Tasman District Council

ESTUARY RESTORATION

Proceedings of a Workshop held on
28-29 April 2008

ESTUARY RESTORATION WORKSHOP PROCEEDINGS

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This document records the presentations of several experts involved in monitoring, restoration and management of estuaries as well as the panel discussions involving all delegates. It is written in a more narrative style than reference texts. Presentations from the following people are included: Trevor Partridge (Christchurch City Council), Leigh Stevens (Wriggle Ltd), Trevor James (Tasman District Council), Paul Sheldon (Nelson City Council), Kim Clark (Cawthron), Shannel Courtney (Department of Conservation) and Rod Asher (Cawthron). Some additional material has been added to provide a more complete picture of estuary restoration.

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Estuary Restoration Workshop

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1 INTRODUCTION

1.1 What are Estuaries?

Intertidal areas are either enclosed (such as inlets and lagoons) or open (such as river mouth deltas). The only difference between inlets and lagoons is the extent of tidal flushing. Lagoons often have a natural bar over the mouth that prevents tidal flushing and usually leads to standing water ponded up behind the bar.

1.2 Why are Estuaries Important?

Our estuaries are fascinating hotspots of biodiversity. They form a mosaic of substrate, floral and faunal patterns found nowhere else. They provide real value for our economy, our cultural heritage, amenity and recreation.

1.3 Estuarine Ecology Overview

Estuarine Zones Controlled by the Tide

Estuaries have essentially two zones separated by mid-tide. Below mid-tide the habitat is essentially marine and above mid-tide the habitat is more terrestrial. Water in estuaries is essentially saline (3% salt), whereas lagoons (areas regularly cut off from the sea by a bar) are usually less saline.

The pattern and distribution of plants in New Zealand estuaries follows a transition over the vertical gradient from eel grass in the lower mudflats, to salt marsh and then to terrestrial communities. Even within the salt marsh there is a very predictable sequence. Most of our estuary plants are found throughout the country. The main differences are that in the north of the North Island (Ohiwa and Kawhia Harbours and north) there are mangroves, and south of Otago, the dominant sea rush (*Juncus krausii*) disappears. Herbaceous species dominate in Otago/Southland but do occur throughout.

Because the coastline is fragmented and estuaries are not connected, salt marsh plants have to find ways of reproducing and dispersing across big distances. Most salt marsh plants seeds float and do not germinate in salt water. Others are bird-dispersed.

Salt Marsh

Salt marsh is essentially any vegetation that is regularly flooded by the tide and occurs above mid-tide, except for eel grass (*Zostera*). As the land rises, a series of distinct zones are found: lower, middle, upper zones and on to non-flooded zones. Salt is the most important factor determining the distribution of plants.

Salt Tolerance

Of the salt-loving plants (halophytes), each has a preferred salinity range. They must take up salt to create the right osmotic gradient across the root boundary and therefore they must deal with salt in their living tissues. There are different mechanisms to remove this salt, such as excretion, storage, succulence, and high leaf turnover.

Sediment particle size in the estuary can also have a large effect on salinity, with fine sediments holding more water and salinity remaining constant. With coarse sediments such as sand and gravel the salinity fluctuates greatly. Estuarine plants in finer sediments, such as mud, have had to adapt to the lower oxygen levels. Hypersaline patches can develop around coarse sediments where there is rapid drying in enclosed embayments. Estuarine plants in finer sediments, such as mud, have also had to adapt to the lower oxygen levels. Thus, there can be considerable differences even in estuaries close to each other that are caused by differences in sediment.

Lower Salt Marsh

In this zone there is the lowest diversity of plants, as only plants that are very salt-tolerant survive. The salinity here is close to that of sea water.

Middle and Upper Marsh Zones

There is a decreasing salinity gradient as you move up towards the land; some areas are flooded by spring tides and others not. There is higher diversity as less salt-tolerant species can become established. At the upper edge there is no influence of salt water. Above this edge there is a grade into terrestrial vegetation.

Salt Marsh to Land Transition

Away from the harsh salt environment there is greater competition and halophytes are replaced with land plants. Occasionally, salt water intrusion into the land zone can occur. This zone is usually the most modified and missing from many marsh/estuarine areas as it is easily converted to other forms of land use. Such reclamations usually preclude inland migration of salt marsh but do not necessarily affect the functioning of plants within lower zone except via secondary effects such as sediment supply rate changes, nutrient leakages or altered wave energy characteristics. The habitat of various animals of the salt marsh, particularly birds, is greatly enhanced by the full estuary riparian buffer.

Vegetation Succession

If estuary plants were able to colonise freely into stable intertidal areas of an estuary, herbaceous plants establish first, followed by rush zone if sediment accumulates. However, there are dynamic processes happening in estuaries and erosion near channels can remove whole swards of plants.

Sensitivity of Vegetation Sequences to Sea Level Rise

With greater tidal range, the vegetation sequence is drawn out, given the same slope. This means that the vertical distances covered by each plant sequence are greater in Nelson than in Otago. There is no reason why plants should not migrate landward as sea level rise occurs, if they have the opportunity. However, some plants (eg, coastal ribbonwood) will find it more difficult to colonise than others as it is a poor competitor with pasture grasses. High sediment supplies to estuaries could offset the effects of sea level rise to a certain degree. Many salt marsh plants (eg, glasswort and sea blite) will colonise new estuary ground very quickly and have good dispersal mechanisms.

The Influence of Groundwater Intrusion on Salt Marsh Communities

Depending on the underlying geology, fresh water springs can be present in estuaries. Raupo can usually be found to occupy these areas. Raupo is very sensitive to saline water so the groundwater flow must be constant around the root zone.

Lagoons

Lagoons are cut off from tidal influences by a bar and do not get regular tidal flushing but may be still partly saline. There is a larger variation in flooding periodicity and the plants of the lower zones need to survive long periods permanently under water. Most of the plants in lagoons are shared with salt marshes but the zonation pattern is the major difference. Contaminant discharges (such as nutrients from farm run-off) to lagoons is expected to cause more adverse effects than in estuaries due to the lack of flushing.

2 ESTUARY RESTORATION

Trevor Partridge, Botanist, Christchurch City Council

2.1 Setting Objectives

Concepts of restoration within estuaries here comprise two types, desire to restore health of the intertidal part of estuaries (mudflats and lower communities) and a desire to do marginal planting for re-establishment of salt marsh. Under the objective of improving biodiversity in a highly accessible area it needs to be established whether birds or plants are the main priority. Often you can have both but not always.

2.2 Planning the Planting Programme

2.2.1 Shaping Your Ground, Terraforming – Starting from Scratch

Develop beaches on the estuary margins. Usually slopes are about 1:20 and 1:15 maximum. Put the soft sediment on top but add a thin layer of gravel or cobble if there is likely to be any wave action. If the sediment is very fine, test by picking up a ball of mud in your hand and if it oozes down your arm, you will have to wait longer for it to settle before planting.

The Benefits of Creating Low Islands

Constructed islands have been successful in many estuary restoration projects. In fact, some islands have been so successful in providing safe bird habitat, they have become over-populated and efforts have been made to encourage birds to use other islands.

In some situations moats have been created to protect nesting sites from dogs, cats and other pests. There are situations where dog owners deliberately release their dogs off their leash in areas that are clearly signposted as bird protection areas. Moats are totally unnatural features in estuaries. However, if your objective is to bring back bird abundance and diversity where pests are an issue, then moats are a good option.

Another way of improving bird protection is improving enforcement. In Christchurch rangers are on 24-hour, 7-day standby to pull up the offending pet owners and aim to be on-site within 10 minutes of getting a call from the public.

In other situations bird habitat may not be so important and plant communities become the main driver of restoration. In these situations the landforms created will be stylistically more natural to bring back natural communities of salt marsh. In some situations you can achieve both plant and animal habitat.

2.2.2 What to Plant Where – Using Indicator Species

Plants that live in the environment can give very good clues as to what will grow there. So, plant the species that match those already present. This is unless the salinity or tidal regime is to change, or you are terraforming for other reasons.

A lot of restorations have wasted time and effort planting salt marsh herbs as these kinds of species will establish quickly by themselves without assistance.

Plants that will come away naturally and that you will not need to plant include: *Sarcocornia, Suaeda, Samolus, Selliera, Apium,* three-square, New Zealand musk, *Triglochin*. Use these primary colonisers for determining what plants to add once they have become established. The longer you leave it, the more accurate the picture becomes. It is suggested that leaving it 1-2 years is appropriate. Planting three-square could be useful if you do not have any nearby that will colonise naturally.

Self-establishing Glasswort Meadows

Plants that you do need to plant are: oioi, sea rush, coastal ribbonwood, estuary needle tussock.

Rare plants: It is usually preferable to plant the rare plants later once it is known that weeds are controlled sufficiently and the site has stabilised. If you plant them too soon, there is a risk of putting these valuable plants in the wrong place where they will not survive.

The two main factors determining where plants grow are: sediment type and salinity regime. Herbaceous species would be the most difficult to determine where to plant but as they colonise naturally, there is no need to be concerned about this. They will grow where they can. Failures usually relate to plants that are planted in the wrong space.

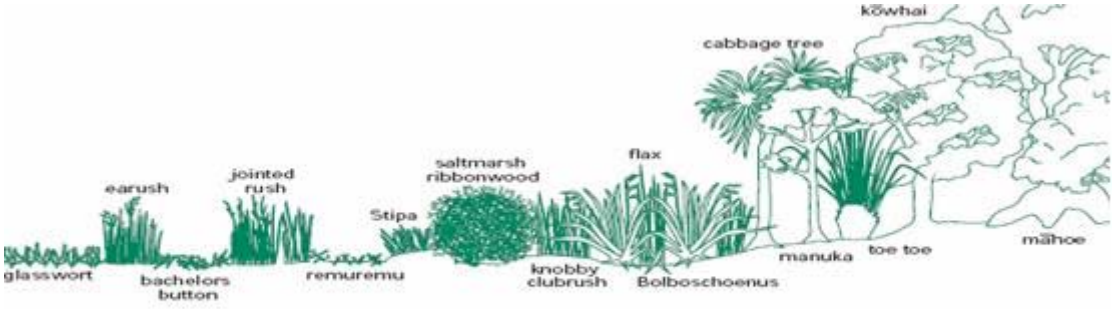
Sediment Preferences

Coarse Sediment		**Fine Sediment**	
High salinity	**Low Salinity**	**High Salinity**	**Low Salinity**
Glasswort*	*Selliera*	Three-square	New Zealand musk *(Mimulus repens)*
Sea Blite (*Suaeda)**	*Apium*	Sea rush *(Juncus krausii)*	*Triglochin*
Samolus	Estuary Needle Tussock *(Austrastipa stipoides)*		Silver Tussock (*Poa cita)*
	Schoenus consinnus		Oioi (*Apodasmia*)
			Leptinella
			Carex littorosa

* Will be fine even in 5% salt

- *Apodasmia* (Oioi) – slow growing, slow to establish, cannot stand drying out too much, not fussy about needing coarse or fine sediment.
- Sea rush – slow to establish.
- Coastal ribbonwood – patchy self-establishing – low salinity (not fussy about sediment).

- Inland from the coastal ribbonwood use the following plants: *Coprosma propinqua* (mingimingi), *Coprosma crassifolia*, manuka, ngaio (in more exposed sites). *C. crassifolia* is often not available due to the paucity of seed-bearing plants from which to raise seedlings.



The Salt Marsh Boundary

A good restoration project tries to restore the whole sequence to land and thus includes non-estuarine coastal plants. For this you will need to work out what the adjacent system is or should be – eg, wetland, forest, shrubland or dunes. Develop a typical land-based restoration for the adjacent area and interleave the salt marsh with it.

Comments by Roger Gaskell regarding local planting – Revegetation of rare plants on Sandy Island in Moutere Inlet, involving trial plantings of coastal cress (*Lepidium*). Doing the restoration in reverse to Dr Partridge's recommendations, ie, planted rare plants first.

A big clue is to look for indicator species. If you find only one species that is normally associated with one or two other species in same habitat, eg, *Carex littorosa* and three-square in Brooklands lagoon, then it is fairly safe to plant the missing species in that zone. The plants will be responding to the local conditions and we must use existing plants as our primary guide. It is advisable to carry out a detailed botanical survey of your estuary. From this you will get good idea of what plant associations are present or should be present in the estuary.

Note: Silver tussock is found in many of Tasman-Nelson's estuaries but further up the sequence from estuary needle tussock. Coastal ribbonwood has marked good and bad years for seedling survival, usually related to moisture content of the soil.

Seasonal Constraints

Are there times of year that are more successful for planting salt marsh? Dry summers and very frosty winters will result in massive die-off of recently-planted plants. If we plant in spring and get good rainfall in summer, we have massive success. If we plant in autumn and get a hard winter, you can also get widespread plant deaths. Writing-off some seasons is just something you will have to factor into the budget.

2.2.3 Propagation and Acclimation of Estuary Plants

One option for propagation is to create in-estuary plant nurseries in order to better-acclimatise estuary plants. Trials in Charlesworth lagoon in Christchurch were very successful. Collecting divots may be the easiest way to go as it avoids as much disturbance of the estuary and the need for resource consents.

Christchurch City Council has two nurseries, which grow plants for restoration programmes in urban areas, ranging from estuarine to forest. Department of Conservation's Moukarara nursery raises some special plants. That is how we have covered ourselves with plant supply.

Additionally, estuary tussock is relatively easy to grow.

Availability of Estuarine Plants in Nelson-Tasman

Provided you plan ahead and get orders in a year or two in advance, Titoki or Mainly Natives nurseries can supply the numbers of plants needed. Anything rare or very difficult to cultivate is purchased from the Department of Conservation nursery.

Acclimation

No benefits have been found from trying to acclimate plants with appropriate concentrations of salt water and can be a big problem if there is over-spray that gets onto other plants that do not tolerate such salt water. Hydroponics can be a very successful method of growing halophytes providing you get the appropriate salinity range. It is not really known how important it is to establish mycorhyzal (symbiotic fungi growing on the roots of plants) associations in the propagation and establishment of salt marsh plants.

Native ice plant – not found naturally occurring in estuarine habitats. Mainly found on cliff faces or rocky shores (at least around Canterbury). This plant is good in gravel situations where the salt can leach out. It grows extremely fast on shell banks.

2.2.4 Timing of Plantings

Earthworks (terraforming) should be done in one concentrated effort and then avoid further tinkering. Once set up, avoid adjusting parameters, such as tidal flush, as this will make it more likely that failure will occur. If doing restoration or planting of sea rush in conjunction with increased flush of culverts, you should wait until the earthworks settle down and you can work with a steady system. The longer you leave it to naturally re-establish the more chance you have, unless you get weed invasion. Once the primary colonisers have established you have a reference point for where to plant other plants that will not establish well on their own. This is especially important to visualise the zone boundaries as defined by the adventives.

2.2.5 Attracting and Managing Community Interest in Restoration

Supervision on planting days is absolutely important. Any less than one supervisor for four planters could lead to failures.

Councils will generally encourage anyone with common sense solution to come forward. Questioning something may be enough to make big change. For example, ask why certain tidal flapgates are needed. While there may have been good reason at the time they were installed, those reasons may no longer apply.

Generally, the public will not be interested in maintenance of plantings but can be very useful for pest surveillance. The message is: “if you see these plants, tell the Council straight away exactly where you found them”.

2.2.6 Restoring Inanga Spawning Habitat

Inanga spawning habitat is grassland or rushland on the floodplains of streams around the upper limit of the salt water wedge associated with high tides and particularly spring tides. Low velocity hydraulic zones are preferred by inanga. These include pools, slow runs or backwaters. Meanders and floodplain vegetation play important roles in reducing water velocities.

The amount of inanga spawning habitat in an area usually correlates with the productivity of whitebait runs. This is true in Golden Bay where there is a much greater amount of habitat available for spawning and there are much higher numbers of inanga coming upstream in the spring runs. Following spawning, the hatchlings get washed out to sea. The coastal circulation pattern in Golden Bay is likely to keep much of the inanga population within this bay. This same is probably true for Tasman Bay. Inanga are not known to seek the same stream year after year, like salmon, so the population will disperse and colonise restored streams.

The inanga spawning zone in many urban streams has been severely modified, particularly around Nelson and Richmond. The following creeks around Waimea Estuary have been mostly denuded of inanga spawning habitat: Borck Creek, Saxton Creek, Orphanage Creek, Poormans Stream and Jenkins Creek. Many creeks flowing into Nelson Haven have likewise been denuded. Often, the streams in this zone have been straightened and the riparian zone mown or lined with rock.

Access to habitat is often an issue, particularly around Motueka and Riwaka, with the number of tidal flapgates on small streams. For example, there are several on creeks in the Motueka River delta, Ferrier Creek, Little Sydney Stream and Hamilton's Drain. Not only is access prevented but this blockage to tidal flow causes stagnant water to build up behind the flapgate and poor water quality, particularly low dissolved oxygen and high water temperatures, often results.

While inanga are surprisingly robust to mild pollution, discharges of contaminants, particularly sediment, should be kept to a minimum and particularly during the summer months.

Pests such as cats, rats and mice that eat the fish or eggs may need to be controlled. Farm stock that feed on the riparian grass should be excluded from inanga spawning areas, at least from late December to end of April. While inanga spawning occurs on spring tides from February to April, it is important to allow 1-2 months of growth of grasses or rushland prior to the spawning period so the habitat is available. Most resource consents for works in the beds of streams required that this whole period be avoided and revegetation as soon as possible after the earthworks. Where excessive weed (either aquatic or riparian) growth is a problem, spraying or mechanical clearance may be needed, but again outside the spawning season.

Native rushes and grasses that are commonly associated with inanga spawning include: Oioi, *Juncus*, Raupo, Flax, Umbrella sedge. Introduced grasses and herbs also provide good habitat. These include: Tall fescue, Yorkshire fog, Lotus, Buttercup, white clover. Eggs are usually laid on lower stems and roots of these plants as well as leaf litter.

Spawning sites can be registered by completing an inanga spawning survey form and submitting this to the Department of Conservation regional conservancy office.

For more information refer to Richardson and Taylor 2002. A Guide to Restoring Inanga Spawning Habitat. NIWA Science and Technology Series No. 50 ISSN 1173-0382.

2.2.7 Pest Plant Management

Weeds can deflect your plantings, especially at the low salinity upper marsh end. The worst weeds in this upper marsh zone include tall fescue, creeping bent, couch. Salt water is usually the best herbicide but in this zone the recently-planted species may suffer as well. Make sure that this spray does not get onto the salt-intolerant plants that may be placed nearby.

Couch is bad because it is reasonably salt-tolerant and has rhizomes that form a deep mat that is almost impossible to control by spraying. Scraping with a digger is the best method. The mat of couch breaks down very slowly and composting is not a good option. Scraping usually needs to go right down to Mean High Water Springs.

Weeds of the lower marsh zone are usually less of a problem but notable examples include *Spartina* and Sea lavender (*Limnolium*). Sea lavender is not in Nelson-Tasman yet but a real problem in Christchurch. It can even displace the hardy Glasswort.

Limnolium

Limnolium competition with Glasswort

Buck's horn plantain is found in both low and high saline areas (in higher saline areas it takes on a redder colour). It is often found on disturbed ground and in between the lower and upper marsh zone. It is usually outcompeted by taller vegetation.

Ongoing weed management is important in ensuring that the plants survive. Never turn your back on a weed. It was thought that *Spartina* was eradicated around Christchurch but, no!

Indian doab and kikuyu are problem weeds of the North Island (and top of the south).

Exotic jointed rushes have been planted is several locations around New Zealand thinking they were native – this shows the importance of using scientific names for the plants as well.

Weeds that were originally thought to be a problem but are not include: Barley grass and sickle grass.

Spartina

In Waimea Inlet and other sites in Tasman eradication of *Spartina* has been largely successful, with any plants found through the annual survey process easily recognised and removed. It was found that a lot of sediment had built up within the *Spartina* beds and had raised the estuary level in these areas. There is an opportunity to plant up sites previously occupied by *Spartina* with other species before the sediment is fully eroded back to a stable state.

Where sediment has not accumulated, there were no native plants that grew in the zone where *Spartina* established. This plant can spend a long time under water and it has an incredible salt excretion system.

Before and after Spartina eradication in Neimans Creek (lower Queen Street, Waimea Inlet)

2.2.8 Pest Invertebrates

Pacific Oysters

Pacific oysters were first found in the Waimea Inlet around 1983 to 1985. Numbers increased dramatically over the next 10 years, but after their initial invasion, their dominance has reduced and the cover of the inlet is now reasonably stable. The ecological productivity or diversity of the inlet has not been compromised by this invasion; to the contrary, the three-dimensional structure of the oyster beds provided extra habitat for other invertebrate species and presumably provides enhanced food resources for several bird species (Rod Asher).

2.2.9 Managing Wildfowl

In Christchurch the main problem is Canadian geese. Within restoration sites the numbers that use them are fortunately nowhere near the numbers that use the sewage treatment area. On a former fill site adjacent to the restoration site there are thousands of Canadian geese at night. Chicks and eggs were removed from areas to keep numbers low. One interesting observation emerged from improving Scaup habitat. Once Scaup numbers built up, Canadian geese moved out. It seems that they do not like the darting movements of the Scaup. The high numbers of mallards can be a problem with their grazing and clearing areas of the salt marsh. Paradise ducks and Scaup are becoming pests and a lot more bold and have learned to co-exist with the mallards.

Pukekos appear to be the biggest problem in Nelson-Tasman as they rip out newly planted plants. Various ways of addressing this problem (in order of escalating severity) have been tried:

- Wiring and anchoring plants into the soil.
- Bend no. 8 wire into a U shape and put two of these perpendicular to each other over the plant and put sleeve of net (use orange net bags) over it.
- Use small weed mat with pins.
- Plastic sleeves with bamboo stakes.
- Plant larger plants with larger root mass so that the plants will more rapidly gain a hold.
- Trench traps. Dig a trench narrow enough so the Pukeko cannot turn around, ramp the entrance down from the surface to a deep point at about 500 millimetres. This allows the pukekos to be caught live and transferred elsewhere.
- Shooting. Permits are issued to various landowners to control these birds.

2.2.10 Follow-up

- Learn from mistakes.
- Get the public involved.
- Maintenance, maintenance, maintenance! - is the mantra during the early stages.
- Celebrate your success.

2.3 Examples of Estuary Restoration

2.3.1 Case studies – Christchurch City Restorations

Avon-Heathcote Estuary

- Main confluence of Christchurch Rivers – Avon and Heathcote
- Highly modified through reclamation – urban, treatment works
- Most of upper parts of sequence lost
- Major weed problems
- Need to restore for plants and birds

2.3.1.1 Bexley Wetland

Bexley wetlands are a freshwater/salt marsh association located near the mouth of the Avon River. Part of the area was contaminated by past industrial activity and became a partial wasteland. The site was abandoned

by birds but remnants of native estuarine plants remained.

The first major issue was how to manage this contaminated material. The cost and regulation involved in removing the material was prohibitive, so in 2003 a resource consent was granted to manage that contamination on-site by isolating the material on-site by lining, sealing, capping and bunding the material. This created a hillock over which clean topsoil was placed and shrubs planted. Beside the hillock was a hole that became the wetland. The management of the contaminated material appears to have been successful with monitoring of groundwater and surface-water around the site failing to detect any contamination.

View of the finished landscape from the track

Most of the area was scraped with excavators to remove couch, a very difficult weed to control any other way. A moat was created around islands to allow the public to come and look at birdlife on islands without dogs or people getting onto the islands.

The islands were planted up with bird habitat in mind. On the mainland opposite the island a walking track was constructed and waist-high plants established adjacent to the track on the estuary side so birds cannot see the lower part of the people or dogs. This was created because the movement of people's legs was found to upset the birds. Birdlife returned in good numbers. Now efforts are being made to try to get them to go to other restored sites.

Grooved surface assisted colonisation

Tidal connection was restored to part of the wetland area. Initially, it looked like hypersaline conditions were developing, with the scraped area looking white with salt. Most of that salt gradually leached out with rain and was colonised quickly by salt marsh species such as glasswort. Freshwater springs adjacent to the contaminated site were very polluted but are now clean.

The initial aim of the project was to restore full tidal flushing to the estuary by disestablishing the causeway that bounded the excavated and restored wetland. However, forming the walkway prior to the causeway removal meant that a loop walk was created, which led the local Community Board to turn down the project to remove the causeway or even develop more culverts to increase tidal flushing. It turned into a defining issue where the Bexley Wetland Trust members resigned in full and the trust was disestablished. The current situation is that at two low points on the walkway the tidewater overtops at high tide. The lesson from this is that public expectation of usage was predominant. If this project was to start over, the recommendation would be to take down the causeway first then build a walkway.

2.3.1.2 Charlesworth Reserve

This reserve is located adjacent to the Avon-Heathcote Estuary near Ferrymead. The tidal connection was lost due to the road constructed (to link with Linwood Avenue). After the road was put in, salt marsh herbaceous plants died and birdlife went elsewhere. The land was set for industrial development but with the values of the estuary becoming better known and articulated by the community, Christchurch City Council then designated the land as a reserve.

Features of this restoration:

- major terraforming undertaken;
- islands and moat created;
- major planting programme but a number of failures of salt marsh revegetation occurred;
- weed management – couch – concerted effort to control before any thing else is done;
- water rat and pest problems.

The area was scraped, tidal connection returned and many Glasswort and sea primrose meadows established within 18 months. The project was set up and continues to be run by ranger and ornithologist, Andrew Crossland. Andrew has tried many experiments in this reserve and has learnt a lot from the successes and failures. Most of the planting effort was around the margins with coastal shrubs.

Sea rush was planted from Christchurch City Council nursery but most of them died, but divots have worked well. This is most likely to be due to salt shock. Of all estuary plants, sea rush is the most sensitive to salinity fluctuation. Andrew is using an area at Charlesworth for next restoration, oioi and sea rush. Birds have become prolific in the area again. Bird viewing areas are being constructed when the vegetation becomes thick enough. Three piers were put in to view the birds. The area still has some impounded water caused by over-excavating in some areas creating pools. However, there is a good tidal outflow through the new 1.5 metre diameter culverts and piers.

Divots planted in Charlesworth wetland

2.3.1.3 Ferrymead Park Wetland

This salt marsh is located near the mouth of the Heathcote River and is an adjunct to other developments. Features of this restoration project:

- Major planting programme
- Ecological versus amenity issues
- Vandalism problems

These areas become useful in gaining connectivity between people and natural environment. A series of stepping stones to educate people and get them interested in natural areas.

2.3.1.4 Other Restorations

- **Brooklands** – a southern back lagoon of the Waimakariri River. This restoration has occurred because of an agreement with the developer of an adjacent subdivision who is doing the work for Christchurch City Council. Again, islands for birdlife and stream channels created in the mudflats.

- **Linwood Paddocks** – Lots of planning has been done to get salt water back into this area. However, the expectations of other users (horse riders) have currently put a hold on this project.

- **Avoca Stream** – The main objective for this reserve is for plant biodiversity protection and enhancement (not birds). In the past, the stream bed was impounded and the water diverted down new straightened channels. This project will return the low flow water to the original meandering stream channel, which flows into the estuary as a natural delta. Around the mouth salt marsh will be replanted and any landforms created will be natural. There has been riparian planting along the freshwater stream but the interesting challenge is how to restore the area where the fresh water and salt water mix.

Cost of Estuary Restoration in Christchurch

The budget Christchurch City Council has outlaid over the last 10 years was $2.5 million for the Avon Heathcote estuary and includes restoration, recreation, pathway construction. The Brooklands area has so far cost a lot less. Councillors are very much in favour of this work, which is why it received a reasonable budget. Arrival and departure of godwits has been handed to the Christchurch events co-ordinator and they make a prominent feature of it, including ringing the Cathedral bells. If you develop iconic events like this and increase its profile, it makes to easier to attract the money to progress the initiative.

2.3.2 Estuary Restorations in Nelson

Hoddy Estuary Park Development, Waimea Estuary – Roger Lusby

This 6 hectare park has been gifted to the people of Tasman/Nelson by Peter Owen. Maybe part of this park could be set aside for the restoration of estuary and margin. A lot of habitat that has been lost could be returned. Tasman District Council's policy in relation to ponds in parks meant that it had to be fenced like a swimming pool. A compromise has been worked out to fence the whole park into two parts, that with the pond being turned into a wildlife reserve with some bird protection, with the other part for recreation.

Hoddy Estuary Park

There is ongoing discussion about creating habitat to try and reintroduce some of the species lost, eg, Banded Rail. Department of Conservation (Graham Elliot especially) has supported this. The plan is to batter the slope to recreate the upper salt marsh so we have the right species being planted for at least 10 metres around the estuary. Some edge has been orchard and there is grass right to the estuary and then a gap where rushes, sedges are growing and then mudflats.

Hoddy Peninsula and O'Connor Creek Delta

Where there has been a lot of disturbance to an estuary in the past, such as siltation and run-off of pesticides from orchards, undertake some trial plantings and see what happens. Let plants tell you. If they survive in some areas and not in others with all habitat parameters the same, then it could be worth taking samples to confirm the issue then undertake remediation as necessary. The alternative is sample the estuary for these chemicals, but that is very expensive. "State of the Environment" monitoring of estuaries generally looks at representative habitat, including bulk vegetation units. Detailed information about discrete or isolated areas of the estuary affected by point-source discharges is done as part of the resource consent process. Toxic chemicals in sediments at concentrations above guidelines should be considered for restoration in areas around major industrial areas such as near the mouth of Jimmy-Lee Creek in lower Beach Road in Richmond.

3 ESTUARY MANAGEMENT ISSUES

3.1 Access and Dogs

A Solution for Reducing Bird Disturbance by People and Dogs

Ornithologists in Canterbury found that birds were only scared off by people walking dogs around wetlands when they detected quick movements. If the rapid movement of people's legs and darting of dogs was screened by waist-high vegetation, birds were remarkably undisturbed. This appears to be a win-win situation because people walking past can still look over the higher plants. The combination of seeing dogs and people together was also more disturbing than each individually.

Studies have shown people with dogs were more of a problem rather than dogs on their own *(R Lusby)*. People needed to be educated. Interpretative signs are also good. If there are none telling people it is a special place, they have less regard for the area. Education plus awareness equals protection. There is a need to show people what the benefits are.

People and Dogs at Motueka River Delta

The Motueka River delta and sandspit is an important open estuary area for wading birds. However, people walking dogs regularly scare off the birds. Options discussed include fencing certain areas for dogs or setting up proper dog exercising areas. The problem with this area is that it appears impossible to get the agencies who administer the land to take responsibility for the area. Department of Conservation administers the land above high tide and Tasman District Council below high tide. Forest & Bird *(led by Beth Bryant)* is particularly keen to see this issue resolved.

Setting up Wildlife Sanctuaries in Estuaries

Forest & Bird would like to see esplanade reserves set aside for biodiversity protection rather than what appears to be the policy of allowing access by people everywhere. In some instances esplanade reserves are managed by Department of Conservation rather than Tasman District Council. This has not necessarily resulted in the kind of outcomes Forest and Bird would like to see. Christchurch City Council has found that creating esplanade reserves in the current political framework very difficult *(Trevor Partridge)*. There have been several cases in different Avon-Heathcote estuaries where people have gone right past the "No Dogs" sign into the reserve and deliberately let dogs off to chase the birds.

Tasman District Council has not discussed segregating areas within estuaries to enhance those particular values, but this discussion will be occurring in the next year for Waimea Estuary.

The Council is developing a walkway link from ASB Aquatic Centre around the estuary to Sandeman reserve (in various stages of completion). In time, this link will extend right to Mapua. The objective is to maximise recreational potential of estuary frontage, giving people close-up experiences of estuarine ecosystems and allowing pedestrians and cyclists a safe and extremely scenic passage from Richmond to Mapua. While this may conflict in some limited situations with biodiversity enhancement, this workshop has helped in trying to achieve a better balance between these competing objectives *(Steve Richards, Parks & Reserves Department, Tasman District Council)*.

Debs Martin, Regional Field Officer, Forest & Bird – there are a lot of people from Forest & Bird (F&B) and other groups restoring habitats in estuaries and in catchments draining into estuaries throughout the District, eg, "Friends of Mangarakau". In the Motueka delta planting has sometimes met with opposition. When it comes to conflicts between recreational use and habitat restoration, Debs stresses that dialogue is important. It is important we have discussions like this workshop. F&B acknowledges people want to walk dogs, but it is best that they are not next to birds nesting. There needs to be recognition of the expertise, knowledge and passion of volunteers. Forums, such as this, help build relationships that are important for getting some of the projects going.

3.2 How to Deal with Off-road Vehicles Driving on Estuaries and Sandspits

Motorbikes, including 4 x 4 bikes, are popular for "tearing-up" areas near and within estuaries. Again, regulations and rapid response by rangers is very important. In Christchurch, as soon as it is reported they are out there in minutes asking people to move on. Rangers have keys to locked gates, which allows them to respond in vehicles if necessary.

In cases where maintenance of infrastructural assets is necessary, eg, for a sewer main or power line, there is a very real need to make sure that the minimum of damage occurs through careful planning.

3.3 Sewage Discharges in Estuaries

With adequate treatment of sewage, as well as adequate dilution and dispersion of the treated effluent, estuarine ecology will not be affected. In fact, the ecological productivity of several New Zealand estuaries has often been found to increase with the additional nutrient supply from sewage treatment plant discharges. With the greater supply of microalgae, shellfish become more plentiful and increased birdlife can result. In most estuaries that are open to good tidal flow, including most of Nelson-Tasman estuaries, the effects of discharges are usually very localised, if present at all.

It also needs to be recognised that where there is intensive land use, including urban development, there will be problems with faecal contaminants. Usually, adverse effects are for a few days after rainfall events, or due to accidental spills. People have the option to avoid swimming within a day or two after a heavy rainfall event and can avoid harvesting of shellfish a week or so after such rain. Again, the health of the ecosystem is not unduly affected by these events and birds such as godwits will not be affected. As a precaution, it is recommended that harvesting of shellfish does not occur within estuaries bordered by urban centres, or those that have wastewater treatment plants that discharge into them.

3.4 Road Building across Estuaries

Impounding estuarine habitat behind causeways and restricting tidal flow usually leads to very significant adverse effects *(Trevor Partridge)*.

Moira Tilling, Tata Beach Coast Care

Makes comment that the healthy little Ligar Bay estuary in Golden Bay is facing pressure from road widening. When it comes to widening Abel Tasman Drive, it needs to be recognised that banded rail may live there and it is a healthy estuary. She does not know how to manage to accommodate traffic and retain a very healthy estuary. There is some desire to straighten the road, which will take the road through the wetland. She would like to see communication between engineers and people who know about the birds.

Mapua Causeway Rehabilitation

On a positive note there are plans in place to improve tidal flushing in the Mapua Inlet by constructing two more culverts under the causeway on Toru Street, Mapua. Currently, the impounded water behind the causeway can lead to excessive algal growths, build-up of organic matter, depleted oxygen and odour issues. Any likely adverse ecological effects that result are likely to be mitigated by the increased flushing from the new culverts and the restoration of a "normal" tidal cycle *(Trevor James)*.

Tasman District Council Planning Controls for Roading across Estuaries?

Steve Markham – Within Tasman District Council we are going through some quite revolutionary processes attempting to apply best environmental practice to traditional engineering. At this stage, it is mainly in regard to urban stormwater; but there is a need to be doing the same in relation to coastal ecosystem management, with green space and service corridors, including widening roads.

3.5 Sediment in Estuaries

Sediment accumulation in estuaries happens naturally at rates of 1-2mm/year (coming from the natural bedload of fine sediment in rivers) but when rates are increased to 20-30mm/year adverse effects occur. Such adverse effects have been witnessed in many estuaries around New Zealand, including parts of Tasman District. Most sediment is delivered to estuaries during big flood events.

There is no easy restorative solution once fine sediment is in the estuary. In most cases, trying to remove the sediment is practically very difficult, expensive and causes far greater adverse effects than doing nothing. In a few cases, sediments may be able to be flushed out, resulting in the least ecological disturbance. In some of these cases, there may be better functional value from reclaiming the area of accumulated mud and planting with terrestrial plants and putting effort into declaiming other areas.

Forest harvesting, roading and tracking can cause dramatically increased sediment discharge rates, if not well managed. For most of Tasman District, forestry practices have vastly improved and environmental management systems have been refined and are now considered as best practice. For example, during forest harvesting logs are no longer routinely dragged over the ground, thereby avoiding ground disturbance.

Tasman District Council is putting more effort into management of sediment at source. Earthworks associated with subdivision activity need a sediment and erosion control plan to be produced, which will differ depending on site conditions. Controlling discharge at source, well before stormwater can get up speed and move the sediment to a waterway, is the recommended priority. Council's Engineering Standards (which are based on Auckland Regional Council's Technical Publication #90) outline a range of best practices including: bunding a site to stop clean stormwater entering the site, working to the contour rather than up and down the slope, placing a series of anchored hay bales and/or silt fences in channels within and downstream of the disturbed earth (particularly small lots), regrassing or revegetating disturbed areas as soon as practicable, and larger sediment traps, with the option of using flocculants for better settling of sediment. Many of these measures slow down run-off and reduce erosive power.

The Resource Management Act requires councils to consider the effects of the land use rather than the land use per se. There are many factors that can cause sediment discharges which are common across different land uses, eg, roading. There is a variety of regulatory controls in the Tasman Resource Management Plan, including site-specific, catchment-specific and practice-specific controls. For permitted activities such as forest harvesting, Council relies on best practice being followed as well as some effects-based outcomes being met, eg, downstream water clarity not being reduced by more than 40%. Many of these best practices are conditions of permitted activities.

4 COUNCIL PLANNING PROCESSES THAT RELATE TO ESTUARY MANAGEMENT

1 The Long Term Council Community Plan (LTCCP) is the most important plan being derived by Council-community consultation. It develops the vision for the longer term in partnership with the community and guides how the Council allocates funding year to year. It looks forward 10 years, with a review every three.

2 Annual Plans are guided by the LTCCP but there is some scope for reprioritisation. These plans are open to submissions annually.

3 Biodiversity Strategy – in formulating Nelson City Council's Biodiversity Strategy, input was sought from a large range of stakeholders, including the Council's parks and reserves people. They were enthusiastic and supportive and wanted the document to underpin reserve management strategies. They are involved in action planning groups to identify priorities. The Strategy relies on individuals and commitment to maintain the progress. This process is working in Nelson. The Tasman District Council has not developed such a strategy but is watching the Nelson process closely. It currently

uses available funding to target biodiversity action now on the ground, rather than spending it on the development of a plan *(Lindsay Vaughan)*.

4 Tasman-Nelson Regional Pest Management Strategy – only those plants or animals listed in this Strategy will be controlled or eradicated (if possible).

5 Protected areas under the Reserves Act. In Christchurch City Council one staff member is employed full-time to sort out the legal status of land in and around reserves. In some cases, they have found areas they thought were reserves were actually not. Christchurch City Council is allocating land to four types of reserves: garden or heritage parks, sports parks, urban parks, regional parks. Management of all reserves and Council land, whether in reserve or not, has been delegated to regional park rangers.

6 Management plans – Christchurch City Council has developed these for many of its estuaries and is now integrating all those around the Avon-Heathcote into one management plan to cover all the estuaries (called Green Edge). This should lead to efficiencies for funding through the LTCCP/Annual Plan process. Having staff (ie, rangers) to give effect to these plans is important for the successful application of these plans. The Reserves Act requires management plans for individual reserves.

7 Resource Management Act plans – eg, the Tasman Resource Management Plan, set out the objectives, policies, and methods (including rules) for the environment. These plans are not an operational framework and therefore do not set out funding allocations.

Steve Markham, Tasman District Council Policy Manager

Tasman District Council's effort in resource management planning has geared up a notch in the last couple of years, with urban development planning happening around all coastal environments, and in particular Richmond West, and long term thinking in immediate months ahead as Council reviews the 10 year plan and servicing needs. Issues raised during this workshop are useful for us in addressing the potential contest between estuary resources. Two major issues that emerged from the workshop were: the impacts of roads reclaiming estuary and allocation of green space (reserve) to protect vulnerable coastal ecosystem from human and dog disturbance on the margin and dry land side of the estuary. This latter issue sees competition for the desire in communities (and through the law) for people to have recreational access (to the estuary) that does not then lead to damaging the system.

All this comes home to Council to try and find a way through, with good input from everyone to avoid conflicts. Council intends to set up a meeting in the near future with representatives of key stakeholder groups to find the best process for resolving these and other issues in the Waimea and other estuaries. Developing a management plan for the estuary is one way to achieve this but it is potentially an expensive tool so we want an efficient community planning process. Through the process, we need to update our scientific knowledge of estuary values and risks, and then review the management issues and priorities for action. This should lead to proposals to amend the planning framework for estuary and contributing catchments under the Tasman and Nelson Resource Management Plans, and other strategies and programmes of investigation or works.

It appears that little is known about the influence of the Seabed & Foreshore Act on land tenure in this region.

There will always be a natural tension between Council's Environment & Planning and Engineering Departments. This tension is similar to tensions with other developers. As best management techniques advance and we communicate more, environmental management improves. Internal seminars across departments, including consents and compliance staff, are all adding to improved performance. Over the last 20 years there has been a lot more emphasis on freshwater environments than estuaries. This changed in 2002, partly due to the Central Government support in starting off our estuary monitoring programmes. Like all organisations, systems do not always work. Not always does the consultation happen as it should

internally. Science input, for example, has not always been applied adequately to all consents. As staff turns over, new people come in and experience is lost and applying the right regulations may slip.

Within each Council there are people who have specialist knowledge that should be applied to the design of developments.

5 THE ROLES OF VARIOUS AGENCIES IN ESTUARIES

1 **Department of Conservation (DoC)**

DoC has handed responsibility of all coastal reserves to Christchurch City Council in its area. While DoC reserves exist in or around many estuaries in Nelson/Tasman, it does not have an operational role in managing estuaries in Tasman-Nelson. However, DoC does undertake some surveys of rare plants and has a project to restore these populations, eg, Sandy Island in Moutere Inlet.

2 **Iwi Agencies**

Monitoring, targeted input into resource management planning.

3 Councils actively manage the estuary in the following regard:

(a) *Regulation*

Regulate discharges to, structures in, on or under (including any reclamation), disturbance to, or other such matters. This includes consenting and compliance monitoring.

(b) *Pest Management*

Tasman District Council/Nelson City Council jointly actively manage certain pests (those listed in the Pest Management Strategy) in and around the estuary. Eradication of the pest plant *Spartina* in the estuary was one major exercise in this regard.

(c) *Designation of Significant Natural Areas*

Several estuaries in Tasman and Nelson have been listed as having special ecological significance (eg, Waimea, Farewell Spit and Motupipi) and this must be taken into account when issuing resource consents.

(d) *Monitoring*

Councils are required to monitor environments that are under pressure from various activities to determine the isolated effects of individual activities and accumulative effects of multiple activities. Both Councils have "State of the Environment" monitoring programmes for estuaries.

(e) *Education and Advocacy*

Where there are adverse effects and degraded environments in estuaries that cannot be addressed through compliance and enforcement (eg, historic activities where responsible parties have moved on), or require integrated management across many landowners, councils are obliged to raise awareness in the community of the issues and look for ways forward to manage this.

6 CULTURAL VIEWPOINTS ON ESTUARY RESTORATION – RESTORING MAUI'S PANTRY

Kai moana and spiritual values of estuaries are of great significance to Maori.

One of the difficulties with Maori cultural health monitoring is the very limited number of individuals able to be involved. This means that the number of sites that can be studied is limited and there is limited opportunity to look at potentially impacted sites. Monitoring is mainly focused on reference sites representative of general health of the estuary. There is a good opportunity for linking Maori cultural health monitoring with Western science monitoring protocols.

Quality of Shellfish in Waimea Estuary

Nelson City Council has monitored shellfish for the purpose of assessing food safety (concentration of *E. coli* and other disease-causing organisms in shellfish meat) at several sites around Nelson. The quality of shellfish varies and in many cases is not suitable for human consumption. It is a very difficult issue to manage around urban development, as there is a wide range of sources of contamination, which are difficult and expensive to track.

Tasman District Council has made a decision not to sample shellfish regularly for food safety reasons around urban areas. We know that after any reasonable rainfall event the shellfish downstream of many urban areas are likely not to be safe to eat for a couple of weeks. This message has been communicated regularly. However, if there is a particular site that has a specific value for recreational shellfish harvest where the options for management have reasonable chance of success, Council would be open to investigate. Faecal matter from pets (particularly dogs) has been found to be a reasonable contribution to contamination. While we provide the doggy-doo bags, many people still fail to take responsibility for their pet's actions.

Monitoring by the Tasman District Council has occurred for bivalves, molluscs and sediments around Mapua for contaminants originating from the former Fruitgrowers' Chemical Company plant, in order to determine the extent of the issue and the remediation required (see field trip notes). Bivalves and molluscs are also targets for monitoring around other industries bordering the estuary.

Tasman District Council continues to run several catchment water quality improvement programmes in priority catchments in rural areas where the sources are more easily controlled (mostly discharges from farms, septic tank and sewage treatment plants) to reduce faecal inputs affecting commercial shellfish harvesting. Such catchments include the Aorere and Pakawau areas, the Motupipi and the Sherry River (subcatchment of the Motueka River).

7 EDUCATION IS PART OF THE KEY TO BETTER ESTUARY PROTECTION

Any new resource management planning provisions need wide support in the community before they can be effective. This support will only come if people understand and recognise the values at hand. With this valuing comes caring and even community policing. Education has a key role to play in this process. People who let their dogs run out and chase the estuary birds most likely do not know the consequences. In Southland's New River estuary, people are so aware of the importance of the estuary that they police their own areas and keep dogs out. The formation of a network of trails and quality interpretation panels has helped build this awareness.

With less understanding of estuarine values, community groups can actively oppose particular restoration. For example, in the Avon-Heathcote estuary in Christchurch, the Christchurch City Council was keen to transform a very straight estuary margin into a more natural margin. The idea was to construct a hooked spit made out of stone that curved around and allowed sediment to accumulate. This project was actively opposed by boaties, who think the estuary should be mostly for recreation and the structure would be too

much of a boating hazard, even though the effect would be temporary. With better communication of the values from both sides, compromises can be reached.

One very successful education campaign developed by "Friends of the Avon-Heathcote Estuary" was the celebration of the godwits' migration. There is a celebration when they arrive and again when they leave. At first, there were 20 or 30 people turning up to the events, and now the Cathedral bells ring out and thousands of people go and see the godwits arrive. This campaign has educated thousands of people about the value of estuaries. Before they heard the godwit story, they hardly knew what an estuary was or its ecological importance. Now it has value for the community. Christchurch City Council began to see the values and policies are changed.

Managed access points to the estuary are important; setting aside areas for high contact and low contact so that people have good exposure to the estuarine environment but managing them so that wildlife have other areas where disturbance is kept to a minimum.

Studies carried out on the Avon-Heathcote estuary in Christchurch over the past 30 years have now been reproduced within a book that is a tremendous educational resource. It would be great to do that for the Waimea Estuary.

8 MONITORING ESTUARY HEALTH

Trevor James, Resource Scientist, Tasman District Council

8.1 How we Measure Estuary Health – The Challenge of Monitoring Diversity in Space and Time

(a) A variety of habitats:

- Salt marshes
- Mangroves
- Seagrass beds
- Unvegetated intertidal flats
- Tidal channels
- Subtidal habitats

(b) Daily and seasonal change:

- Salinity and tides
- Current flow
- Temperature
- Turbidity

8.1.1 Broad Scale Mapping

(a) Identifying and mapping the boundaries of the dominant habitat types.

(b) Habitat identification based on:

- Dominant features of the unvegetated substrate (mud, sand, cobble, etc); or
- Dominant vegetation (combinations of plant species)
- Involving:
    - Aerial photographs
    - Ground-truthing
    - Digital mapping using GIS

Broad Scale Mapping – How Does it Work?

- Producing a series of enlarged photographs that are then "ground-truthed".
- Ground-truthing is mapped to create GIS layers, which can be selected individually and built in layers.
- Areas can be calculated as area units or as percentage cover.

8.1.2 Fine Scale Mapping

(a) Sampling for a suite of variables:

- Sediment core profile
- Epifauna (surface animals)
- Infauna (animals in the sediment)
- Macroalgae (eg, sea lettuce) and microalgae (coloured films)
- Physical and chemical analysis of the sediment:
    - Grain size (percentage mud, sand, gravel)
    - Ash-free dry weight (organic content)
    - Heavy metals (Cu, Cd, Ni, Pb, Zn and Cr)

Three or four sites for each estuary are measured. The selected sites are representative of a larger area. An additional benefit of this type of monitoring is that it links in with consent monitoring.

For further information on monitoring for non-scientists, refer to: *Robertson and Peters, 2006. Turning the Tide, An Estuaries Toolkit for New Zealand Communities.*

8.1.3 Measuring Sedimentation Rates

Until recently, there had been no specific investigations of sediment accumulation in Tasman's estuaries. Visual observations made during walks across the mudflats are useful to identify if there is likely to be an issue with excessive sediment deposition and therefore whether further detailed monitoring needs to be undertaken. The most cost-effective way to measure sediment accumulation is using sediment plates. These work by installing a series of metal or concrete plates in areas representative of larger areas of estuary where mud is likely to accumulate. They are placed about 300mm below the mud surface and measured up to the mud surface. Tasman District's first sediment plates were installed in the Motupipi estuary in 2007. Such plates will be installed in the Waimea Estuary in winter 2008. These plates will be used to measure the rate of accumulation or degradation each year.

Determination of patterns of deposition, resuspension and redistribution of sediment is very useful in addition to the sediment plates. In particular, it can ascertain how much sediment is coming in from external sources and how much is actually resuspension within the estuarine environment. However, this has not been undertaken to date in Tasman or Nelson estuaries due to cost. Several studies in New Zealand estuaries have measured these factors. For those experienced in these matters, a reasonable determination of these factors can be determined intuitively. There is a trade-off in terms of information you want, level of accuracy and actually doing what we know is best land management to minimise sediment inputs.

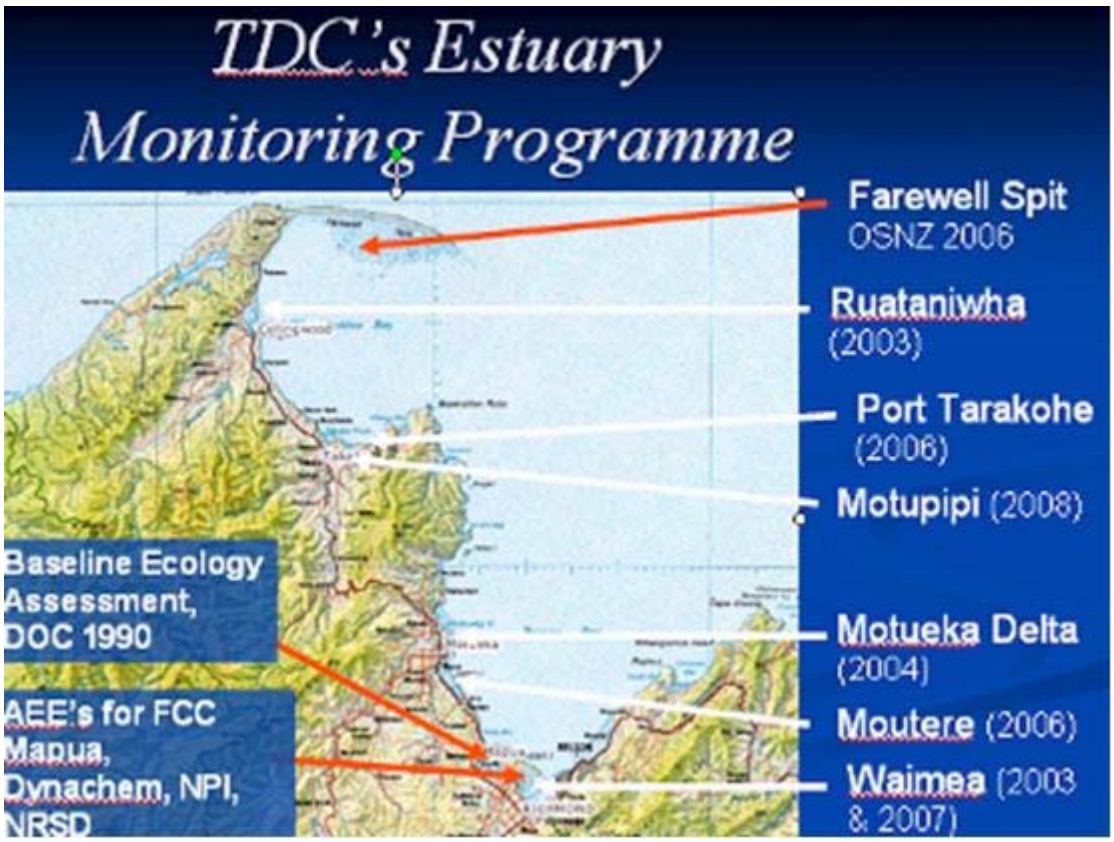
Refined aerial survey or photographic techniques, such as LiDAR, are very useful as they can provide sedimentation rates covering large areas of estuary. However, these methods are costly and the accuracy is limited to =/-10cm. Tasman District Council has flown the Ruby Bay/Mapua area and the coastal area from Tapu Bay to the Kina bluffs with LiDAR and it is hoped that with resurvey in the future changes will be identifiable.

In several estuaries around New Zealand sediment cores have been taken and accurate dating (eg, from pollen indicators or radioactive isotopes) can reveal sedimentation rates over various periods in history. Most often there is a marked increase in these rates in the mid-late 1800s when Europeans arrived and to a

lesser extent with Maori burning off areas of bush. Such sediment coring is expensive ($30,000 per site) and has not been undertaken in this region to date.

8.2 Monitoring Programmes of Tasman's Estuaries

Tasman District Council began its estuary monitoring programme in 2002 and has so far has completed six estuaries or embayments (Ruataniwha, Motupipi, Tarakoe, Motueka delta, Moutere and Waimea). National protocols have been used for this monitoring, which has been contracted out to either Cawthron or Wriggle Ltd. Only one sampling event has been undertaken at each of these estuaries except for the Waimea (two sampling events). Additionally, to provide an historical perspective, each estuary has had two dates in the past selected to have the broadscale habitat mapped from high quality aerial photographs. Typically, these dates are in the 1940s and the 1980s.



Key Investigations in Estuaries in Tasman

In addition to this monitoring, there has been fine-scale infauna monitoring in the Waimea Estuary of various discharges (Fruitgrowers' Chemical Company, Dynea, Nelson Pine Industries and the Nelson Regional Sewage Discharge). The Ornithological Society undertook a major study of Farewell Spit in 2005-06, which integrated bird and infauna investigations. Department of Conservation undertook a groundbreaking baseline assessment of Waimea Estuary in 1990 and a similar survey in the Westhaven Inlet.

Ruataniwha Estuary – view towards Collingwood and Golden Bay beyond. The condition of this estuary was regarded as virtually pristine.

State of Motupipi Estuary – Summary

- Sedimentation – High in Western Arm
- Eutrophication – Fair in Western Arm
- Habitat remaining – Very high (apart from terrestrial buffer areas)
- Contaminants – High faecal contamination but very low levels of toxic chemicals

State of Tarakohe Harbour – Summary

- Sedimentation – Low
- Eutrophication – Low
- Habitat remaining – Low
- Contaminants – Metals – Low, disease-causing organisms – moderate
- Invasive species – *Undaria, Didemnum* and *Gelidium*

State of Motueka Delta – Summary

- Sedimentation – Low-moderate
- Eutrophication – Low
- Habitat remaining – Moderate (pre-1946 200-300 hectares was reclaimed, ~50 hectares reclaimed from 1946-1986, no significant estuary loss between 1985 and 1999)
- Contaminants – Metals – Naturally Moderate
- Disease-causing organisms – Low-moderate

State of Moutere Inlet – Summary

Sedimentation – Generally Low
Eutrophication – Low-moderate (high at times)
Habitat remaining – Not analysed
Contaminants – Metals – Low
Disease-causing organisms – Low

State of Waimea Inlet – Summary

- Sedimentation – Generally Low, no sediment anoxia or gross signs of pollution
- Eutrophication – Low
- Habitat remaining – Moderate (~160 hectares of reclamation since 1946, only 8 hectares lost between 1985 and 1999)
- Contaminants – Metals – Well within acceptable guidelines (except Ni and Cr – elevated due to catchment mineral deposits)
- Disease-causing organisms – Moderate

- Invasive species – *Spartina* (under control)
- Unusually high prevalence of herbfields
- Macrofaunal species richness indicated relatively diverse and healthy sandflat habitats consistent with a range of other New Zealand estuaries

Trend in Estuary Condition

- Conditions in 2006 remained similar to 2002
- All observed changes from 2001 to 2006 may be attributed to natural variation

Aerial photography available from 1940s, 1950s, 1980s and more frequently over the last decade has identified that the major losses of estuarine habitat occurred even prior to 1940. Causeways were installed, industrial development reclaiming more land, drainage of surrounding swamp land. From visual evidence, there has been a large increase in the amount of fine sediment discharged to the estuary since the 1940s. These features are the most prominent. What the more subtle changes to plants and animals are telling us is much more difficult to determine.

Water Quality Monitoring in and near Estuaries in Tasman District

Tasman District Council monitors faecal contamination around recreational beaches in or near estuaries in Tasman District. Below are the sites in Tasman Bay. For more information look up the Council website: http://www.tasman.govt.nz/index.php?Swimmingwaterquality

8.3 Case Study: Sponge Gardens of Waimea Inlet

Kim Clark, Cawthron, Funded by Envirolink, Tasman District Council and Nelson City Council

Through broad-scale mapping of Waimea Inlet as part of Nelson City Council/Tasman District Council estuary monitoring programmes carried out by Cawthron, two areas of biologically diverse sponge-associated communities were discovered. One area is located in the Saxton-Monaco channel and the other near the western end of The Traverse between Rabbit and Rough Islands.

Prior to 1998 the presence of causeway in The Traverse between Rabbit and Rough Islands in Waimea Inlet caused restriction of tidal flows and resulted in a lagoon where thick algal mats of *Enteromorpha* and *Gracilaria* dominated. After the removal of the western causeway in 1998, natural flushing was restored, which has removed much of the mud that covered the naturally stony substrate on which the sponge gardens grow on the spring low tide level. In this narrow arm of the estuary the water velocity is high and flows north-west towards Mapua. One hundred and fourteen species of animal and plants are found in these sponge gardens, making this area a hot spot of biodiversity.

Forest & Bird has been involved in planting in The Traverse to see what would survive. The survival rate has not been brilliant, possibly because of animal pests.

The sponge garden near Monaco has a lower diversity (69 species). This also exists where there are strong current flows passing over shallow subtidal cobble-shingle substrate.

By comparing 1940s aerial photos with later ones it was shown that forestry had been established on what was once estuary. Now that the trees have been removed, salt marsh (mainly glasswort and sea blite) has naturally re-established. There has been discussion about opening the remaining causeway under the main access road to Rabbit Island. Replacing that with a bridge would not change tidal range but would affect flushing regime to some extent. An additional benefit of opening this remaining causeway to a full channel would be that flooding risk from the Waimea River could be reduced. When the Waimea River is in flood The Traverse has an outflow gradient towards western Mapua of approximately 1 metre difference. This may not lead to a significant ecological benefit because at the eastern end reasonable depths of fine sediments exist.

The Traverse is also affected by other activities such as water craft and jet skis. Their propellers directly disturb the muddy bottom when the tide lowers and birds get scared away. There is a need to consider conflict between uses and question what it is that the community wants for that area. A rowing course for this area was proposed but now such a course is suggested for construction on the island itself.

A full report on this topic is available: Asher R, Clark K and Gillespie P 2008. Waimea Inlet Sponge Gardens. Prepared for Tasman District Council. Cawthron report No. 1467.

8.4 Monitoring Programmes of Nelson's Estuaries

Paul Sheldon, Environmental Monitoring Co-ordinator, Nelson City Council

Overview of Current Projects:

- Remapping of the Waimea Inlet
- Broad scale mapping of Nelson Haven and Delaware Inlet
- Fine scale mapping of Delaware Inlet
- Review of dredge exclusion zones
- Nelson Biodiversity Strategy Coastal and Marine Action Plans
- Nelson City Council/Port Nelson Ltd Nelson Haven monitoring
- Top of the South Marine Biosecurity Strategy
- Ongoing bathing water monitoring

Assessment of Nelson Haven and Delaware Bay

Delaware Inlet is still largely unmodified but is under pressure from rural run-off and urban expansion. Iwi have been consulted, are supportive and keen to be directly involved in the sampling.

Broad scale mapping. The output will summarise existing information including:

- Location, size and estuary type
- Morphology, hydrology
- History of human occupation
- Catchment characteristics (area, geology and soils, land use, water quality)
- Historical fine scale benthic data
- Estuary values and uses
- Historical intertidal vegetation maps (in GIS format)
- Recommendations for incorporation into a co-ordinated Nelson Bays State of the Environment monitoring programme

Fine scale sampling will follow the broad scale mapping in spring 2008.

Review of Dredge Fishery Exclusion Zones

- Environlink funded. Work being undertaken by NIWA.

- Advice will research and compile existing information sources to characterise the likely ecological benefits (and/or costs) to the coastal environment resulting from introduction of dredge fishery exclusion zones.

- Uses of this study will include:

    - Assessment of the value of dredge fishery exclusion zones to the local community
    - To aid the fishery managers to configure exclusion areas to maximise benefits to local ecological services and minimise effects to the fishery
    - To form part of a wider resource inventory of Nelson's Coastal Marine Area

Nelson Biodiversity Strategy – Coastal and Marine Action Plans

- Funded by Biodiversity Advice Fund grant

- Undertaken to give effect to the Nelson Biodiversity Strategy through developing an agreed set of priorities and actions within the coastal and marine areas of Nelson City Council (Biodiversity Action Plan)

- Preparation of the action plan is spread across a range of groups and organisations including iwi, Cawthron, NIWA, Forest & Bird, and Nelson City Council

- Cawthron's Board has pledged additional funding to assist the process. It is proposed to use this additional funding to compile an up to date coastal/marine resource inventory for the Nelson City Council area.

- The inventory will also benefit Nelson City Council's Resource Management Act functions, including coastal planning and consents and will make the data more accessible to the general public.

Nelson City Council/Port Nelson Ltd Nelson Haven Monitoring

- A joint initiative between Port Nelson Ltd and Nelson City Council.

- Involves a rolling programme of sediment quality testing within Nelson Haven and the port area.

- Analysis includes metals, pesticides, anti-fouling products, PAHs, sediment toxicity testing, shellfish bioaccumulation, and benthic infauna composition.

- Commenced in 2004, with the first four years (complete round) reported in 2007 (Cawthron 1328).

- The programme is currently being reviewed to ensure its relevance for Nelson City Council/Port Nelson Ltd needs over the next four years and to identify any reductions or efficiencies that can be made without compromising the usefulness of the output.

Top of the South Marine Biosecurity Strategy

- Originally instigated by the Port Nelson Environment Committee in response to repeated marine biosecurity failures in the top of the south and carried forward by Nelson City Council.

- Aims to prepare a high level strategy which is given effect to by agency operational plans. The aim is to improve:

    - understanding the roles and responsibilities of the various parties;
    - communication between the parties;
    - surveillance for potential incursions;
    - reporting of potential breaches; and
    - achieving a co-ordinated response.

- Supported in principle by Nelson City Council, Tasman District Council, Marlborough District Council, Port Nelson Ltd, Port Marlborough, Department of Conservation, Ministry of Fisheries, Aquaculture New Zealand.

- Strategy development funded by Biosecurity New Zealand.

- Facilitation and drafting contracted to The Lawless Edge.

Bathing Water Quality Monitoring

- Undertaken mainly for human health protection reasons but also provides an ongoing measure of faecal contamination of coastal waters.

- Involves weekly testing (during November-April) of main bathing beaches and water sports areas for enterococci.

- Also involves the testing of shellfish and shellfish areas for faecal coliforms.

- Nelson sites include:

    - Monaco
    - Tahunanui Beach
    - Rocks Road
    - Atawhai
    - Cable Bay

- All comply with the guidelines,

9 RECOMMENDATIONS

9.1 Ongoing Communication for Those Involved in Estuary Restoration

This workshop has obviously created a lot of positive energy and many have remarked that they would like to see that continue. One option is to meet in a year or so as part of the Tasman District Council Biodiversity forum (which meets twice yearly, usually during the day in a working week).

9.2 Incorporation of Information from this Workshop in Council Planning Frameworks

Council planning staff who have attended this workshop will have lots of ideas for a planning framework for better estuary management and support for successful restoration. The Waimea Inlet Strategic Plan, which is due to kick off this year, is one example of that. All people who have an interest in Waimea Inlet (such as many of you) will be consulted on this.

9.3 Produce an Estuary Restoration Guidebook

The intention is to start this process in November 2008. Proceedings from this workshop will form the basis of the content, with input from other experts from around the country. The booklet will be a step by step guide for the interested layperson to help with the whole process of estuary restoration.

Proceedings of the field trip are to be found in an accompanying document.

APPENDICES
(Follow-up Information to Issues Raised at the Workshop)

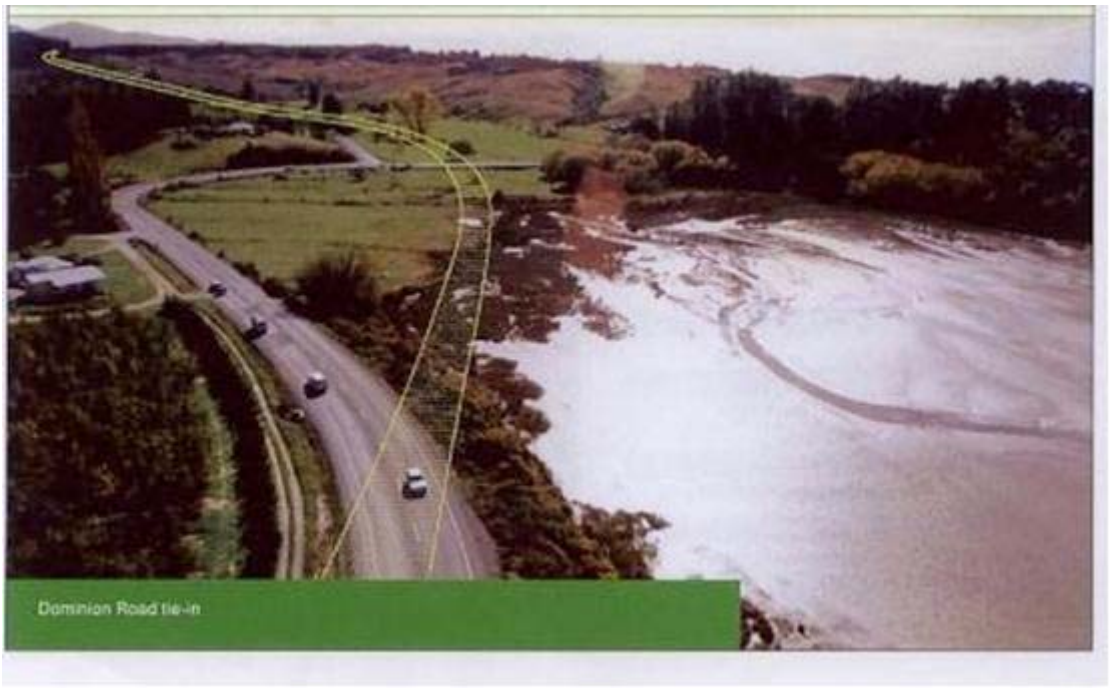
A.1 Ruby Bay Bypass

Consent for this motorway from Dominion Road by the north-west corner of the Waimea Estuary to Tasman on the Moutere estuary (bypassing Mapua and Ruby Bay) was granted 2002 (Resource consent number RM020676). This is a Transit New Zealand project, with Tasman District Council being the Consent Authority. While the project was ready to go in 2002, the funding rules changed and the project failed to get funding.

Anne Sheridan (Tiakina) – Iwi were commissioned to do cultural impact assessment, completed December 2007. People in the late 1990s did not lobby very effectively to keep the road away from the estuary edge. Barney Thomas asked that a Cultural Impact Assessment (CIA) be written. The CIA did not touch on the estuary side of things. The resource consents are in place until 2012. The CIA tried to protect and get estuary edges restored. A CIA is not a statutory document, they are up to applicant to take on board.

The road could have gone inland and been kept away from the estuary edge. Transit New Zealand has said that if it was made to put in a bridge, there would be no bypass.

Designated areas for State Highway at Dominion Road (top) and Trafalgar Road arms of the estuary



A.2 Rock Graffiti/Art in Estuaries

In the Moutere Inlet between Tasman and Motueka there are a considerable number of messages, names and "art" drawn in the estuary using cobbles found from the road embankment. Several people at the workshop expressed a view that it would be nice to see this "graffiti" cleaned up. In the wider community it appears that opinions are divided and this is considered "freedom of expression" or art.

Several years ago an individual got some positive media air play about a memorial to her late daughter written in rocks in the estuary. Others, including some higher profile people, have also spoken out publicly in favour of being able to do this "art". This contrasts with one or two locals in the inlet, who have continued to keep a small area of the estuary clear of the graffiti.

There has been discussion with Transit New Zealand as to whether it was a road safety issue, but Transit concluded that it was not. It is unlikely that there would be any significant adverse ecological effect.

The responsibility falls between Council and Department of Conservation (DoC). Much of the land in the Moutere Inlet is administered by DoC but DoC has said it was a Tasman District Council responsibility. In Golden Bay, DoC has taken on board some responsibility to keep areas free of this graffiti.

Nelson City Council has a policy of removal of estuary graffiti as soon as it appears in the Nelson Haven. Nelson City Council has not had to remove much of this rock work, probably because of the prompt removal.

A.3 The Effects of Treated Wastewater Discharges to the Waimea Estuary

In 2001, prior to the recent commissioning of a major upgrade to the Nelson regional sewage treatment facility, it was found that contaminants returned to background levels 1.6 kilometres downstream of the outfall *(Gillespie et al, 2001)*. Rapid flushing does not allow sufficient time for any effects to occur in the estuary. This is because the ebb tide discharge of effluent into the main channel near one of the tidal outlets results in the rapid dilution and export of nutrient-enriched waters to Tasman Bay, where they are further diluted, transformed and assimilated. During periods of high rainfall, the Waimea River was the main contributor of total N and P. During periods of low flow, the river and effluent contributions of total N were similar with total P contributions dominated by the effluent. Nitrogen concentrations from all sources (including effluent) discharged to Tasman Bay is a minor component of overall nitrogen in the bay *(Gillespie et al 2001, Zeldis 2008)*. While nutrients may not be the issue in this case, cultural and recreational use of shellfish resources is a strong reason for removing effluent. In the case of Waimea Inlet, the small streams feeding the inlet were the dominant source of faecal indicator bacteria compared to the effluent and the river when investigated in 2001. Following the significant upgrades to this regional sewage facility in 2005-2007, the impact of the treated wastewater will be reduced further.

In the case of the Avon-Heathcote estuary, Christchurch City Council aligned with recreational and cultural values and decided to remove the sewage discharge from the estuary altogether and has built an ocean outfall due to be commissioned later this year. It will take time for nutrients to decline and the productivity in the ecosystem to decline with it. The contribution of the wastewater treatment plant in the Avon-Heathcote estuary is vastly more dominant than the wastewater treatment plant is in the Waimea however.

A.4 Impacts of Fruitgrowers' Chemical Company Operation on Waimea Estuary near Mapua

This pesticide factory operated from the 1940s to 1988 and manufactured the persistent organochlorines DDT, dieldrin and lindane, as well as other agrichemicals. The factory discharged some of these contaminants into the estuary via the stormwater system during its operation and more leached from the site once it was closed. Over 1 hectare (1.1ha) of marine sediments near the southern boundary was found to be contaminated above acceptable guidelines and causing adverse effects for shellfish. This material was removed (and remediated) and replaced with clean gravel. Very low levels of contamination were found on the eastern boundary of the site near the Mapua wharf, probably due to strong tidal flushing but remedial work was also undertaken here.

Current monitoring of the site after clean up shows low levels of pesticide marine sediments close to the site, and in some of the surface-feeding snails. This is being monitored and these levels are declining over time.