TURNING A NEGATIVE INTO A POSITIVE: AQUATIC WEED HARVESTING, LAKE ROTOEHU

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Richard is a Senior Land Management Officer based in Rotorua with the Bay of Plenty Regional Council and is currently working on the Rotorua Lakes Programme. Richard has a background in biosecurity including terrestrial and aquatic pest plant management, and has been involved in a number of land and lake management projects including biodiversity management plans, sustainable land use management projects and pest management projects.

As part of the Bay of Plenty Regional Council's role in lake water quality Richard has managed Hornwort harvesting for nutrient management from Lake Rotoehu since its inception in 2006.

ABSTRACT
The submerged aquatic weed hornwort (*Ceratophyllum demersum*) has become widespread through Lake Rotoehu since its establishment in the lake around 2000. This exotic pest plant is surface reaching in large parts of this shallow lake making it a perfect candidate for mechanical harvesting.

As part of the Te Arawa - Rotorua Lakes Programme the Lake Rotoehu Action Plan sets out nutrient reduction targets for nitrogen and phosphorus. Realising these targets is integral if lake water quality is to be restored to the trophic level index (TLI) target for Lake Rotoehu. Restoration measures have included land use management efforts to arrest nutrient inputs, phosphorus locking through alum dosing, floating wetlands, and most recently the deployment of two aerators. To date the most successful in-lake nutrient reduction method has been mechanical harvest of hornwort.

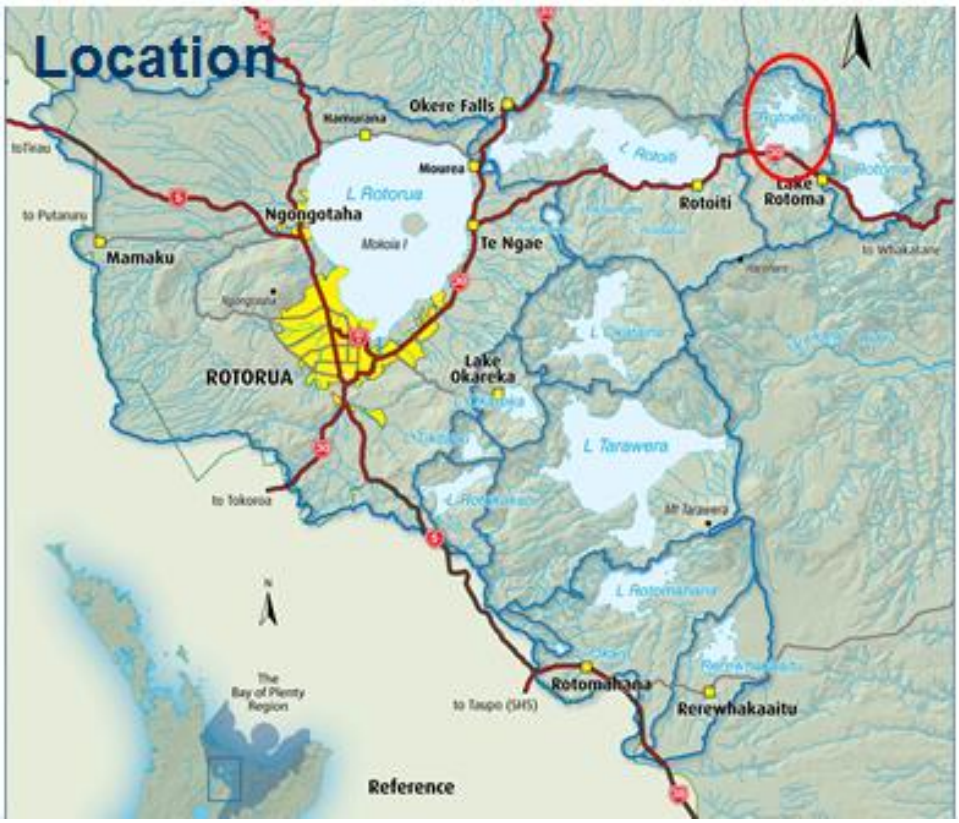
Aquatic weed harvesting has resulted in reaching a significant portion of the annual nutrient target for the lake catchment. Attaining this level of nutrient removal has manifested in tangible water quality gains in the past few years. Most noticeable is the reduction in cyanobacterial (blue-green) algal blooms which had been prevalent in the lake in summer months. We discuss the practicalities and problems of submerged lake weed harvesting, disposal options, and impacts of this activity on the lake.

TRANSCRIPT
A major consideration for the Bay of Plenty Regional Council's programme on Lake Rotoehu is the proximity of this lake to Lake Rotoma and the knowledge that hornwort spreads by fragmentation. We are very aware of the risk of it spreading into another lake. They are within a 5 minute drive of each other, and this fact underlies much of the lake's programme in preventing the spread of this weed between lakes. The installed weed cordons and proactive lake weed spraying and harvesting carried out around boat ramps is all to prevent spread.

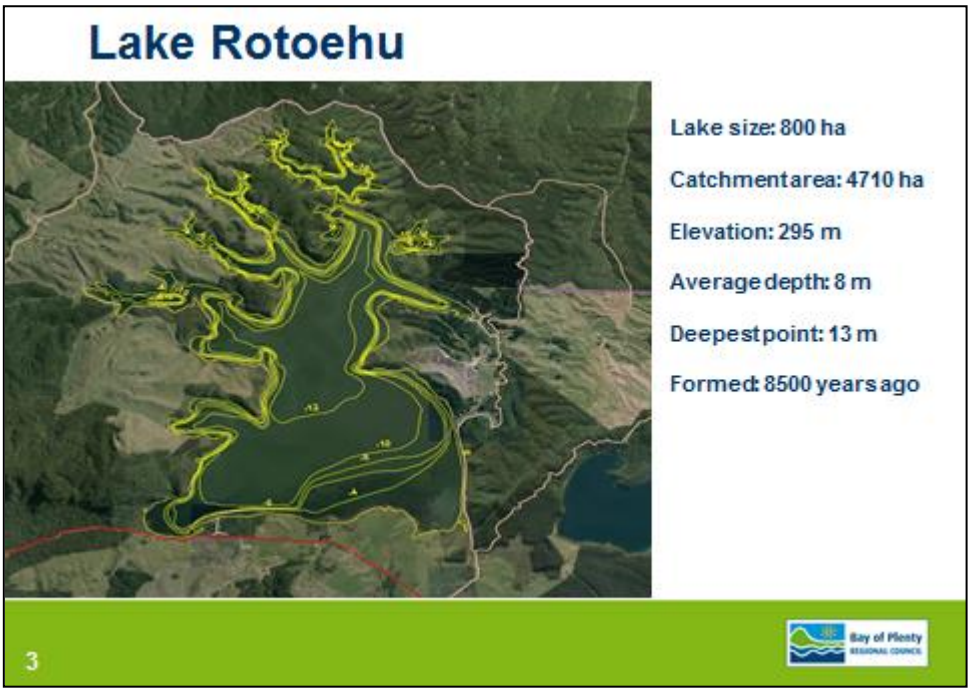
Lake Rotoehu is one of the original four Ministry of the Environment Deed Funded lakes, along with Rotorua, Rotoiti and Okareka. **(Slide 1)** If you were to design a lake to grow hornwort you could not do much better than Lake Rotoehu. The deepest point of the lake

is about 13 metres and hornwort is quite capable of growing down to that depth given good water clarity. It is a lake which will support 100% hornwort growth under ideal conditions. There are a number of sheltered northern bays where it can grow and a prevailing north westerly wind pushes the weed down into the bottom corner where the harvesting is easily done. This addresses some of the concerns about the travel distance to get to harvested weed; it is right on the doorstep at that point. **(Slide 3)**

Slide 1

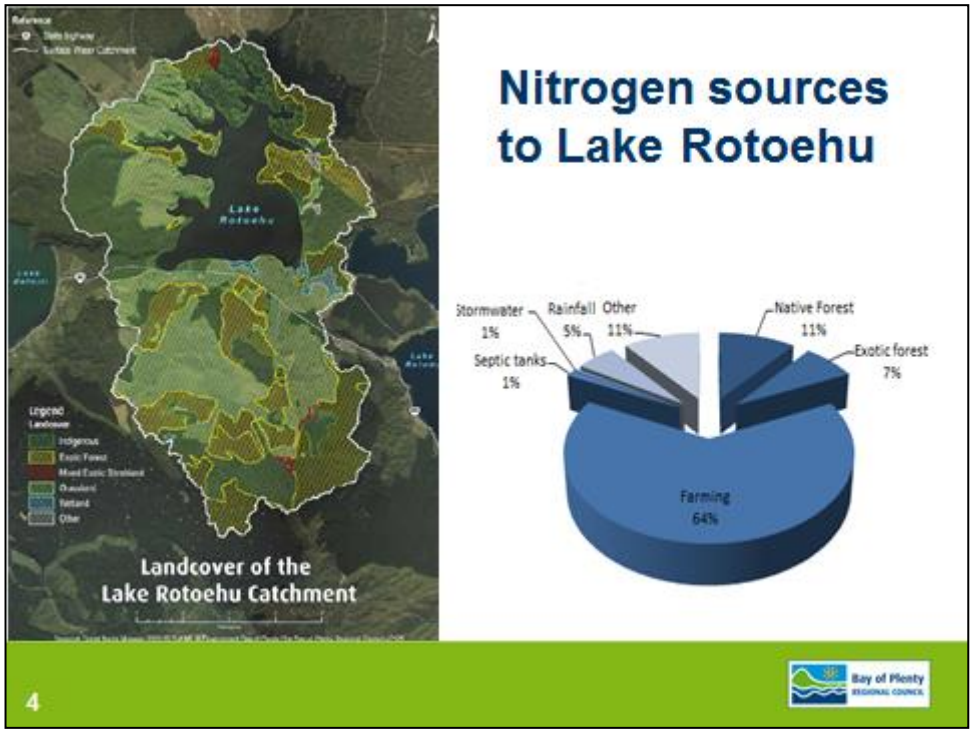


Slide 3



Exact assessment of the nitrogen load into the catchment of Lake Rotoehu is a very important part of the whole process. **Slide 4** is the breakdown of the inputs of nitrogen between farming, exotic forest and native forest and other. The catchment is 4,710 hectares; the total nitrogen load into the lake was estimated to be 53 tonnes of nitrogen. The target was set at 44 tonnes so this is the goal to get down to.

Slide 4



Since the time of compiling this graph, there have been 668 hectares of forestry conversion on the southern side of the lake on Tautara Matawhaura Trust land. An in-lake intervention like harvesting is going to give short term gains, but long term the gains will come from land use change or from some manipulation within the catchment.

The first major algal blooms occurred in Rotoehu in about 1993; a more recent photo on the left was taken in Otautu Bay. The blooms around 2000 were really bad and it was so thick it looked like you could walk on the water and boats left a big green wake behind. Weed growth in the lake was stunted because the light was very limited. The algal blooms certainly needed attention.

Slide 6 taken in March 2009 looks from the south eastern corner of the lake, Te Wairoa Bay towards the Hinehopu end. There were about 60 hectares of surface reaching hornwort which could be harvested. The hornwort growth itself is seasonal, growing through the summer as the water temperature increases and only loosely rooted to the lake bed. Peak growth in late summer has surface reaching or 'Topped Out' weed beds. Then northerly storms easily uproot the infestations and push

them out of the arms and they raft up in the south eastern corner of the lake. They have severe negative impacts on the bio-diversity within the lake, the amenity value to the lake and on the water quality.

Slide 6

In the USA Hornwort is known as coontail, which is quite appropriate looking at **Slide 7**. This NIWA photo shows fresh green shoots of hornwort coming through. Hornwort sampling in Rotoehu gave us 30 kilograms of nitrogen per dry tonne; the wet weight weed is about 4 or 5% dry matter and of that about 3 or 4% is nitrogen. There is a smaller quantity of phosphorus in there as well.

Slide 7

In 2006 we investigated processes for harvesting this weed and the cost efficiencies in taking it out in relation to the amount of nitrogen that can be removed. **(Slide 8)** Using Mighty River Power's harvester called Myrtle, which was used on Whakamaru, we carried out some control work and ascertained the idea that the cost of nitrogen removal this way would be about $40 a kilogram. That information was incorporated into the Action Plan for the lake, released in November 2007 which set targets of 8,880 kg/yr N and 708 kg/yr for P. It addressed the question of whether the target of removing about 8½ tonnes of nitrogen can be achieved by harvesting weed.

Slide 8

Other current initiatives which were put into place in that catchment included the land management change, phosphorus locking, artificial wetlands and aeration, but it was hoped that the end result might be the removal of 2-3 tonnes of nitrogen through harvesting as well. Harvesting operated from 2006 through to 2012 with Mighty River Power's harvester, the photo below taken relatively late in the harvesting season. Much of the weed had started to die back down and most had been removed.

In 2013 about the time the Government sold Mighty River Power the harvester was unavailable. Some alternate methods were trialled, one of them being the use of diggers on pontoons; it was probably the most costly method and it was not particularly efficient. **(Slide 11)** Some elevated levels of arsenic were seen which was likely in relation to the amount of sediment being pulled up

with the weed. The most recent sampling carried out on hornwort in this particular area has shown arsenic within compostable limits, which is around 20 milligrams per kg of nitrogen.

Slide 11

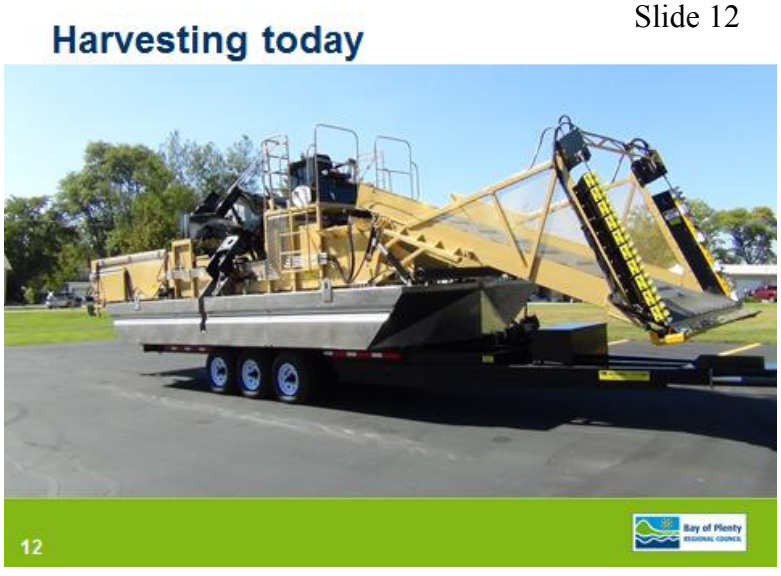
At the end of 2003 Deloittes was commissioned to do a business case study for us looking at four options:

- Continued use of the digger,
- A contractor to purchase and operate a harvester
- BOPRC to purchase a harvester and operate it ourselves
- BOPRC to purchase a harvester and tender out its operation. This option was the most cost effective.

Slide 12 An Aquarius model HM420 is used for harvesting today (March 2015). The hydraulic driven system is powered by an air cooled diesel motor. It has retractable paddle wheels, reciprocating cutter bars onto the cutter arm conveyor belt and the main body conveyors off load from the stern.

We have developed a trailer which acts as an offloading mechanism as well. The Regional Council owns this package which ensures a surety of availability; its operation can be contracted out, which also gives us competitive tendering to operate it. It operated its first full season in 2014 and is currently operating on Rotoehu (March 2015). It gives the flexibility to be used at other sites where amenity weed strandings might be an issue such as

Slide 12

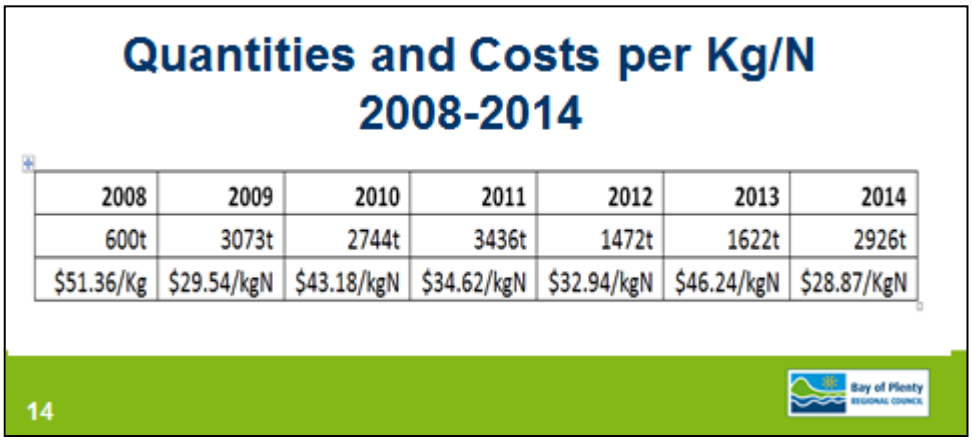


at Okawa Bay on Lake Rotoiti this year.

Slide 13

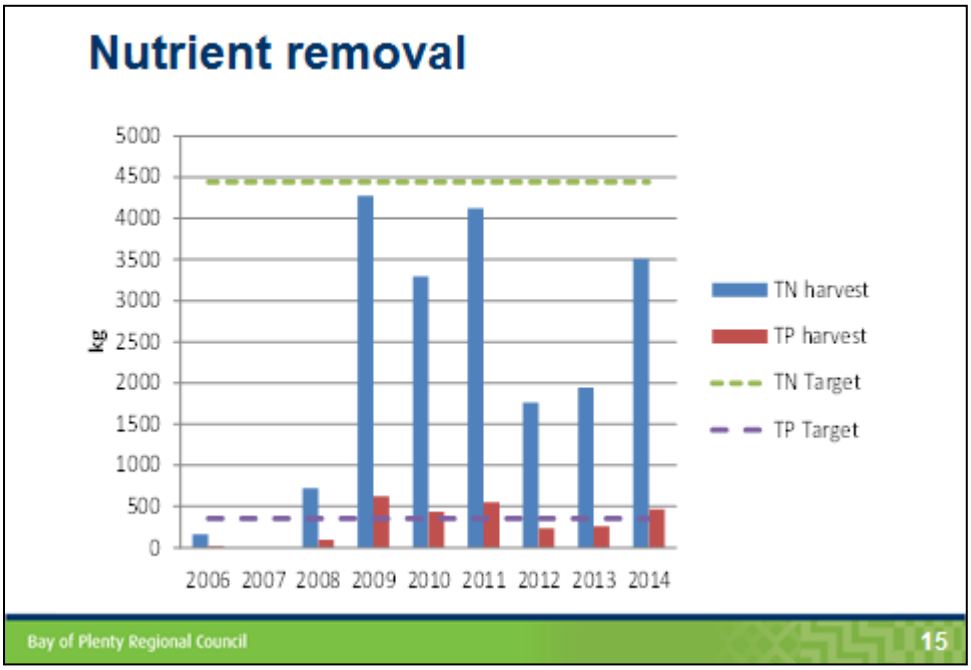
Weed disposal is an issue and several means of weed disposal have been tried. Truck loads have been transported out of the catchment to a composting operation in Te Puke. **Slide 13** Harvested weed mixed with wood pulp waste in a vermicomposting trial in conjunction with Tautara Matawhaura. Containers of worms were released through this mix so a compost/ vermicast product could be produced. This operation was within the catchment and readings with lysimeters showed leaching back into the catchment. About 60% of the removed nitrogen ended up back in the water table, which was not an ideal state of affairs. For this year's operation weed is to be transported out of the catchment to Kawerau. In order to do that permission from the Ministry of Primary Industries was required. Part of that permission involves quite strict quarantine about water blasting loads down before they leave. We are very aware that we travel through the Rotoma catchment and spreading hornwort into that lake must be prevented.

Slide 14



Slide 14 indicates the dollar cost per kilogram of nitrogen removed and the quantities that have been removed from 2008. In 2007 there was little weed, so there was no harvesting. In 2008 a small quantity of weed with a long turn around resulted in increased cost per kg. 2011 was a bumper year, 2012 not quite so, 2013 again a bumper year for weed but was the most expensive because the digger was used. 2014 was the first year using the new harvester and the lower price reflects the efficiencies gained from that. 2015 is looking like it is going to be a bumper year; plenty of weed will come out with the harvester.

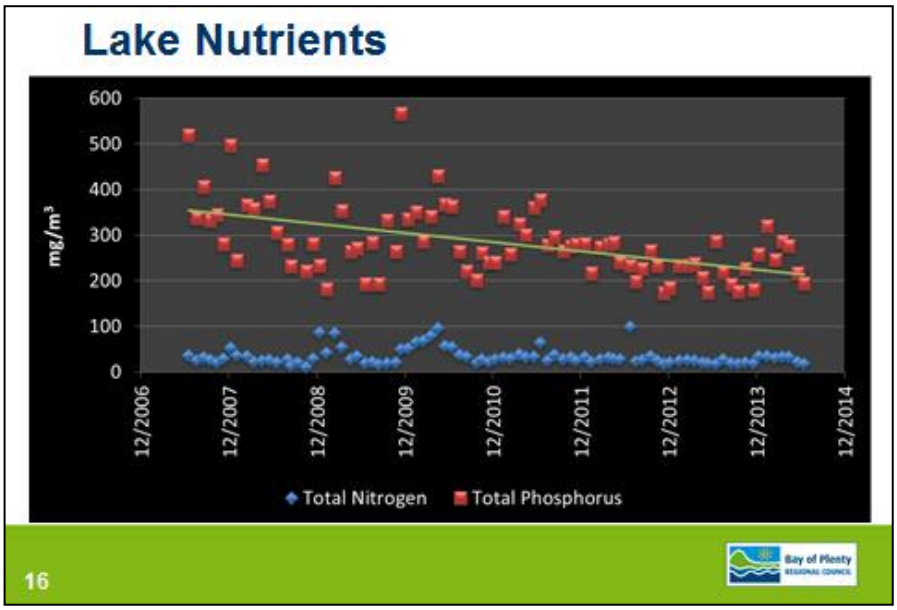
Slide 15



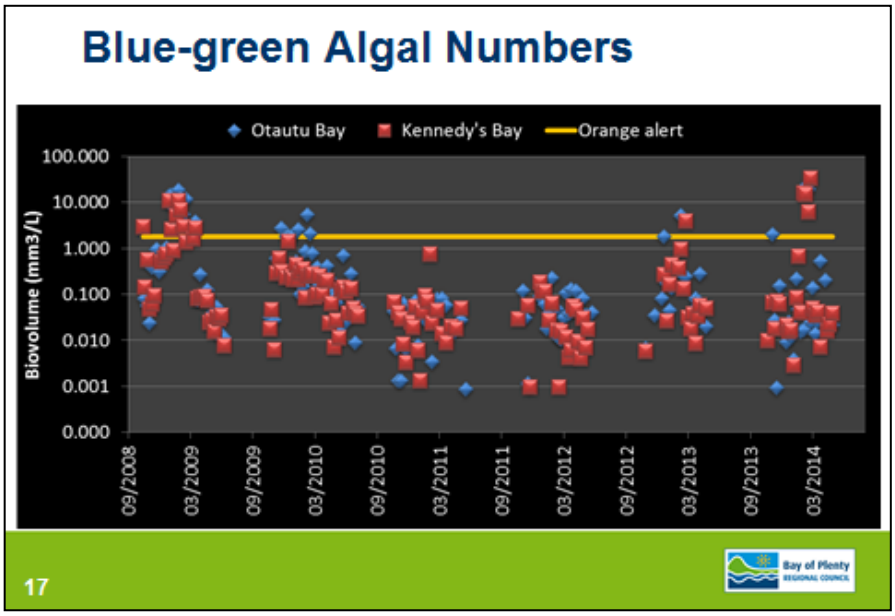
Slide 15 is the total nutrient removal by harvest for years 2006 to 2014. It is variable, there are seasonal variances in how much weed grows and the ability to harvest, but generally speaking it has been quite a successful operation in taking weed out.

Paul Scholes outlined the outcomes of removing some nutrients from Lake Rotoehu. Bay of Plenty Regional Council monitors a range of parameters monthly in the deepest part of the lake. Focussing on the trophic level parameters, nitrogen and phosphorus, there is quite a strong trend in improvement of nitrogen, but not so much in phosphorus since the start of harvesting back in 2006. This translates to far fewer algal blooms than have been seen for many years. **(Slide 16)**

Slide 16



Slide 17



Lake Rotoehu was severely affected by algal blooms up until 2009; the orange line in **Slide 17** of blue-green algae in Rotoehu represents the recreational guideline standard for algal bio-volume. Since the harvesting programme started that algal biomass has dropped below the recreational guideline standard for algal bio-volume, resulting in only one lake health warning in the last 6 years, previous to this season.

This is a positive trend for the Regional Water and Land Plans Trophic Level Index objective for Rotoehu, which is our target for reaching that water quality, based on the four parameters of nitrogen, phosphorus, chlorophyll A, (measure of productivity) and water clarity. It means that things are looking pretty good for Rotoehu at the moment with all those interventions. **(Slide 18)** Although the dominant intervention has been nutrient removal from the harvest, there are now other interventions of aeration, P locking, and a floating wetland.

Slide 18