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State of Knowledge of Marine Habitats of the Northern B.C. Coast in Oil and Gas Lease Areas

État des connaissances sur les habitats marins dans les concessions pétrolières et gazières du nord de la côte de la C.-B

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Abstract

This Working Paper is part of a series of papers (Crawford et al. 2002a, Cretney et al. 2002 a,b,c) addressing marine issues within the Queen Charlotte oil and gas assessment area in British Columbia, Canada, and reviews the knowledge and knowledge gaps of marine habitats. We identify what is known about the principal marine habitats, biota, general trophic structure, and fisheries in the study area.

Habitat types within the study area vary in depth, substrate, relief, currents and exposure; range from nearshore to open ocean; and from sheltered inlets to high exposure sites. Habitat types that have been identified in the study area, and that could be potentially impacted by oil and gas development and associated accidents in the assessment area during development and exploitation, support a variety of potentially sensitive, valuable and complex communities including estuaries and salt marshes, intertidal mussel beds, kelp and eelgrass beds in the intertidal and shallow subtidal, and hexactinellid sponge and coral communities in deep water habitats.

We summarize biological community structure in the following habitats and species groupings:

- the intertidal (sheltered soft-substrate, sheltered hard-substrate, exposed soft-substrate and exposed hard-substrate),
- soft-bottom estuarine habitats,
- benthic subtidal habitats (sheltered, shallow (<30 m), sandy substrates; exposed, shallow (<30 m), rocky habitats; deep (30-100+ m), soft-bottom habitats; very deep (>100 m), soft-bottom troughs; deep (>20 m), rocky subtidal habitats; and very deep (>200 m), soft to mixed-substrate habitats along the Continental Slope),
- pelagic communities (phytoplankton, zooplankton, herring, salmon, and other pelagic fishes),
- marine mammals, and
- marine birds and shorebirds.

We briefly summarize species at risk and trophic structure analyses. We then provide an overview of the fisheries in the assessment area: First Nation and commercial (groundfish, other finfish and invertebrates), and conclude with a discussion on the relevance of both local ecological knowledge and of spatial information, and our knowledge on the general vulnerability of marine communities to oil.

Résumé

Faisant partie d'une série de documents (Crawford *et al.*, 2002a; Cretney *et al.*, 2002 a, b et c) qui portent sur les enjeux marins dans la zone d'exploration pétrolière et gazière des îles de la Reine-Charlotte (Colombie-Britannique, Canada), ce document de travail fait la synthèse des connaissances et des lacunes dans les connaissances sur les habitats marins de cette région. Nous relevons ce que l'on sait des principaux habitats marins, du biote, de la structure trophique générale et des pêches dans la région d'étude.

Allant de milieux côtiers à la haute mer et de baies abritées à des sites très exposés, les types d'habitats de la région d'étude varient sur les plans de la profondeur, du substrat, de la topographie, des courants et de l'exposition. Les habitats relevés dans la région d'étude qui pourraient être touchés par l'exploitation pétrolière ou gazière et d'éventuels accidents connexes abritent diverses communautés complexes et précieuses potentiellement vulnérables, notamment des estuaires, des marais salés, des bancs de moules en zone intertidale, des herbiers de zostère et d'algues brunes en zones intertidale et subtidale ainsi que des communautés d'éponges et de coraux en eau profonde.

Nous résumons la structure des communautés biologiques dans les habitats et groupements d'espèces suivants :

- zone intertidale (substrat mou abrité, substrat dur abrité, substrat mou exposé et substrat dur exposé);
- habitats estuariens à fond mou;
- habitats benthiques subtidaux (habitats abrités peu profonds (< 30 m) à substrat sableux; habitats rocheux exposés peu profonds (< 30 m); habitats profonds à fond mou (de 30 à > 100 m); cuvettes très profondes (> 100 m) à fond mou; habitats rocheux subtidaux profonds (> 20 m); habitats très profonds (> 200 m) à substrat allant de mou à mixte, situés le long du talus continental;
- communautés pélagiques (phytoplancton, zooplancton, hareng, saumon et autres poissons pélagiques);
- mammifères marins;
- oiseaux marins et oiseaux de rivage.

Nous résumons brièvement les analyses des espèces en péril et des structures trophiques, et nous donnons ensuite un aperçu des pêches autochtones et commerciales (poissons de fond, autres poissons et invertébrés). Nous concluons par une discussion portant sur la pertinence des connaissances écologiques locales et de l'information spatiale, ainsi que sur nos connaissances concernant la vulnérabilité générale des communautés marines à l'exploitation pétrolière.

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1.0 INTRODUCTION

The government of British Columbia (BC) is interested in lifting the moratorium on Canada's West Coast offshore oil and gas exploration that has been in place for the past three decades. This Working Paper is in response to information needs communicated by the Pacific Scientific Advice Review Committee (PSARC) of the Pacific Region of Fisheries and Oceans Canada (DFO) for information on marine ecosystems of Northern BC relevant to offshore oil and gas exploration and development. In March 2002 a Working Paper titled "Knowledge Gaps and Risks of Concern for BC Marine Environments from Offshore Oil and Gas Exploration, Development, Production, Transportation and Decommissioning" was reviewed at the PSARC Habitat meeting. The Regional Management Executive Committee (RMEC) then requested the paper be divided into a series of smaller, more focused, working papers. Subsequently, Habitat Managers and the authors divided the paper into the following six working papers:

1. Oceanographic and Geological Setting of a Possible Oil and Gas Industry in the Queen Charlotte Basin
2. Biogeochemical Benchmarks for Source Identification of Contaminants from an Offshore Oil and Gas Industry
3. Modelling Oceanic Fates of Contaminants from the Offshore Oil and Gas Industry with Application to British Columbia
4. State of Knowledge of Marine Ecosystems of the Northern BC Coast
5. Potential Hazards and Impacts of an Offshore Oil and Gas Industry in the Queen Charlotte Basin
6. Role of Modelling in Ecological Risk Assessment and Ecological Risk Management with Emphasis on the Offshore Oil and Gas Industry

This Working Paper, #4 in the above, is thus part of a series of papers (Crawford et al. 2002a, Cretney et al. 2002 a,b,c) addressing marine issues, and reviews the knowledge and knowledge gaps of marine habitats within the Queen Charlotte oil and gas assessment area (Figure 1) so that potential environmental effects of oil and gas development can be knowledgably addressed. Paper 5 has not yet been written.

Most of our current understanding of these marine habitats is based on fisheries surveys and oceanographic cruises. Many surveys had variable sampling sites or were of short duration. The focus of stock assessment studies was often on target species, not biological communities, and so our knowledge of the ecosystem and trophic-level interactions within it is incomplete. Some species have been extensively harvested for many years, e.g., Dungeness crab (*Cancer magister*), intertidal clams, many groundfish, and Pacific herring (*Clupea pallasi*), and it is the catch information associated with fishing these species that comprises much of our knowledge on ecosystems in the study area.

It should be noted that while the original request was for a review of marine ecosystems in the study area, it was concluded that ecosystems remain too poorly defined and described to make this possible, and so marine habitats, defined by arbitrary features such as discrete depth intervals, have been described instead.

1.1 Purpose

The potential for offshore oil and gas exploration and development to impact marine ecosystems in the Queen Charlotte oil and gas assessment area is the impetus for this paper. At present, oil and gas tenures within the Queen Charlotte oil and gas assessment area comprise about 6,303,191 hectares and are held by six companies: Shell, Petro-Canada, Chevron, Mobil, and Unocal (Figure 2). Shell holds 55% of the tenures, followed by Petro-Canada (33%), and Chevron (10%). The other three companies hold less than 5% of the tenures between them. Significant oil and gas reserves have not yet been found in the Queen Charlotte Basin. However, it is hypothesised that up to 9.8 billion bbl of oil and 1.2 billion m^3 of natural gas may occur in this region (Hannigan et al. 2001).

1.2 Objectives

The objective of this paper was to conduct a literature and data review to describe our current knowledge of marine habitats in the study area and to identify knowledge gaps in our understanding of the ecosystems these habitats are in.

This paper identifies the principal marine habitats, biota, general trophic structure, and fisheries in the study area. Specifically this paper presents known information on:

- major aquatic habitats and their associated biota in the context of the physiography and oceanography of British Columbia's Central and North Coasts
- the presently documented vulnerability of biological communities to potential impacts of offshore oil and gas exploration and development
- spatial distributions of biological communities
- major fisheries in the study area, from the intertidal to 400 m depth.
- areas where further research is needed to better understand marine biological processes in the region

2.0 NORTH AND CENTRAL COAST GENERAL DESCRIPTION

2.1 Physiography

The Queen Charlotte Oil and Gas assessment area in the Pacific Ocean is bounded by the mainland coast of central and northern British Columbia to the east, the continental slope to the west, Vancouver Island to the south, and the

United States Border to the north. Specifically, the area includes Queen Charlotte Sound, Hecate Strait, and Dixon Entrance (Figure 1).

This geological assessment area ranges in depth from 400 m in the deep channels of Dixon Entrance and Queen Charlotte Sound to 20 m along the shallow banks of Hecate Strait. However, for our review, we consider right up to the intertidal, since oil floats and biological communities throughout the water column are potentially able to be impacted. The channels in Queen Charlotte Sound were formed in part by retreating glacial ice sheets (Thomson 1981).

2.2 Oceanography

Numerous reports summarize oceanographic conditions off British Columbia's north coast (Crean 1967, Dodimead 1980, Tabata 1980, Thomson 1981, Crawford 2001, Cretney et al. 2002a). Such studies provide the basis for our understanding of temperature and salinity seasonal profiles, current and tidal patterns, and nutrient dynamics, features that largely define the spatial distributions of marine species and communities. An inventory of Pacific coast, ocean physics and ocean chemistry data has been included in the Department of Fisheries and Oceans database "CODIS". In addition to data, the inventory includes citations of Canadian Data Reports relevant to the west coast, a series entitled "West Coast Data Inventory and Appraisal Program (WESCAP – c.f. Nichol et al. 1993). CODIS was originally developed to provide baseline information pertinent to offshore oil and gas exploration. Some of this data is current to 1984, with mammal data current to 1991. Cretney et al. (2002a) provided a detailed description of the oceanographic and geological setting of the Queen Charlotte Basin as it pertains to the offshore oil and gas industry, and this is briefly summarized here, as marine physical parameters are integral to understanding the locations and spatial extents of biological communities..

Average surface water temperature between 1942 and 1995 ranged from 12.8 ^{o}C during the summer months to 7.2 ^{o}C in the winter. Average water temperature at 300 m between 1942 and 1995 was 5.3^{o} C in the summer and 5.8 ^{o}C in the winter (Crawford 2001). The slight increase in water temperature at depth during winter is a consequence of increased wind energy and the ocean becoming less stratified, which results in increased mixing of surface and deeper waters during storm events.

Salinity ranged from 28 ppt in the summer to 32 ppt in the winter. In the spring, the combined discharge of the Nass and Skeena Rivers was ca. 5700 m^3 s^{-1}, which significantly dilutes the salinity of the north side of Dixon Entrance. Salinity is also low in the summer months in nearshore waters along mainland BC due to mainland river runoffs (Thomson 1981).

The movement of water within the Queen Charlotte assessment area is influenced by tides and currents. Tides within the area are primarily semi-diurnal and move in an anti-clockwise direction. Tidal currents range from more than 3.08 m s^{-1} (6 knots) in narrow shallow channels, such as Porcher and Stuart Narrows, Otter Passage and Masset Sound, to less than 0.03 m s^{-1} (0.06 knots) in deep-ocean areas (Cretney et al. 2002a). In the open waters of the assessment area, tidal currents of 2.06-2.57 m s^{-1} (4-5 knots) were observed at Rose Point and Cape St. James (Cretney et al. 2002a).

Upwellings bring cold nutrient rich waters to the surface along mainland BC in both Hecate Strait, as far south as Aristazabel Island, and in Dixon Entrance. Upwellings are responsible for the circulation of cold water along the west coast of both Graham and Moresby Islands. At Cape St. James on the southern tip of Moresby Island and Cape Scott and Cook Bank around the northern tip of Vancouver Island, upwellings mix with warm surface water (Crawford 2001). The Rose Spit and Haida Eddies also play dominant roles in local water circulation and are thought to be influential throughout the Northeast Pacific Ocean (Crawford et al. 2002b; Mackas and Galbraith 2002).

Coastal areas where high nutrient availability occurs are particularly productive. Principal modes of nutrient transport into the euphotic zone of the Pacific Northeast are through upwelling, riverine discharge and the physical mixing by winds of relatively nutrient rich underlying water. Periodic areas of high planktonic productivity in the study area include the east coast of the Queen Charlotte Islands in the spring (Perry and Dilke 1986); around Cape St. James, Rose Spit, Cape Scott and Cook Bank; in coastal upwelling areas along the coast of mainland BC, and estuaries (Crawford 2001). Available inorganic nutrient concentrations are generally highest during winter months, but it isn’t until the spring, as light and temperature increase, that phytoplankton can fully utilize them. Typically as biological uptake increases during spring and fall plankton blooms, bio-available nutrient concentrations are depleted to near or below detection limits (Perry and Dilke 1986).

3.0 MARINE HABITAT CLASSIFICATION SYSTEMS

Numerous ecosystem or habitat classification schemes have been developed for classifying marine environments. Watson (1998) reviewed some of these classification systems and the methods the schemes used to delineate marine ecosystems.

In 1993, Environment Canada initiated the development of an ecosystem classification system, based on physical and biological parameters (Harper et al. 1993). This system was modified by the Ministry of Sustainable Resources Management (MSRM), previously the Land Use Coordination Office (LUCO) for the province of British Columbia to create their British Columbia Marine

Ecosystem Classification (BCMEC) system (Zacharias et al. 1998). Some modifications included 1) the utilization of physical and chemical parameters to delineate ecosystems, instead of the physical and biological parameters used by Harper et al. (1993), and 2) the addition of a fifth tier to incorporate smaller "ecounits," defined by wave exposure, depth, subsurface relief, current, and substrate. In 2001, the BCMEC was expanded to include pelagic components such as salinity, temperature, stratification, slope and relief parameters; and two additional ecounits, benthic (seabed and foreshore) and pelagic (sea surface and water column) (Axys 2001).

At present DFO has not evaluated and accepted any marine habitat classification system as the standard approach to classifying marine ecosystems in BC. Therefore, this document delineates and classifies ecosystems by habitat type and the communities associated with these habitats.

4.0 HABITATS

Habitat types within the study area vary in depth, substrate, relief, currents and exposure; range from nearshore to open ocean; and from sheltered inlets to high exposure sites. The habitat types that have been identified in the study area, and that could be potentially impacted by oil and gas development and associated accidents in the assessment area during development and exploitation, support a variety of potentially sensitive, valuable and complex communities including estuaries and salt marshes, intertidal mussel beds, kelp and eelgrass beds, and hexactinellid sponge and coral communities in deep water habitats.

The MSRM has quantified shoreline areas by both physical and biological characteristics along the central and north coast of BC and the Queen Charlotte Islands. However, these data are currently unavailable to DFO.

4.1 Intertidal

The Intertidal zone is best described as the benthic substrate found between high and low tides, including areas impacted by wave and splash action. Vertical zonation of organisms occurs based on species' tolerances to dessication, change in salinity and light, wave exposure, competition and predation. There are four general types of intertidal habitats: sheltered soft-substrate, sheltered hard-substrate, exposed soft-substrate and exposed hard-substrate.

4.1.1 Sheltered intertidal soft-substrate habitats

Sheltered beaches, with mixed sand, gravel and mud substrates are found in inlets, passages, and channels within the study area. These sites provide habitat for a variety of communities, notably intertidal bivalve communities.

Intertidal clam surveys have been conducted semi-annually in British Columbia since 1990 along BC's central and north coasts as far north as Masset Inlet on the Queen Charlotte Islands, the Lucy Islands in Chatham Sound, and along the mainland BC coast. See Appendix A: Table A-1 for a list of surveys and the locations surveyed. Clam surveys had two objectives: 1) to assess the presence/absence of intertidal clams and determine the clam bearing areas of beaches; and 2) to document the northward dispersal and population parameters of the non-indigenous manila clam (Gillespie and Bourne 2000). Surveys focused on butter (*Saxidomus gigantea*), littleneck (*Protothaca staminea*), and manila (*Venerupis philippinarum*) clams. Other intertidal clams noted if encountered included horse (*Tresus* spp.) and softshell (*Mya arenaria*) clams, cockles (*Clinocardium nutalli*), and geoducks (*Panope abrupta*). A particular beach site may have one, some or all of these clam species, often in different intertidal/subtidal elevations and locations along the beach. Butter clams are mostly found in the lower third of the intertidal zone in porous sand, shell, gravel or mud. Littleneck clams are found in the upper part of the lower-intertidal to the mid-intertidal zone in firm gravelly substrates. Manila clams occur from the lower-intertidal to above the mid-intertidal zone in firm sand-gravel substrates. Softshell clams prefer high intertidal areas with soft substrates (Bourne and Cawdell 1992; Bourne et al. 1994).

Large, widely distributed populations of littleneck and butter clams were found on surveyed beaches along the east side of Queen Charlotte Sound and Hecate Strait, with densities as high as 296 m^{-2} and 700 m^{-2}, respectively (Bourne et al. 1994; Heritage et al. 1998). Stunting of butter and littleneck clams was observed throughout the North Coast and is likely due to adverse environmental conditions, such as overcrowding and occurrence in marginal habitats (Gillespie and Bourne 2000). All horse clams sampled were *Tresus capax*, and their density was highly variable, depending on the beach surveyed (Bourne and Cawdell 1992). The west side of Calvert Island was the only location of razor clams (*Siliqua patuala*) identified during these surveys (Bourne et al. 1994), but these clams support a moderate fishery on North Beach, Queen Charlotte Islands (DFO 2001a).

Surveys found that Manila clams are not widely dispersed along the North Coast, attributed to cold water temperatures and adverse physical conditions, such as high salinity and exposure (Heritage et al. 1998). The furthest north Manila clams have been found to date was on the west side of Aristazabal Island, where there were only a few clams present. Caamaño Sound may be the current northern limit for Manila clam dispersal (Gillespie and Bourne 2000). There are no data to suggest that Manila clam populations have yet become established in the Queen Charlotte Islands (Gillespie and Bourne 1998).

Beaches surveyed with soft sand-mud substrates often had eelgrass beds (*Zostera marina*) associated with the lower intertidal/upper subtidal zone. Cockles, if present, were located in these eelgrass beds or in the lower intertidal zone (Gillespie and Bourne 2000). Common invertebrate species associated with these bivalve communities at low intertidal levels included, sea stars (sunflower sea star (*Pycnopodia helianthoides*) and mottled star (*Evasterias trochelii*)) and Lewis moon snails (*Polinices lewisii*) (Bourne and Cawdell 1992). The introduced seaweed *Sargassum muticum* was often located in the low intertidal/subtidal areas of these beaches as far north as Clifford Bay (Heritage et al. 1998).

4.1.2 Exposed intertidal soft-substrate habitats

Wind-swept, high energy beaches often have relatively low numbers of macroscopic species, but often have a diverse microscopic infauna. One macroscopic invertebrate that requires this habitat type is the razor clam (*Siliqua patula*).

Razor clams are found at two areas along the Central and North Coast: at beaches on the northeast tip of Graham Island in McIntryre Bay (Jones et al. 2001) and at a beach on the west side of Calvert Island (Bourne et al. 1994). Razor clams are found between the mid-intertidal to subtidal on surf-swept beaches from Alaska to California (2001b). Between 1994 and 2000, three beaches on the northeast tip of Graham Island in McIntryre Bay were surveyed for razor clam populations (Jones et al. 2001). Razor clam surveys have not occurred at any other location along the central and north coasts of British Columbia (See Appendix A: Table A-2). Surveys determined the abundance and biomass of razor clams in the area using two different estimation methods, ratio and inflation. Surveys provided data that will be used in the long-term management of the fishery (Jones et al. 2001). Surveys are species specific and there was no mention of species other than razor clams. Using the inflation method, estimated razor clam biomass for the surveyed area was approximately 600 tonnes for 1994, 1996, and 1998; slightly lower in 1995 and 1997; almost 1150 t in 1999; and 1700 t in 2000.

Harper et al. (1994), through a biophysical inventory of the coastal resources of Gwaii Haanas, gathered infaunal information on this habitat type from an exposed beach along Moresby Island (Appendix A: Table A-2). The purpose was to provide background resource information for the development of a national park management plan. In an exposed sand habitat at Woodruff Bay, Harper et al. (1994) observed small clams (*Tellina nuculoides*), gastrotrichs, turbellarians, harpacticoid copepods, and an archiannelid.

Exposed sandy habitats comprised 6% of the sites surveyed by Lamb et al. (2000). Sessile species were rare, and observed mobile species included amphipods (*Hyale* spp.) and mysids (*Mysidella americana*).

Searing and English (1983) and Emmett et al. (1995) also surveyed exposed sandy beaches within the assessment area, but both these surveys found no intertidal biota within this habitat type.

4.1.3 Exposed rocky intertidal habitats

In these intertidal habitats where wave exposure is extreme, intertidal species are mostly found in surge channels, tide pools or small crevices where they are less likely to be washed off the substrate. In less extreme situations, sea mussel (*Mytilus californianus*) and goose barnacle (*Pollicipes polymerus*) beds form a common community type in exposed intertidal to subtidal rocky areas.

A number of physical surveys have been conducted that identify the location and composition of these communities in central and northern BC. MSRM is also in the process of compiling a biophysical inventory of the central and north coast of BC that may provide the locations of many sea mussel/goose barnacle beds. Biophysical information was collected using aerial photography.

Surveys that have been conducted on this habitat type include inventories: in three natural areas in Queen Charlotte Sound (Searing and English 1983), Gwaii Haanas (Harper et al. 1994), and the Goose Islands (Emmett et al. 1995); Allison Harbour to Takush Harbour along the central coast of BC (Lamb et al. 2000); and the west coast of Vancouver Island (Jamieson et al. 2001). The purpose of the first three surveys was to inventory coastal resources for park planning and management purposes. All of the studies described the biological community of this habitat type by exposure, substrate and intertidal height. See Appendix A: Table A-3 for a list of surveys and the locations surveyed.

Sea mussel/goose barnacle communities are one type of community that utilize exposed rocky intertidal habitats. Research has found the structure of these communities to be very diverse. Yamada and Peters (1988) suggested that this community can be comprised of more than 300 invertebrate species. A preliminary study on the west coast of Vancouver Island found a total of 142 species associated with 29 sea mussel/goose barnacle sites (Jamieson et al. 2001). In the study area, communities were composed of gastropods (40%), marine arthropods (20%), annelids (16%), echinoderms (7%), molluscs (5%), cnidarians (3%), insects, chordates and sipunculas (1%) and unknowns (4%). Species diversity in these beds was found to be positively correlated with exposure and the depth of the mussel layer (Jamieson et al. 2001).

Vertical zonation of sea mussel/goose barnacle beds is primarily influenced by physical limitations and secondarily by predators. Physical limitations in the upper intertidal are dessication/exposure and in the lower intertidal/subtidal they are changes in substrate type (Suchanek 1981). In areas of freshwater input, low salinity also limits their distribution (Gillespie 1999). The purple sea star (*Pisaster ochraceus*) is the principle predator that limits the subtidal distribution of mussel/barnacle beds (Paine 1974, Suchanek 1981).

The Queen Charlotte Sound survey inventoried community characteristics on Dundas Island Archipelago, Southeast Moresby Island Archipelago, and Hunter/Calvert Islands Archipelago (Searing and English 1983). Exposed bedrock intertidal locations had the richest species diversity and abundance of all intertidal sites surveyed in the Dundas Island Group. Dominant vegetation included rockweed (*Fucus gardneri),* sea sacks (*Halosaccion glandiforme),* and kelp *(Alaria marginata* and *Laminaria setchellii)*. Fauna were found in zones, with the upper zone dominated by mussels, barnacles, limpets, and periwinkles and the lower zone dominated by anemones, chitons, tubeworms and starfish.

The southeast Moresby Island survey reported dominant upper and lower intertidal species as thatched barnacle (*Balanus cariosus),* sea mussels *(Mytilus califorianus),* dogwhelks *(Nucella emarginata)* and periwinkles (*Littorina* sp). The Hunter/Calvert Islands survey reported dominant vegetation as *Fucus, Halosaccion*, and *Ulva,* and dominant upper intertidal species the same as those found on southeast Moresby Island. Rock crevices in the lower intertidal zone were dominated by sea anemones (*Anthopleura* sp. and the beaded anemone T*ealia coriacea)* (Searing and English 1983).

In a 1993 survey of the Goose Islands (Emmett et al. 1995), dominant upper intertidal fauna included acorn barnacles (*Balanus glandula*), sea mussels and goose barnacles. Rockweed formed a dense band in the lower intertidal zone, and surfgrass (*Phylloxpadix* sp.) and purple sea urchins (*Strongylocentrotus purpuratus*) were common in the lower intertidal to shallow subtidal zones.

The biological community structure of exposed rocky intertidal areas along Gwaii Haanas National Park is similar to the community structure of similar habitats on the west coast of Vancouver Island (Harper et al. 1994). The only regional differences noted between these two communities were: 1) sea palms (*Postelsia*) do not occur as far north as the Queen Charlottes, and 2) a few upper intertidal species from the Queen Charlottes are found in the lower intertidal to subtidal zone off Vancouver Island, (e.g., purple hinged rock scallop (*Crassodoma gigantea*), giant acorn barnacle (*Balanus nubilus*) and northern abalone (*Haliotis kamtschatkana*). Species commonly found on the surveyed exposed rocky intertidal zones included encrusting coralline red agae, knarled tough root weed (*Lessoniopsis littoralis*), bull kelp (*Nereocystis luetkeana*), small ribbon kelp (*Alaria nana*), graceful coral seaweed (*Corallina vancouveriensis*), sea moss (*Endocladia muricata*), sea cabbage (*Hedophyllum sessile*), split kelp (*Laminaria setchellii*), translucent steel grey/purplish green (*Porphyra* spp.), sea tar (*Verrucaria maura*), branching green filament seaweed (*Cladophora* spp.), spongy cushion (*Codium setchellii*), sea sacs, hairy pit rock weed (*Fucus* spp.), Turkish washcloth (*Mastocarpus papillatus*), dark dense knob-tip branches (*Odonthalia* spp.), Scouler's surf-grass (*Phyllospadix scouleri*), and tier-celled fine tufts (*Polysiphonia* spp.).

The central coast survey conducted between Allison Harbour and Takush Harbour summarizes by habitat type the most frequently occurring sessile and mobile species, as well as the characteristic species that utilize each habitat. Some of the most common sessile species found in exposed, rocky habitats include encrusting red algae (*Lithothamnion* spp.), red seaweed (*Corallina gracilis*, *Corallina* spp., and *Mastocarpus* spp.), rockweed, acorn barnacles, and sea grass (*Zostera* spp.). Common mobile species include chink snails (*Littorina sitkana*), finger limpets (*Collisella digitalus*), amphipods, aggregating sea anemones (A*nthopleura* spp.), blue mussels (*Mytilus edulis*), and sea mussels. Characteristic species found in this habitat type include sea mussels, gooseneck barnacles, barnacles, and corraline and encrusting red algae (Lamb et al. 2000).

Bird species that are associated with exposed rocky intertidal communities include resting moulting surf scoters (*Melanitta perspicillata*) and harlequin ducks (*Histrionicus histrionicus*); and nesting black oystercatchers (*Haematopus bachmani*), pigeon guillemots (*Cepphus columba*), and pelagic comorants (*Phalacrocorax pelagicus*) (Rodway and Lemon 1991).

4.1.4 Rocky, semi-sheltered intertidal habitat

Semi-sheltered rocky shores consist of vertical rock cliffs, bedrock outcrops, and boulder-scattered intertidal zones.

Intertidal surveys of rocky, semi-sheltered habitats have been conducted along Gwaii Haanas National Park (Harper et al. 1994), and within Queen Charlotte Sound in the Dundas Island Archipelago, the Southeast Moresby Island Archipelago, and the Hunter/Calvert Islands Archipelago (Searing and English 1983). See Appendix A: Table A-4 for a list of surveys and the locations surveyed.

Harper et al. (1994) reported that species commonly associated with this habitat type included acorn barnacles, checkered periwinkles (*Littorina scutulata*), thatched barnacles (*Semibalanus cariosus*), tiny white tube worms (*Spirorbis* sp.), sitka periwinkles (*Littorina sitkana*), shield limpets (*Lottia pelta*), red turbans (*Astraea gibberosa*), plate limpets (*Tectura scutum*), purple shore crabs (*Hemigrapsus nudus*), green shore crabs (*Hemigrapsus oregonensis*), sea mussels, red jawed porcelain crabs (*Petrolisthes cinctipes*), red calcarious tube worms (*Serpula vermicularis*), carnivorous grey isopods (*Cirolana harfordi*), plumose anemones (*Metridium senile*), whitecap limpets (*Acmaea mitra*), wrinkled amphissas or Joseph's coats (*Amphissa columbiana*), bat stars (*Asterina miniata*), small brown barnacles (*Chthamalus dalli*), leather stars (*Dermasterias imbricate*), black Katy chitons (*Katharina tunicata*), ribbed limpets (*Lottia digitalis*) and hermit crabs (*Pagurus* spp.).

The other survey of this habitat type was conducted in Queen Charlotte Sound in the Dundas Island Archipelago, Southeast Moresby Island Archipelago, and Hunter/Calvert Islands Archipelago by Searing and English in 1992 (1983). Dominant flora were rockweed, sea sacks (*Halosaccion* sp.), sea lettuce (*Ulva* sp.), and sea potatoes (*Leathesia* sp.), while the dominant invertebrates included barnacles (*Balanus* sp.), periwinkles (*Littorina* sp.), plate limpets (*Notoacmea scutum*), hermit crabs (*Pagurus* sp.), black Katy chitons, and anemones (*Anthopleura* sp.).

4.2 Soft-bottom estuarine habitats

Estuaries/eelgrass meadows and salt marshes are often found in the shallow soft-bottom subtidal zones of protected waters at the mouths of freshwater rivers and streams that flow into the ocean.

Although there are more than 400 estuaries in BC (Pacific Estuary Conservation Program 1999), the majority of studies have been conducted on estuaries in southern BC that are being highly impacted by anthropogenic activities, notably the Fraser River Estuary. Published studies have been conducted on five estuaries in northern BC: the Skeena, Kitimat, Bella Coola, and Yakoun Rivers, and Crabapple Creek (Hay 1976; Higgins and Schouwenburg 1973; Levings 1975, 1976, 2002; Paish 1974; Parker 1971; Parker et al. 1971; and Stockner and Levings 1982). Appendix A: Table A-5 lists surveys and the survey locations. Survey objectives included: to obtain reconnaissance data on the intertidal and subtidal benthic communities; to conduct an ecological assessment on the effects of an oil spill on the Crabapple Creek estuary; to assess the biological impacts of artificially fertilising the Yakoun River estuary; to obtain data on amphipods as a food source for salmon; to inventory available information on the environmental aspects of the Kitimat, Skeena and Bella Coola estuaries; and to determine the distribution of fish and their prey.

Other surveys on estuaries in the assessment area include those by Harper et al. (1994) and the BC Ministry of Water, Land and Air Protection (WLAP) and the BC Ministry of Forests (MOF) (MacKenzie et al. 2000). Harper et al. (1994) surveyed seven estuaries and four stream deltas along Gwaii Haanas. These surveys were conducted in 1992 to gather shore-zone information as a first step to creating a resource management plan for the park. WLAP and the MOF surveyed twenty-eight estuaries in the central and north coasts of British Columbia between August-September 1997 and in July 1998 (MacKenzie et al. 2000). Data produced for each estuary included general physical, geographical and biological descriptions and related social and cultural issues. The most common plant community reported was Lyngbye's sedge (*Carex lyngbyei*), which occurs in the lower intertidal zone of estuaries in dense monotypic stands. Other species associated with this dominant plant were tufted hairgrass (*Deschampsia caespitose)*, common spike-rush (*Eleocharis palustris*), hemlock water-parsnip (*Sium suave*), seaside arrow grass (*Triglochin maritimum*), sea-milkwort (*Glaux* *maritima*) and silverweed (*Potentilla anserina*). Five of these 28 estuaries had average salmon escapements over 100,000 salmon: the Kimsquit, Kitkiata/Quaal, Kwinamass, Nass, and Skeena River estuaries (MacKenzie et al. 2000).

Estuaries throughout the world are typically shallow and have mud substrates. However, where strong riverine currents predominate, the substrate may be coarser. They are a highly variable habitat, principally due to the constant influx of fresh and salt waters that causes an alteration in salinity. Typically, estuaries are well oxygenated, but if a thermocline develops, deeper bottom waters may become hypoxic or anoxic. Estuaries provide habitat for a number of aquatic organisms for part or all of their life cycles. However, given their salinity-gradient, estuaries are generally considered to be stressful environments for aquatic organisms and have a relatively low species richness compared to adjacent freshwater or marine habitats (Price 2002). Although estuaries have a lower total species diversity, they typically have high β(turnover)-diversity, as there is change in species composition over relatively short distances due to habitat heterogeneity and variability in species tolerance to salinity (Price 2002).

Estuaries in northern BC are dominated by mud, sand and gravel bed substrates. Terrestrial grasses, such as *Calamagrostis* sp. and tufted hairgrass, typically grow in the upper intertidal zone. The mid-intertidal zone is vegetated with more salt tolerant species such as *Carex* sp., *Juncus* sp., and *Salicornia*; and eelgrass (in some places, such as around Skidegate, both *Z. marina* and the exotic *Z. japonica* (G. Jamieson, pers. obs.)) is typically found in the lower intertidal zone (Hay 1976, Levings 2002, Levings 1975, Stockner and Levings 1982, Harper et al. 1994). Eelgrass is a functionally important species in this community because it provides food for waterfowl, spawning grounds for herring and shelter for invertebrates and fish. Dead eelgrass also comprises a large component of nearshore detritus. Diatoms and dinoflagellates are dominant planktonic algal species (Stockner and Levings 1982). Typical zooplankton species include copepods (*Calanus glacialis*, and *C. plumchrus*), barnacle nauplii, mysids, and zooplankton eggs. Benthic invertebrates include harpacticoid copepods, amphipods, polychaetes, juvenile oligochaetes, burrowing anemones, lugworms, barnacles, bivalves and rock (*Cancer gracilis*) and shore (*Hemigrapsus nudus*) crabs.

Estuaries are primarily utilized as spawning and nursery habitat, feeding areas and shelter. Fish species that utilize estuaries for spawning and as nurseries include salmonids: chum (*Oncorhynchus keta),* coho (*Oncorhynchus ukisutch),* sockeye (*Oncorhynchus nerka),* chinook (*Oncorhynchus tshawytscha),* and pink salmon (*Oncorhynchus gorbuscha),* Steelhead trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*) and Dolly Varden char (*Salvelinus malma)* (Higgins and Schouwenburg 1973, Paish 1971, Parker 1974, Bell and Kallman 1976, Stockner and Levings 1982, Levings 2002); spawning Pacific herring and eulachon (*Thaleichthys pacificus*) (Bell and Kallman 1976); and smelts (Hoos 1975). Marine fish known to utilize estuaries for feeding and shelter include lingcod (*Ophiodon elongatus*), juvenile black rockfish (*Sebastes melanops*), sole (Bothidae), flounder (Pleuronectidae), and halibut (*Hippoglossus stenolepis*) (Bell and Kallman 1976). Analysis of stomach contents of salmon in estuaries identified amphipods and insects as important food sources for coho, chinook and sockeye salmon (Higgins and Schouwenburg 1973, Paish 1974); coho there also feed on pink and chum salmon fry (Parker 1971). Many species of staging marine waterfowl utilize estuaries, including Brant geese (*Branta bernicla)*, trumpeter swans (*Cygnus buccinator*), Western grebes (*Aechmophorus occidentalis*), glaucous-winged gull (*Larus glaucescens*), great blue herons (*Ardea herodias*), and double-crested cormorants (*Phalacrocorax auritus*) (Bell and Kallman 1976, Vermeer et al. 1991, Fraser et al. 1999).

4.3 Benthic Subtidal Habitats

The subtidal zone is defined here as the sea floor that is permanently covered by water, and it extends seaward from the lower intertidal and includes the continental shelf, continental slope, and abyssal plain. Subtidal community structure is influenced by a number of physical factors such as depth, substrate, salinity, water temperature, wave action, currents, upwellings, and light; and biological factors such as larval settlement and dispersal characteristics, predation, productivity, and prey availability (Alaska Department of Fish and Game 2000). There are six general types of subtidal habitats: sheltered shallow soft-substrate, sheltered shallow hard-substrate, exposed shallow soft-substrate, exposed shallow hard-substrate, deep mixed-substrate and deep hard-substrate.

4.3.1 Sheltered, shallow (<30 m), sandy substrates

Commercial species associated with shallow sandy substrates include the geoduck, horse clam and Dungeness crab. Eelgrass is an important structural species on this substrate.

Geoduck clams are found in soft substrates from the intertidal to a depth of at least 110 m (Heizer and Rome 2000). Highest densities of geoducks are found in mud-sand and sand substrates (Goodwin and Pease 1991). Geoduck density is maximal at about 24 m depth (Jamison 1984, cited in Goodwin and Pease 1991).

Geoduck surveys were conducted on the north shore of Burnaby Island and the east shore of Huxley Island in July 1994 to estimate geoduck stocks in the area. An estimated virgin geoduck biomass of 4004 t was found in an area of 284 ha (Hand et al. 1998). This survey focused on geoducks, and there was no mention of other species associated with geoducks.

A study investigating biotic and abiotic factors that affect geoduck densities reported that geoduck density was correlated with a number of organisms, including epibenthic mats of chaetopterid polychate species (*Spiochaetopterus costarum* and *Phyllochaetopterus prolifica) (*Pease and Cooper 1988), sea pens

(*Ptilosarcus gurneyi*), horse clams, red rock crabs (*Cancer productus*), Lewis moon snails, and kelp (*Laminaria* sp.). Other organisms associated with geoducks included giant red sea cucumbers (*Parastichopus californicus*), large and small red algae (Phylum Rhodophyta), sea stars, crabs, soles, and flounder (Goodwin and Pease 1991), with the majority of co-occuring fauna predatory on geoducks.

The only indirect eelgrass surveys conducted in the assessment area were herring spawn surveys (Haegele and Miller 1979). Eelgrass meadows can be found from the mid-intertidal to shallow subtidal zones (Sloan and Bartier 2000). Eelgrass beds are frequently used as a vegetation indicator for herring spawn; they contributed up to 44% of the vegetation used as spawn sites in Chatham Sound in 1979 (Haegele and Miller 1979).

An eelgrass survey was conducted by Lessard et al. (1996) in Saanich Inlet in 1995. They found subtidal eelgrass meadows to be associated with red (*Gracilaria* sp.), green (*Enteromorpha* sp.), and brown algae (*Sargassum* sp.), sand dollars (*Dendraster excentricus*), clams, polychaetes, ghost shrimp (*Callianassa californiensis*), and sea stars (*Pisaster* spp.). Appendix A: Table A-6 lists the surveys and their locations for this habitat type.

4.3.2 Exposed, shallow (<30 m), rocky habitats

Kelp forests are often found in shallow exposed, rocky subtidal areas and support a diverse community with many associated algal and invertebrate species. The estimated annual productivity of kelp along the Pacific coast of Canada ranges from 1.3 kg of carbon m^{-2} (not including detritus) to 2.8 kg of carbon m^{-2} (including detritus) (Foreman 1984, Wheeler and Druehl 1986). In the summer, kelp beds can create between 10-15.4 m^2 of surface area for every m^2 of substrate (Clendenning 1971, Druehl and Wheeler 1986). Individual kelp beds are quite stable in both composition and abundance across years, but there is high variability in composition and structure between kelp beds (Watson 1990).

Numerous studies have been conducted on kelp forests in BC to locate, quantify and assess whether perennial giant kelp (*Macrocystis integrifolia*) or annual bull kelp (*Nereocystis luetkeana*) could support seasonal or continuous exploitation (Field and Clark 1978, Coon et al. 1979, Coon et al. 1980, Druehl and Wheeler 1986, Wheeler and Druehl 1986). Appendix A: Table A-7 lists the surveys and their locations. No known long-term studies have been conducted on these communities in central and northern BC .

Historically, sea otters (*Enhydra lutris*) were an important component in kelp bed food webs in BC, preying in particular on red sea urchins, which in turn graze on kelp. Sea otters were extirpated from BC in 1929 (Sloan and Bartier 2000), but they are currently increasing in numbers and distribution after their re-introduction in the late 1960's and early 1970's. There are two areas along the coast of BC where sea otters are currently abundant, the west coast of Vancouver Island between Estevan Point and Cape Scott, and off the central coast of BC between the Goose Islands and Cape Mark (Watson 2000). Stewart et al. (1982) documented benthic community structure at 19 sites along the west coast of Vancouver Island known to be used as foraging sites by sea otters. In the presence of sea otters, kelps were the dominant algae and northern abalone (*Haliotis kamtschatkana*) and red sea urchins (*Strongylocentrotus franciscanus*) were scarce, and were found only in deep crevices inaccessible to sea otters (Stewart et al. 1982). Sites outside the sea otter's feeding range were abundant in both red sea urchins and northern abalone, while kelp, if present, was restricted to a narrow band in the upper subtidal zone. The dominant algal species in these latter areas were corallines (Stewart et al. 1982). In addition to sea otter predation, exposure and depth also play a role in controlling sea urchin abundance and distribution. In the absence of sea otters, maximum kelp densities were found in exposed sites at 0 - 1 m, while red sea urchins were most abundant from 0 - 4 m below Chart Datum (Jamieson and Campbell 1995).

Typically, BC kelp beds comprise a dense algal overstory, ranging from 1 m to 7-10 m below Chart Datum, that includes giant kelp and bull kelp, and an understory comprised of *Laminaria* spp. and *Pterygophora* spp. (Stewart et al. 1982, Watson 1990). Emmett et al. (1995) found split kelp sparsely distributed to a depth of 20m. At depths greater than 10 m the rocky substrate is commonly covered with articulated corallines. Associated invertebrates include bryozoans, hydroids, sponges, barnacles and sea stars (Stewart et al. 1982). In addition to these species, Emmett et al. (1995) also found nudibranchs, sea cucumbers (*Cucumaria miniata* and *Parastichopus californicus*), and snails (*Tegula* sp., *Calliostoma* sp., *Astraea* sp. and *Margerites* sp.) to be associated with kelp beds. Fish species associated with kelp beds included china and copper rockfish (*Sebastes nebulosus* and *S. caurinus*), quillback rockfish (*Sebastes maliger*), juvenile yellowtail rockfish (*Sebastes flavidus*) and black rockfish, cabezon (*Scorpaenichthys marmoratus*), kelp greenlings (*Hexagrammos decagrammus*), lingcods, and sculpins (Stewart et al. 1982, Watson 1990, Emmett et al. 1995, Love et al. 2002). Kelp beds are also an important habitat for juvenile salmon and for spawning Pacific herring (Watson 1990).

Leaman (1980) studied the ecology of fishes in kelp beds of Barkley Sound, BC, and focused on the distribution of fish species, their diets and the impact of kelp harvesting on fishes. The distribution of benthic fishes in kelp beds changes as they mature, with adults typically more mobile than juveniles. For example, juvenile kelp greenling were often found within kelp beds and are considered resident fish, whereas adult kelp greenlings were often found within 25 m of the kelp beds.

4.3.3 Deep (30-100 m), soft-bottom habitats

Deep-water, soft-bottom substrates are common habitat for many groundfish communities.

Hecate Strait has a rich diversity of groundfish with 17 species of flatfish and over 50 groundfish species in total (Fargo and Tyler 1991). In 1984, Hecate Strait was chosen as a study area by DFO to further understand the ecological basis of mixed-species fisheries management. Over the last 20 years numerous groundfish assemblage surveys have been conducted in the Strait. Groundfish assemblage surveys occurred in 1984 (Fargo et al. 1984), 1986 (Fargo and Davenport 1986), 1987 (Fargo et al. 1988), 1989 (Antonsen et al. 1990), 1991 (Wilson et al. 1991), 1993 (Hand et al. 1994), (Workman et al. 1996), 1996 (Workman et al. 1997), 1998 (Choromanski et al. 2002b) and 2000 (Choromanski et al. 2002a). See Appendix A: Table A-8 for a list of the surveys. Groundfish assemblage trawl surveys classified all fish caught by species and grouped all invertebrates together by weight. Only data from the 2002 survey broke down the catch weight for invertebrates by species (Choromanski et al. 2002a).

Cluster analyses were useful to identify four distinct groundfish-dominated assemblages by depth, substrate type, and temperature within Hecate Strait (Fargo and Tyler 1986, 1991; Fargo et al. 1990; Perry et al. 1994). The four communities identified were the Reef Island community; Butterworth community; Bonilla community; and Moresby Gully community.

The Reef Island community occurs in shallow waters (18 - 70 m depth) with medium-sized sand, coarse sand, and gravel sediment types. The community is dominated in summer by spiny dogfish (*Squalus acanthias*), big skate (*Raja binoculata*), Pacific halibut and rock sole (P*leuronectes bilineatus*). In winter, spiny dogfish are absent from the Reef Island community and the proportion of Pacific halibut biomass is greatly reduced.

The Butterworth community occurs on a fine/gravelly sand or mud substrate between 55 - 130 m. The community is dominated in summer by arrowtooth flounder (*Atheresthes stomias*), spotted ratfish (*Hydrolagus colliei*), dover sole (*Microstomus pacificus*), and rex sole (*Errex zachirus*). In winter, dover sole leave and the proportion of arrowtooth flounder is much lower.

The Bonilla community occurs between 55 - 130 m on fine gravelly sand. The dominant species of this community throughout the year are Pacific sanddab (*Citharichthys sordidus*), Pacific halibut, rex sole, English sole (*Pleuronectes vetulus*), and spiny dogfish.

The Moresby Gully community is the deepest community and is found between 140 - 240 m. In the summer, Pacific ocean perch (*S. alutus*), arrowtooth flounder, dover sole, and rex sole dominate the community. In winter, the proportion of spiny dogfish increases as they migrate to deeper waters and dover sole are absent because they migrate away from Hecate Strait.

Fargo et al. (1990) initially developed density distribution maps for the fourteen dominant demersal species in the area by compiling data from demersal trawl surveys conducted in Hecate Strait between 1956-1985. In the process of analyzing the spatial dynamics of flatfish communities found within Queen Charlotte Sound, Hecate Strait, and Dixon Entrance, these maps have been revised and digitized by the Hecate Strait Ecosystem Project (http://www-sci.pac.dfo-mpo.gc.ca/sa-hecate/default.htm). This analysis was conducted to ascertain the dominant biotic and/or abiotic factors influencing flatfish distribution. Distribution maps summarize seasonal trends in fishing effort, and the location and density of individual demersal species and demersal fish communities. There are thirty distribution maps, one for each of the following demersal fish species: arrowtooth flounder, bocaccio (*Sebastes paucispinis*), butter sole (*Pleuronectes isolepis*), canary rockfish (*S. pinniger*), dover sole, English sole, flathead sole (*Hippoglossoides elassodon*), lingcod, Pacific cod (*Gadus macrocephalus*), Pacific hake (*Merluccius productus*), Pacific halibut, Pacific ocean perch, petrale sole (*Eopsetta jordani*), ratfish, redbanded rockfish (*S. babcocki*), redstripe rockfish (*S. proriger*), rex sole, rock sole, rougheye rockfish (*S. aleutianus*), sablefish (*Anoplopoma fimbria*), sand sole (*Psettichthys melanostictus*), sharpchin rockfish (*S. zacentrus*), shortraker rockfish (*S. borealis*), shortspine thornyhead (*Sebastolobus alascanus*), silvergray rockfish (*S. brevispinis*), skates, spiny dogfish, walleye pollock (*Theragra chalcogramma*), widow rockfish (*S. entomelas*), yellowmouth rockfish (*S. reedi*), and yellowtail rockfish.

Fargo and Tyler (1991) suggested that due to species-specific feeding specializations, flatfish may be distributed according to surficial substrate and depth. Burd and Brinkhurst (1987) previously investigated this possible link by conducting a benthic infaunal study at four sites with distinct depth and substrate types in Hecate Strait in the spring of 1985 and the winter of 1986. All four sites contained polychaetes, bivalves, and amphipods, but the infaunal biomass was different at each site and the abundant species within each taxa varied at all four sites. Cluster analysis identified depth and geographic distance as the principle factors that impacted infaunal species abundance, whereas sediment silt content was less important. Burd and Brinkhurst (1987) suggested that although depth was identified as a primary factor, it may actually be a proxy for underlying factors that weren't measured, such as currents or sedimentation rates.

The dominant invertebrates found to be associated with groundfish communities, based on frequency from tows and total catch (weight), include the pink short-spined star (*Pisaster brevispinus*), anemones (Order Actiniaria), opalescent inshore squid (*Loligo opalescens*), sunflower starfish, Dungeness crab, giant red sea cucumber, and sponges (Phylum Porifera) (Choromanski et al. 2002a).

Of the about 85 shrimp species reported for BC, six are harvested in sport and commercial fisheries. Seven species of harvested Pandalidae occur in the assessment area: Pink (*P. jordani, P. borealis eo*us), sidestripe (*Pandalopsis dispar*), humpback (*P. hypsinotus*), coonstripe (*P. danae,* also called dock shrimp), *flex (P. goniurus*) and spot (*P. platyceros,* called prawns) shrimps. The main species occurring in abundance in the study area are pink shrimp found in deeper waters on mud bottom grounds in Queen Charlotte Sound, and prawns, which are generally associated with deep water rocky terrain.

4.3.4 Very deep (>100 m), soft-bottom troughs

Hexactinellid sponge reefs have been found in glacier scoured seafloor troughs of Queen Charlotte Sound and Hecate Strait at depths between 150 to 250 m, covering an area of 700 km^2 (Conway et al. 1991). The substrate is glacial scoured, coarse muddy sand with currents of 0.15 – 0.30 m s^{-1} (Conway 1999) with low sedimentation rates in some areas (Conway et al. 1991) because of currents. Deep-water corals occur in BC, and are increasingly being identified as a sensitive temperate deepwater ecosystem vulnerable to both trawling, benthic longlining and crustacean trap fisheries; and oil exploration and production. Much information about corals on the Scotian Shelf in eastern Canada is now available. However, to date, there have been no coral-focused studies in BC waters. The only data available are from groundfish trawl bycatchs in recent years, but even here, species are not identified.

Between 1987 and 1988 hexactinellid sponge reefs, previously thought to only exist in the fossil record, were discovered in four locations off the coast of British Columbia within Queen Charlotte Sound and Hecate Strait ecodistricts (Conway et al. 1991).

All four of these reefs were found to be dominated by seven siliceous sponges: *Heterochone calyx, Aphrocallistes vastus, Farrea occa, Rhabdocalyptus dawsoni, Acanthascus platei, Staurocalyptus dowlingi,* and *Acanthascus cactus* (Conway et al. 2001). The three sponge species that provide most of the framework for these reefs are *H. calyx, Aphrocallistes vastus,* and *F. occa* (Conway et al. 2001). Submersible dives conducted in July 1999 provided visual information on invertebrates and fish that utilize the sponge reefs and surrounding sea floor. Organisms found associated with the reef included species of crab, shrimp, prawn, euphausiids, and rockfishes (Conway et al. 2001). Jamieson and Chew (2002) analysed grounddifsh trawl data from the vicinities on and around the reefs. Appendix A: Table A-9 lists the surveys and their locations.

To determine population characteristics of species in and adjacent to sponge reef habitats, Jamieson and Chew (2002) summarized the fisheries catch data using five years of commercial catch statistics. Major groundfish species for reefs A (the most northern reef), C, and D (the most southern reef) were grouped by the dominant groundfish trawl species into three categories: rockfish/thornyheads, flatfish, and others (includes skates, dogfish, tuna, mackerel, and roundfish). There was minimal fishing, and hence little catch data, around Reef B. Reef A was dominated by flatfish, which compromised 83% of the catch, followed by rockfish/thornyheads (12% of the catch). Sponges were only 0.4% of the catch. Reefs C and D were both dominated by rockfish/thornyheads, constituting 72% and 75% of the catch, respectively. Sponges constituted 15% of the catches on both these reefs. The “other” grouping was less than 5% of the catch for all three reef communities. Some dominant invertebrate species associated with Reef A were box crabs, anthazoa, starfish, stony corals, octopods, jelly fish, reptantia, and sea urchins. The dominant invertebrate species for Reefs C and D were primarily stony corals (both 8% of the catches).

4.3.5 Deep (>30-200 m), rocky subtidal habitats

Deep, hard-bottom substrates are common habitat for rockfish communities. Many adult rockfishes are primarily benthic and are commonly associated with both hard substrate and high relief habitats (Love et al. 2002).

Few studies have been conducted on benthic, deep, rocky habitats as they are often below the depth of recreational SCUBA diving (>30 m) and the heterogeneous substrate limits the accuracy of conventional trawl surveys (Yoklavich et al. 2000). Three deep-water rockfish studies have been conducted along the west coast of North America using submersibles. One of the studies observed the depth and habitat distribution of three rockfish species in the Strait of Georgia (Richards 1986), and the other two studies focused on habitat associations of groundfish in rocky habitats, one in California (Yoklavich et al. 2000) and the other in Oregon (Nasby-Lucas et al. 2002). Appendix A: Table A-10 lists the surveys conducted for this habitat type.

In the fall of 1984 a survey was conducted in the Strait of Georgia to observe the depth and habitat distributions of three species of rockfish (*Sebastes elongatus, S. maliger,* and *S. ruberrimus*) (Richards 1986). Observations were conducted along vertical transects between depths of 21-140 m. The survey found highest concentrations of: *S. maliger* associated with complex rocky habitat less than 60 m in depth; *S. ruberrimus* associated with complex and wall habitats at depths between 41-100 m; and *S. elongates* associated with fine-sediment habitats below 80 m. The survey found that all three species had a positive relationship between their size and the depth they were observed. Cloud sponges were also observed in the study.

Yoklavich et al. (2000) assessed habitat associations of deep-water rockfishes (>90 m) in a submarine Canyon off the coast of California. Rockfish were the dominant species observed, accounting for 77% of the total number of individuals caught. Non-rockfish species comprised 17.2% of the total number of individuals and were dominated by: dover sole, lingcod, shortspine thornyhead, Pacific hagfish (*Eptatretus stouti*), and Pacific hake. Cluster analysis was used to group fish species by their associated substrate types into six habitat guilds. Guild six, associated with rock-boulder habitats, was dominated by pygmy rockfish, bocaccio, cowcod (*Sebastes levis*), rosethorn rockfish, and greenspotted rockfish (*S. chlorastictus*).

Nasby-Lucas et al. (2002) conducted a number of submersible dive surveys between 1988 and 1990 along Heceta Bank in Oregon. They describe the relationship between the abundance of eleven species of groundfish and the topography and texture of the benthic habitat. The eleven fish species included: unknown juvenile rockfish (*Sebastes* sp.), greenstriped rockfish (*S. chlorostictus*), pygmy rockfish (*S. wilsoni*), rosethorn rockfish (*S. helvomaculatus*), sharpchin rockfish, yellowtail rockfish, lingcod, shortspine thornyhead, sablefish, dover sole, and rex sole. The study found that yellowtail rockfish, juvenile rockfish and lingcod had the highest association with rock-ridge habitats. There is no mention of the depths that these transects were conducted over.

4.3.6 Very deep (>200 m), soft to mixed-substrate habitats

This habitat is mostly located along the Continental Slope. Tanner crab (*Chionoecetes tanneri*) and sablefish are two commercial species known to be associated with very deep, soft-bottom substrates along the continental shelf within the assessment area.

Information on species associated with this habitat type is predominately from tanner crab and sablefish surveys. Appendix A: Table A-11 lists the surveys conducted for this habitat type. Limited tanner crab assemblage surveys were conducted in BC until 1999. However, since this time, DFO has conducted annual tanner crab surveys (Workman et al. 2000, 2001), at depths between 400-2000 m, and a pilot fishery has been in operation since 2000 (Workman et al. 2002). It is through these activities that DFO has increased its understanding of the species' distribution, depth range, and associated species assemblages.

Three of the first tanner crab surveys in BC were conducted in 1983 and 1984, with the purpose to determine the abundance and distribution of *Chionoecetes bairdi*, *C. tanneri*, and *Lithodes aequispina*. An exploratory fishery for *C. tanneri* was established off the west coast of Vancouver Island between 1988 and 1989. This fishery suspected that quantities of Tanner crab were large enough for ongoing commercial harvest. (Jamieson 1990 a,b). However, in 1991, a moratorium was placed on new and developing fisheries, and it wasn't until 1999 that the next Tanner crab survey was conducted. This survey, along the west coast of Vancouver Island, gave catch weight by species. The dominant large invertebrate in the community was the grooved tanner crab (*Chionoecetes tanneri*), but other dominant species, by weight, associated with this habitat type included: glass shrimp (*Pasiphaea pacifica*), schoolmaster gonate squid (*Berryteuthis magister*), flapjack devilfish (*Opisthoteuthis californiana*), brittle stars (Order Ophiurae), northern sun star (*Solaster borealis*), sablefish, longspine thornyhead (*Sebastolobus altivelis*), dover sole, shortspine thornyhead, pectoral rattail (*Albatrossia pectoralis*), filamented rattail (*Coryphaenoides filifer*), roughscale rattail (*Coryphaenoides acrolepis*), rougheye rockfish, Pacific flatnose (*Antimora microlepis*), longnose skate (*Raja rhina*), arrowtooth flounder, anemone (Order Actiniaria), jellyfish (Class Scyphozoa), sea mouse (*Aphrodita* sp.), and isopods (Order Isopoda) (Workman et al. 2001). Although this survey was not undertaken within the Queen Charlotte oil and gas assessment area, many of the same species would likely be found associated with this habitat type along the continental shelf within the assessment area.

Sablefish surveys have been conducted annually along the Continental Slope from the west coast of Vancouver Island north to Langara Island between 1988 until the present. Objectives of these surveys were to monitor abundance at specific sites and to examine changes in population parameters between years and at various locations and depths (Downes et al. 1997). From 1990 until the present, these surveys sampled sablefish using traps set at five depth zones, 275-457 m (zone 1), 457-641 m (zone 2) , 641-824 m (zone 3), 824-1006 m (zone 4), and > 1006 m (zone 5); prior to this time only three depth zones (366-549 m, 549-732 m, and 732-915 m) were looked at. Starting in 1990, surveys recorded the catch and weight to the species level. Using catch information from surveys conducted between 1990-1995, species associations are supported, where species occurred with sablefish in at least 40% of the total traps collected between 1990-1995. To ensure the catch was representative of species within the Queen Charlotte oil and gas assessment area, only trap data from locations at a latitude of 50^0 or more were analyzed. In depth zone 1, sablefish were associated with rougheye rockfish (69%), redbanded rockfish (73%), arrowtooth flounder (97%), Pacific halibut (73%), and lingcod (52%). In depth zone 2, sablefish were associated only with arrowtooth flounder (61%). In depth zone 3, there were no species, besides sablefish, that occurred in at least 40% of the traps at that depth. In depth zone 4, sablefish were associated with rattail (*Coryphaenoides* spp. (63%)), shortspine thornyhead (55%), tanner crab (*Chionoecetes* spp. (49%)), and king crab (43%). In depth zone 5, sablefish were associated with rattail (63%), Pacific flatnose (43%), and tanner crab (*Chionoecetes spp.* (76%)) (Smith 1996, Downes et al. 1997).

4.4 Pelagic Communities

4.4.1 Phytoplankton

Phytoplankton species abundance and composition is affected by nutrient availability, light quality and quantity, temperature, zooplankton grazing, vertical and horizontal mixing and sedimentation. Net growth is restricted to the euphotic zone. General indicators of biomass (chlorophyll a) and carbon fixation (^{14}C) within Hecate Strait are reviewed. Phytoplankton are often classified by size, as they are traditionally collected using nets with various mesh sizes. Commonly used size classes are megaplankton (> 20 cm), macroplankton (2-20 cm), mesoplankton (20-200 μm), microphytoplankton (20-200 μm), nanophytoplankton (2-20 μm), picophytoplankton (0.2-2 μm), and femtoplankton (0.02-0.2 μm).

As part of the Hecate Strait Ecosystem Project, McQueen and Ware (2002) summarized primary production and chlorophyll from five studies (Dilke et al. 1979, Perry et al. 1981, Denman et al. 1985, Forbes & Waters 1993, Ware and Thomson unpublished data in Pan et al. 1988). See Appendix A: Table A-12 for a list of surveys and the locations surveyed. Their report summarized monthly mean chlorophyll a (Chl a) and primary productivity at different depths. Surface Chl a concentrations where highest in May/June and September/October during the spring and fall phytoplankton blooms (Appendix B: Table B-1). Chl a was found to vary with depth and was highest in the 20-30 m depth zone (Appendix B: Table B-2).

Differences in phytoplankton and zooplankton composition, Chl a, and nitrate concentrations were detected in the summer between the east and west sides of Hecate Strait (Perry et al. 1983). These differences were primarily due to variation in bathymetry. The west side of Hecate Strait is characterized by well-mixed shallow water (<30 m) and had lower diatom and copepod numbers, and lower Chl a and nitrate concentrations than the east side. The east side is more strongly stratified and is deeper (>100 m) (Perry et al. 1983).

Micro- and nanophytoplankton species abundance from three metres below the sea surface were collected in ship-of-opportunity cruises and were used to summarize commonly abundant species (Dilke et al. 1979; Perry et al. 1981). Average percent abundance was calculated across all sampling sites and all sampling dates between 1978 and 1980. Dominant centric diatoms species were *Skeletonema costatum* (74%), *Chaetoceros* spp. (22%), *Thalassiosira* spp. (4%), and *Coscinodiscus* (0.18%); dominant pennate diatoms included *Fragilaria spp.* (22%), *Nitzschia delicatissima* (20%), *Nitzschia pungens* (18%), and unidentified pennates (12%); dominant dinoflagellates were *Gymnodinium* spp. (33%), *Peridinium* spp. (7%) and unidentified dinoflagellates (50%); and the majority of flagellates were unidentified (99%) (Dilke et al. 1979; Perry et al. 1981). Unidentified flagellates were, on average, the most dominant phytoplankton (49%), followed by *Skeletonema costatum* (35%) and *Chaetoceros* spp. (11%).

No detailed species composition data was found for discrete depths between 0 to < 30 m. The chlorophyll peak between 20-30 m may be relevant to understanding how the phytoplankton community is vertically structured (Denman et al. 1985). All five phytoplankton studies summarized by McQueen and Ware (2002) collected nano- and microphytoplankton. However, picophytoplankton are thought to account for 20-30% of the summer primary production in temperate areas (Joint 1986). Therefore, the relative contribution and species composition of picophytoplankton and nano-/microphytoplankton biomass and productivity are important to the structure and function of the pelagic food web in the study area.

An inventory of Pacific coast marine plankton data is included in the Department of Fisheries and Oceans database “CODIS”. In addition to data, this inventory includes citations of Canadian Data Reports about marine plankton along the west coast of BC.

4.4.2 Zooplankton

Zooplankton communities are dynamic and species assemblages constantly change. Zooplankton can be classified into two groups based on life history: holoplankton (entire life cycle spent in plankton) and meroplankton (only a portion of a species’ life cycle spent in plankton). Meroplankton includes larvae and eggs of fish and invertebrates, which are only in the plankton for a relatively short time period of each animal’s life cycle. Zooplankton community structure is a major determinator of marine ecosystem trophodynamics. It links microbial and algal food webs to those of higher organisms and therefore plays a central role in the flux of carbon and the cycling of nutrients.

As part of the Hecate Strait Ecosystem Project, McQueen and Ware (2002) summarized zooplankton data over the last 40-50 years from the Queen Charlotte oil and gas assessment area. Samples were collected within the assessment area between 1990 and 2001 by DFO and are contained in the Institute of Ocean Sciences database, and historical data were collected from various cruises conducted in the summer and winter of 1956-1964 (Pacific Oceanographic Group 1958 and LeBrasseur 1965), winter of 1980 (Fulton et al. 1982), and summers of 1983 (Denman et al. 1985) and 1988 (Burd and Jamieson 1991). See Appendix A: Table A-13 for a list of surveys and their locations. Seasonal peaks in biomass are documented for specific zooplankton taxa; for example euphausiid biomass peaked during late summer/early fall, and small and medium copepod biomass was highest in mid-summer. Long-term trends in zooplankton biomass were also detected, that were hypothesized to be correlated with long-term climate and physical oceanographic variability. Historical sea surface temperature and zooplankton biomass trends suggest that El Niño may have negative effects on zooplankton biomass. However, because the historical data analyzed was from five different studies, each study having different collection methods, and the overall sample size was small, McQueen and Ware (2002) emphasized caution when interpreting trends from these data.

Average monthly zooplankton biomass (mg m^{-3} dry weight) from the samples collected within the assessment area between 1990 and 2001 are summarized in Table B-3**.** Zooplankton annual biomass was on average comprised of copepods (34%); euphausiids (25%); small organics, including eggs (21%); others (10%); chaetognaths (5%); coelenterates (3%); urochordate salps, etc. (1%); amphipods (<1%); and molluscs and polychaetes (<1%).

Perry and Waddell (1997) synthesized seasonal zooplankton biomass cycles and identified the principal factors influencing their distribution and availability to marine bird predators in the Queen Charlotte Islands, Hecate Strait, and Dixon Entrance area. Typically, zooplankton biomass increases to a seasonal maximum in the spring in response to the spring phytoplankton bloom. The large increase in zooplankton biomass is also in part a response to the increased abundance of calanoid copepods that return to the surface after overwintering at depths greater than 500 m (Perry and Waddell 1997).

A major eddy in Hecate Strait is thought to play an important role in maintaining icthyoplankton (fish eggs and larvae) within the assessment area. Currents in Hecate Strait occur in a south to north direction during winter months (Crawford et al. 1988). In addition to this predominant north current, Crawford et al. (1990) suggest the presence of an eddy in southern Hecate Strait and postulate this eddy is responsible for returning approximately half of the icthyoplankton caught in the north current back into the strait. Both the north current and eddy are strongly influenced by wind speed (Crawford et al. 1990). This eddy is important for groundfish recruitment in the area. There is another similar eddy, the Rose Spit eddy, that persists year round in MacIntyre Bay in Dixon Entrance that may have a similar function (Crawford and Jamieson 1996).

Zooplankton often concentrate in areas of greater water circulation and increased prey abundance, such as around seamounts, at the edges of banks, near shelf-breaks; where there are differences in water mass characteristics; coastal upwelling; and eddies and gyres (Perry and Waddell 1997). Some locations for increased zooplankton concentrations around the Queen Charlottes, in Hecate Strait and in Dixon Entrance, include: the shelf-break along the west coast of the Queen Charlottes; seamounts, including Learmonth Bank at the northwest tip of Graham Island; within eddies, including the Rose Spit, Haida and Hecate Strait eddies; the tidal front in Hecate Strait where the shallow well-mixed water meets the deeper thermally-stratified water; and in coastal upwelling areas, including along the west coast of mainland BC, Cape St. James, Cape Scott and Cook Bank (Perry and Waddell 1997; Crawford 2001). Depth, latitude, water temperature, salinity, and distance from shore are also factors that play a role in the offshore dispersal of zooplankton (Reilly 1983).

Impacts of the EVOS on zooplankton biomass and density were investigated, and no significant difference was found between oiled and un-oiled locations both during the year of and during the year following the spill (Celewycz and Wertheimer 1996). However, they pointed out that other studies have shown that crude oil has a negative impact on zooplankton. They suggested two possibilities as to why they didn't find an impact of oil on zooplankton: first, the concentration of oil in the water column may not have been high enough to cause mortality, and second, movement of zooplankton from deeper water to their study area may have obscured the impacts of oil on the localized zooplankton community.

4.4.3 Herring

Small pelagic species, such as herring, anchovy, sardines, smelt and so on, provide an important food for larger piscivorus species, and are often collectively termed forage species. While a number of forage species occur in the study area, herring have been the most abundant and economically important in recent years, and so this is the species we have most information for. See Section 4.4.5 for a discussion on other forage species.

Of the six major Pacific herring stocks in BC, three are found within the study area: the Central Coast, Prince Rupert and Queen Charlotte Islands Stocks (DFO 2002a, b, c). The life cycle of Pacific herring entails annual migrations between summer "feeding grounds", winter "holding areas", and spring "spawning areas" (Hay et al. 1989a). The two dominant winter holding areas in Hecate Strait are Browning Entrance, used by the Prince Rupert herring stock that spawns near Chatam Sound and Porcher Island, and Juan Perez Sound, used by the Queen Charlotte Islands herring stock that spawns around the southern part of the Queen Charlotte Islands (Hay et al. 1989b). The winter holding and spawning areas for the Central Coast herring stock appears to be concentrated in PFMA's 6, 7 and 8 (DFO 2002b).

Numerous winter hydroacoustic surveys for herring have been conducted in Hecate Strait since 1984. The purpose of these surveys has been to estimate the biomass of herring overwintering in Hecate Strait (McCarter et al. 1994), with estimates having ranged from between 12 500 t and 32 000 t for the Prince Rupert Stock and between 10 000 t – 33 000 t for the Queen Charlotte Islands Stock (McCarter et al. 1994). See Appendix A: Table A-14 for a list of surveys and their locations.

Spawning occurs in intertidal areas between February to April on both rocky substrates and benthic vegetation. Along rocky shores, herring spawns can be found in sheltered bays and along beaches on *Fucus evanescens*, on eelgrass and on various kelp species in deeper waters (Taylor 1964). A geographical and historical synopsis of herring spawns off the BC coast between 1928-1998 has been compiled by Hay and McCarter (1999).

Larvae and juvenile herring are distributed along the BC coast in near-shore locations (Hay and McCarter 1989). By the end of their first year, the majority of Pacific Herring migrate from sheltered bays and inlets to the open ocean. In summer, mature herring are found in dispersed schools compared to other times of the year, and feed in open ocean areas where the depth is between 50-200 m (McCarter et al. 1989). Herring have diel movements, and are often located near the bottom during the day and near the surface at night (McCarter et al. 1994).

Brown et al. (1996b) assessed the impact the EVOS had on Pacific herring larvae. They found herring larvae exposed to oil hatched prematurely, had low weights, reduced growth, and increased morphologic and genetic abnormalities. They estimate that oiled areas produced approximately 0.14% of the pelagic larvae produced by unoiled areas. Overall, larval production was reduced by an estimated 53% in Prince William Sound in 1989 due to the oiling of herring eggs from EVOS (Brown et al. 1996b).

4.4.4 Salmon

Salmon are the most important high-profile pelagic species in British Columbia, but while they have been extensively studied in their freshwater habitat, studies on them in the marine environment have been relatively limited, and have focused on the returning adult stages. Only recently have marine studies of juvenile distribution, migration and survival been initiated.

Salmon surveys have been conducted since the mid-1980's within the study area. See Appendix A: Table A-15 for a list of surveys and their locations. The purposes of these salmon surveys were: 1) to gather data on species composition, size composition, and diet of the juvenile salmon population of Hecate Strait; 2) to determine the seaward extent of juvenile salmon on the continental shelf; 3) to relate juvenile salmon distribution to physical and biological oceanographic conditions; 4) to determine if juvenile salmon are using the Alaskan Coastal Current to propel their migrations; and 5) to determine the distribution and biomass of zooplankton.

There are six species of Pacific salmon that occur in British Columbia waters: chum, coho (*Oncorhynchus kisutch),* sockeye, chinook, pink, and steelhead salmon. All six species of salmon are anadromous and transitory, relying on different areas of the assessment area at different stages in their life history in coastal areas. Salmon enter the marine environment through an estuary, where they remain for a few days to more than a year depending on the species (Healey 1991). Upon leaving the estuary, juvenile salmon stay close to shore. All juvenile sockeye, steelhead, chum and pink salmon, as far south as the Columbia River, follow an inshore northward migration route along the continental shelf through Hecate Strait to the Aleutian Archipelago (Welch et al. 2002c). Some juvenile coho and chinook salmon make this extensive migration, while others originating from Washington and southern BC typically forgo extensive migrations and remain in nearby rich feeding grounds until maturity (Godfrey et al. 1975). Offshore movement in the former group does not occur until the winter when the salmon are west of Kodiak Alaska (Welch et al. 2002a, Welch et al. 2002b). Once offshore, the movement of salmon is influenced by factors such as photoperiod, temperature, salinity, currents, maturity, age, size, availability and distribution of food, and place of origin (Burgner 1991). Salmon concentrations in the assessment area are highest between June and September (David Welch, DFO, Nanaimo, BC, pers. comm.). Although most salmon spend over half their marine life history at depths above 15 m, they can be found at times as deep as 100 m. Steelhead salmon are usually found 1-2 m below the surface, while chinook are often located between 30 – 60 m in depth (David Welch, pers. comm.).

Stocks of the same species of salmon that use different rivers and streams for spawning often have different return run times. For example, while chinook return to the Skeena and Fraser Rivers in early spring when the rivers are high because of snow melt; chinook spawning in small BC streams may not return until the fall (DFO 2002e) when the frequency of rain increases. Return migration routes of adult salmon from offshore waters are presently unknown. Studies are currently being conducted by DFO to determine the return migration of Steelhead. It is unknown what role Hecate Strait plays in the return migration route of salmon. However, Hecate Strait is known as a holding area for spawning salmon returning to Rivers and Smith Inlet (David Welch, pers. comm).

Three of the four most important sockeye salmon producing watersheds in BC are within the assessment area: the Skeena River, Rivers and Smith Inlet, and the Nass River (French et al. 1976). Other salmon species are more widespread in distribution and utilize considerably more rivers and streams than do sockeye salmon, as sockeye only utilize systems associated with lakes. According to Aro and Shepard (1967), 75% of Canada's pink salmon population come from 57 rivers or streams, distributed all along the coast of BC and the Queen Charlotte Islands. The highest concentration of pink salmon producing rivers and streams are along the central and north coast of mainland BC (Aro and Shepard 1967). Chinook, chum and coho respectively utilize less than 260, approximately 880 and 970 streams as spawning areas (Aro and Shepard 1967).

Short- and long-term effects of the EVOS on salmon adults, embryos, juveniles and habitat have been well studied (Rice et al. 1996). The potential greatest negative impact on wild salmon occurs when salmon are in nearshore environments, such as estuaries. Impacts of oil contamination on pink salmon were assessed and were determined to include a reduced juvenile growth rate, which likely caused a 1.7-2.2% reduction in their survival to adults (Willette 1996).

To ensure there were no health risks involved in using seafood contaminated by EVOS for subsistence, the U.S. Food and Drug Association (FDA) conducted tissue analysis for aromatic contaminants. The FDA analyzed fish and shellfish samples from 13 subsistence fishing grounds within the impacted area utilized by native Alaskans. They determined that the long-term health risks of eating finfish, including salmon, was essentially zero (Bolger et al. 1996).

4.4.5 Other pelagic fishes

Forage species consist of small pelagic (e.g., herring, anchovy, sardines, surfperchs, capelin, and smelts) and some demersal (e.g., eulachon) species that because of their relatively small size and abundance, are frequent prey for larger piscivorus species. Herring have been discussed separately, in Section 4.4.3, because of their regional biomass dominance. Despite small local fisheries sometimes operating for over a century, the distribution and abundance of these other species have been relatively poorly described, even though they are important elements in the food chain.

The Pacific sardine (*Sardinops sagax*) is an annual migrant to Canadian waters, moving northward from California in the spring and returning south in the fall. A single stock exists in the eastern North Pacific, ranging from northern Mexico to south-eastern Alaska. Sardines are a schooling pelagic species that is an omnivorus filter feeder. The 2003 US stock assessment was 1.00 million t, an increase over the 0.93 million t estimated in 2002 (DFO 2002d).

Sardine populations collapsed to very low levels in the mid-1900s because of both overfishing and unfavourable ocean environmental conditions, but the abundance of sardines off California has increased exponentially since the mid-1980s, and sardines first reappeared in Canadian waters in 1992. Numbers in BC appear to fluctuate because of unknown environmental conditions, but historically, about 10% of the population extended its range to Canadian waters. The current management regime in the US ensures that a minimum spawning biomass of 150,000 t exists prior to considering a harvest, with an exploitation rate above this level of 5-15%, dependent on water temperature, which is directly linked to sardine survival (DFO 2002d).

Pacific sardine have occasionally been reported to over-winter in BC inlets, and coincidently there have been occasional reports of mass mortalities, both recently and historically. Recent observations on the west coast of Vancouver Island and the Central Coast areas of BC suggest this may in part be due to a strain of VHS (viral hemorrahagic septicaemia) similar to that observed in Pacific herring, probably triggered by stresses associated with low water temperatures and possible food limitations.

There are seven Osmeridae found in BC: whitebait smelt (*Allosmerus elongat*es), capelin (*Mallotus villosus*), rainbow smelt (*Osmerus mordax*), night smelt (*Spirinchus starksi*), longfin smelt (*S. thaleichthys*), eulachon (*Thaleichthys pacificus*), and surf smelt (*Hypomesus pretiosus*). Surf smelt and eulachon are the most important commercially.

Surf smelt are a nearshore coastal species distributed from Alaska to California. There are an unknown number of BC populations, and the Prince Rupert population appears to spawn on beaches during the spring. The eggs are buried in the substrate by wave action to 2-15 cm depth, and it may take up to 56 days till hatching, depending on environmental factors. There is insufficient data to estimate spawning biomass for any BC population (Therriault et al, 2002b). The commercial fishery for surf smelt peaked in 1904 at 230 t, and has since disappeared, but has been replaced by a growing recreational fishery, which is now raising concerns that current harvests may not be sustainable (Therriault et al, 2002b).

Eulachon is an anadromous species that occurs from the Bering Sea to California. This species is of major importance and cultural significance to coastal First Nations. For unknown reasons, nearly all eulachon spawning runs from California to Alaska have declined over the past 20 years, especially since the mid-1990s (Hay and McCarter 2000). Eulachon spawning rivers are characterised by having spring freshets, and there are no known spawning rivers on any large coastal islands, including Vancouver Island, and the Queen Charlotte Islands. Although anadromous, eulachon are primarily a marine species, and spend >95 % of their lives in the ocean. The 2-3 years between spawning and hatching is spent mainly in near-benthic habitats in open marine waters, where they are an incidental catch in some trawl fisheries, notably shrimp trawling.

There are believed to be three stocks of anchovy in the north-eastern Pacific. In British Columbia, northern anchovy (*Engraulis mordax*) are at the northern extent of their range (central British Columbia) and though part of the northern stock, local populations might be genetically distinct. For example, it is not clear if anchovy are resident in British Columbia or if they are migrants from southern locations. In contrast to the central and southern stocks, the northern stock is the smallest and currently least exploited of the three stocks. British Columbia has supported intermittent commercial fisheries for this species, but data on their biology and distribution is limited. Northern anchovy landings peaked in 1941 (around 6000 t) but have since declined, with less than 1 t landed between 1996 and 2001, indicating great inter-annual variability in population biomass (Therriault et al. 2002a).

Four species of Embiotocids, or surfperch, are found in inshore waters in BC north of Vancouver Island: pile perch (*Rhacochilus vacca*), shiner perch (*Cymatogaster aggregate*), striped seaperch (*Embiotoca lateralis*), and kelp perch (*Brachyisticus frenatus*) (Lane et al. 2002). These fish are unique among forage species in that they are viviparous, giving birth to only a relatively few highly developed, live young each year, and so are perhaps more vulnerable to population depletion for whatever reason. They can be found in a variety of shoreline habitats, including sandy beaches, rocky shorelines and reefs, kelp beds and estuaries. The first three species often frequent piling habitats, while kelp perch are found only around kelp beds. They are exploited mostly by recreational fishers.

4.4.6 Pelagic/benthic interactions

Walters et al. (1986) identified the possibility of a predator-prey cycle in Hecate Strait between benthic Pacific cod and pelagic Pacific herring as an explanation for the variable recruitment of these two species. They found that Pacific cod and herring population sizes were inversely related, and that when the survival of juvenile herring was plotted against the abundance of Pacific cod, there was a 75% y^{-1} mortality rate for herring.

5.0 MARINE MAMMALS

The Queen Charlotte oil and gas assessment area is utilized by more than twenty species of marine mammals. Of the twelve species of whales, the four most common are the gray whale (*Eschrichtius robustus*), humpback whale (*Megaptera novaeangliae*), Killer whale (*Orcinus orca*), and minke whale (*Balaenoptera acutorostrata*). There are two populations of resident killer whales in BC, the northern community, which live off northern Vancouver Island and the mainland coast as far north as southeast Alaska, and the southern community, found off southern Vancouver Island (Shore 1999). The majority of gray whales seen in BC are migrating between their breeding grounds in Baja, Mexico and their feeding grounds in the Bering and Chukchi seas. During their migration, gray whales follow the coastline north through Hecate Strait, and are most often found within 4 km of the coast (Pike 1962; Searing and English 1983). Some gray whales remain in BC waters during the summer months and can be found feeding in a variety of different habitat types throughout the summer, ranging from protected, shallow soft-bottom bays to exposed, rocky shorelines. They feed on a variety of prey species including herring eggs and larvae, crab larvae, amphipod tube mats, mysiids, and ghost shrimp (*Callianassa californiensis*) (Darling et al. 1998). The greatest concentration of gray whales in Queen Charlotte Sound are from Rivers Inlet south to Cape Caution and along the north end of Vancouver Island (Jacqueline Booth and Associates et al. 1998). The other reported major location of gray whales is on the east coast of the Queen Charlotte Islands at the northern end, but they appear to be there primarily in the spring (William Megill, Coastal

Ecosystems Research Foundation, Port Hardy, BC pers. comm.). Megill also mentioned the potential for gray whales to be located along a few offshore island groups near Aristazabal Island, and along the west coast of the Queen Charlottes.

Seals and sea lions utilize the assessment area for breeding and/or feeding. Both adult harbour seals (*Phoca vitulina*) and adult steller sea lions (*Eumetopias jubatus*) are non-migratory and breed and feed in the assessment area. Steller sea lions congregate in large groups at rookeries between June - July to breed. There are only four rookeries in British Columbia, and all of them occur within the assessment area: the Kerouard Islands at Cape St. James, North Danger Rocks, the Scott Islands, and Forrester Island (Bigg 1985). Harbour seals breed throughout the assessment area and utilize tidally exposed reefs, islets, boulders and sandbars as haul-out sites (Olesiuk 1988).

Sea otters were extirpated from the central and north coasts of BC in 1929. They were re-introduced to BC waters in the late 1960's (Watson 2000) and in 1978, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated sea otters as Endangered. COSEWIC re-examined the status of sea otters in 1996 and down-listed them to Threatened. The estimated population of sea otters in British Columbia waters is ca. 2500 (Watson 2000). Approximately 2000 individuals can be found along the west coast of Vancouver Island between Estevan Point and Cape Scott, and the remaining 500 individuals are off the central coast of BC between Goose Islands and Cape Mark (Watson 2000).

An inventory of Pacific coast marine mammal data is included in the Department of Fisheries and Oceans database "CODIS". In addition to data, the inventory includes citations of Canadian Data Reports about marine mammals along the west coast of BC.

6.0 MARINE BIRDS AND SHOREBIRDS

Information on seabirds in the Queen Charlotte oil and gas assessment area has been collected by a number of organizations, including the Canadian Wildlife Service (CWS), Parks Canada, and the Government of BC Parks and Protected Areas Branch. CWS staff are currently analyzing seabird colony and pelagic bird locations to identify "hot spots", i.e., areas of high use/high concentration of birds (Kathleen Moore, CWS, Delta, BC, pers. comm.). The abundances and statuses of marine seabird species breeding in British Columbia (Canadian Wildlife Service 1999) are given in Appendix B: Table B-4.

The Scott Islands group is the most important nesting site for seabirds in BC (Drever 1999 cited in Boyd et al. 2000), providing nesting sites for an estimated 2.2 million breeding seabirds. Breeding seabird colonies can also be found on or off the Queen Charlotte Islands and on 59 islands along the coast of BC. The majority of seabirds nesting along the Central and Northern Mainland Coasts are on islands near the Moore Islands along the west coast of Aristazabal Island (85%), and on Lucy and Rachael Islands in central Chatham Sound (13%) (Rodway and Lemon 1991). On the Queen Charlottes, nesting birds are primarily along the east coast of Moresby Island (Rodway et al. 1988), where the Anthony Island group provides nesting sites for over 40,000 breeding seabird pairs (Westland Resource Group 1994).

Ninety-eight percent of the nesting seabirds along the Central and Northern Mainland Coasts are comprised of four bird species: rhinoceros auklets (*Cerorhinca monocerata*), fork-tailed storm-petrels (*Oceanodroma furcata*), Leach's storm-petrel (*Oceanodroma leucorhoa*) and Cassin's Auklets (*Ptychoramphus aleuticus*). The remaining 2% of species found nesting in the area include the tufted puffin (*Fratercula cirrhata*), glaucous-winged gull (*Larus glaucescens*), black oystercatcher (*Haematopus bachmani*), pigeon guillemot (*Cepphus columba*), pelagic comorant (*Phalacrocorax pelagicus*), and horned puffin (*Fratercula corniculata*).

The Queen Charlotte Islands provide nesting locations for 12 different seabird species, which constitute more than 1.5 million individuals. Ten of the 12 species that utilize the Queen Charlottes for nesting include: marbled murrelet (*Brachyramphus marmoratus*), ancient murrelet (*Synthliboramphus antiquus*), storm-petrels (*Oceanodroma* spp.), Cassin's auklet, rhinoceros auklet, tufted puffin, glaucous-winged gulls, black oystercatchers, pigeon guillemots, and pelagic comorants (Rodway 1988).

Marbled murrelets, listed as threatened by COSEWIC, nest on old-growth trees at inland sites in the Queen Charlotte Islands (Rodway et al. 1991). Black oystercatchers, glaucous-winged gulls, comorants, prefer to nest on rocky shorelines. The rhinoceros auklet, Cassin's auklet, puffins and storm-petrels all nest in borrows along edges of vegetation near the shore. Pigeon guillemots nest in borrows under rocks and in crevices (Rodway and Lemon 1991).

Pelagic bird populations in Hecate Strait and Queen Charlotte Sound were surveyed in the spring of 1982, the spring and summer of 1983, and the winter and spring of 1984. Waters over and around Cook Bank, and shallow waters of Hecate strait are two areas with the highest species diversity and density of pelagic birds in Central and Northern BC (Morgan et al. 1991). The greatest densities of pelagic bird populations were seen in the month of May when more than 1000 birds were observed for each of the following bird groupings: Shearwaters; Anseriformes (primarily white-winged scoters); Scolopacidaes (primarily phalaropes); and Alcidaes (common murre, ancient murrelet, and Cassin's auklet) (Vermeer and Rankin 1984). It was thought that the presence of food was likely what attracted these large concentrations of birds (Vermeer and Rankin 1984). Depending on the species, seabirds eat zooplankton (e.g. copepods, euphausiids), forage fish (e.g. herring, sandlance) or the youngest age classes of larger commercially-exploited fish (e.g. rockfish or salmon) (Krista Amey, CWS, Delta, pers. comm.).

In the coastal waters of BC, Harlequin ducks, surf scoters and white-winged scoters all congregate in large flocks to moult (Savard 1988). All three ducks moult between July and August along the mainland coast and the Queen Charlotte Islands. Surf scoters are known to moult in flocks of 100 – 5000. Of the 94 locations of moulting flocks of surf scoters identified along the coast, eight of the flocks had over 500 individuals. Three of the eight large flocks are found in northern BC: along Douglas Channel at the junction of Alice Arm and Hastings Arm, at Rose Spit and in Grenville Channel. White-winged scoters also moult in large flocks and occur at over 80 locations along the coast. A flock with more than 500 birds has been found in McIntyre Bay in the Queen Charlotte Islands. Other species known to moult in central and northern BC waters include the black scoter and the greater scaup, both observed in the Queen Charlotte Islands (Savard 1988).

Harfenist et al. (2002) provide a comprehensive literature review of the marine birds of Gwaii Haanas. The review provides seasonal information on migration as well as nesting/breeding and feeding locations for the common seabirds, marine waterfowl, shorebirds and marine raptors found in the vicinity of Gwaii Haanas, which includes Queen Charlotte Sound, Hecate Strait and Dixon Entrance.

The majority of the CWS reports used to summarize the knowledge of marine birds in the assessment area are 12-20 years old. More recent surveys have been conducted by CWS, but this data has not yet been written up. CWS can be approached directly for further details on these data. CWS expects to have a significant involvement in marine conservation issues and their regional priority at the moment is to bring this kind of data onto their GIS data server so it can be internally accessed and queried in regards to coastal development, environmental assessment and identification of marine protected areas (André Breault, CWS, pers. comm).

7.0 SPECIES AT RISK

In 1995, the Canada’s federal, provincial and territorial governments drafted an accord for the protection of species at risk. The primary objective of this Accord was to: “prevent the extinction of species in Canada from becoming extinct as a consequence of human activity” (Environment Canada 2002). See Appendix B: Table B-5 for a listing of marine species found within the assessment area that are listed by COSEWIC and/or the Government of British Columbia.

There are 13 marine species within the study area that are currently classified as threatened or endangered. With the passage of the federal *Species at Risk Act* (SARA) in June, 2003, recovery plans and critical habitat designations will have to be developed, with some already underway. The exact implications of designation on potential oil and gas development will be species-specific and have yet to be determined, but potentially this may influence what impacting activities can occur when and where.

8.0 TROPHIC STRUCTURE

Haggan and Beattie (1999) reconstructed the Hecate Strait and Dixon Entrance ecosystem using the UBC 'Back to the Future' approach. This approach utilizes a modelling software package called 'ECOPATH' to further understand the ecosystem's food web dynamics at present and in the past (100 years ago). The result of this model is the calculated estimation of trophic level characteristics and proportions for the two time frames for various species groupings, where species groupings are groups of species that have similar predator and prey species. Haggan and Beattie (1999) suggested trophic level function for species groupings remains similar between the present and the recent past (100 years ago).

9.0 OVERVIEW OF THE FISHERIES IN THE ASSESSMENT AREA

The entire British Columbia Coast has been divided into Pacific fishery management areas (PFMAs) and subareas for the purposes of regulating activities under the *Fisheries Act*. Pacific Fishery Management Areas (PFMAs) within the study area include: 1, 2, 4, 5, 6, 7, 8, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, and 127. Relevant PFMAs for this analysis were identified by overlaying the oil lease area map on top of the British Columbia statistical Fishery Area map. PFMAs for the North and Central BC Coasts are presented in Figure 3.

In the following, we summarise relevant fishery activities in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance. Food, social and ceremonial (FSC) landings by species and location were not available to us, but are generally low and are much less that that resulting from commercial fisheries. It should be pointed out that many native people are involved in commercial fisheries, and in such cases, there landings data are included in the data presented in Section 9.2.

9.1 First Nation fisheries

Historically, First Nations have relied on coastal regions of BC for the harvest of marine organisms for food, social and ceremonial purposes. Coastal First Nations involved in fisheries in northern BC include: The Council of the Haida Nation residing in the Queen Charlotte Islands; the Nisga'a Council and the

Gityanyow First Nation residing along the Nass River; the Tsimshian Tribal Council, the GitksanWatershed Authority, the Wet'suwet'en First Nation, the Lake Babine First Nation, and the Carrier Sekani Tribal Council residing along the Skeena River and associated watershed; and the Haisla First Nation residing at the head of the Douglas Channel. In central BC, coastal First Nations organizations involved in fisheries include: the Heiltsuk Tribal Council, Kitasoo/XAIXAI Nation, Nuxalk Nation, Oweekeno Nation, Ulkatcho Nation and the Gwa'sala-' Nakwaxda'xw Nation.

9.2 Commercial fisheries

9.2.1 Groundfish fishery

Over a four-year period between 1998 and 2001, groundfish landings for all of BC have represented on average 62% of the commercial fishery landing by weight, with an average landing of 115,625 tonnes for an average landed value of $118.65 M (wholesale value 186.55 M) (http://www.agf.gov.bc.ca/fish_stats/statistics-commfish.htm). Groundfish management areas are different from PFMAs, and are shown in Figure 4.

9.2.1.1 Groundfish by Trawl

Groundfish by trawl is a multispecies fishery, with 77 targeted species landed, of which 27 are annually assessed. The following have Total Allowable Catch (TAC) allocations: *Sebastes* spp. (yellowtail, widow, canary, silvergrey, ocean perch, yellowmouth, rough eye, shortraker, redstripe, quillback, copper, china, tiger), *Sebastolobus* spp., Pacific cod, dover sole, rock sole, English (lemon) sole, petrale sole, lingcod, dogfish, sablefish, pollock, and hake. The fleet consists of both bottom trawlers (mainly soft substrate) and midwater trawlers. Most fishing occurs on the edge of the continental shelf at the 200 m depth contour (Booth et al., 1995). Priority species include Pacific hake, cod, walleye pollock, rockfish, lingcod, soles, sablefish and spiny dogfish.

Historical aspects of the fishery and pertinent commercial information such as closures, catch limits, and gear specifications are all covered in the annual fishery management plan, which can be found on the Fisheries Management web site (www.pac.dfo-mpo.gc.ca/ops/fm/mplans/mplans.htm).

Fishing effort in Hecate Strait in the commercial groundfish-by-trawl fishery has altered between the years 1980 and 1990. From 1980-1986, fishing effort in northern Hecate Strait (Area 5D) was more than double the effort in southern Hecate Strait. Starting around 1987, fishing effort in Area 5C began to increase, and by the early 1990's, fishing effort levels were similar in both Areas 5C and 5D (Fargo and Tyler 1991).

Groundfish trawl catch data, described in Appendix C: Tables C-1 to 25 (Note: because data weren't always available for each year over five years for all of the species, we averaged the weight over the years where data were available (years used shown by cell colour) per species per PFMA. This allows comparison of average species landings, and reduces the number of tables otherwise needed to do so.), were taken from the PacHarvTrawl database, which is maintained by the DFO at the Pacific Biological Station (PBS). This database contains historical catch and effort information for the Pacific groundfish trawl commercial fishery from 1996 to the present. Catch and effort statistics for the British Columbia groundfish fishery has been collected by DFO since 1945 (Rutherford 1999). Prior to 1996, groundfish data was stored in the GFCATCH database, also maintained at PBS. The GFCATCH database has not been used in this analysis of the groundfish trawl catch data as it has some shortcomings, primarily because catch and discard data were voluntarily recorded by the fishers, resulting in an underestimation of both the numbers and weight of species both caught and discarded (Rutherford 1999). Since 1996, to improve the accuracy of groundfish trawl data, there has been 100% observer coverage for the fishery, resulting in a substantial increase in the amount and quality of data available, including bycatch data. Appendix C: Table 1 lists all of the species caught by the British Columbia groundifsh trawl fleet between 1997 and 2001. Appendix C presents groundfish trawl fishing activity (number of CFVs (Tables C-2 and 3) and catch weights (Tables C-4 to 25) within the assessment area from 1997 to 2001. Information from 2002 was incomplete at the time of data analysis (2002 data was missing the fisher’s log data from smaller boats and hake trip data) and hence is not included in this report.

9.2.1.2 Groundfish by Hook and Line (including sablefish by trap)

The hook-and-line fishery targets similar species to that of the trawl fishery, namely, rockfish, lingcod, dogfish, flatfish, cod, and other species such as skates and tuna that may be an indirect bycatch of trawling. Historical aspects of the fishery and pertinent commercial information, such as closures, catch limits, and gear specifications, are covered in the annual fishery management plan and also on associated Fisheries Management web sites (http://www.pac.dfo-mpo.gc.ca/ops/fm/mplans/mplans.htm#Groundfish).

The groundfish hook and line catch data are described in Appendix C: Tables C-26 to 34. Data are from the PacHarvHL database, which is maintained by DFO at PBS, and which contains historical catch and effort information for the Pacific hook and line commercial fishery. Information is primarily based on fishers’ logs and some observer log data.

9.2.2 Other FinFish Fisheries

Fisheries for pelagic species include the roe herring fishery, spawn-on-kelp fishery, and the food and bait herring fall lottery fishery. The minor finfish fishery harvests species such as anchovy, smelt, surf and pile perch, and eulachon (http://www.pac.dfo-mpo.gc.ca/ops/fm/Herring/index.htm). The roe herring and spawn-on-kelp fisheries are the only two pelagic fisheries that occur in the north and central coast regions (Steve Groves, DFO, Prince Rupert, pers. comm.).

9.2.2.1 Pacific Herring Fishery

Herring roe, collected by gillnet and seine net, have been the primary licences for the herring fishery. In 1999, total herring landings were 29,800 t, with a landed value of $51.5 M (wholesale value $119.3 M). In 2000, fishery landings were down slightly to 28,000 t, for a landed value of $51.6 M (wholesale value $130.6 M) (http://www.agf.gov.bc.ca/fish_stats/statistics-commfish.htm). In the late 1990s, returns from lower landings have been propped up by high market prices. The 1991-2000 average landing for the central coast was 8,100 t, though increased landings have occurred in the late 1990s (DFO 2001a). See Appendix C: Table C-35 for herring biomasses in the study area between 1997 and 2002.

Over a four-year period between 1998 and 2001, Pacific herring in all of BC has represented on average 14% of the commercial fishery by weight, with an average landing of 26,150 tonnes for an average landed value of $43.18 M (average wholesale value 118.43 M) (http://www.agf.gov.bc.ca/fish_stats/statistics-commfish.htm). See Appendix C: Table C-36 for the weights of landed herring in the study area between 1997 and 2002.

9.2.2.2 Anadromous Salmon

Historically, commercial salmon fishing in BC was worth over $400 million. Declines in both stocks, landings, and prices have drastically eroded this industry in recent years. From British Columbia government's fisheries statistics (http://www.agf.gov.bc.ca/fish_stats/statistics-commfish.htm), the 1999 total landing of wild salmon was 16,900 t, with a value of $25.4 M (wholesale value: $169.0 M). The harvest for that year was a 50 year low. The most recent statistics release by the BC government for 2000 indicate that wild salmon landings were slightly higher at 18,800 t for a landed value of $50 M (wholesale value: $203.4 M). Inclusion of farmed salmon for those years more than doubles these salmonid landing values.

Seine and gillnet fisheries target nearshore fisheries, whereas the troll fishery targets both nearshore and open strait waters. Primary fished species include sockeye (*Oncorhynchus nerka*), pink *(O. gorbuscha*), coho (*O. kisutch*), chinook (*O. tshawytscha*), and chum (*O. keta*). Reviews of the stock status for Rivers and Smith Inlet sockeye (DFO 1997), Central Coast pink (DFO 1999a), and Skeena sockeye (DFO 1999b) and coho (DFO 1999c) are available at the PSARC web site (http://www-sci.pac.dfo-mpo.gc.ca/sci/default_e.htm). An extensive system of smaller rivers (over 130) comprises most of the North and Central Coast runs. The major salmon runs in the area include the Skeena (Area 4, 5); Rivers Inlet, and Smith Inlet (Areas 9 and 10); and the Nass (Area 3) systems. The Nass and Skeena net fisheries (sockeye, pink, and chum) are managed as a unit. The Skeena system supports one of the largest sockeye runs in BC, which is primarily targeted by seine.

In the late 1990s, fishing effort in the Skeena system was reduced due to low abundance and the result of high smolt and prespawning mortality (1999b). Skeena Sockeye escapements have not recently been as high as desired (1999b) and new management strategies will include a weekly exploration target rate based on the abundance of wild sockeye (www.pac.dfo-mpo.gc.ca/ops/fm/salmon/overview.htm). Upper Skeena Coho stocks have been in serious decline in recent years (DFO 1999c) and have been managed under a 10% ceiling for exploitation rate.

Sockeye in Smith Inlet are managed as a single stock, as are the sockeye of Rivers Inlet. Recent declines of returns for these systems are linked to poor open ocean survival conditions (DFO 1997). Recreational and commercial fisheries will not be allowed to directly target sockeye from these systems for the shortterm. Central Coast Pink stock abundance and return is highly variable (DFO 1999a).

Around the Queen Charlotte Islands (PMFAs 1, 2E and 2W), pink and chum are fished in late summer by gill and seine in local inlets (e.g. Masset, Naden Habour, etc). In Dixon Entrance (part of Salmon Troll Area F (http://www.pac.dfo-mpo.gc.ca/ops/fm/Salmon/area.htm), troll fisheries are mainly targeting pink, chum, and sockeye due to recent conservations efforts aimed at Skeena River coho and Vancouver Island chinook stocks. Fishing for the latter two species continues to be limited to Areas 1 and 2W (www.pac.dfo-mpo.gc.ca/ops/fm/salmon/overview.htm).

Over a four-year period between 1998 and 2001, wild salmon in all of BC has represented on average 12% of the commercial fishery by weight, with an average landing of 22,200 t and an average landed value of $40.53 M (average wholesale value of $178.15 M) (http://www.agf.gov.bc.ca/fish_stats/statistics-commfish.htm).

9.3 Invertebrate Fisheries

Over a four-year period between 1998 and 2001, shellfish in all of BC has represented on average 10% of the commercial fishery by weight, with an average landing of 18,075 t, but an average landed value of $106.58 M (average wholesale value 151.75 M), 27 % of the value of all commercial fisheries. (http://www.agf.gov.bc.ca/fish_stats/statistics-commfish.htm).

The shellfish catch data outlined in Appendix C: Tables C-37 and C-38 are taken by species from the harvest logbooks contained in the Shellfish Database, maintained by DFO at PBS. This database contains historical catch and effort information for all commercial shellfish fisheries. Some shellfish fishery data goes as far back as 1978. Appendix C: Tables 37 and 38 list species landed by various British Columbia shellfish fisheries in the central and north coast regions, and the average total landing weight for each of these species, between 1997 and 2001. Information from 2002 was incomplete at the time of report preparation and has been omitted from analysis.

Major regional invertebrate fisheries are: shrimp-by- trawl, shrimp-by-trap, red and green sea urchin, crab, intertidal clams, and geoduck. Invertebrate fisheries involve both commercial and recreational fishers.

Harvest-log databases maintained by DFO contain catch data for all commercially caught invertebrate species, including: shrimp, crab, prawn, squid, octopus, geoducks, horse clams, red and green sea urchins, and sea cucumbers. The minimum location requirement for reporting is PFMA and sub-area. However, finer resolution of location is available for the following fisheries that have mandatory geo-referencing and that require accurate latitude and longitude catch data: shrimp-by-trap (since 2001), shrimp-by-trawl (since 1997), crab (since 2000), and octopus-dive (since 2000). The following fisheries have mandatory geo-referencing in the form of maps/charts showing locations fished: red sea urchin (since mid 1980's), green sea urchin (since 1987), geoduck (since late 1970's), and sea cucumber (since 1984).

In addition to the commercial shellfish fisheries information, DFO has collected fishery independent information through biological surveys in a limited number of locations for intertidal clams, shrimp, abalone, sea cucumbers. Biological surveys have been used to monitor the impacts of commercial fisheries on stocks, the recovery of previously depleted populations, or the range distributions of various species. Most surveys collected quantitative data to provide biomass estimates and confidence limits in support of stock assessments; however, a few surveys collected mostly distributional information. There are also historical surveys dating back to 1878 (Bernard *et al* 1967). A number of exploratory surveys were done in the Dixon Entrance and Queen Charlotte Sound areas in the 1960's (Quayle 1961, Quayle 1963, Bernard *et al* 1967, Bernard *et al* 1968, Bernard *et al* 1970). However, widespread, recent inventory information has not been available for most of the assessment area.

9.3.1 Shrimp by Trawl and Trap (Shrimp and Prawn)

Fishing occurs primarily between 100 and 150 m over muddy-sandy substrates. Seven species of Pandalid are targeted through trawling. Pink and sidestripe shrimps comprise the majority of landings, whereas humpback, coonstripe, flex and spot shrimps are incidentally caught. This fishery is being monitored for its bycatch of halibut and eulachon (see Boutillier et al., 1999 and Hay et al., 1999). There is a voluntary shrimp trawl closure to ensure protection of the unique glass-sponge reefs described above that are located in Hecate Strait and Queen Charlotte Sound.

Prawn- and shrimp-by-trap are both a commercial and recreational fishery targeting *Pandalus platyceros* and two other shrimp species, humpback shrimp (*P. hypsinotus*) and coonstripe (*P. danae)*, or dock, shrimp.

9.3.2 Sea Cucumber

This dive fishery targets the giant, red sea cucumber (*Parastichopus californicus*). Knowledge of the biology, life history, abundance, and distribution of this species is reviewed at the Fisheries Management web site (http://www.pac.dfo-mpo.gc.ca/ops/fm/shellfish/Sea_Cucumber/default.htm).

9.3.3 Green and Red Sea Urchins

Green and red sea urchins (*Strongylocentrotus droenbachensis* and *S. franciscanus*) are targeted by divers for their roe. Divers commercially harvest them with short aluminium rakes. Roes are extracted at processing plants for shipment as “uni” to fresh markets. The yield of roe ranges from 5-15% of total body weight. Food (benthic marine plants) availability in the wild is an important factor in determining roe quality.

9.3.4 Crabs

This commercial fishery targest five species; Dungeness crab, red rock crab (*Cancer productus*), slender crab (*Cancer gracilis*), golden king crab (*Lithodes aequispina),* and king crab *(Paralithodes camtschatica)*. Recreational crabbing includes these species, but also targets Puget Sound king crab (*Lopholithodes mandtii*), and brown box crab (*L. foraminatus*). Commercial crabbing is being developed for Tanner crabs (*Chionoecetes tanneri*) and the box crab. Fisheries are often species-specific due to different substrate preferences by species. Dungeness crab is one of the most valuable invertebrate fisheries in British Columbia**.**

In the central and north coast regions between 1997 and 2001, only Dungeness crab were caught commercially. The Skeena River estuary and the waters off the large sand beaches of the north and east coast of Graham Island in the Queen Charlotte Islands support large commercial fisheries. The Dogfish Bank area of Hecate Strait has periodic extremely high crab recruitment (late 1960s, 1989, and in the late 1990s), and while landings for BC as a whole only usually average from 1100-1500 t, in peak years, 4000-5000 t may be harvested from Hecate Strait alone. The explanation for the conditions that result in such large recruitments is unknown, but it is likely oceanographic, with crab larvae periodically being brought into the area in very high abundance.

Commercial harvesters generally use baited traps, while recreational fishers often use ring nets. The crab fishery has a passive management system that controls size, sex and season. There is a minimum legal size to allow spawning, females can not be harvested, and there are seasonal closures to protect soft-shell male crab. In addition, there are limitations on trap numbers and specifications to trap design. Catch is the only index of abundance in the crab fishery. There is a lack of catch reporting mechanisms in First Nation and recreational fisheries. In the Area A commercial crab fishery, vessel-based cameras linked to a global-positioning systems monitor on-board activities (Winther 2000).

9.3.5 Intertidal Clams

This fishery targets Butter (*Saxidomus giganteus*), Manila (*Venerupis pilippinarum)*, Littleneck (*Protothaca staminae*), Razor (*Siliqua patula*) and in some areas, Varnish (*Nutallia obscurata*) clams. In 1999, the total BC landing of all clams (littleneck, manila, butter, and razor) was valued at $5.1 million (BC Government 2000).

Intertidal clam fisheries in northern BC (PFMA 1-10) have been closed since 1963 due to Paralytic Shellfish Poisoning (PSP) and the lack of monitoring programs to detect PSP, as well as elevated levels of faecal contamination in some areas. The exception in the north coast is razor clams in Clam Management Area A (Graham Island, east of Masset), and Subareas of PFMA 7 for Manila clam harvesting (DFO 2001b). There has been a commercial fishery for razor clams on beaches near Tow Hill east of Masset since 1924, as well as a small, but important, non-commercial fishery (Table C-39). Arrangements have been made for water quality certification and monitoring to exclude these razor clams from the overall North Coast bivalve closure. The razor clam fishery has been co-managed by the Council of Haida Nations and DFO (Jones and Garza 1998). Landings between 1994 and 2000 fluctuated between 237 t in 2000 to 39.8 t in 1998. Due to concerns of possible overexploitation, the fishery was briefly closed in 2000 until survey results could be analysed and interpreted (Jones *et al.* 2001). This fishery supported six commercial licences and had 94-269 Haida designated fishers between 1995 and 2000.

Commercial Manila clam harvesting in PFMA 7 is co-managed by the Heiltsuk Tribal Council (HTC) and DFO. The co-management of this fishery began in 1993 when a three-year pilot clam fishery was established, under a joint management plan. Originally, the Heiltsuk clam fishery included the harvest of butter, littleneck and Manila clams. However, due to low market demand, butter and littleneck clams were removed from the commercial fishing plan in 1999. The Heiltsuk clam fishery now focuses only on Manila clams, and is managed by annual total allowable catch (TAC) and a minimum size limit. For 1999 and 2000, the TAC for Manila clams was 68.2 t (150,000 lbs.) (Gillespie et al. 2001).

9.3.6 Geoduck and Horse Clams

The geoduck fishery is one of BC's most valuable fisheries, with a peak value of $42 M (DFO 2000b). Geoducks have the highest commercial value of any shellfish. Horse clams are limited to an incidental catch during the geoduck season, and a directed fishery is not presently permitted. There is a recreational fishery for geoducks, but the number of recreational harvesters is unknown; this catch is considered marginal. The First Nations catch is limited to food, social and ceremonial purposes, and again, landings are unknown (Heizer and Rome 2000).

9.3.7 Cephalopods

There is an experimental fishery on the north coast for Neon flying squid (*Ommastrephes bartrami)*. This large oceanic squid in the North Pacific spawns in subtropical waters in the winter, and migrates northward to near the subarctic boundary to feed in the summer and fall. Flying squid generally aggregate near cold-water fronts when feeding near the surface at night and descend to depths greater than 300 m during the day. Flying squid are found in or near BC waters from July to September.

The giant Pacific octopus (*Octopus doefleini*) is one of nine octopus species found in BC waters, but it is the only species commercially harvested in BC. There is a directed-dive fishery, but octopi are also landed incidentally in the prawn trap, the groundfish trawl, and shrimp trawl fisheries. A directed trap fishery was discontinued in 1999.

Octopus landings in northern waters have been small. Between 1995 and 1998, the directed octopus trap fishery landed 9.4 - 23.9 t in the North Coast (PFMAs 3-6) and 3.8 – 24.1 t in the Central Coast (PFMAs 7-11). The commercial dive-fishery landed 2.5 – 14.0 t during the same period in the North Coast close to Prince Rupert. Historically, octopus landed in BC have been primarily used as bait, especially in the halibut fishery. However, attempts are being made to provide food-quality octopus for the European and Asian markets.

10. DISCUSSION

10.1 Local Ecological Knowledge

There is anticipated to be considerable local ecological knowledge (LEK) held by both recreational and commercial fishers that is not available within existing data bases, and that has to date not been broadly collected and compiled. As such, apart from identifying that it would be useful to have this information, it has not been considered in this document, and it is identified as a probable productive area to be further investigated. An example of its utility might be in identifying particularly sensitive habitat areas, such as where deep-water corals are most prevalent or the locations of nursery ground areas for various species, based on unique areas with high proportions of juveniles.

10.2 Spatial distributions

While the above discussion summarises habitats, habitat species characteristics, and species' exploitation in the study area, the timeframe and resources available did not allow our consideration of areal ranges and spatial distributions of species abundance. These are obviously extremely important considerations in developing an understanding of biological communities, and in the future, will need to be addressed to better understand marine biological processes in the region. Recent technological advances with respect to the collection and utilization of geo-spatial referenced data increasingly allows analyses of this nature, although at present, such data are widely scattered both within and among federal and provincial agencies. Some non-governmental organizations (NGOs) have started compiling these data as well, using what data that they have been able to obtain from government agencies, and so there is an increasing need to have a transparent, accessible data storage and processing process for coastal British Columbian biological data.

Some examples of current or existing initiatives include: 1) CWS staff have begun analysing seabird colony and pelagic bird locations to identify hot spots (areas of high use/high concentration of birds) relative to migratory routes and seabird nesting locations, with the final product to include a GIS map with hot spots identified (Kathleen Moore, CWS, Delat, BC, pers. comm.); 2) Adkins (1977) provided useful maps, but being 25 years old, these are not now the most relevant summaries; 3) The MSRM is currently mapping (via GIS) North Coast shorelines and associated communities; and 4) DFO has mapped intertidal clam beaches (G. Gillespie, Nanaimo, BC, pers. comm.) and herring spawn areas (Hay et al. 1989a).

There is also temporal variability to consider, and the effects this may have both on species occurrence, abundance and proportion in various identified communities, and spatial distributions. There have been numerous cyclical changes in abundance of many species, and when analysing data, it is important to consider where in different cycles analyses are making predictions for, or providing material for consideration. This may not be so relevant with long-lived species, whose cycles, if they exist, may be measured in centuries, but this consideration will likely be relevant for species affected by shorter cycles such as El Niňo events and likely North Pacific regime shifts (McFarlane et al. 2000, 2002). There is now an understanding that the proportions of pelagic forage species (anchovy, sardine, herring, etc.) may naturally fluctuate over decadal scales and there may be cycles in other groups that have yet to be fully described or recognised.

The spoiler in all this are the potential effects of global climate change, which may mean that the potentially, or assumed, relatively stable past may not be a good indicator of what the future may bring. The palimpsest may have been wiped clean, and a new series of scenarios may now be developing, which only time will allow us to document and understand.

10.3 General vulnerability of marine communities to oil

Sloan (1999) provides a background on the impact an oil spill can have on marine ecosystems. He outlines (1) how an oil spill will impact marine flora and fauna, and (2) which communities based on habitat types are most vulnerable. We have indicated to a limited extent how various communities might be affected by oiling, but this is not a general area that we have expertise in and which was researched here. Habitats and species that are particularly vulnerable, or susceptible to oiling, need to be better identified and the potential consequences described in further detail so that their appropriate protection or mitigation can be effected.

10.4 Research gaps

In some cases information needs have been identified, such as Savard's (1988) indication that there is a need to gather the following marine bird information and that the lack of this information will impair impact assessments done on coastal areas: a) locate important moulting sites, b) determine the stability of moulting sites, and c) determine the moulting chronology and the composition of moulting flocks. However, such recommendations may now be out of date, are typically widely scattered in the literature, and are generally hard to find and collate. A more cost-effective and practical approach is to initiate a Delphic review of what information gaps might be highest priority, utilizing expertise from across relative agencies.

As stated in the introduction, most studies to date in the study area have focused on one species or a species group, and haven't really investigated the broader habitat and ecosystem perspectives of the assessment area. Such analyses are timely now, both because management agencies are increasingly moving towards ecosystem-based management rather than management of single species, i.e. as if they largely existed in isolation from the biological community around it; and because oil and gas developments have the potential scale and complexity for causing impacts across many more components of the ecosystem that has occurred in this geographical area to date. As recognised by the request for this paper, which we anticipate is only the first step in a long, on-going analysis of issues, this will be a complex process that will require numerous specific studies on various biological community elements.

Recommendations:

1. A Delphic exploration of what research priorities relevant to oil and gas exploration might be of highest priority, utilizing expertise from across relative agencies, shoud be initiated so that the most cost-effective usage of limited assessment resources to expand our state of knowledge of marine organisms can be achieved.
2. Existing databases relevant to the identification of assessment area communities particularly sensitive to any perturbation of the sea by either resource extraction or fishing activities, such as areas of high coral and/or sponge presence, need to be analysed. Significant areas should be mapped as soon as possible and effective protection of the vulnerable species present immediately established. It is important that industry of all types be made aware of the existence of such communities so they can develop appropriate exploitation practices that will allow the conservation of relevant species.
3. Broader ecosystem characterisation of the assessment area needs to be implemented so that broad ecosystem types can be determined and identified, as has to some extent been done for groundfish communities in Hecate Strait (four communities identified: the Reef Island community; Butterworth community; Bonilla community; and Moresby Gully community). This would include expanding species characterisation of communities to include all major taxonomic groups (e.g., invertebrates and pelagics were not included in the above community analyses).
4. Dynamic models of the region that include both physical and biological parameters need to be developed to investigate the dynamics of species within ecosystems or habitats in specific geographical areas, as the dynamics of one area may influence species dynamics or characteristics (abundance, spatial distribution, etc.) of specific species or species groups in other regions.
5. Local ecological knowledge needs to be incorporated into the state of knowledge of the lease assessment areas, as existing documented scientific knowledge is limited both temporally and spatially.

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APPENDIX A: SURVEY INVENTORIES (Tables A-1 to A-15)

Table A-1. List of survey information collected for soft, sheltered, intertidal habitats.

Time frame of survey	Geographic locations	Purpose	Survey focus	References
June 1990	Wilcox Group - Kitkatla Inlet; Campania Island - Weinberg Inlet; Kitasu Bay - Meyers Passage; Mathieson Channel; St. John Harbour; Seaforth Channel - Joassa Channel; Lama Passage - Hunter Channel; Seaforth Channel - Raymond Passage; and Gunboat Passage	Primary focus was to assess the presence/absence of intertidal clams and determine the clam bearing area of the beach.	Littleneck clams (Prothaca staminea), butter clams (Saxidomus giganteus), and manila clams (Venerupis philippinarum)	Bourne and Cawdell 1992
July 1991	Bella Bella to Queen Charlotte Strait (Seaforth-Spiller-Return Channel area; Gale Passage; Thompson Bay; Stryker Island; Spider Anchorage; Kwakshua Channel; Rivers Inlet; West Gilford Island; Indian Channel)	The purpose of this survey was to assess butter, littleneck and manila clam populations.	Littleneck clams (Prothaca staminea), butter clams (Saxidomus giganteus), and manila clams (Venerupis philippinarum)	Bourne et al. 1994
July 1993	Fish Egg Inlet; Smith Sound; and Rivers Inlet	Primary focus was to assess the presence/absence of intertidal clams and determine the clam bearing area of the beach.	Littleneck clams (Prothaca staminea), butter clams (Saxidomus giganteus), and manila clams (Venerupis philippinarum)	Bourne and Heritage 1997

Table A-1. List of survey information collected for soft, sheltered, intertidal habitats.

Time frame of survey	Geographic locations	Purpose	Survey focus	References
July 1994	Cameleon Harbour; Troup Passage; Lama Passage - Gunboat Passage; Spiller Channel - Bullock Channel; Higgins Passage; Aristazabal Island (Weeteeam Bay and Clifford Bay); and Laredo Inlet.	Primary focus was to assess the presence/absence of intertidal clams and determine the clam bearing area of the beach.	Littleneck clams (Prothaca staminea), butter clams (Saxidomus giganteus), and manila clams (Venerupis philippinarum)	Heritage et al. 1998
June - July 1996	Kakushdish Harbour; Return Channel-Bullock Channel-Johnson Channel-Troup Narrows; Gale Passage; Joassa Channel-Boddy Narrows-Louise Channel; and Kwakshua Channel-Safety Cove.	Primary focus was to assess the presence/absence of intertidal clams and determine the clam bearing area of the beach.	Littleneck clams (Prothaca staminea), butter clams (Saxidomus giganteus), and manila clams (Venerupis philippinarum)	Heritage et al. 1998
Sept. 1997	Chatham Sound - Lucy Islands; Queen Charlotte Islands - Masset Inlet (Makai Point, Fraser Island, Yadoun Bay, Wathus Island, Shannon Bay, Dinan Bay, Martin Point) and Naden Harbour (Germania Creek, Stanley Creek and Naden River Estuaries, Tee Island, Mary Point)	Primary focus of the survey was to document dispersal and population parameters of Manila clams. Limited abundance and population characteristics were collected for littleneck, butter, and soft-shell clams, and cockles.	Littleneck clams (Prothaca staminea), butter clams (Saxidomus giganteus), and manila clams (Venerupis philippinarum)	Gillespie and Bourne 1998

Table A-1. List of survey information collected for soft, sheltered, intertidal habitats.

Time frame of survey	Geographic locations	Purpose	Survey focus	References
Aug. 1998	Aristazabal Island - Borrowman Bay and Kettle Inlet; Meyers Passage; Laredo Inlet; Finlayson Channel; Sheep Passage; Mussel Inlet; Mathieson Channel; Chapple Inlet; and Surf Inlet.	Primary focus of the survey was to document dispersal and population parameters of Manila clams. Limited abundance and population characteristics were collected for littleneck, butter, and soft-shell clams, and cockles.	Littleneck clams (Prothaca staminea), butter clams (Saxidomus giganteus), and manila clams (Venerupis philippinarum)	Gillespie and Bourne 2000

Table A-2. List of survey information collected for soft, exposed, intertidal habitats.

Time frame of survey	Geographic locations	Purpose	Survey focus	References
Summer 1982	Queen Charlotte Sound	To assess and rank the natural and cultural features of these three regions for the purpose of determining their suitability for a marine park	Climatology, oceanography, marine communities by habitat type, marine birds, marine mammals and marine history	Searing and English 1983
July 1991	Bella Bella to Queen Charlotte Strait (Seaforth-Spiller-Return Channel area; Gale Passage; Thompson Bay; Stryker Island; Spider Anchorage; Kwakshua Channel; Rivers Inlet; West Gilford Island; Indian Channel)	The purpose of this survey was to assess butter, littleneck and manila clam populations.	Littleneck clams (Prothaca staminea), butter clams (Saxidomus giganteus), and manila clams (Venerupis philippinarum)	Bourne et al. 1994
Summer 1992	Queen Charlotte Islands (Moresby Island)	To inventory coastal resources within Gwaii Haanas for the creation of a management plan	Intertidal communities	Harper et al. 1994
August-September 1993	Goose Islands	To describe and map the marine biological features	Marine algae, invertebrates and fish	Emmett et al. 1995
1994 - 2000	Graham Island - North-1 Beach, South-1 Beach and South-2 Beach	Focus was the abundance and biomass of razor clams.	Razor clams (*Siliqua patula*)	Jones et al. 2001
1999	Central Coast - From Allison Harbour to Takush Harbour	To establish long-term study sites that can be used to assess changes in biodiversity over time	Intertidal, subtidal and terrestrial communities	Lamb et al. 2000

Table A-3. List of survey information collected for exposed rocky-substrate intertidal habitat types.

Time frame of survey	Geographic locations	Purpose	Survey focus	References
Summer 1982	Queen Charlotte Sound	To assess and rank the natural and cultural features of these three regions for the purpose of determining their suitability for a marine park	Climatology, oceanography, marine communities by habitat type, marine birds, marine mammals and marine history	Searing and English 1983
Summer 1992	Queen Charlotte Islands (Moresby Island)	To inventory coastal resources within Gwaii Haanas for the creation of a management plan	Intertidal communities	Harper et al. 1994
August-September 1993	Goose Islands	To describe and map the marine biological features	Marine algae, invertebrates and fish	Emmett et al. 1995
1999	Central Coast - From Allison Harbour to Takush Harbour	To establish long-term study sites that can be used to assess changes in biodiversity over time	Intertidal, subtidal and terrestrial communities	Lamb et al. 2000
Summer 2000	West Coast of Vancouver Island - Amphitrite Point, Tofino area	To determine intertidal community structure	Intertidal communities	Jamieson et al. 2001

Table A-4. List of survey information collected for semi-sheltered rocky-substrate intertidal habitat types.

Time frame of survey	Geographic locations	Purpose	Survey focus	References
Summer 1982	Queen Charlotte Sound	To assess and rank the natural and cultural features of these three regions for the purpose of determining their suitability for a marine park	Climatology, oceanography, marine communities by habitat type, marine birds, marine mammals and marine history	Searing and English 1983
Summer 1992	Queen Charlotte Islands (Moresby Island)	To inventory coastal resources within Gwaii Haanas for the creation of a management plan	Intertidal communities	Harper et al. 1994

Table A-5. List of survey information collected for estuaries.

Time frame of survey	Geographic locations	Purpose	Survey focus	References
August-74	Kitimat River Estuary	To obtain data on amphipods as a food source for salmon	Amphipods	Levings 1976
August-00	Crabapple Creek Estuary	To conduct an ecological assessment on the effects of an oil spill on the estuary	Vegetation, invertebrates, fishes, food web, and impact of spill	Levings 2002
April - July 1980	Graham Island (Masset Inlet)	To assess the biological impacts of artificially fertilizing the estuary	plankton, benthic algae, vascular plants, invertebrates, and fish	Stockner and Levings 1982
July 1972, October 1973, and August 1974	Link River Estuary (Ocean Falls Harbour, Cousins Inlet); Bella Coola River Estuary; Kitimat River Estuary; Skeena River Estuary	To obtain reconnaissance data on the intertidal and subtidal benthic communities	Vascular plants, algae and invertebrates	Levings et al. 1975
Spring - Summer 1972	Skeena River Estuary	To determine the distribution of fish and their prey	Salmon, plankton and benthic invertebrates	Higgins and Schouwenburg 1973
up to 1975	Skeena River Estuary	To inventory available information on the environmental aspects of the estuary	All literature relevant to estuary	Hoos 1975
up to 1976	Kitimat River Estuary	To inventory available information on the environmental aspects of the estuary	All literature relevant to estuary	Bell and Kallman 1976
Summer 1992	Queen Charlotte Islands (Moresby Island)	To inventory coastal resources within Gwaii Haanas for the creation of a management plan	Intertidal communities	Harper et al. 1994
1997 and 1998	Along the north and central coast of BC from Kilbella/Chuckwalla River to the Nass River	To aquire ecological information on the plant community types occuring in estuaries on the north coast; and to survey and describe the estuaries along the north coast of BC	intertidal and supratidal vasular plant-dominated communities	Mackenzie et al. 2000

Table A-6. List of survey information collected for benthic, soft, shallow (<30 m), subtidal habitat types.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
July 1994	Queen Charlotte Islands (North end of Burnaby Island)	To estimate the geoduck stocks in the survey area	Geoduck (*Panopea abrupta*)	Hand et al. 1998
1979	Chatham Sound	To assess the substrate types used by herring for spawn	Herring spawn, aquatic vegetation and substrate	Haegele and Miller 1979
July 1995	Saanich Inlet	To locate and qualitatively describe existing eelgrass beds.	Eelgrass (*Zostera marina, and Z. japonica*)	Lessard et al. 1996

Table A-7. List of survey information collected for benthic, exposed, rocky, shallow (<30 m), subtidal habitat types.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
1975	Barkley Sound, in the Deer Group Islands	To examine the fish community of a *Nereocystis* stand in Barkley Sound; to determine the relationship of species within the community to each other and the habitat; to examine the effect of canopy removal on the community; and to relate the findings to management of kelp resources.	*Macrocystis integrifolia* and *Nereocystis leutkeana*	Leaman 1980
September 1976	The Dundas Group	To locate and quantify the standing crop of *Macrocystis integrifolia* and *Nereocystis leutkeana*	*Macrocystis integrifolia* and *Nereocystis leutkeana*	Field and Clark 1978
September 1976	Northwest side of Graham Island, Queen Charlottes	To locate and quantify the standing crop of *Macrocystis integrifolia* and *Nereocystis leutkeana*	*Macrocystis integrifolia* and *Nereocystis leutkeana*	Coon et al. 1979
August 1976	Goschen Island to the Tree Nob Group	To locate and quantify the standing crop of *Macrocystis integrifolia* and *Nereocystis leutkeana*	*Macrocystis integrifolia* and *Nereocystis leutkeana*	Coon et al. 1980
September 1979	Checleset Bay on the west coast of Vancouver Island	To examine the effect of sea otter foraging on benthic subtidal communities	Sea urchins, other invertebrates and algae	Stewart et al. 1982

Table A-7. List of survey information collected for benthic, exposed, rocky, shallow (<30 m), subtidal habitat types.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
1979-1981	Barkley Sound	To determine the population dynamics of *Macrocysits integrifoli*a in BC over several seasons	*Macrocystis integrifolia*	Wheeler and Druehl 1986; Druehl and Wheeler 1986
August-September 1993	Goose Islands	To describe and map the marine biological features	Marine algae, invertebrates and fish	Emmett et al. 1995
June 1994	Northwest side of Graham Island, Queen Charlottes	To evaluate the impact sea urchins have on kelp when sea otters are absent	Kelp (*Agarum, nereocystis, Costaria, Cymathere, Pterygophora, Laminaria, Alaria, Macrocystis, and Egregia*), and red sea urchins (*Strongylocentrotus franciscanus*)	Jamieson and Campbell 1995

Table A-8. List of survey information collected for deep (30-100+ m), soft-bottom, subtidal habitat types.

Geographic locations	Time frame of survey	Purpose	Topic focused on in survey	References
Hecate Strait	May-June 1984	To map fish assemblages and provide a time-series of relative abundances for major species	Groundfish	Fargo et al. 1984
Hecate Strait	June 1985 - Jan. 1986	To examine the species composition of the sediment from groundfish sampled areas	Infaunal benthic communities	Burd and Brinkhurst. 1987
Hecate Strait	January - February 1986	To determine the interseasonal changes in the identified fish assemblages	Groundfish	Fargo and Davenport. 1986
Hecate Strait	May-June 1987	To map fish assemblages and provide a time-series of relative abundances for major species	Groundfish	Fargo et al. 1988
Hecate Strait	May-June 1989	To map fish assemblages and provide a time-series of relative abundances for major species	Groundfish	Antonsen et al. 1990
Hecate Strait	June 1991	To map fish assemblages and provide a time-series of relative abundances for major species; and to examine the catch-rate variability for species	Groundfish	Wilson et al. 1991
Hecate Strait	May-June 1993	To map fish assemblages; to incorporate oceanographic variables into assemblage distributions; and to provide fisheries-independent indices of relative abundance for single-species stock assessments	Groundfish	Hand et al. 1994

Table A-8. List of survey information collected for deep (30-100+ m), soft-bottom, subtidal habitat types.

Geographic locations	Time frame of survey	Purpose	Topic focused on in survey	References
Hecate Strait	May-June 1995	To examine inter-annual and inter-seasonal changes in abundance and distribution of marine fish species; to collect environmental data and incorporate this data into the abundance indices; and to investigat the trophic interactions among and within the assemblages identified.	Groundfish	Workman et al. 1996
Hecate Strait	May-June 1996		Groundfish	Workman et al. 1997
Hecate Strait	June 1998	To collect stock assessment information	Groundfish	Choromanski et al. 2002b.
Hecate Strait	May-June 2000	To collect stock assessment information	Groundfish	Choromanski et al. 2002a.

Table A-9: List of survey information collected for benthic, very deep (>100 m), soft-bottom troughs.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
1987 and 1988	Queen Charlotte Sound and Hecate Strait	To examine the age, identification and distribution of sponge bioherms	Sponges	Conway et al. 1991
July 1999	Queen Charlotte Sound and Hecate Strait	To further study the geologic and biological aspects of the Hexactinellid sponge reefs	Sponges, invertebrates and sediments	Conway 1999
July 1999	Queen Charlotte Sound and Hecate Strait	To further study the sponge reefs and their physical and oceanographic environment	Sponges and sediments	Conway et al. 2001
1996-2001	Queen Charlotte Sound and Hecate Strait	To summarise the biological data on and around the vicinity of the sponge reefs.	Groundfish trawl catch data	Jamieson and Chew 2002

Table A-10: List of survey information collected for exposed, deep (>30-200 m), rocky-substrate habitats.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
October and November 1984	North-east section of the Strait of Georgia	To quantify spatial distribution patterns of inshore rockfish communities	Inshore rockfish (greenstriped rockfish (Sebastes elongatus), quillback rockfish (S. maliger), and yelloweye rocfish (S. ruberrimus))	Richards 1986
September 1988, 1989, and 1990	Heceta Bank, Oregon	To investigate relationships between the abundance of groundfish and macroinvertebraees and the topography and texture of the seafloor; to document interannual variation in these relationships	Rockfishes and their associated habitats	Nasby-Lucas et al. 2002
August 1992 and October 1993	Soquel Canyon, California	To characterize rockfish assemblages and their relationship to specific benthic habitats within submarine canyons	Rockfishes and their associated habitats	Yoklavich et al. 2000

Table A-11: List of survey information collected for benthic, very deep (>200 m), soft to mixed-substrate habitats, which are mostly along the Continental Slope.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
1999	west coast of Vancouver Island	To assess the abundance of *Chionoecetes tanneri off the west coast of Vancouver Island*	Tanner crabs, and invertebrates and fish bycatch	Workman et al. 2000; Workman et al. 2001
1988-1993	Langara Island, Hippa Island, Buck Point, Gowgaia Bay, Triangle Island, Quatsino Sound, Esperanza and Barkley Canyon	Stock assessment	Sablefish Surveys	Smith et al. 1996
1994-1995	Langara Island, Hippa Island, Buck Point, Gowgaia Bay, Triangle Island, Quatsino Sound, Esperanza and Barkley Canyon	Stock assessment	Sablefish Surveys	Downes et al. 1997

Table A-12: List of phytoplankton surveys.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
March 1978-March 1979	Queen Charlotte Sound, Hecate Strait, and Dixon Entrance	To monitor the marine environment of the northern Northeast Pacific Ocean.	Temperature, salinity, pigments, nutrients, phytoplankton, and zooplankton	Dilke et al. 1979
May 1979-June 1980	Queen Charlotte Sound, Hecate Strait, and Dixon Entrance	To monitor the marine environment of the northern Northeast Pacific Ocean.	Temperature, salinity, pigments, nutrients, phytoplankton, and zooplankton	Perry et al. 1981
August 1981; July 1983	Alice Arm; and Queen Charlotte Sound, Hecate Strait and Dixon Entrance	To determine the species composition of photautotrophic plankton samples collected between 1979 and 1989	Salinity, chlorophyll a, inorganic nutrients, phytoplankton and zooplankton.	Forbes and Waters. 1993
March-October 1979	Queen Charlotte Sound, Hecate Strait, and Dixon Entrance	To examine variation of the surface phytoplankton distribution along the coast of British Columbia	Chlorophyll values to estimate seasonal surface phytoplankton distribution and abundance	Pan et al. 1988.

Table A-12: List of phytoplankton surveys.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
June - July 1983	Queen Charlotte Sound and Hecate Strait	To conduct an intial survey of the biological and physical oceanography of the area	Temperature, salinity, chlorophyll, disolved oxygen, inorganic nutrients, primary productivity, and phytoplankton and zooplankton counts	Denman et al. 1985

Table A-13: List of zooplankton surveys.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
June - July 1983	Queen Charlotte Sound and Hecate Strait	To conduct an intial survey of the biological and physical oceanography of the area	Temperature, salinity, chlorophyll, disolved oxygen, inorganic nutrients, primary productivity, and phytoplankton and zooplankton counts	Denman et al. 1985
January, February, March and April 1980	Queen Charlotte Sound and Hecate Strait	To assess the icthyoplankton distribution, biomass and species composition	Juvenile fishes, fish eggs and fish larvae	Fulton et al. 1982
1956-1964	Queen Charlotte Sound, Hecate Sound, Hecate Strait and Dixon Entrance	To collect zooplankton biomassin the northeastern Pacific Ocean	Zooplankton	LeBrasseur 1965
April to December 1958	Queen Charlotte Sound and Dixon Entrance	To obtain data from the Canadian West Coast	Oceanographic and meteorological observations, serial cast data, bathymetry, and plankton	Pacific Oceanographic Group 1958
June 1988	Queen Charlotte Sound and Hecate Strait	To provide data for a Hecate Strait and Queen Charlotte Sound database; and to assess the effects of seismic sampling on larval commercial species	Icthyoplankton, zooplankton, temperature, and salinity	Burd and Jamieson 1991

Table A-14: List of herring surveys.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
1937-1986	North and central coasts of BC	To identify significant herring spawning areas and locations that support major herring fisheries	Geographic location of herring spawning areas	Hay et al. 1989
1928-1988	Queen Charlotte Islands; Prince Rupert District; and Central Coast	To describe the spatial and temporal variation in herring spawn distribution	Herring spawn distribution and timing	Hay and McCarter 1999
November and December 1993	Hecate Strait	To estimate herring biomass	Herring	McCarter et al. 1994

Table A-15: List of surveys with salmon data collected.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
1986	Hecate Strait	To gather data on species composition, size composition, and diet of the juvenile salmon population of Hecate Strait	Salmon	Morris and Healey. 1987
1987	Hecate Strait	To gather data on abundance, species composition, size composition, and diet of the juvenile salmon population of Hecate Strait	Salmon	Morris and Healey. 1988
Oct. 1996	Dixon Entrance to Gulf of Alaska	To determine the seaward extent of juvenile salmon on the continental shelf; to relate juvenile salmon distribution to physical and biological oceanographic conditions; to determine if juvenile salmon are using the Alaskan Coastal Current to propel their migrations	Salmon	Welch et al. 2002a.
1998	Queen Charlotte Sound; Hecate Strait; Dixon Entrance	To examine the ecology of Pacific salmon during their ocean phase; To collect data on the oceanographic conditions; to determine the distribution and biomass of zooplankton	Salmon	Welch et al. 2002d

Table A-15: List of surveys with salmon data collected.

Time frame of survey	Geographic locations	Purpose	Topic focused on in survey	References
1999	Queen Charlotte Sound; Hecate Strait; Dixon Entrance	To examine the ecology of Pacific salmon during their ocean phase; To collect data on the oceanographic conditions; to determine the distribution and biomass of zooplankton	Salmon	Welch et al. 2002e

APPENDIX B: OCEANOGRAPHIC, ABUNDANCE AND COSEWIC DATA (Tables B-1 to B-5)

Table B-1: Monthly means and standard deviations for chlorophyll a concentrations based on shallow water (< 10 m) data from five data sets (Dilke et al. 1979, Perry et al. 1981 Denman et al. 1985, Forbes & Waters 1993, Ware and Thomson unpulished data in, Pan et al. 1988) from McQueen and Ware 2002).

Month	Mean Chl a ug L^{-1}	Standard deviation	Sample size
Jan	-	-	0
Feb	0.23	0.09	12
April	1.64	1.6	19
May	2.99	1.28	19
June	2.26	1.55	16
July	1.62	1.05	77
August	1.5	0.63	9
Sept	1.93	0.45	6
Oct	2.74	2.76	5

Table B-2: Depth stratified chlorophyll a concentrations in the summer months from Denman et al. (1985) grouped into 5 m depth intervals (from McQueen and Ware 2002).

Depth Interval (m)	Chl a µ g L^{-1}	Standard Deviation	Sample Size
<5	2.21	1.35	9
5-Oct	1.18	0.88	16
Oct-15	2.05	1.45	21
15-20	3.74	3.18	16
20-25	5.1	4.97	17
25-30	9.25	5.89	15
>30	3.73	4.11	9

Table B-3: Average biomass (mg m^{-3} dw) for all of the stations found in Dixon Entrance, Hecate Strait, Goose Island Bank, and Queen Charlotte Sound, aggregated into ten taxonomic groups, and summarized on a monthly basis. From McQueen and Ware 2002, Table 4.6.1.

Month	TIme	Number of samples	Small and medium copepods	Large copepods	Chaetognatha	Euphausiids	Amphipods	Urochordate Salps, etc	Coelenterates	Molluscs (Clione) and Polychaetes	Small things including eggs	Other Remainder
April	night	0	-	-	-	-	-	-	-	-	-	-
May	night	18	9.78	7.27	2.19	9.77	0.07	2.25	4.96	0.2	41.46	23.12
June	night	10	18.61	6.24	2.98	7.49	0.33	2.3	2.56	0.95	30.55	11.58
July	night	2	23.83	1.72	2.42	68.78	0.84	0	6.52	0.1	0.99	5.93
Aug	night	6	73.04	0.34	2.55	0.08	0	0.3	0.02	0	2.23	1.86
Sept	night	2	14.3	0	2.32	24.34	0.11	0	0	0	0.01	2.15
Oct	night	12	10.11	0.38	2.37	24.24	0.06	2.59	0.02	0.01	8.94	3.56
April	Day	3	4.49	1.25	1.34	0.08	0	0	0.02	0	38.06	1.97
May	Day	23	14.41	3.17	0.58	2.4	0.06	1.74	3.95	0.11	48.45	17.13
June	Day	35	30.22	2.38	0.72	1.29	0.09	0.3	14.53	0.19	26.05	9.21
July	Day	23	13.92	0.42	2.05	3.85	0.08	0.2	4.44	0.01	8.4	1.49
Aug	Day	20	24.14	0.19	2.19	4.67	0.05	0.06	0.71	0.02	0.66	1.61
Sept	Day	10	16.91	0.39	4.29	63.49	0.26	0.22	1.43	0.11	2.11	3.69
Oct	Day	15	5.77	0.1	0.83	6.75	0.06	0.57	0.06	0	2.61	1.02
winter	night	5	2.33	0.08	0.71	6.23	0.2	0.03	0.03	0	0.46	2.89
winter	Day	12	1.31	0.12	0.66	0.23	0.01	0.06	0	0.01	0.4	0.52

Table B-4: Status of marine seabird species breeding in British Columbia (Canadian Wildlife Service 1999).

Species	Estimated numbers	Status	Comments
Leach's Storm-Petrel *Oceanodrama leucorhoa*	1,400,000	Trends unknown	status unknown
Fork-Tailed Storm-Petrel *Oceanodroma furcata*	400,000	Trends unknown	status unknown
Double-Crested Cormorant *Phalacrocorax auritus*	4,000	Blue-listed by BC	breeding restricted to Strait of Georgia
Brandt's Cormorant *Phalacrocorax penicillatus*	200	Red-listed by BC	irregular breeder
Pelagic Cormorant - *Phalacrocorax pelagicus* (has 2 subspecies)	9,000	Pelagicus subspecies red-listed by BC - other subspecies is stable	widespread coastal breeder
Glaucous-Winged Gull *Larus glaucescens*	58,000	Increasing	
Common Murre *Uria aalge*	9,000	Red-listed by BC	scarce breeder, mostly on Triangle Island.
Thick-Billed Murre *Uria lomvia*	20	Red-listed by BC	at southern limit of range
Marbled Murrelet *Brachyramphus marmoratus*	66,000	Threatened as per COSEWIC & red-listed by BC	listed due to threats of nesting habitat loss from logging of old growth forests.
Ancient Murrelet S*ynthlibormaphus antiquus*	540,000	Special concern as per COSEWIC & blue-listed by BC	impacted by rat and raccoon predation
Horned Puffin *Fratercula corniculata*	60	Red-listed by BC	at southern limit of range

Table B-4: Status of marine seabird species breeding in British Columbia (Canadian Wildlife Service 1999).

Species	Estimated numbers	Status	Comments
Tufted Puffin *Fratercula cirrhata*	78,000	Blue-listed by BC	severe reproductive failure at Triangle Island 1994-98. No evidence for population decline.
Cassin's Auklet *Ptychoramphus aleuticus*	2,700,000	Blue-listed by BC	Triangle Island population is declining.
Rhinoceros Auklet *Cerorhinca monocerata*	720,000	Stable	some reproductive failure at Triangle Island. No evidence for population decline.
Surf Scoter *Melanitta perspicillata*		Blue-listed by BC	
Pigeon Guillemot *Cepphus columba*	9,000	Trends unknown	scattered; difficult to census

Table B-5: COSEWIC or listed marine species found within the assessment area, as of March 2003.

Species		Status	Distribution
Molluscs			
Northern Abalone	Haliotis kamtschatkana	Threatened (2000) as per COSEWIC	
Fishes			
Wolf-eel	*Anarrhichthys ocellatus*	Not at risk (2003) as per COSEWIC	
Spinynose Sculpin	*Asemichthys taylori*	Data deficient (1997) as per COSEWIC	
Skidegate Lamprey	*Anarrhichthys ocelatus*	New report	
Fourhorn Sculpin	*Myoxocephalus quadricornis*	Not at risk (1989) as per COSEWIC	Salt water form
Coho Salmon	*Oncorhynchus kisutch*	Endangered (2002) as per COSEWIC	Interior Fraser population
Sockeye Salmon	*Oncorhynchus nerka*	Endangered (2002) as per COSEWIC	Cultus Lake population
Sockeye Salmon	*Oncorhynchus nerka*	Endangered (2002) as per COSEWIC	Sakinaw Lake population
Eulachon	*Thaleichthys pacificus*	Blue-listed by BC	
Boccacio	*Sebastes paucispinis*	Threatened (2002) as per COSEWIC	
Marine reptiles			
Leatherback Turtle	*Dermochelys coriacea*	Endangered (1981) as per COSEWIC & red-listed by BC	Distribution unknown

Table B-5: COSEWIC or listed marine species found within the assessment area, as of March 2003.

Species	Status	Distribution
Marine mammals		
Minke Whale *Balaenoptera acutorostrata*	New species	
Sei Whale *Balaenoptera borealis*	Endangered (2003) as per COSEWIC	
Blue Whale *Balaenoptera musculus*	Endangered (2002) as per COSEWIC	
Fin Whale *Balaenoptera physalus*	Special concern (1987) as oer COSEWIC	
Northern Fur Seal *Callorhinus ursinus*	Not at risk (1996) as per COSEWIC	
Common Dolphin *Delphinus delphis*	Not at risk (1991) as per COSEWIC	
Sea Otter Enhydra lutris	Threatened (1996) as per COSEWIC	
Gray Whale *Eschrichtius robustus*	Not at risk (1987) as per COSEWIC & Blue-listed by BC	
Northern Pacific Right Whale *Eubalaena glacialis*	Endangered (1990) as per COSEWIC & red-listed by BC	
Steller Sea Lion *Eumetopias jubatus*	Not at risk (1987) as per COSEWIC & Red-listed by BC	
Risso's Dolphin *Grampus griseus*	Not at risk (1990) as per COSEWIC	
Pacific White-sided Dolphin *Lagenorhynchus obliquidens*	Not at risk (1990) as per COSEWIC	

Table B-5: COSEWIC or listed marine species found within the assessment area, as of March 2003.

Species	Status	Distribution
Northern Right Whale Dolphin *Lissodelphis borealis*	Not at risk (1990) as per COSEWIC	
Humpback Whale *Megaptera novaeangliae*	Threatened (1985) as per COSEWIC & blue-listed by BC	
Killer Whale *Orcinus orca* pop. 1	Endangered (2001) as per COSEWIC & red-listed by BC	Northeast Pacific Southern resident population
Killer Whale *Orcinus orca* pop. 1	Threatened (2001) as per COSEWIC & red-listed by BC	Northeast Pacific Northern resident population
Killer Whale *Orcinus orca* pop. 2	Special concern (2001) as per COSEWIC & blue-listed by BC	Northeast Pacific offshore population
Killer Whale *Orcinus orca* pop. 3	Threatened (2001) as per COSEWIC & red-listed by BC	Northeast Pacific transient population
Harbour Seal *Phoca vitulina richardsi*	Not at risk (1999) as per COSEWIC	
Harbour Porpoise *Phocoena phocoena*	Data deficient (1991) as per COSEWIC	
Dall's Porpoise *Phocoenoides dalli*	Not at risk (1989) as per COSEWIC	
Sperm Whale *Physeter macrocephalus*	Blue-listed by BC	
Striped Dolphin *Stenella coeruleoalba*	Not at risk (1993) as per COSEWIC	

APPENDIX C: FISHERIES CATCH DATA (Tables C-1 to C-39)

Table C-1: List of all species caught by the British Columbia groundifsh trawl fleet within the study area between 1997- 2001.

Common Name	Scientific Name
Commercial Flatfish	
Arrowtooth flounder	*Atheresthes stomias*
Pacific sanddab	*Citharichthys sordidus*
Deepsea sole	*Embassichthys bathybius*
Slender sole	*Eopsetta exilis*
Petrale sole	*Eopsetta jordani*
Rex sole	*Errex zachirus*
Lefteye flounders	Family Bothidae
Righteye flounders	Family Pleuronectidae
Flathead sole	*Hippoglossoides elassodon*
Pacific halibut	*Hippoglossus stenolepis*
Dover sole	*Microstomus pacificus*
Starry flounder	*Platichthys stellatus*
Yellowfin sole	*Pleuronectes asper*
Rock sole	*Pleuronectes bilineatus*
Butter sole	*Pleuronectes isolepis*
English sole	*Pleuronectes vetulus*
C-o sole	*Pleuronichthys coenosus*
Curlfin sole	*Pleuronichthys decurrens*
Sand sole	*Psettichthys melanostictus*
Non-commercial Flatfish	
Speckled sanddab	*Citharichthys stigmaeus*
Roughscale sole	*Clidoderma asperrimum*
Flatfishes	Family Pleuronectiformes
Commercial Rockfish	
Scorpionfishes	Family Scorpaenidae
Rougheye rockfish	*Sebastes aleutianus*
Pacific ocean perch	*Sebastes alutus*
Aurora rockfish	*Sebastes aurora*
Redbanded rockfish	*Sebastes babcocki*
Shortraker rockfish	*Sebastes borealis*
Silvergray rockfish	*Sebastes brevispinis*
Copper rockfish	*Sebastes caurinus*
Dusky rockfish	*Sebastes ciliatus*
Darkblotched rockfish	*Sebastes crameri*
Splitnose rockfish	*Sebastes diploproa*
Greenstriped rockfish	*Sebastes elongatus*
Widow rockfish	*Sebastes entomelas*
Yellowtail rockfish	*Sebastes flavidus*
Rosethorn rockfish	*Sebastes helvomaculatus*
Quillback rockfish	*Sebastes maliger*
Black rockfish	*Sebastes melanops*

Table C-1: List of all species caught by the British Columbia groundifsh trawl fleet within the study area between 1997- 2001.

Common Name	**Scientific Name**
Vermilion rockfish	*Sebastes miniatus*
China rockfish	*Sebastes nebulosus*
Tiger rockfish	*Sebastes nigrocinctus*
Bocaccio	*Sebastes paucispinis*
Canary rockfish	*Sebastes pinniger*
Redstripe rockfish	*Sebastes proriger*
Yellowmouth rockfish	*Sebastes reedi*
Yelloweye rockfish	*Sebastes ruberrimus*
Harlequin rockfish	*Sebastes variegatus*
Sharpchin rockfish	*Sebastes zacentrus*
Thornyheads	*Sebastolobinae*
Shortspine thornyhead	*Sebastolobus alascanus*
Longspine thornyhead	*Sebastolobus altivelis*
Non-commercial Rockfish	
Rockfishes	Family Sebastinae
Brown rockfish	*Sebastes auriculatus*
Puget sound rockfish	*Sebastes emphaeus*
Chilipepper	*Sebastes goodei*
Shortbelly rockfish	*Sebastes jordani*
Blue rockfish	*Sebastes mystinus*
Bank rockfish	*Sebastes rufus*
Stripetail rockfish	*Sebastes saxicola*
Pygmy rockfish	*Sebastes wilsoni*
Dogfish and Skates	
Broad skate	*Amblyraja badia*
Abyssal skate	*Bathyraja abyssicola*
Sandpaper skate	*Bathyraja interrupta*
Roughtail skate	*Bathyraja trachura*
Skates	Family Rajidae
Big skate	*Raja binoculata*
Longnose skate	*Raja rhina*
Starry skate	*Raja stellulata*
Spiny dogfish	*Squalus acanthias*
Commercial Roundfish	
Sablefish	*Anoplopoma fimbria*
Pacific cod	*Gadus macrocephalus*
Pacific hake	*Merluccius productus*
Pacific tomcod	*Microgadus proximus*
Lingcod	*Ophiodon elongatus*
Walleye pollock	*Theragra chalcogramma*
Non-Commercial Roundfish	
Green sturgeon	*Acipenser medirostris*

Table C-1: List of all species caught by the British Columbia groundifsh trawl fleet within the study area between 1997- 2001.

Common Name	Scientific Name
White sturgeon	*Acipenser transmontanus*
Pectoral rattail	*Albatrossia pectoralis*
Longnose lancetfish	*Alepisaurus ferox*
Oxeye oreo	*Allocyttus folletti*
Bigeye thresher	*Alopias superciliosus*
American shad	*Alosa sapidissima*
Pacific sand lance	*Ammodytes hexapterus*
Wolf eel	*Anarrhichthys ocellatus*
Pacific flatnose	*Antimora microlepis*
Brown cat shark	*Apristurus brunneus*
Blackfin poacher	*Bathyagonus nigripinnis*
Bigeye poacher	*Bathyagonus pentacanthus*
Javelin spookfish	*Bathylychnops exilis*
Twoline eelpout	*Bothrocara brunneum*
Blacktail snailfish	*Careproctus melanurus*
Basking shark	*Cetorhinus maximus*
Pacific viperfish	*Chauliodus macouni*
Roughback sculpin	*Chitonotus pugetensis*
Pacific herring	*Clupea pallasi*
Roughscale rattail	*Coryphaenoides acrolepis*
Giant wrymouth	*Cryptacanthodes gigantea*
Shiner perch	*Cymatogaster aggregata*
Striped seaperch	*Embiotoca lateralis*
Northern anchovy	*Engraulis mordax mordax*
Buffalo sculpin	*Enophrys bison*
Black hagfish	*Eptatretus deani*
Sturgeons	Family Acipenseridae
Poachers	Family Agonidae
Lancetfishes	Family Alepisauridae
Slickheads	Family Alepocephalidae
Sand lances	Family Ammodytidae
Daggertooths	Family Anotopteridae
Ronquils	Family Bathymasteridae
Pomfrets	Family Bramidae
Requiem sharks	Family Carcharhinidae
Viperfishes	Family Chauliodontidae
Herrings	Family Clupeidae
Sculpins	Family Cottidae
Wrymouths	Family Cryptacanthodidae
Lumpfishes and snailfishes	Family Cyclopteridae
Surfperches	Family Embiotocidae
Greenlings	Family Hexagrammidae
Ragfishes	Family Icosteidae
Billfishes	Family Istiophoridae
Mackerel sharks	Family Lamnidae
Grenadiers	Family Macrouridae

Table C-1: List of all species caught by the British Columbia groundifsh trawl fleet within the study area between 1997- 2001.

Common Name	Scientific Name
Molas	Family Molidae
Lanternfishes	Family Myctophidae
Hagfishes	Family Myxinidae
Snipe eels	Family Nemichthyidae
Dreamers	Family Oneirodidae
Oreos	Family Oreosomatidae
Smelts	Family Osmeridae
Painted greenling	Family Oxylebiinae
Gunnels	Family Pholidae
Tubeshoulders	Family Platytroctidae
Salmonids	Family Salmonidae
Mackerels and tunas	Family Scombridae
Cat sharks	Family Scyliorhinidae
Sawpalates	Family Serrivomeridae
Pricklebacks	Family Stichaeidae
Electric rays	Family Torpedinidae
Prowfishes	Family Zaproridae
Eelpouts	Family Zoarcidae
Soupfin shark	*Galeorhinus zyopterus*
Slender fangjaw	*Gonostoma gracile*
Red irish lord	*Hemilepidotus hemilepidotus*
Brown irish lord	*Hemilepidotus spinosus*
Bigmouth sculpin	*Hemitripterus bolini*
Kelp greenling	*Hexagrammos decagrammus*
Whitespotted greenling	*Hexagrammos stelleri*
Sixgill shark	*Hexanchus griseus*
Spotted ratfish	*Hydrolagus colliei*
Surf smelt	*Hypomesus pretiosus*
Northern sculpin	*Icelinus borealis*
Threadfin sculpin	*Icelinus filamentosus*
Spotfin sculpin	*Icelinus tenuis*
Ragfish	*Icosteus aenigmaticus*
Inanimate object(s)	*Inanimate object(s)*
Skipjack tuna	*Katsuwonus pelamis*
Salmon shark	*Lamna ditropis*
River lamprey	*Lampetra ayresi*
Pacific lamprey	*Lampetra tridentata*
Pacific staghorn sculpin	*Leptocottus armatus*
Lobefin snailfish	*Liparis greeni*
Snake prickleback	*Lumpenus sagitta*
Shortfin eelpout	*Lycodes brevipes*
Bigfin eelpout	*Lycodes cortezianus*
Blackbelly eelpout	*Lycodes pacificus*
Wattled eelpout	*Lycodes palearis*
Blackfin sculpin	*Malacocottus kincaidi*
Capelin	*Mallotus villosus*

Table C-1: List of all species caught by the British Columbia groundifsh trawl fleet within the study area between 1997- 2001.

Common Name	Scientific Name
Scaleless black dragonfishes	*Melanostomiidae*
Great sculpin	*Myoxocephalus polyacanthocephalus*
Sailfin sculpin	*Nautichthys oculofasciatus*
Spottail shiner	*Notropis hudsonius*
Pink salmon	*Oncorhynchus gorbuscha*
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kisutch*
Sockeye salmon	*Oncorhynchus nerka*
Pacific salmon and native trout	*Oncorhynchus* spp.
Chinook salmon	*Oncorhynchus tshawytscha*
Giant red sea cucumber	*Parastichopus californicus*
Harbour seal	*Phoca vitulina*
Flathead chub	*Platygobio gracilis*
Sturgeon poacher	*Podathecus acipenserinus*
Plainfin midshipman	*Porichthys notatus*
Blue shark	*Prionace glauca*
Pile perch	*Rhacochilus vacca*
Northern ronquil	*Ronquilus jordani*
Pacific sardine	*Sardinops sagax*
Chub mackerel	*Scomber japonicus*
Sauries	*Scomberesocidae*
Cabezon	*Scorpaenichthys marmoratus*
Pacific sleeper shark	*Somniosus pacificus*
Northern lampfish	*Stenobrachius leucopsarus*
Eulachon	*Thaleichthys pacificus*
Albacore	*Thunnus alalunga*
Pacific electric ray	*Torpedo californica*
Jack mackerel	*Trachurus symmetricus*
Pacific sandfish	*Trichodon trichodon*
Roughspine sculpin	*Triglops macellus*
Prowfish	*Zaprora silenus*
Unidentified organic matter	Unknown
Unknown fish	Unknown fish
Invertebrates	
Bristly crab	*Acantholithodes hispidus*
Anemone	Actiniaria (order)
Soft corals	Alcyonacea (order)
Amphipods	Amphipoda (order)
Segmented worms	Annelida (phylum)
Crustaceans	Anomura (section)
Cnidarians	Anthozoa (class)
Sea mouse	*Aphrodita* spp.
Arthropods	Arthropoda (phylum)
Ascidians and tunicates	Ascidiacea (class)
Starfish	Asteriodea (class)

Table C-1: List of all species caught by the British Columbia groundifsh trawl fleet within the study area between 1997- 2001.

Common Name	Scientific Name
Heart urchins	Atelostomata (superorder)
Symmetrical sessil barnacles	Balanomorpha (superorder)
Schoolmaster gonate squid	*Berryteuthis magister*
Bivalve molluscs	Bivalvia (class)
Arthropods	Brachyrhyncha (section)
True crabs	Brachyura (infraorder)
Bryozoans	Bryozoa (phylum)
Calarous sponges	Calcarea (group)
Slender crab	*Cancer gracilis*
Dungeness crab	*Cancer magister*
Red rock crab	*Cancer productus*
Cephalopods	Cephalopoda (class)
Tanner crabs	*Chionoecetes* spp.
Spiny scallop	*Chlamys hastata*
Mollusc	*Chlamys herica*
Pink scallop, (aka reddish scallop)	*Chlamys rubida*
Redclaw crab	*Chorilia longipes*
Barnacles	Cirripedia (subclass)
Coeclenterates	Cnidaria (phylum)
Northern crangon	*Crangon alaskensis*
Crangons	*Crangon* spp.
Sea lilies and feather stars	Crinoidea (class)
Rose starfish	*Crossaster papposus*
Crustaceans	Crustacea (subphylum)
Decapods	Decapoda (order)
Bath sponges	Demospongiae (class)
Leather star	*Dermasterias imbricata*
Sea urchins	Echinacea (superorder)
Echinoderms	Echinodermata (phylum)
Echinoderms	Echinoidea (class)
Giant pacific octopus	*Enteroctopus dofleini*
Basket stars	Euryalae (order)
Nudibranchs	Family Arminidae
Cancer crabs	Family Cancridae
Galatheid crabs	Family Galatheidae
Hermit crabs	Family Paguridae
Pandalid shrimp	Family Pandalidae
Scallop	Family Pectinidae
Oregontriton	*Fusitriton oregonensis*
Gastropods	Gastropoda (class)
Sand dollars	Gnathostomata (superorder)
Squids	*Gonatus* spp.
Gorgonian corals	Gorgonacea (order)
Blood star	*Henricia leviuscula*
Glass sponges	Hexactinellida (class)

Table C-1: List of all species caught by the British Columbia groundifsh trawl fleet within the study area between 1997- 2001.

Common Name	**Scientific Name**
Spiny red sea star	*Hippasteria spinosa*
Leeches	Hirudinea (class)
Sea cucumber	Holothuroidea (class)
Hydroid	Hydrozoa (class)
Invertebrates	Invertebrates
Pedunculate barnacles	Lepadomorpha (superorder)
Golden king crab	*Lithodes aequispina*
Tanner crabs	*Lithodes couesi*
Tanner crabs	*Lithodes* spp.
Opalescent inshore squid	*Loligo opalescens*
Brown box crab	*Lopholithodes foraminatus*
Box crabs	*Lopholithodes* spp.
Sand star	*Luidia foliolata*
Starfish	*Luidiaster dawsoni*
Bent-nose macoma	*Macoma nasuta*
Stony corals	Madreporia (order)
Vermillion starfish	*Mediaster aequalis*
Molluscs	Mollusca (phylum)
Robust clubhook squid	*Moroteuthis robusta*
Squat lobster	*Munida quadrispina*
Shrimp	Nantantia (superorder)
Seaslugs	Nudibranchiata (superorder)
Octopus	Octopoda (order)
Neon flying squid	*Ommastrephes bartrami*
Boreal clubhook squid	*Onychoteuthis borealijaponica*
Brittle stars	Ophiurae (order)
Ophiuroidea	Ophiuroidea (class)
Decorator crab	*Oregonia gracilis*
Long-armed sea star	*Orthasterias koehleri*
Sea whip	*Osteocella septentrionalis*
Spider crabs	Oxyrhyncha (superfamily)
Sidestripe shrimp	*Pandalopsis dispar*
Pink shrimp	*Pandalus borealis*
Humpback shrimp	*Pandalus hypsinotus*
Pink shrimp (smooth)	*Pandalus jordani*
Prawn	*Pandalus platyceros*
Red king crab	*Paralithodes cammtschatica*
Glass shrimp	*Pasiphaea pacifica*
Weathervane scallop	*Patinopecten caurinus*
Bat star	*Patiria miniata*
Sea pens	Pennatulacea (order)
Pink short-spined star	*Pisaster brevispinus*
Purple starfish	*Pisaster ochraceus*
Lewismoon snail	*Polinices lewisii*
Polychaete worms	Polychaeta (class)
Chitons	Polyplacophora (class)

Table C-1: List of all species caught by the British Columbia groundifsh trawl fleet within the study area between 1997- 2001.

Common Name	Scientific Name
Sponges	Porifera (phylum)
Cushion star	*Pteraster tesselatus*
Sea pen	*Ptilosarcus gurneyi*
Sunflower starfish	*Pycnopodia helianthoides*
Radiata	Radiata
Crab	Repiantia (superorder)
Pacific bobtail squid	*Rossia pacifica*
Tusk or tooth shells	Scaphopoda (class)
Jellyfish	Scyphozoa (class)
Tube worms	Sedentaria (subclass)
Morning sun starfish	*Solaster dawsoni*
Sun star	*Solaster paxillatus*
Striped sun starfish	*Solaster stimpsoni*
Fish-eating star	*Stylasterias forreri*
Anemone	*Tealia* spp.
Squids	Teuthoidea (order)
Sea anemones and corals	Zoantharia (order)

Table C-2: Number of Groundfish Trawl Commercial Fishing Vessels (CFVs) by Pacific Fishery Management Area (PFMA) within Study Area between 1997 and 2001.

PFMA	1997 # CFVs	1998 # CFVs	1999 # CFVs	2000 # CFVs	2000 # CFVs	Average Number of CFVs in PFMA Between 1997 and 2001
111	355	339	345	329	283	330.2
102	249	229	264	285	229	251.2
110	265	213	231	261	227	239.4
104	188	174	205	173	157	179.4
108	138	113	114	171	149	137
105	172	153	144	140	66	135
101	116	134	121	142	128	128.2
109	120	105	111	146	131	122.6
107	101	68	69	83	73	78.8
103	38	59	52	64	50	52.6
3	27	17	16	18	18	19.2
11	20	16	19	15	16	17.2
2	6	3	0	31	31	14.2
106	7	2	3	7	19	7.6
4	4	2	1	2	5	2.8
5	3	1	2	2	2	2
9	2	0	0	1	0	0.6
10	1	1	0	1	0	0.6
6	0	0	1	0	0	0.2
7	0	1	0	0	0	0.2
1	0	0	0	0	0	0
8	0	0	0	0	0	0
TOTAL CFVs	**1812**	**1630**	**1698**	**1871**	**1584**	

Table C-3: Average Number of CFVs in study area by month between 1997 and 2001.

Month	Avg # of CFVs in Study area Between 1997-2001
1	75.8
2	112
3	117
4	108
5	201.8
6	207.8
7	215.6
8	138.2
9	204.8
10	166.2
11	121.8
12	50

Table C-4: Landed commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101 ,102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Landed Weight (Metric tons)					
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**Average Landed Weight by Species Between 1997 - 2001**
Arrowtooth flounder	*Atheresthes stomias*	1343	1281	2091	2438	3014	**2033**
Dover sole	*Microstomus pacificus*	1077	1395	1382	1644	1526	**1405**
Rock sole	*Pleuronectes bilineatus*	903	826	970	1109	1013	**964**
English sole	*Pleuronectes vetulus*	614	533	694	558	478	**575**
Rex sole	*Errex zachirus*	218	268	278	303	276	**269**
Petrale sole	*Eopsetta jordani*	98	103	158	176	263	**160**
Flathead sole	*Hippoglossoides elassodon*	10	27	22	28	17	**21**
Starry flounder	*Platichthys stellatus*	20	21	29	30	45	**29**
Sand sole	*Psettichthys melanostictus*	20	12	11	13	22	**16**
Pacific sanddab	*Citharichthys sordidus*	0	0	0	0	0	**0**
Butter sole	*Pleuronectes isolepis*	5	5	5	8	2	**5**
Curlfin sole	*Pleuronichthys decurrens*	8	5	11	10	7	**8**
TOTAL	**Commercial Flatfish**	**4317**	**4476**	**5652**	**6317**	**6662**	**5485**
Commercial Rockfish and Thornyheads							
Pacific ocean perch	*Sebastes alutus*	4859	5197	4919	4878	4349	**4840**

Table C-4: Landed commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101 ,102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Landed Weight (Metric tons)					
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**Average Landed Weight by Species Between 1997 - 2001**
Yellowtail rockfish	*Sebastes flavidus*	2167	1643	2372	1434	1325	**1788**
Yellowmouth rockfish	*Sebastes reedi*	1195	1063	1060	1084	776	**1036**
Silvergray rockfish	*Sebastes brevispinis*	817	843	883	786	624	**791**
Widow rockfish	*Sebastes entomelas*	396	592	814	822	458	**616**
Redstripe rockfish	*Sebastes proriger*	522	479	455	419	420	**459**
Canary rockfish	*Sebastes pinniger*	223	223	273	220	302	**248**
Rougheye rockfish	*Sebastes aleutianus*	160	301	277	224	272	**247**
Redbanded rockfish	*Sebastes babcocki*	239	174	220	230	257	**224**
Shortspine thornyhead	*Sebastolobus alascanus*	182	173	147	269	178	**190**
Bocaccio	*Sebastes paucispinis*	145	127	101	141	124	**128**
Sharpchin rockfish	*Sebastes zacentrus*	49	87	114	106	159	**103**
Longspine thornyhead	*Sebastolobus altivelis*	3	5	2	101	78	**38**
Splitnose rockfish	*Sebastes diploproa*	20	17	31	54	17	**28**
Shortraker rockfish	*Sebastes borealis*	18	18	15	31	14	**19**
Darkblotched rockfish	*Sebastes crameri*	20	21	18	21	13	**19**

Table C-4: Landed commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101 ,102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Landed Weight (Metric tons)					
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**Average Landed Weight by Species Between 1997 - 2001**
Black rockfish	*Sebastes melanops*	5	8	2	4	12	**6**
Greenstriped rockfish	*Sebastes elongatus*	3	3	6	4	3	**4**
Yelloweye rockfish	*Sebastes ruberrimus*	7	2	2	2	4	**4**
Rosethorn rockfish	*Sebastes helvomaculatus*	3	2	3	3	4	**3**
Copper rockfish	*Sebastes caurinus*	4	2	0	1	0	**2**
Quillback rockfish	*Sebastes maliger*	3	1	1	1	0	**1**
Harlequin rockfish	*Sebastes variegatus*	0	1	0	0	0	**0**
TOTAL	**Commercial Rockfish**	**11041**	**10983**	**11715**	**10837**	**9391**	**10793**
Dogfish and Skates							
Big skate	*Raja binoculata*	993	359	754	799	958	**3863**
Longnose skate	*Raja rhina*	142	16	68	113	82	**84**
Skates	*Rajidae*	2	11	49	93	0	**31**
Spiny dogfish	*Squalus acanthias*	10	22	4	2	4	**8**
Sandpaper skate	*Bathyraja interrupta*	0	0	1	1	1	**1**
TOTAL	**Dogfish and Skates**	**1148**	**408**	**876**	**1008**	**1045**	**897**
Commercial Roundfish							

Table C-4: Landed commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101 ,102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Landed Weight (Metric tons)					
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**Average Landed Weight by Species Between 1997 - 2001**
Pacific cod	*Gadus macrocephalus*	1367	1195	721	546	244	**815**
Pacific hake	*Merluccius productus*	616	77	21	3104	0	**764**
Walleye pollock	*Theragra chalcogramma*	550	772	1182	905	105	**703**
Lingcod	*Ophiodon elongatus*	507	500	616	1027	738	**677**
Sablefish	*Anoplopoma fimbria*	48	65	53	61	62	**58**
TOTAL	**Commercial Roundfish**	**3088**	**2609**	**2593**	**5643**	**1149**	**3016**
Non-commercial Roundfish							
Spotted ratfish	*Hydrolagus colliei*	2	1	4	1	3	**2**
Wolf eel	*Anarrhichthys ocellatus*	0	1	2	1	0	**1**
Jack mackerel	*Trachurus symmetricus*	0	0	2	0	0	**0**
Sturgeons	*Acipenseridae*	2	0	0	0	0	**0**
TOTAL	**Non-commercial Roundfish**	**5**	**2**	**8**	**2**	**3**	**4**
Invertebrates							
Octopus	*Octopoda*	7	3	5	6	1	**4**
TOTAL	**Invertebrates**	**7**	**3**	**5**	**6**	**1**	**4**

Table C-5: Discarded commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

Common Name	**Science name**	**Discarded Weight (Metric tons)**					**Average Discarded Weight by Species Between 1997 - 2001**
		1997	**1998**	**1999**	**2000**	**2001**	
Arrowtooth flounder	*Atheresthes stomias*	1830	2421	2945	2742	1678	**2323**
Dover sole	*Microstomus pacificus*	149	159	147	171	158	**157**
Rock sole	*Pleuronectes bilineatus*	135	112	129	172	167	**143**
English sole	*Pleuronectes vetulus*	296	216	252	208	102	**215**
Rex sole	*Errex zachirus*	225	222	219	191	135	**198**
Petrale sole	*Eopsetta jordani*	20	15	16	16	11	**15**
Flathead sole	*Hippoglossoides elassodon*	25	40	31	66	23	**37**
Starry flounder	*Platichthys stellatus*	4	13	27	17	16	**16**
Sand sole	*Psettichthys melanostictus*	22	11	19	39	14	**21**
Pacific sanddab	*Citharichthys sordidus*	11	12	9	45	40	**23**
Butter sole	*Pleuronectes isolepis*	32	11	3	20	9	**15**
Curlfin sole	*Pleuronichthys decurrens*	10	10	10	13	10	**10**
Slender sole	*Eopsetta exilis*	3	4	6	9	8	**6**
Lefteye flounders	*Bothidae*	0	1	0	3	17	**4**
Deepsea sole	*Embassichthys bathybius*	0	3	0	5	6	**3**
C-o sole	*Pleuronichthys coenosus*	2	1	2	1	2	**1**
Yellowfin sole	*Pleuronectes asper*	0	0	0	4	2	**1**
Righteye flounders	*Pleuronectidae*	0	0	0	3	0	**1**
TOTAL	**Commercial Flatfish**	**2764**	**3250**	**3813**	**3726**	**2397**	**3190**

Table C-5: Discarded commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (Metric tons)					**Average Discarded Weight by Species Between**
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**1997 - 2001**
Non-Commercial Flatfish							
Speckled sanddab	*Citharichthys stigmaeus*	0	1	1	0	2	**1**
Flatfishes	*Pleuronectiformes*	0	0	0	0	3	**1**
TOTAL	**Non-commercial Flatfish**	**0**	**1**	**1**	**0**	**4**	**1**
Commercial Rockfish and Thornyheads							
Redstripe rockfish	*Sebastes proriger*	182	185	138	88	70	**133**
Pacific ocean perch	*Sebastes alutus*	152	129	70	52	30	**87**
Sharpchin rockfish	*Sebastes zacentrus*	42	68	47	52	64	**55**
Shortspine thornyhead	*Sebastolobus alascanus*	10	11	10	13	7	**10**
Longspine thornyhead	*Sebastolobus altivelis*	1	0	0	26	8	**7**
Darkblotched rockfish	*Sebastes crameri*	8	7	9	7	2	**7**
Yellowmouth rockfish	*Sebastes reedi*	8	12	4	5	2	**6**

Table C-5: Discarded commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (Metric tons)					Average Discarded Weight by Species Between
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**1997 - 2001**
Greenstriped rockfish	*Sebastes elongatus*	11	8	5	2	1	**6**
Yelloweye rockfish	*Sebastes ruberrimus*	5	7	6	7	3	**6**
Yellowtail rockfish	*Sebastes flavidus*	16	3	2	1	3	**5**
Splitnose rockfish	*Sebastes diploproa*	4	6	6	4	3	**5**
Quillback rockfish	*Sebastes maliger*	5	6	5	3	2	**4**
Silvergray rockfish	*Sebastes brevispinis*	3	5	4	2	3	**3**
Copper rockfish	*Sebastes caurinus*	3	3	4	5	2	**3**
Redbanded rockfish	*Sebastes babcocki*	6	2	2	3	1	**3**
Rosethorn rockfish	*Sebastes helvomaculatus*	3	3	2	4	2	**3**
Harlequin rockfish	*Sebastes variegatus*	0	0	3	3	4	**2**
Canary rockfish	*Sebastes pinniger*	3	3	1	1	1	**2**
Rougheye rockfish	*Sebastes aleutianus*	1	1	0	2	2	**1**
Widow rockfish	*Sebastes entomelas*	2	2	1	0	0	**1**
Bocaccio	*Sebastes paucispinis*	0	0	1	0	0	**0**
Dusky rockfish	*Sebastes ciliatus*	0	1	0	0	0	**0**
TOTAL	**Commercial Rockfish**	**464**	**463**	**319**	**283**	**213**	**349**
Non-Commercial Rockfish							
Chilipepper	*Sebastes goodei*	1	0	0	0	0	**0**

Table C-5: Discarded commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (Metric tons)					Average Discarded Weight by Species Between
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**1997 - 2001**
TOTAL	**Non-commercial Rockfish**	**1**	**0**	**0**	**0**	**0**	**0**
Dogfish and Skates							
Big skate	*Raja binoculata*	331	293	185	136	149	**219**
Spiny dogfish	*Squalus acanthias*	621	869	428	689	426	**607**
Longnose skate	*Raja rhina*	120	145	97	43	67	**94**
Skates	*Rajidae*	20	41	21	10	7	**20**
Sandpaper skate	*Bathyraja interrupta*	2	2	6	15	13	**8**
Starry skate	*Raja stellulata*	0	0	1	0	7	**2**
Roughtail skate	Bathyraja trachura	0	0	0	2	4	**1**
TOTAL	**Dogfish and Skates**	**1094**	**1349**	**739**	**895**	**673**	**950**
Other Commercial Species							
Pacific halibut	*Hippoglossus stenolepis*	339	291	280	361	249	**304**
TOTAL	**Other Commercial Species**	**339**	**291**	**280**	**361**	**249**	**304**
Commercial Roundfish							
Pacific hake	*Merluccius productus*	291	518	243	126	17	**239**

Table C-5: Discarded commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (Metric tons)					**Average Discarded Weight by Species Between**
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**1997 - 2001**
Sablefish	*Anoplopoma fimbria*	222	174	251	272	163	**216**
Lingcod	*Ophiodon elongatus*	88	151	80	80	68	**94**
Walleye pollock	*Theragra chalcogramma*	169	81	37	18	19	**65**
Pacific cod	*Gadus macrocephalus*	104	57	58	26	35	**56**
Pacific tomcod	*Microgadus proximus*	0	0	0	1	10	**2**
TOTAL	**Commercial Roundfish**	**875**	**982**	**669**	**524**	**312**	**672**
Non-commercial Roundfish							
Spotted ratfish	*Hydrolagus colliei*	703	541	606	630	604	**617**
Grenadiers	*Macrouridae*	1	1	0	116	38	**31**
Pacific herring	*Clupea pallasi*	19	16	18	10	4	**13**
Wolf eel	*Anarrhichthys ocellatus*	5	6	6	6	8	**6**
Jack mackerel	*Trachurus symmetricus*	2	1	9	2	1	**3**
Pacific sleeper shark	*Somniosus pacificus*	0	3	0	5	5	**2**
Unknown fish	*Unknown fish*	0	1	0	0	9	**2**
Chub mackerel	*Scomber japonicus*	1	1	7	0	1	**2**
American shad	*Alosa sapidissima*	3	3	1	0	0	**2**
Sculpins	*Cottidae*	2	1	1	1	1	**1**
Bigeye thresher	*Alopias superciliosus*	3	2	0	0	0	**1**
Eelpouts	*Zoarcidae*	0	0	0	2	3	**1**
Green sturgeon	*Acipenser medirostris*	0	0	0	3	2	**1**
Chinook salmon	*Oncorhynchus*	1	0	1	0	1	**1**

Table C-5: Discarded commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (Metric tons)					Average Discarded Weight by Species Between
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**1997 - 2001**
	tshawytscha						
Chum salmon	*Oncorhynchus keta*	0	1	0	0	0	**0**
Greenlings	*Hexagrammidae*	0	0	0	0	1	**0**
Basking shark	*Cetorhinus maximus*	0	0	0	2	0	**0**
Cabezon	*Scorpaenichthys marmoratus*	0	0	0	1	0	**0**
Sixgill shark	*Hexanchus griseus*	0	0	0	1	0	**0**
Cat sharks	*Scyliorhinidae*	0	0	1	0	0	**0**
Lumpfishes and snailfishes	*Cyclopteridae*	0	0	0	0	1	**0**
Brown cat shark	*Apristurus brunneus*	0	0	0	0	1	**0**
Skipjack tuna	*Katsuwonus pelamis*	0	0	1	0	0	**0**
Mackerel sharks	*Lamnidae*	0	0	0	1	0	**0**
Albacore	*Thunnus alalunga*	0	0	1	0	0	**0**
TOTAL	**Non-commercial Roundfish**	**743**	**580**	**656**	**784**	**681**	**689**
Invertebrates							
Starfish	Asteriodea	110	94	164	192	106	**133**
Sponges	Porifera	19	6	3	42	52	**24**
Stony corals	Madreporia	6	12	11	14	12	**11**
Soft corals	Alcyonacea	0	0	1	11	25	**7**
Dungeness crab	*Cancer magister*	15	4	7	2	3	**6**
Calarous sponges	Calcarea	11	0	0	0	0	**2**

Table C-5: Discarded commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (Metric tons)					Average Discarded Weight by Species Between
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**1997 - 2001**
Anthozoa	Anthozoa	0	0	0	7	2	**2**
Anemone	Actiniaria	2	1	2	3	2	**2**
Octopus	*Octopoda*	2	1	1	3	2	**2**
Squids	Teuthoidea	1	1	0	3	2	**1**
Sea cucumber	Holothuroidea	1	2	2	2	1	**1**
Tanner crabs	Chionoecetes	0	0	0	4	3	**1**
Crabs	Repiantia	2	1	0	2	0	**1**
Sea urchins	Echinacea	1	1	1	2	1	**1**
Jellyfish	Scyphozoa	2	0	0	2	1	**1**
Box crabs	Lopholithodes	1	1	1	2	1	**1**
Invertebrates	Invertebrates	0	1	0	0	4	**1**
Glass sponges	*Hexactinellida*	1	0	0	0	3	**1**
Coeclenterates	Cnidaria	0	0	0	4	0	**1**
Gorgonian corals	Gorgonacea	0	2	2	0	0	**1**
Hydroid	Hydrozoa	0	1	0	2	0	**1**
Purple starfish	*Pisaster ochraceus*	3	0	0	0	0	**1**
Schoolmaster gonate squid	*Berryteuthis magister*	0	1	0	0	1	**1**
Zoantharia	Zoantharia	0	0	0	2	0	**1**
Brittle stars	Ophiurae	2	0	0	0	0	**0**
Ophiuroidea	Ophiuroidea	0	1	0	0	0	**0**
Hermit crabs	Paguridae	1	0	0	0	0	**0**
Sunflower starfish	*Pycnopodia helianthoides*	1	0	0	0	0	**0**
Sea pens	Pennatulacea	1	0	0	0	0	**0**

Table C-5: Discarded commercial and non-commercial species from groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (Metric tons)					Average Discarded Weight by Species Between
Common Name	**Science name**	**1997**	**1998**	**1999**	**2000**	**2001**	**1997 - 2001**
Cephalopods	Cephalopoda	0	0	0	0	1	**0**
Echinoderms	Echinodermata	0	1	0	0	0	**0**
TOTAL	**Invertebrates**	**187**	**130**	**198**	**302**	**222**	**208**

Table C-6: Average landed weight of flatfish species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour). (Note: because data weren't always available for each year over five years for all of the species, we averaged the weight over the years where data were available (years used shown by cell colour) per species per PFMA. This allows comparison of average species landings, and reduces the number of tables otherwise needed to do so),

		Average weight (kg) by Pacific Fisheries Management Areas							
Common Name	**Scientific name**	**2**	**3**	**4**	**5**	**6**	**7**	**10**	**11**
Dover Sole*	*Microstomus pacificus*	387	55362	16	3	38	2	17	1894
Arrowtooth Flounder	*Atheresthes stomias*	1137	141	0	0	0	0	0	32987
Rex Sole	*Errex zachirus*	156	8811	25	13	0	0	2	694
Petrale Sole*	*Eopsetta jordani*	1338	51	3149	14	2	13	0	146
Rock Sole*	*Pleuronectes bilineatus*	0	360	3062	528	2	205	0	336
English Sole*	*Pleuronectes vetulus*	16	958	27	31	0	190	0	1033
Flathead Sole	*Hippoglossoides elassodon*	0	502	0	0	0	0	0	188
Starry flounder	*Platichthys stellatus*	0	0	441	31	0	0	0	0
Sand Sole	*Psettichthys melanostictus*	0	2	58	0	0	0	0	0
Curlfin Sole	*Pleuronichthys decurrens*	0	0	0	0	0	0	0	6

Table C-7: Average discarded weight of flatfish species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas							
Common Name	**Scientific Name**	**2**	**3**	**4**	**5**	**6**	**7**	**10**	**11**
Commercial Flatfish									
Arrowtooth Flounder	*Atheresthes stomias*	5645	17490	265	15	31	91	56	4127
Lefteye flounders	*Bothidae*	0	0	0	0	0	0	0	0
Pacific Sanddab	*Citharichthys sordidus*	0	0	0	4	0	0	0	53
Slender Sole	*Eopsetta exilis*	0	0	0	0	0	0	0	29
Petrale Sole*	*Eopsetta jordani*	48	78	23	0	0	0	0	231
Rex Sole	*Errex zachirus*	162	2461	12	5	0	11	34	1096
Flathead Sole	*Hippoglossoides elassodon*	0	429	0	43	0	0	11	376
Dover Sole*	*Microstomus pacificus*	105	4803	5	2	0	9	0	472
Starry flounder	*Platichthys stellatus*	0	5	0	0	0	0	0	0
Rock Sole*	*Pleuronectes bilineatus*	0	19	36	138	0	63	0	15
Butter sole	*Pleuronectes isolepis*	0	0	0	0	0	0	0	5
English Sole*	*Pleuronectes vetulus*	7	254	5	46	0	32	0	445
C-O Sole	*Pleuronichthys coenosus*	0	0	0	2	0	0	0	14
Curlfin Sole	*Pleuronichthys decurrens*	0	0	0	1	0	16	0	18
Sand Sole	*Psettichthys melanostictus*	0	20	0	2	0	0	0	0
Non-commercial Flatfish									
Speckled sanddab	*Citharichthys stigmaeus*	0	0	0	0	0	39	0	54

Table C-8: Average landed weight of flatfish species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Area										
Common Name	**Scientific Name**	**101**	**102**	103	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Arrowtooth Flounder	*Atheresthes stomias*	44200	629280	21001	504748	7491	16	30352	68702	21496	385865	327560
Dover Sole*	*Microstomus pacificus*	262719	199455	335291	169124	46696	38	2214	28422	30370	168460	133196
Rock Sole*	*Pleuronectes bilineatus*	12579	303327	744	38945	315634	1	3810	98939	88967	10926	108428
English Sole*	*Pleuronectes vetulus*	23666	29199	4015	428617	31981	35	0	9177	9277	17790	28295
Rex Sole	*Errex zachirus*	19297	18514	30747	122323	10942	66	728	2117	1522	23885	34240
Petrale Sole*	*Eopsetta jordani*	32752	59493	564	6934	3974	43	2546	18150	5698	14034	16771
Starry flounder	*Platichthys stellatus*	6161	15	4	23309	184	0	0	2	2	0	23
Flathead Sole	*Hippoglossoides elassodon*	1343	619	9070	2027	3611	0	28	141	115	362	3148
Sand Sole	*Psettichthys melanostictus*	987	5678	0	4243	4937	0	0	0	6	4	25
Curlfin Sole	*Pleuronichthys decurrens*	72	2976	0	104	3035	0	95	720	648	138	777
Butter sole	*Pleuronectes isolepis*	191	75	20	4341	283	0	2905	6	3	0	9
C-O Sole	*Pleuronichthys coenosus*	1	12	0	0	36	0	0	0	0	0	1
Lefteye flounders	*Bothidae*	0	1	0	19	0	0	0	0	0	0	0
Deepsea Sole	*Embassichthys bathybius*	10	0	0	0	0	0	0	0	0	0	0

Table C-9: Average discarded weight of flatfish species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Commercial Flatfish												
Arrowtooth Flounder	*Atheresthes stomias*	209951	365308	140731	614951	62564	326	27742	160228	68796	316970	376600
English Sole*	*Pleuronectes vetulus*	6138	18526	825	121539	35085	35	0	6210	4796	6984	17337
Rex Sole	*Errex zachirus*	10404	31697	8669	40934	16024	156	1451	3999	3288	25961	55929
Dover Sole*	*Microstomus pacificus*	21129	32498	22619	17709	12074	65	452	3613	2901	19596	21758
Rock Sole*	*Pleuronectes bilineatus*	1037	37016	202	5489	63694	0	216	7437	10635	1761	18264
Flathead Sole	*Hippoglossoides elassodon*	1075	2243	4267	2712	15194	2	109	514	2406	1795	6719
Pacific Sanddab	*Citharichthys sordidus*	118	2266	0	331	1536	0	136	3252	6689	1296	8311
Sand Sole	*Psettichthys melanostictus*	553	3249	19	11687	3604	0	8	209	453	176	1303
Butter sole	*Pleuronectes isolepis*	460	281	41	12355	2256	0	1017	11	106	26	42
Starry flounder	*Platichthys stellatus*	1633	32	14	14062	194	0	0	3	3	12	9
Petrale Sole*	*Eopsetta jordani*	583	2343	1282	1631	1970	4	265	1195	919	1899	3230
Curlfin Sole	*Pleuronichthys decurrens*	29	2973	5	552	1604	0	191	1404	1887	453	1667
Slender Sole	*Eopsetta exilis*	21	632	7	139	442	0	13	1151	1300	777	1886
Lefteye flounders	*Bothidae*	14	685	0	54	10	0	9	574	1490	303	2588

Table C-9: Average discarded weight of flatfish species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Deepsea Sole	*Embassichthys bathybius*	2058	24	454	2223	0	0	0	33	58	23	376
Righteye flounders	*Pleuronectidae*	0	6	0	11	10	0	0	7	1465	260	0
Yellowfin sole	*Pleuronectes asper*	23	114	0	972	18	0	0	0	499	75	0
C-O Sole	*Pleuronichthys coenosus*	7	559	0	5	384	0	27	52	207	12	240
Roughscale sole	*Clidoderma asperrimum*	0	11	0	0	0	0	0	0	0	0	45
Non-commercial Flatfish												
Flatfishes	*Pleuronectiformes*	0	0	0	0	0	0	241	199	0	371	674
Speckled sanddab	*Citharichthys stigmaeus*	17	63	0	0	185	0	0	462.68	100.09	82.78	392.24

Table C-10: Average landed weight of rockfish and thornyhead species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Area								
Common Name	**Scientific Name**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**11**
Pacific Ocean Perch*	*Sebastes alutus*	109694	8	0	0	23	0	0	2043	125
Yellowtail Rockfish*	*Sebastes flavidus*	56	332	118	5	6	0	8	0	22982
Silvergray Rockfish*	*Sebastes brevispinis*	4857	14	13	0	13	0	0	3	1614
Bocaccio	*Sebastes paucispinis*	667	18	16	0	80	0	0	15	3629
Yellowmouth Rockfish*	*Sebastes reedi*	3391	0	0	0	0	0	0	10	16
Redbanded Rockfish	*Sebastes babcocki*	1776	418	0	0	11	0	0	0	22
Shortraker Rockfish*	*Sebastes borealis*	1910	25	0	0	0	0	0	0	0
Shortspine Thornyhead*	*Sebastolobus alascanus*	1298	59	0	0	0	0	0	3	0
Sharpchin Rockfish	*Sebastes zacentrus*	1230	0	0	0	0	0	0	0	18
Widow Rockfish*	*Sebastes entomelas*	1178	0	0	0	0	0	0	0	31
Canary Rockfish*	*Sebastes pinniger*	22	1	24	0	261	0	0	0	796
Redstripe Rockfish*	*Sebastes proriger*	701	0	0	0	5	1	0	0	278
Rougheye Rockfish*	*Sebastes aleutianus*	334	4	0	0	0	0	0	0	9

Table C-10: Average landed weight of rockfish and thornyhead species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Area								
Common Name	**Scientific Name**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**11**
Darkblotched Rockfish	*Sebastes crameri*	274	0	0	0	0	0	0	0	2
Splitnose Rockfish	*Sebastes diploproa*	235	0	0	0	0	0	0	0	0
Rosethorn Rockfish	*Sebastes helvomaculatus*	46	0	0	0	0	0	0	0	0
Longspine thornyhead	*Sebastolobus altivelis*	28	0	0	0	0	0	0	0	0
Greenstriped Rockfish	*Sebastes elongatus*	1	0	0	0	0	0	0	0	27
Yelloweye Rockfish*	*Sebastes ruberrimus*	1	0	0	4	0	0	0	0	16
Quillback Rockfish*	*Sebastes maliger*	0	0	0	8	5	0	0	0	0
Copper Rockfish*	*Sebastes caurinus*	0	0	0	3	0	0	0	0	0

Table C-11: Average discarded weight of rockfish and thornyhead species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. . Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas					
Common Name	**Scientific Name**	**2**	**3**	**4**	**5**	**7**	**11**
Pacific Ocean Perch*	*Sebastes alutus*	270	1	0	0	0	10
Sharpchin Rockfish	*Sebastes zacentrus*	151	3	0	0	0	16
Redstripe Rockfish*	*Sebastes proriger*	98	0	0	0	7	56
Darkblotched Rockfish	*Sebastes crameri*	122	0	0	0	0	14
Shortspine Thornyhead*	*Sebastolobus alascanus*	130	0	0	0	0	0
Widow Rockfish*	*Sebastes entomelas*	55	0	0	0	0	46
Yelloweye Rockfish*	*Sebastes ruberrimus*	0	5	0	0	5	79
Redbanded Rockfish	*Sebastes babcocki*	39	0	0	0	0	2
Splitnose Rockfish	*Sebastes diploproa*	38	0	0	0	0	0
Silvergray Rockfish*	*Sebastes brevispinis*	23	0	0	0	0	0
Rosethorn Rockfish	*Sebastes helvomaculatus*	22	0	0	0	0	0
Quillback Rockfish*	*Sebastes maliger*	0	7	4	2	9	0
Canary Rockfish*	*Sebastes pinniger*	7	0	0	0	0	7
Greenstriped Rockfish	*Sebastes elongatus*	0	0	0	0	0	13
Yellowtail Rockfish*	*Sebastes flavidus*	0	0	7	0	0	0
Yellowmouth Rockfish*	*Sebastes reedi*	5	0	0	0	0	0
Shortraker Rockfish*	*Sebastes borealis*	3	0	0	0	0	0
Bocaccio	*Sebastes paucispinis*	3	0	0	0	0	0
China rockfish	*Sebastes nebulosus*	0	0	2	0	0	0
Copper Rockfish*	*Sebastes caurinus*	0	0	0	0	1	0
Harlequin rockfish	*Sebastes variegatus*	1	0	0	0	0	0
Rougheye Rockfish*	*Sebastes aleutianus*	0	0	0	0	0	1
Black Rockfish	*Sebastes melanops*	0	0	1	0	0	0

Table C-12: Average landed weight of rockfish and thornyhead species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. . Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Commercial Rockfish and Thornyheads												
Pacific Ocean Perch*	*Sebastes alutus*	630005	2137614	191	1044	108	6343	225945	224438	73479	837771	715176
Yellowtail Rockfish*	*Sebastes flavidus*	125011	94375	1107	39269	4922	1470	116179	233600	30807	364332	790673
Yellowmouth Rockfish*	*Sebastes reedi*	11366	360219	4	5	0	7318	52620	62563	2103	193941	365477
Silvergray Rockfish*	*Sebastes brevispinis*	120371	296692	75	945	1410	7778	54359	24357	9244	125561	160725
Widow Rockfish*	*Sebastes entomelas*	18493	18275	33	18	3	51	27204	35123	1683	23557	503561
Redstripe Rockfish*	*Sebastes proriger*	6399	66166	2	1	208	10048	100735	20542	468	102056	162721
Canary Rockfish*	*Sebastes pinniger*	9053	61137	21	4003	283	991	32632	29126	9597	56065	49560
Rougheye Rockfish*	*Sebastes aleutianus*	213710	18618	20	36	23	12	3882	4265	594	5718	4702
Redbanded Rockfish	*Sebastes babcocki*	6384	64782	2831	1139	1018	12395	45157	15522	21260	40656	17976
Shortspine Thornyhead*	*Sebastolobus alascanus*	86930	63669	3411	533	1	57	1555	3307	5717	21855	5576
Bocaccio	*Sebastes paucispinis*	8786	15503	32	4290	844	673	7785	27603	5611	20038	35355
Sharpchin Rockfish	*Sebastes zacentrus*	16945	47645	0	4	9	778	11628	687	46	11397	15474
Longspine thornyhead	*Sebastolobus altivelis*	37210	1014	0	0	0	0	0	261	94	189	22

Table C-13: Average discarded weight of rockfish and thornyhead species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**1**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Redstripe Rockfish*	*Sebastes proriger*	563	7518	2	**0**11	76	627	41295	3667	379	26062	55169
Pacific Ocean Perch*	*Sebastes alutus*	3681	47788	5	80	17	48	6755	3265	1462	14185	10998
Sharpchin Rockfish	*Sebastes zacentrus*	3479	28429	23	92	1	187	9068	646	23	7760	6172
Shortspine Thornyhead*	*Sebastolobus alascanus*	2502	4644	40	11	5	8	276	498	534	1495	433
Longspine thornyhead	*Sebastolobus altivelis*	6922	201	0	0	160	0	0	161	22	45	29
Darkblotched Rockfish	*Sebastes crameri*	483	2667	1	25	4	2	1205	70	29	1109	1047
Yellowmouth Rockfish*	*Sebastes reedi*	137	2468	0	0	2	6	1128	155	13	1011	1424
Greenstriped Rockfish	*Sebastes elongatus*	83	333	0	0	7	86	843	417	24	1300	2613
Yelloweye Rockfish*	*Sebastes ruberrimus*	33	300	5	10	51	9	2163	398	219	1507	865
Yellowtail Rockfish*	*Sebastes flavidus*	16	478	2	137	770	0	297	715	218	803	1562
Splitnose Rockfish	*Sebastes diploproa*	11	2427	45	0	14	68	459	436	5	1272	76
Quillback Rockfish*	*Sebastes maliger*	43	837	3	146	945	0	227	138	240	30	1693
Silvergray Rockfish*	*Sebastes brevispinis*	128	811	2	4	7	82	669	272	359	425	781
Copper Rockfish*	*Sebastes caurinus*	32	864	15	13	2146	0	4	9	2	5	236
Redbanded Rockfish	*Sebastes babcocki*	84	1483	24	2	17	14	354	160	65	424	242
Rosethorn Rockfish	*Sebastes helvomaculatus*	244	1047	0	84	115	11	448	27	0	408	285
Harlequin rockfish	*Sebastes variegatus*	52	144	9	2	0	0	1559	18	0	425	7
Canary Rockfish*	*Sebastes pinniger*	97	415	1	11	27	0	81	226	30	501	222

Table C-13: Average discarded weight of rockfish and thornyhead species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**1**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Rougheye Rockfish*	*Sebastes aleutianus*	698	410	0	7	0	0	26	11	5	55	14
Widow Rockfish*	*Sebastes entomelas*	12	63	0	0	6	0	6	147	6	89	614
Bocaccio	*Sebastes paucispinis*	131	24	0	13	14	0	29	43	11	49	148
Thornyheads*	*Sebastolobinae*	238	12	0	0	0	0		0	1	11	2
China rockfish	*Sebastes nebulosus*	10	37	0	22	62	0		2	2	19	57
Dusky rockfish	*Sebastes ciliatus*	159	0	4	0	0	0		5	0	0	0
Scorpionfishes	*Scorpaenidae*	5	0	1	0	9	0	0	0	9	136	0
Shortraker Rockfish*	*Sebastes borealis*	120	25	0	0	0	0	0	1	0	1	0
Vermilion rockfish	*Sebastes miniatus*	7	22	0	0	0	0		75	0	0	0
Black Rockfish	*Sebastes melanops*	6	0	0	58	13	0	0	0	18	0	0
Aurora rockfish	*Sebastes aurora*	0	9	0	0	36	0	11	0	0	0	16
Tiger rockfish	*Sebastes nigrocinctus*	0	5	3	0	5	0	4	1	4	1	10
Non-commercial Rockfish and Thornyheads												
Chilipepper	*Sebastes goodei*	0	166	0	0	0	0	11	0	376	197	161
Rockfishes	*Sebastinae*	0	0	0	0	0	0		0	0	0	230
Shortbelly rockfish	*Sebastes jordani*	0	0	0	0	0	0	23	0	0	7	5
Pygmy rockfish	*Sebastes wilsoni*	0	0	0	0	0	0	0	0	0	8	0
Puget sound rockfish	*Sebastes emphaeus*	0	0	0	0	0	0		0	0	1	5
Stripetail rockfish	*Sebastes saxicola*	0	0	0	0	0	0	0	0	0	1	0

Table C-14: Average landed weight of commercial roundfish by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas								
Common Name	**Scientific Name**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**11**
Pacific Hake*	*Merluccius productus*	29	129895	0	0	0	0	21167	0	0
Walleye Pollock*	*Theragra chalcogramma*	446	2490	778	0	0	0	6452	5	314
Pacific Cod*	*Gadus macrocephalus*	136	1875	322	285	11	133	0	23	1057
Lingcod*	*Ophiodon elongatus*	631	78	1347	0	2	176	0	15	683
Sablefish*	*Anoplopoma fimbria*	219	32	0	0	25	0	0	0	8

Table C-15: Average discarded weight of commercial roundfish by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

Common Name	Scientific Name	Average weight (kg) by Pacific Fisheries Management Areas								
		2	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**11**
Sablefish*	*Anoplopoma fimbria*	95	1386	133	0	6	12	0	15	1558
Walleye Pollock*	*Theragra chalcogramma*	507	257	234	1	0	0	0	0	96
Pacific Cod*	*Gadus macrocephalus*	92	158	0	26	0	50	0	0	760
Pacific Hake*	*Merluccius productus*	321	204	0	3	12	0	113	0	327
Lingcod*	*Ophiodon elongatus*	6	13	109	3	0	107	0	0	79
Pacific tomcod	*Microgadus proximus*	0	23	0	0	0	0	0	0	0

Table C-16: Average landed weight of commercial roundfish by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Pacific Cod*	*Gadus macrocephalus*	62021	95689	9606	335717	229563	209	8045	16746	4363	20397	45727
Walleye Pollock*	*Theragra chalcogramma*	513535	14072	4451	167975	2059	200	553	1980	407	3111	4170
Lingcod*	*Ophiodon elongatus*	21723	50700	423	48867	9061	237	27696	138111	82436	165545	144737
Pacific Hake*	*Merluccius productus*	11877	56	7	367	6	0	0	208506	60911	119545	239731
Sablefish*	*Anoplopoma fimbria*	24183	24813	306	263	26	7	724	1013	660	3982	2774

Table C-17: Average discarded weight of commercial roundfish by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA.PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Pacific Hake*	*Merluccius productus*	57158	11137	561	18867	1142	29	4616	13673	4416	36173	95361
Sablefish*	*Anoplopoma fimbria*	15861	22884	11676	21149	20397	5	2058	6007	4503	52731	60481
Lingcod*	*Ophiodon elongatus*	839	2769	32	3202	904	13	1472	11389	12276	40352	22192
Walleye Pollock*	*Theragra chalcogramma*	11190	8699	740	12875	1885	44	835	2204	1480	10444	15074
Pacific Cod*	*Gadus macrocephalus*	2362	9850	676	11315	17410	35	413	1555	718	3088	8748
Pacific tomcod	*Microgadus proximus*	0	35	68	1959	18	0	2	0	1	146	55

Table C-18: Average landed weight of dogfish and skates by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA.PFMAs inc lude 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas						
Common Name	**Scientific Name**	**2**	**3**	**4**	**5**	**7**	**10**	**11**
Big Skate	*Raja binoculata*	8	1001	555	52	99	20	272
Longnose Skate	*Raja rhina*	160	1245	361	24	0	0	108
Spiny Dogfish*	*Squalus acanthias*	5	0	0	0	0	0	90
Sandpaper Skate	*Bathyraja interrupta*	0	15	0	0	0	0	0

Table C-19: Average discarded weight of dogfish and skates by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas							
Common Name	**Scientific Name**	**2**	**3**	**4**	**5**	**6**	**7**	**10**	**11**
Spiny Dogfish*	*Squalus acanthias*	401	1247	290	27	136	23	24	2068
Longnose Skate	*Raja rhina*	350	1126	1	18	0	9	27	84
Big Skate	*Raja binoculata*	75	917	3	2	0	109	0	159
Sandpaper Skate	*Bathyraja interrupta*	29	190	0	0	0	0	0	3
Skates	*Rajidae*	19	156	2	0	0	0	0	
Starry Skate	*Raja stellulata*	0	11	0	0	0	0	0	52

Table C-20: Average landded weight of dogfish and skates by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Big Skate	*Raja binoculata*	51218	43957	12585	449254	65136	25	2402	73014	56931	14911	17275
Longnose Skate	*Raja rhina*	5366	11330	7139	30173	5108	215	1574	7053	3507	6067	6690
Sablefish*	*Anoplopoma fimbria*	24183	24813	306	263	26	7	724	1013	660	3982	2774
Skates	*Rajidae*	4665	2329	0	23186	1425	0	35	0	0	1	52
Spiny Dogfish*	*Squalus acanthias*	103	641	65	970	3182	0	238	169	383	1373	1390
Sandpaper Skate	*Bathyraja interrupta*	25	63	243	156	1	0	26	8	0	18	0
Starry Skate	*Raja stellulata*	0	0	0	35	0	0	0	0	0	0	0

Table C-21: Average discarded weight of dogfish and skates by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Spiny Dogfish*	*Squalus acanthias*	34053	115684	10864	73887	35313	123	48420	93380	66528	67128	69553
Big Skate	*Raja binoculata*	13783	22821	6714	100743	20023	75	1461	18852	14464	10385	12704
Longnose Skate	*Raja rhina*	10835	10727	7015	27881	6010	25	939	10216	6286	6192	8855
Skates	*Rajidae*	4599	1553	868	7833	1874	0	127	697	694	1094	696
Sandpaper Skate	*Bathyraja interrupta*	1806	1164	2362	1555	56	4	24	114	136	247	96
Roughtail Skate	*Bathyraja trachura*	1508	625	210	12	0	0	10	241	113	188	33
Starry Skate	*Raja stellulata*	211	217	55	1184	5	0	8	26	14	37	10
Abyssal Skate	*Bathyraja abyssicola*	335	54	227	0	7	0	5	3	0	32	23
Broad Skate	*Amblyraja badia*	0	68	0	0	0	0	0	0	0	0	0

Table C-22: Average landed weight of other species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

	Average weight (kg) by Pacific Fisheries Management Areas										
Other Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Eulachon	0	0	0	0	0	0	0	0	0	0	0
Non-commercial Roundfish	0	111	111	0	0	0	0	0	0	0	77
Invertebrates	0	0	0	2	4	0	0	0	0	0	4

Table C-23: Average landed weight of other species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

	Average weight (kg) by Pacific Fisheries Management Areas										
Other Species	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Eulachon	0	0	0	0	0	0	0	0	0	0	0
Non-commercial Roundfish	712	194	113	965	89	0	99	296	113	561	894
Invertebrates	233	645	53	2020	1187	0	10	28	61	132	135

Table C-24: Average landed weight of other species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

	Average weight (kg) by Pacific Fisheries Management Areas										
Other Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Eulachon	0	0	13	0	0	0	0	0	0	5	6
Non-commercial Roundfish	0	1424	1424	846	107	18	114	0	9	46	2761
Invertebrates	0	33	616	67	68	8	0	0	0	10	44

Table C-25: Average landed weight of other species by groundfish trawl activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 03, 104, 105, 106, 107, 108, 109, 110, and 111. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

	Average weight (kg) by Pacific Fisheries Management Areas										
Other Species	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Eulachon	15	6	8	5	1	0	1	3	7	6	31
Non-commercial Roundfish	119443	51259	25529	371943	48515	399	12177	22711	16549	28323	79620
Invertebrates	7793	26718	2947	90764	28078	6021	36101	1103	1153	7020	2169

Table C-26: List of species caught by the British Columbia groundifsh hook and line fleet within the study area between 1997- 2001.

Common Name	Scientific Name
Commercial Flatfish	
Arrowtooth flounder	*Atheresthes stomias*
Rock sole	*Pleuronectes bilineatus*
Commercial Rockfish	
Rougheye rockfish	*Sebastes aleutianus*
Pacific ocean perch	*Sebastes alutus*
Redbanded rockfish	*Sebastes babcocki*
Shortraker rockfish	*Sebastes borealis*
Silvergray rockfish	*Sebastes brevispinis*
Copper rockfish	*Sebastes caurinus*
Dusky rockfish	*Sebastes ciliatus*
Greenstriped rockfish	*Sebastes elongatus*
Widow rockfish	*Sebastes entomelas*
Yellowtail rockfish	*Sebastes flavidus*
Rosethorn rockfish	*Sebastes helvomaculatus*
Quillback rockfish	*Sebastes maliger*
Black rockfish	*Sebastes melanops*
Vermilion rockfish	*Sebastes miniatus*
China rockfish	*Sebastes nebulosus*
Tiger rockfish	*Sebastes nigrocinctus*
Bocaccio	*Sebastes paucispinis*
Canary rockfish	*Sebastes pinniger*
Redstripe rockfish	*Sebastes proriger*
Yellowmouth rockfish	*Sebastes reedi*
Yelloweye rockfish	*Sebastes ruberrimus*
Thornyheads	*Sebastolobinae*
Shortspine thornyhead	*Sebastolobus alascanus*
Non-commercial Rockfish	
Blue rockfish	*Sebastes mystinus*
Dogfish and Skates	
Skates	Family Rajidae
Big skate	*Raja binoculata*
Longnose skate	*Raja rhina*
Spiny dogfish	*Squalus acanthias*
Commercial	

Table C-26: List of species caught by the British Columbia groundifsh hook and line fleet within the study area between 1997- 2001.

Common Name	**Scientific Name**
Roundfish	
Pacific cod	*Gadus macrocephalus*
LingcodPacific cod	*Ophiodon elongatusGadus macrocephalus*
Walleye pollockLingcod	*Theragra chalcogrammaOphiodon elongatus*
Walleye pollock	*Theragra chalcogramma*
Non-commercial Roundfish	
Sturgeons	Family Acipenseridae
Sculpins	Family Cottidae
Red irish lord	*Hemilepidotus hemilepidotus*
Kelp greenling	*Hexagrammos decagrammus*
Spotted ratfish	*Hydrolagus colliei*
Cabezon	*Scorpaenichthys marmoratus*

Table C-27: Number of Groundfish Hook and Line Commercial Fishing Vessels (CFVs) by Pacific Fishery Management Area (PFMA) within Study Areas between 1997 and 2001.

PFMA	Number of CFVs					Average Number of CFV's between 1997 and 2001
	1997	**1998**	**1999**	**2000**	**2001**	
1	482	44	39	97	6	133.6
2	894	730	399	508	425	591.2
3	445	223	146	90	118	204.4
4	1898	301	364	786	1006	871
5	472	164	496	414	569	423
6	676	256	764	204	209	421.8
7	1147	1216	1811	2244	2182	1720
8	428	155	318	535	682	423.6
9	121	71	67	147	121	105.4
10	727	438	423	266	218	414.4
11	798	1347	1393	1018	911	1093.4
101	725	114	276	616	479	442
102	161	362	291	183	458	291
103	16	0	50	11	2	15.8
104	6	5	4	17	141	34.6
105	217	245	443	397	477	355.8
106	1056	746	781	112	411	621.2
107	201	41	105	125	140	122.4
108	135	15	98	40	252	108
109	30	0	31	0	30	18.2
110	256	82	280	104	504	245.2
111	939	1228	535	303	638	728.6
TOTAL	**11830**	**7783**	**9114**	**8217**	**9979**	9384.6

Table C-28: Average Number of CFVs in study areas by month between 1997 and 2001.

Month	
1	1099
2	1079
3	431
4	787
5	1227
6	1321
7	608
8	287
9	227
10	70
11	1055
12	1545

Table C-29: Landed commercial and non-commercial species from groundfish hook-and-line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 03, 104, 105, 106, 107, 108, 109, 110, and 111.

		Landed Weight (kg)					Average Landed Weight by Species
Common Name	**Scientific Name**	**1997**	**1998**	**1999**	**2000**	**2001**	**Between 1997 - 2001**
Commercial Flatfish							
Arrowtooth flounder	*Atheresthes stomias*	0	0	30	33	12	15
Rock sole	*Pleuronectes bilineatus*	123	30	43	192	126	103
Total		**123**	**30**	**73**	**225**	**138**	**118**
Dogfish and Skates							
Spiny dogfish	*Squalus acanthias*	8484	2052	71312	110548	111721	60823
Skates	*Rajidae*	2550	0	36	132	518	647
Big skate	*Raja binoculata*	0	0	0	0	31	6
Longnose skate	*Raja rhina*	0	0	0	0	1939	388
Total		**11034**	**2052**	**71348**	**110680**	**114209**	**61865**
Commercial Rockfish							
Rougheye rockfish	*Sebastes aleutianus*	7915	16981	44432	158151	109384	67373
Pacific ocean perch	*Sebastes alutus*	0	0	0	0	537	107
Redbanded rockfish	*Sebastes babcocki*	1959	5787	16881	48009	155998	45727
Shortraker rockfish	*Sebastes borealis*	588	0	613	2193	5981	1875
Silvergray rockfish	*Sebastes brevispinis*	13206	4402	21505	19657	23513	16457
Copper rockfish	*Sebastes caurinus*	57997	41152	42091	42099	43723	45412
Dusky rockfish	*Sebastes ciliatus*	238	50	90	296	55	146
Greenstriped rockfish	*Sebastes elongatus*	104	291	389	246	632	332
Widow rockfish	*Sebastes entomelas*	143	9	8	8	0	34

Table C-29: Landed commercial and non-commercial species from groundfish hook-and-line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 03, 104, 105, 106, 107, 108, 109, 110, and 111.

		Landed Weight (kg)					Average Landed Weight by Species
Common Name	**Scientific Name**	**1997**	**1998**	**1999**	**2000**	**2001**	**Between 1997 - 2001**
Yellowtail rockfish	*Sebastes flavidus*	6703	5180	3511	6357	5758	5502
Rosethorn rockfish	*Sebastes helvomaculatus*	1130	755	468	779	1275	881
Quillback rockfish	*Sebastes maliger*	364585	235785	221030	199685	179449	240107
Black rockfish	*Sebastes melanops*	8038	9035	7725	10599	7576	8595
Vermilion rockfish	*Sebastes miniatus*	8688	4611	1680	3392	2192	4112
China rockfish	*Sebastes nebulosus*	69189	36080	35107	39266	27906	41510
Tiger rockfish	*Sebastes nigrocinctus*	13946	8296	8567	8729	8208	9549
Bocaccio	*Sebastes paucispinis*	4946	965	1671	1213	1281	2015
Canary rockfish	*Sebastes pinniger*	21138	22643	17236	16536	17342	18979
Redstripe rockfish	*Sebastes proriger*	457	109	64	21	174	165
Yellowmouth rockfish	*Sebastes reedi*	0	0	44	665	3442	830
Yelloweye rockfish	*Sebastes ruberrimus*	409610	318555	292708	234050	202677	291520
Thornyheads	*Sebastolobinae*	0	0	0	528	855	277
Shortspine thornyhead	*Sebastolobus alascanus*	1279	19	324	2136	2459	1244
Total		**993856**	**712703**	**718143**	**796612**	**802418**	**804746**
Non-commercial Rockfish							
Blue rockfish	*Sebastes mystinus*	0	0	0	79	18	19
Total		**0**	**0**	**0**	**79**	**18**	**19**

Table C-29: Landed commercial and non-commercial species from groundfish hook-and-line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 03, 104, 105, 106, 107, 108, 109, 110, and 111.

		Landed Weight (kg)					
Common Name	**Scientific Name**	**1997**	**1998**	**1999**	**2000**	**2001**	**Average Landed Weight by Species Between 1997 - 2001**
Commercial Roundfish							
Pacific cod	*Gadus macrocephalus*	1651	484	1147	420	627	866
Lingcod	*Ophiodon elongatus*	162322	98126	185634	70416	574930	218286
Walleye pollock	*Theragra chalcogramma*	0	0	0	3	0	1
Total		**163973**	**98610**	**186781**	**70839**	**575557**	**219152**
Non-commercial Roundfish							
Sturgeons	*Acipenseridae*	0	0	38	0	0	8
Wolf eel	*Anarrhichthys ocellatus*	209	166	186	0	0	112
Sculpins	*Cottidae*	8	0	15	0	0	5
Red irish lord	*Hemilepidotus hemilepidotus*	67	4	289	0	0	72
Kelp greenling	*Hexagrammos decagrammus*	3930	2789	3581	3553	4608	3692
Spotted ratfish	*Hydrolagus colliei*	0	0	0	0	65	13
Cabezon	*Scorpaenichthys marmoratus*	7285	3905	5040	0	0	3246
Total Non-commercial Roundfish		**11498**	**6864**	**9149**	**3553**	**4673**	**7147**

Table C-30: Discarded commercial and non-commercial species from groundfish hook-and-line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 03, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (kg)					Average Discarded Weight by Species Between 1997 - 2001
Common Name	**Scientific Name**	**1997**	**1998**	**1999**	**2000**	**2001**	
Dogfish							
Spiny dogfish	*Squalus acanthias*	0	0	0	0	9179	1836
Total		**0**	**0**	**0**	**0**	**9179**	**1836**
Commercial Rockfish							
Yelloweye rockfish	*Sebastes ruberrimus*	0	0	0	0	1014	203
Quillback rockfish	*Sebastes maliger*	0	0	0	0	270	54
Copper rockfish	*Sebastes caurinus*	0	0	0	0	112	22
Bocaccio	*Sebastes paucispinis*	0	0	0	0	80	16
China rockfish	*Sebastes nebulosus*	0	0	0	0	25	5
Rougheye rockfish	*Sebastes aleutianus*	0	0	0	0	16	3
Canary rockfish	*Sebastes pinniger*	0	0	0	0	7	1
Black rockfish	*Sebastes melanops*	0	0	0	0	6	1
Tiger rockfish	*Sebastes nigrocinctus*	0	0	0	0	5	1
Pacific ocean perch	*Sebastes alutus*	0	0	0	0	3	1
Silvergray rockfish	*Sebastes brevispinis*	0	0	0	0	2	0
Total		**0**	**0**	**0**	**0**	**1538**	308
Commercial Roundfish							
Lingcod	*Ophiodon elongatus*	0	0	0	0	38001	7600

Table C-30: Discarded commercial and non-commercial species from groundfish hook-and-line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997 and 2001. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 101, 102, 03, 104, 105, 106, 107, 108, 109, 110, and 111.

		Discarded Weight (kg)					
Common Name	**Scientific Name**	**1997**	**1998**	**1999**	**2000**	**2001**	**Average Discarded Weight by Species Between 1997 - 2001**
Total		**0**	**0**	**0**	**0**	**38001**	**7600**
Non-commercial Roundfish							
Spotted ratfish	*Hydrolagus colliei*	0	0	0	0	17	3
Kelp greenling	*Hexagrammos decagrammus*	0	0	0	0	4	1
Total		**0**	**0**	**0**	**0**	**21**	**4**

Table C-31: Average landed weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Commercial Flatfish												
Rock sole	*Pleuronectes bilineatus*	0	6	6	68	9	5	32	0	0	3	5
Commercial Rockfish												
Rougheye rockfish	*Sebastes aleutianus*	468	38	14	5	0	9	36	43	0	674	23
Pacific ocean perch	*Sebastes alutus*	0	0	0	0	0	0	0	0	0	0	0
Redbanded rockfish	*Sebastes babcocki*	8444	293	57	21	0	108	608	3	0	0	1138
Shortraker rockfish	*Sebastes borealis*	214	26	0	0	0	0	0	25	0	0	0
Silvergray rockfish	*Sebastes brevispinis*	238	2240	101	501	532	294	1157	361	96	408	211
Copper rockfish	*Sebastes caurinus*	2615	4047	189	6516	4548	1178	10935	1801	244	764	3281
Dusky rockfish	*Sebastes ciliatus*	0	0	20	63	148	0	0	67	1	0	0
Greenstriped rockfish	*Sebastes elongatus*	0	13	1	4	7	18	121	104	24	37	18
Widow rockfish	*Sebastes entomelas*	0	0	0	6	13	4	0	0	2	4	5
Yellowtail rockfish	*Sebastes flavidus*	20	299	83	585	196	219	508	415	502	193	1751
Rosethorn rockfish	*Sebastes helvomaculatus*	54	116	0	0	6	5	105	15	2	13	40

Table C-31: Average landed weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Quillback rockfish	*Sebastes maliger*	7239	15094	2931	22814	19192	14829	52809	11042	3504	8778	24116
Black rockfish	*Sebastes melanops*	184	956	53	584	628	375	774	106	26	536	2311
Vermilion rockfish	*Sebastes miniatus*	263	237	52	0	9	106	676	845	7	225	329
China rockfish	*Sebastes nebulosus*	2419	1977	944	3303	2350	1177	4551	1840	38	1069	8100
Tiger rockfish	*Sebastes nigrocinctus*	408	527	203	1155	776	578	1498	545	29	413	411
Bocaccio	*Sebastes paucispinis*	52	232	143	14	16	227	36	23	7	50	146
Canary rockfish	*Sebastes pinniger*	239	3659	264	490	604	782	2481	509	43	695	1060
Redstripe rockfish	*Sebastes proriger*	0	6	2	80	29	1	15	39	32	31	8
Yellowmouth rockfish	*Sebastes reedi*	0	0	0	0	0	0	0	0	0	0	5
Yelloweye rockfish	*Sebastes ruberrimus*	2876	22731	4637	10172	7660	12243	34787	11998	1458	14268	17975
Thornyheads	*Sebastolobinae*	0	51	0	0	0	0	0	0	0	0	0
Shortspine thornyhead	*Sebastolobus alascanus*	0	37	31	0	0	0	4	0	0	0	0
Non-commercial Rockfish												
Blue rockfish	*Sebastes mystinus*	0	0	0	0	0	0	42	0	0	0	0

Table C-31: Average landed weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Dogfish and Skates												
Big skate	*Raja binoculata*	0	0	0	10	0	0	0	0	0	21	0
Longnose skate	*Raja rhina*	0	0	0	0	0	0	0	0	0	24	0
Skates	*Rajidae*	172	181	9	1018	0	0	80	0	0	0	129
Spiny dogfish	*Squalus acanthias*	829	6252	33	292	3003	5208	2766	2593	0	1765	8863
Commercial Roundfish												
Pacific cod	*Gadus macrocephalus*	0	15	110	140	95	33	254	149	55	62	28
Lingcod	*Ophiodon elongatus*	956	12141	1499	7331	4317	9442	11952	5359	277	6061	8661
Walleye pollock	*Theragra chalcogramma*	0	0	0	0	0	0	0	0	0	0	3
Non-commercial Roundfish												
Sturgeons	*Acipenseridae*	0	0	0	0	0	0	0	38	0	0	0
Wolf eel	*Anarrhichthys ocellatus*	167	0	0	0	0	0	0	9	0	0	43
Sculpins	*Cottidae*	0	0	0	9	0	0	0	0	0	0	0
Red irish lord	*Hemilepidotus hemilepidotus*	37	0	12	11	0	0	0	0	0	0	143
Kelp greenling	*Hexagrammos decagrammus*	186	54	58	645	402	223	791	52	62	54	641
Spotted ratfish	*Hydrolagus*	0	0	0	0	0	0	0	0	0	0	65

Table C-31: Average landed weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
	colliei											
Cabezon	*Scorpaenichthys marmoratus*	215	404	318	114	487	290	512	526	40	394	888

Table C-32: Average discarded weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Commercial Flatfish												
Rock sole	*Pleuronectes bilineatus*	0	2001	1999	22390	4798	1998	12994	0	0	1998	3332
Commercial Rockfish												
Rougheye rockfish	*Sebastes aleutianus*	8001	2666	9324	4994	0	3998	4500	4663	0	2001	3000
Pacific ocean perch	*Sebastes alutus*	0	4002	0	0	0	0	0	0	0	0	0
Redbanded rockfish	*Sebastes babcocki*	16000	7999	6999	3997	0	4662	14392	2000	0	0	2001
Shortraker rockfish	*Sebastes borealis*	2001	2667	0	0	0	0	0	2001	0	0	0
Silvergray rockfish	*Sebastes brevispinis*	11997	74357	24783	71542	44486	41969	154754	46789	14390	47154	41185
Copper rockfish	*Sebastes caurinus*	45443	92335	17588	197533	112354	67949	511013	68782	21991	42368	149527
Dusky rockfish	*Sebastes ciliatus*	0	0	4663	21981	12000	0	0	6000	2001	0	0
Greenstriped rockfish	*Sebastes elongatus*	0	8992	1998	3995	4000	5496	29598	29995	6396	12392	7999
Widow rockfish	*Sebastes entomelas*	0	0	0	3330	3994	1997	2000	0	1998	3995	2665

Table C-32: Average discarded weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Yellowtail rockfish	*Sebastes flavidus*	7326	29976	13589	51161	17195	19585	98371	36790	17597	27579	162722
Rosethorn rockfish	*Sebastes helvomaculatus*	3994	26777	0	0	1999	4664	34793	10399	1999	6498	7501
Quillback rockfish	*Sebastes maliger*	62919	203460	108292	348149	171536	170277	806549	180752	51979	167472	397788
Black rockfish	*Sebastes melanops*	10656	48368	2999	45996	31987	19587	87969	11594	5332	21582	118342
Vermilion rockfish	*Sebastes miniatus*	23972	16489	7988	0	3001	8794	61500	19988	1997	24776	41978
China rockfish	*Sebastes nebulosus*	38455	96322	41959	193510	98352	73539	330306	67579	6796	64341	276633
Tiger rockfish	*Sebastes nigrocinctus*	21976	81134	21578	179474	74376	55555	208341	51185	4999	52351	73963
Bocaccio	*Sebastes paucispinis*	2000	13591	7988	2000	6999	2997	9200	7000	6000	9195	6002
Canary rockfish	*Sebastes pinniger*	19974	131112	21982	67571	47589	67945	215558	49186	8796	63146	137925
Redstripe rockfish	*Sebastes proriger*	0	3995	1999	10987	10005	1999	5000	15997	10664	6494	5333
Yellowmouth rockfish	*Sebastes reedi*	0	0	0	0	0	0	0	0	0	0	2001
Yelloweye rockfish	*Sebastes ruberrimus*	55432	187880	82331	262161	106767	164684	531839	168755	40379	160273	356605
Thornyhead	*Sebastolobinae*	0	2001	0	0	0	0	0	0	0	0	0

Table C-32: Average discarded weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
s												
Shortspine thornyhead	*Sebastolobus alascanus*	0	6003	4997	0	0	0	1999	0	0	0	1999
Non-commercial Rockfish												
Blue rockfish	*Sebastes mystinus*	0	0	0	0	0	0	3001	0	0	0	0
Dogfish and Skates												
Big skate	*Raja binoculata*	0	0	0	2001	0	0	0	0	0	2001	0
Longnose skate	*Raja rhina*	0	0	0	0	0	0	0	0	0	2001	0
Skates	*Rajidae*	3994	4002	2000	35946	0	0	3000	0	0	0	1997
Spiny dogfish	*Squalus acanthias*	6003	6002	1999	18005	20010	7328	8799	10501	4002	7199	25004
Commercial Roundfish												
Pacific cod	*Gadus macrocephalus*	0	2001	5496	17983	6667	4998	16986	12997	3332	5999	2499
Lingcod	*Ophiodon elongatus*	20378	132309	33571	115895	65149	106330	121526	70629	12656	80349	233484
Walleye pollock	*Theragra chalcogramma*	0	0	0	0	0	0	0	0	0	0	2000

Table C-32: Average discarded weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Non-commercial Roundfish												
Sturgeons	*Acipenseridae*	0	0	0	0	0	0	0	1999	0	0	0
Wolf eel	*Anarrhichthys ocellatus*	9985	0	0	0	0	0	0	1999	0	0	7327
Sculpins	*Cottidae*	0	0	0	1998	0	0	0	0	0	0	0
Red irish lord	*Hemilepidotus hemilepidotus*	13979	0	1997	13980	0	0	0	0	0	0	39980
Kelp greenling	*Hexagrammos decagrammus*	25965	19979	13988	102766	51577	19990	178323	17998	14400	21591	107159
Spotted ratfish	*Hydrolagus colliei*	0	0	0	0	0	0	0	0	0	0	12006
Cabezon	*Scorpaenichthys marmoratus*	20971	15985	18976	12650	12658	11986	31308	17974	3994	16646	39303

Table C-33: Average landed weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Commercial Flatfish												
Arrowtooth flounder	*Atheresthes stomias*	33	12	0	0	0	30	0	0	0	0	0
Rock sole	*Pleuronectes bilineatus*	0	11	0	0	0	0	0	0	0	0	16
Commercial Rockfish												
Rougheye rockfish	*Sebastes aleutianus*	56704	9374	272	385	0	19	0	2252	134	1209	3822
Pacific ocean perch	*Sebastes alutus*	0	376	0	0	0	0	0	91	14	20	36
Redbanded rockfish	*Sebastes babcocki*	6350	9276	3206	965	46	919	756	7707	344	23684	5340
Shortraker rockfish	*Sebastes borealis*	1552	388	0	0	0	0	0	356	0	134	841
Silvergray rockfish	*Sebastes brevispinis*	4288	2721	149	1670	289	840	57	365	157	1125	970
Copper rockfish	*Sebastes caurinus*	595	2171	0	419	207	480	22	72	22	10	6294
Dusky rockfish	*Sebastes ciliatus*	51	0	0	0	0	0	0	0	0	0	0
Greenstriped rockfish	*Sebastes elongatus*		6	0	0	0	1	4	16	21	4	1
Widow rockfish	*Sebastes entomelas*	103	0	0	0	4	0		0	0	0	0
Yellowtail rockfish	*Sebastes flavidus*	270	70	16	1	17	206	10	15	1	84	141

Table C-33: Average landed weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Rosethorn rockfish	*Sebastes helvomaculatus*	51	91	3	19	50	81	50	69	0	99	151
Quillback rockfish	*Sebastes maliger*	2708	5762	173	1096	4434	11266	1647	740	453	2188	29024
Black rockfish	*Sebastes melanops*	298	842	0	20	244	285	0	13	0	112	523
Vermilion rockfish	*Sebastes miniatus*	0	94	0		7	276	100	127	59	71	1204
China rockfish	*Sebastes nebulosus*	314	1371	4	162	1099	853	33	403	59	261	10089
Tiger rockfish	*Sebastes nigrocinctus*	154	193	43	49	418	351	61	133	35	261	1634
Bocaccio	*Sebastes paucispinis*	914	79	0	560	16	516	48	24	0	95	57
Canary rockfish	*Sebastes pinniger*	653	1067	0	1521	664	2160	326	222	125	434	2369
Redstripe rockfish	*Sebastes proriger*	0	0	0	0	0	2	0	0	0	0	0
Yellowmouth rockfish	*Sebastes reedi*	34	688	115	0	0	10	0	324	0	1153	343
Yelloweye rockfish	*Sebastes ruberrimus*	26431	10441	1258	528	21535	54591	7940	3437	1262	8653	16326
Thornyheads	*Sebastolobinae*	317	491	0	22	0	0	0	89	0	38	59
Shortspine thornyhead	*Sebastolobus alascanus*	808	209	53	0	0	0	0	896	0	212	1091

Non-commercial Rockfish

Table C-33: Average landed weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Blue rockfish	*Sebastes mystinus*	0	0	0	3	10	0	0	0	0	0	0
Dogfish and Skates												
Longnose skate	*Raja rhina*	0	957	0	0	0	0	0	957	0	0	0
Skates	*Rajidae*	235	0	0	0	47	433	0	0	0	0	427
Spiny dogfish	*Squalus acanthias*	1029	58673	0	0	691	3951	2456	2995	0	585	2490
Commercial Roundfish												
Pacific cod	*Gadus macrocephalus*	47	44	61	0	0	80	51	2	18	21	41
Lingcod	*Ophiodon elongatus*	41588	19339	892	1327	18940	48092	5183	710	97	10565	7341
Non-commercial Roundfish												
Wolf eel	*Anarrhichthys ocellatus*	0	0	0	0	0	12	0	0	0	0	78
Sculpins	*Cottidae*	0	0	0	0	0	0	0	0	0	0	6
Red irish lord	*Hemilepidotus hemilepidotus*	0	0	0	0	0	0	0	0	0	0	146
Kelp greenling	*Hexagrammos decagrammus*	55	130	0	6	4	56	0	2	1	10	413
Cabezon	*Scorpaenichthys marmoratus*	0	332	0	0	28	257	0	10	0	47	1043

Table C-34: Average discarded weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Commercial Flatfish												
Arrowtooth flounder	*Atheresthes stomias*	4000	2001	0	0	0	3998	0	0	0	0	0
Rock sole	*Pleuronectes bilineatus*	0	4002	0	0	0	0	0	0	0	0	2000
Commercial Rockfish												
Rougheye rockfish	*Sebastes aleutianus*	10160 6	19506	4999	6003	0	5329	0	22010	2001	30012	14007
Pacific ocean perch	*Sebastes alutus*	0	22011	0	0	0	0	0	12006	2001	4002	10005
Redbanded rockfish	*Sebastes babcocki*	54389	32505	9996	24012	1999	17486	3000	23509	3001	46018	38019
Shortraker rockfish	*Sebastes borealis*	16999	8002	0	0	0	0	0	5002	0	4000	10005
Silvergray rockfish	*Sebastes brevispinis*	77558	38004	6998	32016	39983	67140	15193	24003	4000	54000	18002
Copper rockfish	*Sebastes caurinus*	15320	35171	0	8669	10398	21584	1998	5995	4002	4499	18544 3
Dusky rockfish	*Sebastes ciliatus*	8495	0	0	0	0	0	0	0	0	0	0
Greenstriped rockfish	*Sebastes elongatus*	0	6002	0	0	0	2000	2001	8004	6999	7333	2000

Table C-34: Average discarded weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Widow rockfish	*Sebastes entomelas*	13979	0	0	0	1999	0		0	0	0	0
Yellowtail rockfish	*Sebastes flavidus*	25579	6666	3998	2001	10798	27478	3333	3998	4002	8793	26792
Rosethorn rockfish	*Sebastes helvomaculatus*	16792	22405	2000	6003	16000	29978	19986	28009	0	21491	12399
Quillback rockfish	*Sebastes maliger*	79933	68759	9991	8801	141952	235781	46779	18782	7326	48359	275772
Black rockfish	*Sebastes melanops*	20484	27179	0	2001	20792	20480	0	1999	0	7328	39171
Vermilion rockfish	*Sebastes miniatus*	0	7993	0		1997	12487	13325	10989	6994	10392	66355
China rockfish	*Sebastes nebulosus*	17317	39170	1997	7601	60778	63543	9194	15986	4663	21186	180662
Tiger rockfish	*Sebastes nigrocinctus*	27187	24385	3996	7001	63984	67931	12790	17986	5330	29974	90739
Bocaccio	*Sebastes paucispinis*	23976	3334	0	18009	2997	24978	3332	3997	0	6494	6001
Canary rockfish	*Sebastes pinniger*	41971	37181	0	26013	63985	94706	27986	12390	9000	27978	103935
Redstripe rockfish	*Sebastes proriger*	0	0	0	0	0	3996	0	0	0	0	0
Yellowmouth rockfish	*Sebastes reedi*	3998	58029	4000	0	0	1999	0	26013	0	81037	8004

Table C-34: Average discarded weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

Average Landed Weight (kg) by Pacific Fisheries Management Areas

Common Name	Science Name	101	102	103	104	105	106	107	108	109	110	111
Yelloweye rockfish	*Sebastes ruberrimus*	165090	83961	11991	12004	159549	261354	58371	33987	11993	82766	203447
Thornyheads	*Sebastolobinae*	11004	26013	0	6003	0	0	0	8004	0	6003	2001
Shortspine thornyhead	*Sebastolobus alascanus*	41984	4000	9995	0	0	0	0	24012	0	17340	10005
Non-commercial Rockfish												
Blue rockfish	*Sebastes mystinus*	0	0	0	2001	2001	0	0	0	0	0	0
Dogfish and Skates												
Longnose skate	*Raja rhina*	0	4002	0	0	0	0	0	4002	0	0	0
Skates	*Rajidae*	3994	0	0	0	1997	5991	0	0	0	0	7998
Spiny dogfish	*Squalus acanthias*	36000	48000	0	0	2000	12662	10666	24012	0	1999	18009
Commercial Roundfish												
Pacific cod	*Gadus macrocephalus*	6994	10005	10991	0	0	5495	3997	2001	4002	2998	2998
Lingcod	*Ophiodon elongatus*	163530	76379	3001	16007	115964	283071	32380	16488	7992	64790	124712

Table C-34: Average discarded weight of species by groundfish hook and line activity in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average Landed Weight (kg) by Pacific Fisheries Management Areas										
Common Name	**Science Name**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Non-commercial Roundfish												
Wolf eel	*Anarrhichthys ocellatus*	0	0	0	0	0	5997	0	0	0	0	5329
Sculpins	*Cottidae*	0	0	0	0	0	0	0	0	0	0	5997
Red irish lord	*Hemilepidotus hemilepidotus*	0	0	0	0	0	0	0	0	0	0	13993
Kelp greenling	*Hexagrammos decagrammus*	5991	10792	0	2999	2798	11995	0	1999	1997	7001	59567
Cabezon	*Scorpaenichthys marmoratus*	0	16652	0	0	1999	5329	0	1998	0	5995	51942

Table C-35: Total estimated weight of herring spawning biomass between 1997-2001 by PFMA.

	Estimated weight (t) by PFMA											
Year	**1**	**2W**	**2E**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1997	0	54	9,522	1,024	18,440	1,614	3,328	19,176	2,627	6	0	0
1998	0	450	18,613	204	9,614	6,453	7,037	17,534	3,991	281	1,416	0
1999	0	37	8,445	3,889	13,905	7,239	7,845	16,849	3,764	249	1,157	0
2000	0	265	4,925	2,334	8,108	5,036	7,099	20,350	1,035	837	707	0
2001	0	254	12,534	187	21,208	9,882	5,292	13,771	3,490	603	786	0
2002	0	225	1,938	483	12,089	5,296	5,281	10,793	3,433	1,921	1,068	0

Table C-36: Total weight of herring landed between 1997-2001 by PFMA.

	Total weight landed (tonnes) by PFMA											
Year	**1**	**2W**	**2E**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1997	0	0	0	1,167	4,373	0	0	3,620	0	0	0	0
1998	0	180	1,372	0	3,217	0	0	8,602	0	0	0	0
1999	0	0	2,973	25	1,833	256	1,524	5,940	0	0	0	0
2000	0	0	1,764	0	3,076	1,239	0	7,366	0	0	0	0
2001	0	0	0	1,905	0	1,012	0	6,130	0	0	0	0
2002	0	0	706	0	2,433	2,061	503	2,790	0	0	0	0

Table C-37: Average landed weight of invertebrates in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by species by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by PFMA										
Common Name	***Scientific Name***	1	2	3	4	5	**6**	7	8	9	10	11
Geoduck	*Panopea abrupta*	36389	961725	65832	199992	425383	239365	637805	116759	31012	50059	0
Green sea urchin	*Stronglyocentrotus droebachiensis*	0	0	0	254	0	0	0	0	0	0	1953
Horse clam	*Tresus sp.*	69	7938	0	125	52	317	108	487	0	0	0
Prawns	*Pandalus platyceros*	0	242416	16458	50093	106359	59921	159479	29312	7754	12516	490
Coonstripe shrimp (prawn logbook)	*Pandalopsis danae*	0	242416	16458	50093	106359	59921	159479	29312	7754	12516	490
Humpback shrimp (prawn logbook)	*Pandalus hypsinotus*	7292	290899	19750	60111	127631	71905	191374	35174	9304	15018	587
Red sea urchin	*Strongylocentrotus franciscanus*	261262	487207	79805	616476	784409	1289990	480639	73090	39541	140445	37833
Sea cucumber	*Holothuroidea*	0	0	0	0	40070	92215	77078	40703	6019	0	0
Dungeness crab	*Cancer magister*	192611	9487	74755	83827	22216	6604	547	160	412	0	1708
Octopus	*Octopus sp.*	0	0	0	0	0	0	0	0	0	0	0
Smelts		0	0	0	21	0	0	0	0	0	0	0
Squid		0	5584	0	0	0	0	3454	2058	758	0	0
Pink shrimp	*P. jordani and/or P. borealis eous*	0	7222	22637	140125	23087	4565	25117	4313	20282	33144	2045

Table C-37: Average landed weight of invertebrates in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by species by PFMA. PFMAs include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by PFMA										
Common Name	***Scientific Name***	1	2	3	4	5	**6**	7	8	9	10	11
Sidestripe shrimp	*Pandalopsis dispar*	0	1846	34854	75180	22078	6320	3435	652	12094	3322	51
Humpback shrimp (Shrimp logbook)	*Pandalus hypsinotus*	0	1970	456	8010	1947	205	637	292	58	56	61
Coonstripe shrimp (Shrimp logbook)	*Pandalopsis danae*	0	0	50	116	15	0	61	0	7	0	15
Octopus (trap)	*Octopus sp.*	0	4884	11599	44686	9425	3628	10669	2341	11045	7304	434

Table C-38: Average landed weight of invertebrates in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by PFMA										
Common Name	***Scientific Name***	1	2	3	4	5	**6**	7	8	9	10	11
Geoduck	*Panopea abrupta*	0	0	0	0	0	36369	0	0	0	0	0
Green sea urchin	*Stronglyocentrotus droebachiensis*	0	0	0	0	0	0	0	0	0	0	0
Horse clam	*Tresus sp.*	0	0	0	0	0	214	0	0	0	0	0
Prawns	*Pandalus platyceros*	0	0	0	0	0	12194	0	0	0	0	0
Coonstripe shrimp (prawn logbook)	*Pandalopsis danae*	0	0	0	0	0	12194	0	0	0	0	0
Humpback shrimp (prawn logbook)	*Pandalus hypsinotus*	0	6	0	0	0	12194	0	0	0	0	0
Red sea urchin	*Strongylocentrotus franciscanus*	29446	0	0	0	9618	147883	0	0	0	0	16088
Sea cucumber	*Holothuroidea*	0	0	0	0	0	0	0	0	0	0	0
Dungeness crab	*Cancer magister*	50665	517599	351	672891	59840	0	45	1111	0	0	0
Octopus	*Octopus sp.*	0	0	0	0	0	0	0	0	0	0	0
Smelts		0	0	0	0	0	0	0	0	0	0	0
Squid		0	0	0	0	0	0	0	0	0	0	0
Pink shrimp	*P. jordani and/or P. borealis eous*	99	1683	2427	472	63	4655	105105	184515	65191	7801	1459

Table C-38: Average landed weight of invertebrates in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance between 1997-2001 by PFMA. PFMAs include 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.Average over 1 y (yellow), 2 y (mauve), 3 y (green), 4 y (pink) and 5 y (no colour).

		Average weight (kg) by PFMA										
Common Name	***Scientific Name***	1	2	3	4	5	**6**	7	8	9	10	11
Sidestripe shrimp	*Pandalopsis dispar*	146	16	2374	857	99	141	490	904	374	50	26
Humpback shrimp (Shrimp logbook)	*Pandalus hypsinotus*	0	28	0	0	0	0	0	0	0	0	0
Coonstripe shrimp (Shrimp logbook)	*Pandalopsis danae*	0	0	0	0	0	0	0	0	0	0	0
Octopus (trap)	*Octopus sp.*	49	345	960	266	32	959	21119	37084	13113	1570	371

Table C-39: Commercial intertidal clam landings by weight and value for PFMAs 1-11. The only intertidal clam landings for 1997 to 2001 were from PFMAs 1 (Jones et al. 2001) and 7. However, due to privacy constraints, data from Area 7 is confidential and is for internal DFO use only (Suzanne Spohn, DFO, Vancouver, BC, pers. comm.).

			PFMA 1	
Year	**Common Name**	**Scientific Name**	**Weight (t)**	**Commercial Value**
1997	Razor Clam	*Siliqua patula*	108.7	$200,000
1999	Razor Clam	*Siliqua patula*	39.9	$79,000
2000	Razor Clam	*Siliqua patula*	78.1	$127,000
2001	Razor Clam	*Siliqua patula*	237.0	$465,000

FIGURES 1 to 4.

Figure 1. Queen Charlotte Basin.

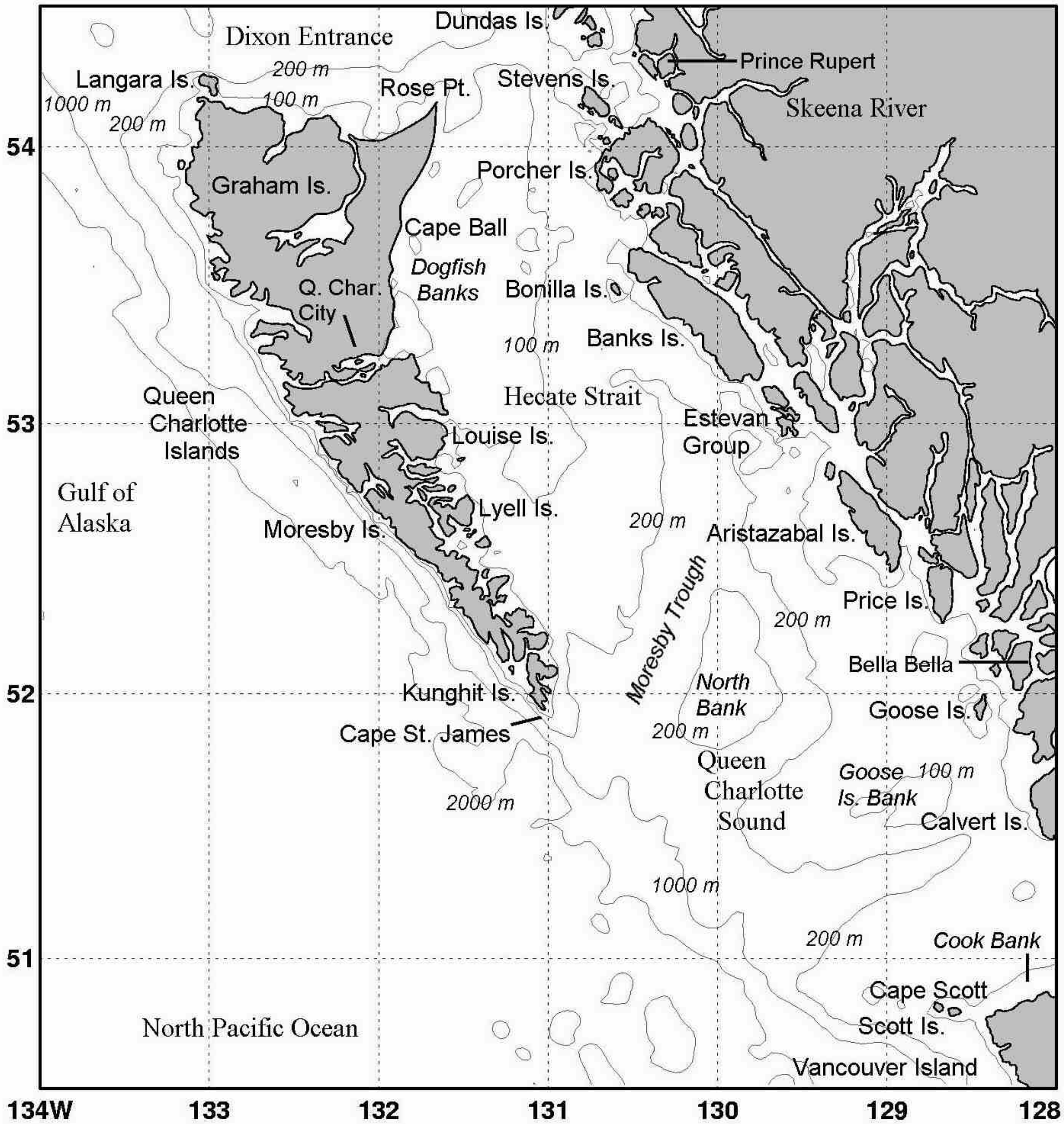

Figure 2. Estimated extent of offshore gas and oil leases, September 14, 2001. Map courtesy of Jeff Ardon, Living Ocean Society, Salt Spring Island, BC, pers. comm..

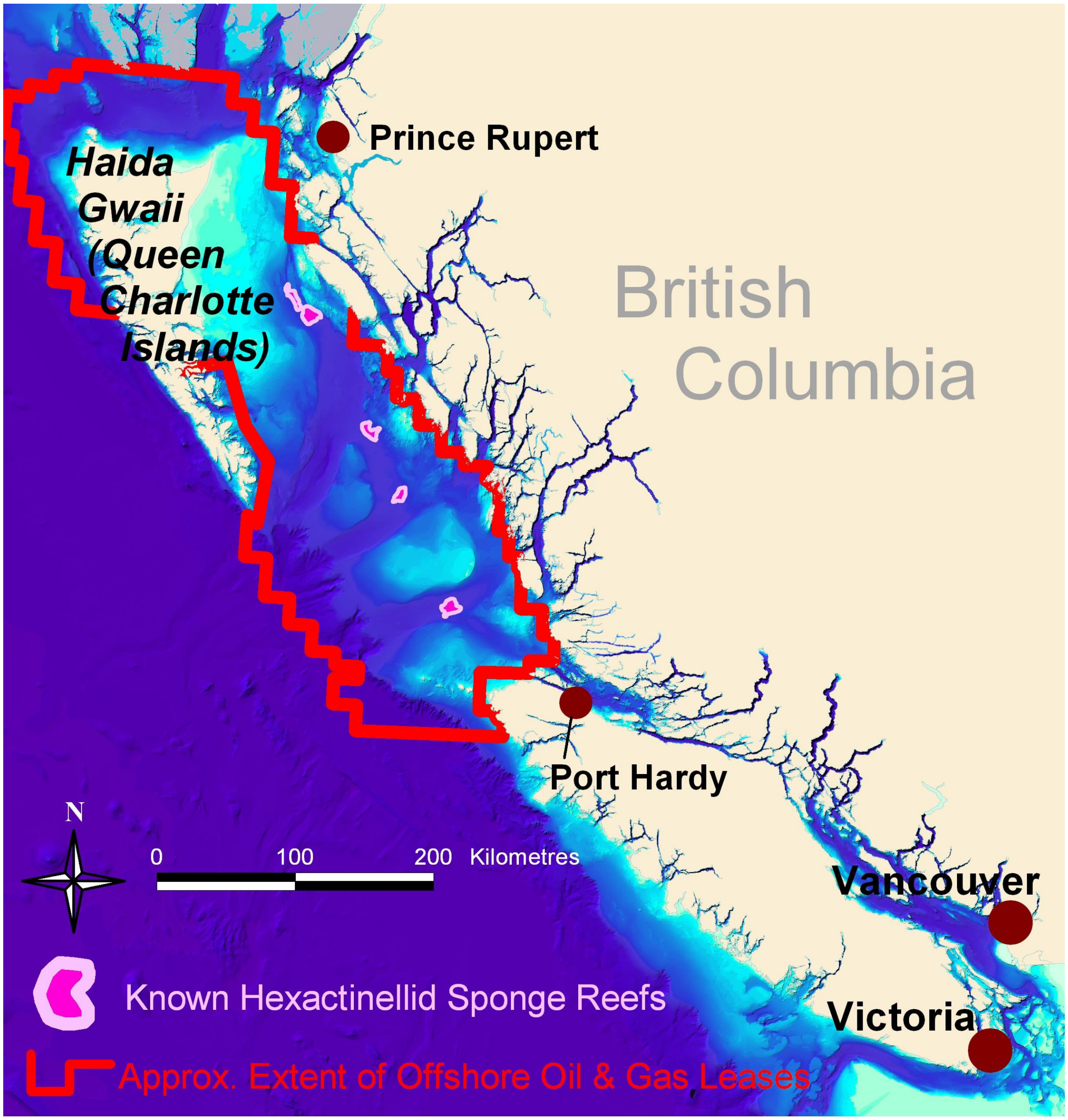

Figure 3. PFMAs for the North and Central BC Coasts.

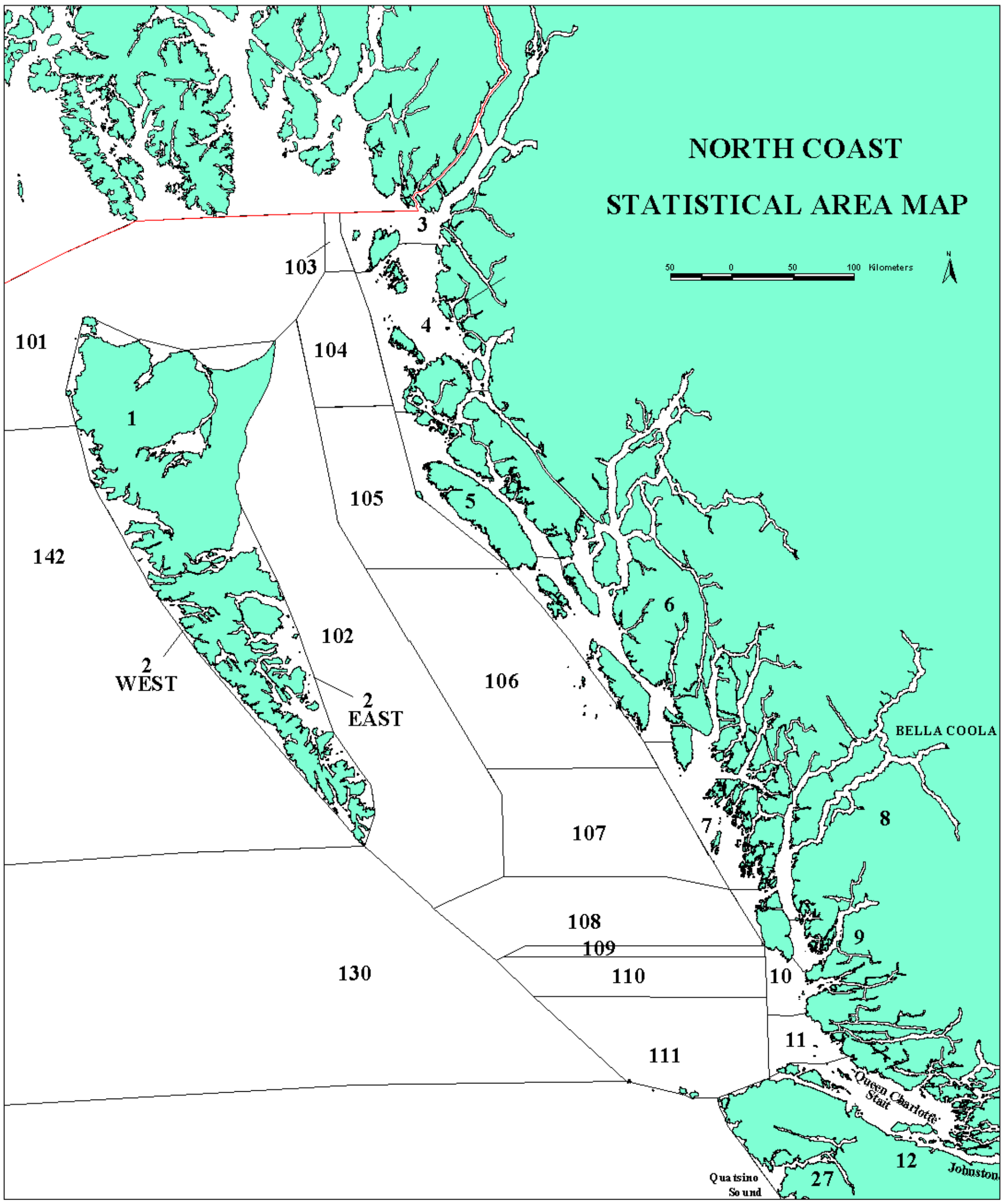

Figure 4: International (major) and minor area divisions of the British Columbia coast used for groundfish statistical data. International areas are agreed upon jointly by Canada and the United States (Pacific States Marine Fisheries Commission).