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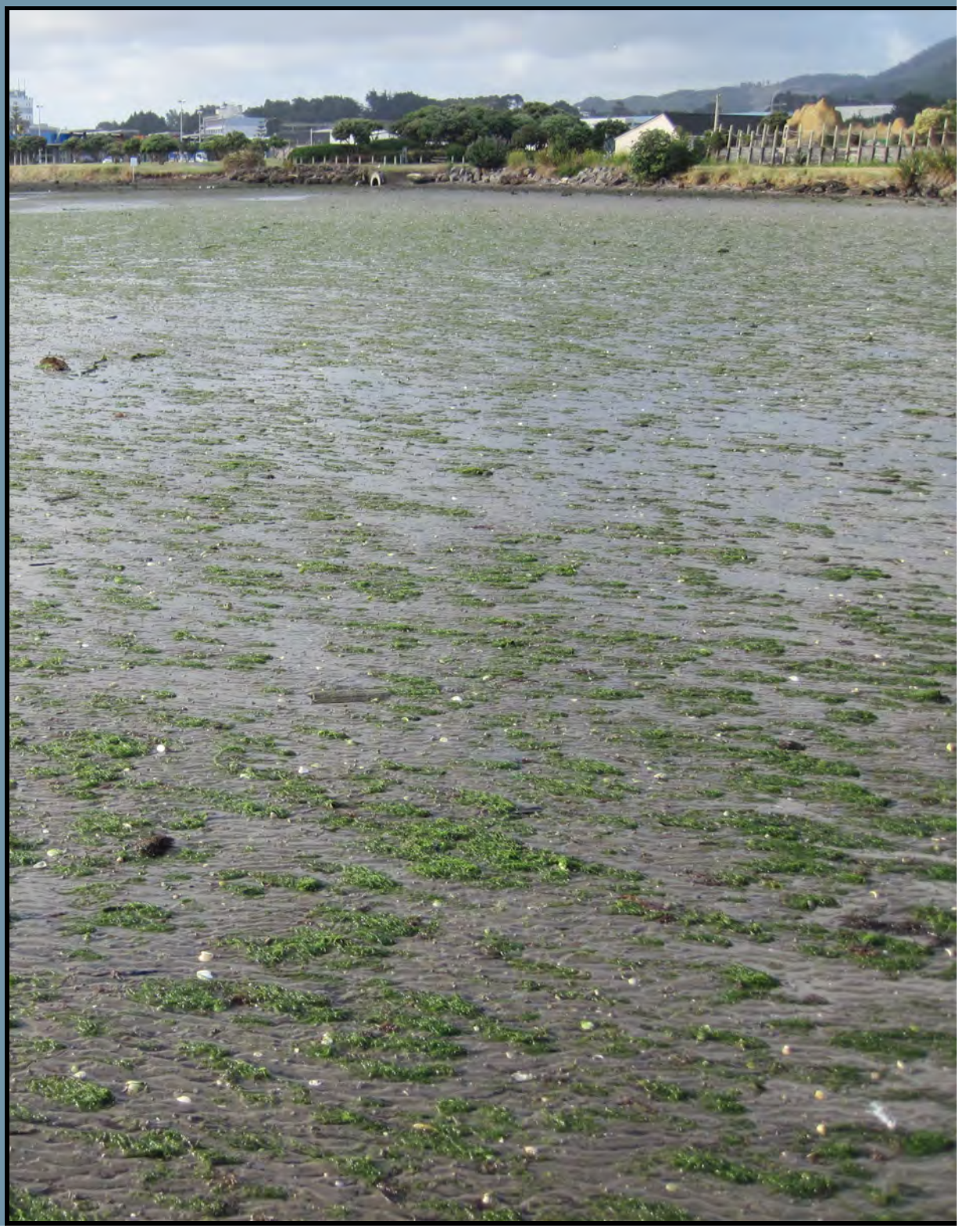
Porirua Harbour

Intertidal Macroalgal Monitoring 2013/14



Prepared for
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Cover Photo: ***Ulva*** **growing at the mouth of Porirua Stream, January 2014.**

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By

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Growths of *Ulva ramulosa* along the intertidal flats adjacent to Porirua Stream.

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 Porirua Harbour, undertaken on 18 and 19 January 2014. The report describes intertidal macroalgal cover - a broad scale indicator of estuary eutrophication - and applies "risk indicator ratings" (described in Section 2) to help assess estuary condition. Overall estuary condition needs to be assessed in conjunction with the wider suite of broad and fine scale monitoring results (e.g. Stevens and Robertson 2013, Robertson and Stevens 2008, 2009, 2010).

METHODS

Broad scale mapping of the percentage cover of macroalgae throughout all the intertidal habitat of Porirua Harbour 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 2009, 2013).

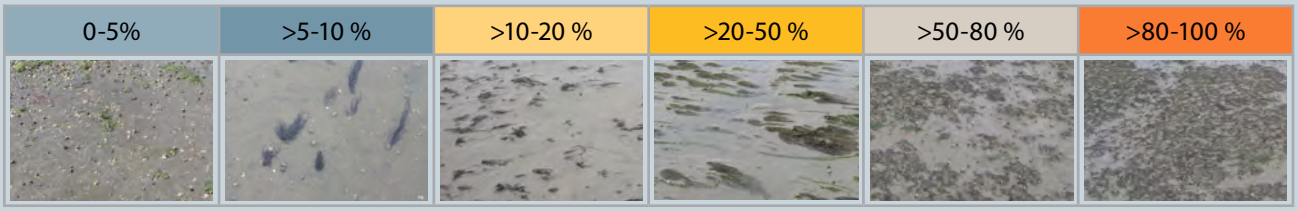
Rectified aerial photographs of the estuary (2010 Greater Wellington Regional Council ~0.3 metre per pixel images) were used as base maps. Experienced coastal scientists then recorded the percentage cover of macroalgae directly onto laminated photos during field assessment of macroalgal cover. The field 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.



Macroalgae growing on intertidal sediments near Takapuwahia Stream, 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, 2012), 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 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 Porirua Harbour 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 macroalgae 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

Figure 2 and Table 2 summarise the results of intertidal mapping of opportunistic macroalgal within Porirua Harbour. The results show:

- A large portion of the intertidal area (33%) had a low/very low percentage cover.
- High-very high (>50%) dense nuisance macroalgal cover was present - 2.9ha (1.3%) in the Pauatahanui Arm, and 9.5ha (15.5%) in the Onepoto Arm.
- Dense macroalgal cover commonly coincided with the presence of soft, poorly oxygenated, muds however no significant areas of gross nuisance conditions were evident.

The red algae *Gracilaria chilensis* was the dominant intertidal macroalgal species throughout the vast majority of the estuary, with the green alga *Ulva lactuca and Ulva ramulosa* both commonly found growing in the same areas as *Gracilaria*. *Ulva* was dominant to *Gracilaria* only on the Mana flats of the Pauatahanui Arm, and on the Porirua Stream delta in the Onepoto Arm.

The 2014 Macroalgae Coefficient (MC) for low density (<50%) cover in the estuary was 2.6, a risk indicator rating of "moderate". The percentage of the estuary with a high density (>50% cover) macroalgal cover was 4.3%, a risk indicator rating of "low". High density macroalgal cover had decreased below that recorded over the previous 6 years, a risk indicator rating of "very low". These results primarily reflect reduced dense cover on the intertidal flats adjacent to Horokiri Stream, and reduced low density growth throughout both arms. Although these 2014 risk indicator ratings for opportunistic macroalgal growth range from "very low" to "moderate", the variable nature of annual "snapshot" monitoring means that results need to be assessed in conjunction with previous findings.

Table 2. Summary of intertidal macroalgal cover, Porirua Harbour, 18-19 January 2014.

Percentage Cover	Pauatahanui Arm			Onepoto Arm			Entire Estuary	
	Ha	%	Dominant species	Ha	%	Dominant species	Ha	%
Unvegetated	61.8	27.7	-	20.1	32.6	-	81.9	28.7
1-5%	9.0	4.0	*Gracilaria, Ulva*	4.3	7.0	*Gracilaria, Ulva*	13.3	4.7
6-10%	58.2	26.0	*Gracilaria, Ulva*	15.5	25.1	*Gracilaria, Ulva*	73.7	25.8
11-20%	59.6	26.6	*Gracilaria, Ulva*	5.9	9.6	*Gracilaria, Ulva*	65.5	23.0
21-50%	32.1	14.4	*Gracilaria, Ulva*	6.3	10.2	*Gracilaria, Ulva*	38.4	13.5
51-80%	2.8	1.3	*Gracilaria, Ulva*	7.6	12.3	*Gracilaria, Ulva*	10.4	3.6
>80%	0.1	0.1	*Ulva, Gracilaria*	2.0	3.2	*Gracilaria, Ulva*	2.1	0.7
TOTAL	**224**	**100**		**62**	**100**		**286**	**100**

Between 2008 and 2013, high density intertidal macroalgal growth was consistently at the upper end of the "moderate" category, or within the "high" category (Table 3, Stevens and Robertson 2013). The variable 8-15% cover most likely reflects fluctuations in observed cover as a consequence of river flows and wave action redepositing macroalgae from the intertidal flats into subtidal areas under flood or storm conditions. Although there is no clear trend to indicate significantly worsening conditions over this period, the stable presence of high density intertidal macroalgal growths (that are on the verge of causing nuisance conditions) shows nutrient inputs to the estuary are sufficient to maintain elevated growths of macroalgae. This is further supported by the relatively steady increase of low density "moderate" nonnuisance macroalgae cover from 2008 to 2013.

The reduced dense macroalgal cover and low density cover coefficient in 2014 (Table 3) superficially indicate improved conditions. However, in the absence of significant reductions to catchment nutrient or sediment inputs, or major changes in estuary condition, a significant improvement in estuary condition is unlikely over the time frame observed. The results are therefore most likely to reflect short-term variation encountered at the time monitoring was undertaken.

Consequently, previous conclusions regarding the need to ensure the assimilative capacity of the estuary is not exceeded are reiterated in the recommended monitoring and management section.

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

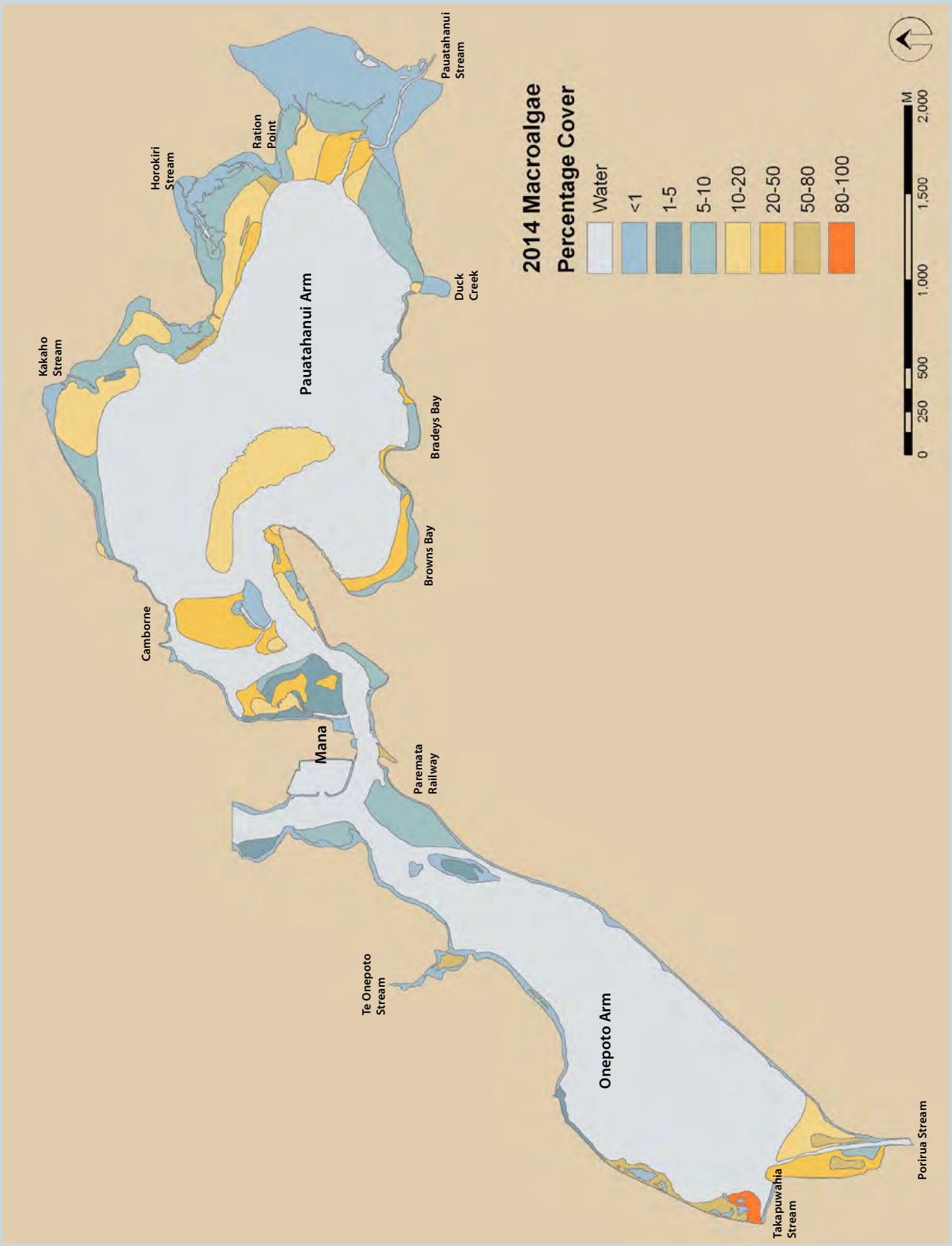


Figure 2. Map of Intertidal macroalgal cover - Porirua Harbour, 18-19 January 2014.

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

Table 3. Summary macroalgal risk indicator ratings and results, 2008-14.

Year	Low Density Coefficient	High Density % cover	Result
2008	Moderate 2.6	Moderate (9%)	High cover (50-80%) near Porirua Stream mouth in Onepoto Arm dominated by *Ulva*. 10-20% cover across most of Pauatahanui Arm, dominated by *Gracilaria*.
2009	Moderate 2.0	High (15%)	High *Ulva* cover (50-80%) near Porirua Stream mouth. Large increase near Pauatahanui Stream mouth (50-80% dominated by *U. intestinalis*). Increased growth by Mana boathouses (20-50%).
2010	Moderate 3.1	Moderate (10%)	High *Ulva* cover (50-80%) near Porirua Stream. Dominant species by Pauatahanui Stream changed from *U. intestinalis* to *Ulva* sp. Increased cover in northeast Pauatahanui (1-5% to 20-50%).
2011	Moderate 3.0	Moderate (10%)	High cover (50-100%) near Porirua Stream mouth dominated by *Ulva* sp. High cover (50-80%) near Pauatahanui Stream mouth dominated by *Gracilaria*.
2012	Moderate 2.9	High (11%)	High cover (50-100%) near Porirua Stream mouth dominated by *Ulva* sp. High cover (50-80%) near Pauatahanui Stream mouth dominated by *Gracilaria*.
2013	Moderate 3.2	Moderate (8%)	High cover (50-80%) near Porirua Stream mouth dominated by *Gracilaria*. High cover (50-80%) near Horokiri Stream mouth dominated by *Gracilaria*.
2014	Moderate 2.6	Low (4%)	Moderate cover (20-80%) near Porirua Stream mouth dominated by *Gracilaria*. Cover near Horokiri Stream mouth significantly reduced over previous 12 months (from 50-80% to 10-20%).

CONCLUSION

Intertidal macroalgal monitoring since 2008 has shown elevated macroalgal growth and localised nuisance conditions (rotting macroalgae and poorly oxygenated and sulphide rich sediments) in both the Onepoto and Pauatahanui Arms.

While the 2014 risk indicator ratings for opportunistic macroalgal growth range from "low" to "moderate", the concentration of growths and localised nuisance conditions near the major streams entering the estuary (e.g. Porirua, Takapuwahia, Pauatahanui, Horokiri, Kakaho Streams) suggest catchment nutrient inputs are a likely driver of the observed growths. Combined with increasing mud deposition in these same areas (Stevens and Robertson 2012, 2013), macroalgal growth and mud deposition remain continuing concerns within the estuary.

RECOMMENDED MONITORING AND MANAGEMENT

Based on the widespread cover of macroalgae and the ongoing presence of localised nuisance conditions, it is recommended that annual macroalgal monitoring be continued, with the next monitoring in Porirua Harbour due in January 2015. At that time it is envisaged that a more comprehensive methodology for evaluating opportunistic macroalgal will be available for use.

It is also recommended that appropriate catchment nutrient guideline criteria be developed, and that the extent to which catchment loads meet these guidelines be assessed. The key steps in such an approach are as follows:

- Assign catchment nutrient load guideline criteria to the estuary based on available catchment load/estuary response information from other relevant estuaries.
- Estimate catchment nutrient loads to each estuary using available catchment models and stream monitoring data.
- Determine the extent to which each estuary meets guideline catchment load criteria.
- Assess the potential for requiring more detailed assessments of priority catchments (e.g. estuary response modelling, stream and tributary monitoring, catchment load modelling).
- Develop plans for targeted management or restoration of priority catchments.

GWRC is currently undertaking a range of investigations in the Porirua Harbour catchment focussing on sediment mitigation and potential nutrient sources. The information will be directly relevant to understanding and managing macroalgal growth in the estuary.

Overall, the approach presented above is intended to ensure that the assimilative capacity of the estuary is not exceeded so that the estuary can flourish and provide sustainable human use and ecological values in the long term.

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

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Wave flushed intertidal margins with no macroalgal growth, Onepoto Arm, January 2014.