LakeSPI assessments for the lakes of the Ashburton River Basin

Lake Emma

NIWA Client Report: HAM2008-017
May 2008

NIWA Project: DOC08208

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Prepared for

Department of Conservation

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Executive Summary

NIWA was contracted by the Department of Conservation to survey the aquatic vegetation of eight lakes in the Ashburton River Basin using the LakeSPI method. LakeSPI (Submerged Plant Indicators) provides a score of overall lake condition, as well as a measure of the native character of the vegetation and the impact of any weeds present. Scores are given as a percentage of the potential maximum for a lake (100%). Scuba surveys of lake vegetation were undertaken in November 2007 and results compared to available data from previous investigations in 1982 and 2005. Results are presented for separate lake basins (i.e., Spider Lakes and Maori Lakes), with two lakes additionally investigated to give a total of eleven surveyed water bodies and including the majority of lakes present within the Ashburton River Basin.

For the four larger lakes, Lake Camp scored highest (58%), then Lake Clearwater (47%), Lake Heron (42%) and Lake Emma scored the lowest (37%). Scores strongly reflected the presence and level of impact by adventive weeds, mostly *Elodea canadensis* (Invasive Condition 36% - 69%). Nevertheless, diverse native plant communities were still present in all lakes to a varying extent (Native Condition 45% - 59%).

Maximum plant depth limits were not recorded in the shallow smaller lakes or lake groups, which were vegetated across the entire lake bed. Their LakeSPI scores ranged widely from 93% where native vegetation only was present (Lake Donne) to a default score of 0% where vegetation formed <10% cover (Maori Lake East). Intermediate scores reflected the varying impact of *E. canadensis* beds.

Comparisons of the 2007 scores with LakeSPI scores generated from historical data for Lakes Camp (61%), Clearwater (42%) and Heron (42%) showed little change over the last 25 years. Plant community composition and depth extent remained largely as described in 1982 (Tanner et al. 1985). This confirms a good baseline condition has been described against which future changes can be detected.

Compared nationally, the four larger lakes score within the upper third to two-thirds of values for 108 lakes, indicating they are amongst the more pristine, less impacted New Zealand water bodies. LakeSPI assessments for these larger lakes would be sensitive to any future deterioration in water clarity, or further introductions of freshwater pests. The smaller lakes represent varying botanical values with the Spider Lakes and Lake Donne having outstanding native vegetation representation and the presence of threatened species. While LakeSPI will not be such a sensitive measure for the smaller, shallower lakes, changes in community composition and cover of plants would signal changed condition.

We recommend LakeSPI reassessments at intervals of 5-10 years, or earlier if land-use changes or new weed invasions are of concern. We also recommend assessments of lake values (waterfowl, fish and

botanical) as well as identification of threats to these values and an assessment of the risk to each waterbody. The highest priority lakes for management should be those of high value that are in good condition (high LakeSPI scores, good water quality) but which are at risk from threats.

1. Introduction

The Ashburton Basin and associated lakes are recognised for their high diversity of wetland types, wildlife and plant communities typical of the complex glaciated terrain of the area. In recognition of the regions natural heritage value, the Ashburton Lakes were recently announced as one of three areas to receive targeted funding for wetland conservation. Concern over possible effects of declining water quality from increasing nutrient and sediment inputs into feeder catchments, and by invasive weeds and animal pests, led to this funding to protect the high conservation values of the sites. One particular stated aim is to work with the communities in the region to manage water quality at source and on surrounding private land to reduce the threats to the lakes. Monitoring of the condition of the lakes is likely to be one important action to track the outcome of protective measures.

Environment Canterbury currently monitor the water quality of four Ashburton Lakes (Heron, Clearwater, Camp and Emma) for Total Phosphorus, Total Nitrogen and Chlorophyll a, but do not include a measure for water clarity (Meredith 2005), which can be an important measure for catchment impacts upon lakes.

LakeSPI is an alternative and complimentary method to water quality analysis which uses Submerged Plant Indicators (SPI) to assess lake condition (Clayton and Edwards 2006). Submerged plants are particularly useful as indicators of long-term water clarity as they integrate the effects of the light climate for growth over time.

NIWA was contracted by DOC to assess eight Ashburton Basin lakes using LakeSPI so that assessments can be potentially used to:

- Monitor trends over time.
- Help assess the effectiveness of catchment and lake management initiatives.
- Assess and compare the ecological condition of different lakes within or between regions.
- Provide relevant information for regional and national reporting requirements.

This report presents current LakeSPI scores (sections 4.2 and 4.4), scores generated from historical data where possible (section 4.3), and an estimated pre-European or pristine score (Appendix 2). A brief description of vegetation features is given for the lakes (section 4.1 and 4.3), with summary survey information provided for reference (Appendix 1). LakeSPI results are compared with other lakes (section 5.1) and their use as indicators of lake condition is discussed (section 5.2). Vegetation values and threats to these values are considered for the area (section 5.3). Finally recommendations are presented on future monitoring needs and suggested frequency of these (Section 6).

2. LakeSPI Method

LakeSPI provides an insight into the native character and impact by invasive species for a lake, each of which is presented as a different index. A Native Condition Index provides a measure (score) of the diversity, quality and abundance of indigenous submerged vegetation. The Invasive Condition Index scores the impact by any of ten invasive alien plant species, if present (higher score = greater impact). These indices are also integrated into an overall lake index that allows for changes in lake condition to be monitored over time. Further information on LakeSPI can be found at www.lakespi.niwa.co.nz or the technical report and user manual at http://www.niwascience.co.nz/ncwr/tools/lakespi. An online LakeSPI webpage reporting system (www.lakespi.niwa.co.nz) enables ready access to results in a form suitable for lake monitoring purposes and trend reporting and it is anticipated that 'report cards' for the lakes of the Ashburton Basin will be added in time.

LakeSPI data is entered into the NIWA LakeSPI database which calculates the three indices. LakeSPI indices are then expressed as a percentage of their maximum (i.e., 100%) potential score (adjusted for lake depth) to enable direct comparisons of small, shallow water bodies with different lake types (e.g., larger, deeper ones). A 'pristine' condition can be estimated as what the lake would have scored in pre-European times, given the likely vegetation composition, water clarity and lake depth. LakeSPI surveys are not be suitable for lakes where vegetation cover does not exceed 10%, in which case a default score of 0% applies.

'Quick survey' data was also recorded according to the method of Clayton (1983), which included each species depth range, estimated covers (Braun-Blanquet scale, see Appendix 1) and heights (where greater than 0.1 m). Data will be entered to NIWA's Freshwater Biodata Information System (FBIS) and freely accessible over the internet (fbis.niwa.co.nz). Also recorded were amphibious turf plants observed on the lake shores immediately above the waterline, which at higher lake levels would have contributed to the diversity of the submerged vegetation.

Surveyed lakes included Heron, Clearwater, Camp, Emma, Denny, Emily, and the Maori and Spider lakes. Surveys were undertaken on 28th to 30th November 2007. At each lake or lake group, three to five baseline survey sites were selected as representative of the lake environment. Additional lakes (Roundabout and Donne) were investigated as time and circumstances allowed. At each site divers/snorkelers recorded relevant vegetation characteristics on data sheets. A full description of the vegetation features that are assessed for the LakeSPI method is found in the technical report and user manual on the web-reporting pages (www.lakespi.niwa.co.nz), and includes measures of diversity from the presence of key plant communities, the depth extent of vegetation and extent that invasive weeds are represented.

Historical data from submerged vegetation surveys of Lakes Heron, Clearwater and Camp in 1982 (Tanner et al. 1985) was also reviewed, towards generating past LakeSPI scores to detect changes over recent times. These three lakes and Lake Emma were briefly investigated at one site each during pest plant surveys for Environment Canterbury (Champion et al. 2006).

3. Site information

Characteristics of the surveyed lakes are given in Table 1, whilst relative size and location of the surveyed lakes is indicated on the map in Figure 1. Selection of survey sites per lake was made in reference to the Bathymetry Series for Lakes Clearwater and Camp, Lake Heron, and Lakes Emma, Roundabout and the Maori Lakes. In other lakes local topography was considered to guide site selection or an exploration was made across the entire lake bed at several sites.

Table 1: Summary of lake characteristics (from database described in Snelder 2006).

Lake	Area (km^2)	*Depth (m)	Altitude (m a.s.l.)	Catchment area	Native catchment (%)	Pasture catchment (%)
Heron	6.95	36.2	692.39	110.94	69	29
Clearwater	1.97	19	675	41.72	71	27
Emma	1.67	3	639.76	35.60	92	24
Camp	0.44	18.9	675.94	6.06	25	73
Emily	0.19	*2.3	674.31	2.41	17	82
Roundabout	0.12	1.7	658.81	8.62	16	75
Maori West	0.10	2.6	629.77	14.93	52	39
Maori East	0.09	1.2	626.83	83.55	15	73
Denny	0.05	*2.1	677.85	18.67	78	33
Spider	0.04	*0.8	671.07	2.03	34	44
Donne	0.01	*1.1	668.5	0.08	15	87

*Lake depths recorded in this survey

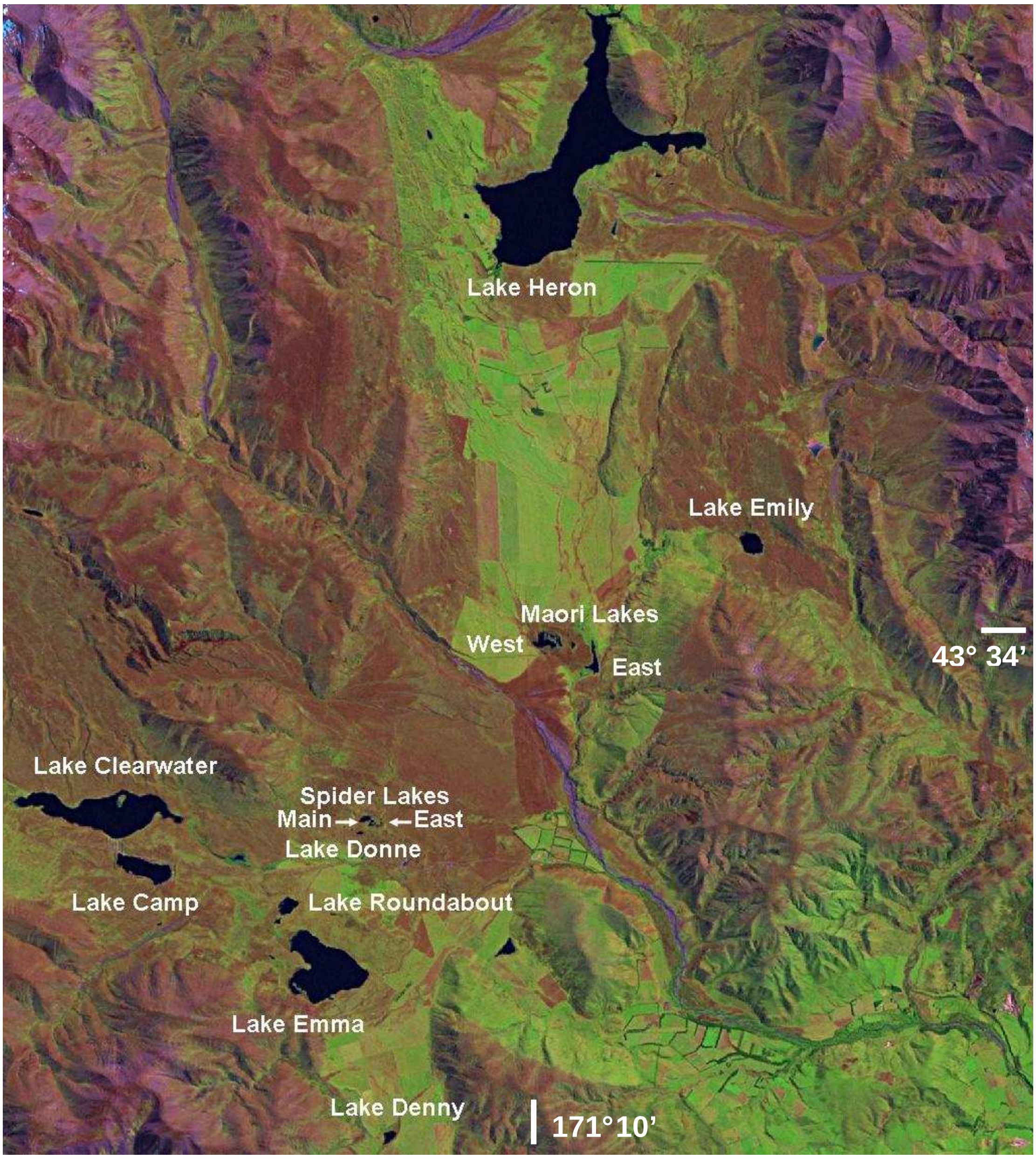

Figure 1: Location of surveyed lakes within the Ashburton River Basin.

4. Results

Lake results are presented as two groups; larger lakes (greater than 0.2 km^2) for which vegetation bottom limits could be established (Lakes Camp, Clearwater, Heron and Emma), and smaller, shallow lakes where vegetation was recorded across the entire lake bottom (Lakes Denny, Emily, Roundabout, Spider and Maori Lakes). This distinction is made because of the subsequent sensitivity of the LakeSPI method for indicating lake condition.

4.1 Vegetation description for the larger lakes

The submerged vegetation of Lakes Camp, Clearwater and Heron remains largely as described in 1982 (Tanner et al. 1985). Three depth-related plant communities were recognised that comprised a shallow-water assemblage of low growing plants, taller vascular plants in mid-depths, including the adventive weeds *Elodea canadensis* (elodea) and *Ranunculus trichophyllus*, and a charophyte understory that extended into deeper water (Appendix 1, Tables A-C). A shallow-water assemblage and tall vascular community were recorded in Lake Emma (Appendix 1, Table D), however the deeper charophyte community was absent, with charophytes contributing to the shallow-water assemblage only.

The maximum depth extent of vegetation in Lake Camp at 11.5 m depth was similar to the 10 m recorded in 1982. Likewise, depth limits in Lake Heron of 9.7 m were close to the 9 m recorded in 1982. In 1982 the plant depth limit for Lake Clearwater could not be established but were known to extend deeper than 4 m, and the 2007 survey established the maximum depth of vegetation to be 7 m deep. Much of the bed of Lake Emma was vegetated, however a plant limit of 2.8 m was established in the deepest basin of the lake. This restricted depth extent was in keeping with low water clarity observed at the time of the survey.

The adventive weed elodea formed localised clumps or bands of high cover (up to >95%) in all the lakes, but co-existence of native species was frequently possible over much of this weeds depth range due to gaps in the weed beds or ‘open canopy’ growth of low-growing beds (≤1.0 m tall). Impacts of elodea were least in Lake Camp due to a smaller depth range (1 to <5 m) and limited presence at only two of the five sites surveyed. Elodea had variable covers across a wider depth range in Lake Clearwater, but formed taller beds of up to 2 m in height. Elodea typically formed low-growing, but extensive beds within Lake Heron. Lake Emma exhibited the greatest elodea domination, with deeper parts (≥2 m depth) dominated by this weed.

The adventive water buttercup, *Ranunculus trichophyllus*, formed a minor component of vegetation in Lake Heron. This seed-spread plant was present and scored as occasional in Lakes Heron and Camp based on records from 1979 (Tanner et al. 1985) and was recorded in all four lakes by Champion et al. (2006).

All plant species that were recorded as abundant or common in Lakes Camp, Clearwater or Heron by Tanner et al. (1985) were also recorded in this survey. Omitted or newly recorded species since 1982 involve those of low frequency (≤50% of sites). Other differences result from the recognition of new endemic charophyte species within what was the *Nitella hookeri* taxa (Casanova et al. 2007), which prevent direct comparison of 1982 taxa to 2007 taxa (Appendix 1, Tables A-C). Therefore, new charophyte species listed for 2007 represent nomenclature changes, with the exception of first records for *N. leonhardii* in Lake Camp and *Chara globularis* in Lake Heron.

Results of a pest plant survey of the larger lakes in 2005 (Champion et al. 2006) also concluded little change in the composition of the vegetation since 1982, although plant depth limits were not attained in Lakes Camp and Clearwater. In 2005, Lake Emma was reported as turbid from an algal bloom and vegetation was described as sparse.

Plate 1: Tall vascular community in Lake Camp of *Potamogeton cheesemanii* (foreground) and elodea are observed to the left and deeper charophyte meadows to the right.

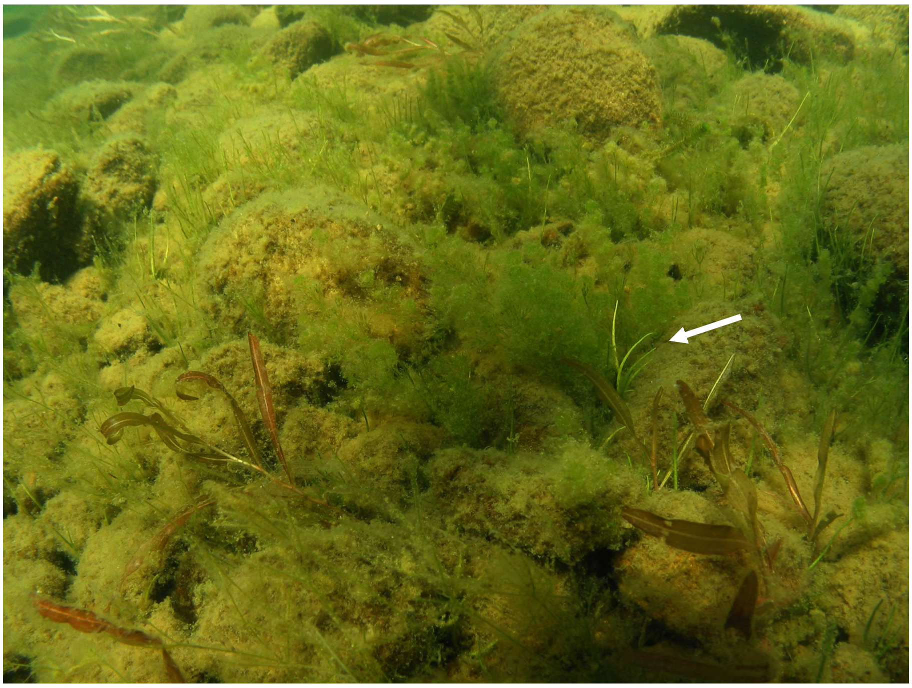

Plate 2: Low-growing plants within the shallow water zone in Lake Camp showing bright green cylindrical shoots of *Lilaeopsis ruthiana* (arrowed), and low stature charophytes and *Potamogeton cheesemanii (*reddish colour).

Plate 3: A diver examines a specimen charophyte (*Chara fibrosa*) from deep-water meadows at c. 7 m depth in Lake Camp.

4.2 LakeSPI for the larger lakes

LakeSPI results are listed in Table 2 and show lake condition decreased in order from Lake Camp, then Clearwater, and Heron to Lake Emma. Lake Camp scored the highest because of the extent of vegetation development (to 11.5 m), the diverse native vegetation present, and the limited impact of elodea. Interestingly, *Isoetes alpinus* was not recorded from Lake Camp currently, or historically. It is present in the other three lakes and, as a recognised 'key' native community, its presence contributes to their LakeSPI scores. The corresponding LakeSPI value of 58% was influenced by the highest Native Condition Index (59%) and lowest (best) Invasive Condition Index (36%) of these four lakes. In contrast, Lake Emma scored the lowest of the larger lakes (LakeSPI value of 37%) because of the prevalence of elodea and absence of deeper charophyte communities that it has likely replaced. Lakes Clearwater and Heron scored intermediate values.

Historic LakeSPI assessments based on the indicative surveys of 1982 suggest little change in the condition of Lakes Camp, Clearwater and Heron (Table 2). Lakes Heron and Camp score similar to identical values to those of 1982, whilst the apparent improvement in the condition of Lake Clearwater is likely to result from obtaining accurate plant depth limits in the 2007 survey.

Pre-European LakeSPI scores are estimated to have been close to the maximum possible, at 98% (Appendix 2).

Table 2: LakeSPI results for the four larger lakes where vegetation depth limits were established. Historic indices were generated from previous survey information (Tanner et al. 1985).

Lake	Date	LakeSPI	Native Condition	Invasive Condition
Camp	29/11/2007	58	59	36
	18/02/1982	61	57	30
Clearwater	29/11/2007	47	51	51
	18/02/1982*	42	40	45
Heron	28/11/2007	42	45	60
	18/02/1982	42	45	59
Emma	30/11/2007	37	45	69

* Plant depth limit not established

4.3 Vegetation description for the smaller lakes

The Spider Lake group of basins, including Lake Donne, were shallow (<1.5 m) and dominated by a mosaic of native, low-growing plants (Appendix 1, Tables E-G) as occurred in the shallow-water assemblage of the larger lakes The most frequent species were *Myriophyllum triphyllum*, *Potamogeton cheesemanii* and *Lilaeopsis ruthiana*. Adventive weeds elodea and *Ranunculus trichophyllus* were either absent (Lake Donne) or only occasional to common components of the vegetation. The rarer turf species *Montia angustifolia* and *Cardimine* 'tarn' were also recorded from the dry lake margins.

Lakes Emily, Denny, Roundabout and Maori Lake West all had largely monospecific beds of elodea that extended over considerable areas of the shallow lake bottom at 1.5 to 2.3 m depth (Appendix 1, Tables H-K). Swan grazing appeared to limit the height of these beds to 1 m below the lake surface. In Maori Lake West, Lakes Roundabout and Denny these weed beds contained isolated, often taller clumps of *Myriophyllum triphyllum*, whereas in Lake Emily low stature plants of *Potamogeton ochreatus* were found in intermittent holes within the elodea bed. Mixed assemblages of additional species could be found at the lake edges. Amongst low-growing species encountered in shallow water were localised growths dominated by *Isoetes alpinus* on the south-eastern side of Lake Emily, and the only lake record for *Utricularia dichotoma* in the surveyed lakes was recorded from Maori Lake West.

Plate 4: An assemblage of elodea (dark green), *Myriophyllum triphyllum* (with pink apices) and *Ranunculus limosella* (pale green, arrowed) growing at the shallow margins of Lake Denny.

Maori Lake East was largely devegetated with submerged plant covers not exceeding 10% (the threshold for LakeSPI assessments) except for a limited turf at one shallow margin (Appendix 1, Table L). Isolated fragments and occasional plants of elodea and *Potamogeton ochreatus* were observed across most of the lake bed.

4.4 LakeSPI for the smaller lakes

LakeSPI results are listed in Table 3 and show lake condition decreased in order from the Spider Lakes group, Maori Lake West, Lakes Roundabout and Emily to Lake Denny. A default value of 0% was recorded for Maori Lake East because vegetation did not exceed 10%.

The highest score was recorded for Lake Donne, because it had only native vegetation (Invasive Condition Score of 0%) extending over most of the bottom of this shallow lake, i.e. it achieved close to the maximum vegetation development expected for a lake of this type. The score for other Spider Lakes was reduced by the presence of adventive weeds (elodea and *R. trichophyllus*), although the impact on native vegetation was minor (Table 3).

LakeSPI scores dropped substantially (Table 3) for the smaller lakes with extensive elodea beds (Invasive Condition score >50%), reflecting the impacts of this invasive species. Although Maori Lake West still recorded a relatively high Native Condition score, with significant native plant representation despite the elodea beds.

Pre-European LakeSPI scores are likely to have been close to the maximum possible at 97% or more (Appendix 2).

Table 3: LakeSPI results for seven smaller lakes where vegetation depth limits were not established.

Lake	Date	LakeSPI	Native Condition	Invasive Condition
Donne	29/11/2007	93	82	0
Spider (Main and East)	29/11/2007	69	76	32
Maori West	29/11/2007	39	60	69
Roundabout	30/11/2007	35	43	72
Emily	30/11/2007	29	27	76
Denny	29/11/2007	26	18	74
Maori East	28/11/2007	0	0	0

5. Discussion

5.1 Condition of the Ashburton Lakes

An evaluation of the condition of high country Canterbury lakes based on submerged vegetation depth extent, species richness, and native species cover, was undertaken in 2004 towards assigning weed pest plant management priorities amongst the lakes (Champion et al. 2006). The four larger Ashburton Basin lakes were ranked in the same order as this report, with Lake Camp ranked as 5th best and Lake Emma ranked as the worst in condition out of 23 high country Canterbury lakes that were assessed (Champion et al. 2006).

LakeSPI scores confirm these larger Ashburton lakes remain relatively pristine and un-impacted compared to the condition of water bodies nationally. When plotted with recent LakeSPI results for 108 other lakes (Figure 2), Lake Camp (58%) scores higher than two-thirds of surveyed lakes, whilst Lake Emma (37%) scores better than one-third of lakes. The scores for these lakes lie within the top 50 percentile in terms of Native Condition, but also for Invasive Condition (Figure 2).

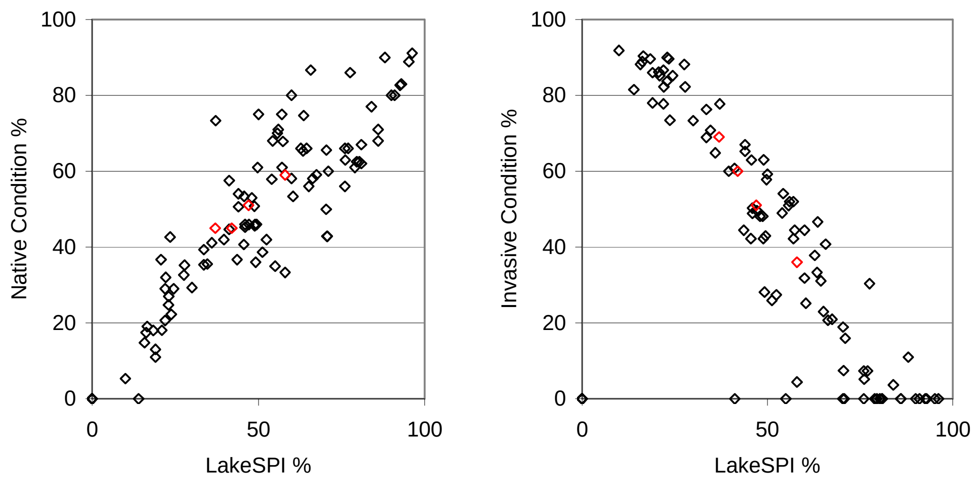

Figure 2: Plots of recent LakeSPI scores for 112 lakes (NIWA unpublished data), with the four larger Ashburton Lakes highlighted in red. Note 13 lakes with a default LakeSPI of 0% (insufficient vegetation) are not distinguishable in the plots.

Compared with other New Zealand lakes (Table 4), the larger Ashburton lakes score lower than waterbodies where extensive native vegetation predominates (e.g., Lake

Moke, Otago) or where elodea is only a minor component of the vegetation (e.g., Lake Mavora North, Fiordland). However, they score higher than waterbodies where elodea dominates and has largely replaced native vegetation (e.g., Lake Diamond, Otago), or where water clarity also strongly restricts vegetation presence (e.g., Lake Okaro, Rotorua). The presence of a more invasive weed species than elodea generally results in higher Invasive Condition scores and reduced LakeSPI scores for lakes. Highly turbid water bodies (>15 mg l^{-1} suspended solids) have limited vegetation, with a default LakeSPI score of 0% where plant covers do not exceed 10% (e.g., Lake Waahi, Waikato).

Table 4: Illustrative LakeSPI scores for water bodies of varying condition.

Lake	Type	Lake size	Lake depth (m)	LakeSPI	Native Condition	Invasive Condition
Moke	Predominantly native, good water clarity	0.81	44.2	78	72	12
Mavora North	Limited elodea, good water clarity	10.8	85	70	72	28
Diamond	Elodea dominated, moderate water clarity	1.8	13+	35	32	67
Okaro	Elodea dominated, poor water clarity	0.28	18	19	6	53
Waahi	De-vegetated, turbid	4.5	3	0	0	0

5.2 Indicators of lake condition

Historical and current LakeSPI values show lake condition has been relatively stable for the larger lakes of the Ashburton Basin, which confirms a good baseline has been described, against which any future change can be detected.

Assessments from Environment Canterbury's water quality monitoring over 2004/05 suggest these larger lakes exhibit the same (Lake Emma) or improved (Camp, Heron, Clearwater) trophic status than was indicated by earlier data (Meredith 2005). Whilst this is in general agreement with our findings of a stable lake condition, it should be noted that LakeSPI has a littoral focus and is a complimentary method to water quality sampling rather than a directly comparable indicator.

LakeSPI is a particularly sensitive measure for the four larger lakes where plant depth limits were recorded. Retractions in the depth extent of vegetation, in turn leading to decreased LakeSPI and Native Condition scores, would result from sustained reductions in water clarity due to increased sediment input or algal productivity responding to greater nutrient availability.

For the shallower lakes that were completely vegetated, LakeSPI scores are less sensitive to reductions in water clarity. This is because the light requirements for plant growth are currently exceeded even at the deepest part of the lake, so reductions in plant depth extent may not be evident until an extreme change in water clarity occurred.

We would, however, expect smaller lakes to be more sensitive to land use changes than the larger lakes due to their smaller volumes and reduced buffering capacity. For these shallow lakes, useful additional indicators of change could include submerged species richness (number, representation), the loss of certain vegetation elements (e.g. low-growing charophytes), or a general reduction in plant covers. Summary survey information has been supplied in this report to compare with any future assessments, whilst raw survey data will be entered to NIWA’s Freshwater Biodata Information System (FBIS) and freely accessible on the web (fbis.niwa.co.nz).

The additional introduction of further submerged weed species (see section 5.3) would also see reductions in the LakeSPI scores for the lakes equivalent to the weediness of the species and its level of impact on native lake vegetation.

LakeSPI indices could be calculated for all lakes except Maori Lake East, where wide scale absence of vegetation was difficult to explain, especially given the vegetated status of adjacent Maori Lake West. It was noted, however, that the East Lake receives more direct inflows from stream systems and may be more susceptible to turbid inflows. The lake sediments were observed to be soft and large amounts of coarse debris were suspended in the water column, so wave and/or swan disturbance may also have contributed to the lack of vegetation in this very shallow lake. Improvements in lake condition would be signalled by more extensive submerged plant development.

5.3 Vegetation values and threats

Native submerged vegetation was well represented in Lakes Camp, Clearwater, Heron and the Spider Lakes especially, and remnant native communities discernable in most other lakes of the Ashburton Basin. Species diversity of submerged plants for the area was relatively high, with 20 species recorded for Lake Heron alone. In the three deepest lakes, native communities of mixed charophytes were present beyond the depth range of elodea. These charophyte “meadows” are being increasingly lost from equivalent depth lakes in the North Island due to a combination of nutrient enrichment, decreasing water clarity and multiple weed invasions.

The recognition of new, endemic charophytes within these lakes likely represents taxonomic advances rather than new records. Of particular note is the species *Nitella claytonii* in Lake Heron, which elsewhere tends to be restricted to deeper habitats (>10 m) within clear-water South Island lakes.

Of the six major native plant community types recognised by the LakeSPI method, all but emergent plants are represented in Lakes Camp, Clearwater and Heron, with their absence due to the wind-exposed nature and rocky shores of these lakes. Emergents, mostly *Typha orientalis*, were represented in Lake Emma and the smaller Lake Roundabout and the Maori Lakes.

Ranunculus limosella is included in the ‘at risk’ category of the New Zealand Threat Classification system, due to concern over declining populations (Hitchmough et al. 2005, Townsend 2008). These surveys show this species was especially widespread in the area, being recorded from nine of the eleven lakes surveyed. The uncommon turf plant species *Montia angustifolia* (Lake Donne, main Spider Lake) is listed under the ‘data deficient’ category of the New Zealand Threat Classification system, while classification of *Cardamine* ‘tarn’ (Lake Donne) awaits taxonomic recognition.

Champion et al. (2006) discuss the risk to the lakes of the Canterbury high country of pest plant invasion. The adventive plants currently present in the Ashburton Basin, elodea and *R. trichophyllus*, are less weedy than other potential pest plant invaders including *Ceratophyllum demersum*, *Egeria densa*, *Lagarosiphon major* and *Vallisneria spiralis* (Champion et al. 2006). Of these, the greatest risk comes from *L. major* because of the proximity of infested sites, such as Lake Benmore and sites in Christchurch and Timaru. Most likely mechanisms of potential spread to Canterbury High Country lakes were considered to be boat traffic or releases from ornamental ponds or aquaria, but the relative isolation of the Ashburton Lakes from main settlements was considered to reduce risk somewhat. The risk of lagarosiphon introduction to Lake Camp was rated as "moderate" on account of permitted motor boat activity, "low" in Lakes Clearwater and Heron due to prohibition of motorised craft, and "very low" in Lake Emma on account of difficult access for boats (Champion et al. 2006). In contrast, the impact of lagarosiphon, should it be introduced, was considered as "extreme" for Lakes Emma and Clearwater, and "moderate" for Lakes Heron and Camp.

The smaller lakes with difficult or no boat access are at lower risk of weed introduction than the larger lakes. However, any new weed establishment in the area would increase risk substantially. For example, new weed incursions in Lake Camp would lead to downstream dispersal to Lakes Roundabout and Emma via stream connections.

Signage warning of weed threats and located at access points to the major lakes was noted as an effective precautionary measure already taken in the area (Champion et al. 2006).

Annual surveillance for weed incursions at Lake Camp was recommended by Champion et al. (2006) by undertaking diver searches at boat ramp sites and major access points. Surveillance at other, lower risk but high value water bodies was recommended at 5-year intervals

Didymosphenia geminata (didymo) is not recorded in the area although recent records have been confirmed in the adjacent Rangitata and Rakaia Rivers. Didymo has not developed in other lakes except as localised growths on the shores of small lakes or more substantial coverings on rocks of the wave-wash zone (0-2 m) of large lakes (NIWA observations). Should didymo be introduced to the area, impacts on the lakes would be expected to be minor.

Coarse fish are another threat to the submerged vegetation resources of the region, with direct herbivory by rudd, indirect disturbance by benthivorus feeding fish (brown bullhead catfish, tench, koi) and possible spawning or feeding damage caused by perch (NIWA observations). Records of coarse fish are apparently limited to a 2003 record for perch from Lake Roundabout (FBIS), although they are also known from

Lakes Camp and Clearwater (Ross pers comm.) and large perch (c. 35 cm) were seen in Lake Denny during this survey.

5.4 Recommendations

1. *LakeSPI monitoring*. In light of the stable vegetation in these lakes, the frequency of LakeSPI monitoring is suggested at 5 to 10 year intervals. However, in the event of intensified land-use or the additional invasive weeds, an early re-assessment would be recommended.

2. *Condition of Maori Lake East*. Factors leading to the restricted vegetation development in Maori Lake East should be considered to at least elucidate possible threats to other lakes of the area. Relevant factors to investigate for the lake are recent land use or drainage changes that could cause turbid inflows such as from earthworks (e.g. track development) adjacent to the major feeder streams to the lake (Gentleman Smith and Jacobs streams), large water level variations, and the presence of coarse fish (e.g. rudd, goldfish) or large swan populations.

3. *Special sites.* Whilst LakeSPI provides a measure of the ecological condition of lakes rather than a measure of ecological value, results of the vegetation surveys suggest the Spider Lakes group (including Lake Donne) have high botanical value that may be worthy of special protection measures. An integration of ecological values, including wildfowl, fish and botanical character for water bodies, would be useful for prioritising lakes for management. The highest priority should be those water bodies of high value that are in good condition (i.e., high LakeSPI scores, good water quality) which are at risk from identified threats (see below).

4. *Identify threats.* An assessment of the threats facing each water body should be undertaken, towards setting management priorities in combination with value-based and condition ranking of sites. Aspects to consider could include % of catchment not in the DOC estate, predominant land cover types, degree of intensification (i.e. irrigation, cropping, discing, pasture improvement, top dressing), extent of riparian retirement (i.e. fencing of streams and lakes), extent of wetlands in catchment, presence of septic tank outfields (e.g. Lakes Clearwater and Heron), drainage channels excavated to lakes, operating quarries, existence of resource consents, range of water level fluctuation.

5. *Weed risk management*. Annual aquatic weed surveillance is undertaken at a range of high country lakes by Environment Canterbury. Of the Ashburton Lakes, Lake Camp was recognised as having the greatest weed risk and surveillance was recommended at an annual frequency, at with checks at other lakes suggested at a 5-year frequency (Champion et al. 2006). Combining future LakeSPI reassessments with weed surveillance programmes is likely to enable cost savings and enhance information gathering and exchange. Additional information from monitoring the intensity of boat use at lakes, or undertaking boater surveys (e.g., usage frequency and other sites visited) could provide better information on risks or identify likely pathways of weed introduction.

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7. Acknowledgements

Thanks for the efforts of the NIWA team who participated in the vegetation surveys; Paul Champion, John Clayton, Rohan Wells, Aleki Taumoepeau, David Burnett and Donna Sutherland. Also many thanks to Michelle Casanova (Charophyte Services, Lake Bolac, Victoria, Australia) for the benefit of her experience in identifying endemic charophyte species and in processing an extensive collection of herbarium specimens. Kennedy Lange (DOC) provided his knowledge on the area, Sjaan Charteris (DOC) provided helpful comments on this report and we also appreciate the assistance of Janine Sidery (DOC) in preparing a plant collection permit.

8. Glossary

Charophytes: Native macroalgae that resemble higher plants and which are widely regarded as beneficial plants in aquatic systems.

Vascular plants: Possessing complex vascular transport tissues which require higher light environments to maintain than non-vascular plants (e.g. charophytes).

Adventive: Outside of a species natural range, synonymous with exotic, introduced, alien.

Incursion: Weed establishment in a new location or environment.

9. Appendix 1: Lake Vegetation Summary Reports

Table A: Summary for Lake Camp based on a 1982 survey at 2 sites and 2007 survey at 5 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,1982: 5=76-100% 2007: 5= 76-95, 6=96-100. † Adventive weeds. * Name changes or new species since 1982.

Species	% of Profiles		Depth Range (m)		Median cover		Maximum cover		Average height (m)		Maximum height (m)	
	1982	2007	1982	2007	1982	2007	1982	2007	1982	2007	1982	2007
Shallow-water, low-growing												
**Lilaeopsis ruthiana*	100	100	0.0 - 3.0	0.2 - 3.1	5	2	5	4				
Pilularia novae-zelandiae	50		0.5 - 0.5				1					
Ranunculus limosella		20		1.1 - 1.1		1		1				
Ruppia polycarpa	50	40	0.0 - 0.5	0.5 - 2.0		1	3	1		0.1		0.1
Tall vascular												
†Elodea canadensis	100	100	2.0 - 4.0	1.0 - 4.6	1 , 2	3	4	6		0.3	0.5	0.6
Myriophyllum triphyllum		20		2.2 - 2.2		1		1				0.1
Potamogeton cheesemanii	100	100	1.0 - 3.0	0.5 - 4.0	1	1	1	3		0.3		0.8
Charophytes												
**Chara australis*	100	100	2.5 - 10.0	2.0 - 11.5	5	5	5	6		0.4	0.5	0.7
Chara fibrosa	100	60	0.9 - 8.0	0.6 - 4.1	1 , 4	3	5	6				
Chara globularis	100	40	4.0 - 10.0	1.4 - 4.6	1 , 4	1	5	3		0.2	0.5	0.2

Species	% of Profiles		Depth Range (m)		Median cover		Maximum cover		Average height (m)		Maximum height (m)	
	1982	2007	1982	2007	1982	2007	1982	2007	1982	2007	1982	2007
**Nitella leonhardii*		40		0.5 - 2.2		1, 3		6				
1982 Nitella hookeri var. hookeri	50		1.0 - 1.0				1					
1982 Nitella hookeri var. tricellularis	100		9.0 - 10.0		1 , 5		5					
**2007 Nitella tricellularis*		80		0.5 - 11.5		5		6		0.1		0.1
Nitella hyalina	100	100	0.0 - 8.0	0.5 - 5.0	1 , 2	2	5	6		0.1		0.2
Nitella pseudoflabellata	100	100	0.5 - 8.0	0.4 - 5.6	1 , 2	1	5	4		0.1		0.2

Table B: Summary for Lake Clearwater based on a 1982 survey at 6 sites and 2007 survey at 3 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,1982: 5=76-100% 2007: 5= 76-95, 6=96-100. †Adventive weeds. * Name changes or new species since 1982.

Species	% of Profiles		Depth Range (m)		Median cover		Maximum cover		Average height (m)		Maximum height (m)	
	1982	2007	1982	2007	1982	2007	1982	2007	1982	2007	1982	2007
Shallow-water, low-growing												
Elatine gratioloides	83	33	0.2 - 1.0	0.3 - 0.3	1	1	1	1				
Glossostigma submersum	50	33	0.0 - 1.0	0.1 - 0.3	1	1	1	1				
Isoetes alpinus	100	100	0.0 - 2.5	0.1 - 2.0	3 , 5	1	5	6				
Juncus sp.	17		0.0 - 0.0				1					
**Lilaeopsis ruthiana*	100	67	0.0 - 1.0	0.1 - 0.6	1	1	1	2				
Ruppia polycarpa	17		0.1 - 0.5				1					
Triglochin striatum	17		0.5 - 0.5				1					
Tall vascular												
†Elodea canadensis	83	100	1 – 4.0+	0.3 - 6.1	1	1	5	6		0.6	0.5	2.0
Myriophyllum triphyllum	67	67	0.0 - 3.0	0.1 - 1.3	1	1, 2	5	2		0.1	0.4	0.1
Potamogeton cheesemanii	100	100	0.5 – 4.0+	0.4 - 3.5	1	1	4	4		0.3	0.8	1.0
Potamogeton ochreatus	33		1.0 - 3.5		1		5				0.5	
Charophytes												
**Chara australis*	100	100	0.1 – 4.0+	1.2 - 7.0	4	5	5	6		0.3	0.5	0.5

Species	% of Profiles		Depth Range (m)		Median cover		Maximum cover		Average height (m)		Maximum height (m)	
	1982	**2007**	**1982**	**2007**	**1982**	**2007**	**1982**	**2007**	**1982**	**2007**	**1982**	**2007**
Chara fibrosa	100	100	0.3 – 4.0+	0.4 - 4.5	2 , 3	2	5	6		0.1		0.2
1982 Nitella hookeri var. hookeri	50		0.2 – 4.0+		1		3				0.3	
**2007 Nitella masonae*		33		0.1 - 1.5		1		1		0.1		0.1
1982 Nitella hookeri var. tricell	17		1.0 - 3.5				1					
**2007 Nitella tricellularis*		33		0.1 - 0.3		1		1				
Nitella hyalina	100	100	0.2 – 4.0+	0.0 - 2.0	1	1	5	4		0.1		0.1
**Nitella leonhardii*	100	100	0.3 – 4.0+	0.4 - 4.8	1 , 2	3	5	6		0.4	0.5	0.5
Nitella pseudoflabellata	100	100	0.1 – 4.0+	0.1 - 4.2	2	1	5	5		0.1		0.2

Table C: Summary for Lake Heron based on a 1982 survey at 6 sites and 2007 survey at 6 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,1982: 5=76-100% 2007: 5= 76-95, 6=96-100**.** † Adventive weeds. * Name changes or new species since 1982.

Species	% of Profiles		Depth Range (m)		Median cover		Maximum cover		Average height (m)		Maximum height (m)	
	1982	2007	1982	2007	1982	2007	1982	2007	1982	2007	1982	2007
Shallow-water, low-growing												
**Crassula sinclairii*		17		0.8 - 0.8		1		1				
Eleocharis pusilla		17		0.5 - 1.0		1		6				
Glossostigma submersum	17	50	0.5 - 1.0	0.1 - 1.8		1	1	1				
Isoetes alpinus	83	50	0.2 - 4.0	0.1 - 3.2	5	6	5	6		0.2	0.2	0.2
**Lilaeopsis ruthiana*	50	67	0.2 - 1.0	0.3 - 2.0	1	1	3	2				
Ranunculus limosella	17	33	0.2 - 1.0	0.4 - 1.0		1	1	2				
Ruppia polycarpa	33	50	0.6 - 1.0	0.3 - 1.0	1	1	1	2			0.2	
Tall vascular												
†*Elodea canadensis*	100	100	0.2 - 7.0	0.4 - 7.5	3	5	5	6		0.2	2.5	0.6
Myriophyllum propinquum	17		0.2 - 1.0				1					
Myriophyllum triphyllum	83	100	0.2 - 2.0	0.2 - 4.0	1	2	4	5		0.7	0.5	2.0
Potamogeton cheesemanii	100	83	0.3 - 5.0	0.5 - 4.1	1	1	4	4		0.2	2.5	1.0
Potamogeton ochreatus		17		0.7 - 1.5		1		1		0.1		0.2
**†Ranunculus trichophyllus*		33		1.0 - 1.2		1		3		0.2		0.2
Charophytes												

Species	% of Profiles		Depth Range (m)		Median cover		Maximum cover		Average height (m)		Maximum height (m)	
	1982	**2007**	**1982**	**2007**	**1982**	**2007**	**1982**	**2007**	**1982**	**2007**	**1982**	**2007**
**Chara australis*	100	33	0.5 - 9.0	0.7 - 4.7	3 , 4	3, 5	5	6		0.3		0.3
Chara fibrosa	50	33	2.0 - 4.5	1.5 - 2.1	1	1, 3	5	5		0.2		0.2
Chara globularis		17		6.5 - 9.0		6		6				
1982 Nitella hookeri var. hookeri	33		3.0 - 9.0									
**2007 Nitella tricellularis*		100		0.3 - 8.5		1, 2		6		0.2		0.3
1982 Nitella hookeri var. tricell	83		0.5 - 9.0		1		5				0.5	
**Nitella claytonii*		33		6.0 - 9.7		2, 6		6				
Nitella hyalina	83	50	0.2 - 5.0	1.4 - 6.0	1	1	5	2		0.1		0.1
Nitella pseudoflabellata	100	67	0.4 - 6.0	0.4 - 6.0	1	1	5	3		0.1		0.5
Nitella stuartii	17	17	4.0 - 4.0	5.4 - 6.0		1	1	2		0.1		0.1

Table D: Summary for Lake Emma based the 2007 survey at 4 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%. † Adventive weeds.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
Shallow-water, low-growing						
Isoetes alpinus	75	0.3 - 1.5	3	6		
Lilaeopsis ruthiana	100	0.1 - 1.3	1, 2	3		
Ranunculus limosella	25	0.4 - 0.4	1	1		
Tall vascular						
†Elodea canadensis	100	0.3 - 2.8	2, 3	6	0.2	1.0
Potamogeton cheesemanii	50	1.6 - 2.3	1	1		0.1
†Ranunculus trichophyllus	100	0.2 - 2.5	1	2	0.2	0.5
Myriophyllum triphyllum	50	1.6 - 2.3	1	2	1.0	1.5
Charophytes						
Chara australis	25	0.6 - 0.7	1	1		0.1
Nitella masonae	50	0.2 - 1.6	1	2	0.1	0.1
Nitella tricellularis	75	0.5 - 1.4	1	2	0.1	0.1
Nitella hyalina	75	0.2 - 1.6	1	1		

Table E: Summary for Lake Donne based the 2007 survey at 2 sites. Heights not shown for species <0.1 m tall, or where insufficient data**.** Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
Chara fibrosa	50	0.2 - 0.7	1	1	0.1	0.1
Lilaeopsis ruthiana	50	0.3 - 0.5	2	3		
Myriophyllum propinquum	50	0.1 - 0.3	2	3		0.1
Myriophyllum triphyllum	100	0.2 - 1.0	2	4	0.3	0.5
Nitella pseudoflabellata	50	0.1 - 1.0	4	6	0.1	0.2
Nitella tricellularis	50	0.2 - 0.5	1	2		0.1
Potamogeton cheesemanii	100	0.3 - 1.0	2	2	0.3	0.5
Ranunculus limosella	50	0.2 - 0.2	1	1		

Recorded outside of survey sites: *Ruppia polycarpa*, *Lilaeopsis ruthiana*, *Glossostigma submersum*, *Crassula sinclairi*, *Selliera radicans*, *Pratia perpusilla*, *Hydocotyle hydrophila*, *Cardamine* 'tarn', *Montia angustifolia*, *Leptinella maniototo*.

Table F: Summary for the main Spider Lake based the 2007 survey at 2 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%. † Adventive weeds.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
Chara braunii	50	0.3 - 0.3	1	1		
Chara fibrosa	50	0.1 - 0.5	1	2	0.1	0.1
†Elodea canadensis	50	0.5 - 0.8	1	3	0.2	0.2
Eleocharis pusilla	50	0.2 - 0.2	1	1		
Limosella lineata	50	0.2 - 0.3	2	3		
Lilaeopsis ruthiana	100	0.1 - 0.4	2	6		
Myriophyllum propinquum	100	0.1 - 0.5	2	4		0.1
Myriophyllum triphyllum	100	0.1 - 0.8	2	4	0.3	0.4
Nitella pseudoflabellata	50	0.1 - 0.4	1	2	0.3	0.3
Nitella tricellularis	100	0.2 - 0.5	1	1		0.1
Potamogeton cheesemanii	100	0.1 - 0.8	2	4	0.2	0.4
Potamogeton ochreatus	50	0.1 - 0.8	1	3	0.2	0.4
†Ranunculus trichophyllus	50	0.2 - 0.3	1	1		0.2
Ranunculus limosella	50	0.2 - 0.3	2	3		
Ruppia polycarpa	50	0.2 - 0.3	1	2		0.2

Recorded outside of survey sites: *Gratiola sexdentata*, *Crassula* sp., *Montia angustifolia.*

Table G: Summary for Spider Lake East based the 2007 survey at 1 site. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%. † Adventive weeds.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
Chara braunii	100	0 - 0.8	2	3	0.1	0.1
Myriophyllum triphyllum	100	0 - 0.8	2	4	0.5	0.8
Nitella pseudoflabellata	100	0 - 0.8	2	2	0.1	0.1
Nitella tricellularis	100	0 - 0.8	1	1	0.1	0.1
Nitella hyalina	100	0 - 0.8	1	2	0.1	0.1
Potamogeton cheesemanii	100	0 - 0.8	3	5	0.5	0.8
†Ranunculus trichophyllus	100	0 - 0.8	2	2	0.5	0.8

Table H: Summary for Maori Lake West based the 2007 survey at 3 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%. † Adventive weeds.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
Chara australis	67	0.5 - 1.7	1	4	0.1	0.1
Chara fibrosa	67	0.5 - 1.7	1, 5	6	0.2	0.2
†Elodea canadensis	100	0.8 - 2.1	3	6	0.7	1.3
Myriophyllum triphyllum	100	0.5 - 2.1	2	6	0.4	0.8
Nitella leonhardii	67	0.5 - 1.8	1	3	0.2	0.2
Nitella pseudoflabellata	67	0.3 - 1.8	1, 3	6	0.2	0.3
Potamogeton cheesemanii	100	0.5 - 1.8	1	3	0.3	1.0
Potamogeton ochreatus	33	1.2 - 1.3	1	2	0.2	1.0
Typha orientalis	67	0.0 - 0.8	2, 6	6	1.9	2.0
Utricularia dichotoma	33	0.1 - 0.3	3	4		

Recorded outside of survey sites: *Lemna minor*.

Table I: Summary for Lake Roundabout based the 2007 survey at 2 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%. † Adventive weeds.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
†Elodea canadensis	100	0.2 - 1.5	5, 6	6	0.4	0.5
Lilaeopsis ruthiana	100	0.2 - 1.0	1, 2	4		
Myriophyllum triphyllum	100	0.2 - 1.5	1, 2	5	1.5	1.5
Nitella masonae	50	0.2 - 1.0	1	1	0.1	0.1
Nitella tricellularis	100	0.2 - 1.0	1	1		
Potamogeton ochreatus	100	0.6 - 0.8	1	2	0.4	0.5
†Ranunculus trichophyllus	100	0.2 - 1.1	1, 2	6	0.3	1.0
Ranunculus limosella	100	0.2 - 1.0	1, 3	3		

Recorded outside of survey sites: *Potamogeton cheesemanii*

Table J: Summary for Lake Emily based the 2007 survey at 4 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%. † Adventive weeds.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
†Elodea canadensis	100	0.2 - 2.3	5	6	0.9	1.3
Elatine gratioloides	25	0.2 - 0.3	1	1		
Eleocharis pusilla	50	0.0 - 0.4	1	2		
Glossostigma elatinoides	25	0.9 - 0.9	1	1		
Isoetes alpinus	25	0.3 - 1.6	5	6		0.1
Lilaeopsis ruthiana	50	0.0 - 0.4	1, 2	2		
Myriophyllum triphyllum	50	0.0 - 0.3	1	2		
Potamogeton cheesemanii	50	0.1 - 1.4	1	2	0.2	0.2
Potamogeton ochreatus	75	0.5 - 2.1	1	1	0.3	0.3
Ranunculus limosella	25	0.1 - 0.5	2	4		

Recorded outside of survey sites: *Glossostigma submersum, Hydrocotyle hydrophila.*

Table K: Summary for Lake Denny based the 2007 survey at 4 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 1=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%. † Adventive weeds.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
Carex sp.	25	0.0 - 0.0	5	6	0.5	0.5
†Elodea canadensis	100	0.2 - 2.1	6	6	0.5	0.5
Myriophyllum triphyllum	75	0.5 - 2.1	1	6	1.4	2.1
†Ranunculus trichophyllus	25	0.2 - 0.3	1	2	0.3	0.3
Ranunculus limosella	50	0.1 - 0.3	1, 3	4		

Recorded outside of survey sites: *Isoetes alpinus*, *Lilaeopsis ruthiana*

Table L: Summary for Maori Lake East based the 2007 survey at 3 sites. Heights not shown for species <0.1 m tall, or where insufficient data. Cover Scale - 11=1-5%,2=6-25%,3=26-50%,4=51-75%,5=76-95, 6=96-100%. † Adventive weeds.

Species	% of Profiles	Depth Range (m)	Median cover	Maximum cover	Average height (m)	Maximum height (m)
unidentified mosses & liverworts	33	0.5 - 0.5	1	1		
†Elodea canadensis	100	0.3 - 0.8	1	1	0.1	0.1
Eleocharis pusilla	33	0.0 - 0.2	3	5		
Limosella lineata	33	0.0 - 0.2	1	2		
Myriophyllum triphyllum	33	0.0 - 0.2	1	2		
Potamogeton cheesemanii	100	0.1 - 0.8	1	1	0.1	0.1
Ranunculus limosella	33	0.0 - 0.2	1	2		
Ruppia polycarpa	33	0.0 - 0.2	1	2		
Typha orientalis	67	0.0 - 0.5	3, 6	6	1.4	1.8

10. Appendix 2

Table M: Likely pre-European LakeSPI scores for the Ashburton Lakes.

Lake	LakeSPI	Native Condition	Invasive Condition
Camp	98	96	0
Clearwater	98	97	0
Heron	98	97	0
Emma	100	100	0
Donne	97	93	0
Spider (Main and East)	97	93	0
Maori West	97	93	0
Roundabout	97	93	0
Emily	100	100	0
Denny	97	93	0
Maori East	97	93	0