

Investigating Site Fidelity and Seasonal Abundance of an Expanding Harbor Seal Population in the Mid-Atlantic

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INTRODUCTION

- Harbor seal distribution along the United States (U.S.) Atlantic coast appears to be expanding to the mid-Atlantic [1]; [2].
- New Jersey was previously recognized as the southern range extent for the Western North Atlantic harbor seal stock, with scattered sightings reported as far south as Florida.
- Within the last decade, harbor seals have been observed returning seasonally (fall to spring) to haul-out locations in coastal Virginia (VA) [3].
 - NOAA reports now indicate the southern extent is North Carolina [4].
- Since 2014, the U.S. Navy has investigated harbor seal presence in the lower Chesapeake Bay and coastal waters of VA (Figure 1), which are important areas to Navy training and testing activities.
 - Project goals:** assess seal occurrence, abundance, habitat use, and haul-out patterns in VA through the use of haul-out counts, photo-ID, and satellite tagging efforts.

METHODS: HAUL-OUT COUNTS AND PHOTO-ID

- Haul-out surveys were conducted annually, from fall to spring, at two different survey areas in southeastern VA (Figure 1):
 - In the lower Chesapeake Bay along the Chesapeake Bay Bridge Tunnel (CBBT), on the four "islands", from 2014-2021 (Figure 2)
 - On the southern tip of the Eastern Shore (ES), where there are five main haul-out locations, from 2016-2021 (Figure 3)
- Series of systematic counts of seals (hauled out and in the water) were conducted during each survey at the CBBT and ES. Counts were done via land, vessel, and drone.
- Images of seals were collected between counts for photo-ID to develop a catalog, assess site fidelity, and for a mark-recapture study.
 - Images were manually graded based on photographic quality and distinctiveness of the pelage pattern.
 - Images that met minimum quality and distinctiveness standards were entered into a catalog and used in the analyses.



Figure 2. A group of harbor seals hauled out near the tip of one of the CBBT islands. Photo taken under NMFS General Permit # 19826



Figure 3. ES survey area with harbor seals hauled out on a mud bank. Photo taken under NMFS General Permit # 19826



Figure 1. CBBT and ES haul-out locations and nearby U.S. Naval installations. VACAPES OPAREA= Virginia Capes Range Complex Operating Area

METHODS: ABUNDANCE ESTIMATION

- Estimated population abundance (**N**) of harbor seals for the study area, including CBBT and ES survey areas, using two approaches.
 - 1) Mark-recapture Approach**
 - Used photo-ID data from 2015-2021 to fit a Lincoln-Petersen mark-recapture model.
$$N = \frac{m_1 n_2}{m_2}$$
 - m_1 = total # of marked animals/captures
 - n_2 = total # of marked/unmarked animals
 - m_2 = # of total re-sightings/re-captures
 - Model was fit for each season and for all six seasons to get a mean estimate.
 - 2) Telemetry Correction Factor Approach**
 - Used seal count data from 2016-2021 and satellite telemetry data from harbor seals that were tagged at the ES in 2018 and 2020 [5].
 - Calculated mean seal count for the study area for each season (**n**) from 2016-2021 and all five seasons to get a mean estimate.
 - Applied a telemetry correction factor based on the mean proportion of time that seals spent ashore (**h**) at VA haul-out sites [6].

Table 1. Seasonal survey effort (# of survey days between first and last seal observation), total seal count, effort-normalized mean (# of seals observed per in season survey day), and max seal count for a single survey day for the CBBT and ES survey areas. SE= standard error.

Field Season	"In Season" Survey Effort (days)	Seal Counts		
		Total	Mean (SE)	Maximum
2014-2015*	11	112	10 (3.7)	33
2015-2016*	14	184	13 (2.9)	39
2016-2017	29	412	14 (2.1)	40
2017-2018	23	537	23 (3.4)	69
2018-2019	21	242	11 (3.1)	66
2019-2020	15	185	12 (3.2)	39
2020-2021	23	351	16 (2.8)	43

*From 2014-2016, counts only conducted at the CBBT survey area

RESULTS: HAUL-OUT COUNTS

- Total of 168 survey days from 2014-2021: 110 survey days for CBBT and 58 survey days for ES.
- Harbor seals observed from November to April, peak counts recorded between January and March.
 - Seals were recorded on a consistent basis (81% of survey days) after arrival until departure in spring.
- Fluctuation in seal presence observed for the study area- increasing trend in mean and maximum seal count from 2014-2018, followed by a decrease from 2018-2020 (Table 1).
 - Seal presence appeared to rebound from 2020-2021.
 - Statistically significant difference between mean counts ($F_{stat}=2.59$, $p=0.041$).

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RESULTS: PHOTO-ID

- From 2015-2021, uniquely identified 155 harbor seals for the study area (Figure 4).
 - 57% (n=88) were observed only once and 43% (n=67) were sighted 2-10 times.
 - Highest number of recorded re-sightings (or re-captures) occurred in 2020/2021 season.
- Identifiable re-sightings ranged from 5 days to 1,889 days (62 months).
- Some seals have been re-sighted across multiple field seasons (Figure 5):
 - 33 individuals sighted across 2 seasons
 - 13 individuals sighted across 3-5 seasons

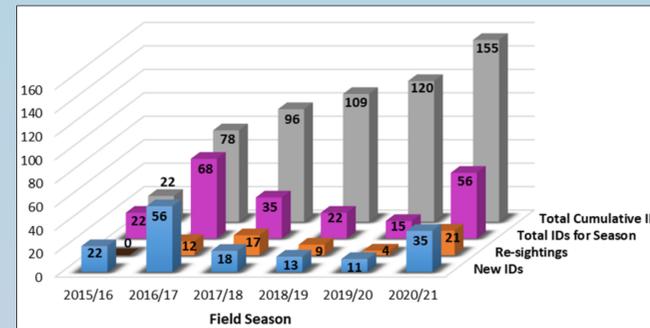


Figure 4. Harbor seal identifications over six field seasons (2015-2021)

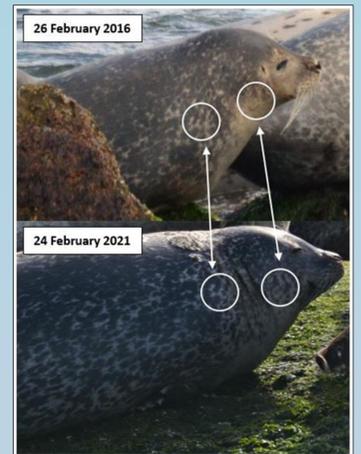


Figure 5. A harbor seal first captured on 26 February 2016 (above) and then re-captured on 24 February 2021 (below)

RESULTS: ABUNDANCE ESTIMATES

- Fluctuation in abundance occurred across seasons for both approaches (Figure 6).
 - 1) Mark-recapture Approach**
 - Estimate range: 81 (95% CI: 44.14–117.19) to 242 (95% CI: 91.35–392.65)
 - Mean estimate of 183 individuals for all six seasons (2015-2021)
 - 2) Telemetry Correction Factor Approach**
 - Abundance slightly higher in comparison for most seasons.
 - Estimate range: 143 (95% CI: 0-388.05) to 245 (95% CI: 39.42–450.77)
 - Mean estimate of 249 individuals for all five seasons (2016-2021)
 - Large 95% CIs may be due to small sample sizes for count and telemetry data for this type of calculation [6].
- Conducted a regression analysis for the seasonal abundance estimates.
 - Slope was not statistically significant for both approaches, indicating no trend in population abundance.

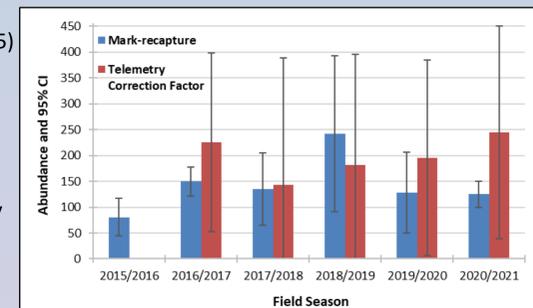


Figure 6. Total abundance estimates and 95% confidence intervals (CIs) for CBBT and ES survey areas (combined) calculated from the mark-recapture and telemetry correction factor approaches for the 2015-2021 seasons.

DISCUSSION

- Harbor seal distribution has expanded south, with a small, established population occurring seasonally within southeastern VA.
 - This study contributed towards the updated geographic range for the Western North Atlantic stock in the 2020 NOAA SAR [4].
- Evidence of site fidelity with re-sightings of individuals both within a season and across multiple seasons.
 - Based on contributed citizen photographs, some of the identified seals have occurred in the region since 2011.
- The local harbor seal population may be relatively stable based on fluctuations in the seasonal abundance estimates and regression analysis results indicating no significant trend.
 - Observed fluctuations could be due to several factors: sampling bias in survey effort, a 2018-2021 unusual mortality event, seasonal differences in haul-out behavior, or displacement by an increasing gray seal population in Northeastern U.S. [2]; [3].
 - Additional haul-out surveys, mark-recapture and tagging efforts are required before making inferences.
- The results from this study will aid the Navy in limiting interactions with these protected species, designing better mitigation measures where interactions are unavoidable, and maintaining environmental compliance.

FUTURE WORK

- Continue with haul-out counts and photo-ID data collection as well as satellite tagging efforts for the 2022/2023 season.
- Develop a more robust dataset to better assess any potential population trends and site fidelity in the region.
 - With additional count and telemetry data, we could explore the use of a generalized additive or linear mixed model framework to improve abundance estimation efforts for the region

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