Annex B: Overview of the rationale for the weed harvesting activity.

Lake weed harvesting was one of the many recommendations of the Horizons & NIWA reports on restoration options for Lake Horowhenua that were incorporated into the Lake Horowhenua Accord, the Lake Accord Action Plan and the Fresh Start for Freshwater Clean-up Fund project for Lake Horowhenua.

Lake Horowhenua is a hypertrophic lake that had a mean trophic level index (TLI) of 6.4 for the 2013-14 year. The lake develops high ammonia concentrations in spring/summer and cyanobacteria blooms in summer.

The lake has two main species of aquatic macrophytes (weeds) – *Potamogeton crispus* (curly-leaf pondweed) and *Elodea canadensis* (Canadian pond weed). Although both weeds are exotic invasive species, they have very different life/growth cycles. *Elodea* is a perennial plant with a clumping growth form. It develops a dense weed bed that eventually reaches the surface. Although the plants flower they do set seed and propagation is entirely from small fragments broken off the surface reaching stems. In contrast, *Potamogeton* is an annual plant that grows from propagules (turions) shed by the mature plants before they die in summer. The propagules germinate in autumn (April –May) and overwinter as low growing plants. In spring these plantlets grow rapidly to reach the water surface. In summer, they flower and produce turions which fall to the lake bed to produce the next year's plants. In mid-summer the mature plants die and collapse onto the lake bed where their decomposition causes anoxia and the release of phosphorus (P) from the sediment beneath the decomposing plant matter.

The weed harvesting operation is viewed as the key project within the overall restoration programme for Lake Horowhenua. Weed harvesting is to be undertaken in the lake to directly break a cycle that is occurring where the introduced lake weed is altering the chemistry of the lake by increasing the pH of the water, lowering the nitrogen concentration and enabling the chemistry to become favourable for phosphorus release from the sediment into the lake. Increased phosphorus and low nitrogen conditions favour the growth of the cyanobacteria in the lake. Cyanobacteria in the lake can be toxic to humans and animals restricting the use of the lake for recreation. Cyanobacteria also impacts on aquatic life. The die off of some of the lake weed in summer also leads to low oxygen levels at the bed of the lake which makes conditions suitable for further release of phosphorus contributing to the cyanobacteria blooms.

The lake weeds influence on pH can also drive a further change in the chemistry of the lake leading to toxic levels of ammonia that can and do kill fish. In 2013/14, ammonia toxicity persisted for a period of several months in summer; however, ammonia toxicity was not observed in the 2014/15 season (according to monthly monitoring data up to January 2015). Figure 1 shows a schematic of the *Potamogeton* growth cycle including the impacts on the lake and how the weed harvesting programme aims to reduce these.

Harvesting the weed aims to reduce the weeds ability to change the pH of the lake as much as it currently does (i.e., less weed equals less photosynthesis) thereby creating conditions in the lake that are more favourable for fish and other aquatic life, including the native lake weeds. Harvesting the weed and managing the removal of the cut weed will reduce or eliminate the development of the high pH that can lead to phosphorus release from the sediment and ammonia toxicity. It will also reduce or eliminate the development of cyanobacteria blooms. Further it will remove part of the nutrient load from the lake. An overview of the weed extent in Lake Horowhenua at various times of the year is shown in Figure 2.

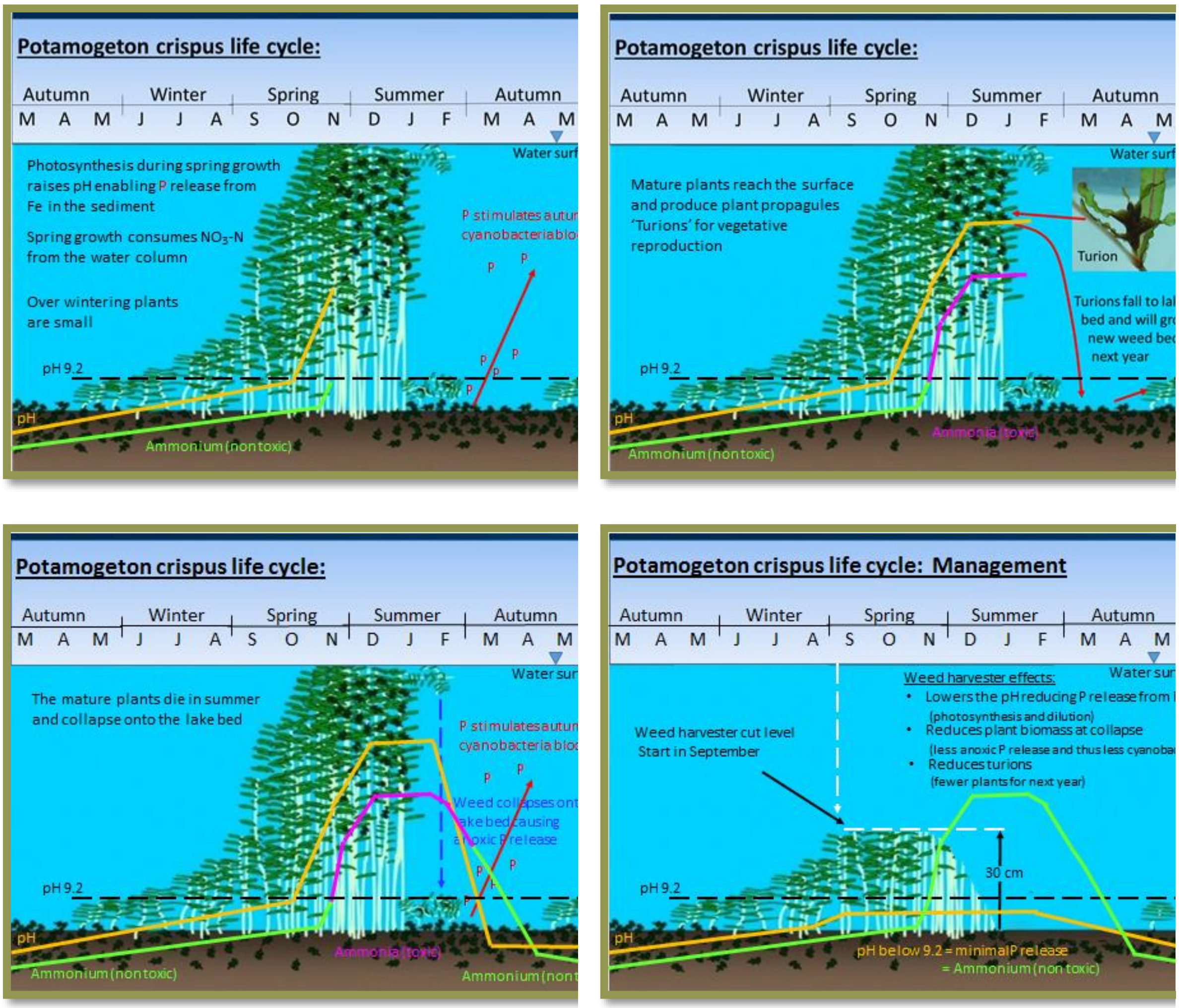

Figure 1: Schematic diagram showing the key parts of the *Potamogeton* life cycle (A) to (C) and the effect of mowing the tops off the weed beds (D).

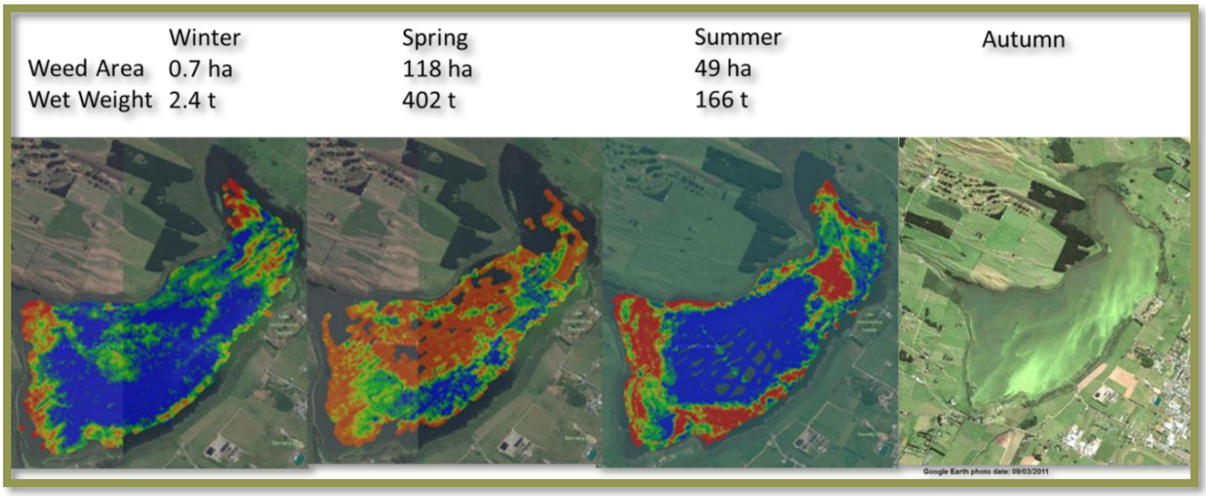

Figure 2: Compilation of three weed mapping surveys arranged to indicate the natural sequence of expansion and decline of the weed beds each year. Surveys are not in chronological order. Red represents 100 % weed cover per unit area and blue represents 0 %. Intermediate colours on a rainbow colour scale represent different percentage cover at those locations.