Wriggle

coastalmanagement

Waituna Lagoon 2007

Macrophyte (*Ruppia*) Mapping

Prepared for Department of Conservation June 2007

Waituna Lagoon 2007

Macrophyte (*Ruppia*) Mapping

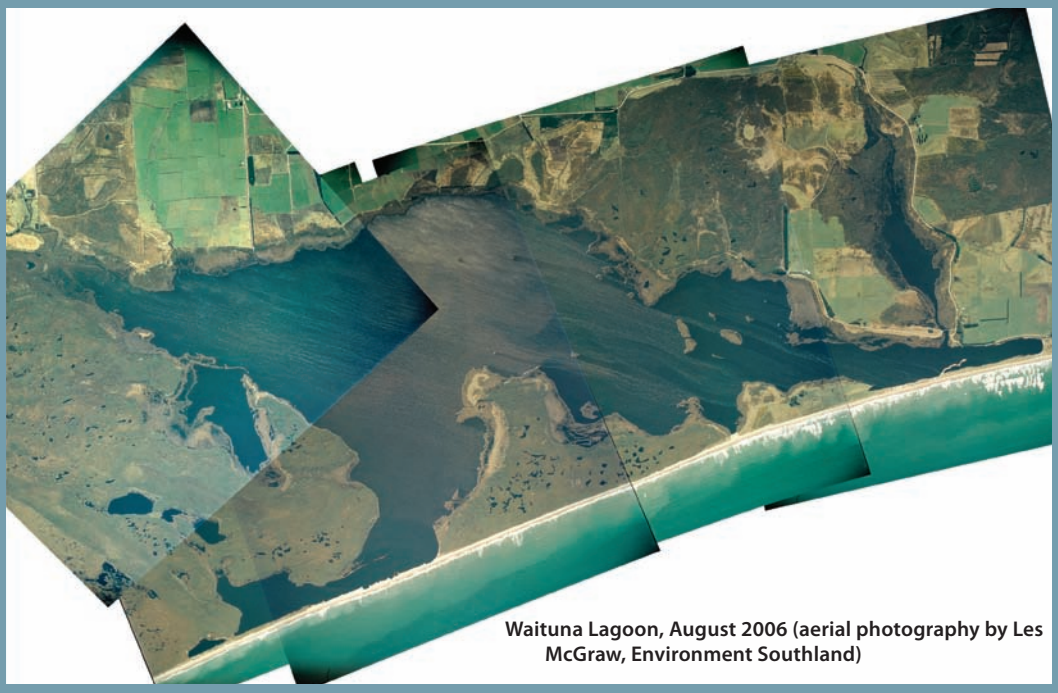
Prepared for
Department of Conservation

By

Barry Robertson and Leigh Stevens

Cover Photo: Waituna Lagoon.

Wriggle Ltd, 148 Hardy St, PO Box 1622, Nelson 7040, Ph/Fax 03 548 0780, Mob 021 417 936, 021 417 935, www.wriggle.co.nz



Waituna Lagoon, August 2006 (aerial photography by Les McGraw, Environment Southland)

Contents

List of Figures

List of Tables

All photos by Wriggle except where noted otherwise.

1. INTRODUCTION

SCOPE

Figure 1 *Ruppia* Waituna Lagoon

Developing an understanding of the condition and risks to coastal lagoon habitats is critical to Environment Southland (ES) and Department of Conservation (DOC) in their resource management roles for the Southland region.

Recent studies have identified a number of key issues associated with the Waituna Lagoon as follows;

- local reports of increased sedimentation
- changes in vegetation both within the lagoon and margins
- fears that the lagoon will become eutrophic with symptoms of algal blooms and low dissolved oxygen
- the lack of a defensible and holistic ecological risk assessment for the lagoon and its associated long-term monitoring and management recommendations

To address these issues and provide a baseline against which change can be measured, ES and DOC (Southland Conservancy) instigated the following studies;

- Broad scale mapping of wetland vegetation
- Broad scale mapping of subtidal sediment types
- Broad scale mapping of the dominant macrophyte beds (i.e. *Ruppia*)
- Broad scale mapping of the dominant macroalgal beds (i.e. *Enteromorpha*)
- Determining current, and recent historical, sedimentation rate estimates using settlement plates and historic coring techniques
- Developing a framework for Ecological Risk Assessment for the lagoon and making preliminary assessments, including monitoring and management recommendations

The present report presents the results of one of these studies, the broad scale mapping of the dominant macrophyte beds (i.e. *Ruppia*) undertaken by Wriggle Coastal Management in March 2007. These results are also presented along with the results of the other studies and a detailed discussion, in the Environment Southland report "Waituna Lagoon 2007, Habitat Mapping (Terrestrial, Subtidal Sediment, Macrophytes, Macroalgae) & Historical Sediment Coring, Robertson and Stevens 2007).

Figure 2 Eastern end of Waituna Lagoon where extensive beds of ***Ruppia*** are present.

2. BACKGROUND GENERAL

BACKGROUND

Figure 3 Eastern end of Waituna Lagoon

Waituna Lagoon (1350ha) and associated wetland (~2,200ha), centred in Toetoes Bay in Eastern Southland, is a large, brackish intermittently open/closed "coastal lake" estuary. It is fed by 3 streams, Currans Creek, Waituna Creek and Moffat Creek (Figure 1), which pass through highly developed pastoral lands. It is separated from the sea by a spit or barrier beach, and the lagoon drains to the sea through a gap at the western end when the lagoon is open. Historically, the lagoon was surrounded by a huge peat bog wetland (area approximately 20,000ha stretching from Fortrose Estuary to New River Estuary) whose drainage gave the lagoon water its characteristic clear brown humic stain, low nutrient status, and low pH.

MODIFICATIONS

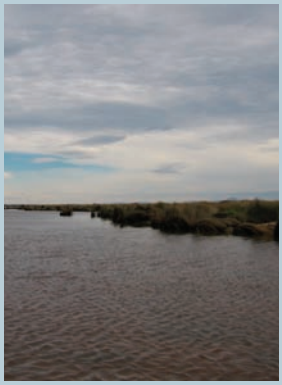


Figure 4 Western end of Waituna Lagoon showing rushland

During the last 150 years, there have been a number of significant modifications to the lagoon and associated wetland as follows:

- **Drainage:** Much of the peat bog catchment has been drained and the land used for agriculture. More recently, there has been a large shift towards intensive dairy farming in the catchment. The combination has almost certainly increased sediment, nutrient and pathogen loads to the lagoon and increased introduced weed growth in wetland areas.

- **Artificial Lagoon Openings:** Historically, the lagoon naturally breached to the sea once water level became too high (approximately 4m above sea level). In 1908, the first artificial breach was made in order to improve fishing. Thereafter, many artificial breaches have been undertaken and since 1972 they have been undertaken almost annually (Thompson and Ryder 2003). The main reason for breaching was to ensure free drainage of surrounding farmland. This has resulted in much longer periods of low water level in the lagoon, higher mean salinities, less habitat for aquatic biota and reduced water volume for assimilation of catchment runoff.

- **Expansion of Rushland:** The area covered by rushland vegetation (predominantly jointed wire rush, *Leptocarpus similis*) has expanded, probably in response to the artificial lagoon openings but possibly enhanced by increased sediment and nutrient loads.

CONSERVATION STATUS

Because Waituna Lagoon, and its associated wetlands, is a largely unmodified example of a temperate shallow coastal lagoon with large areas of intact coastal wetland, it has been given special conservation status. In 1976, it was designated of international significance under the Ramsar Convention. The wetlands and lagoon were recognised under Ramsar on the grounds that "they support an appreciable assemblage of endemic and threatened species and communities, have special value for maintaining the genetic and ecological diversity of the region and provide habitat for plants and animals at critical stages of their biological cycles". In 1983, it was also established as a scientific reserve and is administered by DOC. The lagoon is also culturally significant to the local Ngai Tahu people (recognised under a Statutory Acknowledgement with the Ngai Tahu Claims Settlement Act 1998).

3. BACKGROUND MACROPHYTES

BACKGROUND MACROPHYTES

Waituna Lagoon has a macrophyte community dominated by *Ruppia*. This rooted aquatic plant occurs in saline ponds, lagoons, brackish streams, slow flowing fresh water streams, and fresh water lakes throughout New Zealand. Two species of *Ruppia* occur in New Zealand: *R. polycarpa* sp. nov. and *R. megacarpa* sp. nov. Both spp. are commonly referred to as Horse's mane weed or Lakeweed. *Ruppia* has been suggested as a keystone species in Waituna Lagoon because of its importance as a habitat for invertebrates and fish, as a food source for invertebrates and waterfowl, and its role in regulating water quality.

Recent studies (Johnson and Partridge 1998, Thompson and Ryder 2003, Cadmus and Schallenberg in press, and particularly Schallenberg and Tyrrell 2006), have identified a number of key factors affecting the presence and management of *Ruppia* in Waituna Lagoon.

- The lagoon is unique in New Zealand because of its intact *Ruppia*-dominated macrophyte communities.
- Waituna Lagoon is particularly susceptible to the environmental stressors that could cause *Ruppia* collapse including; extreme wind events (physical uprooting), excess nutrient loading (phytoplankton blooms), decreased light penetration (from excess sediment or phytoplankton), increased water levels (limiting light to plants on bed), sediment oxygen depletion, overgrazing by waterfowl and salinity changes (long periods of excessive salinity).
- If any of these stressors caused "whole lagoon" macrophyte collapse, it is likely that the lagoon would enter an undesirable phytoplankton-dominated regime and that *Ruppia* would be unlikely to re-establish once lost.
- *Ruppia* distribution in Waituna Lagoon is limited to areas where the depth is not so great that light can't penetrate, or so shallow that it is dessicated or stressed by wave action.
- When water depth is too high, large areas of available habitat are lost due to light limitation. There is a recommendation that periods of high water level should be kept to less than 60 days.
- Excessive phytoplankton growth and suspended sediment concentrations reduce light penetration and habitat for *Ruppia* growth.
- The best means of controlling phytoplankton biomass is to reduce phosphorus inputs to the lagoon as this is likely to be the limiting nutrient.
- The best means of controlling excessive suspended sediment concentrations is to reduce suspended sediment concentrations to the lagoon.
- Long periods with the lagoon open to the sea result in higher mean salinities in the lagoon which may adversely affect *Ruppia* if salinities exceed the optimum 4-8 ppt level.
- Periods of closure provide the low salinity conditions important for seed germination and seedling establishment.
- Studies at Lake Ellesmere and in Australia and Europe (Gerbeaux and Ward, 1991), indicate that *Ruppia* requires good illumination and sheltered conditions for growth. Their studies also suggest that, although plants can be absent from some sites in some years, they can appear again under the right environmental conditions (i.e. low water salinities to stimulate germination and high water clarity that enables light to reach the bottom.

Schallenberg and Tyrrell (2006), in their recent risk assessment for *Ruppia* in Waituna Lagoon also identified a number of recommended management and monitoring options. One of these, was to conduct a more detailed mapping survey of macrophyte distribution in the lagoon (one while open and one when closed).

Figure 5 Emily Atkinson (DOC) at eastern end of Waituna Lagoon

Figure 6 *Ruppia*, Waituna Lagoon

4. METHODS

METHODS

Broad scale mapping of *Ruppia* beds was undertaken in early March 2007.

Broad-scale mapping is a method for describing habitat types based on the dominant surface features present (e.g. substrate: mud, sand, cobble, rock, etc; or vegetation: macrophytes, macroalgae etc - including dominant and subdominant species). The approach uses a combination of aerial photography, together with detailed ground-truthing and digital mapping using GIS technology (ArcMap 9.2), to record the primary habitat features present. The procedure, originally described for use in NZ estuaries by Robertson et al. (2002), has subsequently been modified and successfully applied to develop baseline and risk maps of whole region coastlines (e.g. Greater Wellington and Hawke's Bay; Stevens and Robertson 2004, 2005, 2006) and subtidal coastal areas (Stevens and Clark, 2004).

For this project, the area mapped included all the subtidal habitat of Waituna Lagoon, as it appeared in early March 2007. The groundtruthing exercise was undertaken over 3 days by:

- Collecting samples of the surface sediments and attached macrophyte species from a jetboat, canoe, or by wading in shallower water.
- Viewing macrophyte beds through the water column with a viewing scope.
- Viewing flower heads at the water surface.

Sampling positions and photographs were georeferenced and the information collected was used to produce a GIS-based habitat map showing the percentage cover of the two *Ruppia* species (the dominant macrophytes) present in the lagoon.

The broad scale mapping output is presented as an ArcMap GIS layer and is also summarised and presented in tabulated form with full data provided as tables within the GIS itself to enable the data to be easily accessed and managed to address specific questions. Georeferenced digital field photos (GPS- Photolink) are also supplied as a GIS layer.

Figure 7 Checking for *Ruppia*, at surface, Waituna Lagoon

5. RESULTS

RESULTS

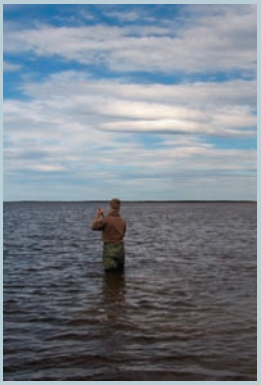


Figure 8 Checking for *Ruppia*, Waituna Lagoon western end

Figure 9 Dense *Ruppia*, growth, Waituna Lagoon western end

Physical Conditions

Physical conditions during the time of sampling were favourable for both the germination of *Ruppia* and for its subsequent growth as follows:

- Water salinity was near freshwater at <5ppm
- Water clarity was relatively high for this deeply humic stained lagoon (secchi depth 1.5-2m). This meant that light was reaching the bed over most of the lagoon.
- Water depth was generally less than 2m (Figure 10) - Lagoon level 1.13m above msl.
- The lagoon had been closed for 9 months.
- Conditions in the preceeding weeks had been relatively calm.

Macrophyte Cover

The results of the dominant macrophyte survey (Figure 11, 12 and 13 and Table 1) indicate that macrophyte presence was dominated by the two species of *Ruppia*, *R. polycarpa* and *R. megacarpa*, and that they were restricted to certain preferred locations.

Table 1 Summary of *Ruppia* cover results, February/March 2007.

% Cover Category		Area (ha)		Percentage	
		R.polycarpa	*R. megacarpa*	*R. polycarpa*	*R. megacarpa*
Very low	<1%	458		33.5	
Low	1-10%	155	306	11.3	22.4
Low-Mod	10-20%	1	4	0.1	0.3
Moderate	20-50%	28	16	2.1	1.2
High	50-80%	231	127	16.9	9.3
Very High	>80%	-	41	-	3.0

The areas of high percentage cover (50-100% cover) were found predominantly in the eastern half of the lagoon. Shallower areas, particularly along the north-eastern shoreline, were dominated by relatively small *R. polycarpa*, while deeper parts of the lagoon to the south and east and were dominated by much larger *R. megacarpa* plants. Substrates in these areas were mostly gravels and sands with relatively little mud. Areas with very high cover (80-100%) were spread throughout the lagoon, but appeared limited to areas relatively sheltered from wind and wave disturbance (e.g. the head of Waituna Creek, the western embayment and arm, and the deep and narrow eastern arm near Currans Creek). Soft muds dominated in the sheltered areas to the west while gravels and sands dominated in the east.

The areas of low to moderate percentage cover (1-50% cover) were located mainly through the central part of the lagoon and in the Currans Creek embayment.

The areas of low and very low percentage cover (<1% cover) tended to be restricted to shallow exposed areas with either muddy or sandy sediments.

FIGURE 10. MAP OF WATER DEPTH - WAITUNA LAGOON MARCH 2007

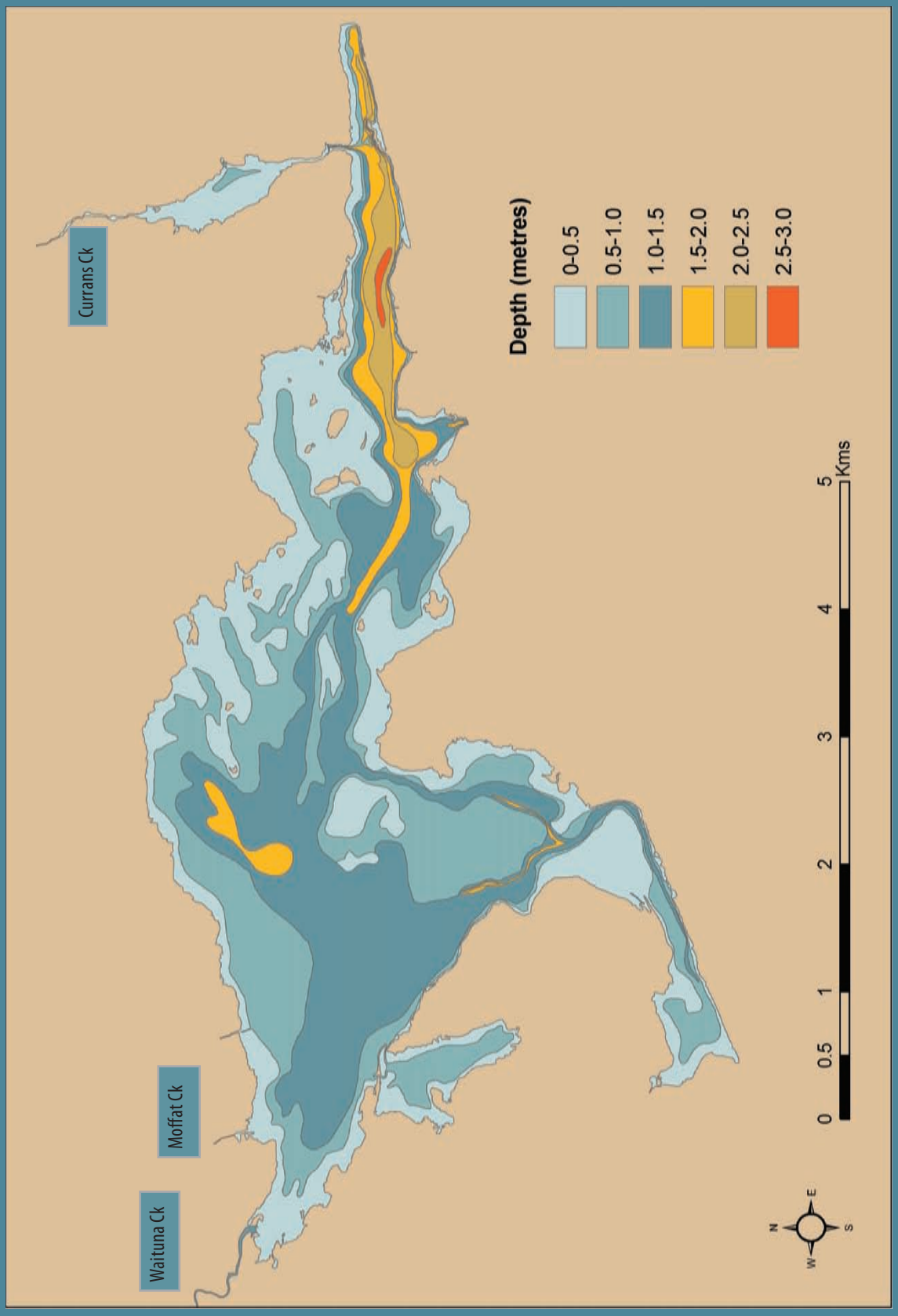


FIGURE 11. MAP OF RUPPIA COVER - WAITUNA LAGOON 2007

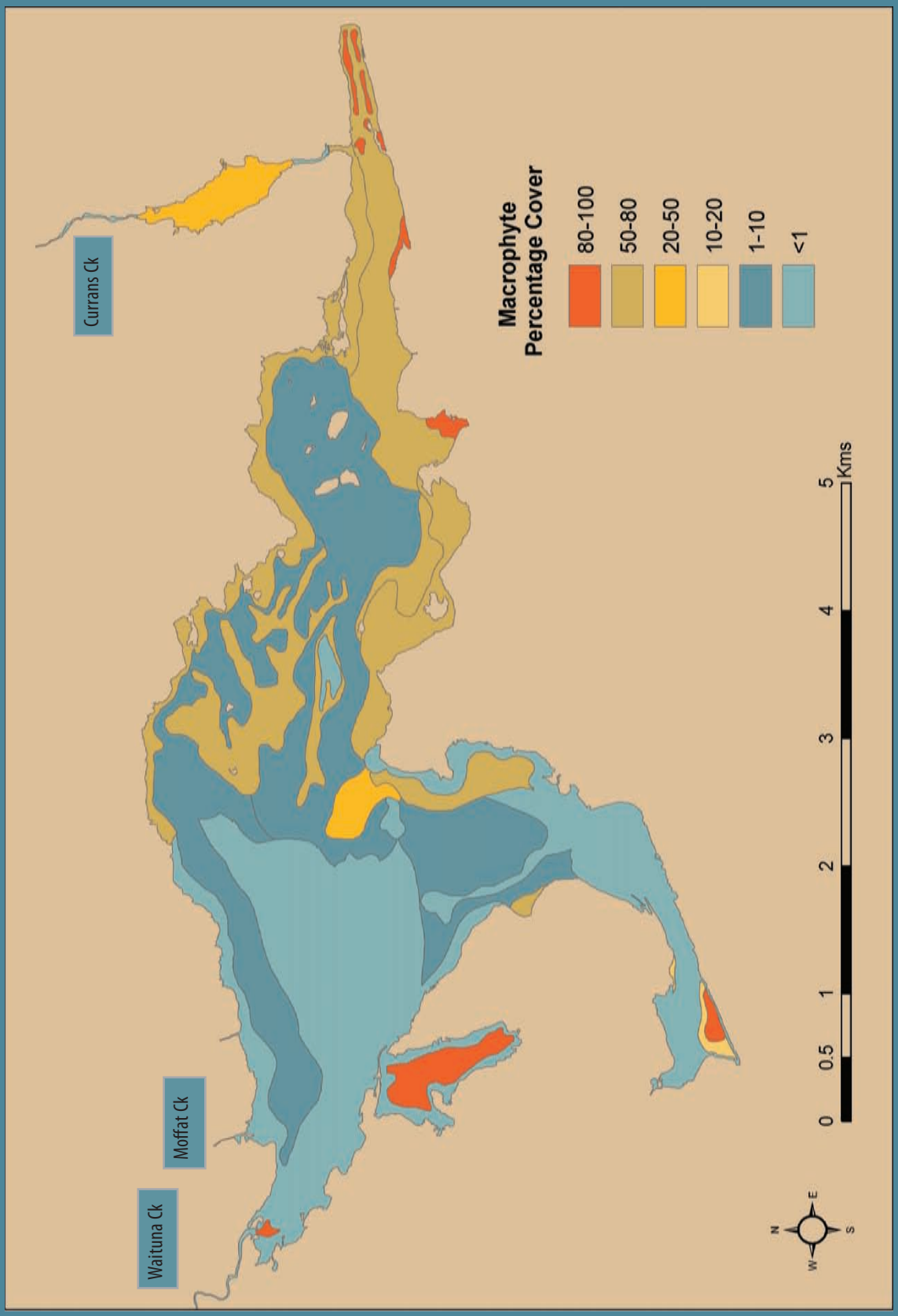


FIGURE 12. MAP OF *RUPPIA MEGACARPA* COVER - WAITUNA LAGOON 2007

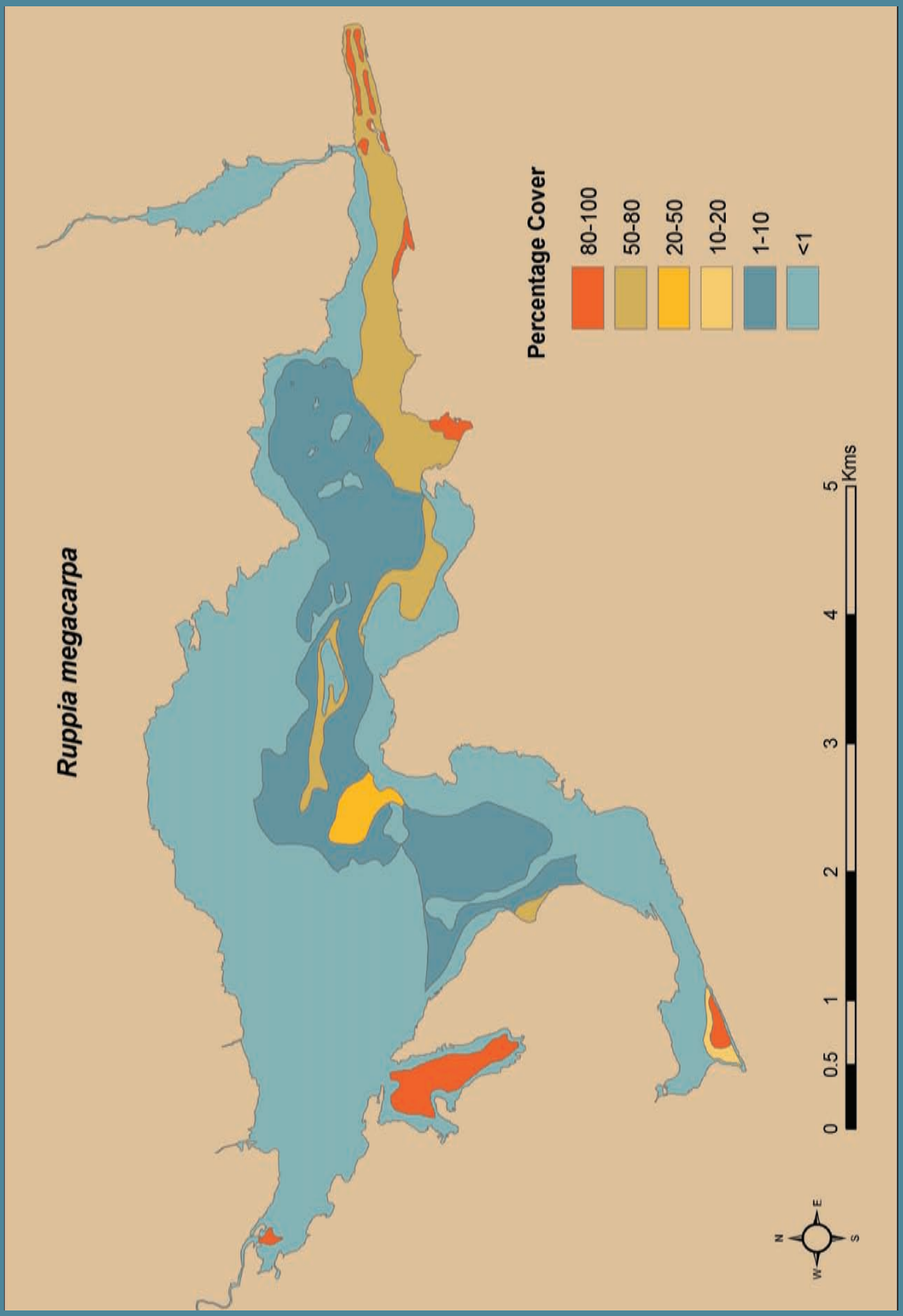
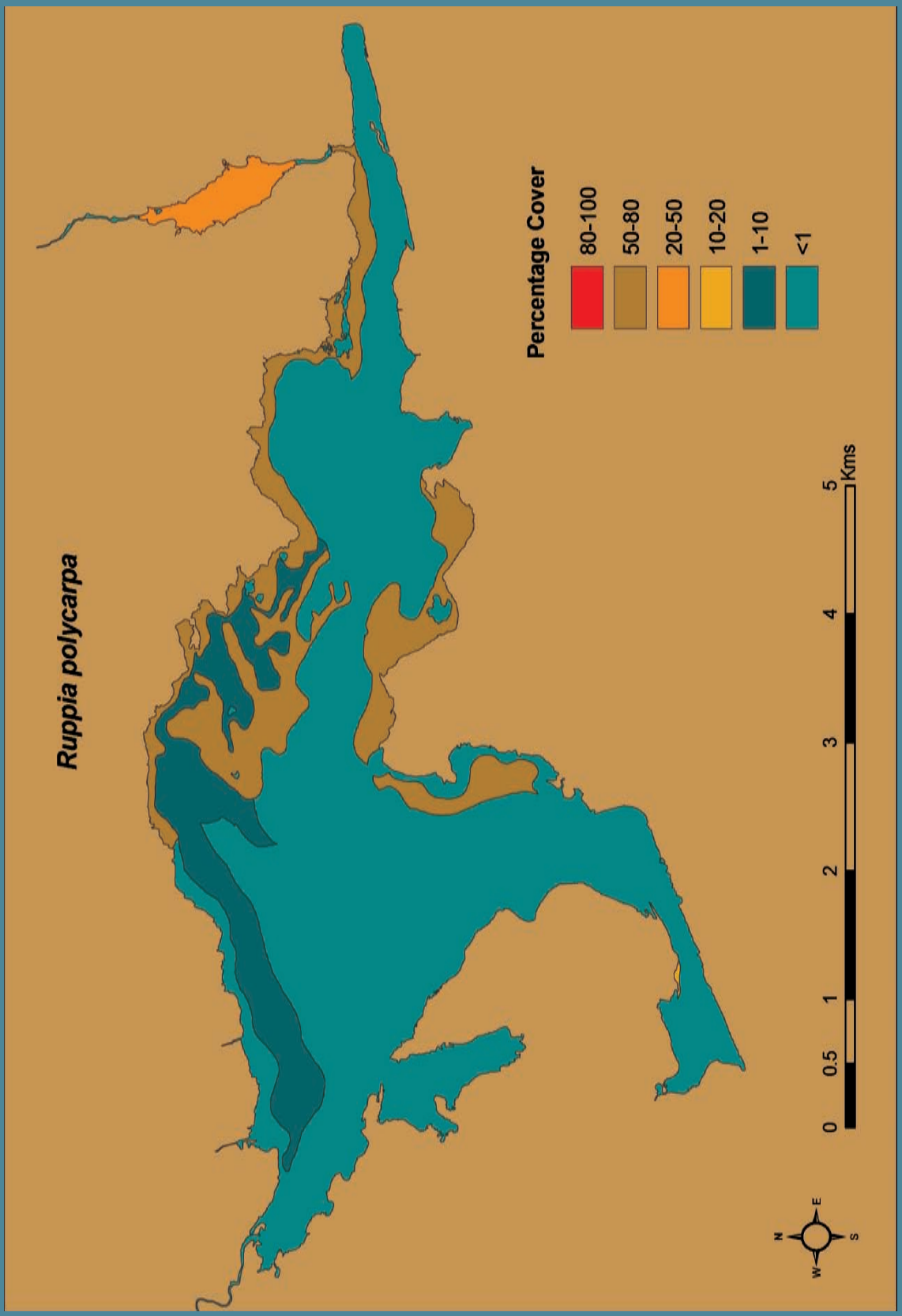


FIGURE 13. MAP OF *RUPPIA POLYCARPA* COVER - WAITUNA LAGOON 2007



5. Results (continued)

DISCUSSION

These results show that the March 2007 *Ruppia* mapping of Waituna Lagoon was undertaken at a time when growth in the lagoon was likely to be optimal. The lagoon had been closed for 9 months, water depth was still at a moderate level (1.13m above msl), the water was clear and salinity was low. Consequently the distribution and density of Ruppia in March 2007 provides an ideal baseline for future comparison. Under these conditions, the survey showed that *Ruppia* was present at all available depth ranges, and a variety of substrate types. However, *Ruppia* is mostly absent from the western side of the lagoon outside of sheltered areas which is most likely attributable to physical disturbance from wind and wave action.

The consequences of changing lagoon levels, particularly through artificial opening of the lagoon, have been well covered by other authors (see Section 3). As an example of likely change, we have estimated the probable loss of *Ruppia* if the lagoon was to be opened and drained from the current level (1.13m above msl) to levels reported for when the lagoon is open (0.63m above msl - Johnson and Partridge 1998). Opening would decrease surface area of the lagoon by about 475ha, of which, based on the March 2007 survey, 305ha (65%) had *Ruppia* growing in it, 140ha of this with >50% cover of *Ruppia*. That is, about 1/3 of the total area of *Ruppia* that was in the lagoon in March 2007 would be lost. Offsetting this loss, an area of ~100ha previously too deep for light to reach the bottom would potentially be available for *Ruppia* growth if light limitation was the only constraint to growth.

The presence of extensive macrophyte (e.g. *Ruppia*) beds in shallow open/closed coastal lake estuaries, like Waituna Lagoon, is likely to be indicative of a healthy and biodiverse ecosystem (i.e. not too muddy or nutrient enriched). As such, it is recommended that % cover of *Ruppia* be used as a "condition indicator" and results reported using pre-developed condition rating categories (see example below).

To facilitate reporting and management, it is recommended that condition rating categories be established for Waituna Lagoon along the following lines:

RATING	DEFINITION	RESPONSE
Very Good	Ruppia cover exceeds that recorded in 2007 survey,	Monitor at annual intervals after baseline established.
Good	Cover similar to 2007 survey	Monitor at annual intervals after baseline established
Moderate	10-30% less cover than 2007 survey	Monitor at annual intervals after baseline established
Fair	30-70% less cover than 2007 survey	Monitor % cover and density annually. Evaluation and Response Plan.
Poor	Ruppia absent from lagoon	Monitor % cover and density annually. Evaluation and Response Plan.
Early Warning Change Trigger	Trend of % cover increasing/decreasing	Undertake evaluation and response plan.

***RUPPIA* CONDITION RATING**

Ruppia Rating March 2007	Good

6. EXECUTIVE SUMMARY

SUMMARY

Figure 14 Waituna Lagoon near ocean western end

In order to provide information on the current extent of the dominant macrophyte beds (i.e. *Ruppia*) and provide a baseline for future monitoring, Department of Conservation initiated a broad scale mapping exercise. In February 2007, Wriggle Coastal Management were contracted to undertake the mapping at the same time as they were undertaking a number of other monitoring surveys for Environment Southland. The methodology and results of the macrophyte mapping are presented in this report. A more detailed discussion of the findings in relation to the other parameters measured in the broader study of Waituna Lagoon is reported in Environment Southland report (Robertson and Stevens, 2007 in press).

The 2007 broad scale mapping of *Ruppia* distribution in Waituna Lagoon after it had been closed to the sea for 9 months, and at a water depth of 1.13 m above msl, indicated the following:

- The survey was undertaken following a period of optimal growing conditions, providing an ideal baseline for future comparison.
- *Ruppia* beds covered approximately 66% of the lagoon bed.
- Both *Ruppia* species were present. *R. polycarpa* was dominant in water less than 0.5m deep, with plants relatively small (mostly 10-20cm). *R. megacarpa* dominated in the depth range 0.5-2.5m but seemed to prefer depths between 1.0-1.5m. Plants were generally large (>20cm) with flower heads reaching up to the water surface.
- The areas of greatest density were spread throughout the lagoon, but appeared limited to areas relatively sheltered from wind and wave disturbance (e.g. the head of Waituna Creek, the western embayment and arm, and the narrow eastern arm near Currans Creek).

RECOMMENDED MANAGEMENT

Figure 15 *Ruppia* bed, Waituna Lagoon

It has been acknowledged that *Ruppia* is something that should be maintained and encouraged in Waituna Lagoon. This survey has identified that under relatively optimal conditions of an extended period of lagoon closure, good water clarity and the availability of suitable habitat, extensive beds of *Ruppia* are present in Waituna Lagoon. We know from studies and experience elsewhere that *Ruppia* growth may be discouraged if water clarity is reduced through such actions as excessive inputs of fine sediments, by frequent changes in water or salinity levels through lagoon openings, or if excessive nutrient inputs result in phytoplankton or macroalgal blooms. We also know that Waituna Lagoon is very susceptible to such problems. To maintain the presence of *Ruppia* in the lagoon the following monitoring and management approaches are recommended:

Monitoring

- Repeat broad scale mapping of % cover of *Ruppia* at annual intervals.
- Develop a *Ruppia* Condition Rating (very good, good, fair, poor) linked to management responses for ease of reporting and management.

Management

- Set Total Daily Maximum Loads (TDMLs) on sediment and nutrients (particularly phosphorus) entering the lagoon in streams and groundwater.
- To ensure available habitat is maximised, set limits on lagoon openings.
- Monitor for and prevent overgrazing by waterfowl.

7. ACKNOWLDGEMENTS AND REFERENCES

ACKNOWLEDGEMENTS

This survey and report has been undertaken with help from various people, local farmers who provided access to the estuary, Chris Owen who provided valuable local information and a skippered boat, staff of the Department of Conservation (particularly Emily Atkinson, Ken Murray, and Eric Edwards), Marc Schallenberg (University of Otago), and Environment Southland (particularly Chris Arbuckle, Jane Kitson, Kirsten Meijer, and Les McGraw).

REFERENCES

Cadmus, R.W. and Schallenberg, M. 2007. Mid-Holocene to Present-Day Environmental Dynamics in Two Lagoon-Wetland Complexes, South Island, New Zealand. In press.

Gerbeaux, P., Ward, J.C. (1991). "Factors affecting water clarity in Lake Ellesmere, New Zealand." New Zealand Journal of Marine and Freshwater Research 25: 289-296

Johnson, P. N. and Partridge, T. R. 1998: Vegetation and water level regime at Waituna Lagoon, Southland, Science for Conservation 98. Wellington: Department of Conservation.

Thompson, R. M. and Ryder, G. R. 2003: Waituna Lagoon: summary of existing knowledge and identification of knowledge gaps. Science for Conservation 215. Wellington: Department of Conservation.

Schallenberg, M. and Tyrrell, C. 2007. Report on Risk Assessment for Aquatic Flora of Waituna Lagoon. In press.

Environment Southland Coastal Monitoring Reports

Robertson B.M., Asher, R. 2006. Environment Southland Estuary Monitoring 2006. Prepared for Environment Southland.

Robertson, B., and Stevens, L. 2006. Southland Estuaries State of Environment Report 2001-2006. Prepared for Environment Southland.

Robertson B.M., Asher R., Sneddon R. 2004. Environment Southland Estuary Monitoring 2004. Prepared for Environment Southland.

Robertson, B., Stevens, L., Thompson, S., and Robertson, B. 2004. Broad scale intertidal habitat mapping of Awarua Bay. Prepared for Environment Southland.

Robertson, B., Stevens, L., Thompson, S., and Robertson, B. 2004. Broad scale intertidal habitat mapping of Bluff Harbour. Prepared for Environment Southland.

Robertson, B., Stevens, L., Thompson, S., and Robertson, B. 2004. Broad scale intertidal habitat mapping of Waikawa Estuary. Prepared for Environment Southland.

Robertson B.M., and Asher R. 2003. Environment Southland Estuary Monitoring 2003. Prepared for Environment Southland.

Robertson B.M., Tuckey B.J., and Robertson B. 2003. Broadscale mapping of Jacobs River Estuary intertidal habitats. Prepared for Environment Southland.

Robertson B.M., Tuckey B.J., and Robertson B. 2003. Broadscale mapping of Fortrose Estuary intertidal habitats. Prepared for Environment Southland.

Robertson, B.M., Gillespie, P.A., Asher, R.A., Frisk, S., Keeley, N.B., Hopkins, G.A., Thompson, S.J., Tuckey, B.J. 2002. Estuarine Environmental Assessment and Monitoring: A National Protocol. Part A. Development, Part B. Appendices, and Part C. Application. Prepared for supporting Councils and the Ministry for the Environment, Sustainable Management Fund Contract No. 5096. Part A. 93p. Part B. 159p. Part C. 40p plus field sheets.

Robertson, B.M. 1997. Southland Coastal Ecology Programme 1996-7. Report prepared for Southland Regional Council. Barry Robertson, Env. Consultant, Nelson. 50p.

Robertson, B.M. 1995. Southland Estuaries: heavy metal monitoring. Report prepared for the Southland Regional Council. Robertson Ryder & Associates, Dunedin. 35p.

Robertson, B.M. 1992. Aparima Catchment Water Quality Review. Report prepared for the Southland Regional Council. Barry Robertson & Associates, Dunedin. 67p.

Robertson, B.M. 1992. New River Estuary: Review of Existing Water Quality. Report prepared for Southland Regional Council. Barry Robertson & Assoc, Dunedin. 76p.

Stevens, L., and Asher, R. 2005. Broad scale intertidal habitat mapping of Haldane Estuary. Prepared for Environment Southland.

Stevens, L., and Asher, R. 2005. Environment Southland Estuary Monitoring 2005. Prepared for Environment Southland.