South Kaipara Head Hornwort Strategy

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Cover image: Lake Rototoa (Ototoa) hornwort (left) invading native meadows.

South Kaipara Head Hornwort Strategy

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Executive summary

Auckland Council is working with stakeholders and the community of South Kaipara Head to manage lakes in the area. Hornwort is an invasive aquatic weed that is affecting the biodiversity, utility and water quality in these lakes. Auckland Council has checked most of the water bodies in the area for hornwort (including drains and streams) and asked NIWA to visit these sites and assist by providing recommendations on the control options to be used with the aim of hornwort eradication for each water body and how the approach might be staged to spread the work over a number of years.

The sites identified with hornwort were (from north to south):

1. South Head Lake
2. Lake Rototoa (Ototoa)
3. Kuwakatai
4. Fuller Road middle lake
5. Fuller Road south lake
6. Te Kanae
7. North Kereta
8. Kereta
9. South Kereta
10. Lake Karaka South One A
11. Lake Karaka South One B (Jenny Bright's front pond)
12. Fordyce Road, nursery pond.

On 31 March 2014 the sites were visited with the exception of sites 2, 3, 6, 7, and 8 which were last surveyed by NIWA in 2012. There are water bodies north of North Kereta that should be inspected.

The two most suitable options for hornwort eradication are grass carp and endothall. The water bodies are suited to these options as they do not have major surface inflows or outflows although most smaller water bodies would not be suitable for grass carp as large parts are too shallow for grass carp grazing and the larger lakes would not be suitable for endothall as logistically the amount of chemical required would be cost prohibitive and the outcome uncertain. Primarily based on lake volume, endothall was recommended for Fuller Road Lake middle, Fordyce Road nursery pond, Lake Karaka South One A, Lake Karaka South One B, Fuller Road south, South Kereta and South Head Lake while grass

carp are recommended for North Kereta, Lake Te Kanae, Lake Kereta (already underway), Lake Kuwakatai and Lake Rototoa.

North Kereta is a priority as it is adjacent to Lake Kereta which is hornwort free now (removed by grass carp) and also Fordyce Road nursery pond as it is easily accessed by many people working in nearby glass houses. Grouping the lakes for economies of scale and location would also be a likely driver of the treatment sequence.

Lake Rototoa can only be rid of hornwort using grass carp, but will lose its current high native biodiversity as a result (although its seed bank will persist). It is suggested the decision to intervene in this lake could be deferred until native biodiversity is minimal and other water bodies are hornwort free. In the meantime diquat should be used or a weed cordon installed at the point of public access to ensure it is free of hornwort.

It is recommended that the activities of eel fishers in the area be determined and controlled to prevent introductions or transfers of weed via their nets. Also public education should be used to inform people of the damage aquatic weeds can do to a lake and to dispel the fallacy that weeds enhance coarse fisheries and wildfowl habitat and so reduce the motivation for deliberate introductions.

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1.0 Background

Auckland Council is working with stakeholders and the community to manage the lakes on South Kaipara Head. One of the major issues affecting the lakes is the invasive aquatic weed hornwort (*Ceratophyllum demersum*) as identified for the Auckland region in 2005 (Champion and de Winton 2005). It threatens the biodiversity, utility and water quality in these lakes and ranks as one of our worst aquatic weeds (Champion and Clayton 2000; Clayton and Champion 2006) causing large scale weed problems with growths up to 10m tall, weed drift that blocks water intakes and a capability to displace desirable aquatic vegetation over a 1m to 14m depth range (de Winton et al. 2009).

Auckland Council has checked most of the South Kaipara Head water bodies to delimit hornwort and asked NIWA to visit the sites identified and assist by providing recommendations on control options for eradication for each water body and how the approach might be staged to spread expenditure over a number of years.

The sites identified with hornwort were (from north to south):

1. South Head Lake
2. Lake Rototoa (Ototoa)
3. Kuwakatai
4. Fuller Road middle lake
5. Fuller Road south lake
6. Te Kanae
7. North Kereta
8. Kereta
9. South Kereta
10. Lake Karaka South One A
11. Lake Karaka South One B (Jenny Bright's front pond)
12. Fordyce Road, nursery pond.

2.0 Options

The options currently available for hornwort eradication are endothall, diquat and grass carp. A background to these options is provided.

2.1 Endothall

Endothall has been evaluated as an aquatic herbicide in New Zealand (Woon and Mason 1969; Wells and Clayton 1993; Hofstra and Clayton 2001; Hofstra et al. 2001) but it was not until 2005 that Aquathol® K (aqueous endothall) and Aquathol® Super K (pellets) were registered for use. Since then endothall has eradicated hornwort from Centennial Lake, Timaru, with a single dose of endothall at 5 mg L^{-1} (Wells and Champion 2010) and similarly lagarosiphon was eradicated in five out of six water bodies (up to 1.4 ha) with treatments as low as 0.11 mg L^{-1} (50 times less than the maximum label rate of 5ppm) (Wells and Champion 2010), suggesting that hornwort eradication might be achievable at lower rates than indicated on the label.

In Lake Otamateoroa (10 ha) two low dose whole-of-lake endothall treatments were evaluated (0.1 mg L^{-1} and two years later at 1 mg L^{-1}) with changes to the lake biota and water quality monitored (Wells and Champion 2014). Both treatments removed virtually all hornwort from the lake and the herbicidal effects were specific to hornwort even though there were 34 other native species (including milfoils and pondweed species) recorded in the lake. Removal of hornwort reduced competition and provided increased habitat for many of the native species, particularly the charophytes (*Chara australis* and *Chara globularis*). Charophyte meadows are a highly desirable attribute for lake management and restoration and their return has the added benefit of restoring their seed banks (de Winton et al. 2000). Despite large volumes of hornwort being killed in a short space of time (< 1 week in the second treatment), monitoring showed the effects of the whole-of-lake weed bed collapse on water quality was minimal. Dissolved oxygen remained above 76% saturation in the top 2.5m and above 61% saturation in the bottom waters. The DO levels did not affect fish abundance, with common bully (*Gobiomorphus cotidianus*) still abundant post treatment and no observed fish mortalities. Rotifer composition and abundance wasn't affected as identified in sampling pre- and post-treatment conducted by the Waikato Regional Council (Dr Bruno David, scientist Waikato Regional Council, pers. comm.). Birds continued to use the lake habitat and black swan (*Cygnus atratus*) continued to nest and raised young. Some water quality parameters improved with nutrient levels (total

phosphorus and total nitrogen) decreased and water clarity increased in the month following treatment, though a causal relationship cannot be assumed.
Overall the level of efficacy for hornwort, its high selectivity for this species and low environmental impacts makes endothall a very useful tool in biosecurity and lake restoration.
Endothall use is subject to the Resource Management Act 1991 consent requirements and an Environmental Protection Authority permission is required with reporting and compliance requirements. There are label restrictions on the use of endothall that cause concern to users and the public relating to swimming, consumption of fish, irrigation, and stock watering. The United States Environmental Protection Agency recently assessed new data for endothall and the outcome was swimming is now permitted immediately following application, withholding periods for fish consumption and use were removed and irrigation and stock watering restrictions were relaxed. In the USA the parent company has now changed their product proprietary name from Aquathol to Cascade to distance itself from the old label restrictions. In New Zealand the “old” restrictions still apply although there are moves to seek a re-assessment to make conditions of use more user friendly.

2.2 Diquat

Diquat is an aquatic herbicide registered for use in New Zealand since the 1960s. It is similar to endothall in that it is effective on most of our invasive species including hornwort and has little effect on our native flora. Diquat has eradicated hornwort successfully in several sites in the South Island but is a strongly charged cation, rapidly de-activated by sediment and organic matter, so is not usually suitable for eradication as the buried portions of the weed remain viable.

2.3 Grass carp

Grass carp are commercially available to water body managers for controlling aquatic weeds in New Zealand. Their use is subject to approval from the Minister of Conservation (provided that there is a low risk of significant environmental impacts), the Ministry of Primary Industries, and from the regional Fish and Game Council (if release is to the habitat of sports fish or game birds), and consultation with Iwi and the public.

Originally the University of Auckland and then MAF Freshwater Fisheries, Rotorua (now NIWA) imported grass carp to evaluate their potential for biological control of aquatic weeds. Much research in New Zealand and overseas has shown their potential benefits for

aquatic weed control and risks to the aquatic environment (Pipalova 2006, Mitchell 1980, Rowe and Schipper 1985, Clayton et. al. 1999, Tanner et. al. 1990, Wells et. al. 2003 and Hofstra and Rowe 2008). There are a number of examples where grass carp have been used to eradicate a nuisance invasive species. For example, lake restoration was achieved in Lake Parkinson (a 1.9ha dune lake south of Auckland) where *Egeria densa* was eradicated. All fish (including unwanted coarse fish) were subsequently removed by treating the whole lake with rotenone (toxic to fish). The native plant populations re-established naturally and native fish were also re-introduced (Tanner et. al. 1990).

Along with satisfied users there are those who have had unrealistic expectations and who found grass carp were inappropriate for their requirements. Grass carp can be controversial as they remove all or most of the aquatic vegetation and can have impacts on aquatic life and water clarity. In a multi-use water body, the effects of grass carp may conflict with values such as fisheries, wildlife and conservation.

Grass carp are often confused with koi carp. The latter are common throughout the Waikato where they (together with rudd) are implicated in the loss of much aquatic vegetation and habitat in lakes. Koi carp can breed in our waterways whereas grass carp are extremely unlikely to do so.

To summarise the benefits of grass carp are:

- Grass carp can cheaply remove nuisance aquatic vegetation at sites suitable for the fish even over large areas that are not easily controlled by alternative means.
- Eradication is possible for aquatic weeds dependent on vegetative reproduction where re-infestation is unlikely.
- Grass carp cannot breed in these lakes.
- Grass carp help prevent undesirable loss of aquatic life associated with de-oxygenation beneath dense weed beds.

The disadvantages of grass carp can be:

- Virtually all aquatic vegetation will be eaten (including to a lesser extent the marginal habitat). This can happen very rapidly and will persist for as long as the fish are present at high enough densities for vegetation control.
- Fish re-capture is difficult and usually costly.
- Grass carp may significantly reduce waterfowl populations (particularly black swan) by removing aquatic vegetation on or within which the birds feed.
- Many invertebrate species require aquatic vegetation during part of their life cycle and their diversity and abundance will likely be reduced when grass carp are used.

2.4 Endothall versus grass carp

Endothall has the potential to eradicate hornwort within 7 to 60 days depending on temperature and amount of endothall used. Eradication with one treatment in smaller water bodies can be achieved but results can be uncertain particularly in larger water bodies. Endothall is a very selective herbicide and few species other than hornwort will be affected. Water use restrictions will apply following endothall application.

Grass carp will eat all the hornwort as long as water quality, depth and predation favour their survival. At about 50 to 100 fish per hectare of weed it will take 2 – 3 years until no hornwort can be found, then several years more to be sure no fragments remain concealed. Nearly all other vegetation will be removed and the marginal emergent vegetation heavily grazed. Water clarity may become poor in small or shallow water bodies and recovery of the fish is currently problematic. Natural attrition of fish can take decades.

In smaller water bodies where either option would be expected to eradicate hornwort, the preferred option is endothall as it gives quicker results and has less impact on desirable vegetation than grass carp.

3.0 South Kaipara Head hornwort sites

Twelve sites were identified with hornwort on South Kaipara Head and their locations are shown in Figure 1.

Figure 1 South Kaipara Head showing the location of the 12 sites with hornwort. 1. South Head Lake, 2. Lake Rototoa, 3. Kuwakatai, 4. Fuller Road Lake middle, 5. Fuller Road south, 6. Te Kanae, 7. North Kereta, 8. Kereta, 9. South Kereta, 10. Lake Karaka South One A 11. Lake Karaka South One B (Jenny Bright's front pond), 12. Fordyce Road, Nursery Pond.

3.1 South Head Lake

Figure 2 South Head Lake located at the top of the South Kaipara Head.

3.1.1 Size, access, vegetation

South Kaipara Head Lake is 157m by 108m (1.7ha). Lake access was through private land requiring 4WD and then wading through a raupo (*Typha orientalis*) swamp. The lake was dived and found to be dominated by hornwort up to 4m tall with 100% cover to 6m deep and 10 – 20 per cent cover across the middle of the lake to its maximum depth of 7.5m. No other submerged species were noted and water clarity was high with the in-water visibility about 5m. The lake was fringed with a wetland of mainly raupo.

3.1.2 Hornwort control options

Endothall would have a good chance of eradicating hornwort in this lake as the lake is relatively small (1.7 ha) and does not have any defined outlet or inflow. Endothall would be the preferred option but if it was not successful then grass carp would be.

3.2 Lake Rototoa (Ototoa)

3.2.1 Size, access, vegetation

Lake Rototoa is a relatively large (1066 ha) lake and up to 28m deep. There is no public vehicle access to launch a boat although it is possible with a 4WD across private property. Motorised boats are not permitted and the lake is no longer stocked with trout.

The native vegetation is well developed with a diverse range of species (Figure 3) and charophyte meadows recorded to 11.7m depth (Wells 2009). Emergents, native turf species and pondweeds are present. The invasive bladderwort, *Utricularia gibba* is also present, but is mostly restricted to shallow water (≤ 1.6 m). Hornwort is present throughout the lake and may become the dominant plant.

Figure 3 Lake Rototoa (Ototoa) has a highly diverse native vegetation growing to in excess of 10m deep. Tall growing pondweed (*Potamogeton cheesemanii*) is shown amongst a species rich charophyte meadow.

3.2.2 Hornwort control options

When hornwort was first found in the lake it was thought to be confined to the North Arm. The arm was netted off to contain the hornwort and attempts made to eradicate it with endothall. There were however difficulties in killing hornwort plants in an area influenced by a stream inflowing to the lake. It is thought the inflow diluted the endothall before the

target weed could receive a lethal dose. Later it became apparent that hornwort was present outside the arm and it has subsequently spread around the lake and threatens the highly diverse native plant communities in the lake. Eradication with endothall is not thought to be possible now. Grass carp could eradicate hornwort but would also remove the native species for as long as grass carp remained in the lake. However, the native species would be expected to re-establish (post grass carp) from seed or oospores present in the lake sediments. The decision to use grass carp would be more acceptable when hornwort has taken over and lake biodiversity is poor. In the meantime diquat could be used to slow down the hornwort invasion, but is not expected to eradicate the weed.

3.3 Lake Kuwakatai

Figure 4 Lake Kuwakatai aerial photograph.

3.3.1 Size, access, vegetation

Lake Kuwakatai is reported to be from 28 to 36ha in size and has a maximum depth of 15m. Access is through private land and requires 4WD to launch a boat from the southern end. In 1950, native charophytes were recorded to 4m depth (Cunningham et al. 1953). Beds of hornwort now extend as complete cover from the lake edge down to between 5 and 7.5m depth. Weed bed heights are commonly 4.5m and are surface-reaching in

shallow areas. Only one native submerged plant, *Myriophyllum triphyllum* was recorded but was not common. Emergent marginal plants were well developed along the northern and eastern shorelines and scattered along the southern shoreline (Figure 5).

3.3.2 Hornwort control options

This lake is too large for endothall to be a practical option. Grass carp are recommended and will impact little on the native biodiversity as hornwort has almost completely taken over. The top of the northern arm (Figure 4) may need endothall if the grass carp avoid this shallow area. The inflows should also be checked for hornwort. Diquat should be used to reduce hornwort biomass prior to grass carp release.

Figure 5 Lake Kuwakatai with some emergent *Eleocharis sphacelata* in the foreground.

3.4 Fuller Road lake middle

Figure 6 Fuller Road lake middle was mostly full of emergent *Carex secta*.

3.4.1 Size, access, vegetation

This is a small wetland about 0.03ha (300m^2) in size (Figure 6) and is accessible across farmland with a 4 WD. It had little water in it and several patches of hornwort (the only submerged species present) in very shallow water or damp ground (Figure 7). Other species present were *Azolla pinnata*, *Persicaria decipiens*, *Ludwigia palustris*, duckweeds, *Typha orientalis*, *Eleocharis sphacelata*, *Myriophyllum propinquum* and *Baumea* spp.

3.4.2 Hornwort control options

This site would be unsuitable for grass carp as it is too shallow. It could be easily controlled with a small amount of endothall.

Figure 7 A 5 m^2 patch of hornwort in Fuller Road lake middle.

3.5 Fuller Road south lake

Figure 8 Fuller Road south lake with open water and a 0.6ha wetland in the foreground.

3.5.1 Size, access, vegetation

The open water area is about 0.7ha and there is about 0.6ha of wetland (Figure 8) that appeared not to have any hornwort. The lake is accessible across farmland with a 4 WD and is used for duck shooting. The lake appears to be very shallow about 1m deep. Hornwort was the only submerged plant seen from a walk around the margin and there was *Azolla pinnata* floating on the surface giving the red colour in Figure 8.

3.5.2 Hornwort control options

Endothall is the recommended control option for hornwort as this lake is too shallow for grass carp (much <0.5 m). A close examination of the wetland will be needed to locate any pools that might harbor hornwort.

3.6 Lake Te Kanae

Figure 9 Lake Te Kanae is surrounded by trees but is accessible by a 4WD track visible at the south east end.

3.6.1 Size, access, vegetation

Lake Te Kanae is 5.6ha and is steep sided with a maximum depth of 18m. It is surrounded by trees but is accessible by a 4WD track at the south east end (Figure 9). Hornwort formed beds up to 3m in height extending from the margin of emergent plants to a maximum of 6.6m depth. The only other submerged plants seen were a native milfoil and fragments of the invasive bladderwort *Utricularia gibba* at one of five dive locations. Koi, rudd and tench (*Tinca tinca*) have been liberated to the lake (Grant Leighton, landowner,

pers. comm. 2008) and a large koi, together with signs of sediment disturbance was observed.

3.6.2 Hornwort control options

It might be possible to eradicate hornwort with endothall in this lake but that would be uncertain and would be expensive. There is a large volume of water in the lake and fragments were seen to 12m deep. Grass carp are recommended as they would eradicate the hornwort and the lake is of low biodiversity value in its present condition.

3.7 North Kereta

3.7.1 Size, access, vegetation

There is a lake north of Lake Kereta (Figure 10 and Figure 13). North Kereta is about 2.8ha and is likely to be < 2m deep if it is similar to Lake Kereta. It is fringed with a wetland and access was difficult. We walked to the south end of the lake from Lake Kereta in 2012 and confirmed it had dense hornwort and relatively clear water.

Looking at aerial photographs of the area there is a wetland complex extending further north with three water bodies (Figure 11) that have not been checked so cannot be commented on at this stage.

3.7.2 Hornwort control options

North Kereta needs to be looked at more closely but it is likely hornwort could be eradicated with either endothall or grass carp. The endothall option is recommended first.

Figure 10 North Kereta.

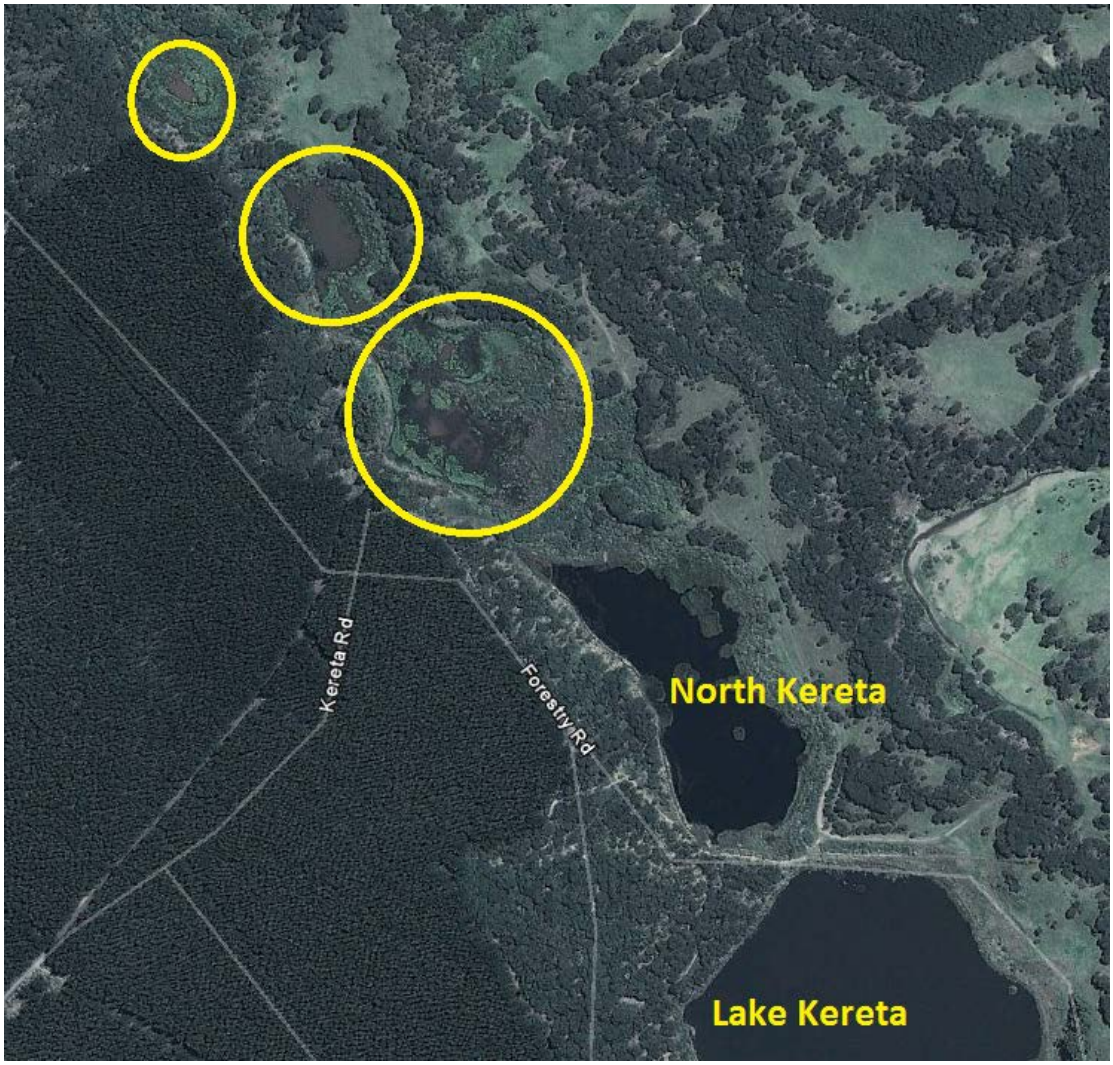

Figure 11 Water bodies north of North Kereta (within yellow circles) were not checked but may have hornwort.

3.8 Lake Kereta

Figure 12 Lake Kereta.

3.8.1 Size, access, vegetation

Lake Kereta is a narrow lake (Figure 12) 1.66km long and 23.6ha in area. It has a maximum depth of 2.3m. The lake is easily accessible with the road running alongside its southern basin (Figure 13), however the only boat ramp is on private land in the north basin which is used for water skiing.

In 1950 the lake was deeper (maximum depth 5 m) and native vegetation dominated by charophytes, pondweeds and milfoils was recorded to 4m deep (Cunningham et al. 1953). In 1988 the lake vegetation was dominated by native milfoils to 1.3m depth and the only invasive plant was the relatively benign *Potamogeton crispus*. This vegetation existed until at least the early 1990s (Gibbs et al. 1999) when hornwort was introduced.

Grass carp (*Ctenopharyngodon idella*) were stocked in Lake Kereta in 2008 and 2009 to improve amenity values of the lake. By the 2012, nearly all the hornwort was gone with only a few plants found amongst dense stems of marginal emergent beds of *Zizania latifolia*.

3.8.2 Hornwort control options

Grass carp have already been introduced to the lake and may have eradicated the hornwort already. The fish may be left in the lake to maintain its amenity value for skiing and prevention of re-establishment.

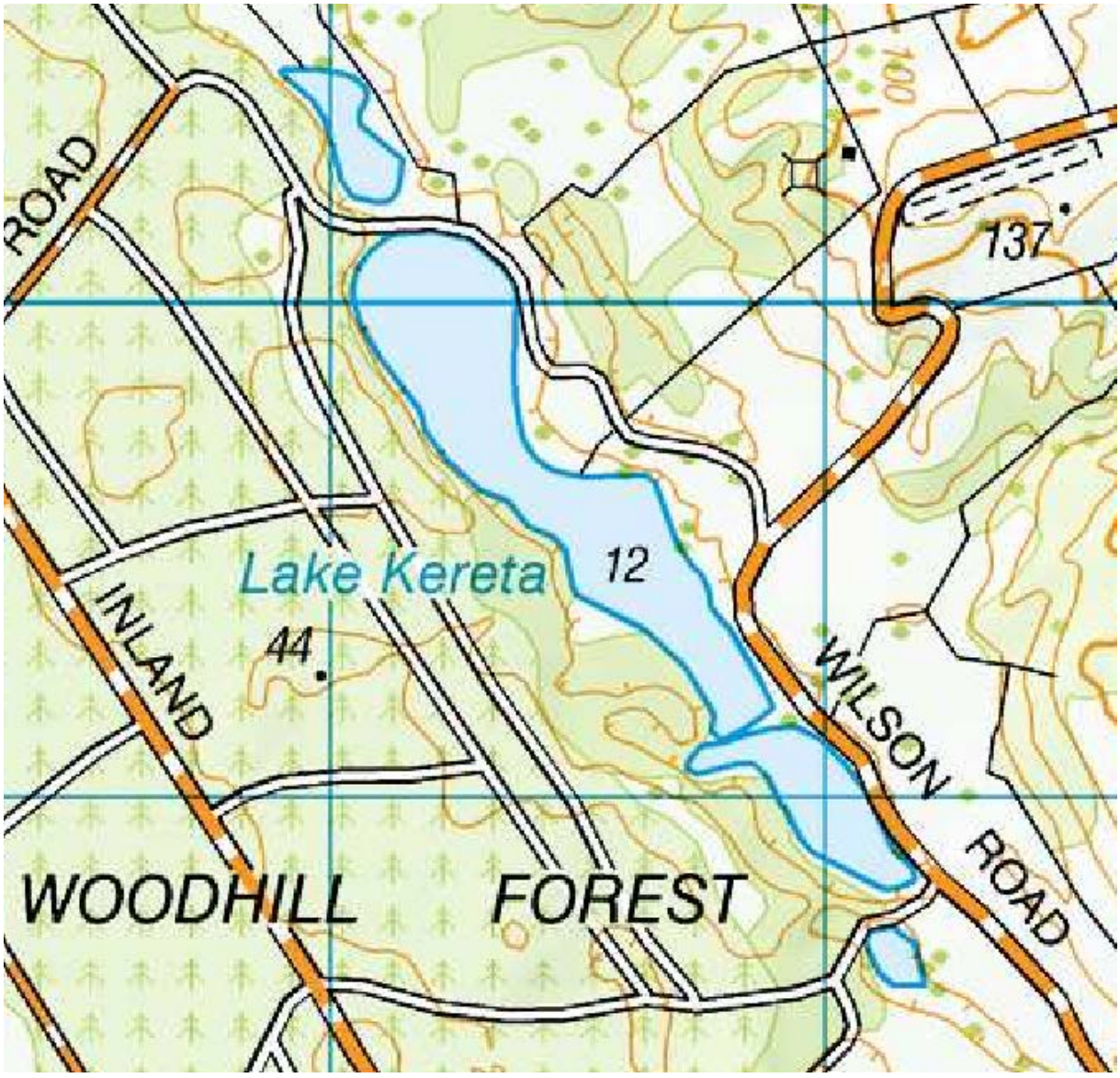

Figure 13 Lake Kereta with smaller water bodies nominally called North Kereta and South Kereta also shown.

3.9 South Kereta

Figure 14 South Kereta aerial view.

3.9.1 Size, access, vegetation

South Kereta is an unnamed water body south of Lake Kereta (Figure 13 and Figure 14). It is about 0.7ha and shallow (<1 m). Hornwort was growing in patches in the lake with an overall cover of about 10% and no other submerged species other than the invasive bladderwort *Utricularia gibba* were noted. The lake was surrounded by the invasive tall grass Manchurian wild rice (*Zizania latifolia*) and some *Eleocharis sphacelata*. As in Lake Kereta the Manchurian wild rice is the target of an eradication program.

3.9.2 Hornwort control options

Endothall would be the most suitable option in this lake.

3.10 Lake Karaka South One A

Figure 15 Lake Karaka South One A (TOP arrow) and Lake Karaka South One B (LOWER arrow).

3.10.1 Size, access, vegetation

The lake is 176m x 67m (at its longest and widest) and has an estimated area of 0.47ha and an average depth <2m. The lake was accessed by walking across farmland from Wilson Road (Figure 15). Hornwort was the only submerged plant recorded. *Azolla pinnata* was also prominent covering about 30% of the lake and there was a clearly defined margin to the lake fringed with abundant *Isolepis prolifera* and *Eleocharis sphacelata*.

3.10.2 Hornwort control options

Endothall would be the most suitable option for this lake with large areas too shallow for grass carp.

3.11 Lake Karaka South One B

Figure 16 Lake Karaka South One B (Jenny Bright's front pond).

3.11.1 Size, access, vegetation

The lake / pond is about 55m x 25m or 0.14ha in size. The pond is located close to Wilson Road and was reached on foot. Hornwort was prevalent in the pond. The native emergent *Eleocharis sphacelata* mostly encircled the pond and also present was the invasive *Ludwigia peploides*.

3.11.2 Hornwort control options

Endothall or grass carp would eradicate the hornwort in the pond. Endothall would be the preferred option but the pond is used as a water supply, so more details would need to be considered in consultation with the landowner.

3.12 Fordyce Road nursery pond

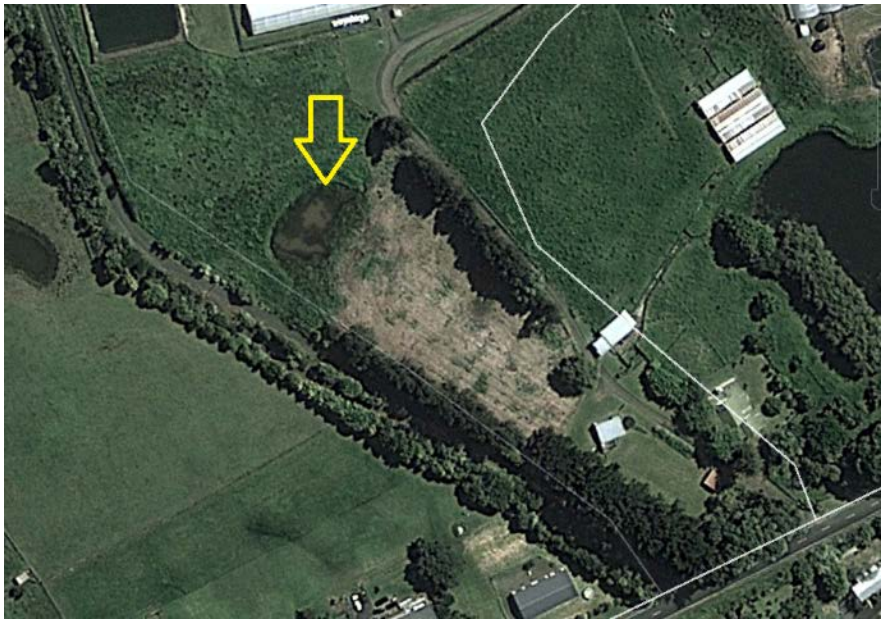

Figure 17 Aerial view of Fordyce Road nursery pond. Yellow arrow locates the pond.

Figure 18 Fordyce Road nursery pond, ground view.

3.12.1 Size, access, vegetation

The pond (Figure 17 and Figure 18) is 35m long x 21m wide or about 0.0735ha (735m^2) in area and about 1m – 2m deep. Hornwort was the only submerged plant seen and grew to the surface over about 90% of the area.

3.12.2 Hornwort control options

Endothall would be the preferred option in such a small water body.

4.0 Strategy

It is recommended that the activities of eel fishers in the area be determined and controlled to prevent introductions or transfers of aquatic weed via their nets. Also public education should be used to inform people of the damage weeds can do to a lake to dispel the fallacy that weeds enhance coarse fisheries and wildlife habitat for shooting and so reduce the motivation for deliberate introductions.

There are no high value water bodies threatened by a nearby one infested with hornwort and none of the lakes are high use water bodies with a public boat ramp. However, once hornwort is eradicated from one water body, it is paramount to prevent re-introduction of hornwort if the eradication process is not to be repeated. In the case of Lake Kereta (currently with grass carp), hornwort is known to be present in an adjacent lake to the north (North Kereta) and the two may be connected at times of higher water levels, which makes North Kereta a priority.

The Fordyce Road nursery pond is also considered a priority as it is relatively close to an access way and is easily eradicated being a small pond.

Lake Kuwakatai has a lakeside dwelling and this slightly increases the chances of hornwort being transferred.

The sequence the lakes are dealt with might be influenced by ease of eradication and by grouping lakes for economies of scale and location (such as if helicopter delivery of endothall is used). Table 1 lists the lakes in order of relative ease of eradication with the recommended eradication method and a suggested priority ranking. Size and depth (volume) are the primary determinants of ease of eradication for endothall in these lakes as they all have no significant inflows or outflows.

Lake Rototoa may be the last lake to be treated as it can only be rid of hornwort using grass carp but at the cost of losing its current high native biodiversity (although its seed bank will persist). If the decision to treat this lake is deferred until native biodiversity is minimal and other water bodies are hornwort free then in the meantime diquat should be used or a weed cordon installed to ensure the public access point is free of hornwort, thereby reducing the chances of it being transferred.

A public information campaign for South Kaipara Head and property check for ponds with hornwort (and egeria and pest fish) is recommended to help reduce the chances of re-infestation. Once lakes are weed free then annual surveillance of high risk sites is recommended for early detection of a re-invasion and contingency planning for a rapid

response would be a recommended proactive approach to managing the threat of potential invasions.

Table 1. South Kaipara Head water bodies listed in order of predicted ease of hornwort eradication with lake size, maximum depth, recommended method of eradication and suggested priority ranking is included. Note Lake Kereta has been stocked with grass carp and the hornwort probably gone.

Water body	Size ha	Max. depth	Method	Priority rank
Fuller Road Middle	0.03	< 0.5 m	Endothall	6
Fordyce Road Nursery Pond	0.07	<2 m	Endothall	2
Lake Karaka South One A	0.47	~2 m	Endothall	4
Lake Kereta South One B	0.14	~2 m	Endothall	3
Fuller Road South	0.7	~2 m	Endothall	7
South Kereta	0.7	<1 m	Endothall	5
South Head Lake	1.7	7.5 m	Endothall	8
Kereta North	2.8	< 2m ?	Endothall / Grass carp	1
Lake Te Kanae	5.6	18 m	Grass carp	9
Lake Kereta	23.6	2.3 m	Grass carp	underway
Lake Kuwakatai	27.8	15 m	Grass carp	10
Lake Rototoa	107	28 m	Grass carp	11

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