Department of Conservation
Te Papa Atawhai

NIWA
Taihoro Nukurangi

Vegetation Status in Waituna Lagoon: Summer 2018

National Centre for Freshwater and Estuaries

www.niwa.co.nz

Department of Conservation
Te Papa Atawhai

NIWA
Taihoro Nukurangi

Vegetation Status in Waituna Lagoon: Summer 2018




This report was commissioned by The Department of Conservation (DOC) and based on work under Project DOC18202.

Authors:

Mary de Winton

Theo Mouton

Published by:
NIWA – National Institute of Water & Atmospheric Research Ltd
PO Box 11115
Hamilton 3251
Phone +64 7 856 7026

Web: www.niwa.co.nz
For more information please contact: mary.dewinton@niwa.co.nz

Acknowledgements:

NIWA staff who have contributed to monitoring events include Aleki Taumoepeau, Rohan Wells, Donna Sutherland, Neil Blair, Eric Stevens, Derek Kater and Susie Elcock. We especially thank Chris Owen (Southern Waterways Boat Contracting) for his knowledge of Waituna Lagoon and skipper expertise. Many thanks to Sarah Crump and Sarah Thorne (DOC) for local orientation and Health & Safety briefings. Hugh Robertson, Emily Funnell, Sarah Crump and Jane Bowen (DOC) contributed to the look and content of this report. Also appreciated is provision of environmental data from the Environment Southland team – thank you.

Layout design: Aarti Wadhwa

Climate, Freshwater & Ocean Science

Contents

DOC commissioned NIWA to undertake the 2018 summer-time Waituna Lagoon survey to document the health of submerged vegetation and to provide an inter-annual comparison of its condition. This report summarises the key findings to guide further ecological management of the lagoon.

Key findings

- In 2018, three out of four ecological targets were achieved for Waituna Lagoon that indicated good health of the submerged vegetation (mainly *Ruppia* species);
  - the lagoon was closed over the critical spring-summer period for *Ruppia* growth (three months) before monitoring,
  - the lagoon-wide target for 'biomass index' (proxy for biomass) was achieved,
  - the threshold for excessive macroalgal development was not exceeded,
  - the target for a lagoon-wide *Ruppia* cover of >30% was not met, but was close to being achieved (26%).
- The number of ecological targets achieved in 2018 was the same as 2016 and highest equal out of all monitoring years (2009–2018).
- Years with late spring to summer lagoon openings did not achieve the ecological targets based on *Ruppia* development.
- Current evidence is that winter openings are the best to ensure closure before the main plant growing season and to flush winter nutrient loads.
- The ecological target for lagoon-wide *Ruppia* cover is more likely to be met in the future if *Ruppia megacarpa* becomes more prevalent.
- Two additional ecological targets are recommended to assess submerged vegetation health in Waituna Lagoon.

Purpose of this report

This report assesses the 2018 annual summer monitoring data for submerged vegetation in Waituna Lagoon in relation to ecological targets that have been identified by the Lagoon Technical Group to guide ecological management. Results are compared to annual monitoring results since 2009.

The document is supported by a technical report[1] that describes the water level regime, water quality (physico-chemical) and substrate conditions, submerged vegetation abundance and composition and *Ruppia* life-stage.

[1] de Winton, M., Mouton, T. (2018) Technical Report on Vegetation Status in Waituna Lagoon: 2009–2018.

Waituna Lagoon is an internationally important example of a coastal waterbody that remains in good ecological condition.

Background

The importance of Waituna Lagoon

Waituna Lagoon on the south coast of New Zealand is included within a Ramsar Wetland of International Importance. It is an Intermittently Closed and Open Lake or Lagoon (ICOLL) of cultural significance to Ngāi Tahu recognised by a Statutory Acknowledgement under the Ngāi Tahu Claims Settlement Act 1998[2]. It is also significant for conservation of biological diversity and as a key recreation site.

The Department of Conservation has been monitoring submerged aquatic plants (including *Ruppia* sp.) in Waituna Lagoon since 2007 under the Arawai Kākāriki Wetland Restoration Programme.

Coastal lowland lakes like Waituna Lagoon are impacted by changes in land use in the catchment including sediment and nutrient loads from upstream run-off. It is now rare to find coastal lowland lakes in intact ecological condition, but Waituna Lagoon remains highly valued for its associated plant, wetland, fish and birdlife.

[2] http://www.legislation.govt.nz/act/public/1998/0097/7.0/DLM431306.html

Ruppia safeguards the lagoon

When *Ruppia* grows densely in Waituna Lagoon it protects water quality, dampens wave action and stops the bed being stirred up.

Risk of Waituna Lagoon shifting to a poor ecological condition

Submerged plants have an important role in keeping shallow lakes and lagoons clean and healthy (Figure 1). If submerged plant communities become too stressed they can collapse. The lake or lagoon then enters a new, dirty water state, with high resuspended sediment and macroalgal mats or phytoplankton blooms instead of plants. The submerged native plant species of *Ruppia* (horse's mane) safeguard water quality in Waituna Lagoon. *Ruppia* tolerates fluctuating levels of saltwater in lagoons better than other submerged plants, but does not occur in the sea.

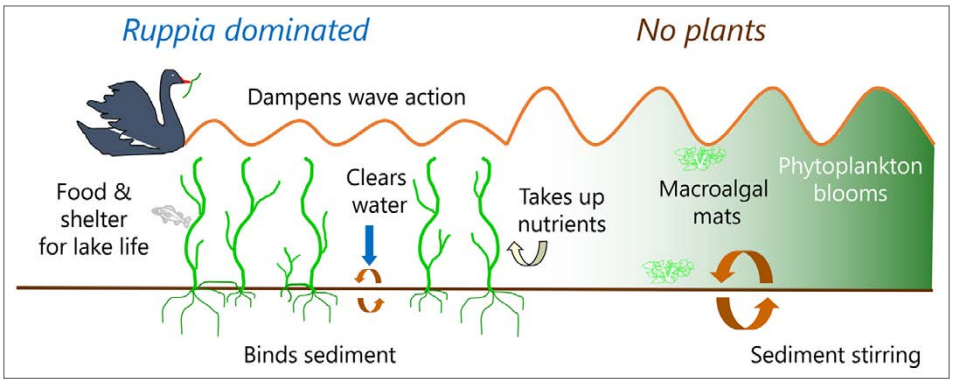


Figure 1: *Ruppia* vegetation can safeguard water quality in the lagoon compared to a system with no plants.

Management of water level at Waituna Lagoon

Agencies, community and iwi are working together to manage and protect Waituna Lagoon. When water levels in the lagoon rise too high, the management response is to mechanically open the lagoon to the sea. Lagoon openings are usually undertaken once or twice a year to prevent catchment flooding and to flush nutrients from the lagoon, but lagoon closing only occurs naturally under certain sea conditions.

Management of these artificial openings considers the Lagoon's ecology. Importantly, the timing and length of openings should not negatively impact on the survival of *Ruppia* vegetation. This requires openings to avoid key times in the life-history of *Ruppia* including critical spring to summer growth and seed production.

The lagoon can be opened to the sea once the water level of Waituna Lagoon reaches a certain trigger level noted in the resource consent[3], which varies at different times of the year and has certain conditions.

Natural lagoon level

Once, Waituna Lagoon would have naturally breached to the sea after several years of filling with freshwater. Today it is regularly opened and infiltrated by the sea.

Catchment management

Agencies and the community have joined forces to reduce sediment and nutrient inputs to Waituna Lagoon[4], focusing on strategies and initiatives for catchment management of contaminants, increasing biological processing of run-off and building freshwater habitat. It is essential that these efforts meet the nutrient load reduction targets developed by the Lagoon Technical Group in 2012 to ensure long term *Ruppia* vegetation in the lagoon.

[3] Resource Consent 20146407-01, 14 February 2017

[4] http://www.waituna.org.nz/

What do we Monitor?

Ruppia

Ruppia acts as ecological sentinel in Waituna Lagoon, providing an early-warning system to detect deterioration. Department of Conservation fund the monitoring of *Ruppia* and other aquatic plants and algae to determine status and trends in ecological health of the Lagoon. Monitoring also supports the resource consent for lagoon opening, contributing to opening decisions at a lower water level where vegetation has been stable (key ecological target met for a number of years), or where poor water clarity is likely to have an adverse ecological effect if the lagoon isn't opened and flushed.

Results of annual monitoring are compared with target conditions sought under the Ecological Guidelines[5] for Waituna Lagoon. These ecological targets are listed in Box 1:

Box 1: Ecological targets for *Ruppia* in Waituna Lagoon.

- Lagoon closed during *Ruppia* growing season (spring and summer).
- >30–60% for average % cover of *Ruppia* (and other native macrophytes[6]).
- <10% cover of benthic and epiphytic filamentous algae (macroalgae).
- >1000 average for *Ruppia* 'biomass index' (% cover x cm height).

[5] Lagoon Technical Group (2013). Ecological Guidelines for Waituna Lagoon. Report prepared for Environment Southland.

[6] Other native macrophytes comprised <35% of all occurrence records.

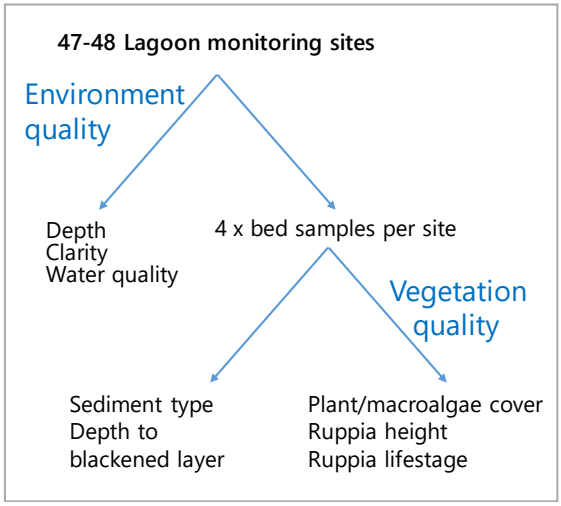


Figure 2: Map showing the location of sampling sites (47-48) and diagram on right showing the sampling design.

Monitoring methods

The lagoon is monitored each year in late summer at 47-48 sites. At each site an assessment of environmental quality includes depth and water quality measurements (Figure 2). Substrate characteristics are measured in four samples of the lagoon bed retrieved using a garden hoe, and the composition and abundance of vegetation is also described, including *Ruppia* life-stage as flowering or vegetative (Figure 2). Submerged native plants can usually be identified directly (Figure 3), but the dominant macroalgae may only be described to type (Figure 3) based on appearance and samples.

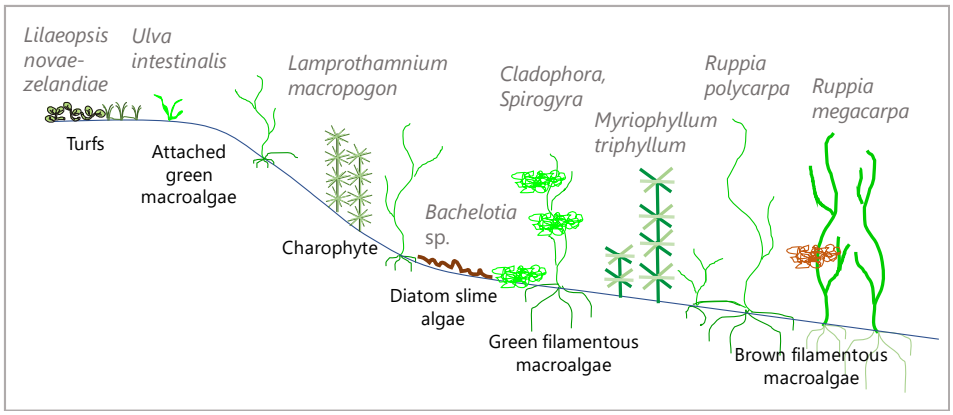
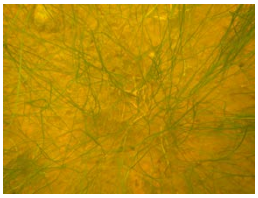


Figure 3: Common submerged plants and macroalgae types in Waituna Lagoon.



Did 2018 results achieve ecological targets for Waituna Lagoon ?

The results of annual summer monitoring of the submerged vegetation in Waituna Lagoon are analysed and compared to the four ecological targets to track the health of the *Ruppia* community.

Target lagoon closure was achieved in 2018, as well as 2009, 2010, 2012, 2015 and 2016

1. Lagoon closure

A closed lagoon over spring and summer (defined as three months before monitoring) is an ecological target that provides stable conditions for the *Ruppia* growing season (Box 1). Whether the lagoon is closed or open has a strong influence on conditions that affect plants, such as depth, salinity and temperature. In 2018, Waituna Lagoon was closed during the *Ruppia* growing season and had been closed for over one year (Table 1).

Table 1: Months that the lagoon has been closed (positive numbers) or open (negative numbers) prior to each monitoring event.

Year	Months closed before monitoring
2009	**4.7**
2010	**4.6**
2011	-5.6
2012	**4.6**
2013	-3.9
2014	-6.2
2015	**6.2**
2016	**3.2**
2017	1.0
2018	**13.7**

2. *Ruppia* cover

A healthy *Ruppia* community occupies a large habitat area in Waituna Lagoon. This is measured by calculating the percentage cover of *Ruppia* across all sites in the Lagoon. In 2018, although *Ruppia* was recorded at all sites (Table 2, Figure 4), the lagoon-wide average percentage cover did not meet the ecological target of >30–60% (Box 1).

Table 2: *Ruppia* measurements including % sites, average cover at sites and % sites where >30% cover, and overall averaged lagoon-wide cover.

Year	% sites where *Ruppia* present	Average cover (sites where present)	Sites with >30% cover (%)	Lagoon-wide average cover
2009	73	**33**	23	24
2010	52	**31**	21	16
2011	25	7	2	2
2012	60	14	8	9
2013	33	22	13	7
2014	19	16	2	3
2015	70	29	23	21
2016	87	**46**	53	**40**
2017	74	12	6	9
2018	100	26	12	26

Target lagoon-wide *Ruppia* cover was not achieved in 2018, but it was achieved in 2016.

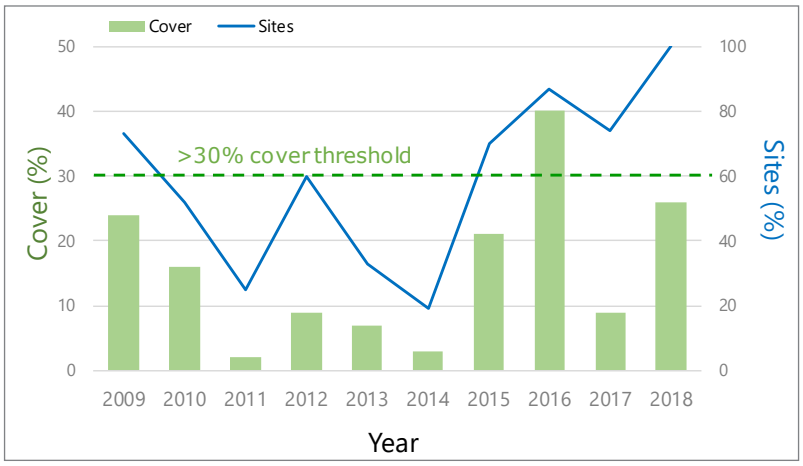


Figure 4: Lagoon-wide cover of *Ruppia* is shown as green bars and percentage of sites at which *Ruppia* was present as a blue line.

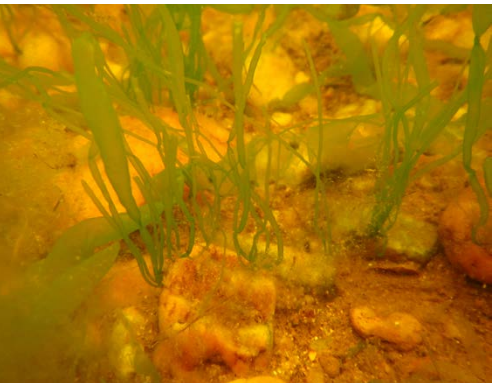
3. *Ruppia* biomass index

Target lagoon-wide *Ruppia* biomass index was achieved in 2015, 2016 and 2018.

Although *Ruppia* biomass is not sampled annually, a proxy for biomass can be derived by multiplying *Ruppia* cover by height as a 'biomass index'. In a healthy *Ruppia* community a biomass index >1000 is expected (Box 1). This might be visualised as a 10% cover of plants that are 100 cm tall or by a 100% cover of plants that are 10 cm tall, and other combinations. The target was exceeded in 2018 (Table 3).

Table 3: *Ruppia* presence at sites, number of sites where target biomass index was achieved and average biomass index calculated lagoon-wide.

Year	% sites where *Ruppia* present	% sites with >1000 biomass index	Lagoon-wide average biomass index
2009	73	25	734
2010	52	21	899
2011	25	0	9
2012	60	4	177
2013	33	2	98
2014	19	2	114
2015	70	23	**1252**
2016	87	32	**1362**
2017	77	9	697
2018	100	19	**1324**



Limit for lagoon-wide macroalgae cover was met in 2018, as well as from 2009 to 2012 and in 2014.

4. Macroalgae cover

Nutrient enrichment of waterbodies may result in excessive macroalgae growth that smothers the lake bed and shades *Ruppia* plants. One ecological target (Box 1) recognises that macroalgae on the lagoon bed (benthic) and on plants or rock (epiphytic) should be no more than minor (<10% cover). Lagoon-wide average macroalgae cover in 2018 was <10%, and one of the lowest total average covers recorded in all the summer monitoring events (Table 4, Figure 5).

Table 4: Percentage of sites recording macroalgae, their average cover, percentage of sites achieving <10% cover and average lagoon wide cover.

Year	% sites where macroalgae present	Average % cover (sites where present)	Sites with >10% cover (%)	Lagoon-wide average cover (%)
2009	19	17	6	**3**
2010	8	29	6	**2**
2011	17	**3**	0	**<1**
2012	23	16	8	**4**
2013	27	52	19	14
2014	27	17	11	**4**
2015	89	50	70	45
2016	79	36	49	28
2017	64	27	26	17
2018	11	**2**	0	**<1**

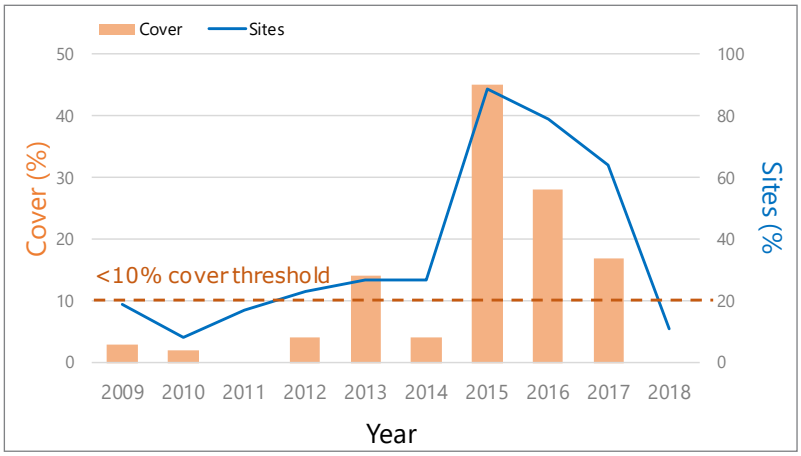


Figure 5: Lagoon-wide cover of macroalgae is shown as orange bars and percentage of sites at which macroalgae was present as a bue line.

Three out of four ecological targets were achieved in 2018, one target for *Ruppia* cover was not met.

Conclusions

Ecological targets in 2018

Four ecological targets were identified by the Technical Group for Waituna Lagoon that are considered compatible with a stable and self-sustaining native submerged plant population (Box 1). These targets were developed to guide management of the lagoon and track ecological improvements or issues.

In 2018, three of the four ecological targets were met (Table 5). The fourth target (*Ruppia* cover), was almost met. Results indicate the lagoon conditions associated with the 2018 monitoring enabled a widespread submerged vegetation, but submerged plant cover has been higher in previous monitoring years. Although macroalgae were of low abundance in 2018, blooms of planktonic cyanobacteria were reported from the lagoon[7] over Spring 2017 to Autumn 2018 that are indicative of ecological deterioration.

Table 5: Summary of 2018 results for four ecological targets.

Ecological target	Targets met?	Comment
Lagoon closure	✓	Lagoon was closed for the *Ruppia* growing season prior to monitoring.
Ruppia cover	✗	*Ruppia* cover lagoon-wide was 5% lower than the target of >30%.
Ruppia biomass index	✓	*Ruppia* biomass index well exceeded the target.
Macroalgae cover	✓	Macroalgae development was very low.

[7] https://www.es.govt.nz/services/environmental-monitoring

Ecological targets over all monitoring years

- No single monitoring year has achieved all four ecological targets for submerged vegetation in Waituna Lagoon (Table 6).
- Years that met fewest targets (one or none) were those that also did not meet the lagoon closure target.
- There are no strong trends in target results over time, although,
  - biomass index was achieved more recently (last four years), and
  - excessive macroalgae were recorded during surveys in four out of the previous six years, which, in addition to other algae blooms recorded by Environment Southland, is a sign of nutrient enrichment.

Table 6: Summary of results for four ecological targets over all monitoring years.

Year	Ecological target				
	Lagoon closure	*Ruppia* cover	*Ruppia* biomass index	Macroalgae cover	Targets met
2009	✓	✗	✗	✓	2
2010	✓	✗	✗	✓	2
2011	✗	✗	✗	✓	1
2012	✓	✗	✗	✓	2
2013	✗	✗	✗	✗	0
2014	✗	✗	✗	✓	1
2015	✓	✗	✓	✗	2
2016	✓	✓	✓	✗	3
2017	✗	✗	✗	✗	0
2018	✓	✗	✓	✓	3

Implications for lagoon health

- Spring to summer lagoon status as open versus closed has a strong influence on water conditions that influences submerged vegetation development.
- Late spring to summer lagoon openings have generally failed to meet ecological targets based on *Ruppia*.
- There are trade-offs between a stable closed lagoon for good *Ruppia* development and risk of nutrient build-up fuelling macroalgae and phytoplankton blooms.
- Results suggest winter openings would be the best to ensure early closure before the main plant growing season and to flush winter nutrient loads.
- The ecological target for lagoon-wide *Ruppia* cover is more likely to be met in the future if *Ruppia megacarpa* becomes more prevalent due its ability to form tall, high cover beds.

Summary of technical findings

The accompanying technical report[8] to this summary document also finds that:

- Lagoon openings, as well as seasons, strongly influence water quality conditions.
- Nutrient levels were higher when the lagoon was closed, and in winter.
- Softer substrates and a shallow blackened 'sulphide' layer in the sediment in 2018 suggest some recent deterioration in lagoon health.
- *Ruppia megacarpa* contributed higher cover and height to macrophyte beds.
- *Ruppia* flowered more for those years when the lagoon was closed for three months or longer before monitoring.
- Annual summer vegetation development was related to environmental conditions that depend on whether the lagoon was open or closed.

Monitoring recommendations

Additional ecological targets are recommended for *Ruppia* reproductive success and to increase the positive influence of *Ruppia* on Waituna Lagoon ecological health.

Continued monitoring of the submerged vegetation in Waituna Lagoon is essential if the outcomes of interacting effects of catchment interventions, water level management and climate change on the ecological health of the lagoon are to be better understood.

Two additional ecological targets are recommended. These are indicators of a good ecological health based on the *Ruppia* development and are attainable for Waituna Lagoon based on results to date.

- ≥40% of *Ruppia* samples in a flowering or post-flowering life-stage.

This ecological target would confirm the reproductive success of *Ruppia* spp. and the likely replenishment of the seed bank which is vital for vegetation recovery after any major deterioration (e.g., extended lagoon opening).

- ≥20% of the sites record *Ruppia megacarpa.*

Ruppia megacarpa is associated with taller, denser submerged vegetation in Waituna Lagoon. It acts as a strong 'ecosystem engineer', with feedback influences on the local environment that promote further vegetation development by buffering waves, settling particles and competing with macroalgae.

[8] de Winton, M., Mouton, T. (2018) Technical Report on Vegetation Status in Waituna Lagoon: 2009–2018.

Glossary

Term	Definition
Benthic	Relating to, or occurring at the bottom of a body of water.
Biomass index	An indicator of biomass for Ruppia species that is based on multiplying measured cover (%) by height (cm).
Catchment	The area of land bounded by watersheds draining into a basin.
Charophyte	A group of freshwater algae that superficially resemble higher submerged plants in that they are anchored to the substrate and have stems and whorls of 'branchlets'.
Ecosystem engineer	An organism that creates, significantly modifies, maintains or destroys a habitat.
Ecosystem health	A way to describe the state of a system relative to a desired management target or reference condition.
Epiphytic	Living on the surface of plants.
Life-stage	Stages in form and functional through which an organism passes during its lifespan that include reproductive status.
Macroalgae	Collective term used for seaweeds and other benthic marine or freshwater algae that are generally visible to the naked eye.
Planktonic cyanobacteria	Photosynthetic bacteria that are microscopic and free-floating but which can be associated with the production of toxic compounds when abundant (blooms).
Resource consent	Official permission to carry out an operation that has an environmental impact.
Run-off	The draining away of water (or substances carried in it) from the surface of an area of land.
Submerged vegetation	Plants that grow entirely beneath the surface of the water, except for flowering parts in some species, including charophytes but excluding macroalgae.

Referral Links

http://www.waituna.org.nz/

https://www.doc.govt.nz/our-work/arawai-kakariki-wetland-restoration/

https://www.mfe.govt.nz/fresh-water/clean-projects/waituna-lagoon

https://www.livingwater.net.nz/catchment/waituna-lagoon/

https://www.dairynz.co.nz/environment/in-your-region/southland-environmental-policy/the-waituna-project/

https://www.es.govt.nz/services/environmental-monitoring/Pages/Lakes-and-lagoons.aspx

http://www.wetlandtrust.org.nz/Site/RAMSAR_CONVENTION/AWARUA_WAITUNA_LAGOON.ashx

Climate, Freshwater & Ocean Science
www.niwa.co.n

NIWA
Taihoro Nukurangi