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Overview and Assessment Report of the Shediac Valley Area of Interest

Fisheries and Oceans Canada, Gulf Region
343 Université Avenue, P.O. Box 5030
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ABSTRACT

The overall objective of this report is to characterize and assess the Shediac Valley Area of Interest (AOI) to inform the decision-making process regarding the feasibility of Marine Protected Area (MPA) establishment. The scope and intensity of ecological, social, economic and cultural features as well as the interactions between human uses and the ecosystem have been evaluated. This overview and assessment report is based primarily upon existing information (e.g., documents, databases, expert advice); therefore, information gaps have been identified.

Research presented in this document indicates that the Shediac Valley AOI is an important area for juvenile cod and has been identified as one of three prime American plaice nursery areas. Based on historical data on the distribution of the species, the Shediac Valley AOI may also be an important area for the recovery of winter skate. The Shediac Valley is not considered a major whelping area for grey seals. However, surveys have shown broad concentrations of grey seals in the Shediac Valley AOI during both the ice-free and ice-covered seasons.

No adverse effects from human activities have been found that are incompatible (*i.e.,* cannot be mitigated) with the AOI. Biomass removal and benthic habitat alteration from the commercial, recreational and Aboriginal (CRA) fisheries are the primary sources of adverse effects to the biological components within the area. However, much of these activities have already been mitigated with the closure of groundfish activities in Fisheries and Oceans (DFO) groundfish area 4T5.

Information regarding any future planned activities (e.g., oil and gas exploration, mineral exploration and wind energy) within the AOI has not been identified in this report. In this regard, consultation with industry, Aboriginal organizations and federal and provincial governments is recommended for use in subsequent phases of the evaluation process.

RÉSUMÉ

L'objectif général du présent rapport est de caractériser et d'évaluer la zone d'intérêt de la vallée de Shediac afin d'éclairer le processus de décisions concernant la faisabilité de l'établissement d'une zone de protection marine (ZPM). La portée et l'intensité des caractéristiques écologiques, sociales, économiques et culturelles, ainsi que les interactions entre les utilisations humaines et l'écosystème ont été évaluées. Ce rapport d'examen et d'évaluation est basé principalement sur les renseignements existants (p. ex. documents, bases de données, conseils d'experts); par conséquent, des lacunes en matière de données ont été déterminées.

La recherche présentée dans ce document indique que le site d'intérêt de la vallée de Shediac est une zone importante pour la morue juvénile et a été déterminée comme étant l'une des trois principales zones d'alevinage de la plie canadienne. D'après les données historiques sur la répartition des espèces, le site d'intérêt de la vallée de Shediac peut également être une zone importante pour le rétablissement de la raie tachetée. La vallée de Shediac n'est pas une zone importante de reproduction pour les phoques gris. Cependant, les enquêtes ont révélé de grandes concentrations de phoques gris dans la zone d'intérêt de la vallée de Shediac pendant la saison des glaces et la saison sans glace.

Aucun effet néfaste découlant des activités humaines et qui soit incompatible (*c.-à-d.* qui ne peut être atténué) avec la zone d'intérêt n'a été découvert. Le prélèvement de la biomasse et l'altération de l'habitat benthique induit par les pêches commerciales, récréatives et autochtones sont les principales sources d'effets néfastes sur les composantes biologiques à l'intérieur de la zone. Toutefois, la plupart de ces activités ont déjà été atténuées avec la fermeture des activités de pêche au poisson de fond dans la zone de pêche du poisson de fond 4T5 de Pêches et Océans Canada.

Des renseignements sur toute activité future prévue (p. ex. exploitation pétrolière et gazière, exploitation minière et énergie éolienne) à l'intérieur de la zone d'intérêt n'ont pas encore été déterminés dans ce rapport. À cet égard, une consultation avec l'industrie, les organismes autochtones et les gouvernements fédéraux et provinciaux est recommandée aux fins d'utilisation dans les phases ultérieures du processus d'évaluation.

1.0 INTRODUCTION

This Overview and Assessment Report of the Shediac Valley Area of Interest (AOI) has been prepared under the contracted services of Stantec Consulting Ltd (Stantec) and by staff of the Oceans Section, Fisheries and Oceans Canada (DFO) - Gulf Region. This report is based on existing written information and other available resources. No new field research was conducted for this report. Data gaps are noted in the report where certain information on species or pertinent features was not available.

1.1 Background

In 2007, as part of Canada's National Water Strategy, the Government of Canada announced the Health of the Oceans (HOTO) initiative. This initiative was a five-year funding program that provided support to various programs including a commitment to establish six new *Oceans Act* Marine Protected Areas (MPA) within each of Canada's five priority Large Ocean Management Areas (LOMA) to meet international obligations.

This I initiative triggered a scoping exercise, undertaken in 2007-2008, to identify potential sites to be considered as AOI. It was determined that already identified Ecologically and Biologically Significant Areas (EBSA) would be used as a starting point for the scoping exercise.

Ten (10) EBSAs were identified by DFO within the Estuary and Gulf of St. Lawrence (EGSL) Large Ocean Management Area (LOMA) as part of the Gulf of St. Lawrence Integrated Management (GOSLIM) Initiative in 2006 (DFO 2007a) (Figure 1.1). Each EBSA was identified based on the significance of its physical and biological features. Physical considerations included physical topography and physical oceanographic conditions. Biological considerations were comprised of primary production, secondary production, meroplankton, benthic invertebrates, pelagic fish, groundfish and marine mammals. Each biological component was ranked in each proposed EBSA using a relative scoring system (1 to 3) on the basis of uniqueness, concentration of the biological component in the area and the function of the area in terms of fitness consequences (also referred to as "adaptive value" in some documents) which is a measure of an area's relative contribution or importance to one or more life history stages of species or biological components present (i.e., whether a given area is obligatory spawning or nursery habitat for a species, or "merely" a preferred area, etc.) (DFO 2007a).

The ten EBSAs identified in the EGSL are as follows (DFO 2007a):

- Western Cape Breton EBSA;
- St. George's Bay EBSA;
- Western Northumberland Strait EBSA;
- Southern Fringe of Laurentian Channel EBSA;
- South-western Coast of the Gulf EBSA;
- Lower Estuary Gulf of St. Lawrence EBSA;
- Western Anticosti Island EBSA;
- Northern Anticosti Island EBSA;
- Strait of Belle Isle EBSA; and
- West Coast of Newfoundland EBSA.

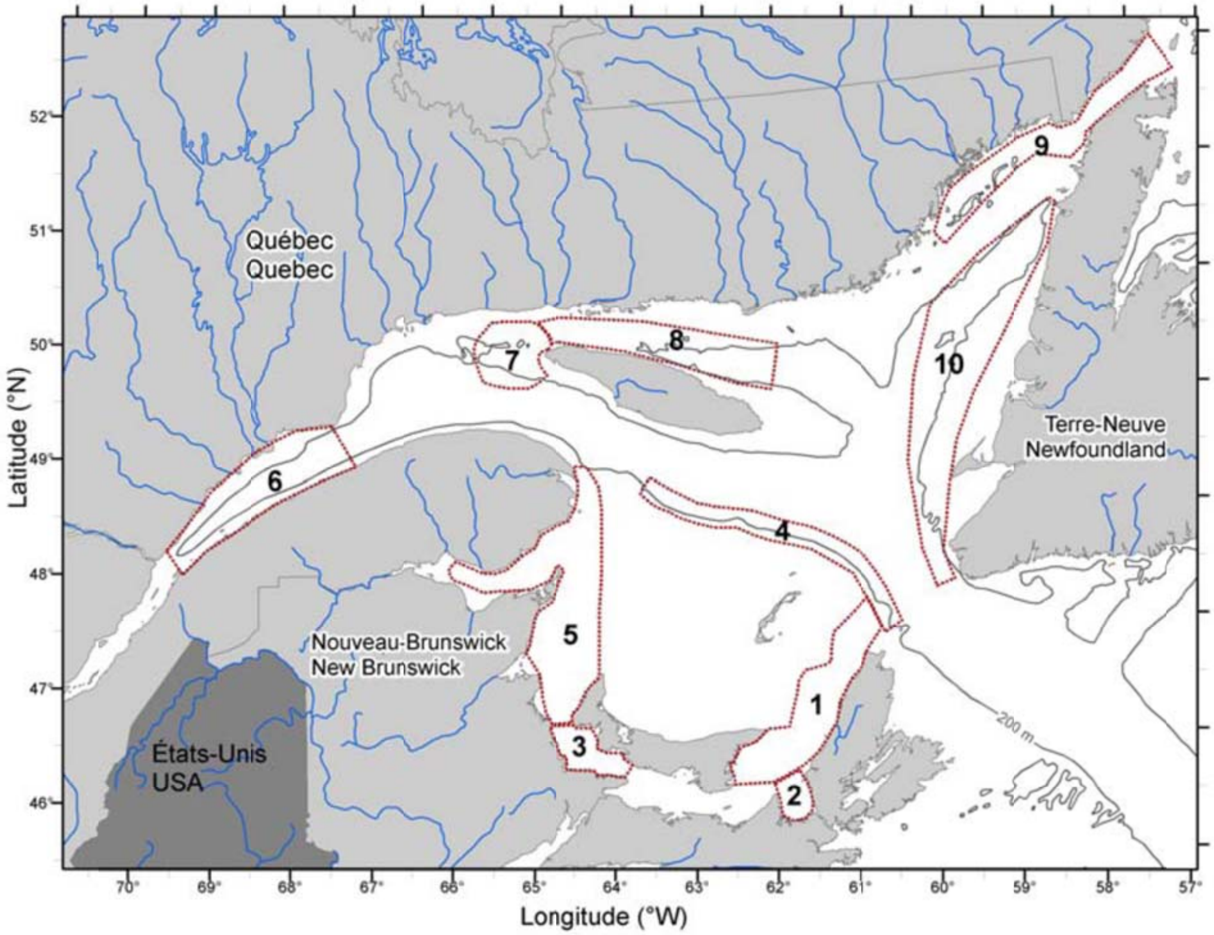

Figure 1.1 Map of the Large Oceans Management Area (LOMA) for the Estuary and Gulf of St. Lawrence showing the previously identified Ecologically and Biologically Significant Areas (EBSA). EBSAs in order: 1) western Cape Breton, 2) St. George's Bay, 3) Northumberland Strait, 4) the southern fringe of the Laurentian Channel, 5) the south-western coast of the Gulf, 6) the lower estuary, 7) western Anticosti Island, 8) northern Anticosti Island, 9) the Strait of Belle Isle and 10) the west coast of Newfoundland (DFO 2007a).

The South-western Coast of the Gulf (also known as EBSA 5) covers an area spanning from the eastern tip of the Gaspé Peninsula, Quebec (QC), southward to North Cape, Prince Edward Island (PEI) and along the west coast of PEI to West Cape, then westward across Northumberland Strait to Richibucto, New Brunswick (NB) and finally northward along the eastern shore of NB to Miscou Island and Chaleur Bay (DFO 2007a) (Figure 1.1). Within EBSA 5 is a distinct biological, hydrographical and geological undersea feature known as the Shediac Valley. The Shediac Valley forms the seaward extension of northern Northumberland Strait to the edge of the Laurentian Channel. An area covering the upper (shallower) portion of the Shediac Valley has been identified as having an important role in various biological functions (feeding, refuge, nursery and spawning) for a variety of commercial fish species. In particular, it is used by Atlantic cod as a summer feeding and nursery area. Other species of conservation interest, such as American plaice and winter skate, are also present in this area.

Drawing on the work undertaken as a part of the Gulf of St. Lawrence Integrated Management (GOSLIM) Initiative, the Shediac Valley emerged as a candidate site having met the *Oceans Act* criteria for an MPA. Shediac Valley was proposed as an AOI (Figure 1.2) in 2008 and was officially announced as an Area of Interest by the Minister of Fisheries and Oceans Canada on June 8, 2011.

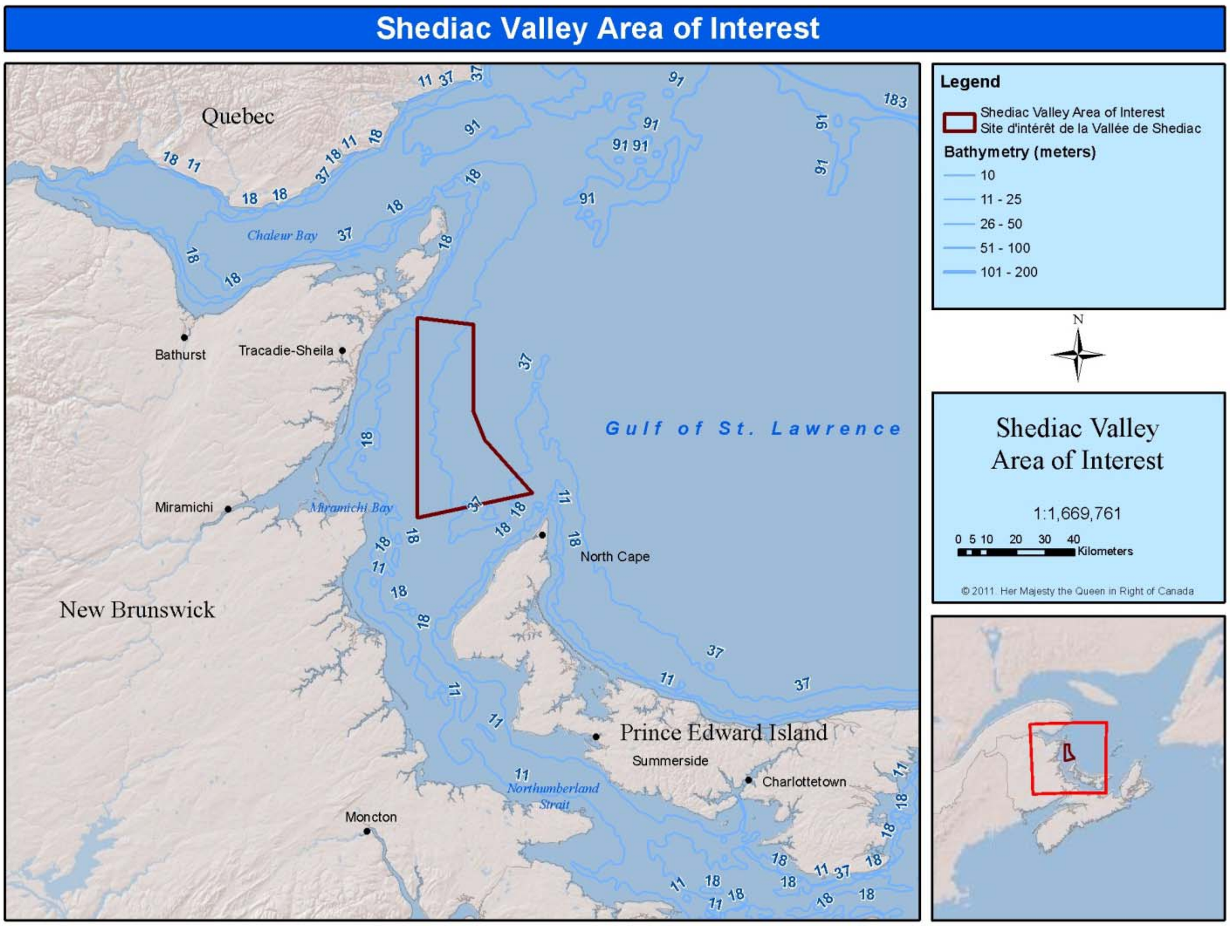

Figure 1.2 Southwestern Gulf of St. Lawrence and Shediac Valley AOI location.

1.2 Objectives

The overall objective of this report is to characterize and assess the ecological and socio-economic features of the Shediac Valley AOI to assist DFO in the decision-making process regarding the potential establishment of an MPA. The purposes of the report are to:

- characterize the ecological, social, economic and cultural aspects of the AOI;
- provide the basis for a recommendation on whether to proceed with the MPA designation process;
- provide information to refine the conservation objectives of the proposed MPA;
- identify the regulatory and management measures necessary to achieve the objectives (regulatory intent); and

- facilitate the identification of who should be consulted (*e.g.,* those who have regulatory authorities or rights or who use the area that will be evaluated in subsequent phases).

2.0 ECOLOGICAL OVERVIEW

This section includes data on ecological components, including the physical, chemical and biological environments of the Shediac Valley AOI and the larger surrounding area. Where possible, the information presented here pertains directly to the Shediac Valley. However, much of the information reviewed is more broadly based geographically and applies to the entire southern Gulf of St. Lawrence (sGSL) or to the entire Gulf of St. Lawrence (GSL), which encompass and may influence conditions in the study area.

2.1 Physical, Chemical and Biological Systems

This section provides a general description of current knowledge in relation to the Shediac Valley AOI study area, including existing data on physical oceanography and the physical, chemical and biological components of the area. The relationships between the marine ecosystem of the study area and that of the surrounding area are also described.

2.1.1 *Physical Systems*

The predominant ocean current which affects the Shediac Valley area originates as the Gaspé current, which flows eastward out of the St. Lawrence Estuary and then southward around the Gaspé Peninsula. A portion of the Gaspé current splits at Chaleur Bay and tends west into the Bay, while the remainder of the Gaspé current moves water southward across the Shediac Valley and over the Magdalen Shelf, as well as into Northumberland Strait. The Chaleur Bay current circulates counter-clockwise around Chaleur Bay and, upon exiting the Bay, moves south across the Shediac Valley to rejoin the predominant southerly current (Loring and Nota 1973).

There are several gyres along the New Brunswick (NB) shore including areas adjacent to the Shediac Valley and these gyres are, according to DFO (2005a), very important to the area "because they concentrate surface production in a temporal retention area, which is used by many species of fish, marine mammals and birds for spawning, juvenile rearing and feeding." Further, "because of the stability of these physical features, the area supports many fish and invertebrate adult species (herring, mackerel, cod, capelin, striped bass, lobster, scallop and crab) and their pelagic larvae" (DFO 2005a).

The tidal regime throughout most of the GSL, including most of the study area, is dominated by the semi-diurnal lunar constituent (M_2) and modulated by the lunisolar diurnal component (K_1). The tides are propagated from the Atlantic Ocean through the Cabot Strait, (a much smaller component also enters through Belle Isle Strait) and sweep counter clockwise around the Gulf, centred on an M_2 amphidromic point (with little or no tide level change) situated north-west of the Magdalen Islands. Another amphidromic point is situated and forms a gyre at the western end of Northumberland Strait, just south of the AOI, as noted above.

In summer, the water column in the GSL has three distinct layers consisting of a seasonal warm surface layer (8 - 18°C), a cold intermediate layer (CIL) (≤ 1 - 4°C) and a permanent and relatively warm deep layer (4 – 6°C) (Galbraith *et al.* 2010, Loring and Nota 1973). In the Shediac Valley AOI we are mostly concerned with the upper two layers, as the CIL extends to a depth of about 190 m (Loring and Nota 1973), which is deeper than the bottom of the AOI.

The permanent deep (warmer) layer below the CIL is mostly confined to the Laurentian Channel (and other deep channels of the northern and eastern GSL). It consists of nutrient-rich high salinity Atlantic Ocean water entering the Gulf at depth through Cabot Strait and flowing counter-clockwise around the GSL in a complex series of currents and counter currents, up the Laurentian Channel and into the Estuary as far as the Saguenay River (Tadoussac, QC). Here, at the head of the Laurentian Channel, this deep water is upwelled by the abrupt rise of the bottom and its dissolved nutrients nourish high primary productivity levels locally and downstream as they are carried once more seaward and into the GSL's surface layers as part of the Gaspé Current, which is a mixture of St.-Lawrence River water and of upwelled ocean water. Other upwelling areas are in the northern part of the GSL and around Anticosti Island. Thus the main impact of the GSL's deep layer on the Shediac Valley AOI is probably through its enrichment of the Gaspé Current (DFO 2005a, Loring and Nota 1973).

During winter the GSL's warm surface layer ceases to exist and the cold layer extends to the surface, where water is cooled by exposure to winter atmospheric conditions and mixed throughout the layer by turbulence and advection. This seasonal deep mixing is important for primary productivity, as it brings nutrient-rich deep water closer to the surface, where photosynthesis and phytoplankton growth (primary productivity) will occur, as seasonal daylight conditions improve with the onset of spring. During summer the cold water persists below the surface, as the warm surface layer is formed above it and gradually thickens. The cold water then exists as an intermediate layer (CIL), sandwiched between warmer water above and below it.

A wintertime GSL-wide survey of the CIL (0–200 m) has been undertaken yearly in early March since 1996, using Canadian Coast Guard helicopters (Galbraith *et al.* 2009). Recent reports (Galbraith *et al*. 2007, 2009) indicate that the CIL extended to the bottom in much of the Shediac Valley over the past 10 years (*i.e.* little or no intrusion of the deep warm layer). However, water temperatures measured near the bottom of the Shediac Valley over the time period 1971 through 2008 indicate a large temperature range. The average September temperature of the near-bottom waters varies between approximately 0 and 15ºC across the Shediac Valley. These temperature variations are mainly depth-dependent: deeper bottoms (50 – 80 m) typically being covered in cold CIL waters, while shallower bottoms closer to the NB and Prince Edward Island (PEI) shores are affected by the warm surface layer as it thickens and deepens (Galbraith *et al.* 2009). During any given summer therefore, the extent of the bottom of the AOI affected (or covered) by warm surface water (as opposed to CIL water) is a function of that summer's solar warming of the surface layer and of the previous winter's atmospheric cooling of the CIL.

As per DFO (2009b), environmental conditions have varied in the sGSL in recent decades. Bottom waters were colder than normal from the late 1980s to late 1990s but then increased to normal or warmer than normal levels in the 2000s. Surface water temperatures have also generally been normal or above normal since the late 1990s, with exceptionally warm temperatures in 1999 and 2006.

According to statistics presented by Petrie *et al.* (2008), sea ice is usually present in the Shediac Valley by January 1 each year and has normally disappeared 90 days into the new year (April 1) (on average, based on 1971 to 2000 data). The mean extent of sea ice in the Gulf by January 1 each year (1971 to 2000) covers the area identified as the Shediac Valley; the minimum extent of sea ice measured over the same time period covers much, but not all, of the

Shediac Valley area. When ice in the Gulf is at its maximum extent, the Shediac Valley is ice covered.

The Canadian Hydrographic Services (CHS) nautical chart #4906 indicates that water depths in the AOI range from 24 m to 51 m, although the seaward portion of the Shediac Valley, northeast of the AOI deepens to 80 m or more as it approaches the Laurentian Channel. The Valley is a feature of the Magdalen Shelf (also called the Magdalen Shallows), a relatively shallow submarine terrace which forms a seaward extension of the New Brunswick and Nova Scotia coastal lowlands. The Valley broadens and deepens in a northeasterly (seaward) direction, to the edge of the shelf break southeast of the Gaspé Peninsula, where the bottom falls off to the much deeper Laurentian Channel.

Data on the bottom sediments and underlying geology of the Shediac Valley are given in Loring and Nota (1973) and repeated by the Geological Survey of Canada (1975). More recently CHS and DFO scientists have carried out sonic mapping of some Shediac Valley bottom areas, but the 1973 and 1975 data are from direct sampling and analysis of sediments and can be considered authoritative. Glacial erosion and deposition, sea level changes and more recent depositional conditions have produced the sediment cover, which overlies bedrock of mostly reddish brown sandstone of Permo-Carboniferous age, of irregular thickness and which frequently breaks through the sediment cover. The sediment cover of the shoreward areas on both slopes of the Valley are characterised by sandy gravel or shell gravel, with pebbles and cobbles of red sandstone (Vilks 1968). This bottom type gives way to fine sand mixed with pelite (clay mud) in deeper areas, with the pelite fraction increasing with depth. The deeper Valley bottom areas are dominated by fine pelite or slightly sandy pelite.

2.1.2 ***Chemical Systems***

Summer salinities in the study area typically vary from 26 to 30 parts per thousand (ppt) as reported by Waite *et al*. (1997a, b), for July 1993 and 1994, at sampling stations over the southern part of the AOI. Salinity typically increased from the surface (1 m) to 40 m depth by as much as 3 ppt. (*i.e.* from 27 to 30 ppt), with a marked halocline typically between 8 m and 18 m depths. This owes probably to fresh water runoff from the coastal area of NB, which includes the extensive inland watersheds of the Miramichi and Restigouche Rivers and other coastal watersheds further up current, including that of the Gaspé Current. Similar results were recorded in several sampling cruises in 1995. However in rough weather the halocline was found to deepen or disappear, as the surface mixing extended to deeper levels (Waite *et al*. 1997c). In July 1996, a cruise directed to the Shediac Valley confirmed the previous salinity values, with one station having a salinity surpassing 31 ppt at a depth of 50 m (Waite *et al*. 1997d).

To put the above data in some perspective, these salinities fall within the range of 26 to 35 ppt previously reported for the GSL as a whole (Loring and Nota 1973). The upper GSL value cited above (35 ppt) is typical of open ocean water worldwide (Cushing and Walsh 1976).

Dissolved nutrients include Nitrogen (N), Phosphorus (P) and Silicon (Si), considered major nutrients for phytoplankton growth; and others such as Iron (Fe), Zinc (Zn), Cobalt (Co) and Manganese (Mn), present as minor but necessary nutrients for plant growth. The nutrients are present in the form of their dissolved salts: Nitrates (NO_3) and Nitrites (NO_2), Ammonia (NH_3), Phosphates (PO_4) and Silicates (SiO_4) being the most routinely measured in ocean productivity studies. These nutrient salts form the base of the marine food web, as they are taken up by plant life, marine phytoplankton and macro algae, in the process of photosynthesis.

The concentrations of dissolved nutrients vary widely throughout the world's oceans, but are highest in coastal, well mixed waters, or upwelling areas, where deeper nutrient-rich water is brought closer to the surface and to sunlight, where photosynthesis can occur. These become areas of high primary productivity. Such an area is the head of the Laurentian Channel, which subsequently enriches the Gaspé Current and waters downstream, as noted in the previous section.

Local concentrations of dissolved nutrients also vary with uptake by marine plants, such as during phytoplankton blooms and subsequent release (regeneration) through herbivore grazing and animal metabolism, as well as from input of terrestrial (and human) origin.

Waite *et al*. (1997 a, b, c, d) reported NH_3, (NO_2 + NO_3), PO_4 and SiO_4 concentrations over the study area. Nutrient concentrations are expressed in micromoles (µM). In July 1996, 25 stations were sampled over the Shediac Valley (12 stations at 4 m depth; 13 through the water column). NH_3 concentrations varied from 0 - 4.46 (avg. = 0.92); (NO_2 + NO_3) from 0 – 10.88 (avg. = 1.13); PO_4 from 0.10 – 1.55 (avg. = 0.41); and SiO_4 from 1.09 – 23 (avg. = 3.41). Nutrient concentrations varied with depth, higher concentration typically being found in deeper water, as surface waters were depleted of nutrients by high summer photosynthetic uptake. Indeed, the concentration of NO_{2+3} frequently fell to zero (or below detection level) in the near surface layer, possibly a limiting factor for photosynthesis and primary productivity in the surface waters. Concentrations of SiO_4 increased by as much as tenfold and those of NO_{2+3} by a hundred fold from the surface to 70 m, with the largest increase occurring between 50 m and 70 m (Waite *et al*. 1997d). Finally, concentrations of all nutrients measured also varied widely horizontally (*i.e.* between sampling stations). These results are typical of those found in the study area and elsewhere in the sGSL over the 4 sampling seasons (1993 – 1996) recorded by Waite *et al*. (1997 a, b, c, d).

2.1.3 *Biological Systems*

Biogeographical context

To provide some context it is worth noting that, due to its geographical location and geomorphology, with the resulting high temperature attained by the sGSL surface waters in summer, the inner Magdalen Shelf, which encompasses the Shediac Valley AOI, has long been recognised as a biogeographical oddity since many of the shallow water invertebrate species found in inlets and sheltered estuaries along the sGSL coasts of NB, PEI and Nova Scotia (NS) are warm water species whose main distribution areas are southward of Cape Cod, on the mid-Atlantic coast. These species are mostly absent from the outer coasts of NS and Maine and as far as Cape Cod, or are restricted to very small localised populations in Bay of Fundy inlets (Ganong 1890, Bousfield and Thomas 1975). Therefore, sGLS populations of the American oyster (*Crassostrea virginica)*, hard shell clam (or bay quahaug) (*Mercenaria mercenaria*), the amphipods *Haustorius canadensis* and *Ampithoe longimana*, the mud crab *Rhithropanopeus harrisi* and several other species, form biogeographic outposts of their respective species and species assemblages.

This is attributed to the high temperatures attained by the surface waters of the sGSL during summer, particularly inshore, which are sufficient to permit reproduction by these species and thereby maintain stable breeding populations. For example, the American oyster requires an ambient water temperature of at least 20°C to initiate spawning (Galtsoff 1964), a temperature attained yearly in many sGSL inlets from Caraquet Bay southward to the St. Georges Bay (NS) area. A further necessary factor in the populations' endurance is the retention of sufficient numbers of their meroplanktonic larvae, for a period sufficiently long to attain metamorphosis and setting, which is a function of prevailing (mostly tidal) currents, food supply and (again) water temperature.

It has been postulated that these invertebrate populations are relicts from the mid-Postglacial period (7000 years b.p.), when warmer water is believed to have extended uninterrupted from the GSL southward to the present day main population areas of these species south of Cape Cod (Bousfield and Thomas 1975). It is unclear what (if any) impact the presence of these largely coastal benthic populations can have on the ecology of the offshore AOI, other than provide larvae to the meroplankton, or populations of settled adults (likely non-reproductive because of cooler bottom waters offshore). These species are, however, common to the coastal waters surrounding the AOI on three sides.

At least one zooplankton species, the calanoid copepod *Acartia tonsa*, is included among the warm water species present as an outpost population in the sGSL. Its overwintering stage is a dormant demersal egg, which hatches in summer as temperatures rise to 10 – 15°C. The species then goes through several generations of planktonic larvae and adults over the summer (McAlice 1981). In sampling carried out in Northumberland Strait offshore from Shediac, in 1968, *A. tonsa* was the most abundant copepod species from May to October, accounting for 29 % of all individual copepods found (Citarella 1982). However it was not found among the list of 24 copepod species recorded at the Shediac Valley Atlantic Zone Monitoring Program (AZMP) fixed station, from 1999 to 2007 (AZMP 2010). This fixed station is north of the AOI, as will be discussed further below.

<u>EBSA context</u>

As presented by DFO (2007a), the South-western Coast of the Gulf EBSA was identified as being significant for the following features:

- maximum uniqueness, concentration and fitness consequences for several pelagic fish species are realized in this area;
- considerable zooplankton production and accumulation (average uniqueness, average to maximum concentration and low to maximum fitness consequences) occurs in this area;
- uniqueness, concentration and fitness consequences can reach maximum values for ground fish species in this area;
- the EBSA is a unique area for winter skate (*Leucoraja ocellata*);
- the EBSA represents the widest meroplankton array of species found anywhere in the Gulf with maximum uniqueness, concentration and fitness consequences;
- high phytoplankton concentrations can be found in this EBSA; and
- significant feeding areas for marine mammals are located offshore of the Gaspé Peninsula.

As part of the EBSA ranking exercise by DFO (2007a), primary production in the Magdalen Shallows (including the Shediac Valley) was ranked high with a medium score for uniqueness, aggregations and fitness consequences. DFO (2007a) identified the Shediac Valley as an area having high biomass of mesozooplankton (> 1 mm), though it was ranked medium for uniqueness and aggregation and low for fitness consequences. DFO (2007a) identified the Shediac Valley as having the greatest biomass of zooplankton, which is a major influence on the survival and recruitment of fish to the area. The entire South-western Coast of the Gulf

EBSA was considered by DFO (2007a) as an area of high abundance of meroplankton, earning the highest ranking possible for combined scores of uniqueness, aggregation and fitness consequences.

According to DFO (2007a), the analysis of benthic species in the GSL identified three regions of importance within the South-western Coast of the Gulf EBSA out of a total of 17 areas of importance in the GSL. DFO identified all areas in the South-western Coast of the Gulf EBSA as having high aggregation and abundance of many benthic invertebrate species.

DFO (2007a) recognized the Shediac Valley as having high uniqueness and aggregation because it is an area of high concentration of pelagic fish species (including alewife (*Alosa pseudoharengus*), spiny dogfish (*Squalus acanthias*), Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*) and rainbow smelt (*Osmerus mordax*)) for multiple biological functions (including feeding, refuge and spawning).

The Shediac Valley was found to be an important area for demersal species, as it is noted for being a nursery area and having high demersal fish biomass including cod, plaice, winter flounder and yellowtail flounder DFO (2007a).

Ten (10) EBSAs were identified for marine mammals in the GSL, including the South-western Coast of the Gulf EBSA (DFO 2007a). The Shediac Valley falls within the latter EBSA, which has been noted for "co-occurrence of several marine mammals for feeding, including deep-divers and grey seals" (Savenkoff *et* al. 2007).

<u>Seabirds</u>

Although DFO does not have a mandated authority to monitor migratory bird populations, their importance to the marine ecosystem is acknowledged and information regarding the presence, diet and anthropogenic threats of seabirds in the Shediac Valley AOI is presented.

The Northwest Atlantic hosts seabirds belonging predominantly to three bird Orders: Procellariiformes (e.g., fulmars, shearwaters, storm-petrels), Charadriiformes (e.g., alcids, gulls, terns, phalaropes) and Suliformes (e.g., gannets and cormorants). Specific information regarding the population structure and movement of seabirds in the Shediac Valley AOI can be found in Appendix 2.

Seabird diet is extremely variable across species and includes: phytoplankton, small zooplankton, small crustaceans (e.g., mysid shrimp, euphausiids, copepods), molluscs (e.g., bivalves, squid) and small fish (e.g., capelin, herring, arctic cod, mackerel, sand lance, larval fish), as well as carrion. Although certain prey types may be considered generally widespread and abundant in ocean environments, seabirds depend entirely on the 'available' component of a given population of prey. In other words, prey may be locally abundant, but these must also be located at a depth in the water column that is within the diving capability (i.e. 'reach') of a given species. Vertical migration of prey (e.g., diurnal movement patterns of plankton) and upwelling currents can contribute to making a greater proportion of prey present 'available'. Further, despite the ability of seabirds to search and forage over broad areas, prey preferably are both spatially and temporally predictable. This is especially true during the breeding season when breeding individuals must search and forage within range of developing young at nest sites (Frederiksen *et al*. 2008). Understandably, predictable congregations of temporally and spatially accessible species, if commercially valuable, are also among the first targeted by the fishing industry.

Direct anthropogenic threats to seabirds include hunting, illegal shooting, oil spills, mortality via drowning in fishing gear (Benjamins *et al*. 2008), marine industrial activities and structures (Fraser *et al*. 2006, Montevecchi 2006, Wiese *et al*. 2001), ingestion of plastics and floating human-made debris and direct exposure to heavy metals and contaminants from agricultural and atmospheric sources (Michelutti 2010). Indirect threats to seabirds include habitat destruction and degradation (e.g., coastal development, industrial fishing, and physical resource extraction), displacement by competitors at colony sites, contamination of prey resources and climate change (e.g., sea level rise, increased storm frequency, changing distribution and abundance of prey, incorrect timing of life history activities, temporal mismatch with prey and increased disease prevalence) (Crick 2004). However, these threats can be expected to be more pronounced at coastal sites used for breeding, colony islands and within seaward extensions of seabird colonies where populations are concentrated and reliant on abundant locally available prey. At sea, bycatch resulting from interaction between seabirds and fishing gear has been identified as a significant threat to populations of several seabird species globally, particularly diving species and pursuit divers (Tasker *et al.* 2000). More pronounced interactions and subsequent bycatch can be expected at biological hotspots created by temporal and spatial aggregations of forage fish, especially when these are commercially valuable species (DFO 2007b).

2.2 Environmental Forcers

The intent of this section is to present the environmental and/or biological conditions that have changed, or may change and that may significantly influence the quality of the environment in the Shediac Valley AOI study area, along with their associated risks.

2.2.1 *Climate Change*

Climate change is likely to affect the physical dynamics (temperature, ice cover, etc.) in the GSL and the distribution of biological resources in the sGSL. Thus it may be an issue to consider in selecting the emplacement and/or boundaries of potential MPAs for conservation purposes. However, given the complexity of GSL oceanography, many of the ecological and biological effects of climate change in the Shediac Valley AOI remain unknown. An example is the effect of increased influx of Labrador Current arctic water to northern portion of the GSL, modifying temperature regimes in that area and possibly introducing new plankton species to the GSL (Smith *et al*. 2003); or impacts from climate induced physical and biological changes in New Brunswick and Quebec watersheds.

The GSL is a highly dynamic region in terms of physical oceanography due to seasonal ice cover, freshwater input and ocean exchange. Even a small change in the regional temperatures may have significant effects on basic physical processes in the Gulf. In turn, changes in the physical environment will affect the biological environment, including the distribution and abundance of resources. For example, data gathered from mackerel egg surveys in the Gulf (see Section 2.3.1) have indicated a recent change in the spatial distribution of the spawning biomass for this species; the change in the distribution has been partially attributed to a period of variant water temperatures in the sGSL (Grégoire *et al.* 2008). Though no link was made to climate change in the foregoing instance, it does illustrate a potential impact of temperature variations.

The most complete sea surface temperature record in terms of spatial coverage and sampling frequency is from satellite remote sensing, but this extends only to 1985. During the intervening period (1985 – 2008) mean summer sea surface temperatures over the entire GSL show a warming of about 2°C (Dufour *et al*. 2010). However, sea surface temperatures extrapolated from averaged air temperature data from 9 stations covering the GSL, suggest no "convincing" overall trend since 1945, "although the two warmest years since 1945 have occurred in the last decade" (Dufour *et al*. 2010). Historic data from Charlottetown show an increase of about 1°C since 1873; at Pointe-au-Père, near Rimouski, the increase was about 2°C. The general trends are however dominated by inter-decadal variability of higher amplitude (Dufour *et al*. 2010).

According to White and Johns (1997) ice cover in the GSL has also seen changes, with the ice edge exceeding the median for the winter of 1991-1992. The following winter also resulted in extensive ice formation with the ice lasting longer than normal. From 1995 to 2008, however, the annual ice cover extent over the GSL trended downward, attaining 30 year lows in 2006 and 2007 (US National Snow and Ice Data Center).

As noted in the previous section, bottom temperature conditions in the Shediac Valley are a function of the depth attained annually by the warm surface layer and by the thickness and temperature of the CIL; summer conditions in the CIL are a function of the extent and severity of the previous winter's cooling and mixing.

Considerable information, much of it recent, has been compiled on the marine climate and trends over the GSL (Dufour *et al*. 2010). DFO's AZMP has existed since 1998, with regular oceanographic sampling at fixed stations and along transects within the GSL, as well as outside over the Canadian Continental Shelf. The AZMP monitors variations in the ocean systems and is accumulating a time series of ocean data. One of the fixed stations is situated over the Shediac Valley, just north of the AOI. There is also a sampling transect over the Magdalen Shelf (AZMP Bulletin 2010).

In addition, overall GSL models have been developed and tested using satellite imagery coupled with direct measurements, to better understand the dynamics of sea surface temperature, photosynthetic pigments (phytoplankton) and turbidity (Le Fouest *et al*. 2006, 2010, Fuentes-Yaco *et al*. 1997). Such models linking conditions in the Shediac Valley AOI to those of the wider GSL may eventually assist in predicting impacts of climate change in the AOI.

2.2.2 *Invasive Species*

DFO scientists are not aware of any invasive species within the Shediac Valley AOI (A. Locke, pers. comm. 2010). However, some invasive species known to occur in the sGSL have the potential to invade the AOI. Information on these species is presented below and was compiled in consultation with DFO scientists.

2.2.2.1 *Colonial Tunicates*

Golden star tunicate (*Botryllus schlosseri*) and violet tunicate (*Botrylloides violaceus*) are invasive colonial tunicates now common in the coastal waters of PEI (Figure 2.1) and have the potential to live on the sea bottom in deeper water, although deep water is not their preferred habitat (A. Locke, pers. comm. 2010). Golden star tunicate was first reported in PEI waters in 2001 (St. Peter's Bay) with the first reported sighting in the Northumberland Strait in 2006 (Borden), while violet tunicate was first observed in PEI waters in 2004 (Savage Harbour and Borden). In 2010 they were found on the NB mainland at Shediac and Caraquet (DFO 2009a; E. Watson, DFO, pers. comm. 2011).

If these colonial tunicate species were to invade the Shediac Valley AOI, the main concerns would be their potential to outcompete other organisms for food and space, thus altering natural community dynamics and posing a threat to certain fishing activities. These species can also affect aquaculture operations and shellfish production, but neither of these activities occurs in

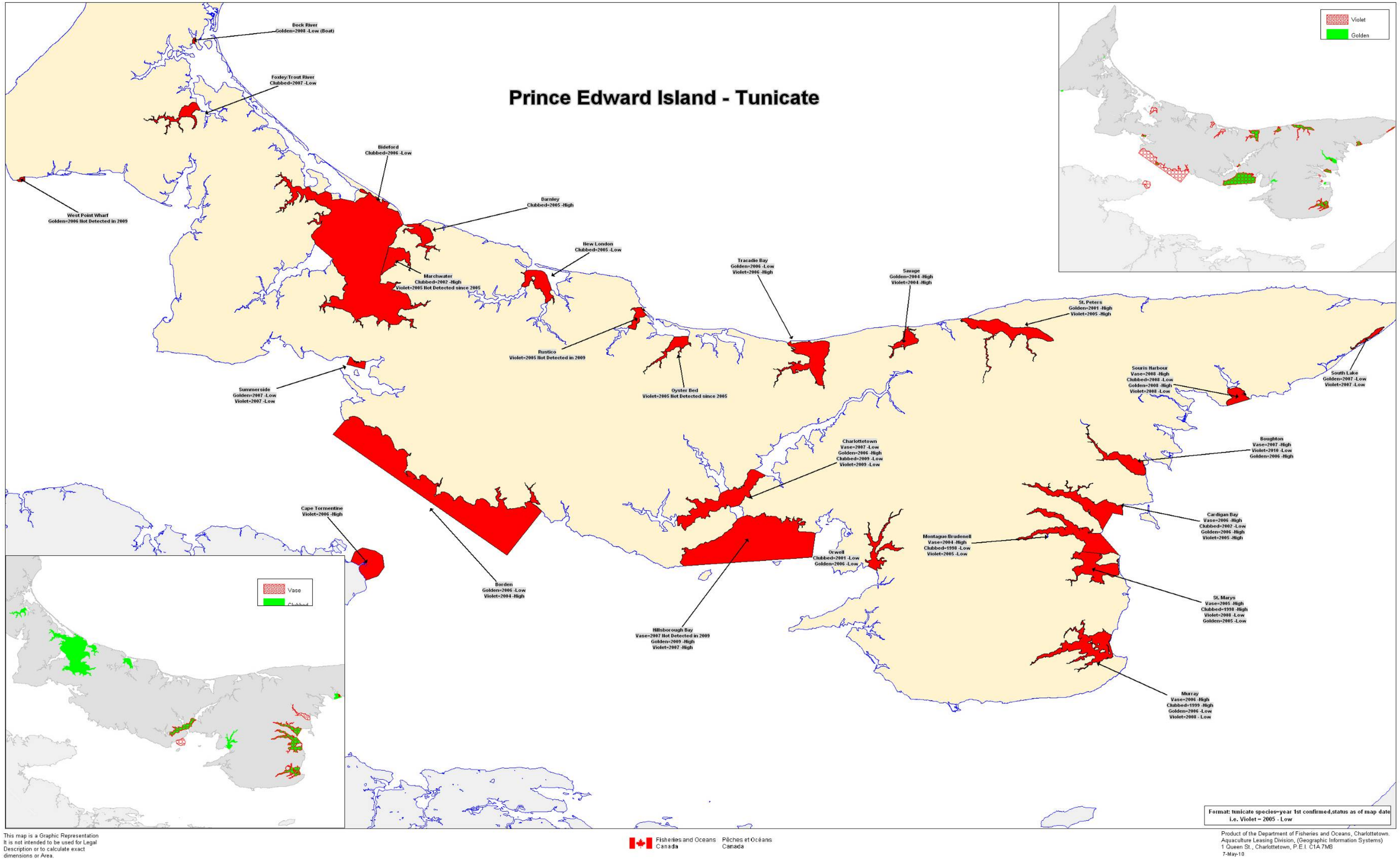

Figure 2.1 Colonial Tunicate Distribution in PEI Waters (2010).

the AOI at this time (see Section 3.2, Activity Sector Profiles). A summary of available information on colonial tunicates is provided in Table 2.1.

Table 2.1 Summary of Colonial Tunicates in the Gulf of St. Lawrence (Carver *et al*. 2006).

Parameter	Description
Diet	Small marine plankton and particles (through filter feeding).
Reproduction	Sexual, hermaphroditic, with large free swimming larvae (1 – 2 days).
Fecundity	Dependant on ambient conditions and food availability; relatively low egg production; embryos are brooded by parent colony, which improves survival rate.
Abundance	Generally increasing in sGSL. Widespread on PEI; present in NB (since 2010).
Growth	Colonies grow by asexual budding from mature zooids.
Mortality	Individual lifespan irrelevant as colonies are self-sustaining. They may be harmed or killed off by heavy siltation (*i.e.* by dredging operations, turbulence). Adult colonies have few known predators, other than some flatworms and gastropods. Little is known of diseases affecting them.
Behaviour	Swimming larvae attach to (clean) hard substrate and metamorphose into sessile zooids, which grow into colonies of zooids embedded in a gelatinous matrix, covering submerged hard substrates and smothering or outcompeting other sessile species. Physiological adaptive capabilities render them resilient to changing environments, but they may be limited by preference for clean substrate and are adversely impacted by silt (which can obstruct filtration organs).
Spatio-temporal Distributions	Occurrence reported on the east and west coasts of Canada from early 20th century. Invasive spreading on PEI since 2001. Distribution in sGSL increasing as invasion spreads to western PEI and to NB mainland (2010); dispersal vectors unproven, but may include human activities (e.g. recreational boating and marine transport) and rafting on floating material.
Habitats	Golden-star tunicate and violet tunicate have the potential to live on the sea bottom in deeper water, although deep water is not their preferred habitat. Growth rates are best in warm (*i.e.* shallow water) environments.
Stock or Population Trends	Short larval period implies limited dispersal potential; spreading may be due in part to human activity.

Data Gaps: Information regarding colonial tunicate species in relation to the Shediac Valley AOI is an apparent data gap.

2.2.2.2 ***Oyster Thief***

Oyster thief (*Codium fragile* spp. *tomentosoides*) is an invasive green alga that occurs in the GSL (Drouin and McKindsey 2007). This species is occasionally found in habitats consistent with the Shediac Valley but deep water is not their preferred environment (A. Locke, pers. comm. 2010).

Oyster thief, also known as “green fleece”, "dead man’s fingers" and "green sponge", originated from the western Pacific Ocean and was first reported in eastern Canada in 1989 and in the sGSL in 1996 (DFO 2009a). It can now be found in several locations along the Gulf coast of NB, with its northern limit believed to be (presently) the southern side of Chaleur Bay (Drouin and McKindsey 2007). Oyster thief replaces native species, including eelgrass and kelp, with subsequent effects to fish, mollusks and crustaceans that use this vegetation as habitat. It can also attach itself to shellfish and interfere with feeding and shellfish production. Drouin and McKindsey (2007) assessed the probabilities and magnitudes of economic, environmental and social impacts related to the establishment of *Codium* in the GSL and predicted that it is likely to continue its range expansion in the region and result in long-term and significant ecological effects to trophic interactions and ecosystem function. Protected species and habitat were considered to be at moderate risk of being affected by the establishment of oyster thief in the GSL (Drouin and McKindsey 2007). A summary of pertinent information on oyster thief is provided in Table 2.2.

Table 2.2 Summary of Oyster Thief in the Gulf of St. Lawrence.

Parameter	Description
Reproduction	Sexually, parthenogenetically; releases swimming cells in the water column which can disperse locally and attach to subtidal hard surfaces (bedrock, boulders, pebbles, mollusc shells) to begin vegetative growth; also reproduces vegetatively (Bégin and Scheibling 2003)
Fecundity	High fecundity. Has the ability to regenerate from broken fragments of the thalli (vegetative reproduction) which can be widely dispersed by marine currents.
Abundance	Thrives in sheltered habitats; spreading in the sGSL; no overall abundance data available for the sGSL.
Behaviour	Can attach to shellfish and interfere with feeding and shellfish production (Drouin and McKindsey 2007). Tolerant of broad salinity and temperature ranges.
Spatio-temporal Distributions	Reported in several locations along the coast of NB; northern limit believed to be southern side of Chaleur Bay (Drouin and McKindsey 2007). Reported to depths of 15 m on the Atlantic coast of NS (Benthic Ecology Lab 2001). It has been found at 22 m depth in its native areas (Drouin and McKindsey 2007).
Habitats	Occasionally found in habitats consistent with the Shediac Valley but deep water is not its preferred environment. Its spread into the deeper areas of the AOI may be limited by daylight attenuation, but kelp (Laminaria sp.) and rockweed beds in shallower habitats may be at risk.
Stock or Population Trends	Invasive in shallow PEI waters; spreading to nearby mainland coast.

Data Gaps: Information regarding oyster thief presence or spread into the Shediac Valley AOI is a data gap.

2.2.2.3 ***Green Crab***

Green crab (*Carcinus maenas*) is an invasive species that occurs in the GSL (Locke and Klassen 2007). This species is occasionally found in habitats consistent with the Shediac Valley but deep water is not their preferred environment (A. Locke, DFO, pers. comm. 2010).

Green crab is native to Europe and North Africa and was first observed in NS waters of the GSL in 1994 (DFO 2009a). It is an aggressive species with a wide tolerance for salinity, temperature, oxygen and habitat type (Locke and Klassen 2007). In the GSL, populations of reproducing green crab have been observed from Pleasant Bay, NS to Baie Verte and Cape Jourimain, NB (Northumberland Strait). The main concerns for green crab with respect to the Shediac Valley AOI would likely be its potential to reduce invertebrate and fish diversity and, to a lesser extent, its potential to destroy shellfish beds. A summary of available information on green crab is provided in Table 2.3.

Table 2.3 Summary of Green Crab in the Gulf of St. Lawrence.

Parameter	Description
Diet	The diet of the green crab includes species from at least 104 families, 158 genera, in 5 plant and protist and 14 animal phyla. Larvae are filter feeders, while early stage juveniles feed predominantly on detritus. Adults feed primarily on bivalves (Locke and Klassen 2007).
Reproduction	Sexual; 4 planktonic larval stages (50 – 80 days larval duration) (Klassen and Locke 2007).
Fecundity	Female green crab can spawn up to 185,000 eggs at a time (Locke and Klassen 2007).
Abundance	No data available in material reviewed.
Growth	In a study conducted at Basin Head, PEI, size at maturity for males was 49 mm while size at maturity for females was 44 mm. Locke and Klassen (2007) reported maximum carapace sizes of 90 to 100 mm in Oregon and 86 mm in Europe.
Mortality	The life span of green crab varies over its range. In Maine it has been reported to have a life span of 6 years while in Oregon the life span is reported as 3-4 years (Locke and Klassen 2007).
Behaviour	Green crab is an aggressive species that does not give warning displays before engaging in physical confrontation (Williams *et al.* 2006).
Spatio-temporal Distributions	The green crab is native to coastal and estuarine waters of Europe and Northern Africa. It is now found on the Atlantic and Pacific coasts of North and South America, South Africa, Australia and Asia (Locke and Klassen 2007).
Habitats	Locke and Klassen (2007) state that green crabs have been found in temperate waters in estuaries and coastal areas in a variety of habitats including rocky intertidal zones, sea grass beds and salt marshes and in water depths from shore to greater than 5 m. The authors indicate that adult green crab prefer temperatures between 3ºC and 26ºC and salinities between 5 and 30 parts per thousand (ppt).
Stock or Population Trends	While the distribution of green crab in the sGSL appears to be expanding, some populations have decreased (Rossong *et al.* 2006). In 2003 and 2004 the populations in NS declined (Rossong *et al*. 2006).

Data Gaps: As indicated in the table above, currently no information exists regarding reproduction and abundance of green grab. Also, information specific to the Shediac Valley is a data gap.

2.2.2.4 ***Invasive Plankton***

Some invasive zooplanktonic species that occur in the GSL could be present in, or spread to, the Shediac Valley AOI. *Penilia avirostris* is a cladoceran that was first recorded in Canada in the GSL in 2000 (Bernier and Locke 2006). Bernier and Locke (2006) reported the first observation of this species in the Souris area on the northeastern coast of PEI (outside of the AOI study area). Bernier and Locke (2006) speculate that this species reached the area in ballast water and there is potential for it to spread to other areas of the sGSL. Its specific effects on other species are unknown and require further study.

There are likely to be some invasive phytoplankton species occurring in, or having the potential to invade, the Shediac Valley. One example is *Noedenticula seminae*, a pelagic diatom normally found in the North Pacific Ocean and reported in considerable numbers throughout the northern GSL (including the Gaspé Current area) in 2001 and 2002 (Smith *et al*. 2003) and thought to have been introduced naturally across the Arctic Ocean and via the Labrador Current to the GSL. It has regularly dominated some phytoplankton assemblages since (Poulin *et al*. 2010), though there is no indication of its arrival in the Shediac Valley AOI. Its seasonal presence in some numbers is likely, however, given the broad influence of the Gaspé Current over the AOI. While it would likely compete (for nutrients) with native diatom species and other phytoplankton populations, its impact is difficult to assess given the complex and constantly evolving seasonal phytoplankton assemblages.

Bonnemaisonia hamifera is an invasive benthic algae that is found in the Northumberland Strait. It is not known whether this species extends as far as the Shediac Valley (A. Locke, pers. comm. 2010), although deeper water is not its preferred habitat.

Data Gaps: There is a lack of information on invasive plankton distribution and abundance in the sGSL and therefore in the Shediac Valley AOI. DFO is currently working on an inventory of invasive phytoplankton species for the sGSL and further information may become available once this inventory has been completed (A. Locke, DFO, pers. comm. 2010).

2.3 Significance of Protected Features

This section on biological community components focuses on species of interest as identified by DFO scientists to assist in the process of identifying a potential AOI in the sGSL. Species were identified based on being a COSEWIC (Committee on the Status of Endangered Wildlife in Canada) assessed species, a commercial fish species or having essential habitats (*e.g.,* spawning, nurseries and over-wintering) within the AOI. Species identified for consideration in this report include:

- Atlantic cod (*Gadus morhua*), white hake (*Urophycis tenuis*), American plaice (*Hippoglossoides platessoides*), winter skate (*Leucoraja ocellata*)
- Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scrombus*), spiny dogfish (*Squalus acanthias*), alewife (*Alosa pseudolarengus*)
- Snow crab (*Chionoecetes opilio*), toad crab (*Hyas araneus* and *Hyas coarctatus alutaceus*) and macroinvertebrates such as brittle stars, sand dollars
- Harp seal (*Pagophilus groenlandicus*), hooded seal (*Cystophora cristata*), grey seal (*Halichoerus grypus*)
- North Atlantic right whale (*Eubalaena glacialis*), killer whale (*Orcinus orca*), harbour porpoise (*Phocoena phocoena*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), white-beaked dolphin (*Lagenorhynchus albirostris*), long-finned pilot whale

(*Globicephala melas*), common minke whale (*Balaenoptera acutorostrata*), fin whale (*Balaenoptera physalus*) and humpback whale (*Megaptera novaeangliae*).

Where possible this report also addresses eggs, larvae and early life stages of the species identified above; as well as phytoplankton and zooplankton.

The information presented below was assessed on a regional basis using available resources. Wherever possible, information pertaining to biological components of the Shediac Valley AOI was considered as it is most useful and relevant to the report. For many species, information pertaining specifically to the Shediac Valley was not available and they are considered in their broader biogeographic range (*i.e.* the sGSL or the GSL).

2.3.1 *Demersal and Pelagic Fish*

Where available, information on species including diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution and habitat (feeding and growth areas, spawning and nursery grounds as well as migratory corridors) is provided.

Where information was available, focus has been placed on describing the current and past conditions as well as the trends of each commercial stock (species and population), with particular attention to cod and herring. At the population level, the official vulnerability status as well as the state of the stock itself is provided (*i.e.,* stable, increasing, decreasing). Also, where possible, any known causes that have led to current conditions are identified.

Figures depicting the distribution of commercial fish species Atlantic cod, Atlantic herring, Atlantic mackerel, white hake, American plaice and winter skate are discussed in the following sections and are based on catch data collected during bottom-trawl surveys conducted by DFO in the sGSL. The survey data for each species was mapped for three five-year time periods: 1996 to 2000, 2001 to 2005 and 2006-2010. Information on the trawl survey methods is provided in Hurlbut *et al.* (2010). The points on the maps indicate trawls that resulted in catches, while the unsuccessful trawls are not shown.

The mapping of GIS data helps contribute to a better understanding of the significance of the Shediac Valley to commercial fish species in the sGSL.

2.3.1.1 ***Atlantic Cod***

Cod in the sGSL is managed as a whole unit (Northwest Atlantic Fisheries Organization (NAFO) 4T), which represents the sGSL fishery. Information specific to the Shediac Valley AOI is inferred from research documents (Hurlbut *et al*. 2010, DFO 2009b, Swain and Chouinard 2008a, b) covering this larger fishery management area.

The sGSL Atlantic cod stock has long been known to migrate from the sGSL in summer and overwinter just outside the GSL in the Sydney Bight area. The stock returns to the sGSL to spawn in early summer (late April – early July). Historically, the fishery has taken advantage of this characteristic by concentrating fishing activities on migratory aggregations in spring and fall (Chouinard and Swain 2005).

The exact spawning areas are not precisely known, but data from the capture of cod in spawning condition, from cod egg and larval surveys, and from the distribution of cod eggs collected during surveys of other species, indicate that the main spawning area is located in the western portion of the sGSL, which includes the Shediac Valley (and the AOI) (Chouinard and

Swain 2005). Other data indicate that the largest spawning concentrations (as deduced from numbers of cod eggs collected in mackerel egg surveys) are in the deeper waters of the Shediac Valley, northeast of the AOI.

The AOI may be an important nursery area for cod. Research has shown that densities of young cod were consistently highest in the Miramichi Bay – Shediac Valley area (which straddles the AOI), compared to other areas of concentration located near the Magdalen Islands and in Chaleur Bay (Hanson and Chouinard 1992).

Atlantic cod (Laurentian south population) has been assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2011). Cod productivity in the GSL has declined to the extent that it is now in danger of extirpation even if the commercial fishing remains closed (Swain and Chouinard 2008a).

Distribution: As noted above and according to DFO (2009b), the sGSL stock is highly migratory. The stock migrates from the sGSL in October and overwinters in fishing region 4Vn, north of Cape Breton Island and in 4Vs, on the eastern Scotian shelf along the Laurentian Channel. In the 2008 groundfish survey in the sGSL, the highest abundances of Atlantic cod were found in the Shediac Valley area, north of PEI and west of Cape Breton (DFO 2009b).

Figures 2.2 to 2.7 show the densities (number caught/km^2) of juvenile (sexually immature) and adult Atlantic cod caught in sGSL trawl surveys by DFO over a 15-year span. All of these surveys were carried out in the month of September. The densities were combined for three five-year periods (1996 – 2000, 2001 – 2005 and 2006 - 2010), to bring to light any trend in density or distribution. The highest density of juvenile cod in the sGSL occurred within or in the waters surrounding the AOI and the Magdalen Islands and northwest of PEI (Figures 2.2 to 2.4). This area of the AOI appears to have some of the highest densities of juvenile cod in the sGSL stock. The greatest densities of adult cod caught during the trawl surveys were outside of the Shediac Valley AOI particularly in recent years. These areas include those north and east of the Magdalen Islands along the Laurentian Channel, north of PEI and within and east of the AOI. (Figures 2.5 to 2.7). No trend is apparent in the density maps; however subsequent stock assessments indicate a further decline of the stock, though its geographic distribution has remained constant (DFO 2009b).

<u>Based on the groundfish trawl survey, the Shediac Valley AOI appears to be an important area for juvenile Atlantic cod.</u>

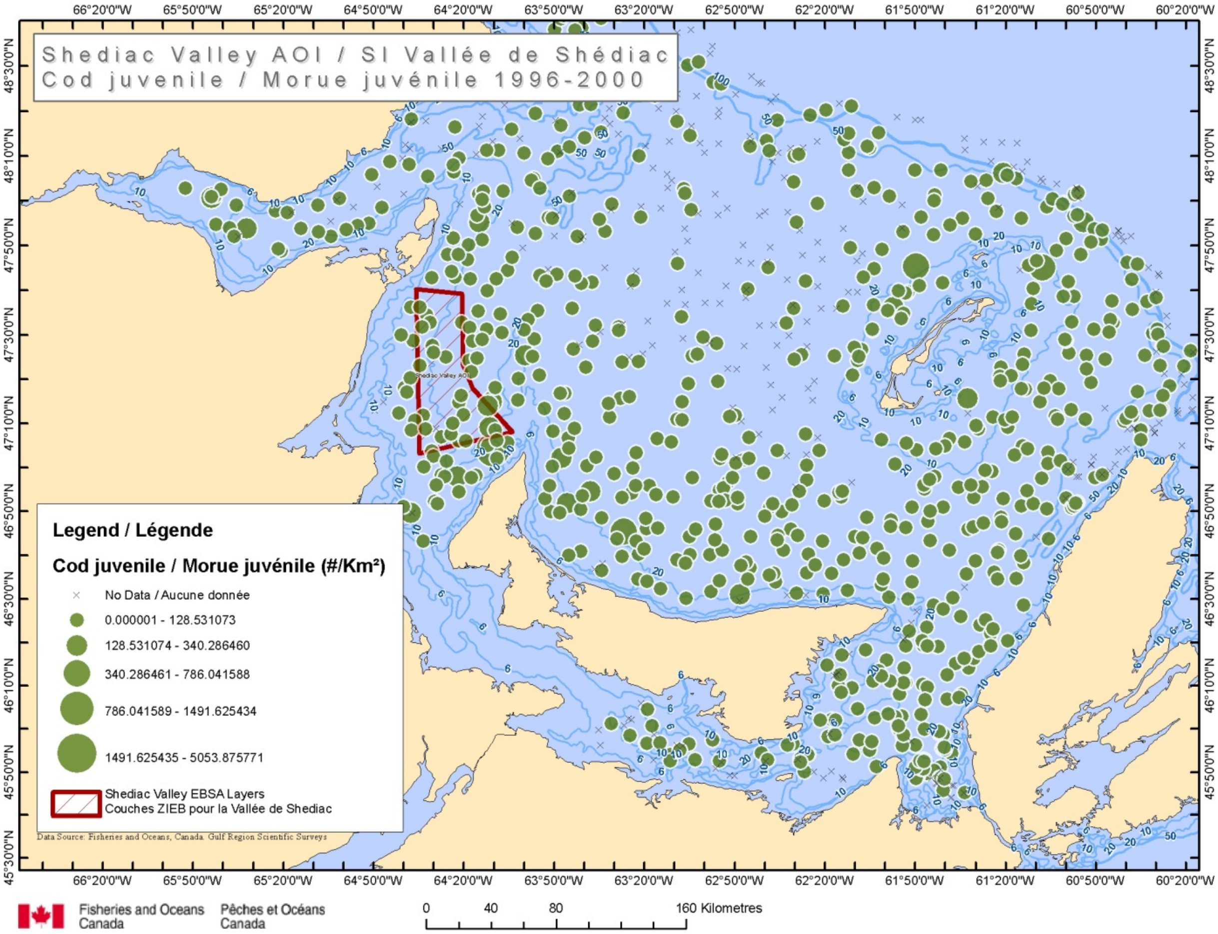

Figure 2.2 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Cod in the sGSL September surveys (1996-2000).

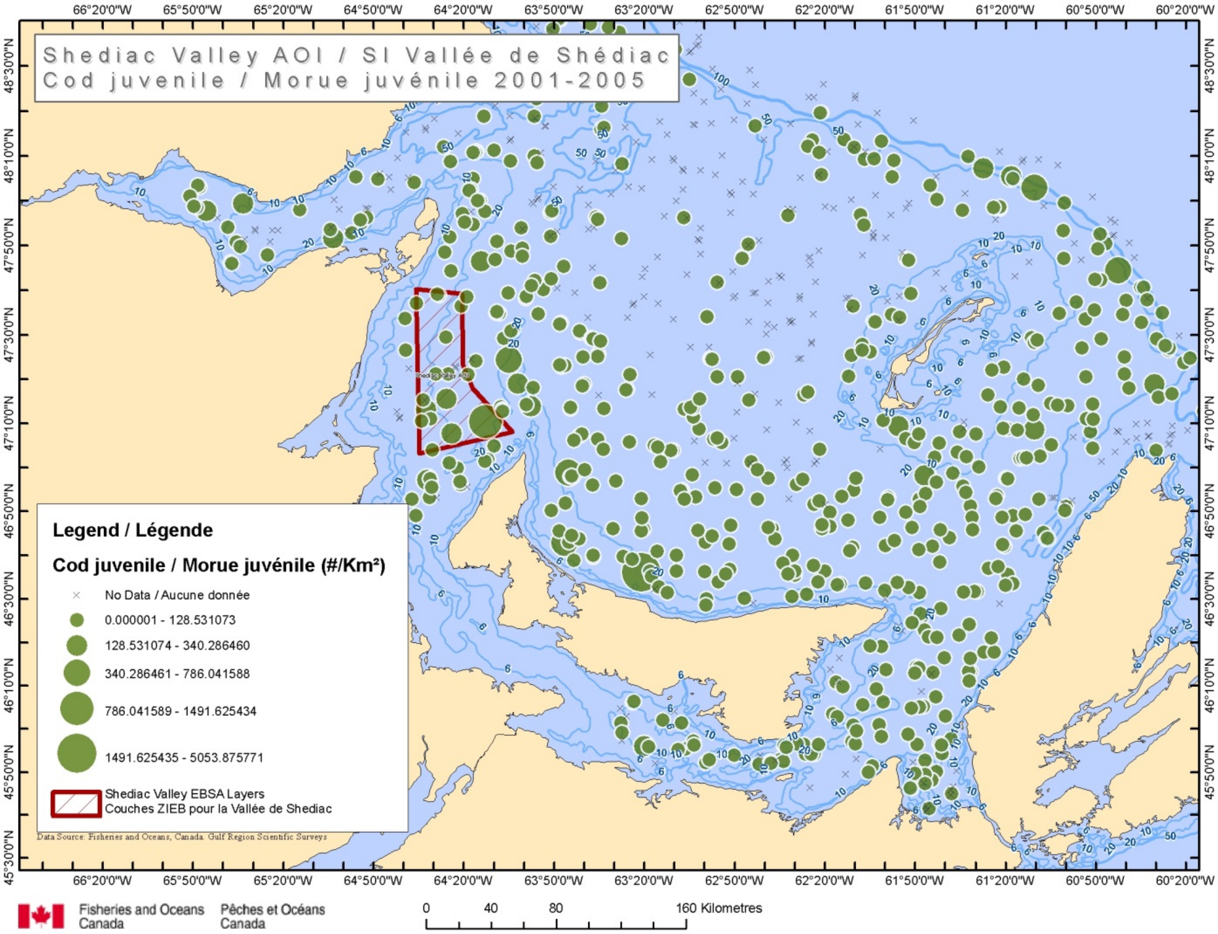

Figure 2.3 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Cod in the sGSL September surveys (2001-2005).

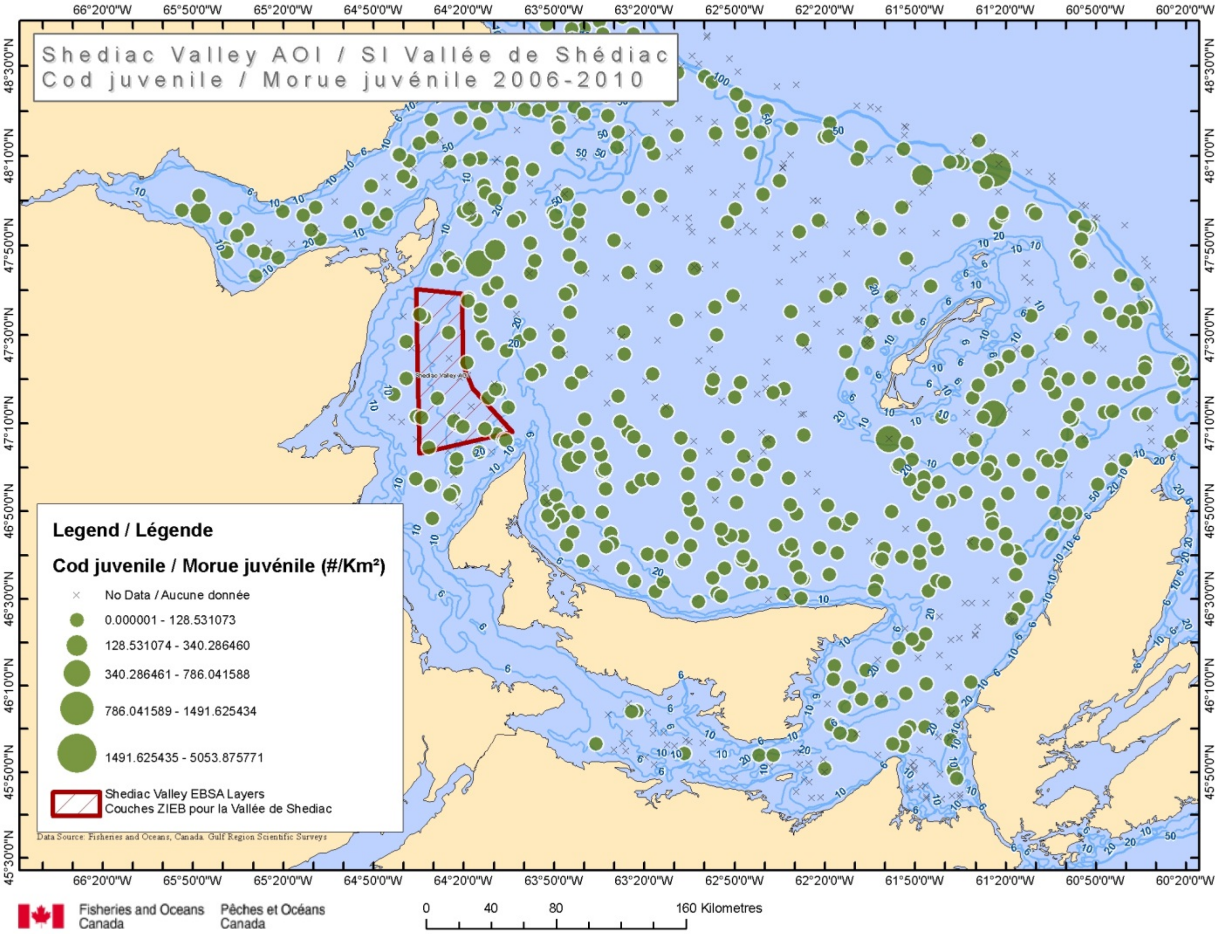

Figure 2.4 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Cod in the sGSL September surveys (2006-2010).

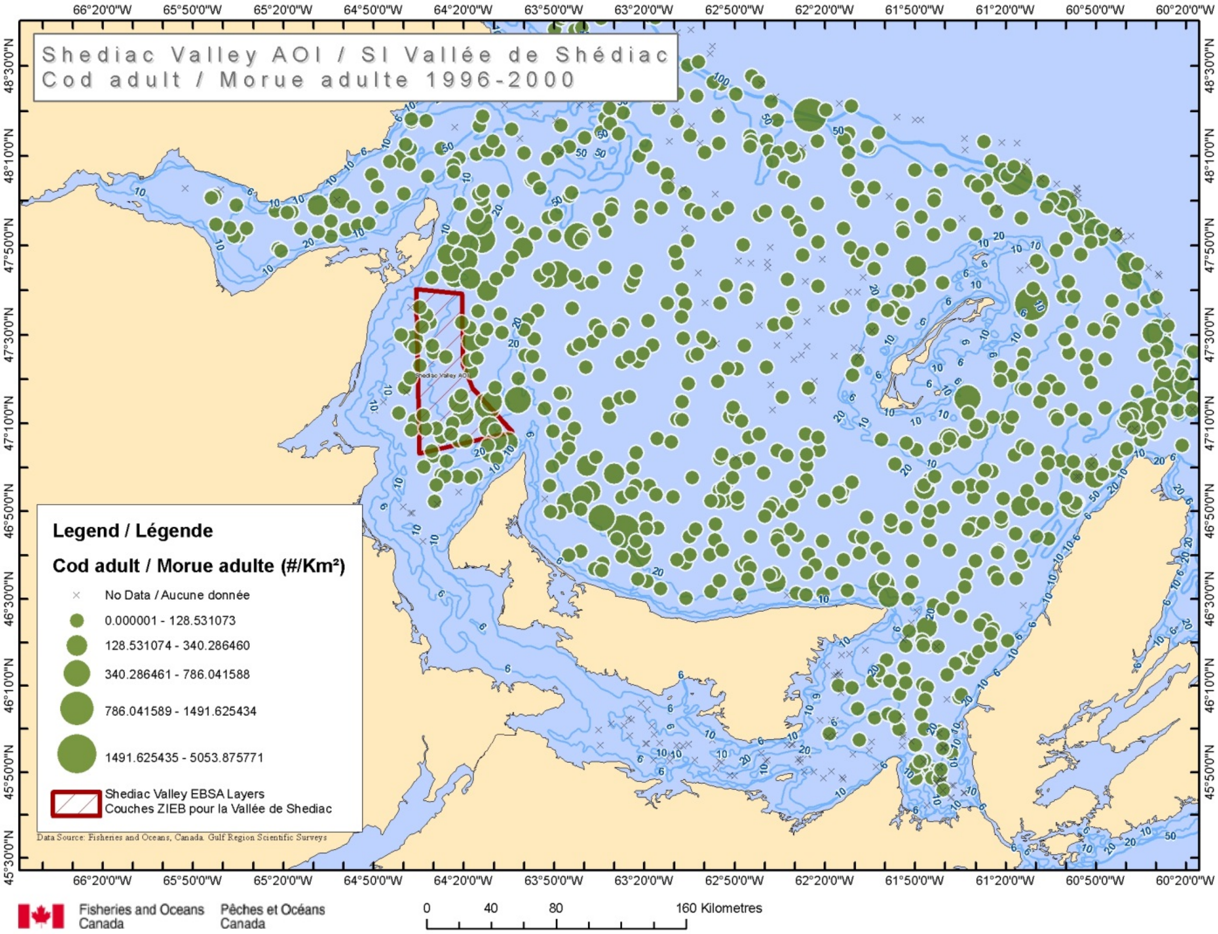

Figure 2.5 Groundfish Trawl Locations and Density (#/km^2) of Adult Cod in the sGSL September surveys (1996-2000).

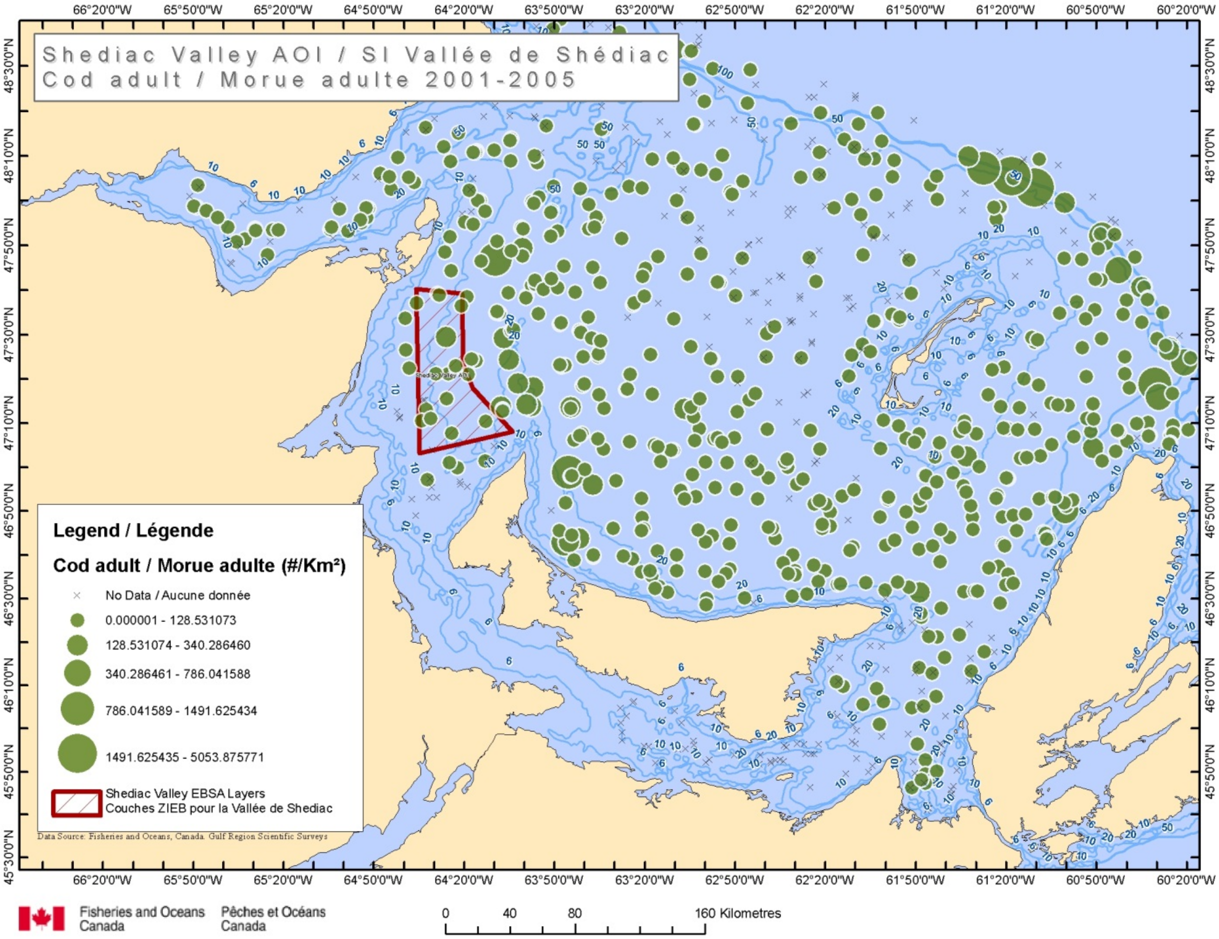

Figure 2.6 Groundfish Trawl Locations and Density (#/km^2) of Adult Cod in the sGSL September surveys (2001-2005).

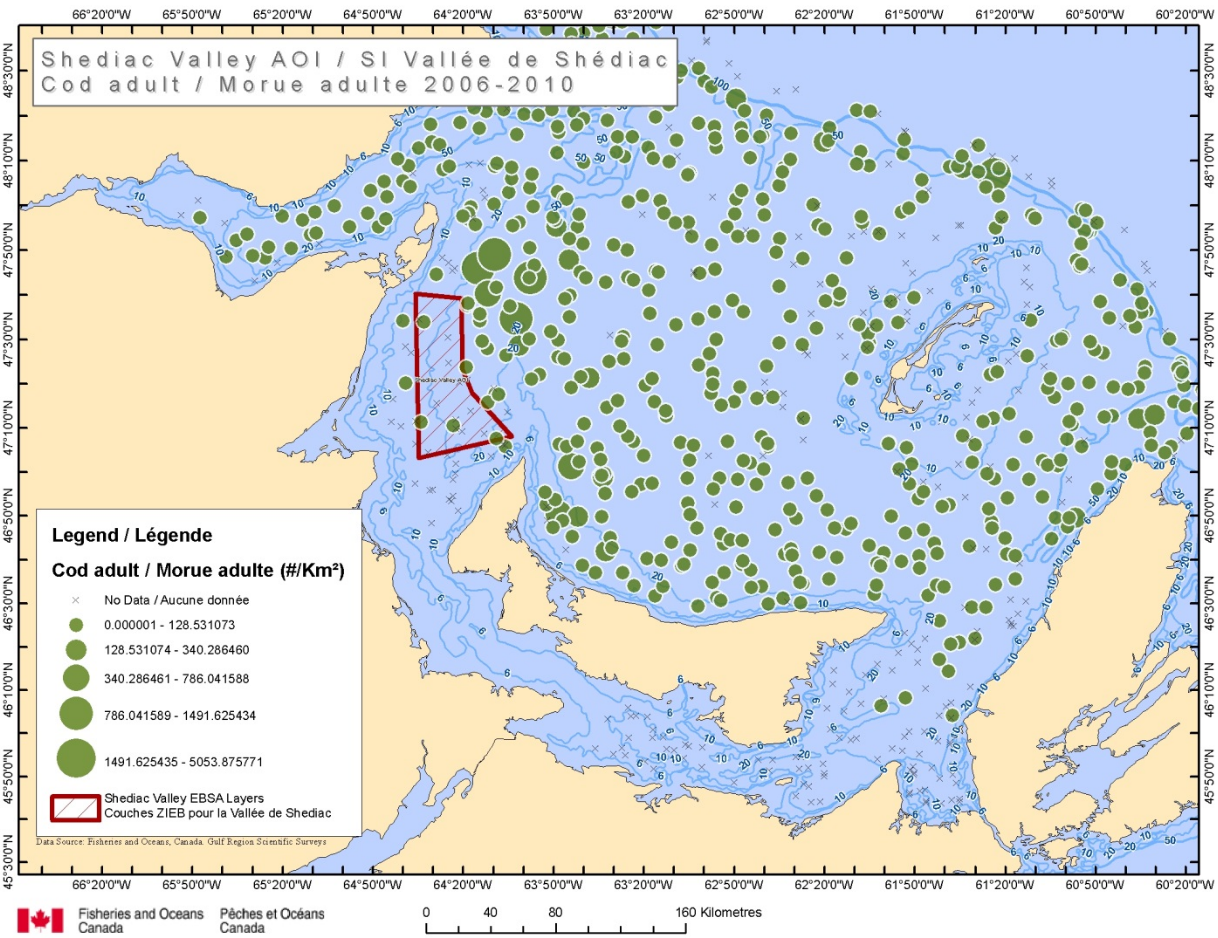

Figure 2.7 Groundfish Trawl Locations and Density (#/km^2) of Adult Cod in the sGSL September surveys (2006-2010).

General Description: Available information on Atlantic cod diet, reproduction, fecundity, abundance, growth, mortality, spatio-temporal distribution, habitat and population trends is provided in Table 2.4.

Table 2.4 Summary of Atlantic Cod in the Gulf of St. Lawrence.

Parameter	Description
Diet	Cod feed on krill, shrimp and small fish (primarily Atlantic herring, American plaice and capelin) during the summer months (DFO 2009b, Hanson and Chouinard 2002). Hanson and Chouinard (2002) summarized results of analyses conducted in 1990 and 1991. They found that in 1990 the smallest cod (<20 cm) fed mainly on mysids, crab and shrimp. For cod 30 to 49 cm long, brittle stars made up a quarter of the diet while fish made up less than 10% of their diet. DFO (2009b) notes that many small fishes have increased in abundance in recent decades and that the most important prey species of cod are at high levels of abundance.
Reproduction	Maturity begins at age 4-5, with most fish sexually mature by age 7. Cod in the sGSL spawn in the Shediac Valley and the area surrounding the Magdalen Islands in the late spring (late April to early June) (DFO 2009b).
Fecundity	Two studies of fertility have been conducted for sGSL stock (1958, 1982) (cited in Chouinard and Swain 2005). There is a strong relationship between length and fecundity: a 51 cm cod can produce 200,000 eggs; a 140 cm cod can produce up to 12 million eggs. Evidence from the studies cited suggests that fecundity was lower in 1981 than in the mid-1950s.
Abundance	The estimate of the spawning stock biomass of sGSL cod was 28,000 mt during the 2008 DFO assessment of cod in the sGSL. This number is the lowest observed in the last 60 years. A risk analyses by DFO (2009b) indicates that even with no catch in 2009, the stock is expected to decline by at least 5%. Information gathered during the annual DFO research vessel survey indicates that the abundance indices between 2005 and 2008 were the lowest levels observed between 1971 and 2008 (DFO 2009b). However, Hurlbut *et al.* (2010) reported higher numbers in the 2009 survey due to higher numbers of young cod (*e.g.*, 3-4 years of age). Catch rates of older cod in the 2009 survey were steady near the record low value.
Growth	Atlantic cod in the sGSL are slow growing compared to other cod populations in the northwest Atlantic (DFO 2009b). Cod in the sGSL begin to reach commercial size (43 cm) at approximately age 5 (DFO 2009b). By 8 years of age all cod are large enough to be fished commercially (DFO 2009b). DFO (2009b) indicates that in the late 1970s individual growth of sGSL cod declined and remains low. The decline could be caused by a decrease in growth rate from increasing competition for food and from the fishery selectively harvesting fast-growing fish. Size has remained low, even while growth conditions are good (e.g., low cod density and high prey abundance). The selection against fast growth by the fisheries in the

Parameter	Description
	1980s and early 1990s may have induced a genetic response leading to the continued slow growth of southern Gulf cod (DFO 2009b).
Mortality	Cod have a high natural mortality rate which is the most significant factor in the decrease of the population. It is estimated that the natural mortality of sGSL cod started to increase in the 1980s and has been high in the 1990s and 2000s (DFO 2009b). Consequently, the sGSL cod population is currently not viable and is expected to be extirpated unless there is an increase in productivity (Swain and Chouinard 2008a). Predation by seals is considered to be a significant component of natural mortality (DFO 2009b). Grey seals, present year round in the sGSL and harp seals, present in winter and early spring, are currently at high levels of abundance.
Spatio-temporal Distributions	The sGSL cod stock is highly migratory (DFO 2009b). The stock migrates from the sGSL in October. The stock overwinters in NAFO division 4Vn, north of Cape Breton Island and in 4Vs, on the eastern Scotian shelf along the Laurentian Channel. The return migration to the Shediac Valley usually begins in mid-April, although this can depend on the breakup of winter ice. The September 2009 DFO groundfish survey (Hurlbut *et al.* 2010) indicated that the highest densities of cod were found in the Shediac Valley off Miscou Island, north of PEI and between the Magdalen Islands and north western Cape Breton.
Habitats	Cod is a benthic, cold water species. A 1990 - 91 study found juvenile cod in the Shediac Valley predominantly beneath the 10°C isotherm in summer (Hanson and Chouinard 1992); cod is absent from AOI during winter. Migration from the Magdalen Shelf to deeper water for overwintering is thought to be to avoid freezing, since Magdalen Shelf (and AOI) bottom winter temperature can fall to – 1.5° C, due to surface exposure and mixing of the water column; overwintering area habitat temperature varies from 4.9 – 5.2°C (Chouinard and Swain 2005)
Stock or Population Trends	Information gathered during the annual stock assessment indicates that numbers of cod have reached an all-time low (DFO 2009b). The 2009 survey indicated higher numbers of 3 to 4 year old fish, however, the number of older fish remained low (Hurlbut *et al*. 2010). Even with the closure of the fishery the population of sGSL cod is still expected to decline.

2.3.1.2 ***White Hake***

White hake (*Urophycis tenuis*) is a demersal fish species often compared to cod. It inhabits the sGSL, the Scotian Shelf and the SW slope of the Grand Banks. White hake are known to be present in the Shediac Valley AOI, but in small numbers only, according to results of annual trawl surveys presented below. The directed fishery for this species in NAFO Area 4T (sGSL) has remained under moratorium since 1995 (T. Hurlbut, DFO, pers. comm.).

Distribution: Hurlbut and Clay (1998) indicate that there are two distinct populations of white hake in the GSL: those occupying shallow waters of the southern Gulf during the summer months and those occupying deep-water (approximately 200 m) throughout the remainder of the year. Swain and Benoît (2007) refer the reader to early studies which indicate that the two components differ morphologically, have different parasite loads and appear to spawn in different areas and seasons.

DFO (2005b) states that the geographical distribution of white hake catches in the 2004 groundfish survey was very similar to recent surveys indicating that the main concentrations were found in St. Georges Bay, the Cape Breton Trough and along the Laurentian Channel. Adjacent to the Magdalen Islands very few white hake were caught. Since the early 1990s catches of white hake in the western portion of the sGSL have been low.

Figures 2.8 to 2.13 show the densities of juvenile and adult white hake caught in the sGSL during the three annual September trawl survey time periods. During these time periods, juvenile and adult white hake were seldom caught in or around the AOI. The greatest densities of juvenile and adult white hake in the sGSL were caught in the deeper waters of the Cape Breton Trough, as well as southeast of PEI and in St. Georges Bay.

<u>Based on the groundfish trawl surveys, the Shediac Valley AOI does not appear to be an important area for white hake</u>.

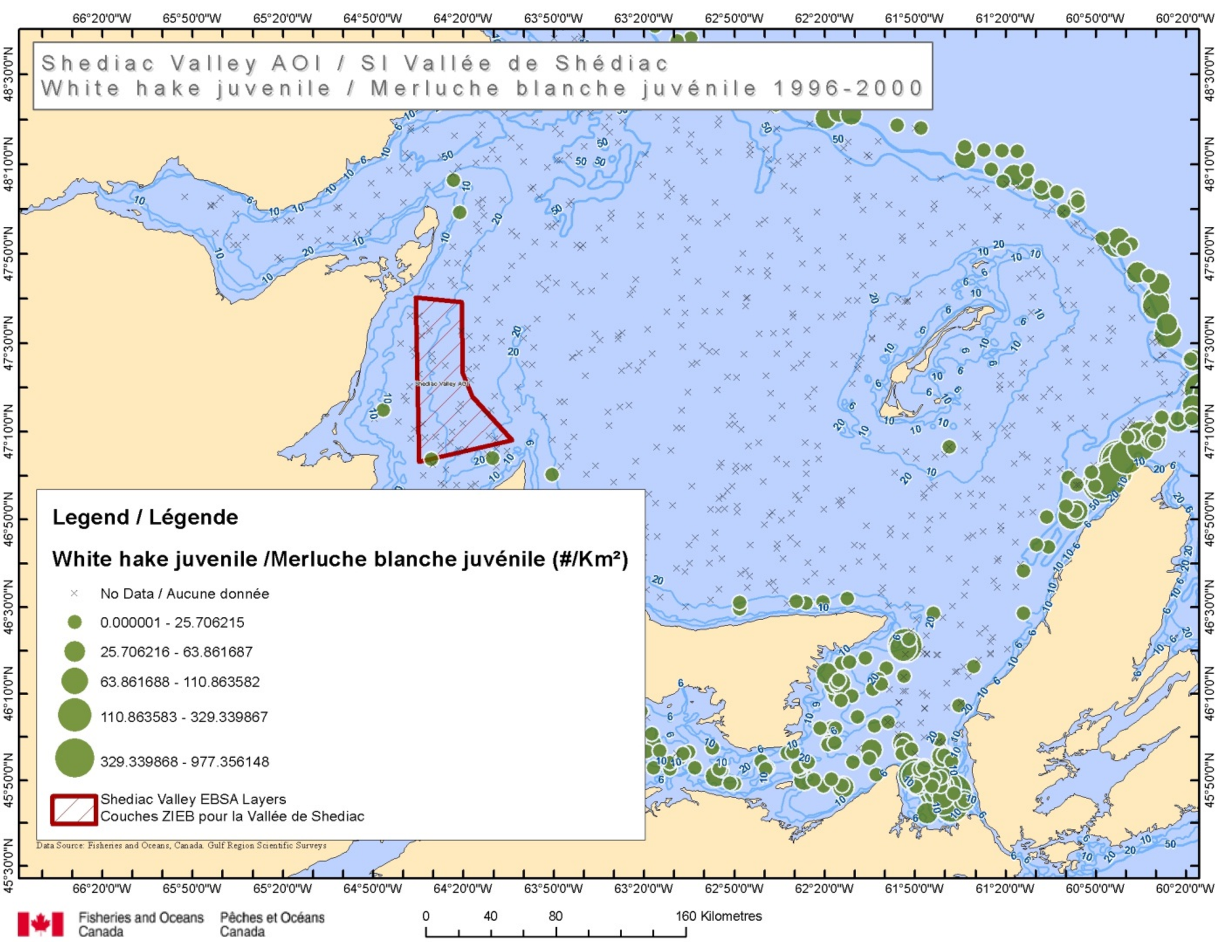

Figure 2.8 Groundfish Trawl Locations and Density (#/km^2) of Juvenile White Hake in the sGSL in September (1996-2000).

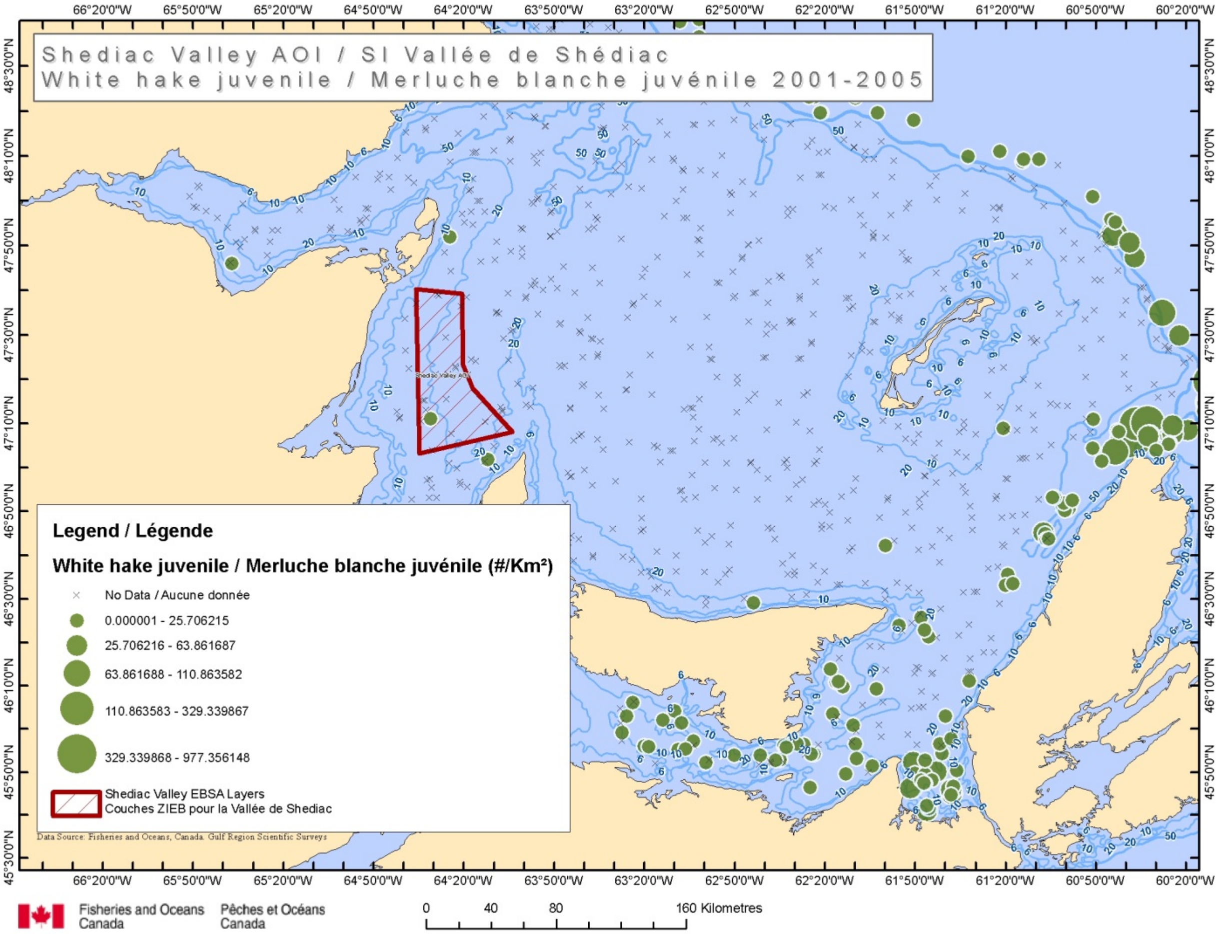

Figure 2.9 Groundfish Trawl Locations and Density (#/km^2) of Juvenile White Hake in the sGSL in September (2001-2005).

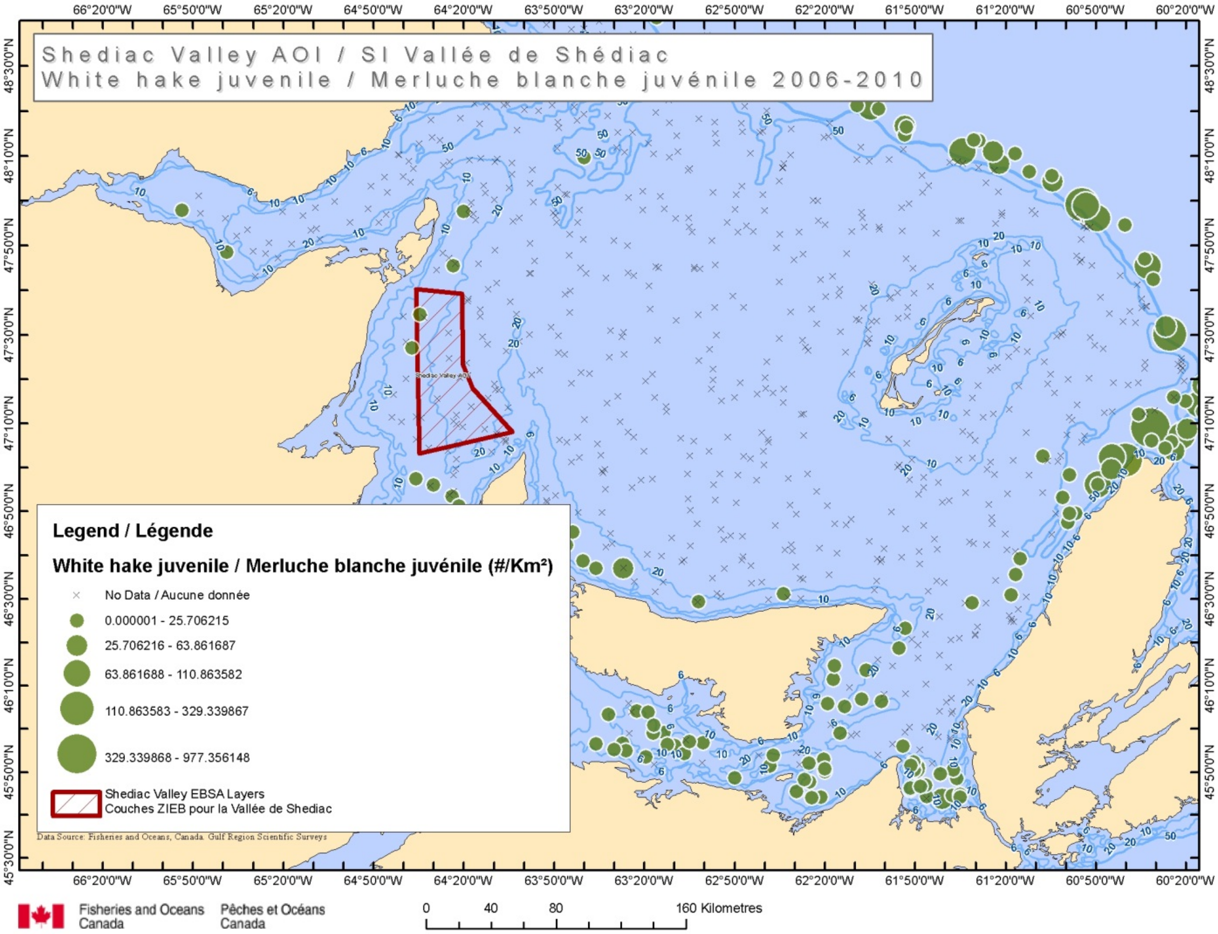

Figure 2.10 Groundfish Trawl Locations and Density (#/km^2) of Juvenile White Hake in the sGSL in September (2006-2010).

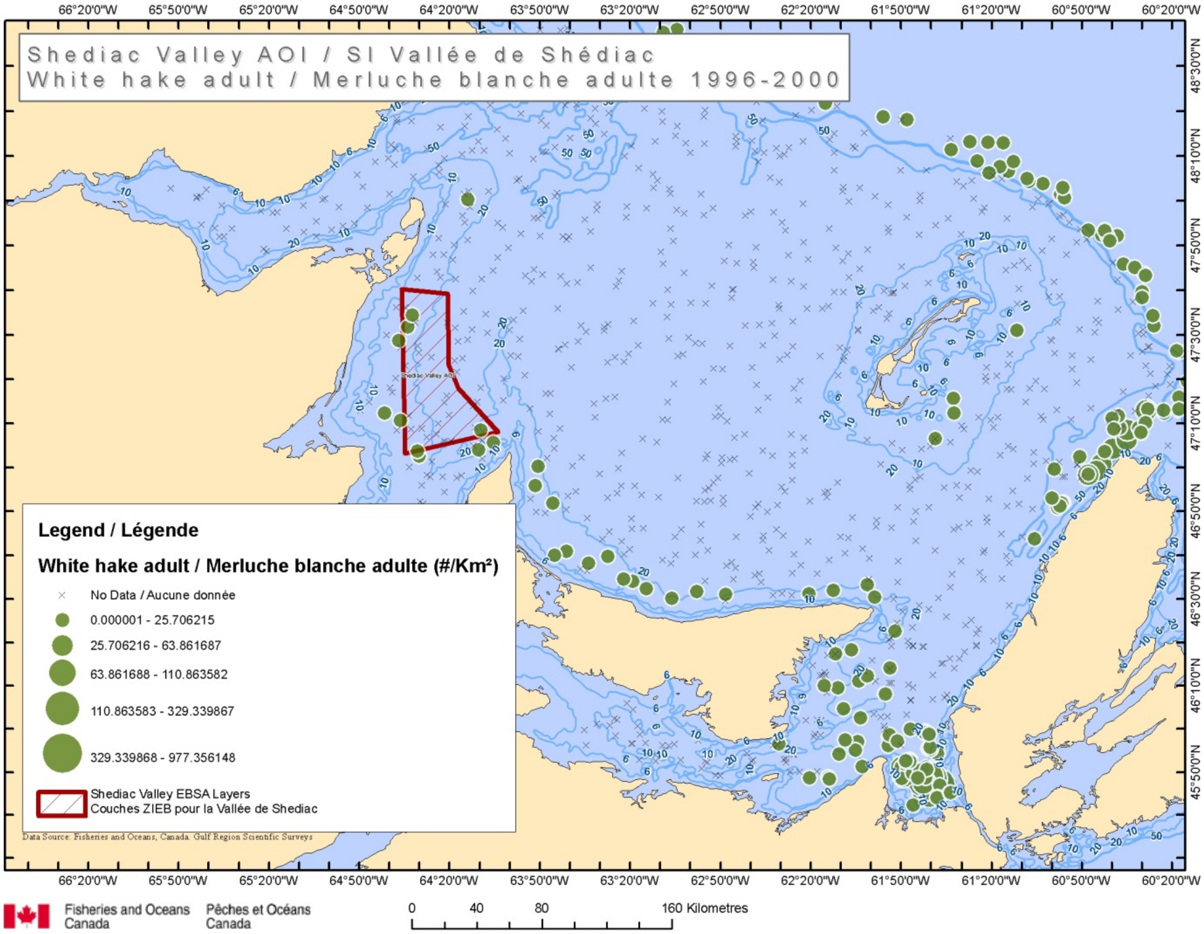

Figure 2.11 Groundfish Trawl Locations and Density (#/km^2) of Adult White Hake in the sGSL in September (1996-2000).

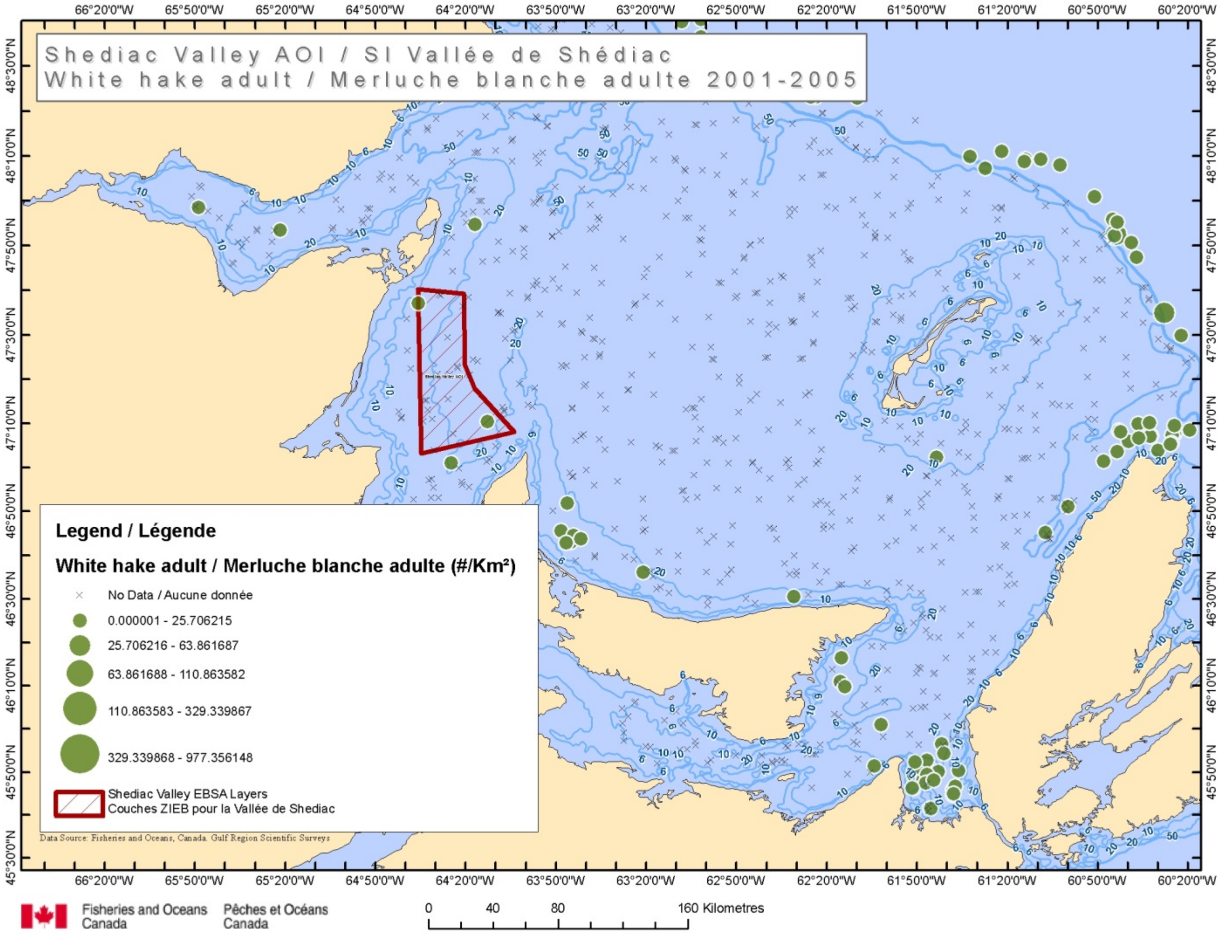

Figure 2.12 Groundfish Trawl Locations and Density (#/km^2) of Adult White Hake in the sGSL in September (2001-2005).

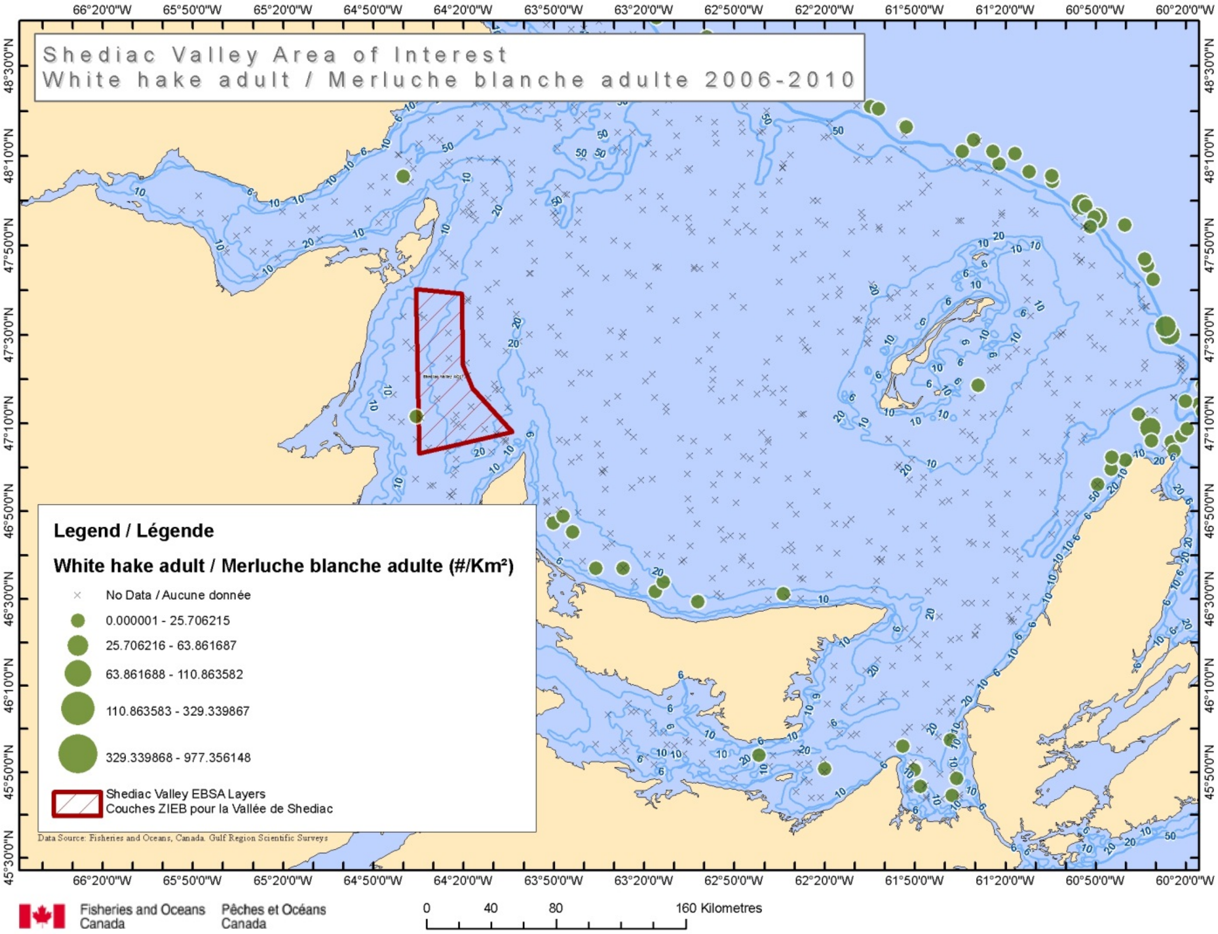

Figure 2.13 Groundfish Trawl Locations and Density (#/km^2) of Adult White Hake in the sGSL in September (2006-2010).

General Description: Available information on white hake diet, reproduction, fecundity, abundance, growth, mortality, spatio-temporal distribution, habitat and population trends is provided in Table 2.5.

Table 2.5 Summary of White Hake in the Gulf of St. Lawrence

Parameter	Description
Diet	Demersal juvenile white hake feed primarily on shrimps, polychaetes and other small crustaceans (Bowman 1981) and post-juveniles (20-30 cm) eat large quantities of decapods shrimps, euphausiids (krill) and some fish (Bowman *et al.* 2000). The diet of adults is dominated by fish (up to 78% by weight of ingested food) (Scott and Scott 1988) including clupeids (mainly Atlantic herring), gadids (Atlantic cod, white and longfin hake), redfish, Atlantic mackerel, northern sand lance and winter flounder (Garrison and Link 2000, Collette and Klein-MacPhee 2002).
Reproduction	Spawning in the sGSL begins in June, with peak spawning activity occurring during second half of the monthes (DFO 2005b). Sexual maturity is reached between the ages of 2 and 5 years with males being approximately 21 cm and females being 44 cm (DFO 2005b).
Fecundity	During a single spawning period, a single female may lay several million eggs (DFO 2005b).
Abundance	In 2002, the indices of abundance and biomass declined to their lowest levels in the time series for white hake at all ages (3.3 fish/tow and 1.3 kg/tow) compared to the average values (8.4 fish/tow and 7.2 kg/tow) between 1984-1994 preceding the moratorium (DFO 2005b). In 2009 the abundance index increased from 3.5 fish/tow in 2008 to 4.8 fish/tow; however, the biomass index decreased from 1.6 kg/tow in 2008 to 1.4 kg/tow. The 2009 indices indicate that the abundance and biomass of white hake remain low when compared with indices from the late 1980s and early 1990s (Hurlbut *et al.* 2010).
Growth	White hake are comparatively fast-growing (Markle *et al*. 1982) and attain large sizes (maximum length of 135 cm and maximum weight of 22 kg) and ages of more than 20 years (Sosebee 1998, Collette and Klein-MacPhee 2002). Females older than 3 years are generally larger than males of the same age (Clay and Clay 1991).
Mortality	Information on the natural mortality of white hake in the sGSL is limited but recent analyses suggest that it increased steadily after the late-1980s to an extremely high level in the mid-2000s and it is mainly responsible for the continued decline of this stock since the moratorium was established in 1995 (Hurlbut, pers. comm. 2010). There is indirect evidence which suggests that predation by grey seals may be a major contributing factor (Hurlbut, pers. comm. 2010).
Spatio-temporal Distributions	Since 2000, the main concentrations of white hake in the sGSL have been found in St. Georges Bay, the Cape Breton Trough and along the Laurentian Channel. Recent surveys have shown very few white hake in the western part of the sGSL with largest concentrations occurring in warmer waters either in shallow inshore areas of deeper waters along the Laurentian Channel (DFO 2005b).

Parameter	Description
	Evidence from seasonal and annual bottom-trawl surveys conducted in the southeastern and southwestern GSL in the later 1980s and early 1990s showed that white hake undertake a seasonal migration in the fall from their shallow-water feeding grounds in the sGSL to the deep (>200m), relatively warm waters of the Laurentian Channel where they overwinter. The return migration to the sGSL occurs in the spring and is usually completed by June (Archambault *et al*. 2001).
Habitats	White hake can be found residing in soft bottom habitats at temperatures ranging between 5 and 11ºC (DFO 2005b).
Stock or Population Trends	The results from the annual bottom-trawl surveys indicate that the abundance and biomass of white hake in the sGSL remains extremely low compared to the levels observed in the late 1980s and early 1990s (Hurlbut *et al.* 2010).

Data Gaps: Data regarding the natural mortality rate of white hake populations in the sGSL is limited.

2.3.1.3 *American Plaice*

American plaice (*Hippoglossoides platessoides)* is a coldwater flatfish widely distributed throughout the NW Atlantic from the Gulf of Maine to western Greenland (Morin *et al*. 2008). American plaice was assessed by COSEWIC as Threatened in April 2009, but is not currently listed on Schedule 1 under the *Species at Risk Act*. In the sGSL American plaice is managed as a single stock unit in NAFO 4T, which includes the Shediac Valley.

Distribution: Morin *et al.* (2008) present distribution maps of American plaice in the sGSL based on the sGSL sentinel program, the annual groundfish trawl survey and commercial catches. Between 2003 and 2007, the distribution of the stock has been concentrated in an east-to-west band running north of PEI from the Shediac Valley to the west coast of Cape Breton. The highest concentrations of the species, in terms of catch weight per tow, have typically been identified north of PEI. A secondary band of relatively high abundance occurs off the west coast of Cape Breton, extending into the Northumberland Strait. Swain and Morin (1996) identified Shediac Valley as one of three prime areas where plaice were found. Based on annual September groundfish trawl surveys of NAFO 4T (1971 to 2006), Busby *et al.* (2007) indicate that American plaice are widely distributed in the sGSL and that since 1971 they have occupied, on average, 86% of the area surveyed. Morin (pers. comm. 2010) indicates that plaice in the sGSL is more centered in intermediate water depths and less in coastal areas.

Figures 2.14 to 2.19 show the densities of juvenile (sexually immature) and adult American plaice caught in the sGSL during the trawl survey periods. During these periods high densities of juvenile American plaice were caught throughout the surveyed area including concentrations within and east of the AOI, while the highest densities of adult American plaice were caught just east of the AOI and elsewhere in the sGSL.

<u>Based on results of the annual groundfish trawl surveys (Figs 2.14 to 2.19 below), the Shediac Valley AOI does not appear to be a particularly important area for adult American plaice in the sGSL, however, as cited in Table 2.6 below, the AOI appears to be an important nursery area for juvenile American plaice.</u>

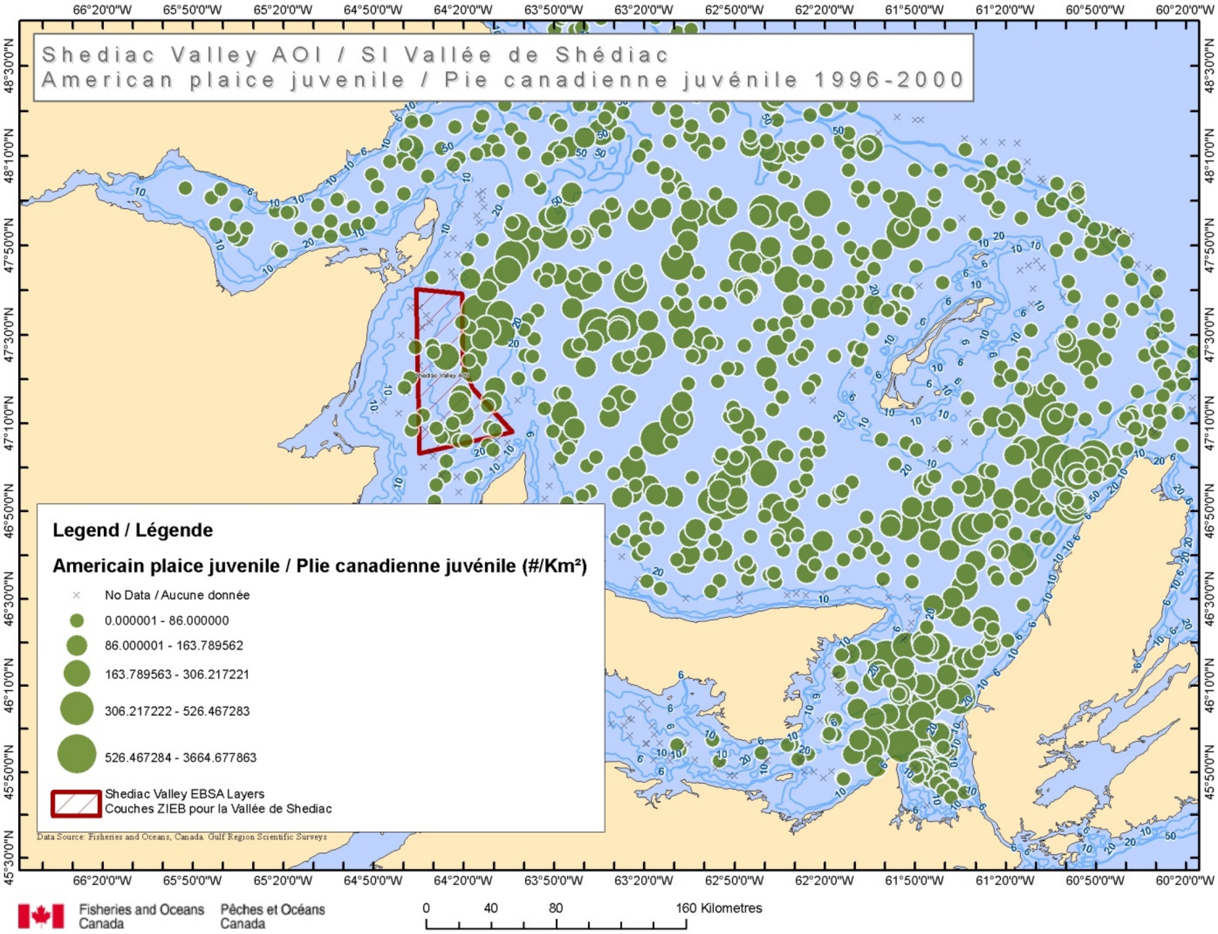

Figure 2.14 Groundfish Trawl Locations and Density (#/km^2) of Juvenile American Plaice in the sGSL in September (1996-2000).

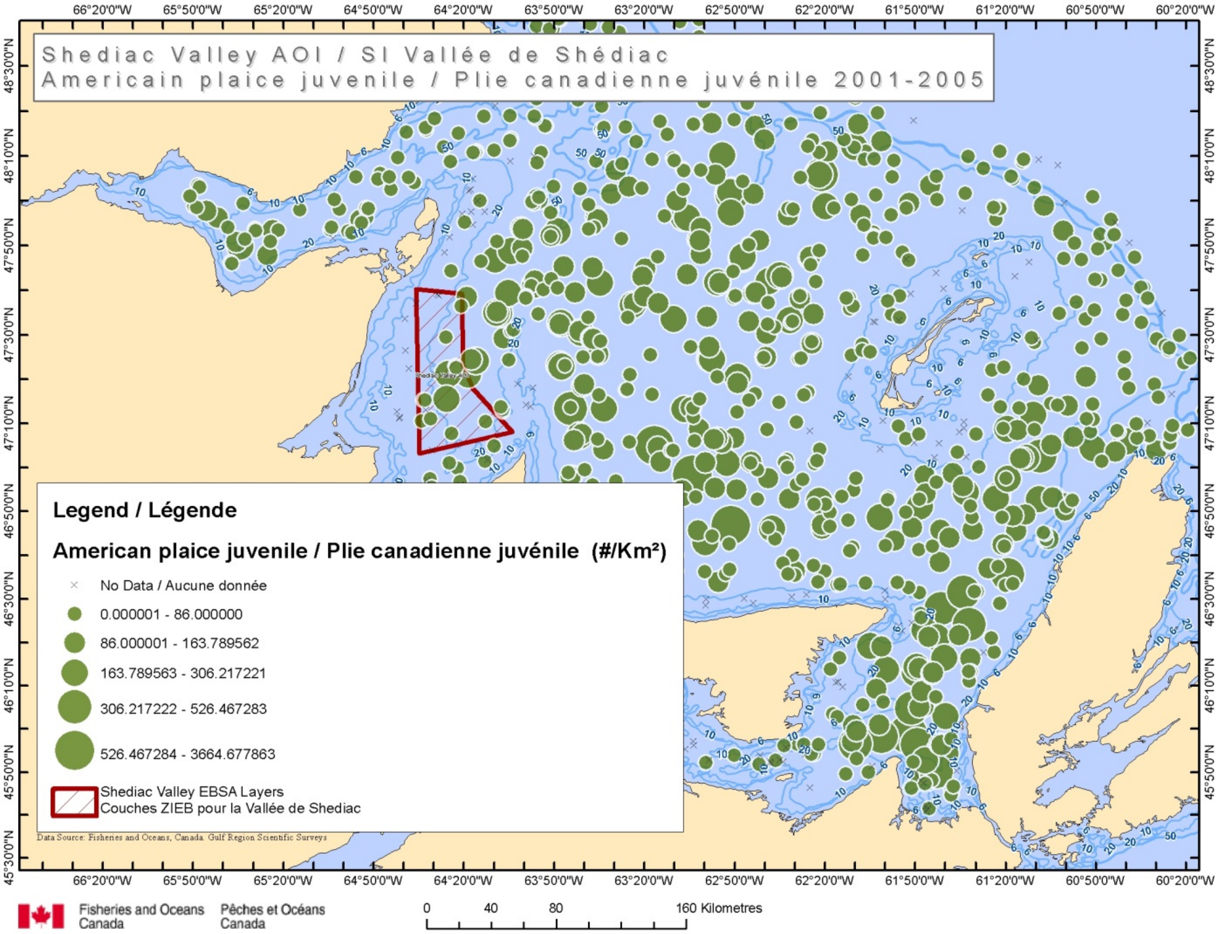

Figure 2.15 Groundfish Trawl Locations and Density (#/km^2) of Juvenile American Plaice in the sGSL in September (2001-2005).

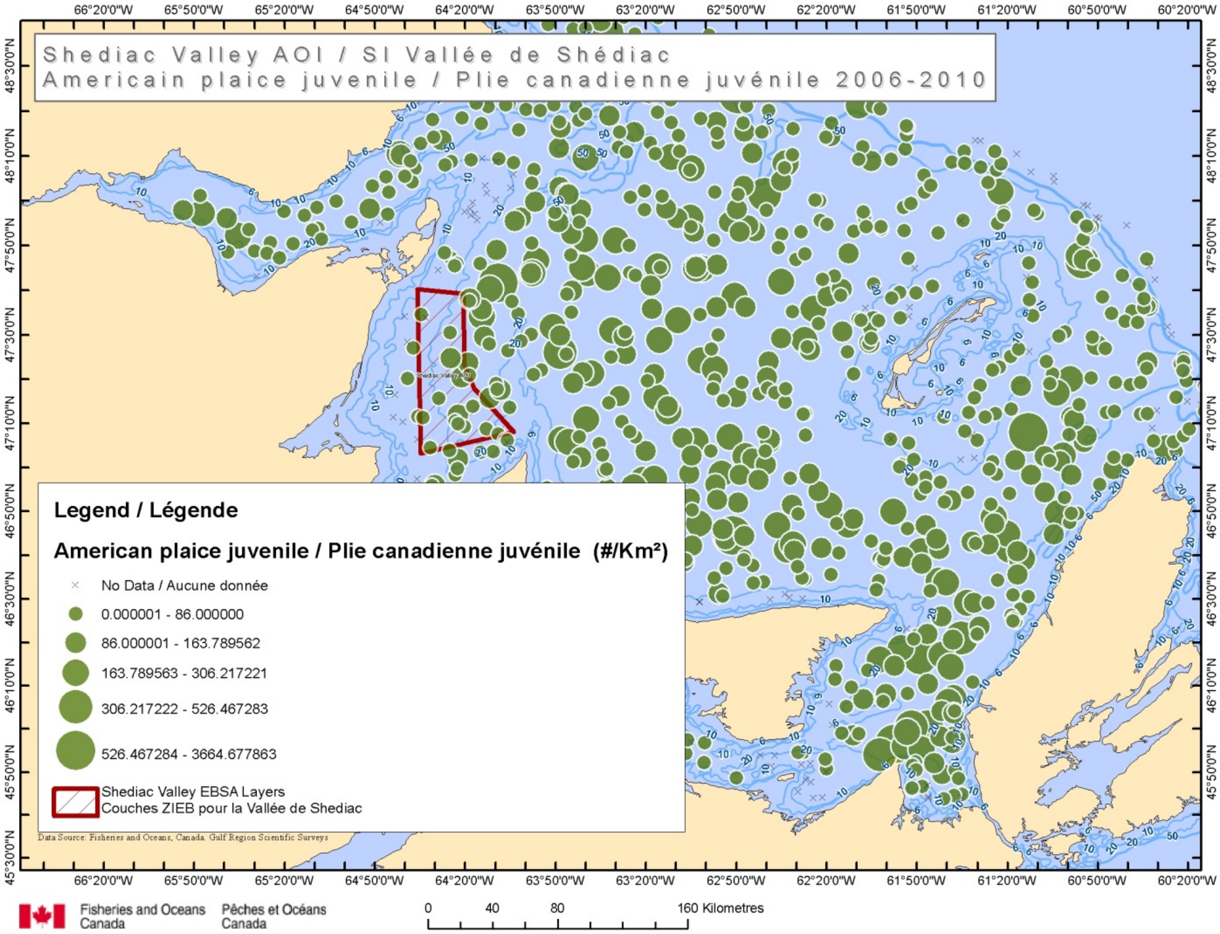

Figure 2.16 Groundfish Trawl Locations and Density (#/km^2) of Juvenile American Plaice in the sGSL in September (2006-2010).

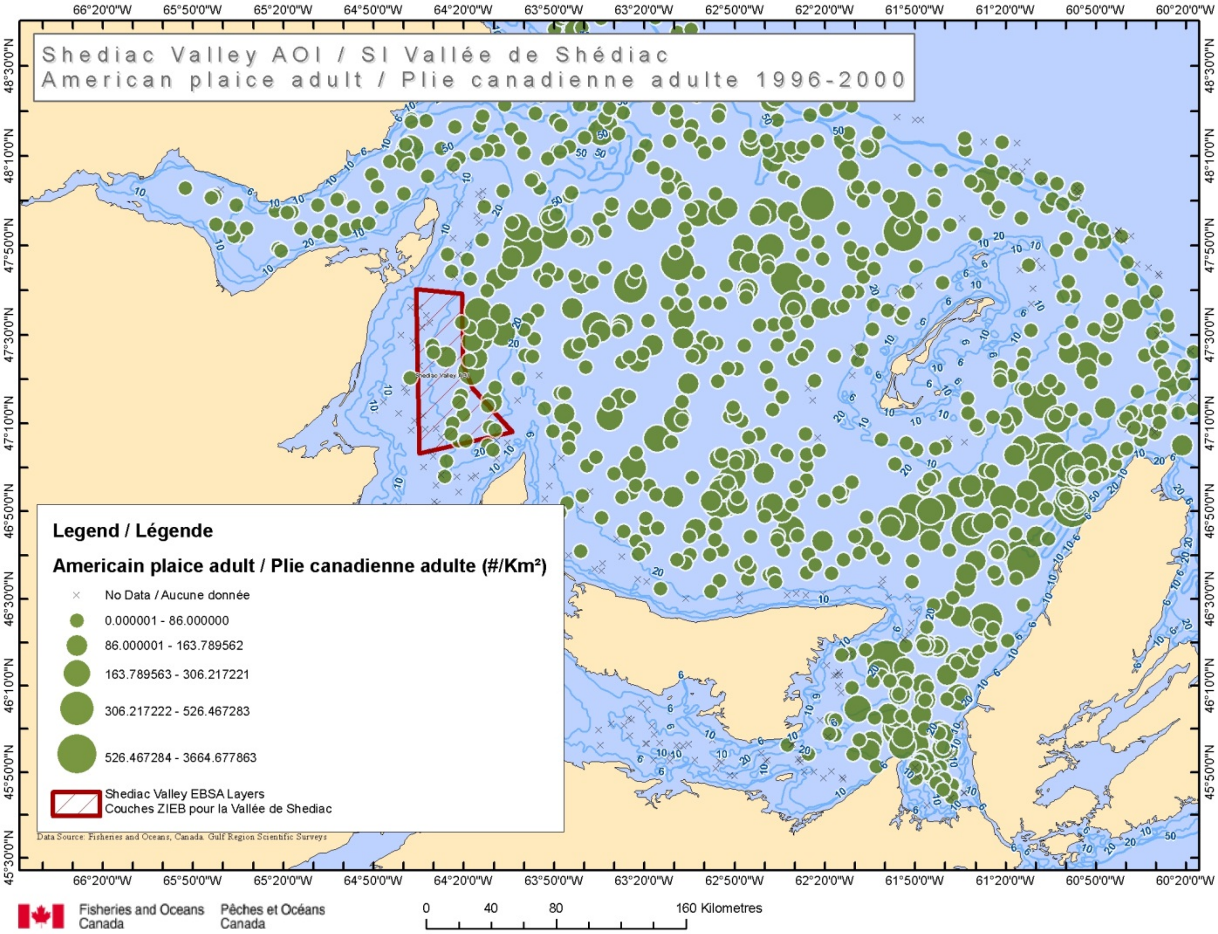

Figure 2.17 Groundfish Trawl Locations and Density (#/km^2) of Adult American Plaice in the sGSL in September (1996-2000).

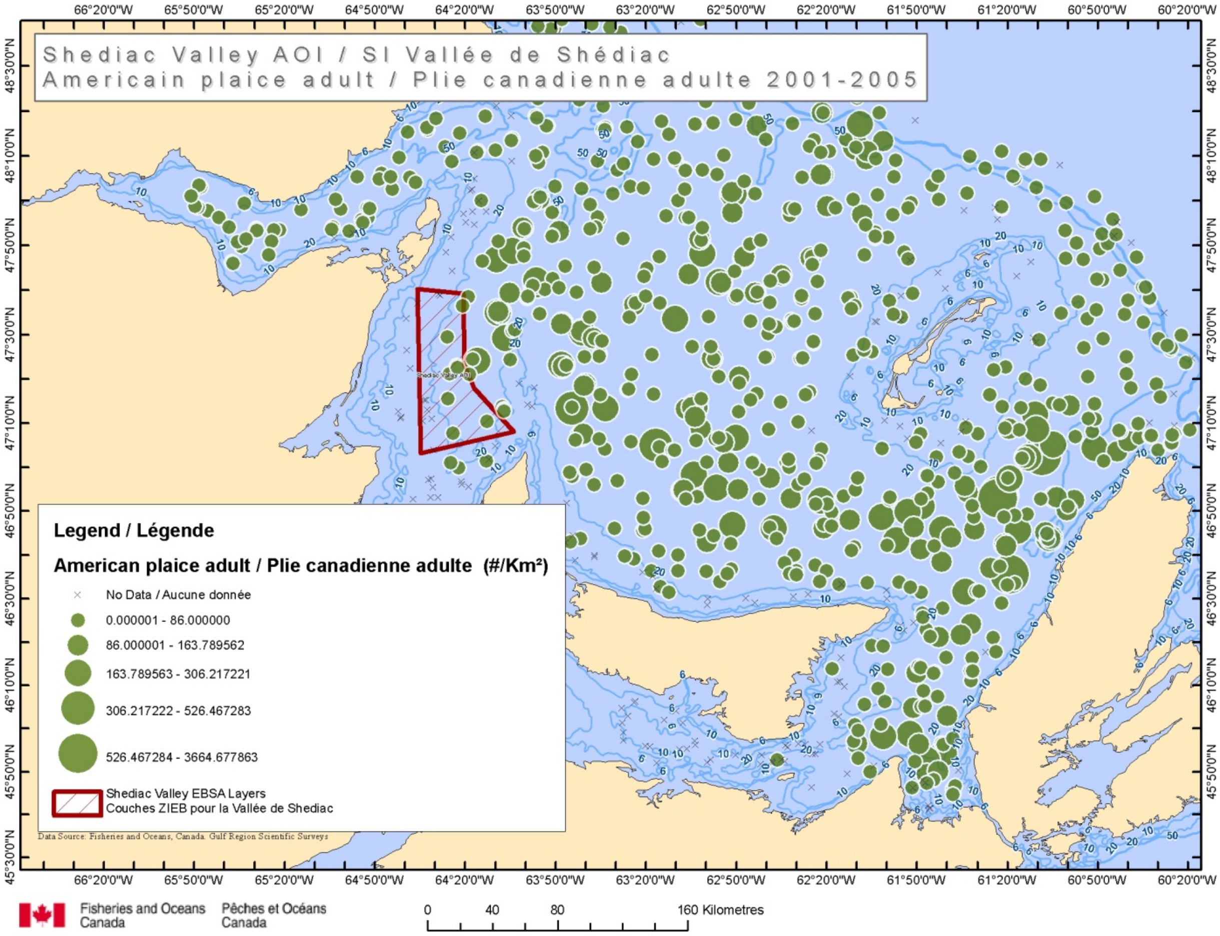

Figure 2.18 Groundfish Trawl Locations and Density (#/km^2) of Adult American Plaice in the sGSL in September (2001-2005).

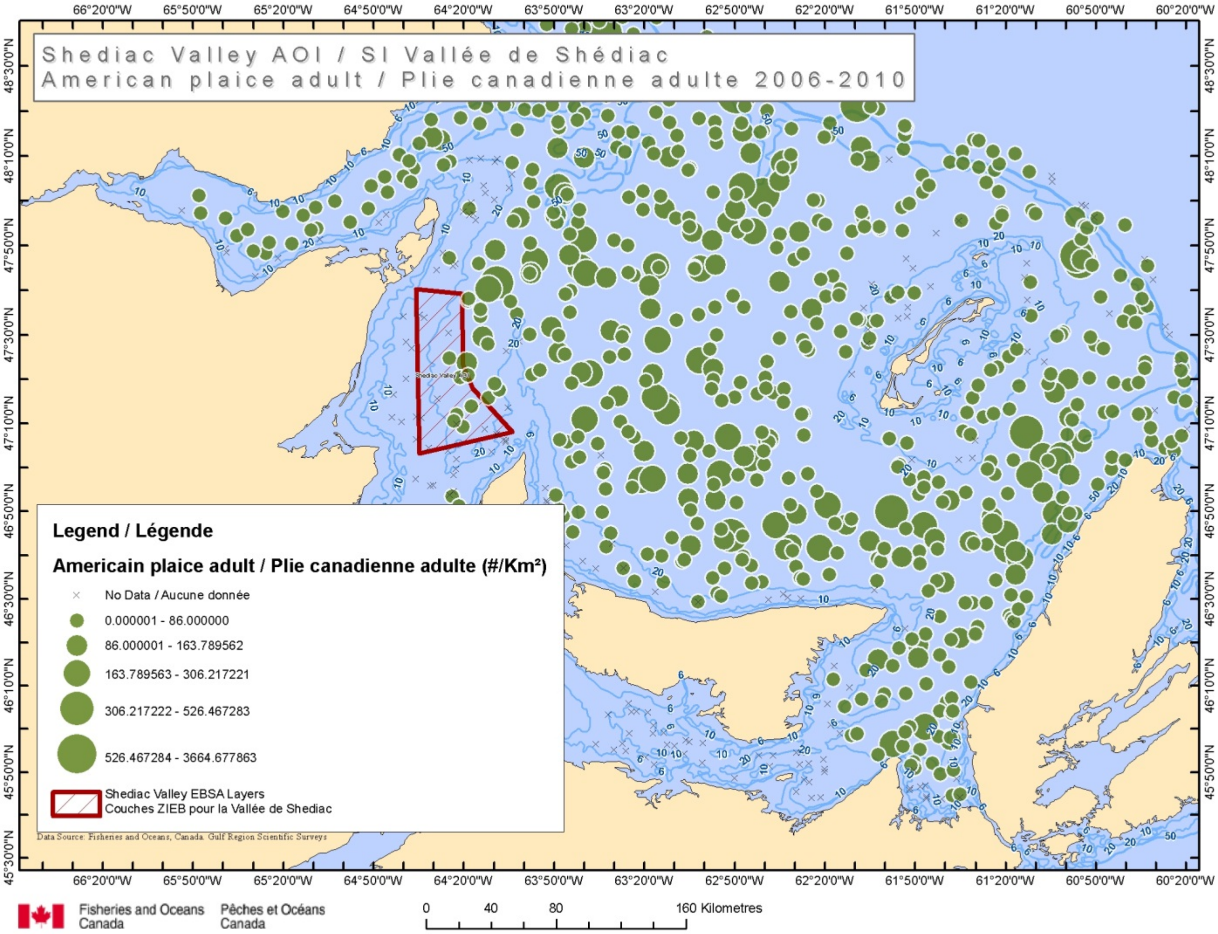

Figure 2.19 Groundfish Trawl Locations and Density (#/km^2) of Adult American Plaice in the sGSL in September (2006-2010).

General Description: Available information on American plaice diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.6.

Table 2.6 Summary of American plaice in the Gulf of St. Lawrence.

Parameter	Description
Diet	Juvenile plaice feed on bottom organisms including mysid shrimp, amphipods, polycheates, echinoderms and molluscs, while adult plaice feed on small fish species and invertebrates (DFO 2005c).
Reproduction	Spawning takes place in the early spring until summer. Each female releases thousands of eggs; generally in batches every few days (Busby *et al*. 2007) and when fertilized they float near the water surface until hatching. Once hatched the larvae are pelagic until they reach a length of at least 18 mm, at which point metamorphosis occurs. After metamorphosis the young plaice become benthic species (DFO 2005c).
Fecundity	According to studies referenced in Busby *et al*. (2007), fecundity of American plaice has not been well studied. Absolute fecundity estimates for plaice found in the southern Grand Banks are approximately 417,000 eggs (female length 30 cm), northern Grand Bank plaice at approximately 148,000 eggs (female length 30 cm) and on the southern Labrador Shelf at approximately 125,000 eggs (female length 32 cm). No data are available for the sGSL area.
Abundance	According to Morin *et al*. (2008), the abundance of the stock has declined nearly ten-fold since the 1970s. The prospects for improvement in abundance of this stock are considered poor and the stock is defined as one of declining biomass. Survey data from 2004 shows that the catch was small within the Shediac Valley AOI and the majority of the catches were located directly east of the AOI (DFO 2005c). Hurlbut *et al.* (2010) reported that the 2009 bottom-trawl survey yielded a low catch of plaice and the lowest level of the population biomass index since 1971.
Growth	Females grow faster and are larger than male plaice. Males reach sexual maturity between ages 5 and 7, while females reach sexual maturity between ages 7 and 15 (DFO 2005c).
Mortality	Mortality of the GSL stock has been measured since 1971. The average total mortality has been 0.54 since 1992 (DFO 2008b).
Behaviour	While plaice reside on the ocean bottom, they have been observed swimming at shallow depths (Busby *et al.* 2007).
Spatio-temporal Distributions	American plaice are widely distributed throughout the sGSL (Hurlbut *et al.* 2010). Concentrations of plaice are found in an area running north of PEI from the Shediac Valley to the west coast of Cape Breton (Morin *et al.* 2008). Busby *et al.* (2007) indicate that plaice undergo seasonal migrations in the GSL, moving from cold, shallow water to warmer deep waters in the fall.
Habitats	American plaice are associated with intermediate depths of 80 to 250 m and water temperatures from below 0ºC to 1.5ºC (DFO 2005c). According to Swain and Benoit (2007), the Shediac Valley is an important nursery

Parameter	Description
	area for many species including the American plaice.
Stock or Population Trends	American plaice shows a declining trend for abundance, recruitment and adult growth (DFO 2008b). Busby *et al.* (2007) observed that all plaice stocks in Atlantic Canada showed declines. Stocks that had enough data for statistical analysis showed declines that ranged from 86.4-94.8%. Even with management strategies in place (*e.g.*, limited quota) the prospects of increasing numbers under the current conditions are poor (DFO 2008b). Model estimates of the spawning stock biomass (SSB) in 2012 showed a general decline from the late 1970s to the early 2000s. SSB was at its lowest level in 2009 at less than 31,000 tonnes; the latest estimate (2012) was 41,676 tonnes (DFO 2012a).

Data Gaps: Information on the location and timing of spawning of American plaice in the sGSL is limited (R. Morin, pers. comm. 2010).

2.3.1.4 ***Winter Skate***

Winter skate (*Leucoraja ocellat)* are part of the subclass Elasmobranchii, which includes sharks, rays and skates and are included in the order Rajiformes. Rajiforms are characterized by the presence of enlarged pectoral fins and a flattened body. Winter skate (sGSL population) was assessed by COSEWIC as Endangered in May 2005 (COSEWIC 2011). At this time it is not currently listed on Schedule 1 under the *Species at Risk Act*.

Swain *et al.* (2006) provides an assessment of the winter skate population in the sGSL. They note that the biology of the sGSL population is not well studied compared to populations on the eastern Scotian Shelf and from more southerly areas. Data from the annual bottom trawl survey indicates that winter skate occurs along the western boundary of the Shediac Valley AOI and to a lesser extent within the AOI (DFO 2005d). According to Swain *et al.* (2006), winter skate in the sGSL appears to be distinct from those in other areas.

Distribution: Over the history of the September annual bottom-trawl survey, winter skate have tended to be caught in shallow inshore areas, with the highest catches occurring along the northeast NB coast from the coastal area shared with western PEI to the coastal area off Miscou Island (although the majority of the catches appear to be located outside the boundary of the AOI), at the eastern end of the Northumberland Strait, southeast of PEI and east of the Magdalen Islands.

Figures 2.20 to 2.25 show the densities of juvenile and adult winter skate caught in the sGSL during the three trawl survey time periods. The highest densities of both juvenile and adult skates occurred along the coast of PEI and NB from PEI to the Acadian Peninsula, including portions of the AOI, as well as east of the Magdalen Islands (adult skate) (Figures 2.20 and 2.25). The catch rates of juvenile and adult winter skate declined between 1996-2000 and 2001-2005 and again in the 2006-2010 period. Juvenile and adult winter skate were caught at fewer locations and at lower densities than during each preceding period.

Results from the annual bottom-trawl survey suggest that the Shediac Valley AOI may have been an important area for winter skate in the past but recently catches have declined in the AOI and throughout the sGSL.

Given the historical data on distribution of the species, the Shediac Valley AOI may be an important area for the recovery of winter skate.

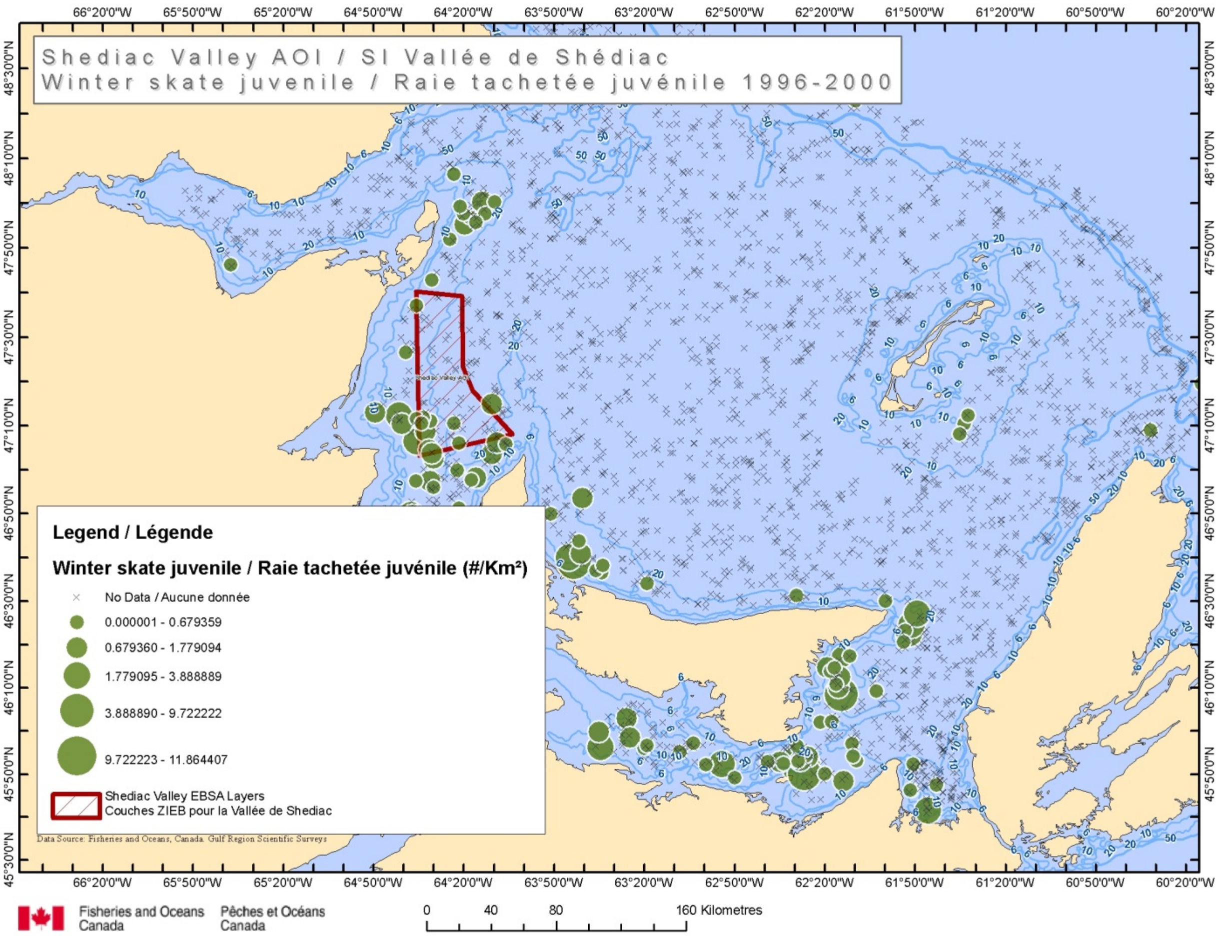

Figure 2.20 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Winter Skate in the sGSL in September (1996-2000).

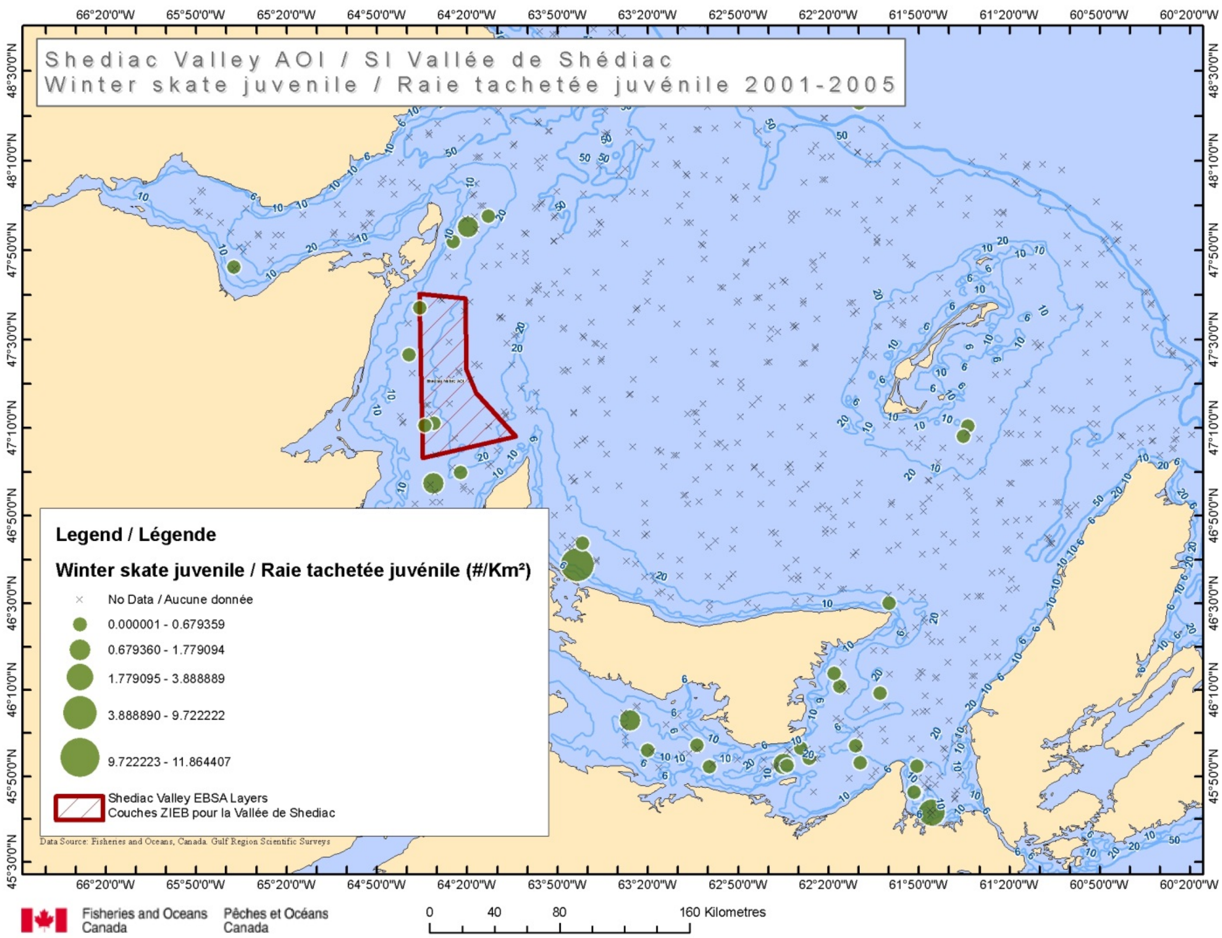

Figure 2.21 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Winter Skate in the sGSL in September (2001-2005).

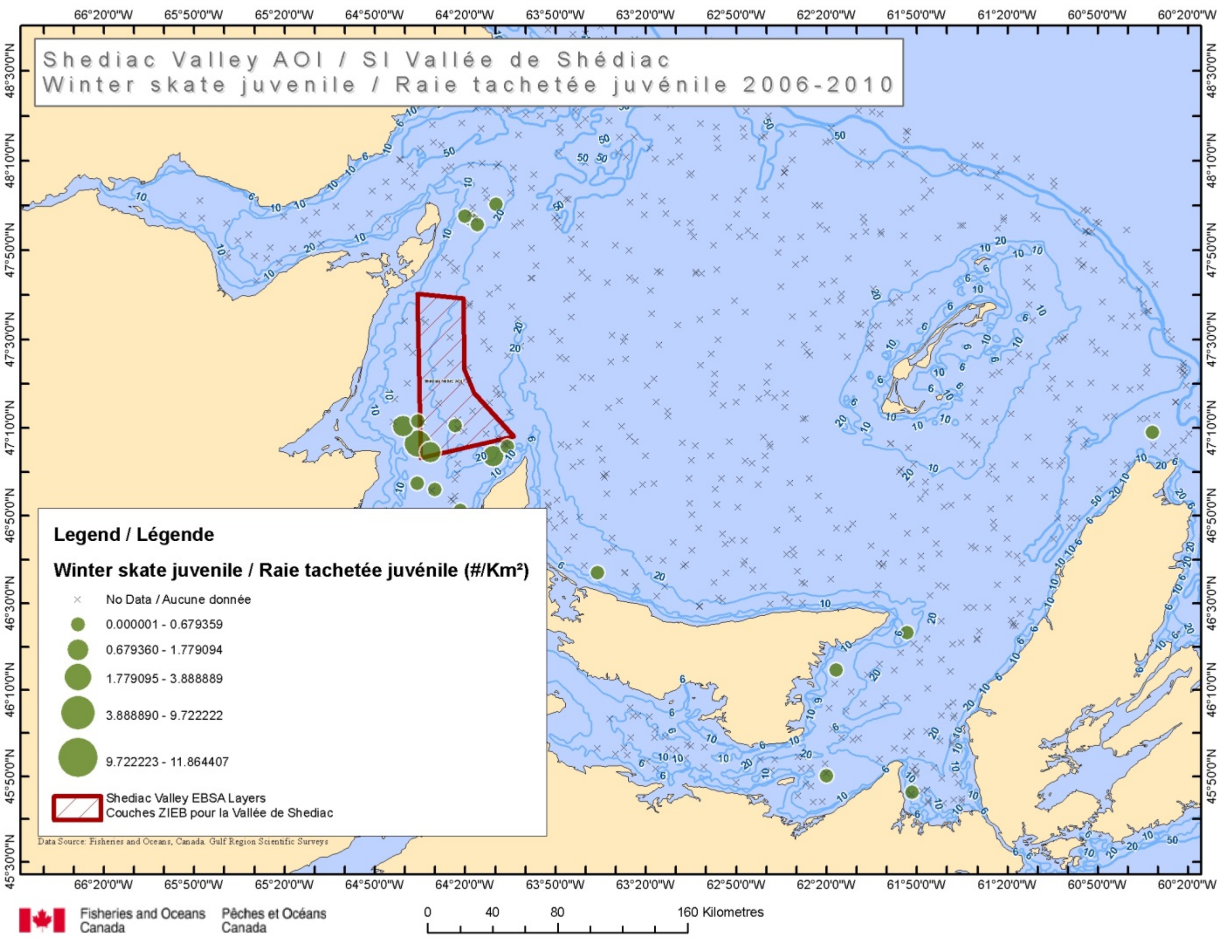

Figure 2.22 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Winter Skate in the sGSL in September (2006-2010).

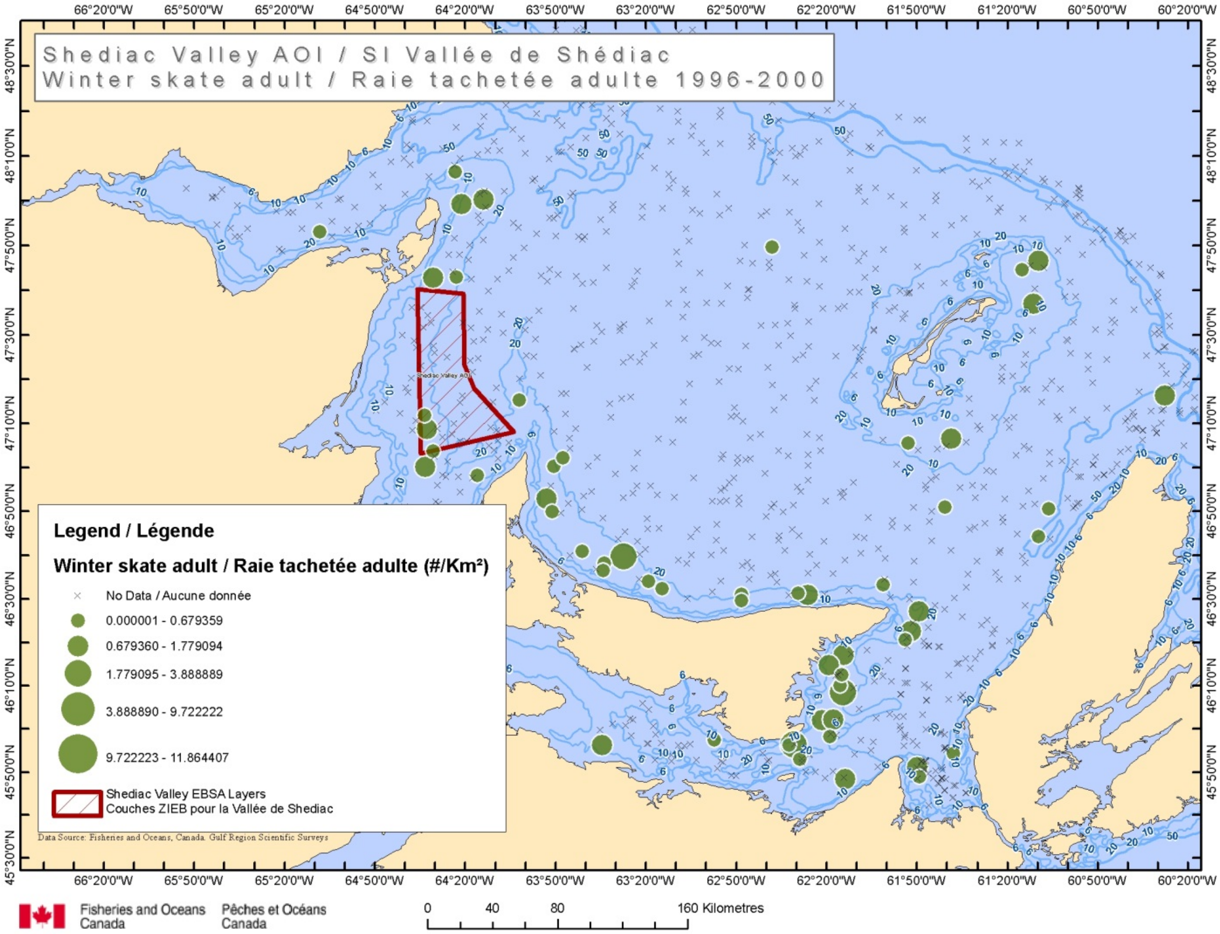

Figure 2.23 Groundfish Trawl Locations and Density (#/km^2) of Adult winter Skate in the sGSL in September (1996-2000).

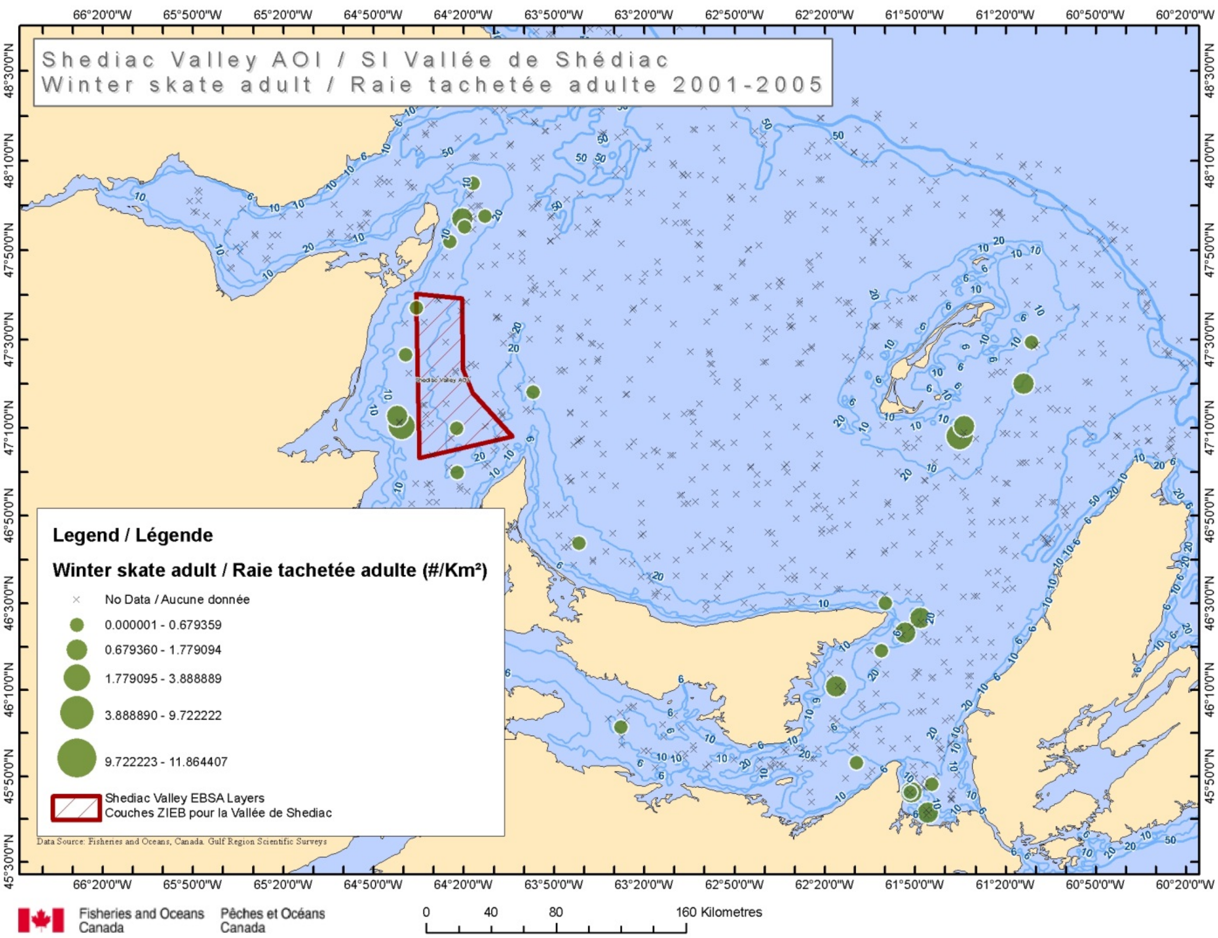

Figure 2.24 Groundfish Trawl Locations and Density (#/km^2) of Adult Winter Skate in the sGSL in September (2001-2005).

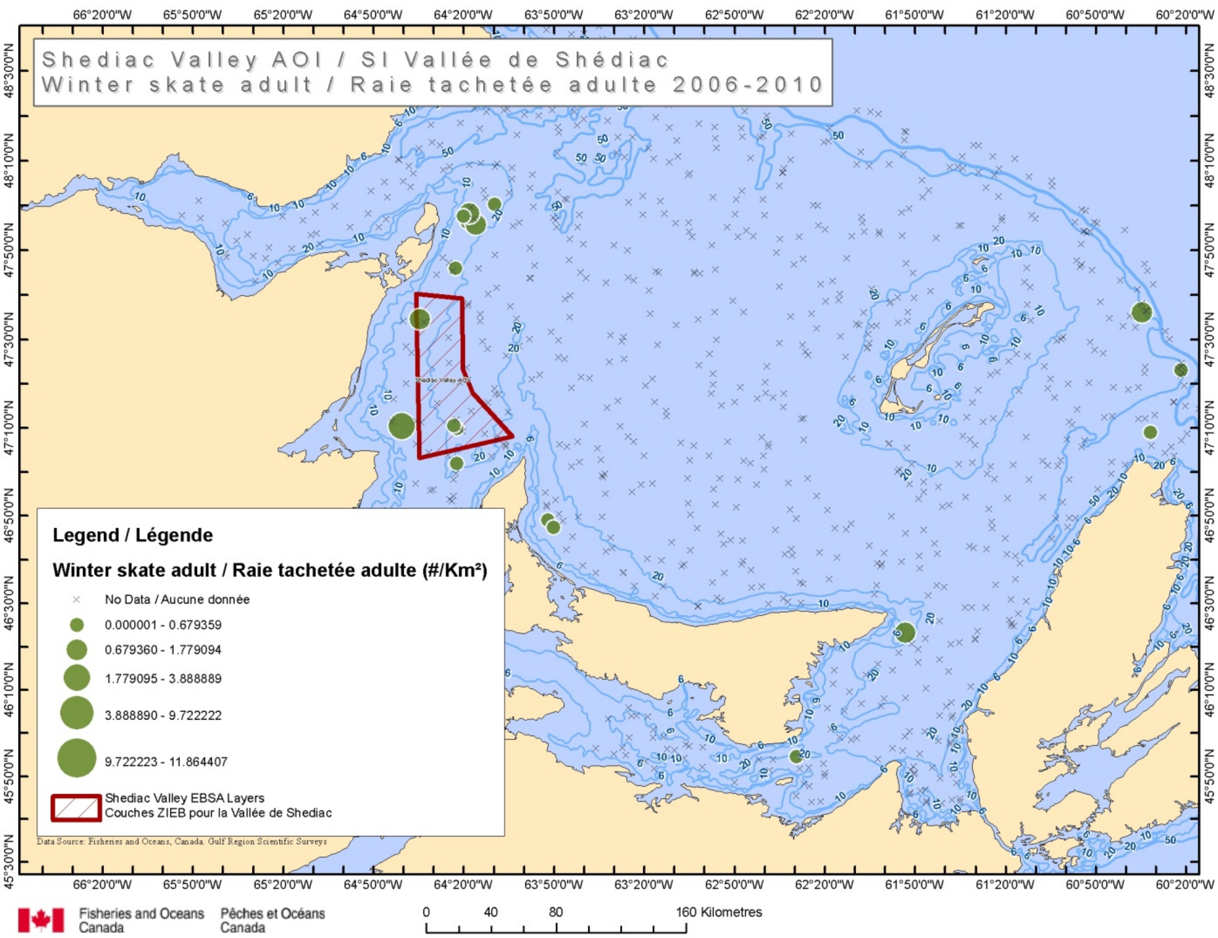

Figure 2.25 Groundfish Trawl Locations and Density (#/km^2) of Adult Winter Skate in the sGSL in September (2006-2010).

General Description: Available information on winter skate diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.7.

Table 2.7 Summary of Winter Skate in the Gulf of St. Lawrence.

Parameter	Description
Diet	The diet of winter skate consists primarily of crustaceans, polychaetes and fishes. On the eastern Scotian Shelf, sandlance was the most frequently consumed fish species (*i.e.*, over 90% by weight) (Swain *et al*. 2006).
Reproduction	Female winter skate in the sGSL appear to mature at a size of about 42 cm total length (TL) (Swain *et al*. 2006). Each egg is deposited in an egg case (Scott and Scott 1988). Gestation time was estimated to be 18-22 months on the Scotian Shelf.
Fecundity	Frisk *et al*. (2002) estimated an average annual fecundity of 35 purses per year for winter skate.
Abundance	Based on survey day-adjusted catch rates, average adult abundance in the sGSL was estimated to be 4.94 million in the 1971-1975 period and 360,000 in the 2000-2004 period. Based catch rates adjusted to night catchability, average adult abundance was 22.06 million during the 1971-1975 period, declining to 1.7 million in the 2000-2004 time period (Swain *et al.* 2006).
Growth	According to Swain *et al*. (2005), age, growth and maturation have not been studied for skates in the sGSL. It is thought that winter skate in the sGSL mature at a length of about 42 cm, which is smaller than the length at maturity reported for winter skate elsewhere (75 cm). Based on growth rates of little skate, which mature at about the same size as winter skate in the sGSL, a length at maturity of 42 cm would correspond to an age of 6 years (DFO 2005d). Frisk (2004) estimated that 50% functional maturity occurred at a total length of 76 cm in winter skate off the northeastern US coast, corresponding to an age of 12.5 years.
Mortality	The estimated exploitation rate declined steadily from the early 1970s to very low levels in the early 1990s. The natural mortality of juveniles appears to have been higher in the 1970s than in the intervening years since. In contrast, the natural mortality of adults appears to have increased in the 1980s and 1990s (DFO 2005d). Predators include gastropods (during egg-capsule stage), other fish and grey seals. Sampling of fish bycatch in the sGSL scallop fishery undertaken in 2006-2008 indicates that this fishing induced mortality is very small compared to mortality from other sources (0.14% for juvenile winter skate and 0.06% for adults) (Benoît *et al*. 2010).
Behaviour	A study, referenced in Swain *et al*. 2006, conducted off Cape Cod showed that winter and little skates remained buried in depressions during the day. This study also suggested that winter skates do not demonstrate site fidelity.
Spatio-temporal Distributions	In the sGSL, winter skate are found in shallow inshore waters during the summer months and they move to deeper offshore waters during the winter. The highest catches in the annual bottom-trawl survey have occurred between western PEI and Miscou Island, east of the Magdalen Islands and between eastern PEI and Cape Breton (Swain *et al.* 2006)

Parameter	Description
Habitats	Winter skate can be found from the shoreline to depths of 371 m, although it is most abundant at depths less than 111 m. Winter skate have been recorded at temperatures ranging from -1.2ºC to 19ºC. In the annual (September) bottom-trawl survey of the sGSL, the median temperature occupied by winter skate was 8.7ºC, with small skate tending to occupy warmer waters than large skate (Swain *et al.* 2006).
Stock or Population Trends	The winter skate is assessed by COSEWIC as endangered in the sGSL (NAFO 4T area) (COSEWIC 2011). Catch rates in the annual bottom-trawl survey indicate a 96% decline in the abundance of adults between 1971 and 2002 (Swain *et al.* 2006). Catch rates of juveniles increased in the survey from the early-1970s to the mid-1980s but have since also declined to low levels (Swain *et al.* 2006).

Data Gaps: Swain *et al.* (2006) have indicated that the biology of winter skate in the sGSL has not been well studied to date and is therefore considered a data gap for this species.

2.3.1.5 ***Atlantic Herring***

Herring in the southern Gulf of St. Lawrence (sGSL) consist of a spring spawner component and a fall spawner component. In the sGSL (NAFO area 4T) Atlantic herring is divided into several management zones (DFO 2006a). Herring fishery management zone 16C is partly situated in the Shediac Valley AOI, although the AOI also encompasses a small portion of Fishing Areas 16B and 16E.

Distribution: Atlantic herring in the sGSL (NAFO area 4T) are found in the area extending from the north shore of the Gaspé Peninsula to the northern tip of Cape Breton Island, including the Magdalen Islands (DFO 2009c).

Figures 2.26 to 2.31 show the densities of juvenile (sexually immature) and adult Atlantic herring caught in the sGSL during the September standardized research vessel bottom-trawl groundfish survey (DFO 2012b).

The greatest concentrations of both juvenile and adult Atlantic herring caught by the September bottom trawl survey during the three periods (1996-2000, 2001-2005, 2006-2010) were in coastal regions between southeastern PEI and Cape Breton with high densities also found in the coastal waters of northern PEI and eastern NB. The distribution of herring was patchy throughout the AOI.

<u>Based on the September groundfish bottom trawl survey, the Shediac Valley AOI is not an important area for Atlantic herring.</u> In addition, most of the Shediac Valley AOI is deeper (>20 m) than areas typically used by herring for spawning (5 to 20 m) in the sGSL.

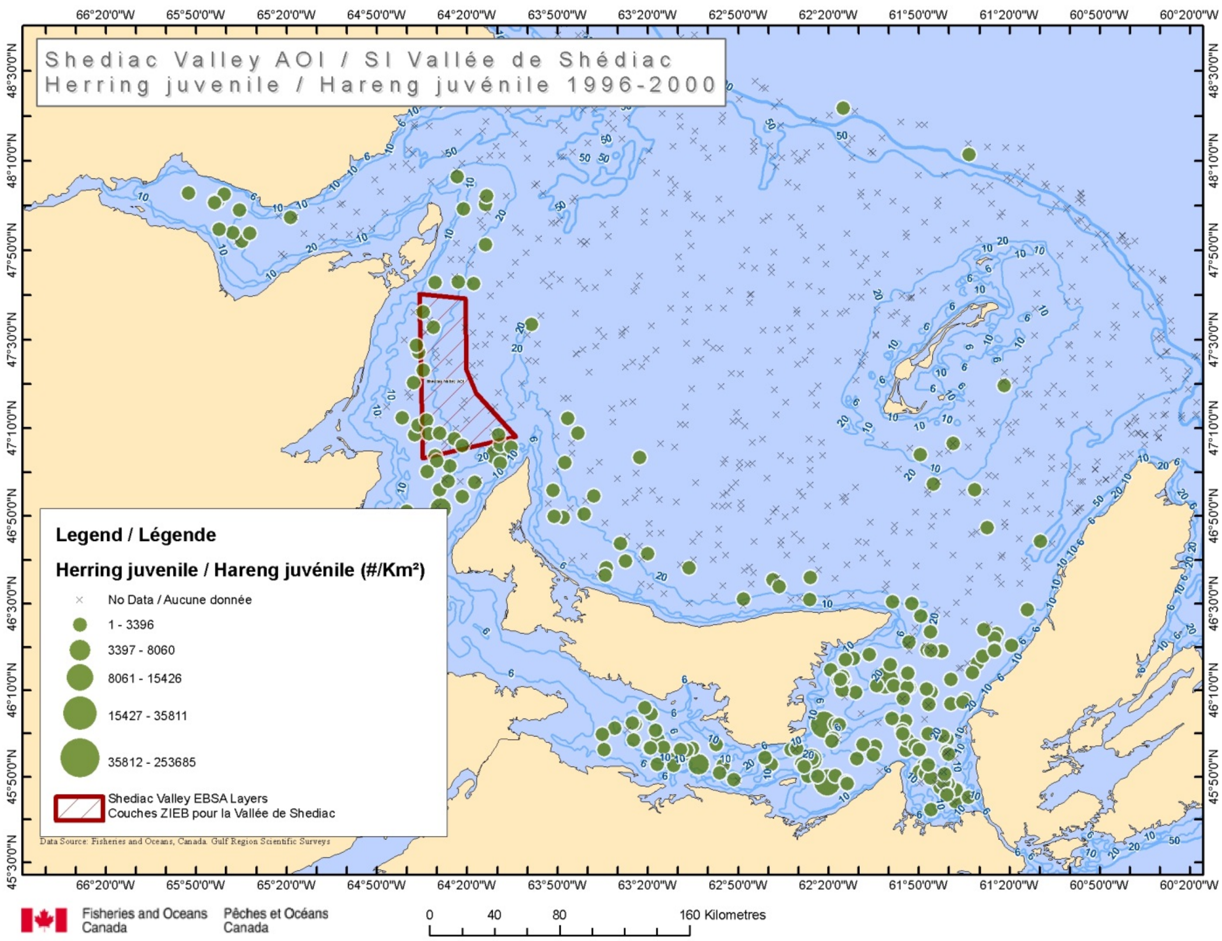

Figure 2.26 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Atlantic Herring in the sGSL September surveys (1996-2000).

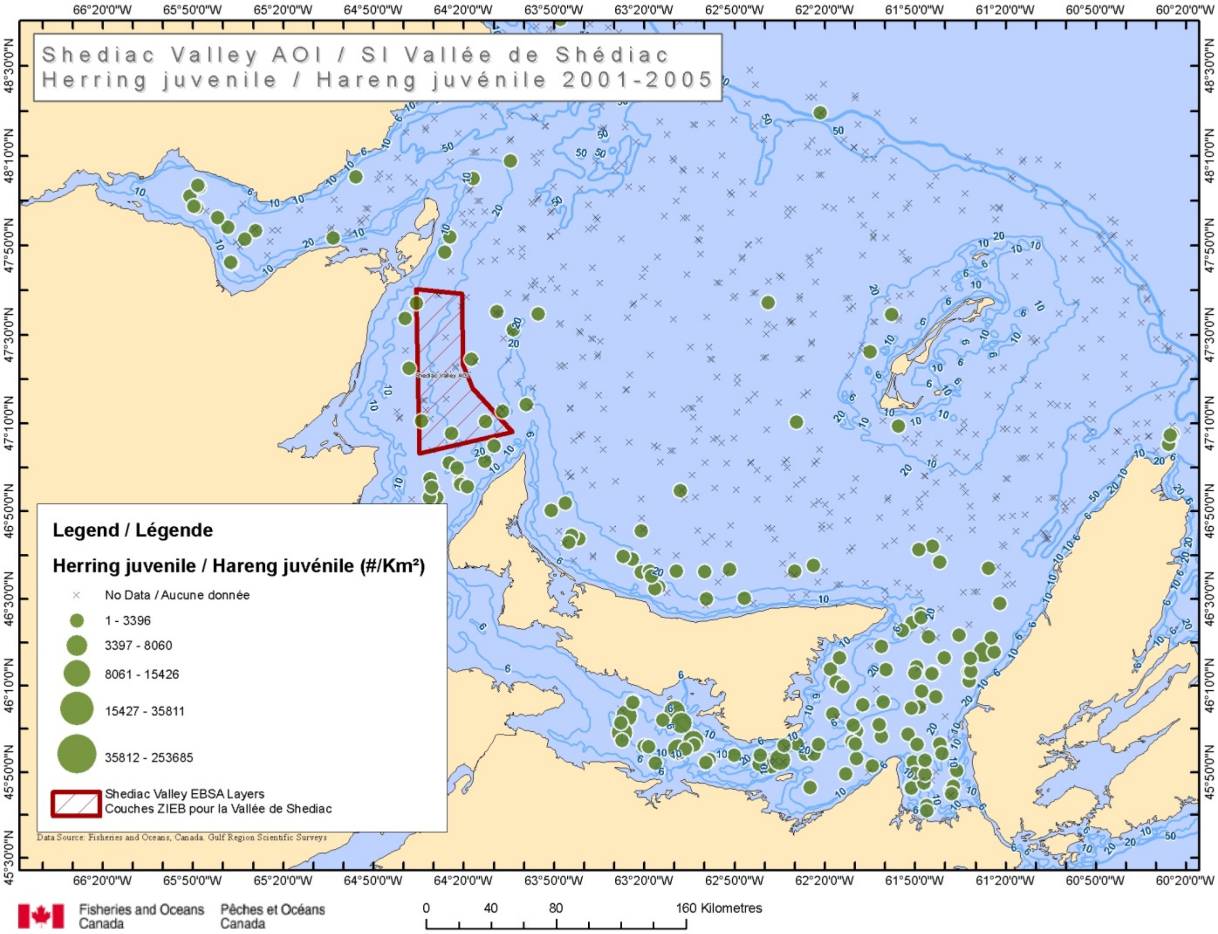

Figure 2.27 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Atlantic Herring in the sGSL September surveys (2001-2005).

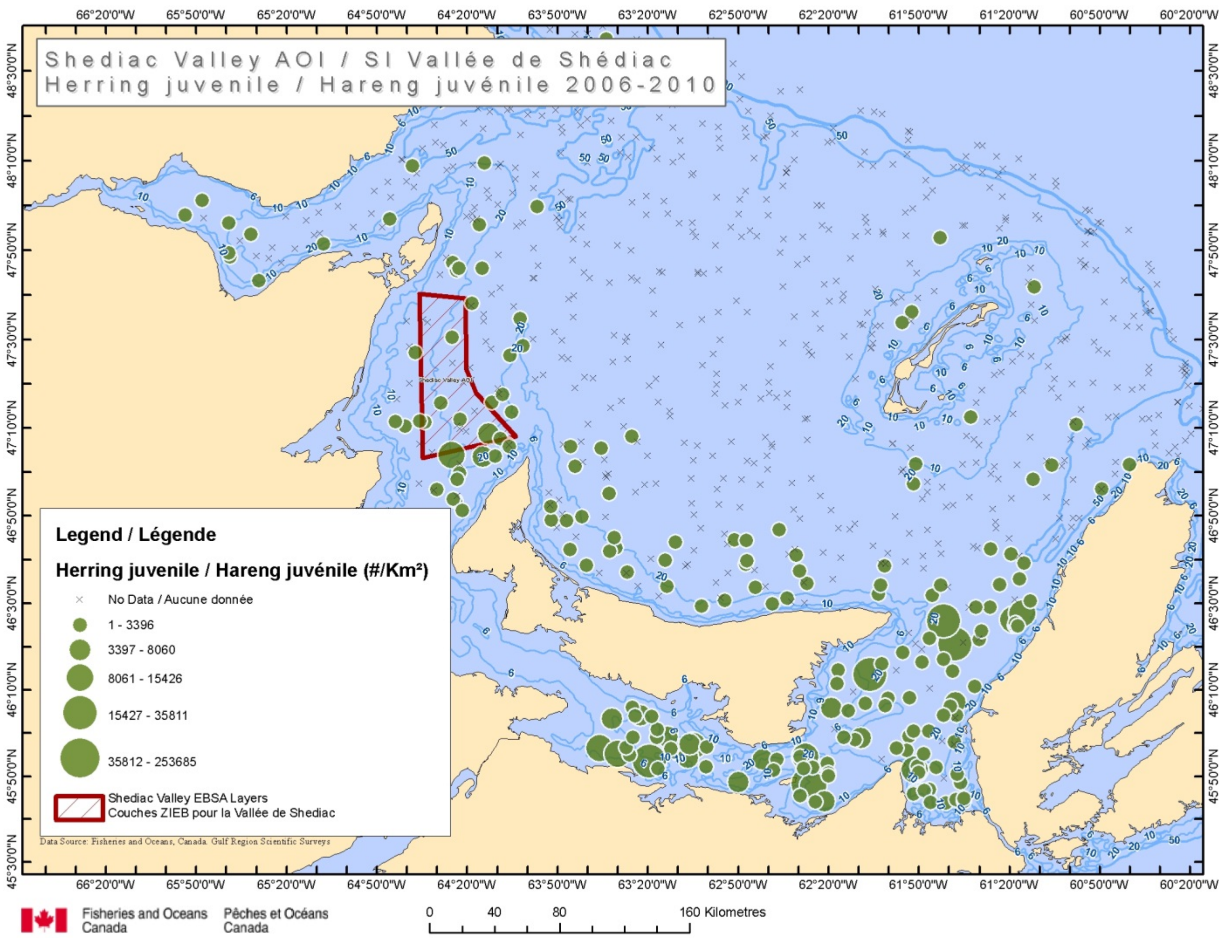

Figure 2.28 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Atlantic Herring in the sGSL September surveys (2006-2010).

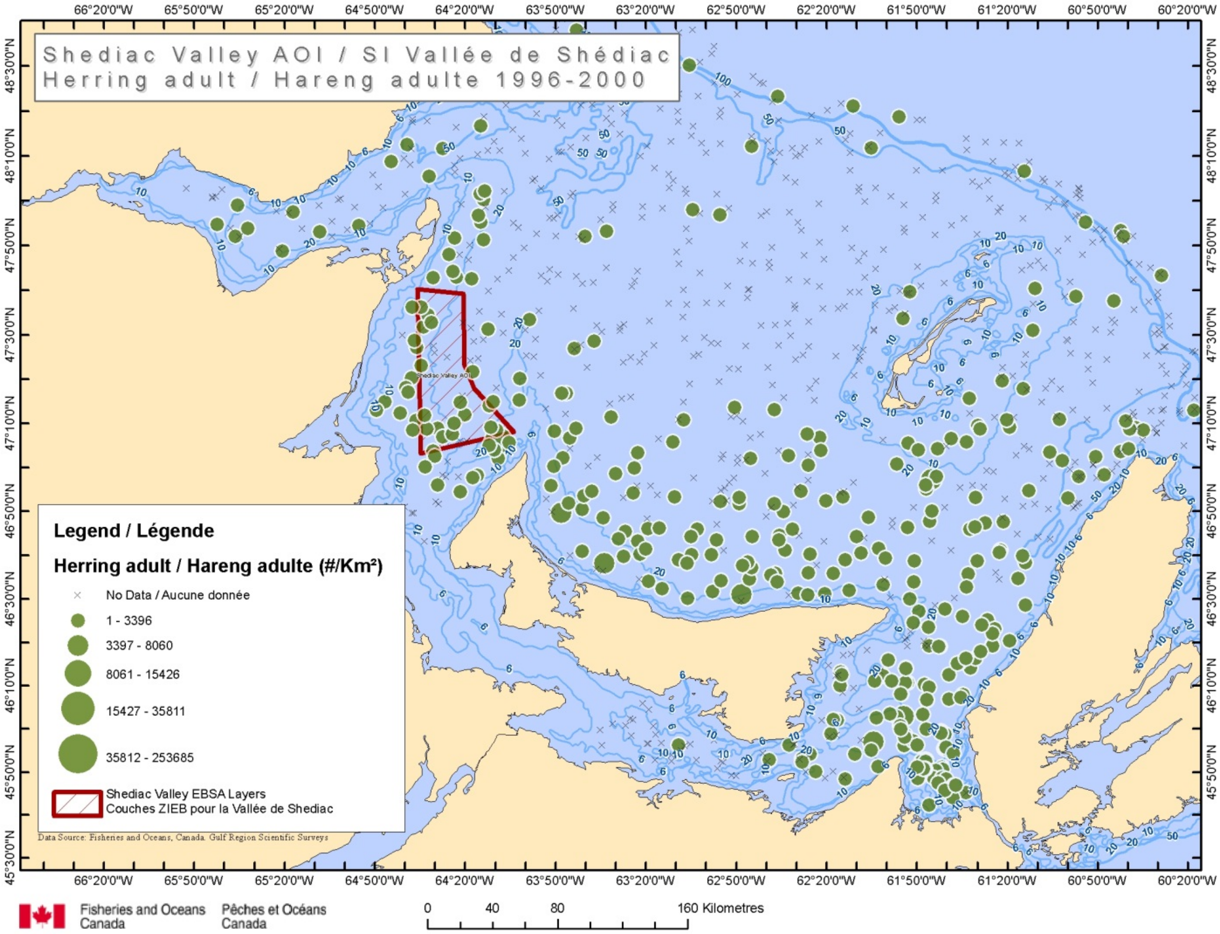

Figure 2.29 Groundfish Trawl Locations and Density (#/km^2) of Adult Atlantic Herring in the sGSL September surveys (1996-2000).

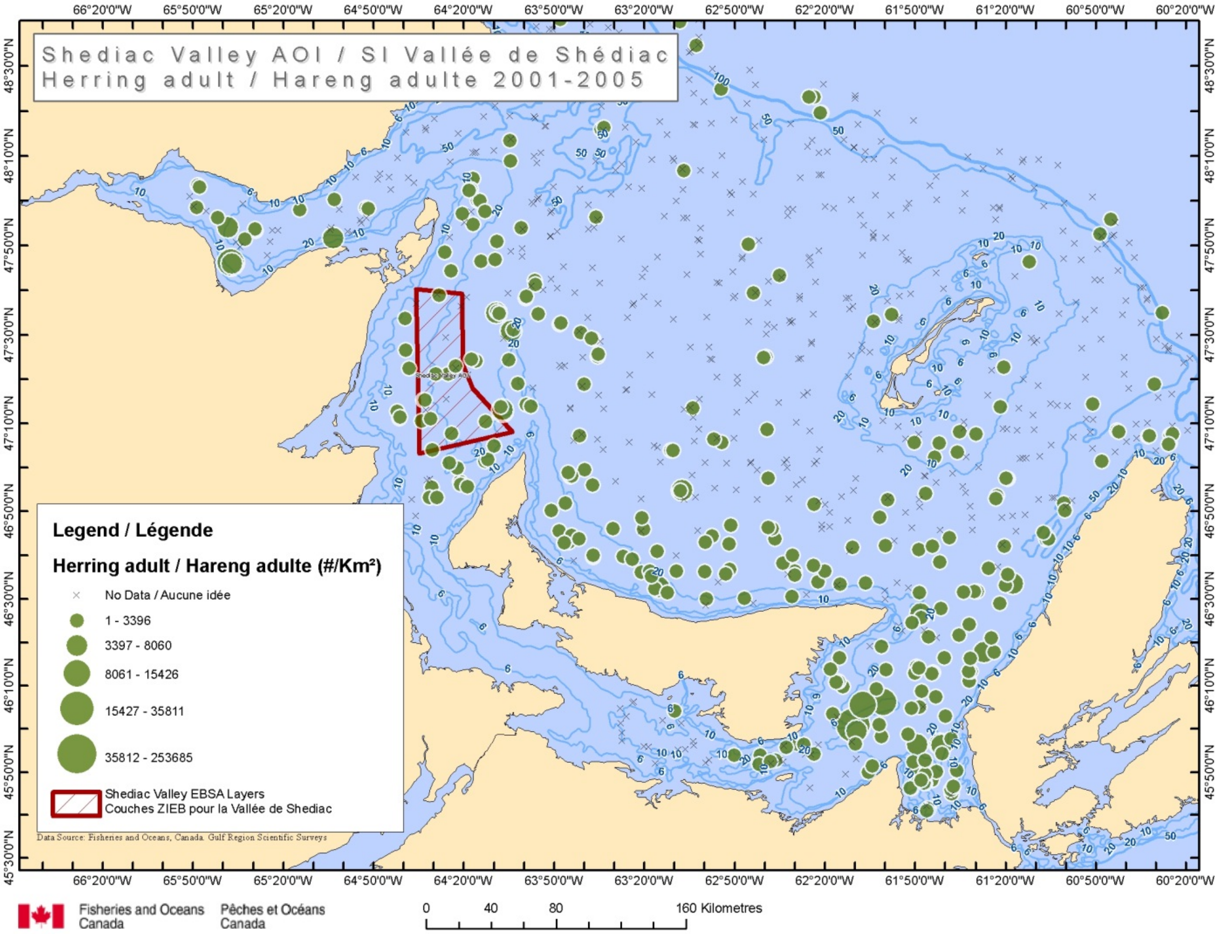

Figure 2.30 Groundfish Trawl Locations and Density (#/km^2) of Adult Atlantic Herring in the sGSL September surveys (2001-2005).

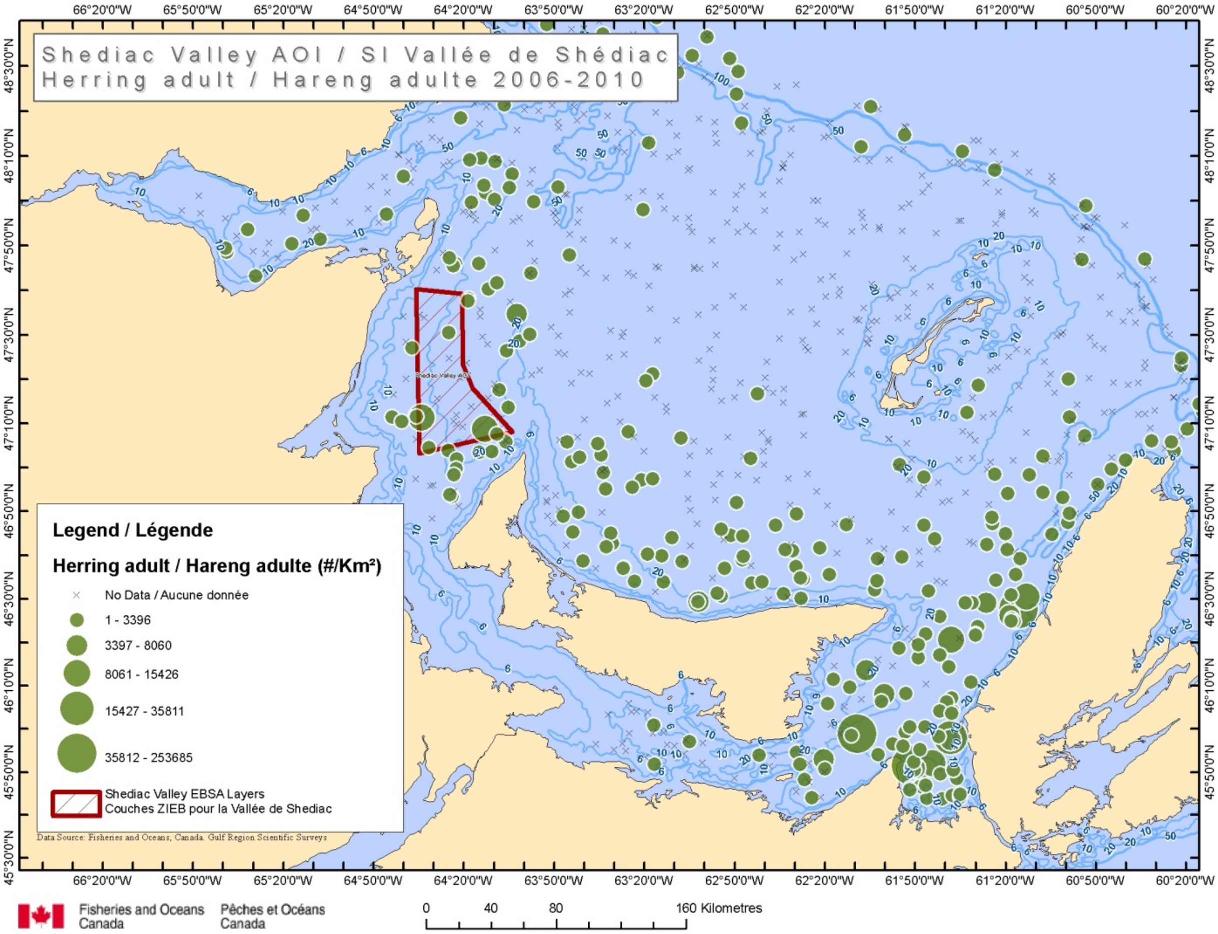

Figure 2.31 Groundfish Trawl Locations and Density (#/km^2) of Adult Atlantic Herring in the sGSL September surveys (2006-2010).

General Description: Available information on Atlantic herring diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.8.

Table 2.8 Summary of Atlantic Herring in the Gulf of St. Lawrence.

Parameter	Description
Diet	The diet of herring in the sGSL is predominantly copepods of the genus *Calanus* (Darbyson *et al.* 2003). A smaller portion of their diet is made up of fishes, mostly capelin (*Mallotus villosus*), euphausiids, mysids and other copepod species (Darbyson *et al.* 2003).
Reproduction	The sGSL population consists of two populations, the spring spawner population (spawning occurs between April and mid-June) and the fall spawner population (mid-August through October). Most of the Shediac Valley AOI is deeper (>20 m) than waters in which herring typically spawn. At present, the area with the largest concentration of spawning herring in the spring is the Northumberland Strait while the largest concentrations of spawning fish in the fall are off Miscou Island and Escuminac NB, North Cape and Cape Bear PEI and Pictou NS (DFO 2009c). First spawning typically occurs at age four. Spring spawning takes place at depths less than 10 m. Fall spawning takes place at depths of 5 to 20 m (DFO 2009c). Fertilized eggs are attached to the ocean bottom (rocks, gravel, algae, zostera) (DFO 2009c).
Fecundity	Large females can produce up to 360,000 eggs (Messieh 1988).
Abundance	Mean gillnet catch rate for the spring spawner component in 2010 was the lowest in the time series, the 2011 gillnet catch rate was the second lowest. The index has been declining since 1997 and remains at a low level in the series that starts in 1990. The 2010 acoustic index was slightly higher than 2009, but declined again in 2011. The 2011 index remains low in the series that starts in 1994. The stock is considered to be within the critical zone but just below the limit reference point. Estimated abundance has increased in recent years from the low level estimated in 2006. The abundances of recent recruiting year-classes (at age 4) are below average (DFO 2012b). Mean gillnet catch rate for the fall spawner component has generally decreased since 2006. The acoustic index has been declining since 2006 and remains at a low level in the series that starts in 1994. Estimated recruitment at age 4 was above average in 2008 and 2009, but below average in 2010 and 2011. Overall, the stock remains at a moderate level of abundance (DFO 2012b).
Growth	Spawning generally occurs first at age four (DFO 2009c). The estimated mean fork length at 50% maturity for both males and females in the sGSL between the years 1999 and 2006 was 23.5 cm (LeBlanc and Morin 2008).
Mortality	The assumed natural mortality rate of Atlantic herring is 0.2 (LeBlanc *et al.* 2008). Spring spawner fishing mortality estimates from 1978 to 2009, for fish aged 6-8 yrs, varied from 1.8 (1980) to 0.09 (2009), with most years falling into the range 0.3 – 0.7. Over the same period, fall spawner fishing mortality estimates (6-8 yrs) varied from 0.98 (1980) to 0.125 (1984), with most years falling into the 0.2-0.5 range; the 2009 estimate is 0.24 (LeBlanc *et al.*

Parameter	Description
	2010).
Behaviour	While feeding and during spawning periods, Atlantic herring form schools (DFO 2009c).
Spatio-temporal Distributions	Atlantic herring in the sGSL are found in the area extending from the north shore of the Gaspé Peninsula to the northern tip of Cape Breton Island, including the Magdalen Islands (DFO 2009c). In the fall, herring migrate out of the GSL. Adults have been observed overwintering off southwest Newfoundland and off the north and east coasts of Cape Breton. These areas correspond with NAFO divisions 4T and 4Vn, respectively (LeBlanc *et al*. 2008).
Habitats	Herring is a coastal pelagic species, swimming and feeding in the water column.
Stock or Population Trends	Spring spawner component projections for the fisheries over the next two years show that the probability of an increase in biomass from January 2012 to January 2014 ranged from 79% with no catch to 21% with catches of 3,000 mt each year (DFO 2012b). Fall spawner component projections for the fisheries over the next two years (2012-2013) show that the probability that SSB would be below the upper stock reference in 2014 varied from 16% with catches of 20,000 mt to 69% with 50,000 mt of catch each year based on recent recruitment rates, and from 14% with catches of 20,000 mt to 58% with 50,000 mt of catch each year when based on recruitment rates over the past 20 years (DFO 2012b) .

2.3.1.6 ***Atlantic Mackerel***

Atlantic mackerel (*Scomber scombrus L.)* is a fast swimming, pelagic and highly migratory species, having major spawning and nursery areas in the sGSL (DFO 2008a). There is a single management zone for all the Northwest Atlantic (NAFO Subareas 2-6), with a total allowable catch (TAC) divided equally between Canada and the USA. In 2001 the annual TAC for the NW Atlantic was reduced from 200,000 to 150,000 mt (*i.e.* 75,000 mt allotted to Canada).

The Canadian TAC (in NAFO Subareas 3 and 4) is managed as a single competitive fishery. For several years 40% of this TAC has been allocated to vessels over 65' (purse seiners and trawlers); and 60% to traditional inshore fisheries. The annual overall TAC has not been harvested since 1987, however, with Canadian annual landings between 1992 to 2007 varying from approximately 13,000 mt (2000) to approximately 54,000 mt (2005) (DFO 2008a). In 2010 the TAC (Canadian) was further reduced to 60,000 mt (DFO 2012c).

Distribution: In the northwest Atlantic, mackerel are found between North Carolina and Newfoundland. Mackerel migrate between inshore waters, where they spawn in spring and summer and deeper waters, where they are found in the late fall and winter (DFO 2008a).

In June and July mackerel originating in Canadian waters spawn predominantly in the sGSL. After spawning is completed the mackerel migrate to the Gulf of Maine and the Georges Bank area (DFO 2008a).

Figures 2.32 to 2.37 show the densities of adult Atlantic mackerel caught in the sGSL during September bottom trawl survey periods. Survey results shown in these figures should be used to reflect the spatial distribution and trends in abundance rather than absolute abundance values. The catch densities of juvenile mackerel were much higher and more distributed than those of adult mackerel in all survey periods. The greatest concentrations of adult were found in the coastal waters off NB, PEI, St. Georges Bay and the Magdalen Islands, while juvenile mackerel were both in the coastal waters throughout the Gulf and in deeper waters stretching as far as the Laurentian Channel.

<u>Based on the groundfish trawl survey, the Shediac Valley AOI is not an important area for adult Atlantic mackerel.</u> This concurs with the June 2007 egg survey, in which the largest concentrations of eggs were found in the area north and east of the AOI (outer Chaleur Bay and northern Magdalen Shelf); moderate numbers of mackerel larvae were found in the AOI, with one station recorded in the 50 – 100 larvae / m^2 range. However the largest concentrations of larvae were found east of PEI, on the southern Magdalen Shelf (DFO 2008a), perhaps transported there by the southward drift of the Gaspé Current.

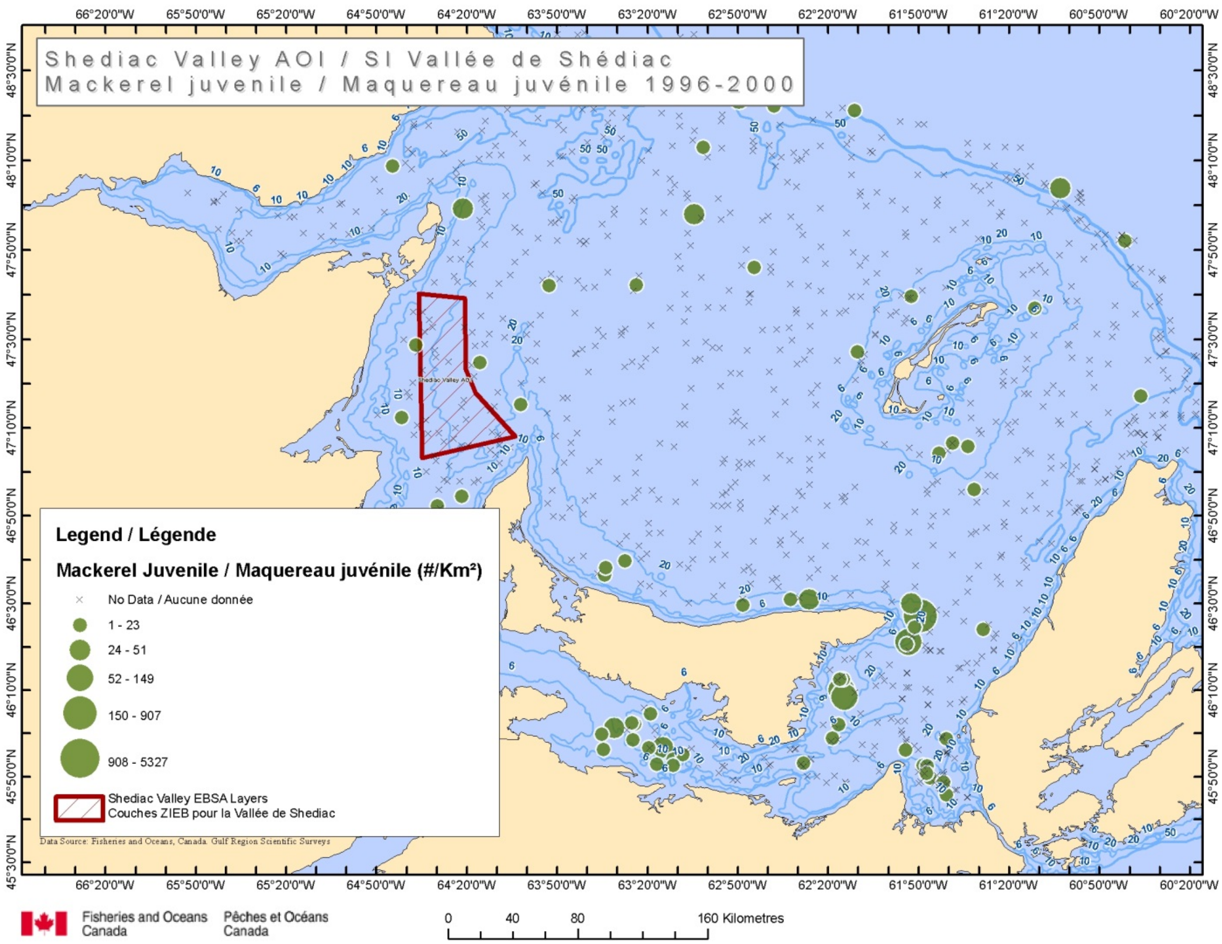

Figure 2.32 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Atlantic Mackerel in the sGSL in September (1996-2000).

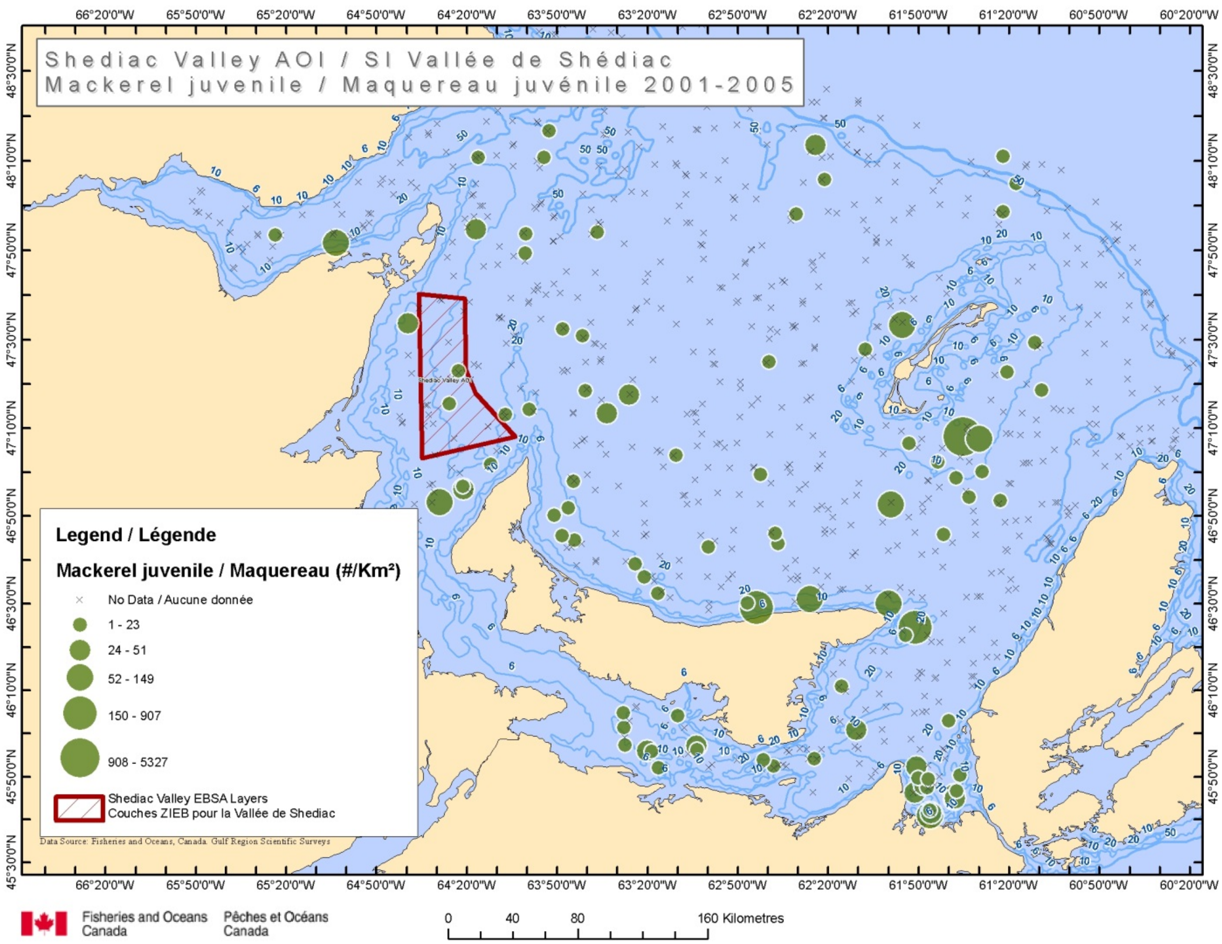

Figure 2.33 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Atlantic Mackerel in the sGSL in September (2001-2005).

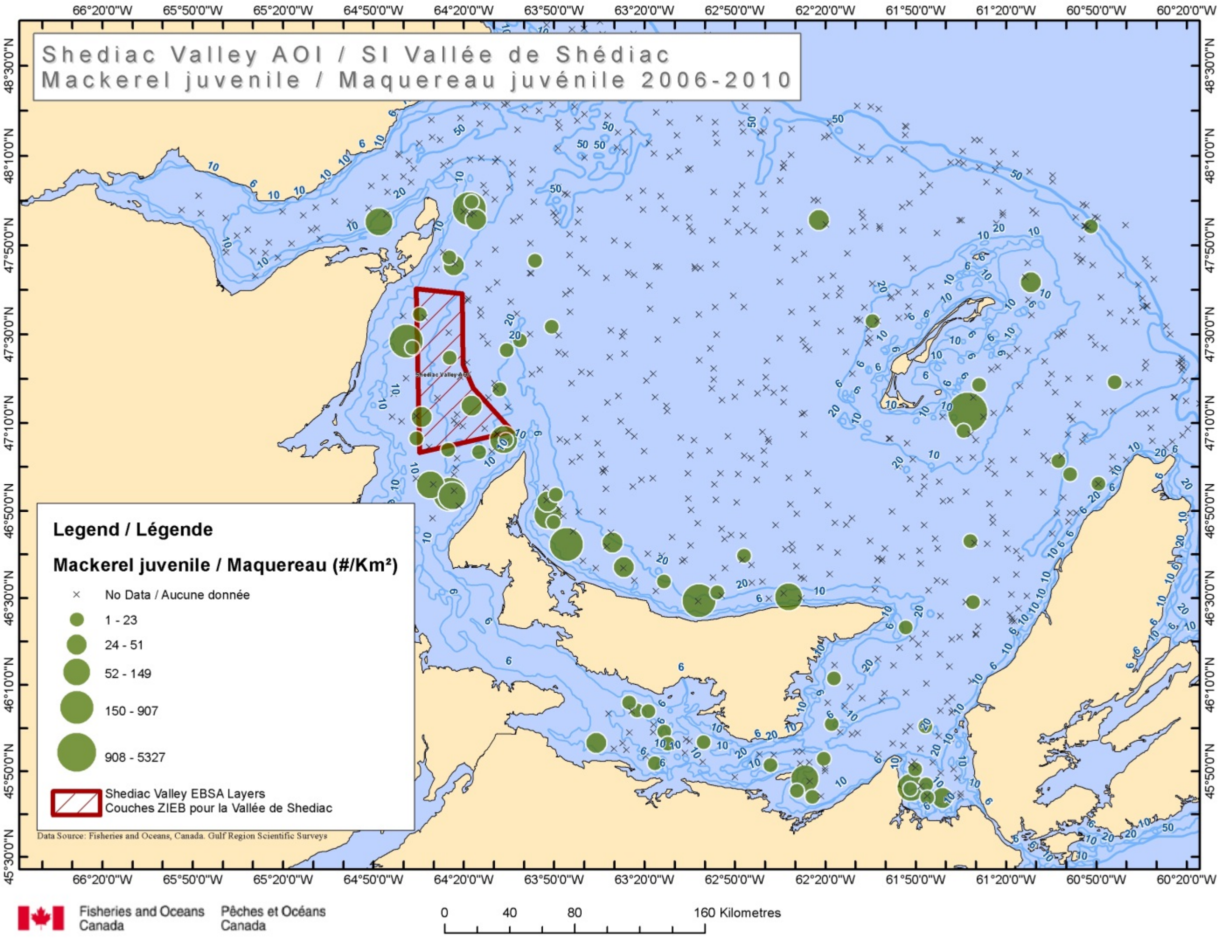

Figure 2.34 Groundfish Trawl Locations and Density (#/km^2) of Juvenile Atlantic Mackerel in the sGSL in September (2006-2010).

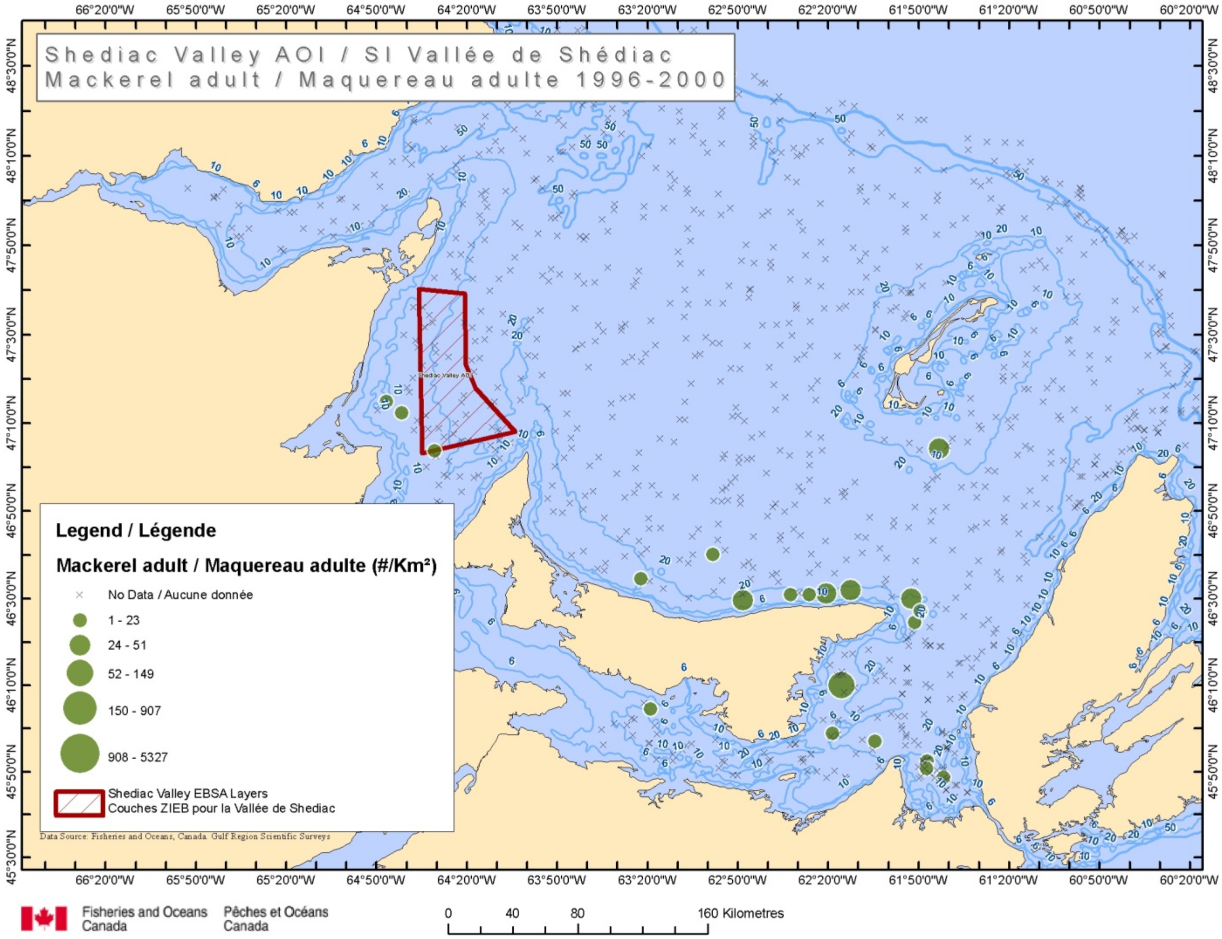

Figure 2.35 Groundfish Trawl Locations and Density (#/km^2) of Adult Atlantic Mackerel in the sGSL in September (1996-2000).

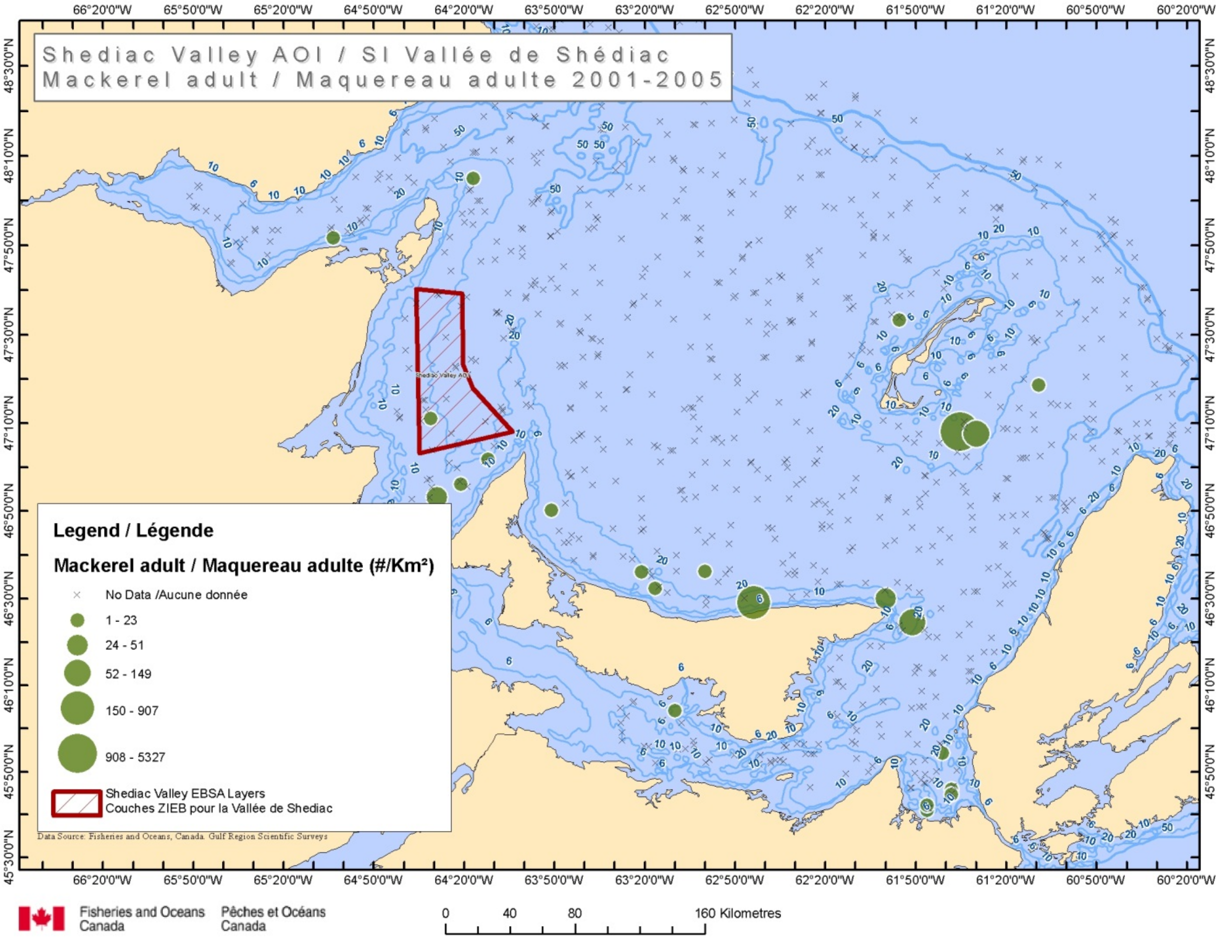

Figure 2.36 Groundfish Trawl Locations and Density (#/km^2) of Adult Atlantic Mackerel in the sGSL in September (2001-2005).

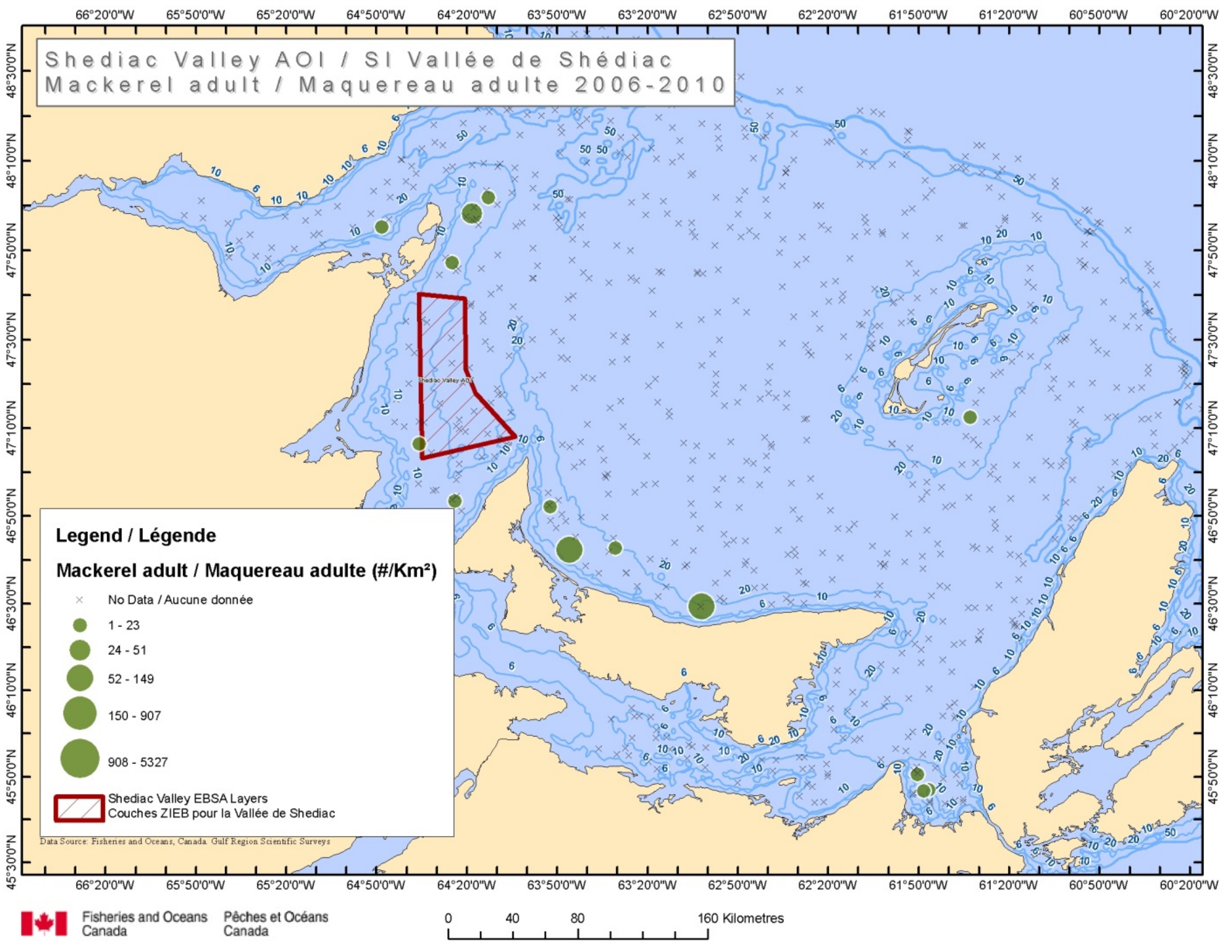

Figure 2.37 Groundfish Trawl Locations and Density (#/km^2) of Adult Atlantic Mackerel in the sGSL in September (2006-2010).

General Description: Available information on Atlantic mackerel diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitats and population trends is provided in Table 2.9.

Table 2.9 Summary of Atlantic Mackerel in the Gulf of St. Lawrence.

Parameter	Description
Diet	The diet of Atlantic mackerel is predominantly zooplankton. In the northern GSL, diet also consists of capelin and shrimp (DFO 2006b).
Reproduction	Mackerel that frequent NAFO areas 3 and 4 (Maritime Provinces, Newfoundland and Quebec) spawn primarily in the sGSL (DFO 2006b). During the 2007 egg survey the most significant densities of eggs were found in the area between the Magdalen Islands and Chaleur Bay (Grégoire *et al.* 2008). Peak spawning occurs when the water temperature is between 10°C and 12°C. Once the eggs are fertilized they float near the surface, incubating for approximately one week (DFO 2006b). Compared to other species, mackerel reach sexual maturity early with less than 40% being mature by 1 year and all being mature by age 4+ (DFO 2006b). The size at 50% maturity was estimated at 254.9 mm in 2005. Since 1999, the size at 50% maturity has been less than or slightly greater than the 250 mm minimum legal catch size (DFO 2006b).
Fecundity	From 2002 to 2007 an estimation of both the daily and the total egg production showed a decrease in numbers, resulting in the lowest biomass values recorded in 2007 (DFO 2008a). A female mackerel can produce from 350,000 to 450,000 eggs in a spawning season, though not in a single spawning (Sette 1943).
Abundance	The spawning biomass index has increased three times over the years; these increases are associated with the arrival of the dominant year-classes of 1982, 1988 and 1999. The index fell sharply between 1993 and 1998. Since 2005, historically low values of approximately 66,590 mt per year have been measured. (DFO 2012c).
Growth	Newly hatched mackerel measure approximately 3 mm (DFO 2006b). The development stages include yolk sack (duration of a few days), larval (duration of about 2 months) and juvenile (when schools are formed). On average, at 2 years of age (age 1+) mackerel are 257 mm in length with a weight of 197 g.
Mortality	Mortality of mackerel in the northern GSL has changed over the last 30 years. In the 1980s, predation mortality was modeled at 0.54 $t/km^2/year$. Primary predators included cetaceans, large cod, large demersal fish and large pelagic fish. In the 1990s and 2000s, predation accounted for approximately 15 $t/km^2/year$. Fishing related mortalities were 2% of total mortality in the mid-1980s, increasing to 15% of total motality in the 1990s and to 30% of total mortality in the 2000s (DFO 2006b).
Behaviour	The Atlantic mackerel is the only species of the *Scomber* genus without a swim bladder, which makes it necessary to swim continually (DFO 2008a). This biological feature along with its high swim speed helps it change position rapidly, making it difficult to catch compared with other pelagic

Parameter	Description
	fish species. Migrations occur in large schools of similarly sized individuals, allowing them to escape their prey more easily while also helping them feed.
Spatio-temporal Distributions	Atlantic mackerel are found in inshore waters during spring and summer and found in the deeper warmer waters at the edge of the continental shelf during late fall and winter (DFO 2008a). They are found in the waters of the North Atlantic, from the Mediterranean to Norway in the east and from North Carolina to Newfoundland in the west. In Canadian waters, spawning mainly occurs in the sGSL during the months of June and July. The spawning period is preceded by a long migration that begins early in spring in the Gulf of Maine and Georges Bank area (DFO 2008a).
Habitats	Atlantic mackerel swim and feed in the water column. DFO (2008a) indicates that recent changes in mackerel migration and distribution may be responsible for the marked increase of landings on the east coast of Newfoundland (Divisions 3K and 3L) since 2004. This increase in landings was also accompanied by a drop in the catches in the sGSL (*e.g.,* Magdalen Islands). Cooler oceanographic conditions that have been occurring in the sGSL in recent years could explain the change in distribution, migration routes and spawning areas. Spring migration of mackerel may be delayed or occur elsewhere in response to cooler surface water in the GSL of recent years (DFO 2008a).
Stock or Population Trends	Trends associated with the Atlantic mackerel are presently hard to determine. In recent years the overall tonnage of Atlantic mackerel caught has increased; however, this is mostly due to a large amount of mackerel seiners fishing off the east and west coast of Newfoundland (DFO 2008a). The current larvae and egg surveys are only conducted in the sGSL and do not cover areas were the most mackerel have been caught in recent years (DFO 2008a). In addition, landings from bait fishing and recreational fishing in the sGSL are not recorded (DFO 2008a). This represents a source of uncertainty in determining stock trends.

Data Gaps: Landings associated with bait and recreational fishing is an existing data gap.

2.3.1.7 ***Alewife***

Alewife (*Alosa pseudoharengus*) is one of three species of anadromous clupeids in the GSL. Alewife lives most of its adult life at sea and enters freshwater only to spawn (Scott and Scott 1988). Alewife, along with blueback herring (*Alosa aestivalis*) are fished commercially throughout the GSL under the common name gaspereau (Chaput and Atkinson 2001).

Distribution: Alewives are found in rivers, estuaries and coastal habitats from Newfoundland to South Carolina. They are known to overwinter outside the GSL, along the Atlantic coast of NS. At sea, they are most often captured at depths of 56 to 110 m (Scott and Scott 1988), though little is known of their movements at sea (DFO 2009d). In the sGSL alewives are abundant in the Margaree and Miramichi River systems during spawning season and proportionately less abundant in smaller stream systems. Further north, they are present in smaller quantities in the Restigouche and other Chaleur Bay river systems. Small populations also spawn in rivers along the western coast of Newfoundland. In the GSL, river entry occurs in May and June. Alewives are absent along most of the St. Lawrence River, but have been found upstream at least as far as Montreal (DFO 2009d). Adults return to sea shortly after spawning, mostly by mid-July and 0+ juveniles migrate from river to the sea later, mostly in August and September, returning to fresh water to spawn four to five years later. Alewives of separate native rivers are separate stocks (DFO 2000).

<u>The available information suggests the Shediac Valley is not important habitat for the alewife</u>.

General Description: Available information on alewife diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.10.

Table 2.10 Summary of Alewife in the Gulf of St. Lawrence.

Parameter	Description
Diet	While alewives are predominantly zooplanktivores they may also consume fish, crustacean, and insect eggs, as well as insects and small fish (Fay *et al*. 1983). Adult alewives feed little (if at all) during their spawning migration (DFO 2009d).
Reproduction	A small percentage of alewife spawn for the first time by 3 years of age while all fish have spawned by the end of their 5th year. Spawning occurs once a year in the spring or early summer. Being anadromous, alewife can spawn in both fresh and brackish water. Spawning takes place at water temperatures between 10.5 and 27 ˚C (Fay *et al*. 1983).
Fecundity	Alewives observed in Chesapeake Bay ranged in fecundity from 60,000 to 100,000 eggs per female (Fay *et al*. 1983). A more recent (Canadian) estimate is given as 60,000 to 200,000, depending upon the size of the females (DFO 2009d). A third estimate is “as many as 250,000 eggs” from a single female (DFO 2000).
Abundance	Historically very abundant in the colonial era, abundance had declined markedly by the mid-1800s, as development brought degradation of rivers (dams, forestry and eventually acid rain, etc.) (DFO 2009d). No recent abundance data are available and existing data are difficult to interpret since commercial harvest data are based on combined harvest of alewife and blueback herring. Combined harvest in Maritime provinces GSL rivers peaked in the mid-1950s (over 14,600 mt in 1952), then declined rapidly and averaged over 5000 mt from 1978 to 2000. In the Miramichi River fishery (closest to the AOI), blueback herring are more abundant than alewife (Chaput and Atkinson 2001)
Growth	Young-of-the-year migrating downstream in late summer or autumn are 32 to 95 mm long; returning adults (4 – 5 yrs.) are 250 – 300 mm long and weigh up to 340 g (DFO 2000). The mean age at maturity for alewife in the Miramichi River is about 3.4 years (Chaput and Atkinson 2001).
Mortality	The fishing mortality rate for alewife has been estimated at 1.05, which is attributed to the high natural mortality rate for first time spawners (0.44) and for repeat spawners (1.05). (Chaput and Atkinson 2001). Overall natural mortality is estimated at 0.49.

Parameter	Description
Behaviour	Through olfaction, alewives have been observed to exhibit homing behaviour, though, not all exhibit the behaviour (Fay *et al.* 1983).
Spatio-temporal Distributions	Alewives are found in rivers, estuaries and coastal habitats from Newfoundland to South Carolina (Fay *et al.* 1983) and their distribution includes the sGSL (Scott and Scott 1988).
Habitats	Alewives have been observed at sea at depths between 56 and 110 m (Fay *et al.* 1983). Spawning occurs mainly along shallow areas of upstream lakes and sluggish areas of streams; and can also occur in ponds behind coastal barrier beaches.
Stock or Population Trends	Chaput and Atkinson (2001) concluded that prospects for both the Miramichi and Richibucto gaspereau stocks (closest to the AOI) were “not positive”.

2.3.1.8 ***Blueback Herring***

Blueback herring (*Alosa aestivalis*) is an anadramous clupeid found throughout the GSL. It is fished commercially in the GSL along with alewife, under the common name gaspereau (Chaput and Atkinson 2001).

Distribution: Blueback herring is found in rivers, estuaries and coastal habitats from Nova Scotia to Florida. Its distribution and general characteristics are very similar to those of alewife, described above.

The available information suggests the Shediac Valley is not important habitat for the blueback herring.

General Description: Available information on blueback herring diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.11.

Table 2.11 Summary of Blueback Herring in the Gulf of St. Lawrence.

Parameter	Description
Diet	Blueback herring are predominantly zooplanktivores although they may also consume fish eggs, crustacean eggs, insects and insect eggs and small fish (Fay *et al*. 1983).
Reproduction	Blueback herring normally spawn in freshwater habitats with fast currents and hard bottoms. Spawning begins at a minimum water temperature of 14˚C and usually takes place between April and July (Fay *et al*. 1983).
Fecundity	Blueback herring observed in the Connecticut River ranged in fecundity from 45,800 to 349,700 eggs per female (Fay *et al*. 1983).
Abundance	Abundance trends are similar to those of alewife. Refer to Table 2.10 for alewife (above).
Growth	Refer to Table 2.10 for alewife (above). The mean age at maturity for blueback herring in the Miramichi River is about 3.9 years (Chaput and Atkinson 2001)
Mortality	The fishing mortality rate for blueback herring has been estimated at 1.01, which is attributed to the high natural mortality rate for first time spawners (0.44) repeat spawners (1.05) (Chaput and Atkinson 2001). Natural mortality is estimated at 0.42.

Parameter	Description
Behaviour	Arrive in the Miramichi generally ten day after alewife (Chaput and Atkinson 2001)
Spatio-temporal Distributions	Blueback herring are found in rivers, estuaries and coastal habitats. Blueback herring are found from Nova Scotia to Florida (Fay *et al.* 1983). They coexist with alewife in GSL rivers; however the relative proportions of the two species varies between river systems and from year to year in a given river (e.g. Miramichi River).
Habitats	Blueback herring have been observed at sea at depths between 27 and 55 m (Fay *et al.* 1983).
Stock or Population Trends	Chaput and Atkinson (2001) concluded that prospects for both the Miramichi and Richibucto gaspereau stocks (closest to the AOI) were "not positive".

Data Gaps: Information on presence of both species of gaspereau in the Shediac Valley AOI is an apparent data gap.

2.3.1.9 ***Spiny Dogfish***

The spiny dogfish is a small shark species found in coastal and inshore waters (Scott and Scott 1988) and was assessed by COSEWIC as a species of Special Concern in April 2010, but is not currently listed under Schedule 1 of the *Species at Risk Act*.

Distribution: Populations of spiny dogfish are widespread and can be found in areas of the coast of Europe, Argentina, New Zealand and Japan (DFO 2007b). Dogfish in the northwest Atlantic are commonly found from North Carolina to southern Newfoundland; however, they have been observed further north and south (DFO 2007b). In Canadian waters they are mostly found in the Bay of Fundy and on the Scotian Shelf.

Annual research surveys of spiny dogfish in the sGSL from 1984 to 1999 indicated their presence in the Shediac Valley AOI during summer, with the highest average concentrations occurring during the 1990-1999 period (averages of 25 to 125 individuals per net tow). No spiny dogfish were found in the AOI in surveys during the 2000-2004 period, when their numbers had also declined dramatically throughout the sGSL, as compared to the 1990-1999 period (Campana *et al*. 2007). It is thought that their abrupt appearance in the sGSL survey in 1985, with a progressive increase in fish size distribution, followed by a gradual decline of the population, are consistent with the characteristics of a "sink population": a "pulse of dogfish that arrives from somewhere, then never leaves" (2007b). The finding of spiny dogfish in surveys of the deep warmer waters of the Laurentian Channel during winter indicated that at least part of the population remained in the GSL all year round (DFO 2007b).

<u>Since it appears that spiny dogfish populations in the sGSL may be transitory, the Shediac Valley AOI is not an important area for this species.</u>

General Description: Available information on spiny dogfish diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitats and population trends is provided in Table 2.12.

Table 2.12 Summary of Spiny Dogfish in the Gulf of St. Lawrence.

Parameter	Description
Diet	The diet of spiny dogfish is predominantly from the class Osteichthyes (*i.e.,* boney fishes) with lesser amount of the diet being composed of molluscs (Bowman *et al.* 2000).
Reproduction	Spiny dogfish are an ovoviviparous species, bearing live young after a gestation period of 22-24 months (Campana *et al.* 2007). While pupping grounds have not been observed, it is assumed that pupping occurs in the deep waters of the edge of the continental shelf and in deep basins off the central shelf (within their range) during the winter months (DFO 2007b).
Fecundity	During an assessment of spiny dogfish in Atlantic Canada DFO (2007b) observed that the number of free embryos in 1,491 pregnant females was between 1 and 14, with a mode of 5. Sixty-two percent of the pregnant females observed, had free embryos with the larger females having significantly more free embryos than the smaller females.
Abundance	Biomass estimates from spring surveys in Canadian and US waters have shown a decreasing trend after the early 1990s with the Canadian index estimated at 300,000 mt in 2007, however the summer/fall indices have shown an upward, stable trend since 1985 with the most recent Canadian biomass value at approximately 350,000 mt (about 200 million dogfish) (DFO 2007b). The sudden appearance of spiny dogfish in 1985, progressive increase in the size composition and the gradual decline in dogfish abundance in the sGSL research vessel survey are consistent with that of a 'sink population' (*i.e.,* a pulse of dogfish that enters and remains in the sGSL having arrived from another location) (DFO 2007b).
Growth	Spiny dogfish are slow-growing and long-lived (Scott and Scott 1988). In Atlantic Canada, the fork length at 50% maturity for males was 55.5 cm (63.6 cm total length (TL)) at age 10, while for females it was 72.5 cm (82 cm TL) at age 16 (DFO 2007b). Campana *et al.* (2007) report that of 525 spiny dogfish that were age determined, the maximum age was 31 years and the mean age was 16 years for males and 18 years for females.
Mortality	The estimated mortality due to discarding of spiny dogfish has been an average of 850 mt per year since 1986 (DFO 2007b). This exceeded the reported catches prior to 1999, however, DFO (2007b) has reported that more recent catches have been signifcantly greater than the discard mortality.
Behaviour	See spatio-temporal distributions below.
Spatio-temporal Distributions	The distribution of dogfish on the Scotian Shelf, the sGSL and off southern Newfoundland show a seasonal movement to deep offshore waters during the winter and spring months, while they move landward to more shallow waters during the summer (DFO 2007b).
Habitats	Observations of dogfish on the Scotian Shelf indicate that while they have been found in areas with water temperatures ranging from 0 to 12ºC, they prefer temperatures between 6 and 11ºC (DFO 2007b). This population of dogfish has been observed in deeper waters between 50 and 200 m (DFO 2007b).

Parameter	Description
Stock or Population Trends	Biomass estimates in Canadian and U.S. waters from spring surveys indicated that there were increasing trends between the early 1980s and the early 1990s but have shown a declining trend to the present (DFO 2007b). Conversely, estimates from the summer/fall trawl surveys also showed an upward or stable trend since 1985 (DFO 2007b).

2.3.1.10 ***Plankton***

Phytoplankton

Phytoplankton organisms are the principal primary producers feeding offshore marine ecosystems, transferring carbon and energy to heterotrophic food webs (zooplankton and benthos). No information is available on individual phytoplankton species presence in the waters of the AOI as such, but lists do exist of species presence in surrounding coastal and offshore waters and there is nothing to suggest they are not representative of the waters of the AOI.

A major species list is found in Bérard-Therriault *et al*. (1999), which contains descriptions of 499 species of phytoplankton recorded throughout the GSL from 1994 to 1998. The records are distributed among 15 biogeographic zones and subzones, as defined in the publication. The Shediac Valley AOI straddles two of these zones, which together cover most of the sGSL : Zone 5, covering Northumberland Strait; and Zone 6, the Magdalen Shelf south and east of Shippagan Gully. A total of 288 species of phytoplankton were recorded in either Zone 5 or Zone 6, or in both these zones. This includes 85 species of diatoms; 87 species of dinoflagellates; 60 species of autotrophic (photosynthetic) microflagellates; and 56 species of protozoans. While many of the protozoans are technically zooplankton (heterotrophs), others are autotrophic for at least part of their life cycle and Bérard-Therriault *et al*. (1999) included them in the phytoplankton. It should be noted that, while some of the organisms were (and are) present annually over much of the sampling season, others were present for only short periods (*i.e.* several weeks) and some rare species were recorded only once in several years of sampling.

Another inventory of phytoplankton species is found in Brunel (1962), covering Chaleur Bay and eastward to Orphan's Bank, sampled mostly in 1954 and 1955. Brunel recorded 74 species of diatoms and 15 of dinoflagellates, all of which are also found in Bérard-Therriault *et al*. (1999). Brunel (1962) did not include flagellates or protozoans, with the exception a commonly found silicoflagellate.

In 1914-15, H.H. Gran recorded 57 species of diatoms, 38 species of dinoflagellates and one silicoflagellate in the GSL and its approaches (cited by Brunel).

In the above publications, as well as in more recent coastal surveys by DFO personnel in Miramichi Bay and PEI (C.E. Léger, DFO, pers. comm.), most of the common diatom and dinoflagellate species recorded are temperate latitude cosmopolitan species (*i.e. Skeletonema costatum, Chaetoceros spp., Leptocylindrus spp., Rhizosolenia spp., Thallassiossira spp., Ceratium spp., Dinophysis spp.)*.

Lavoie *et al.* (2007) reviewed historic chlorophyll-*a* and primary productivity data to identify ecologically/biologically significant areas for primary production in the GSL and estuary. Diatoms and dinoflagellates dominated the autotrophic phytoplankton biomass in the GSL and estuary. Small phytoplankton (< 5 µm) were present year-round in low concentrations, while large phytoplankton (> 5 µm) accounted for seasonal variations in production and biomass. Sea ice melt and the St. Lawrence River runoff were found to control the spatial and seasonal progression of the phytoplankton spring bloom in the GSL. Primary production in the GSL is generally low following the spring bloom, except for the Gaspé Current, which is identified among the most important zones for primary production (along with the Lower Estuary and the Northwestern Gulf). High phytoplankton biomass and production have been reported in the Gaspé Current in June, July and October.

Waite *et al*. (1997d) reported chlorophyll-a concentrations at 25 sampling stations over the Shediac Valley in July 1996. Fourteen of the stations were over the AOI. They recorded chlorophyll-a values ranging from 0.04 µg/L to 1.66 µg/L, with maxima occurring generally at 10 to 12 m depth. This concurs with a model simulated chlorophyll-a concentration of between 1.0 and 2.0 µg/L (reported as mg / m^3) for the area in the month of June, from data compiled from the early 1970s, reported by Lavoie *et al*. (2007).

<u>Zooplankton</u>

As mentioned in a Section 2.2.1, DFO has been collecting zooplankton information at a fixed station in the Shediac Valley (to the northeast of the AOI) since 1998, as part of the Atlantic Zone Monitoring Program. In 2007, the Shediac Valley station was sampled 8 times between April and November (Harvey and Devine 2008). The numbers and trends given below are for samples integrated from surface to bottom.

Overall zooplankton biomass in 2007 followed the same seasonal pattern of fluctuation as that observed during the preceding eight years. However the actual measured biomass was lower in the spring and summer and higher in the autumn, as compared to the long term averages. Over the 2007 sampling season, the total abundance of zooplankton varied between 43,823 and 939,412 individuals/m^2. Long term trends for the Shediac Valley station show broader seasonal fluctuations, but generally higher absolute numbers, than those of the three other fixed stations considered by Harvey and Devine (2008): Rimouski, Anticosti Gyre and Gaspé Current.

Some changes in the zooplankton community structure at the Shediac Valley station were observed in 2007, as compared to the community structure of the preceding eight years. This included some fluctuations in the ranking of the numerically dominant ten taxa and new taxa (polychaete and echinoderm larvae) appearing in the dominant ten taxa that year. Copepod species of the genus *Oithona* accounted for 31% of all individual zooplankters during the period 1999-2006 and for 46% in 2007. Various species of copepods formed the numerically dominant 5 or 6 taxa present in samples throughout the period 1999-2007 and copepods account for approximately 75% of individual animals overall. Bivalve larvae, euphausiacea and appendicularia were among the other forms of zooplankton in the top ten taxa, noted by Harvey and Devine (2008).

A comparative north-south study of copepod populations at 7 stations in the NW Atlantic, from the Shediac Valley AZMP fixed station to the southern Gulf of Maine, showed a broad similarity of the major copepod species populations (AZMP 2010). Of 31 copepod species recorded in the study, 24 were found in the Shediac Valley, the most common being *Oithona similis,* followed closely by *Temora longicornis* and a species of *Pseudocalanus*. As might be expected, the differences between northern and southern localities were in the temperature-sensitive species, with warm water species absent from the Shediac Valley (*i.e. Acartia tonsa* discussed in Section 2.1.3 above) and cold water species absent from the southern Gulf of Maine.

To lend further context to the foregoing paragraphs, a population study of zooplankton at a single station in Northumberland Strait, from May to November 1968, recorded copepods as accounting for 81% of all individual zooplankters and present in 100% of samples taken over the season. Bivalve and echinoderm larvae accounted for another 8% and 5% of individual animals respectively (in 73% and 44% of samples respectively); with 20 other taxa from various orders making up the remaining 6% of individuals. Of the 20 species of copepods recorded, *Acartia tonsa* accounted for 29% of individuals; *Oithona similis* for 15%; and *Temora longicornis* for 7% (Citarella 1982).

Ouellet (2007) conducted an analysis on 20 years of data on the abundance of fish eggs and larvae and for several crustacean decapod species to determine ecologically/biologically significant areas in the GSL and estuary. The sGSL area was found to have a high abundance of fish eggs and larvae and crustacean decapod species. The sGSL area had the greatest abundance of fish egg and larvae species as well as the highest species diversity when compared with all areas identified in the GSL. The abundance of various fish egg and larvae species demonstrates the sGSL's importance for the persistence of many components of the Gulf ecosystem.

2.3.2 *Benthic Invertebrate Species*

In this section, information is provided on benthic invertebrates or groups of benthic invertebrates starting with commercially exploited species. The elements described for each species are the same as those presented in Section 2.3.1 (Demersal and Pelagic Fish). Data gaps for each species or group of species are noted.

2.3.2.1 *Snow crab*

Snow crab (*Chionoecetes opilio*) in the sGSL is assessed as a single population, although there are four commercial fishing zones in the sGSL: Crab Fishing Area (CFA) 12, CFA 19, CFA 12E and CFA 12F. The Shediac Valley AOI is situated within CFA 12. Where possible, information provided here pertains to the Shediac Valley AOI.

Distribution: Tag-recapture results in the sGSL indicate that there is a frequent exchange of crab between the Bradelle Bank and the Magdalen Channel as well as between Cape Breton Island and the Magdalen Islands (Hébert *et al*. 2009).

Hébert *et al*. (2011) indicate that concentrations of snow crab are patchy in the eastern and western portions of the sGSL and that these concentrations have expanded and contracted over the last decade.

Commercial snow crab fishery data for the sGSL collected from 1968 through 2010 are presented in Figure 2.38 below, as reported by Hébert *et al.* (2011). The landings were relatively stable at approximately 5,000 mt annually between 1968 and 1975. Landings increased until the early 1980s, peaked in 1981 at over 31,000 mt and dropped in 1988 to the lowest value since the early 1970s. Landings since 1988 have varied, with a trend towards an increase in numbers caught until 2006, after which time landings fell each year to a dramatic decrease in 2010.

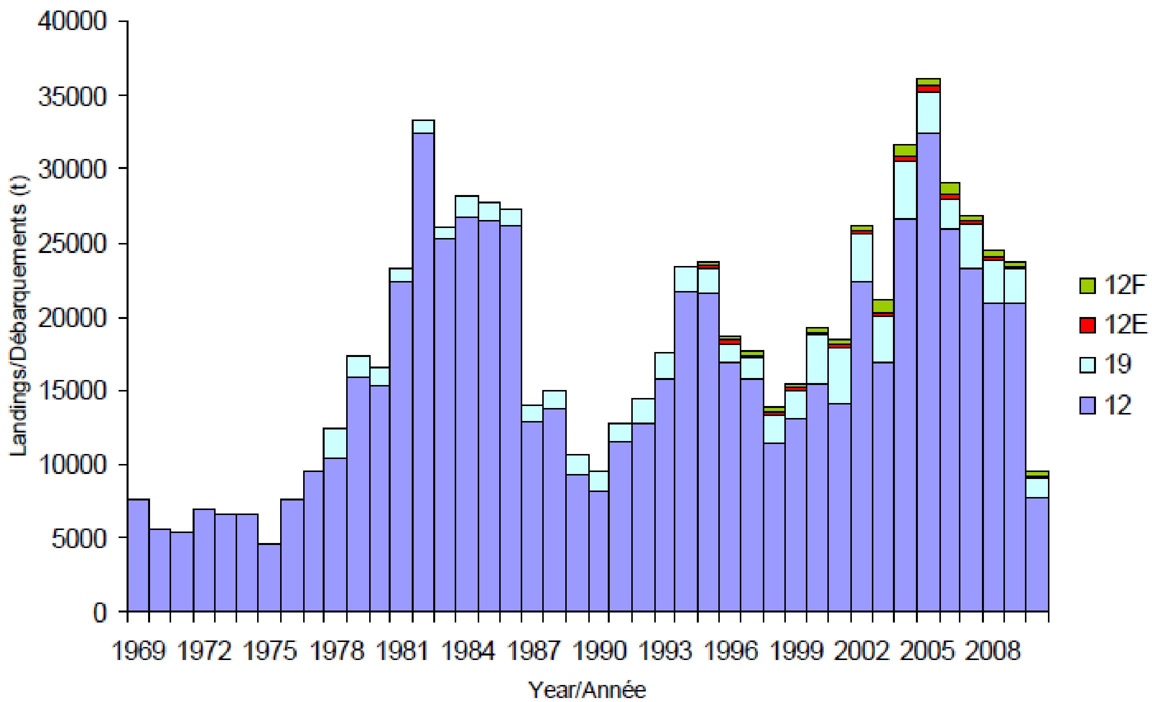

Figure 2.38 Commercial Snow Crab Landings in the Gulf of St. Lawrence (Hébert *et al*. 2011).

Biomass estimates from summer (post-fishing season) scientific trawl surveys directed at snow crab are presented by Moriyasu *et al.* (2008), from 1988 through 2006. The surveys indicate the biomass of the population in CFA 12 ranged from 14,200 mt (1988) to 126,700 mt (1993). This increase in the biomass of the population was followed by a decrease in biomass estimate levels that ranged from 34,200 mt (2000) to 77,300 mt (2004). The 2010 postfishery survey biomass of commercial-sized adult male crab in the sGSL was 30,500 mt (27,400 mt – 33,700 mt), an increase of 17% from the 2009 estimate of 26,100 mt (23,400 mt – 29,000 mt). Fifty six percent (56%) of the 2010 biomass was composed of new recruitment estimated at 17,000 mt (14,900 mt – 19,200 mt), an increase of 10% relative to 2009 (Hebert *et al*. 2011).

Figures 2.39 through 2.50 show the catch trends for juvenile and mature male and juvenile and mature female snow crab, recorded in the sGSL for three distinct periods (1996 – 2000, 2001 – 2005 and 2006 - 2010), as recorded in the DFO scientific snow crab trawl surveys. Information on the trawl survey methodology is provided in Hébert *et al.* (2011).

The trawl survey results indicate overall distribution of snow crab in the sGSL was similar over the three periods, although densities vary to some degree. During the entire survey period snow crab were caught at few locations in the AOI. Much higher densities of snow crab were caught north and east of the AOI.

<u>The results of the DFO scientific snow crab trawl surveys indicate that the Shediac Valley AOI is not an important area for snow crab</u>.

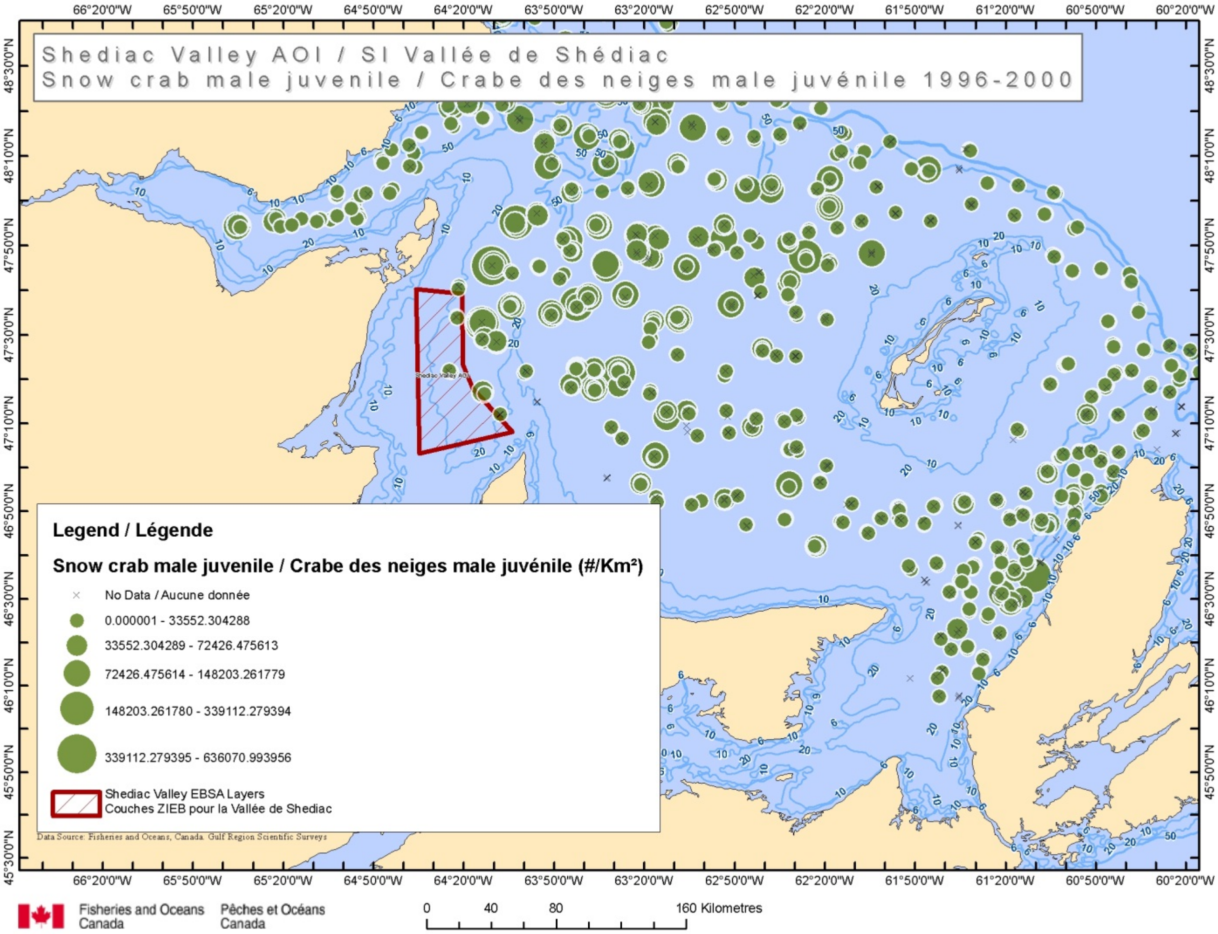

Figure 2.39 Trawl Locations and Density (#/km^2) of Juvenile Male Snow Crab in the sGSL during summer (post-fishing season) (1996-2000).

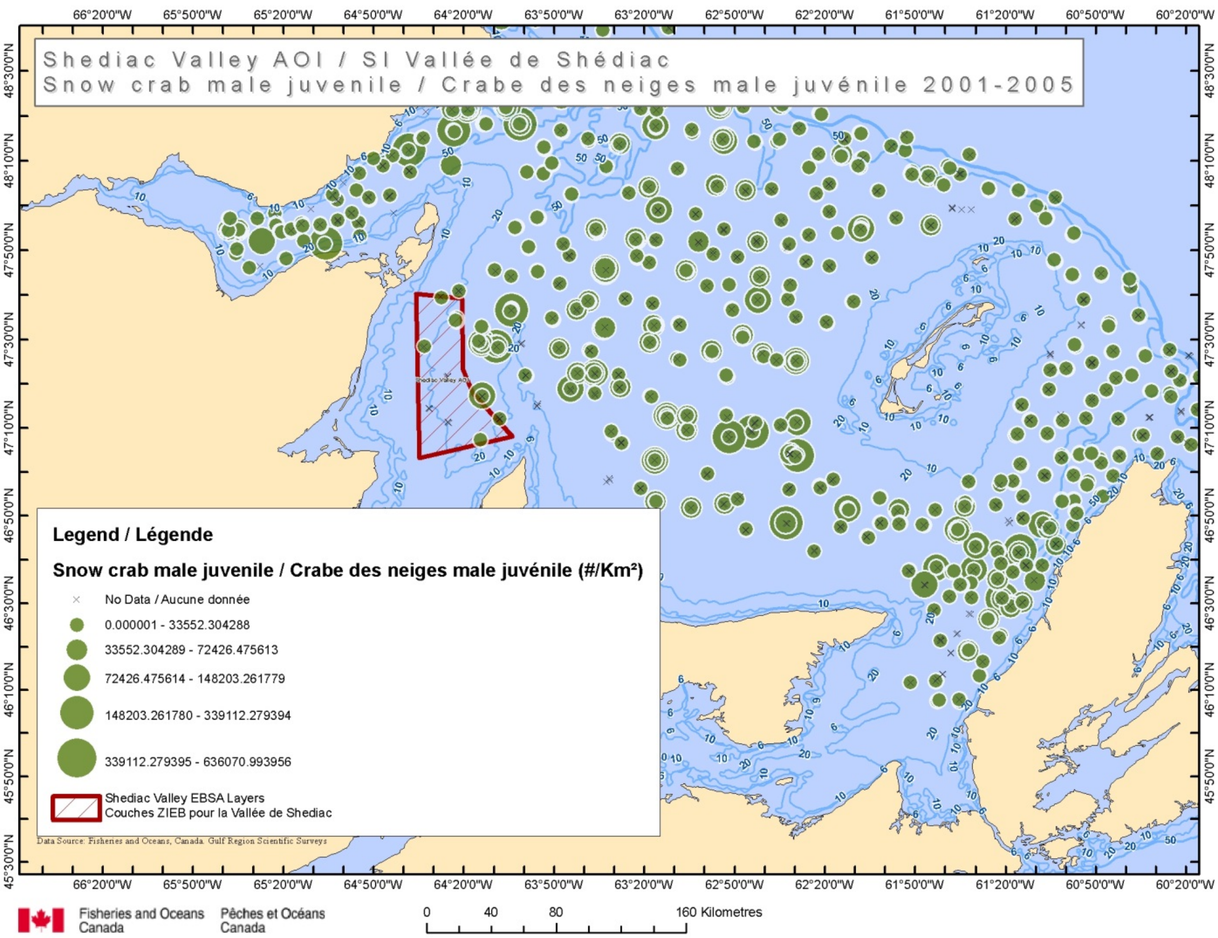

Figure 2.40 Trawl Locations and Density (#/km^2) of Juvenile Male Snow Crab in the sGSL during summer (post-fishing season) (2001-2005).

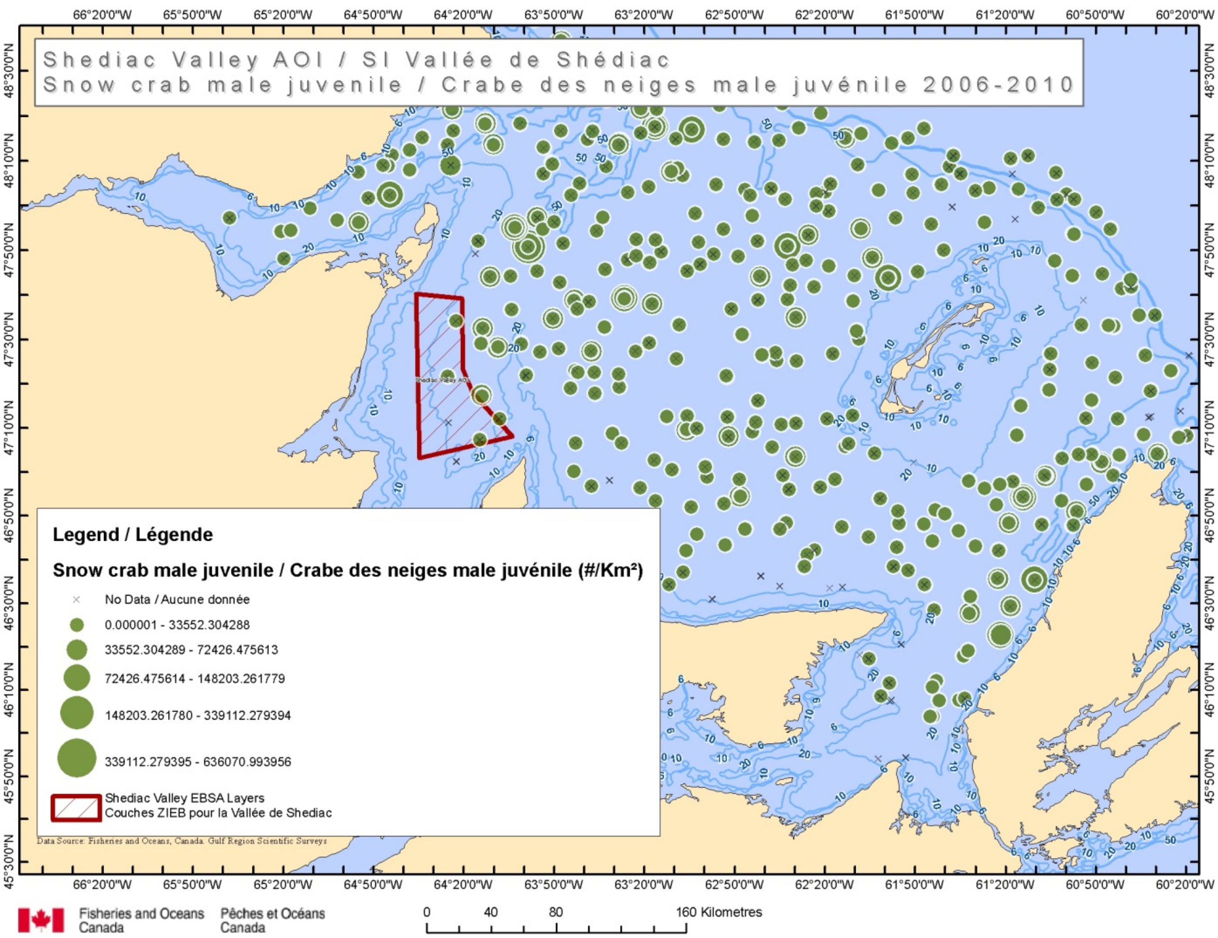

Figure 2.41 Trawl Locations and Density (#/km^2) of Juvenile Male Snow Crab in the sGSL during summer (post-fishing season) (2006-2010).

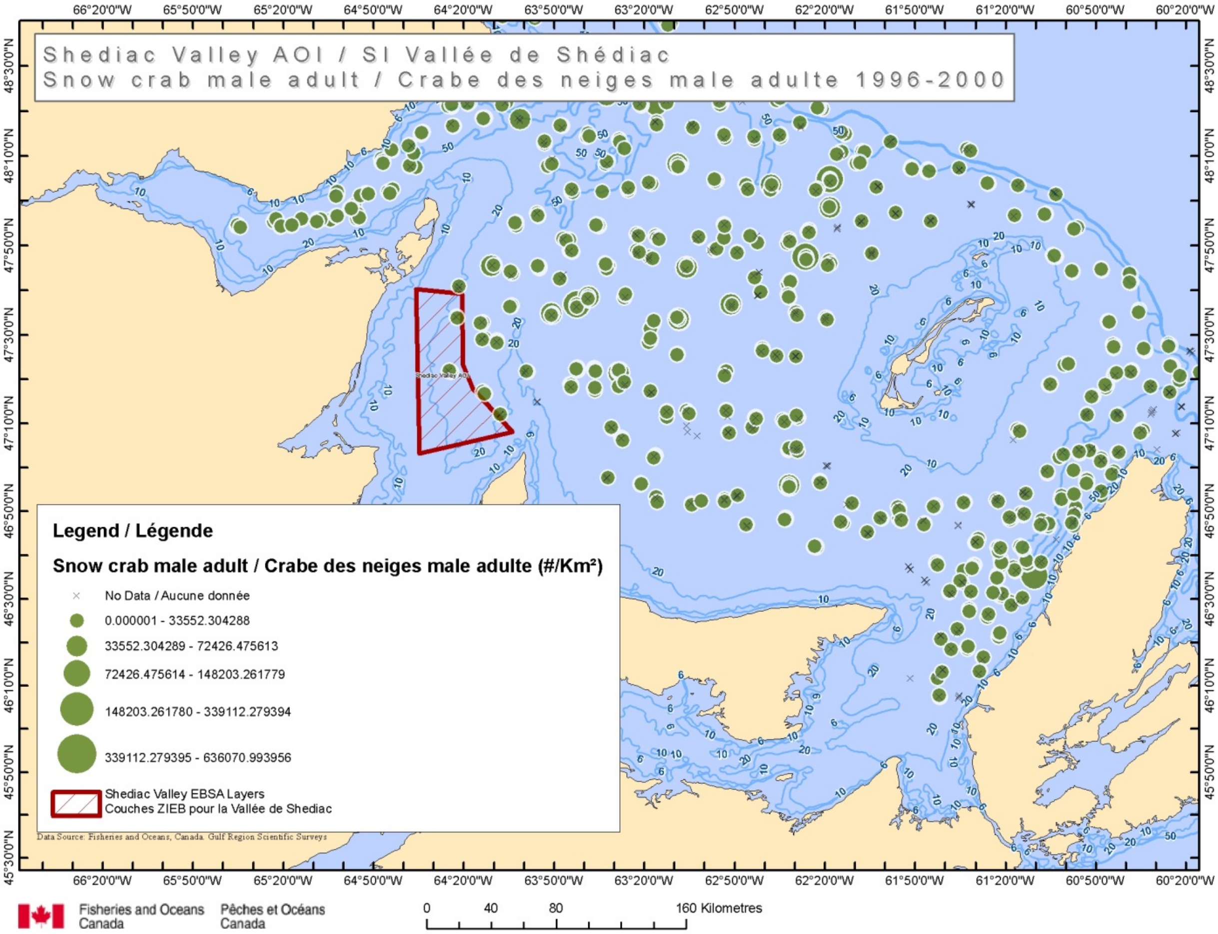

Figure 2.42 Trawl Locations and Density (#/km^2) of Adult Male Snow Crab in the sGSL during summer (post-fishing season) (1996-2000).

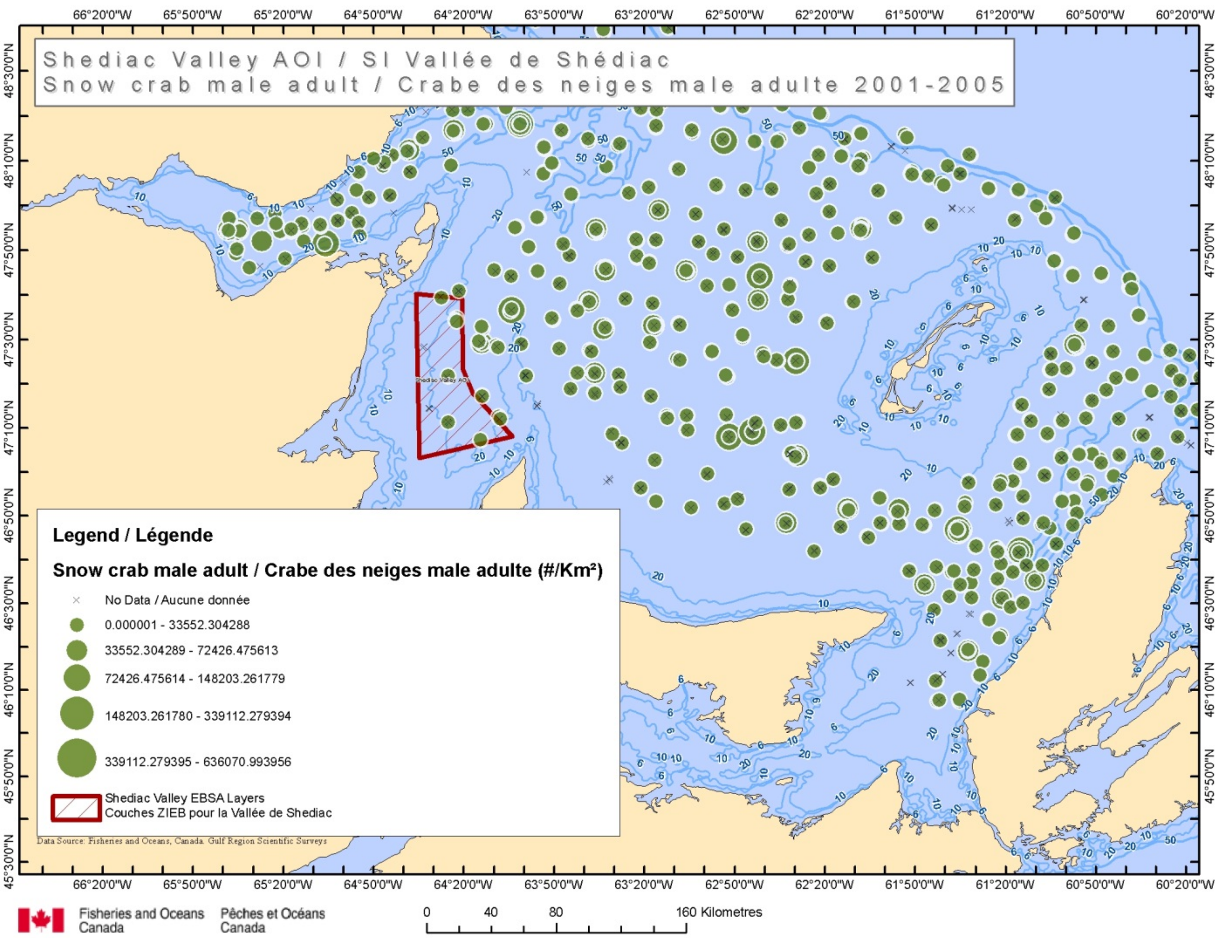

Figure 2.43 Trawl Locations and Density (#/km^2) of Adult Male Snow Crab in the sGSL during summer (post-fishing season) (2001-2005).

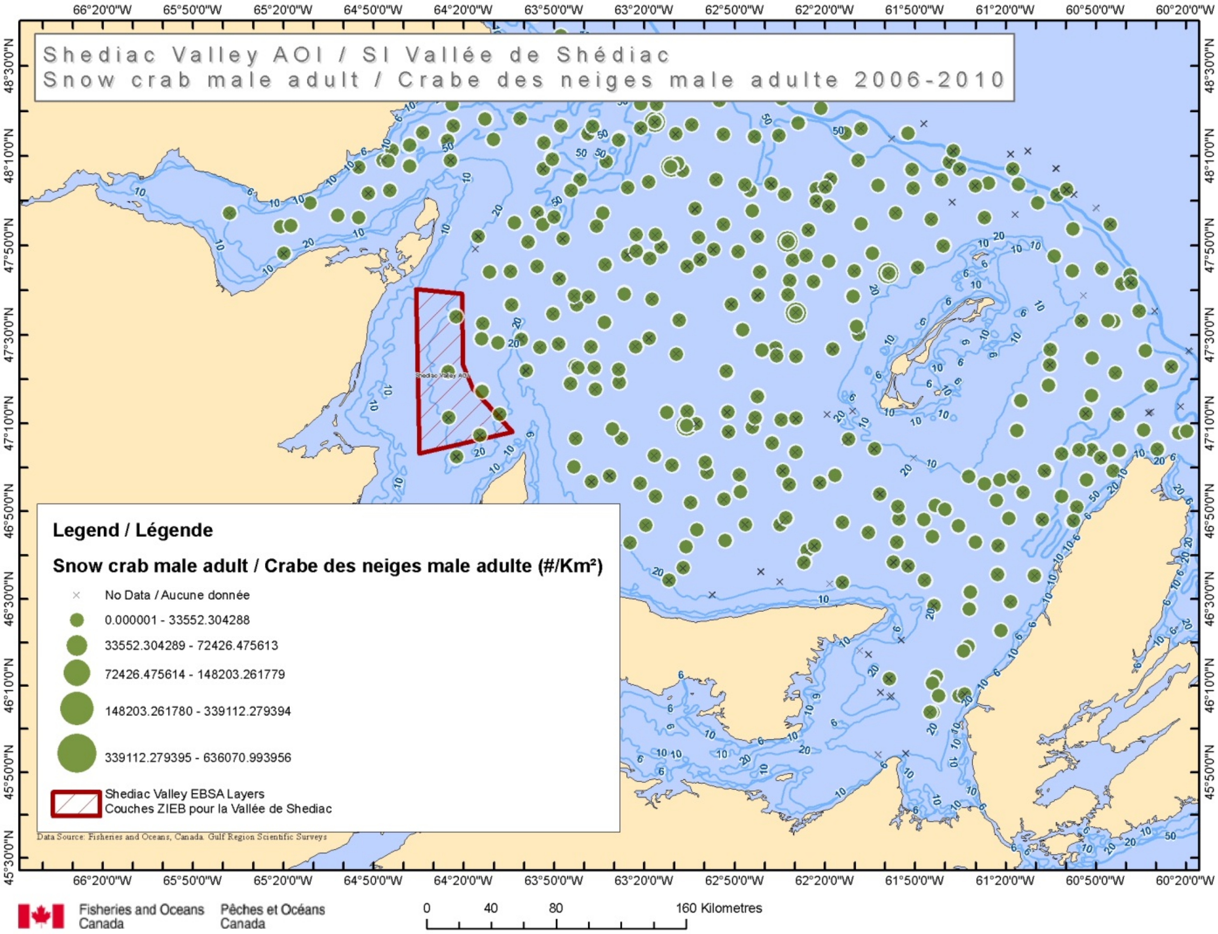

Figure 2.44 Trawl Locations and Density (#/km^2) of Adult Male Snow Crab in the sGSL during summer (post-fishing season) (2006-2010).

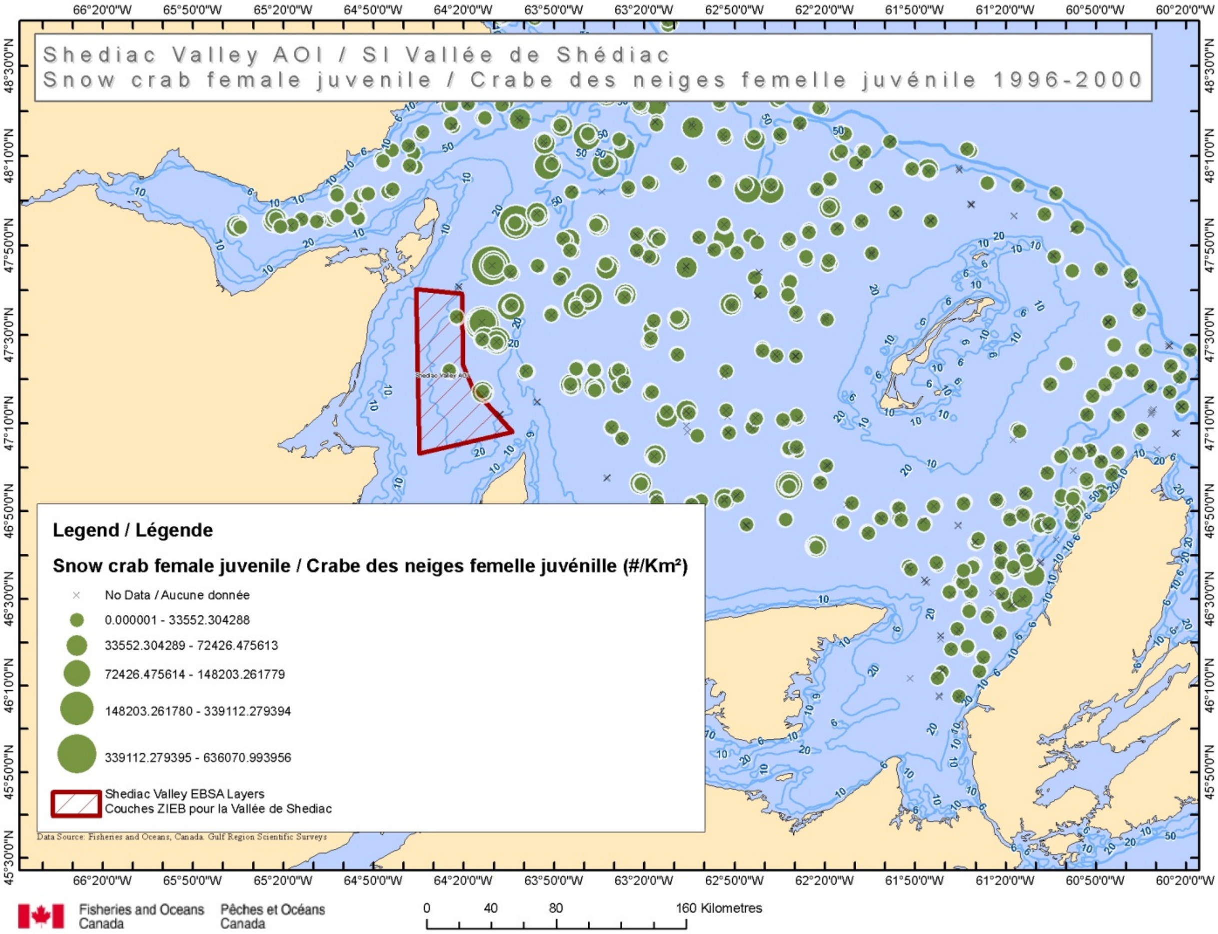

Figure 2.45 Trawl Locations and Density (#/km^2) of Juvenile Female Snow Crab in the sGSL during summer (post-fishing season) (1996-2000).

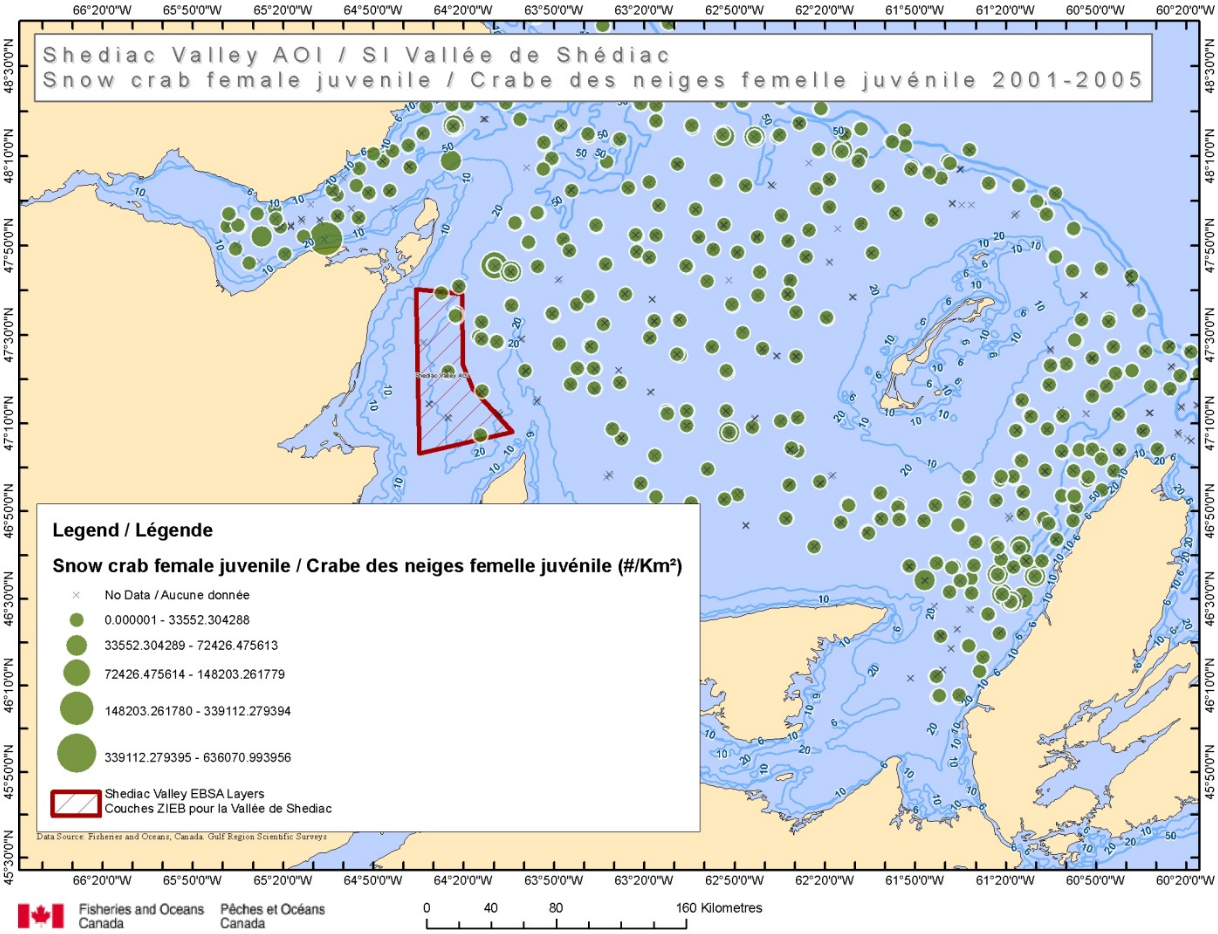

Figure 2.46 Trawl Locations and Density (#/km^2) of Juvenile Female Snow Crab in the sGSL during summer (post-fishing season) (2001-2005).

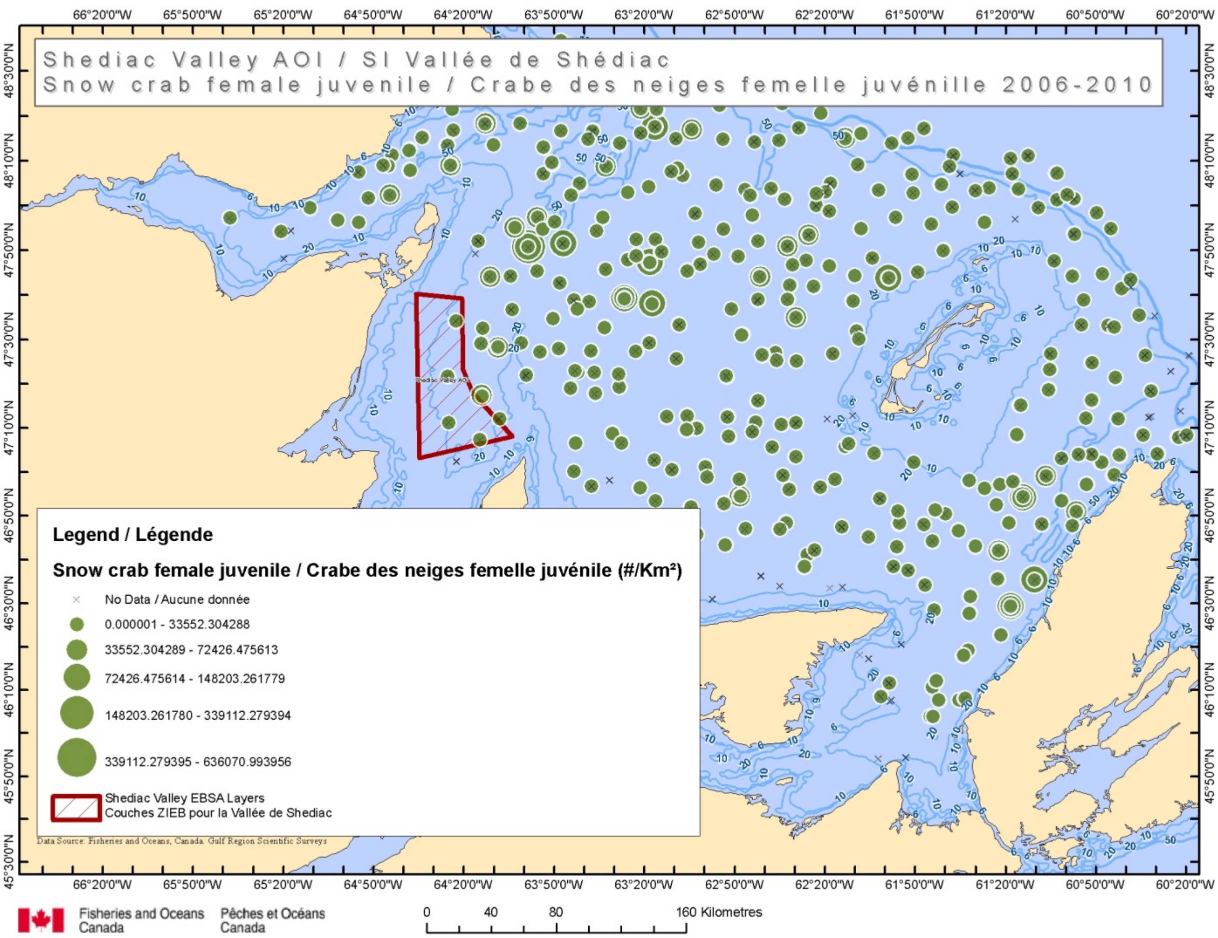

Figure 2.47 Trawl Locations and Density (#/km^2) of Juvenile Female Snow Crab in the sGSL during summer (post-fishing season) (2006-2010).

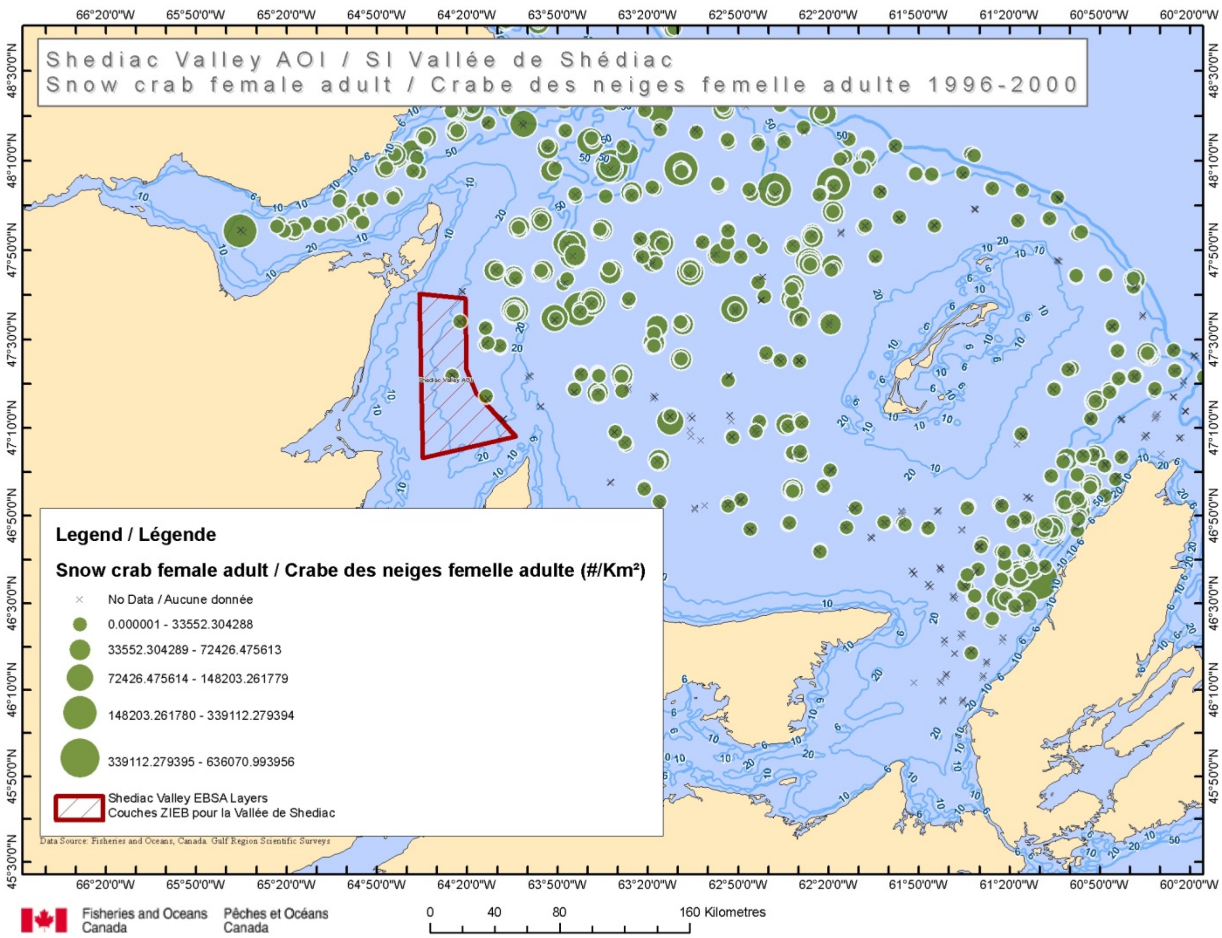

Figure 2.48 Trawl Locations and Density (#/km^2) of Adult Female Snow Crab in the sGSL during summer (post-fishing season) (1996-2000).

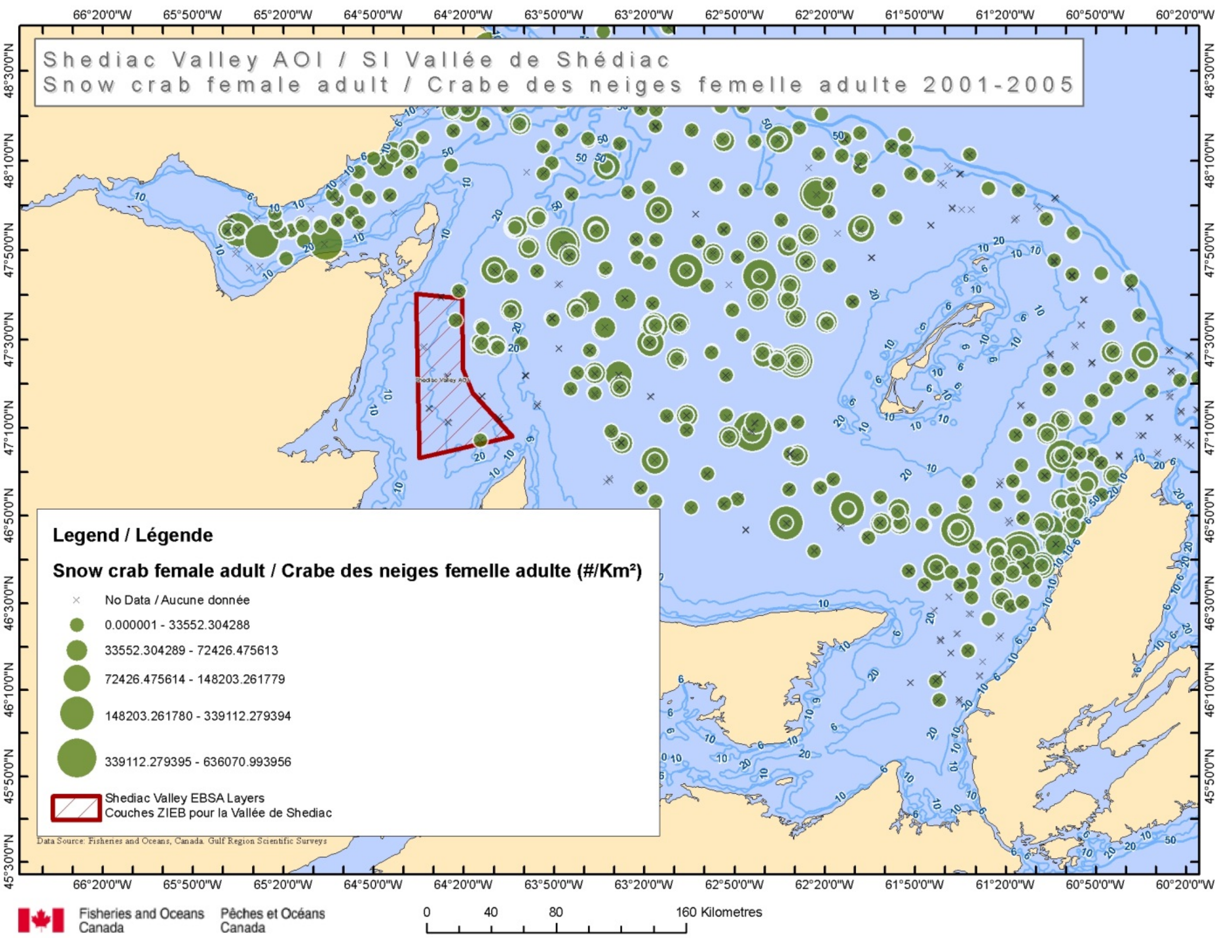

Figure 2.49 Trawl Locations and Density (#/km^2) of Adult Female Snow Crab in the sGSL during summer (post-fishing season) (2001-2005).

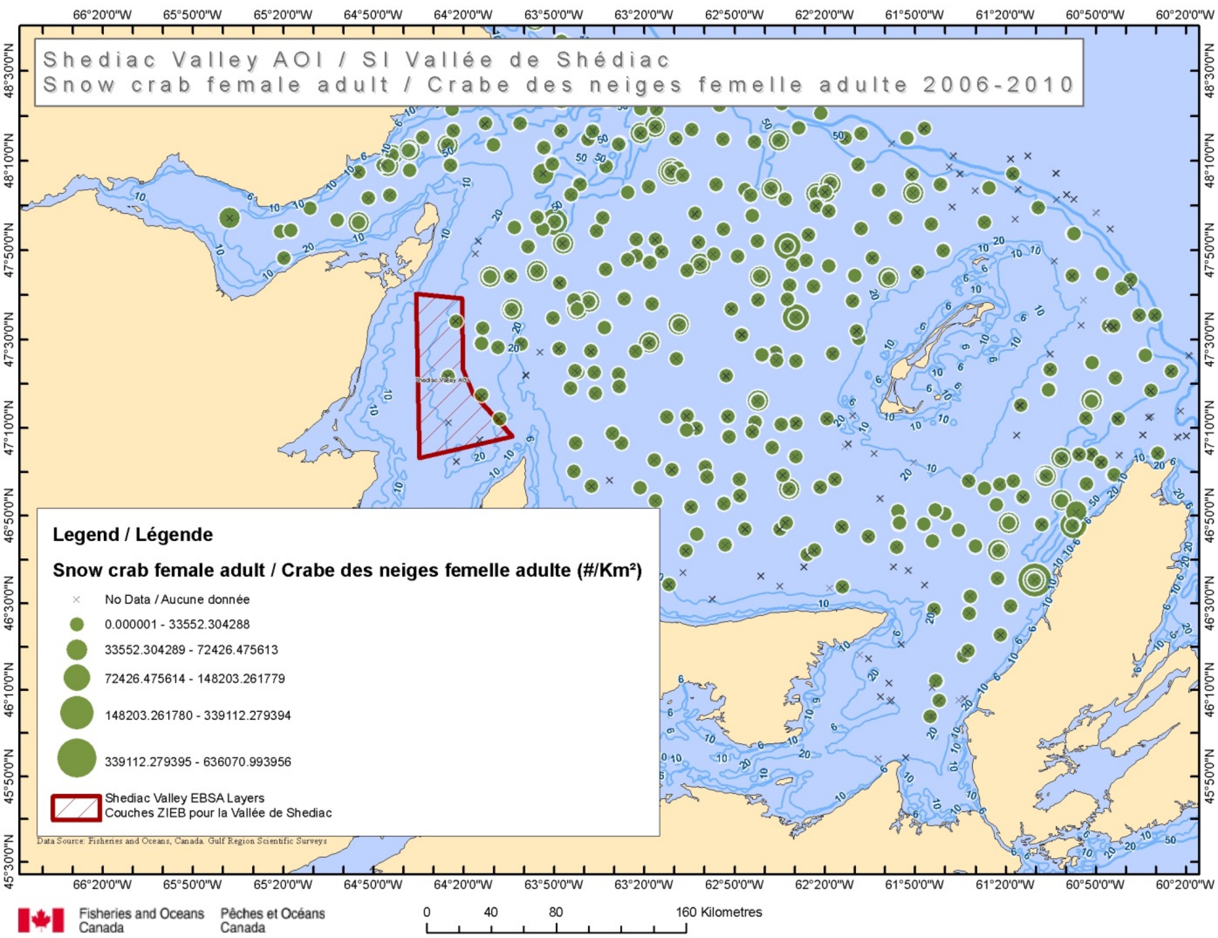

Figure 2.50 Trawl Locations and Density (#/km^2) of Adult Female Snow Crab in the sGSL during summer (post-fishing season) (2006-2010).

General Description: Available information on snow crab diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.13.

Table 2.13 Summary of Snow Crab in the Gulf of St. Lawrence.

Parameter	Description
Diet	Squires and Dawe (2003) indicate that the most common prey of snow crab are shrimp, crabs, small crustaceans and infaunal clams. Pink shrimp and capelin are the most important prey items as indicated by their percentage of the total food mass.
Reproduction	Following settlement, females pass through several ontogenetic stages: immature, prepubescent, pubescent, adult, nulliparous, primiparous and multiparous. Males pass through three stages: immature, adolescent and adult (Sainte-Marie *et* al. 2008). Snow crab moult at least once a year until the final (terminal moult) at which point they are classified as functionally mature. At this time, females develop a broad abdomen for carrying eggs and males develop a widened chela necessary for the mating behaviours (grasping, fighting, etc.) (Sainte-Marie *et al*. 2008). Primiparous females mate immediately following their terminal moult and multiparous females mate between late May and early June (Hébert *et al.* 2009). Larvae hatch approximately two years after mating takes place. Hébert *et al.* (2009) indicate that in the sGSL the majority of females have a two year reproductive cycle.
Fecundity	According to Sainte-Marie (1993), females most likely only hatch two broods during their life span. A female produces approximately 81,630 to 83,143 larvae (at 57.4 mm carapace width).
Abundance	Hébert *et al.* (2009) indicates that the biomass of commercial Atlantic snow crab stocks fluctuates in a cyclical manner with a 3-4 year period of high recruitment which is followed by a 3-4 year period of low recruitment. The most recent available information regarding biomass of the sGSL population, as presented by Hébert *et al.* (2011), indicates the 2010 post-fishery survey biomass of commercial-sized adult male crab in the sGSL was 30,500 mt (27,400 mt – 33,700 mt). Fifty six percent (56%) of the 2010 biomass was composed of new recruitment estimated at 17,000 mt (14,900 mt – 19,200 mt). According to Hébert *et al*. (2011), the abundance of mature females increased in 2010 relative to the low values during 2005 to 2009.
Growth	Eggs are incubated for approximately two years, after which, snow crab larvae follow three planktonic stages (zoeae I, zoeae II and megalopa) which last 3 to 5 months (Sainte-Marie *et al*. 1995). Snow crab settle to the bottom and continue to grow and moult over several instars. Snow crab are a dimorphic species, with females reaching adulthood at smaller sizes and younger ages than males with the average carapace width and age ~30–50 mm and ~2–3 years less for females (Sainte-Marie *et al*. 2008). Sainte-Marie *et al*. 1995 estimate that males reach commercial size at about instar XII (~ age 8.7 years). Snow crabs live approximately 5 to 8 years after the terminal moult (Sainte-Marie *et al.* 2008).
Mortality	Hébert *et al*. (2009) indicate that the discard mortality of the soft shelled crabs has increased from 237,000 crabs in 2004 to 391,559 crabs in 2005

Parameter	Description
	(DFO 2006c). The mean annual instantaneous mortality of male snow crab has been estimated at between 0.26 and 0.48 (Wade *et al.* 2003)
Behaviour	Water temperature can affect the movement of snow crab (DFO 2005e).
Spatio-temporal Distributions	Tag-recapture results in the sGSL indicate that there is exchange of crab between the Bradelle Bank and the Magdalen Channel as well as between Cape Breton Island to the Magdalen Islands. The majority of the Shediac Valley AOI is not fished for this species. According to Moriyasu *et al.* (2008), the majority of the sGSL population is concentrated in the areas east and north of the Shediac Valley.
Habitats	Snow crab are found in cold water (<3°C) (DFO 2006c) between depths of 20 and 400 m (Chassé *et al.* 2006).
Stock or Population Trends	The recruitment to the fishery is expected to increase until the 2015 fishery. The 2010 commercial-sized adult male biomass level is within the cautious zone of the Precautionary Approach framework but close to the upper stock reference point of 34,000 mt (Hébert *et al*. 2011).

2.3.2.2 ***Toad Crab***

In the sGSL there are two species of toad crabs, *Hyas araneus* and *Hyas coarctatus alutaceus*. These species are very similar in size and external anatomy.

Distribution: Toad crab can be found on both sides of the North Atlantic. In the NW Atlantic they range from Newfoundland and Labrador to Rhode Island; off the east and west coasts of Greenland and off Iceland (Sabean 2007). In the sGSL they are widely distributed over the mid-depth areas of the Magdalen Shelf, with concentrations north and east of PEI, including the eastern entrance to Northumberland Strait and off St. Georges Bay. Density distribution maps of males of commercially exploitable size (60 mm carapace width) show concentrations, particulary of *H. c. alutaceus,* in the shallower areas of the Shediac Valley and extending well into the AOI (Sabean 2007).

Based on their known distribution patterns in the sGSL, the AOI may be an important, though not critical, area for both species of toad crabs.

General Description: Available information on toad crab diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.14.

Table 2.14 Summary of Toad Crab in the Gulf of St. Lawrence.

Parameter	Description
Diet	Phytobenthos, crab, hermit crab, shrimp, gammarian amphipods, euphausids, copepods, foraminifers, bivalves, brittle stars, sea urchins, jellyfish, polychaetes, chitons, sponges, fish occasionally (Chabot *et al*. 2007)
Reproduction	Research conducted on *H. araneus* showed that the duration of embryonic development is typically a one or two year cycle, depending on water temperatures (Sabean 2007).
Fecundity	An average of 35,817 eggs (range of 12,667 to 70,400) per female has been found in *H. c. alutaceus* (Sabean 2007).
Abundance	A study conducted by Sabean (2007) in the sGSL (crab fishing areas 12,

Parameter	Description
	12E, 12F, 18 and 19) during 2002 and 2003 showed that the population of *H. c. alutaceus* was larger than the *H. araneus* population. The number of individual toad crabs in the southern Gulf was estimated to be 91.4 million ±34% in 1995, from data collected during a snow crab trawl survey (DFO 1996).
Growth	Both species of toad crab are dimorphic, with females being smaller than males. Male *H. araneus* can attain carapace widths of 99 mm; while females of this species can reach 56 mm carapace width. Male *H. c. alutaceus* can reach 89 mm carapace width; females of this species attain 58 mm carapace width (Sabean 2007). The moulting process in toad crabs appears to be similar to that of the snow crab; however, there has been limited research in this area. Toad crabs reach maturity after a terminal moult which occurs between July and September *H. araneus* (Sabean 2007).
Mortality	Cod and thorny skate (Raja radiata) consume immature Hyas crab.
Behaviour	No data available in material reviewed.
Spatio-temporal Distributions	In the NW Atlantic, *H. araneus* range from Newfoundland and Labrador to Rhode Island; off the east and west coasts of Greenland; and off Iceland (Sabean 2007). *H.c. alutaceus* are found from the Arctic to the GSL. Toad crabs in the GSL are widely distributed. Large concentrations of toad crab are found near Orphan Bank and between PEI and Cape Breton Island (DFO 1996).
Habitats	*H. araneus* prefer soft, muddy substrates and are generally found at depths of less than 50 m and water temperatures ranging from -1ºC to 15 ºC (Sabean 2007). *H. c. alutaceus* is believed to prefer hard bottom, inhabiting waters of similar depth and temperature as that of *H. araneus* (Sabean 2007).
Stock or Population Trends	In 1994 an exploratory fishery for toad crab began in the sGSL. Recorded landings have fluctuated from 110,719 kg (1994) to 899,984 kg (2002). The majority of the landings each year occurred within lobster fishing area 24, off of PEI. The 2002 fishery showed a 33% increase in landings from the 2001 year, however, the landings decreased in 2003 by nearly 8% (Sabean 2007). Landings have continued to decline in recent years with only 44,186 kg landed in 2008 and no active fishery in 2009. However it should be clear that this is a result of fishing effort and does not reflect the current status of the toad crab stock (A. Rondeau, pers. comm., 2011).

2.3.2.3 ***Other benthic macro-invertebrates***

Chabot *et al.* (2007) studied the distribution of benthic invertebrates in the Estuary and Gulf of St. Lawrence, for the purpose of identifying potential EBSAs specific to the benthic invertebrate ecological component. The study looked at past data from annual scientific surveys including the DFO autumn trawl surveys (1971-2005), snow crab trawl surveys (1988-2005), as well as the Northumberland Strait multispecies surveys (2000-2005) conducted by the Gulf Fisheries Centre in Moncton, for the sGSL. Cod stomach contents were also used to determine the distribution of some benthic invertebrates in the sGSL (1987-2004, with some gaps in annual sampling). Distributions of 44 taxa were discussed and used to define the potential EBSAs. These included four general groups (soft corals, anemones, sponges, ascidians), five echinoderm, six mollusc, one mysid, 22 shrimp and six crab species. An index of benthic invertebrate concentration was calculated for each 10 x 10 km square sampled in the study area. As a result of the study, 17 potential EBSAs for benthic invertebrates were identified throughout the Estuary and Gulf. (Six additional species, mostly coastal, were discussed in an appendix to the report but not used in defining the potential EBSAs).

Most of the Shediac Valley AOI falls within an area identified in Chabot *et al.* (2007) as a potential EBSA for benthic invertebrates (referred to as potential EBSA 15), having a high concentration index of benthic invertebrates, although these taxa were also found in other areas in the study. This area 15 included concentrations of somewhat rare shrimp species, including *Spirontocaris phippsi* and *Lebbeus microceros*. The specific concentration indices in area 15 varied from low to high and included a number of species or assemblages that were found throughout this area. Species with high abundance within the area included the snow crab, sea stars, giant scallop (*Placopecten magellanicus*) and sea urchins. Species with moderate abundance included sponges, sea cucumbers, squid, anemones, jellyfish, Iceland scallop, the shrimps *Eaulus macilentus*, *Spirontocaris spinus*, *Lebbeus polaris*, *Pandalus montagui*, *Sabinea septemcarinata* and *Argis dentata*, toad crab, hermit crab and whelk. Area 15 was moderately important for less common shrimp species (*Lebbeus groenlandicus*, *S. phippsi*, *S. lilljeborgi* and *L. microceros*).

In the sGSL, Chabot *et al.* (2007) found that the common sand dollar (*Echinarachnius parma*) was abundant in the periphery of the Magdalen Shelf and in the Shediac Valley. Sea cucumbers were most abundant in the southwest (Chaleur Bay and Shediac Valley) and southeast areas of the sGSL. The main concentrations of whelks (*Buccinium undatum, Neptunea decemcostata, Colus spp.*) were found in the Shediac Valley, as well as the Cape Breton Trough, Chaleur Bay and Orphan Bank. Giant scallop in the sGSL were concentrated in the Shediac Valley as well as other areas in the sGSL (Chabot *et al.* 2007).

There is a significant data gap regarding benthic communities in the GSL, (and therefore those in the Shediac Valley AOI). In their catalogue of (all known) marine invertebrates of the Estuary and GSL, Brunel *et al*. (1998) recorded 2161 species of benthic invertebrates, as cited by Chabot *et al*. (2007). This catalogue includes coastal species, small endofauna (annelids, flatworms, nemerteans), internal parasites of benthic species, as well as pelagic species having benthic stages (*i.e.* Scyphozoa). Many of the catalogued species are not recorded in the sGSL, but are from other areas of the estuary or GSL.

In their GSL-wide macrobenthos study, however, Chabot *et al*. (2007) considered only 50 species, a small proportion (approximately 2%) of the benthic invertebrate species recorded by Brunel *et al*. (1998). They note that their study lacks any data on benthic endofauna. They further caution that "species inventoried adequately tend to be decapod crustaceans whose size or link with species of commercial interest provides greater visibility in the catches. Thus, approximately 31 of the 50 species identified in this study are decapod crustaceans (23 shrimp species, 7 crab taxa and lobster) belonging to the Malacostracan class. This class is largely dominated by gammarian amphipods, which are not represented in this study" (Chabot *et al.* 2007, p. 89). Finally, the authors of DFO's analytical report on potential EBSAs for the estuary and GSL (DFO 2007a) add that "due to a lack of data, benthic invertebrates were particularly under-represented in the analysis regardless of their remarkable diversity and their significant contribution to the ecosystem" (p. 12).

<u>There is insufficient information on benthic infauna to remark on the importance of the AOI for these species assemblages. However the recorded presence of rare shrimp species in the vicinity merits careful consideration.</u>

2.3.3 *Marine Mammals*

Two groups of marine mammals use the study area: cetaceans and pinnipeds. At least nine species of marine mammals may be present in the Shediac Valley AOI at various times of the year. Information on marine mammals in the available materials was sparse and represents a significant data gap in the assessment process. Where possible, the current status and trends of the resource (*i.e.,* stable, increasing, decreasing) are presented. Information on diet, reproduction, fertility rate, growth, mortality, spatio-temporal distribution and habitat (feeding and growth areas, reproduction areas, migratory corridors, etc.) within the GSL and Shediac Valley AOI is provided, where available.

Lesage *et al.* (2007) provide an assessment on the marine mammal population in the Gulf. It is noted that "quantitative information on seasonal distribution and movements, diet composition and reproductive biology is particularly weak to non-existent for many species".

2.3.3.1 <u>*Cetaceans*</u>

Data presented by Lesage *et al.* (2007) indicate that no cetaceans were identified in the three line-transect surveys in the Shediac Valley AOI. This includes the following species, which were identified in at least one other location in the Gulf: blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata*), beluga whale (*Delphinapterus leucas)*, pilot whale (*Globicephala melas)*, harbour porpoise (*Phocoena phocoena)*, Atlantic white-sided dolphin (*Lagenorhynchus acutus)*, short-beaked common dolphin (*Delphinus delphis)* and white-beaked common dolphin (*Lagenorhynchus albirostris*). It is important to note that the absence of marine mammal sightings in aerial line-transect surveys does not exclude the species from existing in a given area.

2.3.3.1.1 <u>*North Atlantic Right Whale*</u>

The North Atlantic right whale is a baleen whale found in the temperate waters of the eastern and western North Atlantic. This species is listed as Endangered on Schedule 1 of the *Species at Risk Act*.

Distribution: Female whales calve off Florida and Georgia during winter months. In Canada, the species is most often noted in the Bay of Fundy and Roseway Basin located on the southwestern Scotian Shelf (Smedbol 2007). Some right whales have also been observed near the Gaspé Peninsula and coastal Newfoundland (Smedbol 2007).

There was no information available in the material reviewed relating to the presence of North Atlantic right whales in the Shediac Valley area. However, their presence near the Gaspé region of the Gulf indicates they could be present, most likely during later summer or autumn.

General Description: Available information on North Atlantic right whale diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.15.

Table 2.15 Summary of North Atlantic Right Whale in the Gulf of St. Lawrence.

Parameter	Description
Diet	North Atlantic right whales feed on zooplankton. They require a concentrated source with a high energy content to meet feeding requirements. In Canadian waters it is believed that they primarily feed on the *Calanus finmarchicus*, a species of calanoid copepod. This copepod is the most abundant species on the Scotian Shelf and in the Bay of Fundy (DFO 2007c).
Reproduction	The first calf is usually spotted with females of approximately 9 years of age. The calving grounds are found in the southern areas of the right whales range (DFO 2007c).
Fecundity	North Atlantic right whales give birth to one calf at a time, with a mean birth interval of 3.7 years between calves (DFO 2007c).
Abundance	There are approximately 322 individuals remaining with 220-240 adult individuals (DFO 2007c).
Growth	According to Smedbol (2007), the North Atlantic right whale can measure up to 16 m long and weigh approximately 70 tonnes. Females can be up to a metre longer than males.
Mortality	No data is available concerning the natural mortality rate of the North Atlantic right whale. DFO (2007c) indicates that historically the species population decreased due to whaling and at present is experiencing high mortality from vessel strikes and entanglement in fishing gear.
Behaviour	North Atlantic right whales migrate within their range from the northern feeding grounds to the southern calving and wintering grounds (Lesage 2007).
Spatio-temporal Distributions	In Canada, this species is most often observed in the Bay of Fundy and Roseway Basin located on the southwestern Scotian Shelf (Smedbol 2007).
Habitats	Due to the high energy requirements of the North Atlantic right whale their habitat has to supply the necessary food sources to sustain basic metabolic needs (DFO 2007c). In Canadian waters, this habitat has been identified as being Grand Manan Basin, the Bay of Fundy and Roseway Basin off southwest Nova Scotia, as noted above.
Stock or Population Trends	Population models using data sets between 1980 and 1995 have shown a trend towards a declining population (DFO 2007c).

Data Gaps: Data specific to the North Atlantic right whale in the sGSL appears to be a data gap.

2.3.3.1.2 *Fin Whale*

The fin whale is the second largest species of baleen whale, belonging to the suborder Mysticeti. The Atlantic population of the fin whale is currently listed as Special Concern on Schedule 1 of the *Species at Risk Act*.

Distribution: Fin whales inhabit most oceans of the world, mostly in temperate or polar regions. They are less commonly found in tropical waters. In the NW Atlantic, the species is distributed from Cape Hatteras to northern Davis Strait, including the Estuary and Gulf of St. Lawrence. Fin whales are frequently observed in the St. Lawrence River and along the north shore of the GSL during summer and autumn months. Aerial surveys in the summers of 1995 and 1996 found the distribution of fin whales was limited to the area in or around the Laurentian Channel and on the north shore shelf (Kingsley and Reeves 1998). They are more rarely reported in the sGSL. However, Lesage *et al.* (2007) states (p. 14) that "regular fin whale sightings by whale-watching companies based in or near Cheticamp (NS) indicate that this species occurs on a regular basis between May and October along the northwestern coast of Cape Breton Island".

General Description: Available information on fin whale diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.16.

Table 2.16 Summary of Fin Whale in the Gulf of St. Lawrence.

Parameter	Description
Diet	Fin whales in the St. Lawrence feed on euphausiids and likely on schooling fish such as capelin, herring and sand lance (Kingsley and Reeves 1998).
Reproduction	Adult males reach sexual maturity at 6-10 years. Gestation is 12 months. Calves are weaned at 6-8 months, when they are 10 – 12 m in length (Amer. Cetac. Soc. 2010)
Fecundity	Calves are believed to be born at 3 – 4 years intervals (Amer. Cetac. Soc. 2010)
Abundance	Present populations in the northern hemisphere are believed to be about 40,000 (Amer. Cetac. Soc. 2010); Kingsley and Reeves (1998) estimated "a few hundred in the northern and central" GSL in 1995–1996.
Growth	Adult males measure up to 24m in the northern hemisphere; females are slightly larger (Amer. Cetac. Soc. 2010)
Mortality	No data available on natural mortality. As many as 30,000 were hunted each year from 1935 to 1965 (Amer. Cetac. Soc. 2010).
Behaviour	Fin whales are most often found alone, but groups of 3-7 individuals are also common (Amer. Cetac. Soc. 2010). Fin whales observed along the north shore of the St. Lawrence River were typically found in groups, surfacing and blowing in synchrony (Kingsley and Reeves 1998).
Spatio-temporal Distributions	Fin whales are frequently observed in the St. Lawrence River as far upstream as the Saguenay confluence and along the north shore of the GSL during summer and autumn months. The distribution of fin whales was limited to the area in or around the Laurentian Channel and on the north shore shelf during the summers of 1995 and 1996 (Kingsley and Reeves 1998). They migrate in winter to subtropical waters for mating and to colder areas for feeding in summer (Amer. Cetac. Soc. 2010).
Habitats	It has been suggested that the fin whales that summer in the St. Lawrence system associate with the steep contours of the Laurentian Channel. This could be due to tidal and current mixing along which drive high biological production or that the changes in depth aid their navigation (Kingsley and Reeves 1998).

Parameter	Description
Stock or Population Trends	They are under the full protection of the International Whaling Commission (IWC) since 1986. A small hunt is permitted to Greenland Aboriginals (10 animals) (IWC website 2011)

2.3.3.1.3 ***Humpback Whale***

The humpback whale is a large species of baleen whale. The humpback whale has a distinctive body shape, with long, jagged fins.

Distribution: The humpback whale is a highly migratory species and inhabits all the world's oceans. In the NW Atlantic, its range extends from Labrador, Davis Strait and West Greenland south to the West Indies and includes the Estuary and Gulf of St. Lawrence (Lesage *et al.* 2007). Most populations follow a regular migration route, summering in temperate and polar waters for feeding and overwintering in tropical waters for mating and calving (Amer. Cetac. Soc. 2010). During an aerial survey, all the humpback whales observed in the GSL were on the north shore shelf, along the lower north shore and in the Strait of Belle Isle (Kingsley and Reeves 1998). There are records indicating the presence of humpbacks along the north shore as far west at the head of the Laurentian Channel and they have also been observed at the mouth of the Gaspé Bay (Kingsley and Reeves 1998). Isolated individuals have been detected in Cabot Strait and regular sighting reports by whale watching companies based out of Cheticamp in western Cape Breton during 2000 indicate that the species may be present in this sector, at least on a seasonal basis. These observations are supported by earlier reports indicating the presence of the species close to shore in the sGSL (Lesage *et al.* 2007).

General Description: Available information on humpback whale diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.17.

Table 2.17 Summary of Humpback Whale in the Gulf of St. Lawrence.

Parameter	Description
Diet	Euphausiids and small schooling fish (e.g., capelin) (IWC 2011).
Reproduction	Attain sexual maturity at 6-10 years, or when males reach 11.6 m (35ft.) in length and females reach 12 m (40 ft.) (Amer. Cetac. Soc. 2010).
Fecundity	Typically females bear a calf every 2-3 years; gestation period is 12 months (Amer. Cetac. Soc. 2010).
Abundance	NW Atlantic estimate at 10,000 – 13,000 for 1992-93 (IWC 2011); global estimate at 30,000 – 40,000 (Amer. Cetac. Soc. 2010). No estimates available for the GSL.
Growth	Adult males grow to 12-15 m; females grow to 13.7-15.5 m (Amer. Cetac. Soc. 2010).
Mortality	No data available on natural mortality.
Behaviour	Humpback whales tend to return to a particular "feeding-group aggregation" area and genetic tagging results confirm general summering area fidelity (Kingsley and Reeves 1998). They are interesting also for their "singing", which may be part of mating behaviour (Amer. Cetac. Soc. 2010).

Parameter	Description
Spatio-temporal Distributions	In the GSL, humpbacks are found primarily on the north shore shelf, mainly along the lower north shore and in the Strait of Belle Isle. Humpbacks have been observed along the north shore as far west at the head of the Laurentian Channel and they have also been seen at the mouth of the Gaspé Bay (Kingsley and Reeves 1998).
Habitats	No data available in material reviewed.
Stock or Population Trends	Heavily exploited in the past, but recovering in most areas; a rate of population increase of 3.1% was obtained from the Gulf of Maine for the period 1979 - 1993 (IWC 2011).

Data gaps: As indicated in the table above, data specific to the humpback whale in the sGSL appears to be a data gap.

2.3.3.1.4 *Minke Whale*

The minke whale is the smallest species of the rorqual family of whales (having baleen, a dorsal fin and throat pleats) (Amer. Cetac. Soc. 2010).

Distribution: Minke whales are found in all oceans, but are rare in the tropics, preferring icy waters ranging to the edge of the ice pack in polar regions. This causes them to become trapped in ice fields on occasion (Amer. Cetac. Soc. 2010). In the NW Atlantic, minke whales range from Davis Strait and Baffin Bay during summer, south to at least the Carribean during winter (Lesage *et al.* 2007). They are regularly observed in the summer and autumn in the St. Lawrence River and the northern shelf region of the GSL (Kingsley and Reeves 1998).

General Description: Available information on minke whale diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.18.

Table 2.18 Summary of Minke Whale in the Gulf of St. Lawrence.

Parameter	Description
Diet	Capelin are generally regarded as the principal prey of minke whales off eastern Newfoundland and at the head of the Laurentian Channel, and they appear to feed on capelin that have been concentrated by converging currents. Little is known about their feeding habits in the GSL, but they are known to prey on a wide variety of fish species elsewhere in the North Atlantic (Kingsley and Reeves 1998).
Reproduction	Sexual maturity is attained at 7-8 years in the northern hemisphere; breeding peaks in summer months and gestation period is 10-11 months; calves nurse for about 6 months (Amer. Cetac. Soc. 2010).
Fecundity	Females bear calves once every two years on average (Amer. Cetac. Soc. 2010).
Abundance	Worldwide population is believed to be over one million (IWC 2011). Based on 1995 and 1996 surveys, an uncorrected abundance of 1,000 individuals was estimated for the Gulf (Kingsley and Reeves 1998).
Growth	Adult males average 8 m in length and can grow to 9.4 m; adult females average 8.2 m and can grow to 10.2 m.

Parameter	Description
Mortality	No data available on natural mortality. Whaling nations have turned their attention to the minke, to replace the now depleted large whales.
Behaviour	Minke whales are typically solitary animals. Where several whales are present in the same area, they space themselves and tend to surface nonsynchronously (Kingsley and Reeves 1998).
Spatio-temporal Distributions	Summer and autumn inhabitants of the St. Lawrence River and the northern shelf region of the GSL (Kingsley and Reeves 1998).
Habitats	Preference for cold waters worldwide, as noted previously.
Stock or Population Trends	A major review is presently underway by the Scientific Committee of the IWC (IWC 2011). It is thought the populations may be increasing as the minke whale exploits food resources previously eaten by the now depleted large whales (Amer. Cetac. Soc. 2010).

Data gaps: As indicated in the table above, reproduction, fecundity, growth, mortality and stock/population trends on the minke whale in the sGSL appear to be data gaps.

2.3.3.1.5 *Long-Finned Pilot Whale*

The long-finned pilot whale is a medium sized whale in the suborder Ondontoceti. While its behaviour is similar to that of the larger whales, this genus is actually a member of the dolphin family.

Distribution: Long-finned pilot whales are widely distributed in cold and temperate waters of the North Atlantic and southern hemisphere. In the NW Atlantic, their distribution ranges from Cape Hatteras to Greenland and includes the Gulf of St. Lawrence and to a much lesser extent, the Estuary (Lesage *et al.* 2007). Long-finned pilot whales are found throughout the GSL. In a 1995-1996 aerial survey, Kingsley and Reeves (1998) found that the presence of pilot whales was limited to the southeastern Gulf. It is believed that pilot whales in the Gulf are likely part of a population centred on the continental shelf and along the shelf edge from Newfoundland to the southern Gulf of Maine (Kingsley and Reeves 1998).

General Description: Available information on long-finned pilot whale diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.19.

Table 2.19 Summary of Long-finned Pilot Whale in the Gulf of St. Lawrence.

Parameter	Description
Diet	Long-finned pilot whales have been linked with inshore occurrences of short-finned squid along eastern Newfoundland and also long-finned squid and Atlantic mackerel in U.S. waters (Kingsley and Reeves 1998). They feed primarily on squid, though worldwide pilot whales are known to feed on octopus, cuttlefish, herring and other small fish when squid are not available (Amer. Cetac. Soc. 2010).
Reproduction	Males attain sexual maturity at 12 years of age and a length of 4.5 m; females attain sexual maturity at 6-7 years of age, at a length of 3.7 m. Gestation lasts 12-15 months; calves can nurse for up to 22 months (Amer. Cetac. Soc. 2010).

Parameter	Description
Fecundity	Calving occurs once every 3-5 years.
Abundance	Has been heavily hunted. A few thousand could inhabit the GSL, but no reliable estimate of abundance exists (Lesage *et al.* 2007).
Growth	Males grow much larger than females. Adult pilot whales males grow to 6.1 m, while females grow to 4.9 m (Amer. Cetac. Soc. 2010).
Mortality	No data available on natural mortality. Their living in social groups has made hunting them easy, as entire groups can be driven onto beaches for slaughter. Mass strandings also occur, possibly as a result of the desire to keep the group together. (Amer. Cetac. Soc. 2010).
Behaviour	Long-finned pilot whales are very social and often observed in small, tight pods travelling in loose association with one another. A mean group size of 9.22 has been found in the GSL (Kingsley and Reeves 1998). In Newfoundland, pilot whales have been observed hunting in groups to help concentrate their prey; high-pitched whistles appear to serve to coordinate their movements (Amer. Cetac. Soc. 2010).
Spatio-temporal Distributions	Long-finned pilot whales occur throughout the GSL and are likely part of a population centred on the continental shelf and along the shelf edge from Newfoundland to the southern Gulf of Maine (Kingsley and Reeves 1998).
Habitats	Long-finned pilot whales in the GSL have been found in areas with deep waters and steep bottom relief (Kingsley and Reeves 1998).
Stock or Population Trends	Few reliable data are available. Not considered endangered (worldwide). One “drive fishery” in Newfoundland killed over 50,000 pilot whales between 1951 and 1961, rapidly diminishing whale numbers in NFLD waters (Amer. Cetac. Soc. 2010).

Data gaps: As indicated in the table above, the natural mortality and population trends of the long-finned pilot whale in the sGSL appears to be a data gap.

2.3.3.1.6 ***Killer Whale***

The killer whale is found in all three of Canada’s oceans. In the Pacific they are the most well-known cetacean both to the scientific community and to the general public. In the Canadian Arctic and Atlantic Oceans, killer whales are seen only occasionally and no in-depth scientific studies have been conducted. The killer whale was assessed by COSEWIC as Special Concern in November 2008, but is not currently listed under the Species at Risk Act.

Distribution: According to Lawson *et al.* (2007), very few killer whale sightings have been made in the GSL.

General Description: Available information on killer whale diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.20.

Table 2.20 Summary of Killer Whale in the Gulf of St. Lawrence.

Parameter	Description
Diet	Killer whales have been reported to feed on squid, octopus, bony and cartilaginous fish, sea turtles, sea birds, otters, dugongs, pinnipeds, other cetaceans and occasionally terrestrial animals. Individual populations of killer whales specialize on particular types of prey (Baird 2001).
Reproduction	The gestation period of killer whales is believed to be between 12 and 17 months. Females become sexually mature between 12 and 16 years of age, while males reach maturity between 10 and 17.5 years (Baird 2001).
Fecundity	Intervals between calving have been observed to range from 2 to 12 years, with a mean interval of approximately 5 years. The fecundity rate declines in a linear manner with increasing age (Baird 2001).
Abundance	According to Baird (2001), no population estimates are available for the Atlantic Canadian waters.
Growth	Adult males are larger than females; however, there are few accurate measurements to go by. The greatest recorded lengths for males and females are 9.0 m and 7.7 m, respectively (Baird 2001).
Mortality	Mortality rates have been found to vary with age. Neonate mortality (birth to six months of age) is high. Average longevity has been estimated to be 29.2 years (maximum estimated at 50-60 years) for male residents and 50.2 years (maximum 80-90 years) for resident females (Baird 2001).
Behaviour	Killer whales have been observed travelling alone and in groups of up to several hundred individuals. Larger groups appear to be temporary gatherings of smaller, more stable groups. Long-term studies have suggested that there are stable multi-year associations between individuals and limited dispersal from maternal groups (Baird 2001).
Spatio-temporal Distributions	Killer whales are occasionally recorded in virtually all areas off eastern Canada, including NS, the GSL, Newfoundland and Labrador, Hudson Bay and the Canadian Arctic (Baird 2001).
Habitats	Killer Whales may not be limited by depth, water temperature, or salinity, as in the case of other cetaceans. They are found in waters ranging in temperature from below 0ºC to warm tropical waters. They have been recorded in depths as shallow as a few metres to open ocean depths. Killer whales occasionally visit areas with brackish water and have been known to enter rivers (Baird 2001).
Stock or Population Trends	According to Baird (2001), there is evidence to suggest that the number of whales that visit the St. Lawrence has decreased in the last 60 years (Baird 2001).

Data gaps: As indicated in the table above, the abundance of killer whales in the sGSL appears to be a data gap.

2.3.3.1.7 ***Harbour Porpoise***

The harbour porpoise is a small whale in the suborder Odontoceti, or toothed whales.

Distribution: In a 1995 aerial survey, the harbour porpoise was found to be ubiquitous in the GSL. Four areas of high density were established from the geographical distribution of sightings, including the area centered on Banc Parent in the entrance of the St. Lawrence estuary, from the center of Jacques Cartier Passage and eastward on the north shore shelf, on the Newfoundland shelf from Bay of Islands northward and immediately outside the entrance of Gaspé Bay (Kingsley and Reeves 1998).

General Description: Available information on harbour porpoise diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.21.

Table 2.21 Summary of Harbour Porpoise in the Gulf of St. Lawrence.

Parameter	Description
Diet	Non-spiny fishes (herring, cod, whiting, sardines, squid, pollock). Requires large amounts of food – up to 10% of its body weight daily (Amer. Cetac. Soc. 2010). In the GSL harbour porpoise feed mainly on capelin, Atlantic herring and redfish (Kingsley and Reeves 1998).
Reproduction	Sexually mature believed to occur at 3-4 years. Nursing period is 8 months (Amer. Cetac. Soc. 2010).
Fecundity	Usual calving interval is 2 years (Amer. Cetac. Soc. 2010).
Abundance	In the GSL numbers of harbour porpoise have been estimated between 36,000 and 125,000 during the summer months (Kingsley and Reeves 1998).
Growth	Maximum length is 1.9 m, though few individuals attain this size and most do not exceed 1.5 m. Females are slightly larger than males (Amer. Cetac. Soc. 2010).
Mortality	Bycatch from commercial fisheries has been an ongoing source of mortality in the GSL (Kingsley and Reeves 1998).
Behaviour	May be seen singly, in pairs or small groups (6-10 animals); larger groups also observed. Often subject to stranding because of its nearshore habitat. Stranded individuals have been transferred to aquaria, but rarely survive (Amer. Cetac. Soc. 2010).
Spatio-temporal Distributions	Four areas of high density were observed in a 1995 aerial survey, including the area centered on Banc Parent in the entrance of the St. Lawrence estuary, from the center of Jacques Cartier Passage and eastward on the north shore shelf, on the Newfoundland shelf from Bay of Islands northward and immediately outside the entrance of Gaspè Bay (Kingsley and Reeves 1998).
Habitats	An inshore species in shallow coastal waters; in northern hemisphere temperate and subarctic waters of less than 15°C; often found in bays and may move into large rivers (Amer. Cetac. Soc. 2010).
Stock or Population Trends	Because of their nearshore habitat they have been extensively hunted. Pesticides and coastal habitat destruction and boat traffic have also contributed to their decline (Amer. Cetac. Soc. 2010).

2.3.3.1.8 *Atlantic White-Sided Dolphin*

The Atlantic white-sided dolphin is a species of small whale which falls under the suborder Odontoceti. They are distinctly coloured with a white to pale yellow patch found behind the dorsal fin on each side.

Distribution: The Atlantic white-sided dolphin is abundant in the North Atlantic. Atlantic white-sided dolphins in the GSL have been found around the perimeter of the GSL during aerial surveys (Kingsley and Reeves 1998).

General Description: Available information on Atlantic white-sided dolphin diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.22.

Table 2.22 Summary of Atlantic White-Sided Dolphin in the Gulf of St. Lawrence.

Parameter	Description
Diet	Squid and fish, often herring and similar fish (Whale Center of New England 2011)
Reproduction	Thought to be mature at 6-10 years (Whale Center of New England 2011).
Fecundity	Intervals between calves unknown, but could be yearly in some cases (Whale Center of New England 2011).
Abundance	In 1995, estimated population numbers were based on aerial surveys in the GSL. The uncorrected estimate for the Gulf was approximately 12,000 dolphins; however, this number was biased towards a greater number. Results from the 1996 survey indicated estimates of 500 individuals (Kingsley and Reeves 1998).
Growth	Adults attain 1.5-2.5 m. Males are slightly larger than females (Whale Center of New England 2011).
Mortality	Can live for 25 years and possibly more (Whale Center of New England 2011).
Behaviour	Atlantic white-sided dolphins in the GSL have been observed travelling in pods of 5 to 25 individuals (Kingsley and Reeves 1998). Appear to be very nomadic and rarely stay in one spot for long, but do not show any set seasonal migrations (Whale Center of New England 2011).
Spatio-temporal Distributions	The Atlantic white-sided dolphin is abundant in the North Atlantic and has been found around the perimeter of the GSL (Kingsley and Reeves 1998).
Habitats	Atlantic white-sided dolphins in the GSL have been found predominantly in areas with steep bottom relief. They are known to inhabit areas with cool temperate waters (Kingsley and Reeves 1998).
Stock or Population Trends	No good estimate of the overall number, but known to be an abundant species. Not commercially hunted, but several animals may be killed each year by Aboriginal groups in northern climates. The primary threats from pollutants (all dolphin species seem to build up unusually high pesticide loads) and entanglement in fixed fishing gear, which is often fatal to the dolphin (Whale Center of New England 2011).

2.3.3.1.9 ***White-Beaked Dolphin***

The white-beaked dolphin is a species of small whale which falls under the suborder Odontoceti. White-beaked dolphins are characterized by their short, thick, white beaks and very noticeably curved dorsal fins.

Distribution: Inhabit cold temperate and subpolar waters of the North Atlantic Ocean, from Davis Strait, around Greenland to the White Sea (IUCN 2011). White-beaked dolphins are normally found in areas farther north in cooler waters and more coastal areas than the white-sided dolphin (Kingsley and Reeves 1998). In 1995 and 1996 aerial surveys of the GSL white-beaked dolphins were spotted in the Strait of Belle Isle and on the north side of the Esquiman Channel. They have been found as far west as the Mingan Islands (Kingsley and Reeves 1998).

General Description: Available information on white-beaked dolphin diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.23.

Table 2.23 Summary of White-Beaked Dolphin in the Gulf of St. Lawrence.

Parameter	Description
Diet	Small pelagic schooling fishes; also demersal species (cod, haddock, poor cod, bib, hake and whiting), squid (IUCN 2011).
Reproduction	No data available.
Fecundity	No data available.
Abundance	The 1995 and 1996 surveys of the Gulf resulted in estimated numbers of white-beaked dolphins close to 2,500 individuals (for each year) (Kingsley and Reeves 1998). A 2006 survey in an area from the Georges Bank to the upper Bay of Fundy to the entrance of the Gulf of St. Lawrence estimated 2,003 animals (IUCN 2011).
Growth	No data available in material reviewed.
Mortality	No data available in material reviewed.
Behaviour	White-beaked dolphins can be found travelling in single, compact pods (Kingsley and Reeves 1998).
Spatio-temporal Distributions	The white-beaked dolphin is native to the North Atlantic and is found in northerly, coastal waters. In the 1995 and 1996 aerial surveys white-beaked dolphins were only spotted in the Strait of Belle Isle and on the north side of the Esquiman Channel. They have been found as far west as the Mingan Islands (Kingsley and Reeves 1998).
Habitats	Found widely over the continental shelf and offshore waters of the cold temperate to subpolar zones, especially along the shelf edge. There is evidence suggesting that their primary habitat is in waters less than 200 m deep.
Stock or Population Trends	No data available.

Data gaps: As indicated in the table above, diet, reproduction, fecundity, growth, mortality, or stock/population trends on the white-beaked dolphin in the sGSL appear to be data gaps.

2.3.3.2 ***Pinnipeds***

Much of pinniped ecology is based on pup production and the Shediac Valley is not considered a major whelping area.

In general, the material reviewed did not present pinnipeds in the context of the Shediac Valley, therefore the information presented here is based on a GSL regional context.

2.3.3.2.1 ***Harp Seal***

According to Hammill and Stenson (2005), the Canadian and Greenland hunt of harp seals is the largest hunt for marine mammals in the world. The harp seal is the most abundant pinniped in the Northwest Atlantic.

Distribution: Widespread in the North Atlantic and Arctic Ocean and shelf seas. Their range extends from northern Hudson Bay and the Foxe Basin, Baffin Island and the Davis Strait, Gulf of St Lawrence and Newfoundland; east to somewhat south of Greenland, Iceland, Northern Norway, the White Sea and the Barents and Kara Seas. The northern limit in the eastern North Atlantic is at least to Franz Joseph Land and Svalbard and may continue to between 82-85 degrees north depending on ice conditions (IUCN 2011). It is highly migratory and Atlantic canadian populations summer in the High Arctic and winter off the northern Newfoundland and Labrador coasts as well as in the Estuary and Gulf of St. Lawrence (Lesage *et al*. 2007). Harp seals whelp on pack ice in the GSL and can be found off the northeast coast of Newfoundland, near the Magdalen Islands and PEI and off the lower North shore of the Northern GSL (Mecatina patch) (Hammill and Stenson 2005).

General Description: Available information on harp seal diet, reproduction, fecundity, abundance, growth, mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.24.

Table 2.24 Summary of Harp Seal in the Gulf of St. Lawrence.

Parameter	Description
Diet	Prey varies along the migration route. Throughout their range, the harp seal diet includes 67 species of fish and 70 species of invertebrates. Pups and juveniles consume a lot of invertebrate prey, especially euphausiids and amphipods. The seals off Newfoundland eat capelin and Arctic cod and off Labrador they eat Arctic cod and Atlantic herring. In the GSL, the seals have been known to consume capelin, herring, Atlantic cod, Arctic cod and redfish (IUCN 2011).
Reproduction	Females reach sexual maturity between 4-8 years of age; males probably do not participate in breeding before they are somewhat older, though they reach sexual maturity around the same time as females. Pups are born on the open free-floating pack ice and nursed for 12 days, during which time they gain weight at about 2.2 kg per day (IUCN 2011).
Fecundity	Current estimated pup production at all world breeding sites combined is approximately 1.4 million pups per year.
Abundance	The harp seal is the most abundant pinniped in the NW Atlantic. The 2005 NW Atlantic stock was estimated to number 5.8-5.9 million (Lesage *et al*. 2007, IUCN 2011). This estimate for Canadian waters was higher than the previous estimate produced in 2000, when the Gulf and Front herds combined were estimated to number 5.5 million (IUCN 2011).
Growth	Adult males and females are approximately 1.8 m long and weigh about 130 kg (IUCN 2011).
Mortality	The maximum life span of a harp seal is approximately 30 years; most animals that reach sexual maturity live to over 20 years.
Behaviour	A highly social species that travels and forages in groups. Maintains a stratification of diet according to age class and depth of the feeding dives. Harp seals are relatively shallow divers. Jan Mayen Island animals stay close to the edge of the pack ice during the spring moult, usually dive to less than 100 m, but by July, satellite-tagged seals in the Barents Sea dove to 400 m. Overall, the deepest dives occur during the day in winter.

Parameter	Description
Spatio-temporal Distributions	Whelping occurs on pack ice off the northeast coast of Newfoundland, near the Magdalen Islands and off the lower North shore of the Northern GSL (Hammill and Stenson 2005).
Habitats	See sections above.
Stock or Population Trends	There has been a marked recovery from an estimated low of around 1.8 million in the early 1970s. Catch levels have been increased repeatedly for this population during the last decade and likely now exceed potential biological removal levels by 1.5 – 5.9 times.

2.3.3.2.2 ***Hooded Seal***

The hooded seal is a large highly migratory phocid mammal that inhabits the pelagic waters of the north Atlantic. Hooded seals are harvested for commercial and subsistence purposes. Hammill and Stenson (2006) note that hooded seals have received considerably less attention than harp seals and as a result our information on many aspects of the biology of this species including pupping are limited.

Distribution: Hooded seals whelp on pack ice around Jan Mayen Island, in Davis Strait, off the NE coast of Newfoundland and in the GSL (Hammill and Stenson 2006). After whelping, hooded seals return to the pack ice off Greenland and then remain in the waters off Greenland during the summer and fall before returning to their breeding areas (Hammill and Stenson 2006).

Aerial surveys from 2005 suggest that approximately 6,600 pups were born in the Gulf in 2005, compared with approximately 107,000 pups born off the NE coast of Newfoundland and 3,300 pups born in Davis Strait. These proportions give some indication of the distribution of the population (Hammill and Stenson 2006).

General Description: Available information on hooded seal diet, reproduction, fecundity, abundance, growth and mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.25.

Table 2.25 Summary of Hooded Seal in the Gulf of St. Lawrence.

Parameter	Description
Diet	A wide variety of fish and invertebrates, including species that occur throughout the water column. Examples of typical prey are amphipods, Greenland halibut, Polar and Atlantic Cod, redfishes, sand eels, herring, capelin, squid and shrimp (IUCN 2011).
Reproduction	Whelping occurs on pack ice in mid-March. The breeding season is very short, usually lasting only about 2.5 weeks and mating takes place in the water. This species has the shortest lactation period for any mammal, with most pups being weaned in four days
Fecundity	Aerial surveys carried out at all three whelping areas in the NW Atlantic in 2005 produced an estimate of 116,900 pups born.
Abundance	Population estimated at nearly 600,000 individuals in 2005, of which a variable, but relatively low proportion reproduced in the Gulf (Lesgae *et al*. 2007).

Parameter	Description
Growth	Adult males average 2.5 m in length and 300 kg, with large animals reaching over 400 kg; Adult females are smaller, averaging 2.2 m and 160 kg, but can reach 300 kg; pups are born at approximately 1 m in length and 24 kg (IUCN 2011).
Mortality	No data available on natural mortality.
Behaviour	They are very capable divers that spend extensive periods at sea without hauling out. Most of their dives are from 100-600 m in depth and last 5-25 minutes. Very deep dives to over 1,000 m and dives lasting almost an hour have been recorded (IUCN 2011)
Spatio-temporal Distributions	Jan Mayen Island, in Davis Strait, off the NE coast of Newfoundland and in the GSL during the whelping season. After whelping, hooded seals return to the pack ice off Greenland and remain in the waters off Greenland during the summer and fall (Hammill and Stenson 2006).
Habitats	See data in sections above.
Stock or Population Trends	Population modelling based on aerial surveys of whelping ares suggest a moderate increase both in pup production and population size between the mid-1980s and 2005 (IUCN 2011).

2.3.3.2.3 ***Grey Seal***

The NW Atlantic grey seal is an abundant species whose population ranges from the Gulf of Maine to southern Labrador, including the GSL. Grey seals in the NW Atlantic all belong to the same genetic population but for the purpose of management they are divided into three groups based on locations of breeding sites (DFO 2007e). These locations include the Sable Island herd, Eastern Shore herd and GSL herd (DFO 2007e). Under the Objective Based Fisheries Management Plan, grey seals have been considered a data poor species (Hammill 2005).

Distribution: The non-Sable Island population of grey seal whelp on the pack ice mainly in the Northumberland Strait and off the west coast of Cape Breton (Hammill 2005). Smaller whelping colonies are found off Amet Island, Deadman Island and along the east coast of NS.

Aerial surveys of pinnipeds in the GSL carried out in early summer of 1996 and 2000 recorded the presence of grey seals along the North shore as restricted to the Mingan Archipelago, all around Anticosti Island, between Île aux Perroquets and Pashashibou, in the Baie de Gaspé, the Magdalen Islands and Prince Edward Island (Hillsborough Bay only). Vessel based surveys found them also at the tip of the Gaspé Peninsula and in Kouchibouguac National Park (NB). Anticosti Island constituted the main area of concentration of grey seals in the GSL (N = 2110), followed by the Magdalen Islands (N = 151), Mingan Archipelago (N= 111), PEI (N = 80), Kouchibouguac National Park (N = 55) and the Gaspé Peninsula (N = 22-47). Grey seals were generally absent from the SW Gulf coastal area, with the exception of Kouchibouguac National Park area, where this species forms large aggregations (Robillard *et al*. 2005).

Surveys using radio-tagging (satellite telemetry) have shown a broad concentration of grey seals offshore, centred south of Miramichi Bay and covering the SW portion of the Shediac Valley AOI during the ice-free season. This concentration shifted further offshore and covered a greater portion of the AOI area during the ice-covered season (Lesage *et al*. 2007). This likely corresponds to the seal population forming the known aggregations in Kouchibouguac National Park.

A recent estimate of the Kouchibouguac National Park summer grey seal population is 300-500 animals. Recent satellite telemetry studies suggest these animals overwinter on the ice off northern PEI (É. Tremblay, pers. comm. March 15, 2011)

<u>Because of its resident population in nearby Kouchibouguac National Park and in the larger Miramichi Bay area, the grey seal is the marine mammal most likely to affect, or to be affected by, decisions concerning the Shediac Valley AOI.</u>

General Description: Available information on grey seal diet, reproduction, fecundity, abundance, growth and mortality, behaviour, spatio-temporal distribution, habitat and population trends is provided in Table 2.26.

Table 2.26 Summary of Grey Seal in the Gulf of St. Lawrence.

Parameter	Description
Diet	15 species of fish occur regularly in the diet of the grey seal in Canadian waters. Atlantic cod, herring and capelin account for 72% of prey by weight (IUCN 2011).
Reproduction	Breeding occurs between December and February (DFO 2007e) on islands, beaches, or on pack ice (DFO 2008c). Combined, the non-Sable Island population contributed approximately 16,000 pups to the population in 2004 (Hammill 2005).
Fecundity	No data available.
Abundance	Hammill (2005) notes that during the period between 1970 and 2004, the non-Sable island population has increased from approximately 21,000 to 53,000 animals.
Growth	Males may reach a length of approximately 0.2.31 m and can weigh up to 350 kg, while females reach a length of approximately 2m and weigh up to 227 kg (DFO 2008c).
Mortality	No data is available on the natural mortality rate of the grey seal. Human induced mortality has resulted from hunting, scientific sampling programs and incidental catch in commercial fisheries (DFO 2008c).
Behaviour	Grey Seals live close to human population centres and shipping lanes and spend much of their time in the vicinity of favourite haul out locations (IUCN 2011). They are generally shallow, short-duration divers. Most adult diving is shallower than 120 m and less than 8 minutes. Female dives are on average slightly longer (5.5 minutes) than those of males (4.9 minutes), although males tend to dive a little bit deeper. In the GSL, maximum depth of dives recorded were 412 m for males and 354 m for females (IUCN 2011).
Spatio-temporal Distributions	The grey seal population is broken into three components, the Sable Island herd, Eastern Shore herd and GSL herd.
Habitats	Grey seals come to land on exposed reefs or on beaches of undisturbed islands (DFO 2008c). Whelping occurs on pack ice during the winter months.

Stock or Population Trends	The overall Atlantic grey seal population is increasing. Most of the harvesting of the species is conducted on Sable Island (DFO 2008c). Pup production estimates for the sGSL population vary from a low of 5,436 in 1984, increasing to 10,700 by 1996, but since then, surveys indicate that pup production has varied from 5,300 in 2000 to 14,200 in 2004. In 2007, pup production was estimated to be 11,400. It is noted that estimates of pup production in the GSL are imprecise and quite variable (Hammill and Stenson 2010).

3.0 SOCIAL, ECONOMIC AND CULTURAL OVERVIEW

This section summarizes the existing data on socio-economic and cultural aspects of the Shediac Valley AOI and the larger study area. The boundaries of the study area have been developed in consultation with DFO (M. Chiasson, pers. comm., 2010). The boundaries vary depending on the activity described, but in general have been defined as the surrounding coastal municipalities of Kent, Northumberland and Gloucester Counties from Richibucto to Caraquet in New Brunswick and the coastal municipalities of Prince County from West Point to Cascumpec Bay on PEI. These boundaries represent a reasonable zone of influence in which potential interactions between human activities and the Shediac Valley AOI (or eventual MPA) could occur. With regard to First Nations, the study area encompasses the historic territory of the Mi'kmaq and Maliseet First Nations.

Emphasis has been placed on human activities in the study area that may be affected by an MPA (should one be established), or conversely human activities that may affect the ecological features that are likely to be the focus of the conservation objectives for the MPA. Where possible, key issues are highlighted including potential user conflicts, opportunities for sustainable development of the marine environment, spatial-temporal trends and the importance of the activities occurring within the AOI in relation to the economic activities in the study area. Much of the information presented has been drawn from Gaudet and Leger (2011).

3.1 Use of Areas within and in the Vicinity of the Area of Interest

The governance mechanisms, social and cultural aspects and land use within the Shediac Valley AOI and larger study area are summarized below (Table 3.1). Cross-references to figures and sections of the report containing additional information on a particular aspect or use have been provided where available and appropriate.

3.1.1 *Administrative Boundaries of the Shediac Valley AOI*

The majority of the Shediac Valley AOI is situated outside of the 12 nautical mile (nm) territorial sea and within the 200 nm exclusive economic zone (EEZ). Under section 14 of the *Oceans Act*, Canada has:

> *(a) sovereign rights in the exclusive economic zone of Canada for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil and with regard to other activities for the economic exploitation and exploration of the exclusive economic zone of Canada, such as the production of energy from the water, currents and winds;*
>
> *(b) jurisdiction in the exclusive economic zone of Canada with regard to:*
>
> *(i) the establishment and use of artificial islands, installations and structures;*
>
> *(ii) marine scientific research; and*

(iii) the protection and preservation of the marine environment; and
(c) other rights and duties in the exclusive economic zone of Canada provided for under international law.

For the portion of the AOI that is within the 12 nm territorial sea, under the *Oceans Act*:

s8. (1) For greater certainty, in any area of the sea not within a province, the seabed and subsoil below the internal waters of Canada and the territorial sea of Canada are vested in Her Majesty in right of Canada.
s9. (1) Subject to this section and to any other Act of Parliament, the laws of a province apply in any area of the sea
(a) that forms part of the internal waters of Canada or the territorial sea of Canada;
(b) that is not within any province; and
(c) that is prescribed by the regulations.

Table 3.1 Aspects and Uses Considered for the Social, Economic and Cultural Overview of the Shediac Valley AOI.

Aspect / Use	**Source**	**Shown on Figure?**	**Additional Information Provided in this Report?**
Administrative boundaries	*Oceans Act* Unpublished data, DFO, Gulf Region Oceans Section Alexander *et al.* (2010) (Section 2.0)	No	Section 3.1.1
First Nations territories	Gaudet and Leger (2011) (Section 3.7)	No	Section 3.1.1 Section 3.2.6
Zoning influencing the maritime territory		No	DFO is not aware of any zoning that currently exists in the Shediac Valley AOI (M. Chiasson, pers. comm., 2010), nor does any appear on the corresponding hydrographic chart (#402401). Commercial fishing zones are covered in Section 3.2.1.
Location of municipalities	National Topographic Data Base (NRCan 2005)	All figures	No
Protected Areas	Gaudet and Leger (2011)	Figure 3.1	Section 3.1.2 Section 3.1.3 Section 3.1.4
Recreational Areas	Gaudet and Leger (2011)	Figure 3.1	Section 3.1.2 Section 3.1.3 Section 3.1.5

Aspect / Use	Source	Shown on Figure?	Additional Information Provided in this Report?
Spiritually and culturally significant areas	Gaudet and Leger (2011)	Figure 3.1	Section 3.1.2 Section 3.1.3 Section 3.1.5
Commercial fishing areas	DFO	Appendix 1	Section 3.2.1
Coastal and marine recreational activities (fishing, kayaking, diving, *etc*).		Figure 3.1	Section 3.1.3 Section 3.2.4
Non-commercial traditional native activities	Gaudet and Leger (2011) DFO 2008d	No	No. Treaties signed in 1760 and 1761 by Mi'kmaq and Maliseet communities include a communal right to hunt, fish and gather in pursuit of a "moderate livelihood". First Nations who fish for food, social and ceremonial purposes hold Communal Fishing Licences. A brief reference to communal rock crab fishing licences in the sGSL was made in a DFO (2008d). Whether non-commercial traditional native activities occur in the Shediac Valley AOI specifically represents a data gap.
Maritime infrastructure	Canadian Hydrographic Service	N/A	No. According to the hydrographic chart (#402401) that shows the EBSA 5 area, no marine cables or other permanent structures (*e.g.*, buoys) are present in the Shediac Valley AOI.
Navigation corridors	Alexander *et al.* (2010)	Figure 3.2	Section 3.2.2
Marine sites with particular status (*i.e.*, dredging disposal)		Figure 3.2	Section 3.2.2
Aquaculture sites	Gaudet and Leger (2011) Alexander *et al.* (2010)	No	Section 3.2.3
Mineral, gas and oil rights	Alexander *et al.* (2010)	No	Section 3.1.6
Contaminated or potentially contaminated sites	Gaudet and Leger (2011)	No	Section 3.1.7 Section 3.2.2

Governance structures in the GSL are thoroughly described by Alexander *et al.* (2010, p. 3), who states, "A multitude of federal and provincial legislative acts and municipal by-laws govern human activities within coastal, marine and estuarine areas throughout the Gulf of St. Lawrence." Federal oceans responsibilities within the Shediac Valley AOI would include regional delegations in Fisheries and Oceans Canada and Environment Canada, as well as Transport Canada, Natural Resources Canada, the National Energy Board and the Department of National Defence. Provincial and municipal authorities in New Brunswick and PEI play a role in regulating human activities in the study area that could interact with the Shediac Valley AOI.

The *Constitution Act* and the *Oceans Act* respect historical treaties and traditional rights of First Nations and other Aboriginal groups, recognizing their traditional ecological knowledge as an important element in understanding marine ecosystems (Alexander *et al.* 2010). First Nations groups may play a role in governance given that the Gulf Region represents traditional territory for a number of Mi'kmaq and Maliseet communities (see Section 3.2.6 below). In 1999, the Supreme Court of Canada recognized the communal right of Mi'kmaq and Maliseet communities to hunt, fish and gather in pursuit of a "moderate livelihood" under Peace and Friendship Treaties signed in 1760 and 1761 (Gaudet and Leger (2011).

3.1.2 *National Parks and Historic Sites*

Significant natural, cultural and historical areas in Canada are protected through a network of national parks and historic sites governed by Parks Canada. Kouchibouguac National Park is the only national park within the study area (Figure 3.1). Established in 1969, the Park is situated near Kouchibouguac, NB and encompasses an area of 239.2 km^2 (Parks Canada, 1997). The boundary for the park and activities therein is mean low tide (E. Tremblay, pers. comm. 2010). The park contains significant archaeological, coastal and marine features, including the second largest tern colony in North America (Gaudet and Leger 2011). Human activities in the park include camping, hiking, swimming, boat tours, recreational boating, bird watching and kayaking.

Two national historic sites exist within the study area: Boishébert and Beaubears Island Shipbuilding National Historic Sites (Figure 3.1). Both of these sites are located on the Miramichi River near Miramichi, NB. The sites contain significant archaeological, coastal, marine and historical features, including the remnants of a nineteenth century ship building centre (Gaudet and Leger 2011). Human activities in the area include tourism and boating.

3.1.3 *Provincial Parks and Historic Sites*

Provincial parks and historic sites range from camping areas to public beaches and day use areas and are governed by provincial governments (NB Department of Tourism and Parks and Heritage Branch; PEI Department of Tourism and Culture). One provincial historic site is located within the study area: the Acadian Historic Village in Caraquet, NB (Gaudet and Leger 2011) (Figure 3.1). The Acadian Historic Village is a major tourist attraction and includes an interpretation centre, a museum and activities aimed at preserving and transmitting Acadian cultural traditions and folk knowledge. Four provincial parks are situated within the study area: all on PEI (Table 3.2, Figure 3.1).

Table 3.2 Provincial Parks in the Shediac Valley AOI Study Area.

Name	Location	Significant Features	Human Activity
Jacques Cartier Provincial Park	Kildare, PEI	Coastal, marine, historical (site of Jacques Cartier's landing)	Camping, swimming, tourist attraction, guided nature tours
Mill River Provincial Park	St. Anthony, PEI	Coastal (golf course), marine	Swimming, recreational boating, golfing, camping

Name	Location	Significant Features	Human Activity
Bloomfield Provincial Park	St. Anthony, PEI	Coastal (golf course), marine	Day use, golf, angling
Cedar Dunes Provincial Park	West Point, PEI	Coastal, marine, historical (lighthouse)	Camping, swimming, recreational boating, tourist attraction, guided nature tours

Source: Gaudet and Leger (2011).

3.1.4 Conservation and Protected Areas

Conservation and protected areas include both national (migratory bird sanctuaries, wildlife areas, heritage rivers) and provincial (ecological reserves, natural/wildlife/wilderness areas) designated areas. These areas may be governed by federal and provincial authorities. Five conservation and protected areas are situated within the study area, all in New Brunswick (Table 3.3, Figure 3.1).

3.1.5 *Museums and Interpretive Centres*

Museums and interpretive centres are places of cultural, historical and/or spiritual significance to their communities. Nine museums and interpretive centres are situated within the study area: seven in New Brunswick and two on PEI (Table 3.4, Figure 3.1).

3.1.6 *Mineral, Gas and Oil Rights*

Oil and gas activity in the Shediac Valley AOI has been limited to seismic operations and any potential development within the AOI is yet undocumented (Alexander *et al*. 2010). No oil and gas exploration or development is currently underway in the AOI. One oil and gas exploration licence holder was identified in the larger study area, in New Brunswick near Miramichi. This licence is landward with coastal boundaries and does not encroach seaward of the high tide mark; therefore, it does not interact directly with the Shediac Valley AOI. Other recent finds of oil and gas on shore in New Brunswick, such as in the Sussex area, appear to be significant and because of lower cost and lower risk are usually of higher priority than those offshore (R. Alexander, pers. comm. 2010).

Nevertheless, the Gulf of St. Lawrence as a whole is known to have oil and gas production potential and production from fields outside the area of interest could still impact the Shediac Valley AOI. This could be either directly through infrastructure development or indirectly through accidental events including major spills. The latter has raised significant concern with the public since the deep water Horizon blow out in the Gulf of Mexico (summer of 2010). Public perception of offshore drilling is negative and projects such as the Old Harry field and interest in the Orphan Basin are coming under even closer scrutiny. The Old Harry field falls outside the AOI and even outside the Gulf Region of DFO yet an accidental release could still impact on the Gulf Region, just as the relatively small spill (approx. 1000 tonnes) (R. Alexander, pers. comm. 2010) from the sinking of the oil barge Irving Whale did in 1970 when oil washed up on the shores of Cape Breton Island and the Magdalen Islands. Oil spill response plans and organizations do exist to respond to such issues (R. Alexander, pers. comm. 2010).

3.1.7 *Contaminated or Potentially Contaminated Sites*

Gaudet and Leger (2011) indicates that many sites in the Gulf Region pose or are likely to pose a hazard to the environment or to human health as a result of contamination through past activities. A tally of known contaminated sites in the Gulf Region that are eligible for funding for management under the Federal Contaminated Sites Action Plan (FCSAP) is provided in Gaudet

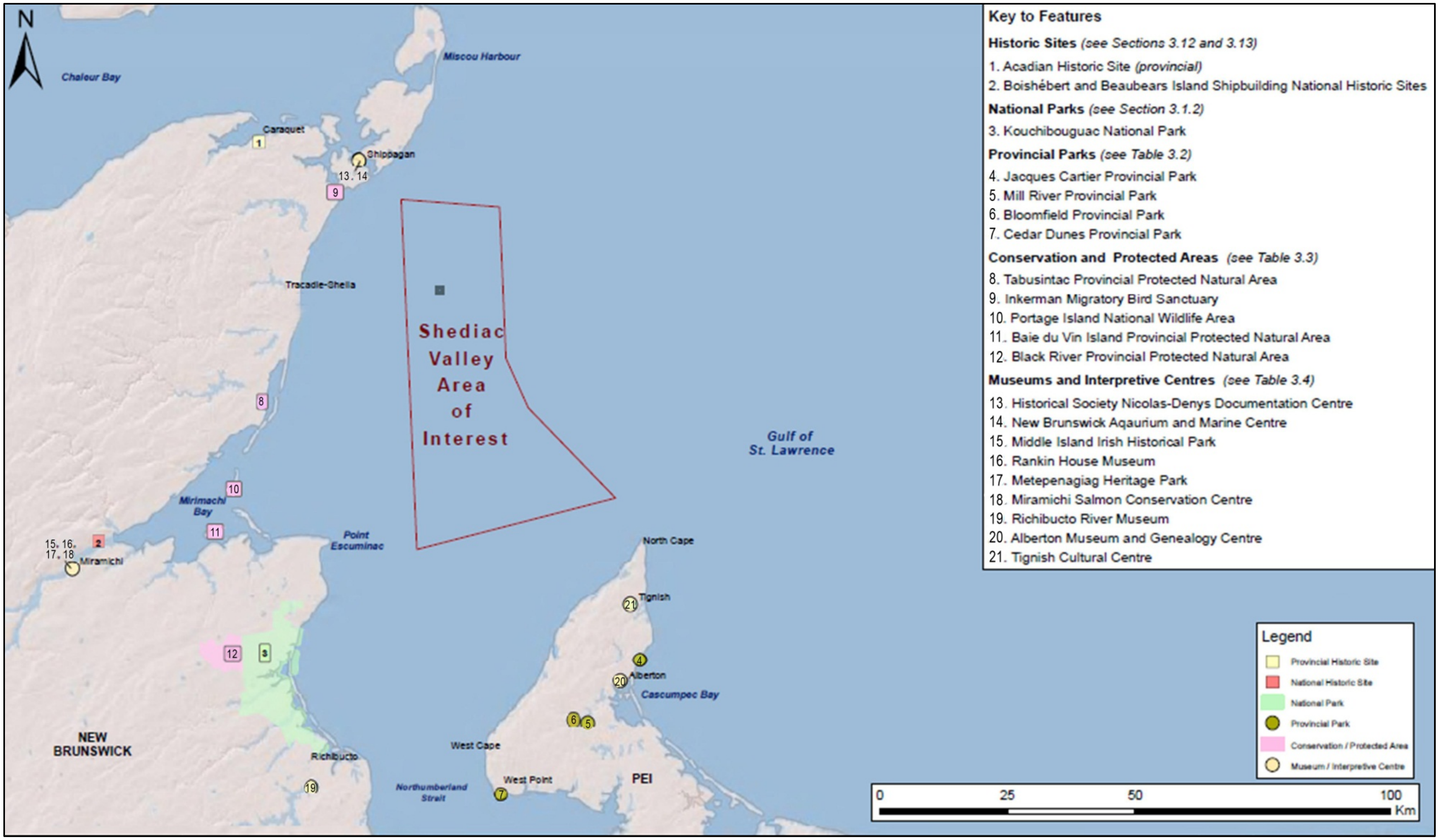

Figure 3.1 Socio-cultural Features.

Table 3.3 Conservation and Protected Areas in the Shediac Valley AOI Study Area.

Name	Location and Area	Significant Features	Human Activity	Administrative Agency
Tabusintac Provincial Protected Natural Area	Eastern Lowlands Eco-Region, NB 108 ha	Coastal (salt marshes, major nesting site for great blue heron and osprey), marine	Restricted to scientific research and monitoring	NB Department of Natural Resources
Inkerman Migratory Bird Sanctuary	Eastern Lowlands Eco-Region, NB 15 ha	Largest and most significant black-crowned night-heron nesting colony in Atlantic Canada; great blue heron nesting colony; part of Pointe-aux-Rats-Musqués heronry Important Bird Area	Restricted to scientific research and monitoring	Environment Canada
Portage Island National Wildlife Area	Miramichi Bay, NB 439 ha	Coastal (series of coastal barrier beaches, salt marshes, sand dunes, migrating waterfowl, shorebirds), marine	Restricted waterfowl hunting, wildlife observation, hiking	Environment Canada
Baie du Vin Island Provincial Protected Natural Area	Eastern Lowlands Eco-Region, NB 214 ha	Coastal (salt marshes, sand dunes, rare flora, major nesting site for great blue heron and osprey), marine	Restricted to scientific research and monitoring	NB Department of Natural Resources
Black River Provincial Protected Natural Area	Eastern Lowlands Eco-Region, NB 4000 ha	Adjacent to Kouchibouguac National Park, coastal (forest, bogs and barrens, area previously affected by human activity)	Restricted to scientific research and monitoring	NB Department of Natural Resources

Source: Gaudet and Leger (2011), Environment Canada 2005.

Table 3.4 Museums and Interpretive Centres in the Shediac Valley AOI Study Area.

Name	Location	Concentration
Société historique Nicolas-Denys Documentation Centre	Shippagan, NB	Documents of local historical importance
New Brunswick Aquarium and Marine Centre	Shippagan, NB	Forms part of the Coastal Zones Research Institute and houses an aquarium and fishing museum
Middle Island Irish Historical Park	Miramichi, NB	Irish immigrant history
Rankin House Museum	Miramichi, NB	Early life in New Brunswick
Metepenagiag Heritage Park	Red Bank, NB	Demonstrates how the Mi'kmaq people lived on the banks of the Miramichi River for nearly 3,000 years
Miramichi Salmon Conservation Centre	South Esk, NB	Atlantic salmon biology
Richibucto River Museum	Rexton, NB	19th century life in Kent County
Alberton Museum and Genealogy Centre	Alberton, PEI	Alberton history and genealogy
Tignish Cultural Centre	Tignish, PEI	Local history and interpretive centre

Source: Gaudet and Leger (2011).

and Leger (2011). A total of 91 FCSAP sites have been identified for New Brunswick, 43 of which are associated with DFO. A total of 73 FCSAP sites have been identified for PEI, 60 of which are associated with DFO (Treasury Board of Canada Secretariat 2005). All of these sites are likely to occur on land. Information on dredge and fish waste locations is provided in Section 3.2.2 (Marine Transportation) of this report.

Data Gaps: The nature and location of the DFO-related FCSAP sites in New Brunswick and PEI could be confirmed through a review of the online database (Treasury Board of Canada Secretariat 2005) to determine whether any of the sites are within the Shediac Valley AOI study area. Additional research may be warranted to supplement the FCSAP information and dredge and fish waste locations to help determine the presence or absence of potentially contaminated sites in the Gulf Region and subsequent implications for the AOI.

3.2 Activity Sector Profiles

The potential social and economic repercussions of conservation measures for the Shediac Valley MPA (should one be established) are described with respect to the main activity sectors in the larger study area. The main activity sectors identified by DFO are:

- commercial, recreational and Aboriginal (CRA) fisheries;
- marine transportation;
- aquaculture;
- recreational activities;
- education, conservation and research activities; and
- First Nations economic activities.

These are the activities for which interactions with the MPA are believed to be most likely. Where available and appropriate, the following information has been included in each activity profile:

- services provided, products and infrastructure;
- economic importance;
- direct and indirect economic benefits;
- social importance;
- timing and location of activities;
- trends and influencing factors (*e.g.,* availability of resources, product value, demand, certification, accessibility);
- presence of user conflicts; and
- development projects.

3.2.1 *Commercial, Recreational and Aboriginal Fisheries*

Commercial, Recreational and Aboriginal (CRA) fishing is likely the most important activity sector in the Shediac Valley AOI study area. Marine fisheries have been the main economic driver for coastal communities within the GSL since the arrival of European immigrants over 500 years ago (Alexander *et al.* 2010). "Most of these communities evolved from the commercial fishing industry and many are still one-industry communities, supported by current fisheries" (Gaudet and Leger 2011, p. 33). In 2007, the value of the landings in the Gulf Region was approximately $350 million (including aquaculture data for mussels) (Gaudet and Leger 2011).

The CRA fishery is governed by DFO under the *Fisheries Act*. Significant changes and challenges to this industry have occurred over the past 30 years in the Gulf Region, including technological advances in equipment and declining resources (Gaudet and Leger 2011, Alexander *et al.* 2010). In recent years, the fishery in the Gulf Region has shifted from groundfish to crustaceans due to moratoria placed on Atlantic salmon, Atlantic cod, white hake and redfish stocks in the early 1990s (Gaudet and Leger 2011). The crustacean fishery consists of potentially more valuable species as statistics show that average landings decreased by 32%, while the average value increased by 37% during the 1997-2001 period relative to the period immediately prior to the moratoria, 1990-1991 (Alexander *et al.* 2010). In 2007, lobster and crab comprised nearly 60% of shellfish (crustaceans and molluscs) landings and represented approximately 90% of the total landed value of shellfish in the Gulf Region (Gaudet and Leger 2011).

The Shediac Valley AOI is within DFO groundfish area 4T5 and 4T3b, Herring Fisheries Sub-District 16C and part of 16B, Lobster Fishing Areas (LFAs) 23 and 25, Scallop Fishing Areas (SFAs) 21C and 22, Snow Crab Fishing Area (CFA) 12 and Mackerel Fishing Area 16 (see Appendix A). The groundfish fishery was once very important in this area. A large part of the Shediac Valley AOI (DFO groundfish area 4T5) is currently closed by variation order to groundfish fisheries. Some minimal to insignificant effort for groundfish remains in a small northern section of the AOI (in DFO groundfish area 4T3B).

The current CRA fishery in the Shediac Valley AOI is limited to a few smaller scale fisheries. Supporting logbook data from fish harvesters are available for some species but not others, making it a challenge to identify the precise location of fishing activities and whether they overlap with the AOI (i.e. Atlantic herring and Atlantic mackerel). Based on a review of the literature available and discussions with DFO, the species in the Shediac Valley AOI that are fished in CRA fisheries appear to be (Table 3.5):

- witch flounder (DFO groundfish area 4T3B only);
- white hake (DFO groundfish area 4T3B only);
- halibut (DFO groundfish area 4T3B only);
- cod (DFO groundfish area 4T3B only);
- American plaice (DFO groundfish area 4T3B only);
- Atlantic herring;
- Atlantic mackerel (unconfirmed); and
- snow crab.

In addition, there may be some lobster and scallop fishing activities in the AOI (unconfirmed) and a very small rock crab fishery. There are 760 and 856 commercial lobster fishing licence holders in LFAs 23 and 25, respectively (DFO 2007d). Areas less than 37 m (20 fathoms) are typically very productive and heavily fished (Davidson *et al.* 2007, M. Comeau, pers. comm., 2010). The areas less than 20 fathoms deep in the Shediac Valley would include the portion of the AOI (about half) off the New Brunswick coast and the southeast corner of the AOI near North Cape, PEI.

Lobster catches are summarized in a Canadian Science Advisory Secretariat (CSAS) Report (DFO 2007d) by LFA from 1947 to 2005, but it would not be appropriate to equate these data to the Shediac Valley AOI as it only encompasses a small portion of these LFAs. In general, landings in LFA 23 are above the long-term median but have been declining since 1993 (although the decline has been more pronounced in Chaleur Bay). Landings in LFA 25 have shown an alarming decline in the sGSL.

According to Davidson *et al.* (2007), 48 fish harvesters in SFA 21C hold a commercial scallop fishing licence. In SFA 22, scallop licences are held by 142 fish harvesters from eastern New Brunswick and 61 fish harvesters from PEI. Davidson *et al.* (2007) show a small number of commercial scallop beds within the AOI based on fish harvester logbook data.

Internal discussions at DFO suggest an insignificant rock crab fishery in the AOI, which is supported by information provided in a CSAS Report on rock crab (DFO 2008d). The same management boundaries used in the lobster fishery (LFAs) in the Gulf Region are used for the rock crab fishery. There are 55 (43 active) and 71 (63 active) rock crab fishing licence holders in LFAs 23 and 25, respectively (DFO 2008d). Rock crab landings from the directed and by-catch fishery are summarized by LFA from 2000 to 2006. By-catch landings were important in LFAs 23 and 25 and directed landings were high in LFA 25. The rock crab fishery is widely distributed in coastal waters of less than 30 m, although fishing locations are not always recorded on logbooks (DFO 2008d). The majority of the fishing activities for rock crab have been located in the Northumberland Strait (which includes LFA 25) and in the Miramichi Bay area (LFA 23).

Gaudet and Leger (2011) presents data on commercial fish harvesters, number of registered vessels, number of processing plants and employees, plant production volumes and markets for the Gulf Region. It is difficult to apply this broad-scale data to an assessment of the Shediac Valley AOI specifically. Based on the information above, the current commercial fishery in the AOI appears to be minor relative to the Gulf Region as a whole and potential interactions between CRA fisheries and an MPA in the Shediac Valley are expected to be relatively limited.

Table 3.5 Shediac Valley AOI Fishing Activities

Time Series (logbook data)	Fishing Zone	Gear Type	Fishing Season
Witch flounder (1991-2007)	4T3B (sporadic/ minimal effort) 4T5 (closed by licence condition)	Gill net fixed, otter trawl stern	May to November
White hake (1991-2007)	Moratorium	Danish seine, gill net fixed, longline	June to October
Halibut (2000-2007)	4T3B (small zone in the northern part of AoI) 4T5 (closed by variation order)	Gill net fixed, hand-line, longline	June to October
Cod (1991-2007)	Moratorium and 4T5 (closed by variation order)	Danish seine, gill net fixed, hand line, longline, otter trawl side, otter trawl stern, Scottish seine	June to November
American plaice (1991-2007)	4T3B (insignificant) 4T5 (closed by variation order)	Danish seine, gill net fixed, longline, otter trawl side, otter trawl stern, Scottish seine	June to November
Atlantic herring (1999-2003)	16B, 16C and 16E	Purse seine, gill net fixed	May to September
Snow crab (1993-2007)	12 (insignificant effort within the AOI)	Trap	April to July

Data Gaps: Further research should be conducted to confirm the extent of the potential lobster fishery in the AOI. Consultation with fish harvesters should be undertaken to confirm whether the scallop beds in the AOI are used by fish harvesters, given the impacts that typical scallop fishing methods are known to have on benthic habitat. Also the extent of the Atlantic mackerel and Atlantic herring fisheries within the bounds of the AOI should be determined.

3.2.2 *Marine Transportation*

The marine transportation sector manages port activities, types of vessels and cargo, vessel speeds, accidents, navigation aids, ice breaking, search and rescue, dredging and fish waste locations. Marine transportation is governed primarily by Transport Canada. The Canadian Coast Guard (DFO) has responsibility for navigation aids, ice breaking and search and rescue operations. Regulations concerning dredging and fish waste are enforced by Environment Canada and DFO. A comprehensive summary of the administrative authorities involved and relevant acts and regulations can be found in Alexander *et al.* (2010).

Commercial marine transportation across the Shediac Valley AOI is relatively light (unpublished data, DFO, Canadian Coast Guard), with major shipping lanes situated well away to the north and east of the area. The only major ports in the study area are found in Miramichi, NB and can be accessed via the Shediac Valley AOI (Figure 3.2). One port was used for shipping paper products from the local pulp and paper mill on paper carrier type vessels (Alexander *et al.* 2010); however, this port is likely not used at present due to mill closures. The other port is used to access the Ultramar Ltd. distribution terminal. According to the Atlantic Pilotage Authority (J. Griffin, pers. comm. 2010), six oil tankers transited to and from ports in the Miramichi in 2008, while nine oil tankers used ports in the Miramichi in 2009.

Vessel traffic to and from the ports of Dalhousie, Belledune and Summerside pass through the study area, although traffic volumes are low (J. Griffin, pers. comm., 2010). The Summerside port is used for exporting agricultural products and it accommodates incoming shipments of cargo on cargo ships (Alexander *et al.* 2010).

As described in Alexander *et al.* (2010), cruise ships generate several types of waste: black water, grey water, garbage and solid waste, hazardous waste, bilge water, ballast water and diesel exhaust emissions. “A typical cruise ship produces 100 gallons of wastewater and 3.5 kg of solid waste per passenger per day. Cruise ships entering the Gulf of St. Lawrence can accommodate anywhere from five hundred to four thousand passengers and crew. The estimated production of bilge water for a typical cruise ship is 7,000 gallons per day, while each release of ballast water can reach 1,000 metric tons” (Alexander *et al.* 2010, p. 75). The production and release of bilge and ballast water applies equally to cruise ships and large vessels. Discharge of waste from vessels into the water can have a detrimental impact on marine life and habitat through the release of nutrients, contaminants and aquatic invasive species.

In general, legislation is in place under the Ballast Water Control and Management Regulations of the *Canada Shipping Act, 2001* to prevent the exchange of ballast water in Canadian waters and the EEZ. This legislation is intended to address issues associated with the introduction of contaminants and invasive species into Canadian waters. The regulations take into consideration the exchange and treatment of ballast water, receipt of ballast water at a retention facility and retention of ballast water on board the ship.

Canadian pollution prevention regulations, as found in the Vessel Pollution and Dangerous Chemicals Regulations of the *Canada Shipping Act, 2001*, are based on international regulations (Annex IV of the International Maritime Organization's International Convention for the Prevention of Pollution from Ships 73/78 (MARPOL)). Pursuant to these regulations, the discharge of oil and oily mixtures, noxious liquid substances and dangerous chemicals, pollutants, sewage or sewage sludge and garbage into Canadian waters is prohibited subject to specified conditions. These regulations apply to all ships in Canadian waters and to all Canadian ships everywhere.

Transport Canada, the lead federal department for preventing pollution from ships, along with Environment Canada, manages a National Aerial Surveillance Program. As part of this program, Transport Canada has pollution surveillance aircraft equipped with a state-of-the-art technology to detect marine polluters. Environment Canada, as well as other departments and organizations, is a partner in the Integrated Satellite Tracking of Polluter’s (I-STOP) Project, which uses Radarsat imagery to look for ocean surface anomalies that could indicate oil spills.

Vessel traffic also has the potential to cause noise disturbance to fish and marine. Given the nature of the vessel traffic in this area, such disturbance would likely be of short duration and intermittent. It is expected that fish would swim away from the area of disturbance and return once the disturbance had passed. Literature suggests that marine mammals are not likely to be residents in this area (Lesage *et al*. 2007), thus reducing the likelihood of disturbance.

A number of dredge locations (both active and closed) exist along the New Brunswick and PEI coastlines in the larger study area, but are outside of the Shediac Valley AOI (Figure 3.2). Potential interactions between these dredge locations and the AOI are unlikely given the distance between them. Ocean disposal of dredge spoils occurred in Miramichi Bay (and further inland) from 1981 to 1983 for the Miramichi Channelization Project, which involved the extension of the usability of ports in the Miramichi estuary (Environment Canada 2006). The disposal sites are situated well away from the AOI, thus interactions or residual impacts are unlikely. The most recent data also do not show any fish waste locations within the study area. The nearest fish waste location is in Chaleur Bay, approximately 40 km northwest of the AOI boundary and its status is closed. Potential interactions between this site and the AOI are not expected.

No munitions dumps from World War II have been identified within EBSA 5. However, the precise locations of munitions dumps on the east coast of Canada remain under investigation by the Department of National Defence (DND). DND operated a firing range, known as the Tracadie Range, on 18 000 hectares of land near Tracadie-Sheila, NB from 1939 to 1994. The federal government transferred the land to the Province of New Brunswick in 1997 following a site clean-up (GNB 2013a). As part of the Tracadie Range, an offshore training area was located off the coast of eastern New Brunswick. This area largely overlaps the Shediac Valley AOI. In addition to past DND activities that occurred in the area, there remains a potential for noise pollution from DND vessels equipped with sonar. However, information regarding the extent of these activities is not available.

A review of the shipwrecks from the Provincial Archives of New Brunswick did not reveal any exposed shipwrecks in the study area (GNB 2013b).

Data Gaps: DND should be consulted to confirm the absence of munitions dumps and sonar activity in the Shediac Valley AOI. Any available shipwreck information for PEI should be reviewed to determine whether any known shipwrecks occur in the study area. Information on vessel accidents in the study area is scarce and investigation into any additional sources of shipwreck information may be useful.

3.2.3 *Aquaculture*

The aquaculture industry is governed by both federal and provincial legislation including the *Fisheries Act*, *Oceans Act*, *Fish Inspection Act*, *Navigation Protection Act* (previously *Navigable Waters Protection Act*), *Canadian Environmental Assessment Act* and various provincial Acts (Gaudet and Leger 2011, Alexander *et al.* 2010). In New Brunswick, aquaculture leases and licences are administered by the provincial government, whereas on PEI, DFO retains this authority. Several government and non-government committees and associations have been established in the Gulf Region for the purpose of strategic development and standardizing industry practices, as summarized in Gaudet and Leger (2011) and Alexander *et al.* (2010).

All of the aquaculture sites in the Shediac Valley AOI study area are for mollusc farming (Gaudet and Leger 2011, Alexander *et al.* 2010). There are no finfish farms in this area of the Gulf Region due to the presence of ice during the winter months. The aquaculture sector in the Gulf Region is most active on PEI, with 1,094 sites distributed throughout nearly every bay and

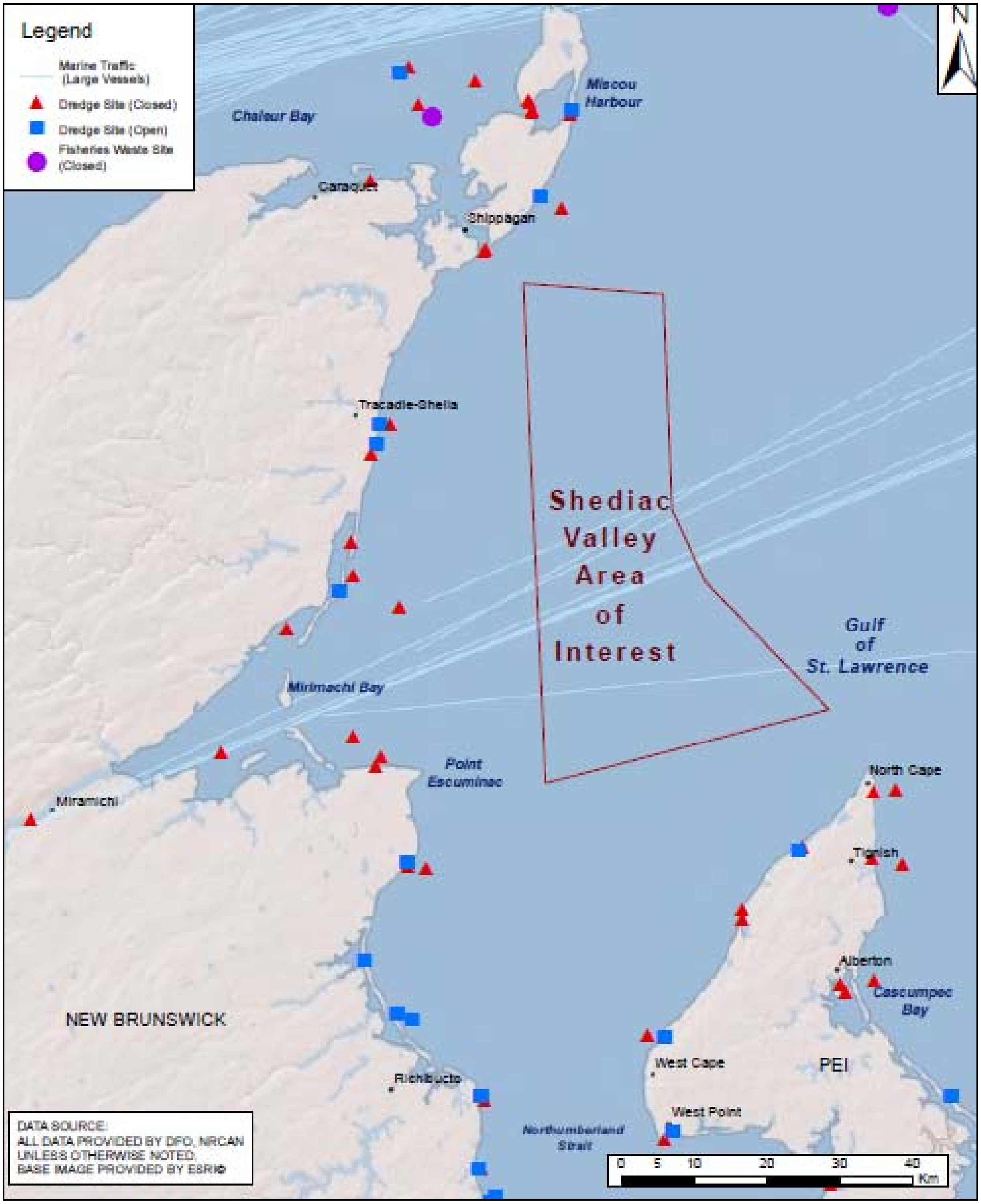

Figure 3.2 Marine Transportation and Disposal Locations[1].

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[1] Note: This figure illustrates information specific to a project conducted by Stantec Consulting Ltd. and should not be used for other purposes.

estuary (Gaudet and Leger 2011). However there are no lease sites on the NW coast of PEI directly facing the AOI because this exposed coastline has few protected inlets or harbours, which are a requirement for the current mollusc rearing techniques to be applied. The PEI aquaculture operations nearest the AOI are situated in Cascumpeque Bay, on the NE coast and within inlets facing Egmont Bay, which opens onto Northumberland Strait. Gaudet and Leger (2011) indicates that there are approximately 540 active aquaculture sites in the Gulf Region of New Brunswick, 70% of which are located between Caraquet Bay and Miramichi Bay. However, these are all coastal aquaculture sites and are not located within the boundary of the AOI itself.

Aquaculture in the study area is currently carried out in protected nearshore sites. Potential interactions between these sites and the Shediac Valley AOI are unlikely, given the distance which separates them. As the availability of inshore sites for oyster and mussel production in the Gulf Region decreases, more focus may be placed on developing aquaculture production further offshore. Because of surface conditions (especially in winter) and the distance from shore and existing wharf installations, any such developments will likely be closer to shore than the current bounds of the AOI. Direct biological or ecological impacts of farmed organisms in open water conditions are unlikely. However, indirect impacts such as increased boat traffic, antifouling compounds applied to submerged infrastructure, entrapment of mobile biota or as yet unforeseen impacts should be considered if aquaculture sites are developed in closer proximity to the AOI.

A general summary of the number of coastal aquaculture sites by species in New Brunswick (Gulf Region only) and PEI is provided below (Table 3.6). Production and value data were presented in Gaudet and Leger (2011) for each Maritime province as a whole for 1997, 2002 and 2007 (Tables 3.6 and 3.7). The primary aquaculture species of economic importance in the Gulf Region for both New Brunswick and PEI are oysters and blue mussels.

3.2.4 *Recreational Activities*

The recreational activities sector includes whale watching, deep-sea recreational fishing, cruise ship activity, sailing and pleasure boating and diving. Recreational activities in the study area vary seasonally and occur mainly during the warmer seasons. Some recreational fishing, cruise travel and marine-related tourist travel data were presented in Gaudet and Leger (2011) for the Maritime Provinces and Gulf Region as a whole, but not refined for the Shediac Valley study area. There are no known whale watching tours currently taking place in the Shediac Valley AOI. Similarly, deep-sea recreational fishing operations are not known to occur in the area.

According to Gaudet and Leger (2011), there are no cruise ship destination ports in the study area. Although Alexander *et al.* (2010) does not indicate any cruise ship activity at the port in Summerside, PEI, it is possible that some cruise ships may be frequenting this port or will do so in the future (D. Conroy, pers. comm. 2010). Summerside is not within the study area but there may be some interaction with the Shediac Valley AOI depending on the route taken in and out of the port by the cruise ships. Also, some cruise ships may pass through or near the AOI en route to and from Charlottetown. If cruise ships do travel through the AOI, the added vessel traffic is likely minimal and not cause for concern with regard to potential noise disturbance to fish, but may contribute to potential impacts from accidental pollution (see discussion in Section 3.2.2 on Marine Transport above).

Recreational boating includes sailboats, cabin cruisers, powerboats, personal water crafts and human powered boats such as canoes and kayaks (Alexander *et al.* 2010). Recreational boating activity may also be disruptive to the behaviour of whales, seabird nesting colonies and

Table 3.6 Shellfish Aquaculture Sites Licensed by Province*.

Province	Blue Mussel	Oyster	Sea Scallop	Bay Scallop	Quahaug	Clams (Soft Shell, Bar, Surf, Razor Clam)	Sea Urchin	Total
Gulf NB	29	535	43	12	94	113	1	769
PEI	286	703	5	-	54	31	--	1,095
Total	**315**	**1238**	**48**	**12**	**148**	**144**	**1**	**1864**

Source: Gaudet and Leger (2011), Alexander *et al.* (2010).
*Note: A number of aquaculture sites contain more than one species and may be accounted for in more than one column of the table.

Table 3.7 Shellfish Aquaculture Production and Value for New Brunswick, 1997, 2002 and 2007.

Species	Data	Year			% change 1997 to 2007
		1997	2002	2007	
Oysters	Production (tonnes)	265	1,235	3,900	1371.7%
	Value (000's of dollars)	567	1,173	4,100	623.1%
Blue Mussels	Production (tonnes)	137	637	550	301.5%
	Value (000's of dollars)	108	801	600	455.6%
Other Species	Production (tonnes)	0	0	0	-
	Value (000's of dollars)	0	0	0	-
Sum of Production (tonnes)		**402**	**1,872**	**4,450**	**1007.0%**
Sum of Value (000's of dollars)		**675**	**1,974**	**4,700**	**596.3%**

Source: Gaudet and Leger (2011).

Table 3.8 Aquaculture Production and Value for Prince Edward Island, 1997, 2002 and 2007.

Species	Data	Year			% change 1997 to 2007
		1997	2002	2007	
Oysters	Production (tonnes)	1,428	2,736	2,812	96.9%
	Value (000's of dollars)	3,181	5,727	6,700	110.6%
Blue Mussels	Production (tonnes)	9,974	16,785	17,052	71.0%
	Value (000's of dollars)	12,096	22,202	21,800	80.2%
Other Species	Production (tonnes)	94	33	14	-85.1%
	Value (000's of dollars)	851	892	1,700	99.8%
Sum of Production (tonnes)		**11,496**	**19554**	**19878**	**72.9%**
Sum of Value (000's of dollars)		**16,128**	**28821**	**30200**	**87.3%**

Source: Gaudet and Leger (2011).

fish. Data on recreational boating (number and type of vessels) in the Shediac Valley study area is not available at present. It is unlikely that a significant amount of recreational boating occurs in the deeper waters of the AOI, other than potentially sailboats transiting from Chaleur Bay or the Gaspé Peninsula to PEI. There may be some recreational boating in the more shallow waters of the AOI off the New Brunswick coast and near North Cape, PEI (*i.e.,* areas less than 37 m deep).

Recreational diving may also occur in the study area off the New Brunswick coast and near North Cape, but would be limited to waters less than approximately 30 m deep. One would only expect divers to be drawn out to deeper, open waters if there were a major attraction present, such as a sunken "reef" or shipwreck and no such attraction is known to be present in the AOI.

Data Gaps: Consultation with the port authorities in Summerside and Charlottetown or the Canadian Coast Guard should be undertaken to determine cruise ship activity levels and routes. Efforts could be directed toward refining the data on recreational activities in Gaudet and Leger (2011) for the Shediac Valley study area to gain a better understanding of the potential interactions with the AOI.

3.2.5 *Education, Conservation and Research Activities*

3.2.5.1 ***Education***

An overview of educational attainment for the population in the Gulf Region aged 25-64 years was presented in Gaudet and Leger (2011) by province (Table 3.9). Educational attainment in the Gulf Region is below the Canadian average, in particular in northern NB. This may be attributed to the migration of the French population from the area to southern NB to attend the Université de Moncton, many of whom stay in the Moncton area after their university education. This results in the remaining population in northern NB having a relatively lower educational attainment (Gaudet and Leger 2011).

As stated Gaudet and Leger (2011, p. 15), the statistics show "a general decrease in the percentage of the population between 25 and 64 that lack a degree, certificate or diploma." This

Table 3.9 Educational Attainment Overview for the 25-64 Year Old Demographic in Areas Relevant to the Study Area for the Shediac Valley AOI.

Variable	NB North (NB Gulf Watershed)	Prince Edward Island	Gulf Region	Canada
% Without Certificate, Diploma, or Degree	30.9%	18.7%	25.2%	15.4%
% With Bachelor's Degree or Higher	10.2%	17.5%	12.7%	22.9%

Source: Gaudet and Leger (2011).

trend is likely due to the modern educational system which requires children to attend public school and the fact that the current demographic of 65 years of age or above were not likely to attain degrees, certificates or diplomas. The same report also states that trade or college certificates are more prevalent than university degrees in the Gulf Region but that the latter is increasing at a faster rate (Table 3.10) (Gaudet and Leger 2011).

Table 3.10 Detailed Educational Attainment (25-64 Years Old) and Percent Change (2001-2006) in Areas Relevant to the Study Area for the Shediac Valley AOI.

Region	Educational Attainment	2001	2006	% Change
NB North	No degree, certificate or diploma	41.2%	30.9%	-24.9%
	High school graduation certificate	19.7%	22.8%	15.7%
	Trade or college certificate or diploma and university certificate or diploma below bachelor level	30.0%	35.9%	19.6%
	University with Bachelor's degree or above	9.2%	10.2%	11.2%
PEI	No degree, certificate or diploma	31.2%	18.7%	-40.1%
	High school graduation certificate	18.0%	23.7%	31.1%
	Trade or college certificate or diploma and university certificate or diploma below bachelor level	36.3%	40.2%	10.7%
	University with Bachelor's degree or above	14.5%	17.5%	20.6%
Canada	No degree, certificate or diploma	24.6%	15.4%	-37.3%
	High school graduation certificate	22.0%	23.9%	8.6%
	Trade or college certificate or diploma and university certificate or diploma below bachelor level	33.7%	37.7%	12.0%
	University with Bachelor's degree or above	19.7%	22.9%	16.4%

Four academic institutions situated within the study area offer opportunities to study and specialize in coastal and marine related fields. The Collège communautaire du Nouveau-Brunswick (CCNB) founded a campus on the Acadian Peninsula (Le Campus de la Péninsule acadienne) with four training centres located in Neguac, Tracadie-Sheila, Shippagan, and Caraquet (CCNB 2013). Opportunities for specialization in the marine sector are offered in aquaculture, maritime navigation and marine diesel mechanics. The Caraquet centre houses a fisheries school that specializes in trades in the marine sector and research and development geared toward the needs of the marine industry. An aquaculture lab and farm are located on-site.

The Université de Moncton has a campus in Shippagan that offers a bachelor's degree in Integrated Coastal Zone Management (Gaudet and Leger 2011). Examples of courses offered include Coastal Communities and Population, Coastal development, Management of Fisheries Resources and Coastal Recreation and Tourism. The associated Biology program is taught mostly at the University's Moncton campus.

Holland College has a campus in Summerside, PEI consisting of a Marine Training Centre that has been in operation for over 30 years (Holland College 2010). The Centre provides Transport Canada approved training including certification ranging from Deckhand to Master Mariner, plus a number of specialized marine-related courses. The University of PEI offers programs in environmental studies, biology and houses a Canadian Aquaculture Institute (CAI 2006, Gaudet and Leger 2011). The University of PEI includes a campus in Tignish.

Opportunities for collaboration may exist with these institutions on research and development related to conservation, monitoring and sustainability objectives if an MPA is designated, in particular with the Université de Moncton campus in Shippagan (see also Section 3.2.5.3 on Research and Development below).

3.2.5.2 ***Conservation***

Conservation and protected areas in the study area were summarized in Sections 3.1.2 (National Parks and Historic Sites), 3.1.3 (Provincial Parks and Historic Sites) and 3.1.4 (Conservation and Protected Areas) above. Conservation activities are known to occur in some, if not all, of these areas. For example, Kouchibouguac National Park's conservation plan is structured around an ecosystem management priority list including clam management, estuarine fisheries and salmonids management, among other priorities, which guides the research and monitoring undertaken in the park (Parks Canada 2009). Conservation activities in these sites are primarily inland or coastal in nature and would not be expected to interact with the Shediac Valley AOI. The establishment of an MPA may have a positive impact on conservation activities in the study area in that it would strengthen the network of conservation areas in the region and be a point of interest to highlight in tourism and conservation marketing materials.

A large part of the Shediac Valley AOI (DFO groundfish area 4T5) is currently closed by variation order to groundfish fisheries in an effort to conserve declining stocks and assist in their recovery. The establishment of an MPA may encourage the recovery of the groundfish fishery in the area through the identification of related conservation objectives and acceptable activities (type and frequency or intensity) that can take place within the MPA.

3.2.5.3 ***Research and Development***

Both the Atlantic Canada Opportunities Agency (ACOA) and National Research Council of Canada (NRC) contribute federal funding to research and development in the Gulf Region through a variety of investment programs, as summarised in Gaudet and Leger (2011). Significant federal funding (including by DFO) is being directed toward research and development in the aquaculture industry. It has already been determined that interactions between the current aquaculture industry (nearshore) and the Shediac Valley AOI (offshore) are unlikely.

DFO is actively conducting scientific research on a variety of species that are fished in the CRA fisheries in the sGSL, including those in the Shediac Valley AOI study area. For example, scallop spat, enhancement and aquaculture studies are summarized in Davidson *et al.* (2007). Additional examples include surveys of groundish, snow crab, herring and sentinel species, among others.

As outlined in sections above, DFO's Atlantic Zone Monitoring Program (AZMP) includes a station in the Shediac Valley that is regularly sampled (DFO 2010a). Implemented in 1998, the objective of the AZMP is to collect and analyze "the biological, chemical and physical field data that are necessary to (1) characterize and understand the causes of oceanic variability at the seasonal, inter-annual and decadal scales, (2) provide multidisciplinary data sets that can be used to establish relationships among the biological, chemical and physical variables and (3) provide adequate data to support the sound development of ocean activities." (AZMP 2010) The data and products of the AZMP include hydrographic data (temperature, salinity, dissolved oxygen, fluorescence, chlorophyll-a and nutrients), climate indices (oceanography, freshwater, ice and atmosphere), plankton, sea levels, remote sensing and meteorological data.

DFO is also researching socio-economic aspects of the GSL, including human systems and human uses of the land and water in the region (*e.g.,* Alexander *et al.* 2010). This research should enhance DFO's understanding of the social, economic and cultural influences associated with the ecological aspects of the AOI.

The Coastal Zones Research Institute Inc. (CZRI) is a private non-profit institution affiliated with the Université de Moncton campus in Shippagan (CZRI 2007, Gaudet and Leger 2011). The CZRI is the result of a merger of three research and development centres on the Acadian Peninsula in 2002: the Peat Research and Development Centre, Marine Products Research and Development Centre and aquaculture research teams of the New Brunswick Department of Agriculture, Aquaculture and Fisheries at the New Brunswick Aquarium and Marine Centre. Areas of research at the Institute include aquaculture, fishery and marine products and the sustainable development of coastal zones, among others (CZRI 2007). In 2009, the Institute received $3 million from ACOA to fund research focused on increasing value and marketing marine co-products (Gaudet and Leger 2011). There may be opportunities for DFO to collaborate with the CZRI in research related to the Shediac Valley.

3.2.6 ***First Nations Economic Activities***

The Gulf Region First Nations include the northern and eastern portions of New Brunswick, the Gulf coast of Nova Scotia and all of PEI (Figure 3.3). In addition, a number of First Nations from the Québec and Maritimes Regions fish in Gulf waters. The First Nations communities currently situated within the Gulf Region as well as those who fish in Gulf waters are summarized in Table 3.11 below.

First Nations were provided with increased access to the fishery following the *Marshall Decision* in 1999. Subsequently, DFO has negotiated fishing agreements and pursued a variety of initiatives to support the participation of the Mi'kmaq and Maliseet First Nations in the fisheries. DFO invested nearly $600 million into the Marshall Response Initiative to support fisheries access (including vessels and gear and commercial fisheries infrastructure) and internal governance development in these communities (DFO 2011).

Total fish landing data (volume and economic value by species) from Communal Commercial Fishing Licences in the Gulf Region from 2000-2007 were provided in Gaudet and Leger (2011). Revenues were shown to come mainly from lobster (38%) and snow crab (57%). Other important species of economic value are rock crab, shrimp, herring, bluefin tuna and mackerel. Again, it is difficult to apply this broad-scale data to an assessment of the Shediac Valley AOI specifically (for example, not all of these species are thought to be relevant to the AOI) According to Davidson *et al.* (2007), thirteen First Nation's licences have access to the scallop resources in the Gulf Region, including 22 licences granted in eastern New Brunswick, 7 licences in northern New Brunswick and 7 licences on PEI.

There is an Aboriginal seal hunt in the Gulf Region but not in the Shediac Valley AOI (Gaudet and Leger 2011).

It will be important for DFO to engage the First Nations communities to learn more about the economic activities of First Nations in this area. This interaction will assist in identifying any concerns by First Nations regarding the establishment of an MPA in this area and determining how First Nations activities might impact the MPA and vice-versa.

Data Gaps: More research is warranted into gathering information on First Nations economic activities in the study area and potential interactions with the AOI. Such information may be available through the Statistics Canada website, existing information, literature on the individual First Nations communities and direct consultation. .

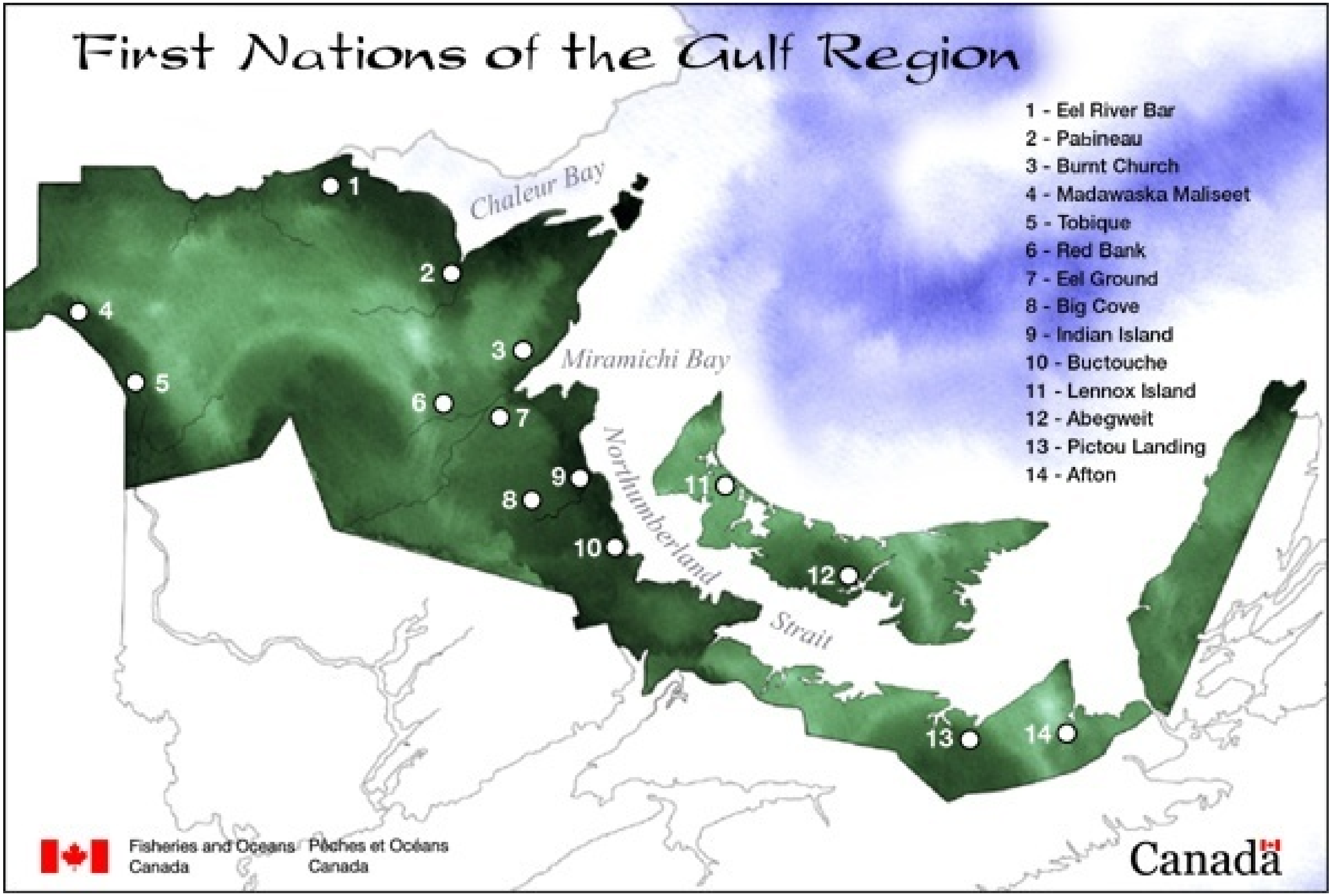

Figure 3.3 Gulf Region First Nations (DFO 2010b).

Table 11 First Nations communities that fish in the GSL.

Province	Aboriginal Group	First Nation
New Brunswick	Mi'kmaq	Eel River Bar
		Pabineau
		Esgenoopetitj First Nation
		Metepenagiag Mi'kmaq Nation
		Indian Island
		Elsipogtog
		Eel Ground
		Buctouche
	Maliseet	Saint Mary's
		Madawaska Maliseet First Nation
		Tobique
Nova Scotia	Mi'kmaq	Pictou Landing
		Paq'tnkek Mi'kmaw Nation
		Potlotek First Nation
		Eskasoni
		Membertou
		Wagmatcook
		Waycobah
		Millbrook
		Glooscap
Prince Edward Island	Mi'kmaq	Abegweit
		Lennox Island
Québec	Mi'kmaq	La Nation Micmac de Gespeg
		Listuguj Mi'gmaq Government
		Micmacs of Gesgapegiag

Source: DFO 2010b, T. Isaac-Mann Crosby, pers. comm, S. Coulombe, pers. comm.

4.0 AREA OF INTEREST EVALUATION

4.1 Introduction and Scope

This section evaluates the impacts of human activities, either on an individual or collective basis, on the important characteristics and ecological functions of the Shediac Valley AOI. The evaluation is based on the existing information and conditions established in Section 2.0 (Ecological Overview) and Section 3.0 (Social, Economic and Cultural Overview) of this report. The following factors have been considered in the evaluation:

- What are the issues that can be identified for each of the biological components (commercial fish and benthic species) of interest for the AOI?
- Which human activities occurring in or near the AOI have an impact on the characteristics or ecological functions to be protected?
- Can the impacts, considered individually and cumulatively, be distinguished from one another?

- What are the activities that may impact the biological components to be protected by the AOI but have the potential to be mitigated? How?
- What are the activities that are incompatible (for which no mitigation measures can be applied)?
- What are the key data gaps that need to be resolved in order to complete the evaluation?

The biological components of interest for the AOI, which have been carried forward for evaluation, are the fish and benthic invertebrate species fished in the CRA fisheries, as identified in Section 2.0 of this report. The potential impacts of human activities on these species are the focus of this evaluation.

Potential interactions between human activities and the AOI were characterized in Section 3.0 of this report. Only key activities from each sector that have the greatest potential to affect the biological components of interest have been carried forward for the evaluation. Potential interactions that were characterized as minor or unlikely to occur in Section 3.0 have not been carried forward. In addition, only those activities that presently occur or are likely to occur in the Shediac Valley AOI study area have been considered; potential future activities that could eventually occur have not been evaluated.

The key activities that are expected to result in primary potential impacts to the biological components of the AOI (whether positive or negative) include activities in the following sectors: CRA fisheries, marine transportation, recreational activities and education, conservation and research activities. Little to no information is known about First Nations economic activities in the AOI at the present time; therefore, it is not possible to identify potential interactions and impacts of activities between this group and the AOI with confidence. However, the importance of First Nations is recognized and it has been included in the evaluation because the potential for interactions exists and needs to be explored. The aquaculture sector has not been carried forward for the evaluation as interactions between activities in this sector and the AOI are considered unlikely due to the offshore location of the AOI (see Section 3.2.3).

In consideration of the key human activities identified as having the greatest potential to affect the biological components of interest in the AOI, the evaluation focuses on the main types of impacts on the biological components: 1) mortality (direct or indirect), 2) change in habitat and 3) change in behaviour.

4.2 Methods

The primary potential impacts on the biological components of each CRA fishery species of interest in the AOI were identified and evaluated by human activity sector. The cause and effect of the impacts were also identified. The degree of impact in the AOI was qualified based on the level or intensity of the human activity, species habitat and distribution and ecological needs (when known). This aspect of the evaluation is subjective and heavily dependent upon the amount of existing information available for both the human activity and the species within the AOI. The degree of knowledge concerning the impacts in the AOI was characterized as *documented*, *poorly documented* or *not documented* (based on the information in Sections 2.0 and 3.0), in order to provide a sense of the level of confidence in evaluating the degree of impact. Note that the degree of knowledge refers to documentation of the actual impact within the AOI, not simply the human activity or species in question relative to the AOI. Key data gaps that need to be resolved in order to complete the evaluation and develop appropriate mitigation measures are highlighted. The results of the evaluation have been summarized in tabular format.

4.3 Limitations

The ecological as well as the social, economic and cultural contexts presented in Sections 2.0 and 3.0, respectively, are based on a review of available information. However, additional information is needed. The results herein should be revisited if and when the existing data gaps are addressed.

4.4 Results and discussion

The evaluation of primary potential impacts of human activities on the biological components to be protected in the Shediac Valley AOI (*i.e.,* CRA fisheries species as identified in Section 2.0) is presented in Table 4.1. Mitigation measures are recommended where appropriate. A discussion of the results according to activity sector follows the table.

4.4.1 *CRA Fisheries*

Removal by capture (intended or accidental), seabed alteration and increased suspended sediments due to fishing (for groundfish and benthic invertebrates) are the primary sources of impacts to the biological components of interest in the AOI from the CRA fishery sector. All fishing activities have a direct impact on mortality of CRA fish species, as well as on non-targeted species. Some fishing techniques (*i.e.,* groundfish trawling and scallop dragging) have a direct impact on fish habitat.

As indicated in Table 4.1, the fish and benthic species of interest found in the Shediac Valley AOI have been categorized as belonging to an open fishery (*i.e.,* Atlantic herring, Atlantic mackerel and snow crab) or to a closed fishery (*i.e.,* DFO Groundfish Area 4T5).

Although the groundfish fishery is closed over much of the AOI (the portion falling within DFO Groundfish Area 4T5), the northern portion of the AOI is outside 4T5 and remains open to the groundfish fishery. This encompasses approximately 20% of the AOI. Even within the closed portion there remains the possibility of mortality due to lost nets (ghost fishing). Ghost fishing is assumed to have a negative impact on the overall abundance of all groundfish species, although the degree of the impact in the AOI is unknown. The development and implementation

Table 4.1 Evaluation of Primary Potential Impacts of Human Activities on the Biological Components to be Protected (*i.e.,* Commercial Fish Species identified in Chapter 2) in the Shediac Valley AOI and Recommended Mitigation Measures.

Biological Sub-component	Impact	Cause of Impact	Effect of Impact	Degree of Impact	Degree of Knowledge of Impact in AOI	Key Data Gaps for Evaluating Impact	Recommended Mitigation Measures
CRA Fisheries (Closed Fishery)							
Groundfish (American plaice cod, Greenland halibut, halibut and redfish)	Mortality	ghost fishing	Negative: Reduced abundance, biomass and spawning potential	Low	Not documented	Existing stock status and trends in AOI	Continue 4T5 groundfish closure Gear loss prevention and recovery initiatives
CRA Fisheries (Open Fishery)							
Groundfish	Mortality	ghost fishing, catch (targeted fishery) or bycatch	Negative: Reduced abundance, biomass and spawning potential	Unknown	Not documented	Existing fisheries bycatch status in AOI	Pending
	Change in habitat	Seabed alteration and increased suspended sediments due to dragging	Negative: Change in benthic biota abundance and/or composition and habitat integrity.	Unknown	Not documented	Existing trawl and dragging activity in AOI	Much of AOI already closed to trawling; consider applying closure to remaining portion of the AOI and to scallop dragging (if the distribution overlaps).
Herring and mackerel	Mortality	Catch (targeted fishery), bycatch or ghost fishing	Negative: Reduced abundance, biomass and spawning potential	Low to moderate	Not documented	Existing fishing activity and stock status in AOI	Gear loss prevention and recovery initiatives
Snow crab	Mortality	Catch (targeted fishery), bycatch, ghost fishing	Negative: Reduced abundance, biomass and spawning potential	Low	Not documented	Existing fishing activity and landings in AOI	Limit fishing in the AOI Gear loss prevention and recovery initiatives
	Change in habitat	Seabed alteration and increased suspended sediments due to	Negative: Change in benthic biota abundance and/or	Low	Poorly documented	Extent of damage caused by bottom trawls and/or drags	Much of AOI already closed to trawling; consider applying closure

Biological Sub-component	Impact	Cause of Impact	Effect of Impact	Degree of Impact	Degree of Knowledge of Impact in AOI	Key Data Gaps for Evaluating Impact	Recommended Mitigation Measures
		trawling or dragging	composition and habitat integrity.				to remaining portion of the AOI and to scallop dragging (if distributions overlap).
	Change in behaviour	Seabed alteration due to trawling and/or dragging	<u>Positive:</u> Increased abundance of feeding snow crab in areas where bottom disturbed (M. Hébert, pers. comm.)	Unknown	Not documented	Extent of occurence in AOI	None recommended
Marine Transportation and Recreational Activities							
Groundfish, herring, mackerel and snow crab	Mortality	Hydrocarbon and waste releases	<u>Negative:</u> Reduced abundance and biomass of planktonic life stages	Low	Not documented	None	Enforcement of existing legislation and regulations for vessel waste discharge and vessel safety.
Herring and mackerel	Change in behaviour	Noise	<u>Negative:</u> Temporary avoidance of area of noise disturbance	Negligible	Not documented	None	None recommended
Education, Conservation and Research Activities							
Groundfish	Mortality	Groundfish closure	<u>Positive:</u> Reduced pressure on stock and juvenile / nursery habitat	Unknown	Not documented	Existing stock status and trends in AOI	Much of AOI already closed to trawling; consider applying closure to remaining portion of the AOI and to scallop dragging (if distribution overlaps)
Herring, mackerel and snow crab	Mortality	Catch quotas, designated fishing seasons and monitoring	<u>Positive:</u> Reduced pressure on stock	Unknown	Not documented	Existing stock status and trends in AOI	Monitoring of biomass
	Mortality	Ongoing research in	<u>Positive:</u> Greater	Moderate	Poorly	Existing biological and	None recommended

Biological Sub-component	Impact	Cause of Impact	Effect of Impact	Degree of Impact	Degree of Knowledge of Impact in AOI	Key Data Gaps for Evaluating Impact	Recommended Mitigation Measures
Groundfish, herring, mackerel and snow crab		the sGSL	understanding of fish species in the area allowing better management of stocks		documented	ecological conditions, stock status and landings in AOI	
			<u>Negative:</u> Reduced abundance	Negligible	Not documented	None	None recommended
First Nations Economic Activities							
Groundfish, herring, mackerel and snow crab	Mortality	Catch (targeted fishery), bycatch or ghost fishing	<u>Negative:</u> Reduced abundance and biomass	Low	Not documented	Existing fishing activity in AOI	None recommended
	Change in habitat	Seabed alteration and increased suspended sediments due to trawling or dragging	<u>Negative:</u> Change in benthic biota abundance and/or composition and habitat integrity.	Low	Not documented	Existing fishing activity in AOI	None recommended

of gear loss prevention (*e.g.,* codes of practice and biodegradable nets) and recovery initiatives may reduce the impact of ghost fishing on all affected species. Continuing the closure of the 4T5 groundfish fishery would mitigate the impacts of fishing on spawning groundfish as well as on nursery habitat of target and non-target species and may reduce other potential factors in the decline of the groundfish stocks (*e.g.,* pollution).

As noted above, the existing groundfish fishery (and any scallop fishery) within the 20% area of the AOI outside of DFO Groundfish Area 4T5 is expected to have a negative impact on groundfish through mortality by directed fishing, bycatch, “ghost” fishing and destruction of vital nursery habitat. There are few means of mitigating the benthic impacts of this fishing activity, apart from regulations already in place. To extend the protection of groundfish species and their nursery habitat to the entire AOI, there is a decision to be made between closing this 20 % area (which is part of DFO Groundfish Area 4T3b) to trawling and dragging, designating an MPA or or accepting the impacts of this fishery. Alternatively, if an MPA is established, the 4T3b area could be left outside of the MPA altogether and the bounds could possibly extended somewhat eastward (within 4T5) to protect more (and deeper) benthic habitat without encroaching on the principal snow crab areas identified in Figs. 2.36 – 2.47, above.

The open CRA fisheries for herring, mackerel and snow crab within the AOI are not expected to have a negative impact, since there is a relatively insignificant fishery for these species within the AOI and none of these fisheries involves dragging or trawling. Ghost fishing by lost nets and/or pots remains a possibility, though unlikely to cause serious impacts due to the limited fishing intensity for herring, mackerel and snow crab in this area. Ghost fishing may also be mitigated by the implementation of gear loss prevention and recovery initiatives.

Since the populations of these species are found elsewhere in the GSL and are not currently at risk, the degree of potential fishing impacts is considered to be low to moderate.

4.4.2 *Marine Transportation and Recreational Activities*

Hydrocarbon and waste releases and noise from vessels are the primary sources of impacts to the biological components of interest in the AOI from the marine transportation and recreational activities sectors.

Hydrocarbon and waste releases from vessels transiting through the AOI may potentially have a negative impact on the biological components of interest through direct mortality to biota, including eggs and larvae. Since vessel traffic through the AOI is relatively light (see Section 3.2.2), the degree of impacts on the biological components is expected to be low, in normal circumstances. Enforcement of existing legislation and regulations as well as awareness building programs, will help to mitigate the potential impacts of these activities, by deterring vessel users from illegal discharge of wastes into waters in or near the AOI.

Any negative impacts of marine transport or recreational activities on the AOI are more likely to come from outside the AOI, as a consequence of accidents or spills occurring in the major sea lanes which pass up current.

The imposition of a shipping lane to avoid passage through the AOI is not recommended as mitigation, given the low levels of ship traffic and the nature of the biological components to be protected (*i.e.,* fish species, not large marine mammals that could be vulnerable to collisions with vessels). Also it may not be feasible, as options for circumventing the AOI may require the lane to pass through shallower waters that would not accommodate large vessels.

Noise from vessels transiting through the AOI could have a negative impact on some biological components ranging from a temporary avoidance of the area (engine noise) to more intense behaviour disturbances caused by sonar. The noise created by vessel traffic is expected to be intermittent and of short duration. In addition, all of the biological components of interest are mobile species, thus it is assumed that in most cases, they would simply move away from the disturbance temporarily. It is also possible that they may become habituated to the disturbance over time. Sonar related disturbances from DND activities are more likely to affect marine mammals, which are not known to be common to this area.

Therefore, the degree of potential impacts from this activity on the biological components is expected to be negligible and no mitigation measures are recommended.

4.4.3 *Education, Conservation and Research Activities*

The closure of DFO Groundfish Area 4T5 would be expected to have a positive impact on conservation of groundfish species in the AOI, by reducing pressures on the stock and the benthic habitat in the area. However, available data indicate that, despite the closure, groundfish stocks in the region are still declining. It may take an indeterminate amount of time for these stocks to recover. Other factors influencing the stocks apparently exist, which are slowing or inhibiting their recovery (*e.g.*, ghost fishing, bycatch from open commercial fisheries outside the AOI, predation pressure, pollution, invasive species, or hydrological (climate) change). Again, ongoing closure of 4T5 is recommended as the best available measure to help mitigate pressures on the stock. A controlled harvest of the adult grey seal population may also be considered to reduce predation pressure.

The establishment of an MPA in the Shediac Valley may encourage the recovery of the groundfish population through identification of related conservation objectives and acceptable activities (type and frequency or intensity) that can take place within the MPA. Surveys indicate that the Shediac Valley is a spawning ground and nursery area for several groundfish species, including Atlantic cod (Figure 2.2 and 2.7). If the Shediac Valley AOI is afforded MPA designation, additional conservation activities for groundfish species could be employed, such as complete closure to all CRA (particularly bottom) fishing activities in the MPA, which would afford protection to juvenile cod and help promote the recovery of sGSL cod stocks.

DFO is conducting a variety of research and development activities in the sGSL that may have a positive impact, either directly or indirectly, on the biological components of interest in the AOI. The research will contribute to a greater understanding of the fish species and their ecological requirements, which should promote sound management of stocks in the area.

Opportunities for collaboration may exist with academic institutions on research and development related to conservation and monitoring in the area, or on sustainability objectives for an MPA, if designated. The establishment of an MPA would also strengthen the network of conservation areas within the study area and may be a point of interest to highlight in regional tourism and conservation marketing materials.

Ongoing research could also have a negative impact on the biological components of interest through direct mortality to fish removed or habitat damaged for research purposes. However the degree of impacts on the biological components is expected to be negligible relative to other pressures on stocks.

4.4.4 *First Nations Economic Activities*

If First Nations communities are conducting fishing activities in the AOI, or have the intention to do so in the future, the types of impacts of these activities on the biological components to be protected would be the same as for the rest of the fishing sector. It is assumed that, if these activities indeed occur, the intensity of activities are likely to be low relative to any non-Native fisheries in the AOI and subsequently the degree of impacts on the biological components would be low.

Consideration of this sector is an important aspect of the MPA process and should be explored for the Shediac Valley. Further research is needed to gather information on First Nations economic activities in the study area and potential interactions within the AOI specifically.

Consultation with the Gulf Region First Nations should be initiated to identify any concerns from First Nations regarding the potential establishment of an MPA in this area and to determine how First Nations activities might impact and/or be impacted by the MPA.

4.5 Summary and Conclusions

The overall objective of this report was to characterize and assess the ecological and socio-economic features of the Shediac Valley AOI to inform the decision-making process regarding the feasibility of establishing an MPA. The current ecological, social, economic and cultural aspects of the AOI were characterized and assessed using existing information and resources currently available.

The issues facing fish and benthic invertebrate species were identified as mortality through open fisheries, bycatch and ghost fishing, as well as habitat alteration due to fishing practices (*i.e.,* trawling and dragging). Change in behaviour was also identified as an issue for herring and mackerel (noise from vessel traffic). These issues are not documented or poorly documented in the Shediac Valley AOI proper. Mitigation measures such as limiting fishing in the AOI, maintaining the groundfish closure in DFO Groundfish Area 4T5, as well as developing and implementing gear loss prevention and recovery initiatives have the potential to alleviate some of these issues.

Some data gaps have been identified that need to be addressed before being able to define or refine conservation objectives for the potential MPA. Notwithstanding that, the current review of existing information suggests that the protection of spawning ground and nursery area for juvenile cod would be a key conservation objective for the potential Shediac Valley MPA. These efforts may be futile however, unless 1) benthic fishing activities (i.e., trawling and dragging) are prohibited in the area and 2) predation pressure on the spawning stocks and juvenile fish is addressed, particularly predation by the resident grey seal population. Other potential conservation objectives may become clearer as data gaps are filled. Given that the conservation objectives for the potential MPA have yet to be confirmed, it is not possible to identify the regulatory and management measures necessary to achieve them at this time.

Thus far, no adverse effects from human activities in the study area have been identified that are incompatible (*i.e.,* cannot be mitigated) with the AOI. However, information on existing or planned First Nations economic activities, additional information on fishing activities and information regarding any future activities (e.g., oil and gas exploration, mineral exploration and wind energy) in the AOI is required to fully make this determination. In this regard, consultation with CRA fish harvesters, federal and provincial governments and industry is recommended for use in subsequent phases of the evaluation process.

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5.2 Personal Communications

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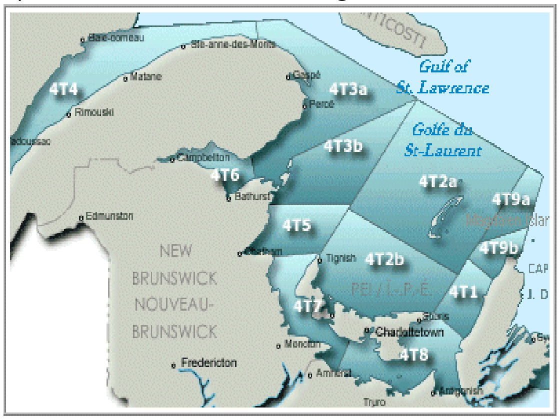
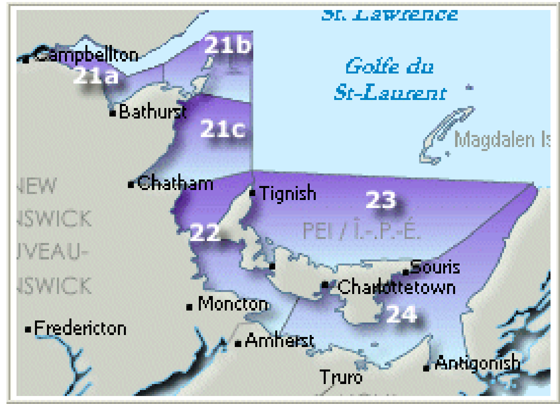
Appendix 1 - DFO Fishing Area Divisions by Species

a) DFO Groundfish Fishing Areas

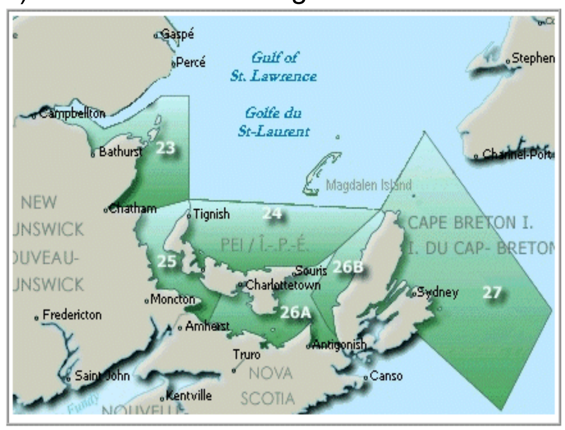


b) DFO Scallop Fishing Areas

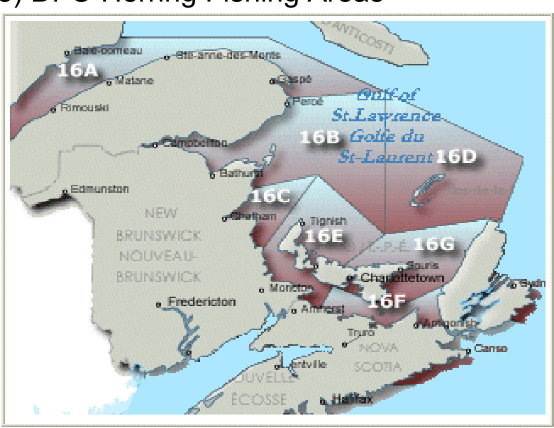


c) DFO Mackerel Fishing Areas

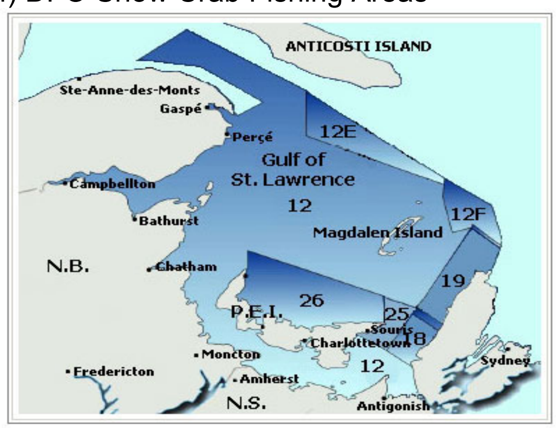
d) DFO Lobster Fishing areas



e) DFO Herring Fishing Areas



f) DFO Snow Crab Fishing Areas



Appendix 2 - Population Structure and Movement of Avian Species in the Shediac Valley AOI
(Compiled By: Environment Canada, Canadian Wildlife Service, Sackville, NB)

Type	Taxonomy	Group	Common Name	Description
Mainly planktivorous, surface seizing species (main diet: marine invertebrates, crustaceans)	Order: Charadriiformes Family: Scolopacidae	Phalaropes	Red Phalarope (*Phalaropus fulicaria*) Red-necked Phalarope (*Phalaropus lobatus*)	Phalaropes likely occur only as migrants within the Shediac Valley AOI limits and area. However, no ship-based surveys have taken place within the AOI itself. Data from limited ship-based surveys in the western half of the Gulf of St. Lawrence indicate that areas 30 to 60 km to the east are known to have hosted low densities (<75th percentile) of phalaropes, while somewhat higher densities (75th to 95th percentiles) have been detected at sites 60-80 km to the northeast of the AOI. With few exceptions, relative densities of phalaropes within the western Gulf of Saint Lawrence appear to be low. Clearly, additional survey effort is warranted in this area.
Mainly planktivorous, surface seizing species (main diet: marine invertebrates, crustaceans)	Order: Procellariiformes Family: Hydrobatidae	Storm-petrels	Leach's Storm-petrel (*Oceanodroma leucorhoa*) Wilson's Storm-petrel (*Oceanites oceanicus*)	The Shediac Valley AOI is within the foraging range of known Leach's Storm-petrel colonies located at Île Brion (QC), and Bonaventure Island (QC). However, together these colonies host about 50 pairs. Ship-based surveys have not taken place in the vicinity of the Shediac Valley AOI. Given limited breeding populations in the Gulf, densities of storm-petrels are unsurprisingly low (<75th percentile). Lack of numbers of both Leach's and Wilson's Storm-petrels together could suggest limited relative value of habitat for these species within the Gulf. However exceptions exist, including records of high densities in the northeastern Gulf of St. Lawrence, Belleisle Strait, and 80-120 km northwest of the Magdalen Islands. Presence of such hotspots, within range of larger colonies on the north shore of the Gulf, suggests greater efforts are warranted to more confidently assess distribution of these species in this area.
Piscivorous/generalists, surface feeding/shallow diving species (main diet: fish; marine invertebrates, crustaceans, molluscs; vegetation; birds; carrion)	Order: Charadriiformes Family: Laridae	Large gulls	Great Black-backed Gull (*Larus marinus*) Herring Gull (*Larus argentatus*) Glaucous Gull (*Larus hyperboreus*) Iceland Gull (*Larus glaucoides*)	Several Great Black-backed and Herring Gull colonies that may total nearly 10000 individuals are located within 100 km of the AOI: Egg Island (NB), Indian Point (PEI), and Iles Mahy (QC). Nonetheless, ship-based surveys have not taken place in the vicinity of the Shediac Valley AOI. Lack of observation of significant numbers of large gulls in the vicinity of the AOI is likely the result of the lack of survey effort in the area. It is reasonable to assume that gulls nesting at the colonies mentioned above rely on broadly distributed pelagic prey resources in addition to what can be found coastally. Additional survey efforts are required in this area to assess the offshore distribution of large gulls in the area.

Mainly piscivorous/generalists, surface feeding/shallow diving species (main diet: fish; marine invertebrates, crustaceans, molluscs; vegetation; birds; carrion)	Order: Charadriiformes Family: Laridae		Black-legged Kittiwake (*Rissa trydactyla*)	Ship-based surveys have not taken place in the vicinity of the Shediac Valley AOI. The nearest breeding colonies of Black-legged Kittiwakes are located in Northern New Brunswick adjacent to the Baie des Chaleurs. It is unlikely that individuals from these breeding colonies venture as far as the AOI during breeding. The lack of observation of individuals in the vicinity of the AOI likely reflects the low breeding numbers of Black-legged in the area. Still, lack of survey effort precludes any confident inference in this respect.
Mainly piscivorous/generalists, surface feeding/shallow diving species (main diet: fish; marine invertebrates, crustaceans, molluscs; vegetation; birds; carrion)	Order: Charadriiformes Family: Laridae	Skuas and jaegers	Parasitic Jaeger (*Stercorarius parasiticus*) Pomarine Jaeger (*Stercorarius pomarinus*) Long-tailed Jaeger (*Stercorarius longicaudus*) Great Skua (*Stercorarius skua*) Southpolar Skua (*Stercorarius maccormicki*)	No ship-based surveys have been undertaken within the AOI and evidence suggests that concentrations of members of this group are infrequent throughout the Gulf of St. Lawrence.
Mainly piscivorous, surface feeding/shallow diving species (main diet: fish; marine invertebrates, squid, crustaceans; carrion)	Order: Procellariformes Family: Procellariidae		Northern Fulmar (*Fulmarus glacialis*)	This species does not nest in the vicinity of the AOI and though survey effort in the area is very limited, nearest detections within the Gulf of St. Lawrence occur 125 km to the northeast, along the southern margin of the inner Laurentian Channel.
Mainly piscivorous, surface feeding/shallow diving species (main diet: fish; marine invertebrates, squid, crustaceans; carrion)	Order: Procellariiformes Family: Procellariidae		Great Shearwater (*Puffinus gravis*)	No ship-based surveys have taken place within the AOI. Nearest detections of shearwaters have occurred 25 km east of the AOI. Concentrations in most of the Gulf do not exceed the 75th percentile.
Mainly piscivorous, surface feeding/shallow diving species (main diet: fish; marine invertebrates, squid, crustaceans; carrion)	Order: Procellariiformes Family: Procellariidae		Sooty Shearwater (*Puffinus griseus*)	No ship-based surveys have taken place within the AOI. Nearest detections of shearwaters have occurred 25 km east of the AOI. Concentrations in most of the Gulf do not exceed the 75th percentile.
Mainly piscivorous, plunge diving species (main diet: fish; marine invertebrates,	Order: Suliformes Family: Sulidae		Northern Gannet (*Morus bassanus*)	No ship-based surveys have taken place within the AOI. Nonetheless, surveys to the north, south and east of the AOI suggest that concentrations up to the 75th percentile for Eastern Canada could be expected in the general area. Given the

squid; carrion)				location of the Bonaventure colony, and the foraging range of the species, surveys in the area are warranted. High concentrations (95th percentile) have been detected 60 km to the north-east of the AOI.
Mainly planktivorous, pursuit diving species (main diet: marine invertebrates, crustaceans, mollusks, marine worms; fish)	Order: Charadriiformes Family: Alcidae		Dovekie (*Alle alle*)	At-sea surveys have not been conducted in this AOI. In addition, the area is largely ice-covered during winter months, when the species is most often detected. Nearest detections (below the 75th percentile) of this species have occurred approximately 30 km to the East of the AOI.
Mainly piscivorous, pursuit diving species (main diet: fish; marine invertebrates, crustaceans, marine worms, squid)	Order: Charadriiformes Family: Alcidae	Large alcids	Thick-billed Murre (*Uria lomvia*) Common Murre (*Uria aalge*) Razorbill (*Alca torda*) Atlantic Puffin (*Fratercula arctica*)	No at-sea surveys have taken place within this AOI. Nearest detections have occurred approximately 30 km to the East and high densities have been observed, likely associated with breeding individuals at Bonaventure Island, 60 km to the north-east. The area lies within the foraging range of birds nesting at the latter location, but efforts would be required to determine use of the area by birds from this and possibly other large alcid colonies.
Mainly piscivorous, pursuit diving species (main diet: fish; marine invertebrates, crustaceans, marine worms, squid)	Order: Charadriiformes Family: Alcidae	Murres	Thick-billed Murre (*Uria lomvia*) Common Murre (*Uria aalge*)	No at-sea surveys have taken place within this AOI. Nearest detections have occurred approximately 30 km to the East and high densities have been observed, likely associated with breeding individuals at Bonaventure Island, 60 km to the north-east. The area lies within the foraging range of birds nesting at the latter location, but efforts would be required to determine use of the area by birds from this and possibly other murre colonies.