

## Te Hiku

Morehu (formerly Morehurehu) (Aupouri), NRC Lake No. 32.



**Morehu** catchment has recently undergone significant change following the first harvest of mature plantation pine (top left 2009), with subsequent re-planting (top right 2013) and growth of young trees (below in 2016).

Summary	Morehu
<b>Surveyed:</b>	2006, 2009, 2013, 2014 and 2016.
<b>Overall ranking:</b>	<b>High:</b> Moderate (mesotrophic) water quality but water heavily stained with little submerged vegetation present. Lake surrounded by a fringe of emergent vegetation within a pine plantation dominated catchment. In 2009, rated Outstanding with diverse native submerged and emergent vegetation including endangered species.
<b>Threats:</b>	Pine harvesting impacting water quality and nutrient status, with extensive loss of aquatic habitat and biodiversity. Low risk of introduction and establishment of invasive pests that could further degrade this lake.
<b>Management recommendations:</b>	Review recent changes in the catchment and document impacts in all receiving waters. Lake monitoring every five years to evaluate rate of recovery. Provide advice to forestry companies or other land-use in these poorly buffered water bodies to modify activities that caused such extensive environmental damage.

## Description

Morehu is a dune lake situated 1599711E, 6166691N and is 36.3 ha in area. Depth is c. 14 m. It is situated on Lower Quaternary sand dunes, formed by a stream system impounded by dunes. The catchment is all plantation pine trees, with a zone of manuka / hakea scrub between the lake and pines. Pine trees were harvested before 2013 and a second crop planted.

There are three inlet 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), is steep and the track is loose sand and overgrown, making trailered boat access very 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*, *Machaerina articulata*, *M. teretifolia*, *M. juncea* and *M. arthropphylla*. The emergent fringe was wide, from 10 to 30 m across, with *E. sphacelata* the deepest growing species (to 1.75 m). Additional emergent species recorded in 2013 were *M. rubiginosa* and *Isachne globosa*.

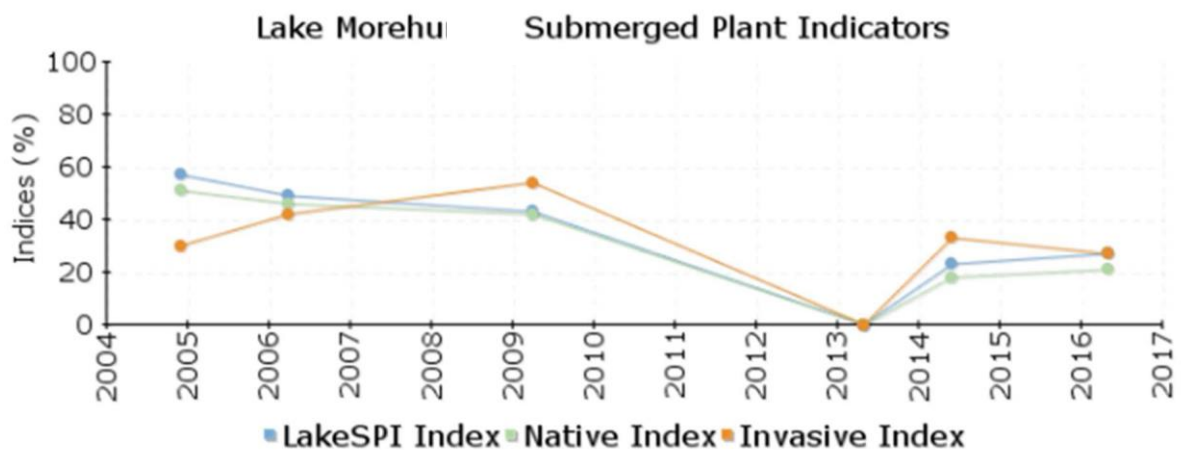
Wetlands contained those emergent species and also harakeke (*Phormium tenax*), swamp coprosma (*Coprosma tenuicaulis*), manuka (*Leptospermum scoparium*), swamp kiokio (*Blechnum novaezelandiae*). Areas of bog vegetation had the regionally significant wire rush (*Empodisma robustum*) and umbrella fern (*Gleichenia dicarpa*).

## Submerged vegetation

In 2009, the aquatic vegetation was abundant and extended down to 5.5 m deep. It was comprised of seven species with charophyte meadows common and abundant with tall-growing native species also present. *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 macrophytes were lost prior to 2013 at which time there was almost no submerged vegetation present with only three submerged species recorded and none exceeding 5% maximum cover. This was associated with the water becoming highly coloured red/brown. In 2014 and 2016, the macrophytes had recovered slightly, growing at low covers to 2 – 3 m water depth and native species diversity was restored. The main impact still showing in the LakeSPI assessment is the marked reduction in macrophyte depth limits.

## LakeSPI



Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
April 2016	Moderate	27%	21%	27%
May 2014	Moderate	23%	18%	33%
April 2013	Non-vegetated	0%	0%	0%
March 2009	Moderate	43%	42%	54%
March 2006	Moderate	49%	46%	42%
November 2004	High	57%	51%	30%

**LakeSPI for Morehu.** Six LakeSPI surveys are recorded. 2013 scored 0% due to very low abundance of submerged vegetation, followed by minor recovery in 2014 and 2016.

A decrease in LakeSPI score from 57% in 2004 to 27% in 2016 was a result of a decrease in submerged vegetation relating to a decline in water quality that occurred around 2013. This also resulted in a decrease of both the Native Condition Index and the Invasive Impact Index (invasive impact from *U. gibba*).

## 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 platyrhynchos*) and a bittern (*Botaurus poiciloptilus*) were seen in previous visits. 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

No fish were seen in 2013 or 2016, but visibility was low. Common bully (*Gobiomorphus cotidianus*) and inanga (*Galaxias maculatus*) were seen during the 2009 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 are abundant.

## Endangered species

The Nationally Critical species *Utricularia australis* has not been seen since 2009 and is apparently now extinct in this lake. Several plants of nationally threatened status were present with *Drosera pygmaea* noted in a lakeshore turf and *Todea barbara* on lake shore banks. The 'At Risk – Declining' inanga (*Galaxias maculatus*) was common in this lake.

## Lake Ecological Value

In 2009 the Lake Ecological Value rating of Outstanding was calculated. A deterioration in the rating of the following parameters: water quality (water transparency and total nitrogen values from 2009 indicated Eutrophic condition whereas chlorophyll *a* and total phosphorus indicated Mesotrophic condition. The loss of aquatic vegetation integrity resulted in a revised score of 12 (High) in 2013 and 2016.

A 1988 vegetation survey recorded similar submerged vegetation to the 2009 description although *Chara australis* was more abundant and extended to a maximum depth of 9.5 m. *U. gibba* was not recorded. The lake has changed from being relatively clear when visited in 2009 to having a dark brown / red stain with less than 1 m in water visibility since 2013. The impact of the invasive

*U. gibba* increased from 2005 to 2009, but like other plants had decreased markedly in 2013 and has recovered since. The nationally endangered *U. australis* has not been seen since 2006.



**Morehu.** This picture illustrates the stained water.



## Threats

The marked change in water clarity and total nitrogen concentration was significant and its causes not clearly understood. This is of concern with regard to restoration and preventing this impact re-occurring in the future. Light is a major determinant of submerged vegetation. Such a marked change in water clarity could account for the loss of submerged vegetation. The recent harvesting of the pine plantation likely caused the change in water quality as similar changes were noted in other water bodies in the area (Te Kahika and Morehu South). The event may have been much wider with a local reporting that the Parengarenga Harbour became heavily coloured making channels impossible to follow after an extended period of heavy rain (Kevin Mathews, local conservationist, pers. comm.).

One hypothesis is the growth of pines has accumulated a layer of pine needles, resin acids and polar humics in the upper soil layer. However, water testing did not identify resin acids as the problem (NRC unpublished information).

Another hypothesis is that pine tree transpiration had been keeping water levels lower in the soil profile for decades. Felling of the trees stopped water loss from transpiration and water logging of pine debris is likely to have occurred following heavy rainfall events occurring post-harvest. Removal of the pine canopy allows rain direct access to a broken soil layer. Quartz sands in the catchment have no ionic binding (M. Gibbs, NIWA, pers. comm.), which may have led to leaching of tannic substances through the sands.

The main risks for the introduction of invasive species come from the 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 construction of an access road to facilitate logging has opened up this area to the public, so risk of pest introductions is heightened.

The lake is probably N limited (Gibbs et al. 2014) and thus sensitive to urea fertiliser addition in forestry or harvesting activities.

## Management recommendations

Lake monitoring every three to five years will enable impacts to be documented and potential recovery rates tracked. A study of the possible causes of this major ecological impact should be undertaken and if related to human activity then it may be possible to mitigate ongoing impacts and avoid a re-occurrence in the future.