3.9 Lake Little Gem, near Ngatu (Aupouri) NRC Lake No. 123; surveyed in 2007.

Plate 1: Lake Little Gem viewed from the north-western access point.

Summary

Overall ranking

Outstanding: Complete fringe of emergent and submerged vegetation with numerous endangered biota. The introduced pest plant *Utricularia gibba* is widespread and the pest fish *Gambusia affinis* was previously recorded, but no other pest species were recorded.

Threats

Low risk of introduction of further invasive pests. Existing emergent vegetation provides a good nutrient buffer for surrounding pastoral land, but intensified land use could threaten this lake.

Management recommendations

Lake condition monitoring every 5 years.

Description

Lake Little Gem (NZMG 2528656E 6684691N) is a small (0.36 ha) dune lake with a maximum depth of 3.5 m. The lake is unfenced and surrounded by pasture. There are no inlets or outlets. The lake is accessed from southwest end of Lake Ngatu via a walking track through private property.

Wetland vegetation

Lake Little Gem was surrounded by continuous wide beds of emergent species *Eleocharis sphacelata* growing from the lake margin to 2.6 m depth with scattered areas of *Baumea articulata*, flax (*Phormium tenax*), raupo (*Typha orientalis*) and manuka (*Leptospermum scoparium*). Within the *Eleocharis sphacelata* was *Isachne globosa*, *Hydrocotyle pterocarpa*, *Myriophyllum propinquum* and large patches of nationally endangered *Myriophyllum robustum* (classified as Gradual Decline, see Plate 2) around much of the lake. The pest species *Utricularia gibba* formed surface floating mats in parts of emergent vegetation (Plate 2). The shallow shoreline was grazed and dominated by *Isolepis prolifer* and also including regionally uncommon *Sparganium subglobosum*.

Submerged vegetation

Charophytes dominated the vegetation from the outer edge of emergent communities to a maximum depth of 3.3 m. The dominant species was *Nitella* aff. *cristata* growing to 1 m tall with local areas of *Chara australis* with the pondweed *Potamogeton cheesemanii* growing up to 2.8 m tall to a depth of 3.0 m. The alien invasive *Utricularia gibba* sprawled over submerged species from the edge of emergent *Eleocharis sphacelata* beds to 2.6 m depth.

LakeSPI

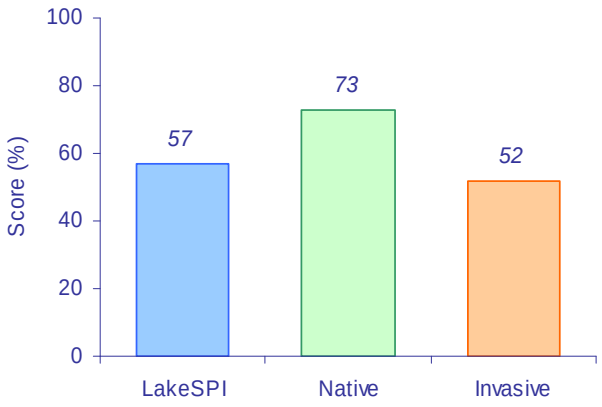

Figure: 2007 LakeSPI Index as % of potential score, Native Condition Index, and Invasive Impact shown**.**

A moderate LakeSPI score of 65% reflects predominantly indigenous vegetation, including extensive charophyte meadows, but reduced by presence of invasive *U. gibba*.

Water birds

Extensive emergent vegetation and relatively undisturbed nature of this lake provides a good habitat for water birds. The nationally threatened bittern (*Botaurus poiciloptilus*) and the regionally rare dabchick (*Poliocephalus rufopectus*) are commonly found on this lake (K. Matthews pers. comm.).

Fish

No fish were seen during the current visit, but NIWA FBIS recorded inanga (*Galaxias maculatus*) and the pest fish gambusia (*Gambusia affinis*) from this lake. The inanga are likely to be similar to Lake Ngatu fish, requiring further investigation.

Aquatic invertebrates

The introduced freshwater jellyfish (*Craspedacusta sowerbyi*) were noted during the submerged vegetation survey.

Changes in indicators

First sampled in 2007.

Threats

The threat posed by the sprawling growths of the weed *Utricularia gibba* is uncertain at this stage.

The pest fish *Gambusia affinis* may have a deleterious impact on other fish like the potentially nationally significant inanga reported from this lake.

Existing emergent vegetation provides a good nutrient buffer for surrounding pastoral land, but intensified land use could threaten this lake.

Management recommendations

Carry out 5 - year lake condition monitoring.

Plate 2: The nationally threatened *Myriophyllum robustum* growing amongst the emergent sedge *Eleocharis sphacelata* in Lake Little Gem in about 0.5 m of water. Note the dense mat of the invasive *Utricularia gibba* with lone small flower stalk (red arrow).

3.10 Mini Lake (Split Lake) (Aupouri), NRC Lake No. 130; surveyed in 2005.

Plate: Mini Lake, set in pasture, showing the narrow ribbon-like nature of the lake with large emergent beds of raupo (*Typha orientalis*) and kuta (*Eleocharis sphacelata*).

Summary

Overall ranking

Low: Submerged vegetation dominated by invasive *Egeria densa*, margin grazed to edges, but deep water protects much of emergent vegetation from cattle, good water bird habitat.

Threats

Invasive *E. densa*, *Ceratophyllum demersum*, *Utricularia gibba* and alligator weed (*Alternanthera philoxeroides*) already present. Grazing and nutrient enrichment impacts.

Management recommendations

Evaluate options for control of alligator weed.

No monitoring.

Description

A dune lake (1617390S, 6118790N), 8.7 ha in area and ~ 2 m deep. The catchment is pasture with unimpeded access for livestock. There are no inflow or outflow streams. Access is through approximately 1 km of private farmland with difficult boat access to the lake.

Wetland vegetation

Despite grazing impacts, approximately 50% of this lake is occupied by dense emergent beds. *Eleocharis sphacelata*, *Typha orientalis*, *Baumea articulata*, *Schoenoplectus tabernaemontani* and *Isolepis prolifer* were the dominant species.

The invasive alligator weed (*Alternanthera philoxeroides*) was present at the southern end of the lake.

Submerged vegetation

The lake was dominated by the invasive weed *Egeria densa* forming a dense surface-reaching bed from 0.5 to 1.5 m deep. Lesser amounts of the exotics *Ceratophyllum demersum* and *Utricularia gibba* and the native *Chara australis* were also present in this area. *Nitella* aff. *cristata* covered the deepest parts of the lake (to ~ 2 m) with 50% cover.

LakeSPI

Reconnaissance only – no LakeSPI score generated.

Water birds

Moderate water bird habitat. The nationally threatened bittern (*Botaurus poiciloptilus*) and the regionally significant dabchick (*Poliocephalus rufopectus*) were reported in the 1990's. Large numbers of black swan (*Cygnus atratus*) and Canada geese (*Branta canadensis*) were noted during the field visit.

Fish

Longfin eel (*Anguilla dieffenbachii*) were reported on the NIWA FBIS database.

Aquatic invertebrates

No invertebrates were reported.

Changes in indicators

No previous vegetation surveys.

Threats

The lake is highly impacted with the worst pest plants already present and impacting on the vegetation.

Lack of riparian vegetation between steep sided pasture and this lake and also the grazing/trampling impacts of cattle provide no buffer to catchment nutrients entering the lake.

Management recommendations

No monitoring.

3.11 Morehurehu (Aupouri), NRC Lake No. 32; surveyed in 2006 and 2009.

Plate: Morehurehu set in plantation pine, with extensive emergent beds.

Summary

Overall ranking

Outstanding: Remote lake with diverse native submerged and emergent vegetation including endangered species, good water quality.

Threats

Exotic invasive species would displace the native vegetation but this lake is remote so the risk is low. Eel fishers would be the most likely source of invasive weeds. Pine harvesting could impact water quality and nutrient status.

Management recommendations

Leaving the zone of scrub would offer some buffer for the lake from nutrient additions associated with logging activities. Lake condition monitoring every 5 years.

Description

Lake Morehurehu is a dune lake situated 1599711E, 6166691N and is 36.3 ha in area. Depth is c. 14 m. The catchment is all plantation pine trees, with a zone of manuka/hakea scrub between the lake and pines. There are 3 inlets streams entering the south-west, north-west and south-eastern arms of this lake, with the outlet flowing

through a wetland at the south-eastern end of the lake into Great Exhibition Bay (East Coast). Wetlands are also associated with the inflow streams. Access is through private forestry roads (4-WD) through a locked gate and permission to cross Maori-owned land is required. There is a track leading to the lake on the peninsula, however access is steep and the track is loose sand, making all but light boat access difficult.

Wetland vegetation

Eleocharis sphacelata was present all around the lake with a diversity of other emergent species well represented, including *E. acuta, Typha orientalis, Baumea articulata, B. teretifolia, B. juncea* and *B. arthrophylla*. The emergent fringe was wide, from 10 to 30 m across, with *E. sphacelata* the deepest growing species (to 2.0 m).

Wetlands contained all of the emergent species, but also flax (*Phormium tenax*), swamp coprosma (*Coprosma tenuicaulis*), manuka (*Leptospermum scoparium*), swamp kiokio (*Blechnum novaezelandiae*) and areas of bog vegetation with the regionally significant wire rush (*Empodisma minus*) and umbrella fern (*Gleichenia dicarpa*). Several plants of nationally threatened status were present with *Drosera pygmaea* noted in a lake-shore turf, *Todea barbara* on lake shore banks, and *Dianella haematica* in a marginal wetland.

Submerged vegetation

Turf species were not well represented as most of the margins were covered with emergent species. A diverse range of native species (9 spp.) dominated the submerged vegetation extending from the margin of emergent plants to a maximum depth of 5.3 m. *Chara fibrosa* was the dominant species, with *C. australis, Nitella leonhardii* and *N. pseudoflabellata* locally dominant, and the tall-growing native *Potamogeton cheesemanii* was common. The invasive exotic *Utricularia gibba* covered native species to about 4 m depth. The nationally endangered *Utricularia australis* was found on 4 of the 5 profiles, scattered throughout other vegetation to 4.6 m depth limit in 2006, but was not found in 2009.

In 2005 the lake had a moderate LakeSPI score of 57% and was driven by diverse native submerged communities but degraded by *U. gibba,* the only invasive species present. In 2006 the extent of *U. gibba* had increased reducing the LakeSPI score to 51; with the Invasive Impact Index up from 30 to 42 and the Native Condition Index down from 51 to 46 % of its maximum potential. In 2009 the Invasive Impact had further increased lowering the LakeSPI Index still further to 43%.

LakeSPI

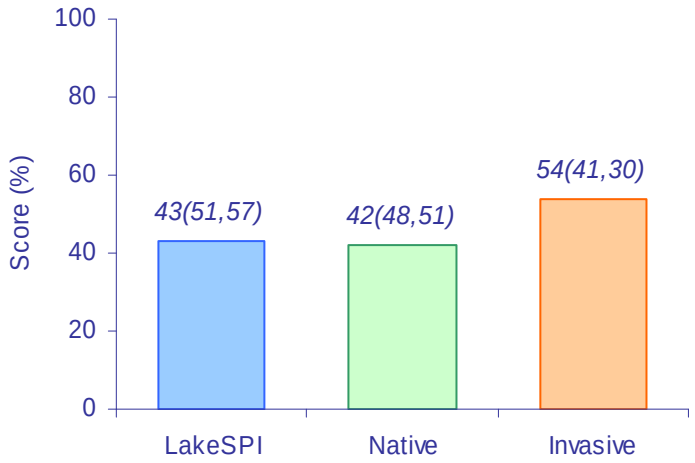

Figure: LakeSPI Index for 2009 (with 2006 and 2005 bracketed respectively) as % of potential score, Native Condition Index, and Invasive Impact Index (from left to right).

Water birds

A remote, large lake with scrub and wetland margins and extensive emergent beds would make this a good habitat for wetland birds. Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchus*) and a bittern (*Botaurus poiciloptilus*) were seen during this visit. DoC SSBI records the regionally threatened fernbird (*Bowdleria punctata vealeae*) as common in the marginal vegetation and wetlands in 1991. None were noted during the field visit or from recent OSNZ visits.

Fish

Common bully (*Gobiomorphus cotidianus*) and inanga (*Galaxias maculatus*) were seen during the survey. Shortfin eel (*Anguilla australis*) were also recorded on the NIWA FBIS database for this lake.

Aquatic invertebrates

Mussels and koura have not been recorded during surveys, but freshwater sponges were abundant.

Changes in indicators

A 1988 vegetation survey recorded similar submerged vegetation to the current description although *Chara australis* was more abundant and extended to a maximum depth of 9.5 m. *U. gibba* was not recorded. The impact of *U. gibba* has increased from 2005 to 2006 and 2009. However, charophytes appear to persist below its dense mats.

Threats

The main risks come from use of diggers in associated streams, or pine plantation harvesting gear that may be contaminated with invasive weeds such as alligator weed, (*Alternanthera philoxeroides*), or eel fishers using nets contaminated with submerged weeds. Introduced invasive species would establish and displace much of the indigenous vegetation.

The lake is probably N limited and thus sensitive to urea fertiliser addition to forestry or harvesting activities.

Management recommendations

Leaving the zone of scrub would offer some buffer for the lake from nutrient additions associated with logging activities. Lake condition monitoring every 5 years.

3.12 Morehurehu South (Aupouri), NRC Lake No. 36; surveyed in 2006.

Plate: Morehurehu South, a coastal dune lake set in mobile sand dunes, scrub and pine plantation forestry.

Summary

Overall ranking

Moderate-High: A small remote lake, with high native biodiversity but also has the invasive *Utricularia gibba.*

Threats

Exotic invasive species would displace the native vegetation but this lake is remote so the risk is low. Eel fishers would be the most likely source of invasive introductions.

Management recommendations

No monitoring.

Description

The lake (1600485E, 6165737N) is small (0.44 ha), and 3.3m deep, with no inflows or outflows. The catchment is 50% mobile sand (southern end) and scrub, with plantation forestry further to the north. Access is through a well-formed track, but is restricted by a padlocked gate. Boat access was difficult.

Wetland vegetation

Emergent species encircled most of the lake in a band 5 to 10 m wide and were dominated by *Eleocharis sphacelata* growing to a depth of 2.0 m. Oioi (*Apodasmia similis*), *Baumea teretifolia* and the regionally significant *Empodisma minus* were all common marginal species. A population of the Nationally Vulnerable *Drosera pygmaea* was observed growing in a lake-side turf.

Submerged vegetation

No turf species recorded. The regionally significant *Triglochin striata* was recorded and charophytes dominated by *Nitella hookeri* aff. *cristata* and *Chara australis* were recorded to the lake's maximum depth of 3.6 m. The tall-growing native *Potamogeton cheesemanii* was also abundant and tall (to 3m). *Utricularia gibba* was present at high covers to 2.5 m covering indigenous vegetation over much of the lake. The nationally endangered *Utricularia australis* was found in small amounts amongst emergent vegetation in previous surveys.

LakeSPI

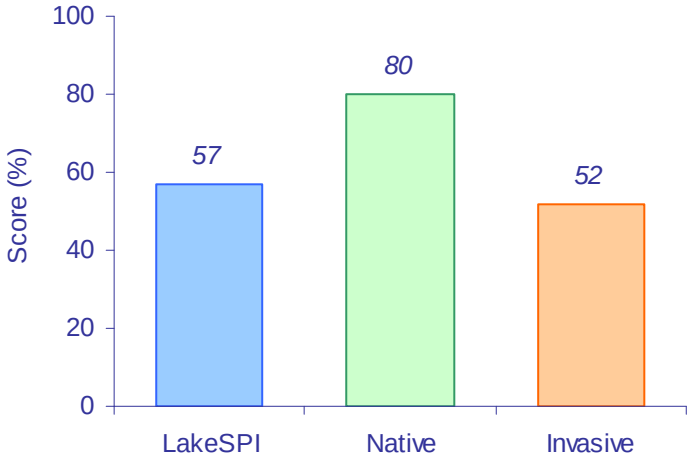

Figure: LakeSPI Index as % of potential score, Native Condition Index, and Invasive Impact Index (from left to right) for 2006 with 2005 data being the same.

A moderate LakeSPI score of 57% reflects continuous charophyte meadows impacted by *U. gibba*, the only invasive species. *U. gibba* was flowering and had seed. The data is unchanged since 2005.

Water birds

No birds were seen or heard, but DoC SSBI report fernbird (*Bowdleria punctata vealeae*).

Fish

Schools of inanga (*Galaxias maculatus*) were observed amongst the emergent vegetation.

Aquatic invertebrates

No mussels or koura seen.

Changes in indicators

Not previously surveyed.

Threats

Access for vectors of pest species is difficult, but if introduced pest species could deleteriously impact on this lake. Forestry fertilising would have impacts on lake nutrients and clarity, although scrub vegetation is likely to buffer much of this impact.

Management recommendations

No monitoring recommended as this lake is very remote and impacts are unlikely.

3.13 Lake Ngakapua (Aupouri), NRC Lake No. 115 (South Basin) and 117 (North Basin); surveyed in 2005.

Plate: Ngakapua South Basin looking towards the North Basin separated by a bed of emergent kuta (*Eleocharis sphacelata*). Note the grazing impacts confining emergent vegetation to deeper water.

Summary

Overall ranking:

Moderate-High: Predominantly native vegetation with some impact by *Utricularia gibba*, declining water quality, cattle access could disturb water birds.

Threats

Restricted access means the risk of pest plant introduction is low, but impact would be high. Nutrient run-off from pasture/stock access threaten water quality.

Management recommendations

Fencing of lake edge is recommended. Lake condition monitoring should be undertaken at 5 yearly intervals.

Description

This dune lake (North Basin; 1617479E, 6124818N, South Basin; 1617755E 6124790N) is comprised of two lake basins separated by a shallow area of reed bed and a manuka/flax island. The North Basin is 2.2 ha in size, is c. 8.2 m deep and has a pastoral and planted forest catchment. The South Lake is 6.7 ha in size, is c. 5.2 m deep and the catchment is predominantly pastoral with some scrub on the southern side. There are no inflow or outflow streams. Access is via well-formed forestry roads.

Wetland vegetation

Emergent vegetation of both basins was dominated by *Eleocharis sphacelata* extending from the lake edge (where fenced) but more commonly from 0.8 to 1 m deep to a maximum depth of 2.1 m. This bed varied from 5 to 20 m across and formed an almost complete zone apart from the eastern part of the South Basin. *Baumea arthrophylla* and *B. articulata* were locally present. The regionally rare *Gratiola sexdendata* was found on the northern shore of the South Basin.

Submerged vegetation

Turf plants were restricted to two sites in the South Basin where the shoreward reed beds had been grazed by cattle. A band of the exotic *Utricularia gibba* had a median cover of 26-50% extending from within the reed beds to c. 3 m depth in the North Basin and to 2.6 m in the South. The remainder of the submerged vegetation was dominated by patchy covers of *Chara australis* to a maximum of 4.0 m depth in the North Basin and 3.0 m in the South Basin. This charophyte was usually accompanied by low covers of *Potamogeton cheesemanii*. The exotic *Juncus bulbosus* was recorded at low cover at one site in each basin. Occasional plants of the nationally endangered *Utricularia australis* were recorded on the shoreward margin of the reed bed in the North Basin and the regionally significant *Triglochin striata* was recorded in shallow turfs in the South Basin.

LakeSPI

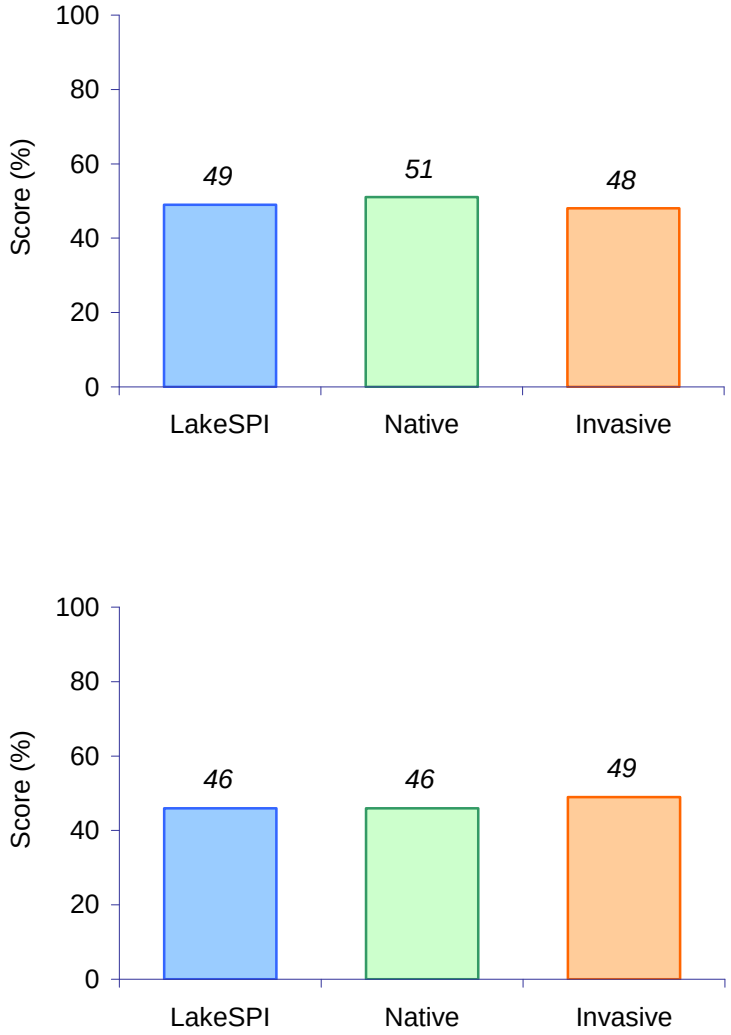

Figure: LakeSPI Index as % of potential score, Native Condition Index, and Invasive Impact Index (from left to right) for North Basin (Top) and South Basin (Bottom).

A moderately low LakeSPI score of 49% for the North Basin and 46% for the South Basin, which reflects the limited depth extent of native vegetation and the significant presence of *U. gibba*.

Water birds

The extensive emergent vegetation provided suitable habitat for many water birds although grazing access could be a disturbance factor. The nationally endangered bittern (*Botaurus poiciloptilus*) was seen with several common birds such as black swan (*Cygnus atratus*), mallard (*Anas platyrhynchus*) and paradise shelduck (*Tardorna variegata*). OSNZ annual surveys reported the regionally uncommon

dabchick (*Poliocephalus rufopectus*) and Australasian little grebe (*Tachybaptus novaehollandiae*) on most surveys (1996-1999 and 2000 respectively).

Fish

Common bullies (*Gobiomorphus cotidianus*) were recorded during the vegetation survey.

Aquatic invertebrates

Freshwater mussels (*Hyridella menziesi*) were common amongst the turf community at one site sampled in the South Basin, but not in other areas. Other invertebrates seen were the introduced ramshorn snail *Planorbarius corneus*, backswimmers (*Sigara arguta*) and the leech *Richardsonianus mauianus.*

Changes in indicators

The South Basin has undergone a reduction in maximum plant depth from 4 & 4.3 m in previous surveys to 3.0 m in the current survey. Vegetation limits in the North Lake decreased from 5 m in 1985 to 3.8 m in 2001, but remained similar at 4 m in 2004. The exotic *U. gibba* is a new record since 2001 and has apparently displaced *U. australis* and *C. fibrosa*. The regionally significant *Myriophyllum votschii* was recorded in 1988 only.

The North Basin has not been previously sampled. The South Lake has been sampled on five occasions since 1991. The current Secchi depth is lower than previous records (2.2->2.7 m). Current nutrient and algal concentrations are within the range or slightly higher than previously reported (TN 600-800 mg N m^{-3}; TP 14-40 mg P m^{-3}, 6-20 mg m^{-3}).

Threats

The difficult access and absence of eels would make the likelihood of further introduction of pest species low. Major impacts are likely should these species be introduced.

The predominantly pastoral catchment is a likely source of nutrients, with cattle access to much of the shoreline impacting those emergent plants susceptible to grazing and trampling.

Management recommendations

Retirement of the lake edges around the lake will encourage vegetation development and the interception of diffuse nutrient-runoff.

An assessment of lake condition at 5 year intervals is recommended.

3.14 Lake Ngakeketa (Aupouri), NRC Lake No. 14; surveyed in 2005.

Plate: Lake Ngakeketa showing steep scrub catchment, mobile dune (right) with outlet behind this.

Summary

Overall ranking

Low: This lake is completely dominated by the submerged pest plant *Ceratophyllum demersum* with poor water clarity and marginal vegetation.

Threats

Moderate risk of introduction and establishment of additional invasive pests. Low risk of nutrient enrichment from fertiliser application to pasture.

Management recommendations

No monitoring.

Description

The lake is situated (1578964E, 6180322N) on sand dunes, formed by a stream system impounded by dunes, and occupies 12.5 ha with a maximum depth of 8.7 m. The catchment is vegetated by native scrub (70%), pasture and pines (20%) and mobile dune (10%) near the outlet. The lake is comprised of two arms, the western arm fed by a stream flowing from the north, with the outflow obstructed by beds of emergent *Typha orientalis*, but presumably flowing into the Te Paki Stream. Access is through privately owned pasture off the Te Paki Stream Road. There are no formed tracks leading to the lake edge and no easy boat access.

Wetland vegetation

There is an almost complete (except the mobile dune face) but narrow fringe of emergent vegetation, mostly < 1 m across. This was dominated by *Typha orientalis*, with lesser amounts of *Baumea articulata* and *Eleocharis sphacelata* which grew to depths of around 1 m, or forming floating sudds extending over water 2.5 m deep.

Submerged vegetation

The submerged vegetation was dominated by the exotic *Ceratophyllum demersum* extending from shallow water to 5 m depth. Beds were up to 2 m tall. Occasional plants of *Potamogeton ochreatus* were seen amongst these beds.

LakeSPI

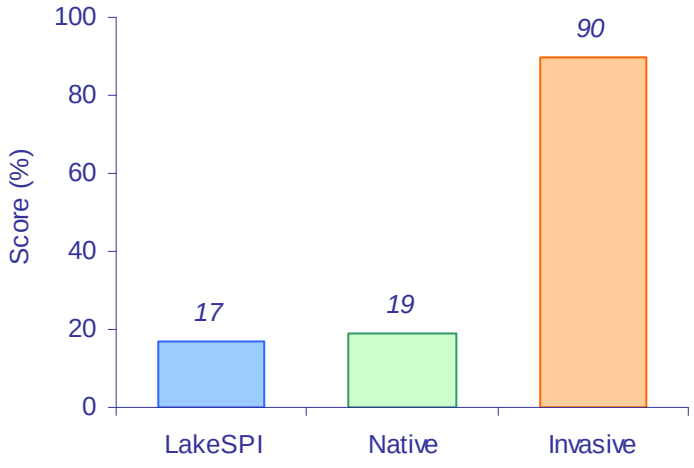

Figure: LakeSPI Index as % of potential score, Native Condition Index, and Invasive Impact Index (from left to right).

The low LakeSPI score of 17% reflects the major impact of the alien invasive *C. demersum* on submerged vegetation in the lake.

Water birds

There is limited emergent and wetland vegetation habitat, but much of the lake is inaccessible to humans and would provide good habitat for aquatic birds, evidenced by the ducklings of paradise shelduck (*Tardorna variegata*) and black swan cygnets (*Cygnus atrata*) seen on the field visit. A nationally endangered bittern (*Botaurus poiciloptilus*) was reported by DoC SSBI in 1991.

Fish

Schools of juvenile and adult mullet (*Mugil cephalus*) and bullies (*Gobiomorphus cotidianus*) were abundant in the lake.

Aquatic invertebrates

Freshwater sponges were noted encrusting submerged logs and plants.

Changes in indicators

Water quality has been sampled on only one other occasion (April 2001) when thermal stratification of the lake was not detected. The current Secchi depth is close to the previous record (1.6 m). Current nutrient concentrations differ from those previously reported (TN 350-500 mg N m^{-3}; TP 18-21 mg P m^{-3}) being lower for N and much higher for P.

Threats

The submerged vegetation of this lake is completely dominated by the submerged pest plant *C. demersum.* No pest fish or marginal weeds were recorded, and their risk of introduction is moderate to low due to the likely low usage of the lake, although access is relatively easy. Nutrient run-off from pasture fertilisation could increase the likelihood of planktonic algal blooms in the future.

Management recommendations

No monitoring or active management is recommended.

3.15 Lake north of Ngakeketa, Te Paki Lake (Aupouri), NRC Lake No. 13; surveyed in 2004 and 2009.

Plate: Lake north of Lake Ngakeketa (head of Te Paki Stream), showing the forested surrounds, with pasture and mobile dunes also in the catchment.

Summary

Overall ranking

Moderate-High: The invasive weed *Egeria densa* has continued its spread throughout the lake, but has not yet completely displaced the indigenous aquatic vegetation. Lake margins are surrounded by native scrub/forest.

Threats

Egeria densa will become the dominant species displacing most of the native vegetation. Low risk of introduction of *Ceratophyllum demersum* from Lake Ngakeketa or Te Werahi Lagoon due to difficult access, but *E. densa* was presumably introduced by the same vector, an eel-fisher. Low risk of nutrient enrichment from inflow stream (partially in pasture).

Management recommendations

Lake condition monitoring every 5 years.

Description

This lake is situated north of Lake Ngakeketa (1577791E, 6180590N) and is 12.7 ha in area with a depth >7 m. It is situated in sand dunes, formed by a stream system impounded by dunes. The lake level continues to rise as evident by the flooding and death of trees (mostly kanuka – *Kunzea ericoides*) on the margins. The catchment is cattle grazed pasture, but the steep-sided lake edges are fenced, with native kanuka dominated bush surrounding most of the lake except for mobile dunes near the outlet stream (Te Paki or Kauaeparaoa Stream). There is a small inflow to the north of the lake. Access is through private farmland (4-WD) with no boat access to the lake apart from up the Te Paki Stream or through bush on the steep sided lake margins.

Wetland vegetation

There was an almost complete fringe of emergent vegetation (apart from the dune face), mostly narrow, about 1 m across due to the steep sided lake edges, apart from the northern area where a larger emergent band was present. Vegetation was dominated by *Eleocharis sphacelata* or *Typha orientalis* which grew to depths of 1.8 and 1 m respectively. Swamp millet (*Isachne globosa*) was also notably common amongst the emergent species. The lake level continues to raise as some marginal plants such as flax (*Phormium tenax*) and cabbage trees (*Cordyline australis*) were partially submerged and dying.

Submerged vegetation

Few areas of turf plants were present, due to high covers of emergent vegetation and the steep bathymetry. However, *Ranunculus amphitrichus* and *Myriophyllum propinquum*, *Myriophyllum votchii*, *Glossostigma elatinoides*, and *Ludwigia palustris* were noted in 2009. The pondweed *Potamogeton ochreatus* dominated the vegetation with tall (up to 2.5 m) beds extending from 0.3 to 4.4 m depth. In 2004 survey found the exotic *Egeria densa* within the mid-depth range at all profiles and up to 2.5 m tall, but with low average covers <25%. *E. densa* was more abundant in 2009, with depth range and cover increasing, although *P. ochreatus* was still common. Other submerged species included *Potamogeton crispus*, *Myriophyllum propinquum*, *Chara fibrosa*, and *Chara australis*.

LakeSPI

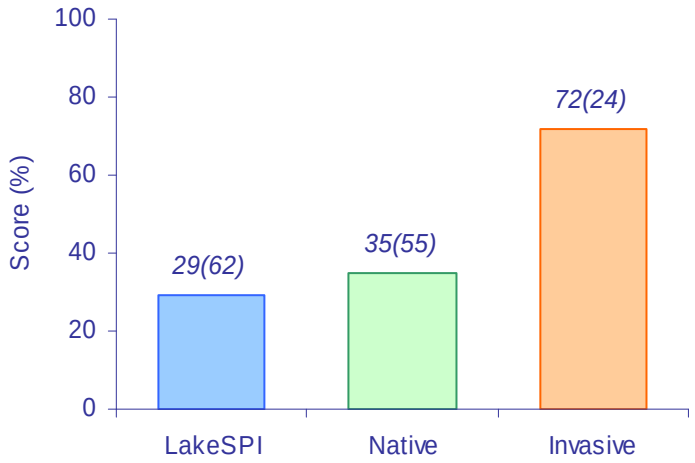

Figure: LakeSPI Index as % of potential score, Native Condition Index, and Invasive Impact Index (from left to right) for 2009 with 2004 data in brackets.

The LakeSPI score of 29% has dropped markedly from 62 in 2004 reflecting the increasing impact of the invasive *E. densa*.

Water birds

The isolated nature of the lake provided good habitat for many aquatic birds, although lack of large emergent vegetation beds would limit habitat value for some species. Marginal trees provided a nesting and roosting site for pied shag (*Phalacrocorax varius*) with nests less than 1 m above the lake level. Large numbers of paradise shelduck (*Tardorna variegata*) were also noted and some black swan (*Cygnus atratus*) and pukeko (*Porphyrio melanotus*).

Fish

Bullies (*Gobiomorphus cotidianus*) were widespread in the lake.

Aquatic invertebrates

The snail *Potamopyrgus antipodarum*, was common as were a freshwater sponges and empty shells of freshwater mussels (*Hyridella menziesi*).

Changes in indicators

This lake was sampled for the first time in November 2004. A fringe of dead trees around the lake indicated a rise in lake level, probably due to water impoundment by the mobile sand dune. *E. densa* has continued to spread within the lake and is having a much greater impact in 2009 than in 2004. The lake has been downgraded in ranking from High to Moderate-High.

Threats

The alien plant *E. densa* was only present at low covers in 2 of the 4 profiles investigated in 2004 and formed low covers throughout the depth range of submerged vegetation at those sites. This species has increased in abundance and spread to all profiles. The average cover of *E. densa* in 2009 was still less than 50% so native vegetation persists. The isolated nature of and difficult access to this lake make further introductions of other pest species (e.g., *Ceratophyllum demersum* from Lake Ngakeketa or Te Werahi Lagoon) a low probability. However, *E. densa* was introduced to the lake, presumably by eel nets.

Fertilisation of pasture near the inflow stream would result in some nutrient addition, although the fringe of emergent vegetation would reduce the level of lake enrichment.

Management recommendations

Further biosecurity threats are low, but any further change in condition (biota) of this lake should be monitored every 5 years.

3.16 Lake Ngatu, (Aupouri) NRC Lake No. 120; surveyed in 2005, surveillance 2007.

Plate 1: Lake Ngatu from the northern boat ramp.

Summary

Overall ranking

Outstanding: Good emergent and submerged vegetation with numerous endangered biota. Pest plants and fish present, possible water quality decline.

Threats

Expansion of *Lagarosiphon major* and apparent increased impact of *Utricularia gibba*, increased boat traffic with increased risk of further species introductions, threats of eutrophication from septic tanks. The pest fish perch (*Perca fluviatilis*) was noted by divers in 2009. This piscivorous species could have a major impact on other fish species.

Management recommendations

Annual surveillance of *L. major* and for new plant pests. Five yearly lake condition monitoring. Survey for perch and assess feasibility of control. Assess feasibility of *L. major* management with endothall.

Description

Lake Ngatu (2528991E, 6685555 N) is a large (50.3 ha) dune lake with a maximum depth of 6.5 m. The catchment is primarily manuka/kanuka scrub and fenced pasture. There are new houses overlooking the lake on the north-western fringe. There are no inlets or outlets. A popular recreational lake with easy access from West Coast Road to the north and from Sweetwater Road along the eastern shore. Boats are launched from firm sand at the northern and southern end.

Wetland vegetation

Most of the lake margins still have large beds of emergent species, with up to 100 m wide beds on the eastern margin associated with islands in this area. The dominant emergent is *Eleocharis sphacelata* growing from the lake margin to 2.6 m depth, with other species including *Apodasmia similis, Baumea articulata, B. arthrophylla* and *Schoenoplectus tabernaemontani* all common. One small clump of the invasive alien *Iris pseudacorus* was noted on the north-eastern edge of the lake. This has since been removed and there were no signs of this plant in 2007 when visited for surveillance. The nationally threatened fern *Cyclosorus interruptus*, was reported from the marginal vegetation for the first time in 2007.

Submerged vegetation

Turf communities were common in areas to ~ 1 m deep where *E. sphacelata* did not form dense emergent beds. Common species were *Lilaeopsis novae-zelandiae, Myriophyllum pedunculatum*, the nationally threatened *Trithuria inconspicua* and *Utricularia australis*, the regionally significant *Triglochin striata* and the exotic *Utricularia gibba* and *Juncus bulbosus*. Charophytes dominated vegetation from the edge of emergent or turf communities to a maximum depth of 5.8 m. The dominant species was *Chara fibrosa* with locally dominant *Nitella leonhardii* and lesser amounts of the pondweed *Potamogeton cheesemanii*. The alien invasive *Lagarosiphon major* was recorded on 3 of the 5 profiles between 0.5 and 3 m, occasionally forming dense beds. More extensive searching in 2006 found significant areas of lagarosiphon with the largest bed (c. 2 ha) off the north access point, and a narrow band from the waka launching area to the south beach (about 10 m x 200 m long) and a small patch (20 m x 10 m) opposite the rushes at the east end of the south beach. In 2007 there was little change.

The 2007 surveillance found that *U. gibba* formed an extensive smothering mat at the northern access point forming a 90% cover over *L. major* and indigenous charophyte vegetation to 3.5 m deep. *L. major* abundance had decreased compared to the 2006 surveillance records. Other parts of the lake surveyed in April 2004 e.g., the waka ama and southern access points showed minor *U. gibba* impact, with wave exposure

apparently limiting the success of this species. Further investigation by Kevin Matthews in late May have documented large mats of this species with associated periphyton rafting up near the water surface (Plate 2). The 2009 surveillance found similar impacts from these species.

LakeSPI

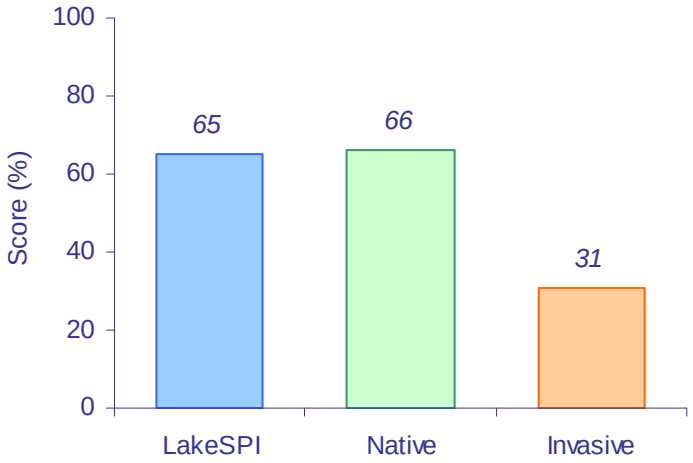

Figure: 2005 LakeSPI Index as % of potential score, Native Condition Index, and Invasive Impact Index (from left to right).

A moderate LakeSPI score of 65% reflects an almost complete cover of indigenous plants, including extensive charophyte meadows, but reduced by a moderate invasive impact from *L. major* and *U. gibba*.

Water birds

Extensive emergent vegetation provides a good habitat for water birds, however human disturbance would reduce the desirability for more secretive species. The nationally threatened bittern (*Botaurus poiciloptilus*) and Caspian tern (*Sterna caspia*) and the regionally rare dabchick (*Poliocephalus rufopectus*) were seen on the field visit, with 14 dabchicks seen in May 2005 (K. Matthews pers. comm.). OSNZ records also include the regionally significant scaup (*Aythya novaezeelandiae*).

Fish

Common bullies (*Gobiomorphus cotidianus*), inanga (*Galaxias maculatus*) and the exotic pest gambusia (*Gambusia affinis*) were observed. The landlocked population of inanga are of special status, possibly a new species (B. David pers. comm.). The introduced rainbow trout (*Oncorhynchus mykiss*), rudd (*Scardinius erythrophthalmus*)

and goldfish (*Carassius auratus*) were also reported in the NIWA FBIS database. The pest fish perch (*Perca fluviatilis*) was noted by divers in 2009. This piscivorous species could have a major impact on other fish species.

Aquatic invertebrates

The introduced ramshorn snail (*Planorbarius corneus*) was common in the lake. The introduced snail *Planorbella scalaris* was reported from Lake Ngatu and identified by Brian Smith (NIWA, Hamilton) in March 2007. It is endemic to the central and southern part of the Florida peninsula where it is found in marshes and lakes. This was the first record of this species in New Zealand. However, it was not found during the April 2007 or 2009 surveillance.

Changes in indicators

The vegetation in Lake Ngatu has been sampled since 1984 and generally the same vegetation patterns are present. *L. major* was first recorded in 1988 and its distribution in the lake is still very limited. Its rate of spread has been very slow and is limited to patches (near the marina) and an area (~330 m^2) to the east of the boat ramp. More intensive searching of the lake may find other areas. *U. gibba* is a new record for this lake (not present in 2001) and it occupies sheltered areas amongst emergent vegetation with low covers extending to 2.6 m. It had increased its abundance in 2007 (Plate 2) and was suppressing the vegetation. *I. pseudacorus* is possibly eradicated from Lake Ngatu. The fern *Cyclosorus interruptus* is an additional endangered species record for this lake.

Threats

L. major may still expand further and have a greater impact. Elsewhere, such as Lake Okataina, it grows to a maximum height of 3 m over a depth range of 0.5 to 6 m. The poor growth of *L. major* in Lake Ngatu is likely due to its particular water chemistry. A change in nutrient status of Lake Ngatu driven by a change in catchment usage could lead to rapid weed growth. Other weed species, such as *Ceratophyllum demersum* are able to tolerate lower nutrient conditions and could displace all other submerged vegetation. The nearest source of this species is Lake Heather, with spread likely to occur in eel nets. As access to Lake Ngatu is easy, the risk of spread from other areas by boat traffic is high.

The threat posed by *U. gibba* is uncertain at this stage. It appears to still be gaining in abundance and at the lagarosiphon sites checked in 2007, it was prevalent and looked like it was suppressing the lagarosiphon.

The pest fish *Gambusia affinis* may have a deleterious impact on other fish like the nationally significant inanga. Rudd do not appear to be impacting submerged vegetation under current conditions. Perch are piscivorous species and could have a major impact on other fish species.

The algal bloom at the time the lake was visited and water quality parameters indicate a decline in lake condition.

Management recommendations

Undertake pest plants surveillance at access points for new incursions of aquatic weeds every one to two years.

Carry out 5 - year lake condition monitoring.

Survey for perch and assess feasibility of control.

Confirm eradication of yellow flag iris (*I. pseudacorus*) by continued monitoring. No re-growth following removal has been noted to date.

The slow growth of *L. major* in Lake Ngatu suggests it could be maintained at minimal levels at least in the medium term by control measures.

Plate 2: Lake Ngatu, *Utricularia gibba*, an invasive plant pictured in autumn lifting off the bottom and rafting on the surface (photo Kevin Matthews 30 May 2007).

Options for *L. major* control are:

- Diquat herbicide (subject to resource consent) will reduce the quantity of green stems markedly but will not kill the basal portion of the plant. This is probably the only practical option for the 2 hectare northern site and would assist in reducing fragments to other sites.

- Recent trials (2008) with endothall near Invercargill, have shown it can kill *L. major*, including the root crowns. Preliminary results suggest it may be a tool that could achieve eradication of this plant.

- Hand weeding is suitable for removal of individual small plants. It would only be practical in areas of low level infestation or as a follow up after spraying to reduce the area of infestation.

- Suction dredging (diver operated) can remove *L. major* at a rate of 100 m^2 per hour, and if done well with follow up can potentially remove all plants in small targeted areas. It is expensive and needs to be carried out by a competent operator to be effective. It is not a favoured options for this lake considering the large areas needing attention. It could be a useful option following targeted diquat applications.

Bottom-lining of smaller patches (coving with plastic sheets) is also now an impractical option because of the extent of the infestation.

A herbicide trial using endothall to evaluate the feasibility of eradication of *L. major* (and possible control of *U. gibba*) is proposed for Lake Ngatu. Charophyte species are tolerant of this herbicide.

3.17 Lake Ngatuwhete (Aupouri), NRC Lake No. 23; surveyed in 2005.

Plate: Lake Ngatuwhete with a mostly pasture catchment, note the beds of emergent vegetation dominated by kuta (*Eleocharis sphacelata*) (middle left).

Summary

Overall ranking

Low: Shallow dammed water body with limited vegetation, possibly good wader habitat.

Threats

Little threat from invasive species, nutrient enriched.

Management recommendations

No monitoring recommended.

Description

Lake Ngatuwhete (6735915E, 1589385N) is a shallow (~ 5.1 m), dammed 8.6 ha lake with a firm iron-pan base. The catchment is primarily unfenced pasture with small areas of pines and manuka scrub. There are no inlet or outlet streams. There is a well-formed track to lakeside across 1 km of private land from the main road. Small boats can be launched from the firm-bottomed lake margins.

Wetland vegetation

Most of the margins lack emergent species, but approximately 25% of the lake margins has beds up to 10 m wide on the southern margin. The dominant emergent is *Eleocharis sphacelata* growing from 1.5 to 1.6 m depth, with lesser amounts of *Baumea articulata* and *Schoenoplectus tabernaemontani* growing in shallower water.

Submerged vegetation

Open turf communities (<10% cover) were common in areas to ~ 1.5 m deep dominated by *Glossostigma elatinoides, Lilaeopsis novae-zelandiae, Myriophyllum propinquum* and low-growing *Potamogeton cheesemanii*. On the southern vegetation profile, surface-reaching areas of the exotic *Ludwigia palustris* were noted from the shore to 0.2 m deep. Also on this profile dense bed of *Nitella* aff. *cristata* extended from the emergent *E. sphacelata* to 1.8 m deep. *P. ochreatus* was also present in this area at low covers (≤5%). No other submerged vegetation was found in the 2 profiles swum.

LakeSPI

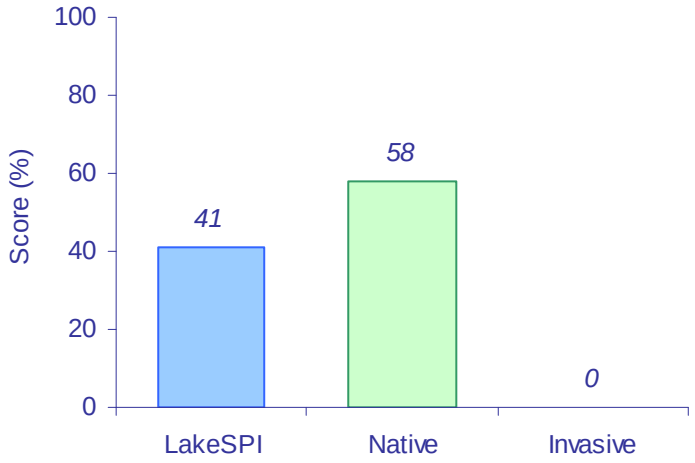

Figure: LakeSPI Index as % of potential score, Native Condition Index, and Invasive Impact Index (from left to right).

A moderately low LakeSPI score of 41% reflects the almost de-vegetated lake bed, although there were no invasive exotic species present (*L. palustris* is not ranked as invasive by LakeSPI). Profiles were limited so this LakeSPI assessment should be considered provisional.

Water birds

The large extent of shallow water may provide good habitat for wading birds. Royal spoonbill (*Platalea regia*), a regionally significant species, were recorded from this lake in 1978 (DoC SSBI). An important moulting site for paradise shelduck (*Tardorna variegata*).

Fish

No fish seen.

Aquatic invertebrates

Backswimmers (*Sigara arguta*) were common in the lake.

Changes in indicators

This lake has not been sampled previously.

Threats

Pest impacts are unlikely due to the hard bottom and shallow exposed nature of the lake.

Management recommendations

No monitoring recommended.