Cawthron Report No. 1034

CAWTHRON

Broad Scale Habitat Mapping of the Coastline of the Hawke's Bay Region

Prepared for

Hawke's Bay Regional Council

June 2005

EMT 05/02
HBRC Plan No 3745

Broad Scale Habitat Mapping of the Coastline of the Hawke's Bay Region

Prepared for

Hawke's Bay Regional Council

by

Leigh Stevens
and Barry Robertson

Cawthron Institute
98 Halifax Street East
Private Bag 2
NELSON
NEW ZEALAND

Phone: +64.3.548.2319
Fax: +64.3.546.9464
Email: info@cawthron.org.nz

Cover photo: Coastline north of Kairakau Beach – Cawthron Institute

EXECUTIVE SUMMARY

Hawke's Bay Regional Council (HBRC) contracted the Cawthron Institute to map the broad scale habitat features of the regional coastline extending approximately 13km south of Porangahau to approximately 5 km north of Mahanga Beach, and including Mahia Peninsula and the coastal areas around Napier (total distance 350km). The purpose of the mapping was to characterise the type and extent of broad-scale habitat features along the coastline between low tide, and the clearest terrestrial delineation point or landscape feature. The information collected is designed specifically for use within a GIS platform and this report presents a summary of information and examples of the outputs generated from the accompanying GIS files.

The approach is based on the National Estuary Monitoring Protocol (Robertson *et al.* 2002) which uses field-verified broad scale mapping of habitat zones to provide a systematic classification of different areas in terms of the dominant vegetation and substrate present. The areas mapped along the HBRC coastline include all intertidal areas, a 20m habitat margin above high water, and a general picture of the surrounding land use and habitat types present adjacent to the coast. These are presented as a series of labelled features within the GIS.

Overall, habitat features reflected the geomorphology of the region with gravel located primarily between Te Awanga and Tangoio Bluff, cliffs were common between Cape Kidnappers and Cape Turnagain, on the west coast of Mahia Peninsula, and north of Mahanga Beach; while sand and duneland were most common around Porangahau, Waimarama, Mohaka, and Wairoa.

Across the entire coastline, intertidal habitat was characterised by 48% firm sand, 35% rock field, 8% gravel field, 7% boulder field, and 2% a mixture of cliff, cobble field, and man-made boulder field. Vegetation was not a dominant cover in intertidal areas. While gravel beaches dominate the coastline around Napier and perhaps give the impression that the entire coastline is like this, firm sand and rock field were by far the most common habitat (83%) across the region. Within the habitat margin, the most common features were cliff (35%), followed by duneland (22%), sand (13%), gravel (10%), grassland (9%), and boulder field (8%).

The vast majority of the land adjacent to the HBRC coastline has been modified from its natural state. In particular, very little native forest cover remains, with most of the region converted to pastoral farming or, to a lesser extent, forestry. While extensive dunes still remain in some areas,

many of these have been significantly modified, for example through grazing, forestry, housing, industry, roading, flood control, erosion protection.

During the mapping, observations were made on environmental pressures that were evident such as the location of industrial areas, man-made constructions etc. and these have been included within the GIS as annotated notes or features. In this report, examples are given of how identified pressures and existing knowledge can be used within a risk assessment framework to provide a starting point for helping decide whether further investigation is justified, and if so, where the priorities may lie.

Another important facet of the current project was to look at potential sites for fine-scale biological State of the Environment (SOE) monitoring across the region. Some important components of SOE monitoring are that it should indicate the general health and measure changes in the environment, should include representative habitats, collect meaningful data, and enable point source monitoring results to be considered in a broader context. While obviously the specific purpose of any monitoring programme would need to be defined before specific sites are proposed, appropriate sites are available across the entire region in sandy substrates, and rocky platform areas. Gravel beaches are not considered appropriate for biological SOE monitoring.

Overall, the primary benefits of the information collected during this work are to:

1. Help end users better understand the ecological status of the region and the impacts of human activities.
2. Assess environmental quality (*e.g.* the extent of sensitive/rare habitat types).
3. Select appropriate monitoring locations.
4. Develop effective management strategies.
5. Provide a regional, and contribute to a national, context of disturbance impacts.
6. Facilitate the assessment of the significance of potential impacts.

The work completed for HBRC will provide a valuable foundation by defining the existing habitat types of the region, identifying how many such areas remain undeveloped, where they are located, what the environmental values of the undeveloped areas are, and providing an understanding of what features are susceptible to different pressures and whether development may adversely or irreversibly affect the area, thereby providing a solid underpinning context for planning and management decisions (including decisions to collect more information).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX

Reviewed and approved for release by:
Dr Barry Robertson, Manager – Coastal and Estuarine

1. INTRODUCTION

Hawke's Bay Regional Council (HBRC) contracted the Cawthron Institute to map the broad scale habitat features of the regional coastline extending approximately 13km south of Porangahau to approximately 5 km north of Mahanga Beach, and including Mahia Peninsula and the coastal areas around Napier (total distance 350km). The purpose of the mapping was to characterise the type and extent of broad-scale habitat features along the coastline between low tide and the clearest delineation point or dominant landscape feature determined by Cawthron in the field. The information generated is intended to assist HBRC in strategic planning, and in the management of specific issues associated with resource consents, pollution, and state of the environment monitoring.

The approach used is based on the National Estuary Monitoring Protocol (Robertson *et al.* 2002) which uses field-verified broad scale mapping of habitat zones to provide a systematic classification of different areas in terms of the dominant vegetation and substrate present. This approach is a rapid and cost effective way to summarise the extent and type of different features. Once a baseline map has been constructed, habitat information can be used to indicate the potential sensitivity of different areas to pressures such as human development, vehicle use, stormwater discharges, *etc*. or to identify areas where further information may be needed to improve resource management.

The mapping also provides a template whereby changes in the position and/or size of habitats (MfE Confirmed Indicators for the Marine Environment, ME6, 2001) can be assessed by repeating the mapping exercise, or comparing it to historical data (usually aerial photographs). This information can then be used to evaluate the implications of natural and human induced changes (and ultimately land use characteristics and related water and sediment quality) on the structure and function of the coastal ecosystem.

The information collected is designed specifically for use within a GIS platform which provides an open and flexible way of using the data to meet management needs as appropriate. HBRC already have a well developed GIS system, and the outputs of this project have been provided as GIS features that will directly integrate with this system. This allows the coastline to be viewed at any scale, and enables other relevant data to be linked to each site of interest using GIS layers or an underlying database as appropriate. This hard copy report provides examples of the type of information that can be generated for representative sites to indicate what is contained within the supplied GIS data layers, and describes the methodology and results of the 2005 broad-scale habitat mapping of the HBRC coastline (Figure 1).

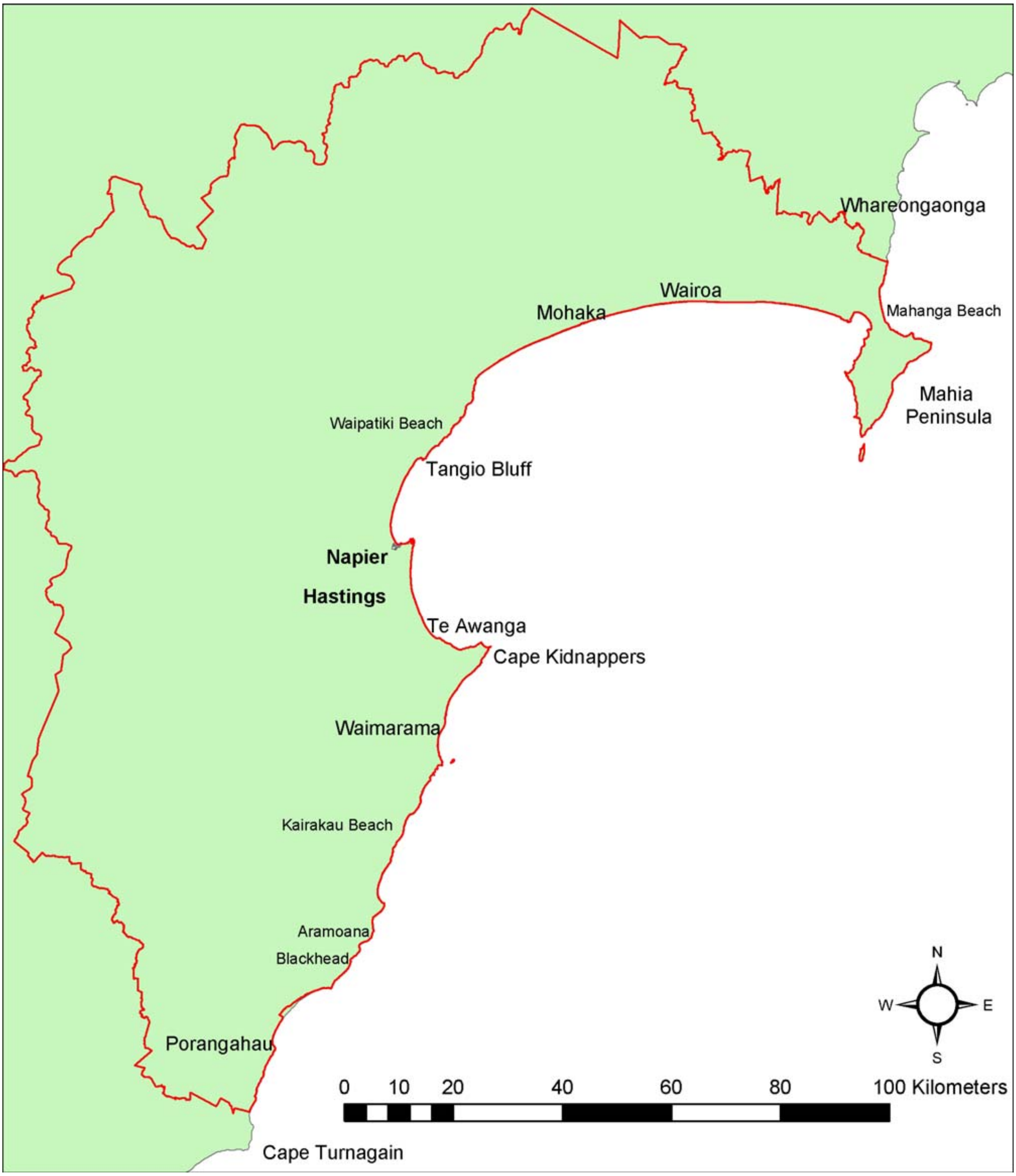

Figure 1 Extent of mapping along the Hawke's Bay Regional Council coastal boundary and location of key areas.

2. BROAD-SCALE HABITAT MAPPING

The aim of the broad-scale habitat mapping is to describe dominant habitat types based on surface features of substrate characteristics (mud, sand, cobble, rock, *etc*) and vegetation type (salt marsh, grassland, coastal plant species, *etc*), in order to develop a baseline map. The procedure, originally developed for use in estuaries (Robertson *et al.* 2002), was recently modified and successfully applied to sections of the coastline around Wellington (Stevens and Robertson 2004). For this project, methods were further modified to account for the long length of the HBRC coastline that needed be mapped (350 km in total), the limited public road access to many areas, and the significant travel time required to gain access to the coast. Very generally, the approach uses aerial photography together with detailed ground-truthing and digital mapping using GIS technology to record the primary habitat features present. The specific methods used are detailed in the following sections.

2.1 Ground-truthing and digitisation of habitat features

Mapping of the coastline was undertaken by experienced coastal scientists identifying the dominant habitat and substrate types and their spatial extents in the field from foot, boat or car at low-mid tide. Identified features were recorded directly on aerial photos at a scale of 1:5,000 or 1:10,000 (*e.g.* Figure 2).

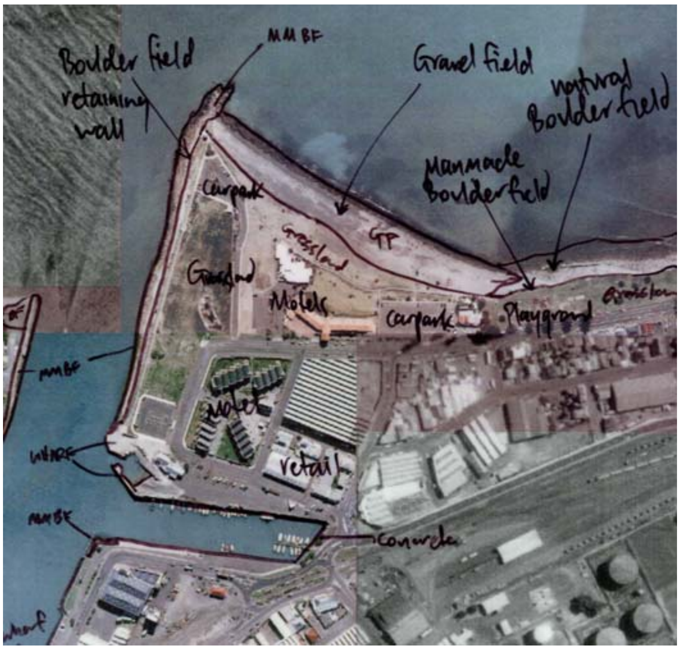

Figure 2 Example of field sheet showing habitat classification on an aerial photo.

For this project, the area mapped included the intertidal zone between mean low and mean high water spring (MLWS and MHWS). A 20m wide strip immediately above MHWS was also mapped to allow the consistent characterisation of the habitat margin adjacent to intertidal beach areas along the entire coastline, and the substrate and vegetation inland of the intertidal habitat margin buffering the beach was mapped to the nearest clear delineation point *e.g.* dunes, roads, manmade seawalls, or ridgelines, to indicate the surrounding features present.

The scale of image shown in Figure 3 (1:5000) is normally used in the field to identify and ground truth habitat types, with the GIS framework used to zoom in on photos to trace around the habitat features using digital mapping tools. Figure 4 shows how it is possible to clearly see different features like sand, boulders, cliffs, grass, and dunes with a high resolution colour photo, enabling accurate maps to be drawn. The better the quality of photos available, the more accurate mapping is.

Along the southern coast between Cape Turnagain and Te Awanga, most of the area was mapped from a boat, supported by on-foot ground-truthing where road access was available. The area between Te Awanga and Tangoio Bluff was directly ground-truthed where public roads provided access. Between Tangoio Bluff and Wairoa, public and private road access was used where available, and local knowledge was also sought on sections of the coast where direct access was not possible. A similar approach was used for Mahia Peninsula and the coast north of Mahanga Beach where coastal access was very limited and weather conditions prevented mapping by boat. Wherever local knowledge was relied on to map coastal features, representative sections of the coastline were directly ground-truthed to verify local estimates and ensure classification was consistent. Overall, local knowledge was found to provide reliable information adequate for the current mapping purposes.

2.2 Classification and definitions of habitat types

The substrate and vegetation classification used to define habitat features is listed in Table 1. Note that Table 1 includes a broader range of habitats than found in Hawke's Bay. Classification is based on surface layers only and does not consider underlying substrate; *e.g.* cobble or gravel fields covered by sand would be classed as sand flat. Where possible, features >2m∅ have been mapped. However, the accuracy of the mapping is directly proportional to the quality and age of the photos available to delineate and identify habitat features. Recently flown high resolution (1 metre per pixel or better) colour photos taken at low tide allow features >2m∅ to be distinguished and digitised. Where photo resolution exceeds 1m per pixel, features become distorted and harder to delineate, and mapping accuracy is consequently reduced. Colour photos enable features to be more easily discriminated than black and white images, particularly for different types of vegetation.

Table 1 Classification Definitions for Structural Habitat Classes.

Forest: Woody vegetation in which the cover of trees and shrubs in the canopy is >80% and in which tree cover exceeds that of shrubs. Trees are woody plants ⩾10 cm dbh. Tree ferns ⩾10cm dbh are treated as trees.
Treeland: Cover of trees in canopy 20-80%. Trees are woody plants >10cm dbh.
Scrub: Woody vegetation in which the cover of shrubs and trees in the canopy is > 80% and in which shrub cover exceeds that of trees (c.f. FOREST). Shrubs are woody plants <10 cm diameter at breast height (dbh).
Shrubland: Cover of shrubs in canopy 20-80%. Shrubs are woody plants <10 cm diameter at breast height (dbh).
Tussockland: Vegetation in which the cover of tussock in the canopy is 20-100% and in which the tussock cover exceeds that of any other growth form or bare ground. Tussock includes all grasses, sedges, rushes, and other herbaceous plants with linear leaves (or linear non-woody stems) that are densely clumped and >100 cm height. Examples of the growth form occur in all species of Cortaderia, Gahnia, and Phormium, and in some species of Chionochloa, Poa, Festuca, Rytidosperma, Cyperus, Carex, Uncinia, Juncus, Astelia, Aciphylla, and Celmisia.
Duneland: Vegetated sand dunes in which the cover of vegetation in the canopy (commonly Spinifex, Pingao or Marram grass) is 20-100% and in which the vegetation cover exceeds that of any other growth form or bare ground.
Grassland: Vegetation in which the cover of grass in the canopy is 20-100%, and in which the grass cover exceeds that of any other growth form or bare ground. Tussock-grasses are excluded from the grass growth-form.
Sedgeland: Vegetation in which the cover of sedges in the canopy is 20-100% and in which the sedge cover exceeds that of any other growth form or bare ground. "Sedges have edges." Sedges vary from grass by feeling the stem. If the stem is flat or rounded, it's probably a grass or a reed, if the stem is clearly triangular, it's a sedge. Sedges include many species of Carex, Uncinia, and Scirpus. Tussock-sedges and reed-forming sedges (c.f. REEDLAND) are excluded.
Rushland: Vegetation in which the cover of rushes in the canopy is 20-100% and in which the rush cover exceeds that of any other growth form or bare ground. A tall grasslike, often hollow-stemmed plant, included in the rush growth form are some species of Juncus and all species of, Leptocarpus. Tussock-rushes are excluded.
Reedland: Vegetation in which the cover of reeds in the canopy is 20-100% and in which the reed cover exceeds that of any other growth form or open water. If the reed is broken the stem is both round and hollow – somewhat like a soda straw. The flowers will each bear six tiny petal-like structures – neither grasses nor sedges will bear flowers, which look like that. Reeds are herbaceous plants growing in standing or slowly-running water that have tall, slender, erect, unbranched leaves or culms that are either hollow or have a very spongy pith. Examples include Typha, Bolboschoenus, Scirpus lacutris, Eleocharis sphacelata, and Baumea articulata.
Cushionfield: Vegetation in which the cover of cushion plants in the canopy is 20-100% and in which the cushion-plant cover exceeds that of any other growth form or bare ground. Cushion plants include herbaceous, semi-woody and woody plants with short densely packed branches and closely spaced leaves that together form dense hemispherical cushions.
Herbfield: Vegetation in which the cover of herbs in the canopy is 20-100% and in which the herb cover exceeds that of any other growth form or bare ground. Herbs include all herbaceous and low-growing semi-woody plants that are not separated as ferns, tussocks, grasses, sedges, rushes, reeds, cushion plants, mosses or lichens.
Lichenfield: Vegetation in which the cover of lichens in the canopy is 20-100% and in which the lichen cover exceeds that of any other growth form or bare ground.
Seagrass meadows: Seagrasses are the sole marine representatives of the Angiospermae. They all belong to the order Helobiae, in two families: Potamogetonaceae and Hydrocharitaceae. Although they may occasionally be exposed to the air, they are predominantly submerged, and their flowers are usually pollinated underwater. A notable feature of all seagrass plants is the extensive underground root/rhizome system which anchors them to their substrate. Seagrasses are commonly found in shallow coastal marine locations, salt-marshes and estuaries.
Macroalgal bed: Algae are relatively simple plants that live in freshwater or saltwater environments. In the marine environment, they are often called seaweeds. Although they contain cholorophyll, they differ from many other plants by their lack of vascular tissues (roots, stems, and leaves). Many familiar algae fall into three major divisions: Chlorophyta (green algae), Rhodophyta (red algae), and Phaeophyta (brown algae). Macroalgae are algae observable without using a microscope.
Firm mud/sand: A mixture of mud and sand, the surface appears brown, and many have a black anaerobic layer below. When walking on the substrate you'll sink 0-2 cm.
Soft mud/sand: A mixture of mud and sand, the surface appears brown, and many have a black anaerobic layer below. When walking on the substrate you'll sink 2-5 cm.
Very soft mud/sand: A mixture of mud and sand, the surface appears brown, and many have a black anaerobic layer below. When walking on the substrate you'll sink greater than 5 cm.
Mobile sand: The substrate is clearly recognised by the granular beach sand appearance and the often rippled surface layer. Mobile sand is continually being moved by strong tidal or wind-generated currents and often forms bars and beaches. When walking on the substrate you'll sink less than 1 cm.
Firm sand: Firm sand flats may be mud-like in appearance but are granular when rubbed between the fingers, and solid enough to support an adult's weight without sinking more than 1-2 cm. Firm sand may have a thin layer of silt on the surface making identification from a distance impossible.
Soft sand: Substrate containing greater than 99% sand. When walking on the substrate you'll sink greater than 2 cm.
Stone field/Gravel field: Land in which the area of unconsolidated gravel (2-20 mm diameter) and/or bare stones (20-200 mm diam.) exceeds the area covered by any one class of plant growth-form. Stonefields and gravelfields are named based on which form has the greater ground cover. They are named from the leading plant species when plant cover of (1%.
Cobble field: Land in which the area of unconsolidated cobbles/stones (20-200 mm diam.) exceeds the area covered by any one class of plant growth-form. Cobble fields are named from the leading plant species when plant cover of ≥1%.
Boulder field: Land in which the area of unconsolidated bare boulders (> 200mm diam.) exceeds the area covered by any one class of plant growth-form. Boulderfields are named from the leading plant species when plant cover is ≥1%.
Rock/Rock field: Land in which the area of residual bare rock exceeds the area covered by any one class of plant growth-form. Cliff vegetation often includes rocklands. They are named from the leading plant species when plant cover is ≥1%.
Artificial structures: Introduced natural or man-made materials that modify the environment. Includes rip-rap, rock walls, wharf piles, bridge supports, walkways, boat ramps, sand replenishment, groynes, flood control banks, stopgates.
Cockle bed: Area that is dominated by primarily dead cockle shells.
Mussel reef: Area that is dominated by one or more mussel species.
Oyster reef: Area that is dominated by one or more oysters species.
Sabellid field: Area that is dominated by raised beds of sabellid polychaete tubes.

For this project, HBRC supplied a range of different resolution colour and black and white aerial photos of varying ages. For most of the coastline, 2.5 metre per pixel black and white photos were available. These allow shape files to be drawn to an accuracy of approximately ±10 m with a scale of approximately 1:5000 needed on screen to see the image clearly (Figure 3, photo A). Between Te Awanga and Tangoio Bluff (the most developed parts of the region) 2.5 metre per pixel colour photos (Figure 3, photo C) and 1.25 metre per pixel black and white photos (Figure 3, photo D) were available. For Mahia Peninsula a 1.5 metre per pixel black and white photo was available (Figure 3, photo B), although parts of the coastline were missing from the image.

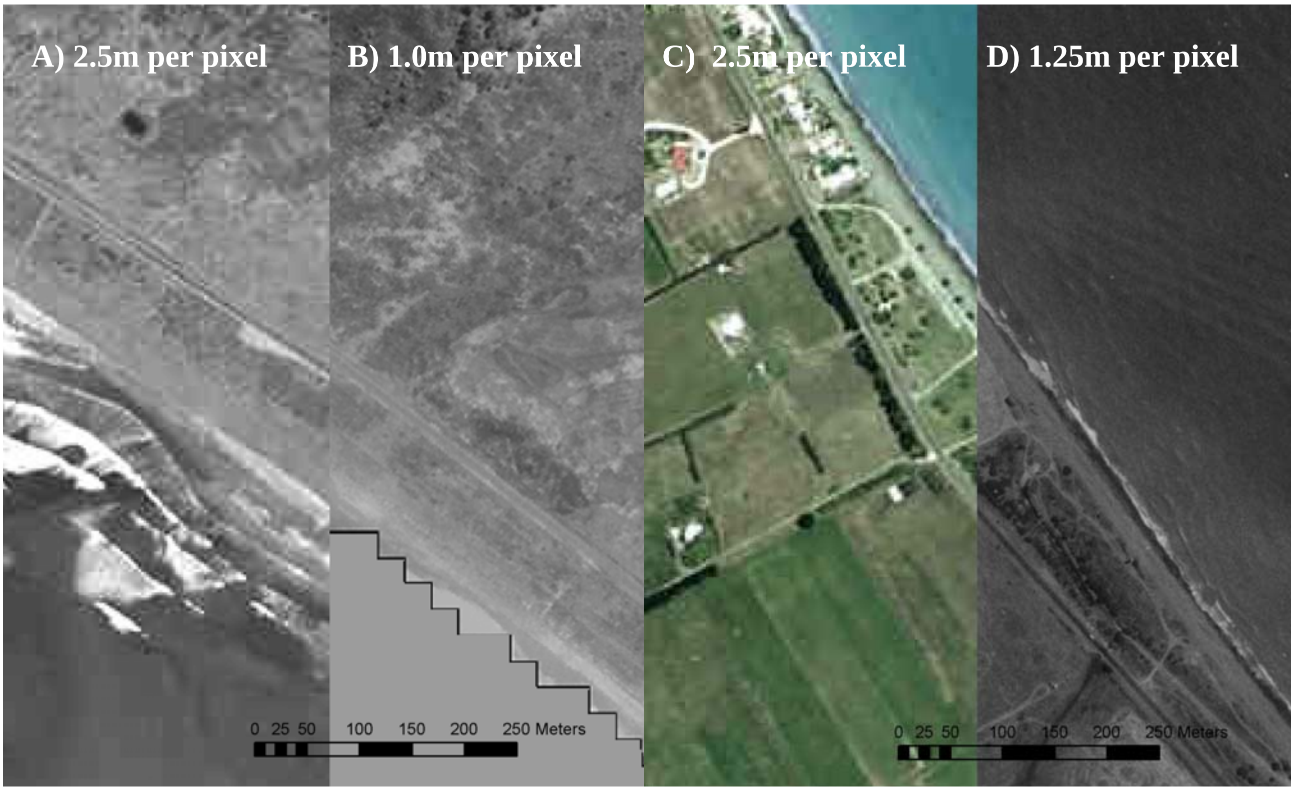

Figure 3 Examples of the differences in quality of different resolution photos used to map the HBRC coastline (scale 1:5000).

No photos were available of the coastline north of Mahanga Beach other than Mahanga Beach itself which had high resolution (20 cm per pixel) colour photos (Figure 4). To assist in mapping areas outside the coverage of the photos, NZMS 260 series topographical maps were used. For all photos, the tidal height at the time the photos were taken was unknown so the MLWS boundary has had to be estimated based on a combination of field observations, local knowledge, and extrapolation from coastal features. As such, the intertidal area mapped is not exact.

Figure 4 Example of the ability to discriminate between different habitat features with high quality aerial photos (scale 1:1000).

2.2.1 Classification of vegetation

Vegetation provides an important buffer between the land and the sea, influencing the visual character of an area, and playing an important role in dune stability, mitigation of contaminant inputs, erosion protection, and the provision of wildlife habitat. Due to its important role we have classified the vegetation present based on its structural class *e.g.* native and exotic forest, native and exotic scrub/shrub/trees, tussockland, grassland.

The criterion for inclusion was dominant vegetation that was visually obvious both in the field, and on the aerial photographs. Because of variable access to areas, and the need to complete the mapping of the coastline within the budgeted time available, it was not possible to provide a definitive list of plant species, nor a consistent coverage of the species present along the entire coastline. In particular, it was impossible to determine the range of plant species present on cliff areas when mapping from the water, while listing more than one or two key species within broad vegetation categories would have made sampling prohibitively slow. In Section 3 we have therefore provided a list of representative species included in the structural class definitions used. Wherever detail on specific vegetation was collected, it has been included in annotated notes within the GIS.

In recording the data we have used an interpretation of the Atkinson (1985) system, whereby dominant plant species are coded by using the two first letters of their Latin species and genus names *e.g.* marram grass, *Ammophila arenaria*, is coded as Amar. An indication of dominance is provided by the use of ( ) to distinguish subdominant species *e.g.* Amar(Caed) indicates that marram grass is dominant over ice plant (*Carpobrotus edulis*). The use of ( ) is not based on percentage cover but the subjective observation of which vegetation is the dominant or subdominant species within the patch. In this study, vegetation was not specifically classified based on height, although a measure of this can be derived from its structural class. Where relevant, the presence of invasive weeds and exotic vegetation has also been noted, although in many cases invasive weeds were present in patches <2m∅.

Table 2 Summary of coastal vegetation recorded during mapping.

Code		Species	Common Name	Code		Species	Common Name
		Scrub/Shrub/Tree				**Grassland/Duneland**	
Arhe	E	*Araucaria heterophylla*	Norfolk pine	Amar	E	*Ammophila arenaria*	Marram grass
Chmo	E	*Chrysantemoides monilifera*	Boneseed	Spse	N	*Spinifex sericeus*	Spinifex
Coau	N	*Cordyline australis*	Cabbage tree	Pecl	E	*Pennisetum clandestinum*	Kikuyu grass
Core	N	*Coprosma repens*	Taupata			**Reedland**	
Cuma	E	*Cupressus macrocarpa*	Macrocarpa	Tyor	N	*Typha orientalis*	Raupo
Luar	E	*Lupinus arboreus*	Tree lupin			**Rushland**	
Lyfe	E	*Lycium ferocissimum*	Boxthorn	Isno	N	*Isolepis nodosa*	Knobby clubrush
Meex	N	*Metrosideros excelsa*	Pohutukawa			**Herbfield**	
Muco	N	*Muehllenbeckia complexa*	Small-leaved pohuehue	Arst	E	*Arctotis stoechadifolia*	Yellow daisy
Myla	N	*Myoporum laetum*	Ngaio	Caed	E	*Carpobrotus edulis*	Ice plant
Ozle	N	*Ozothamnus leptophyllus*	Tauhinu, cassinia	Case	E	*Calystegia sepium*	Pink bindweed
Pira	E	*Pinus radiata*	Pine tree	Loma	E	*Lobularia maritima*	Sweet alyssum
Ptes	N	*Pteridium esculentum*	Bracken fern	Osfr	E	*Osteospermum fruticosum*	Trailing African daisy
Safr	E	*Salix fragilis*	Crack willow	Roru	E	*Rosa rubiginosa*	Sweet briar
Uleu	E	*Ulex europeus*	Gorse	Seel	E	*Senecio elegans*	Purple groundsel
		Tussockland		Segl	E	*Senecio glastifolius*	Holly-leaved senecio
Cofu	N	*Cortaderia fulvida*	Toitoi	Tasp	E	*Tagetes* spp.	Marigolds
Cose	E	*Cortaderia selloana*	Pampas grass			**Introduced weeds**	
Cosp	N	*Cortaderia* sp.	Toetoe	Inwe		Introduced weeds	Unidentified weeds
Phte	N	*Phormium tenax*	Flax, Harakeke				

N=Native, E=Exotic

3. RESULTS AND DISCUSSION

3.1 Overview

A general overview of results is presented and discussed below, with broad scale maps of the entire coastline included in Appendix 1, and in the GIS files that accompany this report. It is intended that the outputs of this project will be used predominantly within the GIS framework. Therefore, this report is intended to provide only a general overview of the information and data contained within the GIS.

Table 3 summarises the substrate and vegetation data for the HBRC coastline including all intertidal areas, the 20m habitat margin above high water, and terrestrial areas that were mapped. Intertidal and habitat margin areas are shown in Figures 5 and 6.

Table 3 Summary of the area (Ha) of substrate and vegetation mapped on the HBRC coastline.

Location	Terrestrial		Habitat margin		Intertidal	
Habitat Type	Ha	%	Ha	%	Ha	%
Native forest	2.6	0.04				
Exotic forest	636.7	10.9				
Native scrub/shrub/trees	38.7	0.7	1.8	0.3		
Exotic scrub/shrub/trees	1.3	0.02				
Tussockland	13.2	0.2	0.6	0.1		
Grassland	1796.1	30.6	64.6	9.2		
Duneland	615.4	10.5	151.2	21.5		
Rushland	34.5	0.6				
Herbfield	42.3	0.7	0.8	0.1		
Industrial	59.3	1.0	9.0	1.3		
Residential	358.5	6.1				
Cliff	2136.8	36.4	247.14	35.1	35.9	1.0
Rockfield			0.9	0.1	1256.2	34.9
Boulder field			56.6	8.0	247.6	6.9
Boulder Field man-made	0.08	0.001			8.6	0.2
Cobble field			0.9	0.1	2.0	0.1
Gravel field	50.95	0.9	73.0	10.4	289.6	8.0
Firm sand	76.84	1.3	92.5	13.1	1741.9	48.4
Water	4.43	0.1	4.9	0.7	16.7	0.5
Total	**5867.8**		**704.1**		**3598.6**	

Within the intertidal area, 48% of the coastline was classified as firm sand, 35% rock field, 8% gravel field, 7% boulder field, with the remaining 2% a mixture of cliff, cobble field, man-made boulder field, and water. Vegetation was not a dominant cover in intertidal areas.

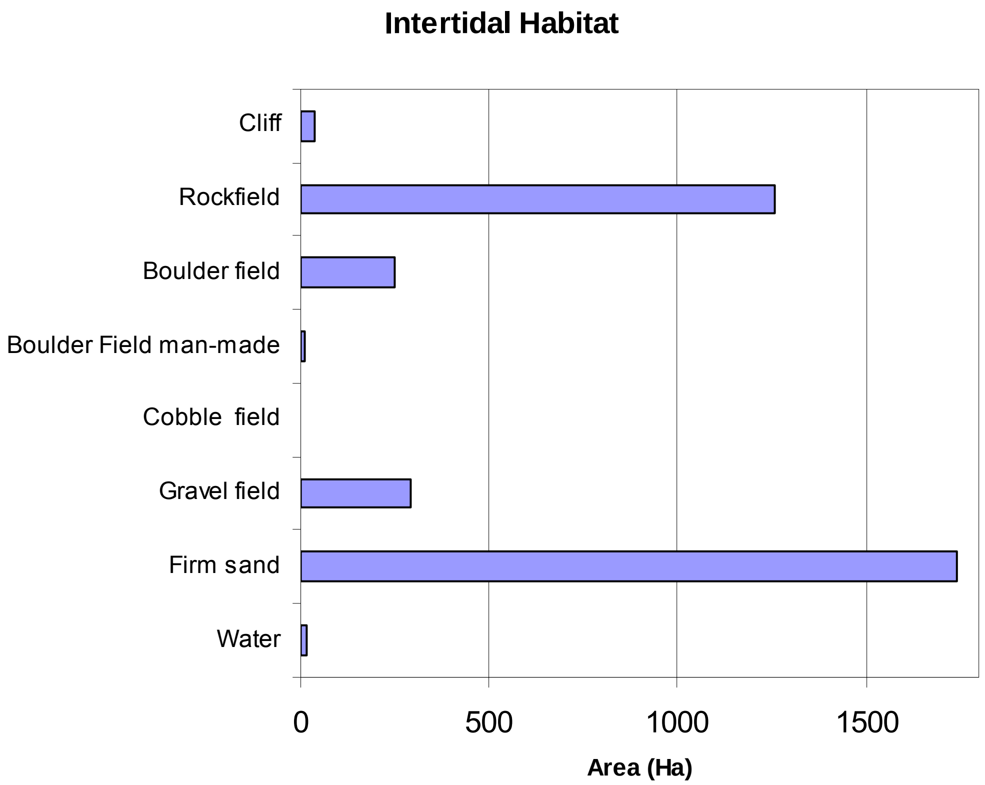

Figure 5 Area (Ha) of intertidal habitat features mapped in the HBRC region.

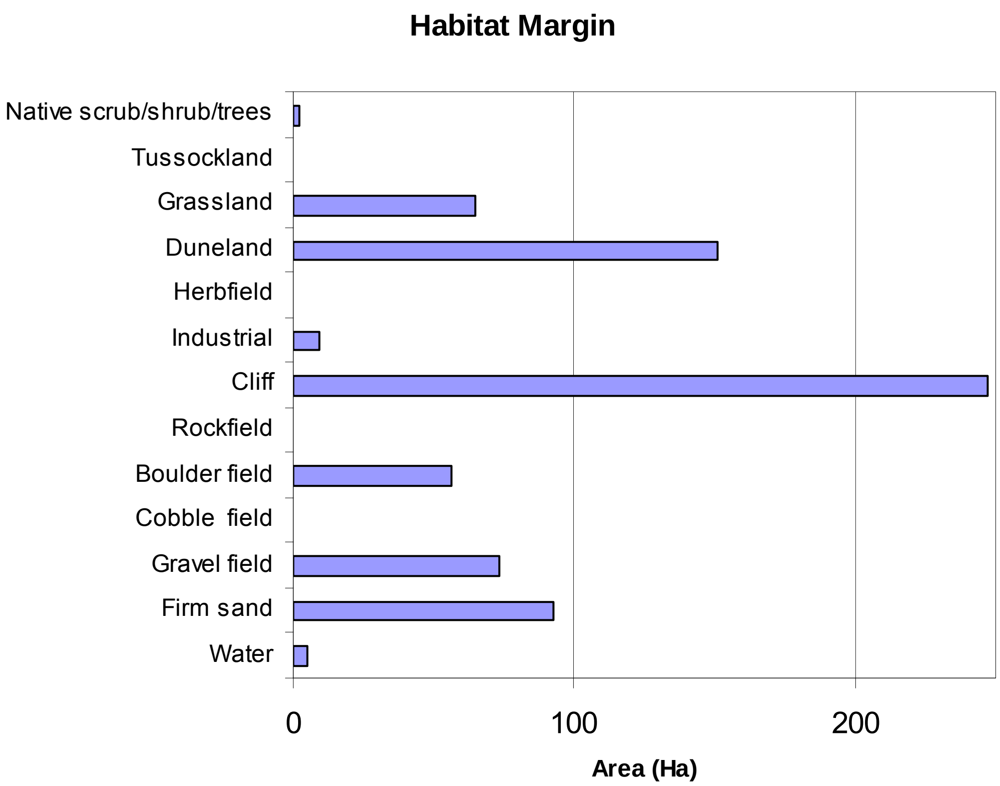

Figure 6 Area (Ha) of habitat margin features mapped in the HBRC region.

Within the habitat margin, the most common features were cliff (35%), followed by duneland (22%), sand (13%), gravel (10%), grassland (9%), and boulder field (8%). In many instances where the habitat margin was sand or gravel, duneland was also present further up the beach but outside the 20m strip adjacent to MHWS that was used as an arbitrary classification boundary. As such, the 22% listed for duneland within the habit margin underestimates the actual extent of duneland along the coast. This duneland (and other features) inland of the defined 20m habitat margin have been included in the mapping of terrestrial areas.

Features were distributed reflecting the geomorphology of the region with gravel located primarily between Te Awanga and Tangoio Bluff. Cliffs were common between Cape Kidnappers and Cape Turnagain, on the west coast of Mahia Peninsula, and north of Mahanga Beach; while sand and duneland were most common around Porangahau, Waimarama, Mohaka, and Wairoa. A feature of all the habitat margin was that it is regularly disturbed by storm events, meaning there is a relatively dynamic zone above high tide where vegetation is only occasionally able to establish, and is frequently disturbed.

The terrestrial areas mapped sought to provide a general picture of the surrounding land use and habitat types present adjacent to the coast. Because the extent of vegetation mapped has a variable internal boundary, it is not appropriate to compare the extent of terrestrial features with habitat margins or intertidal features. However, observations during the mapping work indicated the vast majority of the land adjacent to the HBRC coastline has been modified from its natural state. In particular, very little native forest cover remains, with most of the region converted to pastoral farming or, to a lesser extent, forestry. While extensive dunes still remain in some areas, many of these have been significantly modified, for example through grazing, forestry, housing, industry, roading, flood control, erosion protection.

While the GIS is the most appropriate way to access the specific site data, an overview of the different areas of coastline mapped are presented in the following sections.

3.1.1 Overview of the southern coastline between Cape Turnagain and Te Awanga

The area of southern coast between Cape Turnagain and Te Awanga is characterised by extensive areas of steep cliff (Figure 7 A) that are generally unvegetated, or steep hills and cliffs covered by grassland, flax and toitoi (Figure 7 B). The surrounding land cover along this section of coast is almost exclusively grassland (pastoral farming) (Figure 7 C), with small pockets of exotic forest also present. Native forest is conspicuous by its absence, with only a few small stands of regenerating forest seen in grassland areas.

Where the cliffs meet the coastline there is generally a narrow band of sand and boulders in the upper intertidal zone (Figure 7 B), with horizontal intertidal rock platforms extending up to 200 metres seawards in many areas (Figure 7 D). Sandy beaches are interspersed along the coast, many with subtidal rock platforms offshore.

Dune systems (marram grass, spinifex) flank most of the sandy beaches and coastal areas where there are no cliffs (Figure 7 E), and are also present in some areas where cliffs or steep hillsides are set back from the coast. The majority of beaches have residential developments present. Where not constrained by development or cliffs, dune systems extended hundreds of metres inland in some areas, although many have been modified by grazing.

Overall, land-based access to the southern coastline is generally limited and there are large areas that are inaccessible. Vehicle access along the beaches and rock platforms is possible at low tide in many areas.

Figure 7 Examples of the dominant coastal features between Cape Turnagain and Te Awanga.

3.1.2 *Overview of the central coastline between Te Awanga and Tangoio Bluff*

The central area of coast surrounding Napier and extending from Te Awanga in the south and Tangoio Bluff in the north has generally very good road access to the coastline. The habitat is dominated by a mobile gravel beach (Figure 8 A) which is steeply sloping and subject to regular wave disturbance, with both strong undertows and longshore drift evident. The intertidal area is unvegetated, as is the wide berm present at the top of the intertidal zone.

Inland of the beach, herbfields are the predominant vegetation type present, particularly north of Napier. Low lying plants (Figure 8 B) include the trailing African daisy *Osteospermum fruticosum*, the yellow daisy *Arctotis stoechadifolia*, Cassinia *Ozothamnus leptophyllus*, marigolds *Tagetes* spp., ice plant *Carpobrotus edulis* and a range of exotic cacti. Larger plants (Figure 8 C) are dominated by tree lupin *Lupinus arboreus*, and boneseed *Chrysantemoides monilifera*. In many areas housing or grassland are present where herbfields would naturally exist.

South of Napier, herbfields are less extensive. Wetlands are common behind the frontal dune and several large rivers discharge through the beach. River channels are relatively mobile and subject to natural closure.

Around Napier itself, the port area is dominated by artificial seawalls (Figure 8 D) which extend along to the entrance to Ahuriri estuary.

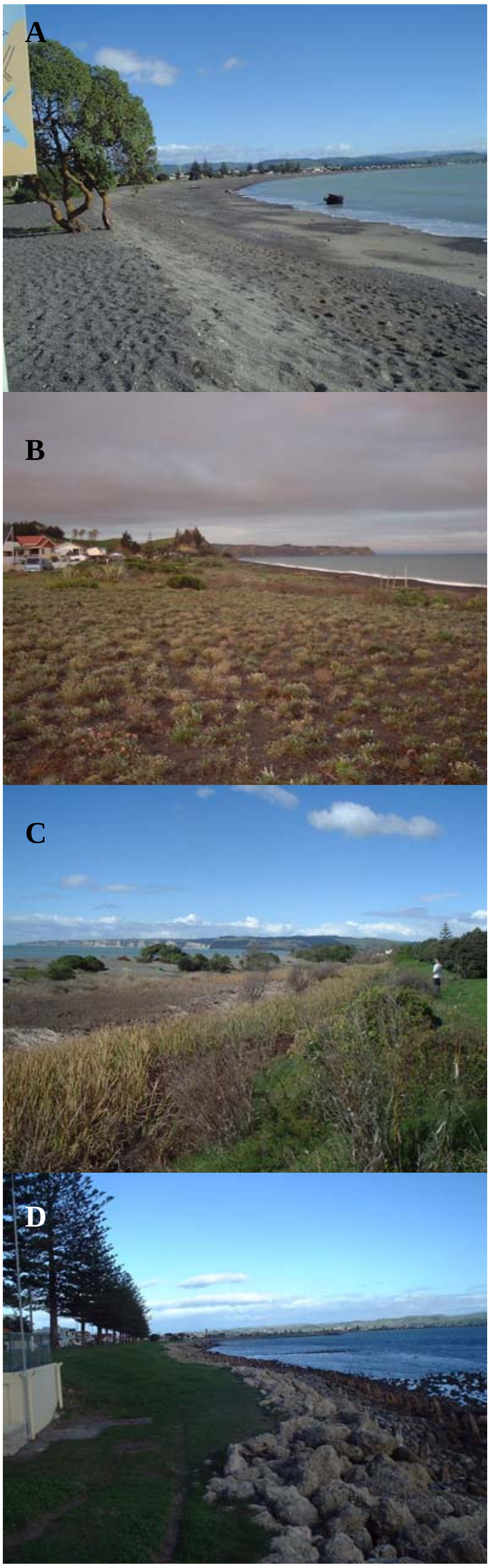

Figure 8 Examples of the dominant coastal features between Te Awanga and Tangoio Bluff.

3.1.3 Overview of the northern coastline between Tangoio Bluff and Mahia

Public access to the coastline between Tangoio Bluff and Wairoa is generally very limited, although it was possible to gain access over private land in several locations. Many of those who gave us permission to access the coast were also able to provide local knowledge on areas we were unable to access directly.

Overall, the coastline is characterised by steep cliffs with grassland vegetation the dominant cover (Figure 9 photo A). Around Moeangiangi River, native scrub (manuka, flax, tauhinu) was common on the cliffs and surrounding hillsides.

Aside from rock outcrops and platforms present around the Tangoio Bluff/Waipatiki Beach area, extensive sand and gravel beaches dominate, with sand common around the river mouths, and sand/gravel in other areas. The beach is generally gently sloping and ranges from 10's to 100's of metres wide (Figure 9 photo B).

Beaches were commonly buffered by low vegetated dunes (Figure 9 photo C), with extensive duneland present round Wairoa. Dunelands were dominated by marram grass and spinifex, but also included pampas grass and knobby clubrush, with gorse and blackberry and other introduced weeds common around Wairoa.

Around Waikokopu (between Wairoa and Mahia), steep cliffs flanked boulder beaches and rock outcrops (Figure 9 photo D), with a cover of grass, occasional flaxes and pampas grass.

Figure 9 Examples of the dominant coastal features between Tangoio Bluff and Wairoa.

3.1.4 *Overview of the coastline of Mahia Peninsula, and Pukenui and Mahanga Beaches*

Mahia Peninsula has similar features to the rest of the HBRC coastline. The west is dominated by steep unvegetated cliffs flanking boulder and rock shorelines (Figure 10, photo A), while the east has mainly steep vegetated hillsides (esp. tauhinu) and cliffs protected by wide rock platforms (Figure 10, photo B). Inland, grassland is the dominant cover, although pockets of native bush are present. Public access is generally very limited and local knowledge was invaluable in mapping the area.

On the east of the peninsula, long sandy beaches with flanking dunes are common, many with rock platforms extending 10's to 100's of metres seaward (Figure 10, photo C). Steep hillsides and cliffs are generally grass covered. Dunes are generally grass covered (kikuyu grass) and modified through grazing. Around Mahia, residential development is present, introduced weeds are common, and erosion protection work is evident in many areas. Beaches are often present at the bottom of small (~2m high) cliffs on the northeast of the peninsula (Figure 10, photo D).

On both sides of the isthmus of Mahia Peninsula, long sandy beaches and dune systems are present (Figure 10, photo E) with many different plants present. The dune vegetation of Pukenui Beach was less modified than Mahia Beach.

North of Mahanga Beach, the coastline is inaccessible by public road and no ground-truthing was undertaken. Mapping was based on descriptions provided by locals familiar with the area who described the coast as predominantly cliff with boulder beaches.

Figure 10 Examples of the dominant coastal features of Mahia Peninsula and Pukenui Beach.

3.1.5 Environmental pressures

During the mapping, observations were made on potentially sensitive areas and habitat types that may be considered regionally 'rare', as well as environmental pressures that were evident.

The environmental pressures looked for included:

- Flooding
- Gravel Extraction
- Beach grooming
- Introduced Weeds
- Landfill Leachate
- Nutrient Pollution
- Sand Extraction
- Shellfish Collection
- Stormwater
- Vehicles

In general, HBRC are likely to already be aware of where most pressures are, or have existing data which compliments the current project. Combining the available information should allow the location and potential significance of identified pressures to be further refined, with priority areas targeted for more detailed field surveys as appropriate.

A basic risk assessment matrix (Figure 11) provides a simple tool to define the level of concern associated with different pressures on a habitat in terms of potential sensitivity and consequence using a colour ranking from high (red) to low (green). The use of letters and numbers (A1-D4) enables further definition of the drivers for the level of concern based on the percentage of the resource affected, and the likely timeframe for recovery. It is important to note that the matrix does not confirm the presence of an impact, it simply indicates where pressures may be present, and the possible consequences associated with specific pressures should they occur.

% OF HABITAT AFFECTED		RECOVERY FROM IMPACT			
		(SLOW) >10 years	5-10 years	1-4 years	(RAPID) <1 year
		1	2	3	4
>50% (LARGE)	A	A1	A2	A3	A4
30-50%	B	B1	B2	B3	B4
10-30%	C	C1	C2	C3	C4
0-10% (SMALL)	D	D1	D2	D3	D4

Figure 11 Risk assessment matrix for evaluating levels of concern to habitat pressures.

The major benefit of the matrix is that it provides a simple but robust way of comparing impacts at different sites and defining planning, monitoring or remediation priorities. This can be done for existing conditions, as well as for predicting previous or future impacts under changed conditions *e.g.* assessing what the pressures may have been prior to residential development, or if there was to be a doubling of a population in an area.

An example, typifying many of the coastal settlements south of Te Awanga, is Kairakau Beach, a small residential development located adjacent to a sandy beach surrounded by farmland. Over time, the area has been gradually modified through an increased population, with housing and impervious surfaces (roads, roofs) altering land use and surface runoff characteristics, and other changes such as wetland drainage, sewage and stormwater disposal through on-site systems (eventually draining to the sea), modification of natural dune systems, the introduction of exotic plants and weeds, boat ramps, vehicle use on the beach, shellfish gathering *etc.* Subsequent pressures include protection from coastal erosion and flooding through the construction and permanence of seawalls, reclamations, stream culverts, roading, *etc*. Each of these factors can be assessed and given a score to indicate its likely significance as shown in Table 4.

Table 4 Example of environmental pressures and possible levels of concern at Kairakau Beach.

	Kairakau Beach
Erosion protection	D1
Flooding	D4
Gravel/Sand Extraction	-
Grooming	-
Landfill Leachate	-
Loss of marginal habitat	D1
Nutrient Enrichment	D4
Residential development	C1
Shellfish collection	C2
Stormwater	D3
Vehicles	D3
Introduced weeds	D2

In terms of the risk posed by such pressures at Kairakau Beach, most are reversible and affect only a small portion of the total habitat (e.g. stormwater impacts). That is, while they may have a local impact, if the source was removed, recovery would be relatively rapid. The main exception is residential development as once an area is sold and developed there is little chance that it will be returned to its natural state so the impact is essentially irreversible. Similarly, once an area is developed, the consequences of erosion and flooding of such areas assume a greater importance and pressure is exerted to modify the environment further to protect against changes that may have occurred naturally in the past, such as dune migration in response to storm events.

This example provides an indication of how identified pressures and existing knowledge can be used within a risk assessment framework to provide a starting point for helping decide whether further investigation is justified, and if so, where the priorities may lie. Although outside the scope of the current project, this type of approach has been found previously to greatly assist in resource planning and management, particularly as it provides a meaningful way to incorporate local knowledge and engage stakeholders. Furthermore, overarching stressors such as land-use/management or climate change which have a direct influence the local stressors *e.g.* flooding, erosion, can be incorporated into the assessment process through the use of Cawthron's Bayesian network and complex systems models (*e.g.* Gibbs 2005, Elemetri and Gibbs 2005). The models look at cause and effect relationships between stressors and are very useful in identifying the types of management strategies that are best suited for dealing with various pressures under a wide range of different scenarios.

3.1.6 Possible monitoring

Another important facet of the current project has been to look at potential sites for fine-scale biological State of the Environment (SOE) monitoring across the region. This type of monitoring is intended to assess the overall quality of the environment away from known sources of localised impacts such as wastewater outfalls. Some important components of SOE monitoring are that it should indicate the general health and measure changes in the environment, should include representative habitats, collect meaningful data, and enable point source monitoring results to be considered in a broader context.

Within the HBRC region there are specific habitats more suited to SOE monitoring than others. For example, the mobile gravel beaches that dominate the shores between Te Awanga and Tangoio Bluff may be considered by many to be the dominant shoreline type within the region, but is not ideal for regional SOE monitoring as it only comprises 8% of the intertidal habitat, will not retain or concentrate contaminants like heavy metals or nutrients because of its coarse grain size, and will have variable biological communities because of high levels of physical disturbance. In contrast, the broad intertidal rock platforms account for 35% of the intertidal habitat in the region, provide a relatively stable physical substrate for monitoring, and includes the Te Angiangi Marine reserve, an ideal reference site that should be protected from commercial and recreational harvesting pressures present elsewhere in the region.

Another important habitat type in the region is firm sand beaches. These areas are likely to support shellfish and a variety of sediment dwelling animals. As the sandy beaches are also areas which settlements tend to have been established nearby to, they offer a potentially good indicator of long term changes from increasing development pressures. While obviously the specific purpose of any monitoring programme would need to be defined before specific sites are proposed, appropriate sites are available across the entire region in both sandy substrates and rocky platform areas, and particular sites can be discussed for SOE monitoring in the future as appropriate.

4. OVERVIEW

The primary output of coastal mapping is to define the type and location of the different habitats across the coastal margins of the region. The primary benefit of such work is to:

1. Help end users better understand the ecological status of the region and the impacts of human activities.
2. Assess environmental quality (*e.g.* the extent of sensitive/rare habitat types).
3. Select appropriate monitoring locations.
4. Develop effective management strategies.
5. Provide a regional, and contribute to a national, context of disturbance impacts.
6. Facilitate the assessment of the significance of potential impacts.

At the simplest level, habitat maps provide fundamental knowledge about where different habitat features are located, and their spatial extent. Therefore, this work will provide a valuable foundation by defining the existing habitat types of the region, allowing undeveloped areas to be identified and their environmental values assessed, as well as providing an understanding of what features are susceptible to different pressures and whether development may enhance or adversely or irreversibly affect the area. Furthermore, it provides insight to the type of infrastructure that may be needed to mitigate the effects of development (*e.g.* sewage reticulation), or to make development feasible (*e.g.* flood control works).

Habitat mapping also maximises the benefit that can be gained from existing data sets. In many instances extensive GIS datasets are available recording infrastructure (*e.g.* sewers, water reservoirs), natural hazards (*e.g.* flood plains, erosion zones), and environmental features (*e.g.* wetlands, forest remnants, parks). By combining this information it is possible to understand how existing environmental pressures may be affecting environmental quality, and how changes to management, or changes to environmental conditions, may influence the region, thereby providing a solid underpinning context for planning and management decisions (including decisions to collect more information).

5. REFERENCES

Atkinson, I.A.E. 1985. Derivation of vegetation mapping units for an ecological survey of Tongariro National Park North Island, New Zealand. New *Zealand Journal of Botany* 23: 361-378.

Elmetri, I.; Gibbs, M. ; Landis, W. 2005. **A**pplication of Relative Risk Model (RRM) to investigate risks of a proposed aquaculture development on the Firth of Thames Habitats. *Cawthron Report No. 1058.*

Gibbs, M. 2005. 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. *Cawthron Report No. 1055.*

Ministry for the Environment. 2001. Environmental performance indicators: Confirmed indicators for the marine environment. ME No. 398, Ministry for the Environment, Wellington. 65p.

Robertson, B.M.; Gillespie, P.A.; Asher, R.A.; Frisk, S.; Keeley, N.B.; Hopkins, G.A.; Thompson, S.J.; Tuckey, B.J. 2002. *Estuarine Environmental Assessment and Monitoring: A National Protocol.* Part A. Development, Part B. Appendices, and Part C. Application. Prepared for supporting Councils and the Ministry for the Environment, Sustainable Management Fund Contract No. 5096. Part A. 93p. Part B. 159p. Part C. 40p plus field sheets.

Stevens, L.; Robertson, B. 2004: Broad scale mapping of intertidal habitat and ecology of 16 sandy beaches and 4 river estuaries in Wellington Harbour, 2004. Prepared for Greater Wellington Regional Council. *Cawthron Report No. 913.*

6. ACKNOWLEDGEMENTS

Thanks are given to Anna Madarasz who took the aerial photos used in the main body of this report, to Anna and Graeme Sevicke-Jones (HBRC) for their project support and guidance. Rectified aerial photographs were provided by HBRC and LINZ.

Also to George on the "Big Kahuna" for transporting us ably to Cape Turnagain and back, and to the many locals we met who freely granted us access across their land and were able to provide invaluable information about the coastline.

Thanks are also due to Susan Jones (Eagle), and especially Kathryn Lawrence and Paul Barter (Cawthron), for their efforts in seeking a solution to the ArcMap file corruption bug uncovered during this project.

APPENDIX

GIS habitat maps
of the HBRC coastline

Note: Habitat maps not included in this version of the report because of file size limits

Location of numbered GIS maps of the HBRC coastline and map legend