Horseshoe Crab Community Scientist Survey Report

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Overview

The Atlantic horseshoe crab (*Limulus polyphemus*) is an important species to the ecosystem, economy, and public health of Massachusetts. These unique animals spawn on beaches in the spring and lay tens of thousands of eggs in the sand, which are a critical food source for shorebirds during their vast, cross-continental migrations. As adults, they host a diversity of benthic life on their shells, including mollusks, crustaceans, and algae. Horseshoe crabs also support the eel and whelk fisheries, who harvest them for use as bait. What's more, horseshoe crab blood is an essential component in tests used by the biomedical industry to detect dangerous toxins in injections and implants.

Given the economic and ecosystem services they provide, it is important to monitor the range and abundance of horseshoe crabs in order to safeguard their populations and protect their natural habitat. Yet, there is little data on horseshoe crab populations on the North Shore of Massachusetts. Their abundance and distribution are well documented on Cape Cod and in southern Massachusetts where they spawn in large numbers, but only anecdotal reports of their presence exist in areas north of Boston (mainly from long-time residents).

Over the past 2 years, Salem Sound Coastwatch (SSCW) has been documenting horseshoe crab sightings from the public on the North Shore through a community science survey in order to better understand the distribution of local horseshoe crabs. This information will provide a clearer picture of their population and spawning habitats so that SSCW can work to implement protections for those areas and secure a sustainable future for the population of horseshoe crabs in Salem Sound and the North Shore.

Methods

SSCW and volunteers began gathering data in May 2023 through a digital survey. In this community science survey, the public was asked to report any horseshoe crab sighting via an ArcGIS Survey123 app. In the survey, observers marked the location of the horseshoe crab on a map, provided photo verification, and recorded general characteristics of the horseshoe crab reported. These included the sex, carapace width, and whether the animal was alive, dead, or a molt. Community scientists were also asked to determine if the horseshoe crab was actively spawning. By tracking the frequency of mating pairs, potential breeding "hotspots" may be identified to focus later monitoring and conservation efforts. Although horseshoe crab sightings could be reported anywhere, the primary focus for this study was the coastal towns of Salem Sound: Marblehead, Salem, Danvers, Beverly, and Manchester.

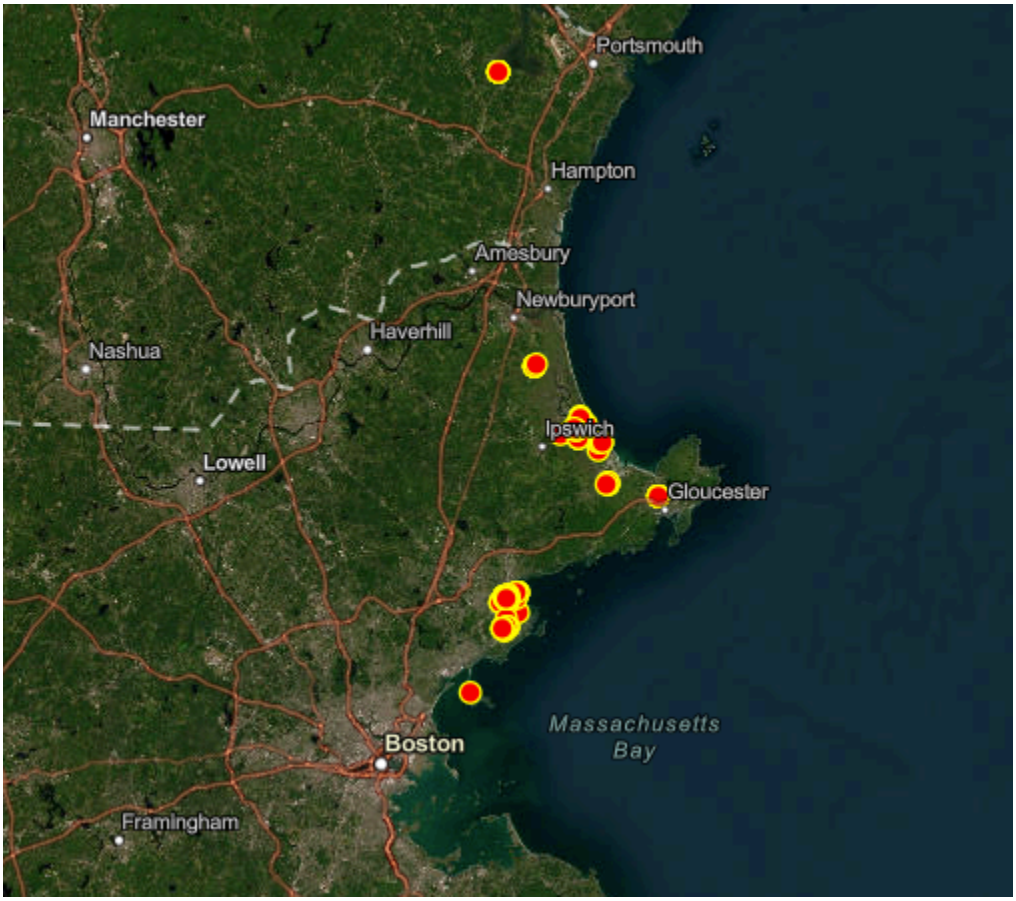

Image 1. Map of the survey area (sightings marked in red).

Results and Discussion

Locations and overall sightings

A total of 129 sightings were recorded over the survey period (May 2023-December 2024), with 52 observations in 2023 and 77 observations in 2024. Reports extended from Nahant, MA to Greenland, NH (Great Bay National Wildlife Refuge) (Image 1), with the majority of sightings in Salem, MA (70) and Ipswich, MA (27) (Image 2). This may be a function of effort and may not necessarily reflect the true distribution of horseshoe crabs, as volunteer bases tended to congregate in these two areas. Based on the reported locations, horseshoe crabs were most frequently observed in protected embayments, at sandy beaches and inland estuaries. The notable exception was Crane Beach (Ipswich), which is exposed to the Atlantic Ocean, where 6 total horseshoe crabs were reported, of which, two were alive.

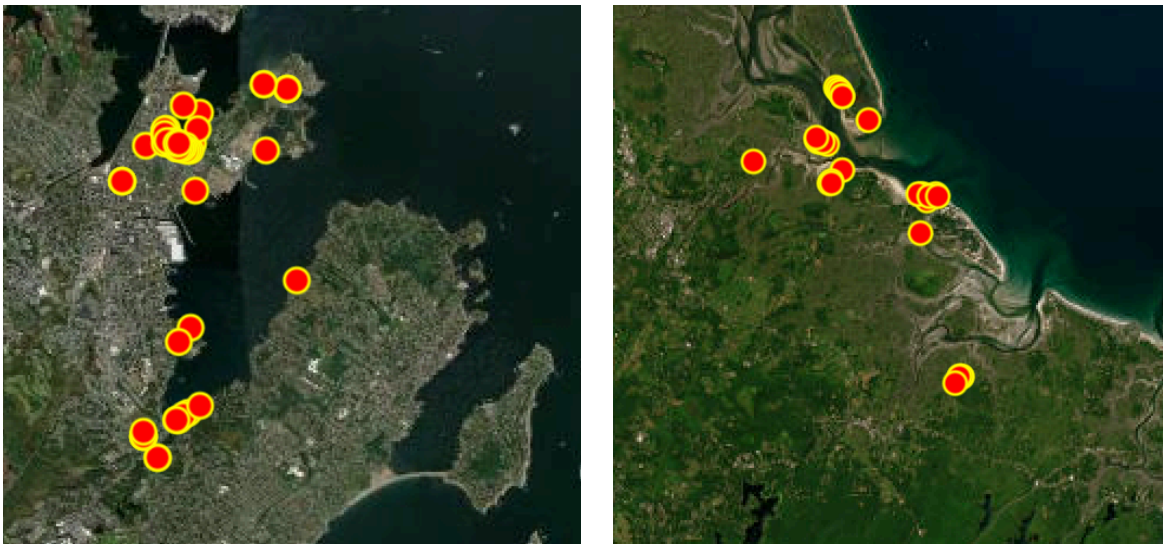

Image 2: Salem/Marblehead sightings (left) and Ipswich/Essex sightings (right).

Alive, Dead, Molt

Molts accounted for 50% of the total number of reported horseshoe crabs (Figure 1). This statistic aligns with expectations; observers walking the shoreline are more likely to encounter a stationary molt washed ashore than a live horseshoe crab under the water's surface. Live horseshoe crabs made up 35% of sightings and were observed almost exclusively in May (42/46), with the majority of sightings occurring during the last two weeks of May. Horseshoe crabs are expected to congregate on beaches between May and June to spawn before returning to deeper waters. By contrast, molts wash ashore year-round, although they were observed in higher numbers in August and October, perhaps coinciding with annual molt events.

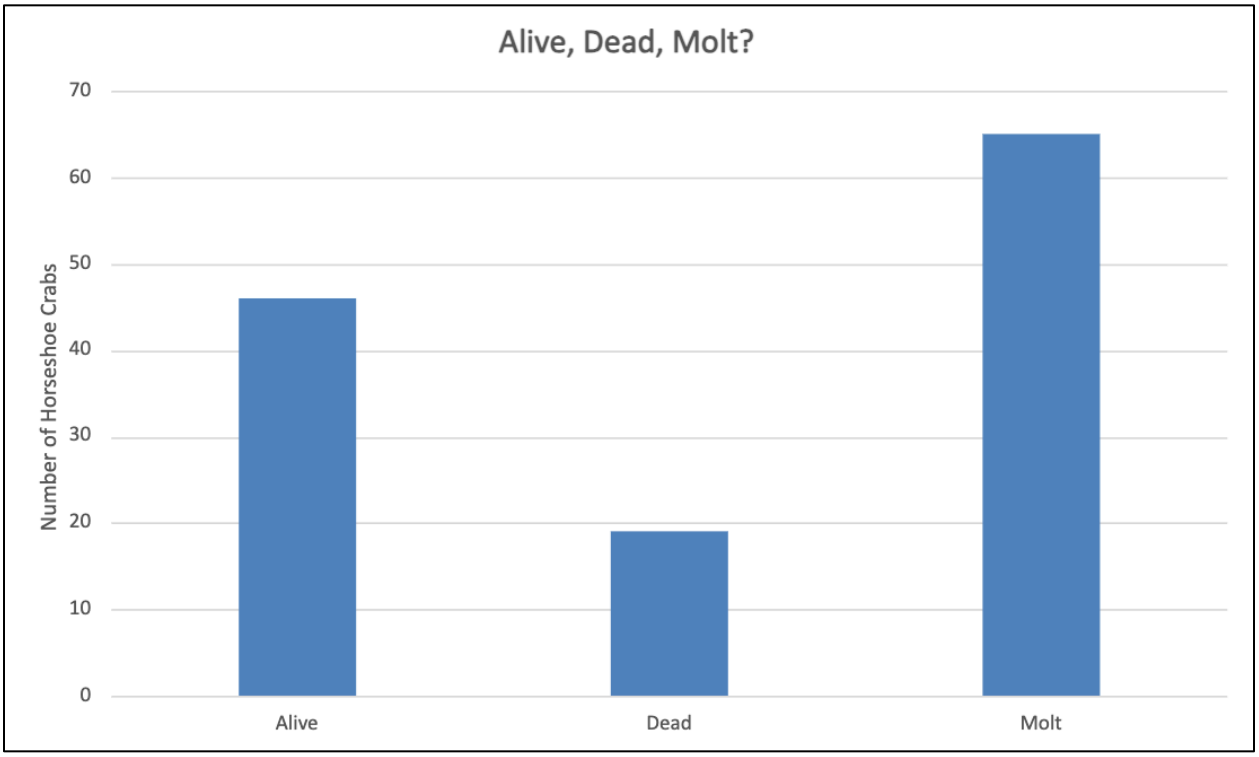

Figure 1: Number of reported horseshoe crabs between May 2023-December 2024 in the study area.

Spawning

More than half of the reported live horseshoe crabs were actively mating (about 55%) (Figure 2). This is exciting news. It provides evidence that beaches on the North Shore support breeding habitat for this species. Most mating pairs (14/25, 56%) were observed in Salem, specifically Collins Cove Beach and Forest River (Pickman Park and Lead Mills Conservation Area), which suggests that these locations may be local spawning "hotspots" (Image 3). Spawning horseshoe crabs were reported almost exclusively in mid- to late-May, and breeding did not seem to coincide with specific lunar phases (Figure 3). Several spawning horseshoe crabs were reported surrounding the first quarter moon, as well as following the full moon and last quarter moon. All spawning horseshoe crabs reported through the survey were mating in pairs. However, a video submitted by a volunteer showed at least 5 spawning "huddles," with satellite males surrounding a spawning female, at Lead Mills Conservation Area (5/14/24).

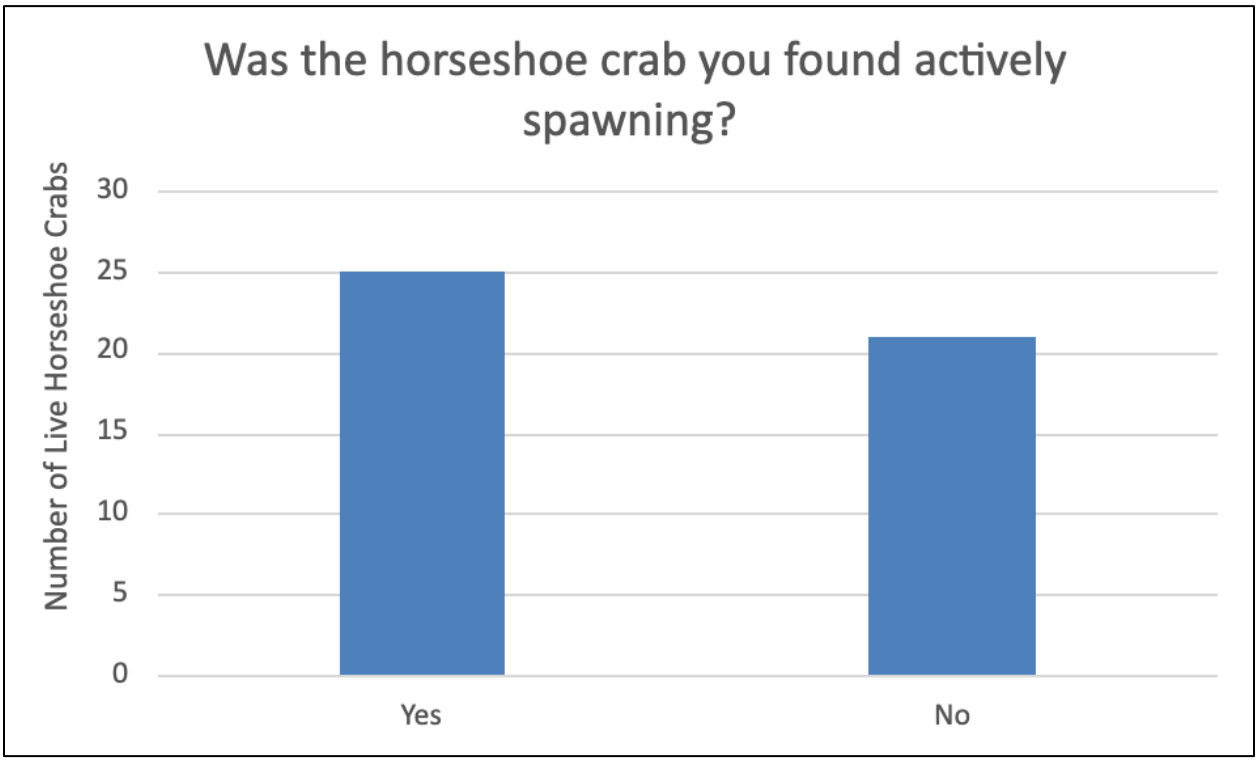

Figure 2: Number of reported live horseshoe crabs that were observed spawning.

Image 3. Spawning horseshoe crabs: a) Collins Cove, b) Lead Mills, c) Pickman Park (photos from anonymous Horseshoe Crab Survey users)

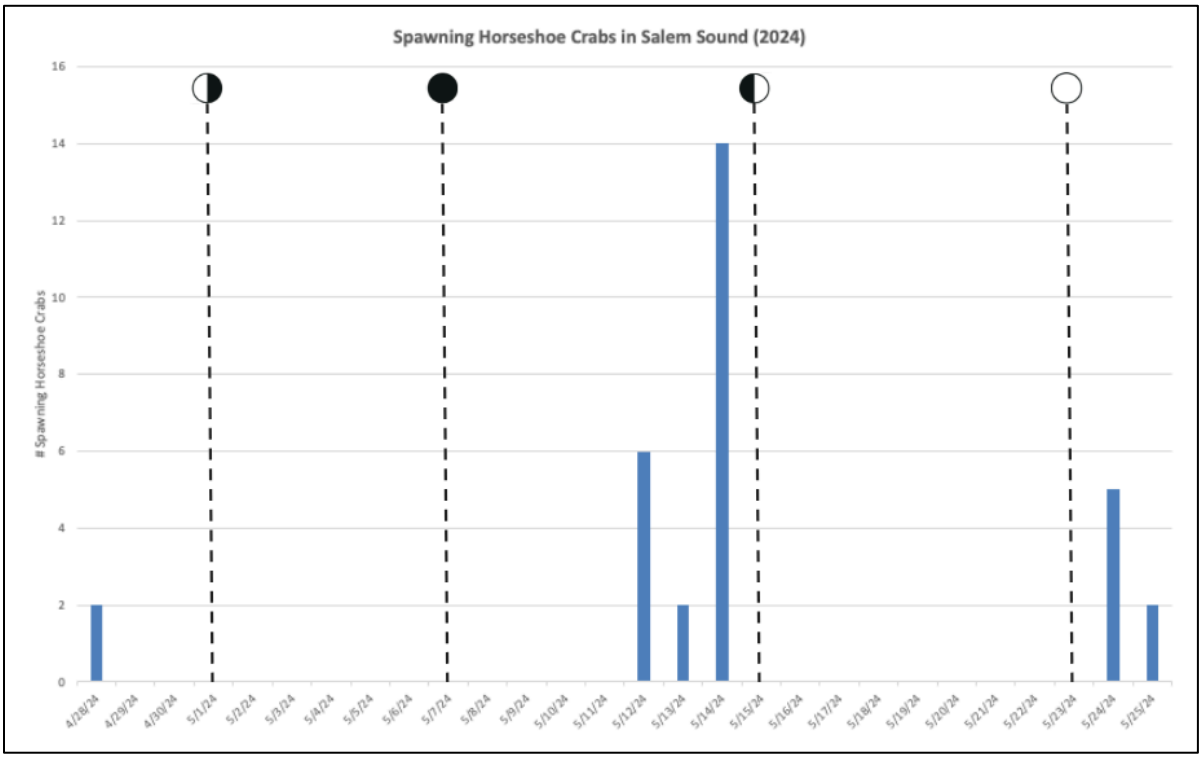

Figure 3: Number of reported spawning horseshoe crabs per day in Salem Sound (Marblehead to Manchester) in 2024. Moon phases (third-quarter, new, first-quarter, and full) are indicated on the day they occurred.

Size

If the region is frequently visited by egg-laying females, then Salem Sound's estuaries could be a nursery ground for juveniles after they hatch. Horseshoe crabs spend the first year or two of their lives in the intertidal flats near their natal beaches before moving further offshore. However, juveniles (< 3 inches) were not frequently reported in this survey, representing about 10% of the observed horseshoe crabs. Adult horseshoe crabs (> 3 inches, but more likely about 4 inches and greater) represented the vast majority of sightings (90%). This could be a function of observer bias, as the public is perhaps less likely to frequent inland marshes where young horseshoe crabs are most likely to inhabit, compared to sandy beaches where adult horseshoe crabs are more likely to be observed. Larger horseshoe crabs, whether molts or live animals, may be more easily spotted than a horseshoe crab less than 3 inches wide. Although younger horseshoe crabs molt more frequently, it's possible smaller molts are more easily damaged by wave action and, therefore, less frequently observed. It's important to note that sizes recorded in the survey were most likely estimated, unless the reporter utilized a ruler in the field. In reviewing the data, it was also clear that some reports provided the horseshoe crab's *length* instead of its *width*. Due to the informal nature of the size data, any trends should be compared with this in mind.

Recommendations

Salem Sound can (and does!) support horseshoe crab spawning habitat along its coastline. By continuing this collaborative monitoring effort into the future, SSCW can develop a better understanding of the population dynamics of local horseshoe crabs. Having evidence to support the protection of specific spawning areas at key times of the year can lead to increased protections for Salem Sound's horseshoe crab population.

Based on the survey's preliminary findings, the Forest River and surrounding parks (Pickman/Lead Mills in Salem/Marblehead) and the beach at Collins Cove (Salem) are

known spawning areas for horseshoe crabs. These locations should be protected as such. A tide gate separates the Forest River/Pickman Park from Salem Harbor. The tide gate is manually controlled by the Salem Department of Public Services, who closes the gate during weather emergencies to prevent flooding upstream. Two mating pairs were reported inside the tide gate and anecdotal reports place young horseshoe crabs (less than 1 year) upstream at the Forest River marshes. We recommend continuing to leave the tide gate below Route 114 open, except in the event of weather emergencies, to allow a continuous connection to Salem Harbor. The beach at Lead Mills Conservation Area (on the Salem Harbor side of the tide gate) also represents a key spawning habitat, with 6 reported mating groups. This area is generally protected from disruptive human activity.

The beach at Collins Cove represents another hotspot for spawning horseshoe crabs, with 7 reported sightings at the beach and intertidal area between Collins Cove Park and the beach. Beach raking is contracted by the City at the popular neighborhood beach. SSCW will work with the Salem Conservation Commission, Park & Recreation Commission, and Department of Public Services to limit manual disturbance of the beach sand from May to early July to accommodate both spawning horseshoe crabs and emerging hatchlings.

While we've uncovered new information about Salem Sound's horseshoe crab population over the past two years of the survey, there's still more evidence to gather and additional questions to answer. In particular, SSCW is interested in gaining a better understanding of horseshoe crabs' distribution along the coast. There are large areas where horseshoe crabs have gone unreported, such as along the Beverly and Manchester coastlines. While it's possible these more exposed areas do not support ideal horseshoe crab habitat, it's entirely possible that sampling bias has left these areas unexplored. Additionally, SSCW suspects that horseshoe crabs are present in the Danvers River, given it is a protected estuarine habitat; however, much of the coastline along the Danvers River is private property, making surveying difficult. There is still more to understand about our local population of horseshoe crabs, including spawning timing, tide cycles, water temperature,

and hatchling habitat. Therefore, SSCW staff will collect additional environmental data, in addition to continuing the community science survey, heading into the 2025 season.