MANAGEMENT OF MANGROVE SEEDLINGS AT MIRANDA - PUKOROKORO

providing outstanding ecological services to sustain and improve our environments

Wildlands

R 3672

MANAGEMENT OF MANGROVE SEEDLINGS AT MIRANDA - PUKOROKORO

Contract Report No. 3672

April 2015

Project Team:
Tim Martin - Report author
William Shaw - Project management
Bruce MacKay - Field survey

Prepared for:
Department of Conservation

AUCKLAND OFFICE: 97A MT EDEN ROAD, MT EDEN, AUCKLAND 1023
P.O. BOX 46-299, HERNE BAY, AUCKLAND 1001, Ph 09-377-4886; Fax 09-377-4889

HEAD OFFICE: 99 SALA STREET, P.O. BOX 7137, TE NGAE, ROTORUA
Ph 07-343-9017; Fax 07-343-9018, email ecology@wildlands.co.nz, www.wildlands.co.nz

CONTENTS

Reviewed and approved for release by:

_____

W.B. Shaw
Director/Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

The Department of Conservation and Fonterra are working in partnership with the Miranda Naturalists Trust in improving estuarine habitat for shorebirds that use the Miranda coastal reserve on the Firth of Thames. The Department of Conservation commissioned Wildland Consultants to undertake the resource consent process for removal of mangrove seedlings that are impacting roosting and foraging habitat. The assessment of effects involves evaluating the distribution, ecological values, and the effects of the potential removal of mangrove seedlings in estuarine habitats of the Miranda shoreline.

Specific land within the project area includes:

- Land owned and/or managed by the Miranda Naturalists Trust (MNT).
- The Finlay QEII covenant (owned/managed by Glen Isla Farms Ltd).

This report provides an overview of the ecological context, ecological values of the mangroves, and impacts or benefits of their possible removal. It describes the methods used for the evaluation (as developed and applied for a similar assessment completed for the Waikato Regional Council (Wildland Consultants 2014a), and it provides a series of maps showing suggested categories for the management of mangrove seedlings.

To date, resource consents have been granted for the removal of mangroves in the Whangamata, Wharekawa, Otahu, and Tairua Harbours. However it is noted from these cases that there have been no issues of debate associated with seedling removal.

2. METHODS

An ecological report, including maps, is required to support the consent application. The following approach was applied to the project:

- A base map was prepared using relevant recent aerial photography and other digital data.
- Relevant existing hard copy and digital data and information was compiled and reviewed.
- The project site was surveyed and mapped to classify and describe the habitat types including mangrove habitat. The mapping categories were based on those developed for the Regional Council in 2014 (Wildland Consultants 2014a), and informed by both the site survey and previous mapping of the subject site for restoration purposes also in 2014 (Wildland Consultants 2014b).
- Aerial photographs and other desktop information available, was used to map and describe where mangroves of different statures and densities occur within the project area.

- Ecological values of areas where mangrove seedlings occur were assessed and maps produced showing where:
  - Mangrove seedling removal is unlikely to cause any potential adverse ecological effects;
  - Mangrove seedling removal may cause potential adverse ecological effects;
  - Mangrove seedling removal is unlikely to cause any adverse ecological effects, or any potential ecological benefits (i.e. neither removal nor protection is recommended).

3. BACKGROUND

3.1 Mangroves In New Zealand

Long-established, closed-cover mangrove communities are a unique, indigenous community type that has been present in New Zealand for a very long time (millions of years) and arrived here without human assistance. The mangrove species found in New Zealand - *Avicennia marina* subsp. *australasica* - is a sub-species of the grey mangrove (Morrisey *et al.* 2007). Silicified wood of *Avicennia* is present in 19 million-year-old rocks on the shores of the Kaipara Harbour (Sutherland 2003), and pollen evidence indicates that mangroves occurred in the Poverty Bay area approximately 9,840 years ago (Mildenhall and Brown 1987).

Mangroves make a valuable contribution to estuarine ecology in northern New Zealand harbours, estuaries, and river mouths. Mangroves are frost-sensitive and mangrove-dominant communities occur naturally north of Ohiwa Harbour on the east coast of the North Island (38^{o}S), with local specimens occurring south of Ohiwa on the east coast and to the Tongaporutu River mouth on the west coast (Morrisey *et al.* 2007). In recent decades, mangroves have expanded in extent relatively rapidly. Aerial photographic records have documented this expansion since the 1940s. The most commonly accepted influence associated with the increased rate of mangrove spread has been increased sediment input to the Coastal Marine Area from developed land catchments.

Demand for mangrove management (generally removal) has most commonly come from human users of the Coastal Marine Area who wish to maintain and/or regain traditional access to intertidal areas for food gathering, active and passive recreation pursuits, maintenance of open vistas, and other social/cultural activities. Ecological triggers for mangrove management may include the reduction of open intertidal areas traditionally used by migrant wading birds (for example at the head of the Firth of Thames) due to mangrove encroachment.

In New Zealand harbours and estuaries where mangroves are not present, the lowest biodiversity and abundance of intertidal benthic biota generally occurs between the high water mark and the upper limit of the cockle community that covers with water for more than four hours per tide (Belton 1986; Larcombe 1971; Grant and Hay 2003). This is the depth range within the intertidal zone where mangroves generally establish and flourish, therefore they can enhance both biodiversity and benthic abundance when occupying this niche. However, when they expand their range further down the intertidal zone, and displace mid- to low-tide seagrass beds or

shellfish beds, mangroves are displacing existing intertidal communities that can be, arguably, of greater ecological value.

3.2 Connectivity of estuarine and terrestrial habitats

Mangrove-lined estuary edges provide 'long-shore corridors' for species such as banded rail, particularly where indigenous vegetation, such as saltmarsh, freshwater wetlands or coastal forest, is lacking or absent on the landward side of the mangroves (Haggitt et al. 2008). Where mangroves provide the only form of vegetative cover on the estuarine edge, their removal is likely to reduce the movement of species such as banded rail between estuarine and terrestrial habitats. Connectivity of habitat is important for maintaining access to food resources and nest sites, and for the movement of species such as banded rail between different inlets and embayments.

3.3 Protection of coastal margins

Mangroves can reduce erosion at the estuary-land interface by reducing current velocities and attenuating waves (Alfaro et al. 2006) although this role is probably of relatively minor importance in the low-energy environments of upper estuaries such as Miranda. By increasing sedimentation (reducing run-up), mangroves provide some protection from storm events, i.e. short period waves and from catastrophic events such as cyclones and tsunami. Depending on the degree of sedimentation, they may also reduce localised effects of sea level rise (i.e. if the rate of sedimentation is greater than rate of sea level rise).

3.4 Estuarine vegetation of Firth of Thames and Coromandel Peninsula

In a clockwise direction, from the mouth of the Kauaeranga River to north of Tairua Harbour, survey and mapping of estuarine vegetation has been undertaken for the inner Firth of Thames (Graeme 2006), Manaia Harbour (Graeme 2009a), Te Kouma Harbour (Graeme 2009c), Coromandel Harbour (Graeme 2009c), Colville Bay (Graeme 2013a), Waikawau Estuary (Graeme 2013b), Kennedy Bay Estuary (Graeme 2013c), Whangapoua Harbour (Graeme 2010), and Whitianga Harbour (Graeme 2009b).

In 2013, mapping of intertidal habitats, including mangroves, seagrass, and shellfish beds, was undertaken by NIWA (2013) for the Manaia, Te Kouma, and Coromandel Harbours, Colville Bay, Port Charles, Waikawau Bay, Kennedy Bay, Whangapoua Harbour, and Purangi Estuary. This latest study involved extensive field surveys, with the boundaries of the habitats mapped using GIS units.

3.5 Ecological values of the Miranda-Pukorokoro coast

The very high ecological values of the Miranda-Pukorokoro area include:

- International importance as the most important high-tide wader roost in the Firth of Thames Ramsar site, including multiple Threatened and At Risk wader species (Battley *et al.* 2007). It meets Ramsar Criterion 5 (regularly supports

>20,000 waterbirds), and Criterion 6 (regularly supports >1% of a population of a species or sub-species of waterbird.

- Habitat for a range of other Threatened, At Risk, or regionally uncommon bird and plant species (Miranda Naturalists' Trust 2013).

- Status as the largest example of a chenier plain ecosystem in New Zealand; a naturally uncommon ecosystem classified as Critically Endangered (Holdaway *et al.* 2013).

- The chenier plain is regarded as an internationally important geopreservation site (Hayward B.W., in MNT 2013).

3.6 Significance of the Miranda-Pukorokoro coast

Chenier Plains

Shell barrier beaches, or chenier plains, are low ridges composed of shells and sand overlying marine sediments, and are formed by a combination of longshore drift and wave action on sheltered coastlines. Only around 12 chenier plain systems have been identified globally, and in New Zealand chenier plains are confined to the Hauraki Gulf and Waitemata Harbour. The coastline at Miranda-Pukorokoro has the most extensive chenier plain system in New Zealand, and is the only known example, globally, of a chenier plain that is currently aggrading (Clarkson *et al.* 2014). The most seaward chenier formed around 1969 and has advanced *c*.1.5 km southward and parallel to the previous shoreline (Hayward B.W., in MNT 2013).

The Miranda-Pukorokoro chenier plain system is regarded as an internationally-important geopreservation site. The following is reproduced from the New Zealand Geopreservation Inventory (http://www.geomarine.org.nz/NZGI/):

- Classification A1: A = International Importance; 1 = vulnerable to complete destruction by human actions

- Significance: internationally important area for study of chenier plain development in a tectonically stable progradational coast. Only known occurrence in the world of a chenier plain gravel ridge association (in conjunction with the Whakatiwai gravel ridges)

Chenier plains have been identified as one of 72 New Zealand ecosystems regarded as naturally uncommon (Holdaway *et al.* 2012) by virtue of having an estimated extent prior to human colonisation of <0.5% of New Zealand's land area (<*c*.134,000 ha). Holdaway *et al.* (2012) assigned the highest level of threat - Critically Endangered - to chenier plain ecosystems in New Zealand (see Table 2 below for the full assessment), noting also that there has been widespread loss of indigenous woody vegetation cover.

Table 1: Threat assessment for chenier plain ecosystems (Holdaway *et al.* 2012).

Criterion	Critically Endangered Factors	Threat(s)[1]	Indicator(s)[1]
B2: Historical decline in ecological function.	Very severe decline throughout >90% of extant distribution.	A, B, R, W	I, E, Cp
C2: Small current distribution and (area of occupancy) and decline, or very few locations.	Area of occupancy ≤10 km^2 and: a) Continuing decline in distribution b) Continuing reduction in ecological function.	A, R, W	E
D: Very small current distribution (area of occupancy) and serious threats.	Area of occupancy ≤5 km^2 and serious plausible threats.	A, R, W	E

1. Threat descriptors: A = agriculture, B = fire, W = invasion by non-indigenous plants, R = residential development.
2. Indicators of declines in ecological integrity (Table 2): I = indigenous vegetation cover, E = non-indigenous plant and animal abundance, Cp = composition (plants).

4. POTENTIAL ECOLOGICAL EFFECTS OF THE MANGROVE SEEDLING CLEARANCE AREAS AT MIRANDA

Potential effects of mangrove seedling clearance at Miranda will depend on two key factors:

- The clearance method(s) used;
- The features and values present at each particular site proposed for clearance.

Clearance of mangrove seedlings at Miranda will be by hand-pulling only.

4.1 Overview of potential effects

Immediate Effects of Clearance

- Maintenance of current extent of habitat/feeding areas for indigenous fauna of open intertidal flats.
- Modification of ecological sequences from estuarine to terrestrial environments.
- Reduction in contribution made by mangroves to the estuarine food chain.
- Maintenance of current level of protection of saltmarsh and shoreline.

Long-Term Effects

- Slowing of estuarine infilling.
- Fewer areas for potential future saltmarsh colonisation (due to less sediment build up under mangroves).

5. CRITERIA FOR ASSESSMENT OF VALUES AND EFFECTS

All areas of mangroves within the area have some degree of ecological value, and contribute to the estuarine food web within the Firth of Thames as a whole. However, the relative importance of different stands of mangroves differ according to factors such as areal extent, age, distances to tidal channels, and proximity to other estuarine vegetation types.

A set of ecological criteria for the ranking of mangrove stands was developed in the previous study for Waikato Regional Council in reference to the Coromandel peninsula (Wildland Consultants, 2014a). These form the basis of the assessment for the current study.

It should be noted that there is a range of considerations other than ecological factors that can be taken into account when requirements for mangrove management are assessed, including:

- Landscape/seascape vistas and values;
- Navigational access (safety and use);
- Erosion and flood mitigation; and
- Land tenure (private land can extend well into inter-tidal habitats).

Only ecological values were used in the following assessments.

5.1 Criteria that may increase ecological value

Mangrove seedlings are likely to have higher ecological value where they meet one or more of the following three criteria:

- Where seedlings are establishing amongst existing adult mangroves of high density;
- Where seedlings are part of a vegetation sequence with terrestrial (e.g. freshwater wetland, coastal shrubland or forest) and marine (e.g. seagrass beds) components.
- Where seedlings will likely lead to the expansion or retention of mangrove habitat of high ecological value (e.g. mature trees on channel edge, banded rail foraging habitat, high diversity of indigenous epiphytes) without causing the loss of seagrass beds, saltmarsh, sandy intertidal flats, or high tide wader roosts.

Each of these criteria are scored +1 point.

5.2 Criteria that may decrease ecological value

Mangrove seedlings are likely to have lower ecological value where they meet one or more of the following two criteria:

- Where seedlings are establishing beyond the extent of adult mangroves, within intertidal habitats that are known to be of high ecological value e.g. shellfish beds, foraging habitat;

- Where seedlings will grow to reduce 'line of sight' for a shorebird roost.

Each of these criteria were scored -4 points. By assigning a score of -4 to criteria that may decrease the ecological value of mangroves (rather than a score of -1), removal areas were identified that will result in the retention of existing vegetation types, e.g. low density adult mangroves were scored for seedling removal and will therefore stay as low density adult mangroves. Conversely, if a score of -1 was applied to these criteria, the only habitats that would be identified for seedling removal would be habitats with no adult mangroves, or habitats with low density mangroves adjacent to high tide bird roosts. An even scoring of +1 for criteria that increase ecological value, and -1 for criteria that decrease ecological value, would not result in a "hold the line" approach but would allow mangroves to continue to increase in density and coverage.

5.3 Explanation of criteria for assessment of higher ecological value

Criterion (a): Seedlings are within existing areas of high-density adult mangroves.

Explanation

Individual mangroves eventually lose their vigour and die of old age. Regeneration, by the establishment of seedlings, is required to maintain the existing areas of adult mangrove habitat. The maintenance of structural diversity of mangrove stands, including seedling recruitment, is likely to be important for maintaining the overall biodiversity of mangrove habitats. Future management should allow for ongoing recruitment of existing mangrove areas within estuarine systems. This criterion is not applied to intertidal areas with scattered adult mangroves as this habitat is more likely to have its primary ecological values associated with open-intertidal habitat (e.g. shellfish beds, wader habitat).

Criterion (b): Seedlings are part of an indigenous vegetation sequence from terrestrial to marine environments.

Explanation

Mangroves are part of a natural successional process in northern New Zealand estuaries. Intertidal flats become colonized by mangroves, which over time, due to sediment accumulation, are then succeeded by saltmarsh. The establishment of mangrove seedlings within open intertidal habitats is the first part of this successional process. Whilst the infilling of estuaries that accompanies this succession has been significantly hastened by human impacts, complete sequences of coastal vegetation from terrestrial to marine environments have become increasingly modified and reduced in extent. Mangrove seedlings are of higher value where they form part of a sequence of indigenous vegetation types from terrestrial to marine environments.

Criterion (c): Seedlings will lead to the maintenance or expansion of an area of high value mangrove habitat.

Explanation

Where mangrove habitat is likely to support taxa that are nationally or regionally Threatened or At Risk, or provide habitat for diverse assemblages of indigenous species, the regeneration and maintenance of mangroves through seedling recruitment is important. For example, the regeneration of large, existing areas of adult mangroves that are likely to provide habitat for banded rail (*Gallirallus philippensis assimilis*). Similarly, older stands of mangroves can support a diverse flora of indigenous lichens, including species that are Threatened or At Risk (Blanchon 2013). Regeneration within stands of older mature mangroves is likely to lead to the maintenance of these stands and their associated botanical values, and greater viability of the supported populations.

5.4 Explanation of criteria for assessment of lower ecological value

Criterion (d): Seedlings are within open intertidal habitats of high ecological value.

Explanation

Where mangroves are establishing within open intertidal habitats of high ecological value, their growth may result in the long-term loss of this habitat (through sediment accumulation and shading). For example, the establishment and growth of mangrove seedlings within cockle beds is likely to result in the progressive loss of these beds through displacement by mangrove shrubland or forest. In places where adult mangroves are low density (i.e. adult trees are widely spaced and canopy cover is estimated at less than *c.*20%), ecological values are more likely to be primarily associated with open intertidal habitats than mangroves, e.g. wader feeding habitat, shellfish beds. Where this occurs, the removal of mangrove seedlings is likely to maintain the status quo (low density mangroves). In the absence of field surveys to determine fauna values of each site, intertidal habitats with scattered adult mangroves were conservatively assessed as open intertidal habitat of high ecological value.

Criterion (e): Seedlings will grow to reduce 'line of sight' for mid to high tide bird roosts.

Explanation

Many wading and shore bird species rely on predator avoidance strategies by selecting roost sites with wide views over the surrounding area. These species then detect incoming predators at sufficient distances to allow movement to other sites. The availability of high tide roosts can be a limiting factor for waders in some estuaries. Where mangrove seedlings are establishing in the immediate vicinity of a high tide roost, their growth may decrease line of sight for wading and shore birds, and therefore the suitability of the roost for wader species. Seedlings were regarded as having the potential to reduce line of sight for bird roosts if they occurred within 100 m of a sand or shell bank exposed at mid to high tide.

Roosts were confirmed by field survey and consultation with the Miranda Naturalists Trust after desk-top analysis of aerial photographs.

6. EVALUATION AND MAPPING OF MANAGEMENT ZONES

The following methods were undertaken to map and assess the ecological values of mangrove seedlings within estuarine habitats. The mapping and evaluation included existing areas of mangrove seedlings and areas where mangrove seedlings may colonise in the future.

- Field work was undertaken in March 2015 to map the current and potential habitats of mangrove seedlings along the Miranda foreshore and wildlife reserve, and assess the habitats using the assessment criteria.

Application of the assessment criteria identified 7 habitat types (Table 1).

One of three possible management categories was then assigned to each habitat polygon:

- No issue with mangrove seedling removal.
- Mangrove seedlings should be retained.
- Neutral.

These categories are described below.

6.1 No issue with mangrove seedling removal

Habitat types that scored less than zero (no issue with mangrove seedling removal) were as follows:

- Tidal channels and mudflats with no adult mangroves;
- Bird roosts with no adult mangroves;

6.2 Mangrove seedlings to be retained

Habitats that scored more than zero (mangrove seedlings to be protected) were as follows:

- High density, high value adult mangroves, not forming part of a terrestrial to marine vegetation sequence;
- High density, high value adult mangroves forming part of a terrestrial to marine vegetation sequence;
- High density, low value adult mangroves not forming part of a terrestrial to marine vegetation sequence; and
- Saltmarsh and rushland, forming part of a terrestrial to marine sequence.

Note that this category includes all areas of high density adult mangroves.

6.3 Neutral

The only habitat type that scored 'neutral' was saltmarsh and rushland where there were no tidal roosts. Removal of mangrove seedlings from this habitat type, if undertaken carefully to avoid all damage to saltmarsh and rushland vegetation, is unlikely to have any adverse ecological effects or ecological benefits. Mangrove seedlings do occasionally establish within saltmarsh and rushland habitats but usually do so along tidal channels or where the vegetation has been disturbed. Saltmarsh typically occurs to the landward edge of the tidal limits for mangroves, and the removal of mangrove seedlings is therefore not needed to protect and maintain saltmarsh habitats.

6.4 Mapping of management zones

A map of proposed mangrove seedling management was produced for the estuarine areas within the management area (Appendix 1, Figures 1-2), with habitat polygons grouped by their recommended management approach (i.e. no issues with mangrove seedling removal, neutral, protection of mangrove seedlings). Figure 1 shows the location for the seedling management areas within the reserve. On the management zone map (Appendix 1, Figure 2), the underlying habitat polygons are retained. This enables the map user to review how the management zones were obtained for each estuarine area.

Table 1: Habitat types and scoring scenarios for potential mangrove seedling removal sites, Miranda.

Criteria	Score	Map/Polygon Category (Habitat Types)						
		1	2	3	4	5	6	7
		Channel and Mudflats, No Adult Mangroves	Tidal Roosts, No Adult Mangroves	High Density, High Value, Adult Mangroves No Terrestrial to Marine Sequence	High Density, High Value, Adult Mangroves Terrestrial to Marine Sequence	Saltmarsh and Rushland, No Terrestrial to Marine Sequence	Saltmarsh and Rushland, Terrestrial to Marine Sequence	High Density, Low Value, Adult Mangroves No Terrestrial to Marine Sequence
Where seedlings are amongst adult mangroves.	+1	0	0	1	1	0	0	1
Where seedlings are part of a terrestrial to marine vegetation sequence.	+1	0	0	0	1	0	1	0
Where seedlings will lead to expansion or maintenance of mangroves of high ecological value.	+1	0	0	1	1	0	0	0
Where seedlings will lead to expansion of mangroves into intertidal habitats of high ecological value (e.g. foraging habitat).	-4	-4	-4	0	0	0	0	0
Where seedlings will reduce the line of sight for mid to high tide roosts.	-4	0	-4	0	0	0	0	0
Site Score		**-4**	**-8**	**2**	**3**	**0**	**1**	**1**
Management recommendation categories		No issue with removal.	No issue with removal.	Retain.	Retain.	Neutral.	Retain.	Retain.

7. RESTORATION OPPORTUNITIES

7.1 Restoration of terrestrial margins

Only a small proportion of the inland edges of the Miranda coastal reserve have a cover of indigenous vegetation. Indigenous vegetation on the margins of estuaries provides important habitat for indigenous plants and fauna, and acts as a buffer between adjacent pastoral landuse and the marine environment. Species appropriate for planting on the harbour margins are listed in Table 2.

Indigenous species should be eco-sourced and matched to the habitat and substrate types where planting is being undertaken.

Table 2: Species suitable for restoration planting on terrestrial margins at Miranda.

Species	Common Name	Spacing (m)	% of Planting Mix
Coprosma propinqua	Mingimingi	1	15
Kunzea robusta	Kanuka	1	22
Leptospermum scoparium	Manuka	1	30
Metrosideros excelsa	Pohutukawa	5	5
Myoporum laetum	Ngaio	5	4
Myrsine australis	Mapou	1	4
Phormium tenax	Harakeke	1	15
Sophora chathamica	Kowhai	5	5
			100%

Note

1. Plant three years after initial plantings, when cover has been established.

7.2 Restoration of saltmarsh

Saltmarsh is threatened locally, by invasion by pest plants. In the longer term, saltmarsh is also threatened by sea level rise, if saltmarsh habitats are prevented from migrating further inland due to their location beside highly developed shorelines.

Decline of saltmarsh due to invasive plants is relatively easy to address. Control of pest plants should be implemented in all remaining areas of saltmarsh throughout the reserve.

7.3 Restoration of dynamic terrestrial - estuarine interfaces

Sea levels around New Zealand have risen by 0.17 m in the past century, at a rate of 1.7mm per year (Hannah *et al.* 2010). Sea levels are predicted to continue to rise, and the rate of sea level rise may be increasing. Sea-level rise poses a threat to estuarine habitats that cannot accumulate sediments, and therefore height relative to sea level, at rates equal or greater to sea level rise. Recent sea level rise could feasibly cause the landward expansion of mangroves. If current sea level continues to rise, mangrove communities could eventually encroach into and replace existing saltmarsh, and saltmarsh could colonize low-lying coastal land currently above mean high water springs, if it is physically able to do so.

However, the balance between sea-level rise and accumulation of estuarine sediments differs on an estuary-by-estuary basis, depending on factors such as the biotic communities present (e.g. presence or absence of mangroves), and catchment land uses. If sediment accumulation within mangrove stands in the Miranda reserve is keeping pace with, or even exceeding, sea level rise, estuarine habitats will continue to migrate seawards, as the estuary gradually fills with sediment. This infilling of estuaries, although greatly accelerated by recent changes in land use, is a natural process. The typical successional pathway of estuaries, driven primarily by sediment accumulation, is for intertidal flats to be replaced by mangroves, mangroves to be replaced by saltmarsh, and saltmarsh to be replaced, eventually, by terrestrial environments such as freshwater wetlands, shrubland, and forest.

7.4 Enhancement of mangrove shrubland to be retained

7.4.1 Control of mammalian pests

The ecological value of areas of mature mangroves, all of which are to be retained, can be enhanced. Several species of mammalian predators, including mustelids and rodents, are known to utilise mangrove habitat (Morrisey *et al*. 2007), and cats also utilise these habitats. Mangroves typically host invertebrate species, such as mud snails and crabs, which in turn are utilised as a food source by indigenous birds. These invertebrates are also likely to be the main prey item for mammalian predators within mangrove habitat. By controlling mammalian predators on the terrestrial margins of mangroves, the availability of food resources for indigenous avifauna is likely to be increased. Pest control can be implemented on the terrestrial margins of the mangroves, rather than within the mangroves, due to the greater difficulty of undertaking pest control in intertidal areas.

7.4.2 Restoration of tidal flows

Existing mangrove habitats can also be enhanced significantly where the natural hydrology has been altered. Poor tidal flushing caused by artificial flow restrictions, for example by causeways or narrow culverts, reduces the health and vigour of mangroves, and reduces their contribution to food webs within the ecosystem as a whole. The causeway near the main carpark reduces tidal flushing of the mangroves and saltmarsh on the northern side of the road, and mangroves in this area are in poor health (Appendix 2: Plate 8). Restoration of full tidal flows at this location could significantly improve the health and ecological values of the estuarine areas upstream of the causeway.

8. CONCLUSIONS

Intertidal habitats of the Miranda shoreline were mapped and assessed for potential removal of mangrove seedlings. Mapping was based on field work undertaken in March 2015.

Assessment criteria previously developed for the Waikato Regional Council (Wildland Consultants 2014a) were applied to all intertidal habitats to produce a map

of the site to show the following: (1) areas of proposed mangrove seedling removal, (2) areas where mangrove seedlings should be retained, and (3) areas where there is no rationale for either removal or retention, e.g. neutral.

There are no issues with mangrove seedling removal in areas where adult mangroves are absent or of low-density. This typically occurs throughout all intertidal habitats to the seaward of high-density adult mangroves. There are similarly no issues with mangrove seedling removal in areas in close proximity to bird roosts. In these environments, removal of seedlings will favour the retention of existing habitat types and their associated ecological values.

Mangrove seedlings should be retained where they occur among existing areas of high-density adult mangroves.. Retention within this habitat type will ensure the long-term retention of existing mangrove areas, and their associated ecological values.

Areas of mangrove seedlings within saltmarsh and rushland that are not used by shorebirds for intertidal roosting are a low priority for management (i.e. they were ranked as neutral as there is no strong rationale for either their removal or retention). With or without mangrove seedling removal, saltmarsh and rushland habitats are likely to remain, until they eventually succeed to terrestrial habitats (e.g. freshwater wetlands, coastal scrub).

Implementation of this management approach would ensure that there will be minimal adverse ecological effects of mangrove seedling removal, and will favour the persistence of the existing intertidal habitats of the Miranda shoreline. Areas of high-density adult mangroves will be retained by allowing for regeneration in these areas, and areas where adult mangroves are of low-density or absent will remain as open intertidal habitats.

ACKNOWLEDGMENTS

Keith Woodley provided useful advice on management objectives and the location of roosting areas. Nicholas Hamon (Department of Conservation) provided client liaison.

REFERENCES

Alfaro A.C. 2005: Benthic macro-invertebrate community composition within a mangrove/ seagrass estuary in northern New Zealand. Estuarine, *Coastal and Shelf Science 66 1-2*: 97-110.

Battley P.F., Boyer J.K., Brownell B., Habraken A.M., Moore S.J., and Walsh J.L. 2007: Population Biology and Foraging Ecology of Waders in the Firth of Thames - Update 2007. *Auckland Regional Council Technical Report TP347*. 90 pp.

Beard C. 2009: Assessment of environmental effects: Mangrove seedling control Wharekawa Harbour July 2009. EWDOCS #1525287. Environment Waikato, Hamilton. 13 pp.

Belton R. J. 1986: The New Zealand clam, *Chione (Austrovenus) stutchburyi*: a study of industries based on similar resources in North America and Europe focusing on harvest, handling, resource management, and aquaculture. Winston Churchill Memorial Trust. Wellington, N.Z. 51 pp.

Blanchon D. 2013: Auckland Lichens. *Auckland Botanical Society Journal 68*(1): 21-27.

Clarkson B., DiBona M., Smale M., and Williams P. 2014: Shell barrier beaches ('Chenier plains'). *Landcare Research Manaaki Whenua Factsheet.* Accessed on-line http://www.landcareresearch.co.nz.

Coffey B. 2008: Annual Report to meet Condition 16 of Consent 113575 that permits the hand weeding of mangrove seedlings from Whangamata Harbour and the Otahu Estuary. Impacts of Trampling on Seagrass Beds and Saltmarsh December 2008. *Brian T. Coffey and Associates Limited: CMR: WHC RC 113575/16, December 2008.* A report prepared for Environment Waikato P.O. Box 4010, Hamilton East on behalf of Whangamata HarbourCare Inc.

Graeme M. 2006: Estuarine Vegetation Survey: Inner Firth of Thames. *Environment Waikato Technical Report 2006/40.* June 2006. 40 pp.

Graeme M. 2007: Estuarine Vegetation Survey: Whangamata Harbour and Otahu Estuary. *Environment Waikato Technical Report 2007/25*. 30 May 2007. ISSN: 1172-4005.

Graeme M. 2009a: Estuarine Vegetation Survey Manaia Harbour. *Environment Waikato Technical Report 2008/44*. June 2009. ISSN 1177-9284.

Graeme M. 2009b: Estuarine Vegetation Survey Whitianga Harbour. *Environment Waikato Technical Report 2009/15*. June 2009. ISSN 1177-9284.

Graeme M. 2009c: Estuarine vegetation survey: Coromandel and Te Kouma Harbours. *Waikato Regional Council Technical Report 2013/40*. June 2009. ISSN 2230-4363.

Graeme M. 2010: Estuarine vegetation survey: Whangapoua Harbour. *Waikato Regional Council Technical Report 2013/38*. June 2010. ISSN 2230-4363.

Graeme M. 2013a: Estuarine vegetation survey: Colville Bay Estuary: *Waikato Regional Council Technical Report 2013/06*. January 2013. ISSN 2230-4363.

Graeme M. 2013b: Estuarine vegetation survey: Waikawau Bay Estuary: *Waikato Regional Council Technical Report 2013/39*. December 2008. ISSN 2230-4355.

Graeme M. 2013c: Estuarine vegetation survey: Kennedy Bay Estuary: *Waikato Regional Council Technical Report 2014/27*. October 2012. ISSN 2230-4355.

Grant C. and Hay B. 2003: A review of issues related to depletion of populations of selected infaunal bivalve species in the Hauraki Gulf Marine Park. A report prepared for the Hauraki Gulf Forum by AquaBio Consultants Ltd., September 2003.

Haggitt T., Mead S., Bellingham M. 2008: Review of environmental information on the Kaipara Harbour marine environment. Prepared by ASR/CASL for the Auckland Regional Council. *Auckland Regional Council Technical Publication Number 354*. 190 pp.

Hannah, J.; Bell, R.; Paulik, R. (2010). Sea Level Change in the Auckland Region.Prepared by Otago University for Auckland Regional Council. Auckland Regional Council Technical Report 2010/65.

Holdaway R.J., Wiser S.K., and Williams P.A. 2012: Status assessment of New Zealand's Naturally Uncommon Ecosystems. *Conservation Biology* 26(4): 619-629.

Larcombe M.F. 1971: The ecology, population dynamics, and energetics of some soft shore molluscs. *Unpubl. Ph.D. thesis*. University of Auckland.

Mildenhall D.C. and Brown L.J. 1987: An early Holocene occurrence of the mangrove Avicennia marina in Poverty Bay, North Island, New Zealand. *New Zealand Journal of Botany* 25: 281-294.

Miranda Naturalists' Trust 2013: *Miranda News - Journal of the Miranda Naturalists' Trust. Issue 87*, Miranda Naturalists' Trust, Pokeno.

Morrisey D., Beard C., Morrison M., Craggs R., and Lowe M. 2007: The New Zealand mangrove: review of the current state of knowledge. *Auckland Regional Council Publication Number 325.*

NIWA 2013: Intertidal habitat mapping for ecosystem goods and services, Waikato Estuaries. *Waikato Regional Council Technical Report 2013/52*. Prepared for Waikato Regional Council. National Institute of Water and Atmospheric Research, Christchurch.

Sutherland J.I. 2003: Miocene petrified wood and associated borings and termite faecal pellets from Hukatere Peninsula, Kaipara Harbour, North Auckland, New Zealand. *Journal of the Royal Society of New Zealand 33*: 395-414.

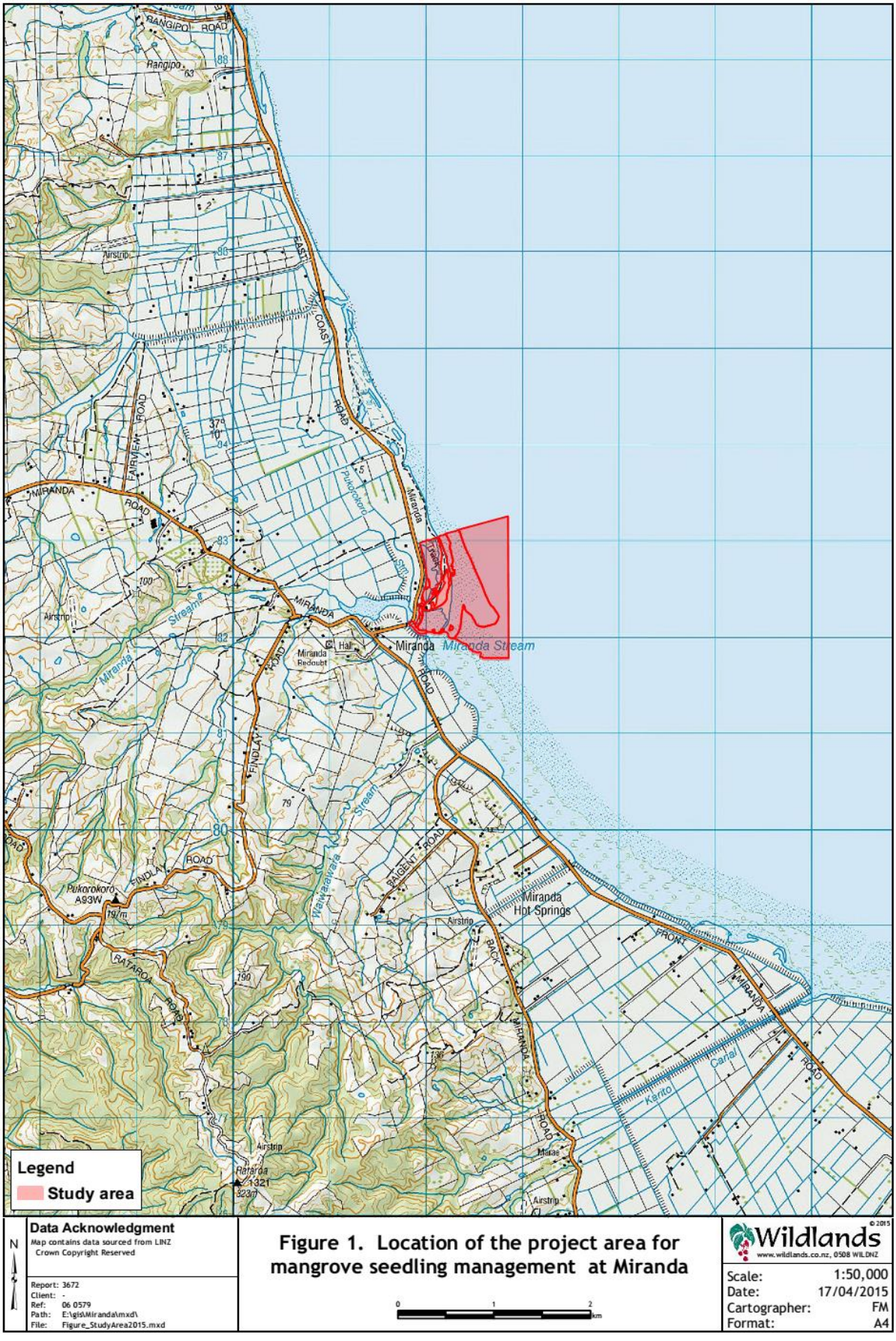
Wildland Consultants 2009: Ecological Assessment of Potential Mangrove Clearance Scenarios at Whangamata. *Wildland Consultants Ltd Contract Report No. 2310,* Prepared for Beca, Tauranga, November 2009. Status: Working Draft for Internal Discussion.

Wildland Consultants 2014a. Management of Mangrove Seedlings within Estuarine Habitats on the Coromandel Peninsula. Stage 1. Wildland Consultants Ltd Contract Report No. 3335. Wildland Consultants Ltd, 17 pp.

Wildland Consultants 2014b. Evaluation of Restoration Management Requirements at Miranda - Pukorokoro. Wildland Consultants Ltd Contract Report No. 3156. Wildland Consultants Ltd, 34 pp.

APPENDIX 1

MANGROVE SEEDLING
MANAGEMENT ZONES


Legend
Study area
Miranda
Miranda Stream
Miranda Hot Springs
Pukorokoro
A93W
197m
Rotaroa
1321
323m
Miranda Redoubt
Airstrip
Data Acknowledgment
Map contains data sourced from LINZ
Crown Copyright Reserved
Report: 3672
Client: -
Ref: 06 0579
Path: E:\gis\Miranda\mxd\
File: Figure_StudyArea2015.mxd
Figure 1. Location of the project area for mangrove seedling management at Miranda
Wildlands
www.wildlands.co.nz, 0508 WILDNZ
© 2015
Scale: 1:50,000
Date: 17/04/2015
Cartographer: FM
Format: A4

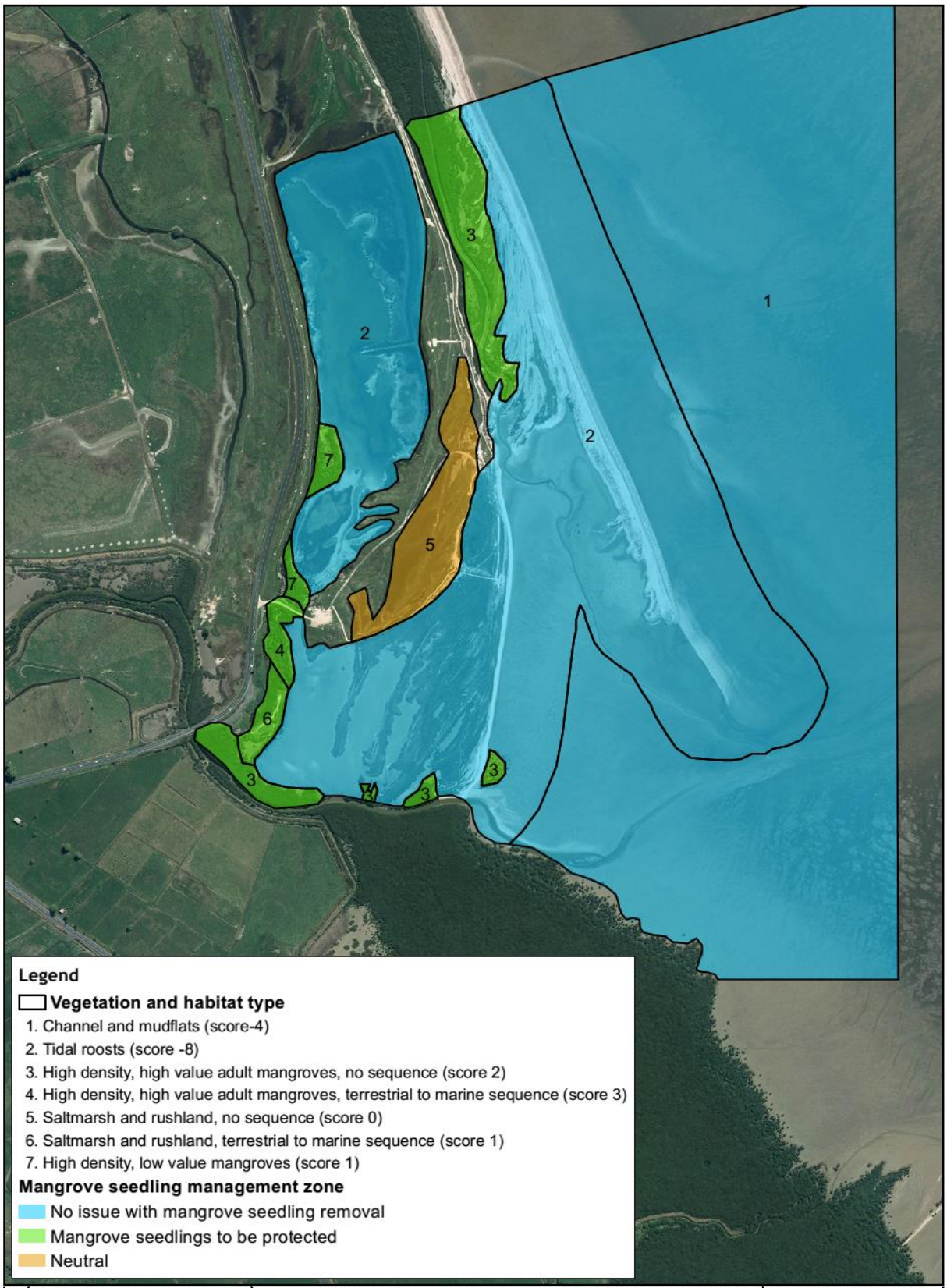


Figure 2. Mangrove seedling management zones for Miranda

SELECTED SITE PHOTOGRAPHS

Plate 1: Management Zone 2 - roost areas with mudflats, salt marsh and rushland

Plate 2: Management Zone 2 - high tide roosting areas around and within the lagoon

Plate 3: Management Zone 3 - high density, high value adult mangroves, no sequence

Plate 4: Management Zone 3 - high density, high value adult mangroves, no sequence

Plate 5: Management Zone 3 - adult mangroves with banded rail present

Plate 6: Management Zone 4 - high density, high value adult mangroves, with partial terrestrial to marine sequence.

Plate 7: Management Zone 5 - Saltmarsh and rushland without tidal roosts

Plate 8: Management Zone 7 - high density, low value adult mangroves, no sequence. (The zone comprises the areas of dead mangroves across the lagoon [management zone 2] i.e. near the culvert outflow).

Providing outstanding ecological services to sustain and improve our environments

Call Free 0508 WILDNZ
Ph: +64 7 343 9017
Fax: +64 7 3439018
ecology@wildlands.co.nz

99 Sala Street
PO Box 7137, Te Ngae
Rotorua 3042,
New Zealand

Regional Offices located in
Auckland, Hamilton, Tauranga,
Whakatane, Wellington,
Christchurch and Dunedin

ECOLOGY RESTORATION BIODIVERSITY SUSTAINABILITY

www.wildlands.co.nz