THE RESTORATION OF NATIVE AQUATIC PLANTS

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Dr Hofstra is a scientist in the Freshwater and Estuaries Centre of NIWA. Deborah leads government funded and commercial projects that focus on research solutions for aquatic plant management including the rehabilitation of native plants and the management of invasive weed species. Collaboration with international colleagues has included projects on aquatic weed control, macrophyte growth and physiology under different environmental conditions, and most recently a review of management for invasive aquatic plants.

TRANSCRIPT

I am very pleased to be here today because I have the privilege of speaking about a good news story, that being the restoration of native aquatic plants instead of weeds. I will start by looking at what native aquatic plants look like, touch on species and communities, and talk about their benefits. You have heard some of this already from Max and Tracey, but we are now going to look at actions for restoration and then move on to outcome examples.

To start with I would like to share some statistics to show the current state of freshwater in New Zealand. We have 88 native aquatic plant taxa, of which 40% are endemic – the remainder are in Australia or elsewhere - and 36% are at risk of, or threatened with extinction, including 7 nationally critical taxa. The primary causes really come down to habitat change and pest species which have altered native freshwater ecosystems, contributing to their decline.

When we talk about native plant communities there are 5 different zones or communities within the freshwater plants that can be categorised as:

- Emergent plants
- Short growing turf plants
- Tall submerged plants
- Charophytes
- Deep water bryophytes

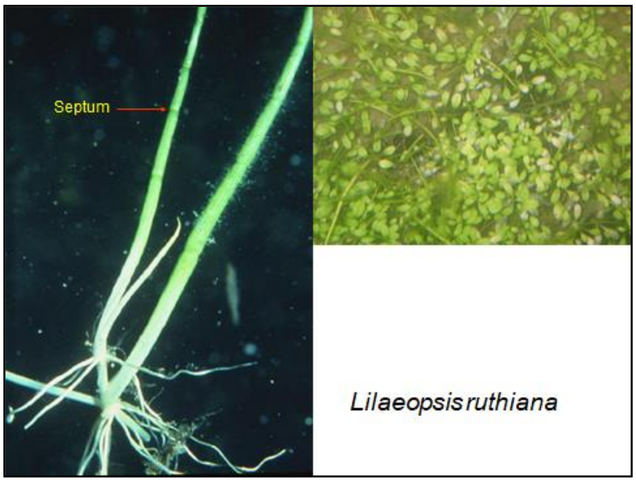
The deep water bryophytes are not relevant to Rotorua. Emergent plants are the ones most familiar because they are seen, as the name suggests, emerging out of the water. Slide 1 shows tall erect plants like the *Typha orientalis* (raupo, or bulrush) in the top left, sprawling emergents or floating leaf plants at the bottom of the slide.

The short growing turf plants are where the biodiversity lies. They occupy the first couple of metres within the water depth, with the exception of *Isoetes* that can grow a little bit deeper. We will spend more time focussing on that plant later. Most of these turf plants grow on moderately exposed shorelines. A few pollinate underwater or are self-pollinating and many flower when they are exposed above the water. Typically, they are referred to as the 'knife', 'fork' and 'spoon' plants because of the way the leaves look.

Short growing turf plants come from a range of different families. This slide helps those unfamiliar with freshwater plants, to recognise some families that are familiar from the terrestrial world, such as buttercups, ferns and daisies.

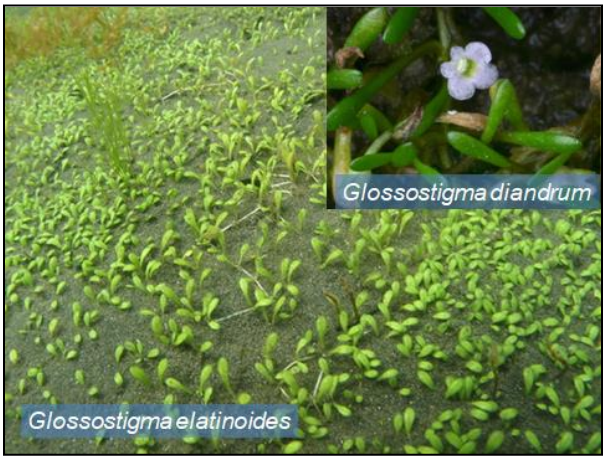
Asteraceae (daisies)	Juncaceae (rushes)
Apiaceae (carrots)	Juncaginaceae
Brassicaceae (cabbages)	Lobeliaceae
Centrolepidaceae	Marsileaceae (ferns)
Crassulaceae	Phrymaceae
Cyperaceae (sedges)	Ranunculaceae (buttercups)
Elatinaceae	Ruppiaceae
Haloragaceae	Tetrachondraceae
Hydatellaceae	Zannichelliaceae
Isoetaceae	

Slide 2 is an example of an underwater plant, thought of as a 'knife' species because it has a simple blade. *Lilaeopsis ruthiana* is easily recognised by the septum (indicated on the photo). You can see it grows with other native aquatic plants in a low growing turf community.



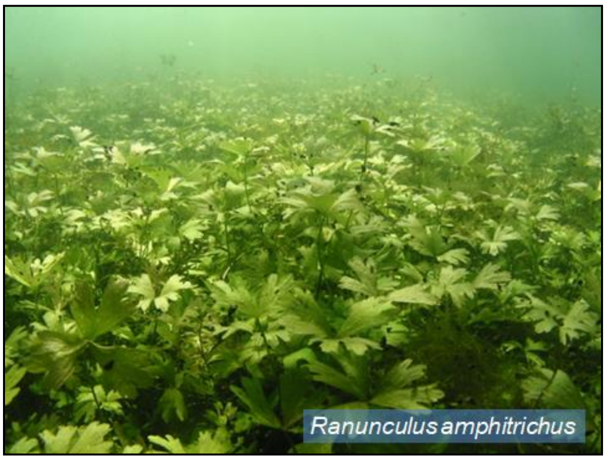
Slide 3 *Limosella lineata* also falls into the 'knife' category. This picture visually highlights the macro-invertebrates, that can be abundant on submerged aquatic plants. Those little brown dots are all snails.

Slide 4 shows two different species of *Glossostigma*, a 'spoon' in terms of the leaf shape, and it shows what that form or growth habit looks like. It is dense enough to see a few little white lines along the sediment, stolons, where different plants join up together and helps to bind the sediment in place. The lake substrate can still be seen, - quite a contrast to Tracey Burton's picture of big black dense invasive weed species. This is, by comparison a very open habitat.



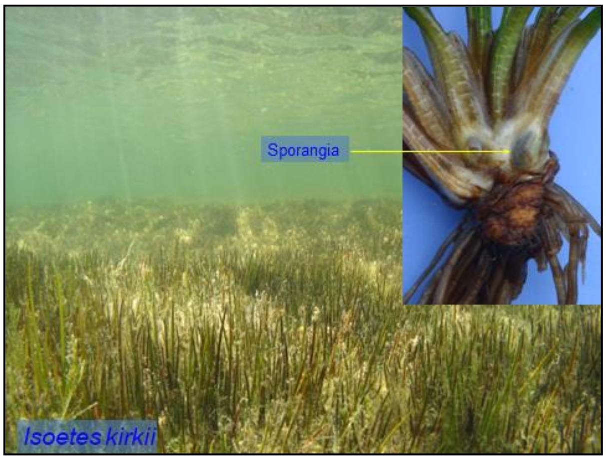
Slide 5 is another example of a low growing turf species, similar to the previous one but a different species altogether. In contrast the *Ranunculus* (in the next slide 12) may be more familiar in appearance to some *Ranunculus* species in the terrestrial world.

Slide 6 - Note again all those snails; they are just little black dots, but the photo illustrates that habitat is provided for macro-invertebrates**.**

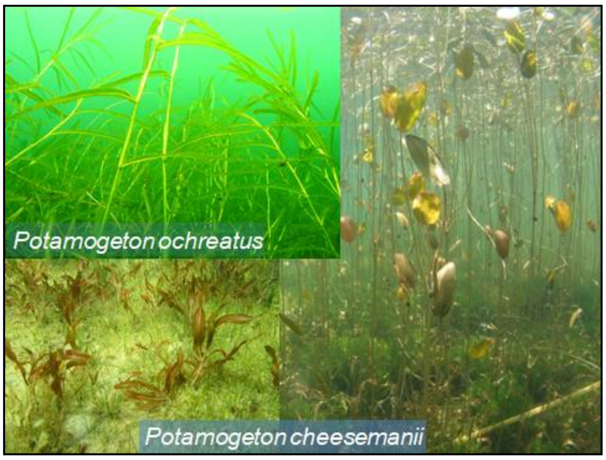


Slide 7 – *Pilularia* is a plant in the fern group – as illustrated in this photo by the koru form of the new 'leaf'. In the top left photo, the plants look a lot like a lawn of grass in the shallow water zone.

Slide 8 - The last plant amongst these examples is *Isoetes*, which grows a little deeper than the others. It can grow down to about 6 metres and forms quite dense swords which you can see in the picture.

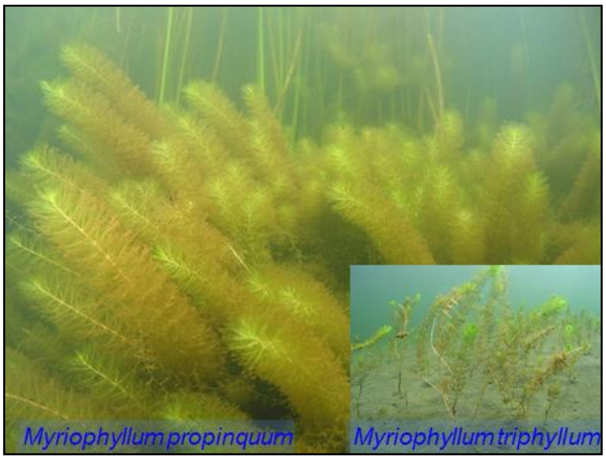


The next group are tall submerged plants within which there are 13 different species, but we will focus primarily on *Potamogeton, Myriophyllum* and *Ruppia*. These are the ones most often displaced from water depths of one to five metres when invasive weed species establish in a lake.



Classic examples in Slide 9 are *Potamogeton ochreatus* on the left hand side and *Potamogeton cheesemanii,* at the bottom, which can have different forms. One is submerged and short with a bronzy leaf and then as it approaches the water surface it has a more oval shaped, slightly tougher leaf.

Slide 10 Two species of *Myriophyllum* are of interest, one is *M. propinquum* and the other is *M. triphyllum*. They have a feathery growth form by contrast to the others we have seen.



You will now recognise that there is wide diversity of form within native aquatic plants which is key to keep in mind.

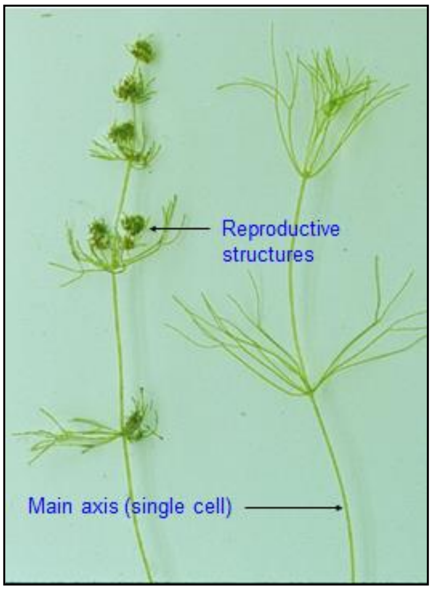
Slide 11 is a bed of *Ruppia*, quite different again in form, but occupying the same water depths as the pondweeds and the milfoils.

Slide 12 is *Utricularia australis,* of historical interest for the region. It was in Rotomahana before the Tarawera eruption, but has not been found since, and is nationally critically endangered.

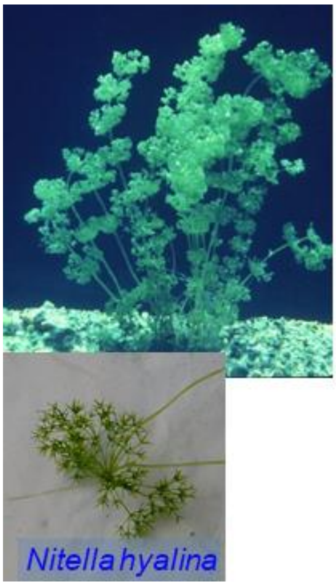
Charophytes are the final group of plants that I wanted to introduce to you, and the ones that form beautiful meadows. They are a type of macro-algae and close relatives of land plants. They are relevant for the Rotorua lakes. There are 5 species of Chara and 3 occur in the Rotorua Lakes. There are 12 species of Nitella and 7 are here in the Rotorua lakes. They develop best in clear lakes forming deep water meadows - 24 metres in Lake Ōkataina and 35 metres in Lake Wakatipu in the South Island.

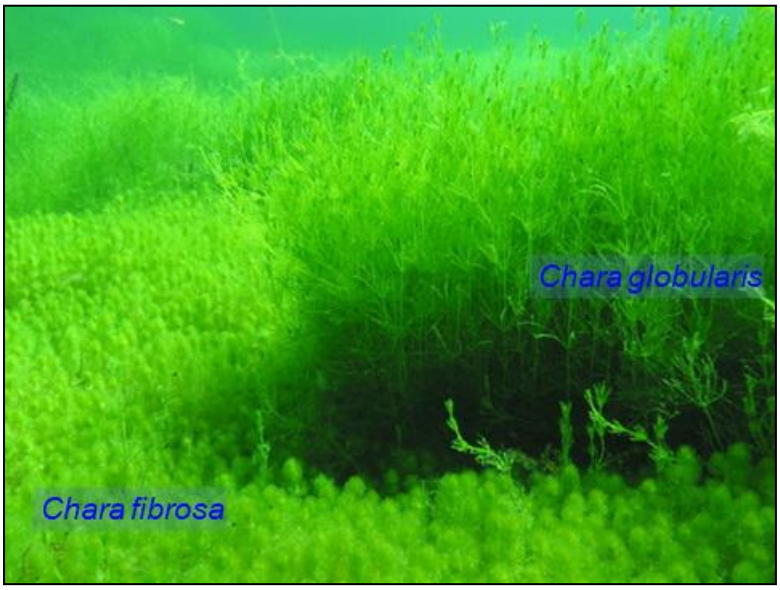
This picture is of oospores. When we talk about native plants we often talk about seeds and seed bank. A major difference between most submerged invasive weed species and native plants is that the latter have a seed bank, the invasive weeds thankfully do not. However rather than seed, charophytes have oospores, functionally the same but different in the terminology that is used.

Slide 13 *Nitella opaca* is important because it is only found in Rotorua and Central North Island lakes.



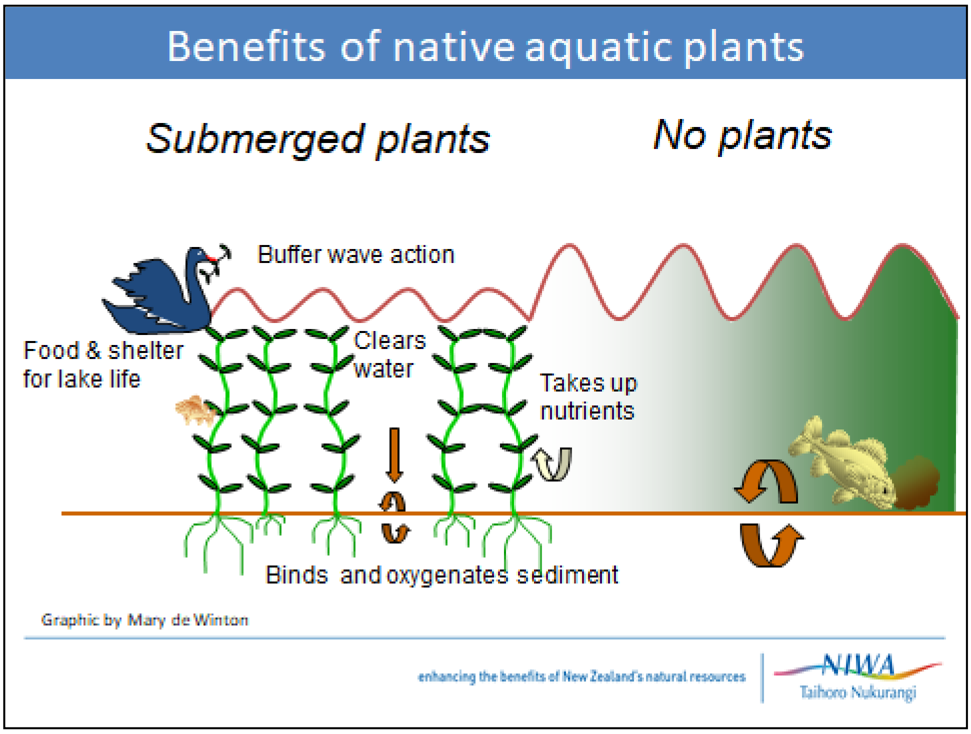
Slide 14 also shows examples of *Nitella*, note again the variety of form between these species, one that is more open and the other tighter clustering branches.



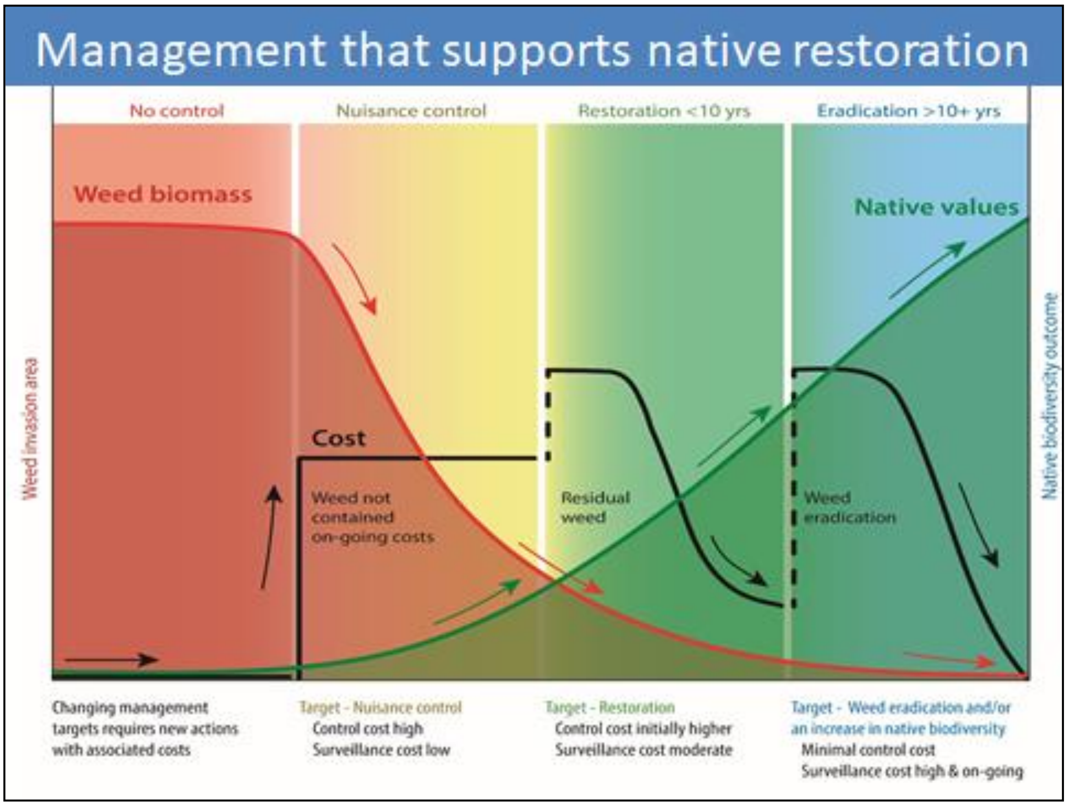


Similarly, these Chara, (Slide 15) seen within a lake, show the diversity and height between different species, again providing variety in habitat.

What are the benefits of native aquatic plants, why should we care whether or not they are in our lakes, and are they weeds? This diagram (Slide 16) highlights the contrast between an aquatic system with macrophytes in the littoral zone and one without. It comes down to the key functions the plants have. One of those functions is the binding of sediments which is important for water clarity. Plants help bind the sediments in the wave wash zone in the shallows which reduces turbidity and minimises the resuspension of sediments. The plants naturally buffer the wave action which also means helping to keep the water clear. They also provide an important habitat food source for water fowl and macro invertebrates and a refuge for fish as well.



There is a well-recognised relationship between structural complexity of the habitats that we have in our freshwater systems and the abundance of different taxa. Structural complexity relates to the diversity of the plants and to the diversity in their form. It relates to the fact that there are still exposed rocks or stones and a lake substrate in and around the base of those plants. That diversity of habitat and structure is what underpins the diversity in the macroinvertebrates, which is really important when it comes to food webs and lake health.

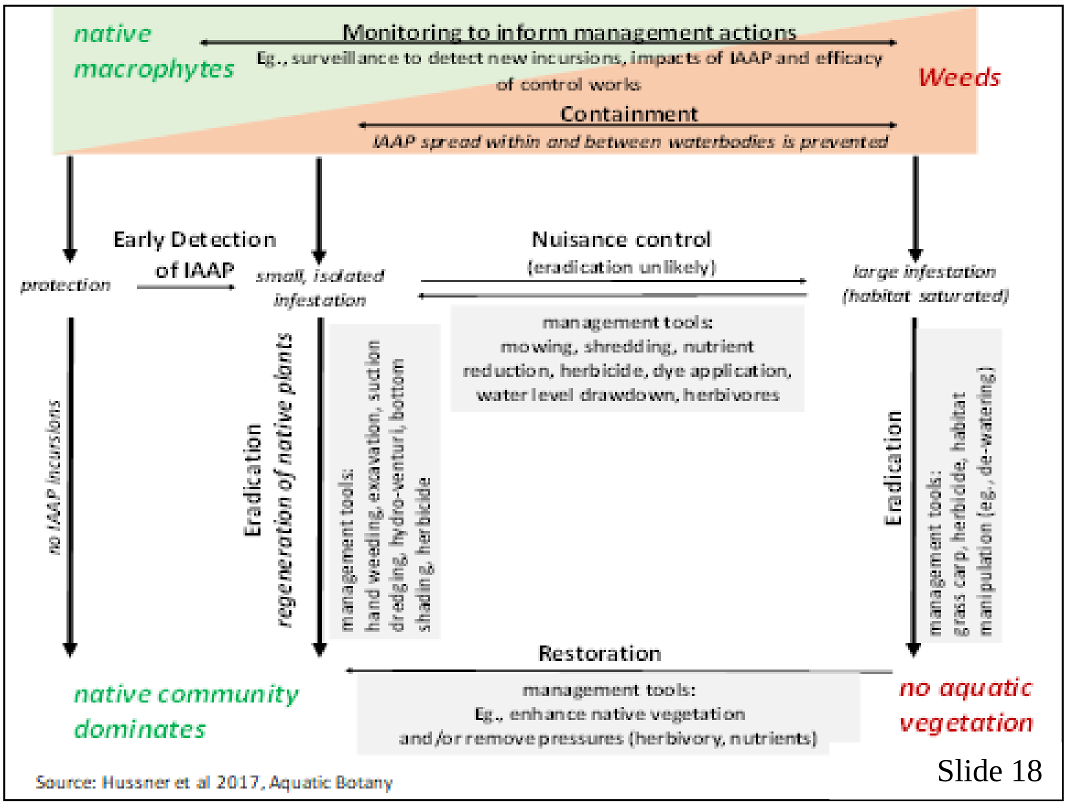


Why should we care whether plants are in our lakes and what they do? Slide 17 illustrates the concept that a high amount of weed biomass (on the left) results in very low native values. The contrast is also true, (the right) that management actions to reduce weed biomass provides the opportunity to improve the condition and diversity for all native plants and fauna. It is an simplified diagram for what we need to support native restoration and the kind of management undertaken.

Slide 18 is the same as the previous slide but more complicated, because it includes the strategic thinking required for native plant restoration and recognises that invasive species management is an essential part of native biodiversity restoration. The colored banner at the top represents the state of the ecosystem and highlights that when you have high native plant biodiversity you do not have weeds. On the right (of the diagram) high weed biomass means the natives are not doing so well.

If you cast your eyes to the bottom of that diagram, on one corner the native community dominates and the other there is no aquatic vegetation. The good news for the Rotorua region is that its lakes are primarily operating on the left. In other words the monitoring and surveillance work that Bay of Plenty Regional Council is doing ensures that when it comes to restoration there are still native plants to restore from, as opposed to a degraded

Waikato lake with no native plants, where more intensive efforts will be required for restoration. The arrow at the bottom, underneath 'Restoration' indicates some different actions for native plant restoration, but it is essential to have something to work with.

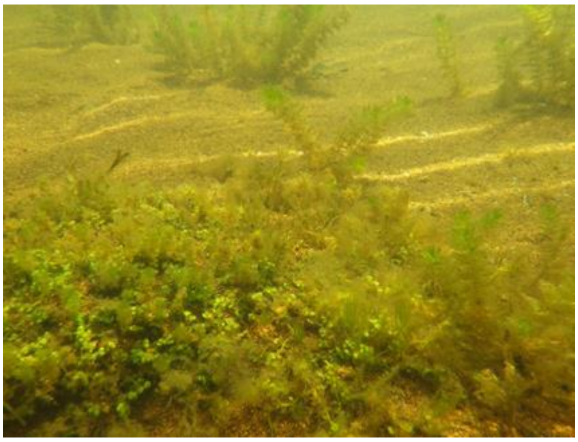


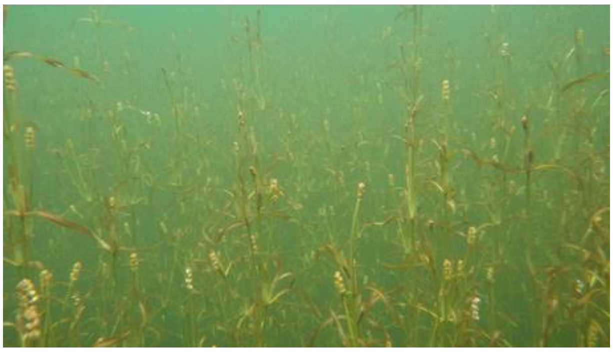
We need a strategic approach, and to recognise that invasive species management is an essential part of native biodiversity restoration. You cannot restore native plants if you have done nothing about the invasive weed species. Not only invasive weeds, but pest fish are a big problem too. It is important to act early because prevention is much easier than restoration. Surveillance activities are important in informing the management actions that can be undertaken. Restoring native plant communities is then about matching the tools and restoration goals – it is about recognising and working with the unique characteristics of the native species present, and an appropriate approach to weed removal. Examples include selectivity and benthic barriers.

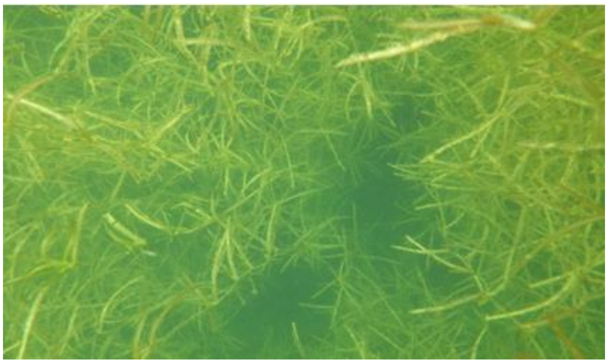
Slide 19) Lake Okareka is the first example. It was in a highly ecological condition. Hornwort was found there in April 2012.

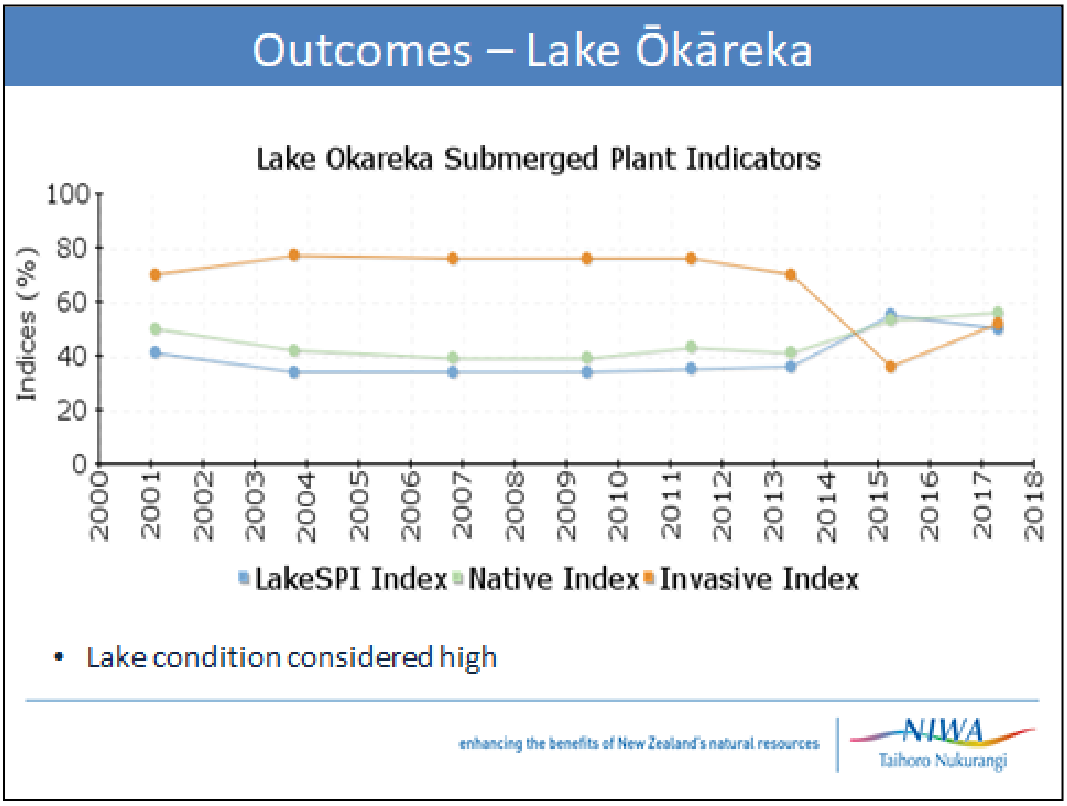
(Slide 20) Surveys were undertaken in 2013 by the Bay of Plenty Regional Council who located the areas of hornwort and a treatment programme was initiated. This was carried out by LINZ with Boffa in 2013, and the targeted areas were treated with diquat herbicide. There are no signs of hornwort in that lake now as a consequence of that programme.

These pictures show native plants flourishing and some are starting to flower. Even if nothing has been done to deal with the invasive weed, flowering is good as it indicates the plants will soon be setting seeds and replenishing the seed bank once more.





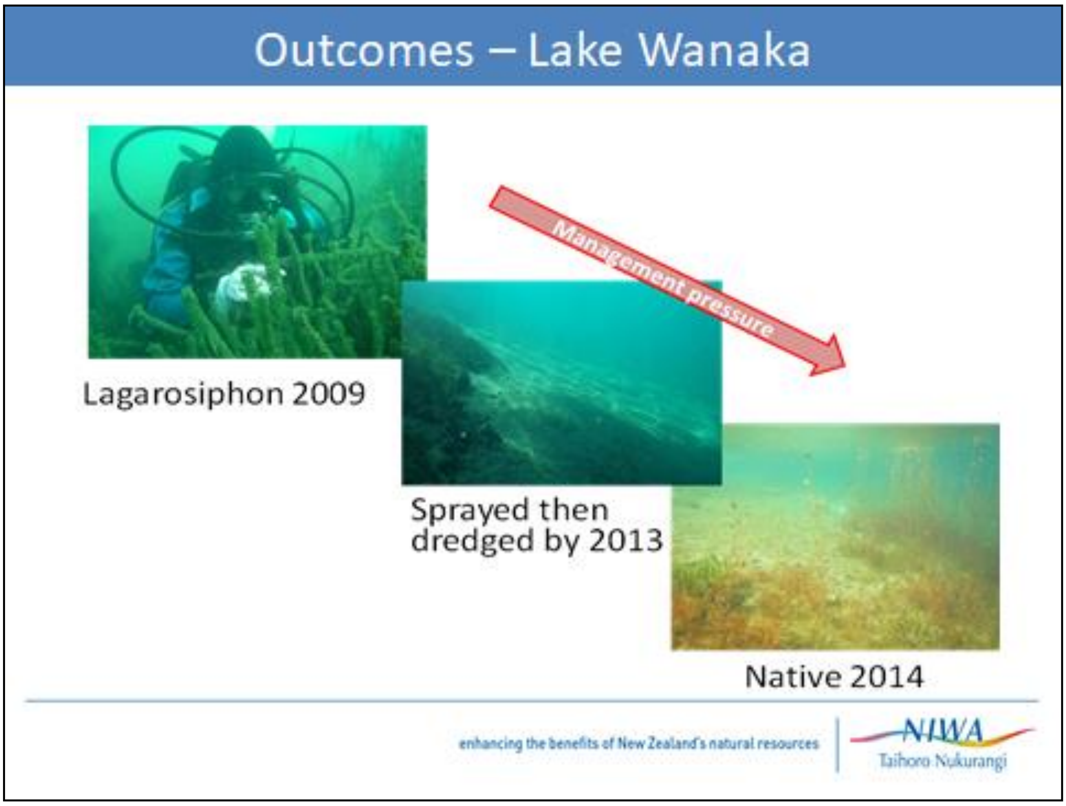




Slide 21 is a typical LakeSPI graph looking at ecological indicators in the lake and how they track over time. There are invasive species still in Okareka, lagrosiphon and egeria, but the dates show that when the hornwort work was done the invasive species index in the lake declined and the native plants improved. That is a good outcome for native plant restoration.

Lake Ōkataina has a similar story. (Slide 22) The weed beds were sprayed with diquat and in the bottom pictures there is recovery of native plants post spray.

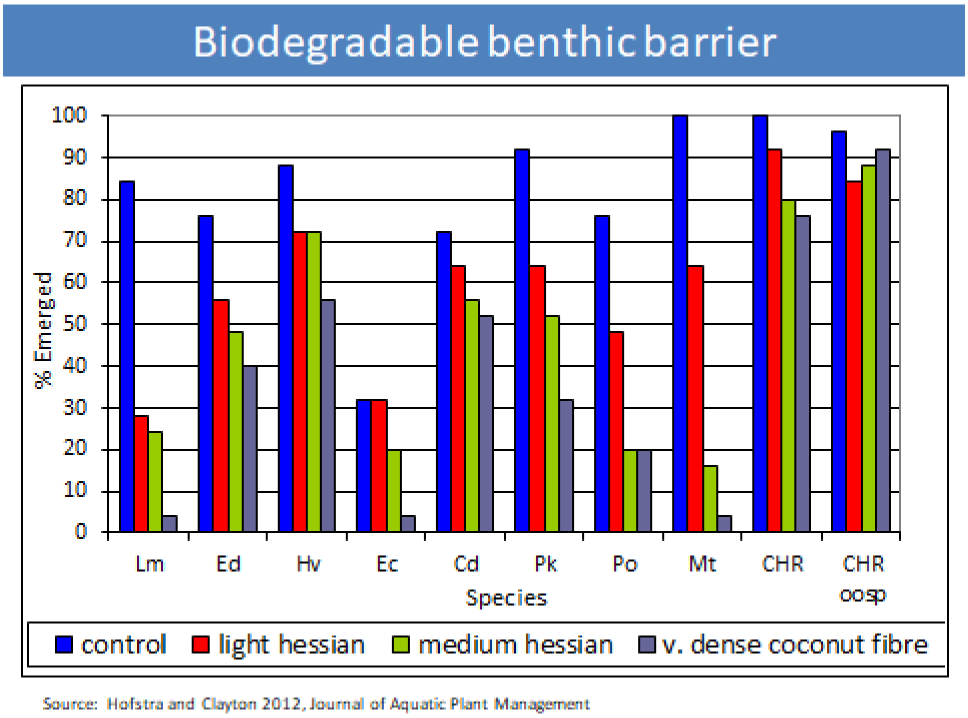
Slide 23 is the third example in Lake Wanaka, a different part of the country but similar successful outcomes. This is work that LINZ and Boffa are doing on the lagrosiphon programme over a relatively short timeframe. Lagrosiphon weed beds were dense and treated in 2009. By 2014 there was native plant recovery within those same areas.



Slide 24. The last example focusses on *Isoetes* which has been declining in the Rotorua region. We know that plants occur in different lakes throughout the country, and there are some quite distinct tetraploid plants in the Central North Island. Recently, in the South Island, we have seen that *Isoetes* also grows through hessian which can be used as a thick barrier to smother weed species.

This idea originally came from a colleague, Joe Caffrey, who found it helped with native charophytes recovery. (Slide 25) We then looked at different products we could potentially use, and also the density of those products.

Slide 26 shows the results. The right of the graph shows our native charophytes were responding positively, for example the blue lines were quite similar to the other bars. In other words the emergence or response of our native charophytes through the hessian benthic barrier was comparable with no barrier being present (the control). This provided an opportunity for a different way to deal with invasive species, in particular lagarosiphon on the far left of the graph.



Mary de Winton took this photo (Slide 27) recently in the South Island, of the work that LINZ and Boffa have undertaken. The hessian went down a couple of months ago, and the little green blades are *Isoetes* growing through it. This could be another tool used to deal with invasive weed species that supports native plant recovery.

In conclusion, restoration and enhancement of native biodiversity is possible. Preventing water quality and clarity deterioration is really important. Biosecurity threats and incursions need to be addressed. There can also be gains for native biodiversity from biosecurity actions. The strategic approach to freshwater biosecurity and biodiversity is very important to maximise all those beneficial outcomes across the board.

I would like to acknowledge other contributors to this presentation. There are a lot of photos by members of the Aquatic Plants Group at NIWA and conversations with colleagues that debate science from which new ideas are drawn. As I mentioned, the biodegradable benthic barrier idea came from Dr Joe Caffrey in Ireland and I have also included information from the LINZ and Boffa work in the South Island.

Thank you.

QUESTIONS

Cr Tipene Marr, Bay of Plenty Regional Council: A question for you Deborah, are you taking seeds from the bottom of the lakes in case it does end up like Waikato?

Deborah Hofstra: No we are not. From work that Mary de Winton and John Clayton have done in the past, we know that native seed banks will decline under those invasive weed species. The treatment of invasive weeds that temporarily reduces that weed biomass, or gets rid of it, even for a couple of seasons, still provides the opportunity for native plants to replenish their seed banks. As long as that is happening there is no need for seedbank sampling. I think that keeping everything in situ with less disturbance is the better way forward.

Cr Tipene Marr: One more thing what is the Maori name for those things? It is great having a scientific name, but there were a few basic weeds that it would be nice to know the Maori name.

Deborah Hofstra: Thank you, yes I will take that on board and change that for the next time, thank you.

Nicki Douglas, Te Arawa Lakes Trust: We know that kākahi, the native mussel, are a good filtration system for water. We also know they cannot survive on sludgy lake beds, could they survive on top of a hessian layer?

Deborah Hofstra:
That is a very good question and something we have thought about as well. There is a desire to look at other ways of dealing with invasive weeds and one of the questions is - What would happen when covering large areas? What kind of macro invertebrates, including kākahi, would survive with that? We have also noticed when dealing with weed beds for other reasons (projects not described in this presentation) that weedbed removal can improve the habitat for kākahi. I agree with you, they do not like mud, they prefer sandy open substrates, the kind you saw under those native plant communities, that is where kākahi will be. Under the dense mounds of invasive weeds we saw earlier in the day (presentation by Tracey Burton) will be dead kākahi. We would love to get together for some further testing of biodegradable benthic barriers and figure out how they would work for kākahi.

Craig Morley, Te Ohomai: Apart from people, what other vectors may be spreading these invasive aquatic weeds? Birds, for example, or any other non-human ways to spread these weeds?

Deborah Hofstra:
For those major weeds we have talked about like the *Ceratophyllum demersum*, (hornwort), *Lagrosiphon major, Egeria densa*, it is simple, people.

Cr Dave Donaldson, Rotorua Lakes Council: Deborah you talked about lake drawdown being a management tool for the enhancement of native species. I wondered how important fluctuating lake levels are. We have sustained high lake levels this year with many wet weather events, is that a good thing or a bad thing for native plants?

Deborah Hofstra:
Management techniques, whatever they are, be it herbicides, drawdowns, hessian benthic barriers, all need to be assessed on a case by case basis. Lakes are all different

depending on water depth, species compositions, what is going on in each lake, so lakes need to be assessed individually.

Don Atkinson, LWQS: Question for Max, I would like to dig down further into your answer in respect to Lake Rotoiti and the oxygen demands, I would like you to consider the consequences to western arm, west of the pylons. What would your answer be where we have got the large rafts of weed in bays where the weed cover is not of 6%, but probably in excess of 60%. And then consider periods of relatively quiet hot warm conditions of summer when we have not got any mixing from the greater lake. How would that impact your answer for those particular sections of the lake?

Max Gibbs: Different set of conditions, it is not stratified, it is not a hypolimnion, but the weed collapse in these shallow arms, Okawa Bay, Te Weta Bay and so forth will consume all the oxygen, the lake will go anoxic and that will have a major effect locally. You have another situation in Lake Rotoiti which is not common in many of the other lakes in the Rotorua area and that is that you have an internal seiche on the Thermocline in the lake.

The seiche sets up an oscillation of the water column as an internal wave on the thermocline whereby the surface water flows in one direction above the thermocline while the bottom water flows in the opposite direction below the thermocline. This means that there is a very large volume of oxygenated water pushed into the western basin and associated bays on the east-west cycle. This flushes the water from the bays back into the eastern basin. On the west-east cycle, oxygen depleted water from just below the thermocline in the eastern basin flows into the western basin displacing the surface water back into the eastern basin.

With respect to the effect on the oxygen concentrations in the western basin and bays, the seiche will cause a fluctuation between fully oxic (saturated) to about 70% saturated (from memory of my measurements in the 1980s) locally. The oxygen loss from the weed decomposition in the bays off the western basin (including Te Weta and Okawa Bays) is included in my calculation for the whole lake. It will be a greater effect locally, say, up to 15% rather than the average of 10% or less across the whole lake. The seiche effect is very complex in this lake and needs modelling.