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Aotearoa New Zealand Marine Pressure–Biodiversity Matrix Development

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Contents

Executive summary **4**

1 Introduction **5**

2 Methodological approach and outcomes **8**

2.1 Expert workshop 8

2.2 Literature review 9

2.3 Matrix population and scoring 11

3 Next steps and concluding remarks **13**

4 Acknowledgements **14**

5 References **15**

Appendix A Description of Pressures used in the Aotearoa New Zealand Pressure – Biodiversity Matrix **16**

Appendix B Description of Biodiversity features used in the Aotearoa New Zealand Pressure–Biodiversity Matrix **23**

Appendix C Matrix evidence **31**

Tables

Table 2-1: Colour coding of evidence types. 11

Figures

Figure 2-1: Example of the populated Pressure–Biodiversity matrix from the expert workshop. 9

Figure 2-2: Populated Pressure–Biodiversity matrix. 12

Figure 2-3: Evidence table. 12

Executive summary

The Department of Conservation (DOC) is developing a suite of three interlinked matrices designed to strengthen national capability to understand, assess, and manage the impacts of human activities on marine biodiversity (Activity-Pressure matrix; Pressure-Biodiversity matrix; Management-Activity matrix). Together, these matrices will form a transparent, expert informed, evidence-based framework that supports marine spatial planning, regulatory decision-making, biodiversity management, and national environmental reporting. DOC previously contracted Earth Sciences New Zealand (ESNZ) to develop an Activity–Pressure matrix, which links human activities with marine pressures. Building on the developed methodology and evidence standards, DOC and regional councils (Environment Canterbury, Bay of Plenty Regional Council) contracted ESNZ to develop a Pressure–Biodiversity matrix, which will form the second tier of the framework and help translate pressures into potential ecological impacts.

DOC, Fisheries New Zealand (FNZ), Ministry for the Environment (MfE) and regional councils collaboratively developed a draft long list of sixty-four biodiversity features for inclusion within the Pressure–Biodiversity matrix, emphasising threatened, protected, naturally rare, important or vulnerable species, habitats and ecosystems of management interest to regional or unitary councils and central government. This phase of work focussed on a prioritised list of thirty-three biodiversity features.

An expert workshop was held to initially populate the matrix, which was used to guide a subsequent literature review to search for supporting evidence of each pressure–biodiversity relationship.

The scoring system developed for the Activity–Pressure matrix was used again for the Pressure–Biodiversity matrix, with scores reflecting the degree of confidence in the supporting evidence for the relationships. Confidence in the relationships was ranked based on the type of supporting evidence (1 highest, 5 lowest), as follows:

1. New Zealand peer-reviewed publications,
2. New Zealand grey literature (council reports, consultant assessments of environmental effects, unpublished theses),
3. published and grey literature from overseas studies,
4. expert opinion (including opinions from the expert workshop for this project), and
5. no evidence found of the pressure-biodiversity relationship.

The Pressure–Biodiversity matrix is presented as a companion file to this report, titled “2026 Pressure-Biodiversity Matrix_v1.xlsx”. The matrix should be treated as a living document and updated as new evidence, revised definitions, and further expert input become available.

1 Introduction

The coastal marine environment is subject to ongoing and changing pressures from a variety of human activities (Halpern et al. 2007; MacDiarmid et al. 2011a; MacDiarmid et al. 2012). However, how these pressures affect different biodiversity features is not well understood. Identifying which pressures impact which marine biodiversity features (species, habitats) is necessary to better target management actions that avoid, minimise or remedy impacts.

The Department of Conservation (DOC) is developing a suite of three interlinked matrices designed to strengthen national capability to understand, assess, and manage the impacts of human activities on marine biodiversity. Together, these matrices will form a transparent, evidence-based framework that supports marine spatial planning, regulatory decision-making, biodiversity management, and national environmental reporting.

This report documents the development of the Pressure–Biodiversity Matrix, the second component of DOC's three-matrix marine pressures framework. Its purpose is to describe the biodiversity features list, development process, evidence approach, and intended use of the matrix as an initial screening and decision-support tool.

DOC previously contracted Earth Sciences New Zealand (ESNZ) to develop the Activity-Pressure matrix which links human activities with marine pressures. The suite of marine pressures was created by DOC by reviewing existing lists of marine activities and pressures from Aotearoa New Zealand and worldwide, including those presented in the Joint Nature Conservation Committee (JNCC) Pressures Activities Database (Robson et al. 2018), the MarHADs tool (MacDiarmid et al. 2011b), and assessments of anthropogenic threats to New Zealand marine habitats (Baird and Wood 2012; MacDiarmid et al. 2012). DOC's review resulted in a categorised list of 65 activities (grouped within 11 activity categories) and 35 pressures and their definitions (Appendix A). The third matrix will link management actions to activities, showing where different interventions can be used to avoid, reduce or remedy the pressures generated by human activities, and helping translate identified risks into practical management responses. A draft long list of biodiversity features (sixty-four) for inclusion within the Pressures-Biodiversity matrix was collaboratively developed by DOC, Fisheries New Zealand (FNZ), Ministry for the Environment (MfE) and regional and unitary councils (Appendix B). The list emphasises threatened, protected, naturally rare, important or vulnerable species, habitats and ecosystems of management interest to regional councils and central government. This phase of work focussed on a prioritised list of 33 biodiversity features, with the remaining biodiversity features to be completed in the next stage of this matrix development.

Building on the developed methodology and evidence standards from the Activity–Pressure matrix, DOC and regional councils (Canterbury Regional Council, Bay of Plenty Regional Council) contracted ESNZ to develop the Pressure–Biodiversity matrix, which forms the second tier of the framework and links pressures to potential ecological impacts.

The finalized marine Pressure–Biodiversity matrix will provide a structured, transparent way to understand how different pressures generated by human activities can impact various biodiversity features of marine ecosystems. By identifying which pressures may affect which biodiversity features, alongside the Activity-Pressure matrix, the Pressure-Biodiversity matrix helps:

- Identify specific pressures that have the potential to impact specific biodiversity features, supporting early recognition of where ecological risk may arise.
- Compare across pressure types, making it easier to prioritise management actions toward pressures that contribute to wider or more significant impacts to marine biodiversity.
- Support spatial planning with the integration of related tools (e.g., Activity–Pressure and Management–Activity matrices), helping translate human activities into potential pressures and ecological impacts on indigenous biodiversity and then into appropriate management responses.

While the matrix is a valuable decision-support tool, several cautions should accompany its use:

- **It reflects potential, not guaranteed, impacts to biodiversity.** A "yes" in the matrix indicates that a pressure could impact the biodiversity feature of interest, but not that it will, in all circumstances, occur.
- **The strength or magnitude of impacts is not assessed.** The matrix identifies presence or absence of a potential pressure–biodiversity relationship but does not describe how intense, frequent, or spatially extensive that impact may be.
- **Evidence varies in quality and completeness.** A substantial proportion of pressure–biodiversity linkages are currently supported by expert judgement alone, highlighting areas where further research is needed and where interpretations should be treated with caution.
- **Precautionary coding may overstate some relationships.** The matrix tends to err on the side of caution—recording "yes" or "maybe" where an impact on a biodiversity feature *could* occur even though it may be unlikely. This supports conservative decision-making but may be misinterpreted if context is not clearly communicated.
- **It is a living document.** The matrix is intended to be updated as definitions evolve, new evidence emerges, and expert workshops refine earlier assessments. Ongoing review is important, especially where pressure definitions change.

When applying the Pressure–Biodiversity matrix, these cautions mean it should be treated as an initial screening tool rather than a direct indicator of ecological risk, and further information is always required to determine whether a pressure is likely to impact a biodiversity feature. The matrix should not be used as a substitute for site-specific assessment, as a direct ranking of ecological risk, or as proof that an effect will occur. The Pressure–Biodiversity matrix is therefore a structured starting point that must be supplemented with contextual pressure and biodiversity data, local environmental information, and biodiversity sensitivity assessments before informing management decisions.

In practice, the Pressure–Biodiversity matrix should be used alongside local environmental and biodiversity information to test whether the screened pressure–biodiversity relationships are likely to be relevant in a particular place.

This includes confirming whether the biodiversity features of interest are known or likely to occur in the area, considering local habitat characteristics and environmental conditions (for example depth, substrate, exposure, salinity, turbidity, and hydrodynamics), and identifying whether the relevant activities and resulting pressures are present at a scale, intensity, frequency, or duration that could plausibly affect those features. Local monitoring data, spatial layers, mātauranga Māori, expert knowledge, and site-specific assessments can all help refine interpretation of the matrix outputs. Used in this way, the matrix provides a transparent first-pass screening step that helps focus attention on plausible pressure–biodiversity interactions, while recognising that further assessment is needed before drawing conclusions about actual risk or management response.

2 Methodological approach and outcomes

The Pressure–Biodiversity matrix is provided as a companion file to this report "2026 Pressure-Biodiversity Matrix_v1.xlsx". This file is divided into the following tabs:

- **Workshop matrix** – results of two expert opinion workshops.
- **Info** – definition of matrix display components.
- **Matrix** – fully populated Pressure–Biodiversity Matrix.
- **Evidence table** – list of references providing evidence for each of the identified pressure-biodiversity relationships (also provided in Appendix C).
- **Evidence table full** – the full matrix evidence table including cell numbers without literature evidence. This table should be retained to facilitate the addition of future evidence.

2.1 Expert workshop

An online workshop was held on 30 March 2026 to determine whether each pressure was anticipated to be associated with each of the 33 prioritised biodiversity features. Decisions were based on the expert opinion and knowledge of the workshop participants (ESNZ: Emily Douglas, Drew Lohrer; DOC: Shane Geange, Jordi Tablada, Debbie Freeman; FNZ: Hannah Mello, Karen Tunley, Jean Davis; MfE: Pierre Tellier; Otago Regional Council: Sam Thomas; Canterbury Regional Council: Melanie Burns; University of Auckland: Judi Hewitt) (Figure 2-1).

	SEA Management Classes		Subtidal benthic invertebrates						Intertidal benthic invertebrates				
	Biodiversity Group	Benthic Invertebrate											
Pressure Category	Pressures \ Biodiversity Features	Spiny Rock Lobster	Attached tunicates	Erect soft sediment inverts	Heart urchin plain	Mobile rocky invertebrate communities	Soft sediment burrow communities	Soft sediment whelks assoc.	Cockle bed	Dog cockle beds	Mud crab bed	Surf clam bed	Wedge shell bed
	Nutrient enrichment												
	Organic enrichment		y	y		y	y	y	y	y	y	y	y
	Radionuclide contamination		y	y		y	y	y	y	y	y	y	y
Physical loss	Physical loss (to land or freshwater habitat)		y	y		y	y	y	y	y	y	y	y
	Physical change (to another seabed type)		y	y		y	y	y	y	y	y	y	y
Physical damage	Temporary and/or reversible change of habitat structure (extraction)		y	y		y	y	y	y	y	y	y	y
	Disturbance of the surface of the seabed		y	y		y	sd	y	y	y	y	y	y
	Penetration and/or disturbance of the substrate below the surface of the		n	y		n	sd	y	y	y	y	y	y
	Changes in suspended solids		y	y		y	y	y	y	y	y	y	y
	Siltation rate changes		y	y		y	y	y	y	y	y	y	y
Other physical pressures	Litter		y	y		y	y	y	y	y	y	y	y
	Electromagnetic changes		n	n		n	sd	n	n	n	y	n	n
	Underwater noise changes		n	n		y	y	y	y	y	y	y	y
	Introduction of light		y	y		y	y	y	y	y	y	y	y

Figure 2-1: Example of the populated Pressure–Biodiversity matrix from the expert workshop.

2.2 Literature review

Evidence for identified pressure–biodiversity relationships was compiled through targeted Google searches of key words, searches of publications produced by key New Zealand experts for each biodiversity feature, as well as collated publications and studies known to the author. Searches were conducted for each biodiversity feature by first starting with broad search phrases, e.g., 'effects of [pressure] on [biodiversity feature]'. When needed, the words 'in New Zealand' or '[species name]' were added to search terms to specifically target New Zealand or species-specific literature. For biodiversity features which include multiple species (e.g., Ceriantheid beds), genus names of representative New Zealand species were used to find local and international literature. The reference sections of relevant publications were also reviewed to identify further relevant evidence.

A suite of 'business rules' were developed for determining when a pressure–biodiversity relationship should be represented in the Pressure–Biodiversity matrix. These rules were intended to ensure the matrix captured meaningful, management-relevant interactions between pressures and biodiversity features while balancing precaution, likelihood, and consequence in support of decision-making.

Rule 1: There needs to be a clear, direct link.

In order for a pressure–biodiversity relationship to be recorded as a 'yes', there must be a clear and direct line between the two. In other words, there should be a simple plausible explanation for how the pressure could cause a change in the biodiversity feature, without relying on long chains of assumptions. This helps keep the matrix focused on plausible and management-relevant relationships that people can understand and trust.

Rule 2: It needs to be reasonably likely to happen.

A pressure–biodiversity relationship was included if the pressure is reasonably likely to interact with the biodiversity feature under normal, realistic conditions, without depending on very unusual or extreme situations. This helps keep the matrix grounded in management-relevant interactions.

Rule 3: It needs to be able to make a difference.

A pressure–biodiversity relationship was included if the pressure could realistically lead to biologically meaningful change. For example, the pressure might affect survival, health, behaviour, habitat quality, or ecosystem functioning. The matrix is intended to identify relationships where a pressure could plausibly have a meaningful biological or ecological effect.

Rule 4: Be cautious when consequences could be serious.

Where a pressure is unlikely to occur and affect a particular biodiversity feature, but if it did occur the consequences could be serious, long-lasting, or hard to reverse; the relationship was included in the matrix as long as the direct links between pressures and biodiversity features makes sense biologically/ecologically. This is intended as a precautionary decision rule.

Decision-logic:

1. Is there a plausible direct mechanism by which this pressure could affect this biodiversity feature?
2. Is the interaction reasonably likely under realistic 'normal' conditions?
3. Could the consequences be biologically or ecologically meaningful?
4. Would exclusion risk under-representing serious, long-lasting or irreversible outcomes?

If "yes" to most → include
If "no" due to implausibility or triviality → exclude

2.3 Matrix population and scoring

The matrix consists of a table enabling visual demonstration of which pressures impact each biodiversity feature and the evidence-based confidence in each relationship (Figure 2-2). The matrix can be read horizontally to observe the biodiversity features impacted by each pressure, or vertically to identify which pressures impact a biodiversity feature of interest.

The matrix was colour-coded according to the evidence type available to support each pressure–biodiversity relationship, as outlined in Table 2-1. Pressure–biodiversity relationships that were found during the literature search, but not identified by experts during the workshop, were subsequently added to the matrix.

Table 2-1: Colour coding of evidence types.

Identifier	Evidence type
1	New Zealand published literature
2	New Zealand grey literature (council reports, consultant assessments of environmental effects etc.)
3	International published and grey literature
4	Expert opinion. i.e., workshop identified a potential stressor impact, but no evidence was found.
-	No known relationship

Matrix cells contain numbers linking to the 'Evidence table' which consists of a list of references that provide evidence of each pressure–biodiversity relationship, and the evidence type (Figure 2-3). In the 'Evidence table', references and evidence types are listed horizontally for each pressure, and a 'Best' evidence column indicates the highest evidence type of those included for each pressure (i.e., a mixture of evidence types is common). Up to six references were included for each relationship, although only one or two were available for some. Where a relationship was identified during the expert workshop, but no additional evidence was found during the literature search, it was scored as 'expert opinion'. The order of references listed from one to six was random and did not indicate relative strength.

SEA Management Classes			Subtidal benthic invertebrates						Intertidal benthic invertebrates				
	Biodiversity Group	Benthic Invertebrates											
Pressure Category	Biodiversity Features / Pressures	Spiny Rock Lobster	Attached tunicates	Erect soft sediment inverts	Heart urchin plain	Mobile rocky invertebrate communities	Soft sediment burrow communities	Soft sediment whelks assoc.	Cockle bed	Dog cockle beds	Mud crab bed	Surf clam bed	Wedge shell bed
Hydrological changes (inshore/local)	Temperature changes - local	1	2	3	4	5	6	7	8	9	10	11	12
	Salinity changes - local*	65	66	67	68	69	70	71	72	73	74	75	76
	Water flow (e.g., tidal current) changes - local	129	130	131	132	133	134	135	136	137	138	139	140
	Emergence regime changes - local	193	194	195	196	197	198	199	200	201	202	203	204
	Oxygen changes	257	258	259	260	261	262	263	264	265	266	267	268
	pH changes	321	322	323	324	325	326	327	328	329	330	331	332
	Wave exposure changes - local	385	386	387	388	389	390	391	392	393	394	395	396
Pollution and other chemical changes	Non-synthetic compound contamination - Transition elements & organo-metals	449	450	451	452	453	454	455	456	457	458	459	460
	Non-synthetic compound contamination - Hydrocarbon & PAH Contamination	513	514	515	516	517	518	519	520	521	522	523	524
	Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	577	578	579	580	581	582	583	584	585	586	587	588
	De-oxygenation	641	642	643	644	645	646	647	648	649	650	651	652

Figure 2-2: Populated Pressure–Biodiversity matrix. Excerpt from matrix showing colour-coded cells with reference numbers corresponding to the evidence table.

SEA Management Classes	Biodiversity feature	Pressure	Matrix cell identifie	Best	Ref 1 Evidence type identifie	Ref 1	Ref 2 Evidence type identifie	Ref 2
Subtidal benthic invertebrates	Attached tunicates	Temperature changes - local	2	3	3	Kang, C.-K.,		
Subtidal benthic invertebrates	Mobile rocky invertebrate	Temperature changes - local	5	1	1	Shellem, C.	1	Schiel, D.R.
Intertidal benthic invertebrates	Cockle bed	Temperature changes - local	8	1	1	Salmond, N	1	Tricklebank
Intertidal benthic invertebrates	Wedge shell bed	Temperature changes - local	12	3	3	Liu, C., Shar		
Biogenic habitats	Horse mussel bed	Temperature changes - local	18	3	3	Liu, C., Shar		
Biogenic habitats	Mussel bed	Temperature changes - local	22	1	3	Liu, C., Shar	1	Benjamin, E
Biogenic habitats	Oyster reef	Temperature changes - local	23	3	3	Rybovich, M	3	Liu, C., Shar
Biogenic habitats	Pāua Bed (Blackfoot Abalo	Temperature changes - local	24	1	1	Cummings,		
Biogenic habitats	Rhodolith bed	Temperature changes - local	26	2	2	Nelson, W.,		
Biogenic habitats	Scallop bed	Temperature changes - local	27	3	3	Liu, C., Shar		
Estauries/Coastal Lagoons/Wetlan	Mangrove Forests	Temperature changes - local	39	1	3	Hagger, V.,	1	Morrisey, D
Estauries/Coastal Lagoons/Wetlan	Seagrass Meadows	Temperature changes - local	41	3	3	Winters, G.	3	York, P.H., C
Kelp forest	Bull kelp forest	Temperature changes - local	57	1	1	Thomsen, M	1	Alestra, T.,
Kelp forest	Ecklonia forest	Temperature changes - local	58	1	3	Liu, C., Shar	1	Stenton-Do
Kelp forest	Macrocystis forest (Macro	Temperature changes - local	59	1	2	Le, D.M. (20	1	Tait, L.W., T
Kelp forest	Mixed brown algae	Temperature changes - local	60	1	1	Tait, L.W., S	1	Alestra, T.,
Marine Flora	Red algae meadow	Temperature changes - local	64	1	1	Schiel, D.R.		
Subtidal benthic invertebrates	Attached tunicates	Salinity changes - local*	66	3	3	Montory, J.		
Subtidal benthic invertebrates	Mobile rocky invertebrate	Salinity changes - local*	69	1	1	Shellem, C.		
Intertidal benthic invertebrates	Cockle bed	Salinity changes - local*	72	1	1	Adkins, S.C.	1	Tallis, H., W
Intertidal benthic invertebrates	Dog cockle beds	Salinity changes - local*	73	3	3	Liu, C., Shar		
Intertidal benthic invertebrates	Surf clam bed	Salinity changes - local*	75	1	3	Manríquez,	3	Dai, Y., Don
Biogenic habitats	Bryozoan thickets	Salinity changes - local*	79	3	3	Cocito, S., M		
Biogenic habitats	Horse mussel bed	Salinity changes - local*	82	3	3	Kurihara, T	3	Liu, C., Shar
Biogenic habitats	Mussel bed	Salinity changes - local*	86	2	3	Liu, C., Shar	3	Carrier-Bel
Biogenic habitats	Oyster reef	Salinity changes - local*	87	3	3	Rybovich, M	3	Liu, C., Shar
Biogenic habitats	Scallop bed	Salinity changes - local*	91	3	3	Liu, C., Shar	3	Navarro, J.M

Figure 2-3: Evidence table. Excerpt from reference information illustrating ranking of each evidence type. Best column indicates the best evidence type and corresponds to the colours in the table.

3 Next steps and concluding remarks

A second project phase will complete the remaining 31 biodiversity features in the matrix using the same methodology. The completed Pressure–Biodiversity matrix will complement the existing Activity–Pressure matrix and the Management–Activity matrix (to be developed), together providing a coherent toolset to support marine spatial planning in Aotearoa New Zealand. Because research and knowledge about impacts in Aotearoa New Zealand's marine environment are continually developing, the matrix should be regarded and maintained as a living document.

4 Acknowledgements

We thank Shane Geange (Department of Conservation), Melanie Burns (Canterbury Regional Council) and Karen Tunley (FNZ) for their guidance on this project and contribution to the expert workshop. We also thank Drew Lohrer (ESNZ), Jordi Tablada, Debbie Freeman (DOC), Hannah Mello, Jean Davis (FNZ), Pierre Tellier (MfE), Sam Thomas (Otago Regional Council) and Judi Hewitt (University of Auckland) for their contribution to the expert workshop. We thank Drew Lohrer, Josie Crawshaw, Shane Geange and Melanie Burns for comments on a draft of this report.

5 References

Baird, S., Wood, B. (2012) Extent of coverage of 15 environmental classes within the New Zealand EEZ by commercial trawling with seafloor contact. *New Zealand Aquatic Environment and Biodiversity Report*, No. 89: 43.

Halpern, B.S., Selkoe, K.A., Micheli, F., Kappel, C.V. (2007) Evaluating and Ranking the Vulnerability of Global Marine Ecosystems to Anthropogenic Threats. *Conservation Biology*, 21(5): 1301–1315. https://doi.org/10.1111/j.1523-1739.2007.00752.x

MacDiarmid, A., Beaumont, J., Bostock, H., Bowden, D., Clark, M., Hadfield, M., Heath, P., Lamarche, G., Nodder, S., Orpin, A., Stevens, C., Thompson, D., Torres, L., Wysoczansk, R. (2011a) Expert Risk Assessment of Activities in the New Zealand Exclusive Economic Zone and Extended Continental Shelf. *NIWA Client Report* WLG2011-39: 140. https://environment.govt.nz/assets/publications/Files/niwa-risk-assessment-2012.pdf

MacDiarmid, A., McKenzie, A., Sturman, J., Beaumont, J., Mikaloff-Fletcher, S., Dunne, J. (2012) Assessment of anthropogenic threats to New Zealand marine habitats. *New Zealand Aquatic Environment and Biodiversity Report*, No. 93: 255.

MacDiarmid, A., Taylor, P., Carbines, M., Hewitt, J., Bolton-Ritchie, L., Maharadz-Smith, A., Townsend, M., Thrush, S., Walker, J. (2011b) Marine Habitat Assessment Decision Support (MarHADS) Tool: Background and Operating Instructions. *NIWA Client Report* ELF09240 25.

Robson, L., Fincham, J., Peckett, F., Frost, N., Jackson, C., Carter, A., Matear, L. (2018) UK Marine Pressures-Activities Database “PAD”: Methods Report. *JNCC Report*, No. 624.

Appendix A Description of Pressures used in the Aotearoa New Zealand Pressure – Biodiversity Matrix

Category Title	Pressure Title	Pressure Description
Local hydrological changes (within a specific, often geographically limited, area)	Temperature changes - local	Events or activities that change local water temperature, like thermal discharges from power stations or temperature changes in the vicinity of subsea power cables, can affect the area around the source. This does not include regional temperature changes from global warming.
	Salinity changes - local	Events or activities increasing or decreasing local salinity. This includes freshwater discharges from pipelines that reduce salinity; hydro-morphological modification (e.g., navigational dredging) if this alters the halocline, or erection of barrages or weirs that alter freshwater/seawater flow/exchange rates.
	Water flow (e.g., tidal current) changes - local	Changes in water movement associated with tidal streams (the rise and fall of the tide, riverine flows), prevailing winds and ocean currents. The pressure is associated with activities that have the potential to modify hydrological energy flows. For example, tidal energy generation devices remove (convert) energy, and such pressures could be manifested leeward of the device; dredging may deepen and widen a channel and therefore decrease the water flow; canalisation &/or structures may alter flow speed and direction; managed realignment (e.g., seawalls) can alter tidal streams.
	Emergence regime changes - local	Events or activities that change how long and how often intertidal species are underwater or exposed during tides. For example, beach re-profiling could change gradients and therefore exposure times, dredging may change the natural tidal range, managed realignment or reclamation in estuaries can reduce the intertidal area. This excludes pressure from sea level rise.
	Oxygen changes	Changes in the oxygen levels in seawater, including marine deoxygenation (decreases in oxygen levels). Anthropogenic-induced marine deoxygenation can result from excessive organic matter and nutrients (like nitrogen and phosphorous) into the marine environment (e.g., from agricultural runoff and wastewater). Excessive nutrients can lead to algal blooms which consume oxygen when they decompose. Excessive organic matter is consumed by aerobic microorganisms which can cause deoxygenation.
	pH changes	Activities that result in changes in the pH of marine waters. This includes the run-off of nitrogen-based fertilizers, which can indirectly affect pH levels through processes like eutrophication, and the discharge of untreated or partially treated wastewater into the ocean, which can introduce various chemicals that alter the pH of marine waters.

Category Title	Pressure Title	Pressure Description
	Wave exposure changes - local	Local changes in length, height and frequency of waves. Exposure on an open shore is dependent upon the distance of open seawater over which wind may blow to generate waves (the fetch) and the strength and incidence of winds. Anthropogenic sources of this pressure include artificial reefs, structures such as piers, jetties, breakwaters, and barrages, and wrecks that can directly influence wave action or activities that may locally affect the incidence of winds, e.g., a dense network of wind turbines may have the potential to influence wave exposure, depending upon their location relative to the coastline.
Pollution and other chemical changes	Non-synthetic compound contamination - Transition elements & organo-metals	The increase in the levels of transition elements compared with background concentrations, due to their input from land/riverine sources, by air or directly at sea. For marine environments the main elements of concern are Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Zinc and Organo-metallic compounds such as the butyl tins (Tri butyl tin and its derivatives). These can be highly persistent and chronic exposure to low levels has adverse biological effects (e.g., imposex in molluscs).
	Non-synthetic compound contamination - Hydrocarbon & PAH contamination	Increases in the levels of these compounds compared with background concentrations. Naturally occurring compounds, complex mixtures of two basic molecular structures: straight chained aliphatic hydrocarbons (relatively low toxicity and susceptible to degradation) and multiple ringed aromatic hydrocarbons (higher toxicity and more resistant to degradation). These fall into three categories based on source (includes both aliphatics and polyaromatic hydrocarbons): petroleum hydrocarbons (from natural seeps, oil spills and surface water run-off), pyrogenic hydrocarbons (from combustion of coal, woods and petroleum) and biogenic hydrocarbons (from plants & animals). Ecological consequences include tainting, some are acutely toxic, and can cause carcinomas and growth defects.
	Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	Increases in the levels of these compounds compared with background concentrations. Synthesised from a variety of industrial processes and commercial applications. Chlorinated compounds, which include polychlorinated biphenols (PCBs), dichlor-diphenyl-trichloroethane (DDT) & 2,3,7,8-tetrachlorodibenzo(p)dioxin (2,3,7,8- TCDD), are persistent and often very toxic. Pesticides vary greatly in structure, composition, environmental persistence and toxicity to non-target organisms. Includes insecticides, herbicides, rodenticides & fungicides. Pharmaceuticals and Personal Care Products originate from veterinary and human applications compiling a variety of products, including over the counter medications, fungicides, chemotherapy drugs and animal therapeutics, such as growth hormones. Due to their biologically active nature, high levels of consumption, known combined effects, and their detection in most aquatic environments they have become an emerging concern. Ecological consequences

Category Title	Pressure Title	Pressure Description
		include physiological changes (e.g., growth defects, carcinomas).
	De-oxygenation	Any deoxygenation that is not directly associated with nutrient or organic enrichment. The lowering, temporarily or more permanently, of oxygen levels in the water or substrate due to anthropogenic causes (some areas may naturally be deoxygenated due to stagnation of water masses, e.g., inner basins of fjords). This is typically associated with nutrient and organic enrichment, but it can also derive from the release of ballast water or other stagnant waters (where organic or nutrient enrichment may be absent). Ballast waters may be deliberately deoxygenated via treatment with inert gases to kill non-indigenous species.
	Nutrient enrichment	Increased levels of nitrogen, phosphorus, silicon (and iron) in the marine environment compared to background concentrations. Nutrients can enter marine waters by natural processes (e.g., decomposition of detritus, riverine, direct and atmospheric inputs) or anthropogenic sources (e.g., wastewater runoff, terrestrial/agricultural runoff, sewage discharges, industrial discharges, aquaculture, atmospheric deposition). Nutrients can also enter marine regions from ‘upstream’ locations, e.g., via tidal currents to induce enrichment in the receiving area. Nutrient enrichment may lead to eutrophication (see also organic enrichment). Adverse environmental effects include deoxygenation, algal blooms, changes in community structure of benthos and macrophytes.
	Organic enrichment	Resulting from the degraded remains of dead biota & microbiota (land & sea), faecal matter from marine animals, flocculated colloidal organic matter and the degraded remains of sewage material, domestic wastes, industrial wastes etc. Organic matter can enter marine waters from sewage discharges, aquaculture or terrestrial/agricultural runoff. Black carbon comes from the products of incomplete combustion (PIC) of fossil fuels and vegetation. Organic enrichment may lead to eutrophication (see also nutrient enrichment). Adverse environmental effects include deoxygenation, algal blooms, changes in community structure of benthos and macrophytes.
	Radionuclide contamination	Introduction of radionuclide material, raising levels above background concentrations. Such materials can come from land or sea -based operations (e.g., oil platforms, medical sources) and historical disposal of radioactive waste from contaminated medical equipment and radium at sea.
Physical loss (permanent change)	Physical loss to land or freshwater habitat	The permanent loss of marine habitats. Activities that claim part of the coastal marine environment, e.g. new coastal defences that encroach on and move the Mean High Water Springs mark seawards, dredging if it alters the position of the halocline. This excludes changes from one marine habitat type to another marine habitat type.

Category Title	Pressure Title	Pressure Description
	Physical change to another seabed type	The permanent change of one marine habitat type to another marine habitat type, through the change in substratum, including to artificial (e.g., concrete). Activities include the installation of infrastructure (e.g., surface of platforms or wind farm foundations, marinas, coastal defences, pipelines and cables), the placement of scour protection where soft sediment habitats are replaced by hard/coarse substrate habitats, removal of coarse substrate (marine mineral extraction) and dredging where the residual habitat differs structurally from the activity state, creation of artificial reefs, mariculture, the protection of pipes and cables using rock dumping and mattressing techniques, placement of cuttings and piles from oil & gas activities. This pressure excludes dredging where the depth of sediment is changed locally but the sediment typology is not changed.
Physical damage (reversible change)	Temporary and/or reversible change of habitat structure (extraction)	Temporary and/or reversible change of habitat structure through extraction, e.g., from marine mineral extraction where a proportion of seabed sands or gravels are removed but a residual layer of seabed is similar to the pre-dredge structure and as such biological communities could re-colonise; or navigational dredging to maintain channels where the silts or sands removed are replaced by non-anthropogenic mechanisms so the sediment typology is not changed. Includes disturbance to foreshore, beach or dune habitats.
	Disturbance of the surface of the seabed, including abrasion	The disruption or alteration of the seabed's top layer due to various activities. This can be caused by natural processes like hydrodynamics and bioturbation, as well as human activities such as bottom contact fishing gear, anchoring, propeller wash from vessels, aquaculture, port anchorage, dredging, swing moorings, the construction and maintenance of offshore installations. These activities can lead to changes in the geological, physical, and chemical conditions of the seabed, impacting the benthic (seafloor) ecosystems. Abrasion relates to the damage of the seabed surface. Activities associated with abrasion can cover relatively large spatial areas (such as fishing with towed demersal trawls) or relatively localised activities (such as swing moorings, potting or bottom longlining).
	Penetration and/or disturbance of the substrate below the surface of the seabed	The disturbance of sediments where there is limited or no loss of substrate from the system. The physical impact on the layers beneath the seabed's surface. This includes activities that penetrate or disturb the sediment, such as anchoring, taking of sediment/geological cores, cone penetration tests, cable burial (ploughing or jetting), certain fishing activities, e.g., scallop dredging, bottom trawling, compression of sediments, e.g., from the legs of a jack-up barge could also fit into this pressure type. These activities can cause changes in the physical structure and composition of the seabed, potentially impacting marine habitats and ecosystems. Includes erosion or disturbance to sub-surface substrate in foreshore, beach or dune environments.

Category Title	Pressure Title	Pressure Description
	Changes in suspended solids	Changes in water clarity from sediment & organic particulate matter concentrations. It is related to activities disturbing or introducing sediment and/or organic particulate matter and mobilising it into the water column. Could be 'natural' land run-off and riverine discharges or from anthropogenic activities such as all forms of dredging, disposal at sea, cable and pipeline burial, secondary effects of construction works such as breakwaters. Particle size, hydrological energy (current speed & direction) and tidal excursion are all influencing factors on the spatial extent and temporal duration. Salinity, turbulence, pH and temperature may result in flocculation of suspended organic matter.
	Siltation (sedimentation) rate changes	Alteration (increases or decreases) of the natural rates of siltation (sedimentation) through the settling out of silt/sediments suspended in the water column. Activities associated with this pressure type include mariculture, land claim, navigational dredging, disposal at sea, marine mineral extraction, cable and pipeline laying and various construction activities. It can result in short lived sediment concentration gradients and the accumulation of sediments on the sea floor. Is related to light smothering, where a thin layer of material covers something, restricting its access to air or light but not completely cutting it off.
Other physical pressures	Litter	Refers to any human-made solid material that is discarded, disposed of, or abandoned in the coastal marine environment or ocean. This includes items like plastics, metals, wood, rope, and fishing gear, as well as their broken-down pieces, such as microplastics. Ecological effects can be physical (smothering), biological (ingestion, including uptake of microplastics; entangling; physical damage; accumulation of chemicals) and/or chemical (leaching, contamination).
	Electromagnetic changes	Localised electric and magnetic fields associated with operational power cables and telecommunication cables (if equipped with power relays). These cables may generate electric and magnetic fields that could alter behaviour and migration patterns of sensitive species (e.g., sharks and rays).
	Noise changes	Increases over and above background noise levels (consisting of environmental noise (ambient) and incidental man-made/anthropogenic noise (apparent)) at a particular location. Species known to be affected are marine mammals and fish. Effects include hearing loss, discomfort, injury, and in extreme cases, death in addition to indirect effects such as acoustic masking and behavioural modification. The impact depends on factors like sound pressure, loudness, exposure level, and frequency. High amplitude and low-frequency sounds are particularly harmful. Noise can travel long distances (10s of kms) but is affected by water depth and seabed features. Noise levels associated with construction activities, such as piledriving, are typically significantly greater than operational phases (i.e., shipping, operation

Category Title	Pressure Title	Pressure Description
		of a wind farm). Includes noise produced by shore-based activities such as vehicle use and tourist activities.
	Introduction of light	Direct inputs of light from anthropogenic activities. This includes lighting on structures during construction or operation to allow 24 h working; new tourist facilities (e.g., promenade or pier lighting), lighting on oil & gas facilities etc. Ecological effects may be the diversion of bird species from migration routes if they are disorientated by or attracted to the lights. It is also possible that continuous lighting may lead to increased algal growth.
	Barrier to species movement	Obstacles that prevent animals from moving freely between different habitats. These barriers can disrupt migration, breeding, feeding, and other essential activities. Barriers include physical structures such as tidal barrages; infrastructure including offshore wind farms, aquaculture setups; pollution where high levels of turbidity act as a barrier by inhibiting navigation; electromagnetic fields that some species find difficult to cross and habitat alteration that fragments habitats and makes it difficult for species to move between them. Includes upriver movements or movements across open waters. Species affected are mostly birds, fish, mammals.
	Death or injury by collision	Injury or mortality from collisions of biota with both static &/or moving structures. Examples include collision with rigs (e.g., birds), static screens in intake pipes (e.g., fish at power stations), wind turbine blades (e.g., birds), tidal devices (e.g., fish & mammals) and fishing vessels (birds).
Biological pressures	Visual disturbance	The disturbance of animals by anthropogenic activities. Examples include increased vessel movements, such as during construction phases for new infrastructure (bridges, cranes, port buildings etc), increased personnel movements, increased tourism, increased vehicular movements on shore disturbing bird roosting areas, seal haul out areas etc
	Genetic modification & translocation of indigenous species	Genetic modification can be either deliberate (e.g., introduction of farmed individuals to the wild, GM food production), accidental (e.g., escapees from salmon farms or the translocation of GM species in ballast water) or a by-product of other activities (e.g., mutations associated with radionuclide contamination). Anthropogenic movement of native species to new regions can also introduce different genetic stock.
	Introduction or spread of non-indigenous species	The introduction of non-indigenous species, e.g., Asian paddle crab, Mediterranean fan worm, exotic Caulerpa, and their subsequent spreading. Ballast water, hull fouling, stepping stone effects (e.g., aquaculture farms) may facilitate the spread of such species.
	Introduction of microbial pathogens	The introduction of microbial pathogens via untreated or insufficiently treated effluent discharges, run-off from terrestrial sources (e.g., toxoplasmosis) and vessels, ballast water releases. Escapees (e.g., farmed salmon) could be infected and spread pathogens. Aquaculture

Category Title	Pressure Title	Pressure Description
		could release contaminated faecal matter, from which pathogens could enter the food chain.
	Removal of target species	The removal of target species through commercial exploitation of fish & shellfish stocks, recreational fishing, bioprospecting and scientific sampling. The physical effects of fishing gear on seabed communities are addressed by the " Disturbance of the surface of the seabed, including abrasion" and "Penetration and/or disturbance of the substrate below the surface of the seabed" pressure types, so this pressure addresses the direct removal / harvesting of biota. Ecological consequences include the sustainability of stocks, impacting energy flows through food webs and the size and age composition within fish stocks.
	Removal of non-target species	By-catch associated with fishing activities, bioprospecting, research, mineral extraction and dredging etc. This pressure addresses the direct removal of individuals, the physical effects of fishing gear on seabed communities are addressed by the " Disturbance of the surface of the seabed, including abrasion" and "Penetration and/or disturbance of the substrate below the surface of the seabed" pressure types. Ecological consequences include disruption of food webs and changes to the population dynamics of marine biota.

Appendix B Description of Biodiversity features used in the Aotearoa New Zealand Pressure–Biodiversity Matrix

Priority column indicates inclusion in current (y) and future (n) project phases.

Priority	Group	Biodiversity feature	Comments/examples	Rationale for inclusion (ecological role & vulnerability)
y	Benthic Invertebrate Habitats	Attached tunicates	e.g., *Pyura pachydermantina, Cnemidocarpa bicornuata, Cnemidocarpa spp.*	Efficient filter-feeding invertebrates that play an important role in nutrient cycling and benthic–pelagic coupling, often forming dense colonies that add structural complexity to marine habitats
y	Benthic Invertebrate Habitats	Brachiopod bed	e.g., *Terebratella inconspicua*, *Terebratella sanguinea*, *Hemithyris nigricans*, *Liothyrella neozelanica*	Aggregation of long-lived suspension feeders with ancient lineages and slow growth. Beds provide stable biogenic structure in deep or low-energy habitats.
y	Benthic Invertebrate Habitats	Bryozoan thickets	e.g., *Adeonellopsis sp., Euthyroides episcopalis, Hippomenella vellicata, Celleporaria agglutinans*	Calcareous colonies forming complex three-dimensional habitat for juveniles of many species. Slow growth rates and fragility justify inclusion.
y	Marine Plants & Macroalgae	Bull kelp forest	*Durvillaea* spp.	Large, canopy-forming seaweeds that create high-energy coastal habitat structure and support diverse assemblages. Their long lifespan and strong exposure to wave regimes make them ecologically pivotal.
y	Benthic Invertebrate Habitats	Cerianthid bed	e.g., *Cerianthus* and *Pachycerianthus spp.*	Tube-dwelling anemones that stabilise sediment and increase habitat heterogeneity. Long-lived individuals and slow recruitment contribute to ecological value.
y	Benthic Invertebrate Habitats	Cockle bed	*Austrovenus stutchburyi*	Sediment-dwelling bivalves that bioturbate and filter water, influencing nutrient and sediment dynamics. Their role in soft-sediment functioning warrants inclusion.
y	Benthic Invertebrate Habitats	Dog cockle beds	*Tucetona laticostata, Glycymeris modesta*	Long-lived, sediment-dwelling bivalves whose robust shells contribute substantial shell hash to the seafloor, creating biogenic substrate that enhances habitat heterogeneity and supports diverse invertebrate assemblages
y	Marine Plants & Macroalgae	*Ecklonia* forest	Generally monospecific stands of mature *Ecklonia radiata* forming a complete canopy	Structurally important kelp forming dense canopies that underpin reef biodiversity. Long lifespan and dependence on light and stable substrate heighten ecological significance.
y	Benthic Invertebrate Habitats	Erect soft sediment inverts	e.g., *Styela plicata, Alcyonium,* crinoids, sponges, hydroids. Excludes horse mussels and cerianthids.	Sponges, ascidians, hydroids, and other upright suspension feeders that create biogenic structure in otherwise flat habitats. Many are slow-growing and sensitive to disturbance.

Priority	Group	Biodiversity feature	Comments/examples	Rationale for inclusion (ecological role & vulnerability)
y	Marine Plants & Macroalgae	Green algal forest	Green algae forming dense mats over the substratum (>40%) e.g., *Caulerpa brownii, Ulva, Codium spp., Chaetomorpha spp.* and *Cladophora spp.*	Dense mats of fast-Giant kelp forming extensive, highly productive three-dimensional habitats. Large size and long lifespan make forests sensitive to environmental fluctuations. Growing green algae that alter productivity, nutrient cycling, and habitat complexity in shallow systems.
y	Benthic Invertebrate Habitats	Horse mussel bed	*Atrina zelandica*	Large bivalves that form biogenic reefs, enhancing biodiversity and stabilising sediments. Slow growth and long lifespan add ecological importance.
y	Marine Plants & Macroalgae	*Macrocystis* forest (*Macrocystis pyrifera*)	Generally monospecific stands of *Macrocystis pyrifera* forming a complete canopy	Giant kelp forming extensive, highly productive three-dimensional habitats. Large size and long lifespan make forests sensitive to environmental fluctuations.
y	Coastal Wetland & Estuarine Habitats	Mangrove Forests	*Avicennia marina*	Coastal trees with specialised root systems that trap sediment, accumulate carbon, and provide nursery habitat. Slow expansion rates and habitat specificity support inclusion.
y	Marine Plants & Macroalgae	Mixed brown algae	Mixture of large brown species, usually only partial canopy e.g., *Ecklonia radiata, Carpophyllum sp., Macrocystis pyrifera, Lessonia variegata*	Diverse macroalgal canopies that provide habitat and primary production across a wide range of reef types. Functional importance derives from structural complexity and species richness.
y	Benthic Invertebrate Habitats	Mixed sedentary encrusting (low relief) invertebrate suspension feeders	e.g., cup corals, anemones, ascidians, hydroids, encrusting sponges, zoanthids. Excludes areas dominated solely by brachiopods or bryozoans.	Encrusting growth forms stabilise substrate, create fine-scale habitat complexity, and support diverse associated fauna. Many taxa are sessile, slow-growing, and long-lived, making their structural role and contribution to community functioning both persistent and ecologically significant.
y	Benthic Invertebrate Habitats	Mixed suspension feeder communities	Areas with high variety of suspension-feeding strategies to capture particles from the water column, collectively shaping community structure and nutrient flow in their habitat	Functional diversity of these communities enhances nutrient processing, water filtration, and organic matter cycling, collectively shaping community structure and supporting high local biodiversity. Many constituent taxa are sessile, slow-growing, and long-lived, making the structural and ecological roles of these communities both significant and enduring.
y	Benthic Invertebrate Habitats	Mobile rocky invertebrate communities	Areas with high densities of sea stars, urchins, and snails that live on hard rocky seafloor habitats and move across the	Diverse assemblages of motile grazers and predators such as urchins and sea stars that strongly control algal and invertebrate distribution through grazing and predation.

Priority	Group	Biodiversity feature	Comments/examples	Rationale for inclusion (ecological role & vulnerability)
			surface to feed, graze, or hunt	
y	Benthic Invertebrate Habitats	Mud crab bed	Stalk-eyed mud (*Hemiplax hirtipes*) & tunnelling mud (*Austrohelice crassa*)	Bioturbating crabs that aerate sediments, influence nutrient fluxes, and structure estuarine soft-sediment communities.
y	Benthic Invertebrate Habitats	Mussel bed	*Perna canaliculus* and *Mytilus galloprovincialis*	Dense aggregations of filter-feeding bivalves that form habitat, enhance water clarity, and stabilise substrate. Moderate longevity and strong habitat effects justify inclusion.
y	Benthic Invertebrate Habitats	Oyster reef	Includes native rock borer oysters (*Saccostrea glomerata*), bluff oysters (*Ostrea chilensis*) and introduced Pacific oysters (*Crassotrea gigas*)	Biogenic reefs formed by multiple oyster species providing complex three-dimensional habitat, filtration, and shoreline stabilisation. Slow growth and episodic recruitment increase ecological importance.
y	Benthic Invertebrate Habitats	Pāua Bed (Blackfoot Abalone)	*Haliotis iris*	Long-lived, grazing gastropods that shape algal communities and form micro-habitats supporting encrusting coralline algae and some small invertebrates. Rely on high water quality for early life stages. Their cultural and ecological importance is high.
y	Marine Plants & Macroalgae	Red algae meadow	Substratum predominantly covered (>40%) by red algae e.g., *Pterocladia lucida, Porphyra sp., Gigartina sp., Gracilaria sp., Adamsiella sp.*	High-cover red algal beds contributing to primary production and providing habitat structure. Many species display slow growth or seasonal sensitivity.
y	Benthic Invertebrate Habitats	Rhodolith bed	Free-living non-geniculate (completely calcified) red algae e.g., *Lithothamnion crispatum, Sporolithon durum*	Free-living calcified algae that form nodules supporting highly diverse benthic communities. Extremely slow growth and habitat-forming role justify inclusion.
y	Coastal Wetland & Estuarine Habitats	Saltmarsh Wetlands	Range of saltmarsh species e.g., raupo, needle sedge, ribbonwood, three-square, slender clubrush	Highly productive plant communities that stabilise coastlines, filter nutrients, and support birds and fish. Many species have specialised tolerances and limited dispersal.
y	Benthic Invertebrate Habitats	Scallop bed	*Pecten novaezelandiae, Chlamys delicatula*	Bivalves with complex life cycles involving settlement on clean sediment and reliance on good water quality. Their ecological role includes filtration and habitat provision.
y	Coastal Wetland & Estuarine Habitats	Seagrass Meadows	*Zostera muelleri*	Clonal, slow-growing vascular plants that provide nursery habitat, stabilise sediments, and support high biodiversity. Sensitivity to light and sediment conditions

Priority	Group	Biodiversity feature	Comments/examples	Rationale for inclusion (ecological role & vulnerability)
				underscores ecological significance.
y	Benthic Invertebrate Habitats	Soft sediment burrow communities	Sandy or muddy seafloor habitats where animals such as worms, crustaceans, and bivalves create burrows that shape the sediment structure and support diverse biological interactions.	Assemblages of burrowing worms, bivalves, and crustaceans that drive nutrient cycling and sediment mixing. Bioturbation processes underpin habitat function.
y	Benthic Invertebrate Habitats	Soft sediment whelks assoc.	e.g., *Cominella glandiformis, Cominella adspersa*	Predatory gastropods that structure benthic food webs via scavenging and predation. Many species show slow movement and strong substrate dependence.
y	Benthic Invertebrate Habitats	Sponge garden	e.g., *Callyspongia sp., Ancorina sp., Psammocinia sp., Iophon prximum, Latrunculia sp., Rapsilia sp.*	Dense sponge assemblages with high filtration capacity, supporting nutrient cycling and diverse associated fauna. Many species have slow growth and long lifespans.
y	Benthic Invertebrate Habitats	Surf clam bed	Pipi (*Paphies australis),* toheroa *(Paphies venticosa),* tuatua *(Paphies subtriangulata)*	Fast-filtering bivalves inhabiting dynamic surf zones, contributing to sediment turnover and coastal nutrient processing.
y	Benthic Invertebrate Habitats	Tubeworm mat	e.g., *Boccardia sp.*	Small, tube-building polychaetes that stabilise sediments and create microhabitats. High density but slow structural recovery supports inclusion.
y	Benthic Invertebrate Habitats	Tubeworm reef	Large structure forming tubeworms e.g., *Serpulidae, Spirorbidae, Sabellariidae*	Large, rigid tube structures formed by reef-building polychaetes that add significant vertical complexity. Formation is slow, highlighting ecological value.
y	Benthic Invertebrate Habitats	Wedge shell bed	*Macomona liliana*	Infaunal bivalves that drive bioturbation and nutrient exchange in sandy sediments, forming an important component of soft-sediment ecology.
n	Birds	Albatross	e.g., Antipodean (*Diomedea antipodensis*) & Southern royal (*Diomedea epomophora*) Buller's (*Thalassarche bulleri*)	Long-lived, wide-ranging seabirds with extremely slow reproduction (typically one egg per year) and delayed maturity, making populations highly sensitive to adult mortality. They structure pelagic food webs through long-distance foraging and nutrient transfer.
n	Marine Mammals	Baleen whales	e.g., southern right, humpback, blue	Large, long-lived filter feeders that play key roles in nutrient cycling ("whale pump") and structuring pelagic ecosystems. Slow reproduction and long migratory routes increase vulnerability to mortality and disturbance.

Priority	Group	Biodiversity feature	Comments/examples	Rationale for inclusion (ecological role & vulnerability)
n	Benthic Invertebrate Habitats	Black Coral	*Antipathella fiordensis*	Long-lived, slow-growing habitat-forming corals that create complex vertical structure. Exceptional longevity and low recruitment rates support their ecological significance.
n	Fish	Blue cod	*Parapercis colias*	A site-attached demersal predator with slow growth and late maturity. Its strong habitat association and role in structuring benthic communities justify inclusion.
n	Marine Mammals	Bryde's Whale	*Balaenoptera edeni*	A resident, warm-water baleen whale with year-round presence in shelf environments. Long lifespan and low fecundity heighten conservation importance.
n	Marine Plants & Macroalgae	Coralline paint	e.g., *Mastophora pacifica, Lithophyllum coralline, Hydroliithon onkodea, Nrogoniolothon brassicaflorida*	Crustose coralline algae forming thin layers essential for substrate stabilisation and larval settlement cues for many invertebrates. Slow calcification rates contribute to sensitivity.
n	Marine Plants & Macroalgae	Coralline turfing algae	e.g., *Corallina officinalis, Corallina spp., Arthrocordia spp., Amphiphora anceps, Jania verrucosa, J. sagitta*	Low-relief, calcifying algae that create complex microhabitats supporting high biodiversity. Slow growth and surface dependence justify inclusion.
n	Benthic Invertebrate Habitats	Deep/cold coral garden	Azooxanthallate corals including those from *Scleractinia, Antipatharia* (except the black coral, *Antipathes fjordensis*), Stylasteridae (except the red coral, *Errina novaezelandiae*) and Octocorals (except the sea pen, *Pteroeides bollonsi*)	Slow-growing, fragile deep-sea corals with extremely long lifespans and low recovery potential. Provide essential habitat for diverse deep-water fauna.
n	Fish	Flatfish	*Rhombosolea plebeia*	Benthic, sediment-associated species with specialised life histories involving metamorphosis and substrate-dependent feeding. Their reliance on soft-sediment nursery habitats is ecologically significant.
n	Birds	Flesh-footed Shearwater	*Ardenna carneipes*	Long-lived burrowing seabird with slow reproduction and wide foraging range. High ingestion of marine debris and declining populations highlight its ecological sensitivity.
n	Benthic Invertebrate Habitats	Heart urchin plain	*Echinocardium cordatum*	Burrowing echinoids that drive sediment turnover, oxygenation, and nutrient cycling. Their functional role lies in bioturbation.
n	Marine Mammals	Hector's & Māui Dolphins	*Cephalorhynchus hectori* and *Cephalorhynchus hectori maui*	Small coastal dolphins with extremely low reproductive rates and very small subpopulation sizes. Maui dolphins are critically endangered, making their functional

Priority	Group	Biodiversity feature	Comments/examples	Rationale for inclusion (ecological role & vulnerability)
				role and conservation significance exceptional.
n	Benthic Invertebrate Habitats	Hydrothermal vents and cold seeps	Deep-sea habitats where chemical-rich fluids emerge from the seafloor, supporting unique ecosystems powered by chemosynthesis instead of sunlight	Chemosynthetic communities built around specialised, often endemic species with unique metabolic pathways. High endemism and narrow environmental tolerances justify inclusion.
n	Fish	Kahawai	*Arripis trutta*	A key mid-trophic pelagic predator that schools extensively, influencing energy transfer between planktonic prey and higher predators. Moderate longevity supports ecological importance.
n	Fish	Kingfish	*Seriola lalandi*	A large, mobile coastal predator with long lifespans and important trophic influence in warmer shelf waters.
n	Fish	Lamnidae sharks	e.g., great white, shortfin mako, porbeagle	Highly mobile apex predators with extremely slow life histories—late maturity, low fecundity, and long gestation. Their ecological role and demographic constraints warrant inclusion.
n	Fish	Marlin	Striped (*Tetrapturus audax*), blue (*Makaira indica*) & black (*Makaira nigricans*)	Large, oceanic apex predators with specialised foraging strategies and long lifespans. Low natural abundance heightens ecological sensitivity.
n	Marine Mammals	New Zealand Sea Lion	*Phocarctos hookeri*	Nationally Critical. A top predator with strong demographic constraints—late maturity and low pup survival. Restricted breeding distribution amplifies vulnerability.
n	Fish	Orange Roughy	*Hoplostethus atlanticus*	Key mesopredators, exceptionally long-lived (150–200 years) with extremely slow growth, late maturity (around 25–35 years), and low natural productivity resulting in inherently slow population turnover and very limited capacity for demographic recovery.
n	Birds	Penguins	e.g., Little blue, erect-crested, Fiordland, rockhopper, Snares, yelloweyed	Flightless, site-faithful seabirds dependent on specific coastal and nearshore habitats. Slow reproduction and colony fidelity make them ecologically and demographically sensitive.
n	Birds	Petrels/shearwaters	e.g., sooty shearwater, Westland petrel, Hutton's shearwater, greyfaced petrel	Long-lived pelagic foragers with high site fidelity and low annual reproductive output. They facilitate nutrient transfer between ocean and land through guano inputs.
n	Marine Mammals	Pinnipeds	Seals and sea lions e.g., New Zealand sea lion, New Zealand fur seal	Top predators with slow reproductive rates and strong reliance on coastal haul-out sites.

Priority	Group	Biodiversity feature	Comments/examples	Rationale for inclusion (ecological role & vulnerability)
				Their presence influences prey populations and energy flow in coastal ecosystems.
n	Fish	Rays	e.g., *Zearaja nasuta, Myliobatis tenuicaudatus, Bathytoshia brevicaudata, Typhlonarke aysoni* and *Dipturus innominatus*.	Long-lived mesopredators with slow growth, late maturity, and low reproductive output, making them inherently vulnerable and important contributors to ecosystem stability. Their specialised benthic and pelagic foraging strategies influence prey populations and energy flow across sand-dominated coastal and shelf ecosystems.
n	Benthic Invertebrate Habitats	Red coral garden	*Errina novaezelandiae*	Habitat-forming stylasterid corals that grow slowly and add structural complexity in deep or low-light environments.
n	Benthic Invertebrate Habitats	Seapen bed	*Pennatulacea spp.*	Soft-sediment cnidarians providing vertical structure in low-relief environments. Many species are long-lived and sensitive to disturbance.
n	Birds	Shags	Phalacrocoracidae e.g., pied, king, black, little, spotted, blue	Coastal pursuit divers with specialised feeding strategies tied to benthic or demersal habitats. Colonial nesting and low annual productivity make populations sensitive.
n	Fish	Snapper	*Chrysophrys auratus*	A long-lived reef-associated predator that regulates invertebrate and urchin populations, influencing kelp forest dynamics. Slow maturity supports inclusion.
n	Benthic Invertebrate	Spiny Rock Lobster	*Jasus edwardsii*	Ecologically important urchin predator on rocky reefs; locally depleted outside marine reserves, leading to unchecked urchin grazing on kelp. Its removal exemplifies fishing-driven ecosystem shifts (urchin barrens).
n	Marine Mammals	Toothed whales and dolphins	e.g., sperm, pilot, orca, Hector's, bottlenose, dusky, common	Long-lived apex or mesopredators with complex social structures and low reproductive rates. Many species rely on specific acoustic or foraging niches, giving them high functional importance.
n	Benthic Invertebrate Habitats	Urchin 'kina' habitat	*Evechinus chloroticus*	Grazing echinoids that strongly influence algal community structure and can drive shifts toward barren states. Slow reproduction in some populations justifies ecological focus.
n	Birds	Wading birds	e.g., oyster catchers (*Haematopus ostralegus finschi*), Black stilt (*Himantopus novaezelandiae*), NZ Dotterals (*Anarhynchus obscurus aquilonius,*	Shorebirds with specialised feeding morphologies and reliance on intertidal habitats. Many species have small populations and long migrations, elevating their conservation importance.

Priority	Group	Biodiversity feature	Comments/examples	Rationale for inclusion (ecological role & vulnerability)
			Anarhynchus obscurus obscurus), godwits, snipes etc.	

Appendix C Matrix evidence

Adams, J.B., Human, L.R.D. (2016) Investigation into the mortality of mangroves at St. Lucia Estuary. *South African Journal of Botany*, 107: 121–128. https://doi.org/10.1016/j.sajb.2016.03.018

Adams, J.B., Rajkaran, A. (2020) Changes in mangroves at their southernmost African distribution limit. *Estuarine, Coastal and Shelf Science*, 247: 106862. https://doi.org/10.1016/j.ecss.2020.106862

Aguilo-Arce, J., Compa, M., Corriero, G., Mastrodonato, M., Savino, I., Semeraro, D., Sureda, A., Trani, R., Longo, C. (2025) Microplastic filtering and its physiological effects on the Mediterranean bath sponge *Spongia officinalis* (Porifera, Demospongiae). *Marine Pollution Bulletin*, 215: 117849. https://doi.org/10.1016/j.marpolbul.2025.117849

Alestra, T., Gerrity, S., Dunmore, R., Marsden, I.D., Pirker, J., Schiel, D. (2019) Rocky reef impacts of the Kaikōura earthquake: quantification and monitoring of nearshore habitats and communities. *New Zealand Aquatic Environment and Biodiversity Report*, No. 212: 124.

Alestra, T., Schiel, D.R. (2015) Impacts of local and global stressors in intertidal habitats: Influence of altered nutrient, sediment and temperature levels on the early life history of three habitat-forming macroalgae. *Journal of Experimental Marine Biology and Ecology*, 468: 29–36. https://doi.org/10.1016/j.jembe.2015.03.017

Anderson, O. (2009) Fish and invertebrate bycatch and discards in southern blue whiting fisheries, 2002–07. *New Zealand Aquatic Environment and Biodiversity Report*, No. 43: 42. https://fs.fish.govt.nz/Doc/22134/AEBR_43.pdf.ashx

Anderson, T., Morrison, M., MacDiarmid, A., Clark, M., D'Archino, R., Nelson, W., Tracey, D., Gordon, D., Read, G., Kettles, H., Morrisey, D., Wood, A., Anderson, O., Smith, A., Page, M., Paul-Burke, K., Schnabel, K., Wadhwa, S. (2018) Review of New Zealand's Key Biogenic Habitats. Prepared for the Ministry for the Environment. *NIWA Client Report* 2018139WN: 190.

Armiger, L.C. (1964) An occurrence of *Labyrinthula* in New Zealand *Zostera*. *New Zealand Journal of Botany*, 2(1): 3–9. 10.1080/0028825X.1964.10428713

Atalah, J., Rabel, H., Forrest, B.M. (2017) Modelling long-term recruitment patterns of blue mussels *Mytilus galloprovincialis*: a biofouling pest of green-lipped mussel aquaculture in New Zealand. *Aquaculture Environment Interactions*, 9: 103–114. https://www.int-res.com/journals/aei/articles/aei00216

Azizan, A., Venter, L., Zhang, J., Young, T., Ericson, J.A., Delorme, N.J., Ragg, N.L.C., Alfaro, A.C. (2024) Interactive effects of elevated temperature and *Photobacterium swingsii* infection on the survival and immune response of marine mussels (*Perna canaliculus*): A summer mortality scenario. *Marine Environmental Research*, 196: 106392. https://doi.org/10.1016/j.marenvres.2024.106392

Barbera, C., Bordehore, C., Borg, J.A., Glémarec, M., Grall, J., Hall-Spencer, J.M., de la Huz, C., Lanfranco, E., Lastra, M., Moore, P.G., Mora, J., Pita, M.E., Ramos-Esplá, A.A., Rizzo, M., Sánchez-Mata, A., Seva, A., Schembri, P.J., Valle, C. (2003) Conservation and management of northeast Atlantic and Mediterranean maerl beds. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 13(S1): S65–S76. https://doi.org/10.1002/aqc.569

Barbier, E.B., Cox, M. (2003) Does Economic Development Lead to Mangrove Loss? A Cross-Country Analysis. *Contemporary Economic Policy*, 21(4): 418–432. https://doi.org/10.1093/cep/byg022

Batson, P., Probert, P.K. (2000) Bryozoan thickets off Otago Peninsula. *New Zealand Fisheries Assessment Report*, 2000/46: 32.

Bell, J.J., McGrath, E., Biggerstaff, A., Bates, T., Bennett, H., Marlow, J., Shaffer, M. (2015) Sediment impacts on marine sponges. *Marine Pollution Bulletin*, 94(1): 5–13. https://doi.org/10.1016/j.marpolbul.2015.03.030

Bellingham, M., Davis, A. (2008) Livestock Grazing Impacts on Estuarine Vegetation in the Southern Kaipara Harbour. *Aristos Consultants Ltd Contract Report* for the Auckland Regional Council: 26.

Benjamin, E.D., Toone, T.A., Hillman, J.R., Handley, S.J., Jeffs, A. (2024) Aerial exposure and critical temperatures limit the survival of restored intertidal mussels. *Restoration Ecology*, 32(4): e14105. https://doi.org/10.1111/rec.14105

Bennion, M., Ross, P.M., Lane, H.S., McDonald, I.R. (2022) Bacterial composition in the toheroa (*Paphies ventricosa*), a threatened surf clam from Aotearoa (New Zealand). *Marine Biology*, 169(3): 39. 10.1007/s00227-022-04025-y

Berkenbusch, K., Hill-Moana, T. (2024) Intertidal shellfish monitoring in the northern North Island region, 2023–24. *New Zealand Fisheries Assessment Report*, 2024/35: 110. https://fs.fish.govt.nz/Doc/25759/FAR-2024-35-Intertidal-shellfish-monitoring-2023-24.pdf.ashx

Berov, D., Todorova, V., Dimitrov, L., Rinde, E., Karamfilov, V. (2018) Distribution and abundance of phytobenthic communities: Implications for connectivity and ecosystem functioning in a Black Sea Marine Protected Area. *Estuarine, Coastal and Shelf Science*, 200: 234–247. https://doi.org/10.1016/j.ecss.2017.11.020

Berthelsen, A., Clement, D., Gillespie, P. (2016) Shakespeare Bay estuary monitoring 2016. Prepared for Marlborough District Council. *Cawthron Report*, No. 2833: 40.

Bertness, M.D., Ewanchuk, P.J., Silliman, B.R. (2002) Anthropogenic modification of New England salt marsh landscapes. *Proceedings of the National Academy of Sciences*, 99(3): 1395–1398. doi:10.1073/pnas.022447299

Biggar, B.S., Jeffs, A., Hillman, J.R. (2025) Effects of suspended sediment on survival, growth, and nutritional condition of green-lipped mussel spat (*Perna canaliculus*, Gmelin, 1791). *Journal of Experimental Marine Biology and Ecology*, 582: 152074. https://doi.org/10.1016/j.jembe.2024.152074

Biggar, B.S., Jeffs, A., Hillman, J.R. (2026) The effects of sudden sediment burial on juvenile green-lipped mussels. *Marine Biology*, 173(4): 61. 10.1007/s00227-026-04818-5

Blain, C.O., Hansen, S.C., Shears, N.T. (2021) Coastal darkening substantially limits the contribution of kelp to coastal carbon cycles. *Global Change Biology*, 27(21): 5547–5563. https://doi.org/10.1111/gcb.15837

Blain, C.O., Shears, N.T. (2019) Seasonal and spatial variation in photosynthetic response of the kelp *Ecklonia radiata* across a turbidity gradient. *Photosynthesis Research*, 140(1): 21–38. 10.1007/s11120-019-00636-7

Bolton, D., Mayer-Pinto, M., Clark, G.F., Dafforn, K.A., Brassil, W.A., Becker, A., Johnston, E.L. (2017) Coastal urban lighting has ecological consequences for multiple trophic levels under the sea. *Science of the Total Environment*, 576: 1–9. https://doi.org/10.1016/j.scitotenv.2016.10.037

Booth, J.D. (2020) Reviewing the far-reaching ecological impacts of human-induced terrigenous sedimentation on shallow marine ecosystems in a northern-New Zealand embayment. *New Zealand Journal of Marine and Freshwater Research*, 54(4): 593–613. 10.1080/00288330.2020.1738505

Botté, A., Payton, L., Lefeuvre, E., Tran, D. (2023) Is part-night lighting a suitable mitigation strategy to limit Artificial Light at Night effects on the biological rhythm at the behavioral and molecular scales of the oyster *Crassostrea gigas*? *Science of the Total Environment*, 905: 167052. https://doi.org/10.1016/j.scitotenv.2023.167052

Botte, A., Payton, L., Tran, D. (2023) The effects of artificial light at night on behavioral rhythm and related gene expression are wavelength dependent in the oyster *Crassostrea gigas*. *Environmental Science and Pollution Research*, 30(57): 120375–120386. 10.1007/s11356-023-30793-1

Bradstock, M., Gordon, D.P. (1983) Coral-like bryozoan growths in Tasman Bay, and their protection to conserve commercial fish stocks. *New Zealand Journal of Marine and Freshwater Research*, 17(2): 159–163. 10.1080/00288330.1983.9515993

Branscomb, E.S., Rittschof, D. (1984) An investigation of low frequency sound waves as a means of inhibiting barnacle settlement. *Journal of Experimental Marine Biology and Ecology*, 79(2): 149–154. https://doi.org/10.1016/0022-0981(84)90215-6

Browne, Mark A., Niven, Stewart J., Galloway, Tamara S., Rowland, Steve J., Thompson, Richard C. (2013) Microplastic Moves Pollutants and Additives to Worms, Reducing Functions Linked to Health and Biodiversity. *Current Biology*, 23(23): 2388–2392. https://doi.org/10.1016/j.cub.2013.10.012

Bulmer, R., Lundquist, C. (2016) Whangamata Mangrove Removal Monitoring: Summary of 36 month post-removal sampling. *NIWA Client Report* HAM2016-027: 60.

Bulmer, R.H., Kelly, S., Jeffs, A.G. (2016) Light requirements of the seagrass, *Zostera muelleri*, determined by observations at the maximum depth limit in a temperate estuary, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 50(2): 183–194. 10.1080/00288330.2015.1120759

Bulmer, R.H., Lewis, M., O'Donnell, E., Lundquist, C.J. (2017) Assessing mangrove clearance methods to minimise adverse impacts and maximise the potential to achieve restoration objectives. *New Zealand Journal of Marine and Freshwater Research*, 51(1): 110–126. 10.1080/00288330.2016.1260605

Bunting, I., Bornemann Santamaría, L., Kok, Y.Y., Krieger, E.C., Mullarney, J.C., D'Archino, R., Cornwall, C.E. (2025) Light limitation and water velocity modify the impacts of simulated marine heatwaves on juvenile giant kelp. *Journal of Phycology*, 61(5): 1173–1194. https://doi.org/10.1111/jpy.70054

Bunting, I.C., D'Archino, R., Barr, N., Bury, S.J., Desmond, M.J., Hepburn, C., Kok, Y.Y., Krieger, E.C., Le, D.M., Cornwall, C.E. (2026) Similar sensitivity and resilience to marine heatwaves of giant kelp (*Macrocystis pyrifera*) sporophytes from the northern and southern edges of their distribution in Aotearoa New Zealand. *Ocean Ecosystems*, 2(1): 1. 10.1186/s44419-025-00002-z

Caley, A., Marzinelli, E.M., Mayer-Pinto, M. (2025) Limited microbial community responses of marine macroalgae to artificial light at night and moderate warming conditions. *Marine Environmental Research*, 212: 107536. https://doi.org/10.1016/j.marenvres.2025.107536

Carrier-Belleau, C., Drolet, D., McKindsey, C., Archambault, P. (2021) Environmental stressors, complex interactions and marine benthic communities' responses. *Scientific Reports*, 11. 10.1038/s41598-021-83533-1

Carrier-Belleau, C., Lauzon, F., Boucher-Fontaine, J., Tiegs, S., Cusson, M., Guichard, F., Nozais, C., Archambault, P. (2024) Interacting effects of local and global stressors on mussel beds and ecosystem functioning. *Journal of Experimental Marine Biology and Ecology*, 579: 152046. https://doi.org/10.1016/j.jembe.2024.152046

Cavanaugh, K.C., Siegel, D.A., Reed, D.C., Dennison, P.E. (2011) Environmental controls of giant-kelp biomass in the Santa Barbara Channel, California. *Marine Ecology Progress Series*, 429: 1–17. https://www.int-res.com/journals/meps/articles/meps09141

Cebrian, E., Uriz, M.J. (2007) Contrasting Effects of Heavy Metals on Sponge Cell Behavior. *Archives of Environmental Contamination and Toxicology*, 53(4): 552–558. 10.1007/s00244-006-0257-2

Charifi, M., Miserazzi, A., Sow, M., Perrigault, M., Gonzalez, P., Ciret, P., Benomar, S., Massabuau, J.-C. (2018) Noise pollution limits metal bioaccumulation and growth rate in a filter feeder, the Pacific oyster *Magallana gigas*. *PLoS One*, 13(4): e0194174. 10.1371/journal.pone.0194174

Chen, S., Shi, C., Migaud, H., Song, C., Mu, C., Ye, Y., Wang, C., Ren, Z. (2022) Light Spectrum Impacts on Growth, Molting, and Oxidative Stress Response of the Mud Crab Scylla paramamosain. *Frontiers in Marine Science*, Volume 9 - 2022. 10.3389/fmars.2022.840353

Christoforou, E., Dominoni, D., Lindström, J., Diamantopoulou, C., Czyzewski, J., Mirzai, N., Spatharis, S. (2023) The effects of artificial light at night (ALAN) on the gaping activity and feeding of mussels. *Marine Pollution Bulletin*, 192: 115105. https://doi.org/10.1016/j.marpolbul.2023.115105

Cocito, S., Novosel, M., Novosel, A. (2004) Carbonate bioformations around underwater freshwater springs in the north-eastern Adriatic Sea. *Facies*, 50(1): 13–17. 10.1007/s10347-004-0007-8

Cottrell, R.S., Black, K.D., Hutchison, Z.L., Last, K.S. (2016) The Influence of Organic Material and Temperature on the Burial Tolerance of the Blue Mussel, *Mytilus edulis:* Considerations for the Management of Marine Aggregate Dredging. *PLoS One*, 11(1): e0147534. 10.1371/journal.pone.0147534

Cranfield, H.J., Carbines, G., Michael, K.P., Dunn, A., Stotter, D.R., Smith, D.J. (2001) Promising signs of regeneration of blue cod and oyster habitat changed by dredging in Foveaux Strait, southern New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 35(5): 897–908. 10.1080/00288330.2001.9517052

Cranfield, H.J., Manighetti, B., Michael, K.P., Hill, A. (2003) Effects of oyster dredging on the distribution of bryozoan biogenic reefs and associated sediments in Foveaux Strait, southern New Zealand. *Continental Shelf Research*, 23(14): 1337–1357. https://doi.org/10.1016/S0278-4343(03)00122-5

Cranfield, H.J., Michael, K.P., Doonan, I.J. (1999) Changes in the distribution of epifaunal reefs and oysters during 130 years of dredging for oysters in Foveaux Strait, southern New Zealand. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 9(5): 461–483. https://doi.org/10.1002/(SICI)1099-0755(199909/10)9:5<461::AID-AQC353>3.0.CO;2-Z

Creese, R., Hooker, S., de Luca, S., Wharton, Y. (1997) Ecology and environmental impact of *Musculista senhousia* (Moilusca: Bivalvia: Mytilidae) in Tamaki Estuary, Auckland, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 31(2): 225–236. 10.1080/00288330.1997.9516760

Crowder, L., Ng, C., Frawley, T., Low, N., Micheli, F. (2019) 8.3 The significance of ocean deoxygenation for kelp and other macroalgae. In: D. Loffoley & J. Baxter (Eds). *Ocean deoxygenation: Everyone's problem. Causes, impacts, consequences and solutions*. IUCN: 309–322.

Cruz, C.D., Fletcher, G.C., Paturi, G., Hedderley, D.I. (2020) Influence of farming methods and seawater depth on *Vibrio* species in New Zealand Pacific oysters. *International Journal of Food Microbiology*, 325: 108644. https://doi.org/10.1016/j.ijfoodmicro.2020.108644

Cruz, C.D., Hedderley, D., Fletcher, G.C. (2015) Long-Term Study of Vibrio parahaemolyticus Prevalence and Distribution in New Zealand Shellfish. *Applied and Environmental Microbiology*, 81(7): 2320–2327. doi:10.1128/AEM.04020-14

Cummings, V., Smith, A.M., Marriott, P., Peebles, B., Halliday, N. (2019) Effect of reduced pH on physiology and shell integrity of juvenile *Haliotis iris* (pāua) from New Zealand. *PeerJ*, 7: e7670. https://doi.org/10.7717/peerj.7670

Cummings, V.J., Thrush, S.F. (2004) Behavioural response of juvenile bivalves to terrestrial sediment deposits: implications for post-disturbance recolonisation. *Marine Ecology Progress Series*, 278: 179–191.

Cunningham, S.C., Smith, A.M., Lamare, M.D. (2016) The effects of elevated pCO2 on growth, shell production and metabolism of cultured juvenile abalone, *Haliotis iris*. *Aquaculture Research*, 47(8): 2375–2392. https://doi.org/10.1111/are.12684

Currie, D.R., Parry, G.D. (1996) Effects of scallop dredging on a soft sediment community: a large-scale experimental study. *Marine Ecology Progress Series*, 134: 131–150. https://www.int-res.com/journals/meps/articles/meps134131

D'Archino, R., Nelson, W., Neill, K., Pallentin, A., Notman, P. (2022) Characterisation of the Evans Bay *Adamsiella* algal bed. *NIWA Client Report* 2022196WN: 57.

da Silva, T.D., Mullarney, J.C., Pilditch, C.A., Coco, G. (2024) The interaction between vegetation patchiness and tidal flows in a shortleaf seagrass meadow. *Limnology and Oceanography*, 69(10): 2422–2435. https://doi.org/10.1002/lno.12679

Dai, Y., Dong, Y., Wu, H., Chen, Z., Yang, F., Jia, J., Chen, Z. (2024) Toxicity of Nitrite to Juvenile Sunray Surf Clam (*Mactra chinensis* Philippi). *Pollutants*, 4(4): 452–462. https://www.mdpi.com/2673-4672/4/4/30

Dai, Y., Dong, Y., Yang, F., Chen, Z., Jia, J., Wu, H., Chen, Z. (2023) Effects of pH and salinity on survival, growth, and enzyme activities in juveniles of the sunray surf clam (Mactra chinensis Philippi). *Fish and Shellfish Immunology Reports*, 5: 100114. https://doi.org/10.1016/j.fsirep.2023.100114

Dalle Carbonare, L., Basile, A., Rindi, L., Bulleri, F., Hamedeh, H., Iacopino, S., Shukla, V., Weits, D.A., Lombardi, L., Sbrana, A., Benedetti-Cecchi, L., Giuntoli, B., Licausi, F., Maggi, E. (2023) Dim artificial light at night alters gene expression rhythms and growth in a key seagrass species (*Posidonia oceanica*). *Scientific Reports*, 13(1): 10620. 10.1038/s41598-023-37261-3

Davidson, R., Richards, L. (2015) Significant marine site survey and monitoring programme: Summary 2014 - 2015. Prepared by Davidson Environmental Limited for Marlborough District Council. *Survey and monitoring report*, No. 819: 52.

Davies, T.W., Coleman, M., Griffith, K.M., Jenkins, S.R. (2015) Night-time lighting alters the composition of marine epifaunal communities. *Biology Letters*, 11(4). 10.1098/rsbl.2015.0080

Davis, A.M., McFarland, K., Plough, L.V., Paynter, K.T. (2024) Predicting the effects of hypoxia on oyster (Crassostrea virginica) growth and reproduction through the Dynamic Energy Budget model. *Ecological Modelling*, 495: 110799. https://doi.org/10.1016/j.ecolmodel.2024.110799

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M. (2017) Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop *Pecten fumatus*. *Proceedings of the National Academy of Sciences*, 114(40): E8537–E8546. doi:10.1073/pnas.1700564114

Dayton, P.K., Thrush, S.F., Agardy, M.T., Hofman, R.J. (1995) Environmental effects of marine fishing. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 5(3): 205–232. https://doi.org/10.1002/aqc.3270050305

De Luca-Abbott, S. (2001) Biomarkers of sublethal stress in the soft-sediment bivalve *Austrovenus stutchburyi* exposed in-situ to contaminated sediment in an urban New Zealand harbour. *Mar Pollut Bull*, 42(10): 817–825. 10.1016/s0025-326x(00)00226-5

de Soto Aguilar, N., Delorme, N., Atkins, J., Howard, S., Williams, J., Johnson, M. (2013) Anthropogenic noise causes body malformations and delays development in marine larvae. *Scientific Reports*, 3(1): 2831. 10.1038/srep02831

Delorme, N.J., Burritt, D.J., Ragg, N.L.C., South, P.M. (2021) Emersion and Relative Humidity Modulate Stress Response and Recovery Dynamics in Juvenile Mussels (*Perna canaliculus*). *Metabolites*, 11(9): 580. https://www.mdpi.com/2218-1989/11/9/580

Delorme, N.J., Sewell, M.A. (2013) Temperature limits to early development of the New Zealand sea urchin *Evechinus chloroticus* (Valenciennes, 1846). *Journal of Thermal Biology*, 38(5): 218–224. https://doi.org/10.1016/j.jtherbio.2013.02.007

Diggles, B.K., Nichol, J., Hin, P.M., Wakefield, S., Cochennec-Laureau, N., Roberts, R.D., Friedman, C.S. (2002) Pathology of cultured paua *Haliotis iris* infected with a novel haplosporidian parasite, with some observations on the course of disease. *Dis Aquat Organ*, 50(3): 219–231. 10.3354/dao050219

Dinamani, P., Hine, M., Jones, J. (1987) Occurrence and characteristics of the haemocyte parasite *Bonamia sp*. in the New Zealand Dredge Oyster *Tiostrea lutaria*. *Diseases of Aquatic Organisms - DISEASE AQUAT ORG*, 3: 37–44. 10.3354/dao003037

Doonan, I.J., Cranfield, H.J., Michael, K.P. (1994) Catastrophic reduction of the oyster, *Tiostrea chilensis* (Bivalvia: Ostreidae), in Foveaux Strait, New Zealand, due to infestation by the protistan *Bonamia sp*. *New Zealand Journal of Marine and Freshwater Research*, 28(4): 335–344. 10.1080/00288330.1994.9516623

Dos Santos, V.M., Matheson, F.E., Pilditch, C.A., Elger, A. (2012) Is black swan grazing a threat to seagrass? Indications from an observational study in New Zealand. *Aquatic Botany*, 100: 41–50. 10.1016/j.aquabot.2012.03.009

Douglas, E.J., Pilditch, C.A., Kraan, C., Schipper, L.A., Lohrer, A.M., Thrush, S.F. (2017) Macrofaunal functional diversity provides resilience to nutrient enrichment in coastal sediments. *Ecosystems*, 20(7): 1324–1336. doi.org/10.1007/s10021-017-0113-4

Douglas, E.J., Pilditch, C.A., Lohrer, A.M., Savage, C., Schipper, L.A., Thrush, S.F. (2018) Sedimentary environment influences ecosystem response to nutrient enrichment. *Estuaries and Coasts*, 41: 1994–2008. doi.org/10.1007/s12237-018-0416-5

Douglas, E.J., Lohrer, A.M., Pilditch, C.A. (2019) Biodiversity breakpoints along stress gradients in estuaries and associated shifts in ecosystem interactions. *Scientific Reports*, 9(1): 17567. doi.org/10.1038/s41598-019-54192-0

Douglas, E.J., Lam-Gordillo, O., Hailes, S.F., Lohrer, A.M., Cummings, V.J. (2025) Simulated heatwave alters intertidal estuary greenhouse gas fluxes. *Nature Communications*, 16(1): 10507. 10.1038/s41467-025-65519-z

Douglas, J., Niner, H., Garrard, S. (2024) Impacts of Marine Plastic Pollution on Seagrass Meadows and Ecosystem Services in Southeast Asia. *Journal Of Marine Science And Engineering*, 12(12): 2314. https://www.mdpi.com/2077-1312/12/12/2314

Duarte, C., Quintanilla-Ahumada, D., Anguita, C., Manríquez, P.H., Widdicombe, S., Pulgar, J., Silva-Rodríguez, E.A., Miranda, C., Manríquez, K., Quijón, P.A. (2019) Artificial light pollution at night (ALAN) disrupts the distribution and circadian rhythm of a sandy beach isopod. *Environmental Pollution*, 248: 565–573. https://doi.org/10.1016/j.envpol.2019.02.037

Duckworth, A.R., Battershill, C.N., Schiel, D.R. (2004) Effects of depth and water flow on growth, survival and bioactivity of two temperate sponges cultured in different seasons. *Aquaculture*, 242(1): 237–250. https://doi.org/10.1016/j.aquaculture.2004.08.046

Duke, N.C. (2008) Corrections and updates to the article by Duke et al. (2005) reporting on the unusual occurrence and cause of dieback of the common mangrove species, *Avicennia marina*, in NE Australia. *Marine Pollution Bulletin*, 56(9): 1668–1670. https://doi.org/10.1016/j.marpolbul.2008.08.001

Duke, N.C., Bell, A.M., Pederson, D.K., Roelfsema, C.M., Bengtson Nash, S. (2005) Herbicides implicated as the cause of severe mangrove dieback in the Mackay region, NE Australia: consequences for marine plant habitats of the GBR World Heritage Area. *Marine Pollution Bulletin*, 51(1): 308–324. https://doi.org/10.1016/j.marpolbul.2004.10.040

Ellis-Smith, B.G., Needham, H.R., Stephenson, F., Hillman, J.R., Lohrer, A.M., Ellis, J.I., Pilditch, C.A. (2025) Environmental drivers of *Atrina zelandica* habitat suitability in Tauranga Harbour. *New Zealand Journal of Marine and Freshwater Research*, 59(5): 1303–1323. 10.1080/00288330.2025.2527219

Ellison, J.C. (1999) Impacts of Sediment Burial on Mangroves. *Marine Pollution Bulletin*, 37(8): 420–426. https://doi.org/10.1016/S0025-326X(98)00122-2

Enever, R., Doherty, P.D., Ashworth, J., Duffy, M., Kibel, P., Parker, M., Stewart, B.D., Godley, B.J. (2022) Scallop potting with lights: A novel, low impact method for catching European king scallop (*Pecten maximus*). *Fisheries Research*, 252: 106334. https://doi.org/10.1016/j.fishres.2022.106334

Erftemeijer, P.L.A., Robin Lewis, R.R. (2006) Environmental impacts of dredging on seagrasses: A review. *Marine Pollution Bulletin*, 52(12): 1553–1572. https://doi.org/10.1016/j.marpolbul.2006.09.006

Evans, S.M. (1999) Tributyltin Pollution: the Catastrophe that Never Happened. *Marine Pollution Bulletin*, 38(8): 629–636. https://doi.org/10.1016/S0025-326X(99)00040-5

Fisheries New Zealand (2025a) Bladder Kelp Attached (KBB G). *Fisheries Assessment Plenary May 2025*: 19. https://www.mpi.govt.nz/dmsdocument/69690-Fisheries-Assessment-Plenary-May-2025-Volume-1-BLADDER-KELP-ATTACHED-KBB-G

Fisheries New Zealand (2025b) Dredge Oyster (OYS 7). *Fisheries Assessment Plenary November 2025*. https://www.mpi.govt.nz/dmsdocument/70881-Fisheries-Assessment-Plenary-November-2025-DREDGE-OYSTER-OYS-7

Fisheries New Zealand (2025c) Green-Lipped Mussel (GLM). *Fisheries Assessment Plenary May 2025*: 7. https://www.mpi.govt.nz/dmsdocument/69717-Fisheries-Assessment-Plenary-May-2025-Volume-1-GREEN-LIPPED-MUSSEL-GLM

Fisheries New Zealand (2025d) Horse Mussel (HOR). *Fisheries Assessment Plenary May 2025*: 6. https://www.mpi.govt.nz/dmsdocument/69780-Fisheries-Assessment-Plenary-May-2025-Volume-2-HORSE-MUSSEL-HOR

Fisheries New Zealand (2025e) Introduction - Cockles (COC). *Fisheries Assessment Plenary November 2025*. https://www.mpi.govt.nz/dmsdocument/69732-Fisheries-Assessment-Plenary-May-2025-Volume-1-INTRODUCTION-COCKLES-COC

Fisheries New Zealand (2025f) Introduction - Pāua (PAU). *Fisheries Assessment Plenary May 2025*: 17. https://fs.fish.govt.nz/Doc/26050/introduction-paua-pau-fisheries-assessment-plenary-may-2025-volume-2.pdf.ashx

Fisheries New Zealand (2025g) Introduction - Pipi (PPI). *Fisheries Assessment Plenary May 2025*: 9. https://fs.fish.govt.nz/Doc/26051/introduction-pipi-ppi-fisheries-assessment-plenary-may-2025-volume-2.pdf.ashx

Fisheries New Zealand (2025h) Introduction - Scallops (SCA). *Fisheries Assessment Plenary November 2025*. https://www.mpi.govt.nz/dmsdocument/70887-Fisheries-Assessment-Plenary-November-2025-INTRODUCTION-SCALLOPS-SCA

Fisheries New Zealand (2025i) Knobbed Whelk (KWH). *Fisheries Assessment Plenary May 2025*: 3. https://www.mpi.govt.nz/dmsdocument/69816-Fisheries-Assessment-Plenary-May-2025-Volume-2-KNOBBED-WHELK-KWH

Fisheries New Zealand (2025j) Tuatua (Tua). *Fisheries Assessment Plenary May 2025*. https://www.mpi.govt.nz/dmsdocument/70014-Fisheries-Assessment-Plenary-May-2025-Volume-3-TUATUA-TUA

Flowers, G.J.L., Needham, H.R., Bulmer, R.H., Lohrer, A.M., Pilditch, C.A. (2023) Going under: The implications of sea-level rise and reduced light availability on intertidal primary production. *Limnology and Oceanography*, 68(6): 1301–1315. https://doi.org/10.1002/lno.12347

Flowers, G.J.L., Needham, H.R., Bulmer, R.H., Lohrer, A.M., Pilditch, C.A. (2024) The Effect of Sediment Mud Content on Primary Production in Seagrass and Unvegetated Intertidal Flats. *Estuaries and Coasts*, 47(6): 1544–1560. 10.1007/s12237-024-01403-1

Forrest, B.M., Atalah, J. (2017) Significant impact from blue mussel *Mytilus galloprovincialis* biofouling on aquaculture production of green-lipped mussels in New Zealand. *Aquaculture Environment Interactions*, 9: 115–126. https://www.int-res.com/journals/aei/articles/aei00220

Foster, M.S. (2001) Rhodoliths: Between rocks and soft places. *Journal of Phycology*, 37(5): 659–667. 10.1046/j.1529-8817.2001.00195.x

Fujii, M., Hamanoue, R., Bernardo, L.P.C., Ono, T., Dazai, A., Oomoto, S., Wakita, M., Tanaka, T. (2023) Assessing impacts of coastal warming, acidification, and deoxygenation on Pacific oyster (*Crassostrea gigas*) farming: a case study in the Hinase area, Okayama Prefecture, and Shizugawa Bay, Miyagi Prefecture, Japan. *Biogeosciences*, 20(22): 4527–4549. 10.5194/bg-20-4527-2023

Gadsby, F. (2023) Environmental Change and Erosion, Pounawea Wetland, Otago, New Zealand. University of Otago, Unpublished MSc thesis: 292.

Gammal, J., Hewitt, J., Gladstone-Gallagher, R., Thrush, S., Douglas, E., Lohrer, A., Pilditch, C. (2022) Stressors Increase the Impacts of Coastal Macrofauna Biodiversity Loss on Ecosystem Multifunctionality. *Ecosystems*. 10.1007/s10021-022-00775-4

Garratt, M.J., Jenkins, S.R., Davies, T.W. (2019) Mapping the consequences of artificial light at night for intertidal ecosystems. *Science of the Total Environment*, 691: 760–768. https://doi.org/10.1016/j.scitotenv.2019.07.156

Geange, S.W., Powell, A., Clemens-Seely, K., Cárdenas, C.A. (2014) Sediment load and timing of sedimentation affect spore establishment in *Macrocystis pyrifera* and *Undaria pinnatifida*. *Marine Biology*, 161(7): 1583–1592. 10.1007/s00227-014-2442-6

Gerrity, S., Alestra, T., Fischman, H.S., Schiel, D.R. (2020) Earthquake effects on abalone habitats and populations in southern New Zealand. *Marine Ecology Progress Series*, 656: 153–161. https://www.int-res.com/journals/meps/articles/meps13458

Gerrity, S., Schiel, D. (2023) Recreational fishing effects on wadeable pāua populations along the Kaikōura coast, 2021-22. *New Zealand Fisheries Assessment Report*, 2023/01: 27.

Gigot, M., Tremblay, R., Bonnel, J., Mathias, D., Meziane, T., Chauvaud, L., Olivier, F. (2024) Noise pollution causes parental stress on marine invertebrates, the Giant scallop example. *Marine Pollution Bulletin*, 203: 116454. https://doi.org/10.1016/j.marpolbul.2024.116454

Gillespie, P.A. (1989) Bioassay of acute toxicity of herbicide mixture dalapon/weedazol 4L on estuarine fauna. *Environmental Toxicology and Chemistry*, 8(9): 809–815. 10.1002/etc.5620080909

Gladstone-Gallagher, R.V., Hughes, R.W., Douglas, E.J., Pilditch, C.A. (2018) Biomass-dependent seagrass resilience to sediment eutrophication. *Journal of Experimental Marine Biology and Ecology*, 501: 54–64. https://doi.org/10.1016/j.jembe.2018.01.002

Gonsilou, A.P., Hadibarata, T., Jusoh, M.N.H.B. (2025) Microplastic, an Emerging Threat to the Global Seagrass Ecosystems: A Review. *Environmental Quality Management*, 35(1): e70122. https://doi.org/10.1002/tqem.70122

Gonzalez-Pineda, M., Salvadó, H., Monràs-Riera, P., Avila, C. (2025) Micro-litter pollution in the ascidian *Cnemidocarpa verrucosa* along the Antarctic Peninsula. *Environmental Pollution*, 384: 127017. https://doi.org/10.1016/j.envpol.2025.127017

Grall, J., Hall-Spencer, J.M. (2003) Problems facing maerl conservation in Brittany. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 13(S1): S55–S64. https://doi.org/10.1002/aqc.568

Grall, J., Hall-Spencer, Jason M. (2025) Maerl Bed Conservation: Successes and Failures. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 35(2): e70058. https://doi.org/10.1002/aqc.70058

Grech, A., Chartrand-Miller, K., Erftemeijer, P., Fonseca, M., McKenzie, L., Rasheed, M., Taylor, H., Coles, R. (2012) A comparison of threats, vulnerabilities and management approaches in global seagrass bioregions. *Environmental Research Letters*, 7(2): 024006. 10.1088/1748-9326/7/2/024006

Green, D.S. (2016) Effects of microplastics on European flat oysters, *Ostrea edulis* and their associated benthic communities. *Environmental Pollution*, 216: 95–103. https://doi.org/10.1016/j.envpol.2016.05.043

Grenier, C., Román, R., Duarte, C., Navarro, J.M., Rodriguez-Navarro, A.B., Ramajo, L. (2020) The combined effects of salinity and pH on shell biomineralization of the edible mussel *Mytilus chilensis*. *Environmental Pollution*, 263: 114555. https://doi.org/10.1016/j.envpol.2020.114555

Grove, S., Probert, P.K. (1998) Bycatch of megabenthic invertebrates from bathyal trawl fisheries off southern and eastern New Zealand. *NIWA Technical Report*, 13: 29.

Gu, H., Shang, Y., Clements, J., Dupont, S., Wang, T., Wei, S., Wang, X., Chen, J., Huang, W., Hu, M., Wang, Y. (2019) Hypoxia aggravates the effects of ocean acidification on the physiological energetics of the blue mussel *Mytilus edulis*. *Marine Pollution Bulletin*, 149: 110538. https://doi.org/10.1016/j.marpolbul.2019.110538

Guo, S., Lee, H.P., Teo, S.L.M., Khoo, B.C. (2012) Inhibition of barnacle cyprid settlement using low frequency and intensity ultrasound. *Biofouling*, 28(2): 131–141. 10.1080/08927014.2012.658511

Hagger, V., Worthington, T.A., Lovelock, C.E., Adame, M.F., Amano, T., Brown, B.M., Friess, D.A., Landis, E., Mumby, P.J., Morrison, T.H., O'Brien, K.R., Wilson, K.A., Zganjar, C., Saunders, M.I. (2022) Drivers of global mangrove loss and gain in social-ecological systems. *Nature Communications*, 13(1): 6373. 10.1038/s41467-022-33962-x

Hale, R., Lam-Gordillo, O., Lohrer, D., Williams, J., Handley, S., Olmeda-Rojas, P., Middleton, I. (2024) Cumulative effects of stressors on scallops and scallop habitats in the Marlborough Sounds: With insights from sites in Northland, Hauraki Gulf, and eastern Coromandel Peninsula. *New Zealand Aquatic Environment and Biodiversity Report*, 337: 109.

Hall-Spencer, J., Grall, J., Moore, P.G., Atkinson, R.J.A. (2003) Bivalve fishing and maerl-bed conservation in France and the UK—retrospect and prospect. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 13: S33–S41. 10.1002/aqc.566

Hall-Spencer, J., White, N., Gillespie, E., Gillham, K., Foggo, A. (2006) Impact of fish farms on maerl beds in strongly tidal areas. *Marine Ecology Progress Series*, 326: 1–9. https://www.int-res.com/journals/meps/articles/meps326001

Hall-Spencer, J.M., Moore, P.G. (2000) Scallop dredging has profound, long-term impacts on maerl habitats. *ICES Journal of Marine Science*, 57(5): 1407–1415. 10.1006/jmsc.2000.0918

Hayes, L., Lukić, I., Moy, S.R., Fagerli, C.W., Rinde, E., Christie, H., Bekkby, T. (2024) Effects of wave exposure and habitat fragmentation on growth and grazing of rocky shore seaweeds: a mesocosm experiment. *Marine Biology*, 171(7): 145. 10.1007/s00227-024-04456-9

Henriques, P. (1980) Faunal community structure of eight soft shore, intertidal habitats in the Manukau harbour. *New Zealand Journal of Ecology*, 3: 97–103. https://newzealandecology.org/nzje/1475

Hine, M., Diggles, D.B.K. (2002a) The distribution of *Perkinsus olseni* in New Zealand bivalve molluscs. *Surveillance*, 29: 8–11.

Hine, P.M., Diggles, B.K. (2002b) Prokaryote infections in the New Zealand scallops *Pecten novaezelandiae* and *Chlamys delicatula*. *Diseases of Aquatic Organisms*, 50: 137–144. https://www.int-res.com/journals/dao/articles/dao050137

Hine, P.M., Wesney, B. (1997) Virus-like particles associated with cytopathology in the digestive gland epithelium of scallops *Pecten novaezelandiae* and toheroa *Paphies ventricosum*. *Diseases of Aquatic Organisms*, 29: 197–204. https://www.int-res.com/journals/dao/articles/dao029197

Hohaia, A., Vopel, K., Pilditch, C.A. (2013) Thin terrestrial sediment deposits on intertidal sandflats: effects on pore water solutes and juvenile bivalve burial behaviour. *Biogeosciences Discussions*, 10(9): 14835–14860. 10.5194/bgd-10-14835-2013

Hooper, C., Hardy-Smith, P., Handlinger, J. (2007) Ganglioneuritis causing high mortalities in farmed Australian abalone (*Haliotis laevigata* and *Haliotis rubra*). *Australian Veterinary Journal*, 85(5): 188–193. https://doi.org/10.1111/j.1751-0813.2007.00155.x

Hoppe-Speer, S.C.L., Adams, J.B., Rajkaran, A. (2013) Response of mangroves to drought and non-tidal conditions in St Lucia Estuary, South Africa. *African Journal of Aquatic Science*, 38(2): 153–162. 10.2989/16085914.2012.759095

Houvener, J., Moreu, I., Cacabelos, E., Gestoso, I., Babarro, J.M.F., Lenz, M. (2025) Entangled ecosystems: the impact of macroplastic litter on *Mytilus galloprovincialis* communities in northwestern Spain. *Frontiers in Marine Science*, Volume 12 - 2025. 10.3389/fmars.2025.1677044

Howells, J., Jaramillo, D., Brosnahan, C.L., Pande, A., Lane, H.S. (2021) Intracellular bacteria in New Zealand shellfish are identified as *Endozoicomonas* species. *Diseases of Aquatic Organisms*, 143: 27–37. https://www.int-res.com/journals/dao/articles/dao03547

Howells, J., Maria, L., Shirkey, T., Carrington, A., Lane, H.S. (2024) Testing a health baseline during a bivalve mollusc mortality event: An investigation into die-offs of pipi *Paphies australis* from Aotearoa New Zealand. *Journal of Invertebrate Pathology*, 204: 108110. https://doi.org/10.1016/j.jip.2024.108110

Jara, R., Varas, O., Aldana, M., Delgado-Rioseco, J., Duarte, C., Quijón, P., Maggi, E., Blanco, F., Pulgar, J. (2025) The influence of artificial light at night on algal phenol concentrations can mediate herbivore–algal interactions. *Proceedings of the Royal Society B: Biological Sciences*, 292(2054). 10.1098/rspb.2025.1600

Jokiel, P.L., Rodgers, K.S., Kuffner, I.B., Andersson, A.J., Cox, E.F., Mackenzie, F.T. (2008) Ocean acidification and calcifying reef organisms: a mesocosm investigation. *Coral Reefs*, 27(3): 473–483. 10.1007/s00338-008-0380-9

Jolivet, A., Tremblay, R., Olivier, F., Gervaise, C., Sonier, R., Genard, B., Chauvaud, L. (2016) Validation of trophic and anthropic underwater noise as settlement trigger in blue mussels. *Scientific Reports*, 6(1): 33829. 10.1038/srep33829

Jones, J.B. (1992) Environmental impact of trawling on the seabed: A review. *New Zealand Journal of Marine and Freshwater Research*, 26(1): 59–67. 10.1080/00288330.1992.9516500

Kang, C.-K., Lee, Y.-J., Han, E., Park, H.-J., Yun, S.-G., Lee, W.C. (2015) Effects of temperature and body size on the physiological energetics of the stalked sea squirt *Styela clava*. *Journal of Experimental Marine Biology and Ecology*, 462: 105–112. https://doi.org/10.1016/j.jembe.2014.10.026

Keeling, S.E., Brosnahan, C.L., Williams, R., Gias, E., Hannah, M., Bueno, R., McDonald, W.L., Johnston, C. (2014) New Zealand juvenile oyster mortality associated with ostreid herpesvirus 1—an opportunistic longitudinal study. *Diseases of Aquatic Organisms*, 109: 231–239. https://www.int-res.com/journals/dao/articles/dao02735

Kim, H.-J., Suematsu, Y., Kaneda, H., Satuito, C.G. (2021) Light wavelength and intensity effects on larval settlement in the Pacific oyster *Magallana gigas*. *Hydrobiologia*, 848(7): 1611–1621. 10.1007/s10750-021-04550-9

Koch, M.S., Schopmeyer, S.A., Nielsen, O.I., Kyhn-Hansen, C., Madden, C.J. (2007) Conceptual model of seagrass die-off in Florida Bay: Links to biogeochemical processes. *Journal of Experimental Marine Biology and Ecology*, 350(1): 73–88. https://doi.org/10.1016/j.jembe.2007.05.031

Kurihara, T., Nakano, S., Matsuyama, Y., Hashimoto, K., Yamada, K., Ito, A., Kanematsu, M. (2018) Survival time of juvenile pen shell *Atrina pectinata* (Bivalvia: Pinnidae) in hyposaline water. *International Aquatic Research*, 10(1): 1–11. 10.1007/s40071-017-0183-0

Lam-Gordillo, O., Douglas, E.J., Hailes, S.F., Cummings, V., Lohrer, A.M. (2025) Effects of in situ experimental warming on metabolic expression in a soft sediment bivalve. *Scientific Reports*, 15(1): 1812. 10.1038/s41598-025-86310-6

Lane, H.S., Brosnahan, C.L., Poulin, R. (2022) Aquatic disease in New Zealand: synthesis and future directions. *New Zealand Journal of Marine and Freshwater Research*, 56(1): 1–42. 10.1080/00288330.2020.1848887

Lane, H.S., Jaramillo, D., Sharma, M. (2023) *Perkinsus olseni* in green-lipped mussels *Perna canaliculus*: diagnostic evaluation, prevalence, and distribution. *Diseases of Aquatic Organisms*, 155: 175–185. https://www.int-res.com/journals/dao/articles/dao03750

Lane, H.S., Webb, S.C., Duncan, J. (2016) *Bonamia ostreae* in the New Zealand oyster *Ostrea chilensis*: a new host and geographic record for this haplosporidian parasite. *Diseases of Aquatic Organisms*, 118: 55–63. https://www.int-res.com/journals/dao/articles/dao02960

Le, D.M. (2022) Thermal tolerance of the giant kelp *Macrocystis pyrifera*. University of Otago, PhD thesis. https://ourarchive.otago.ac.nz/esploro/outputs/doctoral/Thermal-tolerance-of-the-giant-kelp/9926478946701891#file-0

Ledoux, T., Clements, J.C., Comeau, L.A., Cervello, G., Tremblay, R., Olivier, F., Chauvaud, L., Bernier, R.Y., Lamarre, S.G. (2023) Effects of anthropogenic sounds on the behavior and physiology of the Eastern oyster (*Crassostrea virginica*). *Frontiers in Marine Science*, Volume 10 - 2023. 10.3389/fmars.2023.1104526

Liu, C., Shang, Y., Gul, S., Hu, M., Wang, Y. (2025) Energetic Adaptations of Bivalves Under Environmental Stress: A Comprehensive Review on Bioenergetics and Aquaculture Sustainability. *Reviews in Aquaculture*, 17(4): e70052. https://doi.org/10.1111/raq.70052

Lohrer, A.M., MacDonald, I.T., Bulmer, R.H., Douglas, E.J., Massuger, J., Rodil, I.F., Attard, K.M., Norkko, A., Berg, P. (2024) Implications of increased intertidal inundation on seagrass net primary production. *Estuarine, Coastal and Shelf Science*, 298: 108636. https://doi.org/10.1016/j.ecss.2024.108636

Luarte, T., Bonta, C.C., Silva-Rodriguez, E.A., Quijón, P.A., Miranda, C., Farias, A.A., Duarte, C. (2016) Light pollution reduces activity, food consumption and growth rates in a sandy beach invertebrate. *Environmental Pollution*, 218: 1147–1153. https://doi.org/10.1016/j.envpol.2016.08.068

Lynn, K.D., Quintanilla-Ahumada, D., Duarte, C., Quijón, P.A. (2024) Artificial light at night alters the feeding activity and two molecular indicators in the plumose sea anemone *Metridium senile* (L.). *Marine Pollution Bulletin*, 202: 116352. https://doi.org/10.1016/j.marpolbul.2024.116352

Lynn, K.D., Tummon Flynn, P., Manríquez, K., Manríquez, P.H., Pulgar, J., Duarte, C., Quijón, P.A. (2021) Artificial light at night alters the settlement of acorn barnacles on a man-made habitat in Atlantic Canada. *Marine Pollution Bulletin*, 163: 111928. https://doi.org/10.1016/j.marpolbul.2020.111928

MacDiarmid, A., McKenzie, A., Sturman, J., Beaumont, J., Mikaloff-Fletcher, S., Dunne, J. (2012) Assessment of anthropogenic threats to New Zealand marine habitats. *New Zealand Aquatic Environment and Biodiversity Report*, No. 93: 255.

Maggi, E., Bongiorni, L., Fontanini, D., Capocchi, A., Dal Bello, M., Giacomelli, A., Benedetti-Cecchi, L. (2020) Artificial light at night erases positive interactions across trophic levels. *Functional Ecology*, 34(3): 694–706. https://doi.org/10.1111/1365-2435.13485

Manríquez, K., Quijón, P.A., Manríquez, P.H., Miranda, C., Pulgar, J., Quintanilla-Ahumada, D., Duarte, C. (2021a) Artificial Light at Night (ALAN) negatively affects the settlement success of two prominent intertidal barnacles in the southeast Pacific. *Marine Pollution Bulletin*, 168: 112416. https://doi.org/10.1016/j.marpolbul.2021.112416

Manríquez, P.H., González, C.P., Abarca, A., Jofré, V., Astudillo, O., Aguilera, V.M. (2024) 'Behavioural and physiological responses of the surf clam *Mesodesma donacium* to brine discharges'. *Science of the Total Environment*, 922: 171233. https://doi.org/10.1016/j.scitotenv.2024.171233

Manríquez, P.H., Jara, M.E., Diaz, M.I., Quijón, P.A., Widdicombe, S., Pulgar, J., Manríquez, K., Quintanilla-Ahumada, D., Duarte, C. (2019) Artificial light pollution influences behavioral and physiological traits in a keystone predator species, *Concholepas concholepas*. *Science of the Total Environment*, 661: 543–552. https://doi.org/10.1016/j.scitotenv.2019.01.157

Manríquez, P.H., Jara, M.E., González, C.P., Seguel, M., Quijón, P.A., Widdicombe, S., Pulgar, J.M., Quintanilla-Ahumada, D., Anguita, C., Duarte, C. (2021b) Effects of artificial light at night and predator cues on foraging and predator avoidance in the keystone inshore mollusc *Concholepas concholepas*. *Environmental Pollution*, 280: 116895. https://doi.org/10.1016/j.envpol.2021.116895

Marangoni, L.F.B., Davies, T., Smyth, T., Rodríguez, A., Hamann, M., Duarte, C., Pendoley, K., Berge, J., Maggi, E., Levy, O. (2022) Impacts of artificial light at night in marine ecosystems—A review. *Global Change Biology*, 28(18): 5346–5367. https://doi.org/10.1111/gcb.16264

Marsden, I.D., Bressington, M.J. (2009) Effects of macroalgal mats and hypoxia on burrowing depth of the New Zealand cockle (*Austrovenus stutchburyi*). *Estuarine, Coastal and Shelf Science*, 81(3): 438–444. https://doi.org/10.1016/j.ecss.2008.11.022

Marsden, I.D., Taylor, G. (2010) Impacts of Vehicles on Junvenile Tuatua, *Pahies donacina* on Pegasus Bay Surf Beaches. *University of Canterbury Estuarine Research Report*, 38: 32. https://ref.coastalrestorationtrust.org.nz/site/assets/files/9826/c17c_143079_pu1c_7288_report_estuarine_research_report_38_impacts_of_vehicles_on_juvenile_tuatua_paphies_donacina_on_pe.pdf

Marsden, J.R. (1988) Light responses of the larva of the serpulid polychaete *Galeolaria caespitosa*. *Marine Biology*, 99(3): 397–407. 10.1007/BF02112133

Mason, J.M., Blain, C.O. (2024) Vulnerability of kelp, *Ecklonia radiata*, to persistent nitrogen pollution and coastal darkening. *Marine Biology*, 171(12): 225. 10.1007/s00227-024-04545-9

Matheson, F.E., Schwarz, A.M. (2007) Growth responses of *Zostera capricorni* to estuarine sediment conditions. *Aquatic Botany*, 87(4): 299–306. https://doi.org/10.1016/j.aquabot.2007.07.002

Mbense, S., Rajkaran, A., Bolosha, U., Adams, J. (2016) Rapid colonization of degraded mangrove habitat by succulent salt marsh. *South African Journal of Botany*, 107: 129–136. https://doi.org/10.1016/j.sajb.2016.06.011

McDougall, D.R., Toone, T.A., Jeffs, A.G. (2022) Natural heavy metal concentrations in seawater as a possible cause of low survival of larval mussels. *Journal of Trace Elements in Medicine and Biology*, 74: 127071. https://doi.org/10.1016/j.jtemb.2022.127071

McGreer, E.R. (1982) Factors affecting the distribution of the bivalve, *Macoma balthica* (L.) on a mudflat receiving sewage effluent, Fraser river estuary, British Columbia. *Marine Environmental Research*, 7(2): 131–149. https://doi.org/10.1016/0141-1136(82)90038-1

Micaroni, V., Bell, J.J., Strano, F. (2024) Ecologically significant shallow-water (0–30 m) marine animal forests in central New Zealand. *Global Ecology and Conservation*, 54: e03140. https://doi.org/10.1016/j.gecco.2024.e03140

Ministry of Fisheries (2007) Draft Coromandel scallop fishery plan, May 2007: 47. https://fs.fish.govt.nz/Doc/16401/CoromandelscallopsfisheriesplanAppendix1informationbriefMay07.pdf.ashx

Mobilia, V., Cummings, V.J., Clark, M.R., Tracey, D., Bell, J.J. (2021) Short-term physiological responses of the New Zealand deep-sea sponge *Ecionemia novaezealandiae* to elevated concentrations of suspended sediments. *Journal of Experimental Marine Biology and Ecology*, 541: 151579. https://doi.org/10.1016/j.jembe.2021.151579

Molin, J.M., Groth-Andersen, W.E., Hansen, P.J., Kühl, M., Brodersen, K.E. (2023) Microplastic pollution associated with reduced respiration in seagrass (*Zostera marina* L.) and associated epiphytes. *Frontiers in Marine Science*, Volume 10 - 2023. 10.3389/fmars.2023.1216299

Montory, J.A., Pérez-Valdes, M., Colipan, E., Chaparro, O.R., Cubillos, V.M., Lee, M.R., Ramírez-Kuschel, E., Gebauer, P., Salas-Yanquin, L.P., Büchner-Miranda, J.A. (2025) Effects of low salinities on the physiological and cellular response of the Ascidian Pyura chilensis: an experimental approach. *Marine Biology*, 172(11): 166. 10.1007/s00227-025-04713-5

Morrisey, D., Cameron, M., Newcombe, E. (2018) Effects of moorings on different types of marine habitat. *Cawthron Report*, No. 3098: 41.

https://www.envirolink.govt.nz/assets/Envirolink/Reports/1815-MLDC137-Effects-of-moorings-on-different-types-of-marine-habitats.pdf

Morrisey, D.J., Swales, A., Dittmann, S., Morrison, M., Lovelock, C., Beard, C. (2010) The ecology and management of temperate mangroves. *Oceanography and Marine Biology - An Annual Review*, 48: 43–160.

Moyse, E., Firth, L.B., Smyth, T., Davies, T.W. (2025) Artificial light at night alters seaweed reproductive phenology. *Environmental Pollution*, 385: 127155. https://doi.org/10.1016/j.envpol.2025.127155

Naidoo, G., Hiralal, T., Naidoo, Y. (2014) Ecophysiological responses of the mangrove *Avicennia marina* to trace metal contamination. *Flora - Morphology, Distribution, Functional Ecology of Plants*, 209(1): 63–72. https://doi.org/10.1016/j.flora.2013.10.003

Naidoo, G., Naidoo, Y., Achar, P. (2010) Responses of the mangroves *Avicennia marina* and *Bruguiera gymnorrhiza* to oil contamination. *Flora - Morphology, Distribution, Functional Ecology of Plants*, 205(5): 357–362. https://doi.org/10.1016/j.flora.2009.12.033

Navarro, J.M., Gonzalez, C.M. (1998) Physiological responses of the Chilean scallop *Argopecten purpuratus* to decreasing salinities. *Aquaculture*, 167(3): 315–327. https://doi.org/10.1016/S0044-8486(98)00310-X

Nelson, D.A., Miller, J.E., Calabrese, A. (1988) Effect of heavy metals on bay scallops, surf clams, and blue mussels in acute and long-term exposures. *Archives of Environmental Contamination and Toxicology*, 17(5): 595–600. 10.1007/BF01055828

Nelson, P., Behrens, D., Castle, J., Crawford, G., Gaddam, R., Hackett, S., Largier, J., Lohse, D., Mills, K., Raimondi, P., Robart, M., Sydeman, W., Thompson, S., Woo, S. (2008) Developing Wave Energy In Coastal California: Potential Socio-Economic and Environmental Effects. California Energy Commission, PIER Energy-Related Environmental Research Program & California Ocean Protection Council. CEC-500-2008-083.

Nelson, W., Neill, K., Farr, T., Barr, N., D'Archino, R., Miller, S., Stewart, R. (2012) Rhodolith Beds in Northern New Zealand: Characterisation of Associated Biodiversity and Vulnerability to Environmental Stressors. *New Zealand Aquatic Environment and Biodiversity Report*, No. 99: 106.

Nielsen, M.V., Strömgren, T. (1985) The effect of light on the shell length growth and defaecation rate of *Mytilus edulis* (L.). *Aquaculture*, 47(2): 205–211. https://doi.org/10.1016/0044-8486(85)90066-3

Norkko, A., Hewitt, J.E., Thrush, S.F., Funnell, G.A. (2001) Benthic-pelagic coupling and suspension-feeding bivalves: Linking site-specific sediment flux and biodeposition to benthic community structure. *Limnology and Oceanography*, 46(8): 2067–2072. 10.4319/lo.2001.46.8.2067

Norkko, A., Hewitt, J.E., Thrush, S.F., Funnell, G.A. (2006a) Conditional outcomes of facilitation by a habitat-modifying subtidal bivalve. *Ecology*, 87(1): 226–234. 10.1890/05-0176

Norkko, A., Thrush, S.F., Hewitt, J.E., Cummings, V.J., Norkko, J., Ellis, J.I., Funnell, G.A., Schultz, D., MacDonald, I. (2002) Smothering of estuarine sandflats by terrigenous clay: The role of wind-wave disturbance and bioturbation in site-dependent macrofaunal recovery. *Marine Ecology Progress Series*, 234: 23–41. 10.3354/meps234023

Norkko, J., Hewitt, J.E., Thrush, S.F. (2006b) Effects of increased sedimentation on the physiology of two estuarine soft-sediment bivalves, *Austrovenus stutchbury*i and *Paphies australis*. *Journal of Experimental Marine Biology and Ecology*, 333(1): 12–26. 10.1016/jjembe.2005.11.015

Nousek-McGregor, A.E., Mei, F.T.L. (2016) Does Noise From Shipping and Boat Traffic Affect Predator Vigilance in the European Common Hermit Crab? In: A.N. Popper & A. Hawkins (Eds). *The Effects of Noise on Aquatic Life II*. Springer New York, New York, NY: 767–774.

O'Connell-Milne, S.A., Poulin, R., Savage, C., Rayment, W. (2016) Reduced growth, body condition and foot length of the bivalve *Austrovenus stutchburyi* in response to parasite infection. *Journal of Experimental Marine Biology and Ecology*, 474: 23–28. https://doi.org/10.1016/j.jembe.2015.09.012

Olivier, F., Gigot, M., Mathias, D., Jezequel, Y., Meziane, T., L'Her, C., Chauvaud, L., Bonnel, J. (2022) Assessing the impacts of anthropogenic sounds on early stages of benthic invertebrates: The “*Larvosonic* system”. *Limnology and Oceanography Methods*, 21(2): 56–68. https://doi.org/10.1002/lom3.10527Digital

Orchard, S., Fischman, H.S., Gerrity, S., Alestra, T., Dunmore, R., Schiel, D.R. (2021) Threshold Effects of Relative Sea-Level Change in Intertidal Ecosystems: Empirical Evidence from Earthquake-Induced Uplift on a Rocky Coast. *GeoHazards*, 2(4): 302–320. https://www.mdpi.com/2624-795X/2/4/16

Orchard, S., Hughey, K.F.D., Schiel, D.R. (2020) Risk factors for the conservation of saltmarsh vegetation and blue carbon revealed by earthquake-induced sea-level rise. *Science of the Total Environment*, 746: 141241. https://doi.org/10.1016/j.scitotenv.2020.141241

Park, S. (1999) Changes in abundance of seagrass (*Zostera spp*.) in Tauranga Harbour from 1959–96. *Environment Bay of Plenty Report*, 99/30: 19p.

Partridge, T.R. (1987) *Spartina* in New Zealand *New Zealand Journal of Botany*, 25: 567–575. https://www.tandfonline.com/doi/pdf/10.1080/0028825X.1987.10410087

Peng, C., Zhao, X., Liu, S., Shi, W., Han, Y., Guo, C., Jiang, J., Wan, H., Shen, T., Liu, G. (2016) Effects of anthropogenic sound on digging behavior, metabolism, Ca2+/Mg2+ ATPase activity, and metabolism-related gene expression of the bivalve *Sinonovacula constricta*. *Scientific Reports*, 6(1): 24266. 10.1038/srep24266

Peteiro, L.G., Woodin, S.A., Wethey, D.S., Costas-Costas, D., Martínez-Casal, A., Olabarria, C., Vázquez, E. (2018) Responses to salinity stress in bivalves: Evidence of ontogenetic changes in energetic physiology on *Cerastoderma edule*. *Scientific Reports*, 8(1): 8329. 10.1038/s41598-018-26706-9

Pine, M., Jeffs, A., Radford, C. (2015) Effects of Underwater Turbine Noise on Crab Larval Metamorphosis. *Advances in experimental medicine and biology*, 875: 847–852. 10.1007/978-1-4939-2981-8_104

Pineda, M.-C., Strehlow, B., Duckworth, A., Doyle, J., Jones, R., Webster, N.S. (2016) Effects of light attenuation on the sponge holobiont- implications for dredging management. *Scientific Reports*, 6(1): 39038. 10.1038/srep39038

Pridmore, R.D., Thrush, S.F., Wilcock, R.J., Smith, T.J., Hewitt, J.E., Cummings, V.J. (1991) Effect of the organochlorine pesticide technical chlordane on the population structure of suspension and deposit feeding bivalves. *Marine Ecology Progress Series*, 76(3): 261–271. http://www.jstor.org/stable/24825586

Probert, P.K., Mcknight, D.G., Grove, S.L. (1997) Benthic invertebrate bycatch from a deep-water trawl fishery, Chatham Rise, New Zealand. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 7(1): 27–40. https://doi.org/10.1002/(SICI)1099-0755(199703)7:1<27::AID-AQC214>3.0.CO;2-9

Rabalais, N. (2019) 8.7 The significance of ocean deoxygenation for estuarine and coastal benthos. In: D. Loffoley & J. Baxter (Eds). *Ocean deoxygenation: Everyone's problem. Causes, impacts, consequences and solutions*. IUCN: 379–399.

Rajkaran, A., Adams, J., Taylor, R. (2009) Historic and recent (2006) state of mangroves in small estuaries from Mlalazi to Mtamvuna in KwaZulu-Natal, South Africa. *Southern Forests: a Journal of Forest Science*, 71(4): 287–296. 10.2989/SF.2009.71.4.6.1033

Ralph, P., Tomasko, D., Moore, K., Seddon, S., Macinnis-Ng, C., Larkum, A., Orth, R., Duarte, C. (2006) Human Impacts on Seagrasses: Eutrophication, Sedimentation, and Contamination. *Seagrasses: Biology, Ecology and Conservation*. Springer, Dordrecht: 567–593. 10.1007/1-4020-2983-7_24

Ralph, P.J., Short, F.T. (2002) Impact of the wasting disease pathogen, *Labyrinthula zosterae*, on the photobiology of eelgrass *Zostera marina*. *Marine Ecology Progress Series*, 226: 265–271. https://www.int-res.com/journals/meps/articles/meps226265

Ramage, D.L., Schiel*, D.R. (1999) Patch dynamics and response to disturbance of the seagrass *Zostera novazelandica* on intertidal platforms in southern New Zealand. *Marine Ecology Progress Series*, 189: 275–288. https://www.int-res.com/journals/meps/articles/meps189275

Reece, K.S., Stokes, N.A. (2003) Molecular analysis of a haplosporidian parasite from cultured New Zealand abalone *Haliotis iris*. *Diseases of Aquatic Organisms*, 53: 61–66. https://www.int-res.com/journals/dao/articles/dao053061

Reeves, P., Champion, P. (2004) Effects of livestock grazing on wetlands: Literature review. *NIWA Client Report* HAM2004-059: 38.

Ren, J.S., Ragg, N.L.C., Cummings, V.J., Zhang, J. (2020) Ocean acidification and dynamic energy budget models: Parameterisation and simulations for the green-lipped mussel. *Ecological Modelling*, 426: 109069. https://doi.org/10.1016/j.ecolmodel.2020.109069

Reusch, T.B., Williams, S.L. (1998) Variable responses of native eelgrass *Zostera marina* to a non-indigenous bivalve *Musculista senhousia*. *Oecologia*, 113(3): 428–441. 10.1007/s004420050395

Ribeiro, F., Garcia, A.R., Pereira, B.P., Fonseca, M., Mestre, N.C., Fonseca, T.G., Ilharco, L.M., Bebianno, M.J. (2017) Microplastics effects in *Scrobicularia plana*. *Marine Pollution Bulletin*, 122(1): 379–391. https://doi.org/10.1016/j.marpolbul.2017.06.078

Rimondino, C., Torre, L., Sahade, R., Tatián, M. (2015) Sessile macro-epibiotic community of solitary ascidians, ecosystem engineers in soft substrates of Potter Cove, Antarctica. *Polar Research*, 34(0). 10.3402/polar.v34.24338

Riul, P., Targino, C.H., Farias, J.D.N., Visscher, P.T., Horta, P.A. (2008) Decrease in *Lithothamnion sp.* (Rhodophyta) primary production due to the deposition of a thin sediment layer. *Journal of the Marine Biological Association of the United Kingdom*, 88(1): 17–19. 10.1017/S0025315408000258

Roberts, L., Cheesman, S., Breithaupt, T., Elliott, M. (2015) Sensitivity of the mussel Mytilus edulis to substrate-borne vibration in relation to anthropogenically generated noise. *Marine Ecology Progress Series*, 538: 185–195. https://www.int-res.com/journals/meps/articles/meps11468

Roper, D.S., Hickey, C.W. (1994) Behavioral-responses of the marine bivalve *Macomona liliana* exposed to copper-dosed and chlordane-dosed sediments. *Marine Biology*, 118(4): 673–680. 10.1007/bf00347515

Roper, D.S., Thrush, S.F., Smith, D.G. (1988) The influence of runoff on intertidal mudflat benthic communities. *Marine Environmental Research*, 26(1): 1–8. 10.1016/0141-1136(88)90031-1

Ross, P. (2020) Assessment of impacts of mechanical spat harvesting on the surf clams of Te Oneroa-a-Tōhē. *New Zealand Aquatic Environment and Biodiversity Report*, 250: 27.

Ross, P.M., Battershill, C.N., Loomb, C. (2016a) The wreck of the MV Rena: spatio-temporal analysis of ship-derived contaminants in the sediments and fauna of Astrolabe Reef. *New Zealand Journal of Marine and Freshwater Research*, 50(1): 87–114. 10.1080/00288330.2015.1077873

Ross, P.M., Beentjes, M.P., Cope, J., de Lange, W.P., McFadgen, B.G., Redfearn, P., Searle, B., Skerrett, M., Smith, H., Smith, S., Te Tuhi, J., Tamihana, J., Williams, J.R. (2018a) The biology, ecology and history of toheroa (*Paphies ventricosa*): a review of scientific, local and customary knowledge. *New Zealand Journal of Marine and Freshwater Research*, 52(2): 196–231. 10.1080/00288330.2017.1383279

Ross, P.M., Fairweather, R.M., Culliford, D.P., Park, S., Pilditch, C.A., Battershill, C.N. (2016b) In situ sampling reveals rapid uptake and depuration of polycyclic aromatic hydrocarbons by surf clams (*Paphies subtriangulata*) affected by the Rena oil spill. *New Zealand Journal of Marine and Freshwater Research*, 50(1): 56–69. 10.1080/00288330.2015.1084934

Ross, P.M., Pande, A., Jones, J.B., Cope, J., Flowers, G. (2018b) First detection of gas bubble disease and Rickettsia-like organisms in *Paphies ventricosa*, a New Zealand surf clam. *Journal of Fish Diseases*, 41(1): 187–190. https://doi.org/10.1111/jfd.12684

Rowden, A., Berkenbusch, K., Brewin, P., Dalen, J., Neill, K., Nelson, W., Oliver, M., Probert, P., Schwarz, A.-M., Sui, P., Sutherland, D. (2012) A Review of the marine soft-sediment assemblages of New Zealand. *New Zealand Aquatic Environment and Biodiversity Report*, 96: 165.

Rowden, A., Cranfield, H.J., Mann, P., Wood, A. (2007) Benthic macrofauna bycatch of oyster dredging in Foveaux Strait. *New Zealand Fisheries Assessment Report*, 2007/10: 26.

Ruiz, M.B., Servetto, N., Alurralde, G., Abele, D., Harms, L., Sahade, R., Held, C. (2022) Molecular responses of a key Antarctic species to sedimentation due to rapid climate change. *Marine Environmental Research*, 180: 105720. https://doi.org/10.1016/j.marenvres.2022.105720

Rupp, G.S., Parsons, G.J. (2004) Effects of salinity and temperature on the survival and byssal attachment of the lion's paw scallop *Nodipecten nodosus* at its southern distribution limit. *Journal of Experimental Marine Biology and Ecology*, 309(2): 173–198. https://doi.org/10.1016/j.jembe.2004.03.018

Rybovich, M., Peyre, M.K.L., Hall, S.G., Peyre, J.F.L. (2016) Increased Temperatures Combined with Lowered Salinities Differentially Impact Oyster Size Class Growth and Mortality. *Journal of Shellfish Research*, 35(1): 101–113, 113. https://doi.org/10.2983/035.035.0112

Salmond, N.H., Wing, S.R. (2022) Sub-lethal and lethal effects of chronic ammonia exposure and hypoxia on a New Zealand bivalve. *Journal of Experimental Marine Biology and Ecology*, 549: 151696. https://doi.org/10.1016/j.jembe.2022.151696

Salmond, N.H., Wing, S.R. (2023) Sub-lethal and lethal effects of chronic and extreme multiple stressors on a critical New Zealand bivalve under hypoxia. *Marine Ecology Progress Series*, 703: 81–93. https://www.int-res.com/abstracts/meps/v703/p81-93/

Schiel, D., Breen, P. (1991) Population Structure, Ageing, and Fishing Mortality of the New Zealand Abalone *Haliotis iris*. *Fishery Bulletin*, 89(4): 681–691.

Schiel, D.R., Gerrity, S., Orchard, S., Alestra, T., Dunmore, R.A., Falconer, T., Thomsen, M.S., Tait, L.W. (2021) Cataclysmic Disturbances to an Intertidal Ecosystem: Loss of Ecological Infrastructure Slows Recovery of Biogenic Habitats and Diversity. *Frontiers in Ecology and Evolution*, Volume 9 - 2021. 10.3389/fevo.2021.767548

Schiel, D.R., Lilley, S.A. (2007) Gradients of disturbance to an algal canopy and the modification of an intertidal community. *Marine Ecology Progress Series*, 339: 1–11. https://www.int-res.com/journals/meps/articles/meps339001

Schiel, D.R., Lilley, S.A. (2011) Impacts and negative feedbacks in community recovery over eight years following removal of habitat-forming macroalgae. *Journal of Experimental Marine Biology and Ecology*, 407(1): 108–115. https://doi.org/10.1016/j.jembe.2011.07.004

Schiel, D.R., South, P.M., Lilley, S.A. (2016) Effects of the MV Rena oil spill on intertidal rocky reefs in the Bay of Plenty, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 50(1): 70–86. 10.1080/00288330.2015.1031682

Schiel, D.R., Taylor, D.I. (1999) Effects of trampling on a rocky intertidal algal assemblage in southern New Zealand. *Journal of Experimental Marine Biology and Ecology*, 235(2): 213–235. https://doi.org/10.1016/S0022-0981(98)00170-1

Schiel, D.R., Wood, S.A., Dunmore, R.A., Taylor, D.I. (2006) Sediment on rocky intertidal reefs: Effects on early post-settlement stages of habitat-forming seaweeds. *Journal of Experimental Marine Biology and Ecology*, 331(2): 158–172. https://doi.org/10.1016/j.jembe.2005.10.015

Schwarz, A.-M., Taylor, R., Hewitt, J., Phillips, N., Shima, J., Cole, R., Budd, R. (2006) Impacts of terrestrial run-off on the biodiversity of rocky reefs. *New Zealand Aquatic Environment and Biodiversity Report*, No. 7: 109.

Shears, N., Babcock, R. (2004) Community composition and structure of shallow subtidal reefs in northeastern New Zealand. *Science for Conservation*, 245: 65p.

Shears, N.T., Babcock, R.C. (2007) Quantitative description of mainland New Zealand's shallow subtidal reef communities. *Science for Conservation*, 280. Department of Conservation, Wellington. 126 p.,

Shellem, C.T., Pilditch, C.A., Schneider, D.C., Ellis, J.I. (2025) Salinity has a greater effect on sea star righting time than temperature. *New Zealand Journal of Marine and Freshwater Research*, 59(5): 1187–1201. 10.1080/00288330.2025.2506692

Shields, M.A., Woolf, D.K., Grist, E.P.M., Kerr, S.A., Jackson, A.C., Harris, R.E., Bell, M.C., Beharie, R., Want, A., Osalusi, E., Gibb, S.W., Side, J. (2011) Marine renewable energy: The ecological implications of altering the hydrodynamics of the marine environment. *Ocean & Coastal Management*, 54(1): 2–9. https://doi.org/10.1016/j.ocecoaman.2010.10.036

Siciliano, A., Schiel, D.R., Thomsen, M.S. (2019) Effects of local anthropogenic stressors on a habitat cascade in an estuarine seagrass system. *Marine & Freshwater Research*, 70(8): 1129–1142. 10.1071/mf18414

Sim-Smith, C., Lee, S., Daniel, S. (2023) Impacts of seabed disturbance in the Waikato region. *Waikato Regional Council Technical Report*, 2023/04. https://www.waikatoregion.govt.nz/assets/WRC/TR202304.pdf

Smith, F. (2008) Physiological effects of copper, cadmium and reduced salinity on intertidal and cultivated *Perna canaliculus* mussels. University of Canterbury, Unpublished MSc thesis: 244. http://dx.doi.org/10.26021/6206

Solan, M., Hauton, C., Godbold, J.A., Wood, C.L., Leighton, T.G., White, P. (2016) Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. *Scientific Reports*, 6(1): 20540. 10.1038/srep20540

Soliman, T., Inglis, G.J. (2018) Forecasting the economic impacts of two biofouling invaders on aquaculture production of green-lipped mussels *Perna canaliculus* in New Zealand. *Aquaculture Environment Interactions*, 10: 1–12. https://www.int-res.com/journals/aei/articles/aei00249

Spagnuolo, D., Genovese, G. (2024) Macroalgal Diseases: Exploring Biology, Pathogenesis, and Management Strategies. *Phycology*, 4(3): 450–464. https://www.mdpi.com/2673-9410/4/3/26

Speiser, D. (2009) Comparative Morphology of the Concave Mirror Eyes of Scallops (Pectinoidea)*. *American Malacological Bulletin*, 26: 27–33. 10.4003/006.026.0204

Spiga, I., Caldwell, G.S., Bruintjes, R. (2016) Influence of Pile Driving on the Clearance Rate of the Blue Mussel, *Mytilus edulis* (L.). *Proceedings of Meetings on Acoustics*, 27(1). 10.1121/2.0000277

Steller, D.L., Riosmena-Rodríguez, R., Foster, M.S., Roberts, C.A. (2003) Rhodolith bed diversity in the Gulf of California: the importance of rhodolith structure and consequences of disturbance. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 13(S1): S5–S20. https://doi.org/10.1002/aqc.564

Stenton-Dozey, J.M.E., Heath, P., Ren, J.S., Zamora, L.N. (2021) New Zealand aquaculture industry: research, opportunities and constraints for integrative multitrophic farming. *New Zealand Journal of Marine and Freshwater Research*, 55(2): 265–285. https://doi.org/10.1080/00288330.2020.1752266

Stevens, L., Southwick, M. (2021) Evaluation of a simple GIS-based methodology to determine estuary extent and assess potential changes in response to sea level rise. *Salt Ecology Report*, 057: 11.

Stocks, J., Broad, A., Radford, C., Minchinton, T., Davis, A. (2012) Response of Marine Invertebrate Larvae to Natural and Anthropogenic Sound: A Pilot Study. *The Open Marine Biology Journal*, 6: 57–61. 10.2174/1874450801206010057

Stuart, M. (2004) Review of research on *Undaria pinnatifida* in New Zealand and its potential impacts on the eastern coast of the South Island. *DOC Science Internal Series*, 166: 40.

Stubler, A.D., Duckworth, A.R., Peterson, B.J. (2015) The effects of coastal development on sponge abundance, diversity, and community composition on Jamaican coral reefs. *Marine Pollution Bulletin*, 96(1): 261–270. https://doi.org/10.1016/j.marpolbul.2015.05.014

Studer, A., Widmann, M., Poulin, R., Krkošek, M. (2013) Large scale patterns of trematode parasitism in a bivalve host: no evidence for a latitudinal gradient in infection levels. *Marine Ecology Progress Series*, 491: 125–135. https://www.int-res.com/abstracts/meps/v491/p125-135/

Sussarellu, R., Suquet, M., Thomas, Y., Lambert, C., Fabioux, C., Pernet, M.E.J., Le Goïc, N., Quillien, V., Mingant, C., Epelboin, Y., Corporeau, C., Guyomarch, J., Robbens, J., Paul-Pont, I., Soudant, P., Huvet, A. (2016) Oyster reproduction is affected by exposure to polystyrene microplastics. *Proceedings of the National Academy of Sciences*, 113(9): 2430–2435. doi:10.1073/pnas.1519019113

Tait, L. (2022) Giant Macrocystis forests. Distribution and trends for the Otago region. Prepared for Otago Regional Council. *NIWA Client Report* 2022233CH: 44.

Tait, L.W. (2019) Giant kelp forests at critical light thresholds show compromised ecological resilience to environmental and biological drivers. *Estuarine, Coastal and Shelf Science*, 219: 231–241. https://doi.org/10.1016/j.ecss.2019.02.026

Tait, L.W., Schiel, D.R. (2011) Legacy Effects of Canopy Disturbance on Ecosystem Functioning in Macroalgal Assemblages. *PLoS One*, 6(10): e26986. 10.1371/journal.pone.0026986

Tait, L.W., Schiel, D.R. (2013) Impacts of Temperature on Primary Productivity and Respiration in Naturally Structured Macroalgal Assemblages. *PLoS One*, 8(9): e74413. 10.1371/journal.pone.0074413

Tait, L.W., Thoral, F., Pinkerton, M.H., Thomsen, M.S., Schiel, D.R. (2021) Loss of Giant Kelp, *Macrocystis pyrifera*, Driven by Marine Heatwaves and Exacerbated by Poor Water Clarity in New Zealand. *Frontiers in Marine Science*, Volume 8 - 2021. 10.3389/fmars.2021.721087

Tallis, H., Wing, S.R., Frew, R.D. (2004) Historical Evidence for Habitat Conversion and Local Population Decline in a New Zealand Fjord. *Ecological Applications*, 14(2): 546–554. http://www.jstor.org/stable/4493557

Taylor, D.I., Schiel, D.R. (2003) Wave-related mortality in zygotes of habitat-forming algae from different exposures in southern New Zealand: the importance of 'stickability'. *Journal of Experimental Marine Biology and Ecology*, 290(2): 229–245. https://doi.org/10.1016/S0022-0981(03)00094-7

Thomas, F., Renaud, F., de Meeûs , T., Poulin, R. (1998) Manipulation of host behaviour by parasites: ecosystem engineering in the intertidal zone? *Proceedings of the Royal Society B: Biological Sciences*, 265(1401): 1091–1096. 10.1098/rspb.1998.0403

Thompson, R.M., Mouritsen, K.N., Poulin, R. (2005) Importance of parasites and their life cycle characteristics in determining the structure of a large marine food web. *Journal of Animal Ecology*, 74(1): 77–85. https://doi.org/10.1111/j.1365-2656.2004.00899.x

Thomsen, M., Adam, P., Silliman, B. (2009) Anthropogenic threats to Australasian coastal salt marshes. In: B. Silliman, M. Bertness & D. Strong (Eds). *Human Impacts on Salt Marshes: A Global Perspective*. University of California Press.

Thomsen, M., Stæhr, P., Nejrup, L., Schiel, D. (2013) Effects of the invasive macroalgae *Gracilaria vermiculophylla* on two co-occurring foundation species and associated invertebrates. *Aquatic Invasions*, 8(2): 133–145.

Thomsen, M.S., Alestra, T., Brockerhoff, D., Lilley, S.A., South, P.M., Schiel, D.R. (2018) Modified kelp seasonality and invertebrate diversity where an invasive kelp co-occurs with native mussels. *Marine Biology*, 165(10): 173. 10.1007/s00227-018-3431-y

Thomsen, M.S., Metcalfe, I., Siciliano, A., South, P.M., Gerrity, S., Alestra, T., Schiel, D.R. (2020) Earthquake-driven destruction of an intertidal habitat cascade. *Aquatic Botany*, 164: 103217. https://doi.org/10.1016/j.aquabot.2020.103217

Thomsen, M.S., Mondardini, L., Alestra, T., Gerrity, S., Tait, L., South, P.M., Lilley, S.A., Schiel, D.R. (2019) Local Extinction of Bull Kelp (*Durvillaea spp.*) Due to a Marine Heatwave. *Frontiers in Marine Science*, Volume 6 - 2019. 10.3389/fmars.2019.00084

Thomsen, M.S., Mondardini, L., Thoral, F., Gerber, D., Montie, S., South, P.M., Tait, L., Orchard, S., Alestra, T., Schiel, D.R. (2021) Cascading impacts of earthquakes and extreme heatwaves have destroyed populations of an iconic marine foundation species. *Diversity and Distributions*, 27(12): 2369–2383. https://doi.org/10.1111/ddi.13407

Thomsen, M.S., Wernberg, T., South, P.M., Schiel, D.R. (2016) Non-native Seaweeds Drive Changes in Marine Coastal Communities Around the World. In: Z.-M. Hu & C. Fraser (Eds).

Seaweed Phylogeography: Adaptation and Evolution of Seaweeds under Environmental Change. Springer Netherlands, Dordrecht: 147–185. 10.1007/978-94-017-7534-2_6

Thrush, S.F., Dayton, P.K. (2002) Disturbance to marine benthic habitats by trawling and dredging: Implications for marine biodiversity. *Annual Review of Ecology and Systematics*, 33(1): 449–473. doi:10.1146/annurev.ecolsys.33.010802.150515

Thrush, S.F., Hewitt, J.E., Cummings, V.J., Dayton, P.K., Cryer, M., Turner, S.J., Funnell, G.A., Budd, R.G., Milburn, C.J., Wilkinson, M.R. (1998) Disturbance of the marine benthic habitat by commercial fishing: Impacts at the scale of the fishery. *Ecological Applications*, 8(3): 866–879. https://doi.org/10.1890/1051-0761(1998)008[0866:DOTMBH]2.0.CO;2

Toone, T.A., Benjamin, E.D., Hillman, J.R., Handley, S., Jeffs, A. (2023) Multidisciplinary baselines quantify a drastic decline of mussel reefs and reveal an absence of natural recovery. *Ecosphere*, 14(3): e4390. https://doi.org/10.1002/ecs2.4390

Trethewy, M., Mayer-Pinto, M., Dafforn, K.A. (2023) Urban shading and artificial light at night alter natural light regimes and affect marine intertidal assemblages. *Marine Pollution Bulletin*, 193: 115203. https://doi.org/10.1016/j.marpolbul.2023.115203

Tricklebank, K.A., Grace, R.V., Pilditch, C.A. (2021) Decadal population dynamics of an intertidal bivalve (*Austrovenus stutchburyi*) bed: pre- and post- a mass mortality event. *New Zealand Journal of Marine and Freshwater Research*, 55(2): 352–374. 10.1080/00288330.2020.1772323

Turner, S., Schwarz, A.-M. (2006) Management and conservation of seagrass in New Zealand: an introduction. *Science for Conservation*, 264: 1–90.

Ugolini, A., Boddi, V., Mercatelli, L., Castellini, C. (2005) Moon orientation in adult and young sandhoppers under artificial light. *Proceedings of the Royal Society B: Biological Sciences*, 272(1577): 2189–2194. 10.1098/rspb.2005.3199

Underwood, C.N., Davies, T.W., Queirós, A.M. (2017) Artificial light at night alters trophic interactions of intertidal invertebrates. *Journal of Animal Ecology*, 86(4): 781–789. https://doi.org/10.1111/1365-2656.12670

Urlich, S.C., Handley, S.J. (2020) From ‘clean and green’ to ‘brown and down’: A synthesis of historical changes to biodiversity and marine ecosystems in the Marlborough Sounds, New Zealand. *Ocean & Coastal Management*, 198: 105349. https://doi.org/10.1016/j.ocecoaman.2020.105349

Veldkornet, D., Rajkaran, A., Paul, S., Naidoo, G. (2020) Oil induces chlorophyll deficient propagules in mangroves. *Marine Pollution Bulletin*, 150: 110667. https://doi.org/10.1016/j.marpolbul.2019.110667

Venter, L., Alfaro, A.C., Ragg, N.L.C., Delorme, N.J., Ericson, J.A. (2023) The effect of simulated marine heatwaves on green-lipped mussels, *Perna canaliculus*: A near-natural experimental approach. *Journal of Thermal Biology*, 117: 103702. https://doi.org/10.1016/j.jtherbio.2023.103702

Vignier, J., Champeau, O., Atalah, J., South, P., McDougall, D., Jeffs, A., Blackwell, D., Tremblay, L.A., Rolton, A. (2025) Land-derived metals impact the survival and settlement of larval mussels. *Environmental Pollution*, 367: 125675. https://doi.org/10.1016/j.envpol.2025.125675 von Moos, N., Burkhardt-Holm, P., Köhler, A. (2012) Uptake and Effects of Microplastics on Cells and Tissue of the Blue Mussel *Mytilus edulis* L. after an Experimental Exposure. *Environmental Science & Technology*, 46(20): 11327–11335. 10.1021/es302332w

Wale, M.A., Briers, R.A., Hartl, M.G.J., Bryson, D., Diele, K. (2019) From DNA to ecological performance: Effects of anthropogenic noise on a reef-building mussel. *Science of the Total Environment*, 689: 126–132. https://doi.org/10.1016/j.scitotenv.2019.06.380

Wale, M.A., Simpson, S.D., Radford, A.N. (2013a) Noise negatively affects foraging and antipredator behaviour in shore crabs. *Animal Behaviour*, 86(1): 111–118. https://doi.org/10.1016/j.anbehav.2013.05.001

Wale, M.A., Simpson, S.D., Radford, A.N. (2013b) Size-dependent physiological responses of shore crabs to single and repeated playback of ship noise. *Biology Letters*, 9(2). 10.1098/rsbl.2012.1194

Walsh, E.P., Arnott, G., Kunc, H.P. (2017) Noise affects resource assessment in an invertebrate. *Biology Letters*, 13(4). 10.1098/rsbl.2017.0098

Walther, B.A., Bergmann, M. (2022) Plastic pollution of four understudied marine ecosystems: a review of mangroves, seagrass meadows, the Arctic Ocean and the deep seafloor. *Emerg Top Life Sci*, 6(4): 371–387. 10.1042/etls20220017

Wang, S.V., Wrede, A., Tremblay, N., Beermann, J. (2022) Low-frequency noise pollution impairs burrowing activities of marine benthic invertebrates. *Environmental Pollution*, 310: 119899. https://doi.org/10.1016/j.envpol.2022.119899

Want, A., Waldman, S., Burrows, M.T., Side, J.C., Venugopal, V., Bell, M.C. (2024) Predicted ecological consequences of wave energy extraction and climate-related changes in wave exposure on rocky shore communities. *ICES Journal of Marine Science*, 81(7): 1263–1281. 10.1093/icesjms/fsae086

Watts, A.J.R., Urbina, M.A., Corr, S., Lewis, C., Galloway, T.S. (2015) Ingestion of Plastic Microfibers by the Crab *Carcinus maenas* and Its Effect on Food Consumption and Energy Balance. *Environmental Science & Technology*, 49(24): 14597–14604. 10.1021/acs.est.5b04026

White, K.N., Ambrosio, L.J., Edwards, C. (2021) Anthropogenic Sound in the Sea: Are Ascidians Affected? *Gulf and Caribbean Research*, 32(1): 1–7. https://doi.org/10.18785/gcr.3201.02

Wilkens, L.A. (2006) Chapter 5 Neurobiology and behaviour of the scallop. In: S.E. Shumway & G.J. Parsons (Eds). *Developments in Aquaculture and Fisheries Science*. Elsevier: 317–356. https://doi.org/10.1016/S0167-9309(06)80032-3

Wilkens, S.L., Stanley, J.A., Jeffs, A.G. (2012) Induction of settlement in mussel (*Perna canaliculus*) larvae by vessel noise. *Biofouling*, 28(1): 65–72. 10.1080/08927014.2011.651717

Williams, J., Sim-Smith, C., Paterson, C. (2013) Review of factors affecting the abundance of toheroa (*Paphies ventricosa*). *New Zealand Aquatic Environment and Biodiversity Report*, No. 114: 79.

Williams, S.L. (2007) Introduced species in seagrass ecosystems: Status and concerns. *Journal of Experimental Marine Biology and Ecology*, 350(1): 89–110. https://doi.org/10.1016/j.jembe.2007.05.032

Williams, U.-M. (2022) The effects of sedimentation on the physiology of living New Zealand brachiopods. University of Otago, MSc thesis.

Wilson, S., Blake, C., Berges, J.A., Maggs, C.A. (2004) Environmental tolerances of free-living coralline algae (maerl): implications for European marine conservation. *Biological Conservation*, 120(2): 279–289. https://doi.org/10.1016/j.biocon.2004.03.001

Winters, G., Nelle, P., Fricke, B., Rauch, G., Reusch, T.B.H. (2011) Effects of a simulated heat wave on photophysiology and gene expression of high- and low-latitude populations of Zostera marina. *Marine Ecology Progress Series*, 435: 83–95. https://www.int-res.com/abstracts/meps/v435/meps09213

Woods, C.M.C., Schiel, D.R. (1997) Use of seagrass *Zostera novazelandica* (Setchell, 1933) as habitat and food by the crab *Macrophthalmus hirtipes* (Heller, 1862) (Brachyura: Ocypodidae) on rocky intertidal platforms in southern New Zealand. *Journal of Experimental Marine Biology and Ecology*, 214(1): 49–65. https://doi.org/10.1016/S0022-0981(96)02767-0

Yeung, H.T.G., Caley, A., Mayer-Pinto, M. (2025) Artificial light at night reduces predation and herbivory rates in a nearshore reef. *Marine Environmental Research*, 204: 106908. https://doi.org/10.1016/j.marenvres.2024.106908

York, P.H., Gruber, R.K., Hill, R., Ralph, P.J., Booth, D.J., Macreadie, P.I. (2013) Physiological and Morphological Responses of the Temperate Seagrass *Zostera muelleri* to Multiple Stressors: Investigating the Interactive Effects of Light and Temperature. *PLoS One*, 8(10): e76377. 10.1371/journal.pone.0076377

Zabarte-Maeztu, I., Matheson, F.E., Manley-Harris, M., Davies-Colley, R.J., Hawes, I. (2021) Interaction of substrate muddiness and low irradiance on seagrass: A mesocosm study of Zostera muelleri. *Aquatic Botany*, 175: 103435. https://doi.org/10.1016/j.aquabot.2021.103435

Zabarte-Maeztu, I., Matheson, F.E., Manley-Harris, M., Davies-Colley, R.J., Oliver, M., Hawes, I. (2020) Effects of Fine Sediment on Seagrass Meadows: A Case Study of *Zostera muelleri* in Pāuatahanui Inlet, New Zealand. *Journal Of Marine Science And Engineering*, 8(9): 645. https://www.mdpi.com/2077-1312/8/9/645

Zhang, M., Gao, X., Luo, Q., Lin, S., Lyu, M., Luo, X., Ke, C., You, W. (2024) Risk assessment of persistent exposure to artificial light at night revealed altered behavior and metabolic patterns of marine nocturnal shellfish. *Ecological Indicators*, 160: 111807. https://doi.org/10.1016/j.ecolind.2024.111807

Zhang, P., Yongo, E., Feng, H., Pan, S., Sun, A., Zhou, L., Guo, Z., Ke, C. (2022) Effects of substrate, temperature, salinity, size and transportation on burrowing capacity of juvenile undulated surf clam *Paphia undulata*. *Aquaculture Research*, 53(7): 2796–2805. https://doi.org/10.1111/are.15794

Zhou, Z., Bouma, T.J., Fivash, G.S., Ysebaert, T., van Ijzerloo, L., van Dalen, J., van Dam, B., Walles, B. (2022) Thermal stress affects bioturbators' burrowing behavior: A mesocosm experiment on common cockles (*Cerastoderma edule*). *Science of the Total Environment*, 824: 153621. https://doi.org/10.1016/j.scitotenv.2022.153621