Haul-out Counts and Photo-Identification of Pinnipeds in Chesapeake Bay, Virginia: 2015/16 Annual Progress Report

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Cover Photo Credit:

Harbor seals (*Phoca vitulina*) hauled out at a survey site in the lower Chesapeake Bay, Virginia. Cover photo by Deanna Rees, Naval Facilities Engineering Command, Atlantic. Photo taken under NMFS General Authorization (GA) Permit #19826-00.

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Acronyms and Abbreviations

BSS	Beaufort sea state
CBBT	Chesapeake Bay Bridge Tunnel
°F	degrees Fahrenheit
ft	feet
GA	General Authorization for Scientific Research
Hg	Grey seal (*Halichoerus grypus)*
km	kilometer(s)
m	meter(s)
min	minute
MLLW	Mean lower low water
mm	millimeter(s)
MMPA	Marine Mammal Protection Act
n	number of individuals
NAVFAC LANT	Naval Facilities Engineering Command Atlantic
NOAA	National Oceanic and Atmospheric Administration
Photo-ID	photo-identification
Pv	Harbor seal (*Phoca vitulina concolor)*
SLR	Single lens reflex
TNC	The Nature Conservancy
U.S.	United States
UNK	Unknown CBBT location
USFF	United States Fleet Forces Command
VACAPES	Virginia Capes Operating Area
VAQS	Virginia Aquarium and Marine Science Center

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1. Introduction and Background

Two species of pinnipeds, harbor seals (*Phoca vitulina concolor*) and gray seals (*Halichoerus grypus*), are distributed from Canada to New York and, occasionally, south to the Carolinas (Waring et al. 2016). Both pinniped species are protected under the Marine Mammal Protection Act (MMPA). The harbor seal is one of the most widely distributed seals and is found in temperate to polar coastal waters of the northern hemisphere (Jefferson et al. 2015), frequenting coastal, in-shore marine waters. The grey seal is widely distributed over the continental shelf in cold temperate and sub-polar North Atlantic waters (Lesage and Hammill 2001). Harbor and gray seals generally spend a fair amount of time hauled out on land, with time spent on land increasing during pupping and molting seasons (McConnell et al. 1999; Burns 2008).

Harbor and gray seal distribution in northwest Atlantic coastal areas appears to be shifting. Until about 2014, data from National Oceanic and Atmospheric Administration (NOAA) surveys recognized New Jersey as the southernmost extent for harbor and gray seals (NOAA 2015), with occasional sightings being reported as far south as Florida and North Carolina (Waring et al. 2016). In recent years, however, there has been an increase in the number of seals reported in southern New England and the mid-Atlantic region (Kenney 2014; Waring et al. 2016). Conversations with local anglers and Chesapeake Bay Bridge Tunnel (CBBT) workers (B. Lockwood and B. Biegel pers. comm.) indicate seals have been using the CBBT islands to haul out on for many years, although the number of animals appears to be increasing.

The goal of this survey is to document the presence of seals and gain an increased understanding of the occurrence and behavior of seals near Navy installations in the lower Chesapeake Bay (i.e. Joint Expeditionary Base Little Creek-Fort Story and Naval Station Norfolk), the Virginia Capes Operating Area (VACAPES), and important vessel transit routes.

The efforts discussed in this report are part of the United States Fleet Forces Command (USFF) initiative to understand species' occurrence and distribution in order to analyze potential impacts that U.S. Navy training and vessel-transiting activities may have on pinniped species and to develop mitigation options if appropriate. Primary objectives of this project include:

- *assessing seal occurrence, movement, and haul-out patterns adjacent to Navy testing and training areas; and*
- *the use of photo-identification methods to identify and compare individual seals and assess site fidelity among haul-out site locations in the study area.*

The work for this project is being conducted in accordance with MMPA GA 19826-00.

2. Methods

The first season of dedicated haul-out counts (i.e. the 2014/2015 field season) began in November 2014 and was completed in May 2015 (6 days after the last sighting). The 2015/2016 field season began earlier, in October 2015, in an attempt to document the arrival of seals. Surveys for the 2015/2016 field season were completed in May 2016 (27 days after the last sighting).

The survey area (**Figure 1**) is located in the lower Chesapeake Bay, Virginia. Surveys took place at four haul-out sites on the CBBT islands that span approximately 14 kilometers (km) from the first haul-out site (CBBT 1) to the fourth (CBBT 4).

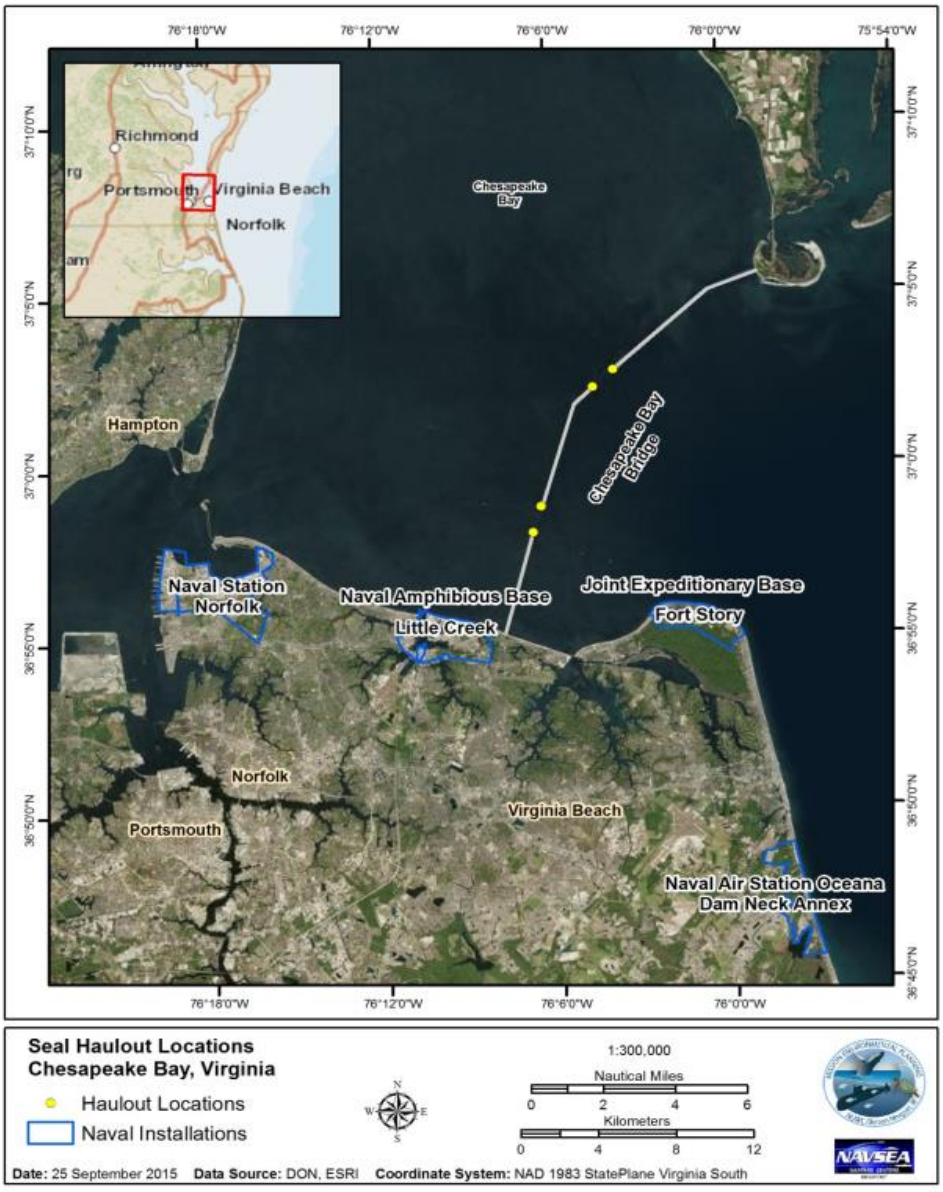

Figure 1. Map of the CBBT haul-out sites and their proximity to U.S. Navy testing and training areas, in Virginia

The haul-out locations are on rock armor formations (**Figure 2**) that protect the two tunnels as they go beneath the water.

Figure 2. Shore-based observation location, where seals generally haul-out at tip of rock armor (100-130 m from observation point). Photo © Sarah Rider, NAVFAC Atlantic

Systematic, land-based counts were conducted at four haul-out survey sites. Each haul-out site was surveyed every 1-2 weeks during the field season. Environmental data were recorded prior to the start of the survey at each of the CBBT haul-out sites or downloaded from https://tidesandcurrents.noaa.gov/ if some variables were unable to be recorded in the field. Data were collected on the following environmental variables: air temperature (˚F), water temperature (˚F), wind speed, wind direction (cardinal and degrees), visibility, tidal height in feet (ft) (Mean Lower Low Water [MLLW]), Beaufort sea state (BSS), glare, and cloud cover. Environmental data, except for visibility, BSS, cloud cover, and glare were acquired from a NOAA weather station buoy CBBV2 – 8638863 located at 36.967 N 76.114 W near CBBT island 1 (CBBT 1). Environmental data were used to investigate relationships between seal presence and environmental variables.

Seal counts and observations were taken from access roads off the Chesapeake Bay Bridge. Each observation location is located approximately 100-130 meters (m) from each haul-out site (**Figure 2**). Observers conducted counts in accordance with MMPA GA 19826-00 and maintained a minimum 50-yard (46-meter) standoff distance while following NOAA's seal watching guidelines (Pompfret 2013).

The survey crew consisted of one to two marine mammal observers and one data recorder. The numbers of seals at each of the four haul-out sites were counted using point sampling techniques. Three separate 2-minute counts (10 minutes apart) were conducted to account for seals moving between the water and haul-out locations and to allow for documentation of other minor changes at each of the haul-out sites. Observers conducted counts from an elevated platform (e.g., vehicle) in order to get an optimal view of the haul-out site (**Figure 3**). 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. 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 these three counts, consistent with similar studies by Grellier et al. (1996) and Pauli and Terhune (1987). Unless otherwise specified, seal count data should be interpreted as the best total estimate of seals present during the survey period.

Figure 3. Observers used a vehicle as an elevated platform for haul-out counts. Photo © Deanna Rees, NAVFAC Atlantic

During the 8-minute rest between counts, one of the observers obtained images of the haul-out location and each seal. A digital single-lens reflex (SLR) camera (Nikon D90 or D7100) with a zoom lens (Nikkor 80 to 400-millimeter or Sigma 150-600 mm) (**Figure 4**) was used for recording images in order to later be used for photo-identification (photo-ID) in the lab. Multiple photos of different views (neck region, dorsal, lateral, verntral) of each seal were taken when possible in order to obtain quality photos of pelage (fur) patterns. We also obtained images that were taken from a personal watercraft and were from B. Lockwood, Jet Ski Fishing & Adventures for the years 2010 to 2015. Images were incorporated into the analysis where appropriate.

Collected images were cropped and graded based on photographic quality and distinctiveness of the pelage pattern. Image grading criteria was based on image grading methods used by Balmer et al. (2008) and Forcada and Aguilar (2000). The photographic quality rating (Q1-Q3) focused on clarity, resolution, glare, and angle of the animal to the photographer. A Q1 signified an excellent photo (sharp focus, no glare, minimum angling of seal to camera, majority [≥75%] of seal captured), a Q2 represented a good photo (clear focus, minimal glare, slight angle, partial [25% to 75%] of seal captured), and a Q3 represented a poor photo (limited focus, glare,

moderate bending, or reduced [<25%] body capture). The distinctiveness rating (D1-D3) focused on the distinctiveness of pelage patterns in addition to any unique markings/scarring in the photo. A D1 represented three or more distinct patterns or markings that were clear and visible. A D2 indicated that there were one to two distinct patterns and markings. A D1 represented no distinct markings or dry pelage with no noticable or distinct markings.

Figure 4. Observers obtained images for photo identification. Photo © JC Kreidel, NAVFAC Atlantic

Using the quality and distinctiveness grades for images, a catalogue of uniquely identified seals was compiled. Photos with a Q1 and Q2 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. Q3 images were not given a unique ID number, but individuals with a Q3 grade who had a good (D2) or excellent (D1) distinctiveness grade were recorded in the seal ID database for future sighting analyses. Fields within the database included: survey date, original photo image name, unique seal ID, file name, quality rating, distinctiveness rating, aspect (part of the seal's body captured), color phase, spot/ring density, notable markings, and additional comments. This catalogue assisted in the sorting and processing of seal photos to allow for the use of manual matching techniques in order to compare and identify individual seals for the mark-recapture portion of the study. Photos were reviewed through the use of this catalogue and re-sighted seals were identified and recorded in the seal ID database.

3. Results

3.1 Haul-out Counts: 2014/2015 Field Season

The initial pilot study was completed in May 2015. Haul-out counts were conducted over the course of 12 survey days, between 20 November 2014 and 20 May 2015, totaling over 20 hours of effort (**Table 1**). Counts were not conducted in January due to weather conditions, access to survey location, and competing workload. Seals were observed on 11 of the 12 (91.7%) survey days. Over the entire season, a best total estimate of 113 seals were recorded (combined in water and hauled out) across the four haul-out survey sites (**Table 1**). The number of seals counted ranged from 0-26 seals per survey day. The majority of seals observed were identified as harbor seals; one gray seal was observed on 25 February 2016.

Table 1. Summary of survey effort and number of seals sighted for the 2014/2015 field season

Date	Survey Effort (min)	Number of Individuals Pv	Number of Individuals Hg
20-Nov-14	101	1	0
03-Dec-14	129	4	0
05-Feb-15	114	10	0
25-Feb-15	102	29	1
13-Mar-15	99	33	0
24-Mar-15	106	22	0
16-Apr-15	98	3	0
23-Apr-15	96	1	0
29-Apr-15	97	6	0
07-May-15	105	2	0
14-May-15	102	1	0
20-May-15	92	0	0
Total	**1,241**	**112**	**1**

Key: min = minute(s); Pv = *Phoca vitulina concolor* (harbor seal); Hg = *Halichoerus grypus* (gray seal)

Seals were most frequently observed at two of the four CBBT survey sites, CBBT 3 and CBBT 4 (**Figure 5**). Of the estimated 113 seals sighted, 65 (57.5%) were sighted at CBBT 3 and 44 were sighted at CBBT 4 (38.9%).

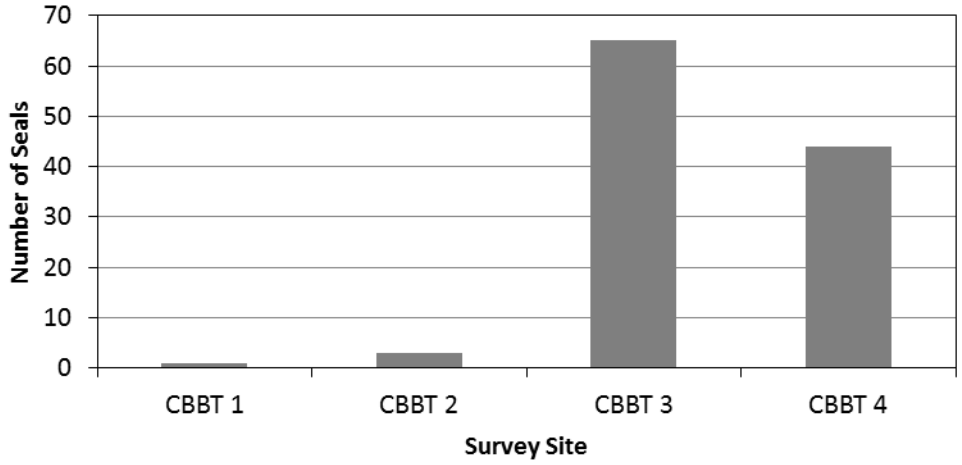

Figure 5. Total number of seals sighted at the CBBT survey sites from November 2014 to May 2015

Seal count data was compared to several environmental variables, which were recorded at the time of observation, via a linear regression and correlation analyses (**Table 2**). This was done to investigate patterns of occurrence, which might explain the variations in seal counts throughout the season. Due to the possibility of varying environmental conditions across CBBT haul-out sites during each survey day, 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 due to the majority of seal sightings occurring at CBBT 3 (57.5%); and a strong linear relationship existing between the total seal count and the CBBT 3 seal count data (**Figure 6**). Several environmental variables showed a noticeable relationship with seal count; however, the strongest relationships were with air and water temperature. Air and water temperature were also the only variables to have a significant relationship ($p \leq 0.05$) with seal count.

Table 2. Regression and correlation analysis of seal count vs. environmental variables for the 2014/2015 field season

Environmental Variables	Regression Analysis (*p*-value)	Correlation with Seal Count (Pearson *r*)
Cloud Cover (%)	0.73	0.13
Glare (%)	0.64	0.15
Beaufort Sea State (BSS)	0.18	-0.44
Tidal Height in feet (MLLW)	0.30	0.33
Wind Speed (knots)	0.28	-0.34
Wind Direction (degrees)	0.26	-0.35
Air Temperature (˚F)	0.001*	-0.82
Water Temperature (˚F)	0.001*	-0.81

*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.

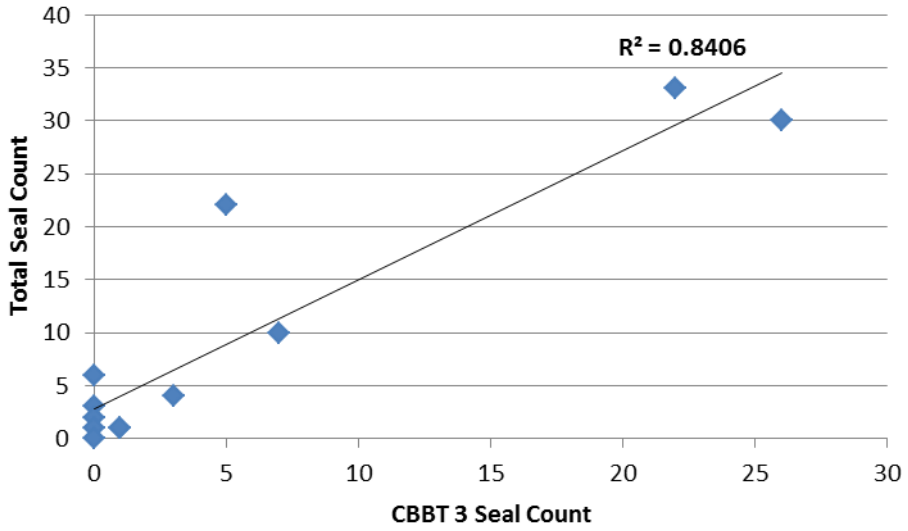

Figure 6. Total seal count vs. CBBT 3 seal count for each survey day of the 2014/2015

Air temperature appeared to have a strong negative correlation (*r* = -0.82) and a significant relationship (*p* = 0.001) with the number of seals sighted (**Table 2**). Counts were higher on the colder survey days, with peak counts recorded at air temperatures between 35-39°F (**Figure 7**). As the air temperature increased, there was a noticeable decrease in counts, with zero seals reported for the survey days that had an air temperature of 55 °F and higher.

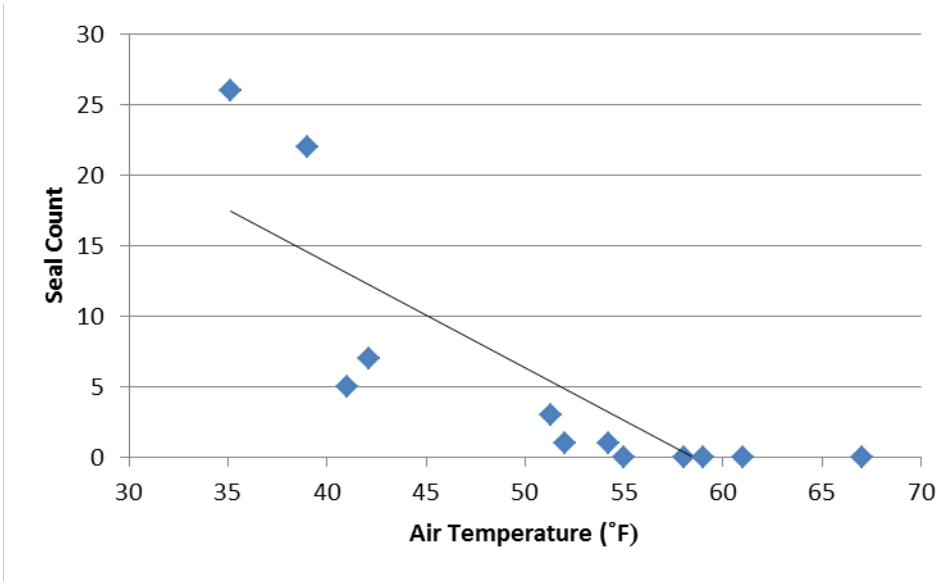

Figure 7. Seal count* vs. air temperature for the 2014/2015 field season

**Seal count data from CBBT 3 haul-out site*

Water temperature also appeared to have a strong negative correlation (*r* = -0.81) and a significant relationship (*p* = 0.001) with the number of seals sighted (**Table 2**). Counts were higher on survey days with the coldest recorded water temperatures, with peak counts between 32.5-38°F (**Figure 8**). As the water temperature increased, there was a noticeable decrease in

counts, with one to zero seals reported for the survey days that had a water temperature of 53 ^{o}F and higher.

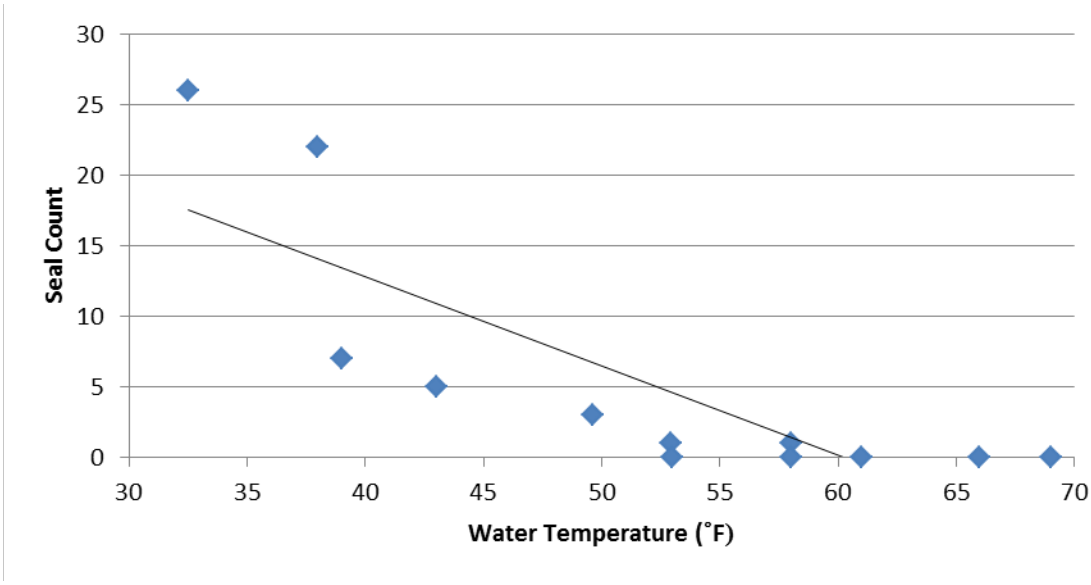

Figure 8. Seal count* vs. water temperature for the 2014/2015 field season
**Seal count data from CBBT 3 haul-out site*

Monthly seal counts were also compared with the environmental variables, air and water temperature, which seemed to have the strongest relationship with the number of seals sighted. In order to standardize this comparison between months, the total seal count per survey month was divided by the number of survey days for that month. **Figure 9** displays the relationship between average monthly seal count and average monthly air and water temperature (NOAA 2016). The increase in seal presence appeared to have occurred when water and air temperature dropped below 40 degrees Fahrenheit (°F). The peak average number of seals occurred during March (though seal counts were not conducted in January, so this result may be biased). As air and water temperatures increased, seal presence decreased. May was the last month that seals were sighted and this was when temperatures were 60°F and higher.

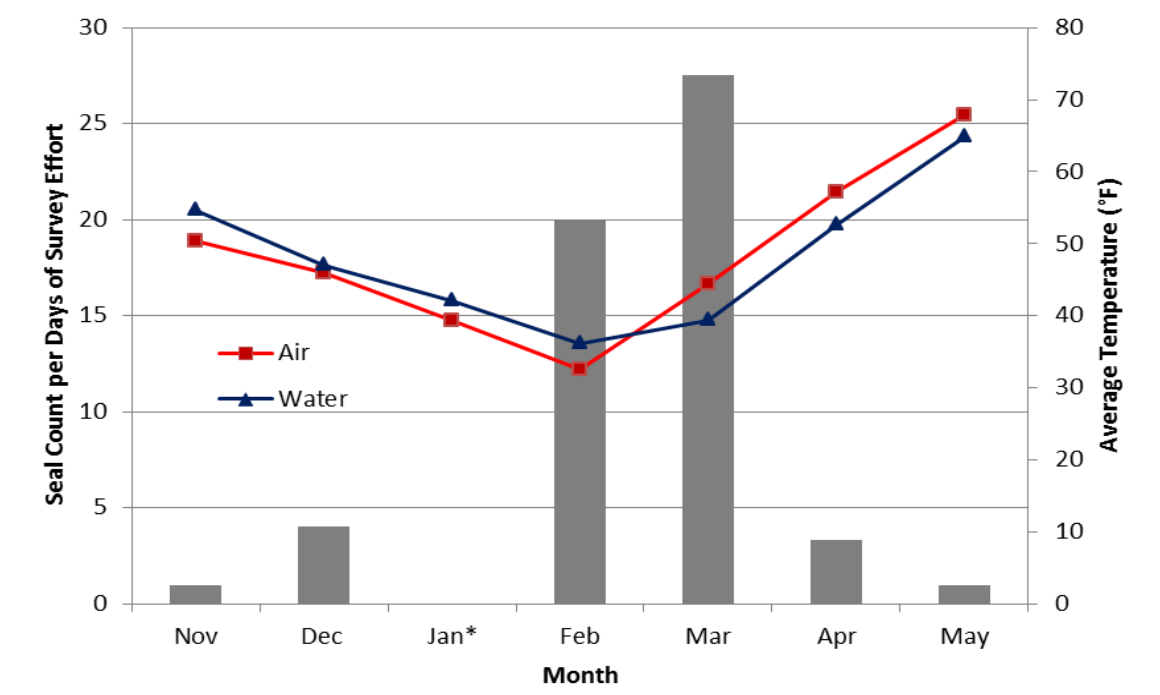

Figure 9. Average seal count by month with corresponding average monthly water and air temperature (F˚) for the 2014/2015 field season

**No counts were conducted in January*

3.2 Haul-out Counts: 2015/2016 Field Season

Haul-out counts commenced in October 2015 for the second field season. Counts were conducted over the course of 22 survey days between 6 October 2015 and 5 May 2016 with over 35 hours of effort (**Table 3**). Seals were observed on 14 of the 22 (63.6%) survey days; a best total estimate of 185 seals were recorded (combined in water and hauled out) across the four haul-out survey sites (**Table 3**). The number of seals counted per survey day ranged from 0-39 seals. The majority of seals observed were identified as harbor seals, with one gray seal observed on 17 February 2016.

Table 3. Summary of survey effort and number of seals sighted for the 2015/2016 field season

Date	Survey Effort (min)	Number of Individuals Pv	Number of Individuals Hg
06-Oct-15	108	0	0
16-Oct-15	89	0	0
23-Oct-15	90	0	0
06-Nov-15	106	0	0
12-Nov-15	92	0	0
20-Nov-15	97	0	0
09-Dec-15	100	3	0
22-Dec-15	88	6	0
07-Jan-16	98	5	0
15-Jan-16	97	8	0
21-Jan-16	108	20	0
03-Feb-16	88	23	0
12-Feb-16	100	18	0
17-Feb-16	95	11	1
26-Feb-16	95	28	0
01-Mar-16	117	11	0
10-Mar-16	103	39	0
17-Mar-16	95	6	0
22-Mar-16	102	5	0
08-Apr-16	88	1	0
25-Apr-16	91	0	0
05-May-16	68	0	0
Total	**2,115**	**184**	**1**

Key: min = minute(s); Pv = *Phoca vitulina concolor* (harbor seal)*;* Hg = *Halichoerus grypus* (gray seal)

Seals were most frequently observed at the CBBT 3 survey site (**Figure 10**). Of the estimated 185 seals sighted, 150 (81.1%) were sighted at CBBT 3.

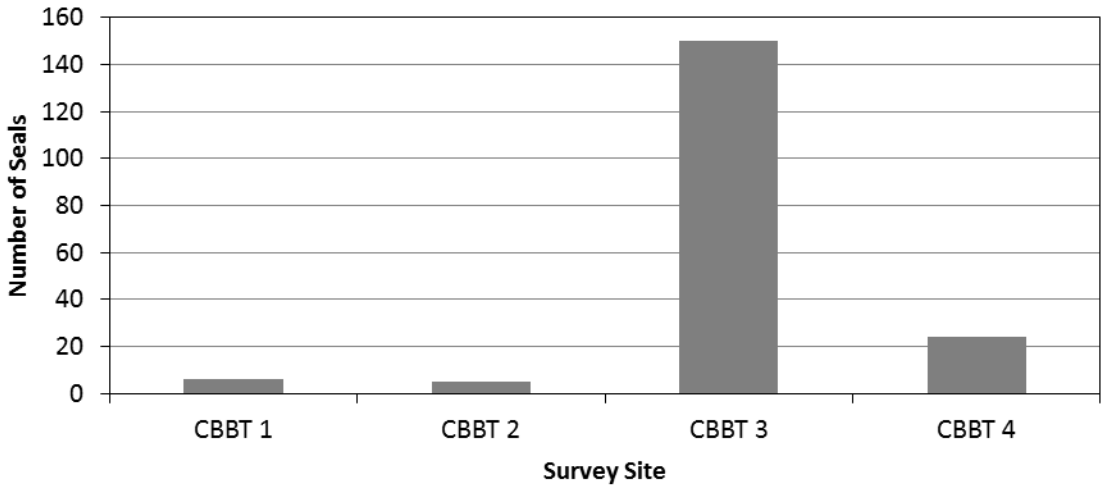

Figure 10. Total number of seals sighted at the CBBT survey sites from October 2015 to May 2016

Seal count was also compared to a variety of environmental variables, which were recorded at the time of observation, via a linear regression and correlation analysis (**Table 4**) to further investigate for patterns, which might explain variations in seal count throughout the season. Due to the possibility of varying environmental conditions across CBBT haul-out sites during each survey day, 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 due to the majority of seal sightings occurring at CBBT 3 (81.1%); and a strong linear relationship existing between the total seal count and the CBBT 3 seal count data (**Figure 11**). Only a couple of variables showed a noticeable relationship with seal count; however, the strongest relationships were with tidal height and water temperature. Tidal height and water temperature were also the only variables to have a significant relationship ($p \leq 0.05$) with seal count.

Table 4. Regression and correlation analysis of seal abundance vs. environmental variables for the 2015/2016 field season

Environmental Variables	Regression Analysis (*p*-value)	Correlation with Seal Count (Pearson *r*)
Cloud Cover (%)	0.99	-0.003
Glare (%)	0.77	-0.07
Beaufort Sea State (BSS)	0.98	0.005
Tidal Height in feet (MLLW)	0.024*	-0.48
Wind Speed (knots)	0.88	-0.04
Wind Direction (degrees)	0.72	-0.08
Air Temperature (˚F)	0.35	-0.21
Water Temperature (˚F)	0.003*	-0.60

*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.

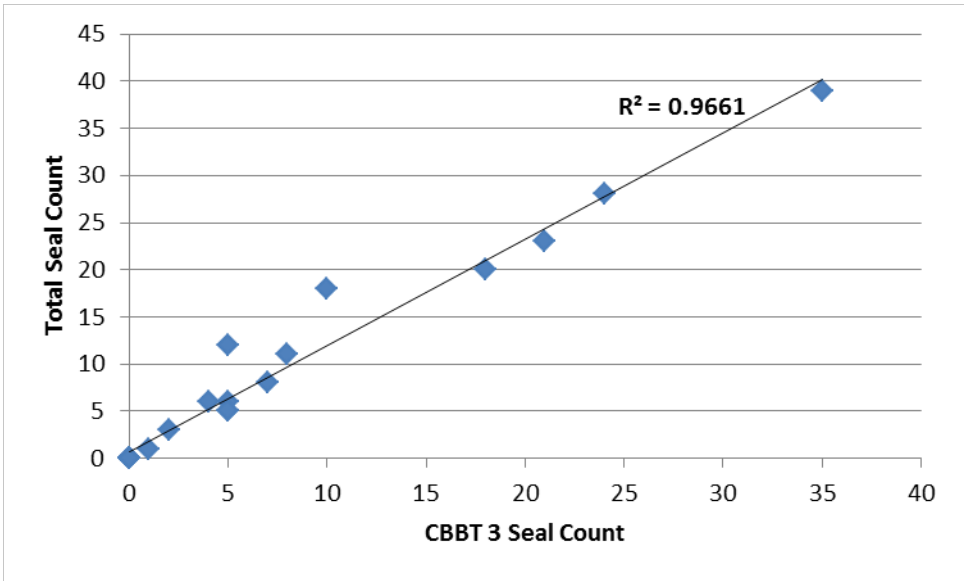

Figure 11. Total seal count vs. CBBT 3 seal count for each survey day of the 2015/2016 field season

Tidal height appeared to have a slight negative correlation (r = - 0.48) and a significant relationship (p = 0.024) with the number of seals sighted **(Table 4)**. Higher counts were observed on survey days with a tidal height of 1.5 ft or lower (**Figure 12**). It appeared that as tidal height increased, the number of seals sighted decreased.

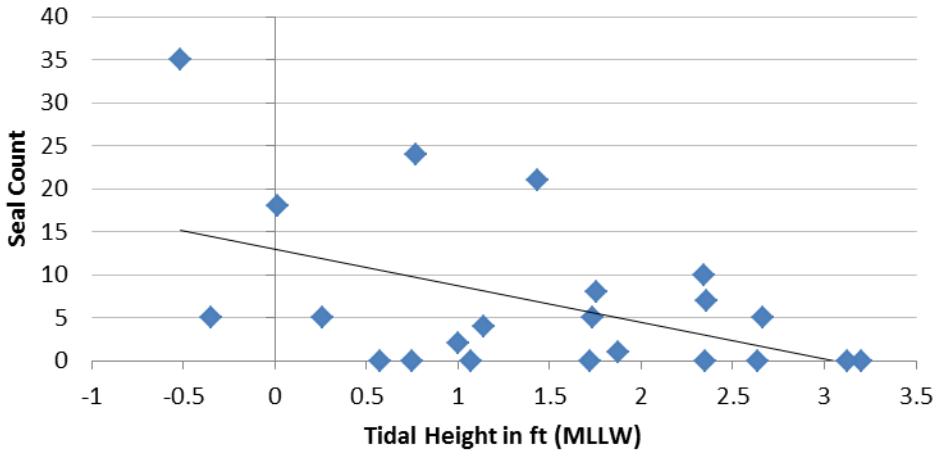

Figure 12. Seal count* vs. tidal height in ft (MLLW) for the 2015/2016 field season

**Seal count data from CBBT 3 haul-out site*

Water temperature also appeared to have a moderate negative correlation (r = -0.60) and a significant relationship (p = 0.003) with the number of seals sighted (**Table 4**). Counts were higher on survey days with water temperatures between 40-49°F (**Figure 13**). As the water temperature increased, there was a noticeable decrease in counts, with zero seals reported for the survey days that had a water temperature of 60 °F and higher.

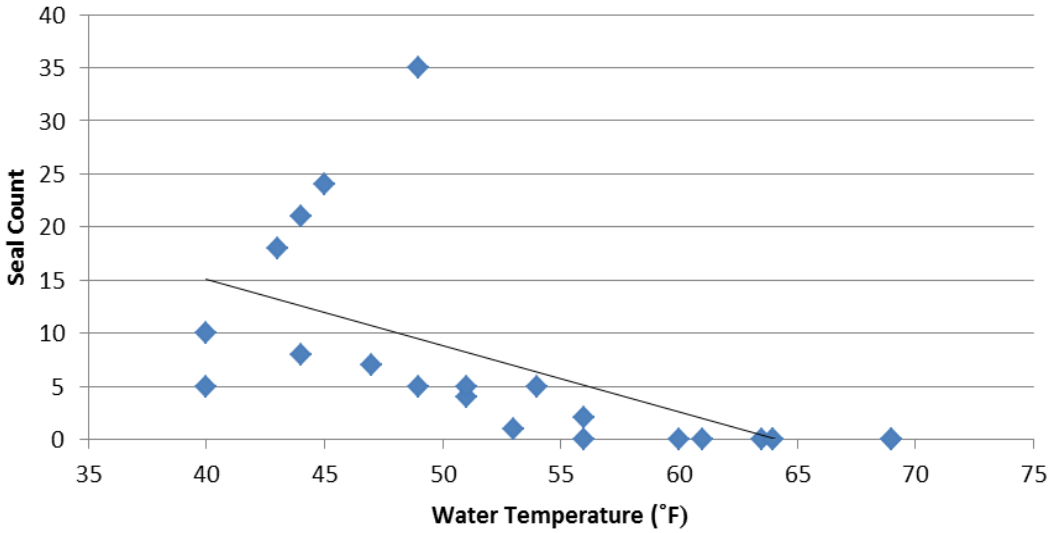

Figure 13. Seal count* vs. water temperature (˚F) for the 2015/2016 field season
**Seal count data from CBBT 3 haul-out site*

Monthly seal counts were compared with water temperature, which seemed to have the strongest relationship with the number of seals sighted. In order to standardize the comparison of seal count and water temperature across survey months, the total seal count per survey month was divided by the number of survey days for that month. **Figure 14** displays the relationship between average monthly seal count and average monthly air and water temperature (NOAA 2016). Seal presence began to increase in December when water temperature dropped below 58°F, with a peak average number of seals during February. As water temperature increased, seal presence decreased. April was the last month that seals were sighted when water temperature was at 55°F and higher. Tidal height was not included in this comparison due to the large fluctuations that are usually observed in tidal height throughout the day; therefore, a monthly average is not the best representation of this variable.

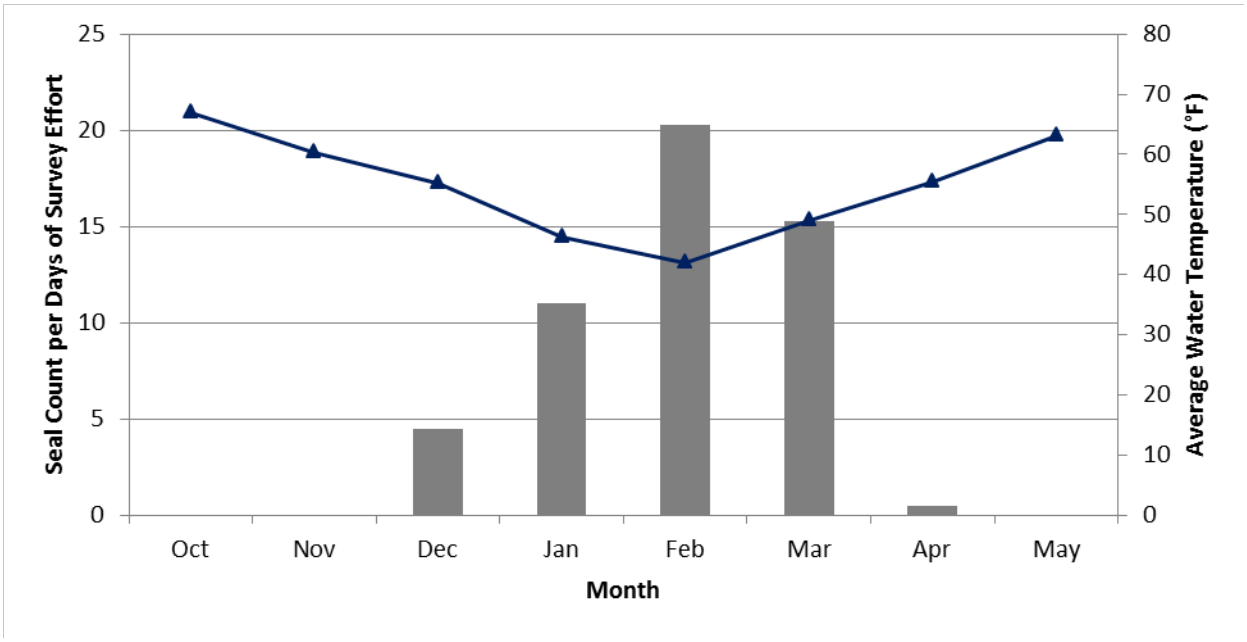

Figure 14. Average seal count by month with corresponding average monthly water temperature (˚F) for the 2015/2016 field season

3.3 Photo Identification

After reviewing all photos from April 2010 to March 2016, 52 harbor seals were uniquely identified (**Table 5**) based upon image grading criteria. Individuals sighted from 22 April 2010 to 20 January 2015 were identified from images provided by B. Lockwood, Jet Ski Fishing & Adventures. Individuals sighted from 24 March 2015 to 22 March 2016 were identified from images collected during NAVFAC LANT surveys. Gray seals (n=2) could not be uniquely identified by collected images based on the image grading criteria for quality; images were too poor of quality.

Of the 52 uniquely identified harbor seals, six (11.5%) were determined, based on photo-identification, to be present in the study area on more than one occasion. These individuals were CB005, CB021, CB023, CB035, CB038, and CB053 (**Table 5**). Identifiable re-sightings (or recaptures) for these six harbor seals spanned from five days to 1,820 days (median = 37 days). One harbor seal (CB053) was photographically captured on five different survey dates between 9 December 2015 and 22 March 2016. Of the six individuals identified to be present on more than one occasion, three (CB005, CB021, and CB023) spanned over multiple years. For example, CB023 was first captured on 20 January 2015 and then recaptured on 26 February 2016 (**Figure 15**).

Table 5. Sighting history of uniquely identified harbor seals at the Chesapeake Bay Bridge Tunnel (CBBT): April 2010-March 2016

NAVFAC Catalogue ID	22-Apr-10	24-Apr-10	2-Mar-11	3-Apr-11	23-Feb-12	17-Mar-13	13-Jan-14	27-Jan-14	1-Feb-14	8-Feb-14	2-Jan-15	20-Jan-15	29-Apr-15	9-Dec-15	7-Jan-16	15-Jan-16	21-Jan-16	3-Feb-16	12-Feb-16	26-Feb-16	1-Mar-16	10-Mar-16	17-Mar-16	22-Mar-16	CBBT Location	Total No. Days Seen
Harbor seals																										
CB001	X																								UNK	1
CB002	X																								UNK	1
CB003		X																							UNK	1
CB004			X																						UNK	1
CB005			X																	X					UNK; 3	2
CB006			X																						UNK	1
CB007			X																						UNK	1
CB008			X																						UNK	1
CB009			X																						UNK	1
CB010				X																					UNK	1
CB011					X																				UNK	1
CB012					X																				UNK	1
CB013						X																			UNK	1
CB014							X																		UNK	1
CB015								X																	UNK	1
CB016									X																UNK	1
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CB019										X															UNK	1
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CB024												X													UNK	1
CB025												X													UNK	1
CB026												X													UNK	1
CB027												X													UNK	1

NAVFAC Catalogue ID	2-Apr-10	24-Apr-10	2-Mar-11	3-Apr-11	23-Feb-12	17-Mar-13	13-Jan-14	27-Jan-14	1-Feb-14	8-Feb-14	2-Jan-15	20-Jan-15	29-Apr-15	9-Dec-15	7-Jan-16	15-Jan-16	21-Jan-16	3-Feb-16	12-Feb-16	26-Feb-16	1-Mar-16	10-Mar-16	17-Mar-16	22-Mar-16	CBBT Location	Total No. Days Seen
Harbor Seals (continued)																										
CB028												X													**UNK**	**1**
CB030*												X													**UNK**	**1**
CB031													X												**4**	**1**
CB032													X												**4**	**1**
CB033																	X								**3**	**1**
CB034																	X								**3**	**1**
CB035																	X	X							**3; 3**	**2**
CB036																	X								**3**	**1**
CB037																	X								**3**	**1**
CB038																		X	X						**4; 4**	**2**
CB039																		X							**3**	**1**
CB040																		X							**3**	**1**
CB041																		X							**3**	**1**
CB042																			X						**4**	**1**
CB043																			X						**4**	**1**
CB044																				X					**4**	**1**
CB045																				X					**3**	**1**
CB046																				X					**3**	**1**
CB047																				X					**3**	**1**
CB048																				X					**3**	**1**
CB049																					X				**3**	**1**
CB050																					X				**3**	**1**
CB051																					X				**3**	**1**
CB052																					X				**1**	**1**
CB053														X		X						X		X	**1; 3; 3; 3; 3**	**5**

Key: UNK= Unknown CBBT haul-out survey site

**CB029 was subsequently removed from the catalogue, as the photo did not meet the minimum quality criteria*

Of the 61 sightings (sightings and re-sightings combined) of individually identified harbor seals, 31 sightings (50.8%) were at an unknown CBBT haul-out location (info on the specific CBBT haul-out location was not available for B. Lockwood images), 23 sightings (37.3%) were at CBBT 3, 7 sightings (11.5%) were at CBBT 4, 2 sightings (3.3%) were at CBBT 1, and 0 sightings (0%) were at CBBT2 (**Table 5** Two individuals, CB035 and CB038, were at the same haul-out site both times they were identified; CBBT 3 and CBBT 4, respectively. CB053 was found at the same haul-out site (CBBT 3) four out of the five (80%) times that it was identified, except for the first sighting of this individual on 9 December 2015 at haul-out site CBBT 1.

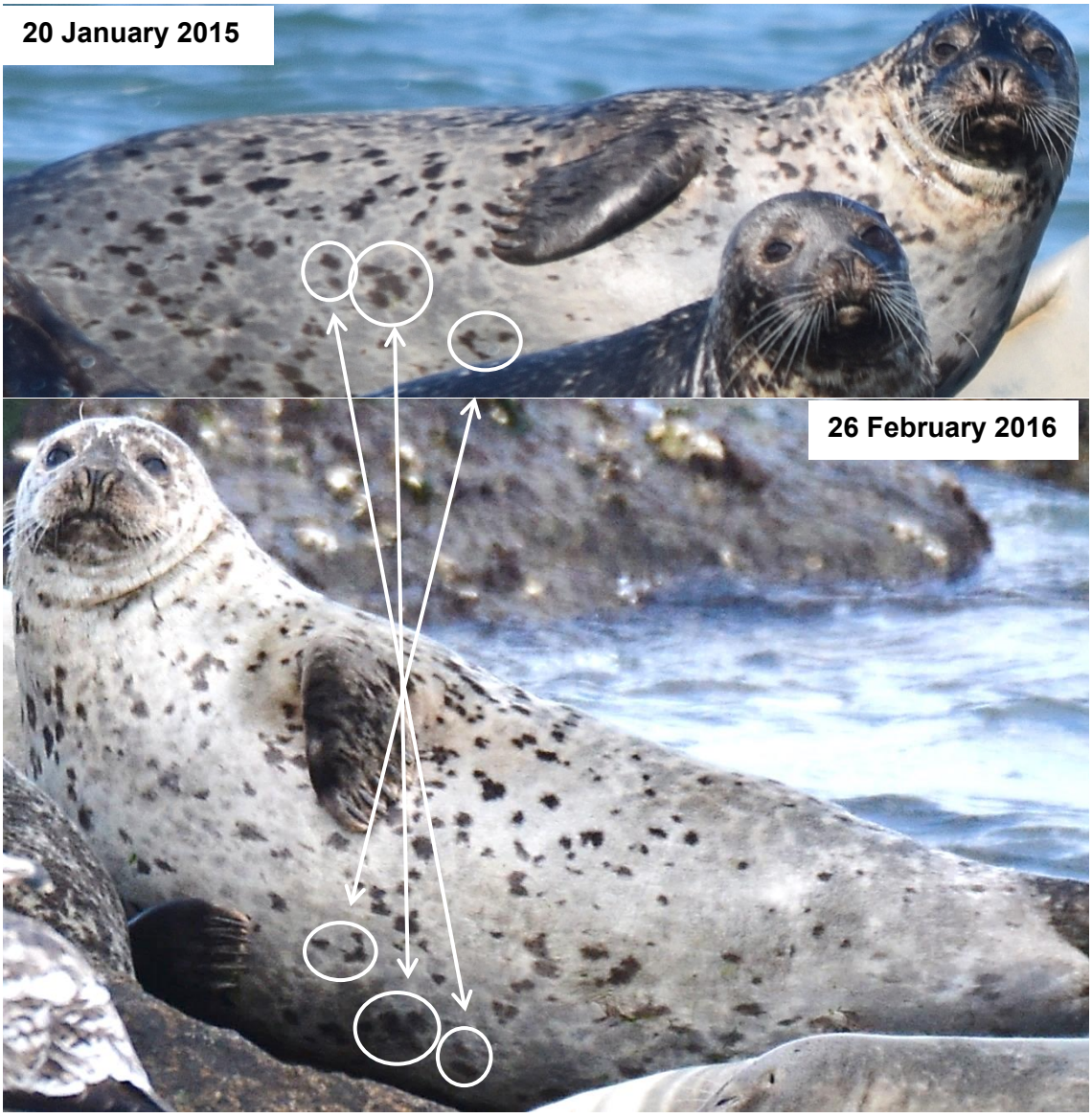

Figure 15. Harbor seal, CB023, first captured on 20 January 2015 at an unknown CBBT haul-out site (above) and then recaptured on 26 February 2016 at CBBT 3 (below)

4. Discussion

During the study period, seal observations during the second field season were 64% higher than the number of seals observed during the first field season; with the majority of the observations comprising harbor seals. An increase of 72 total seal observations occurred between the 2014/2015 and the 2015/2016 field seasons. In the 2014/2015 field season, 112 harbor seals and one gray seal were recorded; in the 2015/2016 field season, 184 harbor seals and one gray seal were recorded. The maximum seal count per survey day in the 2014/2015 field season was 33 on 13 March 2015. The maximum seal count per survey day in the 2015/2016 field season was 39 on 10 March 2016. It is important to keep in mind that the increase in the number of sightings from the first field season to the second field season may be a result of increased survey effort. In the 2014/2015 field season, 12 surveys were conducted, and in the 2015/2016 field season, 22 surveys were conducted. Although, some studies indicate that an increase of seals may be occurring within the Mid-Atlantic (Kenney 2014; Waring et al. 2016), more surveys in the study area spanning multiple field seasons must be conducted before drawing firm conclusions for Virginia.

Preliminary results indicate that the number of seals may vary based on meteorological and oceanographic observations. Out of the suite of environmental variables that were analyzed in comparison to seal count, three variables (air temperature, water temperature, and tidal height) seemed to have at least a moderate correlation as well as a significant relationship with seal count. Preliminary observations indicate that arrival and departure of seals at the study area in the Chesapeake Bay may coincide with changes in air and water temperature. Results showed a noticeable increase in seal count for the 2014/2015 field season as air temperatures decreased; however, air temperature did not have a substantial impact on seal presence for the 2015/2016 field season. For the first field season, seal count appeared to decrease as air temperature began to rise. A similar pattern also occurred for both field seasons when seal count was compared to water temperature. Results showed a noticeable increase in seal count for both field seasons as water temperatures decreased, and the highest counts were recorded during the months with some of the colder recorded water temperatures; February (2014/2015 field season) and March. Seal count also appeared to decrease for both field seasons, as water temperature began to rise. Based on our analysis, water temperature had one of the strongest correlations and significant relationships with seal presence for both field seasons. Air temperature had a slight negative correlation with seal presence, but not a significant relationship for the 2015/2016 field season. Therefore, water temperature may be one of the strongest environmental predictors of seal presence in the lower Chesapeake Bay. Initial seal sightings for both field seasons occurred when the average monthly water temperature was around 55 °F (November for the 2014/2015 field season [**Figure 9**] and December for the 2015/2016 field season [**Figure 14**]). Because seals were observed on the first survey day in November for the 2014/2015 field season, and anecdotal reports indicated a potential for seal presence as early as October, we began surveys in October for the 2015-2016 field season in an attempt to better document arrival in the study area. In the future, surveys should begin in at least mid-October and be consistent across multiple field seasons to ascertain if water temperature may be a strong predictor of seal arrival in the study area. Overall, these

preliminary results show a potential seasonal latitudinal movement of individuals to the study area during winter months, as suggested by Waring et al. (2016).

In certain instances, tidal height may influence seal count within the lower Chesapeake Bay. The 2015-2016 field season displayed a slight negative correlation and a significant relationship between tidal height and seal count; as tidal height increased, seal count decreased. 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. Further survey days with low (-0.5-0.5 ft) and high (2.5-3.5) tidal heights are needed in order to determine if tidal height has a significant relationship with seal presence.

Although analyses of data from this project are ongoing and continued photo-ID effort is necessary, preliminary results show evidence of site fidelity in the study area by at least a portion of the harbor seals utilizing the area. Six out of 52 (11.5%) uniquely identified harbor seals were seen on more than one occasion. Three of these six re-sightings spanned multiple years (CB005 was first sighted in March of 2011 and then re-sighted almost 5 years later in February of 2016; CB021 was first sighted in January 2015 and re-sighted in January 2016; and CB023 was first sighted in January 2015 and re-sighted in February of 2016). These findings support the claim that this area supports a series of regular, winter haul-out sites for harbor seals within the lower Chesapeake Bay, Virginia.

The preliminary results suggest not only is there harbor seal site fidelity in the study area for some individuals, but also site fidelity and preference to a specific haul-out site within the study area for at least some portion of the population. Two re-sighted individuals (CB035 and CB038) were found at the same haul-out site (CBBT 3 and CBBT 4, respectively), both times that they were identified. CB053 was documented at the same haul-out site (CBBT 3) four out of the five (80%) times that it was observed. As the analysis continues and the catalogue grows, further evidence and levels of site fidelity may become evident.

5. Conclusions & Recommendations

Our research continues to document a regular, seasonal presence of harbor seals and possibly gray seals within the lower Chesapeake Bay, Virginia. Patterns of seasonal residency for harbor seals within the region are beginning to emerge; but more research is necessary to determine the level of site fidelity within the study area. Data will continue to be collected and examined for any emerging patterns of habitat utilization, residency pattern, and animal condition.

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

1. **Continue coordinated counts and expand study as information is available.** In February 2016, we commenced coordinated haul-out counts with The Nature Conservancy (TNC) for a haul-out location approximately 30 km from the nearest CBBT haul-out site. TNC conducted counts over the course of six survey days between 17 February 2016 and 19 April 2016. These concurrent counts will provide us with a minimum count for the region. NAVFAC LANT will continue to coordinate counts with

TNC for the 2016/2017 field season. Concurrent counts should be expanded if additional potential haul-outs are identified in the region.

2. **Continue collaboration with other researchers and citizen scientists.** Collaboration with other local and regional researchers and agencies, such as the Virginia Aquarium and Marine Science Center (VAQS) will continue to be sought. Study and citizen photographs will continue to be sorted and processed for inclusion in a photo database that can be compared with databases existing in New England and possibly Canada.

3. **Implement satellite-monitored tagging techniques**. The number of sightings of harbor seals supports the recommendation to continue this study. A proof-of-concept tagging effort is being planned for the beginning of the 2016-2017 field season to investigate seal movement and habitat use near Navy testing and training areas in Virginia. Such information 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.

4. **Possible Utilization of Extract Compare Software**. In the future, the study may incorporate the Extract Compare software, 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.

5. **Submit data to OBIS-SEAMAP**. Currently seal sightings for Virginia are lacking in sightings databases and the published literature. Adding these data to OBIS-SEAMAP allows them to be stored 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.

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of aerial photography. These collaborations will be invaluable in monitoring this population in the years to come.

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