Peconic Estuary Partnership
Draft Horseshoe Crab Conservation Action Plan

Peconic Estuary Horseshoe Crab Workgroup
DRAFT - January 30, 2026

I. Introduction

The Peconic Estuary Horseshoe Crab Workgroup was convened in 2024 to develop a draft Horseshoe Crab Action Plan to advance horseshoe crab conservation in the Peconic Estuary. The draft plan will be submitted to Peconic Estuary Partnership's (PEP) Natural Resources Subcommittee for review and approval.

Action 34 of the 2020 PEP Comprehensive Conservation Management Plan (CCMP) calls for the development of habitat protection and restoration strategies for key species in the Peconic Estuary, including horseshoe crab. Additionally, the PEP Habitat and Wildlife Monitoring Strategy mandates a horseshoe crab protection strategy that uses the shoreline analysis developed in 2019 by the Stony Brook Geospatial Institute (and confirmed by ground-truthing by Cornell Cooperative Extension Suffolk in 2025).

The workgroup was tasked with 1) identifying present and future threats to the health of the estuary's horseshoe crab population, 2) developing a framework for addressing the threats to horseshoe crabs and reversing the population's long-term decline, and 3) identifying research needs to inform and support the effort to conserve horseshoe crabs in the estuary.

II. Background

A. Ecology

The American Horseshoe Crab (*Limulus polyphemus*) is one of four horseshoe crab species occurring in the world and the only horseshoe crab species found in the western hemisphere. The species' distribution ranges from the Gulf of Maine to the Gulf of Mexico; it is found in all coastal waters surrounding Long Island, including the Peconic Estuary (Smith, et al, 2017).

Adult horseshoe crabs spend the winter months in deeper estuarine waters or on the continental shelf. In spring, they move into shallower, warmer waters, with spawning occurring on estuarine beaches and marsh edges during May and June. Adults remain in shallow, near shore habitats through the fall, when cooling waters signal them to return to deeper waters (Smith, et al, 2017).

Horseshoe crab spawning is generally associated with the highest tides occurring during spring lunar cycles. Breeding activity is consistently higher during the full moon than the new moon and is also greater at night (Atlantic States Marine Fisheries Commission, 2025). In one microtidal

estuarine system (Florida), onshore wind was identified as another potential factor in driving spawning activity (Heres, et al, 2024); in another (New Hampshire), seasonal and daily water temperatures were found to be the primary drivers of mating activity (Cheng, et al, 2016).

Horseshoe crabs generally spawn on natural, slightly sloped sandy beaches at the highest point of the high-tide line, which provides ideal sand moisture for the growth and development of their eggs, ensuring that the eggs do not become desiccated or the soil anoxic (Heres, et al, 2024). Horseshoe crabs have been documented also using salt marsh habitat for spawning (Kendrick, et al, 2021 and Sasson, et al, 2024). (See also, Raviraj et al, 2024, noting that "salt marsh conservation and restoration can likely contribute to *L. polyphemus* reproductive efforts and could be vital to maintaining healthy populations in areas with limited breeding habitat.")

Typical spawning activity involves a female crab emerging from deeper water into the intertidal zone where she partially buries herself in the sediment to lay eggs. The eggs are primarily fertilized by a male crab attached to the female's abdomen; however, genetic testing has documented that "satellite" surrounding the mating pair can account for as much as 40% of the external fertilization (Brockman, et al, 1994).

Juvenile horseshoe crabs, which hatch in two to four weeks, spend the first two years of their lives in nearshore areas. As they grow, the crabs will molt more than fifteen times before reaching sexual maturity after approximately ten years. horseshoe crabs are known to live more than twenty years (Smith, et al, 2017).

Over the past several decades scientists have increasingly recognized the important ecological role horseshoe crabs play in estuarine environments (Botton, 2009). Perhaps most notably, their eggs sustain more than a dozen shorebird species, which depend on them as a critically important food source during spring migration (Haramis et al. 2007). Red Knot, a federally and New York State threatened species, rely heavily on horseshoe crab eggs to fuel spring migrations to breeding grounds in the High Arctic (NYSDEC, 2025). Other non-bird species, including whelk, summer flounder, blue crabs, silversides and American eels, also feast on the eggs during the spawning season. Additionally, as they grow, horseshoe crabs are a documented food source for everything from sea turtles to sharks to striped bass (Wall, et al, 2002). Finally, it has been documented that as horseshoe crabs dig through the substrate to feed on benthic organisms, they create food-rich clouds of turbidity that support a wide range of other estuarine species (Atlantic States Marine Fisheries Commission, 2019).

B. Fishery Management

Overarching management of horseshoe crabs falls under the authority of the Atlantic States Marine Fisheries Commission (ASMFC), a partnership chartered by Congress that consists of the fifteen Atlantic coastal states, including New York. ASMFC sets overall coastwide management parameters that are implemented by relevant member states. The Commission's fisheries

management plan (FMP) for horseshoe crab was first established in 1998. The New York State Department of Environmental Conservation (NYSDEC) is the responsible state agency for managing horseshoe crabs in New York State and does so through a management framework that involves harvest limits/restrictions, reporting requirements and enforcement.

In New York, annual harvest is limited by quota, regardless of demand for horseshoe crabs or number of participants in the fishery. In 2000, ASMFC's "Addendum I" to the horseshoe crab FMP established an annual harvest quota for New York of 366,272 crabs. This cap was set at twenty-five percent of New York's reference period landings (1995-1997) of 488,362 crabs (Michels, et al., 2000). In 2004, NYSDEC voluntarily reduced annual harvest limits to 150,000 horseshoe crabs, less than half of the FMP's allowable take (Commercial Fishing, 2025). NYSDEC actively monitors quota usage and can close harvest at any time if the quota is projected to be filled.

Horseshoe crabs are solely harvested for use as bait in New York to catch channeled whelk and to a lesser degree American eel. Currently, no viable or commercially available natural or synthetic alternatives to horseshoe crab bait exist for the whelk or eel fisheries.

In 2022, NYSDEC implemented a requirement that "bait bags" be used in whelk pots to help decrease the amount of horseshoe crabs needed for bait and lessen harvest pressure on New York's population.

In 2020, the agency implemented two five-day harvest bans around the last full or new moon in May and the first full or new moon in June (lunar closures) to allow for more horseshoe crabs to spawn. In 2025, two additional five-day lunar closures were implemented during the spring spawning season. As a result of these harvest bans, New York has closed the horseshoe crab fishery for 5-days around each new and full moon in May and June, resulting in tewnty closed days each spring (see Figure 1 below for the history of horseshoe crab management in New York). The purpose of the closures is to allow horseshoe crabs to spawn uninterrupted during their peak spawning periods. Since the implementation of the closures in 2020, New York has consistently remained below the 150,000 voluntary quota. (See Figure 2 below for NYSDEC's full 2025 horseshoe crab harvest restrictions.)

Harvest of horseshoe crabs within the Peconic Estuary are governed by the state regulations outlined above.

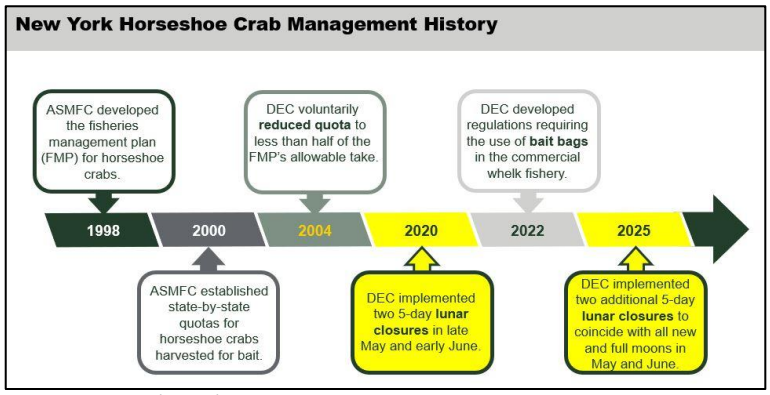


***Figure 1** – NY Horseshoe Crab Management History*

2025 Horseshoe Crab Quota Distribution				
Periods	**Dates**	**Quota (# of crab)**	**Trip Limit (# of crabs)**	**% Distribution**
1	January 1 - April 15	6,000	30	4%
2	April 16 – August 31	138,000	200	92%
2-closed	**May 10 – May 14**	**closed**	**0**	**closed**
2-closed	**May 24 – May 28**	**closed**	**0**	**closed**
2-closed	**June 9 – June 13**	**closed**	**0**	**closed**
2-closed	**June 23 – June 27**	**closed**	**0**	**closed**
3	September 1 – November 30	6,000	250	4%
4	December 1- December 31	TBD[1]	TBD[1]	TBD[1]

***Figure 2** - NYSDEC 2025 HSC Quota Distribution*

C. Research & Monitoring

In 2008, the New York Horseshoe Crab Monitoring Network (Monitoring Network) was established – through a partnership between NYSDEC, Cornell Cooperative Extension of Suffolk County and Stony Brook University – to monitor spawning activity of adult horseshoe crabs in New York during May and June. Large spatial coverage of monitoring sites and consistent annual releases of tags have allowed for assessments of annual spawning activity levels, survival, and movement of horseshoe crabs. This survey has grown to 30 sites throughout the New York marine district with 800 volunteers participating annually.

Each Monitoring Network site follows one of two protocols: total count or quadrat method. The total count protocol, which is used for sites with fewer overall horseshoe crabs, involves counting all crabs present within the survey site, both within and above the surf zone, as well as within the submerged zone (that are clearly visible from the beach). Males and females are counted separately. Instead of counting *all* horseshoe crabs, the quadrat method protocol involves sampling for their presence at 20-meter intervals within the survey site. Sampling is conducted using a square-meter quadrat.

There are currently five Peconic Estuary sites included in the Monitoring Network:

- South Harbor Park, Southold
- West Creek, Southold
- Squires Pond, Hampton Bays
- Northwest Harbor, East Hampton
- Napeague Bay, East Hampton

In addition to data from the several spawning beaches monitored by the Horseshoe Crab Monitoring Network, what is known about the status of the Peconic Estuary's horseshoe crab population is largely based on NYSDEC's annual trawl survey, which has been gathered annually since 1987. These long-term surveys were primarily developed to monitor relative abundance of juvenile finfish, but do regularly catch horseshoe crabs as bycatch (see survey data below).

Finally, horseshoe crab data from offshore waters outside of the Peconic Estuary is collected by the Northeast Area Monitoring and Assessment Program (NEMAP). The program is a state-federal initiative that collects fishery-independent data along the Atlantic coast, from the Gulf of Maine to North Carolina.

D. Horseshoe Crab Stock Status

AFMSC Stock Assessment

ASMFC lists the overall coastwide (New Hampshire through Florida) population abundance of horseshoe crabs as "unknown," noting that it has "fluctuated through time with many surveys decreasing after 1998 but increasing in recent years. (Atlantic States Marine Fisheries Commission, 2025). However, the commission manages horseshoe crabs through four different regions – Northeast, New York (which includes New York and Connecticut), Delaware and Southeast – and generates individual stock assessments for each.

Generally, fisheries management plans rely on "biological reference points" (which combine several components of a species' dynamics –e.g., growth, recruitment, mortality, etc.– into a single index) to establish benchmarks for comparison and assessing a species' stock status. (Gabriel & Mace, 1999) However, because so little was known about horseshoe crabs when ASMFC first adopted the species' FMP, no biological reference points were available. And none

have since been developed for use coastwide or for all of the management regions. (Gabriel & Mace, 1999).

In the absence biological reference points, ASMFC instead develops stock assessments that compare trend analysis of independent survey data to the "1998 reference point," the year when horseshoe crabs first became actively managed by ASMFC. The comparison of current horseshoe crab stock status relative to the 1998 reference point gives an indication of the overall effects of management on populations.

The stock status for horseshoe crabs is based on the percentage of surveys within a region having a greater than 50% probability of being below their 1998 levels by a target year. Under this system, a "Good" status is less than 33% of surveys below the 1998 levels, a "Neutral" status is 34-65% and a "Bad" status is greater than 66% (Atlantic States Marine Fisheries Commission, 2025).

The stock assessment for the New York region is *only* based on the following four fisheries-independent surveys:

- Connecticut - Long Island Sound Trawl Survey
- New York - Jamaica Bay Seine Survey
- New York - Little Neck & Manhasset Bay Seine Survey
- New York - Peconic Trawl Survey

Because three out of the four surveys for the New York Region were below the 1998 reference point, the region's stock was listed as having a "Poor" status (Atlantic States Marine Fisheries Commission et al., 2024). The CT Long Island Sound Trawl Survey was the only New York region index above its 1998 reference point (Atlantic States Marine Fisheries Commission et al., 2024).

Additional notes regarding the 2024 horseshoe crab assessment:

1. The 2024 horseshoe crab stock assessment listed the *coastwide* stock status as "Good" (Atlantic States Marine Fisheries Commission, 2024).

2. To date, no overfishing or overfished definitions have been adopted for management use and there is no data that suggests overharvest has or is occurring (Atlantic States Marine Fisheries Commission, 2025). Data from the stock assessment only shows that relative abundance of horseshoe crabs in three of the New York region surveys are lower than they were in 1998. Population level impacts throughout the species range (i.e., Canada - Mexico) are not anticipated as a result of the New York region stock status (Atlantic States Marine Fisheries Commission, 2024).

3. The 2024 assessment update for the New York region showed a slight improvement from the 2019 benchmark stock assessment, in that all four of the region's surveys below the 1998 reference point in 2019 (Atlantic States Marine Fisheries Commission et al., 2019).

4. The assessment did not include data from the New York Horseshoe Crab Monitoring Network's beach spawning surveys.

5. Data from NEMAP, the Northeast Area Monitoring and Assessment Program (a state-federal initiative that collects fishery-independent data along the Atlantic coast, from the Gulf of Maine to North Carolina), are reported in the 2024 stock assessment, but are *not* utilized in the determining the New York region stack status. The 2024 stock assessment reported an increasing trend for the NY NEAMAP survey since 2017 (see figure 4) (Atlantic States Marine Fisheries Commission, 2024)

6. Despite being below the 1998 reference point, the New York Peconic Trawl Survey was reported in the 2024 stock assessment as having an overall increasing trend since 2017 (see figure 4) (Atlantic States Marine Fisheries Commission, 2024).

New York Region							
Survey	i_t	i_{1998}	$P(i_t<i_{1998})$	Q_{25}	$P(i_t<Q_{25})$	**Trend since 2017**	**Trend since 2012**
CT Long Island Sound Trawl - Fall Combined Sexes	1.02	0.89	37%	0.35	11%	No Trend	⬆
NY Jamaica Bay Beach Seine - Spring Combined Sexes	-1.73	-1.00	99%	-1.52	70%	⬇	⬇
NY Little Neck and Manhasset Bay Beach Seine - Spring Combined Sexes	0.19	1.43	100%	0.26	62%	No Trend	⬇
NY NEAMAP - Fall Combined Sexes	2.03			1.02	4%	⬆	No Trend
NY Peconic Trawl - Fall Combined Sexes	-1.43	0.15	100%	-1.39	55%	⬆	No Trend

***Figure 4** - ASMFC 2024 Horseshoe Crab Stock Assessment Update; Relative trends since the last benchmark assessment (trend since 2017) and last stock assessment update (trend since 2012)*

Pursuant to ASMFC's 10-year benchmark cycle (with 5-year updates in between), the Commission's next benchmark stock assessment for horseshoe crab is scheduled for 2029. This assessment is expected to include data through 2028, incorporating nearly a decade of additional information since the 2019 benchmark. Annual beach spawning survey data from New York and other states is being advocated for inclusion in the next assessment to enhance the assessment's robustness and better inform management decisions.

Peconic Trawl Survey

As outlined above, data from the New York Peconic Trawl Survey is an integral part of ASMFC's assessments of horseshoe crab population status in New York. The trawl survey and the Horseshoe Crab Monitoring Networks' beach spawning surveys provide the only available data available about the horseshoe crab population in the Peconic Bay Estuary. A recent analysis of the trawl survey found an overall drop in horseshoe crab populations in the region, with Peconic Bay exhibited the steepest decline (see Figures 5 and 6 below) (Crosby, et al, 2025).

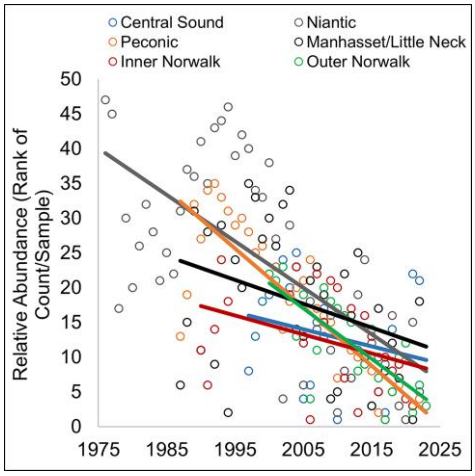


Figure 5. Relative abundance (rank-transformed count per sample, shown with linear regression line) of *L. polyphemus* across six datasets in the Long Island Sound, USA region.

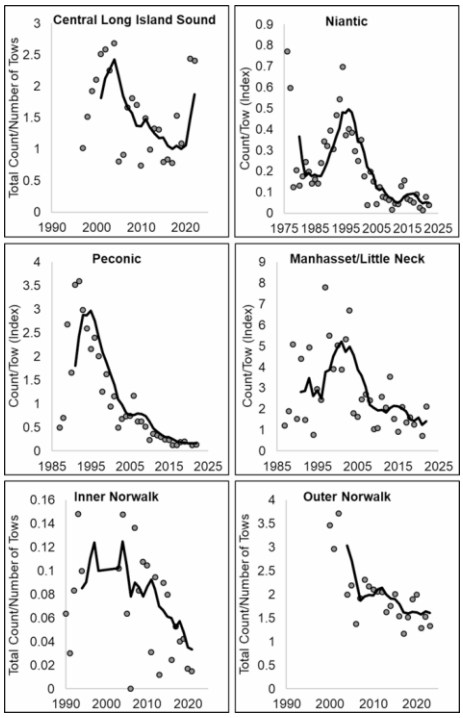
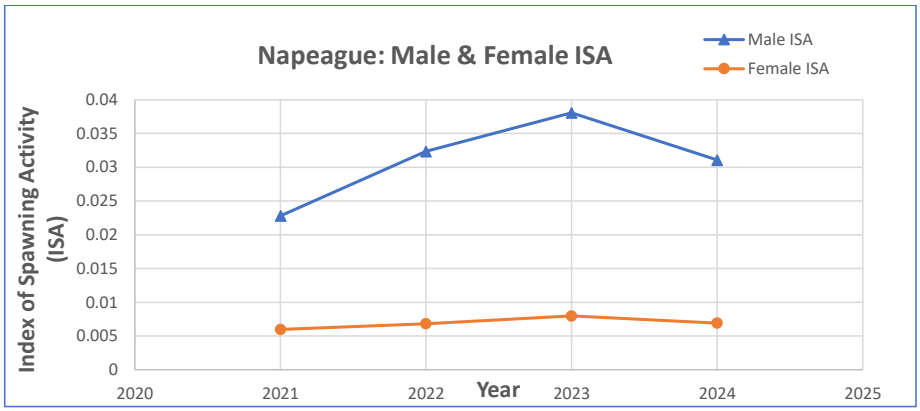
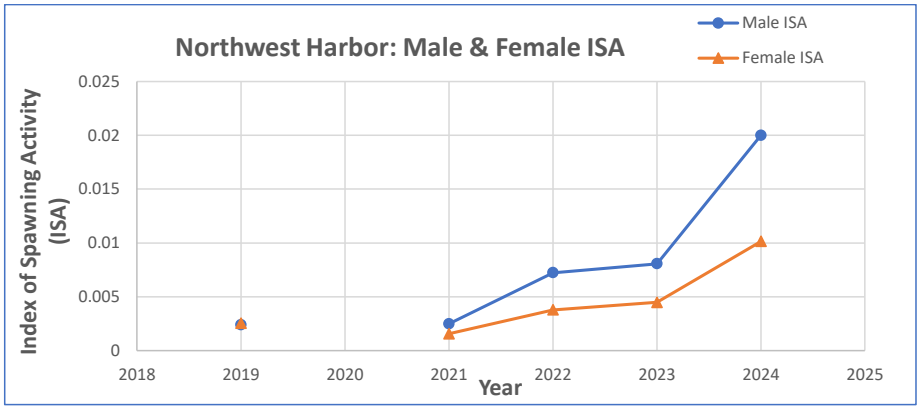


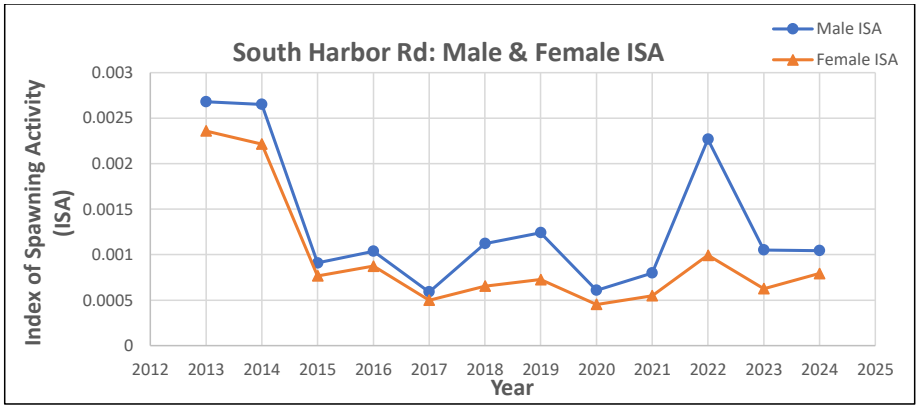
Figure 6. .Observational data on counts of *L. polyphemus* at NYSDEC's Peconic East Survey and Manhasset/Little Neck West Surveys, Harbor Watch's Inner Norwalk Harbor Survey, and The Maritime Aquarium's Outer Norwalk Harbor Survey.

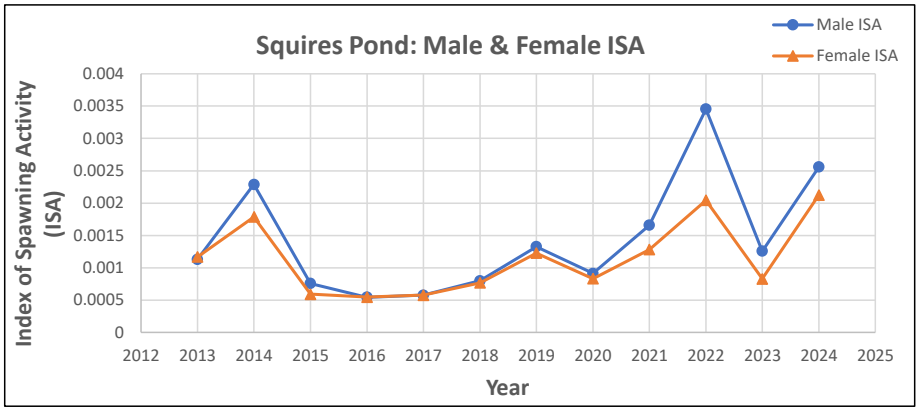
HSC Monitoring Network Data

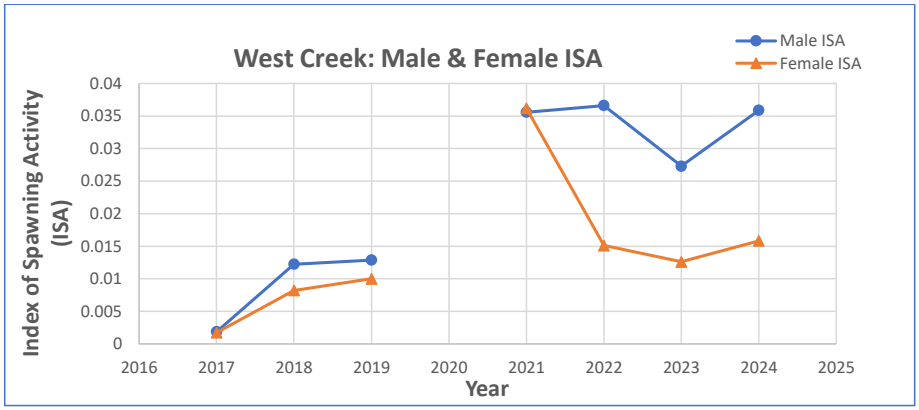
Species specific data from the New York Horseshoe Crab Monitoring Network shows that indices of spawning activity (ISA) for female horseshoe crab Bay have been increasing in the Peconic over both five- and ten-year time periods, albeit at lower spawning intensities than other New York estuaries. The ISA data (which is based on the average number of horseshoe crabs per square meter of beach) from each of the five Peconic survey sites is depicted in the charts below. [*Note: data has yet to go through a quality assurance / quality control process.*]


Napeague: Male & Female ISA
Male ISA
Female ISA
Index of Spawning Activity (ISA)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
2020
2021
2022
Year
2023
2024
2025


Northwest Harbor: Male & Female ISA
Male ISA
Female ISA
Index of Spawning Activity (ISA)
0.025
0.02
0.015
0.01
0.005
0
2018
2019
2020
2021
Year
2022
2023
2024
2025


South Harbor Rd: Male & Female ISA
Male ISA
Female ISA
Index of Spawning Activity (ISA)
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2013
2014
2015
2016
2017
2018
2019
Year
2020
2021
2022
2023
2024
2025


Squires Pond: Male & Female ISA
Male ISA
Female ISA
Index of Spawning Activity (ISA)
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Year


West Creek: Male & Female ISA
Male ISA
Female ISA
Index of Spawning Activity (ISA)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Year

HSC Tagging Data

In addition, a 2019 study analyzed horseshoe crab movement and survivability in New York waters, covering a study period of 2007-2016. The study showed that survival rates, estimated from tagging, differ between the estuaries and reflect different harvest pressures and habitat quality. Furthermore, it showed that there is minimal exchange between estuaries and most tagged individuals were recaptured within their region of release (Bopp et al. 2019).

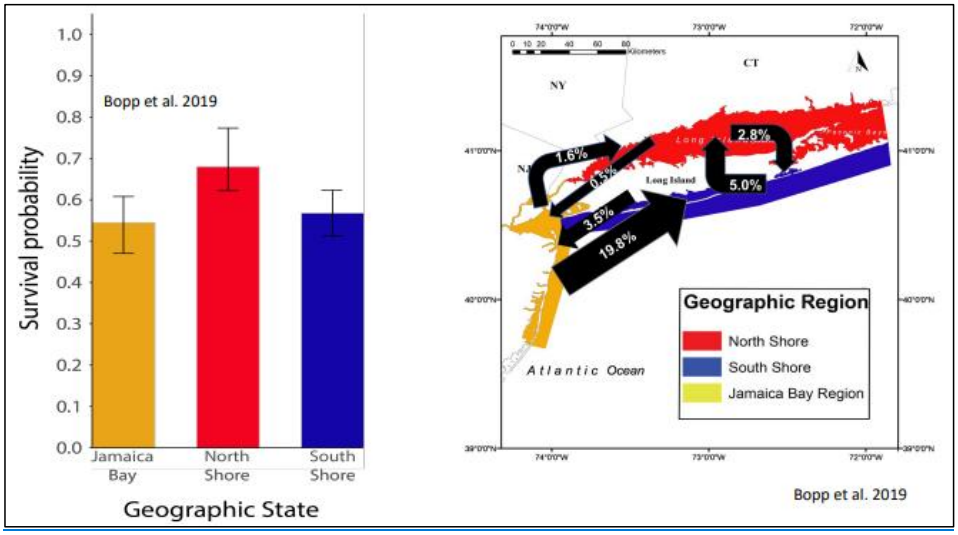


Figure 7. .Horseshoe crab movement and survivability (Bopp et al. 2019)

Data on horseshoe crab abundance, distribution, patterns of movement, and habitat use within the Peconic Estuary could be improved with additional monitoring and tagging efforts. This lack of data also extends to juvenile horseshoe crab, especially as it relates to habitat requirements during their first two years of their lives.

III. Threats

A. Habitat Loss & Sea Level Rise

One of the most significant threats to horseshoe crabs in the Peconic Estuary and throughout their range is the ongoing loss of shoreline spawning habitat. See, e.g., Botton, et, al 2022 (concluding that "the loss of high-quality spawning habitat ultimately poses the greatest threat to horseshoe crabs in Delaware Bay.") In most cases, this habitat loss is a direct consequence of

shoreline armoring, where hardened structures like bulkheads and rip-rap are installed to protect upland property from rising sea levels, wave energy and storm surge.

These artificial structures disrupt natural sediment distribution and, critically, prevent the upland migration of beaches and marshes as sea levels rise. This results in a situation, often called 'coastal squeeze,' that traps essential spawning habitat between the encroaching sea and the immovable shoreline, leading to its erosion and inundation, and eventual habitat loss. (See Figure 8) In addition, instead of absorbing and attenuating wave action like natural shorelines, armored deflect wave energy, which causes additional scouring an exacerbates beach loss. Together, these factors combine to significantly interfere with the natural functioning of shoreline processes and impact the coastal habitat continuum that is so critical for the needs of horseshoe crabs and many other estuarine species.

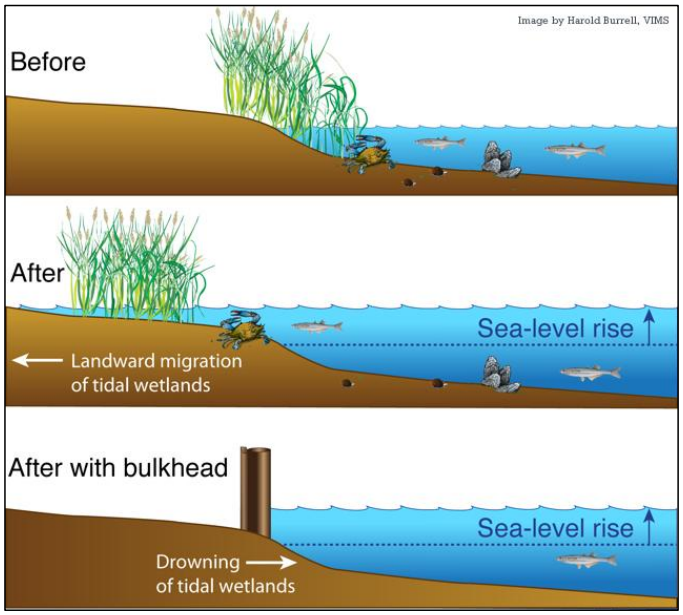
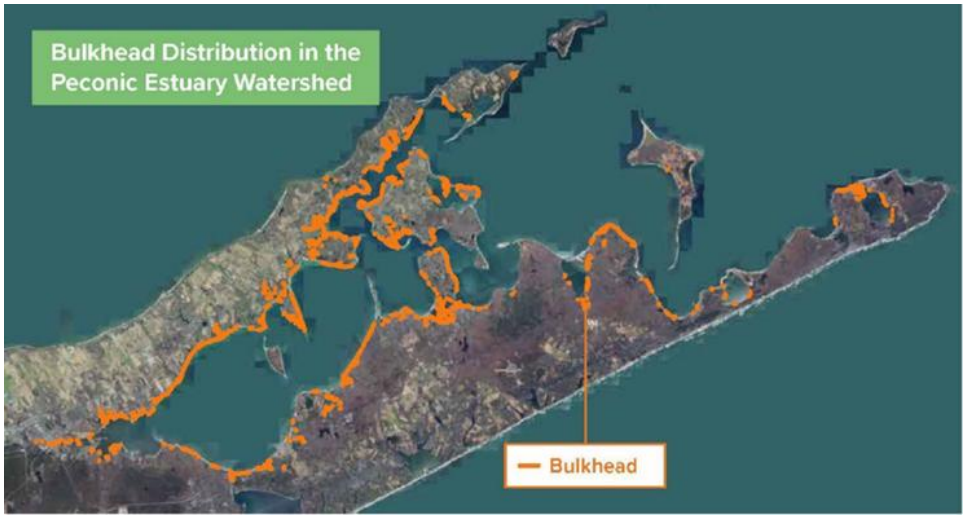


Figure 8. Coastal Squeeze occurs where bulkheads prevent the landward migration of tidal wetlands and beaches. Image by Harold Burrell. From "Study reveals threat to tidal wetlands," David Malmquist, 2009 (Virginia Institute of Marine Science)

Over the past several decades there has been a significant increase in the amount shoreline amoring within the Peconic Estuary, resulting in a substantial loss of suitable spawning habitat for horseshoe crabs. In 2019, in an effort to quantify this increase, PEP completed a GIS-based survey (using 2016 orthoimagery) to document the extent of shoreline within the estuary that has been armored. This survey found that from 2000 to 2016, there was a three-to-four increase in shoreline structures, particularly bulkheads. The map below illustrates the extent of only shoreline bulkheads throughout the estuary.



In 2024, Cornell Cooperative Extension of Suffolk County (CCE) performed a physical field validation survey of a random subsample of the structures identified in PEP's 2019 survey. The data from this field verification effort were then used to create a detailed GIS map showing the results of this validation project, which is now available online (GIS Map linked here). The percent accuracy of PEP's 2019 effort was then calculated based on the number of structures verified as being "present" relative to the total number that were sampled. Of the 147 total structures CCE sampled by vessel, only 6 were found to be 'absent.' Therefore, PEP's 2019 hardened shoreline survey was determined to be 95.92% accurate overall.

B. Harvest for Bait

As noted above, the primary harvest of horseshoe crabs in New York is for use as bait in the whelk and American eel fisheries.

In recent years, bait landings in the New York region have been below the Northeast and Delaware Bay regions and only exceed the Southeast region (Figure 9). The commercial horseshoe crab fishery in New York is predominantly concentrated in the South Shore Bays, which account for most of the annual landings, while the Peconic Bays contribute only 6% of the total harvest for New York. Hand-harvest remains the principal method of collection for New York harvesters, comprising 82% of reported landings in 2024, a trend that aligns with recent years.

Harvest activity in New York peaks in May, reflecting consistent seasonal patterns observed throughout the fishery's landings records.

According to NYSDEC, in 2025, the total reported number of horseshoe crabs harvested was 64,879, the most recent quota usage data shows a 48% reduction in commercial horseshoe crab landings in a year-to-year comparison to 2024. As of September 4, 2025, commercial permit holders have only harvested 44% of the available 150,000 crab quota – and only 18% the original ASFMC quota of 366,272 crabs authorized for New York. The reduction in landings observed in 2025 is likely the result of the additional lunar closures that have been implemented, as well as the changing market conditions for whelk.

Commented [CS1]: We can update these numbers as we get closer to finalizing this document.

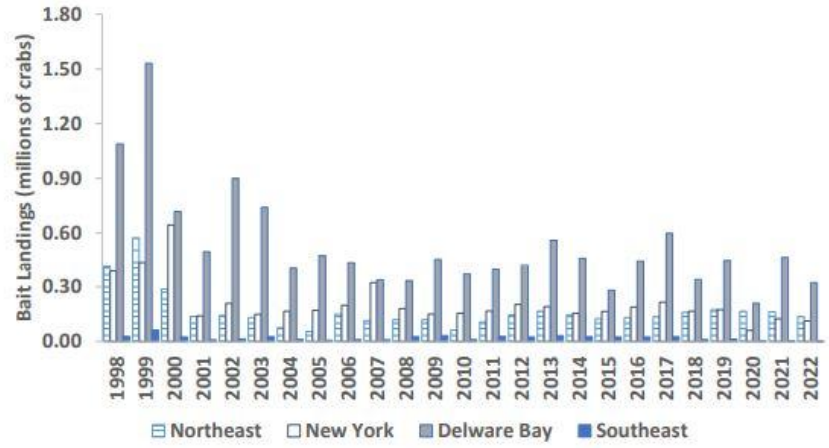


Figure 9. *ASMFC 2024 Horseshoe Crab Stock Assessment Update; Horseshoe crab bait harvest by region, 1998-2022. The four regions are the Northeast (Maine-Rhode Island), New York (Connecticut-New York), Delaware Bay (New Jersey-Virginia), and Southeast (North Carolina-Florida).*

C. Harvest for Bleeding

For over a half century, horseshoe crabs have been harvested and bled for a compound found in their blood - Limulus Amebocyte Lysate (LAL) - that, because of its high reactivity to the presence of bacteria, became standard for contaminant testing for human vaccines, implants and other sterile biomedical products. From 2004 to 2022, the number of horseshoe crabs harvested for bleeding throughout the East Coast states swelled from 101,020 to 828,181 (Atlantic States Marine Fisheries Commission, 2024).

While the crabs are returned to the water after bleeding, a percentage of them do not survive. For ASMFC stock assessments, a bleeding mortality rate of 15% from meta-analysis of bleeding studies is applied to the numbers of bled crabs to estimate bleeding mortality. The ASMFC Stock

Assessment update listed the coastwide bleeding mortality at 145,920 for 2022, which is following an increasing trend in recent years (Atlantic States Marine Fisheries Commission, 2024).

However, over the past decade researchers have developed synthetic, non-animal-derived alternatives, known as recombinant reagents, that are synthesized from horseshoe crab genes. These products have the potential to fully replace the use of LAL and the need to bleed horseshoe crabs.

While these synthetic reagents, including recombinant Factor C (rFC) and recombinant cascade (rCR), have been fully approved and adopted in Europe and other parts of the world for years, the United States has lagged behind. Recently, the United States Pharmacopeia (USP) approved the use of recombinant reagents and finally paved the way to the use of alternatives to LAL testing. Still, adoption of the new reagents by the pharmaceutical industry has been slow and LAL remains the FDA approved standard.

It is important to note that even after full approval, some experts have cautioned that the U.S Pharmacopeia's approval of recombinant reagents action will fail to make a meaningful impact on the overarching conservation issues confronting horseshoe crabs (Gauvry 2024). At the same time, the biomedical industry has argued that horseshoe crab bleeding will be necessary for some time in order to protect human health. In recent testimony to ASMFC, one official pointed out that LAL is also used to diagnose invasive fungal infections (which cause approximately 4 million deaths annually worldwide, with an estimated 40-60,000 invasive fungal infections in the USA annually), for which there is currently no synthetic recombinant reagent (Wills, 2025)

While there is currently no harvest for bleeding in the Peconic Estuary, or anywhere in New York, the potential exists for the adoption of the practice. However, New York has significant barriers to entry for biomedical harvest and use. Regulations require that crabs harvested under the bio-medical harvesters permit may only be legally sold, traded, and/or bartered to the holders of a valid horseshoe crab bio-medical users permit. Further, they require that bio-medical user permits will only be issued to persons who have been approved by the United States Federal Food and Drug Administration (USFDA) to produce amebocyte lysate.

Given this, it not surprising that, to date, NYSDEC has issued no bio-medical harvesters or users permits. In fact, there has only been one inquiry made to NYSDEC in the past five years to discuss attaining a biomedical permit in New York; and the permit was not pursued.

IV. Recommendations

The Horseshoe Crab Work Group recommends the pursuit of a number of strategies to reverse the long-term decline in horseshoe crab abundance in the Peconic Estuary. It has also identified several research and assessments needs that are necessary to inform and support the conservation effort.

A. Conserve remaining natural shorelines and advance the removal of hardened shoreline structures.

1) ***Amend municipal codes regarding shoreline hardening***.
Municipalities within the Peconic Estuary should review their municipal codes regarding shoreline management – particularly the criteria for approving shoreline hardening structures – and amend them to 1) require "softer" and "nature-like" approaches where appropriate, and 2) increase the requirements for hardened structures so such structures are approved only when necessary. Municipalities should also explore opportunities to provide incentives for the removal of hardened shoreline structures on private property.

2) ***Identify opportunities for softening publicly owned shorelines***.
Municipalities within the Peconic Estuary should review shoreline properties they own to determine if they contain shoreline hardening structures that are suitable candidates for removal.

3) ***Identify opportunities for public acquisition of horseshoe crab spawning habitat.***
Municipalities should identify and acquire through their CPF programs property with undisturbed shorelines that is conducive for horseshoe crab spawning (and that would also serve as important habitat for diamondback terrapins, shorebirds and other wildlife).

4) ***Identify opportunities for permanent protection of horseshoe crab spawning habitat.***
Municipalities should assess shoreline properties they own for potential dedication to the town's highest protective land use category of their respective town codes. These include the Town of Shelter Island Chapter 91, Town of Southampton Chapter 231, East Hampton Chapter 182 and Riverhead Chapter 221. Acquisition and protection of shoreline habitat should also be prioritized by Suffolk County, as well as the Peconic Land Trust and other private conservation entities.

5) ***Advance use of CPF funding for shoreline restoration.***
If permissible pursuant to the terms of the "water quality improvement project" provision of the CPF (NY Town L § 64-E), town should utilize program income to work with private property owners to remove bulkheads and other shoreline protection structures and restore natural shoreline habitats. If not currently authorized, advance and support an amendment to the CPF state enabling legislation to permit such projects, perhaps through the use of conservation easements or permanent deed restrictions.

6) ***Eliminate disincentives to bulkhead removal.***
New York State's Tidal Wetlands Land Use Regulations (enacted in 1977 to implemented the 1973 Tidal Wetlands Act) grandfathered in any structures, including bulkheads, that were lawfully in existence in 1977 (6 CRR-NY 661). Such preexisting bulkheads established the landward limit of NYSDEC jurisdiction under the tidal wetland regulations. Removal of these bulkheads potentially extends NYSDEC's jurisdiction over landowners' property, which creates concerns for landowners and disincentivizes the removal of bulkheads and other shoreline hardening structures. Support a legislative amendment to the NYS Environmental Conservation Law to eliminate disincentives to property owners to remove bulkheads from their property.

7) ***Advance alternatives to the use of horseshoe crabs for bait***
Recent studies have documented promising alternatives to replace the use of horseshoe crabs as bait in the whelk and eel fisheries (Munley, et al, 2024). In 2025, NYSDEC, Seatuck Environmental Association and Cornell Cooperative Extension of Suffolk County commenced a study of the potential for alternative baits for use in the whelk fishery in New York.

While the 2025 Horseshoe Crab Protection Act will phase out the harvest of horseshoe crabs, including for use as bait, the fact remains that whelk, American eel and other fisheries remain in place that have historically relied on horseshoe crabs for bait, not only in New York, but throughout the Atlantic coast. The development of a viable replacement bait for these fisheries (and for others species that could be targeted in the future) would eliminate the chance that horseshoe crabs would be harvested for bait in the future, whether legally or illegally.

The Peconic Estuary Program, municipalities, nonprofits, etc. should express support for current efforts to develop an alternative bait to horseshoe crabs for use in the eel and whelk fisheries. Such support can lead to additional funding for research and advances in the development and adoption of alternative baits.

B. Research Needs

1) ***Improve understanding of horseshoe crab habitat within and around the Peconic Estuary.***
- Continue refinement of Peconic Estuary shoreline inventory
- Expand tagging studies
- Compare stable isotope values of spawning horseshoe crabs with spatially explicit isoscapes to
  retrospectively assign regions of critical offshore habitat.
- Employ occupancy-abundance model

- Conduct surveys to identify habitats within the Peconic Estuary important to the development of juvenile horseshoe crabs
- Examine linkages between DEC trawl survey data and environmental variables; assess trawl survey data for spatial distribution changes over time.

2) ***Improve understanding of horseshoe crab spawning areas in the Peconic Estuary.***
- Expand participation in the New York Horseshoe Crab Monitoring Network
- Conduct drone surveys to map and record spawning horseshoe crab and collect physical features of spawning beaches with LiDAR.
- Collect relevant environmental and biological information on beaches to characterize horseshoe crab spawning habitats and spatial use; use data to predict the probability of habitat use of spawning horseshoe crabs (*See Landi et al.'s (2015) model of the CT shoreline*).

3) ***Research connection between climate variation and horseshoe crabs.*** Identify how changes in North Atlantic Oscillations and Atlantic Multidecadal Oscillations are impacting horseshoe crab within the Peconic estuary.

4) ***Advance research to support the development of an alternative bait to horseshoe crabs.*** Conduct research to determine horseshoe crab components that make them are a popular bait for whelk, eel, etc.

5) ***Determine whether horseshoe crabs are adversely impacted by dredging and trawling activities.***
- Assess the extent to which dredging activities taking place within the Peconic Estuary have an adverse impact to horseshoe crabs.
- Assess the extent to which nearshore commercial fishing trawls impact horseshoe crabs as bycatch.

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