Options for the enhancement of Grovetown Lagoon

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Executive Summary

The Grovetown Lagoon Working Group has a vision to improve the present state of the greater Grovetown Wetland and Lagoon area.

To facilitate this process NIWA was engaged to provide:

- An ecological evaluation of the wetland margins of the Grovetown Lagoon describing the flora of the area and options for enhancement.

- A discussion of options for controlling dense aquatic weed beds.

- An evaluation of the feasibility of achieving the vision and goals of the Grovetown Lagoon Working Group.

The wetland was visited with members of the Grovetown Lagoon Working Group on 22 May 2002, to survey the wetland flora.

Approximately 65% of wetland area at Grovetown Lagoon was dominated by invasive crack willow (*Salix fragilis*) but half still retained an abundance of native plants in the understorey. The remaining areas of wetland were relatively intact although they contained small infestations of several problematic weeds including reed sweetgrass (*Glyceria maxima*), hawthorn (*Crataegus monogyna)* and grey willow (*Salix cinerea*).

Significant improvements to the wetland could be gained by reducing crack willow and hawthorn and eradicating reed sweetgrass and grey willow. Using prescribed methods (Section 3) this should be attainable. To improve the areas with few native plants, requires extensive replanting with appropriate native wetland and riparian species.

The lagoon supports vigorous growths of the aquatic weeds, *Egeria densa* and *Lagarosiphon major*. The most feasible methods of controlling these species are either cutting/harvesting and/or chemical control using the herbicide diquat. Both methods will provide short term control only and will need to be repeated on a regular and frequent basis to achieve the vision and goals for the lagoon. There are currently no other management tools for permanently reducing the growth of these weeds that would be suitable for Grovetown Lagoon.

The vision for the Grovetown Lagoon Enhancement Project is considered achievable in the wetland area. Improvement of the lagoon to achieve the desired goals of the Grovetown Lagoon Working Group will require ongoing control of aquatic weeds but is unlikely to result in re-establishment of native aquatic plant communities.

1. INTRODUCTION

Grovetown Lagoon is an old oxbow loop of the Wairau River in Marlborough. Hydrological modifications and nutrient inputs from the surrounding catchment have contributed to the degradation of natural and recreational values. The Grovetown Lagoon Working Group (comprised of the three local Iwi, local community representatives, Nelson-Marlborough Fish and Game Council, the Department of Conservation and Marlborough District Council) have a collective vision to improve the present state of the greater Grovetown Wetland and Lagoon area.

To facilitate this process NIWA was engaged to provide:

- An ecological evaluation of the wetland margins of the Grovetown Lagoon describing the flora of the area and options for enhancement.
- A discussion of options for controlling dense aquatic weed beds.
- An evaluation of the feasibility of achieving the vision and goals of the Grovetown Lagoon Working Group.

2. STUDY SITE

The main channel of the Grovetown Lagoon is 1.9km long, up to 80m wide in parts, and varies in water depth from 1-6m. It is connected to the Wairau River with an inlet and outlet which are controlled by floodgates that open on the outgoing tide. Water also comes from a small rural catchment to the west, the small town of Grovetown and a small spring in a wetland to the northeast of the northern outlet (Figure 1).

Grovetown Lagoon is one of only a few sizeable freshwater wetlands (15ha) remaining on the Wairau River floodplains. Both submerged and wetland vegetation have been extensively modified by introduced plants. Despite this, the lagoon provides valuable habitat for a range of native plants, fish and birds. Of particular note is a significant colony of little shag (*Phalacrocorax melanoleucos brevirostris)* (Department of Conservation, unpublished data), the presence of the uncommon swamp nettle (*Urtica linearifolia*) and swamp buttercup (*Ranunculus macropus*) and high numbers of common bully (*Gobiomorphus cotidianus*), shortfinned eel (*Anguilla australis*) and inanga (*Galaxias maculatus*) (Downes et al. 1999).

In general water quality is reasonably good, although faecal coliforms have been recorded above levels recommended for bathing (Downes et al. 1999).

3. WETLAND VEGETATION

3.1 Vegetation survey and enhancement options

A site visit to Grovetown Lagoon was made with members of the Grovetown Lagoon Working Party (Jeffrey Hynes, Peter Hamill, and David Oberdries) on the 22 May 2002. A number of sites around the lagoon were surveyed and the characteristic species of the broad vegetation types and problem weed species were recorded. This information was used to update an earlier vegetation map prepared by the Department of Conservation (unpublished data from a survey carried out in May 2001) and to determine enhancement options.

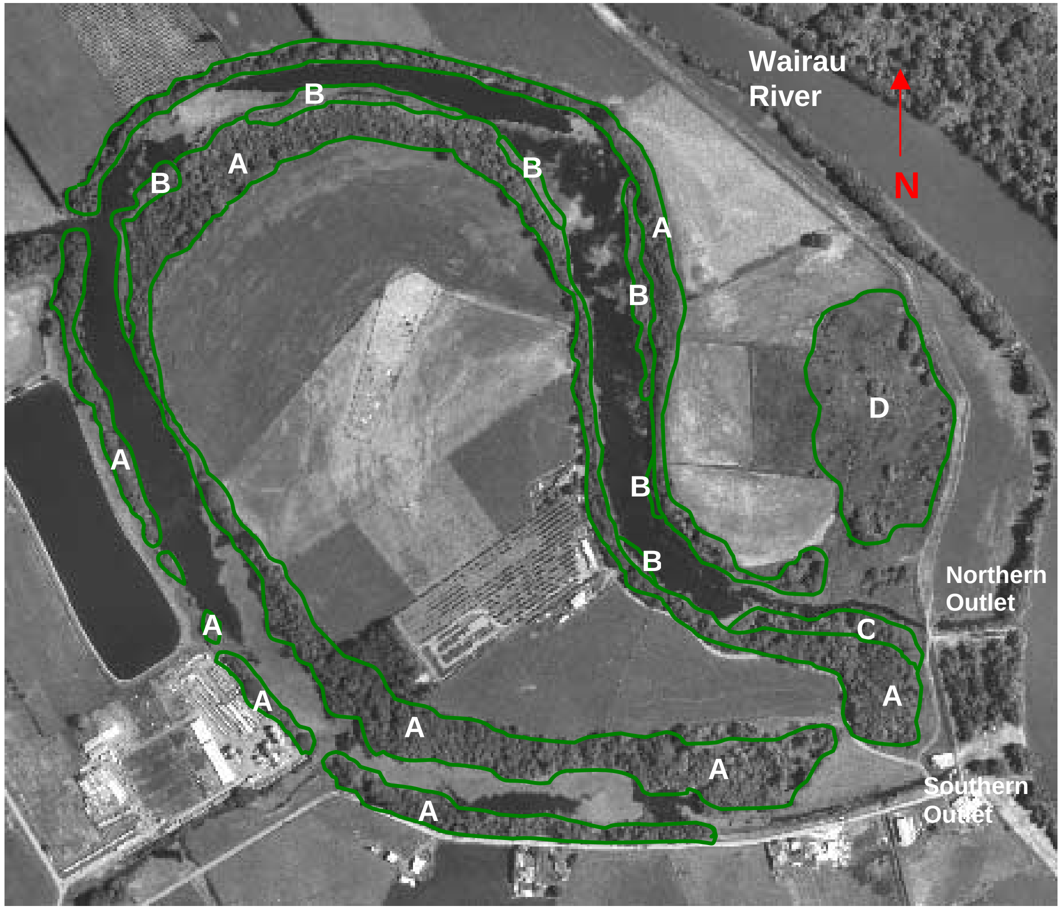
The main vegetation types are shown in Figure 1 and are described below with a discussion of enhancement options. Enhancement was defined by the Grovetown Lagoon Working Group as 'to improve its present state'. This has been interpreted as managing the area towards a more indigenous state.

3.1.1 Crack willow treeland

The crack willow treeland fringing almost the entire margin of the oxbow lagoon covered 10ha (65%) of the wetland area. Crack willow (*Salix fragilis*) was the dominant canopy species although there were small stretches of the oxbow margin where weeping willow (*Salix babylonica*) was more abundant. On the western and southern sides of the outer loop of the oxbow, the understorey contains very few native species probably as a result of past grazing. While the botanical values of this area were low, the tall crack willow provided habitat for roosting birds, nesting sites for little shags and shaded the edges of the lagoon reducing water temperatures and improving habitat for aquatic life.

On the margin of the inner loop of the oxbow and on the eastern outer margin, tall crack willow trees continued to dominate but there was a much higher proportion of native species in the understorey. These native species included the sward forming

Figure 1: Map of vegetation types at Grovetown Lagoon.



KEY

A	Crack willow treeland
B	Raupo reedland
C	Coprosma shrubland
D	*Carex geminata* – raupo sedgeland

Carex geminata and also *Carex secta*, mingimingi (*Coprosma propinqua*) and karamu (*Coprosma robusta*). Native swamp willow weed (*Persicaria decepiens*) and introduced water pepper (*Persicaria hydropiper*) formed a floating mat at the edge of the willow as shown in Plate 1.

Plate 1: Floating mats of swamp willow weed and water pepper (both bright green) fringe the water adjacent to the crack willow.

Enhancement options

Crack willow is an invasive species that spreads by the rooting and sprouting from detached twigs and will out-compete many native wetland and riparian species. It is therefore recommended that the emphasis for enhancing the area covered by crack willow should be to reduce its extent and prevent re-colonisation to allow a self-sustaining area of native vegetation to be established. This will be most difficult on the western and southern sides of the outer loop of the oxbow where there is a lack of native species. This area will need to be planted with appropriate native species (Table 1) after crack willow are killed by the drill and inject method recommended in Section 3.2.

Table 1: Plants suitable for the margins of the oxbow lagoon.

Scientific name	Common name	Life form	Height (m)	Zone
Carex geminata	rautahi	sedge	1	lagoon edge
Carex secta	purei	sedge	0.8	lagoon edge
Carex virgata	swamp sedge	sedge	0.8	lagoon edge
Coprosma propinqua	mingimingi	shrub	1	streambank
Coprosma robusta	karamu	shrub	4	streambank
Cyperus ustulatus	giant umbrella sedge	sedge	1	lagoon edge
Juncus sarophorus	leafless rush	rush	2	lagoon edge
Leptospermum scoparium	manuka	tree	4-6	streambank

Crack willow canopy provides a good microclimate for establishing native plants underneath. It is therefore recommended that underplanting with native species be undertaken either before willows are killed or at the same time (the treated trees will continue to provide some shading as they slowly break down). Particularly dense patches of crack willow may make replanting difficult (because of access and lack of planting space) and in these circumstances it may be more effective to remove willows before establishing native vegetation. If this occurs then all weeds will need to be cleared before planting begins and some ongoing weed control may be necessary.

The rest of the crack willow treeland (i.e. the inner loop of the oxbow lagoon and the eastern margin) will be easier to restore because of the higher proportion of native species present. To return the area to a more indigenous state will again require killing the crack willow. Replanting however can be limited to underplanting with late successional species, particularly tall riparian trees (Table 2) to provide shading of the lagoon edge and nesting and roosting sites for native birds.

Planting is best carried out between April and September to allow plants enough time to gain maximum root growth before hotter and drier summer weather.

Table 2: Plants indigenous to the Wairau Ecological Region that are recommended for planting into existing floodplain and riparian vegetation.

Scientific name	Common name	Life form	Height (m)	Zone
Blechnum novae-zelandiae	swamp kiokio	fern	1	floodplain or streambank
Carex dissita		sedge	0.8	drier part of the floodplain
Cordyline australis	cabbage tree	tree	5	floodplain or streambank
Elaeocarpus hookerianus	pokaka	tree	14	floodplain
Laurelia novae-zelandiae	pukatea	tree	30	floodplain
Myrsine divaricata	weeping mapou	shrub	3	floodplain or streambank
Pennantia corymbosa	kaikomako	tree	12	floodplain or streambank
Pittosporum tenuifolium	kohuhu	tree	10	floodplain or streambank
Plagianthus regius	lowland ribbonwood	tree	17	streambank or floodplain
Prumnopitys taxifolia	matai	tree	40	streambank or floodplain
Sophora microphylla	kowhai	tree	4-6	streambank

Weeping willow are not as invasive as crack willow but their height (~12m) makes them a prominent feature and detracts from efforts to achieve a native dominated landscape. Weeping willow could be removed at the same time as the crack willow using the same drill and inject method.

3.1.2 Raupo reedland

There were a number of dense patches of raupo (*Typha orientalis*) in the northern and eastern parts of the lagoon fringing the crack willow treeland with a dense mat of swamp willow weed and water pepper extending into the lagoon. These stands provide valuable habitat for wetland birds such as banded rail and Pukeko and the mat of willow weed and water pepper provide a food source for waterfowl.

Enhancement options

The raupo reedland was healthy and not threatened by surrounding introduced vegetation. Stock find raupo very palatable and their trampling is likely to eliminate the reedbeds so fencing is recommended to prevent stock access to the lagoon. Removal of crack willow from the oxbow margins is also likely to increase habitat for raupo.

3.1.3 Coprosma shrubland

A small area (0.5 ha) of Coprosma shrubland was located near the northern outlet of the lagoon. The main canopy species were karamu, mingimingi and a cross between the two species *Coprosma robusta* x *propinqua*. Other native species associated with this vegetation type include cabbage tree, kiokio (*Blechnum novae-zelandiae*), *Carex dissita*, mahoe (*Melicytus ramiflorus*) and manuka. There are also several weed species found within this vegetation type, the worst being common hawthorn (*Crataegus monogyna*), and crack willow.

Immediately adjacent to this area is a tall forest of old crack willow with a similar understorey to the Coprosma shrubland that has also been planted with kahikatea (*Dacrycarpus dacrydiodes*). This area has the potential to be returned to Coprosma shrubland and combined with the adjacent area of Coprosma shrubland, could be treated as a 'restoration unit', as both areas will benefit from a similar restoration approach.

Enhancement options

Control of crack willow and hawthorn are recommended in both the Coprosma shrubland and the adjacent area of old crack willow. There is an abundant seed source for most of the lower tier and groundcover species and therefore no additional planting should be necessary. It would however be a suitable environment for re-introducing some of the taller swamp species that are indigenous to the Wairau Ecological region such as pokaka (*Elaeocarpus hookerianus*) and pukatea (*Laurelia novae-zelandiae*) as listed in Table 3. Kahikatea has been planted here but it is not listed as indigenous to the Wairau Ecological Region (Meurk et al. 2001).

3.1.4 *Carex geminata*-raupo sedgeland

In between the oxbow lagoon and the Wairau River is an area of *Carex geminata*-raupo sedgeland. This area contained the least modified wetland vegetation with a diverse mix of native sedges and herbs including the uncommon swamp nettle. The most abundant species were raupo and *Carex geminata*, however there were also swards of spike sedge and slender spike sedge (*Eleocharis gracilis*). Crack willow was found in only a few areas here because of the permanently high water table and so was not considered a threat to this area. Of concern was the presence of small amounts of the problematic weed species, grey willow (*Salix cinerea*) and reed sweetgrass (*Glyceria maxima*). Both of these species can form dense monocultures that exclude all other species as seen in other wetlands in New Zealand. They both appear to be confined to this part of Grovetown Lagoon and in small enough patches to be eradicated.

Enhancement options

Urgent eradication of grey willow (*Salix cinerea*) and reed sweetgrass (*Glyceria maxima*) from this area.

3.2 Weed management

The most significant restoration issue for Grovetown Lagoon is the dominance of crack willow which has already substantially transformed the natural character of the wetland areas particularly along the margins of flowing waterways and in seasonally waterlogged soils such as those that occur on the levees and elevated floodplain areas. There are other species that also threaten to have a substantial impact. These are grey willow, hawthorn and reed sweetgrass. Table 3 lists the recommended methods for controlling weed species.

Table 3: Recommended methods for controlling / eradicating key weed species.

Weed species	Recommended method
Crack willow, grey willow and weeping willow	All of these willow species will spread from stem fragments so the most effective method for controlling these species and preventing their further spread is by using the drill and inject method described by Cook (1999) with the following herbicide mixture; 40g of Escort® + 500mL of water + 1.5L glyphosate + 5mL Pulse® penetrant + 1ml marker dye. If seedlings can be uprooted without breaking off fragments then remove the entire plant and dispose of offsite (burn or landfill). For larger plants with stem diameters too small to be injected (i.e. < 50mm) cut and paint with above herbicide mix. *Timing:* October to January, follow-up in February / March.
Reed sweetgrass	Gallant® (should not affect native sedges). *Timing:* Apply at the early seedhead stage to actively growing plants (early summer) but avoid when drought stressed. May need re-application in the following spring.
Hawthorn	Hand remove by clipping the trunk to 20cm above ground. Either grub out the roots or treat the remaining stem with a brush of either Escort® or Roundup®. Hand pull new growth in spring. *Timing*: November to March.

Willows that have been drilled and injected with herbicide should be left until the tree is dead (this will be evident if there is no re-growth the following spring). Trees can then be either left to degrade where they are, or if they are causing an obstruction, removed carefully to avoid damage to native undergrowth. If the choice is to remove dead willow trees then this should be carried out during the growing season (spring/summer) to allow any understorey plants damaged during the removal, to recover before winter. If there has been extensive underplanting of native plants beneath the willows, then willows shouldn't be removed until the plantings have become well established and have formed a closed canopy (usually takes 2-3 years).

4. SUBMERGED VEGETATION

4.1 Current extent

A 1999 survey of submerged vegetation reported that the lagoon was dominated by the aquatic weeds *Egeria densa* (egeria) and *Lagarosiphon major* (lagarosiphon), (Downes et al. 1999). At the southern end of the lagoon, egeria formed dense surface reaching beds but lagarosiphon became more dominant towards the northern end of the lagoon. This was still the case in May 2002.

While aquatic plants provide a variety of valuable habitats for fish and invertebrates and can improve water quality, the density of weed in the Grovetown Lagoon could be having a detrimental effect on fish populations (Downes et al. 1999) and is not consistent with the goals of the Grovetown Lagoon Working Group, described in Section 5. While it would be desirable to eradicate exotic aquatic weeds from the lagoon this is not possible given the extent of the infestation and the inevitable re-infestation from connecting waterways. The best that can be achieved is to reduce the abundance of aquatic weeds to a level where they provide benefits consistent with the vision and goals, including the enhancement of fish habitat. It is however unlikely that native aquatic plant communities will ever be restored in the lagoon as they are unable to compete with the tall dense beds formed by egeria and lagarosiphon (Howard-Williams et al. 1986).

4.2 Options for weed control

There are a range of methods available for controlling aquatic weeds including chemical control, mechanical control, habitat manipulation and biological control. Each of these methods is evaluated below with regard to Grovetown Lagoon.

4.2.1 Chemical control

Herbicides are a proven method for controlling (but not eradicating) most invasive weeds. The only herbicide registered for use in water in New Zealand is diquat, which is available in both an aqueous and gel formulation. It is usually applied boom spraying equipment mounted on a boat, and is the recommended method for Grovetown Lagoon.

Advantages

- Diquat is a selective herbicide that is highly effective on egeria, moderately effective on lagarosiphon and may cause some dieback of pondweeds (i.e. *Potomogeton* species). It has little effect on native charophytes but may cause a small amount of damage to the native pondweed (*Potomogeton ochreatus*) present in the lagoon, which should recover and also has the ability to re-establish from seed in the unlikely occurrence that it is harmed beyond recovery.

- At herbicidal rates and expected contact times, diquat is not known to be toxic to fish or most other aquatic life (Extoxnet 2001).

- Diquat disappears rapidly in natural waters because it binds to suspended clay and organic particles. Once adsorbed, diquat has no residual toxicity and is slowly degraded to CO_2 by microbial organisms. While it can persist in sediments, in Lakes Okataina, Rotoroa, Rotoiti, Rotorua and Marlborough waterways (where in some cases is has been used annually for over 30 years) it is below detectable levels in the sediments (NIWA unpublished data).

- Acute toxicity of diquat to humans is conservatively estimated to be 50mg kg^{-1} . An adult would need to drink 1500 litres of water treated at maximum allowable herbicidal rates to ingest this quantity.

- The cost is relatively low with application and chemical costs typically in the order of $1600/ha.

Disadvantages

- Weed control will be short term, making repeat applications necessary to maintain biomass at a desirable level. We anticipate that egeria in Grovetown Lagoon will recover to pre-treatment biomass within 3 months during the growing season.

- The level of control can be variable as the efficacy of diquat is affected by water turbidity, epiphytic growths and sediment on plants as well as water movement. Turbidity is generally low in Grovetown Lagoon, but epiphytic growths and sediment deposits were noted in the calmer parts of the lagoon.

- If the water is used for bathing, drinking, stock watering or irrigation then the label requires alternative arrangements are made for 24 hours following application.

- Treated plants remain in water and rot in-situ. In waterbodies with high weed biomass to water volume, as in the Grovetown Lagoon, a maximum of 25% of the waterbody should be taregeted at any one time to minimise oxygen depletion.

4.2.2 Mechanical control

There are a range of mechanical control options including cutting and harvesting, dredging and mechanical diggers.

Dredging involves using a suction dredge to remove weeds and is effective in preventing the spread of fragments. It is however generally not a suitable option for weed management in a waterbody with extensive areas of weed bed, such as Grovetown Lagoon, due to the high cost (c. $15,000- 20,000 ha^{-1}) and slow rate of clearance.

Mechanical diggers are not suitable in an area the size of Grovetown Lagoon due to their limited reach and access.

The only remaining option is cutting and harvesting. Its advantages and disadvantages are listed below.

Advantages

- Weed cutters can target specified areas, ensuring weed is removed where and when it is required.

- Weed harvesting removes nutrients from the system instead of leaving weed to rot, which would be beneficial in the nutrient-rich Grovetown Lagoon.

- Weed cutting does not usually require a consent.

Disadvantages

- Weed control will be short term, and therefore to maintain low levels of weed it will be necessary to cut and harvest several times a year depending on re-growth rates. During the growing season we anticipate that egeria in Grovetown Lagoon will recover its pre-cutting biomass within 3 months.

- Weed harvesting usually results in capturing a wide range of aquatic organisms and small fish that live within the weed beds, which will be lost from the system when the weed is removed.

- Cutting, collecting and dumping of weed is often costly and can vary greatly with the density of weed and the distance to the dump site. It is usually priced between \$2000-4000 ha^{-1}.

- Obstacles can prevent the weed harvester accessing all areas of a waterbody where weed needs to be controlled. This may be a problem in Grovetown Lagoon with dead willow in the main waterway.

4.2.3 Habitat manipulation

Aquatic plants require water and suitable nutrients, oxygen, light, substrates, temperature and pH for growth. Variations outside a definable range can destroy plants. Deliberate manipulation techniques can be used in appropriate situations to control plants.

The most common types of habitat manipulations are;

- Reduction of nutrients entering a waterbody.

- Drawing down water levels to desiccate aquatic plants.

- Shading and substrate modification using groundcovers such as polyethylene and synthetic rubber materials.

Reduction of nutrients into Grovetown Lagoon is unlikely to reduce the biomass of aquatic weeds. Lagarosiphon reaches nuisance proportions in lakes with low levels of nutrients (e.g. Lake Wanaka and Lake Taupo). Nutrient reduction may however reduce algal growths that occur from time to time within the lagoon and would help improve overall water quality. Riparian management along waterways that feed into the lagoon would be a useful method for reducing inputs of nutrients if implementation problems, as outlined in Young et al (2000), can be overcome.

Drawdown would need to be in the order of 2 m or more and can only be carried out in a waterbody where inflows or outflows can be manipulated. This would not be possible at Grovetown Lagoon. Similarly shading using groundcovers isn't a feasible option in the lagoon because of its size, the widespread nature of the infestation and sedimentation would soon render groundcovers useless.

4.2.4 Biological control

The most widely used method of biological control for submerged plants in New Zealand is grass carp (*Ctenopharyngodon idella*). Their use requires approval from the Minister of Conservation and the Ministry of Fisheries. Grass carp feed on aquatic plants including native species before all target species (Cassani 1996). They usually remove all submerged vegetation and can increase phytoplankton (which would reduce water clarity) and reduce fish habitat.

Containment of grasscarp within a waterbody is necessary for Department of Conservation approval and weed control. Containment within the Grovetown Lagoon would require constructing grills on the connections to the Wairau River. This could jeopardise its current use for flood control. Grills on the inflows may also be required if there is concern about grasscarp removing submerged vegetation in these waterways.

The difficulty of achieving containment and the ecological consequences of removing all submerged vegetation from the lagoon make this neither a feasible or desirable option.

4.3 Recommendations

The only feasible methods of aquatic weed control for Grovetown Lagoon are weed cutting/harvesting and chemical control using diquat. Both methods will provide short term control only and will need to be continued on a regular basis to prevent weed beds from reaching nuisance levels.

Both methods have advantages and disadvantages as discussed. The key issues are likely to be cost (mechanical control is potentially twice the cost), the acceptability of the disadvantages of each method to the local community/interested parties and the degree to which each method contributes to the goals for the lagoon. An analysis of the latter (presented in the following section) indicates that cutting/harvesting is more likely to achieve the goal of improving water quality.

5. EVALUATION OF VISION AND GOALS

The vision of the Grovetown Lagoon Working Group is to improve the present state of the greater Grovetown Wetland and Lagoon area. More specifically the group would like to achieve the following goals:

- make the lagoon safe, clean and friendly;
- improve the water quality;
- be visually pleasant;
- provide a source of food and other resources;
- provide a pleasant environment for family recreation.

While the wetland area of the Grovetown Lagoon has been heavily modified by introduced plants, there are still substantial areas of indigenous wetland plant communities that provide a valuable core for restoration efforts to build on. Control of the key weed species should be attainable and will contribute substantially to the vision of improving the present state of the wetland. The most difficult area to improve will be the outer margin of the oxbow loop, which has so few native plants that the area will need to be extensively replanted to return the area to a more natural state. This is however possible with adequate resources and ongoing commitment to maintenance.

Controlling the aquatic weed beds in the lagoon will only provide short term improvements. There are currently no acceptable one-off management tools for permanently reducing the growth of weed beds. The best that could be achieved is a reduction in the rate of growth of weed beds by reducing the level of nutrients entering the lagoon from the surrounding catchment and by weed harvesting. Even this may be optimistic as bottom sediments are likely to be already high in nutrients, given the receiving discharge from surrounding catchment activities (pers comm. Jeffrey Hynes).

On-going short term control of weed beds will however contribute to some of the more specific goals of the working group as described below;

- *improve the water quality*

  The harvesting of aquatic weed in the lagoon will theoretically reduce the amount of nutrients in the lagoon unlike chemical control, which could result in localised oxygen and increase nutrients back in the water column and bottom sediments. The extent of such impacts is not known and would require a nutrient budget for the lagoon to better predict such impacts.

- *be visually pleasant*

In many areas of the lagoon, aquatic weeds reach the surface where they can be aesthetically displeasing and may trap litter and floating vegetation such as duckweed (*Lemna minor*) and Pacific azolla (*Azolla rubra*) as shown in Plate 2. Both mechanical and chemical control will temporarily prevent weeds reaching the surface and contribute to this goal.

Plate 2: Mats of floating Pacific azolla (red) on top of surface reaching weed beds.

- *provide a source of food*

Several fish such as whitebait (inanga), flounder and eel currently utilise the lagoon (Downes et al, 1999). All of these fish benefit from the presence of aquatic plants, however the extremely dense beds that occur in some parts of the lagoon are likely to be limiting fish movement and foraging (Downs et al, 1999). Reduction of weed beds by either method should help increase the populations of harvestable species.

- *be a place for family recreation*

  Swimming, boating and kayaking could be desirable activities if weed beds were prevented from reaching the top 2m of the water surface. Water quality would need to be improved, as faecal coliforms counts exceed acceptable levels for contact recreation. Point sources would need to be located and removed and diffuse sources could be reduced with riparian management.

6. CONCLUSIONS

Approximately 65% of wetland plant communities at Grovetown Lagoon are dominated by the invasive crack willow. Of these areas, half still retain an abundance of native plants in the understorey. Significant improvements to these areas will be gained by reducing crack willow at these sites. To gain sustained improvement in the remaining areas where few native plants remain, extensive replanting with appropriate native wetland and riparian species would be required.

The wetland plant communities that are not dominated by crack willow are relatively intact and require only a small restoration effort to retain their integrity. Problematic weed species at these sites include grey willow, crack willow, hawthorn and reed sweetgrass. Control and or eradication of these species should be attainable and would contribute substantially to the vision of improving the present state of the wetland.

The lagoon supports vigorous growths of the aquatic weeds, *Egeria densa* and *Lagarosiphon major*. The most feasible methods of controlling these species would be either cutting/harvesting with a weed cutter or chemical control using the herbicide diquat. Both methods will only provide short term control and will need to be continued on a regular basis to achieve the vision and goals for the lagoon. Of the two methods, cutting and harvesting is more likely to achieve the goal of improving water quality. There are currently no other management tools for permanently reducing the growth of these weeds that would be suitable for use at Grovetown Lagoon.

The vision for the Grovetown Lagoon Enhancement Project is considered achievable in the wetland area. Improvement of the lagoon to achieve desired outcomes, including the enhancement of fish habitat, will require ongoing control but is unlikely to result in the return of native aquatic plant communities.

7. ACKNOWLEDGEMENTS

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