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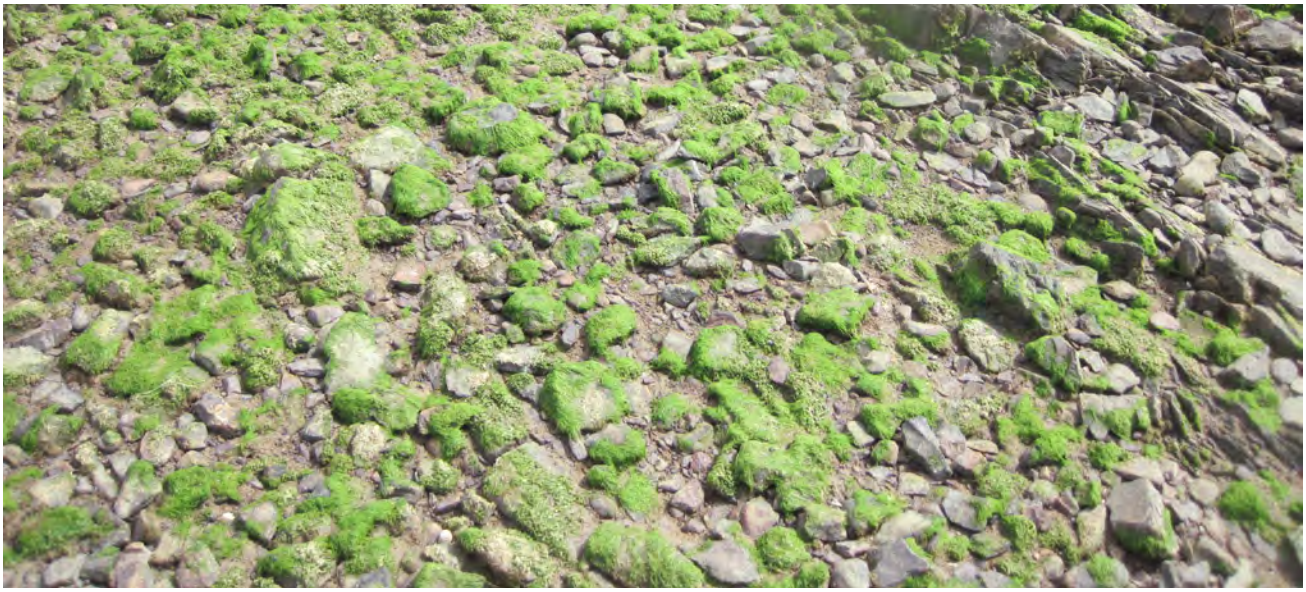
Jacobs River Estuary

Macroalgal Monitoring 2011/12

Prepared for
Environment Southland
August 2012

Cover Photo: Extensive *Gracilaria* and *Ulva* beds, Aparima Arm, Jacobs River Estuary, January 2012.



Ulva (Enteromorpha) intestinalis growth on the edge of the Pourakino River channel.

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By

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1. INTRODUCTION AND METHODS

INTRODUCTION

Macroalgae is an important feature of estuaries, contributing to their high productivity and biodiversity. However, when high nutrient inputs combine with suitable growing conditions, nuisance blooms of rapidly growing algae e.g. *Ulva* (sea lettuce) and *Gracilaria* can occur. At nuisance levels such growths can deprive seagrass of light causing its eventual decline, while decaying macroalgae can accumulate on shorelines causing localised depletion of sediment oxygen, and nuisance odours. When high macroalgal cover coincides with soft muddy sediments, conditions for animal life in the sediments are generally very poor due to toxic sulphides, elevated nutrients, and depleted oxygen.

This brief report summarises the 6th year of macroalgal monitoring in the Jacobs River Estuary, one of the key estuaries in the Environment Southland's long term estuary monitoring programme. The report describes intertidal macroalgal cover - a broad scale indicator of estuary eutrophication, and uses a macroalgal coefficient (described below) developed for Southland's estuaries to rate the condition of the estuary, and recommends monitoring and management actions. These actions need to be considered in conjunction with the fine scale monitoring presented in Robertson and Stevens (2011).

METHODS

Broad scale mapping of the percentage cover of macroalgae throughout all the intertidal habitat of Jacobs River Estuary was undertaken on 29-30 January 2012 using a combination of aerial photography, ground-truthing, and ArcMap 9.3 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. Stevens and Robertson 2007, 08, 09, 10, 11).

Rectified aerial photographs (~0.3 metre per pixel, scale 1:10,000) of the estuary, flown in February 2008 were used as base maps. Experienced coastal scientists then recorded the percentage cover of macroalgae directly onto laminated photos during field assessment of macroalgal cover. The field maps were then used to create a GIS layer from which the percentage cover information was subsequently calculated.

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, 5 yearly if not). The current report presents the 2012 percentage cover of macroalgae within the estuary, and a summary of the dominant species and percentage cover classes (Table 1).

SOUTHLAND ESTUARIES: MACROALGAE CONDITION RATING

The primary fine scale indicators of eutrophication are grain size, RPD boundary, sediment organic matter, nitrogen and phosphorus concentrations, and the community structure of certain sediment-dwelling animals. The broad scale indicators are the percentages of the estuary covered by macroalgae and soft muds. For short residence time estuaries like Jacobs River, highly eutrophic conditions only occur when sediments from large ares of the estuary exhibit all of the following symptoms; high macroalgal growth (>50% cover), are soft and muddy, have a shallow RPD, elevated nutrient and TOC concentrations, and very high invertebrate organic enrichment tolerance ratings.

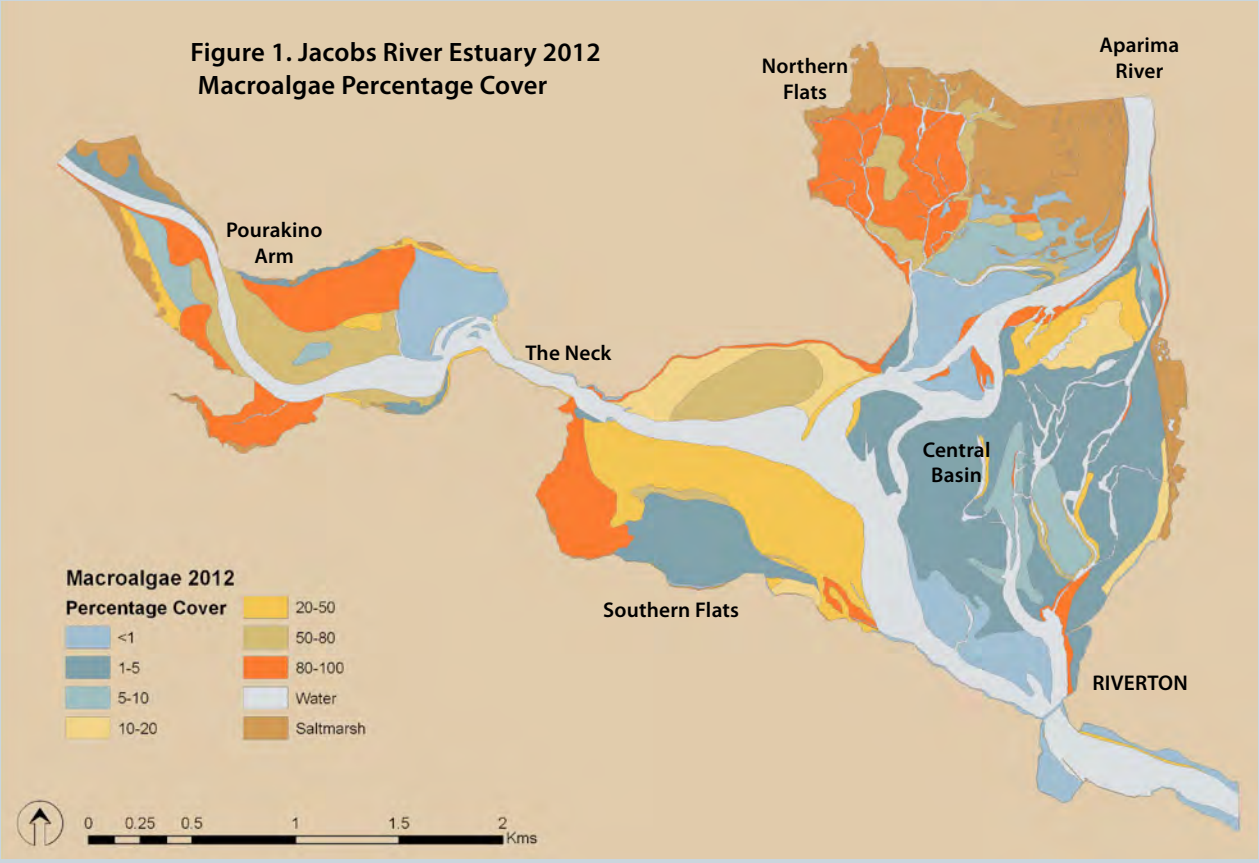
A two part macroalgae condition rating has been developed: 1. for the whole estuary, and 2. for hotspots within the estuary. Whole estuary macroalgal condition is rated using a continuous index (the macroalgae coefficient - MC) based on the percentage cover of macroalgae in defined categories throughout the estuary. The equation used is: ***MC=((0 x %macroalgal cover <1%)+(0.5 x %cover 1-5%)+(1 x %cover 5-10%)+(3 x %cover 10-20%)+(4.5 x %cover 20-50%)+(6 x %cover 50-80%)+(7.5 x %cover >80%))/100.*** The hotspot rating targets areas of heavy growth and is applied where EITHER the percentage cover of intertidal macroalgal exceeds 50%, OR if nuisance conditions are judged as being significantly adverse. The highest rating calculated is applied to determine recommended responses.

MACROALGAE CONDITION RATING

ESTUARY RATING	DEFINITION	MC	RECOMMENDED RESPONSE
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
HOTSPOT RATING	>50% COVER OVER:	NUISANCE CONDITIONS	RECOMMENDED RESPONSE
Good	<5% of estuary	Low	Monitor at 5 year intervals after baseline established
Fair	5-10% of estuary	Moderate	Monitor yearly. Initiate Evaluation & Response Plan
Poor	10-30% of estuary	High	Monitor yearly. Initiate Evaluation & Response Plan
Very Poor	>30% of estuary	Very High	Monitor yearly. Initiate Evaluation & Response Plan

2. RESULTS AND DISCUSSION

Figure 1. Jacobs River Estuary 2012 Macroalgae Percentage Cover



RESULTS

2012 MACROALGAL COVER CONDITION RATING

VERY POOR

Figure 1 and Table 1 summarise the results of the 2012 macroalgal mapping of Jacobs River Estuary. Relative to the rest of the estuary, the well flushed Central Basin had the lowest cover of macroalgae, while the highest densities were found in the more sheltered embayments (where the red alga *Gracilaria* was dominant), and along channel margins (where the green alga *Ulva (Enteromorpha) intestinalis* was dominant). *Ulva lactuca* (sea lettuce) was present throughout the lower estuary, but at low densities. Sands in the lower Pourakino Arm supported a thick growth of benthic microalgae.

Table 1. Summary of macroalgal cover results, 29-30 January 2012.

MACROALGAE	Jacobs River Estuary		
Percentage Cover	Ha	%	Dominant species
<1%	68.3	13.7	-
1-5%	139.0	27.9	*Ulva intestinalis, Gracilaria, Ulva lactuca*
5-10%	36.6	7.4	*Ulva intestinalis, Gracilaria*
10-20%	26.0	5.2	*Ulva intestinalis, Gracilaria*
20-50%	71.6	14.4	*Ulva intestinalis, Gracilaria, Ulva lactuca*
50-80%	59.6	12.0	*Gracilaria, Ulva intestinalis, Ulva lactuca*
>80%	96.3	19.4	*Gracilaria, Ulva intestinalis*
TOTAL	**497**	**100**	

Note: *Enteromorpha intestinalis* (reported as *Enteromorpha* in Stevens and Robertson 2009, 2010) has recently been re-classified as *Ulva intestinalis* which is used in the current report.

2. Results and Discussion (Continued)

RESULTS

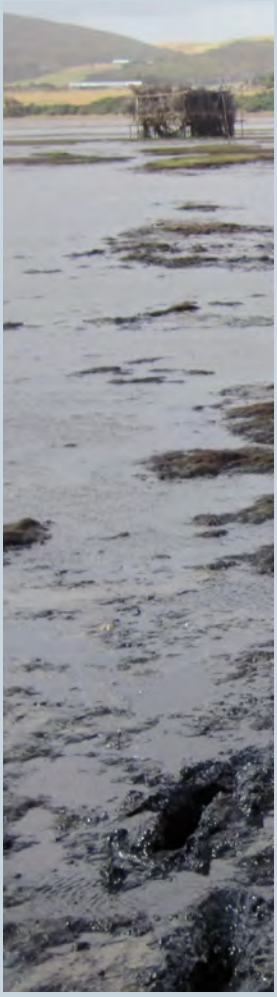
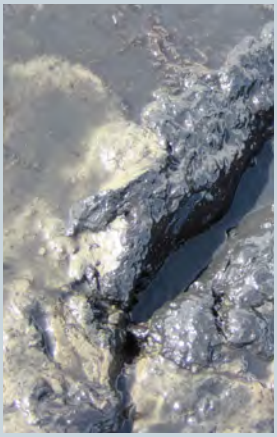


Figure 2. Pourakino Arm showing die-off of *Gracilaria* and *Ulva*. Previously with a 100% cover, it appears anoxic sulphide-rich muds have now made sediment conditions too extreme for macroalgae to survive.



In 2012, 31% of the estuary had macroalgae covering more than 50% of the surface sediment. The areas of highest macroalgal percentage cover were on the soft muds of the Pourakino Arm, and on the Southern and Northern Flats of the estuary (Figure 1). These areas are characterised by an extensive and often smothering cover of growing and decaying macroalgae (see sidebar photos), and represent a continuation of the decline in estuary condition monitored annually since 2007. These most affected parts of the estuary act as settling areas for algae and sediment carried in by the tide and prevailing wind, and also receive the most obvious inputs of drainage from agricultural lands in the catchment via the Pourakino and Aparima Rivers.

The excessive growths of macroalgae have reduced sediment dissolved oxygen, increased sulphide in the sediments, caused nuisance odours, and promoted extensive sediment trapping. These are all contributing to a significant decline in the quality of habitat areas otherwise favoured by high value species such as seagrass. In the Pourakino Arm, the most adversely affected, a localised 1.2Ha reduction in macroalgal cover appears to have been caused by the highly eutrophic, anoxic and sulphide-rich sediment conditions becoming too severe for macroalgae to survive (see Figures 2 and 4).

Table 2 summarises the Condition Rating and Macroalgal Coefficient (MC) results for the 2003-2012 period. The Condition Rating was revised in 2011 following a review of the extensive data set compiled for Southland since 2007. In 2003 the estuary rating was GOOD, in 2007 it was FAIR, and since 2008 VERY POOR, driven by the increased extent of estuary with a >50% cover and the presence of nuisance conditions concentrated in the Pourakino and Aparima Arms, and on the Southern Flats near The Neck. As in 2011, conditions in the lower estuary in 2012 were generally good with macroalgae in the Central Basin and lower Southern Flats of the estuary not causing nuisance conditions. However, there had been an increase of cover in both the upper Pourakino and Aparima Arms from 2011 to 2012, reflecting an increase in the macroalgal coefficient.

The increase in growth, and the presence of gross nuisance conditions of anoxic muds and sulphide odours is evidence that the nutrient supply to the estuary (nitrogen is the most likely to be fuelling macroalgal growths) is currently too high, with large areas of Jacobs River Estuary now eutrophic and supporting excessive macroalgal growth. Much of this growth appears to come from estuary channels where macroalgae grows rapidly wherever substrate allows, and where it regularly breaks off and gets deposited by wind, wave and currents around the estuary margins. However, there are also significant parts of the estuary where macroalgae is growing on the surface of sediments.

Table 2. Summary of condition rating and results, 2007-2012.

Year	MC Rating	Hotspot Rating	Result
2003	-	GOOD	High cover (>50% cover) over less than 5% of the estuary (based on both personal observation and Robertson et al. 2002).
2007	1.2	FAIR	Low-Moderate cover across most of estuary. Isolated patches of high cover in sheltered arms and by Aparima River.
2008	3.3	VERY POOR	Relatively extensive areas of high cover in sheltered arms, by Aparima River, and in lower Central Basin.
2009	3.3	VERY POOR	Relatively extensive areas of high cover in sheltered arms and by Aparima River. Predominantly low cover in Central Basin.
2010	3.4	VERY POOR	Increase in extensive areas of high cover in sheltered arms and by Aparima River. Predominantly low cover in Central Basin.
2011	2.9	VERY POOR	Continued high cover in sheltered upper Pourakino and Aparima Arms. Reduced cover in Central Basin and lower Southern Flats.
2012	3.2	VERY POOR	High nuisance cover in sheltered upper Pourakino and Aparima Arms and Southern Flats. Low cover in Central Basin.

2. Results and Discussion (Continued)

Ulva growing on the sandy intertidal flats in the Central Basin.

Overall, gross nuisance conditions now occupy >30% of the estuary, compared with 4% in 2007 (Robertson and Stevens 2007) and <4% in 2001 (Robertson et al. 2002) - clear evidence that the condition of the Jacobs River Estuary has deteriorated in the last 10 years.

Results from broad scale habitat mapping, fine scale monitoring, sedimentation rate monitoring, and annual macroalgal monitoring (e.g. Robertson et al. 2002, Robertson and Stevens 2006, 2008, 2010, 2011, Stevens and Robertson 2007, 2008, 2009, 2010, 2011) have previously identified eutrophication and sedimentation problems in Jacobs River Estuary. These reports triggered recommendations for nutrient source identification (Stevens and Robertson 2008), and an immediate reduction in nutrient and sediment loads from the catchment (Stevens and Robertson 2007, 2008, 2009, 2010) as follows:

The large increase in macroalgal cover from 2007 (see Stevens and Robertson 2007, 2008, 2009), combined with the ongoing presence of nuisance conditions, means macroalgae should continue to be monitored annually. In addition, the following management is recommended:

Set Limits on Nutrient Inputs

- *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.*

Identify and Implement Catchment BMPs

- *Catchment runoff is one of the major stressors in estuaries. Likely ecological responses are lowered biodiversity, aesthetic and recreational values. To prevent avoidable inputs, best management practices (BMPs) should be identified and implemented to reduce nutrient, sediment, and pathogen runoff from catchment "hotspots".*

The importance of these actions was reiterated in Stevens and Robertson (2011). These management recommendations have not yet been instigated, and estuary degradation has continued. As a consequence, recommendations for ongoing monitoring and management are put forward in Sections 3 and 4.

Figure 3. Soft, muddy, anoxic sediments beneath *Gracilaria* in the Pourakino Arm.

CONCLUSION

The 2012 overall estuary condition rating for macroalgal cover was "VERY POOR" with gross nuisance conditions of rotting macroalgae and poorly oxygenated and sulphide rich sediments present in many parts of the estuary, particularly sheltered settlement areas receiving limited flushing.

3. MONITORING

Jacobs River Estuary has been identified by Environment Southland as a high priority for monitoring, and is a key part of their coastal monitoring programme being undertaken in a staged manner throughout the Southland region. The future monitoring recommendations are outlined as follows:

Macroalgal and Seagrass Monitoring

- Continue with the programme of annual broad scale mapping of macroalgae. Next monitoring due in February/March 2013.

Broad Scale Habitat Mapping

- Continue with the programme of 5 yearly broad scale habitat mapping. Next monitoring due in February/March 2013.

Fine Scale Monitoring

- Monitor the two new fine scale sites established in 2012 (Robertson and Stevens 2012) in representative poorly flushed vulnerable areas in the Pourakino and Aparima Arms in February 2013, 2014, and again in February 2016 when the 5 yearly fine scale trend monitoring at three existing sites falls due.

Sedimentation Rate Monitoring

- Because sedimentation is a priority issue in the estuary it is recommended that all sediment plate depths be measured annually and that additional sediment plates be deployed at representative locations so that the sedimentation rate over much larger parts of the estuary can be determined (see Robertson and Stevens 2011). These plates will also be used to gauge the success of actions taken to reduce sediment inputs.

4. MANAGEMENT

Eutrophication and sedimentation have been identified as a major issue in Jacobs River Estuary since at least 2007-8 (Stevens and Robertson 2007, 2008, Robertson and Stevens 2008), as has been the case for several other Southland estuaries (e.g. New River, Waimatuku and Waituna Lagoon).

To address these issues, it is recommended that appropriate catchment nutrient and sediment guideline criteria be developed for each estuary type in Southland and that these guideline criteria are then used to assess the extent to which catchment loads meet these guidelines. Estuaries where guidelines are exceeded are prioritised for more extensive investigations, monitoring and management. The key steps in such an approach are as follows:

- Assign catchment nutrient and sediment load guideline criteria to each Southland estuary (using criteria appropriate to each type of estuary). Guideline criteria should be based on available catchment load/estuary response information from other relevant estuaries.
- Estimate catchment nutrient and suspended sediment loads to each estuary using available catchment models and stream monitoring data.
- Determine the extent to which each estuary meets guideline catchment load criteria.
- Rank estuaries according to exceedance of recommended guideline criteria.
- Assess the potential for requiring more detailed assessments of priority estuaries (e.g. estuary response modelling, stream and tributary monitoring, catchment load modelling).
- Develop plans for restoration of priority estuaries.

Overall, if the approach is followed, and the estuary and its surroundings are managed to ensure that the assimilative capacity is not breached, then the estuary will flourish and provide sustainable human use and ecological values in the long term.

5. REFERENCES

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Figure 4. Die-off of previously thick *Gracilaria* within anoxic and sulphide-rich sediments in the upper Pourakino Arm.