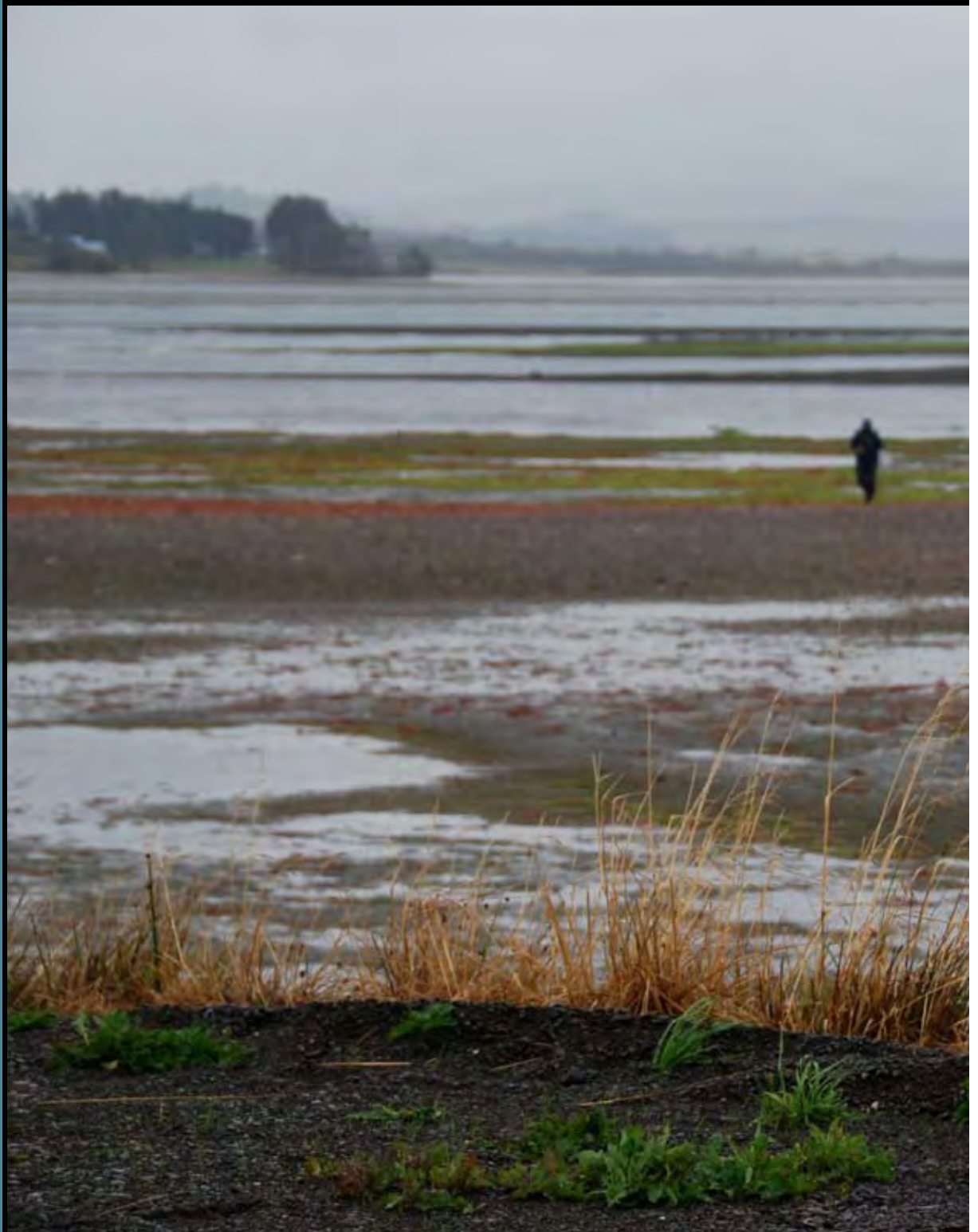


Jacobs River Estuary

Macroalgal Monitoring 2008/09



Prepared
for
**Environment
Southland**
June
2009

Cover Photo: Bands of macroalgae along the edge of the Pourakino River channel, Jacobs River Estuary.



Enteromorpha growth on the edge of sandy intertidal flats near the Riverton road bridge.

Jacobs River Estuary

Macroalgal Monitoring 2008/09

Prepared for
Environment Southland

By

Leigh Stevens and Barry Robertson

Contents

1. Introduction and Methods 1
2. Results, Rating and Management 2
3. References 4

List of Figures

Figure 1. Map of macroalgal cover - Jacobs River Estuary, February 2009 2
Figure 2. Relationship between nitrogen inputs and nuisance macroalgal conditions in selected estuaries . . 3

List of Tables

Table 1. Summary of macroalgal cover results, February 2009. 3
Table 2. Summary of macroalgal cover results, 2007-2009. 3



Thick windblown accumulations of *Gracilaria* and *Enteromorpha* along the edge of the Aparima River channel.

All photos by Wriggle except where noted otherwise.



1. INTRODUCTION AND METHODS

INTRODUCTION

Developing an understanding of the condition and risks to estuarine habitats is critical to resource management in the Southland region. This brief report summarises the third year of macroalgal monitoring results for the Jacobs River Estuary, one of the key estuaries in the Environment Southland's long term estuary monitoring programme. The report describes the macroalgal cover of the estuary in February 2009, and applies the results to the macroalgae estuary condition rating (and recommended management responses) developed for Southland's estuaries. The next monitoring in the Jacobs River Estuary is due in February 2010.

METHODS

Broad scale mapping of the percentage cover of macroalgae throughout all the intertidal habitat of Jacobs River Estuary was undertaken in February 2009 using a combination of aerial photography, ground-truthing, and ArcMap 9.2 GIS-based digital mapping. The procedure, originally described for use in NZ estuaries by Robertson et al. (2002), has subsequently been modified and successfully applied to various estuaries to develop a separate GIS macroalgal layer (e.g. Robertson and Stevens 2007).

Environment Southland supplied rectified aerial photographs (~0.3 metre per pixel, scale 1:10,000) of the estuary, flown in February 2008. Experienced coastal scientists then recorded the percentage cover of macroalgae directly onto laminated photos during field assessment of macroalgal cover. The photographs also formed the GIS base layer onto which the percentage cover information was subsequently digitised.

The report outputs are used to both identify and classify macroalgal cover, and to show changes in macroalgal cover over time by comparisons with previous surveys (annually if a problem estuary, or 5 yearly if not). The current report presents the 2009 percentage cover of macroalgae within the estuary as a GIS-based map (Figure 1), and a summary table of the dominant species and percentage cover classes (Table 1). The report also rates macroalgal condition and provides recommended management actions based on the estuary condition rating (described below), and compares results to previous years (Table 2).

SOUTHLAND ESTUARIES: MACROALGAE CONDITION RATING

Certain types of macroalgae can grow to nuisance levels in nutrient-enriched estuaries causing sediment deterioration, oxygen depletion, bad odours and adverse impacts to biota.

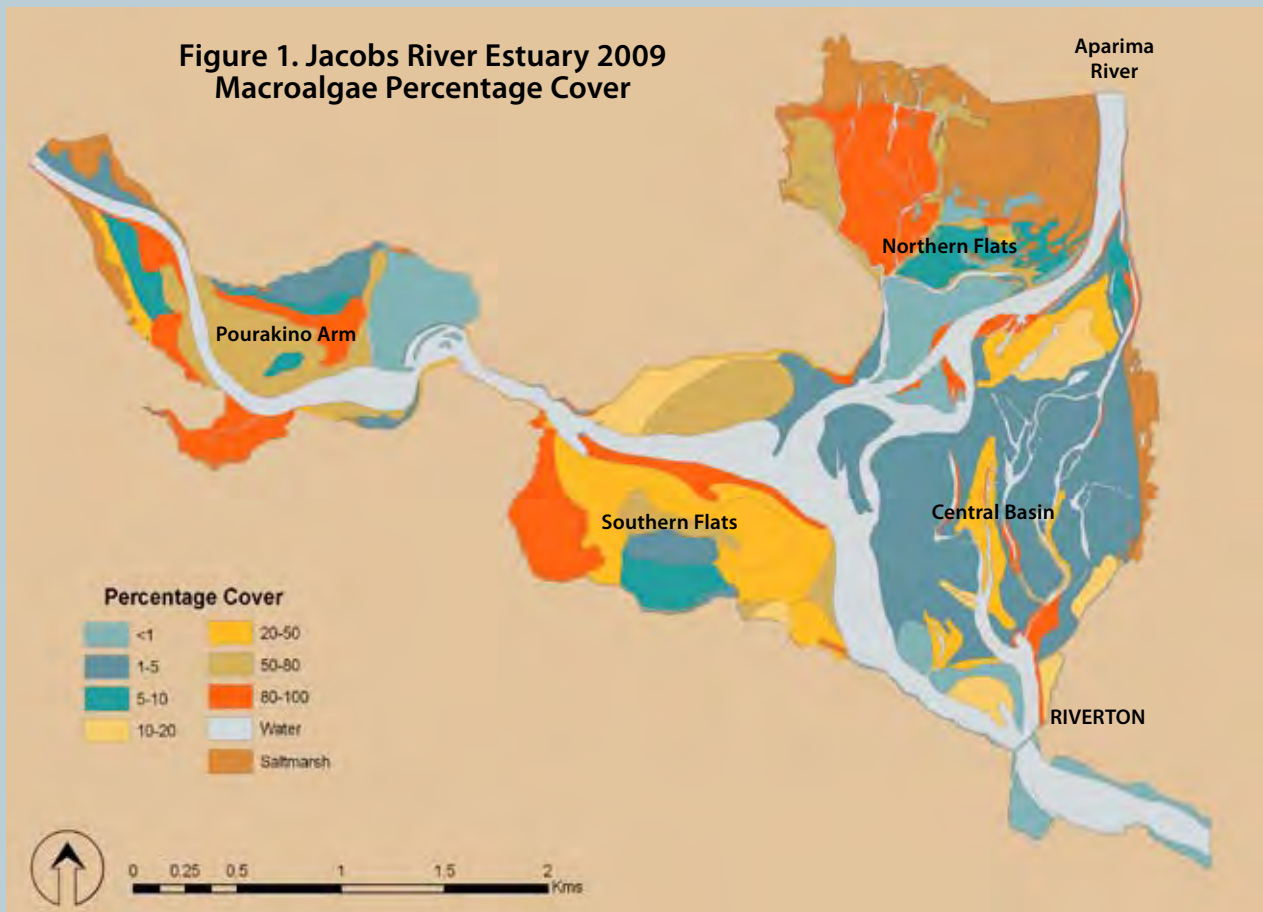
A continuous index (the macroalgae coefficient - MC) has been developed to rate macroalgal condition based on the percentage cover of macroalgae in defined categories using the following equation: $MC = ((0 \times \% \text{macroalgal cover} < 1\%) + (0.5 \times \% \text{cover } 1-5\%) + (1 \times \% \text{cover } 5-10\%) + (3 \times \% \text{cover } 10-20\%) + (4.5 \times \% \text{cover } 20-50\%) + (6 \times \% \text{cover } 50-80\%) + (7.5 \times \% \text{cover } > 80\%)) / 100$. Overriding the MC is the presence of either nuisance conditions within the estuary, or where >5% of the intertidal area has macroalgal cover >50%. In these situations the estuary is given a minimum rating of FAIR and should be monitored annually with an Evaluation & Response Plan initiated. This index will continue to be refined as it is applied to estuary data from throughout NZ.

MACROALGAE CONDITION RATING

RATING	DEFINITION (+Macroalgae Coefficient)	RECOMMENDED RESPONSE
Over-riding rating: Fair	Nuisance conditions exist, or >50% cover over >5% of estuary	Monitor yearly. Initiate Evaluation & Response Plan
Very Good	Very Low (0.0 - 0.2)	Monitor at 5 year intervals after baseline established
Good	Low (0.2 - 0.8)	Monitor at 5 year intervals after baseline established
	Low Low-Moderate (0.8 - 1.5)	Monitor at 5 year intervals after baseline established
Fair	Low-Moderate (1.5 - 2.2)	Monitor yearly. Initiate Evaluation & Response Plan
	Moderate (2.2 - 4.5)	Monitor yearly. Initiate Evaluation & Response Plan
Poor	High (4.5 - 7.0)	Monitor yearly. Initiate Evaluation & Response Plan
	Very High (>7.0)	Monitor yearly. Initiate Evaluation & Response Plan
Early Warning Trigger	Trend of increasing Macroalgae Coefficient	Initiate Evaluation and Response Plan

2. RESULTS, RATING AND MANAGEMENT

Figure 1. Jacobs River Estuary 2009
Macroalgae Percentage Cover



RESULTS

2009 MACROALGAL COVER CONDITION RATING

FAIR



The 2009 Macroalgae Coefficient (MC) for the estuary was 3.25, which equates to a condition rating of “fair”. This rating was primarily driven by large portion of the estuary (32.4%, 162ha) with a high (>50%) macroalgae cover (Table 1), and associated nuisance conditions of anoxic muds and sulphide odours. Figure 1 and Table 1 summarise the results of the 2009 macroalgal mapping. *Gracilaria* was the dominant species in the estuary, followed by *Enteromorpha* with *Ulva* (sea lettuce) widespread but at low densities.

Table 1. Summary of macroalgal cover results, February 2009.

MACROALGAE	Jacobs River Estuary		
Percentage Cover	Ha	%	Dominant species
<1%	60.0	12.1	-
1-5%	143.2	28.7	<i>Enteromorpha</i> , <i>Gracilaria</i>
5-10%	32.3	6.5	<i>Gracilaria</i> , <i>Enteromorpha</i> , <i>Ulva</i>
10-20%	27.2	5.5	<i>Enteromorpha</i> , <i>Gracilaria</i>
20-50%	74.0	14.8	<i>Gracilaria</i> , <i>Enteromorpha</i> , <i>Ulva</i>
50-80%	72.8	14.6	<i>Gracilaria</i> , <i>Enteromorpha</i> , <i>Ulva</i>
>80%	89.0	17.8	<i>Gracilaria</i> , <i>Enteromorpha</i>
TOTAL	499	100	

2. Results, Rating and Management (Continued)

RESULTS



Windblown *Gracilaria* and *Ulva* by central basin river channel.



Enteromorpha growing by the Aparima River channel.

While macroalgae was present throughout most of the estuary, the highest densities tended to be growing in sheltered embayments (dominated by the red alga *Gracilaria*), and along channel margins (dominated by the green alga *Enteromorpha*).

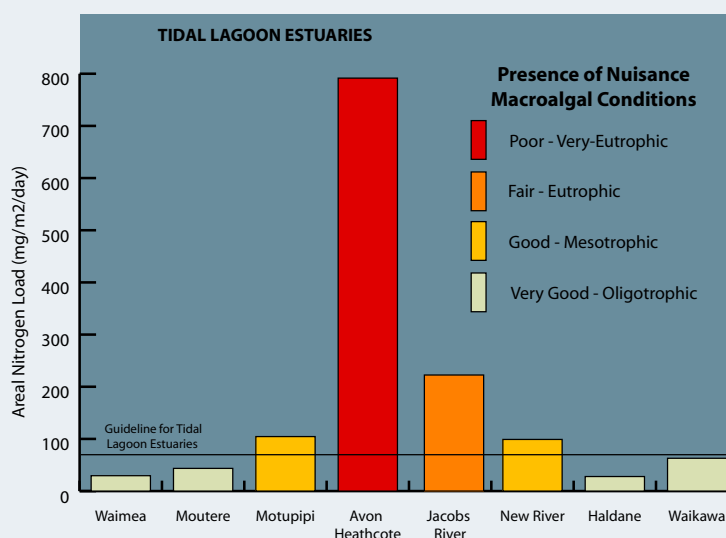
As in 2007 and 2008, the areas of highest percentage cover (>50% cover) in 2009 were on the soft muds of the Pourakino Arm, and the southern and northern flats of the estuary (Figure 1). These areas, which are less well flushed than the central basin of the estuary, act as settling areas for algae carried in from around the estuary with the tide and prevailing wind. They also receive drainage from agricultural lands bordering their margin, along with sediment and nutrients from wider afield, including marine sources. Macroalgae cover was generally low (<5% cover) where flushing in the estuary is greatest, commonly exposed areas with coarser sediments such as found in the central basin and at the eastern end of the Pourakino Arm.

Table 2 summarises the Condition Rating and Macroalgal Coefficient (MC) results for the 2007-2009 period. Although the rating has remained constant across years (due to the extent of estuary with a >50% cover and the presence of nuisance conditions), there was a sharp increase in macroalgal cover from 2007 to 2008. This was concentrated in the sheltered embayments and tidal flats where the increase in decaying macroalgae was causing depletion of sediment dissolved oxygen and nuisance odours. From 2008 to 2009 there was almost no change in the high cover in these areas. The slight reduction in the MC from 2008 to 2009 relates to a decrease in the percentage cover of macroalgae growing in the central basin of the estuary and where the Aparima River enters the estuary. In these areas most macroalgae was windblown accumulations along channel margins (see top photo) or *Enteromorpha* along the main river channels (see middle photo).

Table 2. Summary of macroalgal cover results, 2007-2009.

Year	Rating	MC	Result
2007	FAIR	1.16	Low-Moderate cover across most of estuary. Isolated patches of High cover in sheltered arms and by Aparima River.
2008	FAIR	3.34	Relatively extensive areas of High cover in sheltered arms, by Aparima River, and in lower Central Basin.
2009	FAIR	3.25	Relatively extensive areas of High cover in sheltered arms and by Aparima River. Predominantly low cover in Central Basin.

FIGURE 2. RELATIONSHIP BETWEEN NITROGEN INPUTS AND NUISANCE MACROALGAL CONDITIONS IN SELECTED TIDAL LAGOON ESTUARIES.



2. Results, Rating and Management (Continued)

	<p>Jacobs River Estuary has high nitrogen inputs and is in a eutrophic state (Figure 2) with recent monitoring showing a sharp increase in nuisance conditions since 2007. The estimated nitrogen input to Jacobs River Estuary (as estuary areal load) is 200-250 mg.m².day which is well above the 50 mg.m².day upper limit suggested by Heggie (2006) for ensuring no eutrophication of temperate tidal lagoon estuaries (Figure 2), and is also in the range where nuisance macroalgal conditions in tidal lagoon estuaries are expected. Consequently, the monitoring results highlight a clear need for targeted management actions to reduce nutrient inputs.</p>
CONCLUSION	<p>2009 macroalgal cover had a condition rating of "fair" with nuisance conditions (rotting macroalgae and poorly oxygenated and sulphide rich sediments) in many parts of the estuary, particularly sheltered areas receiving limited flushing.</p>
RECOMMENDED MONITORING AND MANAGEMENT	<p>The large increase in macroalgal cover from 2007 (see Stevens and Robertson 2007, 2008), combined with the presence of nuisance conditions, means macroalgae should continue to be monitored annually. In addition, the following management is recommended:</p> <p>Set Limits on Nutrient Inputs</p> <ul style="list-style-type: none"> Because nutrient inputs to Jacobs River Estuary are high and strongly related to the eutrophication symptoms (Robertson and Stevens 2008), it is recommended that catchment nutrient inputs be reduced. A Total Daily Maximum Load to the Jacobs River Estuary of about 0.7 tonnes N/day (as opposed to the current input of 1.6 tonnes/day) is suggested as a preliminary guideline to achieve a more moderately enriched estuary. <p>Identify and Implement Catchment BMPs</p> <ul style="list-style-type: none"> Catchment runoff is one of the major stressors in estuaries with the likely ecological response one of lowered biodiversity and lowered aesthetic and human use values. To prevent avoidable inputs, best management practices (BMPs) should be identified and implemented to reduce nutrient, sediment, and pathogen runoff from catchment "hotspots".

3. REFERENCES

Southland Coastal Monitoring Reports

- Heggie, D. 2006. *Clean or green – Nitrogen in temperate estuaries*. *Aus. Geo. News*. Issue 81.
- 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. and Stevens, L. 2009. *Waimatuku Estuary 2009 Synoptic Survey, Macrophyte Mapping and Vulnerability Assessment. Report prepared by Wriggle Coastal Management for Environment Southland. 20p.*
- Robertson, B.M. and Stevens, L. 2009. *Waiau Lagoon 2009 Synoptic Survey, Macrophyte Mapping and Vulnerability Assessment. Report prepared by Wriggle Coastal Management for Environment Southland. 20p.*
- Robertson, B.M. and Stevens, L. 2009. *Lake Brunton 2009 Synoptic Survey, Macrophyte Mapping and Vulnerability Assessment. Report prepared by Wriggle Coastal Management for Environment Southland. 17p.*
- Robertson, B.M. and Stevens, L. 2009. *Waituna Lagoon 2009. Macrophyte (Ruppia) Monitoring. Prepared for Department of Conservation. 19p.*
- Robertson, B.M. and Stevens, L. 2008. *Southland Coast - Te Waewae Bay to the Catlins, habitat mapping, risk assessment and monitoring recommendations. Report prepared for Environment Southland. 165p.*

3. References

- Robertson, B., and Stevens, L. 2008. *Waikawa Estuary Fine Scale Monitoring 2007/08*. Report prepared by Wriggle Coastal Management for Environment Southland. 32p.
- Robertson, B., and Stevens, L. 2007. *New River Estuary 2007 Broad Scale Habitat Mapping and Sedimentation Rate*. Report prepared by Wriggle Coastal Management for Environment Southland. 34p.
- Robertson, B., and Stevens, L. 2007. *Waikawa Estuary 2007 Fine Scale Monitoring and Historical Sediment Coring*. Report prepared by Wriggle Coastal Management for Environment Southland. 29p.
- 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. 1997. *Southland Coastal Ecology Programme 1996-7*. Report prepared for Southland Regional Council. Barry Robertson, Environmental 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 Robertson, B., 2009. *Fortrose (Toetoe) Estuary. Macroalgal Monitoring 2008/09*. Report prepared by Wriggle Coastal Management for Environment Southland. 5p.
- Stevens, L. and Robertson, B., 2009. *Jacobs River Estuary. Macroalgal Monitoring 2008/09*. Report prepared by Wriggle Coastal Management for Environment Southland. 5p.
- Stevens, L. and Robertson, B., 2009. *New River Estuary. Macroalgal Monitoring 2008/09*. Report prepared by Wriggle Coastal Management for Environment Southland. 5p.
- Stevens, L. and Robertson, B., 2008. *Waiiau Lagoon. Broad Scale Habitat Mapping 2007/08*. Report prepared by Wriggle Coastal Management for Environment Southland. 19p.
- Stevens, L. and Robertson, B., 2008. *Freshwater Estuary. Broad Scale Habitat Mapping 2007/08*. Report prepared by Wriggle Coastal Management for Environment Southland. 24p.
- Stevens, L. and Robertson, B., 2008. *New River Estuary. Macroalgal Monitoring 2007/08*. Report prepared by Wriggle Coastal Management for Environment Southland. 5p.
- Stevens, L. and Robertson, B., 2008. *Jacobs River Estuary. Broad Scale Habitat Mapping 2007/08*. Report prepared by Wriggle Coastal Management for Environment Southland. 31p.
- Stevens, L. and Robertson, B., 2007. *Jacobs River Estuary 2007. Macroalgal monitoring*. Report prepared by Wriggle Coastal Management for Environment Southland. 4p.
- Stevens, L. and Robertson, B., 2007. *Waituna Lagoon 2007. Broad Scale Habitat Mapping and Historical Sediment Coring*. Report prepared by Wriggle Coastal Management for Environment Southland. 36p.
- Stevens, L. and Robertson, B., 2007. *Waituna Lagoon 2007. Ecological Vulnerability Assessment and Monitoring Recommendations*. Report prepared by Wriggle Coastal Management for Environment Southland. 40p.
- 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.
- Stevens, L. and Clarke, M. 2004. *Broad scale mapping of subtidal habitat and ecology of Bluff Harbour, 2004*. Prepared for Environment Southland.