



# West Coast Lakes aquatic weed surveillance 2021

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# Executive summary

The Bay of Plenty Regional Council surveyed nine lakes throughout the West Coast of the South Island between 16 February and 20 February 2021, for freshwater pest plants and freshwater plant assessments. None of the freshwater pest plant species of interest to New Zealand were visually detected at any new sites. *Lagarosiphon major* was noted in two lakes, where it was previously known to be present Lake lanthe and Lake Paringa. *Egeria densa* was detected at three new sites, using eDNA analysis, but it is likely that these results were false positives and there is follow-up work underway to investigate this.

Visual survey methods used to assess presence of freshwater plants, followed protocols similar to the National Institute of Water and Atmospheric Research's (NIWAs) Lake SPI surveys. Systematic scuba surveillance techniques were utilised at the lake sites in order to collect comprehensive data for freshwater plants. Underwater video footage was collected at all sites.

eDNA monitoring was undertaken at all nine lakes, within the surveillance area at each site, and samples were analysed for pest plants and pest fish.

This project was co-funded by the West Coast Regional Council and the Department of Conservation.

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# Introduction

The West Coast Lakes Surveillance programme is an annual survey undertaken with the purpose of providing early detection of invasive freshwater pest plant incursions to West Coast lakes. Of particular interest is the invasive oxygen weed *Lagarosiphon major* (hereafter referred to as lagarosiphon). Lagarosiphon was first detected in the North Island in the Rotorua district in the 1950s, and subsequently spread around New Zealand. Lagarosiphon was first detected on the South Island's West Coast in 1998 <sup>(1, 2)</sup> is widespread in the Grey River and other small waterbodies, and is present in Lake Ianthe, Lake Paringa, and the Kapitea Reservoir.

Past attempts to eradicate lagarosiphon from areas where it has become established have been proved to be resource intensive. Lagarosiphon was successfully eradicated from Lake Waikaremoana in 2000–2007, and again in 2010. That said, a recent incursion in 2012 is proving more problematic to eradicate and efforts towards this are ongoing. Early detection of invasive freshwater pest plant species before they become widespread will give any incursion response a greater chance of success and will significantly reduce the costs involved.

Like many freshwater plant pests, lagarosiphon can be spread via small plant fragments. Likely vectors include boats and trailers, eel fishing nets, excavation machinery and angling or duck shooting gear. Based on this, the West Coast survey sites were chosen mainly due to their accessibility for boats and trailers, and areas where lagarosiphon and other pest macrophytes would be most likely to establish if introduced at those access points.

Multi species DNA samples were collected at each site. The multispecies eDNA test is designed specifically for Aotearoa's waterways, and is ideally suited to monitoring fish, mammals, birds, amphibians, freshwater invertebrates, freshwater pest plants, tunicates, fungi and bacteria. This method has huge potential but is still being refined, and so is currently used in conjunction with other methods. Further development will hopefully enable this method to be used more reliably as a stand-alone tool.

## Freshwater plants

Three main freshwater plant communities characterise New Zealand lakes (see Figure 1):

- The low-growing turf community is found at the shallowest depths, extending down to 3 m–4 m and generally comprises native species.
- Below this turf community is the taller vascular plant community, extending to depths of approximately 7 m.
- The native *Characean* algal community tends to overlap with the taller vascular plants, and the maximum depth of this community depends on water clarity and light penetration. They can be found at depths of up to 13 m.

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<sup>1</sup> Corne, C. 2019. Southland Lakes Aquatic Weeds Surveillance Programme 2019. Unpublished report, Department of Conservation, Te Anau (DOC-6072208).

<sup>2</sup> Belton, T. 2010 Lagarosiphon Management Plan for West Coast Conservancy. Unpublished report, Department of Conservation, Hokitika (docdm-573204).

There is some overlap with each of the communities. Lagarosiphon has similar light requirements to that of the tall vascular plant community, so it is the 1 m-7 m depth zone that comprises the main focus of the survey. The most common list of species identified during the surveys can be found in Appendix 1.

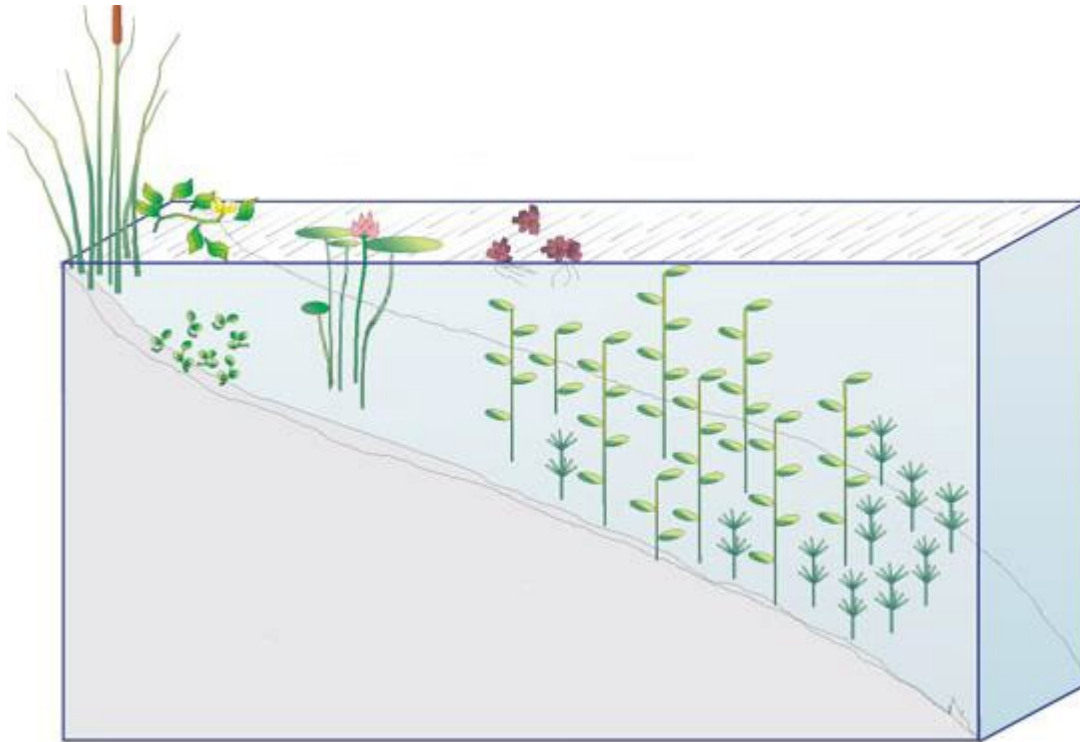


Figure 1 Freshwater plant communities of lakes (adapted from NIWA, 2012<sup>3</sup>)

## Methodology

Surveys at each site followed the same methodology that the Bay of Plenty Regional Council use during their Rotorua Lakes invasive pest plant surveillance with the inclusion of NIWA lake SPI data collection method (see Figure 4). This was undertaken over the survey area and not via a transect run. Environmental DNA (eDNA) samples were collected at one point in each survey area.

### Visual survey methodology

The systematic sampling design placed sample locations within an area on the basis of a grid, with a predetermined spacing between divers. The spacing between the divers was determined by the visibility (1 m-2 m) at each site. The divers initially dived down to the deepest point where a pest plant bed would extend to (normally 4 m-8 m), and then they made their way up the gradient to shallow water where the survey finished (see Figure 2). Swimming was assisted by underwater dive scooters, where visibility permitted. Diver 1 had a GoPro camera attached so a reference video could be viewed as part of the survey. Diver 1 also had a GPS to capture a track of the survey area. The GPS track was then expanded within ArcGIS via a buffer to the visibility level the diver noted during the survey (Figure 3). This allowed for a calculation as the resulting survey

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<sup>3</sup> NIWA. (2012) Species guide – Aquatic Biodiversity and Biosecurity. Retrieved from <http://www.niwa.co.nz/our-science/aquatic-biodiversity-and-biosecurity/our-services/aquaticplants/outreach/species>



(shape file polygon) area and the dive time, to calculate  $m^2$  covered within the survey area per minute (see Appendix 1). Other data that was collected during the dive included bottom time, depth bands of plants, date, species list and Lake SPI data.

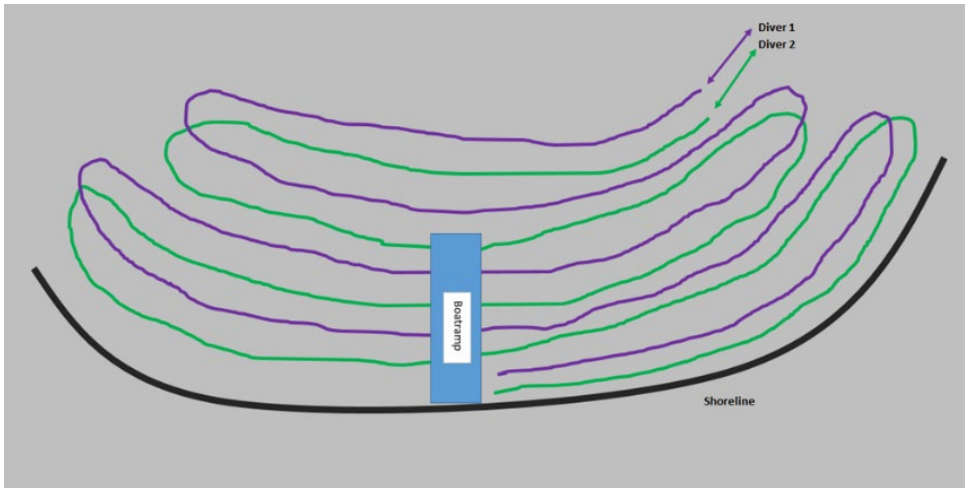


Figure 2 Representation of systematic survey at each site

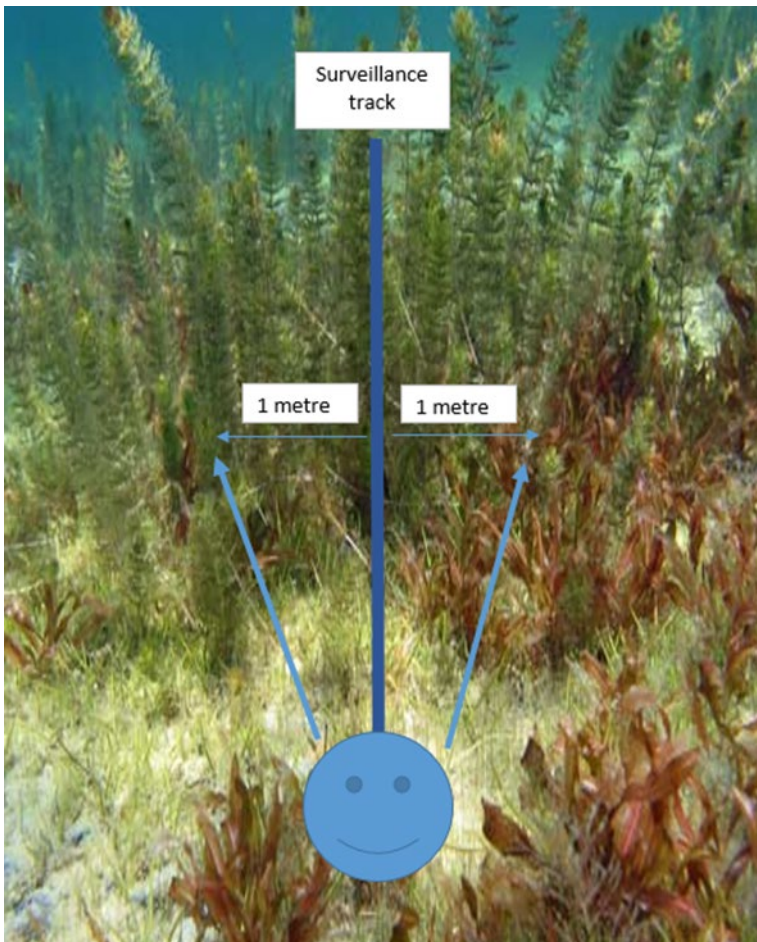


Figure 3 Underwater representation of surveillance track and visual extent of diver

## Lake SPI

Lake Submerged Plant Indicators (Lake SPI) is comprised of three indices: Native Condition Index, Invasive Impact Index and an overall Lake SPI Index. Lake SPI is a survey method for the assessment of ecological condition of Aotearoa/New Zealand lakes and can be characterised by the composition of native and invasive plants growing in them, and the depths to which these plants grow. The data sheet for Lake SPI is displayed in Figure 4.

Methodology was similar to guidelines described in the LakeSPI User Manual Version 2 (NIWA 2006<sup>4</sup>), except that sites were limited to survey areas rather than transects. This means that the results are applicable only to the survey area, rather than the whole lake.

LAKE:		SITE:      A    B    C    D    E				
DATE:		SURVEYOR:				
PROFILE LENGTH: <25m    25–100m    >100m		GPS:				
SITE DESCRIPTION:						

<b>NATIVE VEGETATION</b>	<b>MAXIMUM DEPTH</b>	<input type="text"/> NATIVES (>10% cover) <input type="text"/> CHAROPHYTE MEADOWS (> 75% cover)	
	<b>NATIVE PRESENCE</b>	<input checked="" type="checkbox"/> Emergents <input type="text"/> Turf Plants <input type="text"/> Charophytes <input type="text"/> Isoetes <input type="text"/> Milfoils <input type="text"/> Pondweeds	> 5 m
	<b>RATIO (%)</b>	<input type="text"/> < 5 <input type="text"/> 6 – 25 <input type="text"/> 26 – 50 <input type="text"/> 51 – 75 <input type="text"/> 76 – 95 <input type="text"/> > 95	
<b>INVASIVE VEGETATION</b>	<b>INVASIVE MAXIMUM DEPTH</b>	<input type="text"/> (>10% cover)	
	<b>INVASIVE SPECIES</b>	HEIGHT (m)      = 100% <input type="text"/> Elodea <input type="text"/> Egeria <input type="text"/> Lagarosiphon <input type="text"/> Ceratophyllum <input type="text"/> Hydrilla <input type="text"/> Pot. crispus <input type="text"/> Juncus bulbosus <input type="text"/> Ranunculus tri. <input type="text"/> Vallisneria spp. <input type="text"/> Utricularia gibba	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
	<b>RATIO (%)</b>	<input type="text"/> < 5 <input type="text"/> 6 – 25 <input type="text"/> 26 – 50 <input type="text"/> 51 – 75 <input type="text"/> 76 – 95 <input type="text"/> > 95	
<b>MUSSELS</b> <input type="text"/> <b>KOURA</b> <input type="text"/>		<b>OTHER BIOTA NOTED</b> (eg snails, fish, algae)	
<b>NATURE OF INVASIVE COVER</b>		<input type="text"/> OCCASIONAL <input type="text"/> COMMON <input type="text"/> OPEN CANOPY <input type="text"/> PARTLY CLOSED <input type="text"/> CLOSED	
<b>COMMENTS</b> (profile sketch, land use)			

Figure 4 Lake SPI data sheet

<sup>4</sup> NIWA. (2006) LakeSPI User Manual Version 2. Retrieved from [https://niwa.co.nz/sites/niwa.co.nz/files/import/attachments/lakespi\\_manual.pdf](https://niwa.co.nz/sites/niwa.co.nz/files/import/attachments/lakespi_manual.pdf)



## eDNA

Environmental DNA sampling followed the Wilderlab NZ methodology (Appendix 3). One sample was taken at each site within the surveyed area, with extra samples taken at the Lake Mahinapua survey site and at the Lake Brunner Yacht Club. Date and time of sampling, location, and filtered volume were all recorded. eDNA sample sites are displayed within Table 2. All samples were processed for the presence of plants and animals.

## Sites

Sites that were surveyed and the method undertaken are displayed within Table 1. Lake Pratt was initially considered for surveillance but removed due to difficult of access. The Orangipuku mouth on Lake Brunner was not surveyed this year due to restricted access (his site requires access by boat).

*Table 1 West Coast Freshwater Pest Plant Survey locations and methods, 2021*

Lake Sites		Date	Method	eDNA sample taken	Video taken
Lake Brunner	Iveagh Bay Campground	16/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Brunner	Iveagh Bay boat ramp	16/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Brunner	Main Beach boat ramp	16/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Brunner	Mitchells Beach	16/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake lanthe	Main boat Ramp	17/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Kaniere	Main boat ramp	16/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Kaniere	DOC area	17/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Mahinapua	Boat Ramp	17/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Mapourika	Roadside	18/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Mapourika	Boat ramp	18/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Matheson	Lookout	18/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Moeraki	South ramp	19/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Moeraki	North ramp	20/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Paringa	Main boat ramp	18/02/2021	SCUBA - Scooter systematic search	Yes	Yes
Lake Wahapo	Entry point	17/02/2021	SCUBA - Scooter systematic search	Yes	Yes

Table 2 eDNA samples and locations

Location	Date Sent to Lab	Sample Number	Date sample taken	Time	Volume (mL)	Latitude	Longitude	Analysis Undertaken
Lake Brunner Iveagh Bay boat ramp	25/02/2021	502128	16/02/2021	12:33 pm	500	171.5011325	-42.6102760	Multispecies PCR
Lake Brunner Iveagh Bay Campground	25/02/2021	501021	16/02/2021	10:44 am	350	171.5006891	-42.6146262	Multispecies PCR
Lake Brunner main beach boat ramp	25/02/2021	501065	16/02/2021	9:00 am	350	171.4705473	-42.5762223	Multispecies PCR
Lake Brunner Mitchells Beach	25/02/2021	501062	16/02/2021	1:30 pm	400	171.3987617	42.6349774	Multispecies PCR
Lake Brunner Yacht club (eDNA only)	25/02/2021	501061	16/02/2021	9:33 am	350	171.478239	-42.5773502	Multispecies PCR
Lake lanthe main boat ramp	25/02/2021	501033	18/02/2021	9:55 am	350	170.6340543	-42.0595573	Multispecies PCR
Lake Kaniere DOC area	25/02/2021	501855	17/02/2021	1:10 pm	400	171.12884	-42.8044104	Multispecies PCR
Lake Kaniere main boat ramp	25/02/2021	501856	17/02/2021	11:55 am	350	171.1546226	-42.8069977	Multispecies PCR
Lake Mahinapua boat ramp	25/02/2021	502133	17/02/2021	3:45 pm	80	170.9025969	-42.7962024	Multispecies PCR
Lake Mahinapua boat ramp	25/02/2021	501020	17/02/2021	3:45 pm	50	170.9025969	-42.7962024	Multispecies PCR
Lake Mapourika roadside	25/02/2021	501043	18/02/2021	3:15 pm	500	170.221919	-43.3067853	Multispecies PCR
Lake Mapourika boat ramp	25/02/2021	501048	18/02/2021	3:50 pm	500	170.2140118	-43.3290492	Multispecies PCR
Lake Matheson lookout	25/02/2021	501052	19/02/2021	10:50 am	350	169.9654918	-43.4403452	Multispecies PCR
Lake Moeraki north ramp	25/02/2021	501059	20/02/2021	1:50 pm	200	169.2776354	-43.7233514	Multispecies PCR
Lake Moeraki south ramp	25/02/2021	501056	20/02/2021	1:05 pm	250	169.3012764	-43.7329574	Multispecies PCR
Lake Paringa main boat ramp	25/02/2021	502127	20/02/2021	11:13 am	500	169.4112256	-43.7213239	Multispecies PCR
Lake Wahapo entry point	25/02/2021	501051	18/02/2021	1:29 pm	200	170.2458553	-43.2535490	Multispecies PCR

## Results

Lagarosiphon was detected at two sites, Lake lanthe and Lake Paringa. Refer to Appendix 2 for all species found per site. The majority of the species listed in the tables are native. *Elodea canadensis* (an introduced freshwater plant) is widespread at many sites, such as Lake Brunner. No *Elodea canadensis* was detected at Lake Matheson. Appendix 4 contains a subset of the eDNA results for all sites sampled, listing only the plant and animal species of current surveillance concern. A spreadsheet containing all of the eDNA results is available separately. Note that three sites (Brunner, Moeraki and Mapourika) showed up positive for egeria, via eDNA, but subsequent additional analysis of the samples and plant matter has shown these to be false positives.

### Lake Brunner main beach boat ramp

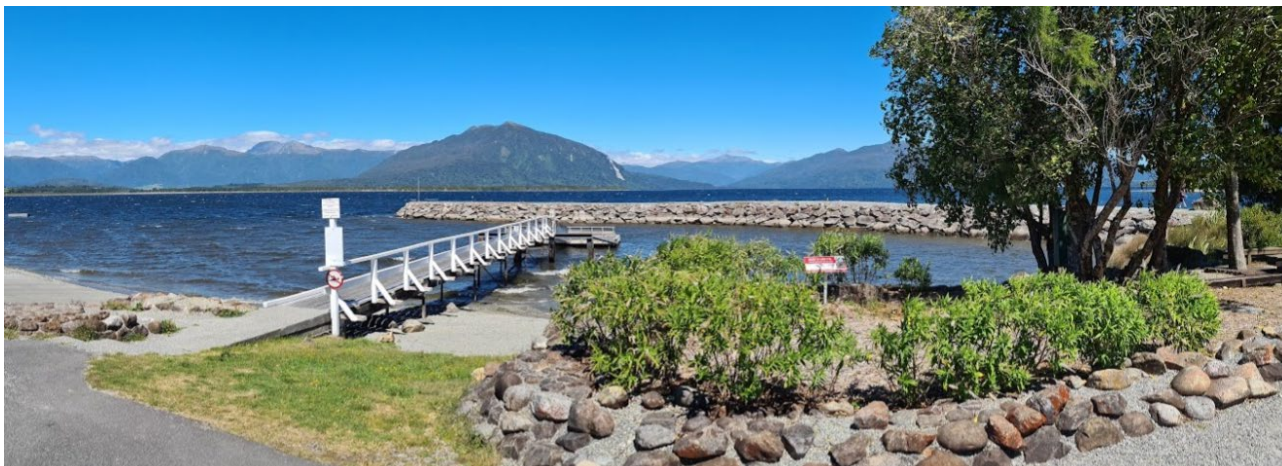


Figure 5 Lake Brunner boat ramp site



Figure 6 Lake Brunner (boat ramp) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 4299 m<sup>2</sup> with 172 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.



The native vegetation at this site consisted of turf plants, charophytes, isoetes, milfoils and pondweeds and were noted to a depth of 3 m. The native index within the survey site was 76%-95% when compared to invasives which was 6%-25%. The invasive species present at this site was *Elodea canadensis*.

## Lake Brunner Iveagh bay campground



Figure 7 Lake Brunner Iveagh Bay site



Figure 8 Lake Brunner (Iveagh Bay campground) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 5233 m<sup>2</sup> with 194 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of turf plants, charophytes, milfoils and pondweeds and were noted to a depth of 3 m. The native index within the survey site was 6%-25% when compared to invasives which was 51%-75%. The invasive species present at this site was *Elodea canadensis*.



## Lake Brunner Iveagh Bay boat ramp



Figure 9 Lake Brunner Iveagh Bay boat ramp site

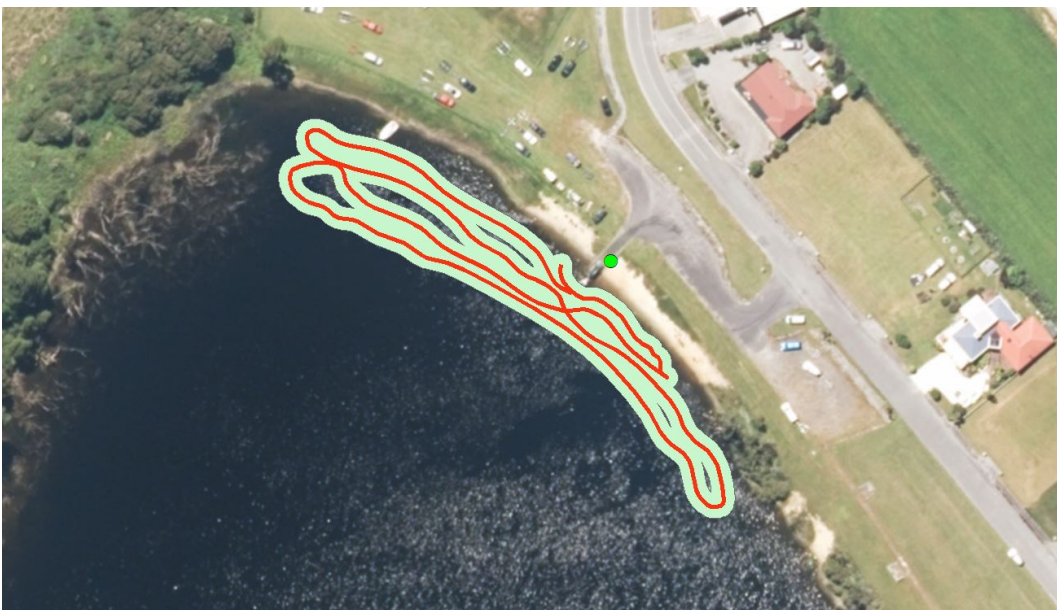


Figure 10 Lake Brunner (Iveagh Bay boat ramp) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 2966 m<sup>2</sup> with 98 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of turf plants, charophytes, milfoils and pondweeds and were noted to a depth of 5.4 m. The native index within the survey site was 6%-25% when compared to invasives which was 51%-75%. The invasive species present at this site was *Elodea canadensis*.



## Lake Brunner Mitchells beach



Figure 11 Lake Brunner Mitchell's beach



Figure 12 Lake Brunner (Mitchell's beach) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 1715 m<sup>2</sup> with 132 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of turf plants, charophytes, isoetes, milfoils and pondweeds and were noted to a depth of 3 m. The native index within the survey site was 51%-75% when compared to invasives which was 51%-75%. The invasive species present at this site were *Potamogeton crispus* and *Elodea canadensis*.

## Lake Kaniere main boat ramp



Figure 13 Lake Kaniere main boat ramp site

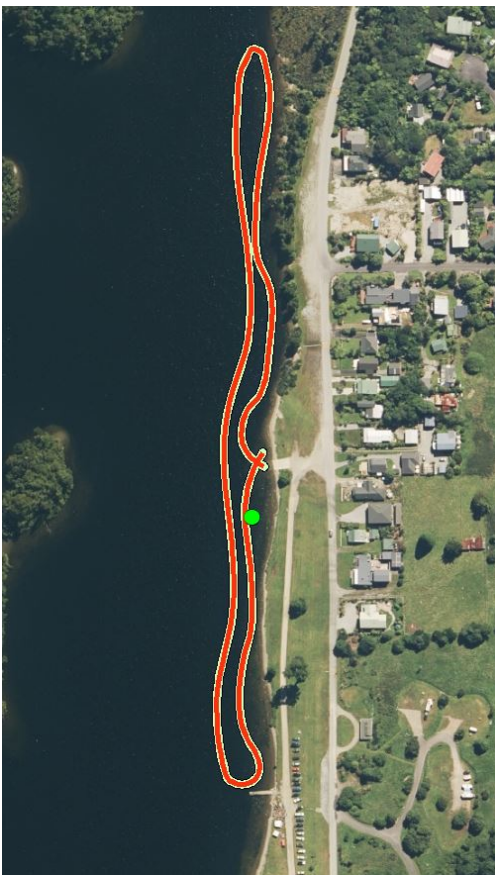


Figure 14 Lake Kaniere (Main beach boat ramp) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 6219 m<sup>2</sup> with 164 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of turf plants, charophytes, isoetes, milfoils and pondweeds and were noted to a depth of 5 m. The native index within the survey site was 51%-75% when compared to invasives which was 6%-25%. The invasive species present at this site was *Elodea canadensis*.



## Lake Kaniere DOC area



Figure 15 Lake Kaniere DOC area site



Figure 16 Lake Kaniere (DOC camp area) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 3582 m<sup>2</sup> with 224 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of turf plants, charophytes, isoetes, milfoils and pondweeds and were noted to a depth of 4 m. The native index within the survey site was 51%-75% when compared to invasives which was 26%-50%. The invasive species present at this site was *Elodea canadensis*.

## Lake Mahinapua boat ramp



Figure 17 Lake Mahinapua boat ramp site

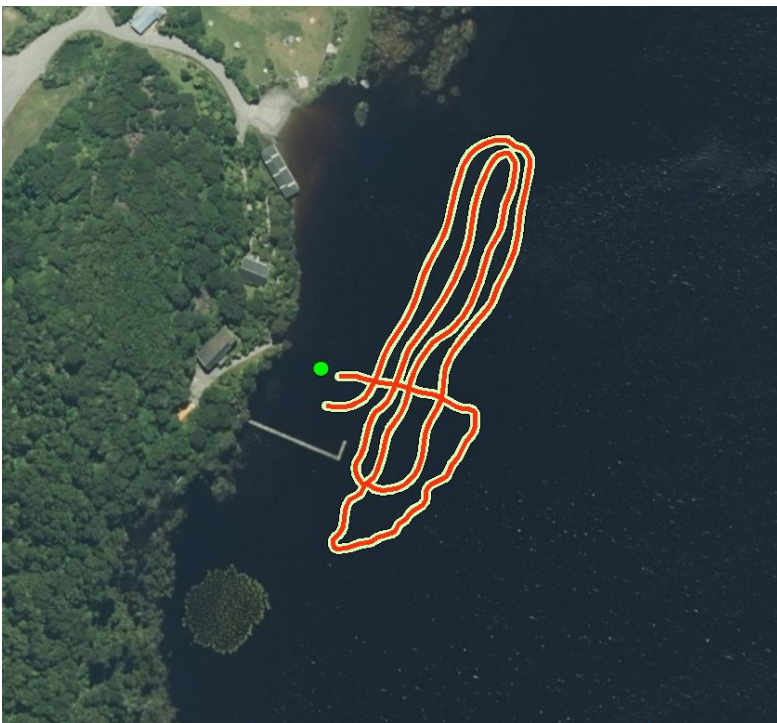


Figure 18 Lake Mahinapua (DOC camp area) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 2718 m<sup>2</sup> with 54 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of turf plants, charophytes, isoetes, milfoils and pondweeds and were noted to a depth of 2 m. The native index within the survey site was <95% when compared to invasives which was <5%. The invasive species present at this site was *Elodea canadensis*.



## Lake lanthe main boat ramp



Figure 19 Lake lanthe main boat ramp site



Figure 20 Lake lanthe (main boat ramp) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 3820 m<sup>2</sup> with 112 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of emergent, turf plants, charophytes, isoetes, milfoils and pondweeds and were noted to a depth of 4 m. The native index within the survey site was <95% when compared to invasives which was <5%. The invasive species present at this site was *Lagarosiphon major*.



Good lagarosiphon control was noted within the survey area. See Figure 21.



*Figure 21 Lagarosiphon control in Lake lanthe*

## Lake Wahapo entry point



Figure 22 Lake Wahapo entry point site



Figure 23 Lake Wahapo (entry point) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 2073 m<sup>2</sup> with 56 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of charophytes and milfoils and were noted to a depth of 4 m. The native index within the survey site was 76%-95% when compared to invasives which was 6%-25%. The invasive species present at this site was *Elodea canadensis*.



## Lake Mapourika road side



Figure 24 Lake Mapourika (road side)



Figure 25 Lake Mapourika (road side) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 1044 m<sup>2</sup> with 52 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of turf plants, charophytes and milfoils which were noted to a depth of 4 m. The native index within the survey site was 75%-95% when compared to invasives which was <5%. The invasive species present at this site was *Elodea canadensis*.

## Lake Mapourika boat ramp



Figure 26 Lake Mapourika boat ramp site

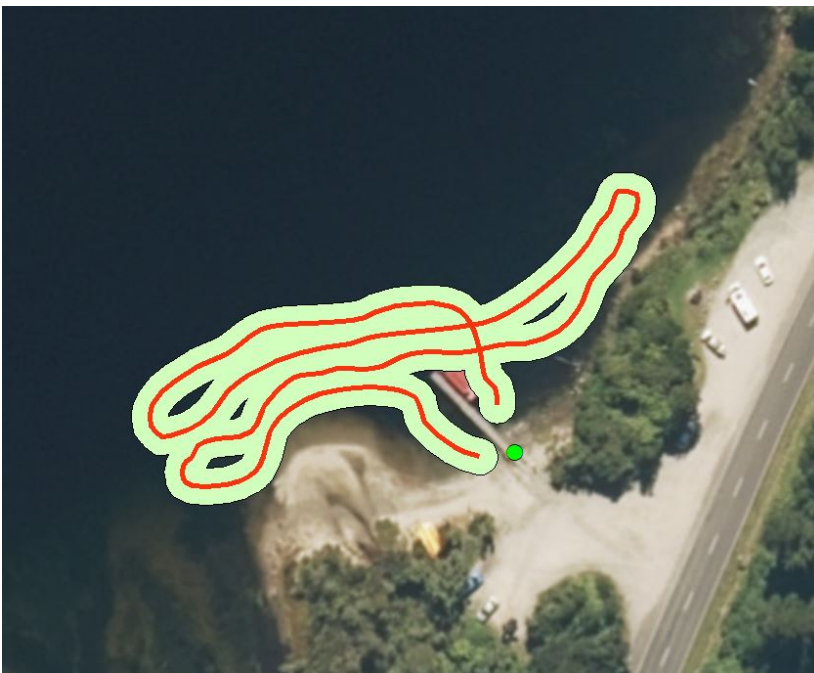


Figure 27 Lake Mapourika (boat ramp) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 1656 m<sup>2</sup> with 75 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of emergent, turf plants, charophytes and milfoils which were noted to a depth of 4.5 m. The native index within the survey site was 51%-75% when compared to invasives which was 26%-50%. The invasive species present at this site was *Elodea canadensis*.



## Lake Matheson lookout



Figure 28 Lake Matheson lookout site



Figure 29 Lake Matheson (lookout) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 159 m<sup>2</sup> with 16 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of emergent, turf plants and milfoils which were noted to a depth of 2.5 m. The native index within the survey site was >95% when compared to invasives which was 0%. No invasive species were present at this site.



## Lake Paringa Main boat ramp



Figure 30 Lake Paringa main boat ramp site



Figure 31 Lake Paringa (main boat ramp) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 4211 m<sup>2</sup> with 114 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of emergent, turf plants, charophytes and milfoils which were noted to a depth of 4.7 m. The native index within the survey site was 51%-75% when compared to invasives which was 26%-50%. The invasive species present at this site were *Elodea canadensis* and *Lagarosiphon major*.

## Lake Moeraki south ramp



Figure 32 Lake Moeraki south ramp site



Figure 33 Lake Moeraki (south ramp) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 2104 m<sup>2</sup> with 105 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of emergent, turf plants, charophytes and milfoils which were noted to a depth of 4.2 m. The native index within the survey site was 51%-75% when compared to invasives which was 51%-75%. The invasive species present at this site was *Elodea canadensis*.



## Lake Moeraki north ramp



Figure 34 Lake Moeraki north ramp site



Figure 35 Lake Moeraki (north ramp) surveys track (red with yellow buffer) including eDNA site (green dot)

The total area surveyed within this site was 1339 m<sup>2</sup> with 38 m<sup>2</sup> surveyed per minute. Species list noted during this site survey is within Appendix 2.

The native vegetation at this site consisted of emergent, turf plants, charophytes and milfoils which were noted to a depth of 4 m. The native index within the survey site was 26%-50% when compared to invasives which was 26%-50%. The invasive species present at this site was *Elodea canadensis*.



# Appendices

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# Appendix 1:

## Overview of survey areas

2021		Area (m <sup>2</sup> )	Dive time (min)	m <sup>2</sup> per minute	Video
Lake Brunner	Lake Brunner Iveagh bay Campground	5233	27	194	Yes
Lake Brunner	Lake Brunner Iveagh bay boat ramp	2648	27	98	Yes
Lake Brunner	Lake Brunner Main Beach boat ramp	4299	25	172	Yes
Lake Brunner	Lake Brunner Mitchells Beach	1715	13	132	Yes
Lake Lanthe	Lake Lanthe main Boat Ramp	3820	34	112	Yes
Lake Kaniere	Lake Kaniere Boat ramp	6219	38	164	Yes
Lake Kaniere	Lake Kaniere DOC area	3582	16	224	Yes
Lake Mahinapua	Lake Mahinapua boat Ramp	2718	50	54	Yes
Lake Mapourika	Lake Mapourika boat ramp	1656	22	75	Yes
Lake Mapourika	Lake Mapourika roadside	1044	20	52	Yes
Lake Matheson	Lake Matheson Lookout	159	10	16	Yes
Lake Moeraki	Lake Moeraki North ramp	1339	35	38	Yes
Lake Moeraki	Lake Moeraki South ramp	2104	20	105	Yes
Lake Paringa	Lake Paringa Main boat ramp	4211	37	114	Yes
Lake Wahapo	Lake Wahapo Entry point	2073	37	56	Yes



## Appendix 2: Species list at each lake site, visual surveys:

Species/Genus	Lake Brunner	Lake Brunner	Lake Brunner	Lake Brunner	Lake Kaniere	Lake Kaniere	Lake Paringa
	Iveagh Bay Campground	Iveagh Bay boat ramp	Main Beach boat ramp	Mitchells Beach	Main boat ramp	DOC area	Main boat ramp
<i>Chara corallina</i>	✓	✓	✓	✓			
<i>Chara fibrosa</i>	✓	✓	✓	✓	✓	✓	✓
<i>Chara globularis</i>	✓	✓	✓	✓			
<i>Native Characeans</i>	✓	✓	✓	✓			
<i>Elatine gratioloides</i>			✓	✓			
<i>Elodea canadensis</i>	✓	✓	✓	✓	✓	✓	✓
<i>Glossostigma sp.</i>							
<i>Juncus bulbosus</i>	✓	✓	✓	✓	✓	✓	✓
<i>Lagarosiphon major</i>							✓
<i>Myriophyllum propinquum</i>		✓	✓	✓	✓	✓	✓
<i>Myriophyllum triphyllum</i>	✓	✓	✓	✓	✓	✓	✓
<i>Nitella hyalina</i>			✓				
<i>Potamogeton cheesemanii</i>							
<i>Potamogeton crispus</i>			✓	✓			
<i>Potamogeton ochreatus</i>			✓	✓			
<i>Ranunculus amphitrichus</i>	✓	✓	✓	✓			
<i>Ranunculus limnosella</i>							
<i>Utricularia geminiscapa</i>							

Species/Genus	Lake Mahinapua	Lake lanthe	Lake Wahapo	Lake Mapourika	Lake Mapourika	Lake Matheson	Lake Moeraki	Lake Moeraki
	Boat ramp	Main boat ramp	Entry point	Roadside	Boat ramp	Lookout	North ramp	South ramp
<i>Native Characeans</i>							✓	
<i>Elatine gratioloides</i>								
<i>Elodea canadensis</i>	✓		✓	✓	✓		✓	✓
<i>Glossostigma sp.</i>								
<i>Juncus bulbosus</i>	✓	✓						
<i>Lagarosiphon major</i>		✓						
<i>Myriophyllum propinquum</i>	✓	✓	✓	✓	✓			✓
<i>Myriophyllum triphyllum</i>	✓	✓	✓	✓	✓	✓		✓
<i>Nitella hyalina</i>								
<i>Potamogeton cheesemanii</i>								✓
<i>Potamogeton ochreatus</i>								
<i>Ranunculus amphitrichus</i>								✓
<i>Ranunculus limnosella</i>								
<i>Sphagnum spp</i>						✓		
<i>Utricularia geminiscapa</i>					✓			

# Appendix 3: eDNA methodology

1. Take the gloves out of the sample bag and put them on.
2. Unscrew the filter from the syringe and draw up 60 ml of water from just below the surface, taking care not to get any sediment into the . If any air enters the syringe chamber hold the syringe vertically and gently push the plunger until water enters the stem. Large air bubbles can be difficult to push through the filter.
3. Screw the filter back on **taking care not to overtighten**.
4. Push the plunger down, discarding the outlet water. If the filter clogs pull the syringe plunger back 1 mm (1 small tick mark) to dislodge the particles before proceeding.
5. Repeat steps 2-4 (counting the number of syringes filtered) until the filter is clogged or 1L is filtered, whichever comes first. If using a caulking gun do not force water through too hard or the filter may rupture.
6. **IMPORTANT:** Unscrew the filter, draw 60 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. This may be aided by using the caulking gun.
7. **NOTE:** The small syringe contains a preservative that can be irritating when in contact with skin or eyes. The safety data sheet can be found at [wilderlab.co.nz/shop/minikit/](http://wilderlab.co.nz/shop/minikit/). Holding the small syringe in an upright position to avoid spilling the preservative, unscrew the black cap and **screw the cap on to the outlet end of the filter**.
8. Unscrew the filter (with the black cap still attached) from the large syringe and screw it on to the small syringe. Push the plunger to inject the preservative solution into the filter. Shake well while holding the plunger down.
9. Place the filter **with both the black cap and small syringe still attached** into the zip-lock sample bag and seal.
10. Record the sample details on the ziplock bag in the space provided. If no GPS unit is available you can get your location coordinates by opening google maps and holding your finger down on the blue dot (your current position) to drop a pin.
11. Fill out the sample submission sheet and include a copy with the samples.
12. Send the samples by standard courier to:  
**Wilderlab NZ Ltd**  
**Level 2, 129 Park Road**  
**Miramar**  
**Wellington 6022**  
Alternatively, small packages can be sent by standard post to  
**Wilderlab NZ Ltd**  
**PO Box 15059**  
**Miramar**  
**Wellington 6243**  
No refrigeration is necessary, but please ensure the kits are packaged securely.





# Appendix 4: Surveillance species detected at each site, from eDNA sampling

Species/Genus	Lake Brunner	Lake Brunner	Lake Brunner	Lake Brunner	Lake Brunner	Lake lanthe	Lake Kaniere	Lake Kaniere
	Iveagh Bay Campground	Iveagh Bay boat ramp	Main Beach boat ramp	Yacht Club	Mitchells Beach	Main boat ramp	Main boat ramp	DOC area
<b>Plants</b>								
<i>Ceratophyllum demersum</i>								
<i>Elodea canadensis.</i>	✓	✓		✓	✓			
<i>Egeria densa</i>	✓	✓	✓	✓	✓			
<i>Lagarosiphon major</i>						✓		
<b>Fish</b>								
<i>Ameiurus nebulosus</i>								
<i>Carassius auratus</i>								
<i>Cyprinus carpio</i>								
<i>Perca fluviatilis</i>							✓	
<i>Scardinius erythrophthalmus</i>						✓		

Species/Genus	Lake Mahinapua	Lake Mahinapua	Lake Matheson	Lake Wahapo	Lake Mapourika	Lake Mapourika	Lake Moeraki	Lake Moeraki	Lake Paringa
	Boat ramp Sample 1	Boat ramp Sample 2	Lookout	Entry point	Roadside	Boat ramp	South ramp	North ramp	Main boat ramp
<b>Plants</b>									
<i>Ceratophyllum demersum</i>									
<i>Elodea canadensis.</i>						✓	✓	✓	
<i>Egeria densa</i>						✓	✓	✓	
<i>Lagarosiphon major</i>									
<b>Fish</b>									
<i>Ameiurus nebulosus</i>									
<i>Carassius auratus</i>	✓	✓							
<i>Cyprinus carpio</i>									
<i>Perca fluviatilis</i>	✓	✓							
<i>Scardinius erythrophthalmus</i>									