Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area: Phase I - Identification of Important Areas

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Abstract

Clarke, C.L., and Jamieson, G.S. 2006. Identification of ecologically and biologically significant areas in the Pacific North Coast Intergrated Management Area: Phase I – Identification of important areas. Can. Tech. Rep. Fish. Aquat. Sci. 2678: vi + 89 p.

This report details the identification process of Ecologically and Biologically Significant Areas (EBSAs) for Pacific North Coast Integrated Management Area (PNCIMA). EBSAs are areas worthy of enhanced management or risk aversion. An area is identified as an EBSA if it ranks highly on one or more of three dimensions (Uniqueness, Aggregation and Fitness Consequences), and can be weighted by two other dimensions (Naturalness and Resilience), agreed upon at a national DFO workshop (DFO 2004c). Regional scientific experts were surveyed to identify Important Areas (IAs) of PNCIMA that met the criteria using a modified Delphic process. Thematic layers produced included species of fish, invertebrates, marine mammals, and reptiles, oceanographic features, provincial ecounits and Parks Canada areas of interest. Experts were also asked to provide rankings of each species' Important Areas identified for each of the five EBSA criteria. The final list of 144 species' Important Areas is identified in 40 thematic layers. This report describes how these IAs were identified, discusses issues around the EBSA identification process, and includes maps displaying each individual thematic layer.

When taken together the entire group of species' Important Areas covers almost the entire area of PNCIMA. This indicates that when viewed at this level, the entire PNCIMA is important in some way to one of the 40 species, species groups or habitat features.

Résumé

Clarke, C.L. et Jamieson, G.S. 2006. Identification des zones d'importance écologique et biologique dans la zone de gestion intégrée de la côte nord du Pacifique : Phase I : Identification des zones importantes. Can. Tech. Rep. Fish. Aquat. Sci. 2678: vi + 89 p.

Le présent rapport détaille le processus d'identification des zones d'importance écologique et biologique (ZIÉB) pour la zone de gestion intégrée de la côte nord du Pacifique (ZGICNP). Les ZIÉB sont des secteurs qui méritent une gestion et une protection accrues. Pour être déclaré ZIÉB, un secteur doit recevoir une cote élevée pour au moins un des trois critères en vigueur (unicité, agrégation et conséquences de la valeur sélective) et être caractérisé par deux autres dimensions (caractère naturel et capacité de récupération/résistance) définies lors d'un atelier national du MPO (MPO 2004c). On a demandé aux experts scientifiques régionaux d'identifier, à l'aide d'une version modifiée de la méthode Delphic, les secteurs importants des ZGICNP qui répondent aux critères en question. Les couches thématiques produites comprennent les différentes espèces de poissons, les invertébrés, les mammifères marins, les reptiles, les caractéristiques océanographiques, les unités écologiques provinciales et les secteurs désignés comme intéressants par Parcs Canada. On a également demandé aux experts de classer les secteurs importants pour chaque espèce en utilisant les cinq critères définis pour les ZIÉB. La liste finale des 144 secteurs importants est identifiée dans 40 couches thématiques. Le présent rapport décrit comment ces secteurs importants ont été identifiés, discute des enjeux relatifs à l'identification des ZIÉB et présente des cartes montrant chaque couche thématique individuelle.

Dans son ensemble, le groupe des secteurs importants pour chaque espèce couvre presque la totalité de la ZGICNP. Cela montre qu'à ce niveau, la ZGICNP dans son entier est importante, d'une certaine façon, pour l'une des 40 espèces, groupes d'espèces ou habitats.

Introduction

Canada's Oceans Act was passed in 1997 and incorporates three important principles in ocean management: sustainable development, integrated management (IM) and the precautionary approach (DFO, 2004b). Integrated Management is "an ongoing and collaborative planning process that brings together interested stakeholders and regulators to reach general agreement on the best mix of conservation, sustainable use and economic development of marine areas for the benefit of all Canadians" (DFO, 2004a). The 2004 Oceans Action Plan identifies five Large Ocean Management Areas (LOMAs) in Canada where Integrated Management will be initially applied: 1) Gulf of St. Lawrence Integrated Management (GOSLIM) Initiative, 2) Eastern Scotian Shelf Integrated Management (ESSIM) Initiative, 3) Beaufort Sea, 4) Placentia Bay/Grand Banks and 5) Pacific North Coast Integrated Management Area (PNCIMA) Initiative.

In Pacific Region, the Central Coast was the initial pilot IM area (CCIM), but in 2004 it was expanded to include all of the Queen Charlotte Basin (Map 1). Background documentation being produced to support IM in PNCIMA is comprised of numerous parts: including an Ecosystem Overview Report; a Marine Use Analysis report; identification of Ecologically and Biologically Significant Areas (EBSAs) (DFO, 2004a), Ecologically Significant Species and Community Properties (ESSCPs), Depleted Species and Degraded Areas. The current report details the methodology for identifying species' Important Areas (IAs) for consideration in determining EBSAs in PNCIMA. It must be stressed that the identification of an EBSA under this decision model, based purely on scientific advice available at the time this report was completed, does not confer any legislative protection for identified areas. We recognise that consideration should also be given to incorporating additional data and data types (e.g. traditional and local ecological knowledge) to address data gaps and acknowledged shortcomings of the existing science-based EBSA identification process, but it is understood this consideration will be part of a later exercise, and so is not included here.

Large Ocean Management Area (LOMA)-scale IAs are believed to be largely non-existent in the more confined oceanographic areas of the archipelago-fjord complex that characterises the mainland coast of British Columbia. This should not imply that regionally significant IAs do not exist there, but rather that IAs there are expected to be more appropriately identified through smaller, Coastal Management Area (CMA)-scale EBSA analyses, which we encourage to be done as soon as possible as part of the PNCIMA process.

Canada's Oceans Act empowers Fisheries and Oceans Canada (DFO) to apply an enhanced level of protection to those areas identified as biologically or ecologically significant. Marine areas can be considered significant based on the life history functions they serve in the ecosystem or because of the structural properties they possess (DFO, 2004c). Significance used in this context is purely a relative term. It is understood that all ecosystems and species functions have some degree of ecological significance. The current initiative seeks to identify those areas known at this time that host ecological structures or functions with greater relative significance. The intent is to facilitate the application of a higher level of protection and/or encourage more cautious risk assessment by managers for activities occurring or planned in identified EBSA areas. Ultimate science definition of EBSAs is simply science advice to managers. Sound ecosystem-based management in PNCIMA will also need to incorporate the nature of impacts under consideration, a specific area's vulnerability to potential impacts, and socio-economic considerations.

Canada's EBSA identification processes began in ESSIM and GOSLIM, and in PNCIMA to a lesser extent, before a November, 2004, national workshop (DFO, 2004c) outlined guidelines for EBSA projects. A summary of criteria guidelines developed at that workshop are presented below in Section 3. Preliminary initiatives provided much useful information that was considered at the national workshop, but it also meant that EBSA identifications prior to November, 2004 were not consistent across regions. With national guidelines now determined, efforts are underway to rectify earlier EBSA identification discrepancies.

There is still some debate within Canada as to the terminology to be used to refer to the "national EBSA dimensions" described. Since rankings by experts of areas for different species are all relative, the final choices of what areas to call EBSAs within a region depend strongly on the range of choices available. Different regions may thus not always consider the same threshold levels of criteria rankings as justifying EBSA identification. However, once a Region has considered its choices, it is presumed to have passed an important milestone in the EBSA identification process. In each IM area, locations of Important Areas were to be identified as to *where* on the continua of each of the five dimensions they occur. Although the national EBSA guidelines do not ensure (or inflict) rigid consistency across the country for these threshold locations, it was hoped they would represent a framework which should theoretically prevent arbitrariness and rampant subjectivity within a region if they could be practically implemented. The national framework attempted to ensure that the same considerations were taken into account in ranking all sites, because the same dimensions should be considered in every case.

The listing and ranking of Important Areas presented here for PNCIMA should be considered steps in the ongoing EBSA identification program, as 1) evaluation time was limited; 2) many experts consulted had collected their data to address other needs, such as stock assessment. Consequently, they may either not have the most appropriate data or have not yet analysed their data in a manner most appropriate for EBSA identification.; 3) data of other types (e.g. traditional and local ecological knowledge), has not yet been included in this process.

Here, we used a modified Delphic process to obtain the opinions of regional scientific experts over a 15-month period. Surveyed experts suggested Important Areas for species and habitat features based on the five EBSA dimensions. We went back to experts that identified Important Areas and asked them to assign continuum vales to each of the areas identified as important, which operationally meant ranking them as of low, medium or high importance. Second, a range of spatial analysis options were utilized in evaluations of potential lists of EBSAs for PNCIMA. Caveats to our analysis are 1) bycatch data has not been sufficiently captured in the current identification, and focus to date is on exploited marine species; 2) the EBSA identification process should at some point include Traditional and Local Ecological Knowledge, but this could not be attempted here due to a lack of resources. It also may be most appropriate at the Coastal management; and 3) Important Area identification is based on a snapshot of information only, i.e., the best available science knowledge at the time of preparation. As new data become available, revisions and additions may need to be considered.

2. Regional Integrated Management Approaches

2.1 ESSIM

IM efforts in Canada began in 1998 in the ESSIM region. Initial efforts (Breeze, 2004) to identify ecologically significant areas attempted to identify those areas having valued ecological attributes, which by definition "…contribute to the functioning and sustainability of the ecosystem, the maintenance and conservation of genetic, species, population, and/or habitat diversity, and/or other similar vital ecological functions. These attributes are present [in EBSAs] to a higher degree than most/all other areas within the region.". Breeze (2004) used seven first-order criteria and three second order or ranking criteria to identify significant areas in Maritimes Region. First-order criteria were: 1) biological productivity, 2) biodiversity, 3) reproductive areas, 4) bottleneck areas, 5) habitat for endangered/threatened species, 6) rare/unique habitats and habitats for rare species, and 7) naturalness. Second-order criteria were: a) dependency/survival, b) fragility/sensitivity, and c) significance.

ESSIM was spatially divided into sub-areas based on historic divisions in the literature and topographic features, producing 35 discrete sub-areas in total. Each sub-area was assessed against both first and second-order criteria using published literature and by considering the level of information available. A sub-area that was ranked high in one or more criteria was then profiled, i.e. described in detail. Twenty-three significant sub-areas were profiled, including some adjacent locations that were combined and profiled together. In 13 of the assessed areas, the level of information available was considered poor. All the areas which failed to be identified as EBSAs had low levels of information available, suggesting it may have been information availability that was particularly important in identifying EBSAs in this process.

2.2 GOSLIM

GOSLIM is a cooperative IM initiative by three DFO regions: Laurentian, Newfoundland and Gulf Regions. IM began in this area in 2000, and in GOSLIM, an EBSA was initially defined as "…a marine space which by virtue of its physio-chemical, geological, and biological characteristics offers habitats of importance to one or more species of aquatic fauna and/or flora, whether seasonally or continually." The identification of EBSAs for GOSLIM (DFO 2004e) was based on six preliminary documents: 1) EBSAs for Western Newfoundland and Southern Labrador (Brennan *et al.*, 2003), 2) EBSAs for Prince Edward Island and Nova Scotia (Therrien *et al.*, 2001), 3) EBSAs for New

Brunswick (Therrien *et al.*, 2000), 4) Canadian Wildlife Service List of National Wildlife Areas and Migratory Bird Sanctuaries, 5) Parks Canada National Marine Conservation Areas System Plan and 6) Zones of Interest for Quebec (DFO, 2002). For this initiative, significant regions were identified based on one or more of eight criteria:

i) significant biodiversity and/or biological productivity,
ii) presence of a particular ecological community,
iii) presence of condition essential for the development, maintenance or genetic survival (e.g., spawning, feeding grounds, etc) of individuals in a population or species,
iv) presence of and/or an important area for species at risk,,
v) presence of a particular oceanographic mechanism and/or unique habitats,
vi) other DFO purposes,
vii) ecologically and/or biologically important for other Departments, agencies or organizations, and
viii) mandate of the minister.

Criteria used in the GOSLIM EBSA identification process can be linked more directly with the criteria for protecting marine areas identified in the Oceans Act (Article 35(1)). In essence, GOSLIM sought to identify areas which are essential to individual species or species groups. All EBSAs flagged by the preliminary documents and by Parks Canada and the Canadian Wildlife Service were included on the final map (DFO 2004e). Each EBSA was numbered and a corresponding legend briefly detailed for each EBSA which criteria it met and the rationale behind its identification. The preliminary map of GOSLIM EBSAs did not rank proposed EBSAs in relative importance.

2.3 PNCIMA

There are two important differences between the earlier, preliminary east coast EBSA initiatives and the current Pacific PNCIMA EBSA initiative: 1) *Spatial scale*. PNCIMA is about ¼ the size of both GOSLIM and ESSIM individually (Figure 1), and so we are considering EBSAs at a much finer scale than is occurring in Atlantic Canada. Some of the proposed Atlantic EBSAs would comprise much of the entire PNCIMA if located in Pacific Canada. There are no biological reasons to suggest that significant habitat for Pacific species of comparable biology to Atlantic species would be any smaller in area than that required for Atlantic species. 2) *Commercial species diversity*. The Pacific Region has a much greater species biodiversity of most, if not all, species groups. For example, among North American intertidal decapod species, there are 20 species in Atlantic Canada and 72 in Pacific Canada (Jamieson *et al*., 1998). For rockfish, there are three primary *Sebastes* species in Atlantic Canada (Agri-Food Trade Service, 2005) and approximately 33 in Pacific Canada (NOAA, 2001). The importance of these regional differences should not be undervalued, as it increases the number of potential species-EBSAs, if all species are considered, by perhaps as much as ten fold in Pacific Canada. Because each species has a unique biology, biological data available per species is typically less in Pacific Canada. Therefore, the quantity/quality of data on which EBSA decisions can be based is generally less in Pacific Canada than is the case in Atlantic Canada. Thus, identification of EBSAs in the Pacific region may be less spatially precise.

3. National EBSA Criteria Guidelines

In order to reduce variation in EBSA identification criteria being used in IM areas across Canada, a national workshop was held Nov 17-19, 2004 in Montreal to develop a standardised EBSA identification process (DFO, 2004c). The decision model that was developed during the workshop was to be adopted in all IM areas. However, the application of these criteria in each region is expected to be tailored to the needs and specific characteristics of individual regions.

The following is a brief summary of the national EBSA guidelines, adapted from DFO (2004c). There are three main dimensions against which areas are to be evaluated (Uniqueness, Aggregation and Fitness Consequences) and two additional ranking dimensions (Resilience and Naturalness). Uniqueness refers to the degree to which the characteristics of areas are unique, rare, distinct, and have no alternatives. The spectrum of uniqueness increases from regional to national to international scales. Aggregation refers to the extent that a) individuals of a species aggregate for part of the year, b) most individuals use the area for an important life history function or c) where a structural feature or ecological process occurs with relatively high density. Fitness Consequences is the degree to which the area itself contributes to the fitness of a population or species, where the actual life history activity taking place there only makes a marginal contribution to fitness. Two additional influencing dimensions are also to be considered during site evaluations: Resilience and Naturalness. Resilience refers habitat structures or species which are sensitive, easily disturbed, and slow to recover. Naturalness is the degree to which areas are pristine and contain native species. The ranking from one of the first three dimensions can be increased if it ranks low in resilience and high in naturalness.

EBSAs include areas which rank high in any of Uniqueness, Aggregation, or Fitness Consequences. Areas can also be identified as EBSAs if a large number of average ranking areas are overlapping. The justification for an EBSA can be thought of as a continuum where justification becomes stronger with increasing numbers of highly ranked dimensions.

The three dimensions can overlap considerably and the boundaries between them may become blurred. For example, birds moulting in large numbers in a specific site may have a high Aggregation ranking, a high Uniqueness ranking if it is the only site of its kind in the region and a high Fitness Consequences ranking because moulting in that particular area results in lower predation for the birds when flightless.

Considering application of the above dimensions to determine EBSAs in an operational sense has proved to be challenging, as will be shown below. In meetings with experts, EBSA dimensions were first defined and then examples given of hypothetical areas that would rank highly for each dimension. Discussion followed to ensure that understanding of the dimensions and how EBSAs should be identified were fully understood. Each expert(s) was then asked to detail specific areas within PNCIMA that, according to their experience and knowledge, stand out in the context of those three dimensions. This resulted in identification of Important Areas (IAs), but initial proposals of species-specific IAs did not ask for rankings of significance. We subsequently had to go back to the experts and have them quantify on a continuum for each EBSA dimension a value (1-10) for each IA they identified, which were converted to a ranking.

4. Methodology

The objective of this project was to implement an acceptable and transparent process for identifying EBSAs in PNCIMA. It is anticipated that there will be follow-up consultations and extensive discussion during the IM development process. The end-product of this identification exercise is also expected to be refined and modified over time as further data become available.

4.1. Delphic Identification

4.1.1. Initial Identification of Important Areas

Identification of IAs for PNCIMA used a modified Delphic method. Delphic approaches have been used in similar projects in the USA, Australia, and by Parks Canada to identify sites for use in marine reserve systems (Muldoon, 1995). The Delphic method offers certain advantages over direct data acquisition and analysis. First, the time frame for Pacific EBSA identification was short compared to initiatives completed in other regions, which did not allow for us to undertake extensive data collection and analysis of our own. Second, possible analyses of unfamiliar data sets could lead to erroneous conclusions since each dataset has unique limitations and issues that need to be considered during analysis. Data must be viewed carefully in light of management restrictions, observer effort, gear selectivity, and species biology; all parameters that can influence the interpretation of spatial and temporal patterns and information that is often difficult and/or time-consuming to acquire or access. Finally, some important data (e.g. logbook and bycatch records) were not readily available for analysis by us due to confidentiality agreements. Therefore, soliciting expert opinions from scientists known to already be intimately familiar with existing datasets was used to eliminate potential errors and facilitate completion of the project within the desired timeline. The experience of regional scientific experts also provided valuable information (Scientific Experiential Knowledge) not captured in existing datasets.

Delphic methods are relatively straightforward to apply and allow easy explanation to a wide audience of user groups and managers. Quantitative approaches may sometimes be more scientifically defensible, but in early discussions, we learned that in many cases, relevant data had either yet to be collected or if present (e.g. distribution by life stage, or trawl bycatch data), may not have been analysed, particularly if it was a side attribute of data collected for other reasons, notably a particular species' stock assessment. Our overall conclusion was that an exhaustive quantitative evaluation of the raw data by us was not justifiable at this time.

To begin the Delphic process, briefings were held for large audiences at the Institute of Ocean Sciences, the Pacific Biological Station and DFO Regional Headquarters in Vancouver to explain the concepts behind EBSAs and the criteria dimensions chosen at the national workshop. Targeted experts were invited to attend these briefings to facilitate large-scale information dissemination in a small amount of time. Discussion time was allowed at the end of each presentation to answer questions about the process and to address concerns and questions from participants. For the few relevant experts that could not attend the large briefings, individual interviews were undertaken to introduce the concepts and dimensions involved with EBSA identification. Regional experts were approached individually or in small groups (all with knowledge on the same species or species group) to gather their expert opinions. In cases where meetings could not be arranged due to logistics, an explanatory EBSA information package was sent to participants and followed up by phone or email.

IAs from experts were spatially drawn by them on paper maps at the PNCIMA scale (1:300,000 to 1:400,000). Experts drew polygons of areas they felt met the EBSA criteria and detailed their rationale for choosing these areas either verbally to the interviewer or by later written submission. Detailed notes were taken during each interview to document the information given and any concerns the interviewee expressed about the EBSA identification process. Special attention was given to detailing datasets, publications and personal observations that the expert's opinion was based upon.

The paper map from each expert was digitized in ArcView 3.2 and ArcGIS 9.1 to produce a thematic layer for each expert consulted. Each expert's layer was given a unique name that included the expert's name and the area of expertise that the layer referred to. The scale of digitization for each polygon was recorded in the attribute table of each GIS theme. The scale at which areas were identified and digitized is important information for future analyses. It provides an indication of the scale at which area boundaries were created and meant to be utilized. Metadata, a standardized text file that describes the data collection process, references to experts, scale, etc, was produced to accompany each thematic layer.

A map of the individual layer produced for each expert was returned to that expert for vetting. This allowed the experts to re-evaluate the layer they created and to check for accuracy and completeness in presentation. Comments were then elicited and any changes requested by an expert were made to their layer of IAs.

The Delphic approach works best with a diversity of expert opinion for a given thematic IA layer and as many experts as possible for each layer were thus consulted in the timeframe available. When more than one expert was consulted about a species or habitat feature, that group of experts was treated as a working group. Maps of the initial layers created by individuals in the group were shared with the other members to allow for discussion and evaluation of the IAs identified. Interim maps of potential areas were returned to the working group members as often as needed until consensus was reached. A final map was then returned to the experts in the working group for confirmation. All layers produced during this process were transferred to the Habitat Enhancement Branch (HEB) GIS unit for storage.

We recognize that there is inherent bias in the selection of species included here (e.g., mostly commercial species) and the places where data on these species was collected (areas where fisheries occur). Implications relating to bias associated with commercially important species, charismatic species, spatial variation, and temporal variation is discussed further in Section 7.1.2.

4.1.2. Ranking Important Areas

In addition to proposing IAs, experts were asked in the fall of 2005 to: 1) to check the areas identified in light of possibly more recent data available (another field season had now passed), 2) to give values for each IA identified for each of the five EBSA dimensions and 3) to give values for each IA identified according to the quality of data available.

Each expert was asked to rank each IA they identified from 1-10 for the five EBSA criteria (Uniqueness, Aggregation, Fitness Consequences, Naturalness and Resilience). When more than one expert was surveyed and a difference of opinion occurred, the following decision rules were followed:

- ≥3 experts: use the value of the majority (e.g. 9, 6, 9 = 9)
  if all different, take the average (e.g. 9, 4, 7 = 7)
- 2 experts: use the highest value (precautionary) (e.g. 8, 6 = 8)

These rankings were then converted to levels in order to reduce small-scale differences in subjective opinion among the experts. The conversion followed was: Low value (1-4), Moderate value (5-7) and High value (8-10). An area's final score was based on the highest ranking of the three primary criteria (Uniqueness, Aggregation and Fitness Consequences). For example, if Area X had been given the following scores: Uniqueness and Fitness Consequences "moderate", and Aggregation "high", the area's final Score would be 'high".

Under special circumstances, an area's score could be adjusted for extreme rankings in the two weighting criteria: Naturalness and Resilience. A low ranking in Naturalness would push the score down and a low score in Resilience would push the score up. However, these two criteria were not applicable for the majority of species and areas examined here, and were not used to adjust rank values. The most relevant application would have been a low Resilience value for corals and sponges, but rankings here were already "high" for both the Aggregation and Uniqueness dimensions.

Experts were also asked to evaluate the quality of information available for each identified area on a scale of 1-3 (Data quality). This allowed the evaluation of the confidence in an area's identification. The highest ranking (3) represents detailed information for the area such as density and spatial locations of life history functions. Areas with a data quality ranking of 2 have information such as the spatial extent and occurrence of life history functions and/or modelling information available for habitat use. A data quality ranking of 1 represents only basic information available, i.e. range or occurrence (sightings) and perhaps an educated guess at habitat use.

4.2. Database structure

In total, 40 IA shapefiles were created for the EBSA project (Table 1), each with 16 fields of information in the accompanying data tables. Descriptions of the fields can be found in Table 2.

5. Important Area Layer Characteristics

This section describes areas identified for species, species groupings and habitat features examined for the PNCIMA EBSA project, including those species for which potential IAs could not be identified. Details used in the rationale for EBSA identification and the datasets experts based their advice upon are provided. Problems associated with IA identification, if any, in each group and recommendations for future analysis are given. A full list of the species and habitat features investigated is in Appendix II.

5.1 Anadromous fish

Species here are highly migratory with specialized life history strategies that involve both freshwater and marine habitats. Spawning and nursery functions occur in natal freshwater rivers while juvenile and adult feeding and migration occurs in the marine environment. For anadromous fish that return to a natal stream to reproduce, each stream is essential habitat for its stock, giving a high significance for streams bearing these species. Ardron (2003) used a measure of species richness and stream magnitude so that large streams with a high number of anadromous species present would be given the highest scores. This measure places emphasis on the physical characteristics of the stream rather than its biological characteristics. A more meaningful biological measure might include anadromid species richness and escapement magnitudes. Migration routes can bottleneck species on their way to natal streams, but with increasing distance from their natal streams, routes can increasingly vary temporally, such as often occurs around Vancouver Island during El Nĩno events as salmon try to avoid warmer waters.

Six species of salmon reside within the bounds of PNCIMA: 1) Coho, 2) Sockeye, 3) Steelhead, 4) Pink, 5) Chum, and 6) Chinook. Each salmon stock has a single natal river from which adults return to breed. Therefore, all salmon rivers are considered essential habitat for their individual stocks. We have not made an attempt to rank the natal areas against each other and as such, none of these are identified as IAs, as most, if not all, these rivers are currently managed intensively. However, research from the Pacific Ocean Shelf Tracking project (Pacific Ocean Shelf Tracking, 2004) has provided some new data to evaluate the relative importance of areas for salmon in the marine habitat. Six hydroacoustic tracking lines (in the Strait of Georgia and Queen Charlotte Strait, and off

Brooks Peninsula, Grays Harbour (Washington), Juan de Fuca Strait and South-East Alaska) were placed on the sea floor to monitor the movements of acoustically tagged salmon across them. Early results indicate that juveniles from southern BC Sockeye and Steelhead stocks move rapidly out of estuaries and through Johnstone/Queen Charlotte Straits (D. Welch, POST & DFO, Nanaimo, pers. comm.). Therefore, this area can be considered an IA because it is a highly important migration route for at least these species. Coho salmon, in contrast, seem to remain in marine areas closer to the entrance of their natal streams (D. Welch, POST & DFO, Nanaimo, pers. comm.), and so in PNCIMA, the Broughton Archipelago-Johnstone Strait area is identified as an IA for Keough and Nimpkish Coho stocks (Map 2). The caveat here, though, is that these IAs are based on only a single season of sampling. However, the POST project is planned to be a multi-year project, with additional sampling seasons and extension of the listening lines anticipated, so new data should soon be available.

Green sturgeon, *Acipenser medirostris*, is a small anadromous fish that occurs from Alaska to Mexico. There is not a great deal of information about this species in PNCIMA. There are only three spawning populations known in North America and all have been listed as threatened under the US Endangered Species Act. A significant number of animals tagged in the US have recently been shown to utilize the Brooks Peninsula area (Welch *et al*., 2004). This is the only place in PNCIMA where this species has been shown to concentrate, but this may be due to limited data availability. From the acoustic tracking studies project underway by POST, it appears that individual green sturgeon may spend approximately six weeks in this area. It is hypothesized that this area acts as a type of staging area for sturgeon travelling to or from Alaska (D. Welch, POST & DFO, Nanaimo, pers. comm.). This area was ranked highly Unique and serves as a possible area of Aggregation and therefore was identified as an IA for green sturgeon (Map 3).

Eulachon (*Thaleichthys pacificus*) is blue-listed by the CDC, and is a species of special concern (Government of British Columbia, 2005). Within PNCIMA eulachon fishing occurs on the Nass and Skeena rivers but is now only a First Nations fishery (Stoffels, 2001). Since 1994 there has been a sharp decline in the entire population of eulachon, from BC to California, which was especially pronounced in southern rivers (DFO 1999). Adults spawn in coastal rivers between March and May. There are 33 rivers in BC where eulachon are known to spawn but only 14 are used regularly (DFO, 2000a). Genetic testing has failed to show that different eulachon runs are separate stocks and an unknown degree of mixing and straying likely occurs between populations and rivers. Only nine potential stock groups (groups of adjacent spawning rivers) are located within PNCIMA. These nine stock group areas have been identified as IAs as a result of their Uniqueness and Aggregation of spawning adults (D. Hay, DFO, Nanaimo, pers. comm.). The Douglas Channel and Gardner Canal stock group was further divided into two IAs (Map 4). Adult eulachon spend two to three years at depth in open marine waters before returning to spawn (DFO, 2000a). Three deep-water IAs have been identified because of summer aggregations of feeding adults (Map 4).

5.2 Birds

Seabirds utilize PNCIMA for breeding, foraging, migration and staging. How PNCIMA is used is species-specific, with different species carrying out different life history processes in different regions within the study area. Fifteen species of marine bird breed on the British Columbia coast with over five million birds nesting at 503 sites (Burger *et al*., 1997). The Scott Islands are the most important breeding grounds for sea birds in British Columbia and support the densest aggregation in the North Pacific (Rodway *et al*., 1991). The Scott Islands has been identified as a globally significant Important Bird Area (IBA) by Birdlife International. Globally significant proportions of Cassin's Auklet, Rhinoceros Auklet, and Tufted Puffin are found there. Nationally significant populations of Common Murres, Brandt's Cormorant, Pelagic Cormorant, Pigeon Guillemot, Glaucous-winged Gull, Leach's Storm-Petrel and Fork-tailed Storm-Petrel breed on these islands (Amey *et al*., 2004). Based on this information and the occurrence of the Black-footed albatross, Northern Fulmar, Sooty Shearwater, Herring and Thayer's gulls, this area was identified as an IA for its high ranking in both Uniqueness and Aggregation (K. Morgan, CWS, Sidney, pers. comm.). Large numbers of seabirds from the Scott Islands' breeding colonies, along with seabirds from elsewhere, forage in the surrounding area (Amey *et al*., 2004) and therefore this IA includes both the breeding colonies at its core and the adjacent wider foraging grounds (Map 5).

The islands at the mouth of Queen Charlotte Strait, which include the Storm Islands, Reid Islets, Tree Islets, Pine Island and the Buckle Group, are considered the most important breeding colonies in BC for storm-petrels and Rhinoceros Auklet (Rodway and Lemon, 1991). They also host significant proportions of Fork-tailed Storm-petrels and Leach's storm-petrels (37 and 53% respectively). This IA also includes both the breeding colonies as its core and the adjacent wider foraging grounds (Map 5).

High densities of shearwaters occur seasonally in the shallow waters of Dogfish Bank in Hecate Strait (Morgan, 1997). Dense aggregations of Sooty shearwaters undergo their primary moult in the spring off the east coast of Moresby Island, and these shallow waters are thought to provide shelter from harsh weather and a refuge from predation (K. Morgan, CWS, Sidney, pers. comm.). In addition, the highest densities of phalaropes, Herring gulls and Ancient Murrelets are found over Dogfish Bank in Hecate Strait in the spring and summer (Morgan, 1997). An IA was identified for this location for a number of species (Map 5). This area was ranked highly in both Aggregation and Fitness Consequences.

High concentrations of Alcids occur around Learmouth Bank, feeding on the rich plankton northwest of Langara Island. This area was identified as an IA because of its high Aggregation of these marine birds (K. Morgan, CWS, Sidney, pers. comm.). McIntyre Bay was identified as an IA for its high concentrations of seabirds, geese, and ducks; migrating sea ducks use the area off the east coast of Rose Spit as a staging area (Ure and Beazley, 2004). Evidence from a satellite-tagging program has shown that Black and White-winged Scoters spend up to six weeks in this area in the spring (S. Boyd, CWS, Delta, pers. comm.). Surveys and satellite telemetry studies have also shown that Black and White-winged Scoters use both the head of the Nass River and the

Prince Rupert area as staging areas on their yearly migration (S. Boyd, CWS, Delta, pers. comm.). Thus these three areas were identified as IAs because they were ranked moderate on each of Uniqueness, Aggregation and Fitness Consequences (Map 5).

The area around Brooks Peninsula supports a high species diversity of breeding and migrating bird species, including Phalaropes, Common Murre, Tufted Puffin, Sooty Shearwater, Glaucous-winged Gull, Rhinoceros Auklet and Black-legged Kittiwake (K. Morgan, CWS, Sidney, pers. comm.). This area was thus identified as an IA for Fitness Consequences (Map 5). An important feeding area skirts the edge of Goose Island bank and sustains aggregations of Black-footed albatross, Northern Fulmar, Sooty Shearwater, Leach's and Fork-tailed Storm-petrels, Cassin's and Rhinoceros Auklets and Herring and Thayer's Gulls (K. Morgan, CWS, Sidney, pers. comm.); this area was identified as an IA for its Fitness Consequences for these species (Map 5).

A number of islands and bays on the east coast of the Queen Charlotte Islands support large seabird breeding colonies. These include Langara Island, Frederick Island, Hippa Island, Englefield Bay, Anthony Island and Marble Island. Cassin's Auklet, Ancient Murrelet, Rhinoceros Auklet, Tufted Puffin, Leach's and Fork-tailed Storm-petrels, and others breed at these colonies and therefore they have been identified as IAs for their Uniqueness, Aggregation and Fitness Consequences (M. Hipfner, CWS, pers. comm.). These IAs each have a 10 km radius foraging area around the breeding colonies, but with little current information on seabird foraging areas, IAs may ultimately need to be even larger for some species than is indicated here (M. Hipfner, CWS, pers. comm.).

The Canadian Wildlife Service is undertaking their own complementary process for identifying significant areas for seabirds. Seven of the IAs identified for marine birds during the current process were also identified by CWS as areas of known or suspected importance for seabirds (Burger *et al.*, 1997). The large species diversity of marine birds in the PNCIMA region and the grouping of them all into one layer for analysis present problems for the EBSA identification process. In subsequent EBSA evaluations, it would be desirable to establish a separate layer for each bird species individually, and in particular, for "designated at risk" species. The Marbled Murrelet and Short-tailed Albatross have been listed as Threatened and the Ancient Murrelet has been listed as a species of special concern by COSEWIC.

5.3 Marine Mammals

5.3.1. Cetaceans

Cetaceans complete their entire life cycle in the marine environment, and are at highest densities when breeding and are more widely dispersed when feeding. Calving grounds are known for only a few species; some species calve during their yearly migrations. Most species calve at lower latitudes and the PNCIMA region is mostly used for feeding purposes. Cetaceans may aggregate on the basis of known biological or physical factors but in other cases, their use of a specific area as opposed to other seemingly similar areas is for no clear reason (e.g., rubbing beaches). Marine mammals are unique in that tradition or social functions (persistent family groupings and specific vocal dialects) must be considered in their protection (Heise *et al*., 2003). Migration patterns may vary within species by age, sex, breeding status and health.

Most of the available information on cetacean spatial distribution comes from opportunistic sightings (Cetacean Sightings Network maintained by the Vancouver Aquarium) and the historical whaling database (held by DFO). Both of these databases are biased by the spatial distribution of observer effort to an unknown degree. There is currently research underway to account for bIAs from effort by the B.C. Cetacean Sightings Network (BCCSN) (N. Pinnell and D. Sandilands, BCCSN, Vancouver, pers. comm.). Sightings data from this database are the best available data for cetaceans; however, because it has not been corrected for effort, the suggested spatial distribution may most reflect areas with high research or tourist effort. The historical whaling database has similar bIAs associated with it - whale catches may be more related to the proximity of the location of the whaling station than actual whale distributions. In addition, there is extreme variation in the distribution of whales in B.C. waters, with fluctuations on an annual to decadal scale (J. Ford, DFO, Nanaimo, pers. comm.). The incorporation of scientific experiential knowledge may serve to reduce this bias. The experts consulted for this group have extensive working knowledge of B.C. waters that allows them to target areas with reliable whale aggregations. We have relied on experts' knowledge to distinguish significant aggregations of cetaceans from the appearance of aggregations due to observer effort for IA identification for cetaceans.

5.3.1.1. Toothed Whales

The harbour porpoise (*Phocoena phocoena*) is a nearshore species with shy, cryptic behaviour making it a difficult animal to study (J. Ford, DFO, Nanaimo, pers. comm.; Heise *et al.* 2003). This species has been listed as vulnerable on the IUCN Red List (IUCN 2004). Concentrations of sightings from the BCCSN are believed to be highly skewed by effort and therefore cannot be used to identify IAs for this species (J. Ford, DFO, Nanaimo, pers. comm.). Habitat for this species is all nearshore waters less than 100 m in depth (J. Ford, DFO, Nanaimo, pers. comm.).

Dall's porpoise (*Phocoenoides dalli)* is one of the most widely distributed of the small cetacean species (Leatherwood *et al*., 1982). They range from the inshore waters of B.C. to Japan, with no particular preference for any area (J. Ford, DFO, Nanaimo, pers. comm.). Therefore, no areas are identified as IAs for this species.

Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) are distributed from the inlets to the offshore waters of B.C. Apparent concentrations of sightings around the Queen Charlotte Islands are believed to be related to effort (J. Ford, DFO, Nanaimo, pers. comm.). These animals are widely distributed, so again there are no locations identified as IAs for this species (J. Ford, DFO, Nanaimo, pers. comm.).

Killer whales (*Orcinus orca*) have been divided into three populations or ecotypes: 1) residents, 2) transients and 3) offshores (Ford *et al.*, 2000; Heise *et al*., 2003). Resident killer whales range from Washington to Alaska and the northern population of resident killer whales falls within the boundaries of PNCIMA. This population has been designated threatened under the Species at Risk Act (SARA). The spatial and temporal distribution of this population is largely driven by their prey populations, salmon. The draft SARA recovery strategy identified areas of critical habitat for resident killer whales which are also areas known for Chinook and Chum salmon fishing (J. Ford, DFO, Nanaimo, pers. comm.; Killer Whale Recovery Team, 2005). From May-September, northern resident killer whale distribution is driven by the distribution of Chinook salmon, their main prey. In October, part of this killer whale population switches to feed on Chum salmon. From December to April, this killer whale population spreads out but is not believed to leave the region, possibly moving north to Southeast Alaska (J. Ford, DFO, Nanaimo, pers. comm.). The Johnstone Strait core area flagged in the Draft Recovery Strategy (Killer Whale Recovery Team, 2005) was identified as a killer whale IA for its high Uniqueness, Aggregation and Fitness Consequences (J. Ford, DFO, Nanaimo, pers. comm.). Additional IAs for the northern resident killer whales are located where the population is known to aggregate for part of the year (Map 06). The areas in between these concentration areas were identified as IAs because these animals have been observed socializing and travelling there, but were ranked moderate for Uniqueness and Fitness Consequences (J. Ford, DFO, Nanaimo, pers. comm.; L. Spaven, DFO, Nanaimo, pers. comm.).

Transient killer whales have been observed everywhere throughout the PNCIMA region. The northeast Pacific transient killer whale population has been listed as threatened under SARA. Transient killer whale prey consists of a wide variety of marine mammal species and no real pattern emerges for their spatial distribution (J. Ford, DFO, Nanaimo, pers. comm.). Even less is known about the spatial distribution of the offshore killer whale population, which seem to be biased towards continental shelf and offshore waters. These animals use the entire PNCIMA area and a lack of information about this population has resulted in a designation of special concern under SARA. Therefore, no IAs were identified for transient or offshore killer whales at this time.

Sperm whales (*Physeter macrocephalus*), listed as vulnerable by the IUCN, are largely offshore, deep water animals (>1000 m depth), and the validity of the few sporadic inshore sightings is questionable (J. Ford, DFO, Nanaimo, pers. comm.). Based on the whaling data and a "critical habitat" model (Gregr & Trites, 2001), a single IA was identified (J. Ford & L. Spaven, DFO, Nanaimo, pers. comms.) for this species: the continental shelf break, bounded by the PNCIMA boundary (Map 07). It should be noted, that identified sperm whale "critical habitat" extends further offshore, beyond the PNCIMA boundary.

5.3.1.2. Baleen Whales

Humpback whales (*Megaptera novaeangliae*) are found in B.C. waters during all months of the year, although peak abundance occurs between May and October (J. Ford, DFO, Nanaimo, pers. comm.). The humpback whale is listed as threatened under the Species at Risk Act (SARA; Environment Canada, 2004a) and Vulnerable on the IUCN's Red List (IUCN, 2004). Humpback whale IAs were identified as known areas of high concentration based on historical whaling records, data from the BCCSN and expert personal experience (Map 08). It must be stressed that these are the only areas that have been documented thus far, and that with more data, other areas in PNCIMA may be equally significant for humpback whales. The three humpback whale IAs in northern PNCIMA were ranked high for Uniqueness, Aggregation and Fitness Consequences. The area in the central coast is ranked high for Uniqueness and Fitness Consequences. The three southern areas were ranked moderate in all three primary EBSA criteria.

Gray whales (*Eschrichtius robustus*) have specific habitat and prey preferences quite different from the other whales. This species is a benthic suction feeder that occupies relatively shallow nearshore waters (J. Ford, DFO, Nanaimo, pers. comm.; Heise *et al* 2003). Gray whales breed in winter calving grounds in Baja California, Mexico (Calambokidis *et al*., 2000). Most gray whales migrate north to the Bering Sea from February to May, travelling and feeding along the west coast of Vancouver Island and the West and East coasts of the Queen Charlotte Islands on the way. From December to January, whales travel the same migratory corridors heading south to breeding grounds. Two IAs were identified based on known migration corridors and these have a moderate ranking in all three primary EBSA criteria (Map 09). The route that these animals travel between the two migration corridors is unknown. Researchers believe that migrating gray whales have to travel through Queen Charlotte Sound to the Queen Charlotte Islands and from northern Graham Island to Alaska and therefore these potential migration routes were identified as moderate IAs. . Skidegate Inlet is an area known for its high concentrations of feeding gray whales and is identified as an IA for its high Uniqueness (Map 09).

A small part of the North Pacific gray whale population, referred to as summer resident gray whales, is repeatedly observed in certain northern areas outside the migration period (Calambokidis *et al*., 2000). These whales remain in B.C. to feed instead of migrating further north to feed (J. Ford, DFO, Nanaimo, pers. comm.; Heise *et al* 2003). Two areas within PNCIMA support summer residents in high densities, around Cape Caution and at the northern tip of Vancouver Island (Map 09). These areas are identified as IAs for their high Uniqueness (J. Ford, DFO, Nanaimo, pers. comm.).

Blue whale (*Balaenoptera musculus*) sightings are extremely rare in post-whaling years, <10 sightings to 2002 (B.C. Cetacean Sightings Network data, 2004). The Pacific population of blue whales has been proposed for listing on Schedule 1 of SARA as endangered (Environment Canada, 2004a) and is listed as endangered on the IUCN Red List (IUCN, 2004). From historical whaling records, blue whales have been reported mainly from the continental shelf edge (Heise *et al.* 2003). The continental shelf break and offshore areas were identified as “critical habitat” for blue whale by modelling physical factors and the whaling database (Gregr & Trites, 2001), and was identified as an IA for this species (J. Ford, DFO, Nanaimo, pers. comm.) (Map 10).

Sei whales (*Balaenoptera borealis*) are listed as endangered under SARA and by the IUCN. Although large numbers were taken during whaling, there have been some sightings in recent years (Heise *et al.* 2003; B.C. Cetacean Sightings Network data, 2004;

J. Ford, DFO, Nanaimo, pers. comm.). The continental shelf break and offshore were identified as “critical habitat” for sei whale as well by modelling physical factors and the whaling database (Gregr & Trites, 2001), making the IA for this species the entire shelf break (Map 11). Predicted “critical habitat” actually extends out beyond the shelf break,, but this portion is not included here since it is outside PNCIMA..

Fin whales (*Balaenoptera physalus*) have been identified as endangered by the IUCN. Predicted “critical habitat” for this species (Gregr & Trites, 2001) in PNCIMA includes the continental shelf break, but there is also an aggregation of animals documented in the BCCSN and historical whaling data that does not seem to be an artefact resulting from the spatial distribution of observer effort (Heise et al 2003; J. Ford, DFO, Nanaimo, pers. comm.). This aggregation is in portions of Hecate Strait and Dixon Entrance, and so the IA for fin whales encompasses both the continental shelf break and parts of Dixon Entrance and Moresby Trough (Map 12).

5.3.2. Pinnipeds

Pinnipeds require stable land habitat for haulout purposes for proper skin metabolism and predator avoidance, typically isolated islets or rocks with water access and refuge from adverse weather conditions. The spatial occurrence of pinniped haulouts differs between species and is affected by the size of foraging grounds available around each haulout area. Sea lions and elephant seals undergo significant migrations for feeding, breeding and/or moulting, while harbour seals reside in the same general locations year round.

Harbour seals (*Phoca vitulina*) have the widest species distribution, occurring throughout the B.C. coast, and occupy a large diversity of habitats. There are hundreds of haulouts occupied by this species within PNCIMA. Many areas of the coast have not been surveyed for harbour seals and some recent research surveys in previously unsurveyed areas have yet to be published (P. Olesiuk, DFO, Nanaimo, pers. comm.). Haulout sites could potentially be ranked by their importance to the overall population, but this analysis is not yet available for PNCIMA. Thus, no IAs were identified for harbour seals.

The Steller sea lion (*EumetopIAs jubatus*) is listed as endangered on the IUCN Red List and occurs on land sites for three reasons: breeding rookeries, year-round haulouts, and winter haulouts. Animals associated with these three land sites are spread out at other times of the year in the marine environment and less is known about their distribution at these times (Heise *et al.*, 2003). There are only three known rookeries in B.C. waters where these animals aggregate in the spring to pup (P. Olesiuk, DFO, Nanaimo, pers. comm.; Heise *et al.*, 2003). These three rookeries and the surrounding waters (20 km radii) were identified as IAs for their high Uniqueness and Aggregation (Map 13). There are approximately 25 year-round haulout sites in B.C. and 16 of them fall within the boundaries of PNCIMA, but use of individual haulouts has a large degree of interannual variation. These 16 haulout sites and the surrounding waters used in foraging (50 km radii) were identified as IAs for this species (P. Olesiuk, DFO, Nanaimo, pers. comm.) (Map 13). While there are numerous winter haulouts for this species that are occupied primarily in the non-breeding season, none of these sites were identified as IAs.

The Northern fur seal (*Callorhinus ursinus*) is a highly pelagic species and spends only a short period of time on land for breeding purposes. Data on the distribution of this species comes from pelagic research collections (1950s-1970s) and commercial sealing records from the early 20th century (Heise *et al*. 2003). An area of Hecate Strait is considered to be an important feeding area that supports a dense aggregation of fur seals, and a second feeding area occurs in Queen Charlotte Sound (P. Olesiuk, DFO, Nanaimo, pers. comm.). Both areas were identified as IAs that rank high for Aggregation (Map 14).

5.3.3 Sea Otters

The sea otter (*Enhydra lutris*) is listed as threatened by COSEWIC and the IUCN. Sea otters were reintroduced to B.C. between 1969 and 1972 and the population is still expanding (L. Nichol, DFO, Nanaimo, pers. comm.). There are two areas within PNCIMA where sea otters have established (Sea Otter Recovery Team, 2002), and these areas were identified as IAs based on their high Aggregation and Fitness Consequences (Map 15). Essentially, all shallow waters habitats found within PNCIMA can be considered potential sea otter habitat if the population continues to expand (L. Nichol, DFO, Nanaimo, pers. comm.). Analyses that relate sea otter historical range with predictions from a habitat model in order to identify priority areas for sea otter protection should be considered when complete.

5.4 Elasmobranchs

There are 14 species of sharks, three species of ray and ten species of skate found in B.C. waters (Benson *et al.*, 2001). This group exhibits a large diversity of habitat and life histories. There is a general lack of knowledge about critical habitat for the members of this group. Further discussion regarding IAs for elasmobranchs can be found in the next section (5.5 Groundfish).

5.5 Groundfish

There is an extremely high diversity of groundfish species found within PNCIMA relative to Eastern Canada and an abundance of commercial fisheries data for this group. Groundfish trawl catch data needs to be evaluated considering management fishing restrictions and gear selectivity to separate fish density spatial distributions from fishing effort distributions, which has not been done to date. Many of the groundfish experts consulted felt that the narrow continental shelf and the high diversity of groundfish species in B.C. did not easily lend itself to IA identification for individual groundfish species. Quantitative methods to identify IAs may not be the most suitable approach for groundfish at this time because of the group's species diversity and data characteristics. After consultation with experts, we felt it was inappropriate to identify IAs based on high densities of catches as a proxy for aggregations. There are various options that we suggest might be explored. For example, cluster analysis or density analysis of the groundfish trawl data may give a clearer picture of aggregations, identify ecological groupings rather than taxonomic ones, and allow identification of the main species indicative of each grouping. We also suggest species-specific analysis where appropriate. The groundfish stock assessment division is currently investigating visual surveys such as ROV and submersible data collection methods as a means of complementing trawl sample data. It was also suggested that habitat-based assessments will assist in addressing integrated management research questions (J. Fargo, DFO, Nanaimo, pers. comm.). Atlases such as those created under the Marine Matters project (Marine Matters, 2004) may prove to be extremely useful in the EBSA identification process. Under this project, the Gwaii Haanas groundfish atlas will be made available online when funding has been secured, and this database can then be included in future rounds of EBSA identification.

The most recent information available to us about life history stages for groundfish was a 1985 map folio published by the West Coast Offshore Exploration Panel. Groundfish spawning and juvenile rearing areas were identified for rockfish, lingcod, Pacific cod, sole, halibut, pollock, hake and sablefish by some undocumented form of Delphic exercise (West Coast Offshore Exploration Panel, 1985). These areas were deemed to be acceptably accurate (i.e. best data currently available) by experts in the groundfish Stock Assessment Division for use in the EBSA process (J. Fargo and A. Sinclair, DFO, Nanaimo, pers. comm.). In their opinion, there is little additional information that would change the areas identified for spawning and rearing in the original report. The spawning and rearing areas detailed in the original map folio were hand-digitized in ArcView 3.2. The resultant maps were provided to the groundfish division in order for the appropriate experts to vet the areas identified and assign EBSA rankings. During this process, the original areas' boundaries were not modified but in some cases, areas were removed because they were no longer considered valid.

Based on this reference, IAs were identified for Pacific Cod (*Gadus macrocephalus*), Walleye Pollock (*Theragra chalcogramma*), Lingcod (*Ophiodon elongatus*), Sablefish (*Anoplopoma fimbria*) and Pacific Halibut (*Hippoglossus stenolepis*) as single species IAs. The other maps represent more than one species, such as the 'sole' grouping, which consists of Arrowtooth flounder (*Atheresthes stomias*), Petrale sole (*Eopsetta jordani*), Butter sole (*Isopsetta isolepis*), Rock sole (*Lepidopsetta bilineata*), Dover sole (*Microstomus pacificus*), and English sole (*Parophrys vetulus*). 'Rockfish' consists of three species: Pacific Ocean perch (*Sebastes alutus*), Yellowtail rockfish (*Sebastes flavidus*), and Yellowmouth rockfish (*Sebastes reedi*). The areas identified in the map folio for Hake largely fall outside PNCIMA, and are considered separately under pelagic fish (Section 5.7).

Three areas were identified for Pacific cod; a large shallow water rearing area in Hecate Strait and two smaller spawning and rearing areas around Goose Island Bank and Cook Bank (West Coast Offshore Exploration Panel, 1985). All three IAs were ranked high in Uniqueness, Aggregation and Fitness Consequences (Map 16) (A. Sinclair, DFO, Nanaimo, pers. comm.). For walleye pollock, six areas were identified; four areas for their spawning and rearing and two as rearing areas (West Coast Offshore Exploration Panel, 1985). These six areas are moderate ranked IAs for Aggregation (Map 17). A single IA was identified for spawning and rearing for lingcod (West Coast Offshore Exploration Panel, 1985) and was ranked high in Uniqueness (Map 18). Three large spawning and rearing IAs were identified for sablefish (West Coast Offshore Exploration Panel, 1985) and were ranked high in all three EBSA criteria (Map 19). Two spawning areas and a single rearing area were identified as IAs for Pacific halibut (West Coast Offshore Exploration Panel, 1985), and were ranked high for Uniqueness and Fitness Consequences (Map 20). A total of four IAs were identified for sole (Map 21). Two areas were identified as spawning and rearing areas, a single area for spawning and a single area for rearing (West Coast Offshore Exploration Panel, 1985). The northwest Queen Charlotte Island spawning area was ranked moderate in all three EBSA criteria. The Hecate Strait rearing area was ranked high in all three EBSA criteria. The two remaining areas were ranked high for Fitness Consequences.

Rockfish are traditionally divided into three groupings, based on their life history characteristics and habitat preferences: Inshore, Shelf and Slope rockfish. Inshore rockfish should be examined at the CMA-level and consider the Rockfish Conservation Areas designated by DFO. In spite of the large diversity of rockfish, the map folio stated that only three species of rockfish were represented, Pacific Ocean perch, Yellowtail rockfish, and Yellowmouth rockfish (West Coast Offshore Exploration Panel, 1985). Four spawning and two rearing IAs were identified for rockfish (West Coast Offshore Exploration Panel, 1985) and all were ranked high in Uniqueness, Aggregation and Fitness Consequences (Map 22).

5.6 Structural Habitat-Forming Species

5.6.1. Sponges

Sponges carry out all non-larval life history functions in the area where settlement occurs. Sponge reef bioherms were only recently discovered (1987-1988) in the deep water troughs of Hecate Strait and Queen Charlotte Sound (Conway *et al*., 1991). They were previously thought not to have existed for millions of years and are believed to be hundreds, if not thousands, of years old (Conway, 1999). These reef-forming species are significant at a global scale. The sponges that comprise the hexactinellid sponge reefs are unique habitat-forming species, long-lived and highly sensitive to disturbance. Individual species are not unique to the bioherms, but the bioherms themselves are unique. The five known PNCIMA hexactinellid sponge reef complexes are in Hecate Strait and Queen Charlotte Sound, and have been identified as marine protected areas of interest by Jamieson and Chew (2002). In addition to their significance based on their own ecology, sponge reefs are also habitat-forming structures that provide relatively high habitat complexity and likely support diverse communities not found elsewhere. Therefore, all known sponge reef representatives were considered IAs because they rank high in Uniqueness, Aggregation, Naturalness and very low in Resilience (Map 23).

Cloud sponge bioherms were recently discovered in Howe Sound and the Georgia Basin (Conway *et al.* 2005). The geomorphology of glaciated channels that causes consistent upwelling of cold seawater from depths seem to be the physical conditions necessary for the formation of boot and cloud sponge bioherms. Howe Sound falls outside PNCIMA but there are areas within PNCIMA which have yet to be explored by divers that possess similar conditions to Porteau Sill in Howe Sound. These PNCIMA areas were identified based on examination of hydrographic charts (Map 24) and are considered moderate value IAs for their possible regional and national uniqueness and the aggregation of unique communities associated with their structural complexity (J. Marliave, VAMSC, Vancouver, pers. comm.). The possible cloud sponge IAs mapped are actually larger than those identified by the expert in order to display them at a Large Ocean Management Area (LOMA, e.g., PNCIMA) scale.

5.6.2. Corals

The abundance and diversity of cold water corals has only recently been recognized. Azooxanthellate cold water corals are often below the photic zone and do not photosynthesize, unlike tropical zooxanthellate corals, which have a symbiotic relationship with photosynthetic organisms called zooxanthellae, (unicellular dinoflagellate algae that live in the gastroderm of reef-building corals). Once settlement occurs, individual azooxanthellate corals, like sponges, are completely dependent upon the passive supply of food. Some cold water coral species are habitat-forming and support unique communities of organisms. Cold-water coral communities are typically long-lived, slow growing and highly sensitive to physical disturbance (Freiwald *et al*., 2004). The identification of aggregations of corals in B.C. to date is based on work by Ardron and Jamieson (2004) analyzing groundfish trawl bycatch data. Their analysis identified 12 areas that contain 90% of the coral and sponge trawl bycatch by weight. Nine of these areas fall within the PNCIMA boundary, all of which were identified as IAs for their high Aggregation and Fitness Consequences (Map 25). The boundaries for these areas were provided directly by the Living Oceans Society (J. Ardron, LOS, Sointula).

5.6.3. Macrophyte Beds

Kelp and eelgrass beds are generally widespread along the entire coastline, so ecologically significant areas would be those that exhibit higher productivity, higher density of beds or those that are temporally stable. A complete dataset of kelp or seagrass beds does not yet exist for this region. Data exists at various scales and have varying degrees of accuracy but as of yet, the entire coast has not been examined. Some datasets available now may be sufficient for CMA-scale EBSA projects. At the PNCIMA scale, density analysis may lead in the future to identification of IAs for macrophyte beds but such an analysis was not available at this time.

5.7 Pelagic Fish

Pacific hake (*Merluccius productus*) consists of two stocks in B.C. waters: one in the Strait of Georgia and an offshore stock (DFO, 2003a). Hake are a migratory species, moving northwards into BC waters from May-September to feed on krill. There is some evidence of a small number of resident populations in BC waters (K. Cooke, DFO, Nanaimo, pers. comm.). Hake spatial distribution in PNCIMA is in deep water areas such as the troughs of Queen Charlotte Sound. There is large interannual temporal variability in hake abundance. Their northern limit to distribution is Queen Charlotte Sound in most years, but hake can reach as far north as Dixon Entrance during warm El Nĩno years (K. Cooke, DFO, Nanaimo, pers. comm.). Two IAs in Queen Charlotte

Sound were identified for their moderate rankings in all three criteria. A third IA was identified in Dixon Entrance but is ranked low on all three criteria because of its variable temporal nature (Map 26). Surveys conducted in the summer of 2005 revealed a new distribution for hake; they were found in shallow waters and more inshore than during any previous survey. Researchers speculate that the change may be related to warmer ocean temperatures. (K. Cooke, DFO, Nanaimo, pers. comm.).

Pacific herring (*Clupea pallasi*) has been an important part of the commercial fishing industry for more than 100 years, with catch records dating back to 1877 (Schweigert, 2004). It is one of the most data-rich fisheries encountered during the EBSA project. The areas identified as IAs for herring were based on four life history processes: spawning, rearing, migration and feeding. The herring fishery and spawn-on-kelp fishery is managed with spawning distribution and abundance databases and the commercial fishery logbook programs, including both herring fishery catch and herring bycatch from other fisheries. Research surveys and offshore hydroacoustic surveys also serve to inform herring management (B. McCarter, DFO, Nanaimo, pers. comm.). Herring are concentrated in certain areas of the coast during spawning. There are five major spawning areas for herring stocks in B.C and three of these areas are within the boundaries of PNCIMA (T. Theirrault, DFO, Nanaimo, pers. comm.). After hatching, herring larvae are advected with the currents out from the hatching site and juveniles are found in the areas surrounding the hatching areas. The major spawning areas and the surrounding rearing areas were identified as IAs for their high rank in Uniqueness, Aggregation, and Fitness Consequences (Map 27). In addition, three unique spawning areas were identified as IAs. These spawning aggregations are considered unique because of their timing and genetics (Doug Hay, DFO, Nanaimo, pers. comm.; Tom Therriault, DFO, Nanaimo, pers. comm.). During the summer months, adult herring feed in high densities at around 100 m depth (D. Hay, T. Theirrault, J. Schweigert, DFO, Nanaimo, pers. comm.). Four summer feeding areas were identified as herring IAs of moderate value and the Langara Island feeding area was identified as a low value IA. Finally, tagging studies have shown that a major migration route for herring is through the bottleneck of Queen Charlotte Strait and Johnstone Strait (B. McCarter, DFO, Nanaimo, pers. comm.). Their high aggregation in this area and lack of alternate routes is the rationale for identification of this area as a high value IA. An unknown degree of migration is believed to occur through Hecate Strait, along the north and east coasts of Vancouver Island and through Juan de Fuca Strait (J. Schweigert, DFO, Nanaimo, pers. comm.).

Pacific sardine (*Sardinops sagax*) is a migratory fish that breeds in California and migrates to BC waters in the summer to feed. Similar to hake, the northern limit of their distribution is dependent on water temperature and therefore can extend into Dixon Entrance in warm El Nĩno years (DFO, 2004d). There were no areas within the sardine summer distribution that rank highly according to the EBSA dimensions (J. Schweigert, DFO, Nanaimo, pers. comm.). Therefore no IAs were identified for sardines at this time.

5.8 Invertebrates

5.8.1. Low Mobility Marine Invertebrates

Species in this group perform all their life history stages in the general area where settlement occurred. Thus, life history events are not performed in separate areas – feeding, reproducing, etc., all must occur at the same location. Dispersal is achieved as planktonic larvae and in most species, dispersal distances have not been investigated. These species survive after settlement in areas where a combination of physical factors creates suitable habitat. There is some anecdotal evidence to suggest there are separate juvenile habitats for sea cucumber (C. Hand, DFO, Nanaimo, pers. comm.). Some species (e.g. sea cucumber and abalone) have juveniles that exhibit a different suite of behaviours than adults to make them more cryptic. This cryptic juvenile behaviour, coupled with their smaller sizes, presents problems in identifying significant juvenile habitats and determining population abundance estimates as juveniles are often missed or excluded from survey data.

IAs for this group may be those beds or habitats that support a high density, full age structure, larger growth, greater productivity, or act as source populations (those that produce successful recruits for other areas). However, for those species exploited by fisheries, the current age structure may not be natural and the density may be altered, so these measures may not be particularly useful for IA identification. Genetic differences, caused by the limits of larval dispersal, may be considered in the future.

The Manila clam, *Venerupis phillipinarum*, was introduced to BC in the 1930s with imported oyster seed and now supports a commercial fishery. Manila clam are found in the upper intertidal zone of mixed sand, mud and gravel beaches (DFO 2005a). Survey data for this species dates back to 1990 (N. Bourne, DFO, Nanaimo, pers. comm.). Concentrations of productive beds are found in the Bella Bella area and this area was identified as an IA for its high Aggregation (Map 28). This is also the most northern population of commercially harvested Manila clams in BC (N. Bourne, DFO, Nanaimo, pers. comm.).

Razor clams, *Siliqua patula*, are found from California to Alaska on high wave action, sandy beaches from the mid-intertidal to 20m depth (DFO 2005). The largest stock in BC occurs from Massett to Rose Spit in Haida Gwaii (G. Gillespie, DFO, Nanaimo, pers. comm.). The fishery for this stock is jointly managed by the Council of the Haida Nation and DFO. This area was therefore identified as an IA for its high Uniqueness and Aggregation (N. Bourne & G. Gillespie, DFO, Nanaimo, pers. comm.) (Map 29).

Other species of intertidal clams are present in PNCIMA but are considered ubiquitous throughout the study area (N. Bourne & G. Gillespie, DFO, Nanaimo, pers. comm.). These include the butter clam, (*Saxidomus gigantean*), littleneck clam (*Protothaca staminea*), softshell clam (*Mya arenaria*) and cockles. Therefore, no IAs were identified for these species at this time.

Geoduck clam, *Panopea abrupta*, is widely distributed from Alaska to the Gulf of California in sandy habitats from the intertidal zone to 110 m depth (DFO, 2000b). In PNCIMA the geoduck population seems to consist of a few discrete stocks, based on genetic studies (C. Hand, DFO, Nanaimo, pers. comm.). The locations of geoduck beds are protected by confidentiality agreements so IAs were identified as aggregations of high productivity and/or high density beds (C. Hand, DFO, Nanaimo, pers. comm.). A single area was identified as an IA for geoduck clams because of its high ranking in Aggregation (Map 30).

Four species of scallop occur in PNCIMA: pink scallop (*Chlamys rubida*), spiny scallop (*Chlamys hastata*), rock scallop (*Crassadoma gigantea*) and weathervane scallop (*Patinopecten caurinus*). There is limited trawl and dive fisheries for scallops however there are no areas in PNCIMA that were identified as IAs for these species (R. Lauzier, DFO, Nanaimo, pers. comm.).

The Olympia oyster, *Ostrea conchaphila*, is listed by COSEWIC as a species of Special Concern (Environment Canada 2004a). Klaskino Inlet hosts large populations with diverse age classes and consistently reproducing animals (G. Gillespie, DFO, Nanaimo, pers. comm.). This area was identified as an IA for its high Uniqueness and Aggregation (Map 31).

The only commercially harvested sea cucumber in BC is the giant red sea cucumber, *Parastichopus californicus*. Sea cucumber harvest bed locations are also protected by confidentiality agreements. Two IAs are identified for sea cucumber based on the concentration of productive and high density beds (Map 32). More detailed analysis could be done to compare the IA ranking on a bed-by-bed basis for CMA-level IA initiatives for both geoduck and sea cucumber (C. Hand, DFO, Nanaimo, pers. comm.).

The northern or pinto abalone (*Haliotis kamtschatkana*) is listed as threatened under Schedule 1 of SARA (Environment Canada, 2004b). In British Columbia, northern abalone is mostly found at less than 10 m depth, preferring rocky substrate in areas with a certain degree of exposure (Mottet 1978, Jamieson 2001). At the time of evaluation for COSEWIC, Jamieson (2001) estimated that population abundance was at less than 5% of pre-exploitation levels. The data available for the IA identification process include two types: fishery independent research surveys and fisher logbook data. Fishery-independent surveys have been conducted by DFO from 1978 to the present (See Campbell, 2000, for list of survey references). Originally, these were surveys of a set of index sites performed every 3-5 years. In recent years, researchers have made efforts to expand to other sites in an attempt to survey the entire BC coast (J. Lessard, DFO, Nanaimo, pers. comm.). Fisher logbook data is available from 1977-1990, after which the fishery was closed (Campbell, 2000). As part of the EBSA project, the DFO Shellfish Stock Assessment Division used the fisher logbook data to create a database with statistical sub-area and corresponding catch and effort data for use in ArcView GIS presentation and analysis (L. Barton, DFO, Nanaimo, pers. comm.). All areas of the PNCIMA coastline less than 10 m in depth are potential abalone habitat and are considered equally important to the recovery of the species (A. Campbell, J. Lessard, DFO, Nanaimo, pers. comm.). The extremely low population density and the conservation status of this species, combined with the lack of surveys in large portions of the study area, resulted in no areas being distinguished as IAs for abalone at this time.

Green sea urchin, *Strongylocentrus droebachiensis*, is distributed on the Pacific coast from northern Washington to Alaska. This species prefers intertidal habitats less than 140 m in depth and may seasonally migrate from shallow to deep water habitats (DFO, 2003b). Green sea urchins have a patchy local distribution, related to bottom topography and current speed (I. Perry, DFO, Nanaimo, pers. comm.). The Queen Charlotte Strait-Johnstone Strait area supports high density and highly productive green sea urchin populations. This area is also considered a core fishing region, producing high yields (DFO, 2003b). This area was identified as an IA for its high Aggregation and Fitness Consequences (Map 33). An additional area in the Prince Rupert area was also identified as a green sea urchin IA because it supports dense aggregations of sea urchin and ranks high in Aggregation and Fitness Consequences (Map 33).

The red sea urchin, *Strongylocentrotus franciscanus*, is the largest sea urchin species in BC. It is widely distributed from Baja California to Alaska and from the Aleutian Islands to Japan (DFO 2005b). The red sea urchin prefers rocky habitats in moderate to strong currents. Red sea urchins are harvested for their roe in a dive fishery. No areas were considered significant for this species and therefore no IAs are identified at this time (D. Leus, DFO, Nanaimo, pers. comm.).

5.8.2. Mobile Marine Invertebrates

Within the mobile marine invertebrates group, there is a large diversity of life history strategies. Most have a highly dispersive planktonic larval stage, but the degree of adult mobility varies between species. Relative mobilities are quite different, from large crabs and squid that can make long distance seasonal migrations to species (e.g. red rock crabs) that tend to stay in local areas. Except for commercially exploited species, very little is known about the life history functions of the majority of this group. Some species will be more similar to sessile invertebrates while others have separate areas for different life history stages. Therefore, not all life history functions are applicable to all species included within this group. Further examination of bycatch data may prove useful in identifying IAs for species not commercially exploited.

Three species of crab are exploited commercially in the PNCIMA region: Dungeness crab, *Cancer magister*, and Tanner crabs, *Chionoecetes tanneri* and *C. bairdi*. Highly productive areas from the fishing logbook data and research surveys conducted by DFO were used to identify IAs for Dungeness and Tanner crabs. (A. Phillips, DFO, Nanaimo, pers. comm.). Two IAs were identified for Dungeness crab (Map 34). The Hecate Strait area represents the major fishing grounds for this species with significant adult aggregations found in the shallow waters of Dogfish Bank. McIntyre Bay has been identified as a significant area of aggregation for adult crabs. This area and the larger oceanographic eddy found in this location have been identified previously as an area of retention for crab larvae (Crawford and Jamieson, 1996). This feature has been captured in the oceanography section (Section 5.10). Thus, the Hecate-Dogfish area was ranked high in Uniqueness, Aggregation and Fitness Consequences. The second area is Prince Rupert harbour, which is also a major fishing ground and supports significant aggregations of Dungeness crab. This area was ranked moderate for Uniqueness, Aggregation and Fitness Consequences. Tanner crabs support an exploratory fishery and as yet, there is not much information available about these species. IA identification for tanner crabs is based on research surveys done on the continental shelf break. The entire shelf break region was identified as an IA for these species, though this area may be modified following future research (Map 35).

There are seven species of shrimp (Family Pandalidae) exploited commercially by the trawl and trap fisheries in PNCIMA. The identification of IAs for this group was based on both trawl industry logbooks and research trawl data. Shrimp are found in soft-bottom habitats of 50-200m depth (D. Rutherford, DFO, Nanaimo, pers. comm.). The prawn, *Pandalus platyceros*, is targeted by the trap fishery, which catches humpback shrimp as bycatch. Prawns are found in rocky bottom habitats mostly within a depth range of 50-70 m. Three PNCIMA areas were identified as IAs for shrimp: 1) Prince Rupert/Chatham Sound, 2) Queens Sound/Calvert Island and 3) Queen Charlotte Strait (Map 36). These areas were ranked low for Uniqueness and Aggregation. The Prince Rupert/Chatham Sound area has the largest diversity of shrimp species and abundant humpback shrimp. Humpback shrimp, *Pandalus hypsinotus*, have a narrower distribution than the other species so areas where this species are concentrated were considered unique (D. Rutherford, DFO, Nanaimo, pers. comm.). Drury Inlet (Statistical Area 12), within the larger Queen Charlotte Strait EBSA, has the largest catch and the most productive prawn trap area, as well as containing humpback shrimp. The Queens Sound/Calvert Island EBSA supports aggregations of sidestripe shrimp, spiny pink shrimp and smooth pink shrimp (D. Rutherford, J. Boutillier, DFO, Nanaimo, pers. comm.). There are other small areas of shrimp aggregation known to shrimp researchers but these are too small for the scale of the current EBSA identification initiative (J. Boutillier, DFO, Nanaimo, pers. comm.).

5.9 Turtles

The North Pacific population of the leatherback turtle (*Dermochelys coriacea*) is listed as endangered by COSEWIC. Breeding and nesting occur in southern latitudes and animals migrate to northern Pacific latitudes to feed on jellyfish and other gelatinous prey (Fisheries & Oceans Canada and the Pacific Leatherback Turtle Recovery Team, 2004). Abundance and spatial distribution of leatherback turtles in B.C. waters is unclear as sighting reports remain few and distributional data on their main prey species (primarily large semastosome jellyfish) is sparse (L. Spaven, DFO, Nanaimo, pers. comm.). Seasonally, the majority of leatherback turtles are sighted from June through September and most appear to be adults (L. Spaven, DFO, Nanaimo, pers. comm.). Little is understood about the spatial distribution of juveniles and young adults and it is unknown whether they too migrate as far north as B.C. (Fisheries & Oceans Canada and the Pacific Leatherback Turtle Recovery Team, 2004).

Sightings data for leatherback turtles have been collected by DFO in partnership with the Cetacean Sightings Network (BCCSN) at the Vancouver Aquarium over the past several years. Although several sightings are reported annually it remains difficult to draw any conclusions about possible significant areas for this species (L. Spaven, DFO, pers. comm.). A large IA was suggested that includes areas where turtles have been repeatedly sighted (N. Pinnell, VAMSC, Vancouver; L. Spaven, DFO, Nanaimo, pers. comm.) (Map 37). This area was ranked high for Uniqueness and Fitness Consequences. The use of other areas by this species is unclear and the importance of such areas to turtles should not be disregarded. Turtles have also been sighted at lower frequency in other locations within PNCIMA. Surveys and sightings solicitation from the public are ongoing in hopes of filling some of the knowledge gaps for this species. Prey-based modelling studies, currently underway, and habitat classification may yield better data on which to base IA identification for turtles.

5.10 Oceanographic Features

Unique physical features may be considered ecologically important because they can be used as an easily measurable proxy for biological attributes. These physical features may offer special conditions that in turn support ecologically significant communities. Many physical oceanographic features such as eddies and current systems are mechanisms by which marine productivity is concentrated or the means by which recruitment is achieved (W. Crawford and D. Mackas, DFO, Sidney, pers. comm.). The presence of these features is often the basis of the population dynamics and spatial structure of the biological community (Crawford & Jamieson, 1996). Experts identified ten oceanographic IAs for their unique characteristics, both regionally and nationally, and for their characteristics that concentrate productivity (Aggregation) (Map 38).

The large IA that covers the upper continental shelf and the canyons/troughs of Queen Charlotte Sound is an area of high aggregation of macrozooplankton (D. Mackas, DFO, Sidney, pers. comm.). The tip of Cape St. James is an area where the Haida eddies are formed. These eddies act as a center of transport because they concentrate plankton and transport them from PNCIMA into the Gulf of Alaska (W. Crawford, DFO, Sidney; I. Perry, DFO, Nanaimo, pers. comm.). The area surrounding the Scott Islands is an area of significant tidal mixing that drives high productivity (W. Crawford, DFO, Sidney. pers. comm.). Dogfish Bank is the largest shallow bank in the region and serves as a larval rearing area for a large diversity of invertebrate species (W. Crawford, DFO, Sidney, pers. comm.). McIntyre Bay has previously been identified as an IA for Dungeness crab. Eddies that occur here have been shown to concentrate decapod larvae and support aggregations of a diversity of plankton (Crawford and Jamieson, 1996; I. Perry, DFO, Nanaimo, pers. comm.). Learmouth Bank is an isolated bank that acts to trap a diversity of plankton in the surrounding water (W. Crawford, DFO, Sidney, pers. comm.). The narrow band in Hecate Strait is a tidal front, effective from spring through fall, which accumulates zooplankton (Perry & Waddell, 1997; I. Perry, DFO, Nanaimo, pers. comm.). Brooks Peninsula often has an offshore flow of nearshore waters and is a significant north/south boundary area for many eastern Pacific species (W. Crawford, DFO, Sidney; I. Perry, DFO, Nanaimo, pers. comm.). The entire mainland coast is an area of concentrated phytoplankton biomass and high primary productivity (D. Mackas, DFO, Sidney, pers. comm.). Two areas within this larger region were identified as IAs because they are areas of particularly high productivity as a result of tidal mixing (W. Crawford, DFO, Sidney, pers. comm.).

5.11 Parks Canada

Parks Canada identified four IAs for PNCIMA based on their National Marine Conservation System. The proposed Gwaii Haanas National Marine Conservation Area was ranked highly by Parks Canada for its Uniqueness. There are a number of smaller IAs within the boundaries of this proposed NMCA but at this time, Parks Canada does not wish to identify these until the negotiation process with the Haida First Nation has been finalized (N. Sloan, Parks Canada, Queen Charlotte City, pers. comm.). Therefore, the entire proposed Gwaii Haanas NMCA is proposed as an IA, with the boundary supplied directly by Patrick Bartier, Parks Canada (P. Bartier, PC, Map 39). In addition, three areas were identified as marine protected Areas of Interest in the central coast region of B.C. by Parks Canada (Booth, 1998; Parks Canada, 1999). These three areas: Laredo Sound, Goose Island Group, and Queen Charlotte Sound were identified as IAs for their Uniqueness (Map 39, T. Tomascik and M. Pellatt, Parks Canada, Vancouver, pers. comm.). Note that these three areas were proposed by Parks Canada through a process other than EBSA identification, and may not meet the EBSA requirements when examined further. The Parks Canada IAs were not subjected to the ranking process for these reasons, and their use in the next phase of EBSA identification should be further evaluated. For instance, representivity is a consideration in choosing areas for inclusion the National Marine Conservation System, while representivity is expressly not included in EBSA identification.

5.12 Provincial Government

IAs proposed by the B.C. Provincial Government were based on their Marine Ecological Classification project. Benthic ecounits were classified by combinations of depth, temperature, slope, current, substrate, exposure, and roughness. Pelagic ecounits were classified based on combinations of salinity and stratification. Suggested IAs were identified as those that are unique under this classification system on a province-wide scale (M. Zacharias, BC MSRM, Victoria, pers. comm.). To achieve this, GIS analysis was performed on the BC-MEC database to identify those ecounits that occur only once. The resulting ArcView shapefiles were provided directly and are presented in Map 40 (from R. Deegan, BC MSRM, Victoria). A total of 75 unique benthic ecounits were identified within PNCIMA (Map 40). Further analysis could be performed to locate aggregations of unique benthic ecounits. A single unique pelagic ecounit was identified, located at Salmon Bay, Johnstone Strait (inset, Map 40). As for Parks Canada IAs, the ecounits were not subjected to the ranking process.

6. Important Areas

The individual maps for each set of IAs will prove useful in risk management and impact mitigation. This dataset could be used as a checklist for managers responsible for impact mitigation when planning activities within PNCIMA. When considered together, the entire set of IAs almost entirely covers PNCIMA (Figure 2). Therefore, as expected, almost every area in PNCIMA is potentially significant for at least one species or habitat feature.

7.1. Important Area Analysis

In trying to follow the national guidelines for EBSA determination, it has become obvious to us that a phased approach to EBSA determination is necessary. The first phase, presented here, starts with the compilation of maps relating to habitat and species distributions within a particular region (IAs), as was done above. A Delphic approach was adopted and the opinions of species experts were obtained. Ranking and weighting of IAs within and among species was necessary, since EBSAs are areas of enhanced management and the entire coastal area cannot therefore be EBSAs. Completion of Phase 1 results in maps of ranked IAs for species and habitat features. The second phase, which will now be briefly discussed but which has yet to be done, involves moving from a set of IAs to identifying a logical and defensible EBSA network. Clearly defining overall conservation goals and specifying the criteria required to be considered in analyses are important next steps, and to achieve them requires input from scientists, managers and stakeholders. Examples of issues that need to be addressed are:

- What process is desired to determine the relative weighting to give layers representing different numbers of species? Options can be provided by researchers, but a nationally accepted process would seem desirable.
- Are some species (e.g. SARA-listed, charismatic species) to be given higher weightings? For example, does a coral species equal a SARA-listed killer whale? Again, final criteria should be nationally accepted.
- Is there some overall desired area of the coast that should ultimately be captured by EBSAs (e.g., 10, 20, 30 %).
- Is it acceptable to use an optimisation approach such as MARXAN to minimise the area defined as EBSAs while at the same time meeting the criteria desired by managers, some of which are perhaps outlined above.

Consensus is now required among researchers and managers to determine the national process to be used in identifying EBSAs from the mix of IAs identified during Phase 1 of the EBSA identification process.

To provide some initial insight into how such analyses might be conducted, and to obtain a feeling for PNCIMA data, analyses of IA data were initiated with the assistance of Murray Manson (DFO, Habitat Enhancement Branch, Vancouver, BC). However, as we have yet to obtain clear objectives from managers to focus our analyses, analyses done to date are simply for illustrative purposes of many of the issues that need considering. For example, overlapping IA layers shows those geographical areas that have the most IAs (see Figure 3a), while MARXAN analyses show those areas that are consistently identified as potential EBSAs, given a specific set (arbitrary to date) of specific management objectives to achieve (Figure 3b).

Once we have a final set of PNCIMA EBSAs identified, it will be possible to produce a wall map of Pacific Region EBSAs. This set can then be compared to 1) areas already protected by some level of legislation (marine protected areas) and 2) priority conservation areas identified by other organizations.

7. Caveats & Special Considerations

This report is Pacific Region's first attempt at the identification of EBSAs. In the process of trying to do so, we have identified IAs and have encountered significant data gaps. We also discuss here concerns voiced by regional science experts about the overall EBSA identification process.

7.1 Data Gaps

We first emphasise that the present report represents information and data available as of December 31, 2005. It is based on the expertise and advice of only those experts that we were able to include (Appendix I) given our timeframe for completion. For many species and habitat features, information desirable for IA identification has either not been collected, analyzed or was unavailable as a result of confidentiality agreements. In some cases, data had been obtained for the determination fishing management options, but had not been analysed for a purpose such as IA identification. Ideally, the identification of IAs would be based on all information, but what we present here is based on the best knowledge available to us. While a 'system document' is often needed for resource management decisions, deadlines for report preparation are often set independently of the actual pace of scientific study and data analysis (Muldoon, 1995). This was the case here – our requirement to have this report completed by Dec 31, 2005 did not consider the capabilities of other science staff to undertake new analyses in support of this deadline. Thus, IAs identified in this report should be considered dynamic, being the first step in an on-going process. We envision a final format that allows changes to be made to existing layers when new information becomes available and the addition of new species and habitat layers not available at the time of publication. IAs therefore may be subject to considerable change over time with the addition of new information. The maps of IAs produced here are thus envisaged as part of an adaptive framework which will be modified over time.

In light of the above, failure of an area to be declared an IA does not negate its ecological value. There was a great deal of concern expressed to us by experts that areas that did not make the list of IAs would never be given a later chance to become EBSAs or Marine Protected Areas. Some areas may fail to become EBSAs purely because of a lack of relevant available information about them. Areas may have escaped previous scientific investigation or industry focus as a result of their inaccessibility, poor fishing yields or a myriad of other reasons. All areas, regardless of identification status should be carefully considered in the ecological assessment and management phases of Integrated Management in PNCIMA.

Experts consulted were sometimes not able to provide information for the identification of IAs, and this created a challenge in ensuring that the best data possible was presented here. Some staff approached had schedules or locations that prevented them from meeting with us, and so input was sometimes obtained via email. Others were unable to do new analyses on their existing data to provide the data interpretations being requested without additional resources. Stock assessment databases are structured with a goal different from that required to support conservation biology queries. In some cases, data needs new analyses to provide the information being requested to address Ecosystem Based Management-related needs. In addition, confidentiality agreements created obstacles to obtaining some analyses.

7.2. Other Data Sources

Scientific Ecological Knowledge (SEK) was identified (DFO, 2004c) as knowledge that should be included in the EBSA identification process. SEK was the basis of the Delphic process employed here to identify IAs. It is not presently clear whether aboriginal knowledge and fishermen's knowledge, commonly referred to as Traditional and Local Ecological Knowledge (TEK and LEK, respectively), will be incorporated into the EBSA identification process. If so, when and what procedure would allow this to occur is another question that needs to be addressed. Such data were not included in this process because of time constraints. Significant effort will be required to obtain TEK and LEK, but this information should prove valuable in adding areas of significance for ecological or biological reasons, particularly at the Coastal Management Area (CMA) scale.

7.3. Scale

The issue of scale repeatedly came up in conversation during the IA/EBSA identification process. The objective of the project was to identify IAs on a PNCIMA-wide (Large Ocean Management Area (LOMA)) scale. However, the scale of IAs/EBSAs must also match the biology and ecology of species being considered. IA identification at the CMA scale would be a logical next step in the identification of locally significant areas. Scale is particularly relevant when considering shallow-water, near shore species, on a PNCIMA-scale map. At the LOMA scale, such areas are typically just a thin line. Also, for wide-ranging, low mobility or sessile species in this habitat, it is not clear whether they are adequately captured in IA-identification process. All estuaries are significant, as are eel grass and kelp beds, yet such features are seldom grouped enough at a LOMA-scale to allow their inclusion in mapping. It is presumed here that such features will later be captured at the CMA scale. Regardless, the ecological significance of such features is recognised, and to a large extent whether IAs or not, management already treats these as special features worthy of an enhanced level of management consideration.

As mentioned earlier, EBSA scale also differs between national regions. The two LOMAs on the east coast have a much larger area than does PNCIMA (Figure 1). Preliminary EBSA identification for GOSLIM included large EBSAs, whose polygon areas on a PNCIMA map would cover most of the IM area. The IAs identified for PNCIMA included a range of sizes, from very large IAs similar to the initial EBSAs identified in GOSLIM to much smaller regions not seen in other EBSA identification initiatives.

The data collected through the Delphic process was collected at a PNCIMA scale. Experts utilized paper maps of 1:300,000 to 1:400,000 scales to draw IA polygons. This process is likely to have a high degree of accuracy, in that the same areas would likely be chosen repeatedly by the same expert. However, the level of precision for this methodology is not high as the boundaries may change slightly with repeated attempts. It must be acknowledged therefore that boundaries of the identified IAs are thus approximate and the identified IAs are not meant to be viewed at different resolutions than those at which they were created.

7.4. Bias

A Delphic approach for the identification of IAs contains inherent biases that need to be acknowledged for results to be used appropriately. Species considered in the present analysis are only a very small subset of the species diversity present in PNCIMA. In most cases, species considered were macrofauna, and of these, exploited species predominated. It is hoped that habitats of species not directly targeted will be captured in some way by the IAs identified, but the extent to which this has occurred is unknown. Species with economic value have more information collected for them, but they may not necessarily be the most important ecologically in the habitats they occur in. Also, while some aspects of the habitat requirements for some of their life stages may be identified, often the habitat requirements of non-exploited life stages are unknown. There is also a bIAs towards charismatic species, such as marine mammals. Animals that capture the public's attention have often become the focus of concentrated research effort, meaning we know more about them relative to other species. In many cases, these iconic animals are top predators (e.g. killer whales) that have spatial distributions that are indicative of areas of high ecosystem productivity (e.g. feeding locations of baleen whales), but this has not always been verified.

There is also a spatial bIAs inherent to this IA identification process. Certain exploited areas, especially those supporting a diversity of commercial species and accessible to fisher and research harvesting gears, have more detailed information about them, and therefore are more likely to be identified as IAs. A major problem is that the IA process does not allow areas lacking information to be flagged. In future stages, data-deficient areas, some of which may be worthy of further study and special consideration under the precautionary principle, could be identified as IAs. With advances in technology, fishers are increasingly able to exploit previously unfished areas, such as deeper habitats. New species and species presence records are continually being described as a result of new surveys or better by-catch monitoring and species identification (J. Boutillier, DFO, pers. comm.). Thus, a lack of information about an area should not exclude its importance, as some of these areas may later be identified as needing enhanced management.

Determination of significant habitats might be partially achieved through a benthic habitat classification process based on existing physical oceanographic data, as proposed by Vlad Kostylev (Arbour and Kostylev 2002). This approach should identify habitats with unique geoclimatic characteristics, which in turn might be assumed to support unique biological communities. Biological data would be incorporated, permitting this approach to identify areas not presently surveyed that might contain features of interest, such as deep-water corals, that with field verification, could later justify them as being IAs.

7.5. Data Quality

The species and habitat features examined during the Pacific EBSA identification process are diverse in their data quality. One of the issues that arose was IA identification of data-rich versus data poor species and/or habitat features. The data quality of these groups can be viewed as a continuum with species such as the leatherback turtle on one end of the spectrum (data poor) and species such as herring at the other end (data rich). It became difficult to apply the EBSA dimensions in the same manner for the two levels of data quality, and we suggest that applying the same decision rules to each situation may not be best. For situations with high data quality, application of a qualitative Delphic approach may be less accurate then when highly specific quantitative decision rules could be used. The converse would apply for data poor situations.

The incorporation of a data quality ranking scheme attempts to capture these differences. We have not used this information in our analyses but it can be found in the associated attribute table for each GIS layer. Therefore there is the potential to use this information in identifying data-deficient areas, as flagged in section 7.4. This at least gives a measure of the data quality for each of the IAs that could be used later to analyze our IA determination process.

The ranking scheme employed in this project allowed a certain level of precautionary identification. Those areas which seem likely to be important habitats could be identified under the current decision model by using lower ranks for the IA criteria and data quality. The logical migration routes of gray whales are a good example. This flexible identification system was especially useful where those areas with less supporting evidence were given lowered rankings, but still included. In this way, areas with a dense number of lower ranking species-IAs could be put forward for enhanced management as PNCIMA-EBSAs.

8. Recommendations

1. At a national level, discuss and come to a consensus on the priorities and process for use in a Phase II analysis to move from IAs to EBSAs.
2. Geographical areas where there is a lack of information available should be flagged as priorities for future research consideration. In particular, bycatch data should be further analysed. Such areas may contain important species (e.g. corals), even if theses species are not presently of commercial importance.

3. The process to identify EBSAs for PNCIMA identified a need for consideration of a science data collection and analysis policy shift so that results more applicable to advancing Integrated Management rather than just Stock Assessment are provided. Much data held by DFO has only been used to date for species-specific stock assessments, and analyses have yet to be done that could support ecosystem-based management (EBM). Data confidentiality issues typically allow only specific people to access these data, and their work loads do not include analyses for EBM per se.
4. The IA/EBSA-identification process should be repeated at the CMA-scale, as many areas deemed important for species (e.g. nearshore ones) were too small for inclusion at a LOMA scale.
5. There is be need for a Phase 3 in EBSA identification to compare the final network of EBSAs with a) marine protected areas already identified by some level of legislation, and b) areas of interest for potential marine protected area designation, to determine how enhanced management for EBSAs can best be achieved.
6. The utility of TEK and LEK information for inclusion in EBSA determination should be assessed and if positive, a process developed to allow its incorporation.

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10. Tables

Table 1: Final EBSA layers and shapefile names

Layer	File name
Salmon	welch_salmon2.shp
Green sturgeon	welch_sturgeon2.shp
Eulachon	hay_eulachon2.shp
Birds	birds_pncima5.shp
Resident killer whale	resident_killerwhale5.shp
Sperm whale	ford_spermwhale2.shp
Humpback whale	humpback_whale7.shp
Blue whale	ford_bluewhale5.shp
Gray whale	ford_graywhale3.shp
Sei whale	ford_seiwhale.shp
Fin whale	ford_finwhale6.shp
Steller sealion	stellersealions_pncima2.shp
Fur seal	olesiuk_furseals4.shp
Sea otter	nichol_seaotters2.shp
Pacific cod	species_location_pacificcod2.shp
Ling cod	species_location_lingcod5.shp
Rockfish	species_location_rockfish2.shp
Sole and flounder	species_location_sole2.shp
Pollock	species_location_pollock2.shp
Sablefish	species_location_sablefish2.shp
Halibut	species_location_halibut2.shp
Sponge reef	sponge_reef_pncima.shp
Cloud sponge	marliave_cloudsponge2.shp
Bycatch areas	coral_sponge_pncima.shp
Herring	herring_pncima_new1.shp
Hake	cooke_hake11_pncima11.shp
Manila clam	manilaclam_pncima2.shp
Razor clam	razorclam_pncima2.shp
Geoduck	hand_geoduck_pncima.shp
Olympia oyster	gillespie_oyster_pncima3.shp
Sea cucumber	hand_seacuc_pncima.shp
Green urchin	perry_greenurchin_pncima3.shp
Dungeness crabs	phillips_dungeness_pncima.shp
Tanner crabs	phillips_tanner_pncima.shp
Shrimp	rutherford_shrimp5_pncima.shp
Leatherback turtle	spaven_leatherbackturtle3.shp
Oceanography	oceanography4.shp
Parks Canada	parks_canada3.shp
Pelagic ecounits	unique_pelagic_ecounits1.shp
Benthic ecounits	unique_benthic_ecounits2.shp

Table 2: Description of the field found in the EBSA shapefile data tables.

Field	**Type**	**Length**	**Description**
Shape			ArcView shape identifier
ID	Number	16	The number assigned to the polygon as it was digitized
Map#	Number	16	Cross-reference number for the hand-drawn polygon on the paper map
Species	String	20	The name of the species or habitat feature the polygon describes
Criteria	String	30	The EBSA criteria the polygon meets (Uniqueness, Aggregation, Fitness Consequences, Naturalness and/or Resilience)
Notes	String	30	Any notes on the polygon
Seasona	String	30	Any seasonal variation for the polygon
Scale	String	16	The scale at which the polygon was digitized
Expert	String	50	The name of the expert(s) responsible for identification
Unique	Number	16	Expert's ranking of the area based on the EBSA criterion "Uniqueness". An increasing scale from 1-10.
Aggreg	Number	16	Expert's ranking of the area based on the EBSA criterion "Aggregation". An increasing scale from 1-10.
Fitness	Number	16	Expert's ranking of the area based on the EBSA criterion "Fitness Consequences". An increasing scale from 1-10.
Natural	Number	16	Expert's ranking of the area based on the EBSA criterion "Naturalness". An increasing scale from 1-10.
Resil	Number	16	Expert's ranking of the area based on the EBSA criterion "Resilience". An increasing scale from 1-10. This criterion is an inverse where areas with higher resilience will have lower value as EBSAs.
Data	Number	16	The expert's opinion of the quality of data on which the area's identification was based. An increasing scale from 1-3.
Score	String	16	The area's cumulative value score based on the experts' ranking of the EBSA criteria (Low, Moderate and High value)

11. Figures

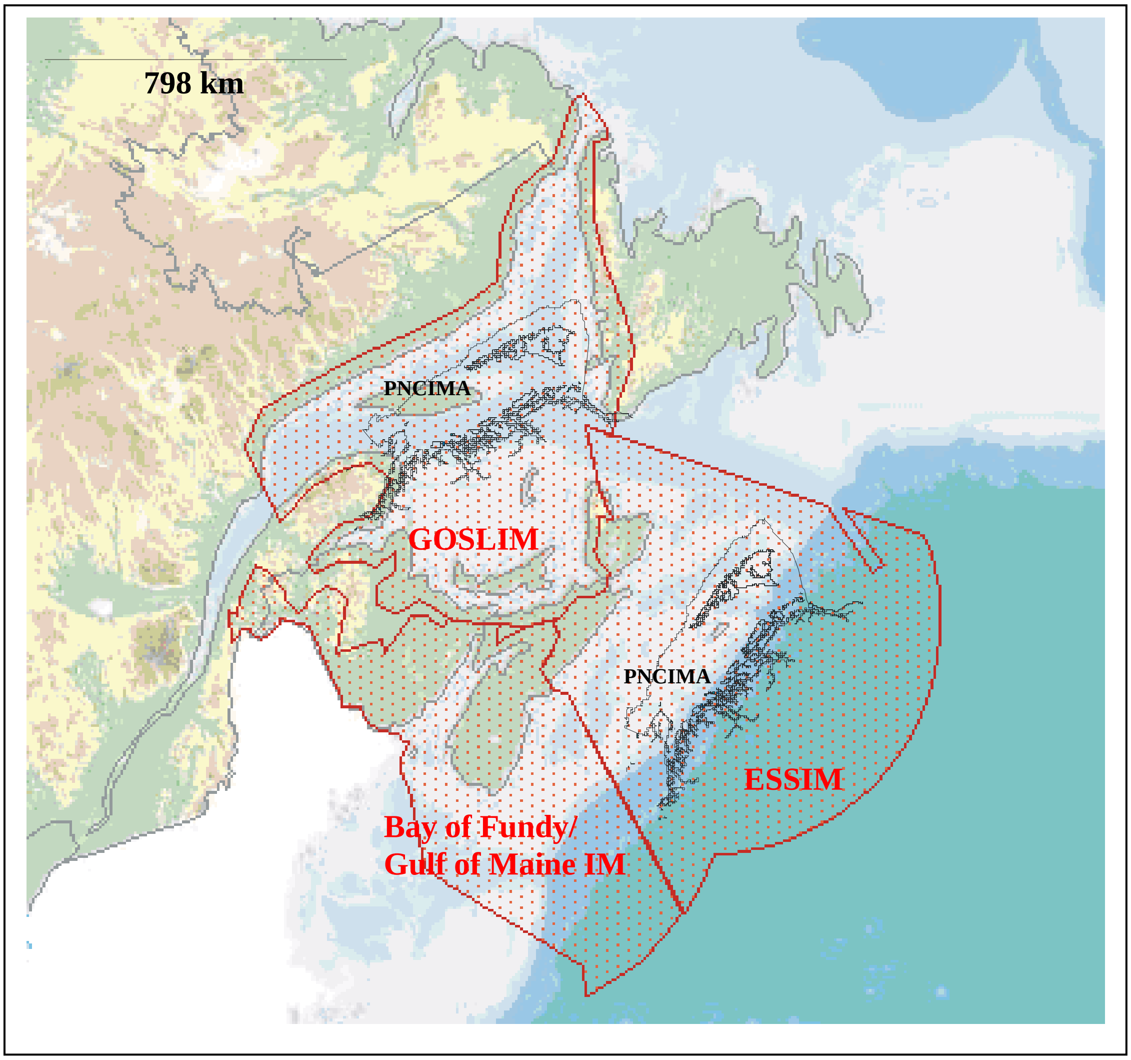

Figure 1: Map of East Coast Large Ocean Management Areas (LOMAs). GOSLIM and ESSIM boundaries in red with the EBSA boundary (black) overlaid at equivalent scales. Bay of Fundy/Gulf of Maine IM boundary also depicted.

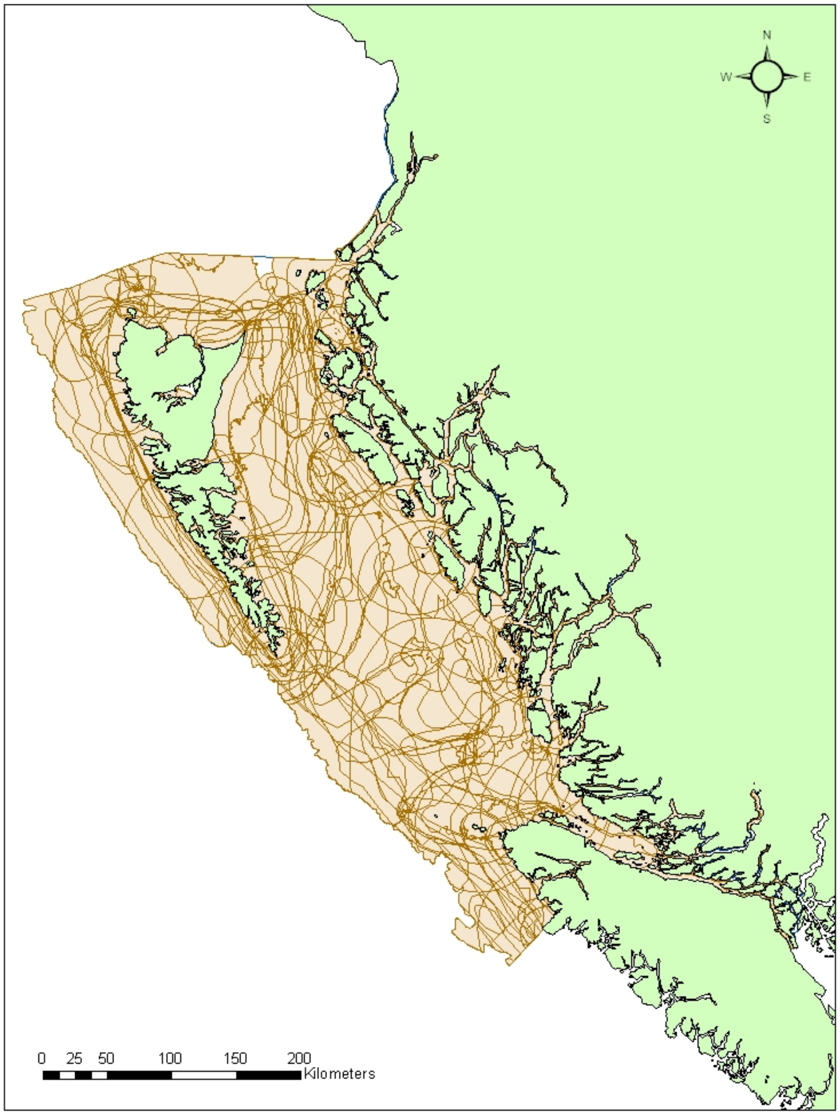

Figure 2: All species EBSAs overlaid on base map of PNCIMA.

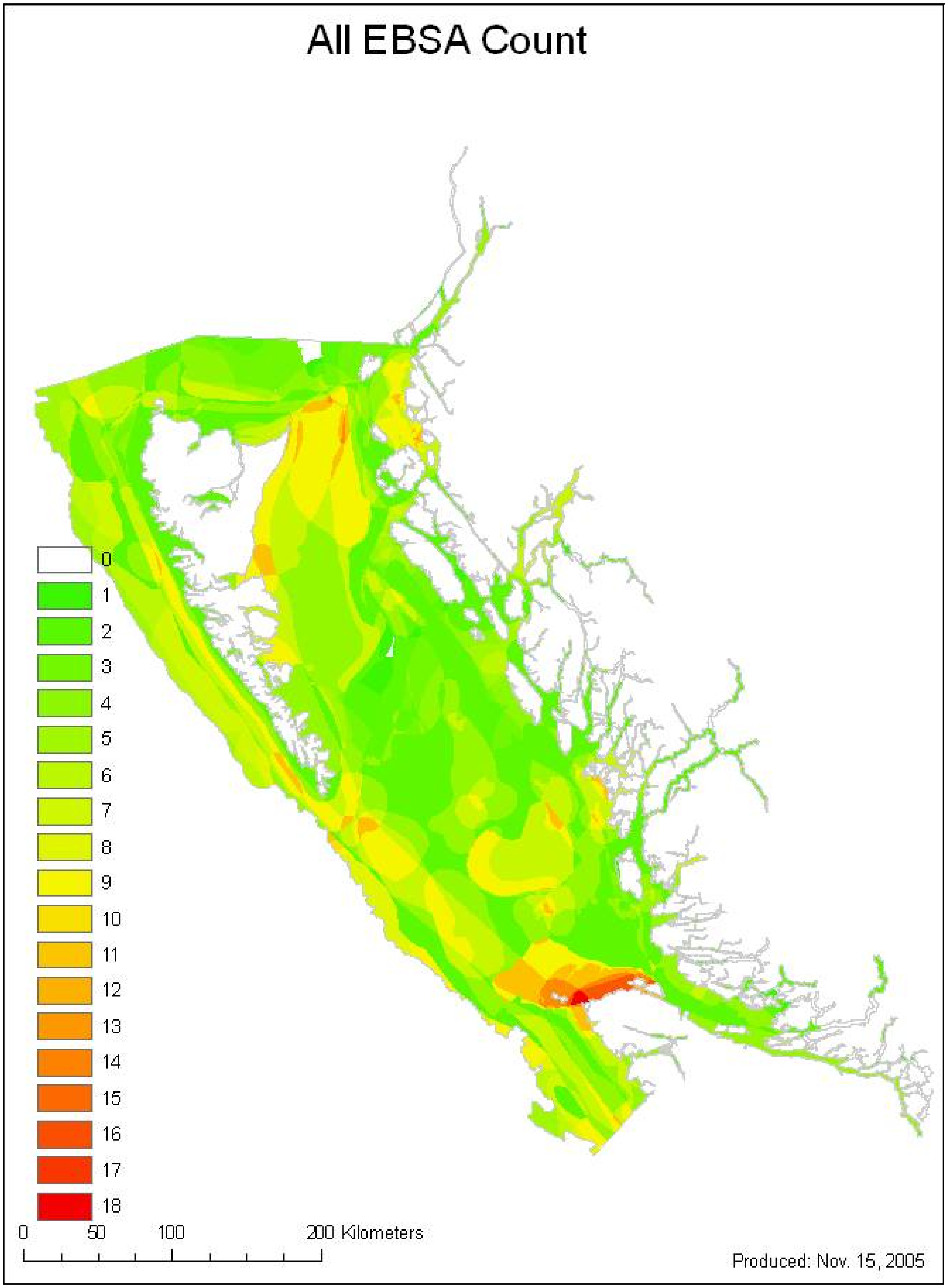

Figure 3a: Simple count of all EBSA polygons overlaid on base map of PNCIMA.

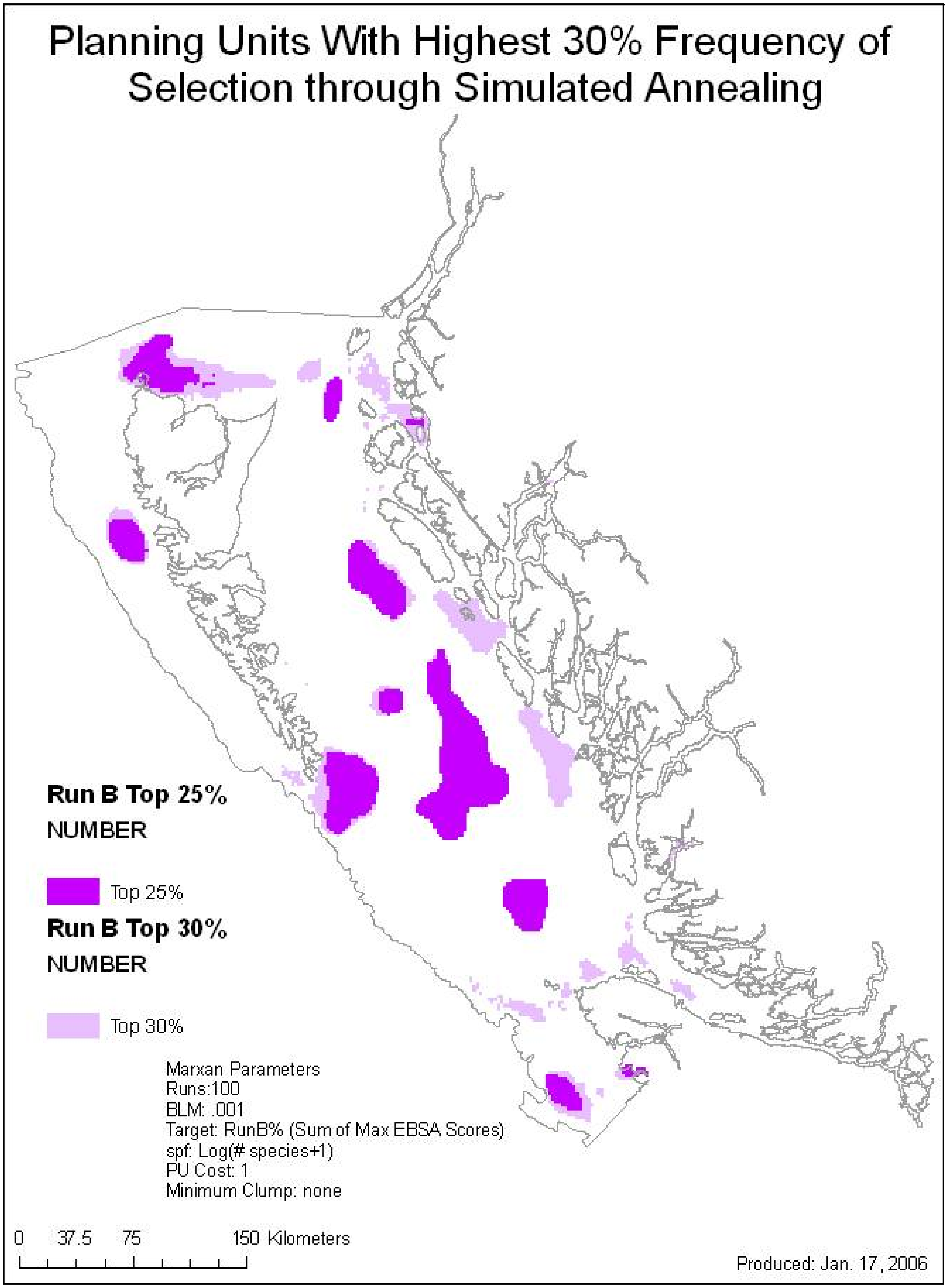

Figure 3b: MARXAN results from Run B, allowed to run 100 times with the following parameters: targets set at 100% of 'special concern' layers, 50% of 'listed' layers and 25% of all other layers. The penalty factor was set by using the log (# species+1) for each layer. The top 25 and 30% units chosen most frequently are displayed.

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Appendix I: List of Delphic participants that provided information.

Last Name	First Name	Organization
Ardron	Jeff	LOS
Austin	Bill	BCRM
Barrett-Lennard	Lance	VAMSC
Barton	Leslie	PBS
Bourne	Neil	PBS
Boutillier	Jim	PBS
Boyd	Sean	CWS
Campbell	Alan	PBS
Cooke	Ken	PBS
Crawford	Bill	IOS
Dunn	Mike	CWS
Ellis	Graeme	PBS
Fargo	Jeff	PBS
Ford	John	PBS
Gillespie	Graham	PBS
Gregr	Ed	UBC
Hall	Anna	UBC
Hand	Claudia	PBS
Hay	Doug	PBS
Hipfner	Mark	CWS
Jamieson	Glen	PBS
Lambert	Phil	BCRM
Lauzier	Ray	PBS
Lessard	Joanne	PBS
Leus	Dan	PBS
Mackas	Dave	IOS
Marliave	Jeff	VAMSC
McCarter	Bruce	PBS
Morgan	Ken	IOS/CWS
Nichol	Linda	PBS
Olesiuk	Peter	PBS
Payntor	Rob	BC MSRM
Peden	Alex	BCRM
Pellatt	Marlow	PC
Perry	Ian	PBS
Phillips	Antan	PBS
Pinnell	Nadine	VAMSC
Rutherford	Dennis	PBS
Sandilands	Doug	VAMSC
Schweigert	Jake	PBS
Sloan	Norm	PC
Spaven	Lisa	PBS
Theirrault	Tom	PBS
Tomascik	Tom	PC
Welch	Dave	PBS
Zacharias	Mark	BC MSRM

Organization Key

BC MSRM	BC Ministry of Sustainable Resource Management
BCRM	BC Royal Museum
CWS	Canadian Wildlife Service
IOS	DFO, Institute of Ocean Sciences
LOS	Living Ocean Society
PBS	DFO, Pacific Biological Station
PC	Parks Canada
UBC	University of British Columbia
VAMSC	Vancouver Aquarium Marine Science Centre

Appendix II: Layers considered in EBSA identification

Species	Species Groups	Physical Features	Organization-identified
Olympia oyster	Sponges	Oceanographic features	Parks Canada
Green sturgeon	Corals	Pelagic ecounits	
Eulachon	Macrophyte beds	Benthic ecounits	
Harbour porpoise	Elasmobranchs		
Dall's porpoise	Flatfish		
Pacific white-sided dolphin	Rockfish		
Killer whale	Roundfish		
Sperm whale	Sole		
Humpback whale	Scallops		
Gray whale	Salmon		
Blue whale	Shrimp		
Sei whale	Tanner crab		
Fin whale	Birds		
Harbour seal			
Steller sea lion			
Northern fur seal			
Sea otter			
Lingcod			
Pacific cod			
Halibut			
Pollock			
Hake			
Sablefish			
Red urchin			
Herring			
Sardine			
Geoduck			
Sea cucumber			
Abalone			
Green sea urchin			
Razor clam			
Manila clam			
Dungeness crab			
Leatherback turtle			

Appendix III: Map Folio

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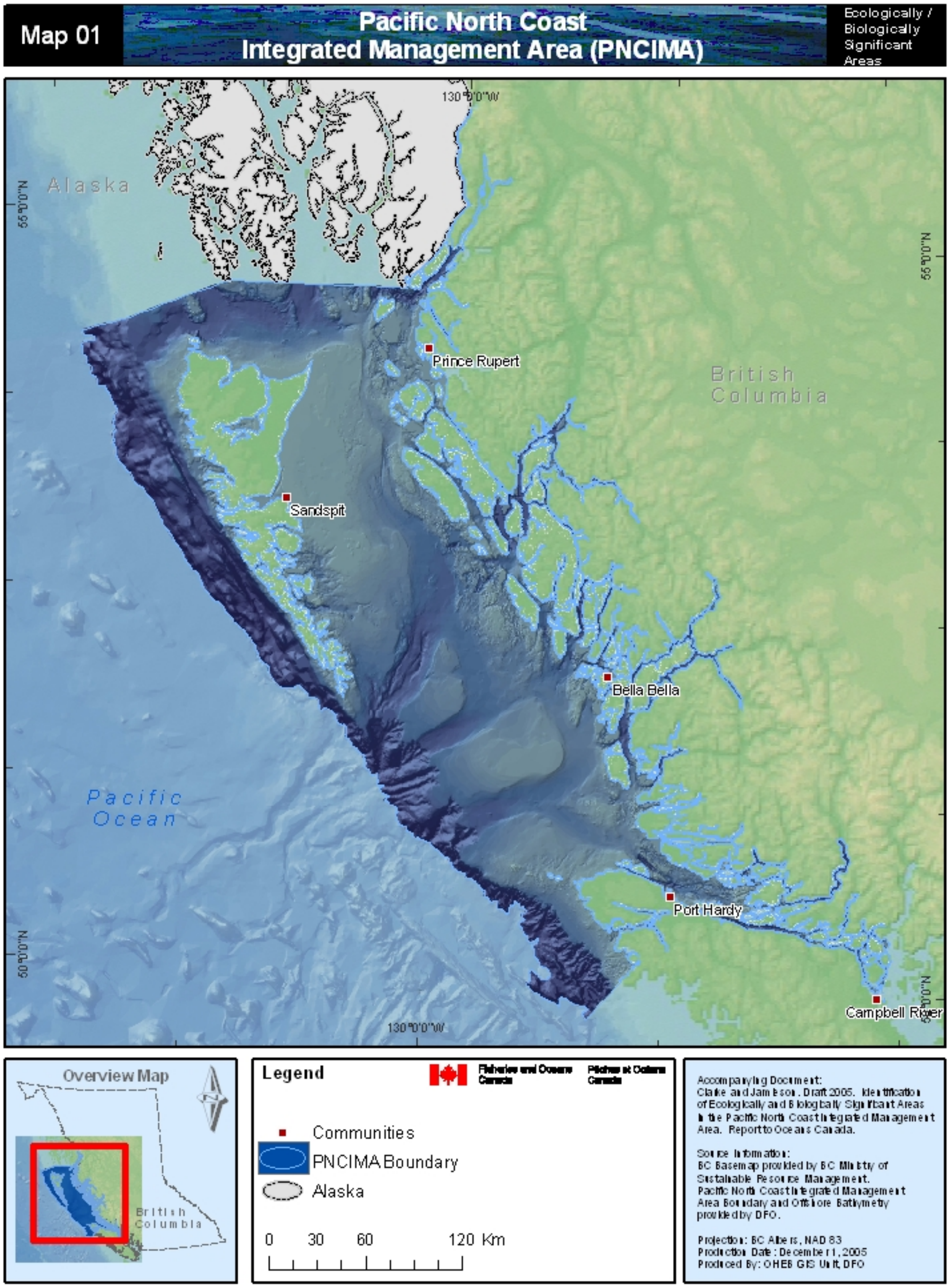
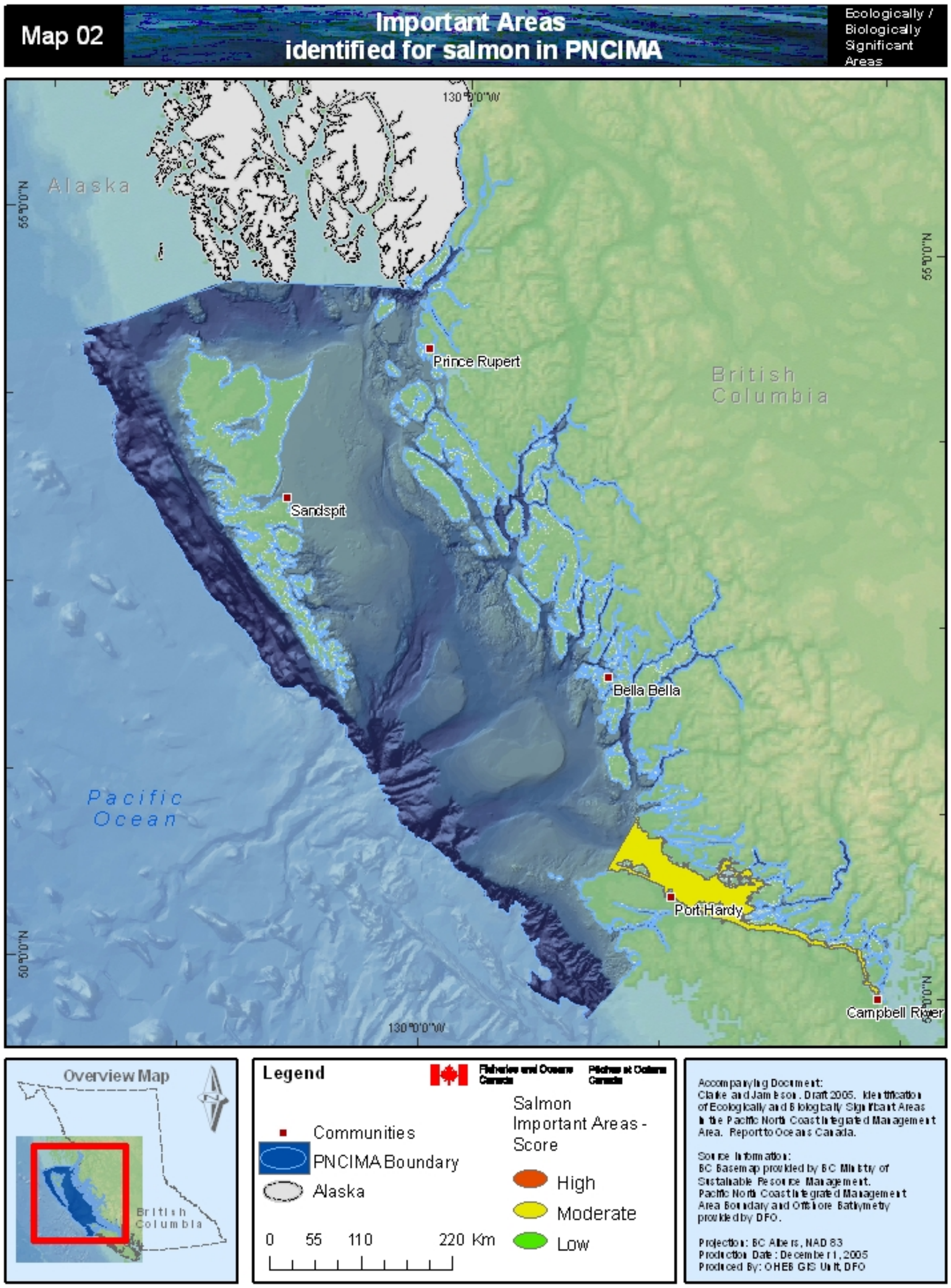
38. Important areas identified for oceanographic features in PNCIMA
39. Important areas identified for Parks Canada in PNCIMA
40. Important areas identified for BC Provincial ecounits in PNCIMA



Map 01
Pacific North Coast
Integrated Management Area (PNCIMA)
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
Alaska
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 02
Important Areas
identified for salmon in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
Alaska
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Salmon Important Areas - Score
High
Moderate
Low
0 55 110 220 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
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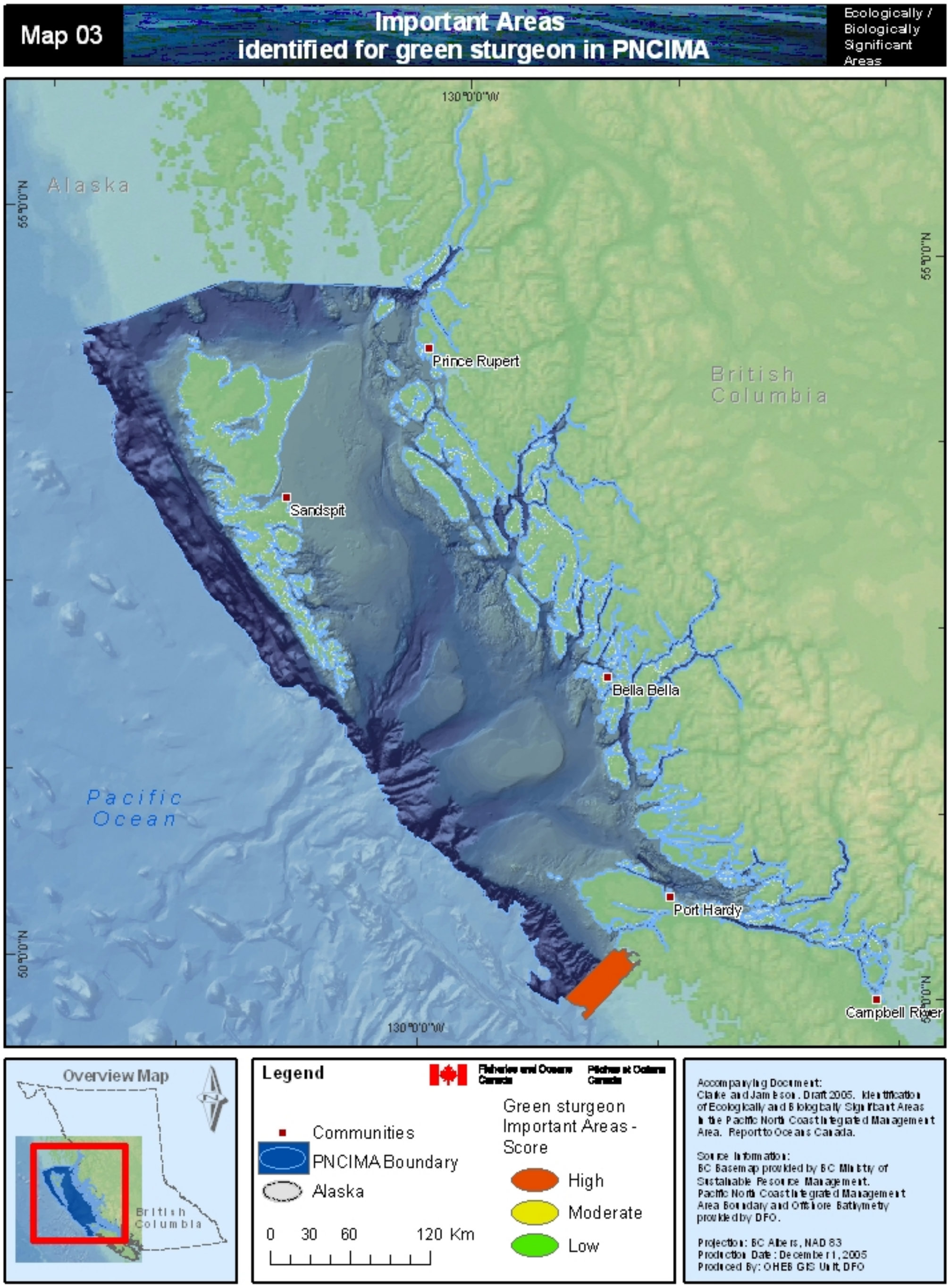
Map 03
Important Areas
identified for green sturgeon in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Green sturgeon Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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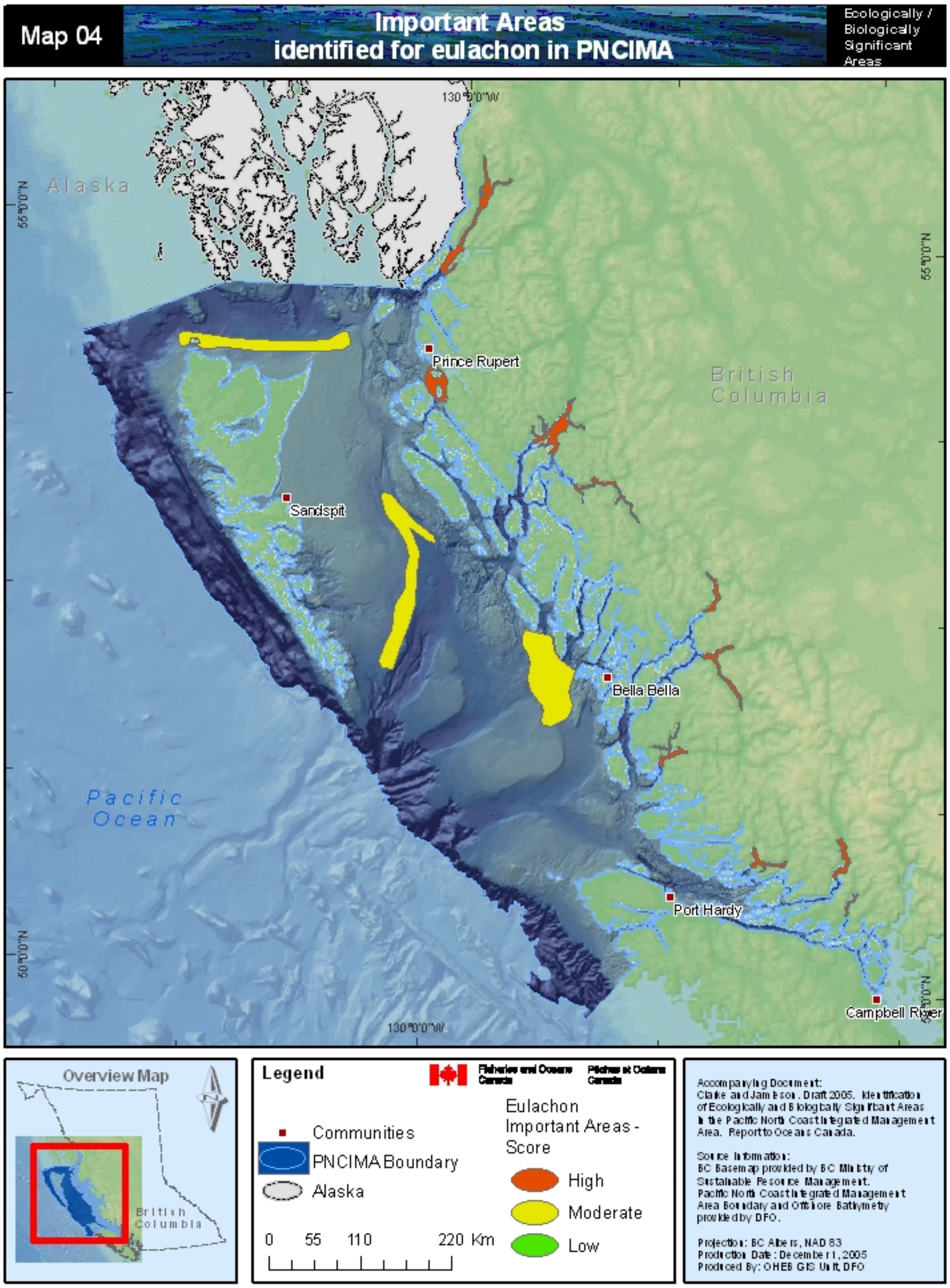
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 04
Important Areas
identified for eulachon in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Eulachon Important Areas - Score
High
Moderate
Low
0 55 110 220 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
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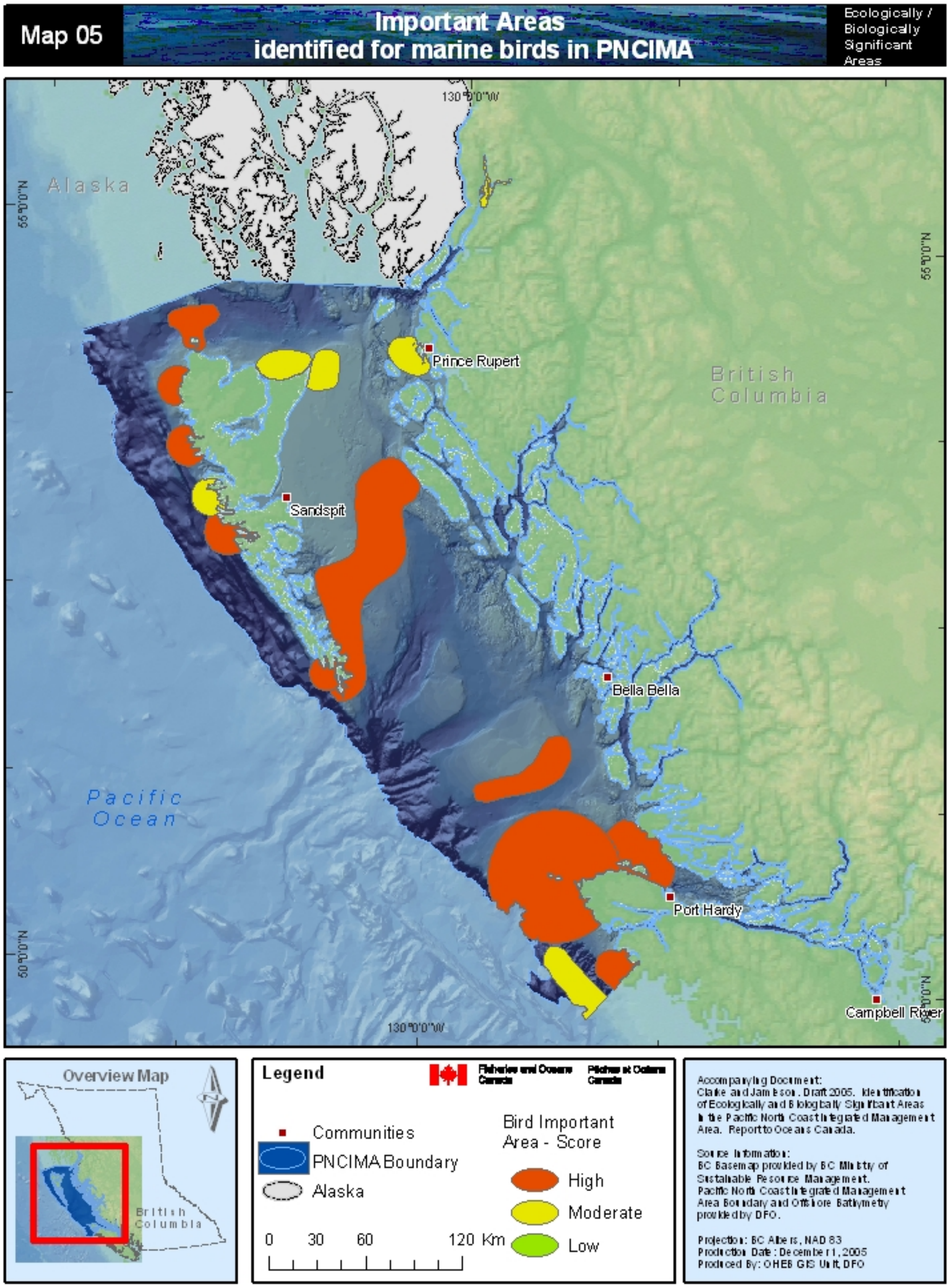
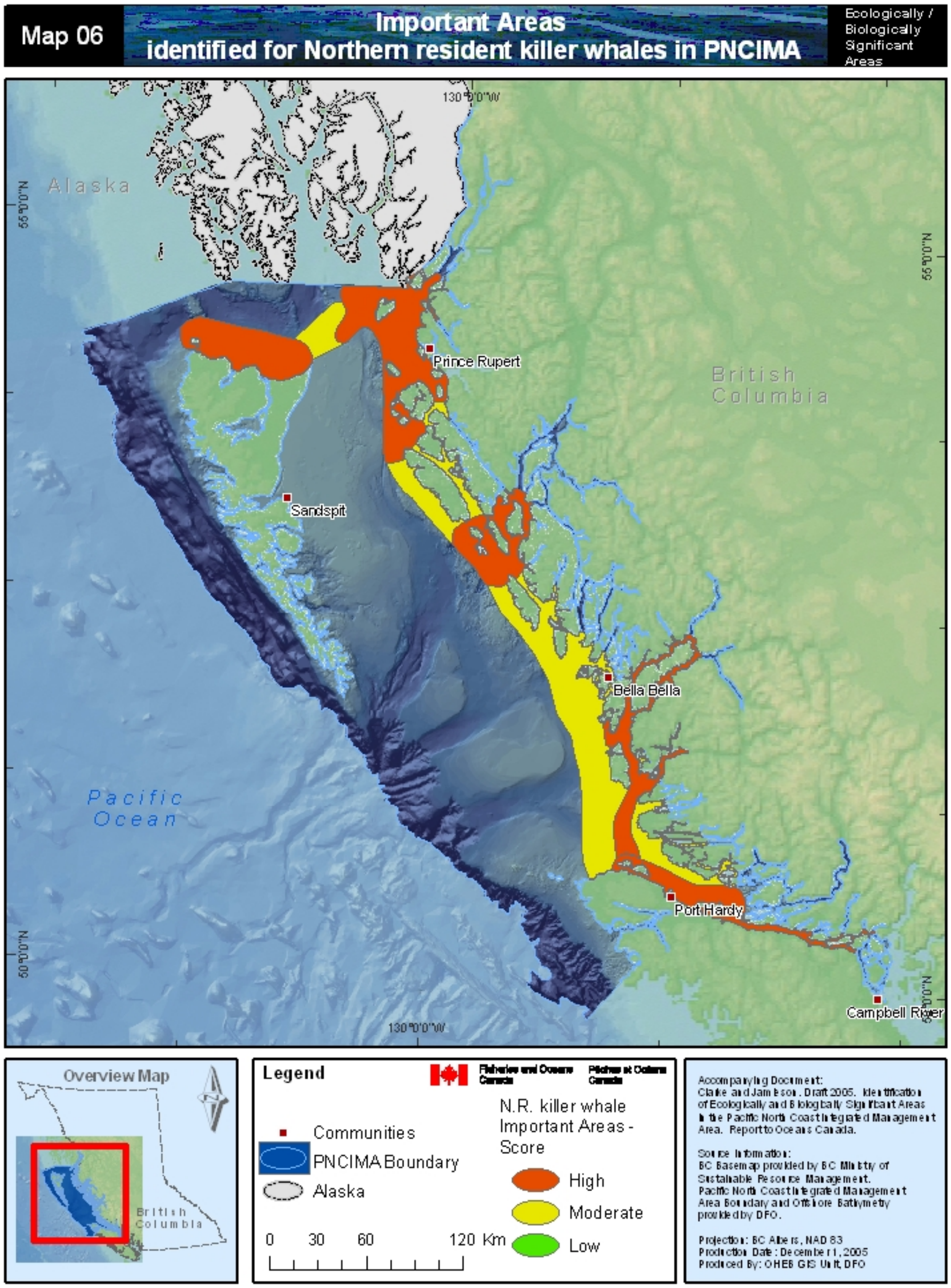


Map 05
Important Areas identified for marine birds in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Bird Important Area - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 06
Important Areas
identified for Northern resident killer whales in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
N.R. killer whale Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
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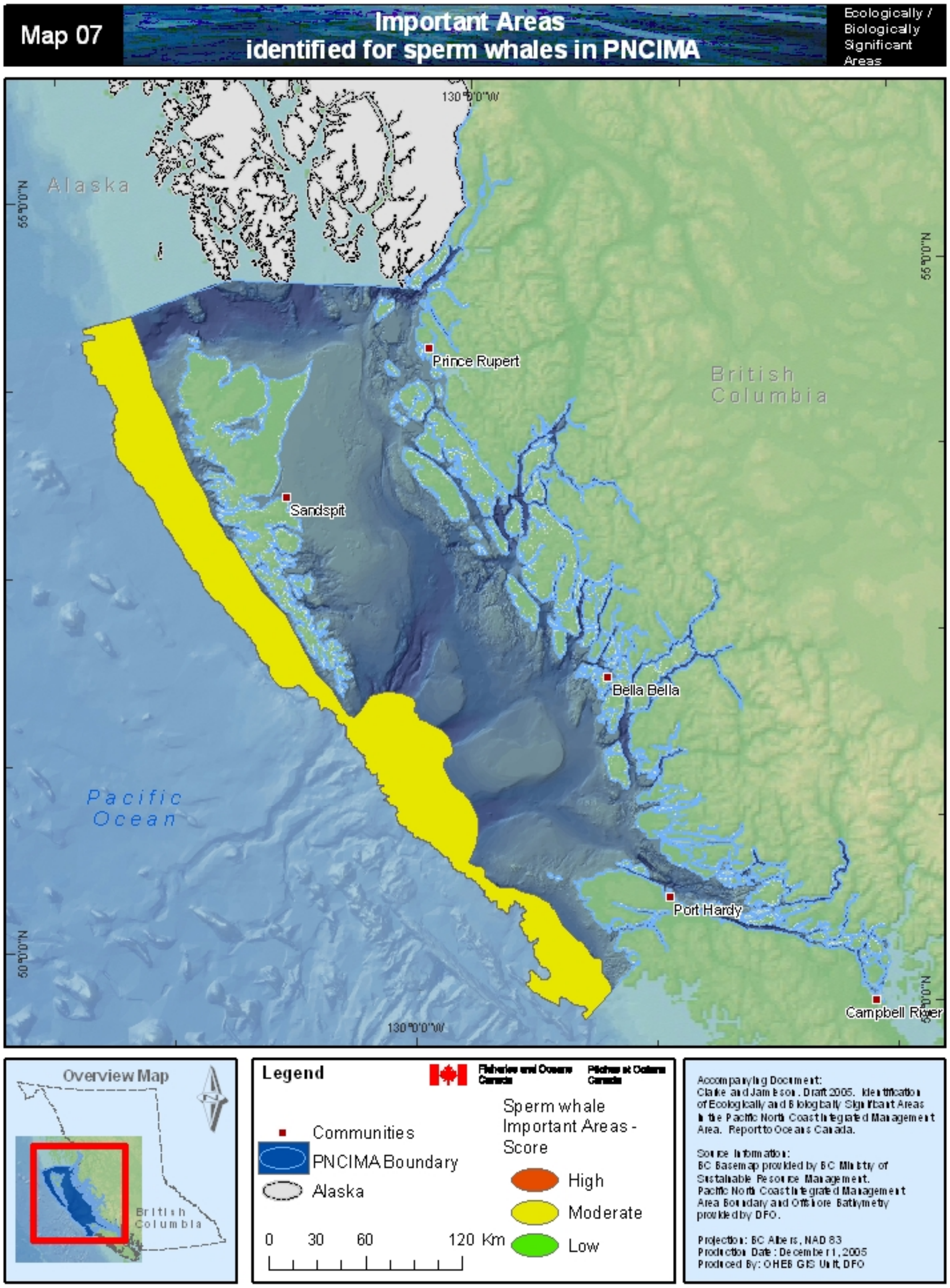
Map 07
Important Areas
identified for sperm whales in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
Alaska
55°0'0"N
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Sperm whale Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
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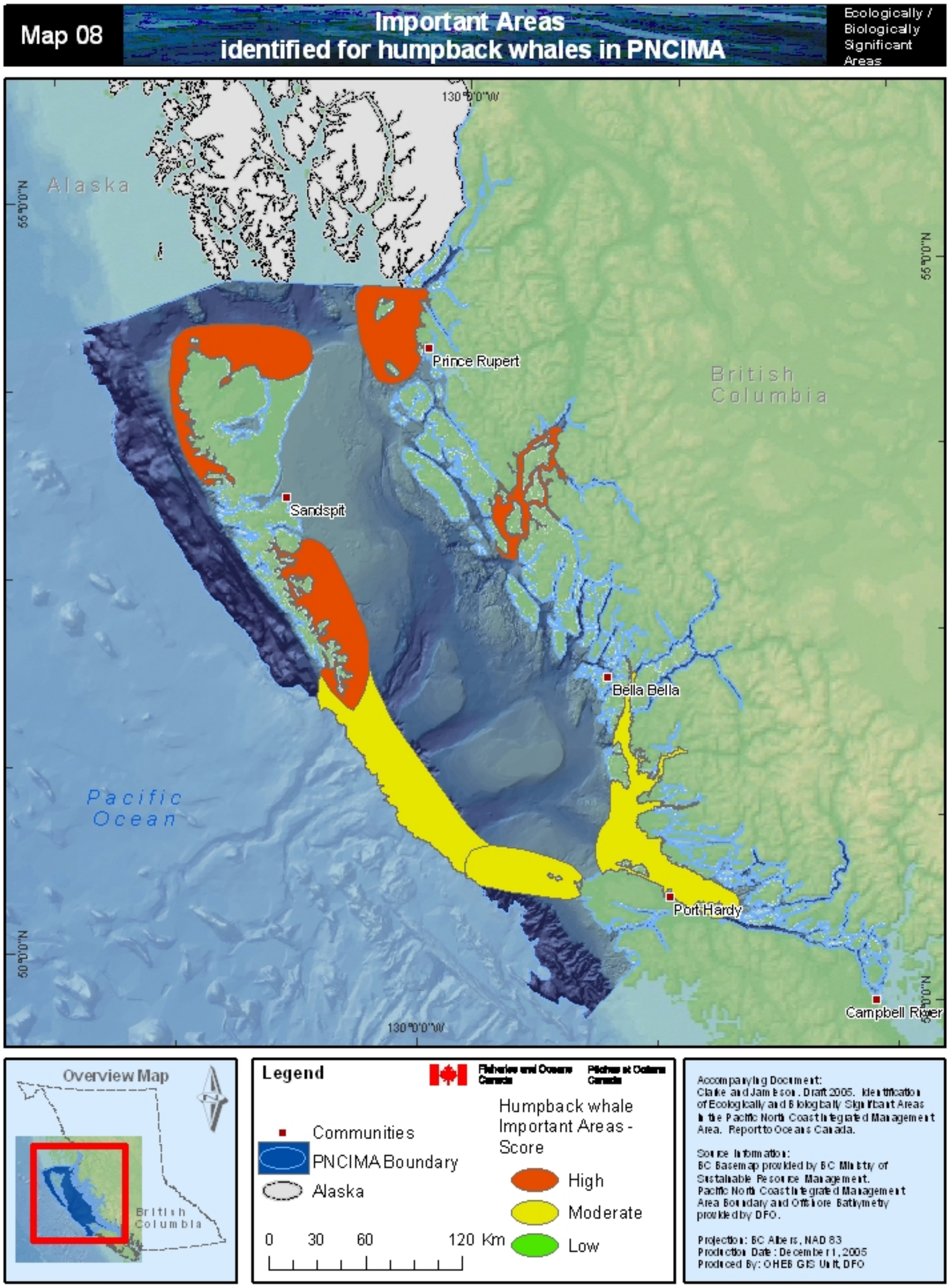
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 08
Important Areas
identified for humpback whales in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
0 30 60 120 Km
Humpback whale Important Areas - Score
High
Moderate
Low
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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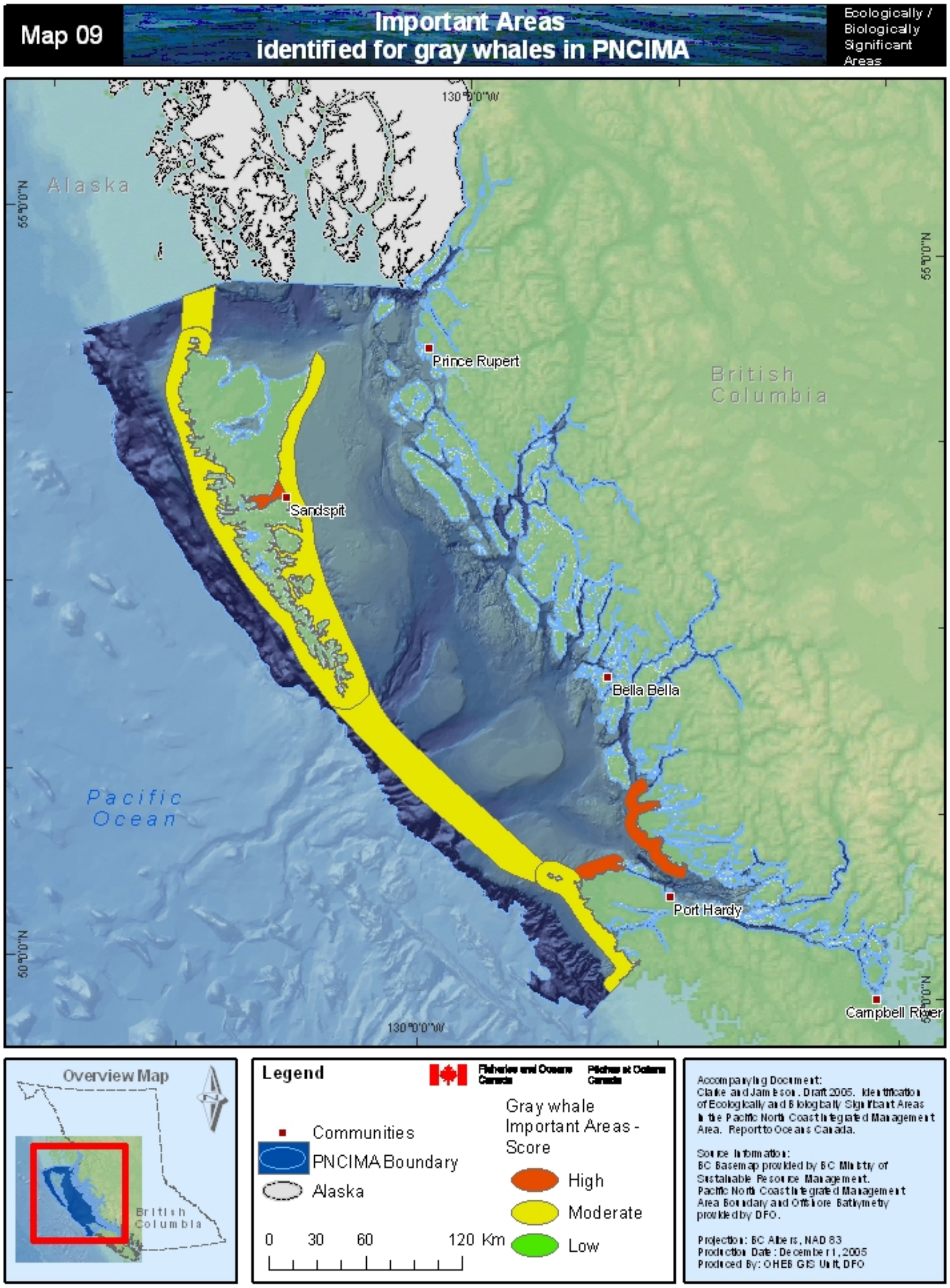
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 09
Important Areas
identified for gray whales in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
Alaska
55°0'0"N
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
50°0'0"N
Campbell River
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Gray whale Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
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Production Date: December 1, 2005
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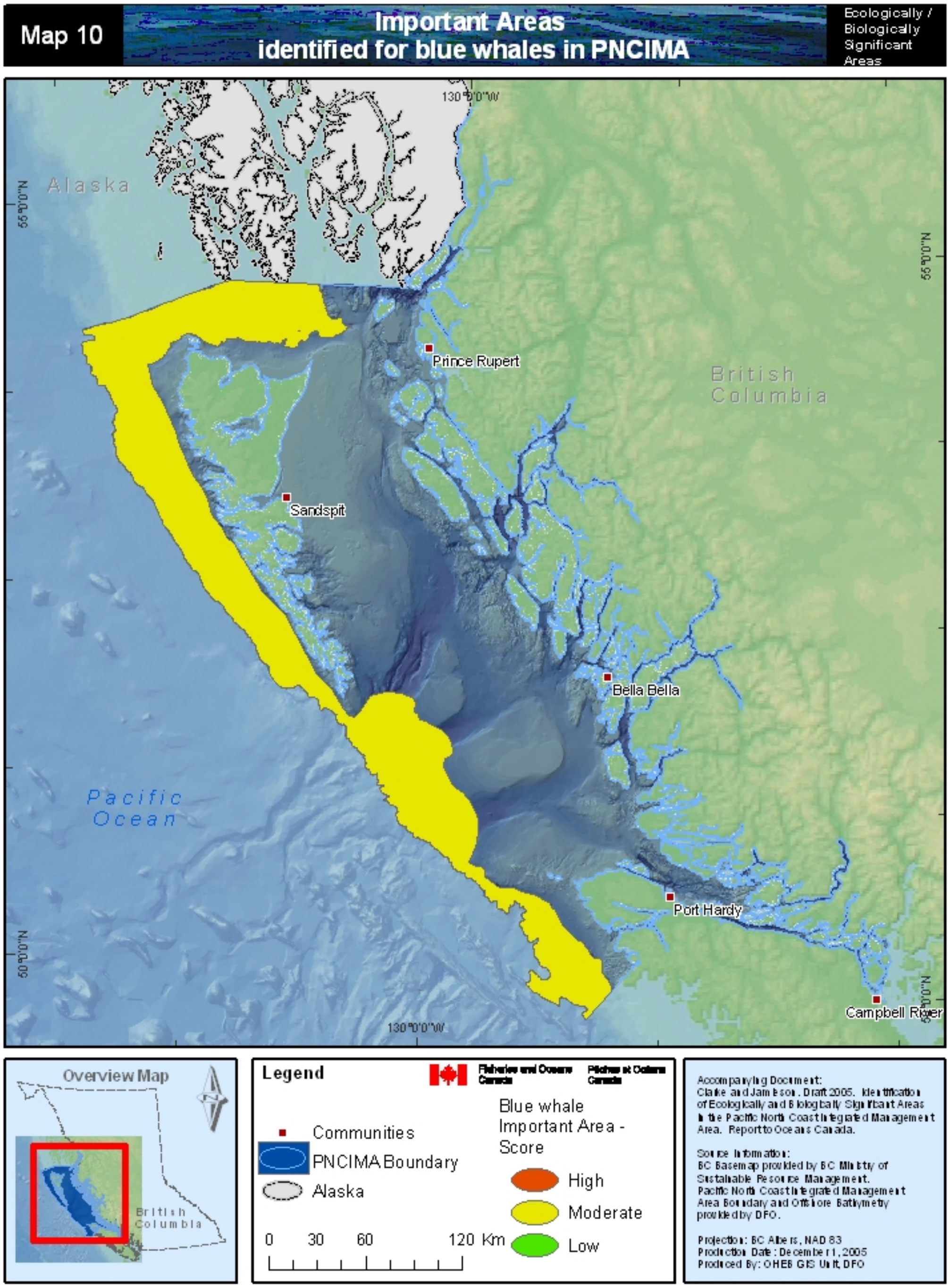

Map 10
Important Areas identified for blue whales in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Blue whale Important Area - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
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Source Information:
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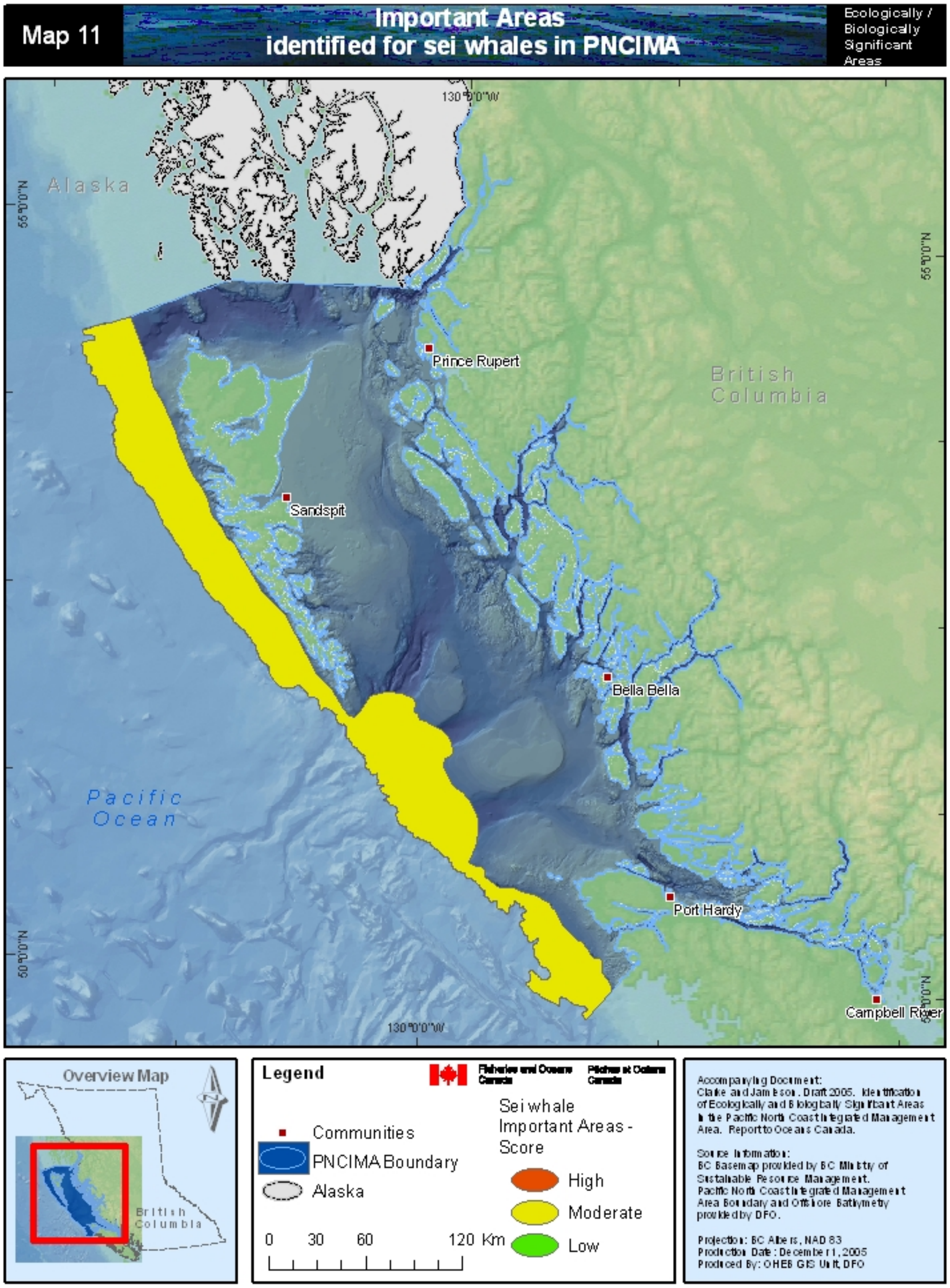

Map 11
Important Areas
identified for sei whales in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
Alaska
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Sei whale Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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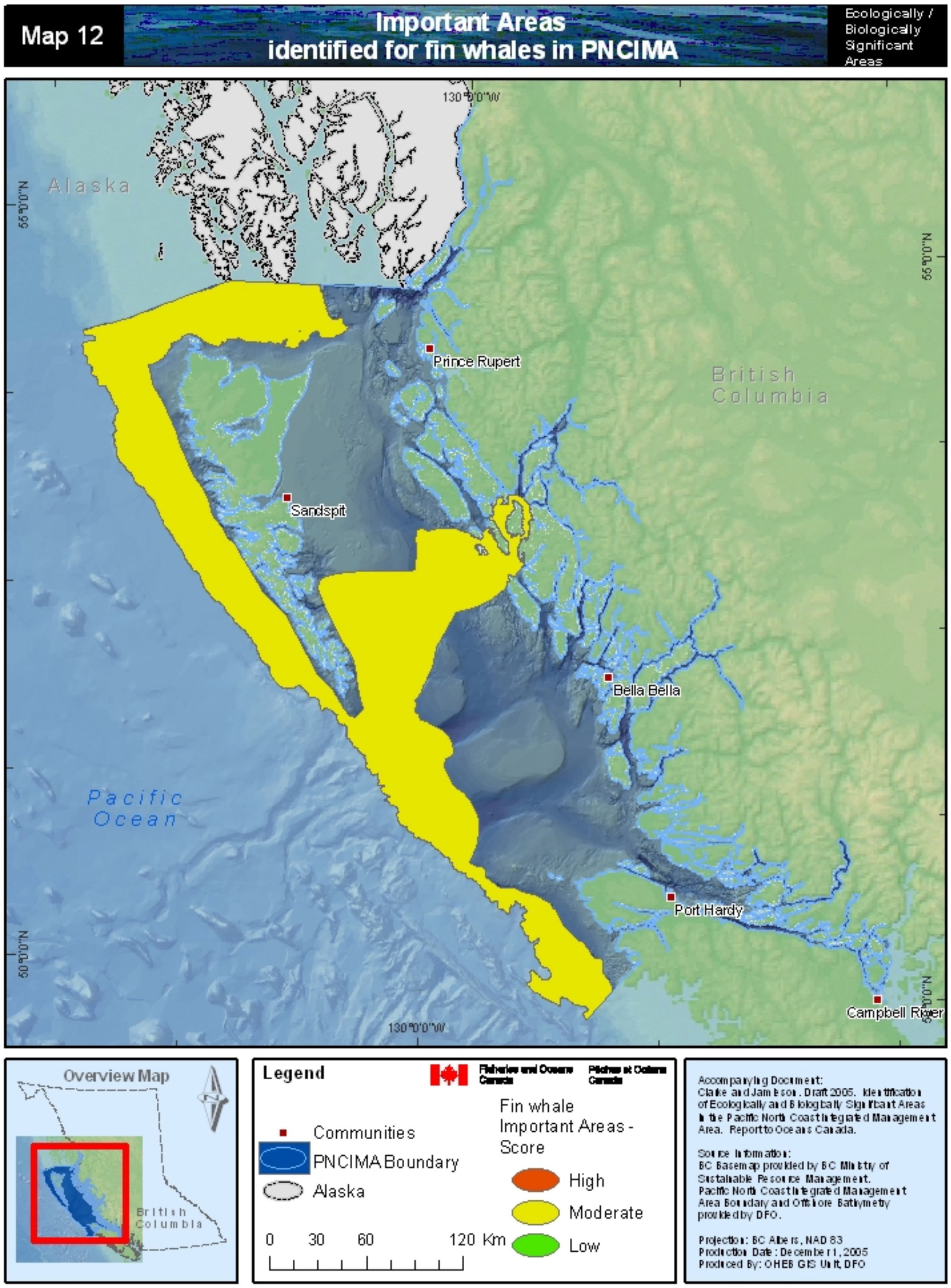
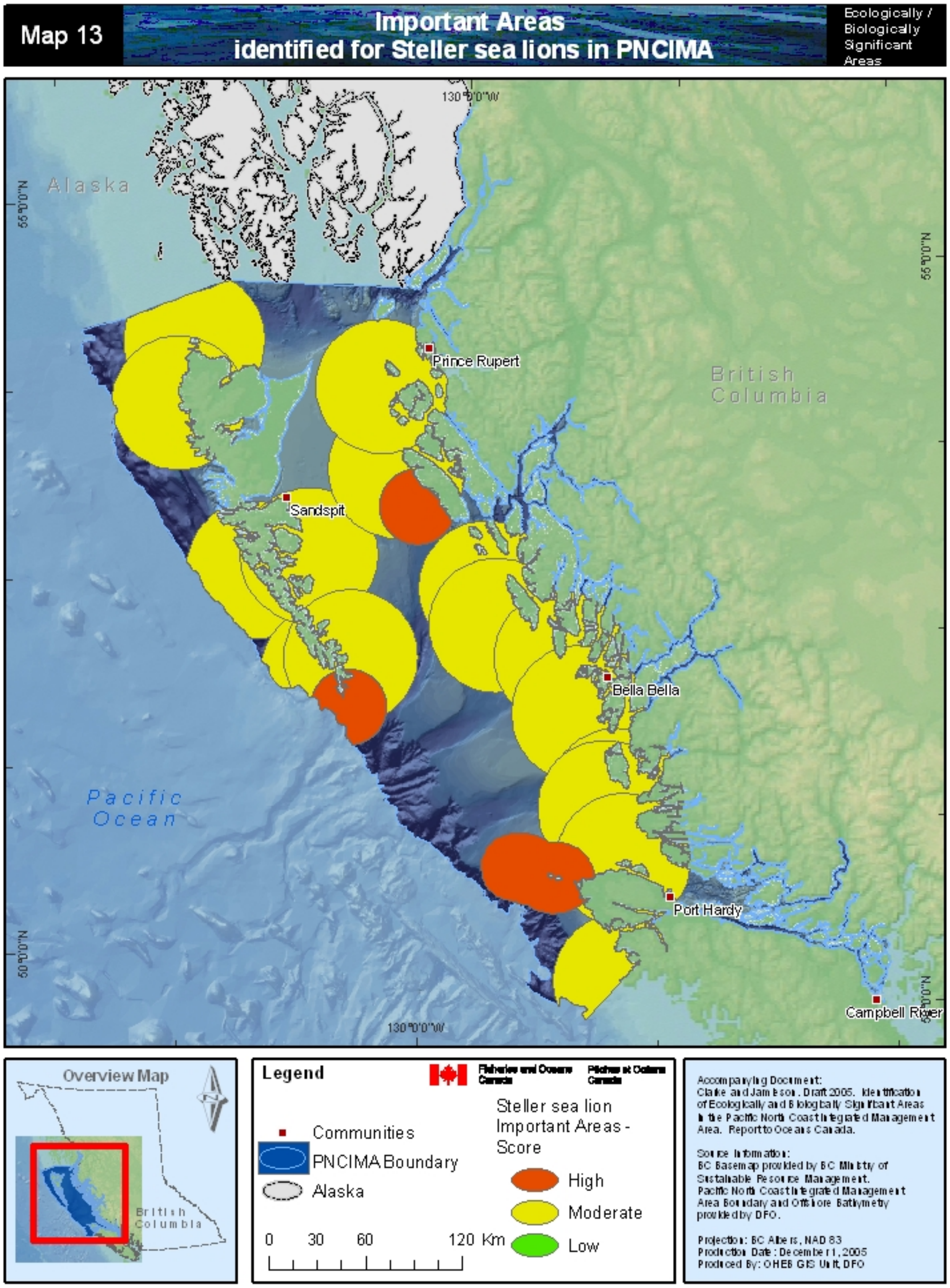
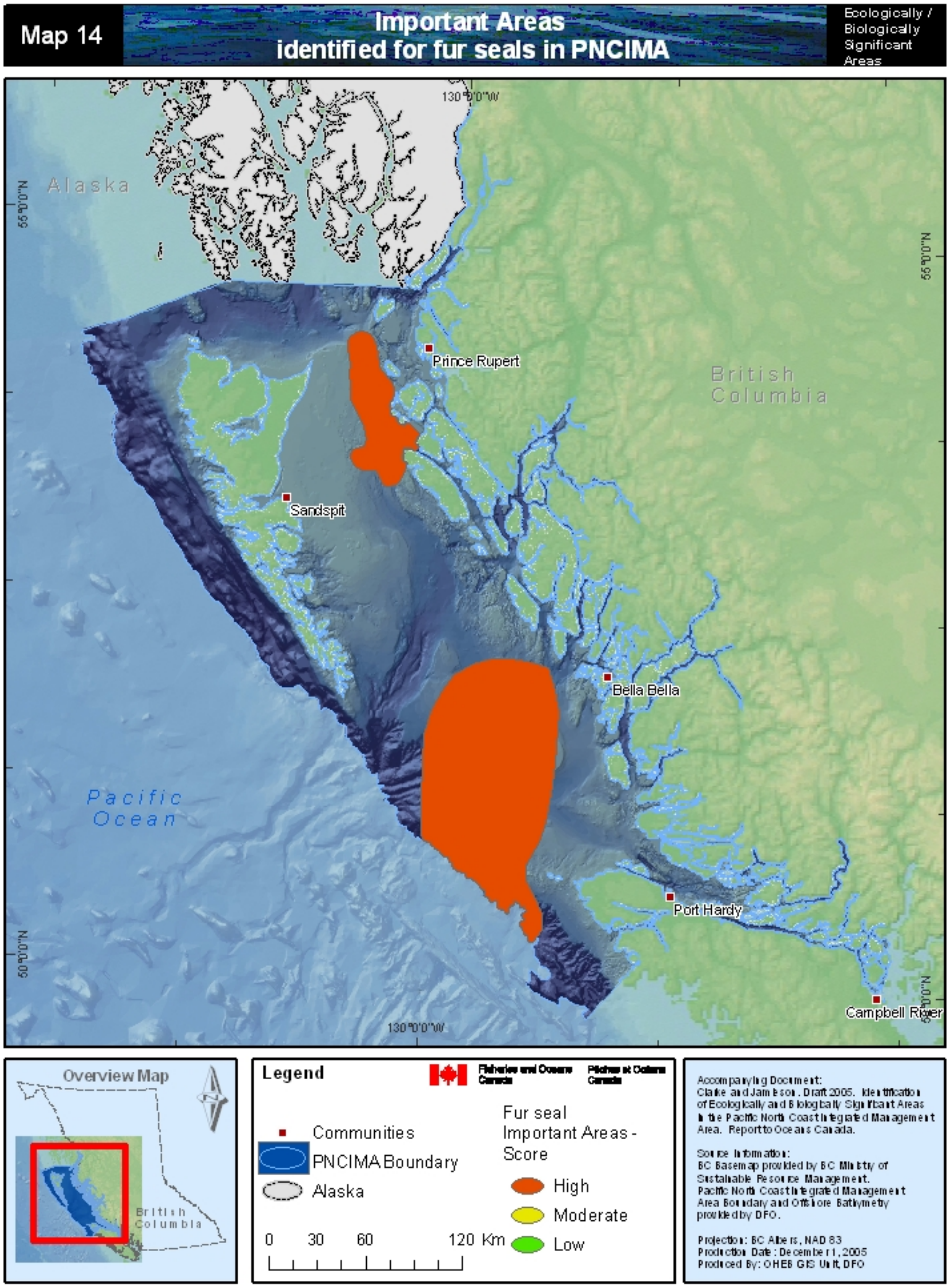


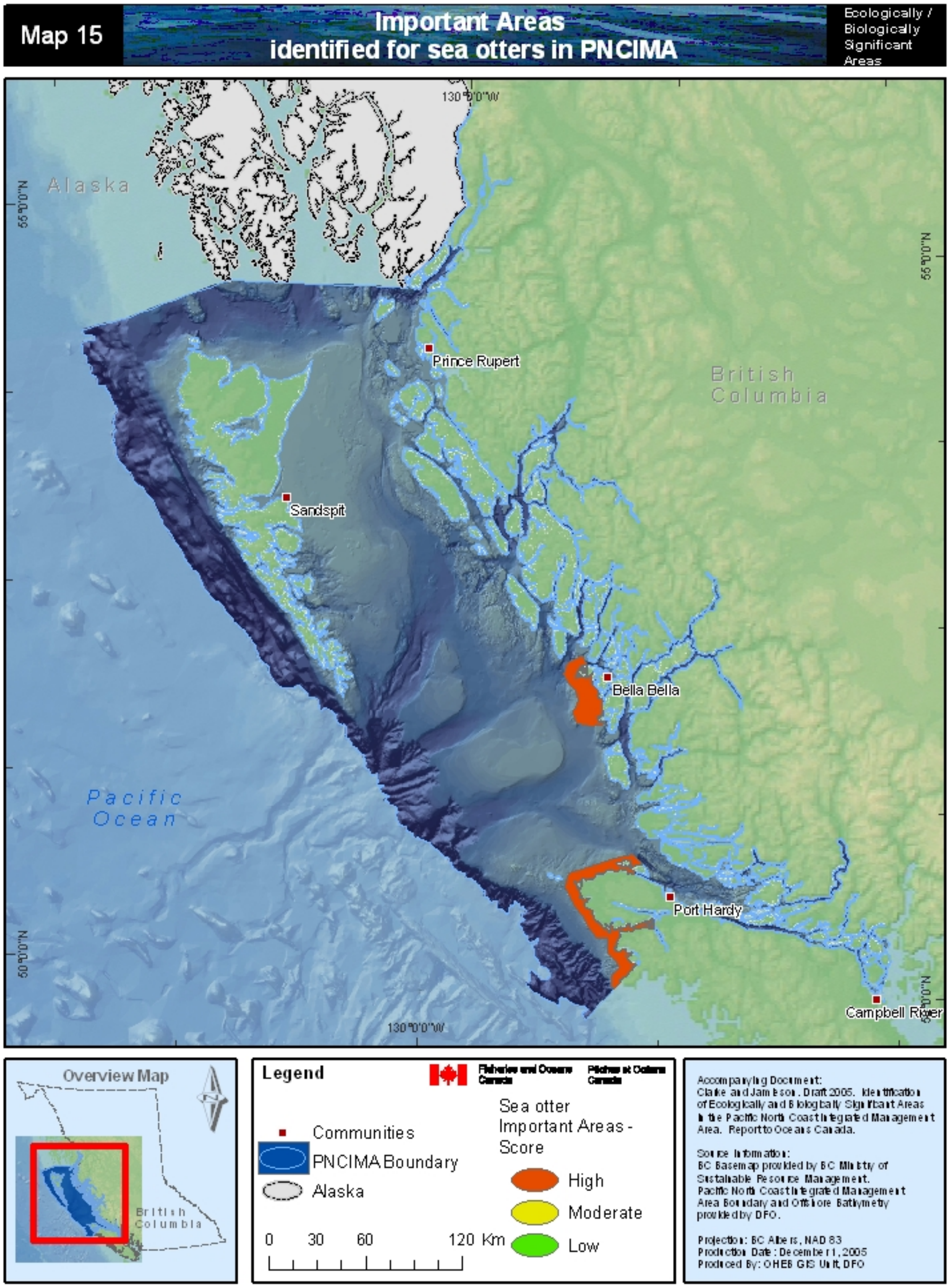
Map 12
Important Areas
identified for fin whales in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Fin whale Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO



Map 13
Important Areas
identified for Steller sea lions in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Steller sea lion Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO



Map 14
Important Areas
identified for fur seals in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Fur seal Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 15
Important Areas
identified for sea otters in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
0 30 60 120 Km
Sea otter Important Areas - Score
High
Moderate
Low
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
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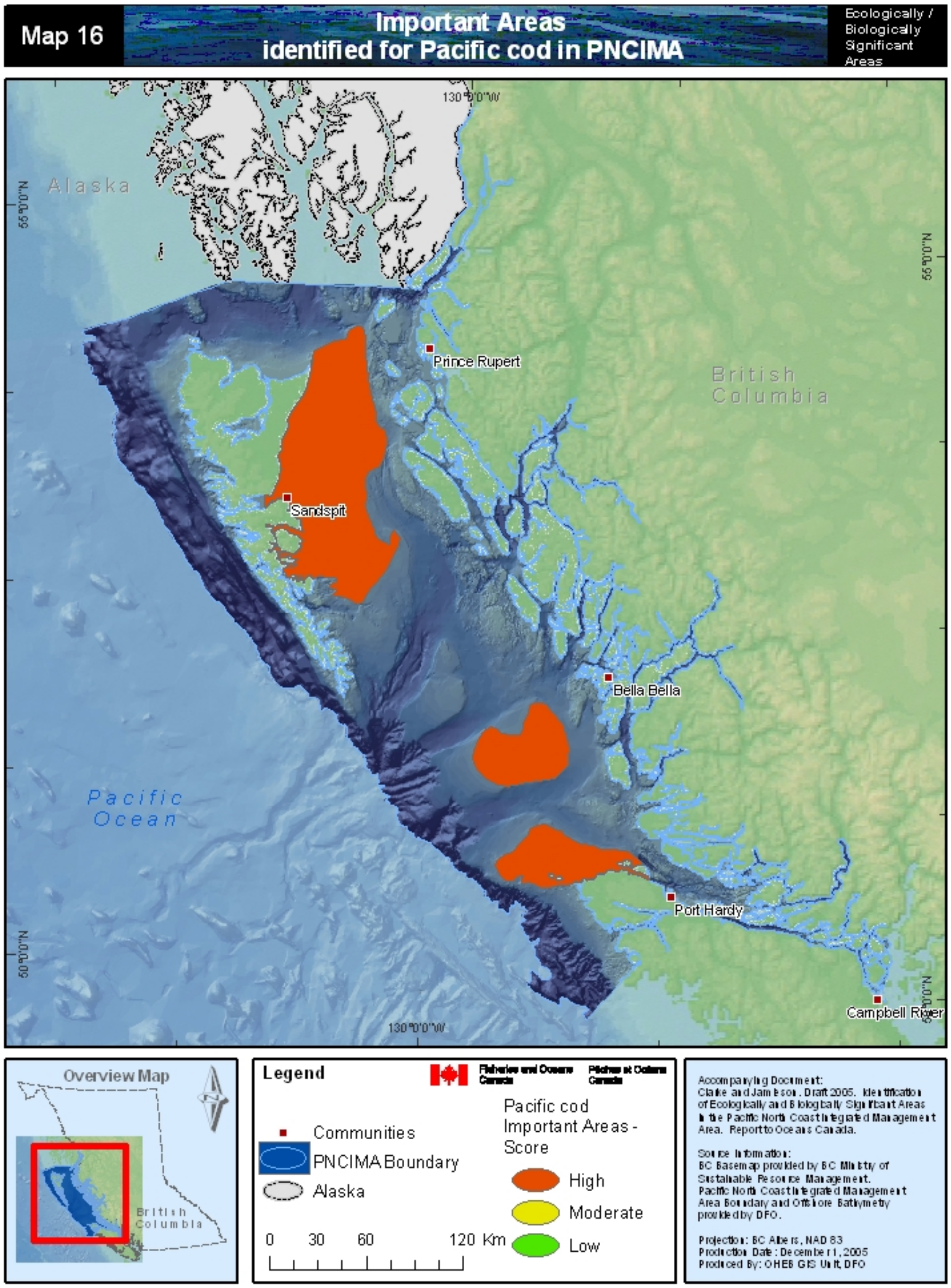
Map 16
Important Areas
identified for Pacific cod in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Pacific cod Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
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Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
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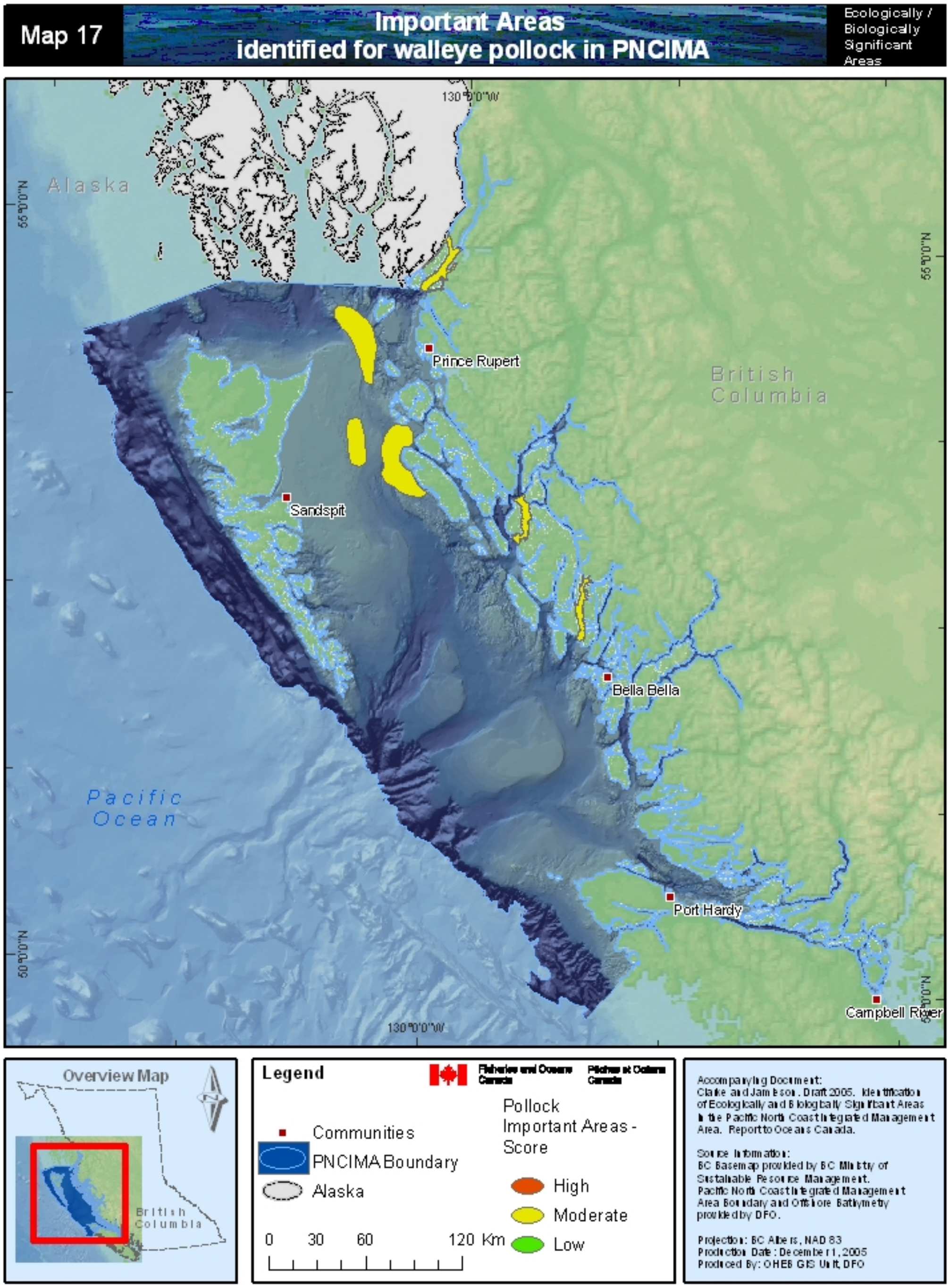

Map 17
Important Areas
identified for walleye pollock in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
Alaska
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Pollock Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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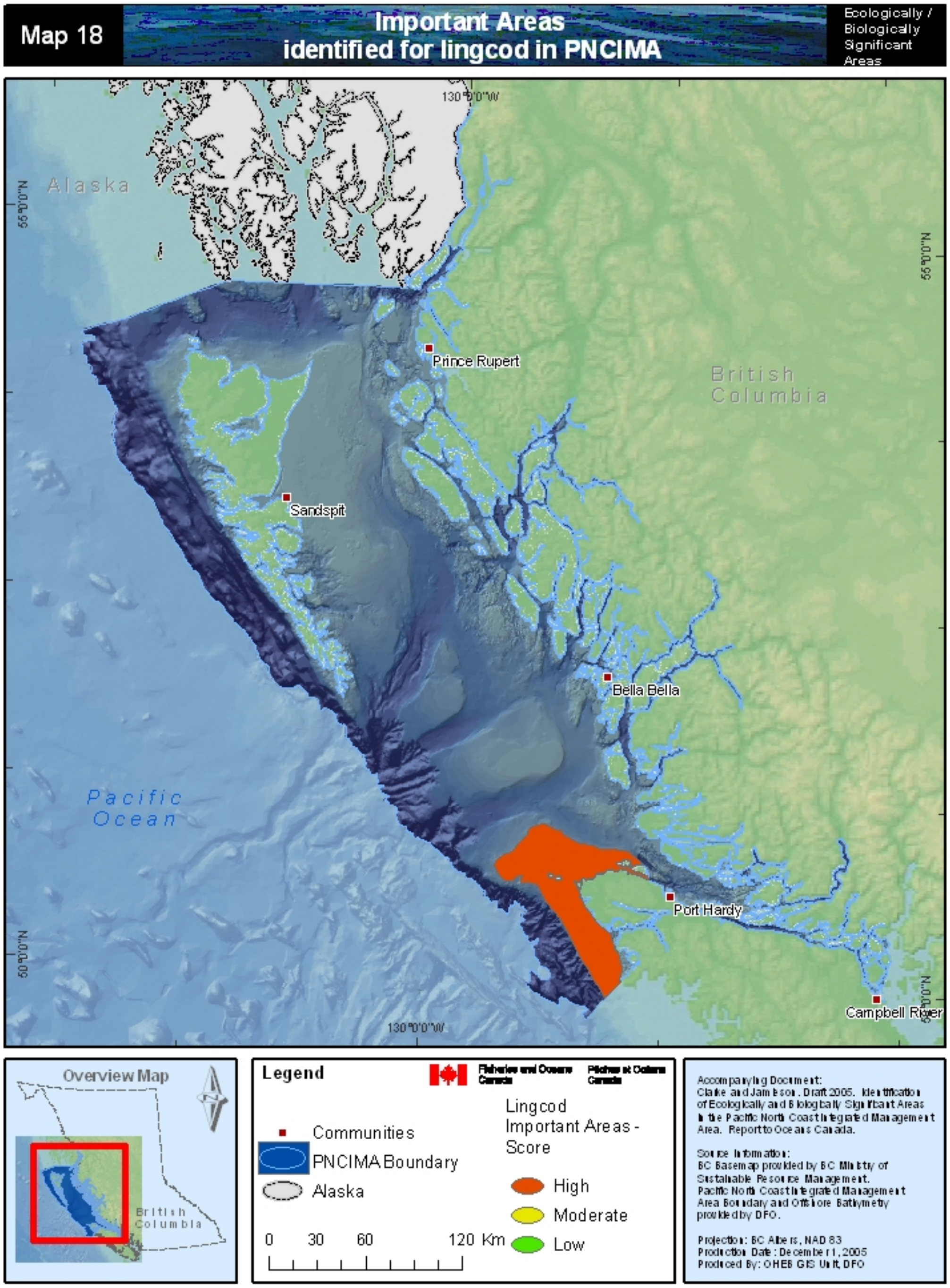
Produced By: OHEB GIS Unit, DFO


Map 18
Important Areas identified for lingcod in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Lingcod Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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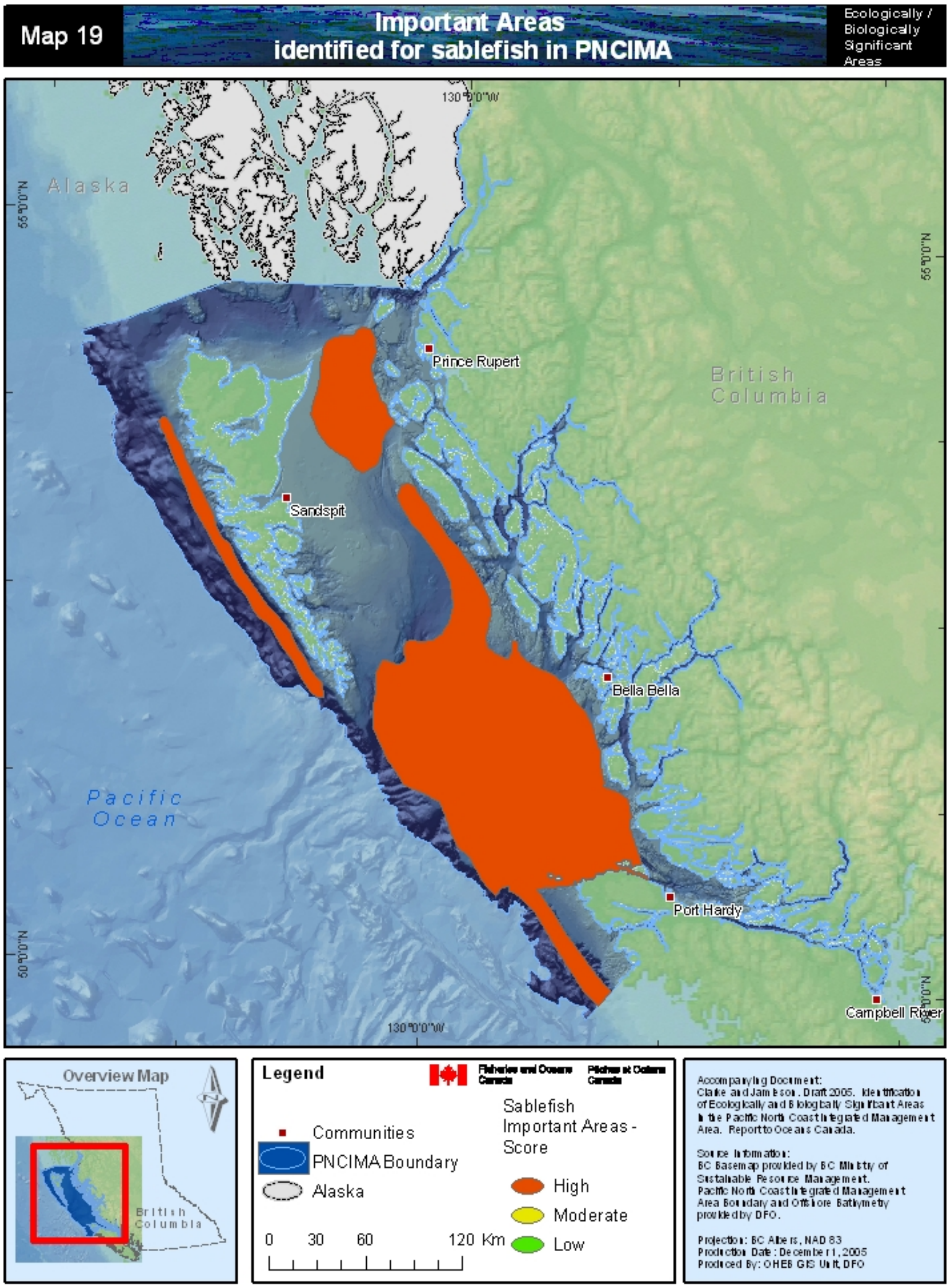
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO



Map 19
Important Areas identified for sablefish in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
Alaska
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Sablefish Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
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Projection: BC Albers, NAD 83
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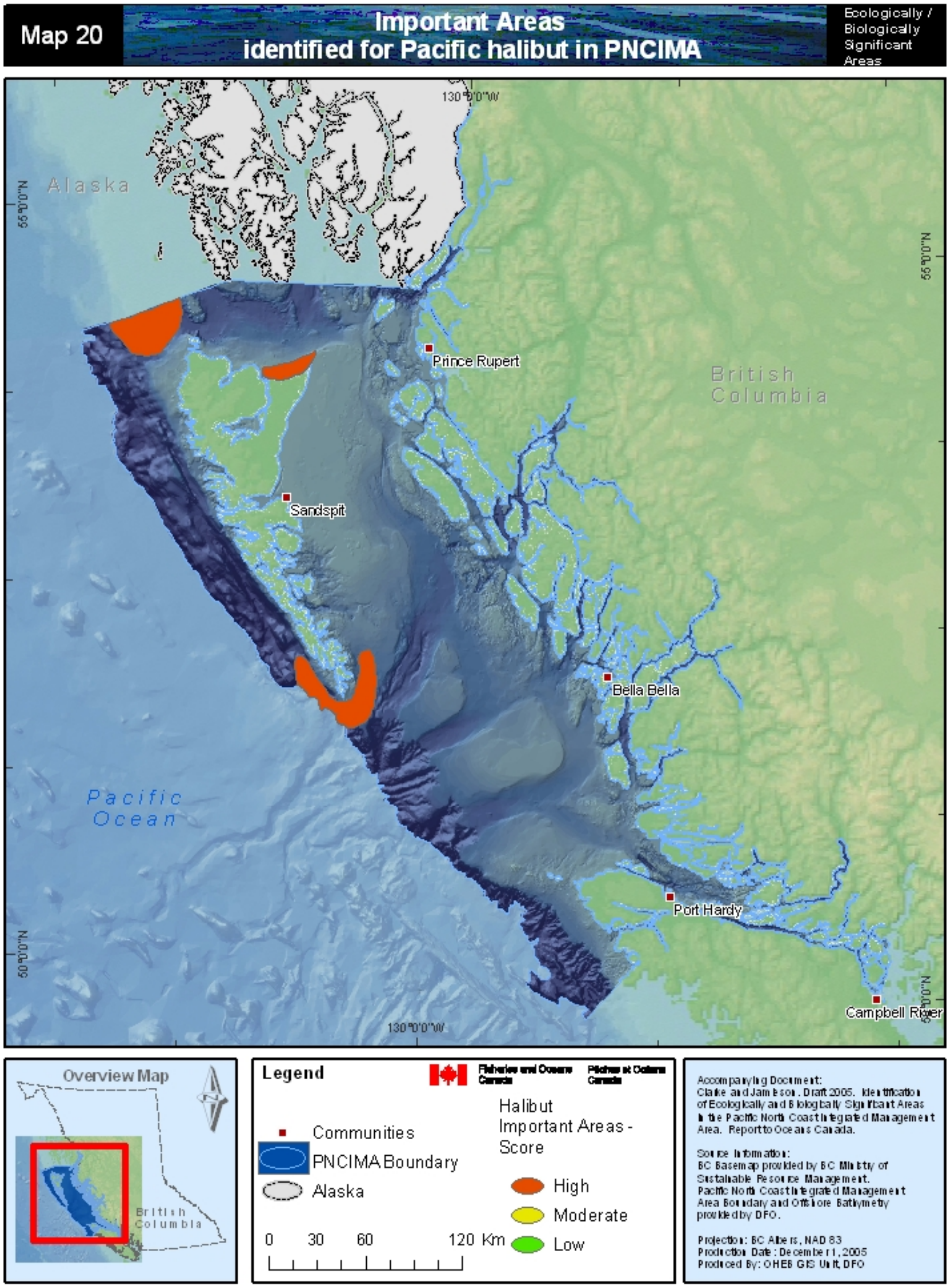
Produced By: OHEB GIS Unit, DFO



Map 20
Important Areas
identified for Pacific halibut in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Halibut Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
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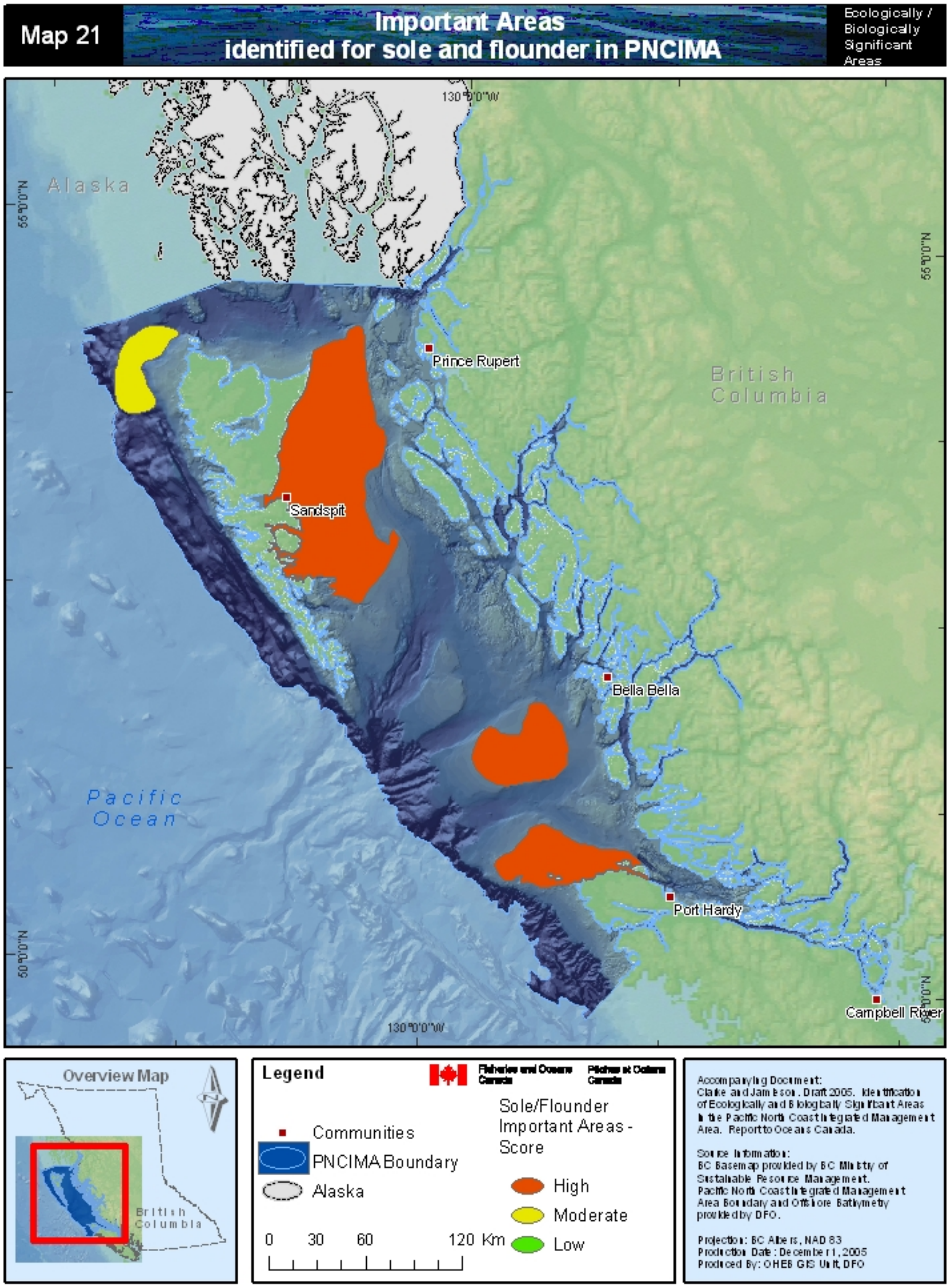
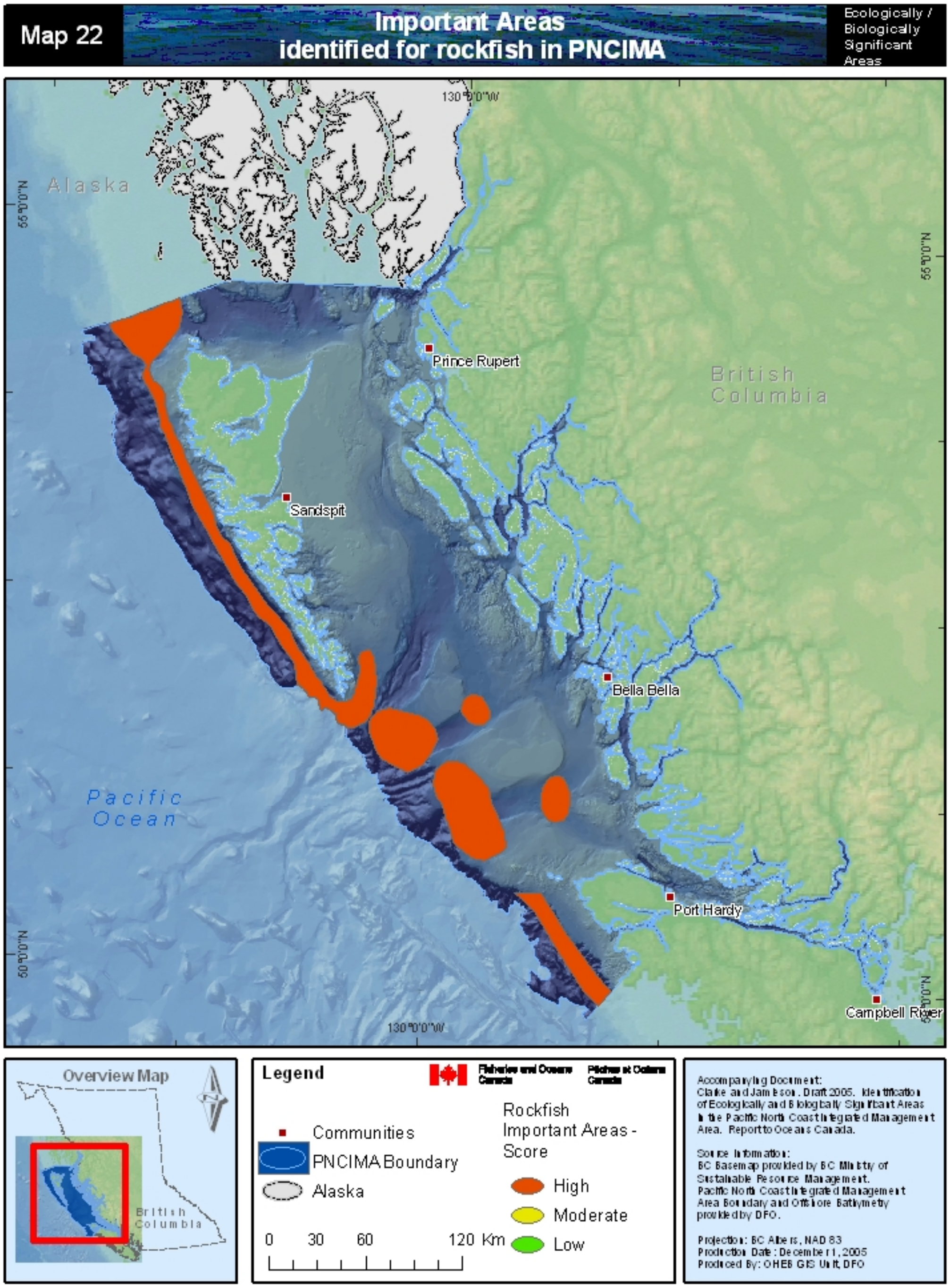
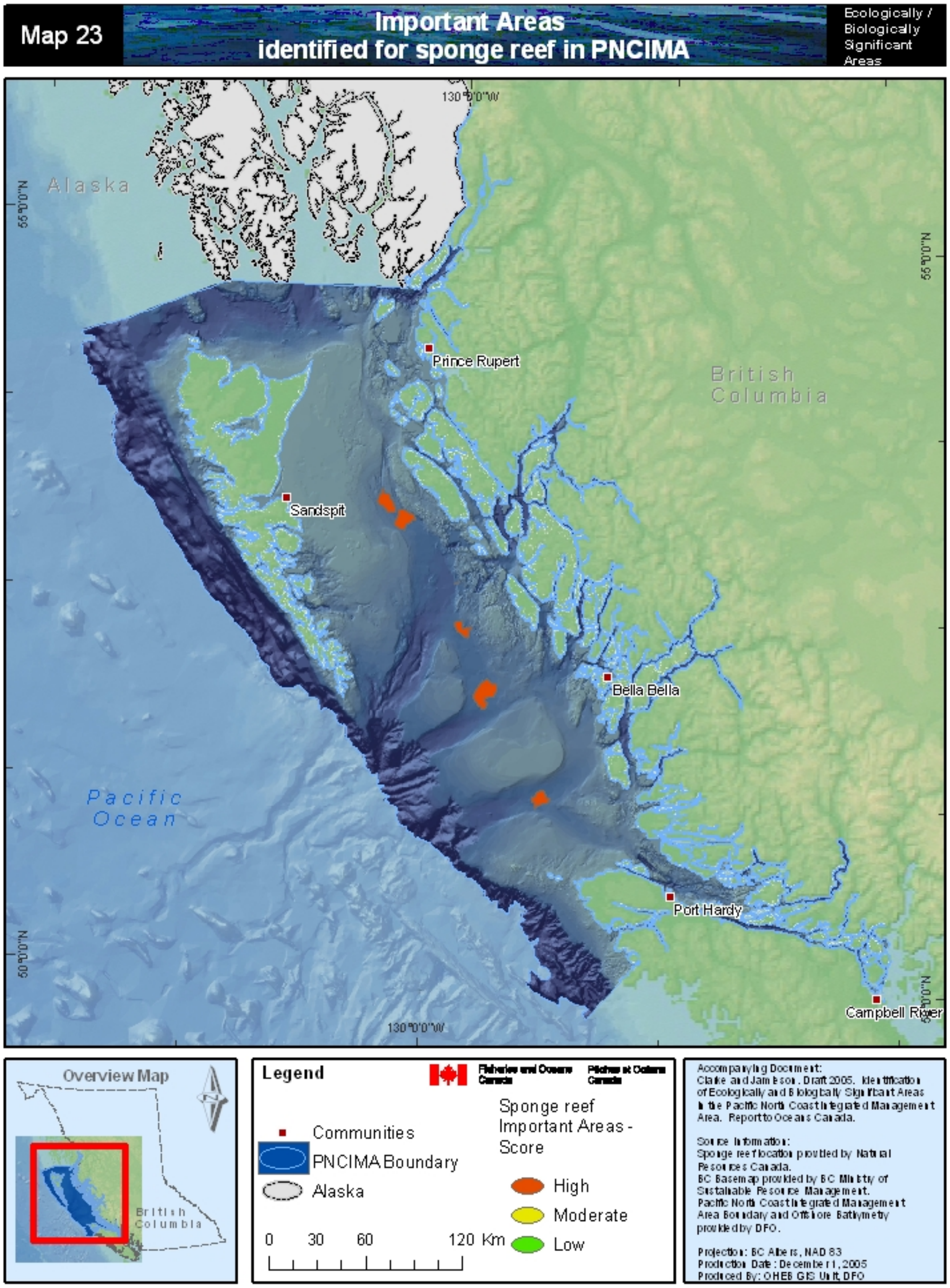
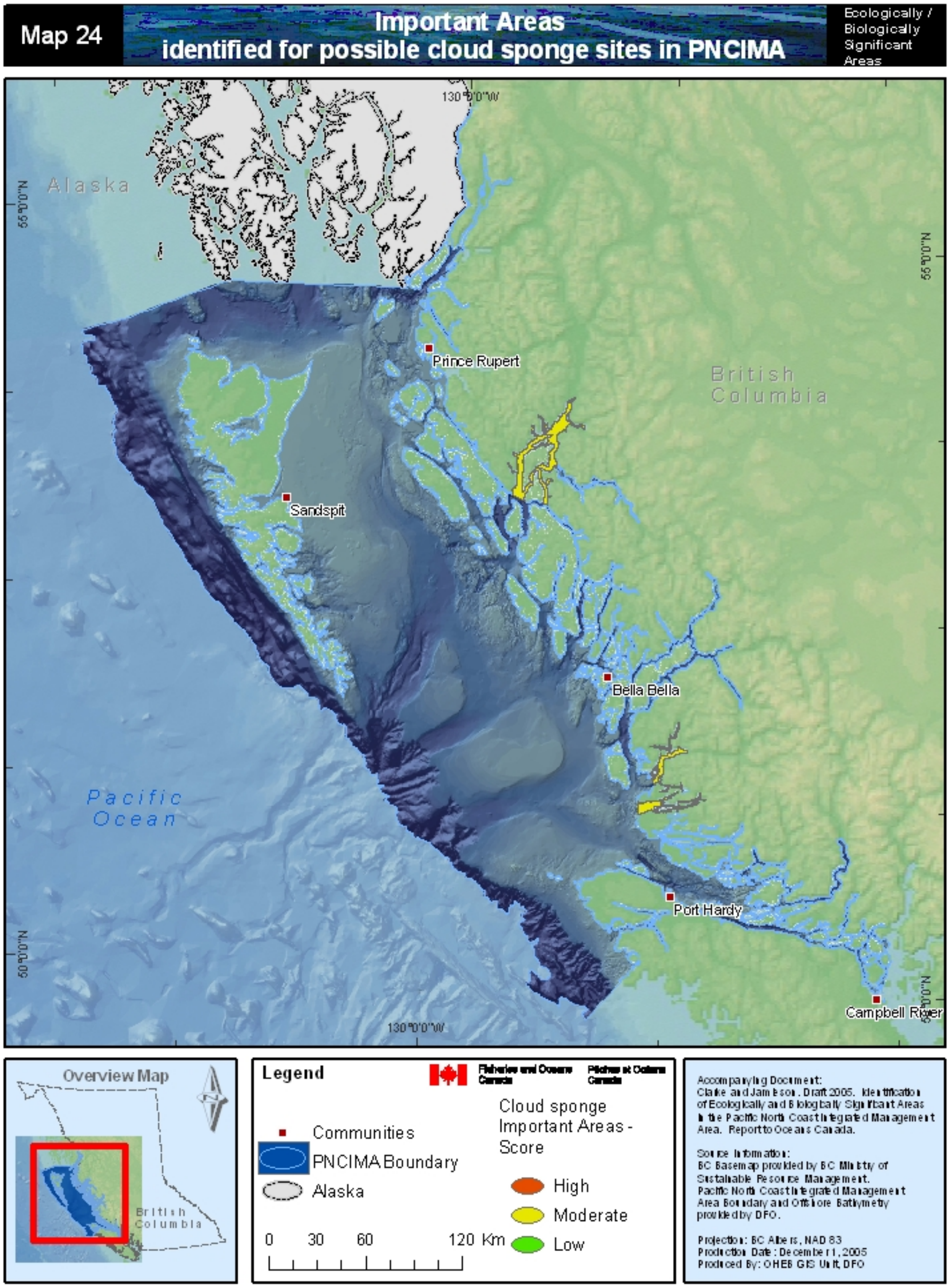
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

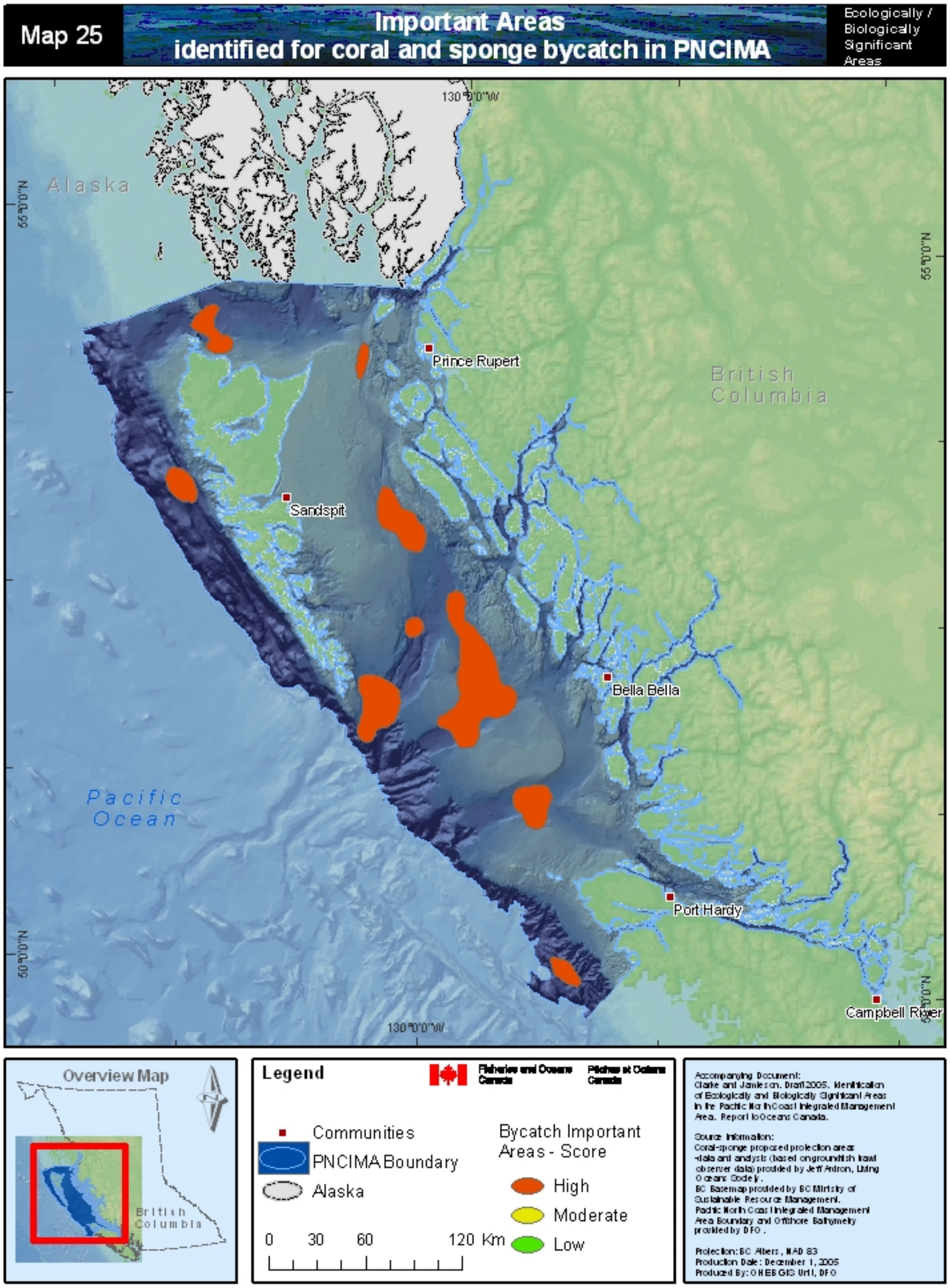


Map 21
Important Areas identified for sole and flounder in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
Alaska
British Columbia
Prince Rupert
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Sole/Flounder Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

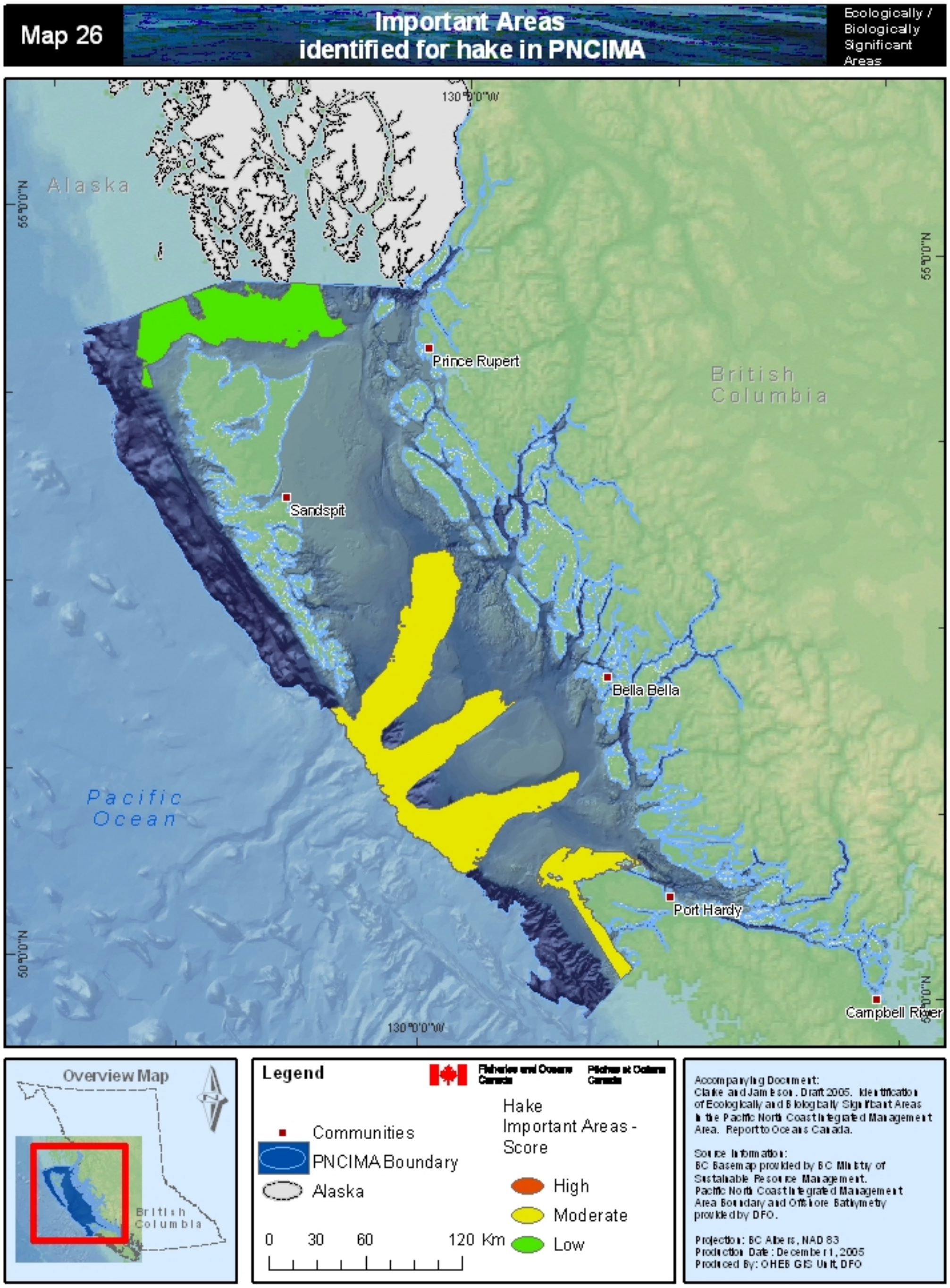

Map 22
Important Areas
identified for rockfish in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Rockfish Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

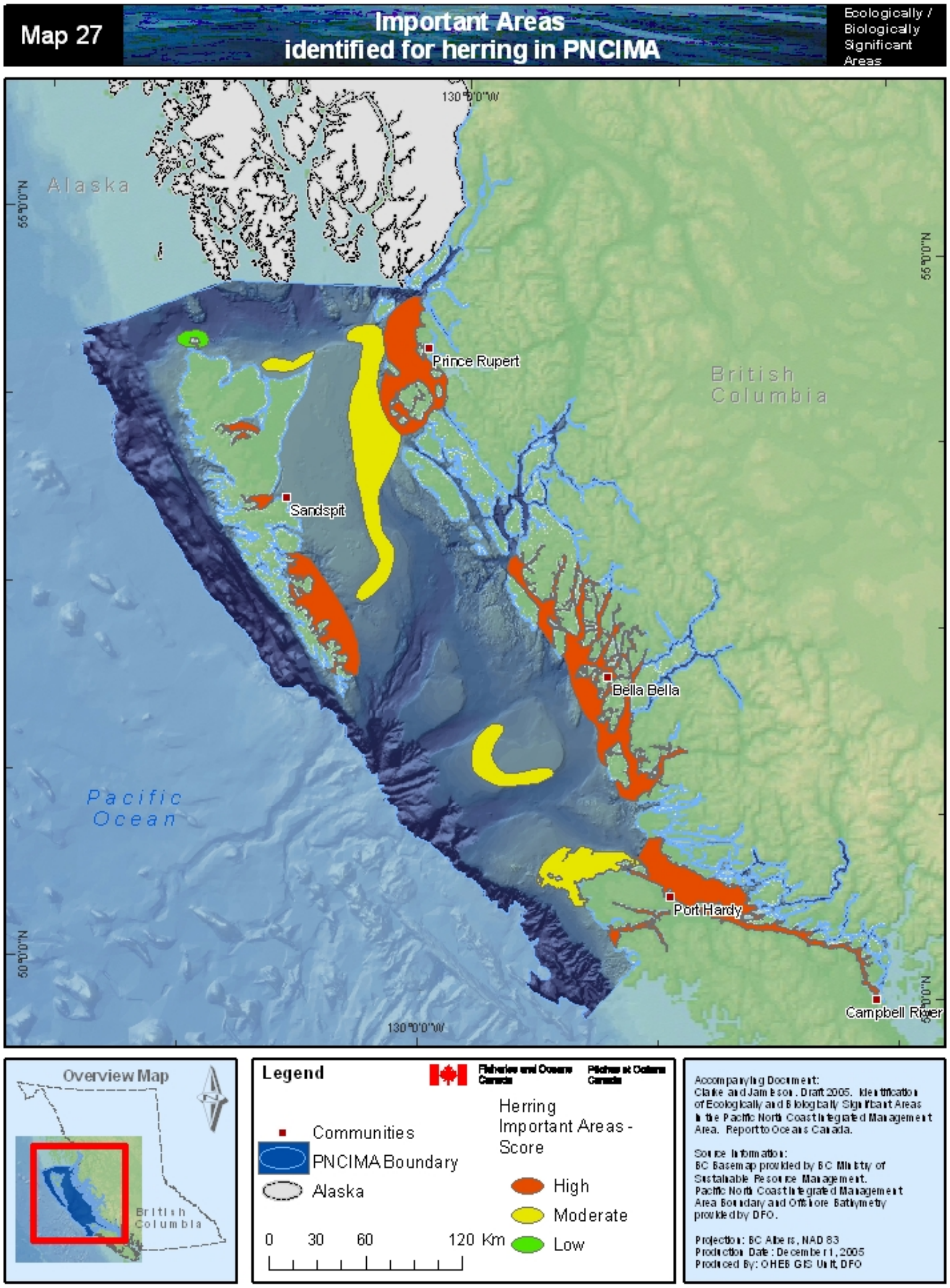

Map 23
Important Areas
identified for sponge reef in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Sponge reef Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
Sponge reef location provided by Natural Resources Canada.
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 24
Important Areas
identified for possible cloud sponge sites in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Cloud sponge Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Fisheries and Oceans Canada
Pêches et Océans Canada
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

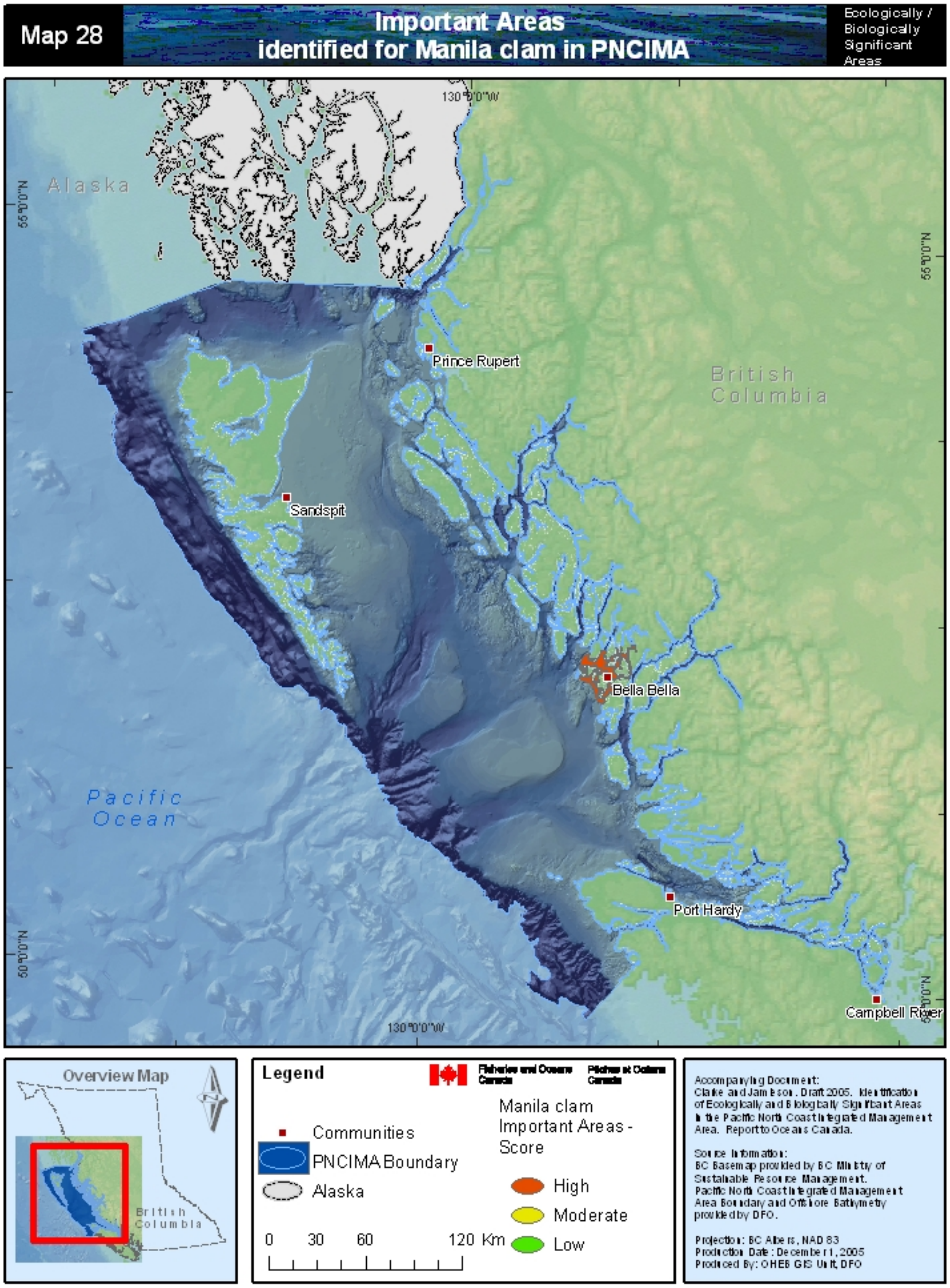


Map 25
Important Areas
identified for coral and sponge bycatch in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Bycatch Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
Coral-sponge proposed protection areas -data and analysis (based on groundfish trawl observer data) provided by Jeff Ardron, Living Oceans Society.
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

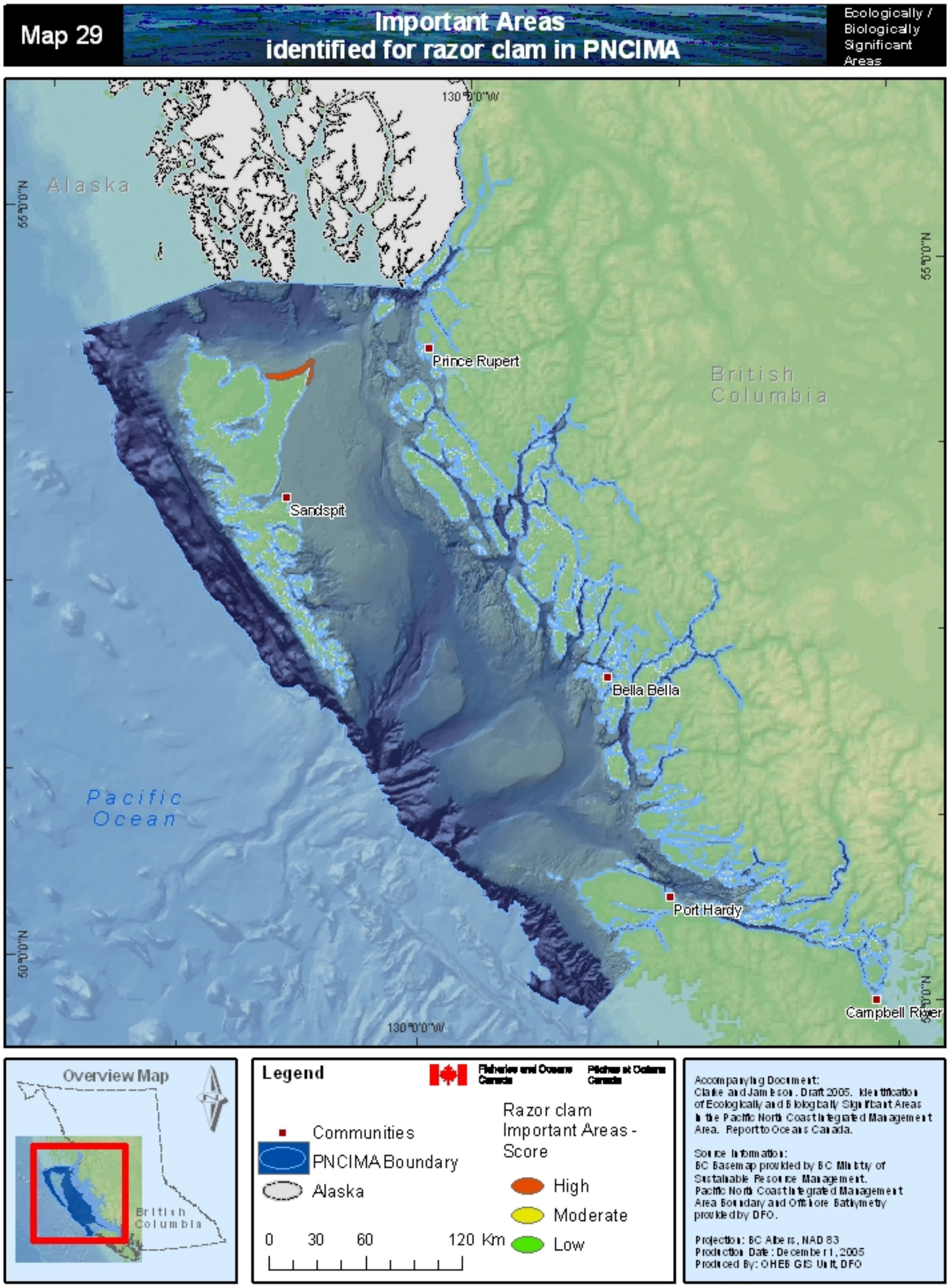

Map 26
Important Areas
identified for hake in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Hake Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO



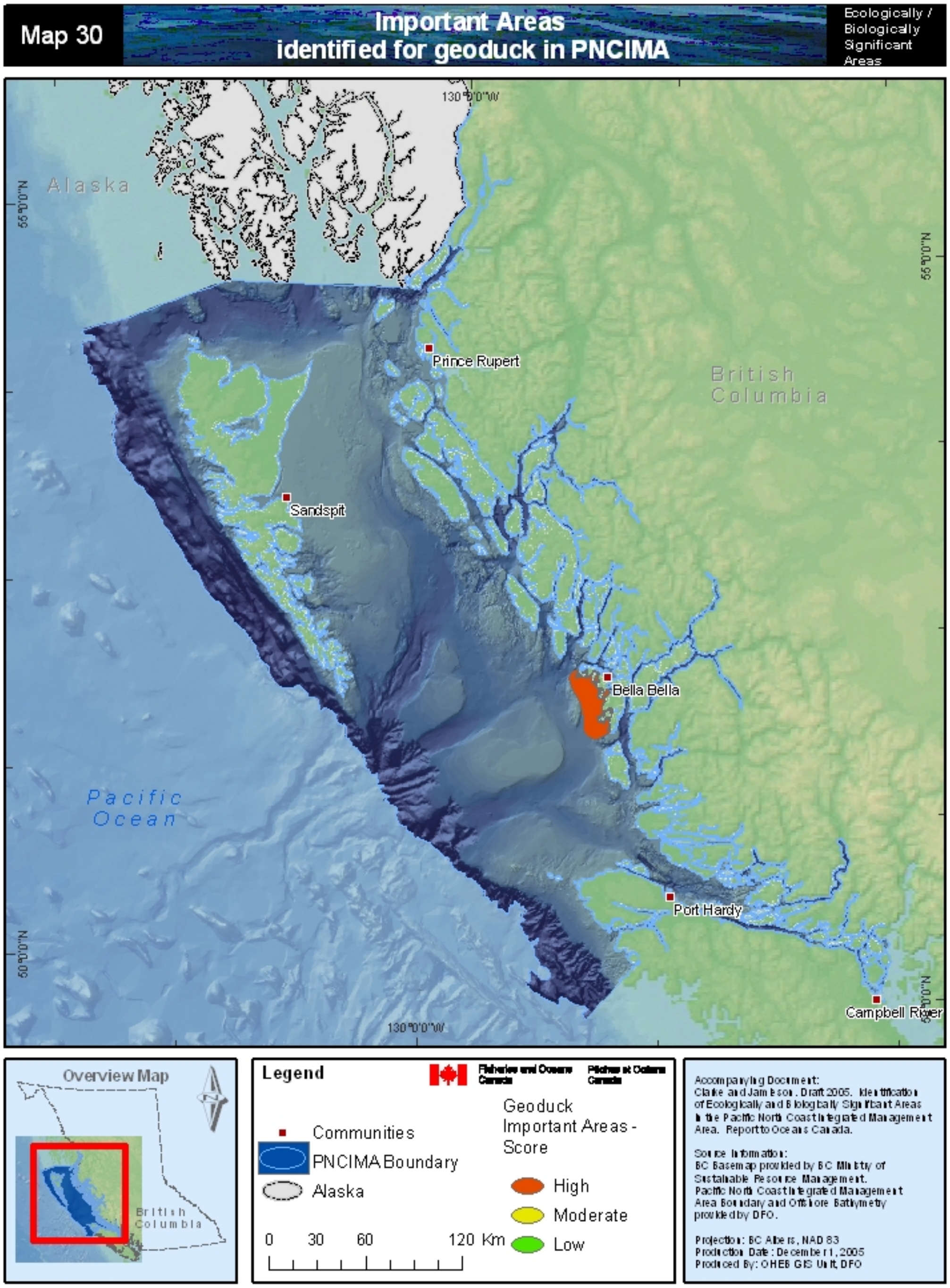
Map 27
Important Areas identified for herring in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
Alaska
55°0'0"N
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Herring Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO



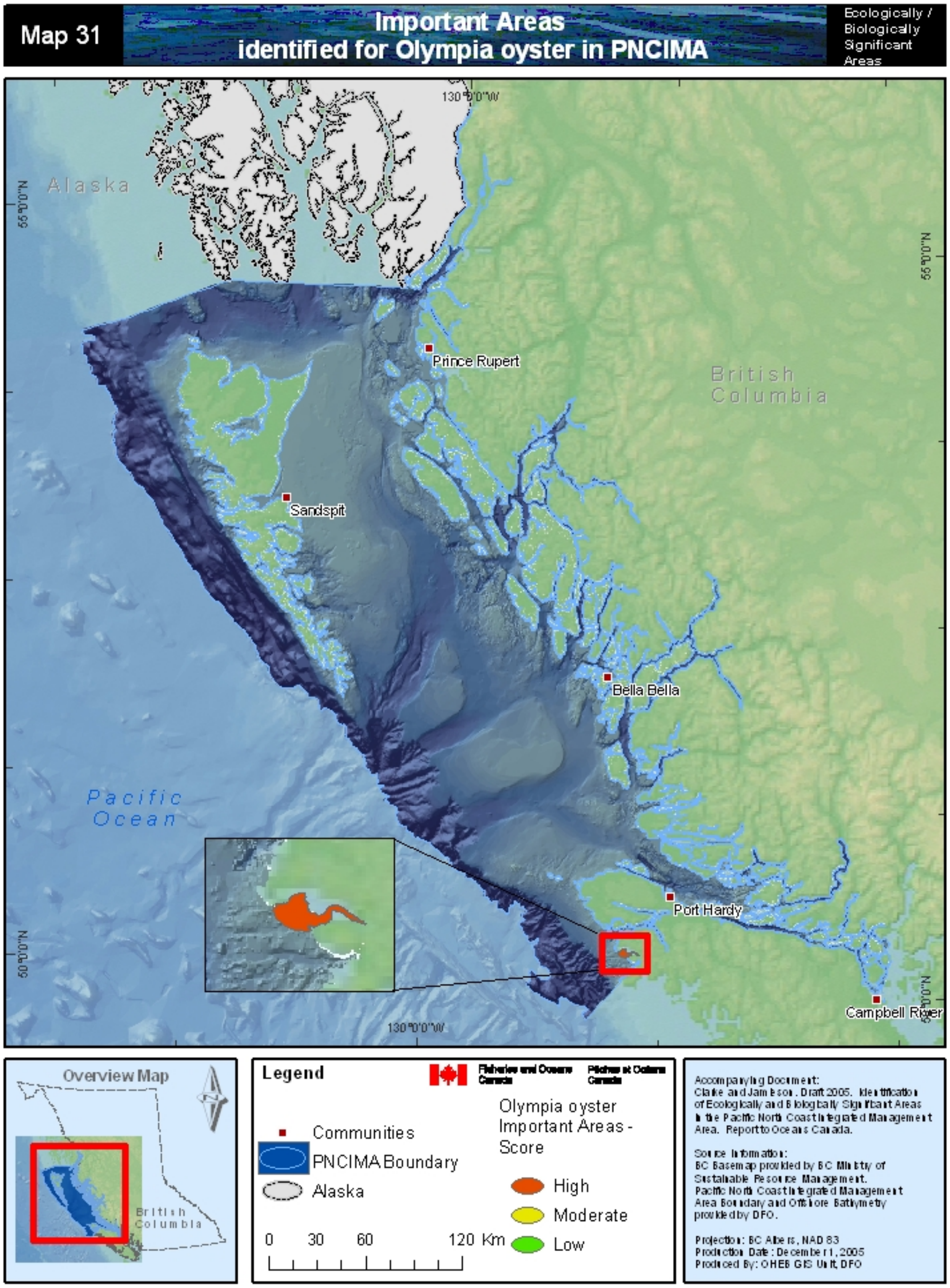
Map 28
Important Areas identified for Manila clam in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Manila clam Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

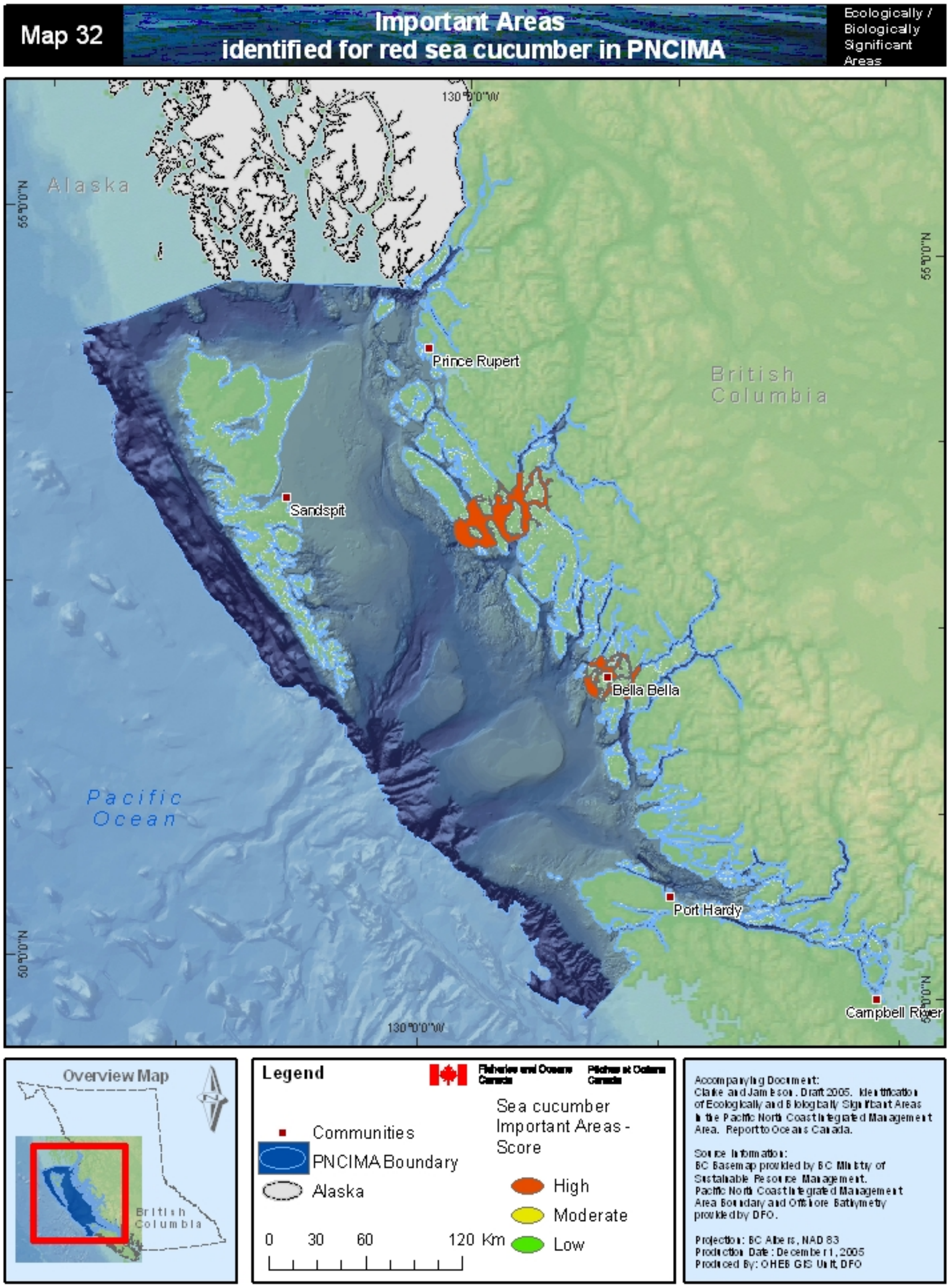


Map 29
Important Areas
identified for razor clam in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Razor clam Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

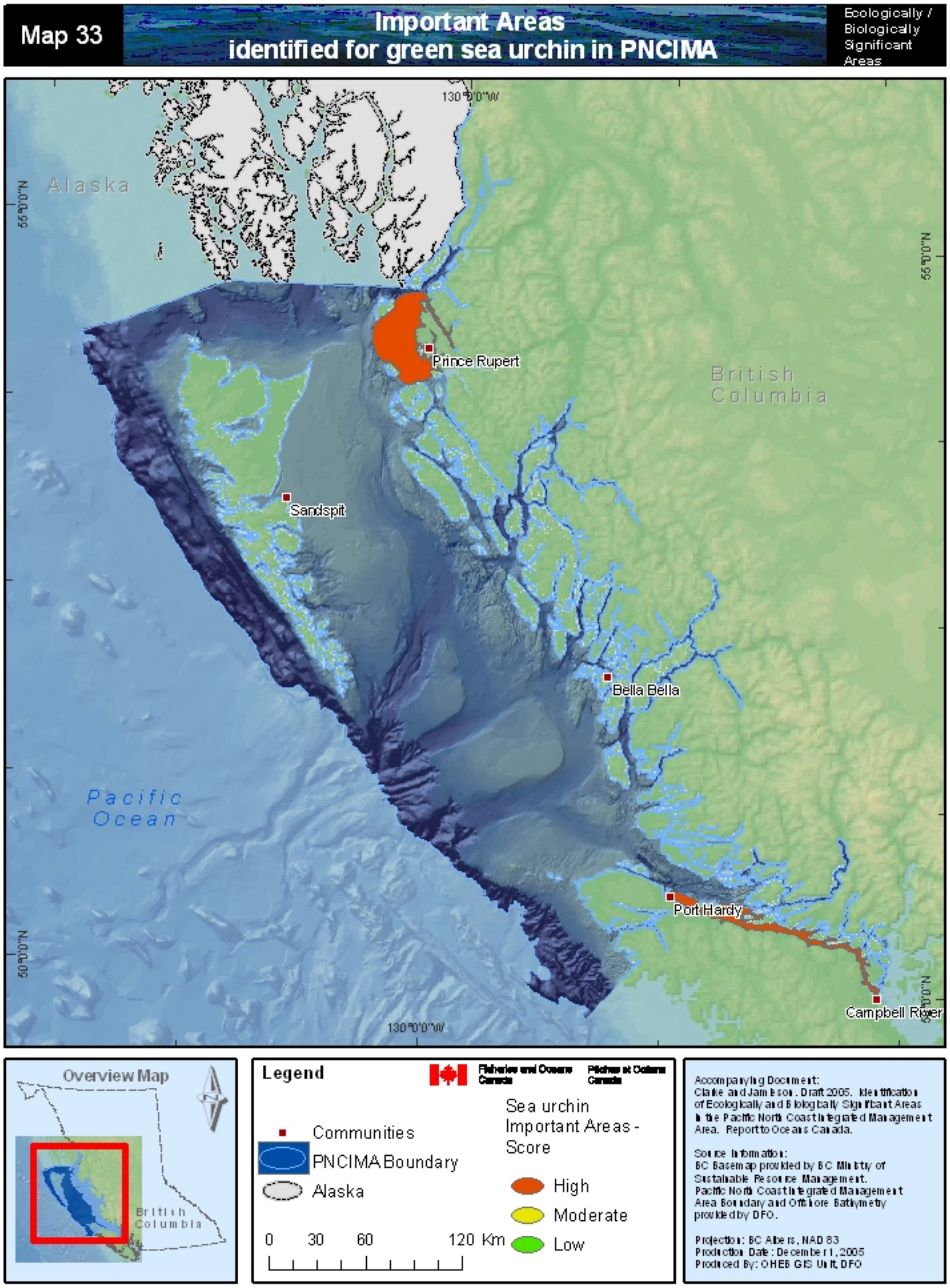


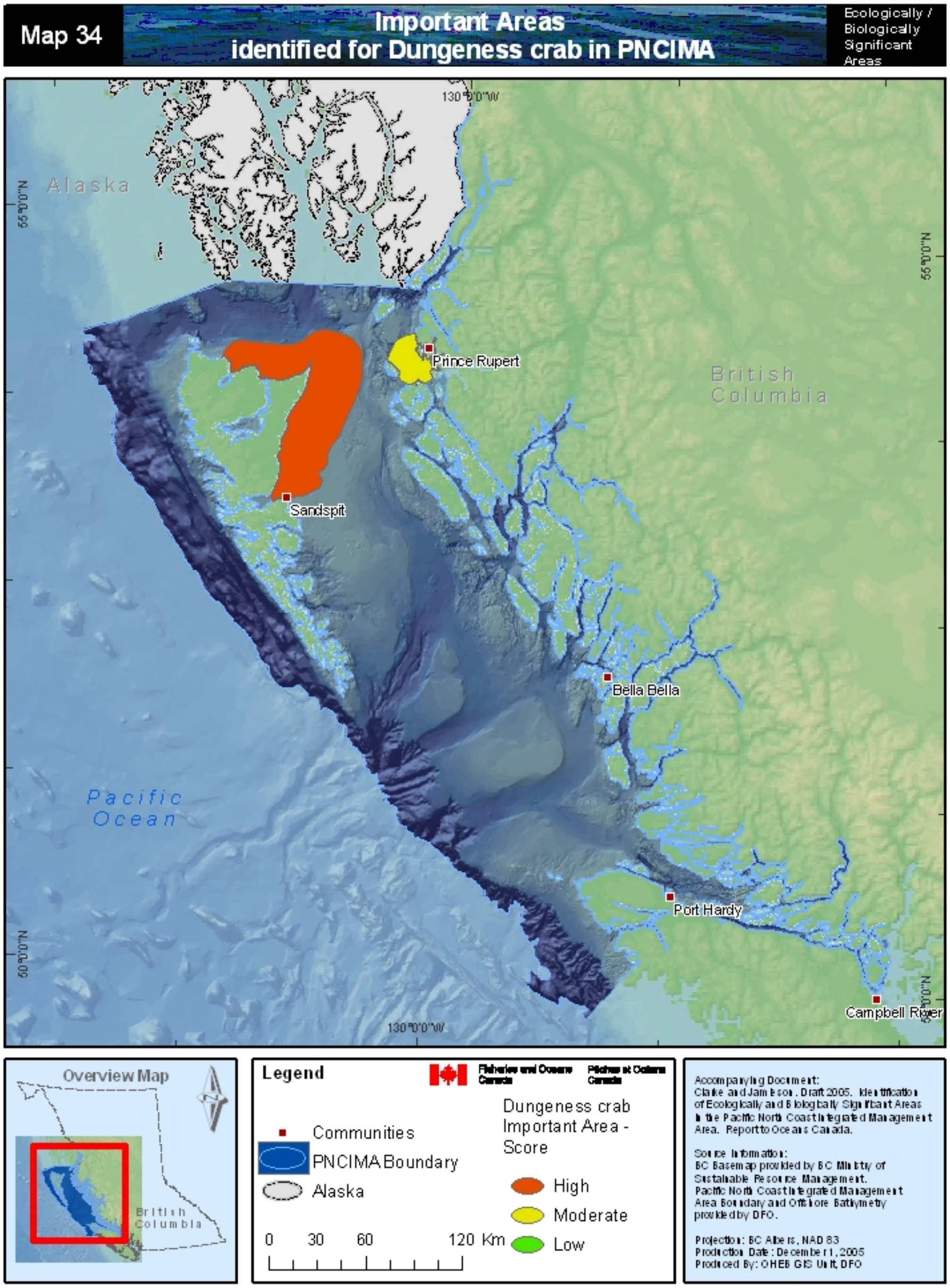
Map 30
Important Areas identified for geoduck in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Geoduck Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 31
Important Areas
identified for Olympia oyster in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Olympia oyster Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

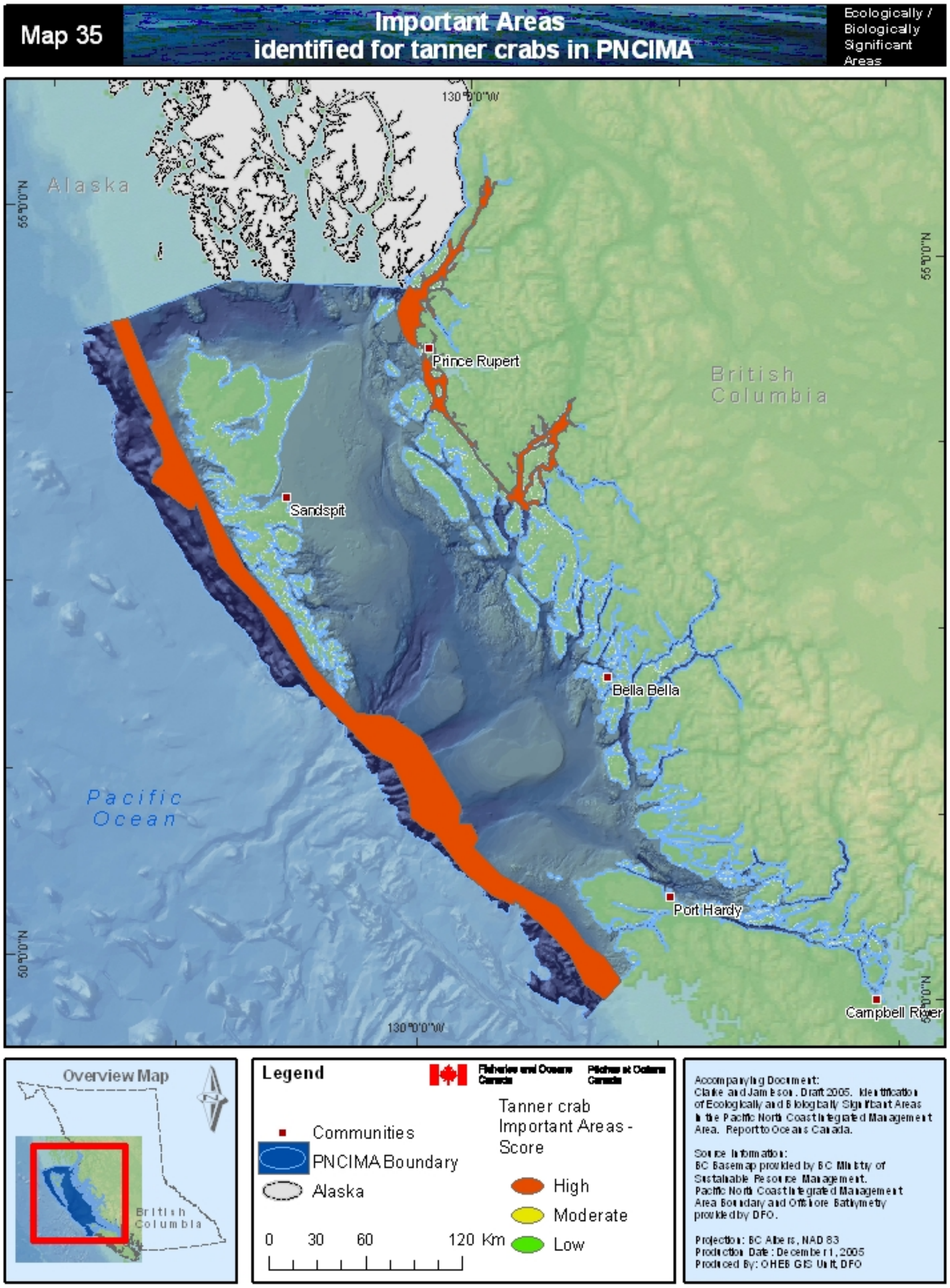


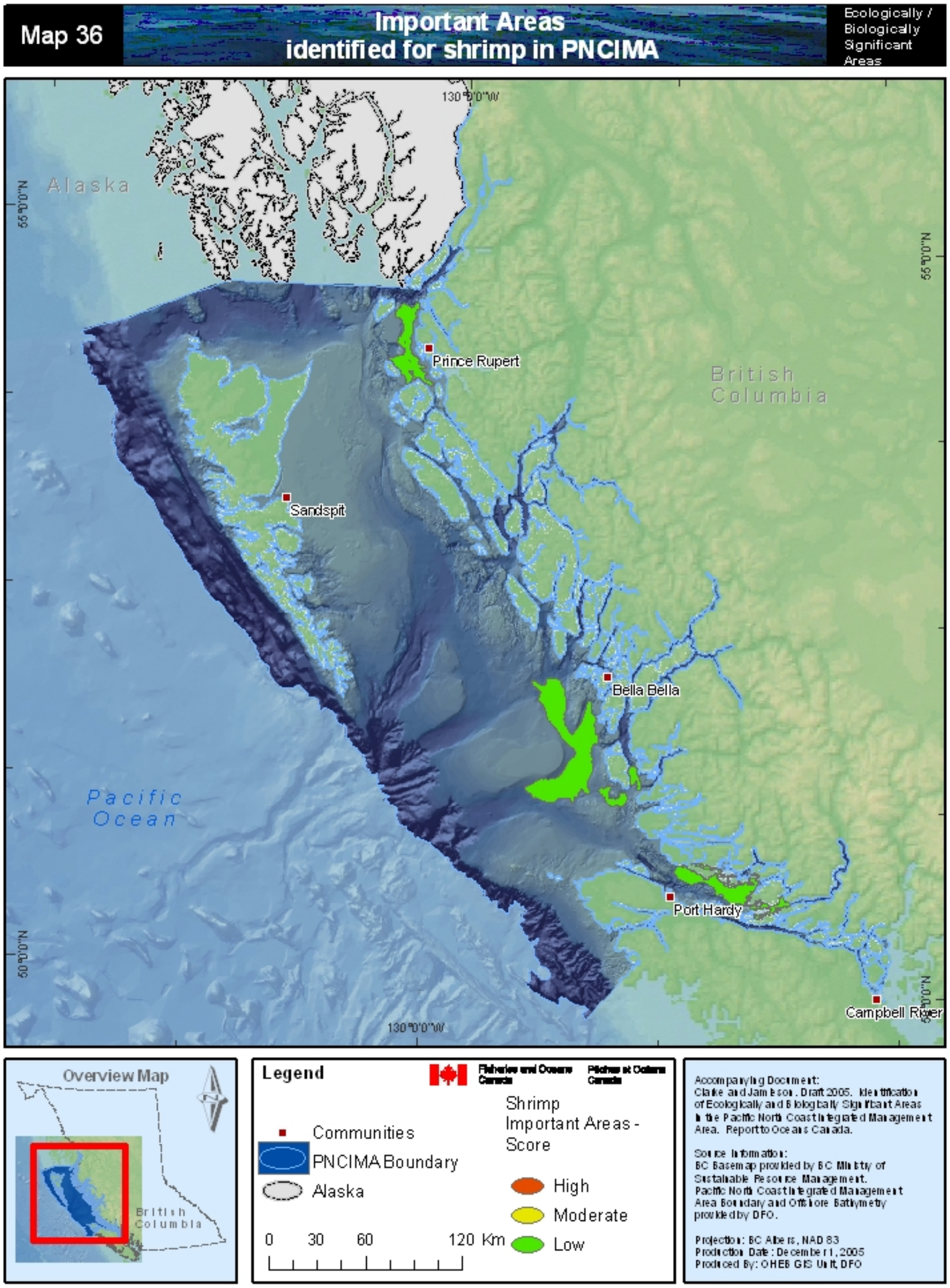
Map 32
Important Areas identified for red sea cucumber in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Sea cucumber Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 33
Important Areas
identified for green sea urchin in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Sea urchin Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

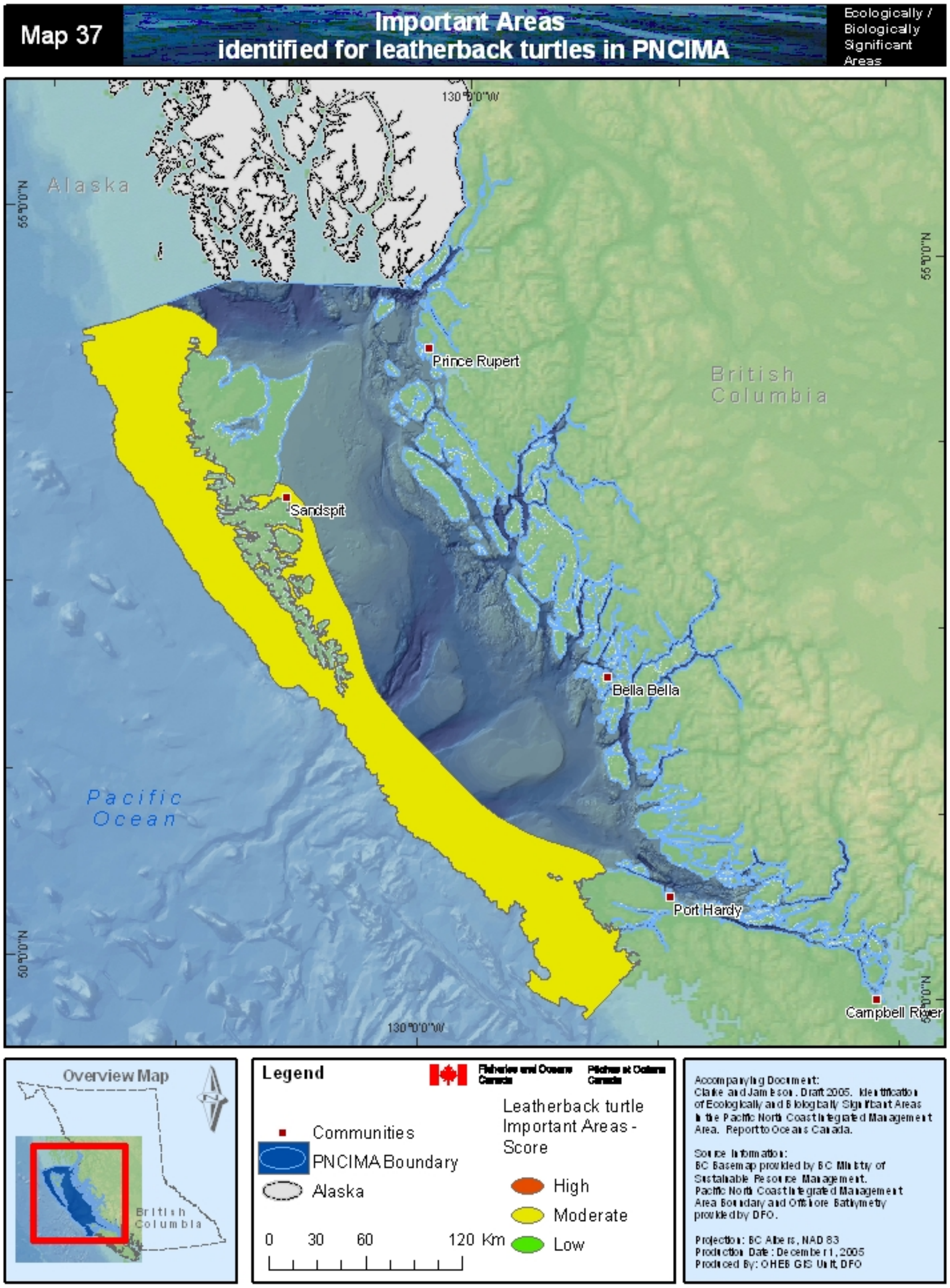


Map 34
Important Areas
identified for Dungeness crab in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Fisheries and Oceans Canada
Pêches et Océans Canada
Communities
PNCIMA Boundary
Alaska
Dungeness crab Important Area - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO


Map 35
Important Areas
identified for tanner crabs in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Tanner crab Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO



Map 36
Important Areas identified for shrimp in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
Legend
Communities
PNCIMA Boundary
Alaska
Shrimp Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

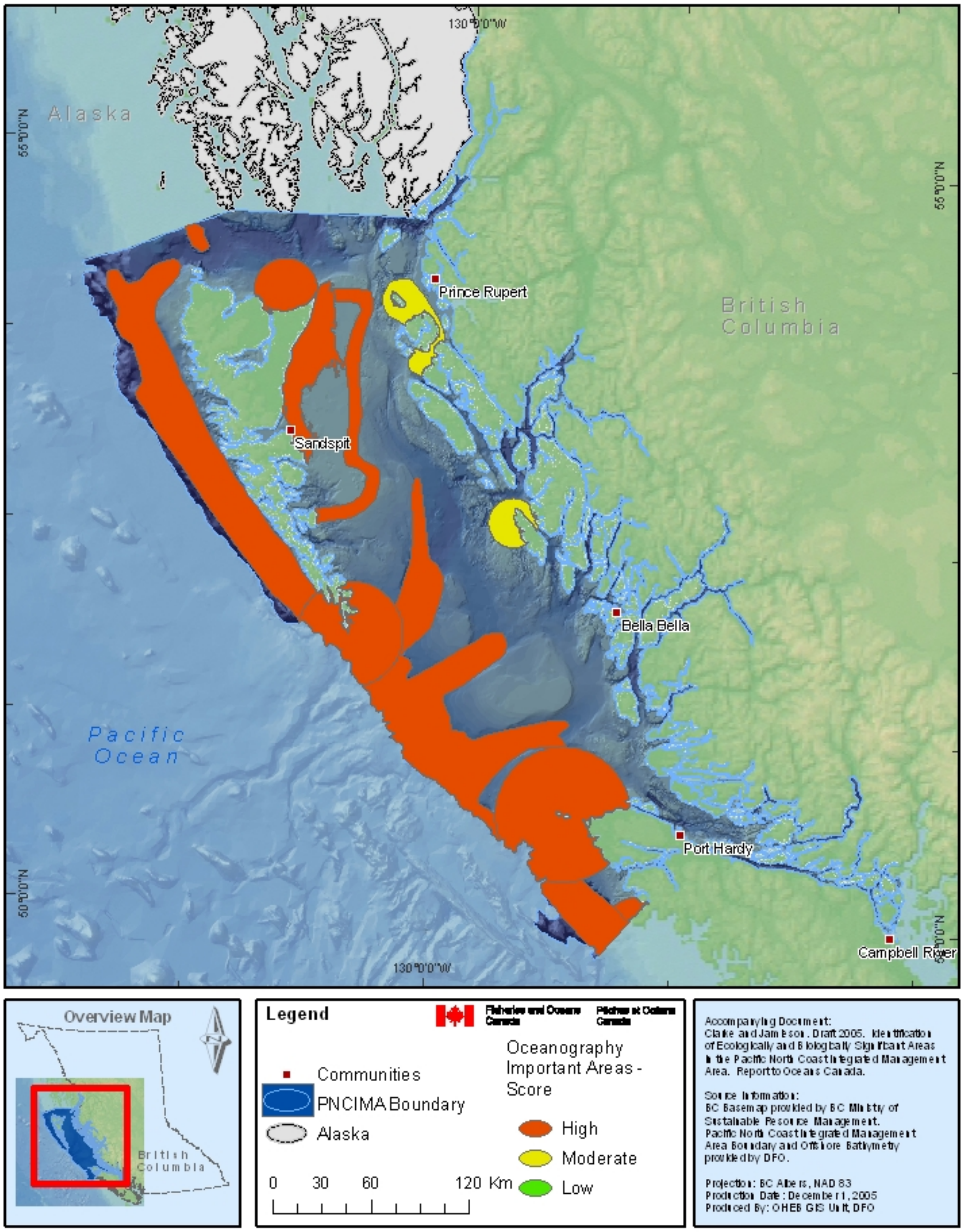


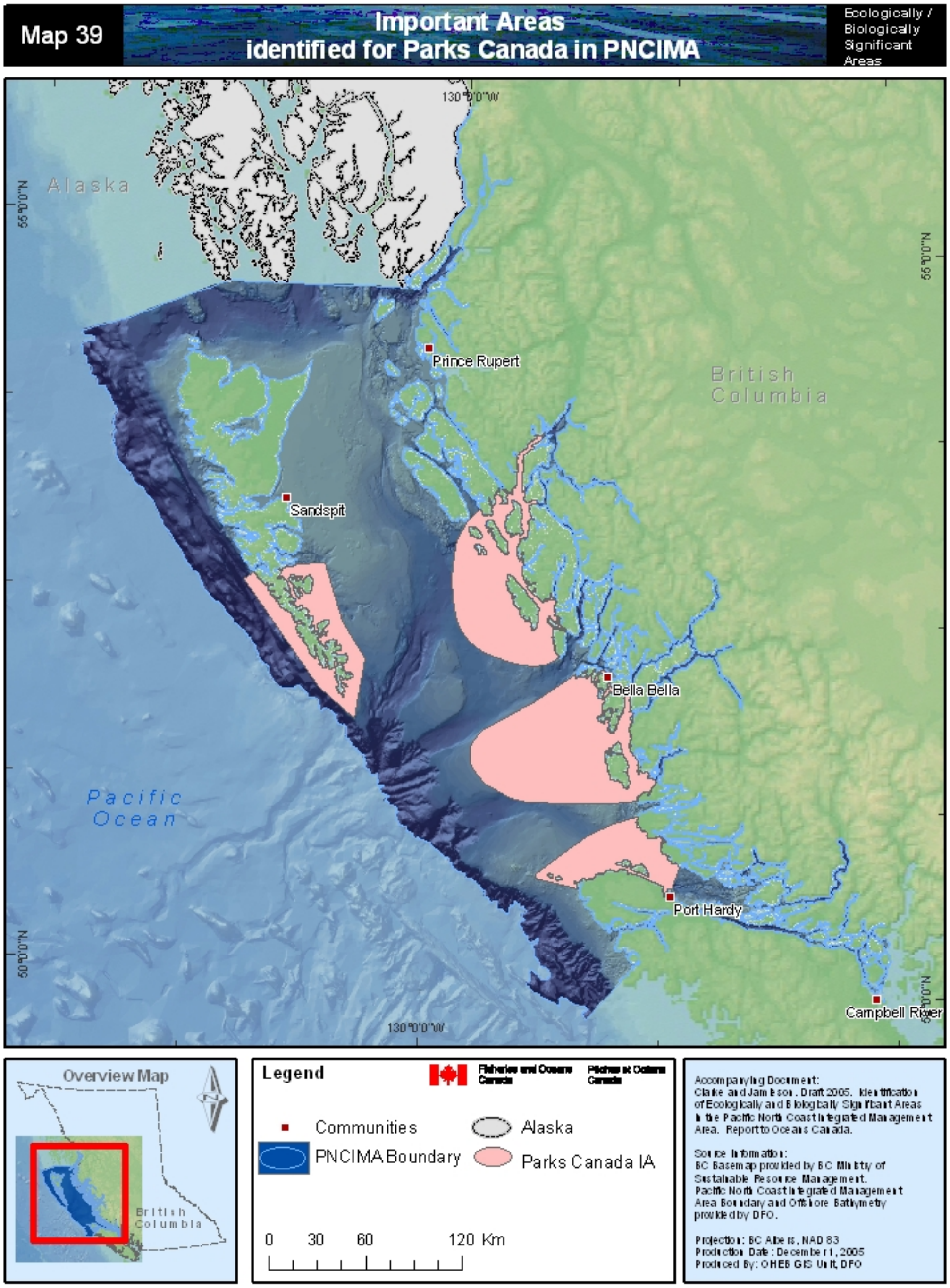
Map 37
Important Areas
identified for leatherback turtles in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
Alaska
Prince Rupert
British Columbia
Sandspit
Bella Bella
Pacific Ocean
Port Hardy
Campbell River
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Leatherback turtle Important Areas - Score
High
Moderate
Low
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO

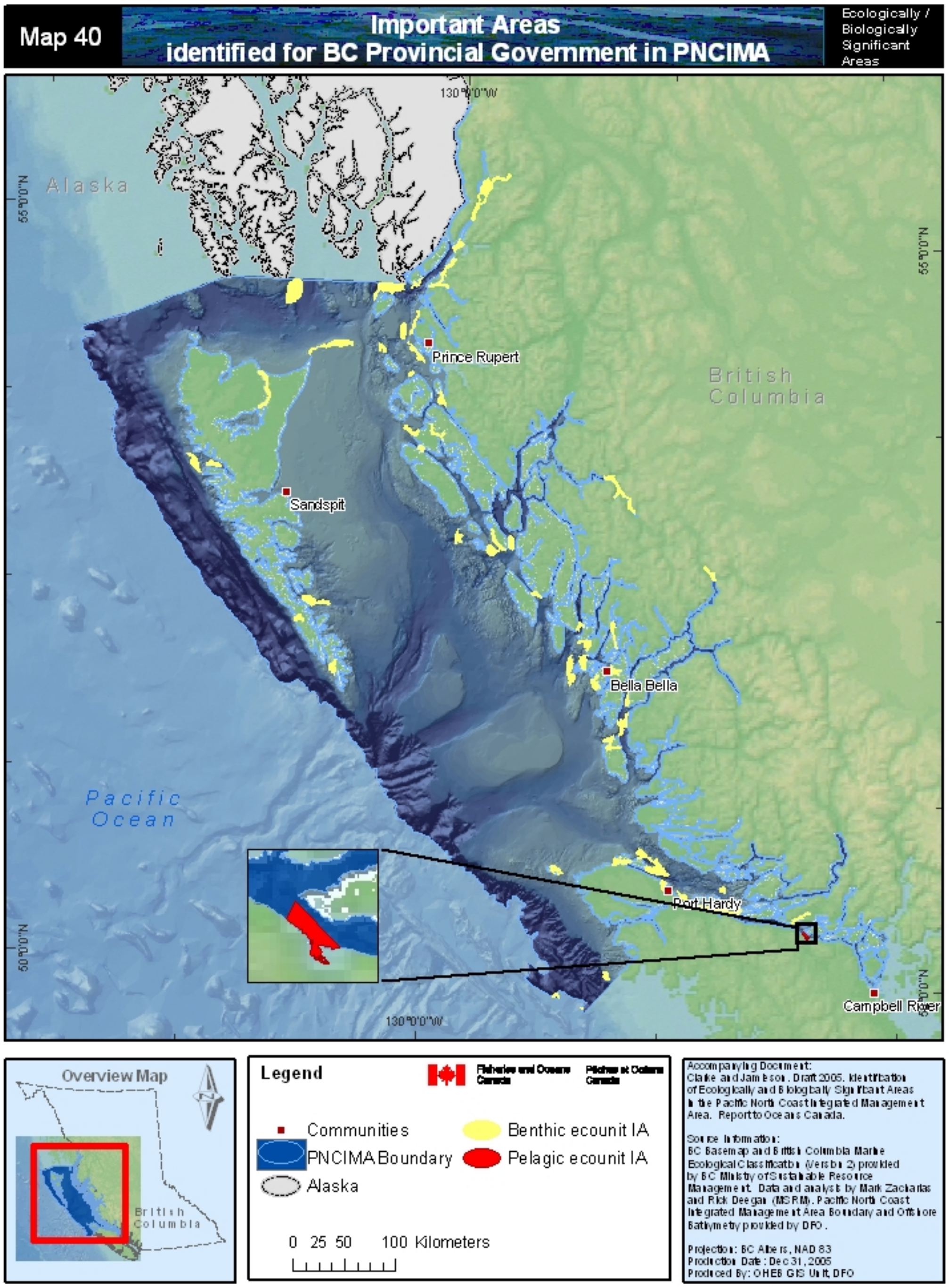
Map 38

Important Areas identified for oceanographic features in PNCIMA

Ecologically / Biologically Significant Areas




Map 39
Important Areas
identified for Parks Canada in PNCIMA
Ecologically / Biologically Significant Areas
130°0'0"W
55°0'0"N
50°0'0"N
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
Overview Map
British Columbia
Legend
Communities
Alaska
PNCIMA Boundary
Parks Canada IA
0 30 60 120 Km
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap provided by BC Ministry of Sustainable Resource Management.
Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: December 1, 2005
Produced By: OHEB GIS Unit, DFO



Map 40
Important Areas
identified for BC Provincial Government in PNCIMA
Ecologically / Biologically Significant Areas
Alaska
British Columbia
Pacific Ocean
Prince Rupert
Sandspit
Bella Bella
Port Hardy
Campbell River
130°0'0"W
55°0'0"N
50°0'0"N
Overview Map
British Columbia
Legend
Communities
PNCIMA Boundary
Alaska
Benthic ecounit IA
Pelagic ecounit IA
0 25 50 100 Kilometers
Accompanying Document:
Clarke and Jamieson. Draft 2005. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area. Report to Oceans Canada.
Source Information:
BC Basemap and British Columbia Marine Ecological Classification (Version 2) provided by BC Ministry of Sustainable Resource Management. Data and analysis by Mark Zacharias and Rick Deegan (MSRM). Pacific North Coast Integrated Management Area Boundary and Offshore Bathymetry provided by DFO.
Projection: BC Albers, NAD 83
Production Date: Dec 31, 2005
Produced By: OHEB GIS Unit, DFO