Marine Mammal and Seabird Surveys

Tidal Energy Demonstration Site — Minas Passage, 2012

Submitted to:

Fundy Ocean Research Centre for Energy (FORCE)

Submitted by:

Envirosphere Consultants Limited
Windsor, Nova Scotia

January 2013

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

FORCE Envirosphere CONSULTANTS LIMITED

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 data collection 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 monitored at the site 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-, second- and third-year monitoring studies in 2008 and 2009-2011, respectively. The monitoring program continued in 2012, undertaking six, one-day shore-based observational surveys (June-August) and three vessel-based surveys in July-August in the outer Minas Basin, Minas Passage and Minas Channel. Shore-based surveys took place on June 21, July 4 & 18, and August 2, 15 & 29, 2012, and vessel-based surveys took place on July 15 & 28 and August 10, 2012.

Overall, for the four years of the monitoring program, 47 species of water-associated birds and shorebirds have been seen in the vicinity of the Tidal Energy Demonstration Site (Minas Basin, Minas Passage & Minas Channel), the majority in Minas Passage specifically at the demonstration site, as the result of shore-based surveys. During the 2012 monitoring, 23 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, Ring-Billed Gull, Black Guillemot, Northern Gannet, Black Tern, Cory's Shearwater, Greater Shearwater and Sooty Shearwater); waterfowl (Common, Pacific, and Red-Throated Loon; Common Eider and Red-Breasted Merganser); and shorebirds (Ruddy Turnstone, Red Phalarope, Red-Necked Phalarope, Sanderling, Semipalmated Sandpiper, Spotted Sandpiper and Greater Yellowlegs). The greatest number of species occurred in early to late August

(August 2 & 29, 14 species) although a moderate number of species occurred in all surveys. Resident seabird and waterfowl species, including gulls (Herring, Great Black-Backed and Ring-Billed), Common Eider, Black Guillemot and Common Loon, were the dominants in the waters of Minas Passage immediately off the tidal demonstration site in most surveys, but other species occurred occasionally in significant abundance to outnumber the regulars. Other species which were occasionally abundant included Double-Crested Cormorant on June 21; Red-Throated Loon on July 4; Northern Gannet (July 18); Ruddy Turnstone (a shorebird, August 2); and Red-Necked Phalarope on August 29. For the first time in the monitoring program, due to the focus on summer sampling, various species of shorebirds, including Ruddy Turnstone, Red and Red-Necked Phalarope, Sanderling, Semipalmated Sandpiper, Spotted Sandpiper and Greater Yellowlegs were observed in Minas Passage at the Tidal Energy Demonstration Site.

Species observed in summer vessel surveys which included parts of Minas Basin, Minas Passage and Minas Channel, included: Herring Gull, Great Black-Backed Gull, Ring-Billed Gull, Double-Crested and Great Cormorant, Black Guillemot, Common Eider, Common Loon, and Razorbill. Densities of seabirds and waterfowl seen on vessel surveys in 2012 were lower than in earlier surveys; however densities on the July 15, 2012 survey were relatively high and comparable to July in earlier years, while densities in mid-August 2012 were particularly low. Bird species diversity determined from vessel surveys (9 species in 2012) was comparable to earlier years, with one more species observed than in 2011, one less species than in 2010, and three fewer species than in 2009. Diversity detected in vessel surveys was similar to that observed at the Tidal Energy Demonstration Site in Minas Passage, with allowance for occurrences of several shorebird and occasional seabird species which raised the species count in the shore-based survey on several occasions. One shorebird, the Least Sandpiper was observed nearshore in Minas Passage.

Harbour Porpoise (*Phocoena phocoena)* occurred frequently at the Tidal Energy Demonstration Site from June 21 to August 29 but the species was absent on July 18. The species was observed on both shore-based and vessel surveys, with particularly elevated abundance in the shore-based surveys in early July (July 4) and mid-August (August 15); and on the July 15 vessel survey. The species occurred typically singly or in groups of 2-3 but groupings of up to 5-8 individuals also occurred; highest numbers were observed on July 4 and August 15, when abundance averaged 1.9 & 2.6 animals per 30-minutes during the 6-hour observation period respectively. Harbour Porpoise typically occurred in the tidal stream outside Black Rock and extending through the proposed turbine installation area the area seaward of Black Rock towards the Minas Channel and Cape Split), usually seen swimming seaward with the outgoing tidal stream which passed over the proposed tidal installation at the site, and was uncommon inside Black Rock. Some of the sightings involved individuals circling as if feeding.

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 mammal 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 geophysics 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). 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 added in May-June and October-November to cover the migration periods [this test of suitability of shore-based surveys proved successful and became routine in later surveys]; vessel surveys were continued in mid-Summer of 2010 (July & August) to continue to develop a continuous baseline and to monitor conditions while the first tidal turbine was in place (November 2009 – December 2010)(Envirosphere Consultants Limited 2011). In 2011, the monitoring program further extended sampling, by conducting surveys earlier in the spring early winter (March-April & December) to cover the annual migration period for waterfowl and seabirds, and two vessel-based surveys in July-August repeating earlier summer vessel surveys. This report presents the results of 2012 monitoring which focused on adding summer coverage by shore-based surveys in June, July and August, as well as continued vessel-based surveys in July and August 2012, intended both to repeat surveys done at the same time of year in 2009, 2010 & 2011, but paired in time with the shore-based surveys to provide a comparison between results obtained by both methods.

2 METHODS

Shore-Based Surveys

Shore-based surveys were carried out at the site on June 21, July 4 & 18 and August 2, 15 & 29, 2012 and the July 18, August 2 and August 15 surveys were paired in time with vessel surveys on July 15 & 28 and August 10, to compare efficacy of the two survey approaches in measuring bird abundance and diversity. Surveys were done by a team consisting of Mr. Fulton Lavender, Halifax, Nova Scotia, an experienced seabird and marine mammal observer, assisted by Mr. Matthew MacLean, Environmental Technologist, Envirosphere Consultants Limited, except on June 21 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 or lobby 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 sightings per period,

and a breakdown by distribution in 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 Jerry Reid, Delhaven), departing from Delhaven. On July 15, the survey began in the morning (departing 1000 hrs) just before high tide and arrived back in port at 2230 hrs[1]. The July 28, 2012 survey began earlier, departing Delhaven approximately 0715 and returning at approximately 2200 hrs with the tide in the evening. The final survey on August 10 began in the early morning, leaving the wharf at 0610 and returning at 1730. Surveys were carried out by Fulton Lavender, assisted by biologist Heather Levy (B.Sc. Hons)(July 15 survey) and environmental technologist Matthew MacLean (August suveys), both with Envirosphere Consultants Limited. Observation conditions were generally good, with skies partly overcast and light winds on July 15, and mostly clear and partially cloudy on July 28 (fog was encountered leaving Delhaven but burned off upon passing Cape Blomidon); and patchy fog in Minas Channel during the August 10 survey. On that occasion, fog was encountered shortly after completing the detailed survey of the installation site, and didn't clear until nearing Cape Spencer. Once the boat turned and began to cruise back, the same fog patch was encountered but only affected 1-2 observation periods. For data analysis, the study area was divided into Minas Basin, Minas Passage, and Minas Channel, with the boundaries determined to be the longitude of Cape Sharp and Cape Split and the western Minas Channel by 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-minute duration were conducted every 10 to 15 minutes and continuously (every five minutes) at the turbine installation site[2]. The observer monitored a strip of water and air 300 m wide approached by the vessel, alternating sides on successive cruises (port on July 15, starboard on July 28, and port on August 10), 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 on seabirds obtained will be given to the Canadian Wildlife Service, and all data to date on marine mammal occurrences has been supplied to Fisheries and Oceans Canada (St. Andrews Biological Station) 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

[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.

axis of Minas Passage-Minas Channel; and also to cover daily movements of birds within the general area (e.g. for feeding)[3]. All surveys to date have included a component focused on the turbine installation area (the 'Crown Lease' area), in which the vessel steams back and forth over the turbine area; as well as the more general geographic survey component. This component has been difficult to carry out due to navigation in the strong tidal currents but has usually provided acceptable data focused on the tidal installations; however this year the survey was arranged to have the boat at the installation site closer to high tide, to avoid the highest currents, and was largely successful (Figure 3). A survey lasted typically from early morning to evening 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 and/or drifted with the peak tidal flow to Cape Spencer, where it waited until the tide reversed, and then cruised back again to the survey origin[4]. 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). The vessel steamed directly to the FORCE site from Delhaven, leaving out some of the coverage in Minas Basin (Figure 2) but a more regular survey pattern was achieved (Figure 3). In part as a result of additional emphasis on the quality of surveys at the turbine installation site, the coverage of Minas Basin was less in 2012 compared to earlier surveys.

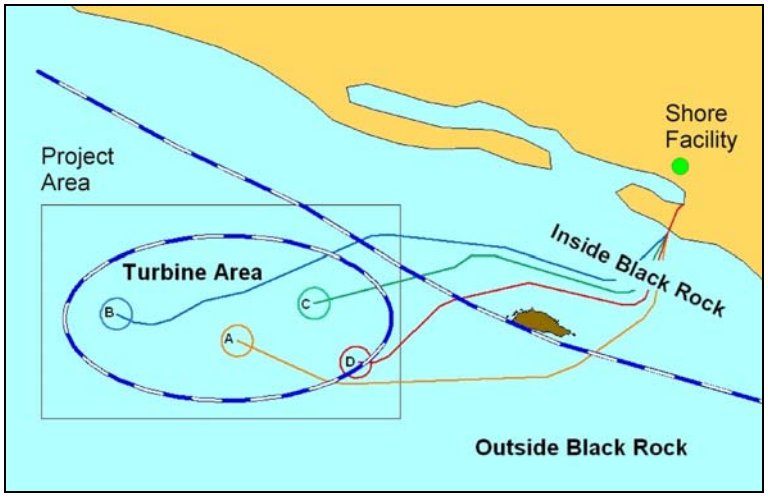


Figure 1a. Study areas for shore-based surveys, showing project location and proposed turbine berths and cable routes.

[3] The survey design was reviewed by a representative of CWS prior to implementation in 2009 and has not changed, except to reduce the number of observation periods from continuous (every five-minute period) to once per 10 or 15 minute period.
[4] After leaving the turbine installation area on the outgoing tide during the August 10 survey, the vessel was drifting with the current and was caught in a clockwise eddy, which took it nearshore near Diligent River, before the normal course was restored. This portion of the cruise track was not included in estimates of effort and bird abundance.

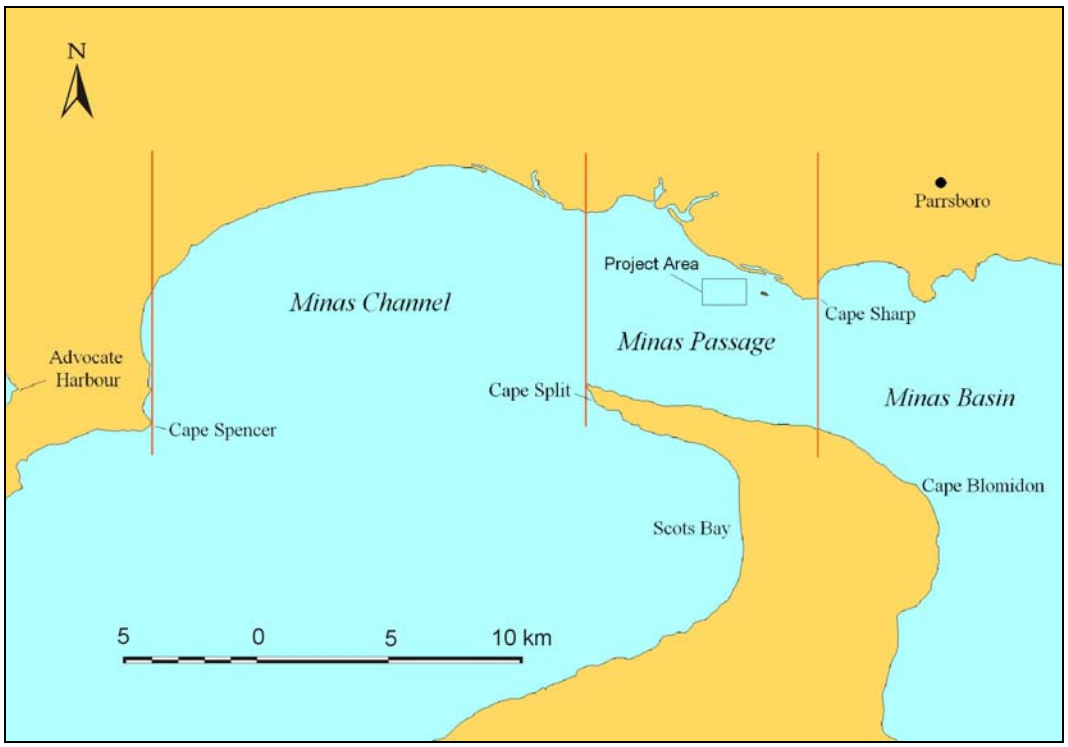


Figure 1b. Study area for vessel surveys, showing project location and major subdivisions.

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 heading and vessel velocity was used for subsequent analysis[5]. 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 observation periods; 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)[6]. Abundance expressed per unit area is a more accurate estimate of density of offshore birds, although it may exclude some species (e.g. less common species seen outside the 300 m distance from the vessel). 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).

[5] Distance based on ship speed was used 2012 because of an omission of GPS endpoints for survey intervals. Distance based on start and end points of survey intervals in 2010 & 2011 while the 2009 survey used vessel speed.
[6] 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.

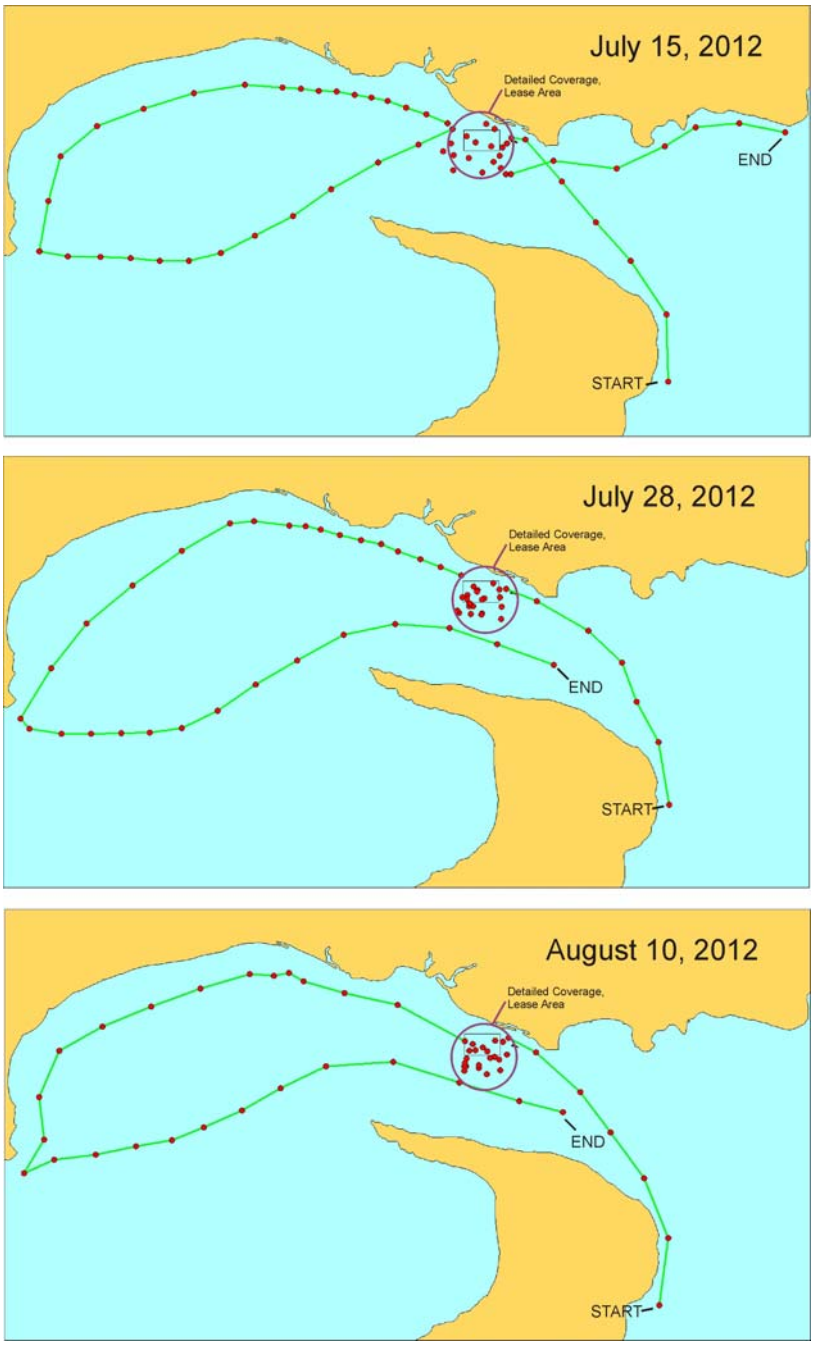


Figure 2. Survey route for July and August seabird surveys in 2012. Points indicate locations of start points for 5-minute observation periods during seabird and waterfowl survey.

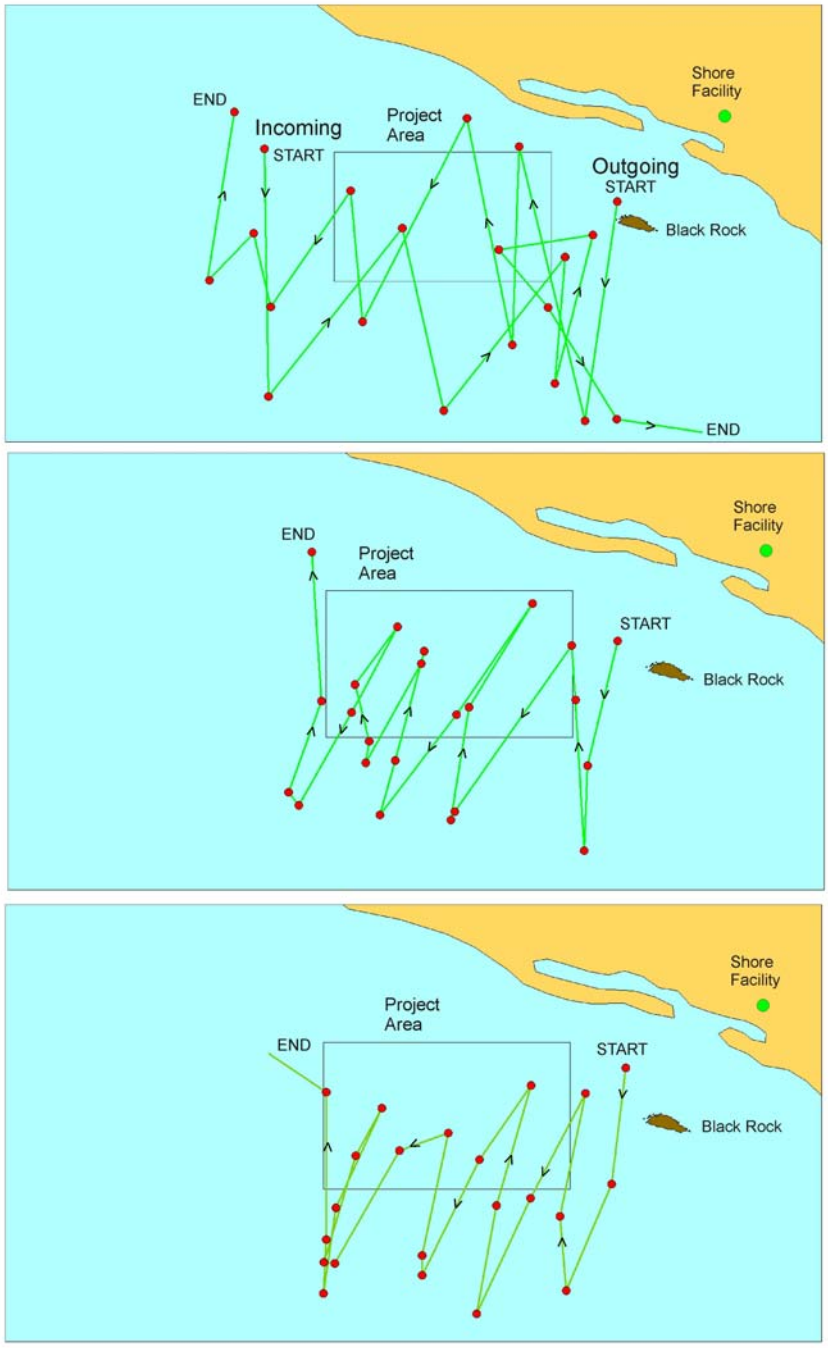


Figure 3. Survey route for seabird observations focused on Project Area, July & August, 2012. Points indicate locations of start points for 5-minute observation periods.

3 RESULTS AND DISCUSSION

3.1 Marine Mammals

Three species of marine mammals, the Harbour Porpoise (*Phocoena phocoena)*, the Grey Seal (*Halichoerus grypus)* and Harbour Seal (*Phoca vitulina*) were observed in the vessel- and shore-based

surveys in 2012. Harbour Porpoise was by far the dominant species (105 individuals observed)[7], versus three Grey Seals (one observed on the July 15 vessel survey & two on the August 29 shore survey); and one Harbour Seal on each of the July 15 (vessel) and August 29 (shore-based) surveys (Table 1; Figure 4). Harbour Porpoise occurred and were sometimes abundant in Minas Passage at the shore facility throughout the observation period (June 21 to August 29), with the highest number of sightings in early July and mid-August (Table 1)(none were observed on July 18). The species typically occurred in Minas Passage and the proposed turbine installation area with no apparent preference, and a single individual was observed between Black Rock and shore. Abundances were comparable to those in earlier surveys (Spring 2011 and Fall 2010), with peak abundance of 2.58 individuals per 30-minute period in the August 15 survey (including 17 individuals in one 30-minute period)(the highest average abundance observed previously was 3.17 per 30-minute survey in late March 2011); and 1.92 individuals per 30-minute survey on July 4. The species occurred typically singly or in groups of 2-3, but groupings of up to 5-8 individuals also occurred (Appendix Figure A1), and similar size groupings were observed in the vessel survey (Appendix Figure A2). Harbour Porpoise observed in the shore-based survey typically were seen in the tidal stream outside Black Rock and extending through the proposed turbine installation area, usually swimming seaward with the outgoing tidal stream which passed over the proposed tidal installation at the site, but some of the sightings involved individuals circling and thought to be feeding. Summer occurrences observed at the shore facility appear to correlate with observations in the vessel survey, which also had significant occurrences of Harbour Porpoise in early July (32 individuals on July 15 versus 5 on July 28 and 1 on August 10). In contrast, Harbour Porpoise were not common or abundant in Minas Passage in previous summer vessel surveys (2009-2011). The observations suggest that Harbour Porpoise may not occur regularly in summer at the site and that 2012 was an exception, possibly in response to changes in food species distribution and availability. The seasonal movements observed at the site has previously been thought to follow the movements of herring into Minas Basin in the Spring, and to be largely absent at other times of the year. In 2012 there were anecdotal accounts of movements of squid into the area in summer, and it is possible the occurrence of Harbour Porpoise this year reflects a response to the availability of this food species.

More Harbour Porpoise were observed on the vessel surveys in 2012 than in all previous years (2009-2011) (the previous high was 19 individuals observed 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 and probably a response to prey species movements.

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 2010-2011 shore-based monitoring showed that both species were present, with Harbour Porpoise relatively common in the Spring as early as March, and late Fall, but not early winter. The present study extends the seasonal occurrence of Harbour Porpoise through the summer (late June to late August) with significant numbers (some of the highest abundances observed at the site) occurring in mid-July and mid-August (Figure 5). Harbour Porpoise are therefore regular visitors to the Tidal Demonstration site, observed during nine of the thirteen surveys conducted in 2010 & 2011 and five of six surveys in 2012, over the early-March to late-November period. Overall abundance of Harbour Porpoise has varied seasonally with moderate numbers occurring in early March, April and November; peak numbers in late March, early July and mid-August, and low to moderate numbers in late April, May, June-August, October and late November (Figure 5). No data is

[7] Harbour Porpoise sightings in the shore survey usually represent unique sightings of individuals, as individuals 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.

Table 1. Marine mammal observations during seabird and marine mammal surveys, Minas Basin, Minas Passage and Minas Channel, June - August 2012.

Date	Time (ADT)	Survey Component	Location	Species	Number
June 21, 2012	1653-1723	Shore	45 22.263N 64 24.348W	Harbour Porpoise	1
	1753-1823	"	"	Harbour Porpoise	1
	1853-1923	"	"	Harbour Porpoise	1
July 4, 2012	1330-1400	Shore	45 22.263N 64 24.348W	Harbour Porpoise	1
	1430-1500	"	"	Harbour Porpoise	6
	1500-1530	"	"	Harbour Porpoise	3
	1600-1630	"	"	Harbour Porpoise	5
	1630-1700	"	"	Harbour Porpoise	3
	1700-1730	"	"	Harbour Porpoise	1
	1830-1900	"	"	Harbour Porpoise	1
	1900-1930	"	"	Harbour Porpoise	3
July 15, 2012	1050-1055	Vessel	45 17.68N 64 19.18W	Harbour Porpoise	4
	1100-1105	"	45 19.02N 64 20.49W	Harbour Porpoise	6
	1110-1115	"	45 19.97N 64 21.75W	Harbour Porpoise	2
	1140-1145	"	45 22.05N 64 21.55W	Harbour Porpoise	7
	1150-1155	"	45 21.13N 64 24.98W	Harbour Porpoise	2
	1200-1205	"	45 22.27N 64 25.37W	Harbour Porpoise	3
	1220-1225	"	45 22.38N 64 21.96W	Harbour Porpoise	2
	1330-1335	"	45 22.60N 64 27.83W	Harbour Porpoise	4
	1610-1615	"	45 18.87N 64 48.45W	Harbour Seal	1
	1740-1745	"	45 21.37N 64 29.52W	Harbour Porpoise	2
	1900-1905	"	45 21.90N 64 24.95W	Grey Seal	1
July 28, 2012	0922-0927	Vessel	45 21.19N 64 25.76W	Harbour Porpoise	5
August 2, 2012	1255-1325	Shore	45 22.263N 64 24.348W	Harbour Porpoise	3
	1355-1425	"	"	Harbour Porpoise	2
	1455-1525	"	"	Harbour Porpoise	2
	1555-1625	"	"	Harbour Seal	1
August 10, 2012	1500-1505	Vessel	45 20.37N 64 24.40W	Harbour Porpoise	1
August 15, 2012	1200-1230	Shore	45 22.263N 64 24.348W	Harbour Porpoise	17
	1300-1330	"	"	Harbour Porpoise	6
	1330-1400	"	"	Harbour Porpoise	8
August 29, 2012	1000-1030	Shore	45 22.263N 64 24.348W	Grey Seal	1
	1030-1100	"	"	Grey Seal	1
	1100-1130	"	"	Harbour Seal	1

available for January and February, as surveys were not conducted during these times. Seals are uncommon visitors to the Minas Passage and the Tidal Demonstration site, and in 2012 a single individual each for Harbour Seal and Grey Seal occurred during the August 29 survey between Black Rock and shore (Figure 4, Table 1).

Both vessel and shore surveys in early July demonstrated highest abundance and frequency of occurrence of Harbour Porpoise (although the August 15 shore survey showed high numbers in several observation periods (Table 1, Figure 5) that was not detected in the August 10 vessel survey. Frequent sightings of Harbour Porpoise, the highest number on vessel surveys to date, were made on the July 15 vessel survey in both Minas Basin and Minas Passage (Table 1 & Figure 6). All but three individuals (two on July 15 and one on August 10) were observed on the high to slightly ebbing tide.

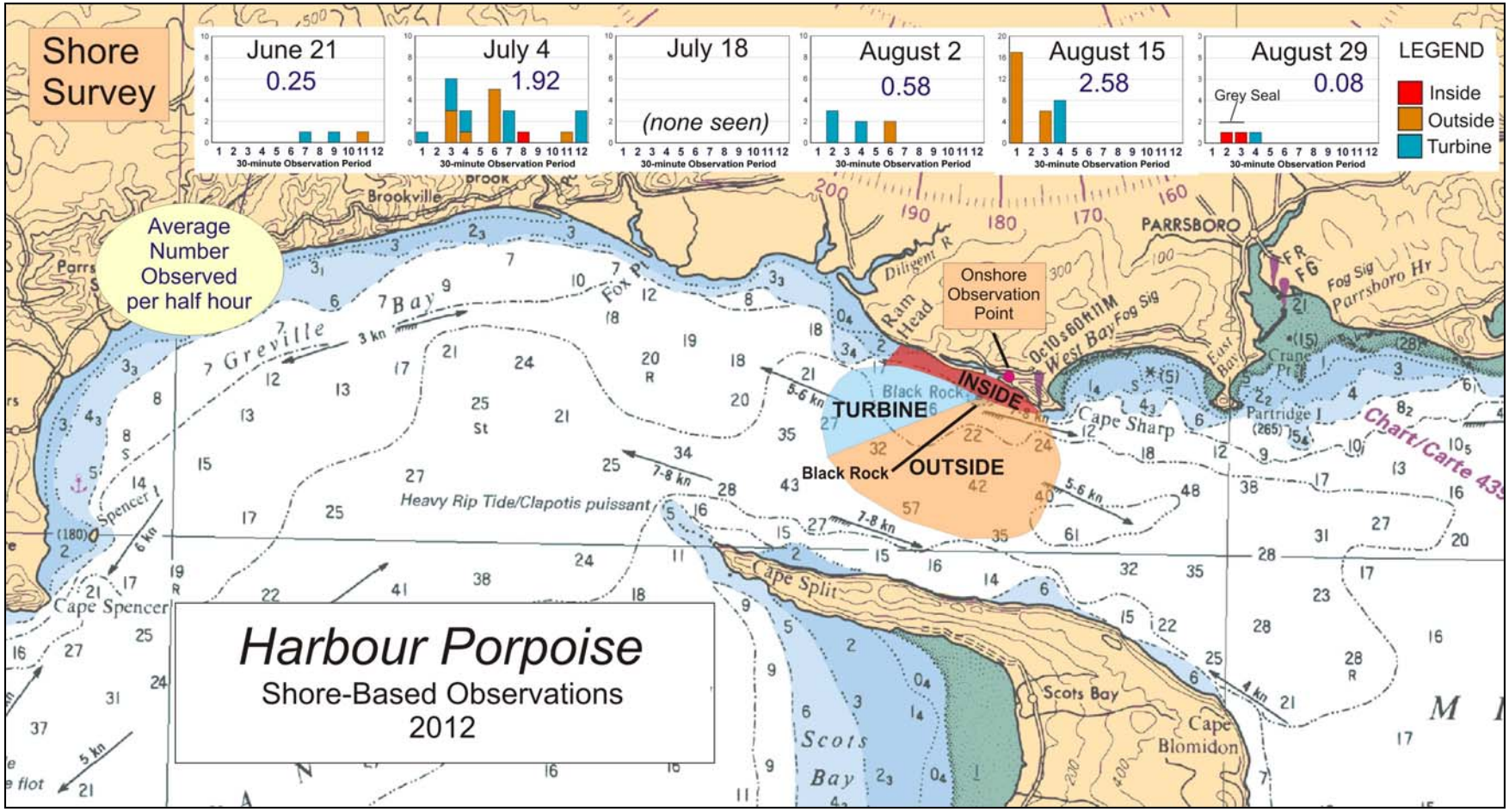


Figure 4. Sightings of marine mammals (Harbour Porpoise and Grey Seal) from shore observations, June to August 2012. Approximate area viewed from shore is shown and terms describe sub-areas used in the text.

Vessel surveys in previous years (2009-2011) did not identify significant Harbour Porpoise occurrences in July-August in the study area; however the vessel survey observations did correlate this year, when shore observations also showed Harbour Porpoise, suggesting that the summer of 2012 had a greater number of Harbour Porpoise in the area than in a typical year.

In addition to Harbour Porpoise, occasional seals (both Harbour Seal and Grey Seal) were the only marine mammals seen in the three vessel surveys in July-August, similar to the results in 2010 (no seals were seen in 2011), and Harbour Seal were seen in the 2009 surveys. The only other marine mammals seen in the monitoring program (2009-2012) were White-Sided Dolphin and an unidentified whale, both occurrences in 2009. 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 typically from Summer to Fall, but as noted in our study, occurring from Spring to Fall in Minas Passage. 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 with major breeding populations in the Gulf of St. Lawrence and on Sable Island, from which the species disperses into nearshore waters. Harbour Seal (*Phoca vitulina*) is a small species widely distributed along the east coast of North America north of Cape Cod. The species is often associated with bays and inlets from which its name is derived. Harbour Seal population trends in the Bay of Fundy are unknown, with trends in adjacent areas ranging from increasing (Maine) to decreasing (Sable Island)(Baird 2001).

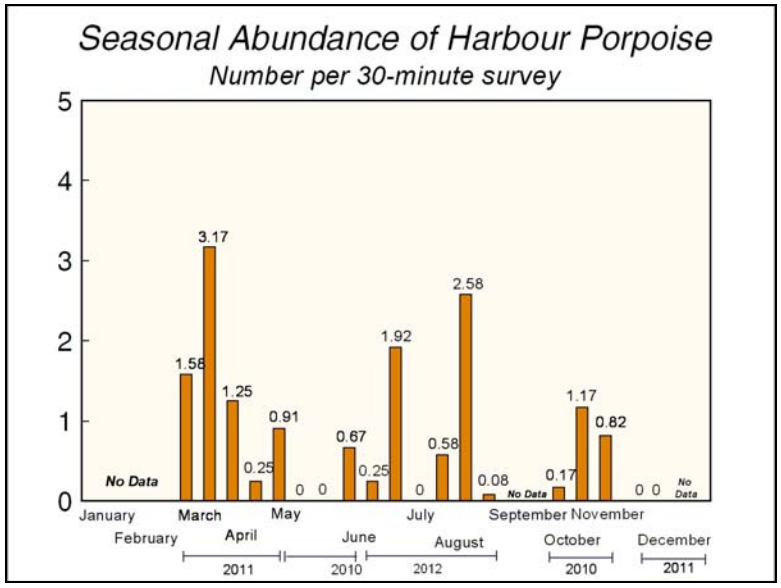


Figure 5. Seasonal occurrence of Harbour Porpoise (*Phocoena phocoena)* during shore-based surveys in Minas Passage at the shore installation of the Fundy Tidal Energy Demonstration Facility, 2010- 2012.

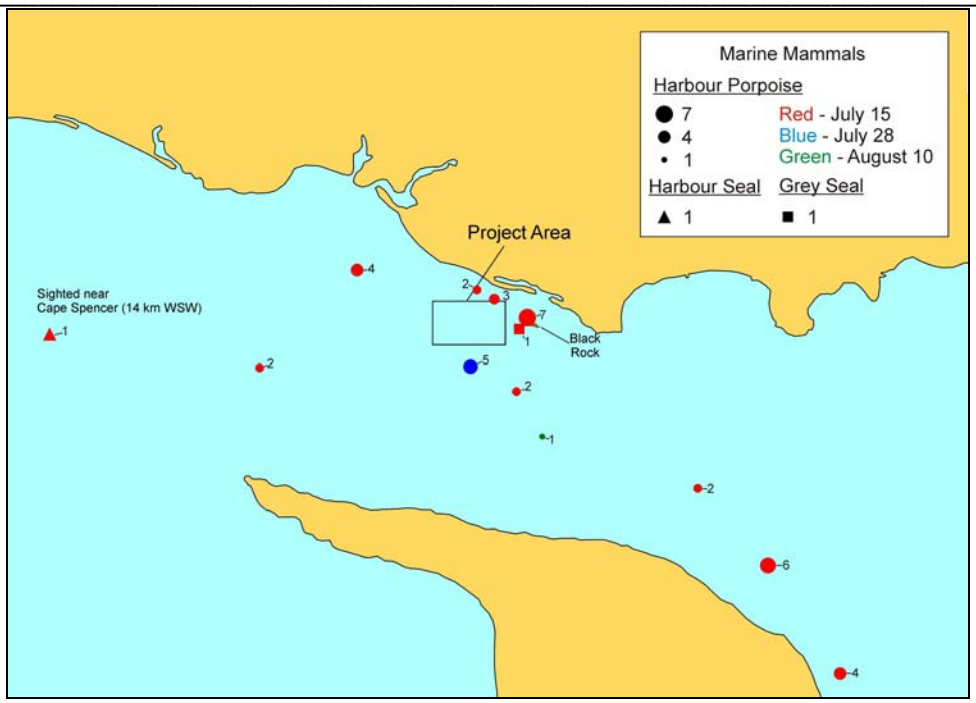


Figure 6. Occurrences of marine mammals in vessel surveys in Minas Basin, Minas Passage and Minas Channel, July & August, 2012. Each point shows sightings in a 5-minute observation period.

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 (July & August, 2009 through 2011) and fell within the range of earlier surveys except for Minas Passage, which had the highest effort for July-August of any of the surveys (Figure 7 & Table 2); Minas Basin had lower effort. Sampling effort in Minas Passage was higher than the other areas, as well as compared with past years[8].

All surveys had good observation conditions, although the August 10 survey had a lower but acceptable visibility in Minas Channel due to intermittent fog. Lower visibility, while not greatly impacting quantitative observations within 300 m of the vessel, would reduce the total number of sightings.

[8] 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 2012 survey effort was about 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 2012.

		Distance Sampled (km)		
	Overall	July 15	July 28	August 10
Minas Basin	28.19	12.80	7.11	8.28
Minas Passage	76.61	26.05	25.72	24.83
Minas Channel	55.55	17.59	18.30	19.66
Total	160.35	56.45	51.13	52.77
	Overall	Area Sampled[1] (km^2)		
Minas Basin	8.46	3.84	2.13	2.48
Minas Passage	22.98	7.82	7.72	7.45
Minas Channel	16.66	5.28	5.49	5.90
Total	48.10	16.93	15.34	15.83
	Overall	Number of Observations Periods[2]		
Minas Basin	22	10	6	6
Minas Passage	87	28	32	27
Minas Channel	64	22	22	20
Total	173	60	60	53

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

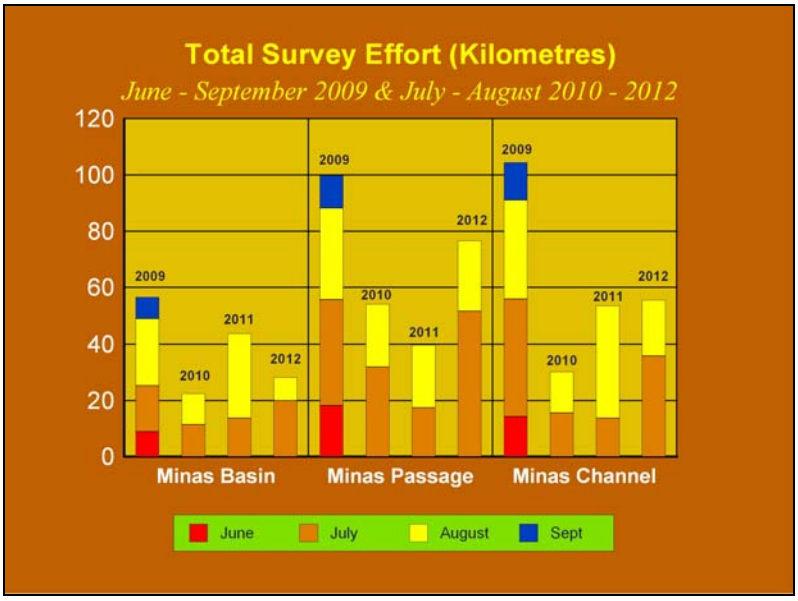


Figure 7. Distance surveyed (kilometres), June to September 2009 and July & August 2010 - 2012.

3.2.1.2 Species Composition

Overall, 235 individuals of 9 species of seabirds and waterfowl were sighted during the vessel surveys (Figures 8-11 and Tables 3-6)[9]. Number of sightings was in the range observed in the 2009-2011 period (Figure 8) but Minas Passage tended to have more sightings. Total sightings reflects effort (i.e. number of sample periods/distance) as well as overall abundance of birds. Number of species of seabirds and waterfowl were similar between areas on individual surveys and in total, ranging from 5-7 in each area on July 15 (total of 9); 3-6 (total of 7) on July 28; and 2-4 in each area on August 10 (total of 5) (Tables 3-6). Herring Gull (*Larus argentatus)* and Great Black-Backed Gull (*Larus marinus*) were the most abundant and common birds (40.9 and 17.9% of individuals sighted respectively, occurring in 25.4 and 13.9% of observation periods, respectively, Table 3). Herring Gull was a dominant in all surveys, and Great Black-Backed Gull was a dominant in the first July survey. Ring-Billed Gull was a dominant species in August (the latter a similar pattern to 2010 & 2011) (Tables 3-6, Figures 10 & 11). Black Guillemot (*Ceppheus grylle*), a coastal Alcid species, and Common Loon (*Gavia immer)*, were also relatively abundant in the July surveys, but only Black Guillemot was relatively common. Double-Crested Cormorant and Common Eider occurred occasionally. Individual Great Cormorant and a Razorbill, an alcid species, were seen in the surveys (Figure 10).

Densities and diversity of seabirds and waterfowl seen during surveys in 2012 were comparable to or lower than those for earlier surveys, but July densities were comparable to earlier surveys and August observations were lower than earlier surveys for both abundance and diversity. Bird species diversity was comparable to earlier years, with one more species observed than in 2011, one fewer species observed than in 2010, and three 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, and Black Guillemot. Common Eider, which had occurred in both 2009 & 2010 and is a relatively common resident of the area, was not seen during the 2011 survey but occurred in 2012.

The number of sightings in the 2012 surveys (235) was in the range of all years for the July-August period (range from 103 to 201 individuals)(Figure 8) but most individuals were seen in the July 15 survey (sightings in late-July & August were among the lowest of the program). Overall bird abundance (number/km) in 2012 (1.47/km) was higher than in 2009 & 2011 but comparable to 2010 (1.51 per km). Abundance per unit area was lowest of all years (153.83 versus 184.72 (2011), 231.31 (2010) and 231.8 birds per 100 km^2 (July-August, 2009) (Tables 3-6). Overall abundance estimates (number per 100 km^2) in 2012 were among the lowest, though the estimate for July 15, 2012 was among the highest, comparable to July 2009 and 2010, though higher than July 2011. Abundances on July 28 and August 10, 2012, were the lowest over all years for most areas, while for Minas Channel, August levels were comparable to August values in most years. Compared with earlier surveys, the abundance of birds in Minas Channel was particularly low in 2012 (due to low numbers seen in August). Of all the surveys, August generally shows the lowest density of seabirds.

[9] One Least Sandpiper (*Calidris minutilla*) was heard in fog when the vessel drifted off transect in Minas Channel near Diligent River during the August 10 survey.

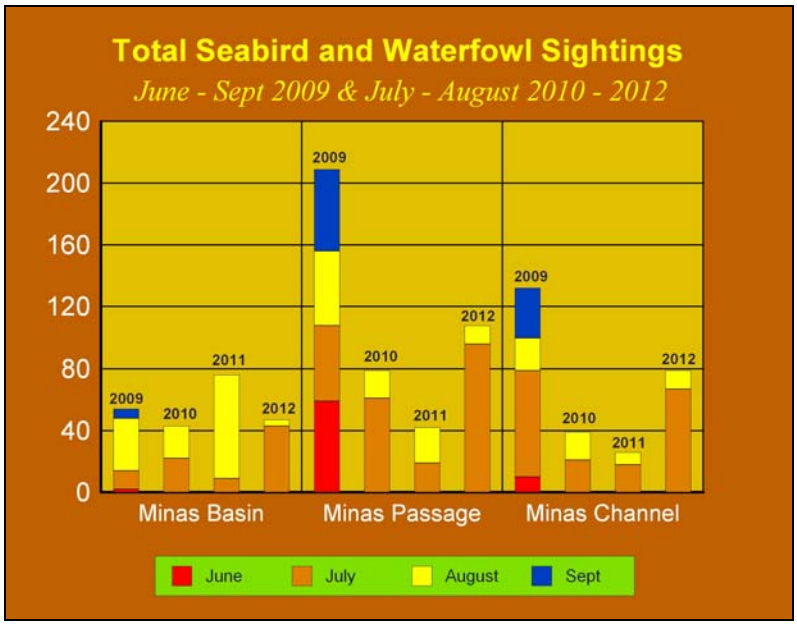


Figure 8. Summary of numbers of sightings of seabirds and waterfowl by area and month, from vessel surveys, June to September 2009 and July & August 2012 - 2012.

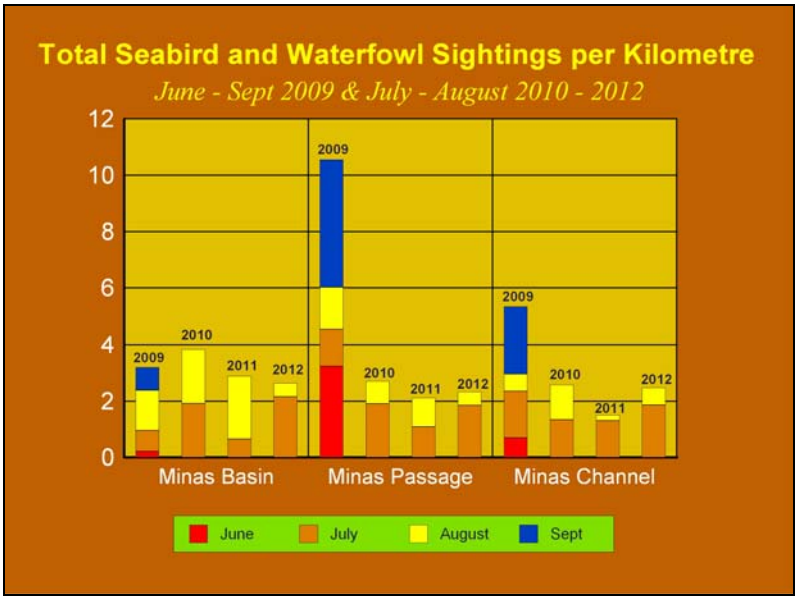


Figure 9. Summary of numbers of sightings of seabirds and waterfowl by area and month, from vessel surveys, adjusted for effort (kilometres surveyed) June to September 2009 and July & August 2010 - 2012.

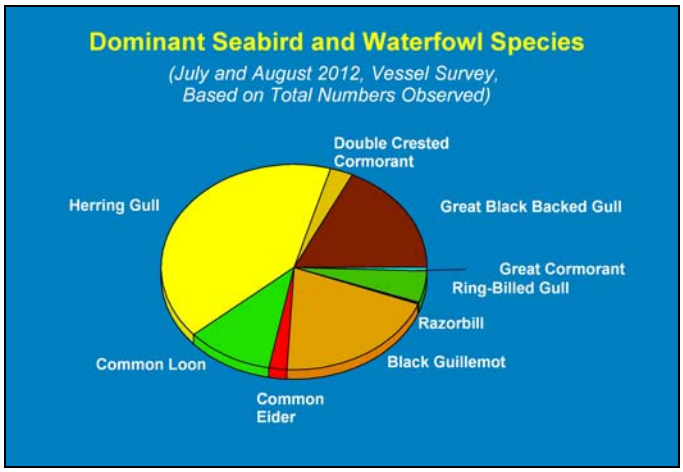
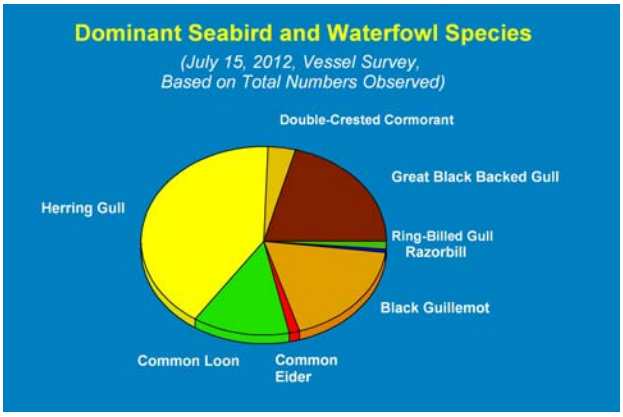
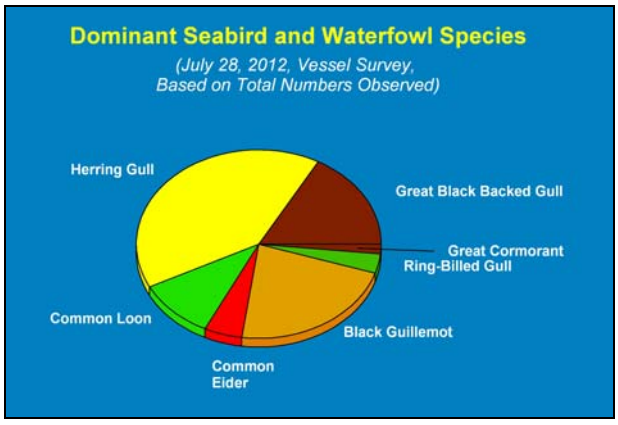


Figure 10. Species composition and relative abundance of seabird and waterfowl species observed in Minas Basin, Minas Passage and Minas Channel on vessel surveys, July & August 2012.





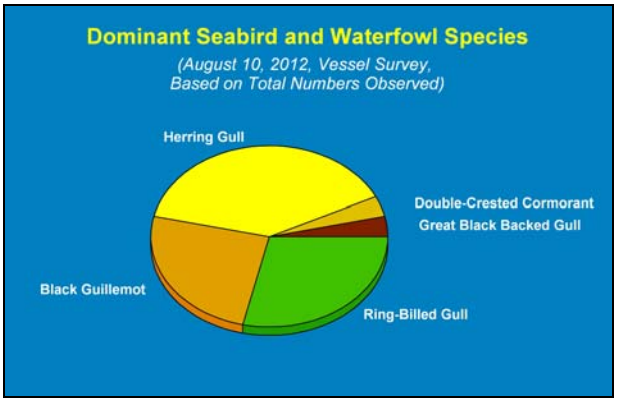


Figure 11. Species composition and relative abundance of seabird and waterfowl species by month, obtained in vessel surveys of Minas Basin, Minas Passage and Minas Channel, July & August 2012.

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 (Figures 12-13)[10]. Highest average abundance reached 3.5 birds per km^2 in Minas Passage on July 15 and lowest in Minas Channel on July 28 (0.2 birds/km^2, respectively, and no birds were seen in Minas Basin on August 10)(Figures 12-13 & 16; Tables 3-6). On July 15, abundances in the three sub-areas (Minas Basin, Minas Passage and Minas Channel) were all relatively high, while abundance in all areas dropped on the July 28 & August 10 surveys. Abundance patterns reflected those of the dominant species (Herring Gull, Great Black-Backed Gull, Common Loon & Black Guillemot) with only Herring Gull responsible for most of the bird numbers on August 10. Lowest abundance was in Minas Basin in August where no birds were seen. Abundance in Minas Passage declined both in terms of total sightings and density (Figures 12 &13). Abundance was typically lower in 2012 than in previous years but abundance on the July 15 survey was comparable to those observed previously (Figures 14 - 17).

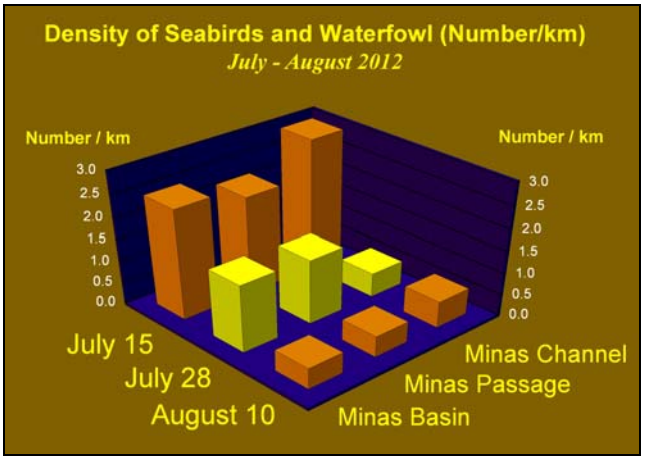


Figure 12. Abundance of seabirds and waterfowl (number/kilometre), July & August 2012.

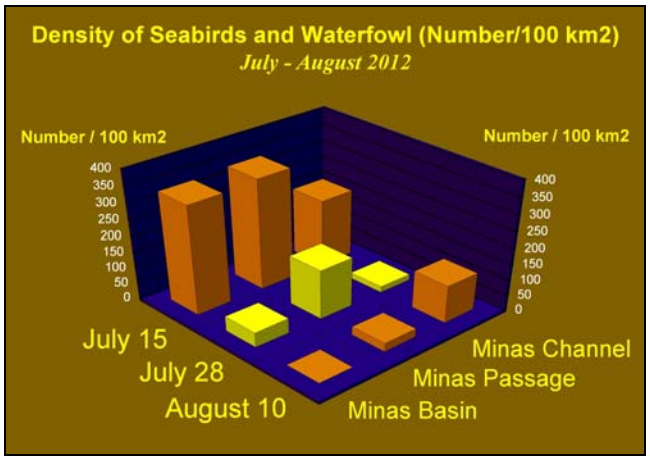


Figure 13. Abundance of seabirds and waterfowl (number/100 km^2), July & August 2012.

[10] 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 100 km^2" refers only to birds observed within 300 m of the side of the vessel on which observations were made.

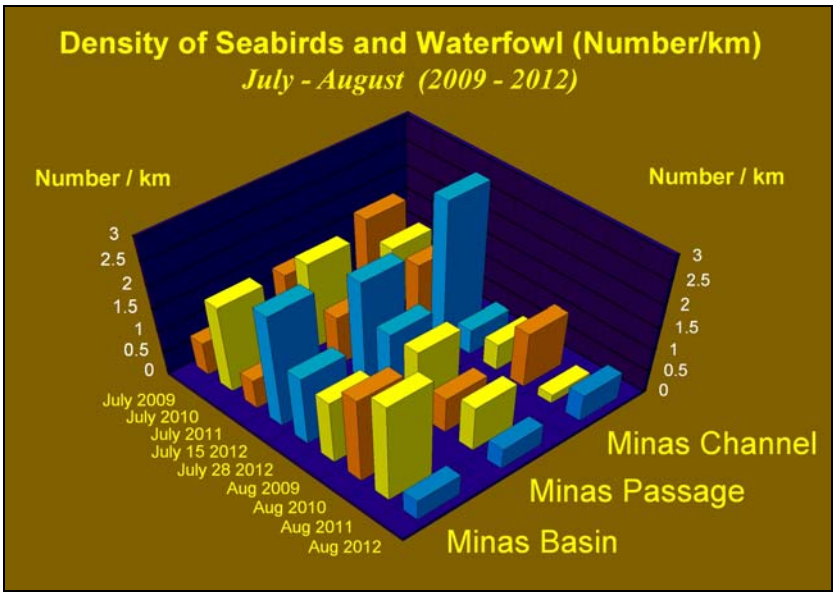


Figure 14. Abundance of seabirds and waterfowl (number/km) in vessel surveys, July & August 2009 to 2012.

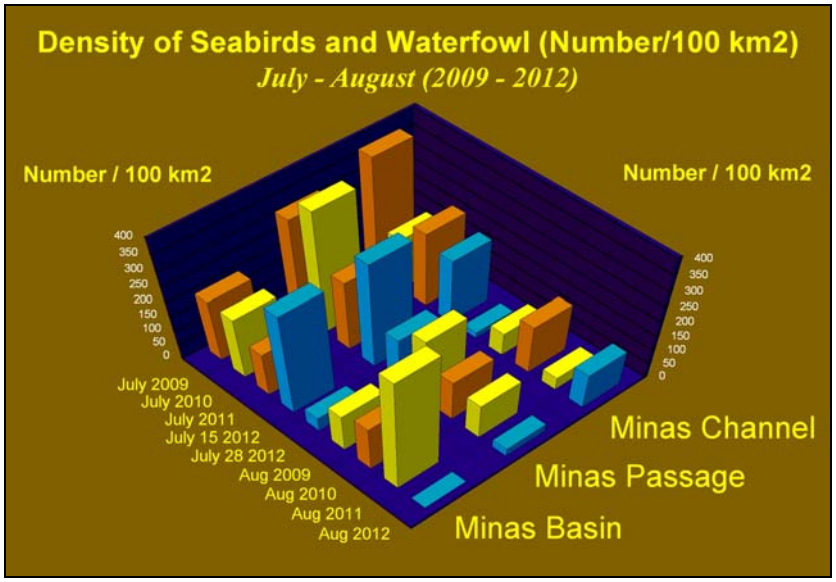


Figure 15. Abundance of seabirds and waterfowl (number/100 km^2) in vessel surveys, July & August 2009 to 2012.

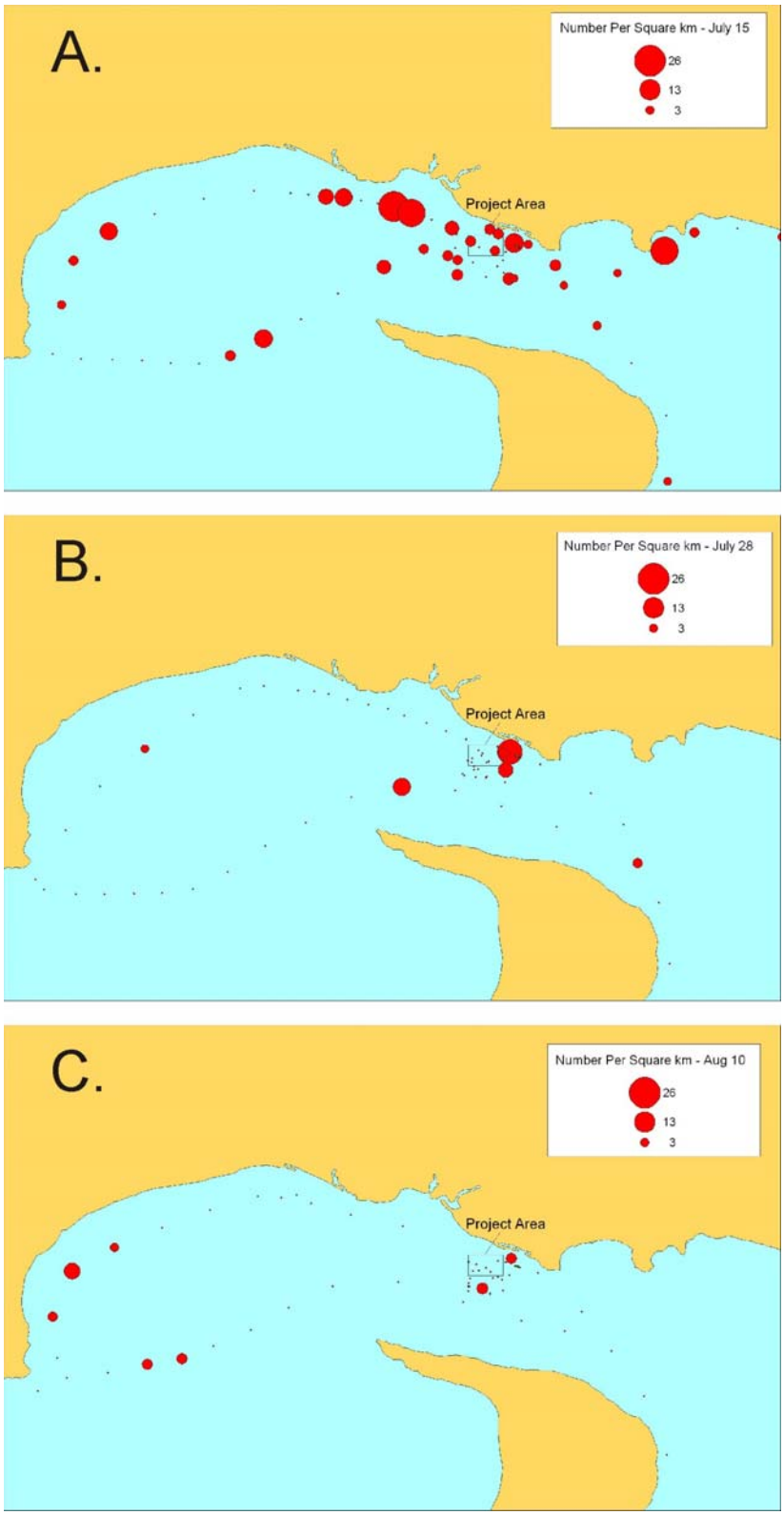


Figure 16. Overall abundance (individuals per square kilometer). of seabirds and waterfowl in Minas Basin, Minas Passage and Minas Channel, July and August, 2012.

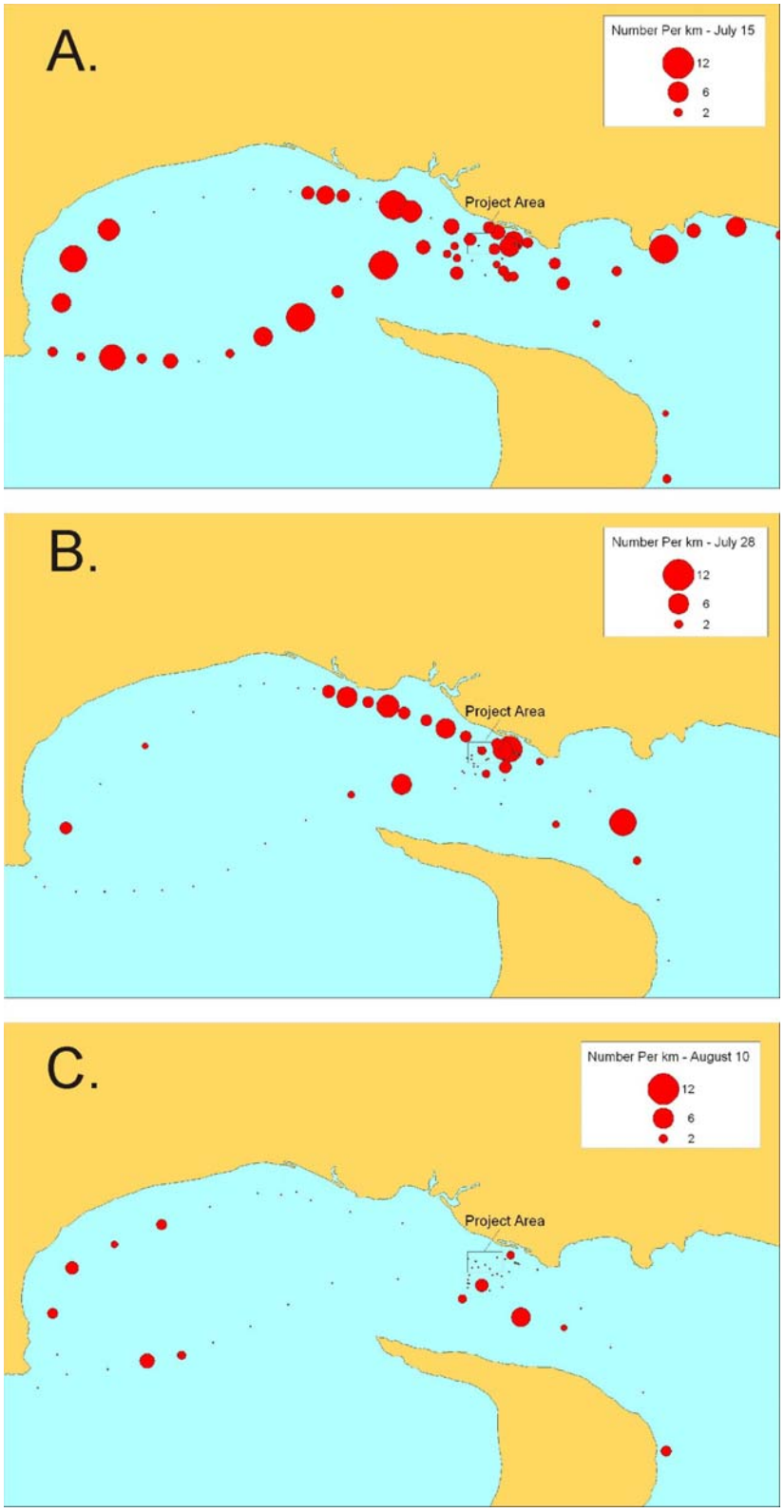


Figure 17. Overall abundance (individuals per kilometer). of seabirds and waterfowl in Minas Basin, Minas Passage and Minas Channel, July and August, 2012.

Table 3. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, July 15 & 28 & August 10, 2012. Number of observation periods: Minas Basin = 22; Minas Passage = 87; Minas Channel = 64. Number of immatures/juveniles shown in brackets.

Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Razorbill	Ring-Billed Gull	Great Cormorant
	Total Number Observed									
Minas Basin	47	1 (1)	1	23 (1)	3 (2)	1	15	0	3 (2)	0
Minas Passage	108	28 (6)	2	47 (5)	8 (4)	2 (1)	13	0	8 (1)	0
Minas Channel	80	13	3	26 (6)	14 (11)	2	19	1	1 (1)	1
Total	235	42 (7)	6	96 (12)	25 (17)	5 (1)	47	1	12 (4)	1
	Number / Kilometre									
Minas Basin	1.67	0.04	0.04	0.82	0.11	0.04	0.53	0.00	0.11	0.00
Minas Passage	1.41	0.37	0.03	0.61	0.10	0.03	0.17	0.00	0.10	0.00
Minas Channel	1.44	0.23	0.05	0.47	0.25	0.04	0.34	0.02	0.02	0.02
Overall	1.47	0.26	0.04	0.60	0.16	0.03	0.29	0.01	0.07	0.01
	Number Observed within 300 m survey area [1]									
Minas Basin	14	0	0	9	0	0	5	0	0	0
Minas Passage	41	10	0	21	0	1	6	1	2	0
Minas Channel	19	4	0	6	2	0	5	1	1	0
Total	74	14	0	36	2	1	16	2	3	0
	Number of Seabirds per 100 km^2									
Minas Basin	165.55	0.00	0.00	106.42	0.00	0.00	59.12	0.00	0.00	0.00
Minas Passage	178.40	43.51	0.00	91.37	0.00	4.35	26.11	4.35	8.70	0.00
Minas Channel	114.02	24.00	0.00	36.00	12.00	0.00	30.00	6.00	6.00	0.00
Overall	153.83	29.10	0.00	74.84	4.16	2.08	33.26	4.16	6.24	0.00
Survey	Observations	Frequency of Occurrence (% of observation periods)								
July 15, 2012	60	26.7	6.7	48.3	1.7	1.7	13.3	1.7	1.7	0.0
July 28, 2012	60	11.7	0.0	15.0	6.7	3.3	10.0	0.0	3.3	1.7
August 10, 2012	53	1.9	1.9	11.3	0.0	0.0	7.5	0.0	5.7	0.0
Overall	173	13.9	2.9	25.4	2.9	1.7	10.4	0.6	3.5	0.6

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

Table 4. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, July 15, 2012. Number of 5-minute observation periods: Minas Basin = 10; Minas Passage = 28; Minas Channel = 22. Number of immatures/juveniles shown in brackets.

Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Razorbill	Ring-Billed Gull	Great Cormorant
	Total Number Observed									
Minas Basin	32	0	0	12	3 (2)	1	15	0	1 (1)	0
Minas Passage	58	20 (3)	2	27 (4)	5 (4)	1 (1)	2	0	1 (1)	0
Minas Channel	58	11	3	22 (5)	11 (9)	0	10	1	0	0
Total	148	31 (3)	5	61 (9)	19 (15)	2 (1)	27	1	2 (2)	0
	Number / Kilometre									
Minas Basin	2.50	0.00	0.00	0.94	0.23	0.08	1.17	0.00	0.08	0.00
Minas Passage	2.23	0.77	0.08	1.04	0.19	0.04	0.08	0.00	0.04	0.00
Minas Channel	3.30	0.63	0.17	1.25	0.63	0.00	0.57	0.06	0.00	0.00
Overall	2.62	0.55	0.09	1.08	0.34	0.04	0.48	0.02	0.04	0.00
	Number Observed within survey area[1]									
Minas Basin	13	0	0	8	0	0	5	0	0	0
Minas Passage	27	7	0	15	0	1	2	1	1	0
Minas Channel	11	3	0	4	2	0	1	1	0	0
Total	51	10	0	27	2	1	8	2	1	0
	Number of Seabirds per 100 km^2									
Minas Basin	338.48	0.00	0.00	208.29	0.00	0.00	130.18	0.00	0	0
Minas Passage	345.43	89.56	0.00	191.90	0.00	12.79	25.59	12.79	12.79	0
Minas Channel	208.44	56.85	0.00	75.80	37.90	0.00	18.95	18.95	0	0
Overall	301.16	59.05	0.00	159.44	11.81	5.91	47.24	11.81	5.91	0

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

Table 5. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, July 28, 2012. Number of 5-minute observation periods: Minas Basin = 6; Minas Passage = 32; Minas Channel = 22. Number of immatures/juveniles shown in brackets.

Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Razorbill	Ring-Billed Gull	Great Cormorant
	Total Number Observed									
Minas Basin	11	1 (1)	0	9 (1)	0	0	0	0	1 (1)	0
Minas Passage	38	8 (3)	0	14	3	1	11	0	1	0
Minas Channel	10	1	0	1	3 (2)	2	2	0	0	1
Total	59	10 (4)	0	24 (1)	6 (2)	3	13	0	2 (1)	1
	Number / Kilometre									
Minas Basin	1.55	0.14	0.00	1.27	0.00	0.00	0.00	0.00	0.14	0.00
Minas Passage	1.48	0.31	0.00	0.54	0.12	0.04	0.43	0.00	0.04	0.00
Minas Channel	0.55	0.05	0.00	0.05	0.16	0.11	0.11	0.00	0.00	0.05
Overall	1.15	0.20	0.00	0.47	0.12	0.06	0.25	0.00	0.04	0.02
	Number Observed within survey area[1]									
Minas Basin	1	0	0	1	0	0	0	0	0	0
Minas Passage	12	3	0	4	0	0	4	0	1	0
Minas Channel	1	0	0	1	0	0	0	0	0	0
Total	14	3	0	6	0	0	4	0	1	0
	Number of Seabirds per 100 km^2									
Minas Basin	46.91	0.00	0.00	46.91	0.00	0.00	0.00	0.00	0.00	0.00
Minas Passage	155.53	38.88	0.00	51.84	0.00	0.00	51.84	0.00	12.96	0.00
Minas Channel	18.21	0.00	0.00	18.21	0.00	0.00	0.00	0.00	0.00	0.00
Overall	91.28	19.56	0.00	39.12	0.00	0.00	26.08	0.00	6.52	0.00

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

Table 6. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, August 10, 2012. Number of 5-minute observation periods: Minas Basin = 6; Minas Passage = 27; Minas Channel = 20. Number of immatures/juveniles shown in brackets.

Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Razorbill	Ring-Billed Gull	Great Cormorant
	Total Number Observed									
Minas Basin	4	0	1	2	0	0	0	0	1	0
Minas Passage	12	0	0	6 (1)	0	0	0	0	6	0
Minas Channel	12	1	0	3 (1)	0	0	7	0	1 (1)	0
Total	28	1	1	11 (2)	0	0	7	0	8 (1)	0
	Number / Kilometre									
Minas Basin	0.48	0.00	0.12	0.24	0.00	0.00	0.00	0.00	0.12	0.00
Minas Passage	0.48	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.24	0.00
Minas Channel	0.61	0.05	0.00	0.15	0.00	0.00	0.36	0.00	0.05	0.00
Overall	0.53	0.02	0.02	0.21	0.00	0.00	0.13	0.00	0.15	0.00
	Number Observed within Survey Area[1]									
Minas Basin	0	0	0	0	0	0	0	0	0	0
Minas Passage	2	0	0	2	0	0	0	0	0	0
Minas Channel	7	1	0	1	0	0	4	0	1	0
Total	9	1	0	3	0	0	4	0	1	0
	Number of Seabirds per 100 km^2									
Minas Basin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minas Passage	26.84	0.00	0.00	26.84	0.00	0.00	0.00	0.00	0.00	0.00
Minas Channel	118.70	16.96	0.00	16.96	0.00	0.00	67.83	0.00	16.96	0.00
Overall	56.85	6.32	0.00	18.95	0.00	0.00	25.27	0.00	6.32	0.00

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 except in 2011, and in 2012 was the most abundant seabird overall and the most commonly observed in the study area. 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 on all surveys, and was highest in abundance in Minas Basin and Minas Passage on July 15 (2.1 & 1.9 birds per km^2), and low in Minas Channel (0.8 birds per km^2). For all areas, abundance of Herring Gull was low on July 28 & August 10 (Figures 18 & 19). No Herring Gull were seen in Minas Basin on August 10. Most individuals were adults with immatures and juveniles making up about a sixth of numbers (July 15, 14.8%; July 28, 4.2%; and August 10, 18.2%)(Tables 3-6, Figure 20).

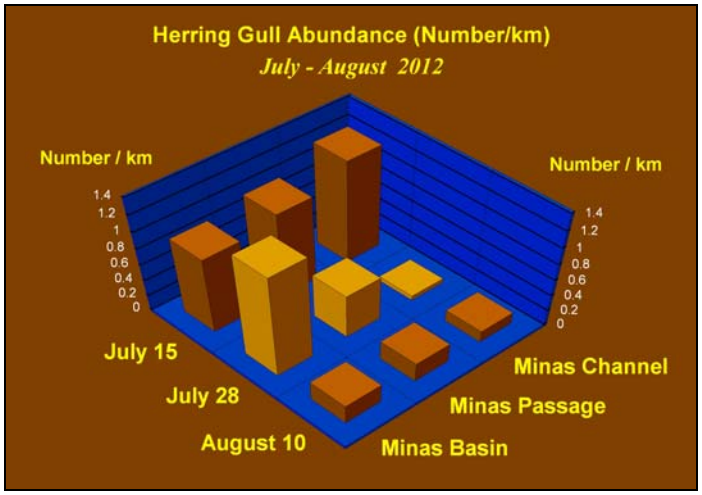


Figure 18. Abundance of Herring Gulls (number/kilometre), July & August 2012.

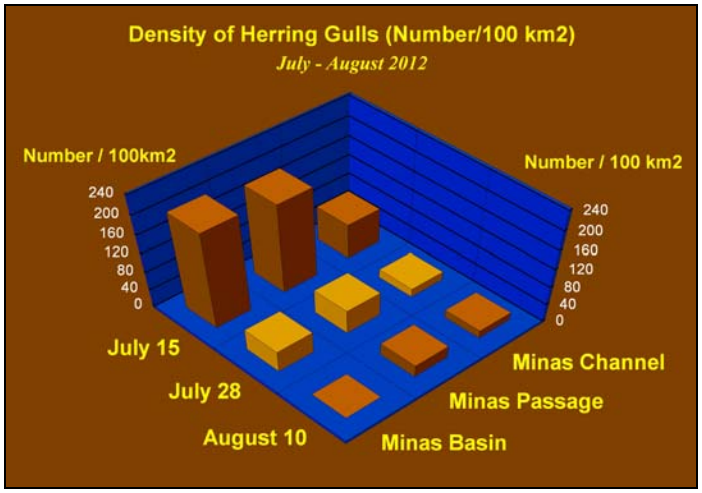


Figure 19. Density of Herring Gulls (number/100 km^2), July & August 2012.

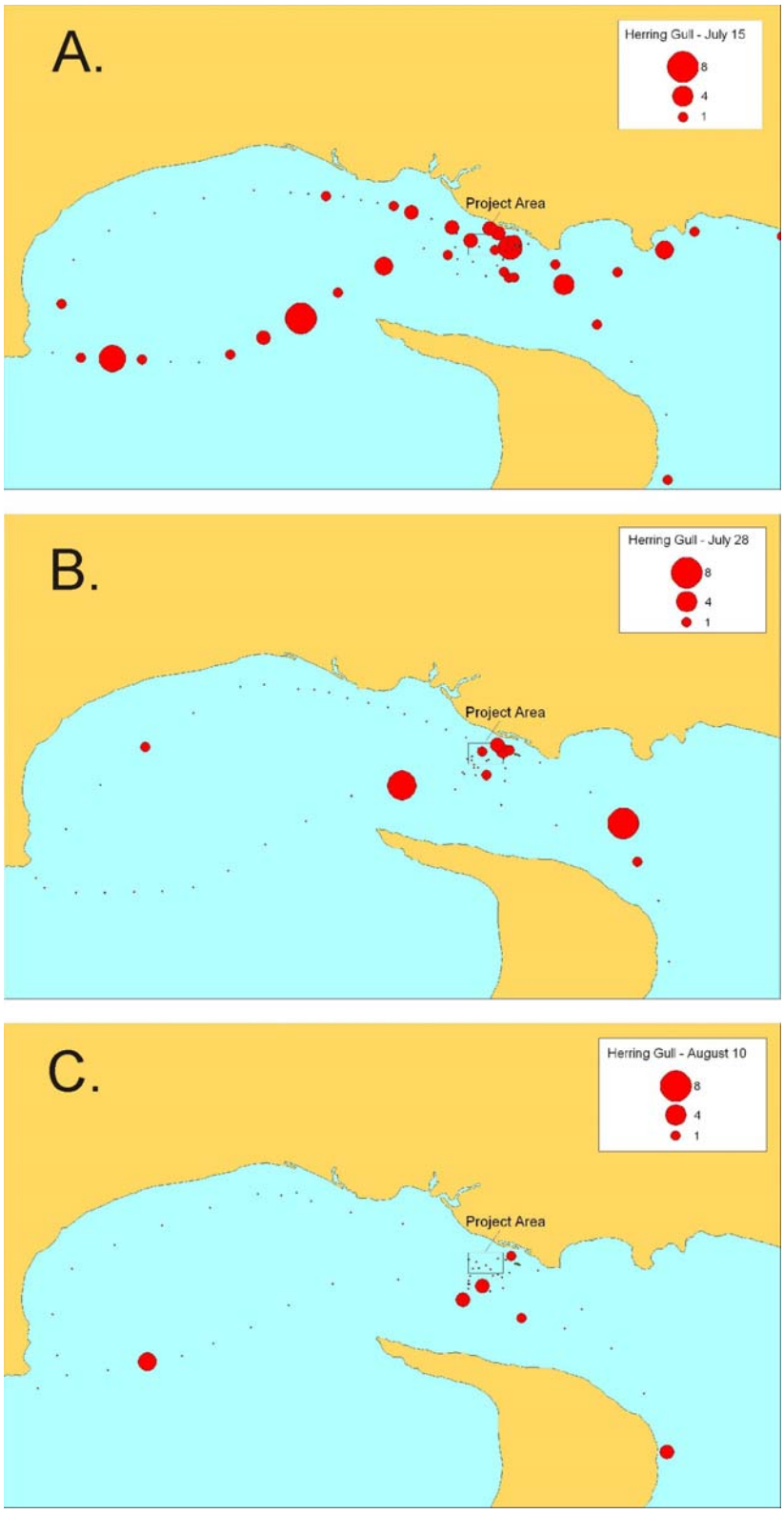


Figure 20. Distribution and abundance of Herring Gull (individuals per 5-minute observation period) in Minas Basin, Minas Passage and Minas Channel, July & August, 2012.

Great Black-Backed Gull

Great Black-Backed Gull occurred occasionally in low abundance in all areas in July and only in Minas Channel in the August survey (Figure 21). Abundance was highest on July 15 at 0.9 birds per km^2 in Minas Passage and 0.6 birds per kilometre in Minas Channel (the species was not observed in Minas Basin (Tables 3-6)). Overall abundances were similar between years. Ninety percent of Great Black-Backed Gulls sighted in July were adults but immatures/juveniles accounted for 40% on July 28 (Tables 3-6). The species is a common annual breeder in Atlantic Canada, nesting 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 abundance and was largely localized to Minas Basin and Minas Passage (Tables 3-6)(Figure 22). Highest abundance was 0.2 birds per km^2 in August (Minas Channel), with a lower abundance in other areas (Table 3). Both adults and immatures/juveniles were observed, with mostly immatures and juveniles present in July and adults in August (Tables 3-6). Ring-Billed Gull is a common annual migrant and occasional summer resident, feeding typically at the water surface.

Black Guillemot

Black Guillemot were relatively abundant, all as adults, occurring in all surveys but most abundant on July 15 (27 individuals, 0.5 per kilometer) and lowest on August 10 (Figure 24). The species was seen in all parts of the study area on July 15, but only in Minas Passage and Minas Channel on July 28, and Minas Channel only on August 10. Highest abundance of Black Guillemot (47 individuals total) was recorded this year, although abundance was comparable to 2011 which also showed relatively high abundances (31 sightings)(only one individual was seen in 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.

Common Loon

The species is typically a common coastal resident which is occasionally abundant as adults in the study area, but was abundant in the July 15, 2012 survey (19 individuals, predominantly juveniles)(Figure 23). Only six individuals were observed on July 28 and none on August 10. Abundances of Common Loon in earlier years ranged from 1-7 per survey (2009), four in August 2011, and one in each 2010 survey (Tables 3-6, Figure 23). 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.

Abundance of Miscellaneous Seabird and Waterfowl Species

Common Eider

Common Eider, singly or in flocks, are typically encountered in vessel surveys, sometimes in high numbers, but occurred only occasionally on the July 28 survey, and none were observed in the August survey (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 2012 were low, less than 0.1 per kilometer.

Double-Crested Cormorant & Great 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 several juveniles were seen in Minas Passage/Minas channel on July 15 and a juvenile in Minas Basin on the August survey (Tables 3-6, Figure 25). Similar numbers were observed in 2009 to 2011 surveys with several individuals usually seen on, but occasionally absent from surveys. 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. Great Cormorant is an uncommon cormorant species which breeds in and migrates through the area in small numbers in Spring and Fall, and also winters in moderate numbers. It has been observed in shore-based surveys in 2010 & 2011 and again this year, and was seen during the vessel survey this year in outer Minas Channel near Cape Spencer (Figure 26).

Razorbill

Razorbill is a stocky alcid which was previously recorded in shore-based surveys in 2010, seen for the first time in the vessel survey in outer Minas Channel near Cape Spencer in 2012 (Figure 26). The species breeds in the Bay of Fundy where it maintains a stable population in the Outer Bay. Populations are highest in Winter, when numbers are augmented by northern migrants.

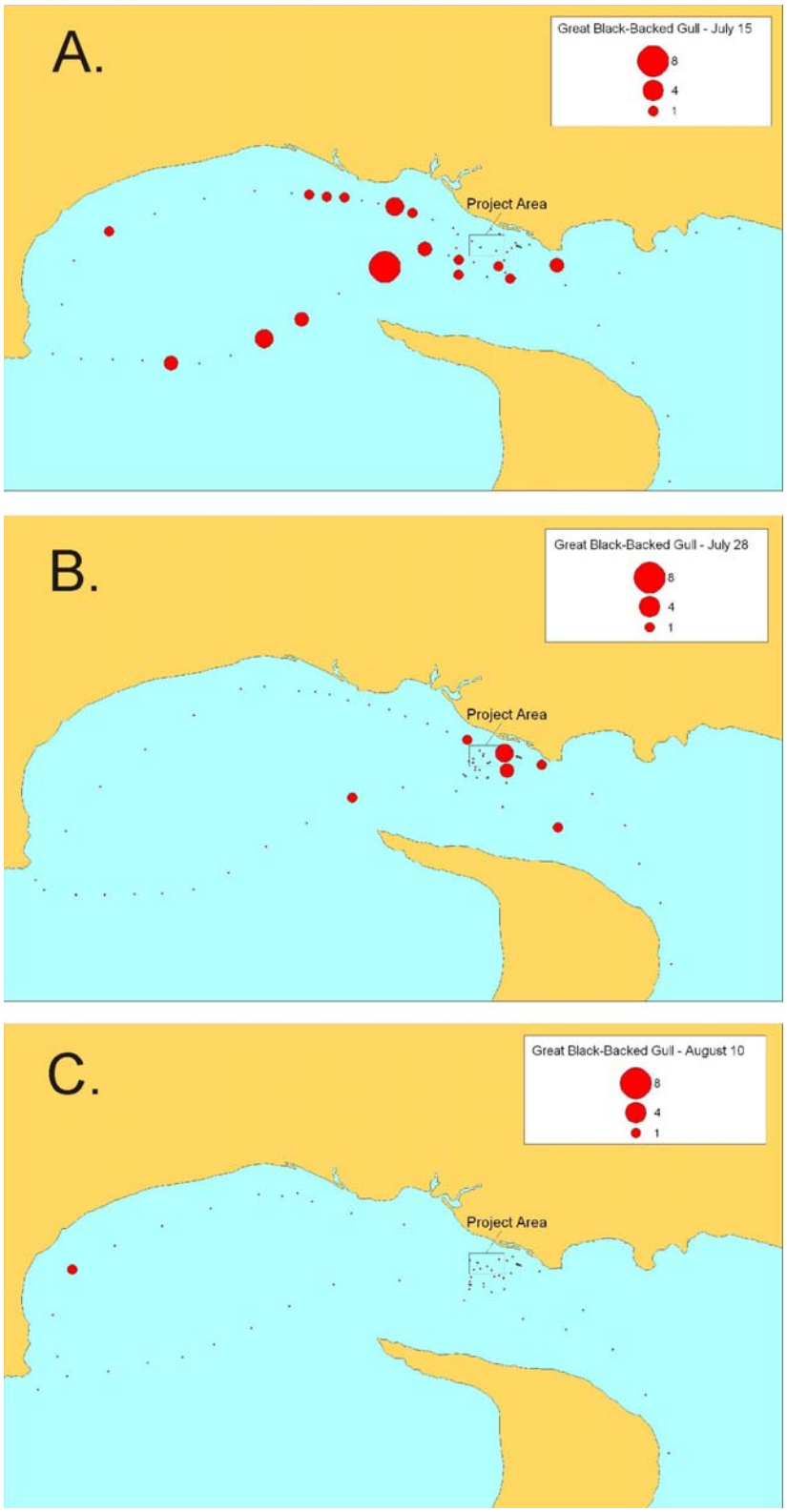


Figure 21. Distribution and abundance of Great Black-Backed (individuals per 5-minute observation period) Gull in Minas Basin, Minas Passage and Minas Channel, July & August, 2012.

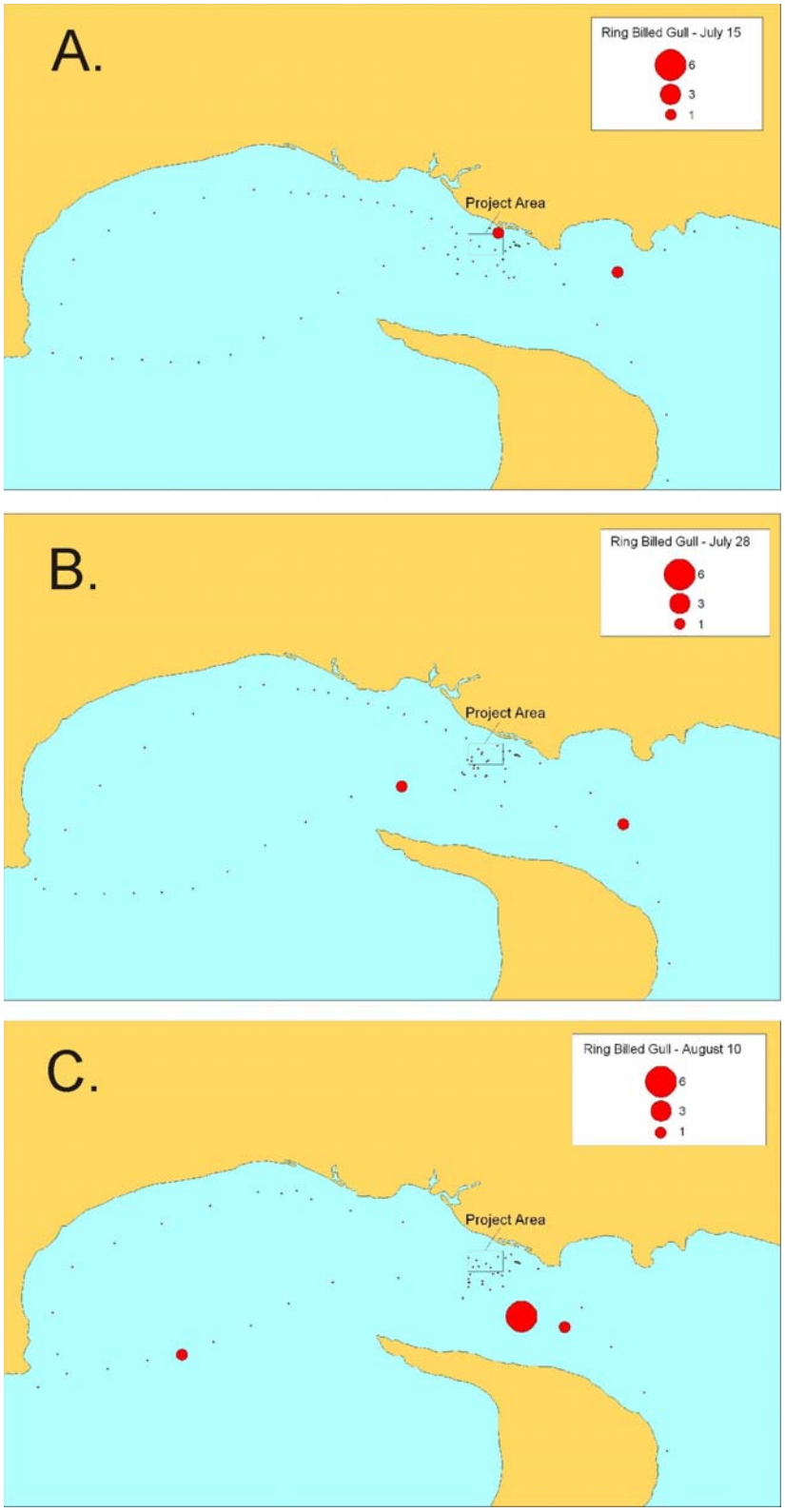


Figure 22. Distribution and abundance of Ring-Billed Gull (individuals per 5-minute observation period) in Minas Basin, Minas Passage and Minas Channel, July & August, 2012.

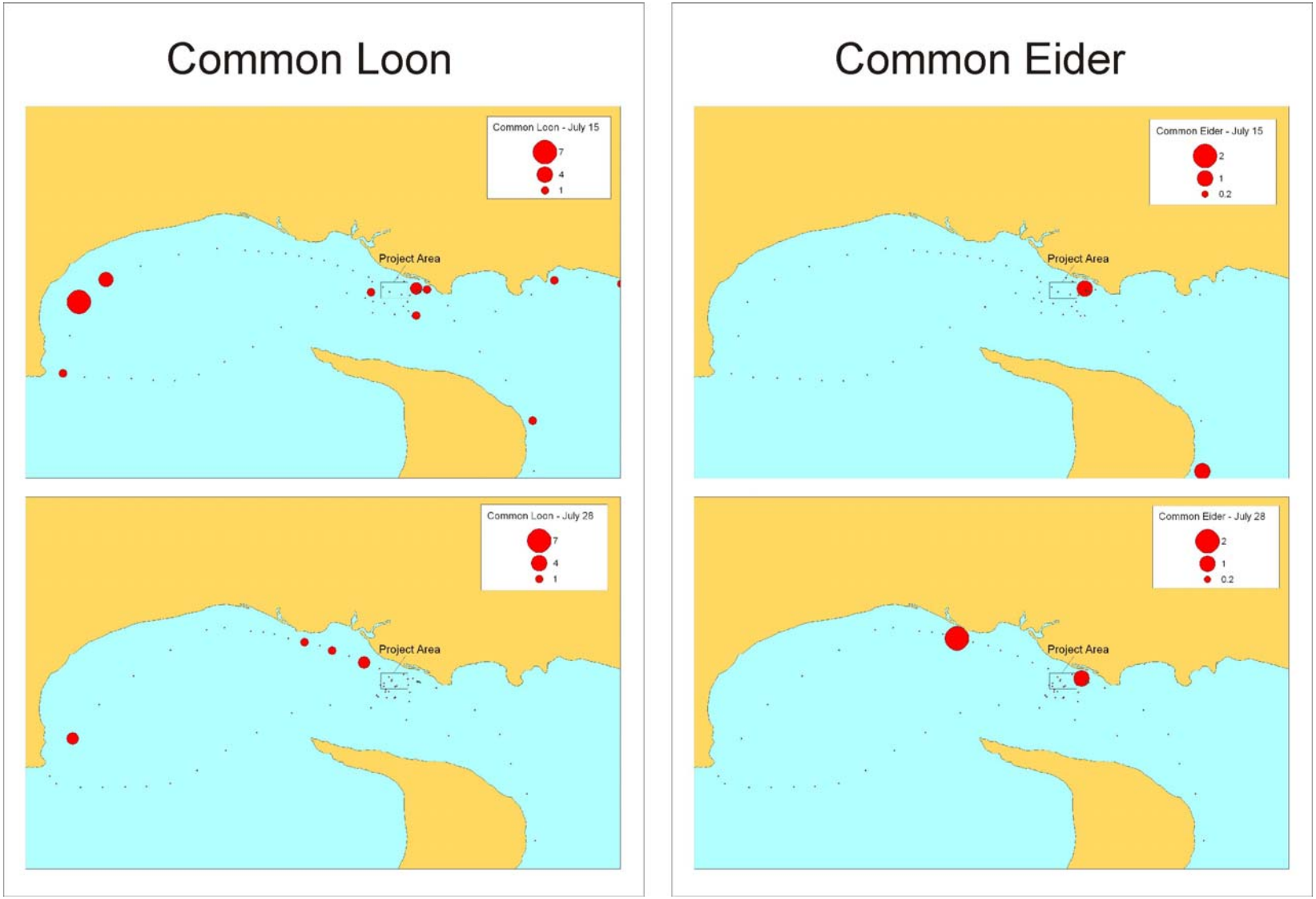


Figure 23. Distribution and abundance of Common Loon and Common Eider (individuals per 5-minute observation period) in Minas Basin, Minas Passage and Minas Channel, July 2012 [the species were not seen in August].

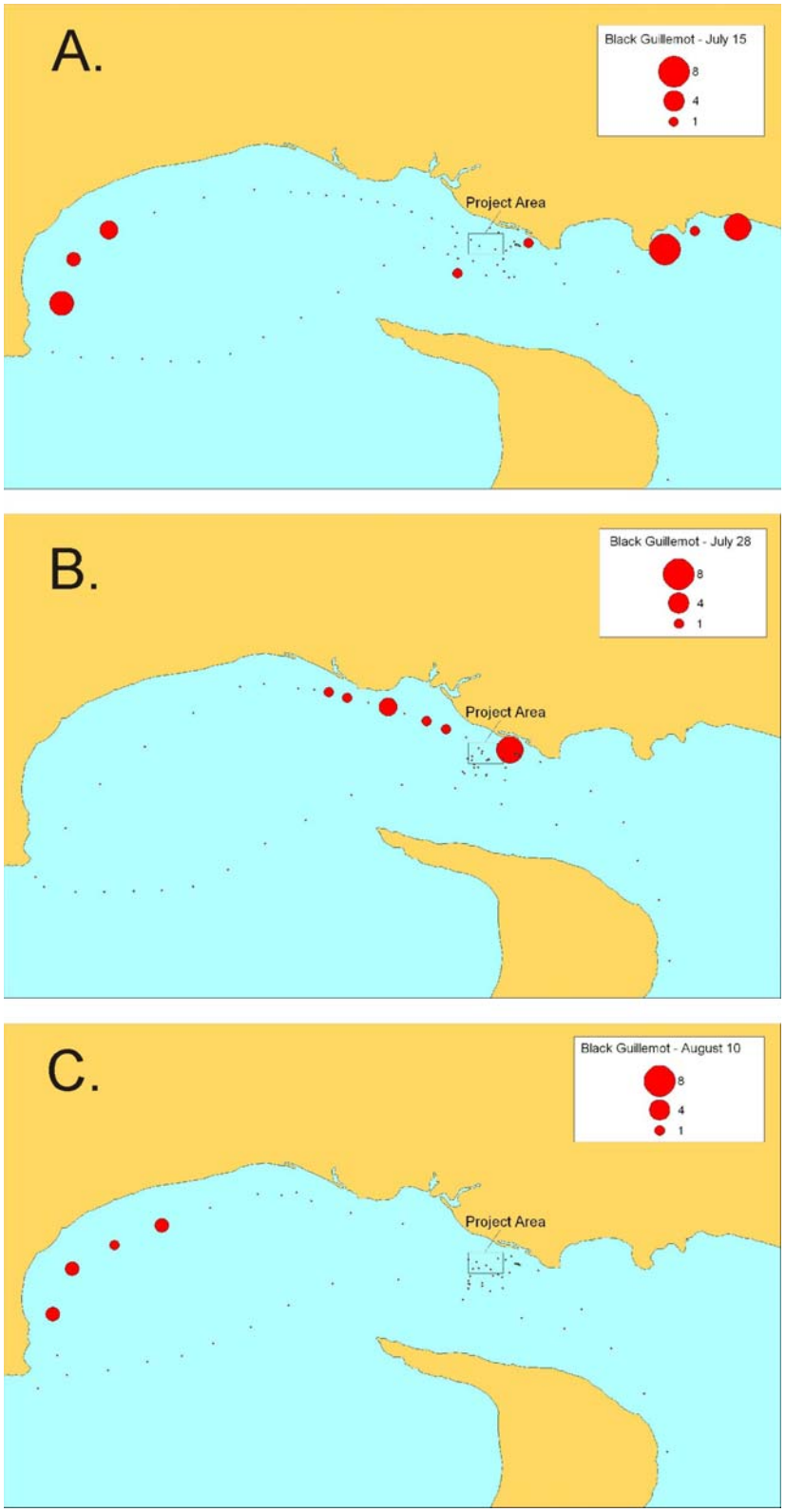


Figure 24. Distribution and abundance of Black Guillemot (individuals per 5-minute observation period), July & August, 2012.

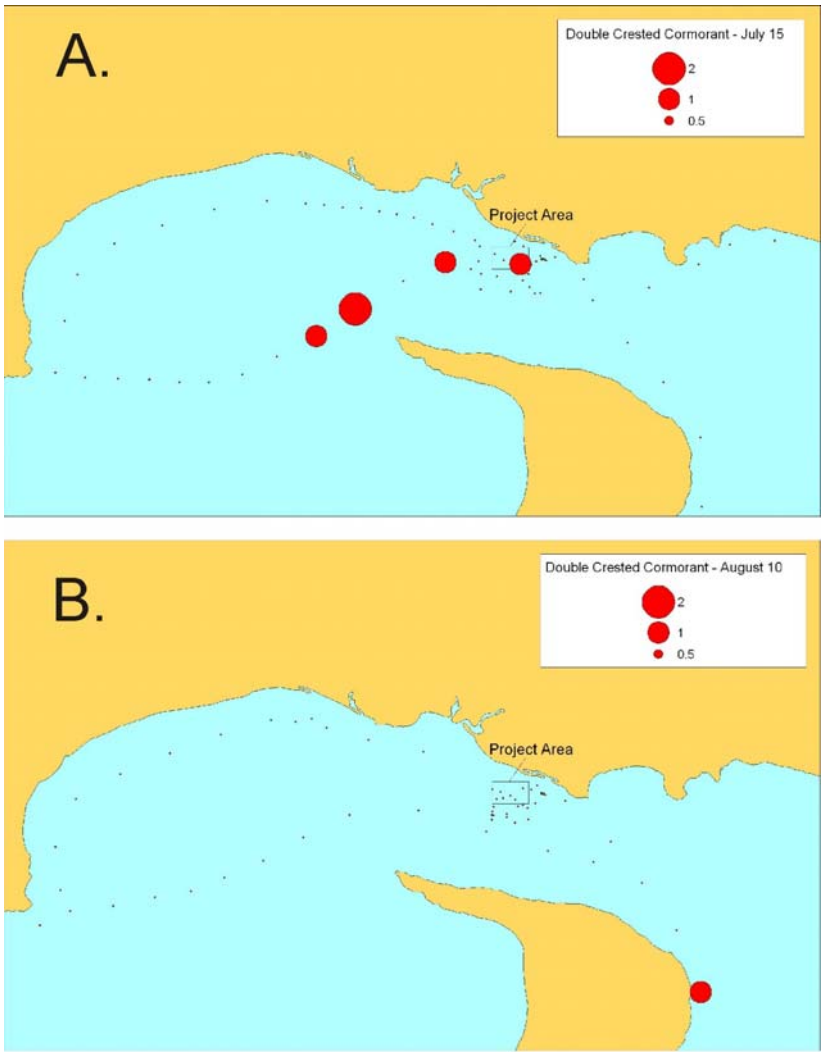


Figure 25. Distribution and abundance of Double-Crested Cormorant (individuals per 5-minute observation period) on July 15 and August 10, 2012.

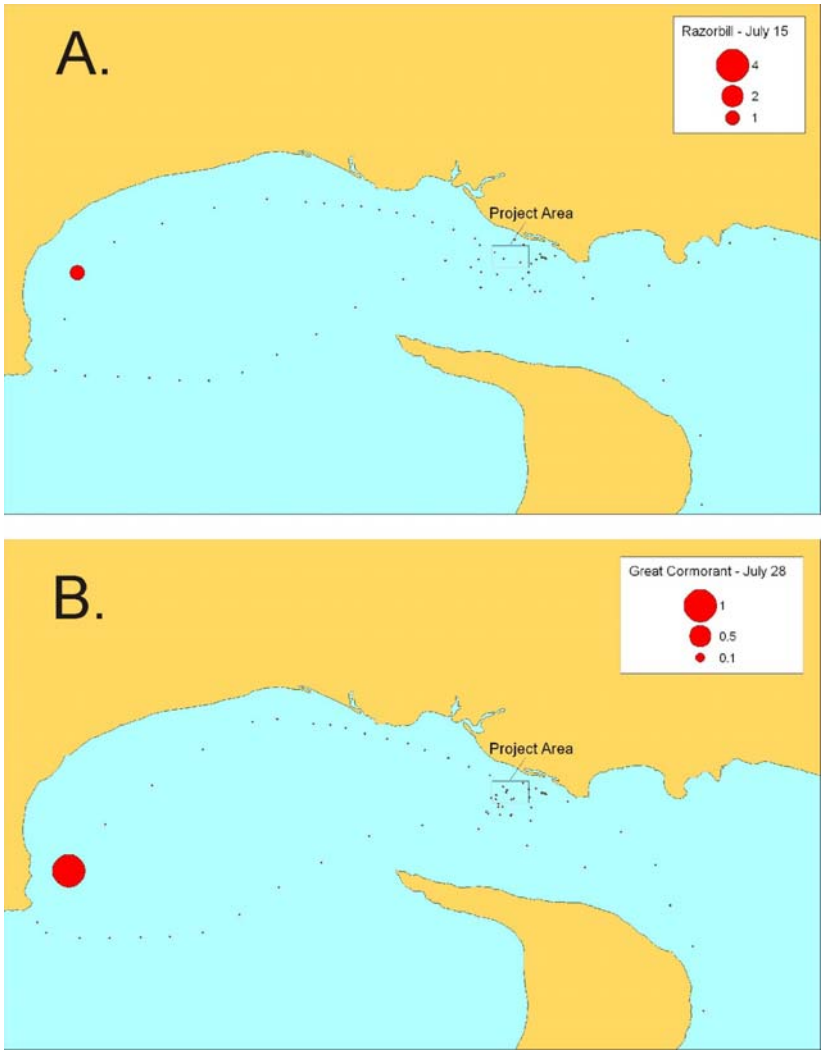


Figure 26. Distribution and abundance of Razorbill and Great Cormorant (individuals per 5-minute observation period) on July 15 (A) and July 28 (B) respectively.

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 7). 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 7. 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, July-August 2012. Total number of birds observed is shown in brackets and includes birds on the wing or on Black Rock.

	July 15, 2012									
Area	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Razorbill	Ring-Billed Gull	Great Cormorant
Minas Basin	0.59 (32)	0	0	0.50 (12)	1.0 (3)	0 (1)	0.67 (15)	0	0 (1)	0
Minas Passage	0.48 (58)	0.60 (20)	0 (2)	0.48 (27)	0.6 (5)	0 (1)	0 (2)	0	0 (1)	0
Minas Channel	0.55 (58)	0.55 (11)	0 (3)	0.50 (22)	1.0 (11)	0	0.40 (10)	0 (1)	0	0
Overall	0.53 (148)	0.58 (31)	0 (5)	0.49 (61)	0.89 (19)	0 (2)	0.52 (27)	0 (1)	0 (2)	0
	July 28, 2012									
	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Razorbill	Ring-Billed Gull	Great Cormorant
Minas Basin	0.64 (11)	0 (1)	0	0.67 (9)	0	0	0	0	1.0 (1)	0
Minas Passage	0.34 (38)	0.25 (8)	0	0.64 (14)	0.67 (3)	1.0 (1)	0.55 (11)	0	0 (1)	0
Minas Channel	0.80 (10)	1.0 (1)	0	1.0 (1)	1.0 (3)	1.0 (2)	0.5 (2)	0	0	0 (1)
Overall	0.59 (59)	0.30 (10)	0	0.67 (24)	0.83 (6)	1.0 (3)	0.54 (13)	0	0.5 (2)	0 (1)
	August 10, 2012									
	Total, All Species	Great Black-Backed Gull	Double-Crested Cormorant	Herring Gull	Common Loon	Common Eider	Black Guillemot	Razorbill	Ring-Billed Gull	Great Cormorant
Minas Basin	0 (4)	0	0 (1)	0 (2)	0	0	0	0	0 (1)	0
Minas Passage	0.58 (12)	0	0	0.17 (6)	0	0	0	0	1.0 (6)	0
Minas Channel	0.33 (12)	1.0 (1)	0	0.33 (3)	0	0	0.29 (7)	0	0 (1)	0
Overall	0.39 (28)	1.0 (1)	0 (1)	0.18 (11)	0	0	0.29 (7)	0	0.75 (8)	0

spills, as well as providing a means of assigning the relative potential of different species to be impacted. About half (53%) of birds seen in the 2012 surveys were on the water (Table 7), comparable to 2011. Common Loon was the species most likely to be seen on water (as in 2011), and the dominant gulls (Herring and Great Black-Backed) as well as Ring-Billed Gull and Common Eider were most often seen on the water, typically 50% of the time. Species usually seen flying were cormorants (Great and Double-Crested). The only Razorbill seen was flying.

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 the six shore-based surveys (June, July & August) with 12, 30-minute observation periods per day. Observation conditions were acceptable with winds typically < 10 km/hr offshore, up to 10-15 km (July 18) and conditions ranging from bright sun to overcast and drizzle. Visibility was relatively poor (2 km) during the August 2 survey. Wave conditions were acceptable on all surveys.

3.2.2.2 Species Composition

Overall, 1078 seabirds, waterfowl and shorebirds in 23 species were seen during the shore-based surveys, including two shorebirds seen on Black Rock (Table 8). Seabirds occurring at the site included: Double-Crested Cormorant, Great Cormorant, Herring Gull, Great Black-Backed Gull, Ring-Billed Gull, Black Guillemot, Northern Gannet, Black Tern, Cory's Shearwater, Greater Shearwater and Sooty Shearwater (Table 7). Waterfowl included: Common Eider, Common Loon, Pacific Loon, Red-Throated Loon and Red-Breasted Merganser. Shorebirds included: Ruddy Turnstone, Red Phalarope, Red-Necked Phalarope, Sanderling and Semipalmated Sandpiper, as well as a Spotted Sandpiper and a Greater Yellowlegs seen on Black Rock. The highest diversity of bird species occurred in early and late-August surveys in which 14 species were observed compared with 8-11 species observed during surveys earlier in the season (Figure 27). In total 47 species of water-associated birds have been recorded at the site during the surveys (2010, 2011 and 2012 combined). Together with birds observed in vessel surveys, 48 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.

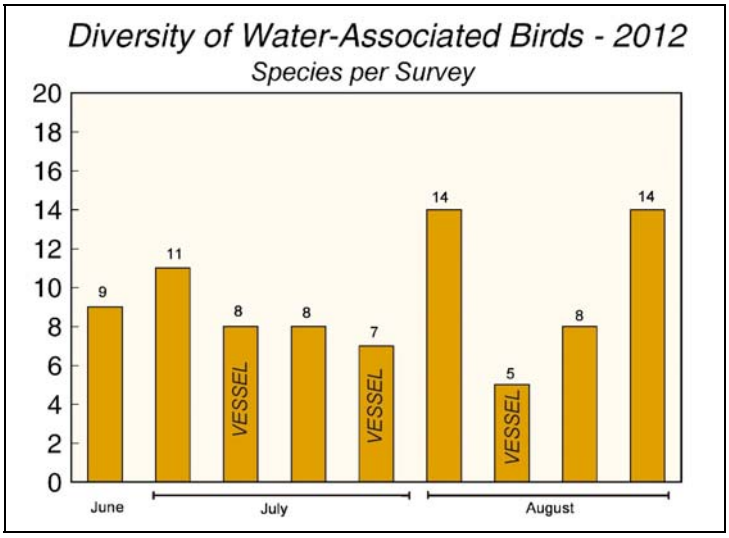


Figure 27. Diversity of water-associated birds (number of seabird, waterfowl and shorebird species) on shore-based and vessel surveys, June-August, 2012. Vessel surveys include Minas Basin, Minas Passage and Minas Channel.

Table 8. Water-associated birds observed at FORCE Tidal Energy Demonstration Site, June (21), July (4 & 18) to August (2, 15 & 29), 2012, 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*
COEI	Common Eider	*Somateria mollissima*
RBME	Red-Breasted Merganser	*Mergus serrator*
Seabirds		
DCCO	Double-Crested Cormorant	*Phalacrocorax auritus*
GRCO	Great Cormorant	*Phalacrocorax carbo*
GBBG	Great Black-Backed Gull	*Larus marinus*
RBGU	Ring-Billed Gull	*Larus delawarensis*
HEGU	Herring Gull	*Larus argentatus*
NOGA	Northern Gannet	*Morus bassanus*
BLGU	Black Guillemot	*Cepphus grylle*
BLTE	Black Tern	*Chlidonias niger*
COSH	Cory's Shearwater	*Calonectris diomedea*
GRSH	Greater Shearwater	*Puffinus gravis*
SOSH	Sooty Shearwater	*Puffinus griseus*
Shorebirds		
RUTU	Ruddy Turnstone	*Arenaria interpres*
REPH	Red Phalarope	*Phalaropus fulicarius*
RNPH	Red-Necked Phalarope	*Phalaropus lobatus*
SAND	Sanderling	*Calidris alba*
SESA	Semipalmated Sandpiper	*Calidris pusilla*
SPSA*	Spotted Sandpiper	*Actitis macularius*
GRYE*	Greater Yellowlegs	*Tringa melanoleuca*

** Species observed on Black Rock only.*

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 Herring Gull, Black Guillemot, Common Eider, Great Black-Backed Gull, Common Loon, and Double-Crested Cormorant. Northern Gannet, Ring-Billed Gull, Great Cormorant and Red-Throated Loon also occurred commonly, but were not among the dominants (Figures 28 & 29). Herring Gulls were the overall most abundant species showing moderate to high abundance in early- & late summer (June 21 & August 29), followed by Ring-Billed Gull, Black Guillemot, Common Eider and Red-Throated Loon (Figures 28 & 30).

Overall abundance of birds was highest in late-June and early July; was moderate in August; and low in mid-July (July 18) (Figure 30). Individual species showed particular seasonal patterns, with abundance of Common Eider highest in late June, while other bird species generally peaked in early to mid-August (e.g. Common Loon and Ring-Billed Gull) and were not as abundant or not observed at all in June and July (June 21, July 4 & 18) surveys (Figures 28 & 29).

A moderate diversity of birds was observed during the survey, highest on August 2 & 29 (14 species), while the lowest diversity occurred during the mid-July & August surveys, respectively (8 species). The remaining surveys had low-moderate numbers (9-11 species) (Figure 27). The high species counts on August 2 & 29 were due to the occurrence of 2-3 shorebird species on both occasions, as well as the occurrence of groups of species normally seen further at sea (e.g. Greater Shearwater and Northern Gannet on August 2 and Greater, Cory's, and Sooty Shearwater on August 29, sighted mostly between Black Rock and Cape Split).

More birds occurred in the area between Black Rock and shore, than in other areas during the June 21 and July 4 surveys; comparable amounts of birds occurred inside Black Rock as well as in the turbine installation area during the July 18 and August 2 surveys; and more birds occurred in the proposed turbine installation area than in the other areas during August 15 and 29 surveys (Figure 30; Table A-8). As in previous years, 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 into the turbine installation area.

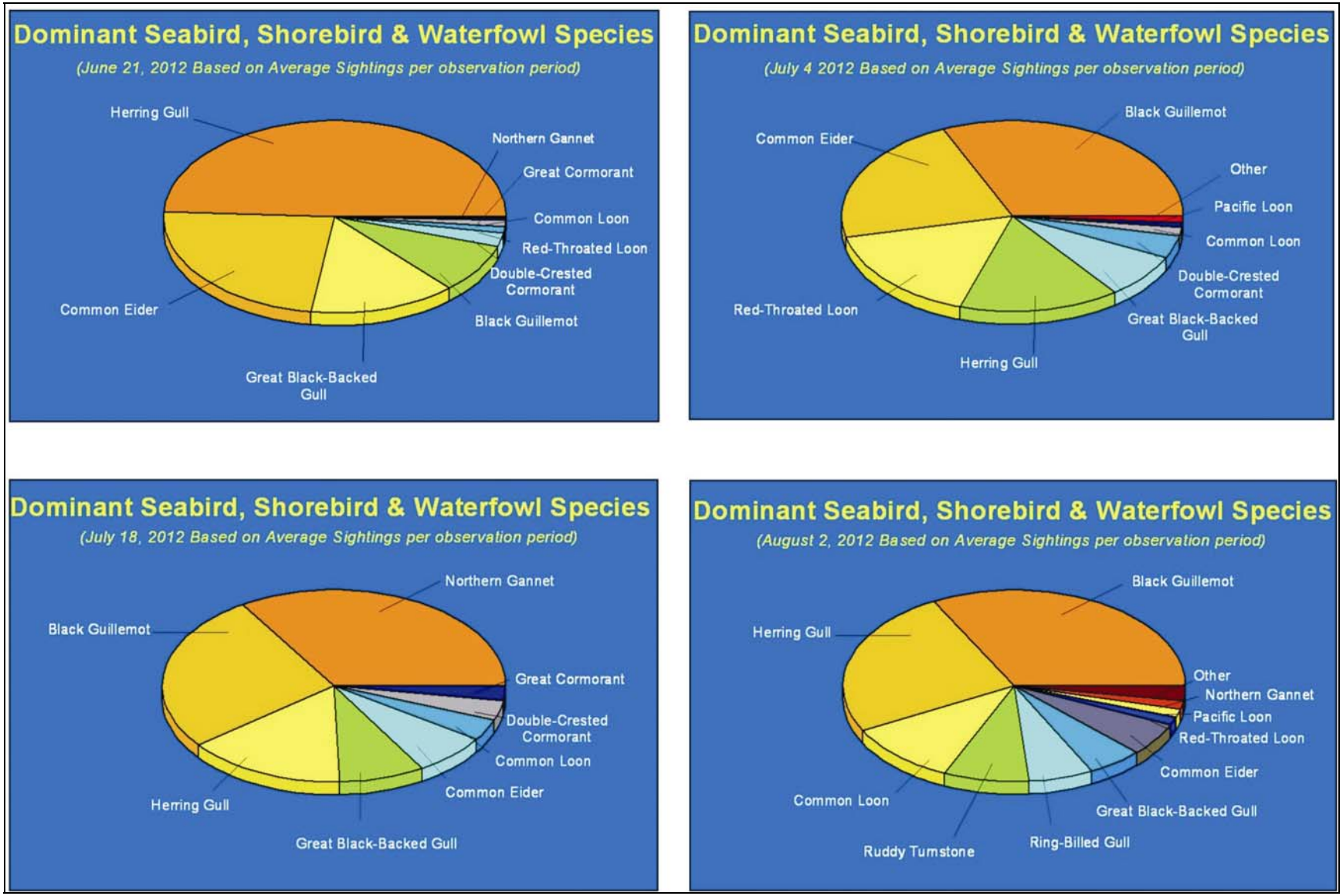


Figure 28. Dominant species of seabirds and other waterfowl at the Fundy Tidal Demonstration Site in summer, observed in shore surveys on June 21, July 4, 18 and August 2, 2012.

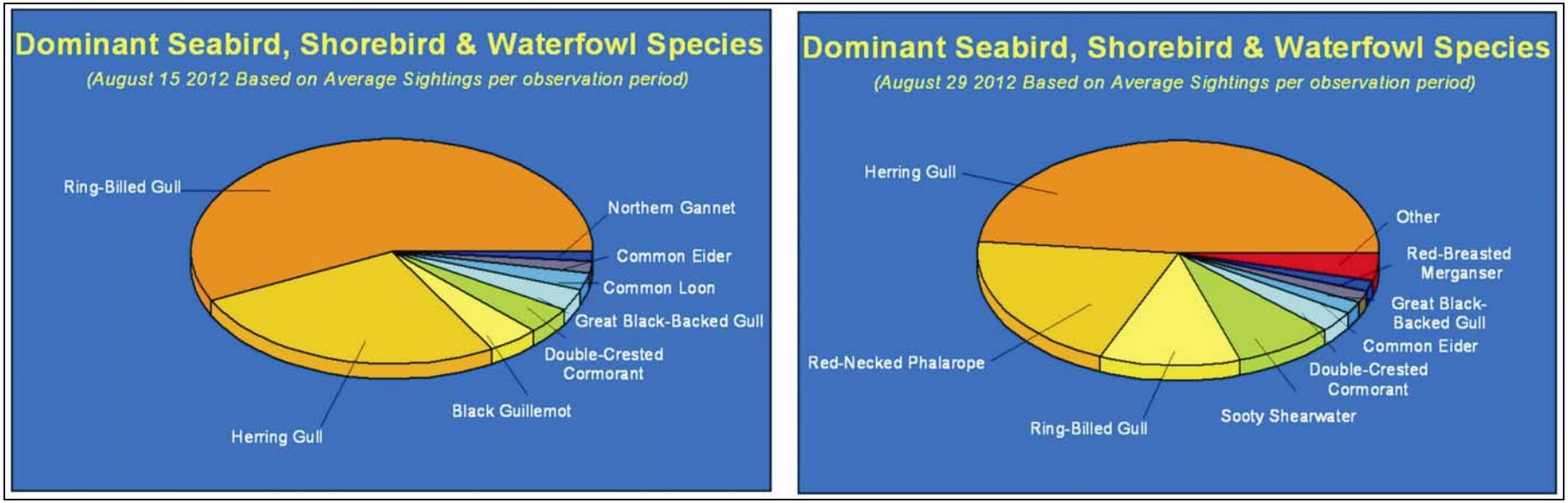


Figure 29. Dominant species of seabirds and other waterfowl at the Fundy Tidal Demonstration Site in summer, observed in shore surveys on August 15 and 29, 2012.

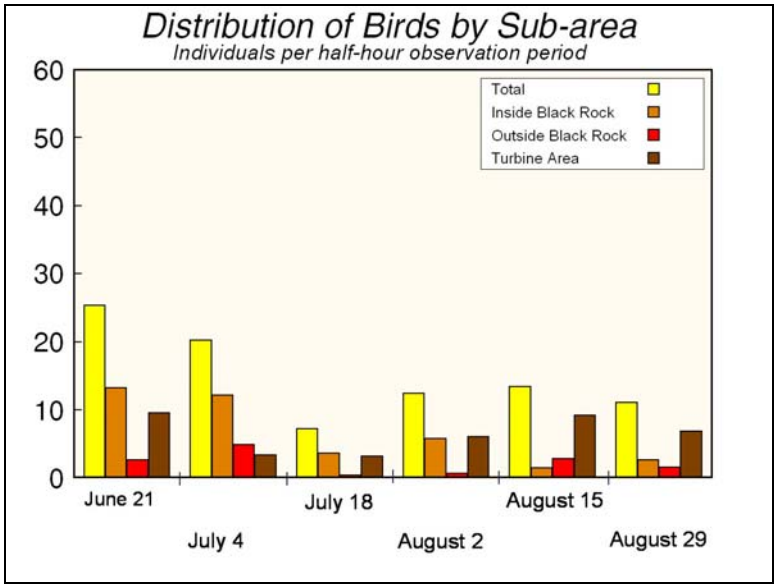


Figure 30. Abundance of seabirds and other water-associated birds (individuals per 30-minute observation period) at the Fundy Tidal Power Demonstration site, June, July & August 2012.

Abundance and Seasonal Occurrence of Gulls

Gulls (Herring, Great Black-Backed and Ring-Billed Gull) were commonly seen at the site. Great Black-Backed and Herring Gulls occurred during all surveys while Ring-Billed Gulls were seen during the last three surveys (Figure 31). Herring and Ring-Billed Gulls had peak abundances during June 21 & August 15 surveys, respectively.

Herring Gull—Herring Gull was the most abundant gull species and was observed during all surveys (Figures 28-19 & 31). It was the dominant and most abundant seabird species in June 21 and August 29 surveys (49.2% & 45.0% of sightings, respectively) and the second most abundant seabird in August 2 & 15 surveys (24.8% & 26.1% of sightings)(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. The species occurred in the three August surveys only, in low to moderate abundance with a peak abundance in mid-August, and was the most abundant seabird during the August 15 survey (Figure 31) (57.2% of total sightings) (Appendix A).

Great Black-Backed Gull—Great Black-Backed Gull was the third most abundant gull, and was observed during all surveys (Figure 31). Overall, it was relatively common (13.8% of sightings on June 21; and 7.4-8.1 %, of sightings on the July 4 and 18 surveys, respectively; although it was less common (5.4, 3.1 & 0.72 % of sightings) in the August 2, 15 & 29 surveys, respectively (Appendix A).

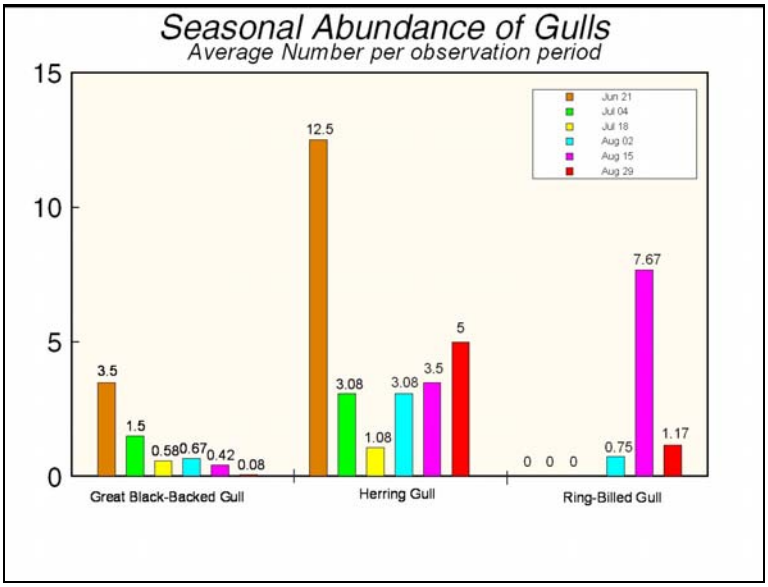


Figure 31. Abundance of gulls (average number per 30-minute observation period) at Fundy Tidal Energy Demonstration site, June, July & August 2012.

Abundance and Seasonal Occurrence of Waterfowl

Only two waterfowl species (Common Eider and Red-Breasted Merganser) were observed in shore-based surveys in 2012, reflecting the summer season when migratory waterfowl are not present at the study site. Common Eider was the most common and abundant species—present during all surveys. Red-Breasted Merganser was observed during the August 29 survey only and in low numbers (Figures 28, 29 & 32).

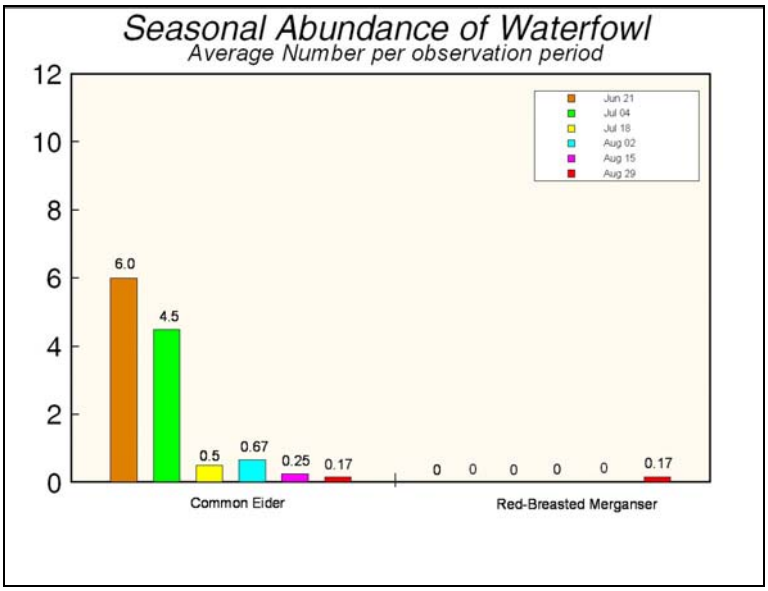


Figure 32, Abundance of waterfowl (average number per 30-minute observation period) at the Fundy Tidal Energy Demonstration site, June, July & August 2012.

Common Eider—Common Eider was common and abundant in all shore-based surveys (Figures 23, 24 & 27). It peaked in abundance in late June & early July (Figure 32), and was the second most abundant species during these survey times (23.6 % & 22.1% of sightings, respectively) (Appendix A).

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 the August 29 shore-based survey in low abundance (2 individuals per observation period and 1.5% of sightings) (Figures 28, 29 & 32)(Appendix A).

Abundance of Loons

Three loon species (Red-Throated, Common and Pacific) were observed during the shore-based surveys, with Red-Throated Loon, and Common Loon present in similar abundance, with lesser abundances of Pacific Loon. Concentrations of Red-Throated Loon were highest on the July 4 survey (Figures 28, 29 & 33).

Red-Throated Loon—Red-Throated Loon migrate through the area in Spring and Fall. The species is common and occasionally abundant, wintering in small numbers. It feeds on small fish at various depths, including the deepest water. It was observed during four of the six surveys and was the third most abundant and dominant bird species during the July 4 survey (7.5 individuals per observation period, and 19.1% of sightings) (Figures 28, 29 & 33)(Appendix A).

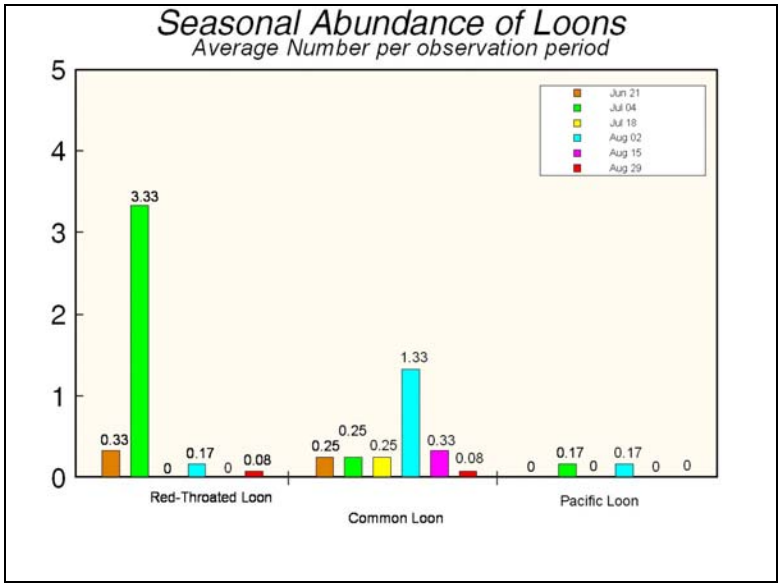


Figure 33. Abundance of loons (average number per 30-minute observation period) at the Fundy Tidal Energy Demonstration site, June, July & August 2012

Common Loon— Common Loon breeds on lakes and is a common coastal resident year-round, but was observed in low numbers during all shore-based surveys. It peaked in abundance on August 2 (4-16 individuals per 30-minute observation period) and generally showed low to moderate dominance (0.72-10.7% of total bird sightings) (Figures 28, 29 & 33)(Appendix A).

Pacific Loon—This species migrates through the area in Spring and Fall. Prior to the surveys in 2009, the species was thought to be rare in Atlantic Canada, and occasionally overwintered; however the species

has been seen regularly in Minas Passage during the surveys, suggesting that it is more common in the area, possibly reflecting an overall movement eastward in its North American range. Pacific Loon feeds on small fish at various depths but mainly in deepest water. It was observed in two of six surveys (July 4 and August 2) in low numbers (0.17 individuals per observation period)(Figures 28, 29 & 33, Appendix A).

Abundance of Shorebirds

Seven shorebird species (Ruddy Turnstone, Red Phalarope, Red-Necked Phalarope, Sanderling, Semipalmated Sandpiper, Spotted Sandpiper & Greater Yellowlegs) were occasionally observed during the shore-based surveys in low numbers. Two of the species (Spotted Sandpiper and Greater Yellowlegs) were observed on Black Rock only (Figures 28, 29 & 34).

Ruddy Turnstone—A flock of twelve Ruddy Turnstone was observed on August 2 (1.0 individuals per observation period) making it the fourth most abundant species observed (8.1 % of sightings) (Figures 28, 29 & 34, Appendix A).

Red Phalarope—An individual Red Phalarope was observed during one of the six surveys (August 29) (0.08 individuals per observation period) and at low dominance (0.72 % of sightings)(Figures 28, 29 & 34, Appendix A).

Red-Necked Phalarope—A flock of 25 Red-Necked Phalarope was observed during one of the six surveys (August 29) in moderate abundance (2.08 individuals per observation period), making it the second most abundant species observed (18.7% of sightings) (Figures 28, 29 & 34, Appendix A).

Sanderling—This small shorebird species migrates through the area in late summer (late July & August) on a southerly migration from the Arctic, stopping to feed on invertebrates in mudflats of upper intertidal areas. It was observed in one of six surveys (August 2) in low abundance (0.08 individuals per observation period)(Figures 28 & 29, Appendix A).

Semipalmated Sandpiper—This small, black-legged bird is often an extremely abundant shorebird species which migrates through the area in late summer/ early fall, feeding on mudflats along the coast. A single individual was observed in one of six surveys (August 2) (0.08 individuals per observation period)(Figures 28 & 29, Appendix A); and an individual was also observed on Black Rock during the July 18 survey.

Spotted Sandpiper—One of the more widespread sandpiper species, the species was observed on Black Rock during the August 2 survey (Appendix A).

Greater Yellowlegs— This shorebird species is a slim grey sandpiper with bright yellow legs, usually associated with marshes, mudflats, streams and/or ponds. An individual was observed on Black Rock during the August 29 survey (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, Double-Crested Cormorant, Great Cormorant and Northern Gannet. Several other species were present only occasionally and generally in lesser numbers, including Black Tern, Cory's Shearwater, Greater Shearwater, and Sooty Shearwater (Figures 28, 29 & 34).

Double-Crested Cormorant—Double-Crested Cormorants were observed during all shore-based surveys. Numbers were greatest during the July 4 survey (0.83 individuals per half hour observation period) when it was the sixth most abundant species observed (4.1% of sightings) (Figures 28, 29 & 34, 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 June to late July & again in late August). Numbers were generally low (0.08-0.17 individuals per half hour) with highest numbers occurring during the July 18 & August 29 surveys (Figures 28, 29 & 34, Appendix A).

Northern Gannet—Northern Gannet were observed during five of the six shore-based surveys (late June to mid-August). Numbers were generally low (0.08-0.17 individuals per half hour) except during the July 18 survey where it was the dominant and most abundant seabird species (2.42 individuals per half hour, 33.6% of sightings) (Figures 28, 29 & 34, Appendix A). 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. Northern Gannet is a common annual migrant and summer resident. Feeding is by diving from great heights to medium and shallow depths to fish.

Black Guillemot—Black Guillemot were observed during five of six surveys with varying abundances (0.58 – 6.42 individuals per observation period), greatest on July 4 and least on August 15. It was the dominant species in July 4 and August 2 surveys (31.6% & 32.9% of sightings, respectively) (Figures 28, 29 & 34, Appendix A).

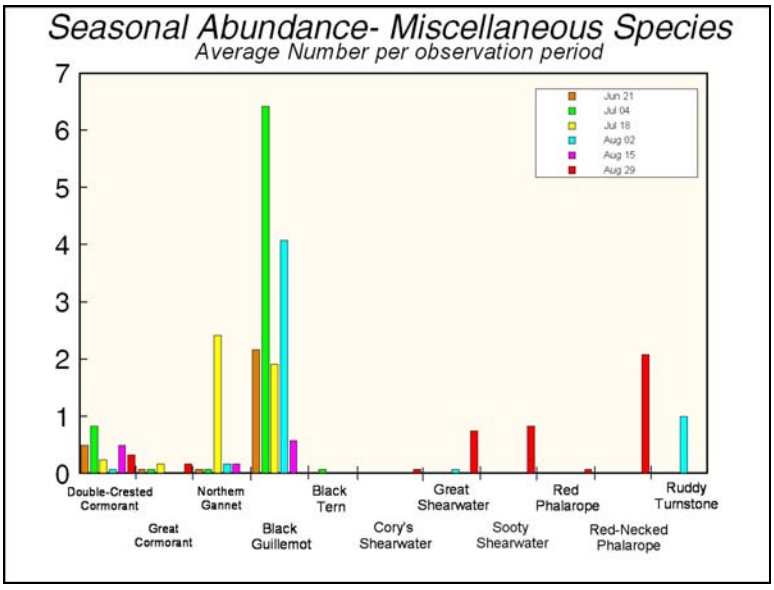


Figure 34. Abundance of miscellaneous seabird and waterfowl species (average number per 30-minute observation period) at the Fundy Tidal Energy Demonstration site, June, July & August 2012.

Black Tern—Black Terns are uncommon residents in the Bay of Fundy. An individual was observed during the July 4 survey (0.08 individuals per observation period)(Appendix A).

Cory's Shearwater—One individual was observed during one of the shore-based surveys (August 29) (0.08 individuals per observation period) (Appendix A).

Greater Shearwater—Greater Shearwater were observed in only two surveys (August 2 when an individual was seen & August 29, when several groups were observed). Overall abundance was low (0.08-0.75 individuals per observation period, respectively) (Figures 28, 29 & 34, Appendix A).

Sooty Shearwater—This species was observed in only one survey (August 29) when a flock of ten was seen in one observation period (0.83 individuals per observation period)(Figure 29, Appendix A).

Annual and Seasonal Comparison

Shore surveys in 2012 focused on the summer, which had only been sampled by vessel surveys previously. The population of water-associated birds was expected to include species known to occur in the area based on vessel surveys. Of the species observed in 2010 and 2011, only 12 of the more common non-migrant species occurred, while some 11 species of summer migrant seabirds and shorebirds occurred at the site. Nine summer visitors observed for the first time included the seabirds—Black Tern, Cory's Shearwater, Greater Shearwater, Sooty Shearwater and shorebirds—Red Phalarope, Red-Necked Phalarope, Ruddy Turnstone, Sanderling, Semipalmated Sandpiper, Spotted Sandpiper and Greater Yellowlegs, the latter two seen on Black Rock. In total, thirty-two species were observed in 2010, twenty-nine in 2011 and twenty-three species in 2012 (Table A-11). Total number of species found for the shore-based surveys at the Fundy Tidal Energy Demonstration site has reached 47.

Information from shore surveys in 2010, 2011 and 2012 was combined to summarize the annual pattern of abundance of water-associated birds at the Tidal Energy Demonstration Site (Figure 35). Abundance showed a steady increase during the Spring to early Summer (March to early July); low-moderate numbers in July to 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 at 57.3 sightings per observation period, reflecting predominantly migratory birds. No data is available for January, February and September, as shore-based surveys were not conducted at these times.

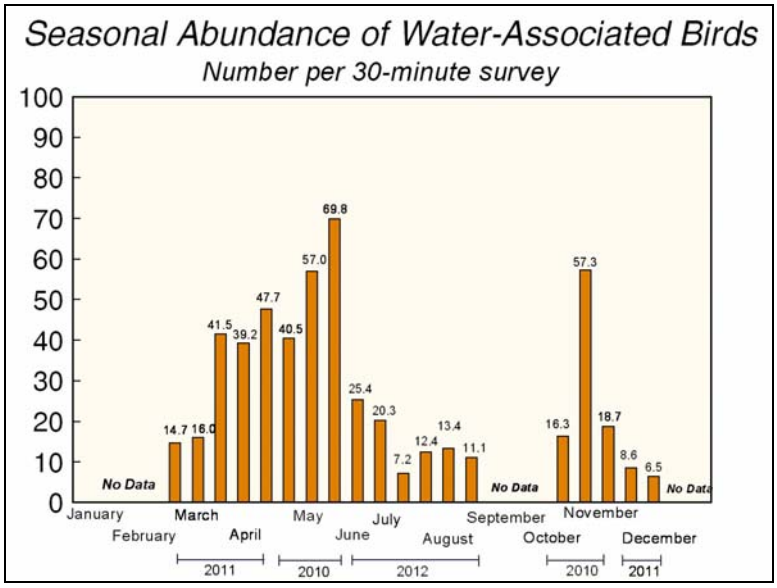


Figure 35. Abundance of water-associated birds (number per 30-minute observation period) at the Fundy Tidal Energy Demonstration Site, March-December, 2010-2012.

Diversity of birds also varied seasonally, showing a March-April peak in number of species observed, followed by low and more stable levels in May-June, low with minor peaks in late July and August, a major peak in October, and moderate levels in November-December (Figure 36). Vessel-survey data which covered July and August in the previous surveys and in 2012, similarly shows low species diversity at the FORCE site (Minas Basin, Minas Passage and Minas Channel) during July and August (Figure 27) but did not pick up the moderate number of species (14) seen on the August 2 and August 29 shore surveys. These results suggest that diversity of birds in Summer (June-September) is low; 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.

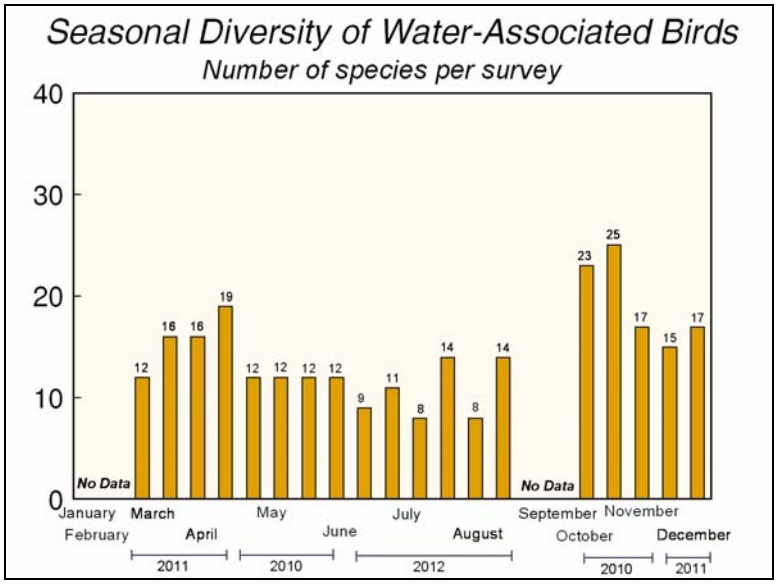


Figure 36. Diversity (number of species per 6-hour survey) of water-associated birds at the Fundy Tidal Energy Demonstration Site, March-December, 2010-2012.

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 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 loons (Common, Red-Throated and Pacific loons), Common Eider, and the Greater Shearwater (August 29 only) although the latter species is typically seen flying (Table A-12). Birds mainly flying included Northern Gannet, Great Cormorant (typically seen flying except on June 21), Great Black-Backed Gull (except on August 15), Herring Gull, Ring-Billed Gull and the occasional Red-Breasted Merganser, shearwaters (Cory's, Sooty & Greater Shearwater), Black Tern and shorebirds (Red Phalarope, Red-Necked Phalarope, Ruddy Turnstone, Sanderling & Semipalmated Sandpiper). Double-Crested Cormorant was observed to be equally on water or flying in August 29, but mainly flying June, early July and early to late August. Black Guillemot was equally on water or flying in June 21, July 18, August 2 & 15, but mainly on water in July 4.

4 CONCLUSIONS AND RECOMMENDATIONS

We now have obtained shore-based coverage of seabirds and marine mammal distributions at the Minas Passage Tidal Energy Demonstration site through most of the year, vessel surveys in summer for four years, and a limited comparison between shore- and vessel-surveys in summer. It is an appropriate time to consider examining the effectiveness of the monitoring to date, and consider design of activities at the site for further monitoring, with a view to ensuring that effects of turbine installations and associated activity on seabirds, if any, can be detected.

General

The fourth year monitoring program for seabirds and marine mammals for the Fundy Ocean Research Centre for Energy (FORCE) Tidal Energy Demonstration Site, was successfully carried out in 2012, including a shore-based program which covered the summer (June 21 to August 29) period; and vessel-based surveys in July-August, continuing observations to document dominant species and summer abundances at the installation site and adjacent Minas Basin and Minas Channel areas. A feature of the 2012 surveys was the pairing of some shore-based and vessel surveys to give an indication of the performance of these different survey types at the same time of year. Overall the focus of the monitoring program (2009 to 2012) 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. The shore-based surveys, although not conducted in the first year, have proved to be important in describing the communities of water-associated birds at the demonstration site, and the surveys conducted in 2012 completed the seasonal coverage, which now extends from early March to late December, virtually the entire year. Although the main emphasis of the program was intended to be on birds, the shore-based monitoring has 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. 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 provides an additional focus for monitoring of environmental change and the impacts of tidal turbines in Minas Passage.

Shore-based monitoring of seabirds and marine mammals at the site in 2012 completed seasonal observations begun in 2010. The approach throughout this period amounted to an adaptive one, in which the timing of observations each year addressed specific issues such as the timing of migratory periods, which were not known with precision initially. In 2012, after early surveys in which critical periods for seabirds and most other water-associated birds were addressed, observations were extended to cover the summer period. In particular, it was recognized that the shore-based survey would be valuable both to provide information on summer occurrences of Harbour Porpoise, as well as providing an opportunity to ‘calibrate’ observations of water-associated birds between the shore-based and vessel surveys (which were longer-running and restricted to summer)—this was done in 2012 by pairing three surveys in the shore-based program with the July 15, July 28 & August 10 vessel surveys. The paired surveys showed a similar composition of dominant species of water-associated birds, and similar diversity, as well as correlations of a peak in Harbour Porpoise abundance in the early July period. Summer observations of both survey types picked up shorebird occurrences (mainly from the shore-based surveys); the migration period for shorebird species entering the study area is in mid- to late-summer (seven species were seen during the shore survey and an additional species (Least Sandpiper) was heard in fog during a vessel survey), but these species have not previously been observed at the FORCE Tidal Energy Demonstration Site because surveys were outside the migration period.

Vessel-based observations in Summer (mid-July to late-August) from inshore fishing vessels continued to provide information to assess regional variability in water-associated birds and marine mammals in the

Inner Bay of Fundy (Minas Basin, Minas Passage and Minas Channel) as well as year-to-year changes, for the monitoring program, which has operated since 2009. A core of dominant species of water-associated birds continued to be present, several at comparable densities and diversity (number of species observed) between years throughout the monitoring program. Monitoring has shown significant year-to-year and regional variability, although representing a natural pattern in the absence of development at the Tidal Energy Demonstration Site. Overall, survey coverage was comparable to previous years; vessel surveys in 2012 were adjusted to sample the Minas Passage areas under more favourable tidal conditions earlier in the tide cycle around high tide, to ensure the focused surveys at the site could be completed with greater precision, which was accomplished. This program could be improved by focusing future survey effort on Minas Passage and Minas Basin to the exclusion of Minas Channel, to provide greater statistical power to the estimates of abundance in the former two areas for similar survey effort. Based on all 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 & 2012). The 2012 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 of the species at the site to the summer. A peak abundance observed in early July with occasional occurrences in late-July and mid-August, contained abundances comparable to, or above, the previous highs observed in the mid-March to early April period, as well as the October period at the site in 2011. The vessel survey has also provided information on limited occurrences of seals in Minas Passage, with both Grey and Harbour Seal observed in 2012, although in low abundance. Consistent with the majority of other summer vessel surveys and all the shore-based surveys, no other marine mammals have been seen in the area from 2010 to 2012. Various cetaceans including whales and dolphins are expected to occur in the Minas Basin, Minas Passage and Minas Channel system, however, and in 2009, White-Sided Dolphin were sighted west of the proposed turbine installation area; however the surveys in the monitoring program are evidently too infrequent to detect occasional or uncommon occurrences of these cetaceans.

Monitoring efforts conducted by FORCE have provided estimates of Harbour Porpoise abundance through the year and a basis for continued monitoring of abundance and behaviour which can be used in monitoring—valuable information which was not known before the monitoring associated with the FORCE project took place. Harbour Porpoise can be potentially impacted by turbines since the species can 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. The Northwest Atlantic population Harbour Porpoise 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 some periods when the species is not seen at the site. Based on the shore-based and vessel surveys, Harbour Porpoise is a common visitor from early

Spring to Fall, with its abundance likely linked to movements of prey species, in particular Atlantic Herring in the Spring and possibly to other species later in the year.

Monitoring carried out at the Tidal Energy Demonstration Site, both shore-based and vessel surveys, has provided, however, only a limited view of the activities of Harbour Porpoise in Minas Passage, which remain as valid research objectives for the area as a whole, though not necessarily part of the FORCE monitoring program, although information addressing aspects of the biology of the species at the site could be used to address change caused by presence of turbines. Most observations at the site have come from shore-based monitoring activities, which, for consistency, have been done from high tide onward on the outgoing tide—and the numbers seen in the surveys provide information on an important component of the species' activity cycle at the site, and also a potential indicator of the local population size. The species must also return through the Minas Passage presumably on the flood tide, and there may be diurnal (day-night) variations in activity and behaviour. How far individuals in the population travel with the tide is not known, but the distance could possibly range as far as, or beyond, the normal tidal excursion, which in Minas Passage is in the vicinity of Cape Spencer, or to an intermediate distance, as the species could hold position nearshore (e.g. in current eddies; nearshore where currents are reduced, such as at the tidal site or along Cape Split; and at the mouth of rivers such as Diligent River entering Minas Passage and Minas Channel). Vessel surveys, in contrast, typically sampled both the period extending from immediately before high tide and into the ebb tide in Minas Basin and at the Minas Passage study site, as well as on the incoming tide typically in the late afternoon-early evening, but detected the species mainly on the outgoing tide (in particular on July 15 when a relatively high abundance of Harbour Porpoise were observed on the vessel survey, the majority seen on the outgoing leg of the survey). In terms of the present monitoring program, changes to vessel survey effort to focus more closely on Minas Passage and Minas Basin, may allow better coverage of distribution of Harbour Porpoise in these areas during the incoming tide. 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.

Seabirds and Waterfowl

The goal of the FORCE monitoring program has been to provide information on primarily seabird and waterfowl species use of the study area to aid in determining potential for impacts of turbine installation. In particular, at the commencement of the program, it was known that diving birds could occur, both resident and migrants, and that it was important to identify their presence and seasonal occurrence because of their greater potential to interact with sub-sea devices such as turbines. A secondary objective of the monitoring was to develop a baseline of species occurrences at the site which could be used as indicators of potential turbine impact on the local ecosystem, as reflected in populations of seabirds. The monitoring has shown overall use of the area by diving birds, either in migration or resident divers such as Common Loon and Black Guillemot; however overall abundances are low to moderate. Diving birds in several taxonomic groups have been shown to be 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. Among the divers, 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) while Pacific Loon, which occurs occasionally at the site, can dive to intermediate depths. 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 2012 monitoring has completed an annual definition of the occurrence of many of these species, showing that in most cases the species are usually seen during migration and are occasional visitors in summer. Of the loon species, the Common Loon is found at the study site year-round, though in low abundance, as is also true of waterfowl species with diving habit, including Common Eider and Black Guillemot, and Great and Double-Crested Cormorant. The study showed that other species of divers are rare in summer, though a common and diverse community was present during the migration periods in April-May and October-November. Other species of water-associated birds commonly also occur at the Tidal Energy Demonstration Site which could be used for monitoring ecosystem impacts. A core group of water-associated bird species occurring at the site, typically the suite of most common and abundant species characterizing and breeding along coasts in the Atlantic Region, include gulls (Great-Black Backed, Herring, and Ring-Billed), Common Eider, Black Guillemot, and Great and Double-Crested Cormorant. Among these species, some did not occur regularly in surveys, but were usually present in low to moderate abundance, occurring year-round. Long-term monitoring of these groups can provide information on trends in population abundance in the study area, and potential indication of impacts of tidal energy facilities.

The FORCE monitoring program has also shown a high diversity of seabird species occurring at the Tidal Energy Demonstration Site—some forty-seven species of water-associated birds have been seen in shore- and vessel-based surveys since 2009. The study has demonstrated that peak times for abundance and diversity of water-associated birds are during the Spring and Fall migration, with the Fall migration in late October the most intense with highest numbers of species seen at the FORCE site on a single outgoing tide. Diversity drops in the summer when typically less than a dozen species occur, but numbers and diversity are augmented by the annual late-summer shorebird migration. For the core species, abundances in summer, as shown by vessel surveys, have been comparable to or trending downward over the course of the monitoring program; this was also true in 2012, although mid-July abundances of seabird species in Minas Passage were comparable to highest levels observed so far, while abundances in late July and August were particularly low.

As in past years, 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. Some of the species, including Herring and Black-Backed Gull and Black Guillemot, may breed on Black Rock, although it has not been possible from shore observations to confirm breeding activity.

In summary, some of the key findings of the FORCE monitoring for seabirds and marine mammals are:

- Harbour Porpoise are common and relatively frequent visitors to Minas Passage from early Spring to Fall although they occur sporadically, occurring at some times at moderate to high abundance, with some periods when the species is not seen at the site.

- Diving birds, either in migration or resident divers such as Common Loon and Black Guillemot, frequently occur at the Tidal Energy Demonstration site; however overall abundances are low to moderate, and deep divers are relatively uncommon and low in abundance. In most cases the species are usually seen during migration and are occasional visitors in summer.

- A high diversity of seabird species occurs at the Tidal Energy Demonstration Site—some forty-seven species of water-associated birds have been seen in shore- and vessel-based surveys since

2009. Peak times for abundance and diversity of water-associated birds Spring and Fall migration, with the Fall migration in late October the most intense.

- Dominant resident seabird species occurring in Minas Passage include gulls (Herring, Great Black-Backed and Ring-Billed), Common Loon, Black Guillemot, Common Eider and Double-Crested Cormorant. For the core seabird species, abundances in summer, as shown by vessel surveys, have been comparable to earliest values, or trending downward, over the course of the monitoring program; this was also true in 2012, although mid-July abundances of seabird species in Minas Passage were comparable to highest levels observed so far, while abundances in late July and August were particularly low.

- As in past years, with the exception of around Black Rock, no particular areas of concentration of seabirds and waterfowl have been observed within the tidal energy demonstration site, and, in particular, not in areas proposed for turbine installation.

Monitoring Considerations

The goal of a monitoring program in the context of environmental assessment is to verify impact predictions made for the activity, in this case the operation of tidal turbines. It is also to confirm the accuracy of information concerning the environmental feature—in this case marine mammals and seabirds—and to further allow prediction of potential impacts. The monitoring program to date has provided suitable baseline information relative to seabirds and marine mammals at the Tidal Energy Demonstration Site to address both these issues.

Some initial predictions of the environmental assessment have been verified by the present monitoring survey. One prediction was that shorebirds were not particularly important at the site due to the absence of extensive mud flat environments, but were expected occasionally during the migratory period in summer; summer sampling this year confirmed the passage of shorebirds through the area. Another prediction of the EA was that Peregrine Falcon (a raptor species at risk), known to nest in the vicinity of Cape Sharp, may be seen at the Tidal Energy Demonstration Site; despite the survey effort this species has not been seen on either shore-based or vessel surveys in the study area. The species continues to be expected to be an uncommon visitor to the site, but the monitoring program has support the predicted likelihood of occurrence.

Of the information provided by the monitoring program so far, few bird species have been identified which would ever encounter operating turbines; and Harbour Porpoise, a species highlighted to occur in the area, although capable of diving to depths occupied by turbines, occurs at the site on a running tide typically near the surface where it would also not encounter them. Although the activity of the species under lower current regimes is unknown, the present observations suggest that Harbour Porpoise would not be particularly likely to encounter turbines during peak currents, when their potential to be harmed is greatest, since they are seen at the surface and are not diving. Seals are not abundant at the study site, though the typical species (Grey and Harbour Seal) could be attracted to the site if food was available, but because of diving depth under a current regime, they also would not likely encounter turbines.

The monitoring program as it stands has been focused on seabird diversity, abundance, and seasonal patterns, but observations on Harbour Porpoise and its activities have been an important spin-off. Now that Harbour Porpoise is known to occur in the area, it may be relevant to develop a separate monitoring objective for Harbour Porpoise, such as to document abundance and movements at critical times of the year (e.g. during herring migration) and if possible to document population size, with a view to assessing changes with time. A monitoring program would have to be responsive to findings of an inshore

monitoring effort for fish species (i.e. to determine when the peak herring migration was underway) and also to focus efforts to monitor influences of activities such as the installation of turbines.

Ecosystem impacts reflect changes in populations resulting from changes in species and food distributions, or that influence interactions between species. In terms of ecosystem impacts, resident species of water-associated birds in the study area would most likely be influenced by changes such as increased or decreased availability of food. The abundance of some coastal species would be influenced by the availability of carcasses of fish and other organisms resulting from turbine impacts (e.g. predatory and carrion-eating birds such as Bald Eagles, and omnivore/scavengers such as Herring Gulls); while species such as Great Black-Backed Gulls, which are often predatory on other gull species, potentially could increase in abundance in response to population changes in other species such as Herring Gulls at the site. There are also current regional trends in seabird abundance, such as a gradual decline in Great Black-Backed and Herring Gull abundance along the Atlantic coast, in response to declining populations of other species such as terns and improved management of waste management facilities. Continuing surveys (both vessel and shore-based) with a focus on the early summer, post-breeding peak of 'resident' species are in the area, could continue to provide a baseline which would be potentially useful in assessing these types of changes and impacts. Other marine mammals including whales and dolphins do not occur with enough regularity to monitor ecosystem changes and furthermore, a definite linkage through feeding changes would be difficult to establish.

Suggestions for Continued Monitoring

Monitoring of seabirds including other water-associated birds and marine mammals at the Fundy Tidal Energy Demonstration Site in advance of installation of any turbines and other infrastructure[11], has provided a sound basis for continuing the monitoring of these components of the environment at the Tidal Energy Demonstration Site. Now that the program has completed coverage of bird and marine mammal occurrences throughout the year, in addition to routine summer monitoring from 2009 to the present, it is an appropriate time to assess the monitoring methods to date for effectiveness, and to determine potential for improvements in continued monitoring at the site in the future. Some of the important features of the data set which can be addressed include:

1) Analysis of trends in abundance of water-associated birds at the study site. Limited emphasis has been placed to date in trend analysis of dominant species including Herring Gull, Great Black-Backed Gull, Black Guillemot, Common Loon, Common Eider, Common Eider and Ring-Billed Gull. Adequate demonstration of population means and trends provides a reference point for levels obtained after turbine installation and operation of the tidal energy demonstration facility. In addition, to year-to year comparison and trend analysis, there may be some other statistics or survey approaches (e.g. focusing of vessel survey effort in Minas Passage at the study site, and Minas Basin) that can be used to compare annual variation. To date a fairly simple non-parametric statistical approach has been applied to the data to provide comparisons of mean abundance. Given the conditions this approach is probably as useful as other analysis methods used for seabird data (e.g. General Additive Models, Clarke *et al.* 2003) but these should also be investigated to determine how to obtain maximum statistical power for measurements at the site (i.e. in Minas Passage). Further efforts could be undertaken to analyze statistical properties of sightings for both birds and Harbour Porpoise from shore-based surveys, and determine improvements for both seabird and porpoise observations (e.g. second observer making behavioural observations, photographic documentation, etc.).

2) Although Harbour Porpoise occurrences have emerged as important at the site, the species is difficult to target cost-effectively in an independent monitoring program but observations could be effectively

[11] The Nova Scotia Power Inc. and OpenHydro turbine was in place from late-2009 to late-2010.

combined with seabird observations, as has already been done at the site. A routine program of shore-based observations for seabird and porpoise monitoring focused on relevant seasons when either of the groups are expected to occur (e.g. some of the observation periods should coincide with the expected Harbour Porpoise occurrences during the Spring Herring migration) would provide a balance in terms of adequate coverage. Harbour Porpoise observations are always infrequent at the site, amounting to a few minutes of observations per six-hour period, so the approach of coupling the porpoise observations with those for seabirds would probably be most cost-effective. It would be useful to fine-tune the timing of the shore-based surveys if there were concurrent observations of fish catch to document herring migration at the site (e.g. catch monitoring at weirs in the area or gill net catch by local fishers to monitor gill net catch through the peak herring migration and perhaps throughout the summer).

3) The summer monitoring program by vessel surveys has provided continuous coverage in Minas Basin, Minas Passage and Minas Channel since 2009. This program should probably place more emphasis on improving better coverage in Minas Passage, and Minas Basin, with a de-emphasis on Minas Channel. Except in the initial 2009 surveys, the amount of sampling effort in Minas Basin was not sufficient to provide enough statistical power to compare a measure such as abundance with the other two areas. The initial goal of the vessel monitoring was to provide information on seabird communities both to the east and west of the Tidal Energy Demonstration Site, as these areas would be potentially impacted if the tidal installations impacted a property of the water column which would relate to food availability, or would result in attraction of species to the turbine site, and to do so in a cost-effective manner. Any changes would be decided based on a more-detailed analysis of the survey results, suggested for the next phase of the monitoring project.

Based on these considerations, the following additions and changes to the program are recommended for 2013, and to aid in maintaining it as an effective long-term monitoring approach:

- Shore-based and vessel data sets should be examined in 2013 to determine if the monitoring approach can be improved; and if there are improvements to statistical estimation approaches for measures of abundance or distribution which can be useful in long-term monitoring. The effort would also involve focused analysis of the vessel survey data set from Minas Passage at the turbine installation site to demonstrate year-to-year trends in abundance of seabirds, both for shore-based and vessel surveys, for the seabird population as a whole or for individual species. One of the goals of this review would be to prepare the information for publishing, and could include an examination of the datasets to date for both shore-based and vessel surveys to determine statistical properties and to optimize the surveys and analysis methods to allow detection of annual changes and trends at the Minas Passage site.

- Continue to conduct shore-based monitoring of water-associated birds and Harbour Porpoise in periods critical respectively to these groups—during the herring migration (March-April) (two surveys, to document Harbour Porpoise abundance); and in the June to mid-July period when the core group of resident water-associated birds is at the site and is in the peak post-breeding period (three surveys). Additional sampling equipment such as a suitable high-powered camera and additional spotting scope for a second observer would improve shore-based observations for Harbour Porpoise. 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 have provided information on species composition during the Summer since the beginning of the program, 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, although with more emphasis on Minas Passage and Minas Basin, and less or no emphasis on Minas Channel, to improve statistical rigour for comparing year-to-year changes. One survey should be done (i.e. early-July, paired with shore-based survey).

As outlined, shore- and vessel-based surveys should be carried out in 2013 to begin shore-based monitoring of both Harbour Porpoise and water-associated birds at relevant times of year for each, and to continue vessel surveys, with adjustments to produce better statistical validity, for long-term monitoring. Recommended surveys and rationale for 2013 are presented in the table below:

Recommended Surveys for Seabirds and Marine Mammals,
Fundy Tidal Power Demonstration Site, 2013.

Type of Activity	Suggested Times	Number of Surveys	Critical Periods and Species Covered
Shore-Based Surveys	March-April	2	Harbour Porpoise; migratory birds.
	Late June, early to mid-July	2	Summering populations of resident water birds and long-term monitoring. Additional observations of Harbour Porpoise in possible critical period. Comparison with vessel survey.
Vessel Surveys	Early-July	1	Summer, repeat earlier surveys of water birds and marine mammals for continuity, comparison with shore surveys, and for monitoring purposes.

In future, early Summer (June-July) may prove to be the most suitable time for monitoring both resident seabirds, waterfowl and Harbour Porpoise, at the Tidal Energy Demonstration Site. 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.

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. Surveys proposed for 2013 will be part of a long-term monitoring record at the site.

5 REFERENCES

Baird, R. 2001. Status of Harbour Seals, *Phoca vitulina*, in Canada. Canadian Field-Naturalist 115: 663-675.

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.

Clarke, E.D., L.B. Spear, M.L. McCracken, F.F.C. Marques, D.L. Borchers, S.T. Buckland and D.G. Ainley. 2003. Validating the use of generalized additive models and at-sea surveys to estimate size and temporal trends of seabird populations. Journal of Applied Ecology, 40: 278-292.

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.

Envirosphere Consultants Limited. 2012. Marine Mammal and Seabird Surveys. Tidal Energy Demonstration Site—Minas Passage, 2011. Report to Report to Fundy Ocean Research Centre for Energy (FORCE), January, 2012.

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.

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, 2012

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

Table A-1a. Overall summary table for June 21, 2012 Survey.													
Species	Date: June 21, 2012, 1353 TO 1923 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		1	2		0.33
COLO				1				2					0.25
GRCO										1			0.08
DCCO			1	1				2	2				0.50
NOGA			1										0.08
COEI	2				7			24	3	9	10	17	6.0
GBBG	2	3	4	3	7	4	6	6	1	2	1	3	3.5
HEGU	4	5	8	6	14	39	14	6	11	5	7	31	12.5
BLGU	1	2	2	6	4	2	1	4	1	2		1	2.17
												Total	25.4

Table A-1b. Inside Black Rock area summary table for June 21, 2012 Survey.													
Species	Date: June 21, 2012, 1353 TO 1923 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													
COLO				1				2					0.25
GRCO									1				0.08
DCCO				1				2	1				0.33
NOGA													
COEI	2				7			24	3	9	10	17	6.0
GBBG			1	1	6			2	1	1	1	1	1.17
HEGU	1	2	3	2	14	6	1		5		3	4	3.42
RBGU													
BLGU	1	2	1	5	4	1	1	4	1	2		1	1.92
												Total	13.2

Table A-1c. Outside Black Rock area summary table for June 21, 2012 Survey.													
Species	Date: June 21, 2012, 1353 TO 1923 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	2		0.25
COLO													
GRCO													
DCCO													
NOGA			1										0.08
COEI													
GBBG			1		1	2	1	2					0.58
HEGU			1	3		5	6	1	2	2	1		1.75
RBGU													
BLGU													
												Total	2.67

Table A-1d. Turbine area summary table for June 21, 2012 Survey													
Species	Date: June 21, 2012, 1353 TO 1923 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								1					0.08
COLO													
GRCO													
DCCO			1						1				0.17
NOGA													
COEI													
GBBG	2	3	2	2		2	5	2		1		2	1.75
HEGU	3	3	4	1		28	7	5	4	3	3	27	7.33
RBGU													
BLGU			1	1		1							0.25
												Total	9.58

Table A-2a. Overall summary table for July 4, 2012 Survey.													
Species	Date: July 4, 2012, 1330 TO 1900 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			5	3				11	20	3.33
COLO	2						1						0.25
PALO						2							0.17
DCCO		1	1			2	1			3	1	1	0.83
GRCO		1											0.08
NOGA		1											0.08
COEI	12		2		1	1	2	8	8	5	10	5	4.5
GBBG	2		2	1	1		3	2		3	2	2	1.5
HEGU	6	1	4	4	3	1		1	7	5	2	3	3.08
BLTE												1	0.08
BLGU	6	9	9	3	5	4	3	8	3	12	8	7	6.42
												Total	20.3

Table A-2b. Inside Black Rock area summary table for July 4, 2012 Survey.													
Species	Date: July 4, 2012, 1330 TO 1900 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													
COLO							1						0.08
PALO													
DCCO		1	1			1				1			0.33
GRCO		1											0.08
NOGA													
COEI	12				1	1	2	8	8	5	10	5	4.33
GBBG	2							1		1		2	0.5
HEGU			3		2	1			4	3			1.08
BLTE													
BLGU	6	7	5	3	5	4	3	8	2	11	8	7	5.75
												Total	12.17

Table A-2c. Outside Black Rock area summary table for July 4, 2012 Survey.													
Species	Date: July 4, 2012, 1330 TO 1900 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					11	15	2.25
COLO													
PALO													
DCCO												1	0.08
GRCO													
NOGA													
COEI													
GBBG			2	1	1		3			2	1		0.83
HEGU	4		1	4	1			1	3	2	2	1	1.58
BLTE												1	0.08
BLGU													
												Total	4.83

Table A-2d. Turbine area summary table for July 4, 2012 Survey.													
Species	Date: July 4, 2012, 1330 TO 1900 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			1			4	3					5	1.08
COLO	2												0.17
PALO						2							0.17
DCCO						1	1			2	1		0.42
GRCO													
NOGA		1											0.08
COEI			2										0.17
GBBG								1			1		0.17
HEGU	2	1										2	0.42
BLTE													
BLGU		2	4						1	1			0.67
												Total	3.33

Table A-3a. Overall summary table for July 18, 2012 Survey.													
Species	Date: July 18, 2012, 1230 TO 1800 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**
COLO										1	1	1	0.25
DCCO						1					1	1	0.25
GRCO		1			1								0.17
NOGA											28	1	2.42
COEI	3			2	1								0.5
SESA													
GBBG		1				2	1			1	1	1	0.58
HEGU				2		2	3	2	1		2	1	1.08
BLGU	7	1	1	5	1				1	2	4	1	1.92
												Total	7.17

Table A-3b. Inside Black Rock summary table for July 18, 2012 Survey.													
Species	Date: July 18, 2012, 1230 TO 1800 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**
COLO										1	1		0.17
DCCO						1					1	1	0.25
GRCO													
NOGA													
COEI	3		2	1									0.50
SESA													
GBBG		1				1	1			1			0.33
HEGU				2		1	3	2	1		1		0.83
BLGU	7	1	1	5	1					2		1	1.50
												Total	3.58

Table A-3c. Outside Black Rock summary table for July 18, 2012 Survey.													
Species	Date: July 18, 2012, 1230 TO 1800 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**
COLO													
DCCO													
GRCO													
NOGA													
COEI													
SESA													
GBBG						1						1	0.17
HEGU												1	0.08
BLGU											2		0.17
												Total	0.42

Table A-3d. Turbine area summary table for July 18, 2012 Survey.													
Species	Date: July 18, 2012, 1230 TO 1800 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**
COLO												1	0.08
DCCO													0
GRCO		1			1								0.17
NOGA											28	1	2.42
COEI													0
SESA													0
GBBG											1		0.08
HEGU						1					1		0.17
BLGU									1		2		0.25
												Total	3.17

Table A4a. Overall summary table for August 2, 2012 Survey.													
Species	Date: August 2, 2012, 1225 TO 1755 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	1					0.17
COLO					1			10	3			2	1.33
PALO							2						0.17
GRSH						1							0.08
NOGA										1	1		0.17
DCCO								1					0.08
COEI		4						4					0.67
RUTU	12												1.0
SAND	1												0.08
SESA										1			0.08
GBBG		1	2				3	1		1			0.67
HEGU	3	5	5	3	3	8	4	2	1	3			3.08
RBGU							2	1		3	2	1	0.75
BLGU	10	12	15	5	2			3				2	4.08
												Total	12.4
Shorebird species, Spotted Sandpiper (SPSA) observed on Black Rock.													

Table A-4b. Inside Black Rock area summary table for August 2, 2012 Survey.													
Species	Date: August 2, 2012, 1225 TO 1755 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													0
COLO													0
PALO													0
GRSH													0
NOGA													0
DCCO													0
COEI		4											0.33
RUTU	12												1
SAND	1												0.08
SESA													0
SPSA													0
GBBG			1					1					0.17
HEGU	1		4	1	1	5		1	1	1			1.25
RBGU								1			2		0.25
BLGU	6	12	7	4	2							1	2.67
												Total	5.75

Table A-4c. Outside Black Rock summary table for August 2, 2012 Survey.													
Species	Date: August 2, 2012, 1225 TO 1755 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					0.08
COLO									1				0.08
PALO													0
GRSH													0
NOGA											1		0.08
DCCO								1					0.08
COEI													0
RUTU													0
SAND													0
SESA													0
SPSA													0
GBBG		1											0.08
HEGU	1			1		1							0.25
RBGU													0
BLGU													0
												Total	0.67

Table A-4d.Turbine area summary table for August 2, 2012 Survey.													
Species	Date: August 2, 2012, 1225 TO 1755 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							1						0.08
COLO					1			10	2			2	1.25
PALO							2						0.17
GRSH						1							0.08
NOGA										1			0.08
DCCO													0
COEI								4					0.33
RUTU													0
SAND													0
SESA										1			0.08
SPSA													0
GBBG			1				3			1			0.42
HEGU	1	5	1	1	2	2	4	1		2			1.58
RBGU							2			3		1	0.50
BLGU	4		8	1				3				1	1.42
												Total	6.0

Table A-5a. Overall summary table for August 15, 2012 Survey.													
Species	Date: August 15, 2012, 1200 TO 1730hrs. 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**
COLO	1	1		1						1			0.33
NOGA				1							1		0.17
DCCO		1		1			1	1	1			1	0.50
COEI										2	1		0.25
GBBG				2	1			2					0.42
HEGU	2	1	2	4	3	4	2	1		7	7	9	3.5
RBGU				1	5	10	6	10	11	39	7	3	7.67
BLGU	2			2		1			1			1	0.58
												Total	13.4

Table A-5b. Inside Black Rock summary table for August 15, 2012 Survey.													
Species	Date: August 15, 2012, 1200 TO 1730hrs . 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**
COLO	1												0.08
NOGA													0
DCCO												1	0.08
COEI										2	1		0.25
GBBG													0
HEGU						2	1	1		4	1		0.75
RBGU					2								0.17
BLGU												1	0.08
												Total	1.42

Table A-5c. Outside Black Rock summary table for August 15, 2012 Survey.													
Species	Date: August 15, 2012, 1200 TO 1730hrs. 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**
COLO		1		1									0.17
NOGA				1									0.08
DCCO		1						1	1				0.25
COEI													0
GBBG				2				2					0.33
HEGU	1		1	2	1	2	1					2	0.83
RBGU						1		6		7			1.17
BLGU													0
												Total	2.83

Table A-5d. Turbine area summary table for August 15, 2012 Survey.													
Species	Date: August 15, 2012, 1200 TO 1730hrs. 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**
COLO										1			0.08
NOGA											1		0.08
DCCO				1			1						0.17
COEI													0
GBBG					1								0.08
HEGU	1	1	1	2	2					3	6	7	1.92
RBGU				1	3	9	6	4	11	32	7	3	6.33
BLGU	2			2		1			1				0.5
												Total	9.17

Table A-6a. Overall summary table for August 29, 2012 Survey.													
Species	Date: August 29, 2012, 0930 to 1500hrs. | 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											0.08
COLO		1											0.08
GRSH							4		1			4	0.75
COSH												1	0.08
SOSH												10	0.83
DCCO							4						0.33
GRCO							2						0.17
COEI											2		0.17
RBME			2										0.17
REPH			1										0.08
RNPH			25										2.08
GBBG					1								0.08
HEGU	5	18	12	3	4	9	4		1	3	1		5.0
RBGU		1	2		1	6	2					2	1.17
												Total	11.08
Shorebird species, Greater Yellowlegs (GRYE) observed on Black Rock.													

Table A-6b. Inside Black Rock summary table for August 29, 2012 Survey.													
Species	Date: August 29, 2012, 0930 to 1500hrs. | 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
COLO		1											0.08
GRSH													0
COSH													0
SOSH													0
DCCO							1						0.08
GRCO							2						0.17
COEI											2		0.17
RBME													0
GRYE													0
REPH													0
RNPH													0
GBBG					1								0.08
HEGU	1	2	3		3	6	1			1			1.42
RBGU					1	6	1						0.67
												Total	2.67

Table A-6c. Outside Black Rock summary table for August 29, 2012 Survey.													
Species	Date: August 29, 2012, 0930 to 1500hrs. | 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											0.08
COLO													0
GRSH									1				0.08
COSH													0
SOSH													0
DCCO													0
GRCO													0
COEI													0
RBME													0
GRYE													0
REPH													0
RNPH													0
GBBG													0
HEGU	2	5	4	1		1	1		1	2			1.42
RBGU													0
												Total	1.58

Table A-6d. Turbine area summary table for August 29, 2012 Survey.													
Species	Date: August 29, 2012, 0930 to 1500hrs. | 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													0
COLO													0
GRSH							4					4	0.67
COSH												1	0.08
SOSH												10	0.83
DCCO							3						0.25
GRCO													0
COEI													0
RBME			2										0.17
GRYE													0
REPH			1										0.08
RNPH			25										2.08
GBBG													0
HEGU	2	11	5	2	1	2	2				1		2.17
RBGU		1	2				1					2	0.5
												Total	6.83

Table A-7. Summary of sightings of water associated bird species at Black Rock Tidal Power demonstration Site, June to August 2012, from shore based observations.

	Individuals observed per 30 minute observation period					
Species	June 21	July 4	July 18	August 2	August 15	August 29
RTLO	0.33	3.33		0.17		0.08
COLO	0.25	0.25	0.25	1.33	0.33	0.08
PALO		0.17		0.17		
DCCO	0.50	0.83	0.25	0.08	0.50	0.33
GRCO	0.08	0.08	0.17			0.17
NOGA	0.08	0.08	2.42	0.17	0.17	
COEI	6.0	4.5	0.5	0.67	0.25	0.17
RBME						0.17
GBBG	3.5	1.5	0.58	0.67	0.42	0.08
HEGU	12.5	3.08	1.08	3.08	3.5	5.0
BLGU	2.17	6.42	1.92	4.08	0.58	
RBGU				0.75	7.67	1.17
BLTE		0.08				
COSH						0.08
GRSH				0.08		0.75
GRYE						--
REPH						0.08
RNPH						2.08
RUTU				1.0		
SAND				0.08		
SESA			--	0.08		
SOSH						0.83
SPSA				--		
TOTAL	25.4	20.3	7.2	12.4	13.4	11.1

Table A-8. Distribution by area of sightings of water associated bird species at Black Rock Tidal Power demonstration Site, June to August 2012, from shore based observations.

	Individuals observed per 30 minute observation period					
Sub-Areas	June 21	July 4	July 18	August 2	August 15	August 29
Inside Black Rock	13.2	12.17	3.58	5.75	1.42	2.67
Outside Black Rock	2.67	4.83	0.42	0.67	2.83	1.58
Turbine Area	9.58	3.33	3.17	6.0	9.17	6.83
Total	25.4	20.3	7.2	12.4	13.4	11.1

Table A-9. Marine mammal sightings at Minas Passage study site, June – August 2012. Average number per 30-minute observation period.

	Abundance (Individuals per 30 minute observation period)					
	June 21	July 4	July 18	August 2	August 15	August 29
Grey Seal						0.17
Harbour Seal				0.083		
Harbour Porpoise	0.25	1.92		0.58	2.58	0.08

Table A-10. Sightings of water associated bird species at Black Rock Tidal Power demonstration Site, June 21 to August 29, 2012, from shore based observations.

	Individuals observed per 30 minute observation period					
Species	June 21	July 4	July 18	August 2	August 15	August 29
BLGU	x	x	x	x	x	
BLTE		x				
COEI	x	x	x	x	x	x
COLO	x	x	x	x	x	x
COSH						x
DCCO	x	x	x	x	x	x
GBBG	x	x	x	x	x	x
GRCO	x	x	x			x
GRSH				x		x
GRYE						x*
HEGU	x	x	x	x	x	x
NOGA	x	x	x	x	x	
PALO		x		x		
RBGU	x			x	x	x
RBME						x
REPH						x
RNPH						x
RTLO	x	x		x		x
RUTU				x		
SAND				x		
SESA			x*	x		
SOSH						x
SPSA				x*		
TOTAL	9	11	8 (+1)	14 (+1)	8	14 (+1)

* Species observed on Black Rock only.

Table A-11. Number of species sightings of water associated bird species at Tidal Energy Demonstration Site, 2010 vs 2011 & 2012, from shore based observations.			
	Individuals observed per 30 minute observation period		
Species	2010	2011	2012
RTLO	⊠	⊠	⊠
COLO	⊠	⊠	⊠
PALO	⊠	⊠	⊠
DCCO	⊠	⊠	⊠
GRCO	⊠	⊠	⊠
NOGA	⊠	⊠	⊠
NSHO		⊠	
ABDU	⊠	⊠	
COEI	⊠	⊠	⊠
KIEI		⊠	
COGO		⊠	
WWSC	⊠	⊠	
SUSC	⊠	⊠	
BLSC	⊠	⊠	
SCSP		⊠	
RBME	⊠	⊠	⊠
COME	⊠	⊠	
HADU	⊠		
GBBG	⊠	⊠	⊠
HEGU	⊠	⊠	⊠
ICGU	⊠	⊠	
LAGU	⊠		
LBBG	⊠	⊠	
BLGU	⊠	⊠	⊠
Alcid sp		⊠	
RAZO	⊠	⊠	
HOGR	⊠	⊠	
BLKI	⊠	⊠	
RBGU	⊠	⊠	⊠
LTDU	⊠	⊠	
RNGR	⊠		
ATPU	⊠		
MALL	⊠		
CAGO	⊠	⊠	
COMU	⊠	⊠	
TBMU	⊠	⊠	
MEGU	⊠		
BLTE			⊠
COSH			⊠
GRSH			⊠
GRYE			⊠*
REPH			⊠
RNPH			⊠
RUTU			⊠
SAND			⊠
SESA			⊠
SOSH			⊠
SPSA			⊠*
TOTAL	32	29 (+2 unid)	21 (+2*)

* Species observed on Black Rock only.

Table A-12. Summary of activity of water associated bird species at Black Rock Tidal Energy Demonstration Site, June to August 2012, 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	June 21		July 4		July 18		August 2		August 15		August 29	
	Number	OW Proportion	Number	OW Proportion	Number	OW Proportion	Number	OW Proportion	Number	OW Proportion	Number	OW Proportion
RTLO	4 (0)	0	40 (40)	1			2 (2)	1			1 (1)	1
COLO	3 (2)	0.67	3 (1)	0.3	3 (3)	1	16 (13)	0.81	4 (4)	1	1 (1)	1
PALO			2 (2)	1			2 (2)	1				
DCCO	6 (1)	0.17	10 (2)	0.2	3 (2)	0.67	1 (0)	0	6 (0)	0	4 (2)	0.5
GRCO	1 (1)	1	1 (0)	0	2 (0)	0					2 (0)	0
NOGA	1 (0)	0	1 (0)	0	29 (0)	0	2 (0)	0	2 (0)	0		
COEI	72 (72)	1	54 (54)	1	6 (6)	1	8 (8)	1	3 (3)	1	2 (2)	1
GBBG	42 (11)	0.26	18 (0)	0	7 (1)	0.14	8 (3)	0.38	5 (3)	0.6	1 (0)	0
HEGU	150 (60)	0.40	37 (3)	0.08	13 (1)	0.08	37 (9)	0.24	42 (17)	0.40	60 (21)	0.35
RBGU							9 (0)	0	92 (40)	0.43	14 (3)	0.21
BLGU	26 (12)	0.52	77 (68)	0.88	23 (12)	0.52	49 (29)	0.59	7 (3)	0.43		
REME											2 (0)	0
REPH											1 (0)	0
RNPH											25 (0)	0
RUTU							12 (0)	0				
COSH											1 (0)	0
BLTE			1 (0)	0								
SAND							1 (0)	0				
SESA							1 (0)	0				
SOSH											10 (0)	0
SPSA												
GRSH							1 (1)	1			9 (0)	0
GRYE												
Overall	244 (170)	0.70	305 (159)	0.52	86 (25)	0.29	149 (67)	0.45	161 (70)	0.43	133 (30)	0.23

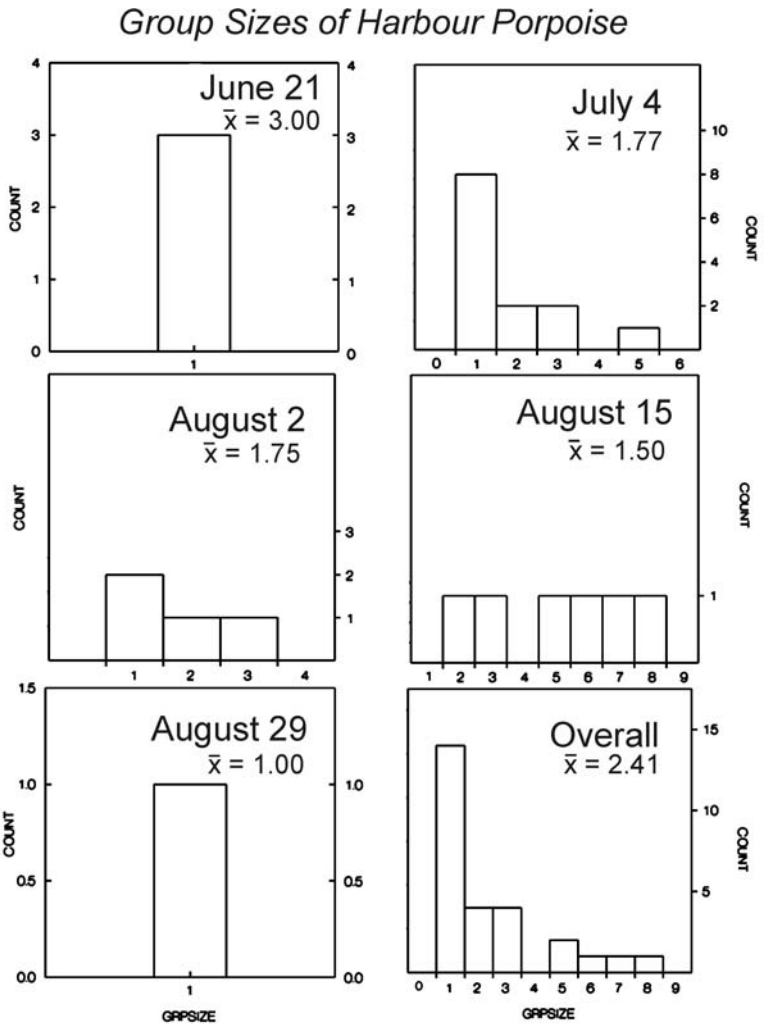


Figure A-1. Estimated group sizes of Harbour Porpoise (*Phocoena phocoena)* observed during shore-based surveys at the Fundy Tidal Energy Demonstration Facility, June-August 2012. No Harbour Porpoise were observed on July 18, 2012.

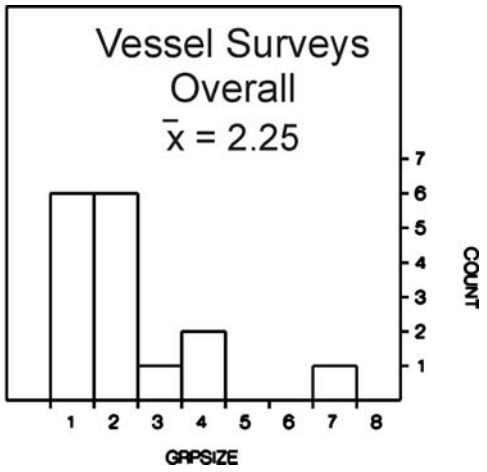


Figure A-2. Estimated group sizes of Harbour Porpoise (*Phocoena phocoena)* observed during vessel surveys in Minas Basin, Minas Passage and Minas Channel, July 15 & 28, and August 10, 2012.