Wriggle

coastalmanagement

Waikanae Estuary

Intertidal Macroalgal Monitoring 2013/14

Prepared for Greater Wellington Regional Council April 2014

Cover Photo: Lower Waikanae Estuary.

Waikanae Estuary

Intertidal Macroalgal Monitoring 2013/14

Prepared for
Greater Wellington Regional Council

By

Leigh Stevens and Barry Robertson

Wriggle Limited, PO Box 1622, Nelson 7040, NZ. Ph 03 545 6315, 03 540 3060, 021 417 936; 0275 417 935, www.wriggle.co.nz

Contents

List of Figures

List of Tables

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.

This brief report summarises the results of the fifth annual survey of intertidal macroalgal cover in Waikanae Estuary, undertaken on 21 January 2014. The report describes intertidal macroalgal cover - a broad scale indicator of estuary eutrophication - using a macroalgal coefficient (described below) developed for Wellington's estuaries to rate the condition of the estuary, and recommend monitoring and management actions. These actions need to be considered in conjunction with the fine scale monitoring presented in Robertson and Stevens (2010, 2011, 2012).

METHODS

Broad scale mapping of the percentage cover of macroalgae throughout all the intertidal habitat of Waikanae River Estuary was undertaken in January 2014 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 2010).

Rectified aerial photographs of the estuary (2010 Greater Wellington Regional Council ~0.3 metre per pixel images) 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.

When present, macroalgae was mapped spatially using a 6 category percent cover rating scale (see Figure 1) to describe density.

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 (e.g. annually if a problem estuary, or 5 yearly if not). The current report presents the 2014 percentage cover of macroalgae within the estuary as a GIS-based map (Figure 2), and a summary table of the dominant species and percentage cover classes (Table 2).

The methodology for assessing macroalgae is currently being updated following a review of international literature, and additions to the method (e.g. added measures of sediment entrained macroalgae and biomass) will be included in future monitoring.

Figure 1. Visual rating scale for percentage cover estimates of macroalgae.

Intertidal flats in the lower Waikanae River Estuary, Jan. 2014.

2. RISK INDICATOR RATINGS

The National Estuary Monitoring Protocol (NEMP, Robertson et al. 2002), and subsequent additions (e.g. Robertson and Stevens 2006, 2007, 2012a), recommend a defensible, cost-effective monitoring design for assessing the long term condition of shallow, intertidally-dominated, NZ estuarine systems. The design is based on the use of indicators that have a documented strong relationship with water or sediment quality. The approach is intended to help quickly identify the likely presence of the predominant issues affecting NZ estuaries (i.e. eutrophication, sedimentation, disease risk, toxicity and habitat change). In order to facilitate this process, "risk indicator ratings" have been proposed that assign a relative level of risk of adversely affecting estuary conditions (e.g. very low, low, moderate, high, very high) to each indicator (see examples below). Each risk indicator rating is designed to be used in combination with relevant information and other risk indicator ratings, and under expert guidance, to assess overall estuary condition in relation to key issues. When interpreting risk indicator results we emphasise:

- The importance of taking into account other relevant information and/or indicator results before making management decisions regarding the presence or significance of any estuary issue.
- That rating and ranking systems can easily mask or oversimplify results. For instance, large changes can occur within a within a risk category, but small changes near the edge of one risk category may shift the rating to the next risk level.
- Most issues will have a mix of primary and secondary ratings, primary ratings being given more weight in assessing the significance of indicator results.
- Ratings for most indicators have not been established using statistical measures, primarily because of the extensive additional work and cost this requires. In the absence of funding, professional judgment, based on our wide experience from monitoring >300 NZ estuaries, has been used in making initial interpretations. Our hope is that where a high level of risk is identified, the following steps are taken:
    1. Statistical measures be used to refine indicators and guide monitoring and management for priority issues.
    2. Issues identified as having a high likelihood of causing a significant change in ecological condition (either positive or negative), trigger intensive, targeted investigations to appropriately characterise the extent of the issue.
    3. The outputs stimulate discussion regarding what an acceptable level of risk is, and how it should best be managed.

The indicators and risk ratings relevant to the Waikanae Estuary macroalgal monitoring programme are presented in Table 1 below:

Table 1. Risk indicator ratings for opportunistic macroalgal cover.

MACROALGAL RISK INDICATOR RATING	LOW DENSITY (>50%) COVER COEFFICIENT[1]	EXTENT OF HIGH DENSITY (>50%) COVER[2]	CHANGE IN HIGH DENSITY (>50%) COVER[3]
Very Low	0.0 - 0.2	<1% of estuary	no increase (or decrease)
Low	0.2 - 1.5	1-5% of estuary	<5% from baseline
Moderate	1.5 - 4.5	6-10% of estuary	5-15% from baseline
High	4.5 - 7.0	11-30% of estuary	16-50% from baseline
Very High	>7.0	>30% of estuary	>50% from baseline

NOTES:

Opportunistic macroalgae can grow to nuisance bloom proportions when nutrient levels are elevated and there is sufficient light to support growth. Opportunistic species generally survive well in conditions in which other species struggle to survive or compete and, consequently, they most commonly reach nuisance conditions in shallow estuaries, or the margins of deeper estuaries.

[1]**Low Density Macroalgal Cover**: This indicator is used as an "early warning" of increases in non-nuisance intertidal macroalgal growth. Low density (<50%) macroalgal cover is rated using a continuous index (the macroalgae coefficient - MC). It is based on the percentage cover of macroalgae in defined categories in the intertidal estuary (excluding saltmarsh) where macroalgal cover is <50%. The equation used is: ***MC=((0 x %macroalgal cover <1%)+(0.5 x %cover 1-5%)+(1.5 x %cover 5-10%)+(4.5 x %cover 10-20%)+(7.5 x %cover 20-50%))/100.***

[2]**High Density Macroalgal Cover**: The high density macroalgae condition rating targets areas of high density growth and is applied to the percentage of the estuary where the cover of intertidal macroalgal exceeds 50%. While this may not necessarily be combined with the presence of nuisance conditions, dense growths are an early warning of the estuary potentially exceeding its assimilative capacity and developing gross eutrophic conditions. A trend of an increasing dense macroalgal cover is likely to correspond with worsening conditions in the estuary. Both the low and high density macroalgal cover ratings are currently being updated and expanded to provide a more robust metric of estuary condition, supported by narrative thresholds.

[3]**Change in High Density Macroalgal Cover:** This indicator is used to assess change from baseline measures over time. Because an extensive cover of dense macroalgae is commonly associated with gross eutrophic conditions that can be very difficult to reverse, even relatively small changes from baseline conditions should be evaluated as a priority.

3. RESULTS, RATING, RECOMMENDATIONS

RESULTS

Lower estuary showing absence of macroalgal growth.

Macroalgal deposits in the flapgate embayment.

Deposits of organic matter on the intertidal flats of the upper estuary.

Figure 2 and Table 2 summarise the results of intertidal macroalgal mapping within Waikanae Estuary. Overall, the vast majority of the intertidal area (90%) had no macroalgae growth (upper sidebar photo). *Ulva intestinalis* was present in patchy deposits in and around the embayment near the flapgate (middle sidebar photo) where minor localised nuisance conditions (anoxic sediments, odours) were present due to rotting macroalgae. This is an obvious accumulation zone for flotsam and drift deposits of macroalgae. The only parts of the estuary supporting a consistent growth of macroalgae were the boulders along the true left bank where a sparse growth (1-5% cover) of *U. intestinalis* was present.

The 2014 Macroalgae Coefficient (MC) for low density (<50%) cover in the estuary was 0.11, a risk indicator rating of "very low". The percentage of the estuary with a high density (>50% cover) macroalgal cover was <1%, also risk indicator rating of "very low". The "very low" cover of high density macroalgal was the same as that recorded in the 2010 baseline year, a risk indicator rating of "very low".

Table 2. Summary of macroalgal cover results, 21 January 2014.

MACROALGAE	Waikanae Estuary		
Percentage Cover	Ha	%	Dominant species
<1%	5.2	91.6	
1-5%	0.3	6.0	*Ulva intestinalis**
5-10%	0.0	0.0	
10-20%	0.1	1.6	*Ulva intestinalis**
20-50%	0.0	0.0	
50-80%	0.0	0.0	
>80%	0.1	0.9	*Ulva intestinalis**
TOTAL	**5.7**	**100**	

* Note, *Ulva intestinalis* is synonymous with *Enteromorpha intestinalis* (reported as *Enteromorpha* in Stevens and Robertson 2010)

Results of annual monitoring since 2010 are summarised in Table 3. As in previous years, results show minor changes in the macroalgal cover recorded, but overall indicate that macroalgal growth is not a significant problem in the estuary.

However, other indicators of increasing eutrophication in the estuary since 2010 have been evident. These, first reported on in Robertson and Stevens (2012), were:

- A reduction in sediment oxygenation (shallow RPD depth).
- Increased sediment nutrient concentrations (total nitrogen and phosphorus).
- Increased organic content (measured as total organic carbon).
- Dense microalgal mats growing on estuary sediments.
- A distinctive green tinge (chlorophyll a) in the estuary water, particularly in temperature/salinity stratified bottom waters.

Symptoms again observed in 2014 were a shallow RPD depth and dense microalgal mats growing on estuary sediments. Based on a visual assessment which showed extensive flood deposition of organic material on the intertidal flats (lower sidebar photo), sediment organic content was also considered likely to have remained elevated, while estuary waters had a moderate green tinge (indicating the presence of chlorophyll a).

Based on these latter symptoms, it is recommended that macroalgae again be quickly reassessed in conjunction with sediment rate monitoring scheduled for January/February 2015. At that time a more comprehensive methodology for evaluating opportunistic macroalgae will be available for use in the estuary and will be used to derive an "ecological quality rating" based on a comprehensive multi-metric index that incorporates macroalgal cover, density, biomass, and entrainment, scored both within available intertidal habitat and in areas affected by macroalgae.

2. Results, Rating and Recommendations (Cont...)

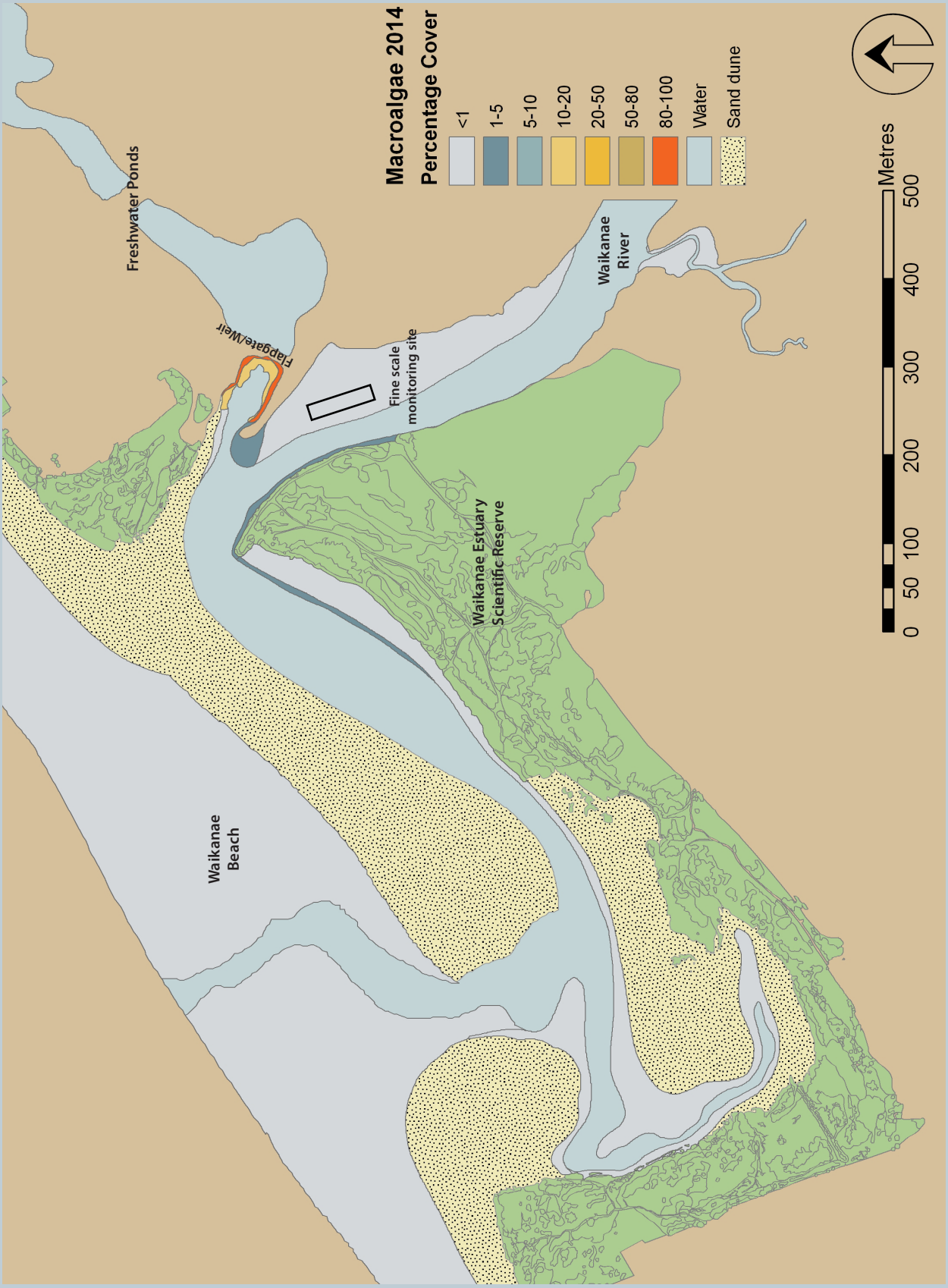

Figure 2. Map of Intertidal macroalgal cover - Waikanae Estuary, 21 Jan. 2014.

2. Results, Rating and Recommendations (Cont...)

Table 3. Summary of macroalgal risk indicator ratings and results, 2010-14.

Year	Low Density Coefficient	High Density % cover	Result
2010*	Very Low (0.01)	Very Low (<1%)	Macroalgae absent from the vast majority of the estuary. Very low cover of *Ulva intestinalis* along the lower true left bank. Dense macroalgal cover = <1%. No nuisance conditions.
2011*	Very Low (0.01)	Low (1-5%)	Macroalgae absent from the vast majority of the estuary. Very low cover of *U. intestinalis* along the true left bank. Dense macroalgal cover = 2.3%. Nuisance conditions by flapgate.
2012*	Very Low (0.04)	Low (1-5%)	Macroalgae absent from the vast majority of the estuary. Low cover of *U. intestinalis* along the lower true left bank. Dense macroalgal cover = 2.8%. Nuisance conditions by flapgate.
2013*	Very Low (0.16)	Low (1-5%)	Macroalgae absent from the vast majority of the estuary. Increase in *U. intestinalis* along the lower true left bank. Dense macroalgal cover = 2.8%. Nuisance conditions by flapgate.
2014	Very Low (0.10)	Very Low (<1%)	Macroalgae absent from the vast majority of the estuary. Sparse *U. intestinalis* cover along the lower true left bank. Dense macroalgal cover = <1%. Nuisance conditions by flapgate.

*see Stevens and Robertson 2010-2013 for full details.

CONCLUSION

Overall, macroalgal cover was low with minor localised nuisance conditions (rotting macroalgae, poorly oxygenated and sulphide rich sediments) present in only a small part of the estuary. Despite low macroalgal cover, other indicators of eutrophication (e.g. reduced sediment oxygenation, increased organic content, dense growths of microalgal mats) show a decline in estuary quality since 2010.

RECOMMENDED MONITORING

Quickly reassess macroalgal growth at the same time sedimentation monitoring is undertaken to ensure growths or nuisance conditions have not increased, and to enable a more comprehensive methodology for evaluating opportunistic macroalgal to be applied. The next monitoring in Waikanae Estuary is therefore recommended for January/February 2015.

REFERENCES

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

Robertson, B.M. and Stevens, L. 2007. Wairarapa Coastal Habitats: Mapping, Risk Assessment and Monitoring. Prepared for Greater Wellington Regional Council. 120p.

Robertson, B.M. and Stevens, L. 2010. Waikanae Estuary: Fine Scale Monitoring 2009/10. Prepared for Greater Wellington Regional Council. 19p.

Robertson, B.M. and Stevens, L. 2011. Waikanae Estuary: Fine Scale Monitoring 2010/11. Prepared for Greater Wellington Regional Council. 21p.

Robertson, B.M. and Stevens, L. 2012. Waikanae Estuary: Fine Scale Monitoring 2011/12. Prepared for Greater Wellington Regional Council. 22p.

Robertson, B.M. and Stevens, L. 2012a. Tasman Coast: Waimea Inlet to Kahurangi Point, habitat mapping, risk assessment and monitoring recommendations. Prepared for Tasman District Council. 167p.

Stevens, L. and Robertson, B.M. 2010. Waikanae River Estuary: Intertidal Macroalgal Monitoring 2009/10. Prepared for Greater Wellington Regional Council. 3p.

Stevens, L. and Robertson, B.M. 2011. Waikanae River Estuary: Intertidal Macroalgal Monitoring 2010/11. Prepared for Greater Wellington Regional Council. 3p.

Stevens, L. and Robertson, B.M. 2012. Waikanae River Estuary: Intertidal Macroalgal Monitoring 2011/12. Prepared for Greater Wellington Regional Council. 4p.

Stevens, L., and Robertson, B.M. 2013. Moutere Inlet broad scale habitat mapping 2012/2013. Prepared for Tasman District Council. 29p.

ACKNOWLEDGEMENT

This survey and report was completed with the support of Greater Wellington Regional Council. The feedback of Megan Oliver is much appreciated.