Marine Mammal and Seabird Surveys

Tidal Energy Demonstration Site — Minas Passage, 2010

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Fundy Ocean Research Centre for Energy (FORCE)

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EXECUTIVE SUMMARY

The Province of Nova Scotia and the Fundy Ocean Research Centre for Energy (FORCE) are presently developing a tidal energy demonstration facility in the Minas Passage area of Nova Scotia's Bay of Fundy. Water-associated birds (seabirds, waterfowl and shorebirds) and marine mammals (seals, dolphins and porpoises, and whales) are important components of the marine ecosystem in Minas Passage that 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-year monitoring studies in 2008 & 2009 respectively. From May to November 2010, a series of one-day shore-based observational surveys for marine mammals and seabirds at the Fundy Tidal Power Demonstration Site, as well as two vessel-based surveys reaching from the outer Minas Basin to Cape Spencer, were undertaken to provide additional baseline as well as environmental monitoring information to assess potential impacts of the project. Shore-based surveys took place in May (1, 13 & 27) and on June 12, October 23, and November 13 & 22, 2010, and vessel-based surveys took place on July 19 and August 18, 2010.

Thirty-two species of water-associated birds were observed from shore in the vicinity of the demonstration facility including: seabirds (Double-Crested Cormorant, Great Cormorant, Herring Gull, Black-Backed Gull, Iceland Gull, Laughing Gull, Lesser-Backed Gull, Ring-Billed Gull, Mew Gull, Black Guillemot, Northern Gannet, Razorbill, Horned Grebe, Red-Necked Grebe, Black-Legged Kittiwake, Atlantic Puffin, Thick-Billed Murre and Common Murre); and waterfowl (Common Eider, American Black Duck, Mallard, Harlequin Duck, Long-Tailed Duck, Canada Goose, Common Loon, Pacific Loon, Red-Throated Loon, Surf Scoter, Black Scoter, White-Winged Scoter, Red-Breasted Merganser and Common Merganser). The greatest number of species occurred during fall migration in late October and early November (October 23 & November 13 surveys), but no migration peak was observed in May, and the expected peak spring movement of birds through the area may have occurred earlier. Ten species were observed in vessel surveys which included parts of Minas Basin, Minas Passage and Minas Channel, including Herring Gull, Great Black-Backed Gull, Ring-Billed Gull, Double-Crested

and Great Cormorant, Common Eider, Black Guillemot, Northern Gannet, Wilson's Storm Petrel and Common Loon. Densities of seabirds measured in vessel surveys were comparable to those observed in 2009, and overall were slightly lower than or comparable to densities in other Nova Scotia coastal and offshore waters.

Herring Gull, Great Black-Backed Gull, Common Eider and Red-Throated Loon were the most common and abundant species, with Great Black-Backed and Herring Gulls dominant in terms of numbers in the spring-early summer (May-June), and Herring Gulls dominant in July-August, shifting to a greater importance of Common Eider and Red-Throated Loon and low abundance of Great Black-Backed Gull in the Fall. Great Black-Backed Gull, which was the most abundant seabird during May, was replaced in dominance by Herring Gull in June through August, and by Common Eider in October. Red-Throated Loons were present during migration in May and in Fall (late-October-November), and were particularly abundant in November.

No pattern was observed in the local distribution of birds in several sub-areas of the installation site—(between Black Rock and shore; in Minas Passage outside Black Rock; and in the turbine installation ("Crown Lease") area. Greatest concentrations of birds were observed in late-May to early-June in the inshore area extending between Black Rock and shore (Great Black-Backed & Herring Gulls dominant); in the turbine installation area in mid-November (Red-Throated Loons dominant); and in Minas Passage during October 23 & November 22 surveys (Common Eider, Herring Gulls and Red-Throated Loons dominant).

Harbour Porpoise (*Phocoena phocoena)* occurred frequently from early May to late November with the exception of mid- to late-May, and a single Grey Seal (*Halichoerus grypus)* was observed on November 13th. Harbour Porpoise occurred typically in groups of 2-3 individuals with the largest group containing four individuals; highest numbers were observed on May 1, and November 13 and 22 when abundance averaged one animal per 30-minute observation period. Individual Harbour Porpoise occurred with about the same frequency in the three operational subdivisions of the study area (inside Black Rock, outside Black Rock (Minas Passage) and 'turbine area' (the area seaward of Black Rock towards the Minas Channel and Cape Split)), usually swimming seaward with the outgoing tidal stream.

1 INTRODUCTION

Seabirds and marine mammals are important components of the marine ecosystem, and in the context of tidal power development, they have the potential to interact with tidal turbines and be affected by associated activities. The location of the tidal energy demonstration site is known to support various seabird, waterfowl and marine mammals species common to coastal environments in Atlantic Canada; however detailed information that can be used in monitoring and impact assessment is not available for the site. Preliminary shipboard surveys for seabirds and marine mammals were carried out in July and October 2008 as part of geophysical cruises to the area to obtain information on occurrence and species composition at the site (Envirosphere Consultants Limited 2009a). A comprehensive survey program was established in 2009, with single day-long seabird surveys conducted in June, July, August and September 2009 to provide additional baseline information for the assessment of potential impacts and for the development of an environmental monitoring program for the project (Envirosphere Consultants Limited 2010). Subsequent review of the results of the first year monitoring report by the Environmental Monitoring Advisory Committee (EMAC) for the project, as well as regulatory agencies, led to recommendations for the collection of additional information on bird species, particularly diving species such as loons, during the Spring and Fall migration periods, which were not represented in sampling in the 2009 monitoring program. This report presents the results of a modified monitoring protocol which includes a series of shore-based, day-long observations of seabirds and marine mammals in the waters in the vicinity of the tidal power demonstration site, as well as two vessel-based surveys carried out in July and August 2010 to repeat surveys done at the same time of year in 2009.

2 METHODS

Shore-Based Surveys

Shore-based surveys were carried out at the site on May 1, 13 & 27; June 12; October 23, and November 13 & 22, 2010. Surveys were done by Mr. Fulton Lavender, an experienced seabird and marine mammal observer, assisted by Mr. Matthew MacLean, Environmental Technologist, Envirosphere Consultants Limited, except on May 1 and November 22 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 and 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. For the first survey (May 1), observations were made from the top of the beach berm in the mid-section of the beach at the site; for the remaining surveys the observation point moved to the top of the berm on the east end of the beach where there was shelter from the wind to stabilize the spotting scope on the several occasions when the winds were moderate. This location provided a good view of all the areas of interest, in particular of the turbine installation area (Figure 1a). The observer scanned the entire study area several times during successive 30-minute periods, noting all birds seen and location, maturity, as well as activities (flying, on water, feeding etc.), providing an estimate of total number of unique bird species per period. 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 (Ed and Fred Huntley, Scots Bay), departing from Scots Bay in early morning just before high tide on July 19

and August 18, 2010[1] and returning with the tide in the evening. Surveys were carried out by Fulton Lavender, assisted by Matthew MacLean, the same team used for the shore-based surveys. Surveys were done under generally good observation conditions although it was foggy on August 18 up to 1300 hrs (visibility <300 m, 14%; 0.3-0.5 km, 43%; and >0.5 km 42.8% of 5-minute periods). Surveys covered areas including parts of Minas Basin extending from approximately off Parrsboro, and along the central to north sides of Minas Passage and Minas Channel extending to Cape Spencer (Figure 1b). A standard watch for seabirds was carried out modeled after the Canadian Wildlife Service protocol (Wilhelm *et al.* 2008) but omitting 'snapshot' sampling for flying birds[2], although all flying birds seen in the 5-minute period were counted. Watches of 5-minute duration were carried out while the vessel was in motion, every 10 to 15 minutes. One of the five-minute observation periods every 30 minutes was always done on the port side of the boat as a standard, although this distinction was not needed for subsequent analysis. The observer monitored a strip of water and air 300 m wide approached by the vessel, on the port side for the July survey and starboard side for the August survey, 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 carried out continuous watches with binoculars for marine mammals, and any sightings by the vessel crew were investigated. 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. After this data is used in this project, the data will be given to the Canadian Wildlife Service and to Fisheries and Oceans Canada for inclusion in respective seabird and marine mammal databases.

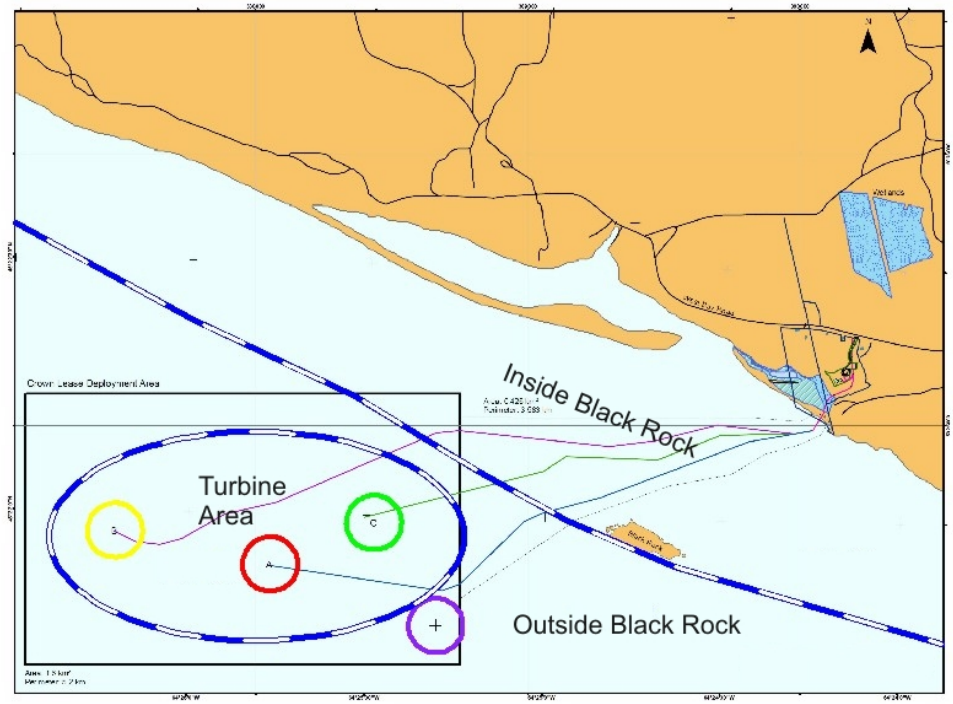

Figure 1a. Study area for shore-based surveys, showing project location and major subdivisions.

[1] Survey times were chosen to catch a high tide early in the morning to allow a full tidal cycle during daylight hours.

[2] The 'snapshot' is an instantaneous count of flying birds within a 300 m radius of the observer and was omitted. All flying birds were included in the normal sampling routine, however, although the density estimate obtained is likely to be higher than if the 'snapshot' approach was used.

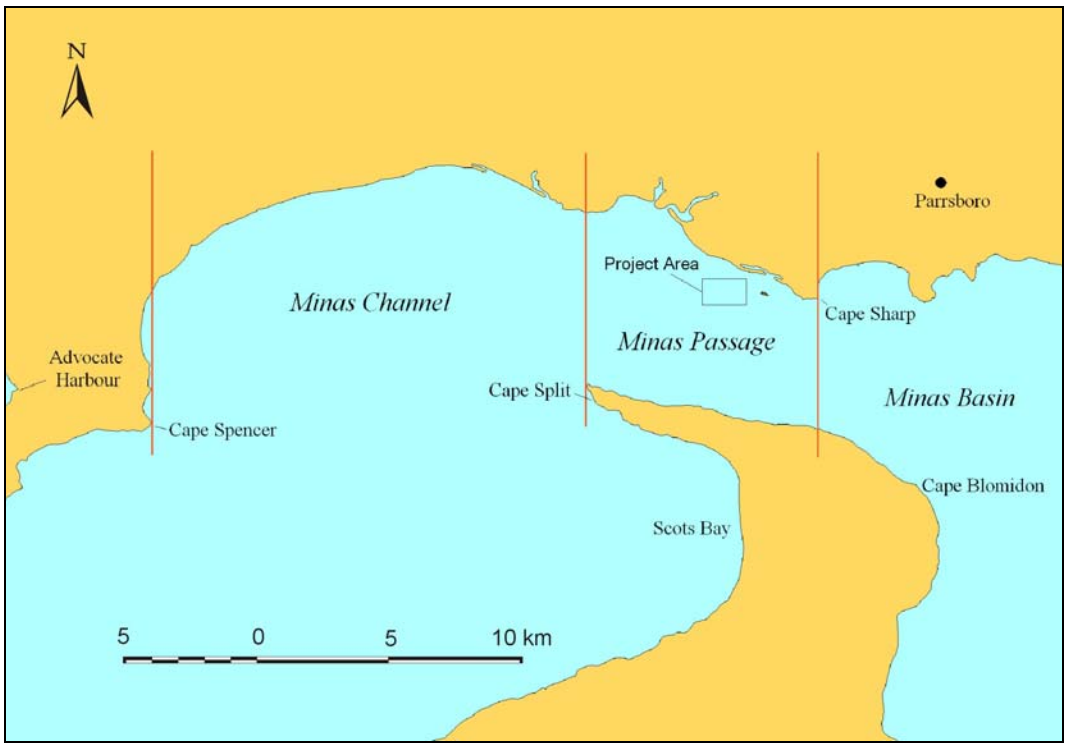

Figure 1b. Study area for vessel surveys, showing project location and major subdivisions.

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

A detailed 'zig-zag' grid of transects was also included as part of the survey to provide focused information on the tidal installation site which is included in the overall analysis but not specifically analyzed in this study (Figures 3 & 4). Difficulties in repeating the grid by different operators of the vessel in July and August resulted in a different pattern in the two months; however it demonstrated a closely-spaced grid pattern could be carried out if such site-specific monitoring of the site is required in future. The increased sampling effort in this grid biases the abundance and species composition estimates for Minas Passage as a whole in this report to more closely reflect the characteristic seabird community at the installation site.

[3] The survey design was reviewed by D. Fifield, CWS, St. John's, NL, prior to implementation.

For each observation period, the distance traveled based on beginning and end coordinates of the period, as well as based on heading and ship speed, was calculated. The two were highly correlated and the distance based on coordinates was used for subsequent analysis[4]. 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 (maps); as a spatial density estimate based on numbers seen 'in transect' (i.e. in the 300 m band on the side of the track traversed by the ship, and therefore the most quantitative estimate); as well as total or individual species abundances per kilometre (includes all birds seen within and outside of the 300 m quantitative observation band and which typically includes more species than the area estimate)[5]. Abundance expressed per unit area is a more accurate estimate of density of offshore birds, although it may exclude some species. Because 'snapshots' were not 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 may be overestimated in this survey (e.g. Wilhelm et al. 2008).

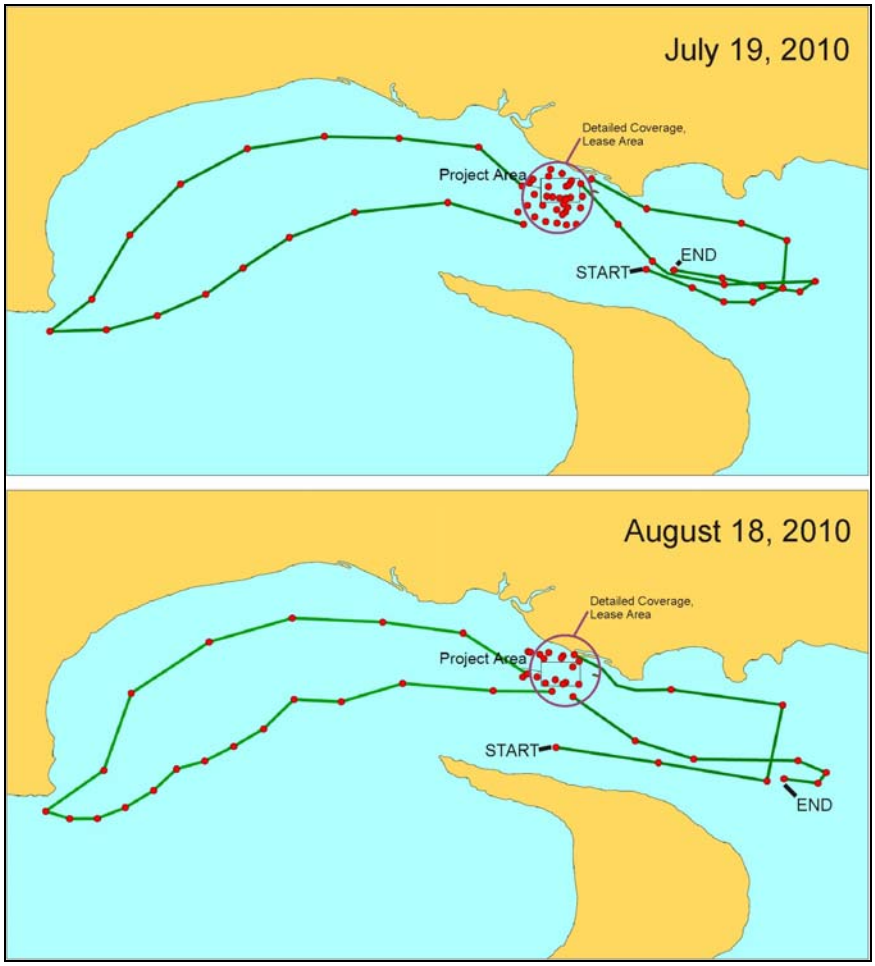

Figure 2. Survey route for July and August seabird surveys in 2010. Points indicate locations of start points for 5-minute observation periods during seabird and waterfowl survey.

[4] In 2010, the recorded geographic position of the start points of the survey were more reliable than in 2009, because an assistant to the seabird observer was provided, and reduced or removed recording errors for speed, heading, and geographic coordinates compared to 2009.

[5] 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.

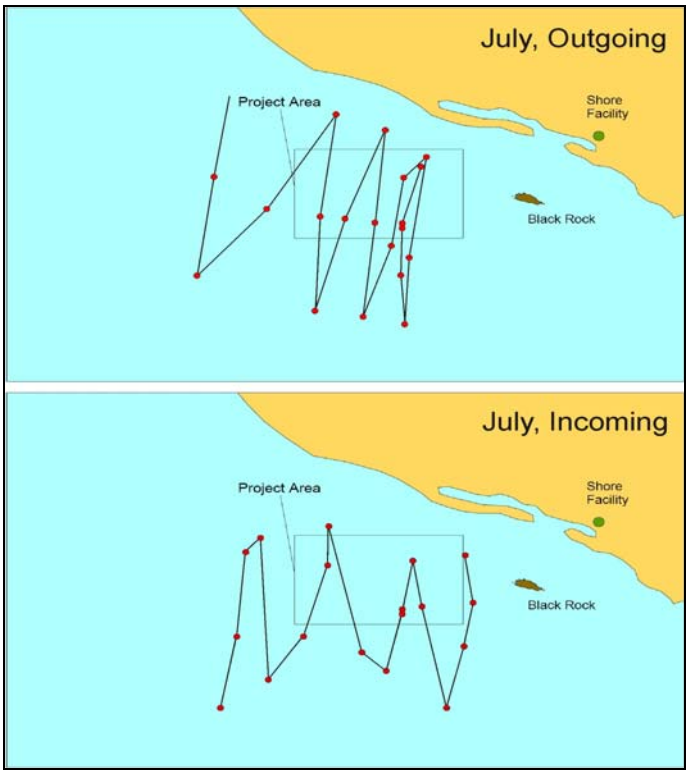

Figure 3. Survey route for July and August seabird surveys in 2010. Points indicate locations of start points for 5-minute observation periods during seabird and waterfowl survey.

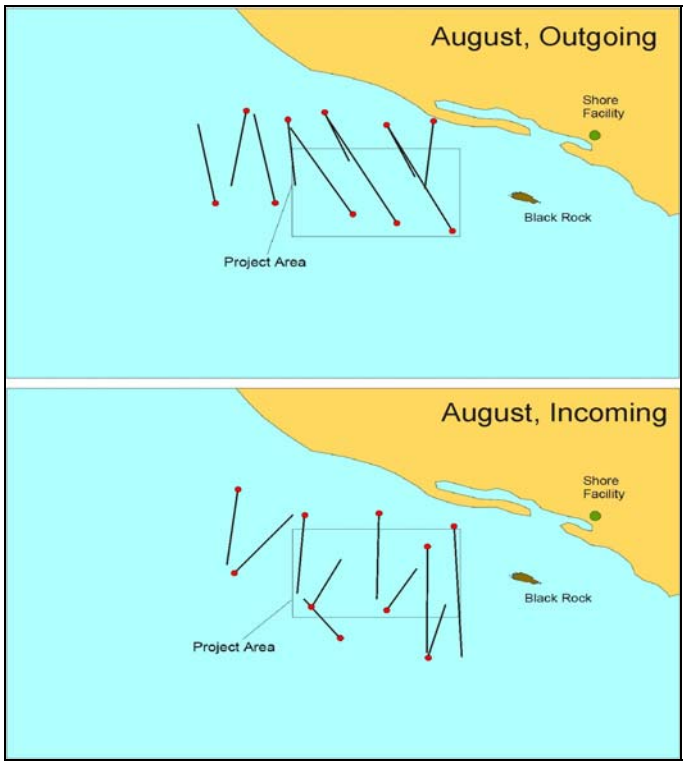

Figure 4. Survey route for July and August seabird surveys in 2010. Points indicate locations of start points for 5-minute observation periods during seabird and waterfowl survey.

3 RESULTS AND DISCUSSION

3.1 Marine Mammals

Two species of marine mammals, the Harbour Porpoise (*Phocoena phocoena)* and the Grey Seal (*Halichoerus grypus)* were observed in the surveys. Harbour Porpoise was by far the dominant species (43 individuals observed), versus only one Grey Seal, the latter seen only in the shore-based survey on November 13. Most of the sightings occurred during the shore-based observations, with only five Harbour Porpoise recorded on the two vessel surveys (Table 1; Figure 5). Harbour Porpoise occurred in the study area throughout the observation period with the exception of mid- to late-May (May 13 and 27) (Figure 5) and highest numbers of sightings were made on May 1, and November 13 and 22, at those times averaging about one animal per 30-minute observation period (Figure 5). A high of seven animals was observed, however, moving through the area in a half-hour period on May 1. There did not appear to be an association of the movements with time of day although most individuals were observed from mid- to late in the observation period (typically mid- to late afternoon or early evening)(Figure 5).

Harbour Porpoise were typically observed in groups of 2-3 individuals with the largest group containing four individuals. The porpoises were nearly always swimming in the direction of the outgoing tide[6]. The only exception was one group of 4 individuals sighted during the vessel survey on August 18, which were heading northeast (further into Minas Basin).

Individual Harbour Porpoise occurred with about the same frequency in the three operational subdivisions of the study area (inside Black Rock, outside Black Rock (Minas Passage) and 'turbine area' (the area seaward of Black Rock towards the Minas Channel and Cape Split)) (Figure 5). All the individuals were swimming seaward with the outgoing tide and appeared to pass through individual areas by chance, depending on their position in the tidal current stream leaving Minas Basin.

Both Harbour Porpoise and Gray Seal are known to occur in the Bay of Fundy and 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. Compared with 2009, fewer Harbour Porpoise were observed on the vessel surveys (only five individuals compared with 19 individuals in the July-August surveys for 2009). No other species were observed in the vessel surveys, compared with three other species (Harbour Seal, White-Sided Dolphin, and an unidentified whale) in 2009. Shore-based surveys (which were not conducted in 2009), in contrast, showed Harbour Porpoise to be relatively common in the Minas Passage at the tidal demonstration site. The species is a small porpoise found in Atlantic coastal areas in the summer to fall. It is commonly taken as by-catch in gill nets (Caswell et al. 1998) which is one of many threats to the survival of local populations, including the Bay of Fundy/Gulf of Maine population. The Northwest Atlantic population of the species is listed as a Species of Concern by COSEWIC and the status is *Threatened* under the Federal *Species at Risk Act*. Grey Seal is a large coastal seal species, which is common in Atlantic Canada.

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

Table 1. Marine mammal observations during seabird and marine mammal surveys, Minas Basin, Minas Passage and Minas Channel, May – November 2010.

Date	Time (ADT)	Survey Component	Location[1]	Species	Number
May 1, 2010	1637 - 1707	Shore	45 22.26 64 24.35	Harbour Porpoise	7
	1707 - 1737	"	"	Harbour Porpoise	3
May 13, 2010	--	Shore	45 22.21 64 24.22	None Observed	--
May 27, 2010	--	Shore	"	None Observed	--
June 12, 2010	1200 - 1230	Shore	45 22.21 64 24.22	Harbour Porpoise	1
	1230 - 1300	"	"	Harbour Porpoise	2
	1330 - 1400	"	"	Harbour Porpoise	3
	1530 - 1600	"	"	Harbour Porpoise	2
July 19, 2010	1758 - 1803	Vessel	45 19.76 64 17.92	Harbour Porpoise	1
August 18, 2010	1812 - 1817	"	45 20.10 64 18.00	Harbour Porpoise	4
October 23, 2010	1500 - 1530	Shore	45 22.21 64 24.22	Harbour Porpoise	1
	1600 - 1630	"	"	Harbour Porpoise	1
November 13, 2010	945 - 1015	Shore	45 22.21 64 24.22	Harbour Porpoise	1
	1015 - 1045	"	"	Harbour Porpoise	3
	1115 - 1145	"	"	Harbour Porpoise	1
	1215 - 1245	"	"	Grey Seal	1
	1245 - 1315	"	"	Harbour Porpoise	1
	1315 - 1345	"	"	Harbour Porpoise	2
	1415 - 1445	"	"	Harbour Porpoise	3
	1445 - 1515	"	"	Harbour Porpoise	2
	1515 - 1545	"	"	Harbour Porpoise	1
November 22, 2010	1300 - 1330	Shore	45 22.21 64 24.22	Harbour Porpoise	2
	1400 - 1430	"	"	Harbour Porpoise	3
	1430 - 1500	"	"	Harbour Porpoise	2
	1530 - 1600	"	"	Harbour Porpoise	2

1. Observation point for shore survey.

3.2 Seabirds, Waterfowl and Shorebirds

3.2.1 Vessel-Based Surveys

3.2.1.1 Survey Effort

Measures of seabird and marine mammal abundance as well as species diversity are influenced by sampling effort. Total numbers observed, as well as number of species occurring (species diversity), are positively correlated with sampling effort, while the quality of abundance estimates (e.g. numbers per kilometre or numbers per unit area) are typically improved by additional sampling effort. Important variations in sampling effort in the present survey included: differences in effort between areas, and differences in intensity of sampling (number of observation periods per unit distance or unit area). In the present study, there were differences in effort between Minas Basin and the other areas (Minas Basin lower and Minas Passage and Minas Channel with a similar level of sampling effort (Figure 6 and Table 2) (due to the shorter distance traveled in Minas Basin)). Differences in sampling effort affect comparisons between study areas, with areas having lower effort having lower species diversity and higher variability than other areas. These differences introduced by sampling effort would tend to obscure the natural differences between these areas that the analyses are trying to detect.

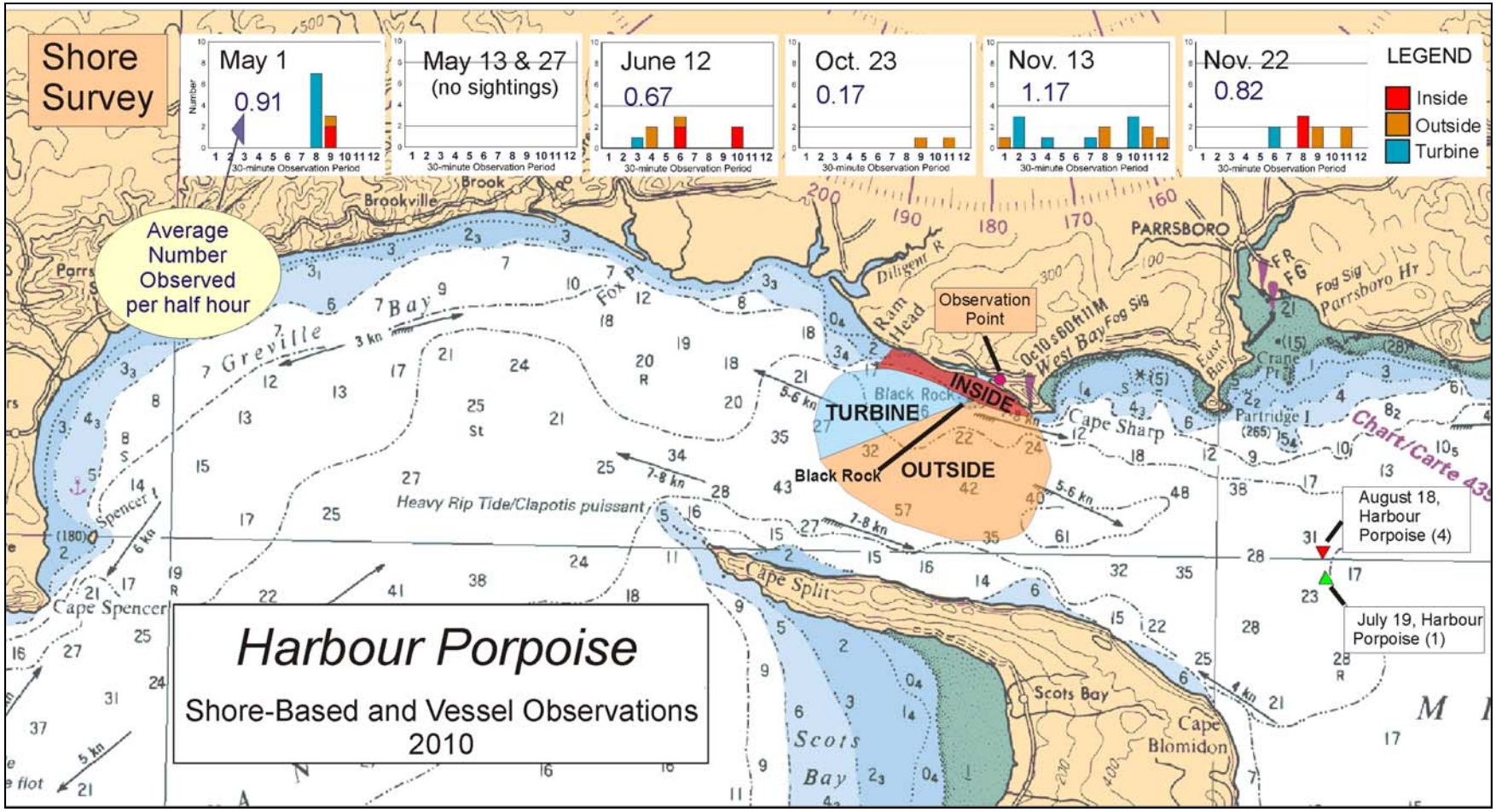

Figure 5. Sightings of marine mammals from shore observations, May-June and October-November, 2010, and from vessel surveys, July and August, 2010. Approximate area viewed from shore is shown and terms describe sub-areas used in the text.

Sampling effort was similar between months (July and August) in terms of number of 5-minute observation periods (Figure 6 & Table 2) and distance surveyed (Table 2), as well as between Minas Basin and Minas Channel in both months and overall. Sampling effort in Minas Passage was higher than the other areas, reflecting the extra sampling on the grid of observation lines run across the tidal demonstration site. Effort was lower overall than in July and August, 2009, resulting from a lower sampling frequency[7]. Effort in Minas Basin, which had been relatively low compared to the other areas in 2009, was increased over June and September 2009 values by extending the cruise route further into the Basin, although it was still lower than in July & August 2009 because of the difference in sampling frequency noted above.

Both surveys had good observation conditions, although the August survey had a lower visibility before noon due to the presence of fog. Lower visibility, while not greatly impacting quantitative observations within 300 m of the vessel, would affect (reduce) the total number of sightings.

Table 2. Observation Effort, Seabird and Marine Mammal Survey of Minas Basin, Minas Passage and Minas Channel, July and August, 2010.

		Distance Traveled (km)	
	Overall	July	August
Minas Basin	22.41	11.46	10.95
Minas Passage	54.06	31.89	22.17
Minas Channel	30.17	15.63	14.54
Total	106.64	58.98	47.66
	Overall	Area Sampled[1] (km^2)	
Minas Basin	6.72	3.44	3.29
Minas Passage	16.22	9.57	6.65
Minas Channel	9.05	4.69	4.36
Total	31.99	17.69	14.30
	Overall	Number of Observations (5-minute periods)	
Minas Basin	25	15	10
Minas Passage	60	38	22
Minas Channel	32	14	18
Total	117	67	50

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

[7] 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. This would have been unsustainable because of the potential for errors and overloading the observer, so a more modest rate was used in 2010.

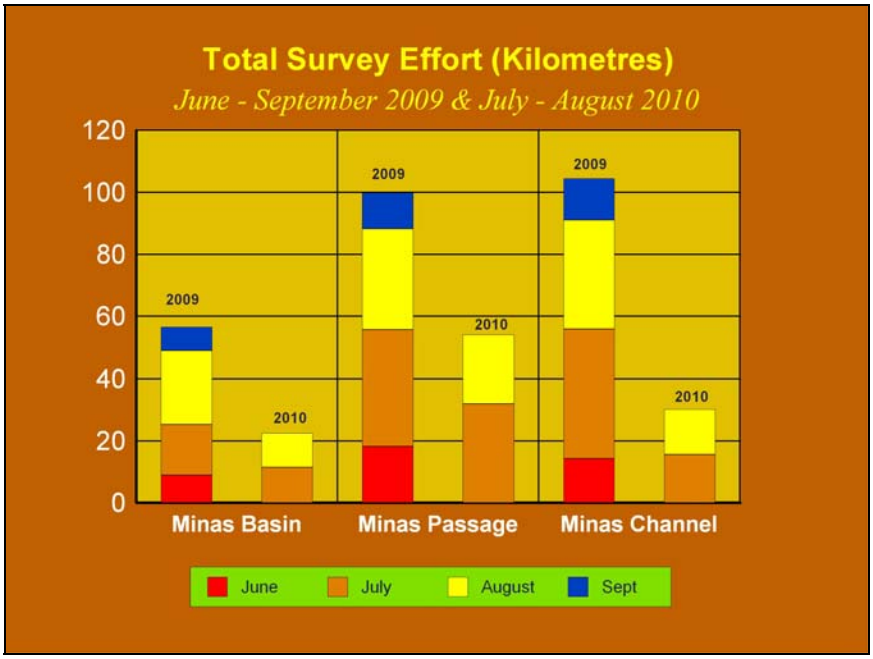

Figure 6. Distance surveyed (kilometres), June to September, 2009 and July & August 2010.

3.2.1.2 Species Composition

Overall, 161 seabirds and waterfowl in 10 species were sighted during the vessel surveys (Figures 7-9 and Tables 3-5). Most sightings were in Minas Passage, about twice the number seen in Minas Basin and Minas Channel. Herring Gull (*Larus argentatus)* was the most abundant and common bird (48.4% of sightings, occurring in 35.0% of observation periods, Table 3) and dominating in both July and August (Table 3-5, Figures 9 & 10). Common Eider (*Somateria molissima*), a coastal seaduck species, was next in abundance in both months (14.4% and 21.1% of individuals in July & August, respectively), but was not common, one flock of 15 occurring in July and one of 12 birds in August (1.5% and 2% of observation periods, respectively). Great Black-Backed Gull occurred in moderate abundance in both surveys (6.7% and 8.8% of individuals in July & August, respectively, and 10.4 and 6.0% of observation periods); and three species occurred in moderate abundance in individual surveys—Northern Gannet (14.4% of individuals and 7.5% of observation periods in July; Wilson's Storm Petrel, an oceanic species only occasionally likely to occur in the area (12.5% of sightings, 16.4% of observation periods in July); and Ring-Billed Gull (15.8% of sightings and 12% of observation periods) in August. Common Loon (*Gavia immer)* occurred occasionally as single sightings in both July and August surveys; and Double-Crested and Great Cormorant, and Black Guillemot were observed in low numbers in the August survey.

Differences between 2010 and 2009 in seabird abundance determined by the vessel surveys included a reduced number of species and total number of sightings in 2010, although density estimates of birds were similar in 2010. Compared to 2009, bird species diversity was lower, with two fewer species observed in 2010. A core group of species which occurred in both years were: Herring Gull, Great Black-Backed Gull, Ring-Billed Gull, Double-Crested Cormorant, Common Eider, Common Loon, Black Guillemot and Northern Gannet. Great Cormorant and Wilson's Storm Petrel occurred only in 2010, and Pacific Loon, Greater Shearwater, Red Phalarope and White-Winged Scoter occurred only in 2009. The number of sightings was also lower in July and August 2010 than in 2009 (69.1% of 2009 overall and 80.0% and 55.3% for July and August, respectively); however sightings adjusted for effort (numbers per kilometre) (Figure 8, Tables 3-5) were comparable overall to 2009, although some differences in individual areas and months occurred. Differences included: higher densities (seabirds per kilometre) in

July 2010 in Minas Basin and Minas Passage; lower densities for August 2010 in Minas Passage; and higher densities in August 2010 in Minas Channel compared to 2009 (Figure 8).

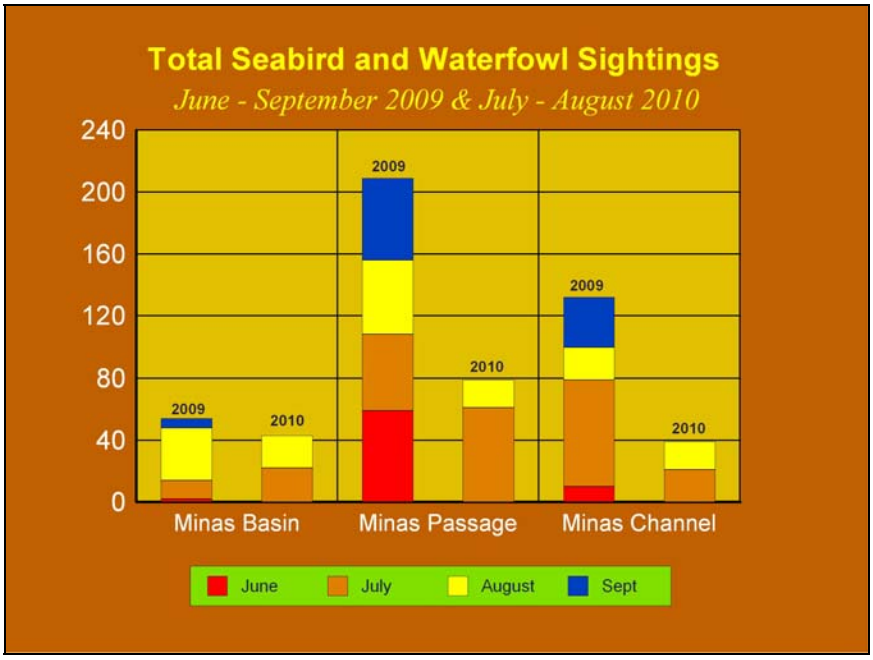

Figure 7. Summary of numbers of sightings of seabirds and waterfowl by area and month, from vessel surveys, June to September, 2009 and July & August 2010.

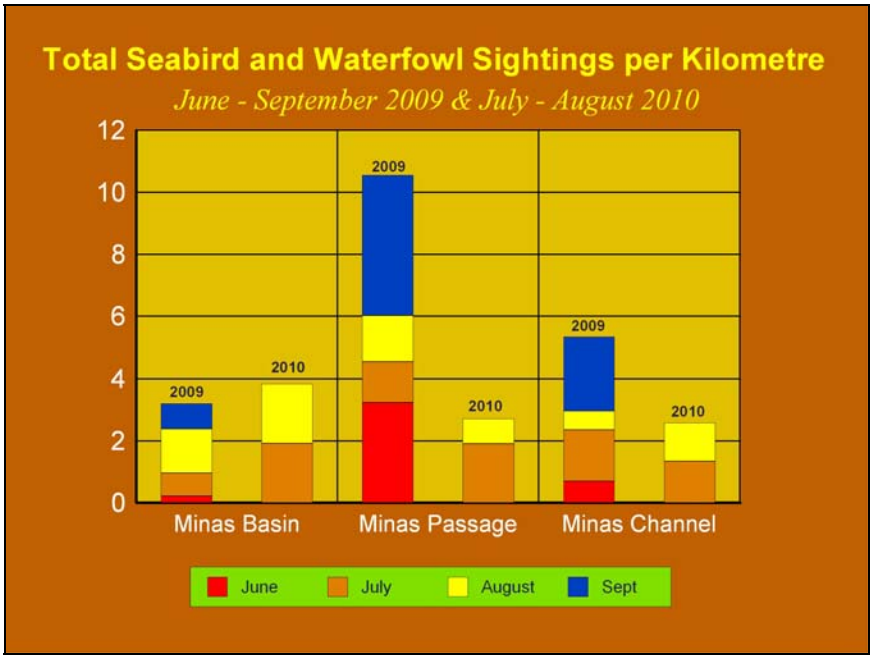

Figure 8. Summary of numbers of sightings of seabirds and waterfowl by area and month, from vessel surveys, adjusted for effort (kilometres surveyed) June to September, 2009 and July & August 2010.

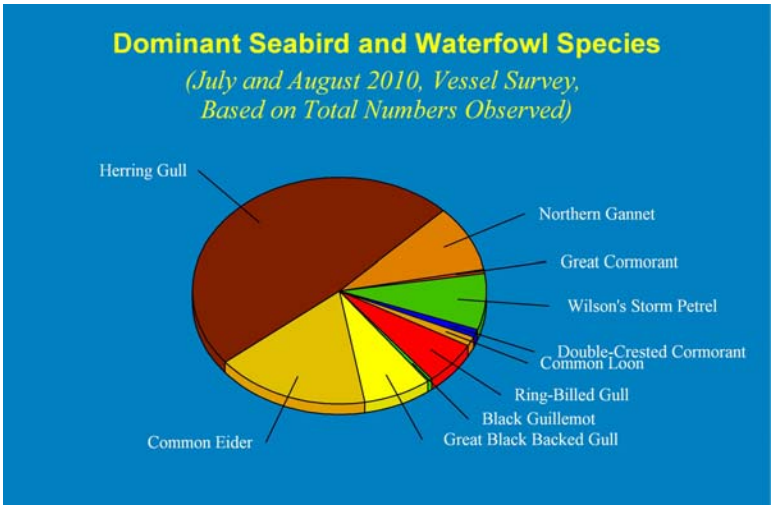

Figure 9. Species composition and relative abundance of seabird and waterfowl species observed in Minas Basin, Minas Passage and Minas Channel on vessel surveys, July & August, 2010.

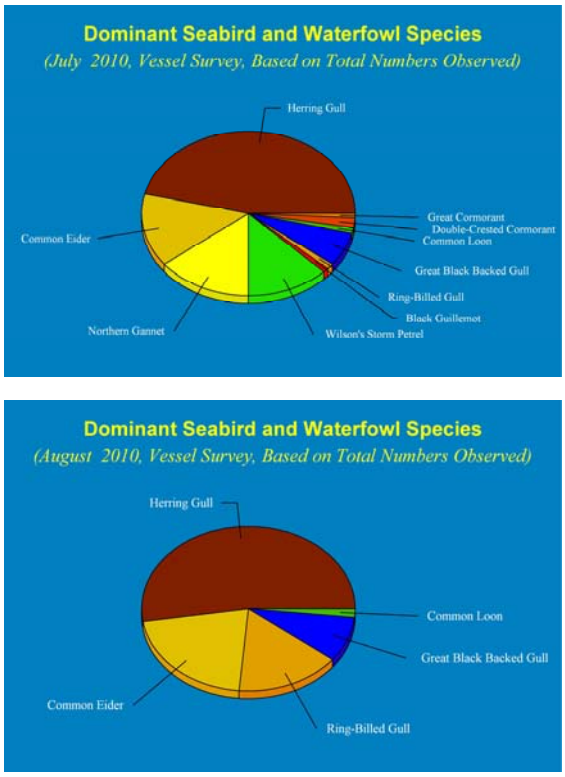

Figure 10. Species composition and relative abundance of seabird and waterfowl species by month, obtained in vessel surveys of Minas Basin, Minas Passage and Minas Channel, July & August 2010.

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 similar in both July and August in Minas Basin and Minas Channel; and higher in July than in August in Minas Passage (Figures 11-12)[8]. Highest average abundance reached 4.0 birds per km^2 in Minas Passage in July and lowest in Minas Channel in both July and August (1.7 and 1.6 birds/km^2, respectively)(Figures 11-12 & 15; Tables 3-5).

Abundance was similar between years, with a tendency for abundance in terms of individuals per kilometre to be higher in 2010 than in 2009 (Figure 13), while density expressed as birds/km^2 was comparable between years (Figure 14).

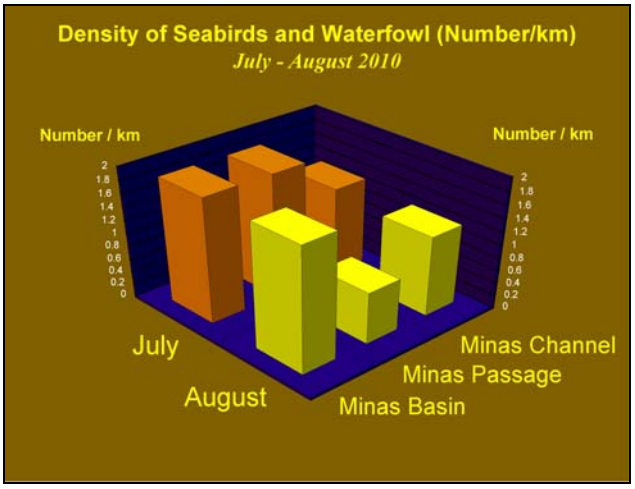

Figure 11. Abundance of seabirds and waterfowl (number/kilometre), July & August, 2010.

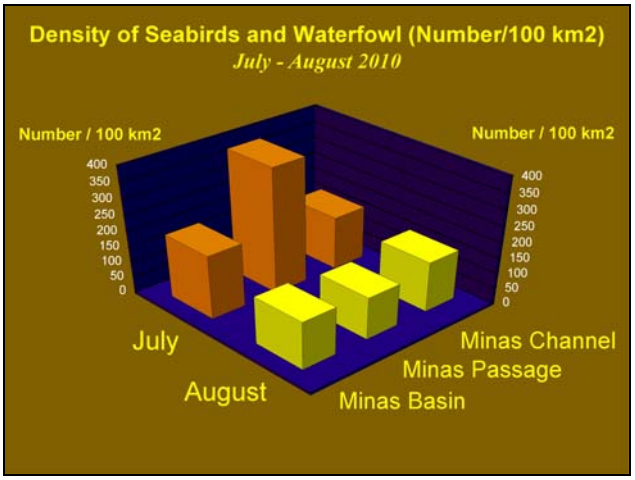

Figure 12. Abundance of seabirds and waterfowl (number/100 km^2), July & August 2010.

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

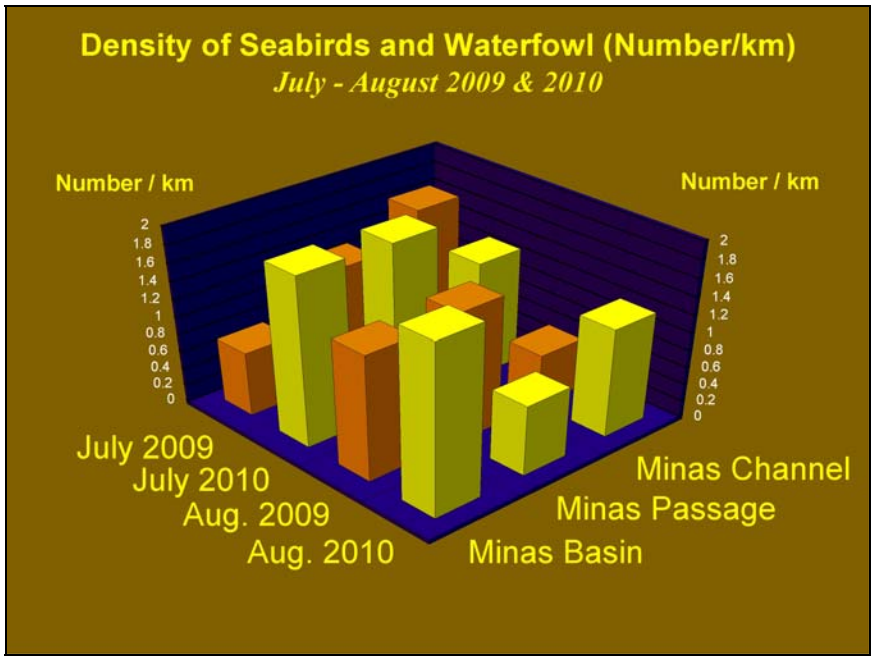

Figure 13. Abundance of seabirds and waterfowl (number/km) in vessel surveys, July & August 2009 & 2010.

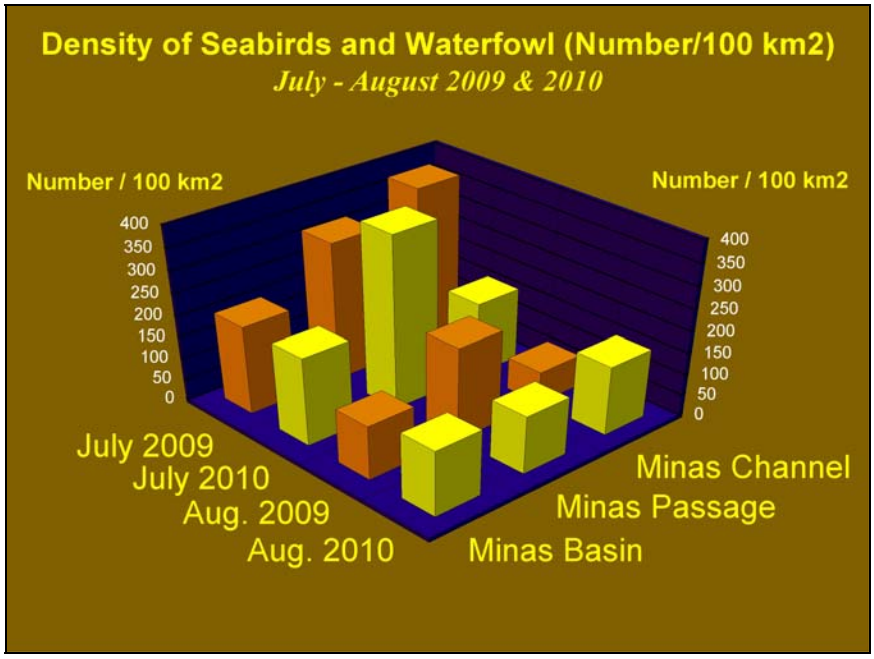

Figure 14. Abundance of seabirds and waterfowl (number/100 km^2) in vessel surveys, July & August 2009 & 2010.

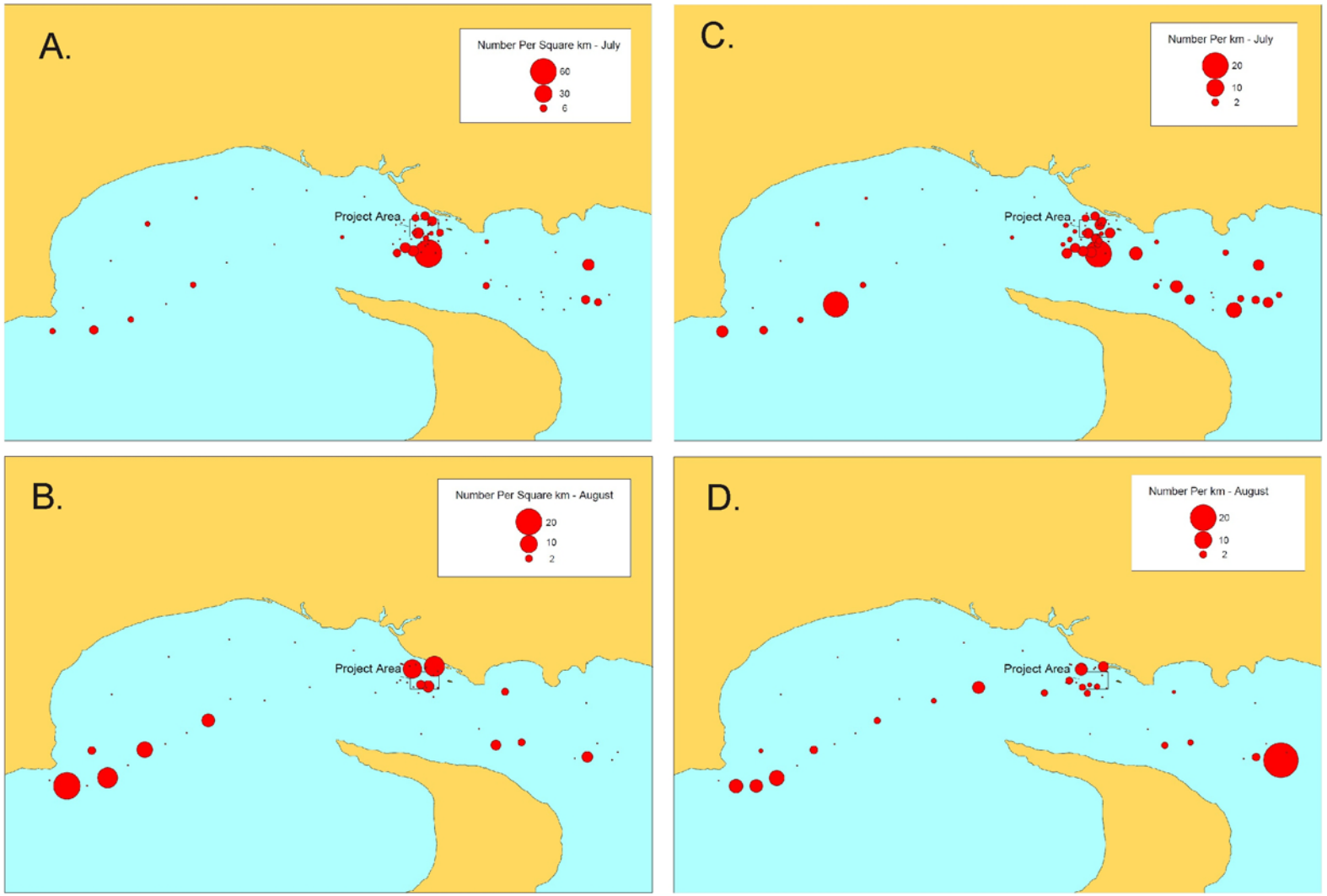

Figure 15. Overall abundance of seabirds and waterfowl in Minas Basin, Minas Passage and Minas Channel, July and August, 2010. A & B, individuals per square kilometre; C & D, individuals per kilometre.

Table 3. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, July & August, 2010. Number of 5-minute observation periods: Minas Basin = 25; Minas Passage = 60; Minas Channel = 32. 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	Wilson's Storm Petrel	Great Cormorant	Northern Gannet	Ring-Billed Gull
	Total Number Observed										
Minas Basin	43	3	0	20 (5)	0	12	1	4[2] (2)	0	1 (1)	2
Minas Passage	79	7 (2)	2 (1)	37 (8)	0	15	0	9[2] (1)	1 (1)	3[2] (1)	5 (1)
Minas Channel	39	2 (1)	0	21 (4)	2 (2)	0	0	0	0	11 (11)	3 (3)
Total	161	12	2	78	2	27	1	13	1	15	10
	Number / Kilometre										
Minas Basin	1.92	0.13	0.00	0.89	0.00	0.54	0.04	0.18	0.00	0.04	0.09
Minas Passage	1.46	0.13	0.04	0.68	0.00	0.28	0.00	0.17	0.02	0.06	0.09
Minas Channel	1.29	0.07	0.00	0.70	0.07	0.00	0.00	0.00	0.00	0.36	0.10
Overall	1.51	0.11	0.02	0.73	0.02	0.25	0.01	0.12	0.01	0.14	0.09
	Number Observed within 300 m survey area [1]										
Minas Basin	12	0	0	8	0	0	1	3	0	0	0
Minas Passage	47	0	1	26	0	15	0	3	0	0	2
Minas Channel	15	1	0	12	2	0	0	0	0	0	0
Total	74	1	1	46	2	15	1	6	0	0	2
	Number of Seabirds per 100 km^2										
Minas Basin	178.49	0.00	0.00	118.99	0.00	0.00	14.87	44.62	0.00	0.00	0.00
Minas Passage	289.82	0.00	6.17	160.33	0.00	92.50	0.00	18.50	0.00	0.00	12.33
Minas Channel	165.71	11.05	0.00	132.57	22.09	0.00	0.00	0.00	0.00	0.00	0.00
Overall	231.31	3.13	3.13	143.79	6.25	46.89	3.13	18.75	0.00	0.00	6.25
Month	Observations	Frequency of Occurrence (% of observation periods)									
July	67	10.4	1.5	37.3	1.5	1.5	1.5	16.4	1.5	7.5	1.5
August	50	6.0	0.0	32.0	2.0	2.0	0.0	0.0	0.0	0.0	12.0
Overall	117	8.5	0.9	35.0	1.7	1.7	0.9	9.4	0.9	5.1	6.0

1. 300 m band on one side of survey vessel.
2. Maturity unknown.

Table 4. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, July 19, 2010. Number of 5-minute observation periods: Minas Basin = 15; Minas Passage = 38; Minas Channel = 14. 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	Wilson's Storm Petrel	Great Cormorant	Northern Gannet	Ring-Billed Gull
	Total Number Observed										
Minas Basin	22	3	0	12 (2)	0	0	1	4[2] (2)	0	1 (1)	1
Minas Passage	61	3	2 (1)	28 (5)	0	15	0	9[2] (1)	1 (1)	3[2] (1)	0
Minas Channel	21	1	0	8 (5)	1 (1)	0	0	0	0	11 (11)	0
Total	104	7	2	48	1	15	1	13	1	15	1
	Number / Kilometre										
Minas Basin	1.92	0.26	0.00	1.05	0.00	0.00	0.09	0.35	0.00	0.09	0.09
Minas Passage	1.91	0.09	0.06	0.88	0.00	0.47	0.00	0.28	0.03	0.09	0.00
Minas Channel	1.34	0.06	0.00	0.51	0.06	0.00	0.00	0.00	0.00	0.70	0.00
Overall	1.76	0.12	0.03	0.81	0.02	0.25	0.02	0.22	0.02	0.25	0.02
	Number Observed within survey area[1]										
Minas Basin	7	0	0	3	0	0	1	3	0	0	0
Minas Passage	38	0	1	19	0	15	0	3	0	0	0
Minas Channel	8	1	0	6	1	0	0	0	0	0	0
Total	53	1	1	28	1	15	1	6	0	0	0
	Number of Seabirds per 100 km^2										
Minas Basin	203.64	0.00	0.00	87.28	0.00	0.00	29.09	87.28	0	0	0
Minas Passage	397.20	0.00	10.45	198.60	0.00	156.79	0.00	31.36	0	0	0
Minas Channel	170.61	21.33	0.00	127.96	21.33	0.00	0.00	0.00	0	0	0
Overall	299.55	5.65	5.65	158.25	5.65	84.78	5.65	33.91	0	0	0

1. 300 m band on one side of Survey Vessel.
2. Maturity not known.

Table 5. Abundance of seabirds in Minas Basin, Minas Passage and Minas Channel, August 18, 2010. Number of 5-minute observation periods: Minas Basin = 10; Minas Passage = 22; Minas Channel = 18. 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	Wilson's Storm Petrel	Great Cormorant	Northern Gannet	Ring-Billed Gull
	Total Number Observed										
Minas Basin	21	0	0	8	0	12	0	0	0	0	1
Minas Passage	18	4	0	9	0	0	0	0	0	0	5
Minas Channel	18	1	0	13	1	0	0	0	0	0	3
Total	57	5	0	30	1	12	0	0	0	0	9
	Number / Kilometre										
Minas Basin	1.92	0.00	0.00	0.73	0.00	1.10	0.00	0.00	0.00	0.00	0.09
Minas Passage	0.81	0.18	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Minas Channel	1.24	0.07	0.00	0.89	0.07	0.00	0.00	0.00	0.00	0.00	0.21
Overall	1.20	0.10	0.00	0.63	0.02	0.25	0.00	0.00	0.00	0.00	0.19
	Number Observed within Survey Area[1]										
Minas Basin	5	0	0	5	0	0	0	0	0	0	0
Minas Passage	9	0	0	7	0	0	0	0	0	0	2
Minas Channel	7	0	0	6	1	0	0	0	0	0	0
Total	21	0	0	18	1	0	0	0	0	0	2
	Number of Seabirds per 100 km^2										
Minas Basin	152.18	0.00	0.00	152.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minas Passage	135.34	0.00	0.00	105.27	0.00	0.00	0.00	0.00	0.00	0.00	30.08
Minas Channel	160.44	0.00	0.00	137.52	22.92	0.00	0.00	0.00	0.00	0.00	0.00
Overall	146.87	0.00	0.00	125.89	6.99	0.00	0.00	0.00	0.00	0.00	13.99

1. 300 m band on one side of survey vessel.
2. Maturity unknown

Abundance of Gulls

Herring Gull

Herring Gull was the most abundant seabird overall and the most commonly observed in the study area during the vessel surveys in July-August 2010. The species is a common, annual breeder, nesting on islands and seacliffs along the Bay of Fundy. It is primarily a scavenger/ omnivore, which feeds at the water surface. Herring Gull abundance is often linked to human activities and associated food sources in coastal areas. Herring Gull occurred in both surveys, and was highest in abundance in Minas Passage in July (2.0 birds per km^2) showing similar lower abundances for both months in Minas Basin and Minas Channel (Figure 16). Lowest abundance was 0.9 birds per km^2 in Minas Basin in July. Herring Gull abundance per kilometre was higher in July in both Minas Basin and Minas Passage, and highest in August in Minas Channel (Figure 17). Most individuals were adults with immatures and juveniles making up about a fifth of numbers (July, 20.8%, and August, 23.3%)(Tables 3-5). The species was observed in all areas in both months (Figure 18).

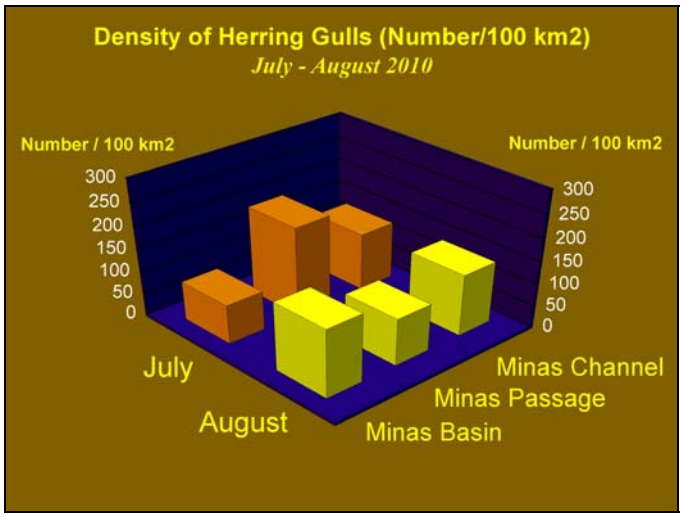

Figure 16. Density of Herring Gulls (number/100 km^2), July & August, 2010.

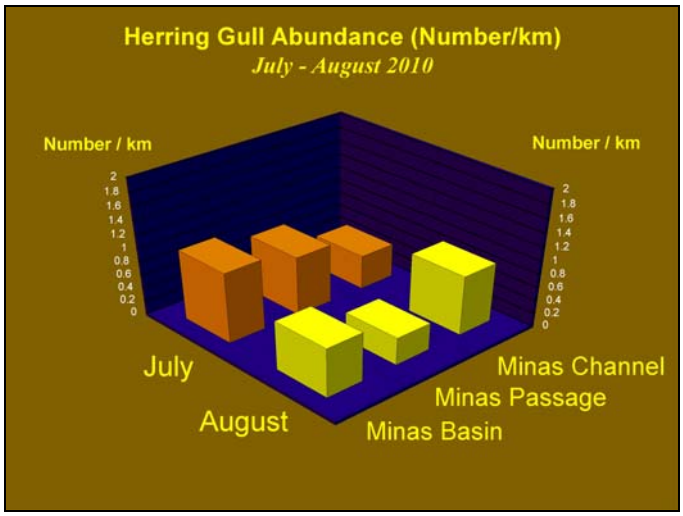

Figure 17. Abundance of Herring Gulls (number/kilometre), July & August, 2010.

Great Black-Backed Gull

Great Black-Backed Gull occurred occasionally in low abundance in all areas in both July and August surveys (Figure 18). Abundance was similar between months, but the species was not seen in Minas Basin or Minas Channel in August. Highest abundance was 0.3 birds per kilometre in Minas Basin in July and lowest 0.1 birds per kilometre in Minas Channel in both July and August (Tables 3-5). Abundances in Minas Passage and Minas Channel were similar between years (0.1 to 0.2 birds per kilometre) and abundance in Minas Passage was highest of both years in July 2010 although most variable (the species was not sighted in Minas Basin in August 2010). All 'Black-Backs' sighted in July were adults but immatures/juveniles accounted for 60% in August (Tables 3-5). The species is a common annual breeder in Atlantic Canada, which nests on islands and seacliffs along the Bay of Fundy, feeding mainly by scavenging along shores and at the water surface.

Ring-Billed Gull

Ring-Billed Gull occurred occasionally in low abundance, observed in Minas Basin in July and in all areas in August (Tables 3-5)(Figure 19). Highest abundance was 0.2 birds per kilometre in August (Minas Passage and Minas Channel), with a lower abundance in Minas Basin (0.1 birds per kilometre) in both July and August (Table 3). The species was also more common and abundant in August in 2009 surveys, at similar densities (0.1 to 0.2 birds per kilometre), although it was not sighted in Minas Channel. Both adults and immatures/juveniles were observed, with immatures and juveniles occasionally important (July, 0%, and August, 44.4%)(Tables 3-5). Ring-Billed Gull is a common annual migrant and occasional summer resident, feeding typically at the water surface.

Abundance of Miscellaneous Seabird and Waterfowl Species

Common Eider

Common Eider occurred occasionally, with sightings of one small flock in each of the surveys, once in the middle of Minas Passage near the tidal demonstration site in July (15 individuals) and once in Minas Basin in August (12 individuals)(Figure 19). In contrast, the species occurred in smaller groups or singly in July and August 2009, with most individuals sighted in Minas Passage near the tidal study site and several sightings in Minas Basin in July. Densities in 2010 ranged from 0.5 birds per kilometre (Minas Basin, July) to 1 per kilometre (Minas Passage, August) (Tables 3-5) compared with densities of 0.1 to 0.3 individuals per kilometre in 2009 (Envirosphere Consultants 2010). All of the individuals observed were adults. 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.

Double-Crested Cormorant

Double-Crested Cormorant is a resident of the area, nesting in colonies in Minas Basin and on Cape Split, and relatively common in inshore waters, but only two individuals were seen on the combined surveys, in July in the vicinity of the project site (Figure 20). Overall densities were less than 0.1 birds per kilometre compared with 0.1 to 0.3 birds per km observed in 2009. The species is a common annual breeder, which nests on islands and seacliffs along the Bay of Fundy, feeding by diving for fish to shallow to medium depths and occasionally deeper.

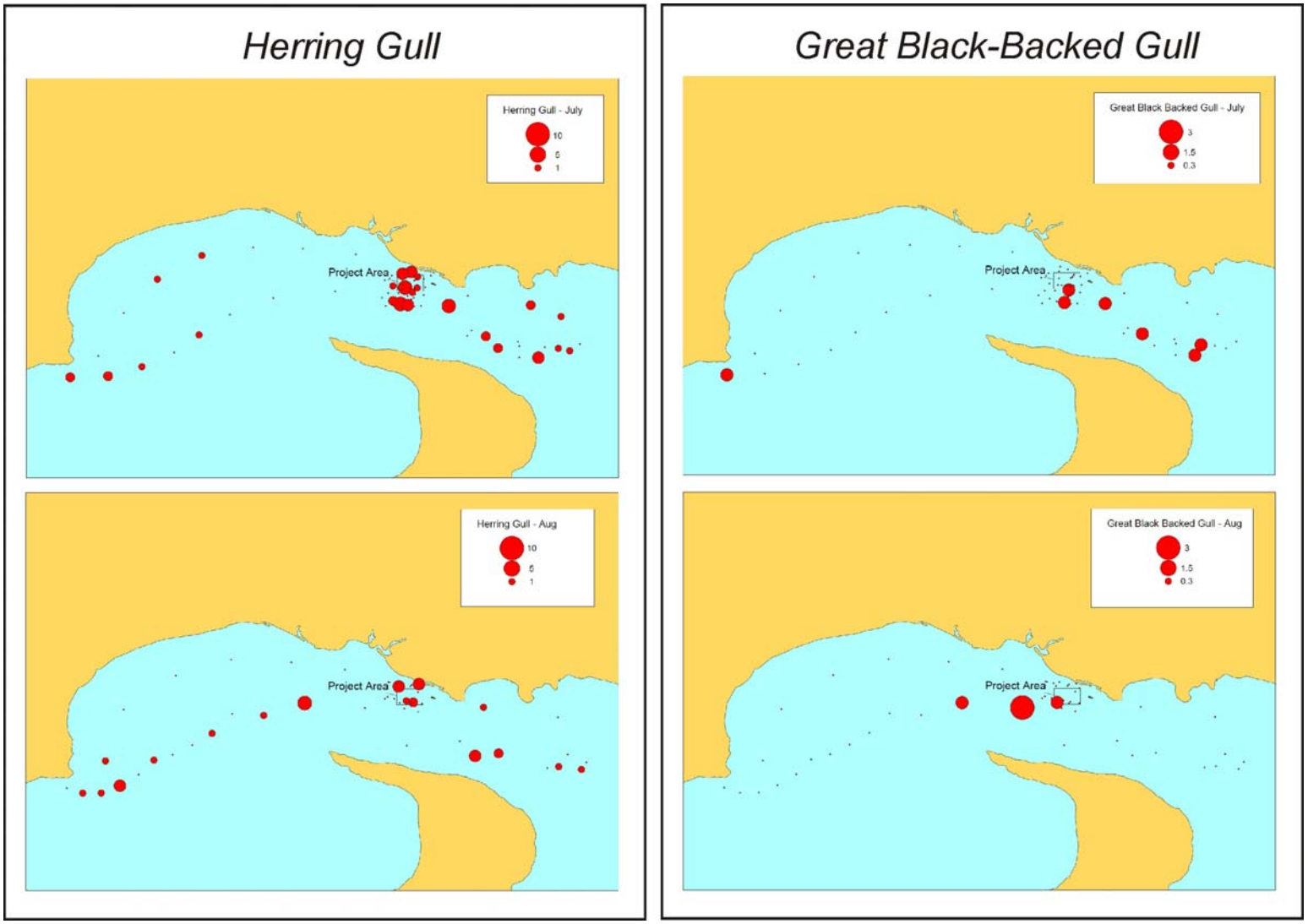

Figure 18. Distribution and abundance (individuals per 5-minute observation period) of Herring Gull and Great Black-Backed Gull in Minas Basin, Minas Passage and Minas Channel, July & August 2010. Area shown is Crown Lease, which contains berths for tidal device installation.

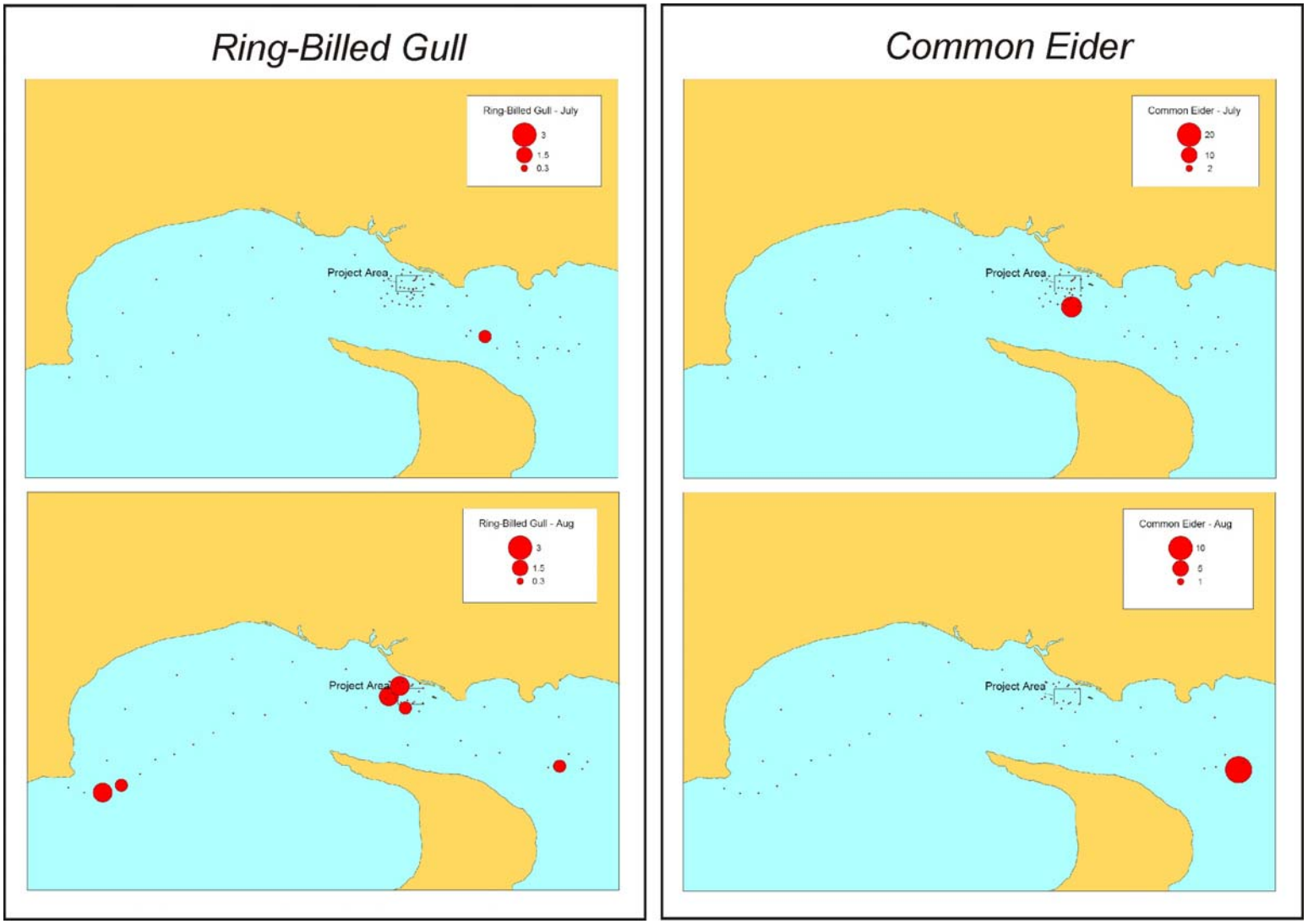

Figure 19. Distribution and abundance (individuals per 5-minute observation period) of Ring-Billed Gull and Common Eider in Minas Basin, Minas Passage and Minas Channel, July & August 2010. Area shown is Crown Lease, which contains berths for tidal device installation.

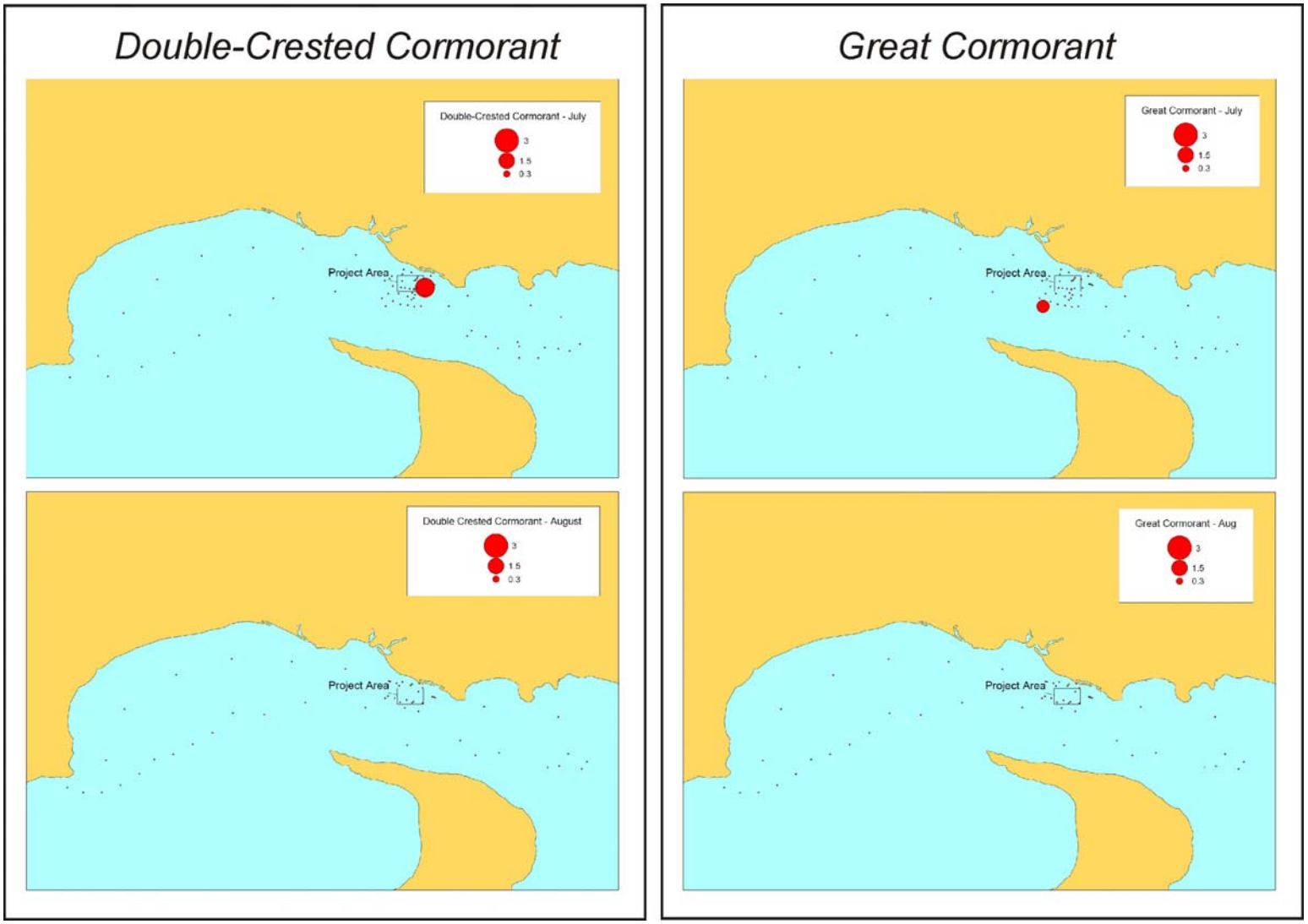

Figure 20. Distribution and abundance (individuals per 5-minute observation period) of Double-Crested Cormorant and Great Cormorant in Minas Basin, Minas Passage and Minas Channel, July & August 2010. Area shown is Crown Lease, which contains berths for tidal device installation.

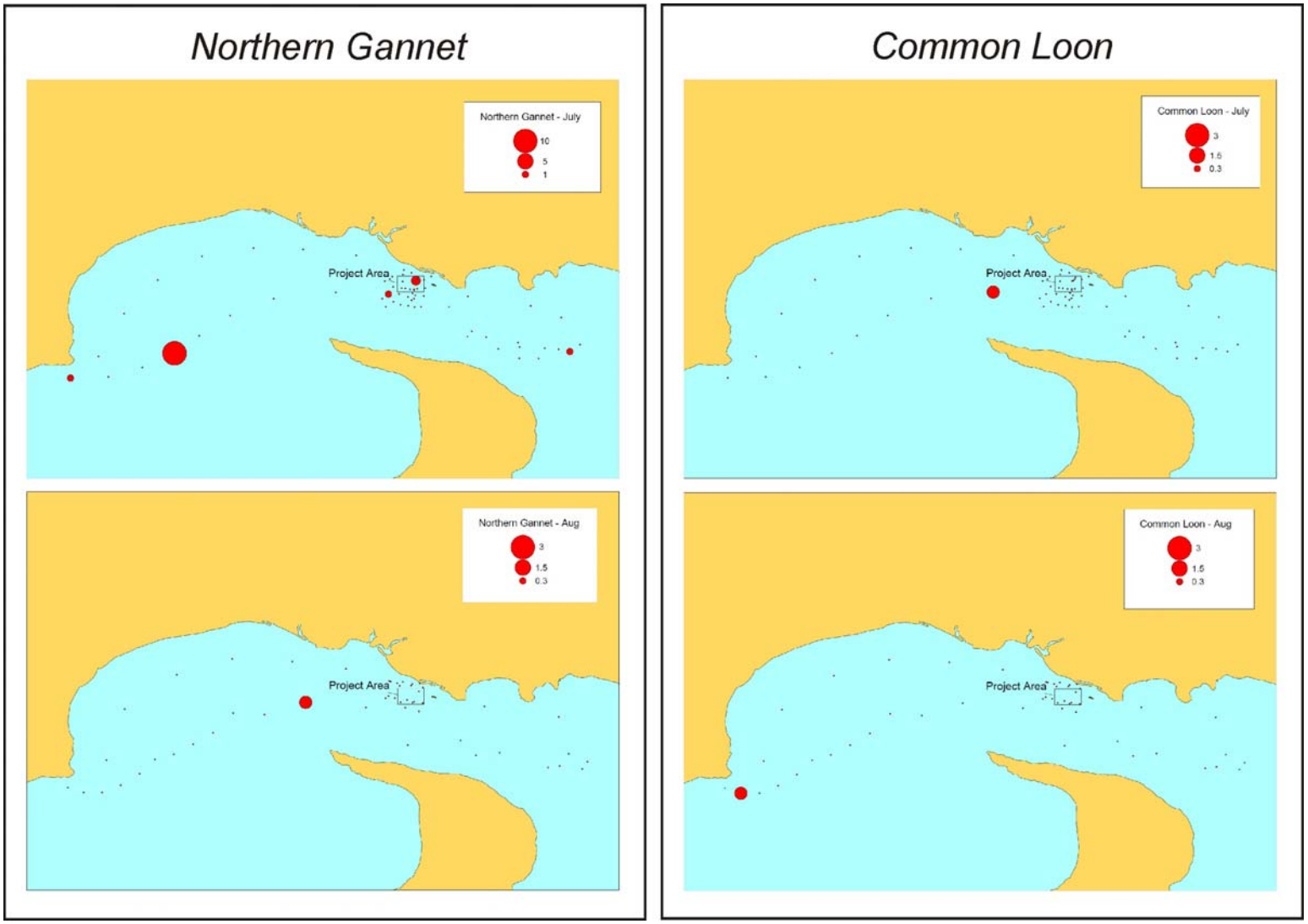

Figure 21. Distribution and abundance (individuals per 5-minute observation period) of Northern Gannet and Common Loon in Minas Basin, Minas Passage and Minas Channel, July & August 2010. Area shown is Crown Lease, which contains berths for tidal device installation.

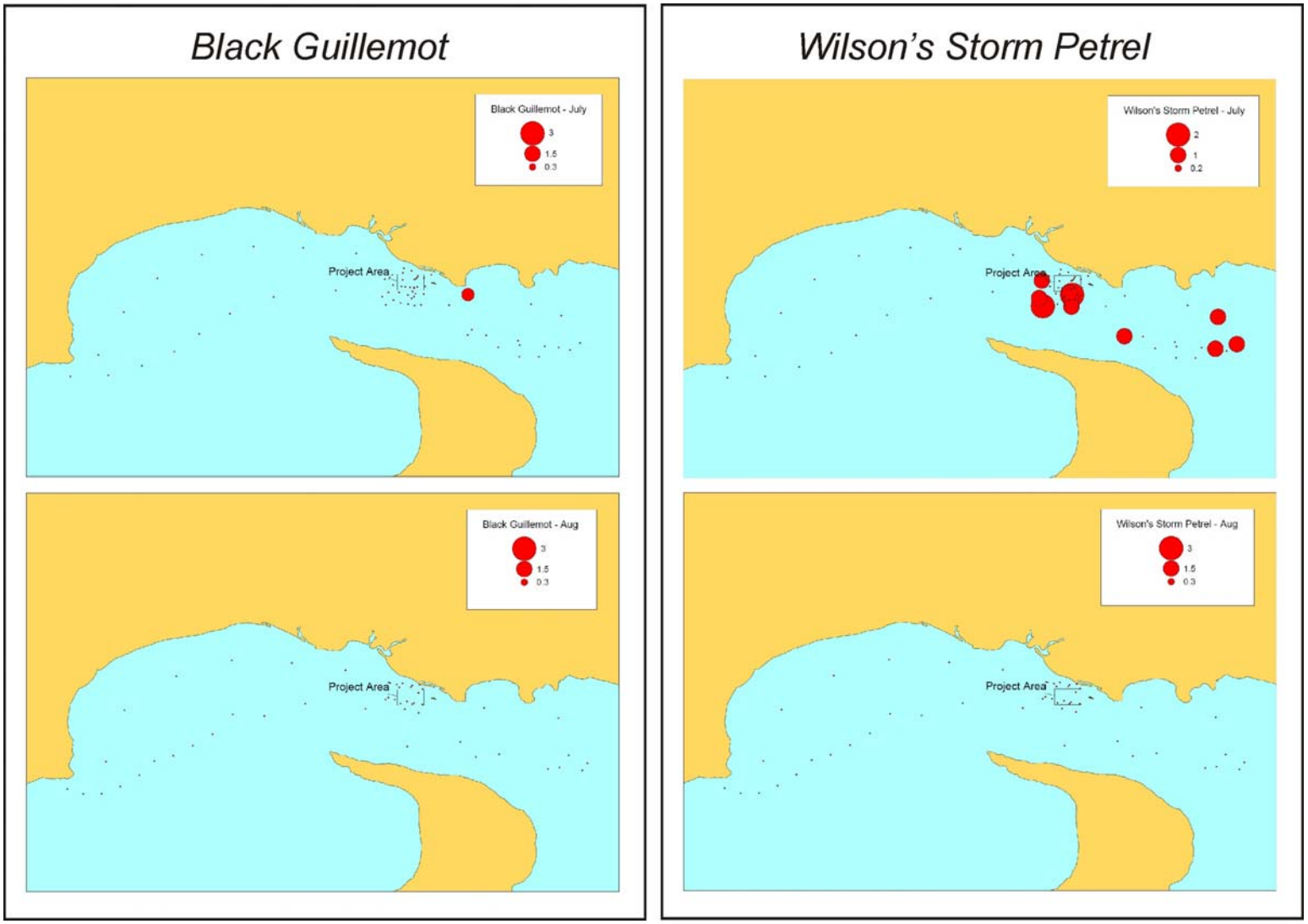

Figure 22. Distribution and abundance (individuals per 5-minute observation period) of Black Guillemot and Wilson's Storm Petrel in Minas Basin, Minas Passage and Minas Channel, July & August 2010. Area shown is Crown Lease, which contains berths for tidal device installation.

Great Cormorant

Great Cormorant breeds in Atlantic Canada and occurs occasionally in the study area. A single immature individual was obseved in the middle of Minas Passage near the tidal demonstration site in July (Figure 20). No individuals of this species were observed in surveys in 2009.

Northern Gannet

This species normally migrates through the area to colonies on the Gulf of St. Lawrence, but the Inner Bay of Fundy may support immatures and late migrants. Northern Gannets, principally immature stages, occurred in moderate numbers in all areas in the July survey, but were not observed in August (Figure 21). Highest concentrations were observed in Minas Channel (0.7 individuals per kilometre) and lower but similar concentrations of 0.1 individuals per kilometre occurred in Minas Basin and Minas Passage. The species was not as abundant in July 2009, with only a single individual observed in Minas Channel, but was more abundant in August 2009 (0.1 to 0.15 individuals per kilometre in Minas Channel and Minas Passage respectively, and 0.2 individuals per square kilometre in Minas Passage) (Envirosphere Consultants 2010). Most of the individuals, all of which were observed in July, were immature. Northern Gannet is a common annual migrant and summer resident. Feeding is by diving from great heights to medium and shallow depths to fish.

Common Loon

The species is typically a common coastal resident in the study area, but was uncommon in the 2010 surveys, with single immature individuals observed in Minas Channel in each of the two surveys (Tables 3-5, Figure 21). The species is an annual breeder on inland lakes and is a summer resident on the Bay of Fundy. Common Loon forages by diving and swimming underwater to catch fish, diving mostly to medium depth, but occasional very deep dives are possible.

Black Guillemot

A single Black Guillemot was observed in Minas Basin in July and none were seen in the August survey (Figure 22). The species had been more common and abundant in July 2009, occurring in all the study sub-areas, and occurring in all time periods (Envirosphere Consultants 2010). Black Guillemot is a common annual breeder on seacliffs and in coastal rocks along the Bay of Fundy, and feeds on fish, diving to shallow to mid-depth.

Wilson's Storm Petrel

Wilson's Storm Petrel is a common oceanic species found in offshore continental shelf waters in summer, and can pass through the Bay of Fundy during migration or be transported in by storms. The species was observed frequently in Minas Basin and Minas Passage in July (Tables 3-5, Figure 22). Densities were from 0.3 to 0.4 individuals per kilometre and 0.3 to 0.9 individuals per square kilometre in Minas Passage and Minas Basin respectively (Tables 3-5). Maturity of most of the individuals could not reliably be determined, but some of the individuals were immatures. No Wilson's Storm Petrels were observed in 2009.

3.2.2 Shore-Based Survey

3.2.2.1 Survey Effort

Sampling effort was similar between shore-based surveys (May to November) with 12, 30-minute observation periods per day (11 on May 1st). Observation conditions varied through the May – November period, which will have affected the results. Ideal survey conditions were overcast days with negligible to slight winds—most of the surveys met these conditions[9]. Overcast conditions were present for the May 1, May 27, October 23 and November 22 surveys, which allowed for greater visibility of birds species at greater distances. Surveys conducted on sunny days (May 13, June 12 and November 13) would have had lower visibility of species due to surface reflections but were still considered to be acceptable.

3.2.2.2 Species Composition

Overall, 1736 seabirds and waterfowl in 32 species were sighted during the shore-based surveys. Seabirds occurring at the site included: Double-Crested Cormorant, Great Cormorant, Herring Gull, Black-Backed Gull, Iceland Gull, Laughing Gull, Lesser-Backed Gull, Ring-Billed Gull, Mew Gull, Black Guillemot, Northern Gannet, Razorbill, Horned Grebe, Red-Necked Grebe, Black-Legged Kittiwake, Atlantic Puffin, Thick-Billed Murre and Common Murre (Table 6). Waterfowl included: Common Eider, American Black Duck, Mallard, Harlequin Duck, Long-Tailed Duck, Canada Goose, Common Loon, Pacific Loon, Red-Throated Loon, Surf Scoter, Black Scoter, White-Winged Scoter, Red-Breasted Merganser and Common Merganser. The highest diversity of bird species occurred during fall migration in late October and early November (October 23 & November 13 surveys) in which 23 and 25 species, respectively, were observed compared with 12-17 species observed during surveys earlier in the year (Figure 23). This was the first time that quantitative shore-based surveys were carried out at the tidal power demonstration site, although some observations were made during terrestrial bird surveys in June-Sept 2009 (Envirosphere Consultants 2009b)[10].

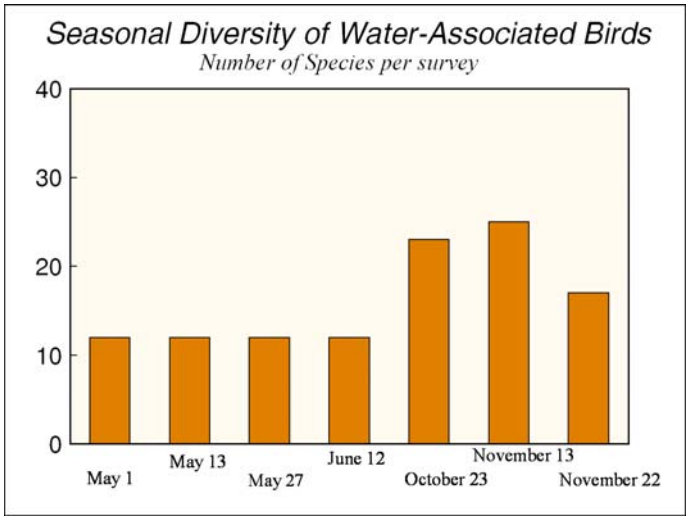

Figure 23. Number of species observed on shore based surveys, May – November 2010.

[9] Visibility on May 13 was reduced because of moderate wind and wave conditions, although visibility was otherwise good; while visibility on June 12 was reduced by glare from sunny conditions and slight winds (15 – 20 km/hr).

[10] Species noted in waters off the site were Herring Gull, Great Black-Backed Gull, Common Eider, Common Loon, Double-Crested Cormorant, and Black Guillemot.

Table 6. Seabirds observed at Black Rock Tidal Power Demonstration Site, May 1 to November 22, 2010, in shore-based surveys.

Species Code	Common Name	Scientific Name
Waterfowl		
RTLO	Red-Throated Loon	*Gavia stellata*
COLO	Common Loon	*Gavia immer*
PALO	Pacific Loon	*Gavia pacifica*
ABDU	American Black Duck	*Anas rubripes*
COEI	Common Eider	*Somateria mollissima*
WWSC	White-Winged Scoter	*Melanitta fusca*
SUSC	Surf Scoter	*Melanitta perspicillata*
BLSC	Black Scoter	*Melanitta nigra*
RBME	Red-Breasted Merganser	*Mergus serrator*
COME	Common Merganser	*Mergus merganser*
HADU	Harlequin Duck	*Histrionicus histrionicus*
LTDU	Long-Tailed Duck	*Clangula hyemalis*
MALL	Mallard	*Anas Platyrhynchos*
CAGO	Canada Goose	*Branta canadensis*
Seabirds		
DCCO	Double-Crested Cormorant	*Phalacrocorax auritus*
GRCO	Great Cormorant	*Phalacrocorax carbo*
GBBG	Great Black-Backed Gull	*Larus marinus*
HEGU	Herring Gull	*Larus argentatus*
ICGU	Iceland Gull	*Larus glaucoides*
LAGU	Laughing Gull	*Larus articilla*
LBBG	Lesser Black-Backed Gull	*Larus fuscus*
RBGU	Ring-Billed Gull	*Larus delawarensis*
MEGU	Mew Gull	*Larus canus*
RAZO	Razorbill	*Alca torda*
HOGR	Horned Grebe	*Podiceps auritus*
BLKI	Black-Legged Kittiwake	*Rissa tridactyla*
NOGA	Northern Gannet	*Morus bassanus*
BLGU	Black Guillemot	*Cepphus grylle*
RNGR	Red-Necked Grebe	*Podiceps grisegena*
ATPU	Atlantic Puffin	*Fratercula arctica*
COMU	Common Murre	*Uria aalge*
TBMU	Thick-Billed Murre	*Uria lomvia*

3.2.2.3 Distribution and Abundance

Overall Abundance & Diversity

Great Black-Backed Gull, Herring Gull and Common Eider were the most common species observed in shore-based surveys at the site with Great Black-Backed and Herring Gulls dominant in terms of numbers in the spring-early summer (May-June) with Common Eider becoming important in the early summer (June) survey (Figures 24 & 25). Although Great Black-Backed Gull was the most abundant seabird during May surveys, it declined in importance through the remainder of the year. Herring Gulls also declined in importance in Fall (October-November), while Common Eider and Red-Throated Loons increased in importance. Red-Throated Loons, which were present in most surveys, were also particularly abundant during November 13 & 22 surveys which captured their Fall migration period (Figure 25).

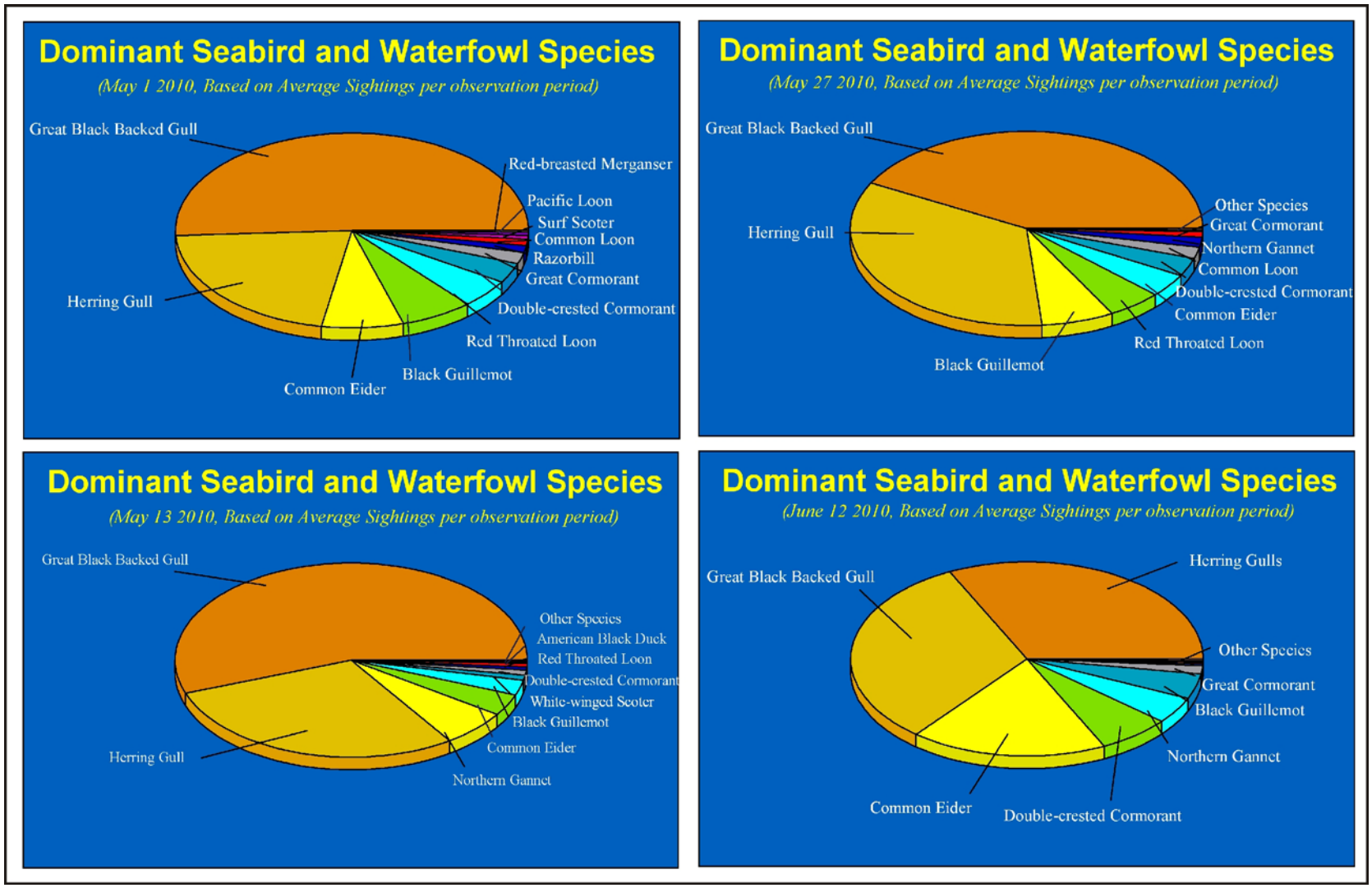

Figure 24. Dominant species of seabirds and other waterfowl at the Fundy Tidal Demonstration Site in late-Spring to early-Summer, obtained in shore surveys on May 1, 12, 27 & June 12, 2010.

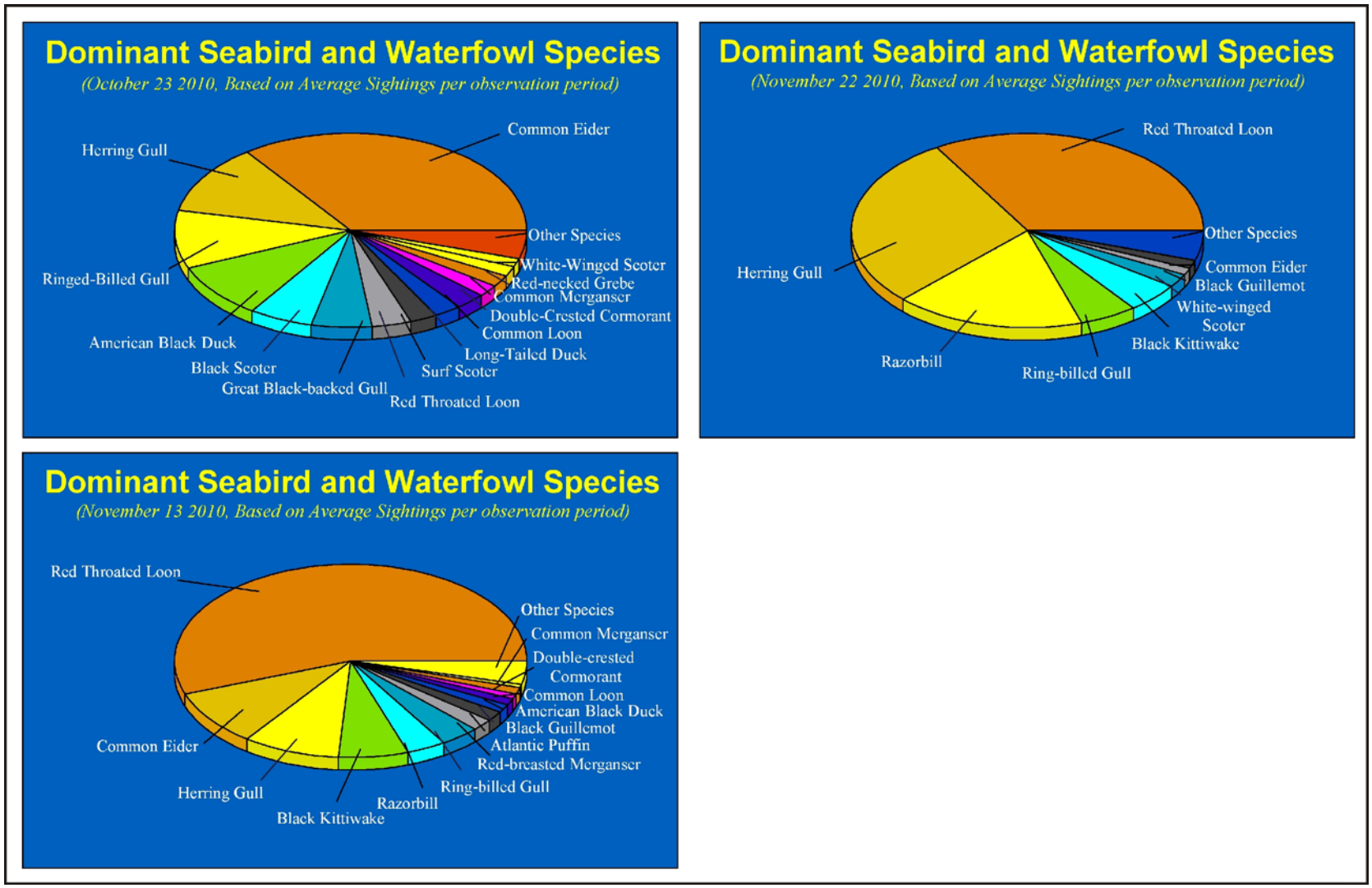

Figure 25. Dominant species of seabirds and other waterfowl at the Fundy Tidal Demonstration Site in late Fall, obtained in shore surveys on October 23 and November 12 & 22, 2010.

Overall abundance of birds was moderate in spring-early summer, reached a peak in mid-June and was moderate in May (May 1st & 27th) (Figure 26) when dominant species were Great Black-Backed & Herring Gulls (Figure 24). Abundance was low in October and in late November, but showed a large peak concentration of migrating Red-Throated Loons in early November (November 13th). Greatest concentrations of birds were observed between Black Rock and shore for the May 27 & June 12 surveys (Great Black-Backed & Herring Gulls dominant); within the proposed turbine development site on November 13th (Red-Throated Loons dominant); and in Minas Passage ('Outside' Black Rock) during October 23 & November 22 surveys (Common Eider, Herring Gulls and Red-Throated Loons dominant)(Figure 26)[11].

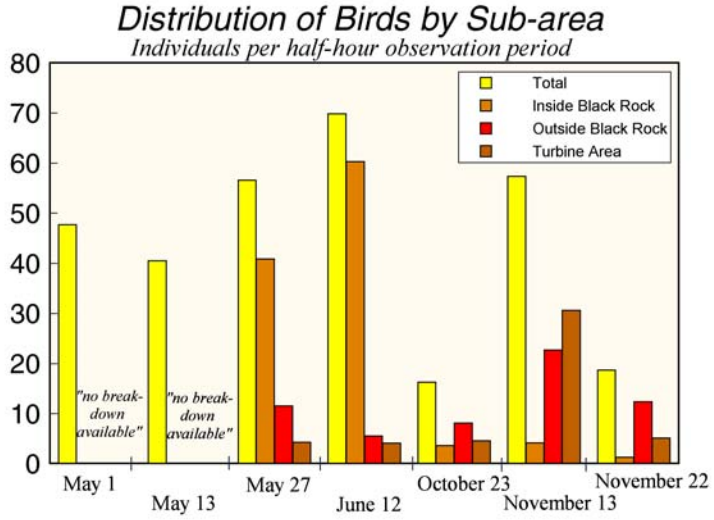

Figure 26. Abundance of seabirds and other water-associated birds (individuals per 30-minute observation period) at the FundyTidal Power Demonstration site, May – November 2010.

Abundance and Seasonal Occurrence of Gulls

Gulls were commonly seen at the site. In total seven gull species, (Great Black-Backed, Herring, Iceland, Laughing, Mew, Lesser Black-Backed and Ring-Billed Gull) were observed with Great Black-Backed and Herring Gull the most abundant gull species and the most abundant bird species overall. Mew and Laughing Gull were each only observed once (November 13 & June 12 surveys, respectively) (Figure 27).

Great Black-Backed Gull—Great Black-Backed Gull was the most abundant gull species overall and was observed during all surveys (Figure 27). It was the most abundant and dominant seabird during May surveys (42-55% of sightings) though numbers declined significantly in the October and November surveys (~6% and 0.3-0.9% of sightings, respectively) (Appendix A).

Herring Gull—Herring Gull was the second most abundant gull species and was observed during all surveys (Figure 27). It was the dominant and most abundant species in June (32% of sightings, averaging 22.5 individuals sighted per observation period), and was second or third most abundant bird species in all other surveys. Lowest abundance occurred during the October survey (11.8% of sightings) (Appendix A).

[11] A breakdown of bird abundance by area was not available for May 1st & May 13th surveys.

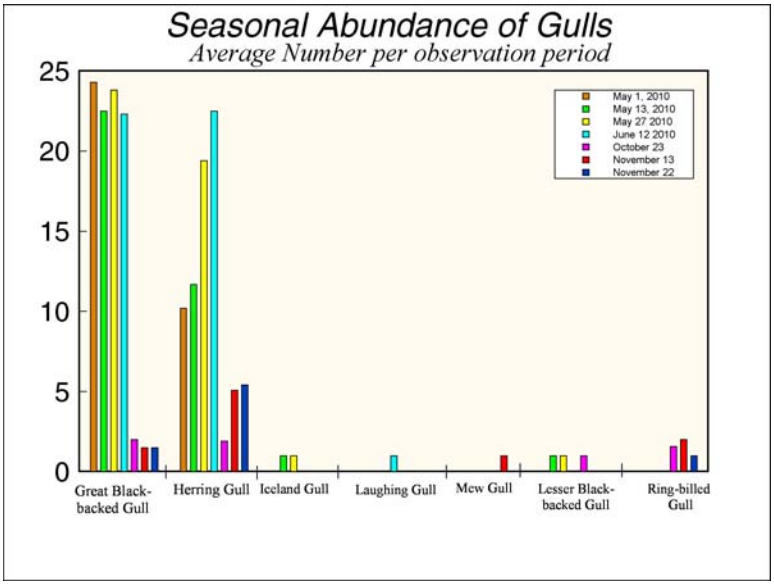

Figure 27. Abundance of gulls at Fundy Tidal Power Demonstration site, May-June and October-November, 2010.

Iceland Gull—Iceland Gulls migrate into the Bay of Fundy in late Fall and leave by late spring, except for a few immature and sub-adults which become summer residents. The winter resident population is less abundant than in past due to climate change (winters are warmer). The species was observed only once on each of the May 13 & 27th surveys and consequently was not a dominant in the community at the site (0.2 & 0.14% of sightings per survey, respectively) (Figure 27)(Appendix A).

Laughing Gull—Laughing Gull breed at the mouth of the Bay of Fundy and occasionally appear further up the Bay following surface 'bait' fish species. This species is an uncommon but regular stray to Nova Scotia, often occurring after storms originating to the south (it is our common 'Hurricane Gull'). Laughing Gull was observed once (June survey) and subsequently was low in abundance and dominance (0.08 per observation period, 0.11% of sightings)(Figure 27) (Appendix A).

Mew Gull—The European Mew or Common Gull appears in Nova Scotia waters as a rare but regular stray from the east via Newfoundland. The species is seen on the Atlantic coast of Nova Scotia most years from Cape Breton to Cape Sable Island, but is seen less frequently on the Fundy shore (there are fewer than ten records). The number reported each year is small, mainly as Spring and Fall transients or Winter residents. One Mew Gull was observed on the November 13th survey (0.08 individuals per observation period, 0.14% of sightings) (Appendix A).

Lesser Black-Backed Gull—The Lesser Black-Backed Gull is an uncommon transient that may breed here. It has been recorded in all seasons including as a winter and summer resident in small numbers. The species was observed during 3 of 7 shore-based surveys (May 13th & 27th and October 23rd) in low abundance and dominance (0.08 per observation period, 0.2, 0.14 and 0.49% of sightings on each survey respectively) (Appendix A).

Ring-Billed Gull—Ring-Billed Gulls occur near the coast and around offshore islands when not breeding; but are found inland on freshwater lakes, ponds, marshes during the breeding season. They feed on insects, crustaceans, mollusks & invertebrates along the shore, and sometimes pirate food from other

species. They occurred occasionally in moderate abundance and dominance during October & November surveys (9.7, 3.5 and 5.4% of sightings) (Appendix A).

Abundance and Seasonal Occurrence of Waterfowl

Waterfowl (ducks & geese, scoters, and mergansers) were also commonly observed at the study site. Of the eleven waterfowl species seen, Common Eider was the most prevalent—present during all surveys with greatest and least concentrations observed on June 12 and November 22, respectively (Figures 24, 25 & 28). Other species including American Black Duck, White-Winged Scoter, Surf Scoter, Black Scoter, Red-Breasted Merganser, Common Merganser, Harlequin Duck, Long-Tailed Duck, Mallard and Canada Goose were observed occasionally and in low concentrations.

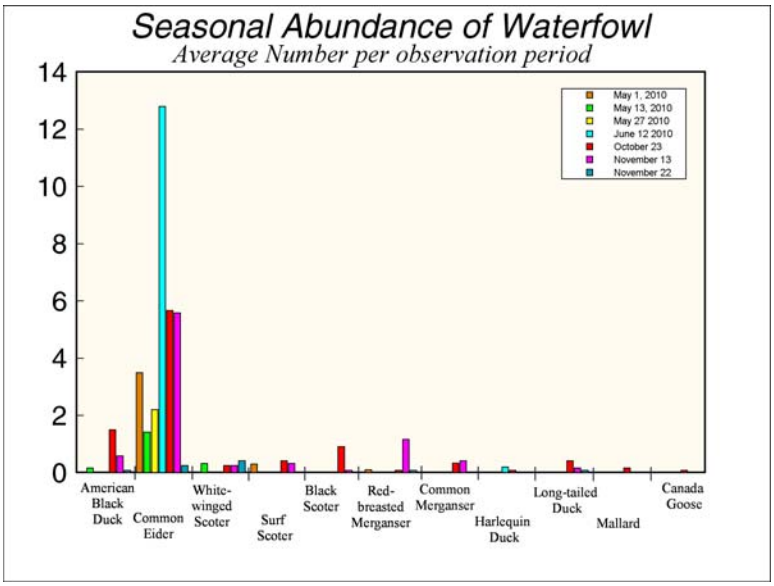

Figure 28. Abundance of waterfowl at the Fundy Tidal Power Demonstration site, May-June and October-November, 2010.

Common Eider—Common Eider was common and abundant in all shore-based surveys and was one of the overall dominants at the site (Figures 24, 25 & 28). It peaked in abundance in June (Figure 28), but was also abundant during the October and November 13 surveys (35% and 9.7% of sightings respectively) (Appendix A).

American Black Duck—This species breeds in, and migrates through, the area in Spring and Fall and is commonly present in winter. It is often seen feeding on tidal flats, and is known to rest on open salt water, occasionally far from shore. American Black Duck occurred occasionally in surveys (mid-May, October and November). It was the fourth most abundant species in the October survey (9.2% of sightings) and present in low abundances and dominance (0.42 to 1.0% of sightings) in the other surveys (Figures 24, 25 & 28)(Appendix A).

White-Winged Scoter—This scoter commonly migrates through the area in Spring and Fall, and regularly winters in moderate numbers. The species feeds over sea ledges and along shorelines, diving to the bottom for shellfish. White-Winged Scoter occurred in low abundances during mid-May, October and November surveys, and was one of the lesser species in terms of dominance (ranging from 0.4 to 6.2% of sightings in the seven surveys) (Figures 24, 25 & 28)(Appendix A).

Surf Scoter—This scoter commonly migrates through the area in Spring and Fall and regularly winters in moderate numbers. Surf Scoter feeds over sea ledges and along shorelines, diving to the bottom for shellfish. The species occurred in low abundance (0.58 - 2.6% of sightings) in early May, October and early November surveys (Figures 24, 25 & 28) (Appendix A).

Black Scoter—Black Scoter commonly migrate through the area in spring and fall and regularly winter in moderate numbers. They feed on shellfish, which they find on the seabed of sea ledges and along shorelines. The species occurred in low abundance (0.92 & 0.08 individuals per observation period) and was relatively abundant in October and early November surveys (5.7% & 1.7% of sightings) (Figures 25 & 28) (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 occasionally seen in low abundance and low dominance (0.19 - 2.0% of sightings) during early May, October and November surveys (Figures 24, 25 & 28)(Appendix A).

Common Merganser—Mergansers breed in and migrate regularly through the area spring and fall. The Common Merganser is rare to uncommon in salt water except where rivers and streams enter the ocean. They are known to feed by diving for fish in shallow water. Common Merganser was observed during the November 13th survey only when it was in low abundance and dominance (0.73% of sightings) (Figures 25 & 28) (Appendix A).

Harlequin Duck—This species migrates in small to moderate numbers through the area in spring and fall, and regularly winters in small numbers along Atlantic shores. It feeds on shellfish along rocky shorelines, diving to moderate depths. The species is listed federally as a species of Special Concern under the *Species at Risk Act.* Harlequin Duck was observed in low numbers in two of the seven surveys (June and October) (0.24 & 0.49% of sightings respectively) (Figures 24, 25 & 28) (Appendix A).

Long-Tailed Duck—This species is a common migrant through the area in Spring and Fall in moderate to high numbers, and is normally abundant in Winter. It dives for small shellfish along shorelines and in shallow bays with sandy bottoms. Long-Tailed Duck were present during fall migration (October-November) in low abundance and were a minor component of the waterfowl community at the site (0.3-2.6% of sightings) (Figures 25 & 28) (Appendix A).

Mallard—American Mallard breeds in, and migrates through, the area in Spring and Fall. The species is an uncommon sight in coastal areas, where it feeds on tidal flats. Mallards were observed during the October survey only, and in small numbers (0.17% of individuals & 1.0% of sightings per observation period) (Figures 25 & 28) (Appendix A).

Canada Goose—Canada Geese breed in and migrate through the area routinely in moderate to large numbers, and the species is a regular winter resident. It feeds in crop fields near the ocean and on mudflats, and is often seen resting on salt water while waiting for the tide to recede. Only one Canada Goose was observed in the shore-based surveys (October survey) and it was a minor species overall (0.5% of October sightings) (Figures 25 & 28) (Appendix A).

Abundance of Loons

Three loon species (Red-Throated, Common and Pacific) were observed during the shore-based surveys, with Red-Throated Loons most abundant, followed by Common Loon and then Pacific Loon.

Concentrations of Red-Throated Loon peaked with the November 13, 2010 survey, dominating numbers of all other seabird and waterfowl species (Figures 24, 25 & 29).

Red-Throated Loon—The Red-Throated Loon migrates through the area spring and fall. It is common and abundant at times, wintering in small numbers. It feeds on small fish at various depths, including the deepest water. It was observed during all surveys and was the most abundant and dominant bird species during the November surveys (31.9 & 6.3 individuals per observation period, and 33 - 56% of sightings). Numbers were significantly lower in other surveys (0.2 – 5.0% of sightings) with the lowest abundance occurring during the June survey (0.17 individuals per observation period) (Figures 24, 25 & 29)(Appendix A).

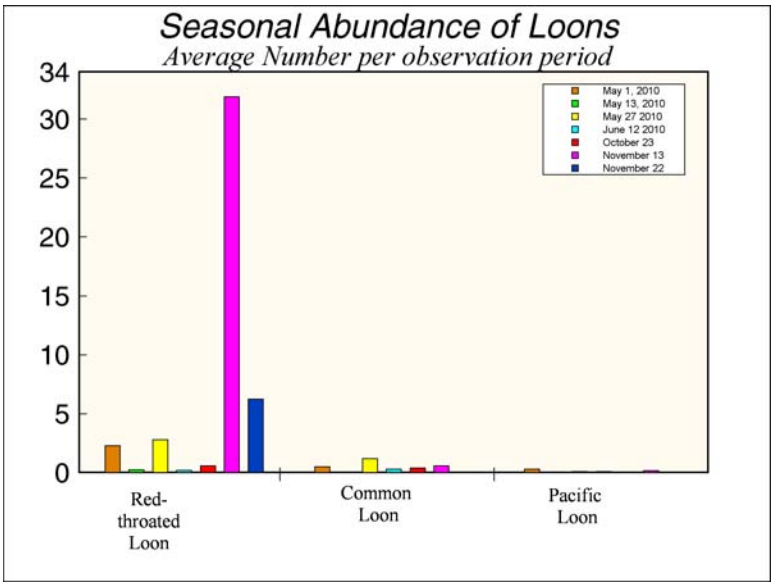

Figure 29. Abundance of loons at the Fundy Tidal Power Demonstration site, May-June and October-November, 2010.

Common Loon—Common Loon were observed during all surveys with the exception of May 13th. The species occurred in generally low abundance (0.08 - 1.17 individuals per observation period) and low dominance (0.36-2.1% of sightings) with the greatest abundance occurring in October and the lowest in late November (Figures 24, 25 & 29)(Appendix A).

Pacific Loon—This species migrates through the area in Spring and Fall. It is rare at all times, and occasionally overwinters. Pacific Loon feeds on small fish at various depths but mainly in deepest water. It was observed in four of seven surveys (May 1, May 27, June 12 & November 13) in low numbers (0.08 - 0.27 per observation period), but was most abundant during the May 1 survey (0.27 individuals per observation period) (Figures 24, 25 & 29)(Appendix A).

Other Seabird 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: Double-Crested Cormorant, Great Cormorant, Northern Gannet and Black Guillemot. Several species including Razorbill, Horned Grebe, Red-Necked Grebe, Atlantic Puffin, Common Murre, Thick-billed Murre and Black-Legged Kittiwake, were present only occasionally and in generally lesser numbers; however flocks of Black-Legged Kittiwakes and most of

the alcid species (e.g. Razorbill) occurred in the Fall migratory period (November 22) (Figures 24, 25 & 30).

Double-Crested Cormorant—Double-Crested Cormorants were observed during all surveys with the exception of the late November survey. Numbers were greatest during May (1 & 27) and June surveys (1.5 - 4.5 individuals per half hour observation period). This cormorant was the fourth most abundant species observed during the June survey (6% of sightings) (Figures 24, 25 & 30) (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. The Great Cormorant is known to dive deeper and feed further offshore than other cormorant species. Great Cormorants were observed during all surveys with the exception of the late November survey. Numbers were greatest during May (1 & 27) and June surveys (0.58 - 1.1 individuals per half hour) (Figures 24, 25 & 30) (Appendix A).

Northern Gannet—Northern Gannet occurred fairly commonly during the study, observed during four of the seven surveys. Abundance of Northern Gannet peaked in June (3.1 individuals per observation period) and it placed as third (6% of sightings) and fifth (4.4% of sightings) most dominant species for the May 13 and June 12 surveys, respectively (Figures 24, 25 & 30) (Appendix A).

Black Guillemot—Black Guillemot were observed during all surveys with varying abundances (0.08 - 3.18 individuals per observation period), with greatest numbers in May 27th (3.8 individuals per period) and least in October 23 (0.08 individuals per period). It was the third and fourth most abundant species (6.6% & 6.7% of sightings) during May 27 and May 1 surveys respectively (Figures 24, 25 & 30) (Appendix A).

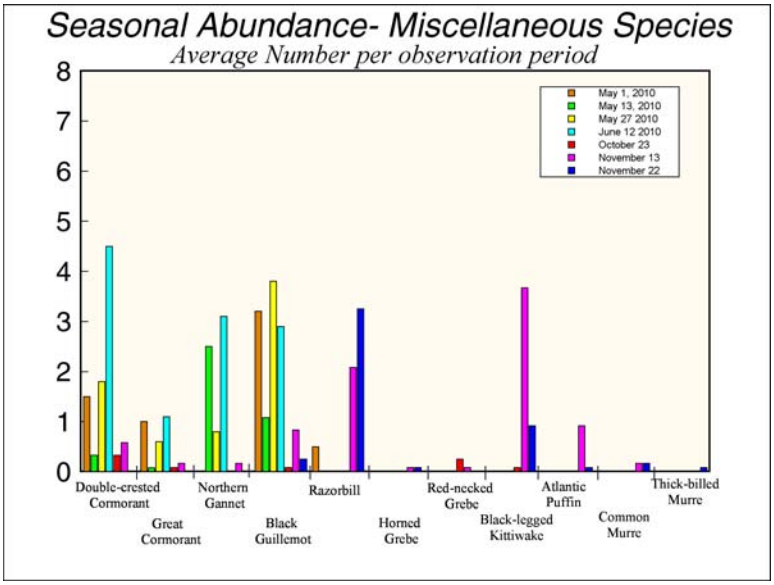

Figure 30. Abundance of miscellaneous seabird and waterfowl species at the Fundy Tidal Power Demonstration site, May-June and October-November, 2010.

Razorbill—Razorbill, a member of the Alcid family, breeds in the Bay of Fundy where it maintains a fairly stable population in the southwest end of the Bay. Populations are highest in the Winter, when numbers are augmented by northern migrants. The species feed on small fish and will sometimes dive to considerable depths to capture prey. Razorbill was observed during May (1st) and November (13th & 22nd)

surveys in moderate abundances (0.55 - 3.25 individuals per observation period). It was the third (17% of average sightings per survey) and fifth (3.6% of average sightings per survey) most abundant species in November 22 and 13 surveys, respectively (Figures 24, 25 & 30) (Appendix A).

Horned Grebe—Horned Grebe is a small waterfowl species which migrates through the area in Spring and Fall. The species is marginally common to uncommon, and sparse to moderately abundant in numbers in winter, feeding on small fish at all depths. Horned Grebe occurred in low numbers, represented by a single individual (0.08 per observation period) during November surveys (Figures 25 & 30) (Appendix A).

Red-Necked Grebe—This species migrates through the area Spring and Fall, and are marginally common to uncommon, and sparse to moderately abundant in numbers in Winter, feeding on small fish at all depths, but mainly in deep water. The species occurred in low numbers and abundance (0.08 & 0.25 individuals per observation period) during early November and October surveys, respectively, and were not observed in other surveys (Figures 25 & 30) (Appendix A).

Atlantic Puffin—Atlantic Puffin breed in the Bay of Fundy and have fairly stable populations at the southwest end of the Bay; populations are highest in the Bay of Fundy in winter, made up of individuals from local populations as well as from northern migrants to the area. Puffin feed on small fish and will sometimes dive to considerable depths to capture prey. The species was moderately abundant during the November 13th survey and a single Atlantic Puffin was observed during the November 22 survey (0.9 and 0.1 individuals per observation period respectively) (Figures 25 & 30) Appendix A).

Common Murre—The Common Murre has only recently begun breeding in the Bay of Fundy and its occurrence is rare. Populations are highest in the winter, augmented by northern winter migrants. The species feeds on small fish and will sometimes dive to considerable depths to capture prey. Common Murre were observed only during November surveys and in low abundance and dominance (0.17 individuals per observation period in both surveys) (Figures 25 & 30) (Appendix A).

Thick-Billed Murre—This northern alcid visits the area from late Fall to early Spring, with stragglers (non-breeders) sometimes summering. Winter residents are present in modest numbers most years, with rare spikes in the population during very cold winters. Thick-Billed Murre often dive for fish in extremely deep waters. Only one was observed (November 22nd survey) throughout the course of the study (Figures 25 & 30) (Appendix A).

Black-Legged Kittiwake—Black-Legged Kittiwakes are regular Summer and Winter residents in the Bay of Fundy, as well as Fall and Spring transients. Modest numbers of mainly sub-adults summer here, while larger numbers overwinter. Occasionally thousands are blown in from the Gulf of Maine by southerly gales. The species was observed only in the last three surveys (October & November) in low to moderate abundances (0.08 - 3.7 individuals per observation period). Abundance and relative dominance (3.7 individuals per period and 6.4% of sightings respectively) peaked in early November when kittiwakes were the fourth most abundant species observed (Figures 25 & 30) (Appendix A).

4 CONCLUSIONS AND RECOMMENDATIONS

Overall

Conducting routine shore- and vessel-based surveys in Minas Passage and adjacent areas in 2010 has been useful as part of an overall environmental monitoring program for the tidal demonstration site. The present surveys, which were intended to provide additional coverage during bird migration periods, provided an overview of bird and marine mammal seasonal distributions, as well as information on timing and abundance of seabirds and waterfowl, both at the tidal power demonstration site and in the Inner Bay of Fundy including Minas Channel, Minas Passage, and Minas Basin. The surveys also provided information on occurrence and seasonal timing of Harbour Porpoise, the most-commonly-occurring marine mammal at the site and also a Species at Risk, with *threatened* status under the federal *Species at Risk Act.* Harbour Porpoise is a representative of one of the important animal groups—Cetaceans—potentially impacted by tidal power turbine installations, and their abundance and activities in the area may be a useful indicator of environmental change and the impacts of tidal turbines in Minas Passage.

Seabird densities in the study area measured in 2009 and 2010 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). The 2010 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.

Marine Mammals

Shore-based surveys for seabirds and waterfowl provided unexpected and significant information on the occurrence of Harbour Porpoise in the study area—showing that the species commonly occurred in most survey periods—as well as providing insight into movement and activity patterns. Only limited information was gathered on the behaviour of the species under different conditions of tide (most observations were made on ebbing tides from the end of slack water at high tide to the beginning of slack water at low tide). Future surveys could plan to collect more detailed information on the species when observed. No particular association of Harbour Porpoise was noted with the proposed location of tidal turbines, and, in addition, all individuals were swimming in the direction of the ebbing tide, and were thus near the surface. However the survey represents only a snapshot of daily activities of the species through the tidal cycle. Additional useful information on behaviour may be obtained by focusing observations on slack tide and flood tide conditions. In addition, the lack of summer to early-Fall observations at the study site, as well as observations in the late-March to early-May period, is a gap in assessing the overall pattern of abundance of Harbour Porpoise at the site. The daily movements of Harbour Porpoise are part of a larger pattern involving adjacent areas of Minas Basin and Minas Channel and also likely interactions with fish movements in the area, little of which can be determined from point observations at the study site. However the observations have provided information on local behaviour and distribution which may be valuable in assessing project impacts. Harbour Porpoise may therefore be an important indicator species at the site meriting additional observational effort in future.

Negligible sightings of marine mammals were made on vessel surveys in 2010 (only 5 Harbour Porpoise and no other species were observed in July and August combined) but similar surveys the previous year were more successful, in particular identifying various species of marine mammal including an unidentified whale and White-Sided Dolphin. Vessel-based surveys for seabirds provide useful additional information on marine mammals, in particular of other less common species of whales and dolphins, to

aid in understanding their distributions and possible impacts of tidal device installations on them. Combining a limited number of vessel surveys with shore-based surveys may be an appropriate monitoring approach for both seabirds and marine mammals at the tidal installation site.

Seabirds and Waterfowl

The goal of the present project was to provide information on seabird and waterfowl species migrating through the study area in the Spring and Fall, and in particular to document the occurrence of diving birds such as loons, which are the most likely—because of their diving habits—to interact with sub-sea devices such as turbines. The shore-based component of the survey showed a Fall peak in migrants but a Spring peak, which was expected to occur, was not demonstrated, suggesting either that it occurred earlier in the year than the period covered by the survey or that it is not as pronounced at the site as in other areas. Many of the same species, including both the dominants and less common birds, were present throughout the May-November survey period, but highest number of species, representing the Fall migration, were only observed in October-November.

Loons were the principal family of water-associated birds targeted by Spring and Fall observations in the study, since they are known to migrate through the area and they feed by diving and consequently may interact with turbines. The Red-Throated Loon was the most abundant of the loon species observed (which also included Common Loon and Pacific Loon) and was particularly abundant in mid-November. In addition to the occurrence of loons in the Fall, however, another group of birds known for diving—the alcids (e.g. Common Murre, Thick-Billed Murre, Razorbill, and Atlantic Puffin)—appeared at the study site in mid- to late-November, and Razorbill occurred in the first May survey. These typically northern species, but which in the Bay of Fundy are a mix of winter migrants to Nova Scotia combined with some residents, are likely to be more common in the study area in winter. Because they are divers, and some (e.g. the Razorbill) are known to be deep divers, and because of their likely occurrence in the area in winter, they have the potential to be affected by interactions with turbines and their winter occurrence in the area is a potential data gap. Surveys extending earlier in the Spring to capture the spring migrants, as well as in mid-March and December, may be sufficient to document the winter occurrences of alcid species. Recommended surveys and rationale for 2011 are presented below:

Recommended Surveys for Seabirds and Marine Mammals,
Fundy Tidal Power Demonstration Site, 2011.

Type of Survey	Suggested Times	Number of Surveys	Critical Periods and Species Covered
Shore-Based Surveys	- mid-March	1	Late winter observations of over-wintering alcids and harbour porpoise.
	- early April - mid- April - early May	3	Early spring migration of loons and overwintering alcids; occurrence of harbour porpoise.
	- early December - mid-December	2	Winter observations of over-wintering alcids and harbour porpoise.
Vessel Surveys	- mid-July - mid-August	2	Summer, repeat earlier surveys of seabirds and marine mammals for continuity and monitoring purposes.

The vessel-based survey provided additional information on seabird abundance in mid-Summer, which allowed comparison to two surveys in July and August 2009, showing a core group of eight species: Herring, Great Black-Backed and Ring-Billed Gull; Common Loon, Common Eider, Black Guillemot, Double-Crested Cormorant and Northern Gannet which occurred with similar dominance relationships in terms of abundance in both years. Repetition of the July-August vessel surveys in future years, using

abundance of the most abundant species as well as the combined abundance estimates of the core group, may provide an indicator of change in the communities in the site as part of a monitoring program (see table above). It would also increase the chances of sighting Harbour Porpoise and other marine mammals such as whales, which are important but poorly-studied components of the ecosystem in the Inner Bay of Fundy, and for which there is a lack of distribution and abundance information in the area.

Additional Ecosystem Components

The shore-based seabird and waterfowl survey also yielded information on the activity and catch of a fisherman using an anchored gill net at the site (although not reported here, herring and mackerel were commonly caught in May-June) and also observations of wildlife and environmental conditions on the shoreline and adjacent salt marsh areas. The shore-based surveys thus provide an opportunity to collect additional relevant environmental information at the site and this opportunity should be considered in deciding on future monitoring for the project.

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APPENDIX A– Observational Data from Shore-Based Surveys, 2010

(Species names and associated codes are shown in Table 6.

Table A-1. Overall summary table for May 1, 2010 Survey.													
Species	Date: May 1, 2010, 13:07 hrs to 18:37 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		
RTLO	5			1				10	8	1			2.3
COLO	2		1		1	1							0.5
PALO		1					1	1					0.3
DCCO	6	3	1				1	3		2			1.5
GRCO	2		1	2	1	1	1	1	1	1			1.0
COEI	15			4	2	1	1	2	10		3		3.5
SUSC	3												0.3
RBME		1											0.1
GBBG	24	28	19	28	24	27	25	20	21	24	27		24.3
HEGU	9	7	8	7	9	9	9	10	8	16	20		10.2
BLGU	2	3			4	4	8	5	7	1	1		3.2
RAZO											6		0.5
												Total	47.7

Table A-2. Overall summary table for May 12, 2010 Survey.													
Species	Date: May 13, 2010, 1130 hrs to 1730 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				3									0.3
DCCO			1	1			1			1			0.3
GRCO			1										0.1
NOGA	1					5		2	1	3	12	6	2.5
ABDU												2	0.2
COEI			4	2	1	2	1	3			3	1	1.4
WWSC											4		0.3
GBBG	26	30	23	31	23	18	22	16	20	20	19	22	22.5
HEGU	9	29	15	12	10	13	7	10	7	7	12	9	11.7
ICGU						1							0.1
LBBG									1				0.1
BLGU	5	5		3									1.1
												Total	40.5

Table A-3a. Overall summary table for May 27, 2010 Survey.													
Species	Date: May 27, 2010.							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	5	2	2	5	6	2	2	1	2	3	3	1	2.8
PALO											1		0.1
COLO			2	3	5					3		1	1.2
DCCO	1	1			1	7		5		2	2	2	1.8
GRCO	1			1		1	1			1	1	1	0.6
NOGA								2		2	6		0.8
COEI	4	7					2	1	6	2	2	2	2.2
GBBG	27	32	35	23	26	30	21	21	21	15	18	17	23.8
HEGU	26	21	32	14	13	28	16	17	17	9	25	15	19.4
ICGU											1		0.1
LBBG											1		0.1
BLGU	2	5	3	7	6	6	5	4	2	1	4		3.8
												Total	57.0

Table A-3b. Inside Black Rock summary table for May 27, 2010 Survey.													
Species	Date: May 27, 2010.							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO									1	1			0.2
PALO													
COLO				3									0.3
DCCO										1		1	0.2
GRCO	1			1		1	1			1	1	1	0.6
NOGA													
COEI	4	7					2	1	6	2	2	2	2.2
GBBG	26	24	26	22	25	25	21	20	18	15	16	17	21.0
HEGU	19	13	17	11	11	12	13	13	14	8	17	15	14.0
ICGU													
LBBG													
BLGU	2	5	3	6	3	2	3	2	1	1	4		2.7
												Total	41.0

Table A-3c. Outside Black Rock summary table for May 27, 2010 Survey.													
Species	Date: May 27, 2010.							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	5	2	2	5	4	2	2		1	2	3	1	2.4
PALO											1		0.1
COLO					2							1	0.3
DCCO	1	1								1	1		0.3
GRCO													
NOGA								2		2	6		0.8
COEI													
GBBG	1	7	8			5		1	3		2		2.3
HEGU	7	8	12	2	2	15	3	2	2	1	4		4.8
ICGU													
LBBG											1		0.1
BLGU						1	2	2					0.4
												Total	12.0

Table A-3d. Turbine area summary table for May 27, 2010 Survey.													
Species	Date: May 27, 2010.							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Turbine area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO					2			1					0.3
PALO													
COLO			2		3					3			0.7
DCCO					1	7		5			1	1	1.3
GRCO													
NOGA													
COEI													
GBBG		1	1	1	1								0.3
HEGU			3	1		1		2	1		4		1.0
ICGU											1		0.1
LBBG													
BLGU				1	3	3			1				0.7
												Total	4.3

Table A-4a. Overall summary table for June 12, 2010 Survey.													
Species	Date: June 12, 2010, 11:00 TO 16:30 hrs | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Overall.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO					1			1					0.2
PALO					1								0.1
COLO				1	1		1						0.3
DCCO	2	2	4	2	1	1	4	1	3	3	1	4	4.5
GRCO	1	1	2	1	1	1	1	1	1	1		1	1.1
NOGA	1	2		2		2		1	2	1	3	1	3.1
COEI	3	1	2	4	2	1	3	4	1	4	4	4	12.8
HADU	1									1			0.2
GBBG	3	6	3	2	2	4	5	2	2	2	3	7	22.3
HEGU	5	6	3	3	2	1	5	6	8	3	7	15	22.5
LAGU			1										0.1
BLGU	3	3	4	3	1	1	2	2	1	2	1	1	2.9
												Total	69.8

Table A-4b.Inside Black Rock summary table for June 12, 2010 Survey.													
Species	Date: June 12, 2010, 11:00 TO 16:30 hrs | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO													
PALO													
COLO				1	1								0.2
DCCO	2	6	6	8	6	2	3	5	3	4	1	5	4.3
GRCO	1	1	3	1	1	1	1	1	1	1		1	1.1
NOGA													
COEI	11	6	10	15	15	18	16	10	6	17	10	19	13.0
HADU	1									1			0.2
GBBG	25	21	27	28	24	21	23	21	14	15	14	13	21.0
HEGU	17	19	13	17	16	20	14	20	16	16	21	33	19.0
LAGU													
BLGU	6	4	6	4	1	1	4	4		1	1	2	2.8
												Total	60.2

Table A-4c. Outside Black Rock summary table for June 12, 2010 Survey.													
Species	Date: June 12, 2010, 11:00 TO 16:30 hrs | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Outside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO								1					0.1
PALO													
COLO							1						0.1
DCCO													
GRCO													
NOGA	3	1		2				1	13		5	1	2.2
COEI													
HADU													
GBBG		3				2			1			2	0.7
HEGU	8	3		1	2		3	3	7		1	2	2.5
LAGU													
BLGU													
												Total	5.5

Table A-4d. Turbine area summary table for June 12, 2010 Survey.													
Species	Date: June 12, 2010, 11:00 TO 16:30 hrs | Observer: Fulton Lavender												
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22,263N, 64 24.348W, **Turbine Area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	Average
RTLO					1								0.1
PALO					1								0.1
COLO													
DCCO			1				2						0.3
GRCO													
NOGA		1				6				3	1		0.9
COEI													
HADU													
GBBG		1		1		3	1				1	6	1.1
HEGU			1				1				4	12	1.5
LAGU			1										0.1
BLGU										1			0.1
												Total	4.1

Table A-5a. Overall summary table for October 23, 2010 Survey.													
Species	Date: October 23, 2010							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						3					3	1	0.6
COLO					1				1	2	1		0.4
DCCO									1	1	1	1	0.3
GRCO					1								0.1
ABDU					3		15						1.5
COEI	5	4	3	28	3	1	15	2	1			6	5.7
WWSC			1	2									0.3
SUSC		5											0.4
BLSC				1			10						0.9
RBME										1			0.1
COME						4							0.3
HADU			1										0.1
GBBG	6	2	3										0.9
HEGU	2	1	5	2		1	2	2	3		2	3	1.9
LBBG												1	0.1
BLGU												1	0.1
BLKI												1	0.1
RBGU	1		1	2		1	2	3	1	3		5	1.6
LTDU		2		1	2								0.4
RNGR			3										0.3
MALL							2						0.2
CAGO		1											0.1
												Total	16.3

Table A-5b. Inside Black Rock summary table for October 23, 2010 Survey.													
Species	Date: October 23, 2010							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**
DCCO									1	1	1	1	0.3
COLO										1	1		0.2
HEGU						1			2				0.3
BLGU												1	0.1
COEI	4	4	3	3	1	1	1	2	1			4	2.0
HADU			1										0.1
BLSC				1									0.1
ABDU					3								0.3
COME						4							0.3
												Total	3.6

Table A-5c. Outside Black Rock summary table for October 23, 2010 Survey.													
Species	Date: October 23, 2010							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				0.2
RTLO						1					3	1	0.4
RNGR			3										0.3
HEGU	2	1	4				2		1		2	2	1.2
RBGU	1			2		1	1	3	1	3		4	1.3
GBBG	6	2	3										0.9
LBBG												1	0.1
COEI				25	2		14					2	3.6
WWSC			1										0.1
RBME										1			0.1
												Total	8.08

Table A-5d. Turbine area summary table for October 23, 2010 Survey.													
Species	Date: October 23, 2010							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**
GRCO					1								0.1
COLO										1			0.1
RTLO						2							0.2
HEGU			1	2				2				1	0.4
RBGU			1				1					1	0.3
BLKI												1	0.1
COEI	1												0.1
SUSC		5											0.4
BLSC							10						0.8
WWSC				2									0.2
LTDU		2		1	2								0.4
ABDU							15						1.3
MALL							2						0.2
CAGO		1											0.1
												Total	4.3

Table A-6a. Overall summary table for November 13, 2010 Survey.													
Species	Date: November 13, 2010							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	7	11	13	8	6	11	13	40	93	129	40	12	32.0
PALO											1	1	0.2
RNGR						1							0.1
COLO		1				1			3		1	1	0.6
HOGR						2	1						0.3
DCCO		2		2	1							2	0.6
GRCO		1									1		0.2
NOGA							1				1		0.2
COEI	2				12		6		17	15	15		5.6
GBBG				1								1	0.2
BLKI	9							35					3.7
MEGU					1								0.1
RBGU	5		2	8	8		2						2.1
HEGU	12	5	8		6		10		20				5.1
RAZO		1		7	12			2	1				1.9
COMU		2											0.2
ATPU				1			4			2	3	1	0.9
ABDU						4						3	0.6
BLSC											1		0.1
SUSC	4												0.3
WWSC	1				2								0.3
LTDU		2											0.2
COME					3	2							0.4
RBME	3	3	4				1				3		1.2
BLGU					1		2	1	2	4			0.8
												Total	57.3

Table A-6b. Inside Black Rock summary table for November 13, 2010 Survey.													
Species	Date: November 13, 2010						Observer: Fulton Lavender						
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO							2	5					0.6
PALO													
RNGR													
COLO													
HOGR						2							0.2
DCCO					1							2	0.3
GRCO		1									1		0.2
NOGA													
COEI													
GBBG				1									0.1
BLKI	2												0.2
MEGU													
RBGU			1										0.1
HEGU	1	2	1		2								0.5
RAZO													
COMU													
ATPU													
ABDU						4						3	0.6
BLSC													
SUSC													
WWSC													
LTDU		2											0.2
COME					3	2							0.4
RBME	3	3	3								3		1.0
BLGU													
												Total	4.2

Table A-6c. Outside Black Rock summary table for November 13, 2010 Survey.													
Species	Date: November 13, 2010							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Outside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	4	5	11	1	1	4	3	28	29	53	10	3	12.7
PALO													
RNGR						1							0.1
COLO						1			3				0.3
HOGR													
DCCO		2		2									0.3
GRCO													
NOGA							1				1		0.2
COEI	2				12					15	15		3.7
GBBG													
BLKI													
MEGU													
RBGU	1			2	4								0.6
HEGU	7		4		4		10		15				3.3
RAZO					11								0.9
COMU													
ATPU							3					1	0.3
ABDU													
BLSC													
SUSC													
WWSC					2								0.2
LTDU													
COME													
RBME													
BLGU								1					0.1
												Total	22.7

Table A-6d. Turbine Area summary table for November 13, 2010 Survey.													
Species	Date: November 13, 2010							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Turbine Area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	3	6	2	7	5	7	8	7	64	76	30	9	18.7
PALO											1	1	0.2
RNGR													
COLO		1									1	1	0.3
HOGR							1						0.1
DCCO													
GRCO													
NOGA													
COEI							6		17				1.9
GBBG												1	0.1
BLKI	7							35					3.5
MEGU					1								0.1
RBGU	4		1	6	4		2						1.4
HEGU	4	3	3						5				1.3
RAZO		1		7	1			2	1				1.0
COMU		2											0.2
ATPU				1			1			2	3		0.6
ABDU													
BLSC											1		0.1
SUSC	4												0.3
WWSC	1												0.1
LTDU													
COME													
RBME			1				1						0.2
BLGU					1		2		2	4			0.8
												Total	30.6

Table A-7a. Overall summary table for November 22, 2010 Survey.													
Species	Date: November 22, 2010							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Overall.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	2	2	4	6	3	12	12	21	9	1	1		6.3
COLO				1									0.1
HOGR											1		0.1
COEI	3												0.250
GBBG							1			1			0.2
BLKI									7	4			0.9
RBGU						2	5		3	2			1.0
HEGU	4	14	9	7	5	5			18	3			5.4
RAZO							1	20	3		15		3.3
COMU								2					0.2
ATPU										1			0.1
ABDU						1							0.1
WWSC										5			0.4
LTDU								1					0.1
RBME				1									0.1
BLGU			1			1	1						0.3
TBMU											1		0.1
												Total	18.7

Table A-7b. Inside Black Rock summary table for November 22, 2010 Survey.													
Species	Date: November 22, 2010							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Inside Black Rock.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO	1	1	2	1		2	2	1	1				0.9
COLO													
HOGR													
COEI	3												0.3
GBBG													
BLKI													
RBGU													
HEGU													
RAZO													
COMU													
ATPU													
ABDU													
WWSC													
LTDU													
RBME				1									0.1
BLGU													
TBMU													
												Total	1.3

Table A-7c. Inside Black Rock summary table for November 22, 2010 Survey.													
Species	Date: November 22, 2010							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			3	1	5	13	10	5	1			3.3
COLO				1									0.1
HOGR													
COEI													
GBBG							1						0.1
BLKI									7	1			0.7
RBGU						2	5		3	2			1.0
HEGU	4	14	6	6	4	5			18	2			4.9
RAZO								7	3		15		2.1
COMU													
ATPU										1			0.1
ABDU													
WWSC													
LTDU													
RBME													
BLGU						1	1						0.2
TBMU													
												Total	12.3

Table A-7d. Inside Black Rock summary table for November 22, 2010 Survey.													
Species	Date: November 22, 2010							Observer: Fulton Lavender					
	Location: Beach berm in front of Fundy Tidal Power shore facility, Black Rock 45 22.263N, 64 24.348W, **Turbine Area.**												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	12	**Average**
RTLO		1	2	2	2	5	6	3	3		1		2.1
COLO													
HOGR											1		0.1
COEI													
GBBG										1			0.1
BLKI										3			0.3
RBGU													
HEGU			3	1	1					1			0.5
RAZO							1	13					1.2
COMU								2					0.2
ATPU													
ABDU						1							0.1
WWSC										5			0.4
LTDU								1					0.1
RBME													
BLGU			1										0.1
TBMU											1		0.1
												Total	5.1

Table A-8. Summary of sightings of water associated bird species at Black Rock Tidal Power demonstration Site, May 1 to November 22, 2010, from shore based observations.

	Individuals observed per 30 minute observation period						
Species	May 1	May 13	May 27	June 12	Oct 23	Nov 13	Nov 22
RTLO	2.27	0.25	2.83	0.17	0.58	31.92	6.25
COLO	0.45		1.17	0.25	0.42	0.58	0.08
PALO	0.27		0.08	0.08		0.17	
DCCO	1.45	0.33	1.75	4.50	0.33	0.58	
GRCO	1.00	0.08	0.58	1.08	0.08	0.17	
NOGA		2.50	0.83	3.08		0.17	
ABDU		0.17			1.50	0.58	0.08
COEI	3.45	1.42	2.17	12.75	5.67	5.58	0.25
WWSC		0.33			0.25	0.25	0.42
SUSC	0.27				0.42	0.33	
BLSC					0.92	0.08	
RBME	0.09				0.08	1.17	0.08
COME					0.33		
HADU				0.17	0.08		
GBBG	24.27	22.50	23.83	22.25	0.92	0.17	0.17
HEGU	10.18	11.67	19.42	22.50	1.92	5.08	5.42
ICGU		0.08	0.08				
LAGU				0.08			
LBBG		0.08	0.08		0.08		
BLGU	3.18	1.08	3.75	2.92	0.08	0.83	0.25
RAZO	0.55					2.08	3.25
HOGR						0.08	0.08
BLKI					0.08	3.67	0.92
RBGU					1.58	2.00	1.00
LTDU					0.42	0.17	0.08
COME						0.42	
RNGR					0.25	0.08	
ATPU						0.92	0.08
MALL					0.17		
CAGO					0.08		
COMU						0.17	0.17
TBMU							0.08
MEGU						0.08	
TOTAL	47.70	40.49	56.58	69.83	16.25	57.33	18.67

Table A-9. Distribution by area of sightings of water associated bird species at Black Rock Tidal Power demonstration Site, May 1 to November 22, 2010, from shore based observations.

	Individuals observed per 30 minute observation period						
Sub-Areas	May 1	May 13	May 27	June 12	Oct 23	Nov 13	Nov 22
Inside Black Rock	--[1]	--[1]	40.83	60.25	3.58	4.17	1.25
Outside Black Rock	--[1]	--[1]	11.50	5.50	8.08	22.67	12.33
Turbine Area	--[1]	--[1]	4.25	4.08	4.58	30.58	5.08
Total	47.7	40.49	56.58	69.83	16.25	57.33	18.67

[1] Observations not separated by sub-area.

Table A-10. Marine mammal sightings at Minas Passage study site, May – November 2010. Average number per 30-mnute observation period.

	Abundance (Individuals per 30 minute observation period)						
	May 1	May 13	May 27	June 12	Oct 23	Nov 13	Nov 22
Grey Seal	0	0	0	0	0	0.25	0
Harbour Porpoise	0.91	0	0	0.67	0.17	1.17	0.82

Table A-11. Occurrence of water associated bird species at Black Rock Tidal Power demonstration Site, May 1 to November 22, 2010, from shore based observations.

	Individuals observed per 30 minute observation period						
Species	May 1	May 13	May 27	June 12	Oct 23	Nov 13	Nov 22
RTLO	x	x	x	x	x	x	x
COLO	x		x	x	x	x	x
PALO	x		x	x		x	
DCCO	x	x	x	x	x	x	
GRCO	x	x	x	x	x	x	
NOGA		x	x	x		x	
ABDU		x			x	x	x
COEI	x	x	x	x	x	x	x
WWSC		x			x	x	x
SUSC	x				x	x	
BLSC					x	x	
RBME	x				x	x	x
COME					x		
HADU				x	x		
GBBG	x	x	x	x	x	x	x
HEGU	x	x	x	x	x	x	x
ICGU		x	x				
LAGU				x			
LBBG		x	x		x		
BLGU	x	x	x	x	x	x	x
RAZO	x					x	x
HOGR						x	x
BLKI					x	x	x
RBGU					x	x	x
LTDU					x	x	x
COME						x	
RNGR					x	x	
ATPU						x	x
MALL					x		
CAGO					x		
COMU						x	x
TBMU							x
MEGU						x	
TOTAL	12	12	12	12	23	25	17