Session Three : The Toolbox

CHAIR – Dr Clive Howard-Williams, Freshwater and Estuaries, NIWA

PURPOSE OF WEED HARVESTING

Dr Fleur Matheson
Aquatic Biogeochemist, NIWA, Hamilton
Fleur.Matheson@niwa.co.nz

Fleur is an Aquatic Biogeochemist with over 13 years' experience in aquatic plant research. During this time she has worked in both freshwater and estuarine ecosystems. Research interests include environmental effects assessment of lake weed control methods, lake weed biosecurity management and surveillance, instream plant and nutrient guidelines, effects of wastewater treatment plant discharges on instream aquatic ecology and the ecology and rehabilitation of seagrass.

ABSTRACT
Harvesting is one potential option to control nuisance growths of lake weeds. Mechanical harvester units can typically remove lake weed to 2-3m below the water surface. Yet common weed species in NZ lakes often grow to deeper depths, so typically only the upper canopy of large weed beds can be removed with this technique. Nevertheless, harvesting can be a useful tool to reduce weed abundance in sensitive areas (e.g. boat ramps, beaches), or from areas where it is likely to detach and form drifting rafts that interfere with various recreational or commercial interests. It is not a suitable option for weed control in areas where weed fragments generated by the harvesting activity pose a biosecurity risk. For example, in areas where an infestation of a new weed has been found or the weed has a limited distribution within the lake. Most New Zealand lake weed species can grow vegetatively from fragments broken off the main weed bed. Even small fragments (<1-2cm length) can remain viable for long periods of time if kept wet.

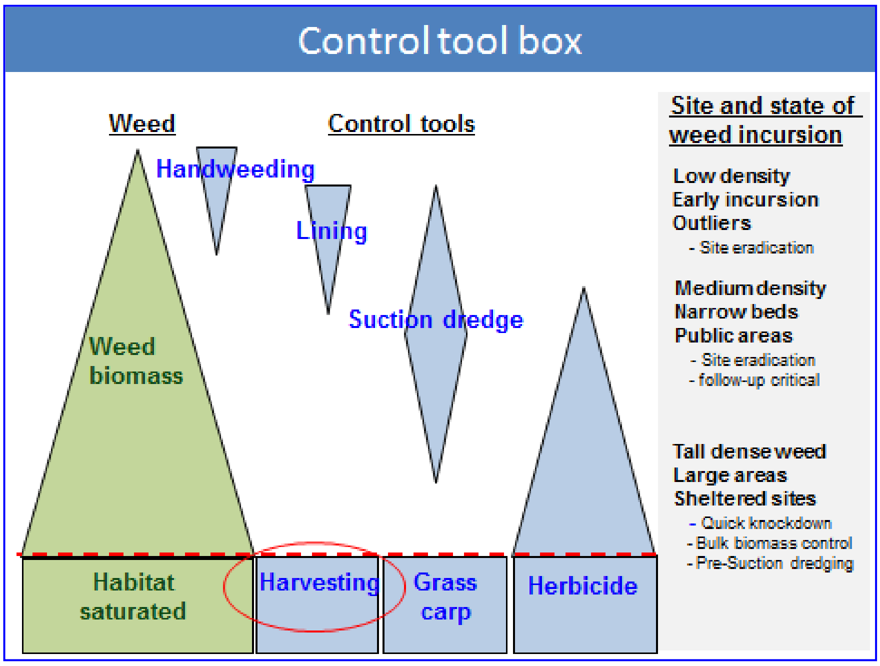
In areas where harvesting units can operate efficiently (e.g. sheltered sites without underwater obstacles), large quantities of weed can conceivably be removed which may benefit lake water quality or offset nutrient inputs from the catchment through removal of nutrients that have been assimilated into the plants as they grow. However, potential downsides of harvesting, particularly where it is done on a large scale, include the kill of fish and other biota trapped in the weed bed at the time of harvest, removal of habitat and flipping of the lake ecosystem to an algal dominated state. Disposal of harvested weed can also be problematic. Lake weeds often bioaccumulate contaminants (e.g. arsenic) that render them unsuitable for use as a compost or stock feed. In lake disposal via pulverizing and/or deep water discharge of negatively buoyant material is a much cheaper option than ferrying harvested weed to shore for transport to an onshore disposal site but is not a suitable option for situations where removal of lake nutrients assimilated into weed is desired. A final consideration is the movement of harvester units between lakes or other waterbodies and any potential biosecurity risks that this raises. A number of New Zealand's worst lake weeds (e.g. hornwort) currently have a limited distribution so ensuring that fragments of such weeds are not inadvertently introduced into a new location by a harvesting unit is paramount. Units must be thoroughly decontaminated before being moved.

This talk will expand upon the general concepts outlined above and provide relevant examples as appropriate for the Rotorua Te Arawa Lakes.

TRANSCRIPT

Harvesting is one of a number of control tools available for the management of lake weeds and selection of an appropriate weed control tool is usually dictated in the first instance by the amount of weed biomass that is present. This paper focuses on harvesting, as circled in the lower part of the diagram, which is, more specifically, large scale mechanical harvesting. (**Slide 1**) This is one of several weed control tools that are appropriate for situations where there is a large and extensive area of weed biomass requiring ongoing management and there is no risk that the weed will be spread further within the lake by the control operation.

Slide 1

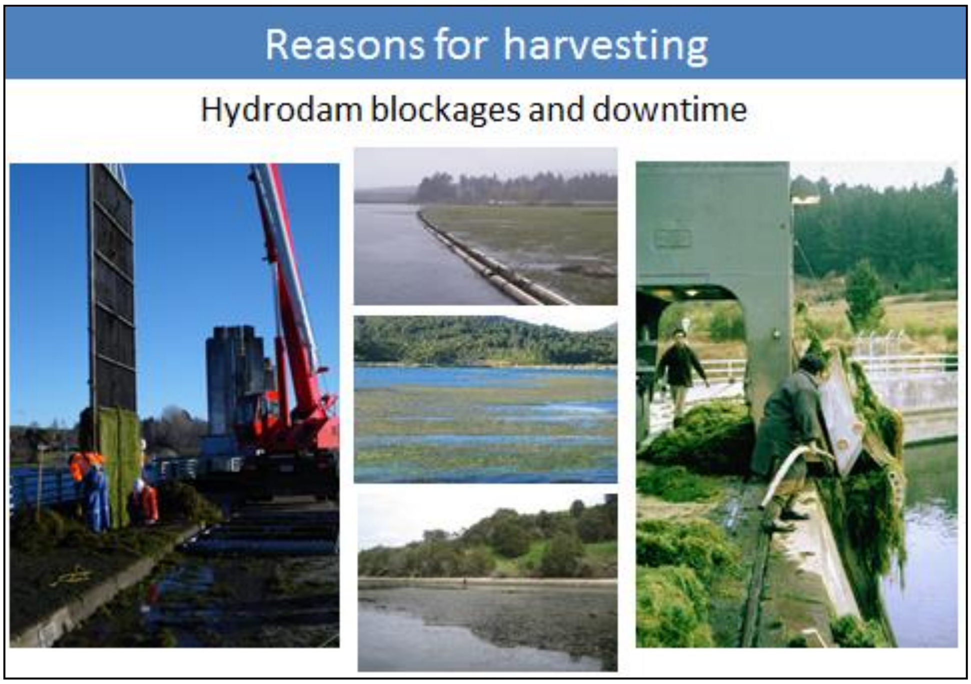


Slide 2

Mechanical harvesting or other large scale weed control operations are typically set up in response to weed having detrimental effects on important lake values, and a key value is lake aesthetics. Weed beds growing close to shore or detached weeds washed up and rotting on shore can have a major impact in areas of high public use. Large weed beds can also be a major nuisance or hazard in areas used for water activities and are particularly hazardous for swimmers. **(Slide 2)**

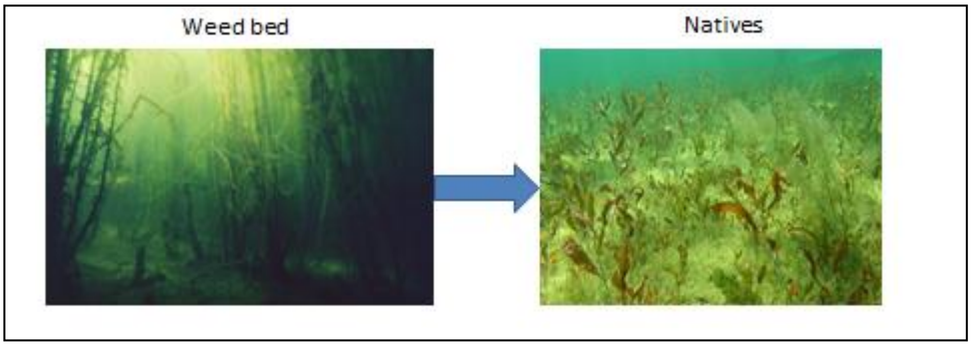
Slide 3 Weeds are also a major problem in hydro lakes used for power generation. Weed biomass dislodged from growing areas can drift and block dam screens leading to costly station downtime. The weed hornwort is particularly problematic in these lakes as it is more easily dislodged than other species due to having no true roots. In the Waikato hydro lakes mechanical harvesting is one of the number of tools that have been used to manage weed biomass.

Slide 3



Slide 4 Dense weed beds are not only a problem for humans, they also create hazardous conditions for lake biota. Large fluctuations in dissolved oxygen levels occur in dense weed beds, which is a problem for fish. Removing weed biomass can therefore improve this situation and may also allow some native plant recovery, particularly if weed is harvested close to the sediment level. Removal of dense weed can also make these areas more accessible to fish and other wildlife.

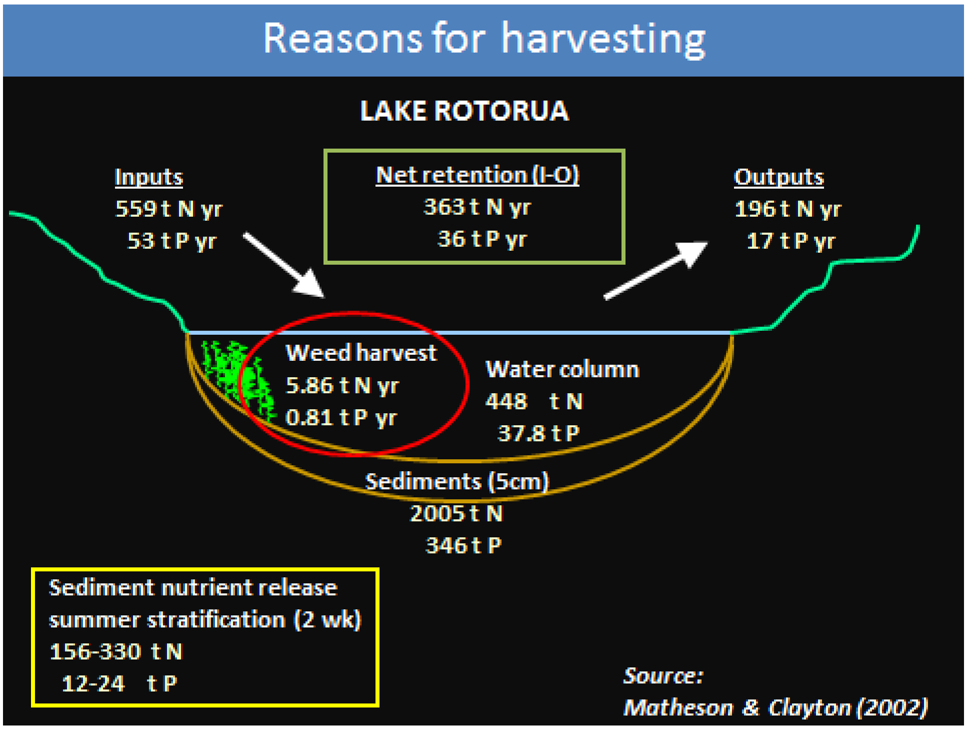
Slide 4



A final reason to harvest which is unique to this particular control tool is nutrient removal. Aquatic plants take out nutrients from lake water and sediments as they grow, so harvesting and removal of these plants from the lake simultaneously removes the nutrient that has been assimilated into the plant tissues. In theory this might improve lake water quality; if the quantity of nutrients that can be removed over time is sufficiently large that the water column and sediment nutrient pools from which the plants assimilate the nutrients start to reduce. The feasibility of this approach needs to be assessed on a case by case basis. But it is usually done by comparing the quantity of nutrients likely to be removed by harvesting within the context of an overall lake nutrient budget. While some studies have shown that an amount of nutrient equivalent to a high proportion of the nutrient inputs to the lake can be removed by harvesting, measureable improvements in water quality have only rarely been documented.

About a decade ago we estimated the amount of nitrogen and phosphorus that could potentially be removed by a harvesting operation in the Rotorua Te Arawa Lakes. This was in relation to lake nutrient budgets using the best information that was available at that time. The key harvesting parameters used in those estimates were a harvesting rate of 0.5 hectare per day, sufficient weed for a year round operation, which was 130 hectares of weed, and the volume of weed removed annually was just over 3,200 tonnes on a wet weight basis.[1]

Slide 5



Slide 5 Thus for all of the lakes where there was potentially sufficient weed for harvest our estimates indicated that the quantity of nutrients that could be removed was very small when viewed as a component of a wider lake nutrient budget. Therefore it was unlikely to affect water column nutrient concentrations and improve lake water quality. The example shown in the slide is Lake Rotorua, where the amount of nitrogen that was estimated to be contained in just the top 5cm of the lake sediments was around 2,000 tonnes, with around

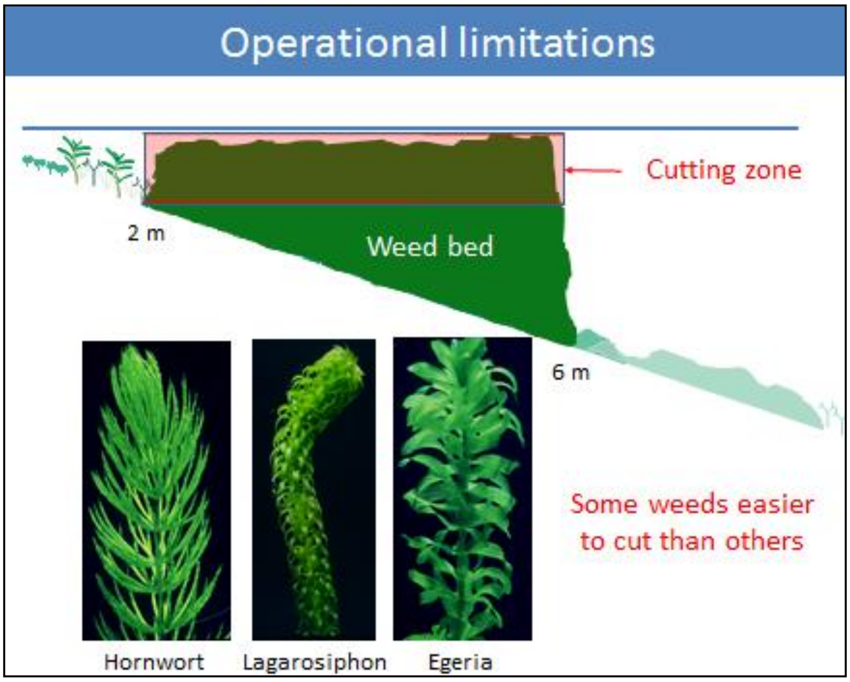
[1] Matheson, F., Clayton, J. (2002). Aquatic plant harvesting in lakes for nutrient renovation. *Report for BOPRC.*

450 tonnes in the water column. Annual net retention (i.e. the difference between inputs and outputs) of around 360 tonnes, and by comparison the amount of nitrogen that might be removed annually by weed harvesting is less than 6 tonnes.

There are a number of reasons for setting up a mechanical harvesting operation, but there are also a number of operational limitations that need to be kept in mind when planning such an operation. **Slide 6** A key limitation is that harvesters can generally only cut weeds to about 2 metres below the water surface, although the development of some very large models used in the USA (such as the Kelpin) have extended this depth range to around 3 metres. Harvesters generally move quite slowly, only slightly more than walking speed and have a relatively limited capacity for storage of harvested weed before unloading is required. On the plus side they are highly manoeuvrable and they can operate in very shallow water.

Slide 6

Slide 7

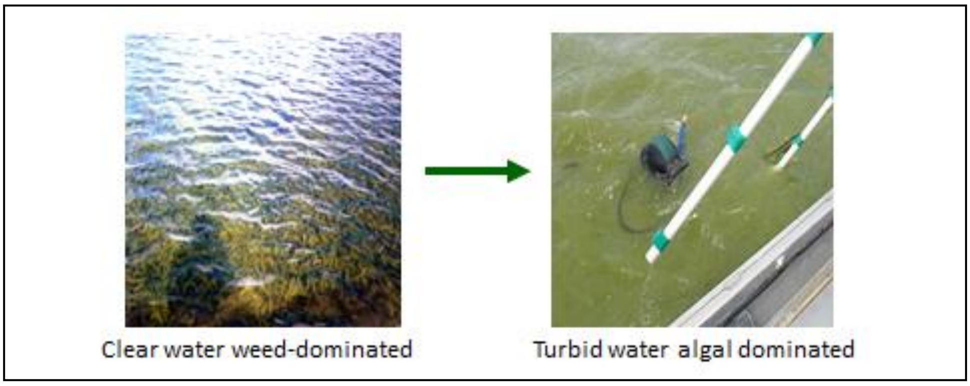


Slide 7 Since the cutting zone of a harvester is usually restricted to the top 2 metres of water column the greatest quantities of weed will usually be removed when the weed is dense and surface reaching. However very dense weeds can sometimes be quite difficult to harvest. In trials in the 1990s, two different harvesters on Lake Rotorua could not cut the dense surface reaching mats of egeria that were present at that time. In contrast, hornwort growths are less dense and appear to be much easier to cut which is demonstrated by the successful harvesting operations in Lake Rotoehu and in the Waikato hydro lakes where this weed is dominant.

There are a number of other operational limitations that also warrant consideration. There must be a suitable access point to launch the harvester and the weed drop off point needs to be close to the work area otherwise much time may be spent travelling to offload the harvested weed unless a transporting barge is also used. Harvesting units can struggle to operate effectively in strong winds and currents. Underwater obstacles and uneven bottom contours can be a problem for operation in shallow water. Weed beds and their growth rates are often variable from year to year so there may be insufficient weed to warrant harvesting in some years but bumper crops that regrow really rapidly in others.

There are also a number of potential ecological impacts that must be weighed up on a case by case basis against the benefits of a harvesting operation. There is usually a bycatch associated with weed harvesting operations. Despite the noise of the machinery some biota are unable to escape and removal of large areas of weed might also result in loss of habitat and cover for some species. Harvesting large areas of weed, particularly in shallow water, can destabilise sediments leading to increased turbidity or nutrient release encouraging a shift away from a macrophyte dominated clear water lake to an algal dominated turbid water state. **(Slide 8)**

Slide 8



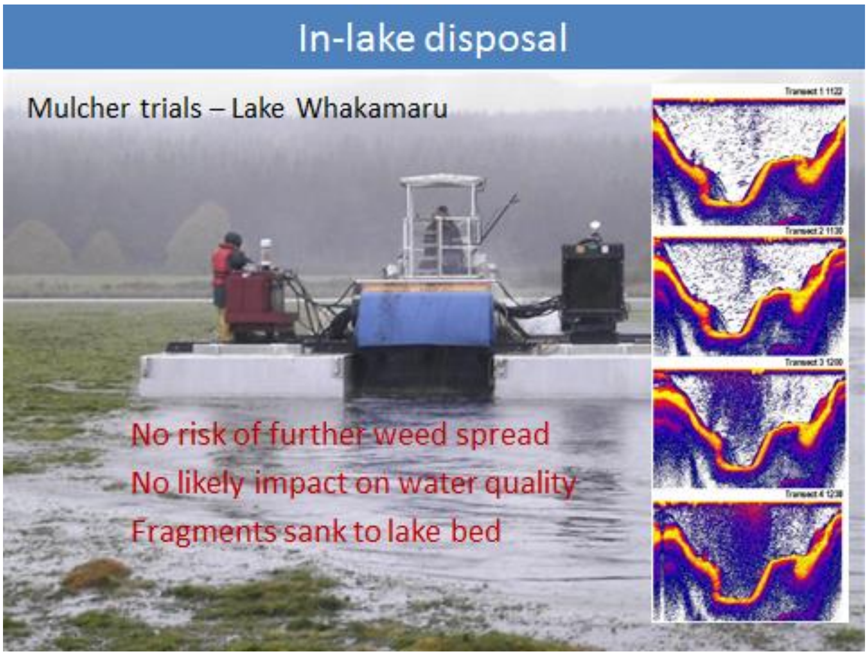
Delving further into the issue of bycatch, overseas research suggests that the amount of bycatch is variable but it some cases it can be large, up to 27,000 fish per acre harvested in one particular study. The amount of bycatch depends on the species that are present in the lake, the location and the timing of the harvest and on the density of weed. A high bycatch is more likely with harvesting close to shore, in dense surface reaching weed and during the spawning season.

Slide 9 Disposal of harvested weed can be problematic and expensive. There are a number of potential options for disposal either in lake or on shore. Transporting weed to shore for disposal can be time consuming and expensive especially if the harvester is operating a long way from the drop off point. So in-lake disposal is therefore an attractive option and suitable in situations where discharge of the processed weed material back into the lake would not have any adverse environmental effects.

Slide 9

An example of in-lake disposal is the mulching of harvested hornwort in the Waikato hydro lakes. In this system hornwort is wide spread, so its habitat is saturated. Theoretical calculations and field tests have shown that the discharge of the harvested weed as mulch fragments back into the water does not have any significant impact on water quality. This is because the quantity of nutrients released from the mulched weed is insignificant compared to the large flux of nutrient that moves through the flowing waters of this system. Concern was expressed about floating weed fragments in the water and fragments being washed up on the shore from the mulching operation. However field trials showed that the mulched fragments were negatively buoyant sinking through the water column and depositing on the lake bed. **Slide 10** shows these sonar profiles run at the time of the trial.

Slide 10

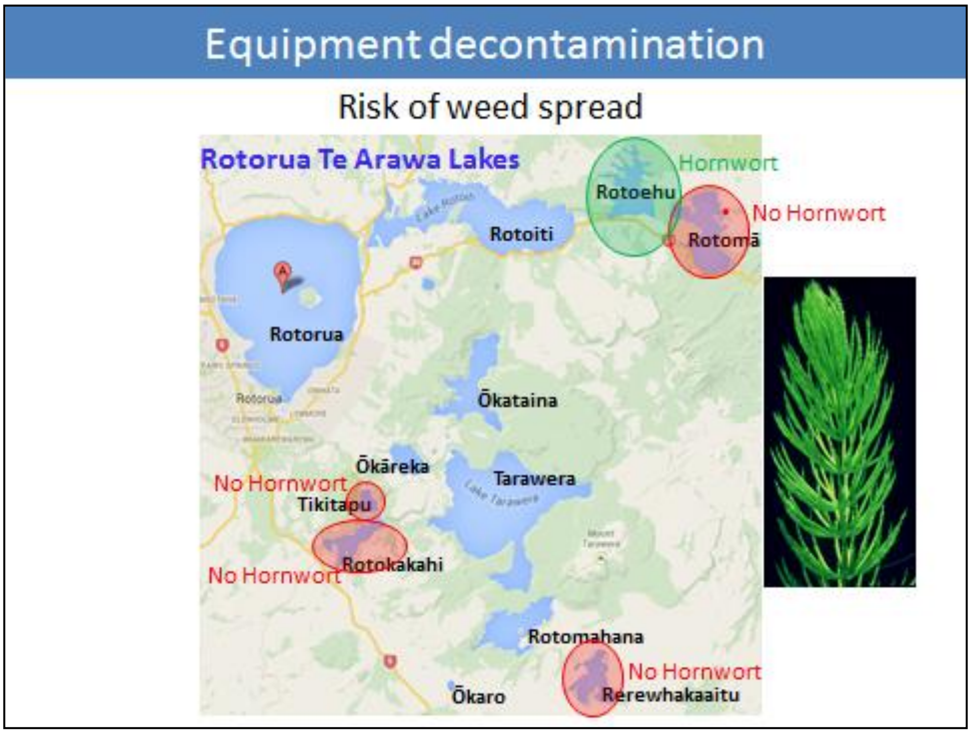


Deep water disposal of weed works on a similar principle in that the material discharged at depth will be negatively buoyant and sink to the lake bed. In the case of unmulched weed that is because the gas spaces within the weed are increasingly compressed by pressure as water depth increases.

For onshore disposal of weed, particularly for use of material as a compost or stock feed, consideration needs to be given to the high water content of the weed and any potential contaminants contained within it. Arsenic, heavy metals and pesticides are of particular concern especially where there are geothermal inputs or industrial, rural or urban discharges. Studies in the Waikato River and Lake Rotoehu have shown that the dominant weeds there contain elevated concentrations of arsenic. However work done by Scion and the Te Arawa Lakes Trust trialling Lake Rotoehu hornwort and vermiculture has shown these concentrations are diluted to acceptable levels if blended with pulp mill solids.

In Lake Horowhenua the suitability of two other lake weed species for use in stock feed compost or vermiculture has also recently been investigated. This work has shown that the unaugmented weed presents some risk if incorporated into stock feed due to elevated arsenic levels in some of the weed. There are also likely to be substantial costs involved in processing the aquatic weed into a pellet form that could be consumed by sheep and cattle. However the concentrations of other contaminants in this weed were generally low therefore indicating that the harvested weed from this lake is probably safe to use in compost or vermiculture.

A final point about all machinery used in these operations is the need for great care to be taken when this machinery is used elsewhere. For example with the current harvesting programme of hornwort on Lake Rotoehu underway; Lake Rotoma, adjacent to it, but also Lakes Tikitapu, Rotokakahi and Rerewhakaaitu do not have hornwort, so any use of the harvester or the associated machinery in those catchments poses a risk to those lakes. **(Slide 11)**



Slide 11

Although it is not the main target of the harvesting operation in Rotoehu, the weed lagarosiphon is also present, but it is not present in Lakes Rotokakahi or Rotomahana. It is unlikely that the harvesting machinery used in Rotoehu would be used in any of these lakes, but it is important that such threats are always recognised and best management practice is that all harvesting equipment is thoroughly decontaminated before being used in any other water body.

In conclusion, mechanical harvesting is a useful tool for ongoing management of extensive areas of lake weed. It is not a quick or complete fix to the problem, it is slow and only the upper parts of the weed beds are typically removed. Measureable improvements in water quality associated with harvesting operations are rare, and bycatch can potentially be significant; this needs to be assessed and managed on a case by case basis. Disposal and use of the harvested weed onshore is a major challenge and the equipment used needs to be thoroughly decontaminated before use elsewhere.