Waimea Inlet restoration

Information for communities on best practice approaches

Department of Conservation
Te Papa Atawhai

CONTENTS

1. Purpose

This document guides landowners, communities and other stakeholders through the steps required to correctly restore **estuarine**, **riparian**, **wetland** and **terrestrial coastal** sites in Waimea Inlet.

If you have any comments, suggestions or contributions, please email the DOC Community Ranger, Motueka office: motueka@doc.govt.nz.

For further details, resources and detailed guides to running a restoration project in your area visit www.doc.govt.nz/get-involved/run-a-project.

2. Context

2.1 Why restore Waimea Inlet's native ecosystems?

Waimea Inlet is the largest semi-enclosed estuary in the South Island. It is recognised as a **nationally important** example of this type of ecosystem. Its estuaries and estuarine margins are home to rare and threatened native plants and animals, as well as important populations of coastal wetland birds and migratory wading birds.

Waimea Inlet from the air.

Estuarine ecosystems like Waimea Inlet play an important and complex role in providing a range of essential **ecosystem services**. Ecosystems are widely considered to provide four kinds of service:

- **Supporting** – e.g. nutrient cycling;, soil formation, and primary production
- **Provisioning** – e.g. providing food, fresh water, wood, fibre, and fuel
- **Regulating** – e.g. water purification, and regulating climate, flood, drought and disease
- **Cultural** – e.g. aesthetic, spiritual, educational, and recreational

Intact freshwater to saline vegetation sequences (how vegetation changes over an area due to changing soil and/or environmental conditions) in Waimea Inlet are extremely rare, as almost all have been removed or modified. Similarly, terrestrial ecosystems on the margins of the estuary, such as dune forests, have been extensively reduced regionally and

nationally. The few remaining examples of these are therefore extremely important not just in terms of biodiversity, but also because the ecosystem services and functions provided by these habitats are greatly reduced and still declining.

Appendix 1 describes Waimea Inlet's native ecosystems and vegetation sequences; ***Appendices 2*** and ***3*** give useful information about potential sites, and target plant, fish and animal species.

Almost gone

A recent estimate shows that:

- Only 5 remaining areas of natural vegetation reach 1 ha in size
- The total extent of all the remaining areas estimated to be just 10 ha (Figure 1)

Most, if not all, of these areas are secondary (i.e. not original) and most have a lot of exotic weeds.

The total land area around Waimea Inlet and up to 700 m inland is 4,085 ha – this means that **there is less than a quarter of a percent (<0.025%) of native terrestrial vegetation within 700m of Waimea Inlet**.

The few remaining examples of original vegetation are found in coastal bays where gentle land gradients allow salt-tolerant plants to grow alongside freshwater species near stream mouths or on drier ground further inland (Figure 1).

Identifying intact remnants and degraded areas where there are significant restoration opportunities is an important first step for landowners, local and regional authorities, stakeholders, and the local community.

Waimea River is the major freshwater input into the estuary, along with 22 other streams, many of which are affected by the tide. These freshwater streams and wetlands feed into Waimea Inlet so are intrinsically linked to the estuary's health and function, but are subject to their own pressures so should also be considered and included in restoration efforts.

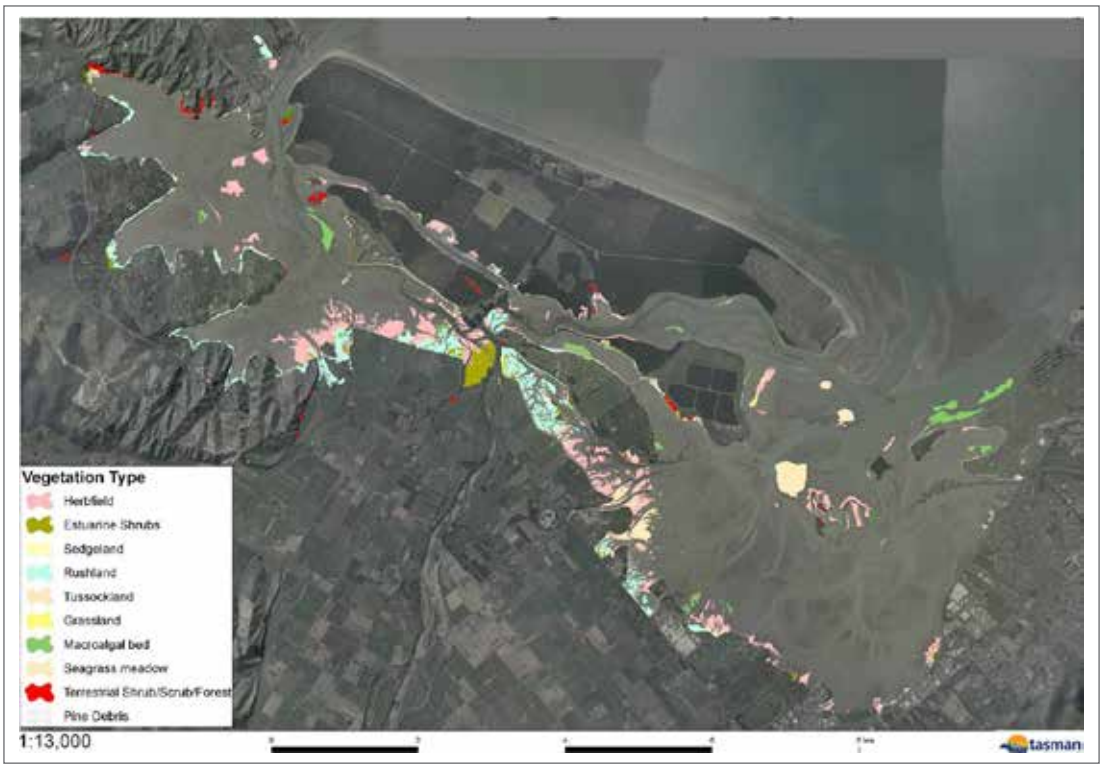


Figure 1. Remaining terrestrial native vegetation around Waimea Inlet (Tasman District Council).

2.2 Long-term benefits of restoration

- Enhanced tangata whenua values due to restoration of taonga species, wairua and mauri.
- Cleaner water feeding into Waimea Inlet estuary and Tasman Bay, improving quality of kaimoana and increasing health, cultural and recreation opportunities.
- Return of threatened native fish.
- Increased area and quality of whitebait/inanga spawning grounds.
- Increased diversity and abundance of macroinvertebrate communities, including crayfish/kōura.
- Preventing further regional extinctions of declining or threatened native plants and animals (e.g. banded rail) by expanding/creating habitat for them to re-establish in.
- Improve the extent, quality and ecological functioning of the last remaining areas of native vegetation sequences.
- Halt, or even reverse, the loss of rare ecosystems (particularly lowland ecosystems) to prevent their regional extinction.
- Creation and enhancement of 'vegetation corridors' from the sea to inland areas for native species to migrate inwards if sea level rises.
- Improved views and enjoyment for the people living and recreating in this area.
- Provide case studies showing the biodiversity gains that community restoration projects can achieve.
- Improved protection against flooding and storm events by reducing sedimentation build-up in streams and the estuary, increasing their buffering capacity.
- Increased public respect for, and enjoyment of, Waimea Inlet's unique natural heritage.

2.3 Threats to Waimea Inlet

Although the Resource Management Act and New Zealand Coastal Policy Statement were introduced to protect New Zealand's natural resources, many freshwater, estuarine and coastal ecosystems remain vulnerable to harmful influences and threats. Much of the loss of indigenous ecosystems on the estuary fringes and islets occurred in the 20th century and led to current land use.

Waimea Inlet ecosystems are under threat from:

- **Sedimentation** due to excess silt flowing in and building up from land clearance and modification.
- **Pollution** from sewage, industrial wastes and agricultural run-off.
- **Invasion** by introduced weed and animal pest species.
- **Reclamation and extraction of sand, gravel and/or the land itself**, which has 'hardened' the estuarine margin. This reduces the ability of native habitats and species to migrate inland in response to future sea level rise. It also limits the opportunities to restore native vegetation communities.
- **Fire** can completely destroy ecosystems and property and can be expensive for those affected. For example, decades of restoration effort at Awarua wetland in Southland were destroyed when one careless match was dropped. Information signs and raising community awareness of fire risk (especially around amenity and picnic areas) are extremely important to reduce risk and can be an integral part of a well-planned restoration programme.

All of these pressures affect the extent and quality of the habitat available for native plants and animals. They also negatively affect the important role that the estuary plays in providing ecosystem services such as recreational activity (e.g. swimming) and healthy fisheries.

2.4 'Future proofing' for climate change

Models for future sea-level rises predict a significant area of Waimea Inlet will become inundated over the next 50–100 years, affecting low-lying freshwater and terrestrial ecosystems.

At risk are inanga spawning sites and flora and fauna communities in 'saline transition zones' (where saltwater meets freshwater), including several Nationally Critical flora and fauna species. To survive, these species, communities and ecosystems must be able to adapt or retreat as sea level rises and salinity changes.

Work done now to increase habitat area, improve water quality, and reduce contamination and sedimentation in the waterways immediately around the estuary will help these species and habitats to buffer long-term sea-level rises. It will also provide security for native seed sources along riparian and coastal margins, and allow these species to naturally retreat inland provided there is space to do so.

3. Legal considerations

Before starting any project, you should first assess the short and long-term effects it might have. Often when doing one bit of work we affect another area, e.g. disturbing neighbouring landowners, consent requirements for certain types of work, the landscape aesthetic, and flooding/drought risk to fragile ecosystems.

DOC – Can provide specialist advice on how to avoid any potential threats to natural, cultural and historic values and whether there are any legal requirements that need to be met.

Tasman District Council's (TDC) Resource Management Plan – Restoration initiatives in Waimea Inlet and surrounding areas should be consistent with this. The plan recognises the significance of tributaries' biodiversity values and the linkage of their ecological health to that of the Waimea Inlet.

DOC has prioritised Waimea Inlet as an ecological management unit (EMU) – Although this has no regulatory consequence in itself, DOC can support restoration initiatives as well as provide technical advice on managing weeds, threatened species and ecosystems.

Iwi – It is extremely important to consult with local iwi before beginning any restoration projects, particularly in coastal regions where they may have been historical settlements or there are current tapu sites.

Useful links/tools

- DOC guide to assessing the impact of your project: tinyurl.com/DOCassessprojectimpact
- TDC Resource Management Plan: tinyurl.com/TDCresmanplan
- DOC information about estuaries: www.doc.govt.nz/nature/habitats/estuaries
- For help assessing cultural and historical impacts: contact your local DOC heritage specialist, your local marae, and/or visit tinyurl.com/DOCheritageprotection

4. Ways to get involved

There are many restoration opportunities in the inlet's western embayments around the estuarine edges and river mouths, where even small-scale restoration projects will add value to the narrow margins.

4.1 Join an existing project

There are several ongoing projects within Waimea Inlet, where iwi, community groups and other stakeholders are working closely with DOC, TDC and NCC. Alternatively, ask around to find local examples of other restoration projects in similar areas and habitats.

All of these restoration projects have the potential to rebuild plant communities around Waimea Inlet that have in many instances totally disappeared or are only now represented by a handful of plants or trees.

Aesthetic considerations such as form, colour and the ultimate size of plants may also be important concerns for a planting project where amenity values are also important.

Waimea Inlet Forum – Created as a result of the Waimea Inlet Management Strategy; an inter-agency strategy that includes Tasman and Nelson councils, statutory agencies, non-statutory groups and organisations, businesses and community groups who have an interest in and a commitment to the Waimea Inlet and its sustainable future.
tinyurl.com/Waimeamanagestrategy

Projects sites include Pearl Creek, Neimans Creek, and Dominion Flats.
waimeainlet.wordpress.com/getting-involved
www.facebook.com/Waimea.Inlet

Battle for the Banded Rail – Aims to increase numbers of banded rail and other shy margin dwelling birds on the margins of Waimea Inlet.
www.tet.org.nz/battle-for-the-banded-railrabbit-island

Tasman Environmental Trust – Promotes and facilitates awareness, appreciation and protection of Nelson's valued ecosystems. www.tet.org.nz

Fish & Game – Regularly monitors water quality and has a regulatory interest in catchment land use activities.
www.fishandgame.org.nz

Forest & Bird – Non-government organisation (NGO) that advocates for the environment through submissions on regional plans, on new or amendments to laws, and in the environment court. www.forestandbird.org.nz

Local landowners – Many have started restoration projects on land adjoining Waimea Inlet – ask around and you're likely to come across many projects you can get involved with.

DOC Volunteer Newsletter Nelson/Tasman – Get involved in volunteer events in the region! This monthly newsletter will bring you information on volunteer events from DOC, community groups, councils, NGO's and from our many other partners in Nelson/Tasman.
www.doc.govt.nz/get-involved/volunteer/in-your-region/nelson-tasman/

4.2 Set up your own project

There are many considerations to take into account. ***Sections 5–7*** provide useful information about how to plan and implement a restoration project. ***Appendices 1, 2*** and ***3*** give useful information about native ecosystems, potential sites and target plant, fish and animal species.

4.3 Other ways to contribute

If you're not able to get hands-on with restoration, there are plenty of ways to fund or sponsor these local projects such as getting involved with mapping, administrative tasks, propagating plants in the DOC nursery, organising logistics etc. Every little bit helps!

For further information contact the DOC Community Ranger, Motueka office, motueka@doc.govt.nz

5. Basic principles for restoration projects

5.1 Habitat restoration and amenity planting values

Estuarine sites are a complicated mix of plant communities, from terrestrial (land-based) to freshwater to salt water, and from mid-stream to bank margins. They often include rare plants and groups of plants.

The way the plant species change between **land-to-freshwater-to-salt water** and **mid-stream-to-bank margin** is called a 'vegetation sequence'.

Estuarine vegetation sequence from tidal saltmarsh (foreground) through to saline-influenced sedge- and reed-land (mid-ground), and finally, fully terrestrial plants (background)

The first step in a well-planned restoration planting project should aim to recreate vegetation sequences that once naturally occurred in that ecosystem type (see ***Appendix 1*** for details of types of native ecosystems and vegetation sequences in Waimea catchment).

5.2 Ecosourcing

Ecosourcing is where you grow native plants from locally-sourced seeds, taken only from plants that naturally grow in that area.

There is huge value in using ecosourced plant material for amenity and restoration projects because:

- Ecosourced seed and plants are well-adapted for the local climate and soils so they're more likely to survive and flourish than outside plant stock.
- It ensures the restored habitat reflects the area's natural character, rather than a hybrid version from some other New Zealand location.
- Planting non-local natives or cultivars can damage the long-term health of native species through interbreeding.

Ask for ecosourced plants at your local native plant nursery.

Useful information

- DOC ecosourcing guidelines: tinyurl.com/DOCecosourcenelson
- DOC guide to collecting native seeds: tinyurl.com/DOCecosourceseeds

5.3 Ecositing

Ecositing means trying to recreate an ecosystem that used to exist in an area. It involves matching each plant species to its preferred habitat.

New Zealand bush can be made up of a complex array of plant species and communities, depending on the local climate, soil type, slope, moisture and fertility.

To successfully recreate an ecosystem you need to choose the right species for each part of your site. Putting the right plants in the right place means they will be more likely to they survive and a more natural forest will be created. Once you're familiar with your site this will be relatively easy. For example, it will be obvious to plant kahikatea and swamp flax in the wetter valley bottoms, tōtara on drier alluvial areas, and ngaio on exposed coastal sites.

It's also important to have the right balance of plants. For example, the big podocarp trees (rimu, mataī, miro, kahikatea) will normally only make up a small percentage of a forest canopy, so don't plant too many of them compared to other species. For forest areas, a good rule of thumb is to plant 50 canopy species for every 1,000 hardy colonising plants such as mānuka.

6. Project planning and design

6.1 Restoration plan and objectives

Good forward planning, with clear long-term objectives and visions, will ensure your aims match your resources and that important steps such as site preparation, plant ordering and plant protection material are all in hand.

You will need to think about:

- Legal and social issues
- Health and safety
- Baseline surveys
- Monitoring and evaluation

Appendix 4 shows how community restoration projects develop and evolve.

Useful links/tools

- DOC guidelines on running community restoration projects: tinyurl.com/DOCcommunityprojguidelines
- CommunityNet Aotearoa guidelines on running community restoration projects: tinyurl.com/CommNetresourcekit
- DOC toolkit, *From seed to success*, advising how to effectively run a community group: tinyurl.com/DOCseedtosuccess
- Nature Space links for community groups starting up restoration projects, including information on funding and writing up restoration plans – crucial for any restoration project! www.naturespace.org.nz/resource-centre

6.1.1 Developing your restoration plan

Restoration projects aim to recreate the vegetation sequences that once naturally occurred in that ecosystem type. ***Appendix 1*** gives details of Waimea catchment's native ecosystems and vegetation sequences.

There are 7 questions that you should consider before developing a restoration plan for an area:

1. **Where does the saltwater influence extend to?**
   This is extremely important as it determines which plants should be placed where and marks the boundaries of potential estuarine habitat. It also helps identify where inanga might spawn, as this happens where saltwater and freshwater meet.
2. **Does the site need re-contouring to reinstate a more natural gradient and hydrology (movement, distribution, and quality of water)?**
   This may be necessary if the edges of the estuarine ecosystem have been hardened and/or modified due to drainage ditches, roads, footpaths etc. It's crucial to get the hydrology right; this may involve reconnecting waterways, removing flow blockages, and reinstating meanders and natural streams that have been re-directed or modified. ***Note: this kind of site work is likely to require consent and could potentially disturb sites that are archaeologically significant – contact your local council and iwi before any earthworks!***
3. **What animals live in/use the area?**
   E.g. birds, lizards, insects (moths, butterflies, and wētā, etc), cockles and inanga eggs in the stream-edge vegetation.

4. **What should remain?**
   Identifying any remnant plants of the original native cover is a good start point. It indicates where, and with which species, to start your planting project, as well as information on the native vegetation or habitats for animals that should not be negatively affected by any restoration work. ***Appendix 1*** gives details of habitat types in Waimea's estuaries and estuarine margins.
5. **What needs to be removed or excluded?**
   E.g. pest weeds that cannot be outcompeted by native plants, even if natives have re-established, such as tall fescue (see ***Sections 7.1.2, 7.1.4*** and ***Appendix 5*** for information about weeds and weed control); domestic and pest animals that will damage plants through grazing and trampling, or prey on native wildlife.

   However, it is important to note that even non-native grasses such as tall fescue can provide spawning habitat for inanga. Therefore, if this grass cover is being removed, this should be completed outside of inanga spawning periods, and alternative habitat options should be provided while native species are restored. For example, providing hay bales on estuarine edges while weed species are being removed successfully imitates the conditions needed for inanga spawning.
6. **What will take care of itself?**
   Most native plants can re-establish once weeds like tall fescue are destroyed. Restoration planting should be aimed at boosting existing biodiversity and outcompeting weeds rather than 'creating' an ecosystem type from scratch. Many projects spend thousands of dollars on restoration planting while ignoring the negative effects of weeds long-term – this results in unsuccessful restoration, wastes time and resources, and demoralises volunteers.
7. **What species should I be planting?**
   See DOC planting lists (link below) for Tasman Bay and Nelson city coastline areas.

Useful links/tools

- DOC habitats map for the Tasman area: tinyurl.com/DOCtasmanhabitatmap
- DOC details about the vegetation types found, and planting lists for the Tasman Bay and Nelson city coastline areas: tinyurl.com/DOCecorestorenelsontasman
- Weedbusters Tasman-Nelson group: tinyurl.com/weedbustersnelsontasman

6.2 Health and safety

A comprehensive health and safety plan, with regular updates and briefings before any fieldwork is begun, is essential for all work with volunteers and members of the public. DOC and/or your local council can assist you with this.

Useful links/tools

- CommunityNet Aotearoa guidelines on writing a H&S policy for a volunteer group: tinyurl.com/CommNetHSpolicy
- WorkSafe NZ templates for H&S documentation: tinyurl.com/worksafeHStemplates
- NatureSpace provide examples of H&S plans for community groups: www.naturespace.org.nz/resource-centre/health-and-safety

6.3 Baseline surveys of the area's history, flora, fauna and threats

It is important to gather as much baseline information as you can, before you start any work, so you can easily track progress. You can use this to prove to funding bodies that you are making a positive difference! It also helps motivate volunteers when you can them show progress over time.

There are a range of factors that can be monitored in estuaries to track their recovery (**Table 1**).

Table 1. Factors to establish a baseline for.

Factor	Description	Useful links/tools
General estuary information and monitoring	Landcare Research has a comprehensive toolkit for planning and monitoring an estuary restoration project.	Landcare Research toolkit *Turning the tide*: tinyurl.com/Landcareturningthetide
Cultural and historical sites	It is important not to disturb historically or culturally significant sites. Estuarine areas were often the first places settled by Māori, and are regarded as a taonga or treasure. They may include wāhi tapu (sacred sites), are mahinga kai (food gathering) sites, and provide significant habitats for a range of culturally important animals including fish, tuna (eel), birds, reptiles, amphibians and insects, while many plants found in estuaries are used for weaving, medicine and carving.	DOC advice on how to avoid disturbing a significant site: tinyurl.com/DOCheritageprotection If in doubt, approach your local iwi, council or DOC before you start.
Flora (plants)	It is important to know what plants you should be planting, and where you should be planting them	TDC, information on the nine ecosystem types and planting lists: tinyurl.com/TDCplantinglists DOC guidelines for long-term vegetation monitoring: tinyurl.com/DOCvegmonitoring
Fauna (animals)		
Birds	Bird sightings and calls can be regularly recorded at your site.	NZ Birds Online is useful for identifying bird calls: nzbirdsonline.org.nz E-Bird, NatureWatch and other websites are useful for recording sightings and calls: ebird.org/content/newzealand and naturewatch.org.nz
Fish	Investigate which native fish could live in your site's waterways once it is restored. Record and restore inanga spawning sites. The return of threatened native fish is a good long-term indicator of stream ecosystem restoration success.	NIWA Freshwater Fish Database – check whether surveys have been carried out at your site/in your catchment: www.niwa.co.nz NIWA guide to restoring inanga habitat: tinyurl.com/NIWArestoreinangahabitat
Reptiles and invertebrates	Monitoring of rare or threatened species is also extremely worthwhile, such as the katipō spider (Latrodectus katipō), tree and ground wētā, and koura (or freshwater crayfish).	DOC information on native animals: www.doc.govt.nz/nature/native-animals
Intertidal values	Cockle and seagrass mapping is an easy activity for anybody to do, and can change over time as catchments are restored and estuaries recover.	tinyurl.com/Landcareturningthetide

Factor	Description	Useful links/tools
Threats		
Pest plants	Pest plants are weeds and plants that are in the wrong place. **Getting weeds under control at the early stages of a restoration project should be your top priority.** Weeds compete with plants for light, space, moisture and nutrients.	See *Sections 7.1.2* and *7.2.1* for information about planning and costing weed control and *Appendix 5* for details of weed control techniques. Draw up a comprehensive weed map with species lists, then systematically remove any pest weeds from the site before you start planting – this will considerably reduce the time and effort needed to deal with weeds once you have plants in the ground. Weedbusters weedlist: tinyurl.com/weedbustersweedlist Tasman District Council Regional Pest Management Strategy: tinyurl.com/TasNelsonpestmanagement
Pest animals	Many introduced animals, including mammals, insects, fish, and even some birds, eat native plants and animals or compete with native animals for food and nest sites.	DOC's A–Z of pest animals: tinyurl.com/DOCanimalpestA-Z See *Sections 7.2.2* and *7.2.3* for information on pest animal control options and monitoring techniques. Tasman District Council Regional Pest Management Strategy: tinyurl.com/TasNelsonpestmanagement Battle for the banded Rail Project (animal trapping): www.tet.org.nz/battle-for-the-banded-railrabbit-island
Water quality	Restoration projects often result in measurable gains for water quality, as well as biodiversity.	Tasman District Council – Sampling locations for swimming water quality: tinyurl.com/TDCswimmingwaterquality Nelson City Council – Information about sampling, locations and results for Nelson's beaches and swimming holes: tinyurl.com/NCCswimmingwatermonitoring LAWA (Land Air Water Aotearoa): www.lawa.org.nz
Sedimentation	**Sedimentation is the biggest threat to estuaries** – if more sediment comes in than flushes out, an estuary will age and eventually die as it fills up with so much sediment that it turns into dry land.	Information on how to record, monitor and mitigate sedimentation: tinyurl.com/Landcareturningthetide (part 2) Tasman District Council reports on sedimentation and risk to coastal areas: tinyurl.com/TDCcoastalmarinebiodiversity
Litter	Collecting litter adds to the sustainability and habitat quality of your project. The amount of litter found in restoration sites tends to quickly reduce as communities become more interested and involved with restoring their local ecosystems, so recording what rubbish is collected and where can be an effective monitoring tool to indicate community engagement.	The Big Beach Clean-Up event is run annually during SeaWeek in March by DOC, TDC, NCC and Nelmac. Kee an eye on the volunteer newsletter and local media for details: www.doc.govt.nz/get-involved/volunteer/in-your-region/nelson-tasman

7. Implementation – doing the restoration work

7.1 The 5 stages of restoration planting

1. Seed collection and propagation
2. Site preparation and initial weed control
3. Initial nurse crop planting
4. Ongoing weed control and 'releasing' your plantings
5. Infill or enrichment planting

7.1.1 Seed collection and propagation

Organising seed collection from your target site according to good ecosourcing principles should be an **early and ongoing job** for any restoration group.

Propagating the number of plants needed for planting stock often takes **two or more seasons before site preparation**.

There is a volunteer-run nursery at DOC Motueka, which can assist with advice on propagating native plants. Otherwise, ensure plants are purchased from a reputable nursery that can ensure eco-sourcing principles are adhered to.

7.1.2 Site preparation and initial weed control

Getting weeds under control at the early stages of a restoration project should be your top priority because weeds compete with plants for light, space, moisture and nutrients.

Controlling invasive weeds at the site before you start planting will considerably reduce the time and effort needed for ongoing weed control once plants are in the ground. Targeted spraying where planting will occur is good practice. Blanket spraying large areas is often not ideal as it opens up large areas for erosion, excessive drying during summer months and invasion by new weeds.

If your site is dry and stony, compacted, or has a heavy clay soil, you may want to consider mechanical ripping with a bulldozer or tractor.

See ***Appendix 5*** for methods of weed control.

7.1.3 Initial nurse crop planting

At the start, large-scale planting projects should be dominated by closely-planted hardy shelter trees or 'nurse crop' species (plants that help other plants grow) that are:

- Fast-growing
- Suitable for your site – look around to see what grows well naturally and check local regional council planting guidelines for lists of suitable ecosourced plants for your region and habitat type.
- Frost-hardy
- Ecosourced

Figure 2 shows an example of densely planted nursery species.

Examples of native species that are suitable for Waimea Inlet as nurse crops are:

- Mānuka (*Leptospermum scoparium*)
- Kānuka (*Kunzea ericoides*)
- Hebe (*Hebe stricta* var. *stricta*)

Figure 2. Restoration area with densely-planted nursery species on an estuarine edge ecosystem, with rabbit-proof plant protective sleeves around the palatable species.

7.1.4 Ongoing weed control and 'releasing' your plantings

Competition from weeds, particularly grasses, is a major reason for plant loss in the early-stages of restoration projects. Getting on to weeds early throughout the site (or your chosen sections), and keeping on top of them, is critical for success.

'Releasing' means handweeding around your plantings to ensure they do not get smothered or outcompeted by weeds.

Mulching and dense planting can help prevent weed re-growth and keep your project manageable, especially during the dry summer months.

7.1.5 Infill or enrichment planting

Middle and late-stage plants (such as the big podocarp canopy trees like rimu, mataī, miro, and kahikatea), and frost-tender species can be planted once your early plants are established and providing a level of shelter and shade – this could take a few years.

Supplementary planting under an existing or developing canopy can be safely carried out any time from autumn to spring, as the forest floor under a healthy canopy will generally be frost-free.

Seed collection and scattering under your initial plantings can be a good way to encourage new seedlings.

You'll need to replace any failed plantings to avoid gaps for weeds to invade.

Figures 3 and 4 show examples of where infill planting is required.

Figure 3. Restoration area with good weed control but needing infill planting with enrichment species.

Figure 4. Area needing intensive follow-up weed control, plant releasing, and infill planting with enrichment species.

7.2 How to prepare your site

Good site preparation has a huge influence on the success of a planting project. It gets plants to get off to a good start, and minimises the amount of follow up maintenance needed during the first growing year.

If a site isn't properly prepared, you'll end up tackling a rapid seasonal onslaught of weeds after planting. Collateral damage of your plantings from weed spraying etc is difficult to avoid.

Two preparation scenarios are outlined below. In reality, a combination of the two will be likely.

Scenario 1: Grass paddock, a blank canvas

Grass control before starting planting is essential particularly where tall fescue grass is dominant because grass growth overwhelming plants is a common failure point for planting projects.

Achieving this will take 2 or more repeat sprayings over the same ground. Spraying large (>1.5m diameter) spots is good practice as there is less bare ground for reinvasion of weedy species than a blanket spraying approach (not recommended). Leave dead litter on the ground to limit invasion by broadleaf weeds and keep moisture in the soil.

Begin grass spraying in late summer with several treatments before the planting season.

The standard herbicide for grass control is glyphosate at 2% rate with penetrant and dye.

Scenario 2: site with gorse, broom, blackberry and woody weeds

Some woody weed cover can provide shelter for your young plantings so there is no absolute requirement to eliminate woody weeds such as gorse.

However, broom, bracken and blackberry will rapidly overgrow new plantings so control is essential for successful planting where these species are present. **It's important to get good ecological advice** if you are considering this, to ensure any assumptions about regrowth and weed nurse crops are correct.

Handy hints

- Planting a site in small stages over several seasons may be easier to manage than doing the whole site at once.
- Costs for site preparation will vary considerably depending on the weed species, terrain, and whether control is being managed professionally or by volunteers.
- Plants, plant protection materials and fertiliser costs combined with the area to be planted and plant spacing formulas can be used to accurately calculate costs for raw materials for any given site (see *Sections 7.2.1*, *7.3.1* and *7.4* for calculation and mapping tools).
- Planting projects are often used alongside walkways or close to residences where you are required to maintain view lines. Vegetation in these areas can minimise disturbance to wildlife from recreational users. However, these types of plantings can have high maintenance demands as sites are often narrow, which can stop trees developing enough shade and canopy closure to stop weeds growing underneath.

7.2.1 Weed control

Weed removal usually opens up an area, offering ideal conditions for other weeds to grow. To stop this happening, it's good to be prepared with a comprehensive restoration plan that guides the project in the right direction over several years.

Table 2 gives estimated costs based on current contractor market rates for weed control in riparian ecosystems. Costs vary depending on several factors, such as the intensity of weed coverage, the number of times follow-up control is required, whether weeding by hand is required, the difficulty of control methods (e.g. spraying versus drilling versus felling of willows), and whether contract labour is needed or if volunteers are doing the work.

Appendix 5 describes different methods of weed control.

Useful links/tools

- Weedbusters, how to dispose of weeds: tinyurl.com/weedbustersdisposal
- Weedbusters, weedlist: tinyurl.com/weedbustersweedlist
- Weedbusters, Tasman-Nelson group: tinyurl.com/weedbustersnelsontasman

Table 2. Approximate cost estimates for weed control at Neimans Creek, a 4 ha site, based on average contractor market rates.

Weed control level	Cost per ha*	Total estimated cost
Minimal	$2,600	$10,400
Medium	$7,800	$31,200
Intense	$13,000+	$52,000

These figures are estimates only, valid for the 2014/15 financial year. A detailed survey by a weed control contractor will be needed before a definitive figure can be assigned to your work.

Steps for successful weed control

- Do a **survey** to find out what weeds you're dealing with.
- **Start small** – avoid creating large cleared areas that allow new weeds to establish.
- **Plan** your control and **work in stages**. Tackle isolated weed patches first to slow the rate of weed spread before starting on the worst areas. Replace weeds with natives or non-weedy plants as you go.
- If your weeds need chemical control, **research** the best herbicide to use and how to apply it. You may need permission or qualifications to use herbicide on public land.
- Use **selective herbicides** so non-weedy plants survive.
- **Destroy weeds before they fruit or seed** to prevent a new generation of weeds growing inside your work area.
- When shifting dead weeds **take care not to spread any seeds or fragments** around that could grow again.
- Decide on the best **disposal method** to use before you start, particularly if working in a large area.
- Provide **shelter** to help existing native seedlings grow.
- Plant **rapid-growing hardy natives** (such as mānuka, coprosmas, wineberry).
- After planting, be prepared to revisit the site regularly to do **follow-up weed control**.
- The best follow-up method depends on the environment you are working in so **do your research before you start**.

7.2.2 Pest control

There are a number of methods for controlling pest animals, but trapping is the most common one for predators like rats, stoats and possums.

Useful links/tools

- DOC, guidance on managing animal pests: tinyurl.com/DOCmanageanimalpests
- DOC, how to monitor and inventory animal pests: tinyurl.com/DOCmonitoranimalpests
- Predator Free NZ, resources and tools: predatorfreenz.org/useful-resources
- Trap.Org allows community groups to easily capture and analyse their trapping data: www.trap.org.nz

7.2.3 Fencing

Depending on the nature of the site, areas to be planted in future may require fencing off to allow for long-term restoration of the site (see Figure 5).

Fencing alone may sometimes be all that is needed depending on the threat you wish to eliminate or reduce, e.g. cattle grazing vegetation right to the estuary edge.

Where you put the fences will vary with each site, property and/or the landowner's wishes. Ideally 8 m or more from the stream or estuary edge should be retired and/or planted to effectively shade the ground from weeds and form a self-sustaining riparian native margin, but a smaller margin of around 3–5 m is still worthwhile if an 8 m buffer is not possible, e.g. because of buildings, owners' wishes, or shading and view retention considerations. Ultimately, estuary margin and riparian widths on private land come down to how much land each landowner is willing to see released from grazing for native planting purposes.

Tasman District Council runs a landowner assistance package for stream or wetland retirement projects, and your project may be eligible to receive this assistance. Usually the Council splits the project costs with the land owner 50/50, often achieved by the Council providing the fencing materials and the landowner building the fence.

Figure 5. A well-fenced riparian planting (around 5 years old) showing closing-in and shade creation from maturing native sedges and rushes.

7.3 How to plant native species

7.3.1 Spacing

Plant spacing varies according to species, habitat, slope, and existing cover. For example, close spacing of sedges and grasses at 1–1.5 m on flat ground is best; and mānuka planted at the same spacing rapidly forms a closed canopy, which reduces weed invasion and ongoing maintenance. Fast growing species such as karamū and kōhūhū are particularly good for creating rapid shade and shelter.

A well planned restoration project supplements initial fast growing plants with later plantings of slower growing species such as kahikatea, tōtara, matai, rimu, miro and beech species, or high light requiring plants such as kōwhai if tall forest is your project's goal.

Many of these plants benefit from specific site management to maintain the best growing conditions. Cutting out or pruning first stage plantings of karamū or kōhūhū is often necessary as podocarps and beeches will fail if they are over-shaded.

Useful links/tools

- Top of the South Maps, use to visualise your project site and approximately measuring any areas to be restored: www.topofthesouthmaps.co.nz
- Dune Restoration Trust planting calculator, once you have the approximate area in m^2 this gives an estimate of the number of plants required for any planting project: www.dunestrust.org.nz/resources/planting-calculator

7.3.2 Grades

Most projects use root trainer grade plants. Rootrainers are the perfect start for nearly all plants, and especially those that are sensitive to disturbance and require deep root runs. They are ideal for growing on seeds, seedlings, plugs and cuttings. The rootrainer system is generally made up of deep seed trays, divided into separate segments known as 'books'. They are unique because they open up like a book, for easy inspection and easy transplanting.

Advantages of root trainer plants:

- Cost effectiveness – around $2.50/plant
- Baskets contain either 48 or 36 plants and can be carried relatively easily
- Deep root structure, strong vertical growth.

Some small leaved species such as kahikatea are slow to establish, so it can be a good idea to use larger 2 litre or 5 litre potted plants.

7.3.3 *Protection*

Plastic sleeves or spray guards are now standard practice for most planting projects.

Poisoning and shooting of browsing animals that damage plantings (e.g. rabbits and hares), is not a recommended option around Waimea Inlet because of public safety concerns, so sleeves are the next best defence. Rabbits and hares can destroy hundreds of plants in one sitting; Combination sleeves (e.g. CombiGuard) protect the plantings if they are tall enough to prevent the animals reaching over the top.

Figure 6 shows rabbit-proof sleeves in use.

Plastic sleeves also provide shelter from wind, frost, and most importantly protect low foliage from over-spray when using herbicide to get rid of weeds.

A reliable and cost effective option uses 3 bamboo stakes and a semi transparent plastic sleeve per plant. ***Note: if less than 3 bamboo stakes are used, it can result in your plants overheating and dying!***

A slightly more expensive option is rigid coreflute shelters. These only need 1 bamboo stake, are more durable, can be re-used multiple times, and are easy to recycle.

If rabbits and hares are very persistent, spray-on plant protection products (e.g. plantskydd) are effective but expensive and temporary.

Figure 6. An ongoing estuarine margin planting project in the Waimea Inlet using green rabbit-proof plant sleeves.

7.4 Cost estimates for planting

Costs will vary depending on the number of plants you need, what type of protection you use, what site preparation is needed, and whether you are using contract or volunteer labour.

Tables 3 and 4 give some useful estimates based on type of protection and size of the area to be planted.

Table 3 Cost estimate per plant using simple plastic sleeve versus more robust protection.

Type of Plant Protection	Option 1	Option 2
Root trainer plant	$2.50	$2.50
Bamboo stake. 50c ea	$1.50	$0.50
Plastic sleeve	$0.50	-
Triguard coreflute	-	$2.00
Plantskydd repellent	$0.20	$0.20
Fertiliser tablet	$0.10	$0.10
Approximate total cost per plant	**$4.80**	**$5.30**

Table 4. Cost estimate based on area.

Size of project area (m^2)	Cost of site preparation*	Number of plants (1.5 m spacing)	Cost @ $5/ plant
10 m x 10 m = 100 m^2	tbc	51	$255
50m x 50 m = 2,500 m^2	tbc	1,273	$6,365
100 m x 100 m = 10,000 m^2 (1 ha)	tbc	5,093	$25,465

** Depends on site requirements and if contractor or volunteer labour.*

7.5 Managing sedimentation

Sometimes silt and weed biomass can build up to almost completely fill a wetland, stream or estuary. In certain circumstances, this can be reduced by dredging, which will quickly improve water quality. However, dredging is a delicate procedure and needs to be carried out by professionals as resource consent will generally be needed due to possible negative impacts on the ecosystem.

If you think it might be needed at your site do not attempt yourself, contact DOC or Tasman District Council to discuss whether this is an appropriate option.

7.6 Restoring whitebait habitat

Identifying suitable inanga spawning sites and planning habitat restoration work that targets them is extremely worthwhile.

Useful links/tools

- Detailed instructions for fencing and planting requirements related to inanga at tinyurl.com/NIWArestoreinangahabitat

7.7 Timelines

Planting – Winter is the best time to plant your restoration site, as it gives your plants time to bed in their root systems before the dry summer months.

Seed collection – see the DOC seed collection calendar (link below).

Fish – see NIWA calendar (link below).

Useful links/tools

- NatureSpace planting calendar – information on the fruiting and flowering times of native plants for attracting birds to your project: tinyurl.com/NatureSpaceplantingcalendar
- DOC seed collection calendars – details the best months for collecting native seeds: tinyurl.com/DOCecosourceseeds
- NIWA's freshwater fish calendar – details of when freshwater fish spawn and migrate to help people working near freshwater minimise effects of their work on freshwater fish species: tinyurl.com/NIWAfreshwaterfishcalendar

7.8 Monitoring and follow-up

This is the recommended **minimum** amount of monitoring you should do for your project:

- **Photos** – One of the easiest and most useful monitoring techniques. It is best to start taking photo surveys at least 3 specific 'photopoints' from the beginning of your restoration project to track the vegetation changes over time.
- **Map your project area** – Using colour aerial photography from Top of the South maps so you can monitor large-scale changes as new aerial photographs become available.
- **Record all fauna** species seen at the site – Especially birds, lizards, fish and invertebrates.
- **Monitor and record % plant survival** – This will let you know where your plants are surviving and flag areas where they aren't, where infill planting may be required.
- **Record % regeneration of existing native plants** – Flowering, fruiting, self-seeded plants etc.
- **Monitor and record trap catches** (if you are doing predator control) – Include the catch location using GPS co-ordinates. You can log your data online and compare with other groups across the country. www.trap.org.nz
- **Survey fish, scallop bed and sea grass** (If you are working in the estuarine zone itself) – This allows you to track habitat quality and number of species present, and if these are improving.

Useful links/tools

- DOC's Biodiversity Inventory and Monitoring Toolbox: tinyurl.com/DOCmonitoringtoolbox
- Nature Space, guide to photopoints: tinyurl.com/photopoints
- Predator Free NZ: tinyurl.com/PFNZpredatorcontroltools
- NZ Landcare Trust, Estuaries Toolkit for New Zealand Communities: tinyurl.com/NZestuariestoolkit

Regular trap checks are an important part of any restoration project

Appendix 1: Native ecosystems and vegetation sequences in Waimea Inlet's estuaries and estuarine margin

Types of ecosystem

There are nine different ecosystem types in the Waimea Inlet and surrounding catchments (Figure A1.1). Each has an associated native vegetation 'framework', which provides guidelines for what its pre-human native vegetation sequence would have been and the plant sequences it contained.

Restoration projects in each of the mapped areas in Figure A1.1 should aim to restore the associated native vegetation sequences.

Detailed descriptions of their associated vegetation sequences are given in Table A1.1.

Further information on all nine ecosystem types and their associated vegetation lists is available at: tinyurl.com/TDCplantinglists

Vegetation sequences

Figure A1.2 the most appropriate vegetation species and where they should be planted for restoration projects in Waimea Inlet's estuaries and estuarine margin.

Figure A1.3 shows what the end result of a estuarine/estuarine margin restoration project in Waimea Inlet would ideally be.

Table A1.2 gives detail about where estuarine/estuarine margin restoration species should be planted and their habitat requirements.

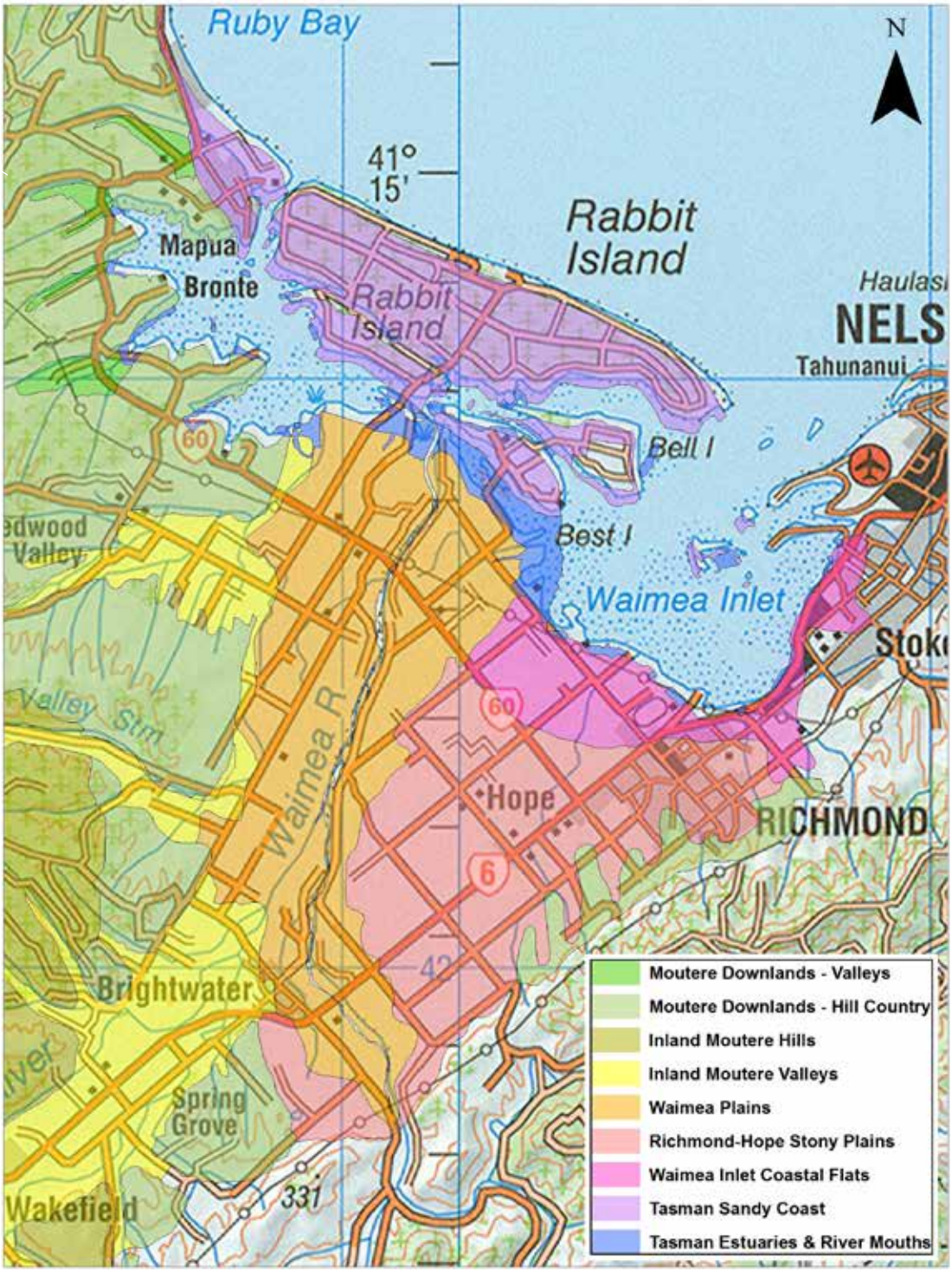


Figure A1.1. Waimea Inlet's native ecosystems provide a framework for native plant restoration.

Table A1.1. Ecosystems in Waimea Inlet's estuarine/estuarine margins, and their associated vegetation sequences and characteristics

Ecosystem type / Factors	Tasman estuaries and river mouths	Waimea Plains coastal flats	Tasman sandy coast
Locality	The high tide fringes of extensive intertidal areas between Richmond and Riwaka, all of which are associated with river mouths and inlets. Includes Waimea and Moutere Inlets and their river mouth deltas, and the major Motueka-Riwaka Rivers delta system.	Coastal flats extending around the southern coast of Waimea Inlet from the western end of Queen Street to Monaco, and up to 1.5 km inland.	Coastal sandy flats between Riwaka River mouth and Tahunanui, including Rabbit, Bells and Bests islands.
Topography (shape of the land)	Tidal flats, low relief islets, deltas and margins of coastal terraces around Mean High Tide. Usually part of an inlet enclosed by a coastal spit or barrier island and fed by a river.	Low-lying flat to gently-sloping terrace.	Low-lying, flat to gently contoured dunes and plains, often with a series of parallel gentle ridges and hollows.
Soils and geology	Sandy mud and organic matter from river deposits and estuarine vegetation. Pebbles and cobbles either below ground or scattered over the surface. Highly saline, infertile and anaerobic with iron and sulphur staining. High-shore flats have greater amounts of cobbles, pebbles and rafted organic matter and are drought-prone in summer.	Slow-draining, alluvial clay loam of low to moderate fertility, with heavy, leached subsoil. Soil is derived from sedimentary and ultramafic rocks, and around 0.5–1 m deep overlying deep gravels. Areas of peat and silt west of Richmond. Not drought-prone except where intensively drained.	Fine-grained unconsolidated sand adjacent to the shoreline, and extensive areas of consolidated sand and gravels inland forming beach ridges; well-drained and drought-prone. Thin swamp deposits in hollows of blue-grey sandy mud; poorly-drained. Derived from Motueka River sediments and eroded Moutere gravels. Fertility low to moderate.
Climate	High sunshine hours; mild frosts; mild annual temperatures; annual rainfall 920 mm.	High sunshine hours; mild to moderate frosts; mild annual temperatures; annual rainfall 900 mm.	High sunshine hours; mild frosts; mild annual temperatures; annual rainfall 920 mm.
Coastal influence	Entirely coastal. Tidal and saline influences of seawater are profound and are the most dominant influences on the ecosystem. Lower estuarine zone inundated by seawater on all but neap tides; high shore flats of the upper estuarine zone inundated only on spring tides. Salt water may wedge up rivers for many metres creating a brackish wetland environment around river mouths.	Semi-coastal influence up to 1.5 km inland.	Entirely coastal.

Ecosystem type Factors	Tasman estuaries and river mouths	Waimea Plains coastal flats	Tasman sandy coast
Original vegetation	Salt marsh shrublands, rushlands, sedgelands, and succulent herbfields. Brackish sedge and reed wetlands. These would have typically graded inland and upslope into tall coastal forest.	Extensively covered in a range of wetlands, especially swamp forest and flaxland.	Podocarp and mixed broadleaf forest, low mixed broadleaf forest, shrublands, and dunelands. Vegetated and open wetlands in sand and gravel dune hollows and on sand flats with high water table.
Human modification	Extensive reclamation (especially around the Motueka and Waimea River deltas) has destroyed habitat, interrupted estuarine vegetation sequences, and profoundly altered the freshwater and saltwater hydrologies and coastal processes.	No indigenous vegetation remains. Hydrology has been profoundly altered by drainage. Base water table has been lowered.	Very few areas of native vegetation remaining. Earthworks have altered the hydrology and many of the original landforms that determine vegetation patterns. Base water table has been lowered.

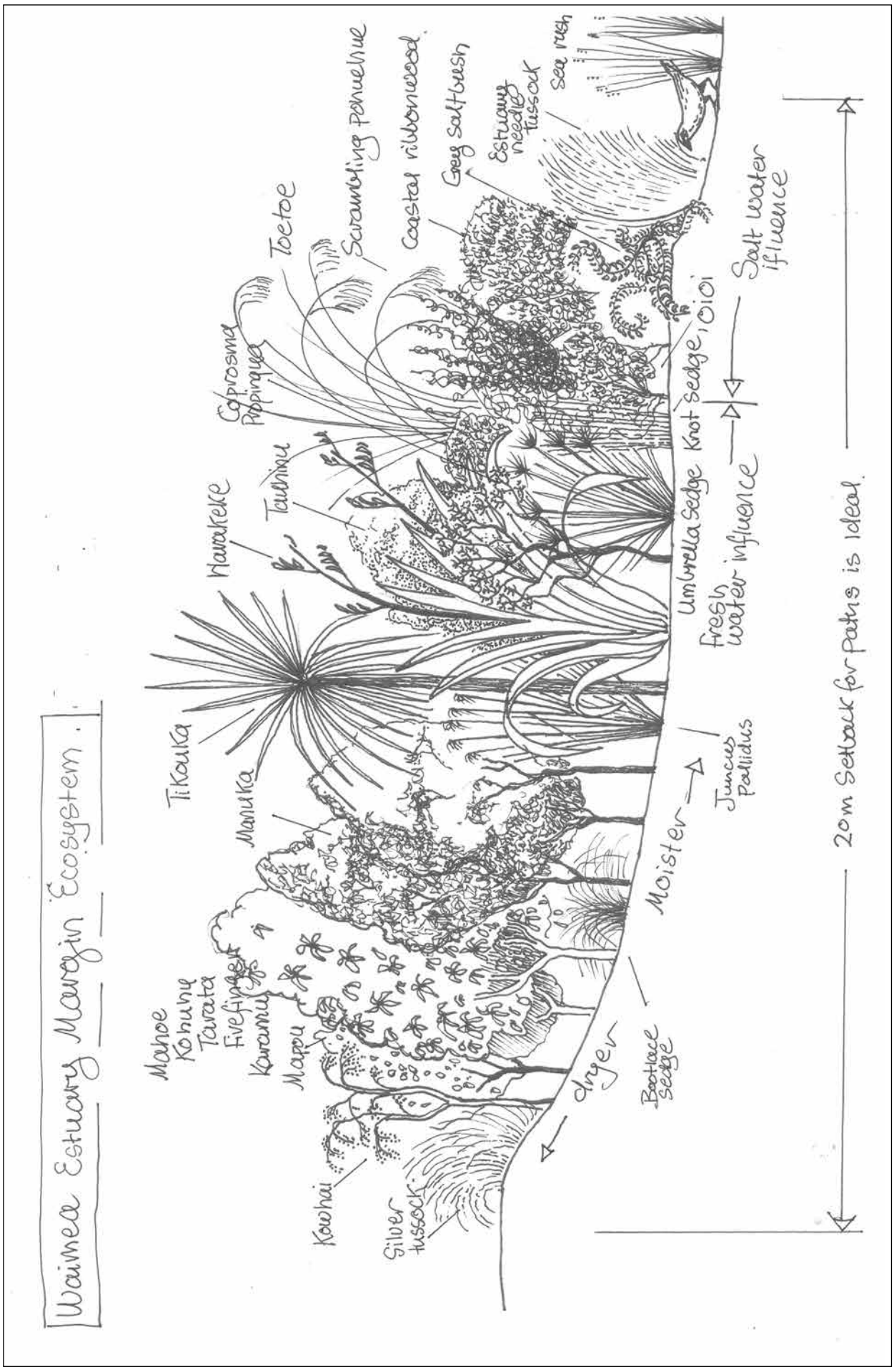


Figure A1.3. Example of what an ideal Waimea Inlet estuarine margin vegetation sequence should look like after restoration.

Table A1.2. Planting and habitat requirements of 'first choice' restoration planting species (some of which are shown in Figure A1.2)

Māori name/ common name	Scientific name	Planting area			Life form	Height	Moisture requirements	Salt and wind tolerant	Planting stage and abundance + plant sparingly ++ plant commonly +++ plant many		Comments
		stream edge	flood area	wet-land					initial*	enrichment**	
Clump formers											
Harakeke/flax	*Phormium tenax*			✓	Monocot clump former	2 m	Wet to dry	✓	++		Very hardy with wide environmental tolerances. Unless the floodplain flats are wide, this species should be planted above frequent flood levels as it resists flood waters and can be torn out of the bank and/or cause scouring around it.
Pūrei	*Carex secta*	✓	✓	✓	Sedge	1 m	Wet		+++		Establishes particularly well on stream banks. Can form short trunks. Plant densely. Best in standing water.
Rautahi/ cutty grass	*Carex geminata*	✓	✓	✓	Sedge	1 m	Wet		+++		Easily grown from fresh seed and by the division of established plants. Plant densely.
Rautahi/ cutty grass	*Carex lessoniana*	✓	✓	✓	Sedge	1 m	Wet		+++		Good for bank stability. Plant densely.
Small swamp sedge	*Carex virgata*	✓	✓	✓	Sedge	0.8 m	Wet to dry		+++		Plant densely.
Toetoe	*Austroderia richardii*		✓		Grass	1.5 m	Wet to dry	✓	+++		Smallest of the toetoes. Can be distinguished from invasive pampas by its drooping flowering spike. Able to grow on dry, disturbed, compacted sites. Plant densely.
Shrubs and small trees											
Karamū	*Coprosma robusta*			✓	Broadleaf shrub	2–4 m	Wet to dry		+++	+	Fast growing, hardy species with wide tolerances from shade to full sun. Functions well as an initial nurse crop. Bird distributed, with abundant autumn berries for birds.
Kawakawa	*Macropiper excelsum*			✓	Broadleaf shrub	4 m	Wet		+	++	Bird distributed. Prefers shade.
Koromiko	*Hebe stricta, Hebe macrocarpa*			✓	Shrub	2 m	Dry		++		Very hardy, fast growing native shrub species.

Māori name/ common name	Scientific name	Planting area			Life form	Height	Moisture requirements	Salt and wind tolerant	Planting stage and abundance + plant sparingly ++ plant commonly +++ plant many		Comments
		stream edge	flood area	wet-land					initial*	enrichment**	
Mānuka/teatree	*Leptospermum scoparium*			✓	Broadleaf tree	4 m	Wet to dry		+++		Grows vigorously and has a wide ecological tolerance, including the ability to colonise inhospitable, low fertility sites and the lower slopes along brackish streams. Needs to be planted in autumn and must not have roots disturbed during planting.
Patē/ seven-finger	*Schefflera digitata*			✓	Broadleaf tree	5 m	Wet		+	+	Grows rapidly in damp sites, particularly if there is some shade. Small fruits in autumn attract birds.
Putaputawētā/ marbleleaf	*Carpodetus serrata*	✓	✓	✓	Broadleaf tree	6 m	Wet to dry		+	+	Bird-distributed. Tolerant of cool, wet sites. Host to pūriri moth.
Trees											
Houhere/ lacebark	*Hoheria angustifolia*		✓	✓	Broadleaf tree	12 m	Dry		+		Leaves provide winter food for kererū, and bark provides nesting material for some native birds.
Kahikatea/ white pine	*Dacrycarpus dacrydioides*	✓	✓	✓	Conifer tree	30 m	Wet to damp		++	+	Succulent fruits are an important food source for birds, which also distribute seeds. Consider planting larger grade specimens.
Kānuka	*Kunzea ericoides*			✓	Broadleaf tree	12 m	Dry		+++		Important coloniser species. Needs to be planted in autumn and must not have root disturbance during planting.
Kaikōmako	*Pennantia corymbosa*		✓	✓	Broadleaf tree	10 m	Damp to dry		+		
Kōhūhū	*Piitosporum tenuifolium*			✓	Broadleaf tree		Dry		+++		
Kōwhai	*Sophora microphylla*		✓	✓	Broadleaf tree	10 m	Dry	P	+	+	Fast-growing, semi-deciduous and useful for erosion control. Yellow flowers in spring attract tūī and kererū
Māhoe/ whiteywood	*Melicytus ramiflorus*		✓	✓	Broadleaf shrub	10 m	Wet to dry		+++		Best planted in autumn. Establishes more slowly than other bank-stabilising species, but is shade-tolerant and purple fruits in late summer attract birds.

Māori name/ common name	Scientific name	Planting area			Life form	Height	Moisture requirements	Salt and wind tolerant	Planting stage and abundance + plant sparingly ++ plant commonly +++ plant many		Comments
		stream edge	flood area	wet-land					initial*	enrichment**	
Makomako/ wineberry	*Aristotelia serrata*			✓	Broadleaf tree	8 m	Damp		+		Fruits are a favourite of tūī and silvereye. Fast-growing and provides shade for other species.
Mānatu/ ribbonwood	*Plagianthus regius subsp. regius*		✓	✓	Broadleaf tree	10 m	Damp to dry	P	+	++	A very fast growing tree which is a beautiful specimen tree. Does well in most situations but prefers a fertile, moist but free draining soil – good on slopes.
Māpou	*Myrsine australis*			✓	Broadleaf tree	6 m	Dry		++		Bird-distributed.
Nīkau	*Rhopalostylis sapida*			✓	Palm	15 m	Damp to dry				
Papauma/ broadleaf	*Griselinia littoralis*			✓	Broadleaf tree	10 m	Dry				
Pigeonwood	*Hedycarya arborea*			✓	Broadleaf tree	12 m	Dry			+	Requires shelter from frosts and wind when young. Fruits attract kererū.
Pukatea	*Laurelia novae-zelandiae*			✓	Broadleaf tree	25 m	Damp to wet			+	Slow-growing, but characteristic of remnant wet sites.
Tarata/ lemonwood	*Pittosporum eugenioides*			✓	Broadleaf tree	12 m	Dry				
Tī kōuka/ cabbage tree	*Cordyline australis*	✓	✓	✓	Monocot tree	8 m	Wet to dry	P	++		Can grow on lower slopes
Tītoki	*Alectryon excelsus*			✓	Broadleaf tree	8 m	Damp			+	Prefers fertile sites. Plant later when shelter established
Tōtara	*Podocarpus totara*			✓	Conifer tree	30 m	Damp to dry			+	Survives well on dry and exposed sites. Orange-red fruits attract many native birds.
Whauwhaupaku/ five-finger	*Pseudopanax arboreus*			✓	Broadleaf tree	8 m	Damp to dry	P	++		Can grow on lower slopes on brackish streams.

* Nursery crops (hardy, fast-growing species that provide shelter for other plants)
** Slower growing species

Appendix 2: Valuable riparian sites in Waimea Inlet for native fish, macroinvertebrates and plants

Species or value	Scientific name	Estuarine (E)/ riverine (R)	National threat status	Streamed for management	Sites “ = present; * = present until recently																		
					Waimea River	Neimans Creek	Pearl Creek	O Connors Creek	Borcks Creek	Reservoir Creek	Jimmy Lee creek	Vercoes drain	Sandeman	Nile Creek (Dominion Rd.)	Stringers Creek	Seaton Valley Str.	Orphanage Creek	Poormans Creek	Jenkins Creek	Arapiki Stream	Orchard Creek	Saxton Creek	Maire Stream
Fish																							
Shortjaw kōkopu	*Galaxias postvectis*	R	At Risk	Y				“										“					
Giant kōkopu	*Galaxias argenteus*	R	At Risk	Y		*	“	“						“		“	“	“					
Kōaro	*Galaxias brevipinnis*	R	At Risk	Y	“													“					
Inanga	*Galaxias maculatus*	R, E	At Risk	Y	“	“	“	“	“	“		“		“	“	“	“	“	“	“	“	“	
Inanga spawning	*n/a*	R, E			“		“	“	“	“				“	“	“	“	“	“			“	
Whitebait fishing	*n/a*	R, E			“	“	“	“									“						
Banded kōkopu	*Galaxias fasciatus*	R		Y	“			“		“	“			“	“	“	“	“	“		“		“
Longfin eel	*Anguilla dieffenbachii*	R	At Risk	Y	“	“		“	“	“	“	“		“	“	“	“	“	“	“		“	
Shortfin eel	*Anguilla australis*	R, E			“	“		“	“	“		“		“	“	“	“	“	“	“	“	“	“
Common smelt	*Retropinna retropinna*	R, E			“	“		“		“								“					
Common bully	*Gobiomorphus cotidianus*	R			“	“		“	“	“				“	“	“	“	“	“			“	
Upland bully	*Gobiomorphus breviceps*	R			“													“	“				
Redfin bully	*Gobiomorphus huttoni*	R	At Risk	Y	“			“									“	“		“			
Giant bully	Gobiomorphus gobioides	R, E			“	“											“	“					
Bluegill bully	Gobiomorphus hubbsi	R	At Risk	Y	“													“					

Species or value	Scientific name	Estuarine (E)/ riverine (R)	National threat status	Streamed for management	Sites (“ = present; * = present until recently)																	
					Waimea River	Neimans Creek	Pearl Creek	O Connors Creek	Borcks Creek	Reservoir Creek	Jimmy Lee creek	Vercoes drain	Sandeman	Nile Creek (Dominion Rd.)	Stringers Creek	Seaton Valley Str.	Orphanage Creek	Poormans Creek	Jenkins Creek	Arapiki Stream	Orchard Creek	Saxton Creek	Maire Stream
Torrentfish	*Cheimarrichthys fosteri*	R	At Risk	Y	“													“					
Lamprey	*Geotria australis*	R	At Risk	Y																			
Dwarf galaxias	*Galaxias divergens*	R	At Risk	Y	“																		
Yellow-eyed mullet	*Aldrichetta forsteri*	R, E	Not Threatened		“	“		“										“	“				
Black flounder	*Rhombosolea retiaria*	R, E	Not Threatened		“																		
Brown trout	*Salmo trutta*	R, E	Sports fish (non native)		“	*												“	“				
Salmon	*Oncorhynchus tshawytscha*	R, E	Sports fish (non native)		“																		
Gambusia (mosquito fish)	*Gambusia affinis*	R	Pest fish (non native)						“		“	“	“										
Macroinvertebrates																							
Freshwater shrimp	*Paratya curvirostris*	R	At Risk			“	“			“					“	“	“	“					
Northern kōura	*Paranephrops planifrons*	R	At Risk			“	“			“	“					“	“	“	“			“	
Blue damselfly	*Austrolestes colensonis*	R	Not Threatened			“	“																
Red damselfly	*Xanthocnemis zealandica*	R	Not Threatened			“	“																
Gray’s dragonfly	Procordulia grayi	R	Not Threatened			“	“																

Species or value	Scientific name	Estuarine (E)/ riverine (R)	National threat status	Streamed for management	Sites																				" = present; * = present until recently
					Waimea River	Neimans Creek	Pearl Creek	O Connors Creek	Borcks Creek	Reservoir Creek	Jimmy Lee creek	Vercoes drain	Sandeman	Nile Creek (Dominion Rd.)	Stringers Creek	Seaton Valley Str.	Orphanage Creek	Poormans Creek	Jenkins Creek	Arapiki Stream	Orchard Creek	Saxton Creek	Maire Stream			
Mud snail	*Potamopyrgus antipodarum, P. estuarinus*	R, E	Not Threatened			"	"																		
Water flea (freshwater amphipod)	*Paracalliope fluviatilis*	R	Not Threatened			"	"																		
Aquatic plants																									
Red pondweed	*Potamogeton cheesemanii*	R	Not Threatened			"																			
	Triglochin striata	R, E				"	"																		
Cape pondweed	*Aponogeton distachyos*	R				"	"																		
Water starwort	*Callitriche stagnalis*	R				"																			
Arum lily	*Arum spp.*	R				"																			
Pacific azolla, red azolla	*Azolla rubra*	R				"	"																		
Aquatic moss	*Leptodictyum riparium*	R				"																			
Milfoil	*Myriophyllum triphyllum*	R				"	"																		
Horses mane	*Ruppia megacarpa*	R, E				"																			
	Lilaeopsis novae-zelandiae	R, E				"																			
	Ranunculus spp.	R				"																			
Watercress	*Nasturtium officinale*	R				"																			

Appendix 3: Tasman District Council list of Significant Natural Areas for native species in Waimea Inlet estuaries, margins and islets

Species or value	Scientific name	Estuary (e) / margins (m) / islets (i)	National threat status	Streamed for management	TDC Significant Natural Areas																																				" = species present
					No Mans Island	Bell Island shellbanks	Rabbit Island east	Rough Island shag colony	Bell Island sewage ponds	Rabbit Island west	off Hoddy Peninsula	off Bronte Peninsula	Waimea/Pearl delta	O'Connor Creek delta	Stringer Creek saltmarsh	Higgs Reserve saltmarsh & forest	Nieman Creek delta area	A&P saltmarsh	Mapua Inlet saltmarsh & Morley Drain	FertiliserWorks saltmarsh	NPI saltmarsh	Matahua Peninsula saltmarsh	Trafalgar saltmarsh	Bell Island west saltmarsh	Dominion saltmarsh	Hoddy Rd saltmarsh	Hoddy Park saltmarsh	Rough Island wetland	Hoddy Peninsula	Bell Island east	Rabbit Island manuka	Bullivant Is	Hunter Brown Reserve	Mapua	Higgs Reserve	Matahua Peninsula	Nieman Creek below Lansdowne Rd	Pearl Creek (above tidegate)	O'Connor Creek	
Birds																																									
Pied oystercatcher/ tōrea	*Haematopus finschi*	e i	Declining	Y		"						"																													
Variable oystercatcher/ tōrea pango	*Haematopus unicolor*	e i	Recovering		"	"	"			"		"											"										"								
Pied stilt/poaka	*Himantopus himantopus leucocephalus*	e i	Declining		"		"		"										"																					
Caspian tern/ tara nui	*Hydroprogne caspia*	e i	Nationally Vulnerable			"																																		
Bar-tailed godwit/ kakao	*Limosa lapponica*	e			"	"	"				"	"																													
Lessr knot	*Calidris canutus*	e				"	"																																		
Wrybill	*Anarhynchus frontalis*	e	Nationally Vulnerable	Y			"																																		
Banded dotterel	*Charadrius bicinctus bicinctus*	e	Nationally Vulnerable	Y		"	"																																		
Black shag	*Phalacrocorax carbo novaehollandiae*	e	Naturally Uncommon																																						
Black-fronted tern	*Chlidonias albostriatus*	e	Nationally Endangered	Y																										"										
Pied shag	*Phalacrocorax varius*	e	Nationally Vulnerable																																						
Grey teal	*Anas gracilis*	e	Not Threatened																																						

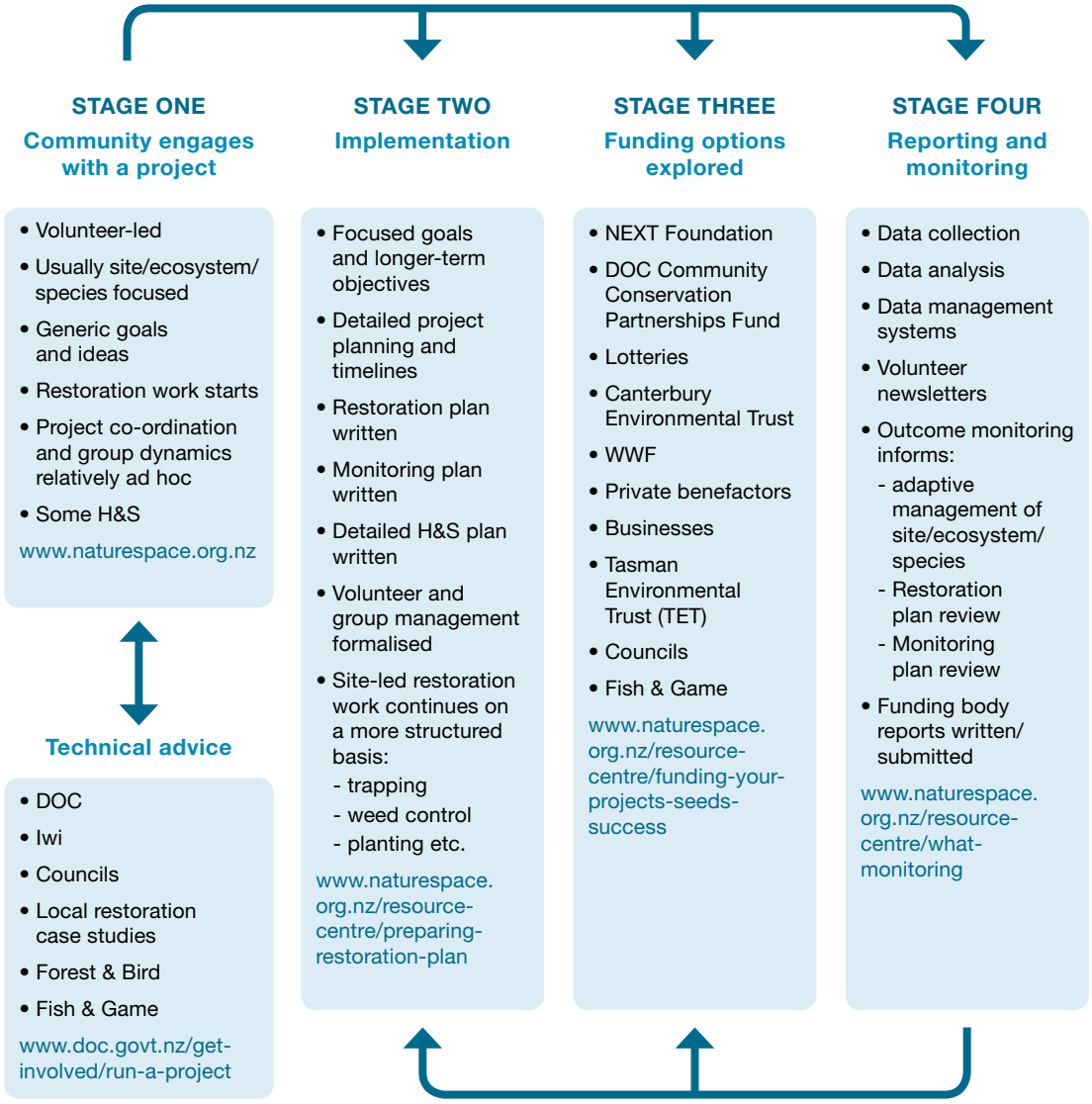
TDC Significant Natural Areas — “ = species present

Species or value	Scientific name	Estuary (e) / margins (m) / islets (i)	National threat status	Streamed for management	No Mans Island	Bell Island shellbanks	Rabbit Island east	Rough Island shag colony	Bell Island sewage ponds	Rabbit Island west	off Hoddy Peninsula	off Bronte Peninsula	Waimea/Pearl delta	O'Connor Creek delta	Stringer Creek saltmarsh	Higgs Reserve saltmarsh & forest	Nieman Creek delta area	A&P saltmarsh	Mapua Inlet saltmarsh & Morley Drain	FertiliserWorks saltmarsh	NPI saltmarsh	Matahua Peninsula saltmarsh	Trafalgar saltmarsh	Bell Island west saltmarsh	Dominion saltmarsh	Hoddy Rd saltmarsh	Hoddy Park saltmarsh	Rough Island wetland	Hoddy Peninsula	Bell Island east	Rabbit Island manuka	Bullivant Is	Hunter Brown Reserve	Mapua	Higgs Reserve	Matahua Peninsula	Nieman Creek below Lansdowne Rd	Pearl Creek (above tidegate)	O'Connor Creek
Little shag	*Phalacrocorax melanoleucos brevirostris*	e	Not Threatened																																				
Pūkeko	*Porphyrio melanotus*	e	Not Threatened																																				
Royal spoonbill	Platalea regia	e	Naturally Uncommon		“							“	“																										
Ruddy turnstone	*Arenaria interpres*	e	Migrant			“	“																																
Northern shoveler	*Anas clypeata*	e	Vagrant																																				
Banded rail	*Gallirallus philippensis assimilis*	m	Declining										“	“	“	“	“	“	“			“	“		“	“	“										“		
Marsh crake	*Porzana pusilla affinis*	m	Relict										“				“		“	“					“														
Australasian bittern	*Botaurus poiciloptilus*	m	Nationally Endangered	Y									“	“																							“		
Fernbird/mātātā	*Bowdleria punctata punctata*	m	Declining	Y									“	“																									
Australasian harrier/kāhu	*Circus approximans*	m	Not Threatened																																				
Kingfisher/kōtare	*Todiramphus sanctus vagans*	m	Not Threatened																																				
Spotless crake	*Porzana tabuensis tabuensis*	m	Relict																																				

Species or value	Scientific name	Estuary (e) / margins (m) / islets (i)	National threat status	Streamed for management	TDC Significant Natural Areas																																					" = species present
					No Mans Island	Bell Island shellbanks	Rabbit Island east	Rough Island shag colony	Bell Island sewage ponds	Rabbit Island west	off Hoddy Peninsula	off Bronte Peninsula	Waimea/Pearl delta	O'Connor Creek delta	Stringer Creek saltmarsh	Higgs Reserve saltmarsh & forest	Nieman Creek delta area	A&P saltmarsh	Mapua Inlet saltmarsh & Morley Drain	FertiliserWorks saltmarsh	NPI saltmarsh	Matahua Peninsula saltmarsh	Trafalgar saltmarsh	Bell Island west saltmarsh	Dominion saltmarsh	Hoddy Rd saltmarsh	Hoddy Park saltmarsh	Rough Island wetland	Hoddy Peninsula	Bell Island east	Rabbit Island manuka	Bullivant Is	Hunter Brown Reserve	Mapua	Higgs Reserve	Matahua Peninsula	Nieman Creek below Lansdowne Rd	Pearl Creek (above tidegate)	O'Connor Creek
Plants																																										
Sea sedge	*Carex litorosa*	m	Declining										"																													
New Zealand spinach/kōkihi	*Tetragonia tetragonioides*	m	Naturally Uncommon																					"							"									
	Atriplex buchananii	m	Nationally Vulnerable																					"																
Native musk	*Thyridia repens*	m	Naturally Uncommon										"	"					"												"						"			
Grey saltbush	*Atriplex cinerea*	i	Nationally Critical		"							"																												
Coastal peppercress	*Lepidium banksii*	i	Nationally Critical	Y	"																			"																
Invertebrates																																									
	Bembidion tillyardi	m	Nationally Critical	Y																																					

Appendix 4: Evolutionary and cyclical nature of community restoration projects

The stages and steps are interchangeable and scaleable depending on group dynamics and project objectives, e.g. project size, needs, number of volunteers involved.



Appendix 5: Methods of weed control

Weedbusters (www.weedbusters.org.nz) is useful for weed identification resources and information on New Zealand's worst weeds.

Cut and squirt

Good for soft trees (quicker to than drilling).

Cut a notch in a downward angle in the trunk and squirt concentrated herbicide in notch. Use drench gun and pack.

Can generally use all year round.

Drill and fill

Generally best for big trees.

Uses less herbicide than most other methods and minimal amounts of water.

Aim is to access cambium layer (under bark) so deep holes are not necessary.

Only suitable for use in areas where eventual tree fall is not a risk to people or property.

Can generally use all year round.

Foliar spray (spraying the leaves)

Can be used to apply non-selective herbicides semi-selectively on large areas.

To ensure minimum drift of spray:

- Do not spray if there is any wind.
- Use a medium sized nozzle or adjust nozzle so that droplet size is big enough that the spray doesn't 'float' away.
- Ideally use a marker dye with the spray mix to avoid missing areas or spraying areas twice.
- Always test the sprayer with water before starting and clean and adjust nozzles if necessary.
- Avoid spraying plants above shoulder height. It is better to cut plants to a more manageable height and minimise spray damage to desirable species.

Frill

Usually inferior to drilling as it uses more herbicide, requires a complete ring of bark to be cut out around the trunk, and herbicide can run off into streams.

Superior to stump painting for large trees, some hardwoods and self-sprouting species (e.g. willows, coral tree).

Semi-frilling (feathering) can hold herbicide better.

Hand dig

Usually only suitable if the entire root system can be dug out.

Soil disturbance can lead to more weeds.

Not recommended for resprouting species (e.g. tradescantia), as any fragments left will regrow.

Machine dig

Occasionally useful to remove hard-to-kill individual plants (e.g. bamboo), or to clear aquatic plants that can be controlled by digging and which are guaranteed to die on dry land.

Machine digging is an extreme measure. It causes a host of environmental effects, so should only be used where the weed has is highly invasive and there is no other suitable control method.

Stump paint

Application of herbicide to cut stump surface. Solution is usually 10% herbicide in water.

The cambium layer (the slippery zone under the bark) must be coated, as this is where most growth sprouts from.

'Feathering' of bark of hardwood species and big trees is generally recommended. This means peeling back the bark so that the cambium layer is well coated and more herbicide mix can be applied.

'Painting' can be done by paint brush, drench gun, knapsack or pistol-grip sprayer. Pistol-grip sprayers are recommended as they don't spill if tipped over and require only one hand to operate.

Stump painting should never be used for resprouting stem species (e.g. coral tree, willows) because felled stems resprout constantly, adding to the problem.

Vial treatment

Used to give selective control of rhizomatous or layering creepers (e.g. jasmine, convolvulus, ivy).

Individual flower vials, available from garden centres, are ideal for this.

Cut vines 5–10 m apart, place end of vine in bottom of bottle containing concentrated herbicide. Vine sucks up herbicide and kills 2+ m away.

Follow up monthly on missed spots.

Weed mat

Offers good control of many submerged aquatic weeds, especially non-seeding species.

However it is expensive and time consuming to install.

Aquatic situations – Can be laid in small sections, beginning at point of infestation farthest upstream, and reused several times.

Terrestrial situations – No disposal needed, but mat can have unwanted effects on soil (lowers water and gas exchange, kills microbes) and can affect adjacent desirable plants by interfering with their roots.

Weed wipe

This is particularly useful for grasses, rushes and soft herbs.

Non-selective herbicides (e.g. glyphosate) can be made to act in a selective manner using a hockey stick type weed wiper.

A residual herbicide (e.g. Metsulfuron, Amitrole, 2,4-D) can be applied by wiper to minimise or even eliminate residues, as the herbicide is contained within the plant rather than drifting or dripping onto the ground.

Most or all of the herbicide is broken down within the weed.

Look for a weed wiper that has a narrow or controlled release reservoir.

Appendix 6: Further resources

Examples of resources that may be useful for Waimea Inlet community restoration projects:

Activity/topic	Link	Comments
Estuary restoration and monitoring	www.doc.govt.nz/nature/habitats/estuaries	DOC's webpages include a wealth of restoration and monitoring resources and examples of best practice from around the country
Freshwater invertebrates and zooplankton	tinyurl.com/DOCnzfreshwaterinvertebrates tinyurl.com/DOCnzfreshwaterzooplankton tinyurl.com/Landcarefreshwaterinvertebrate	Freshwater invertebrate ecology – main groupings, basic ID etc Broad range of species and identification techniques covered
Freshwater plants and algae	tinyurl.com/Landcarefreshwateralgae	Identification and ecology
Inanga	tinyurl.com/NIWArestoreinangahabitat	Information on restoring inanga spawning habitats
Koura/freshwater crayfish	tinyurl.com/DOCnzcrayfish	Good basic information on koura, common in many tributaries of the Waimea Inlet
Freshwater information and water quality, and link to the Tasman-Nelson region	www.lawa.org.nz/explore-data/tasman-region/freshwater/waimea-river/ http://lawa.org.nz/explore-data/tasman-region/river-quality/waimea-river/	LAWA (land and water Aotearoa) – Regional Councils' portal to information sharing. Good context: gives local water quality information, approaches to sampling fish, invertebrates etc
Mangakotukutuku Stream restoration	www.streamcare.org.nz/links.html	Outstanding site with comprehensive links to useful information and nationwide restoration projects
Meet the locals: Electric fishing video	tinyurl.com/DOCelectricfishing	Introduction to the electric fishing technique and some of the fish in local Nelson rivers
Meet the locals: Pest fish video	tinyurl.com/TVNZpestfish	Context to gambusia eradication issue in the Waimea catchment including inlet tributaries
Meet the locals: Waikanae estuary video	tinyurl.com/TVNZwaikanaeestuary	Good comparison to explore Waimea opportunities with
Community estuaries monitoring resource	tinyurl.com/Landcareturningthetide	Toolkit with specific estuary monitoring ideas
Native fish – general Pest fish – general	tinyurl.com/DOCnzfreshwaterfish tinyurl.com/DOCfishpestA-Z	Range of information on freshwater fish, including links to posters and fish passage issues

Activity/topic	Link	Comments
Planning restoration – wetland – science	tinyurl.com/Landcarewetlandecosystem	Portal to wetland restoration guide and access to technical information Basics on developing, planning and monitoring wetland restoration projects
Trees for survival	www.tfsnz.org.nz	Supports schools to set up and run restoration projects including riparian
Tuna/eels	tinyurl.com/DOCnzeels www.longfinfilm.com/About_the_Film.html www.longfineel.co.nz	General information on eels Video for children Advocacy for the protection of manaki tuna
Virtual fieldtrips through Learnz	www.learnz.org.nz	Covers a variety of habitats and environmental issues, including freshwater in Taupo and the Bay of Plenty. Useful for community/schools to watch and possibly develop a short video on 'their' project, stream etc
Waimea Inlet maps, monitoring and scientific papers	tinyurl.com/TDCwaimeainlet	Tasman District Council information
Whitebait Connection programme	www.whitebaitconnection.co.nz	Good education resource and model for school groups as part of education advocacy and participation in restoration
Papers and reports	Davidson, R.J., Moffatt, C.R., 1990: *A Report on the Ecology of Waimea Inlet, Nelson*. Department of Conservation Nelson/Marlborough Conservancy Report Goodman, J., et al., 2013: Conservation status of New Zealand freshwater fish. Science & Technical Publishing, Department of Conservation, Wellington. Robertson, G., Peters, M., 2006: Turning the Tide: An estuaries toolkit for NZ communities. M. Taieri Trust, 98pp.	

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