



Arawai Kākāriki Wetland Restoration Programme 2007–2010

Implementation Report

Whangamarino

Ō Tū Wharekai

Awarua Wetland



Arawai Kākāriki

wetland restoration programme

Whangamarino • Ō Tū Wharekai • Awarua Wetland

Department of
Conservation
Te Papa Atawhai
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Arawai Kākāriki Wetland Restoration Programme 2007 – 2010

Implementation Report

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Christchurch

December 2011

Cover image: Wetland and braided river habitat of the upper Rangitata River, Ō Tū Wharekai (H. Robertson, DOC).

ISBN 978-0-478-14909-8

Published by: Research and Development Group,
Department of Conservation,
Box 10420, Wellington.

In the interest of forest conservation, we support paperless electronic publishing.

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Executive Summary

The Arawai Kākāriki ('Green Waterway') Wetland Restoration Programme aims to enhance the ecological restoration of three of New Zealand's foremost wetland/freshwater sites, making use of strong community involvement and promoting research into wetland restoration techniques.

The three sites in the programme are the Whangamarino wetland in Waikato, Ō Tū Wharekai (Ashburton basin and upper Rangitata River) in Canterbury, and Awarua/Waituna in Southland. \$2.2million per annum was invested between 2007/08 and 2009/10. Funding was split between the three sites (approx. \$500k per annum per site), research and development and communication.

Arawai Kākāriki is focused on delivering outcomes for 10 national objectives, grouped into the themes; *Biodiversity*, *Community* and *Learning*. Key achievements of the programme over the past three years include:

Biodiversity

- Comprehensive inventory of wetland flora and fauna, enabling management goals to be set and providing baseline information to measure success.
- Wetland mapping based on aerial photography to delineate areas of intact wetland habitat (priority for protection) and degraded wetland habitat (priority for restoration).
- Over 15,000 ha of weed control and weed surveillance across the three sites focusing on Spanish heath, Crack willow, Grey willow and Broom.
- 27 km of boundary fencing across the three sites to reduce stock damage to wetlands and 55 km of riparian fencing to reduce sediment and nutrient input
- 19,000 ha of annual deer surveillance with 16 deer culled
- Major upgrade of the Whangamarino weir to restore minimum water levels
- Establishment of hydrological (water level) monitoring at key lake and wetland sites
- Working with regional councils on water quality management initiatives, such as monitoring the health of the Waituna Lagoon Ramsar site.

Community

- Liaison with iwi on wetland values and initiation of cultural assessments such as the Ō Tū Wharekai State of the Takiwa report.
- Establishment of a community Advisory Group for Awarua-Waituna (AWAG) that promotes sustainable land use and implements riparian management projects.
- Installing 6 new recreation facilities for public, including wetland viewing shelters, boat ramps, walking tracks, and Didymo cleaning stations.
- Promotion of wetland values to local community and the general public through >30 organised events.
- Publication of online and postal newsletters to keep community up to date of progress

Learning

- Research on the ecology of wetland birds (e.g. Australasian Bittern, Wrybill) and the population dynamics of mammalian predators that threaten them.
- Assessment of the vulnerability of Waituna Lagoon to changing land use (increased nutrients) and artificial lagoon opening events.
- Development and promulgation of methods to monitor wetland birds, mammalian predators, and wetland vegetation.
- Collaboration with universities and crown research institutes
- Promulgation of research findings with end-users, including the Arawai Kākāriki sponsored session at the 2009 New Zealand Freshwater Science Conference and 2010 National Wetlands Symposium.

Across the sites, and at a national level, the programme is performing well against the national objectives. This is largely due to the development and implementation of a national strategic planning framework, which guides the allocation of resources to the most high priority tasks. This coordination has also increased the national profile of wetlands in the community and with other agencies.

The Arawai Kākāriki Restoration Programme is contributing to the department's Natural Heritage Management Systems (NHMS), and will ultimately support the restoration of wetland ecosystems elsewhere on public conservation land.

Looking forward, the priorities for the programme over the next 2-3 years are to:

- Continue to implement on-ground actions to protect and restore Whangamarino wetland, Ō Tū Wharekai and Awarua-Waituna as guided by the national objectives of the Arawai Kākāriki programme.
- Transition from an inventory phase of data collection to targeted monitoring and reporting on the effectiveness of management actions.
- Disseminate new tools for management and monitoring for use by government agencies and non-government groups.
- Share research findings with other wetland managers.
- Continue to build collaborative partnerships with community, iwi and stakeholders.



Extensive lowland bog found at Awarua wetlands. Waituna Lagoon and Foveaux Strait are in the background.

1. Overview

1.1 Programme background

The Arawai Kākāriki ('Green Waterway') Wetland Restoration Programme began in July 2007 at three of New Zealand's foremost wetland sites. It is a flagship programme for the Department of Conservation aimed at protecting, restoring and understanding these ecosystems with the assistance of community.

The three Arawai Kākāriki sites are; the Whangamarino wetland in Waikato, Ō Tū Wharekai (Ashburton basin and upper Rangitata River) in Canterbury, and Awarua/Waituna in Southland (Figure 1).

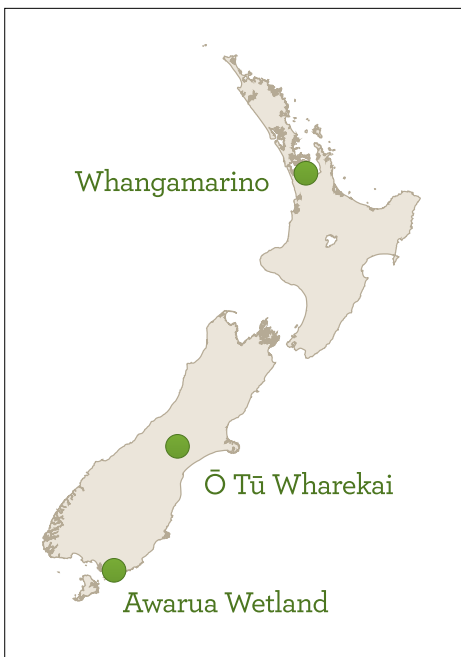


Figure 1. Location of the three sites involved in the Arawai Kākāriki restoration programme.



Empodisma minus (pictured) is an important peat forming plant at both Whangamarino and Awarua

The programme involves a broad range of wetland restoration initiatives that are undertaken in collaboration with local community, iwi and other agencies. Restoration actions are based on the best available science and from gathering new information on wetland values. Working with local community is seen as fundamental to success, taking into account the ecosystem services the three sites support, such as flood protection and recreation.

A focus of the programme is on research to reduce knowledge gaps which currently limit the conservation of New Zealand's wetland ecosystems. Research findings from the three sites are utilised to develop best-practice tools for management and monitoring, and subsequently aims to improve the effectiveness of wetland management both on and off public conservation land.

An important feature of the Arawai Kākāriki programme is its contribution to the development and implementation of the department's Natural Heritage Management System (NHMS). The three sites are being used to trial the NHMS framework for monitoring changes in biodiversity, and also provide new information on the level of investment required to achieve freshwater conservation outcomes. Furthermore, the inventory and monitoring techniques being applied are helping to develop standardised procedures for monitoring wetlands.

The programme is coordinated from the ex-Southern Regional Office with support from the Research and Development Group. A national Advisory Group provides overall direction and guidance (Appendix 1). Funding of \$2.2million per annum has been distributed annually between the three sites (approx. \$500k per site), research and development, and national communication and overheads (Appendix 2).

This Implementation Report summarises the programme objectives and on-ground achievements for the period July 2007 to June 2010.

1.2 National objectives

The three Arawai Kākāriki sites contrast one another in the landscapes, ecosystems, species and land use they support. The specific issues that threaten wetland values also vary from site to site. At a regional and national level, however, the overall objectives for wetland conservation are comparable, such as to restore degraded habitat and promote sustainable land use.

We defined 10 national objectives for the Arawai Kākāriki Wetland Restoration Programme under the themes; Biodiversity; Community; and Learning (Box 1). Application of consistent objectives across the three sites allows priorities for management, monitoring and research to be aligned, and the maximum national benefit from the development of new management and monitoring systems.

Box 1. Objectives of the Arawai Kākāriki Wetland Restoration Programme

Biodiversity

1. Maintain the extent of wetland habitat
2. Maintain and enhance water levels and water quality
3. Protect and restore wetland habitat
4. Maintain and enhance species diversity, including threatened species

Community

5. Conserve historic and cultural sites
6. Promote sustainable land use
7. Improve recreation and visitor facilities
8. Maximise community awareness and involvement

Learning

9. Undertake research to inform wetland management
10. Develop best-practice wetland restoration tools

These objectives are utilised by each site to prioritise on-ground management and monitoring. They also provide a framework for communication about the department's goals with key stakeholders and community.

This report summarises progress under each national objective (section 3). The long-term success of the Arawai Kākāriki Restoration Programme will also be measured against these objectives.

2. Site descriptions

2.1 Whangamarino wetland

Our vision is that Whangamarino, one of New Zealand's largest wetlands, remains an outstanding site for promoting the value of wetlands and species conservation, especially Australasian bittern/matuku.

In December 1989 a 5690 ha portion of the Whangamarino Wetland became formally recognised under the Ramsar Convention as a wetland of international importance. The wetland's Ramsar designation was inspired by the native species and ecosystem values, in particular, the diverse and numerous water birds, including herons, rails, waders and waterfowl. It also supports threatened species such as *Anzybas carsei*, Australasian Bittern and black mudfish. Whangamarino is located within the rohe o Waikato-Tainui and local hapu continue to uphold and value their connection with this taonga.

Whangamarino is one of the largest swamp and raised peat dome wetland complexes in New Zealand. The low fertile, ombrotrophic (rainwater fed) regions of Whangamarino are still largely intact. In contrast, areas influenced by surface water inflows are impacted by increased sediment and nutrient inputs that supports weed invasion, particularly willow (*Salix fragilis*, *Salix cinerea*) and royal fern (*Osmunda regalis*).

Whangamarino is located within the rohe of Waikato-Tainui and local hapu continue to uphold and value their connection with this taonga. Early Maori utilised the resources of the wetland, including tuna, birds and harakeke (flax) for cultural and traditional purposes and the rivers were used for travel and recreation. Dense vegetation prevented much further use of the wetland except during times of war when it offered a place of sanctuary. Maori also used the peat margins to preserve taonga such as waka, tools and weapons.

The Whangamarino area was the site of several major battles during the Waikato War of 1863 -1864 including New Zealand's most fierce land battle at Rangiriri. At the confluence of the Whangamarino and Waikato rivers, visitors can walk up a short track to Te Teoteo's pa and the Whangamarino Redoubt and stand where two forty-pound Armstrong guns fired upon Maori entrenchments at Meremere. This site also offers a good scenic overview of the wetland.

Whangamarino wetland is a popular duck hunting location, with 748 ha of the wetland owned by the Auckland/Waikato Fish and Game Council. Thousands of gamebirds utilise the wetland attracting hunters from Auckland and the greater Waikato region. Recreational fishers also frequently visit Whangamarino targeting coarse fish.

Whangamarino plays a vital role within the flood control scheme on the Lower Waikato River. Its water storage function during peak flows has avoided costs in public works and reduced damage to surrounding farmland during large floods, of which there have been several in the last decade. Other wetland ecosystem services include carbon sequestration, nutrient/sediment filtering and the provision of water for irrigation during dry periods.



Drosera binata (a sundew) grows in the Whangamarino wetland



Ponds at the southern end of the wetland

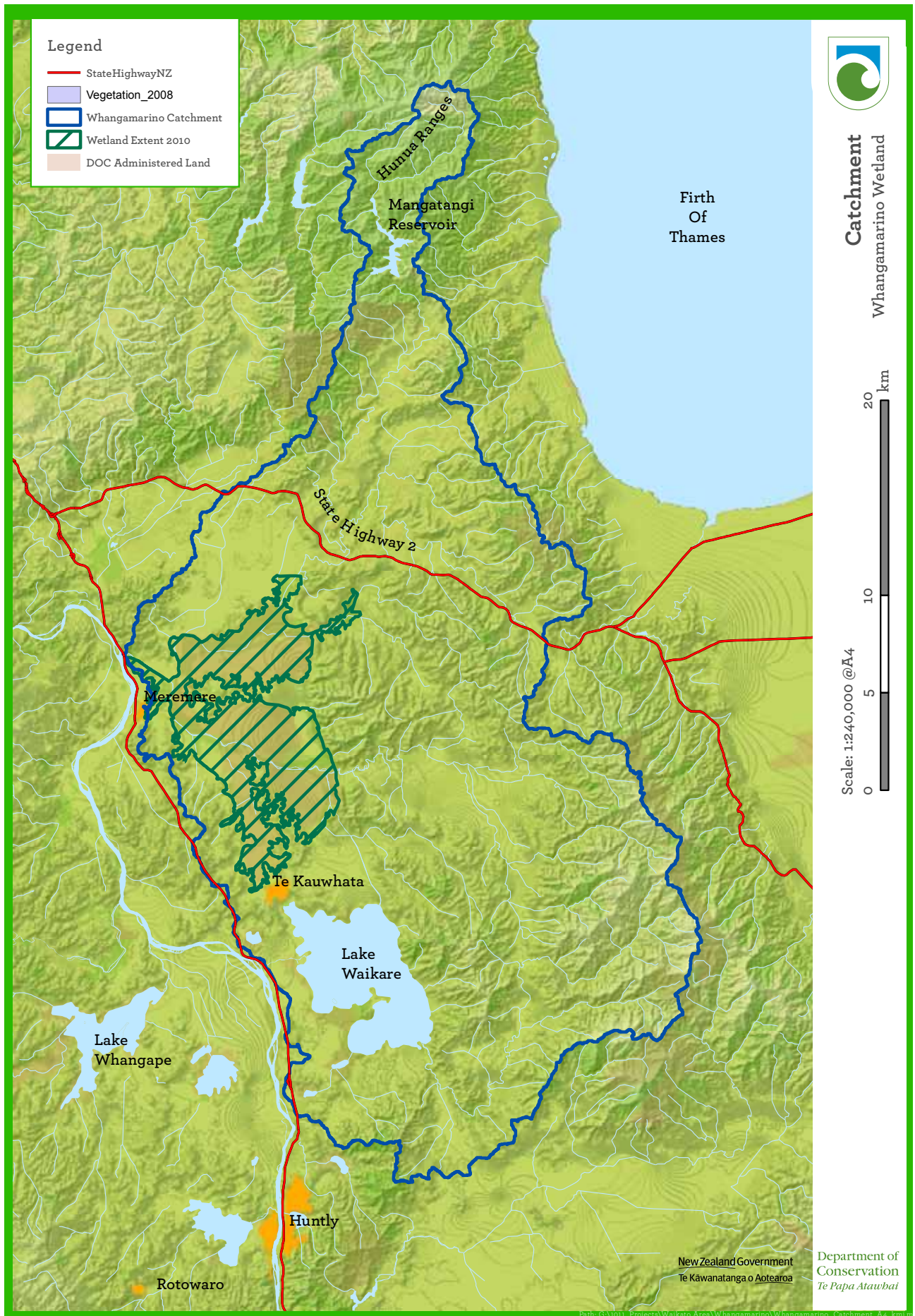


Figure 2. Whangamarino wetland and catchment area

2.2 Ō Tū Wharekai (Ashburton basin and upper Rangitata River)

Our vision for Ō Tū Wharekai is that the intrinsic values of one of the best remaining high country freshwater wetland and braided river ecosystems are protected, enhanced and appreciated.

Ō Tū Wharekai is an inter-montane basin and braided river complex of over 50,000 ha that supports a diverse range of aquatic habitats, largely due to the unique glacial landforms that shaped the landscape. Freshwater lakes of varying size, kettleholes supporting rare ephemeral turf vegetation, red-tussock (*Chionochloa rubra*), sphagnum, *Schoenus pauciflorus* and *Carex secta* dominated wetlands, and relatively pristine rivers and streams make Ō Tū Wharekai a highly valued wetland system. Ō Tū Wharekai also includes two braided rivers – the upper Rangitata and upper South Ashburton.

Ō Tū Wharekai supports the threatened upland longjaw galaxid and longfin eel as well as important sports fish spawning areas. The Rangitata River also supports the largest breeding colony of the endemic wrybill, along with black-fronted tern and banded dotterel populations. The lake edges sustain good populations of marsh crake and low numbers of bittern, and the lakes support the nationally vulnerable Australasian crested grebe. Ō Tū Wharekai is a significant area for lizard species such as scree skink and long-toed skink. Threatened plant species include the endangered marsh arrowrush *Triglochin palustris*, pygmy forget-me-not *Myosotis pygmaea* var. *mintiflora*, pygmy clubrush *Isolepsis basilaris*, a threatened grass *Amphibromus fluitans*, and one of the largest known populations of a threatened native lily, *Iphigenia novae-zelandiae*.



Carex secta swamp within the Ashburton Basin / Ō Tū Wharekai



Endemic Wrybill (photo: G. Iles)

For early Maori the area was a major kaik/village and part of the seasonal mahinga kai and resource gathering trial. The area was also part of the pounamu trials and an ara/path to Poutini/ West Coast. Through the Ngai Tahu Settlement Act 1998, a Statutory Acknowledgement and Deed of Recognition is in place to formally acknowledge the association and values Ō Tū Wharekai holds for Ngai Tahu.

The main threats to the ecological values of Ō Tū Wharekai include the expansion of Broom and Russell lupins on the braided rivers, potential water abstraction and storage for irrigation and stock water, and degraded water quality due to sediment and nutrient inputs from intensified farming. Grey and Crack willow threaten the streams and swamps by increasing sedimentation and displacing native plants. Predators such as mustelids, feral cats, hedgehogs and possums threaten the basins unique bird, lizard and invertebrate communities.

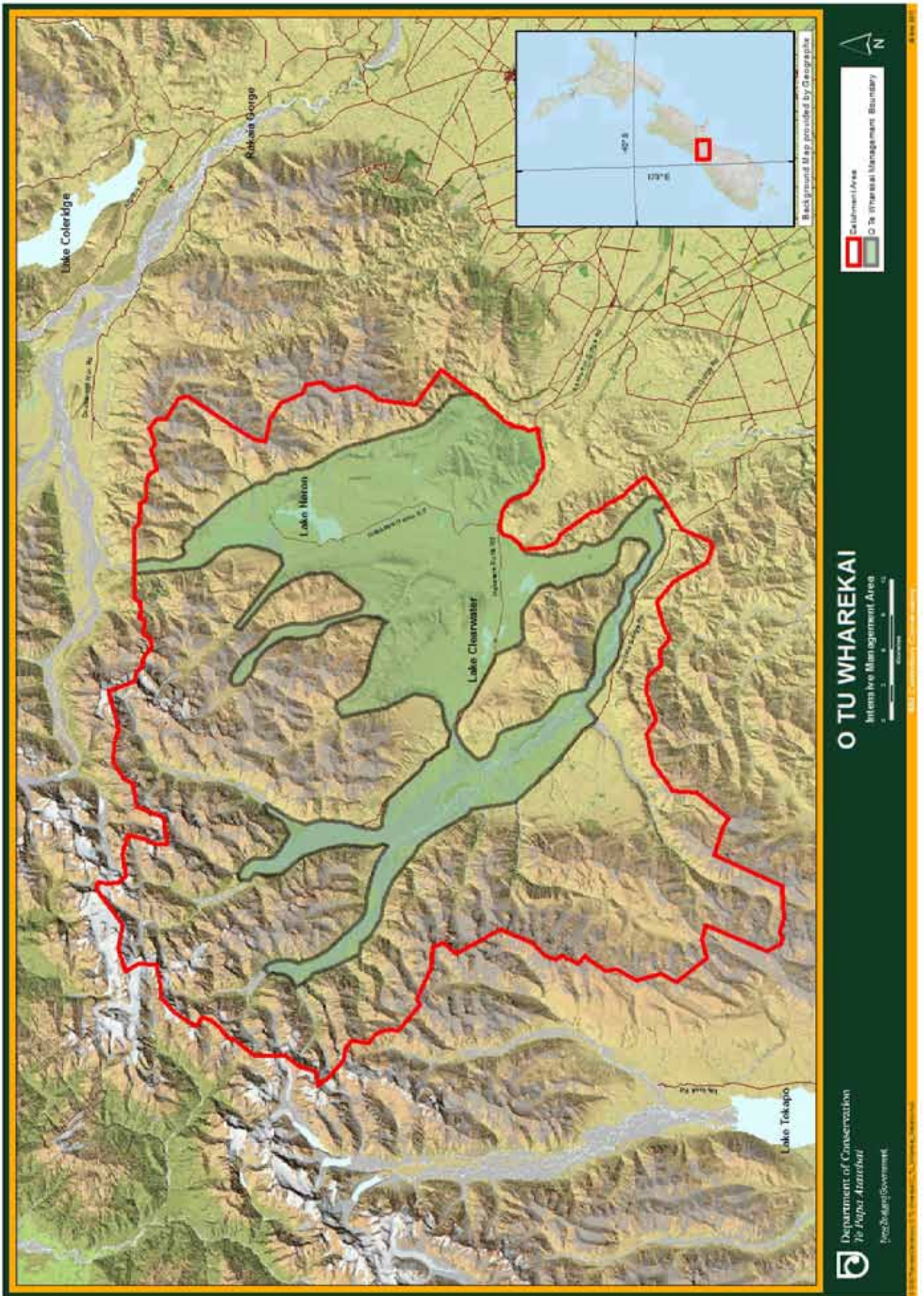


Figure 3. O Tū Wharekai (Ashburton Basin/upper Rangitata River) and catchment area

2.3 Awarua/Waituna

Our vision for Awarua/Waituna is to protect a large coastal low-lying plain of bogs, swamps, heaths, forests and open water, under wise stewardship by local community.

The Awarua-Waituna system was the first site in New Zealand recognised as a wetland of international importance (Ramsar site). The complex comprises over 10,000 ha of wetlands that include wirerush, manuka, and podocarp dominated fen/bog, flax and red-tussock swamps, a coastal lagoon, freshwater streams and the Awarua Bay estuary. This ecological diversity provides habitat for a rich array of flora and fauna. A nationally important site for trans-equatorial wading birds, it is also home to several threatened plants including Shore Spurge (*Euphorbia glauca*) and Buttercup (*Ranunculus recens*) and threatened fauna such as the Australasian Bittern (*Botaurus poiciloptilus*).

A key feature of the Awarua-Waituna wetlands is the 1350 ha Waituna Lagoon, which supports a relatively intact aquatic plant community dominated by *Ruppia* spp. It also contains populations of the threatened giant kokopu (*Galaxias argenteus*), banded kokopu (*G. fasciatus*), inanga (*G. maculatus*), short and long fin eels (*Anguilla australis* and *A. dieffenbachia*) and other estuarine species such as yellow-eye mullet (*Aldrichetta forsteri*), and flounder (*Rhombosolea* spp.).

The relatively shallow coastal lagoon is subject to fluctuating water levels due to an artificial opening regime that maintains drainage from adjacent farmland. The land surrounding the wetlands is dominated by agricultural land use, and in recent times there has been a shift to dairy farming and intensification of farming practices. The water quality of the three main creeks entering Waituna Lagoon is also in decline. Working with farmers to reduce nutrient runoff is essential to maintaining the health of the wetlands. Other threats to the Awarua wetlands are from weed invasion, particularly Spanish heath, uncontrolled wild fire across and predators.

Waituna Lagoon is renowned for its recreational fishing and duck shooting. Other recreational activities supported by the wetlands include kayaking, bird watching, day walking, yachting and windsurfing.



Photos from left to right: Bar-tailed Godwit (*Limosa lapponica*), Cryptic Skink (*Oligosoma inconspicuum*), and a mosaic of peatland habitat

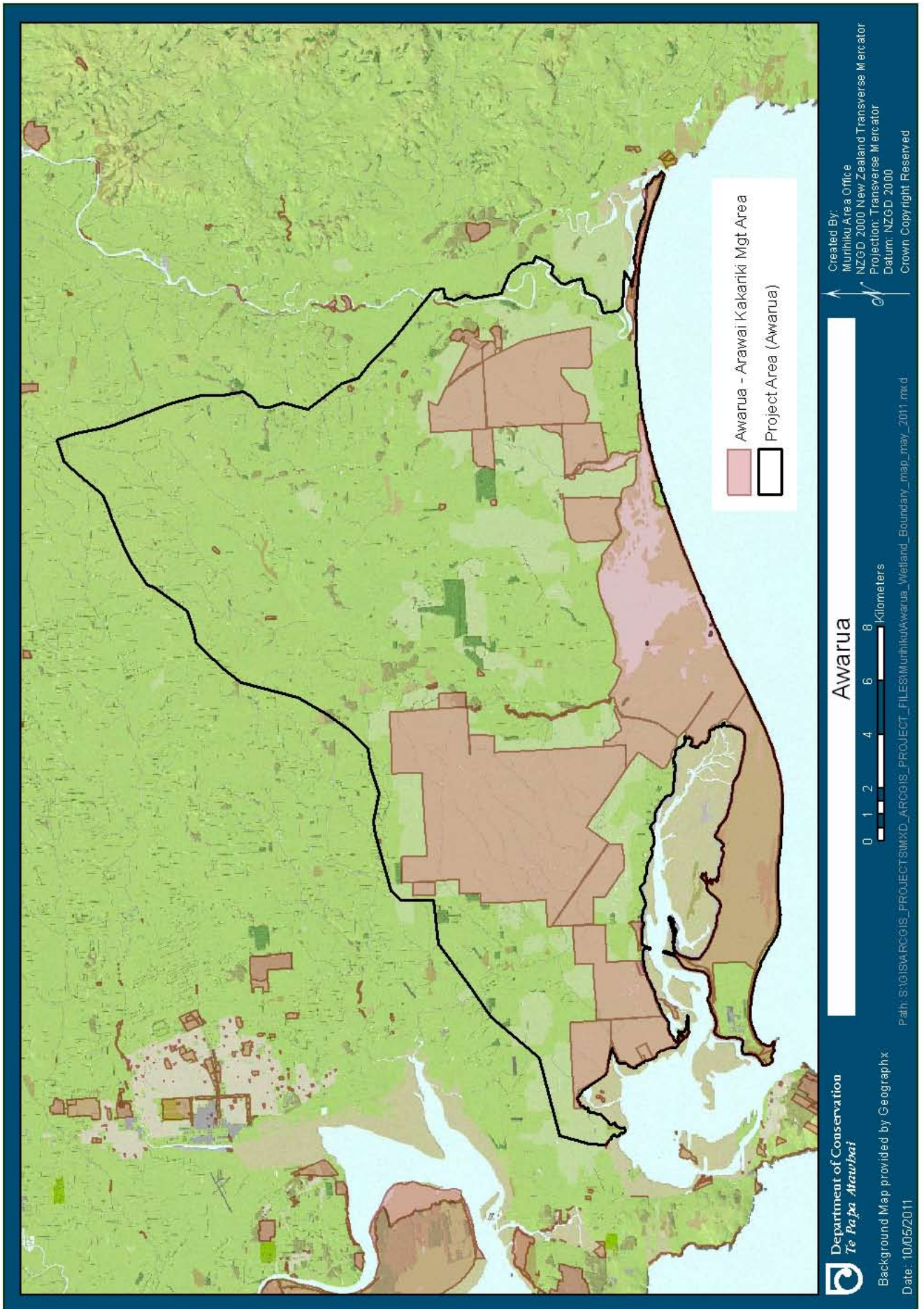


Figure 4. Awarua wetlands and catchment area, including Waituna Lagoon

3. Programme Management

3.1 Planning

A Planning Framework for the programme was established in 2008 and subsequently adapted based on the department’s NHMS approach to setting objectives and management actions (Figure 5). At all sites funding is limited and therefore the Planning Framework is a key element in determining priorities for action. The Arawai Kākāriki framework has provided an opportunity to test the NHMS concepts in an applied way, as a national ‘case-study’ from which the department can learn from.

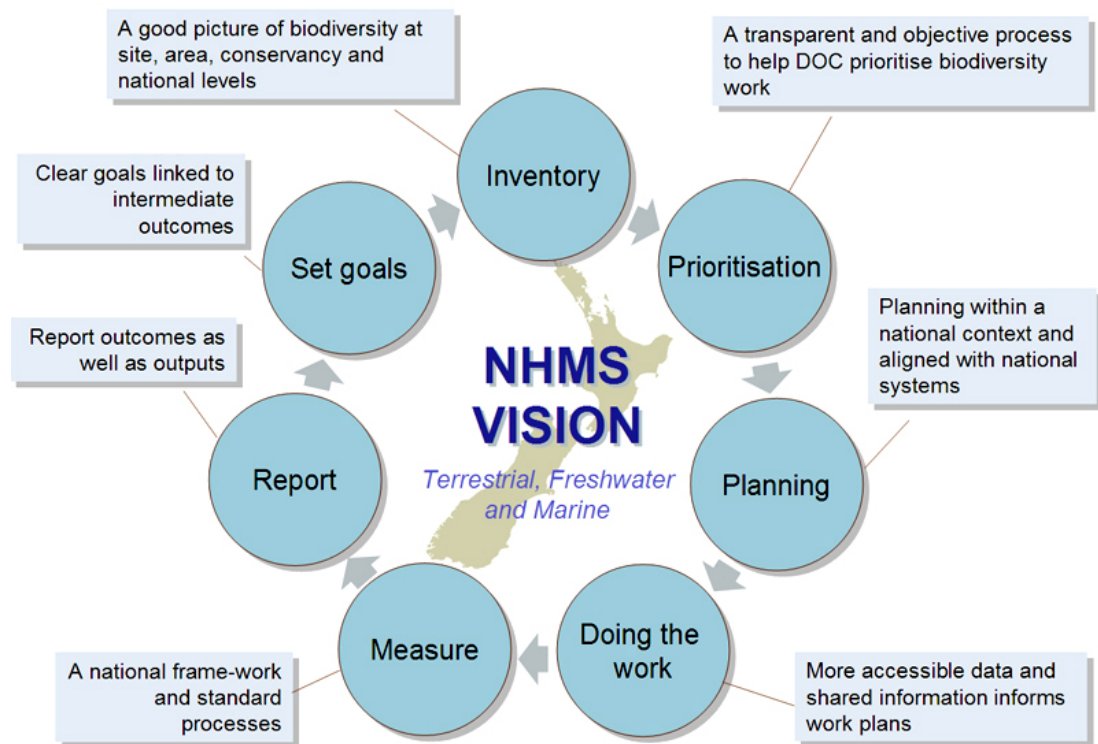


Figure 5. The Department of Conservation Natural Heritage Management System (NHMS) that outlines the recommended approach to biodiversity conservation.

In 2007-08 and 2008-09 each site prepared an Operation Plan that defined priority inventory, management and monitoring actions and the corresponding budgetary needs. This subsequently evolved into a five-year Site Strategic Framework based upon explicit assumptions of the linkages between outputs (management actions) and outcomes (actual changes in ecosystem condition, recreation use, land use and community behaviours). The 2009-10 Operation Plans prepared by the three sites were based on this revised framework. A template for sites to prepare a Site Management Strategy is currently in preparation.

3.2 Site operations

On-ground management and monitoring actions are implemented by Waikato Area, Raukapuka Area and Murihiku Area offices with support from Waikato, Canterbury and Southland Conservancies. The size of the wetland systems under management is considerable, ranging from 7290 ha at Whangamarino wetland to 18808 ha at Ō Tū Wharekai (Table 1).

While some practical measures have been undertaken over the last three years, the real key to the success of this programme has been the acquisition of strong scientific information (baseline data) to drive appropriate management, recognizing that our knowledge of these complex ecosystems is partial at best. Therefore the initial priority work at all three sites has aimed to find out more about how the wetlands work, what the major threats are and what species they contain. This has involved hydrological surveys, liaising with regional councils, understanding community values, vegetation mapping, fish surveys, bird monitoring and inventory of cultural and recreational values. Appendix 6 provides a list of the scientific and technical reports that have been published or are in preparation. Where management actions clearly support the national objectives, restoration actions such as fencing, weed control and riparian planting have been implemented and recreation access enhanced. Where the outcomes and benefits cannot be clearly established, work has been put on hold while the necessary research is undertaken (e.g. large-scale willow control at Whangamarino).

The department is working with others (iwi, local councils, Fish & Game, National Wetland Trust and research agencies) on research, restoration initiatives and raising public awareness. At all three sites community is involved, whether at an individual level with local landowner fencing and planting projects, or as part of a group assisting with weed control and committees. A national Communication Education and Public Awareness (CEPA) plan has guided site-led community participation.

Table 1. Extent of wetlands, lakes and braided river within the Arawai Kakariki sites

Site	Ecosystem extent (ha) ¹			Total
	Wetlands	Lakes/ Lagoons	Braided River	
Whangamarino	7290	-	-	7290
Ō Tū Wharekai	5345	1227	12236	18808
Awarua/Waituna	11847	1350	-	13197

¹ The extent of wetland, lake and river ecosystems was calculated from wetland mapping completed under the Arawai Kakariki programme and from existing geospatial data.

3.3 Communication

A national Communication Plan outlines the goals communication. Arawai Kākāriki has pages on the DOC website and intranet (www.doc.govt.nz/conservation/land-and-freshwater/wetlands/), and a series of factsheets have been printed and distributed. New Zealand Geographic published a feature article on the Arawai Kākāriki Restoration Programme in their January-February 2010 issue (Hansford 2010). The feature increased the profile of wetland conservation and the issues at Whangamarino, Ō Tū Wharekai and Awarua-Waituna. Other publicity has occurred through site initiatives (e.g. TV coverage) and articles in the Dairy Exporter and Wet & Wild the National Wetland Trust newsletter. A summary of media and communication is provided in Appendix 5.

3.4 Technical advice and support

Ongoing technical support is considered critical to the success of the programme. Understanding the range of biological interactions, catchment processes and community relations issues is dependent on sound technical advice and support. For the previous two years technical advice has been provided from Conservancy Office and National Office staff within the department. This included advice on flora and fauna surveys, installing hydrological monitoring equipment, and engagement with community on tenure review. A Technical Advisory Group was also utilised to discuss key wetland management issues. Input from external agencies was utilised where expertise was lacking in specific areas (e.g. hydrological modelling).

3.5 Research

Research projects are coordinated at a national level by the department's Research & Development Group, working in collaboration with the each site. Between 2007 and 2010 research projects were specifically designed to reduce knowledge gaps that limit our ability to effectively conserve wetland ecosystems. This included research to understand the

links between wetland condition and changes in catchment land use and investigations on the ecology and threats to cryptic wetland birds such as Australasian Bittern. Development of biodiversity monitoring tools was also a focus. Investment in research and development was prioritised by focusing on projects that have national implications for wetland management. Refer to section 4.3 for further details.



Establishing vegetation plots to study wetland condition

3.6 Progress reporting

In all conservation projects it is essential to have clear measures of success, which indicate whether the investment is achieving the desired outcomes. A key element of the Arawai Kākāriki programme, therefore, was the development of specific indicators and measures to monitor and report on each of the programme objectives (refer 1.2). This process of developing indicators to report on conservation achievements was initially based on the department’s NHMS framework, and overtime has expanded on the NHMS indicator sets to incorporate freshwater environments.

A reporting framework was developed to link high-level objectives, with specific goals, management actions, monitoring and reporting (Figure 6). This established a process for reporting on the level of management and monitoring at each site (*Implementation Report*), and for evaluating conservation outcomes (*Outcomes Report*).

The full list of indicators and measures that correspond to each objective is given in Appendix 3. The indicators take into account existing monitoring frameworks applied to wetland ecosystems (e.g. Lee et al. 2005, Clarkson et al. 2004, DSE 2005). The monitoring and reporting framework is purposefully generic, so it is able to apply to a range of wetland conservation projects undertaken by government agencies and community groups in New Zealand.

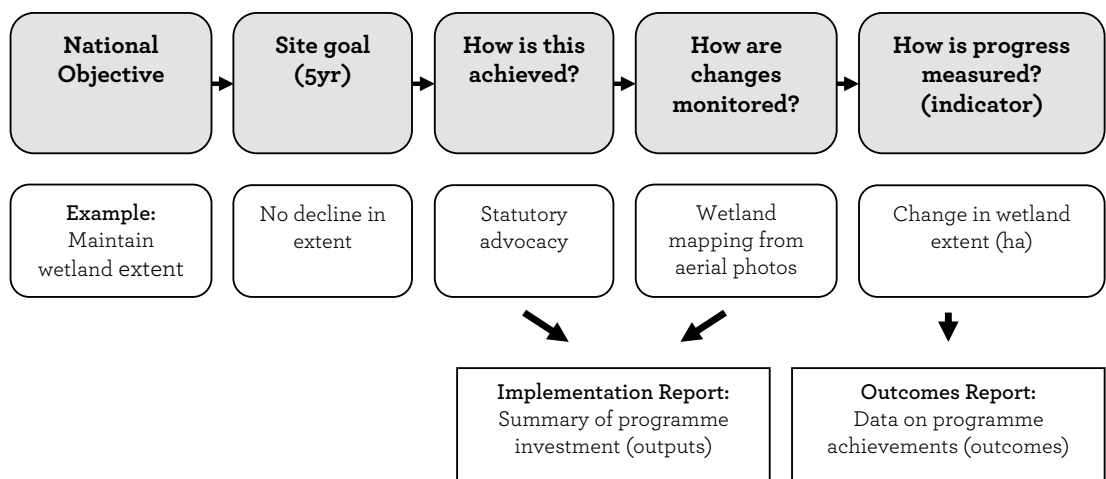


Figure 6. Reporting Framework for the Arawai Kākāriki programme that links national objectives with specific indicators to measure progress at each site

4. Implementation 2007–2010

This section describes the progress of the Arawai Kākāriki Wetland Restoration Programme across the 10 national objectives (section 1.2). For each objective, a brief background is provided and a summary of key management actions, monitoring actions and performance measures. A description of progress at the three sites is provided and a case study to illustrate the broad range of conservation initiatives that were implemented for between 2007 and 2010.

Refer to Appendix 6 for the annual breakdown on management and monitoring at Whangamarino, Ō Tū Wharekai and Awarua/Waituna.

4.1 Biodiversity

Objective 1. Maintain the extent of wetland habitat



Past changes in land use have resulted in loss of wetlands adjacent to Waituna Lagoon.

Loss of wetland habitat has been well reported across New Zealand. Loss of wetlands is correlated with a decline in biodiversity and a reduction in the ecosystem services they provide such as maintaining water quality.

The Arawai Kākāriki sites encompass three of the largest remaining freshwater/wetland sites in the country. Therefore, maintaining or enhancing the area (extent) of wetland habitat is a priority for freshwater conservation. Under this objective, management is focused on protecting wetlands through statutory processes via the Resources Management Act and other legislation and through non-statutory advocacy. In some situations restoration of 'lost wetlands' may also be possible, for example by re-establishing the natural hydrological regime.

Actions to achieve this objective:

- Work with councils and landowners to maintain wetland extent (statutory and non-statutory advocacy)
- On-ground actions to re-create wetland habitat (e.g. drain infilling)

How changes are monitored:

- Map the extent of wetland habitat from aerial photographs and satellite imagery

How progress is measured (outcome performance measures):

- Extent of wetland habitat
- Extent of wetland habitat protected in covenants and reserves

SITE PROGRESS

Whangamarino

Wetland mapping was completed in 2009 (Figure 7). From this mapping the current area of the Whangamarino wetland was calculated at 7290 ha. DOC currently administers 81% and the other major landowner is Fish & Game (10%). The 2009 mapping repeated earlier surveys and is being used to monitor changes in wetland extent over time. There is evidence of recent clearing and drainage of habitat on private land (K. Hutchinson pers. comm. 2009). Statutory and non-statutory advocacy to protect remaining wetland habitat is a focus of the Waikato Area Office and Conservancy, and has included four notices for unauthorised works in the Whangamarino wetland.

Ō Tū Wharekai

Ō Tū Wharekai is a largely intact environment comprising over 18808 hectares of river, lake and wetland ecosystems. High resolution aerial photographs of key areas were obtained in 2008 that will form the basis of wetland mapping.

Changes in land use previously led to the loss of wetlands (e.g. red-tussock swamp) on private land. With landholder support restoration of these zones may be targeted in future. For the period 2007 to 2010 the Raukapuka Area Office and Canterbury Conservancy have led statutory advocacy. Tenure review has resulted in 1014 ha of wetlands being protected in new conservation areas including covenants, and the purchase of Hakatere Station in 2007 added a further 9000 ha to Hakatere Conservation Park.

Awarua/Waituna

The Awarua/Waituna system includes 13197 ha of coastal lagoon and wetland habitat. Detailed mapping using aerial photographs was completed in February 2010 and provides a valuable resource to monitor future changes in wetland extent.

The extension of the Awarua Wetlands Ramsar site from 3500 to 19500 ha was completed early 2008. However, ongoing advocacy by the Murihiku Area Office and Southland Conservancy is needed to limit ongoing clearing and drainage of wetlands on private land. The 240 ha Nature Heritage Fund (NHF) purchase of Cawse Creek provides an opportunity to increase wetland extent through restoration; to date 5 ha is being actively restored (Table 2).

Table 2. Summary of actions implemented to maintain and enhance wetland extent at the Arawai Kakariki sites (Objective 1)

		IMPLEMENTATION SUMMARY (2007–2010)		
Management Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Re-creation of wetland habitats	Area re-created (hectares)	806 ha *	0	5 ha
Statutory land protection (new protected areas)	Area protected (hectares)	0	10014 ha#	240 ha
Inventory & Monitoring	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
OM1 - Wetland mapping/ground-truthing	Mapping status	Baseline map complete (2008)	Aerial photos captured (2008)	Baseline map complete (2010)

* Upgrade of the Whangamarino weir restored minimum water levels to 806 ha of swamp

consisting of a mixture of habitat types

CASE STUDY: Whangamarino wetland mapping [Objective 1]

The Whangamarino wetland vegetation map (Figure 7) is an example of detailed mapping from aerial photographs, which is the foundation for onground management actions to protect important habitat. The mapping also illustrates the close proximity of intensive land use, and provides baseline information on the extent and distribution of different wetland types, such as *Empodisma minus* restiad rushland and the weed dominated *Salix fragilis* treeland.

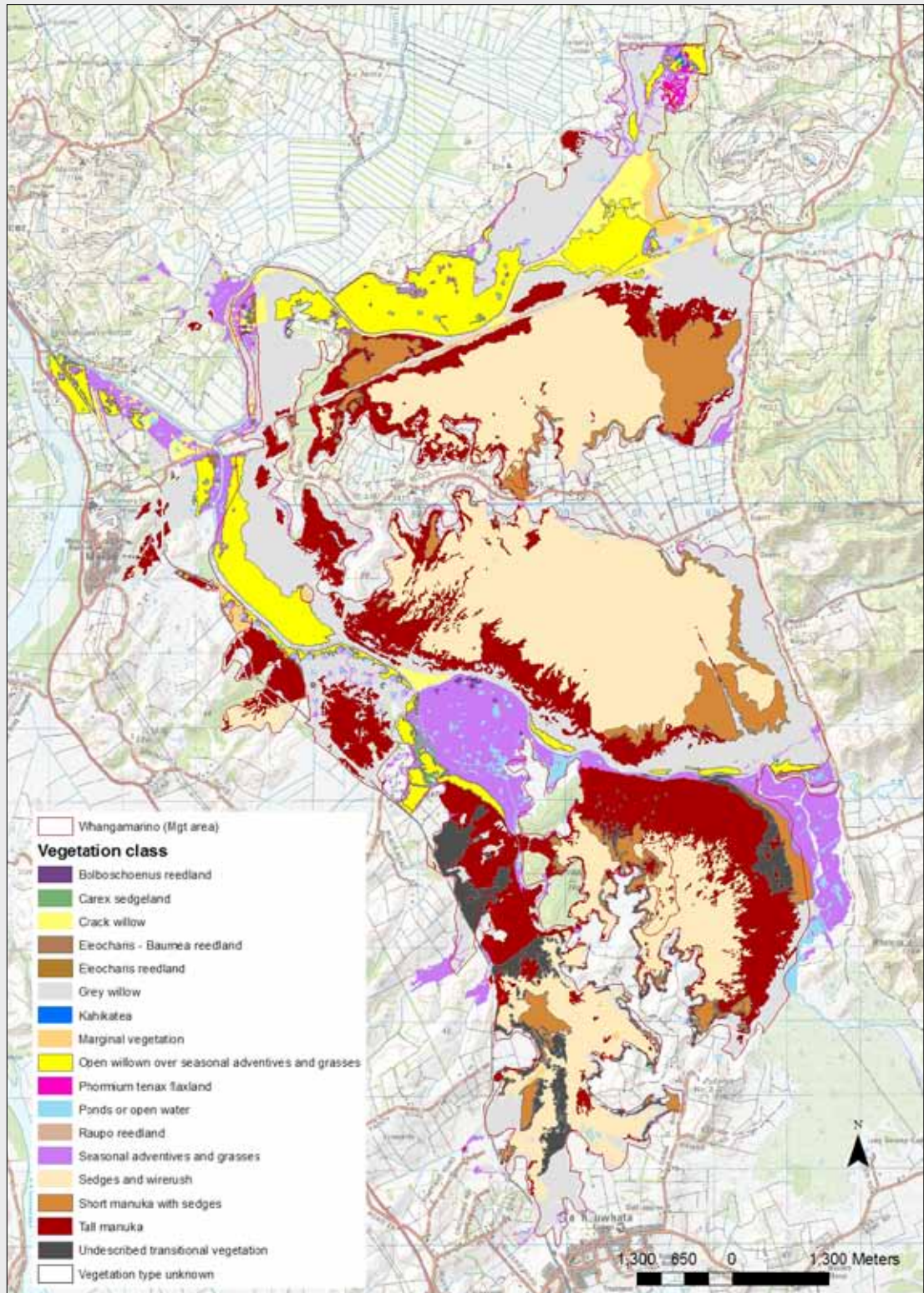


Figure 7. Whangamarino wetland vegetation map. Data captured from aerial photographs and ground truthing (Source: Wildland Consultants 2009)

Objective 2. Maintain water levels and water quality



Collaboration with councils on water quality monitoring is important, such as the partnership with Environment Southland at Waituna Lagoon (pictured)

Changes in hydrology and water quality can have lasting impacts on wetland ecosystems. Water levels can be altered by drainage or the diversion of surface water and groundwater. Decline in water quality, particularly from increased nutrient and sediment loads, is generally correlated to changes in land use.

Understanding the potential threat from altered water levels and water quality is important for all Arawai Kākāriki sites. Using this knowledge, on-ground management to restore water regimes and enhance water quality can be implemented. Effective catchment management requires the formation of partnerships with councils, industry, local community and landowners.

Actions to achieve this objective:

- Upgrade hydrological structures to maintain/restore water levels and water flows
- Work with councils and landowners to improve water quality and limit sediment accumulation
- Riparian fencing and planting to reduce nutrient and sediment levels

How changes are monitored:

- Hydrological, water quality and sediment monitoring in collaboration with regional councils

How progress is measured (outcome performance measures):

- Assessment of wetland hydrology¹
- Assessment of water quality¹
- Assessment of soil nutrient levels and soil pH¹
- Assessment of sediment accumulation¹

¹ Indicators for the assessment of wetland hydrology, water quality, soil chemistry and sediment accumulation vary between sites depending on the ecosystem processes specific to different wetlands (Refer Appendix 3).

SITE PROGRESS

Whangamarino

Scientific investigations have helped to understand the complex hydrology at Whangamarino through the development of a hydrological model (SKM 2009) and installation of water level and climate monitoring equipment. DOC also supported a University of Waikato research project on wetland hydrology, and research by NIWA on the accumulation of sediment since the development of the Lower Waikato flood protection scheme, which utilised Whangamarino for flood storage. This technical work provides the basis to identify options to improve water level and water quality management.

A major upgrade (\$200,000) of the Whangamarino Weir was completed during 2010 (see photo) to restore minimum water levels and ensure important wetland areas do not dry out for prolonged periods.

Ō Tū Wharekai

The Ashburton Basin and upper Rangitata River contain a number of freshwater rivers, lakes and wetlands, each with unique hydrological regimes. Some of these systems are more vulnerable than others to changes in water quality and water flows, such as the Maori Lakes. During 2008/09 the Raukapuka Area Office installed water level equipment at the Maori Lakes to improve understanding of water flows through the Maori Lakes system. A joint project with University of Canterbury was also established in 2010 to describe the relationship between land use, hydrology and water quality in the Lake Clearwater catchment.

Maintaining relatively oligotrophic (low nutrient) freshwater lakes and wetlands, such as the Maori Lakes and Lake Clearwater, is a priority for management (de Winton 2008). This will require collaboration with local landowners. At present no major irrigation developments to alter water flows are proposed in the Ashburton Basin.

Further hydrological monitoring of ephemeral kettleholes in Hakatere Conservation Park will help describe the vulnerability of these rare systems to climate change. Retirement of grazing from the Conservation Park in 2007 is expected to reduce sediment accumulation in these kettleholes.

Awarua/Waituna

Waituna Lagoon is an internationally significant coastal lagoon under increasing pressure from elevated levels of nitrogen and phosphorus. The lagoon is also subject to an artificial opening regime. The department has established working partnerships with regional council (Environment Southland) and local community to improve catchment management (refer objective 6). Research to understand the relationship between the opening regime, water quality and the lagoon's ecology is a focus of the Arawai Kakariki programme (refer objective 9).

The department collaborated with Environment Southland to acquire a high-resolution digital elevation model (DEM) based on LiDAR (airborne laser scanning). The DEM is being used to develop a detailed hydrological model for Waituna Lagoon (Figure 8) that will inform the assessment of lagoon opening options with local community.

Table 3. Summary of actions implemented to maintain and enhance wetland hydrology and water quality at the Arawai Kākāriki sites (Objective 2)*

		IMPLEMENTATION SUMMARY (2007-2010)		
Management Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Maintain appropriate water regime via upgrades to structures or management plan	Number of upgraded structures / management regimes	1 (Whangamarino weir upgrade)	0	1 (drain upgrade to promote flow)
Prepare a hydrological model	Model status	In development (Whangamarino)	In development (Maori Lakes)	In development (Waituna Lagoon)
Riparian fence / planting to improve water quality	Area or length fence / planting established	1 ha	0.4 ha	<i>Refer Objective 6</i>
Inventory & Monitoring	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
OM2 - Hydrological monitoring	Number sites monitored	6 sites (DOC) 2 sites (EW)	10 sites (DOC) 8 sites (Uni. Can)	7 sites (ES)
OM3 - Sediment accumulation	Number sites monitored	4 sites (DOC)	0	4 sites (ES)
OM4 - Water quality monitoring	Number sites monitored	1 site	10 sites (DOC / Uni. Can); 25 sites (ECan)	7 sites (ES)
OM5 - Biological indices of water quality (LakeSPI, TLI)	Number and type of surveys completed	0	LakeSPI 8 lakes (DOC); TLI 7 lakes (ECan)	TLI Waituna Lagoon (ES)

Also refer Objective 6 (Promote sustainable catchment management), which includes projects that aim to improve water quality. Abbreviations: LakeSPI = Lake Submerged Plant Index; TLI = Trophic Level Index; ha = hectares; DOC = Department of Conservation; EW = Environment Waikato; ECan = Environment Canterbury; ES = Environment Southland

CASE STUDY: Whangamarino weir upgrade [Objective 2]



A major achievement in restoring wetland hydrology was the \$200,000 upgrade of the Whangamarino weir (pictured). The weir ensures that minimum water levels across 800 ha of freshwater swamp are maintained, providing habitat for waterfowl and threatened wetland birds.

Upgrade of the Whangamarino Weir during 2010

CASE STUDY: Waituna Lagoon hydrology: remote sensing [Objective 2]

Airborne laser (LiDAR) remote sensing was used to capture high resolution information on the bathymetry of Waituna Lagoon. The digital elevation model (DEM) delineates natural creeks, drains and the raised peat surface (Figure 8a). The DEM enables assessment of natural and human-induced changes on water levels and ecosystem condition, in particular, relating to the artificial lagoon opening events that regularly occur.

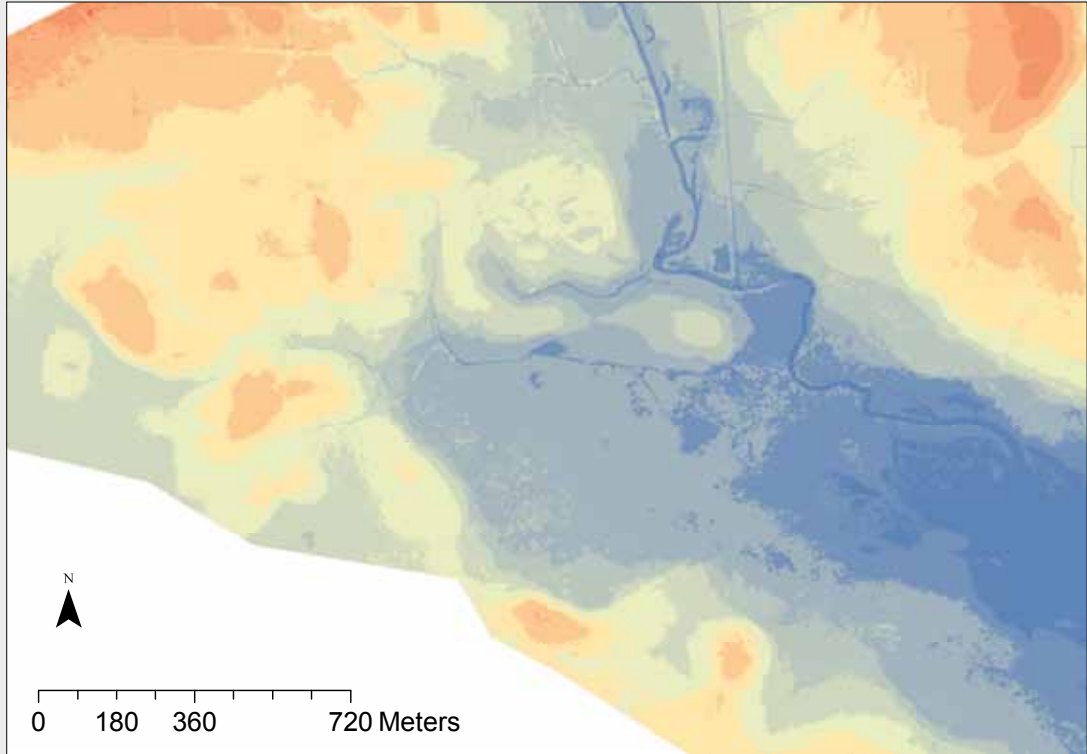


Figure 8a. LiDAR digital elevation model (DEM) of Waituna Creek / Waituna Lagoon.

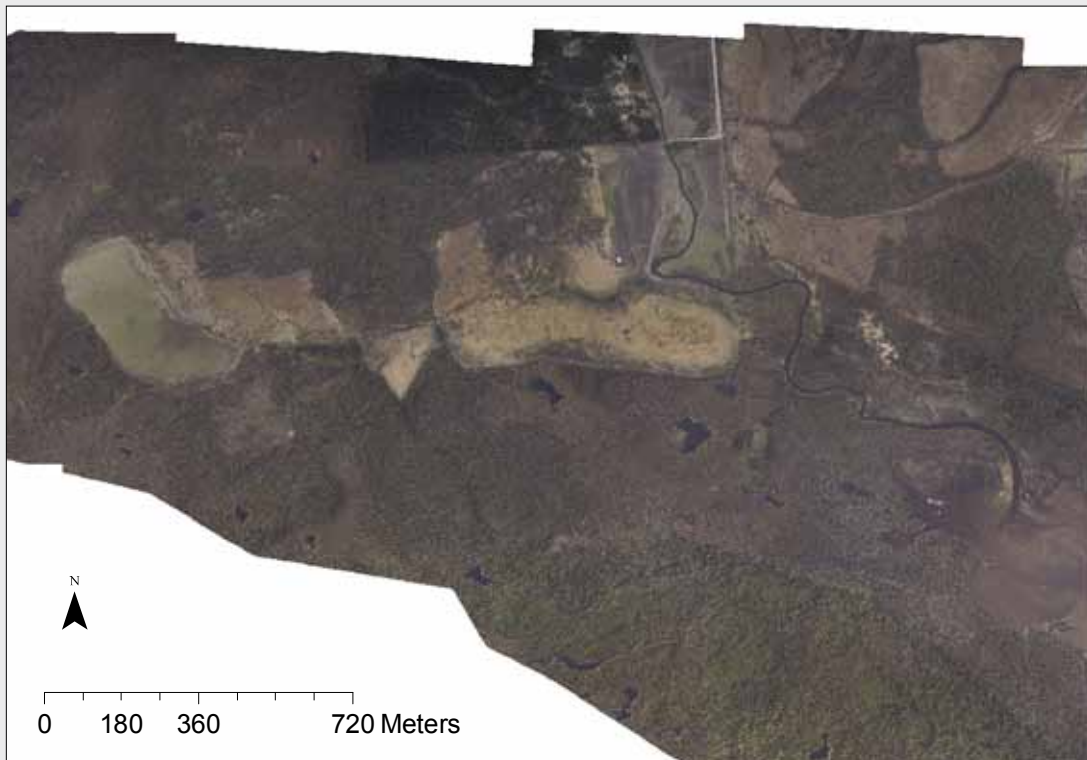


Figure 8b. Aerial photograph of Waituna Creek / Waituna Lagoon (same area as Fig. 6a).

Objective 3. Protect and restore wetland habitat



New boundary fencing has excluded stock from 25 km of Whangamarino wetland.

The Arawai Kākāriki sites contain some of the most outstanding and diverse wetland ecosystems in New Zealand. The significance of the rivers, lakes, estuaries and wetlands is directly related to the habitat condition (ecological integrity). Both the protection and restoration of wetland habitat is a management priority.

Primary causes for habitat degradation include the unrestricted access of livestock, increased abundance of invasive plants and greater fire frequency. The degree of habitat degradation varies between sites.

For the Arawai Kākāriki programme, intact habitats that require protection from potential threats (e.g. fire) are separated from degraded habitats where intervention is needed to restore ecosystem values (e.g. large-scale weed control).

Actions to achieve this objective:

- Eradicate or reduce the distribution and abundance of weeds considered a threat
- Install fences to exclude stock and other exotic herbivores from gaining access
- Pest control of herbivores - deer, possums and other exotic herbivores
- Pest control of black-backed gulls to reduce weed movement
- Replant indigenous plants in degraded habitat
- Respond to wild fire events

How changes are monitored:

- Establish permanent vegetation plots to monitor changes in plant composition and structure
- Map the distribution and abundance of key weed species and exotic herbivores
- Keep records of the extent of wild fires

How progress is measured (outcome performance measures):

- Extent of indigenous-dominated habitat
- Abundance of indicator plant species such as *Carex secta*
- Ratio of indigenous : exotic species
- Extent of wetland habitat impacted by fire
- Distribution of weed species considered a threat

SITE PROGRESS

Whangamarino

The vegetation map of Whangamarino (Wildland Consultants 2009) identified the distribution of intact and degraded habitat, including areas dominated by invasive weeds and vulnerable to livestock. A significant issue at Whangamarino is the spread of willow, particularly Grey willow (*Salix cinerea*), and other weeds such as Royal Fern (*Osmunda regalis*). To inform future operations a review of past willow control was commissioned that highlighted many of the past operations were not successful (Bodmin & Champion 2009). This review has guided the future weed control strategy under the Arawai Kakariki programme. Surveillance of new weeds is also a priority, which led to the identification and eradication of Alligator Weed (*Alternanthera philoxeroides*) and Yellow Flag Iris (*Iris psuedacorus*).

Over 60km of the boundary of conservation land at Whangamarino is unfenced and open to livestock access. To protect wetland habitat fencing is therefore a high priority and between 2007 and 2010 there were 25.5km of new fences installed (Figure 9).

Ō Tū Wharekai

Invasive weeds have established on the upper Rangitata River and on the margins of lakes and wetlands. Large-scale control of both broom (*Cytisus scoparius*) and willow (*S. fragilis*; *S. cinerea*) has been a focus of the Raukapuka Area Office with support from local community. 820 ha of broom and 1656 ha of willow have been chemical-sprayed, which will help protect the braided river habitat used by threatened species such as wrybill, and enhance the ecological integrity of freshwater swamps.

Another threat to the native vegetation is from fire, often associated with camping and recreation activities. 5.8km of fencing was installed to exclude visitors from sensitive areas and decrease fire risk from vehicles.

Field surveys completed over the past two years increased understanding of the aquatic macrophytes within the Ashburton Lakes (de Winton 2008), the rare turf vegetation associated with kettleholes and stream condition. These surveys provide baseline information that is being utilised to prioritise management actions.

Awarua/Waituna

Invasive weeds are also an issue at Awarua-Waituna. Control, surveillance and monitoring of Spanish heath (*Erica lusitanica*) received significant investment between 2007 and 2010, with operations covering more than 13200 ha of wetlands on and off conservation land.

Conservation of the aquatic plants in Waituna Lagoon, in particular the sea grasses *Ruppia megacarpa* and *R. polycarpa*, is also a focus of the Awarua/Waituna programme. This has led to collaborative research on *Ruppia* and on-ground initiatives with local farmers to improve water quality.

Fire continues to be a threat to the Awarua wetland as it facilitates the invasive species and alters the structure and diversity of wetland vegetation. Accidental fire from agricultural land in 2008/09 impacted over 1000 ha of conservation land. Damage to wetland habitat and private property was limited where practical through a coordinated fire response involving the department and rural fire authority.

Other key achievements include the restoration of 2.5 ha of wetlands adjacent to Cawse Creek, and the control of three large black-backed gull colonies. Approximately 2.5 km of boundary fencing was also installed to exclude stock from the Awarua wetlands.

Table 4. Summary of actions implemented to protect and restore wetland habitat at the Arawai Kākāriki sites (Objective 3)

		IMPLEMENTATION SUMMARY (2007-2010)		
Management Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Undertake WEED-Led control projects to eliminate/reduce new weed incursions	Number WEED-Led control projects	2 projects (Alligator weed, Yellow flag)	0	0
Undertake SITE-led control to reduce area and number of environmental weeds considered a threat	Area under sustained weed control using SITE-Led approach	8ha Grey Willow, 7ha Gorse, 0.5ha Glyceria	1656ha Willow, 820ha broom, 65ha stone crop, 57ha lupin	13197ha Sp.Heath/Gorse/Broom 10ha Pines, 893ha Angellica
Boundary fencing to exclude exotic herbivores to prevent grazing impacts on vegetation	Length of fence built (m)	25459m	Stock removed from 10014 ha wetlands *	2500m
Respond to wild fire based on fire management plan	Number DOC call outs for fire in management area	2 call outs	2 call outs	1 call out
Pest control of herbivores (possums)	Area under possum control	0	0	0
Pest control of herbivores (deer)	Area under deer control (+no. killed)	5923 ha p.a. / 13 deer killed	0	13197 ha p.a. / 3 deer killed
Bird control (Black-Backed Gull)	No. colonies and no. birds	0	0	3 colonies / 900 B-B Gull
Restoration plantings (new sites)	Area planted	1 ha	0.4 ha	2.5 ha
Restoration plantings (site maintenance)	Area maintained	0	0.3 ha	2.5 ha
Inventory & Monitoring	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
OM6 - Permanent habitat condition monitoring (vegetation plots)	Number surveys and type (no. plots)	0	3 surveys - Veg. condition 2m plots (16), - Veg. condition 10m plots (27) - Ephemeral turf plots	2 surveys - Lagoon macrophytes (48 sites)
OM7 - Spatial assessment of extent burnt by fire	Mapping status	Completed	Completed	Completed
OM8 - Distribution / abundance weeds	Number surveys (by species)	2 surveys - Crack/Grey willow - Alligator weed/ Yellow flag	1 survey - Stonecrop mapping	0
OM9 - Distribution / abundance pests (possums)	Number surveys (by type)	0	0	1 survey (RTC).

* Stock exclusion by land transferring to DOC via NHF and tenure review

CASE STUDY: Weed management at all sites [Objective 3]

Control of invasive weed species is a priority at all three Arawai Kākāriki sites with over 15,000 ha under weed management. This includes both management of new weed threats such as Alligator weed (*Alternanthera philoxeroides*) and widespread species such as willow and Spanish Heath. Without active management key areas of Whangamarino, Ō Tū Wharekai and Awarua/Waituna would become dominated by invasive species leading to a decline in biological diversity, recreation values and scenic values.



An immediate response was required to control Alligator weed at the Whangamarino wetland in 2010. Ongoing surveillance for this invasive aquatic weed is now undertaken.



Spanish Heath control is a major programme at Awarua with investment of \$80-100,000 pa.



Dead willow after spraying at the Maori Lakes, Ō Tū Wharekai

CASE STUDY: Fencing to exclude stock at Whangamarino [Objective 3]

Prior to the Arawai Kākāriki programme over 60 km of conservation land at Whangamarino wetland was unfenced and easily accessed by cattle and other livestock. This led to the degradation of wetland vegetation and soils and increased the disturbance of habitat supporting threatened plants. Figure 9 illustrates the 25 km of new boundary fences at Whangamarino that are contributing to wetland restoration. This map provides an example of the spatial information the department collects to track our investment in wetland management.



Figure 9. Location of new boundary fencing at Whangamarino wetland

Objective 4. Maintain and enhance species diversity and protect threatened species



Australasian Bittern is nationally threatened. Loss of habitat, predation and fire are key threats. Photo: P. Langlands.

Halting the decline of native species from wetlands and other freshwater environments presents a challenge. The historical loss of wetlands, increased abundance mammalian predators and invasive plants and reduced habitat connectivity, have in combination, reduced the diversity of native plants and animals in New Zealand wetlands.

The three Arawai Kākāriki sites support a number of threatened and rare species dependent on wetlands for at least part of their life-cycle. In addition to actions that enhance habitat condition (covered in Objective 3), on-ground actions to control mammalian predators, promote fish passage, or reintroduce locally extinct populations are often needed to safeguard vulnerable species.

Actions to achieve this objective:

- Collate baseline information on the distribution and abundance of native species.
- Undertake predator control to protect threatened fauna
- Implement management actions to protect freshwater fish
- Implement management actions to protect threatened flora (e.g. translocation)

How changes are monitored:

- Monitor the abundance of indicator species
- Monitor the population dynamics of rare and threatened species

How progress is measured (outcome performance measures):

- Diversity of indigenous species
- Abundance of indicator animal species such as Australasian Bittern
- Number of threatened species that rely on the site
- Population status of rare and threatened species such as Wrybill
- Distribution and abundance of predators considered a threat

SITE PROGRESS

Whangamarino

Whangamarino is the national stronghold for the threatened Australasian bittern/matuku, with the wetland supporting approximately 20% of New Zealand's bittern population. Annual survey of bittern abundance is undertaken to keep track of numbers, and is supporting the trial of bird call recording devices that will benefit bittern monitoring elsewhere in New Zealand. However, little is known about the behaviour of predators in Whangamarino and their impact on native birds. The Waikato Area office is supporting a comprehensive study to identify the relative abundance and distribution of mammalian predators present. Gut samples have been taken from all species and should provide valuable information about the diet preferences of wetland predators.

Whangamarino wetland is a significant site for the threatened black mudfish (*Neochanna diversus*). Annual monitoring of black mudfish populations is undertaken by the department in conjunction with the University of Waikato, providing insight into the status of this species.

The wetland is also an important site for a number of threatened plant species, including the critically threatened swamp helmet orchid *Anzybas carsei*, a plant found at no other site in the world. A long-term trial using fire is underway to enhance critical habitat for *Anzybas carsei*. While a plant survey in 2008 confirmed Whangamarino continues to support *Lycopodiella serpentina*, *Myriophyllum robustum*, *Cyclosorus interruptus*, *Pterostylis paludosa* and *Utricularia australis* (Wildland Consultants 2009).

Ō Tū Wharekai

The Raukapuka Area office coordinated a comprehensive investigation on the status of wrybill on the upper Rangitata River, examining annual variation in wrybill abundance and breeding success. A survey of the river found 325 adults. Flooding and predation are considered the most significant threats.

Broad-scale inventory of native species including freshwater fish, freshwater mussels, lizards, invertebrates and wetland birds was also completed between 2007 and 2010. Freshwater mussels are in gradual decline across New Zealand but are known to be important for regulating water quality. The mussel beds were found to occupy a small portion of the total stream length, with limited recruitment at some sites. Future work will assess the overall population status of freshwater mussels at Ō Tū Wharekai.

Fish surveys discovered good numbers of upland longjaw galaxids in the Lawrence River within the Rangitata headwaters. This native fish is in gradual decline across New Zealand. Until now, the only confirmed populations in Ō Tū Wharekai were from two sections of the upper Rangitata River under threat from invasive didymo.

Similar to the other Arawai Kakariki sites, mammalian predators are identified as a key threat to wetland birds. A field programme was implemented to collect information on how the predators are behaving in the wetlands. Stoats were found almost exclusively in the wetlands. Ferrets, possums, Norway rats, mice and hedgehogs could adapt to all habitats, while cats were largely restricted to the drier habitats. These findings will directly inform any future predator trapping the department undertakes.

Awarua/Waituna

The Murihiku Area office also completed mammalian predator monitoring to determine the distribution and abundance of mustelids, rodents, cats and possums in the Awarua wetlands. Monitoring revealed pest numbers were relatively low. Annual survey of Australasian bittern and Fernbird provided information on the relative abundance of cryptic birds. The degree of predation threat these birds are under remains unclear. Application of pest control using an adaptive management framework process is recommended, where the effectiveness of pest control on bird populations is examined at the same time management is implemented.

Waituna Lagoon is influenced by periodic freshwater inflows and artificial opening to the sea. This dynamic environment is likely to influence the life-cycles of the native plants and animals. Freshwater fish survey in 2008 confirmed that Waituna Lagoon and wider Awarua wetlands are a strong hold of the nationally threatened Giant Kokopu (Atkinson 2009). The role of lagoon opening events on the recruitment and population dynamics of Giant Kokopu is being investigated to help inform future lagoon opening events.

Monitoring of the unique population of *Donatia novae-zelandiae* also occurred in 2008, re-surveying sites previously measured in 2002. *Donatia* is an iconic plant and a botanical highlight within the Awarua-Waituna wetland complex. The Awarua wetland complex is the only known locality where this sub-alpine species occurs at near sea level (Ledgard 2011).

This monitoring found woody shrub removal alone is not enough to halt the decline of *donatia* at some sites and that disturbance, whether by fire or light agricultural disturbance, aids the plant's recruitment and growth, but these are not always aligned with the restoration and management goals for the wider wetland.

Table 5. Summary of actions implemented to maintain and enhance species diversity and protect threatened species at the Arawai Kākāriki sites (Objective 4)

		IMPLEMENTATION SUMMARY (2007-2010)		
Management Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Reduce pressure of predators – pesticide	Area treated	0	0	0
Reduce pressure of predators – traps	Captures per unit effort	143 captures 15 months (97 traps)	109 captures per year (100 traps)	0
Targeted threatened flora restoration actions - habitat management	Area managed (by action)	0.5 ha fire (Anzybas)	0	2ha planting / weed control (Pingao)
Inventory & Monitoring	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
OM10* - Species diversity and occupancy (general survey)	Number and type of surveys	6 surveys (refer Appendix 6b)	16 surveys (refer Appendix 6b)	3 surveys (refer Appendix 6b)
OM11 - Indicator species abundance	Number surveys (list species)	4 surveys - Bittern (2) - Anzybas (2)	8 surveys - Scree skink (3) - Upland longjaw (2) - Marsh crake - Australasian crested grebe (2)	5 surveys - Bittern, Crake and Fernbird (3) - Ruppia (2)
OM12 - Indicator species population dynamics	Number surveys (list species)	0	2 surveys - Wrybill (2)	2 surveys - Giant Kokopu - <i>Donatia</i>
OM13 - Targeted predator monitoring (mammals/fish/birds)	Number and type of surveys	2 surveys - Mammalian predators	2 surveys - Mammalian predators (braided river & wetlands)	1 survey - Mammalian predators

* Considerable investment in inventory and monitoring of native wetland species has occurred under the Arawai Kakariki programme. Refer Appendix 6b for details.

CASE STUDY: Protecting threatened species: Giant Kokopu [Objective 4]

Giant kokopu are the largest of the five whitebait species (*Galaxias* spp.). Adults live in freshwater, and larvae typically develop at sea. When juveniles return from the sea they form part of the whitebait run. Giant kokopu are declining across New Zealand.



Large numbers of giant kokopu were found in the tributaries of Waituna lagoon, and large numbers of small individuals are also present, which indicates a healthy population with ongoing recruitment. Examining the chemistry of giant kokopu otoliths, or ‘ear-stones’, revealed that larval giant kokopu rear in Waituna lagoon rather than the ocean. Using the lagoon as a ‘surrogate sea’ appears to be beneficial for this population, and larvae grow faster when the lagoon is fresh (closed) versus when it is salty (open). Currently, the lagoon is mechanically opened for drainage purposes, without consideration for giant kokopu. Early research suggests opening the lagoon between August and October would be bad for larvae. Further research will determine optimal lagoon management to preserve this self-sustaining population of giant kokopu and help conserve an endemic and charismatic celebrity.

CASE STUDY: Protecting threatened species: *Anzybas carsei* [Objective 4]

Anzybas carsei is New Zealand’s rarest orchid, once common in many north island restiad bogs, is now confined to one small area of the Whangamarino Wetland where it may number less than 50 individuals. As part of our objective to maintain and enhance species diversity, the Whangamarino team are trying increase the population and distribution of *Anzybas carsei*. The remaining population is mostly at risk from vegetation succession. Use of managed fire to open up the vegetation canopy is implemented each year, with small sections of wetland habitat burned to stop *Anzybas* from getting crowded out by other plant species such as manuka. Through this method we have increased the numbers to well over a hundred individuals at last count.



Anzybas carsei, Whangamarino Wetland

Monitoring results are being used to ascertain what frequency of burning is required to ensure long-term recovery. Further research into potential methods of propagation for these orchids is also underway, with an eye to one day translocating them to other sites both within Whangamarino and other raised bogs.

CASE STUDY: Protecting threatened species: Wrybill [Objective 4]



Banded wrybill are being used to monitor nesting success.
Photo: P. Langlands.

Wrybill (*Anarhynchus frontalis*) is an endemic species that breeds on braided rivers in New Zealand. The upper Rangitata River is home to one of the largest breeding colonies with approximately 325 adults being observed (DOC, unpublished data).

Wrybill nests are typically located on 'islands' within the braids and this reduces the risk of predation, although nests in the active riverbed are more prone to flooding. Weed control (broom/lupin) is regularly undertaken by the Rangitata

Landcare Group with support by the department. Weed management aims to increase the availability of suitable nest sites away from active river banks and from vegetation that provides cover for predators.

Surveys of wrybill nesting have been undertaken on the upper Rangitata as part of the Arawai Kākāriki programme to quantify breeding success (Table 4), and to determine the need for large scale predator control on the braided river. Results showed that flood events can have a significant impact on wrybill nests. Instances of chick predation were also observed.

Wrybill chick survival data from the upper Rangitata River in 2008/09 and 2009/10 (Source: DOC, unpublished data)

	2008	2009
Number of nests monitored	48	83
Number of pairs with colour bands	0	12
% nests preyed on	10 (n=31)	14 (n=57)
% nests flooded	35 (n=48*)	3.5 (n=57)
% nests deserted	7 (n=31)	5.2 (n=57)
% nests outcome unknown	17 (n=48)	31 (n=83)
Hatching success ¹	0.58 (n=31)	0.77 (n=57)

¹ Hatching success (probability of ≥ 1 eggs in a nest surviving until they hatch)

* Result using all 48 nests, as even though the outcome was unknown, we know these nests weren't flooded prior to the maximum hatch date.

n sample size

4.2 Community

Objective 5. Conserve historic and cultural sites



Historical buildings at Hakatere Corner, Ō Tū Wharekai

Cultural and historic places of significance to tangata whenua and local community are often found nearby freshwater lakes, rivers and wetlands. Protecting these sites and educating the wider community of their values is important for maintaining this heritage for future generations.

To achieve this objective the department will work with iwi and community to identify the location and significance of cultural and historic sites. Once identified appropriate management and site interpretation can be implemented. Monitoring the condition of

cultural sites may be done in conjunction with other initiatives such as the State of the Takiwa programme developed by Ngai Tahu.

Actions to achieve this objective:

- Prepare a cultural assessment in collaboration with iwi
- Prevent adverse affects on important sites from land development
- Implement on-ground actions to conserve and remediate important historical and cultural sites (e.g. fence areas to exclude vehicle access)
- Interpret sites to increase visitor awareness

How changes are monitored:

- Undertake an inventory of cultural and historical sites
- Survey visitors to assess awareness of cultural and historic sites

How progress is measured (outcome performance measures):

- Level of protection of cultural and historic sites
- Condition of important cultural sites
- Condition of important historic sites
- Number of visitors with increased awareness of important sites

SITE PROGRESS

Whangamarino

Whangamarino is a site of cultural importance to the iwi of Waikato-Tainui. Under the Arawai Kākāriki programme the department has continued to promote partnerships with local mana whenua organisations associated with Waikato-Tainui, including the Ngaa Muka Development Trust. A cultural values assessment was commissioned with the Trust in early 2009 and the department guided kuia and kaumātua around Whangamarino wetland to assist gathering of historical and current information on cultural values. This initial engagement now requires follow-up and there is an opportunity for partnerships at Whangamarino related to the Waikato River Accord signed by government and Waikato-Tainui.

Two historic sites have been identified: the Whangamarino redoubt located at the confluence of the Whangamarino and Waikato Rivers, and New Zealand's only hand dug shipping channel located behind Kopuera mine.

Ō Tū Wharekai

A cultural inventory was undertaken by Ngai Tahu to identify, compile and record the traditional and contemporary cultural values of tangata whenua associated with Ō Tū Wharekai to assist the future management, development and restoration of the area.

State of Takiwa, a cultural health assessment, was undertaken in 2010. State of Takiwa integrates Matauranga Maori and Western science to gather information about the environment and to establish a baseline for the creation of policy and improvement of environmental health. Ō Tū Wharekai is an area of immense cultural significance to Ngai Tahu Whanui, being both an important seasonal mahinga kai area and a major travelling route between the settlements on the eastern coast of Te Waipounamu (the South Island) and those on Te Tai Poutini (the West Coast).

The historic Hakatere Station buildings were purchased in 2007 along with Hakatere Station by the Nature Heritage Fund. These buildings are seen as the gateway to the Ō Tū Wharekai project. The local community have formed the Hakatere Heritage Committee and are raising funds to restore the buildings. The department will provide information on the wetland project for display within the buildings along with details on recreational opportunities and heritage stories.

Awarua/Waituna

Under the Ngāi Tahu Claims Settlement Act (1998), Waituna wetland is acknowledged for its cultural values. Work in the wetlands is undertaken with the input of Runaka through the Kaitiaki Roopu Southland group. Awarua Runaka also has a representative who sits on the Awarua/Waituna Advisory Group.

There are 34 known protected historic sites on lands administered by the department at the Awarua Wetlands. No sites are actively managed because all are considered adequately protected by technical staff and iwi. These historic sites consist of a mixture of middens, stoneworking sites and ovens and burial sites.

Table 6. Summary of actions implemented to conserve historic and cultural sites within the Arawai Kākāriki programme (Objective 5)

		IMPLEMENTATION SUMMARY (2007-2010)		
Management Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Implement remedial actions at historical and cultural sites	Number of sites with remedial actions	0	0	0
Implement maintenance actions at historical and cultural sites	Number of sites with maintenance actions	1 site (redoubt)	0	0
Prepare or implement State of Takiwa (or other cultural assessment)	Description of progress with preparation or implementation	Cultural assessment initiated	State of Takiwa field work completed	0
Inventory & Monitoring	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
OM14 - Inventory historic / cultural sites	Inventory status	Completed	Completed	Completed
OM19 - Survey visitor response to site visits and interpretation	Number and type of surveys	0	0	0

CASE STUDY: State of the Takiwa, O Tu Wharekai [Objective 5]



The resources and biodiversity the Ashburton Lakes provide such as raupo, tuna and matuku were identified in the State of the Takiwa assessment.

The purpose of the State of the Takiwa (SoT) cultural assessment was to identify, compile and record the traditional and contemporary cultural values of tangata whenua associated with Ō Tū Wharekai / Ashburton Lakes to assist the future management, development and restoration of the area. The report was provided in two parts the first an overview of Ngai Tahu Whanui, including Te Runanga o Arowhenua and the history of the Ngai Tahu association with the South Island high country. This included a description of the archaeological

sites and ara tawhito (ancient travel routes) associated with Ō Tū Wharekai and mahinga kai species. The second report used SoT methodology to assess the cultural health of the area in terms of the present health of the resources and access. This included five types of assessment during the fieldwork.

1. Takiwa site assessments
2. Cultural health index - water quality assessment
3. Stream health monitoring assessment
4. E.coli water testing
5. Fish surveys: electric fishing and netting.

Objective 6. Promote sustainable land use

Freshwater ecosystems are directly influenced by their surrounding catchments. Changes in land use often correspond to changes in the trophic status of wetlands, lakes and rivers. For all three Arawai Kākāriki sites, increased sediment and nutrient loads associated with the intensification of land use is linked to a decline in ecological integrity, and may lead to rapid shifts in species composition.

Working with local government, industry groups and private landholders is critical to promoting sustainable land use, for instance, to improve effluent management in agricultural areas upstream of high conservation value wetlands.

This objective of the Arawai Kākāriki programme also aims to promote cultural harvest by local iwi and facilitate sustainable concession activities on conservation land.

Actions to achieve this objective:

- Promote sustainable land use and private land conservation through partnerships with landowners
- Use statutory advocacy mechanisms under the Resource Management Act to promote sustainable land use
- Approve concessions/permits that have a net conservation benefit
- Facilitate sustainable cultural harvest

How changes are monitored:

- Monitor changes in catchment land use in associate with other agencies (e.g. catchment water quality monitoring)
- Keep records of cultural harvest activities

How progress is measured (outcome performance measures):

- Water quality in streams draining from private land
- Extent of indigenous wetland habitat on private land
- Condition of conservation land managed under concession activities
- Satisfaction of iwi on the availability and use of cultural resources

SITE PROGRESS

Whangamarino

A substantial amount of the Waikato Area Office's resources are directed towards statutory/non-statutory advocacy that promotes sustainable land use around wetlands. The Waikato Area Office staff have been active in encouraging landowners adjoining the Whangamarino Wetland to fence their wetland margins. As at June 2010, 25.5 km of wetland boundary fencing has been constructed (of the >50 km unfenced prior to the start of the programme). Large areas of the wetland remain unfenced, however, sustained lobbying is continuing for these to be fenced.

Riparian planting has been undertaken at Falls Road in conjunction with Te Kauri Trust and duck shooters. Te Kauwhata Primary School has committed to continued planting the site for the coming five years. To date approximately 3,000 plants have been added to an area of roughly 1 ha. Scope to undertake further significant riparian planting is limited in the Whangamarino due to the unpredictable and significant fluctuations in water level as a result of the regional flood protection scheme. Planting sites are prone to rapid inundation during key planting seasons, forcing riparian work out onto private land.

Erosion control has been managed by planting sterile willows along the river banks in conjunction with Environment Waikato, as well as by fencing out stock. The department has invested in nose pumps to allow cattle access to drinking water without damaging river banks.

Ō Tū Wharekai

Land development is a potential threat to the ecological integrity of the lakes, rivers and wetlands in the Ashburton Basin and upper Rangitata River. Once the draft Ō Tū Wharekai Recreation Plan is complete it will assist in guiding the development of statutory policies for the Ō Tū Wharekai section of the Canterbury Conservation Management Strategy. This will communicate the intended management directions for Ō Tū Wharekai with the public and interested parties, and to aid decisions on concession applications. Raukapuka Area and the Canterbury Conservancy are also currently submitting on the Ashburton District Plan.

In collaboration with the Research and Development Group, Ō Tū Wharekai is the case study for an economic valuation of the ecosystem services of wetlands. The understanding of the values that public put on wetlands in conservation land will directly inform the level of investment the department makes in wetland management.

Awarua/Waituna

Awarua/Waituna Wetland is surrounded by intensive farming practices which are directly and indirectly impacting on the health of the wetlands. The Murihuku Area held a number of field days, promotional wetland events, and published information to advocate for improved land use management, as well engaging with industry groups such as Fonterra and Dairy NZ. The industry partnership resulted in \$20,000 of funding for improved catchment management between 2007 and 2010.

Local community are directly guiding the catchment programme through the Awarua/Waituna Advisory Group (AWAG), which was established in 2008. This group consists of farmers and other community representatives who provide advice to DOC and other agencies on how to best engage farmers while considering social and economic needs. Some of AWAG's ideas include subsidised riparian fencing and planting, culvert alignment and encouraging agencies to better protect remaining wetlands.

Table 7. Summary of actions implemented to promote sustainable land use at the Arawai Kākāriki sites (Objective 6)

		IMPLEMENTATION SUMMARY (2007-2010)		
Management Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Limit any further decline in wetland condition through statutory advocacy (e.g. RMA)	Number of submissions / consultations on statutory plans /consents	5	0	4
Promote sustainable landuse (non-statutory advocacy). e.g. promote sustainable clearing, drainage, effluent management, erosion control	Fenced length along inflow streams and wetlands (not boundary)	0	0	55 km (new fences)
	Number of farms visited as % of catchment / boundary	tbc	tbc	tbc
Promote covenants on private land	Number of new covenants	1 covenant	0	0
Promote biodiversity restoration initiatives on private land (e.g. BCF)	Number/area of DOC engaged projects	1 project - 261ha ongoing trapping block	1 project - 1.8 km trap line	0
Inventory & Monitoring Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Refer to other I&M actions (e.g. water quality)				

CASE STUDY: Working with landowners in the Waituna Lagoon catchment [Objective 6]



Katrina Robertson the jointly funded DOC and Environment Southland Land Sustainability Ranger checking a drain and fence line in the Waituna Lagoon catchment.

Awarua/Waituna wetland is surrounded by intensive farming practices which are directly impacting on the health of Waituna Lagoon. Due to the high sediment and nutrient loads flowing downstream, treating the cause of water quality issues required the department to work off estate, and engage directly with farmers.

The Awarua team sought to involve the community, listen and learn from their experience, and to empower the locals to make informed decisions. In order to do this a community group was established, where information between farmers

and government agencies was shared. One of the first initiatives to engage farmers was a subsidised Riparian Fencing and Planting scheme. This was used as a tool not only to fence waterway but also as a vehicle to engage land users. Over 55 km of drains and waterways were fenced in the Waituna Lagoon catchment between 2007 and 2010. Another initiative was to jointly fund with Environment Southland a Land Sustainability Ranger dedicated to working with the farmers in the Waituna catchment.

CASE STUDY: Ecosystem services provided by wetlands [Objective 6]

In 2010 a research project was initiated to gain a better understanding of the value of the ecosystem services provided by wetlands in New Zealand. This will help DOC understand the benefits of undertaking a restoration activity and help direct monitoring programmes. The economic valuation is based on the Choice Experiment (CE) method, which asks individuals make trade-offs between ecosystem services of a particular resource, in this case the wetlands of Ō Tū Wharekai (Ashburton Basin). CE is a method that carefully elicits the willingness-to-pay for ecosystem services of individuals from a target community.

In Phase I of this project we undertook a review of the specific values and issues pertaining to Ō Tū Wharekai. This produced a list of the key ecosystem services for Ō Tū Wharekai that would be suitable for valuation using CE (Table 1). Ecosystem services were made up of both use and non-use values. Use values consist of fishing, hunting and hiking, whereas non-use values refer to the values of the benefits generated by environmental goods and services that are unrelated to the value of their current or planned use, such as scenic values.

Phase II of this project will involve conducting the full economic survey that estimates the dollar value people place on different ecosystem services. These monetary values, which represent economic benefits, can then consequentially be compared to the costs of alternative management options. A net benefit signals that social welfare has been increased as a result of ecosystem management.

Table 8. Key ecosystem services for Ō Tū Wharekai identified during interviews with stakeholders and community (Source: Giorgetti et al. 2010)

Ecosystem service	Description	Type
<i>Maintain water quality</i>	Wetlands maintain water quality for use by agriculture, human consumption and recreation, and native plants and animals by reducing nutrient and sediment levels.	Regulating service
<i>Maintain water flows</i>	Wetlands fill-up with water during heavy rain and are a source of water during dry periods. Protecting wetlands and restoring vegetation in the catchment will maintain water flows.	Regulating service
<i>Food and water for livestock</i>	Wetlands, lakes and rivers can provide food and water for sheep and cattle. Intensification or increased agriculture provides income, but can deteriorate other aquatic values.	Providing service
<i>Eco-tourism opportunities</i>	Visitors experience unique New Zealand high-country environments and wetlands through eco-tourism.	Providing service
<i>Native biodiversity</i>	Wetlands provide habitat for native species, and ecosystems, including threatened species	Supporting service
<i>Educational opportunities</i>	Scientists, students and the local community can learn about ecology, land management and history of the aquatic ecosystem.	Supporting service
<i>Scenic landscapes</i>	Visitors enjoy and experience scenic values, nature and tranquillity of Ō Tū Wharekai.	Cultural service
<i>Exists for future generations</i>	Public derives benefits from knowing that Ō Tū Wharekai will be in good condition for future generations and that the option to visit the wetland in the future exists.	Cultural service
<i>Water & land-based recreation</i>	People use Ō Tū Wharekai to tramp, sail, windsurf, fish, hunt, birdwatch, waterski, kayak and swim.	Cultural service
<i>Hunting, fishing & harvesting</i>	Wetlands, lakes and rivers provide habitat for native species (e.g. eels, raupo) and exotic animals (trout, salmon, ducks) for fishing and hunting.	Cultural service

Objective 7. Improve recreation and visitor opportunities



Providing opportunities for visitors to explore and enjoy our wetlands.

Public use and enjoyment of the recreation opportunities and scenic values that Arawai Kākāriki sites provide is one of the key aims of the programme. The establishment of facilities for visitors such as walking trails also provides a mechanism to inform public of the issues that threaten freshwater ecosystems.

For this objective, sites will maintain existing visitor facilities and develop new opportunities that allow sustainable recreation and attract visitors to public conservation land.

Actions to achieve this objective:

- Maintain and develop recreation facilities for public use
- Develop interpretation at key visitor sites

How changes are monitored:

- Monitor visitor abundance and survey visitor satisfaction following site visits

How progress is measured (outcome performance measures):

- Number of visitors
- Use of wetlands for game bird hunting and fishing
- Satisfaction of visitors

SITE PROGRESS

Whangamarino

Public access for recreation in the Whangamarino wetland was identified as limited by local community. In response, the Waikato Area invested in the maintenance and creation of three boat ramp and car park areas. The upgraded boat ramps are also focal points for the display of signage, including warnings about pest plants and fish in both English and simplified Chinese characters.

An interpretation panel was constructed on council land in the Te Kauwhata township. Its location at the entrance of the township, next to a carpark and thriving playground, has provided the Whangamarino project with great profile and an excellent opportunity to promote the Arawai Kākāriki programme.

The Visitor Assets team invested significant resources in planning for a boardwalk and visitor centre off Falls Road. External factors have meant this project is unlikely to come to fruition. An alternative plan for the Whangamarino Wetland will be completed in the coming year. This plan outlines potential for a small scale visitor attraction at Falls Road in conjunction with the Whangamarino Redoubt project.

Ō Tū Wharekai

The Ō Tū Wharekai recreation plan is being drafted to guide the future direction on recreation activities and will be complete by 2011. This document will detail the recreation uses on newly acquired land in Hakatere Conservation Park and other conservation areas.

Recreation use in sensitive areas of Ō Tū Wharekai increases the risk of fire and spread of didymo, an invasive alga. One of the highest risks of fire is from vehicles. The Raukaupka Area is managing this risk by having conditional vehicle access to some areas and closing off other areas. Didymo was first discovered in Ō Tū Wharekai in 2009 in the upper Rangitata River, then subsequently at Buicks Bridge on the upper South Ashburton River in early 2010. The risk to smaller streams and lake margins is very high and staff have produced a mitigation strategy to guide signage and education to inform users of potential impacts. Several didymo cleaning stations for vehicles and boats have been installed at key sites, with smaller spray bottle stations near walking areas.

Ō Tū Wharekai is producing an interpretation plan, and interpretation should be in place at key sites by summer 2011.

Awarua/Waituna

Recreational facilities are the mechanism to introduce farmers, wetland enthusiasts, schools and industry to the Awarua/Waituna wetlands. Consultation with the public revealed a need for better access to the wetlands, for recreational boaters, fishers, bird watchers and walkers. Under the Arawai Kākāriki programme, a new 4.5 kilometre walking track was completed in 2010, and interpretation for the track will be installed shortly. Existing boat access facilities have also been upgraded to enable safer access.

Brochures, field days, events and media coverage has raised the profile of the wetlands and promoted the recreational values available for people to enjoy.

Table 9. Summary of actions implemented to provide recreation opportunities and improve public awareness at the Arawai Kākāriki sites (Objective 7)

		IMPLEMENTATION SUMMARY (2007-2010)		
Management Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Develop appropriate recreation facilities and opportunities	Description of new /upgraded recreation facilities	2 upgraded boat ramps	1 Didymo cleaning station	4500m track; 1 boat access upgraded; 1 toilet relocated
Minimise impacts of recreational use (infrastructure, advocacy, information)	Number and type of actions undertaken to minimise recreation impacts	6 signs (unwanted fish and weed signs); 6 chinese translated signs	3 vehicle signs; 4.5km vehicle exclusion fence (L. Clearwater); 1.2km vehicle exclusion fence (L. Heron); 100m 'grebe fence' L. Clearwater	3 signs upgraded on recreation use 1 community evening to address issue of motor bikes 1 reduce vehicle access to areas, 30m planting.
Develop interpretation at key sites taking into account Conservancy/ site interpretation plan	Number and type of interpretation actions	1 sign at Te Kauwhata	1 draft interp. signage plan	2 signs erected
Inventory & Monitoring Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
OM18 - Visitor use monitoring by counting or survey	Number and type of surveys	0	1 visitor and stakeholder survey	1 informal visitor survey
OM19 - Survey visitor response to site visits and interpretation	Number and type of surveys	0	1 visitor and stakeholder survey	0

CASE STUDY: Upgrading recreation facilities [Objective 7]



The new boat ramp at Te Onetea Stream

Whangamarino wetland has long been used by commercial and recreational fisherman, and for duck hunting. In response to feedback regarding access to the waterways of the Whangamarino the department has invested more than \$10,000 upgrading boat ramps and car parks off Falls Road, Island Block Road and Te Onetea Road. This has made it easier for members of the public to park a car and launch a boat or kayak and explore the Whangamarino Wetland and Lake Waikare from the water.

CASE STUDY: Providing new recreation opportunities [Objective 7]



Access to the over 10,000 ha of wetlands at Awarua-Waituna can be difficult due to the dense manuka and wet soils that visitors encounter. However, the diversity of wetland vegetation, peat stained pools and soft beds of sphagnum are worth exploring, along with the cryptic animals such as fernbird and bittern hidden from sight. A new 4.5 km walking trail was opened by the Murihiku Area with local community and officials in 2010 and provides one of the only opportunities for visitors to experience this relatively pristine and internationally significant site.

The new walking trail is a focus for school groups, locals and visitors, and helps to increase the awareness and understanding of wetlands, while providing a opportunity for recreation on public conservation land.



Waituna walking trail under construction, and the viewing shelter that connects with the new track.

Objective 8. Maximise community awareness and involvement



Involving schools in wetland conservation

Without the support of local community it is often difficult to achieve the goals for biodiversity conservation, improved recreation and research. Successful engagement requires an understanding of community values and the interest of individuals in contributing to wetland conservation. Promoting awareness of the unique features and vulnerability of wetlands to a wider audience through media and other communication tools is equally important. All three sites were profiled in the January/February 2010 edition of the New Zealand Geographic (Hansford 2010).

The key aim of this objective is to increase local community and general public awareness of and engagement in the Arawai Kākāriki programme and freshwater conservation.

Refer to Appendix 5 for a summary of communication from the Arawai Kākāriki programme.

Actions to achieve this objective:

- Implement a communication, education and public awareness (CEPA) plan
- Engage with local community, iwi and stakeholders
- Utilise media to promote wetland values and the objectives of the Arawai Kakariki programme
- Promote wetland education programmes

How changes are monitored:

- Monitor local community, iwi and stakeholder participation and their awareness of the Arawai Kākāriki programme

How progress is measured (outcome performance measures):

- Proportion of community, iwi and stakeholders with improved awareness of the Arawai Kākāriki programme
- Number of partnerships that involve tangata whenua
- Number of volunteers who participate in conservation projects
- Level of external interest (website hits)

SITE PROGRESS

Whangamarino

The Waikato Area Office has maintained a profile in the community by attending local events such as the Te Kauwhata A&P show (winner best trading site 2009 – refer image) and community meetings such as the Te Kauwhata Community Committee. There is currently no community-based care group associated with the wetland although the Regional Council does facilitate a care group focused on Lake Waikare. Two duck hunter collectives – the Northern Whangamarino Wetland Association and the Cocks Wetland Society – regularly undertake conservation work in the vicinity of key shooting ponds. The Whangamarino team engages with Ngaa Muka Development Trust, a collective of local marae, on a semi-regular basis. The team have also maintained a strong working relationship with the National Wetland Trust and provide ongoing support for annual World Wetlands Day events. Other such events supported by the team that raise the profile of wetlands include the World Koi Carp Classic and the National Agricultural Field days at Mystery Creek.

Te Kauri Trust, an organisation for ‘at risk’ school children, assisted in riparian plantings at Falls Road in the first two years of the Arawai Kākāriki project. However, their continued support has been limited in recent years as the effects of funding cuts and increased transportation costs became more evident. To address this, the department has shifted focus to the EnviroSchool certified Te Kauwhata Primary School, which is significantly closer to the planting site and has very strong parent support.



The Whangamarino DOC team at the 2009 Te Kauwhata A&P show.

Ō Tū Wharekai

To inform the community of project progress the Raukapuka Area Office produces an informal monthly update, mainly sent out by email. This has proven successful at keeping interested parties up to date and maintains open communication channels.

Community members regularly assist staff with seasonal bird counts and restoration planting. The Lake Heron Community group was formed by local landowners and community members to trap predators to protect waterfowl on Lake Heron. Forest and Bird have held the annual winter waterfowl survey for 26 years and a wilding pine control day for the last eight years. The Arawai Kākāriki programme has helped to support existing community groups Rangitata Gorge Landcare Group and Clearwater Hut Holders Association with funds for weed control and replanting.

Ō Tū Wharekai hosted LEARNZ in 2009 and 2010. This virtual learning education programme allowed 1600 students to experience Ō Tū Wharekai via video footage, audio conferences and blogs in a week long virtual field trip. Aoraki Polytechnic students contributed to the project in a four day working bee as part of their Outdoor Recreation diploma.

Awarua/Waituna

Engagement of two key groups has been targeted at the Awarua wetlands, the local farming community and the general public. Partnerships on farm were described previously as part of promoting sustainable catchment management (refer objective 6), which included initiatives with Fonterra, landowners and agricultural industry staff.

The Awarua project engages local community through a quarterly newsletter, the “Bog paper”, community events, and farm field days run in conjunction with Environment Southland. A series of evening talks on issues relating to the wetlands were well received. The general public are targeted through national and local media, school holiday events, Conservation Week, World Wetlands Day and other events that highlight the internationally significant wetland on Southland’s door step.

Table 10. Summary of actions implemented to maximise community involvement and engagement at the Arawai Kākāriki sites (Objective 8)

		IMPLEMENTATION SUMMARY (2007-2010)		
Management Action	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
Develop CEPA plan	Status of CEPA plan or equivalent	CEPA plan in draft	CEPA plan in draft	CEPA plan in draft
Consultation and partnerships with iwi	Summary of iwi engagement actions	Instigated cultural assessment, Engagement regard TK sign	SoT field work undertaken	Monthly Kaitiki Roopu, with additional consultation eg. track opening
Share information with community / stakeholders	Number of events	3 information stalls	1 public mtg; 1 stakeholder mtg; 3 information stalls; 5 presentations; regular email newsletter	8 bog papers (newsletter); 2 factsheets; media articles
Encourage community participation in wetland management	Number of activities / opportunities	3 site activities	5 site activities	10 site activities
Develop and implement wetland education programmes	Number of knowledge / skill sharing initiatives	-	3 education events	6 visits with schools
Inventory & Monitoring	Output measure	Whangamarino	Ō Tū Wharekai	Awarua
OM21 - Survey of local community, iwi and stakeholder awareness, understanding and participation in the Arawai Kakariki programme	Number and type of surveys	1 survey - postal community survey	0	1 Survey (draft) - perspective of land use on water quality
OM22 - Website hits database updated	Database status	No	No	Yes
OM25: Database of volunteer participation	Database status	No	Yes	Yes

CASE STUDY: Ō Tū Wharekai part of LEARNZ schools [Objective 8]



DOC ranger Lorraine Cook being interviewed by LEARNZ teacher Paul Millican

Over 1500 students from throughout New Zealand have “visited” Ō Tū Wharekai. The students virtually visit the wetlands as part of the LEARNZ schools project, funded by the Ministry of Education. LEARNZ runs about 20 free virtual field trips each year. Field trips are facilitated by a LEARNZ field trip teacher and hosted by guest “experts” – such as DOC rangers.

Classes log on to the website each morning and can download illustrated background readings, related activities, photos and almost live videos from the field, live and recorded audio-conferences,

daily diaries and an “Ask-an-Expert” web board. A virtual field trip takes place over one week, but classes can access the resources anytime.

Students have learnt about wetland plants like *Carex secta*, set nets to trap eels, electric fish streams, and investigate pit fall traps for geckos and skinks.

For further details see the video and information on

<http://rata.learnz.org.nz/summary.php?vft=highcountrywetlandecology111>

4.3 Learning

Objective 9. Undertake research to inform wetland management



Assessing water clarity in Waituna Lagoon

A coordinated research programme, which targets the knowledge gaps that are a barrier to wetland management, is a critical component of the Arawai Kākāriki programme. Projects to describe the ecological processes and human-induced threats to wetland ecosystems, threatened species and community values will assist managers in making resource allocations.

Through investment in priority research projects and partnerships with universities and crown research institutions, the goal is to publish scientific findings that directly assist the restoration of the Arawai Kākāriki sites while also being beneficial for the wetland conservation elsewhere.

Refer to Appendix 4 for list of science and technical reports and publications from the Arawai Kākāriki programme.

Actions to achieve this objective:

- Develop a research strategy to target key knowledge gaps that limit wetland management
- Establish partnerships with research organisations
- Coordinate and undertake research and publish findings

How changes are monitored:

- Monitor the use of research outputs by wetland managers

How progress is measured (outcome performance measures):

- Level of uptake of research findings in wetland management at the Arawai Kākāriki sites and elsewhere

PROGRESS

Research and Development Group

One of the strengths of the Arawai Kākāriki programme has been the input from a core group of department scientists with expertise on wetland ecology, mammalian predator population dynamics, braided river and swamp bird communities, and freshwater fish conservation. This science group has worked with each site to understand the knowledge gaps that limit on-ground management. Key research projects have examined the 1) status of vulnerability of aquatic macrophytes to eutrophication, 2) movements of mammalian predators in wetlands, 3) historical distribution of Australasian bittern across New Zealand, 4) valuation of ecosystem services of freshwater ecosystems within the Ashburton Basin, and 5) changes in the protection of wetlands on conservation land.

The Arawai Kākāriki programme between 2007 and 2010 also engaged universities to undertake research to support on-ground management decisions. Four MSc students have contributed to our knowledge on wetlands in New Zealand. The student research examined the environmental

history of Waituna Lagoon (University of Otago) and the Ashburton lakes (University of Queensland/University of Canterbury) using palaeolimnological techniques, quantified the relationships between hydrology, nutrients and wetland condition at Whangamarino (University of Waikato) and tested monitoring techniques for wetland birds (Massey University).

Partnerships with research agencies were promoted through coordinating a dedicated session on wetland ecohydrology and conservation at the Freshwater Science Society conference in November 2009. In addition to the partnerships with universities, involvement of CRIs such as Landcare Research and NIWA through their freshwater research programmes is further helping the department to understand the ecological processes that maintain ecosystem functioning.

Sites

The three sites also lead specific research programmes relevant to the particular ecosystems and species they support. Some of the more significant examples are the research on the population status of Wrybill on the upper Rangitata River (Ō Tū Wharekai), quantifying the changes in sedimentation rate due the management of the Waikato River flood control scheme (Whangamarino) and assessing the recruitment of Giant Kokopu in the Waituna Lagoon catchment (Awarua-Waituna).

Table 11. Summary of research undertaken to inform wetland management by R&D and the Arawai Kākāriki sites (Objective 9)

		IMPLEMENTATION SUMMARY (2007-2010)	
Action	Output measure	R&D	Sites
Establish partnerships with research organisations	Number / type of research partnerships (external lead)	6 partnerships Landcare Research (wetland restoration); Env. Southland (Waituna lagoon); NIWA (willow); University (palaeoecology Waituna/Ashburton Lakes, Eco-hydrology Whangamarino)	3 partnerships - Landcare Res. (Awarua); Uni Can (OTW); Uni Otago (OTW)
Undertake and promulgate research	Number / type of research projects (DOC managed)	7 projects - Ruppia; Bittern database; LCDB2; Mammalian predators; Wetland protection; LiDAR & climate change; Ecosystem services; Bittern index	5 projects - Sediment accu; Willow mgt; Ephemeral turfs; Wrybill; Donatia
Inventory & Monitoring	Output measure	R&D	Sites
OM26 - Assess research uptake	Assessment status	Planned 2011/12	NA

CASE STUDY: Vulnerability of Waituna Lagoon to eutrophication and lagoon opening [Objective 9]



A key to research at Waituna Lagoon is collaboration across DOC and with external partners such as Environment Southland and the University of Otago.

Waituna Lagoon is an intermittently open and closed coastal lagoon that supports a relatively intact community of submerged macrophytes dominated by *Ruppia megacarpa* and *R. polycarpa*. The lagoon is vulnerable to increased levels of nitrogen and phosphorus due to changes in catchment land use that may cause the macrophyte community to switch to an algal-dominated state. The artificial opening of the lagoon to the sea also subjects the lagoon to periodic changes in water levels and salinity. An initial survey in 2007 (Figure 11) confirmed *Ruppia* was widespread.

To better understand the resilience of the *Ruppia* dominated macrophyte community to changing water quality and salinity a research project was initiated in 2008 with support from the Southland Conservancy and Environment Southland.

Field work is focused on an assessment of the macrophyte community at 48 sites. Results from the annual survey are helping to understand the dynamic nature of macrophytes in the lagoon. These findings are already being used to inform decisions on future options for lagoon management. Further research is planned to quantify the degree of nutrient limitation on primary productivity, particularly algal growth, which is seen as a major threat to the long-term health of the coastal lagoon ecosystem.

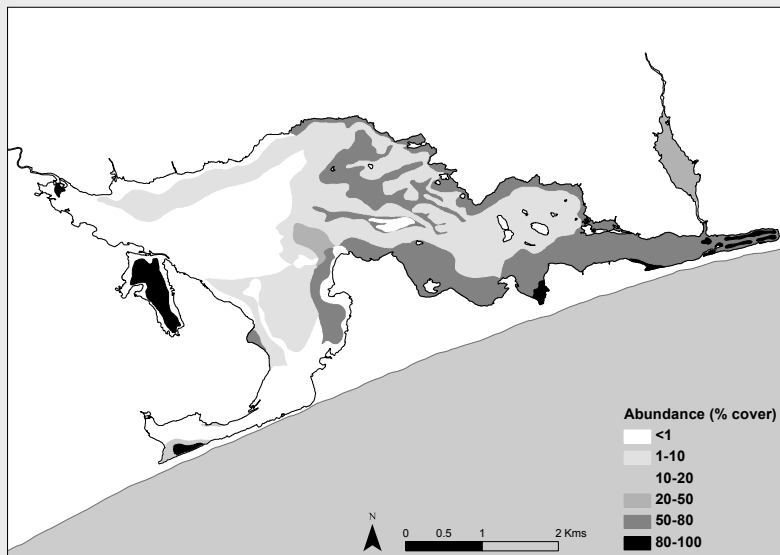


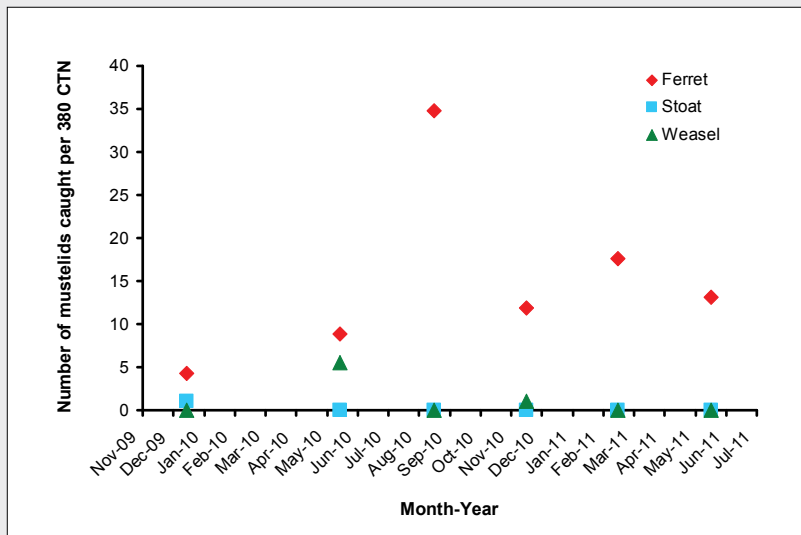
Figure 11. Distribution of submerged macrophytes, particularly *Ruppia* sp., in Waituna Lagoon in 2007 (Source: Robertson & Stevens 2007)

CASE STUDY – Monitoring introduced mammalian predators in the Whangamarino Wetland [Objective 9]

There is currently very little information on introduced mammalian predators in wetland ecosystems in New Zealand compared with other ecosystem types. Furthermore, existing monitoring techniques designed for surveying mammalian predator abundance in forest and grassland environments may not be appropriate for using in wetland conditions.

This four year research programme aims to describe the introduced mammalian predator guild in Whangamarino and validate small mammal monitoring techniques in a wetland environment. Our initial results indicate that feral ferrets (*Mustela furo*) are the most numerous of the mammalian carnivores present (Fig. 12), but weasels (*M. nivalis*) are seasonally abundant, feral cats (*Felis catus*) and stoats (*M. erminea*) are also present in the wetland. Other pest mammals present or seasonally abundant in the wetland include possums (*Trichosurus vulpecula*), two species of introduced rat (*Rattus norvegicus* and *R. rattus*), house mice (*Mus musculus*) and the European hedgehog (*Erinaceus europaeus*). It would appear that the presence and abundance of these small mammals in some parts of the wetland may also be related to the water levels which can fluctuate markedly throughout the year.

To date we have tested WaxTags[®] as a method for measuring rodent and hedgehog abundance and camera traps for detecting the carnivores – both techniques are already showing promise.



Numbers of mustelids caught per 380 CTN in Edgar + Cage traps at Whangamarino. Source: C.Gillies & M.Brady

Figure 12. Initial results from predator research.



A WaxTag[®] mounted on a wooden stake at Whangamarino (left) and a feral cat detected in one of the 'camera traps' at Whangamarino (right).

Objective 10. Develop best-practice wetland restoration tools



Development of wetland vegetation monitoring methods at O Tu Wharekai

The Arawai Kākāriki programme is intended to provide a test bed for developing new monitoring methods and management techniques for wetland restoration projects in New Zealand. It was recognised that standardised methods for monitoring wetland biodiversity were limited. The development of wetland monitoring tools will ensure consistency in data collection across the department. These tools will also be incorporated into the NHMS Inventory & Monitoring Toolbox and shared with other wetland managers.

Actions to achieve this objective:

- Develop monitoring methods for wetland ecosystems
- Test wetland restoration management techniques
- Share monitoring methods and management techniques with other projects

How changes are monitored:

- Record details of other projects utilising methods developed

How progress is measured (outcome performance measures):

- Number of projects using monitoring methods developed by the Arawai Kākāriki programme
- Number of projects using the guidance on wetland management developed by the Arawai Kākāriki programme.

PROGRESS

Research and Development Group

Arawai Kākāriki was established as a national programme to facilitate the development of methods for managing and monitoring wetland ecosystems across New Zealand. After testing, these tools will make the department's work on wetland conservation more efficient by reducing the proliferation of different techniques.

Between 2007 and 2010, the Research & Development Group (R&D) has led the development of methods to: 1) prepare detailed wetland maps to assist conservation projects, 2) undertake inventory and monitoring of cryptic wetland birds (bittern, crake, fernbird), 3) monitor changes in wetland vegetation, and 4) monitor the distribution and abundance of mammalian predators in wetland environments.

It is important to recognise that these R&D led projects have directly supported the sites and were often instrumental in the progress of each sites under the Biodiversity Objectives (1 - 4).

There is already interest from non-government groups, regional councils and other DOC offices in these tools. All methods will be published following testing and peer review.

Sites

The work of R&D in developing new monitoring methods was supported and tested by the Arawai Kākāriki sites. For example, a detailed vegetation map at the Awarua wetlands was based on the draft mapping protocol. All three sites have been involved in testing the cryptic bird survey methods, and this is assisting refinements to the monitoring tool. This collaboration between site level operations and national led R&D is one of the strengths of the programme.

Table 12. Summary of actions to develop monitoring methods and management tools by R&D and the Arawai Kākāriki sites (Objective 10)

		IMPLEMENTATION SUMMARY (2007-2010)	
Management Action	Output measure	R&D	Sites*
Develop and implement survey and monitoring methods	Number and type of survey/monitoring methods under development	Cryptic wetland bird inventory & monitoring (Marsh Crake; Spotless Crake; Bittern; Fernbird) Wetland vegetation monitoring Mammalian predator monitoring Wetland mapping guideline	Larval fish assessment
Develop and promulgate wetland restoration tools (management)	Number and type of restoration tools under development	Strategic planning framework	-
Inventory & Monitoring	Output measure	R&D	Sites
OM27 - Survey of wetland managers. Record details of other restoration projects and stakeholders utilising methods developed	Number surveys	Planned 2011/12	NA

* Note: Sites provide extensive support via trials of monitoring methods and management tools

CASE STUDY: Monitoring cryptic birds in wetlands [Objective 10]

Wetlands support a wide range of threatened bird species in New Zealand. However, management techniques for restoring their populations are poorly developed. Many species are highly cryptic, so we do not have robust methods for surveying them systematically, nor monitoring their response to management.

Thus, we require robust methods for inventory (baseline surveys) to:

- (a) establish a baseline distribution map for specialist swamp birds for specific sites (which species are present and where); and
- (b) identify critical habitat types for swamp bird species (where to focus longer term monitoring and management).

We also require robust methods for long term monitoring populations to:

- (c) monitor response of swamp birds wetland management; specifically the effectiveness of pest control and habitat maintenance and restoration
- (d) monitor wetland health and integrity, including determining whether populations of interest are stable, increasing, or decreasing and when and where management intervention is necessary.



(Top): Colin O'Donnell setting up automatic bittern call recorder at Whangamarino Wetland. (Bottom): Fernbird

Methods need to be sensitive enough to detect significant population changes within relatively short timeframes so that management can be adaptive. As part of this project we developed draft monitoring protocols and a series of trials to determine their effectiveness for 5 specialist swamp birds: Australasian bittern, marsh crake, spotless crake, banded rail and fernbird.

Recording these species depends on "call counts" with either an observer listening for set times or new automatic recorders (electronic recorders developed by the DOC Electronics Lab) being set up and recording calls remotely. Most work has focused on determining the optimum time of year, time of day and environmental conditions for counting these birds and developing the best sampling designs (e.g., layout of calling stations, Figure 13). For example, peak calling in bittern is mainly September to November (Figure 14) and at dawn and dusk.

CASE STUDY: Monitoring cryptic birds in wetlands (continued)

Field trials at Whangamarino wetland in the Waikato region indicate the recorders were excellent at recording bittern calls (up to 50 boom trains per 15 minutes). The recorders generally perform as well as human observers in our initial trials and there is a strong relationship between number of calls per hour and number of different individuals counted, indicating that this index measure is likely to be useful for long term monitoring of relative abundance.



Figure 13. Example of layout of calling stations for surveying Australasian bittern at Whangamarino wetland

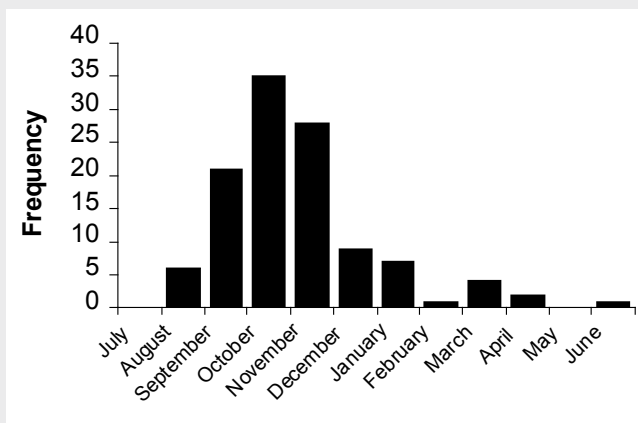


Figure 14. Timing of booming in male Australasian bittern (from National Bittern Database). Source: O'Donnell (2011).

5. Future Directions



Protection of wetlands from impacts associated with land use change remains a challenge.

The national leadership of the Arawai Kākāriki wetland restoration programme is one of its strengths. Actions are being delivered to enhance Whangamarino, Ō Tū Wharekai and Awarua/Waituna and also to answer key research questions of applicability to wetlands nationally. By utilising a planning framework that identifies links between national objectives, site goals, management actions, performance monitoring and indicators for reporting on conservation outcomes, the Arawai Kākāriki programme is a test-bed for the department-wide NHMS framework.

Priority work will continue to be protecting the most significant values at sites and intervening in the ecological drivers that have the greatest likelihood of generating adverse system change. For example, in all three sites nutrient inputs are significant, however the management responses differ. At Whangamarino the flood management features of the Waikato River prevent reduction in nutrient input, whereas at Waituna Lagoon which is under significant threat (a potential flipping system) from increased catchment dairy intensification, community and government action will continue to be a high priority. Wetlands in the Ashburton Basin are also vulnerable to declining water quality, which needs to be closely monitored.

By the end of 2011 it is anticipated that the three sites will have well established multi-year actions that can feasibly produce lasting benefits to the key site values. Outcome reporting should be showing clear benefits from these interventions. These results will be the subject of the Arawai Kākāriki Outcomes Report that is to accompany this Implementation Report. By the end of 2011 management systems should also be sufficiently developed to be applied to other wetland sites. At this point funding can be reviewed to ascertain whether actions at other sites are of higher priority than retaining the project funds only within the current three.

Funding for the three sites has been confirmed to June 2012 at which stage the programme will be reviewed and the outcomes at each site assessed.

Wetland restoration is a challenging discipline. Through the research and development occurring at the three sites, and nationally, the department will be in a position to provide clear and informed advice to assist wetland managers across New Zealand, including other Ramsar sites and community-led restoration initiatives.

Priorities for the programme over the upcoming 2-3 years

- Continue to implement on-ground actions to protect and restore Whangamarino wetland, Ō Tū Wharekai and Awarua-Waituna as guided by the national objectives of the Arawai Kākāriki programme.
- Transition from an inventory phase of data collection to targeted monitoring and reporting on the effectiveness of management actions.
- Disseminate the new tools for wetland monitoring and restoration for use by government agencies and non-government groups.
- Share research findings with other wetland managers.
- Continue to build collaborative partnerships with community, iwi, research organisations and stakeholders.

Acknowledgements

The Arawai Kākāriki wetland restoration programme has benefited from the support of numerous individuals and organisations across New Zealand, and this is seen as critical to the current and future success of the programme and wetland conservation in general.

Various staff within DOC contributed to this report, in particular, Colin O'Donnell, Wendy Sullivan, Rosemary Clucas, Kennedy Lange, Shannon Patterson, Matthew Brady, Kevin Hutchinson, Kathryn Duggan, Jan Simmons, Hannah Sout, Craig Gillies, Sally Chesterfield, Polly Bulling, Emily Atkinson, Andy Hicks, Kate McNutt and Dave West.

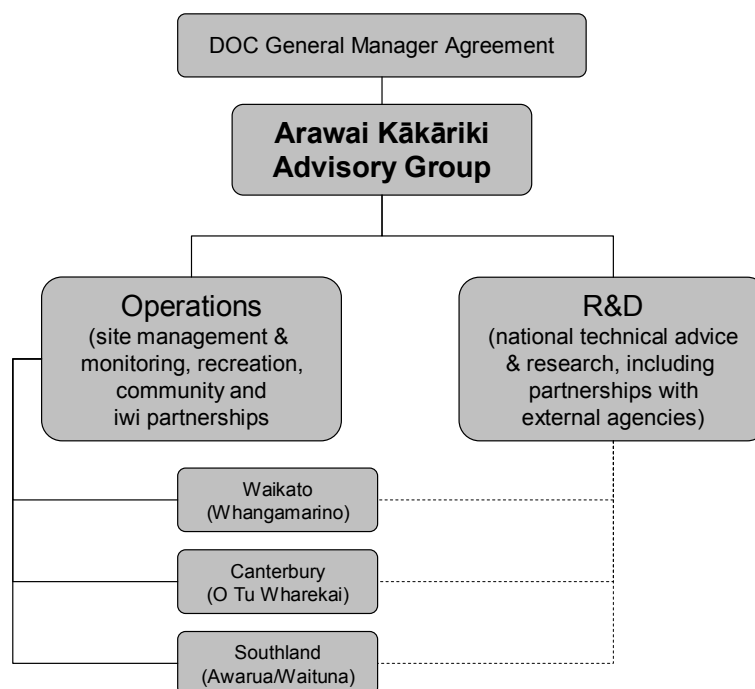
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- Wildland Consultants (2009). Whangamarino wetland vegetation map. Prepared for the Department of Conservation, Wildland Consultants, Rotorua.
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Appendices

Appendix 1: Arawai Kākāriki wetland restoration programme organisational structure

Appendix 1a. Diagrammatic representation of the Arawai Kākāriki organisational structure



Appendix 1b. Members of the Arawai Kākāriki Advisory Group

Member	Position (DOC)	Office location
Richard Suggate	Arawai Kākāriki Co-ordinator, ex-Southern Regional Office	Christchurch
Hugh Robertson	Scientific Officer (Wetlands), Research & Development	Christchurch
Harry Broad	Strategic Issues Manager, Marketing & Communications (2007-2010)	Wellington
Jan Simmons	Community Relations Officer, Waikato Conservancy	Hamilton
Kate McNutt	Senior Technical Support Officer, Research & Development	Christchurch
David West	Scientific Officer (Freshwater), Research & Development	Christchurch
Colin O'Donnell	Scientific Officer (Species), Research & Development	Christchurch
Shannon Patterson	Whangamarino Programme Coordinator, Waikato Area	Hamilton
Wendy Sullivan	Ō Tū Wharekai Programme Coordinator, Raukapuka Area	Geraldine
Sally Chesterfield	Awarua/Waituna Programme Coordinator, Murihiku Area	Invercargill

Appendix 2: Allocation of Arawai Kākāriki funding between 2007/08 and 2009/10

Appendix 2a: Expenditure (operating and capital) in offices and Arawai Kākāriki sites.

Office/Site	2007-08 (\$k)	2008-09 (\$k)	2009-10 (\$k)	Total (\$k)
National Office	300	300	300	900
Southern Regional Office	50	50	50	150
Research & Development	50	150	168	368
Whangamarino	485	387	641	1513
Ō Tū Wharekai	533	511	596	1640
Awarua/Waituna	512	622	673	1807
Total	1930	2020	2428	6378

Appendix 2b: Direct operating expenditure (not including salaries, admin and capital) allocated against national objectives of Biodiversity Conservation, Community and Learning & Development.

Objective (office/site)	2007-08 (\$k)	2008-09 (\$k)	2009-10 (\$k)	Total (\$k)
Biodiversity				
Whangamarino	430	282	337	1049
Ō Tū Wharekai	448	400	170*	1018
Awarua/Waituna	313	314	168*	795
Community				
Whangamarino	38	63	29	130
Ō Tū Wharekai	57	64	70	191
Awarua/Waituna	199	291	234	724*
Learning				
Research & Development	50	150	168	368
Southern Regional Office	50	50	50	150
Whangamarino	17	42	0	59
Ō Tū Wharekai	28	47	36	111
Awarua/Waituna	0	27	55	82
Total (excl. NO overhead)	1630	1730	1317	4677

* includes contract staff, #does not include permanent staff salaries

Appendix 3: Arawai Kākāriki Outcome Reporting Framework. Version 1.2 Jan. 2011

The Arawai Kākāriki outcome reporting framework was systematically compiled in a process involving representatives from R&D, ex-SRO and the three Conservancy Offices involved in the Arawai Kākāriki programme. The reporting framework is based on the department's NHMS model. The resulting indicators and measures enable national and site-level reporting on achievements in wetland management under the themes Biodiversity, Community and Learning, which corresponds to the 10 objectives of the Arawai Kākāriki programme. This reporting framework provides the basis for the 'Arawai Kākāriki Wetland Restoration Programme: II. Outcomes Report' to be published late 2011.

BIODIVERSITY

1. Maintain wetland extent

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
1. Maintain or enhance the extent of wetland habitat	Wetland extent & protection	[AK1.i] Extent of wetland habitats on PCL in management area	OM1 - Wetland mapping/ ground-truthing	5 yr
	Wetland extent & protection	[AK1.ii] Extent of wetland habitats outside of PCL in management area		
	Wetland extent & protection	[AK1.iii] Extent of wetland habitats legally protected outside of PCL in management area		

2. Maintain water regime and water quality

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
2. Maintain and enhance water regime and water quality to support aquatic values	Hydrological regime	[AK2.i] Frequency, duration, extent and timing of inundation for different wetlands, lakes and lagoons	OM2 - Hydrological monitoring / modelling	Continual/ Monthly
	Sedimentation	[AK2.ii] Sediment deposition rates at key sites	OM3 - Sediment accumulation	Annual
	Water chemistry	[AK2.iii] Sediment load of tributary drains/creeks	OM4 - Water quality monitoring	Continual/ Event
	Water chemistry	[AK2.iv] Water properties at key sites - select from nutrients, light, DO, pH, salinity, pollutants		
	Soil status	[AK2.v] Soil N/P levels	OM6 - Permanent habitat monitoring plots	5 yr (general); Annual (restoration)
	Soil status	[AK2.vi] Soil pH		
	Biological water quality metrics	[AK2.vii] Biotic indices of water quality at key sites - select from TLI, MCI, Periphyton (rivers)	OM5 - Aquatic index (combined metrics)	Varies (min. 1 yr - 5yr max)

3. Protect and restore wetland habitat

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
3. Protect and restore habitat	Indigenous habitat extent	[AK3.i] Extent of indigenous habitats on PCL in management area	OM1 - Wetland mapping/ ground-truthing	5 yr
	Indigenous habitat extent	[AK3.ii] Extent of indigenous habitats outside of PCL in management area		
	Ecosystem composition & occupancy	[AK3.iii] Biotic indices of water quality at key sites - select from LakeSPI, Fish IBI	OM5 - Aquatic index (combined metrics)	Varies (min. 1 yr - 5yr max)
	Ecosystem composition & occupancy	[AK3.iv] Abundance of indicator species/plant functional types across height classes	OM6 - Permanent habitat condition monitoring plots	5 yr (general); Annual (restoration)
	Ecosystem composition & occupancy	[AK3.v] Proportion of sites with expected plant functional types (PFTs)		
	Indigenous dominance	[AK3.vi] Ratio of indigenous to exotic plant species (richness) in each habitat type		
	Indigenous dominance	[AK3.vii] Ratio of indigenous to exotic plant species (abundance) in each habitat type		
	Soil decomposition	[AK3.viii] Peat formation		
	Fire impact	[AK3.ix] Number and extent of wild fires	OM7 - Calculate area burnt	Event
	Environmental weed /pest dominance	[AK3.x] Distribution and abundance of weed species considered a threat	OM8 - Distribution / abundance weeds	Varies (min. 1 yr - 5yr max)
	Environmental weed /pest dominance	[AK3.xi] Distribution and abundance of pest species considered a threat (grazers)	OM9 - Distribution / abundance pests (grazers)	Annual
	New weed incursions	[AK3.xii] Number of new incursions of environmental weeds	OM8 - Distribution / abundance weeds	Incidental

4. Maintain and enhance species diversity

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
4. Maintain and enhance indigenous species diversity, including threatened species	Ecosystem composition & occupancy	[AK4.i] Species diversity in target local indicator guilds	OM10 - Species diversity and occupancy.	Annual
	Ecosystem composition & occupancy	[AK4.ii] Proportion of sites with expected indicator guilds		
	Indigenous dominance	[AK4.iii] Ratio of indigenous to exotic species within representative indicator guilds		
	Ecosystem composition & occupancy	[AK4.iv] Counts or indices of abundance of individuals of target indicator species	OM11 - Indicator species abundance.	Seasonal/ Annual
	Threatened species status	[AK4.v] Number of nationally threatened species that rely on this site for long term recovery (>1% of population)		2 yr
	Threatened species status	[AK4.vi] Population dynamics of selected threatened species both under management and not under management	OM12 - Indicator species population dynamics.	Seasonal/ Annual
	Environmental weed /pest dominance	[AK4.vii] Distribution / abundance of predators considered a threat	OM13 - Targeted predator monitoring (mammal/fish/birds)	Seasonal/ Annual

COMMUNITY

5. Conserve cultural and historic sites

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
5. Conserve and interpret historic and cultural values	Historic / cultural site protection	[AK5.i] Level of protection of historic and cultural sites	OM14 - Inventory historic / cultural sites	5 yr
	Historic / cultural site status	[AK5.ii] Proportion of actively conserved sites with maintained / improved condition		Annual
	Historic / cultural site status	[AK5.iii] Proportion of not actively conserved sites with maintained condition		5 yr
	Historic / cultural site awareness	[AK5.iv] Visitor awareness of significant historic and cultural sites	OM19 - Survey visitor response to site visits and interpretation.	Site dependent
	Protection of iwi cultural values	[AK5.v] Identified iwi cultural values adequately protected, restored, or enhanced	OM16 - Qualitative assessment of cultural values and partnerships with iwi	Annual

6. Promote sustainable land use

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
6. Achieve sustainable landuse	Concession impacts	[AK6.i] Concessions impact on conservation land	OM15 - Evaluate impact of concession activity on conservation land	Annual
	Catchment landuse	[AK6.ii] Water quality on private land	OM4 - Water quality monitoring	Bimonthly
	Catchment landuse	[AK6.iii] Indigenous habitat on private land	OM1 - Wetland mapping/ground-truthing	5 yr
	Catchment landuse	[AK6.iv] Private land protected by covenants		
	Cultural harvest (iwi)	[AK6.v] Cultural harvest on conservation land	OM17 - Consultation with iwi	Annual

7. Improve recreation and visitor facilities

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
7. Provide facilities and opportunities for the public to visit the site and increase awareness	Recreational use	[AK7.i] Visitor numbers	OM18 - Visitor use monitoring	Site dependent
	Recreational use	[AK7.ii] Visitor satisfaction	OM19 - Survey visitor response to site visits and interpretation.	Site dependent
	Recreational use	[AK7.iii] Game bird hunting and fishing use	OM18 - Visitor use monitoring	5yr
	Recreational impacts	[AK7.iv] Impacts on habitat and native species from recreation activities	OM20 - Evaluate impact of recreation activity	Annual
	Visitor awareness & appreciation	[AK7.v] Visitor awareness and appreciation of wetland values	OM19 - Survey visitor response to site visits and interpretation.	Site dependent

8. Maximise community involvement and awareness

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
8. Maximise community awareness, appreciation and involvement in the project	Community and stakeholder awareness & appreciation	[AK8.i] Community and stakeholder awareness and appreciation of wetlands	OM21 - Survey of local community, iwi and stakeholder awareness and participation	Site dependent
	Community and stakeholder awareness & appreciation	[AK8.i] Community and stakeholder awareness and appreciation of the site		Site dependent
	Community and stakeholder awareness & appreciation	[AK8.ii] Level of external interest (website hits)	OM22 - Website hits database updated	Annual
	Iwi awareness & appreciation	[AK8.iii] Iwi awareness and appreciation of DOC programmes	OM17 - Consultation with iwi	2 yr
	Education group knowledge development	[AK8.iv] Education group knowledge of wetland valued and development of skills	OM23 - Survey of education clients skill retention	Site dependent
	Community and stakeholder involvement	[AK8.v] Level of engagement of partners and stakeholders with conservation at the site	OM24 - Summary of stakeholder engagement	Annual
	Iwi involvement	[AK8.vi] Level of participation of tangata whenua with conservation	OM17 - Consultation with iwi	Annual
	Community and stakeholder involvement	[AK8.vii] Volunteer contribution to project	OM25: Database of volunteer participation	Annual

LEARNING

9. Undertake research to inform wetland management

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
9. Undertake research to inform wetland management	Research and development uptake at AK sites	[AK9.i] Use of research findings to improve wetland management at Arawai Kakariki sites	OM26 - Site managers to evaluate report usefulness	2 yr
	Research and development uptake at non-AK sites	[AK9.ii] Use of research findings to improve wetland management at other (non AK) sites	OM27 - Survey of wetland managers	5 yr

10. Develop best practice monitoring tools

AK NATIONAL OBJECTIVES	AK Indicator	AK Measure	How changes monitored	When
10. Develop best-practice wetland restoration methods	Best practice monitoring methods	[AK10.i] Number of new projects/ stakeholders using monitoring methods	OM27 - Survey of wetland managers	5 yr
	Best practice management methods	[AK10.ii] Number of new projects/ stakeholders using management methods/ guidelines		

Appendix 4: List of reports and publications for the Arawai Kākāriki Wetland Restoration Programme.

1. Maintain or enhance wetland extent

Boffa Miskell and Urtica Inc (2010) Awarua/Waituna wetlands hydrological and vegetation mapping: methodology, vegetation descriptions and recommendations. Prepared for the Department of Conservation, Boffa Miskell and Urtica Inc.

Wildland Consultants (2009). Whangamarino wetland vegetation map. Prepared for the Department of Conservation, Wildland Consultants, Rotorua.

2. Water levels and water quality

Gibbs, M. (2009) Whangamarino Wetland Pilot Study: Sediment Sources. NIWA Report: HAM2009-033 prepared for the Department of Conservation, National Institute of Water & Atmospheric Research Ltd, Hamilton.

Ryder Consulting (2008). Waituna Lagoon - review of existing information relating to opening regime. Prepared for the Southland Conservancy Office, Department of Conservation. Ryder Consulting, Dunedin.

SKM (2009). Whangamarino Wetland Hydrology Study: Preliminary Analyses. Unpublished report prepared for the Department of Conservation, Sinclair Knight Merz, Auckland.

SKM (2009). Whangamarino Wetland Hydrology Study: Monitoring Report. Unpublished report prepared for the Department of Conservation, Sinclair Knight Merz, Auckland.

3. Protect and restore wetland habitat

Bodmin, K.A. and Champion, P.D. (2010). Response of Whangamarino Wetland vegetation to the willow control programme. NIWA Report: HAM2010-010 prepared for Waikato Conservancy Office, Department of Conservation, National Institute of Water & Atmospheric Research Ltd, Hamilton.

Champion, P. and Bodmin, K. (2009). Whangamarino weed surveillance. NIWA Report HAM 2009-111 prepared for the Department of Conservation. National Institute of Water & Atmospheric Research Ltd, Hamilton.

Champion, P. and Bodmin, K. (2010). Assessment of willow control and environmental factors affecting the vegetation of Whangamarino Wetland. NIWA Report HAM 2010-097 prepared for the Department of Conservation. National Institute of Water & Atmospheric Research Ltd, Hamilton.

Davis, M. (2009). Ephemeral wetlands of the spider lakes moraines. Prepared for the Department of Conservation (Raukapuka Area Office).

de Winton, M. (2008). LakeSPI assessments for the lakes of the Ashburton River Basin. NIWA Report: HAM2008-017 prepared for the Department of Conservation, National Institute of Water & Atmospheric Research Ltd, Hamilton.

Robertson, B. and L. Stevens (2007). Waituna Lagoon 2007: Macrophyte (*Ruppia*) mapping. Prepared for Department of Conservation, Wriggle Coastal Management, Nelson.

4. Maintain and enhance species diversity

Atkinson, E. (2008) What's lurking in the Waituna wetlands? A freshwater fish survey - Arawai Kakariki Project. Southland Conservancy Office, Department of Conservation.

Chinn, W. (2009). A qualitative survey of invertebrate values present on Ō Tū Wharekai / Ashburton Lakes Conservation area. Canterbury Conservancy Office, Department of Conservation.

Crump, G.J. (2008). Southern Crested Grebe habitat survey of the Ashburton Lakes Basin. Prepared for the Department of Conservation (Raukapuka Area Office).

- Dungey, R. (2008) Ashburton Lakes district stream surveys summer 2007-08. A fish survey conducted for the Department of Conservation, Geraldine. Ross Dungey Consulting, Balclutha.
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- Ledgard, G. (2011). *Donatia novae-zelandiae* in the Awarua-Waituna wetland complex: current research, results and future management considerations. Southland Conservancy Office, Department of Conservation.
- Lees, P. and Beech, M. (2010). Analysis of benthic stream invertebrates from the Ashburton Lakes area. Summary report to the Department of Conservation, Environment Canterbury.
- Lettink, M. (2008) Lizard survey of the Awarua/Waituna wetlands and Tiwai Peninsula: Murihiku/Southland Area. Prepared for the Southland Conservancy Office, Department of Conservation.
- Lettink, M. (2008) Lizard survey of the Lake Heron Basin and upper Rangitata River catchment, Raukapuka Area. Prepared for the Department of Conservation (Raukapuka Area Office).
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- Wildland Consultants (2009) Whangamarino threatened plant surveys 2008-2009. Report No. 2090 prepared for the Department of Conservation, Wildland Consultants, Rotorua.

5. Conserve historic and cultural sites

- Te Runanga o Arowhenua, Norton, T. and Pauling, C. (2009). Ō Tū Wharekai / The Ashburton Lakes: An overview of the Ngai Tahu cultural association with Ō Tū Wharekai. Prepared for the Department of Conservation.
- Te Runanga o Arowhenua, Pauling, C. and Norton, T. (2010). Ō Tū Wharekai Ora Tonu: Cultural health assessment of Ō Tū Wharekai / The Ashburton Lakes. Prepared for the Department of Conservation.

6. Promote sustainable land-use

None to date

7. Improve facilities and opportunities for visitors

- DOC (2008). Awarua Recreation Development Plan. Southland Conservancy Office, Department of Conservation.
- DOC (2009). Recreation opportunities in Ō Tū Wharekai (Ashburton lakes and upper Rangitata River): Discussion document. Canterbury Conservancy Office, Department of Conservation.

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Appendix 5: Summary of media and general communication from the Arawai Kakariki Wetland Restoration Programme.

Media (Newspaper, Magazine, Television, Other)

Wetlands (by Dave Hansford). New Zealand Geographic 101, Jan-Feb 2010, pp. 48-73.

Awarua/Waituna

Combining forces to save Awarua Wetlands (2009)

Waituna Loop Track - New Release (2009)

Community involvement in saving wetlands (AWAG) - News Release (2009)

Fragile Wetlands Out of Balance, Southland Times full page article (2009)

Wetland Damage Irreversible, Wilderness Magazine, (2009)

All Fenced In - Southland Express, (Feb 2009)

Farmers Helping Save Wetlands, Dairy Exporter (2008)

Wet and Wild - Showcasing Southland's Wetlands, Southland Express (2011)

Helping Hand for Wetlands, Southland Express (2010)

Southland's Wetland Wonderland, Southland Express (2010)

Open Walkway - Southland Times, (2010)

New Track Offers Chance to get closer to Hidden Wonder, Southland Express (2010)

Funds to Enhance Scenic Reserve, Southland Express (2009)

Right on Track, Wilderness Magazine (2009)

Wetland Volunteers, South Today News, Cue TV, (2010)

Wetland Volunteers A follow up, South Today News, Cue TV, (2011)

Waituna Wetlands - Opening of Waituna Lagoon, South Today News, Cue TV, (2009)

Waituna Wetland, Southern Nature, Cue TV, (2009)

Eels in Waituna, Meet the local's (2009)

Ō Tū Wharekai

Difficult breeding season ends for wrybills, High Country Herald (2009)

Protect our precious wetlands, High Country Herald (2009)

Vehicle exclusion fence, Timaru Herald (2009)

25 years of volunteer bird counts, Ashburton Guardian (2009)

25 years of volunteer bird counts, DOC Intranet (2009)

New research helps Wrybill conservation on the Rangitata River, NZ Wetland Trust Wet and Wild (2009)

Aoraki Polytechnic students get their hands dirty, High Country Herald (2009)

Aoraki Polytechnic students get their hands dirty, DOC Intranet (2009)

Business helps grebes, Ashburton Guardian (2009)

Recreation plan, Ashburton Guardian (2009)

Recreation plan follow up, Ashburton Guardian (2009)

Rangitata River: Conservation action for the unique wrybill, Wetland Restoration Handbook (2010)

Photo competition, Ashburton Guardian (2010)

Lake Heron community group, Ashburton Guardian (2010)

Wild creations artist, Ashburton Guardian (2010)

Predator trial, NZ Wetland Trust Wet and Wild (2010)

Clearwater planting/track/polytechnic/OTW project, Courier, (2010)

Whangamarino

Predator trapping and Pest Control Report - The Cocks Wetlands Society Inc (2008)
General DOC Business update - Northern Whangamarino Wetland Association Newsletter 2008
Wetlands (by Dave Hansford). New Zealand Geographic 101, Jan-Feb 2010, pp. 48-73.
Whangamarino Wetland Fire - Te Kauwhata Chatter (2010)
Help on the Way for Little Wetland Wonder. - Waikato Times (2010)
Wetlands Still a Fire Risk - North Waikato News (2010)
A new wetland sign and a chance to 'meet the ranger' - Te Kauwhata Chatter (2010)
New Whangamarino Wetland sign in Te Kauwhata - Te Kauwhata Chatter (2010)
Predator trapping -Te Kauwhata Chatter (2010)
Whangamarino Survey -Te Kauwhata Chatter (2010)
Thank you from the Department of Conservation: Whangamarino Survey - Te Kauwhata Chatter (2010)
Pond Construction - Northern Whangamarino Wetland Association Newsletter (2010)
Arawai Kākāriki Wetland Restoration Programme Factsheet - DOC fact sheet (2010)
Whangamarino Planting (School planting) - Te Kauwhata Chatter (2010)
Tracking Ferrets in the Wetland - Te Kauwhata Chatter (2010)

DOC produced newsletter

Awarua/Waituna Bog Paper
Ō Tū Wharekai email newsletter

National Wetland Trust newsletter (articles)

Arawai Kākāriki to restore significant wetlands. Wet & Wild Issue 18, March 2008.
Arawai Kākāriki. Wet & Wild Issue 21, May 2009.
Wrybills on Rangitata River. Wet & Wild Issue 22, September 2009.
Understanding predators in Ō Tū Wharekai Wetlands. Wet & Wild Issue 25, September 2010.
Whangamarino Wetland Restoration. Wet & Wild Issue 26, December 2010.
Monitoring the ecological integrity of wetlands in the Ashburton Basin, Canterbury. Wet & Wild Issue 26, December 2010.
Eco-hydrology of Whangamarino wetland. Wet & Wild Issue 26, December 2010.

DOC factsheet

Arawai Kākāriki: An Overview, 2009.
Arawai Kākāriki: Research & Development, 2009.
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Ō Tū Wharekai, 2009
Whangamarino, 2010
Awarua: Ruppia - Waituna Lagoon Macrophyte Community, 2010
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General publications

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Dudley, N., S. Stolton, A. Belokurov, L. Krueger, N. Lopoukhine, K. MacKinnon, T. Sandwith and N. Sekhran [editors] (2009). Natural Solutions: Protected areas helping people cope with climate change, IUCN-WCPA [Whangamarino wetland case study]

Conference/Symposium presentations

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Atkinson, E and Chesterfield, S (2008). Arawai Kākāriki, Awarua Wetland Restoration Project. National Wetland Symposium, Christchurch, February 2008.

Sponsored meetings

Special session on Wetland eco-hydrology and Conservation, Joint New Zealand Hydrological Society and New Zealand Freshwater Science Society Conference, Whangarei, November 2009.

National Wetland Symposium, Rotorua, March 2010.

Community Information Meetings

Whangamarino: Lake Waikare Care Group meeting 2007

Whangamarino: Cock's Wetland Society 2007/2008

Whangamarino: Northern Whangamarino Wetland Association meetings 2009/2010

Ō Tū Wharekai: Mt Somers Community Meeting November 2008

Awarua: General Talk, Southern Institute of Technology, 2007

Awarua: The Importance of Awarua Wetlands and the Effects, Invercargill City Council, Oct 2009

Awarua: General Update and Discussion with community, May 2010

Awarua: Ruppia in Waituna Lagoon, What it all Means, Jun 2010

Awarua: Meetings of the Awarua-Waituna Advisory Group 2007-10

Sponsorship received

Fonterra \$10,000 sponsorship for Awarua/Waituna projects plus 15 staff days' assistance

New World Plastic Bag Fund \$10,000 sponsorship for Awarua/Waituna projects

New Zealand Aluminium Smelter - weed and pest animal control on Tiwai Peninsula.

Appendix 6

Appendix 6a: Summary of 2007-10 Management Actions (Objectives 1-8)

OBJ	MANAGEMENT ACTION	OUTPUT MEASURE	WHANGAMARINO			OTU WHAREKAI			AWARUA		
			07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
1	Re-creation wetland habitat	Area re-created (ha)	-	-	806 ha	-	-	-	-	-	5 ha
	Statutory land protection (land acquisition)	Area protected (ha)	-	-	-	9000 ha Hakatere	8670 ha Mt Potts	-	-	-	-
2	Maintain appropriate water regime via upgrades to hydrological structures or improved management	Number of upgraded structures / management regimes	-	-	1 - weir upgrade	-	-	-	-	-	1 - drain clearing
	Development of hydrological model	Model status	-	Initial stage	Prelim. model	-	Initial stage (Maori Lk)	-	-	-	Initial stage (Lagoon)
	Riparian planting / maintenance	Area / length of planting established	-	-	1 ha	0.2 ha	0.1 ha	Fence – 26923m	Fence – 28382m	Fence – 9164m	
	Undertake WEED-Led control projects to eliminate/ reduce incursions	Number of WEED-LED control projects	-	-	2- Alligator weed, Yellow flag	-	-	-	-	-	
	Undertake SITE-led control to reduce area and number of environmental weeds considered a threat	Area under sustained weed control using a SITE-LED approach	-	1ha - grey willow 1ha- gorse	7ha-grey willow 6ha-gorse 0.5ha- Glyceria	512ha willow, 230ha broom, 32ha lupin	356ha willow, 115ha broom, 60ha stonecrop 15ha lupin	788ha willow, 475ha broom, 5ha stonecrop 10ha lupin	13197ha Heath/ Gorse/ Broom; 10ha Pine; 893ha Angellica	13197ha Heath/ Gorse/ Broom; 10ha Pine; 893ha Angellica	
	Boundary fencing to exclude exotic herbivores to prevent grazing impacts	Length of fence built	7673m	9967m	7819m	Indirect via HCP land purchase	Indirect via tenure review	-	-	2500m	
3	Respond to wild fire based on fire management plan	Number DOC call outs in management area	-	1	1	1	1	-	1	-	
	Pest control of herbivores (possums)	Area under possum control	-	-	-	-	-	-	-	-	
	Pest control of herbivores (deer)	Area under deer control (+no. killed)	5923ha/ 12 killed	5923ha/ 1 killed	5923ha/ 0	-	-	-	13197ha/ 1 killed	5578ha/ 2 killed	
	Bird control (Black-backed gull)	No. colonies / birds	-	-	-	-	-	-	3 sites/900 BFG	-	
	Restoration plantings (new)	Area planted (sites)	-	-	-	0.2ha (5)	0.1ha (5)	1.0 ha (1)	1.5 ha (1)	-	
	Restoration plantings (site maintenance)	Area maintained (number sites)	-	-	-	-	0.2ha (5)	0.3 ha (10)	1.0 ha (1)	2.5ha (1)	
4	Reduce pressure of predators - poison	Total area treated (+ bait per ha)	-	-	-	-	-	-	-	-	
	Reduce pressure of predators - traps	Captures per unit effort	-	143/15 months (97 traps)	-	-	-	109/12 months (100 traps)	-	-	
	Targeted threatened flora restoration actions	Area managed and type of action	0.2ha fire	0.1ha	0.2ha fire	-	-	-	-	-	

OBJ	MANAGEMENT ACTION	OUTPUT MEASURE	WHANGAMARINO			OTU WHAREKAI			AWARUA			
			07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	
5	Implement remedial actions of historical and cultural sites	Number of sites with remedial actions	-	-	-	-	-	-	-	-	-	-
	Implement maintenance actions of historical and cultural sites	Number of sites with maintenance actions	-	-	1	-	-	-	-	-	-	-
6	Prepare or implement State of Takiwa (SoT) or other cultural assessment	Description of progress	-	-	Cultural study instigated	-	SoT instigated	SoT field work	-	-	-	-
	Limit any further decline in wetland condition through statutory advocacy (i RMA)	Number of submissions / consultations on plans /consents	2	4	-	-	-	-	-	-	-	-
7	Promote sustainable landuse, e.g. promote sustainable clearing, drainage, effluent management	Advocacy (hrs)	tbc	tbc	tbc	tbc	tbc	tbc	tbc	tbc	tbc	tbc
	Promote biodiversity restoration initiatives on private land (e.g. BCF)	Length new fences - inflow streams (not boundary)	-	-	-	-	-	-	-	26923m	28382m	9164m
8	Promote covenants on private land	Number of new covenants	1	-	-	-	-	-	-	-	-	-
	Develop appropriate recreation facilities and opportunities	Area of DOC engaged restoration projects (number)	-	261ha (1)	261ha (1)	-	-	1.8km trap line (1)	-	-	-	-
7	Minimise impacts of recreational use	Description of new / upgraded recreation facilities	-	-	2 boat ramps	-	-	-	-	4500m track started	4500m track complete	1 boat access, 1 toilet relocated
	Interpretation at key sites	Number and type of actions to minimise impacts	6 signs (pests)	-	6 chinese signs (pests)	3 vehicle signs	5.7km exclusion fences	100m 'grebe fence'	-	-	-	30m exclusion plantings; 1 sign
8	Develop and implement CEPA plan	Status of CEPA plan or equivalent	-	-	CEPA plan in draft	CEPA plan in draft	1 public mtg; 1 stakeholder mtg; 1 talk	4 talks; brochure	-	4 Bog papers	CEPA plan draft; 4 Bog papers; 2 factsheets	-
	Engagement and consultation with iwi	Summary of iwi engagement actions	-	Cultural study instigated	Engagement re Te Kauwhata sign	-	SoT instigated	SoT field work	Kaitiaki Roopu; Engagement for NZ geo article	Kaitiaki Roopu; Engagement for NZ geo article	Kaitiaki Roopu; Engagement for NZ geo article	6 site activities
	Encourage community participation in mgt	Number of activities / opportunities	-	-	3 activities	-	2 site activities	3 site activities	2 site activities	4 site activities	6 site activities	-
	Develop and implement education programmes	Number of initiatives	-	-	-	-	-	3 educat. initiatives	-	3 educat. initiatives	3 educat. initiatives	3 educat. initiatives

Appendix 6b: Summary of 2007-10 Inventory and Monitoring Actions (Objectives 1-8)

OBJ	INVENTORY & MONITORING	OUTPUT MEASURE	WHANGAMARINO				O TU WHAREKAI				AWARUA			
			07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
1	OM1 - Wetland mapping	Mapping status	Baseline map completed	-	-	-	-	-	-	-	-	-	-	Baseline map completed
	OM2 - Hydrological monitoring	Number sites monitored	3 sites (EW)	6 sites (DOC); 3 sites (EW)	6 sites (DOC); 3 sites (EW)	-	-	8 sites (DOC); weather station	10 sites (DOC); 8 sites (Uni of Can.)	7 sites (ES)	7 sites (ES)	7 sites (ES)	7 sites (ES)	7 sites (ES)
2**	OM3 - Sediment accumulation	Number sites monitored	-	Sediment source pilot study (DOC)	SAP pilot study (DOC)	-	-	-	-	-	-	-	-	4 sites (ES)
	OM4 - Water quality monitoring	Number sites monitored	-	-	1 site (DOC)	1 site (ECan)	1 site (ECan)	1 site (ECan)	10 sites (DOC/Uni. Can) 25 sites (ECan)	7 sites (ES)	7 sites (ES)	7 sites (ES)	7 sites (ES)	7 sites (ES)
3	OM5 - Biological indices water quality (e.g. LakeSPI, TLI)	Number and type of surveys completed	-	-	-	8 lakes Lake SPI (DOC)	4 lakes TLI (ECan)	7 lakes TLI (ECan)	1 lake TLI (ES)	1 lake TLI (ES)	1 lake TLI (ES)	1 lake TLI (ES)	1 lake TLI (ES)	1 lake TLI (ES)
	OM6 - Permanent habitat monitoring (vegetation plots)	Number surveys (type and no. plots)	-	-	-	-	Wetland plot 2m (16), Eph. turf	Wetland plot 10m (27), Eph. turf	Wetland plot 10m (27), Eph. turf	-	-	-	Lagoon macrophytes (48)	Lagoon macrophytes (48)
4	OM7 - Spatial assessment of extent burnt by fire	Mapping status	-	Completed	Completed	Completed	Completed	-	Completed	Completed	Completed	Completed	Completed	Completed
	OM8 - Distribution / abundance weeds	Number surveys (by species)	Crack/ grey willow	-	Alligator weed, Yellow flag	Stonecrop mapping	-	-	-	-	-	-	-	-
5	OM9 - Species diversity and occupancy (general survey)	Number and type of surveys	Fish inventory	Mudfish; Invert. survey; Threatened plants	Mudfish; Cryptic birds	Waterfowl census; Braided river birds (1), Grebe, Fish survey (2), Invert. survey (2)	Waterfowl census; Braided river birds (2), Invert. survey (2);	Waterfowl census; Braided river bird (1), Invert. survey (1), freshwater mussel	Reptile inventory, Fish survey	Eel survey	-	-	-	-
	OM10 - Indicator species abundance	Number surveys (list species)	-	Bittern; Anzybas	Bittern; Anzybas	Scree skink Grebe	Scree skink; Upl. longjaw M. crake; Grebe	Scree skink; Upl. longjaw Wrybill	Scree skink; Upl. longjaw	Bittern; Fernbird; Ruppia	Bittern; Fernbird; Ruppia	Bittern; Fernbird; Ruppia	Bittern; Fernbird; Ruppia	Bittern; Fernbird; Ruppia
6	OM11 - Indicator species population dynamics	Number surveys (list species)	-	-	-	-	Wrybill	Wrybill	Wrybill	Giant Kokopu	Giant Kokopu; Donatia	Giant Kokopu	Giant Kokopu	Giant Kokopu
	OM12 - Targeted predator monitoring (mammals/fish/ birds)	Number and type of surveys	Mammalian predator inventory	Mammalian predator inventory	Mammalian predator research	Mammalian predator (river)	-	Mammalian predator (wetland)	Mammalian predator (wetland)	Mammalian Predator inventory	Mammalian Predator inventory	Mammalian Predator inventory	Mammalian Predator inventory	Mammalian Predator inventory

OBJ	INVENTORY & MONITORING	OUTPUT MEASURE	WHANGAMARINO			OTU WHAREKAI			AWARUA		
			07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
5	OM14 - Inventory historic / cultural sites	Inventory status (by type)	-	-	Yes (historic)	Yes (historic)	-	-	-	Yes (historic)	-
	OM19 - Survey visitor response to site visits and interpretation	Number /type surveys (cultural/historic)	-	-	-	-	-	-	-	-	-
7	OM18 - Visitor use monitoring by counting or survey	Number and type of surveys	-	-	-	1 visitor / stakeholder survey	-	-	-	-	-
	OM19 - Survey visitor response to site visits and interpretation	Number and type of surveys	-	-	-	1 visitor / stakeholder survey	-	-	-	-	-
8	OM21 - Survey of local community, iwi and stakeholder understanding and participation	Number and type of surveys	-	-	1 postal survey	-	-	-	-	-	1 survey
	OM22 - Website hits database	Database updated	-	-	-	-	-	-	-	Yes	Yes
	OM25: Database of volunteer participation	Database updated	-	-	-	-	Yes	-	-	Yes	Yes

** Hydrological and water quality monitoring is multidisciplinary includes partnerships with Regional Councils and other organisations.