Department of Conservation
Te Papa Atawhai

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Taihoro Nukurangi

Vegetation Status in Waituna Lagoon: Summer 2020

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Contents

DOC commissioned NIWA to undertake the 2020 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 2020, only one out of six ecological targets was achieved for Waituna Lagoon and there was a large reduction in the abundance (biomass) of submerged vegetation (dominated by *Ruppia* species) since the 2019 survey;

- the lagoon was open to the sea over the critical spring-summer period for *Ruppia* growth (three months) before monitoring and this was probably responsible for the poor performance of vegetation in 2020,
- the only target met was 'status of *Ruppia megacarpa*', which continued to have a presence at ≥20% of sites as was recorded in 2018 and 2019,
- the target for lagoon-wide *Ruppia* cover (>30%) was not achieved. Lagoon-wide cover was only 5%, but *Ruppia* was still present at almost 70% of sites surveyed.
- the lagoon-wide target for *Ruppia* 'biomass index' (proxy for biomass) also was not achieved,
- a low (6% of sites) *Ruppia* reproductive success (well below the target of >40% of samples) was recorded.
- macroalgal development exceeded the acceptable threshold of <10% cover.

Based on all six ecological targets:

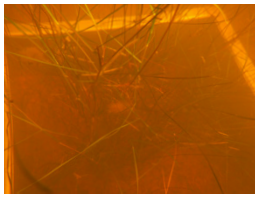
- 2020 had only one target achieved, being one of the poorest results since monitoring commenced.
- A similar result was achieved in 2011 and 2014 with zero targets achieved in 2013 and 2017.
- All five of these surveys were years when the target for lagoon closure (three months before survey) was not achieved.
- Current evidence suggest that winter openings are the best to ensure closure before the main plant growing season and to flush winter nutrient loads.

Purpose of this report

This report presents the 2020 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. (2020) Technical Report on Vegetation Status in Waituna Lagoon: 2009–2020.



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. The Lagoon is 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 recreational site.

The Department of Conservation has been monitoring submerged aquatic plants (including *Ruppia* spp.) 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.

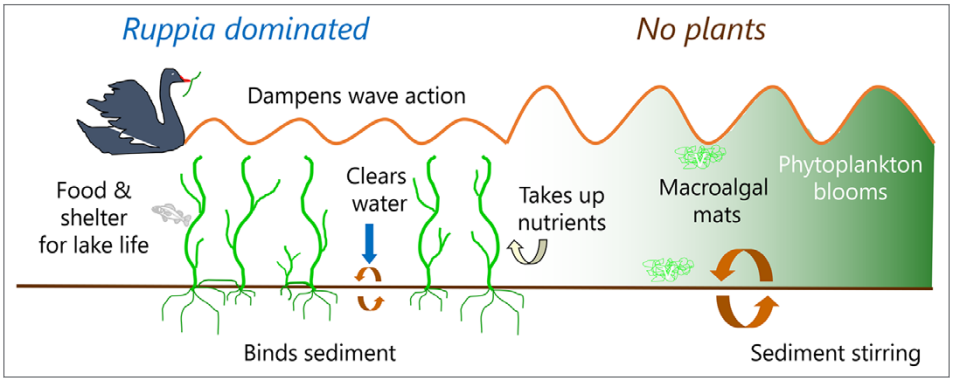


Figure 1: *Ruppia* vegetation can safeguard water quality in the lagoon compared to a system with no plants.

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 managing 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 associated conditions.

What do openings mean for the waters of Waituna Lagoon?

Monitoring of the waters of Waituna Lagoon over time[4] has built up a picture of the key changes caused by opening events[5]. Water level is lower and salinity higher when the lagoon is open and temperature and nutrient concentrations are both reduced with flushing by the sea (Figure 2). These changes and their duration influence the vegetation of Waituna Lagoon.

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

[4] https://www.lawa.org.nz/explore-data/southland-region/lakes/waituna-lagoon/

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

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.

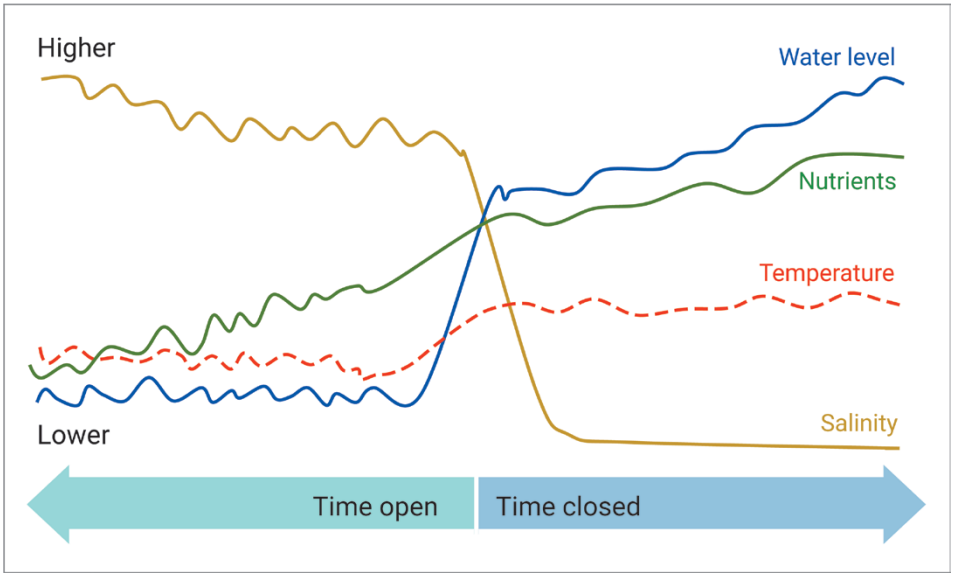


Figure 2: *Key changes in the waters of Waituna Lagoon with time after opening or closing to the sea.*

Catchment management

Agencies and the community aim to reduce sediment and nutrient inputs to Waituna Lagoon[6], focusing on strategies and initiatives for catchment management of contaminants, increasing biological processing of run-off and improving 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 persistence of *Ruppia* vegetation. However, opening the lagoon to flush nutrients provides a short-term solution for the health of the lagoon.

[6] 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.

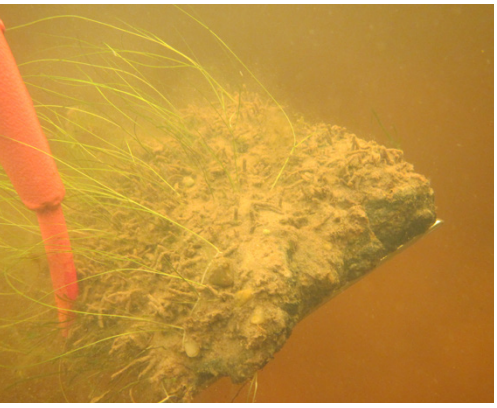
Results of annual monitoring are compared with target conditions sought under the Ecological Guidelines[7] for Waituna Lagoon. These ecological targets are listed in Box 1.

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[8]).
- <10% cover of benthic and epiphytic filamentous algae (macroalgae).
- >1000 average for *Ruppia* 'biomass index' (% cover x cm height).

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

[8] 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[9]. 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 3a). At each site, an assessment of environmental quality includes depth and water quality measurements (Figure 3b). 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 and dominant macroalgae are shown in (Figure 4).

Figure 3a: Map showing the location of sampling sites (47-48).

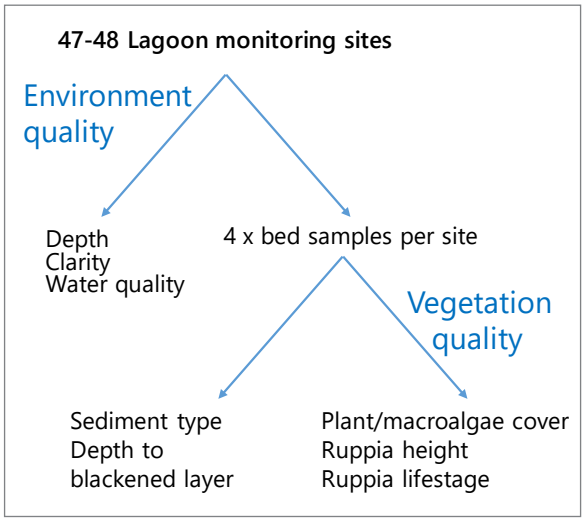


Figure 3b: Sampling design diagram.

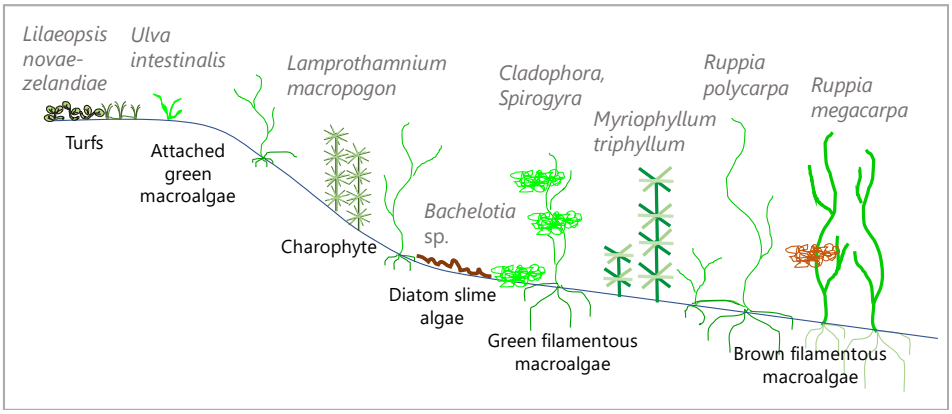
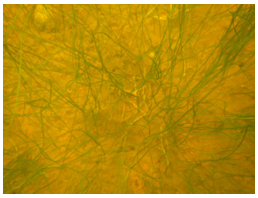


Figure 4: Common submerged plants and macroalgae types in Waituna Lagoon.

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



Did 2020 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 six ecological targets to track the health of the *Ruppia* community.

Target lagoon closure was not achieved in 2020, but was in 2009, 2010, 2012, 2015, 2016, 2018 and 2019.

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 2020, Waituna Lagoon had been open for the duration of the *Ruppia* growing season, being opened 4.1 months before the annual summer 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**
2020	-4.1

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 2020, the lagoon-wide average cover did not meet the ecological target (Box 1) of >30–60% (Table 2, Figure 5).

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

Note: both these years the lagoon had been closed for two consecutive growing 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**
2020	68	8	4	5

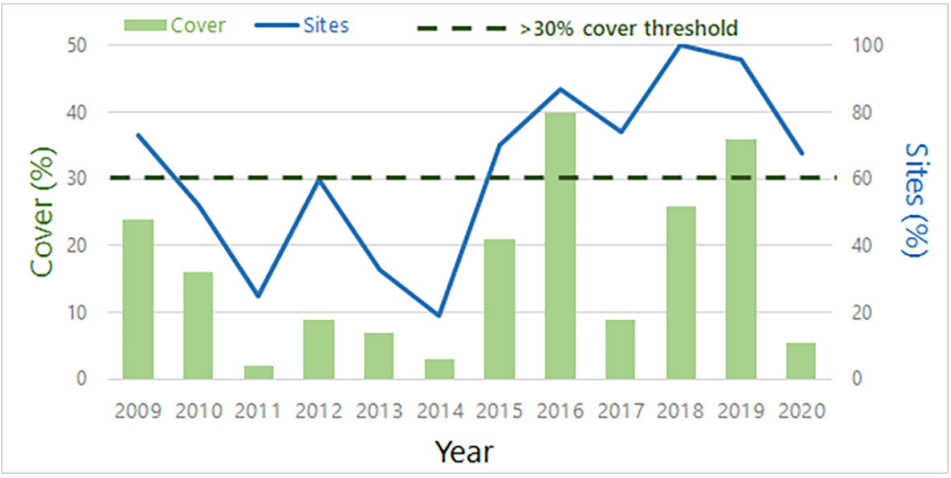


Figure 5: Lagoon-wide cover of *Ruppia* is shown as green bars and percentage of sites at which *Ruppia* was present as a blue line.

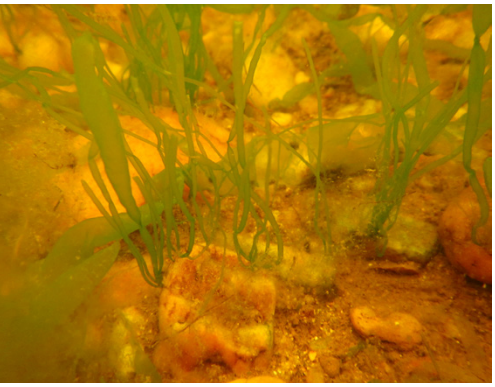
3. *Ruppia* biomass index

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 not met in 2020 (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**
2020	68	4	199



Limit for lagoon-wide macroalgae cover was not met in 2020, 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 lakebed 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 2020 exceeded this limit (Table 4 and Figure 6), however, there was a large reduction in macroalgae cover compared to 2019.

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
2020	79	31	32	25

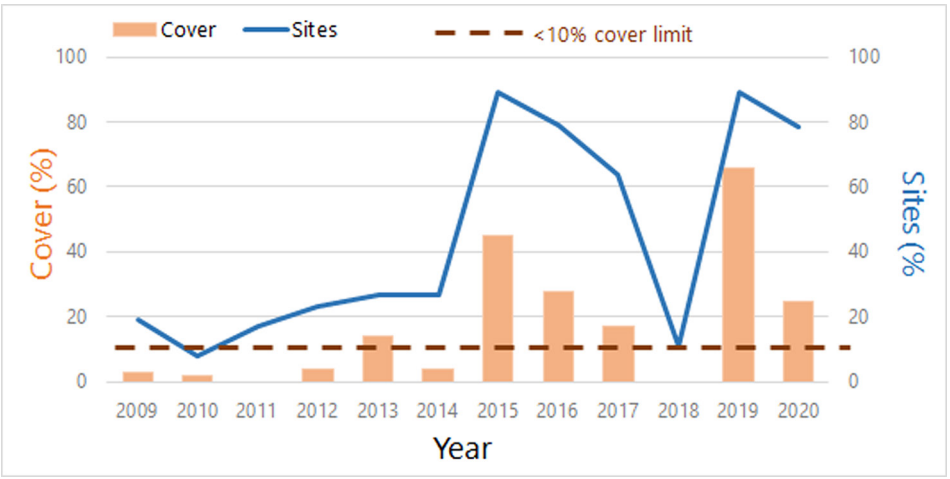


Figure 6: Lagoon-wide cover of macroalgae is shown as orange bars and percentage of sites at which macroalgae was present as a blue line.

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 not achieved in 2020 (Table 5).

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**
2020	6

The target for status of *Ruppia megacarpa* was achieved in 2010, 2018 2019 and 2020.

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 beneficial feedback influences on the local environment that promote further vegetation development. The target added in 2019[10] states ≥20% of the sites should record *R. megacarpa*. This was achieved in 2020 for the third year running. 20% of sites is recommended because this represents known sampled areas that are favourable for this species.

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

Year	% sites recording *Ruppia megacarpa*
2009	10
2010	**23**
2011	17
2012	2
2013	6
2014	0
2015	4
2016	9
2017	6
2018	**30**
2019	**32**
2020	**21**

[10] de Winton, M. (2019) Vegetation Status in Waituna Lagoon: Summer 2019. *NIWA Publication*.

Five out of six ecological targets were not achieved in 2020, only the target for status of *R. megacarpa* was met.

Conclusions

Ecological targets in 2020

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[11].

In 2020, five out of six ecological targets were not met (Table 7). The only target that was met was the measure for status of *Ruppia megacarpa*, indicating this beneficial 'ecosystem engineer' continued to contribute significantly to the vegetation (≥20% of sites). 2020 results show sustained open lagoon conditions result in a reduction in *Ruppia* abundance and health. However, widespread presence of both *Ruppia* species, and previous successful flowering in 2019 with likely replenishment of *Ruppia* seed banks, suggests this vegetation is well positioned for recovery as long as a sustained lagoon closure occurs by early spring 2020.

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

Table 7: Summary of 2020 results for all ecological targets.

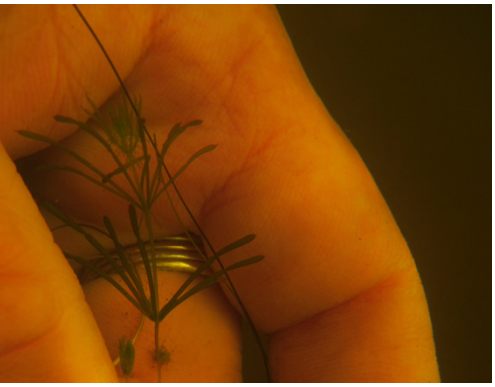
Ecological target	Targets met?	Comment
Lagoon closure	✗	Lagoon was open for the entire *Ruppia* growing season.
Ruppia cover	✗	*Ruppia* cover lagoon-wide was only 1/6th of the target of >30%.
Ruppia biomass index	✗	*Ruppia* biomass index did not meet the target.
Macroalgae cover	✗	Macroalgae development exceeded the acceptable limit.
Ruppia reproductive success	✗	Reproductive success was limited over the growing season.
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 (four out of last six years), and
  - excessive macroalgae were recorded during five out of the previous six 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
2020	✗	✗	✗	✗	✗	✓	1



Implications for lagoon health

- Ecological targets for Waituna Lagoon are not met when lagoon openings occur over 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[12] to this summary document outlines that:

- Mouth status of Waituna Lagoon strongly influences water conditions.
  - Water quality monitoring by Environment Southland showed after the lagoon opening in October 2020 salinity increased, nutrient concentrations decreased and measures for particles suspended in the lagoon waters also decreased (suspended solids, turbidity, chlorophyll *a*).
  - During vegetation monitoring in February 2020, the lagoon was tidal, lagoon waters averaged 75% sea water and were saltier near the opening.
  - Water temperature in February 2020 (average 18.6°C) was amongst the four highest years recorded during vegetation monitoring.
  - February 2020 monitoring showed turbidity was high and water clarity was low compared with previous summer vegetation monitoring events.
- Sediment condition in February 2020 was generally better than recent years, with an apparent redistribution/flushing/processing of fine sediments and a sediment surface that was more oxygenated and 'healthier'.
- *Ruppia* remained widespread in February 2020, but at low cover.
- Other submerged plants (milfoil and charophytes) had declined more than *Ruppia*.
- Potential for *Ruppia* recovery is high if favourable conditions are experienced in the next spring-summer growth season.
- Macroalgae remained relatively abundant in February 2020, suggesting drivers other than lagoon mouth status (e.g., meteorological conditions) are also important.

Overall, vegetation monitoring results for Waituna Lagoon from 2020 continue to support the need for short, winter openings as a means of protecting widespread *Ruppia* vegetation and the ecological benefits that submerged plants provide.

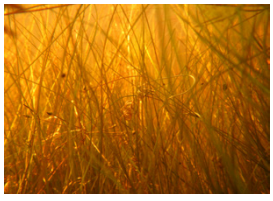
[12] de Winton, M. (2020) Technical Report on Vegetation Status in Waituna Lagoon: 2009–2020. *NIWA Publication.*

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.es.govt.nz/environment/water/lakes
- https://www.wetlandtrust.org.nz/get-involved/ramsar-wetlands/awarua-waituna-lagoon/