2.0 Marine Ecology

Voisey's Bay Nickel Company Limited (VBNC) retained LGL Limited of St. John's to conduct a review of information and to provide marine environmental baseline information on Long Harbour. This chapter of the Marine Environment Study presents the results of the October 2005 to October 2006 sampling program designed to collect baseline information on sea water, marine sediment, and marine biota quality (i.e., fish and fish habitat) in Long Harbour (hereafter termed the "Marine Ecology Study"). The four sampling times during this period were October 2005, May 2006, July 2006, and September/October 2006. Sampling included sea water, surficial sediments, blue mussels, winter flounder, and benthic habitat surveys by Remotely Operated Vehicle (ROV).

Two baseline/technical studies in 1997 (JWE 1997) and 1998 (LGL 1998) were conducted in the Argentia area for an environmental assessment of a proposed VBNC nickel smelter/refinery at Argentia. These studies included a number of marine sampling sites located around the Argentia Peninsula. In 2002, VBNC proposed to construct a demonstration plant at Argentia to test hydrometallurgical processes for commercial development. Subsequently, a third Argentia area baseline investigation was conducted in late 2002 (JWE 2003). The JWE (2003) study included two additional marine sampling sites, both located in Rattling Brook Cove within Long Harbour, at the time a potential location of a treated effluent outfall from one residue storage alternative. Since that time, investigations of additional potential residue storage sites have been conducted. The demonstration plant was assessed pursuant to the Newfoundland and Labrador *Environmental Protection Act* and the *Canadian Environmental Assessment Act* and was subsequently released from further environmental assessment in December 2002.

For the proposed Long Harbour plant, VBNC required additional information to describe the existing marine environment in Long Harbour. The following sections describe the results of data collections between October 2005 and October 2006, and the methodologies used to collect these data.

2.1. Objective

The objective of the sampling program was to establish baseline conditions in Long Harbour for selected variables in various media (i.e., sea water, surficial sediment, and various biota). [VBNC's intention was to obtain baseline data at a variety of locations for the purposes of describing existing conditions in the general area of the proposed Project. It is recognized by VBNC that additional replication may be required for the design of any specific environmental effects monitoring (EEM) programs once the environmental assessment phase is complete.]

2.2. Study Design

Locations of the six sampling stations within Long Harbour were selected to provide the coverage necessary to establish baseline conditions with respect to sea water, surficial sediment, and biota. The locations range from the relatively sheltered head of Long Harbour to the more exposed area towards the

mouth of Long Harbour. Local fishers provided their local ecological knowledge during the station selection process to ensure that the station locations reflected habitat diversity within Long Harbour. The initial uptake of chemicals by biota is through contact with the sea water and/or surficial sediments (i.e., the pathways). A reference station location at Little Seal Cove was selected on the advice of local fishers; not establishing the reference station until May 2006 was an oversight. Local fishers indicated that the direction of water movement out of Long Harbour was typically northward, away from Little Seal Cove (see Figure 2.1). The sampling was also intended to provide data on natural variability and rates of uptake by an indicator species the blue mussel (*Mytilus edulis*). These baseline data will also provide assistance in determining if any future environmental impacts are caused by the Project.

Sea water samples were collected with a Niskin water sampler; a Ponar grab sampler was employed to collect surficial sediment samples, and blue mussel samples were installed on, and removed from, moorings retrievable from surface. The blue mussels were from a commercial aquaculture farm located in Trinity Bay. The advantages of using farmed mussels include

- decreased variability in animal size and age,
- propensity to filter-feed, and
- assurance that a sufficient number of individuals of a single species can be collected at each sampling station.

In addition, past baseline and monitoring studies have been plagued by significant problems associated with the collection of a mixture of blue mussels and horse mussels, as well as the non-occurrence of mussels of either species at some of monitoring stations.

Winter flounder were caught using gill nets deployed by local commercial fishermen. Additional benthic ecology data were collected with an ROV flown by a trained operator from the Marine Institute in St. John’s, NL.

Data collected during the Marine Ecology Study were not statistically analyzed because sample sizes were too small for meaningful statistical analyses, including non-parametric analyses. The present surveys were intended to describe the present baseline levels of various parameters at different locations in the area. It is not necessary to statistically compare stations in order to establish a baseline. However, statistical analyses will be necessary for future monitoring programs once a point source of potential contamination is introduced to the area. In the meantime, more data relating to seawater, surficial sediments, and biota are being collected at the baseline sampling stations. The complete baseline database will be sufficient to make comparisons during a monitoring program.

2.3. Component Study Area

The Marine Ecology Study area extended from Sandy Point, located near the eastern extreme of Long Harbour to Little Seal Cove, located south of the mouth of Long Harbour (Figure 2.1). A candidate location of the treated effluent outfall is located approximately 5.75 km west of the former ERCO wharf between Crawley Island and Shag Rocks. This is a preliminary site based on preliminary oceanographic mixing studies that demonstrated that this area provides a good mixing environment. The final location of the marine outfall will be selected once detailed engineering is completed and during the permitting process. Other candidate outfall locations have not yet been surveyed but present information indicates the outfall will be in the vicinity of the one indicated here. Water depths in Long Harbour (lowest normal tide) range from less than one metre to just under 90 m. Both commercial fishery and aquaculture (mussel farm in St. Croix Bay) activities occur within Long Harbour.

2.4. Study Team

Many individuals contributed to the Marine Ecology Study. John Christian, M.Sc., a senior biologist with LGL Limited, was the primary investigator. LGL technicians/biologists who provided field assistance during the sampling program include William Coffey, Courtney Hayden, Bruce Mactavish, and Valerie Moulton, M.Sc. Jack Bailey and Andy Murphy provided boat and boat crew support for this study and were invaluable in terms of local ecological knowledge and seamanship. Both men made numerous suggestions which strengthened the study. Rick Pippy supplied the blue mussels for the program and provided sound advice on installation of the mussels at the stations. ROV expertise was provided by Phil Walsh of the Marine Institute in St. John's, NL. Maxxam Analytics Inc. of St. John's, NL, and Bedford, NS, performed the chemical analyses. Mark Fitzgerald, a GIS specialist with LGL, provided graphics for the study report. Robert Buchanan, M.Sc., Atlantic Vice-President for LGL, provided advice and editorial support throughout the study.

2.5. Materials and Methods

The following sections describe the materials and methods employed during the Marine Ecology Study.

2.5.1. Field and LGL Laboratory

Six sampling stations within Long Harbour and one reference sampling station outside of Long Harbour were used during the Marine Ecology Study (Figure 2.1; Table 2.1). Sea water, surficial sediment, and mussel samples were collected during field trips in October 2005, May 2006, July 2006, and September 2006. Blue mussels were depurated and processed in the LGL laboratory in St. John's. Additional sampling during the September/October 2006 field trip included winter flounder collection, ROV benthic habitat surveys, and an additional surficial sediment sample collection at the candidate marine effluent outfall location. Mussels from a Long Harbour farm were also sampled in April 2007 for comparison purposes.

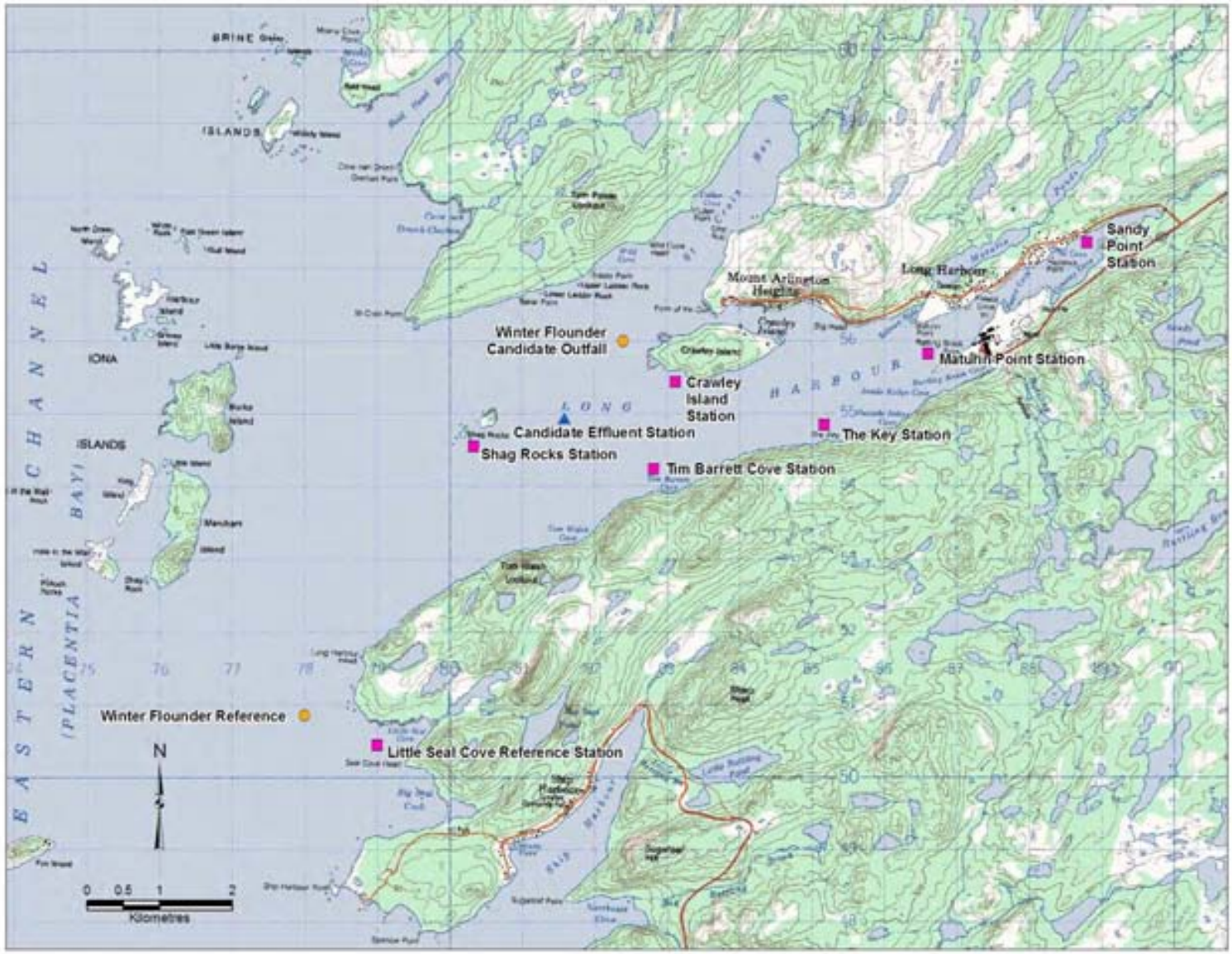

Figure 2.1. Locations of the Sampling Stations of the Long Harbour Marine Ecology Study.

Table 2.1. Location Coordinates (UTM, NAD83) of Long Harbour Marine Ecology Study Sampling Station Components.

Sampling Station	Sampling Component			
	Sea Water	Surficial Sediments	Blue Mussels	Winter Flounder
Sandy Point	288731 E 5257497 N	288750 E 5257497 N	288731 E 5257497 N	
Maturin Point	286983 E 5256201 N	286225 E 5255699 N	286983 E 5256201 N	
The Key	285201 E 5254872 N	285496 E 5255007 N	285201 E 5254872 N	
Tim Barrett Cove	282909 E 5254372 N	283262 E 5254717 N	282909 E 5254372 N	
Crawley Island	283167 E 5255700 N	283042 E 5255569 N	283167 E 5255700 N	
Shag Rocks	280331 E 5254792 N	281253 E 5254958 N	280331 E 5254792 N	
Little Seal Cove (Reference Station)	279180 E 5250616 N	275408 E 5250839 N	279180 E 5250616 N	278104 E 5251089 N
Candidate Effluent Outfall		281668 E 5255175 N		282498 E 5256181 N

All samples collected in the field were rapidly processed and carefully handled to prevent them from being compromised. Any future field sampling in support of EEM will incorporate the use of field blanks, duplicate samples and trip blanks at a suitable frequency relative to the total number of samples. Information on laboratory blanks and replication is contained in Section 2.5.2 below. All relevant location coordinates were determined using both the vessel DGPS and a handheld GPS. The fieldwork was conducted from the deck of a 10.7-m longliner skippered by Jack Bailey of Long Harbour.

2.5.1.1. Sea Water

Surface and bottom sea water samples were collected with Niskin samplers at a location between the two mussel moorings at each sampling station. Surface sea water samples were collected approximately 0.5 m below the surface and bottom sea water samples were collected approximately 0.5 m above the bottom substrate. Water depths associated with sea water sampling at each station are indicated in Table 2.2. Sea water was not collected at the candidate outfall location. Upon final selection of the outfall location, sea water sampling will be conducted.

Sea water requiring various analyses was dispensed into the respective containers supplied by the analytical laboratory (Maxxam Analytics Inc. of Bedford, Nova Scotia). Sea water samples were maintained at about 4ºC in coolers with icepacks, transferred to a refrigerator at LGL in St. John's, and subsequently shipped to the analytical lab within two to three days of sample collection.

Table 2.2. Water Depths and Thermograph IDs at Long Harbour Marine Ecology Study Sampling Stations.

Sampling Station And Components	Water Depth (M)	Thermograph ID
Sandy Point		
Mussel mooring #1	6.0	896604
Mussel mooring #2	6.0	896607
Water sampling	7.0	
Ponar grab sampling	7.5	
Maturin Point		
Mussel mooring #1	7.5	896602
Mussel mooring #2	7.5	896601
Water sampling	8.5	
Ponar grab sampling	27.5	
The Key		
Mussel mooring #1	13.0	885364
Mussel mooring #2	13.0	896605
Water sampling	14.0	
Ponar grab sampling	33.0	
Tim Barrett Cove		
Mussel mooring #1	11.5	882310
Mussel mooring #2	11.5	896603
Water sampling	12.5	
Ponar grab sampling	44.0	
Crawley Island		
Mussel mooring #1	17.0	896606
Mussel mooring #2	17.0	896599
Water sampling	18.0	
Ponar grab sampling	42.0	
Shag Rocks		
Mussel mooring #1	15.0	970021
Mussel mooring #2	15.0	896600
Water sampling	16.0	
Ponar grab sampling	44.0	
Little Seal Cove (Reference Station)		
Mussel mooring #1	10.5	970032
Mussel mooring #2	10.5	970030
Water sampling	11.5	
Ponar grab sampling	70.0	
Winter flounder	30.0	
Candidate Effluent Outfall		
Ponar grab sampling	69.5	
Winter flounder	29.0	

2.5.1.2. Surficial Sediment

Surficial sediment sampling sites were located as close to the mussel moorings as possible. In order to ensure an adequate proportion of sediment fines (<0.0625 mm particle size) in each sample, in some cases, it was necessary to select some sediment sampling sites hundreds of metres from the corresponding mussel moorings.

Marine sediment samples were collected using a stainless steel Ponar grab sampler that was allowed to free-fall to the bottom and was then retrieved using a hydraulic hauler. Surficial sediment samples were extracted from the upper six centimetres of the grab samples. The Ponar grab was rinsed thoroughly with clean sea water between sampling stations. Water depths at the surficial sediment sampling sites are indicated in Table 2.2.

The grab sampler is designed to protect the sediment sample integrity such that the surface sediment is not mixed with the underlying sediment. Sediment samples were removed from the Ponar grab with a stainless steel spoon and placed into glass jars provided by the analytical laboratory. Collected marine sediment samples were maintained at approximately 4ºC in coolers with icepacks until transfer to a refrigerator at LGL in St. John's and subsequent shipment to Maxxam Analytics Inc.

2.5.1.3. Mussel Moorings

Two mussel moorings were deployed at each of the six stations within Long Harbour and at the reference station at Little Seal Cove. Water depths of the mussel mooring sites are indicated in Table 2.2. Each mussel mooring consisted of a 90-kg anchor to which a vertical line to surface and a horizontal groundline were attached. Two pearl nets containing blue mussels and a 36-cm "hardball" vinyl float were attached to the vertical line about one or two metres above the seabed. A line attached to the top of the hardball float extended to surface and was attached to an inflatable surface marker. The 40-m groundline was laid across the seabed at a known bearing. All mooring connections were constructed using thimbles and shackles. Based on the advice of the vessel's skipper, mussel moorings were deployed at locations that minimized potential interaction with purse seining vessels fishing herring in the spring and fall. High flyers equipped with radar reflectors were installed at each pair of mussel moorings in order to assist seiners to detect the moorings at night. Each mussel mooring was designed to hold farmed blue mussels (from Shells & Fins Inc., Trinity Bay) in pearl nets suspended approximately 1.5 m above the sea floor. Each mooring was outfitted with a groundline that can serve as a means of mooring retrieval in the case of loss of the surface buoy. A thermograph was also attached to each mussel mooring to record the ambient water temperature every four hours. Two mussel moorings were deployed at each station to provide back-up marine biota and temperature data at each station. The durations of mussel exposure to the Long Harbour marine environment varied throughout the baseline study. See Section 2.8 for the mussel exposure periods reported in this document. Mussel moorings were not deployed at the candidate outfall location. Consideration may be given to deploying mussels at the selected final marine outfall location.

Mussel samples were returned to the LGL laboratory in St. John's and depurated for 48 hours in sand-filtered sea water obtained from the Ocean Sciences Centre at Logy Bay. Thirty of the mussels were measured for length, width, and height, and then bagged and frozen prior to shipment to the analytical laboratory, Maxxam Analytics Inc. Ten more individual mussels were also measured for length, width, and height, and their soft tissues were oven dried for eight hours at 85ºC. A condition index was then calculated for each of the ten blue mussels.

2.5.1.4. Bottom Water Temperature

Bottom water temperature data were collected every four hours by thermographs (StowAway Tidbit Temperature Loggers, Onset Computer Corporation) at each mussel mooring and downloaded to a portable data storage unit during field trips in May, July, and September 2006. Each thermograph was positioned approximately 1.5 m above the bottom substrate at the same depth as the mussels on each mooring. Data were returned to LGL in St. John's and subsequently analyzed. Thermograph identification numbers are indicated in Table 2.2. Depths of the thermographs on the mussel mooring are the same as the depths of the associated blue mussels indicated in Table 2.2.

2.5.1.5. Winter Flounder

Winter flounder was used in the baseline study because of its direct contact with the surficial sediment in the benthic habitat. Local fishers also suggested that winter flounder would be relatively easy to capture in Long Harbour. Winter flounder were caught using gill nets at two locations: (1) the reference station at Little Seal Cove and (2) the candidate marine effluent outfall area. Eighteen fish were collected at Little Seal Cove and 21 were taken at the candidate outfall location. Winter flounder samples were collected under the commercial groundfish licence of a local fisher. Other species captured during gillnetting included American plaice (three individuals) and northern wolfish (one juvenile). All bycatch fish were released unharmed. All flounder were measured for length, weighed, and subsequently dissected. Samples of muscle, liver, and kidney tissue were removed from each fish and frozen in dry ice. The gastrointestinal tract, spleen, gonads, heart, and gills were also sampled from each fish and archived in 10% formalin. All samples were returned to St. John's where the frozen muscle, liver, and kidney samples were composited into five samples on the basis of fish gender for each sampling location and shipped to the analytical laboratory for analysis. Any future sampling of fish will also include the collection of ageing material (i.e., scales and/or otoliths).

2.5.1.6. ROV Surveys of Benthic Habitat

A Stealth2 ROV (Shark Marine Technologies Inc.) was "flown" approximately one metre above the bottom substrate by a trained operator from the Marine Institute (St. John's) to survey the benthic habitat at different locations in Long Harbour including the candidate location for the marine effluent outfall between Crawley Island and Shag Rocks, and the north and south sides of the old ERCO wharf in Rattling Brook Cove, Long Harbour.

At the candidate outfall area, the longliner was anchored at pre-determined locations, and the ROV was flown on transects from the vessel at bearings of 0º, 90º, 180º, 270º at each anchorage location. The ROV included a built-in compass and depth/pressure sensor. Each transect was 100-120 m in length.

The benthic habitat survey conducted on the north side of the wharf included eight equally spaced transects flown perpendicular from the wharf. Each transect was approximately 100 m in length. The benthic habitat survey conducted on the south side of the wharf in Rattling Brook Cove included four transects from a single vessel anchorage at bearings of 15°, 105°, 195°, and 285°. Each transect was approximately 100-120 m in length, or as long as the distance to shore.

Between five and six hours of video were collected and subsequently analyzed. Benthic habitat characteristics were recorded during the analysis of the videos.

2.5.2. Analyses by Maxxam Analytics Inc.

The analyses performed by Maxxam Analytics Inc. are indicated in Table 2.3. Maxxam Analytics Inc. has developed a quality assurance program which meets or exceeds the requirements of SCC (Standards Council of Canada) and CAEAL (Canadian Association of Environmental Analytical Laboratories). The quality assurance program includes method blanks, certified reference materials, matrix spikes, and spiked blanks. Laboratory quality assurance results were supplied by Maxxam Analytics Inc. and are available on request. The analysis parameters are essentially equivalent to those of other VBNC

Table 2.3. Parameters and Methods Used by Maxxam Analytics Inc.

Matrix	Parameter	Method
Sea Water	pH	pH Meter
	TSS[1]	Gravimetric
	BTEX/TPH[2]	Atlantic PIRI[4]
	Mercury	CVAA[5]
	Metal Scan	ICP-MS[6]
Marine Sediment	Particle Size	Sieve and Pipette
	Mercury	CVAA
	TIC/TOC[3]	Induction Furnace
	Extractable Hydrocarbons (>C_{10}-C_{32})	Atlantic PIRI
	Sulphate	COBAS[7]
	Available Metal Scan	ICP-MS
Blue Mussel	Metal Scan	ICP-MS
	Mercury	CVAA
	Extractable Hydrocarbons (>C_{10}-C_{32})	Atlantic PIRI
Winter Flounder	Metal Scan	ICP-MS
(muscle, liver, kidney)	Mercury	CVAA
	Extractable Hydrocarbons (>C_{10}-C_{32})	Atlantic PIRI

[1] Total suspended solids
[2] Benzene, toluene, ethylbenzene, xylene/total petrogenic hydrocarbons
[3] Total inorganic carbon/total organic carbon
[4] Atlantic Partnership in RBCA (Risk Based Corrective Action) Implementation
[5] Cold Vapour Atomic Absorption Spectrometer
[6] Inductively Coupled Plasma/Mass Spectrometer
[7] Automated Centrifugal Colourimetric Analysis

Argentia area baseline studies conducted between 1997 and 2002. Phosphorus was added to the list of bioavailable metals for surficial sediments in May 2006.

2.6. Results

Results of analyses are described in the following sections.

2.6.1. Sea Water and Marine Sediment Guidelines

Guideline values for some of the parameters measured in sea water and marine surficial sediment samples are indicated in Table 2.4. Various sources were used in order to present guidelines for as many parameters as possible. The CCME (2002) guidelines for sea water in Table 2.4 pertain only to potential impact on aquatic life. Other CCME water guidelines pertain to agriculture, recreation, aesthetics, and consumption. Note that an Interim Sediment Quality Guideline (ISQG) value is lower than the Probable Effect Level (PEL) value for any parameter where both values are available. The PEL is most relevant to biological impact. Note that PEL values have been derived primarily from laboratory experimentation with benthic invertebrates.

Table 2.4. Sea Water and Marine Sediment Guidelines.

Parameter	Water Quality Guideline (WQG) for Marine Biota	Interim Sediment Quality Guideline (ISQG)	Sediment Probable Effects Level (PEL)	Source
pH	7.0-8.7			[1]
Units for Chemicals	**µg/L**	**mg/kg**	**mg/kg**	
Benzene	110			[1]
Toluene	215			[1]
Ethylbenzene	25			[1]
Arsenic	12.5	7.24	41.6	[1]
Barium		48		[2]
Cadmium	0.12	0.7	4.2	[1]
Chromium (trivalent)	56			[1]
Chromium (hexavalent)	1.5			[1]
Chromium		52.3	160	[1]
Cobalt		10		[2]
Copper	2	18.7	108	[1, 3]
Iron	50	20,000	40,000	[3, 4]
Lead	2	30.2	112	[1, 3]
Manganese	100	260		[2, 3]
Mercury		0.13	0.7	[1]
Nickel	8.3	30	50	[3]
Selenium		1		[2]
Silver		1	2.2	[3]
Thallium		0.24	10	[4]
Vanadium		57		[2]
Zinc	10	124	271	[1, 3]

Sources: [1] CCME (2002)
[2] NOAA (1999)
[3] BC MOE (2006)
[4] MacDonald et al. (1999)

2.6.2. Sea Water

Ranges of results of the laboratory analyses of surface and bottom sea water samples collected at each station are presented in Table 2.5. Complete analysis results are available in Appendix 2.A.

2.6.2.1. Guideline Exceedances

- Maximum concentrations of copper in both surface and bottom sea water at The Key (3.8 µg/L and 2.4 µg/L, respectively) and in bottom sea water at Maturin Point (2.7 µg/L) all exceeded the guideline value 2 µg/L (Tables 2.4 and 2.5).

- The maximum concentration of iron in surface sea water at Sandy Point (137 µg/L) exceeded the guideline value 50 µg/L (Tables 2.4 and 2.5).

- Maximum concentrations of lead in bottom sea water at Maturin Point (5.2 µg/L) and The Key (25.7 µg/L) exceeded the guideline value 2 µg/L (Tables 2.4 and 2.5).

- The maximum concentration of zinc in bottom sea water at The Key (19 µg/L) exceeded the guideline value 10 µg/L (Tables 2.4 and 2.5).

In all cases, only one of the four samples collected between October 2005 and September 2006 had a concentration that exceeded the guideline value. Six of the seven guideline exceedances occurred in samples collected in October 2005.

2.6.2.2. Trends

The majority of stations that exhibited the highest concentrations of certain parameters in both surface and bottom sea water samples were those located in the inner part of Long Harbour (i.e., Sandy Point, Maturin Point, and The Key). Parameters whose station concentrations in surface water were consistently higher than those at the reference station at Little Seal Cove include TSS, arsenic, chromium, copper, iron, manganese, and zinc. Parameters whose station concentrations in bottom water were consistently higher than those at the reference station at Little Seal Cove include TSS, iron, and lead.

2.6.2.3. Comparative Data

Surface sea water data were collected at two stations in Rattling Brook Cove in Long Harbour in December 2002 (JWE 2003) during a baseline investigation for VBNC.

Table 2.5. Ranges of Results of Sea Water Analyses, October 2005 to September 2006.

Surface Water Parameter	Reported Detection Level	Sampling Station						
		Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove
Number of samples		4	4	4	4	4	4	3
pH	N/A	7.63-7.99	7.81-8.06	7.94-8.04	7.93-8.03	7.85-8.14	7.65-8.03	7.80-8.03
TSS (mg/L)[1]	1	1-5	2.5-6	1.9-8	1.3-4	2-5	n.d.-8	2.5-4
BTEX/TPH (mg/L)								
Benzene	0.001	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Toluene	0.001	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ethylbenzene	0.001	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Xylene (total)	0.002	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
C_6-C_{10} (less BTEX)	0.01	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
>C_{10}-C_{21} hydrocarbons	0.05	n.d.	n.d.	n.d.	n.d.-0.06	n.d.	n.d.	n.d.
>C_{21}-C_{32} hydrocarbons	0.1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Modified TPH[2] (Tier 1)	0.1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Total mercury (µg/L)	0.01	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Metal Scan (µg/L)								
Arsenic	0.1	0.5-1.1	0.6-1.0	0.6-1.0	0.6-0.9	0.6-1.2	0.5-1.2	0.5-1.0
Cadmium	0.1	n.d.	n.d.-0.1	n.d.	n.d.	n.d.	n.d.	n.d.
Chromium	0.5	n.d.-0.5	n.d.-0.7	n.d.-0.7	n.d.	n.d.-0.8	n.d.-0.6	n.d.-0.6
Cobalt	0.1	n.d.	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	0.1	0.2-1.5	0.3-0.6	0.4-3.8	0.2-0.9	0.2-0.5	0.3-0.5	0.3-0.4
Iron	1	n.d.-137	n.d.-34	n.d.-7	n.d.-10	n.d.-9	n.d.-9	n.d.-4
Lead	0.1	n.d.-0.3	n.d.-0.1	n.d.-0.2	n.d.-0.4	n.d.-0.3	n.d.-0.2	n.d.-0.3
Manganese	1	2-12	1-6	n.d.-2	n.d.	n.d.-2	n.d.-2	n.d.-1
Nickel	0.5	n.d.-0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Zinc	1	n.d.-3	n.d.-2	n.d.-2	n.d.-1	n.d.	n.d.	n.d.-1

Table 2.5 (Continued).

Bottom Water Parameter	Reported Detection Level	Sampling Station						
		Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove
Number of samples		4	4	4	4	4	4	3
pH	N/A	7.84-8.01	7.45-8.05	7.78-8.03	7.81-8.04	7.78-8.04	7.40-8.03	7.80-8.03
TSS[1] (mg/L)	1	1.1-8	1-12	1-6	n.d.-6	2-9	1.7-4	2.1-3
BTEX/TPH (mg/L)								
Benzene	0.001	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Toluene	0.001	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ethylbenzene	0.001	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Xylene (total)	0.002	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
C_6-C_{10} (less BTEX)	0.01	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
>C_{10}-C_{21} hydrocarbons	0.05	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
>C_{21}-C_{32} hydrocarbons	0.1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Modified TPH[2] (Tier 1)	0.1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Total mercury (µg/L)	0.01	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Metal Scan (µg/L)								
Arsenic	0.1	0.6-0.9	0.6-1.0	0.7-1.1	0.6-1.1	0.6-1.3	0.6-1.3	0.5-1.5
Cadmium	0.1	n.d.	n.d.	n.d.-0.1	n.d.	n.d.	n.d.-0.3	n.d.
Chromium	0.5	n.d.-0.6	n.d.	n.d.-0.9	n.d.-0.9	n.d.-0.5	n.d.	n.d.-1.6
Cobalt	0.1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Copper	0.1	0.3-0.6	0.2-2.7	0.1-2.4	0.1-0.3	0.1-0.4	0.1-0.3	0.1-0.6
Iron	1	n.d.-21	n.d.-6	n.d.-8	n.d.-6	n.d.-7	n.d.-7	n.d.-3
Lead	0.1	0.1-0.4	n.d.-5.2	n.d.-25.7	n.d.-0.2	n.d.-0.3	n.d.-0.1	n.d.-0.1
Manganese	1	1-5	n.d.-1	n.d.-1	n.d.	n.d.-1	n.d.	n.d.
Nickel	0.5	n.d.	n.d.-3.8	n.d.	n.d.-6.2	n.d.	n.d.	n.d.
Zinc	1	n.d.-4	n.d.-5	n.d.-19	n.d.-1	n.d.	n.d.	n.d.

[1] Total suspended solids
[2] Total petrogenic hydrocarbons
n.d. denotes 'not detected'
'N/A' denotes not applicable
Shaded cells indicate at least one exceedance of Water Quality Guideline (WQG)

Analytical results for the surface sea water samples collected during this baseline study at the stations nearest to Rattling Brook Cove (i.e., Maturin Point and The Key) were similar to the 2002 results. Notable differences included maximum concentrations of arsenic and copper that were noticeably higher in 2005-6 compared to 2002 results, and maximum concentrations of iron and manganese that are noticeably lower in 2005-6 compared to 2002.

2.7. Surficial Sediments

Ranges of results of the laboratory analyses of marine sediment samples collected at each station are presented in Table 2.6. Complete analysis results are available in Appendix 2.B.

2.7.1. Guideline Exceedances

None of the surficial sediment samples collected during the Marine Ecology Study between October 2005 and September 2006 exceeded any of the PEL parameter guidelines indicated in Table 2.4. The following exceedances are in relation to the ISQG.

- Maximum concentrations of arsenic in surficial sediment at all six sampling stations within Long Harbour exceeded the ISQG value 7.24 mg/kg (Tables 2.4 and 2.6).

- Maximum concentrations of barium in surficial sediment at all six sampling stations within Long Harbour, the reference station at Little Seal Cove, and the candidate outfall location exceeded the ISQG value 48 mg/kg (Tables 2.4 and 2.6).

- Maximum concentrations of cadmium in surficial sediment at Sandy Point, Maturin Point, and The Key (inner three stations) exceeded the ISQG value 0.7 mg/kg (Tables 2.4 and 2.6).

- Maximum concentration of cobalt in surficial sediment at Crawley Island exceeded the ISQG value 10 mg/kg (Tables 2.4 and 2.6).

- Maximum concentrations of copper in surficial sediment at all six sampling stations within Long Harbour and the candidate outfall location exceeded the ISQG value 18.7 mg/kg (Tables 2.4 and 2.6).

- Maximum concentrations of iron in surficial sediment at Maturin Point and Tim Barrett Cove exceeded the ISQG value 20,000 mg/kg (Tables 2.4 and 2.6).

- Maximum concentration of lead in surficial sediment at Sandy Point exceeded the ISQG value 30.2 mg/kg (Tables 2.4 and 2.6).

Table 2.6. Ranges of Results of Surficial Sediment Analyses, October 2005 to September 2006.

Parameter	Reported Detection Level	Sampling Station							
		Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove	Candidate Effluent Outfall
Number of samples		4	4	4	4	4	4	3	1
PSA[1] (%)									
Gravel	0.1	n.d.-6.1	0.3-7.4	n.d.	n.d.-23	n.d.-1.8	n.d.-44	n.d.	n.d.
Sand	0.1	13-34	27-33	30-46	23-61	18-51	18-57	64-70	29
Silt	0.1	22-37	38-47	35-47	9-50	27-48	16-46	17-21	42
Clay	0.1	38-58	22-26	17-23	6.5-27	20-34	11-36	12-15	29
TIC[2] (g/kg)	N/A	5-10	7.6-11	5.9-6.9	2.6-13	10-16	9.1-18	13-25	15
TOC[3] (g/kg)	0.3	69-94	27-37	24-35	4.3-24	13-28	9-26	12-21	20
Total carbon (g/kg)	0.3	74-100	36-47	31-40	11-36	25-45	20-43	33-37	35
Sulphate (mg/kg)	300	7,400-11,000	4,200-4,700	3,400-4,400	730-8,500	2,300-7,500	1,400-4,900	1,800-2,300	4,900
Mercury (mg/kg)	0.01	0.06-0.12	0.02-0.05	0.03-0.04	n.d.-0.03	0.02-0.03	0.02-0.03	0.01-0.02	0.02
TPH[4] (mg/kg)									
$>C_{10}$-C_{21} hydrocarbons	0.3	15-31	3.5-17	4.9-8	2-6.6	4-8.2	5.3-11	1.7-13	4.2
$>C_{21}$-C_{32} hydrocarbons	0.3	41-96	9.2-60	13-25	5.9-18	8.6-23	2.6-22	3.7-9.5	13
Metal Scan (mg/kg)									
Aluminum	10	9,300-10,000	10,000-11,000	11,000	9,400-11,000	9,800-12,000	11,000	8,400-8,800	11,000
Antimony	2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Arsenic	2	14-19	10-13	10-13	4-8	7-9	6-9	4	7

Table 2.6 (Continued).

Parameter	Reported Detection Level	Sampling Station							
		Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove	Candidate Effluent Outfall
Number of samples		4	4	4	4	4	4	3	1
Barium	5	26-51	61-76	55-88	30-92	55-90	56-95	76-79	97
Beryllium	2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Boron	5	110-250	52-62	39-60	9-44	24-51	16-51	24-27	46
Cadmium	0.3	2.1-2.5	0.6-1.1	0.4-0.8	n.d.-0.4	n.d.-0.4	n.d.	n.d.	n.d.
Chromium	2	23-28	25-31	26-29	16-24	19-25	19-23	15-16	22
Cobalt	1	5	8-9	9	9	9-11	9-10	7-8	9
Copper	2	21-28	18-22	16-21	6-20	12-21	10-21	11	29
Iron	50	17,000-18,000	17,000-24,000	19,000-20,000	16,000-21,000	16,000-19,000	17,000-18,000	14,000-15,000	17,000
Lead	0.5	18-54	12-23	15-20	6.4-18	12-19	11-19	8.5-11	18
Manganese	2	290-320	450-500	500-520	500-530	500-560	500-540	450-470	510
Molybdenum	2	10-22	4-5	2-3	3-4	n.d.	n.d.-2	n.d.	n.d.
Nickel	2	18-21	19-24	21-22	15-21	18-22	20-22	15-17	21
Phosphorus	100	3,300-10,000	3,200-9,000	2,300-3,400	980-1,600	1,700	920-1,500	760-880	1,300
Selenium	1	3-4	2	1-2	n.d.-2	1-2	n.d.-2	n.d.-2	1
Silver	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Strontium	5	99-180	96-120	72-120	82-150	130-140	120-214	360-420	190
Thallium	0.1	0.2-0.3	0.2	0.1-0.2	0.1-0.2	0.2-0.3	0.1-0.2	0.1-0.2	0.2
Uranium	0.1	9.1-23	2.6-12	2.9-4.2	0.7-2.1	1.7-1.8	0.9-1.3	0.6-0.9	1.3
Vanadium	2	41-52	38-40	33-40	20-34	27-36	24-34	20-21	34
Zinc	5	59-88	63-71	59-65	50-63	55-63	57-59	44-49	67

[1] Particle size analysis
[2] Total inorganic carbon
[3] Total organic carbon
[4] Total petrogenic hydrocarbons
'N/A' denotes not applicable
'nd' denotes not detected
Shaded cells indicate at least one exceedance of Interim Sediment Quality Guideline (ISQG)

- Maximum concentrations of manganese in surficial sediment at all six sampling stations within Long Harbour, the reference station at Little Seal Cove, and the candidate outfall location exceeded the ISQG value 260 mg/kg (Tables 2.4 and 2.6).

- Maximum concentrations of selenium in surficial sediment at all six sampling stations within Long Harbour and the reference station at Little Seal Cove exceeded the ISQG value 1 mg/kg (Tables 2.4 and 2.6).

- Maximum concentrations of thallium in surficial sediment at Sandy Point and Crawley Island exceeded the ISQG value 0.24 mg/kg (Tables 2.4 and 2.6).

2.7.2. Trends

The majority of stations that exhibited the highest concentrations of certain parameters in surficial sediment samples were those located in the inner part of Long Harbour, particularly Sandy Point and Maturin Point. Concentrations of most parameters at the stations within Long Harbour were consistently higher than those at the reference station at Little Seal Cove. Exceptions to this included C_{10}-C_{21} hydrocarbons, strontium, and thallium.

2.7.3. Comparative Data

Recent surficial sediment sampling has been conducted in the vicinity of the former ERCO wharf in Long Harbour (JWE 2003; Amec 2006).

2.7.3.1. 2002 Baseline Study

Marine sediment data were collected at two stations in Rattling Brook Cove in Long Harbour in December 2002 during a baseline investigation for VBNC (JWE 2003).

The surficial sediments collected at the two 2005-2006 stations nearest to Rattling Brook Cove (i.e., Maturin Point and The Key) had higher maximum levels of numerous parameters compared to sediments collected in 2002. These parameters include sulphate, mercury, C_{21}-C_{32} TPHs, arsenic, barium, chromium, copper, iron, nickel, and vanadium.

Marine sediments collected in December 2002 were much coarser than those collected at the Maturin Point and The Key stations during the present baseline study. The fines component of samples collected in 2002 never constituted more than 4% of a sample. The 2002 marine sediment samples were primarily composed of gravel and sand. The higher proportion of fines in the 2005-2006 samples is likely one factor that explains the higher levels of the forementioned parameters in surficial sediments collected between October 2005 and September 2006.

2.7.3.2. 2006 Preliminary Marine Sediment Sampling at the Wharf

Four marine sediment samples were collected along the edges of the former ERCO wharf in Long Harbour in July 2006 and analyzed for a variety of parameters (Amec 2006). Generally, levels of many parameters were higher in the sediments collected at the wharf than in those collected at the Maturin Point and The Key stations. Parameters with noticeably higher maximum concentrations in the wharf sediments include C_{21}-C_{32} TPHs, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, and zinc. In terms of phosphorus, the maximum available phosphorus concentration found in sediments from Maturin Point and The Key stations was 9,000 mg/kg (Table 2.6). The total phosphorus found in the wharf sediments ranged between 18,100 and 86,200 mg/kg.

2.8. Blue Mussels

Ranges of results of the analyses of composite (30 individuals) blue mussel soft tissue samples collected at each station are presented in Tables 2.7 to 2.9. Duration of exposure of mussels deployed in October 2005 and sampled in May and September 2006 were 209 days and 330 days, respectively (Table 2.7). Duration of exposure of mussels deployed in May 2006 and sampled in July and September 2006 were 68 days and 121 days, respectively (Table 2.8). Table 2.9 presents results of analyses of blue mussels deployed at all stations in July and September 2006. These two July and September 2006 lots have not been sampled since deployment (as of time of writing). Table 2.10 presents results of analyses of samples of blue mussels collected at three sites on the mussel aquaculture farm located in Long Harbour in April 2007. Complete analysis results are available in Appendix 2.C.

2.8.1. Trends

The following two sections discuss physiological and chemical uptake trends associated with blue mussels exposed to the Long Harbour marine environment during different time periods.

2.8.1.1. October 2005 to May 2006 and October 2005 to September 2006 Exposures

Blue mussels at the outer five stations exhibited higher growth rates than those at Sandy Point, and condition indices were highest at the two outer stations and Maturin Point (Table 2.7). The highest maximum concentrations of numerous metals were found in mussels sampled from Sandy Point and Crawley Island stations (Table 2.7).

Parameters whose concentrations in the mussel soft tissue increased at most sampling stations during the 330 day exposure period include mercury, arsenic, cadmium, copper, manganese, selenium, strontium, uranium, and zinc (Table 2.7). None of the parameter concentrations rendered any blue mussels unsafe for human consumption.

Table 2.7. Soft Tissue Analyses for Blue Mussels Deployed In October 2005 and Sampled in May 2006 and September 2006.

Parameter	Reported Detection Level	Deployment (Oct 2005)	Sampling Stations (May 2006/September 2006)						
			Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove[1]
Blue Mussel									
Exposure Time (days)	1	0	209/330	209/330	209/330	209/330	209/330	209/330	
Mean Length (mm)	0.1	61.1	59.3/60.0	60.9/65.7	62.2/65.2	62.1/65.5	61.5/63.8	65.0/65.6	
Mean Width:Height	0.01	0.77	0.78/0.83	0.79/0.79	0.80/0.81	0.79/0.82	0.81/0.81	0.81/0.83	
Mean Condition Index	0.1	21.5	61.0/61.5	73.5/98.2	51.2/76.3	71.3/78.6	60.9/89.9	46.8/118.5	
TEH[2] (mg/kg)									
$>C_{10}$-C_{21} hydrocarbons	15	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
$>C_{21}$-C_{32} hydrocarbons	15	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Mercury (mg/kg)	0.01	n.d.	0.03/0.01	0.02/0.01	0.02/n.d.	0.02/n.d.	0.02/n.d.	0.02/0.01	
Metal Scan (mg/kg)									
Aluminum	2.5	n.d.	n.d.-3.5	n.d./n.d.	2.6/n.d.	n.d./n.d.	n.d.-4.3	n.d./n.d.	
Antimony	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Arsenic	0.50	1.00	1.30/1.66	1.40/1.06	1.20/1.07	1.40/1.40	1.30/1.40	1.30/1.28	
Barium	1.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Beryllium	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Boron	1.5	5.2	4.3/4.4	4.3/4.7	4.6/4.4	4.5/4.5	4.7/4.5	4.3/4.5	
Cadmium	0.050	0.269	0.205/0.381	0.246/0.258	0.239/0.291	0.258/0.261	0.275/0.410	0.250/0.340	
Chromium	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Cobalt	0.2	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Copper	0.50	0.71	1.11/0.77	0.97/0.75	0.87/0.68	1.11/0.99	0.90/0.80	1.04/0.79	
Iron	15	16	n.d.-26	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d.-20	n.d./n.d.	
Lead	0.18	n.d.	n.d.-0.26	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Lithium	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Manganese	0.50	0.53	1.01/1.35	0.92/0.74	0.98/0.63	0.93/1.08	0.85/1.10	0.96/0.87	

Table 2.7 (Continued).

Parameter	Reported Detection Level	Deployment (Oct 2005)	Sampling Stations (May 2006 /September 2006)						
			Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove
Molybdenum	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Nickel	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Selenium	0.50	n.d.	0.63/0.54	0.65/n.d.	0.71/n.d.	0.69/0.65	0.68/0.63	0.67/0.57	
Silver	0.12	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Strontium	1.5	6.1	6.1/5.8	6.1/6.3	6.6/5.9	5.8/5.3	6.0/8.0	5.8/6.4	
Thallium	0.02	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Tin	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Uranium	0.020	n.d.	0.024/0.034	0.025/0.021	0.030/n.d.	0.021/0.022	0.026/0.027	0.024/0.028	
Vanadium	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	
Zinc	1.5	15.7	17.8/30.8	13.7/13.5	14.4/16.2	15.0/14.6	14.7/20.2	14.8/15.6	

Blue mussels not deployed at reference station in October 2005. Reference station was not installed until May 2006.
Total extractable hydrocarbons
n.d. denotes 'not detected'

Table 2.8. Soft Tissue Analyses for Blue Mussels Deployed In May 2006 and Sampled in July 2006 and September 2006.

Parameter	Reported Detection Level	Deployment (May 2006)	Sampling Stations (July 2006 /September 2006)						
			Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove
Blue Mussel									
Exposure Time (days)	1	0	68/121	68/121	68/121	68/121	68/121	68/121	68/121
Mean Length (mm)	0.1	54.0	60.6/62.9	63.3/63.9	62.0/64.8	59.8/62.1	62.1/65.0	61.2/64.8	63.0/66.0
Mean Width:Height	0.01	0.72	0.75-0.79	0.76	0.74-0.76	0.75-0.77	0.75-0.77	0.75	0.75-0.76
Mean Condition Index	0.1	40.7	51.9-59.1	70.8-73.7	62.6-72.6	66.5-79.9	55.0-70.2	50.0-55.0	52.1-62.5
TEH[1] (mg/kg)									
$>C_{10}$-C_{21} hydrocarbons	15	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
$>C_{21}$-C_{32} hydrocarbons	15	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Mercury (mg/kg)	0.01	0.02	0.01./0.01	.n.d./0.01	n.d./0.01	n.d./0.01	n.d./n.d.	n.d./0.01	n.d./0.01
Metal Scan (mg/kg)									
Aluminum	2.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Antimony	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Arsenic	0.50	1.01	1.24/1.42	1.40/1.51	1.34/1.49	1.42/1.28	1.21/1.13	1.46/1.23	1.42-1.65
Barium	1.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Beryllium	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Boron	1.5	5.2	4.7/4.1	4.4/4.7	4.4/4.5	4.3/4.7	4.4/4.5	4.5/4.9	4.4/4.6
Cadmium	0.050	0.253	0.202/0.200	0.226/0.242	0.279/0.294	0.270/0.254	0.257/0.369	0.295/0297	0.309/0.391
Chromium	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Cobalt	0.2	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Copper	0.50	0.71	0.94/0.88	1.04/1.13	0.99/1.03	1.11/1.04	0.98/0.76	1.07/0.89	0.81/0.92
Iron	15	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.

Table 2.8 (Continued).

Parameter	Reported Detection Level	Deployment (May 2006)	Sampling Stations (July 2006 /September 2006)						
			Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove
Lead	0.18	n.d.	n.d./0.18	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Lithium	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Manganese	0.50	0.64	1.10/n.d.	1.26/1.03	1.05/0.73	1.35/0.82	0.99/n.d.	1.22/0.64	0.72/0.56
Molybdenum	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Nickel	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Selenium	0.50	0.58	n.d./n.d.	0.63/0.73	0.60/0.72	0.63/0.69	0.58/0.62	0.60/0.66	n.d./0.81
Silver	0.12	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Strontium	1.5	5.7	5.7/5.6	5.2/5.5	5.1/5.3	5.3/5.5	5.2/5.8	5.4/5.6	5.4/5.4
Thallium	0.02	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Tin	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Uranium	0.020	n.d.	n.d./0.020	n.d./n.d.	n.d./n.d.	0.021/0.025	n.d.-0.024	.0.021/n.d.	n.d./n.d.
Vanadium	0.5	n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.	n.d./n.d.
Zinc	1.5	11.2	15.0/15.6	14.0/15.1	15.3/17.2	15.6/13.1	13.3/13.0	14.6/12.9	13.3/15.9
Total extractable hydrocarbons n.d. denotes ‘not detected’									

Table 2.9. Soft Tissue Analyses for Blue Mussels Deployed In July 2006 and September 2006.

Parameter	Reported Detection Level	Deployed July 2006	Deployed Sept 2006
Blue Mussel			
Exposure Time (days)	1	0	0
Mean Length (mm)	0.1	69.8	65.7
Mean Width:Height	0.01	0.76	0.75
Mean Condition Index	0.1	47.7	52.1
TEH[1] (mg/kg)			
$>C_{10}$-C_{21} hydrocarbons	15	n.d.	n.d.
$>C_{21}$-C_{32} hydrocarbons	15	n.d.	n.d.
Mercury (mg/kg)	0.01	n.d.	n.d.
Metal Scan (mg/kg)			
Aluminum	2.5	n.d.	n.d.
Antimony	0.5	n.d.	n.d.
Arsenic	0.50	1.10	1.02
Barium	1.5	n.d.	n.d.
Beryllium	0.5	n.d.	n.d.
Boron	1.5	4.4	4.6
Cadmium	0.050	.367	.294
Chromium	0.5	n.d.	n.d.
Cobalt	0.2	n.d.	n.d.
Copper	0.50	0.84	0.75
Iron	15	n.d.	n.d.
Lead	0.18	n.d.	n.d.
Lithium	0.5	n.d.	n.d.
Manganese	0.50	0.70	n.d.
Molybdenum	0.5	n.d.	n.d.
Nickel	0.5	n.d.	n.d.
Selenium	0.50	n.d.	n.d.
Silver	0.12	n.d.	n.d.
Strontium	1.5	5.0	5.4
Thallium	0.02	n.d.	n.d.
Tin	0.5	n.d.	n.d.
Uranium	0.020	n.d.	n.d.
Vanadium	0.5	n.d.	n.d.
Zinc	1.5	14.6	15.7

[1] Total extractable hydrocarbons
n.d. denotes 'not detected'

Table 2.10. Soft Tissue Analyses for Blue Mussels Collected at the Mussel Aquaculture Farm in Long Harbour in April 2007.

Parameter	Reported Detection Level	Inner St. Croix Bay	Outer St. Croix Bay	West End of Crawley Island (The Gut)
Blue Mussel				
Exposure Time		3+ years	3+ years	4+ years
Mean Length (mm)	0.1	65.8	69.9	78.6
Mean Width:Height	0.01	0.73	0.73	0.80
Mean Condition Index	0.1	not available	30.0	37.6
TEH[1] (mg/kg)				
$>C_{10}$-C_{21} hydrocarbons	15	n.d.	n.d.	n.d.
$>C_{21}$-C_{32} hydrocarbons	15	n.d.	n.d.	n.d.
Mercury (mg/kg)	0.01	0.02	0.01	0.01
Metal Scan (mg/kg)				
Aluminum	2.5	n.d.	2.8	5.9
Antimony	0.5	n.d.	n.d.	n.d.
Arsenic	0.50	1.81	2.03	2.10
Barium	1.5	n.d.	n.d.	n.d.
Beryllium	0.5	n.d.	n.d.	n.d.
Boron	1.5	4.8	4.4	4.3
Cadmium	0.050	0.321	0.405	0.460
Chromium	0.5	n.d.	n.d.	n.d.
Cobalt	0.2	n.d.	n.d.	n.d.
Copper	0.50	1.04	1.34	1.29
Iron	15	n.d.	18	26
Lead	0.18	n.d.	n.d.	n.d.
Lithium	0.5	n.d.	n.d.	n.d.
Manganese	0.50	1.12	1.44	1.42
Molybdenum	0.5	n.d.	n.d.	n.d.
Nickel	0.5	n.d.	n.d.	n.d.
Selenium	0.50	0.65	0.80	0.72
Silver	0.12	n.d.	n.d.	n.d.
Strontium	1.5	6.0	5.5	6.7
Thallium	0.02	n.d.	n.d.	n.d.
Tin	0.5	n.d.	n.d.	n.d.
Uranium	0.020	0.025	0.030	0.027
Vanadium	0.5	n.d.	n.d.	n.d.
Zinc	1.5	16.4	23.8	20.9

[1] Total extractable hydrocarbons
n.d. denotes 'not detected'

2.8.1.2. May 2006 to July 2006 and May 2006 to September 2006 Exposures

Blue mussels at the outer five stations, except for Tim Barrett Cove, exhibited higher growth rates than those at Sandy Point, and condition indices were highest at the four central stations in Long Harbour (i.e., all but Sandy Point and Shag Rocks). Mussels at the reference station exhibited average increases in growth and condition index (Table 2.8).

There was no obvious trend in station location of the highest maximum concentrations as there was in the mussels exposed from October 2005 to September 2006. In fact, two parameters were found in highest concentration in mussels exposed at Little Seal Cove, the reference station (Table 2.8). Parameters whose concentrations in the mussel soft tissue increased at most sampling stations during the 121 day exposure period include arsenic, cadmium, copper, manganese, selenium, uranium, and zinc. None of the parameter concentrations rendered any blue mussels unsafe for human consumption.

2.9. Comparative Data

Data from naturally-occurring blue mussels were collected at two stations in Rattling Brook Cove in Long Harbour in December 2002 during a previous baseline investigation for VBNC (JWE 2003). The farmed blue mussels deployed and sampled at Long Harbour between October 2005 and September 2006 had maximum concentrations of selenium and zinc that were slightly higher than levels found in wild blue mussels from Rattling Brook Cove in 2002. Numerous metals, including aluminum, arsenic, cadmium, iron, manganese, mercury, strontium, and uranium were found in lower concentrations in the introduced farmed blue mussels compared to the wild ones collected in 2002. Concentrations of the remainder of the parameters were similar in each group of mussels.

Chemical analyses of blue mussels sampled from the existing aquaculture farm in April 2007 at Long Harbour (Table 2.10) indicated higher concentrations of aluminum, arsenic, cadmium, and copper in mussel tissue compared to the mussels attached to the sampling station moorings. Perhaps the levels seen in the Long Harbour aquaculture farm mussels represent a ‘steady state’ concentration for mussels exposed to the Long Harbour environment longer than those attached to sampling station moorings.

2.10. Bottom Water Temperature

Summary descriptive bottom water temperature data are presented in Table 2.11. While there were minimal differences in bottom water temperatures between the sampling stations in winter, the bottom water temperature differences between stations were greatest during late spring to early fall. The bottom water temperature during this period was highest at Sandy Point and lowest at Little Seal Cove. In other words, during late spring, summer, and early fall, the bottom water temperatures decreased from east to west in Long Harbour. The variability in depth of thermograph had an obvious effect on bottom water temperatures. Thermographs were deployed at the same depth as the moored mussels, indicated in Table 2.2 in Section 2.5.

Table 2.11. Bottom Water Temperatures, October 2005 to September 2006.

Parameter	Time Period	Sampling Stations						
		Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Little Seal Cove
Bottom Water Temperature								
Mean Water Temperature (°C)	Oct/05-May/06	3.6	3.5	3.4	3.4	3.3	3.5	
Minimum Water Temperature (°C)	Oct/05-May/06	-0.9	-0.8	-0.5	-0.8	-0.5	-0.7	
Maximum Water Temperature (°C)	Oct/05-May/06	10.9	10.9	10.5	10.4	10.5	10.4	
Mean Water Temperature (°C)	May/06-Jul/06	12.5	10.0	9.4	9.3	8.9	9.4	9.4
Minimum Water Temperature (°C)	May/06-Jul/06	4.6	0.9	1.1	1.3	1.3	2.2	1.8
Maximum Water Temperature (°C)	May/06-Jul/06	19.6	17.2	15.6	15.3	15.1	15.0	16.2
Mean Water Temperature (°C)	Jul/06-Sep/06	16.5	15.4	14.8	15.0	14.8	14.9	14.8
Minimum Water Temperature (°C)	Jul/06-Sep/06	9.9	5.8	4.0	4.9	3.8	4.1	3.1
Maximum Water Temperature (°C)	Jul/06-Sep/06	19.4	18.5	18.3	17.8	18.0	17.8	17.8

2.11. Winter Flounder

Results of the analyses of winter flounder collected at each station are presented in Table 2.12. Complete analysis details are available in Appendix 2.D.

Winter flounder sampled at the reference station were larger than those taken in the vicinity of the candidate outfall location (Table 2.12). Male fish dominated the reference station sample while females were dominant in the candidate outfall sample. All winter flounder collected were sexually mature.

While only six parameters were detected during analyses of the muscle tissue, 12 were detected during the analyses of both the liver and kidney tissue (Table 2.12). Detected parameters common to all three tissue types included C_{21}-C_{32} hydrocarbons, mercury, manganese, and zinc. Detected parameters in both flounder liver and kidney included cadmium, copper, iron, lead, selenium, silver, and vanadium. Arsenic was detected in muscle and liver tissue, strontium in muscle and kidney tissue, and nickel in kidney tissue only. Arsenic levels in nine of the ten composite muscle samples exceeded the Canadian guideline for arsenic in fish and fish products of 3.5 ppm (CFIA 2007). Analyses of the tissues collected at the candidate outfall station indicated detection of five parameters in the muscle, the same ones detected in the reference station muscle tissue except for the hydrocarbons. The same parameters detected in the reference station liver and kidney samples were also found in the same tissues collected at the candidate outfall. Additional metals detected in the candidate outfall liver and/or kidney tissues include aluminum, boron, cobalt, and uranium.

Some parameters had higher concentrations in flounder tissues collected in the vicinity of the candidate effluent outfall. Mercury concentration was higher in all three tissue types collected at the candidate outfall than those collected at the reference station (Table 2.12). Arsenic concentrations in candidate outfall muscle and liver tissues were higher than those at Little Seal Cove, and both manganese and selenium concentrations in candidate outfall liver and kidney tissues were higher than those in the same tissues collected at Little Seal Cove. Other metals with higher concentrations in candidate outfall liver tissue samples relative to reference station liver tissue samples include cadmium, copper, iron, and vanadium.

Based on the results of these analyses, the winter flounder in the vicinity of the candidate outfall location had higher metal loadings than those occurring at the Little Seal Cove reference station.

2.12. Benthic Habitat

The benthic habitat of three areas in Long Harbour were surveyed with an ROV: (1) the candidate marine effluent outfall area, (2) the area immediately adjacent to the north side of the former ERCO wharf, and (3) part of Rattling Brook Cove on the south side of the wharf.

Table 2.12. Results of Winter Flounder Muscle, Liver and Kidney Tissue Analyses, September/October 2006.

Parameter	Reported Detection Level	Sampling Stations									
		Reference Station Composites					Candidate Outfall Station Composites				
		1	2	3	4	5	1	2	3	4	5
Flounder Muscle											
Number of Fish		4	4	3	3	4	3	4	5	4	5
Average Length (cm)	0.1	38.0	38.4	37.0	36.7	37.9	32.7	34.0	35.8	36.8	32.1
Length Range (cm)		35.0-41.0	33.0-43.0	34.0-40.0	34.5-38.5	35.0-41.0	31.0-35.0	29.0-40.0	31.0-38.0	34.0-39.5	28.5-35.0
Average Weight (g)	1	867	877	793	790	849	510	587	672	714	463
Weight Range (g)		689-1,067	598-1,132	576-1,022	655-942	703-1,058	416-630	348-897	400-905	590-842	306-592
Gender		M	M	M	F	F	M	F	F	F	F
TEH[1] (mg/kg)											
$>C_{10}$-C_{21} hydrocarbons	15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
$>C_{21}$-C_{32} hydrocarbons	15	n.d.	20	n.d.	n.d.	27	n.d.	n.d.	n.d.	n.d.	n.d.
Mercury (mg/kg)	0.01	0.03	0.03	0.02	0.02	0.02	0.03	0.04	0.05	0.04	0.03
Metal Scan (mg/kg)											
Aluminum	2.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Antimony	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Arsenic	0.50	4.25	4.31	4.12	8.54	3.44	5.33	13.00	10.90	13.70	11.70
Barium	1.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Beryllium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Boron	1.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cadmium	0.050	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Chromium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cobalt	0.2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Copper	0.50	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Iron	15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

Table 2.12 (Continued).

Parameter	Reported Detection Level	Sampling Stations									
		Reference Station Composites					Candidate Outfall Station Composites				
		1	2	3	4	5	1	2	3	4	5
Flounder Muscle											
Lead	0.18	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Lithium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Manganese	0.50	1.29	1.47	1.25	0.95	1.19	1.99	1.80	1.28	1.36	1.41
Molybdenum	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Nickel	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Selenium	0.50	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.82	0.84	0.98	0.74
Silver	0.12	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Strontium	1.5	18.5	33.1	20.1	22.2	31.4	39.3	40.5	24.8	28.8	34.3
Thallium	0.02	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Tin	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Uranium	0.020	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Vanadium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Zinc	1.5	10.7	20.1	6.9	10.3	17.1	15.8	10.4	7.4	9.6	10.0
Flounder Liver											
TEH[1] (mg/kg)											
$>C_{10}$-C_{21} hydrocarbons	15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	20	n.d.	18	n.d.
$>C_{21}$-C_{32} hydrocarbons	15	360	710	240	400	480	410	380	150	330	270
Mercury (mg/kg)	0.01	0.04	0.03	0.02	0.03	0.03	0.06	0.06	0.06	0.06	0.04
Metal Scan (mg/kg)											
Aluminum	2.5	n.d.	n.d.	n.d.	n.d.	n.d.	3.6	6.9	3.0	4.9	3.5
Antimony	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Arsenic	0.50	6.38	3.61	3.83	14.00	2.30	4.71	29.00	15.9	37.5	16.7
Barium	1.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

Table 2.12 (Continued).

Parameter	Reported Detection Level	Sampling Stations									
		Reference Station Composites					Candidate Outfall Station Composites				
		1	2	3	4	5	1	2	3	4	5
Flounder Liver											
Beryllium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Boron	1.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cadmium	0.050	0.440	0.409	0.252	0.297	0.405	0.971	0.616	0.397	0.885	0.596
Chromium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cobalt	0.2	n.d.	n.d.	n.d.	n.d.	n.d.	0.45	0.23	n.d.	n.d.	0.33
Copper	0.50	8.24	7.40	4.35	6.11	5.11	7.53	14.20	12.90	12.40	20.30
Iron	15	221	295	138	171	171	498	395	435	584	532
Lead	0.18	n.d.	1.31	n.d.	n.d.	n.d.	0.26	0.36	0.56	0.60	0.96
Lithium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Manganese	0.50	1.17	0.85	1.64	1.44	0.90	1.76	1.85	1.99	1.66	2.12
Molybdenum	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Nickel	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.84
Selenium	0.50	2.48	2.68	1.83	2.36	2.49	3.45	3.73	4.41	5.08	6.19
Silver	0.12	0.18	0.15	<0.12	0.20	0.15	0.17	0.38	0.51	0.40	0.56
Strontium	1.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Thallium	0.02	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Tin	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Uranium	0.020	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.026	0.029	0.074	n.d.
Vanadium	0.5	1.0	1.0	n.d.	n.d.	1.0	2.43	2.17	1.41	5.45	1.31
Zinc	1.5	44.0	33.4	54.9	62.7	31.5	36.8	46.0	65.1	44.4	52.9
Flounder Kidney											
TEH[1] (mg/kg)											
$>C_{10}$-C_{21} hydrocarbons	15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
$>C_{21}$-C_{32} hydrocarbons	15	n.d.	n.d.	n.d.	n.d.	32	n.d.	n.d.	n.d.	n.d.	n.d.

Table 2.12 (Continued).

Parameter	Reported Detection Level	Sampling Stations									
		Reference Station Composites					Candidate Outfall Station Composites				
		1	2	3	4	5	1	2	3	4	5
Flounder Kidney											
Mercury (mg/kg)	0.01	0.04	0.06	0.05	0.04	0.05	0.07	0.11	0.08	0.10	0.06
Metal Scan (mg/kg)											
Aluminum	2.5	n.d.	n.d.	n.d.	n.d.	n.d.	3.8	6.8	n.d.	9.2	6.5
Antimony	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Arsenic	0.50	n.d.	n.d.	n.d.	0.56	n.d.	1.50	1.49	1.12	1.57	1.82
Barium	1.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Beryllium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Boron	1.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	1.9	n.d.	1.6
Cadmium	0.050	0.145	0.140	0.115	0.128	0.148	0.216	0.150	0.119	0.193	0.154
Chromium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cobalt	0.2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Copper	0.50	0.96	1.08	1.12	1.03	1.14	1.03	1.31	1.18	1.31	1.35
Iron	15	100	128	124	75	104	445	347	79	165	226
Lead	0.18	n.d.	n.d.	0.19	n.d.	n.d.	0.31	0.62	0.53	0.58	0.71
Lithium	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Manganese	0.50	1.08	0.89	0.83	0.80	0.91	1.00	1.43	1.19	1.55	1.66
Molybdenum	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Nickel	0.5	1.29	1.36	0.66	0.87	0.63	0.90	1.11	0.78	1.39	1.03
Selenium	0.50	2.33	2.61	2.49	2.41	2.68	3.15	4.91	4.05	5.39	3.86
Silver	0.12	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Strontium	1.5	n.d.	n.d.	1.6	n.d.	2.6	1.8	2.0	1.6	2.9	2.6
Thallium	0.02	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Tin	0.5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Uranium	0.020	n.d.	n.d.	0.022	n.d.	n.d.	n.d.	0.027	0.028	0.058	n.d.
Vanadium	0.5	1.0	2.0	1.0	1.0	1.0	1.33	1.63	1.44	4.04	1.89
Zinc	1.5	21.4	22.6	21.5	19.5	22.2	28.4	21.6	20.2	22.2	24.8

[1] Total extractable hydrocarbons; n.d. denotes 'not detected'

2.12.1. Candidate Marine Effluent Outfall Area

The dominant substrate type on transects surveyed in the candidate marine effluent outfall area consisted of soft, silty sediment that readily re-suspends in the water column when disturbed. Water depths in this area ranged from 60 to 74 m. Fauna observed in the soft sediment regions of the candidate outfall area included winter flounder, American plaice, eelpouts (Zoarcidae), bivalves, seastars, brittlestars, and small crustaceans (likely amphipods). Occasional boulder clusters were also observed. Biota associated with these clusters included sea anemones, sea urchins, and sea stars. There is a rocky hump, within 50 m of the candidate outfall location indicated in Figure 2.1, relatively small in area, that tops off at about 60 m and is completely surrounded by the deeper soft sediment habitat. The rocky hump appeared to be a productive area relative to the surrounding area. Biota seen on this hump included echinoderms (seastars, sunstars, and sea urchins), corals, sea anemones, crabs, and cod.

2.12.2. North Side of Former ERCO Wharf

The predominant type of substrate indicated by transects surveyed on the north side of the former ERCO wharf consisted of hard sediments such as sand, gravel, cobble, and small boulder. Water depth of the surveyed area ranged from 8.5 to 14.5 m. Biota observed during the survey included clumps of kelp, areas of low-lying filamentous algae (red, brown, and green algae), cunner, winter flounder, sea stars, sand dollars, mussels, and amphipods. There also appeared to be considerable decomposition (probably kelp) occurring in this area. Close to the wharf at the start of each transect, metal scraps, and other industrial wastes were abundant.

2.12.3. Rattling Brook Cove (South Side of Former ERCO Wharf)

The dominant substrate type indicated by transects surveyed in Rattling Brook Cove consisted of hard sediments such as sand, gravel, and cobble. Water depth of the surveyed area ranged from 0.2 to 9.1 m. Biota observed during the survey includes low-lying filamentous algae (red, brown, and green algae), coralline algae, eelgrass and Irish moss in the shallower areas, periwinkles, hermit crabs, rock crabs, scallops, sea stars, and sand dollars. No fish were seen during the survey within Rattling Brook Cove.

2.13. Summary and Conclusions

The first year of the sampling program designed to collect marine baseline data relating to sea water, surficial sediment, and biota in Long Harbour, Newfoundland and Labrador, was conducted between October 2005 and April 2007. Sea water, surficial sediment, blue mussel, and winter flounder samples were analyzed for various chemical and physical parameters. While some maximum concentrations in both sea water and surficial sediment exceeded their respective guideline values, it occurred neither frequently nor consistently at any one station. Some ISQGs, but not PELs, were exceeded in a few of the surficial sediment samples. The highest concentrations of some metals and hydrocarbons in sea water, surficial sediment, and biota were often observed at stations located in the inner part of Long Harbour. Concentrations typically were lower at stations towards the mouth of the harbour.

Some possible explanations for the higher concentrations of some parameters in samples from inner Long Harbour include spatial differences in geology, spatial and temporal differences in hydrology, and differences in anthropogenic influences. Metal concentrations in various tissue types were generally higher in winter flounder collected at the candidate outfall location than those collected at the reference station. All but one of the ten composite samples of winter flounder muscle tissue collected at both the candidate outfall location and the reference station had arsenic levels exceeding the Canadian Food Inspection Agency guideline of 3.5 ppm. Between five and six hours of underwater video were recorded with an ROV during benthic habitat surveys at various locations in Long Harbour. Both soft and hard bottom substrates and their respective biota were documented. Soft bottom habitat dominated the survey area in the vicinity of the candidate marine effluent outfall and hard bottom habitat dominated the survey areas in the vicinity of the former ERCO wharf.

2.14. Literature Cited

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Appendix 2.A: Seawater Raw Data

Table 2.A-1 Seawater.

		Sample ID:		SP	SP	MP	MP	TK	TK	TBC	TBC	CI
		Depth (m):		7.00	0.20	8.50	0.20	14.00	0.20	12.50	0.20	18.00
		Depth relative:		B	S	B	S	B	S	B	S	B
		Project Number:		SA863	SA863	SA863	SA863	SA863	SA863	SA863	SA863	SA863
		Lab ID:		I95442	I95443	I95444	I95445	I95440	I95441	I95435	I95439	I98993
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	P	P	P	P
		Date Sampled:		20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	23-Oct-05
		Client Description:		Sandy Point	Sandy Point	Maturin Point	Maturin Point	The Key	The Key	Tim Barrett Cove	Tim Barrett Cove	Crawley Island
Parameters	Method	RDL	Units									
Benzene	Atlantic PIRI	1	ug/L									
Toluene	Atlantic PIRI	1	ug/L									
Ethylbenzene	Atlantic PIRI	1	ug/L									
Xylene (Total)	Atlantic PIRI	2	ug/L									
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L									
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L									
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L									
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L									
Isobutylbenzene - Extractable	Atlantic PIRI	-	%									
Isobutylbenzene - Volatile	Atlantic PIRI	-	%									
n-Dotriacontane - Extractable	Atlantic PIRI	-	%									
Total Mercury	CVAA	0.01	ug/L									
Arsenic	ICP-MS	0.1	ug/L	0.9	0.5	1.0	0.6	0.9	0.8	1.0	0.8	0.9
Cadmium	ICP-MS	0.1	ug/L	ND	ND	ND	ND	0.1	ND	ND	ND	ND
Chromium	ICP-MS	0.5	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ICP-MS	0.1	ug/L	0.6	1.5	2.7	0.5	2.4	0.4	0.3	0.7	0.2
Iron	ICP-MS	1	ug/L	21	137	6	34	8	7	6	10	7
Lead	ICP-MS	0.1	ug/L	0.1	0.3	5.2	ND	25.7	ND	0.1	0.2	0.1
Manganese	ICP-MS	1	ug/L	5	12	ND	6	1	2	ND	ND	ND
Nickel	ICP-MS	0.5	ug/L	ND	0.5	3.8	ND	6.2	ND	ND	ND	ND
Zinc	ICP-MS	1	ug/L	1	3	5	1	19	2	1	1	ND
pH	pH meter	-	-									
Total Suspended Solids	Gravimetric	1000	ug/L									

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		CI	CI	SR	SR	SR	SP	SP	MP	MP
		Depth (m):		18.00	0.20	16.00	16.00	0.20	7.00	0.20	8.50	8.50
		Depth relative:		B	S	B	B	S	B	S	B	B
		Project Number:		SA863	SA863	SA863	SA863	SA863	SA863	SA863	SA863	SA863
		Lab ID:		I98993	I98994	I98987	I98987	I98992	I95496	I95497	I95498	I95498
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		D	P	P	D	P	P	P	P	P
		Date Sampled:		23-Oct-05	23-Oct-05	23-Oct-05	23-Oct-05	23-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05
		Client Description:		Crawley Island	Crawley Island	Shag Rocks	Shag Rocks	Shag Rocks	Sandy Point	Sandy Point	Maturin Point	Maturin Point
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L						ND	ND	ND	ND
Toluene	Atlantic PIRI	1	ug/L						ND	ND	ND	ND
Ethylbenzene	Atlantic PIRI	1	ug/L						ND	ND	ND	ND
Xylene (Total)	Atlantic PIRI	2	ug/L						ND	ND	ND	ND
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L						ND	ND	ND	ND
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L						ND	ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L						ND	ND	ND	ND
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L						ND	ND	ND	ND
Isobutylbenzene - Extractable	Atlantic PIRI	-	%						89	98	102	102
Isobutylbenzene - Volatile	Atlantic PIRI	-	%						84	89	85	85
n-Dotriacontane - Extractable	Atlantic PIRI	-	%						93	104	108	108
Total Mercury	CVAA	0.01	ug/L						ND	ND	ND	ND
Arsenic	ICP-MS	0.1	ug/L	0.9	0.6	0.8	-	0.8				
Cadmium	ICP-MS	0.1	ug/L	ND	ND	0.3	-	ND				
Chromium	ICP-MS	0.5	ug/L	ND	ND	ND	-	ND				
Cobalt	ICP-MS	0.1	ug/L	ND	ND	ND	-	ND				
Copper	ICP-MS	0.1	ug/L	0.3	0.5	0.3	-	0.3				
Iron	ICP-MS	1	ug/L	6	9	7	-	9				
Lead	ICP-MS	0.1	ug/L	ND	ND	ND	-	ND				
Manganese	ICP-MS	1	ug/L	ND	2	ND	-	2				
Nickel	ICP-MS	0.5	ug/L	ND	ND	ND	-	ND				
Zinc	ICP-MS	1	ug/L	ND	ND	ND	-	ND				
pH	pH meter	-	-						7.92	7.63	7.45	7.45
Total Suspended Solids	Gravimetric	1000	ug/L						8000	5000	9000	9000

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		TK	TK	TBC	TBC	CI	CI	CI	SR	SR
		Depth (m):		14.00	0.20	12.50	0.20	18.00	18.00	0.20	16.00	16.00
		Depth relative:		B	S	B	S	B	B	S	B	B
		Project Number:		SA863	SA863	SA863	SA863	SA863	SA863	SA863	SA863	SA863
		Lab ID:		I95494	I95495	I95492	I95493	I98993	I98993	I98994	I98987	I98987
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	D	P	P	D
		Date Sampled:		20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	23-Oct-05	23-Oct-05	23-Oct-05	23-Oct-05	23-Oct-05
		Client Description:		The Key	The Key	Tim Barrett Cove	Tim Barrett Cove	Crawley Island	Crawley Island	Crawley Island	Shag Rocks	Shag Rocks
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	-	ND	ND	-
Toluene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	-	ND	ND	-
Ethylbenzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	-	ND	ND	-
Xylene (Total)	Atlantic PIRI	2	ug/L	ND	ND	ND	ND	ND	-	ND	ND	-
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L	ND	ND	ND	ND	ND	-	ND	ND	-
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L	ND	ND	ND	60	ND	-	ND	ND	-
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	-	ND	ND	-
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	-	ND	ND	-
Isobutylbenzene - Extractable	Atlantic PIRI	-	%	97	100	98	97	100	-	100	95	-
Isobutylbenzene - Volatile	Atlantic PIRI	-	%	94	92	83	89	89	-	89	89	-
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	104	106	110	105	102	-	101	102	-
Total Mercury	CVAA	0.01	ug/L	ND	ND	ND	ND	ND	-	ND	ND	-
Arsenic	ICP-MS	0.1	ug/L									
Cadmium	ICP-MS	0.1	ug/L									
Chromium	ICP-MS	0.5	ug/L									
Cobalt	ICP-MS	0.1	ug/L									
Copper	ICP-MS	0.1	ug/L									
Iron	ICP-MS	1	ug/L									
Lead	ICP-MS	0.1	ug/L									
Manganese	ICP-MS	1	ug/L									
Nickel	ICP-MS	0.5	ug/L									
Zinc	ICP-MS	1	ug/L									
pH	pH meter	-	-	7.94	7.95	7.89	7.95	7.82	-	7.85	7.40	-
Total Suspended Solids	Gravimetric	1000	ug/L	6000	8000	6000	3000	9000	-	5000	2000	4000

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		SR	SP	SP	MP	MP	TK	TK	TBC	TBC
		Depth (m):		0.20	7.00	0.20	8.50	0.20	14.00	0.20	12.50	0.20
		Depth relative:		S	B	S	B	S	B	S	B	S
		Project Number:		SA863	SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		I98992	M10352	M10359	M10353	M10360	M10354	M10361	M10355	M10362
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	P	P	P	P
		Date Sampled:		23-Oct-05	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06
		Client Description:		Shag Rocks	Sandy Point	Sandy Point	Maturin Point	Maturin Point	The Key	The Key	Tim Barrett Cove	Tim Barrett Cove
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene (Total)	Atlantic PIRI	2	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	60
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isobutylbenzene - Extractable	Atlantic PIRI	-	%	97	98	97	97	91	100	102	101	105
Isobutylbenzene - Volatile	Atlantic PIRI	-	%	88	77	86	78	86	74	85	75	85
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	113	100	93	92	88	96	101	99	104
Total Mercury	CVAA	0.01	ug/L	ND								
Arsenic	ICP-MS	0.1	ug/L									
Cadmium	ICP-MS	0.1	ug/L									
Chromium	ICP-MS	0.5	ug/L									
Cobalt	ICP-MS	0.1	ug/L									
Copper	ICP-MS	0.1	ug/L									
Iron	ICP-MS	1	ug/L									
Lead	ICP-MS	0.1	ug/L									
Manganese	ICP-MS	1	ug/L									
Nickel	ICP-MS	0.5	ug/L									
Zinc	ICP-MS	1	ug/L									
pH	pH meter	-	-	7.65								
Total Suspended Solids	Gravimetric	1000	ug/L	8000								

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		CI	CI	SR	SR	REF	REF	SP	SP	MP
		Depth (m):		18.00	0.20	16.00	0.20	11.50	0.20	7.00	0.20	8.50
		Depth relative:		B	S	B	S	B	S	B	S	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		M10356	M10363	M10357	M10364	M10358	M10365	M12858	M12917	M12861
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	P	P	P	P
		Date Sampled:		15-May-06	15-May-06	16-May-06	16-May-06	16-May-06	16-May-06	15-May-06	15-May-06	15-May-06
		Client Description:		Crawley Island	Crawley Island	Shag Rocks	Shag Rocks	Seal Cove	Seal Cove	Sandy Point	Sandy Point	Maturin Point
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND			
Toluene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND			
Ethylbenzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND			
Xylene (Total)	Atlantic PIRI	2	ug/L	ND	ND	ND	ND	ND	ND			
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L	ND	ND	ND	ND	ND	ND			
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L	ND	ND	ND	ND	ND	ND			
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND			
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND			
Isobutylbenzene - Extractable	Atlantic PIRI	-	%	89	94	92	109	95	101			
Isobutylbenzene - Volatile	Atlantic PIRI	-	%	88	85	85	83	86	83			
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	95	100	93	109	91	98			
Total Mercury	CVAA	0.01	ug/L							ND	ND	ND
Arsenic	ICP-MS	0.1	ug/L									
Cadmium	ICP-MS	0.1	ug/L									
Chromium	ICP-MS	0.5	ug/L									
Cobalt	ICP-MS	0.1	ug/L									
Copper	ICP-MS	0.1	ug/L									
Iron	ICP-MS	1	ug/L									
Lead	ICP-MS	0.1	ug/L									
Manganese	ICP-MS	1	ug/L									
Nickel	ICP-MS	0.5	ug/L									
Zinc	ICP-MS	1	ug/L									
pH	pH meter	-	-							7.84	7.79	7.81
Total Suspended Solids	Gravimetric	1000	ug/L							2000	1000	1000

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		MP	TK	TK	TBC	TBC	CI	CI	SR	SR
		Depth (m):		0.20	14.00	0.20	12.50	0.20	18.00	0.20	16.00	0.20
		Depth relative:		S	B	S	B	S	B	S	B	S
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		M12918	M12866	M12919	M12867	M12920	M12868	M12921	M12869	M12922
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	P	P	P	P
		Date Sampled:		15-May-06	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06	16-May-06	16-May-06
		Client Description:		Maturin Point	The Key	The Key	Tim Barrett Cove	Tim Barrett Cove	Crawley Island	Crawley Island	Shag Rocks	Shag Rocks
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L									
Toluene	Atlantic PIRI	1	ug/L									
Ethylbenzene	Atlantic PIRI	1	ug/L									
Xylene (Total)	Atlantic PIRI	2	ug/L									
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L									
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L									
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L									
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L									
Isobutylbenzene - Extractable	Atlantic PIRI	-	%									
Isobutylbenzene - Volatile	Atlantic PIRI	-	%									
n-Dotriacontane - Extractable	Atlantic PIRI	-	%									
Total Mercury	CVAA	0.01	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.1	ug/L									
Cadmium	ICP-MS	0.1	ug/L									
Chromium	ICP-MS	0.5	ug/L									
Cobalt	ICP-MS	0.1	ug/L									
Copper	ICP-MS	0.1	ug/L									
Iron	ICP-MS	1	ug/L									
Lead	ICP-MS	0.1	ug/L									
Manganese	ICP-MS	1	ug/L									
Nickel	ICP-MS	0.5	ug/L									
Zinc	ICP-MS	1	ug/L									
pH	pH meter	-	-	7.9	7.78	7.94	7.81	7.93	7.78	8.14	7.87	7.8
Total Suspended Solids	Gravimetric	1000	ug/L	5000	1000	5000	1000	4000	3000	4000	4000	2000

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		REF	REF	SP	SP	MP	MP	TK	TK	TBC
		Depth (m):		11.50	0.20	7.00	0.20	8.50	0.20	14.00	0.20	12.50
		Depth relative:		B	S	B	S	B	S	B	S	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		M12870	M12924	M12896	M12883	M12901	M12884	M12902	M12885	M12903
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	P	P	P	P
		Date Sampled:		16-May-06	16-May-06	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06	15-May-06
		Client Description:		Seal Cove	Seal Cove	Sandy Point	Sandy Point	Maturin Point	Maturin Point	The Key	The Key	Tim Barrett Cove
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L									
Toluene	Atlantic PIRI	1	ug/L									
Ethylbenzene	Atlantic PIRI	1	ug/L									
Xylene (Total)	Atlantic PIRI	2	ug/L									
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L									
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L									
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L									
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L									
Isobutylbenzene - Extractable	Atlantic PIRI	-	%									
Isobutylbenzene - Volatile	Atlantic PIRI	-	%									
n-Dotriacontane - Extractable	Atlantic PIRI	-	%									
Total Mercury	CVAA	0.01	ug/L	ND	ND							
Arsenic	ICP-MS	0.1	ug/L			0.6	1.1	0.6	1.0	1.1	1.0	1.1
Cadmium	ICP-MS	0.1	ug/L			ND	ND	ND	0.1	ND	ND	ND
Chromium	ICP-MS	0.5	ug/L			0.6	0.5	ND	0.7	0.9	0.7	0.9
Cobalt	ICP-MS	0.1	ug/L			ND	ND	ND	ND	ND	ND	ND
Copper	ICP-MS	0.1	ug/L			0.5	0.2	0.2	0.3	0.1	0.5	0.1
Iron	ICP-MS	1	ug/L			ND	ND	ND	ND	ND	ND	ND
Lead	ICP-MS	0.1	ug/L			0.1	0.1	ND	ND	ND	ND	ND
Manganese	ICP-MS	1	ug/L			1	2	1	1	ND	ND	ND
Nickel	ICP-MS	0.5	ug/L			ND	ND	ND	ND	ND	ND	ND
Zinc	ICP-MS	1	ug/L			ND	ND	ND	ND	ND	ND	ND
pH	pH meter	-	-	7.8	7.85							
Total Suspended Solids	Gravimetric	1000	ug/L	3000	4000							

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		TBC	CI	CI	SR	SR	REF	REF	SP	SP
		Depth (m):		0.20	18.00	0.20	16.00	0.20	11.50	0.20	7.00	0.20
		Depth relative:		S	B	S	B	S	B	S	B	S
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		M12886	M12904	M12887	M12905	M12888	M12906	M12889	N34220	N34231
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	P	P	P	P
		Date Sampled:		15-May-06	15-May-06	15-May-06	16-May-06	16-May-06	16-May-06	16-May-06	25-Jul-06	25-Jul-06
		Client Description:		Tim Barrett Cove	Crawley Island	Crawley Island	Shag Rocks	Shag Rocks	Seal Cove	Seal Cove	Sandy Point	Sandy Point
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L								ND	ND
Toluene	Atlantic PIRI	1	ug/L								ND	ND
Ethylbenzene	Atlantic PIRI	1	ug/L								ND	ND
Xylene (Total)	Atlantic PIRI	2	ug/L								ND	ND
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L								ND	ND
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L								ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L								ND	ND
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L								ND	ND
Isobutylbenzene - Extractable	Atlantic PIRI	-	%								105	114
Isobutylbenzene - Volatile	Atlantic PIRI	-	%								84	81
n-Dotriacontane - Extractable	Atlantic PIRI	-	%								101	116
Total Mercury	CVAA	0.01	ug/L									
Arsenic	ICP-MS	0.1	ug/L	0.9	1.3	1.2	1.3	1.2	1.5	1.0		
Cadmium	ICP-MS	0.1	ug/L	ND	ND	ND	ND	ND	ND	ND		
Chromium	ICP-MS	0.5	ug/L	ND	0.5	0.8	ND	0.6	1.6	0.6		
Cobalt	ICP-MS	0.1	ug/L	ND	ND	ND	ND	ND	ND	ND		
Copper	ICP-MS	0.1	ug/L	0.2	0.1	0.2	0.1	0.5	0.1	0.3		
Iron	ICP-MS	1	ug/L	ND	ND	ND	ND	ND	ND	ND		
Lead	ICP-MS	0.1	ug/L	0.1	ND	ND	ND	ND	ND	ND		
Manganese	ICP-MS	1	ug/L	ND	1	ND	ND	ND	ND	ND		
Nickel	ICP-MS	0.5	ug/L	ND	ND	ND	ND	ND	ND	ND		
Zinc	ICP-MS	1	ug/L	ND	ND	ND	ND	ND	ND	1		
pH	pH meter	-	-									
Total Suspended Solids	Gravimetric	1000	ug/L									

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		MP	MP	TK	TK	TBC	TBC	CI	CI
		Depth (m):		8.50	0.20	14.00	0.20	12.50	0.20	18.00	0.20
		Depth relative:		B	S	B	S	B	S	B	S
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		N34232	N34233	N34234	N34235	N34236	N34237	N34240	N34241
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:									
		Sample Type:		P	P	P	P	P	P	P	P
		Date Sampled:		25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06
		Client Description:		Maturin Point	Maturin Point	The Key	The Key	Tim Barrett Cove	Tim Barrett Cove	Crawley Island	Crawley Island
Parameters	Method	RDL	Units								
Benzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Xylene (Total)	Atlantic PIRI	2	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L	ND	ND	ND	ND	ND	60	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Isobutylbenzene - Extractable	Atlantic PIRI	-	%	116	117	124	111	121	120	125	124
Isobutylbenzene - Volatile	Atlantic PIRI	-	%	81	80	79	79	79	78	77	77
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	117	118	124	107	125	124	128	129
Total Mercury	CVAA	0.01	ug/L								
Arsenic	ICP-MS	0.1	ug/L								
Cadmium	ICP-MS	0.1	ug/L								
Chromium	ICP-MS	0.5	ug/L								
Cobalt	ICP-MS	0.1	ug/L								
Copper	ICP-MS	0.1	ug/L								
Iron	ICP-MS	1	ug/L								
Lead	ICP-MS	0.1	ug/L								
Manganese	ICP-MS	1	ug/L								
Nickel	ICP-MS	0.5	ug/L								
Zinc	ICP-MS	1	ug/L								
pH	pH meter	-	-								
Total Suspended Solids	Gravimetric	1000	ug/L								

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		SR	SR	REF	REF	SP	SP	MP	MP	TK
		Depth (m):		16.00	0.20	11.50	0.20	7.00	0.20	8.50	0.20	14.00
		Depth relative:		B	S	B	S	B	S	B	S	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		N34238	N34239	N34242	N34243	N36453	N36455	N36456	N36457	N36458
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	P	P	P	P
		Date Sampled:		25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06
		Client Description:		Shag Rocks	Shag Rocks	Seal Cove	Seal Cove	Sandy Point	Sandy Point	Maturin Point	Maturin Point	The Key
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND					
Toluene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND					
Ethylbenzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND					
Xylene (Total)	Atlantic PIRI	2	ug/L	ND	ND	ND	ND					
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L	ND	ND	ND	ND					
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L	ND	ND	ND	ND					
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L	ND	ND	ND	ND					
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L	ND	ND	ND	ND					
Isobutylbenzene - Extractable	Atlantic PIRI	-	%	124	125	124	126					
Isobutylbenzene - Volatile	Atlantic PIRI	-	%	77	77	79	77					
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	127	130	126	129					
Total Mercury	CVAA	0.01	ug/L					ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.1	ug/L									
Cadmium	ICP-MS	0.1	ug/L									
Chromium	ICP-MS	0.5	ug/L									
Cobalt	ICP-MS	0.1	ug/L									
Copper	ICP-MS	0.1	ug/L									
Iron	ICP-MS	1	ug/L									
Lead	ICP-MS	0.1	ug/L									
Manganese	ICP-MS	1	ug/L									
Nickel	ICP-MS	0.5	ug/L									
Zinc	ICP-MS	1	ug/L									
pH	pH meter	-	-					8.01	7.99	8.05	8.06	8.03
Total Suspended Solids	Gravimetric	1000	ug/L					5000	4000	12000	3000	2000

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		TK	TBC	TBC	CI	CI	SR	SR	REF
		Depth (m):		0.20	12.50	0.20	18.00	0.20	16.00	0.20	11.50
		Depth relative:		S	B	S	B	S	B	S	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		N36459	N36461	N36462	N36465	N36466	N36463	N36464	N36467
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:									
		Sample Type:		P	P	P	P	P	P	P	P
		Date Sampled:		25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06
		Client Description:		The Key	Tim Barrett Cove	Tim Barrett Cove	Crawley Island	Crawley Island	Shag Rocks	Shag Rocks	Seal Cove
Parameters	**Method**	**RDL**	**Units**								
Benzene	Atlantic PIRI	1	ug/L								
Toluene	Atlantic PIRI	1	ug/L								
Ethylbenzene	Atlantic PIRI	1	ug/L								
Xylene (Total)	Atlantic PIRI	2	ug/L								
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L								
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L								
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L								
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L								
Isobutylbenzene - Extractable	Atlantic PIRI	-	%								
Isobutylbenzene - Volatile	Atlantic PIRI	-	%								
n-Dotriacontane - Extractable	Atlantic PIRI	-	%								
Total Mercury	CVAA	0.01	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.1	ug/L								
Cadmium	ICP-MS	0.1	ug/L								
Chromium	ICP-MS	0.5	ug/L								
Cobalt	ICP-MS	0.1	ug/L								
Copper	ICP-MS	0.1	ug/L								
Iron	ICP-MS	1	ug/L								
Lead	ICP-MS	0.1	ug/L								
Manganese	ICP-MS	1	ug/L								
Nickel	ICP-MS	0.5	ug/L								
Zinc	ICP-MS	1	ug/L								
pH	pH meter	-	-	8.04	8.04	8.03	8.04	8.05	8.03	8.03	8.03
Total Suspended Solids	Gravimetric	1000	ug/L	4000	ND	4000	2000	2000	2000	ND	3000

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		REF	SP	SP	MP	MP	TK	TK	TBC
		Depth (m):		0.20	7.00	0.20	8.50	0.20	14.00	0.20	12.50
		Depth relative:		S	B	S	B	S	B	S	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		N36468	N36566	N36567	N36568	N36569	N36570	N36571	N36575
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:									
		Sample Type:		P	P	P	P	P	P	P	P
		Date Sampled:		25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06
		Client Description:		Seal Cove	Sandy Point	Sandy Point	Maturin Point	Maturin Point	The Key	The Key	Tim Barrett Cove
Parameters	**Method**	**RDL**	**Units**								
Benzene	Atlantic PIRI	1	ug/L								
Toluene	Atlantic PIRI	1	ug/L								
Ethylbenzene	Atlantic PIRI	1	ug/L								
Xylene (Total)	Atlantic PIRI	2	ug/L								
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L								
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L								
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L								
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L								
Isobutylbenzene - Extractable	Atlantic PIRI	-	%								
Isobutylbenzene - Volatile	Atlantic PIRI	-	%								
n-Dotriacontane - Extractable	Atlantic PIRI	-	%								
Total Mercury	CVAA	0.01	ug/L	ND							
Arsenic	ICP-MS	0.1	ug/L		0.6	0.7	0.8	0.8	0.7	0.6	0.8
Cadmium	ICP-MS	0.1	ug/L		ND	ND	ND	ND	ND	ND	ND
Chromium	ICP-MS	0.5	ug/L		ND	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.1	ug/L		ND	ND	ND	ND	ND	ND	ND
Copper	ICP-MS	0.1	ug/L		0.4	0.6	0.3	0.6	0.2	0.4	0.2
Iron	ICP-MS	1	ug/L		2	2	2	2	1	2	1
Lead	ICP-MS	0.1	ug/L		0.3	ND	ND	ND	ND	ND	ND
Manganese	ICP-MS	1	ug/L		3	3	ND	1	ND	2	ND
Nickel	ICP-MS	0.5	ug/L		ND	ND	ND	ND	ND	ND	ND
Zinc	ICP-MS	1	ug/L		4	2	2	2	ND	ND	ND
pH	pH meter	-	-	8.03							
Total Suspended Solids	Gravimetric	1000	ug/L	4000							

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		TBC	CI	CI	SR	SR	REF	REF	SP
		Depth (m):		0.20	18.00	0.20	16.00	0.20	11.50	0.20	7.00
		Depth relative:		S	B	S	B	S	B	S	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		N36576	N36579	N36580	N36577	N36578	N36581	N36582	O33346
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:									
		Sample Type:		P	P	P	P	P	P	P	P
		Date Sampled:		25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	17-Sep-06
		Client Description:		Tim Barrett Cove	Crawley Island	Crawley Island	Shag Rocks	Shag Rocks	Seal Cove	Seal Cove	Sandy Point
Parameters	**Method**	**RDL**	**Units**								
Benzene	Atlantic PIRI	1	ug/L								ND
Toluene	Atlantic PIRI	1	ug/L								ND
Ethylbenzene	Atlantic PIRI	1	ug/L								ND
Xylene (Total)	Atlantic PIRI	2	ug/L								ND
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L								ND
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L								ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L								ND
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L								ND
Isobutylbenzene - Extractable	Atlantic PIRI	-	%								83
Isobutylbenzene - Volatile	Atlantic PIRI	-	%								79
n-Dotriacontane - Extractable	Atlantic PIRI	-	%								74
Total Mercury	CVAA	0.01	ug/L								
Arsenic	ICP-MS	0.1	ug/L	0.7	0.6	0.8	0.6	0.7	0.8	0.6	
Cadmium	ICP-MS	0.1	ug/L	ND	ND	ND	ND	ND	ND	ND	
Chromium	ICP-MS	0.5	ug/L	ND	ND	ND	ND	ND	ND	ND	
Cobalt	ICP-MS	0.1	ug/L	ND	ND	ND	ND	ND	ND	ND	
Copper	ICP-MS	0.1	ug/L	0.2	0.3	0.3	0.2	0.3	0.3	0.3	
Iron	ICP-MS	1	ug/L	1	1	1	1	1	1	1	
Lead	ICP-MS	0.1	ug/L	ND	ND	ND	ND	ND	ND	ND	
Manganese	ICP-MS	1	ug/L	ND	ND	ND	ND	ND	ND	1	
Nickel	ICP-MS	0.5	ug/L	ND	ND	ND	ND	ND	ND	ND	
Zinc	ICP-MS	1	ug/L	ND	ND	ND	ND	ND	ND	ND	
pH	pH meter	-	-								
Total Suspended Solids	Gravimetric	1000	ug/L								

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		SP	MP	MP	TK	TK	TBC	TBC
		Depth (m):		0.20	8.50	0.20	14.00	0.20	12.50	0.20
		Depth relative:		S	B	S	B	S	B	S
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		O33347	O33348	O33349	O33350	O33351	O33352	O33353
		Sample Class:		SW	SW	SW	SW	SW	SW	SW
		Sample Number:								
		Sample Type:		P	P	P	P	P	P	P
		Date Sampled:		17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06
		Client Description:		Sandy Point	Maturin Point	Maturin Point	The Key	The Key	Tim Barrett Cove	Tim Barrett Cove
Parameters	**Method**	**RDL**	**Units**							
Benzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND
Toluene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND	ND
Xylene (Total)	Atlantic PIRI	2	ug/L	ND	ND	ND	ND	ND	ND	ND
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L	ND	ND	ND	ND	ND	ND	ND
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L	ND	ND	ND	ND	ND	ND	60
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND	ND
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND	ND
Isobutylbenzene - Extractable	Atlantic PIRI	-	%	59	100	61	95	74	98	98
Isobutylbenzene - Volatile	Atlantic PIRI	-	%	79	80	80	76	75	75	75
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	22	104	22	97	96	94	100
Total Mercury	CVAA	0.01	ug/L							
Arsenic	ICP-MS	0.1	ug/L							
Cadmium	ICP-MS	0.1	ug/L							
Chromium	ICP-MS	0.5	ug/L							
Cobalt	ICP-MS	0.1	ug/L							
Copper	ICP-MS	0.1	ug/L							
Iron	ICP-MS	1	ug/L							
Lead	ICP-MS	0.1	ug/L							
Manganese	ICP-MS	1	ug/L							
Nickel	ICP-MS	0.5	ug/L							
Zinc	ICP-MS	1	ug/L							
pH	pH meter	-	-							
Total Suspended Solids	Gravimetric	1000	ug/L							

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		CI	CI	SR	SR	REF	REF	SP	SP
		Depth (m):		18.00	0.20	16.00	0.20	11.50	0.20	7.00	0.20
		Depth relative:		B	S	B	S	B	S	B	S
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		O33354	O33355	O33356	O33357	O33359	O33362	O37614	O37615
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:									
		Sample Type:		P	P	P	P	P	P	P	P
		Date Sampled:		17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06
		Client Description:		Crawley Island	Crawley Island	Shag Rocks	Shag Rocks	Seal Cove	Seal Cove	Sandy Point	Sandy Point
Parameters	**Method**	**RDL**	**Units**								
Benzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND		
Toluene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND		
Ethylbenzene	Atlantic PIRI	1	ug/L	ND	ND	ND	ND	ND	ND		
Xylene (Total)	Atlantic PIRI	2	ug/L	ND	ND	ND	ND	ND	ND		
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L	ND	ND	ND	ND	ND	ND		
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L	ND	ND	ND	ND	ND	ND		
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND		
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L	ND	ND	ND	ND	ND	ND		
Isobutylbenzene - Extractable	Atlantic PIRI	-	%	98	94	99	103	105	106		
Isobutylbenzene - Volatile	Atlantic PIRI	-	%	74	72	71	71	72	75		
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	98	87	95	97	97	101		
Total Mercury	CVAA	0.01	ug/L							ND	ND
Arsenic	ICP-MS	0.1	ug/L								
Cadmium	ICP-MS	0.1	ug/L								
Chromium	ICP-MS	0.5	ug/L								
Cobalt	ICP-MS	0.1	ug/L								
Copper	ICP-MS	0.1	ug/L								
Iron	ICP-MS	1	ug/L								
Lead	ICP-MS	0.1	ug/L								
Manganese	ICP-MS	1	ug/L								
Nickel	ICP-MS	0.5	ug/L								
Zinc	ICP-MS	1	ug/L								
pH	pH meter	-	-							7.87	7.88
Total Suspended Solids	Gravimetric	1000	ug/L							1100	1200

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		MP	MP	TK	TK	TBC	TBC	CI
		Depth (m):		8.50	0.20	14.00	0.20	12.50	0.20	18.00
		Depth relative:		B	S	B	S	B	S	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		O37616	O37617	O37618	O37619	O37620	O37621	O37622
		Sample Class:		SW	SW	SW	SW	SW	SW	SW
		Sample Number:								
		Sample Type:		P	P	P	P	P	P	P
		Date Sampled:		17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06
		Client Description:		Maturin Point	Maturin Point	The Key	The Key	Tim Barrett Cove	Tim Barrett Cove	Crawley Island
Parameters	**Method**	**RDL**	**Units**							
Benzene	Atlantic PIRI	1	ug/L							
Toluene	Atlantic PIRI	1	ug/L							
Ethylbenzene	Atlantic PIRI	1	ug/L							
Xylene (Total)	Atlantic PIRI	2	ug/L							
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L							
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L							
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L							
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L							
Isobutylbenzene - Extractable	Atlantic PIRI	-	%							
Isobutylbenzene - Volatile	Atlantic PIRI	-	%							
n-Dotriacontane - Extractable	Atlantic PIRI	-	%							
Total Mercury	CVAA	0.01	ug/L	ND	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.1	ug/L							
Cadmium	ICP-MS	0.1	ug/L							
Chromium	ICP-MS	0.5	ug/L							
Cobalt	ICP-MS	0.1	ug/L							
Copper	ICP-MS	0.1	ug/L							
Iron	ICP-MS	1	ug/L							
Lead	ICP-MS	0.1	ug/L							
Manganese	ICP-MS	1	ug/L							
Nickel	ICP-MS	0.5	ug/L							
Zinc	ICP-MS	1	ug/L							
pH	pH meter	-	-	7.99	7.95	7.97	7.99	7.99	8	7.99
Total Suspended Solids	Gravimetric	1000	ug/L	1800	2500	2900	1900	1300	1300	4100

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		CI	SR	SR	REF	REF	SP	SP	MP	MP
		Depth (m):		0.20	16.00	0.20	11.50	0.20	7.00	0.20	8.50	0.20
		Depth relative:		S	B	S	B	S	B	S	B	S
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		O37623	O37624	O37625	O37626	O37627	O37629	O37630	O37631	O37632
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:										
		Sample Type:		P	P	P	P	P	P	P	P	P
		Date Sampled:		17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06
		Client Description:		Crawley Island	Shag Rocks	Shag Rocks	Seal Cove	Seal Cove	Sandy Point	Sandy Point	Maturin Point	Maturin Point
Parameters	**Method**	**RDL**	**Units**									
Benzene	Atlantic PIRI	1	ug/L									
Toluene	Atlantic PIRI	1	ug/L									
Ethylbenzene	Atlantic PIRI	1	ug/L									
Xylene (Total)	Atlantic PIRI	2	ug/L									
C6-C10 (less BTEX)	Atlantic PIRI	10	ug/L									
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L									
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L									
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L									
Isobutylbenzene - Extractable	Atlantic PIRI	-	%									
Isobutylbenzene - Volatile	Atlantic PIRI	-	%									
n-Dotriacontane - Extractable	Atlantic PIRI	-	%									
Total Mercury	CVAA	0.01	ug/L	ND	ND	ND	ND	ND				
Arsenic	ICP-MS	0.1	ug/L						0.8	0.6	0.8	0.6
Cadmium	ICP-MS	0.1	ug/L						ND	ND	ND	ND
Chromium	ICP-MS	0.5	ug/L						ND	ND	ND	ND
Cobalt	ICP-MS	0.1	ug/L						ND	ND	ND	ND
Copper	ICP-MS	0.1	ug/L						0.3	0.7	0.3	0.3
Iron	ICP-MS	1	ug/L						7	29	2	7
Lead	ICP-MS	0.1	ug/L						0.4	0.3	ND	0.1
Manganese	ICP-MS	1	ug/L						2	9	ND	1
Nickel	ICP-MS	0.5	ug/L						ND	ND	ND	ND
Zinc	ICP-MS	1	ug/L						4	2	ND	ND
pH	pH meter	-	-	8.04	8.01	8.01	7.97	7.99				
Total Suspended Solids	Gravimetric	1000	ug/L	3200	1700	1900	2100	2500				

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		TK	TK	TBC	TBC	CI	CI	SR	SR
		Depth (m):		14.00	0.20	12.50	0.20	18.00	0.20	16.00	0.20
		Depth relative:		B	S	B	S	B	S	B	S
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		O37633	O37634	O37635	O37636	O37637	O37638	O37639	O37640
		Sample Class:		SW	SW	SW	SW	SW	SW	SW	SW
		Sample Number:									
		Sample Type:		P	P	P	P	P	P	P	P
		Date Sampled:		17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06
		Client Description:		The Key	The Key	Tim Barrett Cove	Tim Barrett Cove	Crawley Island	Crawley Island	Shag Rocks	Shag Rocks
Parameters	**Method**	**RDL**	**Units**								
Benzene	Atlantic PIRI	1	ug/L								
Toluene	Atlantic PIRI	1	ug/L								
Ethylbenzene	Atlantic PIRI	1	ug/L								
Xylene (Total)	Atlantic PIRI	2	ug/L								
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L								
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L								
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L								
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L								
Isobutylbenzene - Extractable	Atlantic PIRI	-	%								
Isobutylbenzene - Volatile	Atlantic PIRI	-	%								
n-Dotriacontane - Extractable	Atlantic PIRI	-	%								
Total Mercury	CVAA	0.01	ug/L								
Arsenic	ICP-MS	0.1	ug/L	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.5
Cadmium	ICP-MS	0.1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	ICP-MS	0.5	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ICP-MS	0.1	ug/L	0.2	3.8	0.3	0.9	0.4	0.4	0.2	0.4
Iron	ICP-MS	1	ug/L	2	4	3	3	3	8	3	3
Lead	ICP-MS	0.1	ug/L	ND	0.2	0.2	0.4	0.3	0.3	0.1	0.2
Manganese	ICP-MS	1	ug/L	ND	ND	ND	ND	1	1	ND	ND
Nickel	ICP-MS	0.5	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ICP-MS	1	ug/L	ND	ND	ND	ND	ND	ND	ND	ND
pH	pH meter	-	-								
Total Suspended Solids	Gravimetric	1000	ug/L								

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.A-1 Seawater (Continued).

		Sample ID:		REF	REF
		Depth (m):		11.50	0.20
		Depth relative:		B	S
		Project Number:		SA889	SA889
		Lab ID:		O37641	O37642
		Sample Class:		SW	SW
		Sample Number:			
		Sample Type:		P	P
		Date Sampled:		17-Sep-06	17-Sep-06
		Client Description:		Seal Cove	Seal Cove
Parameters	**Method**	**RDL**	**Units**		
Benzene	Atlantic PIRI	1	ug/L		
Toluene	Atlantic PIRI	1	ug/L		
Ethylbenzene	Atlantic PIRI	1	ug/L		
Xylene (Total)	Atlantic PIRI	2	ug/L		
C6-C10 {less BTEX}	Atlantic PIRI	10	ug/L		
>C10-C21 Hydrocarbons	Atlantic PIRI	50	ug/L		
>C21-<C32 Hydrocarbons	Atlantic PIRI	100	ug/L		
Modified TPH (Tier1)	Atlantic PIRI	100	ug/L		
Isobutylbenzene - Extractable	Atlantic PIRI	-	%		
Isobutylbenzene - Volatile	Atlantic PIRI	-	%		
n-Dotriacontane - Extractable	Atlantic PIRI	-	%		
Total Mercury	CVAA	0.01	ug/L		
Arsenic	ICP-MS	0.1	ug/L	0.5	0.5
Cadmium	ICP-MS	0.1	ug/L	ND	ND
Chromium	ICP-MS	0.5	ug/L	ND	ND
Cobalt	ICP-MS	0.1	ug/L	ND	ND
Copper	ICP-MS	0.1	ug/L	0.6	0.4
Iron	ICP-MS	1	ug/L	3	4
Lead	ICP-MS	0.1	ug/L	0.1	0.3
Manganese	ICP-MS	1	ug/L	ND	ND
Nickel	ICP-MS	0.5	ug/L	ND	ND
Zinc	ICP-MS	1	ug/L	ND	ND
pH	pH meter	-	-		
Total Suspended Solids	Gravimetric	1000	ug/L		

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Appendix 2.B: Marine Sediment

Table 2.B-1 Marine Sediment.

		Sample ID:		SP	MP	MP	TK	TBC	TBC	CI
		Depth (m):		7.50	27.50	27.50	33.00	44.00	44.00	42.00
		Depth relative:		B	B	B	B	B	B	B
		Project Number:		SA863	SA863	SA863	SA863	SA863	SA863	SA863
		Lab ID:		I94793	I94794	I94794	I94792	I94740	I94740	I99013
		Sample Class:		MS	MS	MS	MS	MS	MS	MS
		Sample Number:								
		Sample Type:		P	P	D	P	P	D	P
		Date Sampled:		20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	20-Oct-05	23-Oct-05
		Client Description:		Sandy Point	Maturin Point	Maturin Point	The Key	Tim Barrett Cove	Tim Barrett Cove	Crawley Island
Parameters	**Method**	**RDL**	**Units**							
Mercury	CVAA	0.01	mg/kg	0.12	0.02	-	0.03	0.02	-	0.02
Available Aluminum	ICP-MS	10	mg/kg	10000	11000	-	11000	11000	-	9800
Available Antimony	ICP-MS	2	mg/kg	ND	ND	-	ND	ND	-	ND
Available Arsenic	ICP-MS	2	mg/kg	14	13	-	10	8	-	7
Available Barium	ICP-MS	5	mg/kg	51	61	-	60	60	-	55
Available Beryllium	ICP-MS	2	mg/kg	ND	ND	-	ND	ND	-	ND
Available Boron	ICP-MS	5	mg/kg	110	59	-	42	30	-	24
Available Cadmium	ICP-MS	0.3	mg/kg	2.4	0.8	-	0.4	0.4	-	ND
Available Chromium	ICP-MS	2	mg/kg	28	31	-	26	23	-	19
Available Cobalt	ICP-MS	1	mg/kg	5	9	-	9	9	-	9
Available Copper	ICP-MS	2	mg/kg	28	20	-	17	16	-	12
Available Iron	ICP-MS	50	mg/kg	17000	24000	-	20000	21000	-	16000
Available Lead	ICP-MS	0.5	mg/kg	54	12	-	18	15	-	12
Available Manganese	ICP-MS	2	mg/kg	310	500	-	520	530	-	500
Available Molybdenum	ICP-MS	2	mg/kg	10	4	-	3	4	-	ND
Available Nickel	ICP-MS	2	mg/kg	18	24	-	22	21	-	18
Available Phosphorus	ICP-MS	100	mg/kg							
Available Selenium	ICP-MS	1	mg/kg	4	2	-	2	1	-	1
Available Silver	ICP-MS	0.5	mg/kg	ND	ND	-	ND	ND	-	ND
Available Strontium	ICP-MS	5	mg/kg	180	120	-	120	85	-	130
Available Thallium	ICP-MS	0.1	mg/kg	0.3	0.2	-	0.2	0.2	-	0.2
Available Uranium	ICP-MS	0.1	mg/kg	23	2.6	-	3.3	2.1	-	1.7
Available Vanadium	ICP-MS	2	mg/kg	52	40	-	33	29	-	27
Available Zinc	ICP-MS	5	mg/kg	88	65	-	64	63	-	55
Total Inorganic Carbon	LECO	-	g/kg	6.4	11	-	6.9	2.6	-	12
Total Organic Carbon	LECO	-	g/kg	86	37	-	24	23	-	13
Total Carbon-combustion IR		-	g/kg	93	47	-	31	25	-	25
Dry Mass to Volume Ratio		N/A	N/A	1:5	1:5		1:5	1:5	-	1:5
Moisture		1	%	75	64	-	54	50	-	44
Sulphate	Colourimetric	300	mg/kg	7500	4600	4700	3400	2500	-	2300
< -4 Phi	Sieve and pipette	0.1	%	100	100	-	100	100	-	100
< -3 Phi	Sieve and pipette	0.1	%	100	100	-	100	100	-	100
< -2 Phi	Sieve and pipette	0.1	%	100	100	-	100	100	-	100
< -1 Phi	Sieve and pipette	0.1	%	100	100	-	100	100	-	98
< 0 Phi	Sieve and pipette	0.1	%	97	95	-	98	99	-	96
< +1 Phi	Sieve and pipette	0.1	%	94	91	-	97	96	-	87
< +2 Phi	Sieve and pipette	0.1	%	91	86	-	93	92	-	70
< +3 Phi	Sieve and pipette	0.1	%	88	82	-	87	86	-	65
< +4 Phi	Sieve and pipette	0.1	%	79	73	-	62	56	-	47
< +5 Phi	Sieve and pipette	0.1	%	75	58	-	46	33	-	40
< +6 Phi	Sieve and pipette	0.1	%	61	41	-	30	23	-	30
< +7 Phi	Sieve and pipette	0.1	%	47	31	-	21	18	-	22
< +8 Phi	Sieve and pipette	0.1	%	42	26	-	19	16	-	20
< +9 Phi	Sieve and pipette	0.1	%	34	20	-	15	13	-	16
Gravel	Sieve and pipette	0.1	%	0.1	0.3	-	ND	0.1	-	1.8
Sand	Sieve and pipette	0.1	%	21	27	-	38	44	-	51
Silt	Sieve and pipette	0.1	%	37	47	-	43	39	-	27
Clay	Sieve and pipette	0.1	%	42	26	-	19	16	-	20
>C10-C21 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	29	3.5	-	4.9	5.9	5.3	5.4
>C21-<C32 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	92	9.2	-	13	15	12	11
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	92	93	-	91	100	93	89

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.B-1 Marine Sediment (Continued).

		Sample ID:		SR	SR	SP	MP	TK	TBC	CI
		Depth (m):		44.00	44.00	7.50	27.50	33.00	44.00	42.00
		Depth relative:		B	B	B	B	B	B	B
		Project Number:		SA863	SA863	SA889	SA889	SA889	SA889	SA889
		Lab ID:		I98999	I98999	M12762	M12772	M12773	M12774	M12775
		Sample Class:		MS	MS	MS	MS	MS	MS	MS
		Sample Number:								
		Sample Type:		P	D	P	P	P	P	P
		Date Sampled:		23-Oct-05	23-Oct-05	15-May-06	15-May-06	15-May-06	15-May-06	16-May-06
		Client Description:		Shag Rocks	Shag Rocks	Sandy Point	Maturin Point	The Key	Tim Barrett Cove	Crawley Island
Parameters	**Method**	**RDL**	**Units**							
Mercury	CVAA	0.01	mg/kg	0.02	0.02	0.09	0.05	0.03	ND	0.03
Available Aluminum	ICP-MS	10	mg/kg	11000	-	9300	10000	11000	9400	11000
Available Antimony	ICP-MS	2	mg/kg	ND	-	ND	ND	ND	ND	ND
Available Arsenic	ICP-MS	2	mg/kg	6	-	17	11	10	4	8
Available Barium	ICP-MS	5	mg/kg	56	-	39	68	55	30	90
Available Beryllium	ICP-MS	2	mg/kg	ND	-	ND	ND	ND	ND	ND
Available Boron	ICP-MS	5	mg/kg	16	-	150	52	39	9	51
Available Cadmium	ICP-MS	0.3	mg/kg	ND	-	2.5	1.1	0.6	ND	0.4
Available Chromium	ICP-MS	2	mg/kg	19	-	26	25	27	16	24
Available Cobalt	ICP-MS	1	mg/kg	10	-	5	8	9	9	9
Available Copper	ICP-MS	2	mg/kg	10	-	23	18	17	6	21
Available Iron	ICP-MS	50	mg/kg	17000	-	17000	17000	20000	16000	18000
Available Lead	ICP-MS	0.5	mg/kg	11	-	33	23	15	6.4	19
Available Manganese	ICP-MS	2	mg/kg	540	-	300	450	500	500	520
Available Molybdenum	ICP-MS	2	mg/kg	ND	-	11	4	2	ND	ND
Available Nickel	ICP-MS	2	mg/kg	20	-	18	19	22	15	22
Available Phosphorus	ICP-MS	100	mg/kg			10000	9000	2300	980	1700
Available Selenium	ICP-MS	1	mg/kg	ND	-	3	2	1	ND	1
Available Silver	ICP-MS	0.5	mg/kg	ND	-	ND	ND	ND	ND	ND
Available Strontium	ICP-MS	5	mg/kg	120	-	130	120	72	82	140
Available Thallium	ICP-MS	0.1	mg/kg	0.2	-	0.2	0.2	0.2	0.1	0.2
Available Uranium	ICP-MS	0.1	mg/kg	0.9	-	14	12	2.9	0.7	1.7
Available Vanadium	ICP-MS	2	mg/kg	24	-	43	39	33	20	36
Available Zinc	ICP-MS	5	mg/kg	58	-	79	65	60	50	63
Total Inorganic Carbon	LECO	-	g/kg	11	-	6	11	6.5	6.8	16
Total Organic Carbon	LECO	-	g/kg	9	-	92	33	28	4.3	28
Total Carbon-combustion IR		-	g/kg	20	-	98	44	35	11	45
Dry Mass to Volume Ratio		N/A	N/A	1:5	-	1:5	1:5	1:5	1:5	1:5
Moisture		1	%	34	-	80	60	60	23	60
Sulphate	Colourimetric	300	mg/kg	1400	1300	8900	4300	4400	730	4500
< -4 Phi	Sieve and pipette	0.1	%	100	-	100	100	100	100	100
< -3 Phi	Sieve and pipette	0.1	%	100	-	100	100	100	100	100
< -2 Phi	Sieve and pipette	0.1	%	100	-	100	100	100	100	100
< -1 Phi	Sieve and pipette	0.1	%	92	-	100	93	100	77	100
< 0 Phi	Sieve and pipette	0.1	%	84	-	99	88	97	73	99
< +1 Phi	Sieve and pipette	0.1	%	71	-	97	84	94	68	97
< +2 Phi	Sieve and pipette	0.1	%	58	-	95	79	89	55	94
< +3 Phi	Sieve and pipette	0.1	%	51	-	91	74	78	33	91
< +4 Phi	Sieve and pipette	0.1	%	34	-	81	63	54	15	82
< +5 Phi	Sieve and pipette	0.1	%	26	-	74	49	38	11	66
< +6 Phi	Sieve and pipette	0.1	%	20	-	64	36	28	8.9	51
< +7 Phi	Sieve and pipette	0.1	%	15	-	53	27	21	6.9	38
< +8 Phi	Sieve and pipette	0.1	%	14	-	48	25	19	6.5	34
< +9 Phi	Sieve and pipette	0.1	%	11	-	28	20	17	5.5	28
Gravel	Sieve and pipette	0.1	%	8.1	-	ND	7.4	ND	23	ND
Sand	Sieve and pipette	0.1	%	57	-	19	30	46	61	18
Silt	Sieve and pipette	0.1	%	21	-	34	38	35	9	48
Clay	Sieve and pipette	0.1	%	14	-	48	25	19	6.5	34
>C10-C21 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	5.3	5.2	31	17	6.7	2	8.2
>C21-<C32 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	11	11	96	60	24	5.9	23
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	89	91	84	102	78	80	80

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.B-1 Marine Sediment (Continued).

		Sample ID:		SR	REF	SP	MP	TK	TBC
		Depth (m):		44.00	70.00	7.50	27.50	33.00	44.00
		Depth relative:		B	B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		M12777	M12778	N36530	N36533	N36534	N36535
		Sample Class:		MS	MS	MS	MS	MS	MS
		Sample Number:							
		Sample Type:		P	P	P	P	P	P
		Date Sampled:		16-May-06	16-May-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06
		Client Description:		Shag Rocks	Seal Cove	Sandy Point	Maturin Point	The Key	Tim Barrett Cove
Parameters	**Method**	**RDL**	**Units**						
Mercury	CVAA	0.01	mg/kg	0.03	0.02	0.06	0.04	0.04	0.03
Available Aluminum	ICP-MS	10	mg/kg	11000	8800	9400	11000	11000	11000
Available Antimony	ICP-MS	2	mg/kg	ND	ND	ND	ND	ND	ND
Available Arsenic	ICP-MS	2	mg/kg	8	4	19	12	10	8
Available Barium	ICP-MS	5	mg/kg	88	76	32	76	66	92
Available Beryllium	ICP-MS	2	mg/kg	ND	ND	ND	ND	ND	ND
Available Boron	ICP-MS	5	mg/kg	51	27	250	56	39	44
Available Cadmium	ICP-MS	0.3	mg/kg	ND	ND	2.1	0.6	0.6	ND
Available Chromium	ICP-MS	2	mg/kg	23	16	27	27	26	23
Available Cobalt	ICP-MS	1	mg/kg	9	8	5	9	9	9
Available Copper	ICP-MS	2	mg/kg	21	11	24	20	16	20
Available Iron	ICP-MS	50	mg/kg	18000	15000	18000	19000	19000	18000
Available Lead	ICP-MS	0.5	mg/kg	19	11	18	22	17	18
Available Manganese	ICP-MS	2	mg/kg	520	470	290	480	500	500
Available Molybdenum	ICP-MS	2	mg/kg	ND	ND	21	5	3	ND
Available Nickel	ICP-MS	2	mg/kg	22	17	21	21	21	21
Available Phosphorus	ICP-MS	100	mg/kg	1400	800	3300	3900	2700	1600
Available Selenium	ICP-MS	1	mg/kg	1	ND	4	2	2	2
Available Silver	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Available Strontium	ICP-MS	5	mg/kg	210	370	100	110	87	150
Available Thallium	ICP-MS	0.1	mg/kg	0.1	0.2	0.2	0.2	0.2	0.1
Available Uranium	ICP-MS	0.1	mg/kg	1	0.6	9.1	5.8	3.7	1.4
Available Vanadium	ICP-MS	2	mg/kg	32	21	43	38	34	34
Available Zinc	ICP-MS	5	mg/kg	59	48	59	63	59	60
Total Inorganic Carbon	LECO	-	g/kg	18	25	10	8.6	6.4	13
Total Organic Carbon	LECO	-	g/kg	26	12	94	27	25	24
Total Carbon-combustion IR		-	g/kg	43	37	100	36	32	36
Dry Mass to Volume Ratio		N/A	N/A	1:5	1:5	1:5	1:5	1:5	1:5
Moisture		1	%	60	42	81	60	58	60
Sulphate	Colourimetric	300	mg/kg	4900	2200	11000	4700	3500	4100
< -4 Phi	Sieve and pipette	0.1	%	100	100	100	100	100	100
< -3 Phi	Sieve and pipette	0.1	%	100	100	100	100	100	100
< -2 Phi	Sieve and pipette	0.1	%	100	100	100	100	100	100
< -1 Phi	Sieve and pipette	0.1	%	100	100	100	96	100	100
< 0 Phi	Sieve and pipette	0.1	%	99	100	98	93	97	97
< +1 Phi	Sieve and pipette	0.1	%	98	98	95	89	93	94
< +2 Phi	Sieve and pipette	0.1	%	96	93	93	84	87	91
< +3 Phi	Sieve and pipette	0.1	%	93	79	91	78	76	87
< +4 Phi	Sieve and pipette	0.1	%	82	36	87	68	54	77
< +5 Phi	Sieve and pipette	0.1	%	65	26	83	53	39	57
< +6 Phi	Sieve and pipette	0.1	%	51	21	74	37	26	42
< +7 Phi	Sieve and pipette	0.1	%	39	17	63	26	18	31
< +8 Phi	Sieve and pipette	0.1	%	36	15	58	24	17	27
< +9 Phi	Sieve and pipette	0.1	%	29	13	47	18	12	20
Gravel	Sieve and pipette	0.1	%	ND	ND	ND	3.9	ND	ND
Sand	Sieve and pipette	0.1	%	18	64	13	28	46	23
Silt	Sieve and pipette	0.1	%	46	21	29	44	38	50
Clay	Sieve and pipette	0.1	%	36	15	58	24	17	27
>C10-C21 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	8.1	3.1	18	11	8	6.6
>C21-<C32 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	22	9.5	52	29	25	18
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	91	84	64	82	106	114

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.B-1 Marine Sediment (Continued).

		Depth (m):		42.00	44.00	70.00	7.50	27.50	33.00
		Depth relative:		B	B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		N36537	N36536	N36538	O37645	O37659	O37660
		Sample Class:		MS	MS	MS	MS	MS	MS
		Sample Number:							
		Sample Type:		P	P	P	P	P	P
		Date Sampled:		25-Jul-06	25-Jul-06	25-Jul-06	17-Sep-06	17-Sep-06	17-Sep-06
		Client Description:		Crawley Island	Shag Rocks	Seal Cove	Sandy Point	Maturin Point	The Key
Parameters	**Method**	**RDL**	**Units**						
Mercury	CVAA	0.01	mg/kg	0.03	0.03	0.02	0.07	0.04	0.03
Available Aluminum	ICP-MS	10	mg/kg	12000	11000	8800	9700	11000	11000
Available Antimony	ICP-MS	2	mg/kg	ND	ND	ND	ND	ND	ND
Available Arsenic	ICP-MS	2	mg/kg	9	9	4	19	10	13
Available Barium	ICP-MS	5	mg/kg	76	95	79	26	75	88
Available Beryllium	ICP-MS	2	mg/kg	ND	ND	ND	ND	ND	ND
Available Boron	ICP-MS	5	mg/kg	35	45	26	200	62	60
Available Cadmium	ICP-MS	0.3	mg/kg	0.3	ND	ND	2.2	0.8	0.8
Available Chromium	ICP-MS	2	mg/kg	25	22	15	23	28	29
Available Cobalt	ICP-MS	1	mg/kg	11	9	7	5	9	9
Available Copper	ICP-MS	2	mg/kg	16	20	11	21	22	21
Available Iron	ICP-MS	50	mg/kg	19000	18000	14000	18000	21000	19000
Available Lead	ICP-MS	0.5	mg/kg	15	19	9	21	22	20
Available Manganese	ICP-MS	2	mg/kg	540	500	450	320	500	510
Available Molybdenum	ICP-MS	2	mg/kg	ND	ND	ND	22	5	2
Available Nickel	ICP-MS	2	mg/kg	22	20	15	19	22	22
Available Phosphorus	ICP-MS	100	mg/kg	1700	1500	880	4500	3200	3400
Available Selenium	ICP-MS	1	mg/kg	1	2	ND	4	2	2
Available Silver	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Available Strontium	ICP-MS	5	mg/kg	140	190	360	99	96	100
Available Thallium	ICP-MS	0.1	mg/kg	0.3	0.1	0.2	0.2	0.2	0.1
Available Uranium	ICP-MS	0.1	mg/kg	1.7	1.3	0.9	11	4.2	4.2
Available Vanadium	ICP-MS	2	mg/kg	34	34	20	41	40	40
Available Zinc	ICP-MS	5	mg/kg	60	57	44	81	71	65
Total Inorganic Carbon	LECO	-	g/kg	10	9.1	21	5	7.6	5.9
Total Organic Carbon	LECO	-	g/kg	19	25	12	69	36	35
Total Carbon-combustion IR		-	g/kg	29	34	33	74	44	40
Dry Mass to Volume Ratio		N/A	N/A	1:5	1:5	1:5	1:5	1:5	1:5
Moisture		1	%	57	60	40	76	66	63
Sulphate	Colourimetric	300	mg/kg	2900	3600	2300	7400	4200	4000
< -4 Phi	Sieve and pipette	0.1	%	100	100	100	100	100	100
< -3 Phi	Sieve and pipette	0.1	%	100	100	100	100	100	100
< -2 Phi	Sieve and pipette	0.1	%	100	100	100	100	100	100
< -1 Phi	Sieve and pipette	0.1	%	100	100	100	94	99	100
< 0 Phi	Sieve and pipette	0.1	%	97	98	100	86	92	94
< +1 Phi	Sieve and pipette	0.1	%	90	95	98	82	86	89
< +2 Phi	Sieve and pipette	0.1	%	78	90	94	76	80	84
< +3 Phi	Sieve and pipette	0.1	%	71	86	77	70	74	79
< +4 Phi	Sieve and pipette	0.1	%	56	74	30	60	66	70
< +5 Phi	Sieve and pipette	0.1	%	47	59	22	55	52	51
< +6 Phi	Sieve and pipette	0.1	%	34	44	17	49	37	36
< +7 Phi	Sieve and pipette	0.1	%	25	33	14	41	25	26
< +8 Phi	Sieve and pipette	0.1	%	22	30	12	38	22	23
< +9 Phi	Sieve and pipette	0.1	%	17	22	9.8	33	16	18
Gravel	Sieve and pipette	0.1	%	ND	ND	ND	6.1	1	ND
Sand	Sieve and pipette	0.1	%	44	26	70	34	33	30
Silt	Sieve and pipette	0.1	%	35	44	18	22	44	47
Clay	Sieve and pipette	0.1	%	22	30	12	38	22	23
>C10-C21 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	6.7	5.9	1.7	15	14	5.8
>C21-<C32 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	18	15	5.2	41	27	14
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	120	97	105	85	76	73

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.B-1 Marine Sediment (Continued).

		Sample ID:		TBC	CI	SR	REF	OF
		Depth (m):		44.00	42.00	44.00	70.00	69.50
		Depth relative:		B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889
		Lab ID:		O37661	O37662	O37663	O37664	
		Sample Class:		MS	MS	MS	MS	MS
		Sample Number:						
		Sample Type:		P	P	P	P	P
		Date Sampled:		17-Sep-06	17-Sep-06	17-Sep-06	17-Sep-06	4-Oct-06
		Client Description:		Tim Barrett Cove	Crawley Island	Shag Rocks	Seal Cove	Outfall
Parameters	**Method**	**RDL**	**Units**					
Mercury	CVAA	0.01	mg/kg	0.02	0.02	0.02	0.01	0.02
Available Aluminum	ICP-MS	10	mg/kg	10000	12000	11000	8400	11000
Available Antimony	ICP-MS	2	mg/kg	ND	ND	ND	ND	ND
Available Arsenic	ICP-MS	2	mg/kg	8	7	7	4	7
Available Barium	ICP-MS	5	mg/kg	85	72	76	78	97
Available Beryllium	ICP-MS	2	mg/kg	ND	ND	ND	ND	ND
Available Boron	ICP-MS	5	mg/kg	35	36	24	24	46
Available Cadmium	ICP-MS	0.3	mg/kg	0.3	ND	ND	ND	ND
Available Chromium	ICP-MS	2	mg/kg	24	24	22	16	22
Available Cobalt	ICP-MS	1	mg/kg	9	11	10	8	9
Available Copper	ICP-MS	2	mg/kg	18	16	13	11	29
Available Iron	ICP-MS	50	mg/kg	18000	18000	18000	14000	17000
Available Lead	ICP-MS	0.5	mg/kg	15	15	11	8.5	18
Available Manganese	ICP-MS	2	mg/kg	520	560	530	470	510
Available Molybdenum	ICP-MS	2	mg/kg	3	ND	2	ND	ND
Available Nickel	ICP-MS	2	mg/kg	21	21	21	15	21
Available Phosphorus	ICP-MS	100	mg/kg	1300	1700	920	760	1300
Available Selenium	ICP-MS	1	mg/kg	2	2	2	2	1
Available Silver	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND
Available Strontium	ICP-MS	5	mg/kg	110	140	130	420	190
Available Thallium	ICP-MS	0.1	mg/kg	0.1	0.2	0.2	0.1	0.2
Available Uranium	ICP-MS	0.1	mg/kg	1.7	1.8	1.3	0.7	1.3
Available Vanadium	ICP-MS	2	mg/kg	33	33	28	21	34
Available Zinc	ICP-MS	5	mg/kg	62	62	57	49	67
Total Inorganic Carbon	LECO	-	g/kg	13	14	11	13	15
Total Organic Carbon	LECO	-	g/kg	18	17	12	21	20
Total Carbon-combustion IR		-	g/kg	30	31	23	35	35
Dry Mass to Volume Ratio		N/A	N/A	1:5	1:5	1:5	1:5	1:5
Moisture		1	%	53	51	38	43	59
Sulphate	Colourimetric	300	mg/kg	8500	7500	1900	1800	4900
< -4 Phi	Sieve and pipette	0.1	%	100	100	100	100	100
< -3 Phi	Sieve and pipette	0.1	%	100	100	100	100	100
< -2 Phi	Sieve and pipette	0.1	%	100	100	100	100	100
< -1 Phi	Sieve and pipette	0.1	%	100	100	56	100	100
< 0 Phi	Sieve and pipette	0.1	%	99	98	44	100	97
< +1 Phi	Sieve and pipette	0.1	%	96	94	40	99	94
< +2 Phi	Sieve and pipette	0.1	%	91	86	38	94	89
< +3 Phi	Sieve and pipette	0.1	%	84	73	35	77	84
< +4 Phi	Sieve and pipette	0.1	%	62	58	27	30	71
< +5 Phi	Sieve and pipette	0.1	%	40	43	21	20	59
< +6 Phi	Sieve and pipette	0.1	%	27	32	16	16	44
< +7 Phi	Sieve and pipette	0.1	%	21	24	13	14	33
< +8 Phi	Sieve and pipette	0.1	%	19	22	11	13	29
< +9 Phi	Sieve and pipette	0.1	%	15	17	8.6	10	22
Gravel	Sieve and pipette	0.1	%	ND	ND	44	ND	ND
Sand	Sieve and pipette	0.1	%	38	42	29	70	29
Silt	Sieve and pipette	0.1	%	43	36	16	17	42
Clay	Sieve and pipette	0.1	%	19	22	11	13	29
>C10-C21 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	3.5	4	2.6	1.8	4.2
>C21-<C32 Hydrocarbons	Atlantic PIRI	0.3	mg/kg	8.2	8.6	5.8	3.7	13
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	82	80	72	71	103

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Appendix 2.C: Blue Mussels

Table 2.C-1 Blue Mussels.

		Sample ID:		DEP	DEP	SP	MP	TK	TBC
		Depth (m):				6.00	7.50	13.00	11.50
		Depth relative:				B	B	B	B
		Project Number:		SA863	SA863	SA889	SA889	SA889	SA889
		Lab ID:		I96744	I96744	M27236	M27245	M27246	M27247
		Sample Class:		BM	BM	BM	BM	BM	BM
		Sample Number:		1	1	1	1	1	1
		Sample Type:		P	D	P	P	P	P
		Date Sampled:		20-Oct-05	20-Oct-05	17-May-06	17-May-06	17-May-06	17-May-06
		Client Description:		Deployment	Deployment	Sandy Point	Maturin Point	The Key	Tim Barrett Cove
Parameters	**Method**	**RDL**	**Units**						
Mercury	CVAA	0.01	mg/kg	ND	-	0.03	0.02	0.02	0.02
Aluminum	ICP-MS	2.5	mg/kg	ND	-	ND	ND	2.6	ND
Antimony	ICP-MS	0.5	mg/kg	ND	-	ND	ND	ND	ND
Arsenic	ICP-MS	0.5	mg/kg	1.0	-	1.3	1.4	1.2	1.4
Barium	ICP-MS	1.5	mg/kg	ND	-	nd	ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg	ND	-	nd	ND	ND	ND
Boron	ICP-MS	1.5	mg/kg	5.2	-	4.3	4.3	4.6	4.5
Cadmium	ICP-MS	0.05	mg/kg	0.269	-	0.205	0.246	0.239	0.258
Chromium	ICP-MS	0.5	mg/kg	ND	-	nd	ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg	ND	-	nd	ND	ND	ND
Copper	ICP-MS	0.5	mg/kg	0.71	-	1.11	0.97	0.87	1.11
Iron	ICP-MS	15	mg/kg	16	-	nd	ND	ND	ND
Lead	ICP-MS	0.18	mg/kg	ND	-	nd	ND	ND	ND
Lithium	ICP-MS	0.5	mg/kg	ND	-	nd	ND	ND	ND
Manganese	ICP-MS	0.5	mg/kg	0.53	-	1.01	0.92	0.98	0.93
Molybdenum	ICP-MS	0.5	mg/kg	ND	-	nd	ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg	ND	-	nd	ND	ND	ND
Selenium	ICP-MS	0.5	mg/kg	ND	-	0.63	0.65	0.71	0.69
Silver	ICP-MS	0.12	mg/kg	ND	-	nd	ND	ND	ND
Strontium	ICP-MS	1.5	mg/kg	6.1	-	6.1	6.1	6.6	5.8
Thallium	ICP-MS	0.02	mg/kg	ND	-	nd	ND	ND	ND
Tin	ICP-MS	0.5	mg/kg	ND	-	nd	ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg	ND	-	0.024	0.025	0.03	0.021
Vanadium	ICP-MS	0.5	mg/kg	ND	-	nd	ND	ND	ND
Zinc	ICP-MS	1.5	mg/kg	15.7	-	17.8	13.7	14.4	15.0
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	102	104	91	101	98	102
Duration of exposure		1	days	0		209	209	209	209
Average length	Caliper measure	0.1	mm	61.1		59.3	60.9	65.2	65.5
Average width:height	Calciulation	0.01		0.77		0.78	0.79	0.80	0.79
Average condition index	Calciulation	0.1		21.5		61.5	98.2	76.3	78.6

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.C-1 Blue Mussels (Continued).

		Sample ID:		CI	SR	DEP	SP	MP	TK
		Depth (m):		17.00	15.00		6.00	7.50	13.00
		Depth relative:		B	B		B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		M27248	M27249	M27250	N38723	N38724	N38725
		Sample Class:		BM	BM	BM	BM	BM	BM
		Sample Number:		1	1	2	1	1	1
		Sample Type:		P	P	P	P	P	P
		Date Sampled:		17-May-06	17-May-06	17-May-06	24-Jul-06	24-Jul-06	24-Jul-06
		Client Description:		Crawley Island	Shag Rocks	Deployment	Sandy Point	Maturin Point	The Key
Parameters	**Method**	**RDL**	**Units**						
Mercury	CVAA	0.01	mg/kg	0.02	0.02	0.02	0.01	ND	ND
Aluminum	ICP-MS	2.5	mg/kg	ND	ND	ND	ND	ND	ND
Antimony	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.5	mg/kg	1.3	1.3	1.01	1.24	1.40	1.34
Barium	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Boron	ICP-MS	1.5	mg/kg	4.7	4.3	5.2	4.7	4.4	4.4
Cadmium	ICP-MS	0.05	mg/kg	0.275	0.25	0.253	0.202	0.226	0.279
Chromium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg	ND	ND	ND	ND	ND	ND
Copper	ICP-MS	0.5	mg/kg	0.9	1.04	0.71	0.94	1.04	0.99
Iron	ICP-MS	15	mg/kg	ND	ND	ND	ND	ND	ND
Lead	ICP-MS	0.18	mg/kg	ND	ND	ND	ND	ND	ND
Lithium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Manganese	ICP-MS	0.5	mg/kg	0.85	0.96	0.64	1.10	1.26	1.05
Molybdenum	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Selenium	ICP-MS	0.5	mg/kg	0.68	0.67	0.58	ND	0.63	0.6
Silver	ICP-MS	0.12	mg/kg	ND	ND	ND	ND	ND	ND
Strontium	ICP-MS	1.5	mg/kg	6	5.8	5.7	5.7	5.2	5.1
Thallium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND	ND
Tin	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg	0.026	0.024	ND	ND	ND	ND
Vanadium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Zinc	ICP-MS	1.5	mg/kg	14.7	14.8	11.2	15.0	14.0	15.3
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	87	94	94	90	79	79
Duration of exposure		1	days	209	209	0	68	68	68
Average length	Caliper measure	0.1	mm	61.5	65.0	54.0	60.6	63.3	62.0
Average width:height	Calciulation	0.01		0.81	0.83	0.72	0.79	0.76	0.76
Average condition index	Calciulation	0.1		89.9	118.5	40.7	51.9	70.8	62.6

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.C-1 Blue Mussels (Continued).

		Sample ID:		TBC	CI	SR	REF	DEP	SP
		Depth (m):		11.50	17.00	15.00	10.50		6.00
		Depth relative:		B	B	B	B		B
		Project Number:		SA889	SA889	SA889		SA889	SA889
		Lab ID:		N38726	N38728	N38727	N38729	N38731	O41434
		Sample Class:		BM	BM	BM	BM	BM	BM
		Sample Number:		1	1	1	1	2	1
		Sample Type:		P	P	P	P	P	P
		Date Sampled:		24-Jul-06	24-Jul-06	24-Jul-06	24-Jul-06	24-Jul-06	15-Sep-06
		Client Description:		Tim Barrett Cove	Crawley Island	Shag Rocks	Seal Cove	Deployment	Sandy Point
Parameters	**Method**	**RDL**	**Units**						
Mercury	CVAA	0.01	mg/kg	ND	ND	ND	ND	ND	0.01
Aluminum	ICP-MS	2.5	mg/kg	ND	ND	ND	ND	ND	3.5
Antimony	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.5	mg/kg	1.42	1.21	1.46	1.42	1.10	1.66
Barium	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Boron	ICP-MS	1.5	mg/kg	4.3	4.4	4.5	4.4	4.4	4.4
Cadmium	ICP-MS	0.05	mg/kg	0.270	0.257	0.295	0.309	0.367	0.381
Chromium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg	ND	ND	ND	ND	ND	ND
Copper	ICP-MS	0.5	mg/kg	1.11	0.98	1.07	0.81	0.84	0.77
Iron	ICP-MS	15	mg/kg	ND	ND	ND	ND	ND	26
Lead	ICP-MS	0.18	mg/kg	ND	ND	ND	ND	ND	0.26
Lithium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Manganese	ICP-MS	0.5	mg/kg	1.35	0.99	1.22	0.72	0.70	1.35
Molybdenum	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Selenium	ICP-MS	0.5	mg/kg	0.63	0.58	0.6	ND	ND	0.54
Silver	ICP-MS	0.12	mg/kg	ND	ND	ND	ND	ND	ND
Strontium	ICP-MS	1.5	mg/kg	5.3	5.2	5.4	5.4	5	5.8
Thallium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND	ND
Tin	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg	0.021	ND	0.021	ND	ND	0.034
Vanadium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Zinc	ICP-MS	1.5	mg/kg	15.6	13.3	14.6	13.3	14.6	30.8
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	82	94	87	86	88	90
Duration of exposure		1	days	68	68	68	68	0	330
Average length	Caliper measure	0.1	mm	59.8	62.1	61.2	63.0	69.8	60.0
Average width:height	Calciulation	0.01		0.75	0.75	0.75	0.75	0.76	0.83
Average condition index	Calciulation	0.1		79.9	70.2	50.0	52.1	47.7	61.0

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.C-1 Blue Mussels (Continued).

		Sample ID:		MP	TK	TBC	CI	SR	SP
		Depth (m):		7.50	13.00	11.50	17.00	15.00	6.00
		Depth relative:		B	B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		O41441	O41443	O41445	O41447	O41449	O41440
		Sample Class:		BM	BM	BM	BM	BM	BM
		Sample Number:		1	1	1	1	1	2
		Sample Type:		P	P	P	P	P	P
		Date Sampled:		15-Sep-06	15-Sep-06	15-Sep-06	15-Sep-06	15-Sep-06	15-Sep-06
		Client Description:		Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Sandy Point
Parameters	**Method**	**RDL**	**Units**						
Mercury	CVAA	0.01	mg/kg	0.01	ND	ND	ND	0.01	0.01
Aluminum	ICP-MS	2.5	mg/kg	ND	ND	ND	4.3	ND	ND
Antimony	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.5	mg/kg	1.06	1.07	1.40	1.40	1.28	1.42
Barium	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Boron	ICP-MS	1.5	mg/kg	4.7	4.4	4.5	4.5	4.5	4.1
Cadmium	ICP-MS	0.05	mg/kg	0.258	0.291	0.261	0.410	0.340	0.200
Chromium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg	ND	ND	ND	ND	ND	ND
Copper	ICP-MS	0.5	mg/kg	0.75	0.68	0.99	0.8	0.79	0.88
Iron	ICP-MS	15	mg/kg	ND	ND	ND	20	ND	15
Lead	ICP-MS	0.18	mg/kg	ND	ND	ND	ND	ND	0.18
Lithium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Manganese	ICP-MS	0.5	mg/kg	0.74	0.63	1.08	1.10	0.87	ND
Molybdenum	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Selenium	ICP-MS	0.5	mg/kg	ND	ND	0.65	0.63	0.57	ND
Silver	ICP-MS	0.12	mg/kg	ND	ND	ND	ND	ND	ND
Strontium	ICP-MS	1.5	mg/kg	6.3	5.9	5.3	8	6.4	5.6
Thallium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND	ND
Tin	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg	0.021	ND	0.022	0.027	0.028	0.02
Vanadium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND
Zinc	ICP-MS	1.5	mg/kg	13.5	16.2	14.6	20.2	15.6	15.6
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	93	98	97	92	101	79
Duration of exposure		1	days	330	330	330	330	330	121
Average length	Caliper measure	0.1	mm	65.7	62.2	62.1	63.8	65.6	62.9
Average width:height	Calciulation	0.01		0.79	0.81	0.82	0.81	0.81	0.75
Average condition index	Calciulation	0.1		73.5	51.2	71.3	60.9	46.8	59.1

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.C-1 Blue Mussels (Continued).

		Sample ID:		MP	TK	TBC	CI	SR	REF	DEP
		Depth (m):		7.50	13.00	11.50	17.00	15.00	10.50	
		Depth relative:		B	B	B	B	B	B	
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:		O41442	O41444	O41446	O41448	O41450	O41451	O41452
		Sample Class:		BM	BM	BM	BM	BM	BM	BM
		Sample Number:		2	2	2	2	2	2	4
		Sample Type:		P	P	P	P	P	P	P
		Date Sampled:		15-Sep-06	15-Sep-06	15-Sep-06	15-Sep-06	15-Sep-06	15-Sep-06	15-Sep-06
		Client Description:		Maturin Point	The Key	Tim Barrett Cove	Crawley Island	Shag Rocks	Seal Cove	Deployment
Parameters	**Method**	**RDL**	**Units**							
Mercury	CVAA	0.01	mg/kg	0.01	0.01	0.01	ND	0.01	0.01	ND
Aluminum	ICP-MS	2.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Antimony	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.5	mg/kg	1.51	1.49	1.28	1.13	1.23	1.65	1.02
Barium	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Boron	ICP-MS	1.5	mg/kg	4.7	4.5	4.7	4.5	4.9	4.6	4.6
Cadmium	ICP-MS	0.05	mg/kg	0.242	0.294	0.254	0.369	0.297	0.391	0.294
Chromium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg	ND	ND	ND	ND	ND	ND	ND
Copper	ICP-MS	0.5	mg/kg	1.13	1.03	1.04	0.76	0.89	0.92	0.75
Iron	ICP-MS	15	mg/kg	ND	ND	ND	ND	ND	ND	ND
Lead	ICP-MS	0.18	mg/kg	ND	ND	ND	ND	ND	ND	ND
Lithium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Manganese	ICP-MS	0.5	mg/kg	1.03	0.73	0.82	ND	0.64	0.56	ND
Molybdenum	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Selenium	ICP-MS	0.5	mg/kg	0.73	0.72	0.69	0.62	0.66	0.81	ND
Silver	ICP-MS	0.12	mg/kg	ND	ND	ND	ND	ND	ND	ND
Strontium	ICP-MS	1.5	mg/kg	5.5	5.3	5.5	5.8	5.6	5,4	5.4
Thallium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND	ND	ND
Tin	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg	ND	ND	0.025	0.024	ND	ND	0.028
Vanadium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Zinc	ICP-MS	1.5	mg/kg	15.1	17.2	13.1	13.0	12.9	15.9	15.7
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND	ND
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	94	94	90	94	98	89	90
Duration of exposure		1	days	121	121	121	121	121	121	0
Average length	Caliper measure	0.1	mm	63.9	64.8	62.1	65.0	64.8	66.0	65.7
Average width:height	Calciulation	0.01		0.76	0.74	0.77	0.77	0.75	0.76	0.75
Average condition index	Calciulation	0.1		73.7	72.6	66.5	55.0	55.0	62.5	52.1

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Appendix 2.D: Winter Flounder

Table 2.D-1 Winter Flounder.

		Sample ID:		OF	OF	OF	OF	OF	OF	OF	OF
		Depth (m):		29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
		Depth relative:		B	B	B	B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:									
		Sample Class:		WFW	WFW	WFW	WFW	WFW	WFM	WFM	WFM
		Sample Number:		1	2	3	4	5	1	2	3
		Sample Type:		P	P	P	P	P	P	P	P
		Date Sampled:		6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06
		Client Description:		Outfall	Outfall	Outfall	Outfall	Outfall	Outfall	Outfall	Outfall
Parameters	**Method**	**RDL**	**Units**								
Mercury	CVAA	0.01	mg/kg						0.03	0.04	0.05
Aluminum	ICP-MS	2.5	mg/kg						ND	ND	ND
Antimony	ICP-MS	0.5	mg/kg						ND	ND	ND
Arsenic	ICP-MS	0.50	mg/kg						5.33	13.00	10.90
Barium	ICP-MS	1.5	mg/kg						ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg						ND	ND	ND
Boron	ICP-MS	1.5	mg/kg						ND	ND	ND
Cadmium	ICP-MS	0.05	mg/kg						ND	ND	ND
Chromium	ICP-MS	0.5	mg/kg						ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg						ND	ND	ND
Copper	ICP-MS	0.5	mg/kg						ND	ND	ND
Iron	ICP-MS	15	mg/kg						ND	ND	ND
Lead	ICP-MS	0.18	mg/kg						ND	ND	ND
Lithium	ICP-MS	0.5	mg/kg						ND	ND	ND
Manganese	ICP-MS	0.50	mg/kg						1.99	1.80	1.28
Molybdenum	ICP-MS	0.5	mg/kg						ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg						ND	ND	ND
Selenium	ICP-MS	0.5	mg/kg						ND	0.82	0.84
Silver	ICP-MS	0.12	mg/kg						ND	ND	ND
Strontium	ICP-MS	1.5	mg/kg						39.3	40.5	24.8
Thallium	ICP-MS	0.02	mg/kg						ND	ND	ND
Tin	ICP-MS	0.5	mg/kg						ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg						ND	ND	ND
Vanadium	ICP-MS	0.5	mg/kg						ND	ND	ND
Zinc	ICP-MS	1.5	mg/kg						15.8	10.4	7.4
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg						ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg						ND	ND	ND
n-Dotriacontane - Extractable	Atlantic PIRI	-	%						103	70	90
Average length	Measuring board	0.1	cm	32.7	34.0	35.8	36.8	32.2	32.7	34.0	35.8
Average weight	Scales	1	g	510	587	672	714	463	510	587	672
Gender				M	F	F	F	F	M	F	F

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.D-1 Winter Flounder (Continued).

		Sample ID:		OF	OF	OF	OF	OF	OF	OF
		Depth (m):		29.00	29.00	29.00	29.00	29.00	29.00	29.00
		Depth relative:		B	B	B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:								
		Sample Class:		WFM	WFM	WFL	WFL	WFL	WFL	WFL
		Sample Number:		4	5	1	2	3	4	5
		Sample Type:		P	P	P	P	P	P	P
		Date Sampled:		6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06
		Client Description:		Outfall	Outfall	Outfall	Outfall	Outfall	Outfall	Outfall
Parameters	**Method**	**RDL**	**Units**							
Mercury	CVAA	0.01	mg/kg	0.04	0.03	0.06	0.06	0.06	0.06	0.04
Aluminum	ICP-MS	2.5	mg/kg	ND	ND	3.6	6.9	3	4.9	3.5
Antimony	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.50	mg/kg	13.70	11.70	4.71	29.00	15.90	37.50	16.70
Barium	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Boron	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Cadmium	ICP-MS	0.05	mg/kg	ND	ND	0.971	0.616	0.397	0.885	0.596
Chromium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg	ND	ND	0.45	0.23	ND	ND	0.33
Copper	ICP-MS	0.5	mg/kg	ND	ND	7.53	14.2	12.9	12.4	20.3
Iron	ICP-MS	15	mg/kg	ND	ND	498	395	435	584	532
Lead	ICP-MS	0.18	mg/kg	ND	ND	0.26	0.36	0.56	0.6	0.96
Lithium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Manganese	ICP-MS	0.50	mg/kg	1.36	1.41	1.76	1.85	1.99	1.66	2.12
Molybdenum	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	0.84
Selenium	ICP-MS	0.5	mg/kg	0.98	0.74	3.45	3.73	4.41	5.08	6.19
Silver	ICP-MS	0.12	mg/kg	ND	ND	0.17	0.38	0.51	0.4	0.56
Strontium	ICP-MS	1.5	mg/kg	28.8	34.3	ND	ND	ND	ND	ND
Thallium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND	ND	ND
Tin	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg	ND	ND	ND	0.026	0.029	0.074	ND
Vanadium	ICP-MS	0.5	mg/kg	ND	ND	2.43	2.17	1.41	5.45	1.31
Zinc	ICP-MS	1.5	mg/kg	9.6	10.0	36.8	46.0	65.1	44.4	52.9
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	20	ND	18	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	410	380	150	330	270
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	79	73	71	67	85	69	65
Average length	Measuring board	0.1	cm	36.8	32.2	32.7	34.0	35.8	36.8	32.2
Average weight	Scales	1	g	714	463	510	587	672	714	463
Gender				F	F	M	F	F	F	F

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.D-1 Winter Flounder (Continued).

		Sample ID:		OF	OF	OF	OF	OF	REF	REF
		Depth (m):		29.00	29.00	29.00	29.00	29.00	30.00	30.00
		Depth relative:		B	B	B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:								
		Sample Class:		WFK	WFK	WFK	WFK	WFK	WFW	WFW
		Sample Number:		1	2	3	4	5	1	2
		Sample Type:		P	P	P	P	P	P	P
		Date Sampled:		6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	6-Oct-06	27-Sep-06	27-Sep-06
		Client Description:		Outfall	Outfall	Outfall	Outfall	Outfall	Seal Cove	Seal Cove
Parameters	**Method**	**RDL**	**Units**							
Mercury	CVAA	0.01	mg/kg	0.07	0.11	0.08	0.10	0.06		
Aluminum	ICP-MS	2.5	mg/kg	3.8	6.8	ND	9.2	6.5		
Antimony	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND		
Arsenic	ICP-MS	0.50	mg/kg	1.50	1.49	1.12	1.57	1.82		
Barium	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND		
Beryllium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND		
Boron	ICP-MS	1.5	mg/kg	ND	ND	1.9	ND	1.6		
Cadmium	ICP-MS	0.05	mg/kg	0.216	0.150	0.119	0.193	0.154		
Chromium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND		
Cobalt	ICP-MS	0.2	mg/kg	ND	ND	ND	ND	ND		
Copper	ICP-MS	0.5	mg/kg	1.03	1.31	1.18	1.31	1.35		
Iron	ICP-MS	15	mg/kg	445	347	79	165	226		
Lead	ICP-MS	0.18	mg/kg	0.31	0.62	0.53	0.58	0.71		
Lithium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND		
Manganese	ICP-MS	0.50	mg/kg	1.00	1.43	1.19	1.55	1.66		
Molybdenum	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND		
Nickel	ICP-MS	0.5	mg/kg	0.9	1.11	0.78	1.39	1.03		
Selenium	ICP-MS	0.5	mg/kg	3.15	4.91	4.05	5.39	3.86		
Silver	ICP-MS	0.12	mg/kg	ND	ND	ND	ND	ND		
Strontium	ICP-MS	1.5	mg/kg	1.8	2	1.6	2.9	2.6		
Thallium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND		
Tin	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND		
Uranium	ICP-MS	0.02	mg/kg	ND	0.027	0.028	0.058	ND		
Vanadium	ICP-MS	0.5	mg/kg	1.33	1.63	1.44	4.04	1.89		
Zinc	ICP-MS	1.5	mg/kg	28.4	21.6	20.2	22.2	24.8		
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND		
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND		
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	78	72	92	90	91		
Average length	Measuring board	0.1	cm	32.7	34.0	35.8	36.8	32.2	38.0	38.4
Average weight	Scales	1	g	510	587	672	714	463	867	877
Gender				M	F	F	F	F	M	M

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.D-1 Winter Flounder (Continued).

		Sample ID:		REF	REF	REF	REF	REF	REF
		Depth (m):		30.00	30.00	30.00	30.00	30.00	30.00
		Depth relative:		B	B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:							
		Sample Class:		WFW	WFW	WFW	WFM	WFM	WFM
		Sample Number:		3	4	5	1	2	3
		Sample Type:		P	P	P	P	P	P
		Date Sampled:		27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06
		Client Description:		Seal Cove	Seal Cove	Seal Cove	Seal Cove	Seal Cove	Seal Cove
Parameters	**Method**	**RDL**	**Units**						
Mercury	CVAA	0.01	mg/kg				0.03	0.03	0.02
Aluminum	ICP-MS	2.5	mg/kg				ND	ND	ND
Antimony	ICP-MS	0.5	mg/kg				ND	ND	ND
Arsenic	ICP-MS	0.50	mg/kg				4.25	4.31	4.12
Barium	ICP-MS	1.5	mg/kg				ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg				ND	ND	ND
Boron	ICP-MS	1.5	mg/kg				ND	ND	ND
Cadmium	ICP-MS	0.05	mg/kg				ND	ND	ND
Chromium	ICP-MS	0.5	mg/kg				ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg				ND	ND	ND
Copper	ICP-MS	0.5	mg/kg				ND	ND	ND
Iron	ICP-MS	15	mg/kg				ND	ND	ND
Lead	ICP-MS	0.18	mg/kg				ND	ND	ND
Lithium	ICP-MS	0.5	mg/kg				ND	ND	ND
Manganese	ICP-MS	0.50	mg/kg				1.29	1.47	1.25
Molybdenum	ICP-MS	0.5	mg/kg				ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg				ND	ND	ND
Selenium	ICP-MS	0.5	mg/kg				ND	ND	ND
Silver	ICP-MS	0.12	mg/kg				ND	ND	ND
Strontium	ICP-MS	1.5	mg/kg				18.5	33.1	20.1
Thallium	ICP-MS	0.02	mg/kg				ND	ND	ND
Tin	ICP-MS	0.5	mg/kg				ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg				ND	ND	ND
Vanadium	ICP-MS	0.5	mg/kg				ND	ND	ND
Zinc	ICP-MS	1.5	mg/kg				10.7	20.1	6.9
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg				ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg				ND	20	ND
n-Dotriacontane - Extractable	Atlantic PIRI	-	%				72	83	97
Average length	Measuring board	0.1	cm	37.0	36.7	37.9	38.0	38.4	37.0
Average weight	Scales	1	g	793	790	849	867	877	793
Gender				M	F	F	M	M	M

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.D-1 Winter Flounder (Continued).

		Sample ID:		REF	REF	REF	REF	REF	REF	REF
		Depth (m):		30.00	30.00	30.00	30.00	30.00	30.00	30.00
		Depth relative:		B	B	B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889	SA889	SA889
		Lab ID:								
		Sample Class:		WFM	WFM	WFL	WFL	WFL	WFL	WFL
		Sample Number:		4	5	1	2	3	4	5
		Sample Type:		P	P	P	P	P	P	P
		Date Sampled:		27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06
		Client Description:		Seal Cove	Seal Cove	Seal Cove	Seal Cove	Seal Cove	Seal Cove	Seal Cove
Parameters	**Method**	**RDL**	**Units**							
Mercury	CVAA	0.01	mg/kg	0.02	0.02	0.04	0.03	0.02	0.03	0.03
Aluminum	ICP-MS	2.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Antimony	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.50	mg/kg	8.54	3.44	6.38	3.61	3.83	14.00	2.30
Barium	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Boron	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Cadmium	ICP-MS	0.05	mg/kg	ND	ND	0.440	0.409	0.252	0.297	0.405
Chromium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg	ND	ND	ND	0.24	ND	ND	ND
Copper	ICP-MS	0.5	mg/kg	ND	ND	8.24	7.4	4.35	6.11	5.11
Iron	ICP-MS	15	mg/kg	ND	ND	221	295	138	171	171
Lead	ICP-MS	0.18	mg/kg	ND	ND	ND	1.31	ND	ND	ND
Lithium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Manganese	ICP-MS	0.50	mg/kg	0.95	1.19	1.17	0.85	1.64	1.44	0.90
Molybdenum	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Selenium	ICP-MS	0.5	mg/kg	ND	ND	2.48	2.68	1.83	2.36	2.49
Silver	ICP-MS	0.12	mg/kg	ND	ND	0.18	0.15	ND	0.2	0.15
Strontium	ICP-MS	1.5	mg/kg	22.2	31.4	ND	ND	ND	ND	ND
Thallium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND	ND	ND
Tin	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND	ND	ND
Vanadium	ICP-MS	0.5	mg/kg	ND	ND	1.03	1.42	ND	ND	0.8
Zinc	ICP-MS	1.5	mg/kg	10.3	17.1	44.0	33.4	54.9	62.7	31.5
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	27	360	710	240	400	480
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	80	93	91	90	82	91	95
Average length	Measuring board	0.1	cm	36.7	37.9	38.0	38.4	37.0	36.7	37.9
Average weight	Scales	1	g	790	849	867	877	793	790	849
Gender				F	F	M	M	M	F	F

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Table 2.D-1 Winter Flounder (Continued).

		Sample ID:		REF	REF	REF	REF	REF
		Depth (m):		30.00	30.00	30.00	30.00	30.00
		Depth relative:		B	B	B	B	B
		Project Number:		SA889	SA889	SA889	SA889	SA889
		Lab ID:						
		Sample Class:		WFK	WFK	WFK	WFK	WFK
		Sample Number:		1	2	3	4	5
		Sample Type:		P	P	P	P	P
		Date Sampled:		27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06	27-Sep-06
		Client Description:		Seal Cove	Seal Cove	Seal Cove	Seal Cove	Seal Cove
Parameters	**Method**	**RDL**	**Units**					
Mercury	CVAA	0.01	mg/kg	0.04	0.06	0.05	0.04	0.05
Aluminum	ICP-MS	2.5	mg/kg	ND	ND	ND	ND	ND
Antimony	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND
Arsenic	ICP-MS	0.50	mg/kg	ND	ND	ND	0.56	ND
Barium	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND
Beryllium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND
Boron	ICP-MS	1.5	mg/kg	ND	ND	ND	ND	ND
Cadmium	ICP-MS	0.05	mg/kg	0.145	0.140	0.115	0.128	0.148
Chromium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND
Cobalt	ICP-MS	0.2	mg/kg	ND	ND	ND	ND	ND
Copper	ICP-MS	0.5	mg/kg	0.96	1.08	1.12	1.03	1.14
Iron	ICP-MS	15	mg/kg	100	128	124	75	104
Lead	ICP-MS	0.18	mg/kg	ND	ND	0.19	ND	ND
Lithium	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND
Manganese	ICP-MS	0.50	mg/kg	1.08	0.89	0.83	0.80	0.91
Molybdenum	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND
Nickel	ICP-MS	0.5	mg/kg	1.29	1.36	0.66	0.87	0.63
Selenium	ICP-MS	0.5	mg/kg	2.33	2.61	2.49	2.41	2.68
Silver	ICP-MS	0.12	mg/kg	ND	ND	ND	ND	ND
Strontium	ICP-MS	1.5	mg/kg	ND	ND	1.6	ND	2.6
Thallium	ICP-MS	0.02	mg/kg	ND	ND	ND	ND	ND
Tin	ICP-MS	0.5	mg/kg	ND	ND	ND	ND	ND
Uranium	ICP-MS	0.02	mg/kg	ND	ND	0.022	ND	ND
Vanadium	ICP-MS	0.5	mg/kg	1.18	1.97	0.76	0.64	1.11
Zinc	ICP-MS	1.5	mg/kg	21.4	22.6	21.5	19.5	22.2
>C10-C21 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	ND
>C21-<C32 Hydrocarbons	Atlantic PIRI	15	mg/kg	ND	ND	ND	ND	32
n-Dotriacontane - Extractable	Atlantic PIRI	-	%	104	87	97	100	88
Average length	Measuring board	0.1	cm	38.0	38.4	37.0	36.7	37.9
Average weight	Scales	1	g	867	877	793	790	849
Gender				M	M	M	F	F

Note: All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

3.0 Commercial Fisheries and Aquaculture

This chapter provides an overview and description of commercial fisheries and aquaculture activities in Placentia Bay, and in the Long Harbour area in particular. For the purpose of the data analysis, the area described is all of Placentia Bay encompassed by NAFO Unit Area (UA) 3PSc. This area is shown in relation to other south coast Unit Areas in Figure 3.1.

Discussion of Placentia Bay's commercial fisheries includes a historical overview of those activities, recent changes in the area's fisheries regime, a description of key species, and harvesting patterns and locations. Current aquaculture operations and sites are also described, including a brief summary of development trends within this sector during the past decade.

3.1. Study Team

Canning & Pitt Associates, Inc. prepared the commercial fisheries sections. Strat Canning, B.Sc.F., D.T.R.P., Partner, conducted the consultations with fishers and summarized the results. Rob Pitt, B.Sc., B.A., M.A, Partner, wrote the commercial fisheries sections, and Garry Kirby, B.A., P.Ag., GIS Specialist, prepared the commercial fisheries map.

3.2. Data and Information Sources

The statistical information and analysis in this report are based primarily on time-series data from the Department of Fisheries and Oceans (DFO), Newfoundland and Labrador Region and Maritimes Region, which describe the quantity, month, and location (by fisheries management Unit Area) of fish harvesting. Although only a very small proportion of the harvest from within 3PSc is landed in Maritimes (Nova Scotia) Region (less than 15 tonnes in 2005), these datasets are included within the Newfoundland Region data and are used in this analysis. The datasets also include information on fishing gear, vessels, and other information. They were acquired from DFO in digital form, for the period 1984 to 2005, but this description focuses mainly on the current fisheries environment, i.e., the 2003-2005 period.

While all these data indicate the Unit Area of harvest, a small amount of the Placentia Bay catch (i.e., Unit Area 3PSc) is also specifically georeferenced with the latitude and longitude of the harvesting location. The location given is that recorded in the vessel's fishing log, and is reported in the database by degree and minute of latitude and longitude; thus, the position is accurate within approximately 1 km of the reported co-ordinates. It should be noted that for some gear, such as mobile gear towed over an extensive area, or for extended gear, such as longlines which may be several miles long, the reference point does not represent the full distribution of the gear or activity on the water. However, over many data entries, the reported locations create a fairly accurate indication of where such fishing activities occur. About 2% of the harvest by quantity from this Unit Area was georeferenced in 2005 and 15% in 2004. Though this represents quite a small portion of the harvest overall, maps of the georeferenced locations are provided for these data to indicate at least some of the harvesting locations in Placentia Bay.

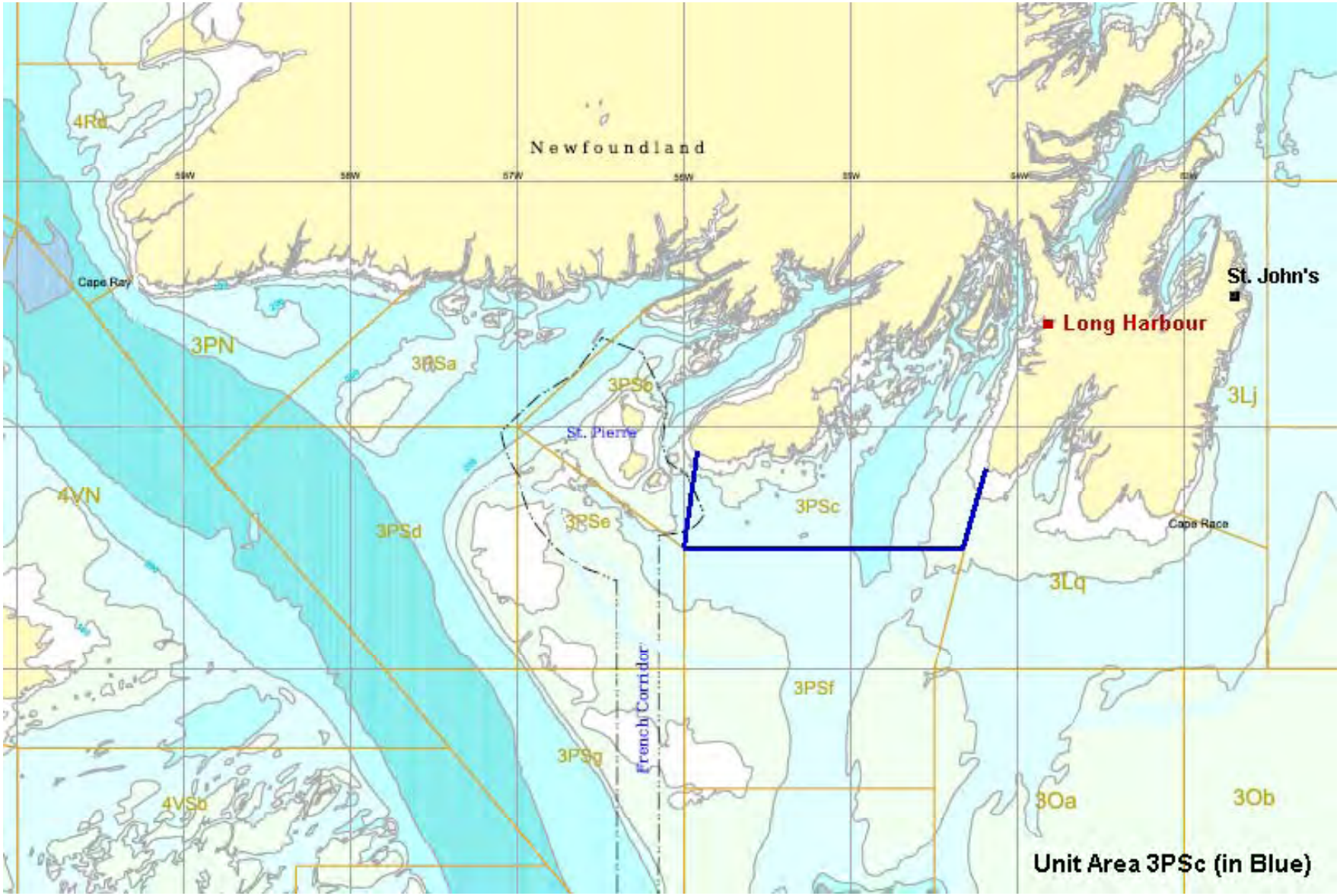


Figure 3.1. Unit Area 3PSc Boundaries.

The Unit Area 3PSc dataset captures species harvested from 3PSc wherever they were landed or processed. Thus, catches by fishers who are not based in Placentia Bay are included, while catches made by Placentia Bay-based vessels are excluded if they were harvested beyond the 3PSc area. For example, some of the larger (greater than 10.7 m) vessels based in the area take a portion of their annual catch on fishing grounds farther offshore, such as the St. Pierre Bank, whereas catches by fishers based in other areas of the province, e.g., in Fortune Bay, are included in the analysis since they are taken within 3PSc.

The calculation of the value of the fisheries is much more complex. In addition to variability that results from changes in the quantity of harvest from year to year (whether due to natural variability or changing quotas), prices also vary from year to year and even within the fishing season, driven primarily by market conditions, which in turn are determined by supply and demand, currency exchange rates, and other market factors. Quality issues also affect the prices paid for many species. Consequently, much of the historical analysis provided in this section involves quantity of harvests (tonnes of fish landed), which is directly comparable from year to year.

Where current landed values for the fisheries are given, they are calculated based on average annual quantities of landings for 2003-2005, applying the most recently available prices. Specifically, these prices are the average landed amounts paid to harvesters in 2005 (averaged over all months) for relevant species within the Newfoundland and Labrador Region (http://www.nfl.dfo-mpo.gc.ca/publications/reports_rapports/Land_All_2005.htm).

Data on aquaculture was provided by the provincial Department of Fisheries and Aquaculture (DFA), including its AquaGIS database.

Other sources consulted for this section include Northwest Atlantic Fisheries Organization (NAFO) data used to capture historical foreign fishing quantities in the St. Pierre et Miquelon French territory and elsewhere, fisheries management plans, stock status reports, quota reports, and other DFO and DFA documents. These are listed in Appendix 3.A.

Consultations for this analysis were undertaken with aquaculture managers with DFA, CCG VTS at Argentia, and fishers from the Long Harbour area. Extensive consultations undertaken with fish processing operators and DFO resource managers in both 2004 and 2006 were also utilized for this report. Appendix 3.A provides a list of all persons consulted for this report.

3.3. Wild Commercial Fisheries

This section presents a detailed review of the commercial fisheries harvesting environment in the Placentia Bay area. This includes the historical context, species harvested, the monthly distribution of fishing activities, fishing gears used, and geographic location of fishing activities, where that information is available. The focus for the following analysis is the domestic Canadian wild (i.e., non-aquaculture) harvest within and adjacent to Placentia Bay. This section describes the species harvested,

typical harvesting locations, seasonality of the harvest and harvesting methods used, as well as the landed quantities and value of the catch.

3.3.1. Historical Context, 1980s to the Present

Drastic changes have occurred in the Newfoundland and Labrador fisheries over the last two decades. On many parts of the Grand Banks, commercial fish harvesting has changed from a completely groundfish-based industry to a more crustacean-based one. In 1992 and 1993, with the acknowledgement of the collapse of several groundfish (demersal) stocks, a harvesting moratorium was declared and directed fisheries for Atlantic cod were no longer permitted in most areas. Subdivisions 3Ps and 3Pn have been exceptions and are now the only remaining Grand Banks areas with a directed (although reduced) Atlantic cod fishery. However, harvesting activities in 3Ps (including Placentia Bay) were still affected by the moratoria. For example, within 3PSc for the period 1984-1990, 74% of the catch by quantity was cod while snow crab made up just 3%; during 1994-1995, immediately after the moratoria were imposed, cod made up only 6% of the harvest and snow crab catches had increased to 24%. In terms of value, cod accounted for nearly 60% of the value of the 3PSc harvest (1984-1992), but only a negligible amount in 1994-1995. A limited cod fishery was reinstated in 3PSc in 1997 under a strict management regime, and during 2000-2002 cod again accounted for nearly 60% of the harvest by quantity. However, in recent years quotas have been reduced once more.

The following charts (Figure 3.2 and Figure 3.3) compare the catch composition for 1984-1986 to the composition during 2003-2005.

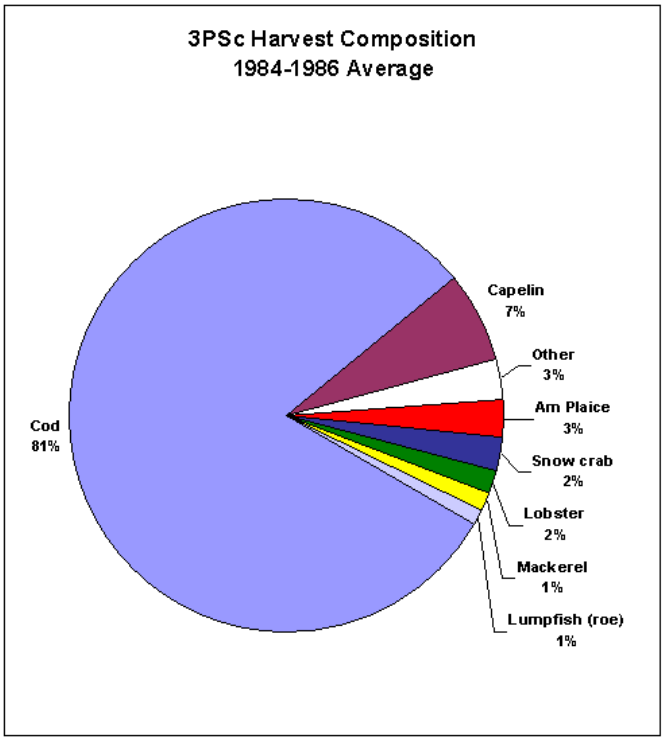


Figure 3.2. 3PSc 1984-86 Fisheries.

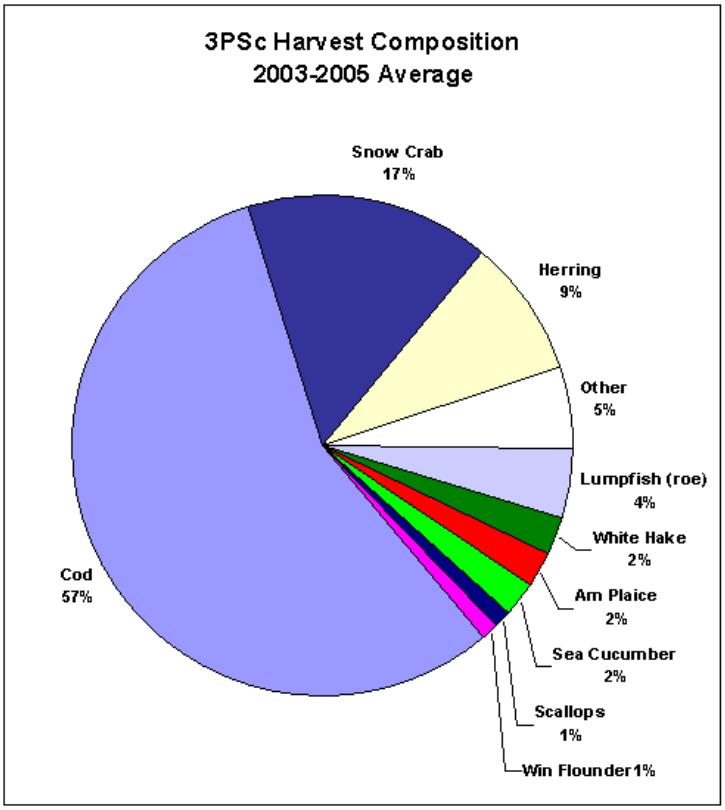


Figure 3.3. 3PSc 2003-05 Fisheries.

The changes in the quantity of the harvest from 3PSc over the last 20 years (1986 – 2005) are shown in Figures 3.4 and 3.5. Figure 3.4 shows the overall quantity harvested (all species), and Figure 3.5 compares groundfish and shellfish harvests (mainly snow crab, scallops, and lobster) over this period.

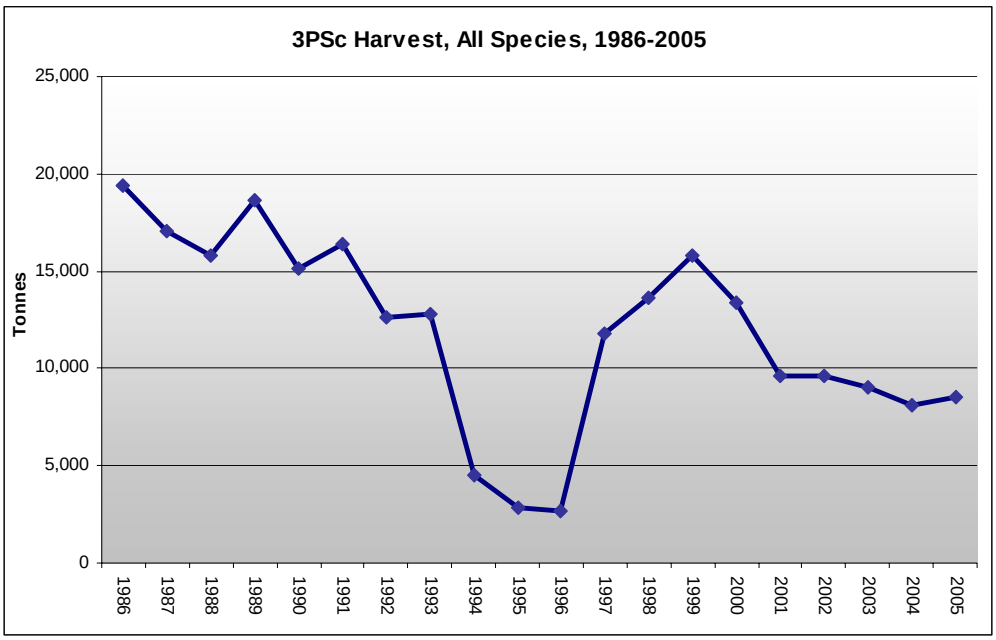


Figure 3.4. 3PSc Harvest, 1986-2005.

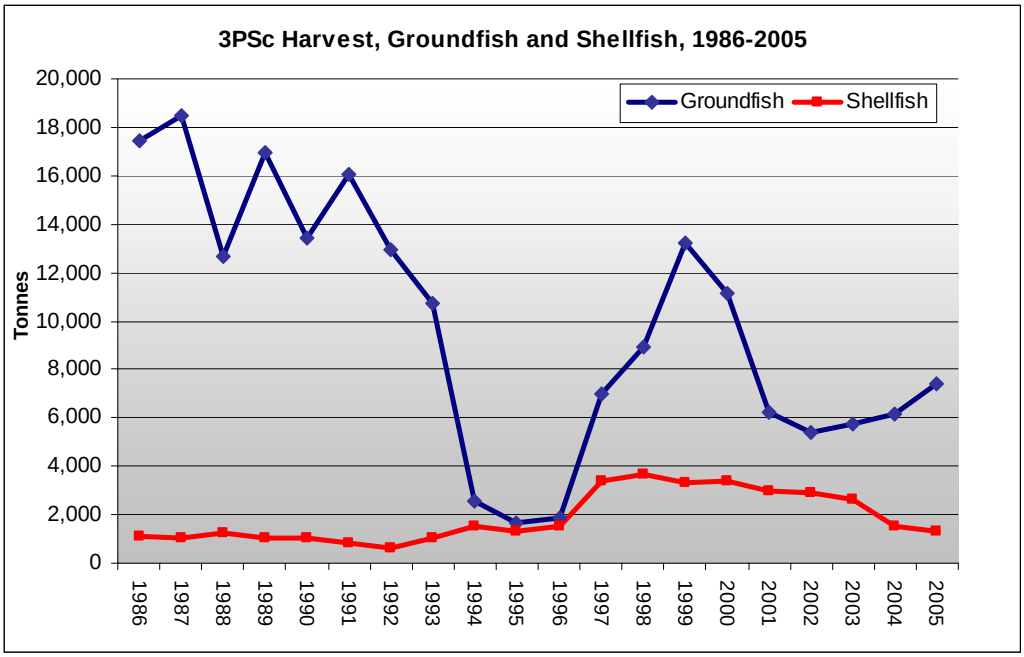


Figure 3.5. 3PSc Harvest, Groundfish vs. Shellfish, 1986-2005.

Between 1986 and 1995, the quantity of biomass taken from Placentia Bay declined from more than 17,000 tonnes to under 2,000 tonnes, a drop of nearly 90%. However, the landed value of the 3PSc fishery did not experience a similar decline, owing to the changed composition of the catch, made up - in 1995 - primarily of high-priced species such as lobster, snow crab, and lumpfish roe. In that year, the value of the fishery was only 8% lower than in 1986 (approximately $9,740,000 vs. $10,634,000). Value continued to rise after 1995; by 2002, the harvest from 3PSc was worth more than $18 million, nearly 180% of the value of the harvest in 1986. Even with weaker prices in recent years, snow crab is still a very valuable species in this area.

Since the mid-1990s, the fisheries and fisheries management, and licencing regimes in Placentia Bay have continued to evolve. Most significantly, a fish harvesting rationalization strategy was implemented in the province that reduced the number of participants in the harvesting sector, and a professionalization process was introduced which prescribed specific levels of experience and training required to be a professional fish harvester. Along with this system, DFO introduced the "core" harvesting enterprise designation, with restrictions on harvesting by those who are not part of such an enterprise.

In recent years (since 2004 in particular), the value of the Newfoundland and Labrador fisheries has again declined, severely affected by the prices paid for crab and shrimp, and there have been sharp losses in landed values, continuing through 2006. In Placentia Bay, however, the decline has not been as severe since groundfish still makes up such a significant part of fisheries there.

3.3.2. Current Commercial Fisheries

The composition of the harvest in 3PSc in recent years, based on 2003-2005 landings (averaged) and the value of these landings based on 2005 prices, is shown in Table 3.1. As these data show, cod is still by far the most important species harvested in the area, with snow crab, herring, lumpfish (roe fishery), scallops, and a few other groundfish species making up most of the remainder.

In terms of economic value, the area's commercial fishers currently depend on four species (cod, snow crab, lumpfish, and lobster) for 90% of their annual fishing income. While lobster accounts for only a small percentage by weight of the annual catch (<1%), given its consistently high value, this species remains very important to many area fishers (nearly 7% of the total value). Although the herring fishery is important (especially as bait), it does not have the direct economic value of the other large fisheries.

Table 3.1. 3PSc Harvest, 2003-2005 (Annual Average).

UA / Species	Tonnes	% of UA Quantity	Value	% of UA Value
Atlantic Cod *(Gadus morhua)*	4,805.2	56.3%	$5,190,858	40.1%
Haddock *(Melanogrammus aeglefinus)*	16.1	0.2%	$15,272	0.1%
Redfish *(Sebastes* spp.)	5.1	0.1%	$2,356	0.0%
Atlantic Halibut *(Hippoglossus hippoglossus)*	4.4	0.1%	$28,195	0.2%
American Plaice *(Hippoglossoides platessoides)*	198.0	2.3%	$144,063	1.1%
Yellowtail Flounder *(Limanda ferruginea)*	6.5	0.1%	$4,857	0.0%
Greysole (Witch) Flounder *(Glyptocephalus cynoglossus)*	1.7	0.0%	$1,487	0.0%
Winter Flounder *(Pseudopleuronectes americanus)*	86.1	1.0%	$36,082	0.3%
Turbot (Greenland Halibut) *(Reinhardtius hippoglossoides)*	2.9	0.0%	$5,943	0.0%
Skate *(Raja* spp.)	56.8	0.7%	$13,774	0.1%
Pollock *(Pollachius virens)*	48.8	0.6%	$24,739	0.2%
White Hake *(Urophycis tenuis)*	198.9	2.3%	$127,170	1.0%
Monkfish *(Lophius americanus)*	55.6	0.7%	$89,480	0.7%
Roughhead Grenadier *(Macrourus berglax)*	1.5	0.0%	$402	0.0%

Table 3.1 (Continued).

UA / Species	Tonnes	% of UA Quantity	Value	% of UA Value
Hagfish *(Myxine glutinosa)*	60.2	0.7%	$106,226	0.8%
Herring *(Clupea harengus)*	754.6	8.8%	$183,002	1.4%
Mackerel *(Scomber scombrus)*	12.3	0.1%	$6,252	0.0%
Capelin *(Mallotus villosus)*	25.1	0.3%	$7,188	0.1%
Scallops *(Placopecten magellanicus)*	17.9	0.2%	$28,050	0.2%
Whelks *(Buccinum undatum)*	28.4	0.3%	$30,043	0.2%
Icelandic Scallops *(Chlamys iskandica)*	100.6	1.2%	$141,955	1.1%
Sea Cucumber[1] *(Cucumaria frondosa)*	192.5	2.3%	$110,363	0.9%
Sea Urchins *(Strongylocentrotus droebachiensis)*	31.5	0.4%	$47,238	0.4%
Lobster *(Homarus americanus)*	71.9	0.8%	$859,009	6.6%
Snow Crab *(Chionoecetes opilio)*	1,367.6	16.0%	$4,371,894	33.8%
Lumpfish (roe) *(Cyclopterus lumpus)*	379.9	4.5%	$1,356,616	10.5%
Other	1.8	0.0%	$2,508	0.0%
UA Total	8,532.1	100.0%	$12,935,022	100.0%

3.3.3. Seasonality

Currently, some harvesting is conducted year-round in Placentia Bay (see Figure 3.6), as it was in the pre-moratoria period, though in recent years it has been much less evenly distributed throughout the months. Since 1996, the peak harvesting months have been June and July, but there has also been a fairly strong fishery in the late fall for cod. More details on the timing of key species fisheries in the area are provided below.

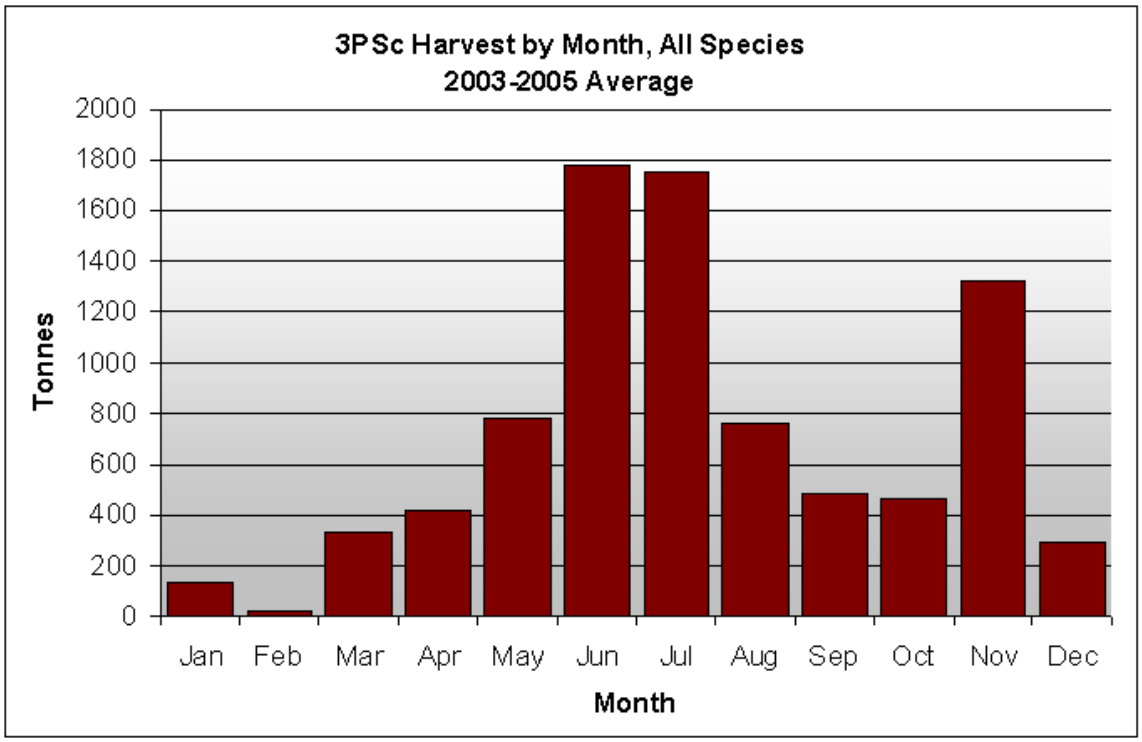


Figure 3.6. UA 3PSc Harvest by Month.

The seasons, for management purposes, of harvesting for species in Placentia Bay in recent years are shown in Table 3.2.

Table 3.2. Species Management Seasons.

Species	Season
Lobster	April 20 to June 30
Crab	April to September (or as per current year Management Plan)
Sea Urchins	October 1 to April 1
Lumpfish	May 1 to June 15 (opening/closing dates may vary).
Scallops	January 1 to December 31 (but usually closed during lobster season)
Herring (fixed gear)	1 March to 31 May and reopened September to December 31 (or until quota is reached)
Herring (mobile gear)	Same as above
Winter Flounder	Mid-May to December (for 2003)
Squid	June to December, depending on availability (but this species usually appears in the early to late fall)
Capelin	June to August, depending on the quota and market demand
Cod	Early May to end of February the following year. This fishery is closed during March and April (the spawning season for this species)

3.3.4. Harvesting Locations

Locations recorded in the DFO georeferenced dataset for all species (see Table 3.1), 2003 – 2005, are shown in Figures 3.7 to 3.9. As discussed in Section 3.2, however, this represents a small sub-set of the 3PSc harvest, and some years have fewer data than others (e.g., just 2% in 2005).

Lobster fishing locations are not georeferenced in the datasets. However, lobster is harvested close to shore, typically close to the community where the fisher lives.

3.3.5. Fishing Gear

The Placentia Bay fisheries employ both mobile gear (typically towed by a ship) and fixed gear (set out and left by the fisher, typically anchored or weighted in place). Fixed gear fisheries (e.g., gillnets, or lobster and crab pots) tend to be more "site specific" than mobile fisheries, with fewer alternative grounds available. Also, fixed gear may be left in place by the fisher for several days while the fishing boat returns to port. Mobile fishing gear (e.g., otter trawls or scallop dredges) is always accompanied by the fishing vessel.

In many cases, the fishing gear used in Placentia Bay is specific to the species harvested: pots for snow crab, scallop drags for scallops, and diving for sea urchins. Cod is harvested using several gear types, but it is harvested primarily (87% in 2003-2005) with gillnets in this area. Table 3.3 shows the quantity of the harvest by each gear type for the 2003-2005 period.

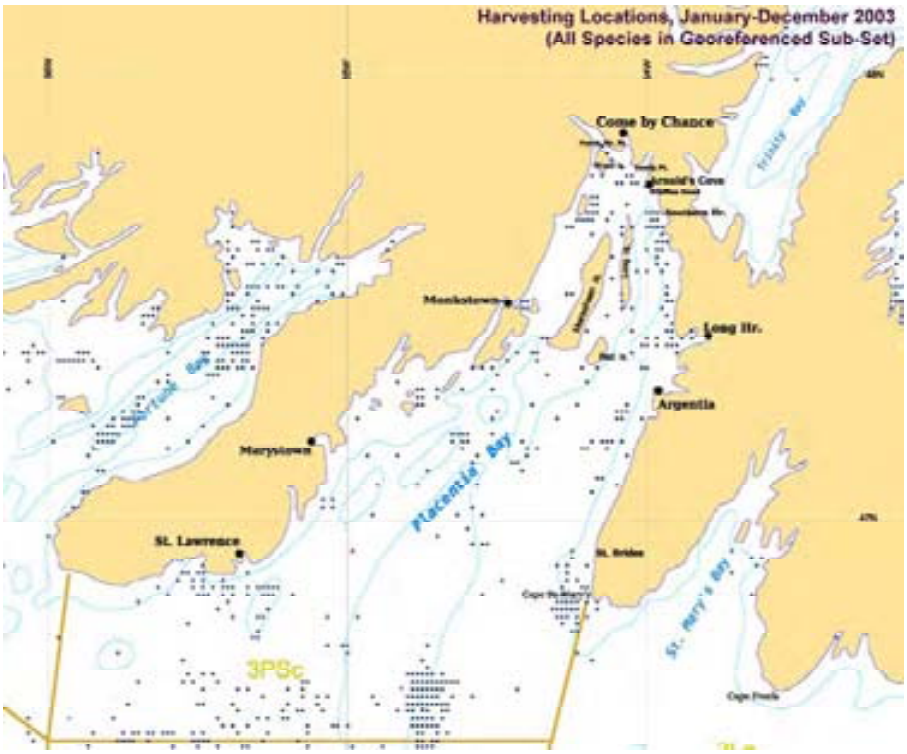


Figure 3.7. 2003 Georeferenced Harvesting Locations, All Species, All Months.

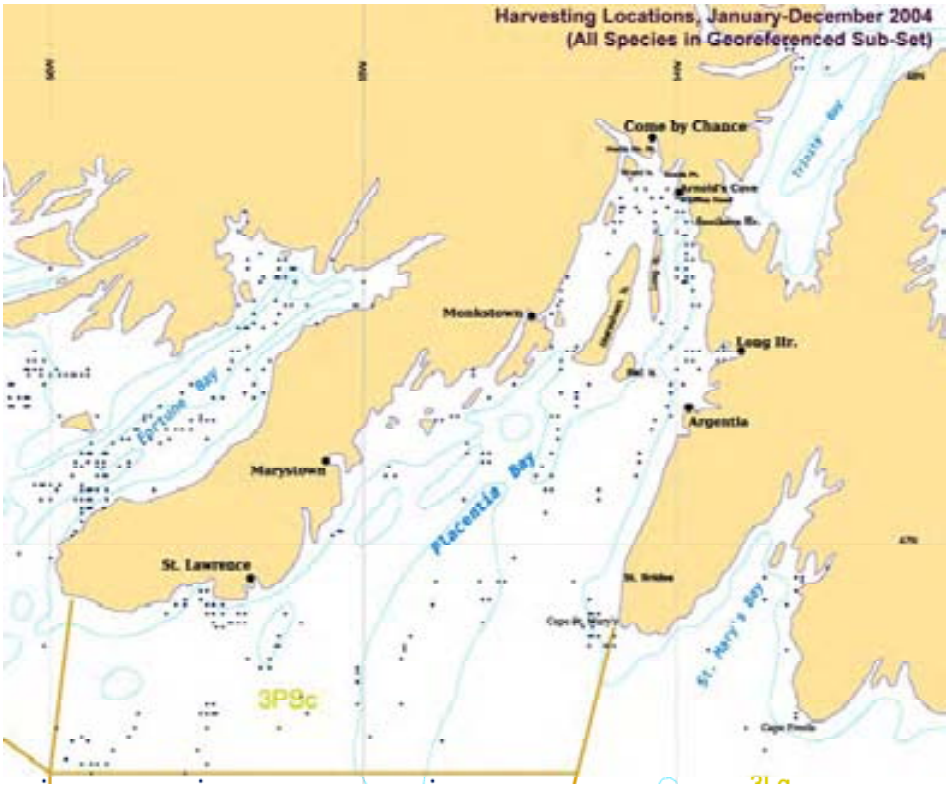


Figure 3.8. 2004 Georeferenced Harvesting Locations, All Species, All Months.

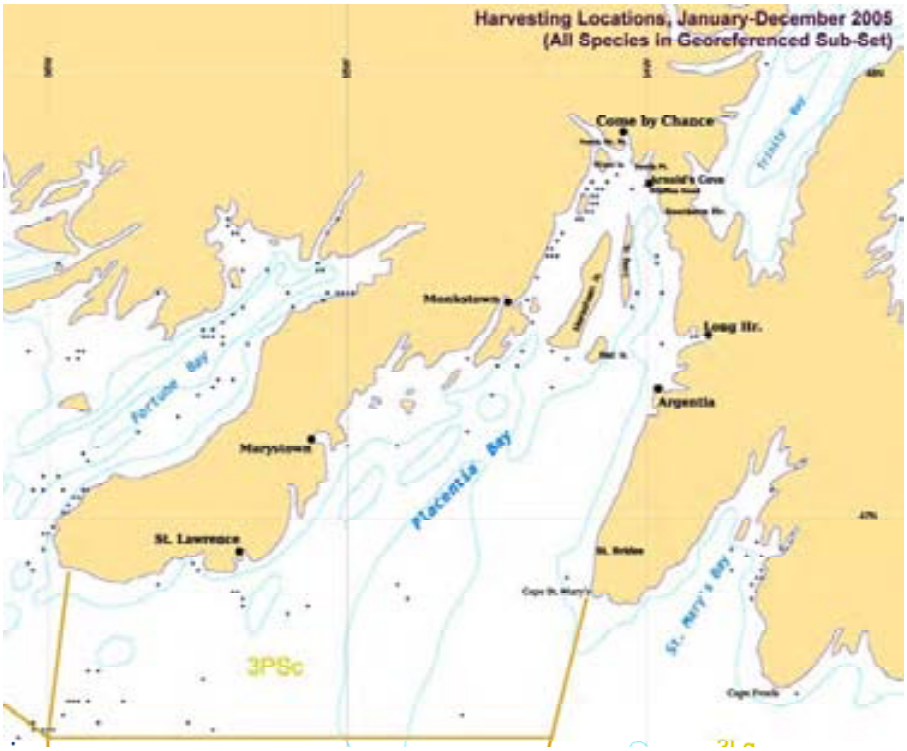


Figure 3.9. 2005 Georeferenced Harvesting Locations, All Species, All Months.

Table 3.3. 3Ps Harvest by Gear Type, 2003-2005 Average.

Gear	Tonnes	% of Total
Stern Otter Trawl	58.8	0.7%
Danish Seine	1.2	0.0%
Beach/Drag/Bar Seine*	37.5	0.4%
Purse Seine	644.7	7.6%
Gillnet*	5,266.7	61.7%
Longline*	329.2	3.9%
Hand Line	267.4	3.1%
Trap Net*	56.5	0.7%
Trap/Pot*	1,465.5	17.2%
Drag/Dredge	311.1	3.6%
Diving	31.5	0.4%
Hagfish Barrel*	60.2	0.7%
All Others	1.9	0.0%
Total	8,532.0	100.0%
* Fixed gear		

Overall, during 2003-2005, nearly 85% of the harvest was taken with fixed gear. The following describes the principal gears used in the area.

Crab Pots. These are fairly large traps made of polyethylene netting or webbing over iron rod frames. They may be conical or rectangular in shape. Snow crab pots are baited and set on the seabed, singly or in strings, buoyed at the surface, typically in deep water. Crab gear generally has a highflyer (radar reflector) at one end at the surface and a large buoy at the other (for strings). Some fishers use highfliers at both ends. Depending on weather, they may be left unattended for several days at a time. The amount of gear fishers are permitted to use varies by licence category and by the area in which a licence holder may be fishing.

Lobster Traps. Inshore lobster fishers, such as those in Placentia Bay, use baited lobster traps (or pots) which are smaller than crab pots. The design may vary, but they generally are made of a curved wooden lath frame covered by cotton or nylon twine netting, and are weighted so that they sink. Some traps are rectangular with metal frames. They are set on the bottom, usually singly in this area, marked with a buoy. Lobster traps are set in much shallower water than crab gear and in areas close to shore.

Gillnets. Fixed or set gillnets are constructed of monofilament netting and are typically set as multiples or "fleets". There are may be 50 nets in a fleet; each net is 91.44 m long, for a typical length of 4,572 m per fleet. Fishers may fish 8 to 10 fleets at once. The nets are anchored to the seabed to keep the gear stationary and have buoys on each end which float on the surface. The net itself is kept open or full through the use of weights attached to the bottom of the net. A highflyer buoy usually marks one end of the set gillnet, though not always. Gillnets are the main fishing gear used for cod, but also for lumpfish, plaice, and white hake.

Purse Seine. The main species harvested by this type of gear in the area is herring. This mobile gear uses nets to encircle a school of fish. The gear has floats to hold up the upper part of the nets and weights at the bottom to keep it vertical in the water. A cable which passes through rings on the bottom of the net allows it to be pulled together to trap the fish. A small boat takes one end of the net around the school, encircling it. It is then winched in by the larger (main) boat.

3.3.6. Boats, Enterprises, and Licences

The fisheries in Placentia Bay are pursued mainly in small (less than 10.7 m) boats. The quantity harvested from 3PSc by each class (length) for the 2003-2005 period, averaged, is shown in Table 3.4.

The number of core and non-core enterprises by community and vessel length for Placentia Bay (Fishing Area 10) in 2003 is shown in Tables 3.5 to 3.7. Table 3.8 lists the numbers of licences. Data on the number or core and non-core fishing enterprises in Placentia Bay, as well as information on the distribution of species licences, were provided by the DFO Licensing Branch in St. John's for the year 2003. It is likely that these data closely reflect the current (2006) situation in the area.

Table 3.4. UA 3PSc Harvest by Vessel Class, 2003-2005 Averages.

Vessel (Length) Class		Tonnes	% of Total
1 - 34 Feet	(0.30 – 10.4 m)	6,406	75.1%
35 - 44 Feet	(10.7 – 13.4 m)	1,541	18.1%
45 - 54 Feet	(13.7 – 16.5 m)	231	2.7%
55 - 64 Feet	(16.8 – 19.5 m)	354	4.2%
65 - 74 Feet	(19.8 – 22.6 m)	0	0.0%
75 - 99 Feet	(22.9 – 30.2 m)	0	0.0%
100 - 124 Feet	(30.5 – 37.8 m)	0	0.0%
125 - 149 Feet	(38.1 – 45.4 m)	0	0.0%
150 - 199 Feet	(45.7 – 60.7 m)	0	0.0%
200 Feet+	(61.0 m+)	0	0.0%
Total		8,532	100.0%

Table 3.5. Number of Core Enterprises and Vessel Size, Placentia Bay (2003 Data).

Home Port	<35 ft (10.7 m)	35-64 ft (10.7 m-19.5 m)	Total
St. Bride's	30	10	40
Patrick's Cove	1		1
Placentia (Incl Southeast)	10	11	21
Dunville	5		5
Jerseyside	2	1	3
Freshwater, P. Bay	1		1
Fox Harbour	5	3	8
Ship Harbour	6	1	7
Long Harbour	2	1	3
Mt. Arlington Heights	2		2

Table 3.5 (Continued).

Home Port	<35 ft (10.7 m)	35-64 ft (10.7 m-19.5 m)	Total
Fair Haven	13	1	14
Little Harbour East P.B.	12	5	17
Southern Harbour	28	16	44
Arnold's Cove	21	3	24
Come By Chance	4		4
North Harbour, P.B.	13	1	14
Garden Cove	6		6
Swift Current	2	1	3
Prowseton & Sand Hr. (Vacated)	4	1	5
Davis Cove (Vacated)	6	1	7
Old Cove-Woody Island (Vacated)	1		1
Bar Haven (Vacated)	2		2
Haystack (Vacated)	1		1
Red Island (Vacated)	4		4
Brewley (Vacated)	1		1
Merasheen (Vacated)	5		5
Tack's Beach (Vacated)	2		2
Isle Au Valen (Vacated)	3		3
Little Paradise (Vacated)	2	2	4
Great Paradise (Vacated)	2		2
South East Bight	23	2	25
Monkstown	5	1	6
Petite Forte	17	3	20
Port Ann (Vacated)	1		1
Boat Hr (Inc. Brookside)	8		8
Parkers Cove	11		11
Baine Harbour	8	3	11
Rushoon	2	1	3
Oderin (Vacated)	2		2
Red Harbour	16	1	17
Jean De Baie	1		1
Rock Harbour	1		1
Little Bay, P.B.		1	1
Beau Bois	1		1
Fox Cove (Near Burin)	1		1
Port Au Bras	1	1	2
Burin	17	7	24
Little St. Lawrence	1		1
St. Lawrence	9	7	16
Lawn	10	11	21
Lord's Cove	13	1	14
Point Au Gal	10		10
Lamaline	17	1	18
Point May	8		8
Total	379	98	477

Table 3.6. Number of Non-core Enterprises and Vessel Size, Placentia Bay (2003 Data).

Home Port	<35 ft (10.7 m)	35-64 ft (10.7 m-19.5 m)	Total
Placentia (Incl Southeast)	3		3
Jerseyside	1		1
Freshwater, P. Bay	2		2
Fox Harbour	2		2
Ship Harbour	1		1
Long Harbour	1		1
Mt. Arlington Heights	1		1
Fair Haven	3		3
Little Harbour East P.B.	4		4
Southern Harbour	6		6
North Harbour, P.B.	2		2
Garden Cove	2		2
Swift Current	1		1
Red Island (Vacated)	1		1
Merasheen (Vacated)	1		1
South East Bight	1		1
Monkstown	1		1
Boat Hr (Inc. Brookside)	2		2
Parkers Cove	1		1
Burin	2		2
Little St. Lawrence	2		2
St. Lawrence	4		4
Lawn	4		4
Lord's Cove	2		2
Lamaline	1		1
Total	51		51

*Key Licence Holders Only

Table 3.7. Number of Core and *Non-core Enterprises and Vessel Size, Placentia Bay (2003).

Home Port	<35 ft (10.7 m)	35-64 ft (10.7 m-19.5 m)	Total
St. Bride's	30	10	40
Patrick's Cove	1		1
Placentia (Incl Southeast)	13	11	24
Dunville	5		5
Jerseyside	3	1	4
Freshwater, P. Bay	3		3
Fox Harbour	7	3	10
Ship Harbour	7	1	8
Long Harbour	3	1	4
Mt. Arlington Heights	3		3
Fair Haven	16	1	17
Little Harbour East P.B.	16	5	21
Southern Harbour	34	16	50
Arnold's Cove	21	3	24
Come By Chance	4		4
North Harbour, P.B.	15	1	16
Garden Cove	8		8
Swift Current	3	1	4

Table 3.7 (Continued).

Home Port	<35 ft (10.7 m)	35-64 ft (10.7 m-19.5 m)	Total
Prowseton & Sand Hr. (Vacated)	4	1	5
Davis Cove (Vacated)	6	1	7
Old Cove-Woody Island (Vacated	1		1
Bar Haven (Vacated)	2		2
Haystack (Vacated)	1		1
Red Island (Vacated)	5		5
Brewley (Vacated)	1		1
Merasheen (Vacated)	6		6
Tack's Beach (Vacated)	2		2
Isle Au Valen (Vacated)	3		3
Little Paradise (Vacated)	2	2	4
Great Paradise (Vacated)	2		2
South East Bight	24	2	26
Monkstown	6	1	7
Petite Forte	17	3	20
Port Ann (Vacated)	1		1
Boat Hr (Inc. Brookside)	10		10
Parkers Cove	12		12
Baine Harbour	8	3	11
Rushoon	2	1	3
Oderin (Vacated)	2		2
Red Harbour	16	1	17
Jean De Baie	1		1
Rock Harbour	1		1
Little Bay, P.B.		1	1
Beau Bois	1		1
Fox Cove (Near Burin)	1		1
Port Au Bras	1	1	2
Burin	19	7	26
Little St. Lawrence	3		3
St. Lawrence	13	7	20
Lawn	14	11	25
Lord's Cove	15	1	16
Point Au Gal	10		10
Lamaline	18	1	19
Point May	8		8
Total	430	98	528

*Key Licence Holders Only

Table 3.8. Core, Non-core and Recreational Licences (832 Fishers), Placentia Bay (2003).

Species	Total Licences
Bait	371
Capelin (fixed gear)	100
Capelin (purse seine)	1
Eel	6
Groundfish (fixed gear)	518
Herring (fixed gear)	124

Table 3.8 (Continued).

Species	Total Licences
Herring (purse seine)	10
Lobster	345
Mackerel (fixed gear)	105
Mackerel (purse seine)	8
Salmon Atlantic	5
Scallop	225
Scallop Recreational	265
Seal	53
Seal Personal Use	42
Snow Crab Inshore	401
Snow Crab Supplementary	68
Squid	245
Tuna Bluefin	4
Whelk	86
Total	2,982

A "core" fishing enterprise is a commercial fishing enterprise holding key species licences, under the system established by DFO in 1996. New core enterprises are not normally created, though existing enterprises may be transferred to a new eligible harvester. DFO requires that the transfer go to a Level II professional fish harvester as certified by the Professional Fish Harvesters Certification Board (PFHCB) of Newfoundland and Labrador. A non-core enterprise is one holding other (perhaps single) species licences.

The DFO datasets indicate fishing vessel homeports for about 57% of the 2005 catch (by quantity) in UA 3PSc. Of these, 98% are harvested by vessels registered in ports adjacent to 3PSc (i.e., within Statistical Sections 29 – 32, Area H). The port of landing of the harvest is indicated for 100% of the catch, and the locations range more broadly in many ports around the island of Newfoundland and in Nova Scotia. These data indicate that, in 2005, almost 82% of the harvest was landed in Placentia Bay ports, although this does not mean it was processed there.

3.3.7. Key Species Fisheries (Details)

The following sections provide additional information about the principal Placentia Bay fisheries.

3.3.7.1. Groundfish

Groundfish constitute nearly 70% of the Placentia Bay fishery by quantity and 55% by value (based on 2003-2005). Cod is the principal species harvested in Placentia Bay, accounting for 56% of the total harvest by quantity during 2003-2005 and 40% of its value, while the lumpfish roe fishery makes up 4.5% by quantity and 10.5% by value (see Table 3.1).

Cod. The overall Division 3Ps cod quota includes a small allocation for France and the remainder goes to Canada. The Canadian portion includes small allocations to aboriginal and sentinel fisheries, while the majority of Canada's share is for vessels less than 30.5 m. DFO (SAR 2005/047) reports that the 3Ps cod stock was exploited heavily in the 1960s and early 1970s by foreign fleets, mainly from Spain, with catches peaking at 84,000 tonnes. After the extension of Canadian jurisdiction in 1977, catches averaged around 30,000 tonnes until the mid-1980s when fishing effort by France increased and total landings reached about 59,000 tonnes. Catches then declined gradually, and the moratorium was established in 1993. The 3Ps fishery opened again in May 1997 with a total allowable catch (TAC) of 10,000 tonnes, increasing to 30,000 tonnes in 1999. In 2000, the management year was changed to start 1 April; the fishery is closed during March because it is the spawning season. For 2000, the TAC was 20,000 tonnes, and for the next five management years ending 31 March 2006, the TAC was set at 15,000 tonnes.

Recorded groundfish and Atlantic cod harvesting locations in the Placentia Bay area based on the georeferenced portion of the DFO data are shown in Figures 3.10 and 3.11. These maps show three years (2003-2005) of aggregated data to better represent harvesting patterns, although the harvesting locations tend to be quite consistent from year to year. There are virtually no georeferenced lumpfish data.

Individual Quotas (IQ) were established for all participants within the 3Ps zone in 1998. This, as well as the change in the management year period, has had some effect on harvesting and vessel activity patterns and on the monthly distribution of cod catches. In the "competitive" fishery which existed prior to 1998, fishers were more or less obliged to take their share of the TAC as fast as they could in order to compete with other harvesters for their share of this resource. With the establishment of IQs, however, fishers are now free to decide when to catch their allocation, and many have chosen to fish their cod in the fall months or until the end of February of the following year if they do not manage to take all of their allowable catch by November or December.

As a result, cod (and other groundfish) catches are now more evenly spread out over the fishing season, although November (and a lesser extent December) is a relatively more important month for this species, as Figure 3.12 indicates.

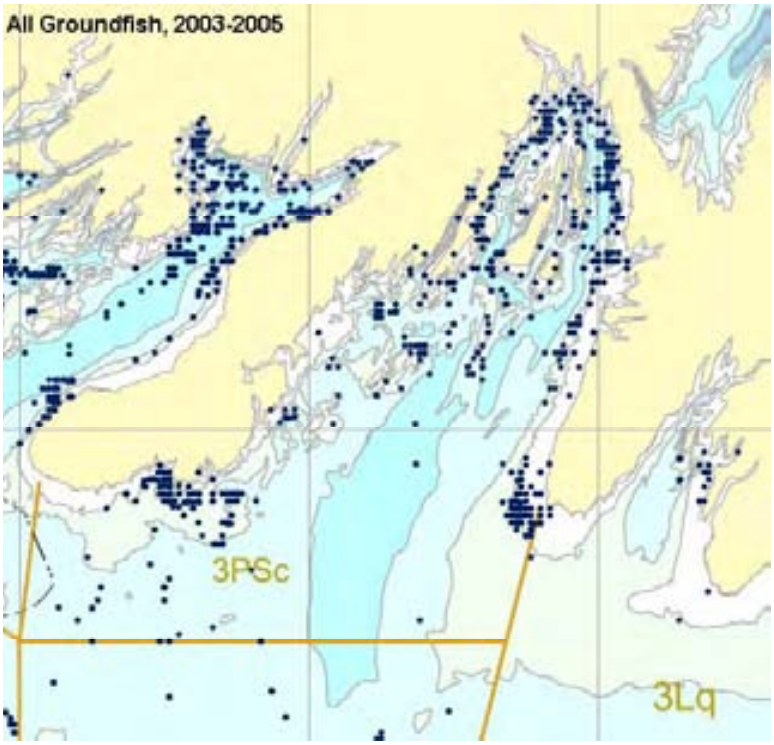


Figure 3.10. Georeferenced Groundfish Harvesting Locations, 2003 – 2005[1].

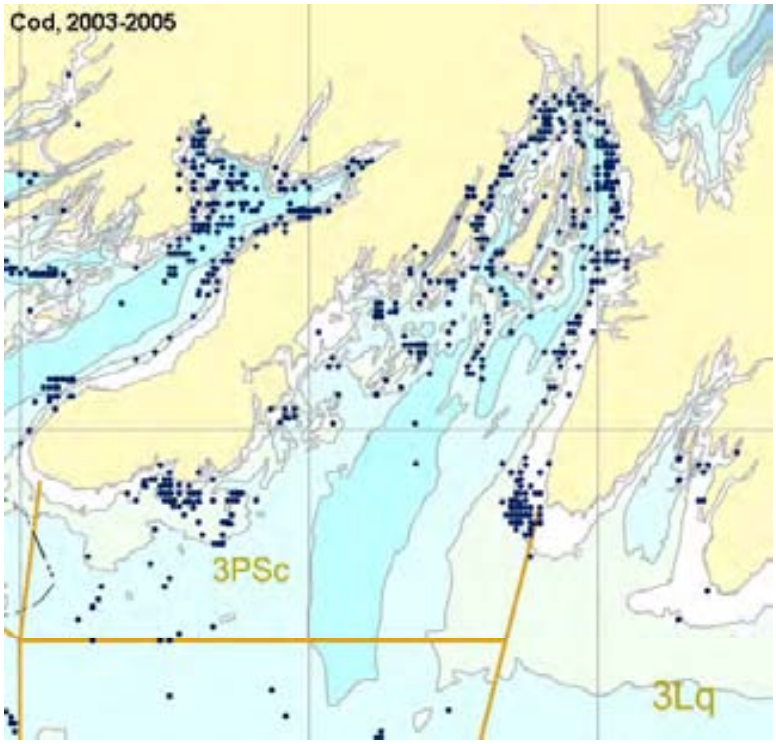


Figure 3.11. Georeferenced Cod Harvesting Locations, 2003 – 2005[1].

[1] Locations plotted on land are due to errors in the original DFO dataset.

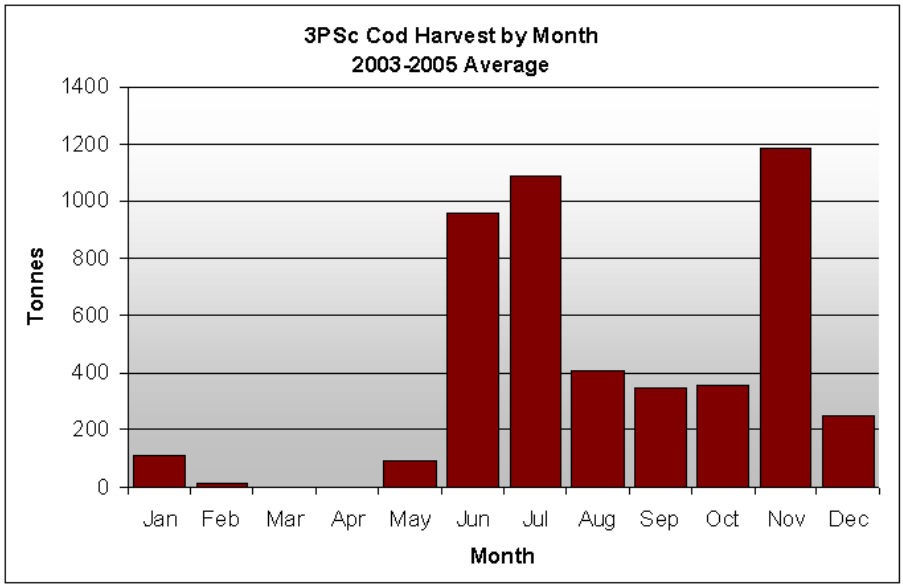


Figure 3.12. UA 3PSc Atlantic Cod Harvest by Month.

3.3.7.2. Lumpfish

This species (*Cyclopterus lumpus*) is harvested for roe; as DFO (2003) notes, the fishery is focused exclusively on pre-spawning mature females, so the spawning stock is vulnerable to over-exploitation. The species is generally taken in the same locations as lobster, including grounds around the islands in Placentia Bay. Lumpfish are harvested using nets (26.7 cm mesh) set relatively close to shore in water depths of 3.7 - 45.7 m.

During the period 1997-1999, the average annual 3PSc catch of this species generated over 451 tonnes of roe and fetched a high price. However, in the early 2000s, the area's lumpfish fishery virtually disappeared, dropping to less than 10 tonnes of roe in 2002. For the 2003-2005 period, it averaged 380 tonnes.

DFO (2002, Stock Status Report A2-17) notes that the fishery has been strictly managed by effort controls since 1992 and, in both 2001 and 2002, harvesters were limited to a three-week fishery and could use a maximum of fifty nets. DFO reports that "landing trends are influenced by economic factors (roe prices and supply management) and may not reflect trends in lumpfish abundance". It goes on to state "that recent declines [in the early 2000s] in landings may not be fully reflective of the state of the stock. The three-week season for this fishery may not be synchronized with the arrival of lumpfish in the inshore area. Also, effort has been diverted to the more lucrative crab fishery which is prosecuted at the same time".

The usual season for this species is from early to mid-May to the end of June, as Figure 3.13 indicates, but sometimes fishing continues into July (as was the case in 2003 when it closed on 12 July).

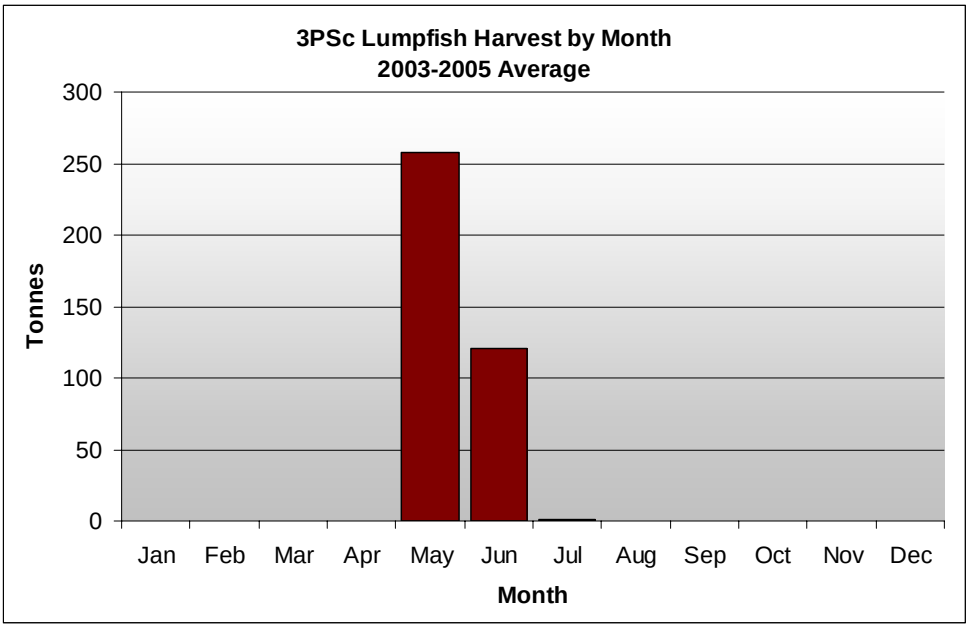


Figure 3.13. UA 3PSc Lumpfish Harvest by Month.

3.3.7.3. Snow Crab

This is an important fishery in 3PSc in terms of both quantity and value. There has been an established crab fishery in this area since 1983, but significant catches were not made until after 1985. In recent years, it has constituted 16% by quantity and 34% by value of the harvests (2003-2005). Over the past few years, however, the Newfoundland and Labrador snow crab fishery has declined in both absolute and relative quantities and particularly in value as prices have fallen.

The most recent DFO status report notes that landings for Newfoundland and Labrador (2J,3KLNOP,4R) snow crab increased steadily from about 10,000 tonnes annually during the late 1980s to 69,000 tonnes in 1999, largely because of the expansion of the fishery in offshore areas. In 2000, landings decreased by 20% to 55,400 tonnes, increased slightly to 59,400 tonnes in 2002 and 2003 and declined to 55,700 tonnes in 2004 with changes in TACs. In 2005, the harvest decreased by 21% to 43,900 tonnes, primarily as the result of a drop in Division 3K landings where the TAC was not taken that year (historically, most of the snow crab landings have been from Divisions 3K and 3L) (DFO 2006a).

DFO (2006a) also observes that, "Negative relationships between bottom temperature and snow crab CPUE have been demonstrated at lags of six to 10 years suggesting that cold conditions early in the life history are associated with the production of strong year classes. A warm oceanographic regime has persisted over the past decade implying poor long-term recruitment prospects."

The Snow Crab Fishing Areas (CFAs) off the Newfoundland south and eastern coasts are shown in Figure 3.14. Placentia Bay is in CFA 10A (Figure 3.14). The study area crab fleet comprises about 400 participants, most of whom pursue this fishery in vessels < 10.7 m within 10A. Until 2002, these fishers held "Temporary Permits" for crab; however, these permits were converted to "inshore crab licences" in 2003. These fishers harvest their crab out to the boundary with CFA 10BCD, at 46º 30′ N.

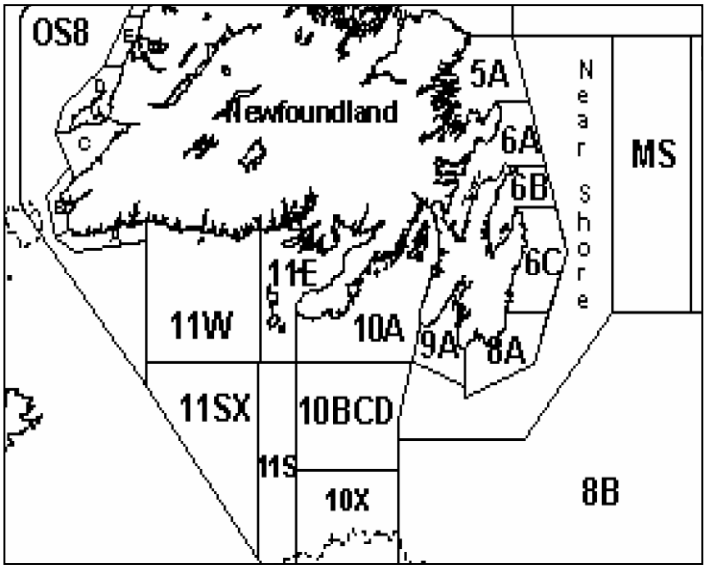


Figure 3.14. Snow Crab Fishing Areas.

DFO has established a small "buffer zone" between CFA 10A and 10BCD, i.e., 28 km or 12 nautical miles, between 46º 30′ N and 46º 40′ N. Inshore crab licence holders fishers share crab ground in this buffer zone with other 3Ps-based vessels which hold Supplementary crab licences. Some participants in the Supplementary fleet are also permitted to fish crab in CFA 10A, and two enterprises in the 3Ps > 10.7 m fleet based in communities beyond the study area also harvest crab in Placentia Bay with IQs.

The CFA 10A crab quota area (which is coincident with 3PSc, see Figure 3.14) is divided into two separate fishing zones, "inside" 12 miles and "outside" 12 miles, within Placentia Bay. This line has been drawn using relevant geographic points of land. In the early 2000s, the inside IQs were harvested by about 277 participants and the outside IQs by 121 fishers. (As is the case in several other quota areas, this "inner" and "outer" arrangement has been established to reduce fishing pressure in certain areas by spreading effort over a larger territory, particularly in the outer portion of the Bay where crab appears to be more abundant.)

Crab are harvested extensively throughout Placentia Bay, including grounds within the Placentia Bay Routing System (PBRS). Fishers do not tend to harvest crab in specific areas or grounds within the Bay, but rather wherever crab are to be found, though usually this is in fairly deep waters (>100-m depths). Nevertheless, harvesting activities tend to be concentrated in three general areas within Placentia Bay/3PSc:

- the middle portion of the outer reaches of the Bay,
- around the north and south ends of Merasheen Island, and
- on grounds relatively close to shore along the bottom of the Burin Peninsula, roughly between Little St. Lawrence and Point May.

Fishers report that very few catches are typically made north of Red Harbour Head.

Figure 3.15 indicates the georeferenced snow crab harvest for 2003-2005 (aggregated), which peaked in June (Figure 3.16).

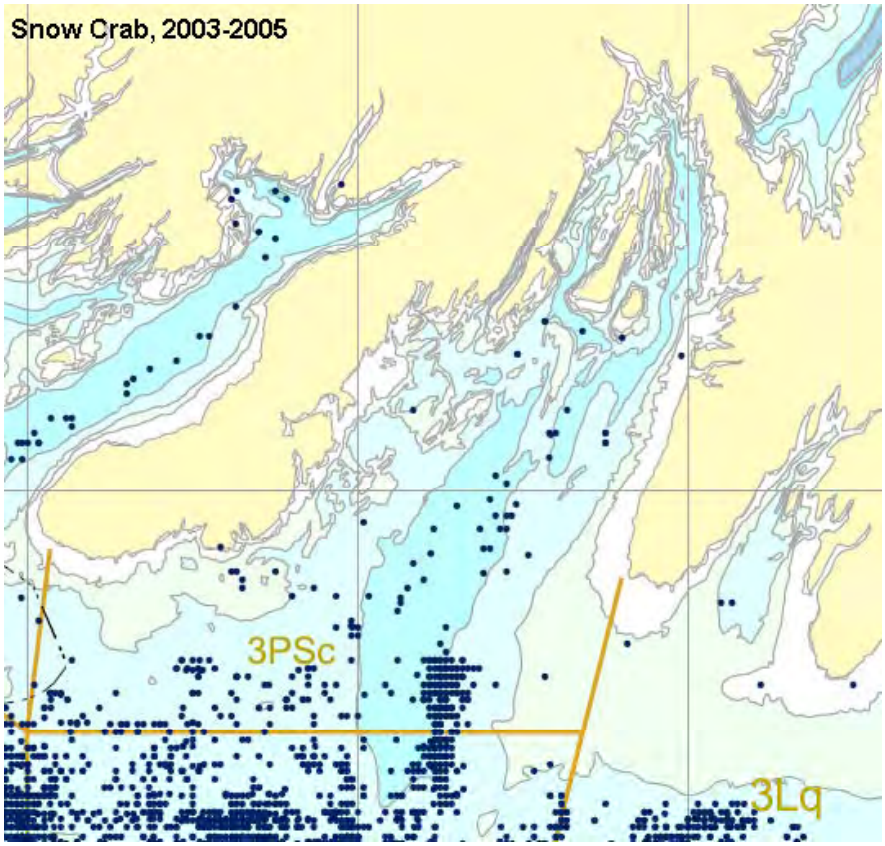


Figure 3.15. Georeferenced Snow Crab Harvesting Locations, 2003 – 2005.

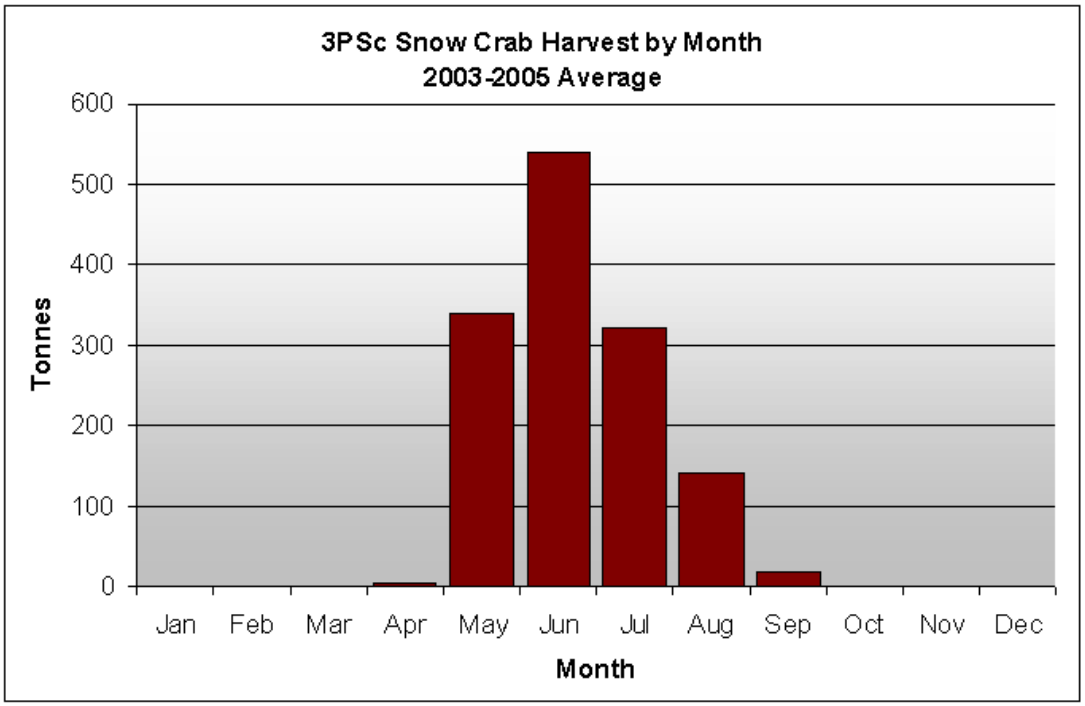


Figure 3.16. UA 3PSc Snow Crab Harvest by Month.

The Fisheries Resource Conservation Council's *Strategic Conservation Framework for Atlantic Snow Crab* (FRCC 2005) recommended to the Minister of Fisheries and Oceans a variety of conservation measures as well as changes to the fishery's management structure. In March 2006, the Minister announced that new management measures would be introduced and others continued for the Newfoundland and Labrador snow crab fishery owing to the uncertainty about future recruitment and the amount of exploitable biomass, as well as concerns about soft-shelled crab (DFO, BG-NL-06-01 and BG-NL-06-02, March 30, 2006). General measures include:

- Shortened fishing seasons in areas to provide additional protection during periods when the incidence of soft-shell crab is high;
- There will be no season extensions; IQs are not a guarantee that the fisher will land that amount of crab;
- Enhanced soft-shell protocols;
- When areas are closed because of a high incidence of soft-shell crab, those areas will remain closed for the remainder of the year;
- Continue with increased observer coverage from 2005;
- In an effort to decrease the levels of wastage of soft-shell and undersized crabs being returned to the water, DFO will shorten fishing seasons and continue education programs with fishers on handling and discard practices;
- The TAC for 2006 was 46,233 tonnes, reduced from 49,943 tonnes in 2005.

In 3Ps, landings declined by 58% from 7,600 tonnes in 2002 to 3,200 tonnes in 2005, while the TAC was reduced by 46%. Effort increased by 59% from 2001-2003 before decreasing by 29% to 2005.

3.3.7.4. Lobster

The lobster fishery made up less than one percent of the 3PSc harvest by quantity in 2003-2005, but 6.6% of its value. The fishery is managed by an integrated fisheries management plan (for 2003-2005), and participants are restricted to fishing in the Lobster Fishing Area (LFA) in which they reside or have historically fished. Placentia Bay is in LFA 10 (Cape St. Mary's to Point Crewe). Other management and conservation measures include size limits, release of berried females, season limits, and a limited numbers of fishers and traps.

The lobster fishery harvest in the area occurs almost exclusively in May and June (Figure 3.17). LFA 10 fishers are limited to 200 traps (pots) per licence.

The fishery is pursued close to shore in these areas, along rocky shorelines and nearshore islands, using small boats. The single, baited traps pots are hauled each day. The general practice is to set these pots along the shoreline in appropriate habitat for this species, in most cases in water depths less than 36 m.

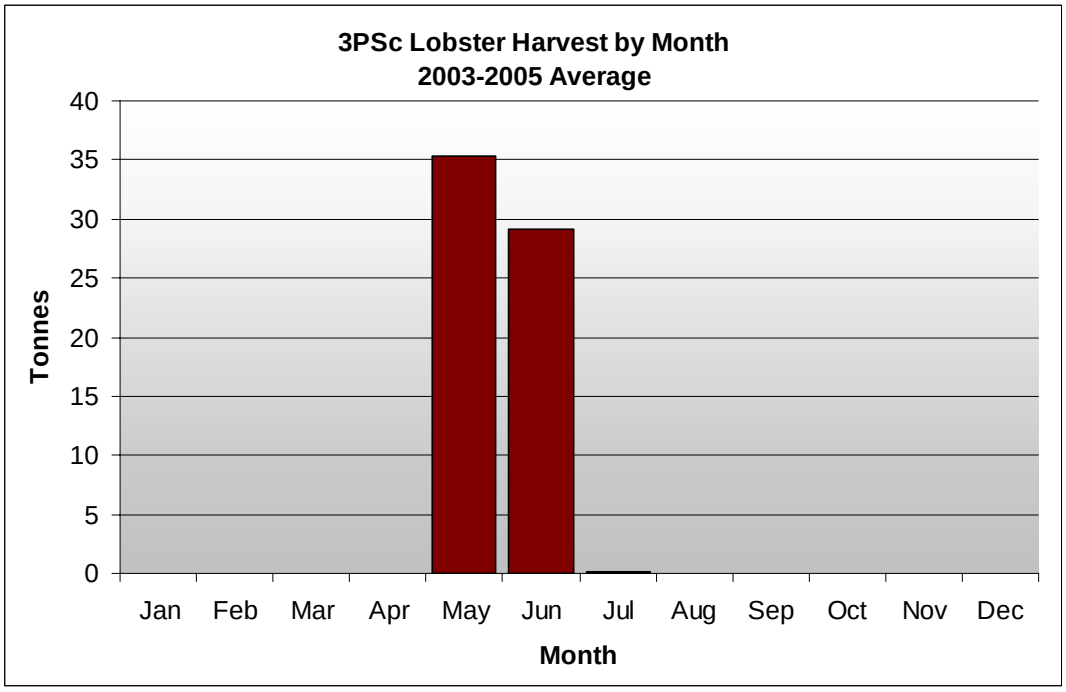


Figure 3.17. UA 3PSc Lobster Harvest by Month.

3.3.7.5. Herring

Herring composed nearly nine percent of the 3PSc harvest by quantity but just 1.4% of its value (2003-2005). On the south coast, it is harvested as a commercial fishery and for bait. The main gear used in 3PSc during this period was purse seines (85%), with smaller quantities harvested with bar seines and gillnets.

DFO's latest south coast herring Stock Status Report (2004/046) (DFO 2004b) states that "documented effort increased from the 1980s to the 1990s. Purse seine effort (sets per fisher) peaked in 1997 and has since declined by 59% from 1997 to 2004. Gill net effort (net nights fished per fisher) peaked in 1998 and has since declined by 94% from 1998 to 2004."

That report notes that in addition to annual reported landings for St. Mary's Bay - Placentia Bay "an unknown amount of herring (considered to be less than 150 tonnes) is caught in the gill net bait fishery. … The purse seine fishery, in March 2004, was concentrated along the eastern sides of Placentia Bay and St. Mary's Bay. The 2004 spring gill net fishery was mostly in Placentia Bay."

In recent years in Placentia Bay the reported landings have been during the spring fishery (Figure 3.18).

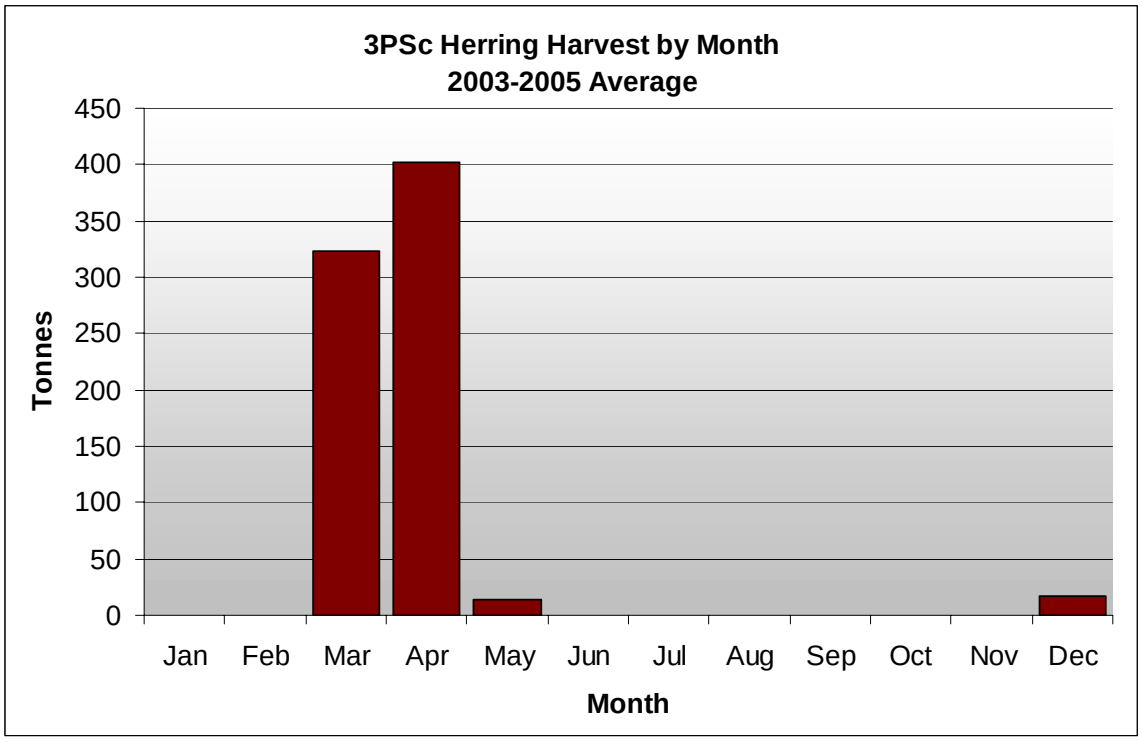


Figure 3.18. UA 3PSc Herring Harvest by Month.

3.4. Aquaculture Sector

The majority of the aquaculture development and investment activities in southern Newfoundland are presently concentrated in the Bay d'Espoir and Fortune Bay areas. The province's aquaculture Strategic Plan notes "The Newfoundland salmonid industry is located in Bay d'Espoir, the only area of the province that is suitable for the growing of steelhead trout and salmon" (Burke Consulting 2000). However, DFA aquaculture managers believe that Placentia Bay has many of the desirable characteristics of Bay d'Espoir, and are confident that Placentia Bay has significant growth opportunities, including possibilities for the development of salmon and rainbow trout farming, as well as further expansion of existing cod and mussel operations.

Aquaculture sites are located in inshore areas, usually in sheltered coves or along protected shorelines. Sites are typically chosen for the quality of the marine environment, and must consider a wide array of factors such as water temperatures, tides, bathymetry, benthic conditions, prevailing winds and currents, salinity, littoral factors and influences, proximity to other human activities such as commercial fishing, use of existing marine areas by pleasure craft, nearby shipping, other marine-oriented industries, community sewage outfalls, and access to services such as roads and electrical service. A potential site must also undergo a regulatory review and assessment of the physical setting and oceanographic conditions of the marine area proposed for the licence.

As a result, much time and money must be invested in an aquaculture operation even before it is established. Once in place and equipped, the operation must acquire "seed" stock and develop that stock and the business to a commercial size before it can establish its full income stream.

The development of aquaculture resources in Placentia Bay has been underway since about the mid-1990s. In 1997, there were about seven active aquaculture operations and several applications to investigate and/or develop additional sites. (Two sea urchin sites were later approved but by 2003 these were no longer active. A cod hatchery was also established in Placentia Bay in the early 1990s, but this was subsequently destroyed by fire.)

During 2000-2003, DFA reported a relatively major level of expansion in the Placentia Bay aquaculture sector and a considerable interest in the development of new sites, particularly on the Burin Peninsula side of the bay and around Merasheen Island. During this period, DFA deployed thermographs in numerous locations to monitor water temperatures in order to assess whether such areas might be suitable for aquaculture.

By 2003, there were 15 approved aquaculture operations, including six blue mussel sites and nine cod grow-out facilities. As of 2004, there were still no full-cycle ("egg to plate") cod aquaculture operations in the province, and all cod enterprises were thus "grow-out" facilities. At that point, most of the cod farming sites were at a "developmental" stage, i.e., they had product in the water, but no significant amount of commercial sales. In 2004, DFA reported that only four operators were selling their product on a commercial basis. These included a cod farming facility at Jerseyman Island, three

blue mussel sites within Long Harbour (at Crawley Island and St. Croix Bay), and two other mussel operations near Merasheen Island.

According to the most recent (April 2007) DFA data, there are currently 13 licenced aquaculture operations within Placentia Bay. These include five mussel farming operations and eight Atlantic cod grow-out sites. DFA is presently reviewing applications for an additional seven new mussel sites, and another currently-licenced operator has applied to add oyster farming activities to his existing mussel production site on Merasheen Island.[2] Figure 3.19 shows the location of existing aquaculture activities in Placentia Bay, and Figure 3.20 shows the Long Harbour area specifically. Table 3.9 provides details about the operators and site locations.

Of the 13 licenced aquaculture sites within the Study Area, only five are presently commercially active, and all of these are involved in mussel production. The eight remaining sites are (or once were) licenced for Atlantic cod, but none of these have had commercial sales since 2003. As of April 2007, two cod operators have renewed their licence, four licences have lapsed, and the licence status of the remaining two is "uncertain". Only one cod farming site (at Jerseyman Island) still has equipment in the water, and the operator has plans to begin steelhead trout farming in 2008.

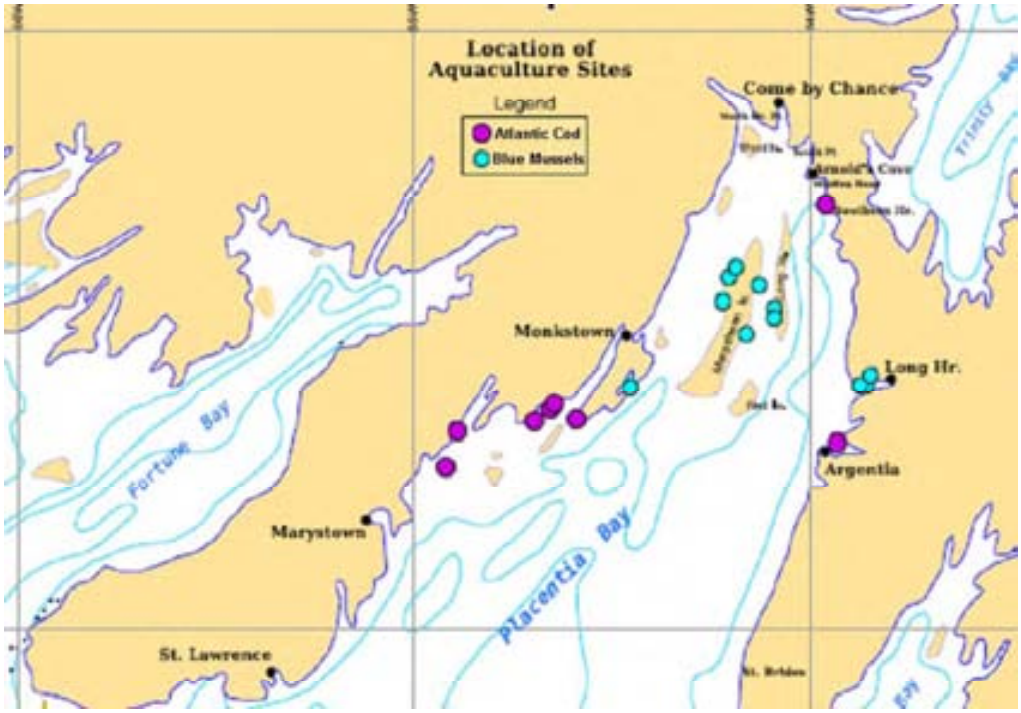


Figure 3.19. Existing Aquaculture Sites in Placentia Bay (2007).

[2] DFA notes that there is no guarantee that all of these applications will receive final approval (T. Budgell, pers comm., August 2006 and April 2007).

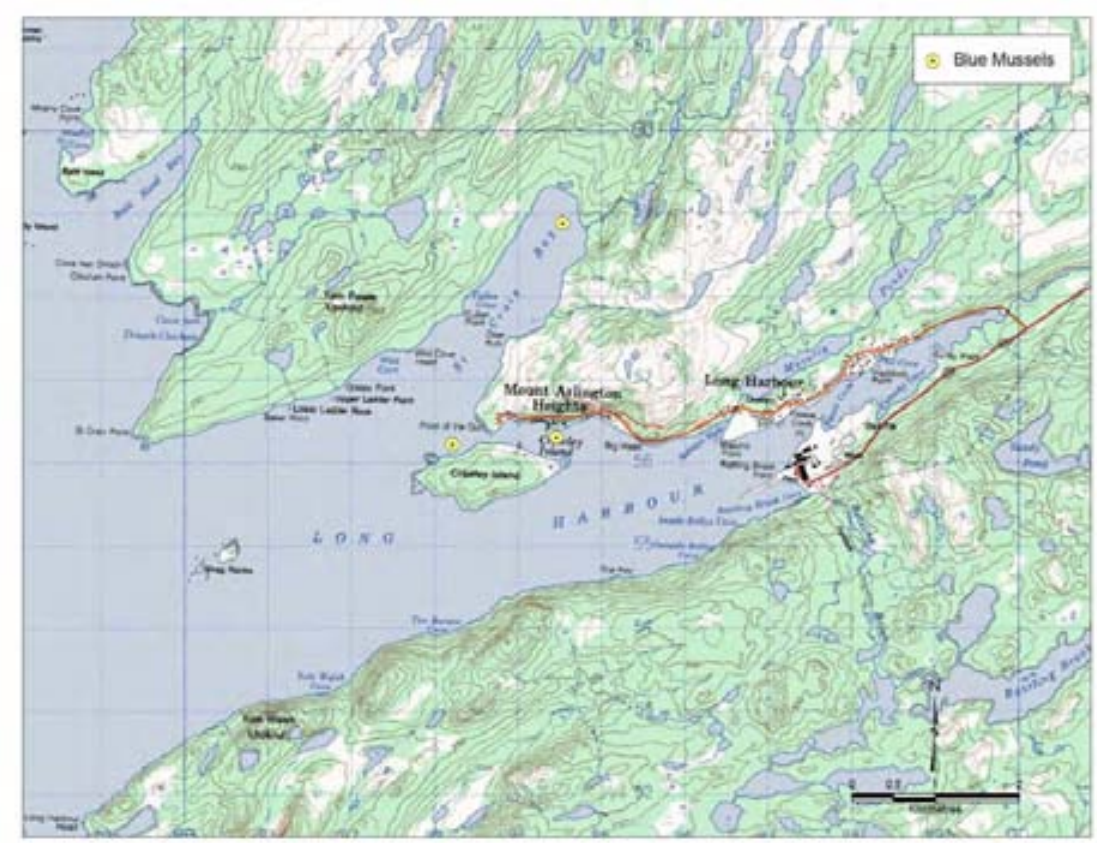


Figure 3.20. Aquaculture Operations in the Long Harbour Area.

Consultations with Placentia Bay aquaculture licence holders (October 2006 and April 2007) indicate that cod farming has not proven to be economically feasible, and only one operator anticipates resuming his cod farming activities in the next year or two. Cod farmers report that a combination of factors - availability of growing stock, feed supply and costs, and market conditions - have made it very difficult to produce and sell farmed cod on an economic basis. One or two operators still remain optimistic that a special allocation of cod from DFO for grow-out stock might allow them to re-enter the aquaculture sector within the next few years. Despite this optimism, however, it will likely be some time before progress is made in the farming of cod in Placentia Bay. DFA is presently reviewing the situation with respect to "inactive" sites and, for various reasons, many of the existing cod site licences will likely not be renewed.

In addition to those sites listed in Table 3.9 above, historical data from DFA indicate that, during the past decade or so, aquaculture activities have been approved, developed, or proposed at many other locations within Placentia Bay. However, the department currently considers all of these sites as "inactive" and "abandoned"; these files are now closed, and the sites have reverted to the Crown. In the future, however, some of these sites may be re-activated, and thus it is useful to list these locations, if only to indicate the potential for a more widespread development of the area's aquaculture sector in the future.

Table 3.10 indicates the location and species of these previously licenced, or proposed, aquaculture sites.

Table 3.9. Placentia Bay Aquaculture Site Licenses and Applications, 2007.

Company Name	Location	Latitude (Deg / Min)		Longitude (Deg / Min)		Species
Licences						
Jones, Ambrose	Petite Forte	47	23.4	54	39.99	Atlantic Cod
Keating, Joseph (Baie Sea Farms)	Crawley Island, Long Harbour	47	25.5	53	51.33	Blue Mussels
Keating, Joseph (Baie Sea Farms)	Crawley Island, Long Harbour	47	25.5	53	52.43	Blue Mussels
Keating, Joseph (Baie Sea Farms)	St. Croix Bay	47	26.8	53	51.57	Blue Mussels
Leonard, Peter W.	Southern Harbour	47	42.8	53	57.6	Atlantic Cod
Moulton, Clayton	Flat Island Harbour	47	16.12	54	55.15	Atlantic Cod
Norman, Bernard	Jerseyman Island, Placentia Bay	47	20.09	54	53.24	Atlantic Cod
Pevie, Joseph and Pearson, Christopher	Woody Island (North Side)	47	22.38	54	42.34	Atlantic Cod
Pomeroy, Donald A. & Barry, John Jr.	Petite Forte Hr.	47	24.06	54	39.49	Atlantic Cod
Pomeroy, Donald A. & Barry, John Jr.	Gaultoin's Cove	47	20.9	54	35.4	Atlantic Cod
Sapphire Sea Farms Ltd.	Dunville, P. Bay	47	15.9	53	55.11	Atlantic Cod
Warren, Christopher J.	Big South West Cove, Merasheen I.	47	34.43	54	10.35	Blue Mussels
Warren, Christopher J.	Merasheen Island	47	36.22	54	9.85	Blue Mussels
Applications						
Merasheen Mussel Farms	Jean de Gaunt	47	32.9	54	14.17	Blue Mussels
Merasheen Mussel Farms	Dog Harbour	47	34.7	54	8.6	Blue Mussels
Merasheen Mussel Farms	Rose au Rue	47	30.1	54	10.86	Blue Mussels
Merasheen Mussel Farms	Barren Island	47	31.2	54	6.36	Blue Mussels
Merasheen Mussel Farms	Presque Hr	47	24.8	54	29.17	Blue Mussels
Warren, Christopher	Big South West (Expansion)	47	34.43	54	10.35	Blue Mussels
Mervin Hollett	Port Royal Arm	47	32.3	54	5.55	Blue Mussels
Merasheen Mussel Farms	Merasheen Island	47	36.22	54	9.85	Oyster add-on

Source: DFA, Newfoundland and Labrador (T. Budgell/Claudette Laing, DFA Grand Falls, April 2007).

Table 3.10. Identified Potential Placentia Bay Aquaculture Sites (ca. 1997-2005).

Site Location	Species	Previous Status
Bar Haven	Blue Mussels	Developmental
Bar Haven (north of Haddock Head)	Blue Mussels	Commercial
Gulch Head	Blue Mussels	Unknown
Bar Haven	Blue Mussels	Commercial
Cooper Island	Sea Urchins	Developmental
Fox Cove	Atlantic Cod	Unknown
Jigging Cove (near Monkstown)	Atlantic Cod	Unknown
Southern Harbour	Atlantic Cod	Developmental
Monkstown	Atlantic Cod	Developmental
Spanish Room Point	Atlantic Cod	Unknown
Cross Island	Blue Mussels	Developmental
Petite Forte Harbour	Atlantic Cod	Unknown
Petite Forte Harbour	Atlantic Cod	Unknown
Muddy Hole, Sound Island	Atlantic Cod	Developmental
Jerseyman Island	Steelhead Trout	Research

Table 3.10 Continued.

Site Location	Species	Previous Status
West of Chambers Island	Atlantic Cod	Unknown
North of Little Chambers Island	Atlantic Cod	Unknown
Southwest of Isle Valen	Atlantic Cod	Unknown
South of Isle Valen	Atlantic Cod	Unknown
North of Little Isle Valen	Atlantic Cod	Unknown
Southwest of Chambers Island	Atlantic Cod	Unknown
Northeast Nonsuch Arm	Atlantic Salmon	Unknown

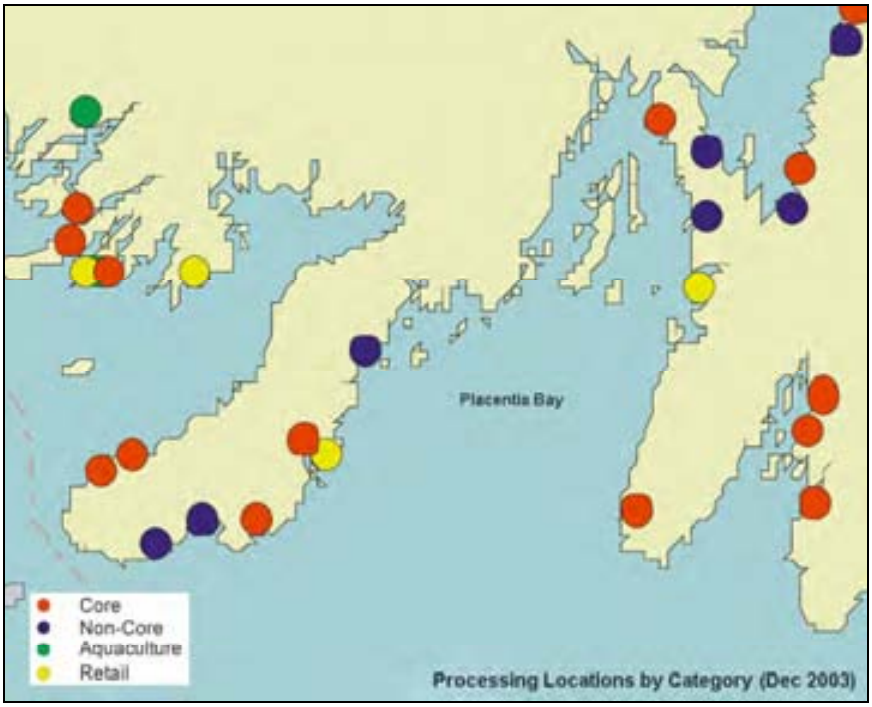
Source: DFA licence files (2003/2004), AquaGIS.com data, and Todd Budgell, pers. comm., August 2006.

3.5. Fish Processing

The locations of fish processing plants on the Island of Newfoundland for 2005-2006 are shown in Figure 3.21. Figure 3.22 shows the locations (December 2003) of Placentia Bay processing plants by category as of December 2003. The status (and ownership) of some of these plants is currently (2006) in flux.

Source: DFA 2005.

Figure 3.21. Newfoundland Fish Processing Plant Locations 2005/06.



Source: Dunne 2003.

Figure 3.22. Southern Newfoundland Fish Processing Licence Locations by Category (December 2003).

Many of the plants in Placentia Bay receive a portion of their raw material inputs from fishing enterprises and suppliers from other areas. For example, FPI's major Marystown facility has traditionally obtained >90% of its raw material inputs (primarily flatfish species) from offshore sources, beyond Placentia Bay. Conversely, some fish harvested in the area go to plants outside the area for processing (Figure 3.21).

Most of the species sold to various processors and buyers are subsequently processed into a variety of final products and sold into various markets at different prices which vary according to product type and mix, quality, exchange rates, and market demand. Depending on its particular production costs, overhead structure, and desired profit margin, a processing firm may be able to sell its final output for a higher price compared to another operator, or at a higher profit margin. Also, large quantities of lobster are purchased directly from fishers and then resold again, without ever being "processed". Hence, a significant portion of the final value of several species is not captured in local plant production figures.

3.6. Long Harbour Area Local Fisheries and Aquaculture

This section provides more detailed information about fisheries and fishing in the immediate vicinity of Long Harbour, based on consultations with area fishers and officials (listed in Appendix 3.A).

3.6.1. Fishers and Vessels

Seven fishers are based in the Long Harbour-Mount Arlington Heights area. Two use longliner-type vessels (one 13.7 m boat and one 10.7 m boat) and the others "speedboats" (all less than 10.7 m). The largest vessel harvests most of its catch (crab and cod) in offshore fishing locations beyond 3PSc (based out of the port of St. Lawrence), while the other longliner operator fishes crab within 3PSc/CFA 10A. The remaining smaller vessels fish a variety of species (cod, herring, mackerel, lobster, squid, blackback flounder, and lumpfish) on inshore grounds within Long Harbour (Figure 3.23), as well as snow crab farther out in Placentia Bay, but within CFA 10A.

Fishers report that, in general, there is very little fishing activity within the immediate vicinity of the port of Long Harbour. In previous years, quantities of squid, herring, lobster, and mackerel were harvested close to the existing wharf in Long Harbour, on both the north and south sides of this facility. Lobsters were once relatively abundant in this area, but fishers report that catches of this species have decreased significantly in recent years, and very few mackerel or squid are now taken in the waters immediately adjacent to the wharf.

Figure 3.23. Long Harbour Area (Detail).

At least one fisher continues to harvest lobster on grounds in the vicinity of the Long Harbour wharf. This fisher sets about 15-20 pots close to shore adjacent to the old ERCO property, but he also noted that lobster are no longer plentiful there. He reports that 15-20 years ago, lobster were also taken well inside the inner, shallow portion of Long Harbour, as far in as Bottom Brook

Herring were taken in significant quantities by bar seines a couple of years ago close to the wharf area in the community of Long Harbour. Fishers report that there is a spawning area for herring in the shallow water in the inner part of Long Harbour between Pierce Cove Point and Bottom Brook Harbour. Herring are also taken by local fishers close to shore near on the south side of Long Harbour in the coastal area from Rattling Brook Cove (on the south side of the wharf) out as far as Tim Barrett's Cove (located on the south side of Long Harbour about halfway between the community of Long Harbour and Long Harbour Head). This herring fishery generally lasts about two to three weeks. Local fishers, as well as larger vessels from St. Mary's Bay and other Placentia Bay ports (such as Southern Harbour and Ship Harbour), harvest herring on grounds around Crawley Island. These seining activities generally take place during March and April.

Cod are harvested using both hand lines and gillnets, though the latter is the preferred gear. However, fishers report that no cod are harvested on a commercial basis in the immediate area of the community of Long Harbour. Gillnetting areas for cod are concentrated between the east end of Crawley's Island out to grounds located to the west of the Iona Islands and in suitable areas to the south as far as Fox Island. Most of these cod fishing activities are located to the west of the Shag Rocks, but at least one small-boat fisher prefers to harvest his cod on grounds inside of these rocks, primarily because gillnets are generally set quite densely on the west side of Shag Rocks, and because it is easier for him to haul his nets in the shallower water to the east of those rocks.

Lumpfish are harvested on grounds relatively close to shore near the community of Long Harbour, but one fisher also takes this species in shallow water to the east of Shag Rocks.

One fisher has fished scallops in St. Croix Bay in the past but reports that this species has not been very plentiful during the past eight to 10 years. For the most part, scallops are no longer fished on a commercial basis, although they are still taken occasionally by divers.

An anchorage area within Long Harbour area was established three or four years ago and is sometimes used by small tankers visiting the Come by Chance Refinery. This anchorage is located in the outer middle portion of Long Harbour, between Shag Rocks and Burke Island/Merchant Island. Some local fishers harvest cod and other species within this anchorage location. CCG reports this is an official anchorage and is known as Anchorage "FF". It is used for tankers with a draft of less than 12 m. The anchorage is located at 47°24'30"N and 53°56'18"W (H. Burge, pers comm., October, 2006).

3.6.2. Aquaculture Operations

There are three blue mussel-farming sites within Long Harbour. Two of these are located on the north side of Crawley Island, and the other is situated within St. Croix Bay (see Figure 3.19 and Table 3.9). All three sites are owned and operated by Baie Sea Farms and have been under active development since the late 1980s.

3.7. Summary and Conclusions

In recent years (2003-2005 data), the most important (in order of total mean landings) commercial species in 3PSc, which includes much of Placentia Bay, included Atlantic cod, snow crab, herring, lumpfish (roe), scallops, and a few other species. Economically cod, snow crab, lumpfish, and lobster account for 90% of fishers' income. American lobster accounts for less than one percent of the catch, but almost seven percent of total value. Herring has indirect economic importance in the area as bait. Most of the fishing gear used is fixed gear (i.e., gill nets, longlines, traps, and pots), although some purse seining is used to catch herring. Fishing in the immediate vicinity of Long Harbour is generally limited to lobster (15-20 pots), herring, and lumpfish.

Of the 13 licenced aquaculture sites within the Study Area, only five are presently commercially active, and all of these are involved in mussel production.

3.8. Literature Cited

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Personal Communication

Budgell, T. DFA Grand Falls, August 2006
DFA Managers 2004

Appendix 3.A: Consultations

Fishers (2006 Consultations)

Jack Bailey, Fisher, Long Harbour
Brian Keating, Fisher, Mount Arlington Heights
David Keating, Fisher, Long Harbour
Gary Keating, Fisher, Long Harbour
Joe Keating, Owner/Operator Baie Sea Farms, Holyrood

CCG/Fisheries and Oceans (2004 and 2006)*

Hedley Burge, CCG VTS, Argentia
Max Eddy*, Fishery Officer, Arnold's Cove
Harvey Locke*, Fishery Officer, Arnold's Cove
Ken Durdle*, Detachment Supervisor, Marystown

Department of Fisheries and Aquaculture (2004 and 2006 Consultations)*

Elizabeth Barlow, Salmonid Aquaculturalist
Todd Budgell, Manager of Aquaculture Licencing and Inspections
Paul James, Aquaculture Development Officer
Steve Moyse, Aquaculture Planning Analyst
Shawn Robinson, Director of Aquaculture
Brent Tompkins, Aquaculture Development Officer
Mike Warren, Executive Director, Policy and Planning

Fish Processing Sector (2004 Consultations)

Tom Osbourne, Plant Manager, Icewater Seafoods, Arnold's Cove
Derek Fudge, Manager, Fleet Administration and Scheduling, FPI Marystown

[The 2004 consultations were conducted by Canning & Pitt Inc. as part of a research project for the Canadian Centre for Marine Communications (CCMC).]

4.0 Bald Eagle

Voisey's Bay Nickel Company Limited (VBNC) is proposing a nickel processing plant at Long Harbour, Placentia Bay. The Project will entail marine shipping, loading, and unloading wharf, and a marine effluent. Placentia Bay is known to support a relatively large population of Bald Eagle (*Haliaeetus leucocephalus*). The Bald Eagle is a ubiquitous species ranging the temperate latitudes of North America, inhabiting both inland and coastal marine environments. Its role as a top predator and its relatively large spatial requirements make it sensitive to anthropogenic stress including physical disturbance, contamination by water-borne pollutants, and other forms of habitat degradation. Because there is little published information on the Bald Eagle in Placentia Bay, VBNC retained LGL Limited of St. John's to conduct a review of information and to provide baseline information on their distribution within eastern Placentia Bay and the Merasheen Island areas as part of the larger marine environmental study. The purpose of the study was to increase the knowledge base in relation to key areas for Bald Eagle and to supplement existing ongoing studies by government in Placentia Bay.

4.1. General Background

Long Harbour is situated at the head of Placentia Bay (Figure 4.1), a deep bay in southeastern Newfoundland that contains a large marine archipelago with some 365 islands. Placentia Bay is a rich marine ecosystem as illustrated by the rich and varied fishing industry, the abundance of seabirds and Bald Eagles, and the unusually large population of river otter (*Lutra canadensis*) adapted to a coastal existence. The head of Placentia Bay supports one of the highest densities of nesting Bald Eagles in eastern North America (Dominguez 1999). Significant numbers of Bald Eagles are also present during the non-nesting season. Another fish-eating raptor, Osprey (*Pandion haliaetus*), is also common in Placentia Bay.

Top predators, such as Bald Eagle and Osprey, are sensitive to the presence of persistent contaminants because they may accumulate high concentrations of toxic substances through processes of bioaccumulation and biomagnification. The Bald Eagle forages extensively by scavenging thereby increasing its potential contact with contaminated prey, notably oiled seabirds (Dominguez et al. 2002). The Bald Eagle population in Placentia Bay was not studied prior to industrialization of the inner Bay area.

The Department of Environment and Conservation (Wildlife Division) has conducted Bald Eagle surveys in Placentia Bay most years since 1983. Since the early 1990s, permanent survey plots in an area of high density of nesting Bald Eagles was established on Long Island, Merasheen Island, Ragged Island, and a section of coastline along the adjacent western Placentia Bay. These sites have been surveyed most years since the early 1990s. This area contains 20-30 active nests annually, with a breeding concentration of 0.1 occupied nests per km of shoreline (n = 300 to 400 km in 1996 and 1997) (J. Brazil, Wildlife Division, pers. comm.), and exhibits stable reproductive performance (82% occupancy, 71% nest success, and 1.1 eaglets/occupied nest) (Dominguez 1999). The coastal population of Bald Eagles is thought to be relatively stable (J. Brazil, pers. comm.), although there is no published

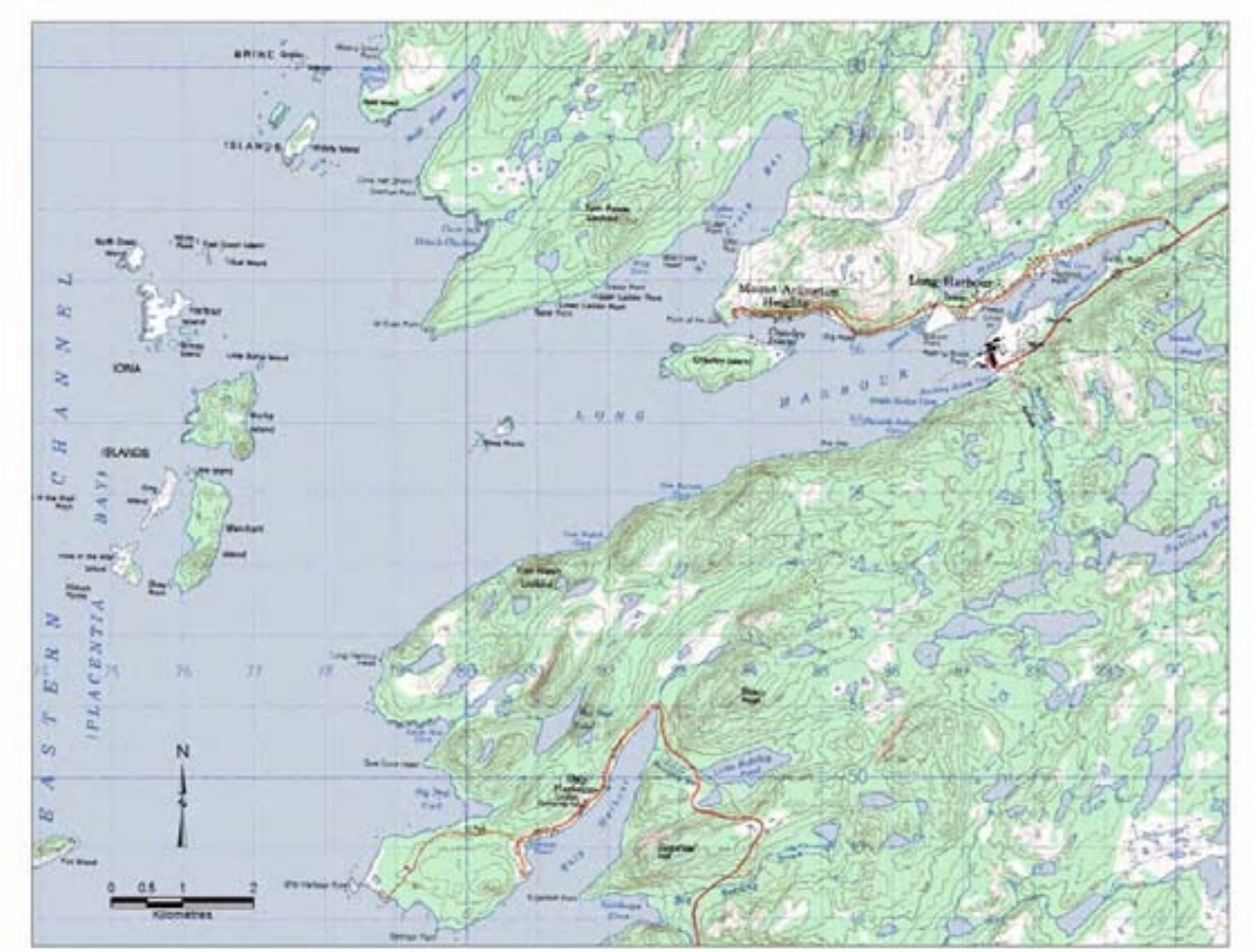

Figure 4.1. Long Harbour, Placentia Bay, Southeastern Newfoundland.

Information to support this assumption. A population estimate of 125 individuals, including immatures and 30 nests, was provided by the Wildlife Division for Placentia Bay (J. Brazil, pers. comm.). Information on other areas of the archipelago and home range of these birds is much more limited or nonexistent. Relatively large numbers of Bald Eagles are known to use Long Harbour. It is assumed that the Bald Eagles using the Long Harbour area are part of the Placentia Bay archipelago population. Research on contaminants in Bald Eagles by Memorial University of Newfoundland provides a baseline against which future results of effects monitoring could be compared (Dominguez 1999; Dominguez et al. 2002).

4.2. Study Team

Field work and reports were conducted by LGL bird and wildlife biologists: Dr. Ian Goudie and Bruce Mactavish. Mike Keating and Andy Murphy of Mount Arlington Heights provided field assistance and boat transportation. Maps and GIS work were completed by Colin Jones and Mark Fitzgerald, both of LGL. Bob Buchanan, M.Sc., reviewed the report.

4.3. Methods

Bald Eagles were surveyed by experienced biologists using both aerial and ground survey techniques.

4.3.1. Aerial Surveys

Under permit from the Wildlife Division to survey Bald Eagles, this VBNC-supported survey expanded coverage to the eastern side of Placentia Bay for nesting Bald Eagles from Come By Chance to Cape St. Mary's. At the same time, any observations of Osprey, other raptors, and seabirds were recorded. The Wildlife Division conducted a Bald Eagle nest survey on their designated survey plots on Long Island, Merasheen Island, Ragged Island, and a section of adjacent western Placentia Bay in 2006. However, they do not normally survey for eagles south or east of Come By Chance. The VBNC surveys were intended to augment the database.

The present survey extended from Arnolds Cove in inner Placentia Bay and along the eastern shore to Northern Head, Cape St. Mary's, on 7 June 2006. [Prior to early June, the young are too small and could be knocked out of the nest by a parent eagle startled by a low flying helicopter (Fraser et al. 1983).] A Bell Long Ranger was used, with two LGL observers (I. Goudie, B. Mactavish) and the pilot on board. The survey procedures were based on advice from Joe Brazil, Endangered Species & Biodiversity Biologist with Provincial Wildlife Division. Bruce Mactavish observed from the front seat on the land facing side of the helicopter. He recorded the survey route and all wildlife sightings on a topographical map. As well, he marked the positions of all sightings with a handheld GPS. Dr. Ian Goudie sat in the back seat behind Mactavish and was dedicated solely to observing. The helicopter transited along the survey area over the water, creating a swath with land on one side of the aircraft and water on the other, because nests face the water and can be hidden by vegetation when viewed from the land side. The observers scanned the tree canopy and cliff edges for Bald Eagles and attempted to ascertain any soaring birds. One pass of the helicopter 50-100-m off shore was generally sufficient, although in some cases a second reconnaissance was necessary (e.g., when adults were observed but there was insufficient time to search for a nest).

4.3.2. Ground Surveys

LGL personnel also undertook day-long reconnaissance level ground surveys of the Long Harbour area on 17 March, 13 April, 3 May, 21 July, and 25 October 2006. The spring dates coincided with herring spawning activity during which time there were large numbers of Bald Eagles being reported by residents. Three sites were selected that provided considerable geographic coverage of portions of the Long Harbour area, and LGL observers recorded all wildlife during a two-hour watch at Site A and one-hour watches each at Site B and Site C (Figure 4.2). Coverage of Site A coincided with low tide when the estuarine-intertidal habitat was most extensive.

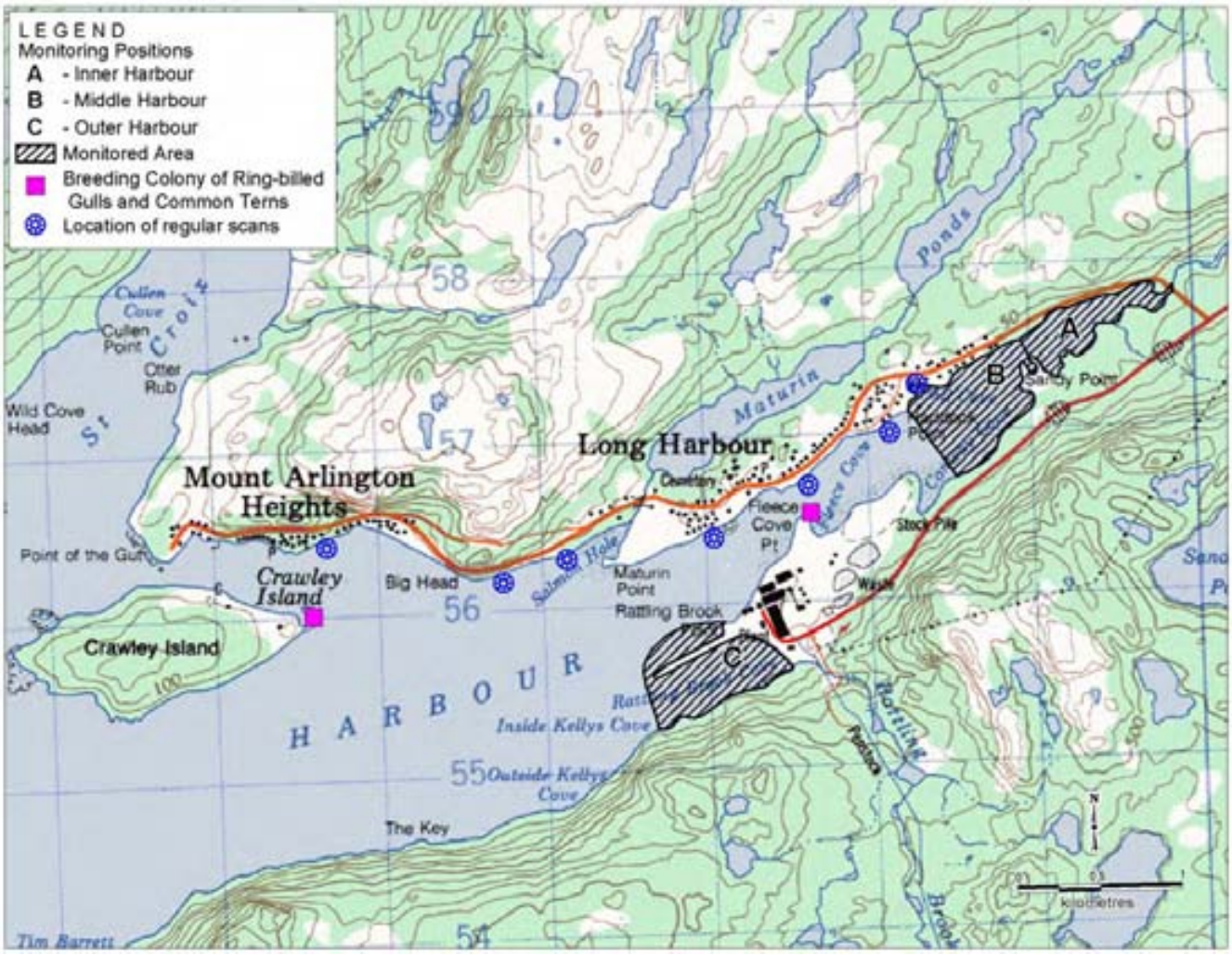

Figure 4.2. LGL Observation Sites in Inner, Middle, and Outer Portions of Long Harbour, 2006.

Additionally, there were ground-based surveys of seven areas (Figure 4.3) conducted intermittently through the late summer and fall every other week, and boat-based otter and seabird surveys. Experienced LGL observers recorded all wildlife observed during these surveys. For these ground-based surveys, each site was visited for twenty to thirty minutes, and all wildlife observed was recorded.

The ~~six~~ designated sites were:

LH1 - Long Harbour Inner Narrows
LH2 - Rattling Brook Estuary and Slag Heap Area
LH3 - Long Harbour Estuary
LH4 - Harbour View Drive Roadside Tidal Flats
LH5 - Long Harbour Unsafe Wharf Area
LH6 - Long Harbour Old Fish Plant
LH7 - Mount Arlington Heights

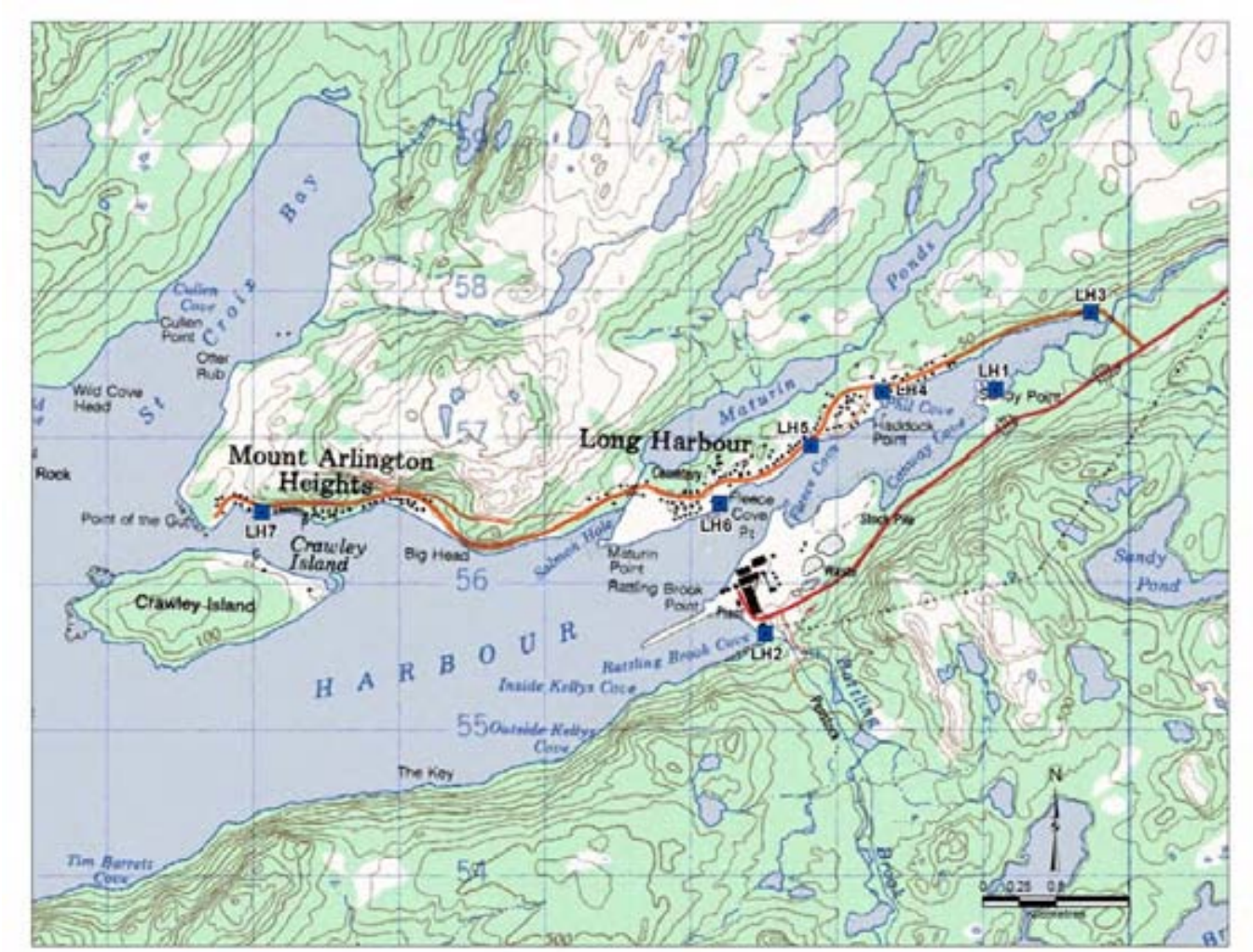

Figure 4.3. Sites Used by LGL for Standardized 20- to 30-Minute Ground-based Counts in Long Harbour, 2006.

4.4. Results

Long Harbour residents reported counts of up to 40 Bald Eagles in the upper reaches of Long Harbour during herring spawning season in May (A. Murphy, Long Harbour resident, pers. comm.). Reconnaissance visits by LGL personnel on 17 March and 13 April 2006 resulted in day counts of over 30 Bald Eagles. On 13 April 2006, a Bald Eagle was observed flying with a medium size silver-coloured fish, presumably a herring, while being pursued by two other eagles. More than half the eagles observed were adults (Table 4.1). Adult Bald Eagles should be attending nest sites from March to July. It is uncertain where these adult Bald Eagles observed at Long Harbour originated.

Table 4.1. Numbers and Maturity of Bald Eagles Observed during Day-long Ground-based Observations of Three Sites in Long Harbour, Placentia Bay in 2006.

Date	Site A		Site B			Site C		Total		
	Adult	Imm	Adult	Imm	Not Aged	Adult	Imm	Adult	Imm	Not Aged
17 Mar 06[1]								8	5	0
13 Apr 06	6	11		1	6	8	2	14	14	6
3 May 06								0	0	0
21 July 06								0	0	0
25 Oct 06								0	0	0

Imm=immature
[1] Sites A, B, C not discriminated on 17 March 2006.

During the LGL aerial surveys, eight active nests, forty-four adults, and eight subadult Bald Eagles were located. Two old inactive nests were noted and two recently-used nests, including one located near Bald Head that had collapsed and was reported to have had young earlier in the year (A. Murphy, pers. comm.) (Table 4.2, Figure 4.4). An active Bald Eagle nest was also found at Long Harbour Head on 17 May 2006 during marine water sampling by LGL personnel (J. Christian, B. Mactavish).

Incidental observations recorded during the aerial survey included apparent colonies of Great Black-backed Gulls, Herring Gulls, Ring-billed Gulls, Black-legged Kittiwakes, terns (Common and Arctic), cormorants (Great and Double-crested), and a nest site of the Common Raven (Appendix 4.A). During boat-based surveys on 13 June 2006, an adult Bald Eagle and a collapsed nest were observed at Drioch-Cloche, an adult Bald Eagle was observed at Burke Island (part of Iona Islands), and two Bald Eagles with two eaglets were observed at Merchant Island (part of Iona Islands). The latter site was recorded during the aerial survey. LGL personnel (I. Goudie) also recorded incidental observations of Bald Eagles during boat-based surveys for otter haul-out areas (Table 4.3). An Osprey was observed over the inner portion of Long Harbour on 21 July 2006, but no nest sites were detected. Other raptor species were limited to Merlin (*Falco columbarius*) observed at the inner narrows on 23 August 2006, and a Northern Harrier (*Circus cyaneus*) observed on the Long Harbour access Road on 21 July 2006. There were frequent observations of the Common Raven (*Corvus corax*) and especially American Crow (*Corvus brachyrhychos*).

In 2006, the Wildlife Division recorded 17 to 20 Bald Eagle nests on their long-term study plots in the area of Long Island, Merasheen Island, Ragged Island, and a section of coastline along the adjacent western Placentia Bay. This count was lower than previous counts, but the reasons for the low counts were unclear (J. Brazil, pers. comm.).

Table 4.2. Locations of Bald Eagles Detected during the 7 June 2006 Aerial Surveys.

Data sensitive and access must be approved by Department of Environment and Conservation.

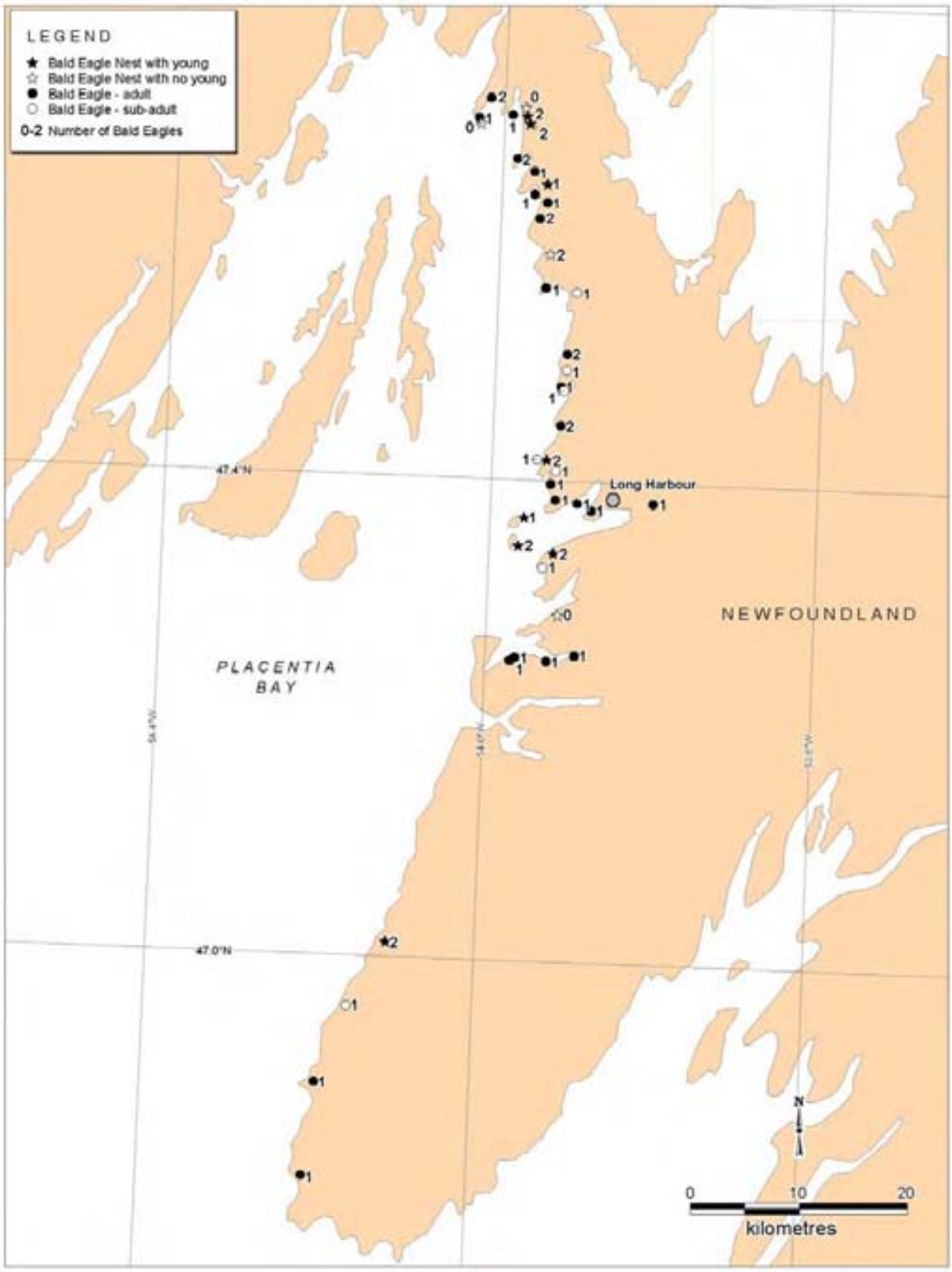

Figure 4.4. Aerial Survey for Nesting Bald Eagles on 7 June 2006.

Table 4.3. Incidental Observations of Bald Eagles Recorded by LGL during Boat-based Surveys for Otter Haul-out Areas in the Long Harbour, Placentia Bay.

Date	Location	Adult	Immature
25 August 2006	Moany Cove Head		1
25 August 2006	Briney Island	3	1
29 August 2006	Beach Cove, The Wild Shore	2	

4.5. Discussion

Long Harbour is clearly an important area for Bald Eagle. There were relatively large numbers recorded there especially for the outer area (Site C) in spring during the herring spawn. By May, these concentrations were more dispersed, and eagles were more evenly distributed throughout all areas investigated. Some high nesting densities were noted, and in one case two active nests were only 100 m apart. The availability of herring in spring is likely an important high-energy supplement to the diet of eagles; it could ensure adults attain optimal body condition for nesting. The lack of historical coverage of areas surveyed by LGL precluded comparisons to previous survey numbers.

When combined with the Wildlife Division 2006 survey, the results present a fairly complete overview of Bald Eagles nesting in the inner and eastern reaches of Placentia Bay in 2006. It is not fully known how far these Bald Eagles range in search of food, although eagles have been observed half way between the Merasheen Island and the coasts of Placentia Bay. It is highly possible that adult Bald Eagles commute the 20-25 km from Merasheen Island to Long Harbour for food (J. Brazil, pers. comm.). Bald Eagles would be expected to follow the fish, including spawning capelin, and have been observed following fishing boats and picking up waste fish, including old bait discarded from lobster traps. Ospreys, like Bald Eagles, are fish eaters, and they are also known to be fairly common in Placentia Bay. They nest inland and prefer tall trees that may be present in some of the sheltered river valleys of the Placentia Bay area. They can actively search for prey in coastal areas, especially estuaries and bar lagoons. Ospreys do not appear to be currently nesting in the immediate area of Long Harbour.

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Dominquez, L., W.A. Montevecchi, N.M. Burgess, J. Brazil, and K.A. Hobson. 2002. Reproductive status, environmental contaminants, and trophic status of nesting bald eagles in eastern Newfoundland, Canada. Journal of Raptor Research 65:1-36.

Fraser, J.D., I.D. Frenzel, J.E. Mathisen, F. Martin, and M.E. Shough. 1983. Scheduling bald eagle reproductive surveys. Wildlife Society Bulletin 11:13-16.

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Howells, D., D. Calamari, J. Gray, and P.G. Wells. 1990. An analytical approach to assessment of long-term effects of low levels of contaminants in the marine environment. Marine Pollution Bulletin 21:371-375.

Wiese, F.K. and P.C. Ryan. 2003. The extent of chronic marine oil pollution in southeastern Newfoundland waters assessed through beached-bird surveys, 1984-1999. Marine Pollution Bulletin 46.

Personal Communication

Brazil, J. Wildlife Division
Murphy, A. Long Harbour resident

Appendix 4.A: Bald Eagle and Incidental Observations of Wildlife Recorded during the Aerial Survey on 7 June 2006

Data sensitive and access must be approved by Department of Environment and Conservation.

5.0 Marine Birds and Other Avifauna

Voisey's Bay Nickel Company Limited (VBNC) is proposing a nickel processing plant at Long Harbour, Placentia Bay. The Project will entail marine shipping, loading and unloading wharf, and a marine effluent. Areas of Placentia Bay are known to support waterfowl, shorebirds, and other avifauna associated with the coastal and marine environment. Because there is little published information on the avifauna in Placentia Bay, VBNC retained LGL Limited of St. John's to conduct a review of information and to provide baseline information for the inner Placentia Bay area as part of the larger marine environmental study being conducted by LGL.

5.1. General Background

Long Harbour is situated at the head of Placentia Bay, a deep and ice-free bay, in southeastern Newfoundland. Placentia Bay is a rich marine ecosystem as illustrated by the rich and varied fishing industry, the abundance of seabirds and Bald Eagles (*Haliaeetus leucocephalus*), and the unusually large population of river otters (*Lutra canadensis*) adapted to a coastal existence.

Placentia Bay is the richest bay in coastal Newfoundland for seabirds. The large colonies of Northern Gannets (*Sula bassanus*), Common Murres (*Uria aalge*), and Black-legged Kittiwakes (*Rissa tridactyla*) at Cape St. Mary's in summer are supported by the rich adjacent marine waters that also host huge numbers of Greater and Sooty Shearwaters (*Puffinus gravis, P. griseus*) that breed in the Southern Hemisphere during the NW Atlantic winter. These seabirds are supplanted in winter by large aggregations of sea ducks, such as Common Eiders (*Somateria mollissima*), the most northerly wintering distribution of Black Scoters (*Melanitta nigra*), and the eastern Harlequin Duck (*Histrionicus histrionicus*), currently listed as a species of *special concern* by the Committee on Species of Endangered Wildlife in Canada (COSEWIC) and *vulnerable* under the *Endangered Species Act* of Newfoundland and Labrador. There are over 365 islands in Placentia Bay, many of which support small colonies of seabirds, such as gulls (*Larus* spp.), terns (*Sterna* spp.), and Black Guillemots (*Cepphus grylle*).

Surveys in the inner reaches of Placentia Bay have been ongoing for several years by the Newfoundland and Labrador Environmental Association (NLEA) (Stan Tobin) along the eastern side of Placentia Bay. In an effort to monitor populations of marine birds and other avifauna in Placentia Bay, VBNC has been supporting these marine bird surveys along the eastern shore of Placentia Bay that consist of weekly surveys at standardized observation points in the study area. More recently, these surveys have been extended northward to include accessible locations at Fair Haven, Little Harbour East, and Southern Harbour. These in-depth coastal surveys are reported in a separate document.

LGL undertook additional surveys to increase the knowledge base in relation to key areas for marine-related avifauna in the Long Harbour area and to supplement existing ongoing studies by the NLEA and government.

5.2. Study Team

Professional LGL bird biologists Bruce Mactavish, Dr. Tony Lang, and Dr. Ian Goudie conducted the field surveys. Bruce Mactavish and Dr. Ian Goudie wrote the report. Mike Keating and Andy Murphy of Mount Arlington Heights provided field assistance and boat transportation. Maps and GIS work were completed by Colin Jones, M.Sc. (*in prep.*) and Mark Fitzgerald, both of LGL. Bob Buchanan, M.Sc., read the draft report.

5.3. Methods

Survey methodology is described in the following sections.

5.3.1. Boat-based Survey

LGL surveyed the islands inside Long Harbour and the Iona Islands group on 13 June 2006 from a chartered fishing boat based in Long Harbour. If necessary, and when possible, biologists landed on the islands to count nests. This was necessary at some sites because although the Canadian Wildlife Service (CWS) had conducted aerial surveys for nesting seabirds (primarily gulls and terns) in most of Placentia Bay as recently as 2005, it did not include Shag Rocks, Crawley Island, or other small-unnamed islets and rocks inside Long Harbour proper. Furthermore, most of the seabirds identified by CWS on the Iona Islands and Brine Island in 2005 were Great Black-backed Gulls (*Larus marinus*) and Herring Gulls (*L. argentatus*). However, these aerial fixed-wing surveys were likely imprecise and overlooked other incidental species.

Birds were identified to species and colonies were ranked based on number of individuals observed as:

1. very small (<10)
2. small (>10 and < 100)
3. medium (> 100 and < 500)
4. large (> 500 and < 1000)

5.3.2. Ground Surveys

LGL personnel undertook day-long reconnaissance level surveys of the Long Harbour area on 17 March, 13 April, 3 May, 21 July, and 25 October 2006. The spring dates coincided with herring spawning activity in the marine area during which there was considerable presence of Bald Eagles being reported by residents (see Chapter 4). Three sites were selected that provided considerable geographic coverage of portions of the Long Harbour area, and LGL observers recorded all wildlife during a two-hour watch at Site A and one-hour watches each at Site B and Site C (Figure 5.1). Coverage of Site A coincided with low tide when the estuarine-intertidal habitat was most extensive.

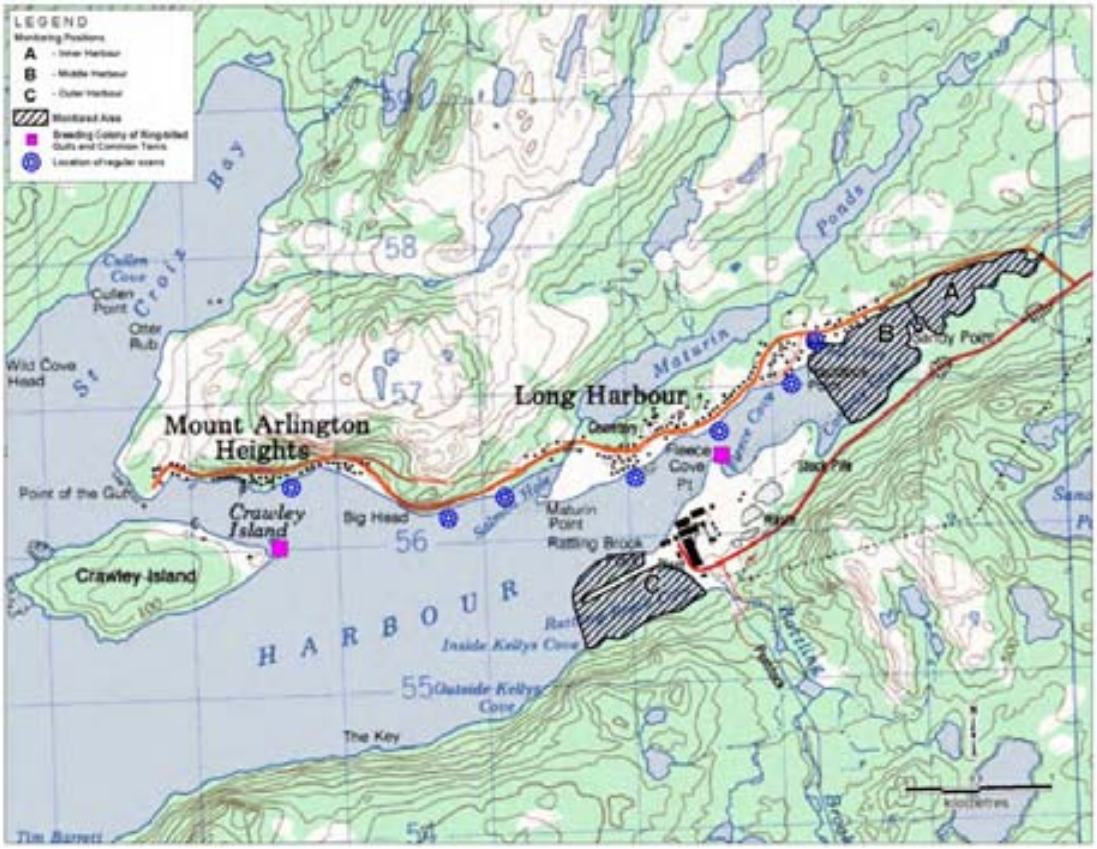

Figure 5.1. LGL Observation Sites in Inner, Middle, and Outer Portions of Long Harbour, Placentia Bay, Newfoundland.

Additionally, there were ground-based surveys of six areas (Figure 5.2) conducted intermittently through the late summer and fall every other week, as well as boat-based seabird surveys on 17 March and 13 June 2006 (Figure 5.3). LGL observers recorded all wildlife observed during these surveys.

For these ground-based surveys, each site was visited for twenty to thirty minutes, and all wildlife observed was recorded.

The designated sites were:

LH1 - Long Harbour Inner Narrows
LH2 - Rattling Brook Estuary and Slag Heap Area
LH3 - Long Harbour Estuary
LH4 - Harbour View Drive Roadside Tidal Flats
LH5 - Long Harbour Unsafe Wharf Area
LH6 - Long Harbour Old Fish Plant
LH7 - Mount Arlington Heights

Figure 5.2. Sites used by LGL for Standardized 20- to 30-Minute Ground-based Counts in Long Harbour.

5.4. Results

The Long Harbour areas that were surveyed (Figures 5.1 and 5.2) were mainly used by large gulls (Tables 5.1 and 5.2). There were lesser numbers of Common Terns (*Sterna hirundo*) present at the spit at Fleece Cove associated with the nesting Ring-billed Gulls (*Larus delawarensis*) now breeding there, and breeding by Arctic Terns (*S. paradisaea*) was confirmed in other areas of the archipelago. Gulls were observed roosting in the area of Rattling Brook Point and Salmon Hole; colonies ranked small to medium, and the most notable was Harbour Island. In specific areas, notably Hole in the Wall Island and King Island (SW face), there were relatively large numbers of cormorants but there was no evidence of nesting. Most cormorants confirmed to species in late August were Great Cormorants. Small numbers of Common Loons and Black Guillemots were also recorded. There was a continuous presence of large gulls in the immediate area of Long Harbour in August through October 2006, whereas other species such as Black Guillemots and Common Loon (*Gavia immer*) were incidental.

Migrating shorebirds were also seen in the area in August and September 2006. Species composition was predominantly Semipalmated Plovers (*Charadrius semipalmatus*), Greater Yellowlegs (*Tringa melanoleuca*), and Semipalmated Sandpiper (*Calidris pusilla*); Lesser Yellowlegs (*Tringa flavipes*) and Short-billed Dowitcher (*Limnodromus griseus*) were seen occasionally (Table 5.3). Shorebirds were limited to a few sites that provided intertidal flats, notably the Harbour View Drive (LH4) site (see Figure 5.2). Spotted Sandpipers (*Actitus macularia*) were ubiquitous in the area as singles or pairs.

Seabird sightings during boat-based surveys on 17 March and 13 June are shown in Tables 5.4 and 5.5, respectively. The boat-based survey of Long Harbour and Iona Islands on 13 June 2006 identified a number of small and medium size colonies of nesting gulls and terns with some Black Guillemots as well as some concentrations of pelagic seabirds such as Northern Gannets (*Sula bassanus*) and Sooty Shearwaters (*Puffinus griseus*) (Tables 5.5 and 5.6, Figure 5.3). Great and Double-crested Cormorants were very common in the area of Hole in the Wall Island and King Island, and were suspected to be nesting there.

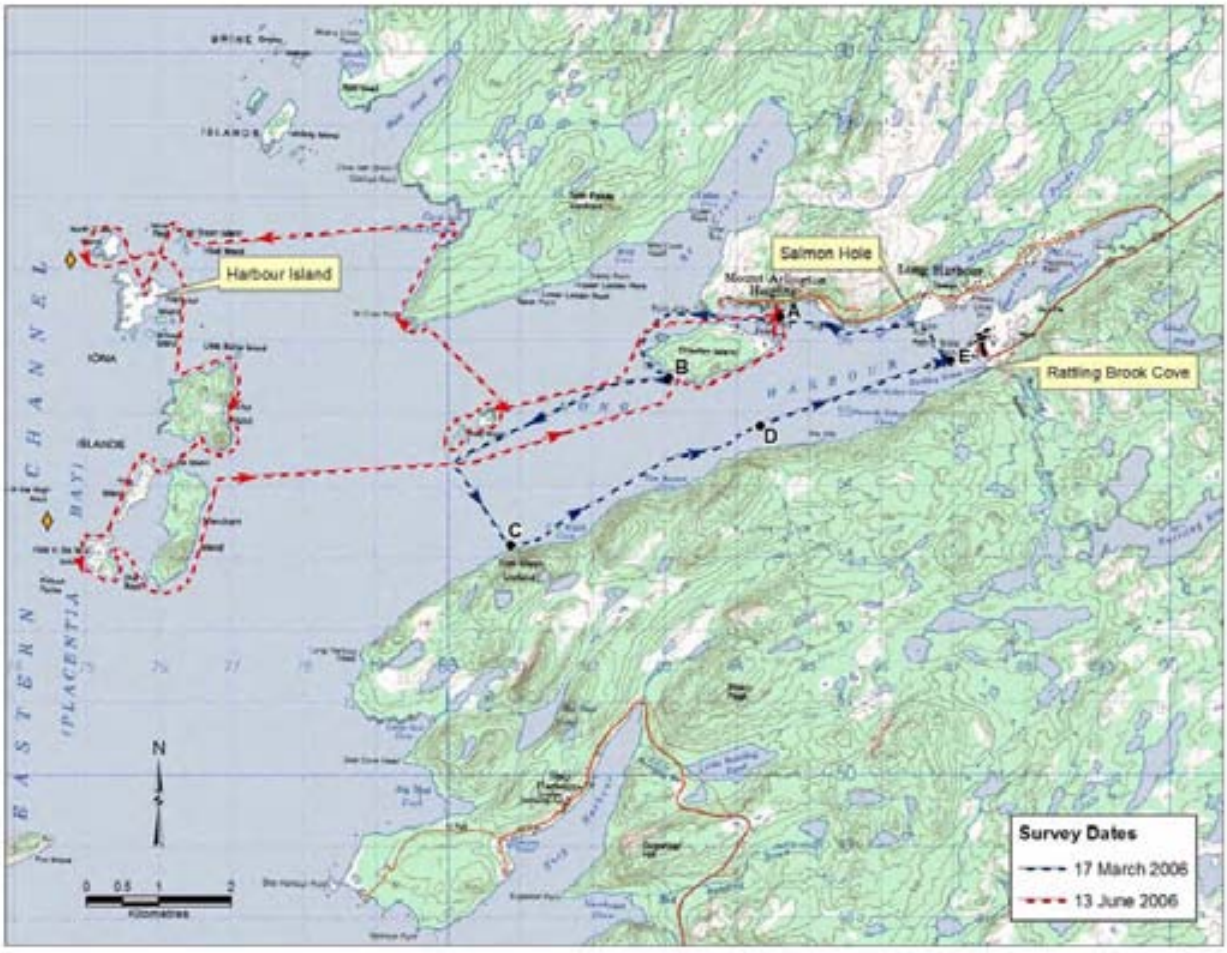

Figure 5.3. Boat-based Survey Routes for Marine Birds in the Long Harbour area, Placentia Bay, and Observed Pelagic Bird Aggregations (indicated by diamond symbols).

Table 5.1. Marine Birds and Shorebirds Recorded during Ground-based Surveys by LGL of Three Zones in Long Harbour, 2006.

Species	Site A				Site B				Site C			
	13-03-06	3-05-06	21-07-06[1]	25-10-06	13-03-06	3-05-06	21-07-06	25-10-06	13-03-06	3-05-06	21-07-06	25-10-06
Common Loon		2	1									
Ring-billed Gull	10	2	500		8	11	244		150	2		
Great Black-backed Gull	6	3			26	5			15	1		
Herring Gull	15	1		3	12	3	5	1		6		10
Unidentified Gull										3		
Black-legged Kittiwake												1
Common Tern			22				1				3	
Leach's Storm-Petrel												1
Dovekie				1								3
Greater Yellowlegs		1	10	1								
Common Raven										1		2
American Crow		5	5	5		3						
Northern Gannet										1		
Spotted Sandpiper							2				1	

[1]New Ring-Billed Gull colony (+ 60 young)
Note: See Appendix 5.A for species names and acronyms.

Table 5.2. Maximum Numbers of Marine Birds and Waterbirds Observed in Long Harbour, Placentia Bay, during Land-based Surveys in August to October 2006.

Location	Site	Date	American Black Duck	Common Loon	Double-crested Cormorant	Cormorant sp.	Ring-billed Gull	Herring Gull	Glaucous Gull	Great Black-backed Gull	Common Tern	Black Guillemot	Belted Kingfisher
Long Harbour Narrows	LH1	Aug to Oct 06	0	2	0	2	0	9	0	3	1	2	0
Rattling Brook Estuary and Slag Heap Area	LH2	Aug to Oct 06	0	1	0	1	1	23	2	2	0	0	0
Long Harbour Estuary	LH3	Aug to Oct 06	3	0	3	0	1	2	0	0	0	0	1
Harbour View Dr. Roadside Tidal Flats	LH4	Aug to Oct 06	0	0	0	0	0	4	0	3	1	0	0
Long Harbour Unsafe Wharf	LH5	Aug to Oct 06	3	2	3	2	1	23	2	3	1	2	1
Long Harbour Old Fish Plant	LH6	Aug to Oct 06	0	0	0	0	0	2	0	0	0	0	0
Mount Arlington Wharf	LH7	Aug to Oct 06	0	0	0	0	0	32	0	0	0	0	0

Numbers of marine birds were recorded incidental to the aerial survey for Bald Eagles on 7 June 2006. Small to large nesting colonies of large gulls, Black-legged Kittiwakes (*Rissa tridactyla*), terns, and cormorants were noted (Table 5.7, Figure 5.4). Seabirds were also recorded during boat-based otter surveys in August 2006 (Table 5.8).

The 2005 boat-based surveys by CWS included Iona Islands, Brine Islands, and Trinny Cove Islands near the entrance to Long Harbour; those crews found a large (992 pairs) Ring-billed Gull colony on Crawley Island. This colony appeared to be active on 13 April and 3 May 2006 during the LGL survey of the area when 130 adults were observed on the spit at the eastern edge of the island with additional birds feeding off the southeastern tip. Lesser numbers of Herring Gulls appeared to be nesting there. By 13 June 2006, this colony had been displaced, and there was evidence of considerable depredation, possibly by otters, at Crawley Island on 13 June 2006. On 21 July 2006, Ring-billed Gulls (500 adults) and Common Terns (22 adults) were recorded as nesting on the spit at the base of the slag heap in Long Harbour at Fleece Cove.

Table 5.3. Maximum Numbers of Shorebirds Observed by LGL in Long Harbour, Placentia Bay Area during Land-based Surveys in August to October 2006.

Location	Site	Date	Black-bellied Plover	Semipalmated Plover	Spotted Sandpiper	Greater Yellowlegs	Lesser Yellowlegs	Yellowlegs sp.	Semipalmated Sandpiper	White-rumped Sandpiper	Short-billed Dowitcher	Wilson's Snipe
Long Harbour Narrows	LH1	Aug to Oct 06	0	9	2	7	1	1	0	2	0	1
Rattling Brook Estuary and Slag Heap Area	LH2	Aug to Oct 06	0	6	0	1	0	0	1	1	0	0
Long Harbour Estuary	LH3	Aug to Oct 06	0	5	0	7	2	0	0	0	0	0
Harbour View Dr. Roadside Tidal Flats	LH4	Aug to Oct 06	1	20	0	5	0	0	6	2	1	0
Long Harbour Unsafe Wharf	LH5	Aug to Oct 06	1	20	2	7	2	1	6	2	1	1
Long Harbour Old Fish Plant	LH6	Aug to Oct 06	0	0	0	0	0	0	0	0	0	0
Mount Arlington Wharf	LH7	Aug to Oct 06	0	0	0	2	0	0	0	0	0	0

Table 5.4. Boat-based Observations of Marine Birds by LGL in Long Harbour on 17 March 2006.

Site	Great Cormorant	Herring Gull	Great Black-backed Gull	Black Guillemot	Bald Eagle	Common Raven	Other
Site A to Site B	12	32	60	3	6	1	1 minke whale
Site B to Site C			5		4		
Site C to Site D	2	11	7	1	3		

Table 5.5. LGL Observations of Marine Birds Recorded on Boat-based Surveys 13 June 2006 in the Long Harbour-Iona Islands Area of Placentia Bay.

Site	Ring-billed Gull	Great Black-backed Gull	Herring Gull	Black-legged Kittiwake	Common Tern	Arctic Tern	Black Guillemot	Common Murre	Northern Gannet	Double-crested Cormorant	Cormorant sp.	Sooty Shearwater
Shag Is.		15	90				15			1		
Big Shag Rk.												
Gull Is.		**4**				**25**						
E. Green Is.		**34**	**8**			**4**	**10**					
Harbour Is.	**40**	**110**	**540**		**131**	**20**						
N. Green Is.	2	**62**	**85**									
L. Burke Is.		2										
Burke Is.												
Little Is.												
King Is.		10	20								1	
Hole In The Wall Is.		**25**	**75**				3				40	
Merchant Is.												
Crawley Is.	**100**				**50**							
Open Ocean		20	50	21				10	95			20
Note: numbers in bold font indicate breeding colony.												

LGL recorded other birds that were incidental to the focal coastal birds, including a Red Crossbill (*Loxia curvurostra*) and a Rusty Blackbird (*Euphagus carolinus*). The Red Crossbill was seen at the head of Long Harbour on 21 July and is currently listed as *endangered* under the federal *Species At Risk Act* in Schedule 1. The Rusty Blackbird was sighted one kilometre south of the intersection of the TCH on the Long Harbour access road on 23 August 2006; this species is currently listed by COSEWIC as a species of *special concern.*

5.5. Discussion

Modest numbers of marine birds, waterfowl, and shorebirds utilize Long Harbour and the adjacent offshore islands. Species documented breeding included the Herring, Great Black-backed, and Ring-billed Gulls that are more or less ubiquitous to coastal Newfoundland. Smaller numbers of Common and Arctic Terns were detected, and these species are of greater conservation concern to management agencies because of displacement and competition from the larger gull species that have been expanding in numbers (CWS Gull Management Plan). In general, cormorants have been expanding in numbers over recent decades, and a healthy population was noted in the area. Waterfowl were sparse, and only incidental numbers of Black Ducks (*Anas rubripes*) were noted. The consistent presence of shorebirds on some of the intertidal sites in Long Harbour supports the contention that these habitats, although limited in size and extent, were important during the fall migration.

Table 5.6. Colonies of Breeding Seabirds Recorded by LGL on Boat-based Surveys 13 June 2006 in the Long Harbour-Iona Islands Area of Placentia Bay.

Colony Name	Size	Species	Nests Located[1]
Gull Island	Small	Arctic Tern	Nesting
		Great Black-backed Gull	1 adult with 3 chicks
East Green Island	Small	Herring Gull	
		Great Black-backed Gull	
		Arctic Tern	
		Black Guillemot	
Harbour Island	Medium	Herring Gull	215 nests
		Great Black-backed Gull	11 chicks
		Ring-billed Gull	45 nests
		Common Tern	55 nests
		Arctic Tern	10 nests
North Green Island	Medium	Great Black-backed Gull	Nesting
		Herring Gull	Nesting
Little Burke Island		Great Black-backed Gull	Former nesting island
Hole In The Wall Island	Medium	Herring Gull	Nesting
		Great Black-backed Gull	Nesting
Crawley Island	Medium	Ring-billed Gull	38 nests
		Common Tern	28 nests

[1] In some cases nesting was confirmed, but islands were not searched due to accessibility and landing conditions.

Table 5.7. Incidental Observations of Seabirds Recorded by LGL during the Aerial Survey of Eastern Placentia Bay, 7 June 2006.

Way Point	Coordinates	Seabirds
13	N47 45.312, W54 01.147	10 terns, colony
15	N47 44.862, W53 59.614	large gull colony, 100's of Black-Legged Kittiwake, 200+ Ring-Billed Gulls, some Herring Gulls
23	N47 41.819, W53 58.173	30 terns on island
24	N47 41.703, W53 58.564	30 Great Black-Backed Gull and Herring Gull nesting
25	N47 41.390, W53 58.594	100-200 Herring Gull and Great Black-Backed Gull nesting, 6 cormorants
87	N47 15.015, W53 59.622	25+ cormorants
88	N47 11.807, W54 02.491	cormorant colony, 30-50+
89	N47 08.893, W54 03.895	20+ cormorant colony
92	N47 00.393, W54 08.992	100+ cormorants (some or all Great Cormorant) Colony
93	N46 58.252, W54 10.121	25+ Great Cormorant nesting colony
95	N46 53.934, W54 11.374	75 Great Cormorant, colony
96	N46 53.102, W54 12.001	Great Black-Backed Gull and Herring Gull colony 100+
98	N47 13.555, W53 56.794	25 terns on island, colony

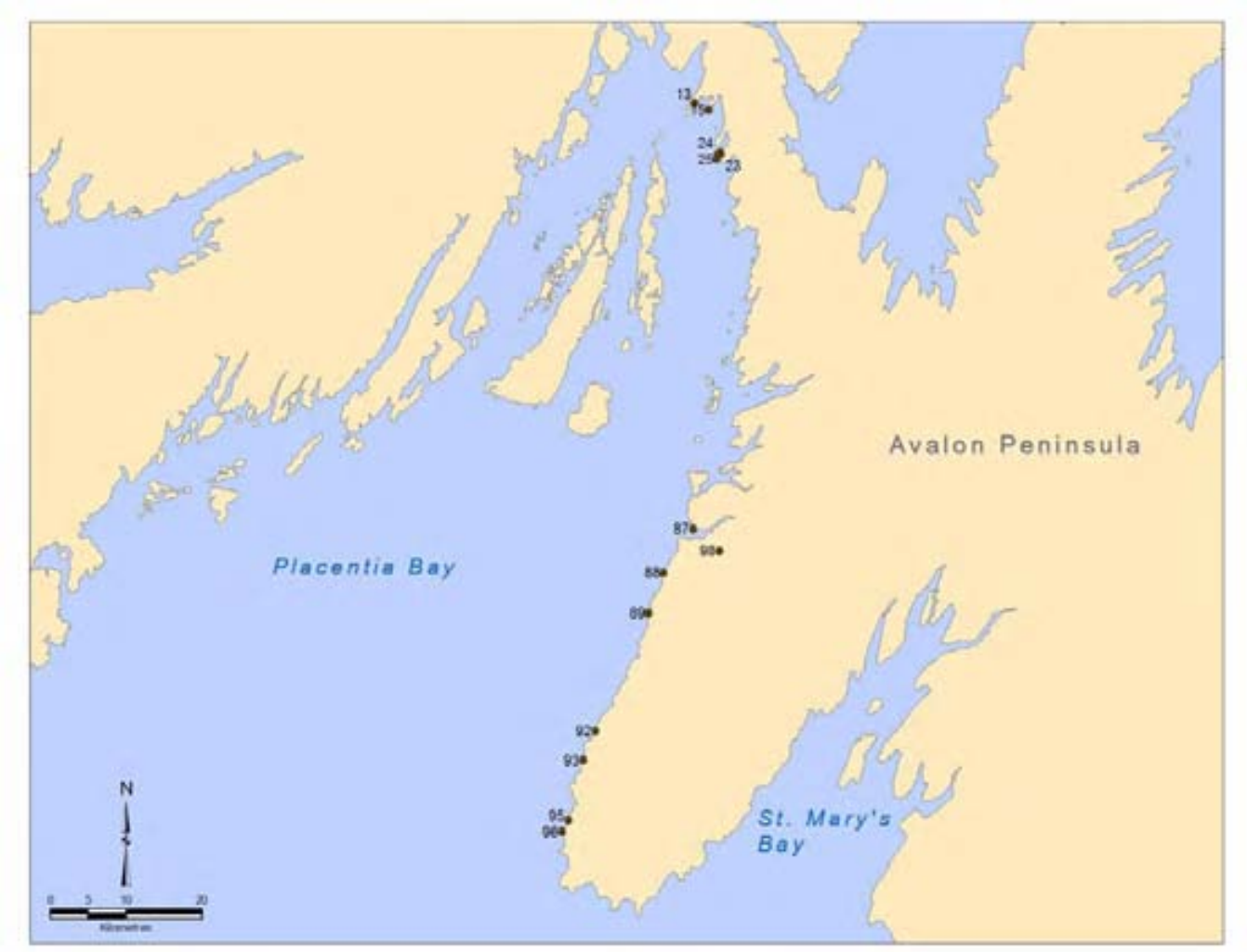

Figure 5.4. Locations of Incidental Observations of Marine Birds recorded during LGL Limited Aerial Surveys for Bald Eagles in Eastern Placentia Bay on 7 June 2007.

LGL observations suggest that the large Ring-billed Gull colony (~992 pairs) recorded at Crawley Island by CWS in 2005 had suffered considerable depredation by otters in spring-summer. The appearance of nesting Ring-billed Gulls and Common Terns at the Spit adjoining the slag heap at Fleece Cove is suspected to be a result of this displacement. It is estimated that there were much smaller numbers of breeding Ring-billed Gulls in the area in 2006 compared to those recorded by CWS in 2005.

The inner reaches of Placentia Bay sustain variable use by pelagic birds depending on food and weather conditions. Sooty Shearwaters and Northern Gannets were observed feeding in the presence of schooling capelin (*Mallotus villosus*). During heavy onshore storms, pelagic species including jaegers, shearwaters, and petrels may be relatively common in the inner Bay.

Table 5.8. Incidental Observations of Seabirds Recorded by LGL during the Boat-based Surveys for Otters in the Long Harbour-Iona-Brine Islands Area, Placentia Bay, August 2006.

Date	Area	Great Black-backed Gull	Herring Gull	Ring-billed Gull	Common Tern	Northern Gannet	Cormorant sp.	Great Cormorant	Common Loon	Red-breasted Merganser	White-rumped Sandpiper	Greater Yellowlegs	Semipalmated Plover	Spotted Sandpiper
14-Aug-06	Long Hr to St Croix Bay	2	89	4							6	1	3	
25-Aug-06	Long Hr to Brine Islands		19		1		28		1	3		1		1
29-Aug-06	Long Hr to Iona Islands	32	102			1	75	6						4

Appendix 5.A: Species Names and Acronyms

List of Bird Species used in this document with Scientific Names and Four Letter Codes.

Species	**Scientific Name**	**Four Letter Code**
American Black Duck	*Anas rubripes*	ABDU
Red-breasted Merganser	*Mergus serrator*	RBME
Common Loon	*Gavia immer*	COLO
Sooty Shearwater	*Puffinus griseus*	SOSH
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	LHSP
Northern Gannet	*Morus bassanus*	NOGA
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO
Great Cormorant	*Phalacrocorax carbo*	GRCO
Osprey	*Pandion haliaetus*	OSPR
Bald Eagle	*Haliaeetus leucocephalus*	BAEA
Black-bellied Plover	*Pluvialis squatarola*	BBPL
Semipalmated Plover	*Charadrius semipalmatus*	SEPL
Spotted Sandpiper	*Actitis macularius*	SPSA
Greater Yellowlegs	*Tringa melanoleuca*	GRYE
Lesser Yellowlegs	*Tringa flavipes*	LEYE
Semipalmated Sandpiper	*Calidris pusilla*	SESA
Least Sandpiper	*Calidris minutilla*	LESA
White-rumped Sandpiper	*Calidris fuscicollis*	WRSA
Short-billed Dowitcher	*Limnodromus griseus*	SBDO
Wilson's Snipe	*Gallinago delicata*	WISN
Ring-billed Gull	*Larus delawarensis*	RBGU
Herring Gull	*Larus argentatus*	HERG
Glaucous Gull	*Larus hyperboreus*	GLGU
Great Black-backed Gull	*Larus marinus*	GBBG
Black-legged Kittiwake	*Rissa tridactyla*	BLKI
Common Tern	*Sterna hirundo*	COTE
Arctic Tern	*Sterna paradisaea*	ARTE
Dovekie	*Alle alle*	DOVE
Common Murre	*Uria aalge*	COMU
Black Guillemot	*Cepphus grylle*	BLGU
Atlantic Puffin	*Fratercula arctica*	ATPU
Belted Kingfisher	*Ceryle alcyon*	BEKI
American Crow	*Corvus brachyrhynchos*	AMCR
Common Raven	*Corvus corax*	CORA

6.0 River Otter

Voisey's Bay Nickel Company Limited (VBNC) is proposing a nickel processing plant at Long Harbour, Placentia Bay. The Project will entail marine shipping, loading and unloading wharf, and marine effluent. Placentia Bay is known to support a relatively large population of river otter (*Lutra canadensis*). This species is listed as a Valued Ecosystem Component (VEC) in Guidelines for the Environmental Impact Statement (Department of Environment and Conservation 2006). Because there is little published information on the river otter in Placentia Bay, VBNC retained LGL Limited of St. John's to conduct a review of information, and to provide baseline information on their distribution within eastern Placentia Bay and the Merasheen Island area. This report presents the results of this review and the 2006 surveys.

6.1. Background Information

The river otter is a large member of the family Mustelidae that includes the weasel, mink, and marten. It is a ubiquitous species ranging the temperate latitudes of North America and inhabiting both marine and freshwater environments. Its role as a top predator and its relatively large spatial requirements make the species sensitive to anthropogenic stress including contamination by water-borne pollutants, the drainage of wetlands, and other forms of habitat degradation (Duffy et al. 1993; Bowyer et al. 1995). Because of this susceptibility, river otters are commonly used as indicators of the health of aquatic ecosystems (Duffy et al. 1993; Elliot et al. 1999). Although technically semi-aquatic in habits, it spends a very large proportion of its time in water relative to other members of the Mustelidae, with the exception of the sea otters of the Pacific Ocean. In various areas of its range, such as in Placentia Bay, this species lives a largely marine existence or may alternate between coastal and interior habitats (Larsen 1984; Stenson et al. 1984). There is a documented presence of otters throughout most of the Placentia Bay archipelago, and they occur in the Long Harbour - Iona Islands and adjacent environs.

Despite its historic presence, exploratory research commencing in the 1970s, local knowledge and traditional trapping activity, there remains very limited and only fragmented information of this mammal in Placentia Bay. The objective of the present study was to gather preliminary information and baseline data on the presence of otters in the area of Long Harbour, the adjacent headlands, and the Iona Islands – Brine Islands area (Figure 6.1).

6.2. Study Team

Dr. Ian Goudie of LGL conducted the field work and wrote the report. Mike Keating of Mount Arlington Heights provided field assistance and boat transportation. Maps and GIS work were completed by Colin Jones of LGL. Bob Buchanan, M.Sc., reviewed the report.

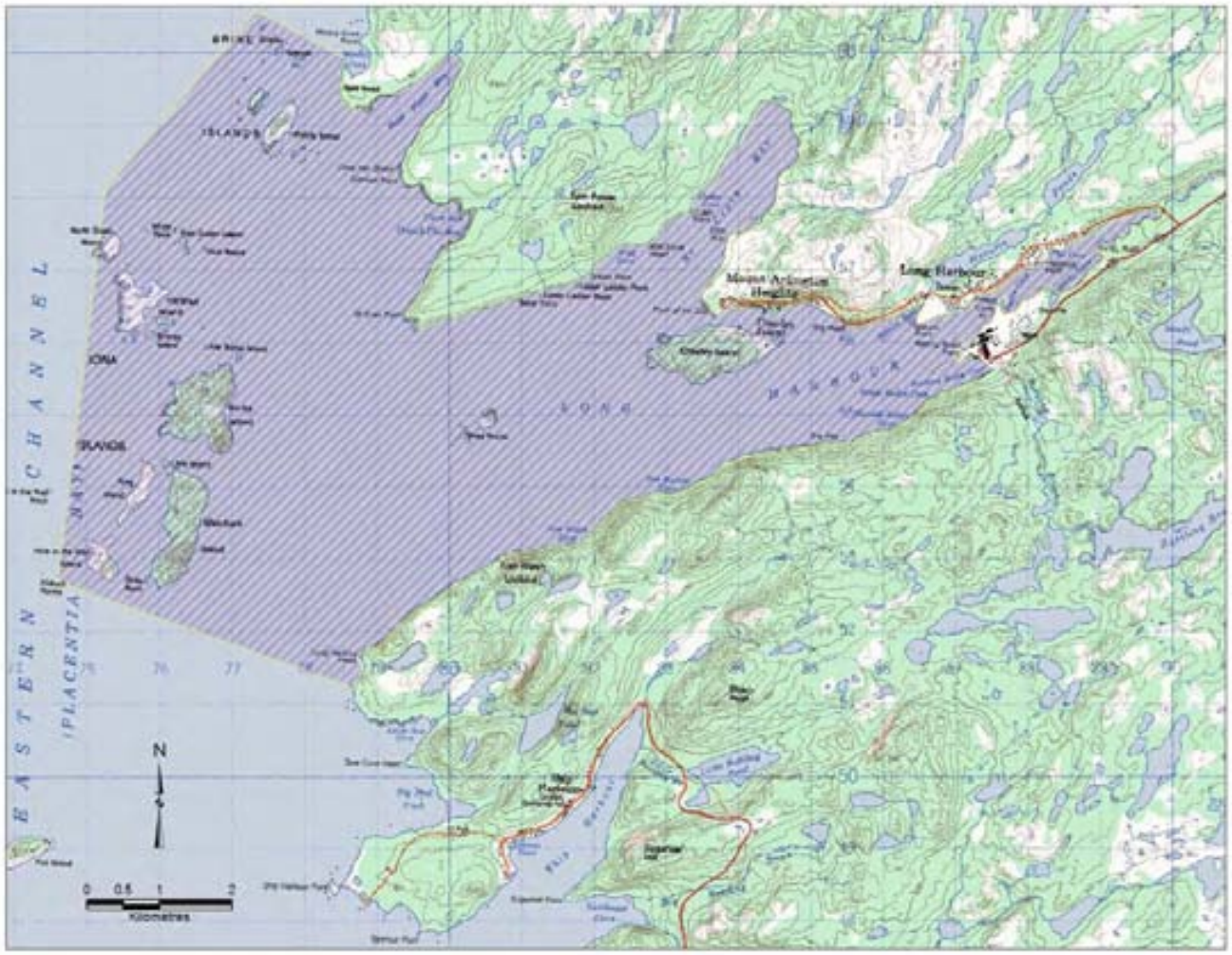

Figure 6.1 Area (Cross Hatch) Searched by LGL for Otter Haul-outs in Long Harbour, Placentia Bay.

6.3. Historical Background

River otters are abundant and widespread in the archipelago areas of Placentia Bay and along the adjacent western and inner mainland shoreline. There is strong anecdotal knowledge because of active trapping of this furbearer population for many decades. Within the Newfoundland and Labrador Wildlife Division it is acknowledged that the inner reaches of Placentia Bay, particularly around Merasheen Island and Long Island, support one the highest densities of river otter in the province. However, there is very limited information on this population. Furbearer biologists Neil Payne, Tom Northcott, and technician David Slade, formerly of the Newfoundland and Labrador Wildlife Division, initiated some preliminary work on otters in Newfoundland in the early to late 1970s in order to assess movement patterns of river otters occupying marine habitats in Placentia Bay. Northcott and Slade (1976) reported on a new live-trapping technique using modified Hancock traps, and reported capturing, marking, and releasing 46 otters in the seven-week summer field seasons of 1972-74. To the best of our knowledge, this is the only peer-reviewed publication on river otter in Newfoundland.

Slade and Pitcher (1971) reported on an otter-tagging project in Placentia Bay that involved the Merasheen Islands (Brule West, Path End, Dog Harbour), Bard Island, King Island, Middle Island, Bread Island, Cheese Island, Long Island (east side, notably Kingwell area), and Sound Island. Slade and Pitcher (1971) reported otter activity in the area of North Harbour and Come-by-Chance. [These authors also incidentally recorded 60 Bald Eagles during their visits over three months.] David Slade (1975, unpublished internal report) reported on the Merasheen Island Otter Tagging Project where they captured 19 otters. Slade (1976, unpublished internal report) refined the use of techniques for live capture of this species that became instrumental for the capture and transfer of six otters to the re-establishment program in Colorado.

The high density of otters in Placentia Bay has been of research interest to the Newfoundland and Labrador Wildlife Division**,** and Ken Curnew (1979) submitted a proposal for a study of a marine population of otters for consideration for funding under the Offshore Labrador Biological Studies (OLABS) program. Frank Phillips (Wildlife Technician, pers. comm.) reported very active trapping of otters in marine areas adjacent to Red Harbour, Placentia Bay (Davis Island, Jude Island, Emberley Island, and others), and speculated that these otters were exceptionally large and may be a genetically larger race than those occurring inland. In coastal areas of St. Mary's Bay and even Cape St. Mary's, otters are regularly observed, and they frequently feed on lobsters there (I. Goudie, LGL, pers. obs.). Otters are also regularly observed on and around islands in Placentia Bay by seasonal residents (P. Hann, Extension Coop, pers. comm.). Mike McGrath, Wildlife Biologist, Newfoundland and Labrador Wildlife Division, undertook some successful preliminary studies to determine the effectiveness of using Trailmaster© cameras to detect frequency of activity by otters at rub sites. The camera projects an infrared beam across a sample station and registers an interception and/or takes a photograph.

In a joint pilot study with the Newfoundland Wildlife Division, the Canadian Wildlife Service (CWS) analysed seven livers from otters trapped near Boat Harbour/Southeast Bight in western Placentia Bay and one liver from an otter trapped near Arnold's Cove. All these animals were trapped in fall 1999, and had low levels of PCBs, organochlorine pesticides, and mercury. Recorded levels were apparently not of immediate concern. No other metals were analysed in the samples. For a graduate study through Memorial University of Newfoundland (Holly Stewart's project), CWS analysed nine otter livers from near Best's Harbour and eleven otters from near Boat Harbour, western Placentia Bay. These animals were trapped in the fall of 2000, and all had low levels of PCBs, organochlorine pesticides, and mercury. No other metals were analysed in the samples. From the above samples, one young female otter from Boat Harbour apparently contained elevated mercury levels, and three otters had slightly elevated PCB levels compared to the others (N. Burgess, CWS, pers. comm.).

More recently, a study was initiated in cooperation between Memorial University (Dr. T. Miller, Biology), Fisheries and Oceans (DFO) (Dr. G. Stenson), Terra Nova National Park (TNNP) (J. Gosse, Terrestrial Ecologist, Terra Nova National Park), and the Wildlife Division (M. McGrath, Wildlife Biologist) to study food habits of otters in Placentia Bay and compare these with analyses from Bonavista Bay (TNNP, marine component). An M.Sc. candidate, Ms. H. Stewart, had previously completed extensive collections and analyses of scats but did not submit a thesis. Those results are now

being analyzed by J. Gosse, and a coauthored draft manuscript was kindly provided to LGL for internal information. This manuscript provided some preliminary breakdown of food types by locations (Table 6.1), and identified cunners, gunnels/pouts, sculpins, flounders, and sticklebacks as the main prey items identified from scats collected in Placentia Bay (Cote et al. *in prep*.). Ed Loder, Wildlife Technician, assisted H. Stewart in those collections, the majority of which were collected at otter haul-out sites in the area of North Harbour-Sound Island (near Come by Chance), although a few samples were collected on Merasheen Island.

Table 6.1. Occurrence of Prey Items in River Otter Scats Collected from Placentia Bay as a Percentage of the Total Number of Scats (*n* = 437) and the Total Number of Prey Items (*n* = 928).

Prey Species	% in total scats	% of total prey items
Cunner (*Tautogolabrus adspersus*)	41.42	19.53
Gadus spp.	10.07	4.75
Rock gunnel/eelpout (*Pholis gunnellus*/Family Zoarcidae)	20.59	9.71
Snowflake hookear sculpin (*Artediellus uncinatus*)	24.71	11.65
Unidentified stickleback (Family Gasterosteidae)	31.35	14.78
Winter flounder (*Pseudopleuronectes americanus*)	17.39	8.20

6.4. Methods

The coastal areas of Long Harbour, St. Croix Bay, and west to Bald Head; the intervening coastline, adjacent headlands, and the archipelago of Brine Islands-Iona Islands; and the south shoreline of Long Harbour out to Long Harbour Head (Figure 6.1), were surveyed in mid to late August 2006 using a boat skippered by an experienced local trapper (Mike Keating).

All sites known to be used by otters as coastal haul-outs locations (rubs) as well as additional sites detected while in the field were visited. Sites were classed as used by otters if there was physical evidence of use, such as slides, scats, tracks, excavated turf, scent piles, fish remains, etc. Otters generally leave their scented excrements on very obvious places such as stones, tuffs of grass, earth mounds, and often at dens, rolling places, slides and runways, and especially in proximity to where they land. In some cases, otters prepare mounds or hillocks by scratching-up loose soil and debris on which they deposit musk (scented fluids). These are sometimes referred to as spraints or sprainting areas (after Bowyer et al. 1995; Erlinge 1967). The scent is located in musk glands in the area of the anus.

Surveys focused on:

- Areas known to be frequented by otters
- Location of slides/rubs and latrine/sprainting areas as evidenced by:
    - compacted trails in peat
    - areas rubbed free of vegetation by activities
    - enhanced vegetation growth (green-up) due to nutrient input from scats and food remains
    - the selective use of natural ravines with running or intermittent water

    - use of narrow topographical depressions to traverse between marine areas or marine and freshwater areas
- Removal of scats/tracks after documentation
- Revisit of sites at a later date to assess for evidence of reuse

Sites having evidence of otter presence were ranked based on the freshness of the sign, for example, tracks, fresh scats, decaying fish parts versus only fully decomposed evidence, such as fish bones and scales. Ranks included:

1. sighting
2. very recent (within 1 week)
3. recent (> 1 week but within 1 month)
4. fairly recent (> 1 month but < 3 months)
5. old (> 3 months)

If sites had evidence of use by otters, latrine areas were cleared of scats (fresh material was collected). Sites were revisited at a later date and assessed for possible re-use. This provided some preliminary indication of the regularity of use of sites by otters (after Northland and Associates 1990). LGL staff collected and archived fresh scat samples for future potential analyses of food habits and population estimation using mark-recapture techniques such as those recently applied in Terra Nova National Park (J. Gosse, pers. comm.). The application of the genetic analyses of scat samples is also a valuable technique to help determine range of these animals.

On 7 June 2006, LGL undertook an aerial survey for Bald Eagles along inner Placentia Bay, commencing at Arnolds Cove and extending along the eastern 'Cape Shore' to Northern Head, Cape St. Mary's (See Chapter 4, this report). Incidental observations of otter haul-out sites (rubs) were recorded on GPS units by observers.

6.5. Results

Twenty-one sites were identified as otter 'rubs' in the area of Long Harbour - St. Croix Bay to Iona Islands, and along the 'Wild Shore' (east side of Long Harbour) (Figure 6.2). Fourteen of these sites had signs of recent use in mid to late August 2006. Many sites were promontories, although straight shoreline areas with bedrock and boulders were also frequently used. Numerous fresh scats were collected and frozen for future analyses (Table 6.2). On 7 November 2006, the sites were revisited and 15 of 20 sites had been reused in the intervening 2 to 2.5 month period (Table 6.3). Incidental to surveys for nesting Bald Eagles conducted on 7 June 2006, 35 sites were identified as otter haul-outs (rubs) in the inner and eastern portion of Placentia Bay (Figure 6.3, Appendix 6.A).

Active 'rubs' were easy to recognize because of the usual presence of fresh scats, well-established trails that were free of recent litter fall from surrounding trees and shrubs, and often large areas (sometimes greater than five metres in diameter) where understory vegetation was reduced by activities of otters. In

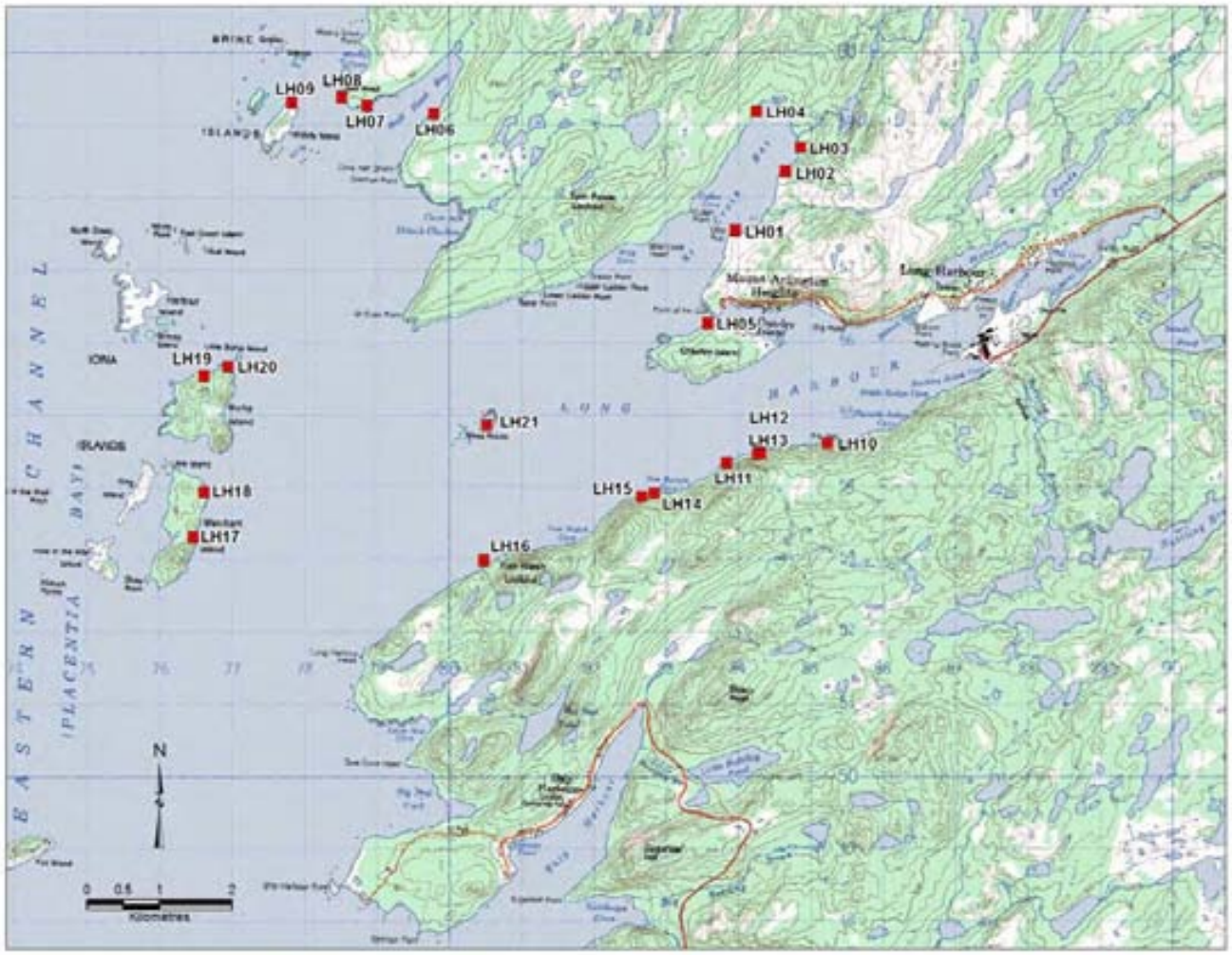

Figure 6.2. Locations of Otter Haul-out Sites (rubs) Identified by LGL in the Long Harbour Study Area, Placentia Bay. Site codes correspond to Table 6.2.

Some cases, runways and traveling routes were noticeable, especially in narrow areas between bodies of water or along intermittent brooks. Many of these sites also possessed burrows that otters may occupy from time to time. Rocks at the entrance trails to these sites frequently had signs of otters, including feces and litter dragged from the site.

Table 6.2. Shoreline Sites Used by Otters in the Long Harbour Area, Based on Local Information and Boat-based Surveys in August 2006.

Data sensitive and access must be approved by Department of Environment and Conservation.

Table 6.3. Shoreline Sites Assessed for Reuse by Otters in the Survey Area on 7 November 2006.

Data sensitive and access must be approved by Department of Environment and Conservation.

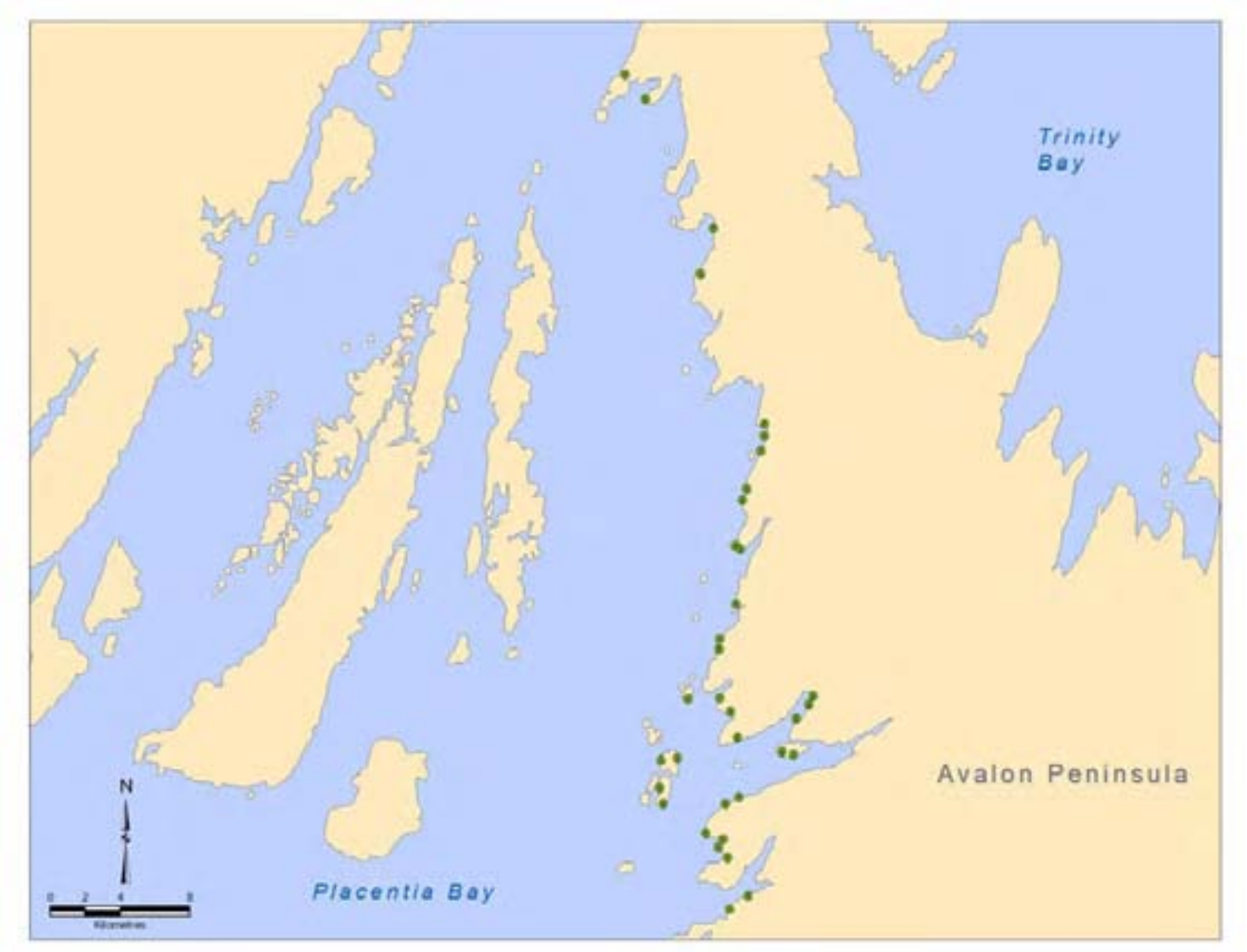

Figure 6.3. Haul-out Sites used by Otter (green) Identified by LGL during an Aerial Survey for Bald Eagles in Placentia Bay Conducted on 7 June 2006.

6.6. Discussion

Results suggest that the river otter is ubiquitous in the Long Harbour area. The assessment of 21 areas where otters were actively 'hauling-out' confirmed that many were currently being used, and the majority had evidence of recent use.

Little information is available on the biology of otters using Placentia Bay. It is likely that the population of otters using Placentia Bay is relatively contiguous given the large home range of this species and the results of studies of populations in other coastal areas. In the 1970s, one juvenile otter captured and tagged in the Kings Island area of Merasheen archipelago, Placentia Bay, was later caught by a trapper in Come-by-Chance area, representing some 40-50 km of range (D. Slade, retired provincial Wildlife Technician, pers. comm.). These findings support a hypothesis that otters in the survey area might encompass most of the Placentia Bay archipelago. Placentia Bay otters could also conceivably interchange regularly with the Trinity Bay population and *vice versa*.

The complexity of shoreline may be an important habitat component favouring the extensive use of the Placentia Bay archipelago by otters, as this was noted in research on the coast of Maine (Dubuc et al. 1990). New advances in genetic analyses using scat samples (and hair samples) have permitted biologists to estimate population size and home range of otters (refined in Prince William Sound, Alaska). These techniques have been applied successfully in Terra Nova National Park and in Bonavista Bay to estimate a population of 38 animals with some individual ranges exceeding 100 km of shoreline (Cote et al. *in prep.*). Alaskan studies also have successfully used radio-tracer implants to track individuals (Testa et al. 1994). Such techniques hold promise for application into any future studies of otters using Placentia Bay.

6.7. Literature Cited

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Appendix 6.A: Locations of Otter Rubs Detected during Aerial Surveys for Nesting Bald Eagles Conducted by LGL on 7 June 2006.

Data sensitive and access must be approved by Department of Environment and Conservation.