Tracking post-release movement patterns of New York's rehabilitated Atlantic green (Chelonia mydas) sea turtles provides insight into their utilization of New York waters

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Introduction

Marine megafauna, including sea turtles, play critical roles in ocean ecosystems, contributing to ecological stability and overall biodiversity. In U.S. waters, all sea turtle species are federally protected under the Endangered Species Act (ESA), yet these species continue to experience significant threats from human activities (Häder et al., 2020; Ford et al., 2022; Lombardo et al., 2025). The increasing overlap between human populations and marine habitats has resulted in heightened direct interactions with fisheries bycatch, vessel strikes, and entanglement in marine debris, in addition to indirect effects such as climate-driven environmental changes (Bath et al., 2023; Venegas et al., 2023; Deng et al., 2023). Understanding the health and behavior of these species, particularly in regions with high human activity, is essential for assessing the impacts of anthropogenic stressors and guiding effective conservation strategies.

Studies have confirmed that New York's coastal and estuarine waters serve as key seasonal habitat for, Kemp's ridley (*Lepidochelys kempii)*, green (*Chelonia mydas)*, loggerhead (*Caretta caretta*), and leatherback (*Dermochelys coriacea)* sea turtles, highlighting the region's importance for conservation-focused research on their health, behavior and threats (Morreale et al., 1998). All four species are frequently observed in Long Island Sound, Peconic Bay, and other coastal regions in New York during the warmer months (Morreale et al., 1992; Montello et al., 2022). These turtles typically begin arriving in the region as early as May but are more commonly observed in June, using these productive waters for foraging before migrating southward in the fall (Morreale & Standora, 1990). Despite these known patterns of habitat use, there remains a lack of information describing the status and trends of these populations, particularly in the northeastern United States, highlighting a critical need for updated ecological data.

Due to the complex life cycle of sea turtles, limited information is known about habitat utilization specifically for juvenile and sub-adult sea turtles. With advances in technology, we can now gather more information quickly about these transient species through animal-borne tracking and instrumented tags. Information from tagged rehabilitated sea turtles released into the ocean offers valuable insights into the broader turtle population while removing the logistical challenges of at sea capture and stress on wild animals. Previous studies have found that rehabilitated turtles resume typical movement behavior of their wild counterpart (Coleman et al., 2017; Levy et al., 2017; Robinson et al., 2020) making them ideal subjects for research initiatives.

Sea grass is a crucial component of the marine ecosystem, providing essential foraging grounds for sea turtles and a wide range of other marine organisms (Hemminga & Duarte, 2000; Scott et al., 2018). Of the four species known to utilize New York waters, the Atlantic green sea turtle is the only herbivore species, with a diet consisting largely of eelgrass and other submerged aquatic vegetation (Hearne et al., 2019; Bjorndal, 1980). The remaining three species primarily forage on marine invertebrates and crustaceans; prey that also depend on seagrass beds as critical habitat (Hemminga & Duarte, 2000). Beyond their ecological importance as feeding areas, these habitats also play a significant role in maintaining water quality and supporting coastal protection. Previous studies have described New York waters as critical habitat for Kemp's ridley and loggerheads (Morreale & Standora, 2005), but there is no study that exists for green sea turtles.

This project examined how juvenile Atlantic green sea turtles utilized New York's nearshore waters, with a focus on post-rehabilitation ecology, movement behavior and the identification of potential key seagrass beds, primarily eelgrass (*Zostera marina*) sites within the Peconic Bay.

Methods

The New York Marine Rescue Center (NYMRC) is permitted through the National Oceanic and Atmospheric Administration (NOAA) and United States Fish and Wildlife Services (USFWS) to rescue and rehabilitate sea turtles throughout the state of New York. Reports of stranded sea turtles came through the 24-hour hotline monitored by NYMRC biologist. All turtles that stranded alive between November 1, 2024 – January 31, 2025, were transported by trained staff and volunteers to NYMRC for rehabilitation. Turtles remained at NYMRC for long-term rehabilitation varying from 6 – 9 months.

Animals selected for this project met several criteria established by NYMRC before being released. All individuals were medically cleared by veterinarian Dr. Robert Pisciotta and released within two weeks of approval. Release took place along the Atlantic Ocean coast of Long Island when water temperatures were optimal (~68 F°; July-August).

For this study, 15 Atlantic green sea turtles (*Chelonia mydas)* were equipped with a Wildlife Computers SPOT 387-A satellite device between July 9, - August 31, 2025, at Tiana Beach in Hampton Bays, NY. All satellite tags were antifouled prior to attachment to minimize biofouling during deployment. Tags were secured directly to each individual's carapace using fiberglass cloth, 5- min epoxy and marine grade putty. Tags were programmed to remain in a standby state prior to release and automatically activated upon contact with saltwater.

All tags transmitted location data via the Argos satellite system, providing near real-time tracking. Unlike GPS derived location, Argos locations are associated with varying levels of positional error depending on location class, with estimated accuracies ranging from <250 m for high quality fixes

to >1.5 km for lower-quality fixes (Boyd & Brightsmith, 2013) As a result, each Argos "hit" represents an estimated position rather than the exact location of the individual at that time.

Data Analysis

Historical green sea turtle stranding data was compiled and analyzed to examine stranding and morphometric trends 1998-2025. To assess whether New York coastal waters function as critical habitat for juvenile hard-shelled sea turtles, and to evaluate interspecific differences in habitat use, satellite tracking data was compiled and processed in RStudio. Erroneous or biologically implausible locations will be removed using a speed filter of >100 km/day and location quality filters to ensure data reliability (Robinson et al., 2020).

To understand the interaction between Atlantic green sea turtles and their habitat in New York waters, tracking data was integrated with additional environmental data, including known locations of eelgrass beds (Peconic Estuary Partnership, 2024). To analyze these interactions, telemetry data was imported into R Studio, where spatial analysis and statistical modeling was conducted. The goal was to identify patterns of habitat use, especially whether sea turtles frequently forage within sea grass beds within the Peconic Estuary.

Results

Historical Atlantic green (Chelonia mydas) sea turtle stranding trends

Between 1998 and 2025, a total of 351 Atlantic green (*Chelonia mydas)* sea turtles stranded on Long Island, New York (Figure 1). Annual strandings ranged from 0 to 59 individuals, highlighting substantial interannual variability in stranding intensity. A negative binomial regression analysis of historical strandings revealed a significant increase over time ($\beta = 0.120$, $p < 0.0001$), corresponding to an approximate 12% annual increase in strandings. this upward trend may reflect a combination of factors, including population recovery, increased use of temperate habitats, and improved reporting efforts over time.

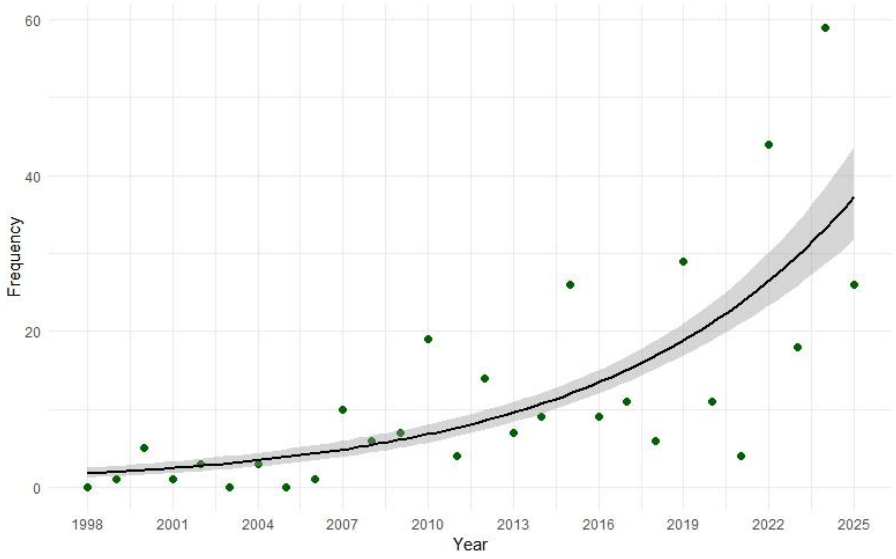


Figure 1. Annual counts of green sea turtle strandings in New York (1998–2025) with fitted negative binomial regression. The model indicates a significant positive association between year and stranding frequency ($\beta = 0.120$, $p < 0.0001$).

Atlantic green sea turtle strandings consisted of mainly juvenile individuals ranging in standard carapace length of 26.6 – 43.3 cm with a mean of 29.7 cm (Figure 2). Overall greens area showing a slight decrease in mean size over time but this was not statistically significant. This predominance of small juveniles suggests New York waters are primarily used by juvenile green turtles, consistent with known life-stage habitat patterns.

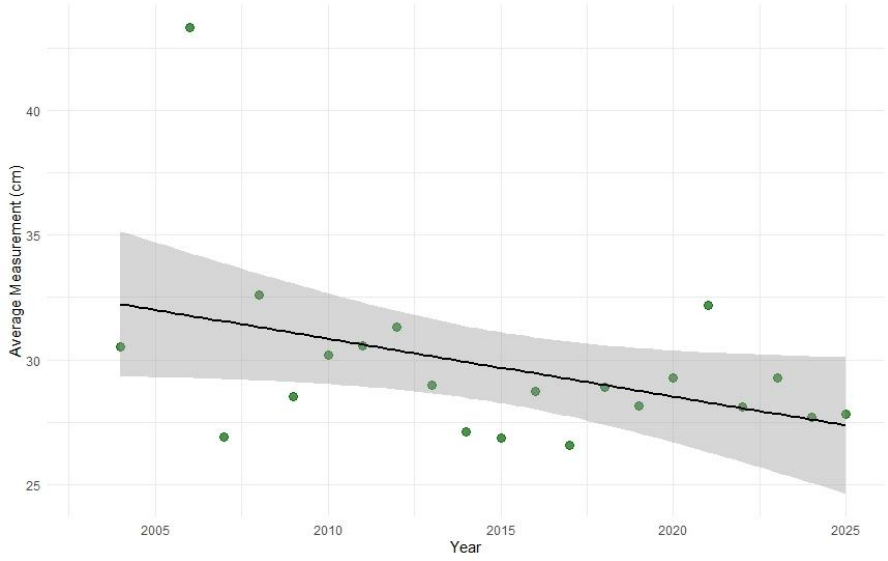


Figure 2. Morphometric distribution and inferred age classes of stranded Atlantic green sea turtles (Chelonia mydas) in New York (2004–2025; n = 325).

During the 2024 cold-stun season, New York Marine Rescue Center (NYMRC) achieved a historic milestone, rescuing a record 157 sea turtles across New York waters (Figure 1). Of these, 44.5% (N=70) were recovered within the Peconic Estuary, identifying this region as a persistent hotspot for cold-stun strandings. The affected individuals were comprised of three species: 6 loggerheads (*Caretta caretta)*, 27 greens (*Chelonia mydas)*, and 37 Kemp's ridleys (*Lepidochelys kempii;* Figure 3). Among the 70 turtles rescued from this region, 43% were successfully rehabilitated and released. Satellite transmitters were deployed on 9 of the released green sea turtles to monitor post-release movements and assess habitat use following rehabilitation.

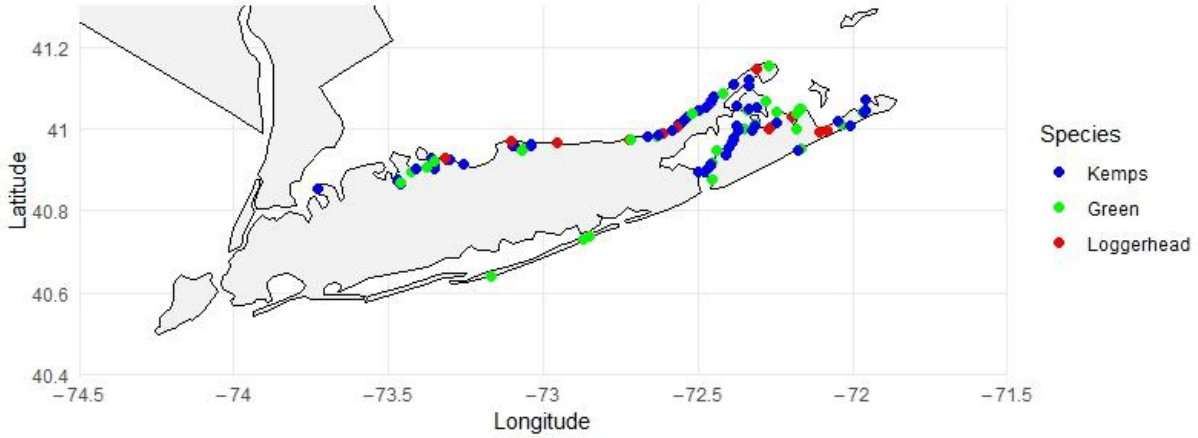


Figure 3. Spatial distribution of cold-stunned sea turtles recorded by New York Marine Rescue Center (NYMRC) during the 2024 season. Points represent individual strandings, color-coded by species. The highest concentration of strandings occurring within the Peconic Estuary, consistent with prior years.

Tag Duration

A total of 15 cold-stunned green sea turtles were equipped with Wildlife Computers SPOT 387-A satellite transmitters and released during the summer of 2025 (Table 1). This included the nine individuals rescued from the Peconic Estuary, and an additional six individuals that were stranded along the Long Island Sound. All turtles were released on the ocean side of Hampton Bays, New York between July 9, 2025 – August 27, 2025 (Figure 4). All tags were considered successful based on continued transmission for more than 30 days post-deployment (range 30 – 260+). Notably, 13 of 15 tags continued to provide tracking data beyond 30 days, with one tag ceasing transmission at 96 days and 12 tags (80%) exceeding 100 days of transmission (141 – 250+). Of those 12 tags, six tags transmitted for nearly 200 days (40%), while the remaining six exceeded 200 days of transmission (203-278), with one tag still active as of May 1, 2026.

Table 1. Summary of fifteen sea turtles rescued from the Peconic Estuary during the 2024 cold stun season and fitted with a satellite transmitter prior to their release in Summer 2025.

Accession #	Strand Date	Strand Beach Location	Strand Town	Released	Name	Tracking Duration	Days NY
NY6436-24	12/03/2024	Seymour Boat Yard	Huntington	7/09/2025	Kale	32 days	32 days
NY6477-24	12/07/2024	Navy Beach	Montauk	7/09/2025	Arugula	148 days	148 days
NY6415-24	12/01/2024	Foster Memorial	Sag Harbor	7/09/2025	Spinach	245 days	138 days
NY6419-24	12/02/2024	Breakwater Beach	Mattituck	7/31/2025	Bok Choy	278 days	90 days
NY6433-24	12/03/2024	Gold Star Beach	Huntington	7/31/2025	Fennel	220 days	137 days
NY6434-24	12/03/2024	Cold Spring Rd	Southampton	8/06/2025	Saccharina	30 days	30 days
NY6443-24	12/03/2024	Noyack Bay	Southampton	8/06/2025	Zostera	203 days	119 days
NY6424-24	12/02/2024	Port Jefferson Beach	Port Jefferson	8/06/2025	Pepper	141 days	130 days
NY6412-24	11/30/2024	Foster Memorial	Sag Harbor	8/14/2025	Fig	164 days	105 days
NY6425-25	12/02/2024	Sebonic Inlet Rd	Southampton	8/14/2025	Celery	215 days	96 days
NY6481-24	12/07/2024	Port Jefferson Beach	Port Jefferson	8/14/2025	Guava	Still live	75 days
NY6429-24	12/02/2024	Steers Beach	Northport	8/27/2025	Cucumber	144 days	75 days
NY6410-24	11/29/2024	Foster Memorial	Sag Harbor	8/27/2025	Leek	160 days	86 days
NY6413-24	12/01/2024	Iodine Beach Napeague Harbor	Montauk	8/27/2025	Pineapple	223 days	82 days
NY6414-24	12/01/2024	Foster Memorial	Sag Harbor	8/29/2025	Bubbles	96 days	20 days



Figure 4. Fifteen Atlantic green sea turtles (*Chelonia mydas)* were equipped with Wildlife Computer's SPOT satellite tag and released during Summer 2025. Tags transmitted between 30 – over 250 days with an average 170 days.

Overall Movement Pattern

During this study, 15 turtles were released at Tiana Beach, Hampton Bays between July 9th – August 27th, 2025. From the 15 turtles, three turtles' tags stopped transmitting before leaving New York waters (20%). One of those included a turtle that restranded, "Arugula" (NY6477-24), during the 2025 cold stun season and that tag was manually turned off. Currently "Arugula is receiving care at NYMRC and will be released during Summer 2026. The remaining 12 turtles demonstrated three movement patterns which included two turtles that moved south but remained coastal as they traveled towards Florida with one currently in the Bahamas (13%; Figure 5). About 40% of tagged individuals moved southern along the coast before moving offshore from North Carolina and connecting with the Gulf Stream. The remaining 27% of individuals moved directly offshore once they departed from New York connecting with the Gulf Stream (Figure 5). A Fisher's exact test was performed to examine the relationship between movement type and month of departure from New York waters, revealing a significant association between the two variables ($p = 0.004$), indicating that departure timing was not independent of movement strategy.

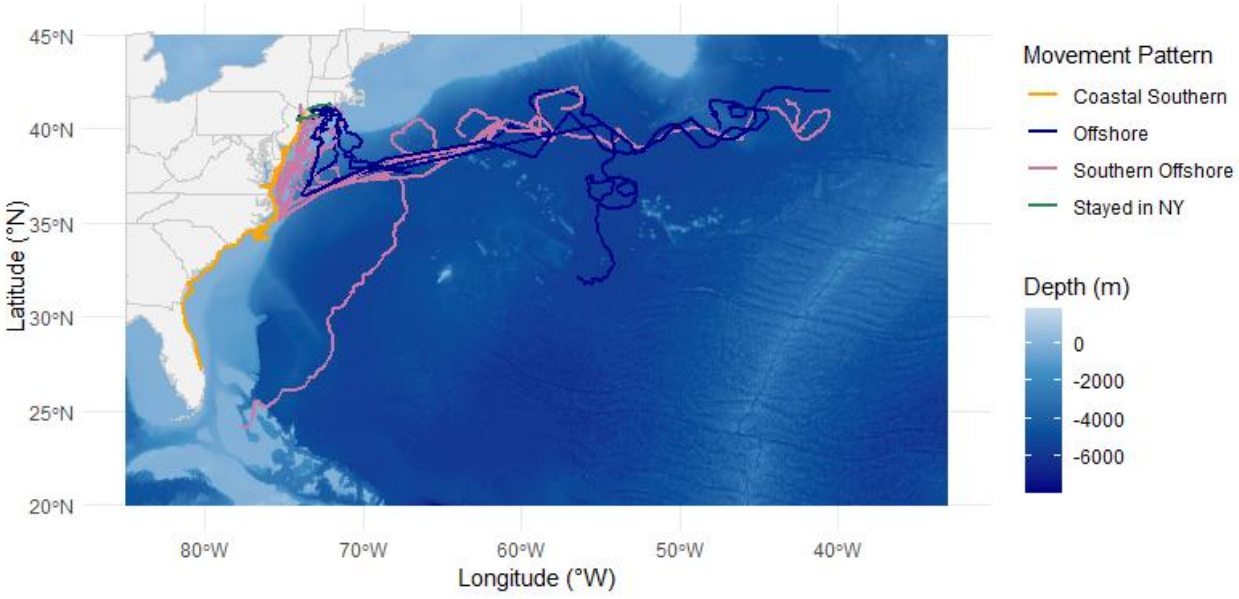


Figure 5. Satellite tracking map of 15 cold stunned green sea turtles released in 2025 demonstrating three movement patterns (Coastal Southern, Southern Offshore, and Offshore). There were two tags that stopped transmitting in New York waters including one turtle that restranded during the 2025 cold stun season.

New York Utilization

Post-release, individuals remained in New York waters for an average of 90 days (20 – 148) before moving south (Figure 4). As noted previously, three turtles had tags that stopped transmitting while still within New York waters; including one individual that re-stranded, one whose tag ceased transmitting in Jamaica Bay, and ones whose tag stopped transmitting in the New York Bight/northern New Jersey waters. When re-stranding events and individuals that never fully exited New York waters are excluded, the average residency period slightly increased to 93 days (20–138 days). Initial analyses suggest that juveniles frequently utilize specific bays and coastal regions, indicating that New York coastal waters may serve as important temporary habitats for sea turtles during critical life stages (Figure 6).

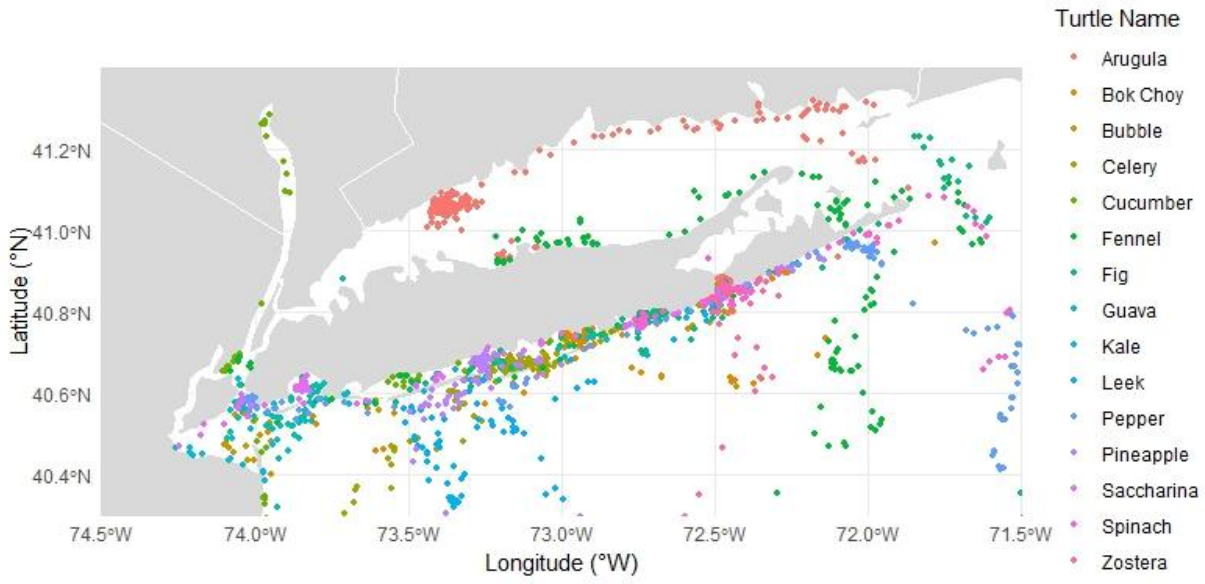


Figure 6. Satellite tracking map of 15 cold-stunned green sea turtles released in 2025, zoomed in on Long Island, New York. Each individual is represented by a unique color, and each colored point represents a single filtered Argos location ("hit") from the satellite telemetry dataset.

Eelgrass bed data were incorporated into the telemetry dataset by overlaying georeferenced eelgrass (*Zostera marina*) polygons with filtered Argos tracking locations. Seven juvenile green sea turtles exhibiting similar spatial use patterns within New York waters were selected for this habitat comparison analysis and overlaid on the same spatial layer to assess potential habitat association (Figure 7). Habitat use was then quantified as the proportion of telemetry locations occurring within mapped eelgrass beds and compared to habitat availability across the study area. Analyses were restricted to individuals that entered the Peconic Estuary, allowing for a focused

assessment of habitat use with this region. A use–availability ratio greater than 1 indicates selection for eelgrass habitat relative to its spatial availability, with results suggesting a positive association (w = 1.57) between juvenile green sea turtle movements and eelgrass habitats within the study area. This pattern may indicate that turtles entering the Peconic Estuary are utilizing these areas in part due to the accessibility of eelgrass beds, potentially reflecting foraging opportunities for this herbivorous species.

Although this use-availability approach provides a useful estimate of habitat association, it is not a fully mechanistic or movement-based habitat selection model therefore it does not account for spatial autocorrelation, temporal dependence, or variation in sampling effort among individuals. Despite these limitations, the results suggest that juvenile green sea turtles may preferentially utilize eelgrass habitats, highlighting the potential ecological importance of these areas within New York waters.

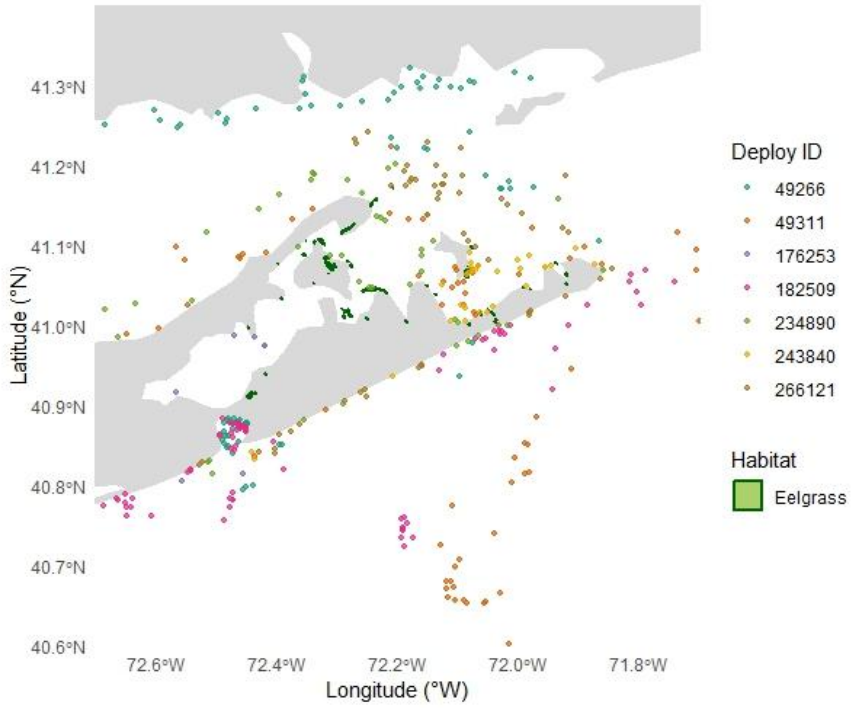


Figure 7. Satellite tracking map of seven tagged juvenile Atlantic green sea turtles, including individuals from a historical dataset and two turtles tagged as part of the PEP project. All individuals utilized portions of Peconic Bay during post-release residency. Eelgrass (*Zostera marina*) beds are overlaid to examine habitat use and potential foraging areas, illustrating spatial overlap and supporting evidence of non-random use of seagrass habitats.

Sightings in urban areas

During this project, three of the 15 turtles were sighted post-release by members of the public. As previously noted, NY6477-24 “Arugula” restranded during the 2025 cold-stun season. Prior to restranding, however, we received multiple reports from the Port Jefferson Ferry documenting

sightings of this individual, which ultimately contributed to its recovery and survival. Two additional turtles were also resighted; NY6433-24 “Fennel,” observed via a drone a few days after release near the Shinnecock Inlet, and NY6425-24 “Celery,” recorded by an underwater camera operated by a local spearfisherman in Moriches Inlet. These increased reports may reflect the growing use of urban coastal environments, which in turn elevates the risk of vessel strikes and human-wildlife interactions.

Discussion/Future Directions

Atlantic green sea turtle strandings in New York have increased from 1998 – 2025, likely reflecting a global population recovery, consistent with the species’ downlisting from *Endangered* to *Least Concern* in 2025 (IUCN, 2025). Increased abundance may drive expanded use of marginal, temperate habitats such as New York waters. The size of individuals in this study aligned with expected juvenile age-glass morphometrics (Morreale & Standora, 1998), supporting the conclusion that New York functions primarily as developmental habitat for juvenile green sea turtles. Post-released tracking indicated that rehabilitated individuals remained in New York waters for an average of 90 days before migrating south or offshore towards warmer habitats. The persistence of individuals in these systems suggest that local environmental conditions provide sufficient resources to support extended occupancy. In particular, the presence of eelgrass (*Zostera marina)* beds and other SAV, may be an important forage resource for juvenile green turtles, playing a key role in retaining individuals within these nearshore habitats post-release. Further investigation into diet composition from post-mortem individuals would help confirm the extent to which these turtles are actively foraging on local vegetation and utilizing these habitats as feeding grounds. Together, these findings highlight the ecological importance of temperate estuarine and nearshore systems in the life history of green sea turtles, emphasizing the New York waters are not merely transitional zones but functionally significant development habitats.

Rehabilitated green sea turtles also appear to remain in New York waters later into fall than previously documented, highlighting the need for expanded research on seasonal habitat use and migration timing. Future work will prioritize additional satellite tags deployments to strengthen the scope of the study. Increasing the sample size of juvenile green sea turtles tagged and released by NYMRC will be critical for improving data reliability of results. Adjustments to release locations, including shifting from ocean-based to bay-based releases, may help reduce potential southern dispersal biases. Additionally, examining patterns of recreational vessel traffic alongside turtle habitat use will help identify overlap areas and potential hotspots for fisheries interaction. Collectively, these efforts will contribute valuable insights to support the ongoing protection and management of these federally protected species.

Works Cited

Bath, G.E., Price, C.A., Riley, K.L., & Morris Jr., J.A. (2023) A global review of protected species interactions with marine aquaculture. Rev. Aquac. 15:1686-1719.

Bjorndal, K.A. (1980) Nutrition and grazing behavior of the green turtle *Chelonia mydas*. Mar. Biol.

Peconic Estuary Partnership (2024). PEP maps and GIS datasets. Eelgrass data layer. ArcGIS Hub. https://hub.gss.stonybrook.edu/arcgis/apps/sites/#/pep-maps-and-gis-datasets/datasets/a461eeb2bcd94ea18dd55bd104c485da/explore

Boyd, J.D., & Brightsmith, D.J. (2013) Error Properties of Argos Satellite Telemetry Locations Using Least Square and Kaman Filtering. PLOS One 8(5).

Coleman, A.T., Pitchford, J.L., Bailey, H., & Solangi, M. (2017) Seasonal movements of immature Kemp's ridley sea turtles (*Lepidochelys kempii)* in the northern Gulf of Mexico. Aquatic Conservation Marine and Freshwater Ecosystems. 27:1.

Deng, Y.; Wu, J.; Chen, J., & Kang, K. (2023). Overview of Microplastic Pollution and Its Influence on the Health of Organisms. *J. Environ. Sci. Health Part A*, *58*, 412–422.

Ford, H.V.; Jones, N.H., Davies, A.J., Godley, B.J., Jambeck, J.R, Napper, I.E., Suckling, C.C., Williams, G.J., Woodall, L.C.,Koldewey, H.J. (2022). The Fundamental Links between Climate Change and Marine Plastic Pollution. *Sci. Total Environ*, *806*, 150392.

Häder, D.P., Banaszak, A.T., Villafañe, V.E., Narvarte, M.A., González, R.A., & Helbling, E.W. (2020) Anthropogenic Pollution of Aquatic Ecosystems: Emerging Problems with Global Implications. *Sci. Total Environ*, *713*, 136586.

Hearne, E.L., Johnson, R.A., Gulick, A.G., Candelmo, A., Bolten, A.B., Bjorndal., K.A. (2019). Effects of green turtle grazing on seagrass and macroalgae diversity vary spatially among seagrass meadows. Aquatic Botany 152, 10-15.

Hemminga, M.A., & Duarte, C.M. (2000). Seagrass Ecology. Cambridge University Press.

Levy, Y., Keren, T., Leader, N., Weil, G., Tchernov, D., & Rilov, G. (2017) Spatiotemporal hotspots of habitat use by loggerhead (Caretta caretta) and green (Chelonia mydas) sea turtles in the Levant basin as tools for conservation. Marine Ecology Progress Series. 575.

Lombardo, J.; Ribas-Taberner, M.d.M.; Quetglas-Llabrés, M.M., Pinya, S., Gil, L., Tejada, S., Sureda, A., & Compa, M. (2025). Human Activity as a Growing Threat to Marine Ecosystems: Plastic and Temperature Effects on the Sponge *Sarcotragus spinosulus*. *Toxics*, *13*, 66. https://doi.org/10.3390/toxics13010066

Montello, M.A., Goulder, K.D., Pisciotta, R.P., & McFarlane, W.J. (2022) Historical Trends in New York State Cold-Stunned Sea Turtle Stranding-to-Release: 1998-2019. Chelonian Conservation and Biology, 21(1): 74-87.

Morreale, S.J. & Standroa, E.A. (1990). Occurrence, movement and behavior of the Kemp's ridley and other sea turtles in New York waters. Ann. Rept. To NYS Dept. of Env. Conservation, Return a Gift to Wildlife Program, April 1989-April 1990.

Robinson, N.J., Deguzman, K., Bonacci-Sullivan, L., DiGiovanni, R.A., & Pinou, T. (2020) Rehabilitated sea turtles tend to resume typical migratory behaviors: satellite tracking juvenile loggerhead, green, and Kemp's ridley turtles in the northeastern USA. Endangered Species Research. 43.

Scott, A.L., York, P.H, Duncan, C, Macreadie, P.I., Connolly, R.M., Ellis, M.T., Jarvis, J.C., Jinks, K.I., Marsh, H., Rasheed, M.A. (2018). The role of herbivory in structuring tropical seagrass ecosystem service delivery Front. Plant Sci., 9 (2018), pp. 1-10

Venegas, R.M., Acevedo, J., & Treml, E.A. (2023). Three decades of ocean warming impacts on marine ecosystems: A review and perspective. Deep Sea Research Part II: Topical Studies in Oceanography, 212. https://doi.org/10.1016/j.dsr2.2023.105318.