An Ecological Perspective on 'Undisturbed' Lake Catchments in the Rotorua District

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William has been a practicing ecologist for more than 30 years, based in Rotorua for most of that time, with nearly 20 years in his current role. He has spent a lot of time on and around the lakes, for work and recreation. His wide portfolio of experience across New Zealand includes ecosystem and species restoration, assessments of environmental effects, natural area surveys, and assessments of ecological significance. He has particular expertise in ecological restoration and the assessment of land use effects, having undertaken assessments of environmental effects for a very wide range of land uses. Previous experience includes science roles with the Department of Conservation and Forest Research Institute of New Zealand, many years of field-based ecological survey work, and tertiary level teaching. He is the author of more than 500 reports, papers, sets of technical evidence, and articles.

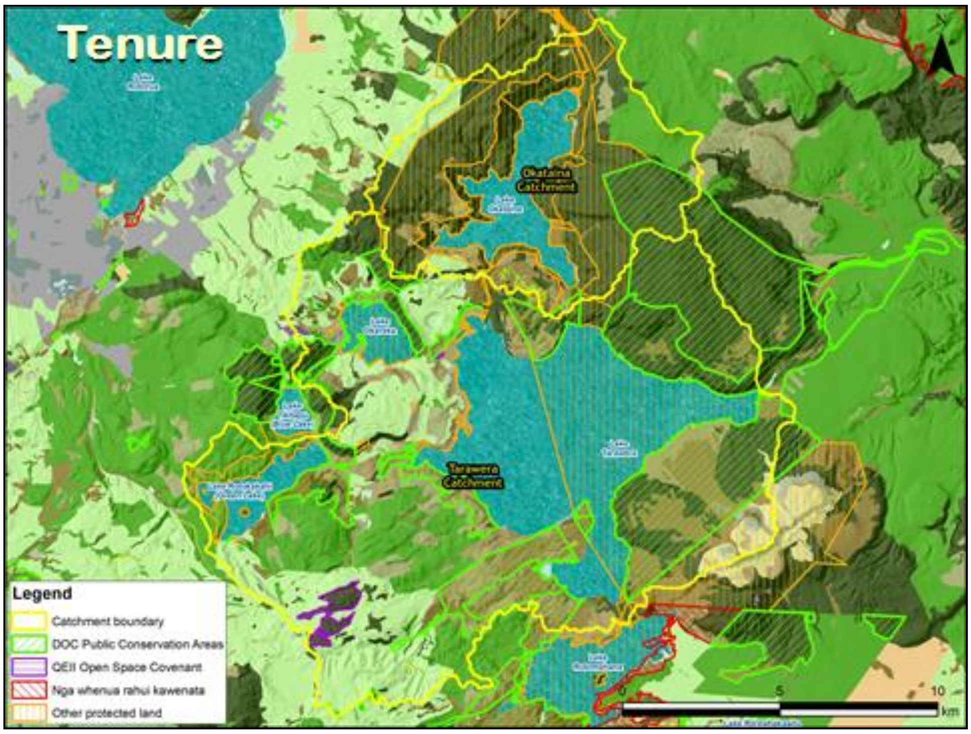
ABSTRACT
There is currently concern about trends in water quality in some lakes in largely natural catchments. Various potential contributing causes are under consideration, including pest animals, such as wallabies, and pest plants. This presentation provides an overview of aspects of ecological history and processes at work in the catchments of selected lakes. By necessity, this is largely an historical analysis, but this provides important background for current trends, and also to understand landscape-level processes. The effects of potentially threatening influences, such as pest plants and animals, need to be evaluated within various contexts, including landscape history, ongoing geomorphological change, human disturbance, vegetation dynamics, and the relative contributions of natural and human-induced changes.

TRANSCRIPT
This presentation is an overview of ecological processes in our lakes catchments, in relation to geology slope, soils, and vegetation history. I will briefly discuss current vegetation and habitats and then address pest animals, monitoring, and potential large scale sediment sources.

This is a photograph taken four days ago of Lake Ōkataina and this is how we picture our lakes: beautiful, natural, and unchanging stable systems. There is, however, quite a lot happening in this image: a fresh delta (due to recent sediment deposition), relatively recent landslides, and some kamahi dieback higher on the slopes.

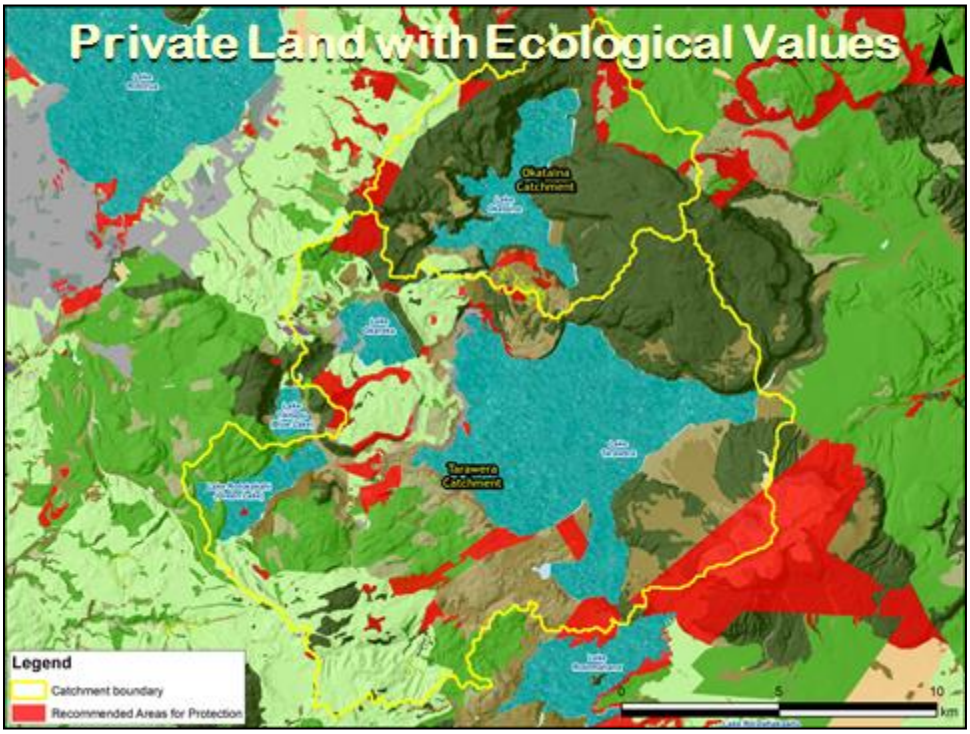
This is almost entirely secondary forest that has developed following fire, which has affected a large part of the Ōkataina catchment, with pohutukawa close to the lake shore.

Slide 1



Slide 1 shows the Ōkataina catchment which is largely Māori land, managed by the Department of Conservation. Large reserves also extend across Lake Tarawera and onto the slopes of the mountain, which is also Māori land. Large parts of the Ōkataina and Tarawera catchments are managed as protected land.

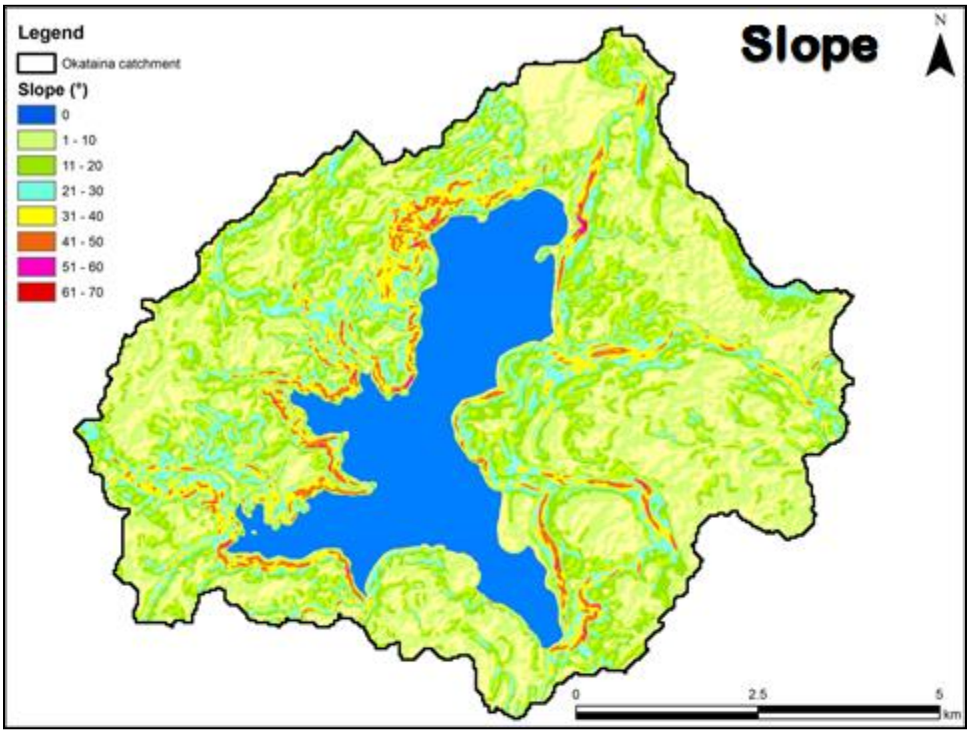
Slide 2



Considerable areas of land in Māori and private ownership have significant ecological values. **(Slide 2)**

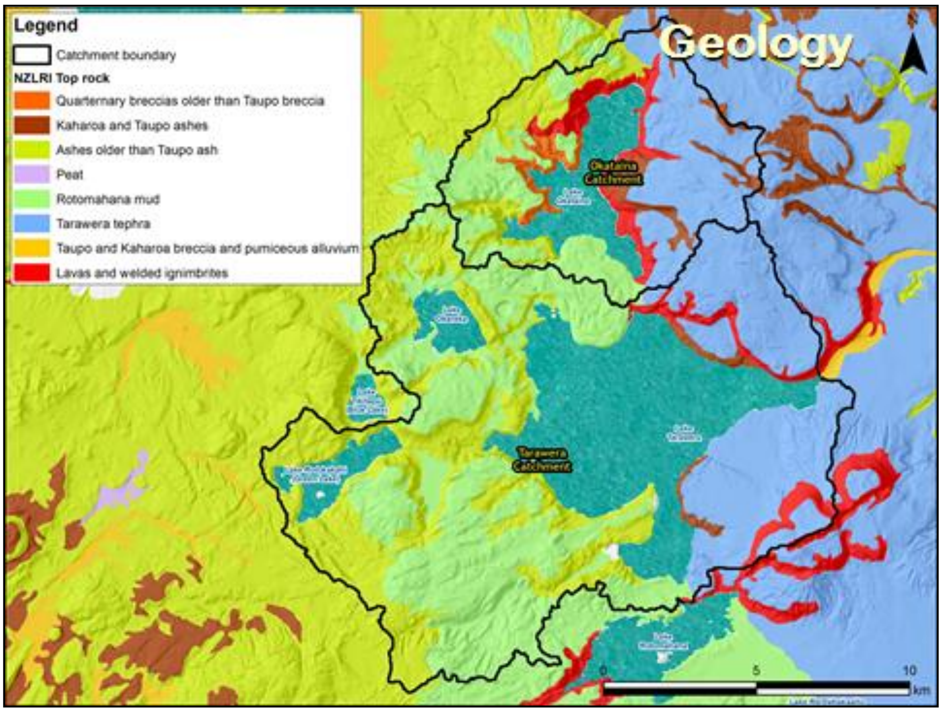
Topography, geology, and soils
Much of the Ōkataina catchment is very steep land, with more gentle slopes on the southern side of Makatiti Dome. Adjacent to the western shores the landform is very steep, especially close to the lake and even on the eastern shores, which I will discuss further later in this presentation. **(Slide 3)**

Slide 3



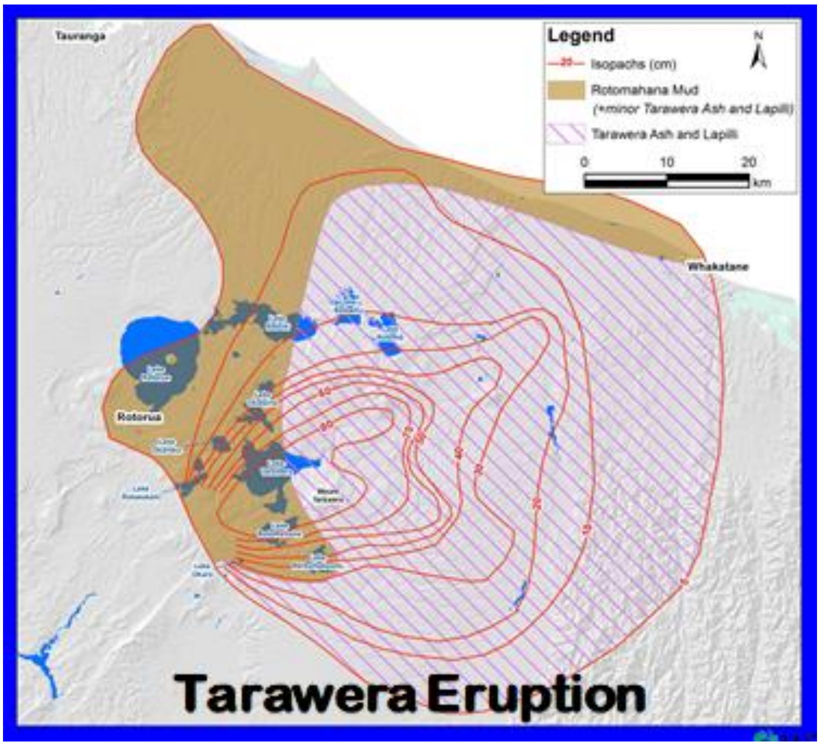
The fundamental picture is that the underlying geology is entirely volcanic, with large areas of tephra, much of which has originated from recent volcanic activity. This has important implications when combined with steep terrain. (**Slide 4)**

Slide 4



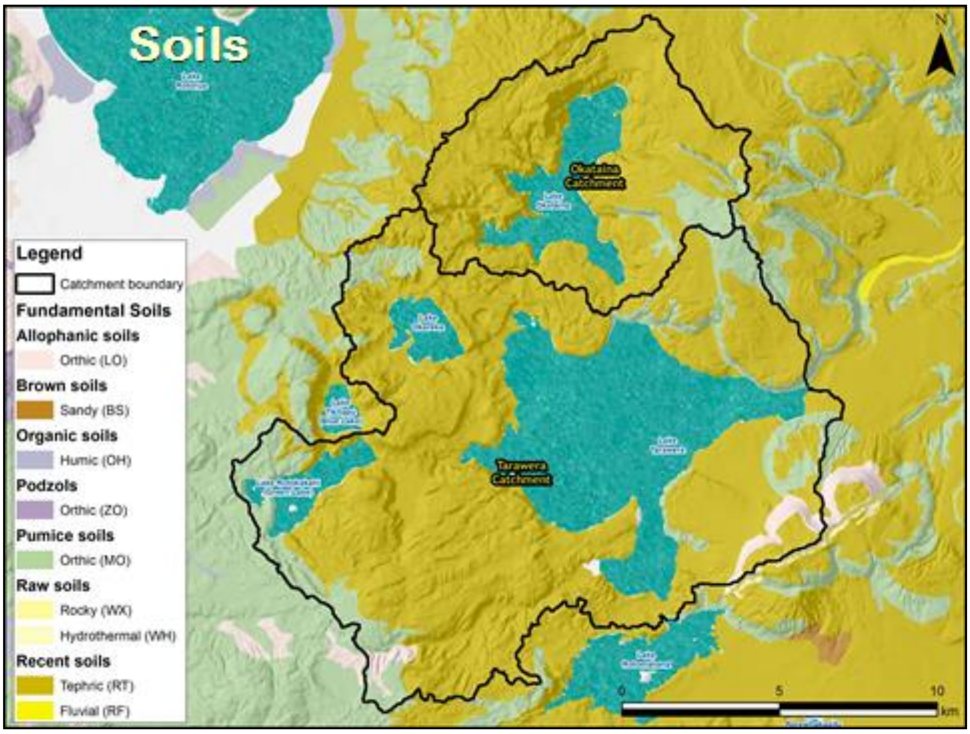
Slide 5 Shows the tephra isopachs from the Tarawera eruption in 1886. The Ōkataina area has quite deep layers of recent material and a sizeable footprint of Rotomāhana mud. Admittedly this latter material is relatively shallow, especially with increasing distance from the eruptive centre. The Tarawera eruption destroyed the indigenous forest cover relatively close to the mountain but the impact lessened dramatically with increasing distance from the eruptive centre.

Slide 5



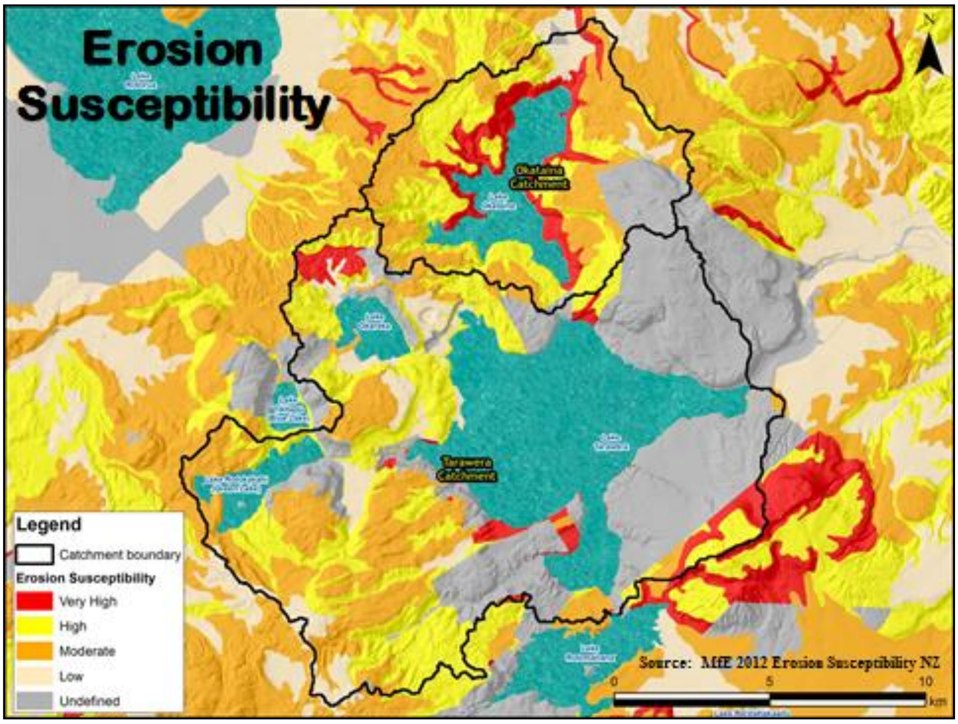
Slide 6 shows that the soils are almost entirely recent unconsolidated tephric soils.

Slide 6



The Ministry for the Environment Erosion Susceptibility map shows that Ōkataina has very high erosion susceptibility, with highly erodible substrates around the lake shores and on adjacent steep slopes. **Slide 7**

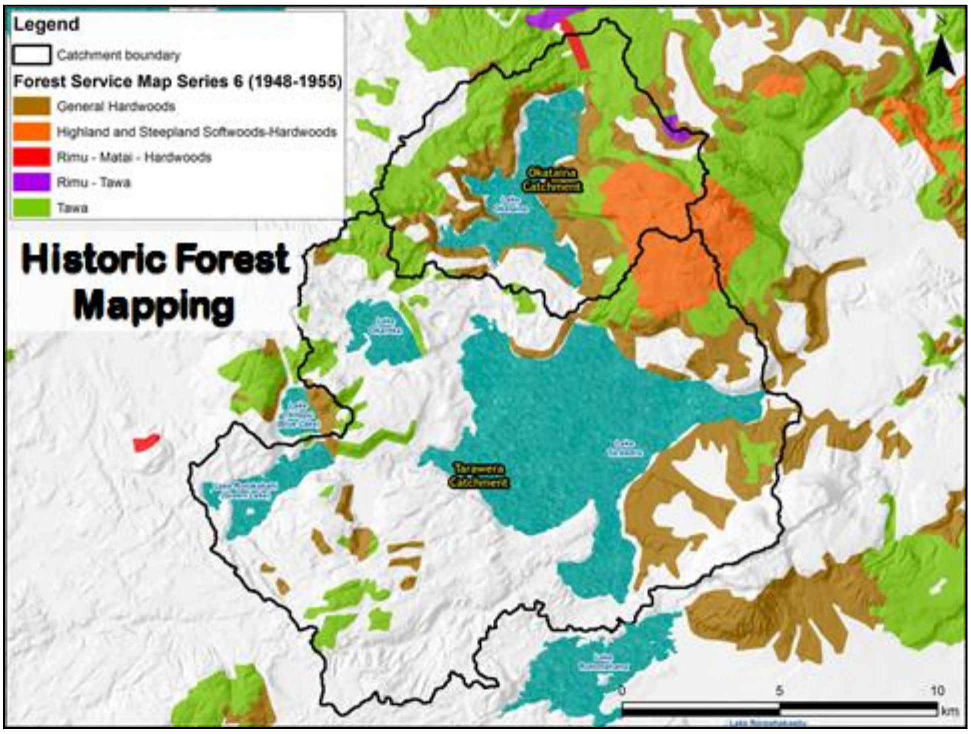
Slide 7



Vegetation pattern

Slide 8 The now somewhat historic Forest Research Institute (New Zealand Forest Service) forest class map shows forest a forest cover across all of this erodible substrate, which makes it look very ‘natural’. I intentionally used this old map as it was compiled using aerial photography from the 1940s and 50s. The area of higher altitude forest on Makatiti Dome is of extremely high ecological value. The tract of tawa-dominant forest at lower altitude, which would have once covered most of the balance of the catchment, had already been logged by the 40s and 50s. Its classification as tawa-dominant, rather than podocarp/tawa, is due to the selective removal of podocarps by logging (and possibly crown fires in places). There has been a lot of logging activity in this catchment and logging tracks are now evident in many places within tawa-dominant forest. The general hardwood zone near the lake is secondary forest originating largely from fire. Overall this is quite a modified landscape with a heavy imprint of human activity across the catchment.

Slide 8

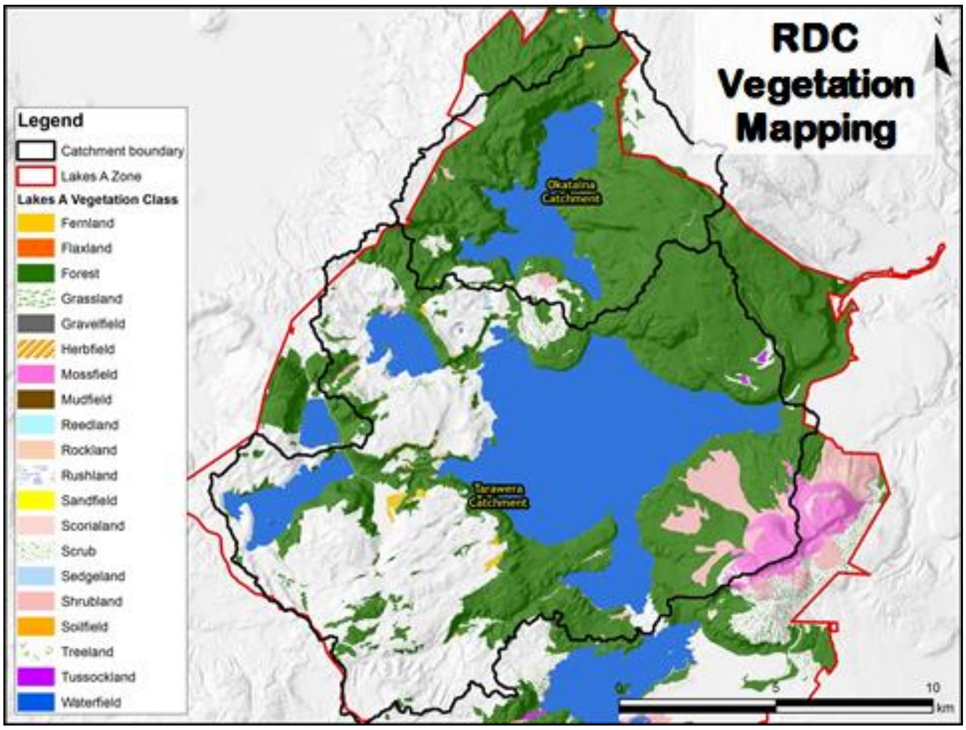


Slide 9 (over) is a more recent map which shows clearly that most of the catchment is currently covered in forest. Several hundred vegetation types have been mapped within the Ōkataina and Tarawera catchments but at a broad scale it is a relatively simple forest pattern with three key classes: highland forest, tawa-dominant forest, which has largely been logged, and secondary forest that has developed following fire.

Pest animals and monitoring

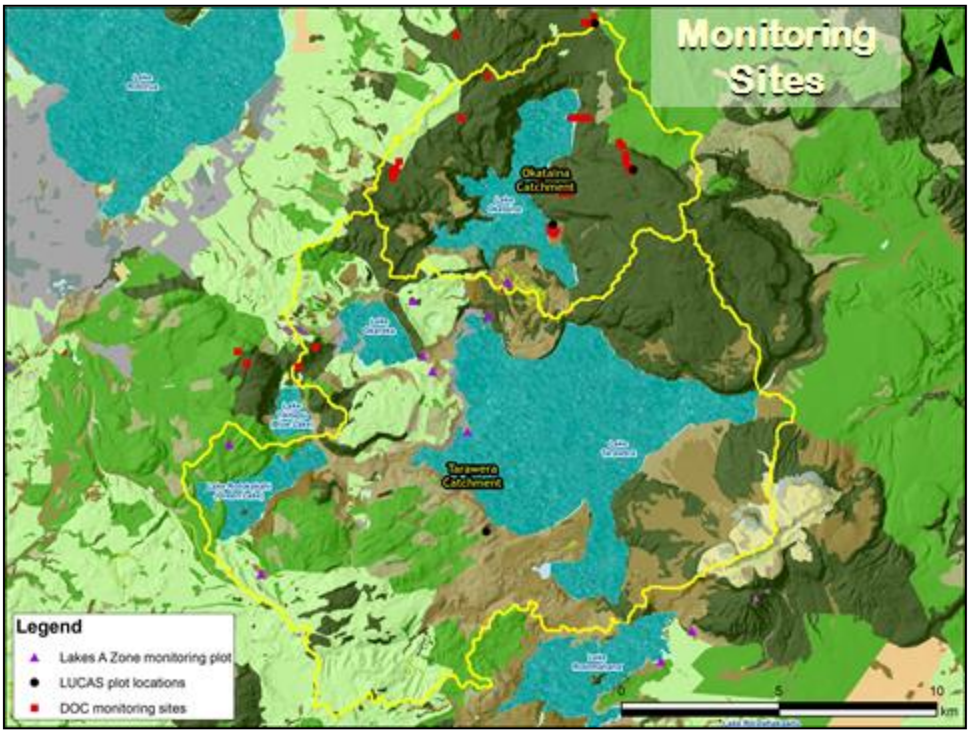
There are deer, wallabies, and possums present in these catchments and all have been present for about a century. The particular effects of each of these species vary by vegetation type. Wallaby effects are generally greatest in drier secondary forest, i.e. the kānuka-dominant forest. Possum effects are greatest for pohutukawa, rata, kamahi, and tōtara. Deer effects are pervasive but there are only very low numbers in these catchments. Wallabies, possums, and deer are all significant ecological threats, but do they significantly exacerbate sediment loss in this environment in their current numbers? This is unlikely but we have little data to support this opinion.

Slide 9



Monitoring started in the 1980s, mostly focused on the animal effects on vegetation. It was initiated by the New Zealand Forest Service, looking in particular at wallaby impacts. The Department of Conservation undertook vegetation plot remeasurements at Ōkataina in 1995. The Department also funded a PhD study through the University of Waikato in 2001 and assessed pohutukawa condition in 2004 (and earlier). Bay of Plenty Regional Council remeasured vegetation plots at Ōkataina in 2007. Department of Conservation carried out walk-through assessments in 2007/08 and there are DOC LUCAS 20 × 20 metre permanent monitoring plots, and exclosures. There are also some vegetation plots in both the Ōkataina and Tarawera catchments which were established as part of work done for Rotorua District Council in the Lakes A Zone.

Slide 10

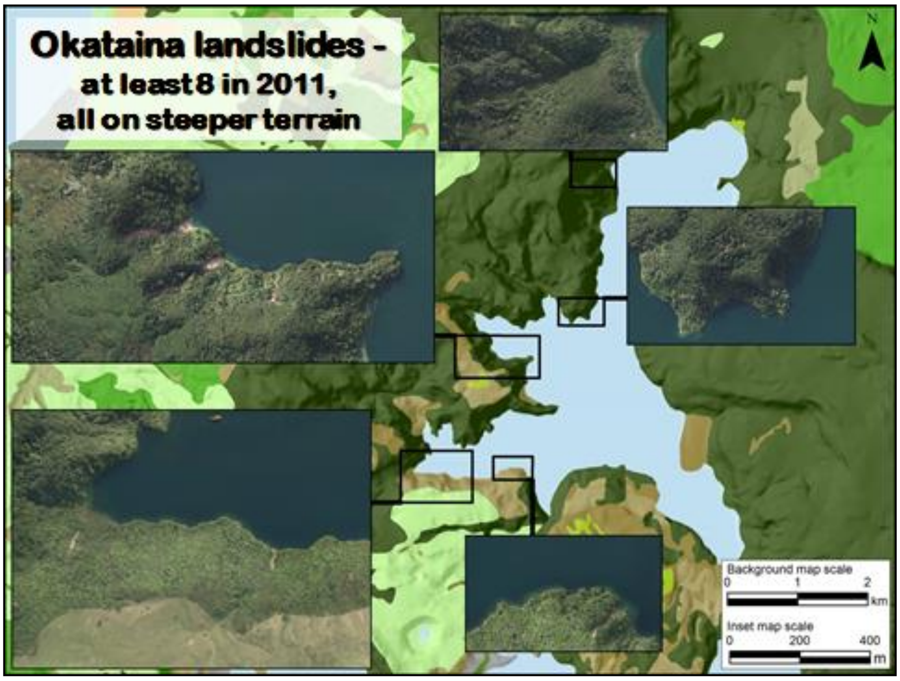


So there is quite a lot of information available and **Slide 10** shows the locations of those plots, which are scattered through the Ōkataina catchment.

Key factors and processes
To reiterate, this is a dynamic recent volcanic landscape, with a volcanic basal geology, steep slopes in parts of the catchment, and with erodible soils. Vegetation cover varies in composition and condition and reflects the impacts of reasonably large scale human modification by fires and logging. Pest animals are also playing an important role in terms of vegetation condition.

But what else is going on? Key stakeholders are currently very concerned about Ōkataina and particularly the potential effects of pest animals. While they are an ecological threat, there are, however, other potential large scale sources of sediment, such as mass movement (landslides) and lakeshore erosion.

Slide 11



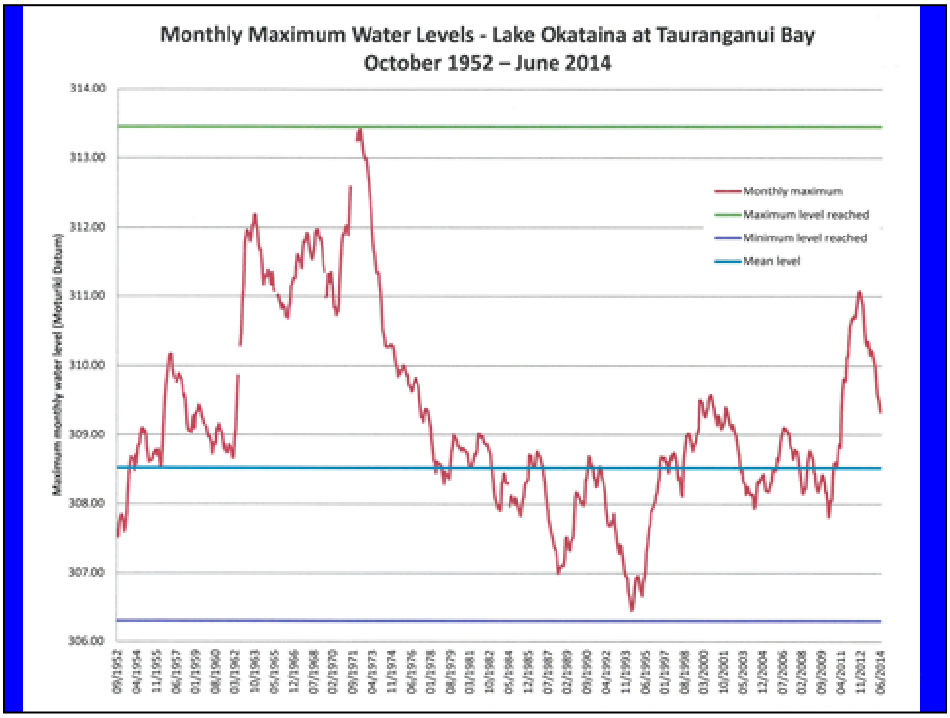
Slide 11 shows that in 2011 alone there were at least eight landslides, all on steeper terrain at Ōkataina and some slid directly into the lake. I have not had time to look at the weather records to see whether there were related weather events, but the landslides were probably triggered by a major weather event.

What about shoreline dynamics? What happens to the shoreline when the lake levels rise and fall? We must consider both of these processes and especially when they happen relatively rapidly. What about other influences such as wind, especially when combined with high lake levels?

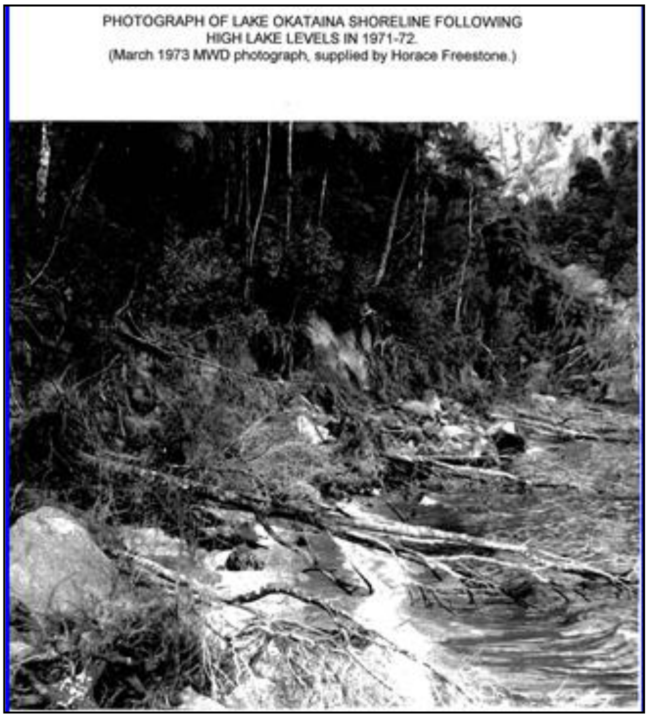
Key parameters for Lake Ōkataina

The lake shoreline is 30.3 kilometres and the lake has no natural outlet. In that sense it is similar to Lakes Rotomā and Rotoehu as their levels also fluctuate relative to rainfall patterns (and their shorelines are also mostly unconsolidated material).

Slide 12



Slide 12 is a plot of lake levels for Ōkataina over the last 62 years, and is very interesting. The lake level peak in 1956/57 was regarded as being a really high peak in some of our lakes. There were much higher peaks following that though, particularly in 1971/72, with a very steep slope on the lake level plot for that event. The lake obviously rose relatively rapidly over quite a period of time and there was then probably a major event which rapidly pushed the lake level up to a very high level. In 2012, only three years ago, the lake attained the highest level recorded since 1972.



The overall natural range recorded over the last 62 years is seven metres, which is huge, and is about the same as the natural range for Lake Waikaremoana (where I have worked for many years monitoring shoreline vegetation processes for Genesis Energy).

This is a photograph of the Lake Ōkataina shoreline in 1973 following the high lake levels in 1971/72. It should be noted that the lake level shown in this image is about two metres lower than the lake reached at the peak of that high level event. This degree of shoreline collapse is not unusual; in fact it is what I call 'business as usual' for a soft-shore lake margin. It can look ugly when it happens but this is what happens on these lakes and is a natural process.

Key lake level effects on margins
There are two types of effects on lake margins related to high level events:

- Inundation of vegetation and related mortality as a result of intolerance of submergence by the vegetation affected.
- Erosion of the soft shorelines.

Vegetation dynamics relative to lake levels are summarised in a short paper by Roger Cameron in 1957 who studied high lake level effects at Rotomā. You will recall the peak shown in **Slide 12** on the lake level graph for 1956/57, which was not really that high, but the Rotomā margin was submerged and forest died there during that summer. Cameron cored those trees and found that they were about 45 to 50 years old. There were larger trees of 200-300 years old but these were *c*.0.6 of a metre above the 1956 flood level and he considered that the 1956 lake level was the highest since an even higher flood in 1905 or earlier. There was no indication of higher floods in recent centuries. It is notable that only 0.6 of a metre above the trees that died in 1956/57 Cameron found the shoreline vegetation to be quite stable. We now know that within 20 years of that high level on Rotomā there was a far higher level at Ōkataina.

Lake shore erosion is affected by wind-driven waves and occurs at all lake levels but the effects are obviously more pronounced during high level events. Saturated and wave-undercut banks can collapse when the lake levels drop. There may be no wind and bank collapse effects might result from the rise and fall of the lake (and associated saturation of bank sediments). If there are windy conditions, however, when the level is high, and the wind comes from different points of the compass then up to 100% of the shoreline could potentially be affected by wind action combined with high lake levels, exacerbating shoreline erosion.

How much sediment goes into the lake when levels rise and fall?
In my view a lot of sediment will enter the lake during high lake level events, but we do not know how much. Most of the Ōkataina shoreline is erodible and the worst case scenario is that most of the shoreline could collapse or erode. I have not measured the length of the beaches but out of the 30 kms of shoreline there would only be a few kilometres at most of beaches, which can also erode. This means that even modest shoreline erosion/ collapse could contribute thousands of tonnes of sediment per episode. Even being quite conservative, large events could be very significant in terms of sediment input to the lake.

Conclusion
What are the key take home messages? This is a dynamic volcanic landscape with an overlay of quite major human-induced effects even though the catchments outwardly look very natural. The system appears stable but it is nevertheless subject to ongoing significant disturbance. We need to understand how the system is operating and the relative significance of different components and processes over time. It is critical to understand how this is happening and also what is happening over time. We only have records of lake levels for the last 62 years, which is a short time period in terms of catchment history. Pest animals are definitely a significant ecological threat. Numbers do fluctuate but they have to some degree been a constant influence in the system for at least a century. We must not underestimate the potential effects of weather pattern and

extreme events on erosion, both on the shoreline and in the wider contributing catchment, even in a fully forested natural catchment.