Karaka Wetland Project

Enhancement Plan

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Version History:

Version	*Date Written*	*Change/Reason for Change*
1	1/07/2015	Initial report written.
2	12/09/2016	Minor edits to the text. Additions of the Appendices on the pest plans, maps of the survey and control methodologies. Final draft presented.
3	13/09/2016	Minor amendments; addition of original photographs; rewording of Recommendations: Section 9 to include Health and Safety.
4	16/09/2016	Final version, approval.
5	22/11/2016	Amended version to reflect agreement with Whanganui District Council (WDC) on the digger maintenance work for the channel. Agreement wording added to Section 3 as subsection (c). Added to the timeline in Appendix 5 to clearance of the channel to reflect WDC as the organisation responsible.

All parties agree to uphold the principles and work to achieving the goals and tasks stated in the Karaka wetland project plan.

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Sara Treadgold, Department of Conservation
Kritzo Venter, Whanganui District Council
Logan Brown, Horizons Regional Council
Graham Dyhrberg, Resident, Wanganui Alliance
Graham Pearson, Coast Care, Castlecliff
Lyn Pearson, Coast Care, Castlecliff
Mike Dickison, Whanganui Regional Museum
Stella McQueen, Independent contractor
Murray Voss, Private citizen

Summary

Karaka Wetland is a large permanent wetland at Castlecliff Beach, Whanganui boarded by an access track and a drainage channel. It is composed of numerous residential sections and Crown land administered by both the Department of Conservation (DOC) and Whanganui District Council.

Banded kōkopu, which is rare in the region are present here as well as deposits of paru (a traditional dye material). Previous channel maintenance by digger would have had a negative impact on fish populations.

A committee was formed to bring together crown management organisations, community groups, residents and other interested parties. This plan was drafted in response to enhancing the habitat of kōkopu. Recommendations focus on alternative methods for controlling vegetation in the channel that avoid negative impacts on fish, as well as to enhance the fish habitat and improve aesthetics of the channel. These include alternative methods of vegetation control, channel flow alteration, pest plant control and native planting.

Figure 1 View of part of the wetland showing the grassy banks of the channel, the wetland proper and the clifftop Karaka St houses.

Introduction

The drainage channel along the edge of Karaka Wetland is home to an unexpectedly large population of banded kōkopu (*Galaxias fasciatus*) – an endemic whitebait species that is common nationally but rare in the Whanganui region (Figure 2). Mechanical maintenance of vegetation in the channel would have been negatively affecting these fish.

The wetland is a patchwork of property boundaries including Crown land administered by the Whanganui District Council and DOC, as well as many private urban properties (Figure 5). Additionally, the track alongside the wetland is an emergency and public access way to the beach. The wetland is dominated by raupō (*Typha orientalis*), flax (*Phormium tenax*), cabbage trees (*Cordyline australis*) and taupata (*Coprosma repens*) intermingled with pest plant woody species such as karo (*Pittosporum crassifolium*) and brush wattle (*Paraserianthes lophantha*).

Beginning in 2014, there was interest in changing the aquatic vegetation control towards fish-friendly practises and to plant the banks of the channel to improve fish habitat and enhance the area. A number of community groups, schools and individuals have already expressed a desire to be involved.

Initial discussions led to representatives from Whanganui District Council, Department of Conservation, residents and other interested parties forming a committee. Discussions have been highly successful with all members having with a desire to enhance the natural values of the area.

Figure 2: A banded kōkopu from Karaka Wetland.

There are already community groups that would like to be part of an ecological enhancement project for the Karaka Wetland. Progress Castlecliff works to promote, foster and encourage the development of Castlecliff. As part of this, the Castlecliff Coast Care Group is dedicated by clearing pest plants and planting natives to restore the dune vegetation and enhance the biodiversity of the area. The Whanganui branch of the Kiwi Conservation Club (Forest & Bird club for kids) has visited the wetland at night to see kōkopu and are interested in being involved with restoring the area.

Local schools have also expressed an interest. There are likely to be other groups or individuals within the Castlecliff or wider Whanganui community that may like to be involved. Māori weavers may also be interested as the wetland is used as a source for traditional black dye.

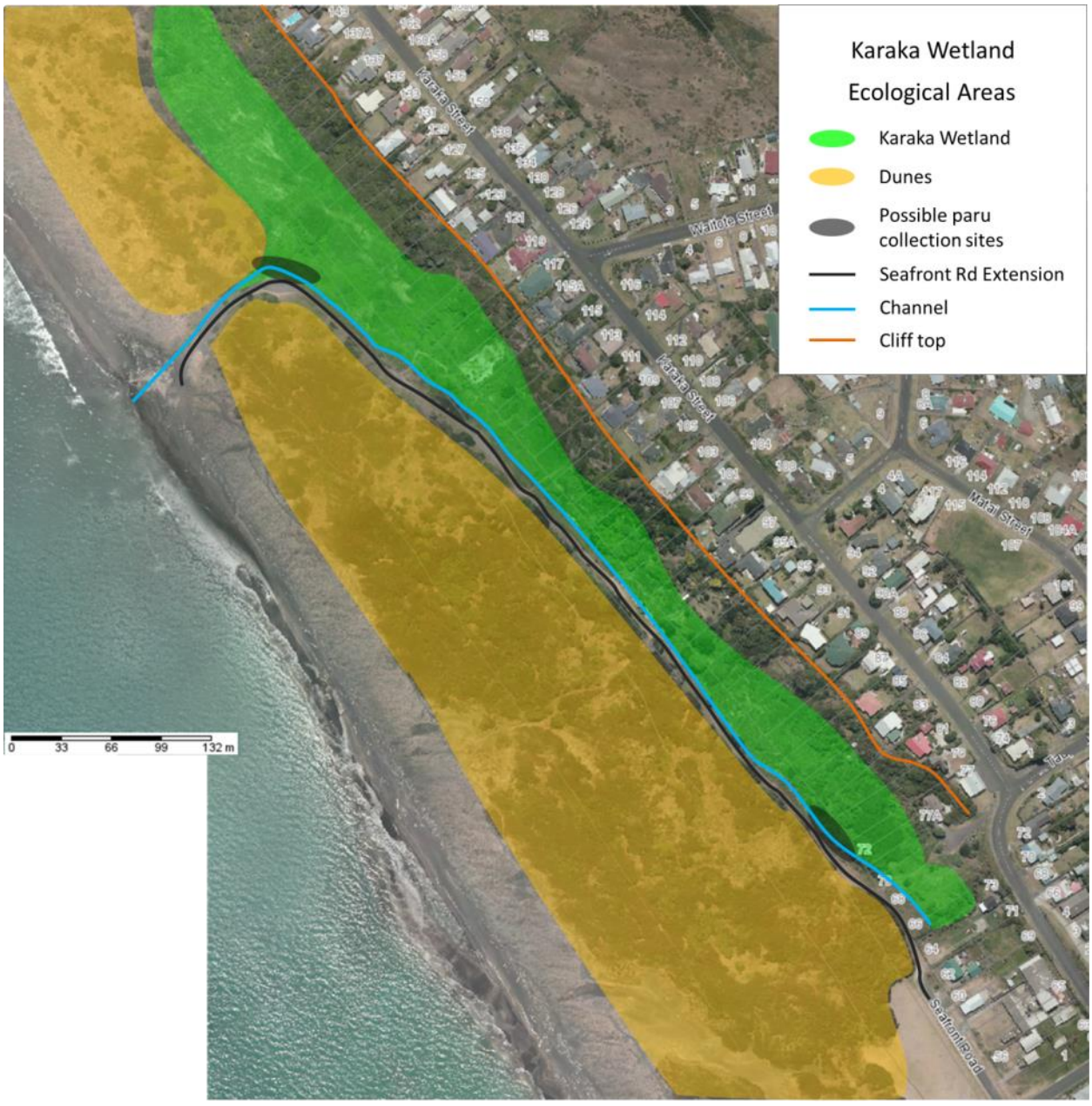


Figure 3: Map of ecological areas within the Karaka Wetland.

Values

Several key ecological, recreational and cultural values of the Karaka Wetland have been highlighted for protection or enhancement.

Banded kōkopu

The Karaka Wetland is a regionally important site for banded kōkopu, one of the five 'whitebait' species. Banded kōkopu are a large, scale less fish, which grow up to 300 mm and commonly live in wetlands and small, lowland streams. The Karaka population has an excellent range of sizes, with a large number of breeding adults and strong recruitment of juveniles. Banded kōkopu are nocturnal and site-loyal requiring habitat with a combination of cover for daytime seclusion and shallow, slow-flowing water for feeding at night. Overhead shade and bankside vegetation is also important.

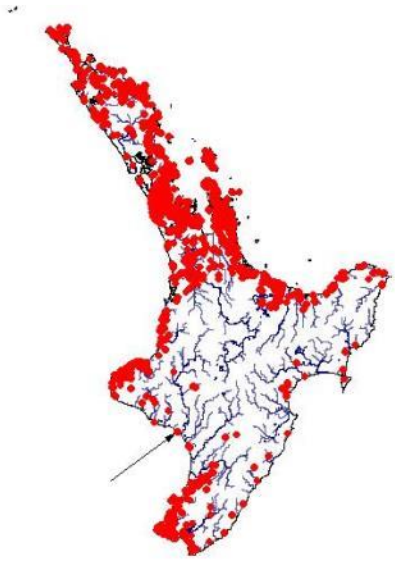


Figure 4: NIWA Freshwater Fish Database records of banded kōkopu showing distribution gaps around Whanganui. The Karaka population is arrowed. Note: migratory fishes are naturally sparse on the east coast of the North Island.

Although the banded kōkopu is the only 'whitebait' species that is listed as not threatened (Allibone et al 2010), they are regionally rare (see distribution map Figure 4). There are only three NIWA Freshwater Fish Database records of this species in the entire Whanganui River catchment and a very sparse presence along the whole coast between South Taranaki and the southern Manawatu. What makes this site especially distinctive is that it hosts a large population of kōkopu. Most of the other records in the wider region noted only single fish.

The population at Karaka Wetland is easily accessible. A popular activity has been educational torchlight trips to see kōkopu in the evening.

Access

The Seafront track extension provides access to the beach for emergency services and the community. Walkers and members of the public with cars, quad bikes and dog walkers frequently use it.

Paru

This fine black mud high in iron is found in at least one part of the stream and is highly valued by Māori weavers who use it to make traditional black dyes. Paru sites are rare around the Whanganui region (Awhina Twomey pers. comm.). The presence of the paru and the importance of the site to traditional weavers was revealed by a member of the public during a site inspection. Two vague areas for paru gathering are known, but there may be others and their locations should be identified. (Figure 3: currently known paru collection sites see ecological map)

Threatened Plants

Pimelea actea was initially suggested as a potential 'focal' species to plant at this site, particularly for advocacy and promotion of rare species. However, this site is not appropriate habitat for this species (Graeme La Cock pers. comm.). Other native plants that are declining or regionally rare suggested for the wetland include swamp nettle (*Urtica linearifolia*) and saltmarsh ribbonwood (*Plagianthus divaricatus*).

Ownership

On paper, the wetland is broken into a patchwork of properties owned by private landowners on Karaka Street, and two parcels of Crown land administered separately by DOC and the Whanganui District Council (Figure 5).

The Castlecliff Domain Recreation Reserve is Crown land administered by the Whanganui District Council. The reserve extends 3.1 km from the mouth of the Whanganui River bordered by the mean spring high tide mark and a narrow strip of Crown land administered by DOC. This 20-35m wide marginal strip extends 5.7 km along the coast from the end of Seafront Road.

The Seafront track extension and the adjacent channel crosses both DOC and council-administered land. The upstream 500m of channel, track and a narrow strip of the wetland is on DOC-administered land while the downstream 170 m stretch, comprising of the channel, track, track corner and a path through the dunes is on council land. The rest of the cliff-ward side of the wetland is within the Karaka Street private properties.

History

When Karaka Street and Seafront Road were formed there were no dunes or wetland. Seafront Road was literally on the sea front and Castlecliff Beach was a very narrow strip of sand. As recently as the early 1950s water lapped the cliffs 3km north of the river mouth (Burgess 1971) only 1km north of where the channel meets the sea.

Starting in the late 1880s, the North and South Moles were constructed at the mouth of the Whanganui River to deepen the harbour entrance and remove the bar of sediment accumulating offshore which limited ship passage. The North Mole stabilised the moving sands at Castlecliff and the beach built up over time to its present size.

As the beach grew, groundwater emerging underneath Karaka Street pooled at the base of the cliffs. By the 1930s this formed a 'lagoon' where local children would learn to swim. Later the dunes rose in front of the 'lagoon' creating a more sheltered environment that favoured the establishment of coastal and wetland plants.

The Seafront track extension was formally developed in the early 1980s as an emergency vehicle access track following an earlier informal access. At the same time the channel was dug alongside the track to trap and redirect water seeping under the dunes and thus protecting access.

Figure 5: Map of property boundaries across the Karaka Wetland.

The eight existing private footbridges and culverts over the drainage channel were constructed in 2002. Before this, residents had informally constructed footbridges across the channel connecting their properties with the beach. These bridges were not structurally sound and could have collapsed causing injury. After consultation with the Karaka Street residents' informal bridges were removed and the present culverted bridges were constructed at the residents' cost. Most consist of a 900mm concrete pipe surrounded by large concrete blocks (although some landowners requested a pipe and boulder construction). The pipes on the Council administered land were 1200mm diameter. Under the agreement, residents are responsible for any maintenance or repair of the culverts.

Some culverts are near to the height of the access track, while others are lower and closer to the water level. Graham Dyhrberg reports that ducks would swim through the culverts when they were first constructed, but now the pipes are generally below the surface of the water. It is possible that some of the culverts have settled and sunk into the sand over time, or the water level has risen, or both.

Hydrology

The Karaka wetland is part of a series of natural dune wetlands extending 4.2 km along the coast from the end of Seafront Road. Much of these wetlands are ephemeral, however the Karaka wetland is probably the largest area of permanent water.

The wetland is fed by groundwater flowing under the suburb of Castlecliff (Figure 6). This emerges through the sand built up against the cliffs and flows down into the wetland. The water collected in the channel exits the wetland through a shallow channel dug through the dunes and flows out to sea. The flow varies little over the year as it is primarily fed by groundwater and is not affected by rainfall.

Over recent decades it has been reported that Karaka Street properties have become boggier and the groundwater is emerging higher up on the properties. This is unrelated to the presence or water level of the wetland since water is emerging above the wetland and flowing downhill into it. These changes are likely due to unknown changes in the groundwater hydrology of the Castlecliff area.

The wetland and channel water level is currently dictated by the depth of the channel where it flows through the dunes to the sea. The depth of this section of channel is naturally balanced between sand being deposited by wind and dune action and sand being removed by water. If this section was dug deeper it would rapidly refill with wave-driven logs and deposited sand, temporary affecting the water level in the wetland but having no effect on the amount of water flowing through Karaka Street properties.

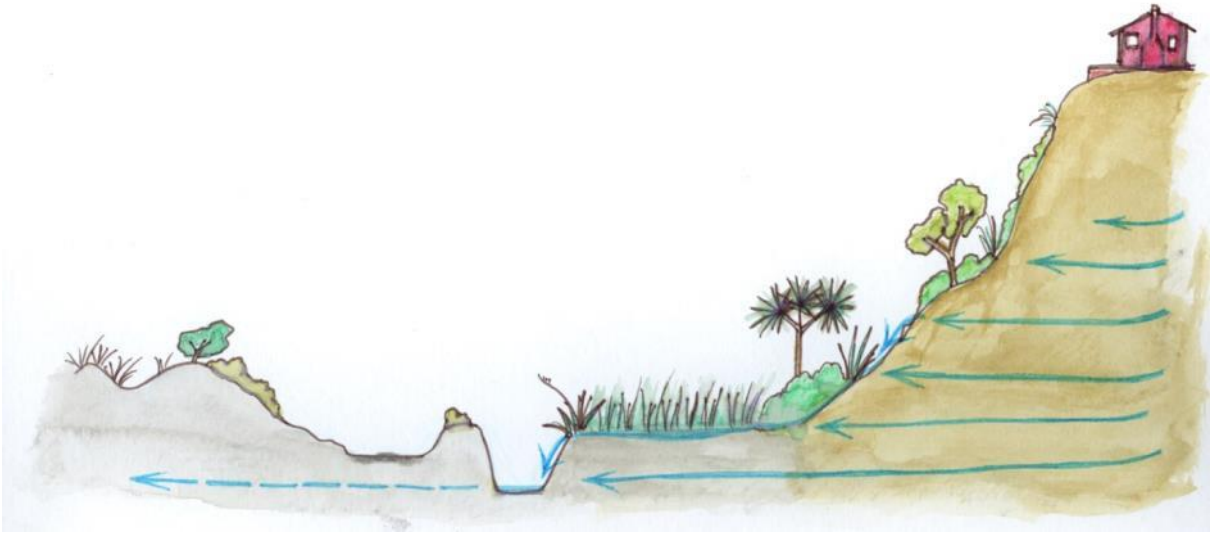


Figure 6: Cross-sectional diagram showing the flow of groundwater through the wetland.

The groundwater has a naturally high concentration of dissolved iron collected as the water flows through the iron sands underneath Castlecliff. When the groundwater emerges, the dissolved iron is converted by bacteria into iron hydroxide precipitate or ochre. This is the distinctive rust-coloured 'mud' seen in the channel and small feeder streams (Figure 10). This is a natural process and not damaging to the ecosystem. In the very low-oxygen conditions at the base of the channel the dissolved iron combines with organic matter to form paru, a fine black mud highly prized by Māori weavers for creating black dye.

Ecology

The wetland is dominated by raupō (*Typha orientalis*), flax (harakeke, *Phormium tenax*) and a few cabbage trees (*Cordyline australis*). There are also a few large sedges (*Carex* sp.).

The channel is partly filled with raupō, monkey mus*k* (*Mimulus guttatus*, Figure 7) and fool's watercress (*Helosciadium nodiflorum*); submerged aquatic plants *Elodea canadensis*, Myriophyllum spp. and starwort (*Callitriche* sp.); and floating plants *Lemna* sp. and *Azolla filiculoides.*

On the bank of the channel and raised edges of the wetland are invasive plants including Cape ivy (*Senecio angulatus*), sand wattle (*Acacia longifolia*) and tree lupin (*Lupinus arboreus*), as well as small native trees, predominately karo (*Pittosporum crassifolium*) and taupata (*Coprosma repens*).

Large numbers of banded kōkopu and īnanga (*Galaxias maculatus*) are found in the channel and are likely to be through the rest of the wetland where standing water is present. Additionally, both longfin (*Anguilla dieffenbachii*) and shortfin eels (*Anguilla australis*) are seen occasionally and a redfin bully (*Gobiomorphus huttoni*) has been seen once. It seems unlikely that bullies or crayfish or koura (*Paranephrops planifrons*) would ever form sizeable populations as they are bottom-dwelling and the substrate of the channel is mostly soft, deep mud.

On the Karaka Street properties, most of the area below the clifftop has been left in a natural state by the landowners, except for maintaining private paths to the culverts. Several of the residents have developed gardens on their properties extending down towards the wetland, and in some cases they have been taking care of the DOC strip adjacent to their properties. Some of these landowners have maintained open water around the culverts by manually removing raupō and other aquatic plants, incidentally creating ideal habitat for the banded kōkopu (Figure 10).

The dunes and wetlands are still extremely young and will continue to develop and change over time.

Maintenance of the Channel

The channel has been maintained by the Whanganui District Council since the early 1980s. Graham Dyhrberg has been involved in maintaining the channel since he moved to the area in the late 1980s, in his joint capacities as an interested resident and council contractor. This involves mechanical removal of vegetation from portions of the channel when a digger and driver is available in the area. The removed vegetation and mud is left next to the channel on the seaward bank. This maintenance extended beyond the council-owned section of the channel (downstream of culvert 7). DOC was aware of the maintenance on the marginal strip but not consulted.

This maintenance was initially conducted annually and all vegetation was removed from the length of the channel. Mr Dyhrberg noticed fish in the channel only after the management was reduced to partial clearance in the early 1990s. He continued with this system in order to preserve the fish populations. It is probable that fish were utilising the channel and wetland before this period, but the regular maintenance kept them in very low numbers.

Following discussion with Stella McQueen in 2012, Mr Dyhrberg made recommendations to the digger drivers to commence work at the downstream end of the channel section to be cleared, deliberately disturbing the water with the digger. The intent was to ‘wake up’ the nocturnal fish and give them a chance to move away from the activity.

Figure 7: Section of channel filled with emergent Mimulus.

Mr Dyhrberg used to manually clear some of the vegetation in the channel in order to reduce vegetation growth between the incidents of mechanical clearance. Since the mechanical clearance has slowly deepened the channel, especially in the downstream half, manually clearing vegetation can be difficult.

Effects of Current Management on the Fish

The use of a digger to remove vegetation from the channel has negative impacts on fish. The stream was visited by Stella McQueen before and after the digger was used in 2012 and 2014. After the clearance fish with injuries and infections were seen within the cleared sections, but none were seen before the clearance. Additionally, fewer fish were seen in the cleared reaches.

The lower half of the channel appears to have been subject to more work from the digger than the upper half. This has resulted in a very deep, steep-sided ditch with a wide, deep and extremely slow-flowing stream (Figure 9). The upstream section has had little vegetation removal and in places the raupō has grown across the channel from the wetland towards the track (Figure 9). In these areas the water is now flowing quickly in a narrow ribbon along the seaward bank. In the middle section (where Karaka Street residents have been tending the vegetation) there is a variety of medium and slow flow areas, and areas of open water are interspersed with raupō and other aquatic vegetation.

Banded kōkopu prefer habitats with a slow current, which carries food towards them while requiring minimal effort from the fish to maintain its position in the stream (Akbaripasand et al 2010). The lower half of the channel is now so pond-like that the fish cannot use the flow to bring food towards them, while the overgrown upstream sections are now too fast flowing for this leisurely feeding technique.

Figure 8: Banded kōkopu found shortly after the 2014 clearance. The creamy patch is an external infection and the reddened lateral line suggests septicaemia. It is likely that this infection was eventually fatal.

Kōkopu are nocturnal and seek daytime refuges close to their night-time feeding areas. They particularly favour robust types of cover such as log jams and overhanging banks and boulders (Rowe and Smith 2003; Baker and Smith 2007). In the absence of these, the Karaka Wetland kōkopu are likely favouring nooks around the culverts for cover and secondarily utilising cover provided by the raupō and *Mimulus*. Maintenance of the downstream section of the channel has left little cover for the fish, and they are more skittish than those in the open-water areas of the middle section where cover is close by.

Several Karaka Street residents, in seeking to develop the channel as an attractive stream feature at the bottom of their gardens, have incidentally created good in-stream habitat for the fish. Extending what they have done along the rest of the channel would greatly expand the amount of good kōkopu habitat available in the channel (Figure 10).

Also important to the fish is overhanging bankside vegetation which both shades the water and provides a source of terrestrial invertebrate food. For example, banded kōkopu obtain up to 85% of their diet from terrestrial invertebrates falling onto stream water surfaces. Currently this is provided on the wetland-side of the channel, but planting up the track-side bank would provide extra cover and food, as well as making this large area of rank grass more attractive.

Banded kōkopu and īnanga spawn terrestrially, depositing the eggs into bankside vegetation inundated by autumn floods. The eggs develop out of water awaiting the next flood to stimulate them to hatch and wash the larvae to sea. The density of this vegetation is critical to the eggs not drying out and dying. It takes years for grasses to achieve the ideal density of stems needed for egg survival. We do not yet know the spawning locations in the Karaka Wetland, but it is most likely happening in the grasses alongside the channel. Unfortunately, the digger removes or flattens these grasses on the sides of both banks, destroying potential spawning habitat. Planting the banks with species that provide suitable spawning habitat would increase the amount of spawning habitat available in the channel.

Nationally, inanga are listed as ‘At Risk: Declining’ and their survival is dependent on conservation measures (Allibone et al 2010). The lack of spawning habitat is a significant bottleneck for the species and it appears that small coastal streams with intact spawning and adult habitat are of far greater importance to the survival of the species than large rivers with poor habitat (Hickford and Schiel 2011). The high numbers of adult fish spawning in the Karaka Wetland, along with the lack of a retentive estuary keeping the fish larvae close to home (Gerry Closs pers. comm.) means that there are likely large numbers of larvae leaving the wetland each year and populating other rivers and streams along the coast.

Figure 10: Ideal kokopu habitat, incidentally created by Karaka St residents, with slow-flowing open water and plenty of adjacent cover. Natural iron bacteria are responsible for the orange iron oxide sediment and the oil-like film.

Figure 9: Unsuitable banded kokopu habitat. Left: The channel is too deep and slow with little cover. Right: The channel filled with raupō pushing water into a narrow, fast-flowing ribbon.

Recommendations for Future Management

The recommendations are laid out in sections with associated recommended solutions or alternative practises. Many of the recommendations, especially pest plant control and native planting, would be best achieved through the engagement with group(s) of volunteers. Some specialised work (spraying of aquatic or pest plants) would be carried out by DOC or Council staff. Groups could adopt different areas of the bank and channel to foster a sense of ownership and community.

1: Previous work has not taken the mixed ownership of the area into account.

The wetland is a patchwork of boundaries and management of the area needs to involve all parties.

1.a Future advocacy and information decisions for the area should include all key agencies and other interested parties where relevant.

1.b Channel maintenance and plantings should be respectful of areas where residents have been maintaining DOC- or Council- administered land.
Planting advice and a list of suitable native plants could be provided to interested residents.

2: Vegetation clearance using a digger to be used responsibly to minimise negative affects on the fish

Clearing the vegetation in the channel with a digger negatively affects resident native fish, while having little effect on the flow of water through the channel or neighbouring properties. Retaining plenty of vegetation along the length of the channel while preventing the vegetation from filling the channel is important for maintaining the fish population.

2.a Clearance of large sections of vegetation in the channel using a digger or other machinery.
Extensive use of machinery will be ceased. It will only be used for spot vegetation clearance, removing silt from the up- and downstream ends of each culvert and clearance of driftwood or sand at the confluence. This clearance would be carried out on an annual basis outside spawning or migration seasons (see Section 3b below).
Note: any maintenance carried out on the track should be carried out in accordance with the enhancement values of this plan.

2.b Maintain vegetation by hand so that it does not fill in the channel.
This is detailed in Sections 3 and 4.

2.c Explore aquatic herbicides as an alternative or adjunct to manual weeding.
Manual weeding may become too demanding, in which case aquatic herbicides would be an alternative. There is a risk to the fish in using herbicides where large amounts of decomposing vegetation can deoxygenate the water. Spraying may also result in the streambed building up as vegetation decomposition builds up organic matter on the streambed. This methodology would be used sparingly.

3: Major works in the channel affect water quality and negatively impact the fish

Any major work within the channel (digger activities and any significant manual removal of vegetation) is likely to stir up large plumes of mud and affect water chemistry. Banded kōkopu are particularly sensitive to changes in water chemistry affecting oxygen uptake.

Banded kōkopu and īnanga spawn in vegetation on the edges of streams from late summer to early winter. During this stage the fish and eggs are vulnerable and it is best to avoid any vegetation clearance during this time. Later, when the juvenile fish return as whitebait, plumes of mud can affect their migratory choices and deter them from entering streams.

3.a Commence any major works in the channel at the downstream end of the channel section first.

This way fish within operational sections will move upstream into fresh water away from the disturbance rather than into the mud plume downstream.

3.b Conduct major works within the channel outside of the peak spawning (March to July) and whitebait migration periods (September to November).

3.c Any major works within the channel will be carried out as part of an agreement within Council groups and in line with this document. This includes:

The watercourse was formed by Council for the purpose of providing drainage for the access track to the beach (for emergency vehicles, and 4WD recreational use). For that reason, it is not part of the roading maintenance regime and therefore Wanganui Alliance is not involved. The maintenance of the track and the watercourse for the purpose of track access is the responsibility of WDC Property group. The WDC Drainage we will assist with this on their behalf.

The watercourse is not for the specific purpose of providing service for draining private property (these are all serviced from Karaka St), however these properties have incidental access to the drain and are allowed to drain their properties into it as allowed for by the Drainage Act and related statutory documentation. There would need to be a lot of work done for these properties to be completely drained, which would be costly and would impact negatively on the habitat. This is in our view outside the scope of the project. WDC therefore cannot guarantee these properties will be completely drained.

WDC supports the proposed ongoing maintenance regime under the enhancement project and have agreed to make the contribution to that effect within the scope as set out in this document from the Property and Drainage Groups. (i.e. habitat enhancement and drainage for the access track).

Residents will be contacted to explain the level of service that can be expected for the track and the watercourse.

4: Aquatic weeds growing quickly and filling in the open water areas

Mimulus, fool's watercress, *Elodea* (Canadian pondweed) and other aquatic and emergent weeds grow best in full sun. As most of the channel receives full sun throughout the year, these plants grow very quickly and spread across the channel, removing open-water habitats for the fish and make the channel look very choked.

4.a Plant location and appropriate native plants on the banks so that they will shade the channel when grown, naturally suppressing growth of the unwanted aquatic weeds.

See plant list in Appendix 1 for recommended planting onsite.

4.b Periodically remove some of the aquatic vegetation by hand to maintain open-water areas along the channel.

Manual labour would achieve this. Some areas are currently too deep and muddy for it to be practicable but it may become possible in the future. Removed vegetation could be used as mulch in areas of the bank being revegetated (see Section 6).

Care would be needed to remove all vegetative parts if pest plant species such as Mimulus or Tradescantia. These would have to be removed, bagged and disposed of offsite. This would avoid further infestation of these species downstream.

5: Excessive growth of raupō is removing fish habitat

Raupō has grown across the channel between culverts 3 and 5, pushing the flow into a narrow, fast-flowing ribbon. Fish are rarely seen in these areas as the water is too swift and shallow. Between culverts 1 and 3 the raupō has filled the channel entirely. Removing some of the vegetation from these areas to create slow-flowing open pools would increase the amount of useable habitat available to the fish.

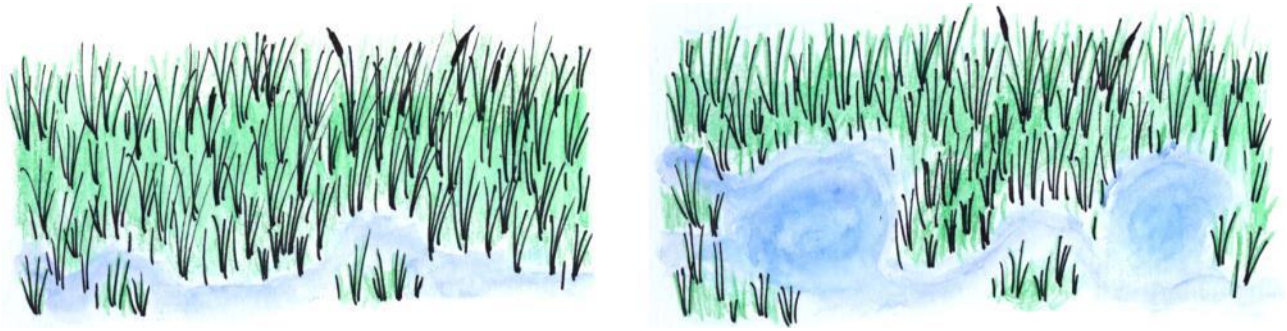
5.a Use a digger to create small pools periodically along the raupō bed, roughly every one to two metres.

This will create an embayment with slower flow as preferred by the fish, with vegetation cover alongside for daytime refuges (Figure 11). However, clearing the stream in this way may limit the amount of planting that can be done.

5.b Periodically remove raupō by hand so that it does not fill in the channel or embayment.

This could be carried out by interested community groups.

Figure 11: **Left:** Section of channel where raupō has grown across the channel restricting the flow.
Right: Areas of raupō removed to create open pools for the fish.



6: Some channel sections have become very wide, deep and slow with no cover

Due to repeated use of the digger, the channel downstream of culvert 5 is now very deep and has very little flow or cover. The fish prefer shallower water with some slow-flow areas and plenty of cover, and thus are not as common in this section. This section will fill in quickly over summer with Mimulus and other aquatic weeds providing cover for the fish but removing open-water feeding areas.

Following storms, the Council clears driftwood from the beach end of the Seafront track extension to restore vehicle access. This driftwood could be placed in the deep section of the channel in clusters, creating a repeating pattern of areas of cover and open water throughout this section of channel. This would provide cover for the fish and narrow parts of the channel causing the water to flow around it creating feeding areas.

6.a Place large driftwood cleared from the beach end of the Seafront track extension in the channel between culverts 5 and 7 to provide stable fish cover and help to create different areas of flow.
This should be combined with planting to shade out the Mimulus and other emergent vegetation as the wood will be harder to weed around.

6.b Raupō removed when creating the embayment could also be planted in this area to the same end.

7: Pest plant control and enhancement planting

Most of the seaward bank of the channel is covered by rank grass and invasive Cape ivy, Japanese honeysuckle, brush wattle and tree lupin (see Appendices 3 and 4) for a pest plant survey map). This is very modified, visually unappealing and the unkempt nature of the area potentially encourages the dumping of waste along the Seafront track extension. The channel banks are a large area so need to be tackled in smaller, achievable stages. Appendix 5 shows a timeline of work tasks to be carried out over the next five years.

7.a Control pest plants and revegetate channel banks using plants native to the area

Pest plants controlled will need time for these to die back and for regrowth to be sprayed to ensure they are removed from the sites before planting (see Appendix 2 for methodologies). Focus of plantings that will shade out pest plants, stabilise the bank, reduce maintenance, provide fish spawning substrate, and enhance conservation values. A planting list and map of areas to focus on first is shown in Appendices 1 and 2.

7.b Engage with community groups

Encourage community groups, schools and iwi to adopt and revegetate a particular stretch of the channel in order to give a sense of ownership.

7.c Ensure that the plantings allow for access to the channel by people wishing to see the fish, gather paru or maintenance of the channel with a digger as necessary.

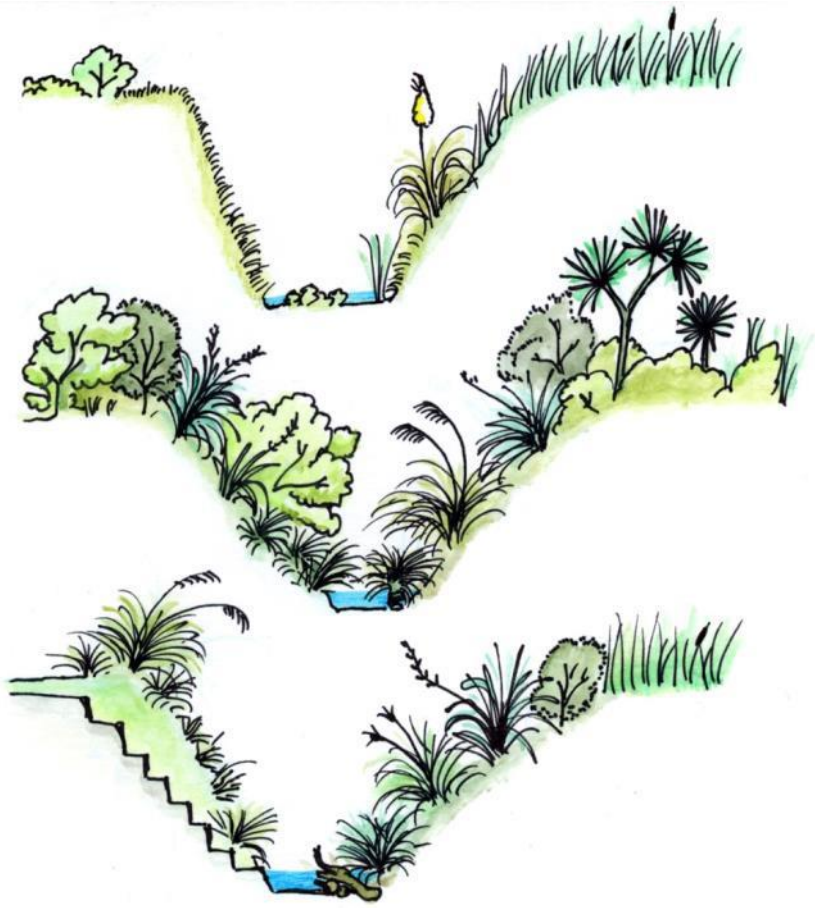


Figure 12: **Top:** Cross-section of the present channel, with a steep, grassy bank on one side and predominantly raupō and pampas on the wetland side. The lack of shade encourages growth of aquatic weeds.

Middle: One planting option where flaxes, shrubs and toetoe are used to shade the channel and naturally reduce aquatic weeds. Carex grasses planted near the water provide cover and spawning habitat for the fish.

Bottom: Another planting option with flaxes, carex grasses and driftwood providing some shade and cover with the lower bank plants allowing visual and physical access to the stream.

8: Paru sites are unknown and unprotected

Paru is gathered from the channel for use as a traditional Māori dye, however the exact site location(s) is unknown and could accidentally be destroyed by a digger or rendered inaccessible through plantings.

8.a Contact Māori weavers to identify the paru sites.

8.b Ensure the sites are clearly identified so that access is retained and diggers do not affect them.

9: Health and Safety - working in and around the Seafront extension track

The extension is currently a single-lane, narrow sand track. The vegetation on the dune side pushes vehicles closer to the bank of the channel, but also makes it harder for drivers to see pedestrians and restricts opportunities for vehicles approaching head on to pass each other. Over time it has worn into an exaggerated series of undulating mounds and dips which slows vehicles down dramatically. This has the benefit of reducing unsafe speeds, however it is likely that it would also slow down emergency vehicles. There are also residents walking dogs off lead and stray dogs seen on the track.

This presents significant hazards to anyone working at the site. Workers and particularly volunteers must be made aware of these hazards and a safety plan and emergency procedures in place to ensure the wellbeing of all those that work on this project.

9.a Working parties to be made aware of hazards of vehicles.

Signage, road cones and workers wearing high-viz. vests will alert drivers to the presence of people working in the area. Workers must remain vigilant and/or temporary barriers could be put in place.

9.b Ensure health and safety and emergency plans are in place and all workers or volunteers are given a safety briefing.

All risks of the site and any related to the work being carried out on the day should be identified and either eliminated, isolated or minimised. All workers should be briefed of these risks before any work is carried out.

9.c Ensure signage is used to alert the public of pest plants having been sprayed.

Poison spraying signs should be displayed while carrying out spray work; blue dye should be used to alert the public of which plants have been sprayed; and temporary warning signs should be displayed to warn the public of the use of herbicides in the area.

Acknowledgements

Acknowledgement goes to the valuable input and suggestions from everyone involved including Jasmine Hessell, Graham Dyhrberg, Mike Dickison, Kritzo Venter, Lyn and Graham Pearson, Sara Treadgold, Ben Potaka, Adele Meyer, Logan Brown and Clare Ridler. Also Finn Michalak, Graeme La Cock and Colin Ogle for botanical advice, and Mike Dickison for the drawings included in this report.

References

Akbaripasand, A., Nichol, E.C., Lokman, P.M. and Closs, G.P. (2011). Microhabitat use of a native New Zealand galaxiid fish, *Galaxias fasciatus*. *New Zealand Journal of Marine and Freshwater Research*, 45: 1, 135—144.

Allibone, R., David, B., Hitchmough, R., Jellyman, D., Ling, N., Ravenscroft, P. and Waters, J. (2010). Conservation status of New Zealand freshwater fish, 2009. *New Zealand Journal of Marine and Freshwater Research*, 44:4, 271—287.

Baker, C.F & Smith, J.P. (2007). Habitat use by banded kokopu (*Galaxias fasciatus*) and giant kokopu (*G. argenteus*) co-occurring in streams draining the Hakarimata Range, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 41:1, 25—33.

Burgess, J.S. (1971) *Coastline Change at Wanganui, New Zealand. A thesis presented to the University of Canterbury, Christchurch, in fulfilment of the requirements for the Degree of Doctor of Philosophy.* 161 pp.

de Lange, P.J., Rolfe, J.R., Champion, P.D., Courtney, S.P., Heenan, P.B., Barkla, J.W., Cameron, E.K., Norton, D.A., Hitchmough, R.A., (2012). *Conservation status of New Zealand indigenous vascular plants, 2012*. Department of Conservation, Wellington, New Zealand. 70pp.

Rowe, D.K & Smith, J.P. (2003). Use of in-stream cover types by adult banded kokopu (*Galaxias fasciatus*) in first-order North Island, New Zealand, streams. *New Zealand Journal of Marine and Freshwater Research,* 37:3, 541—552.

Hickford, M.J.H. & Schiel, D.R. (2011). Population sinks resulting from degraded habitats of an obligate life-history pathway. *Oecologia* 166(1): 131-140.

Smith, G. & Te Kanawa, R. (2008). Some traditional colourants of Maori and other cultures. *Chemistry in New Zealand*, 72:4, 127—131.

Appendix 1: Enhancement Planting

The following are species local to Castlecliff and are considered suitable for planting along the banks of the channel at Karaka Wetland (Graeme La Cock, Finn Michalak pers. comm.). These plants will shade out invasive pest plants, stabilise the bank, shade the waterway, reduce maintenance, provide fish spawning substrate, and enhance conservation values.

Due to the presence of kikuyu grass, any planting sites would need to be prepared first and maintained. Plants should be 'ecosourced'.

Below is a plant list for enhancing the site, including two declining (or geologically absent) species.

	Common Name	**Māori Name**	**Size**
Rare			
Plagianthus divaricatus	saltmarsh ribbonwood		2m
Urtica linearifolia	swamp nettle		1m
Small			
Carex secta	sedge, purei	purei	1 m
Carex virgata	sedge		0.9 m
Medium			
Cyperus ustulatus	giant umbrella sedge	upokotangata	1 m
Austroderia toetoe	swamp toetoe	toetoe	2 m
Austroderia fulvida	cliff toetoe	toetoe	2 m
Muehlenbeckia complexa	small-leaved pohuehue	pohuehue	1 m
Large			
Phormium tenax	NZ flax	harakeke	2 m
Coprosma repens	mirror plant	taupata	4 m
Cordyline australis	cabbage tree	ti	8 m
Leptospermum scoparium	manuka	manuka	4 m

Appendix 2: Karaka Wetland Planting Map

Appendix 2: Karaka Wetland Pest Plant Information

Pest plant - Survey

A survey of pest plant species within the strip between the sand track and the stream (and pest plants within the stream itself) was completed [see attached map]. The major infestation is of Cape ivy and Japanese honeysuckle. Both vine species can smother open areas or native plants. There is also a small patch of Tradescantia beside one of the culverts that is spreading into the wetland area, and periwinkle opposite the Council reserve.

While these vines are the predominant species, there are other woody species (i.e. karo, pohutakawa, Acacia, tree lupin, brush wattle and one wilding pine (on private land), large pampas, aquatic/wetland species such as raupō and Mimulus. A large patch of crack willow with several large Italian lilies underneath is opposite the Council reserve on private land. There is also the odd arum lily, sweet pea plant and pastoral grasses.

In terms of control methodologies, suggestions would be as follows:

- **Woody** species (except willow) can be hand pulled (seedlings only), dug out (lupins) or cut and painted.
- **Arum** lilies and the **Mimulus** could be hand pulled, bagged and disposed of.
- **Tradescantia** being a relatively small patch, could be easily hand weeded and bagged for disposal (essential as it will be spread via any vegetative material left)
- **Cape ivy, Japanese honeysuckle and periwinkle** are best sprayed. This will have to be followed up to ensure regrown is controlled. Periwinkle will have to be spraying multiple times.
- **Crack willow**. This is on private land. However, it will be having a substantial effect on the wetland area and will spread. Needs more consideration and permission from landowners to control.
- **Raupō.** Suggested this should not be a priority for now and does have benefits for the wetland area. Could do limited spraying (in the stream itself) but because of it being over water, EPA restrictions would need to be checked and only certain agrichemical (haloxyfop-R-methyl is the best option), at a certain concentration to be a permitted operation. DOC holds a National permit for this activity.

Pest Plants - Control Efforts

Due to the small area needing control this could be carried out relatively easily. Suggestions would be:

Woody species possession
Controlled as resources allow (volunteers and public), hand pull and bag.
Vine and ground covers
Sprayed by Horizons or DOC staff. Hand pull, bag and dispose of Tradescantia.
Aquatics
Controlled as resources allow (volunteers and public), hand pull and/or bag
Raupō
Staggered approach, beginning with control directly within Karaka Stream itself to allow better water flow and fish passage. This could be hand pulled or sprayed and would be ongoing. Due to the limited area, it may be preferable to hand pull. Leave the majority in the wetland area in the wetland as this has other benefits for the ecosystem and fauna.

Appendix 4: Karaka Wetland Pest Plant Map

Appendix 5: Five-year timeline for work tasks to enhance the Karaka Wetland.

Year	Work involved	Who's responsible	Date to complete work tasks	Comments
1 [2016]	Final draft of the enhancement plan	DOC	September	
	Information sheets for residents	Mike	September/October	
	Info sheet drop off to residents	Mike/Graeme D.	October	
	Public meeting for feedback from the residents	All committee members	October	
	Identifying habitat locations for threatened plant species	DOC	October	
	Chemical spraying of: Cape ivy Japanese honeysuckle Periwinkle raupō	DOC/Horizons	November	
	Public weeding day	Coast care	November	TBC
	Spot clearance with a digger	WDC	December	
2 [2017]	Spot clearance with a digger	WDC	July	
	Respraying of: Cape ivy Japanese honeysuckle Periwinkle raupō	DOC/Horizons	October	As needed
	Public or school planting day – at Planting site 1.	Coast care	September/October	Contingent on sourcing eco-sourced plants
	Planting site maintenance	Coast care	December-April	As needed
3 [2018]	Spot clearance with a digger	WDC	July	
	Respraying of: Cape ivy Japanese honeysuckle Periwinkle raupō	DOC/Horizons	October	If needed
	Public or school planting day – at Planting site 2.	Coast care	September/October	Contingent on sourcing eco-sourced plants. Replant in Planting site 1 depending on the survival rates
	Planting site maintenance	Coast care	December-April	As needed
4	Spot clearance with a digger	WDC	July	

[2019]				
	Respraying of: Cape ivy Japanese honeysuckle Periwinkle raupō	DOC/Horizons	October	If needed
	Public or school planting day – at Planting site 3.	Coast care	September/October	Contingent on sourcing eco-sourced plants. Replant in Planting site 1 and 2 depending on the survival rates
	Planting site maintenance	Coast care	December-April	As needed
5 [2020]	Spot clearance with a digger	WDC	July	
	Respraying of: Cape ivy Japanese honeysuckle Periwinkle raupō	DOC/Horizons	October	If needed
	Public or school planting day – at Planting site 1, 2 or 3.	Coast care	September/October	Contingent on sourcing eco-sourced plants Replant depending on the survival rates
	Planting site maintenance	Coast care	December-April	As needed