3.0 Biological Environment

This section presents an overview of the SEA Area's ecosystem with emphasis on valued ecosystem components (VECs). A VEC in Canadian environmental assessment parlance is a key part of the environment that is recognized by society as important ecologically, scientifically, economically, recreationally, or culturally. A VEC may be of local, national, or international interest. A VEC may be a species or group of species, or valued human activity that has at least some potential to be affected by a proposed project. Typical VECs on the east coast of Canada include fish habitat, fish, fisheries (aboriginal, commercial, recreational, aquaculture), marine birds, marine mammals, sea turtles, Species at Risk (SAR) as listed in legislation, and sensitive areas.

This SEA considers the biological environment from intertidal to offshore areas where water depths reach 4,000 m. 'Continental shelf' refers to areas where water depth ≤200 m, and 'slope/abyssal' refers to the continental slope and rise where water depths range from >200 to 4,000m. The study areas defined in the Laurentian Subbasin and Sydney Basin Offshore Area SEAs are contained within the Southern Newfoundland SEA Study Area (the "SEA Area"); thus, the biological descriptions presented in those two SEAs are summarized and updated in the present SEA. The remainder of the Southern Newfoundland SEA Study Area (i.e., most of NAFO Division 3O) has not been described in prior SEAs and will, therefore, receive much of the focus here.

3.1 Fish Habitat

In this SEA, the fish habitat VEC includes the bottom substrate, macroalgae, phytoplankton and zooplankton, and non-commercial benthic invertebrate fauna (e.g., polychaetes, echinoderms, molluscs). Seawater quality is also discussed, particularly in regard to discharges in later sections.

3.1.1 Bottom Substrate

The physical and chemical nature of the bottom substrate is a critical factor affecting the characterization of the associated marine biological community. Available information pertaining to bottom substrate occurring in the SEA Area is presented in the previous section on the physical environment.

The continental shelf west of the French waters associated with St. Pierre et Miquelon is limited, comprised of a relatively narrow coastal strip extending along most of the SEA Area coastline (e.g., Rose Blanche Bank, Burgeo Bank and part of St. Pierre Bank).

3.1.2 Coastal Algal Communities

Macro-algal communities in the SEA Area are diverse and serve as an important component of the intertidal and shallow subtidal (≤30 m depth) coastal fish habitat.

3.1.2.1 Marine Algae

The high exposure and the rare occurrence of sea ice scour result in south coast algal habitats that are similar to those found in Nova Scotia and New England. The greatest abundance and diversity of non-estuarine algal species in Newfoundland are found on the south coast. Regardless of exposure level, the intertidal zone along the south coast is dominated by brown algae of the order Fucales (i.e., fucoids) (e.g., genera *Ascophyllum*, *Fucus*). In addition to the fucoids, the south coast non-estuarine coastal algal communities are also characterized by various brown algae of the order Laminariales (e.g., genera *Laminaria*, *Alaria*) and red algae such as *Palmaria palmata*. The algae found in the most sheltered areas are predominantly fucoids. Typical non-estuarine algal communities on the southwest coast of Newfoundland that vary by degree of exposure are presented in Table 4.1 on page 82 of the Sydney Basin SEA (JW 2007).

Meltzer (1996) lists and describes many of the more widely distributed nonestuarine coastal habitat/community types found on the south coast, including some key algal groups/species typically associated with the different habitat types. These include

- Sheltered rocky shores (tubular green algae, crustose algae);
- Exposed rocky shores (bladed red algae, filamentous red and green algae);
- Seabird shores (crustose algae, lichen);
- Sea caves and shaded areas (filamentous red algae, crustose algae);
- Saltmarshes (cordgrass, crustose algae, bladed green algae);
- Beaches (stranded, decaying algae);
- Rocky unscoured shores (rockweeds, knotted wrack, Irish moss);
- Ice-free exposed shores (rockweeds, bladed red algae);
- Land-fast ice shores (rockweeds, knotted wrack, crustose algae);
- Sedimentary beaches (diatoms, cyanobacteria);
- Unscoured kelp beds (bladed and filamentous brown algae, bladed red algae);
- Scoured exposed subtidal (bladed and filamentous brown algae);
- Sheltered kelp beds (bladed and filamentous brown algae, Irish moss);
- Ice-covered subtidal (cord weed, Irish moss, crustose algae);
- Irish moss beds (Irish moss);
- Eel grass beds (Eel grass);
- Sea urchin barrens (coralline algae);
- Coralline algae beds (coralline algae, bladed brown algae, bushy red algae);
- Fjord kelp beds (bladed and filamentous brown algae, bladed and filamentous red algae); and
- Exposed deep-water seaweeds (coralline algae, red algae).

The above algal coastal habitat/community categorization is indicative of the diversity associated with non-estuarine coastal algal communities in the SEA Area.

3.1.2.2 Estuarine Algae

Variation in algal community composition in Newfoundland estuaries appears to be primarily dependent on substrate type. On hard, stable substrates in estuarine areas, algal communities are dominated by brown algae including fucoids and *Chorda* sp. while less stable sand and mud substrates in estuarine areas are typically dominated by eelgrass (*Zostera marina*) and epiphytic algal species (plant living on surface of another plant). Deeper estuarine areas typically have a high abundance of diatoms and other unattached microscopic algae. Typical estuarine algal communities of Newfoundland that vary by substrate type are presented in Table 4.2 on page 82 of the Sydney Basin SEA. Meltzer (1996) describes an estuarine coastal habitat/community type found on the south coast. Estuarine shores in the SEA Area are characterized by extreme seasonal and short term variations in flow rates, relatively small watershed drainage areas, low nutrient concentrations and low sediment input. Dominant algal species in this biotype typically include bladed green algae (*Capsosiphon fulvescens*), tubular green algae (e.g., *Enteromorpha* spp., *Blidingia minima*), crustose algae (e.g., *Hildenbrandia rubra*, *Ralfsia verrucosa*) and cyanobacterial species.

3.1.3 Plankton

Plankton refers to free-floating plants and animals that form the basis of the pelagic ecosystem. Members include bacteria, fungi, phytoplankton (plants), zooplankton (e.g., small invertebrates), macroinvertebrate eggs and larvae, and ichthyoplankton (eggs and larvae of fish). Macroinvertebrate eggs/larvae and ichthyoplankton will be discussed in more detail in a later subsection pertaining specifically to macroinvertebrates and fishes. Plankton production is important because areas of enhanced production and/or biomass tend to be congregation areas for fish, seabirds, marine mammals, and possibly sea turtles. Production is enhanced in areas of bottom upwelling where nutrient-rich bottom water is brought to the surface by a combination of bottom topography, wind and currents. Frontal areas are where two dissimilar water masses meet to create lines of convergence and often concentrate plankton and predators alike. A well-known example of this phenomenon is the semi-permanent front between waters of Gulf Stream origin and waters of Labrador Current origin. The two physical processes (upwelling and fronts) may be found together in varying degrees, particularly in coastal areas.

In simplest terms, the phytoplankton (e.g., diatoms) produces carbon through the utilization of sunlight and nutrients (e.g., nitrogen, phosphorus, silicon). This process is called primary production. In the North Atlantic, there is strong seasonal variability in primary production, typically characterized by a peak in the spring (March-June) coincidental with increased light levels. This is known as the spring bloom. Increased light during the spring warms the upper 10 to 20m of the water column, resulting in the establishment of a thermocline. This in combination with intense grazing by zooplankton and a depletion of nutrients results in a mid-summer primary production low. As the thermocline weakens and upwelling increases in the fall, another lesser primary production peak typically occurs (Figure 3.1).

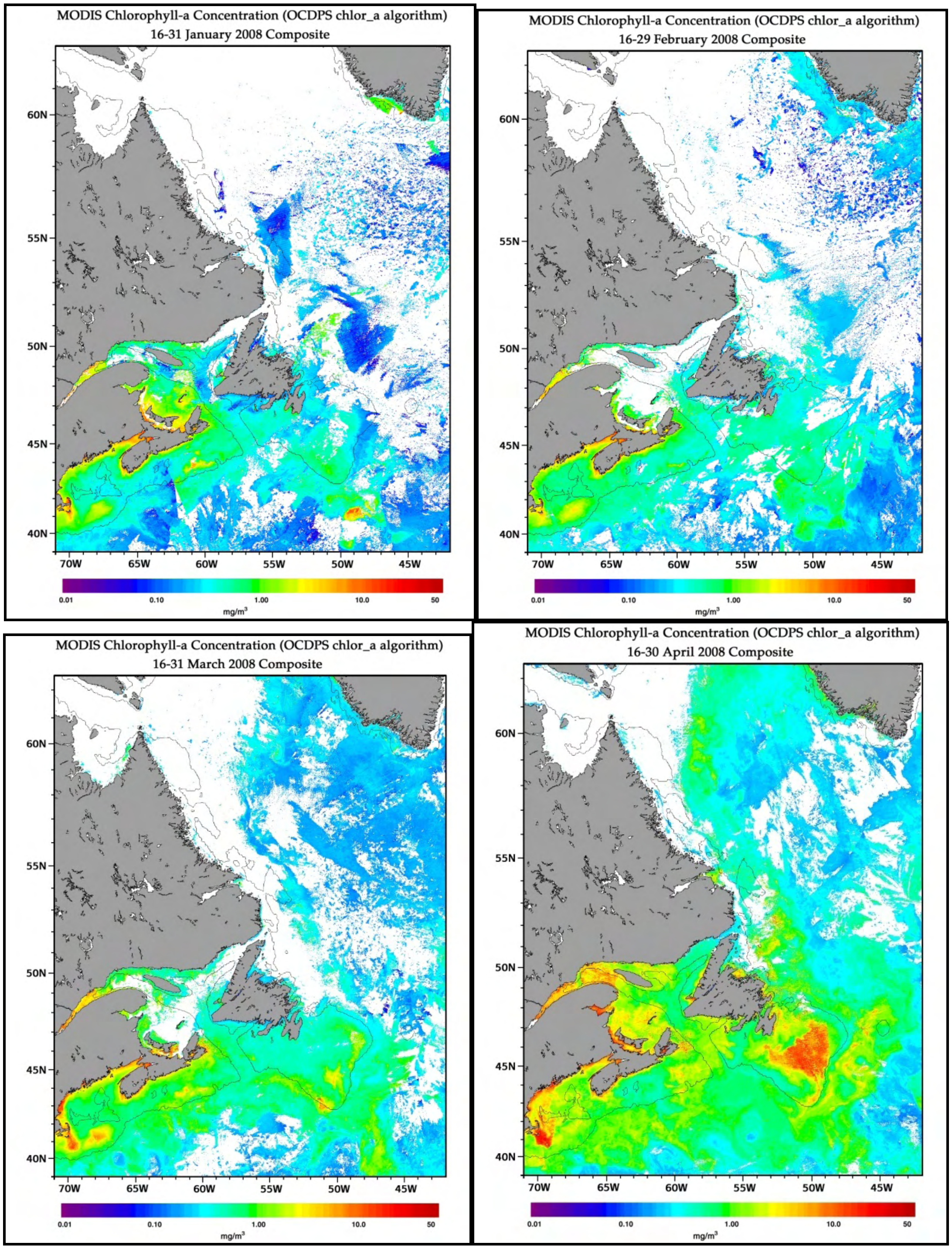
Physical oceanographic conditions and dynamics affect the distribution, abundance and growth rates of phytoplankton. Waters along the edge of offshore banks are often very productive due to the upwelling of nutrient-rich water. These areas of relatively high primary production are typically congregating areas for zooplankton and nektonic marine biota (i.e., actively swimming animals).

As indicated in Figure 3.1, the areas within the SEA Area where primary production was highest at certain times during 2008, based on chlorophyll-a concentration, included the coastal region of the southwest coast of Newfoundland, the western edge of St. Pierre Bank/ Laurentian Channel, and both the shelf edge/slope and shelf of the southwest Grand Bank.

DFO's Atlantic Zone Monitoring Program (AZMP) was initiated in 1998 to provide better understanding of the state of the marine ecosystem and its changes with respect to physical, chemical and biological properties. One element of the AZMP is the assessment of the distribution and variability of nutrients and the plankton they support. Data are collected through a network of sampling locations (i.e., fixed point stations, cross-shelf sections, trawl surveys, satellite remote sensing) in Atlantic waters. For the purposes of this SEA, data from one fixed point station (Station 27 [near St. John's, Newfoundland]) and four cross-shelf sections (Louisbourg [Nova Scotia], Cabot Strait [Nova Scotia-Newfoundland], Southeast Grand Banks [Newfoundland] and Flemish Cap [Newfoundland]) are examined to provide more perspective on phytoplankton and zooplankton in the regional waters. The 2006 average seasonally-adjusted biomass of phytoplankton at Station 27 increased relative to a declining trend between 2002 and 2005. Seasonal fluctuations in phytoplankton biomass in the Newfoundland region are dominated by changes in the abundance of diatoms. While diatoms typically dominate the phytoplankton in the spring bloom, flagellates and dinoflagellates tend to dominate during the fall.

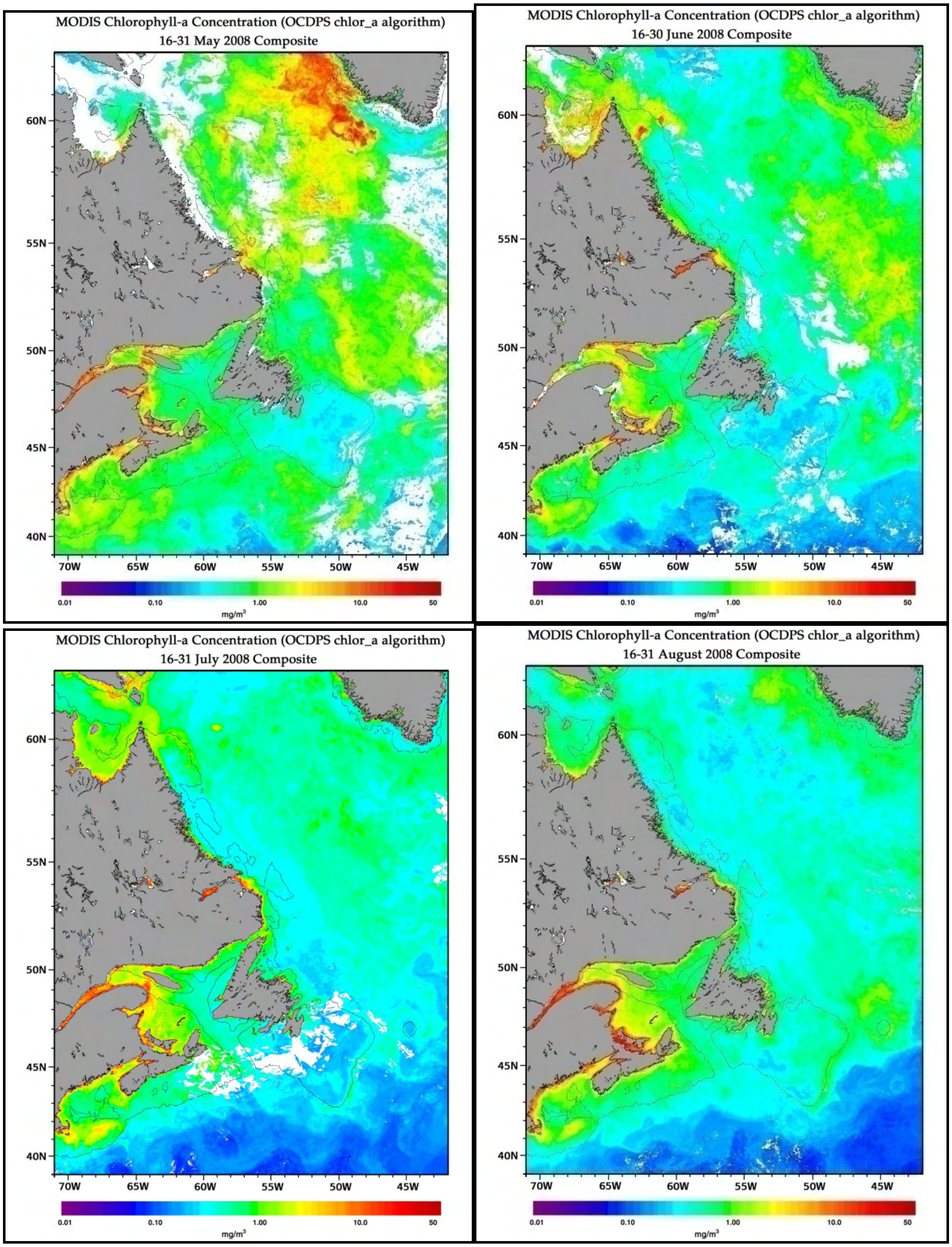
Herbivorous zooplankton (e.g., calanoid copepods, the dominant component of NW Atlantic zooplankton) feed on phytoplankton. This growth process is called secondary production. The herbivores are eaten by predators (i.e., tertiary production) such as predacious zooplankton (e.g., chaetognaths, jellyfish) which in turn are consumed by higher predators such as fish, seabirds, and marine mammals. This food web also links to the ecosystem on the seabed through bacterial degradation processes, dissolved and particulate carbon, and direct predation.

Zooplankton populations typically increase in the spring as a result of feeding during the phytoplankton bloom, then decline in the summer as they are grazed by predators. Population peaks tend to coincide temporally and spatially with the phytoplankton blooms. As indicated in the Sydney Basin SEA, zooplankton within the Laurentian Channel are dominated by euphausiids (*Meganyctiphanes norvegica* and *Thysanoessa* spp.), and calanoid copepods (*Calanus* spp.). Euphausiids and calanoid copepods are important prey for whales in this area. Calanoid copepods dominate the zooplankton that typically occur on St. Pierre Bank and serve as important prey for resident fish larvae (e.g., redfishes (*Sebastes* spp.)). Hyperiid amphipods and chaetognaths are also important components of the zooplankton occurring within the SEA Area. The vertical distributions of many zooplankton species exhibit diurnal variability, whereby concentrations in the surface waters are greater during the day. As is the case with phytoplankton, zooplankton biomass also shows considerable annual variability.



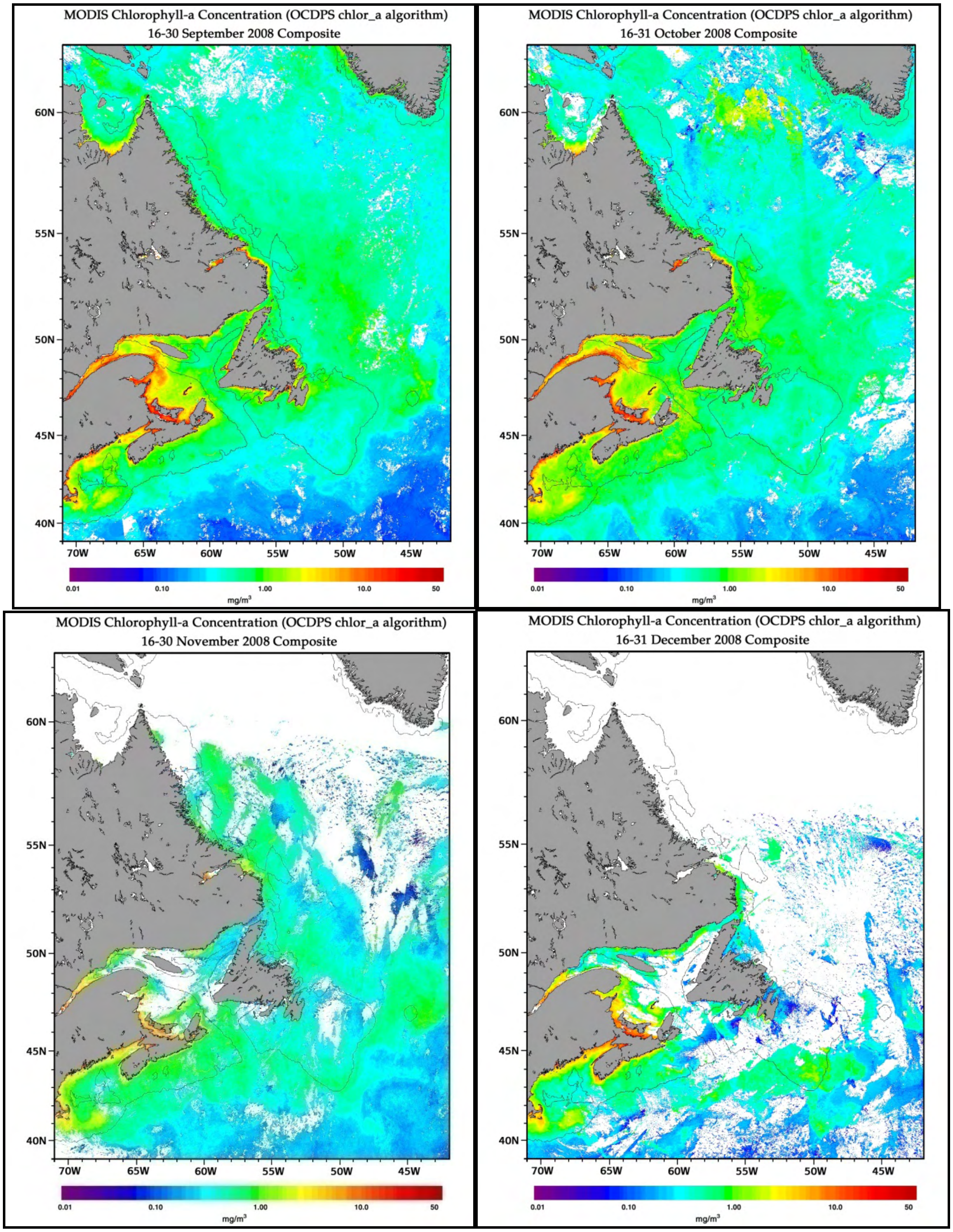
Source: DFO SeaWiFS/MODIS website: http://www.mar.dfo-mpo.gc.ca/bin/cgi/ocean/seawifs_1.pl

Figure 3.1. Chlorophyll-a Concentrations, January to December 2008.



Source: DFO SeaWiFS/MODIS website: http://www.mar.dfo-mpo.gc.ca/bin/cgi/ocean/seawifs_1.pl

Figure 3.1 (continued).



Source: DFO SeaWiFS/MODIS website: http://www.mar.dfo-mpo.gc.ca/bin/cgi/ocean/seawifs_1.pl

Figure 3.1 (concluded).

Relevant summary points in the 2006 '*State of the Ocean*' *Science Advisory Report* (DFO 2007b) for the Newfoundland and Labrador Region, which includes an AZMP transect near the eastern part of the SEA Area, are as follow:

1. The inventories of nitrate, the principal limiting nutrient, have remained relatively stable since 1998 although there appears to be a decline in near-surface levels and an overall reduction in the magnitude of the seasonal cycle in recent years;
2. Indications of a decrease in phytoplankton at Station 27 since 2002 were reversed in 2006 although the magnitude of the change was not statistically significant nor was it reflected along the oceanographic transects;
3. In 2006, the overall abundance of zooplankton at Station 27 was low relative to the long term average in 6 of the 12 dominant species groups, including *Calanus glacialis* and *C. hyperboreus*;
4. The abundance of *C. finmarchius* at Station 27 rebounded from its lowest level the previous year, as did the abundances of euphausiids and *Metridia* spp.; and
5. The abundances of the dominant copepod species on the southern Grand Banks were near or at the lowest levels observed since 2000.

More details of the 2006 chemical and biological oceanographic conditions in the Newfoundland and Labrador Region can be found in Pepin et al. (2007).

Relevant summary points in the 2007 '*State of the Ocean Science Advisory Report* (DFO 2009a) for the Scotian Shelf which includes one AZMP transect across the Cabot Strait (northwest part of SEA Area) and one transect across the eastern Scotian Shelf (eastern part of SEA Area), are as follow:

1. Deep nutrient inventories (50-150m) in spring were low across the entire Scotian Shelf. However, the spring phytoplankton bloom was at record high levels over the entire Scotian Shelf;
2. Chlorophyll levels outside of the bloom period have been declining since 1999;
3. Overall zooplankton biomass and abundance was low in 2007;
4. Warm water zooplankton taxa that are usually abundant during the summer and fall were less abundant than normal on the scotian Shelf, and Arctic species comprised a larger proportion of the community than normal on the eastern Scotian Shelf; and
5. Observations from the Continuous Plankton Recorder indicate that, compared with the historical data record since 1961, current phytoplankton and zooplankton abundances on the Scotian Shelf are close to the long term average.

More details of the 2007 chemical and biological oceanographic conditions on the eastern Scotian Shelf and Cabot Strait can be found in Harrison et al. (2008).

Macroinvertebrate eggs/larvae and ichthyoplankton will be discussed in a following subsection on the Fish VEC, especially from the perspective of known times and locations of high densities of these eggs and larvae.

3.1.4 Benthic Invertebrates

Benthic invertebrates which can be affected by disturbances to the seabed form an important link to higher trophic levels such as fish, marine-associated birds, marine mammals and sea turtles. Physical factors (e.g., tides, depth, substrate, salinity, waves, ice and temperature) that affect the benthic invertebrate fauna are closely interrelated.

Literature reviews of coastal benthic resources of Newfoundland and Labrador are available (e.g., MacLaren 1977; South et al. 1979; Barrie et al. 1980; Campbell and Sutterlin 1981; Thompson and Aggett 1981; LeDrew 1984; Hardy 1985; Gilkinson 1986). However, in a review of marine benthic molluscs in Newfoundland and Labrador waters, Gilkinson (1986) cites 147 references, noting that while several species have been studied intensively, most species have received only very cursory attention.

3.1.4.1 Continental Shelf

For coastal Newfoundland waters, the majority of benthic community composition data exist as a result of EIS-support studies associated with offshore exploration for oil and gas (e.g., Barrie et al. 1980; Hutcheson et al. 1981;

Hardy 1984) or data associated with research conducted at Memorial University or DFO. Due to lack of sea ice along the coastal region of the SEA Area, long-term, stable shore communities of plants and invertebrates occur in the intertidal and shallow subtidal areas (Meltzer 1996).

Intertidal

The composition of intertidal benthic invertebrate communities in the SEA Area is dependent on the combination of physical factors mentioned above as well as certain biotic factors such as predation and grazing. The zonation of intertidal invertebrates is typically quite pronounced. Steele (1983) discussed typical Newfoundland intertidal communities associated with rocky (bedrock, boulder, cobble) shores, sandy beaches, fine substrates and salt marshes. Some of the benthic invertebrate fauna that typically occur in these intertidal communities are indicated in Table 3.1.

Table 3.1. Typical Key Invertebrate Species Associated with General Intertidal Habitat Types Occurring in the SEA Area.

Intertidal Substrate Type			
Rock	**Sand**	**Mud and Silt**	**Saltmarsh**
Various amphipods Barnacles Isopods Blue mussel Various gastropods Rock crab (*Cancer* spp.) Green sea urchin (*Strongylocentrotus droebachiensis*) Sea stars Sea anemones American lobster (*Homarus americanus*)	Nemertean worms Amphipods Cumaceans	Clams Polychaetes	Amphipods

Source: Steele (1983).

Meltzer (1996) lists and describes many of the more widely distributed intertidal habitat/community types found on the south coast, including some key invertebrate species typically associated with the different habitat types. They are as follow:

- Sheltered rocky shores (barnacles, periwinkles);
- Exposed rocky shores (amphipods);
- Seabird shores;
- Sea caves and shaded areas;
- Saltmarshes;
- Beaches (amphipods);
- Rocky unscoured shores (periwinkles);
- Ice-free exposed shores (barnacles, amphipods);
- Ice-scoured exposed rocky shores (periwinkles);
- Land-fast ice shores (periwinkles);
- Estuarine shores; and
- Sedimentary beaches (copepods, cumaceans, decapods, polychaetes, oligochaetes, bivalves, nematodes, etc.).

The above coastal habitat/community categorization is indicative of the diversity associated with intertidal coastal invertebrate communities in the SEA Area.

Shallow Subtidal (≤ 30 m depth)

Similar to the intertidal zone, the composition of shallow subtidal benthic invertebrate communities in the SEA Area is dependent on a variety of physical and biological factors. Characteristic shallow subtidal invertebrate species include lobster, various crabs, sea urchins, mussels, sea scallops, and whelks. Meltzer (1996) lists and describes many of the more widely distributed shallow subtidal habitat/community types found on the section of south coast, including some key invertebrate species typically associated with the different habitat types:

- Unscoured kelp beds (sponges, hydrozoans, bryozoans, mussels, amphipods, gastropods);
- Scoured exposed subtidal (sea urchins, amphipods, gastropods);
- Sheltered kelp beds (lobster, sea scallop, mussels, sponges, bryozoans, tunicates, chitons, sea anemones);
- Ice-covered subtidal (periwinkles, sea urchins);
- Irish moss beds (lobsters, gastropods);
- Eel grass beds (periwinkles, amphipods, mussels, crabs, shrimp, polychaetes, lobster);
- Infaunal communities (bivalves, polychaetes);
- Sea urchin barrens (sea urchins, limpets, whelks);
- Coralline algal beds (sea urchins, chitons, gastropods, limpets, bryozoans, polychaetes, tunicates, bivalves, copepods, amphipods, sponges, nemerteans, nematodes);
- Arctic fjord communities (chitons, sponges, bryozoans, hydrozoans, tunicates, brachiopods, foraminiferans, soft coral);
- Exposed deep-water seaweeds (bryozoans); and
- Arctic fjord basins.

The above coastal habitat/community categorization is indicative of the diversity associated with shallow subtidal coastal invertebrate communities in the SEA Area.

Deep Subtidal (30 to 200 m depth)

Much of the deep subtidal area of the SEA Area's continental shelf is separated into banks (e.g., Burgeo Bank, Green Bank, Whale Bank) by glacially deepened troughs (e.g., Hermitage Channel, Haddock Channel, and Halibut Channel).

Characteristic deep subtidal invertebrate species include lobster, snow crab (*Chionoecetes oplilio*), toad crab (*Hyas* spp.), rock crab, Iceland scallops (*Chlamys islandica*), sea scallops, northern shrimp (*Pandalus borealis*), Stimpson's surf clams (*Mactromeris polynyma*), propeller clams (*Cyrtodaria siliqua*), ocean quahogs (*Arctica islandica*) and sea urchins.

Meltzer (1996) lists and describes some of the deep subtidal habitat/community types likely found on the section of south coast:

- Exposed deep-water seaweeds (and bryozoans), and
- Arctic fjord basins.

Invertebrate fauna associated with these habitat types varies between locations and remains poorly studied.

The Sydney Basin SEA and the Laurentian Subbasin SEA both described benthic invertebrate communities reported by Hutcheson et al. (1981) and Nesis (1965) in deep subtidal areas of the Grand Banks. Reported invertebrate groups included echinoderms, polychaetes, crustaceans, bivalve molluscs and benthic colonial organisms such as bryozoans, hydrozoans, sponges and corals.

Infaunal invertebrates collected at Lewis Hill (SW Grand Banks) in recent years were dominated by polychaetes, followed by nemertean worms, amphipods and sea cucumbers. The invertebrate community found at Lewis Hill was very similar to those found in similar surficial sediment types elsewhere on the Grand Banks (Husky 2003a,b).

3.1.4.2 Slope/Abyssal

Desrosiers et al. (2000) reported on a location in Cabot Strait (47º 40.3'N, 60º 00.0'W) (slightly west of northwest portion of the SEA Area) which was sampled in November/December 1993 and June 1994. The depth of the station was 525 m. The dominant single sediment fraction was silt-clay. The intention was to examine the trophic structure of macrobenthic communities in the Gulf of St. Lawrence in relation to abiotic and biotic characteristics of the sampling sites. Both plankton and sediment were sampled at this station. Levels of both chlorophyll-a and bacterial levels in sediments were higher in summer than in winter.

Macrofauna appeared to be distributed deeper in the sediment during winter than in summer. Most of the macrofauna individuals were found in the upper 10 cm of sediment during the winter. Approximately half of the macrofauna were surface deposit feeders while another 34% were subsurface deposit feeders. Omnivores and carnivores made up the remainder of individuals found. Summer sampling found a similar scenario. Surface deposit feeders at the Cabot Strait sampling site included Spionidae (Laonice sp.), Paraonidae (Paraonis sp.), and the Gammaridae (*Harpinia propinqua*). Subsurface deposit feeders at Cabot Strait include scaphopods (*Antalis occidentale*), bivalves (Nuculana sp.; Nucula sp.), and the mollusc Aplacophora (Chaetoderma sp.) (Desrosiers et al. 2000).

Deeper stations had lower macrofaunal biomasses, due mainly to smaller organisms and less food compared to the shallower benthic communities. Deep-water stations also had higher proportions of mobile and semi-mobile small organisms (Desrosiers et al. 2000). Desrosiers et al. (2000) also concluded that geomorphological characteristics (e.g., bathymetry, topography, substratum) influenced the trophic structure and composition of benthic assemblages at the Cabot Strait location. They also suggested that regular albeit relatively low-level inputs of particulate matter favour the development of benthic communities dominated by surface deposit feeders.

The Laurentian Sub-basin Exploration Drilling Program EA (Buchanan et al. 2006) provided some information on deepwater benthos sampling on the Nova Scotian continental rise. The most abundant invertebrate groups found during sampling included polychaetes, bivalves, isopods and tanaids.

<u>Deep-sea Corals</u>

A recently published DFO technical report (Gilkinson and Edinger [eds.] 2009) presents the most recent knowledge on the ecology of deep-sea corals of Newfoundland and Labrador waters, including information relating to biogeography, life history, biochemistry and relation to fishes. For the purposes of this SEA, this subsection focuses on deep-sea coral biogeography and the relationship between deep-sea corals and fishes.

Deep-sea corals are recognized as important components of deep-sea ecosystems (Mortensen et al. 1995, Freiwald and Roberts 2005 *in* Gilkinson and Edinger [eds.] 2009). They provide habitat for a variety of fish species, including some that are commercial (Jensen and Frederiksen 1992, Hosebo et al. 2002, Buhl-Mortensen and Mortensen 2004, and Edinger et al. 2005 *in* Gilkinson and Edinger [eds.] 2009). Recently, the impact of fishing on deep-sea corals has been recognized as a major environmental concern (Watling and Norse 1998; Willison et al. 2001; Hall-Spencer et al. 2002; Fossa et al. 2001; and Scott et al. 2005 *in* Gilkinson and Edinger [eds.] 2009). Their extreme longevities and assumed slow growth rates can result in estimated recovery times from disturbance measured on time scales from tens to hundreds of years (Hall-Spencer et al. 2002, and Sherwood et al. 2005 in Gilkinson and Edinger [eds.] 2009).

Five functional groups: (1) large gorgonians or antipatharian corals, (2) small gorgonian corals, (3) cup corals, (4) sea pens, and (5) soft corals. The first two groups are considered the most sensitive of the deep-sea corals (Gilkinson and Edinger [eds.] 2009) because these carbonate skeletal corals cannot reattach to substrate if dislodged. Large gorgonians and antipatharians are also thought to be the longest-lived corals.

During DFO scientific multispecies surveys conducted in the SEA Area between 2003 and 2005, the survey areas that had the highest number of sets containing corals were located along the southwest Grand Banks' continental edge and slope extending from Haddock Channel to Whitbourne Canyon. Corals were also caught in sets along the St. Pierre Bank/Laurentian Channel slope. Coral species richness was highest in sets along the slope between Haddock Channel and Whitbourne Canyon which also included the sensitive large gorgonian corals. Commercial fishery bycatch of coral during 2004-2005 reflected the data of the scientific multispecies surveys in that the fished areas with the highest number of sets with coral and the large gorgonian catches also occurred along the southwest Grand Banks continental edge and slope from Halibut/Haddock Channels to the Tail of the Grand Banks. The WWF Coral Report (Edinger et al. 2007) identified the Southwest Grand Banks shelf edge and continental slope as a priority area for coral conservation.

Deep-sea coral distribution data from Newfoundland and Labrador regions that partially fill information gaps previously identified by Edinger et al. (2007) and Wareham and Edinger (2007) is contained in Wareham (2009). She presented data collected during the 2005 Northern Shrimp Multispecies Survey, 2000-2007 multispecies scientific surveys, and 2004-2007 commercial fishing vessels by Fisheries Observers. Sets with corals were distributed throughout the SEA Area, both on the continental shelf and beyond the continental shelf. The area with the highest number of sets with corals was again the southwest Grand Banks edge/slope area occurring from south St. Pierre Bank to the Tail of the Grand Banks. Another area with relatively dense sets of corals occurred at the northwest St. Pierre Bank slope/Laurentian Channel area. Antipatharian corals were collected along the southwest Grand Banks edge/slope area near Desbarres and Treworgie Canyons. Large gorgonians were collected along the entire edge/slope area from southern St. Pierre Bank to Jukes Canyon, and at a couple of locations in the northwest SEA Area in NAFO Division 3Pn. Small gorgonians and solitary stony corals were also caught along the entire edge/slope area from southern St. Pierre Bank to the Tail of the Grand Banks. Soft coral catches were densest along the southwest edge/slope but these corals were also caught on the continental slope and in the region of Rose Blanche Bank/Burgeo Bank/northeast Laurentian Channel. Sea pens were caught along the entire continental edge/slope area in the SEA Area. The NL ROPOS Discovery Cruise also investigated large and/or small gorgonian habitats along the slope at Halibut Channel, Haddock Channel and Desbarres Canyon with ROV.

It is important to note that on January 1, 2008, the CAD-NAFO Coral Protection Zone along the southwest Grand Banks slope was established as a mandatory temporary closure area to fishing between the 800 and 2,000 m. It remains in effect until December 31, 2012. This closure was based upon the work by Edinger and others. Another protected area is the Stone Fence, located just outside the SEA Area along the southwestern edge of the Laurentian Channel. The Stone Fence is the only known Canadian location of the reef-building coral Lophelia pertusa, arguably the most important coral in the area from a habitat perspective.

<u>Association of Deep-sea Corals and Fish/Other Invertebrates</u>

The patterns of association between deep-sea corals fish and invertebrate species, based on DFO scientific surveys and in situ ROV surveys are discussed by Edinger et al. (2009). Although there were no dramatic relationships between corals and abundance of the 10 groundfish species studied, there was a weak but statistically significant positive correlation between coral species richness and fish species richness, suggesting that habitats that support diverse corals are also likely to support diverse assemblages of fishes. By increasing the spatial and hydrodynamic complexity of habitats, deep-sea corals may provide important, but probably not critical, habitat for a wide variety of fishes. Effects of deep-sea corals on fish habitat and communities may include higher prey abundance, greater water turbulence, and resting places for a wide variety of fish size classes (Auster et al. 2005, and Costello et al. 2005 in Edinger et al. 2009).

3.1.5 Planning Implications

Algae associated with some of the more sensitive coastal areas (e.g., saltmarshes, eelgrass beds) are probably of most concern considering the low proportion of these types of habitats along the south coast. At the same time, algae associated with the more common habitat types (i.e., coarser substrate areas) are also important as primary producers and in their interactions with animal biota. Operators would be required to ensure safe operating practices to minimize the probability of accidental events and to be well prepared to react to an accidental event.

There are no specific planning issues associated with plankton alone, although there appear to be areas of enhanced production being utilized by higher trophic levels (e.g., slope regions in the SEA Area). This SEA does not consider plankton to be a VEC per se but has examined plankton production from the perspective that known or recognizable areas of enhanced production may be indicative of potentially important habitat areas for fish, marine birds, marine mammals and sea turtles. These issues would be discussed in more detail in site-specific EAs.

An important issue associated with benthic invertebrates relates to deep-sea corals. Any activities that result in contact with the bottom substrate have the potential to damage corals. These areas where contact with bottom could occur would have to be surveyed, likely with ROV, to determine benthic conditions.

3.1.6 Data Gaps

More data on oil characteristics, spill trajectories, and oil fate and behaviour is required for the SEA Area. The primary potential negative effect on marine algae would be from accidental releases of petroleum hydrocarbons. Continued collection of physical environmental data (e.g., oceanographic, climate) would also help to predict various aspects of accidental hydrocarbon releases and to plan counter measures.

One of the most obvious data gaps on plankton concern the spatial and temporal distributions of macroinvertebrate eggs and larvae, and ichthyoplankton in the SEA Area. These will be discussed in a following section on the Fish VEC.

While benthic research in many cases has been intensive, the studies tend to be targeted to specific coastal areas or are concentrated in restricted time periods. In general, much of the coastline fauna of Newfoundland and Labrador remains to be inventoried (Gilkinson 1986) and there are considerable data gaps for certain geographic regions and deep-sea environments such as the continental margin and slope environments. Surveys that assess benthic community composition rather than species-specific studies are limited for this region. The existing review reports highlight large gaps in the current knowledge of benthic ecosystems of coastal and offshore waters in the Newfoundland-Labrador region (Coady and Maidment 1984; Gilkinson 1986), with the exception of commercially important species such as the sea scallop *Placopecten magellanicus* and the common blue mussel *Mytilus edulis*. Several zoobenthic inventories have been compiled such as the Offshore Labrador Biological Studies program (OLABS) (Barrie et al. 1980; Barrie and Browne 1980) and others (Denbeste and McCart 1979; Gilbert et al. 1982), with studies targeted at specific coastal areas in Labrador.

3.2 Fish

For the purposes of this SEA, the fish VEC includes commercially-harvested macroinvertebrates (e.g., lobster, snow crab, whelks, and scallops) and fishes (target and by-catch species), and ecologically important non-commercial macroinvertebrate and fish species. Brief descriptions of life history and current stock status are included in this subsection. Fish species currently considered to be at risk are indicated in this subsection but details on them are provided in the subsection on Species at Risk (i.e., Subsection 3.7.1). Recent DFO research vessel survey data relevant to the SEA Area are also presented in this subsection.

3.2.1 Commercially-harvested Species

Commercially-harvested species are discussed in decreasing order of SEA Area average catch weight for the 2000-2007 period. Macroinvertebrates and fishes are discussed in separate subsections.

3.2.1.1 Macroinvertebrates

Macroinvertebrates that accounted for at least 0.1% of the SEA Area average catch weight from 2000 to 2007 include snow crab, whelk, sea scallop, Iceland scallop, lobster and sea cucumber (*Cucumaria frondosa).*

Snow crab

This decapod crustacean occurs over a broad depth range in the NW Atlantic from Greenland south to the Gulf of Maine. Snow crab distribution is widespread and continuous in waters off Newfoundland and southern Labrador. Large males are most common on mud or mud/sand, while smaller crabs are common on harder substrates (DFO 2008a). The snow crab life cycle features a 12-15 week planktonic larval period, following spring hatching, involving several stages before settlement. Benthic juveniles of both sexes molt frequently, and at about 40 mm CW (~4 years of age) they may become sexually mature. Female crabs carry the fertilized eggs for about two years. (DFO 2008a). Snow crab typically feed on fish, clams, benthic worms, brittle stars, shrimps and crustaceans, including smaller snow crabs. Their predators include various groundfish and seals (DFO 2008a).

Based on commercial fishery landing data, most snow crab occur on the continental shelf. In the SEA Area, most commercial catches of snow crab in 2006 and 2007 occurred on the eastern St. Pierre Bank, Halibut Channel, Green Bank and Whale Bank. In 2006, snow crab catches on the continental slope in the southeast part of the SEA Area outside of the EEZ were reported. In Division 3NO, trends in snow crab biomass are uncertain because multispecies bottom trawl survey indices are unreliable (DFO 2008a,b). Commercial catch per unit effort (CPUE) has changed little over the past three years and remains high relative to other areas. Recruitment has been low in recent years and short term prospects are uncertain. In the 3Ps offshore and inshore, exploitable biomass remains at a very low level (DFO 2008a). However, it is expected that recruitment in this area should increase over the next three years. Increased removals, in the short term, would likely impair recovery of the exploitable biomass.

Whelk

The species of this gastropod mollusc harvested in Newfoundland waters is the waved or rough whelk. It occurs along the western Atlantic coast from New Jersey to Labrador on a wide range of substrates, and is especially common on mud and sand (NLDFA 2006 *in* JW 2007). While young whelks are common in tide pools and shallow water, adults can inhabit water depths up to 200 m (Gosner 1978 *in* JW 2007). It is most common from the tidal level to depths of about 30 m (DFO 2006a). On the North Shore of the Gulf of St. Lawrence, whelk mating typically occurs between May and July, with egg laying 2-3 weeks after mating (DFO 2006a). This gastropod produces round egg masses which adhere to rocks and often wash onshore during storms (Gosner 1978, Harvey-Clarke 1997 *in* JW 2007). There is not a planktonic larval stage in the life history of the whelk, thereby limiting its capacity for dispersal. Whelks are carnivorous and typically feed on polychaetes, bivalves and urchins as either active predators or as scavengers (Himmelman and Hamel 1993 in JW 2007).

Based on DFO landings data, most commercial catches of waved whelk in 2006 and 2007 occurred on St. Pierre Bank.

Sea Scallop

Sea scallops are benthic, bivalve molluscs found only in the NW Atlantic from the Strait of Belle Isle to Cape Hatteras (DFO 2008b). They typically occur in large aggregations (beds) on sand or gravel substrates at depths of 35 to 120 m. Although sea scallops do not migrate, they are capable of limited movement by water propulsion due to rapid muscle contraction and subsequent 'shell clapping' (Harvey-Clarke 1997 *in* JW 2007). Commercial-sized scallop beds are found on Newfoundland's large offshore banks, including St. Pierre Bank in the northwestern part of the SEA Area. Sea scallops were also harvested in Hermitage Channel/Laurentian Channel to the west of St. Pierre Bank during 2006 and 2007 where water depths exceed 200 m.

The dioecious (i.e., separate sexes) sea scallop typically spawns usually occurs from August to October (DFO 2008b). Ollerhead et al. (2004) indicated that spawning by this bivalve occurs on St. Pierre Bank, although the average number of spawning scallops has decreased since the early 1990s. The first two larval stages of the scallop are pelagic and typically remain in the plankton for over a month after hatching before settling to the seabed by late fall/early winter (Hart and Chute 2004 *in* JW 2007). Larvae appear to prefer settlement on hard surfaces, especially substrates with shell fragments and small pebbles (Hart and Chute 2004 *in* JW 2007).

Iceland Scallop

Iceland scallops are widely distributed throughout the sub-Arctic at depths of 50 to 180 m on hard substrates consisting of sand, gravel, shells and stones (DFO 2006b *in* JW 2007). These bivalve molluscs occur in commercial-sized beds on the St. Pierre Bank (JWEL 2003 *in* JW 2007). Being suspension feeders, Iceland scallops tend to be most abundant in areas with substantial water movements (Naidu 1997 *in* JW 2007).

The spawning season for Iceland scallop is short and is typically sometime between April and August, depending on location (Wallace 1981, Crawford 1992 *in* JW 2007). For example, Iceland scallops on the St. Pierre Bank usually spawn in late summer (Ollerhead et al. 2004) but it appears that current abundance of mature Iceland scallops on St. Pierre Bank is less than in the 1980s and early 1990s (Ollerhead et al. 2004). Juveniles usually settle to the seabed in the fall. After an approximate 5-10 week planktonic larval phase, juveniles usually settle onto substrata consisting of shell debris and filamentous materials (Vahl 1982). The areas of adult Iceland scallop occurrence on St. Pierre Bank have sediments consisting of a mixture of gravel (> 90%) and sand (<10%) (Fader et al.1982).

American Lobster

Lobsters are distributed in the nearshore around the Island of Newfoundland, including the part of the southwest coast that occurs within the SEA Area. Most of the major life-history events (i.e., moulting, spawning, pre-larval hatch) occur between mid-summer and early fall (DFO 2006b). The confirmed depth range of this benthic decapod crustacean is 1 to 700 m, but is typically less than 50 m. Lobsters appear to prefer rocky substrates covered with algae that offer shelter for hiding and foraging. Adult lobsters are found close to the coast in the summer because of warmer water and they typically migrate to deeper areas in the winter to avoid turbulence. Young lobsters generally stay close to the coast in depths of 10 m or less, on gravel and cobble bottoms.

Mating occurs immediately after the female moults her old shell during the summer months. The female carries the embryos under her tail for almost a year (9 to 12 months) until the pre-larval hatch during late May to September. Therefore, female lobsters usually mate only once every two years (DFO 2006b). Once released, the larvae swim upward and undergo a series of three molts during their 6-10 week planktonic phase, during which most mortality is thought to occur. With the third molt, a metamorphosis occurs and the newly developed postlarvae resemble miniature adults and are equipped with considerable swimming and behavioural abilities to locate suitable benthic habitat. Newly settled lobster progress through several juvenile stages and an adolescent phase before reaching adulthood (DFO 2006b).

Lobster diet consists mainly of benthic invertebrates including rock crab, polychaetes, molluscs, echinoderms and fish. Adult lobsters have few natural predators. Commercial fishing accounts for most mortality (DFO 2006b).

Newfoundland lobster landings in recent years have declined in most Lobster Fishing Areas (LFA), from the long term high of 3200 t in 1992 to 1800 t in 2000. Reported landings have since increased to about 2300 t in 2003, due largely to increased landings in LFAs 11, 13A and 13B. Part of LFA 11 occurs in the coastal area of the SEA Area (DFO 2006b).

Orange-footed Sea Cucumber

The orange-footed sea cucumber has been reported almost circumglobally in the high latitudes of the northern hemisphere. It has a wide distribution in the North Atlantic and Arctic Ocean including the Norwegian, Barents, and North Seas. The southern range in the western Atlantic extends to Cape Cod; in the eastern Atlantic it ranges from the far north, to south of Scandinavia and the British Isles (Jordan 1972 *in* Therkildsen and Petersen 2006). This sea cucumber occurs from the intertidal zone down to 300–400 m (Brinkhurst et al. 1975 *in* Therkildsen and Petersen 2006), but is most common in shallower depths (Jordan 1972, Singh et al. 2001 *in* Therkildsen and Petersen 2006). It typically lives in rocky areas, with the body attached to elevated rock surfaces, often just below low tide mark and in shallow water.

As is typical for sea cucumbers, the biology and ecology of C. frondosa is still incompletely understood, but in recent years, a number of extensive studies of the growth and reproduction of this species have been carried out (e.g., Gudimova et al. 2004; Hamel and Mercier 1996a, 1996b, 1998; Medeiros-Bergen and Miles 1997; Organesyan and Grigorjev 1998; Singh et al. 1999, 2001 *in* Therkildsen and Petersen 2006).

Timing of spawning by this sea cucumber species is location specific but typically between late winter to early summer (Coady 1973; Hamel and Mercier 1996b; Medeiros-Bergen and Miles 1997). Coady (1973) found that the timing of sea cucumber spawning in Newfoundland appeared to be more closely associated with the spring phytoplankton bloom than with demonstrable physical environmental parameters. The fertilized eggs and embryos of the orange-footed sea cucumber are buoyant, followed by pelagic larvae that remain in the plankton for 6-8 weeks, typically during mid-spring to mid-summer (Falk-Petersen 1982; Medeiros-Bergen et al. 1995).

3.2.1.2 Finfish

Each of the following fish species addressed in this subsection accounted for at least 0.1% of the SEA Area average catch weight from 2000 to 2007.

Atlantic Cod

Atlantic cod (*Gadus morhua*) is discussed in Subsection 3.7 on Species at Risk. While neither the Newfoundland and Labrador nor the Maritimes population is currently listed on Schedule 1 of *SARA*, the NL population is listed as *endangered* and the Maritimes population as *special concern* under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Redfish

Redfish are benthic fishes that inhabit rocky or clay-silt substrate areas along the slopes of banks and in deep channels with water depths ranging from 100 to 700 m and water temperatures of 3 to 8°C. Redfish typically remain on or near the seabed during the day and move up into the water column at night to feed. These fish are often geographically stratified by size, with smaller fish occurring in shallower water areas (Scott and Scott 1988, McKone and LeGrow 1984 *in* JW 2007). The three species of redfish found in the NW Atlantic are Acadian redfish (*Sebastes fasciatus*), golden redfish (*S. marinus*), and deepwater redfish (*S. mentella*). The three species are similar in appearance and are, managed as a single fishery (Power and Mowbray 2000, Gascon 2003 *in* JW 2007).

Redfish species are somewhat separated geographically. Deepwater redfish is the northern range species off Labrador and Greenland, and Acadian redfish is the southern range species on the Scotian Shelf and the Gulf of Maine (Scott and Scott 1988, Gascon 2003 *in* JW2007). The ranges for these two species overlap in the Laurentian Channel and the Grand Banks (Gascon 2003 *in* JW 2007). In areas of distributional overlap, deepwater redfish generally occur in deeper water (Power and Morbray 2000, Gascon 2003 *in* JW 2007).

Redfish are generally slow growing and long lived fishes (Campana et al. 1990 *in* JW 2007). Redfish fertilized eggs hatch inside the females and live young are subsequently released (Scott and Scott 1988, Gascon 2003 *in* JW 2007). Mating likely occurs during the late fall and early winter and then the females carry the developing embryos until spring. Larvae hatch internally and are extruded during the late spring and early summer (St. Pierre and de Lafontaine 1995, Gascon 2003, Morin et al. 2004 *in* JW 2007).

Based on DFO survey data collected from 1995 to 2002, Ollerhead et al. (2004) indicated a peak in redfish spawning in April along the eastern Laurentian Channel, in Hermitage Channel, and along the continental slope from northwest St. Pierre Bank to Green Bank. In May, redfish spawning in the SEA Area is most intense along the continental shelf edge and slope from south St. Pierre Bank to the Tail of the Grand Banks. Ollerhead et al. (2004) also indicated some July redfish spawning during 1998-2002 along the continental shelf edge and slope from south St. Pierre Bank to Desbarres Canyon and a minimal amount in deep water off the northwest St. Pierre Bank at the mouth of Hermitage Channel. The live young typically congregate in surface waters at night and then migrate below the thermocline during the day to depths of 10 to 20 m (Fortier and Villeneuve 1996 *in* JW 2007). Recent commercial catch data have indicated most catches of redfish along the entire slope of the SEA Area and in deeper water areas in Laurentian Channel and the northwest SEA Area. Redfish are pelagic or bathypelagic feeders, feeding primarily on zooplankton such as copepods, amphipods and euphausiids. Fishes and crustaceans become more important in the diet of larger redfish (Scott and Scott 1988).

Three of the redfish management areas occur in the SEA Area: (1) South Western Grand Bank (3O), (2) Gulf of St. Lawrence-Unit 1 which includes 3Pn4Vn [Jan. to May]), and (3) Laurentian Channel-Unit 2 which includes 3Pn3Ps4Vns [June to Dec.]). Understanding redfish stock structure and their interrelation is a critical issue, more specifically between Unit 1, which is under a moratorium since 1995, and Unit 2, which continues to support a fishery. The importance of addressing the issue of redfish stock definition and boundaries in this area has been repeatedly expressed by the Fisheries Resource Conservation Council. The industry of the Gulf of St. Lawrence has also expressed concerns regarding the possible impacts of the continuing fishing in Unit 2 on stock recovery in Unit 1 (DFO 2008c).

Yellowtail Flounder

Yellowtail flounder (*Pleuronectes ferrugineus*) range from southern Labrador to Chesapeake Bay and are typically caught at depths between 30 and 70 m. Yellowtail flounder have previously been described as relatively sedentary, although a growing body of evidence counters this classification with off bottom movements (Walsh and Morgan 2004; Cadrin and Westwood 2004 *in* Legault et al. 2007-DFO Transboundary Resource Assessment Committee Reference Document 2007/05), and limited seasonal movements (Royce et al. 1959; Lux 1963; Stone and Nelson 2003 *in* Legault et al. 2007). In the SEA Area, principally in the western part just north of the Tail, spawning occurs during May to September with peak spawning time occurring during the latter part of June at depths of less than 100 m (Pitt 1970 in DFO Hab Require). Eggs are deposited on or near the bottom and after fertilization float to the surface where they drift during development. Larvae are pelagic for a month or more, then become demersal and settle to benthic habitats. Growth is sexually dimorphic, with females growing at a faster rate than males (Lux and Nichy 1969; Moseley 1986; Cadrin 2003 *in* Legault et al. 2007). Recent commercial catch data have indicated most catches of yellowtail in the western part of the SEA Area on the southern Grand Bank, and on St. Pierre Bank. Scattered catches were also reported in Hermitage Channel and Halibut Channel.

From 1996-2004 the 3LNO spring survey index has shown an annual variation in stock size and since has shown an increasing trend up to 2006 when the highest stock size biomass of 504,000 t was recorded. In the fall surveys the overall biomass trend has shown an increase for the time period 1992-2001, the highest estimate in the time series, followed by a decrease in 2002. Since 2004 the stock has shown a slight decreasing trend with the 2006 estimate of 305,500 t being 11% lower than the 2005 estimate (Walsh et al. 2007-NAFO SCR 2007 51).

White Hake

White hake (*Urophycis tenuis*) is a bottom dwelling species that ranges from Cape Halteras to Southern Labrador (Kukla et al. 2006, Kulka et al. 2005a *in* JW 2007). They tend to prefer mud bottom areas where water temperatures range from 5 to 11°C (Scott and Scott 1988, Kulka et al. 2005a *in* JW 2007). White hake occur over a wide range of depths, from less than 50 m to approximately 1,000 m (Kulka et al. 2004 *in* JW 2007. White hake are a temperate species at the limit of their temperature range and as a result are spatially restricted to the south western Grand Banks (Kulka et al. 2005a *in* JW 2007).

White hake occur continuously along the southwest portion of the Grand Bank, into the Laurentian Channel, western edge of the St. Pierre Bank, Burgeo Channel, and Hermitage Channel. This pattern of distribution has been consistent from 1971 to 2004 (Kulka et al. 2004 *in* JW 2007). Recent commercial catch data have indicated most catches of white hake along the slope of the SEA Area, particularly at the southern end of Halibut Channel. Catches were also reported in the deeper water areas in the Laurentian Channel and around Burgeo Bank. White hake concentrate at warmest locations with its main concentrations occurring on the western slope of the Grand Banks and St. Pierre Bank (Kulka et al. 2005a *in* JW 2007). Although there have been abundance and biomass fluctuations over the years, the habitat occupied by white hake has remained stable. A subtle shift in distribution occurred during the 1989 to 1995 period and was attributed to colder bottom temperature that further restricted white hake distributions.

White hake less than 30 cm are rarely observed in 3Ps (<2 years old fish). First year fish dominate shallow southern regions of the Grand Banks and nearshore locations, and are largely absent from the southern tip of the Grand Banks to the Laurentian Channel. White hake 2+ years dominate the Laurentian Channel, the majority of them being juveniles. Mature fish (>56 cm) tend not to distribute into the Laurentian Channel, shallow areas or coastal areas. The Grand Banks spawning ground is located in a narrow band along the continental slope. There are data gaps associated with fish maturity and spawning cycles and the timing of the fishery surveys. Spawning is known to occur along the south western slope of the Grand Banks in April and May. Fishery observer reports indicate spawning was complete prior to the July to August period (Kulka et al. 2005a *in* JW 2007).

White hake eggs and larvae are pelagic with young of the year (YOY) observed in August to September over the Grand Banks. The densest concentrations of YOY typically occur on the shallow areas of the southern Grand Bank (Kulka et al. 2005a *in* JW 2007). Newly settled juveniles are geographically separated from larger white hakes and this is a beneficial adaptation as large white hake are known to prey on younger ones. Juveniles are typically found offshore on the southern Grand Banks in autumn at bottom depths ranging from 50 to 80 m that correspond with the warmest areas within the 100 m depth contour (Kulka et al. 2005a *in* JW 2007). Ollerhead and Lawrence (2007) indicate occurrence of white hake juveniles in 3Pn portion of the SEA Area during 1995-2003 DFO RV surveys. White hake from various stocks mix in the Laurentian Channel, with the primary stock an extension of the Grand Banks stock that mix with Scotian Shelf and Gulf of St. Lawrence stocks (Kulka et al. 2005a *in* JW 2007).

White hake prey heavily on other fishes. In Newfoundland waters they prey upon silver (*Merluccius bilinearis*), red (*Urophycis chuss*) and longfin (*Phyois chesteri*) hake, Atlantic cod, herring and flatfishes (Kulka and Simpson 2002 *in* JW 2007).

Data from spring surveys in Div. 3N, 3O, and Subdiv. 3Ps were available from 1975 to 2005. In the 2006 Canadian spring survey, most of Subdiv. 3Ps was not surveyed and only shallow strata in Div. 3NO (to a depth of 77 m in Div. 3N, to 103 m in Div 3O) were surveyed. Data from autumn surveys in Div. 3NO were available from 1990 to 2006. The spring index in Div. 3NOPs, covering the entire stock area, was used as the primary source of information on change in stock size. The spring index for Div. 3NOPs declined in the early 1980s, peaked in the late 1980s and again in 2000. In particular, the very large 1999 year-class resulted in a large peak in the autumn of 1999 and spring of 2000. The indices have since declined to levels similar to 1996-1998. From 2002 to 2005, the population was stable at a low level similar to what was observed in 1996-1998 (Kulka and Miri 2007a).

Skates

Five species of skate (Family Rajidae) are commonly found to occur on the Grand Banks (Kulka et al. 2006 *in* JW 2007: thorny skate (*Amblyraja radiata*), smooth skate (*Malacoraja senta*), spinytail skate (*Bathyraja spinicaudata*), winter skate (*Leucoraja ocellata*) and Barndoor skate (*Dipturus laevis*). The thorny and smooth skate account for approximately 95% of skate landings and are described in greater detail below. The winter skate and spinytail skate are discussed in Subsection 3.7 on Species-at-Risk. The Southern Gulf and Eastern Scotian Shelf populations of winter skate are listed under COSEWIC as *endangered* and *threatened*, respectively. Spinytail skate is listed as a *mid priority candidate species* under COSEWIC.

Thorny Skate

Thorny skate are the most common skate species, making up 90% of all skate caught during DFO surveys (DFO 2003b *in* JW 2007). Thorny skate are commercially harvested in the SEA Area (DFO 2006/2007 landings database).

Thorny skate are a temperate to arctic species widely distributed in the North Atlantic from Greenland to South Carolina (Kulka et al. 2006 *in* JW 2007). Thorny skate have been observed over a depth range of nearshore to 1,700 m but most of its biomass appears to occur at depths ranging from 50 to 150 m (Kulka and Miri 2003a *in* JW 2007). Thorny skate occur on both hard and soft substrates (Kulka et al. 1996 *in* JW 2007) but are primarily associated with muddy, sandy and pebble substrates typical of Grand Banks sediment (Kulka and Miri 2003a *in* JW 2007).

The migration patterns of the thorny skate are not fully understood, but evidence suggests a seasonal migration between the continental shelf edge during December to June, and the top of the banks during the remainder of the year (Kulka and Mowbray 1998 *in* JW 2007).

Observations from 3LNO and 3Ps indicate a relatively continuous distribution. Lack of physical barriers suggest that the thorny skate concentrating on the shallow edge of the Grand Banks from the Tail of the Grand Banks to the southern edge of the St. Pierre Bank constitute a single reproductive unit (Kulka and Miri 2003a *in* JW 2007).

Males mature at smaller sizes than females with size at maturity increasing from north to south. Ovaries of sexually mature females hold 10 to 12 pairs of eggs in various developmental stages (Kulka and Miri 2003a *in* JW 2007). Thorny skate deposit 6 to 40 egg cases per year (DFO 2003b *in* JW 2007). Larger thorny skate produce larger egg cases, but it is not known if egg case size is related to survival rates (Kulka and Miri 2003a *in* JW 2007). Ollerhead and Lawrence (2007) indicate occurrence of thorny skate juveniles in 3Pn portion of the SEA Area during 1995-2003 DFO RV surveys.

Thorny skate feed on a variety of invertebrates and fish including polychaetes, crabs and whelks (Kulka and Miri 2003a *in* JW 2007). The diets of larger skates include fish prey such as sculpins, redfish, sand launce and small haddock. Significant amounts of fish offal have been found in skate stomach and this coupled with the ventral mouth location suggests that thorny skate are opportunistic bottom feeders.

Thorny skate biomass has been stable for about 14 years but the stock had become concentrated in a small area on the southern Grand Bank (hyper-aggregation). Once densely concentrated on the northern Grand Banks, thorny skates are now absent from much of this area. However, the species has shown a minor re-expansion in its distribution during the past 3-4 years. Small thorny skates (10-30 cm TL) have been largely absent from the northern Grand Banks (NAFO Division 3L) since 1996. The largest occurrence of small skates is presently found in NAFO Subdivision 3Ps. Since the mid-1990s, 17% of thorny skate biomass distribute outside Canada’s 200-mile-limit while approximately 70% of skate catches were taken outside 200 miles. The Exploitation Index (commercial catch/spring research survey biomass index) increased from approximately 5% in the mid-1980s to around 15% in 2000 but has declined to an average of about 5% over the past 2 years (Kulka and Miri 2007b).

Smooth Skate

Smooth skate is found along the Atlantic coast of North America ranging from the Gulf of St. Lawrence and Labrador shelf to South Carolina (Packer et al. 2003 *in* JW 2007). Smooth skate typically live on soft mud and clay bottoms, frequently in deep troughs and basins (Scott and Scott 1988). Smooth skate occurs at depths ranging from 46 to 457 m and is most abundant below 110 m. Smooth skate is common in the deep waters along the slope of the Laurentian Channel (Swain and Benoit 2001 *in* JW 2007). One of the five areas (i.e., Designatable Units or DUs) of relatively high concentration of smooth skate is identified as 'Northeast Scotian Shelf / Laurentian Channel / Southwest Grand Banks' which occurs within the SEA Area (Kulka et al. 2006; DFO 2006c).

There is limited information regarding the life history of the smooth skate. The diet of smooth skate is comprised of amphipods, mysids, decopods, euphausids and fish species including yellowtail flounder, hake, witch flounder and sand lance (Packer et al. 2003 *in* JW 2007).

For the DU within the SEA Area, a decline of 80% for adults during the 34 four year period 1971-2005 or 73% in 29 years (1976 to 2005) has been calculated. However, abundance trends were not consistent throughout the area and not all areas of the DU were included in the integrated analysis in the early period. Thus, the long term decline rate is influenced by areas where the decline appears to have been greatest; in the southern Gulf and Scotian Shelf. In contrast to the integrated log model prediction for the Laurentian DU, survey catch rates have increased by about 200% on the southern Grand Bank since the early to mid-1990s Kulka et al. 2006).

Monkfish

Monkfish (*Lophius americanus*) is a bottom dwelling species that ranges from its northern limit on the Labrador shelf to Florida (DFO 2003c *in* JW 2007). Its Grand Banks range is limited to southwest slope of the Grand Banks, western slope of the St. Pierre Bank and the Laurentian Channel. Recent commercial catch data have indicated most catches of monkfish along the slope of the SEA Area and in the deeper water areas in the Laurentian Channel and around Burgeo Bank.

The stock structure of the monkfish is largely unknown and the degree of mixing is also unknown (Kulka and Miri 2003b *in* JW 2007). The discontinuous distribution between the Scotian Shelf, Gulf of St. Lawrence and the Grand Banks is suggestive of distinct populations.

Monkfish inhabit areas ranging in depth from the shoreline out to 800 m (Kulka and Miri 2003b *in* JW 2007). Monkfish distribution is restrictive, occurring in areas of the Grand Banks and Laurentian Channel that exceed 3°C. The highest densities are observed where bottom waters exceed 4°C. The geographical distribution of monkfish on the Grand Banks has changed little over the past 50 years. The centre of distribution has had subtle shifts over the years, attributed to cooler waters that were observed in the mid-1980s to early 1990s. A shift to deeper waters could reflect an avoidance of colder water in those years. Monkfish spread into the Grand Banks in autumn, when bottom temperatures are warmer; however, this seasonal expansion is limited.

There is limited data or information on monkfish spawning and their reproductive cycle for the Grand Banks. Monkfish are a short-lived species, with a maximum age of approximately 11 years. There are deficiencies in the knowledge of monkfish in 3LNOPs limiting DFO's ability to assess the species: information on size and age structure, growth rates, age of maturity, commercial catch size and ages are lacking, and there are uncertainties in reported landings (DFO 2004a).

Survey biomass and abundance show considerable fluctuations with peaks in 1977 and 1988. After declines to their lowest levels, the biomass and abundance indices have increased, with 2003 representing a peak year for abundance (DFO 2004a).

American Plaice

American plaice (*Hippoglossoides platessoides*) is discussed in Subsection 3.7 on Species at Risk. While neither the Newfoundland nor the Maritimes population is currently listed on Schedule 1 of *SARA*, both populations are listed as *threatened* under COSEWIC.

Pollock

Pollock (*Pollachius virens*) is a cod-like fish, but spends more of its time moving through the water column than its bottom-dwelling relatives. They prefer depths between 110 to 181 m and water temperatures of 0°C to 10°C (Scott and Scott 1988; DFO 2006f). They are at the northern extent of their range in Newfoundland waters (DFO 2006f), so are not widely distributed. Pollock distribution in NAFO subzone 3Ps is mainly restricted to the slope waters of the Burgeo and St. Pierre Banks and inshore waters. Mature pollock occur on the slopes of St. Pierre and Burgeo Bank. In the summer months, schools of young pollock are sometimes found in harbors along the south coast of Newfoundland. DFO RV surveys indicate that they are restricted to these slopes and inshore waters (Murphy 2003; DFO 2006f).

There is limited life history information on the pollock of 3Ps, and much of that information is inferred from studies on more southern stocks (Murphy 2003). 3Ps pollock may represent the northern boundary for 4VWX5Zc stock rather than separate stock (Murphy 2003; DFO 2006f).

Young pollock feed almost entirely on small fishes, including herring (*Clupea harengus*), sand lance (*Ammodytes* spp.) and redfish. Adults eat the same species, as well as crustaceans. They have relatively few natural predators, although they are known to fall victim to cannibalism and harbour seals (Scott and Scott 1988).

Greenland Halibut

Greenland halibut (*Reinhardtius hippoglossoides*), commonly known as turbot, is a deepwater flatfish that prefers water temperatures ranging from 0 to 4.5°C. In the NW Atlantic, their range extends from Greenland to the Scotian Shelf, with and most catches occurring in areas with water depths > 450 m. Their depth range of occurrence is about 90 to 1,600 m, with larger individuals occurring in deeper waters. Unlike most flatfishes, the Greenland halibut spends much of its time off the bottom, behaving more as a pelagic fish (Scott and Scott 1988).

It is thought that turbot spawn in the Laurentian Channel and Gulf of St. Lawrence during the winter (Scott and Scott 1988). The eggs are benthic, and upon hatching the young move up into the water column and remain at depths of 30 m until they grow to a length of about 70 mm. As they grow, the young halibut move downward in the water column and are transported by the currents (Scott and Scott 1988).

Greenland halibut is typically found in the channels of the Gulf of St. Lawrence and there are indications that the Gulf of St. Lawrence stock may spend its entire life within the Gulf (DFO 2005e *in* JW 2007). In winter, these fish migrate towards the entrance of the Gulf (Morin et al. 1996 *in* JW 2007). Recent commercial catch data indicate most catches of Greenland halibut along the slope of the SEA Area from southern St. Pierre Bank to the Tail, particularly at the southern end of Halibut Channel, and in the deeper water areas in the Laurentian Channel and around Burgeo Bank.

Atlantic Halibut

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and is typically found along the slopes of offshore banks. Atlantic halibut migrates seasonally between shallow and deep waters, avoiding water temperatures below 2.5°C (Scott and Scott 1988; Kulka et al. 2003 in JW 2007)). Based on recent commercial catch data from SEA Area, Atlantic halibut distribution includes the slope waters throughout the SEA Area, the deeper waters of the Laurentian Channel and area around Burgeo Bank, and on St. Pierre and Green Banks.

Although the spawning grounds of Atlantic halibut are not clearly defined, it is known that this flatfish species, within its Canadian range, spawns between February and April at depths ≥1,000 m. The fertilized eggs are neutrally buoyant and float at depths of 300 to 400 m. As they develop, they sink to the seabed. Once hatched, the larvae rely on their stored yolk for food for four to five weeks while their mouth and digestive tract develops. After a few weeks of feeding on planktonic invertebrates, they metamorphose and move down to the seabed. Benthic juveniles consume mainly benthic invertebrates including annelid worms, crabs, shrimps and euphausiids. Young adults feed on both invertebrates and small fishes, while mature adults feed only on fishes (Scott and Scott 1988; DFO 2006d *in* JW 2007).

Atlantic halibut movements have been monitored since the late 1990s through the Gulf Atlantic Halibut Tagging Program. Its purpose is to study the movements of Atlantic halibut in and out of the Gulf and determine links between the Atlantic halibut of NAFO subdivision 3Pn and adjacent stocks of 4RST and 4VWX3NOPs. The results of the study indicate that individuals are mainly recaptured in the fishing division in which the tagging took place. Only one individual tagged in 3Pn (of 137 tagged) was recaptured outside the subdivision (in 4R). A few individuals from 4R were found in 4S (nine individuals) and 3Pn (two individuals). Only one individual from 4T was found in 3Pn (DFO 2005c *in* JW 2007).

Atlantic Herring

Herring (*Clupea harengus harengus*) is a pelagic, schooling fish that usually occurs either in shallow inshore waters or in the upper 200 m of offshore waters. There are a number of separate herring populations in the NW Atlantic and each has preferred spawning, feeding and wintering grounds. The time and location of spawning depends of the herring stock. Most stocks spawn in spring or fall (Scott and Scott 1988). Herring are demersal spawners, depositing their eggs on stable substrates in high energy environments with strong tidal currents. While spawning can occur on offshore banks at depths of 40 to 80 m, most herring stocks spawn in shallow coastal waters at depths of less than 20 m. In Newfoundland waters, it appears that herring spawn in coastal waters only. The pelagic herring larval stage is much longer for the fall-spawned than spring-spawned herring, often lasting through the winter months. Larvae are very light sensitive, seeking deeper waters on bright days (Scott and Scott 1988).

A herring reconnaissance survey was conducted in the late winter and spring of 2006 along the south coast. The purpose of the survey was to determine whether herring were present along the south coast and, if so, to tag 20,000 individuals to determine their origin (i.e., whether they are part of Southern Gulf population). A 14 day survey of inshore waters from Cape Ray, near Port Aux Basques to Pass Island, near Hermitage Bay caught only 96 herring. The data are insufficient to determine whether these herring are part of the Southern Gulf population. The survey was conducted at a time when herring were expected to be aggregated along this coast. To date, no decision has been made to proceed with a detailed acoustic survey to further assess the biomass (J. Wheeler, DFO, pers. comm. *in* JW 2007).

Witch Flounder

Witch flounder (*Glyptocephalus cynoglossus*) are a deep water flatfish that occur in the NW Atlantic from Hamilton Inlet in Labrador to Cape Hatteras. These relatively non-migratory flatfish are typically found offshore, in moderately deep water (primarily in 45 to 275 m depth range) and appear to prefer mud or sand-mud substrates and water temperatures of 2 to 6°C (Scott and Scott 1988). In 3Ps, witch flounder are primarily distributed along the slope around St. Pierre Bank, and in the Hermitage Channel (Maddock-Parsons 2005a *in* JW 2007). Witch flounder are a slow growing, long-lived species which have been aged at >20 years old (Maddock-Parsons 2005a *in* JW 2007). However, witch flounder older than 13 years have rarely been observed in 3Ps commercial or survey catches since the early 1990s (Maddock-Parsons 2005a *in* JW 2007).

In the NW Atlantic, spawning typically occurs over a prolonged period from March through September. Spawning by witch flounder in 3Ps is early by comparison with the highest intensity usually observed between January and March. During winter and spring, witch flounder can be found in spawning concentrations along the continental shelf of the St. Pierre Bank, particularly in the Halibut Channel. The offshore commercial fisheries often focus their efforts to coincide with the spawning concentrations noted above (Maddock-Parsons 2005a *in* JW 2007). Seabed spawning results in buoyant fertilized eggs that float to the surface, followed by larval hatch approximately one week later. The larvae may remain pelagic for as long as a year before settling to the seabed (Cargnelli et al. 1999 *in* JW 2007). This is the longest pelagic stage of any flatfish in Newfoundland waters (Scott and Scott 1988). Ollerhead and Lawrence (2007) indicate occurrence of witch flounder juveniles in 3Pn portion of the SEA Area during 1995-2003 DFO RV surveys.

The diet of witch flounder consists of benthic polychaetes and crustaceans, small fishes, molluscs and echinoderms (Scott and Scott 1988).

Haddock

Haddock (*Melanogrammus aeglefinus*) are bottom-dwelling fish, occurring over hard, smooth sand and gravel bottoms. They have a marked seasonal depth distribution, preferring depths of 27 to 366 m and temperatures from 1 to 13°C in the winter, but moving to shallower and warmer waters (depths of 55 to 126 m) during the summer. There are seven populations of haddock in the Northwest Atlantic: southwest Newfoundland, Grand Bank, St. Pierre Bank, Emerald Bank and eastern Gulf, Browns Bank – southwestern Nova Scotia, Georges Bank and Gulf of Maine – Bay of Fundy. Each of these populations are separated by deep channels and has differing spawning times and growth rates (Scott and Scott 1988). Kulka et al. (2003) showed that in recent years haddock are present in the Laurentian Channel and along the slope of the St. Pierre Bank during the spring only and were found further south in the fall. To enhance the fisheries research database in 3Ps, fall surveys were funded by the Groundfish Enterprise Allocation Council (GEAC) from 1997 to 2005 (McClintock 2007). In virtually all years of these surveys, haddock catches were primarily located at the southern entrance to the Halibut Channel and in lesser magnitudes on the western portion of St. Pierre Bank. Many of the remaining sets in the surveys had no haddock.

Spawning occurs in June in Newfoundland waters (Scott and Scott 1988). Haddock are known to spawn within the current SEA Area, on the St. Pierre Bank and along its slopes (Page and Frank 1989; Begg 1998; Ollerhead et al. 2004). Historically, spawning in the SEA Area occurred in the spring, peaking March and April; however, recent surveys have not shown spawning occurring in the SEA Area (Ollerhead et al. 2004). Larvae are pelagic, settling to the seabed when they reach 50 mm in length, at ages of three to five months (DFO 2001; Brodziak 2005). Although little is known about their spawning behavior in nature, aquarium observations show that haddock communicate by sound during reproductive rituals. The male emits a series of knocking, rasping and humming sounds during courtship and also changes color during spawning (Hawkins 1986; Scott and Scott 1988). Haddock are primarily bottom-feeders. Adults consume mostly crustaceans, molluscs, echinoderms, annelids and other fishes. Haddock are preyed upon by harbour (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) (Scott and Scott 1988).

During the mid-1950s, a substantial haddock fishery took place on St. Pierre Bank, harvesting mainly the abundant 1949 year-class. There has not been a large haddock fishery in 3Ps since 1957. Recent surveys have found few haddock. Although recent DFO RV surveys have suggested increases in stock size, the biomass in 3Ps is very low when compared with the mid to late 1980s (DFO 2001).

Hagfish

Atlantic hagfish (*Myxine glutinosa*) and lampreys, are the only species that belong to the Agnathans or jawless fishes. These primitive extant vertebrates are found at depths ranging from 30 to >900m, usually at or near sea bottom where substrates are soft and muddy. Hagfish are known to utilize burrows, especially during daylight hours in shallower areas. Hagfish feed primarily through scavenging but are also known to capture live prey (Davis et al. 2001). Little is known about the mode of fertilization used by hagfish during spawning. There is speculation that open ocean fertilization is unlikely considering the relatively small amount of sperm likely released, and that burrow utilization may be important during spawning to ensure the highest possible degree of fertilization success (Davis et al. 2001).

Recent DFO commercial fishery data indicate that hagfish have been caught primarily along the SEA Area continental shelf edge from south St. Pierre Bank to Whale Bank.

Swordfish

Swordfish (*Xiphias gladius*) is a large migratory pelagic fish that is distributed worldwide. Individuals of this species typically occur in Canadian waters during the June to November period. Swordfish may be present in surface waters or as deep as 500 m, although their presence at surface tends to occur during darkness. These large pelagic fish do not reproduce within the SEA Area (Scott and Scott 1988 *in* Buchanan et al. 2006). While in Canadian waters, swordfish are known to feed on fish and invertebrate species that include mackerel, silver hake, redfish, herring and short-finned squid (Scott and Scott 1988 *in* Buchanan et al. 2006).

Recent DFO commercial fishery data indicate swordfish catches along the SEA Area edge and slope from Haddock Channel to the Tail, as well as in deep water areas (i.e., up to 3,000m) off the southwest Grand Bank.

Lumpfish

Lumpfish (*Cyclopterus lumpus*) are considered to be groundfish that range on both sides of the North Atlantic. In the NW Atlantic, lumpfish range from Greenland south to Cheasapeak Bay (DFO 2006h *in* JW 2007). Meltzer (1996 *in* JW 2007) indicates that lumpfish are found within the SEA Area on Rose Blanche Bank, Burgeo Bank, St. Pierre Bank and in the Hermitage Channel. Lumpfish are present in high concentrations on St. Pierre Bank in the spring (D. Mercer, DFO, pers. comm. *in* JW 2007).

Lumpfish undergo a coastal migration for spawning which takes place in May and June (DFO 2006h *in* JW 2007). Lumpfish feature sexual dimorphism with male lumpfish significantly smaller than the females. Males arrive on the spawning grounds several weeks in advance of the females to establish their territories. The females lay two to three egg mass at intervals ranging from 8 to 14 days. Once the eggs are deposited, females migrate back to deeper water leaving the males to guard the egg masses (DFO 2006h *in* JW 2007). Egg mass may contain more than 100,000 to 130,000 eggs measuring 2 mm in diameter with one oil globule and light green to yellowish in colour. Males guard and fan the egg masses for the duration of incubation (Scott and Scott 1988). Larval are approximately 5 mm at release after six to eight weeks of incubation. Juveniles are semi-pelagic, remaining in the top meter of the water column for their first year during which they are often associated with floating algae. During early life stages lumpfish attach to rocks, lobster traps and other solid objects with their pelvic adhesive disc (DFO 2006h *in* JW 2007).

A tagging study conducted in May to June of 2004 and 2005 within the SEA Area provided some limited data regarding lumpfish movements. The longest distance travelled by a lumpfish in the study was 300 km, from 3Pn to Fortune Bay over a three month period. Only 37 of 914 lumpfish tagged in 2004 were recaptured in 2005 and these data are insufficient to determine exploitation rates (DFO 2006h *in* JW 2007).

Wolffishes

All three species of wolffish (i.e., northern, spotted and Atlantic) are discussed in Subsection 3.7.1 on Species at Risk. Both the northern and spotted wolffishes are currently listed as *threatened* on Schedule 1 of *SARA* and under COSEWIC. The Atlantic wolffish is currently listed as *special concern* on Schedule 1 of *SARA* and under COSEWIC.

Atlantic Mackerel

The Atlantic mackerel (*Scomber scombrus*) is a pelagic fish common to temperate waters of the open sea and is one of the most active and migratory of fishes. Mackerel occupy inshore waters during spring and summer. From late fall and in winter, the distribution of the species shifts to deep warm waters at the edge of the continental shelf (DFO 2008d).

Two intense spawning areas occur in the NW Atlantic. During June and July, spawning predominately occurs in the southern Gulf of St. Lawrence. This spawning period is preceded by an extensive migration that begins early in the spring in the Gulf of Maine and Georges Bank Areas. In American waters, spawning occurs during the months of March and April, between the coasts of Rhode Island and Virginia (DFO 2008d). Spawning typically results in a concentration of fertilized eggs in the upper 10 m of the water column. Larval hatching generally occurs within five to seven days at water temperatures of 11 to 14ºC (Scott and Scott 1988). During the 2007 egg survey in the Gulf of St. Lawrence, the most significant egg densities were found in the area between the Magdalen Islands and Chaleur Bay (outside of the SEA Area). Based on the 2007 egg survey, the spawning biomass for the Canadian stock was estimated at 76,532 t, which represents one of the lowest values since the survey began in the early 1980s (DFO 2008d).

Bluefin Tuna

The bluefin tuna (*Thunnus thynnus*) is the largest member of the mackerel-like fishes (family Scombridae) and occurs on both sides of the Atlantic Ocean (Scott and Scott 1988). The species is at its northern range in Canada and often show unpredictable and changeable distribution (Archambault et al. 2001). Bluefin occur in Canadian waters from July to December over the Scotian Shelf, in the Gulf of St. Lawrence, and off Newfoundland (Archambault et al. 2001). It must be noted that the only information available on the distribution of the species (both temporal and seasonal) is commercial fisheries data as there are no fisheries-independent surveys for large pelagic species (Archambault et al. 2001). In the west, Atlantic, bluefin tuna are thought to spawn from mid-April to June in the Gulf of Mexico and Florida Straits, far south of the SEA Area (Archambault et al. 2001). Juveniles are thought to occur over the continental shelf, primarily between 35°N and 41°N in summer and in offshore waters, at the same latitudes, in the winter (Archambault et al. 2001). Opportunistic feeders, the diet of the bluefin tuna commonly consists of fish, squid, and crustaceans (Archambault et al. 2001).

Winter Flounder

The winter flounder (*Pseudopleuronectes americanus*) is an inshore, shallow-water benthic species that inhabits soft muddy to moderately hard bottoms (Scott and Scott 1988). The species is found in coastal waters of the NW Atlantic from North Carolina to Newfoundland (DeCelles and Cadrin 2007). A consumer of a variety of bottom organisms (Scott and Scott 1988), the winter flounder generally occupies shallow estuarine waters from autumn until spring (DeCelles and Cadrin 2007). After spawning occurs in inshore waters, the adults migrate to deeper offshore waters to feed. Over its range, the timing of spawning varies with latitude, occurring earlier in the south and later in the north (Scott and Scott 1988). In Conception Bay, Newfoundland, peak spawning has been observed from May to early June (Kennedy and Steele 1971 *in* DeCelles and Cadrin 2007).

Porbeagle Shark

Porbeagle shark (*Lamna nasus*) is discussed in Subsection 3.7.1 on Species at Risk. Although not listed on Schedule 1 of *SARA*, this shark species is currently listed as *threatened* under COSEWIC.

3.2.2 Non- commercial Species

All of the non-commercial species considered in this subsection are fishes. Atlantic salmon is not a commercial species in the SEA Area but it is an important recreational one.

3.2.2.1 Cusk

Cusk (*Brosme brosme*) is discussed in Subsection 3.7.1 on Species at Risk. Although not listed on Schedule 1 of *SARA*, cusk is currently listed as *threatened* under COSEWIC.

3.2.2.2 Blue Shark

Blue shark (*Prionace glauca*) is discussed in Subsection 3.7.1 on Species at Risk. Although not listed on Schedule 1 of *SARA*, blue shark is currently listed as *threatened* under COSEWIC.

3.2.2.3 Capelin

Capelin (*Mallotus villosus*) is a small pelagic species that has a circumpolar distribution in the Northern hemisphere (DFO 2006g). Capelin are members of the smelt family (Osmeridae), olive in color with an elongated body and exhibit pronounced sexual dimorphism during spawning. Capelin are found along the coasts of Newfoundland and Labrador and on the Grand Banks.

Migration towards the coast precedes spawning on beaches or in deeper waters (DFO 2006g). Capelin role on sandy or fine gravel beaches in water temperatures in the range of 6°C to 10°C. Beach spawning is more prevalent at night. Capelin are able to spawn at the age of two and males usually die following spawning.
Spawning commences in early June and may continue through July depending upon tides, winds and water temperatures (Scott and Scott 1988).

Eggs are red in color, 1 mm diameter and are attached to the substrate. Incubation varies with ambient temperature and lasts approximately 15 days at 10°C. Larval capelin are plankton and remain near the surface until the onset of winter.

Capelin prey consists of planktonic organisms comprised of primarily of euphausiids and copepods. Capelin feeding is seasonal with intense feeding late winter and early spring leading up to the spawning cycle when feed ceases. Feed recommences several weeks after cessation of spawning.

Capelin are major component in marine ecosystem dynamics as they facilitate the transfer of energy between trophic levels, principally between primary and secondary producers to higher trophic levels (DFO 2006g). Capelin predators comprise most major fish species including Atlantic cod, haddock, herring, flatfish species, dogfish and others. Several marine mammal species including minke whales, fin whales, harp and ringed seals as well as a variety of seabirds also prey on capelin.

The primary cause of capelin mortality is associated with predation and as such variations in capelin abundances are directly linked to natural causes (DFO 2006g). Capelin have a short life span (usually five years or less), abundances are linked to a few age classes. Management of capelin fisheries tends to be conservative as a result of the prominent role of capelin in the marine ecosystem.

3.2.2.4 Alewife

Although not listed on Schedule 1 of *SARA*, alewife (*Alosa pseudoharengus*) is currently listed as a *mid priority candidate species* under COSEWIC.

3.2.2.5 Spinytail Skate

The spinytail skate (spinetail ray; *Bathyraja spinicaudata*) is a coldwater skate that is reported infrequently in Canadian Atlantic waters (Scott and Scott 1988). The species reportedly occurs off Newfoundland and in the Gulf of St. Lawrence. It is occasionally caught off southeast Nova Scotia to the eastern slope of Georges Bank.

This skate usually occurs at depths below 165 m where water temperatures range from -1.5 to 3.3°C and it has been caught as deep as 1,463 m. Much of the life history of the spinytail skate is unknown.

3.2.2.6 Spiny Eel

The spiny eel (*Notacanthus chemnitzi*) is a bottom-living fish that typically occurs over a depth range of 250 to 1,000 m, but has been caught in waters as shallow as 125 m on the Grand Bank to more than 3,000 m off the coast of Ireland (Scott and Scott 1988). Data suggest a northward migration of this species as individuals become older and larger. Ripe specimens of the spiny eel have been found near Iceland in September and October yet little is known about the specifics of eggs and young of this species. It is not known where in the water column the fertilized eggs develop or the young hatch from the eggs. Spiny eels appear to be bottom feeders. Identified stomach contents of this species include sea anemones. Predators of spiny eels are not known.

3.2.2.7 Sandlance

Sand lance is a small planktivorous fish found on sandy seabeds. It lives partially buried in the sand and occasionally rising into the water column to feed. It is found in the North Atlantic from Greenland to the Gulf of St. Lawrence and is typically found at depths of less than 100 m. The species of sand lance present in the SEA Area is the northern sand lance (*Ammodytes dubius*). It co-occurs over much of its range with the American sand lance (*A. americanus*) (Scott and Scott 1988).

All species of *Ammodytes* spawn either inshore or on offshore banks (e.g., the Grand Bank off Newfoundland) at depths down to 100 m. Spawning appears to occur within sandy habitat that is occupied year-round, and spawning migrations have not been documented (Robards et al. 1999). There is little information available regarding the time of spawning in the SEA Area. Most sand lance species are reported to spawn in fall or winter, although some populations apparently spawn in spring or summer (Robards et al. 1999). Winters (1983) noted that the main spawning season of northern sand lance on the Grand Bank of Newfoundland occurs from November through January; however, the presence of spent fish in April and May suggests that minor peaks in spawning may also occur in late winter or early spring. This species is not commercially fished, but is an important part of the marine food-web as it is a food source for marine mammals and several species of fish including cod.

3.2.2.8 Atlantic Salmon

Atlantic salmon (*Salmo salar*) is an anadromous fish that lives in freshwater rivers for the first two years of life before migrating to sea. Atlantic salmon return annually to their natal river or tributary for spawning. Both post-smolt (juvenile) and adult salmon migrate from northeastern North America in the spring and summer to waters off Labrador to overwinter. They return to coastal North America in the fall, passing through the Laurentian Channel and St. Pierre Bank in the SEA Area (Reddin 2006). While at sea, adult salmon were found spending a considerable amount of time in the upper portion of the water column (Reddin 2006). Tagging studies of post-smolts indicated that they spend most of their time near the surface but at times dive deeply, likely in search of prey (Reddin et al. 2006).

While still in the river, post-smolts mainly eat aquatic insect larvae including caddisflies and blackflies. Adults at sea consume euphausiids, amphipods and fishes such as herring, capelin, small mackerel, sand lance and small cod. When salmon return to freshwater to spawn, they likely do not eat (Scott and Scott 1988). Causes of at-sea mortality of salmon are poorly understood (Reddin 2006) but it is known that they are prey for seals, sharks, pollock and tuna (Scott and Scott 1988). The commercial net fishing of Atlantic salmon in Newfoundland waters was placed under moratoria in 1992 in an effort to increase the number of salmon spawning in freshwater and thereby increasing production for future years.

The two Atlantic salmon management areas (salmon fishing areas or SFAs) in the SEA Area are SFA11 and SFA12. Twenty-seven scheduled salmon rivers occur in these two SFAs with fourteen occurring within the SEA

Area (DFO 2008e). Some of the most productive of these rivers include Grey River, Grandy River and LaPoile River (Burgeo Diversification Development Board (BDDB) 2003, DFO 2002e *in* JW 2007). There has not been a recent assessment of the stocks of the rivers in SFA 11 and SFA12 that occur in the SEA Area. Some stock status information has recently become available for Conne River and Little River, which are two SFA 11 rivers that occur adjacent the SEA Area (Dempson et al. 2006). Dempson et al. (2006) noted that despite a moratorium on the commercial salmon fishery since the early 1990s, the South coast region (SFAs 9-11) has experienced the greatest declines in returns of both small salmon (<63 cm) and large salmon (>63 cm) when abundances are compared to historic peaks. South coast stocks have declined by 74% from the peak in 1986 to returns in 2005. The assessors also noted that some south coast stocks, such as Conne River and Northeast Brook near Trepassey, have failed to replace themselves at least 50% of the time. In addition, survival of smolts to small salmon in some south coast populations remains low despite the commercial fishery moratorium. Dempson et al. (2006) noted that these negative trends make the south coast stocks of particular concern in terms of salmon stock recovery. It is unknown if the stocks within the SEA Area are experiencing similar trends due to a lack of surveys in the salmon rivers of the SEA Area.

3.2.2.9 Atlantic Saury

The Atlantic saury (*Scomberesox saurus*) is a schooling species that inhabits the temperate and warm surface waters of the open ocean and is rarely observed in coastal waters, except during summer and autumn when surface temperatures rise (Scott and Scott 1988). Distributed from eastern Newfoundland southward to North Carolina in the NW Atlantic, the Atlantic saury is typically found in waters ranging in temperature from roughly 8 to 25°C (Scott and Scott 1988). Diurnal migrations are undertaken from the surface at night to slightly deeper (<50 m) during the day. During late spring and summer there is an annual migration northward while in the fall a southern movement occurs. The north-south migrations are associated with seasonal water temperatures. Spawning generally occurs in warm waters in the southern part of its range during winter and early spring. The diet of the Atlantic saury consists chiefly of zooplankton species with copepods, euphausiids, and amphipods forming a large dietary component (Scott and Scott 1988).

3.2.2.10 Shortfin Squid

The northern shortfin squid (*Illex illecebrosus*) is a highly migratory species that inhabits the continental shelf and slope waters of the NW Atlantic from Iceland to the east coast of Florida (Hendrickson 2004). In Newfoundland, spring surveys indicate shortfin squid undertake an inshore migration from deeper waters during May to shallower waters of the Grand Banks during June (Hendrickson 2006a). Autumn surveys indicate most squid occurred offshore in deep water during October to mid-December; though some occurred near shore during the same time period (Hendrickson 2006a). Like most squid species, the shortfin squid has a lifespan of less than one year and exhibits protracted spawning whereby overlapping “microcohorts” enter the population throughout the year over a wide geographic area (Hendrickson 2006a). Currently, the only confirmed spawning area is located in the Mid-Atlantic Bight where the winter cohort spawns during late May (Hendrickson 2004; 2006b). Spawning is also believed to occur offshore in the Gulf Stream/Slope Water frontal zone (Rowell et al. 1985 in Hendrickson 2006b), and south of Cape Hatteras during winter (Dawe and Beck 1985 *in* Hendrickson 2006b).

3.2.2.11 Sharks

Six species of small dogfish are resident in Canadian waters with the spiny dogfish (*Squalus acanthius*) and black dogfish (*Centroscyllum fabricii*) being the most abundant. Other demersal sharks in Canadian waters included the smooth dogfish (*Mustelus canis*), Portuguese shark (*Centroscymnus coelolepis*), deepsea cat shark (*Apristurus profundorum*) and great lantern shark (*Etmorpterus princes*).

<u>Spiny Dogfish</u>

The spiny dogfish is a widely distributed boreal to warm temperate species distributed over continental and insular shelves and upper slopes of the Pacific and Atlantic oceans (Kulka 2006). Their western Atlantic distribution ranges from Labrador to Florida, with their centre of abundance located between the southern Scotian Shelf and Cape Hatteras. Spiny dogfish concentrate at bottom depth of 10 to 200 m in water ranging between 7°C to 15°C. Thus, the spiny dogfish are at the northern limit of their distribution in Newfoundland and Labrador waters. Spiny dogfish concentrate on the Western portion of the St. Pierre Bank adjacent to the Laurentian Channel and onto the Hermitage Channel in water depths of 100 to 250 m. They congregate in the warmest available water (>5°C) and the population are comprised of mature adults.

Data from commercial catches observed spiny dogfish catches year-round, with the highest catches in winter and spring months (Kulka 2006). The winter catches were concentrated along the western edge of the St. Pierre Bank, which has the highest Grand Banks bottom temperatures (approximately 6°C year-round). This would indicate that a portion of the spiny dogfish distributed over the St. Pierre Bank is resident year-round and the St. Pierre Bank is a winter ground for spiny dogfish. The data suggest there is a local inshore/offshore migration pattern.

The reproductive cycle of the spiny dogfish is one of the longest gestation periods for any invertebrate, making the species relatively unproductive (Campana et al. 2008). Live young are generally born after a gestation period of 22-24 months. Pupping grounds have not been observed in Canadian waters; however, large aggregations of mature females occur in deep warm waters off the edge of the continental shelf and in the deep basins of the central shelf throughout their range in winter. Based on the presumed birth months in the late winter, pupping occurs in these deep offshore areas. Small juveniles are seldom collected in Canadian research surveys, but those that are collected are found in the same areas as the mature females in winter. This suggests that pupping most probably occurs in Canadian waters.

Black Dogfish

Black dogfish is distributed along the slopes of the Atlantic Ocean Basin ranging from Greenland down to Cape Hatteras, possibly Florida and into the Gulf of Mexico (Kulka 2006). Black dogfish are a bathydemersal species resident in waters as shallow as 300 m but generally found in water deeper than 500 m. Spanish research survey data shows that black dogfish on Grand Bank generally occupy depths greater than 900 m (Gonzalez-Costas et al. 2006). Black dogfish are concentrated in the Laurentian Channel, into Hermitage Channel and near the St. Pierre Bank.

Relative abundance estimates are problematic as a significant portion of the black dogfish occupy depth that exceed the range surveys (pre-1995), as well as only spring surveys are conducted in 3Ps where the largest concentrations of black dogfish reside (Kulka 2006). Within the Laurentian Channel, the relative abundance fluctuated at low levels during the 1970s and 1980s, increased rapidly stabilizing through the mid-1990s, after which it has declined possibly becoming stable over resident in the Laurentian Channel are primarily juveniles as well as a substantial portion of mature females in the shallow areas of the Channel. This indicates that the Laurentian Channel appears to be a pupping ground for this species. Black dogfish exhibit a highly structured distribution with a degree of separation by life stage. Large pregnant females migrate to shallow waters in the Laurentian Channel where pupping occurs. The young migrate in to deeper waters of the channel where as they mature, they migrate out of the Laurentian Channel in to the slope waters. They may migrate significant distances to the Labrador shelf. As they continue to grow, they continue to move into deeper waters.

Black dogfish are primarily by-catch in Greenland halibut, crab, redfish, monkfish and witch flounder fisheries.

3.2.2.12 Hakes

Other than white hake, at least three other hake species occur in the SEA Area. They include longfin hake (*Phycis chesteri*), blue hake (*Antimora rostrata*) and silver hake (*Merluccius bilinearis*). The longfin hake is a deepwater demersal species that occurs in continental slope waters from mid-Labrador to Florida (Scott and Scott 1988). DFO R/V survey data indicates that longfin hake are predominately found in the slope waters of Grand Bank and the Laurentian Channel within the SEA Area. On the southern Grand Bank and Flemish Cap, spawning is believed to occur in October with a peak during winter.

3.2.3 Macroinvertebrate and Fish Spawning

Macroinvertebrate eggs and larvae, and ichthyoplankton, introduced in the earlier subsection on plankton, occur throughout the SEA Area. Ichthyoplankton refers to the pelagic eggs and larvae of fishes that typically occur in the upper water column. Table 3.2 presents temporal and spatial information on macroinvertebrate eggs and larvae, and ichthyoplankton that occur in the SEA Area.

3.2.4 DFO Research Vessel (RV) Surveys

This subsection provides a discussion of the invertebrate and fish species caught during 2006 and 2007 DFO RV surveys in the SEA Area. Table 3.3 presents catch weight and depth of catch information for those species accounting for about 90% of the total SEA Area RV survey catch weight, 2006 and 2007 combined.

3.2.4.1 Catch Weight

Five species accounted for more than 75% of the total catch weight of RV surveys in the SEA Area, 2006 and 2007 combined. They include deepwater redfish, thorny skate, yellowtail flounder, American plaice and Atlantic cod. Each of the other eleven species included in Table 3.3 account for 2.8% or less of the total catch weight. The only identified invertebrate species of the '90% group' is the orange-footed sea cucumber. Six of the fish species in Table 3.3 (i.e., American plaice, Atlantic cod, haddock, all wolffishes) are considered to be Species at Risk and are discussed in Subsection 3.7.1.

3.2.4.2 Catch Distribution

Based on the RV surveys average mean catch depth, half of the species in Table 3.3 were caught primarily on the continental shelf and the remaining eight were caught primarily beyond the continental shelf. Distributions of the RV survey catches are indicated in Figures 3.2 to 3.11. Yellowtail flounder and sand lance were caught in the shallowest areas of the SEA Area (Table 3.3; Figures 3.3 and 3.4) while black dogfish, northern wolffish, Greenland halibut and longfin hake were the species most often caught in the deeper water areas (Table 3.3; Figures 3.6, 3.7 and 3.9).

3.2.5 Planning Implications

Sensitive times for fish include spawning periods and larval periods. Table 3.2 outlines the times when those fish species harvested commercially are spawning and times when pelagic larval stages are present. Most commercial species spawn during the spring and summer, but cod and skate reproduce throughout most of the year. Most larval and juvenile pelagic life stages are present in the SEA Area in the late summer and fall. Timing of spawning and sensitive life stages are discussed in detail in the above species descriptions. Directed cod and redfish fisheries in the SEA Area are each closed for several months each year due to declining stocks. Specific mitigative measures for avoidance of sensitive times would likely be established in consultation with authorities for site-specific environmental assessments.

Events have shown over several years that gillnets and crab gear are the ones most often involved in a gear conflicts with the offshore industry and other offshore users. Operators should understand the potential need for special precautions in fixed gear areas such as fisheries liaison officers (FLOs) and guard boats, especially when conducting seismic surveys.

Table 3.2. Spatial and Temporal Planktonic Egg and Larvae Occurrence in the SEA Area.

Species	Occurrence of Eggs/Larvae	Timing of Spawning	Depth Distribution of Eggs/Larvae
Invertebrates			
Snow crab	Eggs: Yes Larvae: Yes	Larval generally hatch in late spring/summer and remain planktonic for 3 to 4 months.	Developing fertilized eggs carried by female on bottom. Larvae occur in upper water column.
Whelk	Eggs: Yes Larvae: Yes	Mating typically occurs between May and July with eggs laid 2-3 weeks after mating	Round eggs deposited in masses on bottom. No planktonic larval stage.
Sea scallop	Eggs: Yes Larvae: Yes	Spawning typically spawns from August to October	Eggs and first two larval stages in upper water column.
Iceland scallop	Eggs: Yes Larvae: Yes	Spawning from spring to fall, depending on water temperature	Eggs: occur somewhere in water column Larvae occur in the upper water column.
Lobster	Eggs: Yes Larvae: Yes	Mating occurs in the summer months and occurs once every two years for the females	Eggs carried under female’s tail for 9-12 months. Larvae have a 6-10 pelagic stage prior to settling to the bottom.
Sea cucumber	Eggs: Yes Larvae: Yes	Timing of spawning is location specific but typically occurs between late winter to early summer	Eggs and larvae occur in upper water column.
Shortfin squid	Eggs: Larvae:	Exhibits protracted spawning whereby overlapping “microcohorts” enter the population throughout the year	Eggs deposited in gelatinous egg mass. Paralarvae possibly occur in upper water column.
Forage Fish			
Atlantic herring	Eggs: Yes Larvae: Yes	Spawning timing depends on the stock with some stocks spawning in spring and others spawn in summer or fall.	Eggs deposited on stable substrates in high energy areas with strong tidal currents. Pelagic larvae found through- out water column depending on light availability.
Atlantic mackerel	Eggs: Yes Larvae: Yes	Spawning occurs from about mid-June to mid-July, largely in Gulf of St. Lawrence and limited off Newfoundland	Fertilized eggs occur in upper 10 m of water column. Larvae occur in upper water column.
Atlantic saury	Eggs: Yes Larvae: Yes	Spawning occurs in warm water in southern part of its range during winter and early spring	Eggs and larvae occur in surface waters.
Capelin	Eggs: Yes Larvae: Yes	Spawning occurs from early June to July on beaches or in deeper waters	Eggs deposited on the bottom. Planktonic larvae remain near surface until onset of winter.
Sandlance	Eggs: Yes Larvae: Yes	Most sandlance species reported to spawn in fall or winter; some populations may spawn in spring or summer.	Eggs demersal and adhesive, attaching to sand and gravel on the bottom. Larvae occur in the upper water column

Species	Occurrence of Eggs/Larvae	Timing of Spawning	Depth Distribution of Eggs/Larvae
Groundfish			
American plaice	Eggs: Yes Larvae: Yes	Eggs and larvae planktonic during spring/summer.	Eggs and larvae occur in upper water column.
Atlantic cod	Eggs: Yes Larvae: Yes	Spawning primarily between April and June.	Fertilized eggs and larvae may occur anywhere within the upper 100 m of the water column, eggs generally most concentrated in the upper 10 m.
Atlantic halibut	Eggs: Yes Larvae: Yes	Spawning likely between January and May.	Fertilized eggs gradually move up into the surface waters. Larvae hatch and remain near surface for approximately six to eight weeks.
Cusk	Eggs: Yes Larvae: Yes	Spawning occurs from May to August, peaking in June	Eggs possibly occur in upper water column. Larvae possibly occur in upper water column.
Greenland halibut	Eggs: Yes Larvae: Yes	Spawning is believed to occur in Laurentian Channel during winter.	Eggs are benthic. Larvae move up in water column and remain at 30 m until a length of about 70 mm is achieved.
Haddock	Eggs: Yes Larvae: Yes	Spawning occurs from January to July, peaking in June off Newfoundland	Eggs and larvae occur in surface waters.
Hagfish	Eggs: Yes Larvae: No	Spawning presumably occurs throughout the year	Horny-shelled large eggs carried by the female.
Longfin hake	Eggs: Yes Larvae: Yes	Spawning believed to occur in October, peaking during winter	Eggs and larvae occur in upper water column.
Lumpfish	Eggs: Yes Larvae: Yes	Spawning occurs in May and June	Egg masses deposited on bottom and guarded by male. Larvae/ juveniles remain near surface, often associated with floating algae.
Monkfish	Eggs: Yes Larvae: Yes	Spawning occurs from June to September in Canadian waters	Eggs are deposited as a mucus sheet or veil that floats at the surface. Larvae float on the surface.
Ocean pout	Eggs: Yes Larvae: Yes	Spawning occurs in crevices and holes under boulder in late August in Newfoundland waters	Eggs deposited in gelatinous masses in clumps on the bottom and guarded by the female. Larvae: unknown.
Pollock	Eggs: Yes Larvae: Yes	Spawning occurs from September until March in Canadian waters, largely Nova Scotia	Both eggs and larvae occur in the upper water column.
Redfishes	Eggs: No Larvae: Yes	Larval extrusion typically occurs in late spring/summer months.	Larvae are pelagic.
Roughhead grenadier	Eggs: Yes Larvae: Yes	Spawning is believed to occur in winter and early spring	Eggs: unknown. Larvae: unknown.
Roundnose grenadier	Eggs: Yes Larvae: Yes	Spawning is believed to occur in spring and autumn	Eggs: free-floating. Larvae: unknown.
Spiny eel	Eggs: Yes Larvae: Yes	Limited information known though ripe adults reported as common in North Atlantic (near Iceland) in September and October	Eggs: unknown. Larvae: unknown.

Species	Occurrence of Eggs/Larvae	Timing of Spawning	Depth Distribution of Eggs/Larvae
Ocean pout	Eggs: Yes Larvae: Yes	Spawning occurs in crevices and holes under boulder in late August in Newfoundland waters	Eggs deposited in gelatinous masses in clumps on the bottom and guarded by the female. Larvae: unknown.
Pollock	Eggs: Yes Larvae: Yes	Spawning occurs from September until March in Canadian waters, largely Nova Scotia	Both eggs and larvae occur in the upper water column.
Redfishes	Eggs: No Larvae: Yes	Larval extrusion typically occurs in late spring/summer months.	Larvae are pelagic.
Roughhead grenadier	Eggs: Yes Larvae: Yes	Spawning is believed to occur in winter and early spring	Eggs: unknown. Larvae: unknown.
Roundnose grenadier	Eggs: Yes Larvae: Yes	Spawning is believed to occur in spring and autumn	Eggs: free-floating. Larvae: unknown.
Spiny eel	Eggs: Yes Larvae: Yes	Limited information known though ripe adults reported as common in North Atlantic (near Iceland) in September and October	Eggs: unknown. Larvae: unknown.
White hake	Eggs: Yes Larvae: Yes	Most spawning believed to occur in winter and early spring	Eggs and larvae occur in the upper water column.
Winter flounder	Eggs: Yes Larvae: Yes	Spawning varies with latitude, occurring earlier in the south and later in the north; occurs from March to early June in Conception Bay, Newfoundland	Eggs occur on bottom singly or in clumps. Larvae drift in surface waters.
Witch flounder	Eggs: Yes Larvae: Yes	Spawning occurs over prolonged period, extending from March to September in the Northwest Atlantic, peaking in July and August in Grand Bank region.	Eggs occur in the upper water column. Larvae float in water column for up to a year before settling to bottom.
Wolffishes	Eggs: Yes Larvae: Yes	Spawning from early fall to early winter.	Eggs are typically benthic/demersal while the larvae are semipelagic, sometimes occurring in near surface waters.
Yellowtail flounder	Eggs: Yes Larvae: Yes	Spawning typically between May and September, peaking in June	Both eggs and larvae occur in the upper water column.
Large Pelagics			
Bluefin tuna	Eggs: Yes Larvae: Yes	Spawning occurs from April to June, but does not occur in Canadian waters.	Eggs occur in upper water column. Larvae possibly occur in upper water column.
Swordfish	Eggs: Yes Larvae: Yes	Western North Atlantic population believed to spawn throughout year in Caribbean Sea, Gulf of Mexico, and off Florida	Buoyant eggs possibly occur in upper water column. Larvae possibly occur in upper water column.
Cartilaginous Fishes			
Black dogfish	Eggs: No Larvae: No	Unknown	
Blue shark	Eggs: No Larvae: No	Young are born from March to July	
Porbeagle shark	Eggs: No Larvae: No	Young born alive usually in late summer in Northwest Atlantic	
Shortfin mako	Eggs: No Larvae: No	Birthing can occur from late winter to mid-summer.	

Species	Occurrence of Eggs/Larvae	Timing of Spawning	Depth Distribution of Eggs/Larvae
Smooth skate	Eggs: Yes Larvae: No	Spawning time not known	Eggs deposited in capsule (one egg per capsule) possibly on bottom
Spiny dogfish	Eggs: No Larvae: No	Young born during cool winter months in offshore waters of northeastern United States.	
Spinytail skate	Eggs: Yes Larvae: No	Unknown	Eggs deposited in capsule (one egg per capsule) possibly on bottom
Thorny skate	Eggs: Yes Larvae: No	Spawning believed to occur year-round.	Eggs deposited in capsule (one egg per capsule) possibly on bottom
White shark	Eggs: No Larvae: No	Little information in global and Canadian waters	
Winter skate	Eggs: Yes Larvae: No	Spawning reported to occur in late summer and early autumn.	Eggs deposited in capsule (one egg per capsule) possibly on bottom
Anadromous/Catadromous Fishes			
Alewife	Eggs: Yes Larvae: Yes	Spawning occurs in spring in freshwater.	Eggs are deposited on the bottom in freshwater and are temporarily adhesive. Larvae occupy freshwater habitats
American eel	Eggs: Yes Larvae: Yes	Believed to spawn from February to July in Sargasso Sea	Eggs and larvae possibly in upper water column
Atlantic salmon	Eggs: Yes Larvae: Yes	Spawning occurs in freshwater in October and November in Canadian waters with a peak usually occurring in late October	Eggs buried in gravel until hatching occurs in spring. Larvae occupy freshwater habitats.
Banded killifish	Eggs: Yes Larvae: Yes	Spawning occurs in freshwater from April to May	Eggs adhere to plants in freshwater. Little information concerning larvae.

Table 3.3. Invertebrate and Fish Species Accounting for Most of the Catch Weight During DFO RV Surveys in the SEA Area, 2006 and 2007 Combined.

Species	Percentage Total Catch Weight (incl. St. Pierre) (%)	Percentage Total Catch Weight (%)	Average Mean Catch Depth (m)	Minimum Mean Catch Depth (m)	Maximum Mean Catch Depth (m)
Deepwater redfish	50.4	53.8	257	63	674
Thorny skate	7.1	6.4	189	42	1,149
Yellowtail flounder	6.8	7.2	82	42	287
American plaice	6.0	6.0	163	42	625
Atlantic cod	5.2	5.3	147	41	463
Sand lance	2.8	2.4	75	42	120
Witch flounder	2.1	1.3	279	63	1,361
White hake	1.7	1.6	274	68	625
Sea cucumber	1.7	0.9	80	41	204
Black dogfish shark	1.6	1.7	676	212	1,410
Longfin hake	1.5	1.4	389	107	821
Greenland halibut	1.1	1.0	473	73	1,410
Haddock	1.0	1.0	118	64	352
Northern wolffish	<0.1	<0.1	626	86	1,361
Spotted wolffish	<0.1	<0.1	274	146	413
Atlantic wolffish	0.4	0.4	123	41	412

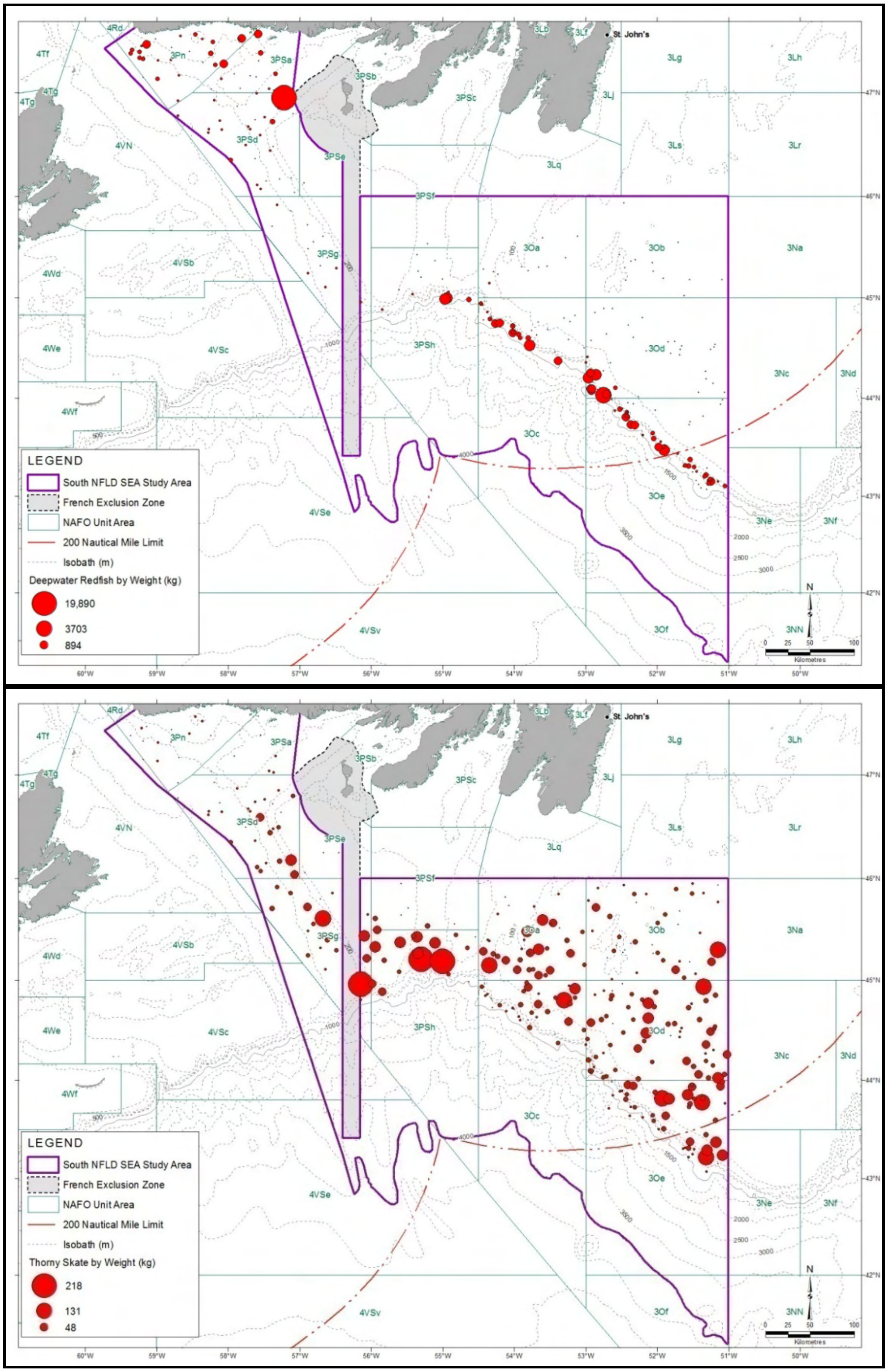


Figure 3.2. Distributions and Relative Catch Weights of DFO RV Survey Catches of Deepwater Redfish (top) and Thorny Skate (bottom) in SEA Area, 2006 and 2007 Combined.

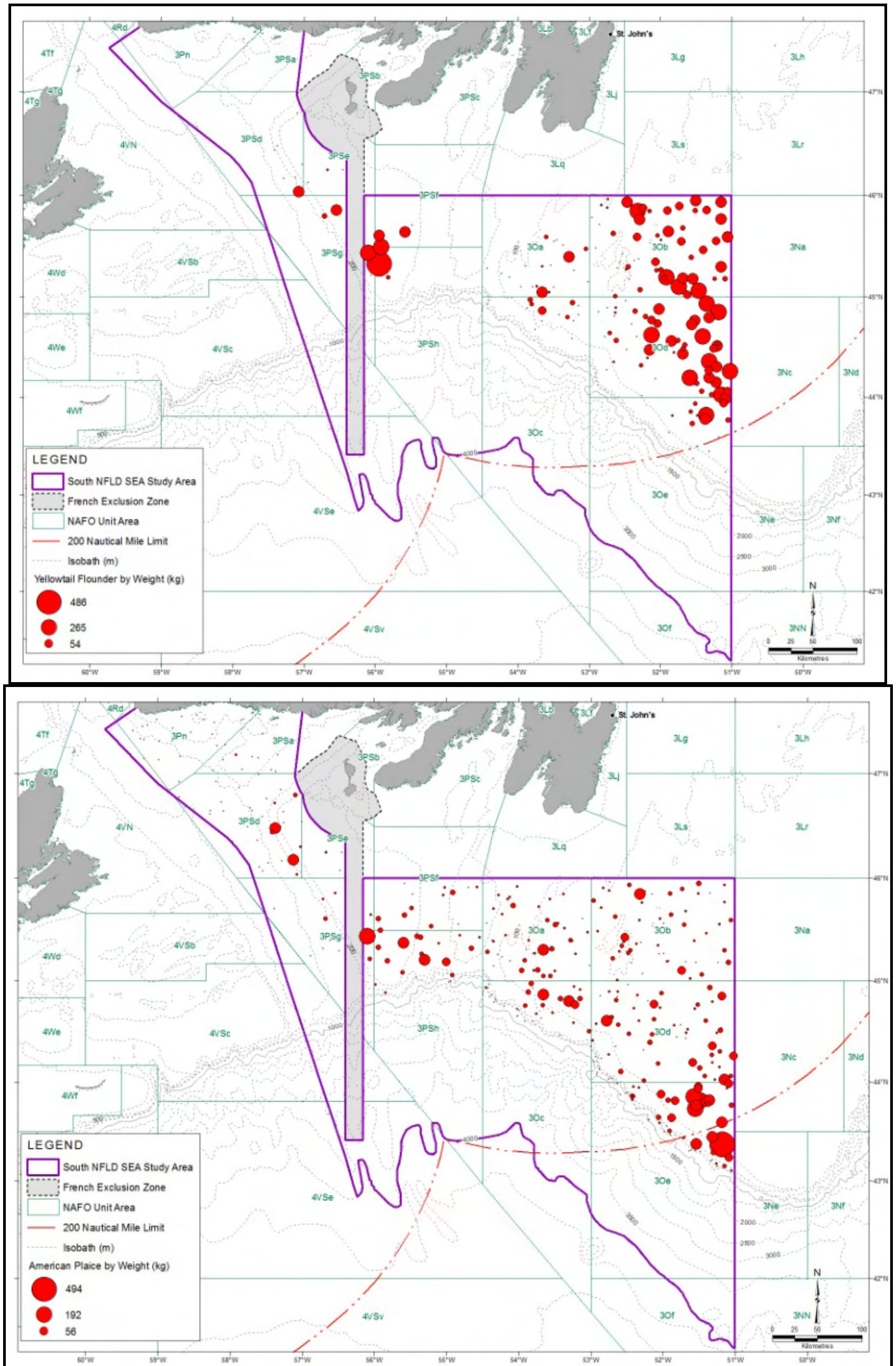


Figure 3.3. Distributions and Relative Catch Weights of DFO RV Survey Catches of Yellowtail Flounder (top) and American Plaice (bottom) in SEA Area, 2006 and 2007 Combined.

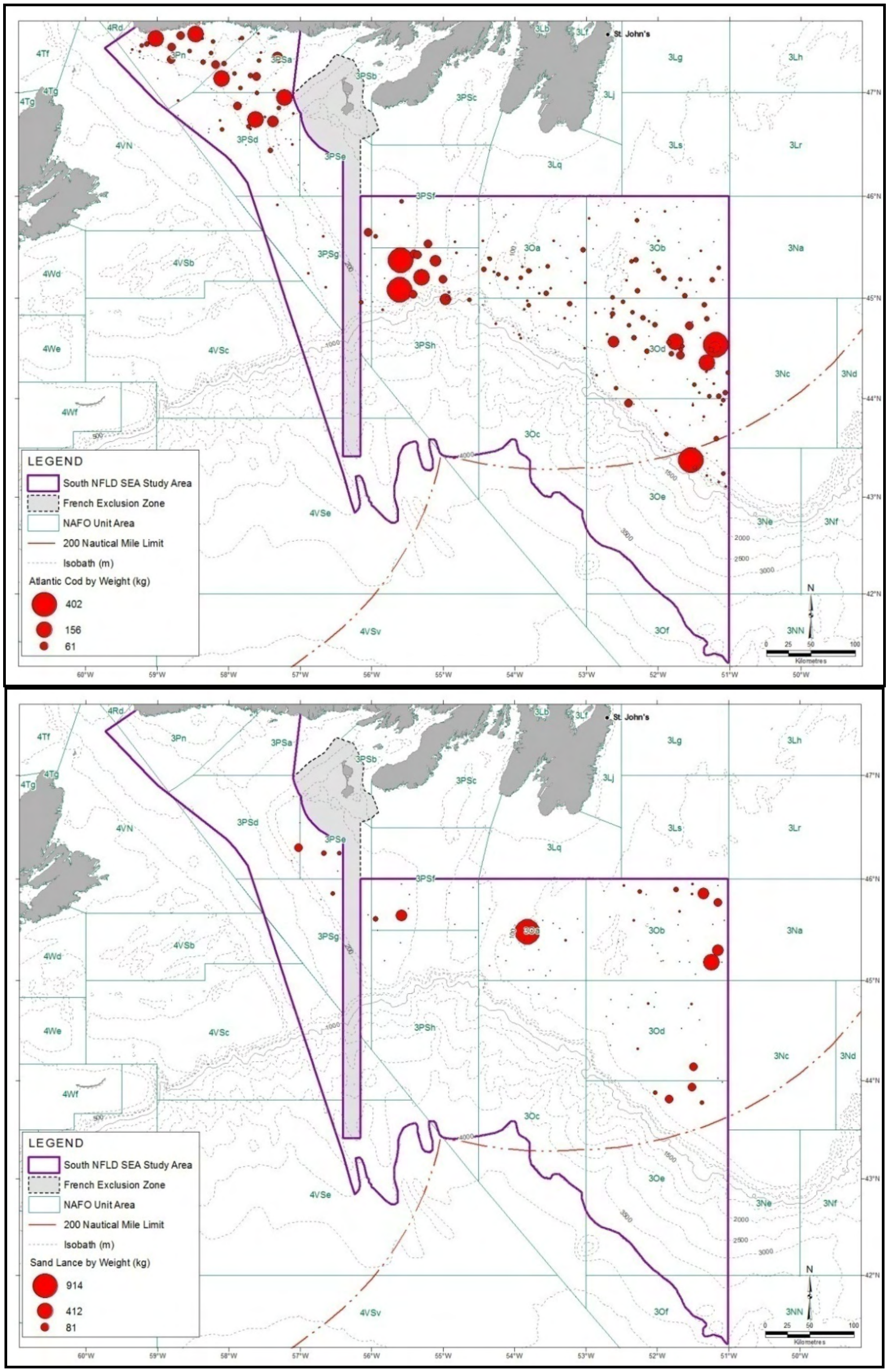


Figure 3.4. Distributions and Relative Catch Weights of DFO RV Survey Catches of Atlantic Cod (top) and Sand Lance (bottom) in SEA Area, 2006 and 2007 Combined.

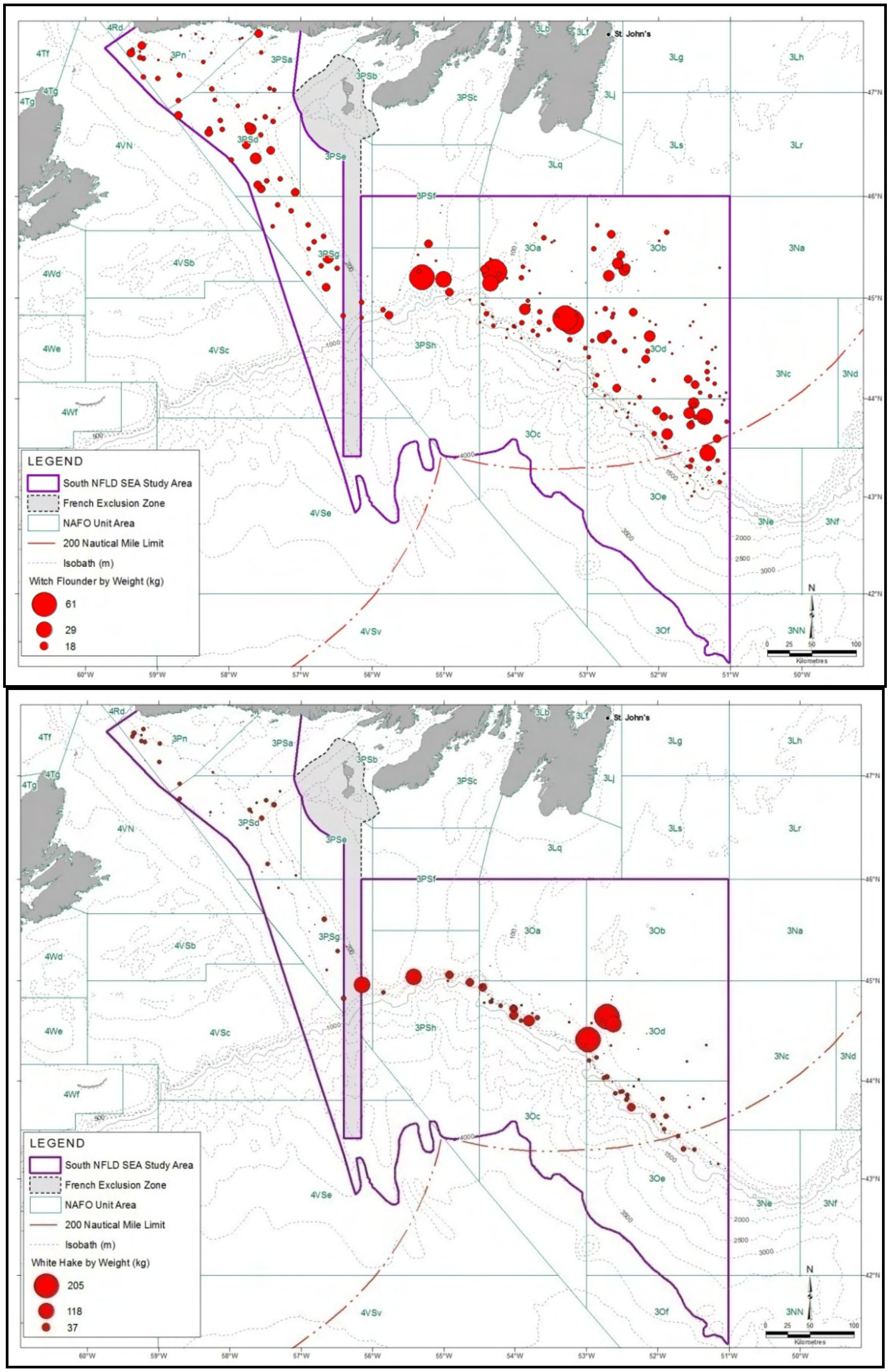


Figure 3.5. Distributions and Relative Catch Weights of DFO RV Survey Catches of Witch Flounder (top) and White Hake (bottom) in SEA Area, 2006 and 2007 Combined.

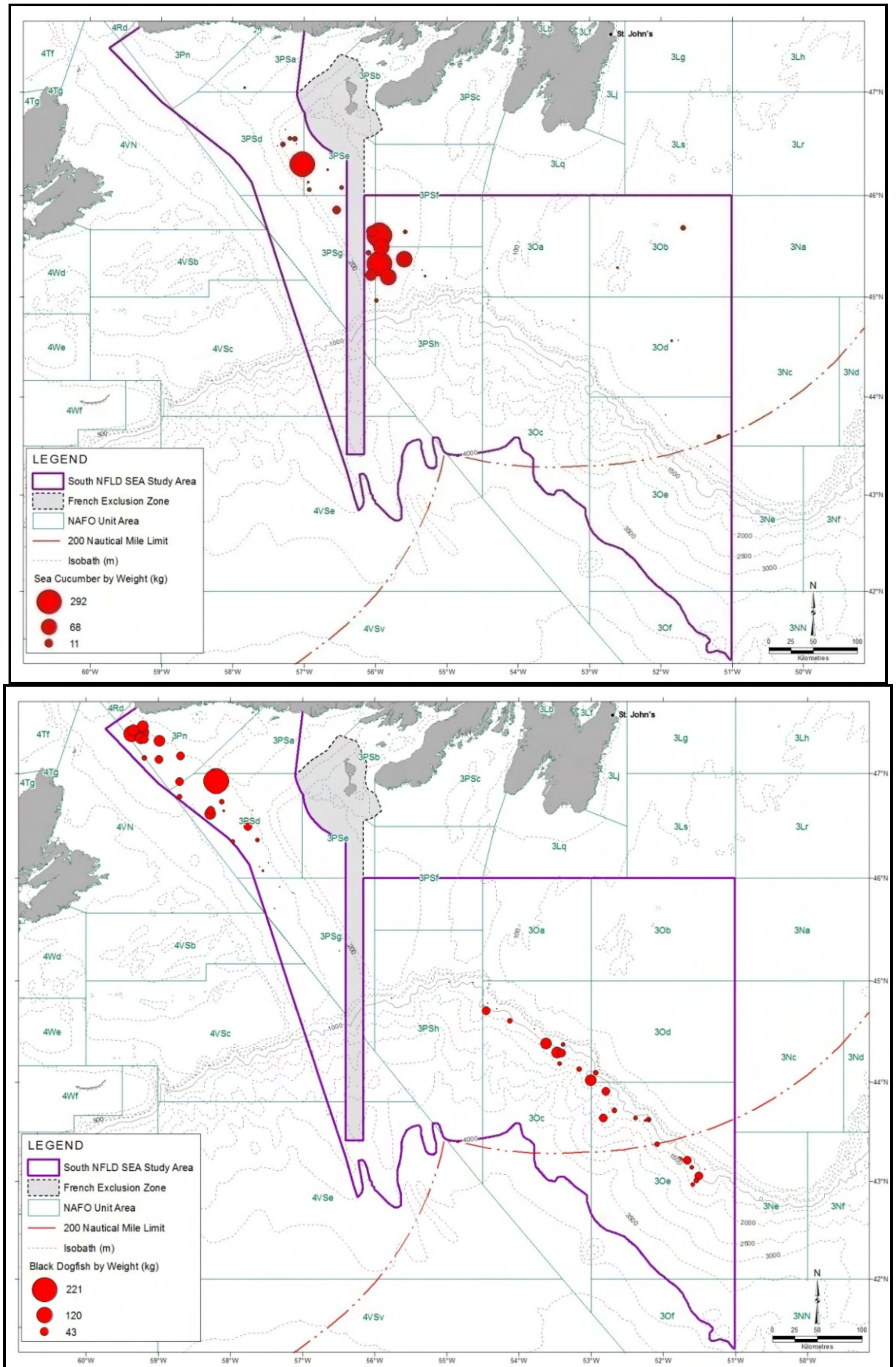


Figure 3.6. Distributions and Relative Catch Weights of DFO RV Survey Catches of Sea Cucumber (top) and Black Dogfish Shark (bottom) in SEA Area, 2006 and 2007 Combined.

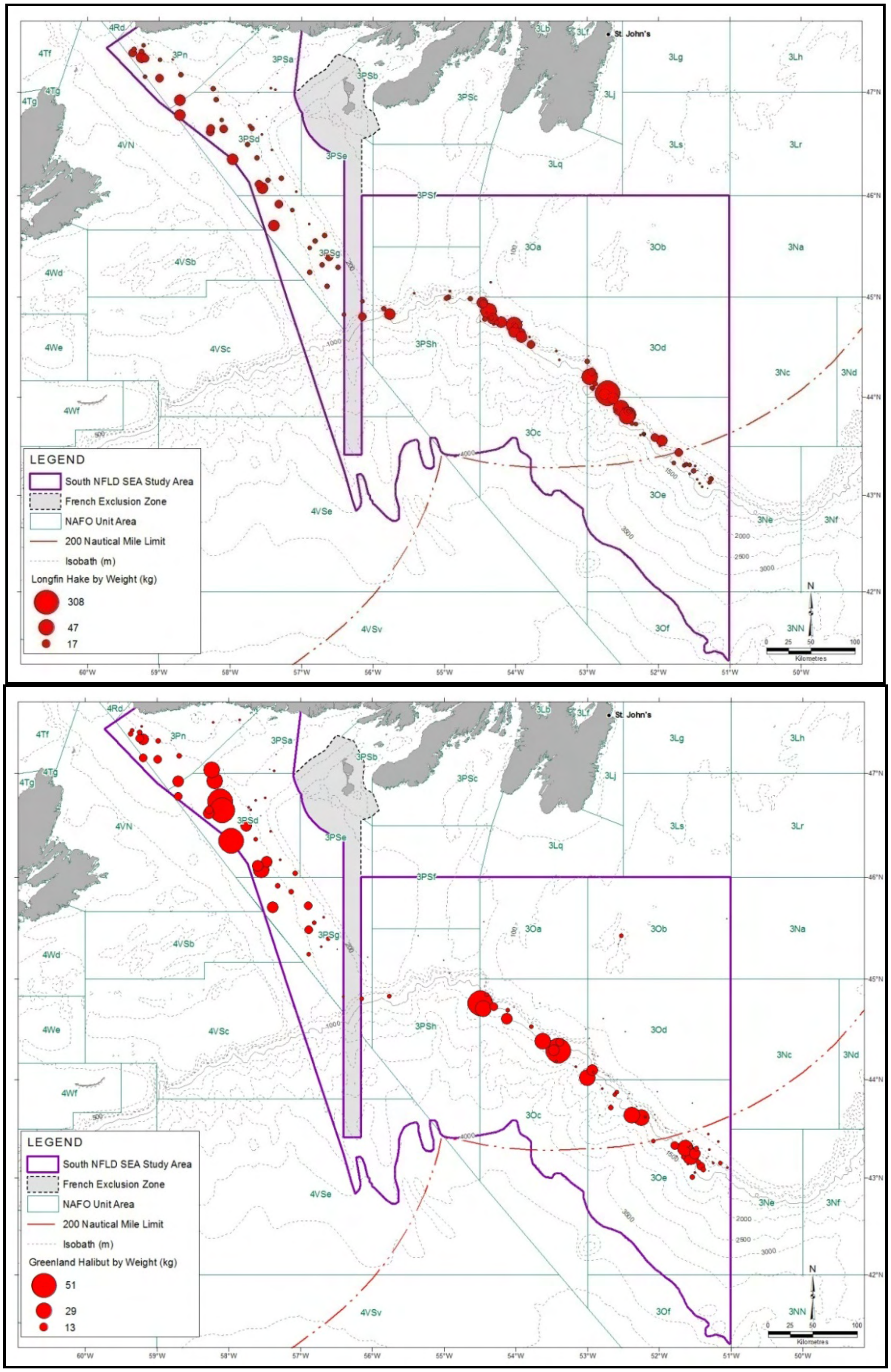


Figure 3.7. Distributions and Relative Catch Weights of DFO RV Survey Catches of Longfin Hake (top) and Greenland Halibut (bottom) in SEA Area, 2006 and 2007 Combined.

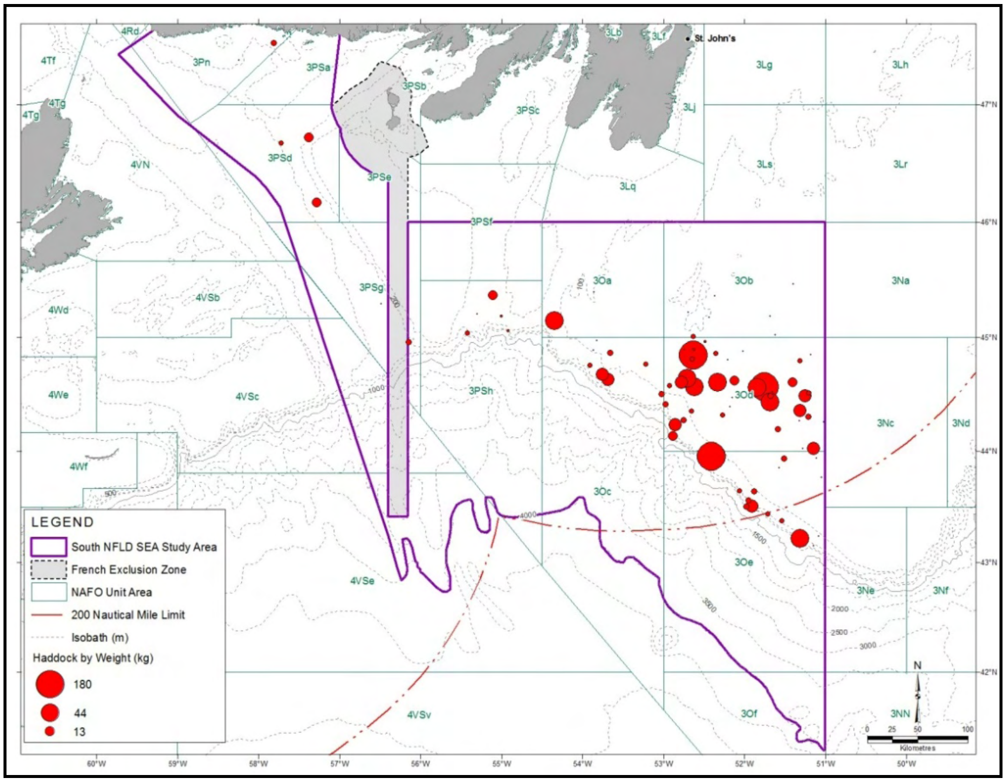


Figure 3.8. Distribution and Relative Catch Weight of DFO RV Survey Catches of Haddock in SEA Area, 2006 and 2007 Combined.

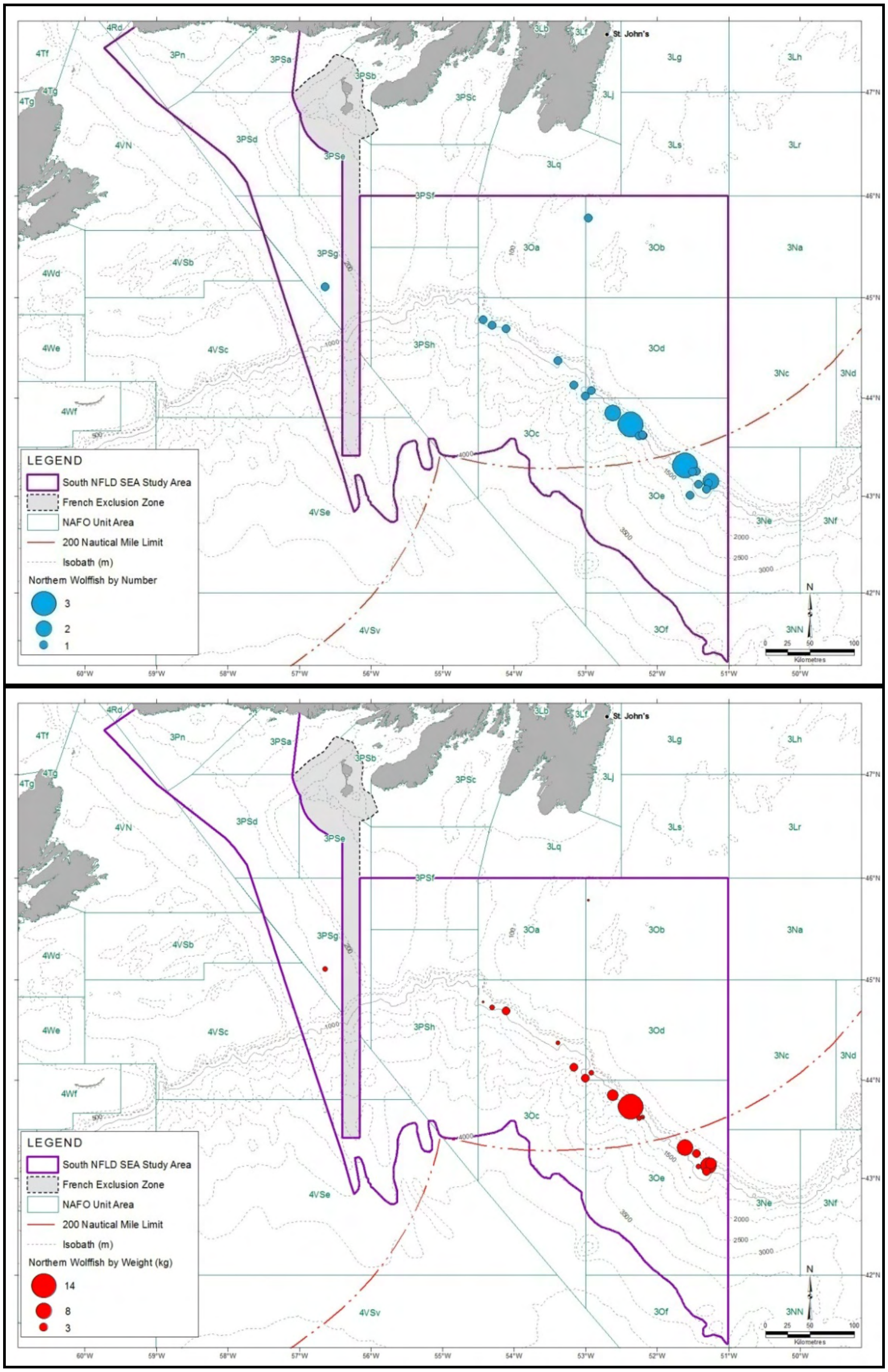


Figure 3.9. Distribution, Number of Individuals (top, blue) and Relative Catch Weight (bottom, red) of DFO RV Survey Catches of Northern Wolffish in SEA Area, 2006 and 2007 Combined.

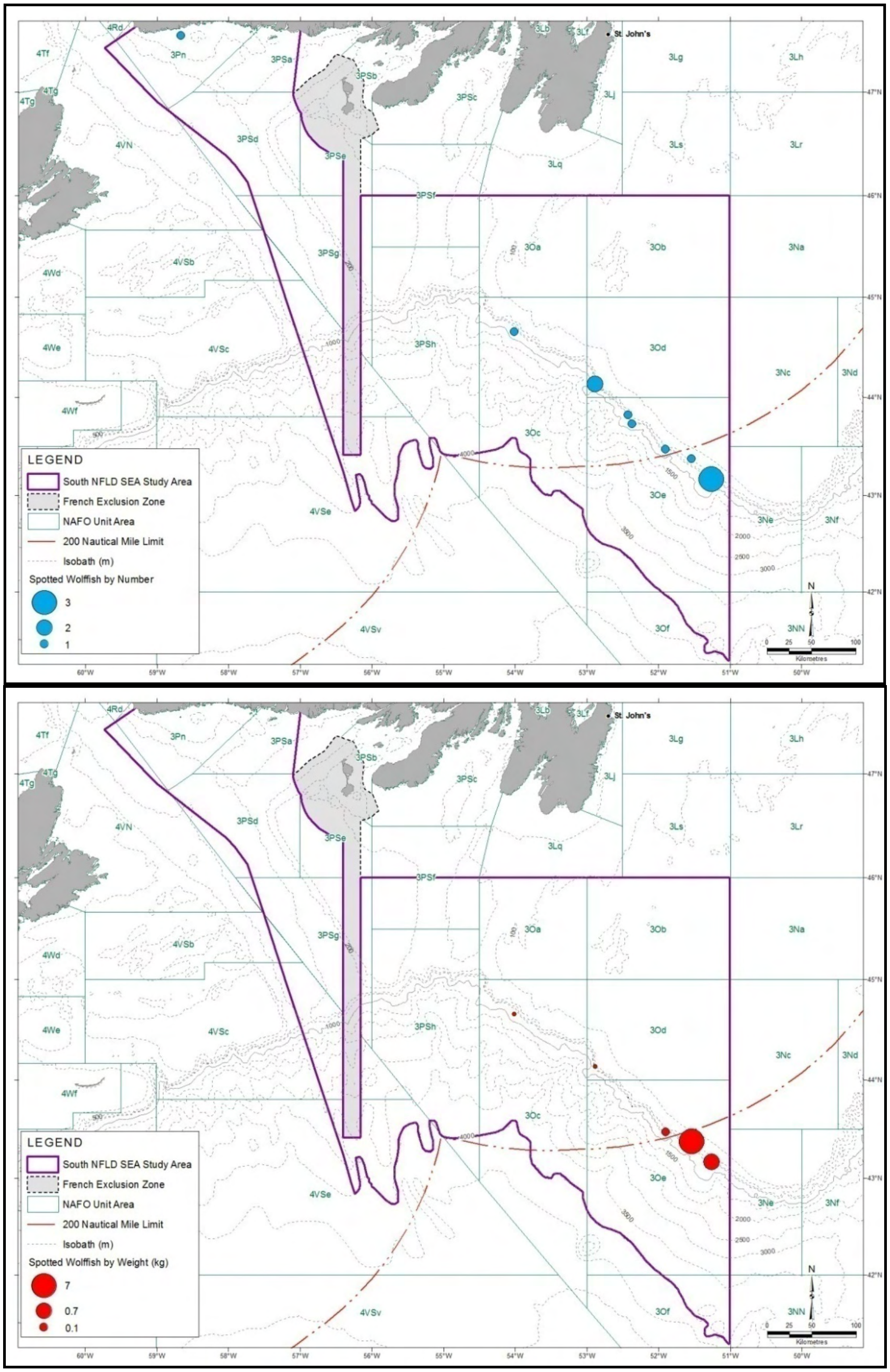


Figure 3.10. Distribution, Number of Individuals (top, blue) and Relative Catch Weight (bottom, red) of DFO RV Survey Catches of Spotted Wolffish in SEA Area, 2006 and 2007 Combined.

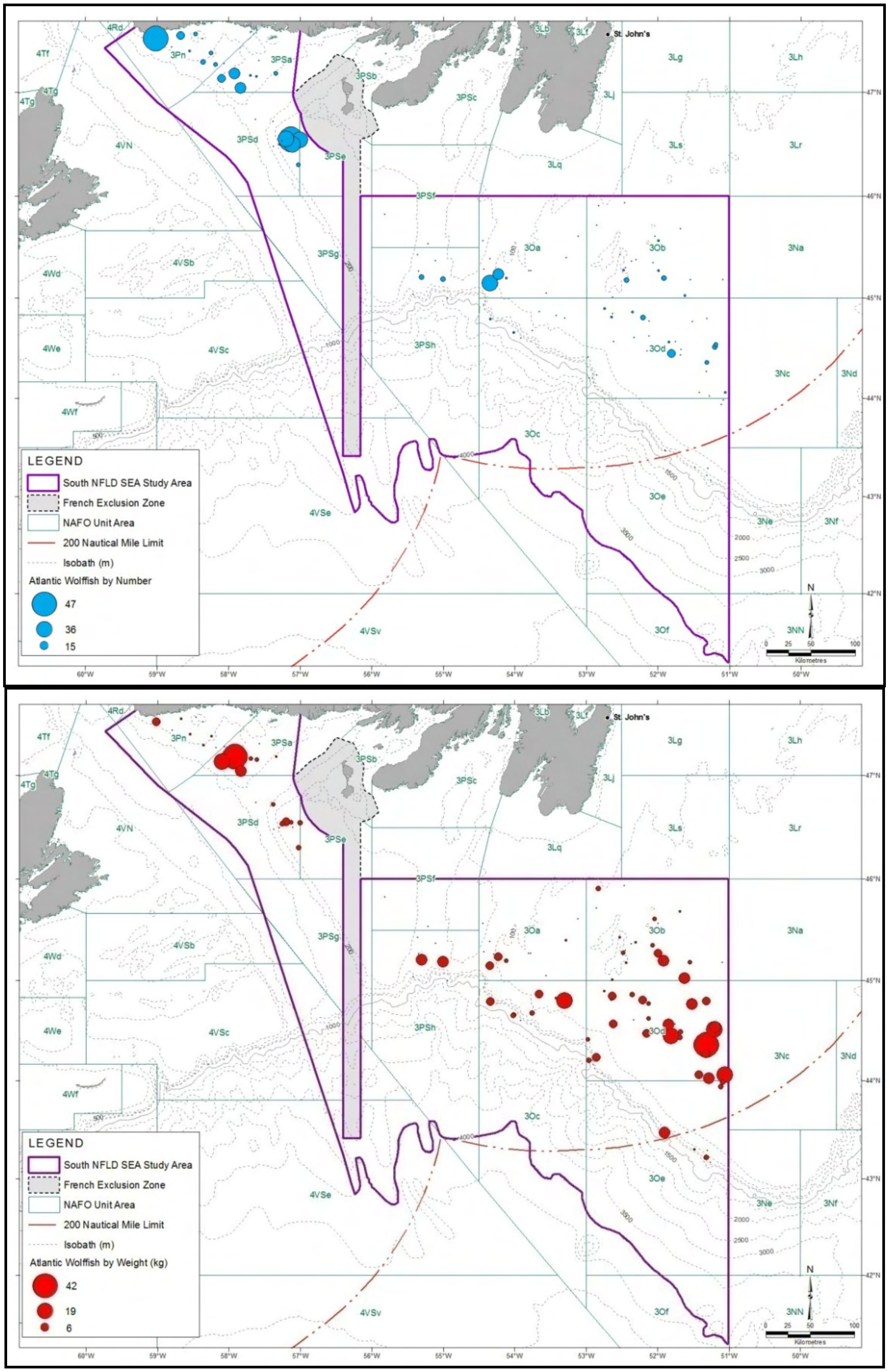


Figure 3.11. Distribution, Number of Individuals (top, blue) and Relative Catch Weight (bottom, red) of DFO RV Survey Catches of Atlantic Wolffish in SEA Area, 2006 and 2007 Combined.