Haul-out Counts and Photo-Identification of Pinnipeds in Chesapeake Bay and Eastern Shore, Virginia: 2017/2018 Annual Progress Report

Prepared by

Danielle V. Jones, Deanna R. Rees, and Brittany A. Bartlett

Naval Facilities Engineering Command Atlantic
Norfolk, Virginia

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Acronyms and Abbreviations

BSS	Beaufort sea state
CBBT	Chesapeake Bay Bridge Tunnel
CI	Confidence Interval
ES	Eastern Shore
°F	degrees Fahrenheit
ft	feet
GA	General Authorization for Scientific Research
Hg	Gray seal (*Halichoerus grypus atlantica*)
km	kilometer(s)
m	meter(s)
min	minute
MLLW	Mean lower low water
mm	millimeter(s)
MMPA	Marine Mammal Protection Act
NAVFAC LANT	Naval Facilities Engineering Command Atlantic
NOAA	National Oceanic and Atmospheric Administration
Photo-ID	photo identification
Pv	Harbor seal (*Phoca vitulina*)
SAR	Stock Assessment Report
TNC	The Nature Conservancy
UAS	Unmanned aircraft systems
U.S.	United States
USFF	United States Fleet Forces Command
VA	Virginia
VAQF	Virginia Aquarium & Marine Science Center Foundation
VDGIF	Virginia Department of Game and Inland Fisheries

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1. Introduction and Background

Harbor seals (*Phoca vitulina*) are one of the world's most widely distributed pinniped species and are found in temperate to polar coastal waters of the northern hemisphere (Jefferson et al. 2015). Gray seals (*Halichoerus grypus atlantica*) are widely distributed over the continental shelf in cold temperate and sub-polar North Atlantic waters (Lesage and Hammill 2001).

Within the last five years, there has been some disagreement about the southern range extent for harbor and gray seal stocks in the Western North Atlantic. References cited by the National Oceanic and Atmospheric Administration (NOAA) 2017 Stock Assessment Report (SAR) state that the gray seal and harbor seal populations currently range from New Jersey to Labrador; with scattered sightings and strandings reported as far south as North Carolina for gray seals and Florida for harbor seals (Hayes et al. 2018). Several researchers, however, report that harbor and gray seal distribution along the United States (U.S.) Atlantic coast appears to be expanding or shifting (DiGiovianni et al. 2011; Johnston et al. 2015; DiGiovianni et al. 2018). This range expansion may be due to rapid growth of gray seal populations in Canada and the Northeastern U.S. (Cammen et al. 2018). Count trend data for harbor and gray seals in southern New England and Long Island index sites from 1986-2011 indicate that harbor and gray seals are showing an increased use of their more southerly range and are extending their time spent at these haul-out sites (DiGiovianni et al. 2011).

In Virginia, reports from local anglers and Chesapeake Bay Bridge Tunnel (CBBT) staff (B. Lockwood and B. Biegel pers. comm.) indicated that seals have been using the CBBT rock armor or "islands" to haul out on for many years, although they believe the number of animals has been increasing. Additionally, annual pinniped stranding numbers have increased in Virginia since the early 1990s (Swingle et al. 2016).

In order to verify the distribution of seals in southern Virginia, biologists from Naval Facilities Engineering Command, Atlantic (NAVFAC LANT) initiated a study in 2014 to investigate and document seal presence in the lower Chesapeake Bay and coastal waters of Virginia. In 2016, in collaboration with The Nature Conservancy (TNC), an additional haul-out location on the Eastern Shore of Virginia was added to this study. Since this project's commencement, there have been four dedicated field seasons of research from 2014-2018. To date, harbor seals have been consistently recorded in all four field seasons from fall to spring. In total, a few gray seals have been sighted during the winter across field seasons, but not on a consistent basis.

The goal of this study is to document the presence and abundance of seals in Virginia and to gain an increased understanding of the seasonal occurrence, habitat use and haul-out patterns of seals near several important U.S. Navy installations, testing and training areas, and vessel transit routes. This report discusses the survey results for the 2016/2017 and 2017/2018 field seasons as well as the analyses conducted using data from all four field seasons. The 2015/2016 progress report (Rees et al. 2016) discusses the survey results for the 2014/2015 and 2015/2016 field seasons.

This work is part of the United States Fleet Forces Command (USFF) initiative to better understand species' occurrence and distribution in order to analyze potential impacts that U.S.

Navy training, installation construction (pile driving), and vessel-transiting activities may have on pinniped species and to develop mitigation options if appropriate. Primary objectives of this project include:

- *assessing occurrence, movement, and haul-out patterns adjacent to Navy testing and training areas;*

- *the use of photo-identification methods to identify and compare individuals and assess site fidelity among haul-out site locations in the study area; and*

- *the use of mark-recapture methods to estimate local population size.*

The work for this project is being conducted in accordance with MMPA Scientific Research Permit GA 19826.

2. Methods

2.1 Study Area

The study area consists of two general survey locations in southeastern Virginia (**Figure 1**): 1) in the lower Chesapeake Bay along the Chesapeake Bay Bridge Tunnel (CBBT) and 2) on the southern tip of the Eastern Shore. The CBBT survey area is comprised of four haul-out sites (referred to as CBBT 1, CBBT 2, CBBT 3, and CBBT 4) along the bridge tunnel that span approximately 14 km from the most southern site (CBBT 1) to the most northern site (CBBT 4). The haul-out sites are on rock armor formations (commonly referred to as "islands"), which are intended to protect the tunnels as they go beneath the water (**Figure 2**).
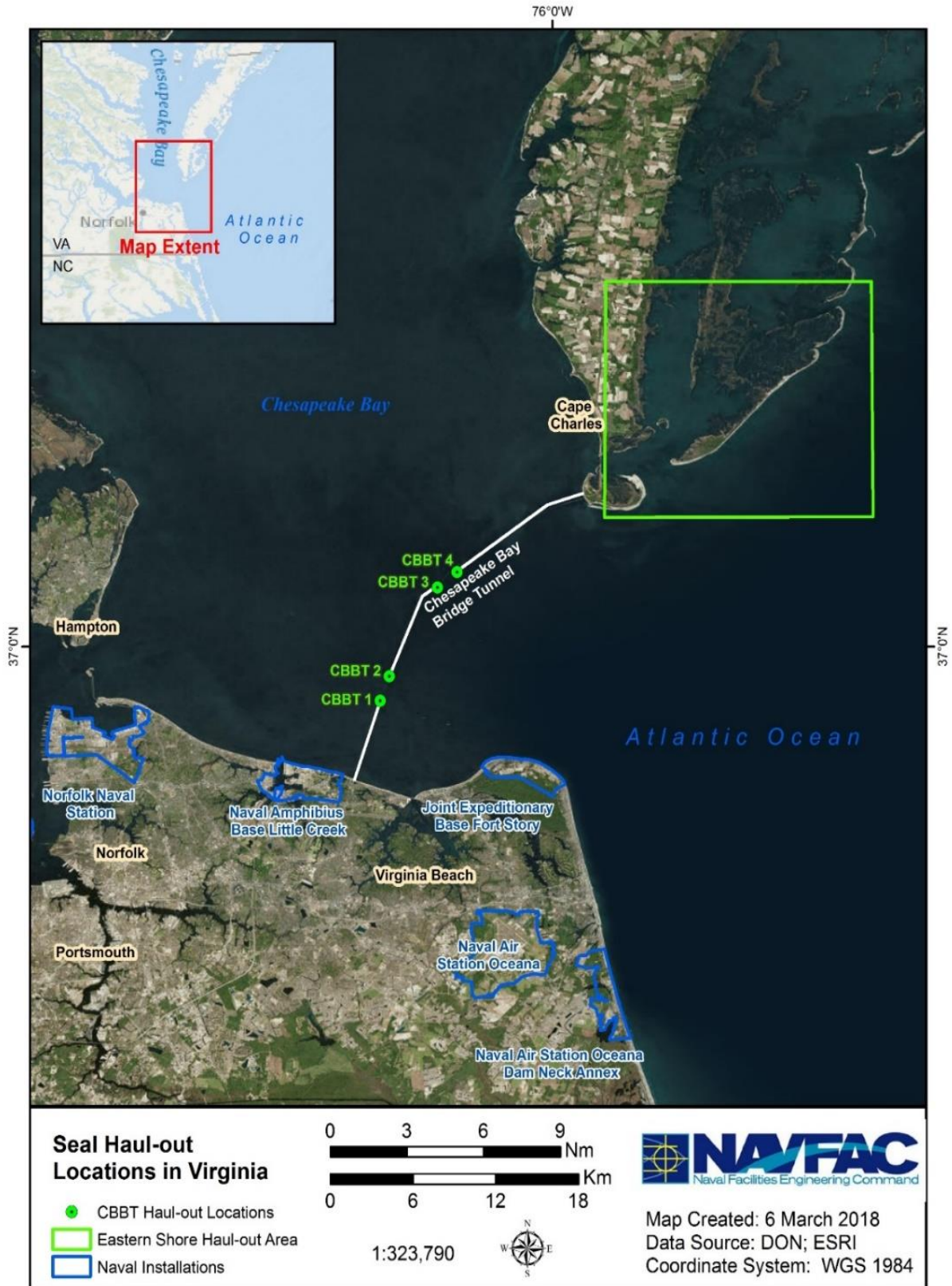
Figure 1. CBBT and Eastern Shore haul-out locations and their proximity to U.S. Naval Installations

Figure 2. Aerial view of a CBBT haul-out site. Seals generally haul-out on the tip of the rock armor farthest from the road. Photo by Sarah Mallette, Virginia Aquarium & Marine Science Center Foundation

Beginning in the fall of 2016, in collaboration with The Nature Conservancy (TNC), a survey area on the Eastern Shore of Virginia was added to the project. The Eastern Shore survey area has several haul-out sites (up to five different locations) where seals have been observed. The haul-out sites are within a tidal salt marsh habitat and are mainly comprised of mud banks with vegetation (**Figure 3**).

Figure 3. Eastern Shore survey area with harbor seals hauled out on a mud bank. Photo by Danielle Jones, NAVFAC Atlantic under NMFS GA Permit #19826

The distance from the northernmost CBBT haul-out site, CBBT 4, to the Eastern Shore survey area is approximately 25 kilometers (km). Both survey areas are in close proximity (< 100 km) to five major U.S. Navy installations (Norfolk Naval Station, Naval Amphibious Base-Little Creek, Joint Expeditionary Base-Fort Story, Naval Air Station Oceana, and Naval Air Station Oceana Dam Neck Annex) (**Figure 1**).

2.2   Survey Seasons and Protocol

For each field season, dedicated seal haul-out surveys started in the fall (October/November) and ended in the spring (April/May). Based on sightings/stranding data and communication with CBBT staff, seals generally begin to arrive in the area between October and November and depart the area by May, at the latest. Therefore, we attempted to start surveying during the fall, at least two weeks prior to previously recorded presence for that time period and ended surveying during the spring, attempting to conduct at least 1-2 survey days after no seals were sighted. This allowed for the documentation of the arrival and departure time frame for the season.

For the 2016/2017 field season systematic, land-based counts were conducted at all four haul-out sites (CBBT 1, CBBT 2, CBBT 3, CBBT 4) at the CBBT survey area. Beginning in the fall of 2016, systematic, vessel-based counts at the Eastern Shore survey area were added to the project, in collaboration with TNC.

For the 2017/2018 season, vehicle access at the CBBT survey area (with the exception of CBBT 4) was not permitted due to the construction for the CBBT expansion project. This will be the case for the foreseeable future. In order to continue survey effort at the CBBT, vessel-based counts were conducted in collaboration with the Virginia Department of Game and Inland Fisheries (VDGIF) beginning in December 2017. It should be noted that vessel based surveys allowed us to access areas, which may not generally be visible during land-based counts, thus, potentially increasing maximum sighting potential. With construction taking place at CBBT 1 and 2, and field time being extended due to transit time from boat launch to the most utilized haul-out site (CBBT 3), observers only surveyed CBBT 3 and 4 during the 2017/18 season. In previous years, few seals (<6% of total sightings) were observed at CBBT 1 and 2. NAVFAC LANT staff occasionally conducted land-based counts at CBBT 4 in the beginning of the season, however, few seals (*n*=2) were recorded at this haul-out site and site access was difficult. Therefore, land-based counts at CBBT 4 were discontinued after January 2018 and were replaced with vessel-based counts. The land-based count data for CBBT 4 will not be used in our analyses for the 2017/2018 season since sampling methodology (vessel-based counts) changed early on in the season.

Vessel surveys with VDGIF were infrequent due to weather and staff availability. To mitigate for this, the survey protocol was shared with the Virginia Aquarium & Marine Science Center Foundation (VAQF), who were conducting eco-tour trips, mainly to CBBT 3, during the seal season. NAVFAC LANT attended one of the eco-tour trips to conduct a count and collect photographs. When NAVFAC LANT staff was unavailable for the eco-tour trips, VAQF staff collected data for the project (date, time, species, best count estimate for seals in water and hauled out, and some photographs). The count data and photographs collected by VAQF were used for analyses.

For the land-based, CBBT surveys, seal counts and observations were taken from access roads off the Chesapeake Bay Bridge. A vehicle was used as a blind/elevated platform and was stationary during the counts (**Figure 4**). The distance from the observer to a haul-out site

ranged from approximately 100-130 meters (m). The survey crew consisted of one marine mammal observer and one data recorder.

Figure 4. Observers used a vehicle as an elevated platform for CBBT haul-out counts. Photo by Deanna Rees, NAVFAC Atlantic

The vessel-based counts conducted at the Eastern Shore and CBBT survey areas were conducted using a 19, 23, or 24 foot (ft) Carolina skiff and an 18 ft Parker, respectively. The vessel acted as an elevated platform for viewing (**Figure 5**). The survey crew consisted of one or two marine mammal observers, one data recorder, and one boat captain.

Figure 5. Observers used a Carolina skiff (vessel) for the Eastern Shore haul-out counts. Photo by NAVFAC Atlantic

The CBBT and Eastern Shore survey areas were surveyed every 1-2 weeks during the field season, using the same survey protocol that was used in previous years for the CBBT. The number of survey days were dependent on weather, tides, and staff/survey vessel availability. Surveys (land-based and vessel-based) were not conducted for both CBBT and the Eastern Shore during inclement weather such as rain and snow. Vessel-based counts at the CBBT and Eastern Shore survey areas were not conducted in Beaufort sea states higher than 3, however, land-based counts at the CBBT (for the 2016/2017 season) were able to be conducted in higher sea states. With vessel access to the Eastern Shore survey area being restricted by tides, we were only able to conduct surveys during tidal heights of 0.01 ft ((Mean Lower Low Water [MLLW]) or higher. The number of seals at each haul-out site for both of the survey areas were counted using point sampling techniques (Raposa and Dapp 2009). Three separate 2-minute counts (10 minutes apart) were conducted at each haul-out site to account for seals moving between the water and haul-out site locations and to allow for the documentation of other minor changes at each of the sites. Counts were conducted using hand held binoculars (Fujinon 7x50 MTRC-SX). During each count, the data recorder documented the survey start and end time, the number of seals present, the species present, photo numbers, standardized animal behaviors and the presence of vessels at the site. The best estimate of seals in the water and hauled out was recorded separately during each count. For analysis purposes, the best total estimate for the overall number of seals sighted (both in the water and hauled out) was used across each of the three two-minute counts, consistent with similar studies by Grellier et al. (1996) and Terhune (1987). Unless otherwise specified, seal count data should be interpreted as the best total estimate of seals present during the survey period.

During the 8-minute between-count breaks, one of the observers obtained images of the haul-out sites. A master photo capturing all of the seals was taken, along with individual seal photos. A digital single-lens reflect camera (Nikon D90 or D7100) with a zoom lens (ranging in size from 70-600 millimeter [mm]) (**Figure 6**) was used. A 1.4x TC-1401 teleconverter was often used to increase focal length of the lens and increase photo quality. Images were recorded in order to be used later for photo-identification (photo-ID). Multiple photos of different views (neck region, dorsal, lateral, ventral) of each seal were taken when possible in order to obtain quality photos of pelage (fur) patterns.

Figure 6. Observers obtained images for photo identification at the CBBT haul-out sites. Photo by JC Kreidel, NAVFAC Atlantic

Images were also obtained from Brian Lockwood, Jet Ski Fishing & Adventures, that were taken from a personal watercraft for the years 2010-2015. We have been able to match animals, which we have identified from our own images, in many of these images. Therefore, these photos were used for historical occurrence information only and were not utilized in our analyses.

Environmental data were recorded prior to the start of each survey at each of the haul-out sites and also later downloaded from the National Oceanic and Atmospheric Association's (NOAA) Tides & Currents page (https://tidesandcurrents.noaa.gov/). Data were collected on the following environmental variables: air temperature (˚F), water temperature (˚F), wind speed, wind direction (cardinal and degrees), wind gusts (knots) visibility, tidal height (ft) (MLLW), Beaufort Sea state (BSS), glare (%), and cloud cover (%).

For the 2016-2017 season, environmental data, with the exception of visibility, BSS, cloud cover, and glare were acquired from a NOAA weather station (ID 8638863) – Chesapeake Bay Bridge Tunnel, VA, located at 36.967 N, 76.114 W. Beginning in December 2017, as a result of the construction, the station was moved closer to CBBT 3 and CBBT 4 and environmental data were then collected from NOAA weather Station (ID 8638901) - CBBT, Chesapeake Channel, located at 37.032 N, 76.083 W. Water temperature for the Eastern Shore survey area was collected from NOAA weather station (ID 8632200) - Kiptopeke, VA, located at 37.165 N, 75.988 W. On 20 December 2017, as a result of the water sensor from the CBBT, Chesapeake Channel station becoming disabled, water temperature for both survey sites was collected from the Kiptopeke station. The average monthly water temperatures for the Kiptopeke station differed by only 1-2 degrees compared to the CBBT, Chesapeake Channel station (prior to December 2017), so data was representative of the CBBT study area. Environmental data were used to investigate relationships between seal presence and environmental variables.

2.3 Photo Identification (Photo-ID)

Upon returning from the field, collected images were cropped and graded based on photographic quality and distinctiveness of the pelage pattern. Image criteria was based on image grading methods used by Balmer et al. (2008) and Forcada and Aguilar (2000). In order to standardize methods for photo-ID across similar projects, and attempt to uniquely identify more individual seals, the photo-ID criteria has been updated (see below) since the 2015/2016 progress report (Rees et al. 2016). Therefore, all photos (with the exception of the 2014/2015 season) have been reassessed using these new criteria. Images from the 2014/2015 field season were not included as they did not meet the new quality standards from the updated methods. Therefore, individuals were not identified until the 2015/2016 field season.

The photographic quality rating (Q1-Q4) focused on clarity, image resolution, glare/lighting distortion, angle of the animal from the camera, bending of the animal, and the proportion of the animal's body captured within the image. A Q1 signified an excellent photo (sharp focus, no glare, minimum angling of seal to camera, and majority [≥ 75%] of seal captured). Q1 photos were generally a perpendicular shot showing an entire side of the animal, with fully wet pelage. A Q2 represented a good photo (minimal glare, minor bending/obstructions, and 50-75% of seal captured, with mostly wet pelage) and, although not perfect, was suitable for both manual and computer aided photo-ID. A Q3 represented a marginal photo; images may have been suitable for photo-ID, but problems were persistent (mediocre focus, moderate glare, bending, obstruction, and only 25-50% of seal captured). A seal that scored a Q3 generally had partially dry pelage or other obstructions that interfered with pattern visibility. A Q4 represented a photo with a quality too poor to reliably conduct photo-ID using either computer software of through manual matching (limited focus, substantial glare, shading, or bending, <25% of animal captured, and/or fully dry pelage).

The photographic distinctiveness rating (D1-D3) focused on the distinctiveness of pelage patterns and/or unique markings/scarring of an animal. A score of D1 represented an individual with very distinct patterns (large and numerous marks, visible scars, and/or 3+ very characteristic marks apparent even in poor quality photos). A D2 score represented 1-2 characteristic marks or some, but limited, distinctive patterning. A D3 represented seals with a uniform pelage and no distinct markings.

Using the quality and distinctiveness grades for images, a catalogue of uniquely identified seals was compiled. Photos with a Q1-Q3 grade, along with a distinctiveness grade of D1-D3, were given a unique ID number (e.g., CB001) and added to a Microsoft Excel catalogue and seal ID database. This grading was used in order to determine population abundance of harbor seals within the study area (Section 2.4.2 [Abundance Estimation]). For each photo selected for inclusion in the catalogue, standardized descriptions were applied for pelage color patterns (color phase) and organized through this catalogue. This allowed for greater ease in manual matching by creating categories of images to match from. The color phases in which the photos were categorized were: light (light background with no to a few/faint spots), intermediate (light background with dark spots), dark (dark background with many light-colored spots/rings), light/intermediate (seal pelage with two distinct light and intermediate color phases), dark/light (seal pelage with two distinct light and dark color phases).

Fields included within the database were: survey date, location, original photo image name, unique seal ID, file name, species, quality rating, distinctiveness rating, aspect (portion of seal's body that was captured), color phase, notable markings, and additional comments. The catalogue allowed for the sorting and processing of seal photos in order to compare and identify individual seals, using visual matching, for the mark-recapture portion of the study. Photos were reviewed through the use of this catalogue and captured and re-captured (i.e., re-sighted) seals were identified and recorded in the seal ID database. Movement of some of the identified seals has been observed between the CBBT and Eastern Shore survey areas. Therefore, mark-recapture data from both surveys areas were included to estimate population size for the region.

2.4 Analytical Methods

2.4.1 Analysis of Seal Presence and Environmental Variables

Mean seal count was compared within the four field seasons (2014/2015, 2015/2016, 2016/2017, and 2017/2018) for the CBBT survey area using a one-way analysis of variance. Mean seal count was also compared within the two field seasons (2016/2017 and 2017/2018) for the Eastern Shore survey area using a t-test.

Seal count data from the CBBT survey area for the four field seasons was compared to several environmental variables, which were recorded at the time of observation. Regression and correlation analyses were used to investigate patterns of occurrence, which might explain seal arrival/departure as well as the variations in seal counts throughout the season. A linear regression analysis (p-value) measures the probability of randomness of sampling, which aids in determining if any of the environmental variables could be a predictor of seal presence. A correlation analysis (Pearson r) indicates the strength of a relationship between two variables (i.e. seal count and an environmental variable). Variables used for the analyses were cloud cover, BSS, tidal height, wind speed, wind gusts, air temperature and water temperature. The weather stations used to collect data for the CBBT survey area were much closer to the survey area compared to the weather stations used to collect data for the Eastern Shore survey area. Therefore, in order to limit a misrepresentation of environmental data at the Eastern Shore survey area, these exploratory analyses were only conducted for the CBBT survey area. In the future, we hope to address this limitation in order to determine if a relationship exists between the two survey areas and/or to determine if seals are potentially moving between the two survey areas in response to changing weather conditions.

2.4.2 Abundance Estimation

To estimate the population abundance (N) of harbor seals utilizing the CBBT and Eastern Shore survey areas, we used the mark-recapture data from the photo-identification portion of the study and fitted a Lincoln-Petersen mark-resight model. The Lincoln-Petersen mark-resight model assumes 1) a closed population (i.e. no recruitment [birth or immigration] or losses [death or emigration] during the study period), 2) all individuals have the same probability of being caught, 3) capture and marking do not impact catchability, 4) samples are random, 5) marks are not lost

between sampling events, and 6) all marks are correctly recorded and reported when recovered in sample two.

$$N = ((m_1 * n_2)/m_2), \text{ where}$$

m_1= total # of marked animals/captures;
n_2= total # of marked/unmarked animals;
and m_2= # of total re-sightings/re-captures

In this study, m_1 was the total number of marked (i.e., uniquely identified) seals with an ID number (e.g., CB001) in the seal catalogue. Only identified seals with a quality grade of Q1-Q3 and a distinctiveness grade of D1 andD2 were used in order to not violate the model's assumption that all individuals have the same probability of being caught. A distinctiveness grade of D3, as previously discussed in Section 2.3 (Photo Identification [Photo-ID]), represented seals with uniform pelage and no distinct markings. Therefore, the probability of "capturing" or identifying seals given a D3 in comparison to those with unique markings (grades of D1 or D2) would be far lower, and thus not equal. For the purpose of this study, we interpreted n_2 as meaning that all catchable animals are marked, therefore m_1 and n_2 are equal. For m_2, this was the number of times each uniquely identified seal was re-sighted. As a result of the small sample size, all re-sightings were counted, as opposed to just one re-sighting per individual.

The Lincoln-Petersen mark-resight model was fit for each individual season (2015/2016, 2016/2017, 2017/2018), as well as for all three seasons combined.

3. Results

3.1 Haul-out Counts: 2016/2017 Field Season

Haul-out counts commenced in October 2016 for the third field season at the CBBT survey area. Counts were conducted over the course of 27 survey days, between 21 October 2016 and 26 April 2017 (**Table 1**). Seals were observed on 19 of the 27 (70.4%) survey days. Over the entire season, a best total estimate (combined in water and hauled out) of 308 seal sightings were recorded across the four CBBT haul-out locations (**Table 1**). The total number of seals counted ranged from 0-40 seals per survey day. The harbor seal was the only pinniped species that we observed at the CBBT survey area during this field season.

Seals were mainly observed at the CBBT 3 haul-out site, similar to the two previous field seasons. Of the estimated 308 seal sightings, 277 (89.9%) were recorded at CBBT 3.

Table 1. Summary of the number of seals sighted for the 2016/2017 field season at the CBBT survey area

Date	Number of Individuals Pv	Number of Individuals Hg
21-Oct-16	0	0
27-Oct-16	0	0
2-Nov-16	0	0
10-Nov-16	1	0
16-Nov-16	0	0
22-Nov-16	0	0
2-Dec-16	7	0
7-Dec-16	3	0
14-Dec-16	5	0
28-Dec-16	9	0
5-Jan-17	22	0
11-Jan-17	33	0
19-Jan-17	25	0
25-Jan-17	40	0
1-Feb-17	26	0
2-Feb-17	11	0
8-Feb-17	33	0
14-Feb-17	18	0
21-Feb-17	18	0
27-Feb-17	13	0
8-Mar-17	7	0
16-Mar-17	21	0
21-Mar-17	13	0
29-Mar-17	0	0
5-Apr-17	3	0
13-Apr-17	0	0
26-Apr-17	0	0
Total	**308**	**0**

Key: Pv = *Phoca vitulina* (harbor seal)*;* Hg = *Halichoerus grypus atlantica* (gray seal)

Haul-out counts commenced in November 2016 for the first complete field season at the Eastern Shore survey area. Counts were conducted over the course of 10 survey days, between 2 November 2016 and 17 April 2017 (**Table 2**). Counts were not conducted in January due to lack of access to survey location (dependent on tidal height) and observer availability. Seals were observed on 7 of the 10 (70%) survey days. Over the entire season, a best total estimate (combined in water and hauled out) of 105 seal sightings were recorded (**Table 2**). The total number of seals counted ranged from 0-24 seals per survey day. The harbor seal was the only pinniped species observed at the Eastern Shore survey area during this field season.

Table 2. Summary of the number of seals sighted for the 2016/2017 field season at the Eastern Shore survey area

Date	Number of Individuals Pv	Number of Individuals Hg
2-Nov-16	0	0
10-Nov-16	1	0
7-Dec-16	16	0
1-Feb-17	24	0
27-Feb-17	24	0
9-Mar-17	22	0
21-Mar-17	15	0
29-Mar-17	3	0
14-Apr-17	0	0
17-Apr-17	0	0
Total	**105**	**0**

Key: Pv = *Phoca vitulina* (harbor seal)*;* Hg = *Halichoerus grypus atlantica* (gray seal)

3.2   Haul-out Counts: 2017/2018 Field Season

Haul-out counts commenced in November 2017 for the fourth field season at the CBBT survey area. Counts were conducted over the course of 16 survey days between 5 November 2017 and 2 April 2018 (**Table 3**). Seals were observed on 15 of the 16 (93.7%) survey days. A best total estimate (combined in water and hauled out) of 340 seal sightings were recorded across the limited CBBT haul-out locations (**Table 3)**. As previously mentioned in Section 2.2 (Survey Protocol), counts were mostly conducted at the CBBT 3 and CBBT 4 haul-out sites due to CBBT construction as well as extended survey time from the vessel-based counts. Counts were not conducted in March and after the last survey day in April due to weather conditions and observer/vessel availability. The total number of seals counted per survey day ranged from 0-45 seals. The harbor seal was the only pinniped species that we observed at the CBBT survey area during this field season.

Table 3. Summary of the number of seals sighted for the 2017/2018 field season for the CBBT survey area

Date	Number of Individuals Pv	Number of Individuals Hg
5-Nov-17	0	0
19-Dec-17	8	0
20-Jan-18*	20	0
21-Jan-18*	21	0
22-Jan-18*	20	0
24-Jan-18*	12	0
25-Jan-18*	12	0
26-Jan-18	11	0
27-Jan-18	29	0
28-Jan-18*	45	0
6-Feb-18*	35	0
9-Feb-18*	15	0
10-Feb-18*	40	0
14-Feb-18	39	0
18-Feb-18*	30	0
2-Apr-18	3	0
Total	**340**	**0**

Key: Pv = *Phoca vitulina* (harbor seal)*;* Hg = *Halichoerus grypus atlantica* (gray seal); * = counts made by VAQF

Haul-out counts commenced in November 2017 for the second field season at the Eastern Shore survey area. Counts were conducted over the course of 8 survey days, between 3 November 2017 and 22 February 2018 (**Table 4**). Only one count was conducted in February due to the capture trips that were conducted that month for an associated seal tagging and tracking project. Counts were not conducted in March and April due to weather conditions, access to survey location, and observer availability. Seals were observed on all 8 survey days. Over the entire season, a best total estimate (combined in water and hauled out) of 197 seal sightings were recorded (**Table 4**). The total number of harbor and gray seals counted ranged from 0-69 seals per survey day. The majority of seals observed were identified as harbor seals; one gray seal was observed on 22 February 2018.

Table 4. Summary of the number of seals sighted for the 2017/2018 field season at the Eastern Shore survey area

Date	Number of Individuals Pv	Number of Individuals Hg
3-Nov-17	2	0
21-Nov-17	5	0
30-Nov-17	6	0
11-Dec-17	25	0
20-Dec-17	22	0
19-Jan-18	29	0
24-Jan-18	39	0
22-Feb-18	68	1
Total	**196**	**1**

Key: Pv = *Phoca vitulina* (harbor seal)*;* Hg = *Halichoerus grypus atlantica* (gray seal)

3.3   Seal Presence and Environmental Analysis Results

A total of 77 survey days have been conducted across four field seasons (see Section 2.4.1 [Analysis of Seal Presence and Environment]) at the CBBT survey area. Seals were recorded from mid-November to mid-May, with most (94%) being sighted at the CBBT 3 haul-out site during the first three field seasons (2014/2015, 2015/2016, 2016/2017). CBBT surveys were mainly conducted at CBBT 3 and occasionally CBBT 4 for the 2017/2018 field season. Once seals arrived, animals were recorded on a fairly consistent basis (62 out of 77 [80.5%] survey days) until departure. Based on this, we termed the number of survey days between and including the first and last seal observation as "in season" survey effort and used this in our analyses. Over four field seasons, the number of seals observed does appear to be increasing. Total count and maximum count for a single survey have increased (**Table 5**). The average number of seals observed per "in season" survey day has also increased from year to year, but this difference was not statistically significant (F_{stat} = 2.701, p = 0.054). This between-season comparison, however, does not take into account the sampling bias for the 2017/2018 season. Values (e.g., average and max count) for the fourth season appear to be much higher than previous seasons, which may be due to a change in sampling methodology (counts being vessel-based instead of land-based) and unequal survey effort across months (e.g., no surveys in March and concentrated survey effort in January and February).

Table 5. "In season" survey effort, total seal count (best estimate), max seal count on a single survey, and effort-normalized average (number of seals observed per "in season" survey day) at the CBBT survey area

Field Season	"In Season" Survey Days	Total Count	Average Count	Max Count
2014-2015	11	113	10	33
2015-2016	14	187	13	39
2016-2017	22	308	14	40
2017-2018	15	340	23	45

A total of 18 surveys have been conducted across two field seasons at the Eastern Shore survey area. For both field seasons, seals were recorded from early November to late March. Once seals arrived, animals were recorded on a fairly consistent basis (15 out of 18 [83.3%] survey days) until departure. Based on this, we termed the number of survey days between and including the first and last seal observation as "in season" survey effort and used this in our analyses. Over two field seasons, the number of seals observed does appear to be increasing. The total count and maximum count for a single survey have increased, with the max count being substantially higher for the 2017/2018 season (**Table 6**). The average number of seals observed per "in season" survey day has also increased, but this difference was not statistically significant (t_{stat} = -1.114, p = 0.291). This between-season comparison, however, does not take into account the sampling bias for the 2016-2018 seasons. There was unequal survey effort across months (e.g., no surveys conducted in January 2017 and March-April 2018) for the two seasons.

Table 6. "In season" survey effort, total seal count (best estimate), max seal count on a single survey, and effort-normalized average (number of seals observed per "in season" survey day) at the Eastern Shore survey area

Field Season	"In Season" Survey Days	Total Count	Average Count	Max Count
2016-2017	7	105	15	24
2017-2018	8	197	25	69

"In season" seal count data from the 2014-2018 field seasons for the CBBT survey area was compared to several environmental variables, which were recorded at the time of observation, via a linear regression and correlation analyses (**Table 7**). This was done to investigate patterns of occurrence, which might explain cues for seal arrival and departure. Due to the possibility of varying environmental conditions across CBBT haul-out sites during each survey day and because each site was surveyed at different times, the count data from the CBBT 3 haul-out site was used as a proxy for all linear regression and correlation analyses in this report. CBBT 3 served as a representative proxy for the CBBT survey area due to the majority of seal sightings occurring at CBBT 3, and a strong linear relationship (R^2 = 0.943) existing between the total seal

count and the CBBT 3 seal count data. Based on initial data exploration, several environmental variables showed a noticeable relationship with seal count. Tidal height and water temperature were the only variables to have a statistically significant relationship with seal count (**Table 7**).

Table 7. Correlation and linear regression analyses of "in season" seal count vs. environmental variables for the CBBT survey area

Environmental Variables	Correlation (Pearson *r*)	Linear Regression (*p* value)
Cloud Cover (%)	0.14	0.36
Beaufort Sea State (BSS)	-0.24	0.09
Tidal Height in feet (MLLW)	-0.27	0.04*
Wind Speed (knots)	-0.22	0.09
Wind Gust (knots)	-0.20	0.12
Air Temperature (°F)	-0.08	0.53
Water Temperature (°F)	-0.60	<0.001*

*The *p*-value measures the probability of randomness in sampling. A *p*-value $\leq$ 0.05 is considered significant.
Note: The absolute value of Pearson *r* indicates strength of a correlation, ranging from 0 (weakest) to 1 (strongest), with the sign (+ or -) denoting a positive or negative correlation.

Tidal height had a very slight negative correlation (*r* = - 0.27) and a significant relationship (*p* = 0.04) with the number of seals sighted **(Table 7)**. Higher counts were observed on survey days with a tidal height of 2 ft or lower, and as tidal height increased, the number of seals sighted decreased. However, counts of zero occurred at low tidal heights. Further survey days conducted at low (-0.5-0.5 ft) and high (2.5-3.5) tidal heights are needed in order to determine if tidal height does in fact have a significant linear relationship with seal presence.

The strongest relationship (*r* = -0.60) was with water temperature, which appears to account for a larger proportion of variation (e.g., for regression between seal count and water temperature, R^2 =0.35, p < 0.001) compared to the other environmental variables. **Figure 7** displays the relationship between average monthly seal count and average monthly water temperature for the CBBT survey area across the four field seasons. Seal presence began to increase in December when water temperature dropped below 59°F. Peak counts were recorded between January and March, and seemed to coincide with some of the lowest recorded water temperatures. As water temperatures rose above 52°F, counts decreased.
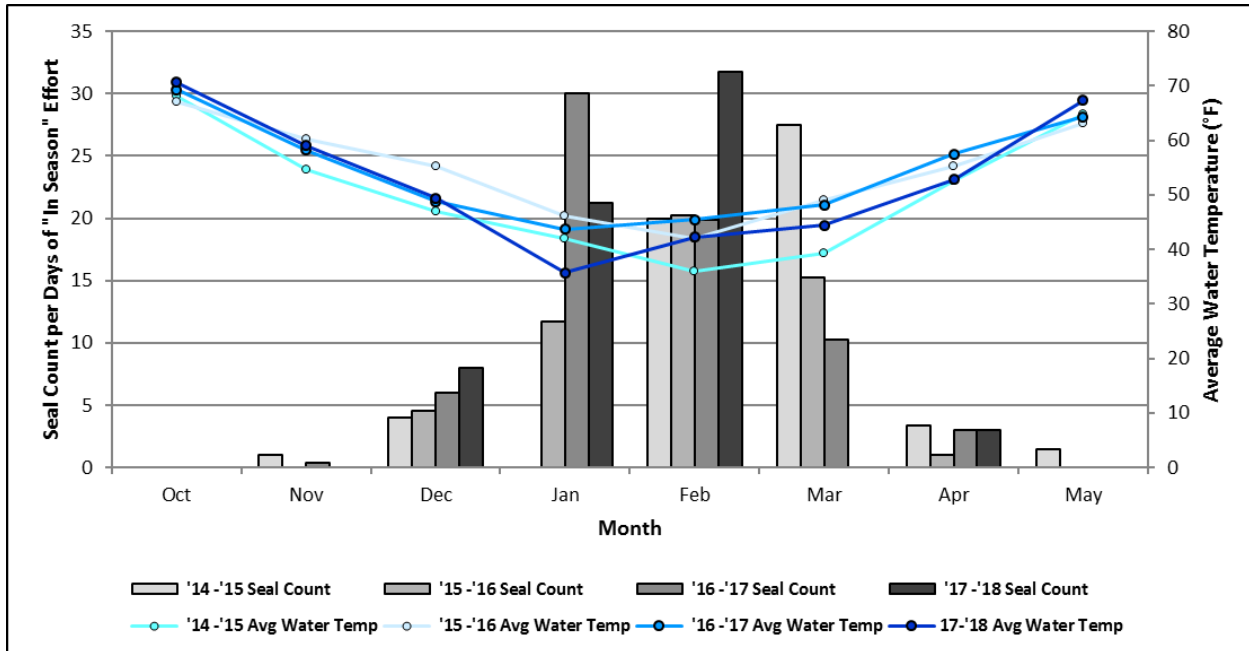
Figure 7. Average seal count by month with corresponding average monthly water temperature (˚F) for the CBBT survey area. Surveys were not conducted in January 2015 or March 2018.

3.4   Photo Identification

After reviewing all images from the 2015/2016, 2016/2017, and 2017/2018 field seasons, 100 harbor seals were uniquely identified (**Table A-1**Error! Reference source not found.) based upon image grading criteria. Gray seals (n=3) could not be uniquely identified by collected images based on the image grading criteria for quality; images were too poor of quality. As previously mentioned, images from the 2014/2015 season did not meet the quality standards for the study. The last images used for photo-ID analysis were collected on 22 February 2018 since images were not collected on the last survey day (2 April 2018) of the 2017/2018 season due to poor survey conditions.

Of the 100 uniquely identified harbor seals, 65 (65%) were observed only once and 35 (35%) were determined, based on photo-identification, to be present in the study areas on more than one occasion across the three field seasons. In an individual season, the minimum number of sightings of a uniquely identified seal was one; the maximum number of sightings of a uniquely identified seal was 9 (CB069) during the 2016/2017 field season.

Between December 2015 and February 2018, the minimum number of days for an identifiable re-sighting (or re-capture) of an individual was 5 days (CB121, 15 March 2017 and 21 March 2017) and the maximum number of days was 756 days (CB020, 28 January 2016 and the last sighting being on 22 February 2018). Across the study period, 21 individuals were observed on two survey days and 14 individuals were observed on three or more survey days, with the maximum number of encounters being 10 (CB069).

However, now that three seasons of photo-ID data have been collected, there is more information pertaining to habitat use patterns and site fidelity for harbor seals. Some seals have

been sighted across multiple seasons. Of the 35 individuals identified to be present on more than one occasion, 23 were sighted across two different field seasons and three (CB005, CB020, CB053) were sighted across three different field seasons. For example, CB023 was first captured on 26 February 2016 and then re-captured on 11 January 2017 (**Figure 8)**. Not only have individual seals been sighted on more than one occasion whether that is within a season or across seasons, but some individuals have been sighted and re-sighted together. For example, CB082 and CB083 were initially sighted at the same haul-out site on 11 January 2017 and then re-sighted together at that same haul-out site on 14 February 2018, which amounts to a 399-day span between sightings.

For the 2015/2016 field season, surveys were only conducted at the CBBT, therefore, individual seals were identified only at the CBBT survey area. Beginning in the 2016/2017 field season (and beyond), surveys were conducted at the CBBT and Eastern Shore survey areas, therefore, individual seals were identified from both survey areas. The majority of identified seals (n=68) have been sighted at only the CBBT survey area, with some (n=27) being sighted at only the Eastern Shore survey area. However, we now have identified five seals (CB020, CB053, CB057, CB087, and CB121) that have been sighted at both survey areas on separate survey days. One seal, CB121, was sighted at both survey areas during the same season, whereas, the other seals (e.g., CB020) were sighted at each survey area across different seasons.
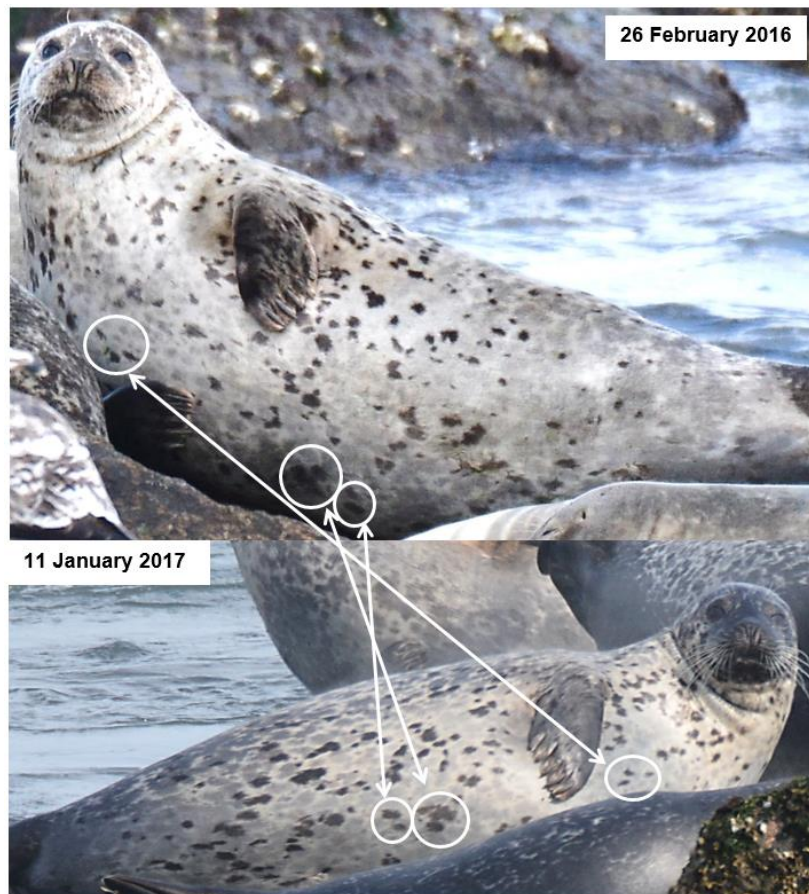

Figure 8. Harbor seal, CB023, captured on 26 February 2016 at the CBBT 3 haul-out site (above) and re-captured on 11 January 2017 at CBBT 3 (below). Photo by NAVFAC Atlantic under NMFS GA Permit #19826

3.5   Abundance Estimates

The abundance estimates calculated from the Lincoln-Peterson model for the 2015-2018 field seasons ranged from 88 (95% CI: 47.67-128.66) to 168 (95% CI: 134.96-201.11) individual harbor seals (**Figure 9**). As previously mentioned in Section 3.4 (Photo Identification), uniquely identified harbor seals were sighted at the CBBT and Eastern Shore survey areas, therefore, capture and re-capture data across both survey areas were used for the abundance estimate calculations. The lowest abundance estimate (88 individuals) occurred during the 2015/2016 field season; however, it should be noted that this season had the lowest number of captures (n=23), which was most likely due to a lower amount of survey effort and not a large enough zoom lens (≤ 400 mm) for photo-ID. In addition, surveys were only conducted at the CBBT during this season, which means that a smaller closed population (in terms of area) was used for this abundance estimate, whereas, a larger closed population (in terms of area) was used for the other two seasons' abundance estimate since capture and re-capture data were used from both the CBBT and Eastern Shore survey areas. Abundance estimates did increase from the 2015/2016 to 2016/2017 field seasons, with the 2016/2017 season having the highest estimate of 168 individuals. A decrease in abundance was observed for the 2017/2018 season, with 125 individuals. However, the 95% confidence interval (CI) for this season's estimate is larger (60.63-189.37) compared to the other seasons, indicating that this estimate may not be the most accurate representation of the number of individuals utilizing both survey areas for this season. This may be due to the low number of captures (n=25) and re-captures (n=5) that were recorded for this season. A regression analysis was conducted for the seasonal abundance estimates to see if there is a potential population trend for the study area. Results indicated that the slope was not statistically significant ($p = 0.69$), therefore, the population does not appear to be increasing or decreasing, and may be stable.
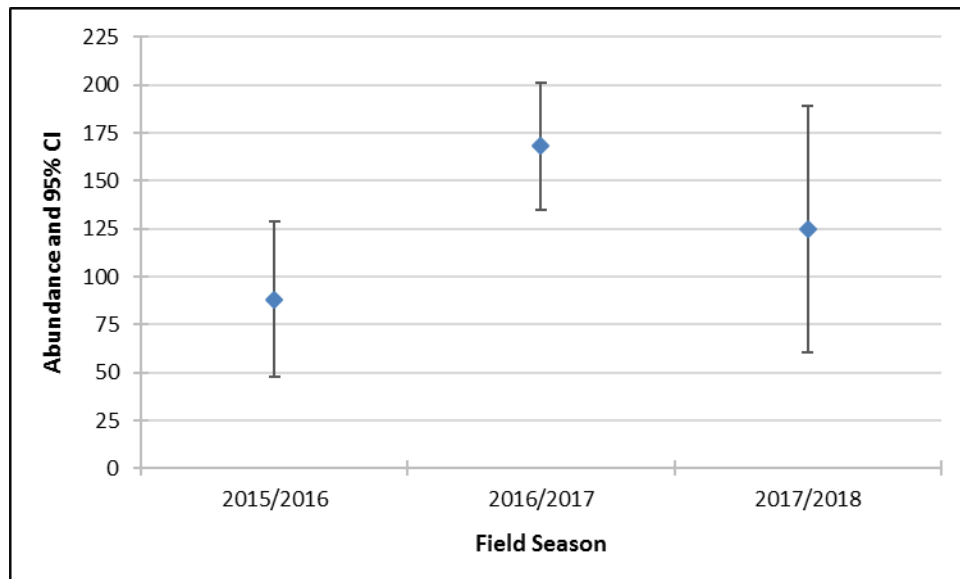

Figure 9. Total abundance estimates (blue diamonds) and 95% confidence intervals (CIs) for the CBBT and Eastern Shore survey areas during each of the field seasons: 2015/2016, 2016/2017, and 2017/2018.

With the abundance showing a fluctuation across seasons and no potential trend, a mean abundance estimate was calculated. The abundance estimate for all three seasons (2015/2016, 2016/2017, and 2017/2018) yielded an estimate of 109 individuals (95% CI: 105.08-113.84). Given the CI, this estimate may be an accurate representation of the number of harbor seals using both the CBBT and Eastern Shore survey areas.

4. Discussion

The results from this study to date indicate that seals regularly occur in southeastern Virginia from the fall to the spring. Furthermore, count data collected from the past four field seasons shows an increase in seal presence from the 2014/2015 season through the 2017/2018 season; with the majority of the observations comprising harbor seals. This increase in numbers is very apparent for the CBBT study area; with maximum seal count for a single survey day increasing from 2014 to 2018. The maximum seal count for a single survey day in the 2014/2015 and 2017/2018 field seasons were 33 and 45 animals, respectively. To account for survey effort, since the number of "in season" survey days conducted has varied each season, we calculated average seal count to see if an increasing trend is a valid assessment. In the 2014/2015 field season, the average seal count was 10 animals and then there was a sequential increase across seasons, with the average seal count being 23 animals for the 2017/2018 field season, albeit this difference was not statistically significant. Caution does need to be taken when comparing these numbers across seasons and drawing conclusions due to a change in sampling methodology (vessel-based counts vs. land-based counts) and survey effort from the 2014-2017 seasons compared to the 2017/2018 season, leading to sampling bias. For future field seasons, the sampling methodology will remain the same and consistent survey effort across months will be made.

An increasing trend in seal numbers may also possibly be occurring for the Eastern Shore survey area. Although data remains limited, count data from the previous two field seasons (2016-2018) have displayed an increase in maximum seal count for a single survey day and average seal count per "in season" survey day. The maximum seal count for a single survey day in the 2016/2017 and 2017/2018 field seasons were 24 and 69 animals (including a single gray seal), respectively. The average seal count per "in season" survey day increased from 15 to 25 animals across the two seasons, albeit this difference was not statistically significant. However, more surveys for the Eastern Shore study area, which span multiple field seasons must be conducted before drawing firm conclusions.

Although the majority of seals observed in the four field seasons were harbor seals, occasional sightings of gray seals (n=4) were recorded at both the CBBT and Eastern Shore survey areas between December and March across the study period. With gray seal sightings not occurring consecutively between field seasons, we cannot say with any certainty that this species regularly occurs in southeastern Virginia and if it is starting to expand its distribution farther south.

Harbor seals were consistently recorded in the CBBT and Eastern Shore survey areas from November to April. Results from initial data exploration of "in-season" seal count for the CBBT survey area, indicate that seal occurrence at the CBBT survey area may vary based on oceanographic and environmental conditions. Out of the suite of environmental variables that were analyzed in comparison to seal count, two environmental variables (tidal height and water temperature) seemed to have at least a slight to moderate correlation as well as a significant linear relationship with seal count. Observations indicate that arrival and departure of seals at the CBBT study area may coincide with changes in water temperature. Results showed a noticeable increase in seal count for all four field seasons as water temperatures decreased, and peak counts were recorded during the months with some of the colder recorded water temperatures (January-March). Seal count also appeared to decrease as water temperature began to rise. Therefore, water temperature may be an environmental predictor of when seals regularly occur in southeastern Virginia. In certain instances, tidal height may influence seal presence within the CBBT survey area; seal count appeared to decrease as tidal height increased. However, counts of zero occurred at low tidal heights, which could be due to other environmental factors (e.g., water temperature) having a stronger influence on seal presence. Other regression analyses (e.g., exponential or multiple regression framework) or a step function should be considered for future analyses to see if the other environmental variables (e.g., air temperature) may have a non-linear relationship with seal count.

Prior to this study, there was no seasonal population abundance estimate for harbor seals in southeastern Virginia. For this study, a population abundance was estimated for the lower Chesapeake Bay and coastal Virginia waters using mark-re-capture data. A total of 109 individuals were estimated as the average seasonal abundance across all three seasons (2015-2018). Abundance estimates were also calculated for each annual field season, with an abundance of 88 individuals for the 2015/2016 season, increasing to 168 individuals for the 2016/2017 season, and decreasing to 125 individuals for the 2017/2018 season. Inferences about population trends in the region cannot be accurately made due to this fluctuation in abundance across seasons. Regression analysis results indicate that there is not a statistically significant trend in population abundance. Therefore, there is reason to believe that the population of animals utilizing the lower Chesapeake Bay and Eastern Shore, Virginia may be relatively stable. It is difficult to draw further conclusions with this limited data. Our aim is to develop a more robust dataset that will allow us to determine if the population is, in fact, stable or if the overall population is potentially increasing and/or harbor seal site fidelity at this southeastern Virginia study area is increasing.

The 2017 NOAA SAR reported that harbor seals of the Western North Atlantic stock are generally found in the coastal waters of Canada and Maine throughout the year (Katona et al. 1993) and occur seasonally (from September to May) from New England south to New Jersey (Schneider and Payne 1983; Schroeder 2000; Hayes et al. 2018). However, results from this study suggest that a small population does, in fact, occur seasonally within southeastern Virginia.

Both the harbor and gray seal, previously formed large colonies (prior to subsistence hunts and government-supported bounties) from Labrador, Canada to Cape Hatteras, North Carolina (Johnston et al. 2015). The increasing trend observed in average seal count and the Virginia

abundance estimates calculated for this study reflect claims made by Johnston et al. (2015), who believe that harbor seals are now beginning to re-occupy substantial portions of their original range. Several researchers report that harbor and gray seal distribution along the U.S. Atlantic coast appears to be expanding or shifting (DiGiovianni et al. 2011; Johnston et al. 2015; DiGiovianni et al. 2018), which could explain the increase in the number of seals observed in the CBBT and Eastern Shore study areas across the past four field seasons. An increase in gray seal abundance in the Northeastern U.S. could create interspecific competition for the two species, whether that is for habitat and/or prey resources, thus leading to changes in species distribution. Recent trends in sighting data for New York indicate that the Western New York Bight harbor seal population may eventually experience displacement by the influx of gray seals, which would result in a southern expansion of harbor seals along the east coast (Sieswerda and Kopelman 2018).

Based on the photo-ID analysis, harbor seals may not only be expanding their distribution farther south, but some individuals are returning to the same southerly haul-out locations across multiple seasons. Photo-ID conducted via visual matching for the 2015 to 2018 field seasons has shown that individual harbor seals (35 out of 100 uniquely identified seals) sighted at the CBBT and Eastern Shore study areas have been re-sighted within a season and across seasons, indicating at least some degree of site fidelity within the lower Chesapeake Bay and coastal Virginia waters. Of the 35 individuals identified to be present on more than one occasion, 23 were sighted across two different field seasons and three were sighted across three different field seasons. Identifiable re-sightings across the study period spanned from 5 days to 756 days. Some of the identified harbor seals have been utilizing the CBBT haul-out sites for longer than our study period captures. Based on contributed citizen photographs, we have been able to determine that some of the individuals (CB004, CB005, CB006, CB057) have been occurring, seasonally, in the region since 2011 and 2012. These findings further prove that this region supports a series of regular, seasonal haul-out sites for harbor seals within the lower Chesapeake Bay and Eastern Shore, Virginia.

Through the use of photo-ID, we have also been able to gather more information on movement and habitat preference within the region. The majority of identified harbor seals (68%) have been sighted at only the CBBT survey area, with some (27%) being sighted at only the Eastern Shore survey area. However, five individuals were re-sighted at both survey areas on separate survey days within a season and across seasons. These results indicate the potential for harbor seals to make localized movements throughout the region during their seasonal occupancy and that while some seals may be utilizing a particular haul-out site within a given season, others may utilize multiple haul-out sites within a season. A pinniped tracking study for southeastern Virginia reinforces the concept of localized seasonal movements within the region (Ampela et al. 2018). Seven harbor seals were captured at a haul-out site from the Eastern Shore survey area in February 2018 and equipped with satellite tags. At least five of the seven harbor seals displayed movements between the Eastern Shore and CBBT survey areas (**Figure 10**).
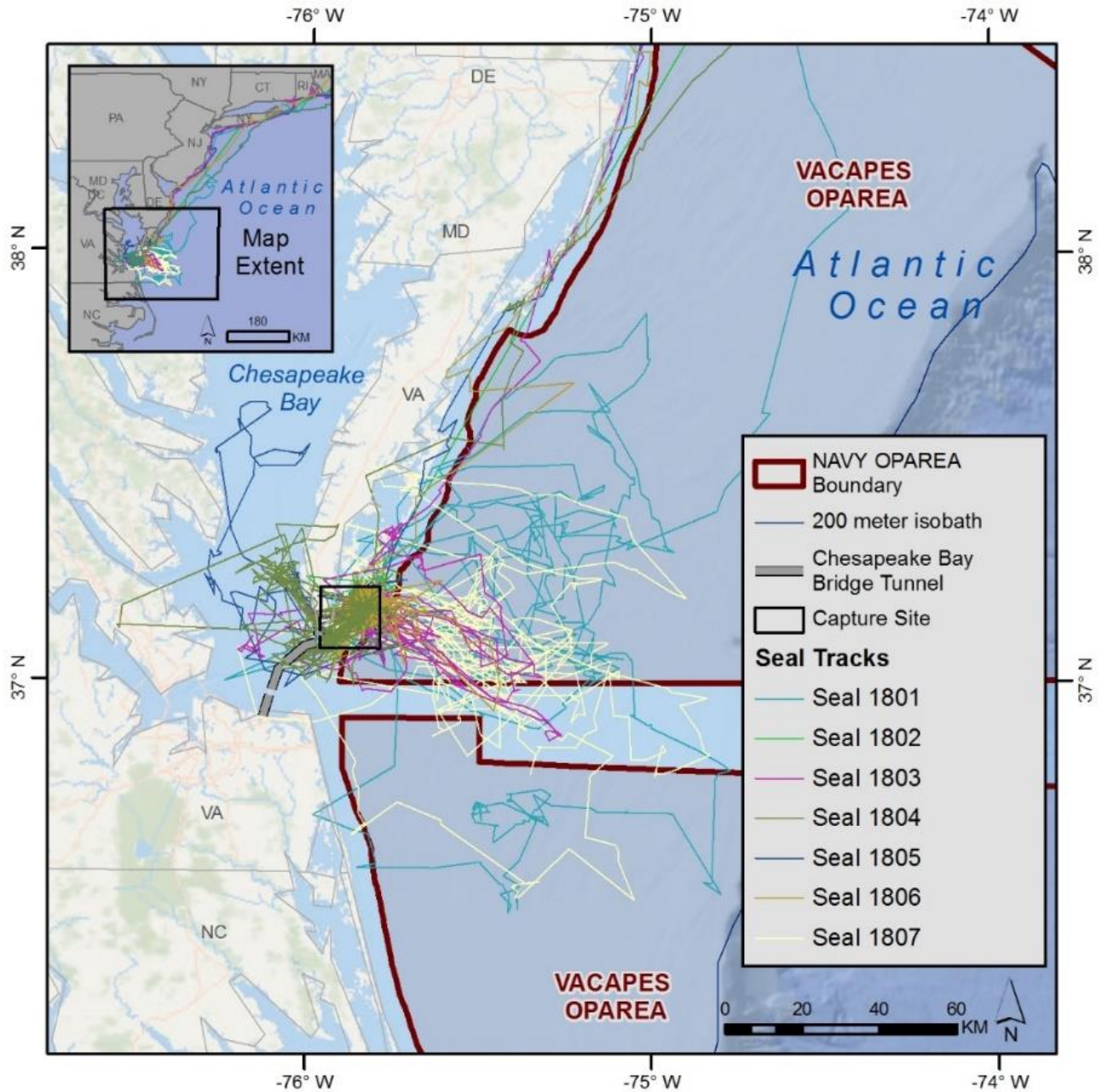
Figure 10. Tracks of the seven satellite tagged harbor seals, focused within the lower Chesapeake Bay and coastal Virginia waters. The seals were tagged at an Eastern Shore haul-out site during the 2017/2018 season.

5. Conclusions and Recommendations

Our research continues to document a regular, seasonal presence of harbor seals and occasional sightings of gray seals within the lower Chesapeake Bay and Eastern Shore, Virginia. Patterns of seasonal residency and a baseline for population abundance for harbor seals within the region are beginning to emerge. However, more research is necessary to determine the level of site fidelity and whether or not harbor seal abundance is increasing within the study area. Data will continue to be collected and examined for any emerging patterns of habitat utilization and residency time, as well as population trends, which will help the Navy with ongoing environmental compliance and conservation efforts.

While the study provides an essential basis towards determining the occurrence and habitat use of harbor and gray seals within the lower Chesapeake Bay and coastal waters of Virginia, recommendations to enhance the project are below:

1. **Expand satellite-monitored tagging effort**. Seven harbor seals were successfully tagged within the Study Area in February 2018 with both satellite and acoustic tags. The satellite data for the tagged seals is available on Movebank.org, and the final report on the 2017/2018 season will be completed in December 2018. The 2018/2019 field season is in the planning phase and field work is scheduled for January and February 2019. Data from this study will better demonstrate the occurrence, migratory routes, and behavior of seals in this area, as well as provide a baseline for behavioral response studies in the future.

2. **Add the use of unmanned aircraft systems (UAS).** The use of UAS will allow biologists to survey on the Eastern Shore to access inaccessible barrier islands for additional haul-outs and possibly improve count and photographic data collected. UAS imaging systems provide a permanent visual record; allow for visual detection of all animals on the haul-out during point counts (animals are less likely to be obscured if viewed from above), which should increase the accuracy of haul-out counts; and improve the identification of species and ability to detect previously captured/tagged/marked animals.

3. **Consider using Extract Compare or other photo matching software**. In the future, the study may incorporate the Extract Compare software (http://conservationresearch.org.uk/Home/ExtractCompare/index.html), which will be used for the extraction and matching of pelage patterns to enhance the photographic mark-recapture potential of the study. This software program has the ability to sort through photographs and identify patterns that have previously been extracted from seals. Automated matching may improve the frequency of matches and improve photo-matching time.

4. **Submit data to OBIS-SEAMAP**. Documentation of seal presence for Virginia is currently lacking in sightings databases and the published literature. Adding these data to OBIS-SEAMAP will allow them to be archived and accessible for use by future researchers and helps us to connect with those who we would collaborate with to

augment our understanding of the distribution and the ecology of pinnipeds in the Mid-
Atlantic.

6. Acknowledgements

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Sightings History Tables

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Table A-1. Sighting history (days/month) of uniquely identified harbor seals at the Chesapeake Bay Bridge Tunnel (CBBT) and Eastern Shore (ES): Dec. 2015-Feb. 2018

NAVFAC Catalogue ID (Harbor Seals)	2015	2016			2016	2017				2017		2018		Location	Total No. Days Seen	Total No. Season Seen
	Season 2 (2015-2016)				Season 3 (2016-2017)					Season 4 (2017-2018)						
	December	January	February	March	December	January	February	March	April	November	December	January	February			
CB004						1							1	CBBT 3	2	2
CB005			1		1	2						1	1	CBBT 3	6	3
CB006				1		1	1							CBBT 3	3	2
CB020		1					1						1	CBBT 3 & ES	3	3
CB021		1												CBBT 3	1	1
CB022					1	2							1	CBBT 3	4	2
CB023			1			2								CBBT 3	3	2
CB034		1												CBBT 3	1	1
CB035		1	1											CBBT 3	2	1
CB036		1				1								CBBT 3	2	2
CB037		1												CBBT 3	1	1
CB038			2											CBBT 4	2	1
CB040		1				1								CBBT 3	2	2
CB041		1												CBBT 3	1	1
CB042		1												CBBT 4	1	1
CB043		1												CBBT 4	1	1
CB044		1				1								CBBT 4/3	2	2
CB045		1				1								CBBT 3	2	2
CB046		1				1								CBBT 3	2	2
CB047			1	1				1						CBBT 3	3	2
CB048		1				1								CBBT 3	2	2
CB051			1											CBBT 3	1	1

NAVFAC Catalogue ID (Harbor Seals)	Season 2 (2015-2016)				Season 3 (2016-2017)					Season 4 (2017-2018)				Location	Total No. Days Seen	Total No. Season Seen
	2015	2016			2016	2017				2017		2018				
	December	January	February	March	December	January	February	March	April	November	December	January	February			
CB053	1	1		2				2		1	1			CBBT 1/3 & ES	8	3
CB057							1				1			CBBT 3 & ES	2	2
CB062			1									1		CBBT 4/3	2	2
CB064			1											CBBT 3	1	1
CB066					1									CBBT 3	1	1
CB067					1									CBBT 3	1	1
CB069						3	5	1				1		CBBT 4/3	10	2
CB070						1								CBBT 3	1	1
CB071						2	1							CBBT 3	3	1
CB072						1								CBBT 3	1	1
CB073						1								CBBT 3	1	1
CB074						1								CBBT 3	1	1
CB076						1								CBBT 3	1	1
CB078						1								CBBT 3	1	1
CB079						1								CBBT 3	1	1
CB080						1								CBBT 3	1	1
CB081						1								CBBT 3	1	1
CB082						1					1		1	CBBT 3	3	2
CB083						2							1	CBBT 3	3	2
CB084						1								CBBT 3	1	1
CB085						1		1						CBBT 3	2	1
CB086						2		1						CBBT 3	3	1
CB087						1					1			CBBT 3 & ES	2	2
CB088						1								CBBT 3	1	1
CB089						1								CBBT 3	1	1
CB090						2								CBBT 3	2	1

NAVFAC Catalogue ID (Harbor Seals)	Season 2 (2015-2016) 2015 December	Season 2 January	Season 2 February	Season 2 March	Season 3 (2016-2017) 2016 December	Season 3 2017 January	Season 3 February	Season 3 March	Season 3 April	Season 4 (2017-2018) 2017 November	Season 4 December	Season 4 2018 January	Season 4 February	Location	Total No. Days Seen	Total No. Seasons Seen
CB091						1								CBBT 3	1	1
CB092						1		1						CBBT 3	2	1
CB094						1								CBBT 3	1	1
CB095						1								CBBT 3	1	1
CB096						1								CBBT 3	1	1
CB097						1								CBBT 3	1	1
CB098						1								CBBT 3	1	1
CB099						1							1	CBBT 3	2	2
CB100							2		1				2	CBBT 3	5	2
CB101							1							CBBT 3	1	1
CB102							1							CBBT 3	1	1
CB103							1							ES	1	1
CB104							2			1			1	ES	4	2
CB105							1							ES	1	1
CB106							1							ES	1	1
CB107							1							ES	1	1
CB110							1							CBBT 3	1	1
CB111							1							CBBT 3	1	1
CB112							1							CBBT 3	1	1
CB113							1							ES	1	1
CB114							1				1			ES	2	2
CB115							1							ES	1	1
CB116							1	1						ES	2	1
CB117							1							ES	1	1
CB118								1						CBBT 3	1	1
CB119								1						CBBT 3	1	1
CB120								1						CBBT 3	1	1

NAVFAC Catalogue ID (Harbor Seals)	Season 2 (2015-2016)				Season 3 (2016-2017)					Season 4 (2017-2018)				Location	Total No. Days Seen	Total No. Seasons Seen
	2015	2016			2016	2017				2017		2018				
	December	January	February	March	December	January	February	March	April	November	December	January	February			
CB121								2						CBBT 3 & ES	2	1
CB122								1						ES	1	1
CB123								1				1		ES	2	2
CB124								1						ES	1	1
CB125								1						ES	1	1
CB126								1				1		ES	2	2
CB127								1						ES	1	1
CB128											1			ES	1	1
CB129											1			ES	1	1
CB130											1			CBBT 3	1	1
CB132												1		CBBT 3	1	1
CB133												1		CBBT 3	1	1
CB134												1		CBBT 3	1	1
CB135												1		CBBT 3	1	1
CB136												1		CBBT 3	1	1
CB137												1		CBBT 3	1	1
CB138												1		ES	1	1
CB139												1		ES	1	1
CB140												1		ES	1	1
CB141												1		ES	1	1
CB143												1		ES	1	1
CB144												1		ES	1	1
CB145												1		ES	1	1
CB146												1		ES	1	1
CB147												1		ES	1	1