SALT
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Hutt Estuary Intertidal Macroalgal Monitoring, January 2020

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GLOSSARY

AA	Affected Area
AIH	Available Intertidal Habitat
aRPD	Apparent Redox Potential Discontinuity
EQR	Ecological Quality Rating
ETI	Estuary Trophic Index
GIS	Geographic Information System
GEZ	Gross Eutrophic Zones, now more commonly called HECs (see below)
GWRC	Greater Wellington Regional Council
HEC	High Enrichment Conditions (eutrophic area)
OMBT	Opportunistic Macroalgal Blooming Tool

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1. INTRODUCTION

Since 2010 Greater Wellington Regional Council (GWRC) has undertaken annual monitoring of intertidal opportunistic macroalgal growth in the Hutt Estuary (Fig. 1) as a primary indicator of estuary eutrophication. Opportunistic macroalgae are highly effective at utilising excess nitrogen, enabling them to out-compete other seaweed species. At nuisance levels they can form dense mats which adversely impact underlying sediments and fauna, other algae, fish, birds, seagrass, and salt marsh. Decaying macroalgae can also accumulate subtidally and on shorelines causing oxygen depletion and nuisance odours and conditions. The greater the macroalgal cover, biomass, persistence, and extent of entrainment within sediments, the greater the subsequent impacts. This brief report summarises the results of the tenth survey of intertidal opportunistic macroalgal cover in Hutt Estuary, undertaken in January 2020.

2. METHODS

The assessment of macroalgae follows the WFD-UKTAG (2014) Opportunistic Macroalgal Blooming Tool (OMBT) approach recommended for use in New Zealand as part of the New Zealand Estuary Trophic Index (ETI) (Robertson et al. 2016a, b). The OMBT, described in detail in Appendix 1, is a 5-part multimetric index which rates macroalgal condition through calculation of an Ecological Quality Rating (EQR) ranging from 0 (major disturbance) to 1 (minimally disturbed). The score, placed within overall quality status threshold bands (i.e. low, poor, good, moderate, high), provides a comprehensive measure of the combined influence of estuary macroalgal growth and distribution.

On 16 January 2020, the estuary was walked at low tide and the percentage cover of macroalgae mapped (to the nearest 10%) directly onto laminated photos guided by a 6-category percent cover rating scale (Fig. 2). Within these percentage cover categories, patches of comparable macroalgal growth were identified and enumerated through field measures of biomass and the degree of macroalgal entrainment (i.e. growth >3cm deep) within the sediment.

Patch biomass was measured by collecting macroalgae from within a defined area (e.g. 25 x 25cm quadrat) and placing it into a mesh bag. Sediment, shell and debris was rinsed or removed from the sample and free water squeezed from the algae before it was weighed using field scales. Triplicate measures were collected from each patch and values used to derive the mean patch biomass per square metre.

If present, areas with symptoms of High Enrichment Conditions (HECs, previously referred to as gross eutrophic zones) were recorded. These are areas where nuisance macroalgal conditions (>50% cover) coincide with the presence of soft muds and the depletion of sediment oxygenation. Sediment

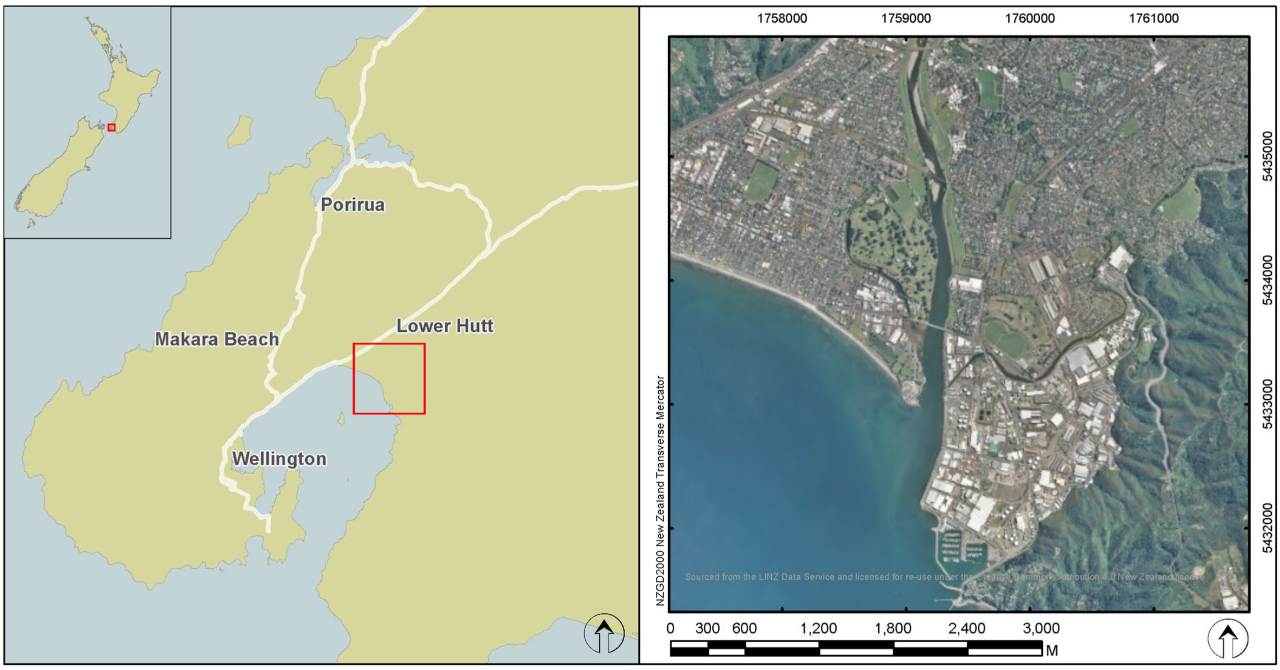

Fig. 1 Location of Hutt Estuary.

oxygenation was visually assessed by removing a core of sediment to reveal the depth at which sediments show a change in colour to grey/black, referred to as the apparent Redox Potential Discontinuity (aRPD) depth.

As well as annotation of field information onto aerial photographs during the field ground truthing, point estimate macroalgal data (i.e. biomass and cover measurements, entrainment), along with supporting measures of sediment aRPD, texture and sediment type were recorded in an electronic template custom-built using Fulcrum app software (see: www.fulcrumapp.com). Pre-specified constraints on data entry (e.g. with respect to data type, minimum or maximum values) ensured that the risk of erroneous data recording was minimised. Each sampling record created in Fulcrum generated a GPS position, which was exported to ArcMAP10.6 GIS software. Other field data were entered into ArcMap using a Wacom Cintiq21UX drawing tablet to spatially summarise results. Macroalgal biomass and cover values were exported to a spreadsheet calculator to derive OMBT EQR values.

The report outputs are presented as a GIS-based map of macroalgal biomass and summary tables, including OMBT EQRs for each metric. Macroalgal cover is classified in relation to the EQR quality status threshold bands, and changes in macroalgae are compared for the surveys conducted since 2015.

3. RESULTS

The results of 16 January 2020 survey are summarised in Table 1, Table 2, Fig. 3 and Fig. 4, with raw data in Appendix 2.

The highly modified estuary is confined within extensive flood banks, with an available intertidal habitat (AIH) of 6.82ha mapped in 2020. The AIH was restricted to small areas of mudflat present at the mouths of the Te Mome and Moera Streams and within Waiwhetu Stream, and in narrow bands along steep rip-rap rock walls or cobble and gravel substrate. All of this area had opportunistic macroalgal growth present in 2020, with almost 4ha (~58% of the AIH) having a macroalgal cover exceeding 50% (Table 1).

Table 1. Summary of intertidal macroalgal cover (A) and biomass (B), Hutt Estuary January 2020.

A. Cover

Percent cover category	Ha	%
Very sparse (1 to <10%)	0.10	1.41
Sparse (10 to <30%)	1.41	20.69
Low-Moderate (30 to <50%)	1.35	19.80
High-Moderate (50 to <70%)	0.45	6.64
Dense (70 to <90%)	2.46	36.15
Complete (>90%)	1.04	15.32
Grand Total	**6.82**	**100**

B. Biomass

Biomass category (g/m²)	Ha	%
Very low (1 - 100)	2.87	42.05
Low (101 - 500)	1.89	27.70
Moderate (501 - 1000)	0.47	6.92
High (1001 - 3000)	1.42	20.80
Very high (>3000)	0.17	2.49
Grand Total	**6.82**	**100**

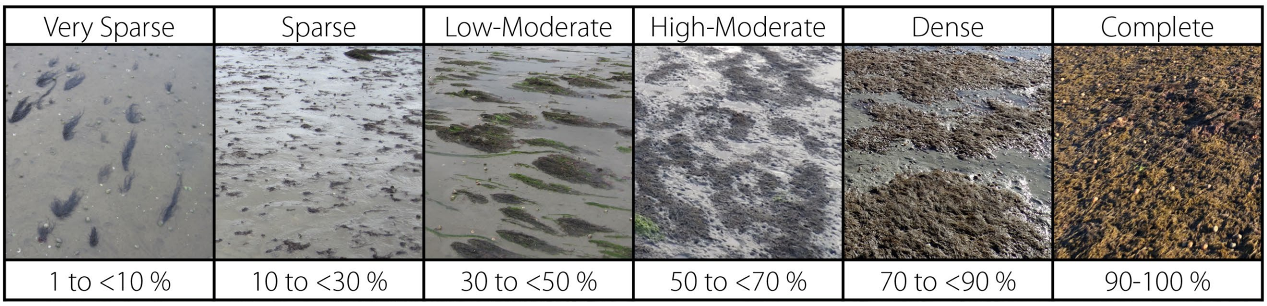

Fig. 2 Visual rating scale for macroalgae percentage cover estimates. Modified from FGDC (2012).

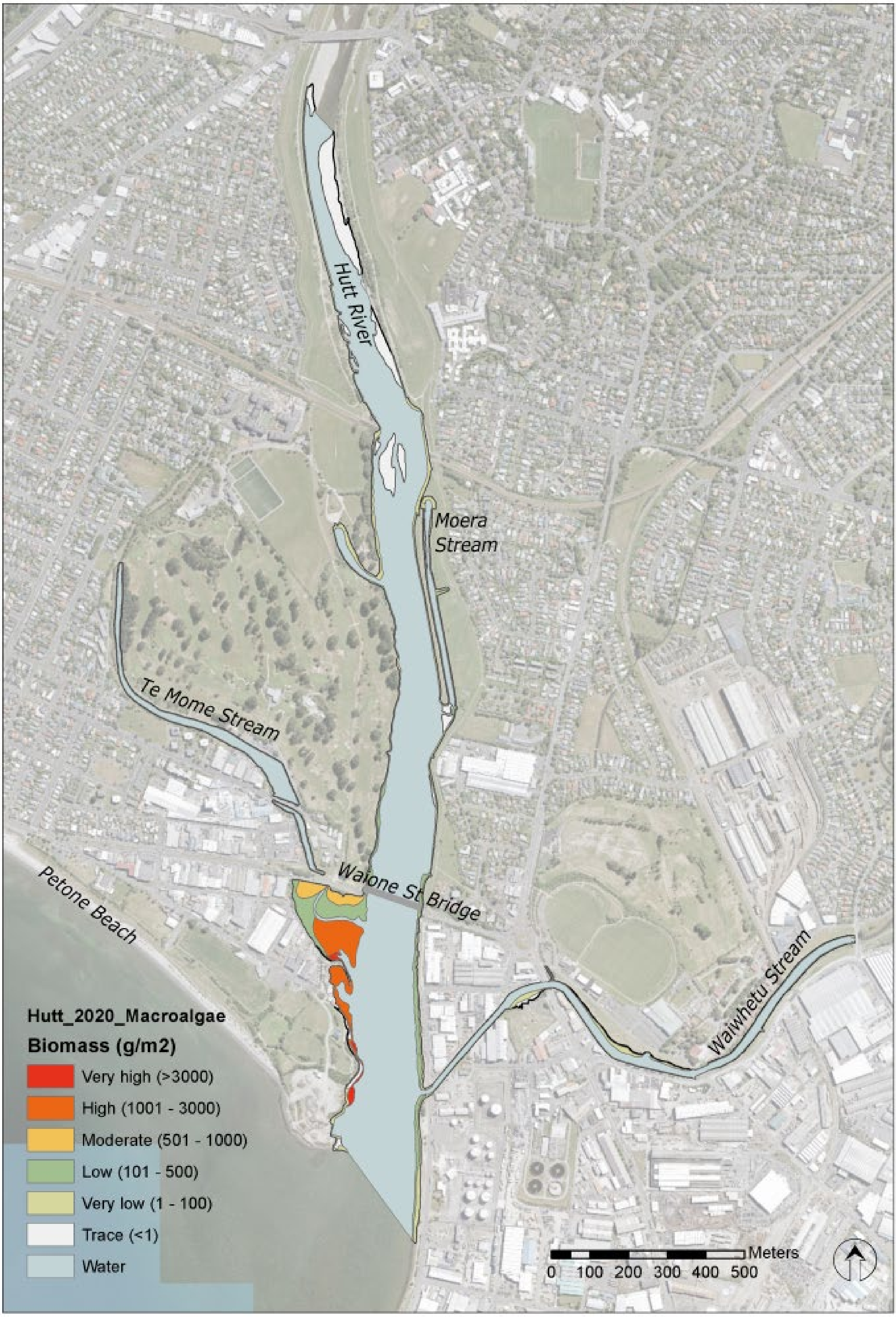

Fig. 3 Biomass (wet weight g/m²) classes of macroalgae, Hutt Estuary January 2020. See Appendix 2 for specific patch locations and measurement data.

The green alga *Ulva* spp. was the dominant species, with the red alga *Gracilaria chilensis* observed as a sub-dominant growth near the estuary mouth.

Macroalgal biomass was generally low, being ≤1kg/m^2 across 77% of the AIH, and generally very low (<100g/m^2) along the predominantly hard substrates of the extensively modified estuary margins (Fig. 3). These substrates are naturally limiting for dense macroalgal growths as they are subjected to strong current flows and do not allow for sediment to become entrained (grow within) the sediment. Patches exceeding 1kg/m^2 occurred in the soft sediments of the Te Mome Stream embayment next to Waione St bridge, and along the western margin further south. The latter do not appear to relate to any specific point source inputs.

Despite these 'hot spots', no intertidal HEC areas were identified (i.e. where entrained macroalgae >50% cover is present in combination with soft muds, and depleted sediment oxygenation).

The OMBT guidance recommends areas dominated by hard substrates be excluded from calculations as algae cannot become entrained and cause degradation of underlying sediment. However, for present purposes, and to enable comparison with previous survey results, these areas have been included due to the dominance of this habitat type in the estuary. As such, the resultant macroalgal EQR scores will be conservative as the quality status metric for entrainment will be rated 'high' (i.e. no problems).

The 2020 opportunistic macroalgal EQR for Hutt Estuary was 0.424, which is rated as a quality status of 'moderate', but is close to the transition to 'poor' (Fig. 4, Table 2). This rating has declined since 2017 and 2018, primarily reflecting a biomass in 2020 that was comparable to that recorded or estimated for the period 2010-2016. Despite the elevated biomass in 2020, the absence of HECs reflects that underlying intertidal sediments have not been significantly adversely impacted by the macroalgal growth.

Nonetheless, monitoring results confirm previous work and provide evidence that nutrient inputs to the estuary are sufficient to maintain consistent widespread intertidal macroalgal growth and a luxuriant high biomass in areas with suitable habitat.

If the high level of opportunistic algal growth in the estuary is to be reduced, then nutrient load reductions are likely to be required.

Ulva **in Te Mome Stream embayment.**

Intertidal sediments did not show significant symptoms of anoxia

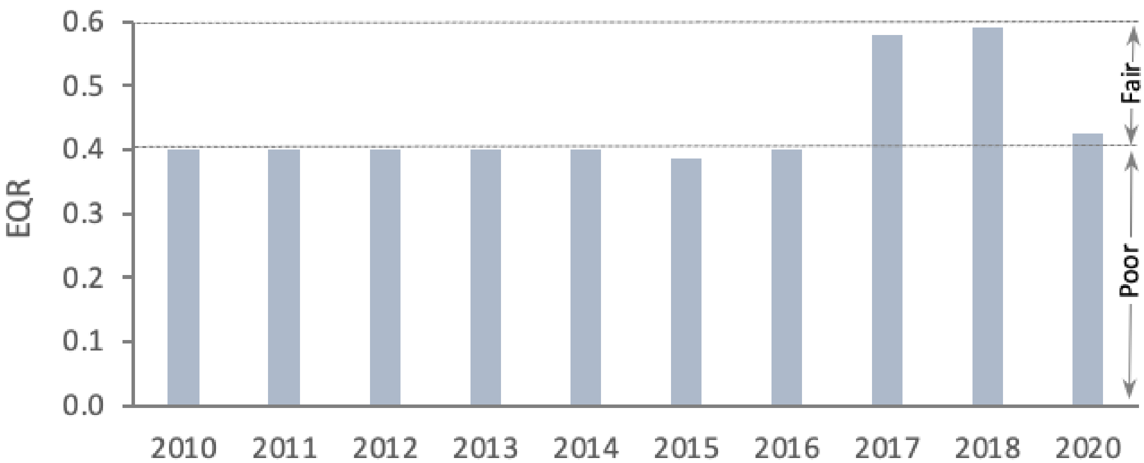

Fig. 4 Macroalgal OMBT Ecological Quality Rating (EQR) scores, Hutt Estuary 2010-2020.

EQR values for 2010-2014 estimated based on previously mapped percentage cover and field photos showing very similar conditions to those quantified in 2015 and 2016.

Table 2. Summary of OMBT input metrics and calculation of overall macroalgal ecological quality rating EQR), Hutt Estuary 2015-2020. Detail is not presented for 2010-2015 as EQR scores were estimates for those years.

Appendix 1 provides full details on the OMBT calculation methods. Face values represent field measurements. These are converted to an equidistant EQR scale to allow combination of the metrics and allocation of the quality status narrative. AA= Affected Area, AIH= Available Intertidal Habitat, EQR= Ecological Quality Rating.

2020 Metric	Face Value	Final equidistant score	Environmental Quality Status
%cover in AIH	48.3	0.307	Poor
Biomass per m^2 AIH	683.4	0.361	Poor
Biomass per m^2 AA	796.7	0.338	Poor
%entrained in AA	0.0	1.000	High
Worst of AA (ha) and AA (% of AIH)		0.114	Bad
AA (ha)	6.8	0.864	High
AA (% of AIH)	85.8	0.114	Bad
Survey EQR		**0.424**	**Moderate**

2018 Metric	Face Value	Final equidistant score	Environmental Quality Status
%cover in AIH	44.5	0.322	Poor
Biomass per m^2 AIH	91.1	0.818	High
Biomass per m^2 AA	93.1	0.814	High
%entrained in AA	0.0	1.000	High
Worst of AA (ha) and AA (% of AIH)	-	0.017	Low
AA (ha)	7.8	0.844	High
AA (% of AIH)	97.9	0.017	Low
Survey EQR		**0.594**	**Moderate**

2017 Metric	Face Value	Final equidistant score	Environmental Quality Status
%cover in AIH	46.9	0.312	Poor
Biomass per m^2 AIH	103.0	0.794	Good
Biomass per m^2 AA	103.4	0.793	Good
%entrained in AA	0.0	1.000	High
Worst of AA (ha) and AA (% of AIH)		0.003	Bad
AA (ha)	7.9	0.842	High
AA (% of AIH)	99.6	0.003	Bad
Survey EQR		**0.581**	**Moderate**

2016 Metric	Face Value	Final equidistant score	Environmental Quality Status
%cover in AIH	63.2	0.247	Poor
Biomass per m^2 AIH	753.1	0.366	Poor
Biomass per m^2 AA	764.6	0.365	Poor
%entrained in AA	0.0	1.000	High
Worst of AA (ha) and AA (% of AIH)		0.012	Bad
AA (ha)	7.8	0.844	High
AA (% of AIH)	98.5	0.012	Bad
Survey EQR		**0.400**	**Poor**

2015 Metric	Face Value	Final equidistant score	Environmental Quality Status
%cover in AIH	60.4	0.258	Poor
Biomass per m^2 AIH	820.2	0.333	Poor
Biomass per m^2 AA	830.0	0.331	Poor
%entrained in AA	0.0	1.000	High
Worst of AA (ha) and AA (% of AIH)		0.009	Bad
AA (ha)	7.9	0.843	High
AA (% of AIH)	98.8	0.009	Bad
Survey EQR		**0.386**	**Poor**

4. SYNTHESIS AND RECOMMENDATIONS

The 2020 'moderate' macroalgal EQR reflects the widespread presence, but generally low biomass and absence of entrainment, of intertidal macroalgae in the estuary, with growths not causing significantly degraded intertidal sediment conditions.

Because extensive historic reclamations of the estuary have restricted much of the intertidal habitat to rock walls, which limit areas where intertidal eutrophic conditions (i.e. HECs) can establish, degraded conditions are not readily expressed in intertidal areas. In addition, regular flushing of the estuary is likely to remove macroalgae from intertidal areas and limit the development of nuisance conditions (rotting macroalgae and poorly oxygenated and sulphide rich sediments) to very localised areas on intertidal flats.

Synoptic monitoring in 2016 (Stevens et al. 2016) found significantly organically enriched and degraded subtidal areas near the Hutt River mouth commonly associated with the presence of rotting macroalgae. These conditions appear to be persistent with ongoing evidence of significant subtidal impacts from excessive nutrient-driven macroalgae growth present in 2020. In the shallow sub-tidal waters near the Waione Bridge sediments were very soft, organically enriched and highly anoxic, with strong hydrogen sulphide odours. Surface waters were dark black in appearance where they were washing over the impacted sediments.

***Ulva* along western margin upstream of Waione St bridge**

Channelised section of the lower Waiwhetu Stream

Ulva and *Gracilaria* along eastern margin near Hutt River mouth

***Ulva* and *Gracilaria* at Waiwhetu Stream confluence**

Highly enriched sediments with strong hydrogen sulphide odours were present in the shallow subtidal zone near the Waione Bridge

The consistent widespread cover of opportunistic green macroalgae throughout the intertidal estuary (monitored annually since 2010) strongly suggests elevated catchment nutrient inputs (from both water column, sediment and groundwater sources) are driving the observed growths. Stevens (2018) discussed potential nutrient sources, and recommended an assessment be undertaken to determine a guideline limit for catchment nutrient inputs along with an evaluation of the feasibility of load reductions.

In the interim, because intertidal macroalgal growth in the estuary is relatively consistent, it is recommended that ongoing monitoring be moved to a 5-yearly cycle unless there are substantive changes in nutrient loads or conspicuous changes in estuary state. The next monitoring is therefore recommended for January 2025.

Ulva **along the western margin downstream of Waione St bridge**

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APPENDICES

APPENDIX 1. OPPORTUNTISTIC MACROALGAL BLOOMING TOOL

The UK-WFD (Water Framework Directive) Opportunistic Macroalgal Blooming Tool (OMBT) (WFD-UKTAG 2014) is a comprehensive 5-part multimetric index approach suitable for characterising the different types of estuaries and related macroalgal issues found in NZ. The tool allows simple adjustment of underpinning threshold values to calibrate it to the observed relationships between macroalgal condition and the ecological response of different estuary types. It incorporates sediment entrained macroalgae, a key indicator of estuary degradation, and addresses limitations associated with percentage cover estimates that do not incorporate biomass e.g. where high cover but low biomass are not resulting in significantly degraded sediment conditions. It is supported by extensive studies of the macroalgal condition in relation to ecological responses in a wide range of estuaries.

The 5-part multimetric OMBT, modified for NZ estuary types, is fully described below. It is based on macroalgal growth within the Available Intertidal Habitat (AIH) - the estuary area between high and low water spring tide able to support opportunistic macroalgal growth. Suitable areas are considered to consist of *mud, muddy sand, sandy mud, sand, stony mud and mussel beds.* Areas which are judged unsuitable for algal blooms e.g. channels and channel edges subject to constant scouring, need to be excluded from the AIH. The following measures are then taken:

1. Percentage cover of the available intertidal habitat (AIH).

The percent cover of opportunistic macroalgal within the AIH is assessed. While a range of methods are described, visual rating by experienced ecologists, with independent validation of results is a reliable and rapid method. All areas within the AIH where macroalgal cover >5% are mapped spatially.

2. Total extent of area covered by algal mats (affected area (AA)) or affected area as a percentage of the AIH (AA/AIH, %).

In large water bodies with proportionately small patches of macroalgal coverage, the rating for total area covered by macroalgae (Affected Area - AA) might indicate high or good status, while the total area covered could actually be quite substantial and could still affect the surrounding and underlying communities. In order to account for this, an additional metric established is the affected area as a percentage of the AIH (i.e. (AA/AIH)*100). This helps to scale the area of impact to the size of the waterbody. In the final assessment the lower of the two metrics (the AA or percentage AA/AIH) is used, i.e. whichever reflects the worse-case scenario.

3. Biomass of AIH (g.m-^{2}).

Assessment of the spatial extent of the algal bed alone will not indicate the level of risk to a water body. For example, a very thin (low biomass) layer covering over 75% of a shore might have little impact on underlying sediments and fauna. The influence of biomass is therefore incorporated. Biomass is calculated as a mean for (i) the whole of the AIH and (ii) for the Affected Areas. The potential use of maximum biomass was rejected, as it could falsely classify a water body by giving undue weighting to a small, localised blooming problem. Algae growing on the surface of the sediment are collected for biomass assessment, thoroughly rinsed to remove sediment and invertebrate fauna, hand squeezed until water stops running, and the wet weight of algae recorded. For quality assurance of the percentage cover estimates, two independent readings should be within ±5%. A photograph should be taken of every quadrat for inter-calibration and cross-checking of percent cover determination. Measures of biomass should be calculated to 1 decimal place of wet weight of sample. For both procedures the accuracy should be demonstrated with the use of quality assurance checks and procedures.

4. Biomass of AA (g.m-^{2}).

Mean biomass of the Affected Area (AA), with the AA defined as the total area with macroalgal cover >5%.

5. Presence of Entrained Algae (% of quadrats).

Algae are considered as entrained in muddy sediment when they are found growing >3cm deep within muddy sediments. The persistence of algae within sediments provides both a means for over-wintering of algal spores and a source of nutrients within the sediments. Build-up of weed within sediments therefore implies that blooms can become self-regenerating given the right conditions (Raffaelli et al. 1989). Absence of weed within the sediments lessens the likelihood of bloom persistence, while its presence gives greater opportunity for nutrient exchange with sediments. Consequently, the presence of opportunistic macroalgae growing within the surface sediment was included in the tool. All the metrics are equally weighted and combined within the multimetric, in order to best describe the changes in the nature and degree of opportunist macroalgae growth on sedimentary shores due to nutrient pressure.

Timing

The OMBT has been developed to classify data over the maximum growing season so sampling should target the peak bloom in summer (Dec-March), although peak timing may vary among water bodies, so local knowledge is required to identify the maximum growth period. Sampling is not recommended outside the summer period due to seasonal variations that could affect the outcome of the tool and possibly lead to misclassification; e.g. blooms may become disrupted by stormy autumn weather and often die back in winter. Sampling should be carried out during spring low tides in order to access the maximum area of the AIH.

Suitable Locations

The OMBT is suitable for use in estuaries and coastal waters which have intertidal areas of soft sedimentary substratum (i.e. areas of AIH for opportunistic macroalgal growth). The tool is not currently used for assessing ICOLLs due to the particular challenges in setting suitable reference conditions for these water bodies.

Derivation of Threshold Values

Published and unpublished literature, along with expert opinion, was used to derive critical threshold values suitable for defining quality status classes (Table A1).

Reference Thresholds

A UK Department of the Environment, Transport and the Regions (DETR) expert workshop suggested reference levels of <5% cover of AIH of climax and opportunistic species for high quality sites (DETR, 2001). In line with this approach, the WFD adopted <5% cover of opportunistic macroalgae in the AIH as equivalent to High status. From the WFD North East Atlantic intercalibration phase 1 results, German research into large sized water bodies revealed that areas over 50ha may often show signs of adverse effects, however if the overall area was less than 1/5th of this, adverse effects were not seen so the High/Good boundary was set at 10ha. In all cases a reference of 0% cover for truly un-impacted areas was assumed. Note: opportunistic algae may occur even in pristine water bodies as part of the natural community functioning. The proposal of reference conditions for levels of biomass took a similar approach, considering existing guidelines and suggestions from DETR (2001), with a tentative reference level of <100g m-^{2} wet weight. This reference level was used for both the average biomass over the affected area and the average biomass over the AIH. As with area measurements a reference of zero was assumed. An ideal of no entrainment (i.e. no quadrats revealing entrained macroalgae) was assumed to be reference for un-impacted waters. After some empirical testing in a number of UK water bodies a High / Good boundary of 1% of quadrats was set.

Class Thresholds for Percent Cover

High/Good boundary set at 5%. Based on the finding that a symptom of the potential start of eutrophication is when: (i) 25% of the available intertidal habitat has opportunistic macroalgae and (ii) at least 25% of the sediment (i.e. 25% in a quadrat) is covered (Comprehensive Studies Task Team (DETR, 2001)). This implies that an overall cover of the AIH of 6.25% (25*25%) represents the start of a potential problem.

Good / Moderate boundary set at 15%. True problem areas often have a >60% cover within the affected area of 25% of the water body (Wither 2003). This equates to 15% overall cover of the AIH (i.e. 25% of the water body covered with algal mats at a density of 60%).

Poor/Bad boundary is set at >75%. The Environment Agency has considered >75% cover as seriously affecting an area (Foden et al. 2010).

Class Thresholds for Biomass

Class boundaries for biomass values were derived from DETR (2001) recommendations that <500 g.m^{-2} wet weight was an acceptable level above the reference level of <100 g.m^{-2} wet weight. In Good status only slight deviation from High status is permitted so 500 g.m^{-2} represents the Good/Moderate boundary. Moderate quality status requires moderate signs of distortion and significantly greater deviation from High status to be observed. The presence of >500 g.m^{-2} but less than 1,000 g.m^{-2} would lead to a classification of Moderate quality status at best, but would depend on the percentage of the AIH covered. >1kg.m^{-2} wet weight causes significant harmful effects on biota (DETR 2001, Lowthion et al. 1985, Hull 1987, Wither 2003).

Table A1. The final face value thresholds and metrics for levels of the ecological quality status.

ECOLOGICAL QUALITY RATING (EQR)	High	Good	Moderate	Poor	Bad
	≥0.8 - 1.0	≥0.6 - <0.8	≥0.4 - <0.6	≥0.2 - <0.4	0.0 - <0.2
% cover on Available Intertidal Habitat (AIH)	0 - ≤5	>5 - ≤15	>15 -≤25	>25 - ≤75	>75 - 100
Affected Area (AA) [>5% macroalgae] (ha)*	≥0 - 10	≥10 - 50	≥50 - 100	≥100 - 250	≥250
AA/AIH (%)*	≥0 - 5	≥5 - 15	≥15 - 50	≥50 - 75	≥75 - 100
Average biomass (g.m^{2}) of AIH	≥0 - 100	≥100 - 500	≥500 - 1000	≥1000 - 3000	≥3000
Average biomass (g.m^{2}) of AA	≥0 - 100	≥100 - 500	≥500 - 1000	≥1000 - 3000	≥3000
% algae entrained >3cm deep	≥0 - 1	≥1 - 5	≥5 - 20	≥20 - 50	≥50 - 100
*Only the lower EQR of the 2 metrics, AA or AA/AIH should be used in the final EQR calculation.					

Thresholds for Entrained Algae

Empirical studies testing a number of scales were undertaken on a number of impacted waters. Seriously impacted waters have a very high percentage (>75%) of the beds showing entrainment (Poor / Bad boundary). Entrainment was felt to be an early warning sign of potential eutrophication problems so a tight High /Good standard of 1% was selected (this allows for the odd change in a quadrat or error to be taken into account). Consequently the Good / Moderate boundary was set at 5% where (assuming sufficient quadrats were taken) it would be clear that entrainment and potential over wintering of macroalgae had started.

EQR calculation

Each metric in the OMBT has equal weighting and is combined to produce the **Ecological Quality Rating** score (EQR).

The face value metrics work on a sliding scale to enable an accurate metric EQR value to be calculated; an average of these values is then used to establish the final water body level EQR and classification status. The EQR determining the final water body classification ranges between a value of zero to one and is converted to a Quality Status by using the categories in Table A1:

The EQR calculation process is as follows:

1. Calculation of the face value (e.g. percentage cover of AIH) for each metric. To calculate the individual metric face values:

- Percentage cover of AIH (%) = (Total % Cover / AIH) x 100 - where Total % cover = Sum of [(patch size) / 100] x average % cover for patch
- Affected Area, AA (ha) = Sum of all patch sizes (with macroalgal cover >5%).
- Biomass of AIH ($g.m^{-2}$) = Total biomass / AIH - where Total biomass = Sum of (patch size x average biomass for the patch)
- Biomass of Affected Area ($g.m^{-2}$) = Total biomass / AA - where Total biomass = Sum of (patch size x average biomass for the patch)
- Presence of Entrained Algae = (No. quadrats with entrained algae / total no. of quadrats) x 100
- Size of AA in relation to AIH (%) = (AA/AIH) x 100

2. Normalisation and rescaling to convert the face value to an equidistant index score (0-1 value) for each index (Table A2).

The face values are converted to an equidistant EQR scale to allow combination of the metrics. These steps have been mathematically combined in the following equation:

*Final Equidistant Index score = Upper Equidistant range value – ([Face Value - Upper Face value range] * (Equidistant class range / Face Value Class Range)).*

Table A2 gives the critical values at each class range required for the above equation. The first three numeric columns contain the face values (FV) for the range of the index in question, the last three numeric columns contain the values of the equidistant 0-1 scale and are the same for each index. The face value class range is derived by subtracting the upper face value of the range from the lower face value of the range. Note: the table is "simplified" with rounded numbers for display purposes. The face values in each class band may have greater than (>) or less than (<) symbols associated with them, for calculation a value of <5 is given a value of 4.999'.

The final EQR score is calculated as the average of equidistant metric scores.

A spreadsheet calculator is available to download from the UK WFD website to undertake the calculation of EQR scores.

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Table A2. Values for the normalisation and re-scaling of face values to EQR metric.

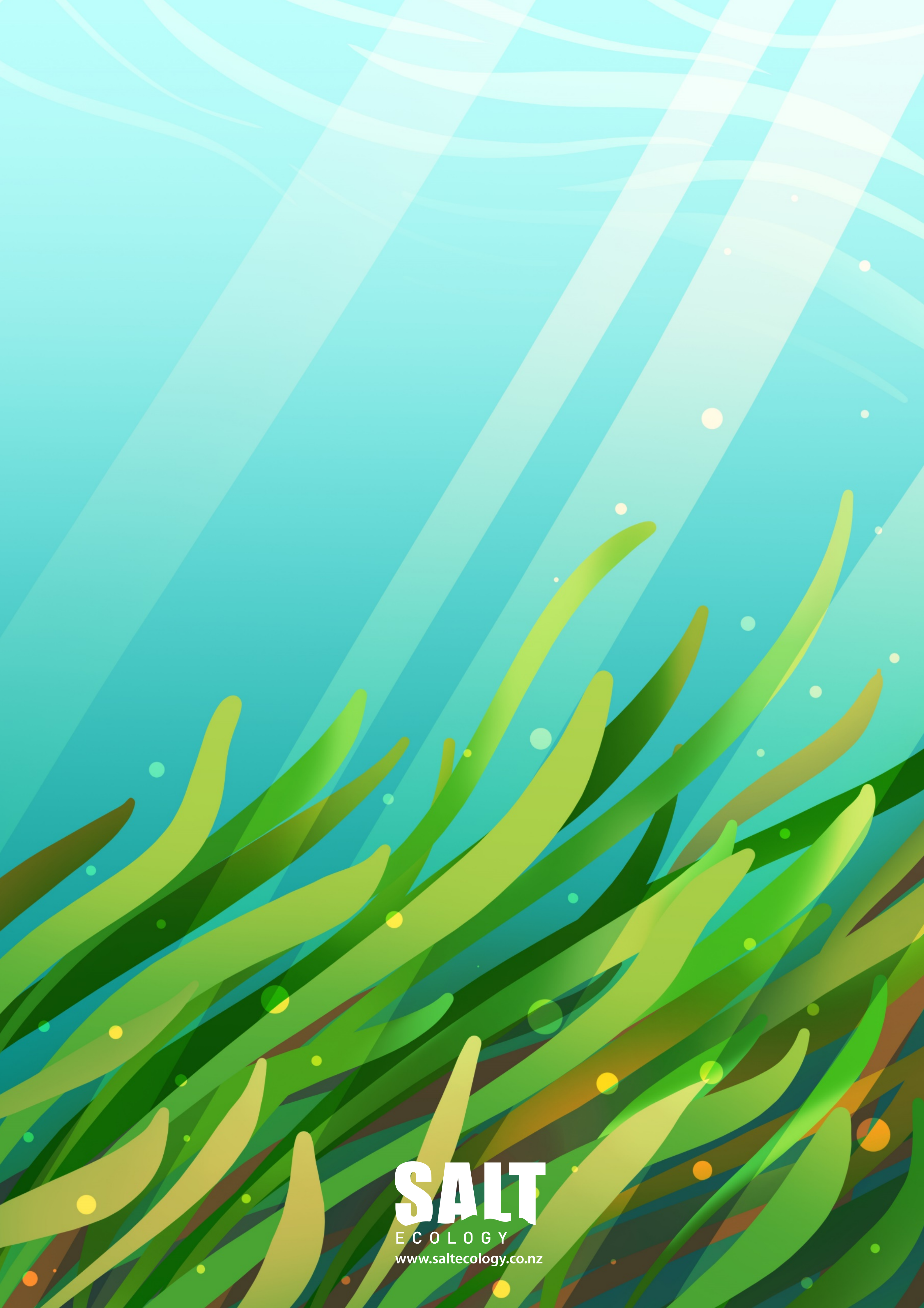
Metric	Quality status	Face value ranges			Equidistant class range values		
		Lower face value range (measurements towards the "Bad" end of this class range)	Upper face value range (measurements towards the "High" end of this class range)	Face Value Class Range	Lower 0-1 Equidistant range value	Upper 0-1 Equidistant range value	Equidistant Class Range
% Cover of Available Intertidal Habitat (AIH)	High	≤5	0	5	≥0.8	1	0.2
	Good	≤15	>5	9.999	≥0.6	<0.8	0.2
	Moderate	≤25	>15	9.999	≥0.4	<0.6	0.2
	Poor	≤75	>25	49.999	≥0.2	<0.4	0.2
	Bad	100	>75	24.999	0	<0.2	0.2
Average Biomass of AIH (g m^{-2})	High	≤100	0	100	≥0.8	1	0.2
	Good	≤500	>100	399.99	≥0.6	<0.8	0.2
	Moderate	≤1000	>500	499.99	≥0.4	<0.6	0.2
	Poor	≤3000	>1000	1999.9	≥0.2	<0.4	0.2
	Bad	≤6000	>3000	2999.9	0	<0.2	0.2
Average Biomass of Affected Area (AA) (g m^{-2})	High	≤100	0	100	≥0.8	1	0.2
	Good	≤500	>100	399.99	≥0.6	<0.8	0.2
	Moderate	≤1000	>500	499.99	≥0.4	<0.6	0.2
	Poor	≤3000	>1000	1999.9	≥0.2	<0.4	0.2
	Bad	≤6000	>3000	2999.9	0	<0.2	0.2
Affected Area (Ha)*	High	≤10	0	100	≥0.8	1	0.2
	Good	≤50	>10	39.999	≥0.6	<0.8	0.2
	Moderate	≤100	>50	49.999	≥0.4	<0.6	0.2
	Poor	≤250	>100	149.99	≥0.2	<0.4	0.2
	Bad	≤6000	>250	5749.9	0	<0.2	0.2
AA/AIH (%)*	High	≤5	0	5	≥0.8	1	0.2
	Good	≤15	>5	9.999	≥0.6	<0.8	0.2
	Moderate	≤50	>15	34.999	≥0.4	<0.6	0.2
	Poor	≤75	>50	24.999	≥0.2	<0.4	0.2
	Bad	100	>75	27.999	0	<0.2	0.2
% Entrained Algae	High	≤1	0	1	≥0.0	1	0.2
	Good	≤5	>1	3.999	≥0.2	<0.0	0.2
	Moderate	≤20	>5	14.999	≥0.4	<0.2	0.2
	Poor	≤50	>20	29.999	≥0.6	<0.4	0.2
	Bad	100	>50	49.999	1	<0.6	0.2
*Only the lower EQR of the 2 metrics, AA or AA/AIH should be used in the final EQR calculation.							

APPENDIX 2. RAW DATA FOR 2020

Location of macroalgal patches >5% cover used in assessing Hutt Estuary, 16 January 2020.

Macroalgal patch information, 2020

PatchID	Pct_Cover	Pct_Cover Class	Biomass (gm2)	Biomass Class	Entrained	Dom Species	SubDomSpp	Area_ha
01	30	Low-Moderate (30 to <50%)	50	Very low (1 - 100)	no	*Ulva* spp.		1.21
02	100	Complete (>90%)	200	Low (101 - 500)	no	*Ulva* spp.		0.02
03	80	Dense (70 to <90%)	250	Low (101 - 500)	no	*Ulva* spp.		0.36
04	80	Dense (70 to <90%)	200	Low (101 - 500)	no	*Ulva* spp.		0.23
05	50	High-Moderate (50 to <70%)	10	Very low (1 - 100)	no	*Ulva* spp.		0.39
06	5	Very sparse (1 to <10%)	10	Very low (1 - 100)	no	*Ulva* spp.		0.10
07	80	Dense (70 to <90%)	300	Low (101 - 500)	no	*Ulva* spp.		0.08
08	40	Low-Moderate (30 to <50%)	10	Very low (1 - 100)	no	*Ulva* spp.		0.14
09	70 10	Dense (70 to <90%)	5000	Very high (>3000)	no	*Ulva* spp.	*Gracilaria chilensis*	0.12
10	60 5	High-Moderate (50 to <70%)	1200	High (1001 - 3000)	no	*Ulva* spp.	*Gracilaria chilensis*	0.06
11	15 5	Sparse (10 to <30%)	2500	High (1001 - 3000)	no	*Ulva* spp.	*Gracilaria chilensis*	0.38
12	90	Complete (>90%)	4480	Very high (>3000)	no	*Ulva* spp.		0.05
13	20	Sparse (10 to <30%)	380	Low (101 - 500)	no	*Ulva* spp.		0.00005
13	20	Sparse (10 to <30%)	380	Low (101 - 500)	no	*Ulva* spp.		1.03
14	80	Dense (70 to <90%)	2520	High (1001 - 3000)	no	*Ulva* spp.		0.98
15	80	Dense (70 to <90%)	800	Moderate (501 - 1000)	no	*Ulva* spp.		0.47
16	90	Complete (>90%)	50	Very low (1 - 100)	no	*Ulva* spp.		0.80
17	90	Complete (>90%)	450	Low (101 - 500)	no	*Ulva* spp.		0.18
18	75	Dense (70 to <90%)	10	Very low (1 - 100)	no	*Ulva* spp.		0.05
19	75	Dense (70 to <90%)	10	Very low (1 - 100)	no	*Ulva* spp.		0.18



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