scientific knowledge base. The Ministry is interested in what is currently able to be measured and areas that need further research, and also databases that are available from which information can be obtained for the development of indicators.

The geomechanics and dispersion of dredge spoil dumped in open water on the inner shelf, Tauranga, New Zealand (1992)
Warren, S.K.
University of Waikato

Spatial Information: Tauranga Harbour, New Zealand
Keywords: Sedimentation, Dredging, Tauranga Harbour

Summary: Tauranga Harbour in the western Bay of Plenty is the site of New Zealand's largest and busiest bulk export cargo port. Expansion of the port and maintenance of shipping channels requires periodic dredging of the harbour floor and ebb tidal delta. The 1990-1991 dredging programme involved the disposal of > 300,000 m: l of harbour sediment on a 0.25 km~ dump ground in 20-30 m of water on the inner shelf about 2 km northeast of Mount Maunganui. This paper aims to investigate the geomechanical behaviour of the dredged material over time, to: (1) better assess the rate of mound consolidation; and (2) determine the sediment transport response to dredged material disposal, particularly bedform development, and likely changes in sediment transport rates near the dump ground.

Chemical processes affecting trace metal transport in the Waihou River and estuary, New Zealand (1995)
Webster, J.G.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Waihou River, North Island, New Zealand
Keywords: Inorganic Pollutants

Summary: The Waihou River, North Island, New Zealand, receives trace metals from two contaminated drainage systems: Ohinemuri River and Tui Stream. In the upper Waihou River and its tributaries, trace metals are transported in bed sediments and in the water column--the latter providing a low-level but continuous flux of dissolved metals (particularly Cu, Zn, Mn, and As) and/or metals bound to suspended sediments (particularly As, Fe, and Pb). As the river water becomes saline, suspended sediment flocculates and settles, increasing the trace metal concentration

of estuarine sediments relative to those of the upper river. Fe, Mn, Pb, and Zn are fully adsorbed onto the suspended sediment in the estuary, and should be effectively removed from the water column by this process. Cu and As are only partially adsorbed and are unlikely to be completely removed from the water column in the estuary region. Trace metal partitioning between dissolved and particulate phases appears to be generally consistent with regulation by adsorption onto hydrous iron-oxide in the sediments.

Source and transport of trace metals in the Hatea River catchment and estuary, Whangarei, New Zealand (2000)
Webster, J.G., Brown, K.L., & Webster, K.S.
New Zealand Journal of Marine and Freshwater Research

Spatial Information: Hatea River catchment and estuary, Whangarei, New Zealand
Keywords: Inorganic Pollutants

Summary: A survey of Cu, Pb, Zn, Cr, and As concentrations in bed sediment, fresh waters, storm waters, and suspended particulate matter (SPM) has been undertaken in the Hatea River catchment, Whangarei, New Zealand. The most recently deposited sediment in the Hatea River estuary has elevated levels of Cu, Pb, and Zn, derived from tributaries draining the more densely-populated western side of the catchment, city stormwater drains, and Cu-bearing antifoulants used in the marina. All trace metals were transported in both "dissolved" and particulate form in the freshwater tributaries. However, an estimated loading of metal transported by the lower Hatea River under different flow regimes indicated that trace metals were predominantly conveyed by coarse (>0.45 µm) SPM during the periods of highest river flow. Of the trace metals studied, Pb showed the strongest association with coarse SPM and the greatest potential for accumulation in estuarine sediment, demonstrating little tendency to be leached from sediment under simulated estuarine conditions.

Evaluation of Impacts of Mitigations on Economics, Productivity and Environmental Outcomes at the Farm Scale (2008)
Wedderburn, E.
AgResearch

Spatial Information: Rotorua and Lake Taupo, New Zealand
Keywords: farm, management, sustainable, dairy, nutrients, impacts, economic, leaching, water quality, green house gas emissions,

Summary: This report gives a summary of the results of work concentrating on three case study farms in New Zealand that demonstrate the economic, environmental and production consequences at a farm scale of applying on-farm mitigations for nutrient emissions. It has been written by AgResearch for the Horizons Regional Council. Two of the case studies, in Rotorua and Lake Taupo, relate to the evaluation of the consequences of having to operate a farm under a nutrient cap set by Regional Council legislation that sets farm nutrient losses to that emitted in the benchmark years. The remaining case study is that of the Dairy Catchments project, established in 2001, to integrate environmentally sustainable practices into dairy farming. Information on these case studies has been mainly sourced from three publications listed in the introduction. *Basing the report on such a limited number of references for the case study areas may affect the accuracy of the findings of the report.* The

authors report that determining the impact of changing on farm management and systems on profitability is very complex. In some cases nutrient emissions can be reduced and there is an increase in profit; while other mitigations will assist in reaching target emission levels but at a cost to the farm. The report suggests that progress on current leaching levels can be made with better adoption of 'best practice principles'. It is recognised that the current research in New Zealand around this topic area has largely focused on dairy systems and there is a gap in the analysis of the performance of sheep and beef farms, as well as the impact of targeting mitigations at a Land Unit Capability scale. The report concludes that the key to this type of evaluation is considering the impact of mitigations across a range of environmental outcomes, for example, green house gas emissions, water quality and farm production (in other words, taking a 'whole system approach'). This will help ensure such things as 'pollutant swapping' (such as a implementing a management option to reduce nitrate to water may in fact increase the output of nitrous oxide - a green house gas). It is also recognises that if production gains continue to grow ahead of efficiency gains there will be not net gain to the environment and targets on nutrient emissions will have to be set to achieve environmental gains.

Marine farming guide: the law, the environment, and how to have your say (1998)
Weeber, Barry; Gibbs, Meredith
Forest and Bird

Spatial Information: New Zealand wide
Keywords: Aquaculture Law and legislation New Zealand.; Aquaculture Environmental aspects.; Coastal zone management Law and legislation.; Environmental protection

Summary: A guidebook to help assess the likely effects of a proposed marine farm on the coastal environment, understand the legislation, decide whether to be involved in the consent process under the Resource Management Act.

Assessment of Water and Sanity Services (2009)
Western Bay of Plenty District Council,
Western Bay of Plenty District Council

Spatial Information: Western Bay of Plenty, New Zealand
Keywords: Western Bay of Plenty, wastewater, Katikati, water supply, stormwater, public toilets

Summary: The assessment provides information on water supply, wastewater and stormwater services, cemeteries and crematoria and public toilets in the District.

Report on the Conservation of Mauao (Mount Maunganui) (1999)
Wharepapa, M.
Bay of Plenty Polytechnic Report no. 87

Spatial Information: Mauao (Mount Maunganui), New Zealand
Keywords: Conservation of Mauao

Summary: This report deals with conservation issues related to Mauao, and recounts the history, cultural and spiritual significance of Mauao. Reveals some of the human impacts on Mauao and lastly addresses the ongoing maintenance programs that are being carried out on Mauao to preserve its longevity. Personal observations and communication with whanau and other members of the public indicate that ongoing track maintenance and the continued planting of native species should progress on Mauao in order to preserve the natural environment.

Recent sediments of Waikareao Estuary, Tauranga, North Island, New Zealand (1979)
White, J.L
University of Waikato

Spatial Information: Waikareao Estuary, Tauranga, North Island, New Zealand
Keywords: Sedimentation, Waikareao Estuary, Tauranga

Summary: Waikareao Estuary is a shallow tidally dominated estuary located in Tauranga Harbour, New Zealand. The primary aim of this study was to determine the seasonal variations in nitrate and ammonium concentrations in sediment pore-waters on a tidal flat margin in the Waikareao Estuary. Long-term monitoring by the Regional Council of Kopurereroa Stream which discharges into Waikareao Estuary, showed higher nitrate concentrations than the tidal flat wells and other monitored sites.

Ecological restoration and enhancement of Waikaraka estuary, Tauranga Harbour (2003)
Wildland Consultants Ltd
Wildland Consultants Ltd

Spatial Information: Waikaraka estuary, Tauranga Harbour, New Zealand
Keywords: Waikaraka estuary, Tauranga Harbour

Summary: The Waikaraka Estuary is situated in the southern basin of Tauranga Harbour, southeast of Te Puna Estuary, near Te Puna. This is a low-energy estuary and is fed by Oturu Creek. Rapid changes in estuary morphology have occurred in recent history. This has been attributed to surrounding land use, particularly horticultural development. The history of the Waikaraka Estuary is virtually identical to that of the Whangamata Harbour. A lot of the restoration work involves the removal of the mangrove weed. The toxic mud that is below all mangroves has now flushed away and has left sand. The snails that form the start of the food chain have returned. Children from the local marae are again able to access their swimming spots. Fish and birdlife have returned.

Tauranga Ecological District Phase 1 Protected Natural Areas Programme (2003)
Wildland Consultants Ltd
Environment Bay of Plenty contract report no. 751

Spatial Information: Bay of Plenty, Kaimai-Mamaku range, Waihi beach, Opotiki, Tauranga Harbour
Keywords: Tauranga Ecological District, Protected Natural Areas Programme

Summary: The Tauranga Ecological District is situated in the western Bay of Plenty, between the eastern foothills of the Kaimai-Mamaku range and the Pacific Ocean, encompassing the western half of the coastal dune systems that stretch between Waihi beach and Opotiki. The district includes three estuarine environments, including the entire expanse of the Tauranga Harbour. The ecological district is largely within the coastal bioclimatic zone, as only small portions of the area extend for more than approximately 1km from the coastal or estuarine environments. Beyond the coastal zone, the rest of the ecological district is in the semi-coastal bioclimatic zone. This report presents a summary of existing information on the physical nature of the Tauranga Ecological District and identifies what is needed to complete a protected natural areas programme survey of the ecological district. Implementation of a PNAP field survey for the Tauranga Ecological District will involve identification of natural areas that maintain the unique indigenous biotic character of the district.

Ecological assessment of a proposed waste water treatment at Maketu (2009)
Wildland Consultants Ltd
Wildland Consultants Ltd

Spatial Information: Arawa Avenue, Maketu, Western Bay of Plenty
Keywords: Western Bay of Plenty District Council, resource consent, discharge treated municipal wastewater, sub-surface irrigation, Maketu

Summary: In December 2009 the Western Bay of Plenty District Council applied for resource consent to discharge treated municipal wastewater to land by way of sub-surface irrigation at Arawa Avenue, Maketu. The applicant also sought resource consent to undertake up to 20,000 m^2 of earthworks at the proposed wastewater treatment plant site.

Indigenous biodiversity of Tauranga district - selection of indicators for State of the Environment monitoring and reporting (2000)
Wildland Consultants Ltd.,
Wildland Consultants Ltd

Spatial Information: Tauranga, New Zealand
Keywords: vegetation maps, Special Ecological Sites, potential restoration sites and corridors, area of indigenous vegetation removed; habitat fragmentation and isolation; land use and development; biodiversity condition and trend; number and distribution of threatened species; area legally protected; pest and weed control

Summary: This report provides detailed vegetation maps, a review of Special Ecological Sites, a review of potential restoration sites and corridors, and analysis of eight biodiversity indicators (area of indigenous vegetation removed; habitat fragmentation and isolation; land use and development; biodiversity condition and trend; number and distribution of threatened species; area legally protected; and location, area, and type of pest and weed control).

Digital mapping of freshwater wetlands in the Bay of Plenty Region - based on the freshwater wetlands database and the regional digital aerial mosaic (2004)
Wildland Consultants Ltd
Environment Bay of Plenty

Spatial Information: Tauranga, New Zealand
Keywords: Wetlands, Bay of Plenty

Summary: Digital mapping of freshwater wetlands in the Bay of Plenty Region - based on the freshwater wetlands database and the regional digital aerial mosaic

Heavy metal and suspended sediment fluxes from a contaminated, intertidal inlet (Manukau Harbour, New Zealand) (1996)
Williamson, R. Bruce; Van Dam, Laurence F.; Bell, Robert G.; Green, Malcolm O.; Kim, Jonathon P.
Marine Pollution Bulletin

Spatial Information: Manukau Harbour, New Zealand
Keywords: Sedimentation, Inorganic Pollutants

Summary: The magnitude of mobilization of Cd, Cu, Fe, Mn, Pb, Zn and suspended particulate matter (SPM) was measured in a 6.5 km^2 contaminated inlet on Manukau Harbour, New Zealand, to assess the importance of this process in the recovery of contaminated sediments from pollution and as a source of secondary pollution to the water column. Mobilization of contaminated surface sediments is the main source of contamination to the water column, and the magnitude of mobilization suggests that this process is very important in contaminant cycling in the inlet sediments. During two surveys, the mass fluxes of SPM and metals were greater during the flood than the ebb tide showing that any mobilized contaminants were largely returned to the inlet, consistent with it acting as a sink for sediments and associated metals. Therefore, pollution recovery by the process of mobilization and dispersal will be slow.

Oceans Management at the Local Level - Research Report for the Oceans Policy Secretariat (2003)
Willis, G.
Enfocus Limited

Spatial Information: New Zealand wide
Keywords: Oceans management, New Zealand, Bay of Plenty, sedimentation, water quality,

Summary: This is a report that presents the results of a survey of 13 local authorities and three DOC conservancies with the intention of identifying the issues facing local government and others at the sub-national level in managing the oceans under existing legislative policy and frameworks. Specifically, identifying barriers and success factors for effective oceans management, in order to assist central government agencies to design an oceans policy that best meets the needs of those operating at sub-national level. Note: Of the local authorities and DOC conservancies surveyed, there was no representation from Taranaki, Manawatu, Canterbury (bar Banks Peninsula), Otago and Northland. The issues most commonly identified by local government were costal water quality (as affected by land based discharges) and coastal erosion. The issues identified by conservatories included threats to marine mammals and human harvest of species/populations. A clear majority (9) rated marine pests as an issue of high potential impact, despite the fact that the majority currently rated the impact of marine pests as low. Other issues that

recognised to have a 'potentially high impact' rating by a clear majority include: sedimentation, loss of natural character/seascape, human harvest and point and non point source pollution. There appears to be little intra- and inter-organisational management when it comes to oceans management. In other words, this research suggests there is no indication that a collective local response based on holistic and collaborative thinking about the oceans and the impacts and pressures on them exists. This may be a reflection of oceans issues seldom rating as high priority by the local authorities interviewed.

Reform of Aquaculture Management - Issues for Regional Councils (2003)
Willis, Gerard; Gunn, Jane;
Enfocus Limited

Spatial Information: New Zealand wide
Keywords: aquaculture, management, New Zealand, aquaculture management areas, AMA, 2004 reform,

Summary: This 'think piece' paper reviews the proposed new (at the time) aquaculture regime with a view to identify the issues facing regional councils and government as they jointly seek to finalise and implement the reform. It is written from the perspective of regional councils. Its purpose is not to purport to offer a comprehensive analysis of problems, nor the solutions to the problems identified, but to stimulate thinking, or rather *rethinking*, of some of the critical elements of the reform. In saying that, it identifies some issues and risks of the new reform and offers some suggestions for reducing those risks. The main purpose of the report is to help resolve the complex policy issues associated with aquaculture: ensuring a strong interest in facilitating economic and social (including Maori) development while maintaining and enhancing environmental quality.

Maori methods and indicators for marine protection. Ngati Kere, Ngati Konohi (2007)
Wilson, C; Freeman, D; Hogan, K; Thompson, K
Ministry for the Environment & Department of Conservation

Spatial Information: Waihau Bay to Taupouri Heads, New Zealand
Keywords: Maori methods & Indicators, marine protection, Ngati Kere, Ngati Konohi

Summary: This report from Ngati Konohi, Department of Conservation (DOC) and Ministry for the Environment (MfE) community research team is the second stage of a pilot study that is being carried out at Whangara and Porangahau in partnership with Ngati Konohi and Ngati Kere respectively (Ngati Konohi et al.2005). This report focuses on the environmental tohu identified by Ngati Konohi as indicators of the health of the marine environment in the rohe moana of Ngati Konohi (Waihau Bay in the north, to Taupouri heads in the south).

Phytoplankton Dynamics (2006)
Wiltshire,K.H.; Boersma,M.; Greve,W.; Reid,P.C.
Unknown Publisher

Spatial Information: No spatial context
Keywords: phytoplankton dynamics

Summary: Phytoplankton are tiny floating plants (algae) that live in the ocean and in lakes. In the process of photosynthesis, phytoplankton produce half of the world's oxygen. Moreover, by primary production, death and sinking they effectively transport carbon from the ocean's surface layer to marine sediments, a process by which phytoplankton exert a global-scale influence on climate (carbon dioxide and the greenhouse effect). Phytoplankton constitute the bottom level of aquatic foodwebs. There are many species of phytoplankton that can be distinguished by their morphology.

Rocky Subtidal Communities (2001)
Witman, JD; Dayton, PK
Sinauer Associates Inc.

Spatial Information: No spatial context
Keywords: subtidal communities

Summary: Descriptions of the distribution and abundance patterns of organisms in subtidal communities play an important role in understanding the organisation of nearshore marine ecosystems. As more hard shore communities are described from different areas of the world, few general patterns of community structure hold over wide geographic scales. Descriptions of subtidal reef communities have been done in most temperate and boreal regions. As for intertidal communities, however, study sites within regions tend to be few in number (Foster 1990). Consequently, it is not generally known whether the variability of assemblages within a geographic region is as great as that between wider areas (e.g. Foster & Schiel 1985, 1988). If the within-region variability is large, it has important consequences for interpreting biogeographic patterns and their putative causative processes.

Diseases and disorders of finfish in cage culture (2002)
Woo, P. T. K.; Bruno, D. W.; Lim, L. H. Susan
CABI Pub.

Spatial Information: No spatial context
Keywords: Fishes Diseases; Cage aquaculture.; Electronic books.

Summary: The primary objective of this book is to produce an authoritative and practical volume on diseases and disorders of finfish in cage culture with the hope that the book will also alert the industry to potential and/or emerging disease problems in specific regions of the world, and to point out gaps in knowledge so as to stimulate further research.

Refuges, disturbance and community structure: marine soft-bottom example (1978)
Woodin, S. A.
Ecology Journal

Spatial Information: No spatial context
Keywords: Community structure; disturbance; marine; polychaetes; refuges; soft bottom; Virginia

Summary: Disturbance is a significant mortality source in many assemblages. The susceptibility of organisms to this mortality source is, in part, a function of the availability of substrate hetero-genetics that act as refuges from the disturbance process. There are at least 5 major categories of temporal and spatial refuges from disturbance; (1) temporal periods outside the activity range of the disturbance process; (2) temporal periods within the activity range of the disturbance process; (3) spatial zones beyond the activity range of the disturbance process; (4) physical heterogeneities within the activity range of the disturbance process; and (5) biologically generated refuges within the activity range of the disturbance process. The last category is particularly interesting because it involves an organism's utilization of a refuge which is the product of another organism or organisms. Data from a marine system are used to demonstrate the effectiveness of several types of refuges, particularly biologically generated refuges. The refuge-forming species is *Diopatra cuprea,* an onuphid polychaete which inhabits shallow water, medium-grained sand flats from Cape Cod to Florida. The abundance and species richness of other members of the infauna are shown to be positively associated with the presence of the tubes of *Diopatra*. This effect is confined to the area immediately surrounding the tubes of *Diopatra*. I demonstrated experimentally that a tube-like structure, such as a plastic straw, has the same effect on the infauna as does the tube of *Diopatra*. Thus, as predicted, the physical and biological refuges affect infaunal abundances similarly. They should not show similar patterns of distribution in space and time however and this is discussed.

Importance of phytoplankton (2010)
Word,K.; Carlowicz,M.; Simmon,R.; Allen,J.; Przyborski,P.; Riebeek,H.; Scott,M.; Griner,C.; Remer,L.
NASA

Spatial Information: No spatial context
Keywords: phytoplankton dynamics

Summary: Phytoplankton are the foundation of the aquatic food web, the primary producers, feeding everything from microscopic, animal-like zooplankton to multi-ton whales. Small fish and invertebrates also graze on the plant-like organisms, and then those smaller animals are eaten by bigger ones. Phytoplankton can also be the harbingers of death or disease. Certain species of phytoplankton produce powerful biotoxins, making them responsible for so-called "red tides," or harmful algal blooms. These toxic blooms can kill marine life and people who eat contaminated seafood. Phytoplankton cause mass mortality in other ways. In the aftermath of a massive bloom, dead phytoplankton sink to the ocean or lake floor. The bacteria that decompose the phytoplankton deplete the oxygen in the water, suffocating animal life and resulting in a dead zone.

Changing the face of the waters the promise and challenge of sustainable aquaculture (2007)
World Bank,
World Bank

Spatial Information: No spatial context
Keywords: Sustainable aquaculture; Aquaculture industry.

Summary: More than half a decade ahead of these projections, aquaculture production has already reached 45 million tons, providing more than 40 percent of the global food fish supply. As production from capture fisheries stagnates, aquaculture is changing the face of our waters.
The objectives of the study are to inform and provide guidance on sustainable aquaculture to decision makers in the international development community and in client countries of international finance institutions. The study focuses on several critical issues and challenges:

- Harnessing the contribution of aquaculture to economic development, including poverty alleviation and wealth creation, to employment and to food security and trade, particularly for least developed countries (LDCs)
- Building environmentally sustainable aquaculture, including the role of aquaculture in the broader suite of environmental management measures
- Creating the enabling conditions for sustainable aquaculture, including the governance, policy, and regulatory frameworks, and identifying the roles of the public and private sectors
- Developing and transferring human and institutional capacity in governance, technologies, and business models with special reference to the application of lessons from Asia to Sub-Saharan Africa and Latin America

Detached chlorophytes as nursery areas for fish in Sulaibikhat Bay, Kuwait (1989)
Wright, J. M.
Estuarine Coastal and Shelf Science

Spatial Information: Overseas - Sulaibikhat Bay, Kuwait
Keywords: nursery grounds; chlorophyta; intertidal environment; Mugilidae; diet; seining; trawling; Arabian Gulf

Summary: This paper describes the role of accumulations of detached chlorophytes as temporary nursery areas for the fish assemblage of Sulaibikhat Bay, Kuwait. The chlorophytes were produced during the spring bloom in the intertidal and near sublittoral. The accumulations in the shallow near shore areas were at a peak during early March. During this time young of *Liza carinata* dominated the assemblage in shallow water and these fish were closely associated with the patches of detached chlorophytes, using them as a physical refuge and as a temporary food resource. In deeper water the catches were dominated by mature *Leiognathus brevirostris*, the numbers of which were related to the volume of weed at the beginning of the bloom but not toward the end of the bloom. Although *L. brevirostris* appeared not to use the weed as a refuge, this species utilized the weed as a temporary food resource. During the study there was no evidence of weed-associated amphipods being utilized as a food resource.

Editorial for special issue on shifting paradigms on assessment of recreational water quality (2010)
Wuertez, S.; Reis, M,
Water Research

Spatial Information: No spatial context

Keywords: water quality, monitoring, faecal indicator bacteria, recreation, microbial risk assessment, method, molecular,

Summary: This is the editorial front for this special edition of Water Research. It discusses the reliability of faecal indicator bacteria (FIB) as indicators of recreational and drinking water quality and why it has come under scrunity. All articles in this special edition add to the ongoing scientific debate about the future of monitoring guidelines and some suggest what they consider more applicable and reliable alternatives. Thus, this whole edition of Water Research would be beneficial to our State of the Harbour report. Additionally, previous special editions of Water Research that discuss how to identify sources of faecal pollution (2007) and how new molecular methods compare with traditional microbial indicator methods (2009) would add depth to our Report.

Cetacean Migration through the Bay of Plenty (1996)
Wullings, M.
Bay of Plenty Polytechnic Report no. 59

Spatial Information: Bay of Plenty, New Zealand
Keywords: Cetacean Migration

Summary: This report encompasses a small portion of a Cetaceans life, it includes all cetacean sightings ever recorded in the Bay of Plenty area, and a number of sightings recorded in the northern region of the North Island. This data can be reviewed in spreadsheet format and on yearly location maps of where the great whales/orca were sighted in the Bay of Plenty. Also included is an analysis of the data, as well as recommendations for changes in the data collection process to make it more accurate and usable for analysis and research purposes.

Aquaculture Project: *Atrina zealandica* (horse mussel) - is it a viable product? (1996)
Wullings, M.; Reid, B.
Bay of Plenty Polytechnic Report no. 41

Spatial Information: pilot bay and south west end of Rangiwaea Island
Keywords: Aquaculture

Summary: This outstanding piece of literature encompasses the unique and unexplored world of the *Atrina zealandica* (Horse Mussel). Within this text the *A.zealandica*'s habitats around the Bay of Plenty Region have been identified. Two sites in the Tauranga Harbour were surveyed to obtain species age size and density in relation to their stratification/distribution. Also included in this text is the most viable method of harvesting/farming this particular species of mussel, the potential markets for this species and permits required for farming/harvesting.

Dusky Dolphins (*Lagenorhynchus obscurus*) off New Zealand: Status of Present Knowledge (1997)
Wursig,B.; Cipriano,F.; Slooten,E.; Constantine, R; Barr,K.; Yin,S.
International Whaling Commission

Spatial Information: New Zealand

Keywords: dolphins and whales

Summary: Whilst this study documented the worldwide distribution of dusky dolphins, it focused on the status of present knowledge of this species off New Zealand, with several case studies presenting knowledge covering many aspects of these animals. One of the case studies was on dusky dolphins of Kaikoura, which present knowledge on their occurrence patterns, group size, foraging behaviour and life history. This study collated information on human-dolphin interactions, emphasising the effect of whale and dolphin watching and swim-with-dolphin operations on dusky dolphins. In addition, the case study documented dusky dolphin's association with the common dolphin in Kaikoura. Genetic analyses indicate that the genus *Lagenorhynchus* is more diverse in morphology than had been believed, and this genus is likely a paraphyletic assemblage of species in need of taxonomic revision. The study also pointed out future research need for this species, for example, population definition and size, bycatch issue, human tourism effects and threat from bioaccumulation of pollutants.

3.24. X, Y, Z

Rock lobster management in New Zealand: the development of devolved governance (2008)
Yandle,T.
Fisheries Technical Paper No. 504

Spatial Information: New Zealand
Keywords: macroinvertebrates

Summary: A critical issue for fisheries management is why devolved governance arrangements develop and how the characteristics of the devolved governance organisation influence its success. Competing theories also seek to explain why devolved governance (self-management or co-management) organisations exist. A large portion of the co-management literature argues that these shared management regimes grow from long lived community-based regimes. Closely linked are the concepts of social capital and civic engagement. However, it is also argued that the devolved governance arrangements can develop out of strong property rights regimes that provide incentives to take on co-management or self-management responsibilities. Management of New Zealand rock lobster (*Jasus edwardsii* and *Jasus verreauxi*) provides an important example for understanding these issues. Because of the rock lobster's history as a set of localised fisheries, an extensive history of local and national cooperation existed prior to the introduction of individual transferable quotas (ITQs) into rock lobster management in the 1980s. However, ITQs and their associated property rights created an incentive structure that encouraged the development of strong regional and national organizations, which work with the New Zealand government to co-manage the lobster fisheries. This case shows a combination of industry activity (at the local and national level) and strengthening property rights as the key to the development of devolved governance in the New Zealand rock lobster industry.

Coastal hazard risk indicators (2003)
Young Cooper, A; Stewart, C

Hill Young Cooper

Spatial Information: No spatial context
Keywords: Climate change

Summary: The purpose of this project is to recommend the most appropriate means of monitoring changes in the total physical risk of coastal hazards in the Bay of Plenty Region. This will be achieved by:

- Agreeing a working definition of total physical risk from coastal hazards;
- Describing the potential measures of changes in this risk;
- Identifying current monitoring or information gathered by councils which relate to these potential measures of risk;
- Identifying other methods which may be readily utilised by councils which relate to these potential measures of risk;
- Evaluating the methods as to their effectiveness in measuring changes in risk over time;
- Recommending the most appropriate means of measuring total physical risk including implementation issues;
- Addressing methods by which effectiveness of the policy in fulfilling the Council's duties in managing coastal hazards under the Resource Management Act can be measured.

The focus of this project is on indicators to monitor the effectiveness of risk management on the landward side of the coastal environment. While it is important to understand and provide information on the nature of the hazards, and the monitoring that EBOP is carrying out on coastal processes, this is not the subject of this project. Rather, it is to better understand subdivision and development processes in areas subject to coastal hazards and how the increased potential for risk associated with increasing development is being managed. The project must identify relevant and useful indicators associated with this development (and other public estate development), which can provide measures of risk and whether it is increasing or decreasing.

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