

BIOPHYSICAL OVERVIEW OF THE LAURENTIAN CHANNEL AREA OF INTEREST (AOI)

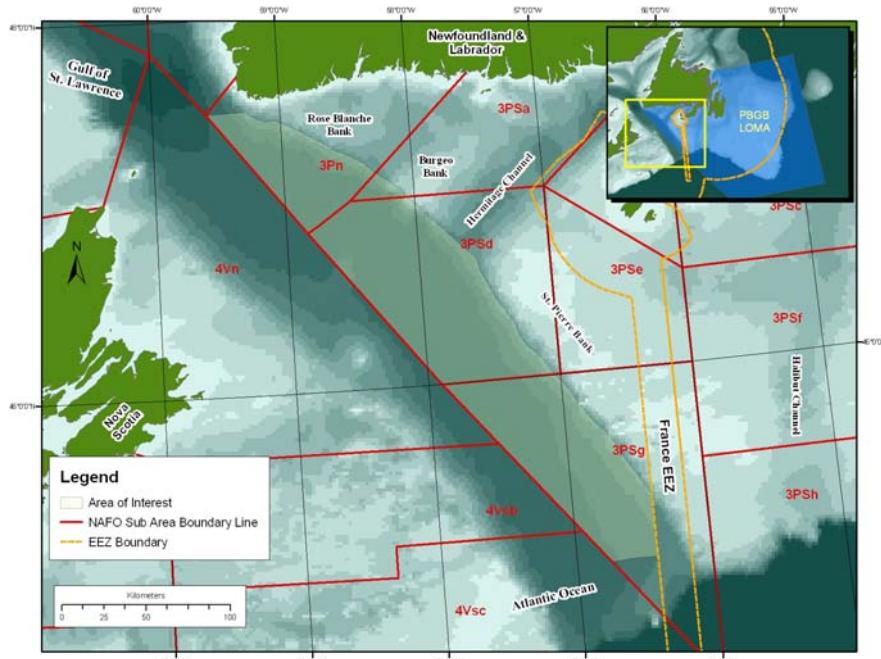


Figure 1. Laurentian Channel Area of Interest within the Placentia Bay-Grand Banks Large Ocean Management Area.

Context :

Under the Health of the Oceans Initiative, Fisheries and Oceans Canada (DFO) Science sector provides advice in support of the establishment and management of Marine Protected Areas (MPAs). On June 8, 2010, following the conclusion of an 18 month regional site selection process and subsequent approval, the Minister announced the Laurentian Channel in the Newfoundland and Labrador Region as an Area of Interest (AOI) for potential MPA establishment.

Once an AOI is identified, detailed information on the key biophysical attributes of the area is required. This biophysical overview is to assist the Department in refining conservation objectives, delineating boundaries, and determining if an Oceans Act MPA is the appropriate management tool for the site. If the Laurentian Channel MPA is established, the biophysical overview will also form the basis to inform monitoring protocols and strategies, identification of information gaps, and the development of a management plan for the area.

A Canadian Science Advisory Secretariat (CSAS) Regional advisory process was held in November 2010 to present, review, and assemble available information on various physical and biological components of the study area (NAFO Division 3P west of the France Exclusive Economic Zone) and to provide scientifically-based conclusions regarding the available baseline information related to habitats and species, as well as to highlight uncertainties and knowledge gaps. This science advisory report contains the conclusions and advice from that meeting.

SUMMARY

- The Laurentian Channel AOI varies in depth from 100 to 500 m, with the basin of the Laurentian Channel being the deepest. Adjacent banks in the study area south of Newfoundland vary from 100 to 200 m in depth.
- Surficial and shallow geology attributes may be sufficient for broad-scale generalizations related to habitat associations of species of interest that interact with the bottom. In general, mud and clay characterize deeper areas, while sand and gravel occur mainly on the banks. Bedrock geology has strong potential for hydrocarbon discoveries.
- The occurrence of sea ice is infrequent in the study area, occurring only during maximum extent years (less than 10 of the last 30 years). The Laurentian and Hermitage Channels and areas to the west of St. Pierre Bank have some of the warmest bottom water temperatures in the Region (2-7 °C), while St. Pierre Bank and regions to the east are somewhat cooler than this (-1 to 1 °C). Circulation in the area is also unique.
- Plankton assemblages in the AOI are similar to other inner shelf areas of the Grand Banks; however, calanoid copepods and macrozooplankton show very different seasonal cycles of abundance and long term changes in the AOI.
- Sensitive habitats occurring in the AOI are represented by various species of corals. However, of the corals occurring in the AOI, sea pens have been recorded in the greatest numbers and with the greatest diversity; and have also been described as having their highest regional concentrations within the Laurentian Channel (just west of the study area).
- Of the fish species of interest, only black dogfish (*Centroscyllium fabricii*) and the northern wolffish (*Anarhichas denticulatus*) occur more frequently within the AOI (69% and 52% inside respectively) than outside the AOI within the study area, based on DFO trawl surveys.
- At least 20 species of cetaceans have been observed both nearshore and offshore in the study area, with the most frequently observed species being humpback, fin, and minke whales. Most cetaceans occur either seasonally (during spring/summer) or as transients in the study area, although some may also occur there year-round.
- Leatherback sea turtles (*Dermochelys coriacea*) are the most frequently occurring sea turtle in the study area, where the south coast of Newfoundland is one of the most highly-frequented leatherback foraging areas in Atlantic Canada.
- Porbeagle sharks (*Lamna nasus*) and basking sharks (*Cetorhinus maximus*) move into the study area around May-June, with movement out of the study area to areas further south occurring in late fall. One of only two known mating grounds for porbeagle occurs in the AOI.
- Uncertainties and knowledge gaps identified within the biophysical overview can be attributed to either information that was not considered for various reasons, e.g., due to scale; non-Regional databases; and migratory species, as well as information that was unknown or unavailable, e.g., survey data for certain species or times; and habitat associations.
- Oceanographic monitoring of two standard AZMP lines can inform the physical, chemical, and biological oceanography of the study area – although these are not monitored

consistently during spring and fall surveys. Continuous Plankton Recorder (CPR) data provide retrospective information on plankton abundance.

- Annual multispecies research vessel (RV) surveys can inform the status and trends of primarily demersal species within the study area. However, these occur only during spring in 3P (the study area) as opposed to during spring and fall as in other areas surveyed in the Region.
- Various components of fishing, oil and gas activities, and vessel traffic have been identified as being of potential risk to some species of interest either spatially or temporally.

BACKGROUND

In order to ascertain the necessary breadth and scope of the various components of the ecosystem to be addressed in a biophysical overview, and to ensure the accurate consideration of the significance of the area of interest to the life histories of those species identified for potential conservation, areas adjacent to an AOI should also be considered as necessary. Considering the geographic scale at which scientific information is currently collected and reported, the **study area** for the biophysical overview supporting the Laurentian Channel Area of Interest is recommended as NAFO areas in 3P west of the Canada-France Maritime Boundary.

The overall objective of the biophysical overview is to provide advice on key physical and biological features of the Laurentian Channel AOI (and adjacent area as required) as they pertain to potential conservation priorities, the subsequent development of conservation objectives, and information for the development of management strategies. Potential conservation priorities, as identified in the Terms of Reference for this meeting, for the Laurentian Channel AOI include: *Black dogfish, Basking shark, Atlantic Cod, Haddock, Monkfish, Pollock, Porbeagle shark, Redfish, Smooth skate, Spiny dogfish, Thorny skate, White hake, Wolffish, Cetaceans, Leatherback sea turtles, and Corals (specifically sea pens)*.

The biophysical overview addresses information pertaining to the study area, including unique physical and biological oceanographic characteristics, habitat features, and distribution and abundance of species of interest, as well as information on various aspects of their biology and ecology. The status of these populations, the abiotic and biotic factors influencing them, and potential sources of risk to these species are also considered. Sources of uncertainties of the information provided, as well as knowledge gaps, are also documented.

ASSESSMENT OF THE LAURENTIAN CHANNEL STUDY AREA

An assessment of the Laurentian Channel study area was presented and reviewed based on detailed information contained primarily within the working papers by Templeman et. al and Kulka.

Bathymetry

The bathymetry of the area of interest varies from 100 to 500 meters depth. The Northeast side of the area is the shallowest part, being delimited by the edge of the Burgeo and St. Pierre Banks. The depth at those edges varies from 200m at the Burgeo Bank to 100m along the St

Pierre Bank. The area slopes gently from northeast to southwest until it reaches the basin of the Laurentian Channel half way through the area of interest. The depth varies from close to 500m on the northwest extremity to about 400m in the southeast extremity.

Geology

New (and updated) surficial and sub-surface geology maps and supporting data in the Laurentian sub-basin area are presently in production by the Geological Survey of Canada (NRCan) and are made available for the geo-characterization of shallow geology in Laurentian AOI and surrounding study area (NRCAN). Surficial and shallow geology attributes may be sufficient for broad-scale generalizations related to habitat associations of species of interest that either interact with the bottom for various life history processes or prey upon the species that live there.

The AOI crosses two deep sedimentary, the Sydney Basin on the northern half, and the Laurentian Basin to the south. There is little expression of bedrock elements at the seabed as much later glacial processes have carved and blanketed the bedrock across much of the Laurentian Channel. However, it has been noted that both these deep basins have significant hydrocarbon potential and proven finds.

The dominant seabed sediments affecting habitat in the study area include the glacial and overlying post glacial mud and clay – occurring mainly in the deeper parts of the study area, such as the Laurentian and Hermitage Channels; the post glacial low-stand derived sand and gravel (sand, shell hash, gravel, cobbles, and boulders) – occurring mainly on the St. Pierre and Burgeo banks; their (paleo) sublittoral equivalents (thin sand) on bank flanks; as well as glacial till (silty, sandy, clay matrix with gravel, cobble, and boulders) distributed on the flanks, moraines and parts of the outer channels. Bedrock outcrop is very rare.

Studies of bottom type at a finer resolution, using sampling tools such as campod, sidescan, and video transects, are available but are very limited in their existence and coverage.

Oceanographic Conditions

Two distinct oceanographic regimes occur in the study area: the Laurentian and Hermitage Channels and areas to the west of St. Pierre Bank remain relatively isolated from Labrador Current Shelf Water and are influenced by warmer slope water (2-7 °C), while much of St. Pierre Bank and regions to the east are influenced by cold-fresh water from the eastern NF Shelf (-1 to +1 °C).

Near-surface temperature in the Laurentian Channel AOI is variable, with a low of near 0 °C during winter and a peak around 15 °C during August. Notably, bottom temperature remains relatively constant within years, averaging near 5 °C (60-year mean of 4.7 °C). There has been less between-year variability in bottom temperatures since the mid 1980's, but there were some distinct warmer and colder periods prior to that time.

Southwest St. Pierre Bank and Southeast St. Pierre Bank are the two standard lines within the Atlantic Zone Monitoring Program (AZMP) that can inform the physical, chemical, and biological oceanography of the study area. Retrospective time series of plankton are generated from Continuous Plankton Recorder (CPR) surveys. Based on these data sources, the composition of the dominant plankton assemblage in the AOI is similar to that observed on the inner shelf across the Grand Banks. No differences in the seasonality in phytoplankton and small copepod

species have been noted on either side of the Laurentian Channel. Calanoid copepods and macrozooplankton, an important link to higher trophic levels, show very different seasonal cycles of abundance and exhibit very different long term changes in the AOI. Inferences based on CPR data indicate plankton production in the Laurentian AOI is highly variable in space and time, making it a challenge to understand the linkages between physical, chemical and biological properties and to forecast changes on an annual time scale. This suggests an understanding of the lower trophic levels and linkages will require a better knowledge of processes on shorter time scales.

Benthic Attributes (Corals)

From DFO research trawl surveys, 3 Orders (Alcyonaceans, Scleractinians, and Pennatulaceans), including 14 species, of corals have been documented through 229 coral specimens from the Laurentian Channel AOI. These include 2 species of gorgonians, 5 species of soft corals, 1 species of solitary cup coral, and 6 species of sea pens.

Within the Alcyonaceans, the large gorgonians require hard substrates, while small gorgonians require soft substrates. Thus, given the characteristic mud and clay substrate of Laurentian Channel, small gorgonians would be expected to occur more frequently in the AOI than large gorgonians; however, only one of each of these types of coral have been encountered there (*Paramuricea spp.* and *Acanella arbuscula*). While soft corals also require hard substrates, a total of 49 specimens have been recorded within the AOI.

Scleractinians (stony cup corals), very small (< 5 cm) cup-shaped corals, require soft substrates. In total, 34 specimens of cup corals (*Flabellum spp.*) have been recorded within the AOI.

Pennatulaceans (sea pens), whip-like corals that are < 2m in height, also require soft substrates. Sea pens have been recorded in the greatest numbers (n= 60), and with the greatest diversity (n = 6 species) within the AOI. Notably, Kenchington et al. (2010), through kernel density analysis of coral distribution, also identified/described higher concentrations of sea pens within the Laurentian Channel, to the west of the study area.

Corals have been noted as being providing important structural habitat for many species. Corals can create unique habitats, e.g. isolated islands; provide structure, e.g. thickets; and add complexity; e.g., sea pen fields in soft mud environments. As microhabitat they provide rest areas, feeding areas, nursery areas, and refuge from predation across various life stages.

Data on corals come mainly from DFO research trawl surveys, and catchability of various coral species likely varies considerably.

The main threats to coral species in the area are those activities that involve contact with the sea floor where corals occur, e.g. primarily bottom contact fisheries, which could result in displacement of individuals.

Fish, shark, and marine mammal species of interest

To examine the distribution of various finfish species inside and outside the AOI in the study area, two DFO Campelen trawl survey series (1994-2009) were examined and the data pooled across all years (Kulka in prep). Catch numbers and catch rates (numbers per standard tow) of the fish species of interest were compared inside and outside the AOI (3P and the Laurentian

Channel portion of the 4V). The percentages reported in the sections below refer to the percent of total catch of a given species, in numbers, relative to the total catch in the study area, for all surveys combined. The technique does not consider seasonal or annual differences in survey distribution, and can be influenced by occasional large catches. These trawl surveys also do not capture large pelagic fish and most sharks. Nonetheless, it was considered that this provided a reasonable snapshot of relative distribution of demerel species inside and outside the AOI.

Redfish species (*Sebastes mentella* and *S. fasciatus*) are currently managed together as "redfish" within two management units which overlap with the AOI study area - UNIT1 corresponds to NAFO Divisions 4RST + Subdivisions 3Pn4Vn (from Jan. to May), and UNIT2 consists of Subdivisions 3Ps4Vs4Wfgj + Subdivisions 3Pn4Vn (from June to Dec.). However, DFO Science has recently recommended that Unit 1 and 2 be grouped as a single biological unit for each of the two species (DFO 2010). Redfish inhabit cool waters (3°C - 8 °C) along the slopes of banks and deep channels in depths of 100-700 m – *S. fasciatus* typically occurs in shallower waters (150-300 m), whereas *S. mentella* is distributed at depths varying between 350 and 500 m (DFO 2010).

Based on spring/summer RV information, redfish are generally distributed outside of the AOI – the number of redfish caught within the AOI represents only 16% of the number caught outside during this time of year. In terms of density (number per tow within the AOI versus outside) the ratio is 0.78. Recent genetic and otolith element composition studies indicated that adult *S. mentella* tend to move out of the Gulf each fall/winter and return during the following spring. Seasonal movements of *S. fasciatus* could not be inferred from the same study. From 2000 to 2009, survey biomass estimates of *S. fasciatus* appeared stable (particularly for the mature biomass) while those for *S. mentella* declined over the same period. Redfish are slow-growing, late maturing (8-10 years), and long-lived (30+ years not unusual), and are therefore characterized by a low natural mortality rate (approximately 6%-11% per year). With reproductive biology unlike most other teleost fishes in the area, redfish mating occurs in the fall and females carry the developing embryos until they are extruded as free swimming larvae from April to July. Mating and larval extrusion do not necessarily occur in the same locations and *S. mentella* releases its larvae about 3 to 4 weeks earlier than *S. fasciatus*. Redfish larvae feed almost exclusively on calanoid copepods while juveniles and adult redfish eat euphausiids, mysids, and fish; the latter becoming increasingly important as redfish increase in size. Redfish are pelagic or bathypelagic feeders, feeding most actively at night when they rise off the bottom following the vertical migration of their prey.

Atlantic cod consist of two stocks (3Ps and 3Pn4RS) whose range overlap with the AOI study area. Cod are usually found near bottom, with larger cod keeping closer to the bottom than smaller cod. However, it is likely that the primary factors affecting distribution and habitat is temperature and food supply. Many studies have suggested the importance of heterogeneous, physical habitat for the survival of juvenile cod during the first years of their lives. Based on the RV survey information, the number of cod caught within the AOI represents only 8% of the number caught outside during this time of year. In terms of density (number per tow within the AOI versus outside) the ratio is 0.65.

Tagging results from within 3Ps suggest that the stock here comprises several offshore; and, several inshore components (Placentia and Fortune Bays) that exhibit limited mixing between them. Regular shoreward migrations of offshore fish also appears to occur during the summer and fall, also resulting in mixing. Cod in 3Pn4Rs, adjacent to the study area, are characterized by extensive summer migrations northward along the west coast of Newfoundland to the middle and lower Quebec north shore. Tagging data from the 4RS3Pn stock suggests mixing occurs in the northwest Gulf of St. Lawrence, the Strait of Bell Isle in summer, and in the Burgeo Bank

area of western 3Ps in winter. Past studies also identified overlap of stocks, particularly during winter months. On the other hand, several studies have identified the Laurentian Channel as a significant barrier to stock mixing with <5% straying across the deep channel. The 3Ps spring RV biomass index from the offshore strata is variable but declined from the mid-1980s to the early 1990s. Values for most of the period from 1997 up to 2004 were higher than those of the early 1990s, but not as high as those of the 1980s. The biomass index shows a general declining trend from 2001 to 2008 but was higher and near the post-moratorium (1997) average in both 2009 and 2010. Spawning is spatially widespread in the study area (3P), occurring close to shore as well as on Burgeo Bank, St. Pierre Bank, and in Halibut Channel. The timing of spawning in the study area is variable and extremely protracted, with spawning fish present from March until August in Placentia Bay. Female cod from this stock are maturing at younger ages in recent years for example, about 35% of the females are mature by age 5 (~47 cm) in recent cohorts, compared to only about 10% at age 5 (~55 cm) among cohorts from the 1970s and early 1980s.

Cod consume a spectrum of prey depending on cod size. Cod larvae consume phytoplankton and small zooplankton. Early juveniles tend to consume small crustaceans, mysids and euphausiids, while larger cod begin feeding on fish, including other cod, as soon as their gape is large enough. Fish consumed by cod include capelin, sand lance, herring, redfish, cunners, haddock, flounder, and mackerel, among others. Adult cod may also consume a variety of invertebrates, including polychaetes.

Haddock, within the study area, is generally distributed outside the AOI (<1% inside) on and along the edges of the banks and Hermitage Channel. This appears influenced by temperature and depth (> 6 °C; < 250 m). Movement within the study area to areas further south does occur on a seasonal basis, i.e., during fall. Over time, abundance in the area has declined significantly to very low numbers. Haddock are known to spawn along St. Pierre bank and its slopes during spring (March). Adult haddock consume mainly benthic invertebrates, while known predators include other fish (preying on mostly juvenile haddock) and seals.

Pollock, within the study area, is generally distributed outside the AOI (~1% inside) along the edges of the banks and the Hermitage Channel. This appears influenced by temperature and depth (> 6 °C; 200-350 m). Movements within the study area are unknown, but it appears that pollock have never occurred in the study area in large numbers; and indices of abundance are unavailable for this species. In addition, very little is known about the biology and life history of pollock, but spawning is believed to occur in the study area. Adult pollock offshore consume mainly sand lance, herring, silver hake, redfish and lanternfish.

White Hake, within the study area, are generally distributed outside the AOI (~23% inside) and are widely distributed from southern Labrador to Cape Hatteras (North Carolina). Limited movement occurs on a seasonal basis, for example extending into shallower or inshore sites in autumn. Females are highly fecund; producing 4-15 million eggs. There is some geographic separation between life stages, and eggs, larvae, and young-of-the-year juveniles are pelagic. Abundance of the 3Ps/Grand Banks stock showed a large, rapid increase in 1999-2000; then declined to lower levels similar to those observed prior to the increase. Bottom-dwelling juveniles mainly eat shrimp, marine worms, and small crustaceans. Older white hake eat shrimp, euphausiids, and some fish. Adults eat herring, Atlantic cod, haddock, sand lance, and winter flounder. Known predators include seals, Atlantic cod, and larger white hake. Pelagic larvae are susceptible to plankton-feeders.

Monkfish, within the study area, are generally distributed outside the AOI (~33% inside) mainly along the edges of the banks. Limited movement occurs on a seasonal basis: to shallower

water during summer and to deeper water during winter. Abundance in NAFO subdivision 3Ps has shown considerable fluctuations over time. After declining to low levels in 1992-1993, abundance increased to its largest observed peak in 2003. Female monkfish are known to deposit ~1 million eggs in a large pinkish, mucous sheet (i.e., “veil”) up to 6-12 m in length at the ocean’s surface in June-July. After hatching, larvae are pelagic for several months until they settle on the bottom at ~8 cm in length. Pelagic larvae consume zooplankton, small juveniles eat mainly crustaceans after settling on bottom (but begin consuming fish), and adults are largely opportunistic, eating mainly fish, crustaceans, squid, and sometimes seabirds and diving ducks. Known predators include swordfish, sharks, and sometimes larger monkfish. Pelagic larvae are susceptible to plankton-feeders, and small juveniles are possibly eaten by other bottom-dwelling fish.

Northern wolffish, within the study area, are generally distributed ~52% inside the AOI and are very widely distributed from the Davis Strait/west Greenland to the Grand Banks and Laurentian Channel. This appears to be influenced by water temperature (the species prefers 1.6 - 4°C). Movement patterns are unknown; although a tagging study by Templeman (1984) showed limited movement in Labrador waters (within 8 km of the tagging site).

Spotted Wolffish, within the study area, are generally distributed outside the AOI (~16% inside) and are also widely distributed from west Greenland to the Grand Banks and eastern Scotian Shelf. This appears influenced by water temperature (the species prefers 3 - 4°C). A tagging study by Templeman (1984) showed limited movement by spotted wolffish. For both spotted and northern wolffish, abundance trends in NAFO subdivision 3Ps are variable throughout the available time series.

Atlantic Wolffish, within the study area, are generally distributed outside the AOI (~0.5% inside) and are widely distributed from west Greenland to the Grand Banks and eastern Scotian Shelf/northern USA. This appears influenced by water temperature (the species prefers 1 - 4°C). A tagging study by Templeman (1984) showed limited movements by Atlantic Wolffish, while Keats *et al.* (1985) reported inshore movement in Spring to depths of 5-15 m for spawning. Abundance in NAFO subdivision 3Ps showed a general decline from the mid-1970's to the mid1990s. An increasing trend in abundance (with some fluctuations) was seen in 1996-2009. After mated pairs formed during summer, Keats *et al.* (1985) observed spawning in August-October.

Sperm and egg production is low in all 3 species of wolffish, and fertilization is internal. Females deposit cohesive egg masses on rocks and in crevices, and males fast while guarding these egg “nests”. Large hatchlings (2 cm in length) possess yolk sacs and are pelagic; the entire larval stage is spent close to the nest area. Wolffish possess large lateral molars to crush hard-shelled prey on the bottom, such as sea urchins, starfish, sand dollars, clams, and cockles. Northern wolffish also eat soft-bodied prey: bathypelagic fish, “sea gooseberries” (comb jellies), and jellyfish. Known predators of juvenile wolffish include redfish, Atlantic cod, pollock, Greenland shark, skates, and seals.

Porbeagle sharks are generally distributed in Atlantic Canada south of Labrador, including throughout the AOI. The distribution appears influenced by temperature (2-15 °C), but not by depth. Movement into the study area occurs around May, with movement out of the study area to areas further south occurring in late fall. Long term abundance in the stock area has declined to about 20% of unfished numbers, although abundance has been stable in the past decade. One of only two mating grounds for porbeagle occurs off southern NL and the entrance to the Gulf of St Lawrence, including in the AOI. Porbeagle consume fish and squid, and have no predators other than humans.

Spiny dogfish are generally distributed in Atlantic Canada south of Labrador, on the Western portion of the St. Pierre Bank adjacent to the Laurentian Channel and onto the Hermitage Channel. The distribution appears influenced by temperature and depth ($> 5^{\circ}\text{C}$; $< 250\text{ m}$). Movement within the study area occurs seasonally, primarily inshore to offshore. Long term abundance through the stock area has declined slightly, but abundance in the study area appears to have remained stable. Spiny dogfish mating and pupping grounds are believed to occur in deep water off of banks, but reproductive grounds in the study area have not been documented. Spiny dogfish consume small fish and invertebrates, while known predators include larger sharks.

Basking sharks are generally distributed in Atlantic Canada south of Labrador, including throughout the AOI. The distribution appears influenced by temperature ($>6^{\circ}\text{C}$), but not by depth. Movement into the study area occurs around June, with movement out of the study area to areas further south occurring in fall. Long term abundance has declined by about 50%, although abundance has been stable in the past decade. Mating may occur in the study area, but it has not been documented. Basking sharks are filter feeders, and often swim in surface waters consuming zooplankton. They have no predators other than humans.

Cetaceans occurring within the AOI and its study area are mainly transient and seasonal in nature. However, it is possible that some species and/or individuals may occur there year-round. At least 20 species of cetaceans have been observed in the study area (both nearshore and offshore), where distribution appears influenced mainly by food availability. For those that move into the area seasonally, this mainly occurs during spring/summer. Migration out of the area to southern overwintering (and calving) grounds mainly occurs during the fall/winter. Regular standardized surveys of cetacean distribution and abundance are unavailable for this and other areas in the Northwest Atlantic. Opportunistic cetacean sightings data can be used to indicate which species may or are known to occur in any given area, but cannot provide fine-scale quantitative representations of marine mammal abundance or distribution. Other uncertainties in such data includes inconsistencies in effort over space and time, as well as potential errors in species identification. DFO has conducted systematic aerial surveys with coverage of at least parts of the study area in 2003, 2007 and 2010. DFO has also deployed an underwater, autonomous acoustic recording system for the first time in the summer of 2010 to detect marine mammal sounds, to assess anthropogenic and natural underwater noise sources, and to verify sound propagation models for this area. Humpback, fin, and minke whales are those most frequently sighted in the study area. These species primarily consume krill and small schooling fishes, with the only known predators being killer whales. Several species occurring in the study area have been identified by COSEWIC or SARA for special protection, including the 'endangered' blue whale, beluga whale, North Atlantic right whale and 'species of concern' fin whale.

Leatherback sea turtles are the most frequently occurring sea turtle in the study area, although loggerhead sea turtles have also been known to occur there. The largest concentrations occur on the continental shelf and slope; but also further offshore. Leatherback turtles undergo an annual migration between breeding areas at low latitudes (e.g., South and Central America, the Caribbean, and continental U.S.) and foraging habitat in temperate waters, including those of the study area. Notably, the south coast of Newfoundland, i.e., the study area, is one of the most highly-frequented leatherback foraging areas in Atlantic Canada (Atlantic Leatherback Turtle Recovery Team 2006). The leatherback "season" in Canadian waters extends from May through December, with the majority of turtles present from July through to mid-October (Atlantic Leatherback Turtle Recovery Team 2006). Here, leatherback turtles are known to aggregate to consume jellyfish. Leatherback sea turtles are listed as 'endangered' under SARA.

Entanglement in lines associated with fixed fishing gear constitutes the principal source of human-induced injury and mortality for leatherbacks in Canadian waters; although vessel strikes and ingestion of marine debris, particularly plastics, constitute additional threats to leatherbacks in the marine environment. Behavioural responses to noise such as seismic have also been observed in marine turtles.

Black dogfish, within the study area, is generally distributed inside the AOI (~ 69% inside). This appears influenced by temperature and depth (>3.8 C and > 300m) where the species is usually distributed by size and sex with respect to depth. Movement within the study area does not occur on a seasonal basis, but rather movements are contained within the area based on reproductive activity and maturity. Over time, abundance in the study area has fluctuated. Low levels during 1970's and early 1980's were followed by rapid increases and then stabilization up to the mid-1990's. There has since been a decline in abundance, perhaps to stability in recent years. Notably, the Laurentian Channel is the only known area for black dogfish pupping in Canadian waters, with specific timing of these events currently under investigation. Black dogfish consume mainly crustaceans, squids, cephalopods, jellyfish, and bony fishes. There is no directed fishery for this species but they are taken as bycatch in a number of deepwater fisheries (~60-100 t annually).

Smooth Skate, within the study area, is generally distributed outside the AOI (~ 44% inside). This appears influenced by temperature and depth (greatest densities at 5-6 C and 400-500 m), and potentially prey availability. Movement within or out of the study area likely does not occur on a seasonal basis. However, a spatial separation of sizes in the study area has been demonstrated where primarily small juveniles occur in the Laurentian Channel, whereas the adjacent banks have much larger fish. Abundance of smooth skate in the area declined significantly from the 1980's to mid-1990's, but has since increased to much greater levels. The reproductive cycle has not been described for this part of the species range; and other life history parameters are also largely unknown. Smooth skate are selective and consume primarily small crustaceans through most of their life, and fish only at their largest sizes.

Thorny skate, within the study area, is generally distributed outside the AOI (~ 11% inside). Thorny skate are widely distributed in the Northwest Atlantic across a very broad range of temperature, depths, and bottom type, and so these are likely not limiting in their distribution. While limited seasonal migrations have been noted in some Thorny Skate on the Grand Banks (Kulka and Miri 2003), a relatively sedentary behaviour has also been noted (DFO 2007). A significant decline in the abundance of this species occurred during the mid-1980s but a stable (lower) abundance since that time has been noted. Thorny Skate is listed as Vulnerable on the IUCN Redlist, and is currently being assessed by COSEWIC. Thorny skate reproduction occurs year round off Canada, while peak spawning appears to occur in the fall and winter further in on the shelf. Age, growth and other life parameters have not been studied in sufficient detail for understanding population dynamics of these skates. Thorny skate consume a wide spectrum of prey (90 species identified) – with sand lance and snow crab being the two most important items of those on the Grand Banks.

Information Gaps and Uncertainties

Information put forward for the biophysical overview had various levels of uncertainty associated with it.

Information that exists but was not considered for all species

- Gulf stocks which occur in or could migrate into the AOI
- Historical and additional inter-regional databases, e.g. pre-Campelen trawl survey indices; Maritimes/Gulf surveys that may be relevant for some species adjacent to the AOI in NAFO Subarea 4 (eg. 4Vs, 4Vn)
- Information related to species not included in the list of conservation priorities, but which occur in the study area
- Species information relative to the stock or population level
- Commercial fisheries data, observer and port sampling data

Information that is not available

- Consistent (spring and fall annually) oceanographic surveys in 3P
- Research vessel surveys across all seasons in 3Ps (available for Spring only from 1993-present)
- Groundtruthing of benthic habitat, e.g., corals, sponges
- Standardized information on distribution and abundance of cetacean and some shark species (sampling gap – information biased by sightings/effort)
- Migratory patterns of marine mammals and leatherback sea turtles relative to the AOI.
- Potential [preferred] structural habitat associations for many of the species considered, and the influence of scale on these

CONCLUSIONS

The bathymetric features of the Laurentian Channel AOI and its adjacent banks in the study area, as well as the general surficial and shallow geology attributes of the area, may be sufficient for broad-scale generalizations related to habitat associations of species of interest that interact with the bottom. In general, depth across banks and channels ranges from 100-500m, and mud and clay characterize deeper areas, while sand and gravel occur mainly on the banks.

Physical and biological oceanographic characteristics in the study area are comparatively unique to others in the Region in many aspects. The occurrence of sea ice is infrequent in the study area, occurring only during maximum extent years (less than 10 of the last 30 years). The Laurentian and Hermitage Channels and areas to the west of St. Pierre Bank exhibit some of the warmest bottom water temperatures in the Region (2-7 °C), while St. Pierre Bank and regions to the east are somewhat cooler than this (-1 to 1 °C). Circulation in the area is also unique. Plankton assemblages in the AOI are similar to other inner shelf areas of the Grand Banks; however, calanoid copepods and macrozooplankton show very different seasonal cycles of abundance and long term changes in the AOI.

Sensitive and unique habitats occurring in the AOI are represented by various species of corals. However, of the corals occurring in the AOI, sea pens have been recorded in the greatest

numbers and with the greatest diversity; and have also been described as having their highest regional concentrations within the Laurentian Channel (just west of the study area).

Of the fish species of interest only the black dogfish and the northern wolffish, occur more frequently within the AOI (69% and 52% inside respectively) than outside the AOI within the boundary of the study area, based on DFO trawl surveys. Similarly, the frequency inside the AOI (within 3Ps) for the remaining demersal fish species is 33% for Monkfish, 29 % for Smooth skate, 23% for White hake, 11% for Thorny skate, 7% for Atlantic Cod, 7% for Spiny dogfish, 5-14% for Redfish species, 2% for Pollock and <1% for Haddock.

Many species (at least 20) of cetaceans have been observed both nearshore and offshore in the study area, with the most frequently observed species being humpback, fin, and minke whales. Most cetaceans occur either seasonally (during spring/summer) or as transients in the study area, although some may also occur there year-round. At the same time, leatherback sea turtles are the most frequently occurring sea turtle in the study area, where the south coast of Newfoundland is one of the most highly-frequented leatherback foraging areas in Atlantic Canada. Porbeagle and basking sharks move into the study area around May-June, with movement out of the study area to areas further south occurring in late fall. One of only two known mating grounds for porbeagle occurs in the AOI.

Uncertainties existing within the biophysical assessment of the Laurentian Channel AOI study area are related to both i) information that was not considered during the review for various reasons, and ii) information that is unavailable. Information not considered for all species included that from historical and additional inter-regional databases, e.g. pre-Campelen trawl survey indices; Maritimes/Gulf surveys that may be relevant for some species; information related to other species occurring in the study area, including all species and stocks which occur in or could migrate into the AOI; a broader assessment of species information relative to the stock or population level; and commercial fisheries data, including observer and port sampling data. Information that was not available for contribution to the assessment is often related to inconsistencies in monitoring, such as oceanographic surveys in 3P across all years; research vessel surveys not existing across all seasons in 3Ps; and lack of standardized information on distribution and abundance of cetacean and pelagic species. Uncertainties due to the lack of available information are also related to ground-truthing of benthic habitat, e.g., corals, sponges; and potential [preferred] structural habitat associations for many of the species considered, and the influence of scale on these.

Monitoring of oceanographic and biological properties in the study area is not as consistent as that for other areas in the Newfoundland and Labrador Region. Oceanographic monitoring of two standard AZMP lines can inform the physical, chemical, and biological oceanography of the study area – although these are not monitored consistently during spring and fall surveys. Annual multispecies research vessel (RV) surveys can inform the status and trends of primarily demersal species within the study area. However, these occur only during spring in 3P (the study area) as opposed to during spring and fall in some other areas surveyed in the Region.

With respect to potential threats to the species of interest in the study area, various activities have been identified as being of potential risk to some species of interest either spatially or temporally, including fishing, oil and gas activities, and vessel traffic. However, further identification of pathways of effects and level of threat on an individual basis should be considered on a case-by-case basis.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Regional Advisory Process of November 9-10th, 2010 on the Biophysical Overview of the Placentia Bay Grand Banks Large Ocean Management Area (LOMA) Area of Interest (AOI). Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at <http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm>.

Atlantic Leatherback Turtle Recovery Team 2006. Recovery Strategy for Leatherback Turtle (*Dermochelys coriacea*) in Atlantic Canada. *Species at Risk Act Recovery Strategy Series*. Fisheries and Oceans Canada, Ottawa, vi + 45 pp.

DFO (Fisheries and Oceans Canada). 2007. National Plan of Action for the Conservation and Management of Sharks. March 2007.

DFO. 2010. Assessment of redfish stocks (*Sebastes fasciatus* and *S. mentella*) in Units 1 and 2 in 2009. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/037.

Keats, D.W., South, G.R., and Steele, D.H. Reproduction and egg guarding by Atlantic wolffish (*Anarhichas lupus*, *Anarhichidae*) and ocean pout (*Macrozoarces americanus*, *Zoarcidae*) in Newfoundland waters. Can. J. Zool., 63: 2565-2568.

Kulka, D.W., and Miri, C.M. 2003. The status of monkfish (*Lophius americanus* Valenciennes 1837; *Lophiidae*) on the Grand Banks, NAFO Divisions 3L, 3N, 3O, and Subdivision 3Ps. Can. Sci. Advis. Sec. Res. Doc. 2003/100. ii+63pp.

Templeman, W. Migration of Wolffishes, (*Anarhichas* sp.), from tagging in the Newfoundland area. J. Northw. Atl. Fish. Sci. 5: 93-97.

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