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Vegetation Status in Waituna Lagoon: Summer 2019

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Contents

DOC commissioned NIWA to undertake the 2019 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 2019, five out of six ecological targets were achieved for Waituna Lagoon that indicated continuing good health (since 2018) 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 target for a lagoon-wide *Ruppia* cover of >30% was met for the second time since monitoring began (in 2009),
- the lagoon-wide target for *Ruppia* 'biomass index' (proxy for biomass) was achieved, with the highest yet level recorded,
- *Ruppia* reproductive success in >40% of samples suggests the likely replenishment of seed banks,
- expansion by *Ruppia megacarpa* to ≥20% of sites represents stronger vegetation influence in the lagoon,
- however, macroalgal development exceeded the acceptable threshold of <10% cover.

Based on all six ecological targets:

- 2019 had the highest number of targets achieved, equal with 2018.
- Years with late spring to summer lagoon openings achieved the fewest ecological targets based on *Ruppia* development, and current evidence is that winter openings are the best to ensure closure before the main plant growing season and to flush winter nutrient loads.
- Additional indicators on *Ruppia* reproductive success and *R. megacarpa* status provide further lines of evidence for management of lagoon vegetation.

Purpose of this report

This report assesses the 2019 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. (2019) Technical Report on Vegetation Status in Waituna Lagoon: 2009–2019.

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.

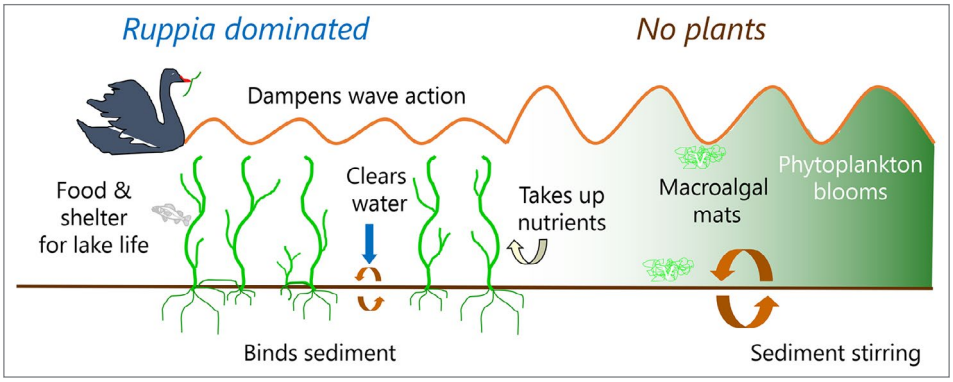


Figure 1: *Ruppia* vegetation can safeguard water quality in the lagoon compared to a system with no plants.

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 is increasingly taking into account the Lagoon's ecology. The timing and length of openings should ideally not negatively impact on the survival of *Ruppia* and other vegetation. This requires openings to avoid key times in the life-history of *Ruppia* including critical spring to summer growth and seed production.

At present, 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 aim 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 2013 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 an ecological sentinel in Waituna Lagoon, providing an early-warning system to detect deterioration. Department of Conservation oversee 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 targets 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.

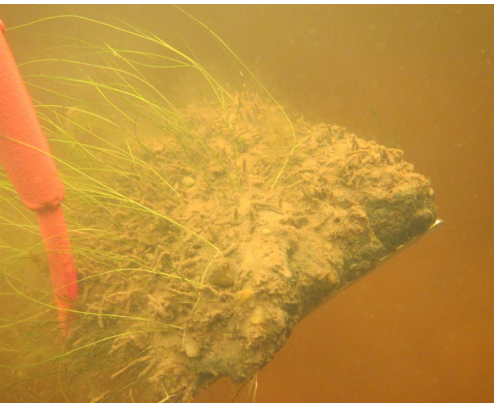
Results of annual monitoring are compared with target conditions sought under the Ecological Guidelines[5] for Waituna Lagoon. These ecological targets are listed in Box 1.

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 for all surveys.



Two additional ecological targets were suggested by an analysis of all monitoring data in 2018[7]. These ecological targets are listed in Box 2.

Box 2: Additional recommended Ecological targets for *Ruppia* in Waituna Lagoon.

- ≥40% of *Ruppia* samples in a flowering or post-flowering life-stage.
- ≥20% of the sites record *Ruppia megacarpa*.

Monitoring methods

The lagoon is monitored each year in late summer at 47-48 sites (Figure 2a). At each site an assessment of environmental quality includes depth and water quality measurements (Figure 2b). 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. 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 2a: Map showing the location of sampling sites (47-48).

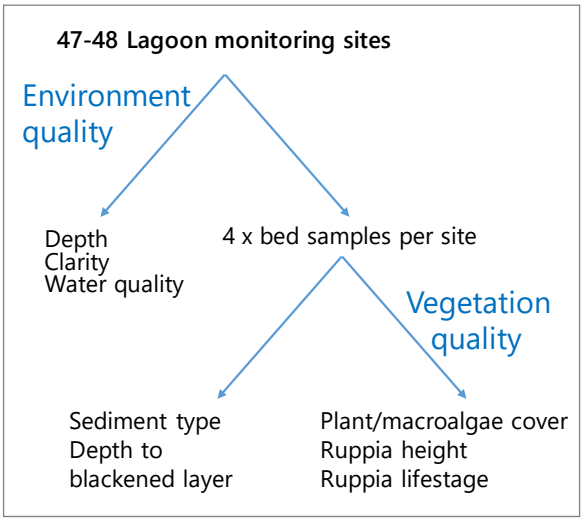


Figure 2b: Sampling design diagram.

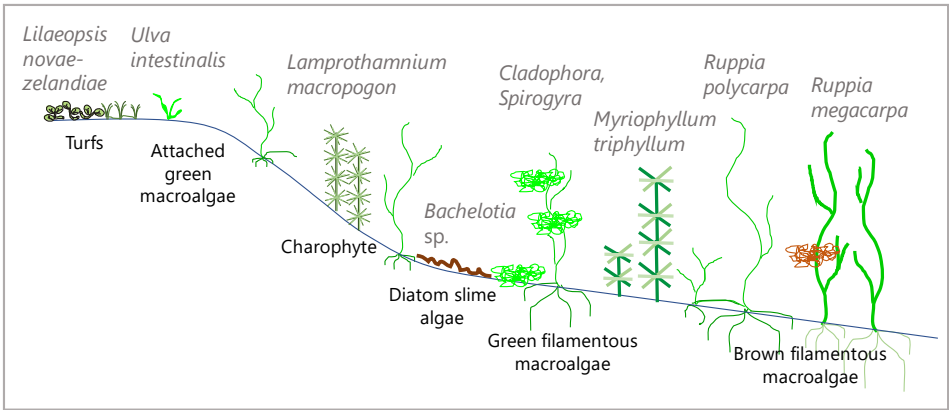
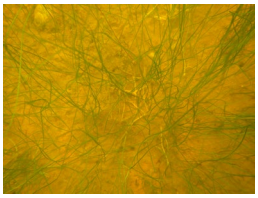


Figure 3: Common submerged plants and macroalgae types in Waituna Lagoon.

[7] de Winton, M., Mouton, T. (2018) Vegetation Status in Waituna Lagoon: Summer 2018.



Did 2019 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. A further two recommended ecological targets are reviewed for all monitoring years.

Target lagoon closure was achieved in 2019, as well as 2009, 2010, 2012, 2015, 2016 and 2018.

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 2019, Waituna Lagoon had been closed during the *Ruppia* growing season, with the duration of closure being 3.5 months before monitoring (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**
2019	**3.5**

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 2019, the lagoon-wide average cover met the ecological target (Box 1) of >30–60% (Table 2, Figure 4).

Target lagoon-wide *Ruppia* cover was achieved in 2019 and 2016.

Note: both these years the lagoon was closed for two consecutive seasons for >3 months.

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
2019	96	**37**	43	**36**

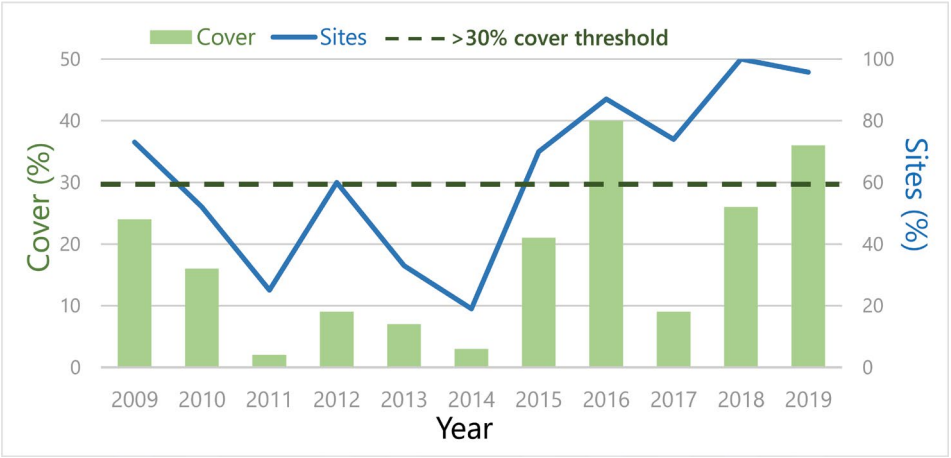


Figure 4: Lagoon-wide cover of *Ruppia* is shown as green bars and percentage of sites at which *Ruppia* was present as a blue line.

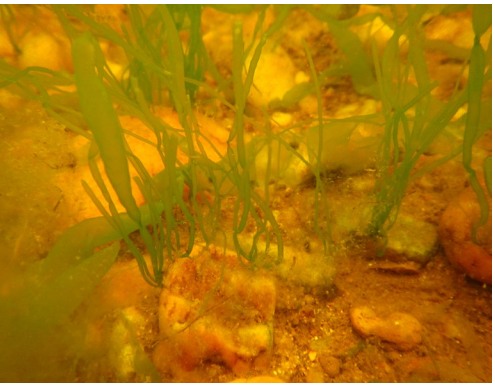
3. *Ruppia* biomass index

Target lagoon-wide *Ruppia* biomass index was achieved in 2015, 2016, 2018 and 2019.

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 2019 and lagoon-wide biomass index was the highest yet recorded (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	75	6	697
2018	100	19	**1324**
2019	96	45	**1872**



Limit for lagoon-wide macroalgae cover was not met in 2019, but was met from 2009 to 2012, 2014 and 2018.

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), on plants (epiphytic) and floating mats should be no more than minor (<10% cover). Lagoon-wide average macroalgae cover in 2019 was the highest yet recorded (Table 4 and Figure 5) but macroalgae did not form floating mats that would shade-out *Ruppia*.

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**
2019	89	73	85	66

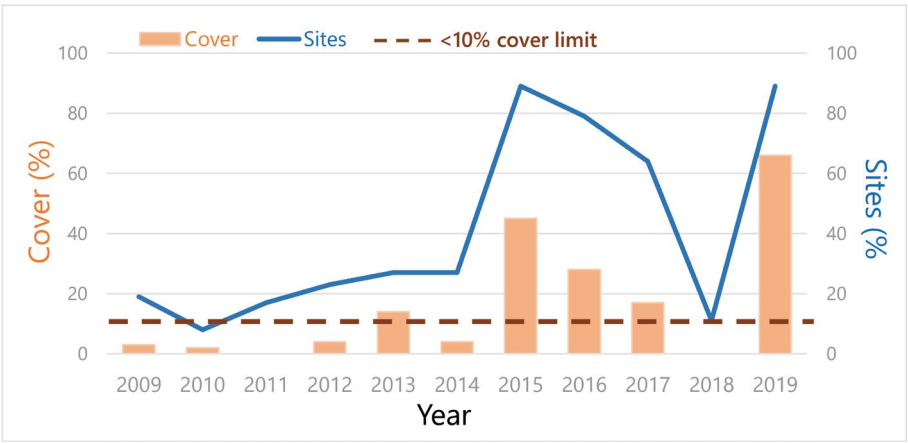


Figure 5: Lagoon-wide cover of macroalgae is shown as orange bars and percentage of sites at which macroalgae was present as a blue line.

The target for *Ruppia* reproductive success was achieved in 2012, 2015, 2016, 2018 and 2019.

5. *Ruppia* reproductive success

An additional recommended ecological target focuses on the reproductive success of *Ruppia* and the likely replenishment of the seed bank which is vital for vegetation recovery after any major disturbance (e.g., extended lagoon opening). The suggested target is ≥40% of *Ruppia* samples in a flowering or post-flowering life-stage, to incorporate sites with both *Ruppia* species (*R. polycarpa* and *R. megacarpa*). This was achieved in 2019.

Table 5: Percentage of sites recording reproductive success for *Ruppia* as either flowering or post-flowering status.

Year	% sites recording reproduction
2009	18
2010	32
2011	0
2012	**53**
2013	9
2014	10
2015	**59**
2016	**71**
2017	3
2018	**44**
2019	**46**

The target for status of *Ruppia megacarpa* was achieved in 2010, 2018 and 2019.

6. Status of *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. An additional recommended target[8] states ≥20% of the sites record *R. megacarpa* and this was achieved in 2019. 20% is recommended because this represents sites that are favourable for this species.

Table 6: Percentage of sites recording *Ruppia megacarpa*.

Year	% sites recording reproduction
2009	10
2010	**23**
2011	17
2012	2
2013	6
2014	0
2015	4
2016	9
2017	6
2018	**30**
2019	**32**

Five out of six ecological targets were achieved in 2019, one target for macroalgae cover was not met.

Conclusions

Ecological targets in 2019

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. An additional two targets (Box 2) were recommended from an analysis of monitoring data in 2018[7].

In 2019, five out of six ecological targets were met (Table 7). Only macroalgae cover did not achieve the target because lagoon-wide levels were higher (>10%) than the acceptable limit set. The 2019 results show recent conditions in Waituna Lagoon have enabled a widespread expansion in *Ruppia* abundance and health. Successful flowering and replenishment of *Ruppia* seed banks, and increased presence of *Ruppia megacarpa* provide further evidence that 2019 has been a good year for macrophyte growth.

Table 7: Summary of 2019 results for all ecological targets.

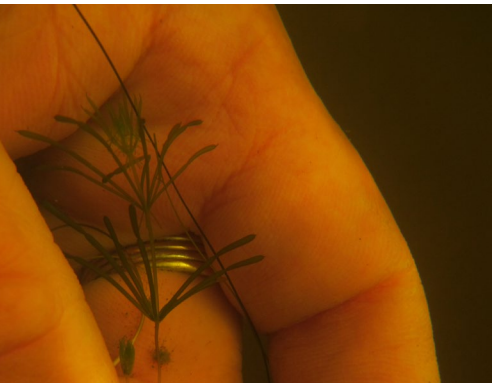
Ecological target	Targets met?	Comment
Lagoon closure	✓	Lagoon was closed for the *Ruppia* growing season prior to monitoring.
Ruppia cover	✓	*Ruppia* cover lagoon-wide above the target of >30%.
Ruppia biomass index	✓	*Ruppia* biomass index well exceeded the target.
Macroalgae cover	✗	Macroalgae development exceeded the acceptable limit.
Ruppia reproductive success	✓	Widespread flowering indicated reproductive success.
Status of *Ruppia megacarpa*	✓	*Ruppia megacarpa* contributed significantly to lagoon vegetation.

Ecological targets over all monitoring years

- No single monitoring year has achieved all six ecological targets for submerged vegetation in Waituna Lagoon (Table 8).
- 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 indicating the system is highly dynamic, although:
  - biomass index was achieved more recently (last five years), and
  - excessive macroalgae were recorded during surveys in four out of the previous five years, which is a sign of nutrient enrichment.

Table 8: Summary of results for six ecological targets over all monitoring years.

Year	Lagoon closure	*Ruppia* cover	*Ruppia* biomass index	Macroalgae cover	*Ruppia* reproductive success	Status of *Ruppia megacarpa*	Targets met
2009	✓	✗	✗	✓	✗	✗	2
2010	✓	✗	✗	✓	✗	✓	3
2011	✗	✗	✗	✓	✗	✗	1
2012	✓	✗	✗	✓	✓	✗	3
2013	✗	✗	✗	✗	✗	✗	0
2014	✗	✗	✗	✓	✗	✗	1
2015	✓	✗	✓	✗	✓	✗	3
2016	✓	✓	✓	✗	✓	✗	4
2017	✗	✗	✗	✗	✗	✗	0
2018	✓	✗	✓	✓	✓	✓	5
2019	✓	✓	✓	✗	✓	✓	5



Implications for lagoon health

- Ecological targets for Waituna Lagoon are not met when lagoon openings occur in late spring to summer.
- Consecutive years of a favourable closed lagoon appear to allow better *Ruppia* development.
- Results suggest winter openings would be the best to ensure early closure before the main plant growing season and to flush winter nutrient loads.
- There are trade-offs between a stable closed lagoon for good *Ruppia* development and risk of nutrient build-up fuelling macroalgae and phytoplankton blooms.

Ecological targets for lagoon-wide *Ruppia* cover and biomass index are likely to be met when *Ruppia megacarpa* is more prevalent, due to its ability to form tall, high cover beds.

Summary of technical findings

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

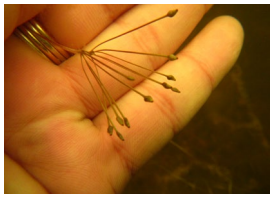
- Lagoon openings influence water quality conditions.
- *Ruppia megacarpa* contributed greater cover and height to macrophyte beds for the second year running.
- *Ruppia* flowered more for those years when the lagoon was closed for three months or longer before monitoring.
- An improvement in lagoon health in 2019 was indicated by clearer water, harder substrates and a deeper blackened 'sulphide' layer in the sediment (more oxygenated).
- However, greater recent macroalgae development suggests nutrient accumulation in the lagoon waters remains a critical issue.
- An unexplained decline of *Ruppia* at one site shows the community is vulnerable and ecology of the lagoon is complex.

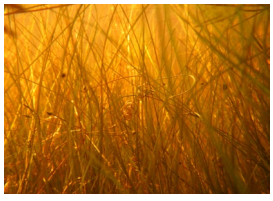
[8] de Winton, M. (2019) Technical Report on Vegetation Status in Waituna Lagoon: 2009–2019. NIWA Publication.

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 function 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.
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

- 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
- https://www.wetlandtrust.org.nz/get-involved/ramsar-wetlands/awarua-waituna-lagoon/

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