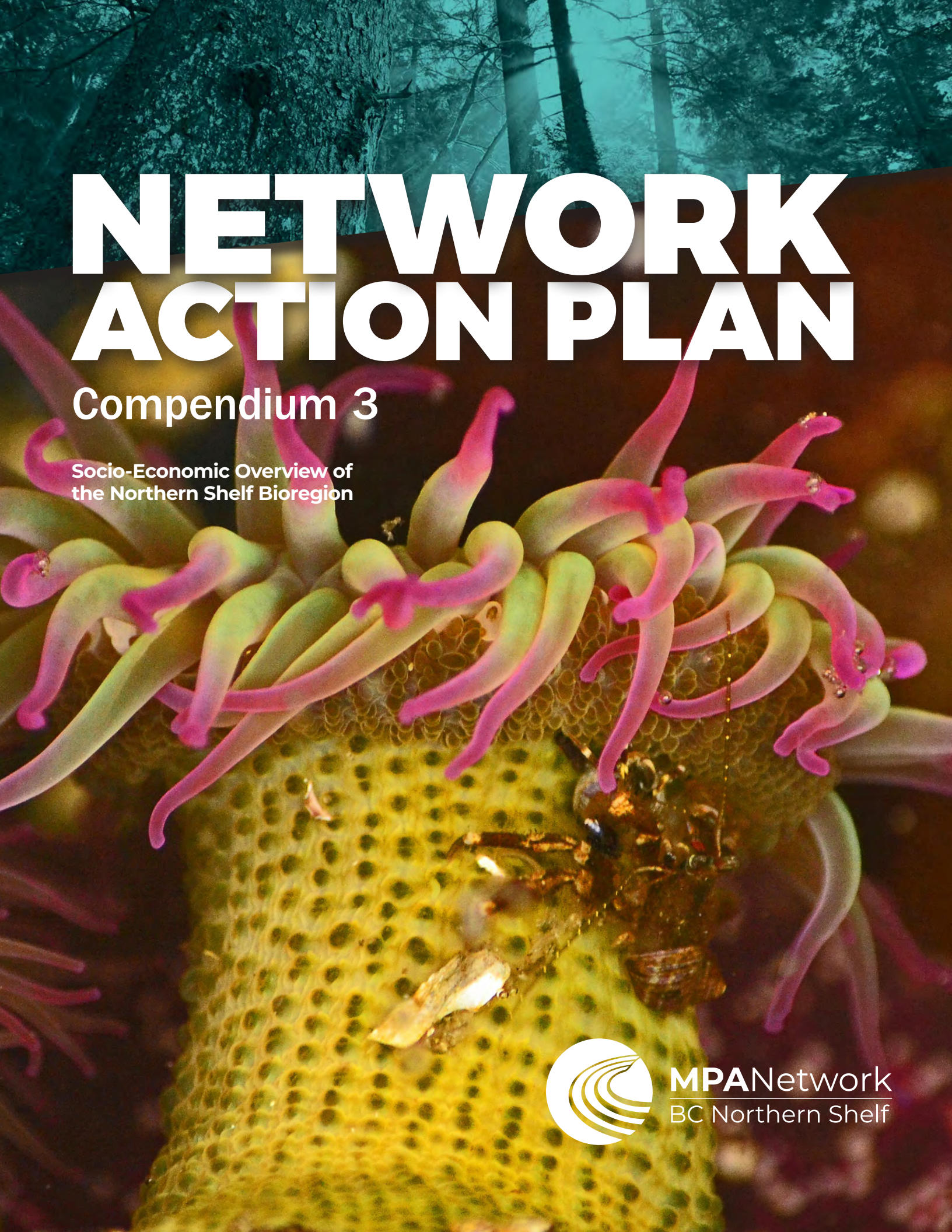

NETWORK ACTION PLAN

Compendium 3

Socio-Economic Overview of the Northern Shelf Bioregion

MPANetwork
BC Northern Shelf

Cover photos: Iain Robert Reid

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Acronyms

CBA	Cost-benefit analysis
C-CP	Cultural conservation priority
DFO	Fisheries and Oceans Canada
EBSA	Ecologically or Biologically Significant Marine Area
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortization
E-CP	Ecological conservation priority
FTE	Full-time equivalent
I/OAC	Integrated/Ocean Advisory Committee
iSEA	Internet Socio-Economic Analysis survey
MaPP	Marine Plan Partnership for the North Pacific Coast
MESM	Marine Ecosystem Service Model
MPA	Marine protected area
MSP	Marine spatial planning
NC	North Coast
NSB	Northern Shelf Bioregion
NVI	North Vancouver Island
PFMA	Pacific Fishery Management Area
PMZ	Protection Management Zone
RCA	Rockfish Conservation Area
(S-E) PM	(Socio-economic) performance measure
SRFC	Survey of Recreational Fishing in Canada

Glossary of Terms[1]

Term	Definition
Activities of concern	Human uses and activities that have been identified as having potential interactions and negative consequences for one or more **zone**-specific **conservation objectives.** For the purposes of the Socio-Economic Overview, activities of concern is the subset of the direct activity overlap that interacts with the conservation objectives.
As-is, where-is zones	Existing MPAs and RCAs in the NSB that contribute to the proposed Network but have no proposed changes in the Network Action Plan. For the purposes of the Socio-Economic Overview, these zones are included as part of the activity in the NSB but do not contribute to activities of concern.
Automatic Identification System (AIS)	Tracking system using transceivers on ships to track location and movement of vessels. This system is mandatory for large vessels in B.C., and voluntary for small vessels. AIS data does not fully capture small fishing and recreational vessels. Vessel traffic data can be viewed on SeaSketch.
Category 3 Areas	Category 3 is applied to areas within the NSB that are important ecologically and culturally, and that (along with any future zones within them) may contribute to the proposed Network objectives, but further work is required to reach agreement among Governance Partners and/or other First Nations regarding how they (and their zones) will be described and implemented.
Implementation (of the proposed Network or Network Action Plan)	Ongoing steps to carry out the recommendations of the Network Action Plan, including development of collaborative governance and management agreements, MPA establishment, and Network monitoring.
Landed value	The commercial market value of seafood products as offloaded by vessels fishing in BC. In this document, landed value is based on prices from the 2018 Seafood Year in Review.[2]
Net processing value	The net monetary value added by seafood processors to commercial landed value through the processing of seafood into products ready for distribution and sale.
Overlap / Direct activity overlap	Human use activity considered during the Network process that is within the borders (overlapping) existing or proposed zone boundaries.
Profits/EBITDA	The net income earned by businesses after subtracting costs of operation, but before considering interest, taxes, depreciation, and amortization.

1 For additional definitions, see the Network Action Plan, Glossary of terms.
2 Available online at https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/statistics/agriculture-and-seafood-statistics-publications.

Term	Definition
Site	Sites are aggregations of zones, often adjacent to one another, that served as the basis for broader area descriptions, previous "site" profiles, and for the reporting of some performance metrics (e.g., size, replication).
Zone	A discrete unit of marine space contained in the proposed Network, including outer boundaries. A zone that contains existing protected areas but with potential enhancements, new marine areas proposed for the Network, or a combination of the two has specific conservation objectives identified in the Network Action Plan. Existing MPAs often contain multiple zones, and Category 1 zones within the proposed Network are aggregated together under identified potential designation tools for future assessment. Within MPA planning in a broader context, individual zones will typically have specific conservation objectives (and associated management direction) that distinguishes them from adjacent zones.

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Socio-Economic Overview of the Northern Shelf Bioregion

1. Introduction and context

This compendium provides supplementary material to the MPA Network Action Plan (the 'Action Plan'). Developed through a trilateral partnership between the governments of Canada, British Columbia (B.C.), and 15 First Nations[3] (the 'Governance Partners'), the Action Plan is a blueprint to guide implementation of a network of marine protected areas (MPAs) in the Northern Shelf Bioregion (NSB) (henceforth 'the Network'). This is one of three compendium documents, which provide additional information on the context, components, objectives, and outcomes of the Network planning process.

Other compendiums:

Compendium 1
• Existing MPAs in the NSB • Stakeholder Engagement and Consultation Details • Network Design Guidelines • Description of Current Activities in the NSB
Compendium 2
• Ecological Conservation Priorities, Spatial Features and Target Ranges • Conservation Gaps Analysis • Performance Measures and Associated Report Cards

Additional materials, including draft management measures and monitoring approaches, have been developed to inform and support future establishment of the proposed Network and will continue to be refined in early implementation of the Action Plan.

This Socio-Economic Overview outlines the economic activities and other human uses of the marine environment in the NSB and provides estimates of the overlap between these activities and the zone boundaries in the proposed Network. The Overview serves to support the Network planning process by providing information for the Governance Partners and other First Nations, stakeholders, local governments, and the general public to evaluate the Action Plan.

3 Gitga'at, Gitxaala, Haisla, Kitselas, Kitsumkalum, Metlakatla, Heiltsuk, Kitasoo Xai'xais, Nuxalk, Wuikinuxv, Mamalilikulla, Kwiakah, Tlowitsis, and Wei Wai Kum First Nations; Council of the Haida Nation.

2. Approach and scope

This analysis is scoped to an overview of the economic activities and other human uses of marine spaces in the NSB. It provides estimates of the overlap between these activities and proposed Network zones, including activities identified in the Action Plan as 'activities of concern' due to their potential to negatively impact the Network's conservation objectives (see Network Action Plan, s. 3.3 and Appendix 1). Baseline estimates of the economic contributions of marine-related sectors are also provided. More detailed information, including overlaps at the zone level for some sectors, can be accessed using the Socio-Economic Overview dashboards available at www.mpanetwork.ca/socio-economic-overview. The appendices to this compendium contain spatial analysis methods and data descriptions for commercial fishing (Appendix A), seafood processing (Appendix B), recreational fishing (Appendix C), ecosystem services (Appendix D), and socio-economic performance measures (Appendix E and Appendix F).

As described in the Action Plan (s. 2.3 and 3.2.1), the proposed Network is comprised of existing protections as well as new areas that, informed by available ecological and human use data, have been proposed to achieve the ecological, social, economic, and cultural objectives of the Network. The Action Plan organizes the proposed Network zones into three categories based on the level of agreement achieved among the Governance Partners and/or other First Nations (see Network Action Plan, s. 3.2.2):

- **Category 1** ones are proposed for implementation by 2025 and are described in the greatest amount of detail in the Action Plan.
- **Category 2** zones are proposed for implementation by 2030.
- **Category 3** is applied to areas within the NSB that are important ecologically and culturally, and that may contribute to the Network objectives, but further work is required to reach agreement among the Governance Partners and/or other First Nations regarding how they (and their zones) will be described and implemented.

Part of the planning process for the proposed Network was the development of conservation priorities and zone-specific conservation objectives (see Network Action Plan, s. 1.3). Activities that pose a risk to the ecological conservation priorities (E-CPs) and associated conservation objectives in Category 1 zones are identified in the Action Plan as 'activities of concern'.[4] These activities are a focus of this overview. In the implementation phase, zone-level assessments will determine the risks associated with activities of concern and any mitigation necessary to ensure that conservation objectives are met. To assist in this future work, the overview provides a summary of information around values and the economic contributions of human uses and activities in the NSB and its subregions, including activities of concern.

2.1 Limitations

The economic activities occurring in the NSB are subject to a range of regulations and management regimes. Reference years used in this analysis vary by activity but are generally from 2018. It is likely that the marine sectors described in this overview will change over time and may have different characteristics (e.g., output levels, distribution of activity) by the time of implementation. Many sectors will have experienced significant

4 Note that some activities require more planning work beyond the Network Action Plan, including marine shipping, research and education, and non-extractive public recreation. The details on these activities in s. 3.3.3 and 3.3.4 of the Action Plan will be considered during the establishment processes for individual MPAs.

changes in their business operations due, for example, to the COVID-19 pandemic, prevailing domestic and international economic conditions, pre-emptive responses to Network implementation, ongoing management, and biological variability. It is therefore uncertain whether reference years are appropriate to use as proxies for sector activities in 2025 and 2030 (i.e., Category 1 and 2 implementation timelines – see Network Action Plan, s. 3.2.2). This uncertainty will be addressed by updating baseline information as planning continues. The human use data presented within this document are based on the boundaries and conservation objectives of the zones in the Action Plan.

This overview does not replace cost-benefit analyses (CBAs) or other analyses that may be required for federal or provincial regulatory processes during the establishment and future management of MPAs (see Network Action Plan, s. 3.1). Required CBAs will assess the benefits and costs associated with MPA management measures developed as per the relevant processes and standards. Those future analyses will be informed by many data sources including this network-level overview, future direction on management measures, and additional data gathering and stakeholder input as laid out in the relevant regulatory processes.

As noted, this document focuses on the outcomes of the quantitative and spatial analysis of economic activities in the NSB. Other qualitative values, including components of health and wellbeing, governance, culture, and other undefined economic and ecological factors are out of the scope of this document.

2.2 Social and Cultural Values

This overview document focuses on economic values and metrics, however social and cultural values are important topics for future assessment. Network-level assessment of social and cultural values has been limited to date. Mapping, planning, and assessment of First Nations cultural conservation priorities (C-CPs) undertaken at the community level informs partner First Nations' understanding of the implications of Network implementation for zone-specific social and cultural values. Stakeholders at Integrated/Ocean Advisory Committee (I/OAC) meetings expressed that the Network would impact values including sense of place and community, connection to the water, and contributions of recreational activities (including fishing) to stakeholder and community wellbeing, local stewardship, and access. The importance of social and cultural values is recognized in the *Canada-B.C. MPA Network Strategy* through goals related to supporting social and community stability, recreational and tourism opportunities, traditional use and cultural heritage, and educational opportunities, in addition to those centred on protecting productive habitats and sustaining fisheries resources (Canada and B.C. 2014).

Assessing social and cultural values is challenging at this stage given the limited detail about the future establishment of MPA sites, and the need for further zone-specific data and analysis. Information from First Nations, stakeholders, and the public, around implications of the Network to their wellbeing will be presented alongside ecological and economic overviews for consideration by decision makers. Further opportunities for more targeted assessment of these values may include zone-level assessments as part of establishment processes. In addition, the Network planning process and engagement sessions provided opportunities for methods and considerations to be expanded and refined ahead of the Action Plan implementation phase. As the Network monitoring framework is developed there is also an expectation that consideration of Network outcomes for cultural, social, and economic values will be included and linked to the Network objectives.

3. Planning Area Overview: The Northern Shelf Bioregion (NSB)

This section provides an overview of the NSB planning area, ecological conservation values, Indigenous communities, and existing marine planning and management regimes in the bioregion. An overview of the ocean economy sectors and related employment within the NSB is also presented to frame the activities occurring within the bioregion as a whole. The section finishes with a brief introduction to the proposed MPA Network and a summary of activities associated with key marine sectors, including those identified as activities of concern in the Action Plan.

The NSB encompasses 102,000 km², extending from the B.C.-Alaska border south to Bute Inlet on the Mainland, across to Campbell River on the east side of Vancouver Island and the Brooks Peninsula on the west side of Vancouver Island, out to the edge of the continental shelf (Figure 1). It is split into four subregions for the purpose of planning and coordination: North Coast, Haida Gwaii, Central Coast, and North Vancouver Island (NVI). Across the four subregions the footprint of the proposed Network is a combination of new and existing MPAs.

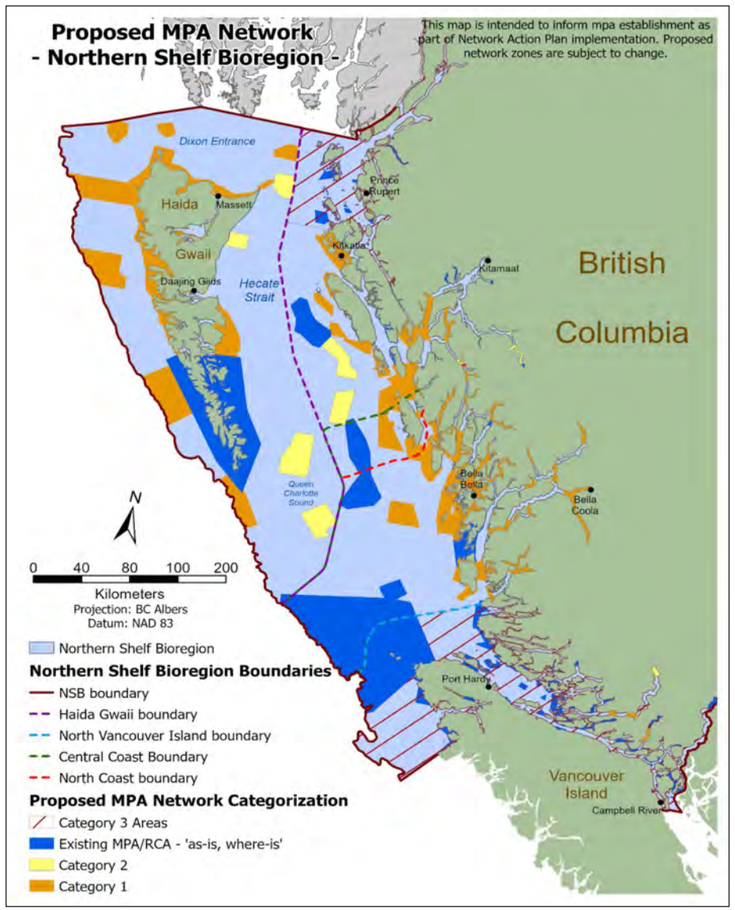

Figure 1. Overview of Planning Area. See Network Action Plan, Chapter 2, for more details. Note that the boundary extends into the Strait of Georgia bioregion (capturing Bute Inlet) to align with boundaries of previous marine planning initiatives and territorial boundaries of partner First Nations.

3.1 Ecological Conservation Priorities in the NSB

The NSB is a critical area for diversity and richness of marine species as represented in 277 unique ecological conservation priorities (E-CPs) – the ecologically significant species, habitats, areas, and other natural features prioritized for protection within the MPA Network. These conservation priorities range from different forms of benthic (seafloor) habitats that support critical life stages of fish and invertebrate assemblages, to specific marine species that support cultural practices, fisheries incomes, forms of subsistence harvest, and recreational uses that are critically important to the coastal communities of B.C. Further information on the E-CPs of the Network beyond what is provided below can be found in Compendium 2 of the Action Plan.

Table 1 lists E-CPs by species group. These E-CPs are highlighted below for their role in contributing to important provisioning and regulating services. The services they provide include the supply of food we consume, the air we breathe, and the environments that support employment, recreation, and cultural activities that are shared by coastal communities and visitors to these areas. The total value or importance of these services to human wellbeing is challenging to quantify due to their scale, complexity, and dynamic nature. This qualitative discussion is complemented by ongoing ecosystem service modelling work, which is described in Appendix D. This work aims to estimate the value of the ecosystem services provided by coastal ecosystems, and study how marine conservation efforts may increase or safeguard these benefits.

Table 1. Number of Ecological Conservation Priorities by Species Group.[5]

Species Group	Number of Unique E-CPs
Plants and algae	10
Birds	53
Fish	56
Invertebrates	23
Mammals and reptiles	15
All Species Features	157

3.1.1. Plants and Algae

This species group includes eelgrass and surfgrass habitats, several species of kelp, and phytoplankton hotspots. Surfgrass and eelgrass habitats are critically important for fish and invertebrate species in B.C. These habitats are nursery grounds for many species of juvenile salmon, play a multitude of roles in the life cycles of shellfish, crab, and finfish, and have been noted as important spawning grounds for Pacific herring. Eelgrass also plays a key role in estuary habitats by forming the foundation of many marine food chains. The plant biomass is consumed by various migratory bird species and marine organisms, while their surfaces also provide space for the growth of algae and diatoms – a further source of food for different species of invertebrates. Kelp forests play a similar role in providing fish and invertebrate habitat, where elaborate three-dimensional canopies support high levels of biodiversity and shelter from predation. As a primary producer, kelp also represents an important food resource for species at higher trophic levels (needing higher levels of nutrition). In B.C, these habitats have been shown to be important to countless benthic (seafloor) and

5 As not all E-CPs are species-related, species group totals will not add up to the Network total of 277.

pelagic (free swimming) species, including many that are commercially and recreationally targeted. Kelp is also a valuable material in many spawn-on-kelp fisheries – activities traditionally important to many First Nations communities in the NSB. Finally, these vegetated marine ecosystems also contribute to blue carbon sequestration (absorption of atmospheric carbon dioxide by the oceans through transfer and storage in marine plants and sediment), as well as services related to mitigating coastal erosion by contributing to wave dampening and sediment capture.

3.1.2. Birds

The NSB contains habitats for many marine bird species, many of which are reflected in the Network's conservation priorities. These include staging areas and other areas important for migration, as well as those important for supporting local bird populations year-round. Marine birds play a vital role in marine ecosystems as top predators and contribute to important biological processes including nutrient cycling between terrestrial and marine habitats, and positive impacts on phytoplankton production (Wainright et al., 1998). Many of these species are also important for forms of marine and land-based recreational activities in the NSB, including guided birdwatching boat tours around parts of Vancouver Island.

3.1.3. Fish

Many fish species are important for commercial, recreational, social, and cultural uses in B.C. All species of Pacific salmon are represented by priorities within the Network, including key areas for juveniles and areas marked for species biodiversity. Many individual fish species, including various species of rockfish such as yelloweye, bocaccio, china, and canary are also included in the Network as E-CPs.

3.1.4. Invertebrates

Invertebrate E-CPs include species of clams and oysters, prawn, shrimp, and crab. Areas of unique importance for invertebrates, including several types of reef formations, are also included in this species group. Invertebrates are foundational to marine food webs and are therefore invaluable to subsistence and commercial fisheries along the coast. Geoduck, crab, prawn, sea cucumber and urchin are all important commercial fisheries, and coastal communities draw on these and other species as year-round foods. Healthy and robust invertebrate populations also support marine predators such as sea otters.

3.1.5 Mammals and Reptiles

Many of the species included in the mammal and reptile species group represent conservation priorities related to iconic and charismatic species in B.C. tidal waters. This includes various species of whale (blue, grey, killer), porpoises, seals, sea lions, and sea turtles. While also serving their own important biological roles in marine ecosystems, these species are important for many forms of marine recreation within the province, including those related to ecotourism and different forms of charter or guided boating.

3.2 Indigenous communities in the NSB

The NSB is encompassed by the traditional territories of 42 First Nations. The MPA Network planning process is one of several collaborative processes that recognizes the cultural, historic, and contemporary importance of the region to First Nations. Participating First Nations have been sharing their expertise and traditional knowledge in planning and governance, and are actively negotiating agreements concerning fisheries, forestry, and tourism to more effectively steward their lands, waters, and natural resources. These processes and agreements reflect and support the existing stewardship authorities of First Nation governments, enabling more effective Government-to-Government collaboration to take place within the NSB and beyond.

The marine ecosystem is a fundamental component of coastal Indigenous communities' livelihoods and cultures. For example, Indigenous workers living on reserve are twice as likely to work in sectors of the economy that are partially or fully reliant on the ocean, compared to other workers in coastal B.C. In coastal B.C., 18% of the Indigenous workforce living in-community works in ocean related industries, including fishing, aquaculture, and water transportation. By contrast, these industries only employ 6% of the non-Indigenous workforce in coastal B.C. Beyond existing employment, sectors of the ocean economy are also more likely to attract entrepreneurial activity by Indigenous peoples, with a recent study showing a strong desire within First Nations for community-based ocean-related businesses (Big River Analytics 2021a). As well, many First Nations have developed successful tourism enterprises, providing economically viable and community driven employment.

While recognizing that the marine environment and ocean-based activities are fundamental to the cultures, traditions, provision of food and other materials, and transmission of knowledge of First Nations, this analysis is limited to the available economic data. It does not attempt to quantify the extent of the interactivity nor the full value and importance of the marine environment to First Nations. Various parts of this overview have attempted to outline gaps and describe the range of benefits that are expected to accrue from conservation, many of which overlap with values and priorities of First Nations within the NSB.

3.3 Ocean Sectors in the NSB

The NSB is home to a diverse marine economy serving the region, the province, and the world. A recent study on the ocean economy in B.C. describes the varied marine industries active in the bioregion, finding that in 2018 ocean-related economic activities in the NSB generated approximately $1.3 billion in local gross domestic product (GDP) (Big River Analytics 2021b). These activities also provided around 11,520 jobs (full-time equivalent; FTE) *(ibid)*.[6] The values and opportunities provided by the marine environment are extremely important to the economic vitality of the region's communities, as well as to the overall wellbeing of those living, working, and visiting there.

This section explores several ocean-based industries, their economic contributions in the NSB, and their overlap with the proposed Network. Network-level information for these sectors is presented here, and further details are discussed in the subregional summaries in Sections 4-7. In addition to each sector's contributions to the NSB's economy (Table 2), some important Network-level implications are discussed for some of the sectors. These include expected trends for the sector across all regions, opportunities directly resulting from the creation of the Network, and other comments and insights arising from a regional understanding of sectors. Sectors are high-level groupings and individual activities within each sector might have different interactions with the proposed Network, and as a result different expectations regarding the Network's potential (positive or negative) implications.

6 It is unknown how many of these jobs are held by residents of the NSB and how many are held by workers who are based elsewhere.

Table 2. Economic contributions of marine sectors to the Northern Shelf Bioregion

Sector	Direct GDP contribution ($ million)	Direct Employment (FTEs)	Direct Employment Income ($ million)
Aquaculture	$299.8	933	$77.6
Commercial Fishing	$87.3	1,802	$73.2
Seafood Processing	$89.3	1,249	$55.9
Tourism (Recreation, Tourism, and Recreational Fishing)	$111.9	1,660	$72.5
Transportation (shipping, ferries, support activities, and storage)	$251.3	2,102	$187.2
Port Construction, Boat and Ship repair	$91.5	298	$28.5
Marine Technology, Innovation, Research (NGOs, private sector, universities)	$25.3	324	$21.5
Marine-reliant forestry	$265.7	2,076	$185.9
Total Marine Economy in the NSB (includes some sectors not summarized here)	**$1,300**	**11,520**	**$702.3**

Source: Big River Analytics (2021b) Economic Contributions of BC's Ocean Economy. All values in 2018 Canadian dollars.

Direct Effects: Effects of an industry's gross output in terms of gross domestic product, taxes, labour income, and jobs within that industry. Additional indirect and induced effects of marine sectors are available in the full report (see Big River Analytics 2021b).

Full Time Equivalencies (FTEs): The number of full-time positions, or part time positions equivalent to a full-time position that these activities generate.

***Note on commercial fishing** – this row displays the estimated contribution of commercial fishing to the NSB based on estimated landing location. The waters of the NSB account for large proportion of commercial fishing landed value, however because of concentration of processing, and accessibility of export markets, considerable amounts of harvest from the NSB are not landed there.*

3.3.1. Aquaculture

Aquaculture is the commercial breeding, raising, and harvesting of fish, shellfish, and aquatic plants. Within the NSB, aquaculture contributes $300 million in direct GDP per year, generating over 900 FTEs. It is an industry of growing interest in all four subregions, which have aquaculture operations targeting various commercially viable species. Existing aquaculture operations and tenures are not included in the analysis, as no impacts are anticipated for existing aquaculture operations from the creation of the Network. The potential for future expansion of shellfish and plant aquaculture in the NSB has been considered in the planning process, mainly through alignment with marine-use plans developed through MaPP (also see s. 3.4, below).

3.3.2. Commercial fishing

Wild capture fishing in B.C. is a major sector in coastal communities in the NSB. Harvest activities within the bioregion employed over 1,800 FTEs, generating over $87 million annually in direct GDP across an average of 1,100 active vessels. On average between 2015-2018, roughly 1,400 fisher registration cards (required to participate in commercial fishing) were purchased or renewed annually by residents in the NSB, representing 27% of the coastwide total. The bioregion also comprises some of the most profitable harvest areas for many of B.C.'s highest-value fisheries. Not all who harvest commercially in the NSB are based in the bioregion, so changes to harvest opportunity will affect businesses and crews based in the NSB and elsewhere in the province.

Commercial harvesting logbook data are used to estimate the direct activity overlap between harvest activity and the proposed Network zone boundaries. 2018 Seafood Year in Review prices are applied to estimated landings to estimate the landed value of this overlapping harvest. See Appendix A for full description of spatial analysis methods.

3.3.3. Seafood processing

Seafood processing takes seafood inputs from aquaculture, commercial fishing, and imports from other countries to process seafood for consumption. This sector is concentrated in the Greater Vancouver Area, though there are also processors in the NSB (mainly in the North Coast and NVI subregions). Some communities in the NSB have relatively higher dependence on employment opportunities afforded by processing activities, as there are fewer alternative employment opportunities in other economic sectors. The seafood processing sector employs 1,249 FTEs in the NSB, and a further 3,651 FTEs elsewhere in B.C., which rely to some extent on harvest from within the NSB.

This sector depends on both commercial harvest and cultivated finfish and shellfish as inputs, with most inputs sourced from Canada's Pacific Exclusive Economic Zone (EEZ). Assessments of linkages between harvesters and processors show that the general trend is for fish caught on the north coast to be processed either there or transported to the south for processing, whereas fish caught in the south are processed in the south.

Seafood Year in Review wholesale value ratios are applied to overlapping fishing events at the species level to estimate the processing added value and wages that come from commercial harvest within the proposed Network. This sector's relationship to the proposed Network is primarily in terms of local processing plants' contributions to the economies of communities in the NSB, expressed in the number of jobs (FTEs) supported in the subregion, and the processing activity (by non-NSB processors) supported by harvest from within the NSB. These economic outputs are expressed in terms of the net processed value and processing employment income attributable to activity in the NSB.

3.3.4. Tourism

Visitors are drawn to the NSB by the opportunities for enjoying nature, wildlife viewing, and outdoor recreation. Popular activities include general sightseeing, whale watching, guided tours, kayaking, visiting heritage sites, and fishing (discussed below). Recreation and tourism (including recreational fishing) in the NSB generated $106 million in direct GDP activity in 2018, supporting nearly 1,400 FTEs. Tourism and recreation activities lead to expenditures across the accommodation, food and beverage, recreation and entertainment, and transportation sectors, among others. In the NSB, accommodation is the highest

value expenditure category by gross output, with 36% of tourism expenditures ($82 million) attributable to accommodations by domestic and international travelers in 2018. The tourism contribution to the ocean economy includes spending on recreation (where individuals traveled more than 40 km from their home) as well as recreational fishing expenditures.

3.3.5. Recreational fishing

Recreational fishing is a widespread and popular activity in the NSB. With roughly 687,000 fishing days annually by resident and non-resident anglers (35% of B.C.'s tidal-water fishing days), it represents a pastime that is woven into the social fabric as well as being an important economic opportunity. Recreational fishing can be guided (e.g., using lodges, guides, or charter boats) or unguided (e.g., independent anglers fishing from a dock or private boat), and can be done by B.C. residents, other Canadians, and visitors to Canada. Recreational fishing is often valued economically in terms of the expenditures participants make to undertake the activity. These expenditures are often captured through the tourism and recreation accounts, which define tourism as traveling a distance of at least 40 km.

Roughly 47% of recreational fishing spending in the NSB is attributable to non-B.C. residents, compared to 26% of coast wide spending by non-B.C. residents. While B.C. residents also engage in tourist activity in the NSB, the participation of non-B.C. residents more clearly demonstrates the interconnectedness of tourism and recreational fishing in the NSB. Recreational fishing is considered separately from public recreation and tourism here because of the importance of this activity to communities in the NSB, and because it has the unique nature of being an important recreational value as well as a potential stressor that is identified as an activity of concern in the Action Plan. Of note fishing days affected by future management in the proposed Network may be associated with a change in economic and non-economic values. If anglers already fish at a preferred spot any change to status quo fishing activity could be associated with a change (decline) in intangible social, family, and/or cultural values of the initial fishing location. While recreational fishing is a highly mobile activity these intangible values may not rebound as quickly as economic activity from this sector.

3.3.6. Public (non-extractive) recreation

Public recreation can be distinguished from commercial tourism interests in order to recognize the distinct ways that residents use the marine space when compared to visitors to the NSB. It is difficult to disentangle these sectors from each other in the available data, however. The important economic contributions of public recreation activities are captured through the tourism and recreation account, but overlaps between the proposed Network and recreational values can also be considered through performance measures that speak to features of interest or importance to public recreation, such as boat ramps, marine trails, and proximity to upland protected areas. Recreational activities are also associated with non-monetized values, including sense of place, health, and wellbeing, sharing knowledge with younger generations, and sharing experiences with friends and family.

Public (non-extractive) recreation is considered within the NSB using a combination of spatial information related to recreational activities. These recreational assets include kayaking and boating routes, anchorages, and dive sites (see Appendices E and F for more details). Public recreation is also highly integrated with other sectors, including tourism and recreational fishing. Some of these interconnections are referenced throughout the sector descriptions in these sections.

Each subregional summary in Sections 4-7, below, includes overlaps between recreational features/amenities and the proposed Network. Additional input on how public recreation values may interact with the proposed Network are welcomed through public engagement, including through surveys available at https://www.mpanetwork.ca.

3.3.7. Marine Transportation

The transportation sector comprises large ships, tankers, bulkers, cruise ships, ferries, barges, and passenger boats transporting people and goods throughout the NSB and to ports and harbours in the region. Marine shipping is a major activity within the NSB, along with local marine vessel activity for a wide range of purposes (e.g., shipbuilding, repair, transportation, harvest). There are several major transportation routes traversing the bioregion to access, among other places, the northern marine hub at Prince Rupert, and the main Canadian Pacific shipping hub in Greater Vancouver. Significant further planning and discussions are required by partners to address this sector, and further information is available in the Action Plan, s. 3.3.3.5.

3.3.8. Technology, Innovation, and Research

The technology, innovation and research sector engages in a set of highly specialized goods manufacturing and service delivery activities aimed at supporting marine-based activities in both domestic and international markets. Examples of activities in the sector include surveying, marine control and guidance, environmental monitoring and stewardship, and international stock management and science initiatives. This sector employs more people working in the NSB than port and ship construction and repair – accounting for more than $21 million in direct wages and $25.3 million in direct contribution to GDP. Activities within the sector may benefit from – and contribute to – the proposed Network. The stewardship and monitoring programs needed to implement the Action Plan, for example, will rely heavily on research activities and experts to help gauge the results stemming from implementation.

3.3.9. Forestry

Forestry in the NSB relies on the ocean for access to timber, storage of log booms, and transportation to mills and markets. The Network is not intended as a harvest management tool, but it could affect forestry activities that directly impact marine ecosystems and species. A number of proposed Network zones overlap with log storage, log dumping, and helicopter drop zone activities. Where possible, marine spatial planning already agreed to through the MaPP plans has been taken into account and should simplify decision-making for future zoning. This activity clarification presents a potential benefit to the sector, though the proposed Network may also increase operating and extraction costs in some areas. A separate impact analysis of forestry activities will be conducted by the Governance Partners during implementation to support various management scenarios.

3.3.10. Other Activities

Many other activities occur near or on the waters of the NSB that are not discussed in this overview. The subset above was selected based on discussions to date in the MPA network planning process. Activities listed in the Action Plan for future site-level discussion and consideration include renewable energy, cable laying, events related to oil pollution, ballast water and other vessel discharge, sonar, aircraft, ocean enhancement, and wild plant harvest (see sections 3.3.3 and 3.3.4 of the Action Plan for more details).

3.4. Marine Planning & Management of Marine Activities in the NSB

The NSB is an area with an extensive marine spatial planning history. The Marine Plan Partnership for the North Pacific Coast (MaPP) is a partnership between the Province of British Columba and 17 member First Nations that developed marine spatial plans for the bioregion. The partners used scientific evidence, local and traditional knowledge, and stakeholder input to provide recommendations in key areas of marine management. The MaPP plans inform the spatial management of many marine activities, including but not limited to tenures for log handling and storage, and renewable energy infrastructure. The Pacific North Coast Integrated Management Area (PNCIMA), another major planning initiative, provides a strategic integrated management plan through a marine ecosystem-based management framework for the NSB. The MaPP and PNCIMA plans outline paths to conserve ecological diversity, provide direction on activities, and sustain human economic uses.

A number of federal agencies and provincial ministries have jurisdictional responsibilities in the NSB. Regulatory and non-regulatory management measures currently in effect in the NSB pertain to fishing, research, conservation, resource extraction, tourism, and marine transportation. These measures will form part of any baseline scenario in future spatial analyses to support decision-making in the development of an MPA or MPA network.

The Province's marine accountabilities are divided between several ministries:

- **Ministry of Agriculture and Food** and the **Ministry of Forests** jointly administers the *Fish and Seafood Act*, which supports the management of seafood processing, wild marine plant harvest, and aquaculture regulations.
- **Ministry of Forests** manages marine tenures for marine activities, including aquaculture facilities, log handling and storage, and floating lodges.
- **Ministry of Water, Land and Resource Stewardship** is responsible for marine spatial planning and marine protected area design, provides science support, manages aquatic habitats, supports fisheries management and salmon recovery, and leads the development of a coastal marine strategy.
- **Ministry of Environment and Climate Change Strategy** manages environmental regulations and provincial marine parks.
- **Emergency Management BC** coordinates with search and rescue operations, and helps coastal communities prepare for future emergencies.

Federal marine accountabilities are also spread across agencies:

- **Fisheries and Oceans Canada (DFO)**is responsible for managing fishing activities and other activities that may affect marine species and habitats through the *Fisheries Act, Oceans Act, Species at Risk Act,* and other legislative tools.
- **Canadian Coast Guard (CCG)** is responsible for navigational aids, marine communications and traffic services, search and rescue, and marine pollution response.
- **Natural Resources Canada (NRCan)** is responsible for the management of oil and gas, and mineral resources.
- **Transport Canada (TC)'**s marine transportation program regulates commercial vessels and pleasure craft, monitors vessels entering Canadian waters, and certifies the officers and crew of Canadian ships.
- **Parks Canada** protects examples of Canada's marine heritage and is mandated to conserve areas representing the full range of ecosystems in Canada's oceans and the Great Lakes.
- **Environment and Climate Change Canada (ECCC)** has responsibilities for protecting migratory birds and important wildlife habitat, terrestrial and migratory birds and terrestrial species listed under the Species at Risk Act, environmental monitoring, and minimizing threats to Canadians and their environment from pollution.

Fisheries management is also governed through international agreements and legislation. Fishing activities in the NSB are subject to the same legislation and management regime as the Canadian Pacific Territorial Sea and EEZ. Existing management measures include closure of most of the marine area to bottom trawling for groundfish. Pacific halibut, Pacific salmon, sablefish, albacore tuna, and Pacific hake are all harvested in the NSB and include some component of international management. More comprehensive descriptions of existing management measures pertaining to fisheries in the NSB can be found in their Integrated Fisheries Management Plans (IFMPs), which are available at www.pac.dfo-mpo.gc.ca/fm-gp/ifmp-eng.html.

Since 1972, the federal government and the government of B.C. have placed moratoriums on offshore oil and gas exploration and development in the province. However, multiple permits and licences for those activities already existed, so in essence the moratoriums suspended these without voiding their validity. If the moratoriums are lifted the owners could exercise the rights conferred in their permits and licences, provided they receive the required authorizations from the Minister of Natural Resources and/or the National Energy Board (NEB), and from provincial authorities. At present there is no petroleum activity (exploration or development) in the NSB.

The proposed MPA Network will bring management changes to the NSB; however careful planning has ensured that the proposed Network builds from existing statutes, regulations, and stewardship plans. By doing so the partners aim to reduce regulatory changes for existing resource users, recognize the important work that has gone before, and build a feasible plan for implementation based on measures and approaches to governance that already exist or may be created. Existing measures also influence any assessment of the contributions and changes resulting from the proposed Network, as such measures are considered to have taken effect before the implementation of the Network (i.e., the outcomes of the Network are in addition to those of existing plans, regulations, and management measures).

3.5. The Proposed MPA Network

This section gives a brief description of the proposed MPA Network and its overlap with the main marine sectors in the NSB (for further details see Chapter 2 of the Action Plan).

The proposed Network will consist of a combination of existing and new protected areas (Table 3). Existing sites and protections being considered for inclusion include long-term spatial closures such as Rockfish Conservation Areas (RCAs); federal MPAs such as Scott Islands, Gwaii Haanas, and Hecate Strait Glass Sponge Reefs; and provincial designations such as marine conservancies. There are currently 114 MPAs and 69 Rockfish RCAs within the NSB. Informed by MPA network design principles and local knowledge of zone-specific ecological contexts, the proposed Network will build on these existing protections to establish "an ecologically comprehensive, resilient, and representative network of marine protected areas that protects the biological diversity and health of the marine environment for current and future generations" (Canada and B.C. 2014, 9).

Supporting sustainable marine economies can be an important benefit of MPA networks (see Network Action Plan, s. 1.2 and Section 8, below). Much of the proposed Network will be managed for sustainable mixed use and the implementation of the proposed Network is expected to have many economic and social benefits for those living in and beyond the NSB.

Table 3. Existing and new protections within the proposed Network *(see the Network Action Plan, Chapter 2 for further details)*

	Area (km²)	Proportion of proposed Network	Proportion of NSB
Existing MPA/RCA - no change	15,140	49.6%	14.9%
Existing MPA/RCA – if modified	3,620	11.9%	3.6%
New area (with underlying Protection Management Zones only)	6,916	22.7%	6.8%
New area	4,817	15.8%	4.7%
Total	**30,493**	**100%**	**30%**

Table 4 shows the baseline activity[7] of the main marine sectors in the NSB (see s. 3.3, above, for sector descriptions) and the subset of these activities that is identified in the Action Plan as activities of concern in Category 1 zones.[8] Further assessments will occur in the implementation phase to assess what measures might be appropriate for achieving Network goals. More information for most sectors can be found in the Socio-Economic Overview dashboards on the MPA network website,[9] and on SeaSketch,[10] which has maps and metadata for most of the types of activities and spatial features presented below.

Table 4. Summary of marine sectors in the NSB: Baseline activities and activities of concern in proposed Category 1 zones

Marine Sector	Activity in the NSB	Activity of concern in proposed Category 1 zones
Commercial Fishing	$307M in landed value is harvested from the NSB each year. **By fishery:** • Geoduck - $43.2M • Crab - $27.5M • Bottom trawl - $33.3M • Midwater trawl - $10.3M • Halibut - $28.3M • Prawn - $25.7M • Sablefish - $17.7M • Seine - $41.6M • Red sea urchin - $7M • Sea cucumber - $8.6M • Salmon gillnet - $28M • Salmon troll - $22.8M • All others, total of $12.8M. This landed value represents approximately $105.3M of annual profits (earnings before interest, taxes, depreciation, and amortization; EBITDA) derived from the above fishing activity. Over the entire study period ~2,300 vessels had harvest within the proposed Network zones, including in existing MPA/RCA – 'as-is, where-is' zones.	Approximately $24.1M of landed value, or half (50%) of the landed value within Category 1 zones, is identified as an activity of concern. **By fishery:** • Geoduck - $4.6M • Crab - $2.9M • Bottom trawl - $2.6M • Midwater trawl - $0.2M • Halibut - $2.8M • Prawn - $3.3M • Sablefish - $2.5 • Seine - $0.4M • Red sea urchin - $0.6M • Sea cucumber - $1M • Salmon gillnet - $0.4M • Salmon troll - $1M • All others, total of $1.9M. This landed value represents approximately $9.1M of annual profits (EBITDA) derived from the above fishing activity. Approximately 1,150 of the vessels have harvest within Category 1 zones, but only half (50% of landed value) of that activity has been identified as an activity of concern.

7 The baseline is what current or historical activity has occurred in the NSB and subregions.

8 Equivalent tables in Sections 4-7 give the subregional breakdowns of these activities.

9 https://mpanetwork.ca/socio-economic-overview

10 https://www.seasketch.org/#projecthomepage/59767c74bac2eb558ded3d9c

Marine Sector	Activity in the NSB	Activity of concern in proposed Category 1 zones
Seafood Processing	$226.1M in net processing value added is created by processing the commercial harvest sourced from within the NSB. **By fishery:** • Geoduck - $9.3M • Crab - $6.6M • Bottom trawl - $55.3M • Midwater trawl - $18.2M • Halibut - $6.5M • Prawn - $21.3M • Sablefish - $2.4M • Seine - $42.6M • Red sea urchin - $14.2M • Sea cucumber - $2M • Gillnet - $21.4M • Troll - $11.2M • All others, total of $15M. Most fishes harvested in the NSB are processed outside the region.	Seafood processing is not identified in the Action Plan as an activity of concern. Contents of this column are the seafood processing value added associated with commercial fishing harvest identified as an activity of concern. $15.2M in net processing value added is sourced from harvest activity that is an activity of concern. This represents about half (49%) of total processing value added from harvest in Category 1 zones. **By fishery:** • Geoduck - $1M • Crab - $0.7M • Bottom Trawl - $4.6M • Midwater Trawl - $0.3M • Halibut - $0.7M • Prawn - $2.7M • Sablefish - $0.4M • Seine - $0.6M • Red Sea Urchin - $1.2M • Sea Cucumber - $0.2M • Gillnet - $0.5M • Troll - $0.5 • All others, total of $1.9M.
Recreational Fishing	**Fishing Days:** • The marine space in the NSB enables 687,000 marine recreational fishing days per year. In pursuit of these fishing days, anglers spend $207.8M per year in expenditures. Of this expenditure, $44.1M is attributable to major purchases in pursuit of fishing, such as boats, vehicles, or buildings.	• Fishing Days: 41,000 • Direct Expenditures: $12.3M • Major Fishing Purchases: $2.9M

Marine Sector	Activity in the NSB	Activity of concern in proposed Category 1 zones
Ports & Harbours	Some zones may be in areas near ports or harbours. These zones may limit the expansion of infrastructure or the type of activities that can take place (e.g., disposal of wastewater). Generally, few impacts are expected and would be addressed during zone selection and planning in Category 3 areas. Marine Industrial Sites: 994	No activity of concern identified at this time.
Combined Tourism	Monetized activity estimates are not available for the areas included in the proposed Network. The proposed Network overlaps a variety of recreational features: **Feature Type, count:** • Anchorages, 1,176 • Coastal Campsites, 332 • Dive zone, 401 • Kayak Routes, 749 • Rec Boating Routes, 1,917 • Rec Features, 360 • Ecotourism lodge, 19 • Public wharf, 10 There are also 49 commercial tourism businesses with active commercial use permits for B.C. Parks in the NSB. These companies lead guided wildlife viewing, boat tours, hot springs visits and many other activities within existing protected areas.	No activity of concern identified at this time. More information on features and methods can be found in Appendices E and F).
Aquaculture	• Finfish Tenures: 76 in the NSB • Plant Tenures: 2 in the NSB • Shellfish Tenures: 66 in the NSB	No activity of concern identified at this time. The outcomes of other aquaculture planning processes will inform future Network planning.
Forestry	• Log Handling and Storage Tenures (Count) in the NSB: 533 • Log Handling and Storage Tenures (km^2) in the NSB: 62	Log-storage and handling tenures identified as activities of concern: • 88 Log Handling and Storage Tenures • The total area covered by these Log Handling and Storage Tenures (km^2): 14 Generally, the Network planning process has followed the direction for forestry in the subregional MaPP plans.

Marine Sector	Activity in the NSB	Activity of concern in proposed Category 1 zones
Marine Transportation	Based on Automatic Identification System (AIS) transceivers data there are 487,000 hours of marine vessel activity per year in the NSB. This covers any vessel equipped with an AIS transponder. In the NSB there are 14,648 km² considered High-Density Large Vessel Traffic Areas.	No activity of concern identified at this time. Significant further planning and discussions are required by partners to address this sector (further information is available in the Action Plan, s. 3.3.3).

Totals and subtotals may not always align due to rounding and filtering data for privacy concerns.

4. Haida Gwaii Subregional Overview

4.1. Description of subregion

The Haida Gwaii subregion, which is home to approximately 5,000 people, is an archipelago of over 200 islands situated about 100 km off the coast of northern B.C. Major communities include Masset, Old Masset, Skidegate, the Village of Daajing Giids, and Sandspit. The subregion includes important heritage sites, bodies of water, islands, and mountains, including the Gwaii Haanas National Park Reserve and Haida Heritage Site, Masset Inlet and Hecate Strait, Graham and Moresby Islands, and the San Christoval range. Primary marine economic activities in the subregion include communal/commercial fishing, forestry, marine transportation, and tourism, many of which have historical significance to the Haida Nation (CHN 2017).

Two MPAs are proposed for consideration in Haida Gwaii, one in the offshore and one in the nearshore areas. For offshore areas, an *Oceans Act* MPA is proposed, while nearshore areas are proposed to be covered under a marine National Wildlife Area. A combination of Wildlife Management Areas and *Fisheries Act* tools are also proposed within the Masset and Skidegate Inlet. Three existing 'as-is, where-is' MPAs/RCAs are also included in the proposed Network.

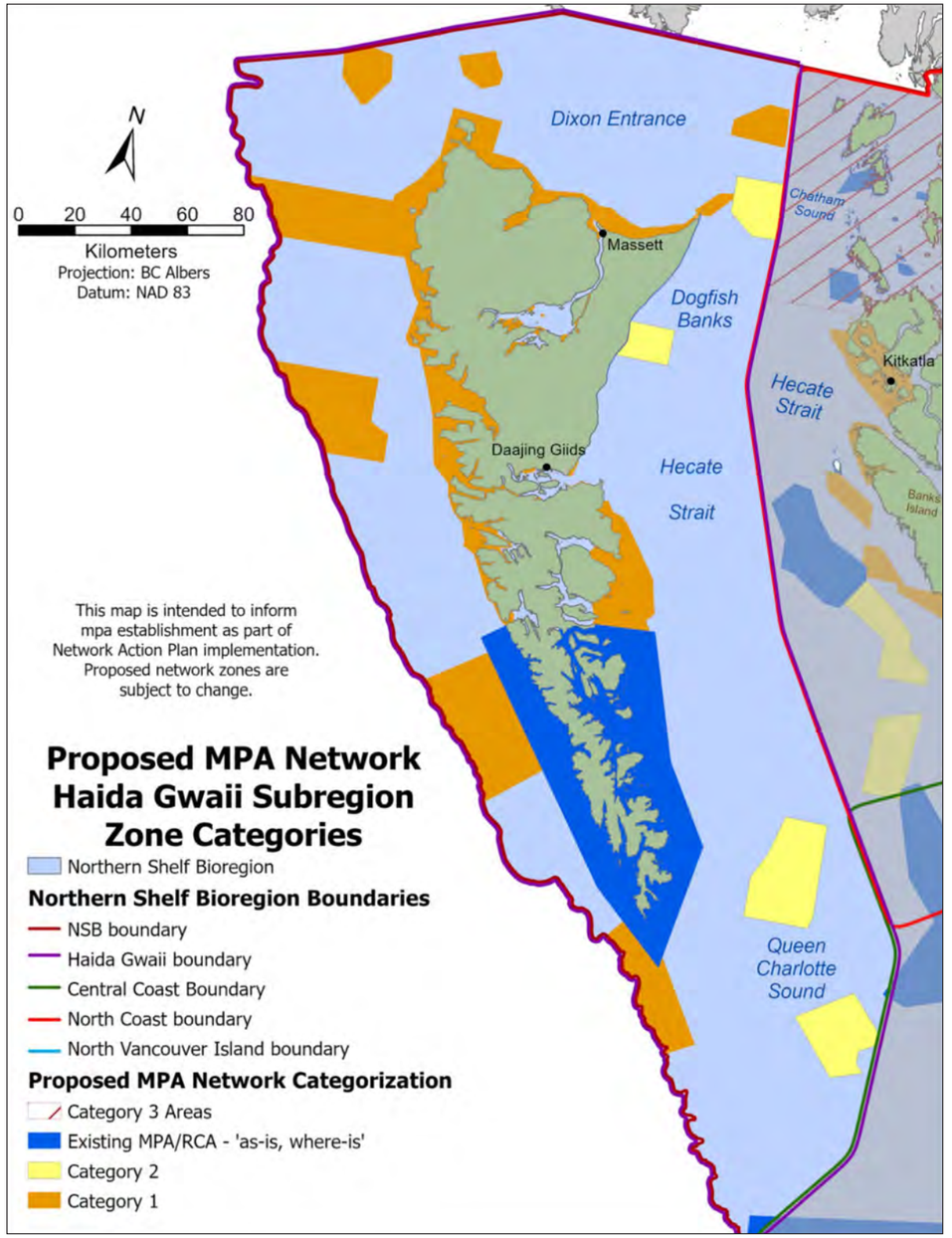

Figure 2. Proposed MPA Network in the Northern Shelf Bioregion – Haida Gwaii subregion

4.2. Overview of Human Activities

Many marine sectors operating in Haida Gwaii benefit from the abundance and diversity of species and habitats in the marine environment. However, Haida Gwaii communities and the local economy do not always benefit from extractive marine activities such as guided recreational fishing (Lefebvre Consulting, 2006).

The waters of Haida Gwaii are host to a wide range of commercial and recreational fisheries. The estimated landed value of commercial fishing in Haida Gwaii is $104.2M. Preliminary analysis indicates that the fisheries with the most overlap (in terms of landed value) with proposed Network zones are crab, groundfish bottom trawl, halibut, and geoduck. The harvest identified as an activity of concern makes up approximately 52% of the total landed value within new proposed Category 1 zones ($12.6M).

The estimated net value added associated with harvest processing in Haida Gwaii is roughly $59.6M per year. Approximately $10M of this net value added is in Category 1 zones, of which $7.7M (or 77%) is sourced from harvest identified as an activity of concern. This processing activity generates $3M annually in wages and supports roughly 45 jobs. Only a tiny fraction of commercial harvest is landed or processed in Haida Gwaii; commercial vessels from across B.C. travel to the subregion to participate in a range of fisheries.

Recreational fishing is also an important activity in the region, with an average of 98,600 fishing days per year. An estimated 51,800 fishing days overlap with zones in the proposed Network. Of these, 50,100 are attributable to overlap with Category 1 zones, associated with $30.4M in direct expenditures and $1.2M in major fishing purchases. Roughly 5,300 of these fishing days (5% of the subregional baseline) take place in areas where recreational fishing is an activity of concern. These 5,300 fishing days are associated with $3.2M in direct expenditures and $100,000 in major fishing purchases. Of the total overlapped activity in Category 1 zones, non-B.C. residents make up 15% of the effort and 61% of expenditures. According to the baseline proportions, 73% of the days fished in the proposed Network zones were done with the services of a fishing lodge/charter/guide.[11] Businesses supporting recreational fishing in Haida Gwaii are based both in the subregion and elsewhere, including many south coast operators.

Public recreation and tourism (other than recreational fishing) are also prevalent activities in the Haida Gwaii subregion. The 2020 Haida Gwaii Visitor Survey conducted by the Align Consulting Group noted that between March 2019 and February 2020 there were 21,442 visitors to Haida Gwaii whose primary reason for visiting was not recreational fishing. Leisure spending during this same period totaled $12.9M, which excluded spending by fishing lodge visitors who did not spend additional time in Haida Gwaii. The survey also reported that the top three reasons for travelling to Haida Gwaii identified by visitors in summer 2019 were “Visiting Friends and Relatives”, “Family Vacation”, and “Sightseeing/Nature/Wildlife". The region is home to the Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site, the Naikoon Provincial Park, 11 heritage sites/conservancies, various accommodations, and a variety of nature-tourism outfits and opportunities. Ecotourism activities in the subregion include hiking, kayaking, cultural tours, land and sea-based wildlife viewing, and diving. On Haida Gwaii, marine tourism was found to “[represent] over half (59%) of direct jobs in the marine sector” (Gunton and Broadbent 2012, 17).

In terms of recreational features and/or infrastructure that occur within the subregion, there are 123 anchorages, 77 coastal campsites, 34 dive sites, and 382 kayak route segments. Efforts are underway by the Governance Partners to incorporate these elements into an ecosystem service model of public recreation to help illustrate how recreation and tourism may benefit from the establishment of MPAs.

11 See Appendix C (Recreational fishing lodges).

Another important sector in Haida Gwaii is forestry. The Network planning process has followed the directions in the MaPP Haida Gwaii plan for forestry, and there are only five zones where forestry activities on Haida Gwaii are identified as activities of concern requiring further planning or attention.

The protection of E-CPs within the subregion is expected to benefit reliant communities and individuals over time. A further discussion of the potential pathways for realizing benefits from MPAs is provided in Section 8. A summary of potential conservation outcomes specific to the proposed Network in Haida Gwaii is presented in Table 5. These values represent the percentage of conservation priorities – within the subregion and separated by species type – that fall within their target range for representation within the proposed Network. Table 6 provides an overview of activities in the subregion, including subregional totals and values of activities of concern.

For more information on the ecological conservation priorities of the Network, refer to Compendium 2.

Table 5. Haida Gwaii subregional summary of overlapping ecological features

Type of Conservation Benefit	Description of Measure	Interactions with the Network
Protection of species with social, cultural, and economic importance.	% of E-CPs in each species group falling within recommended protection ranges, scaled for human activity.	• Birds: 96% • Fish: 59% • Invertebrates: 30% • Marine plants: 100% • Marine mammals: 85%
Protection of ecologically important areas and marine features.	Area of a habitat type or number of distinct features within the Network boundaries contributing to specific targets.	• **Total area** 11,692 km^2 • **Length of Coastline:** 3,752 km • **Zones:** 84 • **Ecologically or Biologically Significant Areas (EBSAs):** All eight identified EBSAs in the Haida Gwaii subregion meet or exceed the “High” representation targets within the proposed Network. • **Estuaries:** Haida Gwaii contributes nearly 1/3 of proposed Network coverage for estuary zones. • **Important Nearshore Habitats:** 10 unique zones within the Haida Gwaii subregion contribute to conservation of rich nearshore habitats.

Table 6. Summary of marine sectors in Haida Gwaii: Baseline activities and activities of concern in proposed Category 1 zones

Marine Sector	Activity in the Haida Gwaii Subregion	Activity of concern in Category 1 zones
Commercial Fishing	$104.2M in landed value is harvested from the Haida Gwaii subregion each year. **By fishery:** • Halibut - $18.7M • Bottom trawl - $18.5M • Crab - $16.2M • Troll - $15.7M • Sablefish - $14M • Geoduck - $12.9M • Rockfish - $1.8M • Prawn - $1.2M • Red sea urchin - $1.2M • Lingcod - $1.1M This landed value represents approximately $38M of annual profits (EBITDA) derived from the above fishing activity. Over the entire study period ~575 vessels had harvest within the proposed Network zones, including in existing MPA/RCA – 'as-is, where-is' zones.	Approximately $12.6M of landed value – nearly three quarters (72%) of the landed value within Category 1 zones – is identified as an activity of concern. **By fishery:** • Bottom trawl - $2.6M • Crab - $2.4M • Sablefish - $2.5M • Halibut - $2M • Troll - $1.1M • All others, total of $2M This landed value represents approximately $4.3M of annual profits (EBITDA) derived from the above fishing activity. Approximately 500 vessels harvest within Category 1 zones.
Seafood Processing	$59.6M in net processing value added is created by processing the commercial harvest sourced from within the Haida Gwaii subregion. **By fishery:** • Bottom trawl - $30.6M • Troll - $6.9M • Halibut - $4.3M • Crab - $3.9M • Geoduck - $2.8M • Red sea urchin - $2.4M • Sablefish - $1.9M • Prawn - $1M • Tuna - $4M • All others, total of $1.8M Most fishes harvested in Haida Gwaii are processed outside the NSB.	Seafood processing is not identified in the Network Action Plan as an activity of concern. Contents of this column are the seafood processing value added associated with commercial fishing harvest identified as an activity of concern. $7.7M in net processing value added is sourced from harvest activity that is an activity of concern. This represents 77% of total net processing value added from harvest in Category 1 zones. **By fishery:** • Bottom trawl $4.5M • Crab - $0.6M • Troll - $0.5M • Red sea urchin - $0.3M • Tuna - $0.4M • Halibut - $0.5M • Sablefish - $0.4M • All others, total - $0.5M
Recreational Fishing	The marine space in the Haida Gwaii subregion enables 98,600 marine recreational fishing days per year. In pursuit of these fishing days, anglers spend $59.5M per year in expenditures. Of this spending, $3.1M is attributable to major purchases in pursuit of fishing, such as boats, vehicles, or buildings.	**Recreational fishing activity identified as an activity of concern:** • Fishing Days: 5,300 • Direct Expenditures: $3.2M • Major Fishing Purchases: $0.1M
Ports & Harbours	Some zones may be in areas near ports or harbours. These zones may limit the expansion of infrastructure or the type of activities that can take place (e.g., disposal of wastewater). Generally, few impacts are expected and would be addressed during zone selection and planning in Category 3 areas. Marine Industrial Sites: 201	No activity of concern identified at this time.

Marine Sector	Activity in the Haida Gwaii Subregion	Activity of concern in Category 1 zones
Combined Tourism	Monetized activity estimates are not available for the areas included in the proposed Network. The proposed Network overlaps a variety of recreational features: **Feature Type, count:** • Anchorages, 123 • Coastal Campsites, 77 • Dive site, 34 • Kayak Routes, 382 • Rec Boating Routes, 268 • Rec Features, 24 • Eco tourism lodge, 2 • Public wharf, 1	No activity of concern identified at this time. More information of features and methods can be found in Appendices E and F.
Aquaculture	• Finfish Tenures: 0 • Plant Tenures: 0 • Shellfish Tenures: 4	No activity of concern identified at this time. The outcomes of other aquaculture planning processes will inform future Network planning.
Forestry	• Log handling and storage tenures in the Haida Gwaii subregion (Count): 28 • Log handling and storage tenures in the Haida Gwaii subregion (km^2): 4.3	Log handling and storage tenures identified as activities of concern: • 1 tenure falls within Category 1 boundaries. The total area covered by this tenure (km^2): 0.2 Generally, the Network planning process has followed the direction for forestry in the subregional MaPP plans.
Marine Transportation	Based on AIS transceiver data there are 66,700 hours of marine vessel activity per year in Haida Gwaii. This covers any vessel equipped with an AIS transponder. There are 2,703 km^2 considered as a High-Density Large Vessel Traffic Area in the subregion.	No activity of concern identified at this time. Significant further planning and discussions are required by partners to address this sector (further information is available in the Action Plan, s. 3.3.3).

Totals and subtotals may not always align due to rounding and filtering data for privacy concerns.

5. Central Coast Subregional Overview

5.1. Description of subregion

Close to two-thirds of residents on the B.C. Central Coast are of Indigenous ancestry (Heiltsuk, Kitasoo Xai'xais, Nuxalk or Wuikinuxv). For millennia, the wellbeing of these Indigenous people has been linked, inextricably, to the health of the marine environment. Indigenous stewardship of marine resources – salmon, crab, groundfish, etc. – supported an economy of abundance that enabled rich and complex cultures, economies, and societies to develop (Reid et al 2022). Archaeologists have dated the origins of village sites on the Central Coast to as far back as 14,000 years, making them some of the oldest continually occupied sites in Canada. Pre-contact, the Central Coast supported a rich marine-based economy and some of the highest population concentrations in North America.

Today, the main communities of the Central Coast include Bella Coola, Bella Bella, Ocean Falls, Rivers Inlet, Shearwater and Klemtu. The Central Coast subregion is one of B.C.'s most remote areas, covering an area of 24,559.5 km^2 and with a population of fewer than 4,000 permanent residents.[12]

Over the last century, Central Coast economies have relied primarily on commercial logging and fishing industries. Over that time the Nations have observed precipitous declines of marine species essential to coastal ecosystems, culture, and economies (Reid et al., 2022). Reid et al. (2022) further observe that recent trends in climate change and ocean acidification, as well as an increase in industrial shipping, are exacerbating ecological declines. While fishing and forestry industries are still critical to the local economies, they too are in decline. The local economies of the subregion are diversifying, with a recent focus on aquaculture, tourism, and other service sectors.

As described in the Action Plan (s. 3.2.3.2, and Appendix 1 – Central Coast Profile), Central Coast Nations and Parks Canada began a feasibility study in 2022 for a National Marine Conservation Area Reserve (NMCAR) and Indigenous Protected Areas to protect the conservation objectives of the proposed zones in the subregion.

12 The Central Coast and North Coast sub-regional boundaries overlap due to associated First Nations planning boundaries. To simplify analysis and outputs and avoid issues associated with double-counting, sub-regional 'assessment boundaries' (which do not overlap) were created to determine values for the Network analysis.

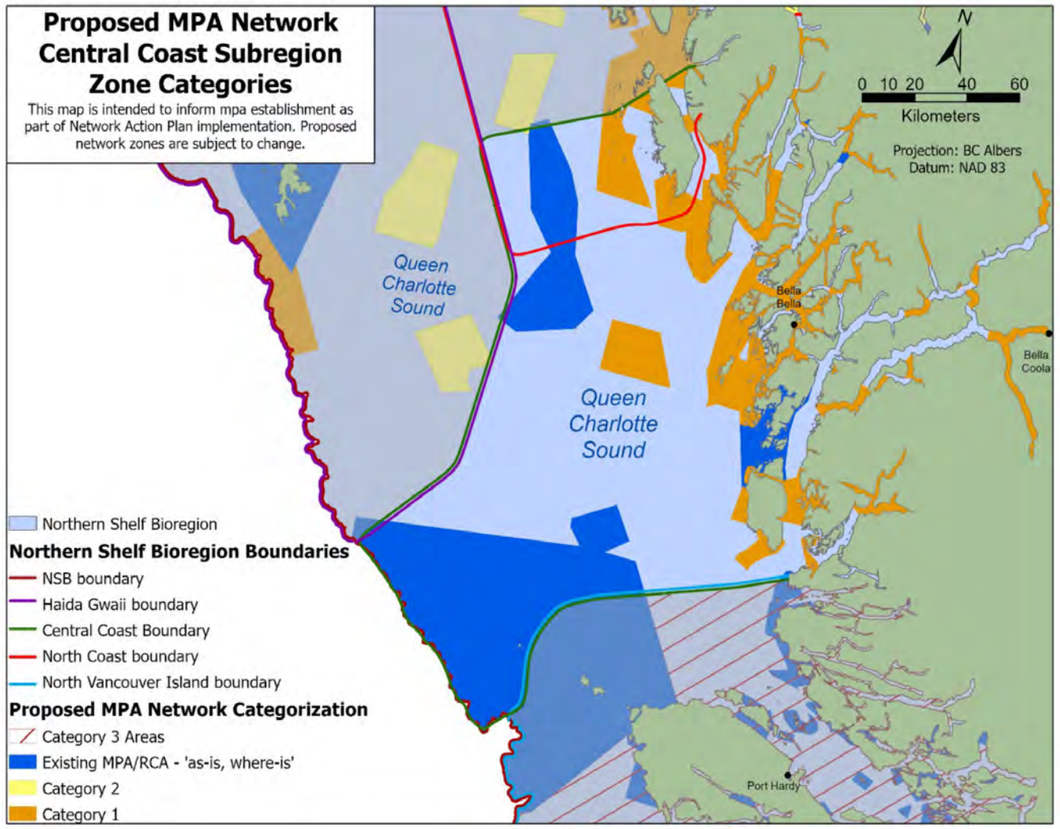

Figure 3. Proposed MPA Network in the Northern Shelf Bioregion – Central Coast subregion

5.2. Overview of Human Activities

Marine areas of the Central Coast support a range of sectors that in turn create employment and economic activity locally and throughout the province.

The Central Coast accounts for 17% of the total landed catch (in kilograms) and 20% of the landed value for commercial fisheries in the NSB. The estimated landed value of those fisheries is $60M, and the estimated annual profits derived from that landed value is $21M. The processing sector adds $43.1 million of net value to this harvest; however, most of the seafood harvested from the Central Coast is processed elsewhere in B.C. The Central Coast fisheries are concentrated in shellfish dive, prawn, and salmon seine and gillnet fisheries. Geoduck dive fisheries in the Central Coast account for 21% of the total subregional landed value.

Central Coast fishing activity identified as an activity of concern in Category 1 zones accounts for 6% of the total landed catch and 3% of the landed value for commercial fisheries in the NSB. The estimated annual profits derived from this activity is $4M, and the value of those fisheries is $8.9M. Geoduck and prawn represent 70% of the landed value identified as an activity of concern in the subregion. Salmon seine, salmon gillnet, and sea cucumber by dive account for a further 5%.

The Central Coast is home to about 14% of the total recreational fishing effort in the NSB (roughly 98,900 fishing days) and there are several important lodges operating in the region. The recreational fishing activity overlapping the proposed Network zones is approximately 43,800 fishing days. Of these, 34,800 overlap Category 1 zones and are associated with $12.5M in recreational fishing expenditures (direct expenditures and major fishing purchases). Approximately 29,300 fishing days (30% of the subregional baseline) associated with $10M in recreational fishing expenditures (direct expenditures and major fishing purchases) take place in areas where recreational fishing is an activity of concern. Of the total overlapped activity in Category 1 zones, non-B.C. residents make up 29% of the effort and 53% of expenditures. According to the baseline proportions, 19% of the days fished in these areas were done with the services of a fishing lodge/charter/guide.

Public recreation and tourism other than recreational fishing are also prevalent activities in the Central Coast subregion. Wildlife viewing boat tours, cultural tours, eco-lodges, and kayaking are common activities, and there are 43 conservancies and provincial parks in the subregion with marine components, drawing over 2,825 commercial client days per year. Renowned destinations in this region include the Great Bear Rainforest, the Fiordland Conservancy, and the Hakai/Luxvbalis Conservancy and Conservation Study Area. Previous studies have estimated that marine tourism, including guided angling, accounts for 23% of marine employment on the North and Central Coasts (Gunton and Broadbent 2012, 12).

Recreational and tourism activities in the Central Coast are supported by a large number of recreational features, including 274 anchorages, 30 coastal campsites, 44 dive zones, 145 kayak routes, and 553 recreational boating routes. Additionally, many proposed MPAs are adjacent to existing upland conservation areas, further increasing their value as wilderness destinations.

Forestry operations on the Central Coast are complex and rely heavily on the marine space for transportation and access to upland harvest areas. Currently there are 17 zones in the Central Coast region where the Action Plan identifies log handling and storage as an activity of concern.

Central Coast communities, including First Nations, residents, and businesses can expect a variety of benefits from the proposed MPA Network. While some of these are expected to be more immediate for the tourism and recreation sectors (e.g., reputation, employment, ongoing funding for monitoring programs), it is also expected that benefits will grow over time. Additional discussion on the benefits pathways for MPAs are provided in Section 8. Additional benefits might include improved wildlife viewing and reduced overlaps between different groups of resource users.

A summary of ecological features associated with potential conservation benefits specific to the Central Coast subregion is presented in Table 7. Table 8 provides an overview of activities in the subregion, including subregional totals and values of activities of concern.

Table 7. Central Coast subregional summary of overlapping ecological features

Type of conservation benefit	Description of measure	Interactions with the Network
Protection of species with social, cultural, and economic importance.	% of E-CPs in each species group falling within recommended protection ranges, scaled for human activity.	• Birds: 100% • Fish: 64% • Invertebrates: 41% • Marine plants: 100% • Marine mammals: 82%
Protection of ecologically important areas and marine features.	Area of a habitat type or number of distinct features within the Network boundaries contributing to specific targets.	• **Total area within proposed Network:** 9,097 km^2 • **Coastline area within proposed Network:** 5,718 km • **Zones:** 83 • All four EBSAs identified within the Central Coast well exceed “High” representation targets within the proposed Network. • The Central Coast contributes the majority (>60%) of proposed Network achievement for protections of glass sponge reefs, a vital filter feeder and habitat component for many fish species.

Table 8. Summary of marine sectors in Central Coast: Baseline activities and activities of concern in proposed Category 1 zones

Marine Sector	Baseline activity in Central Coast	Activity of concern in proposed Category 1 zones
Commercial Fishing	$60M in landed value is harvested from the Central Coast subregion each year. **By fishery:** • Gillnet - $13,1M • Geoduck - $12.7M • Bottom trawl - $8.6M • Prawn - $5.7M • Halibut - $4.5M • Seine - $3.7M • Midwater trawl - $3.7M • Sea cucumber - $3.5M • Sablefish - $1.4M • Crab - $1.4M • All others, total of $1.7M This landed value represents approximately $21M of annual profits (EBITDA) derived from the above fishing activity. Over the entire study period ~870 vessels had harvest within the proposed Network zones, including in existing MPA/RCA – ‘as-is, where-is’ zones.	Approximately $8.9M of landed value, or half (52%) of the landed value within Category 1 zones is identified as activity of concern. **By fishery:** • Geoduck - $3.8M • Prawn - $2.4M • Sea cucumber - $0.6M • Gillnet - $0.4M • Seine - $0.4M • All others, total of $1.2M This landed value represents approximately $4M of annual profits (EBITDA) derived from the above fishing activity. Approximately 725 of the vessels have harvest within Category 1 zones.
Seafood Processing	$43M in net processing value added is created by processing the commercial harvest sourced from the Central Coast subregion. **By fishery:** • Gillnet - $14.6M • Bottom Trawl - $6.7M • Seine - $5.5M • Midwater trawl - $4.7M • Prawn - $4.7M • Geoduck - $2.7M • Halibut - $1M Most fishes harvested in the Central Coast are processed outside the NSB.	Seafood processing is not identified in the Action Plan as an activity of concern. Contents of this column are the seafood processing value added associated with commercial fishing harvest identified as an activity of concern. $4.7M in net processing value added is sourced from harvest activity that is an activity of concern. This represents about half (49%) of total net processing value added from harvest in Category 1 zones. **By fishery:** • Prawn - $2M • Geoduck - $0.8M • Seine - $0.5M • Gillnet - $0.5M • Red sea urchin - $0.3M • All others, total of $0.6M

Marine Sector	Baseline activity in Central Coast	Activity of concern in proposed Category 1 zones
Recreational Fishing	**Fishing Days:** The marine space in the Central Coast subregion enables 98,900 Marine Recreational Fishing days per year. In pursuit of these fishing days, anglers spend $34.4M per year in expenditures. Of this, $7.9M is attributable to major purchases in pursuit of fishing, such as boats, vehicles, or buildings.	Recreational fishing activity identified as an activity of concern: • Fishing Days: 29,300 • Direct Expenditures: $7.7M • Major Fishing Purchases: $2.3M
Ports & Harbours	Some zones may be in areas near ports or harbours. These zones may limit the expansion of infrastructure or the type of activities that can take place (e.g., disposal of wastewater). Generally, few impacts are expected and would be addressed during zone selection and planning in Category 3 areas. Marine Industrial Sites: 65	No activity of concern identified at this time.
Combined Tourism	Monetized activity estimates are not available for the areas included in the proposed Network. The proposed Network overlaps a variety of recreational features: **Feature Type, count:** • Anchorages, 274 • Coastal campsites, 30 • Dive site, 44 • Kayak routes, 86 • Rec boating routes, 553 • Rec features, 15 • Ecotourism lodge, 2 • Public wharf, 4	No activity of concern identified at this time. More information on features and methods can be found in Appendix E (Socio-Economic Performance Measures).
Aquaculture	• Finfish tenures: 6 • Plant tenures: 0 • Shellfish tenures: 2	No activity of concern identified at this time. The outcomes of other aquaculture planning processes will inform future Network planning.

Marine Sector	Baseline activity in Central Coast	Activity of concern in proposed Category 1 zones
Forestry	Log handling and storage tenures in the Central Coast subregion (Count): 114 Log handling and storage tenures in the Central Coast subregion (km^2): 17.5	Log handling and storage tenures identified as an activity of concern: • 58 tenures fall within Category 1 zones. • The total area covered by these Log handling and storage tenures (km^2): 9 Generally, the Network planning process has followed the direction for forestry in the subregional MaPP plans.
Marine Transportation	Based on AIS transponder data there are 94,400 hours of marine vessel activity per year in the Central Coast. This covers any vessel equipped with an AIS transponder. In the Central Coast, there are 2,431 km^2 considered as a High-Density Large Vessel Traffic Area.	No activity of concern identified at this time. Significant further planning and discussions are required by partners to address this sector (further information is available in the Action Plan, s. 3.3.3).

Totals may not always align due to rounding and filtering data for privacy concerns.

6. North Coast Subregional Overview

6.1. Description of subregion

The North Coast subregion includes an impressive stretch of coastline that is indented with deep fjords and dotted with thousands of islands. It is a region of profound beauty, significant ecological diversity, and remarkable cultural richness. The subregion is home to some 42,000 people, the largest communities being Prince Rupert, Terrace, and Kitimat. Many of the smaller communities are predominantly First Nations, belonging to the Gitga'at, Gitxaala, Haisla, Kitselas, Kitsumkalum, Lax Kw'alaams, Metlakatla, and Nisga'a Nations. Not all of these nations have participated in the MPA Network planning process to the same extent, and as such a large portion of this subregion has been included as a Category 3 area.[13]

Major economic activities in this subregion include natural resource development, forestry, shipping, government services, and the service sector. Commercial fishing and processing generate less employment than in the past but continue to be prominent in the culture and identity of North Coast communities. Conversely, shipping is a rapidly growing industry in the region, with ports for cargo traffic in Kitimat, Prince Rupert, and Stewart all expanding in recent years.

There are two regional districts within the subregion: the North Coast Regional District (including Prince Rupert) and the Kitimat-Stikine Regional District. First Nations make up a large component of the North Coast population. In 2016, Indigenous people made up 35.9% of the Kitimat-Stikine Regional District, and 38.8% of the North Coast Regional District identified as Indigenous (Statistics Canada 2017).

13 See the Network Action Plan, Chapter 3 (s. 3.2.2) and Appendix 1 for further details.

The North Coast is the most northern of the four NSB subregions. It extends from Portland Inlet to the south end of Aristazabal Island, where it overlaps the northern boundary of the Central Coast.[14] The western edge of the North Coast subregion borders Haida Gwaii (Figure 4).

Within the North Coast subregion, a Marine Refuge is proposed to complement four existing RCAs. Similarly, an existing ecological reserve is proposed to be complimented by *Fisheries Act* tools, and the introduction of a marine National Wildlife Area. Finally, two *Oceans Act* MPAs are proposed within the subregion, one to aggregate zones within the Caamano Sound, and another around Kitkatla.

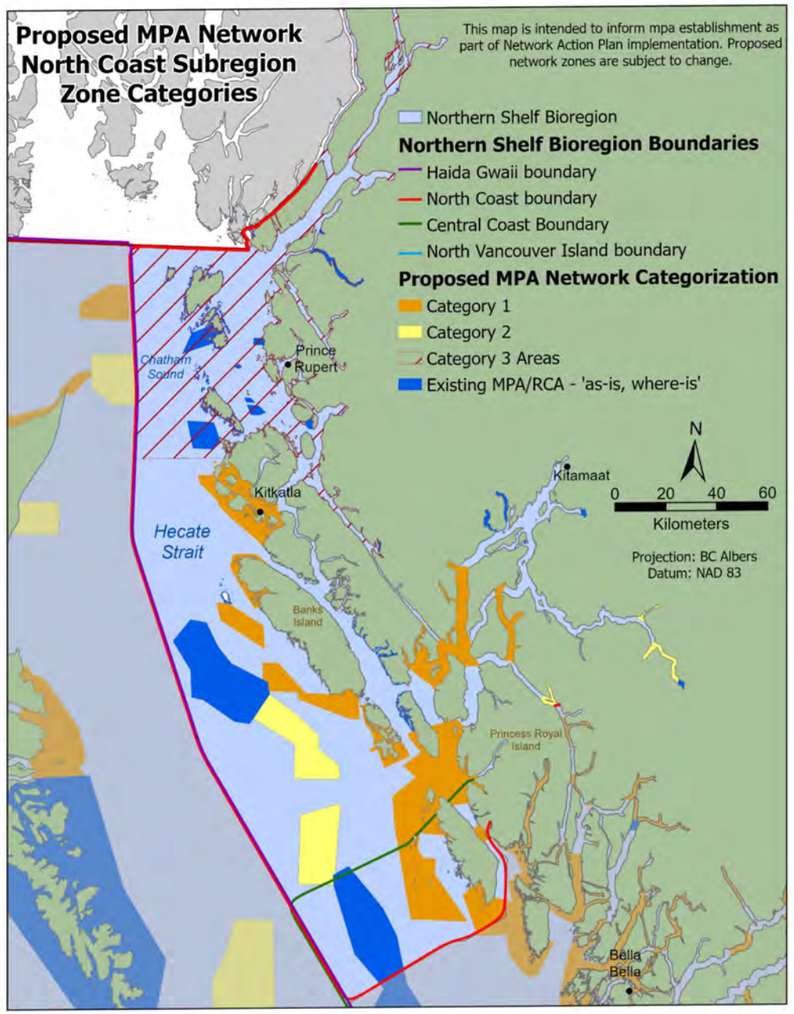

Figure 4. Proposed MPA Network in the Northern Shelf Bioregion – North Coast subregion

14 The Central Coast and North Coast sub-regional boundaries overlap due to associated First Nations planning boundaries. To simplify analysis and outputs and avoid issues associated with double-counting, sub-regional 'assessment boundaries' (which do not overlap) were created to determine values for the Network analysis.

6.2. Overview of Human Activities

The majority of newly proposed zones are in the southern half of the subregion, from the southern edge north to Porcher Island (Figure 4, above). In the northern half of the subregion, planning may still continue to outline additional zones for implementation as MPAs. In conjunction with this planning, further analysis will be required around key activities, such as shipping activities around Port of Prince Rupert, log handling and storage, commercial fishing, and recreational fishing.

The North Coast accounts for 26% of the landed value for commercial fisheries in the NSB. The estimated landed value of those fisheries is $79.9 million, with estimated annual profits of $28.6M. The processing sector adds $81.8 million of net added value to this harvest; however, most of the seafood harvested from the North Coast is processed elsewhere in B.C.

Activities of concern that have been identified in the North Coast account for approximately $1.8M in landed value per year. This represents half a percent (0.5%) of the total NSB commercial fishing activity. The profit associated with identified activities of concern is $500,000 per year. The main fisheries within Category 1 zones in the North Coast include halibut, prawn, and sea cucumber and commercial geoduck, with commercial geoduck being the fishery with the most historic activity within new zones of the proposed Network.

Seafood processing in the North Coast subregion provided roughly $7M in labour income in 2015, though since then the number of processors operating in the subregion has decreased. Processors in the North Coast source inputs predominantly from the NSB (Gislason 2017). The net processed value of the North Coast commercial harvest within Category 1 zones is estimated at roughly $2.3M annually.

The North Coast accounts for 20% of the total recreational fishing effort in the NSB, with roughly 136,900 fishing days annually. Of this, 13,700 fishing days fall within Category 1 zones. Recreational fishing identified as an activity of concern within proposed Category 1 zones includes roughly 6,100 fishing days (4% of the subregional baseline) and is associated with approximately $1.8M in expenditures (direct expenditures and major fishing purchases). Of the total activity in Category 1 zones, non-B.C. residents make up 12% of the effort and 52% of expenditures. Survey data indicate that 12% of the days fished in these areas were done with the services of a fishing lodge/charter/guide. Growing economic and recreational opportunities in the North Coast are driving annual increases in recreational fishing activity in the subregion.

Public recreation and tourism other than recreational fishing are also prevalent activities in the North Coast. Wildlife and bear viewing boat tours, cultural tours, and kayaking are common activities, and there are 73 conservancies and provincial parks in the subregion with marine components. Renowned destinations include Bishops Bay/Monkey Beach and the associated hot springs, and guided commercial tours bring close to 1,000 visitors to provincial parks and conservancies in the subregion each year.

Recreational and tourism activities in the North Coast are supported by a large number of recreational features. Many of these overlap with the proposed Network and existing zones. Presence in the subregion includes 316 anchorages, 21 coastal campsites, 76 dive sites, 136 kayak routes, and 240 recreational boating routes. Additionally, many existing and proposed MPA zones are adjacent to existing upland conservation areas, further increasing their value as wilderness destinations.

Forestry operations on the North Coast are complex and rely heavily on the marine space for transportation and access to upland harvest areas. Currently, there are 11 existing tenures that overlap with proposed and existing MPA zones. Only 7 Category 1 zones within the proposed Network identify forestry as an activity of concern, and only two of those zones include active forestry operations. Further forestry specific analysis will be conducted during zone implementation to understand how any changes in forestry activities resulting from the Network implementation fits into other existing land use planning processes.

North Coast communities including First Nations, residents, and businesses can expect many benefits from the MPA Network. While some benefits of creating an MPA network will be immediate for some communities and industry groups, it is also expected that benefits will grow over time. Benefits might include improved wildlife viewing and reduced overlaps between different groups of resource users. Additional descriptions of benefits pathways for MPAs are provided in Section 8.

A summary of ecological features underlying potential benefits specific to the North Coast subregion is presented in Table 9. Table 10 provides an overview of activities in the subregion, including Network overlaps and values of activities of concern.

Table 9. North Coast subregional summary of overlapping ecological features

Type of conservation benefit	Description of measure	Interactions with the Network
Protection of species with social, cultural, and economic importance.	% of E-CPs in each species group falling within recommended protection ranges, scaled for human activity.	• Birds: 100% • Fish: 62% • Invertebrates: 35% • Marine plants: 100% • Marine mammals: 83%
Protection of ecologically important areas and marine features.	Area of a habitat type or number of distinct features within the Network boundaries contributing to specific targets.	• **Total area within proposed Network:** 5,159 km² • **Coastline area within proposed Network:** 4,495 km • **Zones:** 71 • **Ecologically or Biologically Significant Areas (EBSAs):** Both EBSAs identified within the North Coast exceed “High” representation targets within the proposed Network. • **Important marine mammal hotspots:** Several zones within the North Coast contribute to protecting critical habitats for humpback, grey, fin, and northern resident killer whales. • **Important nearshore habitats:** 8 unique zones within the North Coast subregion contribute to conservation of rich nearshore habitats.

Table 10. Summary of marine sectors in the North Coast: Baseline activities and activities of concern in proposed Category 1 zones

Marine Sector	Activity in the North Coast Subregion	Activity of concern in proposed Category 1 zones
Commercial Fishing	$79.9M in landed value is harvested from the Northern Shelf Bioregion each year. **By fishery:** • Geoduck - $16.1M • Crab - $6.6M • Bottom trawl - $3M • Midwater trawl - $0.3M • Halibut - $4.3M • Prawn - $3.2M • Seine - $17.8M • Red sea urchin - $4.5M • Sea cucumber - $3.5M • Gillnet - $11M • Troll - $4.4M • Herring roe - $4M • All others, total of $0.9M. This landed value represents approximately $28.6M of annual profits (EBITDA) derived from the above fishing activity. Over the entire study period ~1,100 vessels had harvest within the proposed Network zones, including in existing MPA/RCA – ‘as-is, where-is’ zones.	Approximately $1.8M of landed value, or 15% of the landed value within Category 1 zones, is identified as activity of concern. **By fishery:** • Crab - $0.05M • Midwater trawl - $0.1M • Halibut - $0.3M • Prawn - $0.2M • Herring roe - $0.5M • Red sea urchin - $0.3M • Sea cucumber - $0.4M • All others, total of $0.03M. This landed value represents approximately $0.5M of annual profits (EBITDA) derived from the above fishing activity. Approximately 451 of the vessels have harvest within Category 1 zones.

Marine Sector	Activity in the North Coast Subregion	Activity of concern in proposed Category 1 zones
Seafood Processing	$81.8M in net processing value added is created by processing the commercial harvest sourced from within the NSB. **By fishery:** • Geoduck - $3.5M • Crab - $1.6M • Bottom trawl - $6.4M • Midwater trawl - $0.8M • Halibut - $1M • Prawn - $2.6M • Seine - $37.7M • Red sea urchin - $9.1M • Sea cucumber - $0.8M • Gillnet - $7.1M • Troll - $2.9M • Herring roe - $8.1M • All others, total of $0.4M. Most fishes harvested in the Central Coast are processed outside the subregion.	Seafood processing is not identified in the Network Action Plan as an activity of concern. Contents of this column are the seafood processing value added associated with commercial fishing harvest identified as an activity of concern. $2.3M in net processing value added is sourced from harvest activity that is an activity of concern. This represents about half (49%) of total processing value added from harvest in Category 1 zones. **By fishery:** • Midwater trawl - $0.3M • Halibut - $0.1M • Prawn - $0.2M • Red sea urchin - $0.6M • Herring roe - $1M • All others, total of $0.3M.
Recreational Fishing	**Fishing Days:** The marine space in the North Coast enables 136,900 marine recreational fishing days per year. In pursuit of these fishing days, anglers spend $49.1M per year in expenditures. Of this expenditure, $17.1M is attributable to major purchases in pursuit of fishing, such as boats, vehicles, or buildings.	Recreational fishing activity identified as an activity of concern: • Fishing Days: 6,100 • Direct Expenditures: $1.3M • Major fishing purchases: $0.4M
Ports & Harbours	The North Coast is home to several important ports, including Prince Rupert and Kitimat. Many communities also rely on smaller harbours for access to and from their communities. Some zones may be in areas near ports or harbours. These zones may limit the expansion of infrastructure or the type of activities that can take place (e.g., disposal of wastewater). Generally, few impacts are expected and would be addressed during zone selection and planning in Category 3 areas. Marine Industrial Sites: 467	No activity of concern identified at this time.
Combined Tourism	Monetized activity estimates are not available for the areas included in the proposed Network. There are 49 commercial tourism businesses with active commercial use permits for B.C. Parks in the NSB. These companies lead guided wildlife viewing, boat tours, hot springs visits and many other activities within existing protected areas. The proposed Network overlaps a variety of recreational features: **Feature Type, count:** • Anchorages, 316 • Coastal Campsites, 21 • Dive site, 76 • Kayak Routes, 136 • Rec Boating Routes, 240 • Rec Features, 42 • Ecotourism lodge, 1 • Public wharf, 1	No activity of concern identified at this time. More information on features and methods can be found in Appendix E (Socio-economic Performance Measures).
Aquaculture	• Finfish tenures: 0 • Plant tenures: 2 • Shellfish tenures: 4	No activity of concern identified at this time. The outcomes of other aquaculture planning processes will inform future Network planning.
Forestry	• Log handling and storage tenures in the North Coast (Count): 77 • Log handling and storage tenures in the North Coast (km^2): 7.9	Log handling and storage tenures identified as an activity of concern: • 12 tenures fall within Category 1 zones. The total area covered by these tenures (km^2): 0.9 Generally, the Network planning process has followed the direction for forestry in the subregional MaPP plans.
Marine Transportation	Based on AIS transponder data there are 151,000 hours of marine vessel activity per year in the North Coast. This covers any vessel equipped with an AIS transponder. In the North Coast there are 5,335 km^2 considered High-Density Large Vessel Traffic Areas.	No activities of concern identified at this time. Significant further planning and discussions are required by partners to address this sector (further information is available in the Action Plan, s. 3.3.3).

Totals and subtotals may not always align due to rounding and filtering data for privacy concerns.

7. NVI Subregional Overview

7.1. Description of subregion

The North Vancouver Island (NVI) subregion is home to approximately 47,000 people. Major communities include Campbell River, Port McNeill, Port Hardy, and Alert Bay. This subregion includes important bodies of water, islands, inlets, and fjords, such as Queen Charlotte Strait, Johnstone Strait, and the Bute and Knight Inlets. The region is home to many First Nations, including partner First Nations,[15] who maintain a strong connection to the ocean. Some remote communities in the region, such as the Da'naxda'xw/Awaetlala village of Tsatsisnukwomi on Harbledown Island, can only be accessed by boat and are incredibly dependent on the marine environment for access, food, employment, recreation, and all other aspects of daily coastal life. Main marine economic activities in the region include shellfish and finfish aquaculture, commercial fishing, seafood processing, forestry, tourism, and transportation.

Within the NVI subregion are two Category 1 zones, each of which are proposed to be addressed with a combination of *Fisheries Act* and provincial management tools. These zones aim to satisfy both ecological and First Nations cultural conservation objectives, in line with the goals of the Network. Other pre-existing protected areas, including RCAs and conservancies, are included pending further discussion with local First Nations. Planning for much of this subregion requires further discussion with First Nations before zones can be advanced for inclusion in the Network.

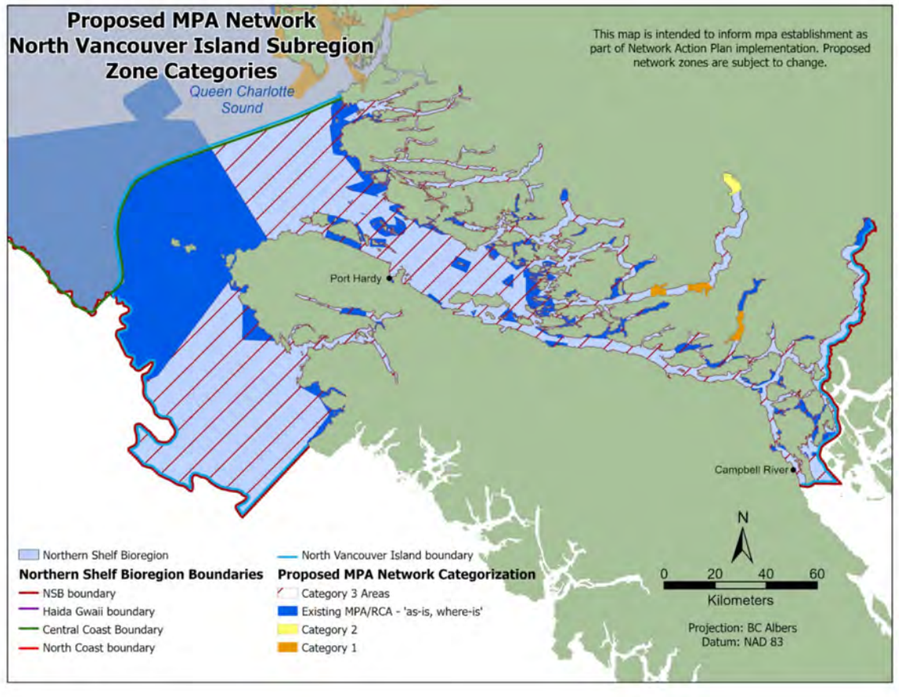

Figure 5. Proposed MPA Network in the Northern Shelf Bioregion – NVI subregion

7.2. Overview of Human Activities

Residents of and visitors to NVI benefit from the economic opportunities and recreational, cultural, and social values supported by the marine environment.

For commercial fishing, new zones in the proposed Network overlap with an estimated $952,000 in landed value per year, with most of this activity falling within Category 1 zones. For reference, the amount of activity overlapped by existing zones is roughly $14,982,000 in landed value (24% of the baseline activity in the subregion). The main fisheries within the new zones are prawn (72% of the total overlapped landed value), crab (25%), and sea cucumber (1%). The estimated net processed value of this harvest is roughly $640,000 per year. This processing activity generates <$100,000 in annual processing wages and supports roughly 3 jobs. While the processing of this harvest may occur in other subregions, the processing sector in NVI may also be involved.

Seafood processing operations in the subregion rely on inputs from other subregions, potentially including from fishing activity identified as an activity of concern. In 2015, seafood processing resulted in roughly $9.5M in labour income for the residents of NVI. These businesses depend on wild harvest and aquaculture to reliably supply sufficient inputs to maintain operations.

Recreational fishing is also an important regional activity, with 352,000 fishing days per year (roughly 51% of all fishing days in the NSB). Recreational fishing activity overlapping with the proposed Network is estimated at roughly 12,200 fishing days per year, which is associated with $2.5M in recreational fishing expenditures (direct expenditures and major fishing purchases). Activities of concern within Category 1 zones make up roughly 250 fishing days (<0.1% of the subregional baseline), associated with approximately $30,000 in direct expenditures and $10,000 in major purchases attributable to recreational fishing. Of the total overlapped activity in Category 1 zones, non-B.C. residents make up 77% of the effort and 38% of expenditures. Survey data indicates that none of the days fished in these areas were done with the services of a fishing lodge, charter service, or guide.

Public recreation and tourism other than recreational fishing are prevalent activities in NVI. There are 40 existing marine provincial parks and conservancies overlapping the subregion, many of which are jointly managed through collaborative management agreements. Activities available from ecotourism operators in the subregion include hiking, kayaking, camping, cultural tours, swimming, land and sea-based wildlife viewing, and diving. From 2014-2019, commercial tourism operators in the subregion reported an average of 5,983 client days per year inside B.C. parks. Highly valuable areas to the tourism sector are not uniform throughout NVI; nevertheless, information collected from ecotourism operators offering diving, kayaking, and wildlife viewing put revenue at between $12M and $16M in 2013 (Bodtker et al. 2015).

From 2014-2018, an average of 7,867 people per year engaged in self-guided hiking and camping in Cape Scott Provincial Park alone. In 2013, self-guided marine recreational users generated added revenue of $3-5M in the NVI subregion. These recreational users rely extensively on recreational features and/or infrastructure. There are 463 anchorages, 204 coastal campsites, 247 dive sites, and 145 kayak routes and marine trails that overlap with the proposed Network in NVI. Aquaculture is another important sector in NVI. However, of 127 existing aquaculture tenures for finfish, shellfish, and marine plants, none are expected to be affected by the proposed Network.

15 Mamalilikulla, Tlowitsis, Wei Wai Kum and Kwiakah First Nations. Also see Network Action Plan, s. 1.1.

Another important sector is forestry, which primarily relies on the marine environment for transportation and access to forests. Of the 11 new zones being proposed for NVI, there are only two in which forestry is an activity of concern without existing mitigations in place.

A summary of ecological features underlying potential benefits specific to the NVI subregion is presented in Table 11. Table 12 provides an overview of activities in the subregion, including Network overlaps and values of activities of concern.

Table 11. North Vancouver Island subregional summary of overlapping ecological features

Type of Conservation Benefit	Description of Measure	Interactions with the Network
Protection of species with social, cultural, and economic importance	% of E-CPs in each species group falling within recommended protection ranges, scaled for human activity.	• Birds: 96% • Fish: 65% • Invertebrates: 38% • Marine plants: 100% • Marine mammals: 83%
Protection of ecologically important areas and marine features.	Area of a habitat type or number of distinct features within the Network boundaries contributing to specific targets.	• **Total area within proposed Network:** 4,546 km² • **Coastline area within proposed Network:** 2,959 km • **Zones:** 120 • **Ecologically or Biologically Significant Areas (EBSAs):** The NVI subregion contributes 100% of proposed Network representation for three EBSAs present in the area. • **Major contributions to protection of pelagic and shorebird habitats:** The NVI subregion contributes more than 50% of proposed Network achievement E-CPs for six unique species of pelagic birds and shorebirds. • **Important nearshore habitats:** 21 unique zones, including existing MPA/RCA – 'as-is, where-is' zones within the NVI subregion contribute to the conservation of rich nearshore habitats.

Table 12. Summary of marine sectors in North Vancouver Island: Baseline activities and activities of concern in proposed Category 1 zones

Marine Sector	North Vancouver Island Activity Baseline	Activity of Concern
Commercial Fishing	$62.7M in landed value is harvested from the NVI subregion each year. **By fishery:** • Geoduck - $1.5M • Crab - $3.2M • Bottom trawl - $3.2M • Midwater trawl - $5.6M • Halibut - $0.8M • Prawn - $15.6M • Sablefish - $2M • Seine - $19.7M • Red sea urchin - $0.9M • Sea cucumber - $1.7M • Gillnet - $3.8M • Troll - $2.8M • All others, total of $1.2M. This landed value represents approximately $17.8M of annual profits (EBITDA) derived from the above fishing activity. Over the entire study period ~1,200 vessels had harvest within the proposed Network zones, including in existing MPA/RCA – 'as-is, where-is' zones.	Approximately $0.9M of landed value, or 90% of the landed value within Category 1 zones is identified as an activity of concern. NVI has nine Category 1 zones. **By fishery:** The catch that is an activity of concern is dispersed across several fisheries, notably: • Prawn: $0.6M • Crab: $0.2M • All others, total of $0.1M This landed value represents approximately $0.2M of annual profits (EBITDA) derived from the above fishing activity. Approximately 75 of the vessels have harvest within Category 1 zones.

Marine Sector	North Vancouver Island Activity Baseline	Activity of Concern
Seafood Processing	$51.4M in net processing value added is created by processing the commercial harvest sourced from within the NSB. **By fishery:** • Geoduck - $0.3M • Crab - $0.8M • Bottom trawl - $2.8M • Midwater trawl - $13.2M • Halibut - $0.2M • Prawn - $13M • Sablefish - $0.3M • Seine - $14.2M • Red sea urchin - $1.8M • Sea cucumber - $0.4M • Gillnet - $0.3M • Troll - $1.4M • All others, total of $0.7M.	Seafood processing is not identified in the Action Plan as an activity of concern. Contents of this column are the seafood processing value added associated with commercial fishing harvest identified as an activity of concern. $0.6M in net processing value added is sourced from harvest activity that is an activity of concern. This represents about half (49%) of total processing value added from harvest in Category 1 zones. **By fishery:** • Prawn: $0.5M • Crab: $0.05M • All others, total of $0.1M
Recreational Fishing	**Fishing Days:** The marine space in NVI enables 352,000 marine recreational fishing days per year. In pursuit of these fishing days, anglers spend $64.9M per year in expenditures. Of this expenditure, $16.0M is attributable to major purchases in pursuit of fishing, such as boats, vehicles, or buildings.	Recreational fishing activity identified as an activity of concern: • Fishing Days: 250 • Direct Expenditures: $0.03M • Major fishing purchases: $0.01M
Ports & Harbours	Some zones may be in areas near ports or harbours. These zones may limit the expansion of infrastructure or the type of activities that can take place (e.g., disposal of wastewater). Generally, few impacts are expected and would be addressed during zone selection and planning in Category 3 areas. Marine Industrial Sites: 261	No activity of concern identified at this time.
Combined Tourism	Monetized activity estimates are not available for the areas included in the proposed Network. The proposed Network overlaps a variety of recreational features: **Feature Type, count:** • Anchorages, 463 • Coastal campsites, 204 • Dive site, 247 • Kayak routes, 145 • Rec boating routes, 856 • Rec features, 279 • Ecotourism lodge, 14 • Public wharf, 4	No activity of concern identified at this time. More information of features and methods can be found in Appendices E and F.
Aquaculture	• Finfish tenures: 67 • Plant tenures: 0 • Shellfish tenures: 56	No activity of concern identified at this time. The outcomes of other aquaculture planning processes will inform future Network planning.
Forestry	• Log handling and storage tenures in NVI (Count): 314 • Log handling and storage tenures in NVI (km^2): 32.4	Log handling and storage tenures identified as activities of concern: • 17 tenures fall within Category 1 zones. The total area covered by these tenures (km^2): 2.1. There are 7 zones within the proposed MPA Network area where future forestry could be an activity of concern. Measures to mitigate the impacts of that activity will be explored during site implementation. Generally, the Network planning process has followed the direction for forestry in the subregional MaPP plans.
Marine Transportation	Based on AIS transponder data there are 175,000 hours of marine vessel activity per year in NVI. This covers any vessel equipped with an AIS transponder. In NVI there are 4,179 km2 considered as a High-Density Large Vessel Traffic Area.	No activity of concern identified at this time. Significant further planning and discussions are required by partners to address this sector (further information is available in the Action Plan, s. 3.3.3).

Totals and subtotals may not always align due to rounding and filtering data for privacy concerns.

8. Realizing Benefits and Understanding Costs of the Proposed MPA Network

The Action Plan presents a proposed network that would protect and maintain marine biodiversity, ecological representation, and special natural features. As the new protected areas are implemented, incremental costs and benefits will be realized by various user groups and to varying degrees. This section discusses the pathways that lead to benefits and costs. In general, the establishment of MPAs is associated with costs borne by specific groups, while many benefits accrue over time. It takes time for benefits of conservation to materialize, for habitats to revert to more natural and productive states, and for species to grow and complete their life cycles in a more productive and healthier environment.

8.1. Cost Pathways

As Network implementation is expected to span several years there will be a stream of realized costs across time, subregions (as well as the broader provincial and national economy), and various users and sectors. One potential avenue for costs is reduced human activity. An example of this is commercial fishers who are no longer able to fish in certain areas, or have to alter the gear, depth, or time of year they fish within MPAs. These responses could lead to either increased costs or decreased revenues, forcing fishermen to find next best alternatives that are less efficient or profitable. In some cases, fishermen may even choose to move to other fisheries or transition to another sector of the economy altogether. Participants in sectors that overlap extensively with the proposed Network are understandably concerned about potential reductions to activities such as commercial fishing and recreational fishing on their wellbeing and livelihood.

The proposed Network overlaps with roughly 30% of the NSB's commercial fishing landed value, some portion of which may be affected by future management of protected areas. There is the potential for decreases in harvest due to future fisheries restrictions, which could result in shifts in fishing patterns and lost harvest opportunities in regional fisheries. Seafood processing operations may also experience a loss in profits associated with decreased harvest if processing inputs cannot be sourced elsewhere. If changes to availability of inputs causes processing plants to reduce employment, relocate, or close, the effects would be felt throughout the community as well as the sector itself. These community impacts would also be more important to consider in smaller coastal communities, where seafood processing is a major local employer. Based on trends in the movement of unprocessed fish from point of harvest to processing location, northern processing operations are dependent on northern fish harvests, and may be more sensitive to changes in local harvest levels (Gislason, 2017).

Recreational fishing also has overlaps with the proposed Network, especially in nearshore areas and areas closer to communities. The economic impact of any future restrictions on recreational fishing will depend on the extent to which anglers 'replace' those fishing days with trips to other fishing areas, or to fish other species. A high proportion of fishing days made up in open areas would mitigate the overall economic impacts. However, the effects at finer scales near the closed areas could be greater if there are not sufficient alternative fishing opportunities to support local businesses. Additionally, location-based values, such as connections to specific areas held by anglers, may still be impacted by the implementation of the proposed Network even if it is possible to relocate fishing activity. These impacts may not be reflected in changes to angler expenditures, but will still be felt by affected individuals.

Sectors and businesses that support fish harvest, processing, transportation, and recreational outfitting will likely see changes in step with the amount of fishing activity that is displaced in the future. Impacts to a group of businesses can have implications for business partnerships at several geographic scales. While some costs are likely to be felt outside the NSB, such as reduced processing inputs for southern processing plants, the communities within the planning area may have greater economic dependence on activities of concern identified in the Network Action Plan.

The timing of costs and benefits is also an important consideration. Typically, the costs of conservation coincide with protected area designation, whereas benefits can take longer to be realized. In the NSB, implementation of the proposed Network will be implemented over several years, sot that not all costs will be incurred at the same time.

8.2. Benefit Pathways

Consistent with evidence from both contemporary scientific literature and the traditional knowledge of partner First Nation, the creation of an MPA network is expected to have wide-ranging ecological, social, cultural, economic, and governance benefits for the NSB, B.C., and Canada (Reid et al 2022; Ban et al. 2019).

As described below, MPA networks have been shown to be more effective than other marine conservation tools, in:

- protecting and conserving biological diversity and ecosystem function, and increasing the resiliency of protected ecosystems and communities to climate change;
- rebuilding exploited stocks and species;
- protecting older, larger, and more fecund (productive) female fish;
- protecting habitats critical for fisheries productivity and carbon sequestration; and
- generating benefits for user groups.

By focusing on habitat connectivity and replication, and providing protections for whole ecosystems rather than specific exploited stocks, the international scientific community has highlighted MPA networks as effective tools for mitigating the effects of climate change on affected communities. Important benefits include combatting local ocean warming and acidification (Roberts et al., 2017; Bindoff et al., 2022), sea level rise (Bindoff et al., 2022), and changes to food web structure and resilience (Eisaguirre et al., 2020).

MPAs have also been proven effective tools for rebuilding exploited stocks and species, if properly implemented, managed, and enforced (Reid et al. 2022; Di Lorenzo et al., 2020; Edgar et al., 2014; Vandeperre et al. 2011). Effects on protected stocks include increased biomass and species richness, both inside MPAs (Di Lorenzo et al. 2020; Egerton et al., 2018; Sala and Giakoumi, 2016; Sala et al., 2021, Aburto-Oropeza et al., 2011; Halpern and Warner, 2002; Claudet et al., 2008), as well as beyond zone borders through the export or spillover of adult fish and larvae (Di Lorenzo et al. 2020; Follesa et al. 2011; Vandeperre et al., 2011; Qu et al., 2021; Quinn et al., 1993; Gell and Roberts, 2003; Le Port et al. 2017; Baetscher et al. 2019; Di Lorenzo, Claudet, and Guidetti 2016; Kerwath et al., 2013). This ability of MPAs to export benefits beyond their borders highlights their importance as a conservation tool that is also capable of enhancing fisheries incomes, as evidenced by the many examples of benefits to adjacent fisheries arising from MPA network implementation (Murray & Hee 2019; Kerwath et al., 2013).

Protection of older, larger, and more fecund female fish within protected areas increases the resilience of exploited stocks to existing anthropogenic and environmental stressors (Micheli et al. 2012; Marshall et al. 2021). These more mature females produce exponentially more eggs than their younger counterparts, providing disproportionately larger contributions to recruitment (Reid et al. 2022; Micheli et al. 2012). Fishing

activity has been identified as one of the major drivers of the removal of large-bodied individuals from marine ecosystems, implying an important role for no-take marine reserves in protecting these productive, more mature fish, and realizing their effect on stock health and recovery (Bosch, 2021).

As the Network is implemented to meet its conservation objectives there may be socio-economic benefits associated with more abundant fish and invertebrate populations. Increased abundances may lead to improved community outcomes such as wellbeing, employment, and food security. Harvesting, processing, and support businesses may also benefit from increases of harvest into the future, as well as potentially more stable and resilient fish populations in the face of climate change (Pinsky et al. 2020). The outcome of spatial protections on individual species is dependent on characteristics that impact how species respond to area-based protections, such as size, mobility, and life history (Barceló et al., 2021). Making any general statement about the timing of benefits is difficult due to the variability between species.

A network of spatial protections will also do more for protecting habitats critical for fisheries productivity and carbon sequestration than conservation tools targeting specific commercially or recreationally harvested stocks. Reducing fishing gear contact to eelgrass beds, kelp forests, and glass sponge reefs promotes the provisioning of important services by reducing habitat destruction or damage. Eelgrass beds within the NSB sequester organic carbon at an average rate of 24.8 grams per m2/Y (Reid et al., 2022; Prentice et al. 2020). Seagrasses have also been identified for their role in providing coastal protection from sea level rise driven by climate change (Ondiviela et al., 2013). Similarly, glass sponge reefs remove 1 g of carbon per m2/day (Dunham et al. 2018), with 7% to 11% of their tissues (depending on species) consisting of organic carbon (Archer et al. 2020). Sponges have also been documented sequestering additional carbon into marine sediments (Reid et al., 2022), where it can be effectively trapped for hundreds or even thousands of years.

Benefits may also accrue to specific user groups, whose opportunity for access may increase as a result of other human uses no longer being permitted within an area. This may include several forms of recreation and ecotourism, and select forms of marine harvest, which provide valuable opportunities for local employment while having limited impact on zone-level conservation priorities. Instances may also arise where the implementation of an MPA acts to attract increased expenditure and use of a specific zone. This may be especially true if the planning and engagement process leads to increased awareness of zone-level conservation objectives and the human-use opportunities they may support.

Developing a robust monitoring framework as part of Network implementation may also provide individuals and communities with new opportunities for local employment and participation. The framework would support scientific research, helping the Governance Partners better understand and track the biological effects of the Network over time to inform ongoing management.

8.3. Ecosystem Services

The benefits of MPA networks are related to improvements in ecosystem health and are often defined as ecosystem services: the benefits to individuals and communities arising from nature and its systems (Böhnke-Henrichs et al., 2013). While a comprehensive list of all ecosystem services potentially provided by the NSB is not currently achievable, we acknowledge that these services cover a vast array of quantifiable and non-quantifiable values. Some of these values have already been discussed within this document, such as increases in future marine harvest (a direct and quantifiable benefit). However, many if not most ecosystem services accrue to communities as indirect benefits and lack a market value as they are not extracted, sold, or traded within a formal market. More information related to work being conducted to understand the impact of the proposed Network on local ecosystem services can be found in Appendix D, and Figure 6 shows an example framework for conceptualizing the different forms of these services.

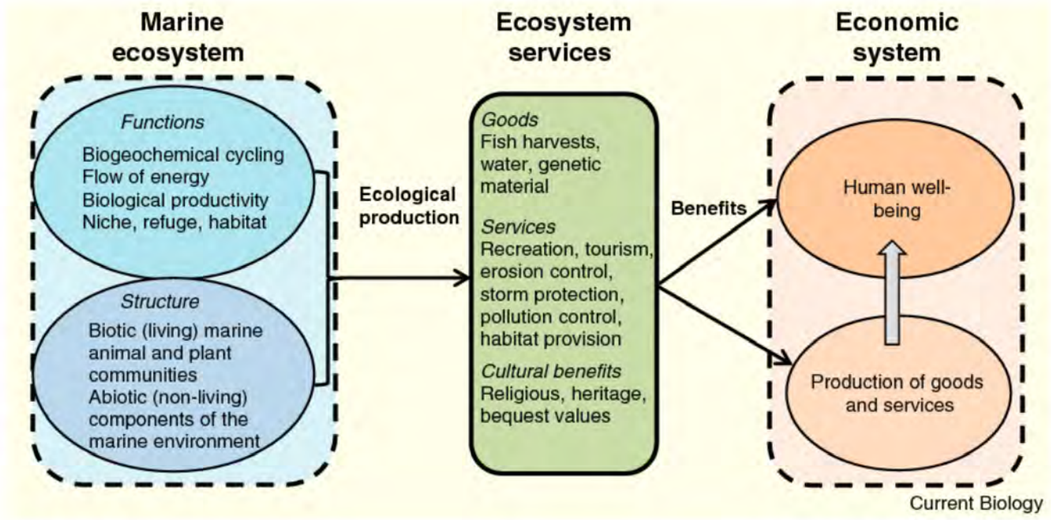

Figure 6. Conceptualizing Contributions of Ecosystem Services to Human Well-Being.

Source: Barbier, E. (2017). Marine ecosystem services. Current Biology. Vol 27. Issue 11. Pgs R507-510.

The proposed Network will strengthen protections for habitats that provide ecosystem services, and the provisioning of many ecosystem services is expected to be enhanced as a result of Network implementation (Leenhardt et al., 2015; Marcos et al., 2020). To explore these potential changes and the benefits they could bring to communities, a quantitative model for six ecosystem services was built, which presents potential changes in service provisioning arising from changes in spatial conservation measures and associated environmental benefits. The modeled services were carbon sequestration, tourism and recreation values, water filtration, production of yelloweye rockfish, and enhanced protection from coastal erosion associated with the protection of vegetated coastal ecosystems (see Figure 6, above). Ultimately, benefits realized through Network implementation will depend on permitted activities within new MPAs, the ecological features within the MPA, and the MPA's ability to attenuate habitat stressors. There are also many more services that have not yet been assessed but could be included in future additions to this work, including regulatory benefits on biological communities, disease and pest control, and qualitative treatment of cultural and heritage values linked to healthy ecosystems.

Also significant are non-use values, which can take many forms. People may place value in the continued existence and improved future outlooks of species and habitats, for example, or in protecting against future uncertainties like climate change and ocean acidification. The ability of other generations to access marine resources is a significant value to many.

Finally, while non-extractive tourism does not benefit directly from the harvest value of increased species abundance, the sector does benefit from increased biomass and overall improvements to ecological conditions. This can include increased prevalence of viewable species, as well as similar benefits to non-extractive recreation, such as spending time with friends and family, and enjoying nature's splendour.

9. Conclusion

The economic, social, and cultural dimensions of the proposed MPA Network have been considered throughout the planning process, from the development of the Network goals (set out in the *Canada-B.C. MPA Network Strategy*) and design guidelines, to the incorporation of human use data layers and consideration of First Nations cultural conservation priorities (C-CPs). Where possible, metrics with social or cultural dimensions were selected to aid in developing and refining the proposed Network design, including the C-CP and other data on SeaSketch, economic metrics with a social dimension such as labour (number of FTEs, income), and the distribution of network interactions across user groups and communities. Nevertheless, network-level assessment of the implications for socio-economic values in the NSB has been limited to-date and will depend on the management measures put forward during implementation processes. At this stage in the planning process this overview seeks to support stakeholder and public engagement on the Action Plan, help decision-makers understand the potential implications of the proposed Network, and support final refinements to the Action Plan.

Much of the information presented here is similar to a social, cultural, and economic overview of an Area of Interest (AOI) for designation under the Oceans Act. The methods developed to estimate activities and values within proposed Network zones will also be useful for estimating baselines and undertaking cost benefit analyses (CBAs), as required for the establishment of specific MPAs. Localized, community-level assessments of Network implications for economic, social, and cultural values have not been undertaken by the Governance Partners; understanding the available information will help to identify data that can or should inform other scales of analysis and identify data gaps.

The location and community-based specificity of many values means that in some cases these will be more meaningfully assessed at a zone level rather than on a Network-wide basis. The establishment of individual MPAs will require additional analysis as set out by the relevant statutory authorities, and may include further opportunities for stakeholder and public input. In the meantime, drawing on the best available information to consider how the proposed Network could create opportunities as well as challenges for different communities' and user groups' economic, social, and cultural values continues to be an important component of the Network planning process and will help to inform the implementation of the proposed Network.

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Appendix A. Commercial Fishing Analysis Methodology

Purpose, context, and objectives of this analysis

This document presents a socio-economic overview assessing the activities that overlap the zones of the proposed MPA Network. The areas that make up the proposed Network are a combination of existing zones, proposed zones identified in previous marine spatial planning processes in B.C.'s marine waters (e.g., MaPP), and new zones to fill conservation gaps. At this stage in the planning process a network-level direct activity overlap analysis is being conducted to inform the Governance Partners and planners about the potential scale of affected fishing activity and the relative fishing activity within the proposed and existing zones. The overlap analysis is limited in that it only looks at the direct activity that overlaps (occurs within) proposed Network zones. The network space is as described in the technical scenario created by the Governance Partners. The technical scenario is not yet a complete representation of what the final Network may look like, as some areas still have significant planning to undertake, and the partners have not agreed to any set of proposed management measures at this time.

A major component of providing information on the ongoing human uses within the proposed Network spaces is the assessment of commercial fishing activities. This methodology focuses on the fishery-specific considerations for accurately assessing the direct activity overlaps of the zones in the proposed Network.

With the implementation of new areas, federal regulatory policy requires that a cost-benefit analysis (CBA) be conducted to identify and then monetize where possible the incremental impacts expected with the establishment of the proposed MPA. These future analyses will give more attention to specific zones at a granular level, as opposed to this network-level analysis, and will incorporate more granular analysis and local knowledge, as well as analysis of management measures. The regulatory CBAs support the public consultation process associated with the establishment of new protected zones, and forms one part of the advice provided to decision makers during the development of the regulations that establish the MPA, along with the biological analyses and the results from consultations with Canadians.

This document outlines the broad steps and major data sources and considerations for the direct activity overlap analysis (which identifies the amount of commercial fishing activity that is overlapping the proposed Network), along with data and reports that support the translation of that activity into economic metrics such as jobs, wages, and GDP. Methods, models, and sensitivity analyses will continue to be developed and presented throughout implementation, and expanded upon through engagement with planning partners, stakeholders, and the public.

This appendix presents the methodology and general steps of the spatial analysis, and its results to outline the commercial fishing overlaps presented in this compendium overview. Critical elements related to the activity are reviewed, including current activity and measures, data sources, methodology with maps, and limitations to the analysis. Main results are presented in summary tables in the main body of this overview, with the online Socio-Economic Overview dashboards containing more granular data. Totals may not always align between this report and the dashboards due to filtering for privacy and rounding.

Analytical framework

Approach

The Socio-Economic Overview of the Northern Shelf Bioregion (NSB) seeks to describe the economic activity that is attributable to the proposed Network. Results are presented this way to provide direct comparisons for planners to better understand the activities within and in adjacent areas. These estimates are specific to the zone boundaries as provided in the technical scenario. Additional considerations related to vessel and business viability, supporting industries, and other sensitivity analyses will continue to be developed and made available prior to implementation.

Current activity and management measures

This section describes the existing regulatory and non-regulatory management measures in place, as well as the commercial fishing uses, with historic data used as a model for future use of the NSB and existing zones.

Fishing Activity

The waters of the NSB yield the majority of B.C.'s fishing harvest value, with the most active fisheries and several of B.C.'s most valuable fisheries (geoduck, crab, prawn, salmon seine, halibut, sablefish). Further description of the fishing activity is within the data section, which identifies the direct datasets used for this analysis. Additional high-level details and economic information are presented in the Ocean Sector Economy Report (Big River Analytics 2021).

Baseline years for this analysis vary by fishery. They are informed by feedback from industry experts and Fisheries and Oceans Canada (DFO) Fisheries Management staff and are presented below.

Existing zones

The MPA Network is evaluating 357 distinct areas within the NSB. 137 of these areas, representing over half of the total marine space within the proposed Network, are existing zones that are being incorporated 'where is, as is.' These existing areas vary in terms of their implementation and management and were established through a variety of federal and provincial regulatory, policy, and management tools. Some of these areas were only implemented recently, such as Hecate and Gwaii Haanas. Impacts associated with these zones are not attributable to Network implementation. Commercial fishing overlaps associated with these zones are presented as additional information to demonstrate the significance of spatial access changes to which the fishing fleets have recently had to absorb and adjust to.

Time frame

Data used is 2009-2018, varying by fishery, to describe the fishing activity that is overlapping the zones of the Network. Baselines will be updated over time to incorporate changes in fishing patterns of historic use.

Data Sources

Fisheries data overview - Logbooks

In the analysis, the main datasets are composed of individual fishing events (specific locations are described spatially as points, fishing on a set line or trawl/troll path as lines, or areas as polygons) or the most granular data available for fisheries. These points, lines, and polygons, which are plotted spatially, are generated directly from DFO commercial logbooks. Based on discussions with fishery advisory boards in 2016-2018 we have selected multi-year baselines to smooth out harvest cycles and have shortened some year ranges in order to reflect changes in fishery behavior (e.g., groundfish reaction to quota choke species).

Year ranges are the result of the most current and available processed spatial logbooks, and engagement with various DFO fishery advisory boards, fishing industry bilateral discussions, and advice from fisheries managers. Year spans are fishery-specific and are described in Table A- 1, below.

Each dataset is created from the unique data structure of each fishery, resulting in different datasets that require specialized methods and assumptions for spatial analysis.

Table A- 1. Fishing data table

Fishery	Year Range / data format	Reason for year range
• Salmons • Gillnet • Seine • Troll	10 years (2009-2018)	Most recently available.
	Pacific Fisheries Management subarea species harvest totals as polygons, RCAs removed for troll.	Captures multiple harvest cycles of stocks.
• Groundfish • H&L • Trawl • Trap	5 years (2014-2018)	Most recently available.
	Fishing Event Lines	Shorter period to reflect recent fisher responses to quota choke species
• Herring • Roe Seine • Roe Gillnet • SOK • F&B • Special use	5 years (2014-2018)	Most recently available.
	Stat Area Polygons	Shorter period to reflect changing balance of NSB vs rest of coast herring harvests.
• Shellfish Dive • Geoduck • Red sea urchin • Green sea urchin • Sea cucumber	9 years (2010-2018)	Most recently available
	Fishing Event Points	Captures 3 complete harvest rotations
• Shellfish Trap/ trawl • Prawn • Crab	10 years (2009-2018)	Most recently available
	Fishing Event Points	

Some small, experimental, and historic fisheries were also analyzed, but those results are not presented due to the negligible amount of overlap with the Network, and privacy concerns. Such fisheries include, euphausiid trawl, scallop trawl, dogfish (in recent years), and octopus dive.

Prices

Through ongoing communication with industry stakeholders, the main price source has been the 2018 Seafood Year in Review (SYIR) compiled by DFO, with added input and published by the Province of B.C (BC Ministry of Agriculture. 2018). and reviewed and adjusted by Gordon Gislason.

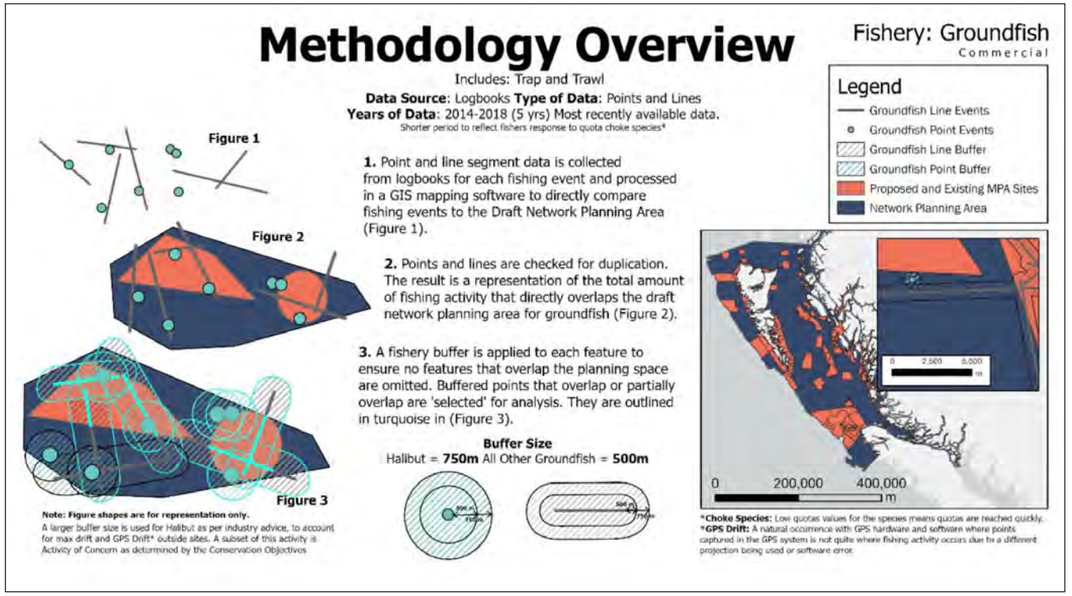
Methods – Overlap analysis

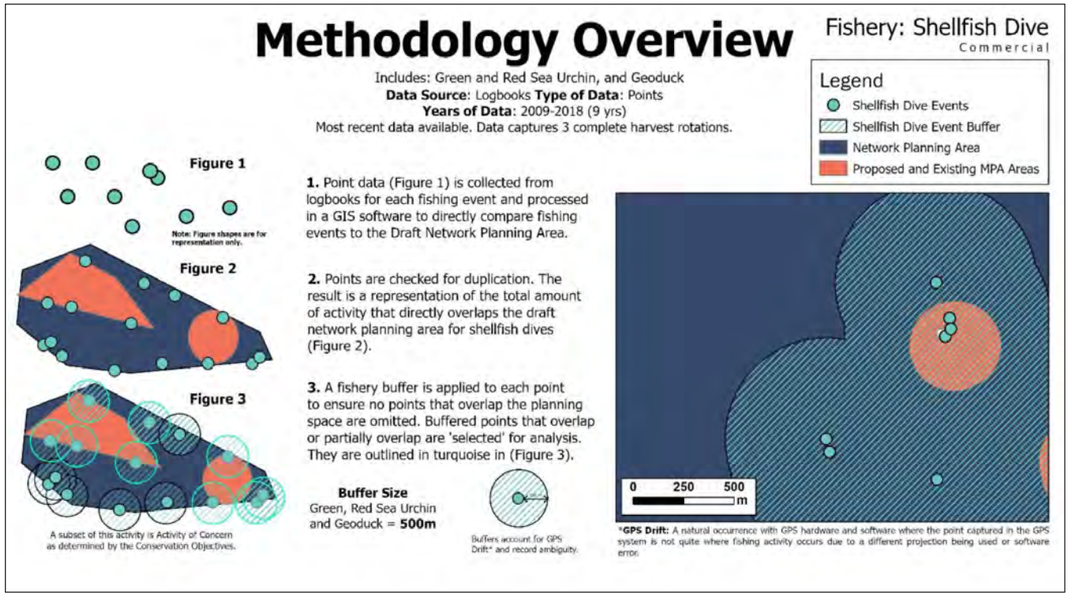
The first step of the analysis is a Geographic Information Systems (GIS) mapping exercise to visually discern and assess the spatial relationship between all retained fishery events and fishing areas, within the proposed zone boundaries described in the technical scenario prepared by Governance Partners.

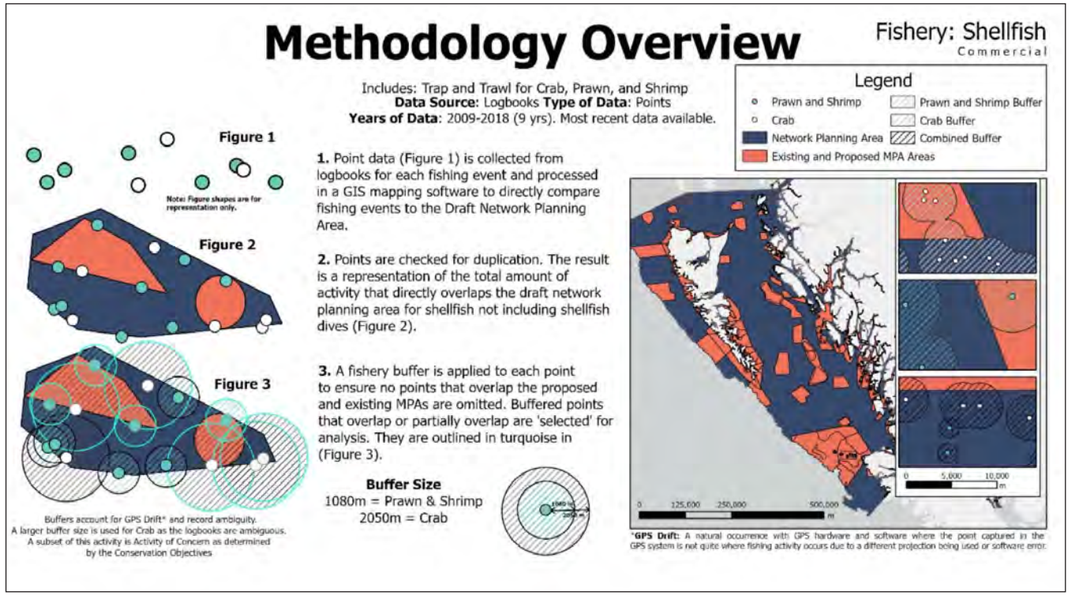
The fisheries with points and lines are loaded into the processing software (FME) and compared directly to the Network zones. A random duplication check is done, ensuring that each fishing event only be selected once. Results represent the current estimated total amount of fishing activity that directly overlaps the Network space for shellfish and groundfish fisheries. See the methodology overview diagrams below and further in this section for an illustration on this analysis process.

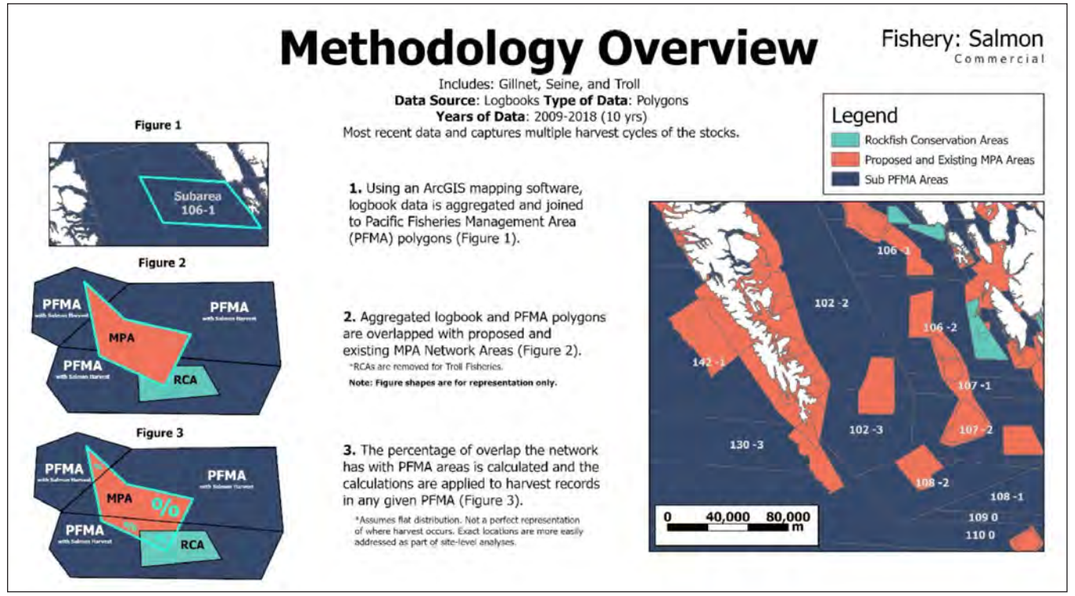
A fishery-specific buffer is then applied to each feature (point, line, polygon) to ensure that all features that may overlap the planning space are included. The buffers are to account for recording Global Positioning System (GPS) drift (the 'drift' is the difference between an actual location and the location recorded by a GPS receiver - this is a natural occurrence with any GPS hardware and software) and recording ambiguity (e.g., where a kilometre-long shrimp trawl event is represented by a point when it should be a line), as well as gear drift (in-direct harvesting gear movement activity).

A suite of fishery specific buffers, presented below in Table A- 2, were developed in April 2021. Initial review with fisheries managers, regional Oceans Advisory Committee (OAC) members, and commercial fishing sector representatives were conducted, with further discussion to refine buffers to occur.









Salmon logbooks are recorded at the Pacific Fisheries Management Area (PFMA) subarea level. To assess the amount of overlap from these fisheries, the percentage of the overlap the Network has with each subarea is calculated and then applied to the harvest records in those given areas. It assumes a flat or even distribution, which is not a perfect representation of where harvest actually occurs but is a reasonable extraction from the logbook data. Confirming exactly where activity may occur is more easily addressed as part of zone-level implementation processes.

Rockfish Conservation Areas (RCAs) currently already restrict salmon troll activity, with subarea harvest for that fishery applied evenly throughout the subarea, mirroring the process for salmon after cutting out any area that is part of an RCA.

Herring catch data have been transcribed into a grid (and displayed as polygons), which is similar to the presentation of 2016 filtered datasets on SeaSketch, and as was also used in earlier, previously presented versions of this analysis. The grid cells that occur within the Network provide the aggregated sum used for the analysis.

Table A- 2. Fishery buffers

Fishery	Selection Buffer (M)	Application Notes
Groundfish trawls – Line segment	500	Assess how much of each event overlaps proposed MPA Network, account for point recording inaccuracies.
Groundfish hook & line segment	500 750 for Halibut	Assess how much of each event overlaps proposed MPA Network, account for point recording inaccuracies. 750m halibut from industry advice to account for max drift in outside sites.
Salmon	n/a	Moved away from grid process, buffer no longer applicable due to subarea method.
Herring	500	Ensure to get grid cells (PUIDs) that are just outside of a given area.
Dive shellfish – points	500	Account for point recording inaccuracies.
Other shellfish – points	1080	Max gear drift and length from start to end of gear deployment.
Crab	2500	Logbooks are ambiguous to a large degree, to be supplemented with Electronic Monitoring Systems.

This analysis represents a current index of all commercial fishing activity falling within each zone in the proposed Network. Individual events are aggregated and averaged into annual mean results. The overlap result total is much larger than the anticipated number of activities of concern from the Network, since the majority of fishing activity tabulated, even if occurring in the proposed Network, is not identified as an activity of concern.

The main measures are the landed weight of species (kilograms) and their related 2018-adjusted Canadian dollars of landed value, as presented in the main report. To account for various anomalies, variations, drift, size, and/or non-location specific data, the selection buffers add approximately 7% of value to the total landed value estimates. The majority of this is in the sea cucumber fishery, where points are slightly offset onto land and need the buffer to include all the points that should be in the marine areas selected. The use of a selection buffer increases sea cucumber overlap with the Network by 44% due to the large number of points that fall on land in logbooks. For most fisheries the use of a selection buffer only increased their overlap with the network by 1-3%.

Limitations/caveats and other considerations beyond this analysis

1. Intertidal handpicking of shellfish: due to constraints of data availability this activity is not yet assessed but may be included as the planning process continues.

2. Inclusion of existing MPA/RCA – ‘as-is, where-is' zones (in Category 3): fishing overlaps may be identified that have occurred since their implementation but will not be impacted pursuant to implementation of the proposed Network. These events are often around RCAs and may be an example of fishers ‘fishing the line’ – the practice of increasing harvest intensity just outside of MPA boundaries to capture ‘spill over’ (targeted species moving outside MPA or other conservation zones). The buffers and ambiguity of spatial data sometimes cause this spillover catch to be erroneously identified as associated with an activity of concern. These elements contribute to the proposition that existing sites need to be presented and understood separately from those in Category 1 and 2.

3. Tuna: Tuna numbers are an estimate and not actual fishing events overlapping each site. Due to lack of specific fishing locations recorded in logbooks the location of fishing is ambiguous (may be up to hundreds of kilometres away from the start and end points of a trip, which is all the spatial information recorded in tuna logbooks). The tuna-fishing fleet has been active within the NSB approximately one year in every ten, with low average activity records. When active in the NSB, most of the harvest landed for sale or processing is still sourced from outside of NSB. Climate change, or movement of adjacent stocks dependent by or on tuna, may cause tuna to be encountered in the NSB more frequently in future.

   While ocean environmental conditions affect all species in varying ways, species response to elements such as changing water and temperature conditions due to, inter alia, climate change, or movement of adjacent stocks dependent by or on tuna may cause Tuna to be encountered in the NSB more frequently in future – and thus become an increasing portion of commercial harvest, with corresponding demand for better data.

   The United States – Canada Albacore Tuna Treaty (signed in 1981, amended in 2002, and codified in 2004) allows U.S. vessels to fish for albacore tuna in Canada’s EEZ and the 12-nautical-mile territorial sea, and vice versa. The treaty also allows Canadian vessels to use certain U.S. ports to obtain supplies and services and to land fish, and vice versa. In addition, the treaty calls for the exchange of fisheries data between the two national governments. The relevant consequences may result in a potential corresponding reduction of $15-20M of landed value by Canadian harvesters from US waters, per year, if the MPA Network impacts the treaty access by U.S. vessels. That is, if American vessels are excluded from any part of the Canadian territorial sea, even if the conservation goals are meant to ameliorate long-term stock sustainability, it may violate the current treaty and endanger the access to USA waters by Canadian vessels. Canadian vessels currently capture a large amount of tuna from USA waters, while the USA fleet captures relatively little in northern B.C. Deeper analysis on this possible overlap has not been conducted but remains a possible risk as induced repercussion of the proposed Network and pursuant zoning and management changes.

Harvester Profits

In order to assess the potential affected profits to the wild-harvest industry associated with an amount of landed value, profit margins as reported in Gislason (2020), which provide fishing revenues and net returns (EBITDA) by fishery, were used to estimate the profits associated with particular fishery harvest amounts in proportion – for example, the profits associated with harvest identified as activity of concern.

References

Big River Analytics. 2021a. “Economic Contribution Analysis for the Economic Contribution of the Oceans Sector in Coastal BC).” Prepared by Big River Analytics on behalf of B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Gislason, G. (2017). Linkages between Seafood Harvesting and Processing. Prepared for Fisheries and Oceans Canada. Available online: https://waves-vagues.dfo-mpo.gc.ca/Library/40652816.pdf. Last accessed November 17, 2021.

GSGislason & Associates Ltd.., “Linkages Between Seafood Harvesting and Processing”, Prepared for Canada Fisheries & Oceans, August 2017.

GSGislason & Associates Ltd., “Northern Shelf Bioregion MPA – Economic Impacts”, Prepared for BC Ministry of Agriculture, January 2020.

BC Ministry of Agriculture. 2018. “British Columbia Seafood Industry Year in Review 2018”, Prepared by BC with data from BC and DFO, 2018.

Appendix B. Seafood Processing Sector Analysis Methodology

Commercial fishing activity supports downstream processing activities that also contribute to coastal communities and the provincial economy. Processing sector activity often has separate locations of harvest and processing, with most of the harvest from the NSB being processed in the Lower Mainland and Southern Vancouver Island. Because of these disparate locations of activity, a variety of data sources are needed to describe this sector of the ocean economy.

Subregional net processing value estimates associated with commercial fishing overlaps

Subregional estimates for the net value of the seafood processing industry are presented within each relevant section in the main report. This includes net processed value of the subregional baseline harvest, and net processing value associated with harvest identified as activities of concern.

Wholesale Value

In order to assess the economic value to the processing industry of harvest occurring within the NSB, as well as interacting with the proposed MPA Network, processed value per kilogram was used, as reported and defined in the report "Linkages Between Seafood Harvesting and Processing" (GSGislason & Associates Ltd 2017). That report provided post-processing prices of annual harvest by species, which are consistent with those reported in the B.C. Seafood Year in Review,[16] which is a related resource that provides wholesale value of annual harvest by species. This wholesale value represents "the value of the fish after processing," while net wholesale value represents the value added to landed fish from processing and transportation. Using the estimated processed prices of commercially harvested species, a marked-up wholesale value of baseline and commercial harvest identified as an activity of concern associated with the proposed Network is provided.

Direct GDP and Employment

Estimates of direct GDP and employment attributable to seafood processing activity within the NSB are also presented within this report. However, while the above metrics can be associated with potential changes at the subregional level, estimates of effects on employment in the seafood processing sector cannot be attributed to specific subregions based on subregional harvest changes. This is because employment estimates come entirely from input-output models, which simply estimate and attribute a constant ratio of jobs to output in the sector for all of B.C. Thus, the distribution of these employment effects within the NSB subregions and their more defined boundaries is unknown and thus are presented at this high level only. The Ocean Economic Contribution Report by Big River Analytics details these NSB and province wide estimates.

16 Available online at https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/statistics/agriculture-and-seafood-statistics-publications

Assumptions and limitations

Wholesale values are computed based on estimated average processed prices for coastwide harvest by species as presented in marked-up prices presented in GSGislason (2017) which are, however, not NSB-specific since they reflect the coastwide average markup post-processing by species. Similarly, the estimates used for wage rates and labour intensity are computed as averages based on coastwide harvest and not specific to the NSB.

While efforts are undertaken to estimate the post-processing value of harvest specifically in the NSB, this processed or wholesale value would actually be realized in other areas of B.C. For example, as stated in the overview, the processing sector is highly concentrated in the Greater Vancouver Regional District (GVRD), with over 60% of the reported jobs in 2015 based in Greater Vancouver.[17] Much of the harvest from areas in the NSB is routinely transported out of or landed outside the NSB. However, applicable estimates of the distribution of harvest from the NSB to various processing locations were unavailable at the time of analysis. There are processing plants in the NSB that will likely feel more acute effects of reduced processing inputs than would southern counterparts who are more able to access other sources of seafood for processing inputs.

References

Big River Analytics. 2021a. "Economic Contribution Analysis for the Economic Contribution of the Oceans Sector in Coastal BC)." Prepared by Big River Analytics on behalf of B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Gislason, G. (2017). Linkages between Seafood Harvesting and Processing. Prepared for Fisheries and Oceans Canada. Available online: https://waves-vagues.dfo-mpo.gc.ca/Library/40652816.pdf. Last accessed November 17, 2021. Last accessed November 17, 2021.

GSGislason & Associates Ltd.., "Linkages Between Seafood Harvesting and Processing", Prepared for Canada Fisheries & Oceans, August, 2017.

GSGislason & Associates Ltd., "Northern Shelf Bioregion MPA – Economic Impacts", Prepared for BC Ministry of Agriculture, January, 2020.

17 2015 Statistics Canada Census data.

Appendix C. BC Tidal Recreational Analysis Methodology

The proposed MPA Network as described in the Network Action Plan (Chapter 2 and Appendix 1) overlaps many human uses in the NSB. A prominent use of marine space in the area is recreational fishing, which involves fishers participating in harvesting species for their own consumption and/or for recreational enjoyment. To estimate the amount of economic activity that could fall within the proposed Network, several data sources are combined. This appendix will provide information about those data sources and how they are used in this analysis.

Survey of Recreational Fishing in Canada

Fisheries and Oceans Canada (DFO) uses a variety of data products and analytical tools to estimate the market value of recreational fishing in the waters off the B.C. coast. The national Survey of Recreational Fishing in Canada (SRFC) provides statistically derived population estimates of recreational fishing activity (fishing days, catch, expenditures, etc.). For B.C., estimates were provided for both freshwater and tidal water recreational fishing. For the analysis, these provincial totals were then disaggregated into 7 subregions and 4 species groups (salmon, halibut, other groundfish/finfish, and shellfish). The monetized components of this estimated activity (i.e., direct expenditures and major purchases) were adjusted for inflation to 2018 figures. Table A- 3 lists the subregions used for the analysis, as well as the Pacific Fishery Management Areas (PFMAs) within each subregion.

Table A- 3. Subregions (and associated PFMAs) used to disaggregate SRFC provincial data

Subregion	Pacific Fishery Management Area (PFMA)
Haida Gwaii	1, 2, 101, 102, 130, 142
North Coast	3, 4, 5, 103, 104, 105
Central Coast	6, 7, 8, 9, 10, 106, 107, 108, 109, 110
Johnstone Strait	11, 12, 13, 111
Strait of Georgia	14, 15, 16, 17, 18, 19, 28, 29
Barkley Sound	20, 21, 22, 23, 121, 123
West Coast Van. Isl.	24, 25, 26, 27, 124, 125, 126, 127

DFO Pacific Internet Socio-Economic Analysis Survey (iSEA)

The Internet Socio-Economic Analysis survey (iSEA) is an annual survey conducted by DFO in the Pacific region to provide pertinent socio-economic information on fisher activity at the subarea level (a subarea is a subdivision of a PFMA). The survey asked roughly 16,000 licenced recreational fishers about various aspects of their activity in the 2019/20 season. Estimates of recreational fishing effort (fishing days) were then used to distribute expenditures estimated by the 2015 National Survey of Recreational Fishing in Canada to the subarea level. More recent results of the survey contain expenditure information, however as a result of COVID-19 survey results for the 2020/21 season are not representative of typical years and are thus not included in the present analysis. The survey will be repeated on a yearly basis, and post-covid years will be used to update analyses as they become available, ahead of and during Network implementation.

DFO Creel Survey

Creel survey[18] data does not provide socio-economic information, and the catch-and-activity estimates are of insufficient quality to support marine planning processes.

hile estimates of catch are available, coastwide coverage is irregular and not regarded as sufficiently representative of the region (e.g., there are no creel results for the B.C. central coast, even though recreational fishing in an important economic contributor to the region). For this reason, catch estimates from iSEA are used instead to calculate the distributed estimated angler activity from the Survey of Recreational Fishing in Canada (SRFC) across PFMAs.

Data integration process

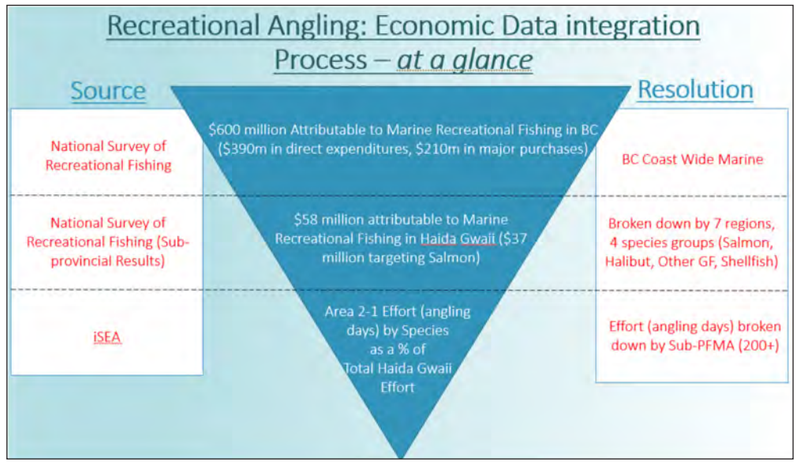
To integrate the subregional SRFC 2015 results with subarea-level activity, the results are distributed across PFMAs using iSEA 2019 fishing days by species group. The relevant socio-economic information (i.e., direct expenditures, major purchases attributable to fishing, fishing days) is then estimated at the subarea level by species group (salmon, halibut, other groundfish/finfish, and shellfish).

Using the combination of the iSEA estimates of effort and the subregional SRFC results, the proposed Network can be overlaid onto the baseline estimated activity. To assess the amount of overlap with recreational fisheries, the percentage of the overlap the Network has with each subarea is calculated and then applied to the species records in those given areas.

The figure below provides an overview of the data integration process. The subregional National Survey of Recreational Fishing results are distributed amongst the contained subareas using iSEA estimates of fishing effort by species group.

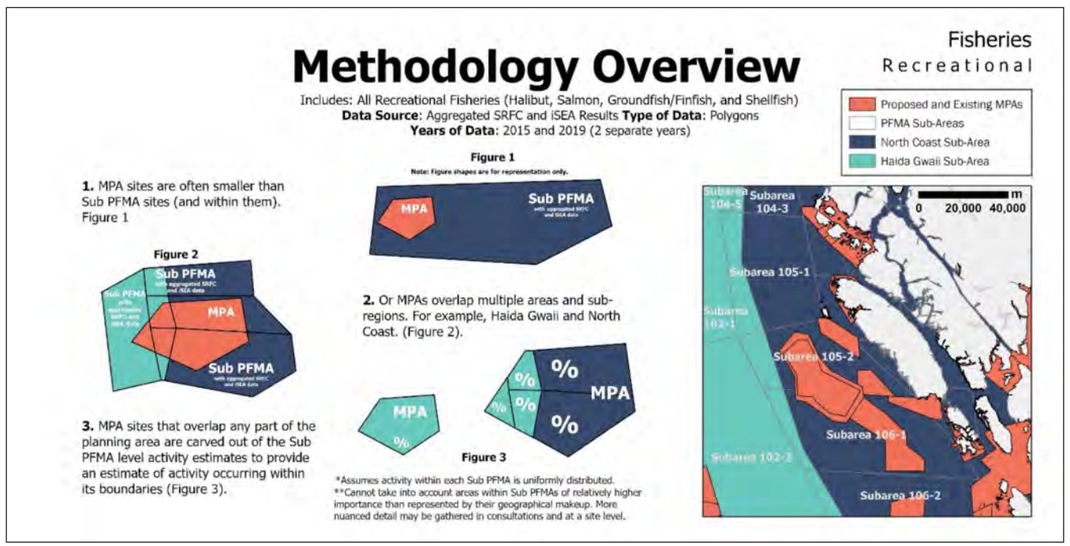
These results are further augmented based on the proportion of each subarea falling within the proposed site boundaries. This final step constitutes the estimated overlapped activity, assuming uniform distributions of activity across subareas (see Recreational Activity Overlap Analysis, below).

18 DFO uses “creel”, which refers to the wicker basket traditionally used for holding caught fish, to label the sport-fishing catch.



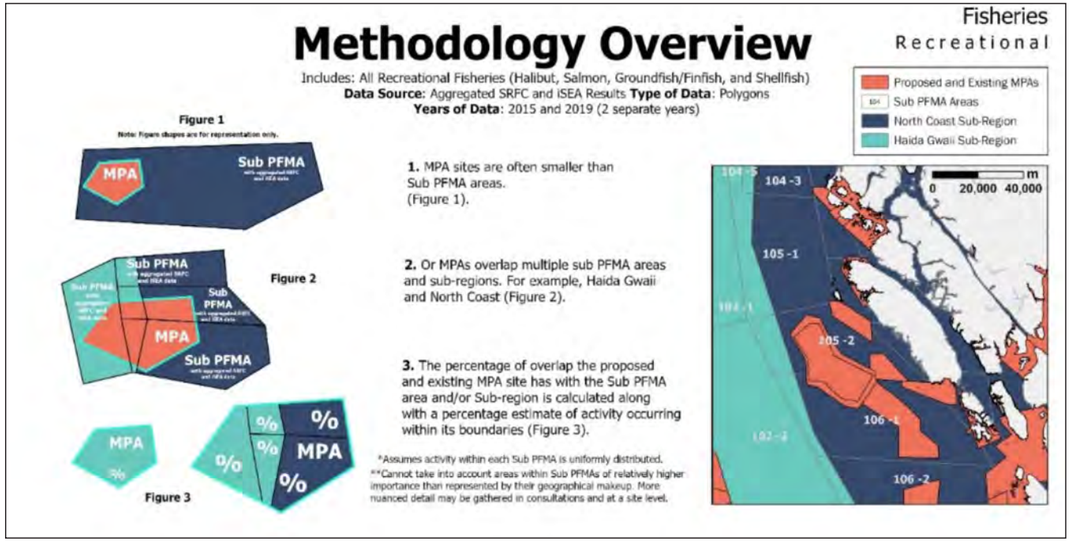
Recreational Activity Overlap Analysis

The proposed MPA Network zones are often smaller than a subarea and in some cases overlap multiple subareas. To determine the amount of activity overlapped by the proposed Network, the area covered by the Network is carved out of the subarea-level activity estimates to provide an estimate of the activity occurring within the Network boundaries. This constitutes the "overlapped" recreational fishing activity (as explained above and shown below). However, this method assumes the activity within each subarea is uniformly distributed. This artificially creates areas within subareas of equal importance due to geographical area makeup, but is not reflective of actual site activity and return given the methods used and availability of data. More nuanced detail on specific areas of relative importance may be gathered in consultations with stakeholders and at site-level discussions. Site-level data is assessed if it has been identified as an activity of concern.



Recreational Fishing Lodges, Charters, Guides – business activity estimation

Using iSEA we estimate the proportion of activity that was done privately or with a charter/lodge/guide under the baseline by species group and subarea. These baseline proportions are used to estimate the share of activity attributable to recreational fishing with lodges, charters, and/or guides.



Exclusion from Tourism and Other Non-extractive Recreation

Recreational activities in the NSB are plentiful and diverse, including kayaking, snorkeling, boating, sightseeing, walking/running/hiking, camping, and fishing. In many cases, recreational fishing is a part of other activities – e.g., many opt to fish recreationally while on a camping trip or boating trip. Participation in these outdoor recreation activities could thus be affected by restrictions on recreational fishing. It has been shown that the establishment of catch-and-release restrictions on recreational fishing has been shown to increase non-fishing related "other outdoor recreation" by 23% (Murphy et al, 2017), thereby introducing a possible increase in other outdoor recreation activities because of recreational fishing restrictions.

The recreational fishing activity expected to be affected by the proposed MPA Network includes activity attributable to recreational fishing tourists from outside B.C. and/or Canada. To present a breakdown of tourist fishing activity by NSB subregion, the distribution of activity by resident status is shown (i.e., B.C. residents, non-B.C. residents). This is available in the Socio-Economic Overview dashboards (available online at www.mpanetwork.ca/socio-economic-overview).

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Appendix D. Marine Ecosystem Service Model Introduction

The proposed MPA Network for the NSB is designed to protect specific ecological conservation priorities (E-CPs). These species, habitats, and other natural features provide a range of important biological services and associated socio-economic benefits to communities within and outside of the planning region. These benefits include, but are not limited to, many of those discussed in Section 3.1. To evaluate the role of MPAs in protecting and improving the flow of benefits to reliant communities, a Marine Ecosystem Service Model (MESM) was developed for application within the MPA Network planning process.

Enhanced protections afforded to E-CPs is expected to safeguard and bolster the delivery of key ecosystem services and underlying biological processes, thereby improving the wellbeing of the communities that depend on their provisioning (supply/quality). As previously discussed, however, many of these benefits are difficult to quantify, and often accrue over longer time horizons than do the costs of the proposed management changes. As such, many of these benefits risk not being considered by stakeholders and partners within the planning process, or by policy makers considering the costs and benefits of these proposed policy changes. The MESM is designed to fill this gap and is currently capable of estimating the provisioning of six ecosystem services (see below), incorporating both extent and relative contribution of specific E-CPs to each service, and under user-specified marine spatial planning (MSP) scenarios.

The model builds on existing open-source ecosystem service provisioning models produced by the InVEST Natural Capital Project at Stanford University (USA), as well as peer-reviewed research in the B.C. context to estimate the provisioning (supply/quality) of the following six unique ecosystems services in the marine environment (detailed further in this appendix):

1. **Carbon Sequestration (capture and retention) and Storage** – (kelps, eelgrass, and saltmarshes)
2. **Coastal Erosion Prevention** – (kelps, eelgrass)
3. **Water Quality Regulation** – (sponges)
4. **Marine Plant and Algae Production** – (general kelp, bull kelp, giant kelp)
5. **Food Production** – (fish; yelloweye)
6. **Recreation and Tourism Opportunities**

Provisioning of each service is estimated within separate sub-models (see table below), which are provided with sets of indicators. The main spatial inputs for each sub-model include contributing habitat or human-use extent, Network polygons, and study area and subregion extent. This spatial data is combined with sub-model parameters that represent the relative contribution of each habitat/human use to overall service provisioning, habitat disturbance assumptions that affect these contributions, and assumptions related to the effect of Network zones in mitigating these disturbances.

Each sub-model incorporates this information and produces estimates of different indicators representing ecosystem service quality or supply under the user-inputted model scenario. By comparing these indicators between Network design scenarios, this model may inform estimates of ecosystem service supply or quality given changes in spatial management.

Ecosystem Service	Sub-model Indicator
Carbon Sequestration and Storage	• Total carbon sequestered (tonnes, CO_2) • Total carbon accumulated (tonnes, CO_2)
Coastal Erosion Prevention	• % of study area shore points under (low/med/high) wind and wave exposure
Water Quality Regulation	• Volume of water filtered (litres)
Marine Plant and Algae Production	• Total production potential (tonnes, dry biomass)
Food Production (Outside Yelloweye)	• Total biomass in final period (kg) • Number of recruits in final period (#)
Recreation and Tourism Opportunities	• Total (weighted) recreational opportunities

Future improvements

Due to various constraints and limitations stemming from data availability and scoping of preliminary work, there are improvements planned for these sub-models that were not incorporated in this overview.

These improvements include producing more accurate representation of:

- contributing habitats and species,
- habitat quality,
- habitat stressors, and Network effectiveness in alleviating stressors.

There are also plans to expand on the MESM by incorporating additional sub-models for entirely new ecosystem services.

Ecosystem Services sub-model review

This section outlines each of the six ecosystem service sub-models. Sub-model descriptions include data inputs and outputs, model parameters and mechanics, and key assumptions and their implications. This information can be supplemented by the complete record of design produced by ESSA technologies, the model developers. In instances where models build off existing open-source ecosystem service models, model documentation may also be publicly accessed via their respective websites.

Carbon Sequestration and Storage – Kelps, eelgrass, and saltmarshes

Carbon dioxide (CO_2) is a heat-trapping gas produced both naturally and by human activity (from burning fossil fuels in power generation and transportation, and through impacts on land use and land use change). Carbon emitted through these processes either remains in the atmosphere or is absorbed by other organic matter. Oceans help to absorb carbon by storing it in organic matter (sediment, plants, and animals). This absorption is known as sequestration.

The retention and storage of carbon at a rate greater than the carbon released is referred to as a ‘sink’, and the ocean is the largest carbon-sink in the world, estimated to have absorbed roughly 40% of global CO_2 emissions since the beginning of the industrial era (Sabine et al., 2004; Houghton, 2007; DeVries et al., 2017; Krabbe et al., 2022). The contribution of coastal habitats to carbon sequestration and storage is also disproportionately large, considering that while the footprint of these habitats constitutes only 2% of overall ocean area, they account for nearly 50% of total carbon sequestered in ocean sediment (IUCN, 2017). The role of local carbon sequestration by marine flora also has direct implications for the health and existence of local fisheries. This is especially true where levels of ocean acidification (driven by increased marine carbon absorption) is a direct driver of fisheries vulnerability (Fabry et al., 2008; Ekstrom et al., 2015; Branch et al., 2013; Haigh et al., 2013).

Kelp forests also contribute to carbon sequestration, but to a lesser extent than other vegetated marine and coastal habitats due to the need for trapped carbon to accumulate in deep sea sediment. For the organic carbon within kelp to be sequestered, detached kelp must sink to be captured in sediment. Despite these differences, research indicates that macroalgae (including seaweeds and forms of kelps) are the largest marine net primary producer and could sequester as much as 173 teragrams (Tg)[19] of carbon a year, 88% of which is estimated to be sequestered in the deep sea (Krause-Jensen and Duarte, 2016). This estimate of the total amount of carbon sequestered annually by macroalgae is equivalent to the annual emissions required to power roughly 35.69M homes in Canada (NRCAN, 2022).

To evaluate changes in carbon sequestration and storage services due to changes in spatial management, the MESM leverages the existing InVEST Coastal Blue Carbon (iCBC) model (Stanford Natural Capital Project). The model quantifies the value of marine plant carbon storage and sequestration services within a study area under various habitat disturbance scenarios. The existing iCBC tool was expanded to allow the model to be confronted with alternative Network scenarios, under which variations in habitat disturbances can be produced. By comparing resulting outputs of the iCBC under alternative Network (and therefore habitat disturbance) scenarios, differences in disturbances are translated within the model to estimate resulting changes in carbon sequestration and storage rates by affected habitats.

The iCBC model outputs include spatial totals for net carbon sequestration, net present value of avoided emissions, and total carbon stocks over the model time-period (e.g., 25yrs). The model comprises two separate tools: 1) the blue carbon pre-preprocessor, and 2) the blue carbon calculator. The pre-processor amalgamates all inputted spatial layers to create a raster-based transition matrix that estimates changes in vegetation biomass based on changes in land/marine uses. The blue carbon calculator then uses this output to quantify carbon storage across the landscape/seascape using a simplified carbon cycle approach that sums the carbon stored in three main “pools”: biomass, litter, and soil, where the soil pool can also be used to represent marine sediments.

19 1 Tg equals 1 billion kilograms or 100 million tonnes.

The model estimates the effect of carbon pool disturbances (habitat disturbances) on total carbon storage and sequestration based on user-defined assumptions about the extent of disturbance, habitat-specific carbon accumulation rates, and habitat-specific carbon half-life values that are used as inputs to a carbon decay function. "Disturbances" within the model can be classified as high, medium, and low impact depending on the expected amount of biomass loss and the depth to which the soil/sediment profile will be altered.

MPA Network design scenarios are also incorporated into the model spatially, as habitat disturbance assumptions are modified in areas within site borders, leading to differences in total carbon sequestration and storage rates between scenarios. Consistent tabular and spatial results are produced across alternative model (Network designs, baseline) scenarios, facilitating this comparison.

Data Inputs

Spatial Layers

- Vegetation/organism extent (seagrasses, kelps, salt marshes, corals/sponges).
- Network polygons.

Model Parameters

- Carbon half-life; initial carbon stocks in each carbon pool (Mt CO2e/ha); biomass disturbance proportions for low, medium and high impact human uses; annual rate of carbon accumulation for each carbon pool.
- Assumptions about proportion of biomass inside/outside MPA borders that is disturbed by human activities.

Mechanics of Model

MPA Network spatial layer is overlaid with vegetation extent layer

- For habitats within network borders, the proportion of habitat affected by human disturbances is set to 0.
- All habitats outside zone borders are assumed to be impacted at a uniform rate (defined within configuration). Habitat disturbance assumptions are translated into reductions in annual sequestration by components.
- Within new MPAs, in areas with appropriate habitat characteristics for potential eelgrass expansion (depth, substrate) and no present habitat, emergence of new habitats is also modeled. Emerging habitats further contribute to carbon sequestration and storage services.

Outputs

Spatially explicit total carbon sequestration (t CO_2), accumulation and emissions (t CO_2) over model time-period, as well as total carbon stocks at the end of the time period (t CO_2).

- Accessible via geospatial software (e.g., QGIS, ArcGIS).

Tabular results depicting totals for key indicators mentioned above.

- Broken down by study area / user-defined sub regions.
- Accessible via Microsoft Excel.

Key Assumptions

1. All ecological component's (ECs) experience low-impact disturbances. If ECs are within site borders, disturbances shift from low to none. Disturbances are modelled as a one-time event to all contributing ECs outside MPAs at the end of the model simulation time-period.
2. If two or more ECs (e.g., eelgrass, bull kelp, giant kelp) are present in the same grid cell, the initial biomass and accumulation rates within the cell is calculated by the sum of these values between both components.
3. The sub-model uses average – not spatially variable – storage and sequestration (i.e., analysis regards an even distribution across an area, and not specific to actual sites).
4. Model assumes that an equilibrium in terms of spatial extent is already achieved inside current MPAs.
5. The habitat suitability model ESSA used to predict eelgrass growth areas only captures two of the parameters known to impact eelgrass habitat (depth and substrate).

Implication of Assumptions

1. Results reflect user-based assumptions of magnitude of habitat disturbance outside MPAs. Modelling disturbances is also coarse (two-level, inside-outside).
2. This may be inappropriate in areas where the presence of multiple components affects total biomass (potential) and accumulation rates in a synergistic (positive) or competitive (negative) manner.
3. Rates of storage and sequestration may vary along the coast due to regionally specific, ecosystem-specific, or habitat-specific factors.
4. Expansion of existing EC footprints is only modelled in new MPAs, making it impossible to model expansion of ECs within existing MPAs.
5. Related to modelling expansion of ECs in new MPAs, this is a very coarse model of prediction of habitat. Predictors could be added at a later date. It should be noted that this limitation extends to the coastal vulnerability model that also makes use of potential eelgrass habitats.

Marine Plant and Algae Production – General kelp, giant kelp, bull kelp

Kelp and other marine plants form elaborate habitats that support high levels of biodiversity, forming key habitats for many fish and invertebrates by providing shelter from predation. Material from these forests has also been shown to act as a key food resource for associated communities (Ramshaw et al., 2021), including those of commercial and recreational value (Vásquez et al. 2014). The protection of these key habitats is critical now more than ever, with global estimates indicating that kelp forest abundance has decreased at a rate of ~2% per year over the past fifty years (Wernberg et al. 2019), and with anthropogenic pressures being implicated as a major stressor (Filbee-Dexter and Wernberg, 2018).

To evaluate changes in potential marine plant/algae production arising from enhanced habitat protections, this work once again leverages the iCBC model. In addition to carbon storage, kelps and seagrasses provide materials that individuals and communities need for commercial, subsistence, and cultural-artistic

purposes. It is possible to evaluate the impact of different MPA configurations on the production of marine plant biomass that serves these purposes by using the iCBC model's *biomass* carbon pool (which focuses on above-ground biomass). To do so, the same approach is taken as in the carbon storage and sequestration sub-model, with only the impacts to above ground biomass carbon stock considered. Habitat-specific conversion factors are then used to translate original model outputs (in Mt CO_2e) to dry-weight biomass, by also incorporating rates of annual turnover (production/standing biomass) across the number of years simulated. In this way, reductions in habitat disturbances are translated into increases in marine plant production (potential) over the model period.

Data Inputs

Spatial Layers

- Vegetation/organism extent (seagrasses, kelps, salt marshes, corals/sponges).
- MPA egetation/organism extent (seagrasses, kelps, salt marshes, corals/sponges).

Model Parameters

- Same model parameters as the carbon sequestration and storage sub-model, but model only considers above-ground biomass pools (see above).
- Annual turnover rate is used in addition to translate MT Co2e into (annual) biomass production rates.

Mechanics of Model

MPA Network layer is overlayed with vegetation extent layer.

- For habitats within network borders the proportion of habitat affected by human disturbances is set to 0.
- All habitats outside zone borders are assumed to be impacted at a uniform rate (defined within configuration), habitat disturbance assumptions are translated into reductions in annual biomass production for impacted habitats.
- Within new MPAs, in areas with appropriate habitat characteristics for potential eelgrass expansion (depth, substrate) and no present habitat, emergence of new habitats is also modeled. Emerging habitats further contribute to total production potential.

Outputs

Spatially explicit marine plant production potential (tonnes, dry weight) over time period

- Accessible via geospatial software (e.g., QGIS, ArcGIS etc.)

Tabular results depicting totals for key indicators mentioned above

- Broken down by study area / user-defined sub regions.
- Accessible via Excel.

Key Assumptions

1. This model, like the carbon sequestration sub-model, leverages the iCBC model. The same assumptions apply as for carbon storage and sequestration.

Implication of Assumptions

See above.

Erosion Prevention – General kelp, giant kelp, bull kelp, and eelgrass

To evaluate potential changes in coastal erosion prevention arising from Network implementation, this work leverages the existing InVEST Coastal Vulnerability Model, which produces a coastal exposure index delineating stretches of coastline with relatively high, medium, and low erosion vulnerability based on geophysical and natural habitat characteristics. This model is adopted for the NSB context to understand how restrictions to marine plant harvest can benefit vegetated coastal ecosystems and allow for reductions in overall wind/wave exposure through expansion of those habitats.

The model computes an exposure index for each shoreline point, calculated as the geometric mean of scores assigned to seven biophysical input variables at that location: geomorphology, relief, natural habitats, wave exposure, wind exposure, surge potential, and sea level change. Variations in exposure are then generated across model runs (depicting Network design scenarios) where the contribution of natural habitats is affected by the restriction (or absence of restriction) of marine plant harvest.

Data Inputs

Spatial Layers

- Bathymetry, DEM, wind and wave exposure (WaveWatchIII global dataset), spatial polygon or rasters of vegetation/organism extent and potential habitat (eelgrass and kelp distribution), Network Polygons and activities of concern.

Model Parameters

- Maximum fetch distance (see record of design), radius around each shore point to compute average elevation

Mechanics of Model

A relative exposure index is created for every 1 km x 1 km shoreline point within the study area based on wave/wind exposure, and geographic (bathymetry) and other ecological relief data (eelgrass/kelp distribution). Network polygons (and associated activities of concern) are then overlaid, and habitats within areas that restrict human disturbances to contributing ECs (areas restricting marine plant harvest) are assumed to grow undisturbed over the time period, increasing their relative contribution to erosion prevention and modifying the exposure index of adjacent shoreline point. Within new MPAs, in areas with appropriate habitat characteristics for potential eelgrass expansion (depth, substrate), and no present habitat, emergence of new habitats is also modeled, contributing to further erosion prevention.

Outputs

- 1km spaced shoreline exposure index within planning subregions (can be classified as High, Med., Low for presentation purposes); total area of protective habitats within the MPA network.

Key Assumptions

1. The wind/wave exposure sub-model relies on Wave Watch III wind/wave information which is at a relatively coarse resolution (33 km x 33 km grid).
2. The impacts of all input variables (e.g., wind/wave exposure, relief, habitat) are equally weighted (e.g., if all have a score of 1 they are treated equally). Weighting is a feature that could be added in future.
3. The quality of habitat is not captured (only presence/absence).
4. The same habitat suitability model limitations as for carbon sequestration and storage, and marine plant/algae production apply here, as the spatial outputs from that model were also used to evaluate how eelgrass and kelp may expand in new MPAs.
5. Because the main change that MPA alternatives can affect in relation to coastal vulnerability is in protecting eelgrass and kelp habitat, this sub-model is not very sensitive to alternate MPA scenarios. However, there are some areas where we observed a minor impact.

Shoreline protection from other natural habitats is not accounted for.

Implication of Assumptions

1. This coarse granularity will reduce the overall accuracy of the model and may cause an over-or under-prediction of benefits depending on the true distribution of wind/wave exposure.
2. If habitat or other forms of geographic relief make a relatively larger (or smaller) contribution to erosion prevention than others, this model may under- (or over-) estimate their relative contribution to erosion prevention, and in turn under- (or over-) estimate the contribution of the habitats that we are interested in.
3. Relative habitat quality will likely also affect the degree to which they contribute to erosion prevention.
4. As mentioned above, the habitat suitability model employed by InVest is relatively coarse and may be updated in the future to more accurately predict suitable habitat. In its current form, it may over- or underestimate the emergence of new contributing habitats.
5. The main value in implementing this sub-model may be in delineating areas of more/less coastal vulnerability rather than comparing across MPA alternatives.
6. Saltmarshes are an example of a habitat that can contribute to coastal erosion prevention, but is not included at this stage.

Water Quality Regulation (Sponges)

Glass sponges play an important role in filtering water and removing carbon in the NSB. A study by Dunham et al. (2018) found that 19 reefs in the Salish Sea filtered a mass of water equivalent to the entire Strait of Georgia and Howe Sound every 100 days. In addition, the estimated carbon removal rate for sponges is comparable to carbon sequestration rates reported for terrestrial old growth forests and marine vegetation. However, anthropogenic activities such as fishing and other bottom-contact activities can physically damage glass sponge reefs directly, as well as impact them indirectly through sediment disturbance.

The water quality regulation sub-model is based on the work by Dunham et. al. (2018) to quantify water filtration rates for sponges, and the assumption that anthropogenic activities outside of protected areas cause harm to the organisms and reduce filtration rates. The MESM applies a reduced filtration rate (which can be specified in the configuration files) to areas outside of MPAs.

Data Inputs

Spatial Layers

- Spatially explicit Sponge habitat; Network polygons and associated activities of concern.

Model Parameters

- Carbon removal rate by sponges ($g/m^2/d$); Water Filtration Rate by sponges ($L/m^2/d$); Disturbance outside MPAs (%).

Mechanics of Model

- Spatial extent for contributing components (sponges) is overlaid with Network polygons. Habitats within zone borders are assumed to be undisturbed within the model period, while those outside the border are assumed to be affected by human disturbances, reducing their rate of filtration.

Outputs

- Spatially explicit (bound to sponge input layer) totals of water filtrated (L) over the study time period. Tabular totals are also produced.

Key Assumptions

1. The model assumes that all MPAs protect sponges from disturbance, regardless of management measures.
2. The MESM assumes all sponge reefs have uniform biomass and filtration rates.
3. The sub-model does not account for variations in quality of habitat or other physical factors (e.g., depth).
4. The distinction between different types of glass sponge reefs is not captured in the model.

Implication of Assumptions

1. While this can be refined at a later stage, this may over-state benefits to sponges in areas where current management measures don't restrict habitat-damaging activities.
2. Reef quality (intact/total biomass) will affect filtration rates of the habitat; this assumption therefore reduces overall model accuracy.
3. This may cause further inaccuracies within model estimates by not accounting for habitat quality (and therefore relative filtration ability), or by over-estimating protections offered to sponges in areas where habitat characteristics such as depth may cause these habitats to be subject to disturbances, regardless of Network implementation.
4. This reduces overall model accuracy by not being able to distinguish between the relevant species of sponge that may have differences in rates of filtration, or other relevant characteristics.

Food Production – Fish, yelloweye rockfish

Oceans are one of our greatest sources of food, globally. Wild fisheries and forms of aquaculture and mariculture currently account for roughly 17% of global production of edible meat (Costello et al., 2020; FAO 2020). Given the increased reliance on these practices for local food production in coastal communities, contributions to local diets in the NSB from the ocean are likely much higher. The importance of healthy marine ecosystems for food security is also increasing globally, with total food fish consumption increasing 122% between 1990 and 2018 (FAO, 2020). This implies a greater stress on an already critical resource for many communities and highlights the need for drastic actions to preserve a rapidly changing ecosystem.

Many fish and invertebrate species that are important for social, subsistence, economic, and cultural harvest practices in B.C. tidal waters are included in the proposed Network as conservation priorities. Their inclusion is based on the understanding that MPAs can be effective tools in stock rebuilding and can even be effective in the co-generation of benefits between fishery-reliant communities and conservation in considering larval and adult spillover of protected stocks into unprotected waters (Baetscher et al., 2019; Di Lorenzo, Claudet & Guidetti, 2016; Kerwath et al., 2013; Lenihan et al., 2021; Le Port et al., 2017; Qu et al., 2021).

The InVEST Fisheries production model is a single species age- or stage- structured, deterministic, population dynamics model (InVEST 2021). For pre-defined sub-units and study area, model users supply a set of input parameter values related to species life history, survival, and exploitation to estimate changes in total biomass harvested. This model is adapted within this work to configure the existing InVEST production model to estimate changes in stock biomass for yelloweye rockfish, while confronting the model with alternative Network designs in which zone-level activities of concern modify assumptions about exploitation of stocks. The model is therefore able to estimate changes in total stock biomass resulting from changes in spatial protections or human use management.

This model was also designed to simulate, at a very coarse level, how spatial protections of stocks can lead to increases in fish abundance outside of zone borders through larval dispersal. In the preliminary version of this model, larval dispersal is permitted between the subunits depicting Network zones of interest (see management measure discussion, below), with a 5 km buffer surrounding the zones. This larval dispersal allows for increases in fish abundance beyond the Network zones arising from increased larval dispersal from within the zones. Yelloweye, specifically, are understood to exhibit exponential increases in fecundity at older age-classes, leading to correspondingly exponential benefits in fish abundance given proper protection of the dispersed larvae. This mechanism has been added to the model to account for this important fact in life history and its resulting importance for spatial changes in fish abundance even beyond the borders of spatial protections. There are hopes of returning in the future to improve the accuracy of the assumptions currently used to model larval dispersal, including expanding dispersal beyond the 5 km buffer currently used.

The InVEST Fisheries model relies on the delineation of subregions within the study area. ESSA's implementation of the model bases subunits on Network borders and activities of concern. To simplify assumptions about exploitation, the model is currently only assessing changes in biomass within (and surrounding) zones considered "full protections" for yelloweye rockfish. "Fully protected" is defined as areas that have a combination of full restrictions to the gear targeting the species (currently parameterized for commercial longline and bottom trawl). This is also an important note for interpretation of results, as there could also be contributions to coastal yelloweye abundance from zones that have only one of these restrictions, in which case contributions would be partial and therefore more difficult to parameterize.

Within these "fully protected" areas, stock exploitation is set to 0 following Network implementation. The model then incorporates life history information of the species into the designated recruitment function (see ESSA record of design) to estimate total change in biomass within these areas, as well as larval dispersal to the buffered regions. These buffered regions, likewise, formulate changes in biomass within their borders over the study period, with the addition of an exploitation assumption for the stock and larval dispersal from the nearby protected areas.

Data Inputs

Spatial Layers

- Estimates of the number of total recruits (n) and biomass (kg), distributed across species extent layers; Network polygons and associated activities of concern.

Model Parameters

- Life history information for relevant species (age/sex classes, survival rates by sex, age); exploitation rate for inside MPA spillover areas; larval dispersal rate for dispersal to MPA spillover areas; % of mature individuals in each age class; % of each age class vulnerable to harvest; Ricker or Beverton-Holt a and b parameter values (max egg-to-adult survival, density dependence) and any adjustment parameters (e.g., to fecundity to represent influence of MPAs on size).
- OYE stock information taken from (Cox et al., 2020).

Mechanics of Model

- Spatial layer of all Network zones that afford complete protection to yelloweye (see list of activities of concern in config file) is overlaid with spatial layers of estimated number of recruits (n) and total biomass (kg) of the stock. In areas where full protection is afforded, harvest rates are set to zero. These stocks are then assumed to grow undisturbed over the model period, allowing for increases in unfished biomass and fecundity among older females. Specific life-history information for stocks is then incorporated, translating these reductions in harvest into estimates of increased of biomass, larvae production, and stock spillover (within buffer region).

Outputs

- Harvested biomass in over simulation period (kg), recruits in final year (n), biomass in final year (kg).

Key Assumptions

1. For “inside MPAs” we use the literature to assume a proportional increase in body size under spatial protection. For instance, Lester et al. 2009 estimate a 27% increase in individual body sizes inside temperate reserves (the time to achieve that body size increase varies with the life history characteristics of the species).
2. Fisheries closures for an MPA are assumed to have no effect on fishing activity outside the buffer area.
3. The “a” parameter in the Beverton-Holt relationship (that is proportional to fecundity and represents recruits per spawners at very low spawner number) is assumed not to change with area.
4. Peak Recruitment (Pr) for the Beverton-Holt stock-recruitment relationship (and thus the b value) is assumed to scale linearly with area, based on theories for carrying capacity and density dependence.
5. Fish larvae are assumed not to disperse beyond the MPA and buffer area.
6. Harvest does not change with changing fish biomass.

Implication of Assumptions

1. This parameter can be modified later, as our understanding of the impacts of spatial measures on fish sizes increases, as well as across species, as species other than yelloweye are added to the sub-model.
2. It is possible that the introduction of spatial restrictions within a zone border would increase the frequency and intensity of that activity outside of the zone, as activity is concentrated into outside waters. This dynamic is not captured in the model, which may cause an over-estimation of biomass increases if unprotected stocks experience an increase in fishing pressures.
3. One possible implication of this assumption is that differences in the limit to recruitment for an area (defined as “aK” in the Beverton-Holt model) between relatively small and large areas within the network may not be accurately reflected in the original version of the model. This relationship can be updated as our understanding of the relationship between area and recruitment is updated.
4. Non-linearities in these relationships would cause us to over- (or under-) estimate changes in stock biomass and number of recruits.
5. This assumption reduces the accuracy to which we can speak about stock spillovers or the final distribution of protected stocks. As our understanding of larvae and adult dispersal is improved, we will be able to better model these dynamics.
6. This may cause an underestimation of harvest in instances where fishing pressure increases in response to increases in fish abundance. This would in turn overestimate changes in biomass resulting from spatial protections.

Tourism and Recreation Opportunities

To evaluate potential changes in recreation and tourism opportunities following Network implementation, a quantitative representation of the quality of these opportunities was developed across the study area based on an assessment of cumulative impacts from other human uses, some of which can be affected by MPA configurations. This approach closely follows the methods introduced by Singh et al. , which overlay maps of recreational locations of use (e.g., kayaking, recreational boating) and access infrastructure (e.g., small craft harbors, ports, campsites) with maps of other human uses that may negatively impact those activities (e.g., log handling and storage tenures, marine pollution sites, commercial fishing areas, commercial marine traffic), and alters user-preference weights based on proximity to those impacting activities.

This approach produces a spatially explicit index of cumulative impacts, or tourism/recreation “quality.” The main difference between the approach applied in this work and that of Singh et al. (2020) is to introduce the influence of alternative MPA configurations by modifying the index, whereby modeled MPA management measures restrict identified activities of concern that could negatively affect recreational and tourism value.

Data Inputs

Spatial Layers

- Tourism/Recreation Assets: Dive sites, anchorages, small craft harbors, ports, coastal campsites, kayak routes, recreational boating routes, recreational fishing areas, recreational sites & features.
- Tourism/Recreation Impacts: Log handling storage locations, commercial fishing areas, marine pollution sites, vessel traffic density grid, shellfish harvest areas.
- Network polygons and activities of concern.

Model Parameters

- User-preference weights for recreation impacts. See Singh et al. (2020), Supplementary table S6.

Mechanics of Model

- Spatial layers of recreational use and competing activities (see tourism/rec impacts) are overlaid to produce spatialized estimates of relative recreational quality and cumulative impacts to these uses within the study area. This information is then combined with Network polygons (and associated activities of concern), and impacts are removed in areas where conflicting activities are restricted (and conversely, impacts are increased in areas where assets are restricted). Estimates of relative impacts produced to rec/tourism assets from competing activities are based on those from Singh et al. (2020).

Outputs

- 1x1 km grid of recreation opportunities (use intensity); 1x1 km grid of recreation quality based on cumulative impacts. Tabular totals are also generated.

Key Assumptions

1. All recreation/tourism impacts are weighted based on Singh et al. (2020) in the development of the composite impacts layer.
2. Some activities are both a recreation/tourism activity and an impact (e.g., recreational fishing).
3. The model cannot produce outputs by recreation activity type, only aggregate outputs for the combined opportunities/impacts layer.

Implication of Assumptions

1. Any new impacts that do not have weights available in Singh et al. (2020) will need to be parameterized.
2. This causes issues with running the sub-model across all recreational activities, as these conflating activities will generate both costs and benefits for users, which may net-out in model calculations.
3. This issue (as well as the one mentioned above) can be solved by modifying the weighting of each recreational activity prior to each model run (within configuration file). Setting a weight of 0 for all activities except one and running the model, then repeating for each activity in sequence could provide a relative contribution of each activity to overall recreation/tourism quality, and the relative change in quality for each use before/after Network implementation.

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Appendix E: Social and Economic Performance Measures

The social and economic performance measures (S-E PMs) were developed in parallel with the ecological, cultural, and administrative performance measures (PMs) in Compendium 2. Information presented in the Commercial and Community S-E PM sections supports the design guidance to consider the full range of human uses and values associated with the NSB. S-E PMs enable comparisons between Network design scenarios and the inclusion of a wide range of social and economic values into Network planning. Additionally, some PMs can inform Network goals 3-6, as referenced in the "Further PM Details" column. S-E PMs do not represent social and economic impacts to commercial sectors and communities, and do not replace or reduce the need for more formal benefit-cost analysis during implementation. The S-E PMs support the Governance Partner's ability to assess Network design according to the principle of maximizing the positive and minimizing the negative (Canada and B.C., 2014). Many of the S-E PMs are not directional and recognize the range of preferences possible for S-E PMs. Some will be reported both in the units described and as a proportion of activity overlap with the Network. S-E PMs can be calculated based on both overlap with an entire scenario footprint and the overlap with zones in which an activity is flagged as an activity of concern. In Compendium 3 we have focused on overlaps for activities of concern.

MPA Network PM Summary – Socio-Economic – Commercial Sectors

Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Commercial Fisheries • Groundfish • Shellfish by trap or trawl • Shellfish by dive • Salmon (data limitations noted) • Pelagics (data limitations noted)	**Overlap with Commercial fishing**	km² /%	X	X	Aggregated area of overlap between areas currently open to commercial fishing and the proposed Network design scenario sites, by fishery.	Area is one dimension for understanding interaction between a sector and proposed Network sites, other dimensions include number of businesses or individuals using a space (e.g.: # of vessels) and how intensely the space is used (e.g., effort, harvest).	Not currently reported, may be part of future socio-economic assessment(s).
	Overlap with landed value	$1000s/%	X	X	Aggregated landed value of fisheries catch from commercial fishing areas that overlap with the proposed Network design scenario zones.		Compendium 3, Tables: 4 (Northern Shelf Bioregion), 6 (Haida Gwaii), 8 (Central Coast), 10 (North Coast), 12 (North Vancouver Island).

MPA Network PM Summary – Socio-Economic – Commercial Sectors

Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Commercial Fisheries • Finfish Aquaculture • Shellfish Aquaculture	**Aquaculture zones (existing and proposed zones)**	# zones	X	X	The aggregated number of commercial aquaculture zones, including zones with tenure applications and existing licensed zones and tenures located within the proposed Network design scenario zones. This PM can also be reported by aquaculture type (finfish, shellfish, kelp).		Results in Report Card.
Commercial Fisheries • Seafood Processing	**Seafood Processing Employment**	Wage Income generated	X	X	The employment derived from processing of fish harvested from commercial fishing areas and aquaculture areas overlapping with the Network design areas.		Not currently reported, may be part of future socio-economic assessment(s).
	Seafood Processing Value	$1000s	X	X	The wholesale value from processing of fish harvested from commercial fishing areas and aquaculture areas overlapping with the Network design area.		Compendium 3, Tables: 4 (Northern Shelf Bioregion), 6 (Haida Gwaii), 8 (Central Coast), 10 (North Coast), 12 (North Vancouver Island).

MPA Network PM Summary – Socio-Economic – Commercial Sectors

Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Tourism Services • Recreational Fishing	**Recreational Fishing lodges**	#	X	X	Number of fishing lodges located in or within 1 km² of the proposed Network design scenario zones.	This is specific to addressing concerns around permitting issues within new MPAs and highlighting areas that could have regulatory concerns in the future.	Results in Report Card.
	Recreational fishing areas	km²	X	X	The area of overlap between important recreational fishing areas and proposed Network design scenario zones in aggregate and broken down by fishery.	Important recreational fishing areas interacting with activities of concern will be reported, as will all IRFA's overlapping with the Network.	Results in Report Card.
Tourism Services • Non-fishing	**Ecotourism Opportunities**	# zones	X	X	The number of "High Value Commercial Tourism Areas" (HVCTA) within the proposed Network design scenario zones.	Non-extractive tourism is an important economic driver on the coast. This analysis will focus on the areas of interest to tourism and rec users that fall within the Network. HVCTA data is from 2013 MaPP plans, additional high value areas may be available in stakeholder submissions.	Results in Report Card.
	Recreational Tenures	% overlap with Network	X	X	The portion of marine recreation tenures that overlap with proposed Network sites.	This data can be reported for both fishing camps and non-extractive/ecotourism uses.	Results in Report Card.

MPA Network PM Summary – Socio-Economic – Commercial Sectors

Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Forestry	**Forestry operation sites**	#	X	X	The number of forestry operation sites in the marine environment (active and past/potential future*) within Network scenario. **where data exists and has been made available, noting that datasets identifying past and potential future forestry operation sites in the marine environment are not comprehensive throughout the planning area.*	Differentiation between heli-drop zones and other log-handling operations will be made where supporting data is available.	Results in Report Card.
	Area of forestry operation sites affected	km²	X	X	The area of forestry operation sites in the marine environment (active and past/potential future*) within Network scenario. **where data exists and has been made available, noting that datasets identifying past and potential future forestry operation sites in the marine environment are not comprehensive throughout the planning area.*	Area of affected sites can be an indicator of how significant an operation is, as well as its potential impacts to the surrounding environment. This PM can also be expressed as a ratio of sites falling within the Network compared to the total footprint of marine forestry activities.	Results in Report Card.

MPA Network PM Summary – Socio-Economic – Commercial Sectors

Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Forestry	**Potential future use areas**	#		X	The amount of overlap between the Network scenario and potential future logging use areas not identified as low risk to closure (i.e., areas with high future logging use value).	Forestry is an industry that is highly temporally variable. Existing and past tenures data does not include all the sites that are needed to actively harvest the coastal land base. The potential future use PMs is calculated using a data layer built to try and address the concerns around the temporal nature of forestry.	Subregional results in Report Card.
Shipping & Transportation	**High density large vessel traffic**	% and # zones	X	X	The amount of overlap between the Network scenario and a data layer representing high density large vessel traffic.	Could be further refined based on pending discussions with Transport Canada and industry.	Results in Report Card.
	Presence of vessels (by vessel type)	# zones	X	X	Number of zones in Network scenario with large vessel traffic, broken down by vessel type. Examples of potential vessel types include: • Ferries, • Passenger vessels (e.g., Cruise Ships), Container Ships, Tugs	To be further refined based on pending discussions with Transport Canada and industry.	Not Advanced.

MPA Network PM Summary – Socio-Economic – Commercial Sectors

Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Marine Renewable Energy	**Number of renewable energy sites**	#	X	X	This PM reports the number of tenures, application for tenures, and within the proposed Network design scenario zones.	As there are no activities of concern flagged within this sector, it will be presented in aggregate in the Report Card, however data are available for tidal, wind, and wave power generation and will be carried forward for consideration during zone-based discussions.	Results in Report Card.

MPA Network PM Summary – Socio-Economic – Community Interests

Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Scientific Research, Education & Awareness	**Research facilities and programs**	#	X		This PM reports on the # of research facilities and programs located within 1 km² of the proposed Network design scenario zones. Research facilities and programs include formal institutes, established base camps, and community-based monitoring programs.	Linkages to Goal 6: To provide opportunities for scientific research, education, and awareness.	Report pending availability of data.

MPA Network PM Summary – Socio-Economic – Community Interests

Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Commercial fishing harvest landed in the NSB • Groundfish • Dive Fisheries • Shellfish by trap and trawl	**Landing Location of Commercial Harvest**	% of catch landed	X	X	The percentage of catch landed in NSB that was harvested in Network zones. This PM can only be reported for fisheries where the data allow us to directly estimate the potentially affected fishing events – otherwise the landing location would be based on general relationships and wouldn't vary by siting of MPAs. (e.g., salmon).	Not all harvest from the NSB is landed within the region's communities. This PM is intended to show the interaction between harvest from proposed Network zones and communities in the NSB which may have fewer economic opportunities to absorb fishing restrictions than southern landing locations such as the Greater Vancouver Area. This PM requires protecting the confidential information of both fishing vessels and buyers. It is expected that this will be achieved by aggregating the data within the proposed fishery groupings and reporting landings by subregion. For crab, prawn, and shrimp fisheries the sales slip database is the main source of information about landing location. For the reference period, this means landing location for X% of catch is known, and this is assumed to be the overall distribution of landings in B.C. (i.e., it is assumed there is no spatial bias in the sales slips that aren't submitted).	Not currently reported, may be part of future socio-economic assessment(s).

MPA Network PM Summary – Socio-Economic – Community Interests							
Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Infrastructure	**Municipal and Marine Infrastructure**	#	X	X	This PM reports the number of facilities related to municipal and marine infrastructure, by facility type in or within 1 km² of the proposed Network design scenario zones. Marine and municipal infrastructure can create many types of interactions with the MPA Network, including creating access, highlighting important recreational uses, detailing safety implications, and indicating high-traffic and use areas.	Facilities can include Ferry Terminals, Coast Guard Stations, Anchorages, boat launches, Harbour Authorities, Major Ports, Small Craft Harbours, manned lighthouses, search and rescue areas. Where feasible this PM will be disaggregated between the different types of infrastructure and included in zone level discussions.	Results in Report Card.
	Fuel Services	#	X		This PM reports the number of fuel services within 1 km² of the proposed Network design scenario sites.	Fuel services are important infrastructure for recreational users of MPAs and will influence how people are able to access the marine parks. They are also potential point source pollutants.	Results in Report Card.
Recreation	**Recreational Fishing**				The recreational fishing areas PM developed for the Tourism – Recreational Fishing (see previous table) will be used as a proxy for non- commercial community recreational fishing activities.		Results in Report Card.

MPA Network PM Summary – Socio-Economic – Community Interests							
Sector	Performance Measure						
	Name	Units	Geographic Scope		Description	Further PM Details	Reporting mechanism
			Bioregion	Subregions			
Recreation	**Recreation Facilities/ Sites**	#	X	X	The number of recreation facilities and sites (e.g., boat launches, marinas, provincial campgrounds, resorts, coastal camping sites, mooring sites, anchorage areas) that are located in or within a specific distance (1 km²) of the proposed Network design scenario sites.	Recreation sites and facilities supports goal 3, maintain and facilitate opportunities for tourism and recreation.	Results in Report Card.
	Recreation Routes/ Features	#	X	X	The number of recreation routes (e.g., kayak, boating, etc.) and recreation features (e.g., recreation reserves, dive sites, etc.) that are located within the Network design scenario sites.	Recreation sites and facilit. ies supports goal 3, maintain and facilitate opportunities for tourism and recreation. The PM can also be broken out into kilometres of overlapping recreation routes and the number of recreation features.	Results in Report Card.

Appendix F: Scenario P3 Socio-Economic Performance Measures Report Cards

This appendix details the results of Socio-Economic Performance Measures Analysis as described in the tables within Appendix E. The following tables present NSB and subregional overlaps of socio-economic datasets that have been previously identified as having marine spatial planning value to stakeholders and planners. Descriptions and interpretations are found below each table. Commercial Fishing PMs are presented in the NSB and subregional overlap tables in the main body of this overview.

Interpreting Socio-economic Performance Tables:

NSB Presence – Amount of a given feature or dataset that occurs within the NSB, with NSB totals and subregional breakdowns presented. For example, the NSB contains approximately 133,848 km² of marine space. Of this, the Haida Gwaii subregion contains 48,307 km² (42.4% of the total).

Overlap with all zones – Amount of a given feature or dataset that occurs within the boundaries of the proposed Network, including Category 1, Category 2, and existing MPA/RCA – 'as-is, where-is' zones. For example, 7,761 km² of important groundfish recreational fishing areas (44.6% of the total in the NSB) overlap with sites in the proposed Network. NVI has the most overlap, with 2,692 km² of these areas (15.6% of the NSB total) overlapping with proposed and existing Network sites in the subregion.

Activity of concern – For activities that could have negative consequences for the E-CPs and associated conservation objectives of Category 1 zones, the amount of a given feature or dataset that falls within the boundaries of these zones. For example, 327 km² of important groundfish recreational fishing areas (1.9% of the NSB total) is identified as an activity of concern in Category 1 zones in Haida Gwaii.

E.1 Important Recreational Fishing Areas

Measure	Fishery	HG	NVI	CC	NC	NSB Total
NSB Presence, km² (% of NSB)	NSB Marine Space (km²) -DFO Grid	48,307 (42.4%)	17,022 (15.0%)	24,810 (21.8%)	23,709 (20.8%)	113,848
	All Groundfish	3,227 (18.8%)	5,872 (34.1%)	2,577 (15.0%)	5,532 (32.1%)	17,208
	All Shellfish	1,424 (22.5%)	3,765 (59.6%)	354 (5.6%)	779 (12.3%)	6,322
	All Salmon	3,218 (18.1%)	6,207 (34.9%)	2,155 (12.1%)	6,221 (34.9%)	17,801
	All Tuna / Other	0 (0%)	3,868 (76.7%)	1,136 (22.5%)	40 (0.8%)	5,044
Overlap with all sites, km², (% of NSB)	All Groundfish	1,827 (10.6%)	2,692 (15.6%)	1,259 (7.3%)	1,893 (11.0%)	7,671 (44.6%)
	All Shellfish	792 (12.5%)	2,080 (32.9%)	223 (3.5%)	167 (2.6%)	3,262 (51.6%)
	All Salmon	1,828 (10.3%)	2,763 (15.5%)	1,262 (7.1%)	2,477 (13.9%)	8,330 (46.8%)
	All Tuna/Other	0 (0%)	970 (19.2%)	1,136 (22.5%)	0 (0%)	2,106 (41.8%)

Measure	Fishery	HG	NVI	CC	NC	NSB Total
Activity of Concern, km² (% of NSB)	All Groundfish	327 (1.9%)	952 (5.5%)	1,071 (6.2%)	499 (2.9%)	2,849 (16.6%)
	All Shellfish	147 (2.3%)	21 (0.3%)	166 (2.6%)	16 (0.3%)	350 (5.5%)
	All Salmon	258 (1.4%)	991 (5.6%)	874 (4.9%)	530 (3.0%)	2,653 (14.9%)
	All Tuna/Other	0 (0%)	1 (0.0%)	0 (0%)	0 (0%)	1 (0.0%)

Description: This table describes overlap of IRFA (separated by target species) with the NSB, the proposed Network, as well as area associated with activities of concern.

Interpretation example: All Shellfish portion of the survey has 1,424 km² of space overlapping the NSB (22.5% of the total NSB space within the Important Recreational Fishing Areas in the survey). Compared to the network, the survey shows 831 km² of space (13.1% of total NSB survey presence) overlap, and 143 km² (2.3%) of space associated with activities of concern.

Technical Description: The Important Recreational Fishing Area Survey data (DFO & SFI 2017, available on SeaSketch) is a compilation of more than 600 polygons indicating the respondent's (experienced B.C. anglers, guides, and lodges) understanding of areas that are important to local recreational fishing. This survey is not an exhaustive inventory of recreational important fishing areas in the B.C. Territorial Sea. The survey was placed on the 1 km x 1 km DFO planning grid and overlapped with the proposed Network scenario.

Notes on Data: The source data for this layer is posted on SeaSketch under Uses and Activities: Recreational Fishing Mapping Survey. Metadata can be accessed through SeaSketch (right click on layer > View description).

E.2 High Density Vessel Traffic Areas

Measure	HG	NVI	CC	NC	NSB Total
All Vessels, no fishing or rec vessels, Top 20% Vessel Traffic Area (km²), **NSB Presence**	2,703 (18.5%)	4,179 (28.5%)	2,431 (16.6%)	5,335 (36.4%)	14,648
All Vessels, no fishing or rec vessels, Top 20% Vessel Traffic Area (km²), **Overlap with all sites**	288 (2.0%)	1,000 (6.8%)	1,051 (7.2%)	1,217 (8.3%)	3,556
All Vessels, no fishing or rec vessels, Top 20% Vessel Traffic Area (km²), **activity of concern**	No activity of concern can be highlighted at this point in the planning process related to vessel traffic.				

Description: This Performance Measure is based on the amount of overlap between the proposed Network scenario and a data layer representing high density large vessel traffic in the B.C. EEZ (2012-2015). An area is considered High Density if it falls within the top 20% densest grid cells.

Interpretation: Haida Gwaii has a total of 2,703 km of the top 20% Vessel Traffic of the B.C. EEZ within the subregion. 288 km² (2.0% of NSB footprint) is overlapping the proposed Network sites in Haida Gwaii.

Technical Description: To identify areas representing the top 20% of intensity of large vessel transits, times were summed for vessel classes included, the values were normalized using the natural log function to reduce the skewed distribution of the data, and 20% of cells (those with the highest values) were extracted for this dataset.

See TR-NEMEs for more information on base NEMEs data.

Notes: The source data for this layer is posted on SeaSketch under Uses and Activities > Shipping Transportation. Metadata can be accessed through SeaSketch (right click on layer, view description).

E3. Annual Hours of Vessel Presence

Vessel Presence Category	HG	NVI	CC	NC	NSB Total
All Vessels, no fishing vessels, Annual Mean Hours of Presence, **NSB Presence**	66,688.4 (13.7%)	175,207.3 (36.0%)	94,380.2 (19.4%)	151,056.5 (31.0%)	48,7332.4
All Vessels, no fishing vessels, Annual Mean Hours of Presence, **Overlap with all sites**	12,408.4 (2.5%)	39,539.3 (8.1%)	44,967.4 (9.2%)	22,497.3 (4.6%)	487,332.40
All Vessels, no fishing vessels, Annual Mean Hours of Presence, **activity of concern**	No activity of concern has been identified for vessel transportation at this time.				

Description: This Performance Measure is based off the historical annual hours of vessel presence, in aggregate as well as by vessel type, in the B.C. EEZ (2012-2015 data), applied to the Network scenarios.

Interpretation: Haida Gwaii has an average of 66,688.4 hours of mean annual hours of presence in the subregion of vessels with AIS Satellite receivers (excluding fishing vessels). This represents 13.7% of all tracked vessel time in the NSB.

Technical Description: The data consists of a marine grid that covers the entire B.C. EEZ and includes measures of vessel presence. Data used were satellite AIS data, provided by exact Earth Ltd. 2018, and processed courtesy of MEOPAR, NEMES and the Institute for Big Data Analytics at Dalhousie University. Traffic intensity was provided for 27 classes of vessels. See below for original NEMEs categories and category aggregation, and caveats.

These NEMES data were shifted into the NSB planning unit grid by the Governance Partners, and values represent an index of total time of transit in each planning unit over a 4-year period (2012-2015). The accuracy of the data in the shifted grid is approx. +- 300m N/S and +-140m E/W. 57% of each grid cell accurately represents the source data.

AIS is only required on vessels that operate far from the coast; some vessels may opt into the system for safety reasons. Several vessel categories have vessels that are active in the B.C. EEZ but do not carry AIS equipment, thus their activity will not be reflected in these NEMEs datasets. This is especially relevant for Recreational and commercial fishing vessels, where a majority of those vessels active in the B.C. EEZ each year would not be represented in the datasets due to not being required to carry them.

Notes: The source data for this layer is posted on SeaSketch under Uses and Activities > Shipping Transportation. Metadata can be accessed through SeaSketch (right click on layer, view description).

E4. Public Recreation Features

Row Label	Feature Type	HG	NVI	CC	NC	NSB Total
NSB Presence, Count (% of NSB)	Anchorages	123 (10.5%)	463 (39.4%)	274 (23.3%)	316 (26.9%)	1,176
	Coastal Campsites	77 (23.2%)	204 (61.4%)	30 (9.0%)	21 (6.3%)	332
	Dive Sites	34 (8.5%)	247 (61.6%)	44 (11.0%)	76 (19.0%)	401
	Kayak Routes	382 (51.0%)	145 (19.4%)	86 (11.5%)	136 (18.2%)	749
	NVI Marine Trails	0 (0%)	247 (98.4%)	4 (1.6%)	0 (0%)	251
	Rec. Boating Routes	268 (14.0%)	856 (44.7%)	553 (28.8%)	240 (12.5%)	1,917
	Rec. Features	24 (6.7%)	279 (77.5%)	15 (4.2%)	42 (11.7%)	360
	Rec. Sites	6 (5.2%)	85 (73.3%)	6 (5.2%)	19 (16.4%)	116
Overlap with all zones, Count (% of NSB)	Anchorages	92 (7.8%)	182 (15.5%)	184 (15.6%)	149 (12.7%)	
	Coastal Campsites	47 (14.2%)	69 (20.8%)	22 (6.6%)	7 (2.1%)	
	Dive Sites	33 (8.2%)	98 (24.4%)	29 (7.2%)	43 (10.7%)	
	Kayak Routes	356 (47.5%)	73 (9.7%)	77 (10.3%)	74 (9.9%)	
	NVI Marine Trails	0 (0%)	40 (15.9%)	2 (0.8%)	0 (0%)	
	Rec. Boating Routes	219 (11.4%)	320 (16.7%)	397 (20.7%)	97 (5.1%)	
	Rec. Features	12 (3.3%)	35 (9.7%)	0 (0%)	2 (0.6%)	
	Rec. Sites	2 (1.7%)	1 (0.9%)	0 (0%)	0 (0%)	
Activity of Concern, Count (% of NSB)	Anchorages	0 (0%)	9(0.8%)	0 (0%)	0 (0%)	
	NVI Marine Trails	0 (0%)	3 (1.2%)	0 (0%)	0 (0%)	
	Rec. Boating Routes	0 (0%)	16 (0.8%)	0 (0%)	0 (0%)	
	Rec Features	0 (0%)	2 (0.6%)	0 (0%)	0 (0%)	

Short Description: Various provincial and NSB datasets, collected by MaPP and further updated with crown tenures, provides a breakdown of how several recreational features overlap and interact with the proposed Network. Activity of concern features that are not listed in the table have zero feature overlaps with Category 1 zones, or the activities associated with those features require further discussion and planning.

Interpretation Example: There are 123 (10.5 % of NSB) anchorages overlapping the proposed Network in Haida Gwaii, with 92 anchorages falling inside the border of proposed Network zones (7.8% of NSB anchorages). None of these anchorages are currently associated with activities of concern.

Technical Description: This is a mix of B.C. provincial data and MaPP enhanced data, taking the same basic features found in the B.C. data and adding significant details on feature attributes. For example, Rec Features and Rec Sites is basically the same point dataset for the NSB, where Rec Features is the coastwide provincial data, and Rec sites is MaPP enhanced points with several attributes noting site-level activities and infrastructure. Rec Features should be considered the better representation of coastwide features, but Rec Sites can provide valuable zone-level information. A third recreational feature type is High Value Rec Tourism Areas, as identified by the Wilderness Tourism Association of B.C. in 2008. These represent especially valuable areas to non-extractive tourism.

From the PM Summary Table: The number of recreation facilities and sites (e.g., boat launches, marinas, provincial campgrounds, resorts, coastal camping sites, mooring sites, anchorage areas) that are located in or within a specific distance (1 km²) of the proposed Network zones.

E5. Municipal and Marine Infrastructure

Measure	Infrastructure Type	HG	NVI	CC	NC	NSB Total
NSB Presence, Count (% of NSB)	Marine Industrial Sites	201 (20.2%)	261 (26.3%)	65 (6.5%)	467 (47.0%)	994
	Boat launches	14 (19.7%)	40 (56.3%)	6 (8.5%)	11 (15.5%)	71
	Eco-tourism lodge	2 (10.5%)	14 (73.7%)	2 (10.5%)	1 (5.3%)	19
	Marina	3 (8.6%)	23 (65.7%)	4 (11.4%)	5 (14.3%)	35
	Private dock	0 (0%)	2 (100%)	0 (0%)	0 (0%)	2
	Public wharf	6 (20%)	14 (46.7%)	2 (6.7%)	8 (26.7%)	30
	Public wharf TC	1 (10%)	4 (40%)	4 (40%)	1 (10%)	10
Overlap with all zones, Count (% of NSB)	Marine Industrial Sites	1 (0.1%)	27 (2.7%)	10 (1.0%)	5 (0.5%)	
	Boat launches	1 (1.4%)	1 (1.4%)	1 (1.4%)	0 (0%)	
	Eco-tourism lodge	0 (0%)	3 (15.8%)	2 (10.5%)	0 (0%)	
	Marina	0 (0%)	3 (8.6%)	0 (0%)	0 (0%)	
	Private dock	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
	Public wharf	1 (3.3%)	1 (3.3%)	0 (0%)	1 (3.3%)	
	Public wharf TC	0 (0%)	1 (10%)	1 (10%)	1 (10%)	
Activity of Concern, Count (% of NSB)	Marine Industrial Sites	0 (0%)	5 (0.5%)	7 (0.7%)	3 (0.3%)	
	Boat launches	0	0	0	0	
	Eco-tourism lodge	0	0	0	0	
	Marina	0	0	0	0	
	Private dock	0	0	0	0	
	Public wharf	0	0	0	0	
	Public wharf TC	0	0	0	0	

Measure	Infrastructure Type	HG	NVI	CC	NC	NSB Total

Short Description: This PM reports the number of facilities related to municipal and marine infrastructure, by facility type in or within 1 km² of the proposed Network design scenario zones.

Interpretation Example: 201 (20.2% of NSB) Marine industrial sites are present in the Network planning area, 0 (0%) are overlapping the proposed Network in Haida Gwaii, and 0 (0% of NSB) of those marine industrial sites are associated with activity of concern.

Technical Description: Municipal and marine infrastructure: Various provincial and NSB datasets, collected by MaPP and further updated with crown tenures, provides the number of facilities and areas related to municipal and marine infrastructure, by facility type in or within 1 km² of the proposed Network zones. Municipal and marine infrastructure can create many types of interactions with the MPA Network, including creating access, highlighting important recreational uses, detailing safety implications, and indicating high-traffic and use areas.

Marine Industrial Sites: Contains 995 point features split into 65 groups of types of marine industrial sites. This includes most types of marine industrial infrastructure, including buildings, tanks, forestry features, mines/quarries, loading docks of various types, fish processing/buying, pulp mills, smelters, municipal infrastructure (fuel docks, boat works, coast guard bases), hatchery sites, and effluent sources. Will be most useful in disaggregate form at the site level. Complex features interacting with activities of concern not directly targeted (in some cases). From Province of B.C.

Notes: Municipal and marine infrastructure can create many types of interactions with the Network, including creating access, highlighting important recreational uses, detailing safety implications, and indicating high-traffic and use areas. Facilities can include ferry terminals, Coast Guard stations, anchorages, boat launches, harbour authorities, major ports, small craft harbours, manned lighthouses, and search-and-rescue areas. Where feasible, this PM will be disaggregated into the different types of infrastructure and included in site-level discussions.

E6. Municipal and Marine Infrastructure Continued

Measure	Infrastructure Type	HG	NVI	CC	NC	NSB Total
NSB Presence, Count (% of NSB)	Seafood processors	6 (13.0%)	15 (32.6%)	4 (8.7%)	21 (45.7%)	46
	Aerodrome	0 (0%)	0 (0%)	0 (0%)	1 (100%)	1
	Fish processing	8 (11.8%)	24 (35.3%)	7 (10.3%)	29 (42.6%)	68
	Fishing lodge	14 (30.4%)	12 (26.1%)	14 (30.4%)	6 (13.0%)	46
	Harbour authority	3 (11.1%)	13 (48.1%)	2 (7.4%)	9 (33.3%)	27
	Moorages	198 (13.1%)	687 (45.4%)	132 (8.7%)	497 (32.8%)	1514
	Pulp and paper mill	0 (0%)	5 (71.4%)	0 (0%)	2 (28.6%)	7
Overlap with all sites, Count (% of NSB)	Seafood Processors	1 (2.2%)	1 (2.2%)	0 (0%)	0 (0%)	
	Aerodrome	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
	Fish processing	2 (2.9%)	0 (0%)	1 (1.5%)	0 (0%)	
	Fishing lodge	6 (13.0%)	0 (0%)	3 (6.5%)	2 (4.3%)	
	Harbour authority	0 (0%)	0 (0%)	1 (3.7%)	1 (3.7%)	
	Moorages	16 (1.1%)	33 (2.2%)	15 (1.0%)	13 (0.9%)	
	Pulp and paper mill	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Activity of Concern, Count (% of NSB)	Seafood Processors	1 (2.2%)	1 (2.2%)	0 (0%)	0 (0%)	
	Aerodrome	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
	Fish processing	2 (2.9%)	0 (0%)	2 (2.9%)	0 (0%)	
	Fishing lodge	10 (21.7%)	0 (0%)	6 (13.0%)	2 (4.3%)	
	Harbour authority	0 (0%)	0 (0%)	1 (3.7%)	1 (3.7%)	
	Moorages	76 (5.0%)	121 (8.0%)	57 (3.8%)	72 (4.8%)	
	Pulp and paper mill	0 (0%)	0 (0%)	0 (0%)	0 (0%)	

Measure	Infrastructure Type	HG	NVI	CC	NC	NSB Total

Short Description: This PM reports the number of facilities related to municipal and marine infrastructure, by facility type in or within 1 km² of the proposed Network zones.

Interpretation Example: 14 (30.4% of NSB) fishing lodges are overlapping the proposed Network in Haida Gwaii, and 6 (13% of NSB) of those fishing lodges interact with activities of concern.

Technical Description:

Municipal and marine infrastructure - Various provincial and NSB datasets, collected by MaPP and further updated with crown tenures, provides the number of facilities and areas related to municipal and marine infrastructure, by facility type in or within 1 km of the proposed Network zones. Municipal and marine infrastructure can create many types of interactions with the MPA network, including creating access, highlighting important recreational uses, detailing safety implications, and indicating high-traffic and use areas.

Recreational fishing lodges - A NSB dataset collected by MaPP and further updated with crown tenures, provides a breakdown of how fishing lodges are distributed throughout the NSB and proposed Network.

Notes: Fish vs seafood

Seafood processors is an older (2017-2018) dataset than the province, received through Amos. It only contains the point location and owner company of seafood processing facilities, coastwide. Fish processors is the same source data, but with MAPP enhancements. Taking the B.C. provincial data, filtering to the NSB and adding enhanced details on the availability of Offloading, Processing, Weighing, Ice, Owner, and Commercial/Sport Fish distinction. From a broad NSB-wide context, seafood processors data is better for an NSB comparison (newer), but lacks many site-level details, whereas the fish processor dataset is more complete. The site-level details of fish processors (MAPP data) will be much more useful than seafood processing, but may miss new sites, hence both are included. This description will need to be added to the report cards.

E7. Logging Areas of Interest

Measure	HG	NVI	CC	NC	NSB Total
Forestry Marine Space NSB (km²) Low/Very Low Risk to Closure. NSB **Presence**	899.9 (1.9%)	4,060.1 (49.4%)	8,814.9 (36.1%)	5,133.3 (23.8%)	
Forestry Marine Space NSB (km²) Medium+ Risk, **Overlap with all sites**		4,159.8 (50.6%)	15,579.4 (63.9%)	16,471.6 (76.2%)	
Forestry Marine Space NSB (km²), Medium+ Risk, **Activity of concern**		1,765.9 (21.5%)	4,282.5 (17.6%)	3,338.9 (15.5%)	

Description: PM is based on the amount of overlap between the Network and potential future logging use areas not identified as low impact from closure (i.e., areas with high future logging use value).

Interpretation: For example, NVI has 3,934 km² (47.9% of NSB) of space that is low or very low risk to marine forestry in the event of the presence of conservation priorities that interact with marine forestry operations. The inverse of low-risk areas are medium and greater risk areas, or unsurveyed areas. Of areas that are potential medium or higher risk to marine forestry if closed, NVI has 1,765 km² (21.5% of the NSB) of area potentially associated with activities of concern.

Technical Description: The Low to Very Low risk Forestry areas is a compiled list of areas considered to be at low risk of impacting the marine forestry sector if those marine areas were made inaccessible at some point. These coastline polygons focus on the Central Coast, with arms reaching into the North Coast and NVI subregions. There is minimal overlap with the Haida Gwaii subregion near the subregional border. The Haida Gwaii subregion is effectively excluded from this dataset.

Inverse overlap area then taken to indicate where potential medium or higher risk areas may be in relation to the proposed Network. This metric is not an indication of how forestry may be affected in the Haida Gwaii subregion, due to the limited spatial scope of the dataset.

Notes: Areas that are low or very low risk should have minimal risk of impacts to marine forestry operations if closed. Inversely, the dataset can show potential medium or higher risk areas, however the low-risk polygons are not an exhaustive inventory of the low and very low risk areas of marine space within the NSB. Due to this limitation, potential medium+ risk areas are likely over-estimated.

The dataset does not contain Haida Gwaii; it is not available. Only a small sliver extends into the Haida Gwaii subregion, away from land.

E8. Forestry Operation, Sites and Tenures

Category	Measure	HG	NVI	CC	NC
NSB Presence	TSA, Marine Space, km², NSB TOTAL SR MARINE SPACE	47,305.16453	8,219.862395	24,394.33174	21,604.88777
	Log Handling and Storage (LHS) Tenures, count	28 (5.3%)	314 (58.9%)	114 (21.4%)	77 (14.4%)
	LHS Tenures, km²	4.3 (6.9%)	32.4 (52.3%)	17.5 (28.2%)	7.9 (12.7%)
	Log Drop & Booming Use, Shoreline km	0 (0%)	24.2 (100%)	0 (0%)	0 (0%)
Overlap with all zones	TSA, Marine Space, km², Overlap	14,209.2	5,640.1	0	5,468.8
	LHS Tenures, count, Overlap	4 (0.8%)	80 (15.0%)	65 (12.2%)	12 (2.3%)
	LHS Tenures, km², Overlap	0.9 (1.4%)	9.0 (14.5%)	9.4 (15.2%)	0.9 (1.5%)
	Log Drop & Booming Use, Shoreline km, Overlap	0 (0%)	18.3 (75.5%)	0 (0%)	0 (0%)
Activity of Concern, Category 1 zones only	TSA, Marine Space, km², Activity of concern	10,370.2	2945.1	0	3,673.7
	LHS Tenures, count, Activity of concern	1 (0.2%)	17 (3.2%)	58 (10.9%)	12 (2.3%)
	LHS Tenures, km², Activity of concern	0.2 (0.3%)	2.1 (3.4%)	9.0 (14.6%)	0.9 (1.5%)
	Log Drop & Booming Use, Shoreline km, Activity of concern	0 (0%)	3.0 (12.2%)	0 (0%)	0 (0%)

Short Description: The number and area of forestry operation sites in the marine environment (active and past/potential future*) present within the Network planning area, as well as overlapping proposed Network zones, and estimated to be associated with activity of concern.

Interpretation Example: Haida Gwaii has 13,928.2 (46.6% of the NSB) km² of marine space overlapping Timber Supply Areas. Of that, 14,928.2 km² is overlapping the proposed Network, and 11,138.6 (11% of the NSB) is associated with activities of concern.

Technical Description: Three distinct datasets are presented: Timber supply areas, Log Handling and Storage Tenures, and Log Drop & Booming Use.

TSA: Total marine space of Timber Supply Areas within the NSB and proposed Network. Takes marine-relevant TSA space (whole coast coverage) and compares it against the Network to compare footprints. The amount of marine space in each subregion, as indicated by the presence of TSAs.

LHS: Compares the LHS tenures from the B.C. Crown Tenures database to the proposed Network and summarizes subregional totals of tenure counts and tenure area. Includes past tenures, present tenures, and applications.

Log Drop & Booming: The Log Drop and Booming Use shoreline dataset draws shore polylines throughout the NSB, focusing on the Central Coast, showing whether a given shoreline is important for log drop and booming. The kilometer length of the line is the metric ("useful coastline"). Haida Gwaii is not included in this dataset, thus all metrics are zero.

Notes: Forestry is an industry that is highly temporally variable. Existing and past tenure data does not include all sites that are needed to actively harvest the coastal land base. The potential future use PMs is calculated using a data layer built to try and address the concerns around the temporal nature of forestry.

E9. Aquaculture Tenures

Measure	Infrastructure Type	HG	NVI	CC	NC	NSB Total
NSB Presence, Count (% of NSB)	FF Tenures, NSB Total	1 (1.3%)	67 (90.4%)	8 (5%)	0 (0%)	74
	Plant Tenures, NSB Total	0 (0%)	0 (0%)	0 (0%)	2 (100%)	2
	SF Tenures, NSB Total	4 (6.1%)	56 (84.8%)	2 (3.0%)	4 (6.1%)	66
	Total Tenures, NSB Total	5 (3.5%)	123 (85.4%)	10 (6.9%)	6 (4.2%)	144
Overlap with all sites, Count (% of NSB)	FF Tenures, Overlap	0 (0%)	25 (32.9%)	2 (2.6%)	0 (0%)	76 (35.5%)
	Plant Tenures, NSB Total	0 (0%)	0 (0%)	0 (0%)	0	0
	SF Tenures, Overlap	0 (0%)	23 (34.8%)	1 (1.5%)	0 (0%)	66 (36.4%)
	Total Tenures, Overlap	0	48	3	0	134
Activity of concern, Count (% of NSB)	FF Tenures, Activity of concern	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0
	Plant Tenures, Activity of concern	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0
	SF Tenures, Activity of concern	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0

Short Description: The aggregated number of commercial aquaculture sites, including sites with tenure applications and existing licensed sites and tenures located within the proposed Network zones. This PM can also be reported by aquaculture type (finfish, shellfish, kelp).

Interpretation Example: Currently, no tenures are associated with activity of concern. Two tenures within the NSB are within the Mt Douglas sunsetted aquaculture tenures; they will cease operations before implementation of the Network.

Technical Description: Finfish, shellfish, and plant aquaculture tenures are extracted from the Province of B.C. TANTALUS database and compared to the Network.

Notes: There are other significant and ongoing marine aquaculture planning processes underway now, such as the open-net pen transition and discovery islands sunsetted area. These other processes may have significant changes to how aquaculture is managed and practiced within B.C. that will inform future Network planning.

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