

Northland Lakes Annual Report 2018

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Executive summary

Northland Regional Council (NRC) has a programme of lake monitoring for around 90 lakes, of which 36 lakes are surveyed on a rotational basis over a maximum of five years. Lakes were assessed for ecological value including endangered species, wetland and emergent vegetation extent, submerged vegetation abundance and composition (including LakeSPI assessment), water bird, fish and aquatic invertebrate presence and abundance. NRC water quality sampling results and trends detected are referred to in this annual report to assist with calculation and interpretation of the Ecological Value Score. Identified threats and management recommendations were made for each lake. Additionally, annual surveillance is undertaken on prioritised lakes for early detection of weed incursions. NRC engaged NIWA to update its information by conducting the following assessments of lakes and water bodies. The field assessments involved a team of NIWA, Northland Regional Council and Department of Conservation aquatic and wetland ecologists with diving capability. The programme for 2018 was:

1. Lake Ecological Assessments for:

Central and East Northland: Owhareiti, Waro.

Kai Iwi and North of Dargaville: Kai-Iwi, Taharoa, Waikare, Waipuna.

Pouto: Rototuna.

- 2. Reconnaissance visits to Jack's Lake (*Central and East Northland*), Greer's (Black) Lake, Waipoua Lagoon South and Lake Waingata (*Kai Iwi and North of Dargaville*).
- 3. Surveillance for new submerged weed incursions in Lakes Kai-Iwi, Taharoa and Waikare, and detection of wetland and riparian weeds during the survey.

The central Northland lakes were assessed in moderate or poorer ecological condition. The new incursion of egeria (*Egeria densa*) to Jack's Lake was detected. No further regular ecological monitoring is recommended for that lake or Lakes Owhareiti and Waro. Fencing repairs around Owhareiti are suggested and if Waro continues to be used recreationally, then monitoring of water quality parameters and *E. coli* levels are recommended for human health reasons.

Lake Waipuna and Greer's Lakes were surveyed for the first time and provisionally ranked as in moderate and high condition respectively. Further monitoring of birds, fish, invertebrates and water quality are advocated for both lakes (and LakeSPI for Greer's), with five yearly ecological monitoring recommended. Lake Waingata has become the latest Northland lake to generate a zero LakeSPI score. The harvesting of pines in the steep catchment around the lake is the most likely explanation of the dark brown water observed in 2018. Waipoua Lagoon South was also surveyed for the first time, with a moderate to poor ranking and no further regular monitoring is recommended.

The largest three of the Kai-Iwi lakes are all in the best condition recorded, with outstanding ecological condition and the deepest yet recorded depth of submerged vegetation.

Lake Rototuna is assessed to be in high to moderate condition reflecting improving trends in the cover of native plantings and emergent vegetation balancing declining trends in water quality and lake level.

Surveillance found no new submerged weed incursions to Lakes Kai-Iwi, Taharoa and Waikare, although the minor introduced weed *Potamogeton crispus* was recorded and removed from Lake Waikare in 2017 as part of a NorthTec student fish survey.

Eradication of low incidence plants such as reed sweet grass in Rototuna and giant reed in Waro are advocated. Of greatest concern is the first Northland detection of New Zealand's worst wetland weed grey willow (*Salix cinerea*). It was first detected in a wetland on the roadside of SH 12 just north of Kaihu and then found a day later adjacent to Lake Rototuna. All efforts must be made to delimit the infestations of this species. If both sexes are present, then seed set and dispersal of wind-adapted seed could spread this plant to suitable sites down wind. Eradication of all grey willows should be undertaken.

1 Introduction

Northland Region has some of New Zealand's highest ranked examples of intact natural aquatic ecosystems (Champion and de Winton, 2012). However, they are being lost at an alarmingly rapid rate as invasive species spread as a result of human activities, and land use practices impact on lake condition. Often pristine lakes are limited to remote areas with difficult human access and limited land use development. With adequate recognition, community support and active protection, such exceptional lakes could be maintained in a close to pristine state for perpetuity.

Northland Regional Council (NRC) has a programme of lake monitoring for around 90 lakes that are surveyed on a rotational basis. This includes surveillance on prioritised lakes for early detection of weed incursions. From 30 April to 4 May 2018 NRC engaged NIWA to undertake:

1. Lake Ecological Assessments for:

Central and East Northland: Owhareiti, Waro.

Kai Iwi and North of Dargaville: Kai-Iwi, Taharoa, Waikare, Waipuna.

Pouto: Rototuna.

- 2. Reconnaissance visits to Jack's Lake, Greer's (Black) Lake, Waipoua S and Waingata.
- 3. Surveillance for new submerged weed incursions in the Kai-Iwi lakes.

2 Methods

2.1 Ecological assessments and reconnaissance visits

2.1.1 Lake description

Lakes were referenced according to assigned lake number and location (NZTM Easting and Northing) in the NRC lakes database. In addition, water bodies were photographed and observations of catchment features and ease of access were noted.

2.1.2 Wetland and emergent vegetation

The extent of emergent vegetation (percentage of shoreline, width of beds and depth range), plant species present around the lake, and wetlands associated with the lake were described.

Presence of pest plants were reported along with an estimate of population size.

2.1.3 Submerged vegetation

The submerged vegetation was surveyed by divers using a method based on Clayton (1983). Divers swam perpendicular to the shore recording plant species present, their depth ranges, average and maximum heights and covers. These and other details including those required to complete LakeSPI surveys were recorded on data sheets (Figure 2-1).

Generally, lakes were sampled at five localities with profiles selected as representative of the underwater vegetation and the range of plant communities present in the lake. Fewer than five sites were surveyed where lakes were small (< 1ha) or de-vegetated.

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Figure 2-1: Survey sheet. Data collection for an aquatic vegetation profile and LakeSPI assessment.

2.1.4 LakeSPI

LakeSPI (Submerged Plant Indicators) is a well-used method of measuring lake ecological condition (Clayton and Edwards 2006 a & b, de Winton et al. 2012). LakeSPI surveys were carried out at preselected baseline sites to record key characteristics of the vegetation structure and composition. These included measures of diversity from the presence of up to six key plant communities; emergent or amphibious low-growing turf plants, isoetes, native tall vascular plants (milfoils and pondweeds), charophytes and high-cover charophyte meadows, and the depth extent of vegetation. Also scored was the presence of invasive exotic weeds and the extent to which they dominated (based on plant cover, height and depth range).

Survey data was entered into the NIWA LakeSPI database and used to generate three LakeSPI Indices:

- Native Condition Index characterises the status of native vegetation within a lake.
- Invasive Impact Index captures the degree of impact from invasive weed species (note that higher scores for the Invasive Impact Index denote lower lake ecological condition).

 LakeSPI Index – integrates scores from the other two indices and provides an overall indicator of lake ecological condition.

LakeSPI indices are expressed as a percentage of their maximum potential score (adjusted for lake depth) to enable direct comparisons of small, shallow water bodies with different lake types (e.g., larger, deeper ones).

A full description of the vegetation features that were assessed for the LakeSPI method can be found in the technical report and user manual (Clayton and Edwards 2006a) and on the LakeSPI web-reporting website (<u>www.lakespi.niwa.co.nz</u>).

LakeSPI assesses aquatic plant indicators of ecological condition and should not be confused with the 'Lake Ecological Value Assessment' which provides an overall assessment of indigenous biota and their habitat.

2.1.5 Water birds

Habitat suitability for birds was assessed during the field visit, with bird species presence and abundance observed with binoculars. Results were compared with previous records from Ornithological Society of New Zealand (OSNZ) and DOC Species-Specific Biological Information (SSBI) surveys, with any nationally or regionally threatened species noted. The combination of scuba divers and various water craft involved in this survey was not conducive to observing water birds, with many flying away before their identity was ascertained. However, some secretive species such as the Nationally Critically endangered bittern (*Botaurus poiciloptilus*) were often disturbed and flight allowed their detection, whereas shore-based observation would probably not detect such species. A concerted effort to record bird species and abundance has been undertaken since 2015.

2.1.6 Fish

Fish records for the Northland Region extracted from NIWA FBIS comprised 295 records since 1980. These records were assessed to identify lakes containing pest fish. While surveying plants, divers also recorded observations of fish but these were not specifically sampled for or quantified.

2.1.7 Aquatic invertebrates

Large aquatic invertebrates such as torowai or freshwater mussels (*Echyridella menziesii*), kewai or freshwater crayfish (*Paranephrops planifrons*) and snails were noted by divers in the course of macrophyte surveys. Mussels are potentially important indicators of lake condition and are likely to be incorporated into LakeSPI methodology in the future.

2.1.8 Endangered species

Estimation of population sizes were made based on presence of endangered species (de Lange et al. 2018; Forester and Townsend 2004; Goodman et al. 2014; Grainger et al. 2014; Robertson et al. 2017) and discussion of known occurrences with Department of Conservation (DOC) and NRC staff.

2.1.9 Lake Ecological Value Assessment

The rating of Lake Ecological Value uses the methodology presented in Champion and de Winton (2012), and is a refinement of the 'Lake Biodiversity Assessment' method undertaken in previous NIWA lake reports.

The Lake Ecological Value Assessment is based on the following parameters:

- Habitat size.
- Buffering.
- Water quality.
- Aquatic vegetation diversity.
- Aquatic vegetation integrity.
- Endangered species.
- Presence of key species.
- Connectivity.

The higher the score, the higher the Lake Ecological Value Rating.

2.1.10 Changes in indicators

Any significant changes in biota and lake condition compared with previous surveys were reported; for example, new species records, and / or change in species dominance, or vegetation depth range.

2.1.11 Threats

Biosecurity threats (current pest plant and fish impacts, potential impacts and risk of pest introduction), nutrient enrichment (nutrient sources, livestock access) and decreasing water levels were considered for impacts on ecological condition on each lake based on the surveys and discussion with landowners, NRC and DOC staff. Water quality monitoring is carried out by NRC for high ranked lakes and data are held by NRC.

2.1.12 Summary

A summary of overall ranking, identified threats and recommendations is presented for each lake in the report Section 3.1 Ecological Assessments.

2.1.13 Pest plant surveillance

Annual surveillance for aquatic weeds was undertaken for seven high-risk lakes. Lakes were surveyed using scuba and snorkel, visually inspecting sites where introductions would be most likely, such as known access points and popular anchoring spots. The areas were inspected thoroughly (i.e., grid search) by scuba divers at depths where weed colonisation was likely to occur, to ensure all vegetation in the area was observed. Where large areas required surveillance, a diver was towed behind a boat to cover likely sites of colonisation.

The lake margins were walked and checked for drift of weed fragments on shore and marginal vegetation was also checked for emergent and sprawling wetland weeds both from the landward edge (where possible) and by boat.

This year surveillance was carried out by Northland Regional Council and NIWA in the Kai-Iwi Lakes (Kai Iwi, Taharoa and Waikare). Other lakes were monitored by other dive contractors.

2.2 Management recommendations

A monitoring strategy for each of the highest ranked lakes was reviewed and includes:

- Lake biodiversity monitoring, LakeSPI, additional assessment of nationally or regionally significant biota and assessment of any new threats to ecological condition.
- Pest plant surveillance targeting lake access and anchoring sites to detect early incursions of weed species.
- Additional routine monitoring of water quality, including measurement of all parameters required to generate the Trophic Level Index (TLI) as outlined by Burns et al. (2000).

Practical measures that could mitigate or avert threats to Northland lakes are identified where appropriate. We recommend that:

- Lakes where pests threaten lake ecology are identified alongside possible mitigation measures.
- Lakes where indicators suggest nutrient enrichment or catchment activities have (or threatens to have) significant impacts on lake ecology are identified and mitigation strategies put in place.

3 Results and Discussion

- 3.1 Ecological assessments and Reconnaissance visits
- 3.1.1 Jack's lake (Central Northland), NRC Lake No. 180





Summary

Surveyed 2001, 2005, and 2018.

Overall ranking

Moderate to low: This artificially dammed lake has little current ecological value, with the 2018 detection of an incursion of *Egeria densa*, most likely sourced from the neighbouring Lake Owhareiti, further reducing its value.

Threats

Situated on private property, but used for recreation. Further pest introductions are unlikely.

Management recommendations

No regular monitoring.

Description

This dammed lake (1684321E, 6083377N), adjacent to Lake Owhareiti, was created ~ 20 years ago. It is accessed via well-formed tracks across private pastoral land and ~ 20% of the catchment is in indigenous forest. The lake is 16.6 ha in size, 6.5 m depth and while the lake level is currently

maintained by a dammed outlet, it has been known to have dried out in the past (landowner pers. comm.). There is one inlet drain to the south of the lake, with no outlet. Boat access is difficult.

Wetland vegetation

The only tall emergent species recorded at the lake was *Eleocharis sphacelata* restricted to around 25% of the lakeshore, with grazing on much of the margin except for forest areas. The regionally uncommon *Gratiola sexdentata* was found in marginal turf areas and the pest plant *Glyceria maxima* was seen adjacent to the forest remnant in 2005, but neither were noted in the 2018 reconnaissance visit.

Submerged vegetation

In 2001, the submerged flora of this lake comprised 9 species, dominated by beds of *Chara australis*. These grew from 0.5 m to a maximum of 3.4 m with high covers. Other native species included *Myriophyllum propinquum, Potamogeton ochreatus, P. cheesemanii, Nitella hyalina, Elatine gratioloides* and *Glossostigma elatinoides,* along with the introduced *Ludwigia palustris* and *Potamogeton crispus*.

In 2005, the turf plant *Glossostigma elatinoides* was common, together with low covers of *Myriophyllum propinquum*, *M. triphyllum* and *Nitella pseudoflabellata* that were also restricted to the shallow margin in depths <1 m. Beyond 1 m depth the vegetation was equally dominated by *Potamogeton ochreatus* and the exotic *P. crispus* to a maximum depth of 2.9 m. *Chara australis* and *Potamogeton cheesemanii* were occasionally encountered to 2.5 m.

A similar assemblage of submerged species was recorded in 2018, with the invasive introduced oxygen weed *Egeria densa* and the introduced swamp lily *Ottelia ovalifolia* all new records for Jack's Lake. Egeria was locally common to depths of 2 m, but *P. ochreatus* remained dominant to depths of 3 m. Although present, *P. crispus* was not as abundant as in 2005, and was recorded as occasional in shallow water to 1.5 m deep.

LakeSPI

In 2005, the moderately low LakeSPI score of 50% (46% Native Condition Index; 43% Invasive Impact Index) reflected a restricted development of native vegetation and the presence of *P. crispus*. No LakeSPI score was generated in 2018, but the continued invasion of egeria is likely to progressively increase the Invasive Impact Index and reduce LakeSPI, as is the case in the neighbouring Lake Owhareiti.

Water birds

The restricted emergent vegetation provides limited water bird habitat, and the lake is fairly isolated. Black shag (*Phalacrocorax carbo*), black swan (*Cygnus atratus*) and mallard (*Anas platyrhynchus*) were noted during the visit. DOC SSBI reports regionally threatened dabchick (*Poliocephalus rufopectus*) and scaup (*Aythya novaezeelandiae*) in 1991, with only common species recorded by the more recent OSNZ survey.

Fish

Common bullies (Gobiomorphus cotidianus) were seen in 2005.

Aquatic invertebrates

The indigenous snails *Austropeplea tomentosa* was noted as abundant in the vegetation and stranded on the shoreline in 2018. *Potamopyrgus antipodarum*, pea mussel (*Sphaerium novaezelandiae*) and backswimmers (*Sigara arguta*) were recorded in 2005.

Endangered species

No threatened species have been observed in and around Jack's Lake on the three NIWA surveys, although the snail *Austropeplea tomentosa* has been designated a Data Deficient species by Grainger et al. (2014). This reflects a lack of recent collections of this widespread species (reported as common by Winterbourn 1973), that has previously been collected from four Northland sites including Lakes Omapere and Waiparera (Spurgeon 2018). The occurrence of this species is not used to generate an endangered species score for lake ecological value.

Lake Ecological Value

Jack's Lake ecological value rating is assessed as "4 - moderate to low", with a poorly buffered habitat, low biodiversity and no threatened species.

Threats

The risk of *Egeria densa* being spread to Jack's Lake from the neighbouring Lake Owhareiti was identified in previous lake condition reports. This risk has been realised and this weed is likely to further expand to dominate this lake, as is the case in Lake Owhareiti. As access to the lake is limited, further pest introductions are unlikely.

Much of the dam is bordered by pasture and nutrient enrichment is likely to continue unless livestock are excluded from lake margins.

Management recommendations

No monitoring recommended for this dammed water body with limited natural values and likely increasing impact from invasive submerged weed egeria. Further investigation of invertebrate fauna of Northland lakes would undoubtedly provide valuable information and better understanding of the distribution and abundance of this key component of the lake biota.

3.1.2 Lake Owhareiti (Central Northland), NRC Lake No. 177



Figure 3-2: Lake Owhareiti. Photo taken from the north to show the main basin and pastoral catchment on volcanic soils. (Photo: Paul Champion 30 April 2018)

Summary

Surveyed 2001, 2006, and 2018.

Overall ranking

Moderate: This large lake was severely impacted by the pest plant *Egeria densa* and water quality is poor, but provides valuable habitat for endangered water birds.

Threats

Highly impacted by pest plants and nutrient enrichment.

Management recommendations

No regular monitoring.

Description

This lake (1685502E 6083555N) is 95.9 ha in area, with a maximum depth of 16 m. It was formed by a volcanic flow damming the outlet. Surrounding catchment is mostly pasture. The lake has one inflow (to the south east) but no outflows. Access is through well-formed private roads and with gate access to adjacent farmland. Boat access requires a 4-WD.

Wetland vegetation

There was a fringe of emergent vegetation around much of the lake, 5-10 m across to 2.5 m deep. It was dominated by *Eleocharis sphacelata* with lesser amounts of *Machaerina articulata* and *Schoenoplectus tabernaemontani* (first recorded in 2018). There was cattle access to much of the lake, with several fences collapsed or broken.

Submerged vegetation

In 2001, the submerged vegetation was composed of four species with *Egeria densa* dominant between 0.3 m and ~4 m water depth with isolated shoots to 5 m. *Myriophyllum propinquum, Potamogeton cheesemanii* and *P. ochreatus* had low covers and were all present in water <1 m deep.

In 2006, the submerged vegetation was dominated by tall beds of the exotic *Egeria densa* growing from the emergent vegetation zone to 4 m, with scattered plants to 5 m deep.

Egeria also was the dominant submerged species in 2018, growing to a maximum depth of 6.1 m. Scattered native plants included *Potamogeton ochreatus, P. cheesemanii, Myriophyllum propinquum* and *Chara australis,* along with the invasive *Utricularia gibba,* with the turf species *Gratiola sexdentata, Glossostigma elatinoides* and *Lilaeopsis novae-zelandiae* found in areas lacking tall emergent vegetation.



LakeSPI

Lake Owhareiti Submerged Plant Indicators

The low LakeSPI Index was driven by the very high Invasive Impact Index with *E. densa* dominating the vegetation and displacing native values. A slight improvement between 2006 and 2018 may reflect improving water clarity, but invasive impact still remained high.

Water birds

The large areas of emergent and wetland vegetation provide good habitat for many aquatic birds. A recent OSNZ survey reported over 1000 birds seen including the following regionally rare species: fernbird (*Bowdleria punctata vealeae*), dabchick (*Poliocephalus rufopectus*), Australasian little grebe (*Tachybaptus novaehollandiae*) and scaup (*Aythya novaezeelandiae*), with 6 nationally endangered bittern (*Botaurus poiciloptilus*) seen in 1990.

Fish

Common bullies (Gobiomorphus cotidianus) were seen in the lake.

Aquatic invertebrates

Few aquatic invertebrates were noted.

Endangered species

No threatened species have been observed in and around Lake Owhareiti.

Lake Ecological Value

Lake Owhareiti ecological value rating is assessed as "6 - moderate", a relatively large and deep water body, with a poorly buffered habitat, low biodiversity, invasive plants present and no threatened species.

Threats

Egeria densa had a major impact on other submerged vegetation, displacing other species from much of the depth range, but if introduced, hornwort could displace the egeria and lead to greater invasive impacts.

There was livestock access to the lake, contributing to the poor water quality.

Management recommendations

No monitoring is recommended.

3.1.3 Lake Waro (Hikurangi) Lake No. 410



Figure 3-3: Lake Waro. A lake frequently used for contact recreation, particularly swimming. (Photo: Aleki Taumoepeau 30 April 2018)

Summary

Surveyed 2006, 2011 and 2018.

Overall ranking

Moderate to low: A flooded quarry severely impacted by the pest plant *Egeria densa*. Water quality is poor, but provides valuable habitat for endangered water birds.

Threats

Popular recreational lake, with potential for further pest plant and fish liberations and continued nutrient enrichment from the catchment.

Management recommendations

No regular ecological monitoring. Management of submerged weeds, giant reed and water quality and *E. coli* level monitoring are required for continued recreational use of the lake.

Description

This lake (2627470E 6623010N) is a 4 ha lake, 6.4 m deep. The surrounding catchment is reserve with a refuse dump, some pasture and residential development, currently dominated by kikuyu and scrub weeds. Access is by road but no power boating is permitted and currently, boat access is difficult. It is used for contact recreation with distance swimming popular.

Wetland vegetation

There were two wetland areas at each end of the lake and a narrow emergent zone around most of the lake margin. The main species were *Typha orientalis* and *Eleocharis sphacelata*. There were several small patches of the invasive giant reed *Arundo donax*.

Submerged vegetation

In 2006, the lake was clear and fully vegetated, with charophyte meadows of *Chara fibrosa* and *Nitella* sp. aff. *cristata*, with *Potamogeton cheesemanii* and *Myriophyllum propinquum* and some *Potamogeton ochreatus* present. There was also a blanket of the invasive *Utricularia gibba* to 3 m water depth and significant growths of the oxygen weed *Egeria densa* through the lake.

In 2011, the whole lake floor was vegetated to 5 m deep but below this the water was dark with putrefying plant material to the maximum lake depth of 6 metres. Both egeria and *Utricularia gibba* had increased in abundance.

In 2018, vegetation had recolonised to 6.4 m at one transect and over 5 m in the others. *Egeria densa* dominated throughout the depth range, with *Potamogeton cheesemanii* and *Myriophyllum propinquum* at each profile, with scattered *Potamogeton ochreatus* and a deep water bed of *Nitella* sp. aff. *cristata*, at one site. *Utricularia gibba* had declined in range and abundance, and was only noted at one transect with low covers from the emergent zone to 3.1 m deep.

LakeSPI

March 2006



75%

Waro Quarry Lake Submerged Plant Indicators

Moderate

50%

59%

The LakeSPI score from Lake Waro has steadily declined in this lake over time, declining from the boundary between high and moderate in 2006 to just above the boundary between moderate and poor status (20%) at 26% in 2018. The decline reflects the increasing extent of the invasive exotic species *Egeria densa* and loss of extensive charophyte beds before 2011, likely due to anoxia.

Water birds

Spotless crake, geese, domestic ducks have been noted during surveys.

Fish

A silver (migratory) shortfin eel and abundant gambusia were seen in 2011.

Aquatic invertebrates

Ramshorn snail and mollusc-feeding leeches were abundant in 2011.

Endangered species

No threatened species have been observed in and around Lake Waro.

Lake Ecological Value

Lake Waro ecological value rating is assessed as "5 – moderate to low", a small artificial water body, dominated by invasive submerged plants and deteriorating water quality.

Threats

Water quality is threatened by stratification and anoxic bottom waters releasing nutrients from sediments. Dense growths of *E. densa* will add more organic matter to the lake increasing BOD. There may also be other significant catchment sources of nutrients to the lake that require investigation. The ease of access to this lake gives it a relatively high likelihood of additional submerged weed transfer. Species such as hornwort would drastically impact the lake. Alligator weed would also spread and dominate marginal vegetation. Further nutrient enrichment could render the lake a health hazard to swimmers and dense beds of egeria pose a drowning risk.

Management recommendations

This lake has moderate to low ecological value and is not recommended for regular ecological health monitoring. However, the lake is becoming more degraded and may require management if the lake is still to be recommended for recreational uses. Perhaps control of submerged weeds could be contemplated using grass carp and water quality and *E. coli* level monitoring continued to assess potential human health hazards.

Remove the Arundo donax before it dominates the riparian margins of this lake.





Figure 3-4: Freidrich's Lake. Photo shows the artificially maintained area of open water evidenced by the straight line of emergent kuta (Photo: Paul Champion 4 May 2018).

Summary

Surveyed 2005 and 2018 (reconnaissance only).

Overall ranking

Moderate to low: A small, shallow, fully fenced lake, dominated by the emergent sedge kuta (*Eleocharis sphacelata*), which has been cleared to maintain an open water area.

Threats

Lake on private property with limited access, but the possible presence of eels may present a risk of future pest plant introductions. Alligator weed (*Alternanthera philoxeroides*) has limited impacts on the lake, after over ten years since its introduction.

Management recommendations

No regular ecological monitoring.

Description

A small (7.15 ha) dune lake (1668632E, 6022433N), with a maximum depth of 2 m. Pasture catchment grazed by cattle, now entirely fenced. No inflows or outflows. Access is across private farmland, and can be reached by 2WD in dry weather.

Wetland vegetation

Kuta (*Eleocharis sphacelata*) was the dominant emergent vegetation and would entirely fill the lake if the owner did not maintain open water, presumably for duck shooting. Biodiversity has been enhanced by this action as it creates habitat for submerged species. The invasive alligator weed (*Alternanthera philoxeroides*) was well established amongst marginal kikuyu (*Cenchrus clandestinum*). The introduced spike sedge *Eleocharis* sp., previously noted on the floodplains of the Northern Wairoa and Kaihu Rivers, was found here for the first time in 2018.

Submerged vegetation

In 2005, the submerged vegetation was dominated by *Chara australis*, with small amounts of *Potamogeton cheesemanii* and *P. ochreatus*. Plants grew across the deepest parts of the lake. The exotic bladderwort *Utricularia gibba* was common in areas to 1 m deep where it sprawled over other vegetation. One shoot of the nationally endangered *Utricularia australis* was found.

In 2018, a low (0.1 m tall) meadow of *Chara australis* covered most of the open area, with lesser amounts of *Nitella* sp. aff. *cristata* and *N. pseudoflabellata*. *Potamogeton ochreatus* was also common. *Utricularia gibba* was less abundant than in 2005, with covers reducing from dense mats in shallow areas to scattered plants around 5% cover. No *U. australis* was located.

LakeSPI

In 2005, the moderately low LakeSPI score of 57% (68% Native Condition Index; 44% Invasive Impact Index) reflected a restricted development of native vegetation and the impact of dense mats of the invasive *Utricularia gibba*. No LakeSPI score was generated in 2018, but the reduced impact of *U*. *gibba* should decrease the Invasive Impact Index and increase LakeSPI score. As open water is artificially maintained through kuta control, LakeSPI is not considered to be an appropriate metric for this lake.

Water birds

The areas of emergent vegetation provide moderate waterfowl habitat, with black swans (*Cygnus atratus*) and mallard (*Anas platyrhynchus*) the only species seen. There are 1980's records of the nationally threatened bittern (*Botaurus poiciloptilus*) and regionally important dabchick (*Poliocephalus rufopectus*).

Fish

Several shortfin eels (*Anguilla australis*) were seen on both sampling occasions. The invasive *Gambusia affinis* was not seen on either sampling occasion.

Aquatic invertebrates

Freshwater sponges were noted on submerged vegetation. Back swimmers were noted in 2018.

Endangered species

No threatened species have been observed in and around Freidrich's Lake.

Lake Ecological Value

Freidrich's Lake ecological value rating is assessed as "5 – moderate to low", a small, shallow dammed water body, dominated by the emergent sedge kuta, but with good native aquatic plant biodiversity. The lake has now been completely fenced to prevent livestock access to the water body.

Threats

Alligator weed (*Alternanthera philoxeroides*) has limited impacts on the lake, after over ten years since introduction. The shallow nature of the lake means that water fowl have access to submerged vegetation throughout the open water area.

Tall-growing exotic pest plants have potential to invade this lake if introduced, but the risk of introduction is minimal, unless eel fishing is undertaken.

The lake is unsuitable for boating, but eel fishing and shooting activities are likely.

Management recommendations

No regular monitoring for lake native biodiversity value required.

3.1.5 Greer's (Black) Lake (Kai-Iwi Lakes), NRC Lake No. 226.



Figure 3-5: Greer's Lake. Photo shows the entire emergent margin and regenerating forest within the catchment (Photo: Paul Champion 2 May 2018).

Summary

Surveyed 2018 (reconnaissance only).

Overall ranking

High: A small, fully fenced lake, with fenced wetland and regenerating forest catchment, totally surrounded by raupo (*Typha orientalis*) and other emergent vegetation, with a predominantly native submerged vegetation.

Threats

Lake on private property with limited access, despite its proximity to the Kai-Iwi lakes. Fencing the lake and wetland will increase the biodiversity values of the lake and potentially improve water quality.

Management recommendations

Further monitoring including water quality, LakeSPI and a fish survey (potential black mudfish (*Neochanna diversus*) habitat). Manage gambusia present in drains on the property.

Description

A small (1.5 ha) lake (1656385E, 6038510N), with an estimated maximum depth of 2 m. Surrounded by a recently fenced wetland (0.86 ha), with over 2 ha of regenerating forest in the catchment, the remainder is grazed by cattle. Access is across private farmland, with no boat access to the lake.

Wetland vegetation

Raupo (*Typha orientalis*) was the dominant emergent vegetation, with associated harakeke (*Phormium tenax*), *Machaerina rubiginosa, Isolepis prolifera, Persicaria decipiens, Ranunculus amphitrichus* and *Isachne globosa*. This vegetation formed a complete almost 20 m band surrounding the lake, to a depth of 1.5 m. The wetland further away from the emergent vegetation was dominated by *Juncus* rushland, with four species noted including *Juncus pauciflorus*.

Submerged vegetation

The submerged vegetation was dominated by *Chara australis*, with both male and female fruiting plants seen from 1.5 to approximately 3 m deep. *Potamogeton ochreatus* and *Nitella* sp. aff. *cristata* were also common in the submerged vegetation, with the invasive *Utricularia gibba*, commonly attached to raupo roots and sprawling over the other submerged species.

LakeSPI

No LakeSPI score was generated in 2018 (reconnaissance only), but the lake should score in the moderate to high status based on the dense charophyte meadows, with some *U. gibba* impact.

Water birds

No water fowl were recorded during the visit.

Fish

No fish including the invasive *Gambusia affinis* (abundant in the adjacent Kai-Iwi lakes) were seen during the visit.

Aquatic invertebrates

Freshwater sponges were noted on submerged vegetation and the roots of raupo.

Endangered species

Juncus pauciflorus is rated as Nationally Vulnerable in the 2017 threat assessment (de Lange et al. 2018), with a national area occupied < 100 ha with a decline rate of 10 to 50% over ten years.

Lake Ecological Value

A preliminary ecological value rating of "11-high" is assigned to Greer's Lake based on the largely indigenous catchment, entire emergent fringe and charophyte meadows, also including a nationally threatened species. Further assessments are warranted.

Threats

Greer's Lake is on private property with limited access, despite its proximity to the Kai-Iwi lakes. Fencing the lake and wetland will increase the biodiversity values of the lake and potentially improve water quality. The risk of gambusia entering the lake from Lake Waikare is rated as high, with efforts to block drains between the two water bodies being supported.

Management recommendations

Conduct a full ecological assessment, with fish surveys (targeting mudfish) and assessment of water quality is also advocated.



3.1.6 Lake Kai-Iwi (Kai-Iwi Lakes), NRC Lake No. 236.

Figure 3-6: Lake Kai-lwi. with emergent *Machaerina arthrophylla* in the immediate foreground, then a zone of kuta (*Eleocharis sphacelata*) (Photo: Lisa Forester, NRC 2 May 2018).

Summary

Surveyed 1984, 1985, 1987, 2001, 2005, 2007, 2011, 2014 and 2018.

Overall ranking

Outstanding: A native plant dominated lake, with nationally rare plants and *U. gibba* the only pest plant species present. However, water quality trends show increases in chlorophyll a (planktonic algae) and total nitrogen with decreased water clarity and a change in TLI from oligotrophic to mesotrophic.

Threats

A locked gate has stopped access to the lake for trailered boat traffic, with a decreased risk of inadvertent pest plant introductions. However, should an introduction occur then subsequent impact is likely (cf. Lake Taharoa). High impact from *Gambusia affinis* has contributed to the possible extirpation of the nationally near-threatened dune lakes galaxias. Water quality parameters have deteriorated indicating nutrient enrichment from surrounding land. Pine harvesting could be a cause.

Management recommendations

Lake native biodiversity value monitoring every 5 years, pest plant surveillance every three years.

Further monitoring including water quality and a fish survey.

Description

This dune lake (1659066E, 6036450N) is 22.6 ha in area, with a 16 m maximum depth. The lake margin is predominantly vegetated by scrub (70%) and logged pine plantation (30%), with pasture in the larger catchment. Minor drainage inflows from Lake Taharoa at the south of the lake with no outlet. There is no road access to this lake and the final approach is prevented by a locked gate and no formed boat ramp.

Wetland vegetation

Most of the lake had a 3 - 10 m wide margin of emergent vegetation, with dense oioi (*Apodasmia similis*) and occasional *Schoenus brevifolius* closest to the terrestrial margin and *Machaerina arthrophylla* (especially on the exposed eastern shore). *Machaerina articulata* and *M. juncea* were common in shallow water up to 0.7 m deep and an outer zone of *Eleocharis sphacelata* extended up to 2.6 m deep on one transect. One patch of raupo (*Typha orientalis*) was noted for the first time in 2014. This could indicate a local source of nutrient enrichment. Small saplings of the conifer pond cypress (*Taxodium distichum* var. *imbricarium* (syn. *T. ascendens*)) were noted amongst the oioi on the eastern shoreline. This is the first known naturalised record of this plant.

Submerged vegetation

Turf plants occurred to 2 m depth in several locations with abundant *Trithuria inconspicua, Triglochin striata, Lilaeopsis novae-zelandiae* and *Myriophyllum votschii*.

Surveys prior to 2018 recorded charophyte meadows that extended from < 2 m to ~12 m, dominated by *C. fibrosa* to ~7 m and *Chara australis* to ~12 m deep. *Potamogeton cheesemanii* frequently occurred at low covers to about 4 m water depth. The invasive *Utricularia gibba* was found in deep water in three of the five transects to depths approaching 10 m deep. However, it was localised and of low covers, not apparently impacting other submerged vegetation. In the past, vegetation bottom limits have varied averaging around 12 m. However, in 1985 the bottom limit was only 8.5 m and there was very poor visibility in the hypolimnion, suggesting anoxia. Subsequent surveys showed bottom limits had extended to around 12 m.

As with the other two main Kai-Iwi lakes, Lake Kai-Iwi had record vegetation depth limits in 2018. *Chara australis* meadows extended to 13.3 m in three transects and 13.9 m in another. The maximum depth of vegetation was not established on the other transect. *Utricularia gibba*, although present, was only found on three transects, within the emergent zone with low covers.

LakeSPI



The 2018 LakeSPI score saw a return to the 'Excellent' status after two subsequent monitoring occasions with 'High' status. This increase in status reflected the increased extent of charophyte vegetation and apparently reduced *U. gibba* presence and impact (reduced from 22% in 2011 to 17% in 2014 to 12% in 2018).

Water birds

The isolated nature of much of this lake and extensive emergent and scrub vegetation provide good habitat for water birds, probably acting as a refuge from the human-mediated disturbance in the two adjacent lakes. There are earlier reports of large numbers of waterfowl utilising this lake, including the Nationally Threatened bittern (*Botaurus poiciloptilus*). A pair of dabchick (*Poliocephalus rufopectus*) were noted in 2018.

Fish

Native fish records include common bullies (*Gobiomorphus cotidianus*) and historically dune lakes galaxias were found, also a single fish was captured in a recent DOC survey (Andrew Knock, DOC, pers. comm.). Exotic fish present include gambusia (*Gambusia affinis*), rudd (*Scardinius erythrophthalmus*) and a stocked population of rainbow trout (*Oncorhynchus mykiss*).

Aquatic invertebrates

Invertebrates were abundant in the lake. No freshwater mussels (*Echyridella menziesii*) were seen but empty shells have been noted in previous surveys. The remains of koura (*Paranephrops planifrons*) were commonly observed along the water's edge in 2014.

Endangered species

Lake Kai iwi supports possibly the largest Northland population of the Nationally Critical *Trithuria inconspicua* with a c.10 m band of this species in shallow water or exposed sand (average cover of 10%) around much of the lake. The total population size was estimated at 2 ha. It was most commonly associated with open emergent beds of *M. arthrophylla*, but was absent in local areas of dense *M. articulata*. De Lange et al. (2018) recognise the taxonomic difference between Northland and South Island *Trithuria* plants. The reappraisal was based on a 50–70% decline in Northland plants with a total area of occupancy \leq 10 ha. Dead plants of the Nationally Endangered *Centrolepis strigosa*, an annual species, were found in the marginal turf in 2018, the first collection from Lake Kai-Iwi since the 1980's. The status of this species has improved from Nationally Critical based on surveys of the Kai-Iwi lakes, with the population assessed as stable and occupying \leq 10 ha.

The At-Risk Naturally Uncommon dune lakes galaxias (restricted to the Kai Iwi lakes) may be present in extremely low numbers in this lake. An increase in threat status is advocated for this species, as is a targeted fish survey.

Lake Ecological Value

Lake Kai-Iwi ecological value rating is assessed as "14 – outstanding", based on the deep charophyte meadows, high species diversity and large populations of threatened species. Previous assessments of water quality indicated this had deteriorated with increases in chlorophyll *a* (planktonic algae), total nitrogen and decreasing water clarity resulting in a change in TLI from oligotrophic to mesotrophic.

Threats

The lack of motorised boat traffic to this lake reduces the risk of pest introduction. However, conditions in this lake are suitable for the establishment and growth of invasive vascular weeds. If pest plants were introduced they would be expected to establish quickly and would severely impact lake values.

Rudd have been present in the lake since c.1991 with little apparent impact on plants, however, these herbivorous fish have been implicated in the loss of vegetation elsewhere so remain a threat if a population still survives in the lake.

Management recommendations

Invasive pest plants pose a greater threat to this lake than the adjacent lakes as higher nutrient conditions would favour their rapid growth. However, boat access is now extremely difficult. Continuance of annual surveillance of the access point for pest plant incursion needs discussion, with a possible 3-yearly surveillance adequate.

A targeted fish survey is recommended for pest fish and also the At Risk Naturally Uncommon dune lakes galaxias. An increase in threat status of this fish would be advocated, should no fish be located during this survey.



3.1.7 Lake Taharoa (Kai-Iwi Lakes), NRC Lake No. 229.

Figure 3-7: Southern shoreline of Lake Taharoa. The photo shows oioi (*Apodasmia similis*) on the shoreline and pampas (*Cortaderia selloana*) in the area previously under pine plantation forest (Photo: Aleki Taumoepeau 2 May 2018).

Summary

Surveyed 1984, 1987, 2001, 2005, 2007, 2011, 2014 and 2018.

Overall ranking

Outstanding: The best example of a clear-water lake in Northland, with the deepest recorded (27.5 m) submerged vegetation in the North Island.

Threats

Biosecurity: high risk of pest plant introduction but subsequent impact is likely to be low due to very low nutrient status and steep sides.

Catchment: moderate-high risk of increased nutrient loading with impact on current values and increased biosecurity risk.

Management recommendations

Surveillance for pest plant introductions at access points annually and lake native biodiversity value monitoring at 5 year intervals.

A survey of Lake Taharoa fish is advocated.

Continue investigations into ground water and identification of possible nutrient sources from the catchment with consideration of appropriate mitigation measures.

Description

This dune lake (1658567E, 6037260N) is the second largest (197 ha) and deepest lake (37 m) in Northland. It is a situated in a catchment comprised of ~1.8 M year old consolidated, nutrient-poor, sand dunes with shrub land, pastoral land and planted forest. The immediate surrounds include a domain with two camping grounds and the lake is popular for boating swimming and water skiing. There are two minor inflows at the south-west end of the lake, with no outflow. Access is via public roads with three boat launching areas.

Wetland vegetation

Much of shore was wave exposed with hard iron pan and compacted sand that is unsuitable for emergent vegetation. Low covers (25%) of oioi (*Apodasmia similis*) and *Schoenus brevifolius* were present in places. Additional emergent species recorded included *Machaerina arthrophylla*, *M. articulata*, *M. juncea*, *Eleocharis acuta*, *E. sphacelata*, *Ficinia nodosa*, *Isachne globosa*, *Isolepis prolifera* and *Juncus pallidus*.

The major woody weeds on the lake surrounds were delimited during 2014 with Sydney golden wattle (*Acacia longifolia*), coastal banksia (*Banksia integrifolia*) and two wilding pines (*Pinus pinaster* and *P. radiata*) the dominant species found.

Submerged vegetation

Sparse turf plants grew on the shallow (0-1 m) sandy substrates of the wave-cut shelves and included *Trithuria inconspicua, Triglochin striata* and *Myriophyllum votschii*. The exotic rush, *Juncus bulbosus*, was also recorded in these areas along with isolated plants of the bladderwort *Utricularia gibba*. Steep slopes immediately beyond these shelves were largely devoid of plants from 1 to 6 m. In 2018, charophyte meadows, dominated by *Chara fibrosa* and *Nitella leonhardii* (the deepest growing species) and lesser amounts of *N. pseudoflabellata* extended from 5.9 m to 27.5 m water depth. No *U. gibba* was recorded on the five transects.

The bottom depth limits of charophyte meadows have fluctuated from 18 to 27.5 m over the 8 surveys since 1984, but no trend in these fluctuations was apparent.

Low diversity of submerged vegetation reflects the low nutrient status of Lake Taharoa, with no tall vascular species, or charophytes more typical of more enriched water bodies e.g., *Chara australis* and *Nitella* sp. aff. *cristata*.

LakeSPI



An 'Excellent' LakeSPI score of 87% reflects the depth extent of vegetation, the predominance of the native charophyte community and lack of impact by invasive exotic plants. LakeSPI condition remains very stable.

Water birds

The limited development of marginal and emergent vegetation and popular use of this lake by the public reduce its suitability for water birds. Despite this, large numbers of waterfowl are reported to utilise the Kai-Iwi lakes, although the numbers were noted to be declining. The regionally rare dabchick (*Poliocephalus rufopectus*) was reported. Few birds were seen during the current survey.

Fish

Native fish sighted during surveys include common bullies (*Gobiomorphus cotidianus*), while the exotic pest gambusia (*Gambusia affinis*) were also observed. Previous surveys have recorded shortfin eels (*Anguilla australis*) and rainbow trout (*Oncorhynchus mykiss*) stocked by Northland Fish and Game. Dune lakes galaxias were last recorded in the 1999 survey.

Aquatic invertebrates

Koura (*Paranephrops planifrons*) and freshwater crab (*Amarinus* (was *Halicarcinus*) *lacustris*) were observed during the 2018 survey.

Endangered species

The Nationally Endangered *Centrolepis strigosa*, an annual, was found in the marginal turf in 2010 and has been found in the same location subsequently, usually as dead plants. Over 100 plants of this species were found on iron pan outcrops and beach areas in November 2013. No sign of this species was found in most of these areas during our 2018 survey, suggesting our annual surveys do not correspond with the actively growing stages of its life-cycle. The National Critical *Trithuria*

inconspicua was uncommon in this lake, with few plants seen during our shoreline survey in 2014. It was locally common at one site amongst *Machaerina arthrophylla* in the "Sin-bin" area. The At-Risk Relict sundew *Drosera pygmaea* was noted amongst mosses on iron pan outcrops.

The At-Risk Naturally Uncommon dune lakes galaxias (restricted to the Kai iwi lakes) has not been seen during our vegetation surveys since 1999 and a survey of Lake Taharoa fish is advocated.

There appears to be a secure population of the freshwater crab (At Risk Naturally Uncommon).

Lake Ecological Value

Lake Taharoa remains the best example of a clear-water lake in Northland with the deepest recorded (currently 27.5 m) submerged vegetation in the North Island. This is dominated by the charophyte, *Chara fibrosa*. The deepest extent of high cover *C. fibrosa* and *N. leonhardii* meadows has varied between 18 and 27.5 m between vegetation surveys and is currently the deepest recorded at 27.5 m. This measure will be a sensitive baseline for future assessments of long-term water clarity. Water quality trends show this lake is stable with an oligotrophic status. Its ecological value rating remains "Outstanding" with a score of 15.

Threats

The only pest plants present were *J. bulbosus* and *U. gibba*, which were sparse and of insignificant impact on the lake's ecology. While good boat access to the lake results in a high risk for introduction of pest plants, the potential impacts are currently very low. Firstly, the exposed wave cut platforms around the lake reduce the likelihood of establishment and secondly, unusual water chemistry limits the development of large vascular plants, likely due to dissolved carbon limitation. However, changes in water chemistry could make the lake more vulnerable to pest plant invasion. Such a change would be initially indicated by development of tall-growing native vascular plants such as *Myriophyllum* spp. and *Potamogeton* spp.

Large numbers of the pest fish gambusia could threaten the population of the endangered dune lake galaxias.

Nutrient loading from the catchment is a major threat with potential sources from nitrogen-fixing woody vegetation, pine harvesting and livestock farming. Resulting changes in water chemistry would not only decrease water quality but could also facilitate native vascular and pest plant establishment.

Management recommendations

Pest plant surveillance at access points annually. Lake native biodiversity value monitoring every 5 years.

A survey of Lake Taharoa fish is advocated.

Continue investigations into ground water and identification of possible nutrient sources from the catchment with consideration of appropriate mitigation measures.

3.1.8 Waikare (Kai-Iwi Lakes), NRC Lake No. 227



Figure 3-8: Lake Waikare. Photo taken from the ridge between this and Greer's Lake to the west (Photo: Paul Champion 2 May 2018).

Summary

Surveyed 1985, 1987, 2001, 2005, 2007, 2011, 2014 and 2018.

Overall ranking

Outstanding: A native plant dominated lake with the presence of nationally rare plants and fish. Negligible impact by pest plants.

Threats

Biosecurity: high risk of pest plant introduction but subsequent impact likely to be low due to very low nutrient status and steep sides. The introduced *Potamogeton crispus* was found in the lake for the first time in 2017.

Catchment: moderate risk of increased nutrient loading with impact on current values and consequent increased biosecurity risk.

Management recommendations

Pest plant surveillance at access points annually. Lake native biodiversity value monitoring every 5 years.

Continue investigations into ground water and possible nutrient sources from the catchment and consider appropriate mitigation measures.

Description

The lake (1656902E, 6038255N) is accessible for trailer boat traffic via a sealed road and concrete boat ramp. The catchment is predominantly manuka scrub (50%), felled pine plantation (45%), and a campground. This moderately large (26.5 ha) and deep (30 m) dune lake was an important venue for water skiing, but in 2016, the Kai Iwi Lakes (Taharoa Domain) Reserve Management Plan banned power boats from the lake. There is no outlet and only minor drains enter the lake.

Wetland vegetation

Emergent vegetation was sparse, only occurring around 15% of the lake shore, with *Eleocharis sphacelata, Machaerina arthrophylla, M. articulata, M. juncea, Apodasmia similis* and *Schoenus brevifolius* present in some areas. Emergent plants were usually in narrow bands < 2 m wide extending to water depths between 0.5 m and 2 m.

Submerged vegetation

Turf plants were not abundant due to the prevalent iron pan reefs around the lake but were locally common and associated with emergent vegetation. Species included *Trithuria inconspicua, Lilaeopsis novae-zelandiae* and *Myriophyllum votschii*. Isolated plants of the exotic rush, *Juncus bulbosus* were also recorded in shallow areas.

Surveys prior to 2018 recorded charophyte meadows that extended from < 2.5 m to 19 m depth with *Chara fibrosa* dominant in the upper profile and *C. australis* solely from 13 m to a maximum recorded depth of 19.7 m. Before 2005, *Chara fibrosa* dominated the charophytes to the bottom limit, which was 19 m in 2001. *Utricularia gibba* was recorded from between 11 and 16 m in 2014, the deepest record yet for this invasive species, where it formed high covers on charophyte meadows. One small patch of the native *Potamogeton ochreatus* was noted near the boat ramp in 2012 and the introduced *P. crispus* was recorded in the same location in 2017 as part of a dune galaxias survey (Alisha Frost NorthTec pers. comm.). This may indicate increased nutrients in that area. The plant was removed and the species was not seen in the 2018 survey.

The 2018 survey found record depths for charophyte meadows in Lake Waikare, reaching 22.6 m. *Chara australis* was the deepest growing species but *Nitella leonhardii* and *N. pseudoflabellata* were also recorded in deep vegetation (>15 m). *Potamogeton cheesemanii* was found in three transects at depths < 5 m, with the introduced *Juncus bulbosus* and the invasive *Utricularia gibba* both found in the shallows (<2 m) at three transects. The deep water (11 to 16 m) *U. gibba* band described in previous sampling occasions was not seen in 2018.

LakeSPI



Lake Waikare Submerged Plant Indicators

The 2018 LakeSPI score saw a return to the 'Excellent' status after two subsequent monitoring occasions seeing this reduce to 'High' status. This increase in status reflected the increased extent of charophyte vegetation and loss of the high cover, deep-water *U. gibba* mats, with Invasive Impact Index reduced from 38% in 2014 to 19% in 2018. Native Condition and LakeSPI indices have increased to scores seen in the early 2000's.

Water birds

The developed emergent vegetation limits the habitat available in this lake to water birds. Banning power boats may lead to an increase in emergent vegetation with improved water bird habitat in the future.

Fish

Native fish records include common bullies (*Gobiomorphus cotidianus*) and dune lakes galaxias, shortfin eel (*Anguilla australis*) and longfin eel (*Anguilla dieffenbachii*). Large pelagic schools of juvenile bullies were noted at several sites. Exotic fish present were gambusia (*Gambusia affinis*), common in shallow areas, and a stocked population of rainbow trout (*Oncorhynchus mykiss*). DOC conducted a fish survey during 2014 using a combination of Gee minnow (4) and fyke nets (2). They recorded a total of 96 gambusia, 589 common bullies, 20 dune lakes galaxias, 8 longfin and 2 shortfin eels (all large ≥540 mm long).

Aquatic invertebrates

Koura (*Paranephrops planifrons*) and pea mussels (*Sphaerium novaezelandiae*) were recorded from Lake Waikare, although they were not abundant. The DOC fish survey in 2014 recorded 3 dragonfly nymphs and one koura.

Endangered species

The Nationally Endangered *Centrolepis strigosa* was abundant in marginal vegetation in 2014. The Nationally Critical *Trithuria inconspicua* was locally abundant in this lake with three large populations

adjacent to the concrete boat ramp on the western shore and the eastern side of the southernmost bay.

The At Risk Naturally Uncommon dune lake galaxias (restricted to the Kai iwi lakes) appears to be abundant in Lake Waikare with large schools of this fish commonly seen during dive surveys and also sampled during the 2014 DOC fish survey. A few At-Risk Declining longfin eel were also sampled by DOC.

Lake Ecological Value

Lake Waikare, like the neighbouring Lake Taharoa, is a good example of a clear-water Northland lake. Submerged vegetation is dominated by dense charophyte meadows with *Chara australis* now extending to a maximum recorded depth of 22.6 m, with three other charophyte species recorded in these meadows. The lake does stratify over summer and should low dissolved oxygen levels develop in the hypolimnion this could threaten its 'Outstanding' status in the future. Its ecological value score is 15, the maximum score of any Northland lake (equal to Lake Taharoa).

Threats

The ease of access and boat traffic to this lake results in a very high risk of pest plant introduction, however the ban on power boats has undoubtedly reduced the risk substantially. Water chemistry currently limits the development of large vascular plants and pest plants are unlikely to establish. However, changes in water quality parameters could increase the likelihood of pest plant establishment. Nevertheless, hornwort (*Ceratophyllum demersum*) may be able to thrive in this lake under current nutrient levels. *Potamogeton ochreatus* and *P. crispus* noted near the boat ramp may indicate localised nutrient enrichment in that area.

The biggest threat would be if increased nutrient loading from the catchment were to occur which would not only impact upon water clarity and current ecological values but also create an increased threat of pest plant establishment. Given the excellent water quality of this lake and 'Outstanding' ecological value rating, the possibility of water quality deterioration requires further consideration.

Management recommendations

Pest plant surveillance should be carried out at access points annually.

Lake native biodiversity value should be monitoring every 5 years.

Lake water quality and catchment nutrient sources need to be closely monitored and managed.

3.1.9 Lake Waingata (Waipoua) NRC Lake No. 200A



Figure 3-9: Lake Waingata. Photo from the west, showing the steep, pampas dominated catchment (Photo: Lisa Forester, NRC 3 May 2018).

Summary

Surveyed 2006 and 2018.

Overall ranking

Low: A small steep sided lake, within recently harvested plantation pine forestry in the catchment. No submerged vegetation noted, lake very brown-stained.

Threats

Very low risk of pest plant introduction due to very difficult access, with subsequent impact likely to be low due to lack of favourable habitat. Moderate risk of increased nutrient loading dependent on forestry management.

Management recommendations

No regular monitoring.

Description

A small (0.9 ha) dune lake (1642935E, 6053750N), with a maximum depth ~3 m. Pine plantation forest catchment, all but the southern end of lake had been harvested prior to 2018 visit, now dominated by pampas (*Cortaderia selloana*). No outflows or outflows are apparent. Access is via forestry roads, then by walking down a steep bank through dense pampas, with no access for boats/canoes.

Wetland vegetation

The lake had a narrow (2-5 m) wide fringe of emergent vegetation dominated by *Eleocharis sphacelata* and locally common *Machaerina articulata*, with a larger emergent area at the northern end, which also contained *M. arthrophylla*. *M. juncea* and *Isachne globosa*.

Submerged vegetation

In 2006, the *Eleocharis sphacelata* extended with a high cover into about 2.5 m of water. Submerged vegetation was all native but generally sparse throughout the lake down to 5-6 m deep, with most in the north end where the slope was much less. *Chara australis* was the dominant charophyte but *C. fibrosa* and was also present with some *Potamogeton ochreatus*.

In 2018, the lake was highly tannin-stained, with poor underwater visibility and no submerged vegetation was noted.

LakeSPI

In 2006, no invasive species were present but the low cover of native species accounted for the LakeSPI Index score of 80. Submerged vegetation was absent in 2018 with a zero score.

Water birds

None recorded.

Fish

Eels were probably present as holes were frequent in the bottom sediment in 2006.

Aquatic invertebrates

None noted.

Endangered species

No threatened species were observed in and around Lake Waingata.

Lake Ecological Value

Lake Waingata ecological value rating is assessed as "2 - low", a small water body, with poorly buffered habitat, low biodiversity and lacking submerged vegetation, possibly as a result of pine felling and consequent increased staining due to the release of tannic acids from decomposing pine roots/mycorrhizae.

Threats

There is a very low risk of pest plant introduction due to the difficult access, with subsequent impact likely to be low due to lack of favourable habitat. The felling of pines around much of lakes steep catchment is likely to have led to the loss of an already sparse submerged vegetation. There is a moderate risk of increased nutrient loading dependent on forestry management, but the lake is already degraded.

Management recommendations

No regular monitoring is recommended.





Figure 3-10: Waipoua Lagoon South. Photo taken from the southern end (Photo: Lisa Forester, NRC 3 May 2018).

Summary

Surveyed 2018 (reconnaissance only).

Overall ranking

Moderate to Low: A narrow lagoon, situated at the seaward end of an unnamed stream, formed by dune encroachment at the outlet. A mostly native submerged vegetation, in water up to 1 m deep.

Threats

Low risk of pest plant introduction due to difficult access along the beach from the Waipoua River, and a large wetland bounding much of the upstream area. The lower catchment is mostly open dune, with moderate risk of increased nutrient loading dependent on forestry and pasture management in the upper catchment of the stream.

Management recommendations

No regular monitoring.

Description

A small (0.63 ha) lagoon (1645020E, 6050455N) with a 30 m wide channel extending for around 250 m. The maximum depth was approximately 2 m. The seaward end of the catchment was open spinifex (*Spinifex sericeus*) and pampas (*Cortaderia selloana*) dominated duneland. The upper catchment of the unnamed stream was around 25% pine plantation forest, with the remainder a

combination of pasture, scrub and wetland vegetation. Access is via 4-WD on forestry roads, then driving along the beach.

Wetland vegetation

Waipoua Lagoon South had a narrow (1 m) fringe of emergent oioi (*Apodasmia similis*), with localised *Schoenoplectus tabernaemontani*, raupo (*Typha orientalis*), spike sedge (*Eleocharis acuta*) and *Persicaria decipiens*.

Submerged vegetation

Submerged vegetation was primarily native with *Ruppia polycarpa, Myriophyllum propinquum* and the introduced swamp lily (*Ottelia ovalifolia*) all with maximum covers > 5%. Lower covers of *Potamogeton ochreatus, P. cheesemanii, Nitella* sp. aff. *cristata* and the invasive *Utricularia gibba* were recorded. The normally short growing turf plant *Lilaeopsis novae-zelandiae* grew to 0.3 m tall in scattered areas. The water was turbid and visibility was poor, estimated to be ~0.8 m.

Water birds

None recorded.

Fish

Inanga (*Galaxias maculatus*) were observed in the lagoon, with the stream currently discharging to the Tasman Sea in a wide shallow channel.

Aquatic invertebrates

None noted.

Endangered species

Inanga (*Galaxias maculatus*) are considered to be At-Risk Declining with a large national population > 100 000 mature individuals, but a predicted decline of 10–70% (Goodman et al. 2014).

Lake Ecological Value

Waipoua Lagoon South ecological value rating is assessed as "5 – moderate to low", a small water body. Derived from a stream draining pasture and forestry, it is formed by mobile dune obstruction of the outlet. Mainly native vegetation, but with limited habitat and a population of the at-risk inanga.

Threats

There is a very low risk of pest plant introduction due to difficult access. Catchment activities in the pasture and forestry areas could include either nutrient enrichment or pest species introduction, but impacts are likely to be buffered by the large wetland bounding much of the upstream area.

Management recommendations

No regular monitoring is recommended.

3.1.11 Waipuna Lake



Figure 3-11: Waipuna Lake. Viewed from the west, note mobile dunes at the western end and scrub vegetation further east (Photo: Paul Champion 1 May 2018).

Summary

Surveyed 2018.

Overall ranking

Moderate: A small lake, formed from Waipuna Stream dammed by mobile devegetated sand dunes, with no outlet. The upper catchment is within recently harvested plantation pine forestry, with scrub surrounding the eastern lake margins. A diverse and predominantly native submerged vegetation.

Threats

Very low risk of pest plant introduction due to very difficult access. Moderate risk of increased nutrient loading dependent on forestry management.

Management recommendations

Five yearly monitoring.

Description

A small (1 ha) dune lake (1631125E, 6071825N), with a maximum depth of 6.3 m. The seaward half of this lake is bounded by mobile sand dunes, with scrub and pampas dominating the landward half. The Waipuna Stream drains a pine plantation forest catchment, which had been harvested prior to 2018 visit. Three inflows were noted, but there is no apparent outflow, with the lake around 20m above sea level. Access is difficult and for 4-WD only, via forestry roads, then driving along coastal dunes and scrub and a steep dune face.

Wetland vegetation

Emergent vegetation was restricted to the northeastern end of the lake, with kuta (*Eleocharis sphacelata*), *Machaerina articulata*, *Schoenoplectus tabernaemontani* and raupo (*Typha orientalis*) common. Sprawling species included *Persicaria decipiens* and two introduced species, water cress (*Nasturtium officinale*) and the pest plant primrose willow (*Ludwigia peploides*).

Submerged vegetation

A diverse submerged vegetation was found in clear water with underwater visibility of 3 to 4 metres. Submerged vegetation restricted to areas deeper than 1.2 m to a maximum 6.3 m deep in areas adjacent to mobile dunes, but from 0.3 m to 5.3 m further east. Five charophyte species were seen, with *Nitella pseudoflabellata* the commonest, with average covers >5% for *Chara globularis* and *N. hyalina*. *Myriophyllum propinquum, M. triphyllum, Potamogeton ochreatus* and *P. cheesemanii* were also present with the introduced swamp lily (*Ottelia ovalifolia*). The invasive *Utricularia gibba* was present at low covers over much of the submerged vegetation, occasionally forming dense mats.

LakeSPI

Lake Waipuna (Mitimiti) Submerged Plant Indicators

Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
May 2018	High	70%	73%	28%

The high covers of charophyte dominated vegetation resulted in a 'High' status, with a 28% Invasive Impact Index score resulting from the presence of *U. gibba*.

Water birds

None recorded.

Fish None noted.

Aquatic invertebrates

None noted.

Endangered species

No threatened species were observed.

Lake Ecological Value

Waipuna Lake ecological value rating is assessed as "6 - moderate", a small water body, with poorly buffered habitat, but high biodiversity and diverse charophyte dominated submerged vegetation.

Threats

There is a very low risk of pest plant introduction due to difficult access. The felling of pines around much of lakes catchment did not seem to have impacted the water clarity of this lake. There is a moderate risk of increased nutrient loading dependent on forestry management.

Management recommendations

An isolated lake that is difficult to access, but further information on biota and water quality is required to assign a full ecological condition score. Five yearly monitoring is recommended.

3.1.12 Lake Rototuna (Pouto), NRC Lake No. 328.



Figure 3-12: Lake Rototuna. Viewed from the south (Photo: Lisa Forester, NRC 4 May 2018).

Summary

Surveyed 1988, 2001, 2005, 2007, 2012, 2014 and 2108.

Overall ranking

High-Moderate: A lake with retired margins, native vegetation, endangered biota previously recorded and pest fish. Water level and water quality have declined over the past decade, but improving catchment and emergent vegetation result in a similar lake ecological value.

Threats

A lowering water level and declining water quality, with regular heavy algal blooms, threaten the lake's ecology. Invasive submerged weeds would displace the existing vegetation, though access is now more difficult. The invasive reed sweet grass (*Glyceria maxima*) threatens the lake margins. Grey willow (*Salix cinerea*) was recorded here (and in Northland) for the first time in 2018.

Management recommendations

Address water level and nutrient concerns. Lake ecological assessment every 5 years. Eradicate reed sweet grass and grey willow.

Description

Lake Rototuna is a dune lake 6 ha in area and 5.1 m deep, depending on water levels. The catchment was pasture (now mostly planted with native species) and pine plantation forestry. Ninety percent of the lake margin has been fenced since 1999 and native vegetation or a thick mat of kikuyu (*Cenchrus clandestinus*) surrounds the lake. There were no inflow or outflow streams. The lake is adjacent to Pouto Road, accessible with a 4-WD.



Figure 3-13: Google Earth images of Lake Rototuna in 2004 and 2017. Note the establishment of native vegetation in the catchment and increased emergent vegetation.

Wetland vegetation

About 90% of the shoreline had emergent species with raupo (*Typha orientalis*), *Eleocharis sphacelata*, *E. acuta*, *Machaerina articulata* and *Schoenoplectus tabernaemontani* forming a 10 m wide band. *E. sphacelata* beds extended to 1.2 m deep, the other species were < 0.5 m. The invasive reed sweet grass (*Glyceria maxima*) was found for the first time in 2007. It was located amongst raupo on the south-eastern shore of the lake, and was still present in 2018. A few small shrubs of grey willow (*Salix cinerea*) were noted amongst planted vegetation near the Pouto Road for the first time in 2018.

Submerged vegetation

From 1988 to 2014, the lake has been dominated by *Nitella* sp. aff. *cristata* with depth limits steadily decreasing from 5.6 m to 3.1 m. This appears to be driven by lower water levels rather than the bottom limit retracting. Over that period, surveys have been difficult with heavy algal blooms and low visibility (0.4 m, in 2012). Turf species were present around about 20% of the lake, with *Glossostigma elatinoides* and *Lilaeopsis novae-zelandiae* most common but always at low covers (<26%). Tall-growing native species were present on all profiles with *Potamogeton ochreatus, P. cheesemanii* and *Myriophyllum triphyllum* the most abundant (0-5% median cover). No tall-growing exotic species were present except *Potamogeton crispus* and *Juncus bulbosus*, found in 2005, but they have not been seen since. Charophytes were the dominant vegetation in the lake, with *Nitella* sp. aff. *cristata* at high (>75%) average cover at all profiles and growing to a depth of 3.1 m in 2014.

Chara australis was also present, but *Nitella pseudoflabellata* and *N. hyalina* were not recorded in 2014. The At Risk Naturally Uncommon *Stuckenia pectinata* was recorded in 2005 but has not been found since.

In 2018, submerged vegetation extended from the margin of emergent plants to a maximum depth of 3.3 m. The turf species were restricted to the remaining grazed lake margin (~130 m). Composition of the submerged vegetation was similar to previous surveys, although both *Nitella pseudoflabellata* and *N. leonhardii* were recorded, and *Myriophyllum propinquum* was noted in submerged vegetation for the first time, but *M. triphyllum* was not seen. No introduced species were recorded, apart from *Utricularia gibba*, present in only one profile to a depth of 1.4 m.

LakeSPI



Lake Rototuna is categorised as being in 'High to Moderate' status with a LakeSPI index of 78%. LakeSPI values for this lake have remained stable since surveys began in 2001 with only a small change noted in the invasive impact scores during the 2001 and 2005 surveys on account of *Potamogeton crispus* and *Juncus bulbosus* being present at that time and the minor impact of *U. gibba* in 2018.

Water birds

The regionally significant dabchick (*Poliocephalus rufopectus*) and scaup (*Aythya novaezeelandiae*) were noted in previous visits, with 18 other common birds, the most dominant being black swans (*Cygnus atratus*) and paradise shelduck (*Tardorna variegata*). In addition to the two regionally significant birds, an endangered Australasian bittern (*Botaurus poiciloptilus*) was seen during the 2012 and 2014 visits.

Fish

Nationally threatened dwarf inanga (*Galaxias gracilis*) were recorded by the NIWA FBIS database although none were seen during the survey. Common bully (*Gobiomorphus cotidianus*) and exotic *Gambusia affinis* were observed. Rudd (*Scardinius erythrophthalmus*) were also reported.

Aquatic invertebrates

The introduced snail *Physa acuta* was recorded during the vegetation survey.

Endangered species

No threatened plant, fish or aquatic invertebrate species were observed, but there are records of dwarf inanga (*Galaxias gracilis*) in the lake in the past.

Lake Ecological Value

Lake Rototuna ecological value rating is assessed as "8 high to moderate", an increase from moderate in 2014. The increase results from the improved condition of the catchment and established emergent vegetation, which countered declining water level and water quality over the past decade.

Threats

A lowering water level and declining water quality, with regular heavy algal blooms, threaten the lake's ecology. Five degrading water quality trends have been recorded in Lake Rototuna – decreasing water clarity and increasing ammoniacal nitrogen, total nitrogen, total phosphorus and TLI. This may be related to the steady fall of Lake Rototuna's water level with a loss of 2.74 m of head since 2004. There was also an apparent earlier level drop in excess of 1 m when the lower Rototuna lake blew out during a storm in the late 1990s (L. Forrest pers. comm.). The lake is approaching a supertrophic TLI.

The vegetation is native dominated and introduction of other weed species is a risk. Invasive submerged weeds would displace the existing vegetation, though access is now more difficult. The invasive reed sweet grass (*Glyceria maxima*) threatens the lake margins.

New Zealand's worst wetland weed grey willow (*Salix cinerea*) was found for the first time in Northland at Kaihu on 3 May 2018, with the discovery of plants at Lake Rototuna the following day. It is likely that these plants are mature and if both sexes are present then wind dispersed seed could be produced.

Pest fish are of concern. Gambusia could extirpate dwarf inanga in Lake Rototuna. Rudd are largely herbivorous and have been implicated in the loss of vegetation in nutrient stressed lakes similar to Lake Rototuna. However, rudd have been present in the lake for around a decade with little apparent impact.

Management recommendations

Lake ecological assessment every 5 years. Eradicate reed sweet grass and grey willow from the lake margins. A grass-specific herbicide such as haloxyfop would be recommended for the grass, whereas willows should be cut and the stumps painted with metsulfuron and surfactant.

Fish surveys and water quality monitoring are both advocated.

3.2 Annual surveillance 2018

Annual submerged plant surveillance was carried out in the Kai-Iwi lakes and other plant invaders were reported during the week-long survey.

3.2.1 Kai-Iwi Lakes

No submerged weeds were detected in Lakes Kai-Iwi, Taharoa or Waikare during the 2018 surveillance programme. The introduced minor submerged weed *Potamogeton crispus* was recorded near the boat ramp at Lake Waikare in 2017 (Figure 3-14) as part of a dune galaxias survey (Alisha Frost, NorthTec pers. comm.). The plant was removed and was not seen in the 2018 survey.



Figure 3-14: Specimens of *Potamogeton crispus* collected from Lake Waikare. Photo: A. Frost, NorthTec 17 August 2017.

3.2.2 Grey willow

Grey willow (*Salix cinerea*) is regarded as New Zealand's worst wetland weed. It is found in most parts of New Zealand, but was thought to be absent from Northland. On 3 May 2018, investigation of a suspect tree in a wetland on the roadside of SH 12 just north of Kaihu (1660995E, 6041885N) revealed a small clump of this tree, around 2.5 m tall (Figure 3-15). As described in Section 3.1.12, small trees were also found adjacent to Lake Rototuna the following day. All efforts must be made to delimit the infestations of this species. If both sexes are present, then seed set and dispersal of wind-adapted seed could spread this plant to suitable sites (wetlands or even disturbed bare soils, e.g., road cutting cropping areas, gardens) down wind. Fortunately seed have limited viability. Eradication of all trees should be undertaken.



Figure 3-15: Grey willow (Salix cinerea), Kaihu. A small stand of saplings in a roadside wetland.

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