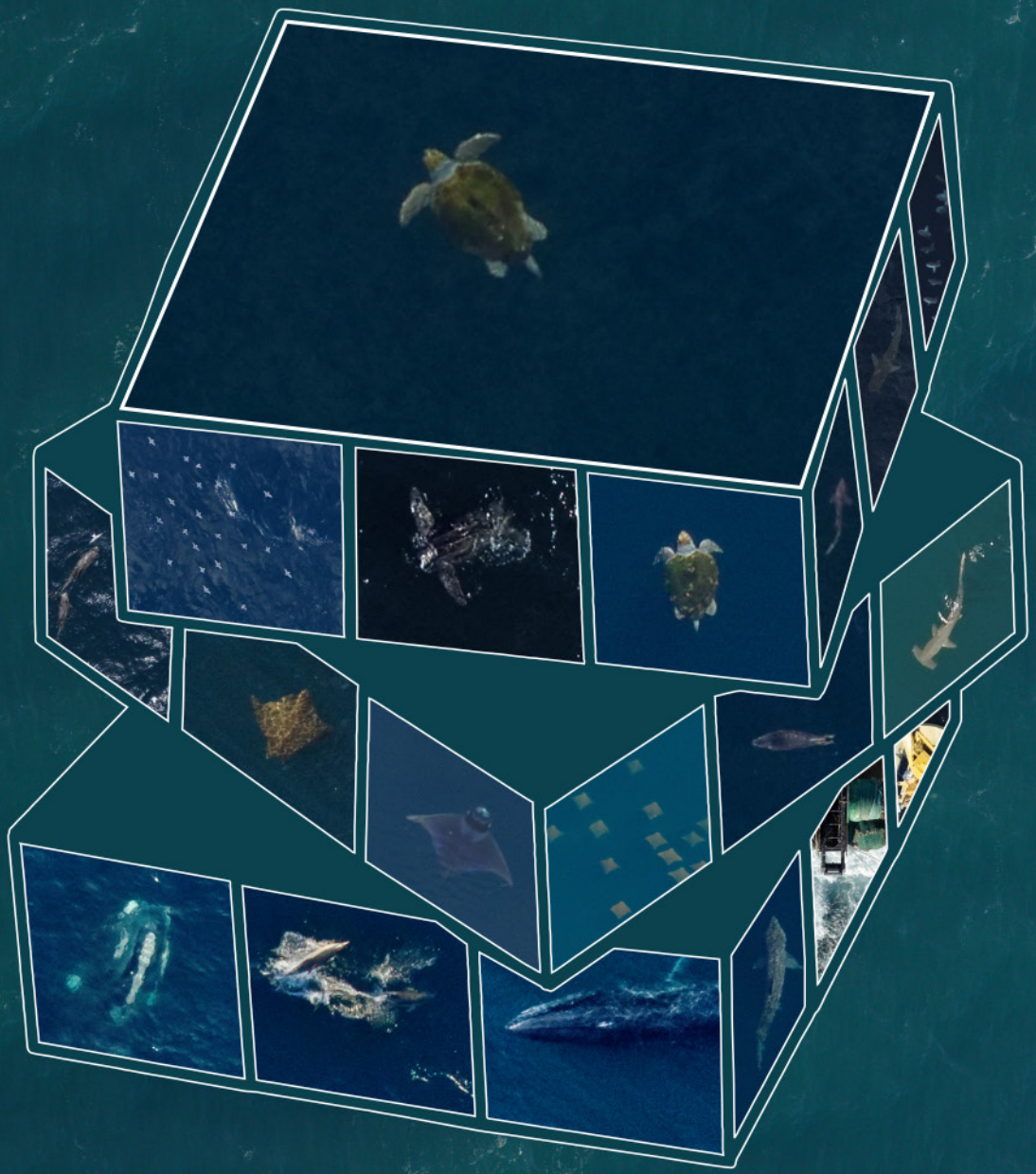
Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy

Spatial and Temporal Marine Wildlife Distributions in the New York Offshore Planning Area, Summer 2016–Spring 2019

Final Report
Volume 3: Results (Turtles)



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ENVIRONMENTAL CONSULTANTS

APEM

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Final Report
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Abstract

NYSERDA tasked Normandeau Associates, Inc., and their teaming partner APEM Ltd. to collect aerial digital imagery over the New York Offshore Planning Area during 12 surveys spaced seasonally over three years between 2016 and 2019. Imagery was captured at a resolution of 1.5 cm at the sea surface and provides information on spatial and temporal abundances of birds, marine mammals, turtles, rays, sharks, large bony fishes, and fish shoals. Spatial patterns were analyzed within distance from shore and water depth zones and reference the proposed Call Areas within the surveyed planning area identified by BOEM at the time of writing. Seasonal density comparisons highlight the differences among zones for each species group. Except for turtles, densities were generally lower in the zone containing the identified BOEM Call Areas. Full Summary and Final Reports can also be found on remote.normandeau.com https://remote.normandeau.com/aer_docs.php?pj=6

Keywords

Marine mammals; Birds; Turtles; Rays; Sharks; Aerial Digital Surveys; NYSERDA; Normandeau; APEM; Call Area; Density; Distribution; Abundance; Marine Wildlife; Offshore Wind

Acknowledgments

Normandeau Associates, Inc., and APEM Ltd. would like to thank NYSERDA for this opportunity, which, at the beginning of the project, was the largest survey of its type ever undertaken in the world. During the project, QA/QC protocols were developed that created confidence in data quality, and data sharing platforms evolved that allowed easy information sharing to all.

Normandeau would also like to thank Dr. Greg Skomal, Dr. Robert Kenney, Calusa Horn, Jessica Pate, and Dr. Nick Farmer for their taxonomic expertise and for their interest in the data generated by these surveys. Special thanks to Greg Lampman of NYSERDA for his help and support throughout the project. Normandeau would also like to thank the Project Advisory Committee for their interest and advice throughout the project.

All aerial images were collected by APEM Ltd., and flight height calculation methodology information was provided by APEM Ltd.

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1 Introduction

In support of New York State's commitment to incorporating offshore wind into its energy portfolio, the New York State Energy Research and Development Authority (NYSERDA) embarked on a multi-year ultra-high resolution aerial digital survey of marine resources in a 43,745.20 km^2 (12,754.06 mi^2) offshore planning area (OPA) in 2016. The OPA encompasses the waters of the New York Bight from Long Island southeast to the continental shelf break. Surveys were conducted on a quarterly basis and timed to coincide with periods of abundance of bird and marine species that could be vulnerable to impacts from offshore wind activities.

Each survey collected images covering at least 7% of the OPA. All survey data have been summarized and are freely available at https://remote.normandeau.com/nys_aer_overview.php

This report summarizes the results of the 12 surveys for all turtle species. It is volume 3 of five volumes:

- Volume 1: Methods, General Results, Limitations, and Discussion
- Volume 2: Results (Birds)
- Volume 3: Results (Turtles)
- Volume 4: Results (Marine Mammals)
- Volume 5: Results (Sharks and Rays)

2 Results (Turtles)

Four species of turtle were identified in imagery during surveys of the OPA (Table 1). Throughout the 12 surveys, 1,885 individuals were recorded with most encounters in the Summer surveys (Table 2). No turtles were encountered in the Fall 2018 survey or the Winter 2017–2018 or 2018–2019 surveys, and only one turtle was found in the Winter 2016–2017 and Spring 2018 surveys (Table 2). During turtle imagery review, examples were found of interactions between multiple individuals of loggerhead turtles, as well as associations between four Kemp's ridley turtles and sargassum/weed. Example images from each survey are included in Appendix A.

Table 1. Turtle Species Identified in Imagery Captured over 12 Surveys in the New York OPA

Common Name	Scientific Name
TURTLES	**Reptilia**
Soft-shell Turtle	
Leatherback Turtle	*Dermochelys coriacea*
Hard-shell Turtle	
Loggerhead Turtle	*Caretta caretta*
Green Turtle	*Chelonia mydas*
Kemp's Ridley Turtle	*Lepidochelys kempii*

Table 2. Number of Turtles per Survey Identified in Imagery Captured over 12 Surveys in the New York OPA

Species	Total	Raw Counts											
		Summer			Fall			Winter			Spring		
		2016	2017	2018	2016	2017	2018	2016–17	2017–18	2018–19	2017	2018	2019
Leatherback Turtle [a]	**47**	9	5	3	28	2	-	-	-	-	-	-	-
Loggerhead Turtle [a]	**1,397**	388	649	340	6	5	-	1	-	-	5	-	3
Loggerhead/Kemp's Turtle [a]	**99**	10	20	66	-	1	-	-	-	-	2	-	-
Green Turtle [a]	**1**	1	-	-	-	-	-	-	-	-	-	-	-
Kemp's Ridley Turtle [a]	**64**	15	24	18	1	5	-	-	-	-	1	-	-
species unknown [a]	**277**	137	13	120	4	-	-	-	-	-	2	1	-
Totals	**1,885**	560	711	547	39	13	-	1	-	-	10	1	3

[a] Listed under the Endangered Species Act

2.1 Species Identification

Across all surveys, 81% of turtles were ascribed to species, the remaining were ascribed to the species blend loggerhead/Kemp's (n=99) or turtle-species unknown (n=277) (Table 2). Thirty-two percent of the loggerhead/Kemp's species blend were significantly submerged, and 73% (n=203) of those not ascribed to any species were significantly submerged (Table 3).

Table 3. Number of Significantly Submerged Individuals Per Survey

Species	Total	Significantly Submerged											
		Summer			Fall 2018			Winter			Spring		
		2016	2017	2018	2016	2017	2018	2016–17	2017–18	2018–19	2017	2018	2019
Leatherback Turtle [a]	**14**	9	1	2	2	0	0	0	0	0	0	0	0
Loggerhead Turtle [a]	**430**	225	96	107	1	1	0	0	0	0	0	0	0
Loggerhead/Kemp's Turtle [a]	**32**	6	3	22	0	1	0	0	0	0	0	0	0
Green Turtle [a]	**1**	1	0	0	0	0	0	0	0	0	0	0	0
Kemp's Ridley Turtle [a]	**14**	11	1	0	0	2	0	0	0	0	0	0	0
species unknown [a]	**203**	121	7	74	1	0	0	0	0	0	0	0	0
Total	**694**	373	108	205	4	4	0	0	0	0	0	0	0

[a] Listed under the Endangered Species Act

At the species group level there was 100% agreement between the original identification and the QC identification (Table 4). At the species level, turtle identification accuracy was high (>95%) for all species (Table 4). Accuracy was lower for the species blends loggerhead/Kemp's turtle and turtle-species unknown; however, this was expected given that species blends are used when confident species identification cannot be performed on a target. Of the 99 individuals initially identified as loggerhead/Kemp's, only 13 individuals were QC'd as something else and 12 of the 13 individuals were QC'd as a Kemp's or loggerhead turtle. While the exact species blend was not matched in 13 cases, it was correctly matched to one of the two species in the blend 12 of 13 times.

Table 4. Initial Identification Accuracy and QC ID Accuracy for Turtle Species

Species Group	Initial ID Success	QC ID Success	n (initial ID)	n (QC ID)
Leatherback Turtle	97.9%	100.0%	47	46
Loggerhead Turtle	95.9%	98.1%	1,397	1,366
Loggerhead/Kemp's Turtle	86.9%	72.3%	99	119
Green Turtle	0.0%	NA	1	0
Kemp's Ridley Turtle	96.9%	96.9%	64	64
Turtle-species unknown	91.3%	87.8%	277	288

[a] An NA value means that no individuals of that species group were identified by the respective observer.

2.2 Species Composition and Density by Survey

Peak encounters for turtles were in the Summer surveys when 97% of turtles for all surveys were observed (Table 5). Loggerhead turtles were the most frequently encountered, consisting of 74% of the total observations. In the Fall 2016 survey, peak encounters were leatherback turtles whereas in the Fall 2017 survey it was loggerhead and Kemp's ridley turtles. For the remaining surveys, loggerhead turtles were the most abundant species (Table 5). A single green turtle was found in the Summer 2016 survey. No turtles were observed during the Winter 2017–2018, Winter 2018–2019, or Fall 2018 surveys (Table 5).

Table 5. Density per km^2 and Percent of Total of Individuals in the OPA over 12 Surveys in the New York OPA

Species	Summer						Fall						Winter						Spring						Total
	2016		2017		2018		2016		2017		2018		2016–17		2017–18		2018–19		2017		2018		2019		
	Density	%	Density	%	Density	%	Density	%	Density	%	Density	%	Density	%	Density	%	Density	%	Density	%	Density	%	Density	%	
Leatherback Turtle	0.0028	19.15	0.0016	10.64	0.0010	6.38	0.0072	59.57	0.0006	4.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0132
Loggerhead Turtle	0.1211	27.77	0.2071	46.46	0.1079	24.34	0.0015	0.43	0.0016	0.36	-	-	0.0003	0.07	-	-	-	-	0.0015	0.36	-	-	0.0010	0.21	0.4420
Loggerhead/Kemp's Turtle	0.0031	10.10	0.0064	20.20	0.0209	66.67	-	-	0.0003	1.01	-	-	-	-	-	-	-	-	0.0006	2.02	-	-	-	-	0.0314
Green Turtle	0.0003	100.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0003
Kemp's Ridley Turtle	0.0047	23.44	0.0077	37.50	0.0057	28.13	0.0003	1.56	0.0016	7.81	-	-	-	-	-	-	-	-	0.0003	1.56	-	-	-	-	0.0202
species unknown	0.0428	49.46	0.0041	4.69	0.0381	43.32	0.0010	1.44	-	-	-	-	-	-	-	-	-	-	0.0006	0.72	0.0003	0.36	-	-	0.0870
Total	**0.1748**	**29.71**	**0.2269**	**37.72**	**0.1736**	**29.02**	**0.0100**	**2.07**	**0.0041**	**0.69**	**-**	**--**	**0.0003**	**0.05**	**-**	**--**	**-**	**--**	**0.0030**	**0.53**	**0.0003**	**0.05**	**0.0010**	**0.16**	**0.5940**

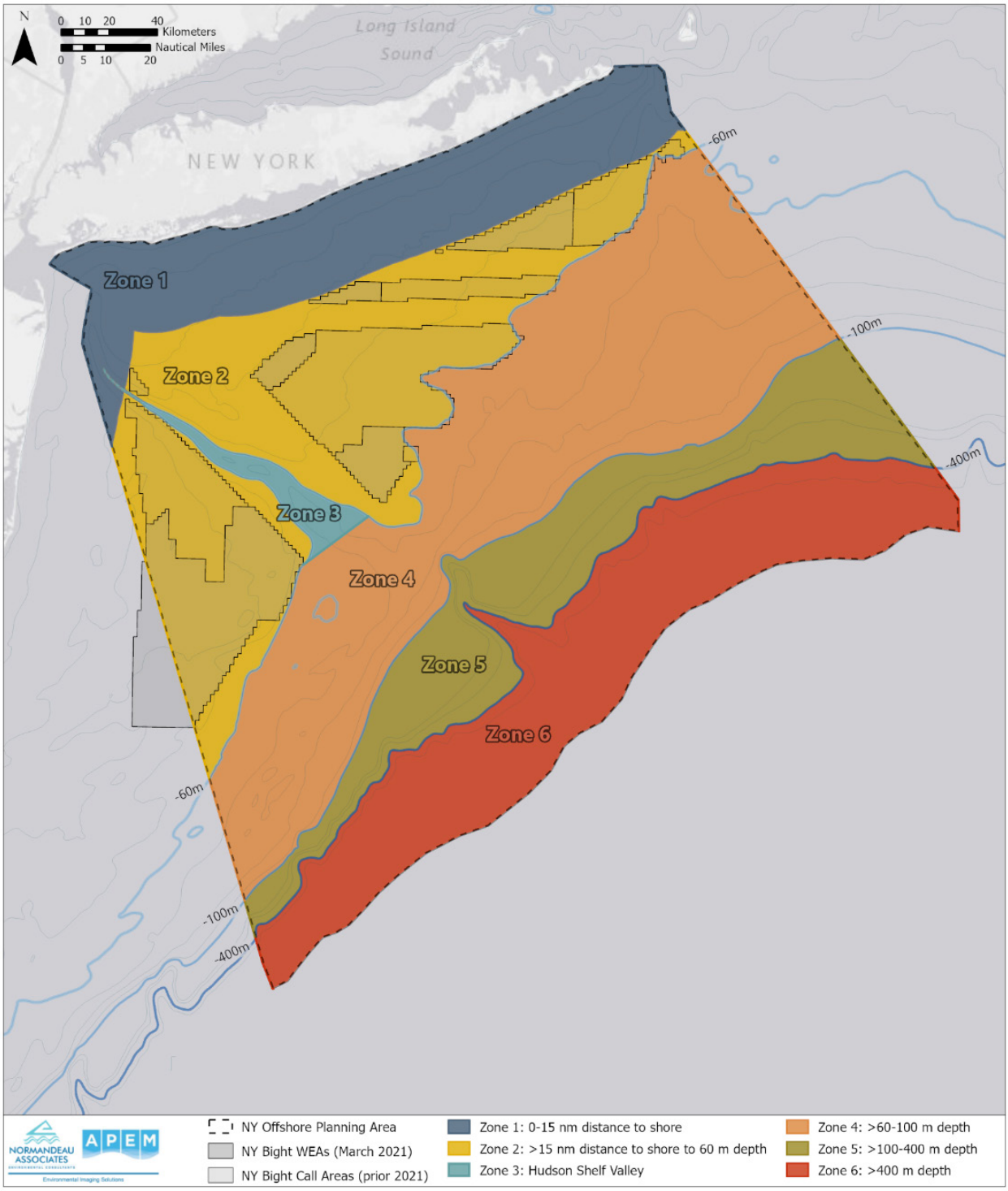
2.3 Spatial Distribution and Direction of Travel

To account for spatial variation more effectively within the OPA, six discrete zones were considered (Figure 1):

- Zone 1: Coastal Zone
- Zone 2: Area for Consideration Zone
- Zone 3: Hudson Shelf Valley Zone
- Zone 4: Shelf Zone
- Zone 5: Shelf Slope Zone
- Zone 6: Shelf Break Zone

Density was quantified for species with 30 or more total observations by dividing the total count of individuals of a species within the strip transect by the strip transect area. Densities are presented as individuals per square kilometer (km^2) surveyed plus or minus standard error of the mean. On the resulting heat maps, density is scaled to the maximum density across all seasons for each taxon. For species with fewer than 30 total observations, a single point map shows the occurrence record spatially and temporally. To gain a deeper understanding of direction of travel, a Rao spacing test was used for species and seasons with greater than 30 occurrences to test the hypothesis that the underlying direction of travel distribution is uniform and report the test statistic as t and the p-value as p where appropriate.

Figure 1. Zones Defined in the Analyses and Location of the Call Areas



2.4 All Turtles

In total, 1,885 turtles were observed. Considering all turtles, mean density was greatest during Summer surveys (n=1,818; $\bar{x}$ = 0.12 ± 0.01 turtles/km^2), more than 15 times greater density than during Fall (n=52; $\bar{x}$ = 0.007 ± 0.003 turtles/km^2), Spring (n=14; $\bar{x}$ = 0.002 turtles/km^2), and Winter (n=1; $\bar{x}$ = 0.0001 turtles/km^2) (Table 2, Figure 2, Figure 3). During Summer, density was greatest in Zone 2 (n=1,269; $\bar{x}$ = 0.41 ± 0.04 turtles/km^2) and above average in Zones 3 and 4 (Figure 3). During Fall and Winter surveys there was no observed pattern of travel direction (Figure 4). During Spring and Summer surveys, turtles exhibited a bimodal pattern of travel direction with most individuals traveling east or west (Figure 4).

2.4.1 Leatherback Turtle

Leatherback turtle were observed 47 times through the Fall and Summer surveys and were absent during Spring and Winter surveys (Table 2, Figure 5). Leatherback turtle was the only turtle species more abundant during Fall than Summer. Mean density during Fall (n=30; $\bar{x}$ = 0.12 ± 0.002 turtles/km^2) was more than twice that of Summer (n=17; $\bar{x}$ = 0.0019 ± 0.0007 turtles/km^2). During Fall, density was greatest in Zone 1 (n=21; $\bar{x}$ = 0.02 ± 0.01 turtles/km^2). During Summer surveys, Zone 2 had the greatest number of observations (n=9) (Figure 5). During Fall there was no observed pattern of travel direction; however, during Summer, individuals exhibited either westerly or northeasterly directions of travel (Figure 6).

2.4.2 Loggerhead Turtle

In total, 1,397 loggerhead turtles were observed (Table 2). Mean density was greatest during Summer surveys (n=1,377; $\bar{x}$ = 0.09 ± 0.008 turtles/km^2), with few observations and low density in Fall (n=11; $\bar{x}$ = 0.0007 turtles/km^2), Spring (n=8; $\bar{x}$ = 0.0012 turtles/km^2), and Winter (n=1; $\bar{x}$ = 0.0001 turtles/km^2) (Figure 7, Figure 8). During Summer, density was greatest in Zone 2 (n=970; $\bar{x}$ = 0.30 ± 0.03 turtles/km^2) and above average in Zones 3 and 4 (Figure 8). During Fall and Winter surveys there was no observed pattern of travel direction (Figure 9). During Spring and Summer surveys, turtles exhibited a bimodal pattern of travel direction with most individuals traveling east or west (Figure 9).

2.4.3 Green Turtle

Across all surveys green turtle were only observed on one occasion (Table 2, Figure 10). The observation occurred within Zone 2 during the 2016 Summer survey.

2.4.4 Kemp's Ridley Turtle

In total, 64 Kemp's ridley turtle were observed during surveys within the OPA (Table 2, Figure 11, Figure 12). The vast majority were encountered during Summer surveys (n=57; $\bar{x}$ = 0.0041 ± 0.001 turtles/km^2) (Figure 12). During Summer surveys, mean density was greatest in Zone 1 (n=20; $\bar{x}$ = 0.01 ± 0.004 turtles/km^2) and Zone 2 (n=28; $\bar{x}$ = 0.01 ± 0.001 turtles/km^2). During Fall, five of six individuals were observed traveling in a southwesterly and westerly direction (Figure 13). During Summer, there was no observed pattern associated with direction of travel (Figure 13).

2.4.5 Loggerhead/Kemp's Ridley Turtle

Ninety-nine targets were classified as loggerhead/Kemp's ridley turtle (Table 2, Figure 14, Figure 15). Most individuals were encountered during Summer surveys (n=96; $\bar{x}$ = 0.0063± 0.001 turtles/km^2) (Figure 15). During Summer surveys, mean density was greatest in Zone 2 (n=76; $\bar{x}$ = 0.02 ± 0.005 turtles/km^2). During Summer, there was no observed pattern associated with direction of travel (Figure 16).

Figure 2. Spatial Distribution of Turtle Species During Fall and Winter by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

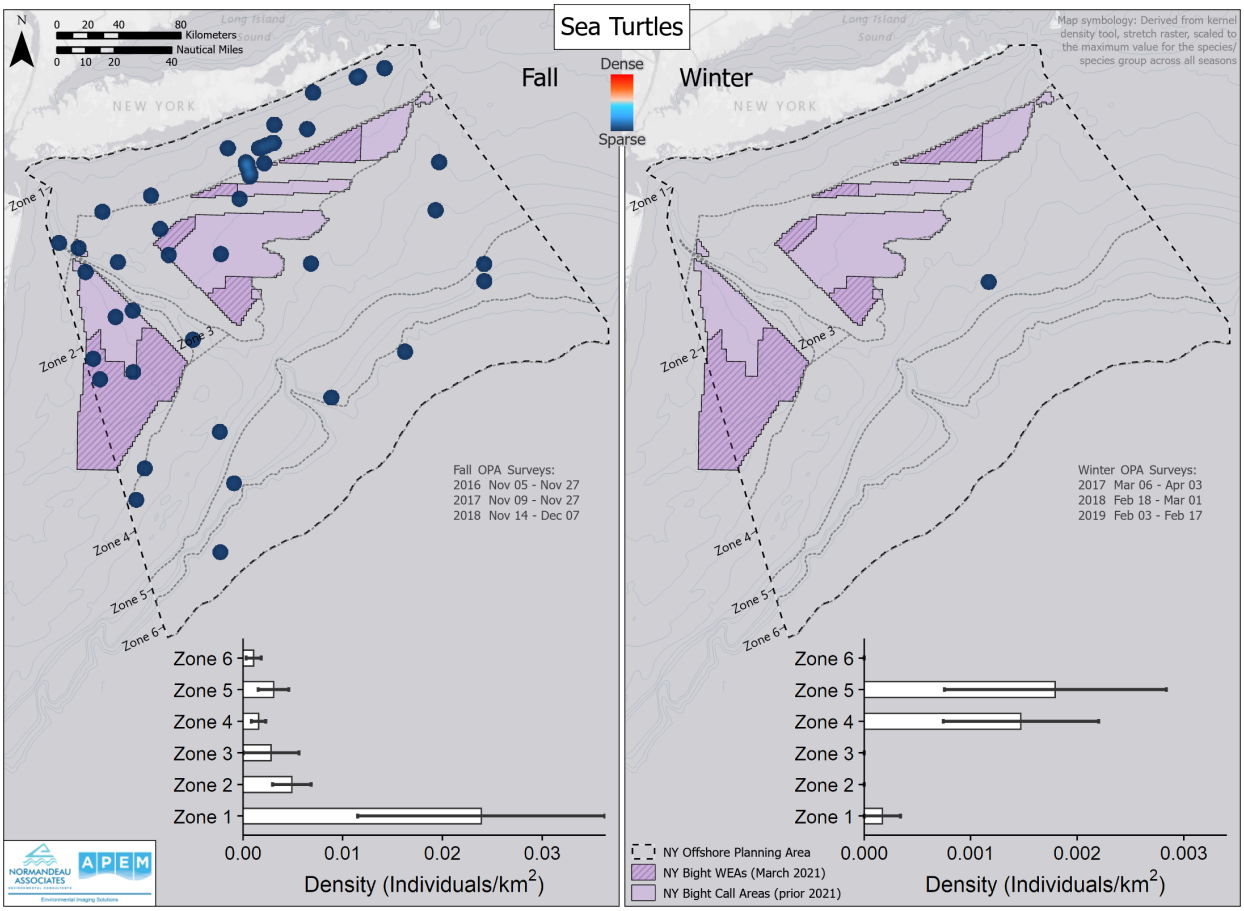


Figure 3. Spatial Distribution of Turtle Species During Spring and Summer by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

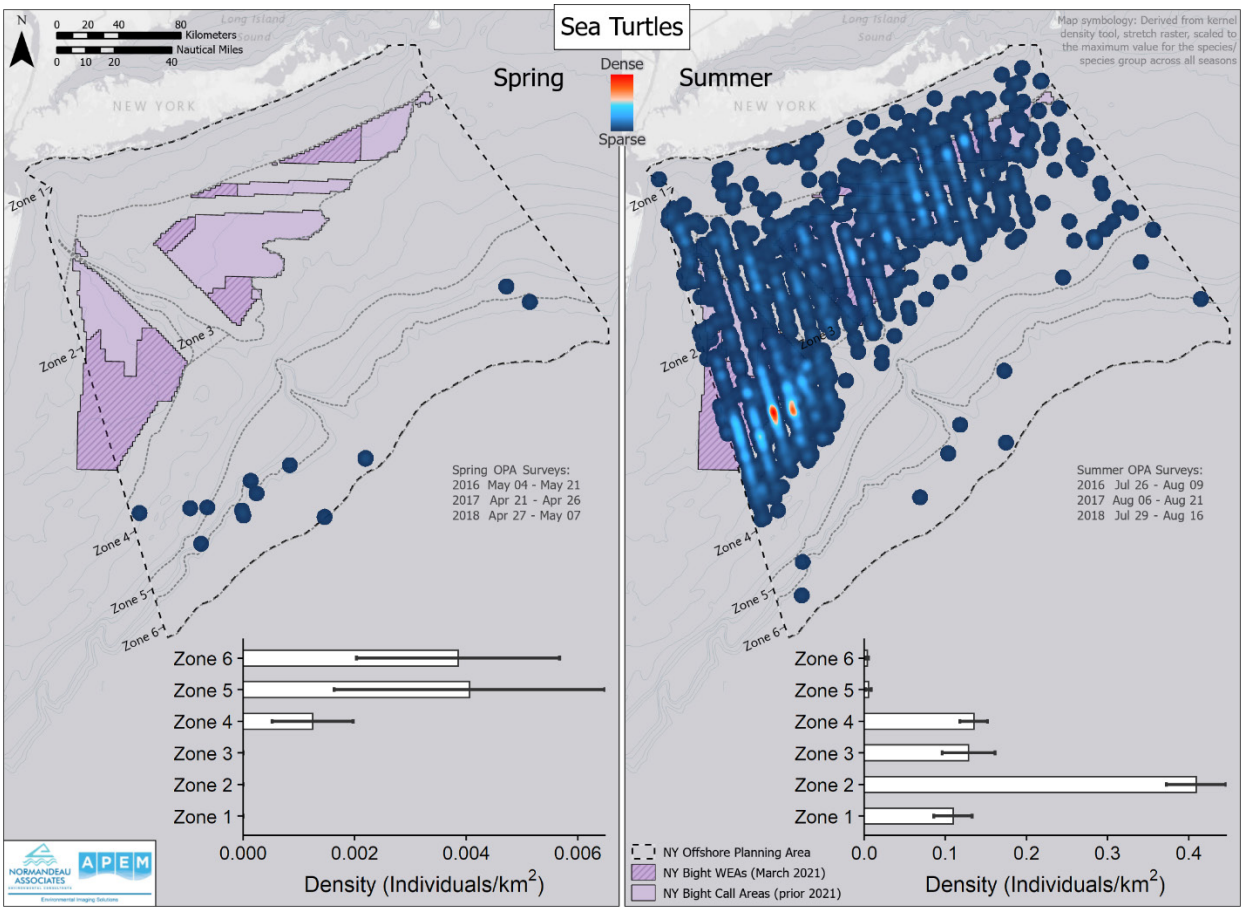


Figure 4. Direction of Travel of All Turtles for All Surveys

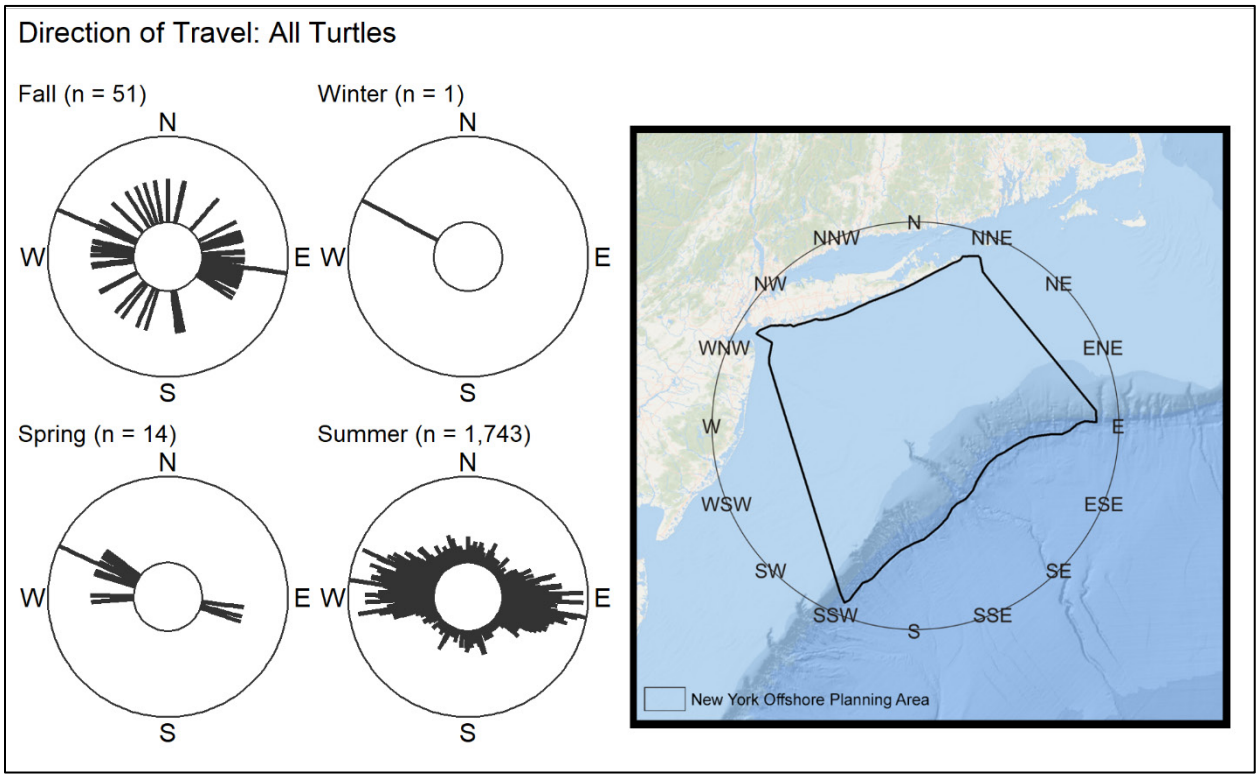


Figure 5. Spatial Distribution of Leatherback Turtle During Fall and Summer by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

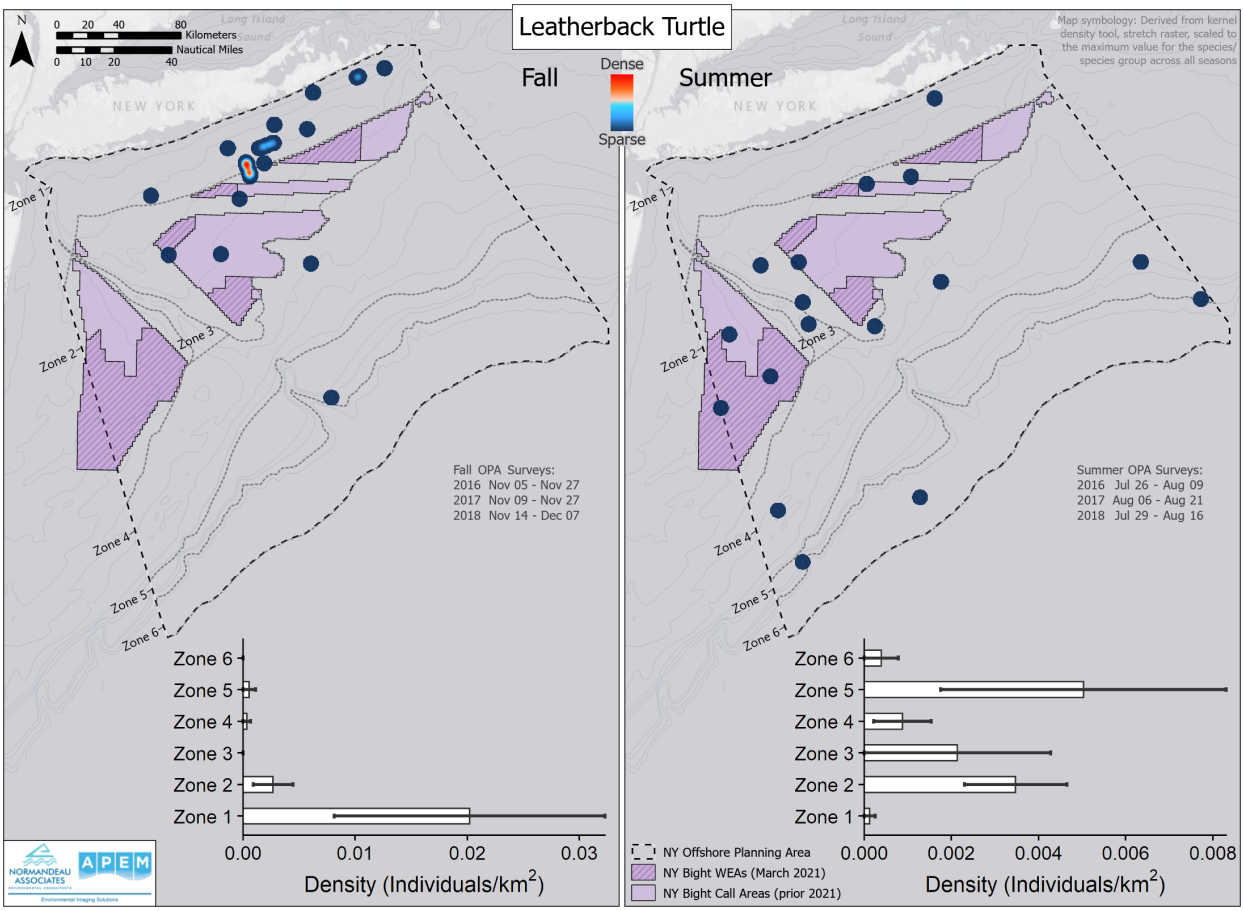


Figure 6. Direction of Travel of Leatherback Turtles for All Surveys

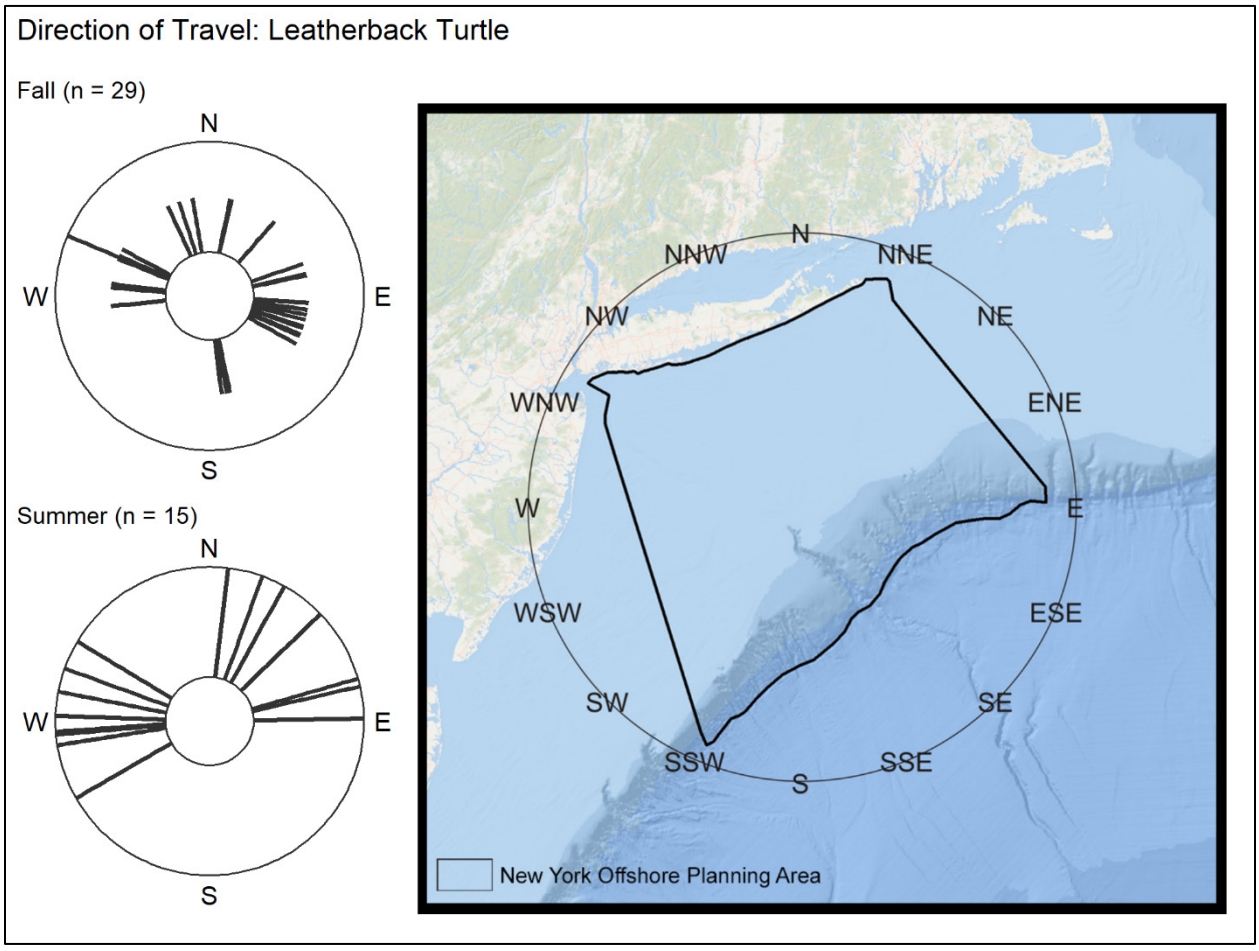


Figure 7. Spatial Distribution of Loggerhead Turtle During Fall and Winter by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

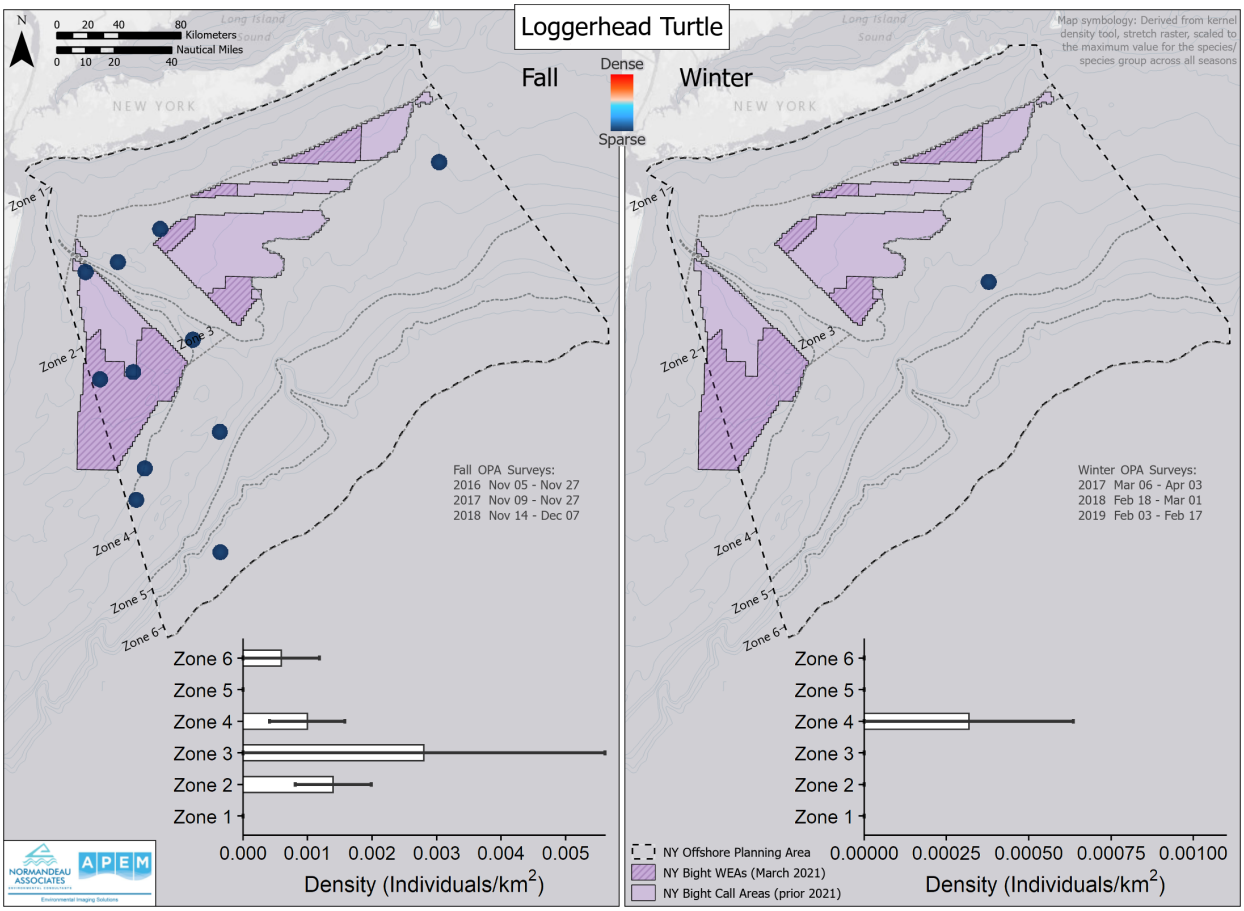


Figure 8. Spatial Distribution of Loggerhead Turtle During Spring and Summer by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

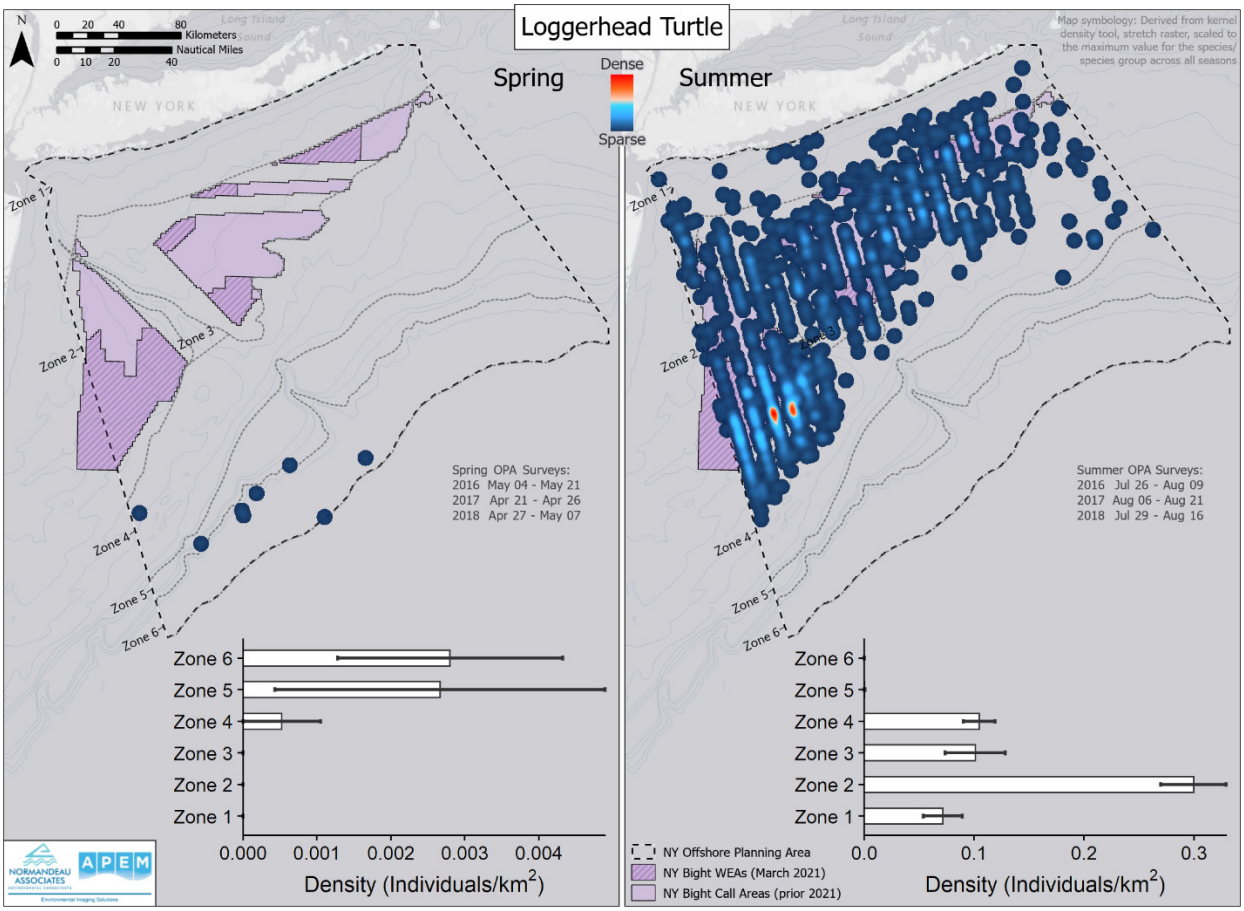


Figure 9. Direction of Travel of Loggerhead Turtles for All Surveys

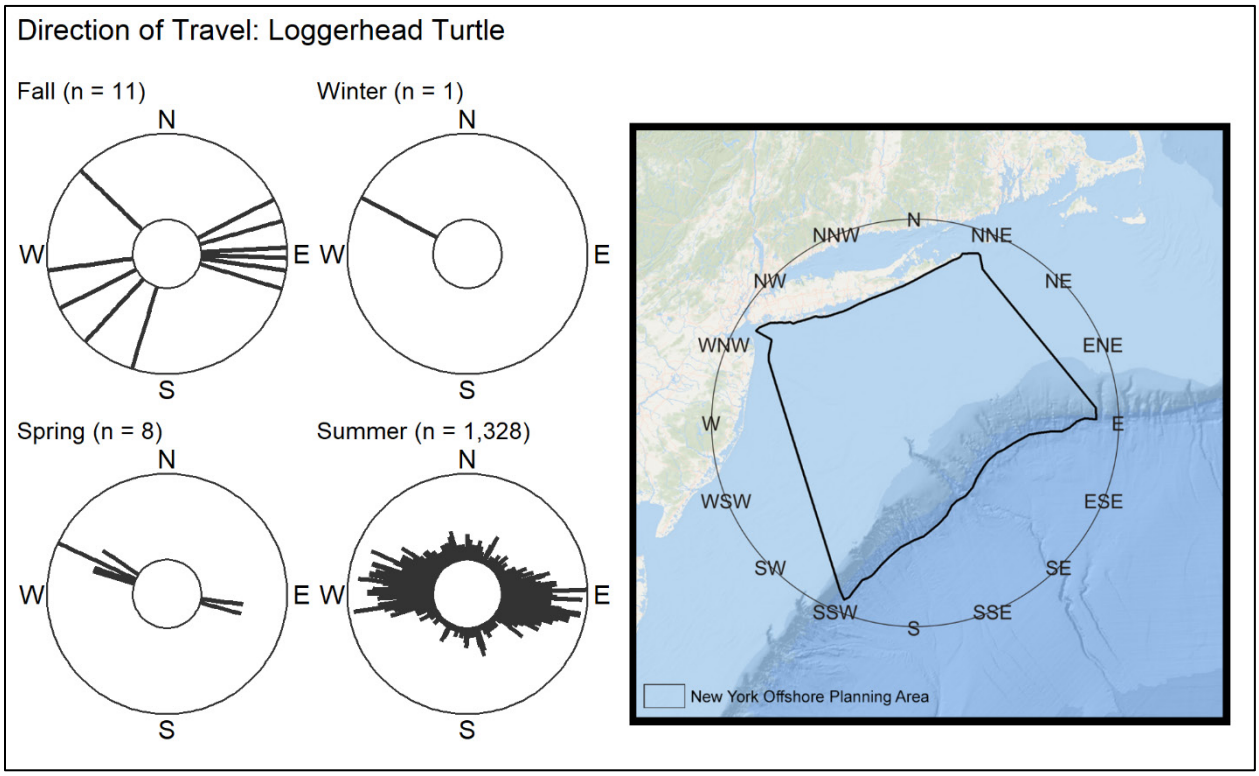


Figure 10. Spatial Distribution of Green Turtle

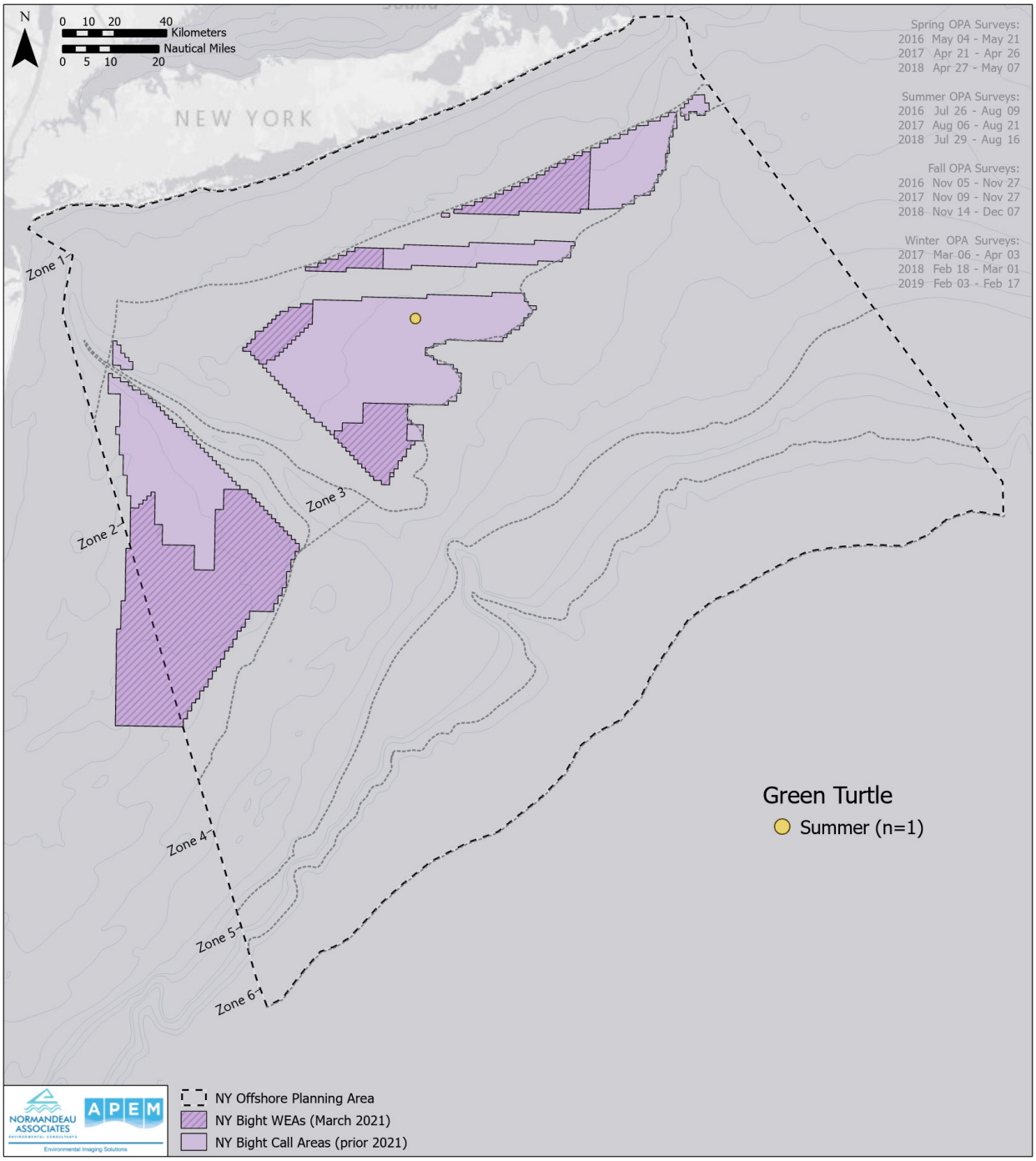


Figure 11. Spatial Distribution of Kemp's Ridley Turtle During Fall and Winter by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

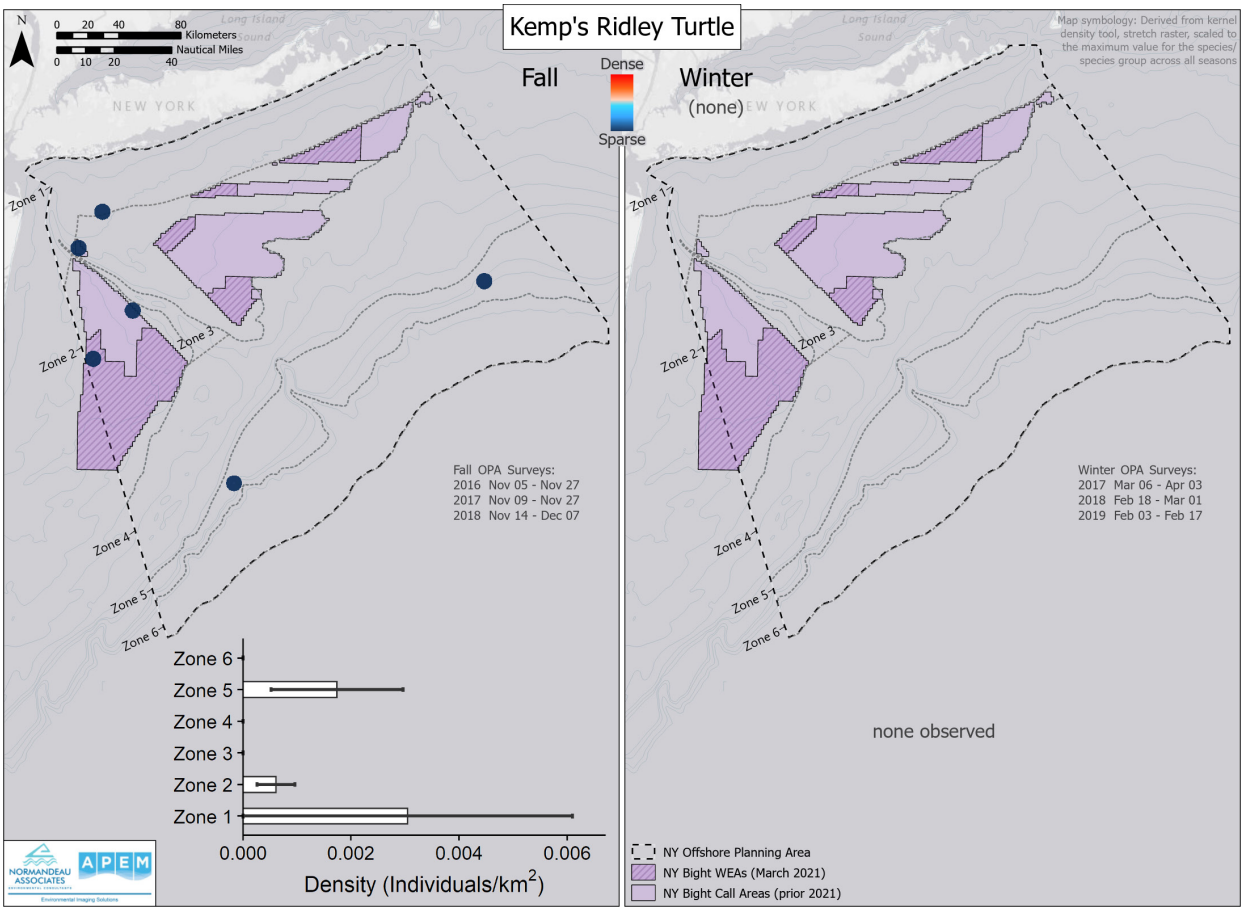


Figure 12. Spatial Distribution of Kemp's Ridley Turtle During Spring and Summer by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

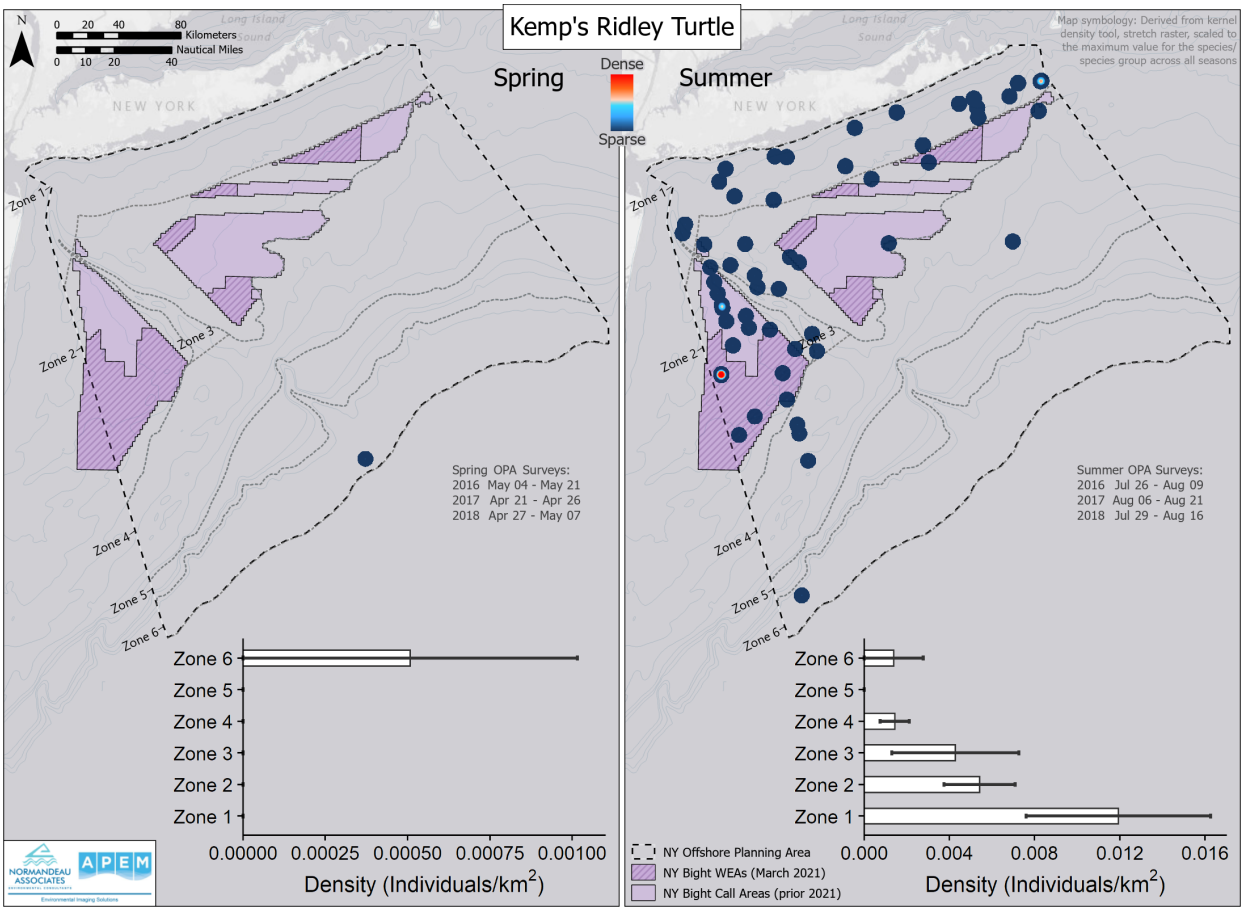


Figure 13. Direction of Travel of Kemp's Ridley Turtles for All Surveys

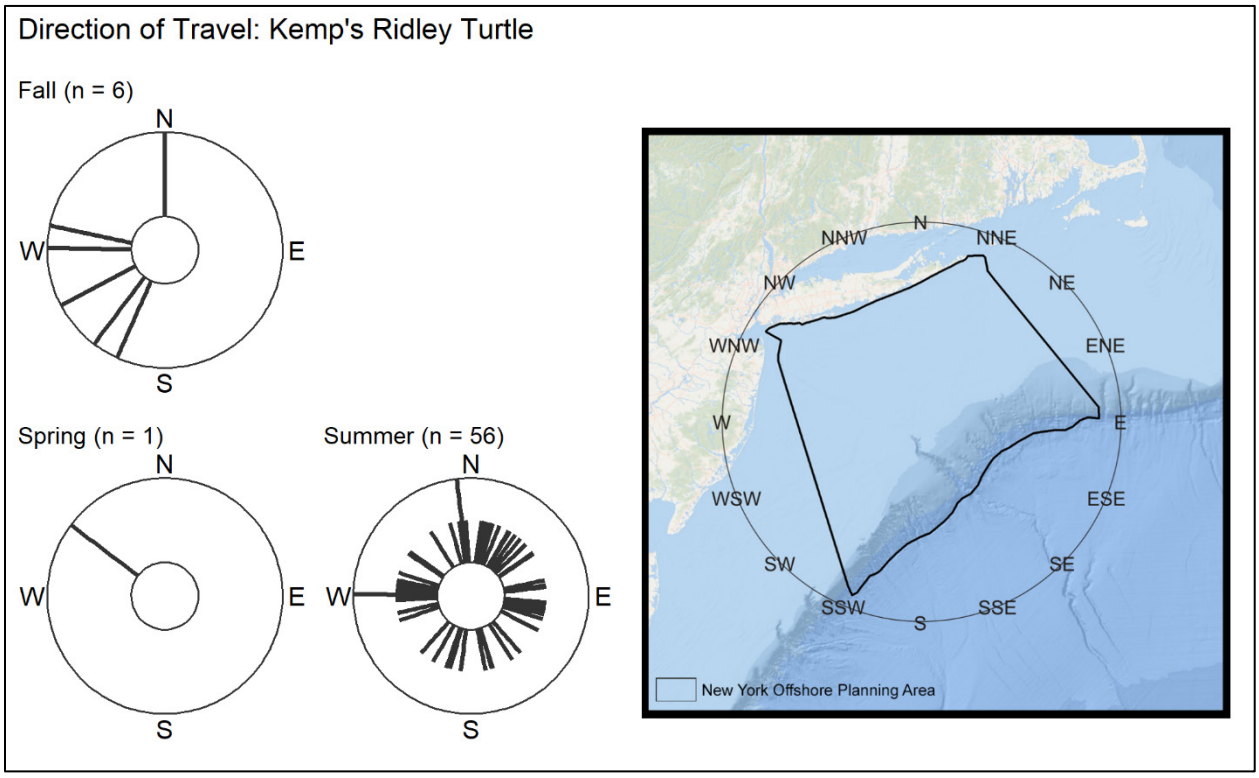


Figure 14. Spatial Distribution of Loggerhead/Kemp's Ridley Turtle During Fall and Winter by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

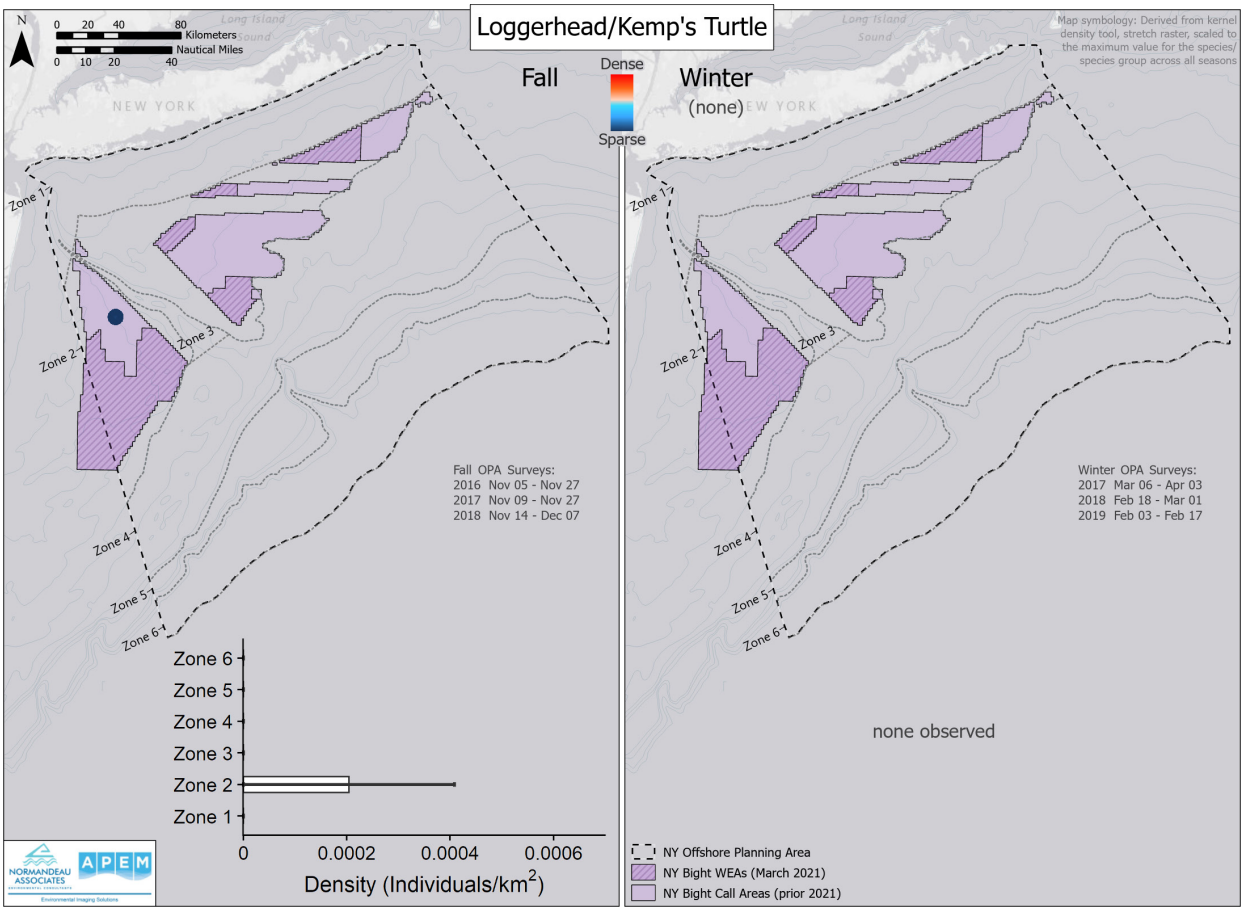


Figure 15. Spatial Distribution of Loggerhead/Kemp's Ridley Turtle During Spring and Summer by Zone and Proximity to Call Areas

Heat map is scaled to the maximum density for the species/species group across all seasons. Inset bar plots display mean estimated densities ± standard error of the mean for each zone.

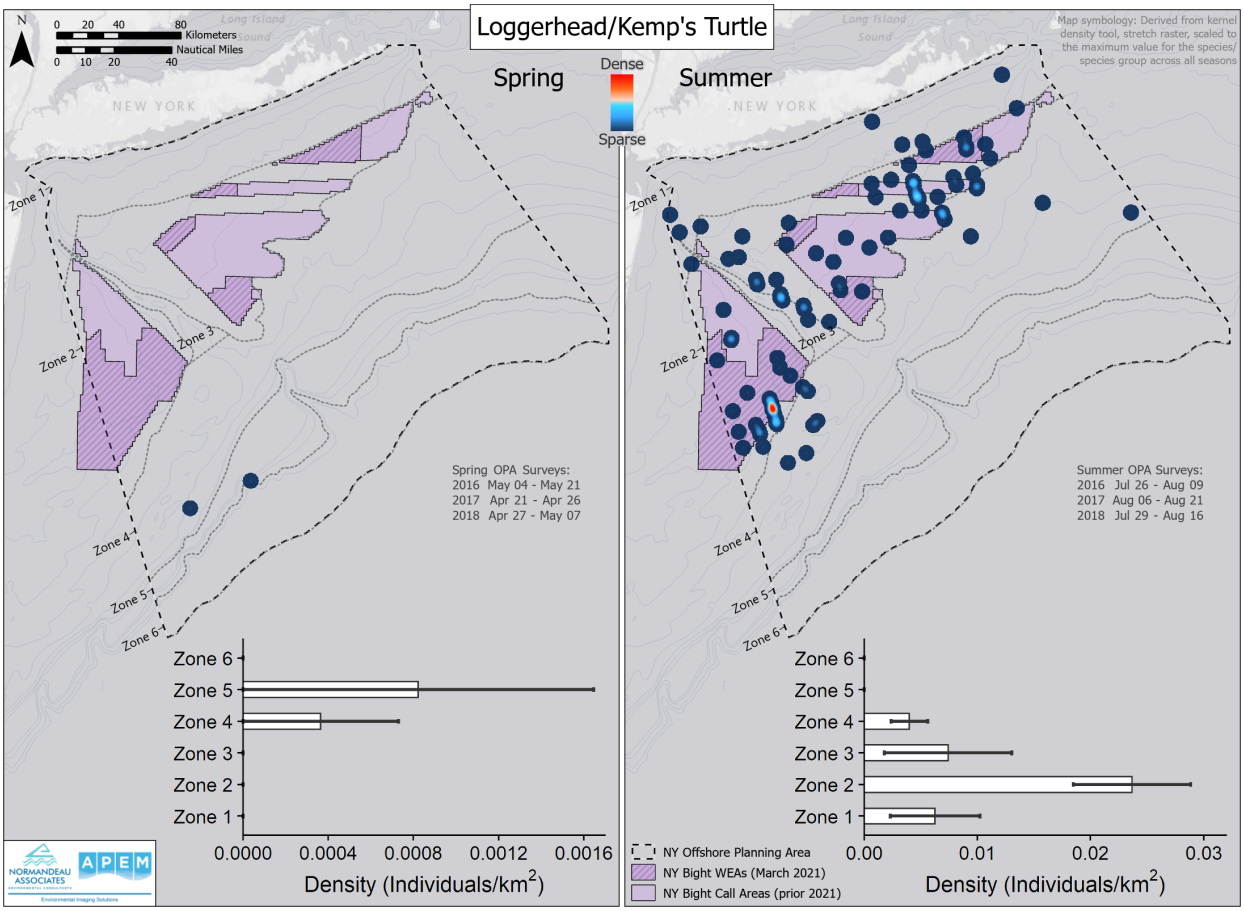
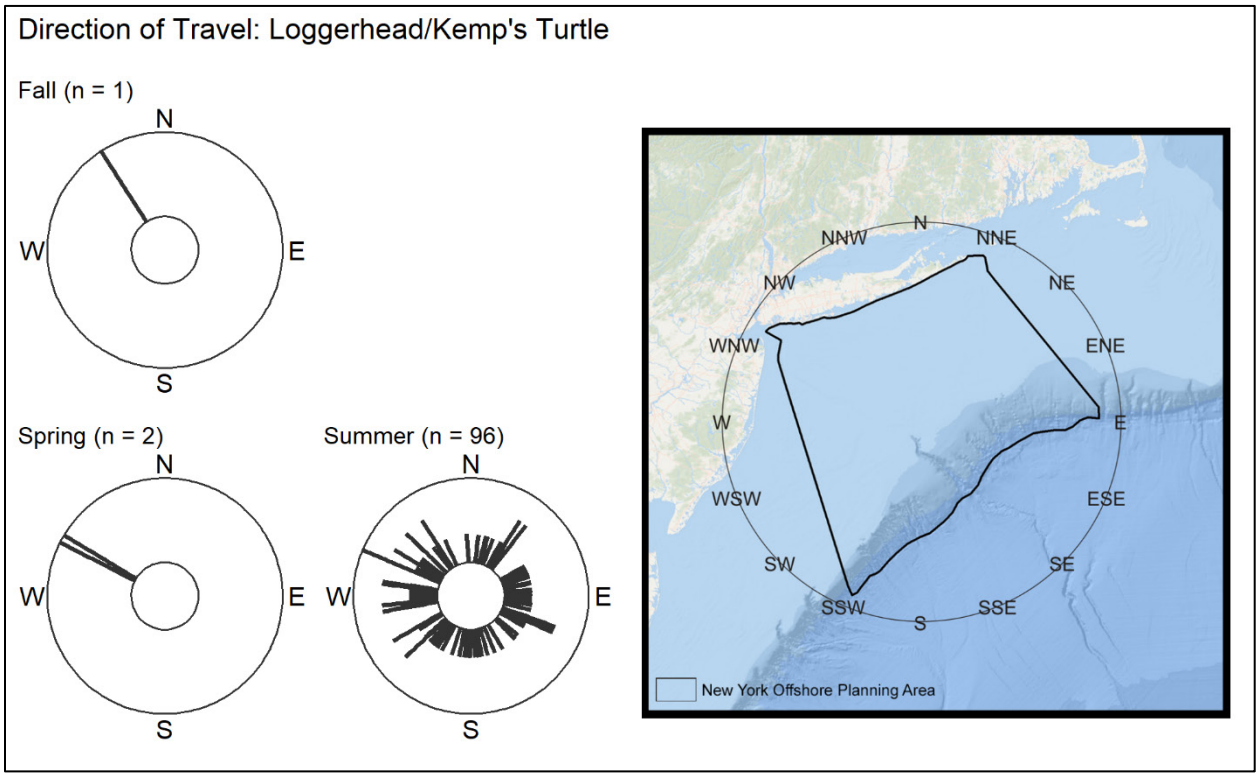
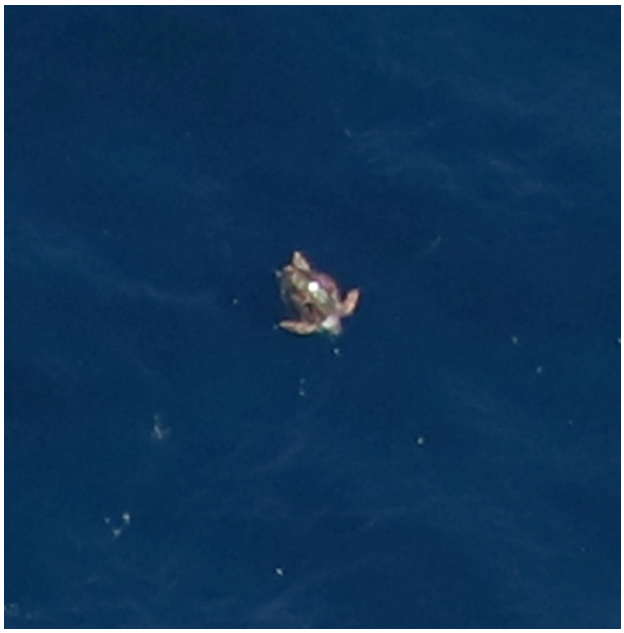


Figure 16. Direction of Travel of Loggerhead/Kemp's Ridley Turtles for All Surveys



Appendix A. Representative Turtle Images from Each Survey

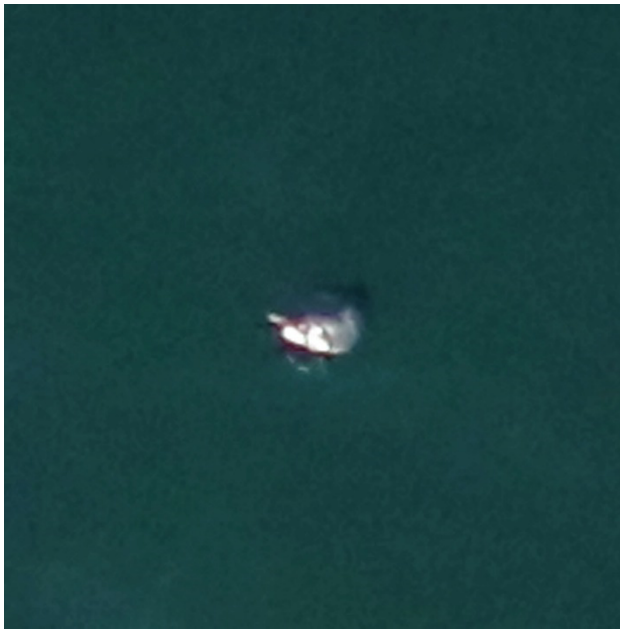
Summer 2016



Loggerhead

Loggerhead

Leatherback



Kemp's Ridley

Fall 2016

Kemp's Ridley

Leatherback

Loggerhead

Winter 2016–2017

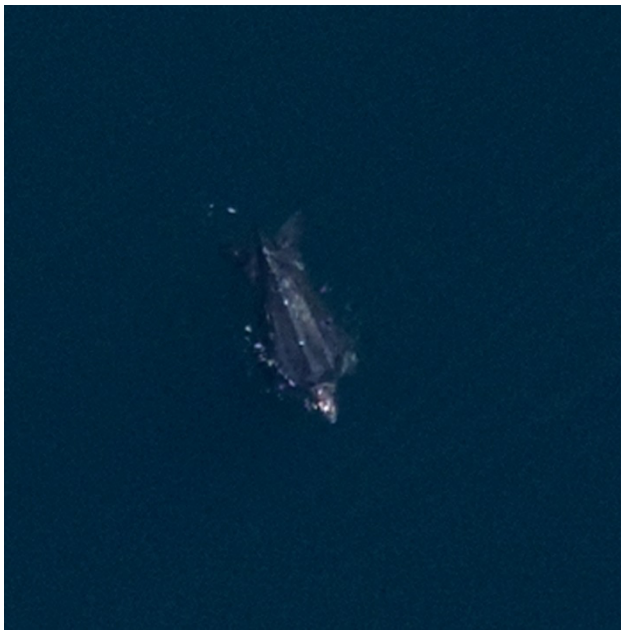
Loggerhead

Spring 2017

Loggerhead

Kemp's Ridley

Summer 2017



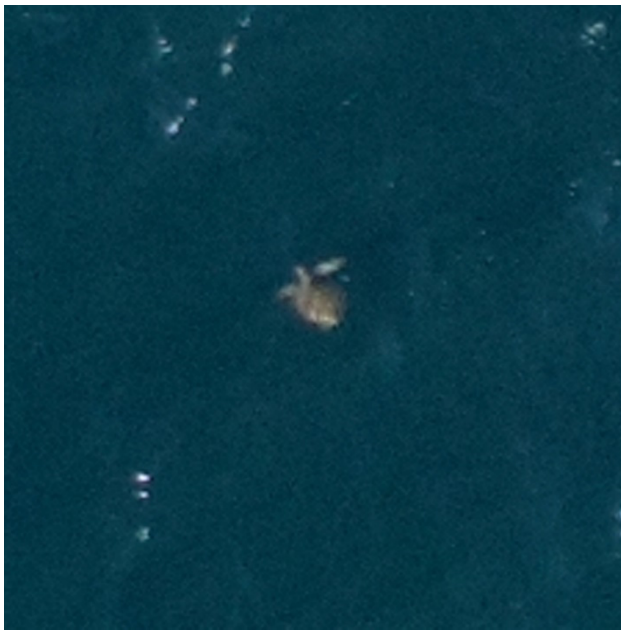
Leatherback

Loggerhead

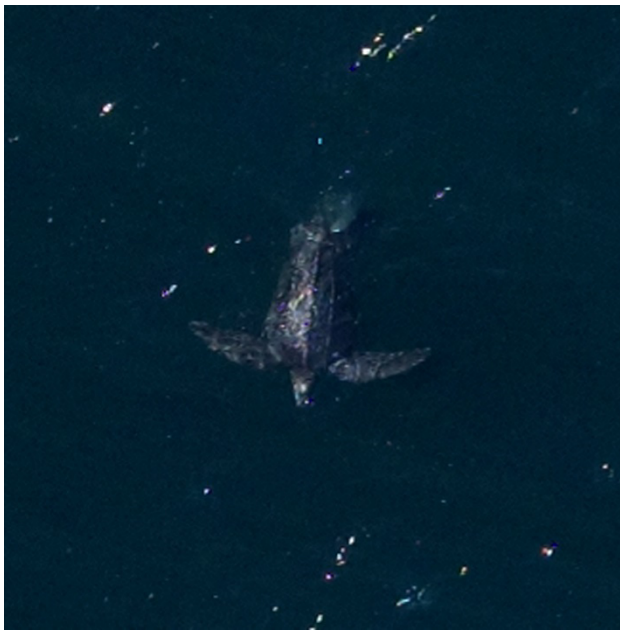
Loggerhead

Kemp's Ridley with Sargassum

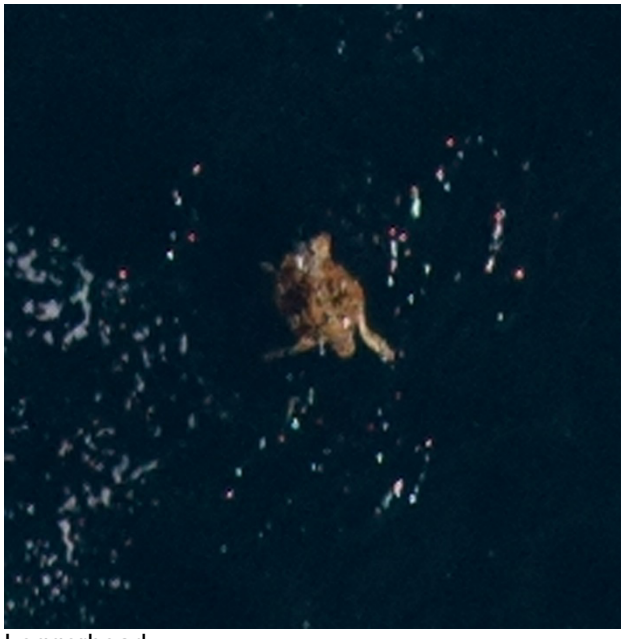
Fall 2017



Kemp's Ridley



Leatherback



Loggerhead

Spring 2018

Turtle species-unknown

Summer 2018

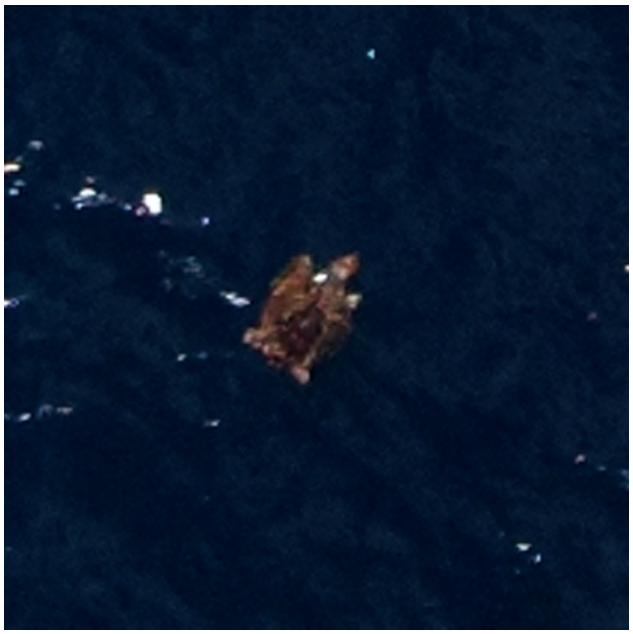
Loggerhead

Kemp's Ridley

Leatherback

Loggerhead Interaction

Spring 2019



Loggerhead