

Assigning Ecological Value to Marine Benthic Habitats

ECOLOGICAL IMPACT ASSESSMENT

EIANZ guidelines for use in Aotearoa New Zealand: terrestrial, freshwater, and marine ecosystems

Addendum Module 1

Assigning Ecological Value to Marine Benthic Habitats

Introduction

In 2015 EIANZ published 'Ecological Impact Assessment: Guidelines for use in New Zealand: terrestrial and freshwater ecosystems' and followed this with a second edition in 2018. The purpose of the guidelines is the provision of a consistent framework for the assessment of effects of resource use and management on ecosystems and their values in Aotearoa New Zealand. These guidelines have proved to be highly utilised with a large uptake amongst practitioners, and for the most part helpful in decision-making.

Since their publication some aspects of impact assessment practice and natural resource management have progressed. Recent hearing decisions, expert commentary, and feedback from practitioner experience has led EIANZ to consider that the time is right for another look at what improvements can be made to the guidelines. This is particularly timely with pending changes to Aotearoa New Zealand's environmental use and management legislation.

EIANZ intends to update the guidelines through a series of modules or addenda, each one related to a specific topic, that will replace or be added to the guidelines and will be available online at EIANZ.

This Addendum Module 1 to the guidelines introduces marine ecosystems to the EcIA, a notable omission from the guidelines published earlier, which dealt only with terrestrial and freshwater ecosystems. This module 'Assigning Ecological Value to Marine Benthic Habitats' largely follows the form of values assessment for terrestrial and freshwater ecosystems by providing a hierarchy of ecosystem characteristics set against a hierarchy of ecological values ranging from Negligible to Very High values.

Where this module is placed in the guidelines.

'Assigning Ecological Value to Marine Benthic Habitats' contributes to Chapter 5 of the EclA Guidelines. Chapter 5 sets out the importance of assigning ecological values to ecological components of the environment to make informed judgements about avoidance or alternatives; to assess the level of predicted effects; and to quantify those effects so that appropriate impact management can be designed or recommended. The explanations within Chapter 5 of the EclA guidelines are relevant to marine benthic habitats and provide guidance on when and how to use these values assessments.

Assigning value to marine benthic habitats

Attributes

In the same way as terrestrial and freshwater ecosystems are evaluated, the ecological value of a location (e.g., estuary, rocky reef, saltmarsh, intertidal and subtidal habitat) is determined by the assemblage and function of species, communities and habitats found there as well as the ecological context of the location. The ecological values of marine ecosystems have aspects of both quantity (rarity or extent) and quality (integrity, functionality or condition) and equally the value attributes include both qualitative and quantitative metrics to measure the quantity of quality of the habitats in question.

Some regulatory documents identify and specify the values and significance of specific marine locations, such as Significant Ecological Areas (SEAs). Marine reserves or no-take areas, regional policy statements, regional plans and/or district plans for the Project Site or ZOI location should be consulted first to determine what matters to consider and criteria to use to meet regulatory requirements.

Although a wide range of metrics and measures are used in the assessment of marine ecosystems there is no unifying set of attributes used to assign ecological values. Measures that are considered when assigning ecological value to a marine site do fall broadly into the matters discussed in section 5.2 and detailed in Table 4 Chapter 5 (Roper-Lindsay et al., 2018), although the application of these attributes varies widely and is somewhat inconsistent amongst practitioners. Table 1 of this module indicates how some of the broadscale habitat characteristics commonly recognised in terrestrial ecosystem evaluation may be applied in marine ecosystems.

Marine Ecology/Habitat Classification Systems

There are many marine habitat classification systems that could be used to inform values and impact assessments. The selection of a classification system will be relevant to the type of existing environment potentially affected. Several marine habitat classifications have been carried out for New Zealand each with a variety of attributes and, as at the time of writing, include:

- BOMECS, 2012 (Leathwick et al., 2012)
- Benthic Protected Areas (Clark et al., 2019)
- Marine Reserves, 2016 (Ministry for the Environment, 2016b)

- DoC Marine Mammal Sanctuaries, 2016 (Ministry for the Environment, 2016a)

Most Common habitat types in Coastal Waters, 2011 (Ministry for the Environment, 2011)

- NZ Seafloor Community Classification, 2020 (Stephenson et al., 2021)
- NZ Benthic Marine Habitat Ecosystem Service Potential Matrix, 2019 (Geange et al., 2019)
- Estuarine health national approach (Clark et al. (2019) Marine Pollution Bulletin 150, 110602)
- Functional Integrity – for both soft sediment and rocky shores (de Juan et al (2018), Journal of Environmental Management 228:319-327).
- Habitat Suitability Modelling for protected coral species. NIWA report WLG2014-69. Department of Conservation.

The habitat classification examples are not a finite list and are provided to give guidance to determine what habitat is involved in the ecological assessment. Fine scale criteria are provided later (Table 2) in this guidance document.

Table 1. Broadscale attributes that may be considered when assigning ecological value to a marine site, habitat or area.

Matters	Broadscale attributes
Representativeness	<ol style="list-style-type: none"> 1. Extent to which a site is typical or characteristic of a natural example of the habitat type e.g. estuary, open high energy sandy beach, subtidal reef 2. Site/habitat size 3. Indigenous species dominate 4. Expected species and tiers are present
Rarity/distinctiveness	<ol style="list-style-type: none"> 1. Supporting nationally or locally¹ Threatened, At Risk or uncommon species 2. National distribution limits 3. Endemism 4. Distinctive ecological features 5. Type of marine environment
Diversity and pattern	<ol style="list-style-type: none"> 1. Degree of natural diversity / habitat modification 2. Diversity metrics/indices 3. Complexity of community 4. Biogeographical considerations - pattern, complexity, size, shape 5. Temporal life history or seasonal habitat usage
Ecological context	<ol style="list-style-type: none"> 1. Local environmental conditions and influences, site history and development 2. Intactness, health and resilience of populations and communities 3. Contribution to ecological networks, linkages, pathways 4. Role in ecosystem functioning 5. Sensitivity to change 6. Project is within New Zealand's Coastal Marine Area (CMA) (under RMA legislation) or Exclusive Economic Zone (EEZ) (under EEZ legislation).

EclA in marine ecosystems has been less reliant on the current Resource Management Act (RMA) criteria in Section 6(c)² than similar assessments applied to terrestrial ecosystems. Even where criteria for the assignment of 'significance' exist within a regulatory plan, the established practice for marine practitioners is to default to measured and observed attributes recorded from the Project area under investigation. In part, this is because qualitative and quantitative indicators and metrics that include a scale or ranking for developing a hierarchy have been developed by marine ecologists.

¹ Locally – defined as Ecological District

² RMA Section 6(c) - The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna

This has led to marine benthic habitat assessments being closely aligned with RMA s88 and Schedule 4³ requirements.

Ecology Characteristics used to guide assessment of marine benthic ecological value

In keeping with the current EclA guidelines a set of largely qualitative broadscale and fine scale attributes that characterise marine ecological values (for rocky/hard substrate habitats and soft sediment habitats respectively) in New Zealand has been established ranging from Very High to Negligible value estuarine and marine benthic habitats (Tables 1-3). These value assessments can be applied to different marine habitats to help inform a statement of ecological value.

Tables 2 and 3 include fine scale assessment of infauna and epifauna invertebrates, macroalgae, sediment grain size and oxygenation, sediment contaminants, sedimentation rate, water quality, marine vegetation, invasive species, habitat modification and threat status of marine species. Typically, while not all attributes assessed for a habitat type are contained within one level of ecological value in the tables, the approach used for terrestrial EclA (Table 6 of the 2018 EIANZ Guidelines) could be used. The reasons for both the selection and the exclusion of the broadscale or fine scale ecological attributes/characteristics should be agreed with relevant stakeholders prior to any assessment and be set out early in the assessment of effects (e.g., methods section).

We suggest a broad scale assessment of ecological value of the site could be undertaken initially, depending on the project scale and complexity (Table 1), to guide marine assessments, followed by a fine scale assessment (Tables 2 and 3) for detailed marine assessments.

The fine scale tables have been applied to assessments and have broadened over time to include the attributes listed above. Furthermore, earlier versions of the marine ecological values assessment have been used in resource consents and Notice of Requirement applications under the RMA with outcomes accepted by decision makers at Council Hearings, Environment Court and Boards of Enquiry (see Box 1 below).

The ecologist should use their own expertise and experience to determine overall ecological value based on a balance of value attributes.

³ Information required in an application for resource consent

Table 2: Qualitative and quantitative fine scale attributes for assigning ecological values for rocky/hardshore benthic habitats

ECOLOGICAL VALUE	ATTRIBUTE	VERY HIGH TO NEGLIGIBLE
VERY HIGH	Rocky/artificial substrate abundant, providing very high topographic complexity	
	Very low sediment cover on rocky substrate	
	Very high diversity and abundance of sessile benthic organisms for the habitat type	
	Very high diversity and abundance of mobile macroinvertebrates for the habitat type	
	Sessile and mobile benthic organisms comprise many sensitive taxa. Invasive, opportunistic and/or disturbance tolerant species largely absent or low abundance.	
	Biogenic habitat formations (e.g., perennial algal canopies, shellfish aggregations) have very large spatial extent and very low patchiness	
	Very high diversity and abundance of fish ⁴ for the habitat type	
	Threatened or At Risk marine species ² present and may be abundant	
	Large areas of threatened ecosystem type present	
	Habitat unmodified	
	Water quality contaminant concentrations typically at or better than ANZG 99% species protection level and/or scored as 'Excellent' on a recognised Water Quality Index (WQI).	
HIGH	Rocky/artificial substrate abundant, providing high topographic complexity	
	Low sediment cover on rocky substrate	
	High diversity and abundance of sessile benthic organisms for the habitat type	
	High diversity and abundance of mobile macroinvertebrates for the habitat type	
	Sessile and mobile benthic organisms comprise many sensitive taxa. Invasive, opportunistic and/or disturbance tolerant species largely absent	
	Biogenic habitat formations (e.g., perennial algal canopies, shellfish aggregations) have large spatial extent and low patchiness	
	High diversity and abundance of fish for the habitat type	
	Threatened or At Risk marine species ² present	
	Threatened ecosystem type present	
	Limited habitat modification	
	Water column contaminant concentrations typically between ANZWQG 95% and 99% species protection levels and/or scored as 'Good' on a recognised WQI	
MODERATE	Rocky/artificial substrate provides moderate topographic complexity	
	Moderate sediment cover on rocky substrate	
	Moderate diversity and abundance of sessile benthic organisms for the habitat type	
	Moderate diversity and abundance of mobile macroinvertebrates for the habitat type	
	Sessile and mobile benthic organisms comprise both tolerant and sensitive taxa	
	Biogenic habitat formations (e.g., perennial algal canopies, shellfish aggregations) have moderate spatial extent and moderate patchiness	
	Moderate diversity and abundance of fish for the habitat type	
	Few Threatened or At Risk marine species ² present	
	Few Threatened ecosystems present	

⁴ Species of fish and other large fauna can be separated into individual values assessment, depending on the scale of the activity and the species present.

	Moderate habitat modification	
	Water column contaminant concentrations typically between ANZWQG 90% and 95% species protection levels and/or scored as 'Fair' on a recognised WQI	
LOW	Rocky/artificial substrate provides limited topographic complexity	
	High sediment cover on rocky substrate	
	Low diversity and abundance of sessile benthic organisms for the habitat type, but high cover of opportunistic macroalgae possible	
	Low diversity and abundance of mobile macroinvertebrates for the habitat type	
	Sessile and mobile benthic organisms comprise mostly invasive, opportunistic and disturbance-tolerant taxa, with very few sensitive taxa present	
	Biogenic habitat formations (e.g., perennial algal canopies, shellfish aggregations) absent, but biogenic habitat formers may be present in low abundance	
	Low diversity and abundance of fish for the habitat type	
	No Threatened or At Risk marine ² species present	
	No Threatened ecosystem type present	
	High habitat modification	
	Water column contaminant concentrations typically between ANZWQG 80% and 90% species protection levels and/or scored as 'Marginal' on a recognised WQI	
NEGLIGIBLE	Rocky/artificial substrate sparse, providing limited topographic complexity	
	Rocky substrate smothered by sediment	
	Very low diversity and abundance of sessile benthic organisms for the habitat type	
	Very low diversity and abundance of mobile macroinvertebrates for the habitat type	
	Sessile and mobile benthic organisms comprise only invasive, opportunistic and disturbance-tolerant taxa, with no sensitive taxa present	
	Biogenic habitat formations (e.g., perennial algal canopies, shellfish aggregations) absent	
	Very low diversity and abundance of fish for the habitat type ⁵	
	No Threatened or At Risk marine species ⁶ present	
	No Threatened ecosystem ⁷ type present	
	Very High habitat modification	
	Water column contaminant concentrations typically at or worse than ANZWQG 80% species protection levels and/or scored as 'Poor' on a recognised WQI	

⁵ Species of fish and other large fauna can be separated into individual values assessment, depending on the scale of the activity and the species present.

⁶ Marine mammals and coastal birds have been excluded as a characteristic of marine habitats as separate specialist experts in marine mammals and coastal birds should be engaged. Marine mammals and coastal birds can form part of the characteristics around presence of 'Threatened' or 'At Risk' species when supported by a relevant expert.

⁷ As per (Holdaway et al., 2012) for this parameter in all levels of ecological value.

Table 3: Qualitative and quantitative fine scale attributes for assigning ecological values for soft sediment benthic habitats⁸

ECOLOGICAL VALUE	ATTRIBUTE	VERY HIGH TO NEGLIGIBLE
VERY HIGH	Benthic invertebrate community typically has very high diversity, species richness and abundance for the habitat type	
	Benthic invertebrate community is dominated by taxa that are sensitive to organic enrichment, contaminants and mud e.g. rated as 'Excellent' using the Auckland Council (AC) or National Benthic Health Model (BHM) ⁹ or similar index	
	Invasive opportunistic and disturbance tolerant species absent ¹⁰	
	Marine sediments typically comprise < 20% silt and clay grain sizes ¹¹ (mud) or rated as 'Excellent' using the AC BHMmud or similar index	
	Surface sediment oxygenated to >5 cm depth ¹² with no anoxic sediment present	
	Annual average sedimentation rates typically less than 1 mm above background levels ¹³	
	Contaminant concentrations in surface sediment significantly below DGV and AC ERC-Orange effects threshold concentrations ¹⁴ .	
	Contaminant concentrations in shellfish at or below natural background levels or not above conservative laboratory detection limits	
	Water column contaminant concentrations typically at or better than ANZWQG 99% species protection level and/or scored as 'Excellent' on a recognised Water Quality Index (WQI) ¹⁵	
	Fish community typically has very high diversity, species richness and abundance ¹⁶	
	Native estuarine vegetation or macroalgae community intact and provides significant habitat for native fauna	
HIGH	Benthic invertebrate community typically has high diversity, species richness and abundance for the habitat type	
	Benthic invertebrate community contains many taxa that are sensitive to organic enrichment, contaminants and mud. E.g. rated as 'Good' using the AC or National BHM or similar index	
	Invasive opportunistic and/or disturbance tolerant species largely absent	
	Marine sediments typically comprise <40% silt and clay grain sizes or rated as 'Good' using the AC BHMmud or a similar index	
	Surface sediment oxygenated up to 5cm depth	
	Annual average sedimentation rates typically less than 2 mm above background levels	
	Contaminant concentrations in surface sediment rarely exceed DGV	

⁸ Methodologies and considerations for measuring a number of these attributes can be found within the "National Estuary Monitoring Protocol" and "Managing Upstream" project reports. Go to <https://environment.govt.nz/publications/> to search for the latest versions.

⁹ Hewitt, J E., Lohrer, A M and Townsend, M (2012). Health of estuarine soft-sediment habitats: continued testing and refinement of state of the environment indicators. Prepared by NIWA for Auckland Council. Auckland Council technical report, TR2012/012

¹⁰ <https://www.marinebiosecurity.org.nz/>

¹¹ Silt and clay percentage of sediment adjusted to be consistent with BHMud Model

¹² Robertson, B.M, Stevens, L., Robertson, B., Zeldis, J., Green, M., Madarasz-Smith, A., Plew, D., Storey, R., Oliver, M. 2016. NZ Estuary Trophic Index Screening Tool 2. Determining Monitoring Indicators and Assessing Estuary Trophic State. Prepared for Envirolink Tools Project: Estuarine Trophic Index, MBIE/NIWA Contract No: C01X1420. 68p.

¹³ Townsend and Lohrer (2015). ANZECC Guidance for Estuary Sedimentation. Prepared for Ministry for the Environment by NIWA

¹⁴ ANZG (2018) Default Guideline Value concentrations, or Auckland Council's Environmental Response Criteria contaminant threshold concentrations (Auckland Regional Council TP168, 2004)

¹⁵ E.g., Ingley, R (2021). Coastal and estuarine water quality state and trends in Tāmaki Makaurau / Auckland 2010-2019. State of the environment reporting. Auckland Council technical report, TR2021/02.

¹⁶ <https://www.mpi.govt.nz/legal/legislation-standards-and-reviews/fisheries-legislation/maps-of-nz-fisheries/>

	concentrations and AC ERC-Orange effects threshold concentrations.	
	Where shellfish are present, flesh has contaminant concentrations close to natural background levels or not above conservative laboratory detection limits	
	Water column contaminant concentrations typically between ANZWQG 95% and 99% species protection levels and/or scored as 'Good' on a recognised WQI	
	Fish community typically has high diversity, species richness and abundance	
	Native estuarine vegetation or macroalgae community dominated by native species and provides high quality habitat for native fauna	
	Nuisance phytoplankton or macroalgal blooms may occur infrequently at a limited spatial scale	
	Threatened or At Risk marine species present	
	Threatened ecosystem types present	
	Physical habitat largely unmodified	
MODERATE	Benthic invertebrate community typically has moderate species richness, diversity and abundance for the habitat type	
	Benthic invertebrate community has taxa both tolerant and sensitive to organic enrichment, contaminants and mud present E.g. rated as 'Fair' using the AC or National BHM or similar index	
	Few invasive opportunistic and/or disturbance tolerant species present	
	Marine sediments typically comprise less than <60% silt and clay grain sizes or rated as 'Fair' using the AC BHMmud or similar index	
	Shallow depth of oxygenated surface sediment to 1-2 cm depth	
	Annual average sedimentation rates typically less than 5 mm above background levels	
	Contaminant concentrations in surface sediment generally below DGV and AC ERC-Red effects threshold concentrations ¹⁷	
	Where shellfish are present, flesh has low to moderate contaminant concentrations present compared to natural background levels	
	Water column contaminant concentrations typically between ANZWQG 90% and 95% species protection levels and/or scored as 'Fair' on a recognised WQI	
	Fish community typically has moderate species richness, diversity and abundance	
	Native estuarine vegetation and macroalgae community dominated by native species and provides moderate habitat for native fauna	
	Nuisance phytoplankton or macroalgal blooms may occur sporadically over a moderate spatial scale	
	Few Threatened or At Risk marine species present	
	Few Threatened ecosystems present	
	Physical habitat moderately modified	
LOW	Benthic invertebrate community degraded with low species richness, diversity and abundance for the habitat type	
	Benthic invertebrate community dominated by organic enrichment tolerant, contaminant tolerant and mud tolerant organisms with few/no sensitive taxa present e.g. rated as 'Marginal' using the AC or National BHM or similar index	
	Invasive, opportunistic and/or disturbance-tolerant species dominant	
	Marine sediments dominated by silt and clay grain sizes (>60%) or rated as 'Marginal' using the AC BHMmud or similar index	
	Surface sediment predominantly anoxic (lacking oxygen)	
	Annual average sedimentation rates typically less than 10 mm above background levels	

¹⁷ Auckland Council's Environmental Response Criteria contaminant threshold concentrations (Auckland Regional Council TP168, 2004).

	Elevated contaminant concentrations in surface sediment, between ANZG Default Guideline Values (DGV) and GV-High effects threshold concentrations	
	Where shellfish are present, flesh has moderate contaminant concentrations present compared to natural background levels	
	Water column contaminant concentrations typically between ANZWQG 80% and 90% species protection levels and/or scored as 'Marginal' on a recognised WQI	
	Fish community depleted with low species richness, diversity and abundance	
	Native estuarine vegetation and/or macroalgae community provides minimal/limited habitat for native fauna.	
	Nuisance phytoplankton or macroalgal blooms may occur commonly over a moderate scale	
	No Threatened or At Risk marine species present	
	No Threatened ecosystem present	
NEGLECTIBLE	Physical habitat highly modified	
	Benthic invertebrate community dominated by organic enrichment tolerant, contaminant tolerant, and mud tolerant organisms with no sensitive taxa present. E.g. rated as 'Poor' using the Auckland Council or National ¹⁸ Benthic Health Models or similar indices	
	Invasive, opportunistic and disturbance tolerant species highly dominant	
	Marine sediments dominated by silt and clay grain sizes (>80%) or rated as 'Poor' using a BHMmud or similar index	
	Surface sediment anoxic (lacking oxygen)	
	Annual average sedimentation rates typically greater than 10 mm above background levels	
	Elevated contaminant concentrations in surface sediment, above ANZG Guideline Values – High (GV-High) effects threshold concentrations ¹⁹	
	Where shellfish are present, flesh has moderate-high contaminant concentrations Present compared to natural background levels	
	Water column contaminant concentrations typically at or worse than ANZWQG 80% species protection levels and/or scored as 'Poor' on a recognised WQI	
	Fish community depleted with very low species richness, diversity and abundance ²⁰	
	Native estuarine vegetation or macroalgae absent or so sparse as to provide very limited ecological value	
	Nuisance phytoplankton or macroalgal blooms may occur frequently over a large spatial scale	
	No Threatened or At Risk marine species present ²¹	
	No Threatened ecosystems present	
	Physical habitat extremely modified	

¹⁸ D.E. Clark, J.E. Hewitt, C.A. Pilditch, J.I. Ellis (2020). The development of a national approach to monitoring estuarine health based on multivariate analysis. Marine Pollution Bulletin, Volume 150.

¹⁹ ANZG (2018) Australian and New Zealand Guidelines for Freshwater and Marine Water Quality (replaced previous ANZECC guidelines)

²⁰ Species of fish and other large fauna can be separated into individual values assessment, depending on the scale of the activity and the species present

²¹ Marine mammals and coastal birds have been excluded as a characteristic of marine habitats as separate specialist experts in marine mammals and coastal birds should be engaged. Marine mammals and coastal birds can form part of the characteristics around presence of 'Threatened' or 'At Risk' species when supported by relevant experts

Examples of use

Earlier versions of the tables of fine scale attributes assigning ecological value to marine benthic habitats (Tables 2 and 3) have been successfully applied to several 'Assessments of Ecological Effects' in New Zealand for a variety of different projects. The examples listed in Box 1 have all been submitted as part of applications for resource consents or Notification of Requirement under the RMA.

BOX 1: Examples of Assessment of Ecological Effects applying ecological values to marine habitats.

Ara Tūhono Pūhoi to Wellsford Road of National Significance (RoNS), Pūhoi to Warkworth section
<https://www.nzta.govt.nz/assets/projects/puhoi-to-warkworth-application/docs/assessment-report-marine.pdf>

Transmission Gully Project
<https://www.nzta.govt.nz/assets/projects/transmission-gully-application/docs/technical-report-10.pdf>

Mackay's to Peka Peka Expressway
<https://www.nzta.govt.nz/assets/projects/mackays-to-peka-peka-application/docs/technical-report-31.pdf>

Warkworth to Wellsford. Marine Ecology and Coastal Avifauna Assessment
<https://www.nzta.govt.nz/assets/projects/ara-tuhono-warkworth-to-wellsford/marine-ecology-and-coastal-avifauna-assessment.pdf>

East West Link Road
<https://www.nzta.govt.nz/assets/projects/east-west-link-application-to-the-environmental-protection-authority-epa/Technical-Report-16-Ecological-Impact-Assessment-Part-2-of-2-Ch4-6.pdf>

Kaiwharawhara Wellington Ferry Terminal
<https://www.epa.govt.nz/assets/Uploads/Documents/Fast-track-consenting/Kaiwharawhara/Application-documents/Appendix-14-Benthic-Marine-Ecology-Assessment.pdf>

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Authorship

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