Key Ecological Areas of the
Hawke's Bay Coastal Marine Area

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Executive summary

A present priority for regional coastal management is the identification of Significant Conservation Areas (SCAs) for regional coastal plans. Key marine biodiversity and ecosystem datasets, increasingly available at national and regional scales, can be used to assist in the identification of significant sites, when screened to provide pertinent data. Hawke's Bay Regional Council contracted NIWA to review different criteria used to assess key ecological areas (KEA) and recommend a set of criteria to be used. Following this, NIWA acquired the relevant data, assessed comprehensiveness and gaps in data layers, and performed some initial spatial prioritisation using the collated data layers.

This report recommends a suite of selection criteria to Hawke's Bay Regional Council based on current national 'key ecological areas' (KEA) criteria, which are comprised of: 1) Uniqueness / rarity / endemism; 2) Importance for threatened / declining species and habitats; 3) Special importance for life history stages; 4) Biological productivity; 5) Biological diversity; 6) Naturalness; 7) Vulnerability, fragility, sensitivity or slow recovery; 8) Ecological function; and 9) Ecological services. SCAs, identified in the Hawke's Bay prior to the development of these criteria, were assessed across the KEA criteria to determine which criteria each SCA satisfied.

National datasets, collated as part of the central government Marine Protected Areas Science Advisory Group projects, along with datasets provided by Hawke's Bay Regional Council from the Hawke's Bay Information Review, were used to determine information available that satisfied the recommended key ecological area selection criteria. Datasets were collated across a broad area encompassing the Hawke's Bay Coastal Marine Area and neighbouring continental shelf and slope habitats. Numerous gaps or biases in the available data were apparent. Some of these are related to multiple sources of information that have not been amalgamated (e.g., seal haul outs) and others are likely to be filled if regional sources were updated (e.g., with national demersal and rocky reef fish). Data from national fish layers did not well relate to areas identified as important for local fisheries. Invertebrate data layers showed the least relevance in the Hawke's Bay broader region; many national layers (bryozoans, Vulnerable Marine Ecosystem taxa that are of high sensitivity to seafloor disturbance) either did not cover inshore Hawke Bay, or were poorly correlated with locally identified information on biotic habitats or other ecologically significant features.

A pilot scoping exercise, using the spatial decision support tool Zonation, showcased how the existing marine datasets (both national KEA and regional HBRC datasets) could be used to identify additional areas of significant conservation value in the Hawke's Bay region. The exploratory exercise demonstrated how the use of different data layers influences identification of priority areas and provided an initial set of ecologically significant areas, many of which had already been identified as SCAs through anecdotal or expert assessment. The exercise highlighted that Zonation could be used in conjunction with KEA criteria as a decision support tool. The set of ecologically significant areas identified by the exercise could be used within stakeholder participatory processes to further inform a more comprehensive assessment of ecological significant areas in the Hawke's Bay.

1 Introduction

1.1 Background and policy framework

In New Zealand, regional authorities have management responsibilities over the coastal marine area (CMA), which extends from mean high water springs (MHWS) out to 12 nm. Within this context, regional councils are obliged to give effect to policies listed in the Resource Management Act 1991 (RMA) and the New Zealand Coastal Policy Statement (NZCPS: DOC 2010). Specifically, regional councils must provide for the preservation of natural character of the coastal environment (including the CMA), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development (RMA Section 6(a)), and the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna (RMA Section 6(c) and NZCPS Policy 11). Ecological criteria have been used by many regional authorities in New Zealand to identify areas of significant indigenous vegetation and significant habitats of indigenous fauna.

The Hawke's Bay coastal marine area (CMA) is extensive, encompassing approximately 770,000 ha from MHWS out to the 12 nm boundary, and 353 km of shoreline from Mahanga Beach in the north to just south of Porangahau at its southern limit. The CMA is composed of diverse habitats ranging from estuarine intertidal sandflats, to shallow and deep rocky reefs, to deeper (> 200 m) continental slope habitats (Haggitt and Wade 2016). Twenty Significant Conservation Areas (SCAs), also commonly referred to as significant natural or ecological areas (SNAs, SEAs), have been identified based on anecdotal and/or expert assessment of areas of ecological significance in the Hawke's Bay CMA, however no systematic or comprehensive assessment of ecological significance has been completed in the region.

The Hawke's Bay Regional Council (HBRC) has acknowledged significant limitations in the data available to assess the status of the CMA, and is actively filling gaps in data required for effective coastal management. Haggitt and Wade (2016) reviewed and compiled available data on the marine environment for HBRC, and performed a gap analysis to inform research needs to enhance management of the CMA. Perceptions of a degraded marine ecosystem have also led to the formation of the Hawke's Bay Marine and Coastal Group (HBMaC), a multi-stakeholder group with representation from government agencies, tangata whenua, recreational and commercial fishing interests. This group was established in 2016 due to concerns over the perceived localised depletion of inshore finfish stocks and environmental degradation in the Hawke's Bay marine area. Key stressors include both sediment deposition from land-based activities, and bottom contact of commercial trawl gear. Increased understanding of the biodiversity and habitats of the Hawke's Bay will assist in identifying and mitigating against their stressors in the CMA.

Nationally, the Department of Conservation is addressing significant gaps in data on marine ecosystems and biodiversity, recently completing a study of key ecological area (KEA) criteria to inform placement of marine protected areas and other marine conservation management activities (Stephenson et al. 2018, Lundquist et al. 2020). This project involved compilation of all best available information that satisfied nine different ecological criteria that had been identified by the Marine Protected Areas Scientific Advisory Group (MSAG), a central government advisory group that includes the Department of Conservation, the Ministry for Primary Industries and the Ministry for the Environment. These criteria were based on seven criteria identified by Clark et al. (2014) to support the identification of Ecologically or Biologically Significant Areas (EBSAs), with two additional criteria to represent ecological function and services (Table 1-1). These national key ecological area layers provide a valuable opportunity to fill gaps in understanding of marine ecosystems in the Hawke's Bay. They also provide an opportunity to assess the ecological values protected within the current suite of regional areas of significant conservation value.

Table 1-1: National Key ecological area (KEA) criteria for marine ecosystems as identified by MSAG. Based on Freeman et al. (2017).

Key ecological area criteria as identified by MSAG	
1. Vulnerability, fragility, sensitivity of slow recovery.	6. Biological diversity.
2. Uniqueness / rarity / endemism.	7. Naturalness.
3. Special importance for life history stages.	8. Ecological function.
4. Importance for threatened / declining species and habitats.	9. Ecological services.
5. Biological productivity.	

Decision support tools such as the software Zonation can be used to identify areas of interest for their role in supporting biodiversity and other ecological services and functions. These tools are being widely used in New Zealand and internationally (e.g., Leathwick et al. 2008; Geange et al. 2017; Rowden et al. 2019) to inform spatial management and biodiversity prioritisation, and can be used by councils in informing location of areas of significant conservation value, and in providing background information on marine ecosystems to inform revisions of Regional Coastal Plans.

1.2 Scope

NIWA was contracted by HBRC to assess ecologically significant areas in the Hawkes Bay region using a combination of existing data collated as part of the national MSAG Key Ecological Areas project funded by the Department of Conservation (DOC) and regional layers collected as part of the HBRC Marine Information Review. This project included an assessment and recommendation of best available ecological significance criteria based on what has been used nationally and internationally, a spatial modelling approach to identify hotspots of ecological significance based on data available to evaluate these criteria, and an assessment of gaps in data availability to evaluate these criteria in the Hawke's Bay region.

Key tasks include:

1. Review and assessment of the different criteria used to determine ecological significance used at regional, national and international scales, and recommendation of the best criteria that would satisfy the objective of identifying KEAs.
2. Identification and acquisition of data layers of interest to HBRC, collated under the national Key Ecological Areas (KEA) project.
3. Inclusion of HBRC data layers collated during the Hawke's Bay Marine Information Review that may suit ecological significance criteria.
4. Performance of initial spatial prioritisation to identify key areas of ecological significance using collated data layers.
5. Assessment of comprehensiveness and gaps in data layers with respect to ecological significance criteria.

1.3 Report Outline

This report summarises analyses supporting the five key tasks, including the review, recommendation, and gap analysis of ecological significance criteria, description of datasets selected for analysis, and brief details of the spatial prioritisation methodology and the scenario parameters that were selected.

This report comprises six sections:

- Section 1 (above) provides an introduction to the background and scope of the report.
- Section 2 provides a brief review and assessment of ecological significance criteria, and recommends suitable criteria for the HBRC to inform statutory obligations within the RMA and NZCPS.
- Section 3 assesses existing Hawke's Bay Significant Conservation Areas (SCAs) against recommended ecological significance criteria.
- Section 4 summarises national and regional datasets available to inform ecological significance.
- Section 5 presents a preliminary prioritisation of the Hawke's Bay CMA based on collated data layers for ecological significance.
- Section 6 provides a short conclusion and recommendations, including identification of gaps to inform cost-effective collection of information required to better model KEAs in the future by the HBRC.

2 Review and assessment of ecological significance criteria

Various ecological criteria have been used in regional, national and international exercises to determine ecological significance in marine ecosystems. Fenwick (2018) demonstrated that there is no nationally agreed set of criteria for defining or identifying significant coastal biodiversity, though typically criteria used at a regional level overlap both with each other and with internationally identified criteria. In a review of regional criteria for identifying ecological significance, Fenwick (2018) compared regional criteria with two recent international sets of marine ecological criteria: that of Clark et al. (2014) which included criteria identified for prioritisation of Ecologically and Biologically Significant Areas (EBSAs) for the identification of offshore seamounts, and that of Asaad et al. (2017) for determining global biodiversity conservation priorities. The EBSA criteria have also been adapted by the Marine Protected Areas Scientific Advisory Group (MSAG) and provide a comprehensive set of criteria suggested by most regional, national and international reviews (Table 2-1). The national MSAG criteria do not include Representativeness, because while important for marine protection planning, this criterion is less important when referring to the identification of individual areas of ecological significance.

Table 2-1: National Key Ecological Area (KEA) Criteria. Based on criteria selected by the Marine Protected Areas Special Interest Group (MSAG) to inform identification of priority sites for marine protected areas (Freeman et al. 2017).

Criteria	Definition	Rationale	New Zealand Examples
Vulnerability, fragility, sensitivity, or slow recovery	Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.	In the absence of protection, associated biodiversity may not be able to persist.	Biogenic habitats, including bryozoan beds, sponge communities and coldwater corals. Low fecundity and, or high longevity (fish) species such as bramble sharks, hapuku, king tarakihi, orange roughy.
Uniqueness / rarity / endemism	Area contains either (i) unique ("the only one of its kind", rare (occurs only in a few locations) or endemic species, populations or communities; and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanography features.	These areas contain biodiversity that is irreplaceable; non-representation in protected areas may result in loss or reduction in biodiversity or features. These areas contribute towards larger-scale biodiversity.	Hydrothermal vents; seeps; areas containing co-occurring geographically restricted species; biogenic habitats.
Special importance for life history stages	Areas that are required for a population to survive and thrive.	Species' particular requirements make some areas more suitable for carrying out life history stages.	Fish spawning or nursery grounds; pinniped breeding colonies; migratory corridors; sites where animals aggregate for feeding.
Importance for threatened / declining species and habitats	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area	Protection may enable recovery or persistence of these threatened / declining species or habitats.	Estuaries with populations of threatened shorebirds; foraging areas for marine mammals and seabirds.

	with significant assemblages of such species.		
Biological productivity	Area containing species, populations or communities with comparatively higher natural biological productivity.	These areas can support enhanced growth and reproduction, and support wider ecosystems.	Hydrothermal vents; frontal zones; areas of upwelling.
Biological diversity	Area contains comparatively higher diversity of ecosystems, habitats, communities or species, or has higher genetic diversity.	These areas are important for evolutionary processes, for species' and ecosystem resilience and contribute towards large-scale biodiversity.	Structurally complex communities such as deepwater sponge and coral communities; seamounts. Areas with high diversity of fish and invertebrate species.
Naturalness	Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation.	Provides enhanced ability to protect biodiversity that is in better condition; reduces need to rely on recovery from degraded state (recovery may occur on a different trajectory); these areas may include species and/or habitats that do not occur or are not represented well in more degraded areas; important role as reference sites.	Remote areas; marine areas adjacent to protected terrestrial areas; areas not impacted by bottom trawling or invasive species.
Ecological function	Area containing species or habitats that have comparatively higher contributions to supporting how ecosystems function.	Some species, habitats or physical processes play particularly important roles in supporting how ecosystems function – their protection provides coincidental protection for a range of other species and wider ecosystem health.	Soft sediment habitats containing high densities of bioturbators; areas of high functional trait diversity; areas with functionally important mesopelagic communities (including myctophids).
Ecosystem services	Area containing diversity of ecosystem services; and/or areas of particular importance for ecosystem services.	Provides for ability to protect species and habitats that provide particularly important services to humans. Provides ability to better contribute to CBD Aichi Target 11[1].	Areas containing dense populations of filter-feeding invertebrates; areas important for seafood provisioning. Areas important for supporting or regulating ecosystem services (e.g., areas of nutrient regeneration, biogenic habitat provision, carbon sequestration,

[1] In decision X/2, the tenth meeting of the Conference of the Parties of the Convention on Biological Diversity (CBD), held from 18 to 29 October 2010, in Nagoya, Aichi Prefecture, Japan, adopted a revised and updated Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets, for the 2011-2020 period. Target 11 states that: *By 2020, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape*.

			sediment retention, gas balance, bioremediation of contaminants, storm protection) that underpin the delivery of provisioning or cultural ecosystem services.

These national 'MSAG' criteria generally align with international criteria, and can be associated with the requirements for biodiversity protection in the NZCPS (DOC 2010) (Table 2-2). In addition, we present a summary of Fenwick's review of regional council criteria, compared to the MSAG criteria (whereas Fenwick used the Asaad et al. (2017) criteria for his comparison (Table 2-3)).

Table 2-2: Comparison of MSAG key ecological area criteria with international criteria and with national NZCPS. CBD criteria are those reported by Clark et al. (2014) for the identifications of EBSAs. Universal criteria are international criteria developed by Asaad et al. (2017) for identifying areas important for biodiversity conservation. NZCPS refers to clauses within the New Zealand Coastal Policy Statement (DOC 2010) with respect to biodiversity protection. Expanded analysis based on review of criteria presented in Fenwick (2018)

MSAG Criteria	CBD criteria	Universal criteria	NZ CPS
Uniqueness / rarity / endemism	**Uniqueness or rarity**: Area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features.	**Restricted range species and/or habitats**. An area inhabited by a species that has a restricted geographic distribution. If naturally restricted this is an 'endemic' species. **Unique and rare habitat (or ecosystems).** A habitat that occurs only at a specific site or a small number of sites.	a(iii) Indigenous ecosystems and vegetation types that are threatened in the coastal environment, or are naturally rare. a(iv) Habitats of indigenous species where the species are at the limit of their natural range, or are naturally rare.
Importance for threatened / declining species and habitats	**Importance for threatened, endangered or declining species and/or habitats**. Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species.	**Species and habitats of conservation concern**. An area that is inhabited by species that are categorized as threatened or protected (e.g., Listed in the IUCN Red List of Threatened species, CITES Appendix, EU Bird and Habitat Directive Annex or other regional/national legislations).	a(i) Indigenous taxa that are listed as threatened or at risk in the NZ Threat Classification System list. a(ii) Taxa that are listed by the International Union for Conservation of Nature as threatened. a(iii) Indigenous ecosystems and vegetation types that are threatened in the coastal

			environment, or are naturally rare. a(vi) Areas set aside for full or partial protection of indigenous biological diversity under other legislation.
Special importance for life history stages	**Special importance for life-history stages of species.** Areas that are required for a population to survive and thrive.	**Important area for life history stage**. An area that is important for evolution and/or life history, such as areas of species' aggregation, refugia, spawning, breeding, nursery or migratory routes.	b(ii) Habitats in the coastal environment that are important during the vulnerable life stages of indigenous species. b(v) Habitats, including areas and routes, important to migratory species. b(vi) Ecological corridors, and areas important for linking or maintaining biological values identified under this policy.
Biological productivity	**Biological productivity.** Area containing species, populations or communities with comparatively higher natural biological productivity.		
Biological diversity	**Biological diversity.** Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity.	**Biological diversity.** An area that is inhabited by a large number of species, and/or will increase the number of species in the network of areas.	Potentially applies across multiple NZCPS requirements: a(v), a(vi), b(i), b(ii), b(iii), b(v), b(vi).
Naturalness	**Naturalness.** Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation.	**Ecological integrity.** An area that exhibits a contiguous natural habitat with negligible anthropogenic disturbance.	

Vulnerability, fragility, sensitivity, or slow recovery	**Vulnerability, fragility, sensitivity, or slow recovery.** Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.	**Fragile and sensitive habitats.** A habitat that is highly susceptible to natural or human induced threats.	b(i) Areas of predominantly indigenous vegetation in the coastal environment. b(iii) Indigenous ecosystems and habitats that are only found in the coastal environment and are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, dunelands, intertidal zones, rocky reef systems, eelgrass and saltmarsh.
Ecological function			
Ecosystem services			
Representativeness*. Considered for marine protected area planning, but not for identification of ecological significance in MSAG criteria.		**Representativeness**. An area that enables a network to encompass a full range of biodiversity.	a(v) Areas containing nationally significant examples of indigenous community types.

Fenwick (2018) recently reviewed ecological significance criteria used to inform Regional Policy Statements and Regional Coastal Policies (particularly in selection of coastal sites of ecological significance) of the West Coast Regional Council, Northland Regional Council, Auckland Council, Waikato Regional Council (WRC), Greater Wellington Regional Council, Tasman District Council, Marlborough District Council and Environment Southland. Fenwick compared these criteria across councils and to those international criteria developed in a review of international biodiversity platforms and internationally significant areas for biodiversity (Asaad et al. 2017) and the Clark et al. (2014) EBSA criteria. Separately, MSAG selected seven of the ecological criteria in Clark et al. (2014), and these (plus two additional criteria, ecological function and ecological services) were used to generate the national MSAG criteria to inform MPA networks (Table 2-2, Table 2-3).

Based on broad correspondence of the national MSAG criteria with relevant national policy NZCPS for managing the coastal zone, as well as with international criteria and with criteria used to date by most regional and district councils, we recommend the MSAG criteria (Table 2-2). HBRC should consider if an extra criterion of 'Representativeness' would be useful at a regional scale. Typically representativeness is included in some regional criteria, such that lists of important ecological areas should include a representative of all habitat types. However, to date it has typically not been used to identify criteria in any of the regions; rather, other criteria (e.g., importance for threatened species or habitats, life history stages) have dominated the identification of significant ecological sites.

Table 2-3: Comparison of MSAG key ecological area criteria with criteria from various regional and district council in regional policies. Expanded analysis based on review of criteria presented in Fenwick (2018). West Coast based WCRC (2014) criteria for terrestrial wetlands; Northland based on NRC Regional Council Plan, Appendix 9, Areas of important conservation value (NRC 2016); Auckland based on Auckland Unitary Plan, Schedule 4 Significant Ecological Areas (AC 2016); Waikato based on Regional Policy Statement, Chapter 11a, Areas of significant indigenous biodiversity (WRC 2014); Wellington based on Proposed Regional Policy Statement (2010), Policy 22, and Proposed natural resources plan for the Wellington region (2018), Policy P40(d) (GWRC 2010); Tasman based on Tasman Resource management plan, Schedule 10C (TDC 2016); Marlborough based on Proposed Marlborough Environment Plan, Volume 3, Appendix 3 (MDC 2016); and Southland based on Environment Southland Regional Policy Statement, Appendix 3 (ES 2017).

MSAG Criteria	West Coast	Northland	Auckland	Waikato	Wellington	Tasman	Marlborough	Southland
Uniqueness/rarity/endemism	x	x		x	x	x	x	x
Importance for threatened / declining species and habitats.	x	x	x	x	x	x	x	x
Special importance for life history stages.	x	x	x	x	x	x	x	x
Biological productivity (not assessed by Fenwick (2018)).	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Biological diversity.	x		x	x	x	x	x	x
Naturalness.	x	x	x	x	x	x	x	x
Vulnerability, fragility, sensitivity, or slow recovery.	x		x	x			x	x

MSAG Criteria	West Coast	Northland	Auckland	Waikato	Wellington	Tasman	Marlborough	Southland
Ecological function (not assessed by Fenwick (2018)).	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ecosystem services (not assessed by Fenwick (2018)).	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Representativeness*. Considered for marine protected area planning, but not for identification of ecological significance.	x	x	x	x	x	x	x	x

3 Assessment of existing Hawke's Bay SCAs against recommended ecological significance criteria

20 sites have been previously identified as Significant Conservation Areas (SCA) in the Hawke's Bay region (Figure 3-1). These sites were evaluated against the nine national KEA criteria, noting individual species or taxa relevant to each criteria when relevant (Table 3-1, Table 3-2). Descriptions of the ecological values previously identified for each site were provided by HBRC. Individual SCA sites ranged from estuaries to intertidal and subtidal areas of known ecological significance; SCAs also sometimes included neighbouring terrestrial features important for taxa in the CMA.

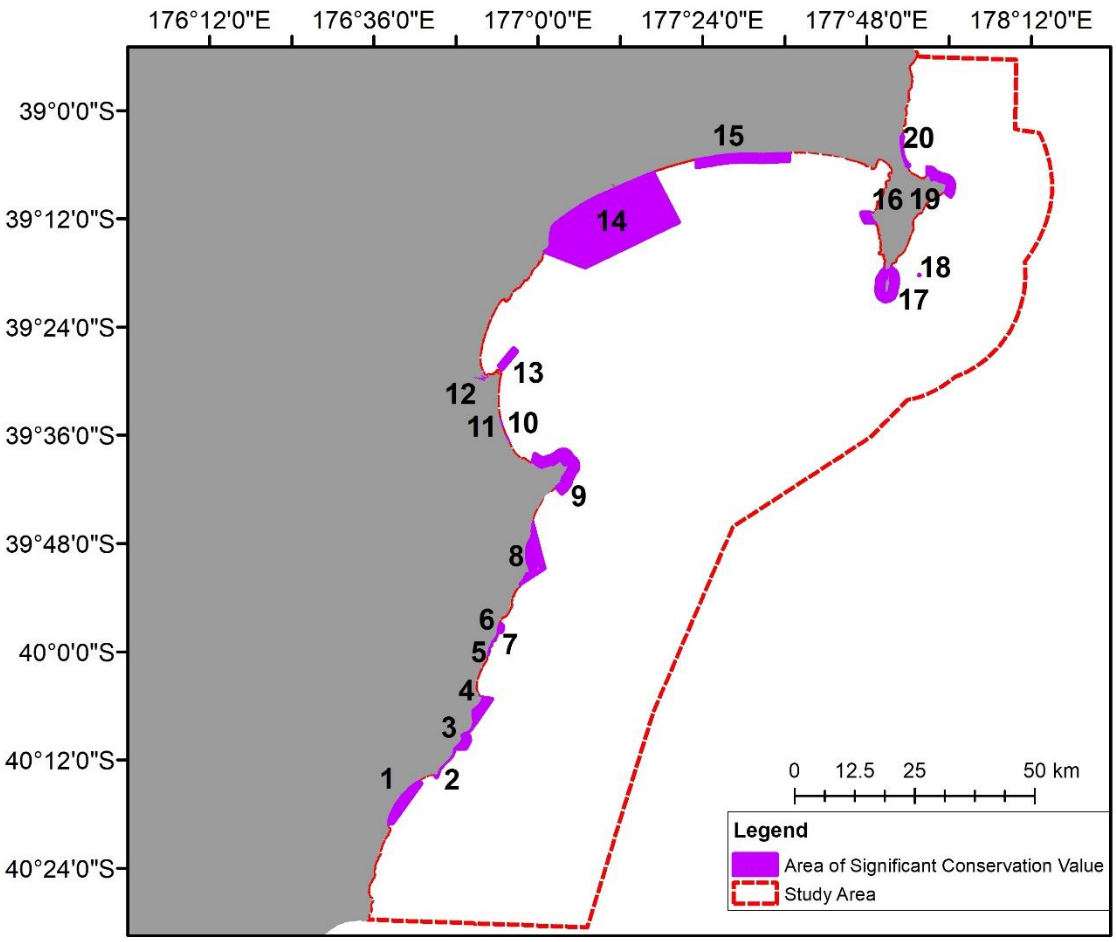

Figure 3-1: Significant Conservation Areas (SCAs) identified in the Hawke's Bay CMA.

SCAs were assessed as satisfying an average of three KEA criteria, with two SCAs satisfying only one KEA criteria, and one SCA satisfying six of the nine criteria (Table 3-1). The most common criteria being used to designate SCAs appeared to be Uniqueness / rarity / endemism (n = 13), Special importance for life history stages (n = 17), Importance for threatened/ declining species and habitat (n = 16), and Biological diversity (n = 16). In contrast, SCAs were rarely selected for their role in satisfying some KEAs, with no SCAs selected for their role in Biological Productivity and Ecosystem Services, and only one SCA each selected for Naturalness and Ecological Function (Table 3-1). Six SCAs were selected for their role as representing habitats or species that satisfy the KEA of Vulnerability, fragility, sensitivity, or slow recovery. SCAs did show a bias in selection for their role as Wildlife Refuges and/or areas that serve as habitat for seabirds and shorebirds or other threatened taxa (Table 3-1).

Table 3-1: Summary of key ecological area (KEA) criteria satisfied by the Hawke's Bay SCAs.

SCA	Site name	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/ rarity/ endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat	Biological productivity	Biological diversity	Naturalness	Ecological function	Ecosystem services
Total sites satisfying a particular KEA		6	13	17	16	0	16	1	1	0
SCA 1	Porangahau Estuary	X	X	X	X		X			
SCA 2	Blackhead Point-Pohatupapa Point Intertidal Platform			X	X		X			
SCA 3	Aramoana-Blackhead Beach		X	X	X		X			
SCA 4	Ouepoto - Paoanui point		X	X	X		X			
SCA 5	Mangakuri Intertidal Platform			X	X		X			
SCA 6	Kairakau Intertidal Platform			X	X		X			
SCA 7	Hinemahanga Rocks		X							
SCA 8	Waimarama		X	X	X		X			
SCA 9	Cape Kidnappers		X	X	X					

SCA	Site name	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/ rarity/ endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat	Biological productivity	Biological diversity	Naturalness	Ecological function	Ecosystem services
SCA 10	Tukituki River Mouth	X		X	X					
SCA 11	Waitangi Estuary	X	X	X	X		X			
SCA 12	Ahuriri Estuary		X	X	X		X			
SCA 13	Pania Reef		X				X		X	
SCA 14	Wairoa Hard		X	X			X			
SCA 15	Wairoa Estuary and Coastal Wetlands	X	X	X	X		X	X		
SCA 16	Long Point			X	X		X			
SCA 17	Portland Island	X	X	X	X		X			
SCA 18	Bull Rock						X			
SCA 19	Table Cape			X	X		X			
SCA 20	Maungawhio Lagoon / Pukenui Beach	X	X	X	X					

Table 3-2: Descriptions of specific ecological criteria, including taxa found, in individual SCAs in the Hawke's Bay region. Descriptions as per information available in Hawke's Bay Regional Council (2012), based on work undertaken by Department of Conservation in the early 1990s for input into the first generation of regional coastal plans.

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 1	Porangahau Estuary	Estuary	Dune Habitat	Largest and least modified estuary on the east coast of the North Island south of Ohiwa Harbour. Classified as Nationally significant wildlife habitats. Its dunes have endemic sand daphne (*Pimelea villosa*) and matagouri (*Discaria toumatou*). The only known locality of *Austrofestuca littoralis* (aka *Poa billardierei*) in the Hawke's Bay. The Porangahau bar is the best example of a longshore bar in the Hawke's Bay Region.	Feeding and wintering area for migratory waders and nesting for several threatened species.	Banded dotterel (Status: Threatened, Nationally vulnerable), wrybill (Status: Threatened, Nationally vulnerable), Caspian tern (status: Threatened, Nationally vulnerable), eastern bar-tailed godwit (Status: At risk, Declining), lesser knot (Status: Threatened, Nationally vulnerable). Pingao (Status: At risk, declining), *Pimelea villosa* (aka *Pimelea arenaria*) (sand Daphne) (Status: At Risk, Declining), *Austrofestuca littoralis* (aka *Poa billardierei*) (Status: At Risk, Declining), Matagouri (Status: At Risk, Declining).

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 2	Blackhead Point-Pohatupapa Point Intertidal Platform	Intertidal			Important for Migratory wading birds, feeding habitat for at least 15 species of native birds.	Variable oystercatcher (Status: At risk, Recovering), red-billed gull (Status: At risk, Declining), eastern bar-tailed godwit (Status: At risk, Declining), white-fronted tern (Status: At risk, Declining), black shag (Status: At Risk, Naturally uncommon). *Zostera* (Status: At Risk, Declining).
SCA 3	Aramoana-Blackhead Beach	Intertidal and subtidal		Includes Te Angiangi Marine reserve. Rare boulder stack in the reserve.	Important for migratory wading birds, feeding habitat for at least 15 species of native birds.	Variable oystercatcher (Status: At risk, Recovering), red-billed gull (Status: At risk, Declining), eastern bar-tailed godwit (Status: At risk, Declining), white-fronted tern (Status: At risk, Declining), black shag (Status: At Risk, Naturally uncommon). *Zostera* (Status: At Risk, Declining).

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 4	Ouepoto - Paoanui point	Intertidal and subtidal		Charity Reef supports regionally significant rock lobster fishery. Fossil horizon nationally significant because it contains the youngest larger fossil foraminifera in New Zealand.	Important for migratory wading birds, feeding habitat for at least 15 species of native birds.	Variable oystercatcher (Status: At risk, Recovering), red-billed gull (Status: At risk, Declining), eastern bar-tailed godwit (Status: At risk, Declining), white-fronted tern (Status: At risk, Declining), black shag (Status: At Risk, Naturally uncommon). *Zostera* (Status: At Risk, Declining).
SCA 5	Mangakuri Intertidal Platform	Intertidal			Important for migratory wading birds, feeding habitat for at least 15 species of native birds.	Variable oystercatcher (Status: At risk, Recovering), red-billed gull (Status: At risk, Declining), eastern bar-tailed godwit (Status: At risk, Declining), white-fronted tern (Status: At risk, Declining), black shag (Status: At Risk, Naturally uncommon). *Zostera* (Status: At Risk, Declining).

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 6	Kairakau Intertidal Platform	Intertidal			Important for migratory wading birds, feeding habitat for at least 15 species of native birds.	Variable oystercatcher (Status: At risk, Recovering), red-billed gull (Status: At risk, Declining), eastern bar-tailed godwit (Status: At risk, Declining), white-fronted tern (Status: At risk, Declining), black shag (Status: At Risk, Naturally uncommon). *Zostera* (Status: At Risk, Declining).
SCA 7	Hinemahanga Rocks	Terrestrial and subtidal		Six rock stacks connected by subtidal reef system, significant geological site represent part of a once continuous sheet of Mid Oceanic Ridge basalts currently being subducted beneath Upper Cretaceous sediments. These stacks are one of only two known significant occurrences of Red Island Volcanic sediments.		

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 8	Waimarama	Terrestrial, intertidal and subtidal		Only New Zealand fur seal hauling ground in the Hawke's Bay Region. Coastal platform south of Waimarama, Cray Bay boulders, and Karamea Island are nationally significant geological sites. Includes the Waimarama Fishing Reserve. Motu-O-Kura is the only true island between Wairoa and Wellington. The Te Apiti thrust zones and the Cray Bay boulders are nationally significant geological sites.	Motu-O-Kura is a nesting ground for Northern blue penguin, black shag, sooty shearwater, black-backed gulls. The Island is also a hauling ground for New Zealand fur seal.	Northern blue penguin (Status: At Risk, Declining), black shag (Status: At Risk, Naturally uncommon), sooty shearwater (Status: At risk, Declining).
SCA 9	Cape Kidnappers	Intertidal and subtidal		The Black Reef and Saddle gannet colonies are Nature Reserves. The scenic and geological values of the cliffs from Clifton to Cape Kidnappers are listed as being internationally significant.	Important preening and washing areas for gannets. Nesting for white-fronted terns (along cliffs), winter roost for spotted shag.	White-fronted tern (Status: At risk, Declining).

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 10	Tukituki River Mouth	Estuary	Wildlife threatened by high human use.		Feeding area for little black shag, little shag, bar-tailed godwit, black-fronted dotterel. Roosting for Caspian tern, black backed gulls. Spotless crake and Australasian bittern found in Grange creek. Spawning site for inanga.	Little black shag (Status: At Risk, Naturally Uncommon), Caspian tern (status: Threatened, Nationally vulnerable), eastern bar-tailed godwit (Status: At risk, Declining), black-fronted dotterel (Status: At Risk, Naturally uncommon), spotless crake (Status: At Risk, Declining), Australasian bittern (Status: Threatened, Nationally critical). Inanga (Status: At risk, Declining).

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 11	Waitangi Estuary	Estuary	Threatened by high human use and development.	Its lower reaches, including those adjoining the coastal marine area, are a designated Wildlife Refuge.	Used by migratory waders. Nesting, roosting and feeding areas for many species of wetland and coastal birds, including white-fronted terns, black-billed gulls, spotless crake, Australasian bittern, pied stilts, black-fronted terns. Spawning ground for inanga. Other native fish include lamprey, short-finned eel, common smelt ,torrent fish, common, red-finned and giant bully and black flounder. Provides a corridor for diadromous native fish.	Banded dotterel (Status: Threatened, Nationally vulnerable), black-fronted dotterel (Status: At Risk, Naturally uncommon), spotless crake (Status: At Risk, Declining), Australasian bittern (Status: Threatened, Nationally critical) white-fronted tern (Status: At risk, Declining), black-fronted tern (Status: Threatened, Nationally endangered). Inanga (Status: At risk, Declining), lamprey (Status: Threatened, Nationally vulnerable), torrent fish (Status: At risk, Declining), giant bully (Status; At risk, Naturally uncommon).

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 12	Ahuriri Estuary	Estuary		Includes a wildlife refuge. Estuary is classified as a nationally significant fisheries habitat. Close to the southern limit of distribution on the east coast of the North Island for parore.	Roosting, nesting, feeding of waterfowl and waders including, spotless crake, Australasian bittern, grey teal, NZ shoveller, pied stilt, royal spoonbill, eastern bar-tailed godwit and Pacific golden plover. Nursery, spawning and corridor for fish. At least 9 commercial fish species breed in the estuary.	Spotless crake (Status: At Risk, Declining), Australasian bittern (Status: Threatened, Nationally critical), royal spoonbill (Status: At risk, naturally uncommon), eastern bar-tailed godwit (Status: At risk, Declining).
SCA 13	Pania Reef	Subtidal		Only significant offshore reef system inside Hawke Bay west of Mahia Peninsula.		
SCA 14	Wairoa Hard	intertidal and subtidal		Protected as a fish nursery.	Nursery for snapper, hammerhead shark, rig, bronze whaler, school shark, John dory, trevally, red moki, hapuku and warehou.	

SCA 15	Wairoa Estuary and Coastal Wetlands	Estuary and coastal wetlands	Dunes	Part of a chain of wetlands that collectively constitute the largest system on the east coast of the North Island. The Ngamotu Lagoon is a Government Purpose Administration Reserve and gazetted Wildlife Management reserve. Whakamahi Lagoon Conservation area is a Closed Game Area managed by DOC. The Lagoons all have a high Sites of Special Wildlife Interest (SSWI) rating and have a high importance in the Wetlands of Ecologically and Representative Importance (WERI) database.	Important habitat for coastal birds, waders and waterfoul including: white heron, Australasian bittern, North Island fernbird, dabchick , spotless crake, wrybill, eastern bar-tailed godwit, golden plover, grey teal, NZ shoveller and Canada geese. Spawning habitat for inanga. Habitat for short-finned eel. Access to inland water for native species such as longfin eel, smelt, koaro, torrent fish and Cran's bully.	White heron (Status: Threatened, Nationally critical), Australasian bittern (Status: Threatened, Nationally critical), North Island fernbird (Status: At risk, Declining), dabchick (Status: At Risk, recovering), spotless crake (Status: At Risk, Declining), Wrybill (Status: Threatened, Nationally vulnerable), eastern bar-tailed godwit (Status: At risk, Declining). Plant species: Pingao (Status: At risk, declining), *Mimulus repens* (Status: At Risk, Naturally uncommon). Inanga (Status: At risk, Declining), longfin eel (Status: At risk, Declining), koaro (Status: At risk, Declining), torrent fish (Status: At risk, Declining).
SCA 16	Long Point	Terrestrial, Intertidal			Important habitat for coastal birds.	Variable oystercatcher (Status: At risk, Recovering), Caspian tern (status:

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
		and subtidal				Threatened, Nationally vulnerable), eastern bar-tailed godwit (Status: At risk, Declining), white-fronted tern (Status: At risk, Declining).
SCA 17	Portland Island	Terrestrial, Intertidal and subtidal	Dunes	Only significant island on the Hawke's Bay coast, Portland island has a High SSWI rating.	One of four known breeding grounds for black-winged petrel.	Variable oystercatcher (Status: At risk, Recovering), Caspian tern (status: Threatened, Nationally vulnerable), white-fronted tern (Status: At risk, Declining), banded dotterel (Status: Threatened, Nationally vulnerable), Australasian bittern (Status: Threatened, Nationally critical), red-billed gull (Status: At risk, Declining). Pingao (Status: At risk, declining).
SCA 18	Bull Rock	Subtidal				

SCA	Site name	Type	Vulnerability, fragility, sensitivity, or slow recovery	Uniqueness/rarity/endemism	Special importance for life history stages	Importance for threatened/ declining species and habitat
SCA 19	Table Cape	Terrestrial, Intertidal and subtidal			Important habitat for coastal birds.	Variable oystercatcher (Status: At risk, Recovering), Caspian tern (status: Threatened, Nationally vulnerable), white-fronted tern (Status: At risk, Declining), eastern bar-tailed godwit (Status: At risk, Declining), pied shag (Status: At risk, Recovering).
SCA 20	Maungawhio Lagoon / Pukenui Beach	Terrestrial and intertidal	Wildlife Management Reserve	National importance in the WERI Index, High SSWI.	Important habitat for coastal birds, waders and waterfowl including; Australasian bittern, banded rail, New Zealand dotterel and Caspian tern. Supports inanga.	Caspian tern (status: Threatened, Nationally vulnerable), Australasian bittern (Status: Threatened, Nationally critical), banded rail (Status: At risk, Declining), northern New Zealand dotterel (Status: At risk, recovering). Inanga (Status: At risk, Declining).

Continued.

SCA	Site name	Biological productivity	Biological diversity	Naturalness	Ecological function	Ecosystem services
SCA 1	Porangahau Estuary		Habitat diversity, saltmarsh, intertidal sand/mudflats, shallow tidal channels, sand dunes. A diverse fish assemblage.			
SCA 2	Blackhead Point-Pohatupapa Point Intertidal Platform		Habitat forming *Zostera* and *Hormosira*. Diverse intertidal zone with 85-100 species of plants, macro invertebrates and fish[2].			
SCA 3	Aramoana-Blackhead Beach		Habitat forming *Zostera* and *Hormosira*. Diverse intertidal zone with 85-100 species of plants, macro invertebrates and fish[3]. Subtidal rocky reefs provide attachment for diverse encrusting species including red algae, sponges, hydroids, bryozoans and ascidians which in turn form habitat for fish etc. 150 subtidal species recorded (55 fish) within reserve.			
SCA 4	Ouepoto - Paoanui point		Habitat forming *Zostera* and *Hormosira*. Diverse intertidal zone with 85-100 species of plants, macro invertebrates and fish.			
SCA 5	Mangakuri Intertidal Platform		Habitat forming *Zostera* and *Hormosira*. Diverse intertidal zone with 85-100 species of plants, macro invertebrates and fish.			

[2] Creswell & Warren, 1990; Haddon, 1993; Haddon & Anderlini, 1993, as referenced in HBRC (2006).

[3] Ibid.

SCA	Site name	Biological productivity	Biological diversity	Naturalness	Ecological function	Ecosystem services
SCA 6	Kairakau Intertidal Platform		Habitat forming *Zostera* and *Hormosira*. Numerous large, deep rock pools and channels dominated by large brown algae. Approx. 89 species of plants, macro invertebrates and fish recorded.			
SCA 7	Hinemahanga Rocks					
SCA 8	Waimarama		Habitat mosaic.			
SCA 9 SCA 10	Cape Kidnappers Tukituki River Mouth					
SCA 11	Waitangi Estuary		Coastal wetland habitat, mudflat.			
SCA 12	Ahuriri Estuary		29 species of fish recorded.			
SCA 13	Pania Reef		Reef system has lots of habitat-forming species: beds of mussels, *Ecklonia* forests, sponges, hydroids and anemones. All of these fauna and flora support large populations of reef fish.		Dense mussel beds, filter feeders.	
SCA 14	Wairoa Hard		Some offshore reefs but little known of the area.			
SCA 15	Wairoa Estuary and Coastal Wetlands		Diverse native flora in dune system.	Relatively unmodified dune system.		

SCA	Site name	Biological productivity	Biological diversity	Naturalness	Ecological function	Ecosystem services
SCA 16	Long Point		The subtidal limestone canyons off-shore of Long Point are reputed to support an abundant and diverse benthic and demersal marine life which has not yet been surveyed in detail.			
SCA 17	Portland Island		Extensive subtidal reef systems offshore are known to support a diverse marine ecosystem.			
SCA 18	Bull Rock		Reputation of supporting a rich and diverse assemblage of benthic, demersal and pelagic species.			
SCA 19 SCA 20	Table Cape Maungawhio Lagoon / Pukenui Beach		Extensive intertidal platform supports a rich and diverse plant and animal community.			

4 National and regional datasets available to inform ecological significance

The Department of Conservation recently funded the Key Ecological Areas project, which acquired best available datasets to address key ecological area criteria to inform placement of marine protected areas and other marine conservation management activities (Stephenson et al. 2018, Lundquist et al. 2020). This project involved compilation of all best available information that satisfied nine different ecological criteria that had been identified by the Marine Protected Areas Scientific Advisory Group (MSAG). These criteria were based on seven criteria identified by Clark et al. (2014) to support the identification of Ecologically or Biologically Significant Areas (EBSAs), with two additional criteria to represent ecological function and services (Table 1-1, Table 2-1). These national key ecological area layers were assessed to determine which contained information of interest to fill gaps in understanding of marine ecosystems in the Hawke's Bay.

National marine biodiversity datasets were initially visually assessed to determine which contained biodiversity records or modelled presence or likelihood presence of biodiversity features within the broader Hawke's Bay region (encompassing the CMA and areas to the north, south and east) (Figure 4-1).

Datasets were also provided by HBRC (Table 4-1) and compiled together with the national datasets to use in a scoping analysis of identifying sites of ecological significance.

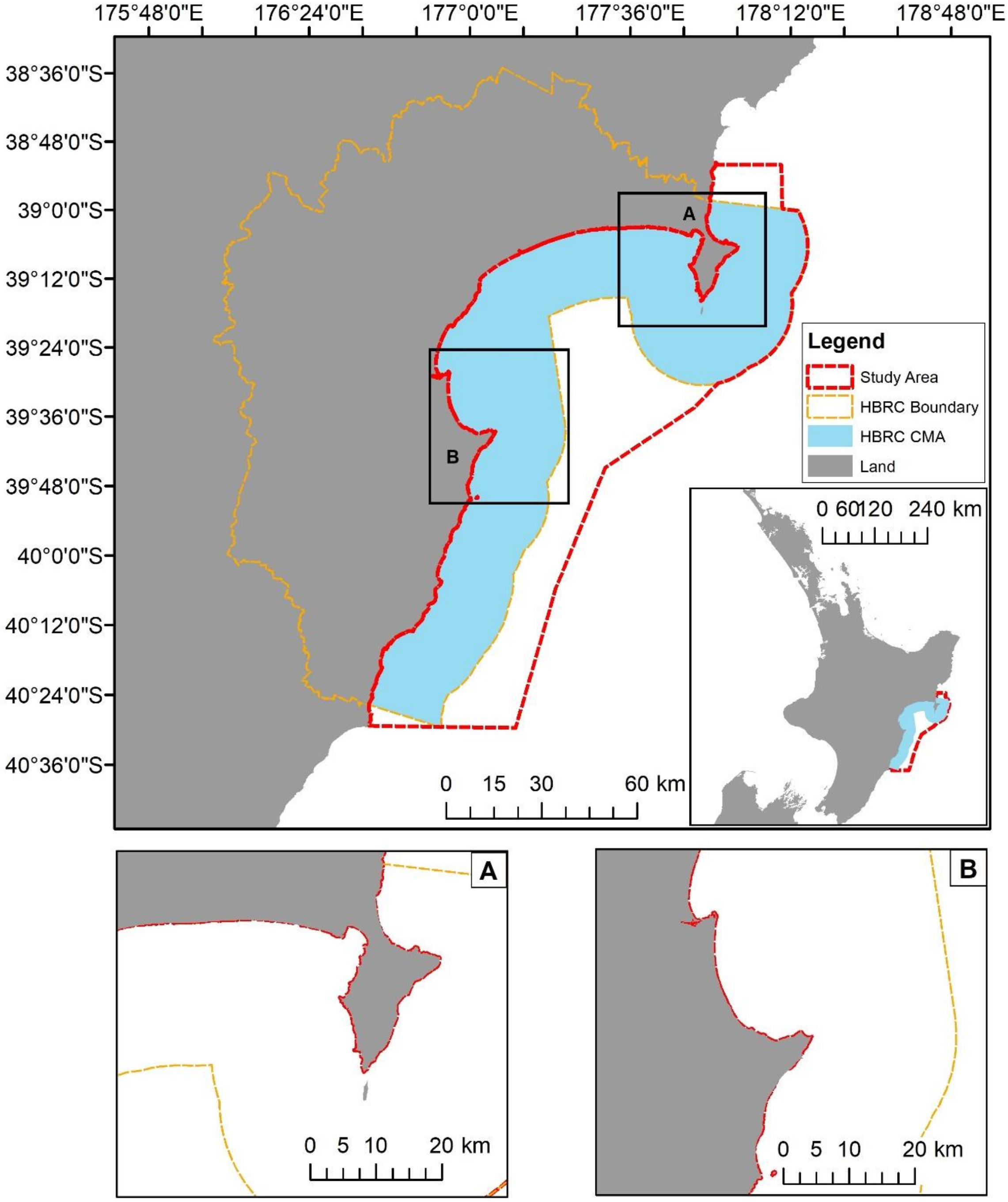

Figure 4-1: Study Area, indicating Hawke's Bay Regional Council boundary and Coastal Marine Area, and neighbouring area for which national and regional data were available. Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

4.1 Hawke's Bay RC data layers

A suite of regional data layers that may be used to assess the ecological significance criteria were provided by HBRC, and include GIS based maps prepared during the Marine Information Review (Haggitt and Wade 2016) (Table 4-1). All data layers were clipped to the larger model area, and rasterised for use in Zonation analyses. Data layers have been provided to HBRC as *.tif files, a suitable format to upload in ArcGIS.

Table 4-1: Overview of HBRC data layers.

Data Name	Brief description	Data format	Data extent	Relevant KEA criteria
Abiotic	Broad /Physical habitat classification for sediment substrate type (Figure 4-2) and bathymetry (Figure 4-3).	Polygons	HBRC broader region	1,2,3,4,5
Biotic	Broad biotype / biotope complex for marine benthic communities including Biogenic habitat, macroalgal canopies, sponge communities, Epifaunal and Infaunal communities (Figure 4-4).	Polygons	HBRC broader region (part coverage)	1,2,3,4,5,6,8,9
Physical Habitats	DOC Inshore Habitat Classification (Ministry of Fisheries and Department of Conservation 2008, Department of Conservation and Ministry of Fisheries 2011). Depth contours down to 2000 m, for four corresponding environment characteristics; coastal vs. estuarine, depth, exposure, sediment type; not used as regional habitat data was assessed as being better resolution than this national dataset.	Polygons	National	1,2,3,4,5
Administrative boundary	HBRC administrative boundary and CMA (Figure 4-1).	Polygon	HBRC CMA	
Significant Conservation Areas (SCAs)	Areas identified as significant conservation areas in regional coastal environment plan (RCEP) (Figure 3-1).	Polygon	HBRC CMA	1,2,3,4,5,6,7,8,9
Fisheries Management	Polygons representing a range of licensed management areas including MPI controls areas, Customary areas, DOC marine reserves and fishing reserve / no commercial take areas (Figure 4-5).	Polygon	HBRC broader region	5,6,7

Data Name	Brief description	Data format	Data extent	Relevant KEA criteria
Other consented activities	List of consented marine activities including: Aquaculture, Beach nourishment, dredging, gravel extraction, historic heritage sites, port management, stock management and hovercraft restricted sites (Figure 4-6).	Polygon	HBRC CMA	7
GDb consent discharge summary	List of land, water and air discharge consents near to or surrounding the marine environment (Figure 4-7).	point	HBRC CMA	7
Fisheries	Primary fishing grounds for species of commercial interest and catch method based on summaries of expert interviews presented in Haggitt and Wade (2016). All species were caught via trawling method apart from flatfish which were caught by gill netting (Figure 4-8).	Polygons	HBRC broader region	5,6,7
Duneland Inventory & Hawkes Bay Dunes	These dunes are located landward of the CMA / study area and were not utilised in this assessment. The Hawkes Bay Dunes are a smaller dataset of 69 polygons of dune locations, by dune name, which are the more landward of the two. The Duneland Inventory has 149 polygons, which are separated by habitat type. The datasets do not overlap.	Polygon	HBRC Terrestrial only	1,2,3,4

4.1.1 Abiotic datasets

Sedimentary habitat types were available from Haggitt and Wade (2016) (Figure 4-2), and suggest coarser sediments near shore, with muddier sediments dominating deeper areas of the Hawke's Bay CMA. Bathymetry shows a significant portion of the Hawke's Bay broader region includes continental slope and shelf habitats deeper than 200 m (Figure 4-3).

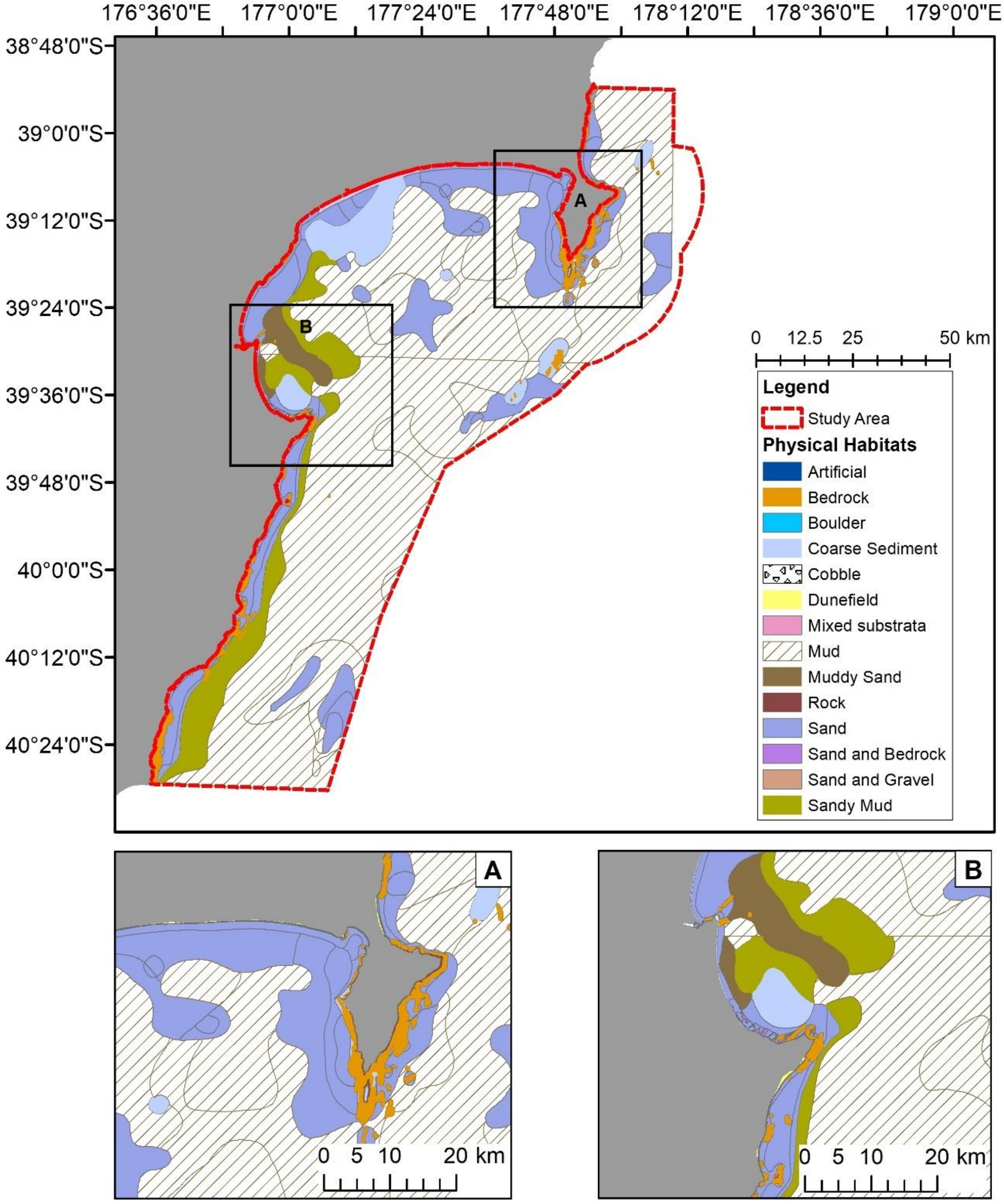

Figure 4-2: Abiotic datasets - broad scale habitats as evaluated by Haggitt and Wade (2016). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

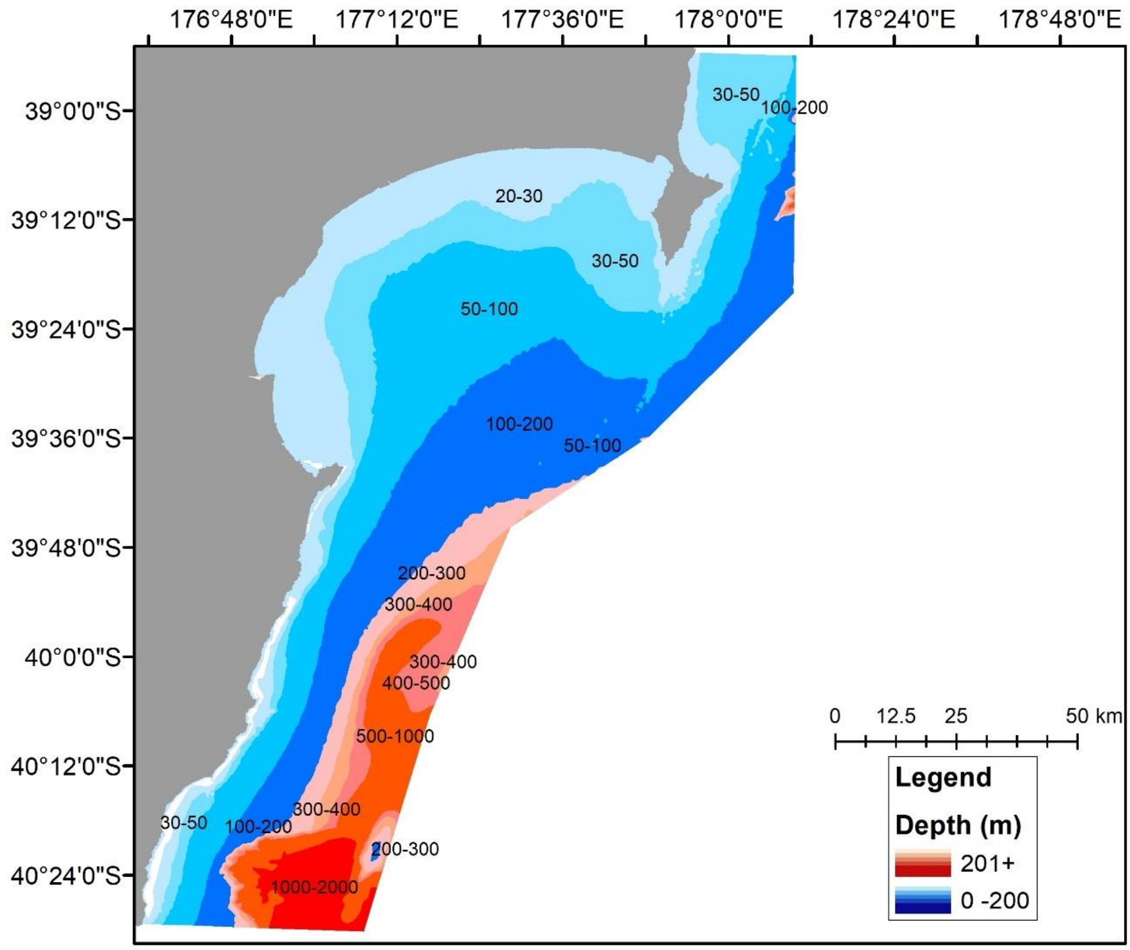

Figure 4-3: Bathymetry of the Hawke's Bay CMA.

4.1.2 Biotic datasets

Biotic datasets compiled by Haggitt and Wade (2016) show the diversity of biogenic habitats found within the Hawke's Bay CMA (Figure 4-4). This dataset holds locations of a suite of biotic habitats, including many biogenic habitats that are commonly identified in SCAs as having high ecological value (e.g., biogenic reefs, bivalve- and sponge-dominated soft sediment communities, epifaunal and infaunal soft sediment communities). These biotic habitats at the regional scale are higher resolution data than any available through the national datasets. These regional scale biotic habitat maps are based on prior surveys by McKnight (1969), Duffy (1992) and anecdotal information, and they have not been ground-truthed following the 1969 survey. However, they are likely a more accurate representation of actual biotic habitats than the national scale information which includes predictive model of biogenic habitats, and a limited number of point records in the Hawke's Bay (see section 5; Stephenson et al. 2018, Anderson et al. 2019). Regardless, as noted in Haggitt and Wade (2016), improving understanding of subtidal habitats, and how they have changed over space and time, was identified as a priority in the Hawke's Bay Marine Information Review.

GIS data records indicate both broad biotypes (e.g., biogenic, bivalve dominated) as well as biotope complex (e.g., *Tawera-Venericardia*, *Paphies australis*) and sub-biotype complex (e.g, mixed algae, polychaetes infaunal). Other information available in the GIS data record for biotic habitats include data type (qualitative, quantitative), the data confidence (primarily categorised as moderate, moderate to low, or low), and the data source and reference for the biotic information.

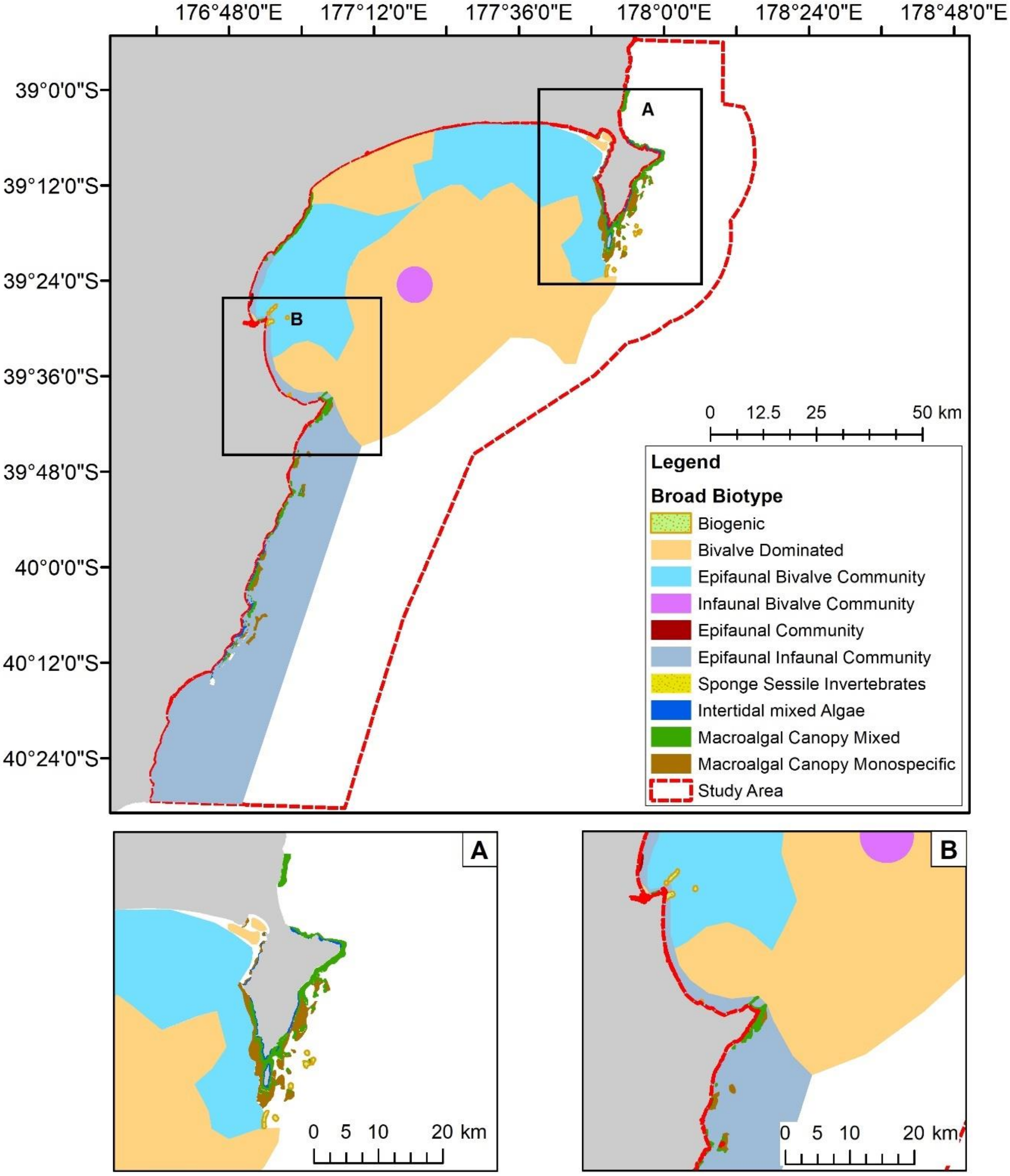

Figure 4-4: Spatial distribution of HBRC-provided dataset of biotic habitats within the Hawke's Bay CMA. Biogenic in this dataset refers to biogenic reefs, whereas other non-macroalgal habitat types are primarily soft sediment habitats. Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

4.1.3 Resource use/extraction

Regional council layers also included a variety of management areas, including DOC marine reserves and other MPI fishery and customary management areas (Figure 4-5), other consented activities (Figure 4-6), and discharge consents (Figure 4-7). These layers can be used in spatial prioritisations to either mandate allocation of protected areas (i.e., in existing marine reserves) or exclude protection if existing uses preclude ecological significance, or to include habitat quality or condition. These layers could be used to inform the Naturalness criteria through identification of sites that are either pristine (having minimal impact from land-based or ocean-based disturbances, or having a long history of protection from resource use), or are heavily impacted.

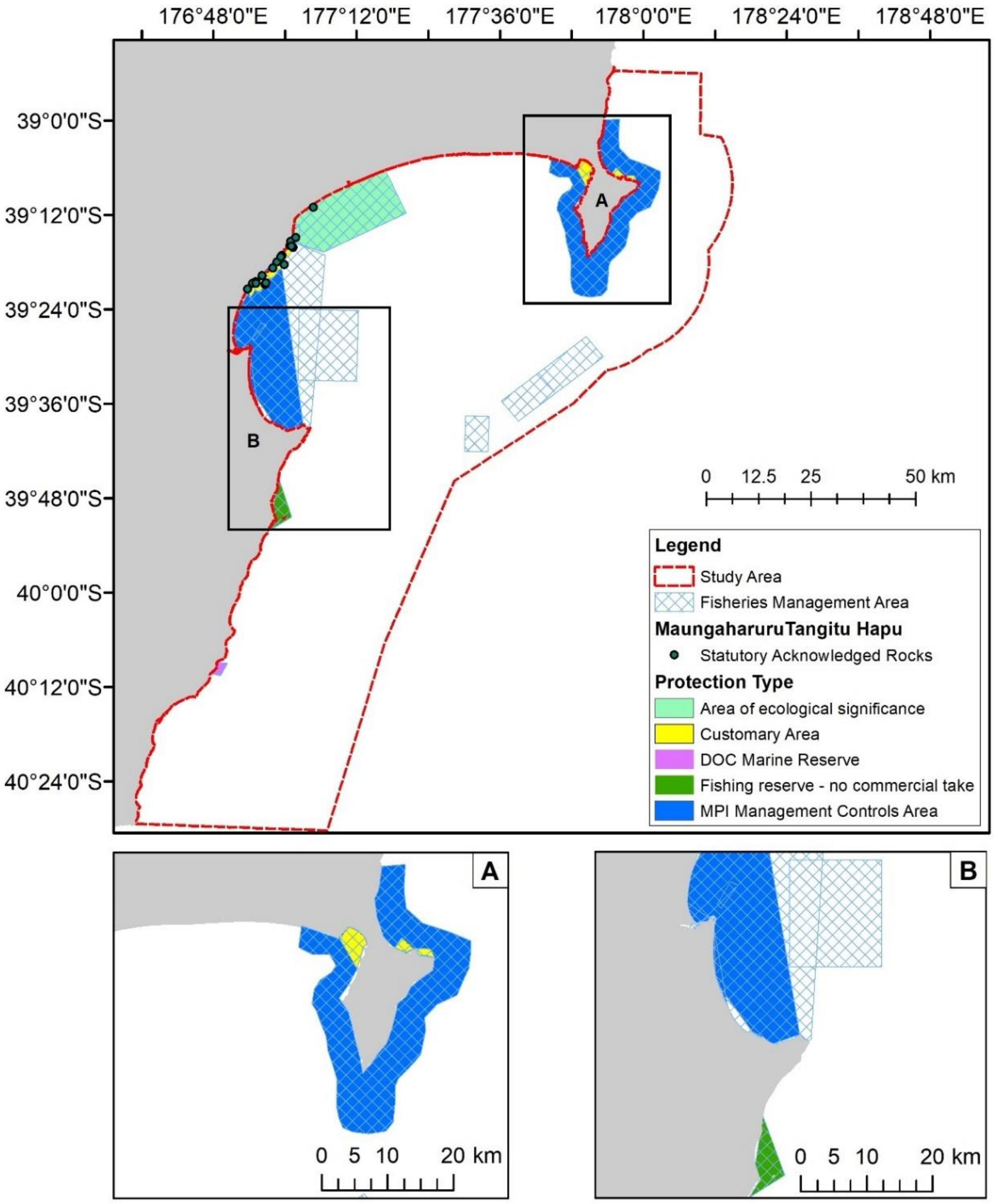

Figure 4-5: Management boundaries in the Hawke's Bay CMA. Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

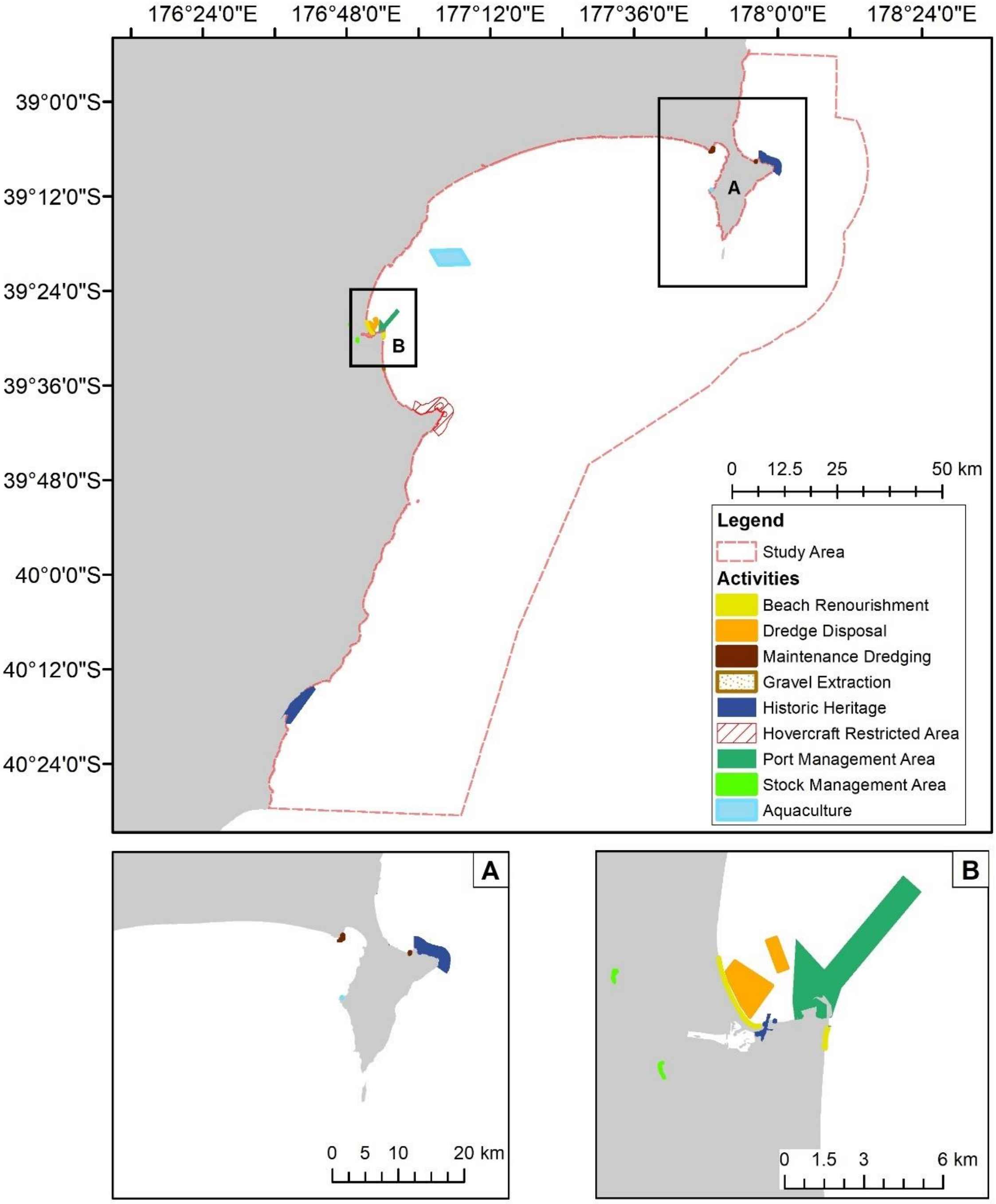

Figure 4-6: Other consented activities in the Hawke's Bay CMA. Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

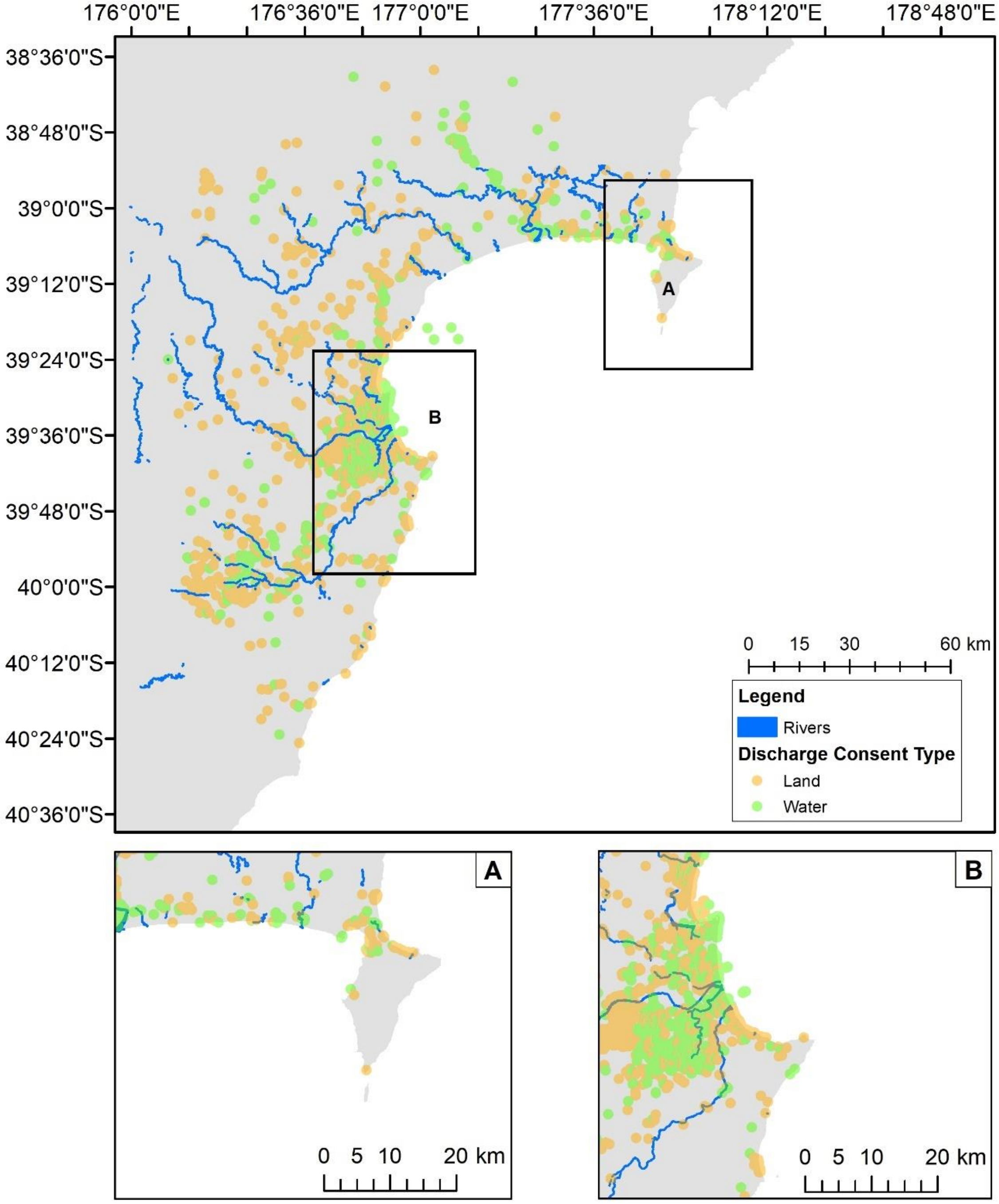

Figure 4-7: Discharge consents in the Hawke's Bay CMA. Identified rivers represent dendritic (branched) linkages of river segments from the national River Environments Classification (REC2 v2.4). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

Primary fishing grounds for species of commercial interest and catch method were identified by experts/local fisherman (Haggitt and Wade 2016). These layers include all species caught via trawling method apart from flatfish which were caught by gill netting (Figure 4-8). Polygons were associated with individual fish species, which were used to identify primary commercial species of importance in the Hawke's Bay.

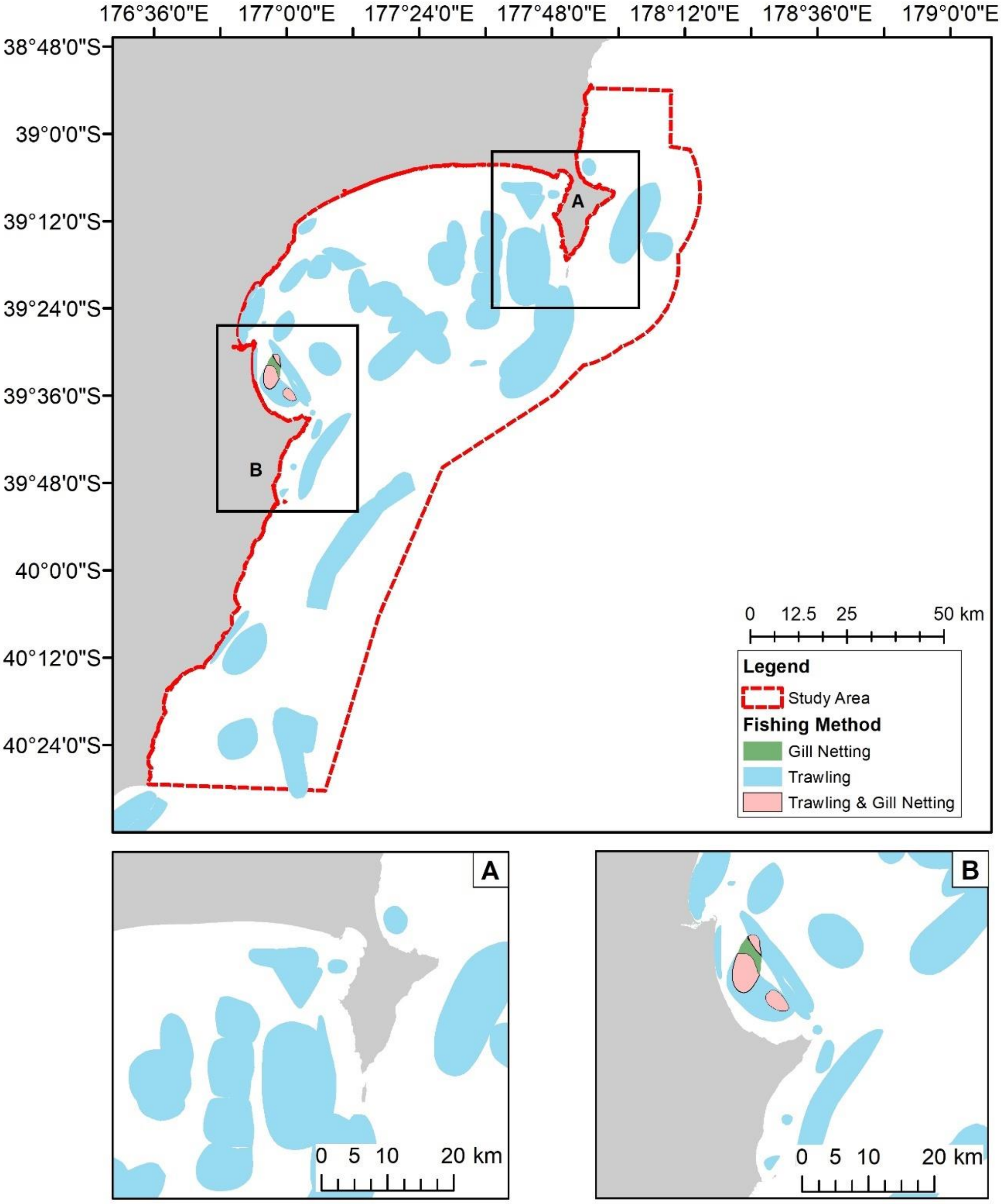

Figure 4-8: Expert derived areas of importance for fisheries in the Hawke's Bay CMA. Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

4.2 National Key Ecological Areas criteria datasets

Data layers collated under the DOC Key Ecological Areas project (Stephenson et al. 2018, Lundquist et al. 2020) were evaluated for their potential use in identifying ecologically significant features within the Hawke's Bay regional area.

Table 4-2: Overview of data layers that inform Key Ecological Area criteria. For KEA criteria codes see Table 2-1. Based on datasets compiled in Stephenson et al. (2018) and Lundquist et al. (2020). n/a is used for those data where the measure is not applicable, e.g., polygons do not have a grid resolution.

Data Name	Brief description	Data format	Data extent	Data resolution	Relevant KEA criteria
Regional Council identified important areas (ASCVs, SCAs, SEAs, SNAs)	Various layers representing important areas identified in regional council plans. This data is a duplicate of the Significant Conservation Areas (SCAs) provided by HBRC (Figure 3-1).	Polygons	Regional	various	1, 2, 3, 4, 6, 8, 9
Marine mammal and reptile sightings	Marine reptile point records (locations) extracted from OBIS, TRAWL & NIWA databases (2015 extract for project: Lundquist et al. 2015). Records were groomed and quality controlled. Marine Mammal records (locations) from MPI database (collated from multiple sources) (Stephenson et al. 2020a).	Point data	National	n/a	4, 6
Marine mammal distributions	Predicted distribution (occurrence) of 30 cetacean species and species complexes (Stephenson et al. 2020a).	Raster	National	1 km^2	4, 6
Seal breeding grounds	Location of seal colonies and haul-outs (NABIS 2012; DOC, unpublished). Both Black Reef, and Table Cape seal haulouts are located on Mahia Peninsula.	Polygons	National		3
Bird feeding and breeding grounds	Location of Important Bird Areas (IBA) (Forest & Bird, 2014). Only one IBA is present within HBRC, the gannet colony at Cape Kidnappers.	Polygons	National		3
Demersal fish species richness	Predicted demersal fish species richness based on layers developed for gradient forest demersal fish classification (Stephenson et al. 2020b) (Figure 4-10).	Raster	National	1 km^2	6
Fish spawning grounds	Annual spawning distribution for 39 species (NABIS 2012). National hotspots of annual spawning distribution as summarised in Stephenson et al. (2018). 25 species were shown to have spawning distribution within the study area (Figure 4-11).	Polygons	National		
Marine reef fish	Predicted distribution (occurrence) and relative abundance of 72 shallow coastal species of rocky reef fishes (Smith et al. 2013). Modelled to 'out of date' rocky reef substrate layer, with updated layers not yet available (completed approximately April 2020).	Raster	National only shallow water	1 km^2	3, 5, 8

Data Name	Brief description	Data format	Data extent	Data resolution	Relevant KEA criteria
NZ fish records (threatened, at risk, rare and endemic)	Species records (locations) for primarily shark species assessed at being at risk for both Quota Management System and non QMS species (Ford et al. 2018). Species data across the following categories were shown to have a presence within the study area: fish at risk, fish rare, and fish endemic (Figure 4-12).	Point data	National	n/a	1; 2
Biogenic habitat - bryozoans	Modelled distributions of 11 habitat-forming bryozoan species (Wood et al. 2013) (Figure 4-13).	Raster	National	1 km^2	1; 3; 4; 5; 8; 9
Biogenic habitat provision (modelled layer)	Predicted biogenic habitat provision using ecosystem services rule-based mapping (Townsend et al. 2011, Townsend & Lohrer 2019). The same methodology was used to recreate the biogenic habitat provision within the defined study area, and values were normalised to this extent (Figure 4-14).	Raster	National – only coastal	1 km^2	Validated (regionally)
Key biogenic habitats	15 biogenic habitats defined nationally, and mapped primarily as point records from a number of sources (Anderson et al. 2019). 7 of the 15 habitats included point records within the Hawke's Bay region (Figure 4-15).	Various	Regional - National	various	
Vulnerable Marine Ecosystems (VME)	Predicted distribution of occurrence and associated uncertainty layers of 11 indicator taxa for Vulnerable Marine Ecosystems (VME) (Anderson et al. 2016). All taxa were predicted to have suitable habitat in the Hawke's Bay, particularly in depths >200 m. Datasets without 'local' observations were excluded from Zonation analyses, resulting in selection of a total of 3 VME models (Figure 4-16**Error! Reference source not found.**).	Raster	National - only deep water	1 km^2	1
Benthic invertebrate records	Benthic invertebrate records (locations) extracted from national and international databases (2015 extract for project: Lundquist et al. (2015). Records were groomed and quality controlled (Figure 4-17).	Point data	National	n/a	2; 4
Benthic invertebrate species richness	Predicted benthic invertebrate species richness (Stephenson et al. 2018) (Figure 4-18).	Raster	National	1 km^2	semi-validated (bootstrapped models)
Naturally uncommon habitats in NZ coastal environment	Identification and mapping of naturally uncommon habitats in NZ coastal environment (Wiser et al. 2013). Datasets were located in terrestrial habitats, and not used in this analysis (Figure 4-19).	Polygons	National - only coastal		

4.2.1 Megafauna

Models of cetacean distributions (probability of species occurrence) were available based on Stephenson et al. (2020a) using Relative Environmental Suitability (RES) for taxa with < 50 recorded sightings (n = 15), and Boosted Regression Tree (BRT) models for taxa with ≥ 50 recorded sightings (n = 15). These models were based on a total of 14,513 cetacean sighting records across 30 cetacean taxa. A diversity of cetaceans are found in the Hawke's Bay, with a total of 261 recorded sightings in the national database, including 12 individual species (Figure 4-9, Table 4-3). Common dolphins are the most frequently observed species, with point records throughout the region, and abundant records in the inshore regions of Hawke's Bay (Figure 4-9). Species richness maps illustrate that many different cetacean species are occasionally found in the Hawkes Bay offshore region, though most of these species are rarely observed. Fewer species are commonly found inshore, though individual species such as the common dolphin may be regularly observed (Figure 4-9). This inshore-offshore difference matches national patterns between inshore and offshore cetacean species, where inshore species may be more commonly observed, but offshore species include a larger pool of species.

Table 4-3: Cetacean sightings by species from national database of 14,513 total records (based on data presented in Stephenson et al. 2020a).

Cetacean species (common name)	Number of sightings in the Hawke's Bay model area
Bottlenose dolphin	6
Common dolphin	167
Dusky dolphin	2
Fin whale	4
Hector's dolphin	13
Humpback whale	5
Killer whale	13
Minke whale	1
Pilot whale	21
Right whale	10
Sei whale	3
Southern bottlenose whale	1
Sperm whale	15

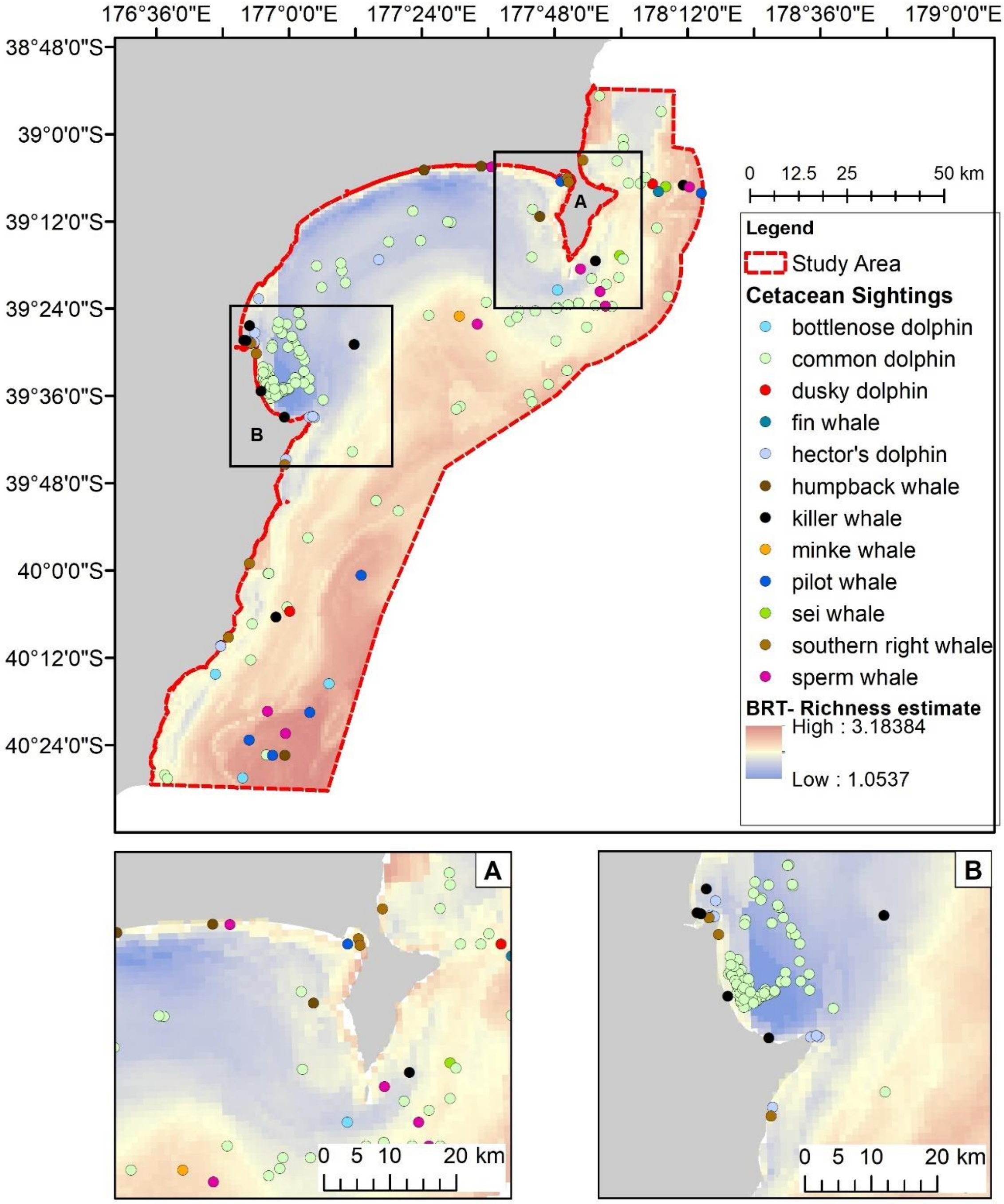

Figure 4-9: Cetacean species richness and cetacean species sightings within the Hawke's Bay region from the national cetacean records database. Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

Locations of seal breeding colonies and haul-outs (New Zealand fur seals, *Arctocephalus forsteri*, New Zealand sea lion, *Phocarctos hookeri* and the southern elephant seal, *Mirounga leonina*) are available from NABIS (2012) and were recently updated by DOC in 2018. These include two NZ fur seal haul outs in the Hawke's Bay, on the west side (Black Reef) and the east side (Table Cape) of the Mahia Peninsula. HBRC sites of ecological significance identify a further NZ fur seal haul out in the Hawke's Bay, located at Waimarama (SCA 8, Figure 3-1).

Location of bird colonies and proposed important bird areas (IBA) for New Zealand seabirds were provided by Forest & Bird (2014) based on global analyses developed by BirdLife International. Criteria applied in the marine environment for identification of IBAs are: regular presence of threatened species; or more than 1% of global population regularly occurring (Forest & Bird, 2014). In the Hawke's Bay, one IBA is identified at the gannet colony at Cape Kidnappers, and includes a seaward extension from the breeding colonies to include the foraging area that covers much of the Hawke's Bay (radius of ~60 km from breeding colony). This colony was also identified in the HBRC significant areas layer as SCA9 polygon (Figure 3-1), though the SCA polygon includes a more limited foraging area. The HBRC SCAs also identify a number of individual seabird and shorebird species commonly present at a number of sites in the Hawke's Bay (Table 2-3).

4.2.2 Fish

Demersal fish presence/absence data were available from research bottom trawl surveys in the waters surrounding New Zealand between 1979–2005, comprising ~207,000 presence/absence observations of 253 species at 27,440 unique sample locations. Record numbers were adequate to develop species occurrence models for 217 species. Only a very small portion of these (n = 747 individual point records) occurred within the Hawke's Bay; of these records, 211 were from depths of 0-100 m, 265 were from depths of 100-200 m, and 271 were from depths of greater than 200 m. These point records were used to create species occurrence models and to quantify species richness at a national scale (Figure 4-10). The average number of unique point record locations per species was 1662 (maximum: 13,926; minimum: 50). The model AUC criteria (a measure of predictive ability) was on average 0.966 (maximum: 0.998; minimum: 0.873).

The national species richness maps suggest higher demersal fish diversity on the shelf and slope within the Hawke's Bay region relative to Hawke Bay. This is partially explained by the larger number of shelf and slope species included in the national dataset of modelled distributions compared to fewer (~40% of 217 individual species occurrence models) of modelled distributions for inshore species (Figure 4-10). The addition of additional inshore point locations to these models could improve their predictive ability in waters shallower than 200 m.

Demersal fish were further examined for those fish species of particular local interest, or those for which the Hawke's Bay is an important area for a particular life history stage (i.e., spawning). A total of 39 species were recorded as either being an important commercial fisheries stock in the Hawke's Bay (Table 4-4), and/or were shown to have spawning within the Hawkes' Bay (Figure 4-11). Two of these (grouper, *Epinephelus daemelii*; butterfish *Odax pullus*) are primarily reef-associated fish, and did not have species occurrence models available from the demersal fish dataset, though they had both been previously modelled within the reef fish datasets (see next section). Two further shark species (blue shark and porbeagle shark) are listed as important commercial species in the Hawke's Bay, but also do not have species occurrence models in the demersal fish dataset. The mackerels are noted as important commercial species in the Hawke's Bay, and individual species layers are available for both *Trachurus declivis* and *Trachurus novaezelandiae,* though the two species are reported as one combined fisheries code. Thus of 39 fish species (or species groups) identified as important commercial fisheries in the Hawke's Bay, we lack species occurrence models for 4 of these, and for one, we have models for two species that comprise this stock; in total, we have models for 36 locally important demersal fish species in the Hawke's Bay (Table 4-4).

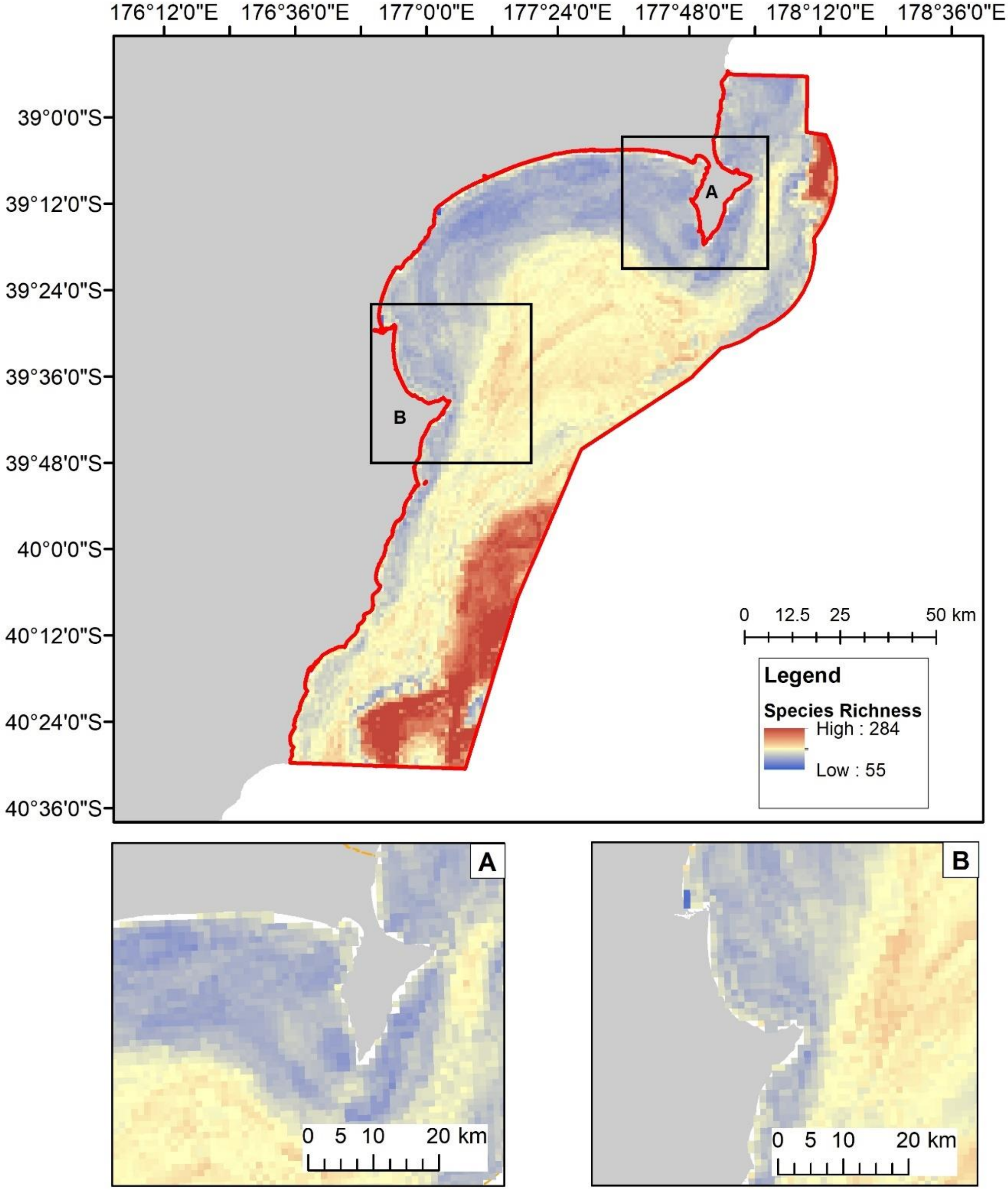

Figure 4-10: Demersal fish species richness in the Hawke's Bay region based on national demersal fish species distribution models of 217 species. Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

Table 4-4: Commercially important fish species in the Hawke's Bay. Indication of spawning presence based on finfish spawning layers from NABIS (Hurst et al. 2000).

Fish Code	Common Name	Scientific Name (as reported on Fisheries NZ species codes)	Spawning in HB (NABIS/KEA)	Identified by HB fisherman as commercially important stock
ANC	Anchovy	*Engraulis australis*	Y	N
BAR	Barracouta	*Thyrsites atun*	Y	N
BAS	Bass	*Polyprion americanus*	N	Y
BCO	Blue cod	*Parapercis colias*	N	Y
BRI	Brill	*Colistium guntheri*	N/A	Y
BUT	Butterfish	*Odax pullus*	Y	N
BWS	Blue shark	*Prionace glauca*	Y	N
ELE	Elephant fish	*Callorhinchus milii*	Y	N
EPT	Black cardinal fish	*Epigonus telescopus*	Y	N
ESO	New Zealand sole	*Peltorhamphus novaezeelandiae*	N/A	Y
GUR	Gurnard	*Chelidonichthys kumu*	Y	Y
HAP	Hapuka	*Polyprion oxygeneios*	Y	Y
HOK	Hoki	*Macruronus novaezelandiae*	Y	Y
JDO	John dory	*Zeus faber*	Y	Y
JMD	Japanese horse mackerel	*Trachurus japonicus*	Y	N
JMM	Murphy's mackerel	*Trachurus murphyi*	Y	N
KAH	Kahawai	*Arripis trutta*	Y	N
LIN	Lig	*Genypterus blacodes*	Y	Y
LSO	Lemon sole	*Pelotretis flavilatus*	N/A	Y
MOK	Blue moki	*Latridopsis ciliaris*	Y	N
POS	Porbeagle shark	*Lamna nasus*	Y	N
RCO	Red cod	*Pseudophycis bachus*	Y	Y

Fish Code	Common Name	Scientific Name (as reported on Fisheries NZ species codes)	Spawning in HB (NABIS/KEA)	Identified by HB fisherman as commercially important stock
RIB	Ribaldo	*Mora moro*	Y	N
SBG	Grouper	*Epinephelus daemelii*	N	Y
SDF	Spotted flounder	*Azygopus pinnifasciatus*	N/A	Y
SFL	Sand flounder	*Rhombosolea plebeia*	N/A	Y
SKI	Gemfish	*Rexea solandri*	Y	Y
SLS	Slender sole	*Peltorhamphus tenuis*	N/A	Y
SNA	Snapper	*Chrysophrys [Pagrus] auratus*	Y	Y
SOL	Speckled sole	*Peltorhamphus latus*	N/A	Y
STA	Giant stargazer	*Kathetostoma giganteum*	Y	N
TAR	Tarakihi	*Nemadactylus macropterus*	Y	Y
TRE	Trevally	*Pseudocaranx georgianus*	Y	Y
TRU	Trumpeter	*Latris lineata*	N/A	Y
TUR	Turbot	*Colistium nudipinnis*	N/A	Y
WAR	Warehou	*Seriolella brama*	N	Y
WIT	Witch	*Arnoglossus scapha*	N/A	Y
WWA	White warehou	*Seriolella caerulea*	Y	N
YBF	Yellow-belly flounder	*Rhombosolea leporina*	Y	Y

Annual spawning distribution for 39 finfish species were available from NABIS (2012) based on datasets with spatial estimates of catch of ripe females from fisheries databases, integrated with literature and expert opinion, and hand-drawn by an expert scientist (Hurst et al. 2000). Spawning layers were interrogated to determine which of the 39 species spawned in the Hawke's Bay, as well as to determine which of the previously identified commercially important species had spawning maps available from this national database (Table 4-4). A total of 14 spawning layers were available for commercially important species as identified by local fishers (Haggitt and Wade 2016), and an additional 14 layers were available for other species determined to have spawning distributions in the Hawke's Bay. A summary layer of 'spawning species richness' was created by spatially accumulating these 28 overlapping spawning distributions (Figure 4-11, Table 4-4).

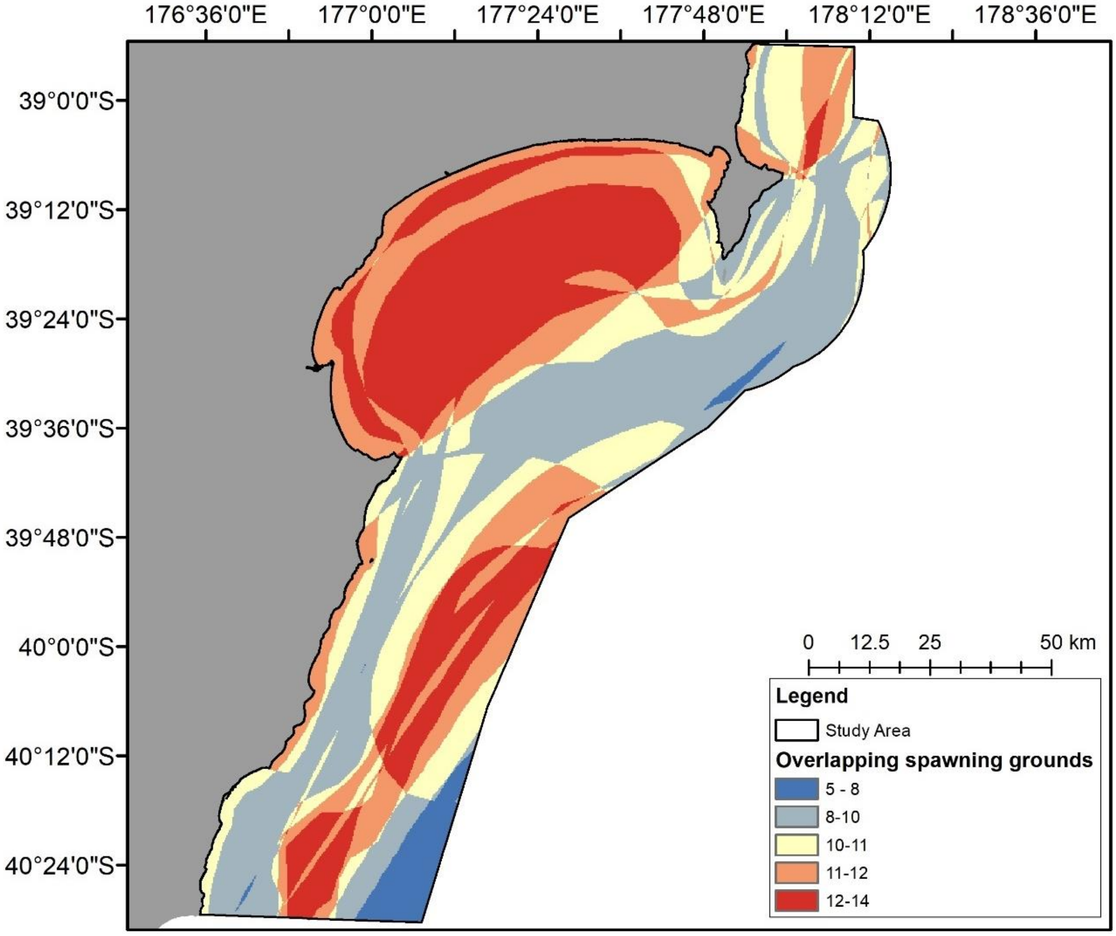

Figure 4-11: Summation of overlapping finfish spawning grounds in the Hawke's Bay region.

Fish species records (locations) were available from the national datasets (Stephenson et al. 2018) based on national databases and prior analyses in Lundquist et al. (2015). This dataset includes point records extracted from OBIS and TRAWL databases and NIWA invertebrate databases, groomed and quality-controlled to provide a database of historical records to 31 December 2013 (Lundquist et al. 2015). Further sub-datasets based on this larger data extraction include 'unique species', those fish species with only a single observation recorded in the New Zealand EEZ (n = 39); 'rare species', those species with 2-10 records in the New Zealand EEZ (n = 97); and endemic species as per Gordon et al. (2010) (information available online at the New Zealand Organisms Register - http://www.nzor.org.nz/) (Figure 4-12). Only one 'unique/rare' species was recorded in the Hawke's Bay model area, *Thunnus albacares* (yellowfin tuna) (Figure 4-12). Endemic species included in the NZOR are a total of 193 endemic bony fish species/subspecies, and 29 chondrichthyan species/subspecies. 'At risk' fish species (n = 32) include chondrichthyan species (sharks, skates and rays, chimaeras) for which a qualitative risk assessment of the impact of commercial fishing was available and used to identify species which were deemed to be vulnerable, fragile, sensitive, or slow to recover (Ford et al. 2018). Data are available as point records, and exhibit both taxonomic bias (with high abundance of chondrichthyans – sharks/rays, due to recent risk assessment for this taxonomic group (Ford et al. 2018)), and offshore bias (based on majority of the records coming from deeper water research trawls (Figure 4-12)).

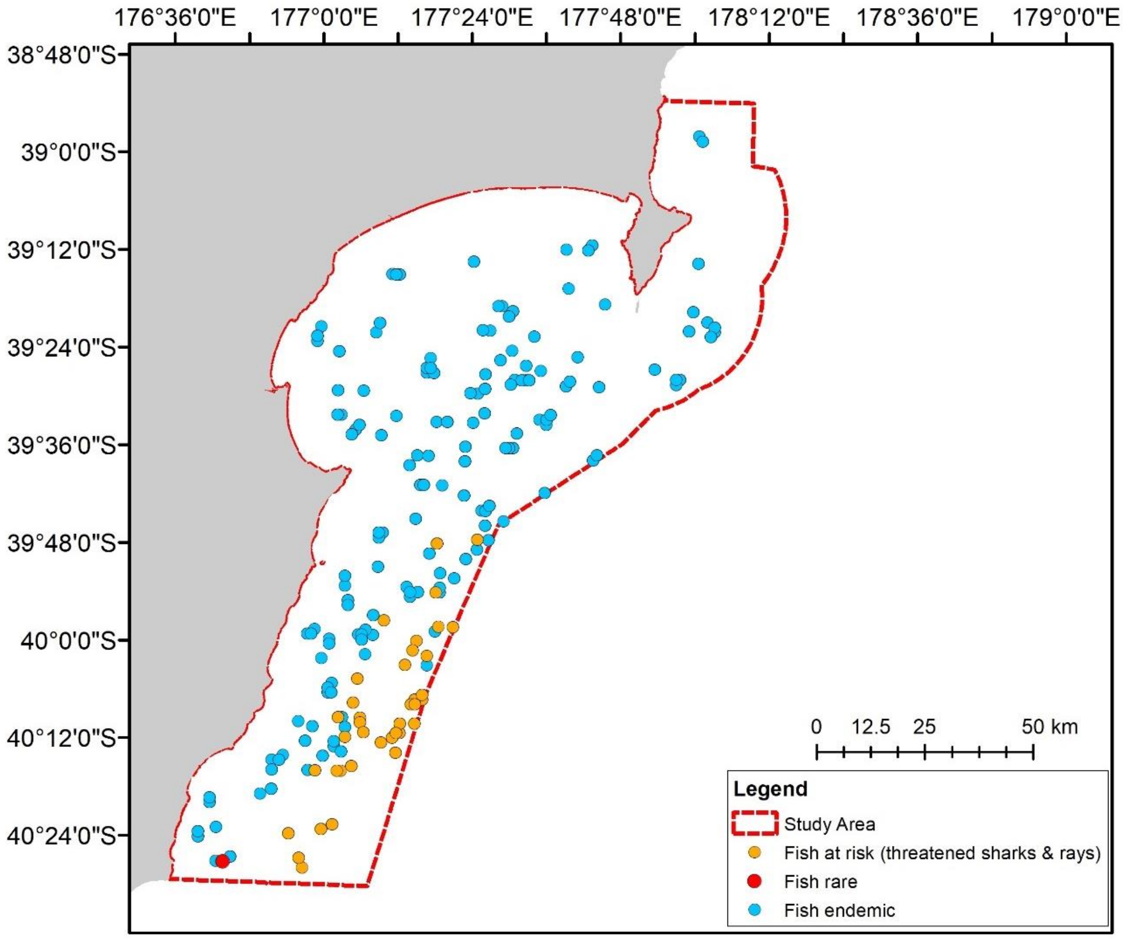

Figure 4-12: Point records of endemic, rare, and at risk fish species.

The predicted distributions and abundances and associated uncertainty layers of 72 species of rocky reef fishes were available from the national dataset (Stephenson et al. 2018), sourced from Smith et al. (2013). These data layers are based on somewhat outdated rocky reef layers, and are in process of being updated by NIWA; thus these older reef fish layers are not presented here. Models were limited to 'known' rocky reef habitats, and newer, continuous layers are likely to provide more robust models of these reef-associated species.

4.2.3 Invertebrates and biogenic habitat

The national key ecological areas dataset included modelled distributions of habitat suitability for eleven common bryozoans in New Zealand waters (Wood et al. 2013; Stephenson et al. 2018). Eight of these species (*Arachnopusia unicornis, Cellaria tenuirostris, Celleporaria agglutinans, Celleporina grandis, Diaperoecia purpurascens, Galeopsis porcellanicus, Hippomenella vellicata,* and *Smittoidea maunganuiensis*) had distributions within the Hawke's Bay model area. A map of species richness based on these eight species shows highest bryozoan richness in areas of anecdotal biogenic habitat, such as around the Mahia Peninsula, the Wairoa Hard, and off Cape Kidnappers (Figure 4-13). As the models used sediment as one environmental driver of habitat suitability, the areas of high richness are highly correlated with the abiotic habitat layers (Figure 4-2). A total of 10 environmental drivers were used, ranging in resolution from 1 km^2 to 2^o (Wood et al. 2013). More recent national invertebrate predictive models (see Figure 4-18) were informed by 20 updated environmental layers, and additional point records, as available, to improve model predictive ability (Lundquist et al. 2020). Only one point record of bryozoans was available within the Hawke's Bay model area (*Celleporaria agglutinans*) (Figure 4-15).

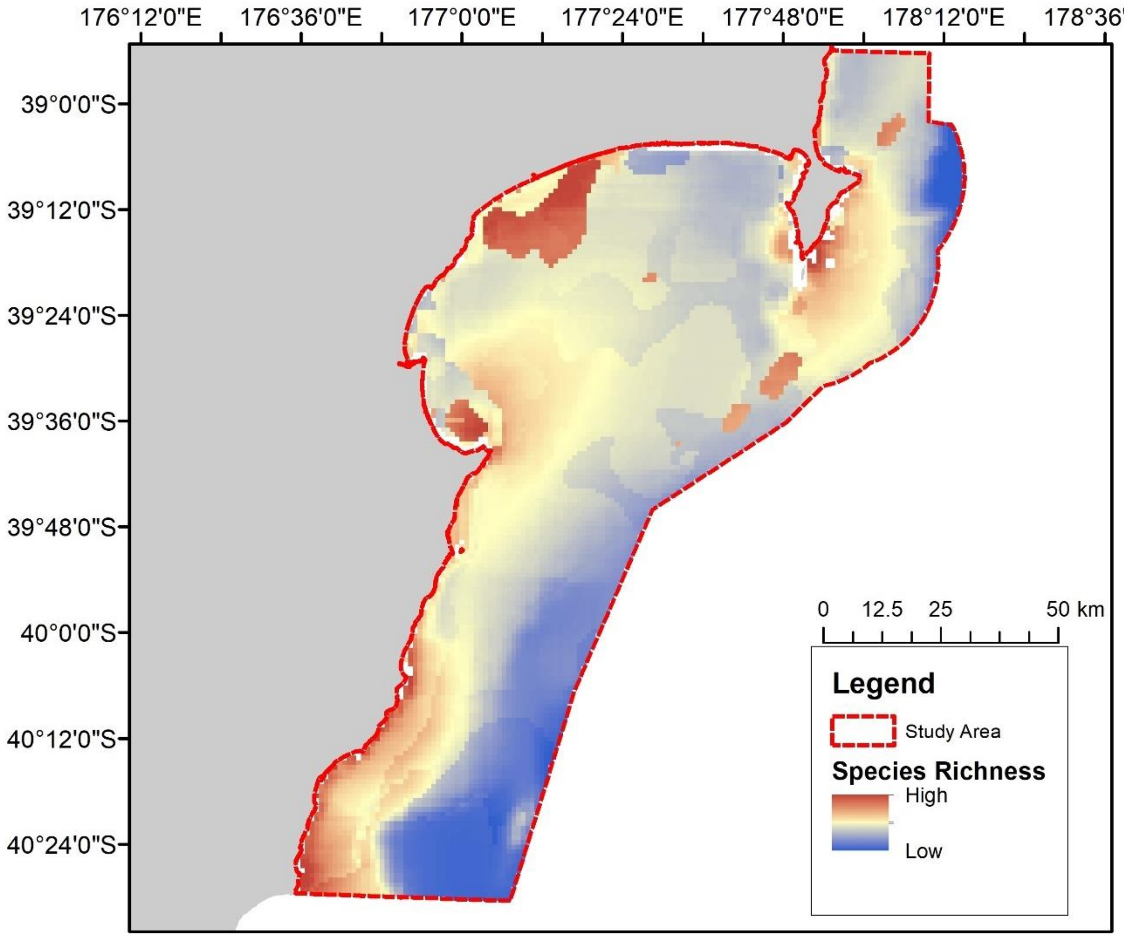

Figure 4-13: Species richness of 8 bryozoan taxa. Based on data presented in Wood et al. (2013) and compiled within national key ecological areas dataset (Stephenson et al. 2018).

A predictive model layer of the provisioning of biogenic habitat was developed at a national scale based on methods presented in Townsend et al. (2011), and has since been validated (Townsend and Lohrer 2019). This model defines biogenic habitat provisioning from a series of 'ecosystem principles' based on current ecological understanding of their relationship to marine biophysical parameters. The modelling approach was redone for the Hawke's Bay, and normalised to the maximum value found in the Hawke's Bay model area (Figure 4-14).

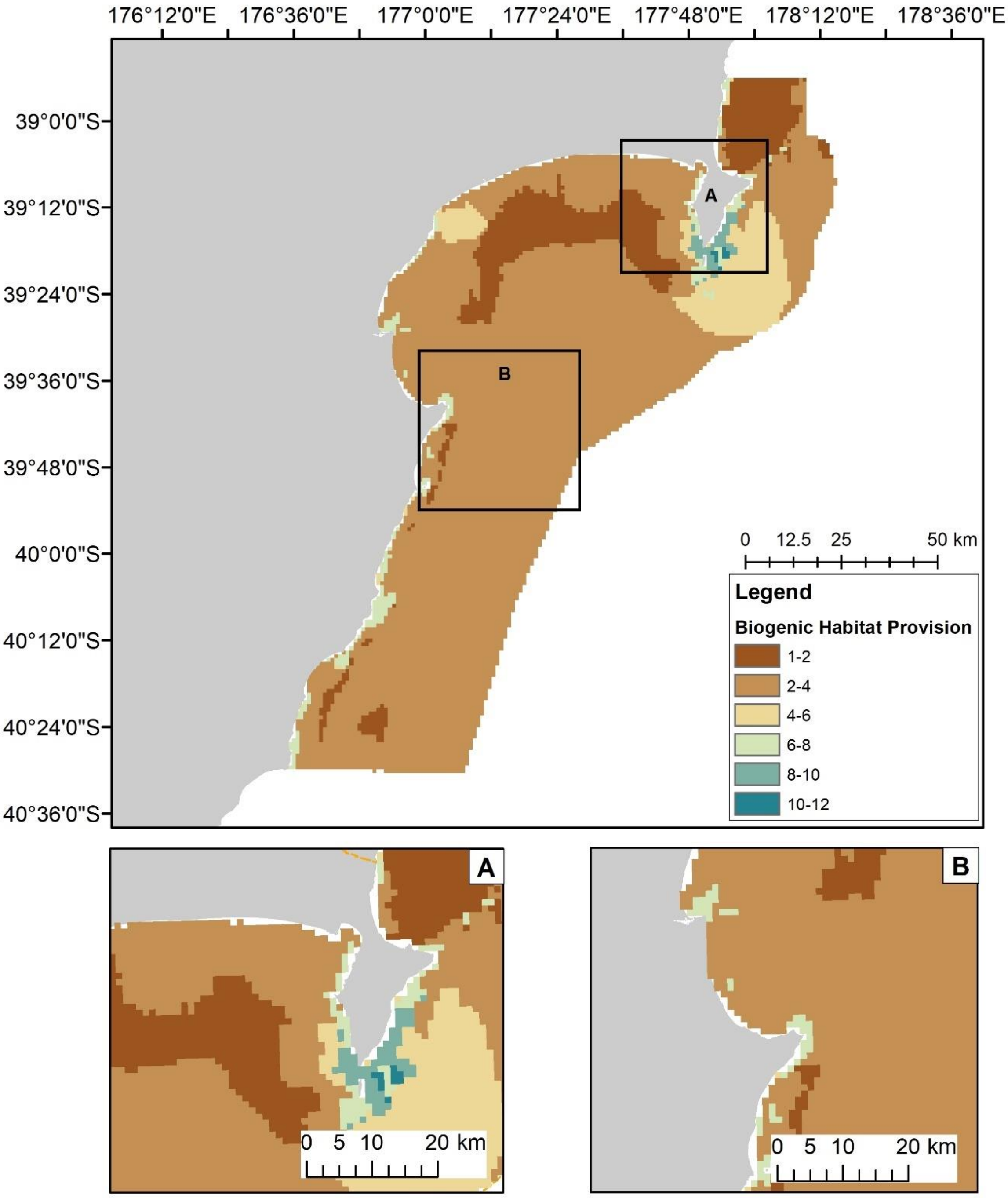

Figure 4-14: Modelled biogenic habitat prediction based on ecosystem principles approach. Ranking shows relative importance for biogenic ecosystem services, from highest values (blue colours) to lowest values (tan and brown colours). Based on methods in Townsend and Thrush (2010). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers

Collated data for 15 nationally recognised biogenic habitats that occur within New Zealand's EEZ and territorial waters were sourced from a national compilation of spatial records of these habitats and are described in Anderson et al. (2019), and available from the national KEA dataset (Figure 4-15). These layers were collated to inform the 2019 State of the Marine Environment Report, based on multiple databases and sources (e.g., New Zealand and Australian Museum records, fisheries research databases, and online biodiversity databases, research institutes and agency databases, and VME indicator taxa). These data are mostly presence-only point data, with only a few dozen records available within the Hawke's Bay (Figure 4-15). Where no records exist, this should be interpreted only as a lack of sampling effort in that region. These point records generally poorly overlap (due to their limited number of inshore point records in Hawke Bay) with the more comprehensive biotic habitat maps for the inshore Hawke's Bay developed by Haggitt and Wade (2016) (Figure 4-4). However, there is some correlation between the three biogenic/biotic habitat layers, for example with bivalve point records and bivalve biotic habitats recorded in two datasets in Hawke Bay, and kelp biogenic habitats recorded in all three datasets on the Mahia Peninsula (though limited to one record in the national point record dataset). The modelled biogenic habitat provisioning layer appears poorly correlated with infaunal biogenic habitats (Figure 4-14), though it does suggest an area of high biogenic habitat provisioning in the area of SCA 14 (the Wairoa Hard).

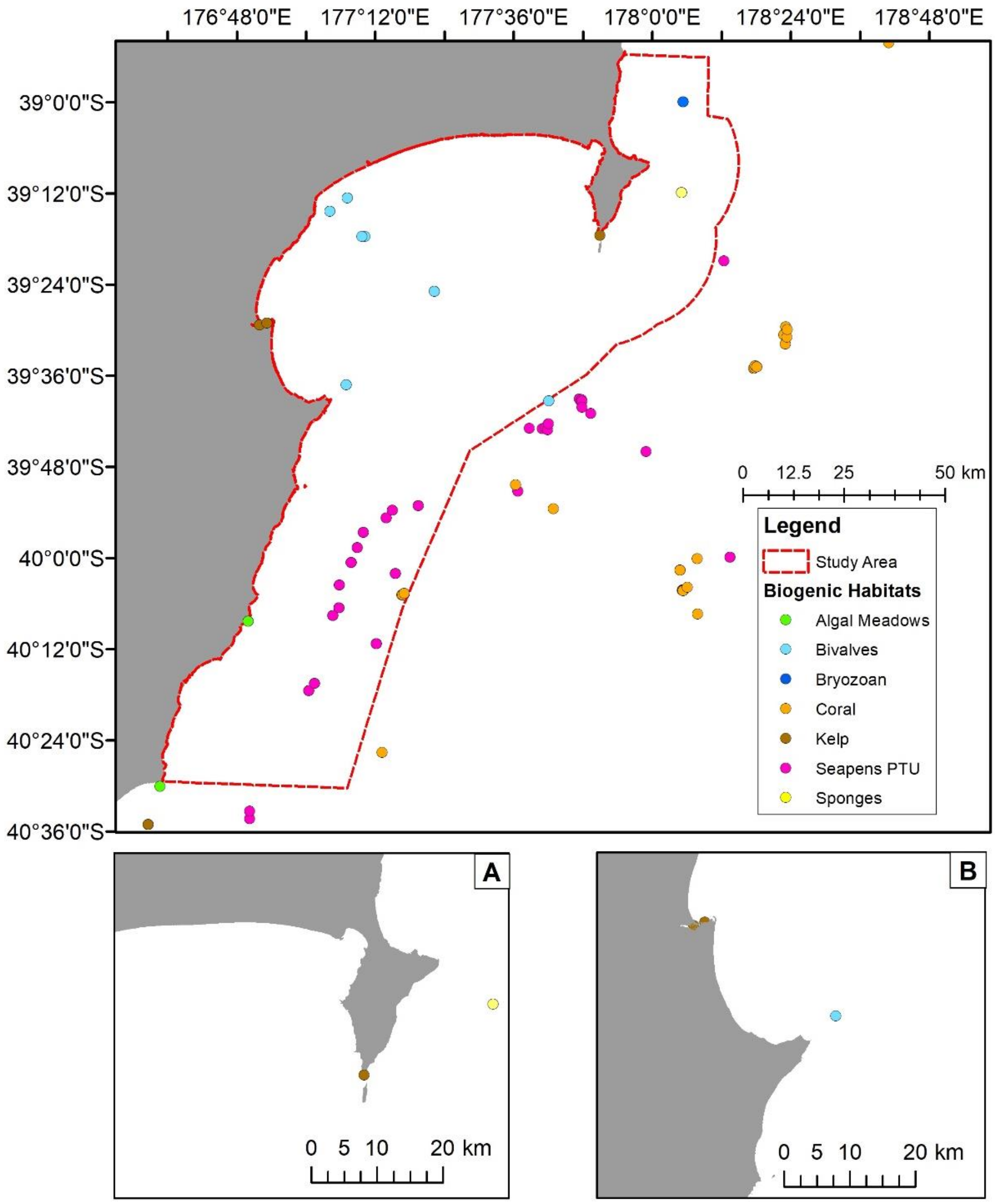

Figure 4-15: Point observations from national dataset of key biogenic habitats (Anderson et al. 2019). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers

Predicted distribution of occurrence and associated uncertainty layers of 11 indicator taxa for Vulnerable Marine Ecosystems (VME) for depths greater than 200 m were available from the national dataset (Stephenson et al. 2018), based on methods in Anderson et al. (2016). One of these taxa, brisingids (BRG), was later shown to have poor correlation with VME taxa, thus updated model layers were not available. A total of three VME taxa (Figure 4-16) were assessed as being more likely to represent true distributions in the Hawke's Bay CMA due to the existence of observations in shallower waters within the Hawke's Bay CMA (COR: S Stylasteridae, DEM: Demospongia and PTU: Pennatulacea), with 3, 2 and 12 records, respectively, inside the Hawke's Bay CMA (whereas a larger number of observations occurred in deep water >200 m within the broader model area (Table 4-5).

Table 4-5: Vulnerable marine ecosystem taxa. Taxa for which habitat suitability models have been developed (for depths > 200 m), and the number of records for each taxon in the Hawke's Bay.

Name	FNZ code	FAO code	Number of records in wider Hawke's Bay study area
Brisingidae	BRG		6
Antipatharia	COB	AQZ	85
Stylasteridae	COR	AXT	38
Demospongia	DEM	DMO	7
Enallopsammia rostrata	ERO	FEY	65
Goniocorella dumosa	GDU	GDV	11
Hexactinellida	HEX	HXY	8
Madrepora oculata	MOC	MVI	49
Pennatulacea	PTU	NTW	1
Solenosmilia variabilis	SVA	RZT	34

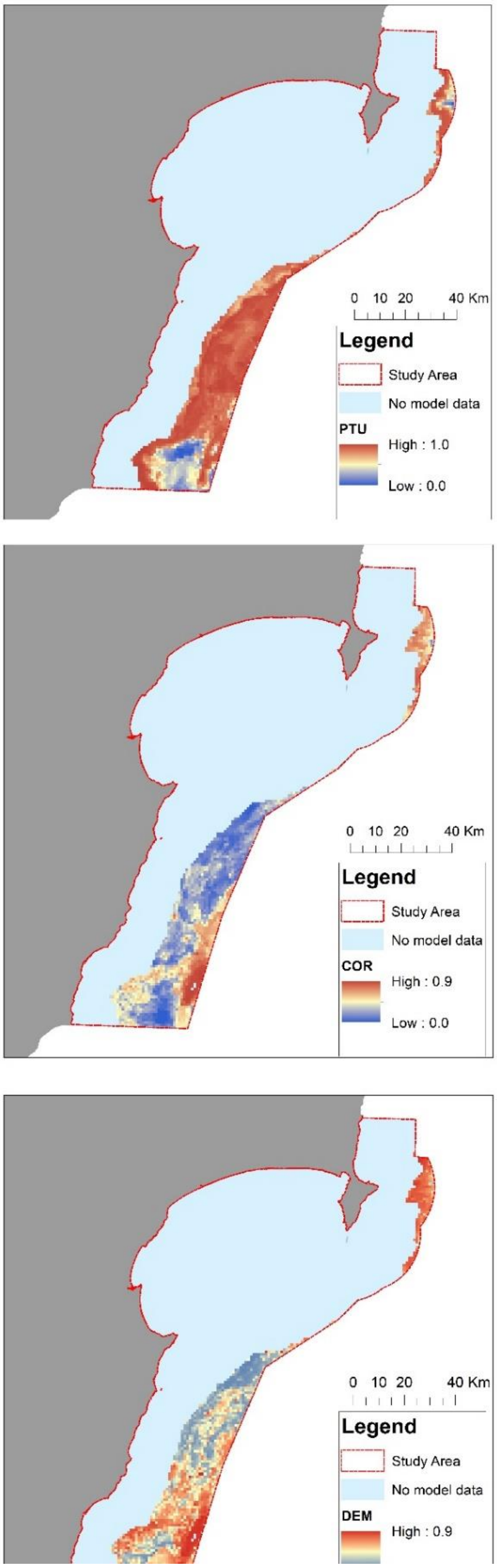

Figure 4-16: Modelled distributions of Vulnerable Marine Ecosystem taxa. COR – Stylasteridae; DEM – Demospongia; PTU – Pennatulacea. Note that the predictive model was limited to deeper depths, and no model data is available for depths shallower than 200 m.

Benthic invertebrate species records (locations) were extracted from national databases and were groomed and quality controlled for Lundquist et al. (2015) and updated for the KEA dataset collation (Stephenson et al. 2018). Benthic invertebrate species records were split into several datasets including 'unique species' with only a single record in the New Zealand EEZ, 'rare species' with 2-10 records in the New Zealand EEZ (n = 97) and endemic species as per Gordon et al. (2010) (information available online at the New Zealand Organisms Register - http://www.nzor.org.nz/, including a total of 1627 endemic benthic invertebrates). Data are available as point records, and exhibit an offshore bias with the majority of the records coming from deeper water research trawls (Figure 4-17). A total of 106 records occurred within the Hawke's Bay model area, including a total of 50 individual species (Table Appendix 1, Table Appendix 2).

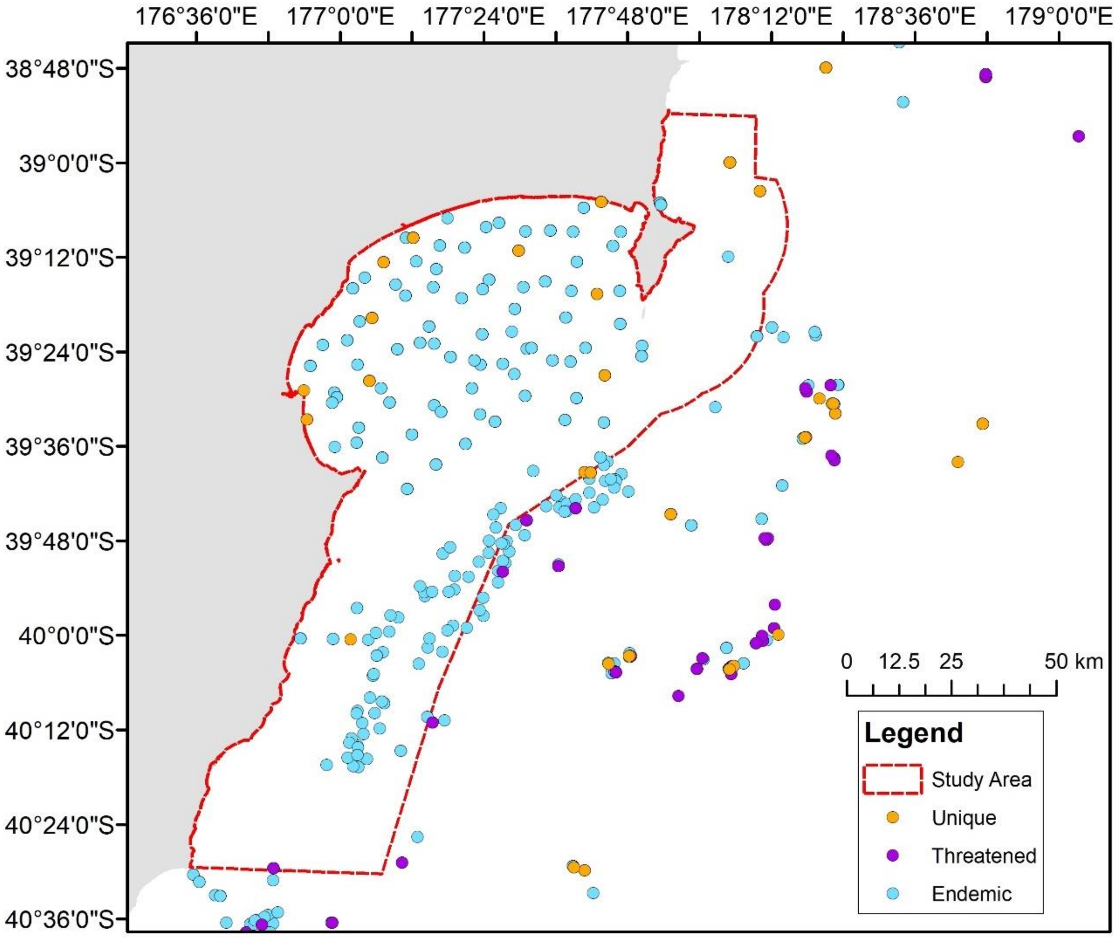

Figure 4-17: Point records of unique, endemic and threatened invertebrates available in the wider Hawke's Bay study area. Based on data collated for Stephenson et al. (2018).

Predicted benthic invertebrate species richness was modelled specifically for the MSAG KEA analysis (Appendix 7.2 in Stephenson et al. 2018) (Figure 4-18). Predicted benthic invertebrate species turnover and community assemblages (30, 50, and 100 classification groups) was also modelled, with 11 of the groups in the 30 group classification being found in the Hawke's Bay area (Figure 4-18). These groups show similar spatial patterns in the inshore Hawke Bay to that of the modelled biogenic habitat layer (Figure 4-14), illustrating the dependence of both modelling techniques on the same environmental layers (depth, sediment).

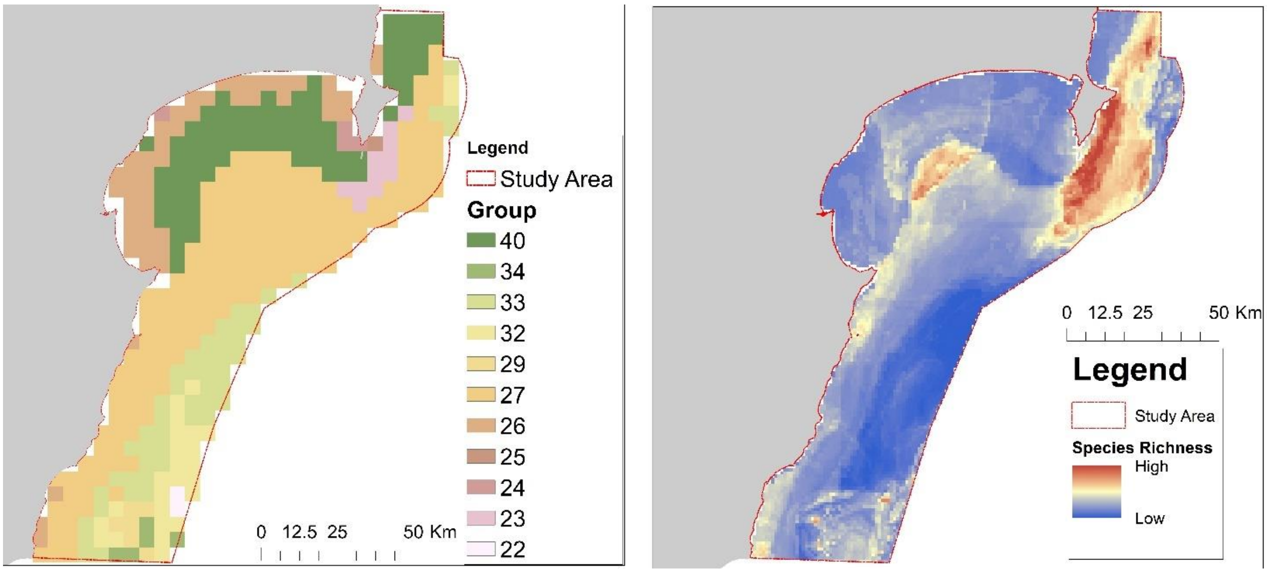

Figure 4-18: Geographic distributions of the 30-group benthic invertebrate classification and species richness. Left: 11 groups present in the Hawke's Bay region, based on group assemblages derived from a hierarchical Gradient Forest model fitted to benthic invertebrate point records for depths to 2500 m, clipped to the Hawke's Bay region; Right: species richness based on bootstrapped Boosted Regression Tree models of benthic invertebrate taxa (Stephenson et al. 2018).

4.2.4 Naturally uncommon ecosystems

Naturally uncommon ecosystems in New Zealand (terrestrial environments) were available from Wiser et al. (2013) and collated in the national dataset (Stephenson et al. 2018). 72 ecosystems were identified as naturally uncommon; coastal ecosystems in this dataset include: Shell barrier beaches ('Chenier plains'); Coastal turfs; Geothermal ecosystems; Seabird guano deposits; Marine mammal rookeries and haul-outs (all of which are described in detail in Wiser et al. (2013)). These ecosystems are terrestrially biased, though a number of them may be relevant to marine-based species of ecological significance that may rely on terrestrial habitats as part of their life history. Most of these naturally uncommon ecosystems are also identified within the SCA layer (Figure 4-19).

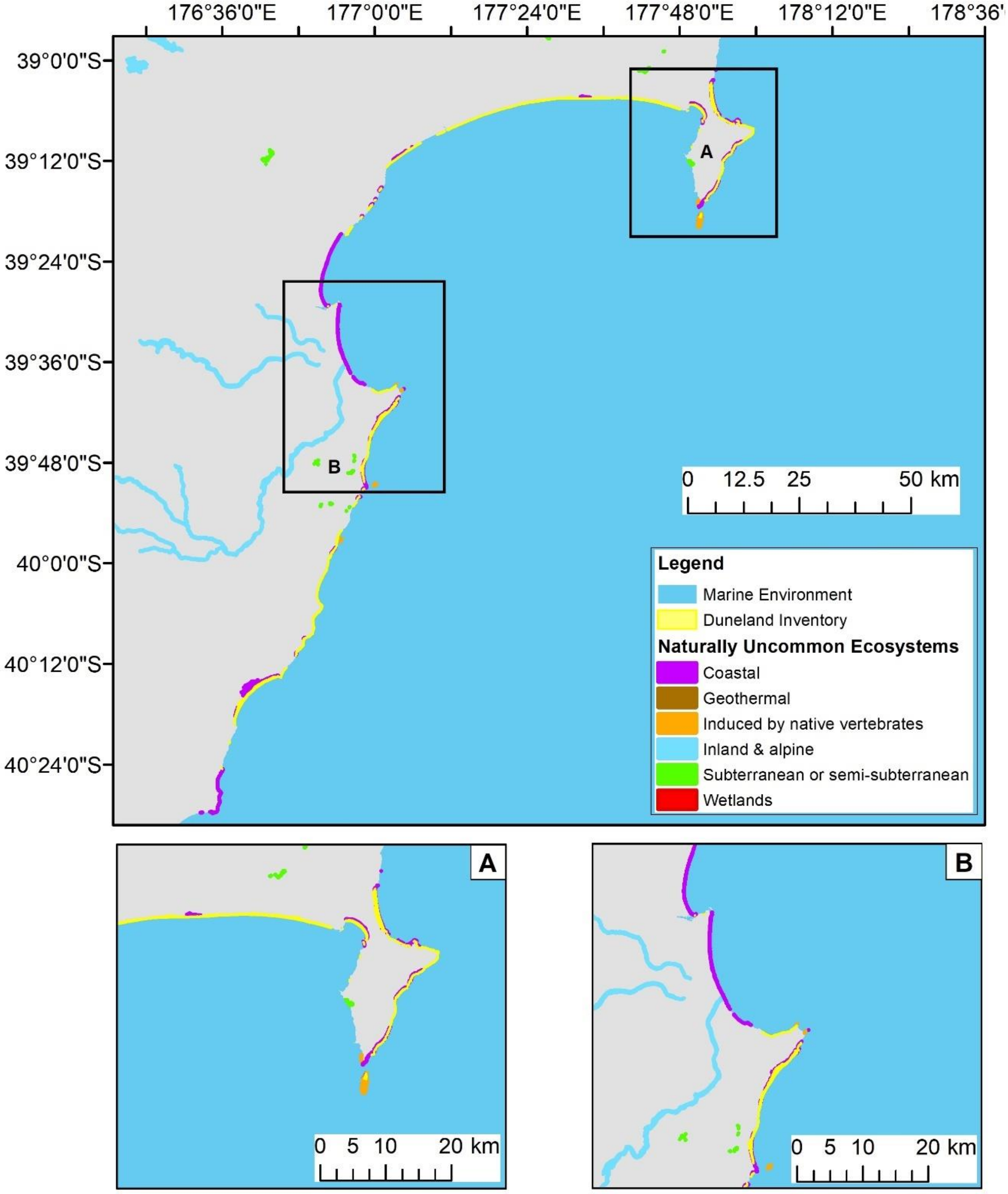

Figure 4-19: Naturally uncommon assemblages. Based on datasets reproduced from Wiser et al. (2013). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

5 Preliminary prioritisation of the Hawke's Bay CMA for ecological significance

The software *Zonation* was used in a pilot exercise to showcase how this decision support tool could be used with the datasets compiled by this project to determine areas of ecological significance. Dataset selections for the exploratory models were based on assessment of quality and comprehensiveness of individual datasets, and whether the available datasets were sufficient to describe each ecological significance criteria (Table 5-1). The model input layers included both national and HBRC datasets, with default Zonation options. Habitat datasets (abiotic and biotic) were determined to be higher resolution in the HBRC datasets, whereas the majority of biodiversity datasets (e.g., species models) were only available from the national datasets. For biogenic habitats, two layers were selected, with the HBRC biotic habitats layer including many biogenic habitats in the inshore region of the model, and the modelled biogenic habitat layer providing comprehensive coverage of the entire model region (Table 5-1). Model scenarios were developed with HBRC, including selection of datasets to include in the exploratory analyses, and other relevant model options. Scenario outputs were discussed with HBRC to confirm that these exploratory model outputs made sense based on expert knowledge of the Hawke's Bay marine region.

Zonation creates a hierarchical ranking of all sites across the landscape (or seascape in this case) where areas are identified from the highest to lowest priority in terms of value to biodiversity features used as input layers (Moilanen et al. 2014). Zonation starts with a full set of grid cells that encompass the entire area of interest, and sequentially removes cells of the lowest conservation 'value' (Moilanen et al. 2014). The default Core Area Zonation function (CAZ) algorithm was used to select priority cells for identification of significant conservation values with a focus on representation of all features rather than on hotspots of species richness (Moilanen et al. 2014). Default settings were used for other model parameters (e.g., edge removal, no aggregation algorithm, no cost layers, no administrative unit analysis). Weightings for datasets in each scenario are presented in Table 5-1.

Four initial biodiversity prioritisation scenarios were explored (Table 5-1). These scenarios represent a starting point for discussions surrounding the identification of areas of significant value for biodiversity across the nine key ecological area criteria. The four scenarios included three 'biodiversity' focussed scenarios and one combined scenario including biotic and abiotic habitat datasets. This approach allowed for exploration of how scenario output was influenced by different elements of biodiversity (full set of national demersal fish models versus only those listed as locally important species versus only invertebrate datasets). A further 'habitat' only scenario, including biotic and abiotic habitat layers as drivers of priorities, was explored but not presented here, as Zonation performed poorly for this scenario as input datasets were non-overlapping (i.e., for both abiotic and biotic habitat datasets, every location is only represented by one habitat type). In contrast, most biodiversity layers were contiguous, including the full model area, allowing for Zonation to optimise across >200 and >40 layers, respectively, in the fish scenarios, and >10 layers in the invertebrate scenarios. The different scenarios also allowed for examination of how well scenarios based on national datasets matched expectations of HBRC, as well as how well each scenario correlated with priority areas identified in other scenarios.

Table 5-1: Datasets and associated model weightings used in Zonation spatial prioritisation scenarios.

	Weightings of layers used in Zonation scenarios			
Master list of weighted/unweighted biodiversity features	**Scenario 1 – National demersal fish layers**	**Scenario 2 – Locally important demersal fish**	**Scenario 3 – Invertebrates**	**Scenario 4 – Combined layers**
FISH				
Demersal fish, 217 national modelled layers; layers available for 36 of 39 species identified as locally important fish species or as spawning in the HB (Figure 4-10).	All layers (n = 217)	HB layers only (n = 36), weighted 3	None	HB layers only (n = 36), weighted 3
Finfish spawning (cumulative overlap of 28 species identified as spawning in model area) (Figure 4-11).	0	1	0	3
Finfish spawning (individual polygons representing 14 species identified as locally important fisheries) (Table 4-4).	0	3	0	3
Finfish spawning (individual polygons representing 14 species identified as spawning in the HB region) (Table 4-4, Figure 4-11).	0	1	0	1
Demersal fish species richness (Figure 4-10).	0	3	0	3
INVERTEBRATES				
Bryozoan modelled distributions - retain only 8 species with observations in model area, exclude other 3 species (Figure 4-13).	0	0	1	1
Vulnerable Marine Ecosystem modelled distributions – retain only 3 species with observations in model area, exclude other species with no records in the CMA (Figure 4-16).	0	0	1	1
Invertebrate species richness modelled layer (Figure 4-18).	0	0	3	3
Invertebrate classification groups (n = 11) (Figure 4-18).	0	0	1	1
HABITATS				
Abiotic habitats (n = 12 abiotic habitat types; two abiotic habitats, 'Cobble', and 'Sand and Gravel', were not used as they had minimal distributions within the CMA) (Figure 4-2).	0	0	0	1
Biotic habitat (n = 10 biotic habitat types) (Figure 4-4).	0	0	0	3

	Weightings of layers used in Zonation scenarios			
Master list of weighted/unweighted biodiversity features	**Scenario 1 – National demersal fish layers**	**Scenario 2 – Locally important demersal fish**	**Scenario 3 – Invertebrates**	**Scenario 4 – Combined layers**
Biogenic habitat modelled layer (Figure 4-14).	0	0	0	3
MEGAFAUNA				
Seal haul outs.	0	0	0	1
Seabird colonies.	0	0	0	1
Cetacean richness (Figure 4-9).	0	0	0	1
OTHER LAYERS FOR REPORTING ONLY.				
SCAs (Figure 3-1).	0	0	0	0
Expert-derived important areas for commercial fisheries (Figure 4-8).	0	0	0	0

5.1 Interpreting Zonation outputs

Zonation outputs include a map of biodiversity prioritisation, where areas are identified from the highest to lowest priority in terms of conservation prioritisation (Moilanen et al. 2014). In this study, outputs were presented as maps that identified the top 5%, 10%, 20% and 30% priority areas for biodiversity optimisation. Further, tables summarising the proportion of each biodiversity feature's range protected within these priority areas are provided. These tables provide information on whether biodiversity features are poorly- or well-represented in each scenario. A prioritisation would be deemed to be 'of minimum' efficiency if at least the same proportion of the features' range is protected relative to the proportion of the total area (e.g., if feature A has at least 5% of its range protected within the top 5% priority areas this would be considered a minimum efficient solution for Feature A). Preferably, Zonation can provide spatial optimisations that deliver far larger efficiencies, i.e., 20% of a feature within 5% of the total model area.

5.2 Zonation scenario results

Scenarios showed some consistency in areas prioritised, although with large variability in the relative protection of each group. Scenarios also demonstrated that some group data layers were good proxies for other groups, whereas others (e.g., invertebrates) were poorly correlated with protection of other groups (Figure 5-1 to Figure 5-4, Table 5-2 to Table 5-6).

In Scenario 1, prioritising only national demersal fish layers (n = 217) resulted in 15.0% protection on average of demersal fish distributions within the top 5% of the priority areas. This scenario also resulted in high protection (double or greater than minimum relative efficiency) of nationally identified finfish spawning distributions, VME distributions, and seal haul outs (Figure 5-1, Table 5-2). This scenario provided minimum or just below minimum efficiency of protection for finfish spawning richness, locally important finfish species, demersal fish species richness, invertebrate species richness, and cetacean richness. Average protection of invertebrate assemblages was high (12.4% within the top 5% of the priority areas). However the range of protection was large with a minimum of 1.5% and maximum of 37.3% of individual groups protected, and 7 of 11 groups found in the Hawke's Bay had <5% of their range in the top 5% priority solution. Seabird colonies showed low protection in the top 5% of the priority areas, but higher relative protection in the top 10, 20 and 30% of priority areas. Bryozoans were consistently protected at below minimum efficiency.

Scenario 1 resulted in much lower protection allocated to biotic and abiotic habitats, with approximately half the percent protection allocated to abiotic and biotic habitats relative to the average protection of demersal fish distributions across the 5-30% top priority areas. Scenario 1 outputs showed just below minimal efficiency relative to their overlap with the expert derived fishery areas, and with SCAs. While SCAs were not typically selected for the presence of demersal fish, the lack of overlap of expert-derived fishery areas is likely due to inclusion of the full suite of national demersal fish layers, many of which are not commercial important in the Hawke's Bay.

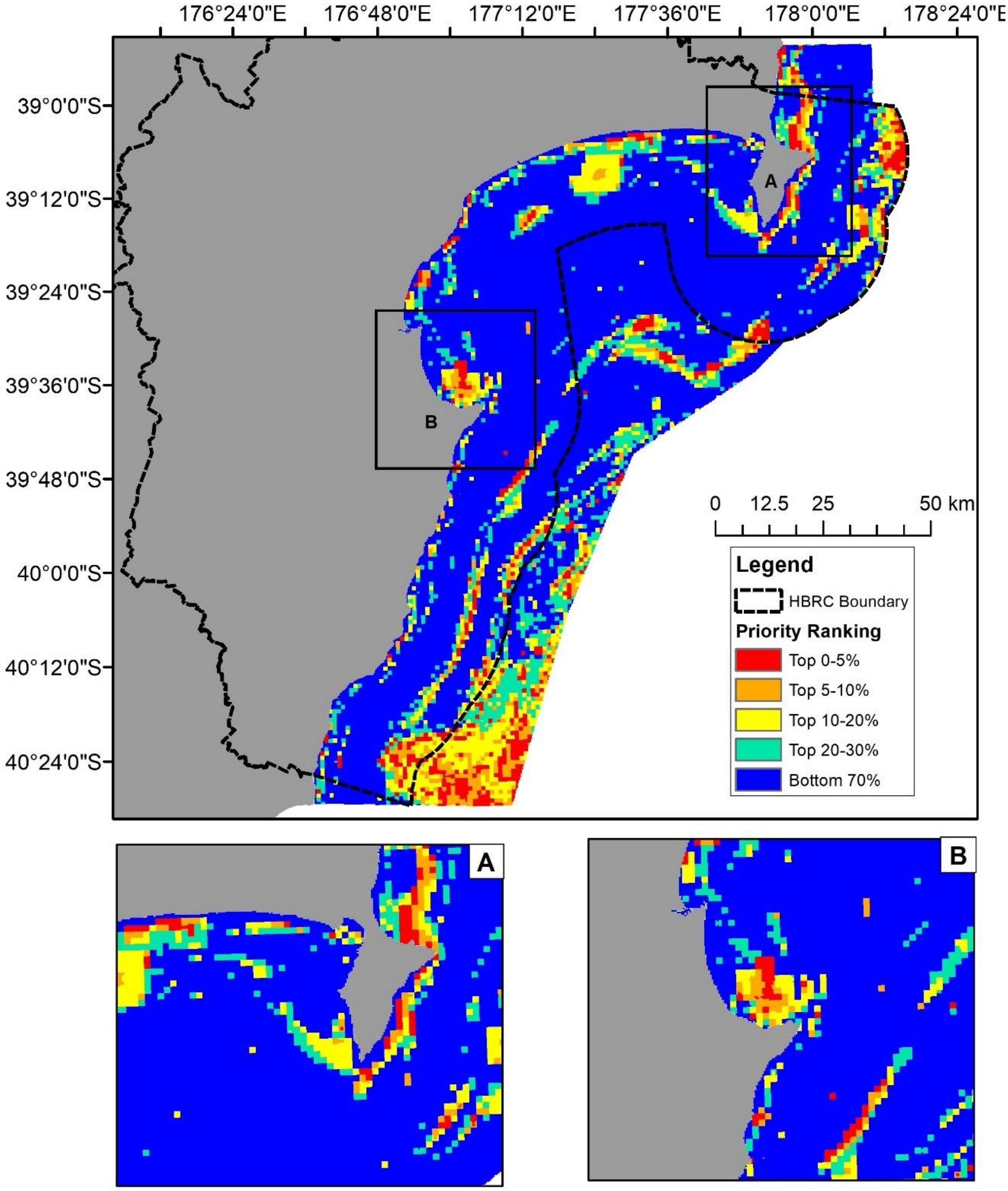

Figure 5-1: Spatial biodiversity prioritisation for Scenario 1 (All national demersal fish datasets) in the Hawke's Bay study area. Areas were identified from the highest to lowest priority in terms of conservation prioritisation (top 5%, 10% 20% and 30% priority areas). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

Table 5-2: Biodiversity features protected by Scenario 1 (all national demersal fish distributions). * indicates layers driving the scenario. Values indicate the percent of a feature included within each top priority solution.

Biodiversity feature	Proportion of area in priority solution			
	5%	10%	20%	30%
FISH				
*Demersal fish species distributions (mean of 217 species)	15.0%	28.1%	49.3%	61.4%
*Demersal fish species distributions (max of 217 species)	47.8%	85.7%	98.8%	99.7%
*Demersal fish species distributions (min of 217 species)	2.3%	4.7%	10.4%	16.9%
*Finfish spawning richness (based on 28 species)	4.7%	9.4%	19.1%	29.3%
*Finfish spawning (locally important species) (mean of 14 species)	5.7%	11.3%	22.7%	33.8%
*Finfish spawning (nationally identified species) (mean of 14 species)	11.9%	18.6%	30.3%	41.3%
*Demersal fish species richness (mean of 217 species)	5.9%	11.7%	23.0%	33.7%
INVERTEBRATES				
Bryozoan modelled distributions (mean of 8 species)	3.7%	7.5%	15.8%	24.9%
Vulnerable Marine Ecosystem modelled distributions (mean of 3 taxa)	15.5%	29.2%	52.8%	72.5%
Invertebrate species richness	4.8%	9.7%	19.0%	26.8%
Invertebrate classification groups (mean of 11 groups)	12.4%	24.0%	44.3%	53.7%
Invertebrate classification groups (max of 11 groups)	37.3%	70.0%	99.8%	100.0%
Invertebrate classification groups (min of 11 groups)	1.5%	3.0%	4.9%	7.3%
HABITATS				
Abiotic habitats (mean of 12 abiotic habitat types)	6.5%	12.9%	22.6%	29.8%
Abiotic habitats (max of 12 abiotic habitat types)	21.9%	41.1%	47.8%	57.1%
Abiotic habitats (min of 12 abiotic habitat types)	0.0%	0.2%	1.7%	5.4%
Biotic habitat (mean of 10 biotic habitat types)	4.5%	12.5%	22.2%	30.7%
Biotic habitat (max of 10 biotic habitat types)	28.8%	75.0%	100.0%	100.0%
Biotic habitat (min of 10 biotic habitat types)	0.1%	0.2%	0.4%	0.5%
Biogenic habitat modelled layer	4.8%	9.5%	19.4%	29.3%
MEGAFAUNA				
Seal haul outs	10.7%	24.6%	53.2%	72.6%
Seabird colonies	0.7%	12.7%	44.7%	58.0%
Cetacean richness	5.8%	11.4%	22.2%	32.9%
OTHER LAYERS FOR REPORTING ONLY				
SCAs (mean of 20 areas)	4.4%	13.9%	21.5%	30.5%
SCAs (max of 20 areas)	28.8%	75.0%	100.0%	100.0%
SCAs (min of 20 areas)	0.0%	0.0%	0.0%	0.0%
Expert-derived important areas for commercial fisheries	4.7%	10.3%	19.4%	25.3%

In Scenario 2, prioritising locally important demersal fish layers (n = 36) resulted in 7.2% protection on average of demersal fish distributions within the top 5% of the priority areas, approximately half of the average protection provided for demersal fish in Scenario 1 (Table 5-3). Scenario 2 was similar to Scenario 1 for other fish layers, providing roughly minimum efficiency of protection for finfish spawning richness, locally important finfish species, and demersal fish species richness, and providing high protection (double or greater than minimum relative efficiency) of nationally identified finfish spawning distributions (Figure 5-2, Table 5-3). Scenario 2 was a large improvement in protection over Scenario 1 for seal haul-outs and sea birds. Average protection of invertebrate assemblages (7.9% within the top 5% of the priority areas) was lower than Scenario 1, though like Scenario 1, the range of protection was large with a minimum of 1.4% and maximum of 39.6% of individual groups protected. Protection of the modelled biogenic habitat layer, bryozoans, invertebrate species richness and cetacean richness was at or just below minimum efficiency.

Scenario 2 resulted in much higher protection allocated to biotic and abiotic habitats than Scenario 1, with 8.8% and 12.0% average protection for abiotic and biotic habitats, respectively, within the top 5% of the priority areas. Scenario 2 priority areas overlapped poorly with the expert derived fishery areas, which was surprising as this scenario was prioritised for locally important fish species. Top prioritised areas covered SCAs well, with 13.9% on average protected within the top 5% priority area, though SCA protection levels off by the top 30% of priority areas to 36.4% protection.

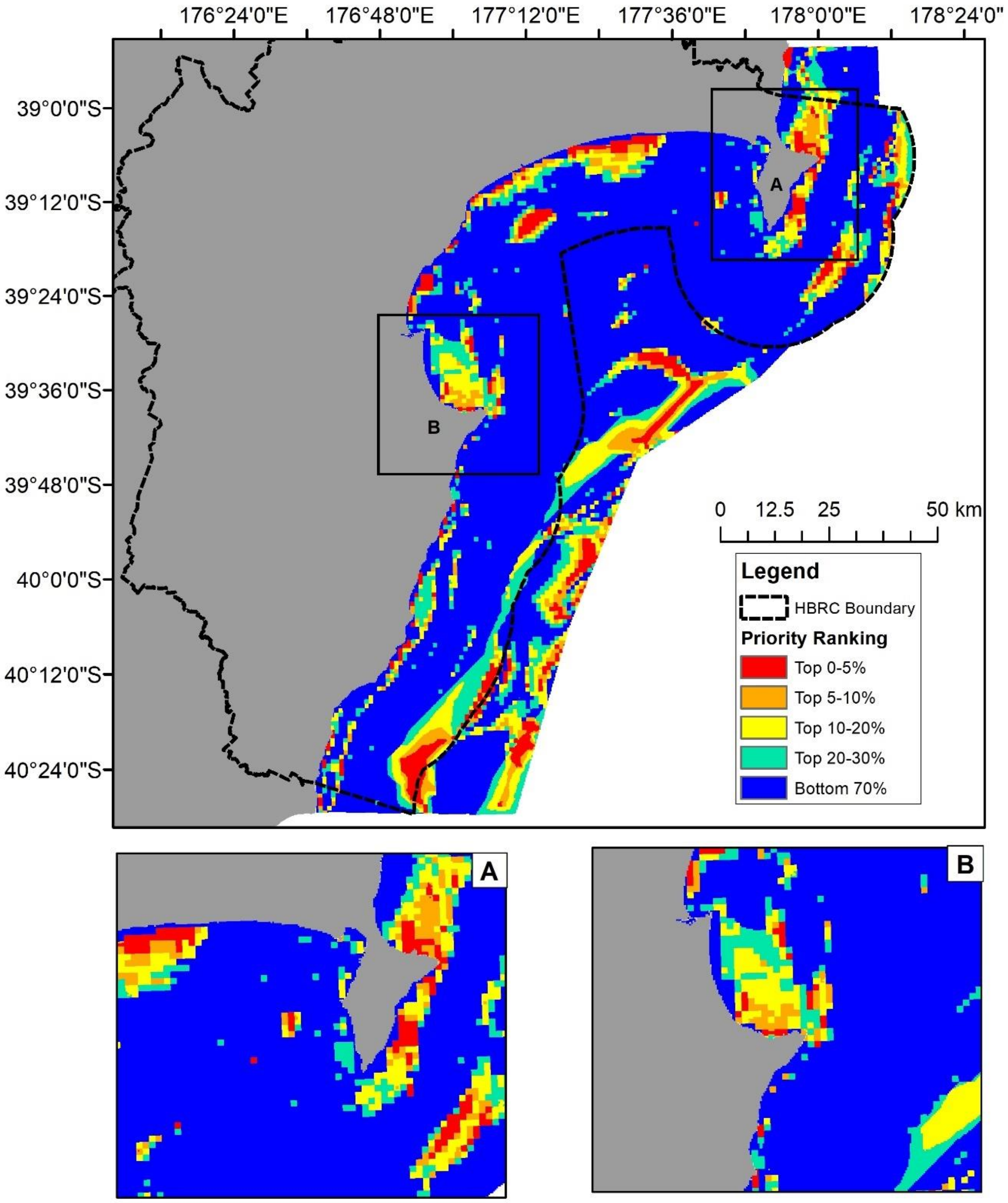

Figure 5-2: Spatial biodiversity prioritisation for Scenario 2 (Locally important demersal fish datasets) in the Hawke's Bay study area. Areas were identified from the highest to lowest priority in terms of conservation prioritisation (top 5%, 10% 20% and 30% priority areas). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

Table 5-3: Biodiversity features protected by Scenario 2 (locally important fish distributions).* indicates layers driving the scenario. Values indicate the percent of a feature included within each top priority solution.

Biodiversity feature	Proportion of area in priority solution			
	5%	10%	20%	30%
FISH				
*Demersal fish species distributions (mean of 36 species)	7.2%	13.8%	26.0%	37.3%
*Demersal fish species distributions (max of 36 species)	18.4%	30.6%	51.0%	70.2%
*Demersal fish species distributions (min of 36 species)	3.1%	6.5%	13.1%	19.5%
*Finfish spawning richness (based on 28 species)	5.1%	10.1%	20.1%	30.3%
*Finfish spawning (locally important species) (mean of 14 species)	6.0%	11.9%	23.4%	35.4%
*Finfish spawning (nationally identified species) (mean of 14 species)	12.6%	18.8%	31.3%	43.5%
*Demersal fish species richness (mean of 36 species)	5.5%	10.8%	21.5%	32.1%
INVERTEBRATES				
Bryozoan modelled distributions (mean of 8 species)	4.3%	8.7%	17.9%	27.2%
Vulnerable Marine Ecosystem modelled distributions (mean of 3 taxa)	12.1%	23.9%	44.2%	64.9%
Invertebrate species richness	4.6%	9.2%	18.1%	26.5%
Invertebrate classification groups (mean of 11 groups)	7.9%	14.3%	30.5%	42.2%
Invertebrate classification groups (max of 11 groups)	39.6%	53.2%	78.5%	95.0%
Invertebrate classification groups (min of 11 groups)	1.4%	1.8%	8.8%	13.2%
HABITATS				
Abiotic habitats (mean of 12 abiotic habitat types)	8.8%	15.1%	25.1%	33.9%
Abiotic habitats (max of 12 abiotic habitat types)	24.8%	48.2%	58.9%	66.8%
Abiotic habitats (min of 12 abiotic habitat types)	0.3%	2.5%	4.3%	7.0%
Biotic habitat (mean of 10 biotic habitat types)	12.0%	17.0%	26.9%	36.4%
Biotic habitat (max of 10 biotic habitat types)	100.0%	100.0%	100.0%	100.0%
Biotic habitat (min of 10 biotic habitat types)	0.1%	0.2%	0.4%	2.6%
Biogenic habitat modelled layer	5.1%	10.0%	20.3%	30.6%
MEGAFAUNA				
Seal haul outs	24.2%	43.3%	45.6%	82.5%
Seabird colonies	10.7%	37.3%	54.7%	75.5%
Cetacean richness	5.3%	10.5%	20.9%	31.5%
OTHER LAYERS FOR REPORTING ONLY				
SCAs (mean of 20 areas)	13.9%	17.9%	27.9%	36.4%
SCAs (max of 20 areas)	100.0%	100.0%	100.0%	100.0%
SCAs (min of 20 areas)	0.0%	0.0%	0.0%	0.0%
Expert-derived important areas for commercial fisheries	3.2%	5.5%	12.5%	20.0%

Prioritising only invertebrate layers, Scenario 3 resulted in high protection for few groups (Figure 5-3, Table 5-4). Not surprisingly in this invertebrate focussed scenario, average protection of invertebrate assemblages was high (34.2% within the top 5% of the priority areas). Invertebrate richness (7.0% for the top 5% priority area) and VME taxa (12.1% for the top 5% priority area) both received high protection. Most fish layers were at or below minimum efficiency for protection in priority areas, with average protection of demersal fish distributions, finfish spawning richness, and finfish spawning of nationally important species being below minimum efficiency, and demersal fish richness and finfish spawning of locally important species being just above minimum efficiency. Protection for seal haul outs was high (20.2% within the top 5% of priority areas), but no protection was provided for seabird colonies in the top 30% of priority areas.

Protection of abiotic habitats was below the minimum efficiency level, whereas abiotic habitats and the modelled biogenic habitat layer both received moderate levels of protection about the minimum efficiency (7.0% and 6.8% within the top 5% of priority areas, respectively); habitat protection was in between protection levels of Scenario 1 and Scenario 2.

Prioritised areas cover SCAs poorly, with SCA protection by the top 30% of priority areas of only 11.2% protection. Expert derived important fishery areas were protected at higher levels in priority areas than in both Scenario 1 (all demersal fish) and Scenario 2 (local fish), with slightly greater than on minimum efficient protection (6% protection within the top 5% of priority areas).

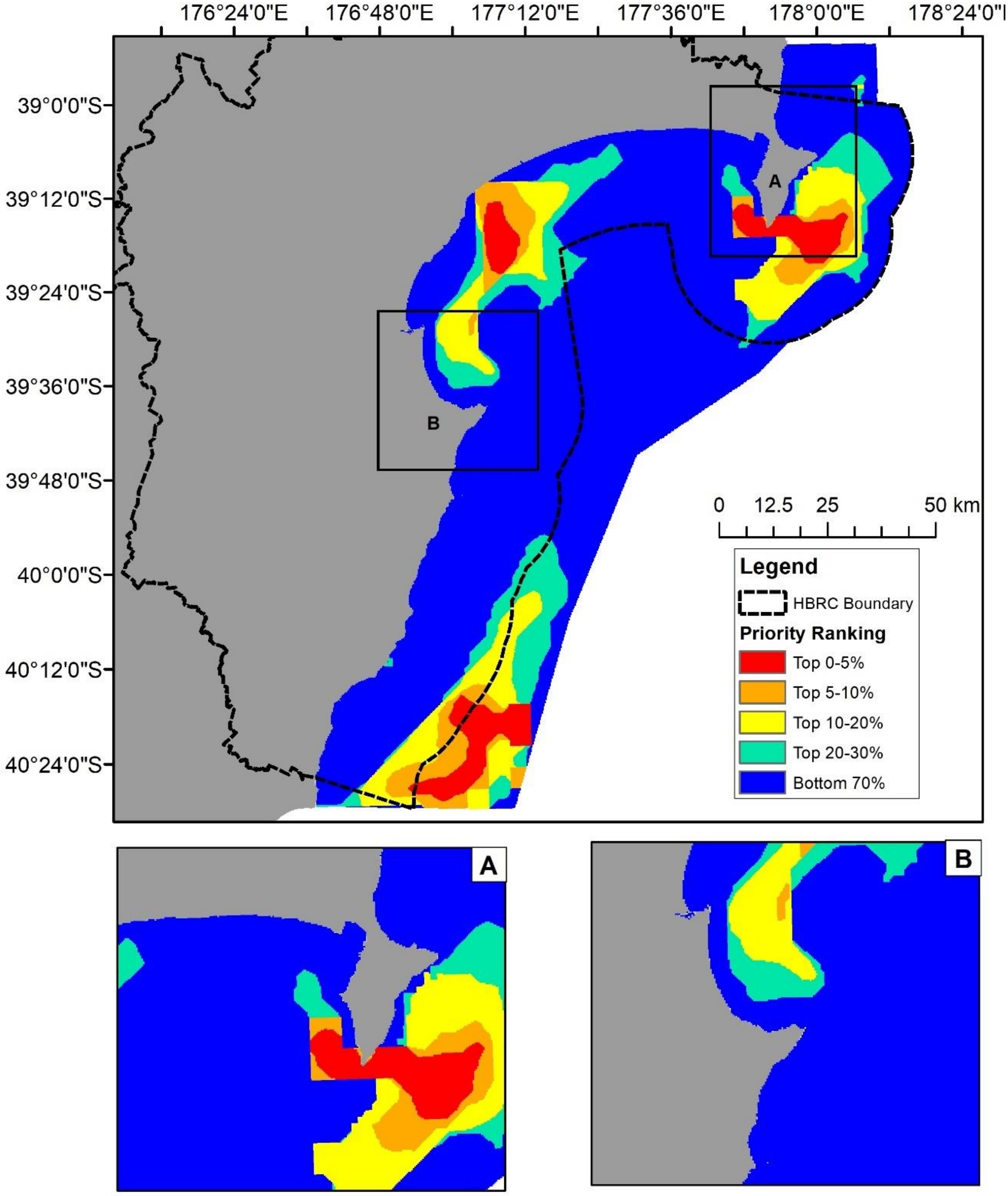

Figure 5-3: Spatial biodiversity prioritisation for Scenario 3 (Invertebrate and biogenic habitat datasets) in the Hawke's Bay study area. Areas were identified from the highest to lowest priority in terms of conservation prioritisation (top 5%, 10% 20% and 30% priority areas). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

Table 5-4: Biodiversity features protected by Scenario 3 (national invertebrate datasets). * indicates layers driving the scenario. Values indicate the percent of a feature included within each top priority solution.

Biodiversity feature	Proportion of area in priority solution			
	5%	10%	20%	30%
FISH				
Demersal fish species distributions (mean of 36 species)	4.4%	8.7%	18.8%	29.9%
Demersal fish species distributions (max of 36 species)	12.2%	25.4%	46.0%	69.4%
Demersal fish species distributions (min of 36 species)	2.1%	4.4%	11.7%	18.3%
Finfish spawning richness (based on 28 species)	4.8%	9.8%	19.9%	30.4%
Finfish spawning (locally important species) (mean of 14 species)	5.7%	12.0%	23.3%	35.2%
Finfish spawning (nationally identified species) (mean of 14 species)	4.6%	9.2%	18.5%	29.1%
Demersal fish species richness (mean of 36 species)	5.4%	10.9%	21.3%	32.3%
INVERTEBRATES				
*Bryozoan modelled distributions (mean of 8 species)	4.7%	9.8%	20.7%	30.4%
*Vulnerable Marine Ecosystem modelled distributions (mean of 3 taxa)	12.1%	21.9%	39.2%	59.1%
*Invertebrate species richness	7.0%	13.3%	26.5%	36.8%
*Invertebrate classification groups (mean of 11 groups)	34.2%	51.0%	64.9%	72.7%
*Invertebrate classification groups (max of 11 groups)	100.0%	100.0%	100.0%	100.0%
*Invertebrate classification groups (min of 11 groups)	1.2%	2.6%	6.6%	11.5%
HABITATS				
Abiotic habitats (mean of 12 abiotic habitat types)	4.7%	8.7%	17.8%	24.6%
Abiotic habitats (max of 12 abiotic habitat types)	14.2%	21.6%	41.3%	65.7%
Abiotic habitats (min of 12 abiotic habitat types)	0.0%	1.7%	3.3%	5.0%
Biotic habitat (mean of 10 biotic habitat types)	7.0%	8.9%	12.8%	16.5%
Biotic habitat (max of 10 biotic habitat types)	100.0%	100.0%	100.0%	100.0%
Biotic habitat (min of 10 biotic habitat types)	0.1%	0.2%	0.4%	10.9%
Biogenic habitat modelled layer	6.8%	12.4%	23.7%	33.1%
MEGAFAUNA				
Seal haul outs	20.2%	23.4%	23.4%	27.4%
Seabird colonies	0.0%	0.0%	0.0%	0.0%
Cetacean richness	5.5%	10.8%	20.8%	30.9%
OTHER LAYERS FOR REPORTING ONLY				
SCAs (mean of 20 areas)	6.9%	8.2%	9.5%	11.2%
SCAs (max of 20 areas)	100.0%	100.0%	100.0%	100.0%
SCAs (min of 20 areas)	0.0%	0.0%	0.0%	0.0%
Expert-derived important areas for commercial fisheries	6.0%	11.0%	25.5%	37.0%

Prioritising all biodiversity and habitat layers in Scenario 4 resulted in an averaging of protection across all feature layers, and thus greater than minimum efficiency across most biodiversity and habitat features (Figure 5-4, Table 5-5). All fish layers were at or just above minimum efficiency for protection in priority areas, with average protection of demersal fish distributions, finfish spawning richness, finfish spawning of locally important species, and demersal fish richness ranging from 5.0-5.9% on average in the top 5% priority areas; finfish spawning of nationally important species was approximately double with 11.8% in the top 5% of priority areas. Average protection of invertebrate assemblages was high (17.4% in the top 5%) but highly variable with a range of 1.8% - 66.4%. Invertebrate richness was just above minimum efficiency and bryozoan modelled distributions were just below minimum efficiency. VME taxa (8.3% for the top 5% priority area) received higher protection than these other invertebrate layers. Seal haul outs and seabird colonies were consistently covered in high priority areas with 100% and 52.4% in the top 5% priority areas; cetacean richness received minimum efficiency protection.

Habitats scored high protection in this scenario, partially as a result of the internal mathematical algorithms in Zonation, whereby ‘small’ features (i.e., rare habitats) were selected as they contain a higher proportion of their total range in each individual cell in which they are present. Average protection of abiotic and biotic habitats was over 40% within the top 5% of priority areas, though high variability of individual habitats was found, ranging from complete or nearly complete (100%) protection) to ~2% protection in the top 5% of priority areas. Biogenic habitat received 6.6% protection in the top 5% of priority areas.

High overlap with SCAs occurred (on average 33.5% of SCAs within the top 5% of priority areas), again likely due to these often being selected for their coverage of particular biotic habitats that were well represented in this scenario. Expert derived important fishery areas were allocated highest protection of all Scenarios, with 6.5% protection within the top 5% of priority areas.

Scenario outputs varied in their overlap with individual SCA sites (Table 5-6). Priority solutions in Scenario 3 (invertebrates) overlapped with only 3 SCAs, where the fish solutions (Scenario 1 and Scenario 2) showed slight improvements, with top 10% solutions overlapping 11 and 9 SCAs, respectively. Scenario 4 showed strong overlap with SCAs, with partial (and often substantial) overlap with 16 and 17 of the SCAs, respectively, in its top 10% solutions.

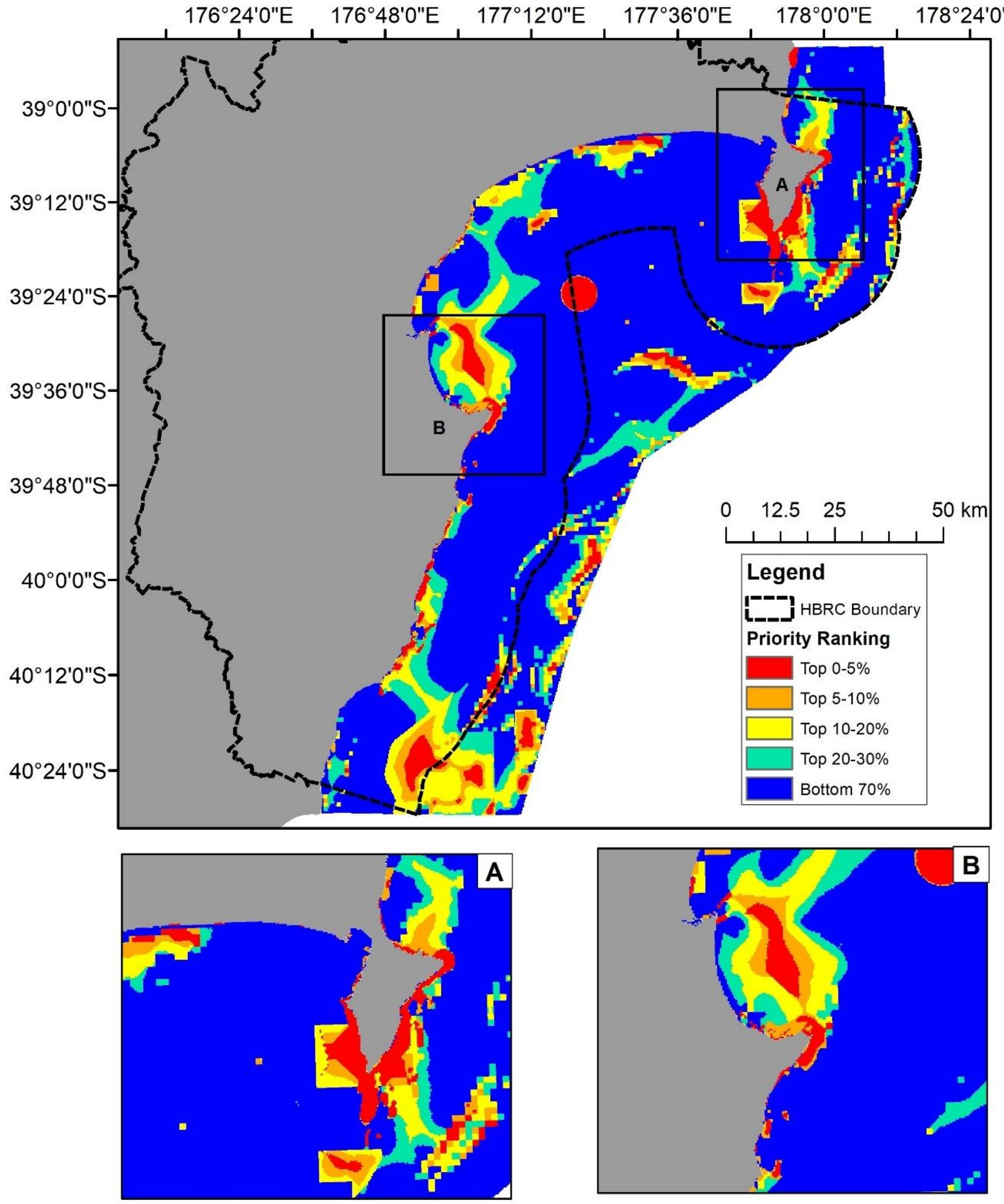

Figure 5-4: Spatial biodiversity prioritisation for Scenario 4 (Combined datasets) in the Hawke's Bay study area. Areas were identified from the highest to lowest priority in terms of conservation prioritisation (top 5%, 10% 20% and 30% priority areas). Inset maps: A) Mahia Peninsula; B) Cape Kidnappers.

Table 5-5: Proportion of biodiversity features protected by Scenario 4 (Combined analysis of all features). * indicates layers driving the scenario. Values indicate percent of a feature included within each top priority solution.

Biodiversity feature	Proportion of area in priority solution			
	5%	10%	20%	30%
FISH				
Demersal fish species distributions (36 species) mean*	5.9%	11.9%	23.2%	34.1%
Demersal fish species distributions (36 species) max*	14.2%	27.7%	46.6%	61.3%
Demersal fish species distributions (36 species) min*	2.5%	5.4%	11.5%	19.1%
Finfish spawning richness (based on 28 species)*	5.1%	10.1%	20.1%	30.3%
Finfish spawning (locally important species) (mean of 14 species)*	5.7%	11.7%	23.7%	34.9%
Finfish spawning (nationally identified species) (mean of 14 species)*	11.8%	17.4%	28.4%	39.3%
Demersal fish species richness (mean of 36 species)*	5.0%	10.2%	20.8%	31.0%
INVERTEBRATES				
Bryozoan modelled distributions (8 species)*	4.5%	9.0%	18.8%	29.4%
Vulnerable Marine Ecosystem modelled distributions (3 taxa)*	8.3%	19.2%	38.0%	52.3%
Invertebrate species richness*	5.2%	10.2%	20.2%	29.6%
Invertebrate classification groups (mean of 11 groups)*	17.4%	33.6%	54.9%	65.9%
Invertebrate classification groups (max of 11 groups)*	66.4%	100.0%	100.0%	100.0%
Invertebrate classification groups (min of 11 groups)*	1.8%	3.3%	8.4%	15.1%
HABITATS				
Abiotic habitats (mean of 12 abiotic habitat types)*	40.8%	46.5%	54.9%	63.9%
Abiotic habitats (max of 12 abiotic habitat types)*	97.2%	98.1%	99.8%	99.9%
Abiotic habitats (min of 12 abiotic habitat types)*	2.6%	6.4%	15.6%	25.0%
Biotic habitat (mean of 10 biotic habitat types)*	40.1%	50.0%	55.9%	59.5%
Biotic habitat (max of 10 biotic habitat types)*	100.0%	100.0%	100.0%	100.0%
Biotic habitat (min of 10 biotic habitat types)*	1.9%	4.7%	10.7%	16.5%
Biogenic habitat modelled layer*	6.6%	11.9%	22.2%	32.7%
MEGAFAUNA				
Seal haul outs*	100.0%	100.0%	100.0%	100.0%
Seabird colonies*	52.4%	100.0%	100.0%	100.0%
Cetacean richness*	5.0%	10.0%	20.3%	30.5%
OTHER LAYERS FOR REPORTING ONLY				
SCAs (mean of 20 areas)	33.5%	43.8%	50.7%	53.8%
SCAs (max of 20 areas)	100.0%	100.0%	100.0%	100.0%
SCAs (min of 20 areas)	0.0%	0.0%	0.0%	0.0%
Expert-derived important areas for commercial fisheries	6.5%	11.5%	20.2%	27.4%

Table 5-6: Comparison of overlap of individual SCAs with biodiversity features in each scenario. Values indicate the percent of each SCA included within each top priority solution.

SCA	Scenario 1				Scenario 2			
Proportion of area in priority solution	**5%**	**10%**	**20%**	**30%**	**5%**	**10%**	**20%**	**30%**
SCA 1 Porangahau Estuary	0%	0%	6%	36%	0%	0%	17%	29%
SCA 2 Blackhead Pohatupapa	15%	15%	15%	15%	15%	15%	15%	15%
SCA 3 Aramoana Blackhead Beach	0%	34%	34%	45%	45%	45%	54%	60%
SCA 4 Ouepoto Paoanui	1%	2%	16%	43%	10%	19%	25%	40%
SCA 5 Mangakuri intertidal platform north	0%	0%	0%	0%	0%	0%	0%	0%
SCA 5 Mangakuri intertidal platform south	0%	75%	100%	100%	100%	100%	100%	100%
SCA 6 Kairakau intertidal platform	0%	0%	0%	0%	0%	0%	0%	0%
SCA 7 Hinemahanga rocks	0%	14%	43%	43%	0%	0%	0%	0%
SCA 8 Waimarama	9%	12%	17%	32%	14%	15%	15%	38%
SCA 9 Cape Kidnappers	1%	13%	45%	58%	11%	37%	55%	76%
SCA 10 Tukituki River	0%	0%	0%	0%	0%	0%	0%	0%
SCA 11 Waitangi Estuary	0%	0%	0%	0%	0%	0%	0%	0%
SCA 12 Ahuriri Estuary	0%	0%	0%	0%	0%	0%	0%	0%
SCA 13 Pania Reef	0%	0%	0%	31%	0%	0%	8%	34%
SCA 14 Wairoa Hard	1%	4%	10%	21%	7%	15%	27%	40%
SCA 15 Wairoa Estuary Coastal Wetland	24%	35%	43%	46%	37%	39%	45%	45%
SCA 16 Long Point	0%	0%	0%	0%	0%	0%	0%	0%
SCA 17 Portland Island	13%	26%	40%	51%	0%	0%	35%	63%
SCA 18 Bull Rocks	0%	0%	0%	0%	0%	0%	100%	100%
SCA 19 Table Cape	29%	64%	70%	88%	53%	90%	92%	93%
SCA 20 Maungawhio Lagoon	0%	0%	14%	31%	0%	0%	0%	31%

SCA	Scenario 3				Scenario 4			
Proportion of area in priority solution	**5%**	**10%**	**20%**	**30%**	**5%**	**10%**	**20%**	**30%**
SCA 1 Porangahau Estuary	0%	0%	0%	0%	0%	0%	0%	7%
SCA 2 Blackhead Pohatupapa	0%	0%	0%	15%	54%	62%	85%	85%
SCA 3 Aramoana Blackhead Beach	0%	0%	0%	0%	38%	76%	96%	96%
SCA 4 Ouepoto Paoanui	0%	0%	0%	0%	29%	56%	70%	70%
SCA 5 Mangakuri intertidal platform north	0%	0%	0%	0%	50%	50%	50%	50%
SCA 5 Mangakuri intertidal platform south	0%	0%	0%	0%	75%	75%	100%	100%
SCA 6 Kairakau intertidal platform	0%	0%	0%	0%	75%	75%	75%	75%

SCA	Scenario 3				Scenario 4			
SCA 7 Hinemahanga rocks	0%	0%	0%	0%	0%	21%	21%	21%
SCA 8 Waimarama	0%	0%	0%	0%	13%	31%	37%	39%
SCA 9 Cape Kidnappers	0%	0%	0%	0%	52%	100%	100%	100%
SCA 10 Tukituki River	0%	0%	0%	0%	0%	0%	0%	0%
SCA 11 Waitangi Estuary	0%	0%	0%	0%	0%	0%	0%	0%
SCA 12 Ahuriri Estuary	0%	0%	0%	0%	0%	0%	0%	0%
SCA 13 Pania Reef	0%	0%	0%	0%	37%	38%	61%	73%
SCA 14 Wairoa Hard	11%	39%	64%	75%	1%	4%	22%	55%
SCA 15 Wairoa Estuary Coastal Wetland	0%	0%	0%	0%	24%	34%	37%	44%
SCA 16 Long Point	0%	0%	0%	0%	31%	31%	31%	31%
SCA 17 Portland Island	33%	33%	36%	36%	71%	74%	80%	82%
SCA 18 Bull Rocks	100%	100%	100%	100%	100%	100%	100%	100%
SCA 19 Table Cape	0%	0%	0%	9%	53%	85%	93%	95%
SCA 20 Maungawhio Lagoon	0%	0%	0%	0%	0%	8%	8%	8%

6 Recommendations and gap analysis

Key ecological criteria were assessed, and a suite of criteria were recommended for Hawke's Bay Regional Council. These recommended selection criteria were based on current national 'key ecological areas' (KEA) criteria, which are comprised of: 1) Uniqueness / rarity / endemism; 2) Importance for threatened / declining species and habitats; 3) Special importance for life history stages; 4) Biological productivity; 5) Biological diversity; 6) Naturalness; 7) Vulnerability, fragility, sensitivity or slow recovery; 8) Ecological function; and 9) Ecological services.

Previously identified SCAs in the Hawke's Bay were assessed across the KEA criteria to determine which criteria each SCA satisfied, showcasing biases in criteria typically used to identify ecologically significant sites, notably toward sites with unique features, or those that are inhabited by threatened species or important for species' life history stages (particularly roosting, breeding and haul out sites for megafauna).

Future assessments of the Hawke's Bay marine region for identification of additional SCAs could be informed by key ecological area selection criteria based on more comprehensive marine datasets than were available when the existing SCAs were identified. National datasets collated as part of the central government Marine Protected Areas Science Advisory Group projects, along with datasets provided by Hawke's Bay Regional Council from the Hawke's Bay Information Review, were used to determine information available that satisfied the recommended key ecological area selection criteria. Datasets were collated across a broad area encompassing the Hawke's Bay Coastal Marine Area and neighbouring continental shelf and slope habitats.

As part of the assessment, comprehensiveness of the recommended ecological significance criteria was evaluated, and a number of gaps in available data were evident (Table 6-1). Across taxonomic groups, seal haul outs were identified from multiple sources that should be combined into national layers held by DOC. National seabird and shorebird layers were limited, showing only the Cape Kidnappers gannet colony, but not including other seabird and shorebird sites, whereas many bird sites were identified in regional SCAs. National fish layers were comprehensive for the broader Hawke's Bay region, though these to date have only been updated for demersal fish, and updated national rocky reef fish datasets will be available later in 2020. However, often national demersal fish layers (species distribution models, species richness) showed little overlap with areas identified as important for local fisheries. Invertebrate data layers showed the least relevance in the Hawke's Bay broader region; many national layers (bryozoans, Vulnerable Marine Ecosystem taxa that are of high sensitivity to seafloor disturbance) either did not cover inshore Hawke Bay, or showed only limited overlap with locally identified information on biotic habitats or other ecologically significant features. Invertebrate classification groups appear strongly correlated with national sediment layers, which often are poorly correlated with regionally identified biotic habitat types.

A pilot scoping exercise, using the spatial decision support tool Zonation, showcased how the existing marine datasets (both national KEA and regional HBRC datasets) could be used to identify additional areas of significance conservation value in the Hawke's Bay region. The exploratory exercise resulted in a prioritisation of areas of ecological significance throughout the Hawke's Bay marine region, and showed how different data layers influence selection of priority areas. Many of the prioritised areas (e.g., Wairoa Hard) had already been identified as SCAs through anecdotal or expert assessment of ecological significance. These scenarios are a pilot exploration of the potential usefulness of these decision-support tools in the Hawkes' Bay, and may serve as a starting point for discussions of priorities for additional biodiversity protection, and for dataset acquisition to increase comprehensiveness of the SCAs in the Hawkes' Bay. These decision support tools could also be used within stakeholder participatory processes to further inform a more comprehensive assessment of ecological significant areas in the Hawke's Bay.

Table 6-1: Assessment of regional and national data layers relative to Key Ecological Area criteria. Key ecological area criteria include: Vulnerability, fragility, sensitivity, or slow recovery; Uniqueness, rarity and/or endemism; Special importance for life history stages; Importance for threatened and/or declining species and habitats; Biological productivity; Biological diversity; Naturalness; Ecological function; and Ecosystem services.

	Relevant KEA criteria	Comments
Marine mammals and birds		
Cetacean richness based on species distribution models (National dataset).	Vulnerability, fragility, sensitivity, or slow recovery; Biological diversity.	Higher richness offshore due to more NZ offshore species than inshore; potentially confusing for council staff and stakeholders.
Cetacean species distribution models (National dataset).	Vulnerability, fragility, sensitivity, or slow recovery; Threatened species/habitats.	Habitat suitability models, thus may represent areas where a species is no longer present (e.g., Maui's) and should not be interpreted as either current occurrence or abundance; higher species richness offshore due to more NZ offshore species than inshore; potentially confusing for council staff and stakeholders.
Marine mammal and reptiles sightings (National dataset).	Threatened species/habitats.	Substantial coverage by marine mammal sightings, with majority of common dolphins, but a number of other species.
Seal haul outs (HBRC, DOC).	Threatened species/habitats; Life history stages.	Inconsistencies between national and regional sites demonstrate need for reconciliation.
Seabird distributions (International dataset).	Threatened species/habitats; Life history stages; uniqueness, rarity and/or endemism; biological diversity.	KEA dataset had limited species information; new KEA layers available in April will have additional point records.
Bird feeding and breeding grounds (International dataset).	Threatened species/habitats; Life history stages.	Cape Kidnappers Gannet colony: only bird feeding area noted; SCAs and other seabird layers compiled for new KEA project may provide more comprehensive information.
Fish		
Demersal fish species turnover and classification groups; individual species distribution models (217 in total) (National dataset).	Uniqueness, rarity and/or endemism; biological diversity.	Published datasets; reasonably robust national scale models; need to investigate why layers don't match up with local fisher expert derived layers.
Fish records (rare, endemic, threatened species) (National dataset).	Uniqueness, rarity and/or endemism; Threatened species/habitats.	Point records, primarily endemic chondrichthyans, mostly sightings in deep waters >200 m.
Fish spawning grounds (MPI).	Life history stages.	Low resolution at scale of HB, primarily species that either are suggested to spawn in all of the HB or not at all.

	Relevant KEA criteria	Comments
Marine reef fish (National dataset).	Uniqueness, rarity and/or endemism; biological diversity.	Out of date, new species distribution models in process.
Invertebrates		
Vulnerable Marine Ecosystems (VME) (National).	Vulnerability, fragility, sensitivity, or slow recovery; Uniqueness, rarity and/or endemism; Threatened species/habitats; Ecological function.	In process of being updated, available June 2020; limited to depths >200 m.
Benthic invertebrate records (National).	Uniqueness, rarity and/or endemism; Threatened species/habitats.	Point records, mostly sightings in deep waters >200 m.
Invertebrate classification groups (National).	Uniqueness, rarity and/or endemism; Biological diversity.	In process of being updated to a Seafloor Community Classification, available early 2020, based on four taxonomic groups.
Bryozoans (National).	Vulnerability, fragility, sensitivity, or slow recovery.	National scale models, limited differentiation in the Hawke's Bay.
Habitats		
Key Biogenic Habitats (National).	Vulnerability, fragility, sensitivity, or slow recovery; Uniqueness, rarity and/or endemism; Life history stages; Threatened species/habitats; Biological productivity; Biological diversity; Ecological function; Ecosystem services.	Point records, few total habitat occurrence records, not comprehensive with significant spatial bias in sampling effort; record of presence but not absence.
Ecosystem service: Biogenic habitat provision (National).	Vulnerability, fragility, sensitivity, or slow recovery; Uniqueness, rarity and/or endemism; Ecosystem services.	National modelled layer based on published technique; has been normalised to Hawke's Bay.
Abiotic habitats (HBRC).	Representativeness.	Locally generated; some very rare habitat types.
Biotic habitats (HBRC).	Uniqueness, rarity and/or endemism; Representativeness.	Locally generated; some very rare habitat types; improvement on national layer.
Physical habitats (DOC).	Representativeness.	National layer, driven by sediment, depth and exposure; often poor correlation with biodiversity.
Regional Council identified important areas (e.g., IBAs, SCAs) (HBRC).	Vulnerability, fragility, sensitivity, or slow recovery; Uniqueness, rarity and/or endemism; Life history stages; Threatened species/habitats; Biological productivity; Biological diversity; Ecological function; Ecosystem services.	20 identified sites in the Hawke's Bay
Locally identified areas of fisheries importance (HBRC).	Life history stages; Biological diversity.	Locally identified sites based on expert interviews; poor correlation of national fish models with these polygons.
Naturally uncommon ecosystems.	Uniqueness, rarity and/or endemism; Representativeness.	National dataset; primarily terrestrial habitats in the Hawke's Bay.

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Appendix A Records of rare and unique taxa

Table Appendix 1 Records of rare and unique benthic invertebrates.

Species	Count	Species	Count
Aegiochus kanohi	1	*Leucon (Epileucon) latispina*	2
Alcithoe fusus	1	*Lincula gallinacea*	1
Ampelisca bouvieri	5	*Mactra discors*	2
Andaniotes abyssorum	1	*Mactra murchisoni*	2
Arthritica bifurca	1	*Marikellia rotunda*	1
Asychis amphiglyptus	3	*Microvoluta biconica*	1
Bathymedon neozelanicus	2	*Murexsul octogonus*	1
Bowerbankia gracilis	1	*Nimba verrucosa*	1
Brada villosa	6	*Oediceroides microcarpa*	2
Buccinulum fuscozonatum	2	*Ophionereis novaezelandiae*	4
Bugula stolonifera	1	*Parawaldeckia parata*	2
Calliostoma osbornei	1	*Penion sulcatus*	1
Cellana denticulata	3	*Photis brevicaudata*	5
Cellana radians	1	*Protophoxus australis*	1
Charonia lampas	1	*Spisula discors*	7
Colurostylis longicauda	2	*Spisula murchisoni*	3
Conopeum seurati	1	*Tanystylum excuratum*	1
Crassimarginatella gibba	2	*Tricellaria porteri*	1
Cyclaspis argus	3	*Uberella denticulifera*	1
Cyclaspis triplicata	4	*Volvulella nesentus*	1
Cyclohombronia depressa	1	*Watersipora subtorquata*	1
Diastylis insularum	3	*Xymenella pusilla*	1
Diastylopsis elongata	1	*Zeatrophon tmetus*	1
Eurystheus thomsoni	7		
Glycera cirrata	3		
Harpinia pectinata	4		
Leptanthura chiltoni	2		

Table Appendix 2 Geospatial coordinates of rare and unique benthic invertebrate records. Note records differ in resolution provided within OBIS dataset; highest available resolution is provided. In some cases, more than one record is available for the same species at the same location.

Species	Count	Species
Aegiochus kanohi	-39.865	177.42
Alcithoe fusus	-38.9675	178.0963
Ampelisca bouvieri	-39.3183	177.1067
Ampelisca bouvieri	-39.3333	177.2667
Ampelisca bouvieri	-39.3467	177.4167
Ampelisca bouvieri	-39.6133	177.145
Ampelisca bouvieri	-39.58	177.3783
Andaniotes abyssorum	-40	177
Arthritica bifurca	-39.3667	177.0383
Asychis amphiglyptus	-39.2317	177.59
Asychis amphiglyptus	-39.1683	177.5133
Asychis amphiglyptus	-39.1525	177.7767
Bathymedon neozelanicus	-39.4233	176.9367
Bathymedon neozelanicus	-39.2567	177.05
Bowerbankia gracilis	-39.4748	176.9191
Brada villosa	-39.3067	177.65
Brada villosa	-39.2717	177.3567
Brada villosa	-39.4617	177.3917
Brada villosa	-39.3683	177.2433
Brada villosa	-39.6783	177.2167
Brada villosa	-39.6133	177.145
Buccinulum fuscozonatum	-38.9675	178.0963
Buccinulum fuscozonatum	-38.9675	178.0963
Bugula stolonifera	-39.4748	176.9191
Calliostoma osbornei	-38.9675	178.0963
Cellana denticulata	-39.5	177
Cellana denticulata	-39.5	177
Cellana denticulata	-39.5	177
Cellana radians	-39.34	177.5
Charonia lampas	-38.9675	178.0963

Species	Count	Species
Colurostylis longicauda	-39.2567	177.05
Colurostylis longicauda	-39.2567	177.05
Conopeum seurati	-39.4748	176.9191
Crassimarginatella gibba	-39.4517	177.1033
Crassimarginatella gibba	-39.4517	177.1033
Cyclaspis argus	-39.3667	177.0383
Cyclaspis argus	-39.5367	176.93
Cyclaspis argus	-39.2567	177.05
Cyclaspis triplicata	-39.4233	176.9367
Cyclaspis triplicata	-39.5367	176.93
Cyclaspis triplicata	-39.3667	177.0383
Cyclaspis triplicata	-39.2567	177.05
Cyclohombronia depressa	-39.585	176.98
Diastylis insularum	-39.3667	177.0383
Diastylis insularum	-39.1883	177.6767
Diastylis insularum	-39.3683	177.2433
Diastylopsis elongata	-39.1467	177.2167
Eurystheus thomsoni	-39.3667	177.0383
Eurystheus thomsoni	-39.3667	177.0383
Eurystheus thomsoni	-39.5367	176.93
Eurystheus thomsoni	-39.5933	177.01
Eurystheus thomsoni	-39.5933	177.01
Eurystheus thomsoni	-39.5367	176.93
Eurystheus thomsoni	-39.2	177.135
Glycera cirrata	-39.5933	177.01
Glycera cirrata	-39.5933	177.01
Glycera cirrata	-39.5933	177.01
Harpinia pectinata	-39.2567	177.05
Harpinia pectinata	-39.3833	177.18
Harpinia pectinata	-39.3683	177.2433
Harpinia pectinata	-39.4617	177.3917
Leptanthura chiltoni	-39.475	177.5417

Species	Count	Species
Leptanthura chiltoni	-39.5317	177.46
Leucon (Epileucon) latispina	-39.5133	177.3067
Leucon (Epileucon) latispina	-39.475	177.5417
Lincula gallinacea	-39.2317	177.59
Mactra discors	-39.0575	177.9043
Mactra discors	-39.0575	177.9043
Mactra murchisoni	-39.0575	177.9043
Mactra murchisoni	-39.0575	177.9043
Marikellia rotunda	-39.1525	177.7767
Microvoluta biconica	-39.475	177.5417
Murexsul octogonus	-38.9675	178.0963
Nimba verrucosa	-39.4517	177.1033
Oediceroides microcarpa	-39.4233	176.9367
Oediceroides microcarpa	-39.2567	177.05
Ophionereis novaezelandiae	-39.4967	177.1617
Ophionereis novaezelandiae	-39.2	177.135
Ophionereis novaezelandiae	-39.4617	177.3917
Ophionereis novaezelandiae	-39.6133	177.145
Parawaldeckia parata	-39.27	177.1983
Parawaldeckia parata	-39.27	177.1983
Penion sulcatus	-38.9675	178.0963
Photis brevicaudata	-39.4233	176.9367
Photis brevicaudata	-39.4233	176.9367
Photis brevicaudata	-39.3667	177.0383
Photis brevicaudata	-39.2567	177.05
Photis brevicaudata	-39.1683	177.5133
Protophoxus australis	-40.4267	176.7183
Spisula discors	-39.062	177.907
Spisula discors	-39.062	177.907
Spisula discors	-39.062	177.907
Spisula discors	-39.062	177.907
Spisula discors	-39.062	177.907

Species	Count	Species
Spisula discors	-39.062	177.907
Spisula discors	-39.062	177.907
Spisula discors	-39.062	177.907
Spisula discors	-39.062	177.907
Spisula murchisoni	-39.062	177.907
Spisula murchisoni	-39.062	177.907
Spisula murchisoni	-39.062	177.907
Tanystylum excuratum	-39.4967	177.1617
Tricellaria porteri	-39.4748	176.9191
Uberella denticulifera	-39.3467	177.4167
Volvulella nesentus	-39.4883	177.0133
Watersipora subtorquata	-39.4748	176.9191
Xymenella pusilla	-39.2117	177.2833
Zeatrophon tmetus	-39.2117	177.2833