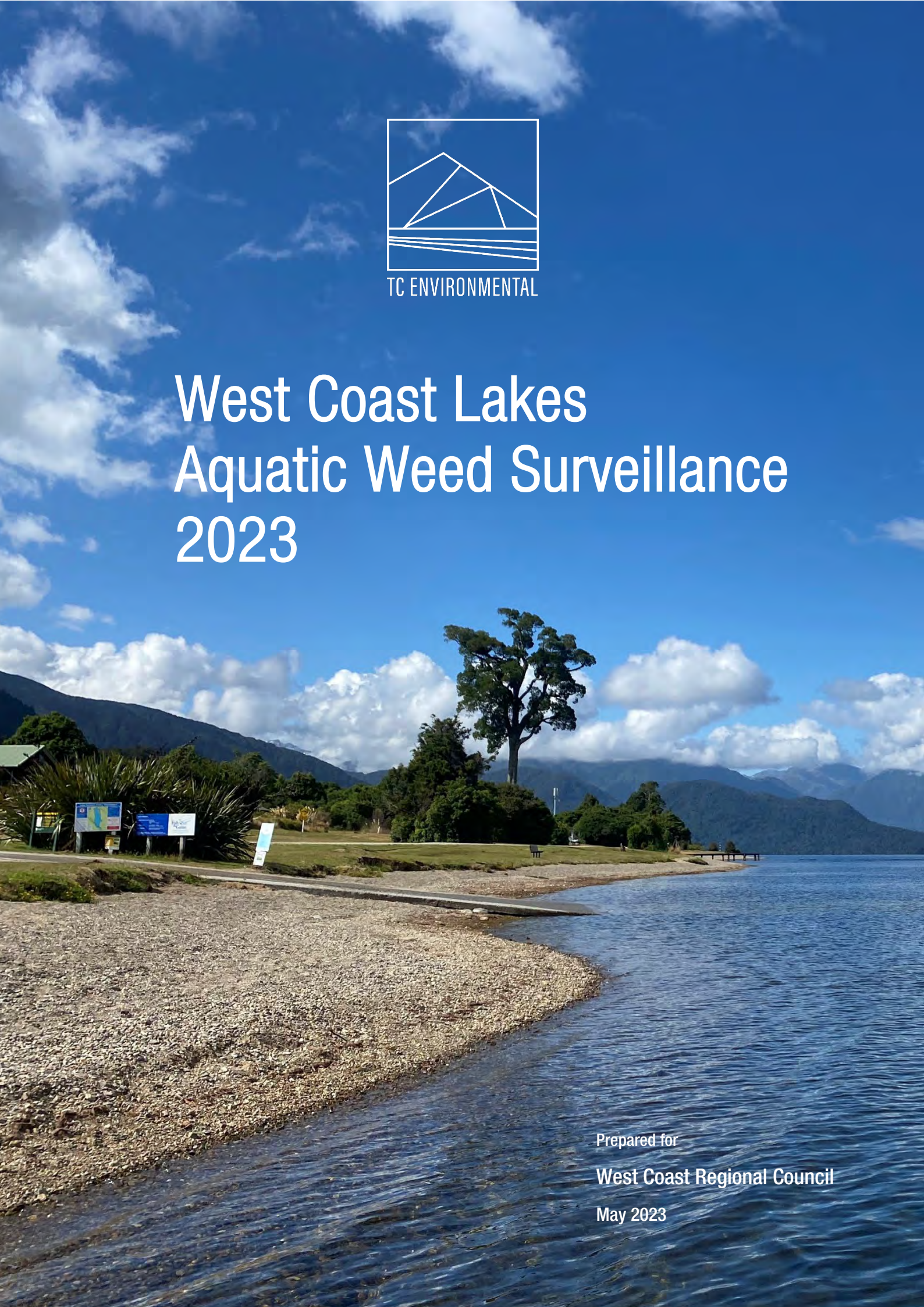
TC ENVIRONMENTAL

West Coast Lakes Aquatic Weed Surveillance 2023



Prepared for

West Coast Regional Council

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Prepared by:

TC Environmental Ltd
51 Beach Road, Nelson
Mobile 027 6308097
E-mail thomas@tcenviro.co.nz
courtney@tcenviro.co.nz

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Introduction

The West Coast Regional Council (WCRC) and Department of Conservation (DOC) operate an annual surveillance programme to detect incursions of introduced aquatic weeds within the West Coast Lakes. Each summer a number of lakes are selected for surveillance based on incursion risk and previous surveillance history.

While a number of problem species have previously been recorded in West Coast waterbodies (Champion & Clayton, 2004; Champion & Larned, 2015; Lass, 2019; BOPRC, 2021; Rayes and Scott-Simmonds, 2022), of most concern are the submerged macrophytes; *Lagarosiphon major*, *Ceratophyllum demersum* and *Egeria densa*, of which *L. major* is already known in Lake Paringa, Ianthe and the Kapitea Reservoir.

Despite the presence of invasive species in the region, numerous West Coast lakes still have outstanding natural value and early detection is vital in managing new incursions.

This report provides diver surveillance results for 28 sites within 9 West Coast Lakes located between Haast and Greymouth, West Coast (Figure 1). An additional 2-3 LakeSPI transects were undertaken in each lake (with the exception of Kapitea Reservoir) to provide a current ecological condition based on submerged plant indicators (SPI). Multi-species eDNA samples were also collected at numerous sites as a complimentary tool for early detection of introduced aquatic weeds and fish.

Methods

Nine West Coast Lakes located between Haast and Greymouth were visited between January and March 2023 (Figure 1). Within these lakes a total of 28 sites were surveyed for introduced aquatic macrophytes following similar methodology to previous surveys (BOPRC, 2019 & 2021; Rayes and Scott-Simmonds, 2022). A list of the lakes surveyed are presented in Table 1. An additional 19 LakeSPI transects were conducted within the lakes to assess current ecological condition of each lake.

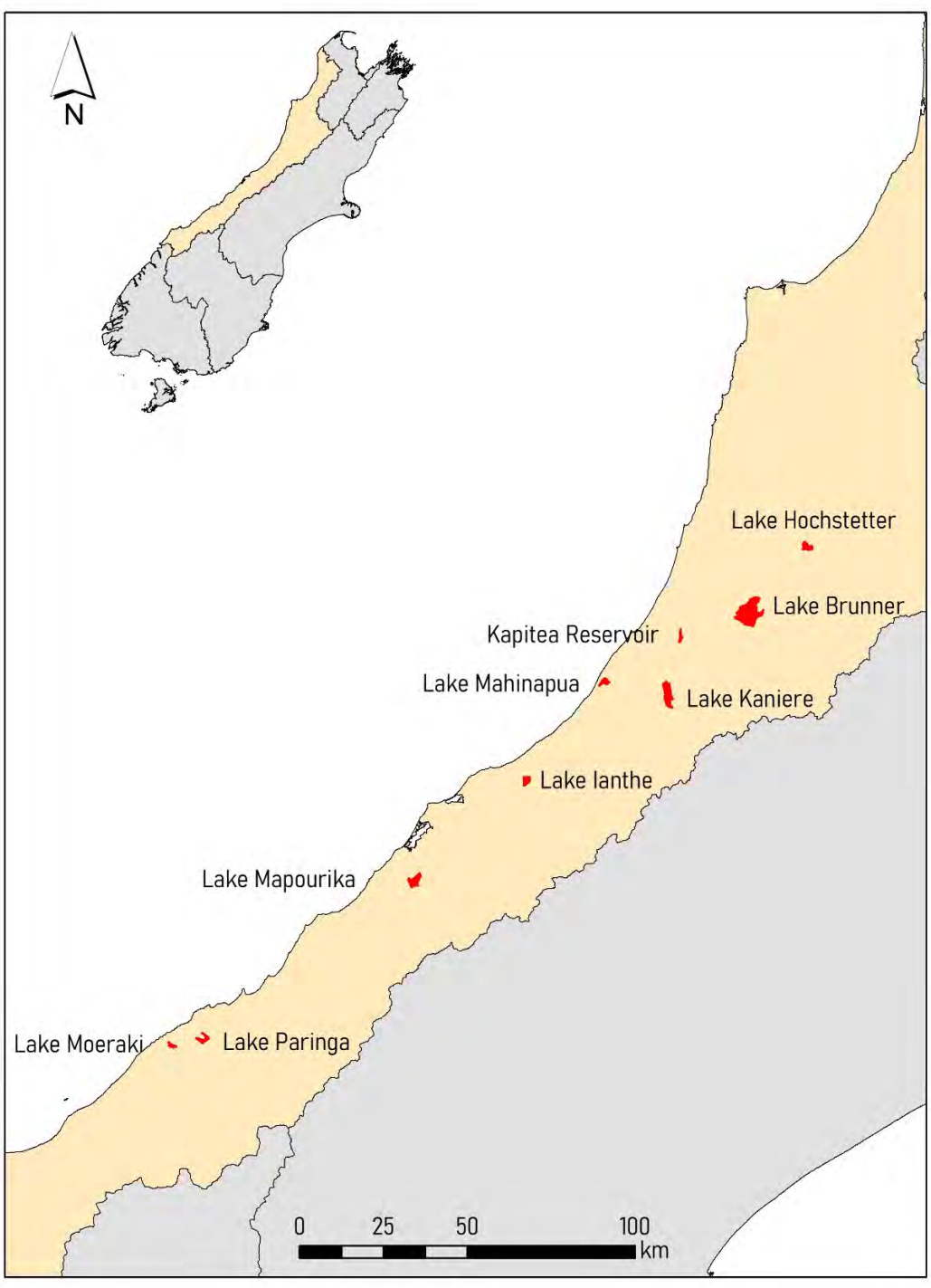


Figure 1 Location of West Coast Lakes surveyed during summer 2023.

Underwater visual surveillance

Underwater surveillance was undertaken by divers using SCUBA or snorkel (where less than 2m depth) who performed a systematic grid search at each site (Table 1). The spacing between divers varied between 1 and 2 m depending on the nature of the lake bathymetry, vegetation cover and in-water visibility. To begin the search, divers entered the water via shore or vessel and swam to the deepest extent of the submerged macrophytes before undertaking a grid pattern back and forward working their way into the shallows. At some sites it was not possible for divers to reach any depth due to the shallow nature of the lakes, therefore divers focussed on the area surrounding the entry points.

GoPro footage representative of each site was captured during the dives. A GPS unit was also towed above one diver to track the area of survey and a buffer later included using ArcGIS to account for the area covered by the second diver (Appendix 3). Details of common native plant species were also recorded during each dive (Appendix 1).

In addition, shoreline surveillance directly adjacent to each site was conducted by foot to detect any washed-up weeds.

To ensure no transfer of weed species between lakes, dive gear, field equipment and the vessel were thoroughly disinfected and lakes with known *L. major* were left to the end of the fieldwork.

Table 1 Lakes, dates and sites surveyed for invasive aquatic macrophytes in 2023.

Lake	Date Surveyed	Sites Surveyed	Number of additional LakeSPI transects
Hochstetter	12/03/2023	Main Ramp and Outflow	3
Brunner	23/01/2023	Moana Boat Ramp, Yacht Club, Crooked River Mouth, Cashmere Bay, Orangipuku River Mouth, Mitchells Boat Ramp, Hohonu River Mouth	-
Kapitea	27/01/2023	North Ramp, West Ramp, Kumara Inlet	-
Kaniere	24/01/2023	Canoe Cove, Sunny Bight, Hans Bay	2
Mahinapua	25/01/2023	Main Ramp, Daylight Bight, Picnic Bay	2
Ianthe	26/01/2023	Jetty, Ianthe Creek Outlet, The Landing	2
Mapourika	13/03/2023	Boat Ramp, DOC Area, Okarito Outlet	2
Paringa	15/03/2023	Main Ramp, Lodge Jetty	3
Moeraki	14/03/2023	North and South Ramps	3

LakeSPI

LakeSPI has been developed as a management tool, which utilises Submerged Plant Indicators (SPI) to assess the ecological condition of New Zealand Lakes (Clayton & Edwards, 2006). The method can be repeated over time to monitor trends in lake condition and is intended to compliment other lake assessment methods.

A more extensive understanding of LakeSPI methodology can be gained from the user manual and technical report:

https://niwa.co.nz/sites/niwa.co.nz/files/import/attachments/lakespi_report.pdf

https://niwa.co.nz/sites/niwa.co.nz/files/import/attachments/lakespi_manual.pdf

LakeSPI assessments typically include 5 representative sites within a lake and site selection aims to avoid unfavourable influences including boat ramps, river mouths and weed control areas. However, due to the locations of surveillance sites some transects were conducted in close proximity to these unfavourable areas. During the previous three surveillance events, divers have also recorded LakeSPI details across the broader surveillance area. The current survey utilised standard LakeSPI transect methodology, therefore some variation from previous results is expected.

A LakeSPI transect was completed at each surveillance site with results discussed below. An additional 2-3 LakeSPI transects were conducted within each lake to gain a more comprehensive understanding of macrophytes for LakeSPI analysis. Summarised transect results are provided for each lake in Tables 3-10.

eDNA

Water samples were collected from above the macrophytes at 45 sites and processed for eDNA following Wilderlab NZ methodology (Table 2, Appendix 2). These samples were later processed by Wilderlab NZ for multi-species presence of plants and animals. Sites where eDNA samples were taken are displayed in Table 2 and key introduced species are presented in Appendix 1 (an additional spreadsheet with all eDNA results is provided).

It should be noted that six replicates per site are recommended for comprehensive eDNA analyses. Currently, eDNA can be considered a complementary tool rather than a stand-alone approach and molecular techniques will likely improve in accuracy with time.

Table 2 eDNA sample sites and details.

Site	Sample No.	Date Sample Taken	Volume (ml)	Lat	Long	Analysis
Mahinapua-Main Ramp	707051	25/01/2023	300	-42.796306	170.902639	Multispecies PCR
Mahinapua-Main Ramp	707052	25/01/2023	250	-42.796306	170.902639	Multispecies PCR
Mahinapua-Main Ramp	707053	25/01/2023	300	-42.796306	170.902639	Multispecies PCR
Mahinapua-Picnic Bay	707054	25/01/2023	700	-42.795612	170.932424	Multispecies PCR
Mahinapua-Picnic Bay	707055	25/01/2023	800	-42.795612	170.932424	Multispecies PCR
Mahinapua-Picnic Bay	707056	25/01/2023	600	-42.795612	170.932424	Multispecies PCR
Kaniere-Hans Bay	707061	24/01/2023	1000	-42.806656	171.154761	Multispecies PCR
Kaniere-Hans Bay	707062	24/01/2023	1000	-42.806656	171.154761	Multispecies PCR
Kaniere-Hans Bay	707063	24/01/2023	1000	-42.806656	171.154761	Multispecies PCR
Kaniere-Sunny Bight	707064	24/01/2023	1000	-42.804605	171.128779	Multispecies PCR
Kaniere-Sunny Bight	707065	24/01/2023	1000	-42.804605	171.128779	Multispecies PCR
Kaniere-Sunny Bight	707066	24/01/2023	1000	-42.804605	171.128779	Multispecies PCR
Kapitea-Main Ramp	707071	27/01/2023	1000	-42.66377	171.196511	Multispecies PCR
Kapitea-Main Ramp	707072	27/01/2023	800	-42.66377	171.196511	Multispecies PCR
Kapitea-Main Ramp	707073	27/01/2023	600	-42.66377	171.196511	Multispecies PCR
Kapitea-Ramp 2	707074	27/01/2023	700	-42.670259	171.193548	Multispecies PCR
Kapitea-Ramp 2	707075	27/01/2023	600	-42.670259	171.193548	Multispecies PCR
Kapitea-Ramp 2	707076	27/01/2023	1000	-42.670259	171.193548	Multispecies PCR
Brunner-Main Ramp	707081	23/01/2023	1000	-42.576273	171.470748	Multispecies PCR
Brunner-Main Ramp	707082	23/01/2023	1000	-42.576273	171.470748	Multispecies PCR
Brunner-Main Ramp	707083	23/01/2023	1000	-42.576273	171.470748	Multispecies PCR
Brunner-Mitchell's	707084	23/01/2023	700	-42.634906	171.398917	Multispecies PCR
Brunner-Mitchell's	707085	23/01/2023	600	-42.634906	171.398917	Multispecies PCR
Brunner-Mitchell's	707086	23/01/2023	700	-42.634906	171.398917	Multispecies PCR
Brunner-Cashmere	707101	23/01/2023	600	-42.610433	171.501010	Multispecies PCR
Brunner-Cashmere	707102	23/01/2023	500	-42.610433	171.501010	Multispecies PCR
Brunner-Cashmere	707103	23/01/2023	500	-42.610433	171.501010	Multispecies PCR
Ianthe-Outlet	707104	26/01/2023	1000	-43.066755	170.610005	Multispecies PCR
Ianthe-Outlet	707105	26/01/2023	1000	-43.066755	170.610005	Multispecies PCR
Ianthe-Outlet	707106	26/01/2023	1000	-43.066755	170.610005	Multispecies PCR
Mapourika-Main Ramp	524762	13/03/2023	1000	-43.32896	170.21388	Multispecies PCR
Mapourika-Main Ramp	524743	13/03/2023	1000	-43.32896	170.21388	Multispecies PCR
Mapourika-Main Ramp	524786	13/03/2023	1000	-43.32896	170.21388	Multispecies PCR
Mapourika-DOC Area	524405	13/03/2023	1000	-43.297097	170.223280	Multispecies PCR
Mapourika-DOC Area	524759	13/03/2023	1000	-43.297097	170.223280	Multispecies PCR
Mapourika-Okarito Outlet	524396	13/03/2023	1000	-43.29310	170.21972	Multispecies PCR
Paringa-Main Ramp	707091	15/03/2023	1000	-43.721289	169.411261	Multispecies PCR
Paringa-Main Ramp	707092	15/03/2023	1000	-43.721289	169.411261	Multispecies PCR
Paringa-Main Ramp	707093	15/03/2023	1000	-43.721289	169.411261	Multispecies PCR
Paringa-Main Ramp	707094	15/03/2023	1000	-43.721289	169.411261	Multispecies PCR
Paringa-Main Ramp	707095	15/03/2023	800	-43.721289	169.411261	Multispecies PCR
Paringa-Main Ramp	707096	15/03/2023	800	-43.721289	169.411261	Multispecies PCR
Moeraki-South Ramp	707111	14/03/2023	800	-43.73310	169.30073	Multispecies PCR
Moeraki-South Ramp	707112	14/03/2023	1000	-43.73310	169.30073	Multispecies PCR
Moeraki-South Ramp	707113	14/03/2023	1000	-43.73310	169.30073	Multispecies PCR
Moeraki-South Ramp	707114	14/03/2023	800	-43.73310	169.30073	Multispecies PCR
Moeraki-South Ramp	707115	14/03/2023	600	-43.73310	169.30073	Multispecies PCR
Moeraki-South Ramp	707116	14/03/2023	1000	-43.73310	169.30073	Multispecies PCR

Results and Discussion

No new incursions of invasive *Lagarosiphon major*, *Egeria densa* or *Ceratophyllum demersum* were detected in the sites surveyed or through eDNA in 2023 (Appendix 1). *Lagarosiphon major* remains a dominant species at surveillance sites in Lake Paringa (Figure 2), Ianthe and Kapitea Reservoir, and *E. canadensis* was present in all lakes surveyed apart from Lake Hochstetter.

One marginal, wetland grass, *Phragmites australis* was detected in a single eDNA sample taken at Mapourika Outlet (Figure 15). It is recommended further surveillance be conducted along the margins of this lake, and any *P. australis* present be eradicated as soon as possible.

Other detected introduced weeds of less concern due to most presenting a non-invasive nature included, *Ranunculus trichophyllus*, *Potamogeton crispus*, *Ludwigia palustris*, *Utricularia geminiscapa* and *Juncus bulbosus*. *Aponogeton distachyos* (Cape pondweed) and *Nymphaea alba* (Common water lily – Figure 2) were also recorded in Lake Mahinapua.

Sites where introduced species were recorded during the present survey include:

Elodea canadensis – Kapitea Reservoir, Kaniere, Mahinapua, Brunner (Figure 2), Ianthe, Mapourika, Paringa, Moeraki. *Elodea canadensis* was the dominant invasive in all lakes apart from those with *L. major* and Hochstetter where no *E. canadensis* was observed.

***Lagarosiphon major* –** Kapitea Reservoir, Ianthe and Paringa (Figure 2). Already known to inhabit these lakes with an extensive distribution in each.

***Ranunculus trichophylls* –** Brunner (Orangipuku). Present as a minor component of the vegetation among indigenous species and recorded here previously (Champion & Clayton, 2004).

***Potamogeton crispus* –** Brunner (main ramp, Orangipuku River Mouth). Minor component of overall vegetation and present among indigenous vegetation. Previously recorded in Lake Brunner (BOPRC, 2021, Rayes and Scott-Simmonds, 2022).

Ludwigia palustris – Kapitea Reservoir (inlet), Kaniere (Sunny Bight), Mahinapua (Picnic Bay and Daylight Bight), Brunner (Main ramp, Yacht club, Mitchell's), Ianthe (Main ramp), Mapourika, and Paringa. Previous records for Brunner, Kapitea, Kaniere and Mahinapua (Champion & Clayton, 2004), and Mapourika and Paringa (Rayes and Scott-Simmonds, 2022).

Utricularia geminiscapa – Mahinapua and Paringa (Main ramp). It does not currently appear to be displacing indigenous vegetation. First recognised in Lake Mahinapua and Okarito Lagoon by Champion and Clayton (2004).

***Juncus bulbosus* –** Recorded in Hochstetter as the dominant vegetation at surveillance sites. Also recorded at Kapitea Reservoir (Main ramp and Inlet), Mahinapua and Mapourika where it appears to be a minor component of the marginal vegetation.

Aponogeton distachyos - Mahinapua (Main ramp and Picnic Bay), known in Mahinapua since 1950 (Champion & Clayton, 2004). It does not currently appear to be displacing native species at these sites.

Nymphaea alba – Mahinapua, previously known in this lake (Champion & Clayton, 2004; BOPRC, 2019) (Figure 2).

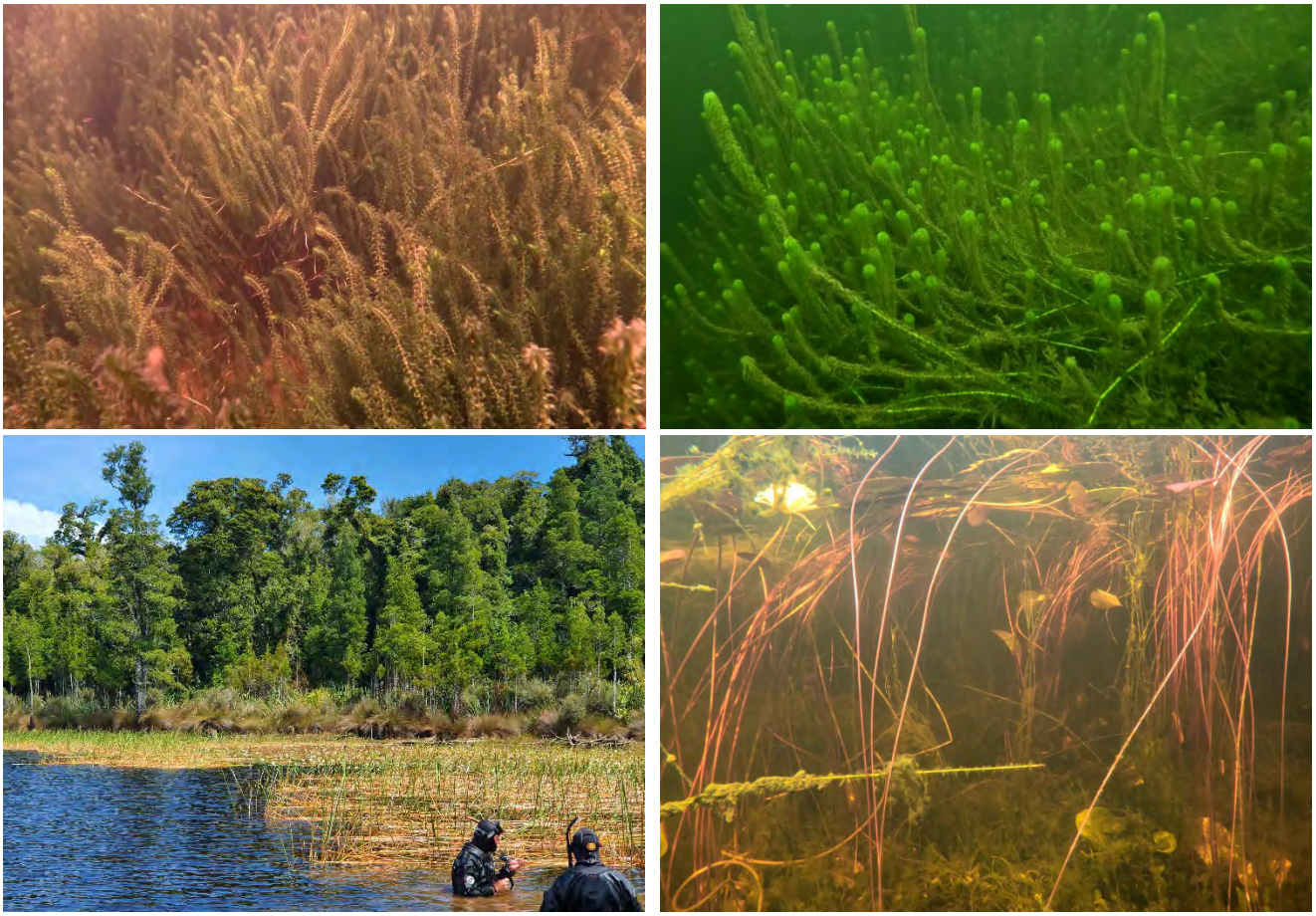


Figure 2 Examples of dense areas of Elodea canadensis in Brunner (top left), Lagarosiphon major in Paringa (top right) and Nymphaea alba above (floating white flowers in background) and below the water (bottom images).

Lake Hochstetter

Two sites were surveyed for submerged aquatic weeds in Lake Hochstetter (Figure 3), with *J. bulbosus* the only invasive recorded. An additional 3 LakeSPI transects were conducted (Table 3). Overall, Lake Hochstetter has very little submerged vegetation.

Main Ramp

The survey area was located adjacent to the boat ramp on the south-eastern lake border (Figures 3 & 4, Site A). The site was dominated by invasive *J. bulbosus* (Figure 4). Native presence included emergents, turf, charophytes, isoetes and milfoils at a ratio of 6-25% compared to 76-95% invasives. The survey area was very shallow, with dark, tannin-stained water likely limiting the growth of submerged plants. Natives were recorded at a maximum depth of 2m, while *J. bulbosus* was shallower at 0.6m.

Nelson Creek Outlet

Submerged vegetation in the area surrounding Nelson Creek Outlet was largely absent, aside from a few patches (Figures 3 &4, site D). The site was dominated by *J. bulbosus* at >95% ratio compared to natives. A very low cover of charophytes were present down to 2m, with native emergents at the lake edge.

Figure 3 Lake Hochstetter showing locations of 5 LakeSPI transects and two surveillance sites (yellow).

Figure 4 Lake Hochstetter surveillance sites, Site A (Top left) and Site D (Top right). Native milfoils (bottom left) and invasive J. bulbosus (bottom right).

Table 3 Summary of LakeSPI features for Lake Hochstetter 2023

Site	Profile Length	Latitude	Longitude	Max depth native species >10% (m)	Max depth charophyte meadows >75% (m)	Max depth invasives >10% (m)	Ratio natives %
A	M	-42.450280	171.683200	2	-	0.6	6-25
B	M	-42.445590	171.682520	1.2	-	1.25	<5
C	S	-42.442580	171.666270	1.5	-	0.2	>95
D	M	-42.451020	171.643723	2.1	-	1	<5
E	M	-42.451991	171.676412	1.2	-	0.3	>95

Lake Brunner

Seven sites were surveyed at Lake Brunner (Figures 5 & 6). The dominant invasive species recorded was *E. canadensis.* Minor components of *P. crispus*, *R. trichophyllus* and *L. palustris* were also present. Six LakeSPI transects were used for analysis and where possible were shifted slightly away from surveillance sites (Table 4). Due to the complexity and size of Lake Brunner, it is suggested additional LakeSPI transects are conducted to achieve greater representation of the lake and effort be made to avoid influences such as river mouths.

Main Ramp

The surveyed area by the main ramp was shallow (<3m) with invasive *E. canadensis* (95%) and *P. crispus* (5%) recorded. Native presence included emergents, turf, charophytes, isoetes, milfoils and pondweeds at a ratio of 51-75% compared to 26-50% invasives, with dense areas of *E. canadensis* reaching 1.2m height. Introduced, *L. palustris* was also present.

Yacht Club

The surveyed area was consistently shallow (<3m) with invasive *E. canadensis* present at 0.8m height. Native vegetation included turf, charophytes, isoetes, milfoils and pondweeds at 51%-75% compared to 26-50% invasives. Introduced *L. palustris* was also present.

An additional LakeSPI transect was conducted between the main ramp and yacht club in order to reach a maximum vegetation depth. Native vegetation reached 6m and invasives, 5m. *Elodea canadensis* was recorded at much greater heights on this transect at 2.6m in a dense, closed canopy band.

Hohonu River Mouth

The vegetation surrounding Hohonu River Mouth remained patchy and was bare in most places. *Elodea canadensis* was occasional, but present at 26-50% ratio compared to natives at 51% -75%. Patches of *E. canadensis* were less than 1m in height. Native charophytes, milfoils and pondweeds were also present. The bank dropped off relatively steeply, with vegetation recorded to a depth of 3m.

Mitchell's Ramp

Vegetation adjacent to Mitchell's Ramp extended to 5m depth for natives and 4.7m for invasives. *Elodea canadensis* was the dominant invasive species, with introduced *L. palustris* also present at the site, although not within the LakeSPI transect. Dense areas of *E. canadensis* reached 1.6m in height. Native species included emergents, turf, charophytes, isoetes, milfoils and pondweeds, at a ratio of 26-50% compared to 51-75% invasives.

Orangipuku River Mouth

The area surrounding the river mouth was shallow (<3m) with dense *E. canadensis* dominating the site, reaching a height of 1.8m. A small amount of *P. crispus* and *R. trichophyllus* were noted. Native vegetation present included emergents, turf, charophytes, isoetes, milfoils and pondweeds, at a ratio of 6-25% compared to invasives at 76-95%.

Cashmere Bay Ramp

The site at Cashmere boat ramp was dark and silty with filamentous algae blanketing macrophytes. Vegetation was dominated by dense *E. canadensis*, near 2m tall, at a ratio of 76-95% compared with 6-25% natives. Native vegetation included charophytes and pondweeds. Charophytes were recorded down to 4.7m and *E. canadensis*, 3.5m.

Crooked River Mouth

The area surrounding the Crooked River Mouth was mainly bare, with patchy vegetation (Figure 6). Native vegetation consisted of pondweeds and charophytes extending to 3.5m. Invasive *E. canadensis* was occasional in cover extending to 3.5m depth and less than 1m height. The ratio of vegetation was 26-50% native to 51-75% invasive.

Figure 5 Location of surveillance sites (yellow) and additional LakeSPI transects, Lake Brunner.

Figure 6 Site Photos left to right from top. Main Ramp, Yacht Club, Hohonu River Mouth, Mitchell's Ramp, Orangipuku River Mouth, Cashmere Bay and patchy vegetation at Crooked River Mouth, Lake Brunner.

Table 4 Summary of LakeSPI features for Lake Brunner 2023. Only transects used for analysis are displayed.

Site	Profile Length	Latitude	Longitude	Max depth native species >10% (m)	Max depth charophyte meadows >75% (m)	Max depth invasives >10% (m)	Ratio natives %
A	M	-42.578448	171.474940	6	5.6	5	51-75
B	S	-42.610483	171.418086	3	-	3	51-75
C	S	-42.634519	171.398475	5.5	5.2	4.7	26-50
D	M	-42.646910	171.429320	5.2	4.6	4	51-75
E	M	-42.610920	171.501190	4.7	4.4	3.2	6-25
F	L	-42.609470	171.473440	5.7	5.3	4.7	<5

Kapitea Reservoir

Surveillance was undertaken at three sites within Kapitea Reservoir (Figure 7 & 8). At the time of survey, the water level was very low and large areas of vegetation were no longer submerged. All surveillance was conducted by snorkel from shore. *Lagarosiphon major*, previously recorded here, was present at all sites.

North Ramp

Native vegetation adjacent to the main ramp consisted of turf, charophytes, milfoils and pondweeds over a short profile down to 2.8m. Invasive species present included *E. canadensis*, *J. bulbosus* and *L. major* all of which are previously known here. The native ratio was 51-75% compared to 26-50% invasives.

West Ramp

Vegetation at the west ramp was dominated by *L. major* at a ratio of 51-75% invasive to 26-50% native. *Lagarosiphon major* reached depths of 1.7m with a height of 2.8m forming dense, closed canopy patches (due to the low water level height exceeds depth). Native vegetation included emergents, turf, milfoils, pondweeds and charophytes to a depth of 2.4m. It is noted much of the turfing community was exposed at the time of survey.

Inflow

The area adjacent to the inflow was characterised by a shallow shelf extending more than 100m offshore. The majority of the recorded vegetation was on this shelf which was above the water level at the time of survey, with a slightly deeper channel flowing in from the Kumara Reservoir. Divers were unable to reach the depth limit of vegetation due to the nature of the area. The channel was dominated by dense *E. canadensis* with *L. major* and *J. bulbosus* also present at this site. Natives recorded (exposed and along the channel edge) included emergents, turf, charophytes, milfoils and pondweeds. The native ratio was 51-75% to 26-50% invasive.

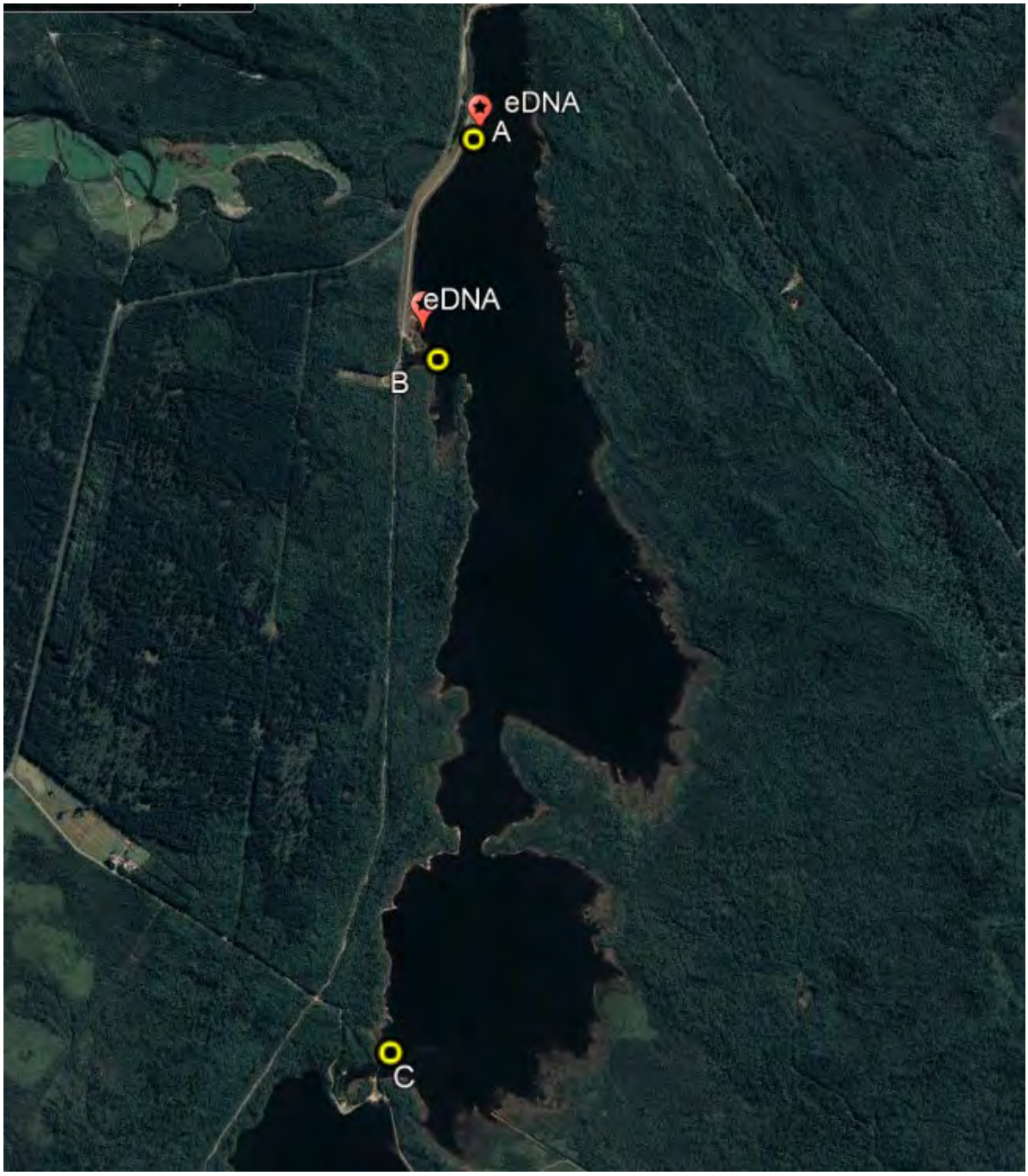


Figure 7 Locations of surveillance, Kapitea Reservoir. North ramp (A), West ramp (B) and Inflow (C).

Figure 8 Site photos – north ramp (left), west ramp (middle) and inflow (right) showing exposed vegetation.

Lake Kaniere

Surveillance was undertaken at three sites in Lake Kaniere (Figures 9 & 10). *Elodea canadensis* remained the dominant invasive species. An additional 2 LakeSPI transects were conducted with summarised results provided in Table 5.

Hans Bay

Hans Bay surveillance included a band of vegetation adjacent to the boat ramp and a LakeSPI transect was conducted north of the ramp (Figures 9 & 10). Native charophytes extended to 7.5m. Other natives present included turf plants, isoetes, milfoils and pondweeds at 51-75% ratio compared to invasive, 26-50%. Dense areas of *E. canadensis* were present down to 5.5m reaching a height of 0.9m.

Canoe Cove

Canoe Cove surveillance included the area around the outlet and walkway, with a LakeSPI transect conducted near the viewing point (Figures 9 & 10). Native vegetation included turf, charophytes, isoetes, milfoils and pondweeds at a ratio of 95% native to 5% invasive species. *Elodea canadensis* was the only invasive species recorded with occasional cover.

Sunny Bight

Sunny Bight surveillance included a shallow shelf area which sloped off to the edge of the charophytes at 6.5m (Figures 9 & 10). A LakeSPI transect was conducted to the west of the boat ramp. Native vegetation was diverse and included emergents, turf, charophytes, isoetes, milfoils and pondweeds at 51-75% ratio compared to 26-50% invasives. Invasive species included dense areas of *E. canadensis* down to 5.2m and 0.8m in height. *Ludwigia palustris* was also recorded at the surveillance site, however was not recorded on the LakeSPI transect.

Table 5 Summary of LakeSPI features for Lake Kaniere 2023

Site	Profile Length	Latitude	Longitude	Max depth native species >10% (m)	Max depth charophyte meadows >75% (m)	Max depth invasives >10% (m)	Ratio natives %
A	S	-42.805773	171.154800	7.5	7	5.5	51-75
B	S	-42.799152	171.139271	6.5	5.6	-	>95
C	S	-42.805084	171.129383	6.5	6.2	5.2	51-75
D	S	-42.860521	171.139424	7.3	5.9	-	>95
E	S	-42.858798	171.155386	7.4	6.5	-	>95

Figure 9 Sites at Lake Kaniere. Hans Bay (A), Canoe Cove (B), Sunny Bight (C) and additional LakeSPI transects (D & E).

Figure 10 From left to right, Hans Bay, Canoe Cove and Sunny Bight sites, Lake Kaniere.

Lake Mahinapua

Lake Mahinapua is a shallow lake with dark tannin-stained water, thus submerged vegetation is relatively restricted. Surveillance was undertaken at three sites with natives more common than invasives at each of the sites (Figures 11 & 12). An additional 2 LakeSPI transects were conducted in Lake Mahinapua with summarised results provided in Table 6.

Main Ramp

Mahinapua main ramp surveillance included the very shallow (<2m) area to the left and lakeward from the jetty. The water visibility during surveillance was very poor making it difficult to distinguish species. Invasive species, *E. canadensis*, *J. bulbosus* and *U. geminiscapa* were present at the site, in addition to floating *N. alba* and *A. distachyos*. Only *E. canadensis* was recorded on the LakeSPI transect with occasional cover. Native species on the transect included emergents, charophytes, milfoils and pondweeds at a ratio of 95% compared to 5% invasives. Vegetation reached a maximum depth of 1.2m.

Daylight Bight

Daylight Bight was also very shallow (<1.5m) across the entire survey site, directly out from Johnnies Creek and the treetop walkway. Native vegetation included emergents, turfing, charophytes, isoetes, milfoils and pondweeds at 95% ratio. Invasive species were occasional 5% and included *E. canadensis* and *J. bulbosus*. Other introduced species recorded during surveillance were *U. geminiscapa* and *L. palustris*. The at-risk and declining native *Myriophyllum robustum* was also recorded at Daylight Bight.

Picnic Bay

Picnic Bay surveillance was conducted at the end of Picnic Point Track. The majority of the area was shallow (<1m), with a drop-off to 3m offshore. Native emergents, turf, charophytes, isoetes, milfoils and pondweeds were all present at 95% ratio compared to 5% invasives. The main invasive present was occasional specimens of *E. canadensis* and less often, *U. geminiscapa*. Introduced *L. palustris* and *J. bulbosus* were also present along the margins.

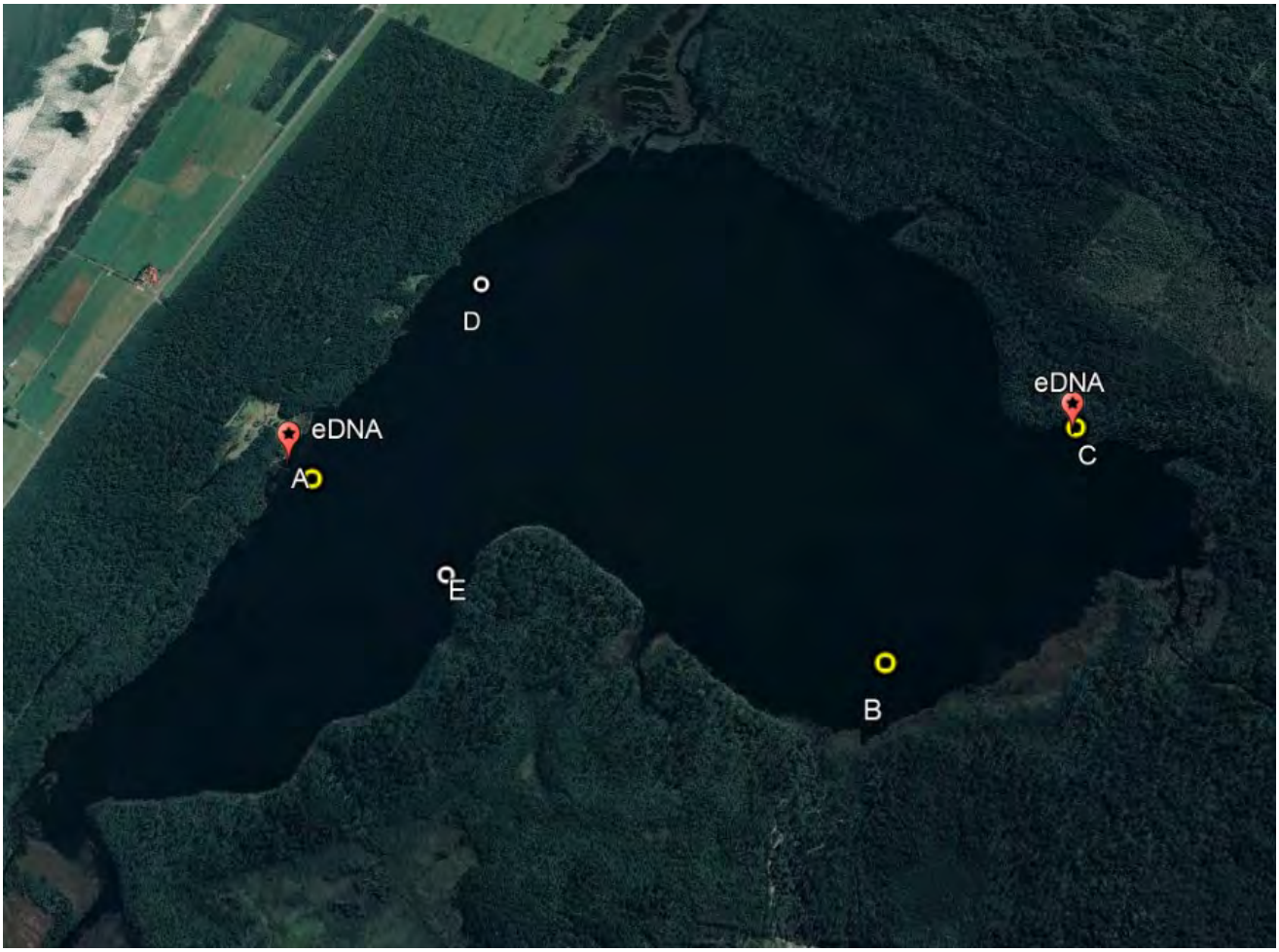


Figure 11 Lake Mahinapua surveillance sites - Main ramp (A), Daylight Bight (B) and Picnic Bay (C) and LakeSPI sites (D & E).

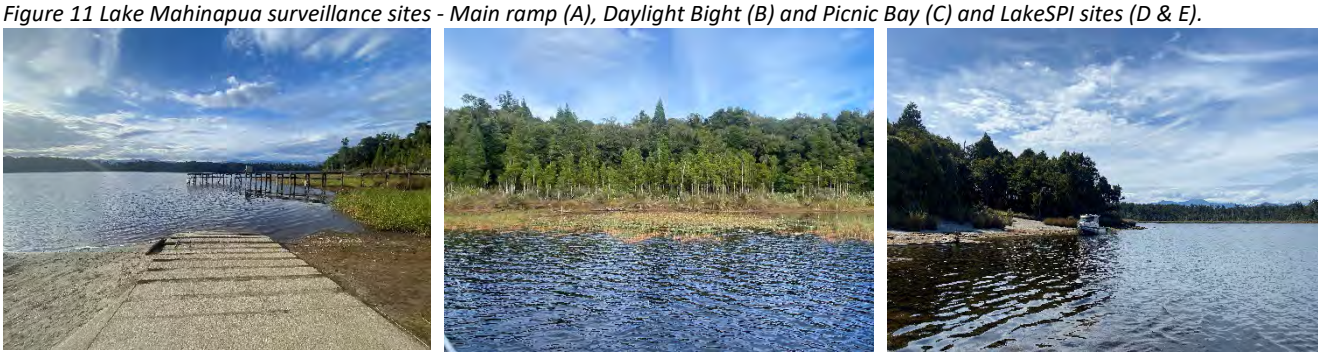


Figure 12 From left to right, Lake Mahinapua main ramp, Daylight Bight and Picnic Bay.

Table 6 Summary of LakeSPI features for Lake Mahinapua 2023

Site	Profile Length	Latitude	Longitude	Max depth native species >10% (m)	Max depth charophyte meadows >75% (m)	Max depth invasives >10% (m)	Ratio natives %
A	M	-42.796983	170.903683	1.2	1.2	-	>95
B	L	-42.802200	170.924717	1.5	1.5	-	>95
C	M	-42.795524	170.932623	2.4	2.3	-	>95
D	L	-42.790850	170.909667	1.7	1.7	-	>95
E	S	-42.799726	170.908902	2.7	2.6	-	>95

Lake Ianthe

Lagarosiphon major is known in Lakes Ianthe and Paringa, as well as Kapitea Reservoir. Three sites were surveyed in Lake Ianthe and *L. major* remains a prominent feature at all sites (Figures 13 & 14). An additional two LakeSPI transects were conducted within Lake Ianthe and summarised results are displayed in Table 7.

Main Ramp

Lagarosiphon major was common across the surveillance site. The native ratio on the LakeSPI transect was greater at 76-95% compared to 6-25% invasive. Native species included emergents, turf, isoetes, milfoils and charophytes to a depth of 4.8m. *Lagarosiphon major* was present in patches of up to 1.1m high to a depth of 3.9m. Although not present within the LakeSPI transect, native pondweeds and introduced *L. palustris* were recorded during the surveillance survey.

The Landing

Native vegetation out from the landing extended to 5.8m, with emergents, turf, charophytes, isoetes, milfoils and pondweeds present. The ratio of natives on the transect was 76-95% to 6-25% invasives. *Lagarosiphon major* was the only invasive recorded on the LakeSPI transect, found in open canopy patches down to 3.7m and 1m in height. In addition, occasional specimens of *E. canadensis* were also present.

Ianthe Creek Outlet

The shallow area surrounding Ianthe Creek Outlet had a ratio of 26-50% natives to 51-75% invasives. The invasive present was *L. major* in dense patches, 1.9m high, among charophytes and other natives. Native emergents, turfing species, charophytes, isoetes, milfoils and pondweeds were present. The surveillance area was expansive and shallow, so no maximum depths were reached for vegetation.

Table 7 Summary of LakeSPI features for Lake Ianthe 2023

Site	Profile Length	Latitude	Longitude	Max depth native species >10% (m)	Max depth charophyte meadows >75% (m)	Max depth invasives >10% (m)	Ratio natives %
A	M	-43.059833	170.633217	4.8	4	3.9	76-95
B	L	-43.049200	170.636328	5.8	5.5	3.7	76-95
C	L	-43.063764	170.612854	>2.2	>2.2	>2.2	26-50
D	M	-43.044933	170.628500	5.9	4.7	-	>95
E	M	-43.046115	170.611363	5.2	5	1.6	76-95

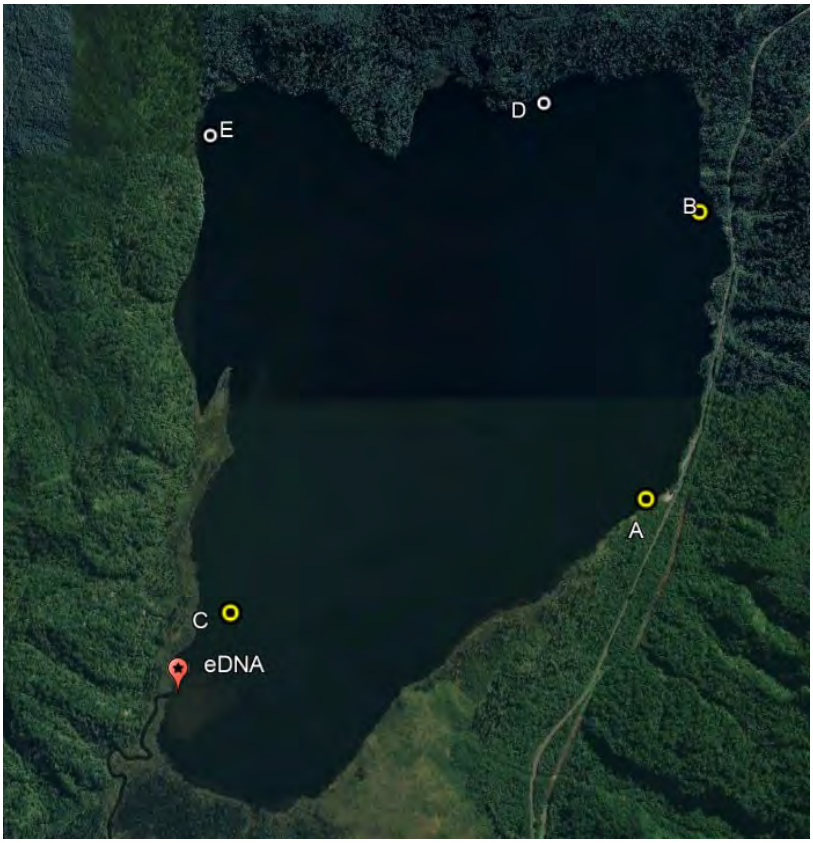
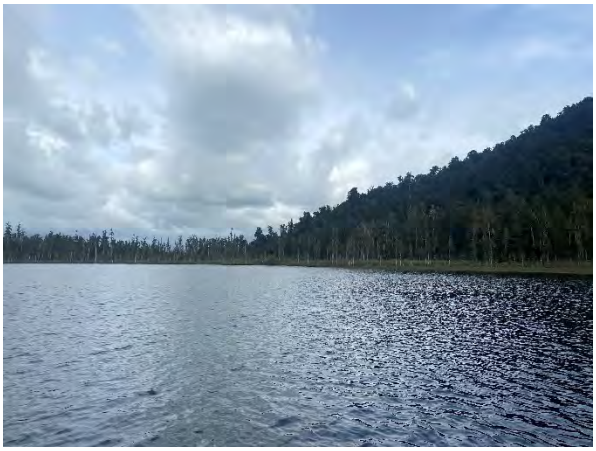


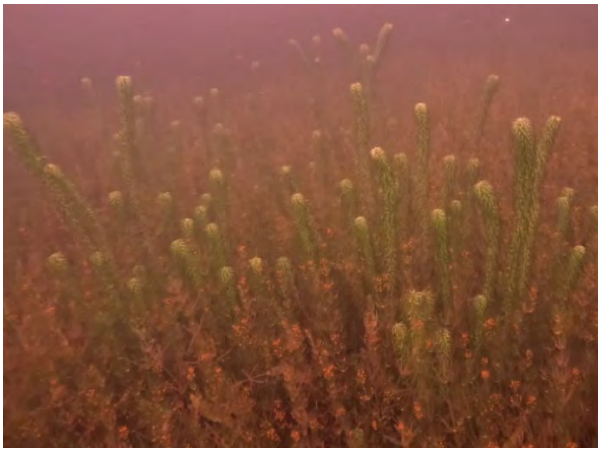
Figure 13 Lake Ianthe showing surveillance sites (yellow) and LakeSPI sites (A-E)

Figure 14 Ianthe sites. Main Ramp (A)

The Landing (B)



Ianthe Creek Outlet (C)



New L. major shoots among charophytes

Lake Mapourika

Three sites were surveyed in Lake Mapourika where *E. canadensis* was the dominant invasive species (Figures 15 & 16). An additional two LakeSPI transects were conducted in Mapourika and summarised results are displayed in Table 8.

An eDNA sample taken at the Mapourika outlet (Figure 15) detected *Phragmites australis*, a pest plant and notifiable organism under the Biosecurity Act (1993). A follow-up to this potential incursion is underway.

Main Ramp

Native vegetation adjacent to the main ramp included emergents turf, isoetes, milfoils and charophytes down to 5.4m depth. The native ratio was 51-75% to 26-50% invasive, dominated by *E. canadensis.* The *E.* canadensis was measured at 1.3m height and formed a dense, closed canopy band down to 4.2m depth. Introduced *L. palustris* and *J. bulbosus* were also present at the surveillance site.

DOC Area

Native vegetation included emergents, turf, isoetes, milfoils and charophytes at a ratio of 76-95% to 6-25% invasives. Natives reached a depth of 5.8m while invasives were shallower at 2.6m. Invasive *E. canadensis* of 1.3m height formed a dense, closed canopy and was the dominant invasive present. Introduced species, *L. palustris* and *J. bulbosus* were also recorded at this site.

Okarito Outlet

The vegetation observed surrounding Okarito River mouth was dominated by native species including emergents, turf, charophytes, isoetes and milfoils at 76-95% compared to 6-25% invasives. Charophytes reached depths of 4.7m and *E. canadensis*, 3.4m. Where present, *E. canadensis* formed a dense, closed canopy at 1.1m height. *Ludwigia palustris* and *J. bulbosus* were also present on the margins.

Table 8 Summary of LakeSPI features for Lake Mapourika 2023

Site	Profile Length	Latitude	Longitude	Max depth native species >10% (m)	Max depth charophyte meadows >75% (m)	Max depth invasives >10% (m)	Ratio natives %
A	M	-43.328224	170.214122	5.4	4.9	4.2	51-75
B	S	-43.296363	170.222280	5.8	5.8	2.6	76-95
C	M	-43.293563	170.218311	4.7	4.5	3.4	76-95
D	M	-43.311055	170.195289	5.5	4.5	3.8	76-95
E	M	-43.31528	170.21506	5	4.9	3.7	76-95

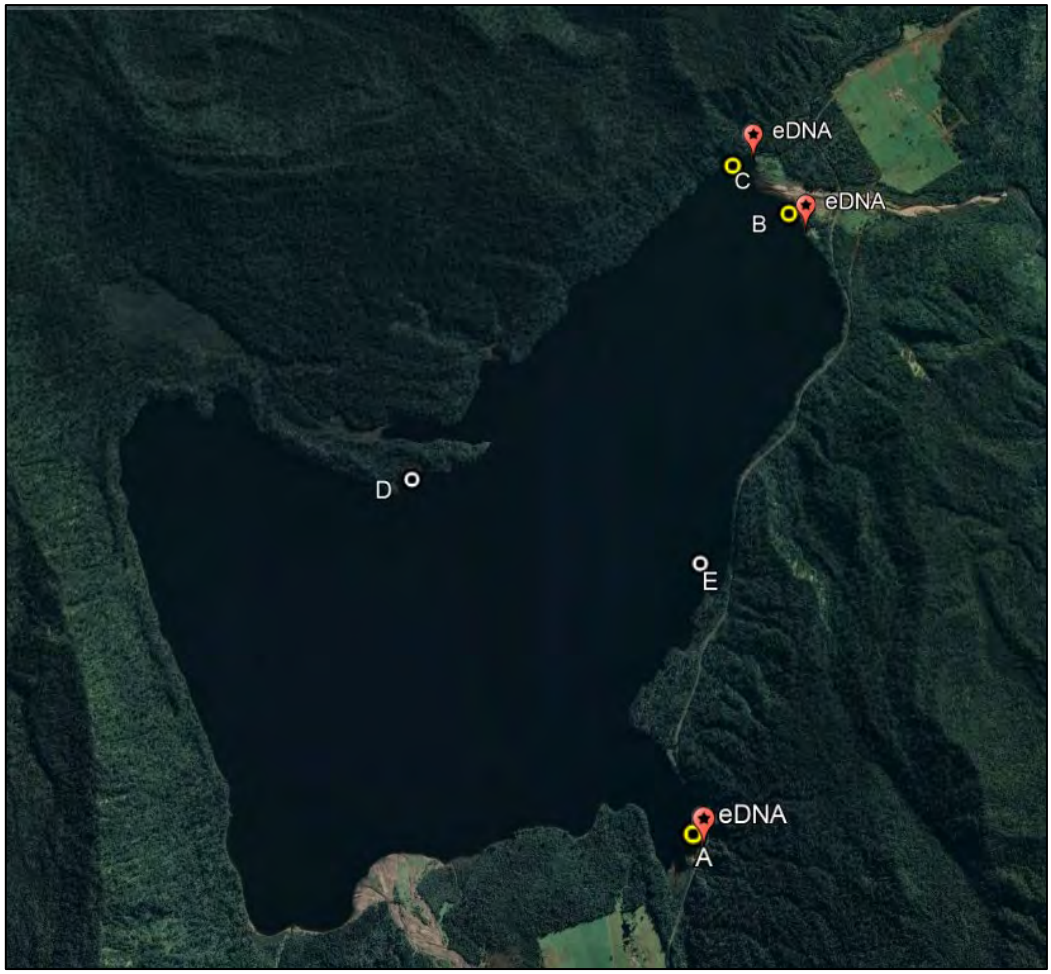


Figure 15 Lake Mapourika surveillance sites (yellow) and LakeSPI sites (A-E).

Figure 16 Mapourika surveillance sites (clockwise from top left) - Main ramp, DOC area, Okarito Outlet and southern aspect of lake.

Lake Paringa

Lagarosiphon major is known in Lake Paringa and was recorded as the dominant invasive at all surveillance sites, as well as additional LakeSPI sites (Figures 17 & 18). Three additional LakeSPI transects were conducted in Paringa with summarised results in Table 9.

Main Ramp

Native vegetation on the transect included turf, charophytes, milfoils and pondweeds, at a ratio of 6-25% compared to 76-95% invasives. Invasives included *L. major* and smaller amounts of *E. canadensis*, *U. geminiscapa* and *L. palustris*. *Lagarosiphon major* extended down to 4.1m depth reaching 1.45m height, and charophytes to 5.4m depth. Despite past treatment within the area, *L. major* dominated the transect and looked to be in good health.

Paringa Lodge

A large shallow platform extended over 100m out from the lodge jetty before eventually dropping away. *Lagarosiphon major* was dense at the site reaching 2.1m height and 4m depth. It largely accounted for 76-95% of the observed vegetation with *E. canadensis* and *L. palustris* also present to a lesser extent. Emergents, turf, charophyte and milfoils were among the native vegetation observed on the transect at a 6-25% ratio. Charophytes extended down to 6.6m depth. Closer to the jetty, a green filamentous algae was observed blanketing the bottom.

Table 9 Summary of LakeSPI features in Lake Paringa 2023

Site	Profile Length	Latitude	Longitude	Max depth native species >10% (m)	Max depth charophyte meadows >75% (m)	Max depth invasives >10% (m)	Ratio natives %
A	S	-43.721248	169.411807	5.4	4.6	4.1	6-25
B	L	-43.71463	169.420050	6.6	5.5	4	6-25
C	M	-43.714717	169.407367	5.8	5.4	4.5	6-25
D	M	-43.725917	169.398483	5.6	5.5	4.4	51-75
E	L	-43.708817	169.414400	5.8	5.1	4.3	6-25

Figure 17 Lake Paringa surveillance sites (yellow) and LakeSPI sites (A-E).


Figure 18 Lake Paringa showing topside near main ramp (left) and underwater near Paringa lodge jetty (right)

Lake Moeraki

Surveillance was undertaken in areas surrounding the two Lake Moeraki boat ramps (Figures 19 & 20). *Elodea canadensis* was the dominant vegetation at both sites and was the only invasive species recorded. An additional three LakeSPI transects were conducted in Moeraki and results summarised in Table 10.

Southern Ramp

Dense *E. canadensis* was recorded at the southern ramp site in Lake Moeraki down to 5.3m depth and 3.1m height. Native emergents, turf, charophytes, milfoils and pondweeds were present at a 6-25% ratio compared to 76-95% invasives. No other invasive species were observed.

Northern Ramp

The northern ramp site was also dominated by dense *E. canadensis* at 1.6m height and down to 4.8m depth. Invasive ratio was > 95% compared to natives. Native emergents, turf, pondweeds and charophytes were present down to 5.9m depth.

Figure 19 Lake Moeraki surveillance sites (yellow) and LakeSPI sites (A-E).

Figure 20 South Ramp area (left) and North Ramp area (right), Lake Moeraki.

Table 10 Summary of LakeSPI features in Lake Moeraki 2023

Site	Profile Length	Latitude	Longitude	Max depth native species >10% (m)	Max depth charophyte meadows >75% (m)	Max depth invasives >10% (m)	Ratio natives %
A	M	-43.732830	169.300920	5.9	5.5	5.3	6-25
B	M	-43.729867	169.292900	4	4	3.4	6-25
C	S	-43.736783	169.290183	3.5	-	5.3	6-25
D	M	-43.732900	169.274717	6.7	5.7	4.5	6-25
E	M	-43.723667	169.277800	5.9	5.8	4.8	<5

LakeSPI

LakeSPI results are presented in Table 11 showing a current lake condition based on LakeSPI results. A higher LakeSPI or Native Index reflects a better lake condition, while a higher Invasive Index, a poorer lake condition. Overall, the West Coast Lakes are ranked between moderate and high ecological condition based on the current survey.

Table 11 Values for LakeSPI, Native and Invasive Indices expressed as a percentage of each Lake's maximum scoring potential.

Lake	Current Status	LakeSPI Index	Native Index	Invasive Index
Hochstetter	Low Cover - Moderate	39.1%	26.7%	46.7%
Brunner	Moderate	36%	37.3%	63.4%
Kaniere	High	53.2	51.3%	39.3%
Mahinapua	High	68.6%	58.2%	20%
Ianthe	Moderate	45.8%	47.9%	50.4%**
Mapourika	Moderate	37.6%	43.3%	58.5%
Paringa	Moderate	32.4%	36.7%	71.1%**
Moeraki	Moderate	33.2%	34.7%	71.1%

* Physical depth of each lake was used as the key 'natural' factor limiting LakeSPI score potential. Alternatively, scores can be adjusted for dystrophic lakes where water clarity data and photic depth is available.

** *Lagarosiphon major* control has been conducted within Lakes Paringa and Ianthe, reducing the impact near main ramps. It is likely scores will change considerably following the regrowth of *L. major* in these lakes.

Recommendations

Overall, the West Coast lakes continue to present moderate to high value ecosystems in regard to native submerged vegetation and a lack of major invasive macrophytes. Therefore, early detection of invasive weed species remains an important component to lake preservation. In lakes containing major invasive weeds (Ianthe, Paringa and Kapitea), surveillance also enables a routine assessment of change to aquatic vegetation and informs management actions.

The main threat to the West Coast lakes remains the spread of *L. major* from Ianthe, Paringa or Kapitea Reservoir. Based on findings of the current survey it is recommended that WCRC and DOC consider the following:

- Continue to undertake routine lake weed surveillance within the West Coast region. Those lakes with ease of access, high use areas, high natural value, and close proximity to other lakes containing high-risk invasives (i.e., *L. major*) should be prioritised.
- Annual surveillance is suggested for lakes Brunner, Kaniere, Mahinapua, Mapourika, Ianthe, Paringa and Moeraki.
- For lower risk lakes such as Hochstetter a comprehensive surveillance survey should be undertaken every 5 years.
- Maintain an adaptive management approach and contingency plan for responding rapidly to any new weed incursion.
- Undertake a review of interpretation/signs at main entry points to ensure public are suitably aware of the risks and prevention methods to stop the spread of aquatic weeds. Consider the use of personnel (for example, a summer student or volunteers) at Lake Brunner during peak periods to educate the public around the risks of spreading invasive weeds through recreation.
- Installation of weed cordons within high use areas as a tool to compliment other biosecurity measures.

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Appendices

Appendix 1

Common indigenous vegetation observed at each lake from surveillance sites.

	Hochstetter	Brunner Main Ramp	Brunner Yacht Club	Brunner Hohonu River Mouth	Brunner Mitchel's Ramp	Brunner Orangipuku Mouth	Brunner Cashmere Bay	Brunner Crooked River Mouth
Chara sp.	+	+	+	+	+	+	+	+
Nitella sp.		+	+		+		+	
Elatine gratioloides	+	+			+			
Glossostigma sp.	+	+			+	+		
Isoetes.	+	+	+		+	+	+	
Lilaeopsis novae-zelandiae	+	+	+			+		
Myriophyllum triphyllum		+	+		+	+	+	
Myriophyllum propinquum	+	+	+	+	+	+	+	
Potamogeton cheesemanii		+	+			+		
Potamogeton ochreatus		+	+	+	+	+	+	+
Ranunculus amphitrichus		+	+		+			
Ranunculus limosella	+	+	+		+	+		
Lobelia perpusilla					+			
Callitriche petriei		+	+		+			

	Kapitea North Ramp	Kapitea West Ramp	Kapitea Inlet	Kaniere Sunny Bight	Kaniere Hans Bay	Kaniere Canoe Cove	Mahinapua Main Ramp	Mahinapua Daylight Bight	Mahinapua Picnic Bay
Chara sp.	+	+	+	+	+	+	+	+	+
Nitella sp.	+	+		+	+	+	+	+	+
Elatine gratioloides			+	+	+	+			
Glossostigma sp.	+	+	+	+		+			+
Isoetes				+	+	+	+	+	+
Lilaeopsis novae-zelandiae		+		+		+		+	
Myriophyllum triphyllum				+	+	+		+	
Myriophyllum propinquum	+	+	+	+	+	+	+	+	+
Potamogeton cheesemanii		+	+	+			+		
Potamogeton ochreatus	+	+	+	+	+	+	+	+	+
Ranunculus amphitrichus								+	+
Ranunculus limnosella					+				
Lobelia perpusilla			+	+	+			+	+
Callitriche petriei	+	+		+	+			+	+
Crassula sp				+	+	+	+		
Pilularia novae-zelandiae				+	+				

	Ianthe Main Ramp	Ianthe The Landing	Ianthe Creek Outlet	Mapourika Main Ramp	Mapourika DOC area	Mapourika Okarito Outlet	Paringa Main Ramp	Paringa Lodge jetty	Moeraki North	Moeraki South
Chara sp.	+	+	+	+	+	+	+	+	+	+
Nitella sp.	+	+		+	+	+	+	+	+	+
Elatine gratioloides		+					+	+		+
Glossostigma sp.	+	+	+	+	+		+	+	+	+
Isoetes	+	+	+	+	+	+	+		+	
Lilaeopsis novae-zelandiae				+		+	+		+	+
Myriophyllum triphyllum	+	+			+		+	+		+
Myriophyllum propinquum	+	+	+	+	+	+	+	+	+	+
Potamogeton cheesemanii	+	+				+			+	
Potamogeton ochreatus	+	+	+	+			+	+	+	+
Ranunculus amphitrichus					+	+			+	+
Ranunculus limnosella	+			+	+	+	+		+	
Lobelia perpusilla			+						+	+
Callitriche petriei	+				+		+	+		
Crassula sp.			+	+	+					
Pilularia novae-zelandiae				+					+	

Introduced surveillance species detected in eDNA sampling.

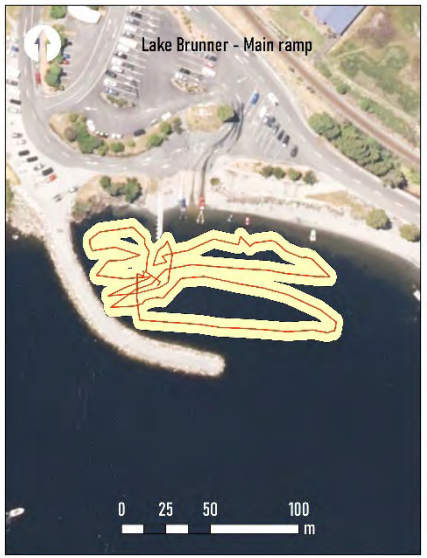
Lake	Plants						Fish					
	Lagarosiphon major	*Elodea canadensis*	*Ludwigia sp.*	*Aponogeton distachyos*	*Utricularia Sp.*	*Phragmites australis*	*Ameiurus nebulosus*	*Carassius auratus*	*Perca fluviatitis*	*Salmo trutta*	*Scardinius erythrophthalmus*	*Cypriniformes*
Brunner-Main Ramp		+	+					+		+		+
Brunner-Mitchell's		+	+							+		
Brunner-Cashmere		+	+					+		+		+
Kapitea-Main Ramp									+			
Kapitea-Ramp 2	+								+			
Kaniere-Hans Bay									+	+		
Kaniere-Sunny Bight		+			+				+			
Mahinapua-Main Ramp		+	+	+	+		+	+	+			+
Mahinapua-Picnic Bay			+		+		+	+	+			+
Ianthe-Outlet	+		+								+	
Mapourika- Main Ramp		+								+		
Mapourika-DOC Area		+	+							+		
Mapourika-Okarito Outlet			+			+						
Paringa-Main Ramp	+									+		
Moeraki-South Ramp		+								+		

Appendix 2

eDNA Methodology (as per Wilderlab NZ instructions)

1. Take the gloves out of the sample bag, put them on, and take out the large syringe.
2. Draw up 50 ml of water from just below the surface of the water. Take care not to suck up any sediment from the bottom.
3. Screw the filter on the large syringe taking care not to overtighten.
4. Push the plunger down to squeeze the water out through the filter. Avoid getting air bubbles in the filter as they can be difficult to push through.
5. Unscrew the filter from the large syringe.
6. Repeat steps 2-5 until the filter is clogged and water is only dripping out, or until 1L is filtered (20 syringefuls), whichever comes first. If using a caulking gun do not force water through too hard or the filter may rupture.
7. Unscrew the filter, draw 50 ml of air into the large syringe, re-attach the filter, and holding the syringe vertically with the filter pointing down, force the air through to squeeze out the remaining water from the filter. Leave the filter attached to the large syringe for the next step.
8. Holding both the large syringe (with filter attached) and the small syringe (with black cap attached) in the same hand and in an upright position, unscrew the black cap from the small syringe and screw the black cap on to the outlet end of the filter. See figure (A) below.
9. Unscrew the filter (with the black cap still attached) from the large syringe and screw it on to the small syringe (B-C). Push the plunger to inject the preservative into the filter (D). Shake well while holding the plunger down. Do not remove the syringe or cap from the filter. Don't worry if there are air bubbles in the filter or if the plunger springs back – this is normal.
10. Place the filter with both the black cap and small syringe still attached into the clear zip-lock sample bag and seal (E).
11. Record the sample details on the ziplock bag in the space provided. Ensure that the coordinates are entered in WGS84 decimal format (for example -41.30951, 174.82110 as displayed on google maps).
12. Fill out the eDNA sample submission form at wilderlab.co.nz/submit-samples and include a hard copy with the samples.
13. Send the samples by standard courier (no refrigeration necessary) to:
Wilderlab NZ Ltd
Level 2, 129 Park Road
Miramar
Wellington 6022

Appendix 3 – GPS Tracks



Appendix 3 – GPS Tracks

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