RECOGNISING THE NEGATIVE IMPACTS OF AQUATIC WEED MANAGEMENT: OKAWA BAY, LAKE ROTOITI CASE STUDY

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After completing an undergraduate degree in Geology at the University of Auckland, Paul headed for the mining mecca of Western Australia. There he brokered a career in geotechnical engineering before chasing the gold veins under the Kalgoorlie Goldfields. His geologist stint ended with a period working in the Super Pit, the largest man-made hole in the southern hemisphere. Returning to New Zealand, Paul completed a Masters in Resource Studies though the School of Natural Resources Engineering at Lincoln University, after which he applied his newfound skills on the Manapouri Tailrace Tunnel II project in Fiordland. Moving into local government Paul worked for two years in Gisborne as a Soil Conservator, followed by brief spell at Carter Holt Harvey Tasman Pulp and Paper Mill as an Environmental Engineer. He currently works for Bay of Plenty Regional Council and over the past 11 years has been heavily involved in the Te Arawa Rotorua Lakes Programme as an Environmental Scientist.

ABSTRACT
The Te Arawa Rotorua Lakes Programme continues to implement measures to maintain and restore lake water quality in line with trophic level indices (TLI's) for respective lakes. In Lakes Rotorua and Rotoiti this has also meant not only reducing nutrients to and in the lakes but also managing periodic cyano-bacterial (blue-green) algal blooms.

Restoration measures in the Rotorua and Rotoiti catchments have included land use management efforts to arrest nutrient inputs; diversion of Lake Rotorua waters from entering Rotoiti; sewage reticulation of lakeside communities; and treatment of inflows with aluminium sulphate (alum). While restoration efforts have produced water quality gains in both lakes, in recent years, cyano-bacterial blooms have occurred in the shallow embayment of Lake Rotoiti, known as Okawa Bay.

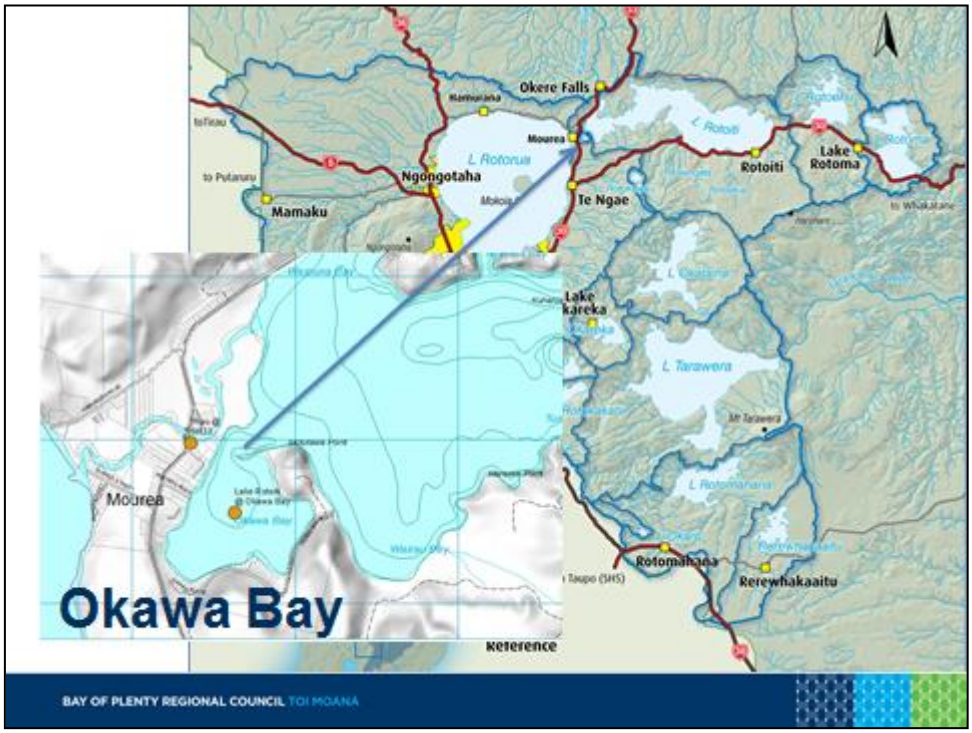
These water quality gains have not come without a cost. Submerged aquatic weeds such as Hornwort are an increasing problem in the Rotorua Te Arawa Lakes and significant resources are needed to manage infestations primarily for aesthetic and recreational amenity. Control of exotic aquatic weed is mostly with application of herbicide. Herbicide treatment leaves a decomposing biomass in the waterbody, potentially increasing the nutrient status.

We examine the impact aquatic weed decomposition has had on Okawa Bay's nutrient status and the cyano-bacterial blooms over recent summers, and Bay of Plenty Regional Council's response to reduce localised bloom development.

TRANSCRIPT
This paper looks at the interest in weeds, water quality and resulting actions over the last decade in Okawa Bay. How has lake weed management contributed to the water quality in this lake?

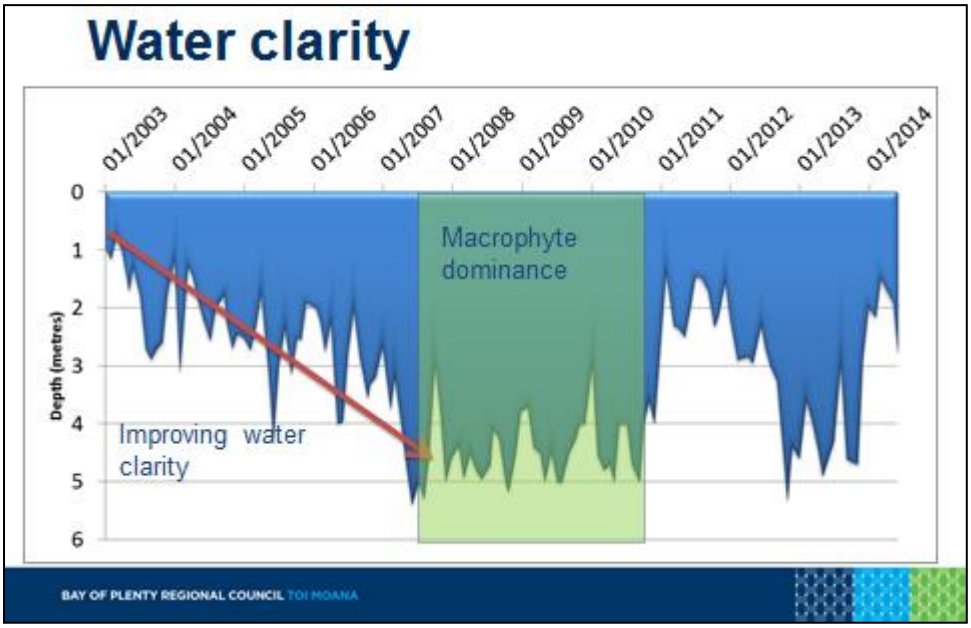
Slide 1 shows Okawa Bay on the western side of Lake Rotoiti, a 45 hectare embayment connected to the greater lake of Rotoiti. Its maximum depth is just over 5 metres, so it is quite a shallow embayment. There has been some action in recent times to improve water quality; sewage reticulation in 2006 and, of course, the Ohau diversion wall. This has improved the water quality of the greater Rotoiti lake and it has had a flow on effect into Okawa Bay.

Slide 1



Slide 2 is a graph of the water clarity as measured by Secchi depth since 2003, and over the period 2003 to 2008 there has been a real trend of improving water clarity. The massive algal blooms back in 2002-2003 galvanised the LakeWater Quality Society and

Slide 2



the Council into action and water clarity improved. As a result of this, there was a shift in algal dominance to macrophyte dominance up until 2008. The result was scenes like these large drifts of hornwort washing up on shore. (**Slide 3)** This picture was taken in the autumn of 2008 and the increased water quality encouraged the hornwort to really take off.

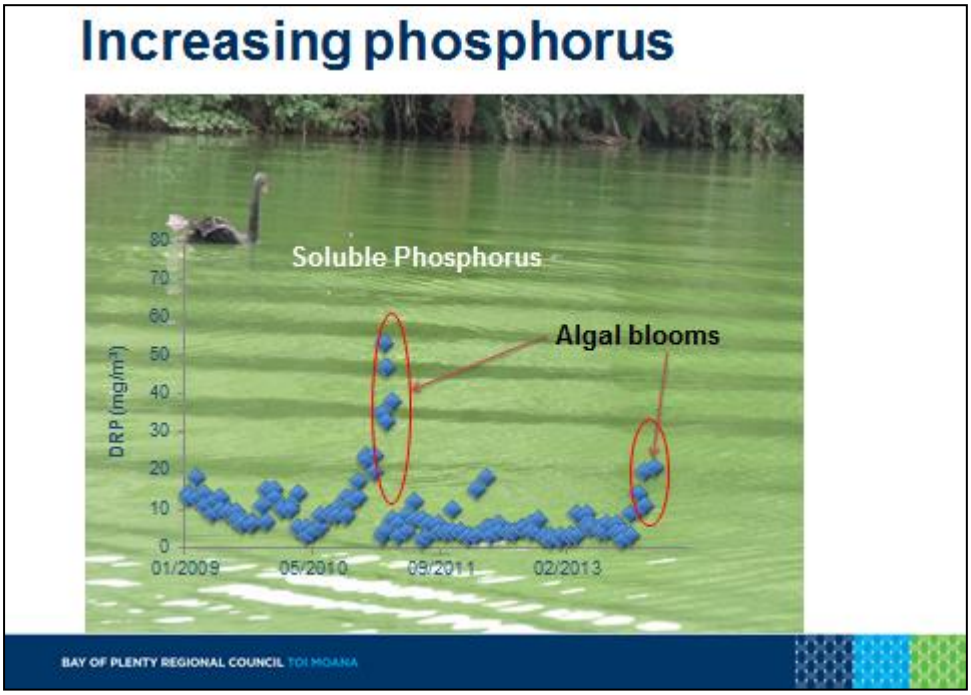
Slide 3

In more recent times that water clarity has dropped again. Small algal blooms appear, specifically a species of the nitrogen fixing algae anabaena. **(Slide 4)**

Slide 4

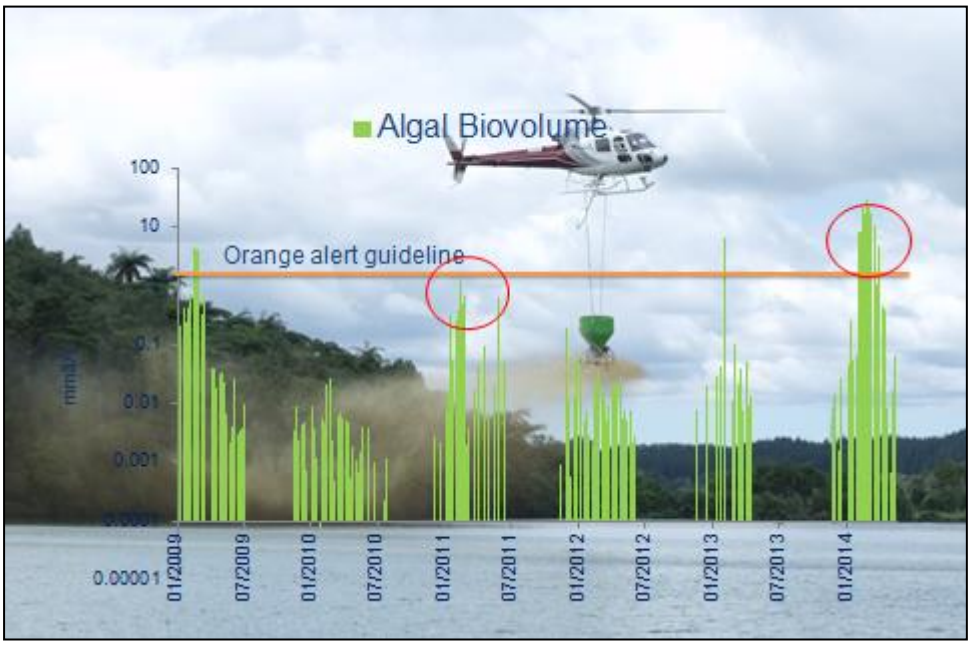
Why are these algal blooms appearing again?
Looking for causes, an obvious possibility is the increase in soluble phosphorus, seen at the time that these algal blooms occurred. **Slide 5** illustrates the concentration of phosphorus occurring over the early summer period when those algal blooms start to develop.

Slide 5



Slide 6 graph illustrates the prevalence of those blooms in the last few years. They have been decreasing and for the most part below the contact recreational guideline. The exception was last season's bloom where a warning status on Okawa Bay was reached.

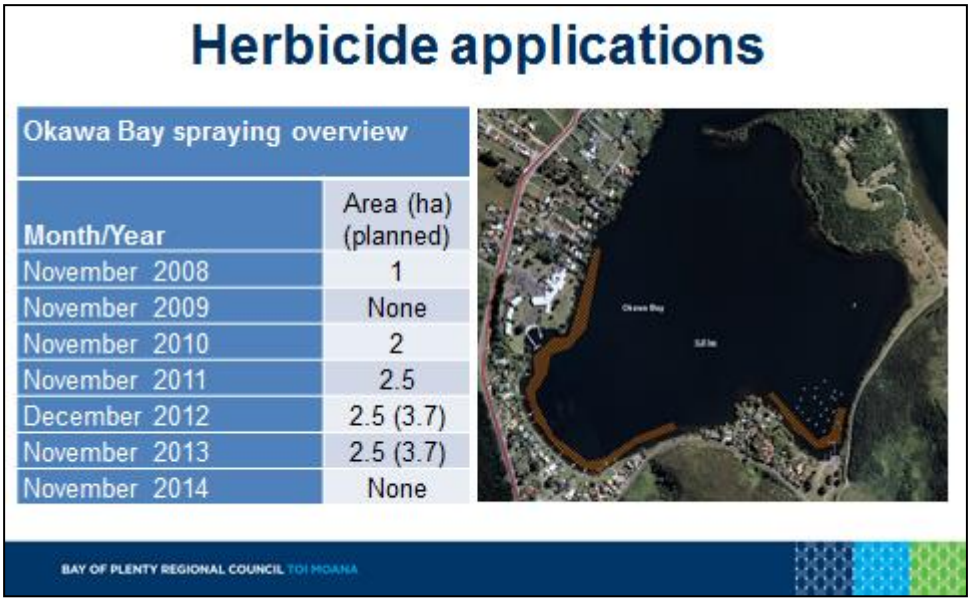
Slide 6



What might be the drivers of this recent increase in algal blooms?
Max Gibbs (NIWA) talked about anoxia, lack of oxygen in the bottom waters, as a potential for nutrient release in the sediments. Monthly monitoring in our programme shows little evidence of stratification, but this is not continual monitoring. Stratification events can happen quite quickly in these shallow systems, so anoxia could still be occurring. Max also mentioned sediment nutrient release with elevated pH, another potential mechanism.

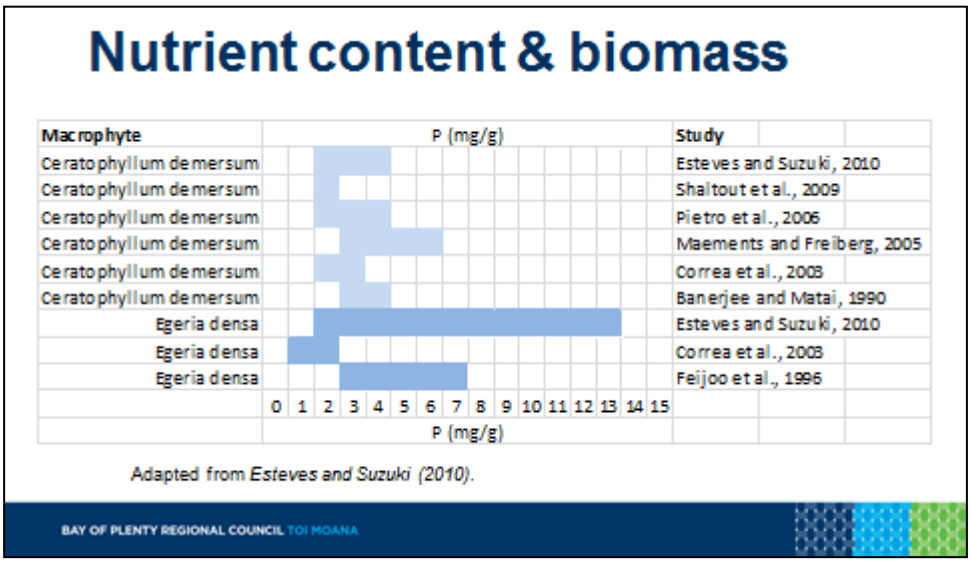
We have had a management programme of herbicide application in the bay for the last few years, and we explored if it had influenced these algal blooms. LINZ operates the spray programme through Boffa Miskell and the Regional Council. **Slide 8** shows the areas of about 2½ hectares, that have been sprayed in Okawa Bay since 2008. There was no spraying last season.

Slide 8

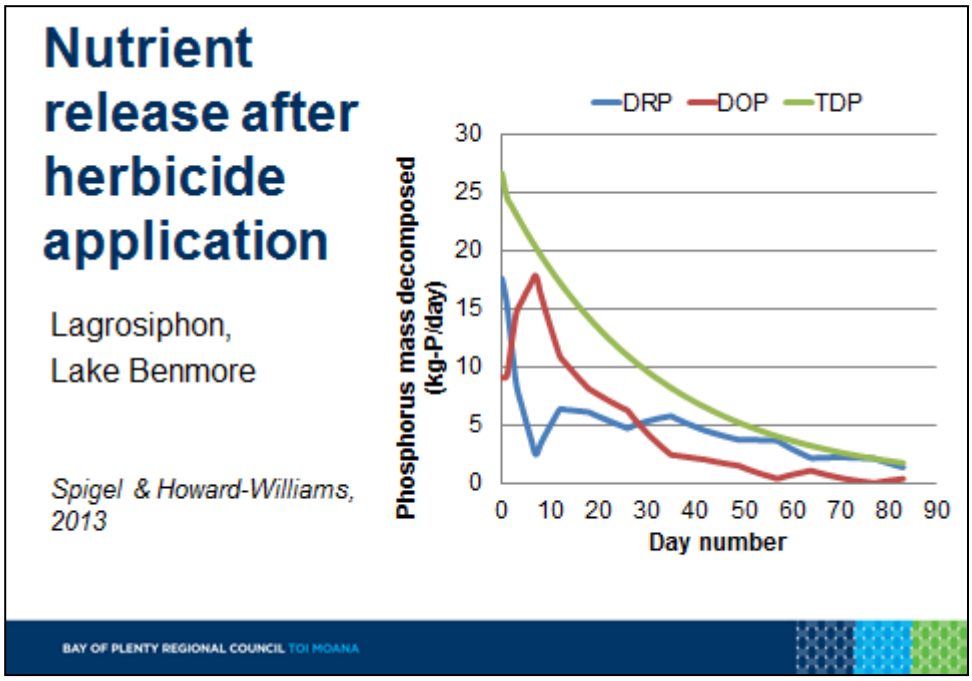


Slide 9 is evidence from the literature of nutrient contribution from a decomposing biomass of sprayed aquatic weeds which gives a picture of nutrient release into the water column.

Slide 9



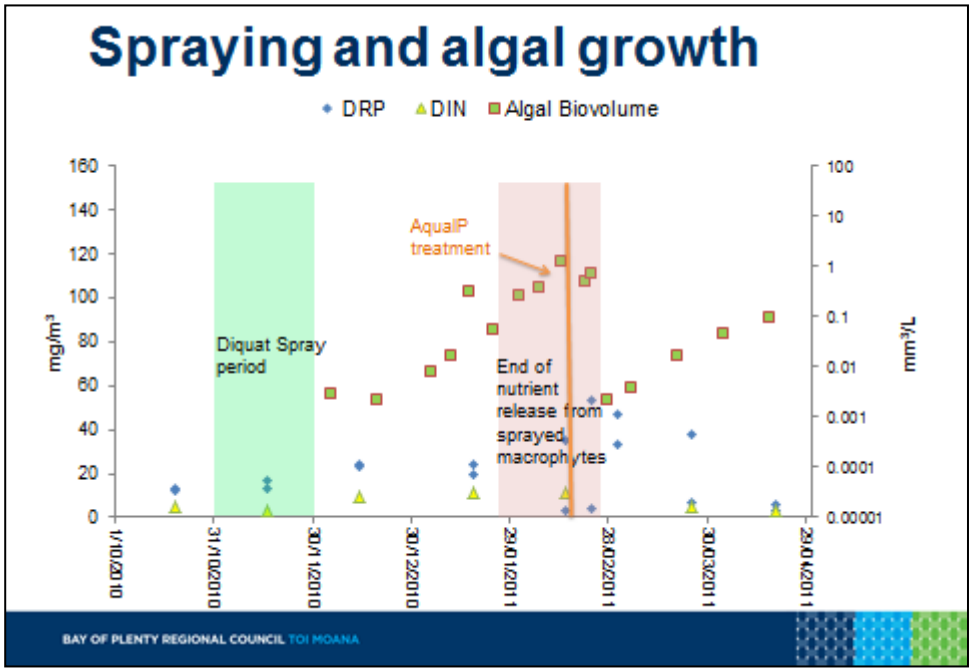
Slide 10



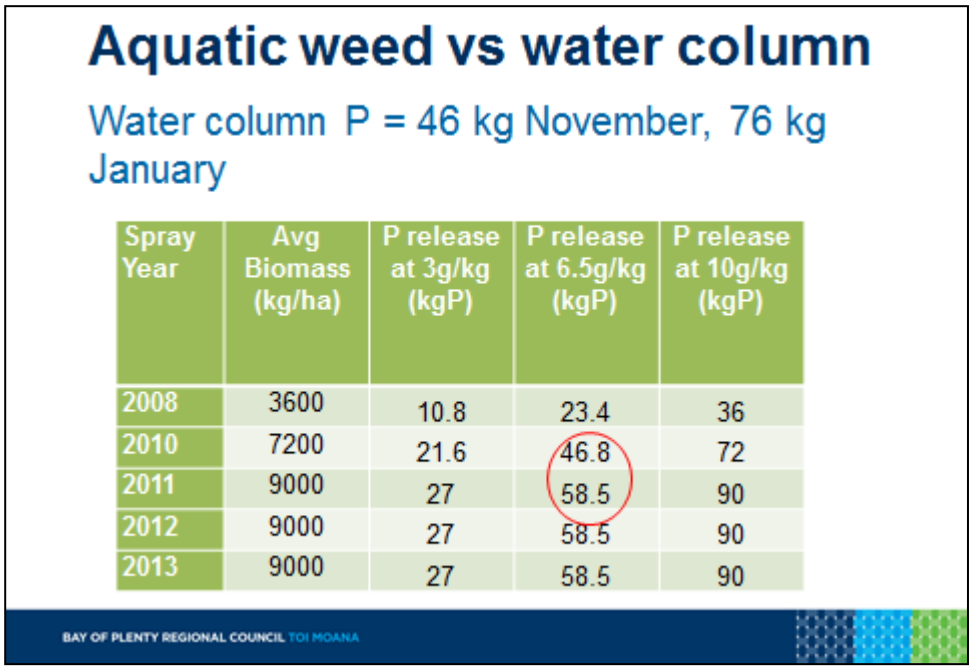
Slide 10 is some recent work by Clive Howard Williams and Bob Spiegl of NIWA at Lake Benmore. It shows that decomposition nutrients took around 84 days to be released into the water column in that system and probably most was released in the first 20 days.

What does that mean for Okawa Bay?
During the Diquat spray and potential release period, the biomass of algae increased slowly. **Slide 11** graphs the use of Aqual P treatment by helicopter to address the phosphorus and shows that it impacted slightly on the bloom at that stage. Conversely a similar treatment in 2014 using alum did not have the same effect, but that might be a result of timing and product.

Slide 11



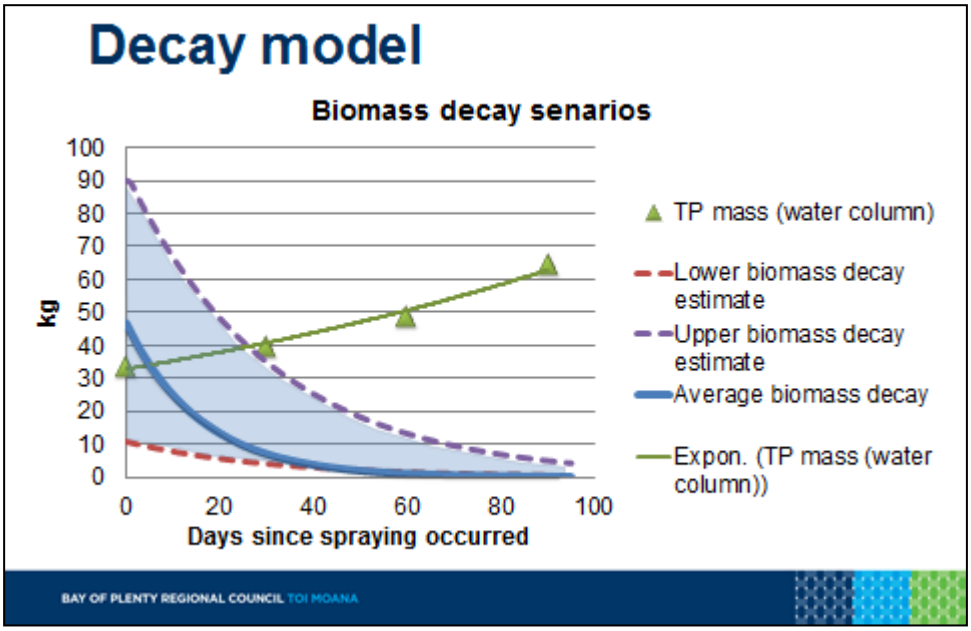
Slide 12



Slide12 shows a scenario of the estimated nutrient contribution from weeds compared to the water column phosphorus. A picture emerges of the possible nutrient contribution from 2½ hectares of weed mass compared with that existing in the water column, and it does not look like an inconsiderable amount.

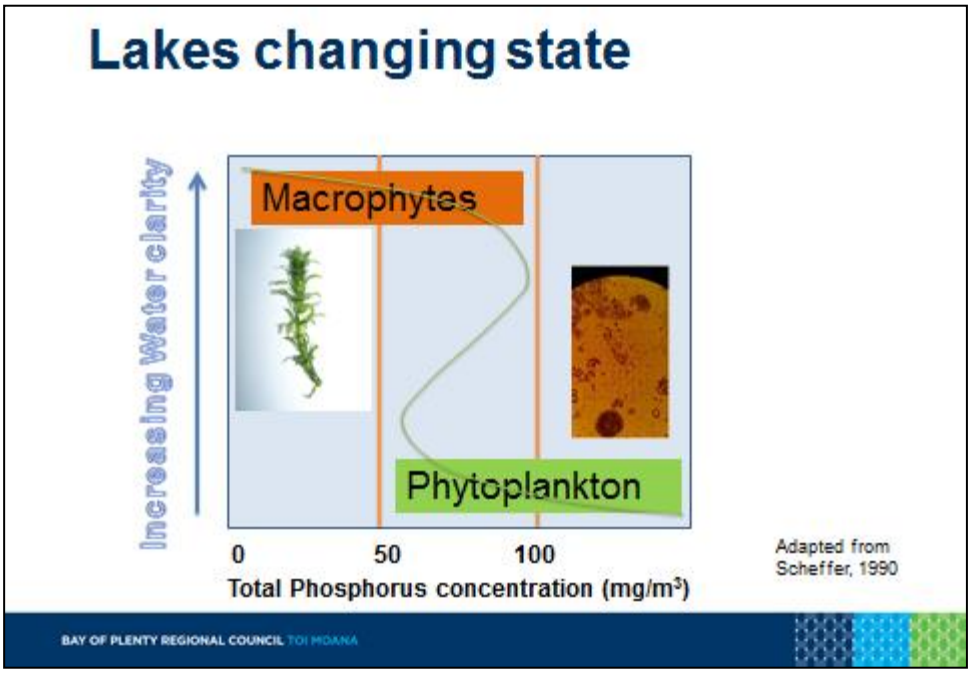
Looking at a model of those limits we can estimate an upper and lower limit and also look at the increase of the summer phosphorus in the water column. **Slide 13** shows phosphorus in kilograms versus days since aquatic weed were sprayed. The water column for phosphorus mass is shown to increase as the plant decay biomass occurs, using the example of 84 days of decomposition that NIWA found. Looking at that relationship of increasing phosphorus, it is very similar to a mid-range of that decreasing biomass nutrient, in this case the phosphorus.

Slide 13



What does that mean for our management implications?
The spraying programme has introduced nutrients into the water column, coinciding with conditions when algae do best in the height of summer. **Slide 14** indicates the lake's changing state swinging from a macrophyte dominated system to a phytoplankton dominated one. With no spraying over the last 2 summers and a very steady warm summer, a bloom has not occurred to date (early March 2015), although it is just starting to pick up.

Slide 14



Looking towards the future we know that herbicide application can impact the trophic state of the lake depending on the situation. That is not necessarily so for some lakes, but **Slide 15** shows the recent example of how much hornwort can accumulate in Okawa Bay in a season.

Slide 15

There are probably two opposing drivers affecting management options. The need to supress algal blooms and increase water clarity, which in turn increases macrophyte growth. A lake management dilemma.

Some possible management methods for aquatic weeds are the use of alternative herbicides and changes to the time of year of application. There has been some mechanical weed management in Okawa Bay, but there are other potential management options which might include biological control, shading, and dredging.