

Short Note

Heading South for the Winter: The Seasonal Occurrence of Harbor Seals (*Phoca vitulina vitulina*) Near Oregon Inlet, North Carolina, USA

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In the western North Atlantic, harbor seals (*Phoca vitulina vitulina*) range seasonally from the mid-Atlantic states in the United States to the Canadian Arctic (NOAA Fisheries, 2022). For most of the past century, harbor seals were largely absent from the marine mammal fauna of North Carolina after the population was significantly reduced in size following widespread persecution and government-sponsored culls in New England (Lelli et al., 2009). The population is concentrated in higher latitudes in the spring and summer before dispersing toward southern New England and the Mid-Atlantic during autumn and winter (Waring et al., 2007). However, over the past few decades, harbor seals have also been appearing regularly along the Outer Banks of North Carolina during winter and spring months (Doshkov, 2019; North Carolina Division of Parks and Recreation, 2023).

Herein, we report the results of surveys of harbor seals on Green Island Shoal (referred to as Green Island before 2019), conducted just inside Oregon Inlet, North Carolina, between December 2010 and February 2023 (Figure 1). Previous reports have not shown consistent haul-out sites in North Carolina. We believe that Green Island Shoal is now the southernmost limit of the regular occurrence of harbor seals in the western North Atlantic.

Our observations of harbor seals were made using a spotting scope and binoculars from the Bonner Bridge from December 2010 until its replacement, the Marc Basnight Bridge, opened in February 2019 (Table 1). We also conducted periodic surveys from the Bonner Bridge Pier and the adjacent strip of land to the south-southeast of Bonner Bridge Pier, both very close to the

bridge observation point. The seal haul-out location on the shoal is approximately 1 km from the bridge. We obtained tide height at the time of each survey from National Oceanic and Atmospheric Administration (NOAA) tide predictions for the Oregon Inlet Bridge, North Carolina, as surveys were not consistently conducted at or around the same tide height (NOAA Tides & Currents, n.d.). The North Carolina Department of Transportation provided a construction timeline for the Marc Basnight Bridge and repairs to and demolition of the Bonner Bridge.

We observed harbor seals on Green Island Shoal during the winters of 2010, 2011, 2012, 2013, 2014, 2015, 2022, and 2023. After February 2019, all surveys were conducted from the Marc Basnight Bridge. We suspended surveys when Green Island disappeared after Hurricane Dorian made landfall near Cape Hatteras on 5 September 2019, and we resumed them when the shoal reappeared in January 2022. Changes in the physiography of Green Island and Green Island Shoal between 2011 and 2023 are apparent in Figure 2. The greatest number of seals we observed in any year was 461 in 2011: 99 in January, 271 in February, 78 in March, and 13 in April (Figure 3).

Harbor seals were present only between December and April (Figure 4), with most observed in February. In 2011, February also had the largest single group observed with 35 seals. The tidal range at Oregon Inlet is typically less than 1 m, and we found very little correlation between the number of seals hauled out and tide height ($r^2 = 0.0326$). There was an average tidal range of only 0.138 m during periods when harbor seals were present.



Figure 1. The location of the harbor seal (*Phoca vitulina vitulina*) haulout on Green Island Shoal, located in Cape Hatteras National Seashore, just inside Oregon Inlet, North Carolina

Table 1. Number of surveys conducted per month by year in the study area (Green Island Shoal, North Carolina) to monitor and record the presence and number of harbor seals (*Phoca vitulina vitulina*)

Year	Month	Quantity
2010	December	2
2011	January	14
	February	23
	March	30
	April	30
	December	13
2012	January	31
	February	4
	March	6
2013	January	10
	February	9
2014	January	15
	February	19
	March	17
	April	1
	December	3
2015	January	13
	February	14
	March	14
	April	22
	May	3
2016	January	6
	February	16
	March	15
	April	22
2017	January	6
	February	12
	March	7
	April	2
2018	January	8
	February	2
	April	1
2019	January	2
	February	5
	March	3
2022	January	1
	February	16
	March	10
	December	4
2023	January	21
	February	12

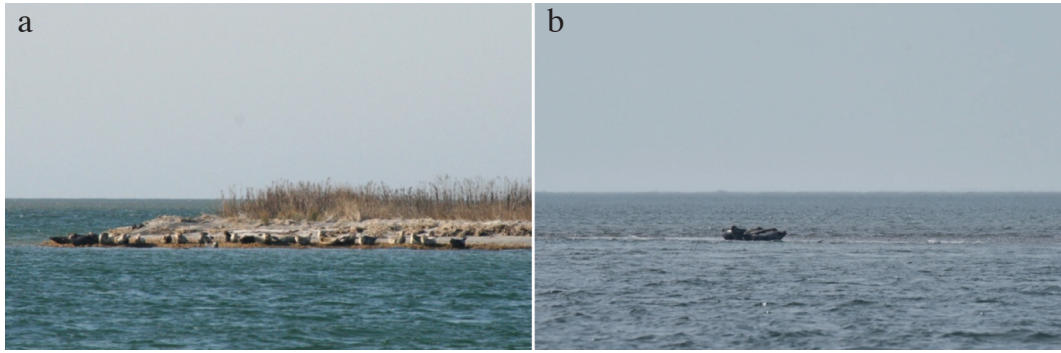


Figure 2. Observations of harbor seals hauled out on (a) Green Island in 2011 and (b) Green Island Shoal, North Carolina, in 2023

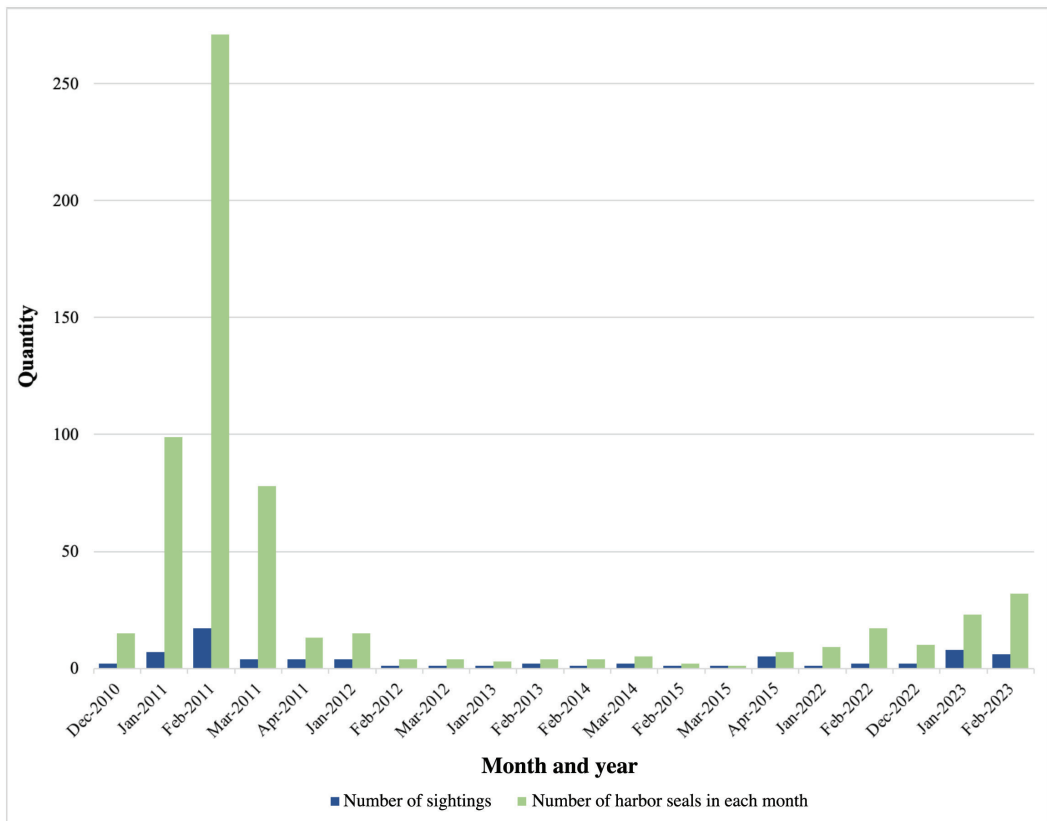


Figure 3. Temporal observations of the number of harbor seals observed by month by year and number of sightings (occasions in which at least one seal was observed) in each month and year in Green Island Shoal, North Carolina

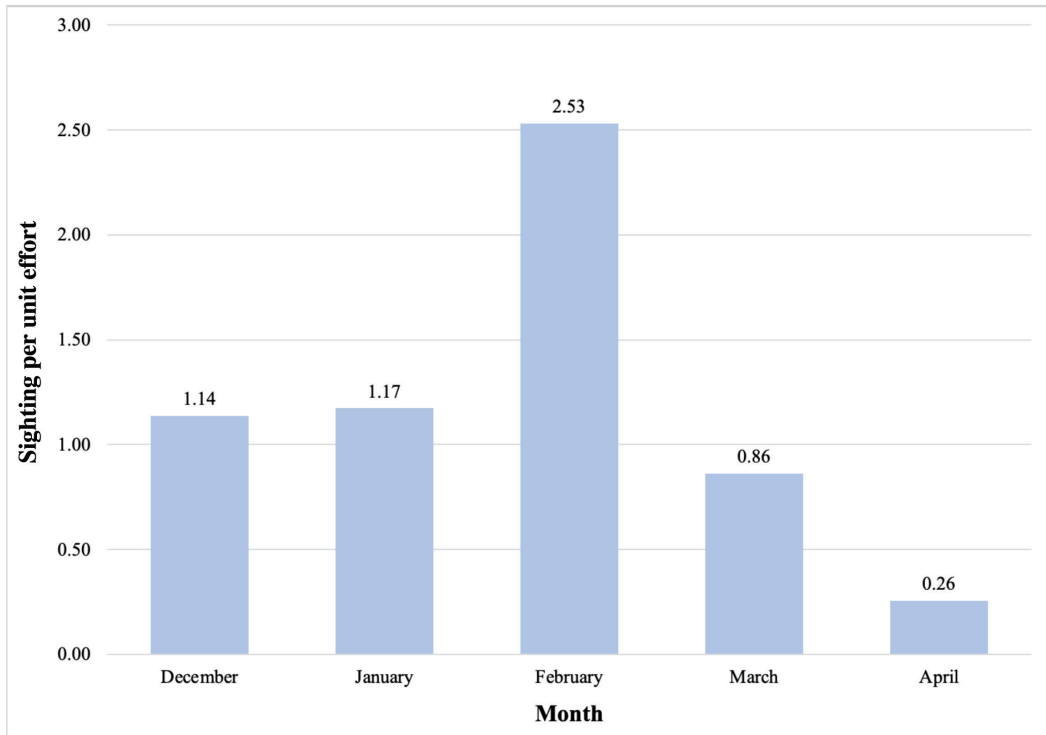


Figure 4. Monthly sightings per unit effort (SPUE; the total number of harbor seals sighted in each month divided by the total number of surveys conducted) from December 2010 to February 2023 in Green Island Shoal, North Carolina

Repairs to the Bonner Bridge were performed from 2012 to 2015, and construction of the Marc Basnight Bridge started in March 2016 and lasted until February 2019. Specific details regarding the schedule of construction during this period were unavailable; however, we were able to obtain information on which months dredging occurred but not the specific dates of this activity. After completion of the Marc Basnight Bridge, demolition of the Bonner Bridge began and was completed in June 2022. Few or no harbor seals were present during the period of bridge construction and demolition (Figure 5; Table 1). During this period, no reports were made of seals hauling out elsewhere in the area. We conducted only two surveys in December 2010 when the first group haul-out of harbor seals was observed for Green Island. Construction and demolition activities may have negatively impacted the seasonal occurrence of harbor seals, although this conclusion should be tempered by the disappearance of the haul-out site in 2019, 2020, and 2021 and the lack of survey effort from September 2019 to January 2022.

We initially believed that the harbor seals seen near Oregon Inlet might be juveniles or subadults, but our observations included adults, based on their size, suggesting that there is adequate habitat and prey for all age and sex classes of harbor seals at Oregon Inlet during winter and early spring. The seasonal range expansion to coastal North Carolina we document herein may represent a recolonization of areas previously occupied, like that observed for gray seals in the Gulf of Maine. This recolonization has been supported by 50 years of protection afforded by the U.S. Marine Mammal Protection Act.

The most recent estimate of harbor seal abundance, taken from surveys conducted in 2018 along the entire U.S. East Coast, was 61,336 (CV = 0.08; Sigourney et al., 2021). The population is concentrated in the Gulf of Maine during spring and summer before it moves south when temperatures cool in the fall (Toth et al., 2018). New Jersey has supported consistent winter haulouts (Waring et al., 2007; Toth et al., 2018). The U.S. Navy's Marine Species Monitoring (2017) has documented harbor seal haulouts in the lower Chesapeake Bay during winter consistently for several years, indicating that their seasonal range has extended southward into the Mid-Atlantic.

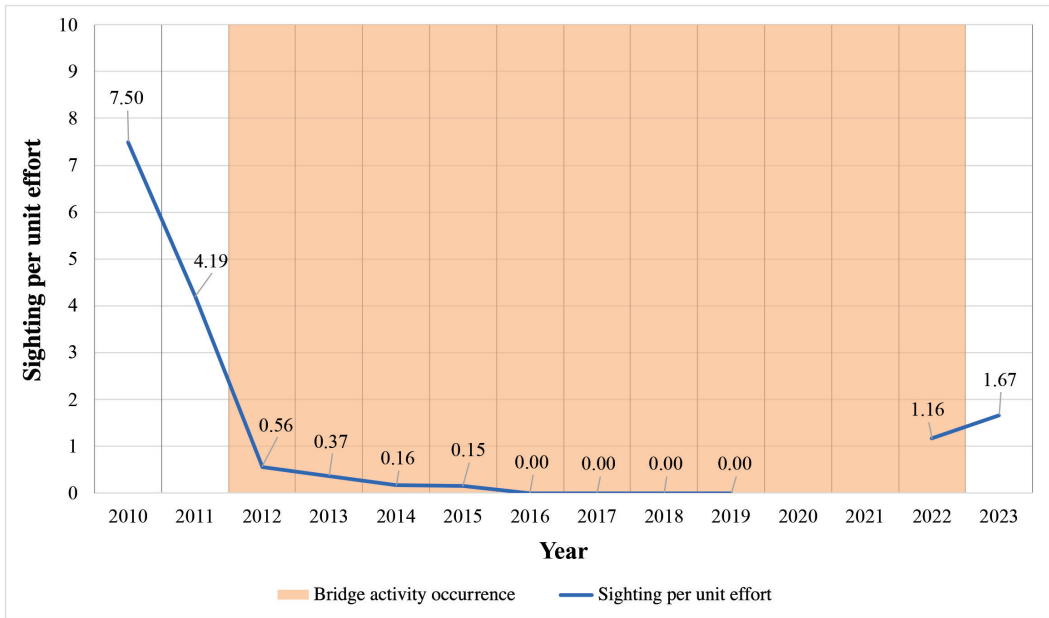


Figure 5. Graph showing the bridge activity in the Oregon Inlet overlaid with SPUE (the total number of harbor seals sighted in each year divided by the total number of surveys conducted in the corresponding year) by year

We predict that harbor seals will continue to recolonize their historical range and become a regular component of the winter marine mammal fauna throughout coastal North Carolina. This conservation success will bring management challenges, including the potential for bycatch in commercial fisheries and public harassment when resting on land, and the need to take account of the presence of these federally protected marine mammals in future construction activities. This latter concern is especially pertinent given that harbor seal presence appeared to be impacted by bridge construction and demolition at Oregon Inlet. In addition, the Outer Banks dredge spoil islands around inlets provide important habitats for seal haulouts. We recommend that further studies should be conducted to study the ecology and behavior of the species in North Carolina.

Acknowledgments

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