Marine Seabirds Monitoring Program

Tidal Energy Demonstration Site – Minas Passage, Year-2: 2017 – 2018

July 2018

Submitted to:

Fundy Ocean Research Center for Energy (FORCE)
Halifax, Nova Scotia

Submitted by:

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Joe H. Kozak, 1947-2018

This report is dedicated to Joe Kozak, who, in his position as environmental advisor and consultant—first to Minas Basin Pulp and Power, which developed the tidal energy project, as well as later, when the responsibility for the tidal energy demonstration site transitioned to FORCE—guided the early environmental monitoring efforts at the Minas Passage site. Joe was the energetic and tireless force behind the successful environmental effects monitoring program and baseline studies—and used his extensive knowledge and experience in federal and provincial government processes, to 'stickhandle' the nascent tidal energy project through its various environmental regulatory requirements. Most important, though, he was a kind, fun-loving, and respectful colleague, and also a friend to many on the FORCE team. Joe passed away suddenly on July 4, 2018 after retiring to B.C. He will surely be missed.

Joe on the Parrsboro Wharf leading a cruise to the FORCE Site for Parrsboro residents, Fall 2009.

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EXECUTIVE SUMMARY

The Fundy Ocean Research Center for Energy (FORCE) developed and operates a tidal energy demonstration site and support facility along the north shore of Minas Passage near Parrsboro in Nova Scotia's Bay of Fundy. As a condition of operating approvals, FORCE has been required to carry out an environmental effects monitoring program (EEMP) which includes surveys of seabirds and other water-associated birds. The surveys provide information on occurrence, seasonality and local distribution of seabirds to allow testing of environmental assessment predictions that seabirds will not be impacted by tidal energy devices and associated activities. FORCE conducted baseline surveys from 2009 to 2012 and undertook a program of annual EEMP surveys beginning in May 2016—proposed to continue annually to 2021. This report covers the second year (May 17, 2017 to May 10, 2018). A grid-connected instream tidal turbine was installed in November 2016 during the first year and removed in June 2017 early in the second year of the monitoring program.

Monthly to semi-monthly shore-based surveys documented the occurrence, relative abundance, local distribution, and annual pattern of composition and abundance of seabirds and water-associated birds (including gulls, alcids, loons, cormorants, ducks, sea ducks and other waterfowl and shorebirds), in coastal waters of Minas Passage at the FORCE site. The study area included the zone designated for deployment of tidal energy devices (the 'Crown Lease' area) and adjacent waters both inshore and offshore and on Black Rock, an island at the site. Thirty-six (36) species of water-associated birds and shorebirds, and two marine mammal species (Harbour Porpoise and Harbour Seal) were observed during the year. The most common and abundant species included Great Black-backed Gull, Herring Gull, Common Eider, Black Scoter and Ring-billed Gull. Other species occurring commonly or in moderate abundance included Common Loon, Red-throated Loon, Pacific Loon, American Black Duck, Surf Scoter, Lesser Black-Backed Gull, Black Guillemot, Double-crested Cormorant and Great Cormorant. Least common species included shorebirds (Black-bellied Plover, Least Sandpiper, Lesser Yellowlegs, Semipalmated Plover, Spotted Sandpiper), Horned Grebe, Black-legged Kittiwake, Common Goldeneye, Canada Goose, Harlequin Duck, Long-tailed Duck, King Eider, Red-breasted Merganser and Common Murre, which were each observed on single surveys. Black Guillemot and Great Black-backed Gull were nesting on Black Rock during the year.

Seabird abundance showed seasonal peaks corresponding to migratory movements (March-April and October-December); a late-spring-to-early-summer occupation by local resident breeders Great Black-backed Gull, Black Guillemot and Common Eider; and a low summer abundance when migrants are not present. Number of species observed per survey ranged from five to 16. Fewer species visited the site overall than in the baseline surveys in 2010-2012 (36 species versus 45). Common and abundant species were the same as in the earliest surveys, but Northern Gannet was nearly absent in both Year-1 and Year-2. Abundance and peak abundance was similar to earlier surveys.

Birds showed moderate and generally equal utilization of survey subareas including the 'Crown Lease' and areas to the east around Black Rock. Black Rock was a focal point for bird activity, with birds typically occupying it for varying periods, for nesting (e.g. Black Guillemot), or as a base for local feeding. During migration, however, birds moving through the area over water dominated numbers using Black Rock. Because of the short deployment of the tidal turbine, there was limited opportunity to conduct

analyses to determine potential effects. Statistical comparisons of overall abundance, abundance of birds on Black Rock and in over water areas separately, however showed no evidence for either a positive or negative effect of the turbines on bird abundance.

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1 INTRODUCTION

The Fundy Ocean Research Center for Energy (FORCE) operates a tidal energy demonstration site and testing facility in Minas Passage, near Parrsboro, Nova Scotia. The site is important for the high energy potential of the tidal currents which occur there, the unique biological conditions they provide, as well as serving as a migration route for birds, fish and marine mammals through the Bay of Fundy and into the biologically productive Minas Basin located at its eastern end.

As a condition of its regulatory approvals to operate, FORCE has been required to conduct environmental effects monitoring (EEM) which includes surveys of seabirds and other water-associated birds, to provide information on occurrence, seasonality and local distribution which will allow testing of environmental assessment predictions that seabirds will not be impacted by tidal energy devices or associated activities. FORCE undertook various studies as part of its initial Environmental Effects Monitoring Program (EEMP) (FORCE 2011, 2014), including a three-year project to provide baseline information on the occurrence, abundance, species composition and seasonality, of seabirds and marine mammals (Envirosphere Consultants Limited 2011; 2012; 2013; FORCE 2011; 2014) against which impacts of present and future project activities might be assessed.

Seabirds and other water-associated birds are among the most important organisms in the Bay of Fundy. They are generally less numerous than other organisms in the ecosystem, have legal protected status under Canadian and international law, and are of high interest and concern to the public. In the context of tidal energy development, seabirds have the potential to interact both directly and indirectly (e.g. through effects on the food chain), with tidal energy devices and activities. FORCE's baseline and EEMP activities from 2009-2012 revealed 45 species of seabirds and water-associated birds and several marine mammal species, including Harbour Porpoise, Grey Seal and Harbour Seal occurring at the FORCE site (Envirosphere Consultants Limited, 2010-2012).

Potential impact of tidal energy activities on seabirds and other water-associated birds is an important concern and has been assessed at various stages of the development of the FORCE site; in reviews conducted as part of the environmental assessment process (JWEL 2008; AECOM 2009); and through evaluation of information arising from baseline and environmental monitoring studies (e.g. FORCE 2011, DFO (2016)). FORCE has been allowed to proceed by regulatory agencies with various conditions, most recently being required to conduct an operational phase EEMP from 2016-2021, during which use of the site by tidal energy developers is expected to increase. A tidal energy turbine was installed at the site from November 2009 to December 2010 and most recently from November 2016 to June 2017[1] (FORCE 2016).

In this latest phase of EEM, observations of seabirds and marine mammals have been made on a series of half-day (six-hour), monthly to semi-monthly surveys conducted from the FORCE Visitor Center, located on shore at the site. Since it began in May 2016 (Year-1) the monitoring study has focused on determining local distribution, abundance, and seasonality of seabirds in subareas of the nearshore environment at the FORCE test site, including areas designated for deployment of tidal turbines, and

[1] Cape Sharp Tidal Development Inc. installed an Open Hydro turbine on November 7, 2016 and withdrew it on June 15, 2017.

including Black Rock—a prominent island at the site. The results of the second year (Year-2) of the monitoring study, extending from May 2017 to May 2018, are presented in this report.

2 METHODS

2.1 STUDY AREA

The FORCE tidal energy demonstration site is located on the northern side of Minas Passage, a narrow (5 km) strait which connects the outer Bay of Fundy to Minas Basin, a shallow estuarine, macrotidal bay at its eastern end. The study area consists of the "Crown Lease", a 1 x 1.5 km box located approximately 1 km from shore (Figure 1) within which berths for tidal energy devices are located, and inshore and offshore areas around the lease, including coastal and offshore waters and Black Rock. The site has an unobstructed view of about 5 km across Minas Passage and a panoramic view from due south to west which includes Cape Split and Cape Spencer. The Crown Lease is serviced by submarine transmission cables; and instrumentation platforms and supporting power and data cables to shore. Onshore infrastructure includes an operations and interpretive center (FORCE Visitor Center[2])(45° 22.21' N 64° 24.22' W, 22 m above mean high water); a weather station and RADAR installation; and a high voltage grid-connected transmission line. Seabird observations were made from the observation deck or glassed atrium of the Visitor Center, the onshore operations center for the facility.

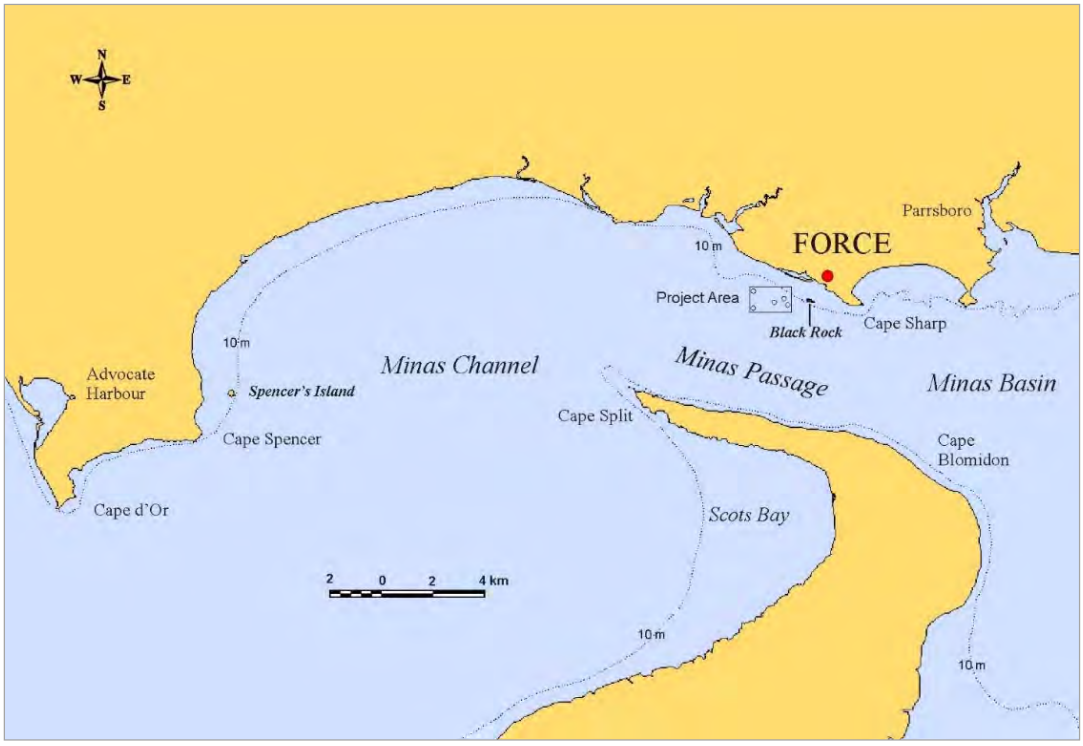

Figure 1. Study area showing project location and major geographic features.

[2] The Visitor Center allows observations from both indoors and outdoors depending on weather conditions, with nearly identical fields of view.

2.2 SURVEY PROTOCOL

Fifteen half-day (six-hour) shore-based surveys consisting of approximately twelve, half-hour observation periods per day, were carried out at the site between May 17, 2017 and May 10, 2018 (Table 1)(Figure 2). Timing of surveys coincided as much as possible with days when high tide occurred near mid-day, and observations continued through the outgoing tide, consistent with the earlier 2010-2012 baseline and Year-1 EEMP surveys. Monitoring at a consistent time of day and tidal phase reduces statistical variability potentially arising from environmental factors.

Table 1. Tide times and heights (meters) for seabird surveys at the Fundy Tidal Power Demonstration Site (FORCE Visitor Center) during the 2017 – 2018 survey (Year-2).

SURVEY DATE	START TIME	END TIME	HIGH TIDE TIME	WATER LEVEL (m)	LOW TIDE TIME	WATER LEVEL (m)	NO. OF SURVEY INTERVALS
17 May 2017	12:00	18:00 (ADT)	18:19	10.9	11:59	2.4	12
14 June 2017	12:30	18:30	17:01	11.4	10:45	1.8	12
14 July 2017 (AM Survey)	6:35	10:35	4:54	12.1	11:04	1.4	16
14 July 2017 (PM Survey)	12:15	16:15	17:21	12.0	--	--	
22 August 2017 (AM Survey)	7:30	11:30	--	--	7:38	0.2	16
22 August 2017 (PM Survey)	13:20	17:20	13:44	13.2	19:59	0.4	
18 September 2017	11:45	17:45	11:46	12.6	18:01	0.9	12
18 October 2017	12:00	18:00	12:13	12.7	18:31	0.8	12
2 November 2017	12:15	18:15	11:51	12.3	18:05	1.2	12
17 November 2017	11:30	17:00 (AST)	11:34	12.5	17:53	1.1	11
5 December 2017	11:30	17:00	13:37	13.7	19:53	-0.1	11
15 January 2018	12:00	17:00	11:24	11.6	17:46	1.9	11
13 February 2018	11:30	17:30	10:58	11.3	17:18	2.3	12
19 March 2018	11:45	17:45 (ADT)	14:59	12.7	21:07	0.8	12
5 April 2018	12:15	18:15	17:10	11.6	10:59	1.6	12
19 April 2018	11:30	17:30	16:09	12.8	9:53	0.4	12
10 May 2018	12:00	18:00	9:20	10.6	15:37	2.8	12

Surveys used a geographic grid system to locate the observations in space and in relation to the Crown Lease area, following standard practice in monitoring of seabirds in general, and in particular in monitoring studies used in monitoring tidal energy development sites in the United Kingdom (e.g.

Jackson and Whitfield 2011; Robbins 2012). Subareas were chosen to be relevant to data analysis in terms of a Before-After Control Impact statistical design (Green 1979) for environmental effects monitoring. Subareas included the 'Crown Lease' (CL); two areas inshore of the CL, "Inside Black Rock 1" (IB1) and "Inside Black Rock 2" (IB2); three areas outside the CL, "Outside Black Rock 1-3" (OB1, OB2, OB3); and three "Farfield" reference sites (FF1, FF2, FF3) (Figure 3). In May 2016 panoramic photographs of the site were taken when a support vessel occupied reference points (the four corners of the Crown Lease). The photos have been used subsequently as a reference for conducting the surveys. Positions of grid areas on the water as they appear from the FORCE Visitor Center are shown in Figure 4.

Figure 2. Bird Observer, Fulton Lavender, June 12, 2018.

Observations were recorded on field data sheets on which information on bird species, age, subarea and activity (flying and direction, on water, direction, feeding, diving etc.) as well as weather conditions can be reported. Weather conditions included wind speed, direction, and temperature obtained at the beginning of each period from the FORCE weather station; and cloud cover, visibility, atmospheric phenomena such as fog, and precipitation, and an estimate of wind on the Beaufort Scale, summarized in Appendix B. Survey and environmental information is contained a Microsoft Access database developed for the project.

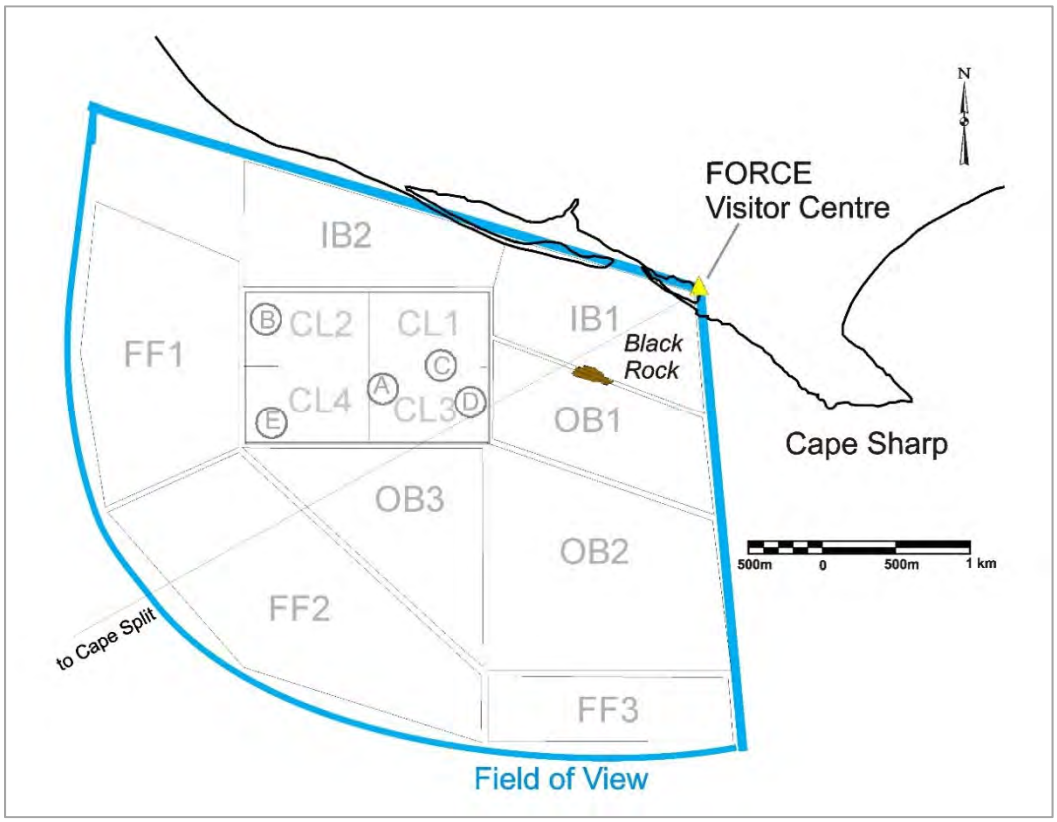

Figure 3. Spatial grid showing subareas used in seabird survey. Berths currently assigned to FORCE berth holders are shown as circles in Crown Lease (CL) area.

Figure 4. Photograph of the view from the observation point at the FORCE Visitor Center, showing subareas used in survey, including Black Rock. Red lines show reference directions to assist in locating subareas.

3 RESULTS AND DISCUSSION

3.1 SEABIRDS AND OTHER WATER-ASSOCIATED BIRDS

Various seabirds and water-associated birds use Minas Passage at the FORCE site throughout the year. These include oceanic species such as shearwaters and petrels, which spend their lives at sea, except for breeding; gulls, cormorants, and other species whose life cycle spans a spectrum of oceanic and coastal environments; waterfowl such as ducks, geese, and loons, which may occupy marine, freshwater and estuarine environments during their life cycle; shorebirds which are often found seasonally in intertidal areas; and other species which from time to time occur.

Dynamics of birds in Minas Passage are influenced by various factors, in particular food availability, breeding and foraging habitat, proximity to shore, exposure to spatially- and temporarily-varying tidal currents, presence of Black Rock, the small coastal island at the site, and also by the proximity to important coastal features which attract birds. For example, the site is near a major point of land (Cape Sharp), a coastal salt marsh, a sand spit and lagoon system, and nearby shoreline and tidal flats—all of which may influence bird distribution. Black Rock in particular, is an important feature of the site, attracting birds for roosting, resting, and nesting, and as a base for active feeding in the adjacent waters. Individual factors in bird abundance could not be addressed separately in the study design; rather the approach used the aggregate measures, and focused on determining differences between periods when a tidal device was installed versus other periods.

3.1.1 Seabird Community – Species Diversity

Thirty-six (36) species of water-associated birds and shorebirds were recorded at the site during the survey (Tables 2 and 3; Figure 5). The number of species occurring during individual surveys was lowest in mid- to late-winter, and was higher, though showing considerable variability between surveys, for the rest of the year (Figure 5). The low number in mid-winter (five in mid-October and five to seven in surveys from mid-January to mid-March), consisted of common resident species, including species which overwinter in the area. In contrast, fifteen species occurred in late August, early November, and late April, and sixteen species in early December (Figure 5). In the first year of the EEMP, highest number of species per survey were observed during spring and fall migrations—this year highest number of species were also recorded during the spring migration (April 19, 2018)(fifteen species) and fall migration (November 2 and December 5, 2017)(15-16 species)(Figure 5). Comparable numbers of species were seen, however, on late August and mid-September surveys (15 and 14 species respectively) during the late summer shorebird migration when four species of shorebirds occurred in August and three were observed in mid-September (Figure 5). The species on a given survey typically included several residents and local breeders; and the remainder were annual migrants (e.g. Red-throated Loon) or seasonal visitors (e.g. Atlantic Puffin, Razorbill).

Table 2. Seabirds and other water-associated bird species observed at the Fundy Tidal Power Demonstration Site (FORCE Visitor Center) during the 2017 - 2018 shore-based survey (Year-2). A total of 36 species were observed. Species in bold were not observed in year-1. Occurrences are birds seen in individual periods.

Species Code	Common Name	Scientific Name	Total Occurrences
SEABIRDS AND SEA DUCKS			
ALCID	Alcid unidentified	*Alcidae*	*1*
ATPU	Atlantic Puffin	*Fratercula arctica*	*2*
BLGU	Black Guillemot	*Cepphus grylle*	*206*
BLKI	**Black-legged Kittiwake**	***Rissa tridactyla***	***2***
BLSC	Black Scoter	*Melanitta nigra*	*555*
COMU	Common Murre	*Uria aalge*	*9*
DCCO	Double-crested Cormorant	*Phalacrocorax auritus*	*276*
GBBG	Great Black-backed Gull	*Larus marinus*	*1068*
GRCO	Great Cormorant	*Phalacrocorax carbo*	*140*
HEGU	Herring Gull	*Larus argentatus*	*885*
ICGU	Iceland Gull	*Larus glaucoides*	*9*
LBBG	Lesser Black-backed Gull	*Larus fuscus*	*7*
LTDU	Long-tailed Duck	*Clangula hyemalis*	*2*
NOGA	Northern Gannet	*Morus bassanus*	*35*
RAZO	Razorbill	*Alca torda*	*18*
RBGU	Ring-billed Gull	*Larus delawarensis*	*152*
SUSC	Surf Scoter	*Melanitta perspicillata*	*28*
WWSC	White-winged Scoter	*Melanitta fusca*	*8*
WATERFOWL, LOONS, GREBES			
ABDU	American Black Duck	*Anas rubripes*	*8*
CAGO	Canada Goose	*Branta canadensis*	*1*
COEI	Common Eider	*Somateria mollissima*	*563*
COGO	Common Goldeneye	*Bucephala clangula*	*8*
COLO	Common Loon	*Gavia immer*	*15*
HADU	Harlequin Duck	*Histrionicus histrionicus*	*1*
HOGR	**Horned Grebe**	***Podiceps auritus***	***1***
KIEI	King Eider	*Somateria spectabilis*	*2*
LOON	Loon Unidentified	*Gaviidae*	*1*
PALO	**Pacific Loon**	***Gavia pacifica***	***4***
RBME	Red-breasted Merganser	*Mergus serrator*	*1*
RNGR	Red-necked Grebe	*Podiceps grisigena*	*3*
RTLO	Red-throated Loon	*Gavia stellata*	*125*
SHOREBIRDS			
BBPL	**Black-bellied Plover**	***Pluvialis squatarola***	***1***
LESA	**Least Sandpiper**	***Calidris minutilla***	***5***
LEYE	Lesser Yellowlegs	*Tringa flavipes*	*1*
SPPL	**Semipalmated Plover**	***Charadrius semipalmatus***	***4***
SPSA	Spotted Sandpiper	*Actitis macularius*	***3***
		Total	***4150***

Table 3. Seasonal occurrence of seabirds and water-associated birds observed in Year-2 surveys, Fundy Ocean Research Center for Energy (2017 - 2018). Parrsboro, Nova Scotia.

Species	Spring		Summer			Fall				Winter		Spring				Total Number of Survey Days Observed	Percent of Surveys (%) Observed
	May 17, 2017	June 14, 2017	July 14, 2017	August 22, 2017	September 18, 2017	October 18, 2017	November 2, 2017	November 17, 2017	December 5, 2017	January 15, 2018	February 13, 2018	March 19, 2018	April 5, 2018	April 19, 2018	May 10, 2018		
Loons (Gaviidae)																	
Common Loon	✓			✓	✓		✓		✓							5	33%
Loon Unidentified				✓												1	7%
Pacific Loon				✓			✓		✓						✓	4	27%
Red-throated Loon	✓				✓		✓	✓	✓	✓	✓	✓		✓	✓	10	67%
Waterfowl (Anatidae)																	
American Black Duck					✓		✓		✓	✓		✓	✓	✓		7	47%
Black Scoter	✓	✓	✓	✓	✓		✓	✓	✓				✓	✓	✓	11	73%
Canada Goose					✓											1	7%
Common Eider	✓	✓	✓	✓	✓	✓	✓		✓				✓	✓	✓	11	73%
Common Goldeneye											✓					1	7%
Harlequin Duck	✓															1	7%
King Eider														✓		1	7%
Long-tailed Duck									✓							1	7%
Red-breasted Merganser													✓			1	7%
Surf Scoter			✓					✓	✓					✓		4	27%
White-winged Scoter	✓					✓			✓							3	20%
Auks, Murres, Puffins (Alcidae)																	
Alcid Unidentified									✓							1	7%
Atlantic Puffin								✓	✓					✓		3	20%
Black Guillemot	✓	✓	✓	✓			✓		✓						✓	7	47%
Common Murre							✓									1	7%
Razorbill							✓	✓	✓							3	20%
Cormorants (Phalacrocoracidae)																	
Double-crested Cormorant	✓	✓	✓	✓	✓	✓	✓							✓	✓	9	60%
Great Cormorant	✓	✓	✓	✓	✓								✓	✓	✓	8	53%
Gulls, Kittiwakes (Laridae)																	
Black-legged Kittiwake								✓								1	7%
Great Black-backed Gull	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	12	80%
Herring Gull	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15	100 %
Iceland Gull											✓		✓	✓		3	20%
Lesser Black-backed Gull					✓					✓	✓				✓	4	27%
Ring-billed Gull		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	12	80%
Northern Gannet (Sulidae)																	
Northern Gannet	✓		✓											✓		3	20%
Grebes (Podicipedidae)																	
Horned Grebe							✓									1	7%
Red-necked Grebe									✓	✓				✓		3	20%
Shorebirds (Scolopacidae)																	
Black-bellied Plover					✓											1	7%
Least Sandpiper				✓												1	7%
Lesser Yellowlegs				✓												1	7%
Semipalmated Plover				✓	✓											2	13%
Spotted Sandpiper				✓												1	7%

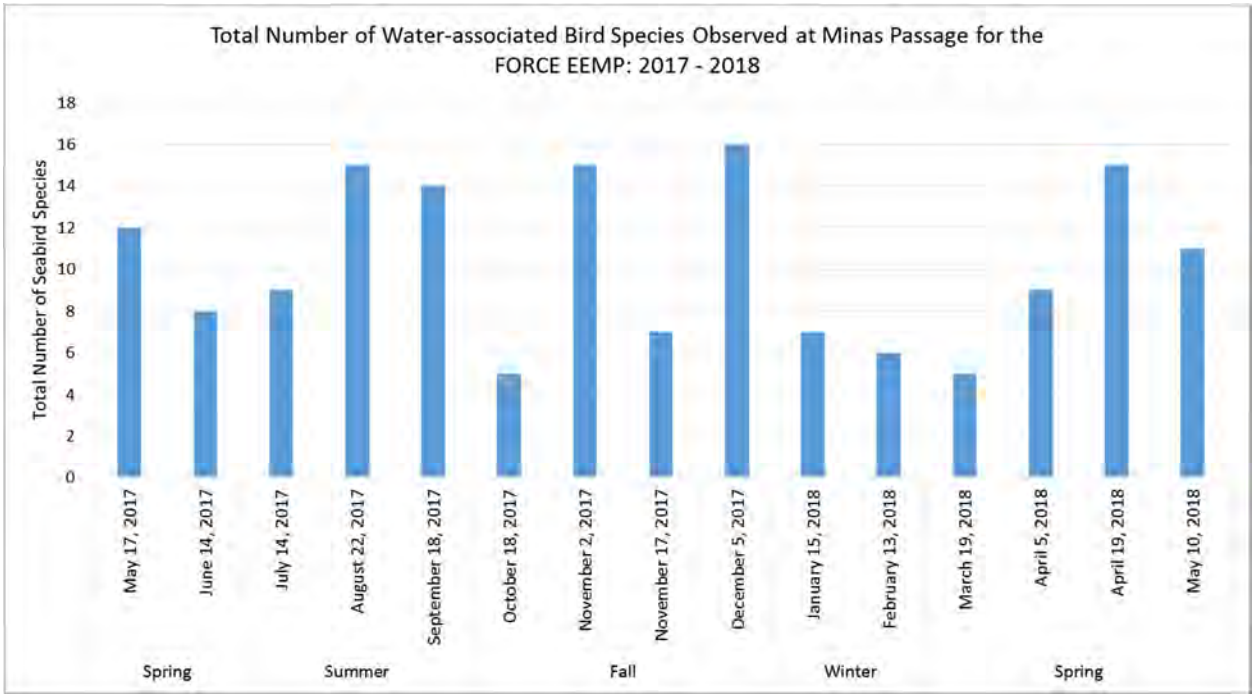

Figure 5. Number of water-associated bird species observed on each survey during Year-2 (May 2017 – May 2018) of the Shore-Based Seabird Survey – Tidal Energy Demonstration Site, Fundy Ocean Research Center for Energy. Parrsboro, Nova Scotia.

3.1.2 Species Composition

Herring Gull and Great Black-backed Gull typically occurred throughout the year; and Black Guillemot, Ring-billed Gull, Red-throated Loon, Common Eider, Black Scoter, and Double-crested Cormorant and Great Cormorant were seasonally abundant (Tables 2 & 3, Figure 6, Appendix Table G1). Black Scoter were frequent visitors (73% of surveys) although only occasionally in high abundance. Individuals or pairs of American Black Duck were seen in approximately half (47%) of surveys typically in fall and spring. Ring-billed Gull occurred on 80% of surveys and were seasonally abundant. Various species observed on single surveys, included shorebirds (Black-bellied Plover, Lesser Yellowlegs, Least Sandpiper, and Spotted Sandpiper), Horned Grebe, Black-legged Kittiwake, Common Murre, Atlantic Puffin, Red-breasted Merganser, Long-tailed Duck, King Eider, Harlequin Duck, Common Goldeneye, and Canada Goose (Figure 6, Table 3). Harlequin Duck[3], a species of conservation concern, was seen at the site in May 2017 (Table 3). The species overwinters in the Bay of Fundy and has been observed occasionally at the FORCE site in previous years. Conservation status of recorded species is shown in Appendix D, Tables D1 & D2).

Two coastal upland species—Bald Eagle and Peregrine Falcon—were observed at the site this year. Gulls and other species will leave the area if Bald Eagle are present, observed on several occasions. Bald Eagles were recorded on July 14, 2017 and April 5th 2018[4]. A single Peregrine Falcon was seen flying east

[3] Harlequin Duck is listed as *Special Concern* under both the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the federal *Species at Risk Act* (SARA), and *Endangered* under the Nova Scotia *Species at Risk Act.*

[4] Occurrences of upland raptors including Bald Eagle, Osprey, Peregrine Falcon, and Northern Harrier are recorded in the project database although they are not included in estimates of seabird abundance.

parallel to shore in IB1 during the April 5th 2018 survey. Peregrine Falcon is a species of *Special Concern* under the federal *Species at Risk Act* and listed as *vulnerable* in Nova Scotia. The species nests on cliffs in the area, in particular at Cape Sharp located east of the FORCE site, and has been seen on other occasions, including one flying past the site on October 1, 2016 during the Year-1 surveys.

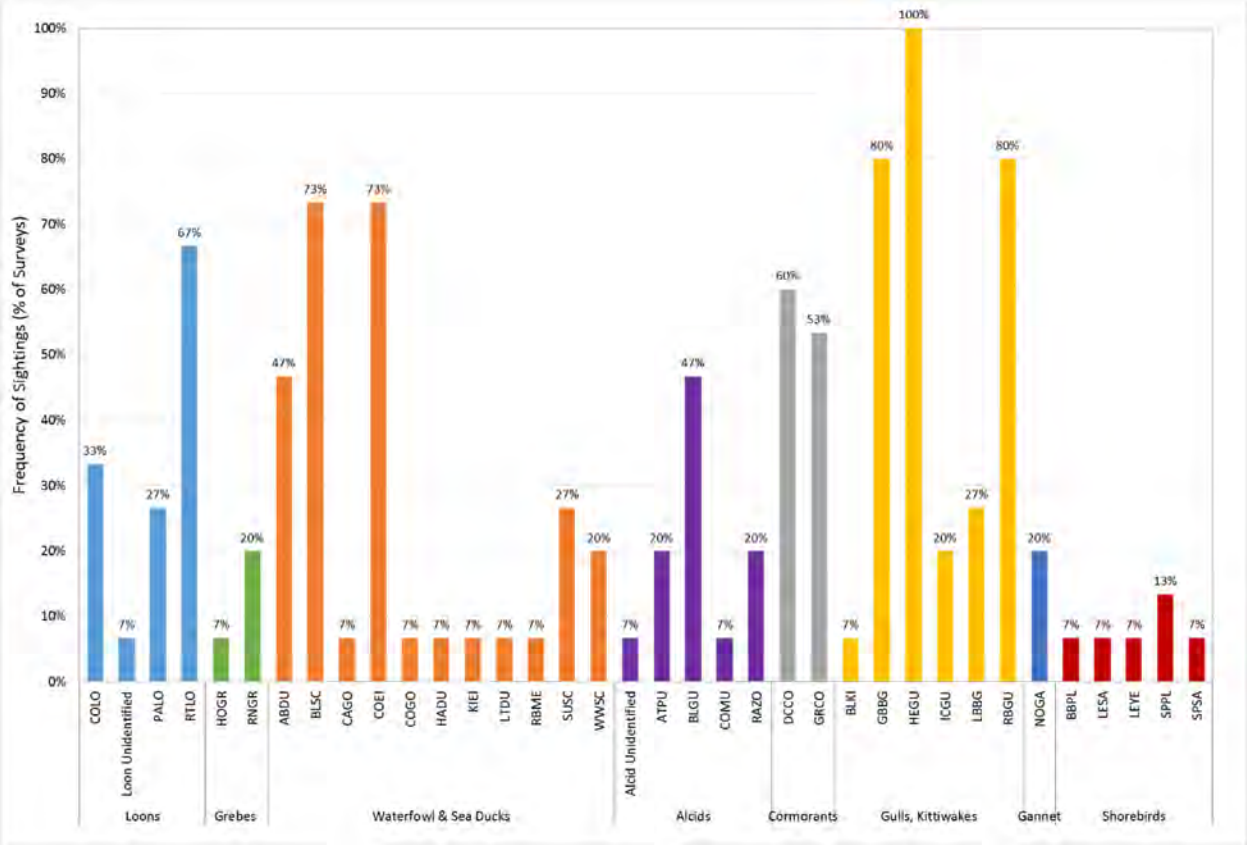

Figure 6. Frequency of occurrence (% of surveys) of seabird and water-associated birds observed in 15 shore-based surveys, Year-2, Fundy Ocean Research Center for Energy. Parrsboro, Nova Scotia.

3.1.3 Abundance

The monitoring approach provides a measure of abundance for the site (i.e. counts per 30-minute period) which can be compared between surveys, but is not an absolute estimate abundance (i.e. birds per unit area). Consequently the results not allow regional comparisons, for example to determine relative abundance at the FORCE site compared with other marine coastal areas in Atlantic Canada.

3.1.3.1.1 Black Rock

The relative abundance of birds on Black Rock (Table 4, Figure 7) is an important indicator of activity for species such as Black Guillemot, Great Black-backed Gull, and Herring Gull, which nest on the island, since it reflects breeding activity and success, as well as use of adjacent waters for feeding. Several resident species—birds which breed and spend a significant part of the year in the Inner Bay of Fundy—including Great Black-backed Gull and Herring Gull, Double-crested Cormorant and Great Cormorant, Black Guillemot, and Common Eider—frequently occur at the site, and often are seen occupying Black Rock, sometimes occurring in large numbers. Birds on Black Rock formed the largest proportion of total birds on most surveys, occurring prominently in late spring, early summer, summer and winter. No birds

used Black Rock from October to December (Figures 7 & 8) reflecting the absence of birds at the site during the survey. Birds typically seen over water were often moving to and from Black Rock, but the most abundant seen over water were migrants, in particular Red-throated Loon, and sea ducks including Black Scoter, Surf Scoter and White-winged Scoter, which occurred in high numbers during peak migration.

For species which do not nest on Black Rock, including Double-crested Cormorant, Great Cormorant, and Common Eider, numbers observed on Black Rock reflect the population abundance in the general vicinity of the site (i.e. in the system encompassing the outer Minas Basin, Minas Passage, and Minas Channel) and patterns of use of and movement through the area which may be relevant to assessing impacts of tidal energy devices.

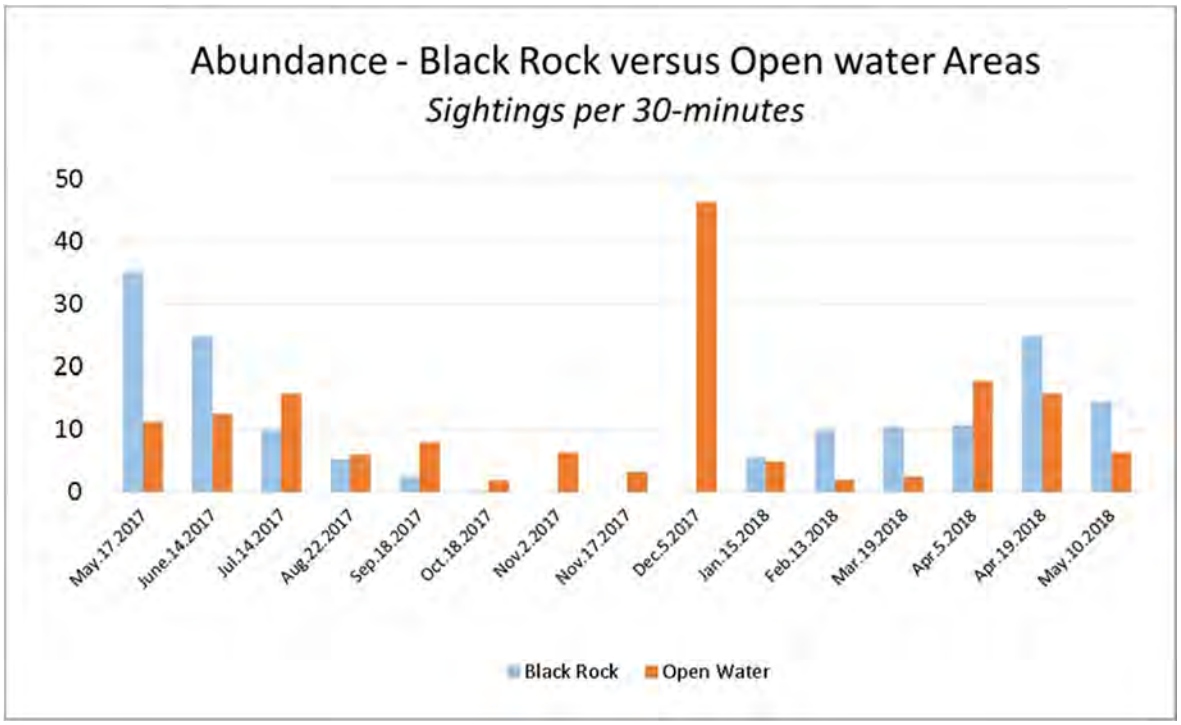

Figure 7. Average abundance of seabirds and water-associated birds (Black Rock versus open water) observed in 15 shore-based surveys, Year-2, Fundy Ocean Research Center for Energy. Parrsboro, Nova Scotia.

Table 4. Average abundance of seabirds and water-associated birds (number per 30-minutes) at the FORCE Tidal Energy Demonstration Site, Black Rock, Nova Scotia, 2017-2018. Number in brackets is standard deviation.

Total Bird Abundance								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	4.00 (8.62)	1.58 (3.37)		2.17 (4.63)	1.83 (4.91)	0.67 (1.30)	0.30 (0.81)	35.17 (10.71)
Jun.14.2017	0.08 (0.29)	6.50 (12.47)		4.25 (7.26)	1.00 (2.86)	0.42 (1.16)	0.08 (0.29)	24.83 (12.79)
Jul.14.2017	3.13 (4.27)	10.63 (13.24)	0.13 (0.50)	1.19 (1.60)	0.25 (0.58)	0.19 (0.54)	0.25 (1.00)	9.88 (12.91)
Aug.22.2017	1.75 (2.44)	3.13 (2.03)		0.63 (0.96)	0.06 (0.25)	0.38 (1.26)		5.25 (5.78)
Sep.18.2017	1.42 (2.39)	5.42 (5.65)	0.08 (0.29)	0.83 (2.29)	0.17 (0.58)			2.50 (3.26)
Oct.18.2017	0.33 (0.65)	1.17 (1.19)		0.25 (0.62)				0.08 (0.29)
Nov.2.2017	3.92 (6.11)	1.33 (2.02)		0.83 (1.99)	0.08 (0.29)	0.17 (0.39)		
Nov.17.2017	0.36 (0.81)	2.91 (2.39)						
Dec.5.2017	44.91 (57.93)	0.55 (0.82)		0.55 (1.51)	0.18 (0.40)	0.18 (0.60)		
Jan.15.2018	0.09 (0.30)	4.55 (11.82)		0.09 (0.30)		0.18 (0.40)		5.55 (17.74)
Feb.13.2018	0.08 (0.29)	1.58 (1.98)				0.08 (0.29)	0.25 (0.62)	9.92 (19.76)
Mar.19.2018	0.17 (0.39)	1.25 (2.05)		0.75 (2.60)	0.17 (0.58)		0.08 (0.29)	10.33 (3.08)
Apr.5.2018	4.25 (9.61)	2.08 (2.02)		11.25 (35.33)			0.17 (0.58)	10.67 (8.44)
Apr.19.2018	7.33 (6.85)	3.08 (3.78)		2.75 (5.21)	2.00 (3.16)		0.29 (0.75)	24.92 (7.74)
May.10.2018	1.92 (2.27)	3.17 (3.13)		0.83 (1.19)	0.25 (0.87)		0.08 (0.29)	14.50 (4.01)
Black Guillemot								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017		0.58 (0.90)						3.17 (2.92)
Jun.14.2017		0.33 (1.15)		0.25 (0.45)				0.08 (0.29)
Jul.14.2017	1.88 (3.58)	4.19 (3.49)	0.06 (0.25)	0.50 (0.97)				0.06 (0.25)
Aug.22.2017				0.06 (0.25)				
Nov.2.2017	0.25 (0.87)							
Dec.5.2017					0.09 (0.30)			
May.10.2018	0.08 (0.29)	2.17 (3.13)		0.25 (0.87)				0.25 (0.87)
Black Scoter								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	1.42 (4.91)							
Jun.14.2017		0.08 (0.29)						
Jul.14.2017		0.19 (0.54)	0.06 (0.25)					
Aug.22.2017		0.13 (0.50)						
Sep.18.2017		0.17 (0.58)						
Nov.2.2017	0.08 (0.29)	0.42 (1.44)		0.50 (1.73)				
Nov.17.2017	0.18 (0.60)							

Table 4. Average abundance of seabirds and water-associated birds (number per 30-minutes) at the FORCE Tidal Energy Demonstration Site, Black Rock, Nova Scotia, 2017-2018. Number in brackets is standard deviation.

Dec.5.2017	40.09 (52.33)							
Apr.5.2018	1.25 (4.33)			0.91 (3.02)				
Apr.19.2018	2.50 (5.84)			1.50 (5.20)				
May.10.2018		0.08 (0.29)						
Common Loon								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	0.08 (0.29)	0.08 (0.29)						
Aug.22.2017		0.44 (0.63)						
Sep.18.2017	0.08 (0.29)	0.08 (0.29)			0.08 (0.29)			
Nov.2.2017		0.08 (0.29)						
Dec.5.2017	0.09 (0.30)							
Apr.5.2018	2.50 (8.66)							
Common Eider								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	0.33 (1.15)	0.17 (0.58)						0.33 (0.65)
Jun.14.2017		5.25 (10.23)		3.67 (6.85)				10.25 (11.30)
Jul.14.2017	0.44 (1.31)	0.50 (1.21)						0.31 (0.79)
Aug.22.2017		0.13 (0.34)		0.13 (0.50)				
Sep.18.2017	0.67 (2.31)	0.92 (2.15)						
Oct.18.2017		0.33 (0.49)						
Nov.2.2017		0.08 (0.29)						
Dec.5.2017		0.09 (0.30)		0.18 (0.60)				
Apr.5.2018				10.25 (32.49)				0.17 (0.39)
Apr.19.2018	1.17 (3.01)	1.50 (2.32)						4.58 (2.43)
May.10.2018								0.83 (0.39)
American Black Duck								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
Sep.18.2017	0.08 (0.29)							
Nov.2.2017				0.08 (0.29)				
Dec.5.2017	0.09 (0.30)							
Jan.15.2018		0.09 (0.30)						
Mar.19.2018		0.08 (0.29)						
Apr.5.2018		0.08 (0.29)						
April.19.2018		0.17 (0.58)						

Table 4. Average abundance of seabirds and water-associated birds (number per 30-minutes) at the FORCE Tidal Energy Demonstration Site, Black Rock, Nova Scotia, 2017-2018. Number in brackets is standard deviation.

White-winged Scoter								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	0.33 (1.15)							
Oct.18.2017		0.08 (0.29)						
Dec.5.2017				0.27 (0.90)				
Surf Scoter								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
Jul.14.2017					0.13 (0.50)			
Dec15.2017	2.00 (6.63)			0.09 (0.30)				
Apr.19.2018				0.08 (0.29)				
Red-throated Loon								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	0.67 (1.23)			0.08 (0.29)	0.17 (0.39)	0.33 (0.78)	0.08 (0.29)	
Sep.18.2017	0.08 (0.29)							
Nov.2.2017	0.50 (0.52)							
Nov.17.2017		0.09 (0.30)						
Dec.5.2017	1.64 (5.10)	0.27 (0.65)						
Jan.15.2018	0.09 (0.30)							
Feb.13.2018		0.25 (0.45)						
Mar.19.2018		0.08 (0.29)						
Apr.19.2018	2.92 (4.19)	1.17 (2.21)		0.25 (0.62)	0.50 (1.17)			
May.10.2018	0.92 (1.51)			0.25 (0.87)				
Red-breasted Merganser								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
Apr.5.2018	0.08 (0.29)							
Ring-billed Gull								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
Jun.14.2017				0.08 (0.29)				
Aug.22.2017	1.19 (1.76)	0.38 (0.62)		0.19 (0.75)	0.06 (0.25)	0.38 (1.26)		
Sep.18.2017		0.08 (0.29)						
Oct.18.2017	0.17 (0.39)			0.08 (0.29)				
Nov.2.2017	0.75 (1.06)	0.17 (0.39)		0.17 (0.39)				
Nov.17.2017		0.91 (1.51)						
Dec.5.2017	0.18 (0.60)				0.09 (0.30)			
Jan.15.2018		3.64 (12.06)						1.82 (6.03)

Table 4. Average abundance of seabirds and water-associated birds (number per 30-minutes) at the FORCE Tidal Energy Demonstration Site, Black Rock, Nova Scotia, 2017-2018. Number in brackets is standard deviation.

Mar.19.2018	0.08 (0.29)							
Apr.5.2018	0.08 (0.29)	0.08 (0.29)						
Apr.19.2018	0.25 (0.87)	0.08 (0.29)		0.50 (0.90)	0.33 (1.15)			
May.10.2018							0.08 (0.29)	
Double-crested Cormorant								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	0.17 (0.39)				0.17 (0.58)		0.17 (0.58)	6.08 (7.30)
Jun.14.2017	0.08 (0.29)	0.08 (0.29)					0.08 (0.29)	3.75 (1.91)
Jul.14.2017	0.13 (0.34)	0.75 (1.00)		0.06 (0.25)				1.25 (1.13)
Aug.22.2017		0.75 (1.29)						2.50 (3.25)
Sep.18.1017		0.83 (0.83)		0.42 (1.16)				1.00 (1.13)
Oct.18.2017		0.08 (0.29)		0.08 (0.29)				0.08 (0.29)
Nov.2.2017		0.08 (0.29)						
Apr.19.2018		0.08 (0.29)						1.42 (0.51)
May.10.2018	0.08 (0.29)							0.08 (0.29)
Great Cormorant								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	0.08 (0.29)							2.25 (1.86)
Jun.14.2017								0.17 (0.39)
Jul.14.2017				0.06 (0.25)				0.06 (0.25)
Aug.22.2017		0.13 (0.34)						2.25 (3.26)
Sep.18.2017		0.17 (0.39)						1.58 (2.35)
Apr.5.2018								1.25 (2.30)
Apr.19.2018								2.42 (1.08)
May.10.2018		0.08 (0.29)		0.08 (0.29)				0.33 (0.65)
Great Black-backed Gull								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	0.08 (0.29)	0.17 (0.58)		0.08 (0.29)				10.92 (2.71)
Jun.14.2017		0.67 (2.02)		0.17 (0.39)	0.08 (0.29)	0.17 (0.39)		7.75 (3.91)
Jul.14.2017	0.19 (0.75)	1.00 (2.00)		0.06 (0.25)				1.69 (2.36)
Aug.22.2017		0.06 (0.25)						
Sep.18.2017		0.08 (0.29)						
Nov.2.2017	0.08 (0.29)							
Jan.15.2018								0.18 (0.60)
Feb.13.2018		0.17 (0.39)						9.00 (17.61)

Table 4. Average abundance of seabirds and water-associated birds (number per 30-minutes) at the FORCE Tidal Energy Demonstration Site, Black Rock, Nova Scotia, 2017-2018. Number in brackets is standard deviation.

Mar.19.2018		0.58 (1.16)		0.64 (2.11)				9.58 (2.54)
Apr.5.2018	0.17 (0.58)	1.08 (1.78)		0.08 (0.29)			0.08 (0.29)	8.17 (4.65)
Apr.19.2018		0.08 (0.29)		0.25 (0.62)				13.17 (4.43)
May.10.2018	0.42 (0.67)	0.50 (1.00)		0.17 (0.58)	0.17 (0.58)			10.25 (2.38)
Herring Gull								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
May.17.2017	0.67 (1.44)	0.58 (1.73)		0.67 (1.50)	1.50 (4.34)	0.33 (0.78)	0.58 (2.02)	12.42 (7.84)
Jun.14.2017		0.08 (0.29)		0.08 (0.29)	0.92 (2.87)	0.25 (0.87)	0.08 (0.29)	2.83 (1.64)
Jul.14.2017	0.44 (0.63)	4.00 (9.97)		0.50 (0.89)	0.13 (0.34)	0.19 (0.54)	0.25 (1.00)	6.50 (10.89)
Aug.22.2017	0.38 (0.72)	0.88 (1.41)		0.19 (0.54)				0.31 (0.48)
Sep.18.2017	0.42 (0.67)	2.25 (3.47)	0.08 (0.29)	0.33 (0.89)				
Oct.18.2017	0.17 (0.58)	0.67 (0.78)		0.08 (0.29)				
Nov.2.2017	0.42 (0.67)	0.42 (0.90)		0.08 (0.29)	0.08 (0.29)	0.17 (0.39)		
Nov.17.2017		1.64 (2.16)						
Dec.5.2017						0.18 (0.60)		
Jan.15.2018		0.82 (1.25)				0.18 (0.40)		3.27 (10.85)
Feb.13.2018	0.08 (0.29)	0.42 (1.16)				0.08 (0.29)	0.25 (0.62)	0.67 (1.78)
Mar.19.2018	0.08 (0.29)	0.50 (1.00)		0.17 (0.58)	0.17 (0.58)		0.08 (0.29)	0.75 (0.97)
Apr.5.2018	0.08 (0.29)	0.67 (0.98)		0.08 (0.29)			0.08 (0.29)	0.75 (1.76)
Apr.19.2018	0.25 (0.62)			0.08 (0.29)	0.33 (1.15)		0.17 (0.58)	3.33 (1.72)
May.10.2018	0.25 (0.45)	0.42 (0.79)		0.08 (0.29)	0.08 (0.29)			2.75 (1.76)
Long-tailed Duck								
SUBAREA	CL	IB1	IB2	OB1	OB2	OB3	FF	BR
Dec.5.2017		0.18 (0.60)						

Greatest abundances on Black Rock occurred during the spring (April to early June), and peaked on May 17th 2017, at 35 birds per half-hour with six species occurring, dominated in numbers by Herring Gull and Great-black Backed Gull (Figure 8). Both Great Black-backed Gull and Herring Gull were also typically dominant during the spring surveys with lesser numbers of Double Crested Cormorant, Great Cormorant, Black Guillemot, and Common Eider (Figure 8). Black Guillemot were observed in small numbers during the May surveys, with at least four pairs observed, nesting on Black Rock. Great Black-backed Gull were also relatively abundant during late winter (February), when Black Rock is used as a roosting and feeding location for other species. No birds were observed on Black Rock during the three fall surveys (November – December, 2017). Less frequent or single observations of Iceland Gull, Ring-billed Gull, and Lesser Black-backed Gull on Black Rock occurred later during the winter and early spring. Single occurrences of two shorebirds, Semipalmated Sandpiper and Least Sandpiper, were recorded on Black Rock during the August 22, 2017 survey, coinciding with the expected southerly shorebird migration through the area (Table 3; Figure 8).

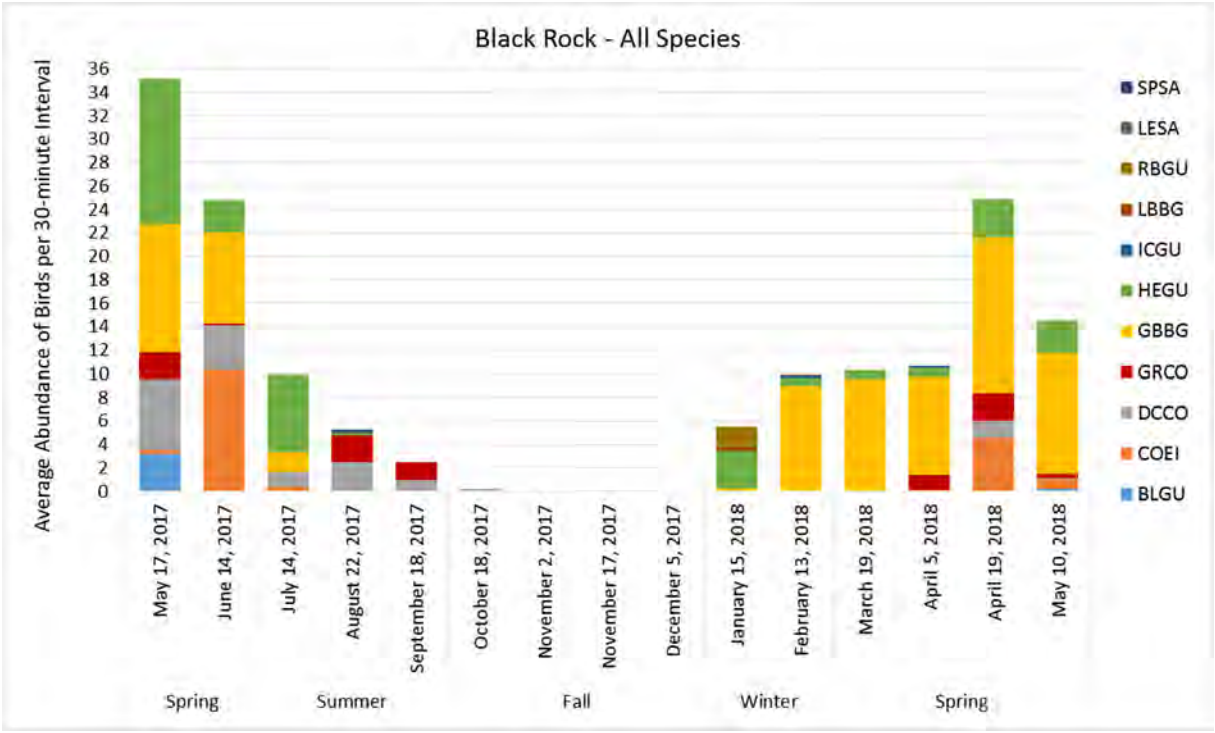

Figure 8. Average abundance of bird species per 30-minute interval in subarea BR (Black Rock).

Individual or multiple sightings of several bird species, which are not aquatic but may be associated with coastal areas, were observed landing on or flying over Black Rock, including Common Raven, American Crow and various songbirds.

3.1.3.1.2 Abundance in Open Water Areas

Birds occupied most of the open water subareas of the study site from time to time and about half of the total sightings in the study occurred in these areas (Figure 9). Highest average number of birds overall were observed in open water subareas IB1, OB1, and CL. Flocks of scoters and other migratory species, such as Red-throated Loon, also travel through these sub areas *en route* to West Bay and Minas

Basin, as well as to Outer Bay of Fundy locations. Some birds seen in IB1 were flying along the shore or occupying the water adjacent to shore. Black Rock is positioned in the middle of areas IB1 and OB1 and the numbers in these areas in part reflect birds landing on or flying from Black Rock.

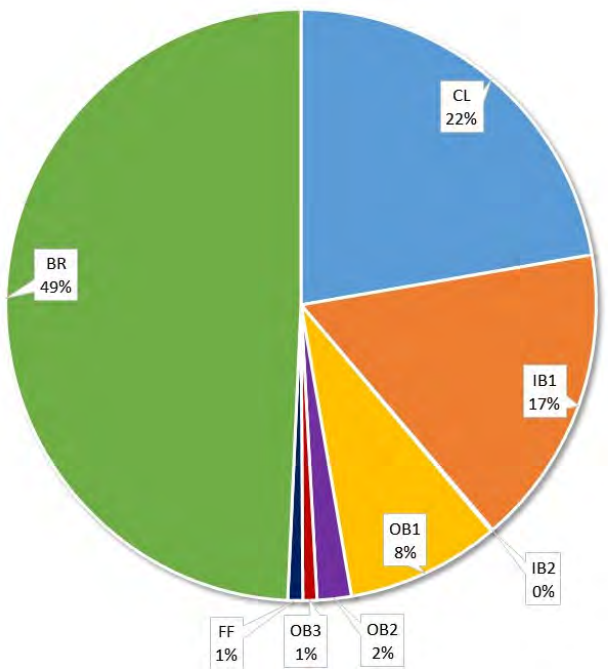

Figure 9. Proportion of seabird sightings by subarea for Year-2 of the FORCE shore-based seabird survey. FORCE Visitor Center, Parrsboro, Nova Scotia. (May 2017 – May 2018). Total includes birds flying or on the water; and sitting on or in the water immediately adjacent to Black Rock (BR).

Abundance of birds in the CL ("Crown Lease") area was highest of all open water subareas, with peak abundances occurring through the spring and into early fall, reflecting the occurrence of spring and fall migrant species including Red-throated Loon and scoters (Figures 10 and 11). Rafts of Black Scoters were observed on December 5th 2017 moving east through CL. Low numbers of birds and few species were observed here during the winter and early spring surveys (January 15th, February 13th, and March 19th 2018). The reason for the 'concentration' of birds in the CL area is not known. However the location of parts of CL immediately 'downstream' in the tidal currents passing Black Rock, and a tendency of birds on the water to drift with the current, before flying upstream to maintain an overall position relative to Black Rock, may be influencing the preference of birds for CL.

IB1 also supported large numbers of birds during spring and fall migration, but peak abundances were observed in late spring and summer, coinciding with the presence of seasonal residents and breeders including Common Eider and Black Guillemot, the latter of which nest on Black Rock and use the adjacent waters for feeding and fly-through *en route* to the nest sites (Figures 12 to 14, A3 and A4). Abundance and occurrence of species in OB1 was similarly highest during the spring surveys and included nesting and seasonal species as well as year-round gull species and cormorants (Figures 12 to 14, A6 and A7).

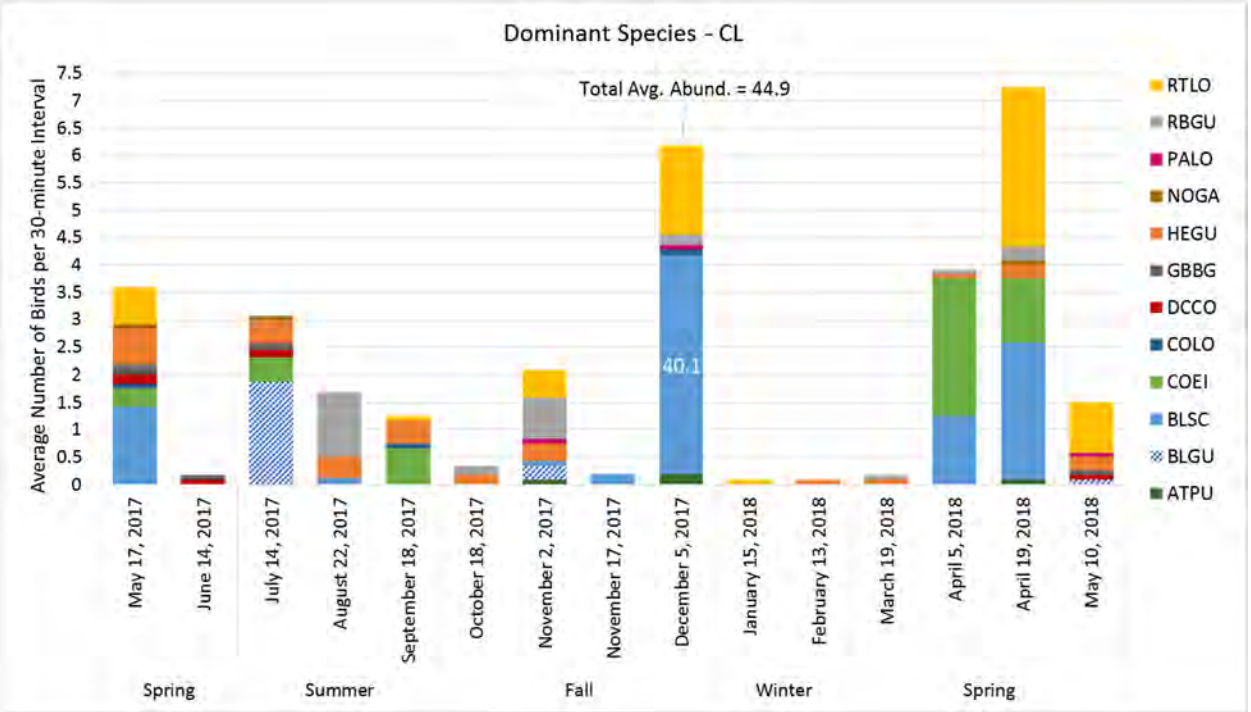

Figure 10. Average abundance of dominant birds per 30-minute interval in subarea CL.

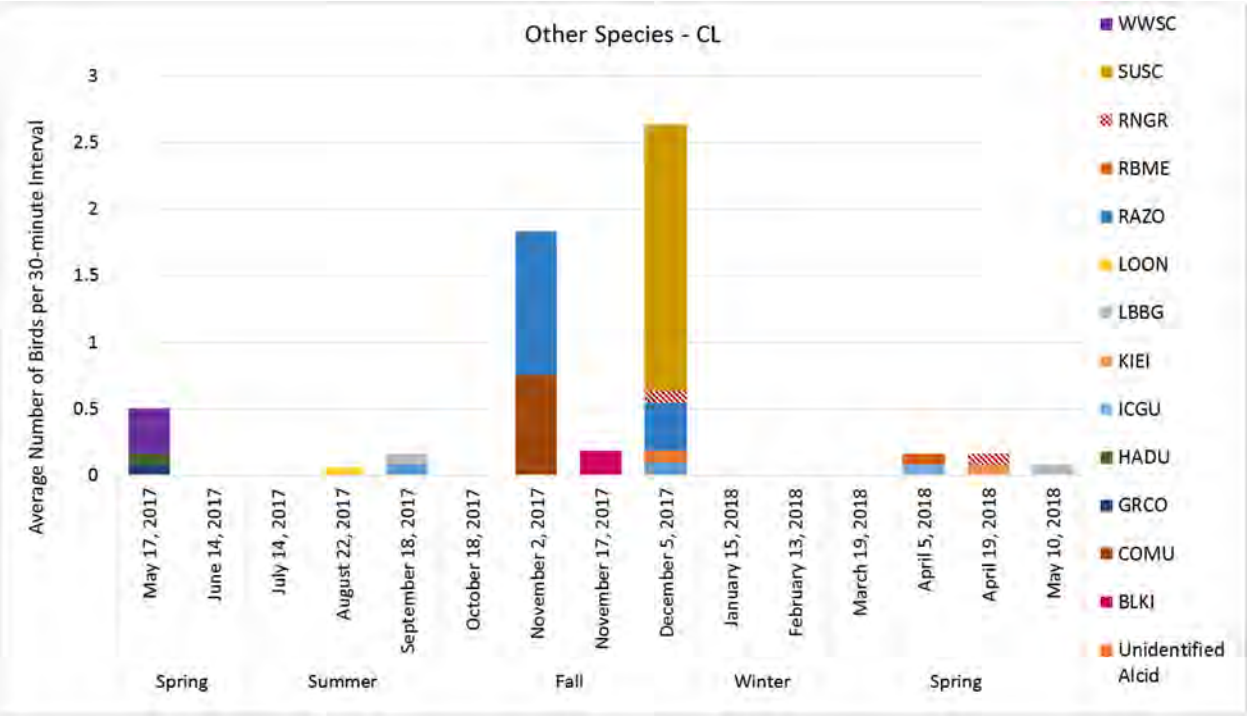

Figure 11. Average abundance of non-dominant birds per 30-minute interval in subarea CL.

The “Farfield” (FF) sites FF1, FF2 & FF3 supported lower frequencies of occurrence and lowest abundance of birds compared to IB1, OB1 and CL (Figures 12 to 14, A10). Birds were observed at the FF sites in late winter, spring, and early summer, and included both a resident gull species (Herring Gull), resident Double-crested Cormorant, and seasonal species including Ring-billed Gull, Red-throated Loon, and Northern Gannet. Lower numbers in the Farfield subareas compared with other subareas are consistent with the 2016-2017 (Year-1) survey and provide further support to suggest that the inner parts of the study area such as IB1, CL and the OB1 to OB3 sites are more attractive to birds than the distant sites. We don’t think that this observation is due to ‘distance effects’ (i.e. that some observations in the furthest sites will be missed, due to increasing difficulty in accounting for all birds with distance from the observation site)(Buckland et al 2001; Gjerdrum et. al. 2012) as our view of the area and the observation equipment is more than adequate for locating birds beyond the CL site. There are other reasons for bird abundance to be higher closer to shore, such as the complexity and availability of different habitats in the local environment including Black Rock, the comparative shelter of waters at the site, the proximity to Cape Sharp (a coastal feature which may attract seabirds), a coastal marsh, a sand spit system, and nearby shoreline and tidal flats; however these possibilities were not assessed.

The IB2 site, situated west along the coast from Black Rock, and the OB (“Outside Black Rock”) sites, OB2 and OB3, usually supported lower numbers and types of birds than IB1, OB1 and CL, consistent with Year-1 results (Figures 12 to 14, A8). Herring Gull, Black Scoter and Black Guillemot were the only three species observed in IB2 over two surveys out of 15 (July 14, 2017 (Black Guillemot; Black Scoter);

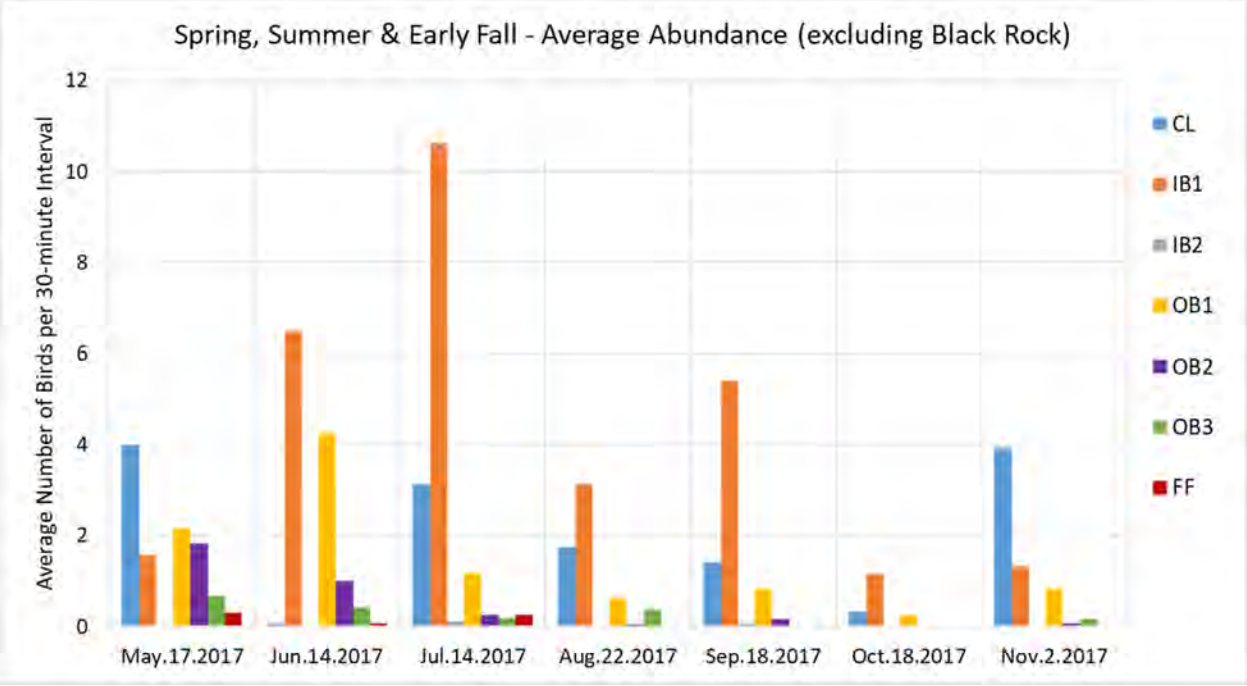

Figure 12. Utilization by seabirds of sub-areas of the FORCE site in spring, summer and early fall.

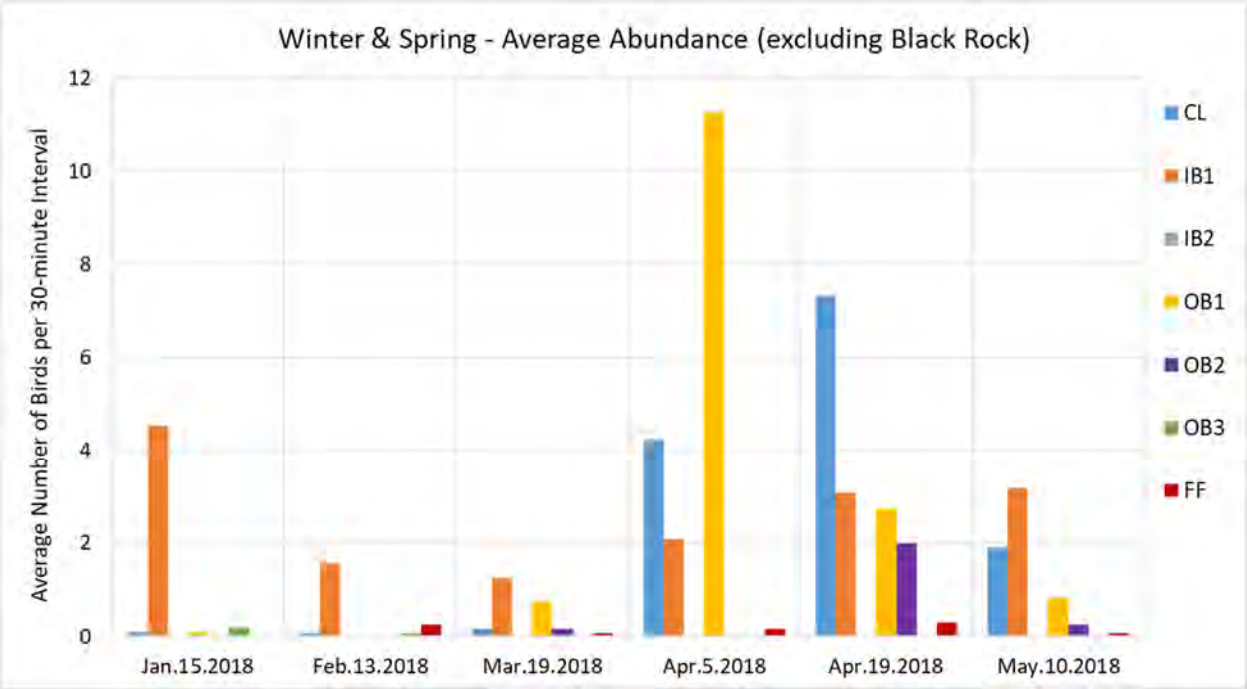

Figure 13. Utilization by seabirds of sub-areas of the FORCE site in winter and spring.

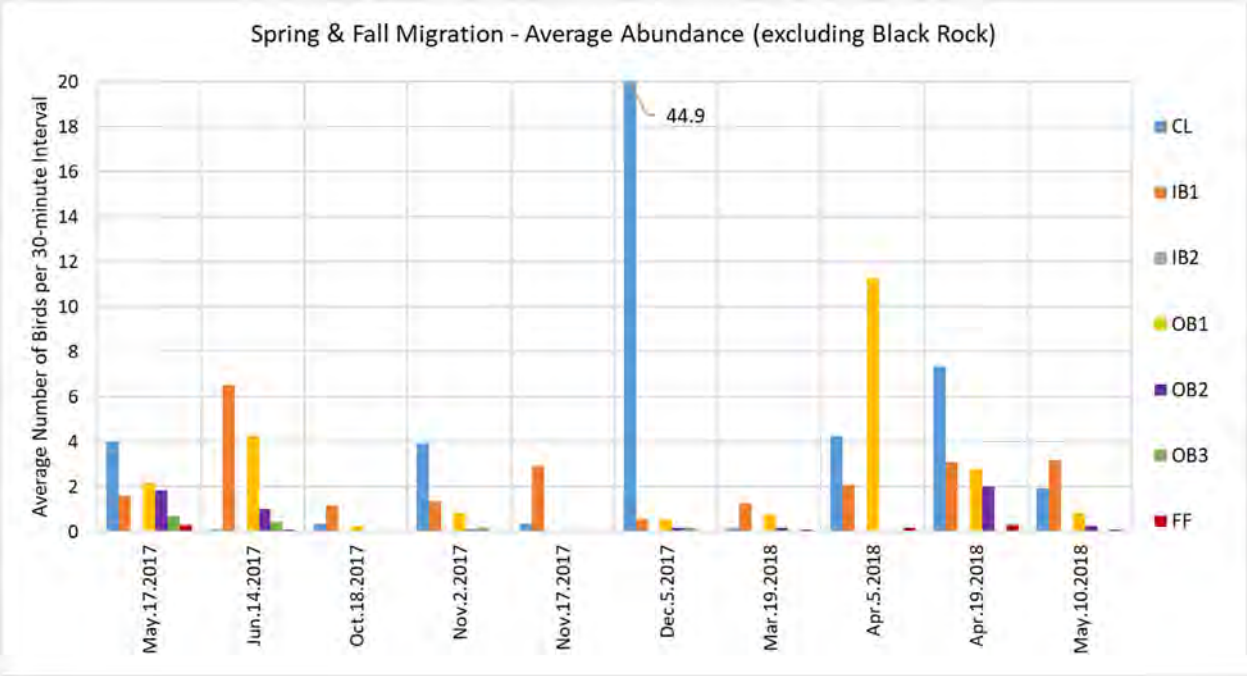

Figure 14. Utilization by seabirds of sub-areas of the FORCE site in migration periods.

September 18, 2017 (Herring Gull)). Occasional sightings of gull species and a single occurrence of Red-throated Loon were made in the OB3 subarea (which is near the CL site and is also close to Black Rock) in eight of the 15 surveys. OB1 had the highest number of birds on the June 14, 2017 survey (Black Guillemot, Common Eider, Herring Gull, Great Black-backed Gull, and Ring-billed Gull), which were all also seen in the adjacent subareas around Black Rock and the CL area, and including OB3 (Figures 12 to 14, A9).

3.1.4 Species Composition Based on Seasonality

3.1.4.1 Dominant Species

Dominant bird species [5] included Black Scoter, Black Guillemot, Common Eider, Red-throated Loon, American Black Duck, Double-crested Cormorant and Great Cormorant, Herring Gull, Ring-billed Gull, and Great Black-backed Gull (Figures 15 and 16). Both cormorant species, Black Guillemot, Common Eider, American Black Duck and the three dominant gull species are common residents and breeders in Atlantic Canada and the Bay of Fundy. Black Scoter and Red-throated Loon are migratory species which pass through the Bay of Fundy at certain times of year, although individuals can often be found year-round.

Common Eider – Common Eider is a sea duck which breeds on islands and shorelines of the Bay of Fundy. The species feeds in shallow water and occasionally deeper to reach shellfish and other aquatic organisms. Common Eider was observed on consecutive surveys during the breeding season and into the fall (May 17 – November 2, 2017). It was sighted once during the winter (December 5, 2017) and again on consecutive surveys the following spring (April 5 – May 10, 2018) (Figure 14). Overall, densities were low with small numbers including both males and females, observed on the water in IB1, close to and on Black Rock or near shore. Average abundance was highest on June 14th 2017 (19.2 birds per 30-minute interval) and lowest on November 2nd 2017 (0.1 birds per 30-minute interval) (Figure 16).

American Black Duck – American Black Duck is a common duck species in the Atlantic Region, found in a range of habitats including freshwater lakes, ponds and marshes, as well as bays and estuaries. The species is present year-round in Nova Scotia, often found in large concentrations in marine coastal areas including the Bay of Fundy in winter. The species feeds on aquatic plants, seeds, insects and other aquatic invertebrates. Single sightings, and one pair, were observed during seven surveys intermittently between late summer 2017 and spring 2018 (Figures 15 and 16, Table 4). Birds were typically sighted while flying through IB1, and occasionally in subareas outside Black Rock.

[5] Dominant species are defined as those which were observed on at least 7 of the 15 surveys.

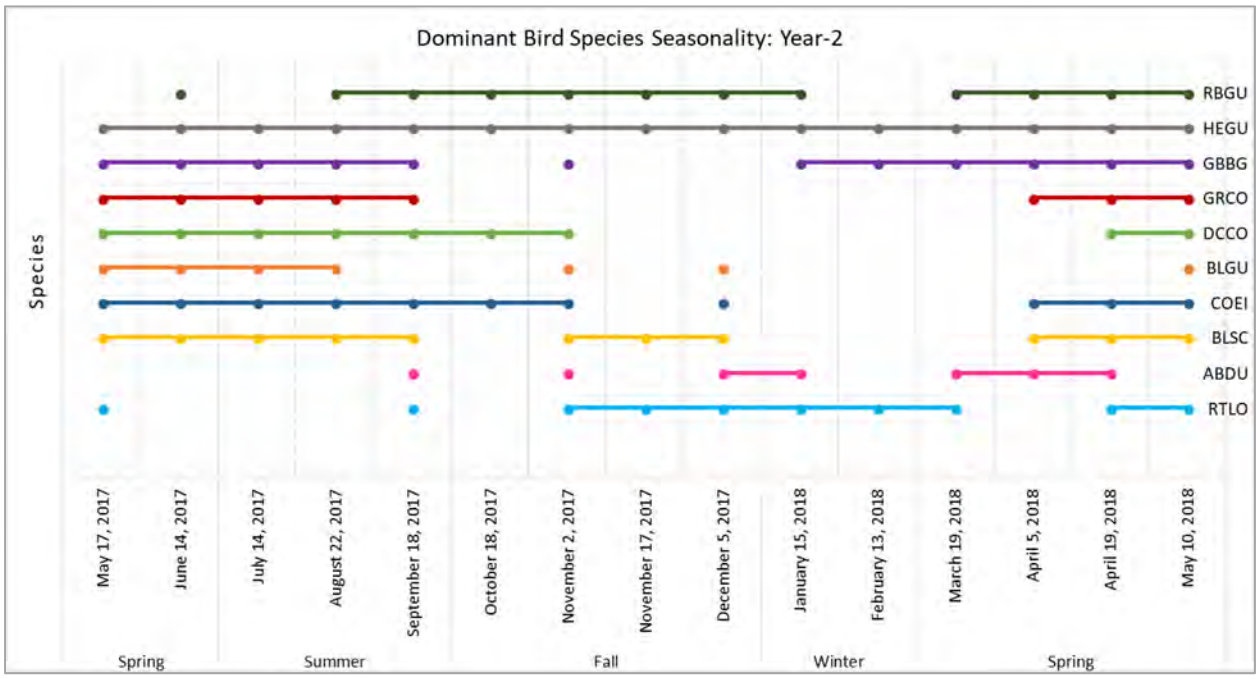

Figure 15. Seasonal occurrence of dominant bird species based on season for Year-2 (15 surveys) of FORCE shore-based seabird survey. FORCE Visitor Center, Parrsboro, Nova Scotia. (May 2017 – May 2018).

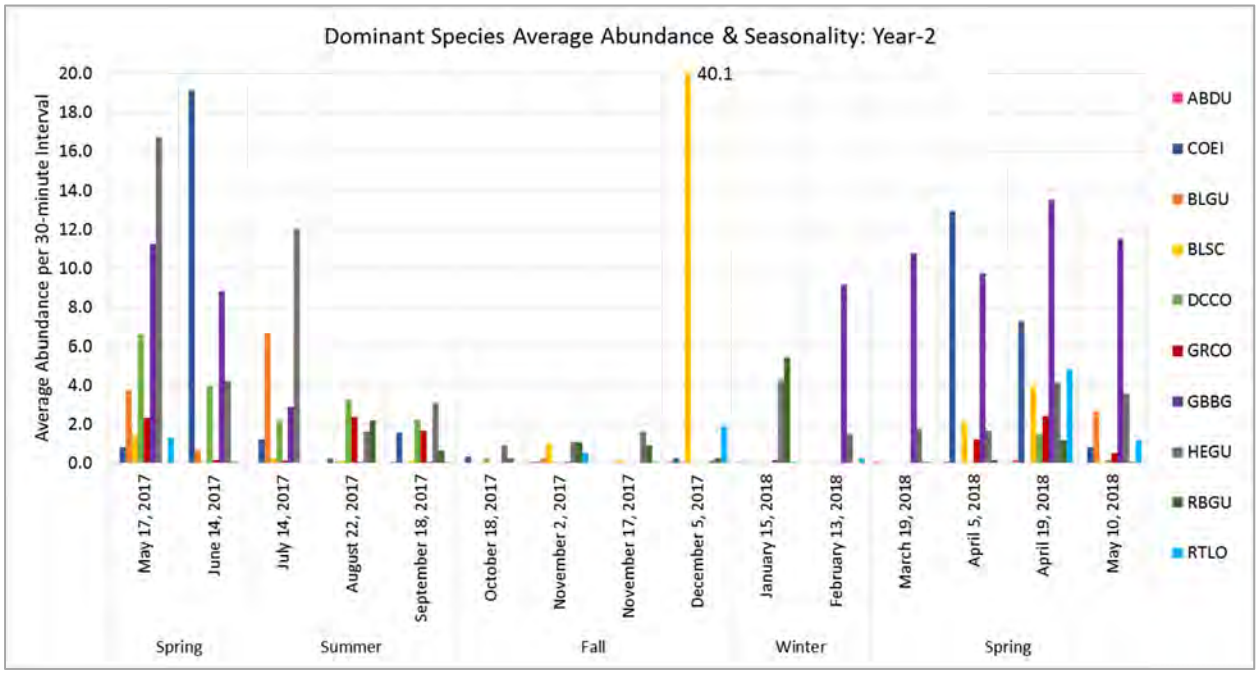

Figure 16. Average abundance and seasonal occurrence of dominant bird species for Year-2 (15 surveys) of FORCE shore-based seabird survey. FORCE Visitor Center, Parrsboro, Nova Scotia. (May 2017 – May 2018).

Double-crested Cormorant and Great Cormorant –Double-crested and Great Cormorant are colonial resident species in the area, nesting and breeding in the inner Bay of Fundy and migrating through the study site during spring and fall, but also found at other times of year. Cormorants feed primarily on fish which they catch through diving. Great Cormorant is the least abundant of the two, diving deeper and feeding farther offshore than Double-crested Cormorant.

Both species were observed throughout the year, commonly seen on Black Rock, with Double-crested Cormorant more abundant and more frequently seen. Both species occurred in spring, summer, and fall, although neither was sighted during the late fall, winter and early spring (November 17, 2017 to March 19, 2018) (Figure 15). In contrast, in the Year-1 survey, both species were seen through the winter. Abundances were relatively low for both species, with peak abundance for Double-crested Cormorant on May 17th (6.6 birds per 30-minute interval); and peak abundance for Great Cormorant occurring on May 17th, August 22nd 2017, and April 19th 2018 (2.3, 2.4, and 2.4 birds per 30-minutes, respectively) (Figure 16).

Red-throated Loon – Red-throated Loon was observed consistently during the fall and early spring (November 2, 2017 to March 19, 2018) and occasionally in the later spring and summer.. Birds were predominantly flying through CL and in subareas outside Black Rock but occasionally on the water feeding or drifting in the tidal current (May 17, September 18, 2017; April 19, May 10, 2018) (Figure 15). Peak abundance occurred during the spring migration on April 19th 2018 survey (4.8 birds per 30-minutes), consistent Year-1 when large flocks of Red-throated Loon were observed in mid-April at slightly higher densities of 15 birds per 30-minutes (Envirosphere Consultants Limited 2017).

Black Scoter – Black Scoter are large sea ducks which feed by diving in shallow water for shellfish and other bottom-dwelling organisms. The species is a regular Atlantic coastal migrant, passing through the Bay of Fundy in spring and fall, commonly accompanied by Surf Scoters and White-winged Scoters, with individuals also seen occasionally throughout the year. Black Scoter were observed on consecutive surveys, typically in large flocks, during the fall and spring migration (Figures 15 and 16) as well as through the summer. Peak abundance of Black Scoter occurred on December 5th 2017, with an average of over 40 birds per 30-minute interval, including a flock of approximately 150 birds. Average abundances observed during all other surveys ranged between 0.1 and 4.0 birds per 30-minute interval (Figure 16). Black Scoter were typically seen flying east into West Bay, or on the water drifting with the tidal current.

Black Guillemot – Black Guillemot is a resident alcid species and breeder in the inner Bay of Fundy, and occurred regularly at the site during the breeding season and occasionally at other times of year. The species nests on Black Rock and breeding pairs were observed around and on the island during spring and summer 2017 and spring 2018, as well as during two fall surveys (November 2nd and December 5th 2017). Birds could be seen moving between nests in rock crevices and the water, diving and feeding. Between one and four pairs of birds were documented during spring and summer 2017 surveys, consistent with 2016 surveys at the same time of year (Figures 15 and 16).

3.1.4.2 Gulls (Laridae)

Herring Gull and Great Black-backed Gull are common, annual breeders, nesting on islands and sea cliffs year-round in the Bay of Fundy. Herring Gull were observed year-round, during all surveys; and Great Black-backed Gull occurred on all but three surveys late in the year (October 18th, November 17th, and December 5th 2017). Ring-billed Gull was also present for all but three surveys (May 17th, July 14th 2017, and February 13th 2018) but in lower abundance compared with Herring Gull and Great Black-backed Gull. Other gulls—Iceland Gull, Lesser Black-backed Gull, and Black-legged Kittiwake (the latter a single occurrence on November 17, 2017)—also occurred at the site, but less frequently and in low abundance. Gulls in coastal areas feed mainly by scavenging along shores and at the water surface, and preying on juveniles of other bird species.

Herring Gull – Herring Gull was the most common gull, observed during all surveys, often seen on Black Rock, flying in and out of the study area, and circling above the water searching for food. Abundance was consistent throughout the year (Figure 15), with highs of on May 17th 2017 (16.8 birds per 30-minutes), and July 14th 2017 (12.0 birds per 30-minutes) (Table 4, Figure 16).

Great Black-backed Gull – Great Black-backed Gull occurred on 12 surveys (80%)(Figure 6), usually seen on Black Rock, but also flying through and circling above searching for food in all subareas. This species nested on Black Rock this year, as in Year-1, evidenced by the presence of downy young. Abundance of Great Black-backed Gull was highest in spring (March – June) ranging from 8.8 (June 14th 2017) to 13.5 (April 19th 2018) sightings per 30-minute period. Abundances were lowest during late summer and into winter, when the species was also less frequently observed. Average abundances were lowest—less than 0.1 birds per 30-minute interval—during August, September and November surveys (Table 4, Figure 16).

Ring-Billed Gull – Ring-Billed Gull is a common annual late summer migrant and occasional summer resident of the area but individuals can frequently be found year-round. The species breeds near fresh surface waters in inland areas of central North America including the Great Lakes region, and moves to Atlantic coastal areas post-breeding in late summer. Ring-billed Gulls were observed in low abundance on all but three surveys (80%)(Figure 6), predominantly summer, through fall and winter and into the spring surveys, generally seen flying through subareas OB1, IB1 and CL. Highest abundance was observed on January 15th 2018 (5.5 birds per 30-minute interval) (Table 4, Figure 16).

Iceland Gull – Iceland Gull overwinters in Nova Scotian coastal areas, including the Bay of Fundy. Low numbers were observed on three surveys (February 13th, April 5th and April 19th). On the first two surveys, four birds were seen, either on Black Rock or flying in IB1, while a single bird was sighted on April 19th 2018 in OB1 (Table 4, Figure 17).

Lesser Black-backed Gull – Lesser Black-backed Gull shares a similar habitat preference to Herring Gull, and was seen on four occasions (September 18th 2017, January 15th, February 13th and May 10th 2018) in subareas IB1, OB1, CL, and on Black Rock. Highest average abundance for Lesser Black-backed Gull occurred on January 15th 2018 (0.3 birds per 30-minute interval) (Table 4, Figure 17).

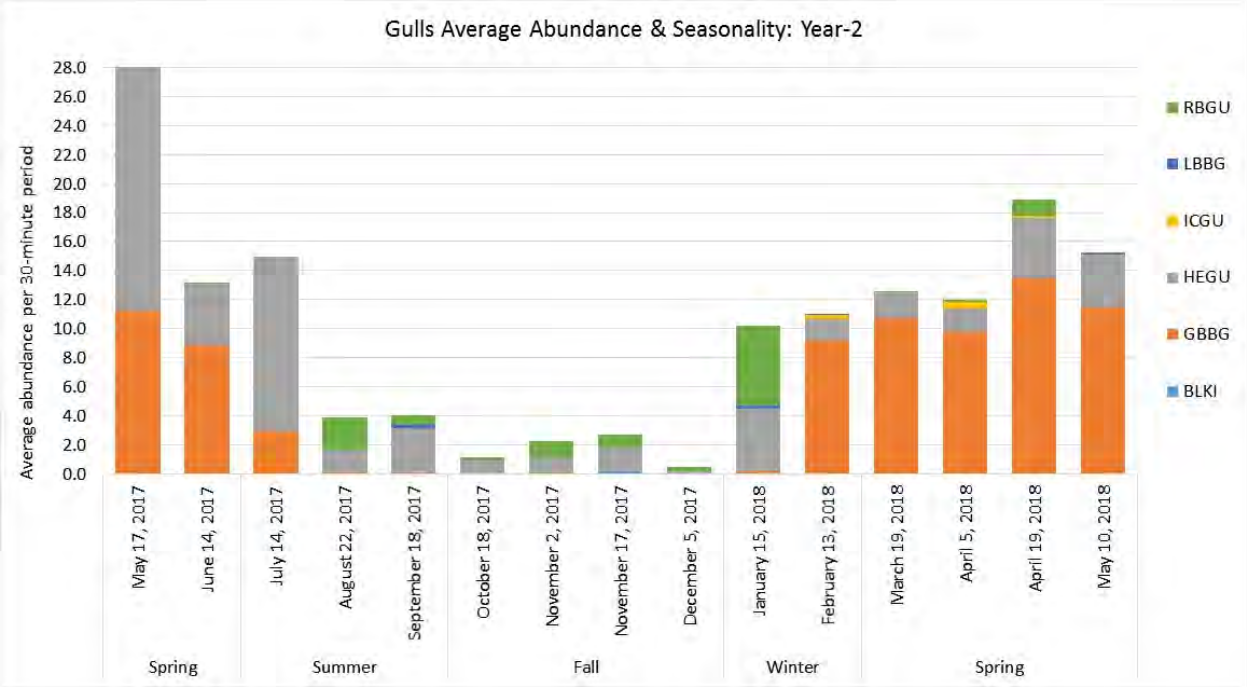

Figure 17. Average abundance and seasonal presence of gull species for Year-2 (15 surveys) of FORCE shore-based seabird survey. FORCE Visitor Center, Parrsboro, Nova Scotia. (May 2017 – May 2018).

3.1.4.3 Occasional Seabirds and Sea Ducks

Several seabirds and sea ducks were observed regularly during the survey, although at times less frequently, and generally in lower abundance than dominant species. These included alcid species (Atlantic Puffin, Common Murre, and Razorbill); sea ducks including Long-tailed Duck, Harlequin Duck, Surf Scoter and White-winged Scoter; as well as Northern Gannet.

Alcids – Alcids (Family Alcidae) are stocky, diving- and predominantly-fish-eating birds, which nest in colonies on cliffs and islands in cold northern waters, including the Bay of Fundy for some species. Individual Atlantic Puffin were observed flying through CL during three surveys (November 2nd, December 5th 2017, and April 19th 2018) (Figure 18). The species is commonly seen in coastal waters year-round although occurrence in the study area is low due to the absence of breeding colonies in the inner Bay of Fundy. Summer distribution is along the Canadian East Coast and Greenland where it nests in colonies along the coast.

A group of four Common Murre were observed on November 2nd 2017 flying west through the CL subarea. The species nests on coastal cliffs and ledges of eastern Canada from Newfoundland to the eastern Arctic and Greenland and disperses along the Canadian East Coast post-breeding.

Razorbill were observed three times (November 2nd and 17th, and December 5th 2017) (Figure 18), with a group of 13 birds seen flying through the CL subarea on November 2nd, while one to three birds were seen during the other surveys. The species nests on rocky offshore islands and disperses to coastal waters in eastern Canada and the northeastern U.S. Occurrences in our study of Razorbill and Atlantic Puffin are consistent with use of the outer Bay of Fundy, Gulf of Maine and offshore areas by

overwintering birds from East Coast colonies and for other alcids from winter offshore dispersal from coastal and generally more northerly nesting areas.

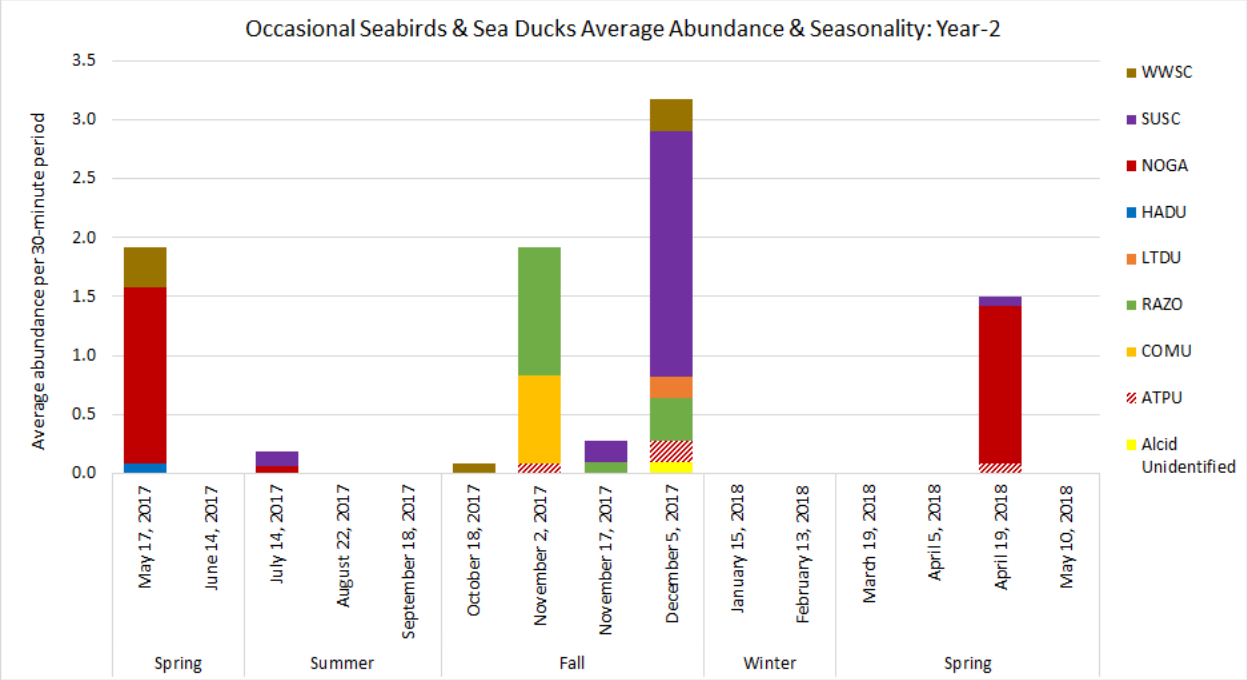

Figure 18. Average abundance and seasonal presence of occasional seabird and sea duck species for Year-2 (15 surveys) of FORCE shore-based seabird survey. FORCE Visitor Center, Parrsboro, Nova Scotia. (May 2017 – May 2018).

Long-tailed Duck – A single male and female pair of Long-tailed Duck was observed on December 5th 2017 moving through the IB1 subarea, consistent with the species use of the Atlantic coast for over-wintering. The low abundance and infrequent occurrence (Figure 18) contrasts with Year-1 when the species was observed in small and large flocks in fall and spring.

Harlequin Duck – Harlequin Duck is a rare winter resident occurring in the lower Bay of Fundy and along the eastern coast of Nova Scotia and overwinters in the inner Bay of Fundy, in particular the Hall's Harbour area (Kendall et al. 2018). Breeding occurs in more northerly coastal areas of Quebec and Labrador and northward. A single Harlequin Duck was observed moving east through the CL subarea on May 17th 2017 (Figure 18).

Northern Gannet—Northern Gannet were observed during two spring (May 17, 2017 and April 19, 2018) and one summer (July 14, 2017) surveys. Groups of more than a dozen birds, were observed during the spring surveys (average abundance of 1.5 (May 17, 2017) and 1.3 (April 19 2018) birds per 30-minutes), while a single bird was sighted in July (Figure 18). All individuals were moving through subareas including the CL and farfield subareas. This species normally migrates through the Eastern Canadian waters to colonies in the Gulf of St. Lawrence, but the Inner Bay of Fundy also support immatures and late migrants at other times.

Surf Scoter and White-winged Scoter – Surf Scoter and White-winged Scoter are large sea ducks, similar in biology and behaviour to Black Scoter (one of the dominant bird species at the site, discussed in Section

3.1.4.1). These species are regular migrants through Nova Scotian coastal waters including the Bay of Fundy in spring and fall, frequently migrating together, and individuals may occur casually year-round. Both Surf Scoter and White-winged Scoter were less common and abundant than Black Scoter at the FORCE site. White-winged Scoter was least abundant, observed on three occasions in spring and fall (May 17th, October 18th and December 5th 2017) corresponding with migratory movement of the species. Surf Scoters also occurred infrequently— observed on four surveys—but in higher abundance compared to White-winged Scoter (Figure 18). A flock of 22 birds was observed on December 5th 2017 moving through CL, and four or fewer birds were seen on July 14th, November 17th 2017, and April 19th 2018, generally in the vicinity of Black Rock (Figure 18). Observations of both Scoter species in the fall and spring correspond to migratory periods.

3.1.4.4 Other Waterfowl

In addition to species noted above, eight species – Pacific Loon and Common Loon, Red-necked Grebe and Horned Grebe, Red-breasted Merganser, Canada Goose, Common Goldeneye, and King Eider— occurred at the site, although in lower frequency and abundance.

Pacific and Common Loon – Pacific Loon occur across Canada, breeding in the northern and northwestern Canadian Arctic and wintering mainly on the Pacific coast, but occur occasionally on the East Coast, presumably after following other migrating species such as Red-throated Loon, which have overlapping breeding ranges. Single Pacific Loon were seen on three occasions, August 22nd November 2nd and December 5th 2017, each moving through the CL subarea (Figure 27).

Common Loon occur widely throughout eastern Canada as a year-round resident, occupying coastal areas in winter and inland lakes for the rest of the year for breeding. Occasionally, non-breeding individuals stay at sea year-round. Low numbers of common Loon were seen during the spring and fall in three surveys (May 17th, November 2nd and December 5th 2017), and late summer (two sightings on August 22nd and September 18th 2017), with one or two birds observed each time, mostly on the water and feeding in IB1 (Figure 27). The majority of Common Loons observed were second-year juveniles.

Red-necked Grebe and Horned Grebe –Red-necked Grebe occupy freshwater habitatw year-round, and coastal areas during winter. Individual Red-necked Grebe were observed in late fall and winter (December 5th 2017 and January 15th 2018), and again on April 19th 2018, moving westward through CL and OB1 subareas. Horned Grebe winter uncommonly along the Atlantic Canadian coast, but are considered a fairly common transient. A single Horned Grebe was observed flying west in IB1 on November 2nd 2017 (Figure 27). Grebes feed by diving for small fish and other aquatic organisms.

Red-breasted Merganser – Mergansers migrate regularly through the inner Bay of Fundy in spring and fall and Red-breasted Merganser can overwinter in the study area. They feed by diving for fish in shallow water. A single Red-Breasted Merganser was present during one spring survey (April 5th 2018) flying east through the CL subarea (Figure 27).

Canada Goose – Although more typically found in terrestrial and freshwater settings, Canada Goose can be found in marine coastal waters, saltmarshes and eelgrass beds feeding on grasses, seeds, aquatic plants and shellfish year-round in Nova Scotia. A single Canada Goose was heard along the shoreline (IB1) on September 18th 2017 but was not seen. The species has occurred more frequently and in

greater numbers in earlier surveys; in particular, flocks of 10 and 20 Canada Geese were observed during Year-1 spring surveys.

Common Goldeneye – Common Goldeneye is a duck species typically found in lakes and coastal bays and estuaries during winter, and forested lakes during the reminder of the year. It feeds by diving for aquatic plants and animals as well as marine invertebrates in shallow coastal areas. A group of four males was observed on a single occasion on February 13th 2018 near the shoreline of IB1 (Figure 19).

King Eider – King Eider are rare to uncommon along the Atlantic Canadian coast, where the species over-winters. A single sighting of a King Eider flying east through the CL subarea on April 19th 2018, coincided with the normal northward spring migration (Figure 19).

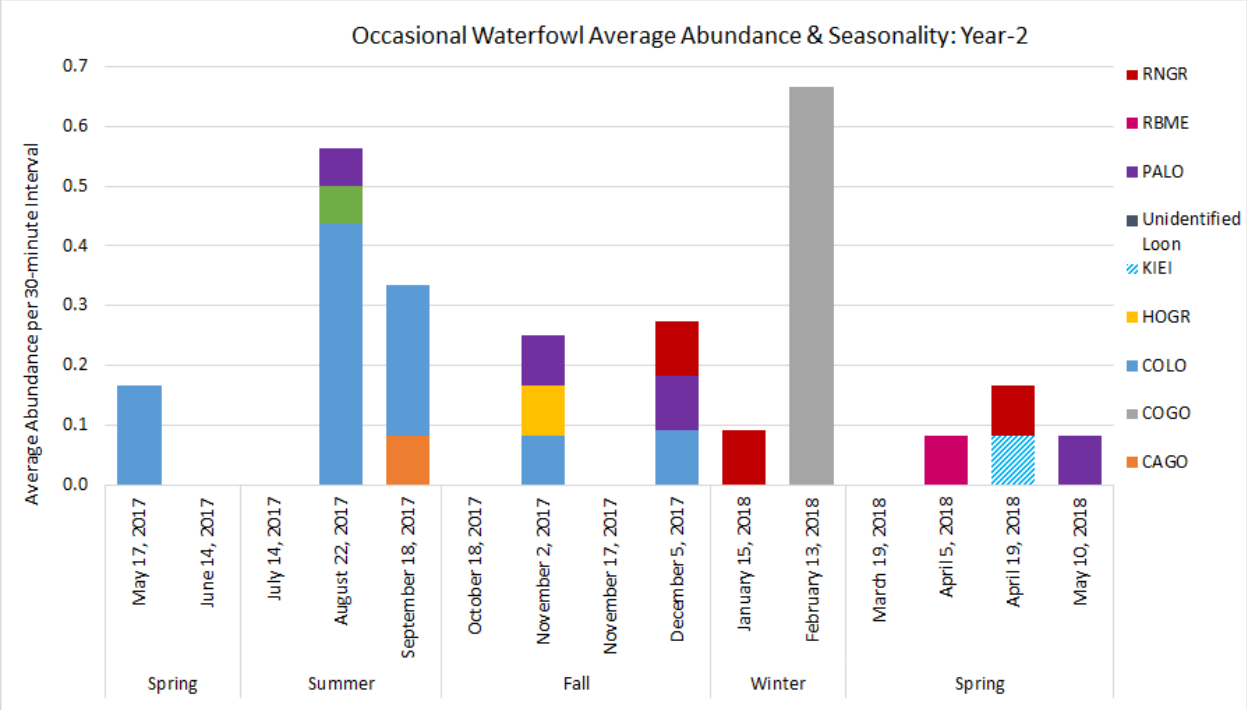

Figure 19. Average abundance and seasonal presence of occasional waterfowl species for Year-2 (15 surveys) of the FORCE shore-based seabird survey. FORCE Visitor Center, Parrsboro, Nova Scotia. (May 2017 – May 2018).

3.1.5 Comparison with Earlier Surveys

3.1.5.1 Species Composition

Fewer species were observed overall at the site in Year-2 compared with the number seen in the first surveys (2010 – 2012) (36 versus 45 respectively) (Figure 20, Table 5) but the average number per survey was not significantly different from the number observed in 2016-2017 when 32 species overall were observed (Kruskal-Wallace One-Way Analysis of Variance, p=0.78, n=15).[6] The overall lower number of species in both Year-1 and Year-2 compared to the initial surveys was largely due to the absence of

[6] In contrast, the difference in average number of species per survey observed in year-1 versus the initial surveys in 2010-2012 was highly statistically significant (Kruskal Wallace One-Way Analysis of variance, p<0.001, n=14).

common and abundant resident species were present including Great Black-backed Gull, Herring Gull, Double-crested Cormorant, Great Cormorant, Common Eider, Common Loon, and Black Guillemot, as well as common migrants (Red-throated Loon, Ring-billed Gull, Northern Gannet, Black Scoter, Surf Scoter, White-winged Scoter and Long-tailed Duck) and seasonally important species (American Black Duck and Red-breasted Merganser).

No new species for the monitoring program as a whole were added this year, although several species occurred this year which didn't occur in Year-1 including Black-legged Kittiwake, Horned Grebe, Pacific Loon, and the shorebirds Black-bellied Plover, Least Sandpiper and Semipalmated Plover.

3.1.5.2 Species Diversity & Seasonality

Diversity of species as expressed by number of species (species richness) at the site in Year-2 was uniform throughout the year with a small peak in spring migration in April 2018, as well as in late-summer (August and September surveys) and a fall migratory peak in early December. Earlier baseline surveys had shown stronger peaks in both fall and spring (Figure 28, Table 5). Overall, species diversity showed similar levels and patterns throughout the year in the current survey versus Year-1. Low diversity (lowest number of species per survey at 5 species) in October and March repeated the previous low observed on two surveys in 2016-2017 (Figure 20, Table 5). Through the spring and summer of 2017, number of species per survey was comparable to that observed in similar periods during 2016 and the baseline (2010-2012) surveys; the August, September and December surveys had among the highest numbers of species per survey in Year-2 versus Year-1 (Figure 20, Table 5). In particular, late summer has typically had low numbers of species and abundance of birds and the 14 and 15 species observed in August and September surveys respectively—due to detection this year of the late-summer shorebird migration—was not expected. The fall migration period in 2017 had approximately two-thirds of the peak number of species observed in 2010 (Figure 20, Table 5). Number of species at the site during spring migration, was similar in May 2017, but lower in March and April, than in earlier surveys.

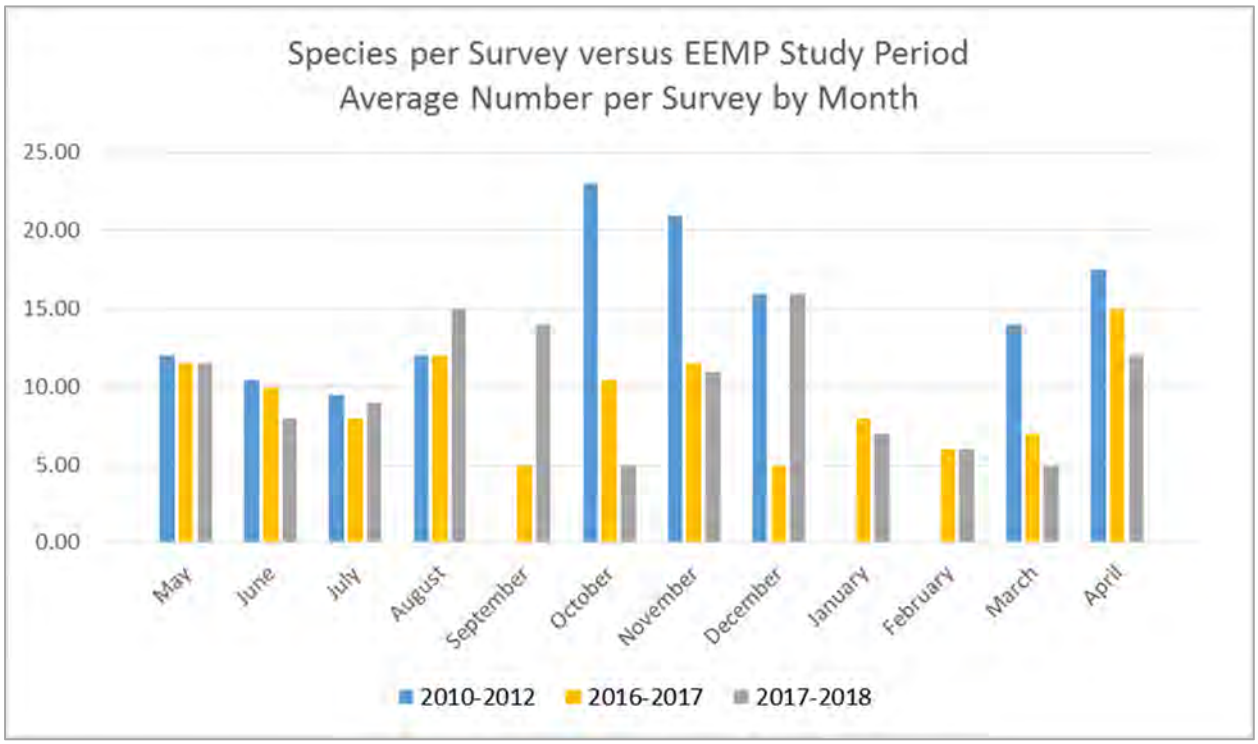

Figure 20. Comparison of diversity of species (number of species per survey) of seabirds and water-associated birds at the FORCE tidal energy demonstration site in 2016-2017 with EEMP studies conducted in 2010-2012.

3.1.5.3 Abundance and Seasonality

Abundance of birds at the FORCE site in Year-2 (2017-2018) overall was comparable to that observed in the baseline surveys (2010-2012) and Year-1 and followed similar seasonal cycles, although abundances in the fall migration season were lower than in baseline surveys, with the fall peak delayed until early December[7]. Spring numbers were comparable to the initial surveys, but did not reach the high abundances recorded in April 2017 (Figure 20, Table 5). Abundances in Year-1 and Year-2 surveys were not significantly different statistically (Kruskal-Wallace One-Way Analysis of Variance, p=0.45, n=15)[1] (Figure 21, Table 5).

[7] See Appendix C for the seasonal distribution shown as a smoothed curve produced by polynomial least squares regression.

Table 5. Comparison of average abundance (sightings per 30 minutes) and total species per survey, in Year-1 and Year-2 versus 2010-2012. (T) denotes presence of turbine.

SURVEY	ABUNDANCE			SPECIES		
	2010-2012	2016-2017	2017-2018	2010-2012	2016-2017	2017-2018.
May.1.2010 (T)	47.70	--	--	12	--	--
May.1.2017 (T)	--	75.00	--	--	13	--
May.6.2016	--	35.09		--	10	--
May.10.2018	--	--	20.75	--	--	11
May.13.2010 (T)	40.49	--		12	--	--
May.17.2017 (T)	--	--	46.33	--	--	12
May.27.2010 (T)	56.58	--	--	12	--	--
June.2.2016	--	42.33	--	--	10	--
June.12.2010 (T)	69.83	--	--	12	--	--
June.14.2017 (T)	--	--	37.25	--	--	8
June.21.2012	25.40	--	--	9	--	--
Jul.2.2016	--	19.17	--	--	8	--
Jul.4.2012	20.30	--	--	11	--	--
Jul.14.2017 (T)	--	--	25.63	--	--	9
Jul.18.2012	7.20	--	--	8	--	--
Aug.2.2012	12.40	--	--	14	--	--
Aug.2.2016	--	20.00	--	--	12	--
Aug.15.2012	13.40	--	--	8	--	--
Aug.22.2017 (T)			11.19			15
Aug.29.2012	11.10	--		14	--	--
Sep.1. 2016	--	22.17		--	5	--
Sep.18.2017 (T)	--	--	10.42	--	--	14
Oct.1, 2016	--	11.08		--	12	--
Oct.17.2016	--	1.75		--	9	--
Oct.18.2017 (T)	--	--	1.83	--	--	5
Oct.23.2010 (T)	16.25	--		23	--	--
Nov.2.2017 (T)	--	--	6.33	--	--	15
Nov.3.2016	--	40.92	--	--	11	--
Nov.13.2010 (T)	57.33	--	--	25	--	--
Nov.17.2016 (T)	--	10.27	--	--	12	--
Nov.17.2017	--	--	3.27	--	--	7
Nov.22.2010	18.67	--	--	17	--	--
Dec.1.2016 (T)	--	17.89	--	--	5	--
Dec.2.2011 (T)	8.60	--	--	15	--	--
Dec.5.2017	--	--	46.36	--	--	16
Dec.13.2011	6.50	--		17	--	--
Jan.15.2018	--	--	10.45	--	--	7
Jan.16.2017 (T)	--	55.80		--	8	--
Feb.13.2018	--	--	11.92	--	--	6
Feb.21.2017 (T)	--	10.92	--	--	6	--
Mar.13.2017 (T)	--	8.83	--	--	7	--
Mar.16.2011	14.70	--		12	--	--
Mar.19.2018	--	--	12.75	--	--	5
Mar.31.2011	16.00	--		16	--	--
Apr.2.2017 (T)	--	21.83		--	13	--
Apr.5.2018	--	--	28.08	--	--	9
Apr.15.2011	41.50	--	--	16	--	--
Apr.17.2017 (T)	--	267.75		--	17	
Apr.19.2018			41			15
Apr.30.2011	39.20	--		19	--	

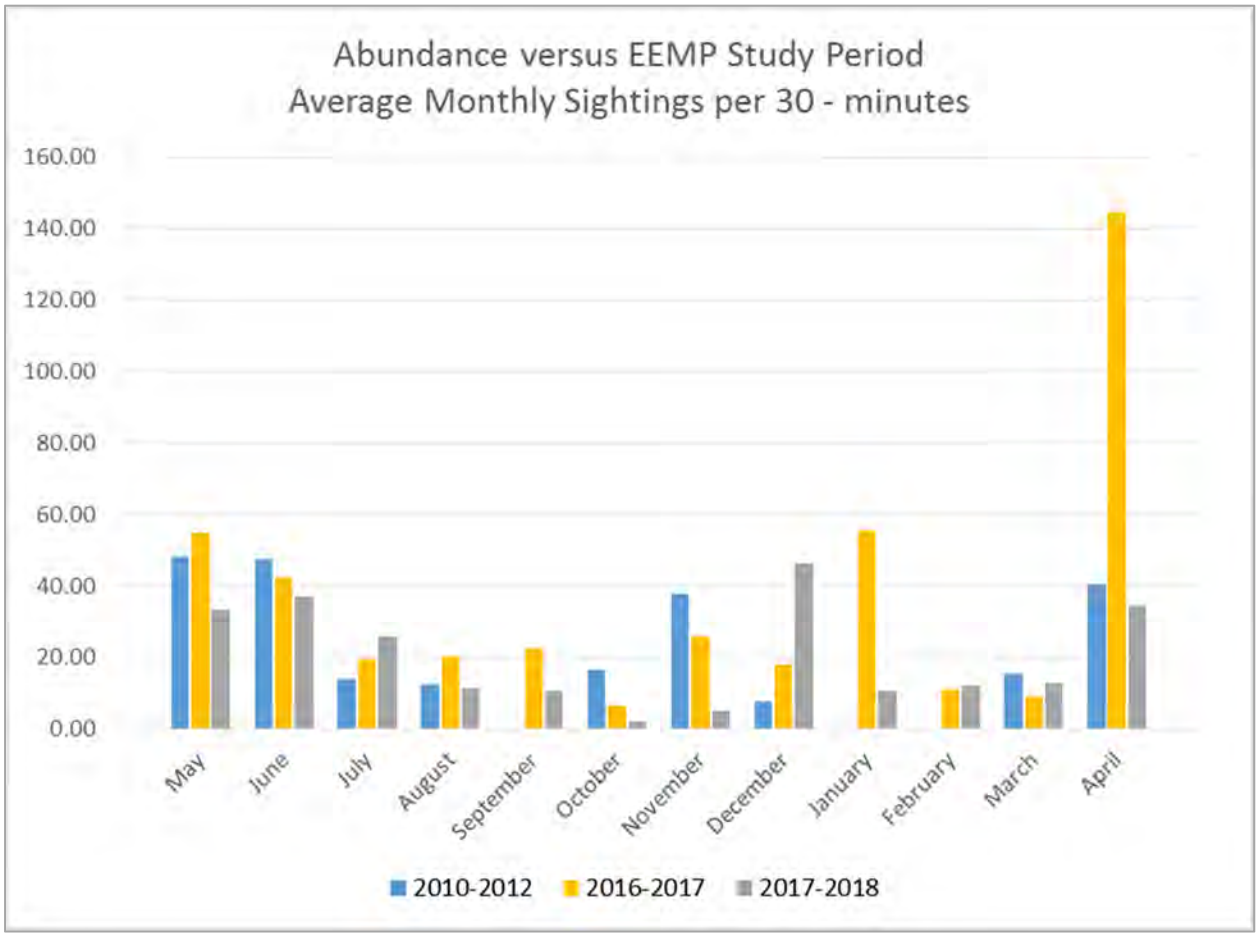

Figure 21. Monthly comparison of abundance of seabirds and water-associated birds (number per 30-minute survey) at the FORCE tidal energy demonstration site in 2017-2018 with EEMP studies conducted in 2010-2012 and 2016-2017.

3.1.6 Use of Open Water Areas

Seabirds and other water-associated birds surveyed at the FORCE site include both those occupying Black Rock[8] or the water immediately adjacent to it; as well as birds swimming or drifting with the tide, or flying through the area. Both groups are important in assessing impacts of tidal energy devices; with those flying or on water most likely to be closest to operating equipment. Seabirds and water-associated birds over open water at the FORCE site were recorded as either flying or on the water, a feature which reflects their utilization of the area and is relevant to assessing risk for interactions with tidal energy devices. Birds may fly through the area while moving between distant areas, or pass through open water areas to access or leave from Black Rock and other coastal areas. More seabirds and water-associated birds occupying open water areas in both Year-1 and Year-2 were flying, typically in a ratio of 1.2:1—in

[8] Birds such as Common Eider, Black Guillemot, Double-crested Cormorant and Great Cormorant, and waterfowl such as American Black Duck frequently occupy the intertidal zone of Black Rock or the water immediately adjacent to it in subarea IB1. Although some venture out into the tidal currents and drift into the Crown Lease (CL) area, many will stay around Black Rock until the intertidal zone is submerged and then leave for other areas.

both years 40.0% of birds occurred on water (Table 6, Figures 22 to 24). As in 2016-2017, relatively more birds were seen on water than were flying during peak migration periods (e.g. December 5, 2017 and April 5 and 19, 2018), but also in early summer (June and July surveys)(Table 6, Figure 22). Number of seabirds on water were higher than those flying on only 6 of 14 surveys (43%) overall.

Table 6. Average abundance (sightings / 30-minute survey) of seabirds seen flying or on water at the FORCE tidal demonstration site, 2016-2017.
n= number of birds observed.

SURVEY	FLYING		ON WATER		
	Average	n	Average	n	Proportion
May.17.2017	10.50	52	2.08	6	0.17
Jun.14.2017	2.67	16	9.75	23	0.79
Jul.14.2017	5.25	61	6.44	57	0.55
Aug.22.2017	3.00	41	2.94	31	0.49
Sep.18.2017	5.75	36	1.92	14	0.25
Oct.18.2017	1.33	15	0.50	5	0.27
Nov.2.2017	6.00	43	0.92	7	0.13
Nov.17.2017	3.09	25	0.09	1	0.03
Dec.5.2017	6.27	25	40.36	18	0.87
Jan.15. 2018	1.18	10	3.73	2	0.76
Feb.13.2018	1.17	10	0.50	3	0.30
Mar.19.2018	2.25	17	0.08	1	0.04
Apr.5.2018	8.33	34	9.25	3	0.53
Apr.19.2018	6.75	47	8.92	25	0.57
May.10.2018	4.17	38	2.08	13	0.33

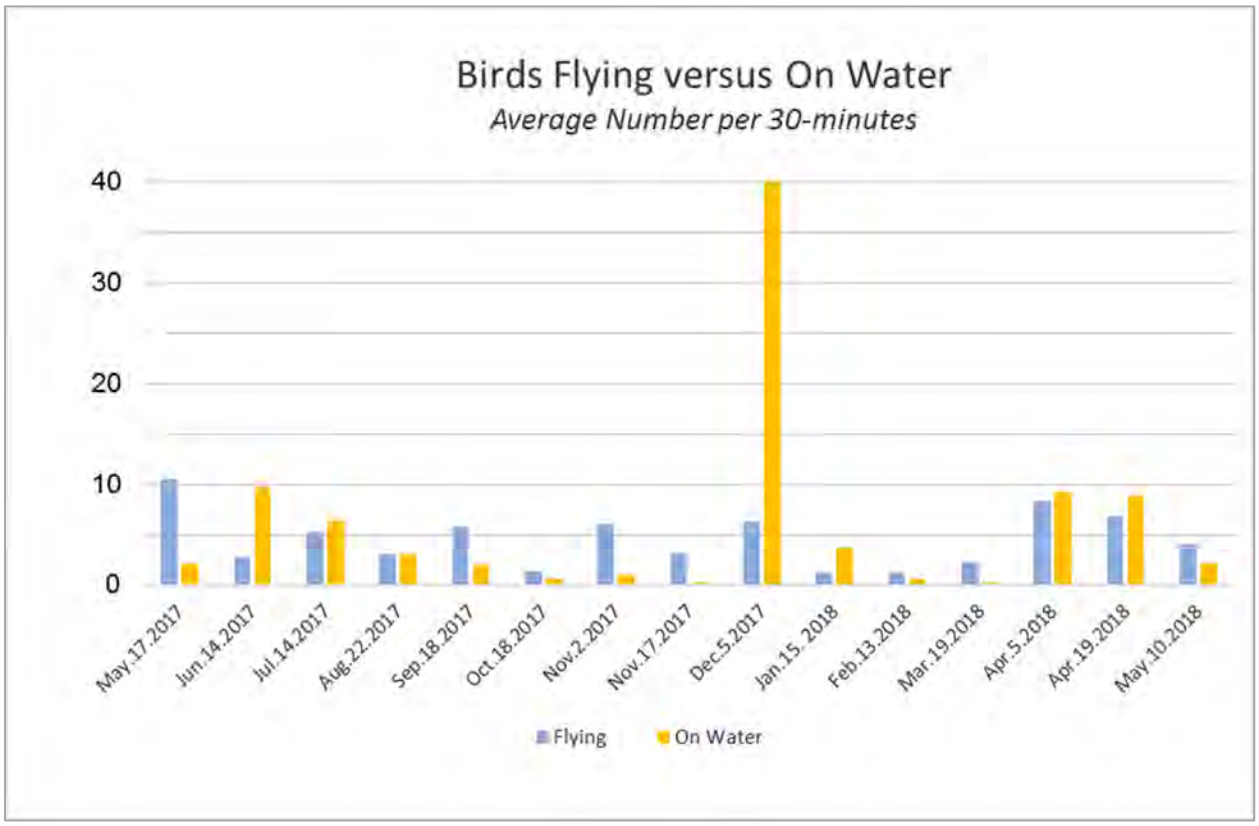

Figure 22. Abundance of seabirds and water-associated birds which were seen flying or on water in shore-based surveys at the Fundy Ocean Research Center for Energy, Tidal Energy Demonstration Site, 2017-2018.

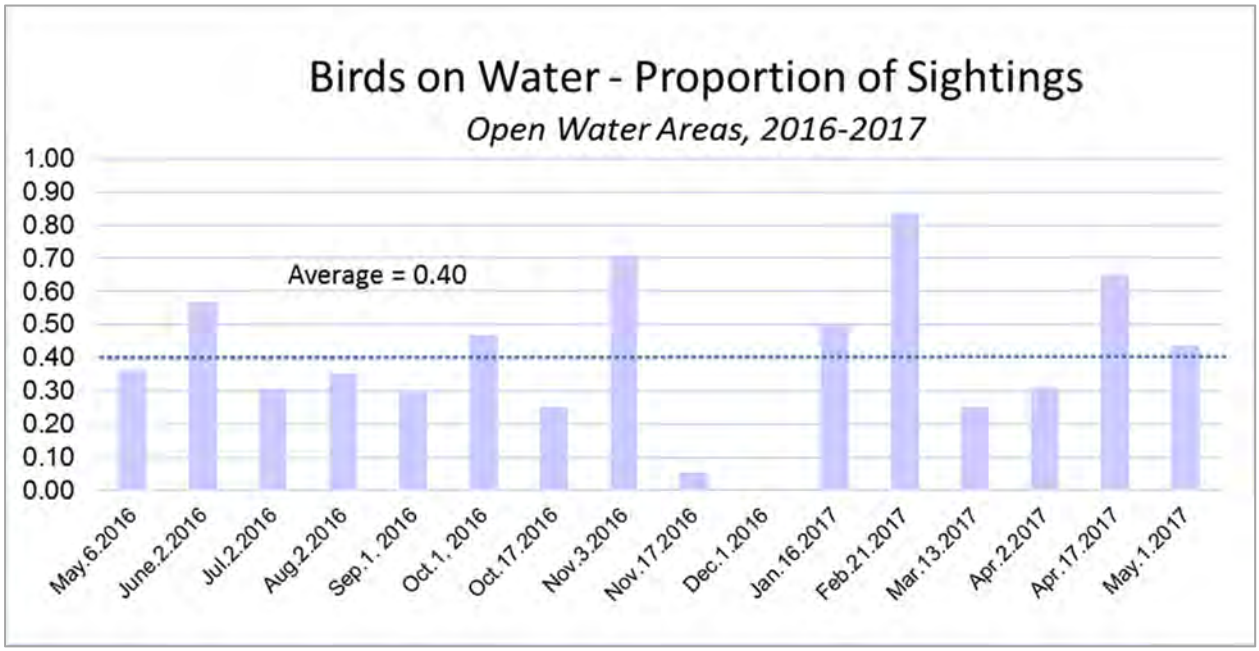

Figure 23. Proportion of seabirds and water-associated birds which were on water during shore-based surveys at the Fundy Ocean Research Center for Energy, Tidal Energy Demonstration Site, 2016-2017.

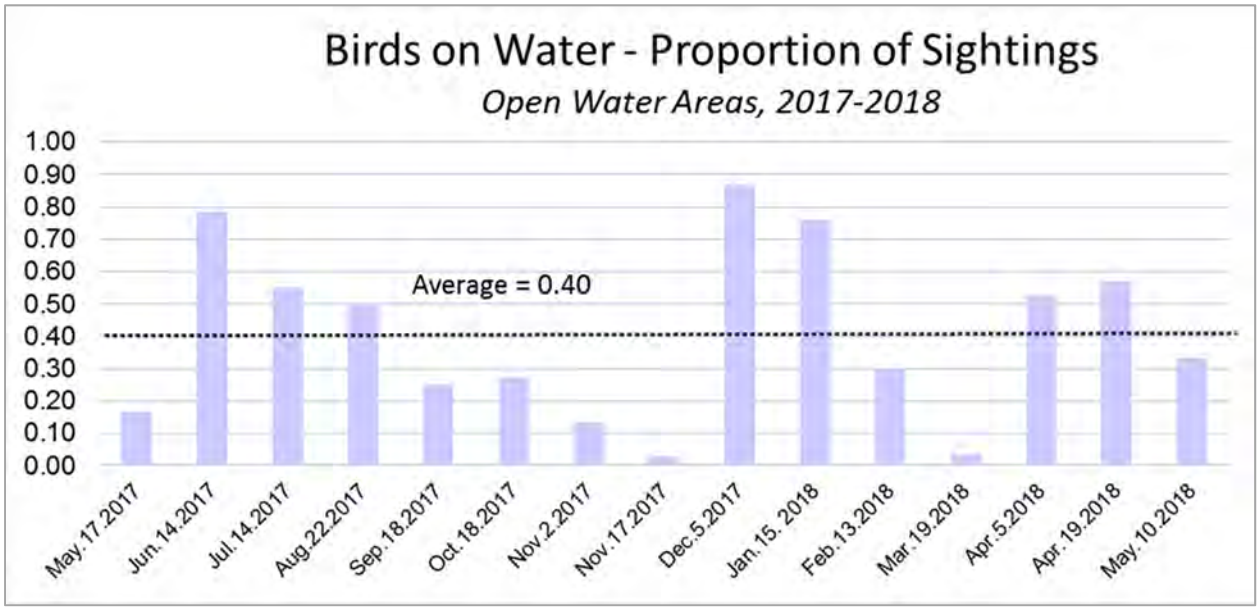

Figure 24. Proportion of seabirds and water-associated birds which were on water, during shore-based seabird surveys at the Fundy Ocean Research Center for Energy, Tidal Energy Demonstration Site, 2017-2018.

3.1.7 Influence of Time of Day and Tidal Cycle

Biological processes including behaviour and movements of seabirds occur on daily cycles. Abundance of birds at the FORCE site during each survey in 2017-2018 typically did not show a consistent pattern of change or trend during the survey period (from noon and high tide to late afternoon and low tide). We used two statistical approaches to determine whether trends occurred through the survey: 1) linear regression analysis; and 2) parametric and non-parametric statistical comparisons of counts of birds in blocks of time (i.e. consecutive groups of periods) as the day progressed.

On most surveys, abundance of seabirds was stable or highly variable through the day. Occasionally, however, statistically significant trends in the form of significant linear regression relationships of abundance on survey period were observed, either increasing or decreasing through the afternoon during the ebb tide (Tables 8 - 10)[9]. The analysis to determine trends was subdivided into three groups of observations: 1) birds on Black Rock during the survey; 2) birds in other sub-areas; and 3) all birds at the site at the time (i.e. those on Black Rock and those in other subareas combined). Overall abundance (i.e. birds on Black Rock plus those in other subareas) showed statistically significant linear regression relationships ($p<0.05$) of log-transformed (log (x+1)) abundance on survey period in four out of fifteen surveys, with downward trends or negative relationships (i.e. the number of birds declining during the afternoon) on July 14 and September 18, 2017, and May 10, 2018; and an upward trend on February 13, 2018 (Table 8). Significant trends were observed in numbers of birds on Black Rock alone on six surveys,

[9] The count of birds observed in each 30-minute period was the independent variable and the sequential order of the periods (i.e. Period 1, 2, 3, etc.) was the dependent variable in the regression analysis, which was performed for each survey and each group of observations (i.e. Black Rock, Other subareas, and Total).

Table 8. Statistical significance of linear regression relationships of overall bird abundance (log-transformed counts/period) with time in survey (periods), 2017 – 2018. N = 11 or 12 periods per survey. Surveys with significant relationships are shaded blue.

DATE	Multiple r	Proportion of Variation Explained (r^2)	Probability Null Hypothesis Supported	Significance (* p< 0.05); **p<0.01)
May.17.2017	0.32	0.10	0.32	NS
Jun.14.2017	0.39	0.15	0.21	NS
Jul.14.2017	-0.72	0.52	0.002	**
Aug.22.2017	0.43	0.19	0.09	NS
Sep.18.2017	-0.82	0.67	0.001	**
Oct.18.2017	0.51	0.26	0.09	NS
Nov.2.2017	-0.40	0.16	0.20	NS
Nov.17.2017	0.31	0.10	0.36	NS
Dec.5.2017	-0.37	0.14	0.26	NS
Jan.15. 2018	0.61	0.38	0.05	*
Feb.13.2018	0.78	0.61	0.003	**
Mar.19.2018	0.17	0.03	0.59	NS
Apr.5.2018	0.24	0.06	0.45	NS
Apr.19.2018	0.45	0.20	0.15	NS
May.10.2018	-0.63	0.40	0.03	*

Table 9. Statistical significance of linear regression relationships of seabird abundance on Black Rock (log-transformed counts/period) with time in survey (periods), 2017 – 2018. N = 11 or 12 periods per survey. Surveys with significant relationships are shaded blue.

DATE	Multiple r	Proportion of Variation Explained (r^2)	Probability Null Hypothesis Supported	Significance (* p< 0.05); **p<0.01)
May.17.2017	0.54	0.29	0.07	NS
Jun.14.2017	0.18	0.03	0.59	NS
Jul.14.2017	-0.52	0.27	0.04	*
Aug.22.2017	0.88	0.77	<0.001	**
Sep.18.2017	0.27	0.07	0.40	NS
Oct.18.2017	0.39	0.15	0.21	NS
Nov.2.2017	No birds on Black Rock			
Nov.17.2017	"			
Dec.5.2017	"			
Jan.15. 2018	0.60	0.36	0.05	*
Feb.13.2018	0.76	0.58	0.004	**
Mar.19.2018	0.38	0.15	0.22	NS
Apr.5.2018	0.89	0.79	<0.001	**
Apr.19.2018	0.76	0.58	0.004	**
May.10.2018	-0.48	0.23	0.12	NS

Table 10. Statistical significance of linear regression relationships of seabird bird abundance over water (log-transformed counts/period) with time in survey (periods), 2017 – 2018. N = 11 or 12 periods per survey. Surveys with significant relationships are shaded blue.

DATE	Multiple r	Proportion of Variation Explained (r^2)	Probability Null Hypothesis Supported	Significance (* p< 0.05); **p<0.01)
May.17.2017	-0.22	0.05	0.49	NS
Jun.14.2017	0.33	0.11	0.30	NS
Jul.14.2017	-0.60	0.36	0.014	*
Aug.22.2017	-0.33	0.11	0.21	NS
Sep.18.2017	-0.62	0.38	0.03	*
Oct.18.2017	0.50	0.25	0.10	NS
Nov.2.2017 13	-0.40	0.16	0.20	NS
Nov.17.2017	0.31	0.10	0.36	NS
Dec.5.2017	-0.37	0.14	0.26	NS
Jan.15. 2018	0.57	0.33	0.07	NS
Feb.13.2018	0.34	0.11	0.29	NS
Mar.19.2018	-0.15	0.02	0.65	NS
Apr.5.2018	-0.13	0.02	0.69	NS
Apr.19.2018	0.003	0.00	0.99	NS
May.10.2018	-0.59	0.35	0.04	*

with a downward trend on July 14, 2017, and upward trends on August 18, January 15, February 13, and on the two April, 2018 surveys (Table 9). The analysis of the group of sightings of birds over water showed significant trends, all downward, on three surveys—July 14 and September 18, 2017 and May 10, 2018 (Table 10). The tendency of birds to move either into or out of the area during the observation period didn't appear to follow a pattern related to season as shown in Tables 8 to 10 as both positive and negative trends occurred over all seasons.

In summary, the linear regression analysis showed that typically a small proportion—40% or less—of all surveys demonstrated significant trends (i.e. linear regression relationships) in abundance during the afternoon (ebb tide period) on given surveys. Of the statistically significant trends in abundance observed, five out of six showed an increasing trend for birds on Black Rock (abundance increasing later in the day)(Table 9); and all three of the significant trends for bird sightings over water were decreasing (i.e. birds leaving the site during the survey)(Table 10). The significant trends occasionally coincided (that is, where a significant trend was observed for birds on Black Rock, the same trend was observed for birds over water). Of the significant trends for the overall abundance at the site three were decreasing trends (i.e. birds leaving the site later in the afternoon) and one was increasing (Table 8). In conclusion, this analysis suggests that seabird abundance does not follow a trend through the day on most surveys, nor was a consistent pattern (i.e. either increasing or decreasing abundance through the survey) observed.

The non-parametric statistical approach (Kruskal-Wallace One-Way Analysis of Variance[10]) to detect trends provided similar results to the linear regression analysis (i.e. no consistent trends through the afternoon or ebb tide were detected on most surveys) when abundance in the first half of each survey (6 survey periods) was compared with the remaining periods in the survey. Significant trends ($p<0.05$) were detected for birds on Black Rock (April 5, a downward trend); birds over water on May 10 (upward trend); and for total bird abundance at the site (upward trends on September 18 and May 10 and downward on February 13). Several trends were observed but at a lower level of probability for rejecting the null hypothesis ($p<0.10$) for birds on Black Rock (January 15, upward; February 13 and April 19, both downward trends) and for over water sightings (October 18, downward). Overall abundance at the site showed downward trends at the $p<0.10$ level for July 14, 18 and April 19 surveys. Many but not all of the trends revealed by this analysis corresponded to those identified in the linear regression analysis. The statistically significant trends (differences between the first half of each survey and the last, $p< 0.05$) for total abundance measured at the site were upward in two cases and downward in the remainder; for birds on Black Rock, three of four trends were downward; and for birds observed over water, the two cases of statistically significant trends were opposite.

Analysis of Variance (ANOVA) was also applied to surveys beginning in October 2017 and extending to May 10 2018 to determine if trends (regular changes in abundance through the afternoon or ebb tide period) were present in the bird observations over surveys[11]. Differences in time of day (i.e. the three time periods—early, mid- and late afternoon) were highly significant ($p<0.001$) for bird abundance on Black Rock overall (i.e. in all surveys from October to May); and significant at the $p<0.001$ level in both winter (January to March surveys), and in spring (April and May surveys), reflecting that, as noted for the other analyses, there were changes in abundance with time of day, both increases and decreases. Time of day was a significant factor ($p<0.05$) for bird abundance overall at the site; and was significant at the $p<0.001$ level in winter surveys; but not in the fall and spring. Birds observed over water did not show a significant effect of time of day overall, and although there wasn't a statistically significant effect of time of day in the fall surveys, winter and spring surveys both demonstrated significant effects at the $p<0.05$ level. Detection of effects of time of day (i.e. early-, mid- and late-afternoon) supports the results of the other trend analyses which detected significant trends in all the seasonal periods.

Early morning surveys conducted on July 14 and August 22, 2017 gave additional information on occupation and distribution of seabirds at the site, although no consistent patterns of occupation on the two days emerged. On July 14, moderate numbers of birds were seen (37.5 sightings per 30 minutes in the morning; and 13.5 sightings per 30 minutes in the afternoon, on the falling tide from about mid-ebb to low).

[10] The K-W Analysis of Variance is a non-parametric 'rank-order' statistical test. The values (counts of birds in each survey period) of the first six periods were compared as a group with those of the following six periods on a given survey. A trend was suggested to occur if there was a statistically significant difference between the first or second half of the survey.

[11] Over that period and presently ongoing, the survey protocol was changed slightly by including a second 'snapshot' scan of the FORCE demonstration site mid-way through the half-hour observation period, which provided a second estimate of instantaneous bird abundance (i.e. for the first half and second half of the survey) which provided an estimate of error variability (i.e. the variability of two observations of bird abundance within each period) for the Analysis of Variance[11]. This change allowed analysis of differences between three survey periods corresponding to early afternoon, mid-afternoon, and late afternoon (four periods each).

Most common and abundant species were Herring Gull, Great Black-backed Gull, Black Guillemot and Double-crested Cormorant, all of which were present through the day, while Great Black-backed Gull was absent in the afternoon. Nine species (7 in the morning and 8 in the afternoon) were observed, including. in addition to the dominants, Common Eider, Great Cormorant, Surf Scoter, Black Scoter and Northern Gannet. The dominant gulls (Herring Gull and Great Black-backed Gull) occupied Black Rock in the early morning, and moved into adjacent waters later in the day, with Herring Gull returning late in the day. During the August 22, 2017 survey, in contrast, gulls (Herring and Great Black-backed) didn't congregate on Black Rock in the early morning, and showed lower abundances of Herring Gull overall, virtual disappearance of Great Black-Backed Gull and Common Guillemot, and increased abundance of Ring-billed Gull. Black Guillemot and Great Black-backed Gull also moved out of the area at this time of year in 2016, reflecting for the former the abandonment of the Black Rock nesting and feeding sites; and normal seasonal movement of Great Black-backed Gull to areas further offshore.

3.1.8 Assessment of Impacts

The principal objective of the FORCE EEMP is to test predictions that the placement of tidal energy devices will not negatively impact seabirds at the tidal energy demonstration site, including both at the population level and for individual interactions of birds with tidal devices. Addressing this objective involves accumulation of a database of quantitative information on bird abundance to allow a greater understanding of seasonal and spatial patterns of abundance; and making specific comparisons of bird abundance when tidal devices are present. At times during baseline studies and monitoring at the site (i.e. 2010 – 2012, 2016-2017 and 2017-2018), Open Hydro turbines were installed at Site D of the Crown Lease Area (see Figure 3 for location of berths at the FORCE site). The first was in place from November 2009 to December 2010, and the most recent, a grid-connected turbine[12], from November 2016 to mid-June, 2017, and which thus operated through the end of the most recent survey period. In addition to the presence of turbines, activities related to turbine deployment and maintenance, principally vessel traffic and use of the site for activities such as equipment installation and removal, have the potential to interact with, and potentially affect seabirds, although not necessarily negatively, and typically at a negligible level of effect. The FORCE site is also used for personnel transport from shore at the FORCE site to West Bay, and principally for vessels used in turbine deployment and support vessels; however no negative impacts of these activities have been predicted.

Tidal energy devices and associated operations at the FORCE site are expected to be negligible factors potentially influencing the occurrence and abundance of seabirds and other water-associated birds at the site, compared with changes attributable to weather, changes in physical factors such as water temperature, food availability etc., as well as natural changes due to population variability and natural changes in movement patterns which are irrespective of any physical factors. Such conclusions have been reached in overview studies of the tidal energy industry world wide (e.g. Frid et al. 2012; Copping et al. 2016). The analysis comparing baseline and Year-1 EEMP studies (Envirosphere Consultants Limited 2017) suggested that patterns of overall abundance and species diversity were comparable throughout the surveys (from 2010 to 2017) during periods when turbines were both operating and absent from the site. There also appeared to be no particular correlation with timing of deployment of the tidal turbine at the site, when surveys were separated specifically on the basis of the presence of

[12] Cape Sharp Tidal Development Inc., installed the turbine on November 7, 2016 and removed it June 15, 2017.

tidal turbines. Other differences in 2016-2017 compared with earlier surveys (e.g. a lower number of species than in the initial baseline surveys due to the absence of oceanic and other migrant species) were attributed to natural variability (Envirosphere Consultants Limited 2017).

In Year-1 and Year-2 of the EEMP, there have been few occasions for comparing bird occurrences in the presence and absence of tidal turbines. Between November 2016 and May 2018, there were ten surveys in which the Cape Sharp Tidal Development Limited Open Hydro turbine were installed versus eleven surveys at corresponding times of year when no turbine was present (Tables 5 and 11).

Abundance of birds at the site is used as the measure of the seabird community to be compared to demonstrate potential effects. Abundance overall, abundance of birds observed on Black Rock, and birds observed over water provided three sub-sets of the data which were analyzed separately. Two non-parametric statistical analysis approaches were employed to assess differences in bird abundance between periods of turbine deployment versus those when no turbine was present:

1) Average abundance in the period of turbine deployment was compared to the average abundance when the turbine was absent by the Kruskal-Wallace One-Way Analysis of Variance.

2) Differences in abundance in separate months were compared in a paired, non-parametric test (Wilcoxon Signed Ranks Test). This test determines whether one component of the pair (presence of the turbine versus absence) was consistently greater than the other, potentially indicating an effect.

Kruskal-Wallace One-Way Analysis of Variance (Sokal and Rohlf 1981) demonstrated that seabird abundance was higher overall, as well as for abundance of birds on Black Rock and birds in open water areas analyzed separately, when the Open Hydro turbine was present (all comparisons, $p<0.01$)(Table 11).

Table 11. Statistical significance (Kruskal-Wallace One-Way Analysisis of Variance) of differences in average seabird abundance (log-transformed counts/period) over surveys during which a Cape Sharp Tidal Development Inc., Open Hydro turbine was present versus when it was absent, 2016-2018 (N = 9 to 12 periods per survey. Probability test statistic, Mann-Whitney U, 1 d.f.).

Abundance	Turbine Present / Absent	Count (Survey Periods)	Rank Sum	Kruskal-Wallace Test Statistic (18 d.f.)	Probability Null Hypothesis Supported	Significance (* p< 0.05); **p<0.01)
Overall	Turbine	115	14,170.5	120.624	0.002	**
	No Turbine	105	10,139.5			
Black Rock	Turbine	115	13,968.5	163.943	0.005	**
	No Turbine	105	10,341.5			
Over Water	Turbine	115	13,653.5	85.002	0.044	**
	No Turbine	105	10,656.5			

Abundances observed in the presence of the turbine versus when it was not present, were highly variable but were equivalent, with no particular condition (i.e. higher or lower abundance in the presence of the turbine) dominating. A Wilcoxon Signed Ranks Test (Sokal and Rohlf 1981) on log-transformed paired data for overall abundance of birds, birds on Black Rock and, birds in open water areas (Table 12, Figures 25-27), as well as on abundances of a list of dominant species which occurred in four or more months in the deployment period[13] (Table 13) also showed that there were no statistically significant differences in abundances between deployment and non-deployment periods, with usually as many birds occurring when the turbine was present as when it was absent (Tables 12 and 13, Appendix Tables E1-E11). If there were an effect of the presence of the turbine, it would be expected that a consistent difference (either higher or lower) in abundance would be observed. In three cases, American Black Duck, Common Eider and Herring Gull, however, the abundances in the presence of the turbine were higher and the probability of rejecting the null hypothesis was low (i.e. < 0.10)(Table 13); however the differences were not significant at the p<0.05 level.

Table 12. Comparison of average abundance (counts per 30 minutes) in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	8.3	0.0	8.3	22.1	0.0	22.1
December	17.9	16.7	1.2	46.4	0.0	46.4
January	55.9	29.6	26.3	10.5	5.5	4.9
February	10.9	6.1	4.8	11.9	9.9	2.0
March	8.8	6.5	2.3	12.8	10.3	2.4
April**	147.0	59.7	87.3	34.5	17.8	16.8
May**	60.7	48.2	12.5	29.2	23.7	5.5
June	37.3	24.8	12.5	42.6	37.2	5.4

**average of 2 surveys for both turbine present and absent.

[13] American Black Duck, Black Guillemot, Black Scoter, Common Eider, Common Loon, Double-crested Cormorant, Great Cormorant, Great Black-backed Gull, Herring Gull, Ring-billed Gull and Red-throated Loon.

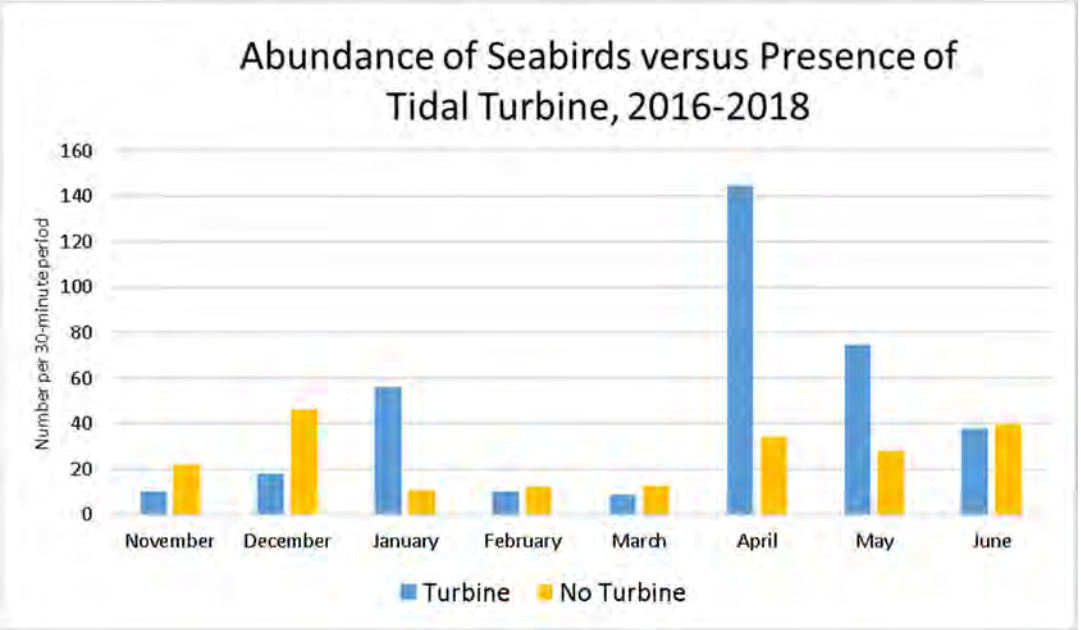

Figure 25. Abundance of seabirds and water-associated birds versus periods of turbine operation in shore-based surveys at the Fundy Ocean Research Center for Energy, Parrsboro, Nova Scotia, 2016-2018.

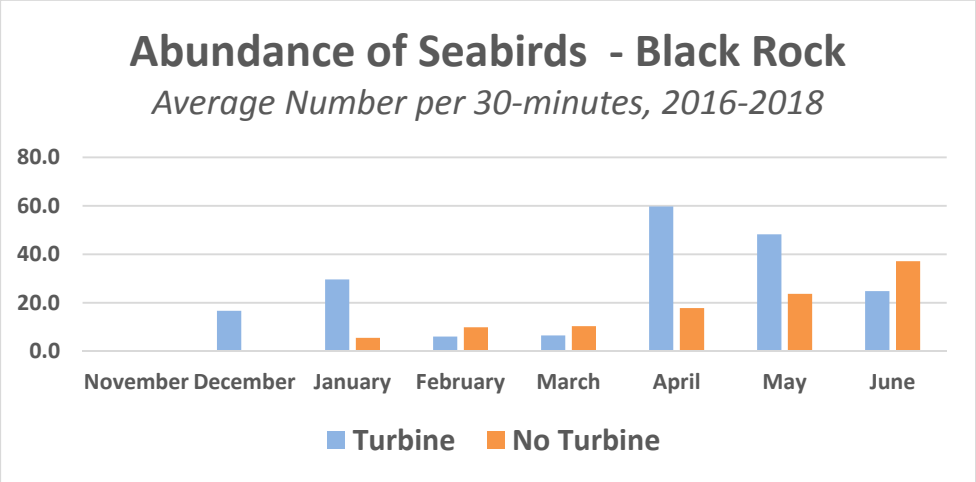

Figure 26. Abundance of seabirds and water-associated birds on Black Rock versus periods of turbine operation in shore-based surveys at the Fundy Ocean Research Center for Energy, 2016-2018.

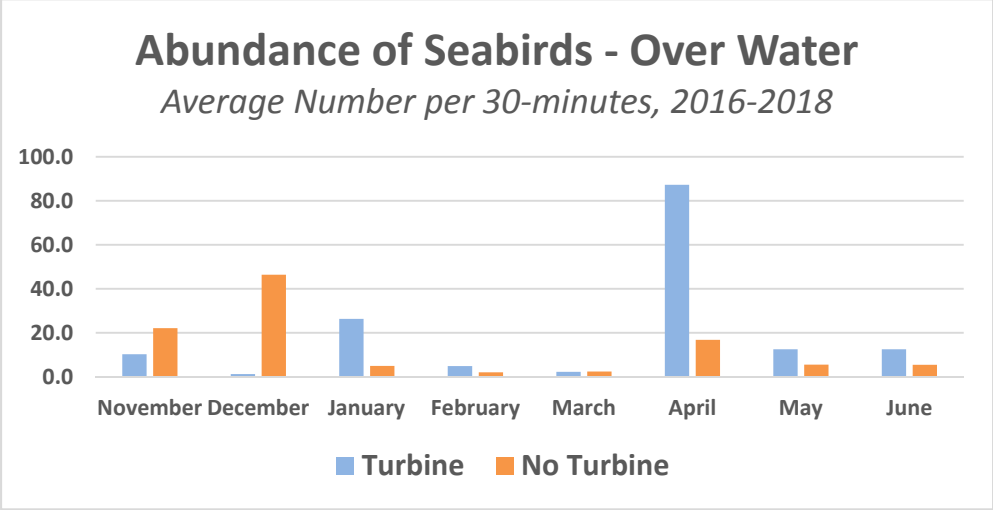

Figure 27. Abundance of seabirds and water-associated birds in open water subareas versus periods of turbine operation in shore-based surveys at the Fundy Ocean Research Center for Energy, 2016-2018.

Although it could be argued that birds were attracted to the area because of the presence of the turbine and other activity, elevated abundance while the turbine was installed more likely represents the influence of natural factors affecting bird abundance in the area than the influence of the turbine. The Wilcoxon test (Table 13) was more informative, indicating that there were no consistent differences attributable to the turbine presence. The Kruskal- Wallace test showed that although there were differences in overall abundance during the period of turbine deployment compared with other times (namely abundance generally greater during the turbine deployment), it could not determine whether other factors, such as environmental changes (e.g. food availability) or natural variability in abundance such as large-scale movement patterns of birds may have contributed to the difference.

Number of species occurring showed a similar pattern of variability depending on the presence or absence of a tidal turbine (Figure 28), although the differences were not tested statistically. The number of species with the turbine was greater on only four of eight surveys.

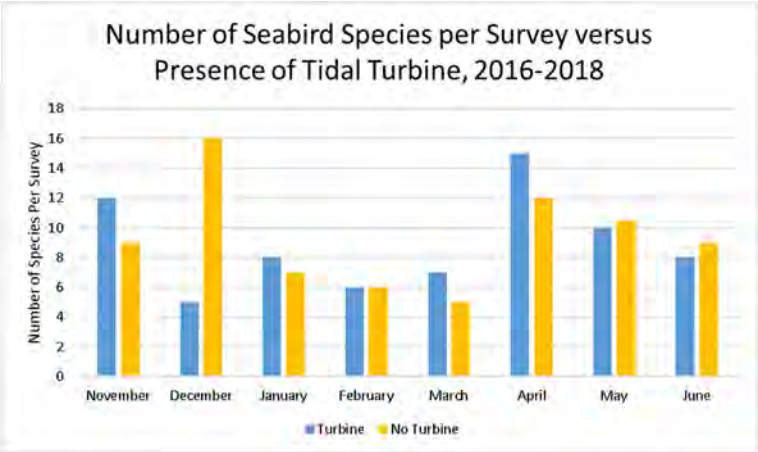

Figure 28. Diversity (number of species per survey) of seabirds and water-associated birds versus periods of turbine operation in shore-based surveys at the Fundy Ocean Research Center for Energy, 2016-2018.

Table 13. Statistical significance (Wilcoxon Signed Ranks Test) of differences in seabird abundance between months when a Cape Sharp Tidal Development Inc., Open Hydro turbine was present versus when it was absent, 2016-2018. "All Birds" refers to Table 11. Comparable tables of abundance of species listed are presented in Appendix E. Note that some species occurred only over water and the result for the "Overall" category is the same as for "Over Water" and only the result for the latter is presented.

SPECIES	LOCATION	Number of Months with Counts	Number When Turbine Count is Higher	Significance	Probability of Rejecting Null Hypothesis
ALL BIRDS	Overall	8	5	NS	0.67
	Black Rock	8	4	NS	0.26
	Over Water	8	3	NS	0.48
American Black Duck	Over Water	5	4	NS	0.08
Black Guillemot	Over Water	4	1	NS	0.27
Black Scoter	Over Water	5	3	NS	0.41
Common Eider	Overall	7	5	NS	0.18
	Black Rock	3	2	NS	0.59
	Over Water	7	5	NS	0.09
Common Loon	Over Water	7	4	NS	0.61
Double Crested Cormorant	Overall	4	3	NS	0.28
	Black Rock	3	3	NS	0.11
	Over Water	4	3	NS	0.47
Great Cormorant	Overall	5	3	NS	0.89
	Black Rock	4	2	NS	0.47
	Over Water	4	2	NS	1.00
Great Black-backed Gull	Overall	7	3	NS	0.61
	Black Rock	8	3	NS	0.48
	Over Water	8	6	NS	0.48
Herring Gull	Overall	8	6	NS	0.16
	Black Rock	7	5	NS	0.18
	Over Water	8	7	NS	0.07
Ring-billed Gull	Overall	6	1	NS	0.17
	Black Rock	3	1	NS	0.59
	Over Water	7	1	NS	0.59
Red-throated Loon	Over Water	8	4	NS	0.88

3.2 MARINE MAMMALS

Two species of marine mammal, the Harbour Porpoise (*Phocoena phocoena*) and Harbour Seal (*Phoca vitulina*) were observed during the year (May 2017 – May 2018). Both species were observed on three of the fifteen surveys. Abundances on each occurrence were low – single seals, and typically a single or pair of porpoises, and on two occasions groups of three and five porpoises (Table 14; Figure 29).

Harbour Porpoise (Northwest Atlantic population) is listed as a Species of Concern by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the status is *threatened* under the Federal *Species at Risk Act*. Harbour Seal (*Phoca vitulina*) is a small species widely distributed along the east coast of North America north of Cape Cod. The species is often associated with bays and inlets from which habit its name is derived. Harbour Seal population trends in the Bay of Fundy are unknown, with trends in adjacent areas ranging from increasing (Maine) to decreasing (Sable Island)(Baird 2001). Grey Seal are relatively common large seal species occurring in coastal and offshore waters of Atlantic Canada.

In total, twelve Harbour Porpoise were seen at the site (Table 14; Figure 29), occurring in summer and winter, and twice as small groups in the spring. Overall, occurrence and abundance of Harbour Porpoise in the study area is lower than observed in earlier surveys, from June to August in 2012, as well as Year-1 of the seabird monitoring program (May 2016 – May 2017). However, the general location of sightings are similar (Envirosphere Consultants, 2012; 2017), most commonly seen in the tidal stream outside Black Rock and the Crown Lease area, south and southwest of Black Rock—generally moving with the tide (Table 14).

Harbour Porpoise abundance appears to follow the local pattern of fish distribution and availability, as herring and other runs of migratory species usually take place in late spring to early summer. In particular herring movements into Minas Basin take place largely in the spring, and are largely absent at other times (Baker et al 2014).

Table 14. Summary of marine mammal observations made during shore-based marine seabird surveys, Fundy Tidal Power Demonstration Site. 2017 – 2018.

DATE	APPROXIMATE TIME (ADT)	LOCATION & DIRECTION OF SIGHTING	TIDE DIRECTION AT TIME OF SIGHTING	NUMBER OBSERVED
Harbour Porpoise				
14 July 2017	15:45	OB1 - Moving east	Flood	1
14 July 2017	16:11	IB1 - Moving east	Flood	1 - adult 1 - juvenile
13 February 2018	12:15 – 12:30	CL	Ebb	1
19 April 2018	14:00	CL - Moving east, outer edge of CL into OB2	Flood	3
19 April 2018	17:00 – 17:15	CL - Moving west	Ebb	5
Harbour Seal				
14 July 2017	09:00	OB1 - Moving west	Flood	1
19 April 2018	15:45 – 16:30	IB1 - Close to shoreline	Flood	1
10 May 2018	19:00 – 17:30	IB1	Ebb	1

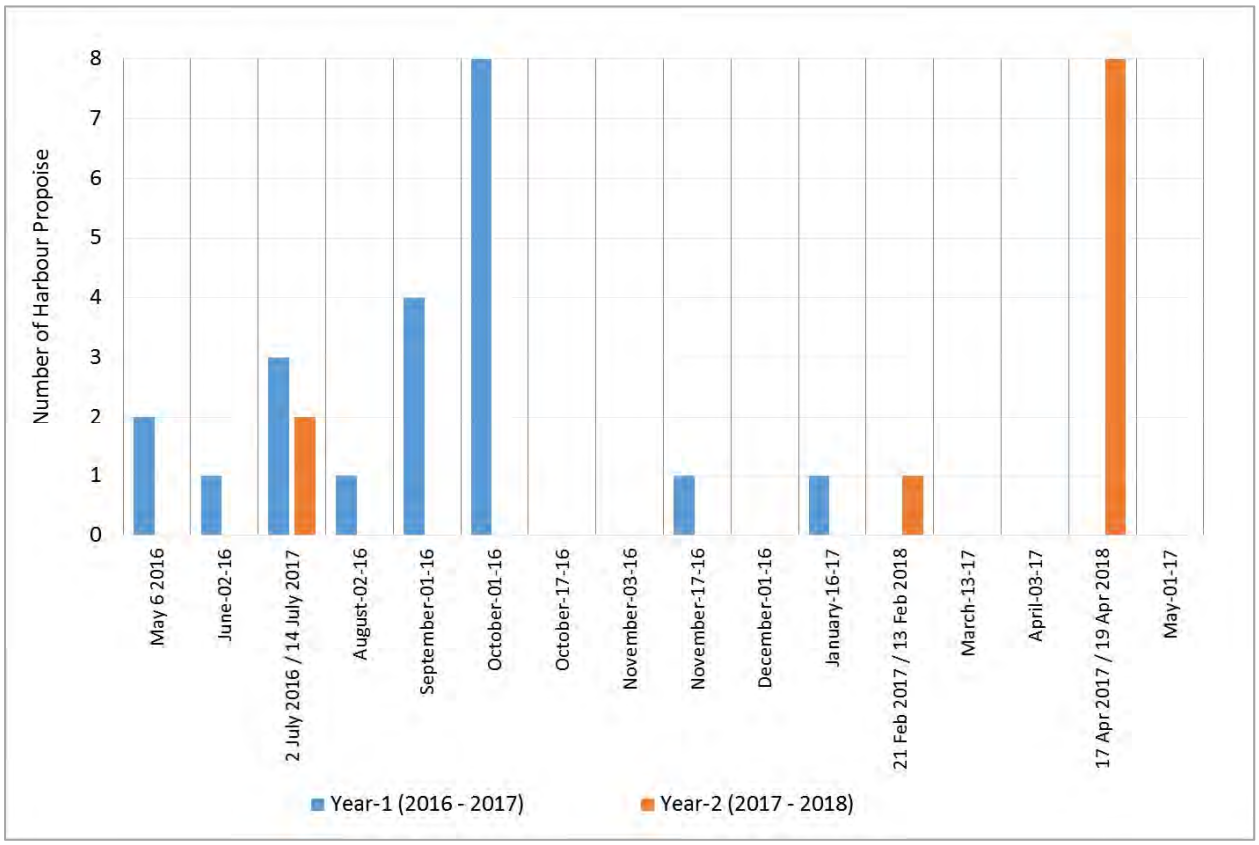

Figure 29. Comparison of Harbour Porpoise occurrence and abundance observed in the study area during the Year-1 and Year-2 Shore-Based Seabird Survey – Tidal Energy Demonstration Site, Fundy Ocean Research Center for Energy. Parrsboro, Nova Scotia.

Prior to the monitoring undertaken by FORCE in 2009, Harbour Porpoise, Harbour Seal, and Grey Seal were expected to occur in the study area, but their relative abundance and seasonal occurrence was unknown, as there were few previous recorded sightings for the area. The 2010-2011 shore-based surveys showed these species to be present, with Harbour Porpoise relatively common in the spring as early as March, and late fall, but not early winter. The 2012 study extended the seasonal occurrence of Harbour Porpoise through the summer (late June to late August) with significant numbers (some of the highest abundances observed at the site) occurring in mid-July and mid-August (Envirosphere Consultants, 2012).

4 CONCLUSIONS AND RECOMMENDATIONS

Surveys for seabirds conducted at the FORCE tidal energy demonstration from 2017-2018, have continued to provide information relevant to assessing the potential for interactions and impacts of installations of in-stream tidal energy devices and associated activities, as well as increasing the database of information on seabirds and water-associated birds, Harbour Porpoise and seals. The information generated so far (i.e. from 2010-2018) consists of more than three years of observations, with coverage from all seasons, providing a series of snapshots of occurrences and abundance of seabirds and marine mammals through the year.

4.1 SEABIRDS AND WATER-ASSOCIATED BIRDS

The Year-1 and Year-2 surveys including baseline studies (2010-2012) provided information on seabirds both in the presence, and absence, of a tidal energy device (an Open Hydro turbine installed in 2009-2010 and 2016-2017). Information collected provides a baseline useful for assessing trends in distribution and abundance, to assist in determining whether impacts of future operational phases of the tidal energy demonstration site have occurred. Various environmental factors also influence local distribution of birds, including food availability, protection from predators, presence of geographic features such as passages and points which can direct a bird's movements and lead to concentrations, and proximity to colonies and breeding areas, among others. Comparisons made of seabird abundance both during and before and after these deployments have not shown differences which would indicate turbine impacts. The purpose of the monitoring program is to verify predictions of a lack of impact of tidal energy devices on seabird and water-associated birds, and from this perspective, the predictions have so far been confirmed.

The current approach to seabird monitoring used by the FORCE EEMP employs regularly-scheduled surveys (sixteen per year[14]); increased frequency during expected migration periods when diversity and abundance is typically highest; and a focus on a single time of day and phase in tidal cycle. Added observations in the early morning on two summer surveys during 2017-2018, intended to look at occurrences at a time of day known to be important for coastal birds, showed a high variability in occurrences typical of observations at other times. Differences are expected in bird abundance and activity during times of day not sampled in the current program, as well as from day to day, and additional effort to look at patterns of bird occurrence and abundance through the day and at relevant sampling intervals to provide variability estimates for statistical analysis (e.g. day to day, week to week) in future surveys is recommended. Additional field survey effort is also recommended during critical migratory periods to assist in documenting these movements. The present monitoring schedule, which includes surveys every two weeks during expected migration periods has not been consistent in capturing migration peaks such as those seen in the earliest surveys. Additional effort, for example weekly surveys focused in April to mid-May, and November to mid-December would help to detect and confirm these movements. Day-to-day patterns of behaviour and abundance are also not assessed in the current monitoring program and would provide information on assessing variability; several such surveys focused on the late-spring, early-summer breeding period for the dominant species, would both provide information on variability and additional information to ensure that this key period was adequately sampled, and to begin to provide additional information on daily and tidal cycles.

The use of Black Rock by birds at the FORCE site for breeding, feeding, resting and aggregation is an important biologically and for monitoring impacts of tidal energy devices. Black Rock is near the Crown Lease and many birds typically associated with it, such as cormorants, Black Guillemots and Common Eider, as well as Great Black-backed Gull and Herring Gull, occupy the waters there for feeding and food searching. The tidal stream which runs past Black Rock on the outgoing tide passes directly through the Crown Lease. A program focused more closely on monitoring movements and activities of birds, in particular cormorants, Black Guillemot, and Common Eider which use the nearby waters most

[14] Fifteen surveys are reported for this year. One survey from this year's (Year-2) cycle was included in the Year-1 report to make up for a survey cancelled on site due to a snow storm in December 2016.

commonly, may be a useful addition to the EEMP program. Such a program would be focused on the breeding season for several of these species, which extends from May to July. Detailed documentation of use by these species of the nearby waters throughout the day, may identify patterns which could be quantified, and used as indicators which could be developed to assist in identifying impacts or lack of impact of tidal devices on these species.

Opportunities for bird observations during project activities which would assist in determining interactions with activities by developers at the FORCE site are not routinely available due to the set schedule of the monitoring plan, and the tendency for principal developers to not disclose the timing of operations such as turbine deployment except to FORCE and other immediate participants. It would be useful to schedule additional surveys to coincide with turbine installation or retrieval, as well as major operations such as cable or instrument installation or retrieval.

As in the first year of the monitoring program in 2016-2017, observations have documented both the population of resident birds (i.e. birds which occupy, feed, and breed) in the immediate vicinity (i.e. in the outer Minas Basin, Minas Passage, and Minas Channel system of the Inner Bay of Fundy); as well as migrants which occur in the area, and which can at times be numerous; and casual or occasional species which may occur by chance at the site. Residents are species including Great Black-backed Gull and Herring Gull, Double-crested Cormorant and Great Cormorant, Common Eider, Black Guillemot, and Common Loon; migrants include shorebirds, Red-throated Loon, sea ducks including Black Scoter, Surf Scoter and White-winged Scoter, and Long-tailed Duck, as well as waterfowl such as Red-Breasted Merganser; and casuals such as Canada Goose as well as other seasonally-occurring species such as American Black Duck, alcids (e.g. Atlantic Puffin, Common Murre, Razorbill) which occur at the site at certain seasons.

Several basic approaches to statistical analysis and modeling of the seabird data have been incorporated in the study to date. In future, as the data set expands, modeling approaches such as General Additive Modeling (GAM) could be tested to determine if they can provide additional insight into patterns of seabird abundance at the site, and in particular, in helping to assess whether tidal devices are affecting birds at the site.

The statistical study design for assessment of impacts of tidal devices on seabirds at the site is a before-after, control-impact (BACI) approach. The impact zone consists of open water zones at the study site both located in close proximity to the tidal devices (“Crown Lease”) and zones located at increasing distances from the Crown Lease area (outside Black Rock (OB) and farfield (FF) sites. In addition, the overall abundance of birds at the site, and their general behaviour and patterns, obtained during the monitoring program, provide the ability to determine changes resulting from the presence of tidal devices at the site by making comparisons throughout the study period both before and after periods when tidal devices are installed, or associated activities are taking place at the site. Although the monitoring program has shown that lower numbers of birds occur naturally in the OB and FF sites, this difference will not affect assessment of effects of turbines through Analysis of Variance, and the BACI approach should be continued.

In 2017-2018, opportunities did not arise to observe birds at the site during turbine installation or removal, or during phases of operations requiring significant vessel support, since surveys did not

coincide with such activity. In the Year-1 surveys, observations suggested that overall, seabird activity was not correlated with project activity. A consideration for future continuation of the monitoring program might be to conduct additional surveys whenever activities, such as the deployment or retrieval of gear, are taking place.

As in the Year-1 monitoring, the surveys in 2017-2018 have followed methodologies outlined in the FORCE 2016-2021 Environmental Effects Monitoring Program (EEMP) (SLR 2015), which reflects survey approaches used in other areas of the world for monitoring seabirds and other water-associated birds in the vicinity of tidal energy installations. Observations have been focused on subareas of the site which reflect potential areas of concern (e.g. the zone for turbine deployment—'Crown Lease') as well as nearby 'nearfield' or farfield areas. Observation height (~22 m) has been suitable and consistent throughout the survey, and has proven to be effective for our purposes. Observation distances are consistent with other studies (e.g. Robbins 2012; Jackson and Whitfield 2011) (the furthest corner of the Crown Lease area is approximately 3 km from the observation site) and our bird observer can confidently identify the presence of birds at and beyond that distance.

The Year-2 Environmental Effects Monitoring survey at the FORCE site is the second year-round survey of seabirds and water-associated birds at the FORCE site, using methods which were consistent with those in the baseline monitoring. Overall, the present survey has shown similar abundance and comparable diversity to the first year of monitoring, though both abundances and diversity are reduced compared with the earliest surveys (2010-2012). Abundance of some species of birds at the site, however, by all measures (including species comparisons between periods of time from earlier surveys) is reduced compared with the earlier observations over three years. Locally-nesting species (Black Guillemot and Common Eider) and other dominant species are not notably different in abundance and seasonal pattern. Compared with earlier surveys, the number of species observed in summer was larger this year; while in many surveys late in the year (2017) birds were virtually absent. Seabirds and water-associated birds using the site in Year-2 were represented mostly by coastal species which use inshore waters on a regular basis or during migration.

Several factors which are potentially important in influencing overall bird abundance at the site include: food availability; changes in atmospheric and oceanographic conditions; direct and indirect effects of presence of the demonstration site (i.e. activity associated with tidal energy development and tidal energy devices--much more activity at present than in earlier surveys); long term trends in abundance of migrants due to conditions in northern breeding areas and overwintering areas; and even fishing activity, in particular seine fisheries for Atlantic Herring in the area, are all potential factors. In particular, an increased understanding of food availability at the site may help to explain some of the observations from the survey.

The observation protocol used in the survey has been suitable for long-term monitoring. Data recording methods have been the same through the overall program, with minor refinements. In October, 2017 the protocol was changed slightly to include an additional 'snapshot' survey of birds present at the site, recorded mid-way through each half hour period. The additional information will help to improve estimates of variability in numbers within survey periods, which is useful in statistical analysis. In recent surveys, the on-site weather station at the FORCE Visitor Centre has provided more-detailed information

on atmospheric conditions at the site, and in the Year-1 and Year-2 surveys, sea state information has been routinely recorded.

4.2 Marine Mammals

FORCE's EEMP for seabirds has provided information on marine mammal occurrences at the tidal energy demonstration site, particularly Harbour Porpoise activity. Fewer sightings of Harbour Porpoise were made overall this year than in the earlier baseline surveys, including the Year-1 surveys (2016 – 2017). Abundance estimates are not as quantitative those for birds as Harbour Porpoise are not the primary focus of observations. The continued focus on ebb tidal periods has shown porpoises mainly travelling with the tidal current, although the species was sighted in Year-1 occasionally traveling with the incoming tidal current. Observations of Harbour Porpoise obtained in the FORCE monitoring program overall have provided important information on the occurrence and some of the activities and behavioural traits such as group size, of the species, which was not known before the FORCE EEMP took place. Based on the shore-based surveys, Harbour Porpoise is a common visitor from early spring to fall, with its abundance likely linked to movements of prey species, such as Atlantic Herring.

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Appendix A – Seabird Abundance by Sub-area

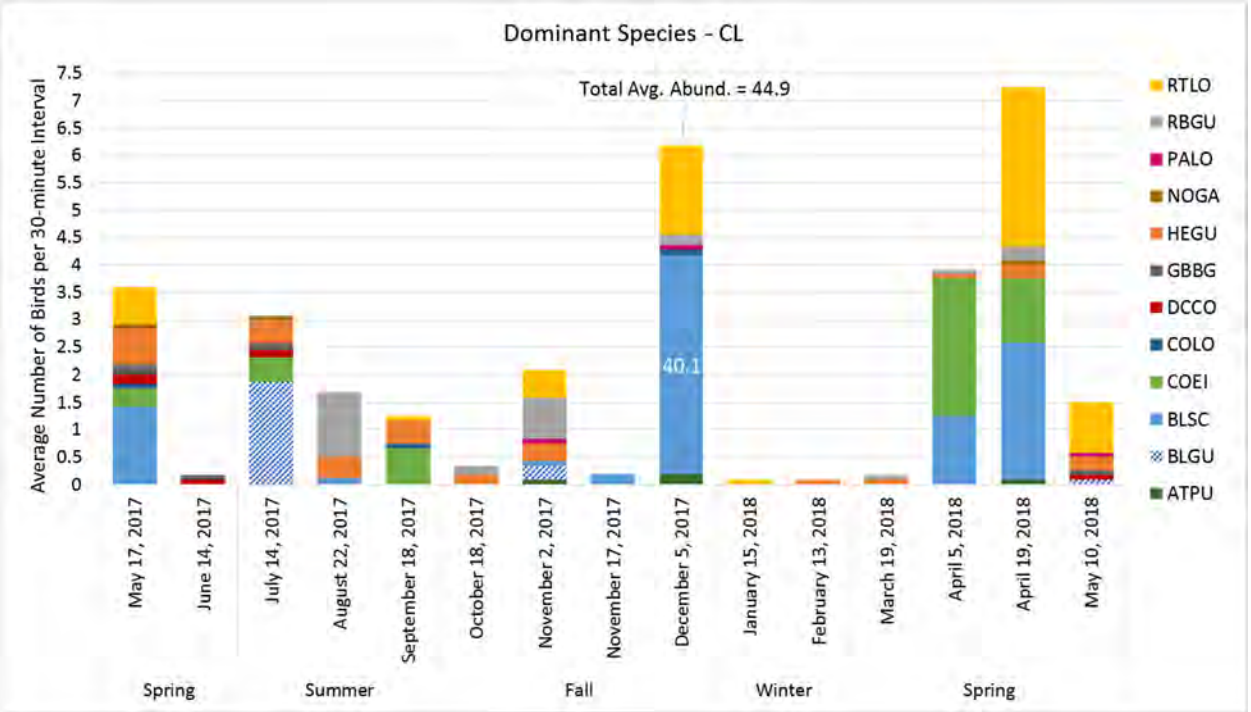

Figure A1. Average abundance of dominant birds per 30-minute interval in subarea CL.

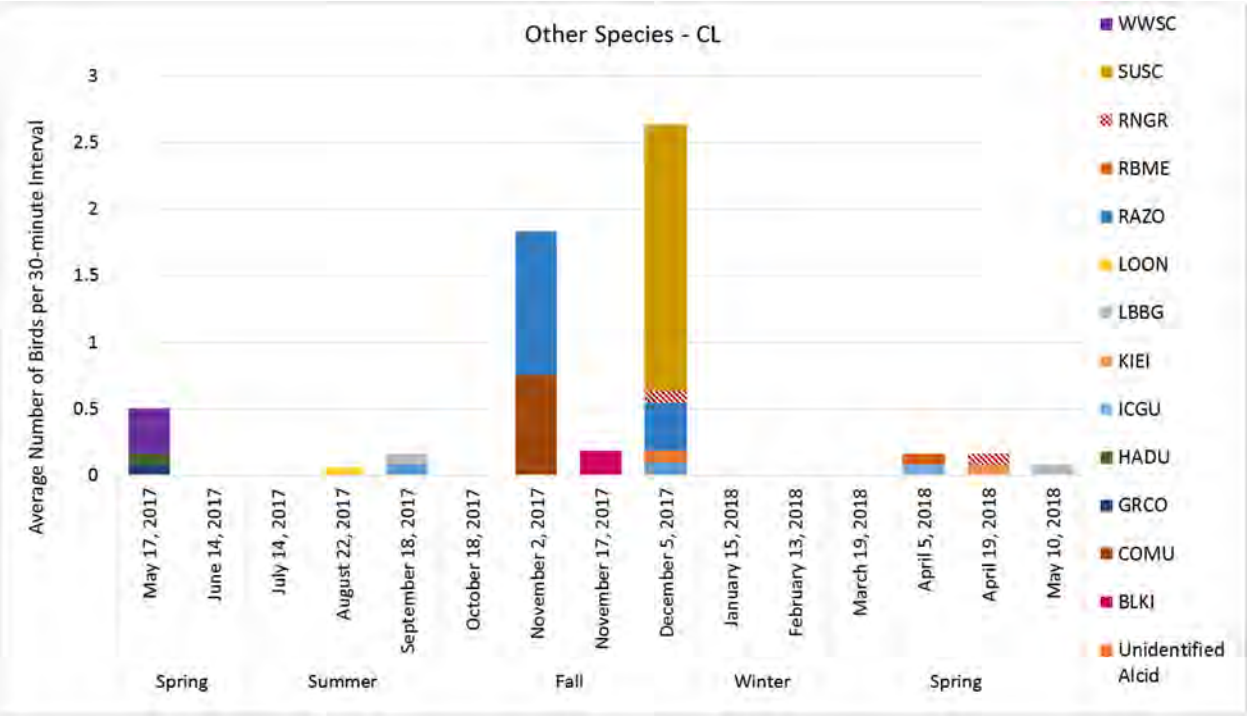

Figure A2. Average abundance of non-dominant birds per 30-minute interval in subarea CL.

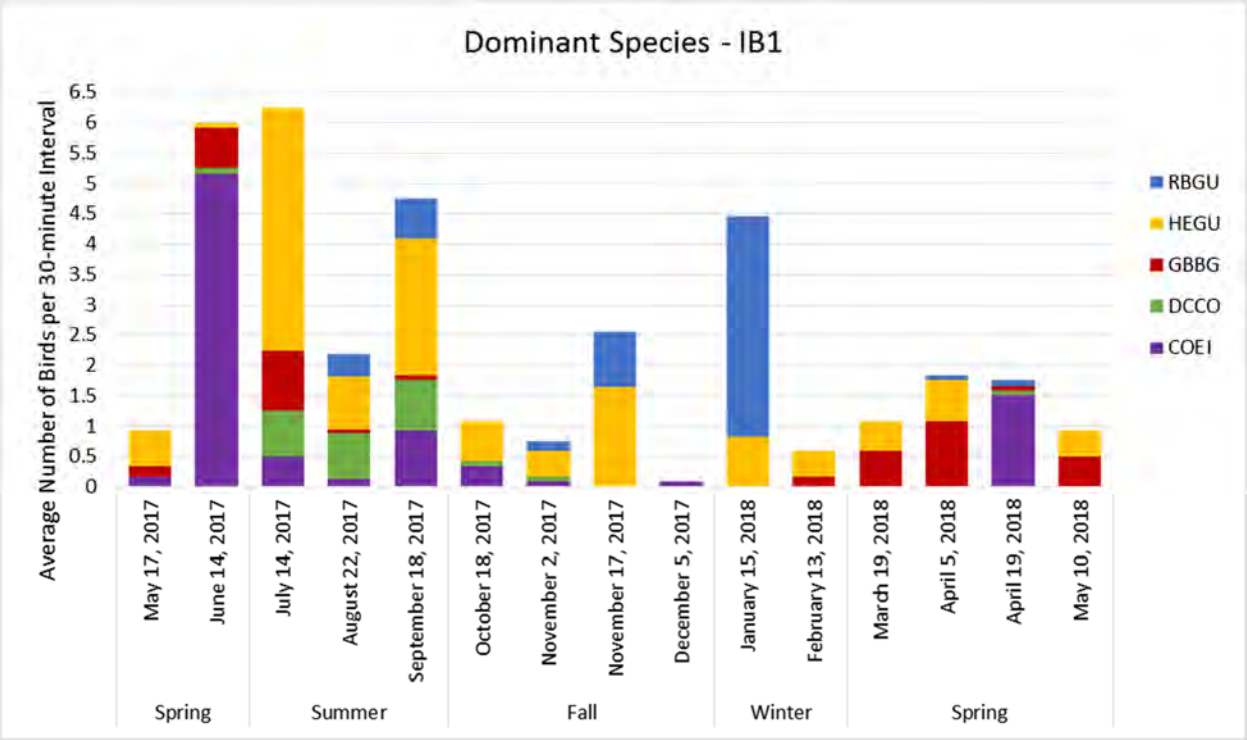

Figure A3. Average abundance of dominant birds per 30-minute interval in subarea IB1.

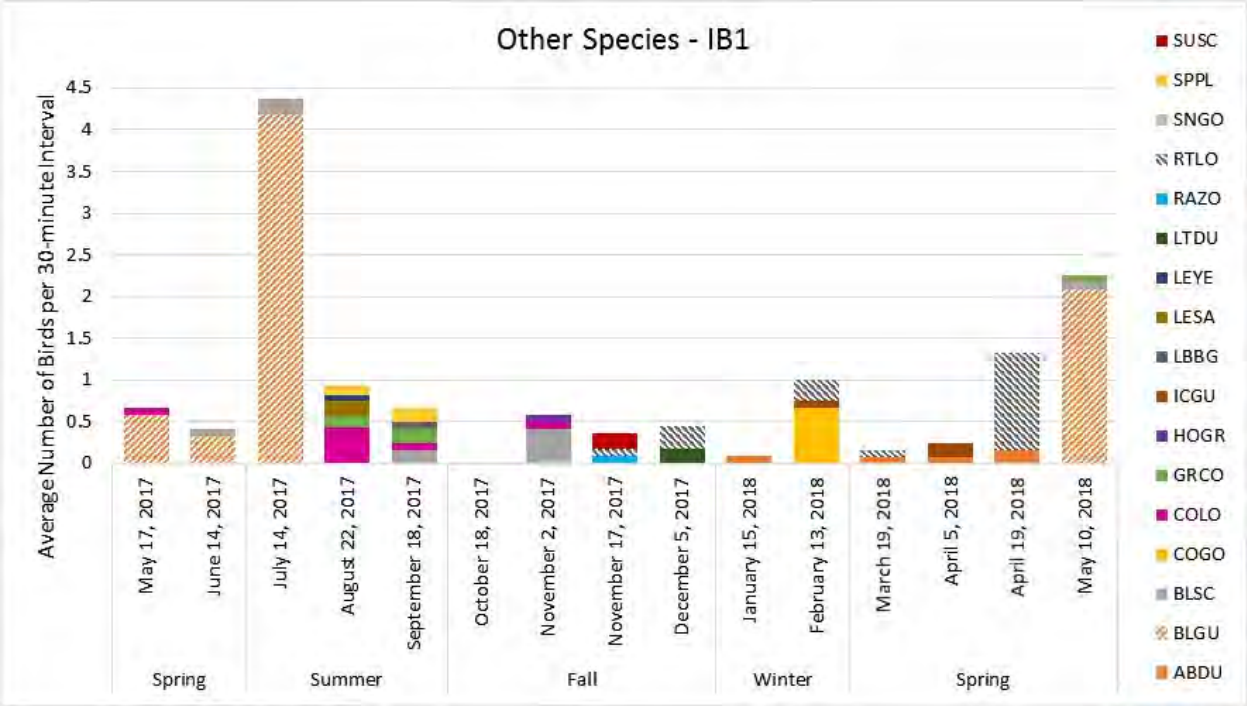

Figure A4. Average abundance of other birds per 30-minute interval in subarea IB1.

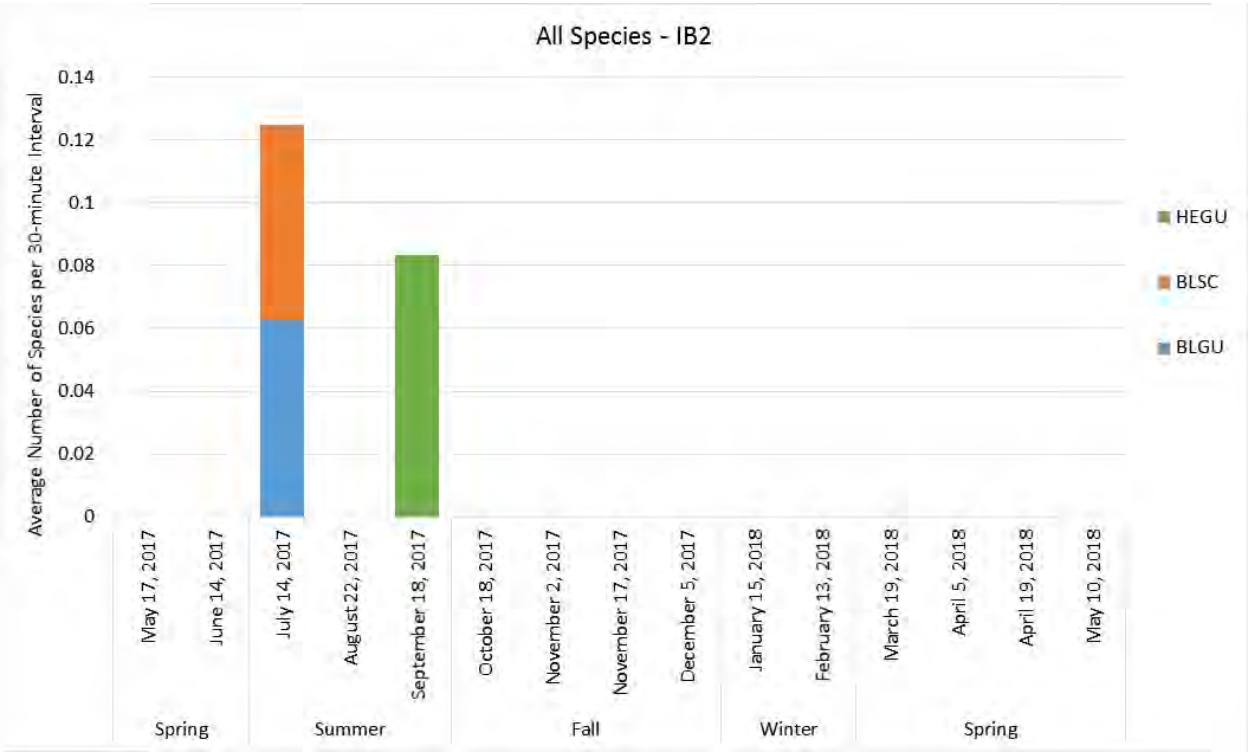

Figure A5. Average abundance of all birds per 30-minute interval in subarea IB2.

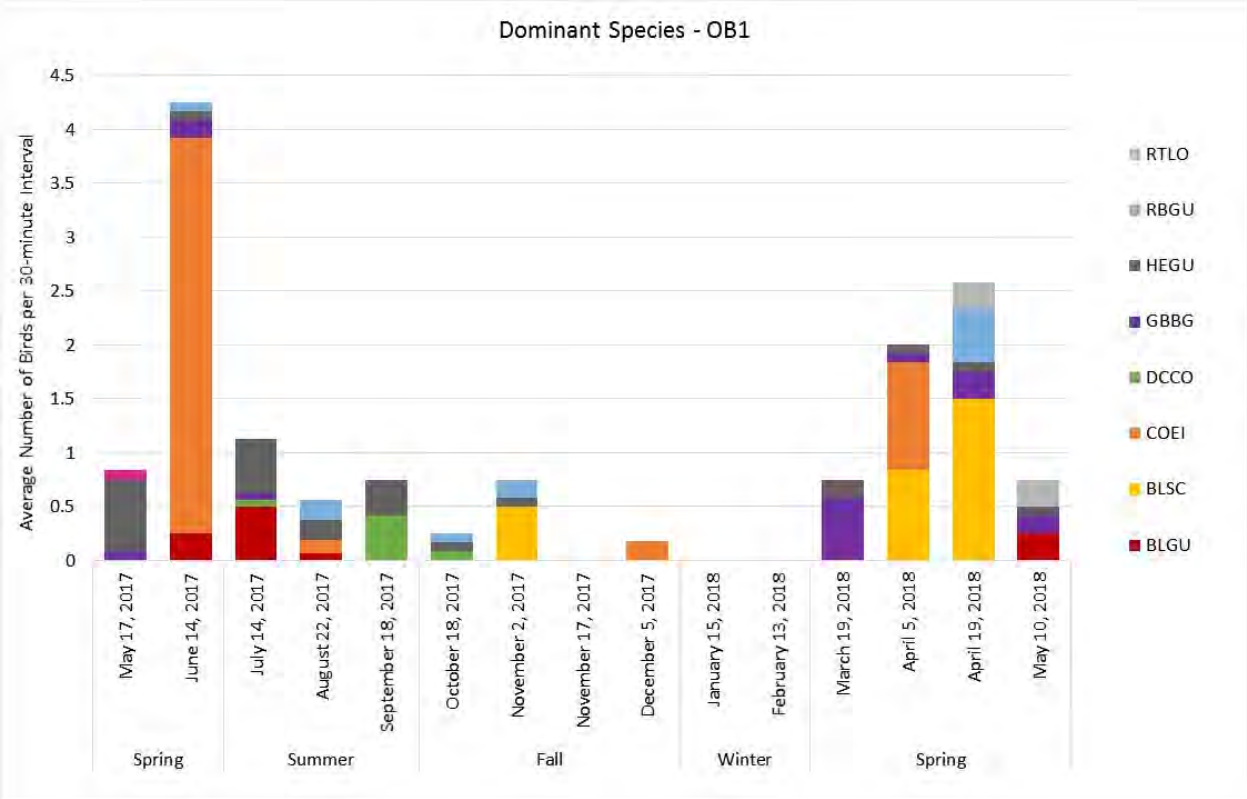

Figure A6. Average abundance of dominant birds per 30-minute interval in subarea OB1.

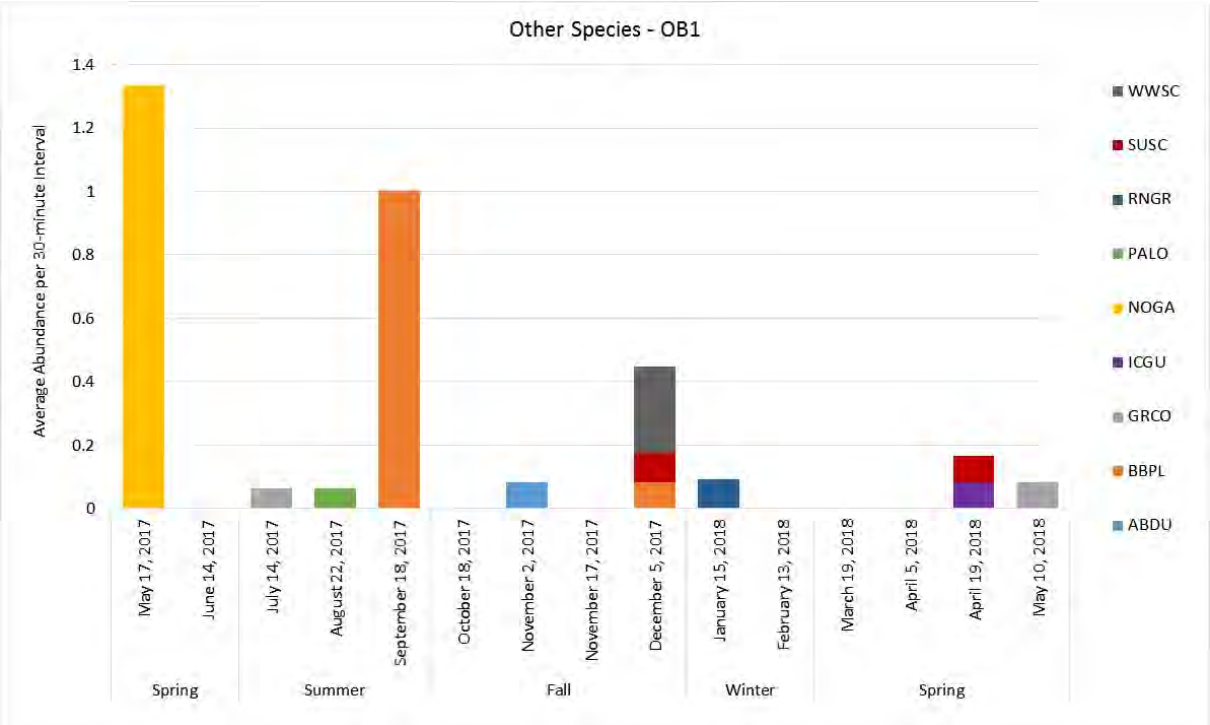

Figure A7. Average abundance of non-dominant birds per 30-minute interval in subarea OB1.

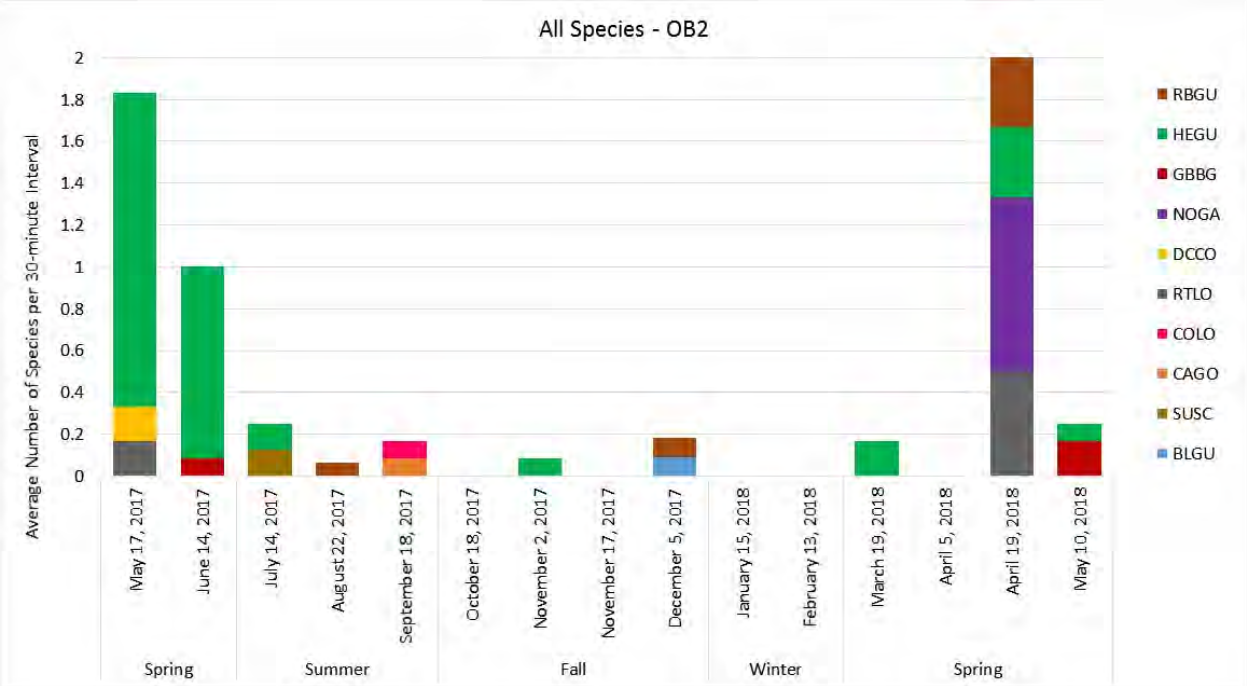

Figure A8. Average abundance of all birds per 30-minute interval in subarea OB2.

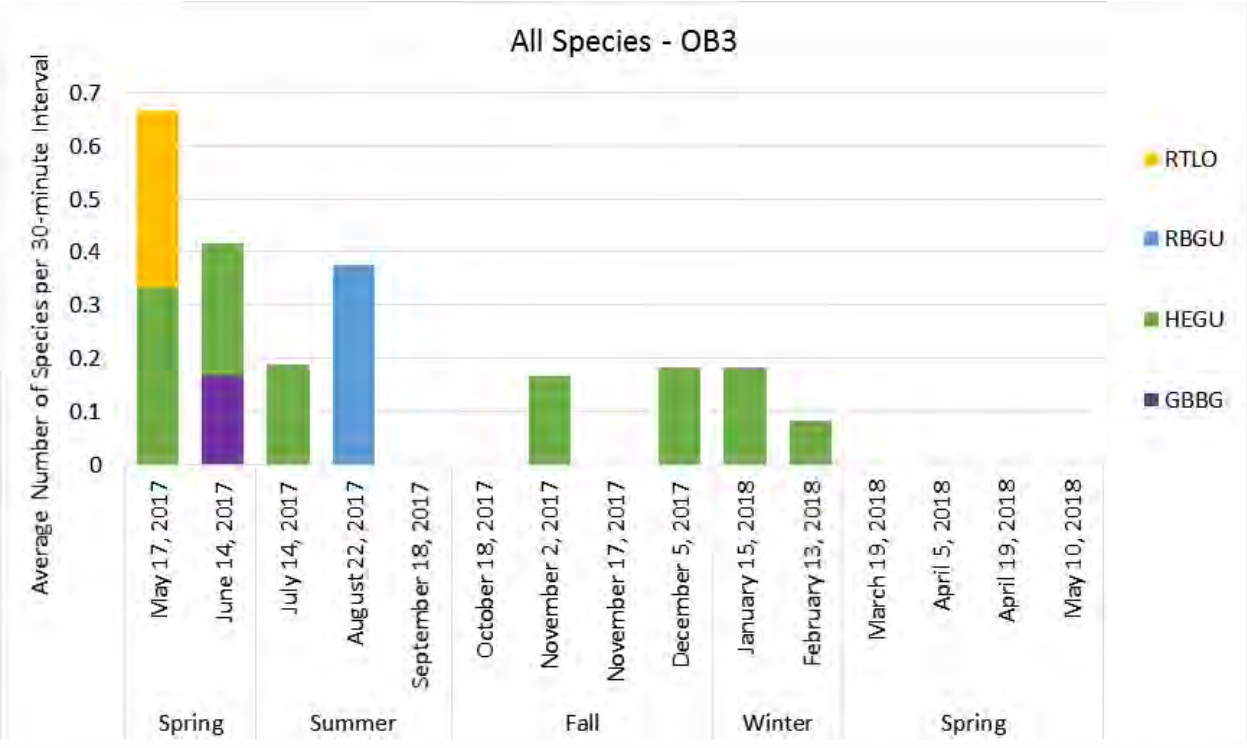

Figure A9. Average abundance of dominant birds per 30-minute interval in subarea OB3.

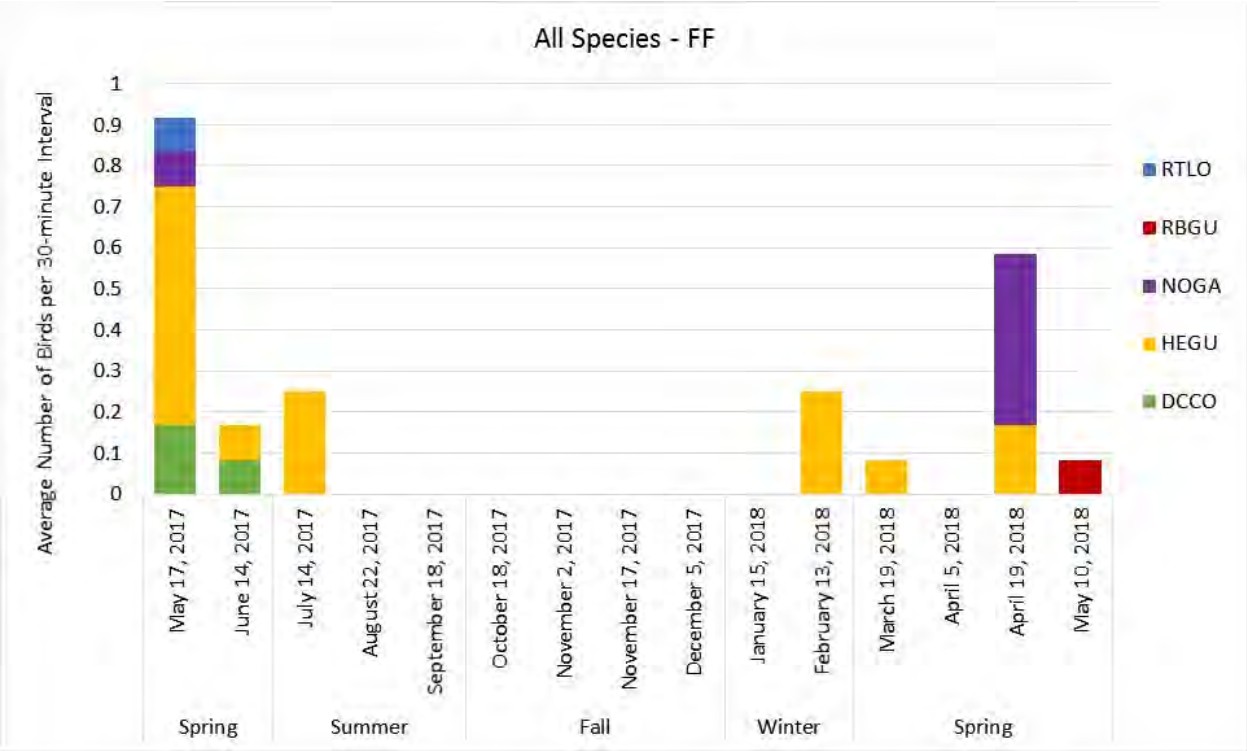

Figure A10. Average abundance of all birds per 30-minute interval in the farfield subareas.

Appendix B – Environmental Observations

Table B1. Environmental observations, Year-2 Marine Seabird Survey, FORCE Visitor Center, 2017-2018.

Survey Date	Survey Time	High Tide Time	Wind Speed (kph)			Average Wind Direction (Degrees)	Temperature (°C)			Sea Conditions		Cloud cover (%)	Visibility (km)
			High	Low	Average		High	Low	Average	Wave Height (m)	Surface Description		
ADT													
May.17. 2017	1200 - 1800	1817	29	12.6	18.8	298.0	14.0	11.4	12.6	< 0.5	ripples	5 - 100	> 5
June.14.2017	1200 - 1800	1703	25	11.5	15.4	74.3	17.7	16.1	16.9	< 0.5	ripples	15 - 90	> 5
July.14.2017	0635 - 1035	1721	11	0	5.7	NR	15.3	10.1	13.4	< 0.5	ripples / flat	0 - 50	> 5
	1215 - 1615		9	0.8	4.8	NR	22.8	18.7	20.5	< 0.5	ripples / flat		> 5
August.22.2017	0730 - 1130	1344	14	6.3	8.5	285.7	21.9	16.6	19.1	< 0.5	ripples	0 - 5	> 5
	1320 - 1720		12	4.6	6.9	293.8	24.1	22.2	23.0	< 0.5	ripples		> 5
September.18.2017	1145 - 1745	1145	11	1.8	7.6	115.7	19.7	16.7	18.3	< 0.5	flat	100	> 5
October.18.2017	1200 - 1800	1213	47	29.2	39.8	269.9	16.1	13.9	15.5	< 0.5	ripples	0	> 5
November.2.2017	1215 - 1815	1151	14	3.6	8.6	102.2	15.2	11.2	13.9	< 0.5	ripples	50 - 90	> 5
AST													
November.17.2017	1130 - 1700	1134	58	15	35.2	291.8	6.2	4.3	5.4	< 0.5	white caps / ripples	100	> 5
December.5.2017	1130 - 1700	1335	10	1.2	5.4	118.5	3.3	2.3	2.7	< 0.5	ripples	100	> 5
January.15.2018	1200 - 1700	1125	21	15.2	18.4	83.7	-5.3	-6.8	-6.1	< 0.5	ripples	80 - 100	>5
February.13.2018	1130 - 1730	1058	19	9.2	13.4	280.9	-4.5	-7.1	-5.3	< 0.5	ripples	0	> 5
ADT													
March.19.2018	1145 - 1745	1503	46	32.2	40.1	278.1	-1.3	-4.7	-3.0	< 0.5	white caps / ripples	5 - 10	1 - <0.5
April.5.2018	1215 - 1815	1215	66	52.9	60.0	273.5	0.5	-0.3	0.1	< 0.5	white caps / ripples	10 - 40	1 - <0.5
April.19.2018	1130 - 1730	1609	21	0.6	9.5	260.8	9.6	6.4	7.2	< 0.5	ripples / flat	70 - 100	>5
May.10.2018	1200 - 1800	920	16	7.6	11.4	115.3	10.8	8.7	9.5	< 0.5	ripples	100	>5

Appendix C – Seabird Abundance by Species and Survey-Year-2

Table C-1. Seabird and waterfowl abundance, shore-based observations – May 17, 2016 Survey.

Species	Date: May 17, 2017			Time: 12:00 – 18:00			Observer: Fulton Lavender Assistant: Valerie Kendall							
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.D.
BLGU	2	2	2	6	1	2	2	4	5	4	7	8	3.75	2.30
BLSC					17								1.42	4.91
COEI	2						4		1		2	1	0.83	1.27
COLO				1					1				0.17	0.39
DCCO			13	5	4	3	2	5	2	2	20	23	6.58	7.77
GBBG	11	12	12	10	9	5	9	10	14	13	16	13	11.17	2.86
GRCO					3	3	3	2	4	3	5	5	2.33	1.92
HADU							1						0.08	0.29
HEGU	20	19	22	21	23	21	16	11	9	12	2	23	16.58	6.68
NOGA					1		16					1	1.50	4.58
RTLO	1	1	1		4	2		4	1			2	1.33	1.44
WWSC					4								0.33	1.15
Average number of individual birds per half hour													**46.08**	**13.75**
Total Number of Species				**12**			**Average number of species per half hour**						**6.25**	**1.60**

Table C-2. Seabird and waterfowl abundance, shore-based observations – June 14, 2017 Survey.

Species	Date: June 14, 2017			Time: 12:30 – 18:30			Observer: Fulton Lavender Assistant: Patrick Stewart & Richard Hatch							
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.D.
BLGU					4	1		1	1			1	0.67	1.15
BLSC							1						0.08	0.29
COEI	7	6	21	32	29	29	28	21	22	13	2	20	19.17	10.03
DCCO	8	7	6		2	3	3	4	4	4	3	4	4.00	2.17
GBBG	7	4	3	7	6	10	11	9	11	12	17	9	8.83	3.81
GRCO			1									1	0.17	0.39
HEGU	4	1		3	3	3	5	5	7	14	3	3	4.25	3.57
NOHA											1		0.08	0.29
RBGU												1	0.08	0.29
Average number of individual birds per half hour													**37.33**	**9.66**
Total Number of Species				**9**			**Average number of species per half hour**						**4.67**	**0.98**

Table C-3. Seabird and waterfowl abundance, shore-based observations – July 14, 2017: Early Survey.

Species	Date: July 14, 2017			Time: 06:35 – 10:35			Observer: Fulton Lavender Assistant: Patrick Stewart & Richard Hatch							
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8					Average	S.D.
BLGU	4	6	5	6	10	16	16	8					8.88	4.76
COEI		4				2	5	3					1.75	2.05
DCCO	2	3	2	2			2	3					1.75	1.16
GBBG	7	13	9	10	2	2	2						5.63	4.75
GRCO	1												0.13	0.35
HEGU	45	62	27	12	1	3	1	2					19.13	23.39
SUSC			2										0.25	0.71
Average number of individual birds per half hour													**37.50**	**25.44**
Total Number of Species				**7**	**Average number of species per half hour**								**4.38**	**0.74**

Table C-4. Seabird and waterfowl abundance, shore-based observations – July 14, 2017: Late Survey.

Species	Date: July 14, 2017			Time: 06:35 – 10:35			Observer: Fulton Lavender Assistant: Patrick Stewart & Richard Hatch							
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8					Average	S.D.
BLGU	6	2	3	7	5	6		6					4.38	2.45
BLSC		2	1	1									0.50	0.76
COEI					4	2							0.75	1.49
DCCO	4	2	2	2	2	3	2	4					2.63	0.92
GBBG	1							1					0.25	0.46
GRCO				1									0.13	0.35
HEGU	1	9	1		3	7	9	8					4.75	3.88
NOGA					1								0.13	0.35
Average number of individual birds per half hour													**13.50**	**4.00**
Total Number of Species				**8**	**Average number of species per half hour**								**3.88**	**0.83**
Total Species for Early & Late Surveys							**9**							

Table C-5. Seabird and waterfowl abundance, shore-based observations – August 22, 2017: EARLY SURVEY.

Species	Date: August 22, 2017			Time: 07:30 – 11:30					Observer: Fulton Lavender Assistant: Valerie Kendall					
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.D.
BLSC						2							0.25	0.71
COEI	1	3											0.50	1.07
DCCO	1					5		1					0.88	1.73
GBBG							1						0.13	0.35
HEGU	1	2	2	5	1		2	3					2.00	1.51
LEYL						1							0.13	0.35
LESA	1												0.13	0.71
RBGU		9	3	7		6	1						3.25	3.62
SEPL			2										0.25	0.71
Average number of individual birds per half hour													**7.51**	**5.04**
Total Number of Species				**8**		**Average number of species per half hour**							**2.75**	**1.04**

Table C-6. Seabird and waterfowl abundance, shore-based observations – August 22, 2017: LATE SURVEY.

Species	Date: August 22, 2017			Time: 13:20 – 17:20					Observer: Fulton Lavender Assistant: Valerie Kendall					
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8					Average	S.D.
BLGU					1								0.13	0.35
COLO			2	1	1	1	1	1					0.88	0.64
DCCO	7	6	7	8	8	10	2	3					6.38	2.67
GRCO	1	2	2	5	10	7	5	7					4.88	3.09
HEGU	1	3	2	1		3							1.25	1.28
LESA		2				2	2						0.75	1.04
Loon			1										0.13	0.35
PALO	1												0.13	0.35
SPSA	2					2							0.50	0.93
Average number of individual birds per half hour													**15.00**	**5.07**
Total number of species			**8**			**Average number of species per half hour**							**4.38**	**0.92**
Total Species for Early & Late Surveys							**14**							

Table C-7. Seabird and waterfowl abundance, shore-based observations – September 18, 2017 Survey.

Species	Date: September 18, 2017			Time: 11:45 – 17:45			Observer: Fulton Lavender Assistant: Valerie Kendall							
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.D.
ABDU											1		0.08	0.29
BBPL		1											0.08	0.29
BLSC				2									0.17	0.58
CAGO										1			0.08	0.29
COEI			13	6									1.58	3.99
COLO										2	1		0.25	0.62
DCCO		5	1	4	4	1		1	3	2	2	4	2.25	1.71
GBBG				1									0.08	0.29
GRCO				8	6	2	1		1	1	1		1.67	2.61
HEGU	12	6	2			3	4	6		2	1	1	3.08	3.53
LBBG							1		1				0.17	0.39
RBGU	8												0.67	2.31
RTLO											1		0.08	0.29
SPPL							1	1					0.17	0.39
Total	**20**	**12**	**16**	**21**	**10**	**6**	**7**	**8**	**5**	**8**	**7**	**5**		
Average number of birds per half hour													**10.42**	**5.65**
Total number of species				**14**		**Average number of species per half hour**							**2.93**	**3.20**

Table C-8. Seabird and waterfowl abundance, shore-based observations – October 18, 2017 Survey.

Species	Date: October 18, 2017			Time: 12:00 – 18:00			Observer: Fulton Lavender Assistant: Valerie Kendall							
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.D.
COEI						1		1	1	1			0.33	0.49
DCCO											3	1	0.33	0.89
HEGU		2	1			1		2	2	1	2		0.92	0.90
RBGU											2	1	0.25	0.62
WWSC	1												0.08	0.29
Total	**1**	**2**	**1**	**0**	**0**	**2**	**0**	**3**	**3**	**2**	**7**	**2**		
Average number of birds per half hour													**1.92**	**1.93**
Total number of species				**5**		**Average number of species per half hour**							**3.20**	**2.39**

Table C-9. Seabird and waterfowl abundance, shore-based observations – November 2, 2017 Survey.

Species	Date: November 2, 2017			Time: 12:15 – 17:45			Observer: Fulton Lavender Assistant: Valerie Kendall							
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.D.
ABDU	1												0.08	0.29
ATPU		1											0.08	0.29
BLGU				3									0.25	0.87
BLSC		1						5			6		1.00	2.13
COEI		1											0.08	0.29
COLO		1											0.08	0.29
COMU		5		4									0.75	1.76
DCCO												1	0.08	0.29
GBBG				1									0.08	0.29
GRCO						1							0.08	0.29
HEGU	1	1	1	1	2	3	1	1	2			1	1.17	0.83
HOGR		1											0.08	0.29
PALO			1										0.08	0.29
RAZO		2		11									1.08	3.18
RBGU		1	3	2	2	2			3		1		1.17	1.19
RTLO	1			1	1		1	1	1				0.50	0.52
Total	**3**	**14**	**5**	**23**	**5**	**6**	**2**	**7**	**6**	**0**	**7**	**2**		
Average number of birds per half hour													**6.67**	**6.24**
Total number of species			**16**			**Average number of species per half hour**							**2.50**	**2.73**

Table C-10. Seabird and waterfowl abundance, shore-based observations – November 17, 2017 Survey.

Species	Date: November 17, 2017			Time: 11:30 – 17:00			Observer: Fulton Lavender Assistant: Valerie Kendall							
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.D.
BLKI				2									0.18	0.60
BLSC	2												0.18	0.60
HEGU			2	2	3		6		1	1	5		1.82	2.09
RAZO			1										0.09	0.30
RBGU							1	5	1	1	2		0.91	1.51
RTLO						1							0.09	0.30
SUSC	2												0.18	0.60
Total	**4**	**0**	**3**	**4**	**3**	**1**	**7**	**5**	**2**	**2**	**7**			
Average number of birds per half hour													**3.45**	**2.25**
Total number of species			**7**			**Average number of species per half hour**							**2.43**	**2.51**

Table C-11. Seabird and waterfowl abundance, shore-based observations – 5 December 2017.

Species	Date: 5 December 5 2017			Time: 11:30 – 17:00				Observer: Fulton Lavender Assistant: Valerie Kendall					
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	Average	S.Dev
ABDU			1									0.1	0.3
Alcid Sp.								1				0.1	0.3
ATPU								1	1			0.2	0.4
BLGU									1			0.1	0.3
BLSC	50	100	50				10	156	75			40.1	52.3
COEI	1		2		2							0.5	0.8
COLO								1				0.1	0.3
HEGU									2			0.2	0.6
LTDU				2								0.2	0.6
PALO								1				0.1	0.3
RAZO								3	1			0.4	0.9
RBGU								2		1		0.3	0.6
RNGR								1				0.1	0.3
RTLO		1			1			19				1.9	5.7
SUSC							22		1			2.1	6.6
WWSC					3							0.3	0.9
Total	**51**	**101**	**53**	**2**	**6**	**0**	**32**	**185**	**81**	**1**	**0**		
Average number of birds per half hour:												**46.5**	**15.9**
Total number of species: 16								**Average number of species per half hour:**				**2.6**	**4.8**

Table C-12. Seabird and waterfowl abundance, shore-based observations – 15 January 2018.

Species	Date: 15 January 2018				Time: 12:00 – 17:30				Observer: Fulton Lavender Assistant: Valerie Kendall				
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.												
	Number of Individuals Sighted per Observation Period												
	1	2	3	4	5	6	7	8	9	10	11	Average	S.Dev
ABDU						1						0.1	0.3
GBBG											2	0.2	0.6
HEGU	1			1	2			1	4	2	36	4.3	10.1
LBBG										2	1	0.3	0.6
RBGU											60	5.5	17.3
RNGR			1									0.1	0.3
RTLO	1											0.1	0.3
Total	**2**	**0**	**1**	**1**	**2**	**1**	**0**	**1**	**4**	**4**	**99**		
Average number of birds per half hour:												**10.5**	**29.4**
Total number of species: 7								**Average number of species per half hour:**				**1.3**	**1.1**

Table C-13. Seabird and waterfowl abundance, shore-based observations – 13 February 2018.

Species	Date: 13 February 2017					Time: 11:30 – 17:30						Observer: Fulton Lavender Assistant: Valerie Kendall		
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.Dev.
COGO									4			4	0.7	1.6
GBBG							1		1	22	33	53	10.0	17.5
HEGU	1	2		1	1		4				2	7	1.5	2.1
ICGU						1						2	0.3	0.6
LBBG										1			0.1	0.3
RTLO					1					1	1		0.3	0.5
Total	**1**	**2**	**0**	**1**	**2**	**1**	**5**	**0**	**5**	**24**	**36**	**66**		
Average number of birds per half hour:													**11.9**	**20.4**
Total number of species: 6						**Average number of species per half hour:**							**1.7**	**1.0**

Table C-14. Seabird and waterfowl abundance, shore-based observations – 19 March 2018.

Species	Date: 19 March 2018					Time: 11:45 – 17:45						Observer: Fulton Lavender Assistant: Valerie Kendall		
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.D.
ABDU												1	0.1	0.29
GBBG	10	9	7	11	12	12	10	12	12	12	6	16	10.8	2.63
HEGU	6	1	1				1	2	4	2		4	1.8	1.96
RBGU	1												0.1	0.29
RTLO												1	0.1	0.29
Total	**17**	**10**	**8**	**11**	**12**	**12**	**11**	**14**	**16**	**14**	**6**	**22**		
Average number of birds per half hour:													**12.8**	
Total number of species: 5						**Average number of species per half hour:**							**1.9**	

Table C-15. Seabird and waterfowl abundance, shore-based observations – 5 April 2018														
Species	Date: 5 April 2018				Time: 12:15 – 17:45				Observer: Fulton Lavender Assistant: Valerie Kendall					
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.Dev
ABDU	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.08**	**0.29**
BLSC	0	10	0	15	0	0	0	0	0	0	0	0	2.1	4.98
COEI	0	114	1	0	0	0	30	0	0	10	0	0	12.9	33.02
GBBG	1	5	7	7	7	7	7	8	17	12	18	21	9.8	5.97
GRCO	0	0	0	0	0	4	0	0	0	0	6	5	1.3	2.30
HEGU	1	4	2	0	1	0	1	0	1	1	5	4	1.7	1.72
ICGU	0	0	0	0	0	0	0	0	0	2	3	0	0.4	1.00
RBGU	0	0	0	1	0	0	0	0	0	0	1	0	0.2	0.39
RBME	0	0	0	1	0	0	0	0	0	0	0	0	0.1	0.29
Total	**2**	**133**	**11**	**24**	**8**	**11**	**38**	**8**	**18**	**25**	**33**	**30**		
												Average number of birds per half hour:	**28.4**	
Total number of species: 9												**Average number of species per half hour:**	**3.0**	

Table C-16. Seabird and waterfowl abundance, shore-based observations – 19 April 2018														
Species	Date: 19 April 2018				Time: 11:30 – 17:30				Observer: Fulton Lavender Assistant: Valerie Kendall					
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.Dev
ABDU	2	0	0	0	0	0	0	0	0	0	0	0	0.2	0.58
BLSC	18	0	15	0	0	0	0	0	15	0	0	0	4.0	7.27
COEI	5	2	3	3	6	6	20	9	10	7	8	8	7.3	4.73
DCCO	1	1	1	1	2	2	2	2	3	1	1	1	1.5	0.67
GBBG	5	10	11	9	14	16	14	16	22	16	17	12	13.50	4.44
GRCO	3	3	3	3	4	0	1	2	3	2	2	3	2.4	1.08
HEGU	0	3	2	9	3	4	5	5	5	4	4	6	4.2	2.21
ICGU	0	0	0	0	0	0	0	0	1	0	0	0	0.1	0.29
KIEI	1	0	0	0	0	0	0	0	0	0	0	0	0.1	0.29
NOGA	10	3	0	1	0	0	0	0	0	0	2	0	1.3	2.90
RBGU	0	0	1	3	4	1	0	0	3	0	2	0	1.2	1.47
RNGR	0	0	0	0	0	0	0	0	1	0	0	0	0.1	0.29
RTLO	2	1	3	1	1	0	3	6	4	1	24	12	4.8	6.86
SUSC	0	0	0	0	0	0	0	0	1	0	0	0	0.1	0.29
Total	**47**	**23**	**39**	**30**	**34**	**29**	**45**	**40**	**68**	**31**	**60**	**42**		
												Average number of birds per half hour:	**40.67**	
Total number of species: 14												**Average number of species per half hour:**	**7.25**	

Table C-17. Seabird and waterfowl abundance, shore-based observations – 10 May 2018														
Species	Date: 10 May 2018					Time: 12:00 – 18:00						Observer: Fulton Lavender Assistant: Valerie Kendall		
	Location: FORCE Visitor Center observation deck facing water, Parrsboro Nova Scotia.													
	Number of Individuals Sighted per Observation Period													
	1	2	3	4	5	6	7	8	9	10	11	12	Average	S.Dev
BLGU	6	5	1	3	0	0	2	3	0	11	1	0	2.7	3.31
BLSC	0	0	0	0	0	0	0	0	0	0	0	1	0.1	0.29
COEI	0	1	1	1	1	1	1	1	1	1	1	0	0.8	0.39
DCCO	2	0	0	0	0	0	0	0	0	0	0	0	0.2	0.58
GBBG	16	16	13	9	13	12	9	8	9	10	10	13	11.5	2.75
GRCO	1	2	0	0	0	0	1	0	0	0	0	2	0.5	0.80
HEGU	4	6	9	5	3	3	0	4	2	2	1	4	3.6	2.39
LBBG	0	0	0	0	1	0	0	0	0	0	0	0	0.1	0.29
PALO	0	0	0	0	0	1	0	0	0	0	0	0	0.1	0.29
RBGU	0	0	0	0	0	1	0	0	0	0	0	0	0.1	0.29
RTLO	0	5	1	2	0	5	0	1	0	0	0	0	1.2	1.90
Total	29	35	25	20	18	23	13	17	12	24	13	20		
Average number of birds per half hour:													20.8	
Total number of species: 11					Average number of species per half hour:								4.6	

Appendix D – Conservation Status of Seabirds, Other Water Associated Birds, And Coastal Raptors at the Force Site, 2010-2018

Table D1. Conservation status of seabirds and other water-associated birds and coastal raptors at the FORCE Tidal Energy Demonstration Site, 2010-2017. NAR=Not at Risk; SC = Special Concern; VUL=Vulnerable; THR=Threatened; EN=Endangered.

Common Name	Scientific Name	Conservation Status/Rank					
		COSEWIC	SARA	NS Endan-gered Status	Provincial Rarity Rank	Provincial General Status Rank (NR=not rated)	Other
American Black Duck	*Anas rubripes*				S5	4 Secure	
Arctic Loon	*Gavia arctica*					NR	Accidental
Atlantic Puffin	*Fratercula arctica*				S3B, S5N	3 Sensitive	
Bald Eagle	*Haliaeetus leucocephalus*	NAR			S5	4 Secure	Terrestrial
Black-Bellied Plover	*Pluvialis squatarola*				S3M	4 Secure	
Black Guillemot	*Cepphus grylle*				S4	4 Secure	
Black-Legged Kittiwake	*Rissa tridactyla*				S3B, S5N	3 Sensitive	
Black Scoter	*Melanitta nigra*				S4N	4 Secure	
Black Tern	*Chlidonias niger*	NAR			S1B	2 May Be At Risk	
Blue-Winged Teal	*Anas discors*				S3S4B	2 May Be At Risk	
Canada Goose	*Branta canadensis*				SNAB, S4N	4 Secure	
Common Eider	*Somateria mollissima*				S3S4	4 Secure	
Common Goldeneye	*Bucephala clangula*				S2B, S5W	4 Secure	
Common Loon	*Gavia immer*	NAR			S3B, S4N	2 May Be At Risk	
Common Merganser	*Mergus merganser*				S5	4 Secure	
Common Murre	*Uria aalge*				S1?B, S5N	4 Secure	
Cory's Shearwater	*Calonectris diomedea*				SNA	8 Accidental	
Double-Crested Cormorant	*Phalacrocorax auritus*	NAR			S4B	4 Secure	
Great Black-Backed Gull	*Larus marinus*				S4S5	4 Secure	
Great Cormorant	*Phalacrocorax carbo*				S2S3	3 Sensitive	
Great Shearwater	*Puffinus gravis*				S5N	4 Secure	
Greater Yellowlegs	*Tringa melanoleuca*				S3B, S3S4M	3 Sensitive	
Harlequin Duck	*Histrionicus histrionicus*	SC	SC	EN	S2N	1 At Risk	
Herring Gull	*Larus argentatus*				S5	4 Secure	
Horned Grebe	*Podiceps auritus*				S4W	4 Secure	
Iceland Gull	*Larus glaucoides*				S4N	4 Secure	
King Eider	*Somateria spectabilis*				SNA	4 Secure	
Laughing Gull	*Larus atricilla*				SHB	2 May Be At Risk	
Lesser Black-Backed Gull	*Larus fuscus*				SNA	8 Accidental	
Least Sandpiper	*Calidris minutilla*				S1B, S3M	4 Secure	
Lesser Yellowlegs	*Tringa flavipes*				S3M	4 Secure	
Long-Tailed Duck	*Clangula hyemalis*				S5N	4 Secure	
Mallard	*Anas platyrhynchos*				S5	4 Secure	
Mew Gull	*Larus canus*				SNA	8 Accidental	
Northern Gannet	*Morus bassanus*				SHB, S5M	4 Secure	
Northern Harrier	*Circus cyaneus*	NAR			S3S4B	4 Secure	Terrestrial
Northern Shoveler	*Anas clypeata*				S2B	2 May Be At Risk	
Pacific Loon	*Gavia pacifica*				SNA	8 Accidental	
Peregrine Falcon	*Falco peregrinus*	NAR	SC	VUL	S1B, SNAM	3 Sensitive	Terrestrial
Purple Sandpiper	*Calildris maritima*				S3?N	3 Sensitive	
Razorbill	*Alca torda*				S2B, S4N	3 Sensitive	
Ring-Billed Gull	*Larus delawarensis*				SUB, S5N	4 Secure	
Red-Breasted Merganser	*Mergus serrator*				S3S4B, S5N	4 Secure	
Red Phalarope	*Phalaropus fulicarius*				S2S3M	3 Sensitive	

Red-Necked Grebe	*Podiceps grisigena*				S4N	4 Secure	
Red-Necked Phalarope	*Phalaropus lobatus*	SC			S2S3M	3 Sensitive	
Red-Throated Loon	*Gavia stellata*				S4N	4 Secure	
Ruddy Turnstone	*Arenaria interpres*				S3M	4 Secure	
Sanderling	*Calidris alba*				S3M, S2N	4 Secure	
Semipalmated Plover	*Charadrius semipalmatus*				S1B, S3S4M	4 Secure	
Semipalmated Sandpiper	*Calidris pusilla*				S3M	3 Sensitive	
Sooty Shearwater	*Puffinus griseus*				S5N	4 Secure	
Snow Goose	*Anser caerulescens*				SNA	4 Secure	
Spotted Sandpiper	*Actitis macularius*				S3S4B	3 Sensitive	
Surf Scoter	*Melanitta perspicillata*				S4N	4 Secure	
Thick-Billed Murre	*Uria lomvia*				SNA	4 Secure	
Wilson's Storm-Petrel	*Oceanites oceanicus*				S5N	4 Secure	
White-Winged Scoter	*Melanitta fusca*				S4N	4 Secure	

Table D2. Conservation status codes used in Table D1. Source: Atlantic Canada Conservation Data Centre, http://www.accdc.com/en/rank-definitions.html

Provincial) Rarity Rank

S1 **Critically Imperiled-** Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.

S2 **Imperiled-**Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.

S3 **Vulnerable-**Uncommon throughout its range in the province, or found only in a restricted range, even if abundant in at some locations (21 to 100 occurrences).

S4 **Apparently Secure**-Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the Element is of long-term concern (e.g. watch list). (100+ occurrences).

S5 **Secure**-Demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions.

SU **Unrankable -** Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

SNA **Not Applicable –** A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

Codes Attached to Provincial Rarity Rank

B **Breeding-** Conservation status refers to the breeding population of the province.

NB **Nonbreeding-**Conservation status refers to the non-breeding population of the province.

M **Migrant-**Migrant species occurring regularly on migration at particular concentration spots where the species might warrant conservation attention; status refers to the agtregatin transient population of the species in the area.

? **Inexact or Uncertain-**Denotes inexact or uncertain numeric rank (The ? qualifies the character immediately preceding it in the S-rank.)

Provincial General Status of Wild Species Rank listed for Nova Scotia

0.2=Extinct (Blue);
0.1=Extirpated (Purple);
1=At Risk (Red);
2=May be at Risk (Orange);
3=Sensitive (Yellow);
4=Secure (Green);
5=Undetermined (light grey);
6=Not Assessed (dark grey);
7=Exotic (Black);
8=Accidental (Aqua).

Appendix E – Tables Comparing Abundance of Common Seabird Species During Periods of Deployment of Cape Sharp Tidal Inc. Turbine at the FORCE Site with Periods when Turbine was Absent, 2016-2018

Table E1. Comparison of average abundance (counts per 30 minutes) of Herring Gull in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	1.2	0.0	1.2	3.5	0.0	3.5
December	16.8	16.4	0.3	0.2	0.0	0.2
January	25.2	2.8	22.4	4.3	3.3	1.0
February	3.4	1.5	1.9	1.5	0.7	0.8
March	2.7	1.5	1.2	1.8	0.8	1.0
April**	24.8	19.2	5.6	2.9	2.0	0.9
May**	13.4	10.4	3.0	5.0	4.3	0.7
June	4.2	2.8	1.4	13.0	12.8	0.3

**2 surveys for both turbine present and absent.

Table E2. Comparison of average abundance (counts per 30 minutes) of Great Black-backed Gull in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.0	0.0	0.0	0.0	0.0	0.0
December	0.2	0.1	0.1	0.0	0.0	0.0
January	27.5	26.7	0.8	0.2	0.2	0.0
February	4.8	4.6	0.3	9.2	9.0	0.2
March	4.9	4.9	0.0	10.8	9.6	1.2
April**	11.0	8.6	2.4	11.5	10.7	0.9
May**	16.1	15.7	0.4	15.5	14.6	0.9
June	8.8	7.8	1.1	19.3	18.5	0.8

**2 surveys for both turbine present and absent.

Table E3. Comparison of average abundance (counts per 30 minutes) of Ring-billed Gull in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.8	0.0	0.8	0.5	0.0	0.5
December	0.1	0.1	0.0	0.3	0.0	0.3
January	0.0	0.0	0.0	5.5	1.8	3.6
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.1	0.0	0.1

Table E3. Comparison of average abundance (counts per 30 minutes) of Ring-billed Gull in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
April**	0.2	0.0	0.2	0.7	0.0	0.7
May**	0.0	0.0	0.0	0.0	0.0	0.0
June	0.1	0.0	0.1	0.1	0.1	0.0

**2 surveys for both turbine present and absent.

Table E4. Comparison of average abundance (counts per 30 minutes) of Red-throated Loon in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	3.3	0.0	3.3	0.6	0.0	0.6
December	0.0	0.0	0.0	1.9	0.0	1.9
January	0.0	0.0	0.0	0.1	0.0	0.1
February	0.2	0.0	0.2	0.3	0.0	0.3
March	0.2	0.0	0.2	0.1	0.0	0.1
April**	8.2	0.0	8.2	2.4	0.0	2.4
May**	1.2	0.0	1.2	1.0	0.0	1.0
June	0.0	0.0	0.0	0.2	0.0	0.2

**2 surveys for both turbine present and absent.

Table E5. Comparison of average abundance (counts per 30 minutes) of Common Loon in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.1	0.0	0.1	0.0	0.0	0.0
December	0.0	0.0	0.0	0.1	0.0	0.1
January	0.3	0.0	0.3	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.1	0.0	0.1	0.0	0.0	0.0
April**	0.0	0.0	0.0	1.3	0.0	1.3
May**	0.1	0.0	0.1	0.0	0.0	0.0
June	0.0	0.0	0.0	0.4	0.0	0.4

**2 surveys for both turbine present and absent.

Table E6. Comparison of average abundance (counts per 30 minutes) of Black Scoter in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.5	0.0	0.5	16.4	0.0	16.4
December	0.0	0.0	0.0	40.1	0.0	40.1
January	0.0	0.0	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0	0.0	0.0
April**	25.9	0.0	25.9	3.1	0.0	3.1
May**	1.2	0.0	1.2	0.2	0.0	0.2
June	0.1	0.0	0.1	0.0	0.0	0.0

**2 surveys for both turbine present and absent.

Table E7. Comparison of average abundance (counts per 30 minutes) of Common Eider in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.4	0.0	0.4	0.0	0.0	0.0
December	0.0	0.0	0.0	0.3	0.0	0.3
January	0.4	0.0	0.4	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.4	0.0	0.4	0.0	0.0	0.0
April**	5.3	0.8	4.5	8.8	2.4	6.5
May**	1.6	0.8	0.8	0.0	0.0	0.0
June	19.2	10.3	8.9	3.6	2.2	1.4

**2 surveys for both turbine present and absent.

Table E8. Comparison of average abundance (counts per 30 minutes) of Black Guillemot in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.1	0.0	0.1	0.0	0.0	0.0
December	0.0	0.0	0.0	0.1	0.0	0.1
January	0.0	0.0	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0	0.0	0.0
April**	0.0	0.0	0.0	0.0	0.0	0.0
May**	2.6	1.9	0.7	1.6	0.2	1.4

Table E8. Comparison of average abundance (counts per 30 minutes) of Black Guillemot in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
June	0.7	0.1	0.6	0.8	0.0	0.8

**2 surveys for both turbine present and absent.

Table E9. Comparison of average abundance (counts per 30 minutes) of Double-crested Cormorant in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.0	0.0	0.0	0.0	0.0	0.0
December	0.0	0.0	0.0	0.0	0.0	0.0
January	0.0	0.0	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0	0.0	0.0
April**	36.8	30.6	6.2	0.8	0.7	0.0
May**	17.8	17.1	0.8	2.0	1.7	0.4
June	4.0	3.8	0.2	4.2	3.1	1.2

**2 surveys for both turbine present and absent.

Table E10. Comparison of average abundance (counts per 30 minutes) of Great Cormorant in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.0	0.0	0.0	0.0	0.0	0.0
December	0.0	0.0	0.0	0.0	0.0	0.0
January	0.0	0.0	0.0	0.0	0.0	0.0
February	0.3	0.0	0.3	0.0	0.0	0.0
March	0.2	0.1	0.1	0.0	0.0	0.0
April**	2.1	2.1	0.0	1.8	1.8	0.0
May**	1.1	1.1	0.0	1.4	1.3	0.1
June	0.2	0.2	0.0	0.8	0.5	0.3

**2 surveys for both turbine present and absent.

Table E11. Comparison of average abundance (counts per 30 minutes) of American Black Duck in surveys in months in the 2016-2018 period (Year-1 and Year-2 surveys) when the Cape Sharp Tidal Inc. turbine was installed compared to surveys when no turbine was present.

MONTH	Turbine Present			No Turbine		
	Overall Abundance	Black Rock	Open Water Areas	Overall Abundance	Black Rock	Open Water Areas
November**	0.0	0.0	0.0	0.0	0.0	0.0
December	0.2	0.0	0.2	0.1	0.0	0.1
January	0.3	0.0	0.3	0.1	0.0	0.1
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.4	0.0	0.4	0.1	0.0	0.1
April**	0.0	0.0	0.0	0.1	0.0	0.1
May**	0.0	0.0	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0	0.0	0.0

**2 surveys for both turbine present and absent.

Appendix F – Modeling Seasonal Abundance Patterns of Seabirds and Water-associated Birds at the FORCE Site, 2010-2018

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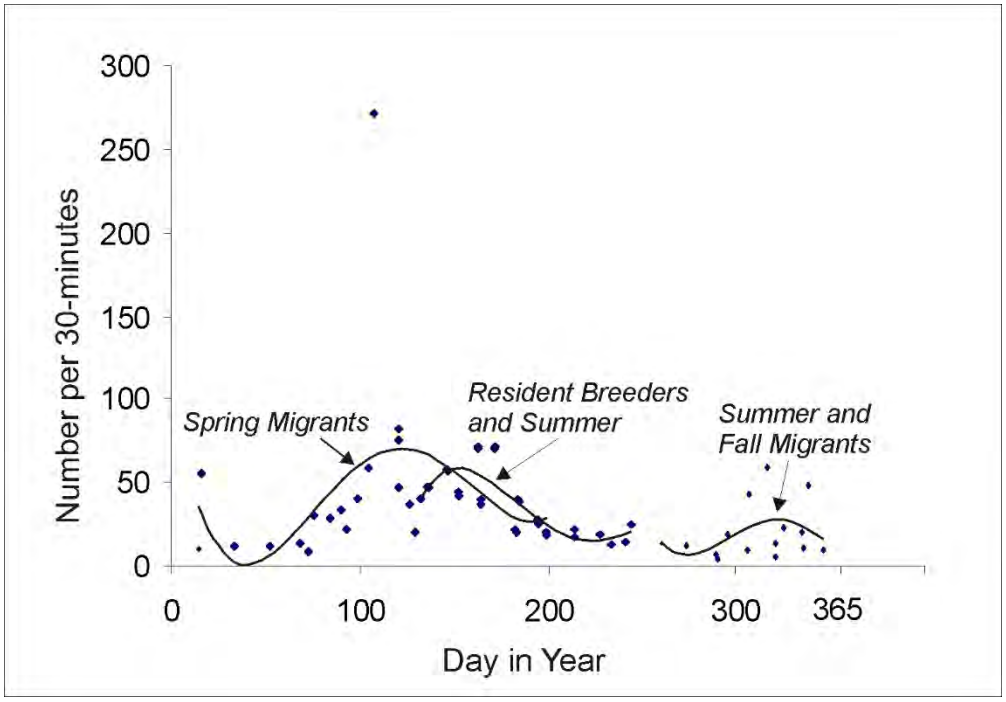

Fourth order polynomial curves fitted by least squares regression to bird abundance (number per 30-minutes) at the FORCE site, 2010-2018, illustrating timing peaks of spring migrants, resident and summer occurrences, and late summer / fall migrants. The periods covered by each curve were: Spring Migrants (January 1 – July 31); Resident Breeders and Summer Migrants (May 13 – August 31); and late summer, fall and early winter residents and migrants (mid-September to mid-December). The best fit obtained was for resident breeders and summer occurrences which explained 72% of the variance; the other two curves explained less of the variance (17% and 15% for spring and fall, respectively) owing to the high variability introduced by migrants both in numbers and in timing of the peaks in different years. Times of peak abundance determined from the analysis were: Spring migrants (April 15); resident breeders and summer migrants (May 30); and late summer and fall migrants (December 1). Polynomials were generated using the least-squares polynomial curve-fitting feature of Microsoft Excel.

Appendix G – Seasonal Abundance of Seabirds and Water-associated Birds at the FORCE Site, 2016-2018

Table G1. FORCE Marine Seabirds Monitoring Program Year 2, (2017-2018). Average abundance per 30-minute period.

		Date	May. 17.17	Jun. 14.17	Jul. 14.17	Aug. 22.17	Sep.18.17	Oct.18.17	Nov.2.17	Nov.17.17	Dec. 5.17	Jan. 15.18	Feb.13.18	Mar.19.18	Apr. 5.18	Apr.19.18	May.10.17
		Julian Day	137	165	195	234	261	291	306	321	339	15	34	68	85	99	130
Code	Common Name	Scientific Name / Periods per day	12	12	12	16	12	12	12	11	11	11	12	12	12	12	12
ABDU	American Black Duck	*Anas rubripes*					0.08		0.08		0.09	0.09		0.08	0.08	0.17	
ALCID	Alcid Unidentified	*Alcidae*									0.09						
ATPU	Atlantic Puffin	*Fratercula arctica*							0.08		0.18					0.08	
BBPL	Black-Bellied Plover	*Pluvialis squatarola*					0.08										
BLGU	Black Guillemot	*Cepphus grylle*	3.75	0.67	6.69	0.06			0.25		0.09						2.67
BLKI	Black-Legged Kittiwake	*Rissa tridactyla*								0.18							
BLSC	Black Scoter	*Melanitta nigra*	1.42	0.08	0.25	0.13	0.17		1.00	0.18	40.09				2.08	4.00	0.08
CAGO	Canada Goose	*Branta canadensis*					0.08										
COEI	Common Eider	*Somateria mollissima*	0.83	19.17	1.25	0.25	1.58	0.33	0.08		0.27				12.92	7.25	0.83
COGO	Common Goldeneye	*Bucephala clangula*											0.67				
COLO	Common Loon	*Gavia immer*	0.17			0.44	0.25		0.08		0.09						
COMU	Common Murre	*Uria aalge*							0.75								
DCCO	Double-Crested Cormorant	*Phalacrocorax auritus*	6.58	4.00	2.19	3.25	2.25	0.25	0.08							1.50	0.17
GBBG	Great Black-Backed Gull	*Larus marinus*	11.25	8.83	2.94	0.06	0.08		0.08			0.18	9.17	10.75	9.75	13.50	11.50
GRCO	Great Cormorant	*Phalacrocorax carbo*	2.33	0.17	0.13	2.38	1.67								1.25	2.42	0.50
HADU	Harlequin Duck	*Histrionicus histrionicus*	0.08														
HEGU	Herring Gull	*Larus argentatus*	16.75	4.25	12.00	1.63	3.08	0.92	1.08	1.64	0.18	4.27	1.50	1.75	1.67	4.17	3.58
HOGR	Horned Grebe	*Podiceps auritus*							0.08								
ICGU	Iceland Gull	*Larus glaucoides*											0.25		0.42	0.08	
KIEI	King Eider	*Somateria spectabilis*														0.08	
LBBG	Lesser Black-Backed Gull	*Larus fuscus*					0.17					0.27	0.08				0.08
LESA	Least Sandpiper	*Calidris minutilla*				0.31											
LEYE	Lesser Yellowlegs	*Tringa flavipes*				0.06											
LOON	Loon Unidentified	*Gaviidae*				0.06											
LTDU	Long-Tailed Duck	*Clangula hyemalis*									0.18						
NOGA	Northern Gannet	*Morus bassanus*	1.50		0.06											1.33	
PALO	Pacific Loon	*Gavia pacifica*				0.06			0.08		0.09						0.08
RAZO	Razorbill	*Alca torda*							1.08	0.09	0.36						
RBGU	Ring-Billed Gull	*Larus delawarensis*		0.08		2.19	0.67	0.25	1.08	0.91	0.27	5.45		0.08	0.17	1.17	0.08
RBME	Red-Breasted Merganser	*Mergus serrator*													0.08		
RNGR	Red-Necked Grebe	*Podiceps grisigena*									0.09	0.09				0.08	
RTLO	Red-Throated Loon	*Gavia stellata*	1.33				0.08		0.50	0.09	1.91	0.09	0.25	0.08		4.83	1.17
SPPL	Semipalmated Plover	*Charadrius semipalmatus*				0.13	0.17										
SPSA	Spotted Sandpiper	*Actitis macularius*				0.19											
SUSC	Surf Scoter	*Melanitta perspicillata*			0.13					0.18	2.09					0.08	
WWSC	White-Winged Scoter	*Melanitta fusca*	0.33					0.08			0.27						