Marine Mammal and Seabird Surveys

Tidal Energy Demonstration Site — Minas Passage, 2011

Submitted to:

Fundy Ocean Research Centre for Energy (FORCE)

Submitted by:

Envirosphere Consultants Limited
Windsor, Nova Scotia

January 2012

Authors: Patrick L. Stewart, Fulton L. Lavender, and Heather A. Levy

FORCE Envirosphere CONSULTANTS LIMITED

Dedication

This report is dedicated to Croyden Wood Jr. of Parrsboro who died accidentally and too young, at 49 years, in January 2012 as final drafts were being prepared. A lobster fisherman, he proved himself in an industry and in the challenging environment of the Bay of Fundy where only the exceptional succeed. Croyden piloted his vessel the Cape Rose for us during the June and August 2009 surveys, which formed the basis of the monitoring program. His kindness and skill will long be remembered.

Fundy Ocean Research Centre for Energy (FORCE)
PO Box 2573
Halifax, Nova Scotia B3J 2N5

Envirosphere Consultants Limited
P.O. 2906, Unit 5 – 120 Morison Drive
Windsor, Nova Scotia B0N 2T0
Tel: (902) 798-4022
Fax: (902) 798-2614
www.envirosphere.ca

FORCE Envirosphere CONSULTANTS LIMITED

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Fundy Ocean Research Centre for Energy (FORCE) has developed and operates a tidal energy demonstration site and support facility along the north shore of Minas Passage in Nova Scotia's Bay of Fundy. Under its environmental approvals to operate at the site, FORCE has been carrying out background and environmental monitoring studies to assist in the assessment of the impacts if any of the tidal energy device installations and associated infrastructure. Important components of the ecosystem at the site, which are included in the FORCE monitoring activities, include water-associated birds (seabirds, waterfowl and shorebirds) and marine mammals (seals, dolphins and porpoises and whales) which occur in Minas Passage and may potentially interact with tidal devices. To gather information on marine mammals and seabirds in the vicinity of the tidal demonstration site, FORCE carried out baseline and first- and second-year monitoring studies in 2008 and 2009-2010, respectively. The monitoring program continued in 2011, undertaking six, one-day shore-based observational surveys (March-April & December) and two vessel-based surveys in July-August in the outer Minas Basin, Minas Passage and Minas Channel. Shore-based surveys took place on March 16 & 31, April 15 & 30, and December 2 & 13, 2011, and vessel-based surveys took place on July 24 and August 27, 2011.

Overall, for the three years of the monitoring program, 40 species of water-associated birds have been seen in the vicinity of the Tidal Energy Demonstration Site (Minas Basin, Minas Passage & Minas Channel), 35 of which occurred in Minas Passage specifically at the demonstration site and were observed in shore-based surveys. During the 2011 monitoring activities, 29 species of water-associated birds were observed in Minas Passage at the tidal demonstration facility, including: seabirds (Double-Crested Cormorant, Great Cormorant, Herring Gull, Great Black-Backed Gull, Iceland Gull, Lesser Blacked-Backed Gull, Ring-Billed Gull, Black Guillemot, Northern Gannet, Razorbill, Horned Grebe, Black-Legged Kittiwake, Thick-Billed Murre, and Common Murre); and waterfowl (Common Eider, King Eider, American Black Duck, Long-Tailed Duck, Canada Goose; Common, Pacific, and Red-Throated Loon; Surf, Black, and White-Winged Scoter; Northern Shoveler, Common Goldeneye, Red-Breasted

Merganser and Common Merganser). The greatest number of species occurred during Spring migration in mid- to late-April (April 15 & 30) although a moderate number of species occurred in all seasons. Fewer species were observed in summer vessel surveys which included parts of Minas Basin, Minas Passage and Minas Channel, including Herring Gull, Great Black-Backed Gull, Ring-Billed Gull, Double-Crested Cormorant, Black Guillemot, Northern Gannet, Common Loon, and Bonaparte's Gull. Densities and diversity of seabirds and waterfowl seen on vessel surveys in 2011 was lower than in earlier surveys; compared to 2010, bird species diversity was lower, with two fewer species observed in 2011 and four fewer species than in 2009.

Resident seabird and waterfowl species, including Canada Goose, gulls (Herring and Great Black-Backed), Common Eider and American Black Duck, were the dominants in the waters of Minas Passage immediately off the tidal demonstration site in March. Migratory waterfowl including Scoters (Black and Surf) and water-associated Red-throated Loon became dominant in mid- to late-April, suggesting that the Spring migration had begun. Winter (December) observations identified a moderate abundance of a wide range of species in low numbers. Herring Gull and Ring-Billed Gull were the most abundant and common birds in Minas Basin, Minas Passage and Minas Channel in July & August, the latter only occurring in August. Black Guillemot a coastal alcid species, was next in abundance in both months, but was not common. Great Black-Backed Gull occurred in moderate abundance in July but few were seen in August, while Common Loon, Double-Crested Cormorant, and Northern Gannet occurred occasionally and single Bonaparte's Gull was observed in Minas Basin during the July vessel survey. Compared with earlier surveys, the abundance of birds in Minas Channel was particularly low in 2011. Abundance of seabirds in Minas Basin was higher than in previous years, reflecting higher abundances of Ring-Billed Gull observed there in August 2011. Densities of seabirds measured in vessel surveys were lower than those observed in previous surveys in 2009 & 2010, and overall were slightly lower than or comparable to densities in other Nova Scotia coastal and offshore waters.

Harbour Porpoise (*Phocoena phocoena)* occurred frequently at the Tidal Energy Demonstration Site from early mid-March to late April but were absent in December. The species occurred typically in groups of 2 but groupings of up to 8 individuals were observed; highest numbers were observed on May 31, when abundance averaged 3.2 animals per 30-minutes during the 6-hour observation period. Individual Harbour Porpoise occurred more frequently in the operational subdivision of the study area corresponding to the proposed location of the tidal turbines (the area seaward of Black Rock towards the Minas Channel and Cape Split), than in the other of the two areas (inside Black Rock, outside Black Rock (Minas Passage), usually seen swimming seaward with the outgoing tidal stream which passed over the proposed tidal installation at the site. One of the shore-based surveys the previous year (October 23, 2010) overlapped with a period of deployment of passive acoustic monitoring equipment (C-PODs) in the study area (Tollit *et al* 2011; FORCE 2011). Individual Harbour Porpoise observed from shore moving through the site were detected by the acoustic instrumentation, which captured the sounds ("clicks"). Shore-based observations thus provided valuable additional information on behaviour and abundance of the porpoises, to corroborate the observations made by the acoustic devices.

1 INTRODUCTION

Seabirds and marine mammals are important in the marine ecosystem of the Bay of Fundy, and in the context of tidal power development, they have the potential to interact with tidal turbines and be affected by associated activities. The location of the tidal energy demonstration site is known to support various seabird, waterfowl and marine mammals species common to coastal environments in Atlantic Canada; however at the commencement of efforts to create a tidal energy demonstration site on the shore of the Minas Passage—the location of the highest tidal currents—sufficient information on birds and marine mammals to allow monitoring and impact assessment was not available. Preliminary shipboard surveys for seabirds and marine mammals were carried out in July and October 2008 as part of geophysical cruises to the area to obtain information on occurrence and species composition at the site (Envirosphere Consultants Limited 2009a). A comprehensive survey program was established in 2009, with single day-long, vessel-based seabird surveys conducted in June, July, August and September 2009 to provide additional baseline information for the assessment of potential impacts and for the development of an environmental monitoring program for the project (Envirosphere Consultants Limited 2010). Subsequent review of the results of the first year monitoring report by the Environmental Monitoring Advisory Committee (EMAC) for the project, as well as regulatory agencies, led to recommendations for the collection of additional information on bird species, particularly diving species such as loons, during the Spring and Fall migration periods—this was addressed by a monitoring program in 2010 in which shore-based surveys were undertaken in May-June and October-November to cover the migration periods, and vessel surveys were continued in mid-Summer (July August) to continue to develop a reference record and to monitor conditions while the first tidal turbine was in place (November 2009 – December 2010)(Envirosphere Consultants Limited. 2011). The present report presents the results of 2011 monitoring which extends seasonal coverage by using shore-based, day-long surveys in March, April and December, as well as continued vessel-based surveys in July and August 2011 to repeat surveys done at the same time of year in 2009 & 2010.

2 METHODS

Shore-Based Surveys

Shore-based surveys were carried out at the site on March 16 & 31, April 15 & 30 and December 2 & 13, 2011. Surveys were done by Mr. Fulton Lavender, an experienced seabird and marine mammal observer, assisted by Mr. Matthew MacLean, Environmental Technologist, Envirosphere Consultants Limited, except on April 30 when Patrick Stewart, M.Sc., Senior Biologist, Envirosphere Consultants Limited, assisted. The observer team arrived on site at approximately high tide and observations were made during the approximately 6-hour period of the outgoing tide. Observations were made by eye from the deck of the FORCE Interpretive Center, using a tripod-mounted, 22x magnification spotting scope for the observer, as well as 8 x 40 or 10 x 50 binoculars, for both principal observer and the assistant. The observer scanned the entire study area several times during successive 30-minute periods, noting all birds and marine mammals seen and location, maturity, as well as activities (flying, on water, feeding etc.), providing an estimate of total number of unique bird species per period, and a breakdown by local areas of significance (proposed turbine deployment area as well as the area between Black Rock and shore, and the Minas Passage beyond Black Rock) (Figure 1a). For subsequent analysis and interpretation, the average number of birds of each species per period based on all 30-minute periods was used to summarize bird and marine mammal occurrence on each survey.

Vessel-Based Surveys

Day-long surveys for marine mammals and seabirds were carried out from a chartered lobster boat (Dale Millett and Gerry Reid, Delhaven), departing from Delhaven. On July 24, the survey began in early morning (departing 0733 hrs) just before high tide and arrived in port at 1900 hrs[1]. The August 27, 2011 survey began later, departing Delhaven approximately 1045 and returning at approximately 1930 hrs with the tide in the evening. Surveys were carried out by Fulton Lavender, assisted by biologist Heather Levy (BSc.Hons) and environmental technologist Matthew MacLean, both with Envirosphere Consultants Limited, in July and August, respectively. Surveys were done under generally good observation conditions, with skies partly overcast (40% cover) on July 24 and mostly clear and partially cloudy on August 27 with fog encountered leaving Delhaven and in Minas Basin almost to Parrsboro in the August survey. Surveys covered areas including parts of Minas Basin extending from off Blomidon to Parrsboro, and along the central to north sides of Minas Passage and Minas Channel extending to Cape Spencer (Figure 1b). A standard watch for seabirds was carried out modeled after the Canadian Wildlife Service protocol (Wilhelm *et al.* 2008) and included 'snapshot' sampling for flying birds, although all flying birds seen in the observation period were counted. Watches of 5- and 10-minute duration (July and August respectively) were conducted every 10 to 15 minutes[2]. The observer monitored a strip of water and air 300 m wide approached by the vessel, on the port side, recording information on counts, identification, stage (adult, immature, juvenile etc.), distance (distance classes as required in Wilhelm et al. (2008)), as well as on birds observed beyond 300 m. At the beginning of each observation period, the observer's assistant recorded the time, vessel coordinates, heading, speed, wind-speed, and weather conditions. All data was recorded in notebooks and subsequently transferred to the CWS standard form for a moving vessel survey (Wilhelm et al. 2008). At the same time, the observer took note of marine mammals. A protocol and reporting forms used by DND-MARLANT for marine mammal observations, including the MARLANT Whale identification Guide (Envirosphere Consultants 2006) were on board for use in identification. Data obtained will be given to the Canadian Wildlife Service and to Fisheries and Oceans Canada for inclusion in respective seabird and marine mammal databases.

The survey route (Figure 2) was designed to provide coverage not only of the study site but also of areas to the east (Minas Basin) and west (Minas Channel) since these areas are likely to have seabird distributions which will overlap the tidal demonstration site; to cover nearshore areas as well as along the axis of Minas Passage-Minas Channel; and also to cover daily movements of birds within the general area (e.g. for feeding)[3]. A survey lasted typically from early morning to evening (but as noted the August survey departed in the late morning), from one high tide to the next, allowing transects at the project site to be done before the peak ebb and repeated after the peak flood, thereby reducing the amount of time steaming against the tide. After sampling at the project site, the boat steamed with the peak tidal flow to Cape Spencer, where it waited until the tide reversed, and then cruised back again to the survey origin. For the purposes of data analysis, the study area was divided into three sub-areas: Minas Passage was between Cape Sharp and Cape Split; Minas Basin was east of Cape Sharp; and Minas Channel the area west of Cape Split (Figure 1b). Compared to 2009, the surveys in 2010 & 2011 included more

[1] Survey times are chosen to catch a high tide early in the morning to allow a full tidal cycle during daylight hours. There are a limited number of times each month, however, when tide and daylight coincide and the survey can be successfully carried out. In 2011, bad weather resulted in postponement of the first survey from earlier in the month to July 24. The August survey also was postponed from mid-month and bad weather further delayed the survey, and resulted in it being shortened, with a departure on the high tide later in the day (i.e. 1045 hrs); as a result of the shorter survey, the usual intensive sampling at the tidal energy site was dropped although a full survey of the rest area was carried out.

[2] The 'snapshot' is an instantaneous count of flying birds within a 300 m radius of the observer. In addition, all flying birds were included in the normal sampling routine.

[3] The survey design was reviewed by D. Fifield, CWS, St. John's, NL, prior to implementation in 2009 and has not changed.

observations in Minas Basin to better balance the survey effort there with that in the other areas. The shortened survey on August 27 included more-frequent observations, resulting in a survey effort, which was comparable to the earlier surveys.

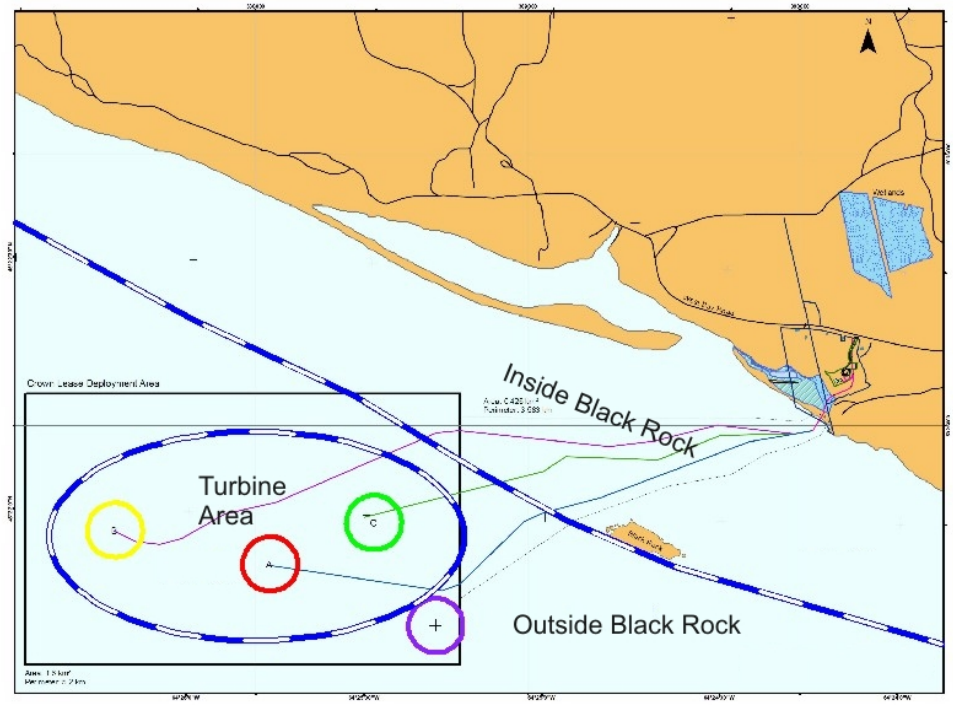


Figure 1a. Study area for shore-based surveys, showing project location and major subdivisions.

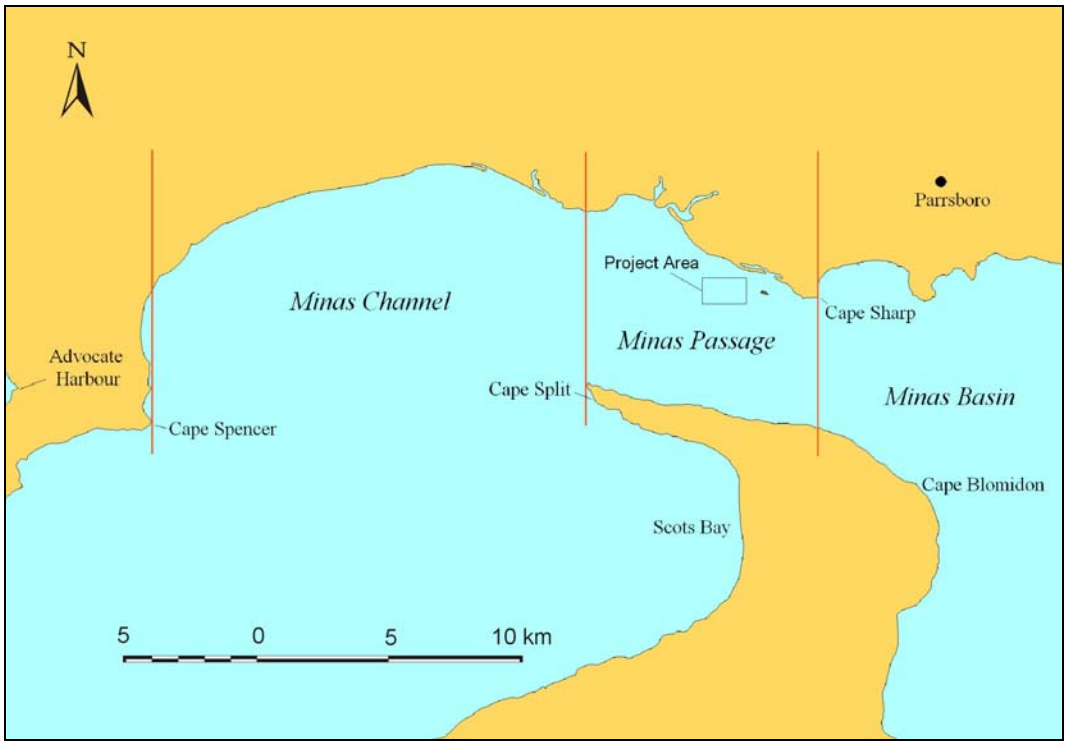


Figure 1b. Study area for vessel surveys, showing project location and major subdivisions.

A detailed 'zig-zag' grid of transects was also included as part of the survey design to provide focused information on the tidal installation site which is included in the overall analysis but not specifically analyzed in this study (Figure 3). The zig-zag course was not completed successfully in the July survey as the vessel captain was new to the project and had difficulty navigating in the high current regime at the site (Figure 3); while the zig-zag pattern was not attempted in August due to the shortened cruise duration brought about by earlier weather delays and the reduced availability of a suitable tide.

For each observation period, the distance traveled based on beginning and end coordinates of the period, obtained in the field by hand-held GPS, as well as based on heading and ship speed, was calculated. The two were highly correlated and the distance based on coordinates was used for subsequent analysis. Seabird densities are estimated and presented in several different ways in this report: as total numbers of birds or numbers of individual species observed in 5-minute or 10-minute observation periods (maps); as a spatial density estimate based on numbers seen 'in transect' (i.e. in the 300 m band on the side of the track traversed by the ship, and therefore the most quantitative estimate); as well as total or individual species abundances per kilometer (includes all birds seen in the observation quadrant of the ship, and which typically includes more individuals and species than the area estimate)[4]. Abundance expressed per unit area is a more accurate estimate of density of offshore birds, although it may exclude some species. Because 'snapshots' were done (the 'snapshot' is a procedure to observe flying birds at one point in time and therefore avoid the possibility that they would fly back into the area during the observation period and be recounted), the density of flying birds accurately reflects their abundance (e.g. Wilhelm et al. 2008).

[4] Observed abundances were not adjusted for birds 'missed' which is a phenomenon of reduced ability of the observer to see all the birds as distance from the vessel increases, and hence numbers reported in this report slightly underestimate true density.

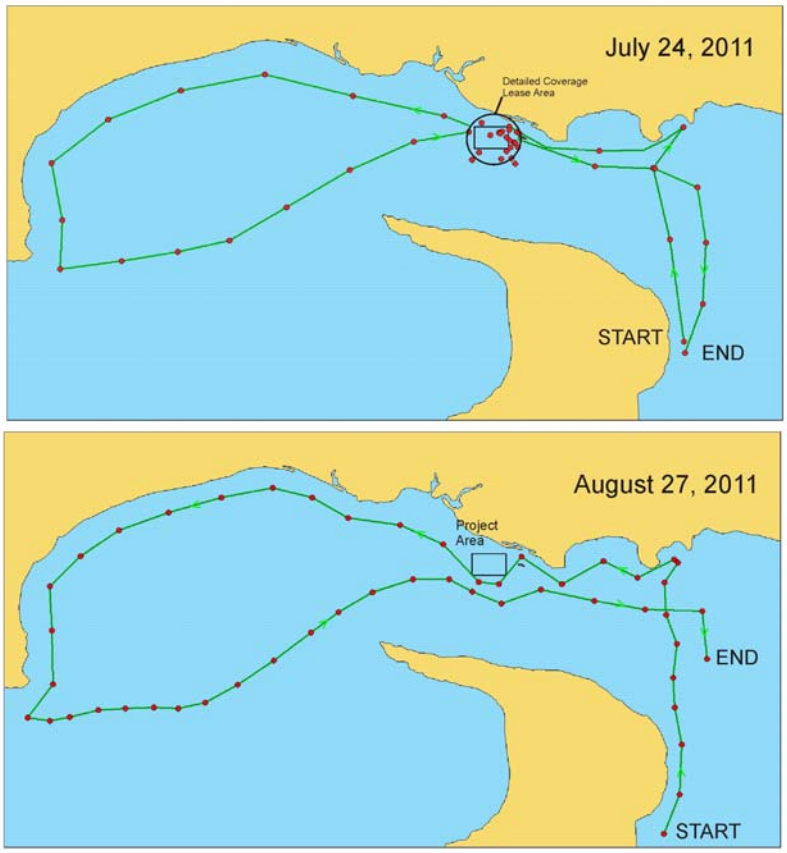


Figure 2. Survey route for July and August seabird surveys in 2011. Points indicate locations of start points for 5-minute observation periods during seabird and waterfowl survey.

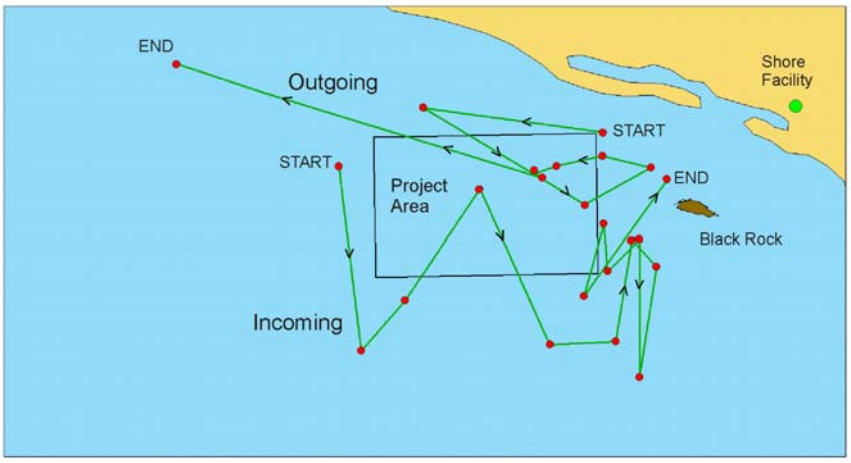


Figure 3. Survey route for seabird observations focused on Project Area, July 2011. Points indicate locations of start points for 5-minute observation periods.

3 RESULTS AND DISCUSSION

3.1 Marine Mammals

Two species of marine mammals, the Harbour Porpoise (*Phocoena phocoena)* and the Grey Seal (*Halichoerus grypus)* were observed in the surveys. Harbour Porpoise was by far the dominant species (77 individuals observed)[5], versus only two Grey Seals, the latter seen only in the shore-based survey on April 15. Most of the sightings occurred during the shore-based observations, with only three Harbour Porpoise recorded on the two vessel surveys (Table 1; Figure 4). Harbour Porpoise occurred in the study area throughout the observation period with the exception of August and early to mid-December (Figure 4). Highest numbers of sightings were made from March 16 to April 15, at those times averaging about 1 to 1.5 animals per 30-minute observation period with a peak of 3.2 per 30-minute period on March 31 (Figure 4). A high of twelve animals was observed in a half-hour period on March 16 and eleven on March 31. There did not appear to be an association of the movements with time of day (Figure 4). Those observed during shore surveys were observed in groups of up to 8 individuals (March 31)[6] and a peak size of 7 was observed on March 16, but the average group size was 2.64 individuals, ranging from an average of 1.5 on April 30 to 3.6 individuals on March 16 (Appendix Table A-9 & Figures A-1 & A-2). The observations of Harbour Porpoise can be used to make a crude estimate of the total number moving through Minas Passage on a given tide[7].

Unlike 2010, Harbour Porpoise occurred more frequently southwest of Black Rock in the approximate proposed turbine installation zone (Figure 4). Individuals were nearly always swimming seaward with the outgoing tide and appeared to pass through individual areas by chance, depending on their position in the tidal current stream leaving Minas Basin[8]. Individuals or groups seen between Black Rock and shore occasionally swam in circles, evidently feeding, while continuing to move with the tide[9].

Harbour Porpoise were also seen during the vessel survey in the vicinity of the proposed turbine installation area and slightly to the west, and in both sightings the animals were swimming approximately with the tidal current. The single harbour porpoise seen at 0930 hrs on July 24 was heading west and the group of two in the Project lease area at 1551 on July 24 were heading to the northwest.

Fewer Harbour Porpoise were observed on the vessel surveys in 2011 than in either 2009 or 2010 (only three individuals compared with five in 2010 and 19 individuals in the July-August surveys for 2009). These observations probably do not indicate a trend and illustrate the natural high variability in surveys for marine mammals in the area.

[5] All Harbour Porpoise sightings in the shore survey likely represent separate individuals, as they all move past the site on the outgoing tide. These observations could be used to generate a population estimate of individuals as the number observed in each survey represents roughly those in the total distance traveled by the tidal water mass (tidal excursion) during the 6-hour period of falling tide surveyed.

[6] There are uncertainties in determining group size due to the difficulty in observing the animals, keeping track of individuals seen, particularly in groups, their behaviour, and the skill of the observer. Porpoise often travel in groups, so observations of even single individuals may indicate a pair or more are present, and large group sizes (e.g.7-8) could include repeat counts of individuals, or not include individuals, which were in the group and not accounted for.

[7] Minas Passage is approximately 5.5 km wide, roughly 3.7 times the 1.5 km example distance in which reliable observations can be assumed to be made [porpoise may actually be seen at greater distances]. On March 31, when at least 38 individuals moved past the study site on the falling tide, if the species is exiting uniformly across Minas Passage, a minimum estimate of the number of animals leaving Minas Basin is 3.7 x 38 = 140 or 23 per hour.

[8] Observations were coordinated with the tidal cycle, capturing the period from the high tide to low tide, and the water flowed from Minas Basin to Minas Passage.

[9] Porpoise showing circling movements inside Black Rock included a group of 5 on March 16; one group of 2 on March 31; and one individual on April 30.

Table 1. Marine mammal observations during seabird and marine mammal surveys, Minas Basin, Minas Passage and Minas Channel, March – December 2011.

Date	Time (ADT)	Survey Component	Location[1]	Species	Number
March 16, 2011	1030-1100	Shore	45 22.263N 64 24.348W	Harbour Porpoise	12
	1100-1130	"	"	Harbour Porpoise	5
	1230-1300	"	"	Harbour Porpoise	1
March 31, 2011	1030-1100	Shore	"	Harbour Porpoise	2
	1200-1230	"	"	Harbour Porpoise	5
	1230-1300	"	"	Harbour Porpoise	9
	1300-1330	"	"	Harbour Porpoise	11
	1330-1400	"	"	Harbour Porpoise	4
	1530-1600	"	"	Harbour Porpoise	5
	1600-1630	"	"	Harbour Porpoise	2
April 15, 2011	1115-1145	Shore	"	Harbour Porpoise	5
	1145-1215	"	"	Harbour Porpoise	5
	1215-1245	"	"	Harbour Porpoise	2
	1445-1515	"	"	Harbour Porpoise	3
	1015-1045	"	"	Grey Seal	1[2]
	1045-1115	"	"	Grey Seal	1[2]
	1515-1545	"	"	Grey Seal	1
April 30, 2011	1230-1300	Shore	"	Harbour Porpoise	2
	1630-1700	"	"	Harbour Porpoise	1
July 24, 2011	0935-0940	Vessel	45 22.48N 64 26.12W	Harbour Porpoise	1
	1551-1556	"	45 21.90N 64 25.20W	Harbour Porpoise	2

1.Observation point for shore survey.
2.The same seal was observed in both periods.

Prior to the monitoring undertaken by FORCE in 2009, both Harbour Porpoise and Grey Seal were expected to occur in the study area, but their relative abundance and seasonal occurrence was unknown, as there were few previous recorded sightings for the area. The 2010 shore-based monitoring showed that both species were present, with Harbour Porpoise relatively common in the Spring and late Fall. The present study further extends knowledge of seasonal occurrence of Harbour Porpoise to early Spring (March-April) and shows the species has comparable if not greater abundance at that time. The species was not present as late as December, however, although it was observed in late November in 2010. Harbour Porpoise were observed during nine of the thirteen surveys conducted in 2010 & 2011. Overall abundance varied seasonally with moderate numbers occurring in early March, April and November, peak numbers in late March and low to moderate numbers in late April, May, June October and late November (Figure 5). No data is available for January, February and July to September, as surveys were not conducted during these times. One Grey Seal was sighted between Black Rock and shore on several occasions on April 15 and a juvenile individual was seen on Black Rock (Figure 4, Table 1).

No other species of marine mammal were observed in the vessel surveys in 2011, similar to the results in 2010. In 2009, three other species (Harbour Seal, White-Sided Dolphin, and an unidentified whale) were seen. Shore-based surveys (which were not conducted in 2009), in contrast, showed Harbour Porpoise to be relatively common in Minas Passage at the Tidal Energy Demonstration Site. The species is a small porpoise found in Atlantic coastal areas in the Summer to Fall. It is commonly taken as by-catch in gill nets (Caswell et al. 1998), which is one of many threats to the survival of local populations, including the Bay of Fundy/Gulf of Maine population. The Northwest Atlantic population of the species is listed as a Species of Concern by COSEWIC and the status is *threatened* under the Federal *Species at Risk Act*. Grey Seal is a large coastal seal species, which is common in Atlantic Canada.

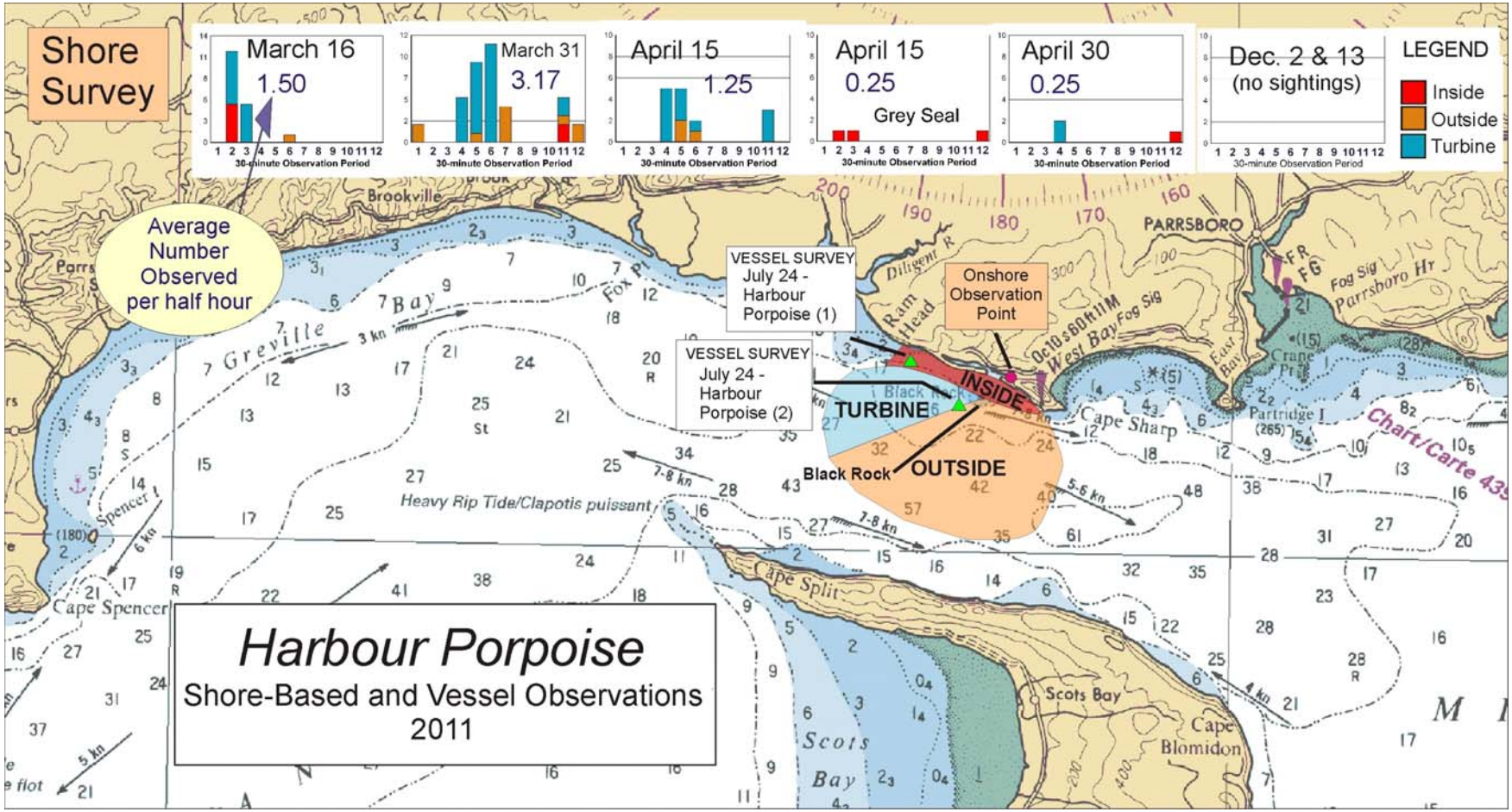


Figure 4. Sightings of marine mammals from shore observations, March-April and December 2011, and from vessel surveys, July and August 2011. Approximate area viewed from shore is shown and terms describe sub-areas used in the text.

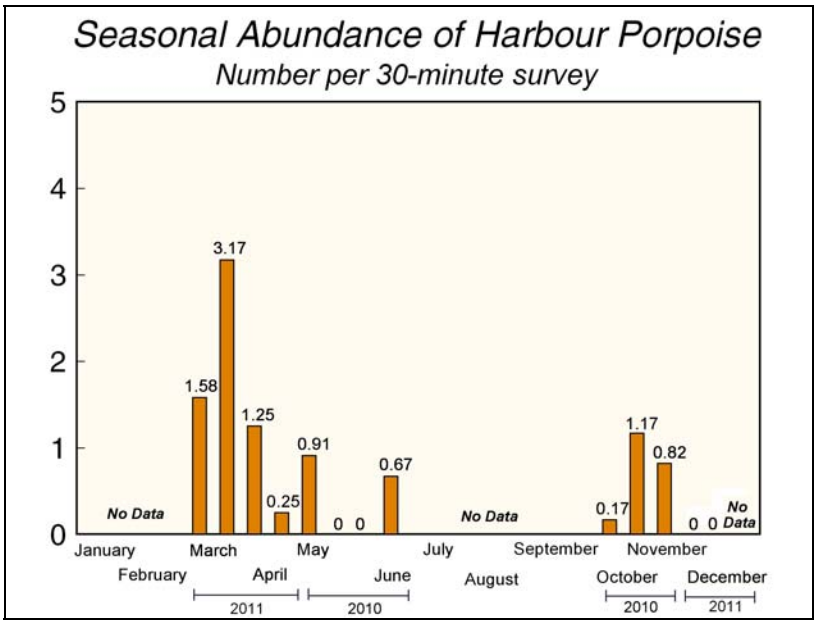


Figure 5. Seasonal occurrence of Harbour Porpoise (*Phocoena phocoena)* observed during shore-based surveys in Minas Passage at the shore installation of the Fundy Tidal Energy Demonstration Facility, 2010 & 2011.

3.2 Seabirds, Waterfowl and Shorebirds

3.2.1 Vessel-Based Surveys

3.2.1.1 Survey Effort

Sampling effort was comparable to that in earlier surveys (2009 & 2010); although effort in August was approximately double that for July and also for both months in 2010. Surveys in 2011 had a similar number of observation periods, although they were longer (10 minutes) in August (Table 2) and consequently the distance surveyed was greater (Figure 6 & Table 2). Sampling effort in Minas Passage was lower than the other areas, as well as compared with past years, reflecting the lower number of observation lines run across the tidal demonstration site in 2011 (due both to vessel operator inexperience (July), and their omission due to the shortened survey in August)[10].

Both surveys had good observation conditions, although the August survey had a lower visibility initially in Minas Basin from Delhaven to Parrsboro due to fog. Lower visibility, while not greatly impacting quantitative observations within 300 m of the vessel, would affect reduce the total number of sightings.

[10] In the July-August surveys in 2009, sampling took place nearly continuously, at about twice the rate as in June & September 2009 and July-August 2010. Sampling effort in July 2011 was comparable to that in 2010 while the August 2011 survey effort was a bout twice both the July 2010 and July 2011 rate, and was similar to the sampling intensity in 2009.

Table 2. Observation Effort, Seabird and Marine Mammal Survey of Minas Basin, Minas Passage and Minas Channel, July and August 2011.

		Distance Sampled (km)	
	Overall	July	August
Minas Basin	43.81	13.73	30.08
Minas Passage	39.80	17.47	22.33
Minas Channel	53.53	13.74	39.79
Total	137.14	44.94	92.20
	Overall	Area Sampled[1] (km^2)	
Minas Basin	13.14	4.12	9.02
Minas Passage	11.94	5.24	6.70
Minas Channel	16.06	4.12	11.94
Total	41.14	13.48	27.66
	Overall	Number of Observations Periods[2]	
Minas Basin	27	11	16
Minas Passage	36	24	12
Minas Channel	28	12	16
Total	91	47	44

1. Observations 'in transect' (i.e. within 300 m band parallel to one side of vessel).
2. 5-minute periods (July) & 10-minute periods (August).

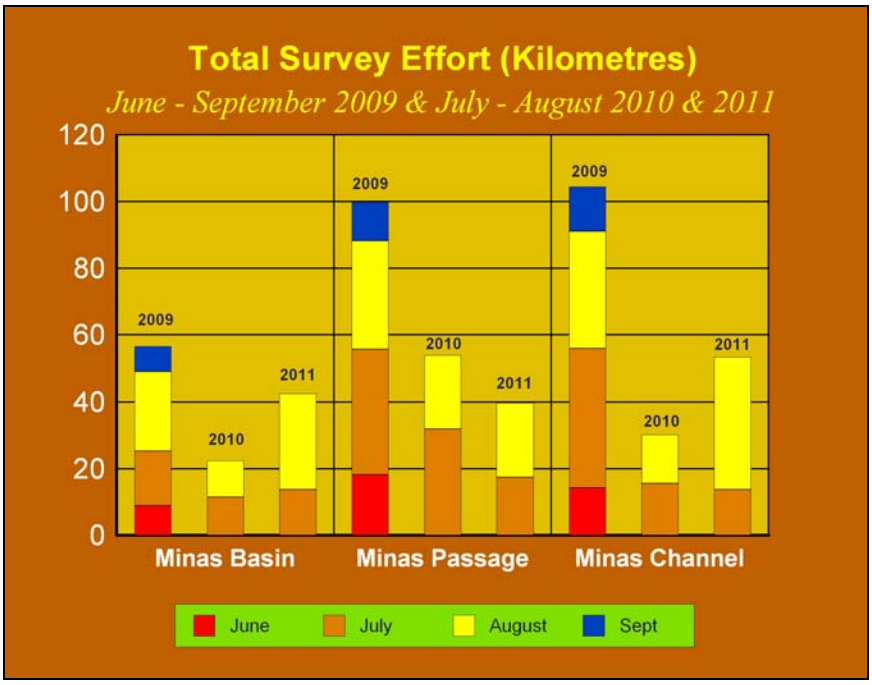


Figure 6. Distance surveyed (kilometres), June to September 2009 and July & August 2010 & 2011.

3.2.1.2 Species Composition

Overall, 144 individuals of 8 species of seabirds and waterfowl were sighted during the vessel surveys (Figures 7-10 and Tables 3-5). Most birds were seen in Minas Basin, about twice the number seen in Minas Passage and three times that in Minas Channel, showing the influence of localized concentrations of Ring-Billed Gull and Black Guillemot which occurred mainly in Minas Basin. Number of species of seabirds and waterfowl were similar between areas on individual surveys and in total, ranging from 3-4 in each area in July (total of 5) and 4-5 in each area in August (total of 6) (Tables 3-5). Herring Gull (*Larus argentatus)* and Ring-Billed Gull (*Larus delawarensis*) were the most abundant and common birds (28.5 and 34.0% of individuals sighted respectively, occurring in 33.0 and 15.4% of observation periods, respectively, Table 3). Herring Gull was a dominant in both July and August and Ring-Billed Gull occurred only in August (the latter a similar pattern to 2010) (Tables 3-5, Figures 9 & 10). Black Guillemot (*Ceppheus grylle*), a coastal Alcid species, was next in abundance in both months (21.7% and 21.4% of individuals in July & August, respectively), but was not common. Great Black-Backed Gull occurred in moderate abundance in the July survey (21.7% of individuals and 17.0% of observation periods) but few were seen in August. Common Loon (*Gavia immer),* Double-Crested Cormorant, and Northern Gannet occurred occasionally. A single Bonaparte's Gull (*Larus philadelphia*) was observed in Minas Basin during the July survey.

Densities and diversity of seabirds and waterfowl seen during surveys in 2011 were lower than in earlier surveys. Compared to 2010, bird species diversity was lower, with two fewer species observed in 2011 and four fewer species than in 2009. A core group of species which occurred in all years were: Herring Gull, Great Black-Backed Gull, Ring-Billed Gull, Double-Crested Cormorant, Common Loon, Black Guillemot and Northern Gannet. Common Eider had occurred in both 2009 & 2010 and is a relatively common resident of the area, but was not seen during the 2011 survey. Bonaparte's Gull occurred only in 2011 as a single individual, while other species occurring in a single year were Great Cormorant and Wilson's Storm Petrel (2010) and Pacific Loon, Greater Shearwater, Red Phalarope and White-Winged Scoter (2009). The number of sightings in the 2011 surveys was comparable to 2010 (144 versus 161) but lower than July-August 2009 (201 sightings). Abundance estimates adjusted for effort (number/km and number per 100 km^2) were also lower in July and August 2011 than in 2010. Overall bird abundance (number/km) in 2011 was lower than in 2010 (1.05 vs 1.51 per km) but comparable to July-August 2009 (0.99 per km). Abundance per unit area was similarly lower than in both 2010 (184.72 vs 231.31 birds per 100 km^2) and July-August 2009 (231.8) (Figure 8, Tables 3-5). Compared with earlier surveys, the abundance of birds in Minas Channel was particularly low in 2011 (due to low numbers seen in August).

Abundance of seabirds in Minas Basin was higher than in previous years, reflecting higher abundances of Ring-Billed Gull observed there in August 2011 (Figures 7 & 8).

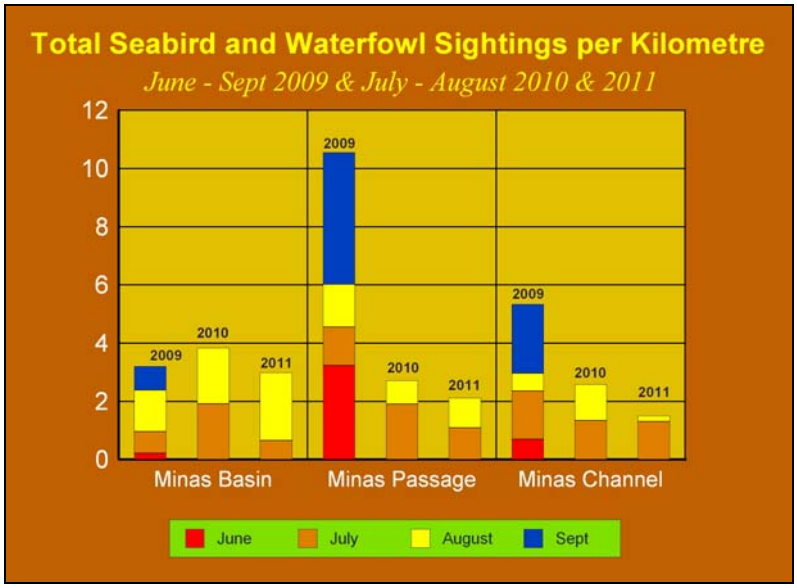


Figure 7. Summary of numbers of sightings of seabirds and waterfowl by area and month, from vessel surveys, June to September 2009 and July & August 2010 & 2011.

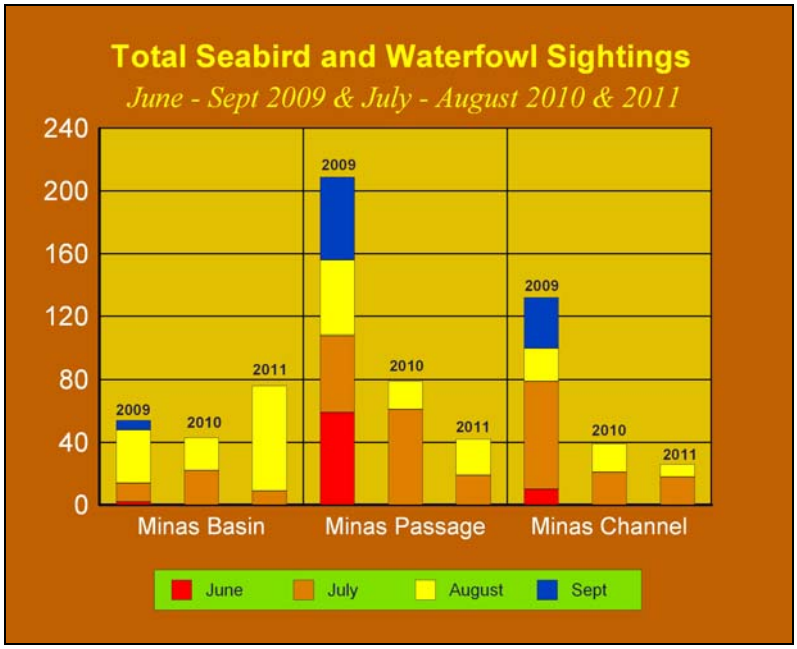


Figure 8. Summary of numbers of sightings of seabirds and waterfowl by area and month, from vessel surveys, adjusted for effort (kilometres surveyed) June to September 2009 and July & August 2010 & 2011.

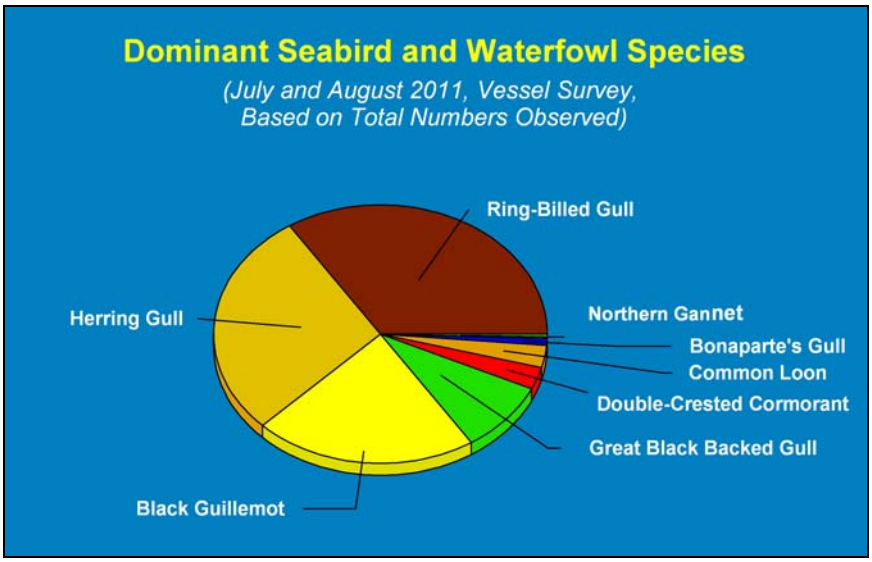
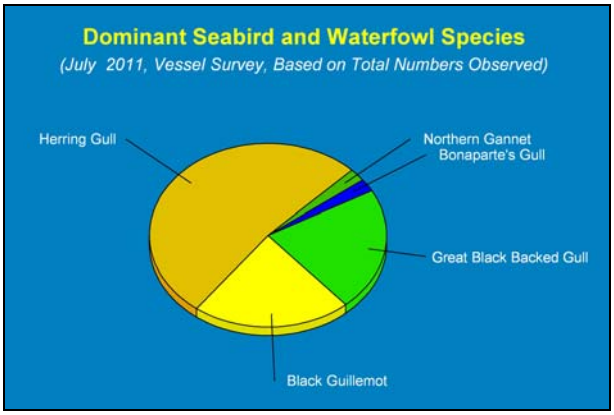


Figure 9. Species composition and relative abundance of seabird and waterfowl species observed in Minas Basin, Minas Passage and Minas Channel on vessel surveys, July & August 2011.



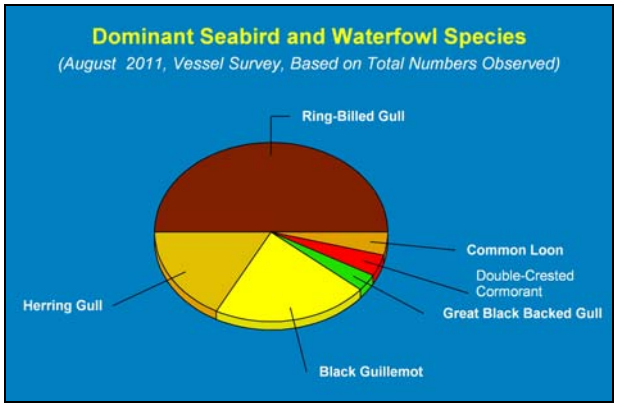


Figure 10. Species composition and relative abundance of seabird and waterfowl species by month, obtained in vessel surveys of Minas Basin, Minas Passage and Minas Channel, July & August 2011.

3.2.1.3 Distribution and Abundance

Overall Abundance

Overall abundance of seabirds and waterfowl observed in vessel surveys, expressed either per kilometre or per square kilometre, was variable between areas and months, reflecting an overall low number of birds and occurrence of flocks in certain areas and seasons (Figures 11-12)[11]. Highest average abundance reached 3.9 birds per km^2 in Minas Basin in August and lowest in Minas Channel in August (0.4 birds/km^2, respectively)(Figures 11-12 & 15; Tables 3-5). In July, abundances in the three sub-areas (Minas Basin, Minas Passage and Minas Channel) differed, with Minas Basin lowest and Minas Channel highest, while in August the pattern was reversed. Highest abundance occurred in Minas Basin in August, the result of contributions by Ring-Billed Gull, which weren't present in July. Lowest abundance was in Minas Channel in August where only 5 birds were seen. Abundance in Minas Passage was comparable between months in terms of total sightings but lower in August in terms of the density (Figures 11 &12).

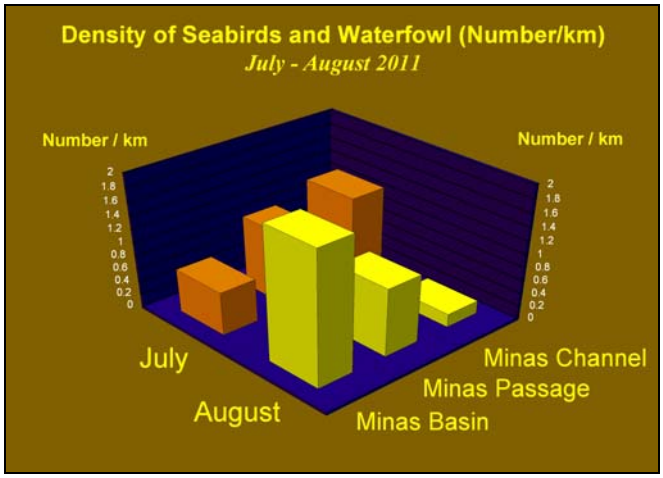


Figure 11. Abundance of seabirds and waterfowl (number/kilometre), July & August 2011.

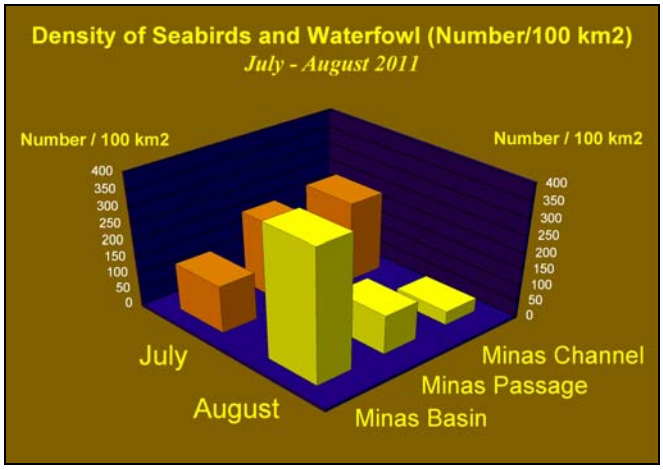


Figure 12. Abundance of seabirds and waterfowl (number/100 km^2), July & August 2011.

[11] The measure of "number per km" includes all birds seen, typically extending to 500 m or more from the vessel, while the measure "number per km^2" refers only to birds observed within 300 m of the side of the vessel on which observations were made.

Abundance was typically comparable to or lower in 2011 than in previous years for both Minas Passage and Minas Channel, but abundances in Minas Basin in August were comparable to those observed previously. Abundance per kilometer and per unit area in Minas Channel in August were the lowest observed in any areas or previous surveys (Figures 13 & 14).

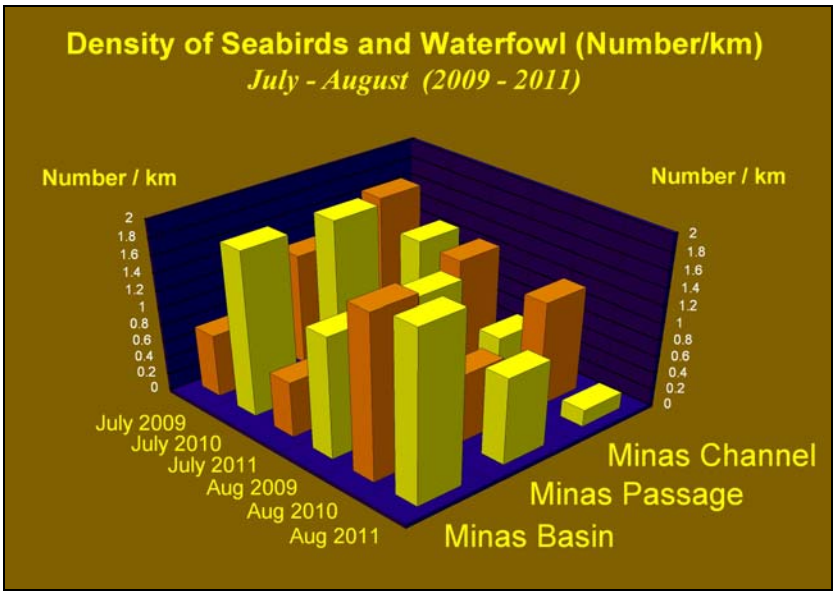


Figure 13. Abundance of seabirds and waterfowl (number/km) in vessel surveys, July & August 2009 to 2011.

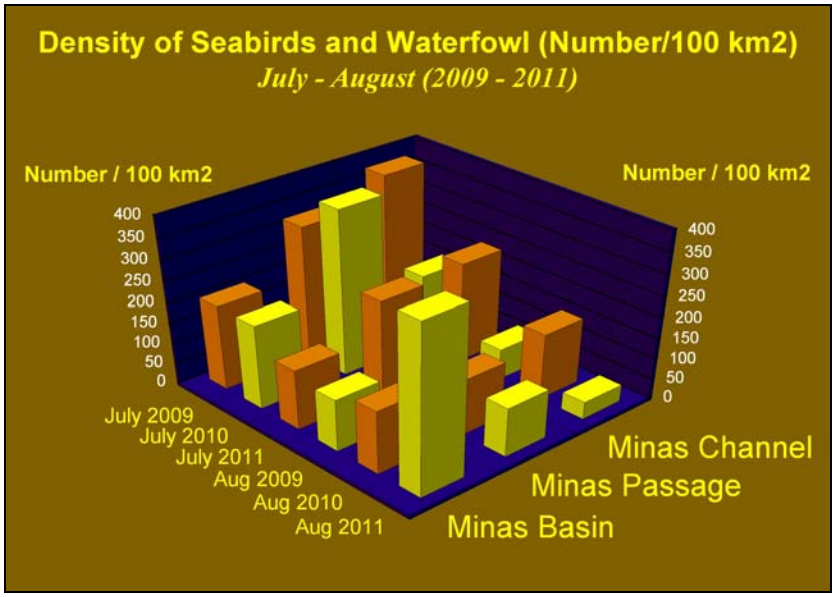


Figure 14. Abundance of seabirds and waterfowl (number/100 km^2) in vessel surveys, July & August 2009 to 2011.

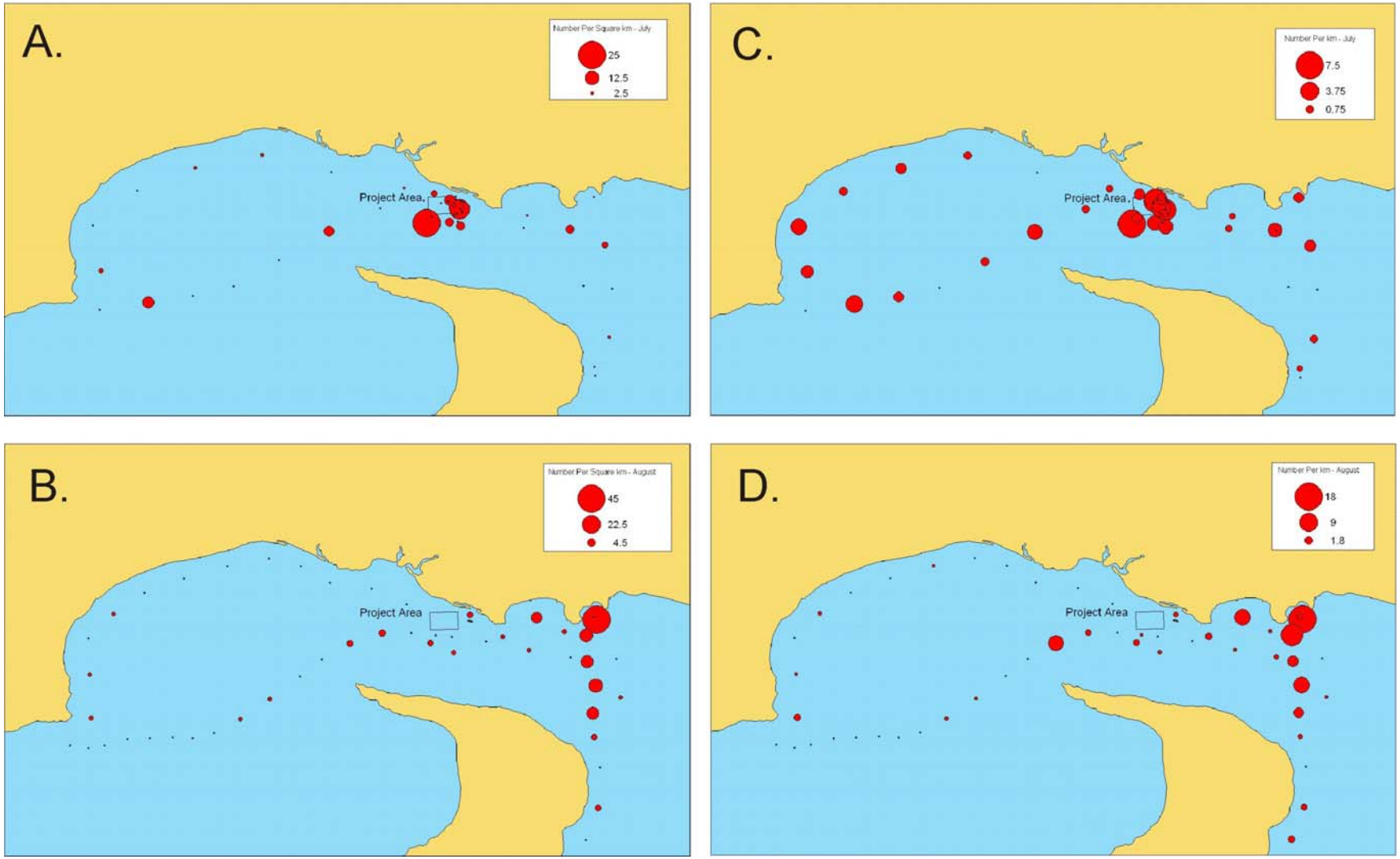


Figure 15. Overall abundance of seabirds and waterfowl in Minas Basin, Minas Passage and Minas Channel, July and August, 2011. A & B, individuals per square kilometre; C & D, individuals per kilometre. Less intensive sampling in the Project Area in August partly explains the appearance of lower abundances there in August compared with July.

Table 3. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, July & August 2011. Number of observation periods: Minas Basin = 27; Minas Passage = 36; Minas Channel = 28. Number of immatures/juveniles shown in brackets.

Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Bonaparte's Gull	Black Guillemot	Northern Gannet	Ring-Billed Gull
	Total Number Observed								
Minas Basin	76	2 (1)	1	11 (2)	3 (2)	1	20 (3)	0	38 (2)
Minas Passage	42	10 (2)	2	14 (4)	0	0	5	0	11 (6)
Minas Channel	26	1	1 (1)	16 (7)	1 (1)	0	6	1	0
Total	144	13	4	41	4	1	31	1	49
	Number / Kilometre								
Minas Basin	1.73	0.05	0.02	0.25	0.07	0.02	0.46	0.00	0.87
Minas Passage	1.06	0.25	0.05	0.35	0.00	0.00	0.13	0.00	0.28
Minas Channel	0.49	0.02	0.02	0.30	0.02	0.00	0.11	0.02	0.00
Overall	1.05	0.09	0.03	0.30	0.03	0.01	0.23	0.01	0.36
	Number Observed within 300 m survey area [1]								
Minas Basin	41	2	0	6	1	0	11	0	21
Minas Passage	20	7	0	9	0	0	2	0	2
Minas Channel	15	1	0	12	1	0	1	0	0
Total	76	10	0	27	2	0	14	0	23
	Number of Seabirds per 100 km^2								
Minas Basin	312.04	15.22	0.00	45.66	7.61	0.00	83.72	0.00	159.83
Minas Passage	167.51	58.63	0.00	75.38	0.00	0.00	16.75	0.00	16.75
Minas Channel	93.40	6.23	0.00	74.72	6.23	0.00	6.23	0.00	0.00
Overall	184.72	24.31	0.00	65.63	4.86	0.00	34.03	0.00	55.90
Month	Observations	Frequency of Occurrence (% of observation periods)							
July	47	17.0	0.0	38.3	0.0	2.1	17.0	2.1	0.0
August	44	4.5	6.8	27.3	6.8	0.0	13.6	0.0	31.8
Overall	91	11.0	3.3	33.0	3.3	1.1	15.4	1.1	15.4

1. 300 m band on one side of survey vessel.

Table 4. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, July 24, 2011. Number of 5-minute observation periods: Minas Basin = 11; Minas Passage = 24; Minas Channel = 12. Number of immatures/juveniles shown in brackets.

Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Bonaparte's Gull	Black Guillemot	Northern Gannet	Ring-Billed Gull
	Total Number Observed								
Minas Basin	9	2 (1)	0	6 (1)	0	1	0	0	0
Minas Passage	19	7	0	7	0	0	5	0	0
Minas Channel	18	1	0	11 (4)	0	0	5	1 (1)	0
Total	46	10	0	24	0	1	10	1	0
	Number / Kilometre								
Minas Basin	0.66	0.15	0.00	0.44	0.00	0.07	0.00	0.00	0.00
Minas Passage	1.09	0.40	0.00	0.40	0.00	0.00	0.29	0.00	0.00
Minas Channel	1.31	0.07	0.00	0.80	0.00	0.00	0.36	0.07	0.00
Overall	1.02	0.22	0.00	0.53	0.00	0.02	0.22	0.02	0.00
	Number Observed within survey area[1]								
Minas Basin	6	2	0	4	0	0	0	0	0
Minas Passage	12	6	0	4	0	0	2	0	0
Minas Channel	10	1	0	8	0	0	1	0	0
Total	28	9	0	16	0	0	3	0	0
	Number of Seabirds per 100 km^2								
Minas Basin	145.66	48.55	0.00	97.10	0.00	0.00	0.00	0.00	0.00
Minas Passage	228.95	114.48	0.00	76.32	0.00	0.00	38.16	0.00	0.00
Minas Channel	242.58	24.26	0.00	194.07	0.00	0.00	24.26	0.00	0.00
Overall	207.67	66.75	0.00	118.67	0.00	0.00	22.25	0.00	0.00

1. 300 m band on one side of Survey Vessel.

Table 5. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, August 27, 2011. Number of 10-minute observation periods: Minas Basin = 16; Minas Passage = 12; Minas Channel = 16. Number of immatures/juveniles shown in brackets.

Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Bonaparte's Gull	Black Guillemot	Northern Gannet	Ring-Billed Gull
	Total Number Observed								
Minas Basin	67	0	1	5 (1)	3 (2)	0	20 (3)	0	38 (2)
Minas Passage	23	3 (2)	2	7 (4)	0	0	0	0	11 (6)
Minas Channel	8	0	1 (1)	5 (3)	1 (1)	0	1	0	0
Total	98	3	4	17	4	0	21	0	49
	Number / Kilometre								
Minas Basin	2.23	0.00	0.03	0.17	0.10	0.00	0.66	0.00	1.26
Minas Passage	1.03	0.13	0.09	0.31	0.00	0.00	0.00	0.00	0.49
Minas Channel	0.20	0.00	0.03	0.13	0.03	0.00	0.03	0.00	0.00
Overall	1.08	0.03	0.04	0.18	0.04	0.00	0.23	0.00	0.53
	Number Observed within Survey Area[1]								
Minas Basin	35	0	0	2	1	0	11	0	21
Minas Passage	8	1	0	5	0	0	0	0	2
Minas Channel	5	0	0	4	1	0	0	0	0
Total	48	1	0	11	2	0	11	0	23
	Number of Seabirds per 100 km^2								
Minas Basin	387.84	0.00	0.00	22.16	11.08	0.00	121.89	0.00	243.04
Minas Passage	119.43	14.93	0.00	74.64	0.00	0.00	0.00	0.00	29.86
Minas Channel	41.88	0.00	0.00	33.51	8.38	0.00	0.00	0.00	0.00
Overall	173.53	3.62	0.00	39.77	7.23	0.00	39.77	0.00	83.15

1. 300 m band on one side of survey vessel.

Abundance of Gulls

Herring Gull

Herring Gull has typically been the dominant seabird in terms of numbers in the vessel survey, but in 2011 was the second most abundant seabird overall and the most commonly observed in the study area during the vessel surveys in July-August 2011. Ring-Billed Gull was more numerous in 2011 but was localized to Minas Basin and Minas Passage and was only observed in August. The species is a common, annual breeder, nesting on islands and seacliffs along the Bay of Fundy. It is primarily a scavenger/ omnivore, which feeds at the water surface. Herring Gull abundance is often linked to human activities and associated food sources in coastal areas. Herring Gull occurred in both surveys, and was highest in abundance in Minas Channel in July (1.9 birds per km^2). For both Minas Basin and Minas Channel, abundance of Herring Gull was particularly low in August, although densities in Minas Passage were comparable between months (Figures 16 & 17). Lowest abundance was 0.2 birds per km^2 in Minas Basin in August. Most individuals were adults with immatures and juveniles making up about a fifth of numbers (July, 20.8%, and August, 47.1%)(Tables 3-5). The species was observed in all areas in both months (Figure 18).

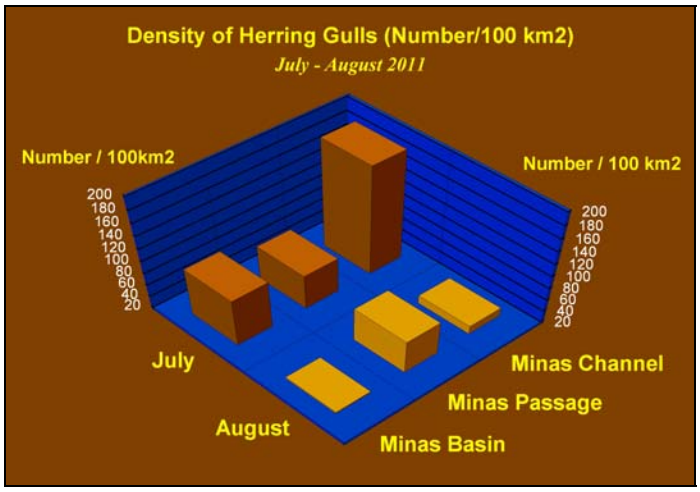


Figure 16. Density of Herring Gulls (number/100 km^2), July & August 2011.

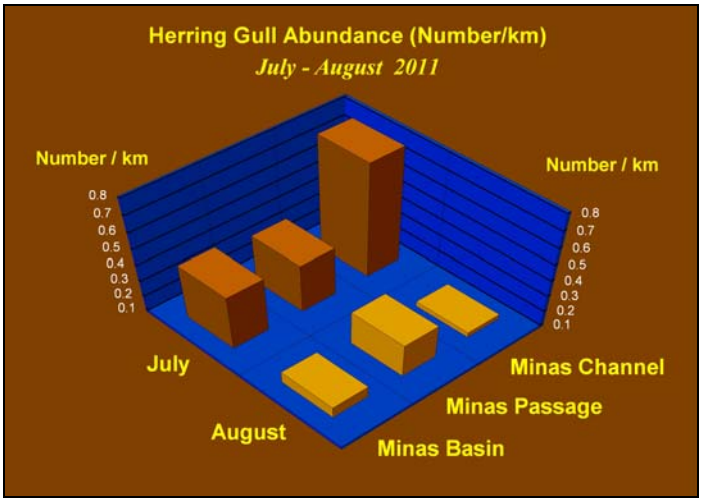


Figure 17. Abundance of Herring Gulls (number/kilometre), July & August 2011.

Great Black-Backed Gull

Great Black-Backed Gull occurred occasionally in low abundance in all areas in July and only in Minas Passage and Minas Channel in August surveys (Figure 18). Abundance was similar between months. Highest abundance was 1.0 birds per km^2 in Minas Passage in July and lowest 0.2 birds per kilometre in Minas Channel in July (the species was not observed in Minas Basin or Minas Channel in August (Tables 3-5). Overall abundances were similar between years. Ninety per cent of Great Black-Backed Gull sighted in July were adults but immatures/juveniles accounted for 66% in August (Tables 3-5). The species is a common annual breeder in Atlantic Canada, which nests on islands and seacliffs along the Bay of Fundy, feeding mainly by scavenging along shores and at the water surface.

Ring-Billed Gull

Ring-Billed Gull occurred occasionally in low to moderate abundance and localized to Minas Basin and Minas Passage in July (the species was not seen in August (Tables 3-5)(Figure 19). Highest abundance was 2.4 birds per km^2 in August (Minas Basin), with a lower abundance in Minas Passage (0.3 birds per km^2) (Table 3). Both adults and immatures/juveniles were observed, with immatures and juveniles making up 16% in August)(Tables 3-5). Ring-Billed Gull is a common annual migrant and occasional summer resident, feeding typically at the water surface.

Abundance of Miscellaneous Seabird and Waterfowl Species

Common Eider

Adult Common Eider, singly or in flocks, has typically been encountered in vessel surveys but none were seen in 2011. Common Eider is a common breeder on islands and shorelines of the Bay of Fundy. The species typically feeds on molluscs such as mussels, which it finds in intertidal and upper subtidal areas. Eider can dive to medium depths and occasionally deeper to reach shellfish beds. Densities in 2010 ranged from 0.5 birds per kilometre (Minas Basin, July) to 1 per kilometre (Minas Passage, August) compared with densities of 0.1 to 0.3 individuals per kilometre in 2009 (Envirosphere Consultants 2010). All of the individuals observed were adults.

Double-Crested Cormorant

Double-Crested Cormorant is a resident of the area, nesting in colonies in Minas Basin and on Cape Split, and relatively common in inshore waters, but only four individuals were seen on the August survey, in Minas Basin near Cape Sharp east of the project site (Figure 19). Similar numbers of the species were observed in 2009 & 2010 (Envirosphere Consultants Limited 2011). Double-Crested Cormorant is a common annual breeder, which nests on islands and seacliffs along the Bay of Fundy, feeding by diving for fish to shallow to medium depths and occasionally deeper.

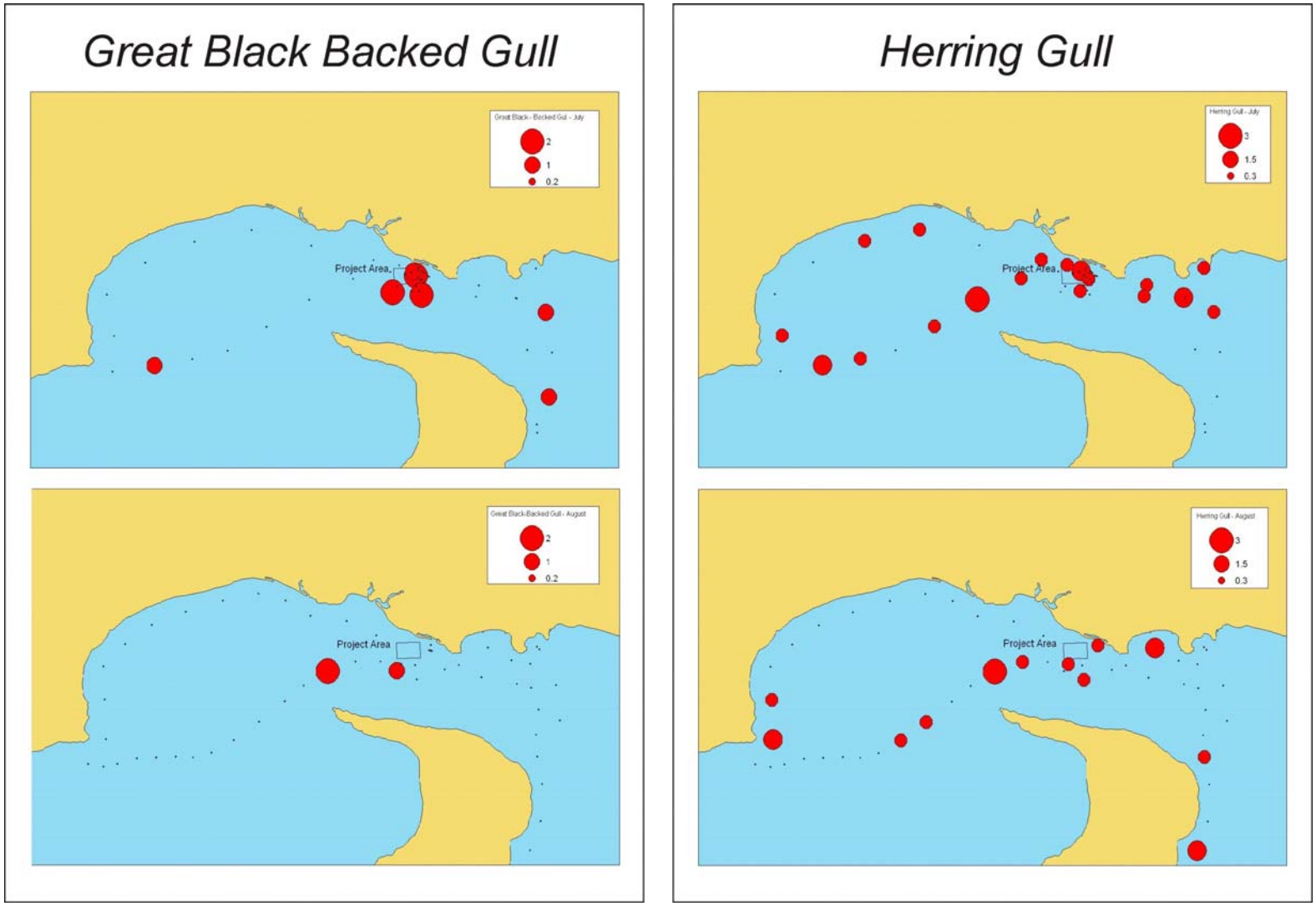


Figure 18. Distribution and abundance (individuals per observation period [5-minutes in July & 10-minutes August]) of Great Black-Backed Gull and Herring Gull in Minas Basin, Minas Passage and Minas Channel, July & August 2011. Less intensive sampling in the Project Area in August partly explains the appearance of lower abundances there in August compared with July.

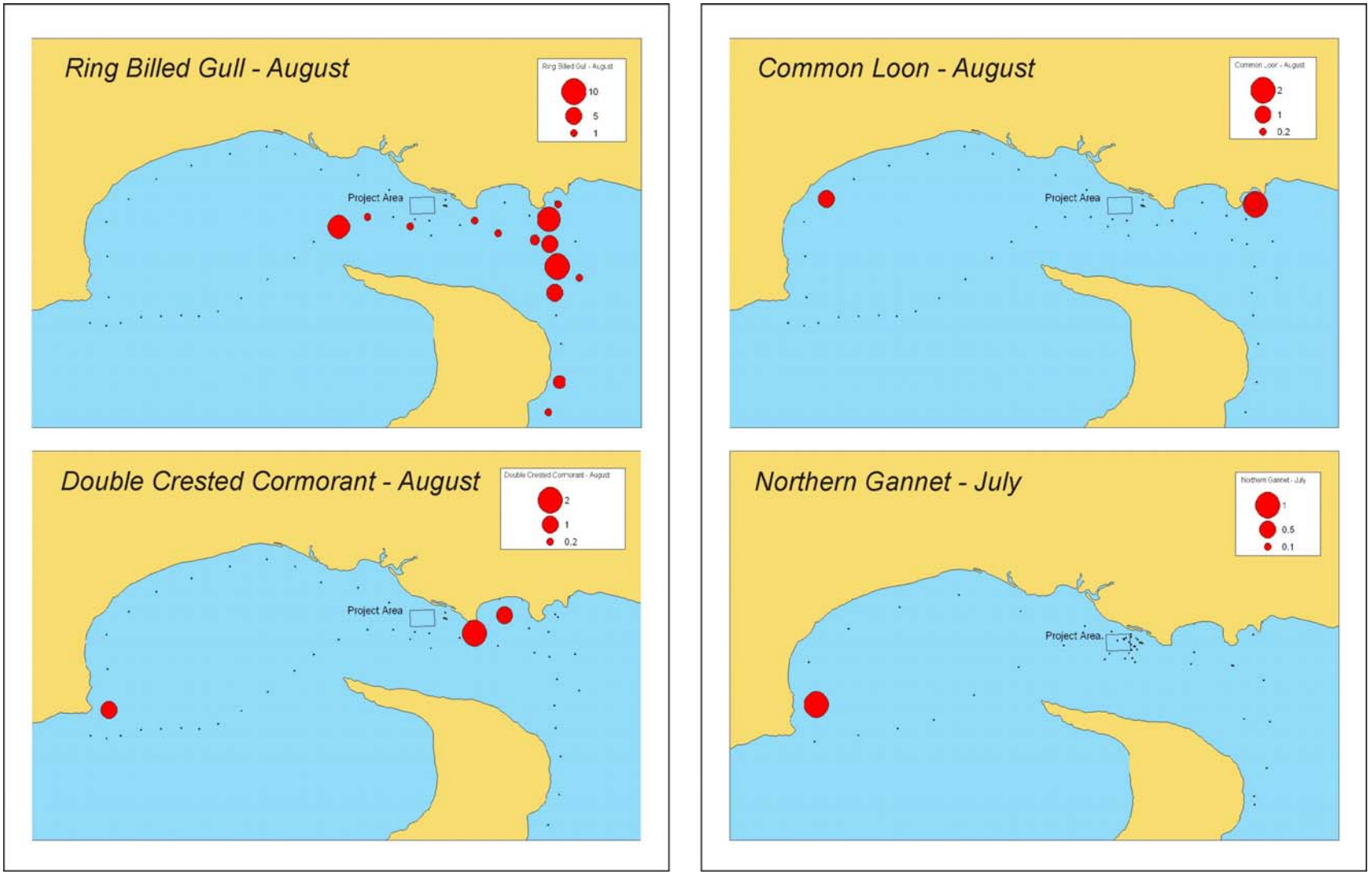


Figure 19. Distribution and abundance (individuals per 5-minute observation period (10-minute period, August) of Ring-Billed Gull, Common Loon, Double Crested Cormorant and Northern Gannet in Minas Basin, Minas Passage and Minas Channel, July & August 2011. Each species occurred on one survey only.

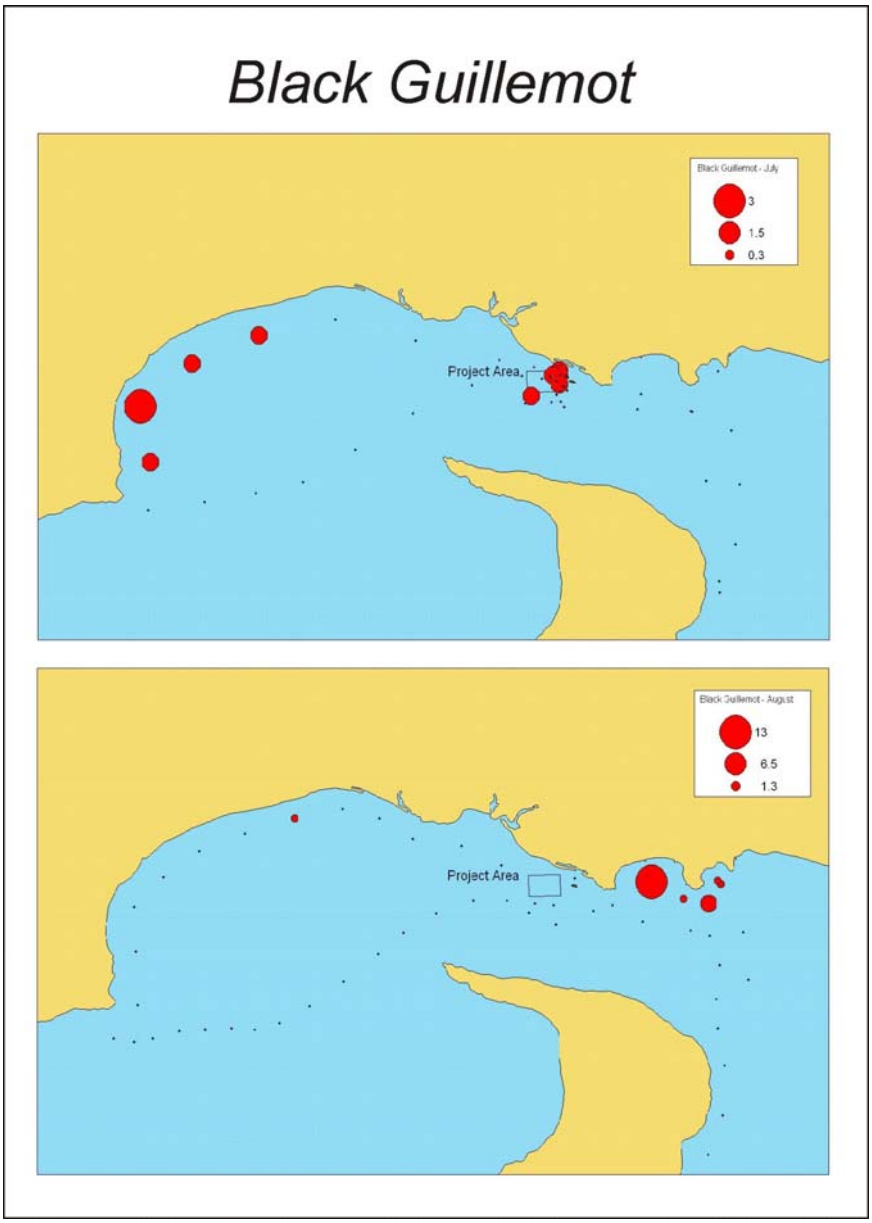


Figure 20. Distribution and abundance of Black Guillemot (individuals per 5-minute observation period, July & 10-minute period (August) 2011.

Northern Gannet

This species normally migrates through the area to colonies on the Gulf of St. Lawrence, but the Inner Bay of Fundy may support immatures and late migrants. One adult Northern Gannet was seen near Cape Spencer in Minas Channel in July (Figure 19). Northern Gannet is a common annual migrant and summer resident. Feeding is by diving from great heights to medium and shallow depths to fish.

Common Loon

The species is typically a common coastal resident in the study area, but was uncommon in the 2011 surveys, with only four individuals (3 immature) observed in the August survey (Tables 3-5, Figure 19). The species is an annual breeder on inland lakes and is a summer resident on the Bay of Fundy. Common Loon forages by diving and swimming underwater to catch fish, diving mostly to medium depth, but occasional very deep dives are possible.

Black Guillemot

Black Guillemot were relatively abundant, occurring in Minas Passage and Minas Channel in July and Minas Basin in August and accounting for the third and second most abundant sightings in July and August respectively (Figure 20). The species was neither common nor abundant in 2010, but was more common and abundant in 2009, occurring in all the study sub-areas, and occurring in all time periods (Envirosphere Consultants 2010). Black Guillemot is a common annual breeder on seacliffs and in coastal rocks along the Bay of Fundy, and feeds on fish, diving to shallow to mid-depth.

Bonaparte's Gull

A single adult Bonaparte's Gull was seen in Minas Basin on the July survey. The species occurs occasionally during Spring and Fall in the Bay of Fundy, with greatest numbers seen on the New Brunswick side, mainly in Passamaquoddy Bay, as well along Northumberland Strait where high numbers can be seen during migration (Figure 21).

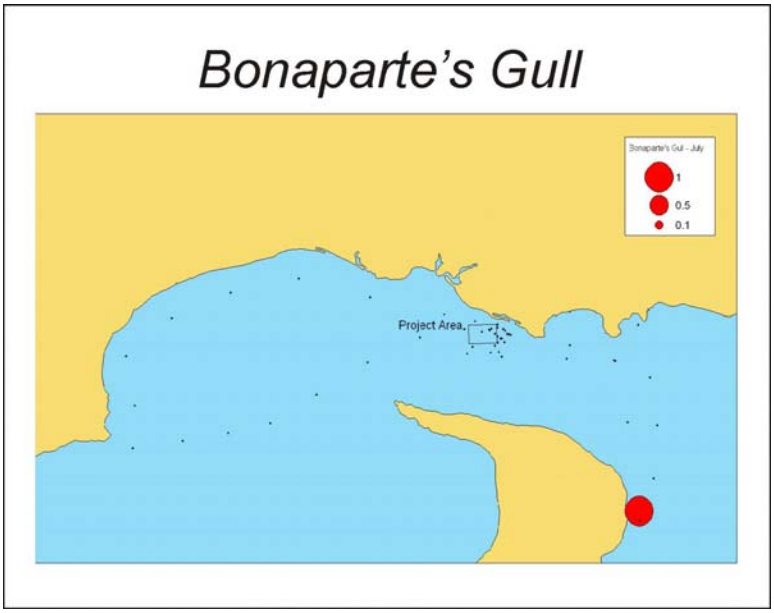


Figure 21. Distribution and abundance (individuals per 5-minute observation period) of Bonaparte's Gull, July 2011. Area shown is Crown Lease, which contains berths for tidal device installation.

Bird Activity Patterns

Observations of the frequency of seabirds and waterfowl occurring on the water represent feeding and resting activities and give an indication of the use by these species of the study area (Table 6). Potentially the percentage of sightings gives an indication of the tendency of the species to occur where it has the potential to be impacted by activities such as project-related work, by accidents such as hydrocarbon

Table 6. Activity of water-associated birds, expressed as the proportion of birds 'on water 'during vessel-based surveys in the vicinity of the Fundy Tidal Energy Demonstration Site, June-September, 2009, July-August 2010 & July-August 2011. Total number of birds observed is shown in brackets and includes birds on the wing or on Black Rock.
.

	2009												
Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Northern Gannet	Ring-Billed Gull	Greater Shearwater	Red Phalarope	Pacific Loon	White-Winged Scoter
Minas Basin	0.33 (54)	0.60 (5)	0 (3)	0.27 (30)	1 (3)	0 (2)	0.25 (4)	0	0.40 (5)	0 (1)	0	1 (1)	0
Minas Passage	0.67 (209)	0.50 (18)	0.14 (7)	0.39 (59)	0.75 (4)	0.96 (100)	0.50 (4)	0.20 (5)	0.40 (10)	0 (2)	0	0	0
Minas Channel	0.47 (132)	0.33 (9)	0 (2)	0.42 (57)	0.86 (7)	1 (25)	0 (8)	0.25 (4)	0 (1)	0.22 (9)	0 (9)	0	0 (1)
Total	0.55 (395)	0.47 (32)	0.08 (12)	0.38 (146)	0.86 (14)	0.95 (127)	0.19 (16)	0.22 (9)	0.38 (16)	0.17 (12)	0 (9)	1 (1)	0 (1)
	2010												
	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Northern Gannet	Ring-Billed Gull	Wilson's Storm Petrel	Great Cormorant		
Minas Basin	0.60 (43)	0 (3)	0	0.20 (20)	0	0 (12)	0 (1)	0 (1)	0.50 (2)	0 (4)	0		
Minas Passage	0.95 (79)	0.86 (7)	0 (2)	0.49 (37)	0	0 (15)	0	0 (3)	1 (5)	0 (9)	0 (1)		
Minas Channel	0.69 (39)	0 (2)	0	0.33 (21)	1 (2)	0	0	0 (11)	0 (3)	0	0		
Overall	0.80 (161)	0.5 (12)	0 (2)	0.37 (78)	1 (2)	0 (27)	0 (1)	0 (15)	0.60 (10)	0 (13)	0 (1)		
	2011												
	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Northern Gannet	Ring-Billed Gull	Bonaparte's Gull			
Minas Basin	0.50 (76)	0 (2)	0 (1)	0.45 (11)	1 (3)	0	0.95 (20)	0	0.29 (38)	0 (1)			
Minas Passage	0.33 (42)	0.50 (10)	1 (2)	0.29 (14)	0	0	0.20 (5)	0	0.18 (11)	0			
Minas Channel	0.15 (26)	1 (1)	0 (1)	0.13 (16)	1 (1)	0	0 (6)	0 (1)	0	0			
Total	0.39 (144)	0.46 (13)	0.50 (4)	0.28 (41)	1 (4)	0	0.63 (31)	0 (1)	0.27 (49)	0 (1)			

spills, as well as a means of assigning the relative potential of different species to be impacted. About half (55%) of birds seen in the 2011 surveys were on the water (Table 6). Common Loon and Black Guillemot were most often seen on the water (100% and 63% respectively) and the dominant gulls—Herring Gull and Ring-Billed—were seen on water 28 and 27% of the time respectively.

Proportion of birds on water in Minas Passage and Minas Channel in 2011 were the lowest seen in the monitoring program (15% to 33% versus 67-95% in Minas Passage in 2009-2010, and 47-69% in Minas Channel in 2009-2010). Dominant gulls (Herring Gull, Great Black-Backed Gull and Ring-Billed Gull) were less commonly seen on water (Great Black-Backed Gull, 46-50%; Herring Gull, 28-38%; and Ring-Billed Gull, 27-60%) than Common and Pacific Loons (75-100% on water respectively). Common Eider nearly all occurred on water when seen in 2009 & 2010 (the species was not seen in 2011). Northern Gannet typically was rarely seen on water (0 – 33%)(Table 6).

The numbers of birds on water varies during the day and night and probably undergoes daily cycles, in particular in relation to time of day and tidal current. All the vessel surveys were carried out in daylight and include the full tidal cycle beginning at a morning high tide.

3.2.2 Shore-Based Surveys

3.2.2.1 Survey Effort

Sampling effort was similar between shore-based surveys (March, April & December) with 12, 30-minute observation periods per day. Observation conditions varied through the March – December period, which will have affected the results. Ideal survey conditions were overcast days with negligible to slight winds which allowed for greater visibility of birds species at greater distances—most of the surveys (March 16, April 15, April 30 and December 13) met these conditions. Surveys conducted on sunny days (March 31 and December 2) would have had lower visibility of species due to surface reflections but were still considered to be acceptable. Winds and wave conditions were acceptable on all surveys.

3.2.2.2 Species Composition

Overall, 1516 seabirds and waterfowl in 29 species were sighted during the shore-based surveys. Seabirds occurring at the site included: Double-Crested Cormorant, Great Cormorant, Herring Gull, Great Black-Backed Gull, Iceland Gull, Lesser-Backed Gull, Ring-Billed Gull, Black Guillemot, Northern Gannet, Razorbill, Horned Grebe, Black-Legged Kittiwake, Thick-Billed Murre and Common Murre (Table 7). Waterfowl included: Common Eider, King Eider, American Black Duck, Common Goldeneye, Long-Tailed Duck, Canada Goose, Common Loon, Pacific Loon, Red-Throated Loon, Surf Scoter, Black Scoter and White-Winged Scoter, Northern Shoveler, Red-Breasted Merganser and Common Merganser. The highest diversity of bird species occurred in late April during migration in which 19 species were observed compared with 12-17 species observed during surveys earlier and later in the year (Figure 22). In total 35 species of water-associated birds were recorded at the site during the surveys (2010 and 2011 combined). Together with birds observed in vessel surveys, 40 species of water-associated birds have been identified from Minas Basin, Minas Passage and Minas Channel area, including a Northern Fulmar observed in Minas Basin in an early baseline survey for the project.

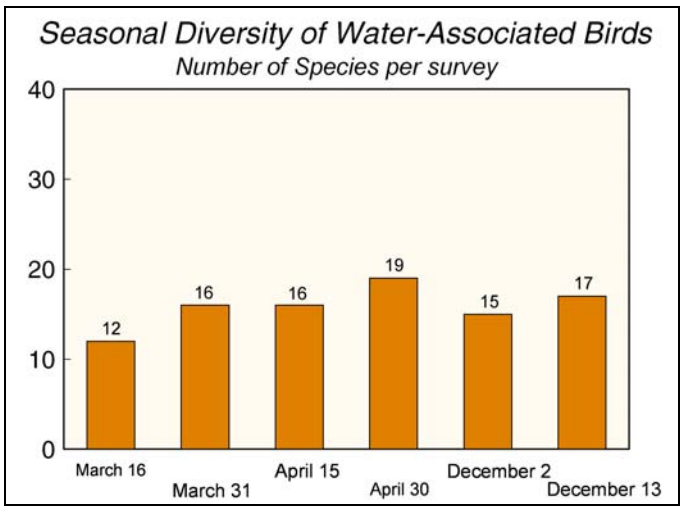


Figure 22. Number of species observed on shore based surveys, March, April & December 2011.

Table 7. Seabirds observed at Black Rock Tidal Energy Demonstration Site, March (16 & 31), April (15 & 30) to December (2 & 13), 2011, in shore-based surveys.

Species Code	Common Name	Scientific Name
Waterfowl		
RTLO	Red-Throated Loon	*Gavia stellata*
COLO	Common Loon	*Gavia immer*
PALO	Pacific Loon	*Gavia pacifica*
ABDU	American Black Duck	*Anas rubripes*
COGO	Common Goldeneye	*Bucephala clangula*
COEI	Common Eider	*Somateria mollissima*
KIEI	King Eider	*Somateria spectabilis*
WWSC	White-Winged Scoter	*Melanitta fusca*
SUSC	Surf Scoter	*Melanitta perspicillata*
BLSC	Black Scoter	*Melanitta nigra*
NSHO	Northern Shoveler	*Anas clypeata*
RBME	Red-Breasted Merganser	*Mergus serrator*
COME	Common Merganser	*Mergus merganser*
LTDU	Long-Tailed Duck	*Clangula hyemalis*
CAGO	Canada Goose	*Branta canadensis*
Seabirds		
DCCO	Double-Crested Cormorant	*Phalacrocorax auritus*
GRCO	Great Cormorant	*Phalacrocorax carbo*
GBBG	Great Black-Backed Gull	*Larus marinus*
LBBG	Lesser Black-Backed Gull	*Larus fuscus*
RBGU	Ring-Billed Gull	*Larus delawarensis*
HEGU	Herring Gull	*Larus argentatus*
ICGU	Iceland Gull	*Larus glaucoides*
RAZO	Razorbill	*Alca torda*
HOGR	Horned Grebe	*Podiceps auritus*
BLKI	Black-Legged Kittiwake	*Rissa tridactyla*
NOGA	Northern Gannet	*Morus bassanus*
BLGU	Black Guillemot	*Cepphus grylle*
COMU	Common Murre	*Uria aalge*
TBMU	Thick-Billed Murre	*Uria lomvia*

3.2.2.3 Distribution and Abundance

Overall Abundance & Diversity

No species consistently dominated shore-based observations at the site, but a number of species occurred regularly throughout most of the survey periods and occasionally were dominants. Included in this group were American Black Duck, Common Eider, Scoters (White-Winged, Surf and Black), Red-Breasted Merganser, Great Black-Backed Gull, Herring Gull, Black Guillemot, and Red-Throated Loon (Figures 23, 24, & 25-29). Several other species were occasionally abundant including: Canada Goose in March; and Surf and Black Scoter, Double-Crested Cormorant, Long-Tailed Duck and Black Guillemot in April. Black Scoters were the overall most abundant species showing moderate to high abundance mid-Spring (April 15 & 30), followed by Long-Tailed Duck, Surf Scoter, Canada Goose and Red-Throated Loon (Figures 23 & 24).

Overall abundance of birds was moderate in early (i.e. March), peaked in mid- to late-April, and was low in December (Figure 25). Individual species showed particular seasonal patterns, with Canada Geese peaking in early March, while other bird species generally peaked in late March to late April and were not abundant in early Winter (December 2 & 13) surveys (Figures 26 to 29).

A relatively high diversity of birds was observed during the survey, highest on April 30 and December 13 (19 & 17 species, respectively), while the lowest diversity occurred during the mid-March survey (12 species). The remaining surveys had moderate numbers (15-16 species) (Figure 22). In comparison, the peak number of species observed at the site in the current baseline survey was 25 per 30-minute period observed on November 13, 2010 (Envirosphere Consultants Limited 2011).

Except for the December surveys, more birds occurred in the sector proposed for turbine installation than in the other areas (Figure 25; Table A-8). These included Canada Goose, Great Black-Backed Gull & Herring Gull, Black and Surf Scoter & Long-Tailed Duck, Red-Throated Loon and Double-Crested Cormorant. Other localized distributions shown by individual species included Common Eider, and Common Merganser, which were among the only birds observed between Black Rock and shore on December 13; and Red-Throated Loon, Herring Gull & Surf Scoter which were most abundant and common beyond Black Rock in Minas Passage on December 2 and 13 (Figure 25). The ‘turbine’ area is downstream from Black Rock and some of the occurrences could be accounted for by drifting of birds, which landed on the water in the vicinity of Black Rock and subsequently drifted downstream from it.

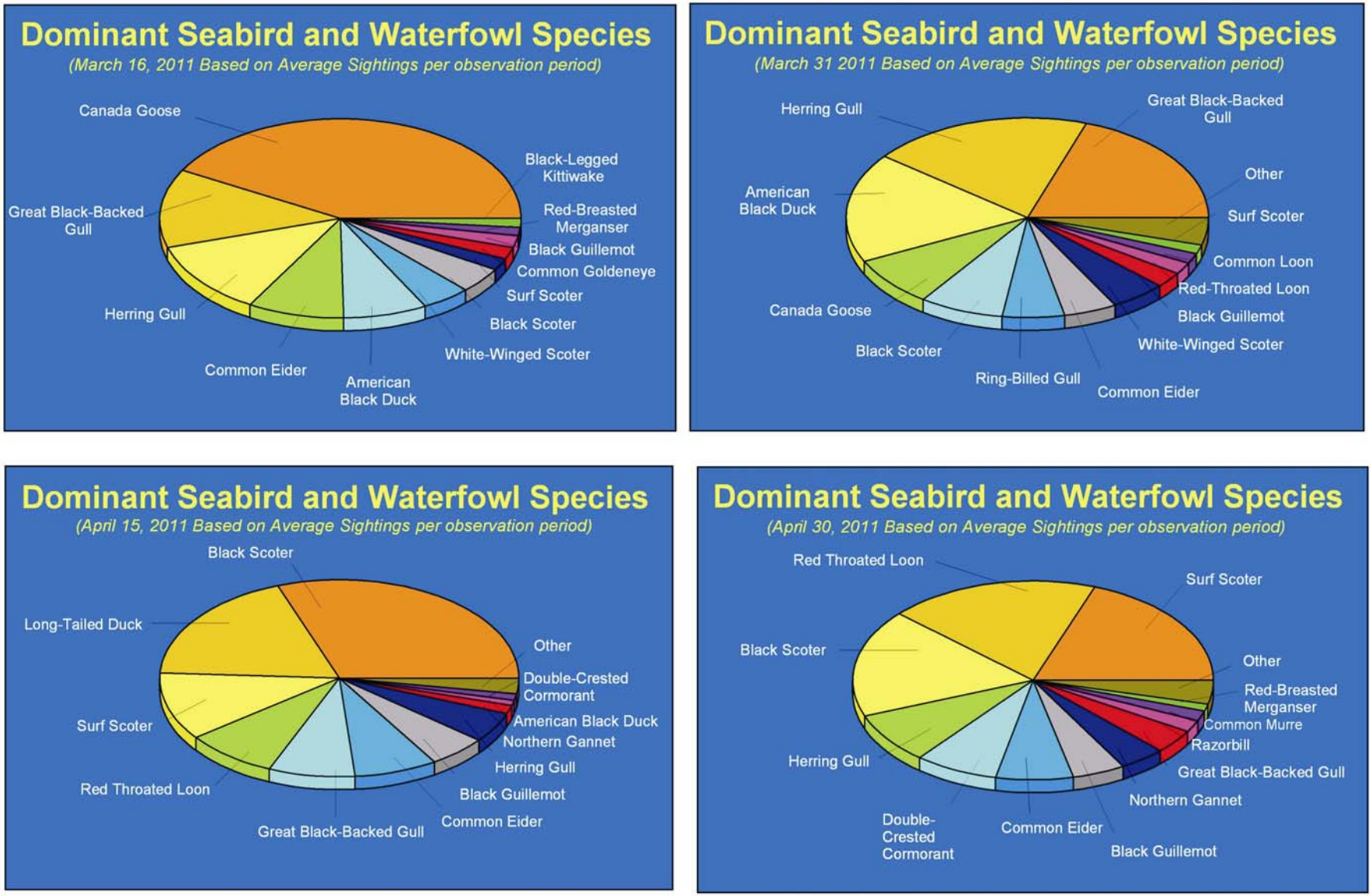


Figure 23. Dominant species of seabirds and other waterfowl at the Fundy Tidal Demonstration Site in early to late-Spring, obtained in shore surveys on March 16, 31 and April 15, 30, 2011.

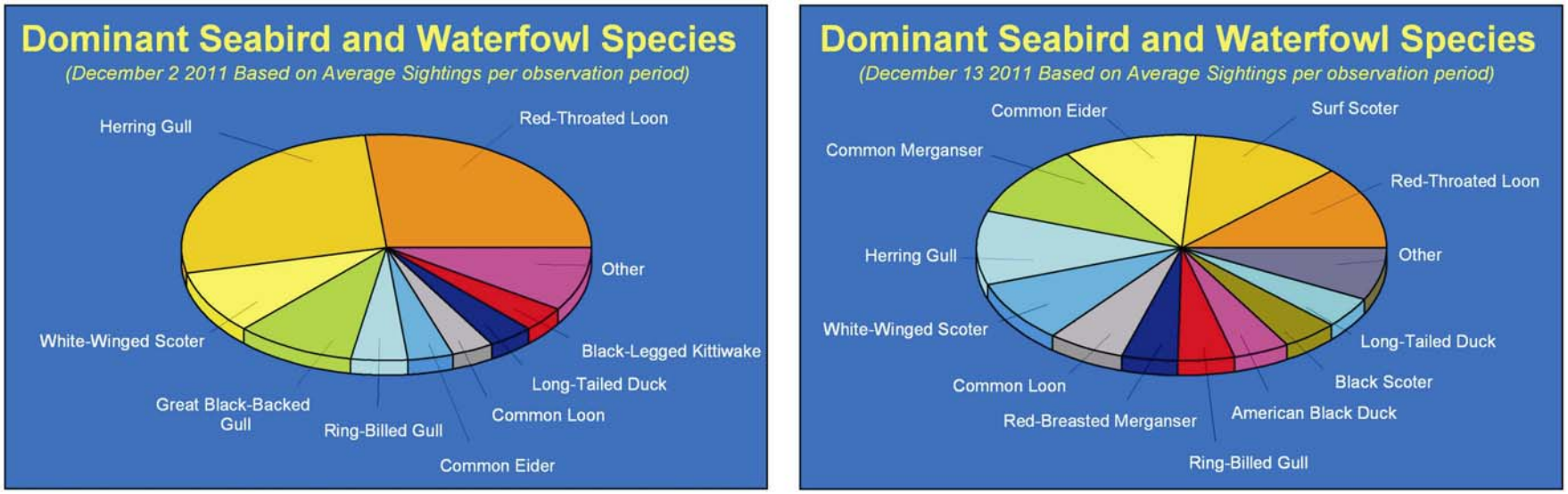


Figure 24. Dominant species of seabirds and other waterfowl at the Fundy Tidal Demonstration Site in early Winter, obtained in shore surveys on December 2 and 13, 2011.

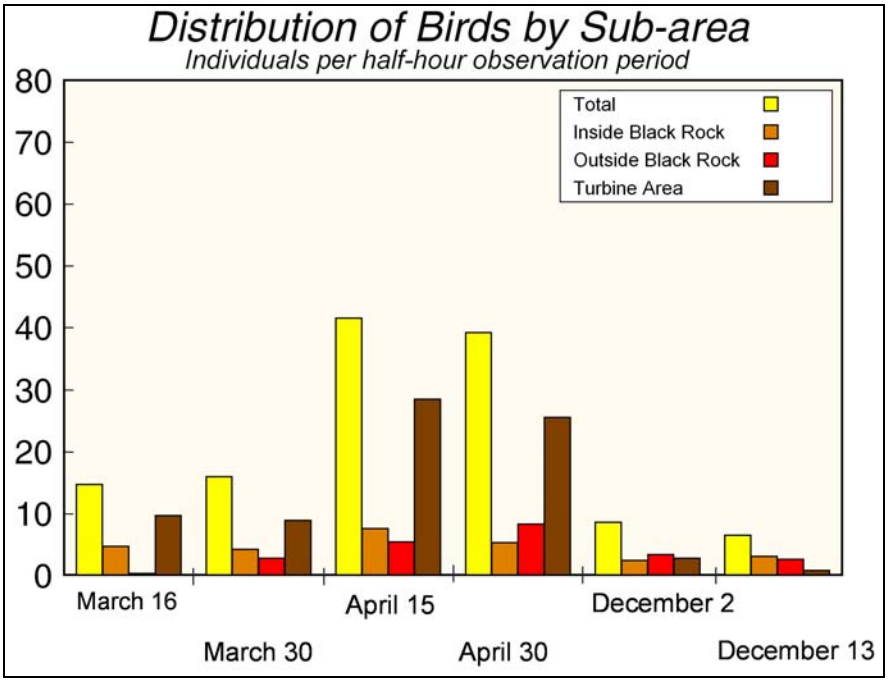


Figure 25. Abundance of seabirds and other water-associated birds (individuals per 30-minute observation period) at the Fundy Tidal Power Demonstration site, March, April & December 2011

Abundance and Seasonal Occurrence of Gulls

Gulls were commonly seen at the site. In total five gull species, (Great Black-Backed, Herring, Iceland, Lesser Black-Backed and Ring-Billed Gull) were observed with Great Black-Backed and Herring Gull most abundant. Ring-Billed Gulls were sighted on several surveys in similar numbers, and Lesser Black-Backed Gull and Iceland Gull were each only observed once (March 31 & December 13 surveys, respectively) (Figure 26).

Herring Gull—Herring Gull was the most abundant gull species and was observed during all surveys (Figure 26). It was the dominant and most abundant seabird species in both December surveys (26.7% & 10.8 % of sightings, on December 2 & 13 respectively) and tied with Great Black-Backed Gull as the most abundant seabird in March 31st (20% of sightings)(Appendix A).

Great Black-Backed Gull—Great Black-Backed Gull was the second most abundant gull and was observed during all surveys (Figure 26). It was the most abundant and common seabird during March (12.9-20% of sightings on March 16 & 31 respectively); 8.0% of sightings on the April 15 survey; and 3.8% and 1.5-9.3% of sightings in the late April and December surveys respectively (Appendix A).

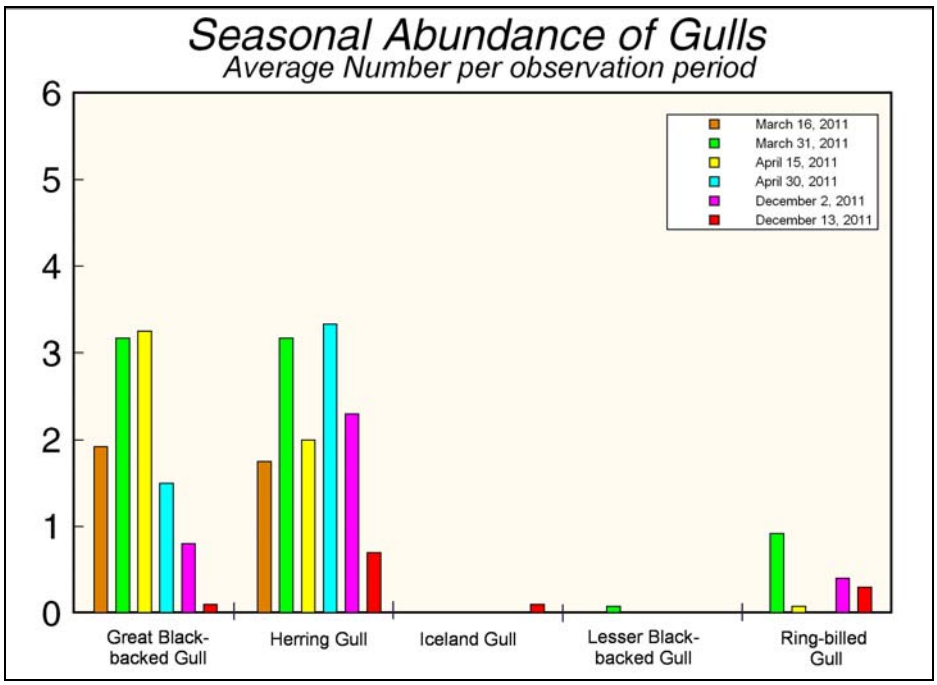


Figure 26. Abundance of gulls (average number per 30-minute observation period) at Fundy Tidal Energy Demonstration site, March, April & December 2011.

Iceland Gull—Iceland Gulls migrate into the Bay of Fundy in late Fall and leave by late, except for a few immature and sub-adults which become summer residents. The winter resident population is less abundant than in past due to climate change (Winters are warmer). The species was observed only once on December 13 survey (1.5% of sightings) (Figure 26, Appendix A).

Lesser Black-Backed Gull—Lesser Black-Backed Gull is an uncommon transient that may breed in Nova Scotia. It has been recorded in all seasons including as a Winter and summer resident in small numbers. It was neither abundant nor dominant (a single individual was observed on March 31) (0.08 individuals per observation period, 0.63% of sightings) (Figure 26, Appendix A).

Ring-Billed Gull—Ring-Billed Gulls occur near the coast and around offshore islands when not breeding; but are found inland on freshwater lakes, ponds, marshes during the breeding season. They feed on insects, crustaceans, mollusks & invertebrates along the shore, and sometimes pirate food from other species. They occurred occasionally in low to moderate abundance and dominance during the March 31, April 15 and December 2 & 13 surveys (Figure 26) (5.6, 0.24, 4.7 and 4.6% of total sightings, respectively) (Appendix A).

Abundance and Seasonal Occurrence of Waterfowl

Waterfowl (ducks & geese, scoters, and mergansers) were also commonly observed at the study site. Of the thirteen waterfowl species seen, American Black Duck, Common Eider, White-Winged Scoter, and Red-Breasted Merganser were the most common and were present during all surveys. Black Scoter, however, which was observed during all surveys except December 2, was the most abundant waterfowl species overall with greatest concentrations observed on April 15 (Figures 23, 24 & 27). Other species including Long-Tailed Duck, Surf Scoter, Canada Goose, Common Merganser, Northern Shoveler, King Eider and Common Goldeneye were observed occasionally and in low numbers.

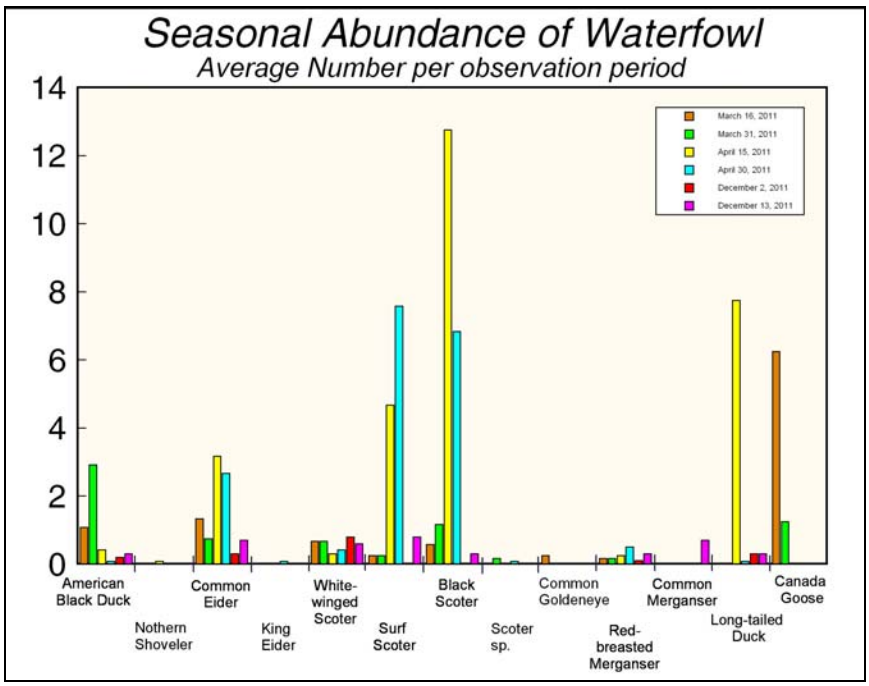


Figure 27. Abundance of waterfowl (average number per 30-minute observation period) at the Fundy Tidal Energy Demonstration site, March, April & December 2011.

Common Eider—Common Eider was common and abundant in all shore-based surveys (Figures 23, 24 & 27). It peaked in abundance in April (Figure 27), but was the most abundant species during the December 13 survey (10.8% of sightings) (Appendix A).

King Eider—King Eider was observed only once, with a single individual observed on April 30 (0.26 % of sightings) (Appendix A). The species breeds along Arctic coasts and overwinters in subarctic marine areas including eastern Canada and the United States.

American Black Duck—This species breeds in, and migrates through, the area in Spring and Fall and is commonly present in Winter. It is often seen feeding on tidal flats, and is known to rest on open salt water, occasionally far from shore. American Black Duck occurred during all surveys (March, April & December). It was the third most abundant species in the March 31 survey (18.1% of sightings) and was present in low abundances and dominance (0.26% to 7.5% of sightings) in the other surveys (Figures 23, 24 & 27)(Appendix A).

White-Winged Scoter—This scoter commonly migrates through the area in Spring and Fall, and regularly winters in moderate numbers. The species feeds over sea ledges and along shorelines, diving to the bottom for shellfish. White-Winged Scoter occurred during all surveys in low abundance and was one of the lesser species in terms of dominance (ranging from 0.7 to 9.3% of sightings in the six surveys) (Figures 23, 24 & 27)(Appendix A).

Surf Scoter—This scoter commonly migrates through the area in Spring and Fall and regularly winters in moderate numbers. Surf Scoter feed over sea ledges and along shorelines, diving to the bottom for shellfish. The species occurred in moderate abundance (11.3-19.4% of sightings) in April surveys, and in low abundance in both March surveys and the December 13 survey (Figures 23, 24 & 27) (Appendix A).

Black Scoter—Black Scoter commonly migrate through the area in Spring and Fall and regularly winter in moderate numbers. They feed on shellfish, which they find on the seabed of sea ledges and along shorelines. The species was the most abundant waterfowl species overall with its peak in mid April (peak and average abundance of 70 and 12.8 per observation period respectively, and 30.8% of sightings) and was observed during all surveys except one (December 2), occurring in low to moderate abundance (2.6-15.4% of sightings) (Figures 24 & 27) (Appendix A).

Common Goldeneye— Common Goldeneye was observed only on March 16 (3 individuals) representing 2.0 % of sightings) (Appendix A). The species breeds in the boreal forest region of North America and can occur in coastal areas during migration.

Red-Breasted Merganser—Mergansers breed in, and migrate regularly through, the inner Bay of Fundy in Spring and Fall. The Red-Breasted Merganser is common in moderate numbers in shallow coastal areas, and feeds by diving for fish in shallow water. Red-Breasted Mergansers were observed during all shore-based surveys in low abundance (1 - 4 individuals per survey and (1.2 - 6.8% of sightings) (Figures 23, 24 & 27)(Appendix A).

Common Merganser—Mergansers breed in and migrate regularly through the area Spring and Fall. The Common Merganser is rare to uncommon in salt water except where rivers and streams enter the ocean. They are known to feed by diving for fish in shallow water. Common Merganser was observed during the December 13 survey only, when four individuals were seen (0.7 per observation period, 10.8% of sightings) (Figures 24 & 27) (Appendix A).

Long-Tailed Duck—This species is a common migrant through the area in Spring and Fall, occurring in moderate to high numbers, and is normally abundant in Winter. It dives for small shellfish along shorelines and in shallow bays with sandy bottoms. Long-Tailed Duck were present during the last four surveys (April & December). Abundance was moderate (18.8% of sightings) on the April 15 survey and low on the other three surveys, making up 0.26-4.6% of sightings (Figures 24 & 27) (Appendix A).

Canada Goose—Canada Geese breed in, and often migrate through, the Inner Bay of Fundy in moderate to large numbers, and the species is a regular Winter resident. It feeds in crop fields near the ocean and on mudflats, and is often seen resting on salt water while waiting for the tide to recede. Canada Geese were observed during the March surveys only, occurring in high abundance and dominance in mid-March (42.9% of all individual bird sightings) and low to moderate abundance and dominance in late March (8.1% of sightings) (Figures 24 & 27) (Appendix A).

Northern Shoveler—A single Northern Shoveler was observed only once (April 15) (0.08 per observation period, 0.24 % of sightings) (Appendix A). Northern Shoveler breeds in southern Ontario, Quebec and the Maritimes, and occurs at the tidal energy demonstration site during migration.

Abundance of Loons

Three loon species (Red-Throated, Common and Pacific) were observed during the shore-based surveys, with Red-Throated Loons most abundant, followed by Common Loon and then Pacific Loon. Concentrations of Red-Throated Loon were highest on the April 30 survey, when the species was abundant and shared dominance with Surf Scoter (Figures 23, 24 & 28).

Red-Throated Loon—Red-Throated Loon migrate through the area Spring and Fall. The species is common and abundant at times, wintering in small numbers. It feeds on small fish at various depths, including the deepest water. It was observed during all surveys, with the exception of March 16, and was the second most abundant and dominant bird species (Surf Scoter was most abundant) during the April 30

survey (7.5 individuals per observation period, and 19.1% of sightings). Numbers were lower in other surveys though the species continued to be important in the community in December (26.7% of sightings in the December 2 survey and 12.3% on December 13) (Figures 23, 24 & 28)(Appendix A).

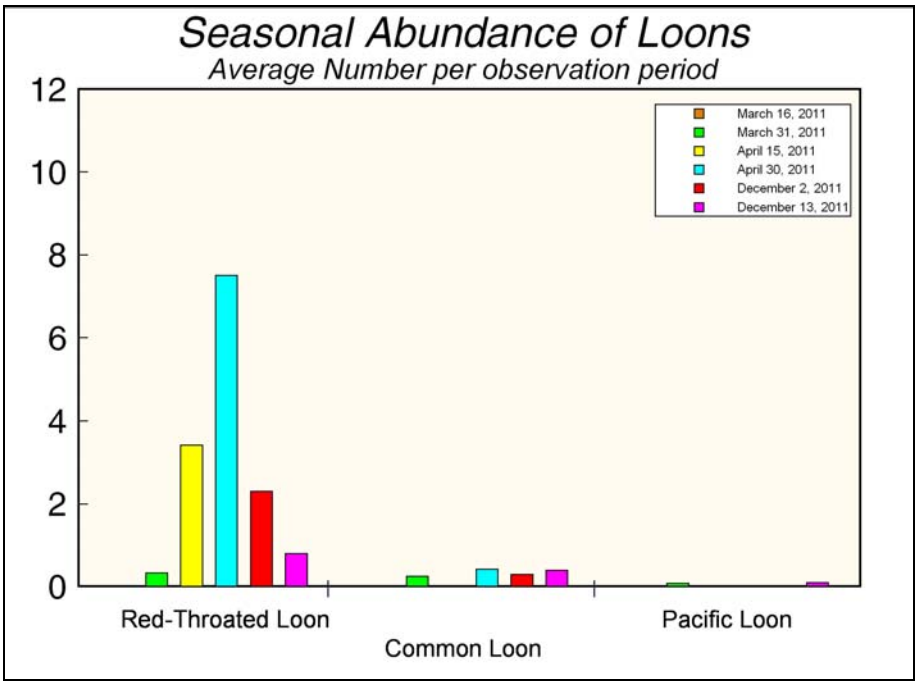


Figure 28. Abundance of loons (average number per 30-minute observation period) at the Fundy Tidal Energy Demonstration site, March, April & December 2011.

Common Loon—Common Loon were observed in low numbers during four of the six surveys (0.25-0.41 individuals per 30-minute observation period) and low to moderate dominance (1.0-6.2% of total bird sightings) (December 13 and April 30 respectively) (Figures 23, 24 & 28)(Appendix A). Common Loon breeds on lakes and is a common coastal resident year-round.

Pacific Loon—This species migrates through the area in Spring and Fall. It is rare at all times, and occasionally overwinters. Pacific Loon feeds on small fish at various depths but mainly in deepest water. It was observed in two of six surveys (March 31 and December 13) in low numbers (0.08 per observation period)(Figures 23, 24 & 28, Appendix A).

Other Seabird and Waterfowl Species

Various other seabird species were observed during most surveys, some of which were relatively abundant, while some occurred only occasionally. Species which were more important in terms of numbers and frequency of occurrence included: Black Guillemot, Great Cormorant, Black-Legged Kittiwake, Double-Crested Cormorant, Northern Gannet and Razorbill. Several other species were present only occasionally and generally in lesser numbers, including Horned Grebe, and Common and Thick-billed Murre (Figures 23, 24 & 29).

Double-Crested Cormorant—Double-Crested Cormorants were observed during two of the six surveys. Numbers were greatest during the April 30 survey (3.0 individuals per half hour observation period) where it was the fifth most abundant species observed (7.7% of sightings) (Figures 23, 24 & 29, Appendix A).

Great Cormorant—This species breeds in and migrates through the area in small numbers in Spring and Fall, and also winters in moderate numbers. Great Cormorant is known to dive deeper and feed further offshore than other cormorant species. Great Cormorants were observed during four of the six surveys (late March to early December). Numbers were generally low (0.08-0.25 individuals per half hour) with highest numbers occurring during the April 15 & 30 surveys (Figures 23, 24 & 29, Appendix A).

Northern Gannet—Northern Gannet occurred in low numbers during the April 15 & 30 surveys. Abundance was higher on April 30, when it accounted for 1.7 individuals per observation period and 4.3% of sightings (Figures 23, 24 & 29, Appendix A).

Black Guillemot—Black Guillemot were observed during all surveys with varying abundances (0.08 – 2.17 individuals per observation period), greatest on April 15 and least on December 13. It was among the most abundant species on April 15 and 30 surveys (5.3% & 4.6% of sightings, respectively) (Figures 23, 24 & 29, Appendix A).

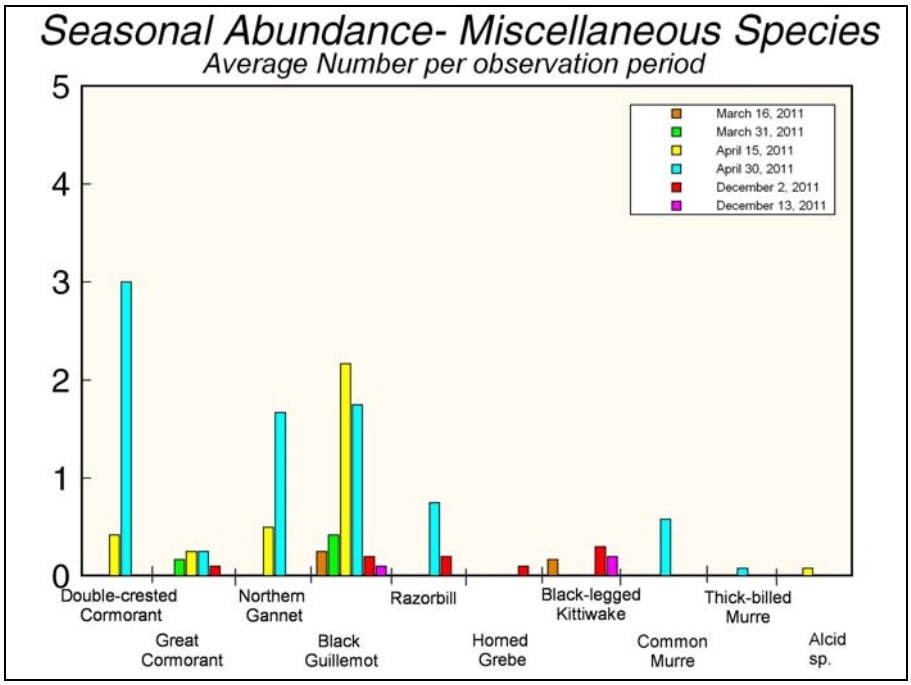


Figure 29. Abundance of miscellaneous seabird and waterfowl species (average number per 30-minute observation period) at the Fundy Tidal Energy Demonstration site, March, April & December 2011.

Razorbill—Razorbill breeds in the Bay of Fundy where it maintains a fairly stable population in the southwest end of the Bay. Populations are highest in Winter, when numbers are augmented by northern migrants. The species feed on small fish and will sometimes dive to considerable depths to capture prey. Razorbill was observed during April 30 and December 2 surveys only, in low abundances (0.75 – 0.17 individuals per observation period, respectively, and 2.0% and 2.3% of average sightings per 30-minute observation period (Figures 23, 24 & 29, Appendix A).

Horned Grebe—Horned Grebe is a small waterfowl species, which migrates through the area in Spring and Fall. The species is marginally common to uncommon, and sparse to moderately abundant in numbers in Winter, feeding on small fish at all depths. A single Horned Grebe visited the site during the December 2 survey (Figures 24 & 29, Appendix A).

Common Murre—Common Murre have only recently begun breeding in the Bay of Fundy and its occurrence is rare. Populations are highest in the Winter, augmented by northern Winter migrants. The species feeds on small fish and will sometimes dive to considerable depths to capture prey. Groups of 2-5 Common Murre were observed during April 30 survey only (0.58 individuals per 30-minute observation period)(Figures 24 & 29, Appendix A).

Thick-Billed Murre—This northern alcid visits the area from late Fall to early Spring, with stragglers (non-breeders) sometimes summering. Winter residents are present in modest numbers most years, with rare spikes in the population during very cold Winters. Thick-Billed Murre often dive for fish in extremely deep waters. One Thick-Billed Murre was observed on the April 30 survey (Figures 24 & 29, Appendix A).

Black-Legged Kittiwake—Black-Legged Kittiwakes are regular Summer and Winter residents in the Bay of Fundy, as well as Fall and Spring transients. Modest numbers of mainly sub-adults summer here, while larger numbers overwinter. Occasionally thousands are blown in from the Gulf of Maine by southerly gales. The species was observed in only three surveys (March 16 and December 2 & 13) in low abundance (0.17 – 0.25 individuals per observation period)(Figures 24 & 29, Appendix A).

2010 and Seasonal Comparison

Most of the birds observed in 2010 were also seen in 2011. Six species (Mew Gull, Laughing Gull, Mallard, Atlantic Puffin, Ring-Necked Grebe and Harlequin Duck) were not observed in 2011, while three new species were observed in 2011 (Northern Shoveler, King Eider and Common Goldeneye). In total, thirty-two species were observed in 2010 versus twenty-nine in 2011 (Table A-11). Total number of species found for the shore-based surveys at the Fundy Tidal Energy Demonstration site has reached 35[12].

Information from both 2010 and 2011 was combined to summarize the annual pattern of abundance of water-associated birds at the Tidal Energy Demonstration Site (Figure 30). Seasonal abundance showed a steady increase in numbers during the Spring to early Summer (March to June); low-moderate numbers in October; a Fall peak in early November and declining numbers through to December. Overall, abundance was highest in June (69.8 sightings per 30-minute observation period) when the population contains predominantly resident birds, and peaked again in early November 57.3 sightings per observation period reflecting predominantly migratory birds). No data is available for January, February and July to September, as shore-based surveys were not conducted at these times.

[12] Forty species of water-associated birds have been observed in the study area, when birds seen on vessel surveys are included.

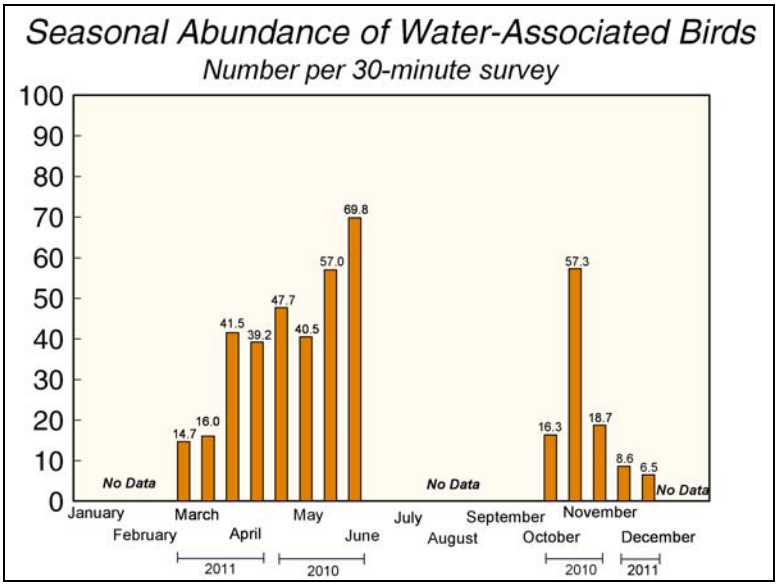


Figure 30. Abundance of water-associated birds (number per 30-minute observation period) at the Fundy Tidal Energy Demonstration Site, March-December, 2010-2011.

Diversity of birds also varied seasonally, showing the March-April peak followed by low and more stable levels in May-June, a peak in October and moderate levels in November-December (Figure 31). Vessel-survey data suggests diversity of birds in Summer (June-September) is lower; however the two sets of measurements cannot strictly be compared since there are expected to differences related to bird use and preferences of inshore versus offshore areas; and the vessel survey covers a broader area and shorter observation periods. In addition the vessel survey is carried out from the moving tidal mass of water, which may affect species representation.

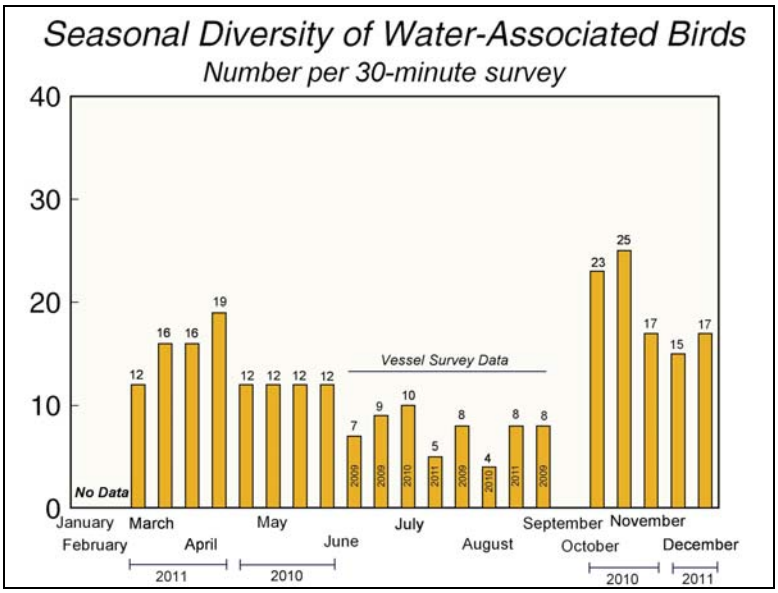


Figure 31. Diversity (number of species per 6-hour survey) of water-associated birds at the Fundy Tidal Energy Demonstration Site, March-December, 2010-2011. Vessel survey information indicates number of per approximately 12-hour survey.

SeaBird and Waterfowl Activity

Activity of birds observed during shore-based surveys has been summarized in terms of the frequency of birds observed on water versus those flying or sitting on Black Rock (Table A-12). Birds carry out many different activities during the day, including flying, feeding, diving, resting on water etc. The summary appears to supports generalizations regarding the typical behaviour of certain species or groups. Species occurring primarily on the water included Black Guillemot, American Black Duck, Scoters (Black, White-Winged and Surf Scoter) and Common Loon (Table A-12). Birds mainly flying included Red-Throated Loon (except on April 15), Northern Gannet and Common Eider (typically seen flying except on April 15 and 30). Great Black-Backed Gull and Herring Gull were observed to be equally on water or flying in March, but only flying in April and December. The abundant Long-Tailed Duck observed on April 15 and Canada Geese were mainly on water when surveyed.

4 CONCLUSIONS AND RECOMMENDATIONS

General

The third year monitoring program for seabirds and marine mammals for the Fundy Ocean Research Centre for Energy (FORCE) Fundy Tidal Energy Demonstration Site, was successfully carried out in 2011, including a shore-based program which covered the early Spring migration and early Winter period of seabirds and other water-associated birds and marine mammals; and vessel-based surveys in July-August to document dominant species and abundances at the installation site and adjacent Minas Basin and Minas Channel areas. Overall the focus of the monitoring program in its initial stages (2009 to 2011) has been to develop an appreciation of the use of the Fundy Tidal Energy Demonstration Site by resident and migratory birds (species occurring and seasonal abundance) and marine mammals. Although the main emphasis of the program was intended to be on birds, one aspect of the program—the shore-based monitoring—begun in 2010 provided significant information on abundance and seasonal timing of Harbour Porpoise, the most-commonly-occurring marine mammal at the site and also a Species at Risk, with *threatened* status under the federal *Species at Risk Act.* Harbour Porpoise is a representative of one of the important animal groups—Cetaceans—potentially impacted by tidal power turbine installations, and their abundance and activities in the area may be a useful indicator of environmental change and the impacts of tidal turbines in Minas Passage.

Shore-based monitoring of seabirds and marine mammals at the site in 2011 extended seasonal observations at the site begun in 2010, including earlier time periods to better capture Spring and Fall migrations as well as Winter occurrences of birds. Monitoring in Spring as early as mid-March detected significant abundances of migratory birds, as well as significant numbers of Harbour Porpoise, whose seasonal abundance in the area was previously poorly known. In contrast, sampling in December, representing the beginning of the Winter period, showed lower abundances of water-associated birds than earlier periods although various species were seen, no new species or particular occurrence of northern cold-water associated birds particularly Alcids, and the absence of Harbour Porpoise.

Vessel-based observations in Summer (late-July and late-August) continued to develop a perspective on regional variability within the Minas Basin, Minas Passage and Minas Channel as well as year-to-year changes, for the monitoring program, which has operated in the late-June to early-September period since 2009, focusing on July-August in 2010 & 2011. A core of dominant species of water-associated birds continued to be present, several at comparable densities between years throughout the survey, although the diversity (number of species) was lowest in 2011. The study has shown significant year-to-year and regional variability, both of which appear to have increased over the course of the monitoring program,

although representing a natural pattern. Surveys in 2011 were hampered by weather conditions, which forced both the July and August surveys to be carried out later than in previous years (5 days for July & 9 days for August) and forced a reduction in sampling intensity in the proposed turbine installation area in Minas Passage, though overall coverage was comparable to previous years and the comparisons are likely meaningful. Based on the surveys, seabird densities in the study area are slightly lower than or comparable to densities for other Nova Scotia waters. Densities were lower than typical seabird densities in coastal and shelf areas in Nova Scotia waters (Fifield et al. unpublished manuscript) although peak densities can be comparable to those from adjacent areas of the Bay of Fundy (Lock et al. 1994) (Envirosphere Consultants 2010 & 2011). The 2011 observations, combined with those of earlier baseline and monitoring studies carried out by FORCE, continue to suggest that the tidal demonstration site is not exceptionally important in terms of seabird and waterfowl abundance in the Inner Bay of Fundy, although there are resident populations year-round, and many species use it during Spring and Fall migrations.

Marine Mammals

The FORCE monitoring program, in particular the shore-based survey, has continued to provide insight into Harbour Porpoise activity in Minas Basin, Minas Passage, and Minas Channel by extending the seasonal occurrence at the site to early Spring (mid-March to early April), showing abundances comparable to or above those observed in the early Summer and Fall at the site in 2010. It has also provided information on limited occurrences of seals and other marine mammals in Minas Passage, although the only other species observed at the site in 2011 was Grey Seal.

Harbour Porpoise Northwest Atlantic population is a species at risk with *threatened* status under the *Species at Risk Act*, although overall, the population is abundant, owing to threats to the population through bycatch in gill net fisheries, habitat degradation, displacement from habitat by the use of acoustic harassment devices in aquaculture, and environmental contamination (COSEWIC 2006). Densities have been thought to be low, however, in the upper reaches of the Bay of Fundy (Gaskin 1992; COSEWIC 2006) but the area hasn't been a focus of research, and local population estimates are not available. The pattern of occurrence of Harbour Porpoise continues to be sporadic, occurring at some times at moderate to high abundance, with periods (i.e. May 2010, December 2011) when the species was not seen at all at the site. Based on the shore-based surveys, Harbour Porpoise is a fairly common visitor from early Spring to Fall. The movement pattern shows that the species passes through the tidal demonstration site from Minas Basin on the outgoing tide—the standard period used for the surveys—so the numbers seen in the surveys provide information on an important component of the species' behaviour, and a potential indicator of the local population size. In 2011, but not in 2010, many of the Harbour Porpoise seen were in the general location proposed for the tidal turbines. The porpoise seen were usually moving with the current—a consequence of the outgoing tidal stream passing through the proposed turbine installation area, and not from any particular attraction to the site. From the perspective of tidal impacts, the observations show that up to 38 individuals (March 31) can pass through the zone between the shore and the outer boundary of proposed turbine installation zone in a single outgoing tide. The species has usually been near the surface when seen moving through Minas Passage, and if this behaviour is typical, the likelihood of interactions with turbines are not particularly large. Harbour Porpoise can, however, dive to significant depths to feed (e.g. up to 100 to 125 m (Gaskin 1992)) and it is not out of the question that occasionally individuals could reach the operating depth of the turbines where they have the potential to interact with them. Some Harbour Porpoise also pass between Black Rock and shore on their outward movement down the Bay of Fundy, and the only Harbour Porpoises observed to be circling in 2011 (thought to be feeding) occurred in the zone between Black Rock and shore where they would not be impacted by the project.

The present shore-based monitoring program on Harbour Porpoise does not cover the Summer period, which represents a significant gap in information provided by the surveys. In addition, further emphasis placed on Harbour Porpoise, in particular monitoring during the incoming tide and making other efforts to track movements of the species through Minas Passage, could provide additional information to determine population size and indirectly a means of determining behavioural and ecosystem impacts of turbine installation.

One of the shore-based surveys in 2010 (October 23) overlapped with a period of deployment of passive acoustic monitoring equipment (C-PODs) in the study area and a reference offshore at the site (Tollit *et al* 2011; FORCE 2011). Individual Harbour Porpoise observed from shore moving through the site were detected by the acoustic instrumentation, which captured the sounds ("clicks") at the same time. Shore-based observations thus have provided valuable additional information on the behaviour and abundance of the porpoises, which were 'heard' by the acoustic devices.

Seabirds and Waterfowl

The goal of the present project was to provide information on seabird and waterfowl species migrating through the study area in the early Spring and early Winter, in particular to document the occurrence of diving birds which are most likely—because of their diving habits—to interact with sub-sea devices such as turbines. Diving birds in several taxonomic groups are present at the Tidal Energy Demonstration Site year-round, including loons, cormorants, eiders and alcids. In addition, most other waterfowl occurring at the site dive for food to some degree. Alcids (Black Guillemots, Atlantic Puffin, Common and Thick-Billed Murres, Razorbills, Dovekies) are the deepest divers, with some species (Common and Razorbill Murre) capable of reaching over 100 m (Johnsgard 1987). Black Guillemot which is common at the Minas Passage site, as well as some of the loons (e.g. Arctic loon) can reach 40-50 m, although Common and Red-Throated Loon, which were both relatively common visitors to the site, more commonly forage in water shallower than 10 m (Johnsgard 1987). Commonly occurring Double-Crested Cormorant as well as the less common Great Cormorant can feed as deep as 12 and 20 m respectively (Ross 1974; Hatch and Veseloh 1999).

The present study has further defined the seasonal occurrence and abundance of some of these species. Observations in 2010 had shown a high abundance of migrating Red-throated Loon in early May; however the 2011 observations showed that Red-Throated Loon movements don't appear to extend into the earlier mid- to late-March period, but some movements through the area were occurring in mid- to late-April. The species was not observed in mid-March and was only a minor species in late March, but increased in abundance, being one of the dominants, although only at moderate abundance, through April. Occasionally Red-throated Loons have been sighted throughout the year, and the species was one of the dominants in December 2011.

Instead of migrants, normally resident species were the dominants in March, including Canada Goose, and gulls (Herring and Great Black-Backed), Common Eider and American Black Duck. Migratory waterfowl including Scoters (Black and Surf) and water-associated Red-throated Loon became the dominants in mid- to late- April, suggesting that the Spring migration had begun. Winter (December) observations identified a moderate number of species at low numbers.

The monitoring program has shown a high diversity of species occurring at the Tidal Energy Demonstration Site. Forty species of water-associated birds have been seen in shore- and vessel-based surveys since 2009. The site is part of the Bay of Fundy, which forms a natural route for migratory birds and is a breeding location for various resident species such as Herring and Great Black-Backed Gulls and Double-Crested Cormorants. The project site is not expected to have the same high diversity as 'hot spots' along the coast in the outer Bay of Fundy (e.g. Brier Island) where migratory flyways overlap with

both the population of both oceanic and coastal species, but the study area can be expected to support many of the same migratory species. The study has demonstrated both Spring and Fall peaks in migration, with the Fall migration in late October the most intense with highest numbers of species (23-25 species) seen at the site during the 6 hours of the outgoing tide, and relatively high abundance, and the late-Spring and early Fall, with a low diversity of species (typically 12 species) but relatively high abundances. The Summer period from late-June to early-September has only been surveyed by vessel-based surveys, which have shown a comparatively low diversity of 'core' resident species present at that time. For the core species, abundances have been comparable to or trending downward over the course of the monitoring program, but the local population shows high variability. Abundances in the Summer haven't been determined by the shore-based program, but they are expected to be moderate to high, with relatively low species diversity, resulting from the use of the site by a core group of resident species. Summer monitoring at the site should be a component of continued monitoring, both because the individuals will represent resident populations which are those most likely to experience ecosystem impacts if any of the tidal turbines, and because their numbers may be less variable and make improve the statistical basis of comparisons used further in the monitoring program.

Within the tidal energy demonstration site, with the exception of around Black Rock and downstream from it in the turbine installation area, no particular areas of concentration of seabirds and waterfowl have been observed. Black Rock and the tide rips associated with it, is a focal point of bird activity although there is a steady movement of birds of many species through the area, either associated directly with the moving water from the falling tide, or daily activity patterns of the birds involved. On a falling tide, some of the birds, which land on water to use the Black Rock, are moved into the turbine installation area; however no particular association of birds with the proposed turbine area was observed. A more intensive analysis of the association of birds with local sub-areas of the study site could be done in future, but initially it appears that birds do not associate with the turbine installation area except by chance.

Monitoring Considerations

The purpose of a monitoring program in the context of the Fundy Tidal Energy Demonstration Project, in common with any project that takes place in a natural environment, is to provide information, which can be used to assess the hypotheses made during the Environmental Assessment regarding potential impacts on the environment by the project. For the present project, the monitoring program for seabirds and marine mammals addresses the contention that tidal energy devices and associated coastal and seabed infrastructure will have negligible impact on seabirds and marine mammals at the Minas Passage site and in adjacent areas.

The monitoring program to date has used a combination of shore-based and vessel-based observational approaches to profile seasonal occurrence and diversity of water-associated birds and marine mammals (shore-based survey) and abundance and regional distribution (vessel-based survey) at the tidal energy demonstration site. The program has been relatively effective in documenting species and abundance at the Tidal Energy Demonstration Site, providing both baseline seasonal information through the shore-based surveys, and annual information through the vessel-based surveys. The following changes to the program are recommended for 2012 and to aid in transforming it into an effective long-term monitoring approach:

- Shore-based monitoring has not been conducted in mid- to late-Summer and early Fall. Consequently the relative importance of Summer (compared with other seasons) in terms of seabird abundance and Harbour Porpoise occurrence and behaviour cannot be assessed. Shore-based surveys should be carried out in the July-August period in 2012 to address this deficiency. If passive acoustic monitoring devices are deployed at the site as part of other research programs,

it may also be relevant to conduct shore-based surveys to provide corroborative information for those surveys.

- Vessel-based surveys provide information on species composition during the Summer, and produce absolute quantitative estimates of bird abundance (i.e. birds per unit area). Vessel surveys, in addition, provide information on conditions over a broader area (i.e. the Minas Basin, Minas Passage, and Minas Channel), therefore allowing comparisons of bird abundance at the tidal site with adjacent areas, which is relevant to determining tidal power impacts, since, due to the tidal action, the tidal energy demonstration site is not isolated from the adjacent areas. The vessel-based surveys have been conducted since 2009 and provide a long-term record of variability in seabird populations, which is useful in assessing the impacts of tidal energy development, and probably should be continued. Continuing these surveys, coupled with shore-based surveys in July-August, proposed above, would also provide a means of comparing the density estimates provided by the two types of surveys and would be valuable in the assessment of impacts of the tidal demonstration project in the long-term.

- Both types of surveys (shore-based and vessel-based) provide information on species composition of birds in the area, which is more readily compared between the two survey types; both, however, involve sampling under slightly different conditions, which may result in discrepancies. For example the Summer vessel-based surveys show lower species diversity than it appears may occur during shore surveys done during the same time of year. Concurrent sampling using both shore- and vessel-based surveys during July-August would be a means of calibrating the two types of surveys, as well as providing required estimates of diversity in the Summer period.

- Vessel-based surveys conducted in the first year of the monitoring program (2009) had more sampling periods and sufficient statistical rigor to allow meaningful comparisons between areas, but the present program, which involves single surveys in each of July and August doesn't have sufficient power to detect year-to-year differences in abundance. Increasing the number of vessel surveys from two to four surveys is recommended for 2012.

For various reasons, Summer may prove to be the most suitable time for monitoring seabirds, waterfowl and Harbour Porpoise, at the Tidal Energy Demonstration Site. Both shore- and vessel-based surveys could be carried out over a relatively short time period. The usefulness of Summer monitoring will be contingent, however, on the Summer proving to be an active time for Harbour Porpoise—a feature which is not known at present—and has become an important requirement of any proposed future monitoring at the site. Initially, Summer shore- and vessel-based surveys should be carried out in 2012 to complete seasonal sampling, providing a comparison or calibration of the measurements produced by the two types of surveys, and to provide further information to assist in determining an approach for long-term monitoring. Recommended surveys and rationale for 2012 are presented in the table below:

Recommended Surveys for Seabirds and Marine Mammals, Fundy Tidal Power Demonstration Site, 2012.			
Type of Survey	Suggested Times	Number of Surveys	Critical Periods and Species Covered
Shore-Based Surveys	- Late June, early & mid-July	3	Summering populations of resident seabirds and Harbour Porpoise. Baseline for long-term monitoring. Comparison with vessel surveys
	- Early & mid-August	2	"
Vessel Surveys	- Early & mid-July	2	Summer, repeat earlier surveys of seabirds and marine mammals for continuity, comparison with shore surveys, and monitoring purposes.
	- Early & mid-August	2	"

Monitoring surveys undertaken by FORCE have provided an important insight into components of the ecosystem—seabirds and waterfowl as well as Harbour Porpoise—which are present at and potentially will interact with the Tidal Energy Demonstration Site. With completion of surveys proposed for 2012, the project will have a basis for developing a long-term monitoring program for future development at the site.

5 REFERENCES

Caswell, H., S. Brault, A.J. Read and T.D. Smith. 1998. Harbor Porpoise and Fisheries: An Uncertainty Analysis of Incidental Mortality. Ecol. Applications 8: 1226-1238.

COSEWIC 2006. COSEWIC assessment and update status report on the harbour porpoise *Phocoena phocoena* (Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 32 pp.

Envirosphere Consultants Ltd. 2006. Identifying Whales, Dolphins, Seals and Sea Turtles in the MARLANT Operations Area. Including Porpoises and Walrus. Report to MARLANT Formation Safety and Environment, March 2006.

Envirosphere Consultants Limited. 2009a. Marine Bird and Mammal Observations—Minas Passage Study Site. Report to Minas Basin Pulp and Power Company Limited, May 2009.

Envirosphere Consultants Limited. 2009b. Terrestrial Bird Survey, Minas Passage Tidal Demonstration Site—Shore Facilities and Cable Landfall. June–September 2009. Report to Fundy Ocean Research Centre for Energy (FORCE), December 18, 2009.

Envirosphere Consultants Limited. 2010. Marine Mammal and Seabird Surveys. Tidal Energy Demonstration Site—Minas Passage, 2009. Report to Report to Fundy Ocean Research Centre for Energy (FORCE), March 10, 2010.

Envirosphere Consultants Limited. 2011. Marine Mammal and Seabird Surveys. Tidal Energy Demonstration Site—Minas Passage, 2010. Report to Report to Fundy Ocean Research Centre for Energy (FORCE), January, 2011.

Fifield, D.A, K.P. Lewis, C. Gjerdrum, G.J. Robertson, and R. Wells. unpubl. Environmental Studies Research Fund: Offshore Seabird Monitoring Program. Canadian Wildlife Service - Environment Canada.

FORCE 2011. Environmental Effects Monitoring Report for the Period of September, 2009 to January, 2011. Fundy Tidal Energy Demonstration Project. Report to the Province of Nova Scotia and the Environmental Monitoring Advisory Committee, October 2011.

Gaskin, D.E. 1992. Status of the Harbour Porpoise, *Phocoena phocoena*, in Canada. Canadian Field-Naturalist 106: 36-54.

Hatch, J. J., and D. V. Weseloh. 1999. Double-crested Cormorant (*Phalacrocorax auritus*). *In* A. Poole and F. Gill, eds., *The Birds of North America*. Philadelphia, PA.

Johnsgard, P.A. 1987. *Diving Birds of North America.* Papers in the Biological Sciences. 4-1-1987. University of Nebraska, Lincoln, Nebraska.

Lock, A. R., R.G.B. Brown and S.H. Gerriets. 1994. Gazetteer of marine birds in Atlantic Canada. An atlas of sea bird vulnerability to oil pollution. Canadian Wildlife Service. Environmental Conservation Branch, Environment Canada Atlantic Region.

Ross, R. K. 1974. A comparison of the feeding and nesting requirements of the Great Cormorant (*Phalacrocorax carbo* L.) and Double-crested Cormorant (*P. auritus* Lesson), in Nova Scotia. Proc. N.S. Institute of Science. 27:114-132.

Tollit, D., J. Wood, J. Broome and A. Redden. 2011. Detection of Marine Mammals and Effects Monitoring at the NSPI (OpenHydro) Turbine Site in the Minas Passage during 2010. Final Report to FORCE by Sea Mammal Research Unit Ltd and Acadia Centre for Estuarine Research. Publication No. 101, Acadia Centre for Estuarine Research, Acadia University, Wolfville, Nova Scotia.

Wilhelm, S. I., C. Gjerdrum, and D.A. Fifield. 2008. Standardized protocol for pelagic seabird surveys conducted in eastern Canada from moving and stationary platforms. Canadian Wildlife Service, Atlantic Region, Technical Report Series Number (in press).

APPENDIX A– Observational Data from Shore-Based Surveys, 2011

(Species names and associated codes are shown in Table 7).

Table A-1a. Overall summary table for March 16, 2011 Survey.													
Species	Date: March 16, 2011, 10:00 TO 15:30 hrs Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Overall.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
CAGO				20					35	20			6.3
COEI	7			1	1						7		1.3
WWSC			1	1	1	1	1		1		1	1	0.7
SUSC	3												0.3
BLSC	4	3											0.6
COGO	3												0.3
RBME								1	1				0.2
ABDU	1	4		1					7				1.1
GBBG		12	4	3	3	1							1.9
HEGU	2	5	3	5			2	1		1		2	1.8
BLKI	1									1			0.2
BLGU							1	1	1				0.3
												Total	14.7

Table A-1b. Inside Black Rock area summary table for March 16, 2011 Survey.													
Species	Date: March 16, 2011, 10:00 TO 15:30 hrs Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
CAGO													0.0
COEI	7		1	1									0.8
WWSC			1	1	1	1	1		1		1	1	0.7
SUSC													0.0
BLSC													0.0
COGO	3												0.3
RBME								1	1				0.2
ABDU	1	4		1					7				1.1
GBBG		2		3	3								0.7
HEGU		1		3			2	1		1		2	0.8
BLKI													0.0
BLGU							1	1	1				0.3
												Total	4.7

Table A-1c. Outside Black Rock area summary table for March 16, 2011 Survey.													
Species	Date: March 16, 2011, 10:00 TO 15:30 hrs. | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Outside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
CAGO													0.0
COEI													0.0
WWSC													0.0
SUSC													0.0
BLSC	1												0.1
COGO													0.0
RBME													0.0
ABDU													0.0
GBBG													0.0
HEGU	2												0.2
BLKI										1			0.1
BLGU													0.0
												Total	0.4

Table A-1d. Turbine area summary table for March 16, 2011 Survey.													
Species	Date: March 16, 2011, 10:00 TO 15:30 hrs. | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Turbine area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
CAGO				20					35	20			6.3
COEI											7		0.6
WWSC													0.0
SUSC	3												0.3
BLSC	3	3											0.5
COGO													0.0
RBME													0.0
ABDU													0.0
GBBG		10	4			1							1.3
HEGU		4	3	2									0.8
BLKI	1												0.1
BLGU													0.0
												Total	9.7

Table A-2a. Overall summary table for March 31, 2011 Survey.													
Species	Date: March 31, 2011, 10:00 TO 1600 hrs. Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Overall.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO						2		1	1				0.3
COLO	1			1		1							0.3
PALO							1						0.1
GRCO												2	0.2
CAGO							15						1.3
ABDU	12	7	6		3			3	4				2.9
COEI	5		2						2				0.8
WWSC	2						1	1	1	1	1	1	0.7
SUSC												3	0.3
BLSC								5	6		1	2	1.2
SCSP												2	0.2
RBME		1				1							0.2
GBBG	11	1	3	12	7	3			1				3.2
HEGU	3		7	3	10	10	1	1		1		2	3.2
RBGU	7	1	2						1				0.9
LBBG					1								0.1
BLGU	3		2										0.4
												Total	16.0

Table A-2b. Inside Black Rock area summary table for March 31, 2011 Survey.													
Species	Date: March 31, 2011, 10:00 TO 1600 hrs. Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO									1				0.1
COLO				1									0.1
PALO													0.0
GRCO													0.0
CAGO													0.0
ABDU	10	4	6		3			3	4				2.5
COEI			2										0.2
WWSC								1	1	1	1	1	0.4
SUSC													0.0
BLSC											1		0.1
SCSP													0.0
RBME						1							0.1
GBBG		1							1				0.2
HEGU	1		3					1					0.4
RBGU	1												0.1
LBBG													0.0
BLGU	1												0.1
												Total	4.2

Table A-2c. Outside Black Rock area summary table for March 31, 2011 Survey.													
Species	Date: March 31, 2011, 10:00 TO 1600 hrs. Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Outside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO								1					0.1
COLO						1							0.1
PALO													0.0
GRCO													0.0
CAGO													0.0
ABDU													0.0
COEI													0.0
WWSC							1						0.1
SUSC												3	0.3
BLSC												1	0.1
SCSP												2	0.2
RBME													0.0
GBBG	4		3		2	3							1.0
HEGU	1		2	1	4	4	1						1.1
RBGU													0.0
LBBG													0.0
BLGU													0.0
												Total	2.8

Table A-2d. Turbine area summary table for March 31, 2011 Survey.													
Species	Date: March 31, 2011, 10:00 TO 1600 hrs. Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Turbine area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO						2							0.2
COLO	1												0.1
PALO							1						0.1
GRCO												2	0.2
CAGO							15						1.3
ABDU	2	3											0.4
COEI	5								2				0.6
WWSC	2												0.2
SUSC													0.0
BLSC								5	6			1	1.0
SCSP													0.0
RBME		1											0.1
GBBG	7			12	5								2.0
HEGU	1		2	2	6	6				1		2	1.7
RBGU	6	1	2						1				0.8
LBBG					1								0.1
BLGU	2		2										0.3
												Total	8.9

Table A-3a. Overall summary table for April 15, 2011 Survey.													
Species	Date: April 15, 2011, 10:30 hrs to 16:00 hrs							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Overall.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO		1		2		1	1		1	4	22	9	3.4
DCCO				5									0.4
GRCO				3									0.3
COEI	11	6	8				1	2	2	2	3	3	3.2
NOGA		1	3	1	1								0.5
NSHO			1										0.1
ABDU			4									1	0.4
WWSC										4			0.3
SUSC	35		1		1			4				15	4.7
BLSC	26	6			70	15		10		24		2	12.8
RBME			3										0.3
LTDU	36					10	10			30	5	2	7.8
GBBG	3	10	2	10	5		1	6			1	1	3.3
HEGU	1	4	4	3	2	3	2		2	2		1	2.0
RBGU						1							0.1
BLGU	2	4	3	5	4	2	2	2	1			1	2.2
Alcid sp.					1								0.1
												Total	41.5

Table A-3b. Inside Black Rock summary table for April 15, 2011 Survey.													
Species	Date: April 15, 2011, 10:30 hrs to 16:00 hrs							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO		1							1	1	7		0.1
DCCO													
GRCO													
COEI	11	6	4				1	2	2	2	3	3	2.8
NOGA													
NSHO			1										0.1
ABDU			4									1	0.42
WWSC													
SUSC			1										0.1
BLSC												2	0.2
RBME			3										0.3
LTDU													
GBBG			1		2			5				1	0.8
HEGU		2	2			1	1		2				0.7
RBGU						1							0.1
BLGU	2	3		3	2	2	2	1	1			1	1.4
Alcid sp.													
												Total	7.6

Table A-3c. Outside Black Rock summary table for April 15, 2011 Survey													
Species	Date: April 15, 2011, 10:30 hrs to 16:00 hrs							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Outside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO				2		1	1				3	1	0.7
DCCO													
GRCO													
COEI													
NOGA				1	1								0.2
NSHO													
ABDU													
WWSC													
SUSC													
BLSC		6				15							1.8
RBME													
LTDU							10						0.8
GBBG	3	8			1								1
HEGU	1	2	2	3	2	1							0.91
RBGU													
BLGU													
Alcid sp.					1								0.1
												Total	5.4

Table A-3d. Turbine area summary table for April 15, 2011 Survey													
Species	Date: April 15, 2011, 10:30 hrs to 16:00 hrs							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Turbine area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO										3	12	8	1.9
DCCO				5									0.4
GRCO				3									0.3
COEI			4										0.3
NOGA		1	3										0.3
NSHO													
ABDU													
WWSC										4			0.3
SUSC	35				1			4				15	4.6
BLSC	26				70			10		24			10.8
RBME													
LTDU	36					10				30	5	2	6.9
GBBG		2	1	10	2		1	1			1		1.5
HEGU						1	1			2		1	0.4
RBGU													
BLGU		1	3	2	2			1					0.8
Alcid sp.													
												Total	28.5

Table A4a. Overall summary table for April 30, 2011 Survey.													
Species	Date: April 30, 2011, 11:00 to 16:00 hrs. | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Overall.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	11	3	19	18	4	13	12	2	1	2	5		7.5
COLO			1			1		2	1				0.4
NOGA		7					1	4		6		2	1.7
GRCO									3				0.3
DCCO			2	8	8	4		5	2	1	5	1	3.0
ABDU										1			0.1
COEI	11					2	6		10			3	2.7
KIEI											1		0.1
WWSC										5			0.4
SUSC	50	1		11	2		15		1		11		7.6
BLSC	2	2				25	12	1		5	10	25	6.8
LTDU					1								0.1
RBME								1	4			1	0.5
SC sp.	1												0.1
GBBG	1	2		2	3	4	1		3		1	1	1.5
HEGU	2	1	6	3	1	4	5	2	6	2	5	3	3.3
BLGU	4	6	2	1	2				2	1		3	1.8
RAZO	4		5										0.8
COMU				5	2								0.6
TBMU				1									0.1
												Total	39.2

Table A-4b. Inside Black Rock area summary table for April 30, 2011 Survey.													
Species	Date: April 30, 2011, 11:00 to 16:00 hrs. Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	1		1										0.2
COLO									1				0.1
NOGA													0.0
GRCO													0.0
DCCO			2					1					0.3
ABDU													0.0
COEI	2						2					3	0.6
KIEI													0.0
WWSC													0.0
SUSC		1			1				1				0.3
BLSC	2							1					0.3
LTDU													0.0
RBME								1	4				0.4
SC sp.													0.0
GBBG		2		2	1	3	1		3		1	1	1.2
HEGU		1			1	1	1	1	5	2		3	1.3
BLGU	3	2	2							1		3	0.9
RAZO													0.0
COMU													0.0
TBMU													0.0
												Total	5.3

Table A-4c. Outside Black Rock summary table for April 30, 2011 Survey.													
Species	Date: April 30, 2011, 11:00 to 16:00 hrs. | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Outside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	4		12	12		4	4		1	2	1		3.3
COLO			1										0.1
NOGA							1			6		2	0.8
GRCO													0.0
DCCO													0.0
ABDU													0.0
COEI	7												0.6
KIEI													0.0
WWSC										5			0.4
SUSC								11					0.9
BLSC												10	0.8
LTDU													0.0
RBME													0.0
SC sp.	1												0.1
GBBG					1								0.1
HEGU			4	1		1	3						0.8
BLGU													0.0
RAZO			5										0.4
COMU													0.0
TBMU													0.0
												Total	8.3

Table A-4d.Turbine area summary table for April 30, 2011Survey.													
Species	Date: April 30, 2011, 11:00 to 16:00 hrs. | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Turbine area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	6	3	6	6	4	9	8	2			4		4.0
COLO						1		2					0.3
NOGA		7						4					0.9
GRCO									3				0.3
DCCO				8	8	4		4	2	1	5	1	2.8
ABDU										1			0.1
COEI	2					2	4		10				1.5
KIEI											1		0.1
WWSC													0.0
SUSC	50			11	1		15						6.4
BLSC		2				25	12			5	10	15	5.8
LTDU					1								0.1
RBME												1	0.1
SC sp.													0.0
GBBG	1				1	1							0.3
HEGU	2		2	2		2	1	1	1		5		1.3
BLGU	1	4		1	2				2				0.8
RAZO	4												0.3
COMU				5	2								0.6
TBMU				1									0.1
												Total	25.6

Table A-5a. Overall summary table for December 2, 2011 Survey.													
Species	Date: December 2, 2011 | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Overall.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	2		2	4				3	4	5	1	7	2.3
COLO										1	1	1	0.3
HOGR									1				0.1
GRCO										1			0.1
ABDU						2							0.2
COEI		2				2							0.3
WWSC			1	1	1	1	1	1	1	1	1	1	0.8
LTDU								3					0.3
RBME			1										0.1
GBBG		2	1							7			0.8
HEGU	7	5	9	3	1	1		1			1		2.3
RBGU	1		1			2	1						0.4
BLGU								2					0.2
BLKI					2			1					0.3
RAZO											1	1	0.2
												Total	8.6

Table A-5b. Inside Black Rock summary table for December 2, 2011 Survey													
Species	Date: Date: December 2, 2011							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO										2		2	0.3
COLO											1	1	0.2
NOGA													0.0
GRCO													0.0
DCCO													0.0
ABDU						2							0.2
COEI						2							0.2
KIEI													0.0
WWSC			1	1	1	1	1	1	1	1	1	1	0.8
SUSC													0.0
BLSC													0.0
LTDU													0.0
RBME													0.0
SC sp.													0.0
GBBG		2											0.2
HEGU		3	2										0.4
BLGU													0.0
RAZO											1	1	0.2
												Total	2.4

Table A-5c. Outside Black Rock summary table for December 2, 2011 Survey.													
Species	Date: December 2, 2011							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Outside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO			1	4				1	2		1	1	0.8
COLO										1			0.1
NOGA													0.0
GRCO										1			0.1
DCCO													0.0
ABDU													0.0
COEI		2											0.2
KIEI													0.0
WWSC													0.0
SUSC													0.0
BLSC													0.0
LTDU													0.0
RBME													0.0
SC sp.													0.0
GBBG										7			0.6
HEGU	6		5	1	1						1		1.2
RBGU			1			1							0.2
BLGU								2					0.2
BLKI					1			1					0.2
RAZO													0.0
												Total	3.4

Table A-5d. Turbine area summary table for December 2, 2011 Survey.													
Species	Date: December 2, 2011							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Turbine area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	2		1					2	2	2		4	1.2
COLO													0.0
HOGR									1				0.1
NOGA													0.0
GRCO													0.0
DCCO													0.0
ABDU													0.0
COEI													0.0
KIEI													0.0
WWSC													0.0
SUSC													0.0
BLSC													0.0
LTDU								3					0.3
RBME			1										0.1
SC sp.													0.0
GBBG			1										0.1
HEGU	1	2	2	2		1		1					0.8
RBGU	1					1	1						0.3
BLGU													0.0
BLKI					1								0.1
RAZO													0.0
												Total	2.8

Table A-6a. Overall summary table for December 13, 2011 Survey.													
Species	Date: December 13, 2011							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Overall.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	1											9	0.8
COLO			1	1			1			1	1		0.4
PALO					1								0.1
HOGR													0.0
NOGA													0.0
GRCO													0.0
DCCO													0.0
ABDU									3				0.3
COEI	1	1	1	1					1	1	1	1	0.7
KIEI													0.0
WWSC	1	2			1	1	1	1					0.6
SUSC		4		4							1		0.8
BLSC				1	1	1							0.3
LTDU								3					0.3
COME	4	4											0.7
RBME	2	2											0.3
SC sp.													0.0
GBBG	1												0.1
HEGU	2		2					3				1	0.7
RBGU								3	1				0.3
BLGU												1	0.1
ICGU					1								0.1
BLKI								1	1				0.2
RAZO													0.0
												Total	6.5

Table A-6b. Inside Black Rock summary table for December 13, 2011 Survey.													
Species	Date: December 13, 2011							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO													0.0
COLO			1							1	1		0.3
NOGA													0.0
GRCO													0.0
DCCO													0.0
ABDU													0.0
COEI	1	1	1	1					1	1	1	1	0.7
KIEI													0.0
WWSC	1	1			1	1	1	1					0.5
SUSC											1		0.1
BLSC				1	1	1							0.3
LTDU								3					0.3
COME	4	4											0.7
RBME	2	2											0.3
SC sp.													0.0
GBBG													0.0
HEGU	1												0.1
BLGU													0.0
RAZO													0.0
												Total	3.1

Table A-6c. Outside Black Rock summary table for December 13, 2011Survey.													
Species	Date: December 13, 2011							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Outside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO												7	0.6
COLO													0.0
PALO					1								0.1
NOGA													0.0
GRCO													0.0
DCCO													0.0
ABDU													0.0
COEI													0.0
KIEI													0.0
WWSC		1											0.1
SUSC		4		4									0.7
BLSC													0.0
LTDU													0.0
RBME													0.0
SC sp.													0.0
GBBG													0.0
HEGU	1		2					3				1	0.6
RBGU								3					0.3
BLGU												1	0.1
ICGU					1								0.1
BLKI								1	1				0.2
RAZO													0.0
												Total	2.6

Table A-6d. Turbine area summary table for December 13, 2011Survey.													
Species	Date: December 13, 2011							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Turbine area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	1											2	0.3
COLO				1			1						0.2
HOGR													0.0
NOGA													0.0
GRCO													0.0
DCCO													0.0
ABDU									3				0.3
COEI													0.0
KIEI													0.0
WWSC													0.0
SUSC													0.0
BLSC													0.0
LTDU													0.0
RBME													0.0
SC sp.													0.0
GBBG	1												0.1
HEGU													0.0
RBGU									1				0.1
BLGU													0.0
BLKI													0.0
RAZO													0.0
												Total	0.8

Table A-7. Summary of sightings of water associated bird species at Black Rock Tidal Power demonstration Site, March to December 2011, from shore based observations.

	Individuals observed per 30 minute observation period					
Species	March 16	March 31	April 15	April 30	December 2	December 13
RTLO		0.3	3.4	7.5	2.3	0.8
COLO		0.3		0.4	0.3	0.4
PALO		0.1				0.1
DCCO			0.4	3.0		
GRCO		0.2	0.3	0.3	0.1	
NOGA			0.5	1.7		
ABDU	1.1	2.9	0.4	0.1	0.2	0.3
COEI	1.3	0.8	3.2	2.7	0.3	0.7
KIEI				0.1		
WWSC	0.7	0.7	0.3	0.4	0.8	0.6
SUSC	0.3	0.3	4.7	7.6		0.8
BLSC	0.6	1.2	12.8	6.8		0.3
SC sp.		0.2		0.1		
RBME	0.2	0.2	0.3	0.5	0.1	0.3
COME						0.7
GBBG	1.9	3.2	3.3	1.5	0.8	0.1
HEGU	1.8	3.2	2.0	3.3	2.3	0.7
ICGU						0.1
LBBG		0.1				
BLGU	0.3	0.4	2.2	1.8	0.2	0.1
RAZO				0.8	0.2	
HOGR					0.1	
BLKI	0.2				0.3	0.2
RBGU		0.9	0.1		0.4	0.3
LTDU			7.8	0.1	0.3	0.3
NSHO			0.1			
CAGO	6.3	1.3				
COGO	0.3					
COMU				0.6		
TBMU				0.1		
Alcid sp.			0.1			
TOTAL	14.7	16.0	41.5	39.2	8.6	6.5

Table A-8. Distribution by area of sightings of water associated bird species at Black Rock Tidal Power demonstration Site, March to December 2011, from shore based observations.

	Individuals observed per 30 minute observation period					
Sub-Areas	March 16	March 31	April 15	April 30	December 2	December 13
Inside Black Rock	4.7	4.2	7.6	5.3	2.4	3.1
Outside Black Rock	0.3	2.8	5.4	8.3	3.4	2.6
Turbine Area	9.7	8.9	28.5	25.6	2.8	0.8
Total	14.7	16.0	41.5	39.2	8.6	6.5

Table A-9. Marine mammal sightings at Minas Passage study site, March – December 2011. Average number per 30-minute observation period.

	Abundance (Individuals per 30 minute observation period)					
	March 16	March 31	April 15	April 30	December 2	December 13
Grey Seal	--	--	0.25	--	--	--
Harbour Porpoise	1.58	3.17	1.25	0.25	--	--

Table A-10. Occurrence of water associated bird species at Black Rock Tidal Power demonstration Site, March 16 to December 13, 2011, from shore based observations.

	Individuals observed per 30 minute observation period					
Species	March 16	March 31	April 15	April 30	December 2	December 13
RTLO		✓	✓	✓	✓	✓
COLO		✓		✓	✓	✓
PALO		✓				✓
DCCO			✓	✓		
GRCO		✓	✓	✓	✓	
NOGA			✓	✓		
ABDU	✓	✓	✓	✓	✓	✓
COEI	✓	✓	✓	✓	✓	✓
NSHO			✓			
KIEI				✓		
WWSC	✓	✓	✓	✓	✓	✓
SUSC	✓	✓	✓	✓		✓
BLSC	✓	✓	✓	✓		✓
RBME	✓	✓	✓	✓	✓	✓
COME						✓
GBBG	✓	✓	✓	✓	✓	✓
HEGU	✓	✓	✓	✓	✓	✓
ICGU						✓
LBBG		✓				
BLGU	✓	✓	✓	✓	✓	✓
RBGU		✓	✓		✓	✓
RAZO				✓	✓	
HOGR					✓	
BLKI	✓				✓	✓
LTDU			✓	✓	✓	✓
CAGO	✓	✓				
COGO	✓					
COMU				✓		
TBMU				✓		
TOTAL	12	16	16	19	15	17

Table A-11. Comparison of species list of marine mammals and seabirds at Fundy Tidal Power Demonstration Site, from shore based observations, 2010 vs 2011.		
	Individuals observed per 30 minute observation period	
Species	2010	2011
RTLO	✓	✓
COLO	✓	✓
PALO	✓	✓
DCCO	✓	✓
GRCO	✓	✓
NOGA	✓	✓
NSHO		✓
ABDU	✓	✓
COEI	✓	✓
KIEI		✓
COGO		✓
WWSC	✓	✓
SUSC	✓	✓
BLSC	✓	✓
RBME	✓	✓
COME	✓	✓
HADU	✓	
GBBG	✓	✓
HEGU	✓	✓
ICGU	✓	✓
LAGU	✓	
LBBG	✓	✓
BLGU	✓	✓
RAZO	✓	✓
HOGR	✓	✓
BLKI	✓	✓
RBGU	✓	✓
LTDU	✓	✓
RNGR	✓	
ATPU	✓	
MALL	✓	
CAGO	✓	✓
COMU	✓	✓
TBMU	✓	✓
MEGU	✓	
TOTAL	32	29

Table A-12. Summary of activity of water associated bird species at Black Rock Tidal Energy Demonstration Site, March to December 2011, from shore-based observations. Number represents the total number of birds observed with number observed on water (OW) [in brackets], and the OW proportion.

	Individuals observed per 30 minute observation period											
Species	March 16		March 31		April 15		April 30		December 2		December 13	
	Number	OW Proportion	Number	OW Proportion	Number	OW Proportion	Number	OW Proportion	Number	OW Proportion	Number	OW Proportion
RTLO			4 (1)	0.25	41 (30)	0.73	90 (31)	0.34	28 (10)	0.36	10 (0)	0
COLO			3 (2)	0.67			5 (3)	0.60	3 (2)	0.67	5 (3)	0.60
PALO			1 (0)	0							1(0)	0
DCCO					5 (0)	0	36 (13)	0.36				
GRCO			2 (0)	0	3 (0)	0	3 (0)	0	1 (0)	0		
NOGA					6 (1)	0.17	20 (0)	0				
ABDU	13 (8)	0.62	35 (24)	0.69	5 (0)	0	1 (0)	0	2 (2)	1	3 (0)	0
COEI	16 (0)	0	9 (2)	0.22	38 (34)	0.89	32 (18)	0.56	4 (2)	0.5	8 (8)	1
KIEI							1 (0)	0				
WWSC	8 (8)	1	8 (5)	0.63	4 (4)	1	5 (0)	0	10 (10)	1	7 (7)	1
SUSC	3 (0)	0	3 (3)	1	55 (34)	0.62	91 (75)	0.82			9 (1)	0.11
BLSC	7 (3)	0.43	14 (13)	0.93	153 (97)	0.63	81 (59)	0.73			3 (0)	0
SC sp.			2 (2)	1			1 (0)	0				
RBME	2 (2)	1	2 (0)	0	3 (0)	0	6 (1)	0.17	1 (0)	0	4 (4)	1
COME											8 (8)	1
GBBG	23 (12)	0.52	38 (21)	0.55	39 (5)	0.13	18 (3)	0.17	10 (0)	0	1 (0)	0
HEGU	21 (1)	0.05	38 (20)	0.53	22 (4)	0.18	40 (11)	0.28	28 (4)	0.14	8 (0)	0
ICGU											1 (0)	0
LBBG			1 (1)	1								
BLGU	3 (3)	1	5 (5)	1	26 (21)	0.81	22 (17)	0.77	2 (0)	0	1 (0)	0
RAZO							9 (9)	1	2 (2)	1		
HOGR									1 (0)	0		
BLKI	2 (0)	0							3 (0)	0	2 (0)	0
RBGU			11 (0)	0	3 (0)	0			5 (1)	0.2	4 (0)	0
LTDU					93 (83)	0.89	1 (0)	0	3 (0)	0	3 (0)	0
NSHO					1 (0)	0						
CAGO	75 (55)	0.73	15 (15)	1								
COGO	3 (3)	1.0										
COMU							7 (5)	0.71				
TBMU							1 (1)	1				
Alcid sp.					1 (0)	0						
Overall	176 (95)	0.54	191 (114)	0.60	498 (313)	0.63	470 (246)	0.52	103 (33)	0.32	78 (31)	0.40

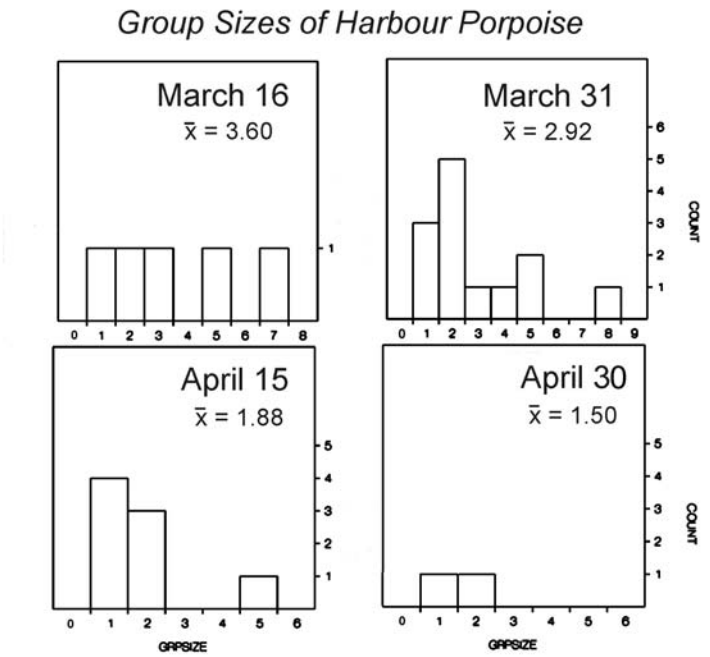


Figure A-1. Estimated group sizes of Harbour Porpoise (*Phocoena phocoena)* observed during shore-based surveys at the Fundy Tidal Energy Demonstration Facility, March-April 2011. No Harbour Porpoise were observed on December 2 & 13, 2011.

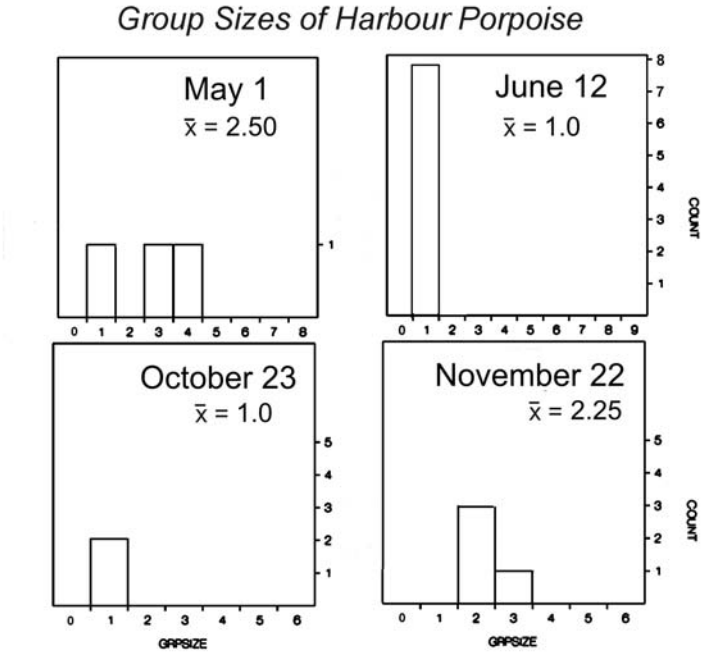


Figure A-2. Estimated group sizes of Harbour Porpoise (*Phocoena phocoena)* observed during shore-based surveys at the Fundy Tidal Energy Demonstration Facility, May – November 2010. No Harbour Porpoise were observed on May 13 & 27, 2010.