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coastalmanagement

New River Estuary

Macroalgal Monitoring 2010/11

Prepared for
Environment Southland
July 2011

Cover Photo: *Gracilaria* and *Ulva (Enteromorpha)* on mobile sandy intertidal flats southeast of Bushy Point.

Ulva (Enteromorpha) growth in the east of New River Estuary on old *Spartina* roots.

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By

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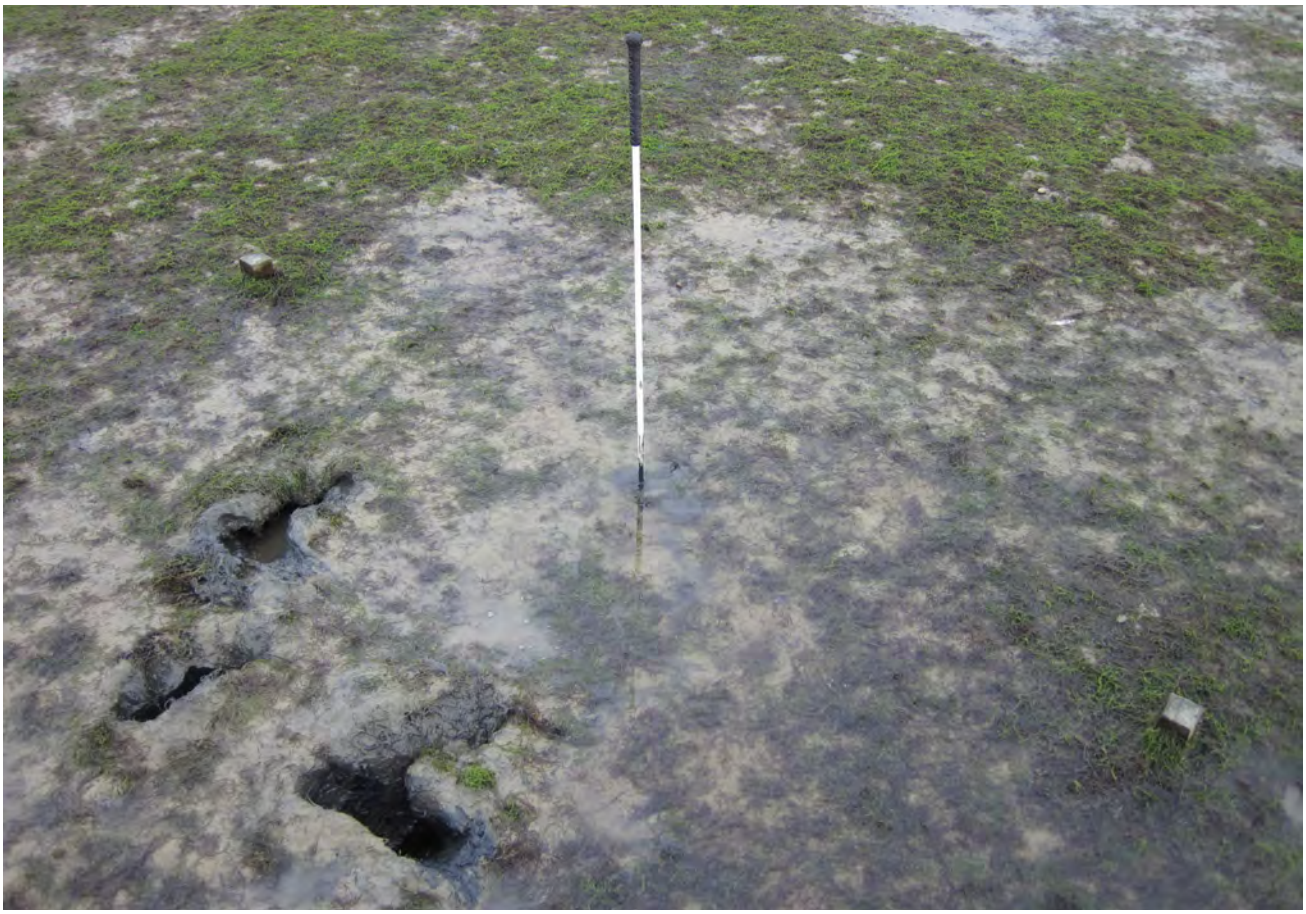


Buried sediment plate site in the Waihopai Arm. Thick *Gracilaria* and *Ulva (Enteromorpha)* promoting accelerated sediment settlement.

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), *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 fifth year of macroalgal monitoring in the New 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 - using 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 (2010, 2011).

METHODS

Broad scale mapping of the percentage cover of macroalgae throughout all the intertidal habitat of New River Estuary was undertaken in February 2011 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 2008, 2009, 2010).

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 2011 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 New 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

RESULTS

2011 MACROALGAL COVER CONDITION RATING

POOR

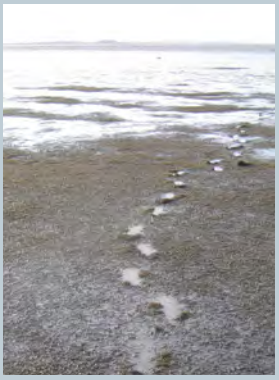


Figure 1 and Table 1 summarise the results of the 2011 macroalgal mapping of New River Estuary. 11% (308ha) of the estuary had >50% macroalgal cover, the most extensive growths located on the northwestern flats between Bushy Point and the Waihopai River channel (e.g. top photo), and in pockets around the Oreti River mouth and on the relatively sheltered western flats, particularly Daffodil Bay (Figure 1). The area covered by both high macroalgal cover and soft muddy sediments in 2011 was estimated to be 8% of the whole estuary (Robertson and Stevens 2011), with the majority in the western side of the Waihopai Arm and a smaller area in Daffodil Bay. In these areas macroalgae was causing gross nuisance conditions which had worsened over the past year. Sediment oxygenation beneath thick macroalgae was very poor with sediments anoxic from the surface to >15cm (middle photo), and sulphide bacteria growing at the surface (Figure 2).

These conditions will kill or displace most estuarine animals and shellfish, and also release nutrients previously bound in the sediments. As these nutrients will predominantly be released in the form of ammonia, which is much more readily available to fuel macroalgal growth, a cycle of increasing habitat deterioration has established that is likely to be difficult to reverse. Because this is occurring predominantly in the relatively rare sheltered tidal flats of the estuary most favourable for the growth of high value seagrass habitat, the ecological cost of such extensive growths is significant.

Compared to 2010, there was a decrease in the thick macroalgal cover southwest of Bushy Point from mostly 80-100% to 50-80% cover. In this area *Gracilaria* remained the dominant species (see cover photo) but despite the high cover, extensive tidal flushing was maintaining well oxygenated sediment conditions (measured as the depth to the Redox Potential Discontinuity - RPD), with the RPD >5cm in this area.

Extensive parts (77%) of the estuary also had a low (<5%) macroalgal cover with no nuisance conditions. These areas were located predominantly in the well-flushed lower estuary and central basin, and the northeastern and eastern flats. Degraded conditions were apparent just east of the entrance to Mokomoko Inlet on the lower south side of the estuary. Macroalgae, which grows rapidly in channel areas wherever substrate allows, regularly breaks off. It then gets moved by wind, wave and currents and commonly accumulates on the shoreline in this part of the estuary.

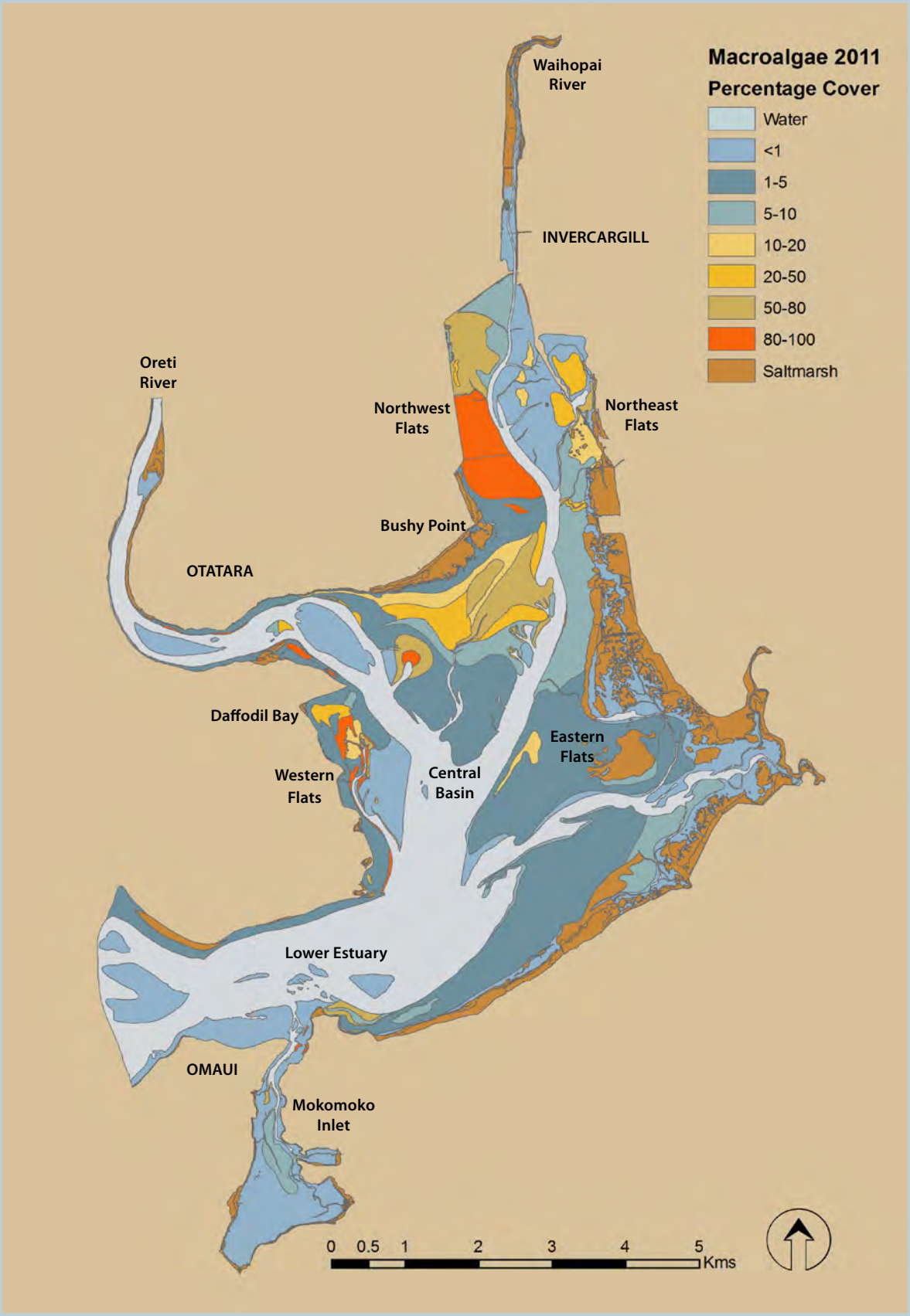
Overall, the red alga *Gracilaria* was the dominant species in the estuary, followed by the green alga *Ulva (Enteromorpha) intestinalis. U. intestinalis* is most common along channel margins and on the root systems of sprayed *Spartina* beds, while *Ulva lactuca* (sea lettuce) was most common on sandy flats near Bushy Point and Omaui (bottom photo).

Table 1. Summary of macroalgal cover results, February 2011.

MACROALGAE	New River Estuary		
Percentage Cover	Ha	%	Dominant species
<1%	765	28.3	-
1-5%	1,039	38.5	*Gracilaria, Ulva lactuca, Ulva intestinalis*
5-10%	358	13.3	*Gracilaria, Ulva lactuca, Ulva intestinalis*
10-20%	94	3.5	*Gracilaria, Ulva lactuca, Ulva intestinalis*
20-50%	138	5.1	*Gracilaria, Ulva intestinalis, Ulva lactuca*
50-80%	177	6.5	*Gracilaria, Ulva lactuca, Ulva intestinalis*
>80%	131	4.8	*Gracilaria, Ulva intestinalis*
TOTAL	**2,701**	**100**	

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

FIGURE 1. MAP OF MACROALGAL COVER - NEW RIVER ESTUARY, FEBRUARY 2011



2. Results and Discussion (Continued)

RESULTS

Waihopai Arm

Table 2 summarises the Condition Rating and Macroalgal Coefficient (MC) results for the 2001-2011 period. The Condition Rating was revised in 2011 following a review of the extensive data set compiled for Southland since 2007. The estuary rating was GOOD in 2001, FAIR in 2007 and has been POOR since 2008 - driven by the area of estuary with gross nuisance conditions (the area covered by both high macroalgal cover and soft muddy sediments). The deteriorating condition primarily reflects the dramatic expansion of extensive macroalgae growth in soft sediment areas of the western side of the Waihopai Arm and in Daffodil Bay.

Table 2. Summary of condition rating and results, 2001-2011.

Year	MC Rating	Hotspot Rating	Result
2001	-	GOOD	High cover (>50% cover) over <1% of the estuary (based on both personal observation and limited broad scale mapping (e.g. Robertson et al. 2002).
2007	0.9	FAIR	Low cover across most of estuary. Rating driven by patches of high cover near the Oreti River mouth and west of the Waihopai channel by Bushy Point.
2008	1.2	POOR	A large increase in cover and nuisance conditions on the west side of the northern arm from 2007. Low cover across most of the central and lower estuary.
2009	1.4	POOR	A large increase in cover and nuisance conditions on the west side of the northern arm and Bushy Point since 2008. Low cover across central and lower estuary.
2010	1.4	POOR	Rapid deterioration of sediment quality on the northwest flats. Extensive growths at Bushy Point and Daffodil Bay. Low cover across central and lower estuary.
2011	1.2	POOR	Extensive areas of poor sediment quality on the northwest flats. Heavy growths at Bushy Point and Daffodil Bay. Low cover across central and lower estuary.

Areas with extensive macroalgal cover continue to have very poor condition with the smothering macroalgal growths trapping fine muds at a rapid rate. At the same time they limit the natural removal of mud from the exposed flats by reducing the re-suspension of sediment by wind-generated waves. As a consequence, the sediments are becoming deeper, softer, and muddier - for example, mean sediment depth increased 72mm over the past 12 months in the middle of the northwestern flats. A synoptic survey of fine scale conditions in this part of the estuary has recently been undertaken and is reported on in Robertson and Stevens (2011).

The highest density seagrass (*Zostera*) beds in the estuary are also located in the northwestern flats and are very susceptible to reduced oxygen levels, and smothering by fine sediments and macroalgal growths. Consequently, adverse impacts are expected from the monitored decline in sediment and water quality.

There are two other areas in the estuary where *Gracilaria*-dominated macroalgal growth is excessive - Daffodil Bay and Bushy Point. Sediment conditions in Daffodil Bay are not as bad as in the Waihopai arm but declining oxygen levels, increasing organic enrichment where macroalgal cover exceeds 50%, and the presence of soft muds, provide a clear indication, and early warning, of deteriorating conditions.

Bushy Point also has extensive macroalgal beds of mostly 50-80% cover. However, in contrast to the northwestern Waihopai arm and Daffodil Bay, underlying sediments are still sandy and relatively well oxygenated. Strong tidal flushing in this area is likely to limit the rate of sediment deterioration. However, any increase in macroalgal growth or sediment deposition could still result in rapid sediment deterioration.

2. Results and Discussion (Continued)

Overall, gross nuisance conditions now occupy 8% of the estuary (Robertson and Stevens 2011), compared with 1-2% in 2007 (Robertson and Stevens 2007) and <1% in 2001 (Robertson et al. 2002) - clear evidence that the condition of the New 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 2007, 2008, 2010, Stevens and Robertson 2008, 2009, 2010) have previously identified eutrophication and sedimentation problems in New 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 2009, 2010) as follows:

The increase in macroalgal cover from 2007, combined with the presence of nuisance conditions, and declining sediment quality, means macroalgae should continue to be monitored annually. In addition, the following management is recommended:

Set Limits on Nutrient Inputs

- *Because nutrient inputs to New 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 New River Estuary of 2.0-2.5 tonnes N/day (as opposed to the current input of 3.6 tonnes/day) is suggested as a preliminary guide to maintain the mesotrophic state in the lower estuary and achieve less enriched conditions in the upper estuary areas near the Oreti and Waihopai River inputs. Further work is needed before a definitive limit can be set.*

Identify and Manage Major Nutrient Sources

- *The identification of nutrient sources to the estuary is seen as a priority given the very significant nature of both point and non-point discharges. Once identified, a plan should be developed to priortise and reduce the key inputs.*

Unfortunately, these management recommendations have not yet been instigated and therefore estuary degradation has continued. As a consequence, further recommendations for monitoring and management are put forward in Sections 3 and 4. Also, the presence of large "highly eutrophic" zones in the estuary, that are currently not addressed in the fine scale monitoring programme, indicate that it is time that the fine scale programme was expanded to include at least two of these areas. Fine scale monitoring at such sites would provide additional information (nutrients, organic carbon, RPD, macroinvertebrates, grain size and heavy metals) to help in making more effective management decisions.

Figure 2. Soft, muddy, anoxic sediments with sulphide bacteria growing on the surface - northwestern flats of the Waihopai Arm.

CONCLUSION

The 2011 macroalgal cover in New River Estuary had an overall condition rating of "POOR". Gross nuisance conditions of rotting macroalgae and poorly oxygenated and sulphide rich sediments are causing significant problems in the northwestern Waihopai Arm, and in sheltered areas in the western flats near Daffodil Bay. These areas require targeted management action. Macroalgae in the well flushed central basin and lower estuary is not currently causing significant problems.

3. MONITORING

New 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 2012. In addition, in order to assess changes in seagrass cover (particularly in the Waihopai Arm), it is recommended that seagrass cover in key locations be monitored annually in tandem with the macroalgal monitoring.

Broad Scale Habitat Mapping

- Continue with the programme of 5 yearly broad scale habitat mapping. Next monitoring due in February/March 2012. Note this will include seagrass mapping of the whole estuary.

Fine Scale Monitoring

- Expand the number of fine scale monitoring sites to include two more sites that are representative of more vulnerable poorly flushed areas in the estuary. Monitor the two new sites in February 2012, and again in February 2015 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 Stevens and Robertson 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 New River Estuary since at least 2007-8 (Robertson and Stevens 2007, Stevens and Robertson 2008), as has been the case for several other Southland estuaries (e.g. Jacobs 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.

4. Management (Continued)

- 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.

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