NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

APEM

Environmental Imaging Solutions

Ornithological and Marine Fauna Aerial Survey Results

Equinor Wind US, LLC

Annex I: Summer 2016 – Spring 2017

APEM Ref: P00002032

Issued February 2019

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1. Executive Summary

- Normandeau Associates Inc. (hereafter referred to as Normandeau) and APEM Inc. (hereafter referred to as APEM) and were contracted to provide a programme of four quarterly aerial digital surveys of offshore ornithology and marine fauna (including fish, sharks, turtles and marine mammals) of the site termed 'Wind Energy Area' (Lease Area OCS-A 0512, subsequently leased out by Equinor Wind US, LLC hereafter referred to as Equinor) in the New York Bight. These aerial digital surveys were conducted between summer 2016 and spring 2017 on behalf of the New York State Energy Research and Development Authority (NYSERDA) using APEM's high-resolution camera system to capture digital still imagery. Equinor has contracted APEM to report on results of these four quarterly aerial digital surveys in order to form the 'Year 1' data collection of the Lease Area OCS-A 0512 site. Equinor also contracted APEM to undertake an additional 12 monthly aerial digital surveys of the Lease Area OCS-A 0512 site from November 2017 to October 2018. These two years of data are combined and summarized in a separate offshore ornithology baseline technical report in support of the draft Construction and Operation Plan (COP).

- Aerial digital survey images collected were analyzed by APEM and quality assured by Normandeau. Raw count data and design-based abundance estimates (and densities) of all species of birds and marine fauna and incidental observations recorded during the surveys are presented in this report. Additional information on species' spatial distribution and behavioral information including flight direction are also presented in this report. A summary of the quarterly results are provided below;

- Survey 1 – Summer 2016

    - The most abundant species group recorded was rays (n=191), followed by sharks (n=158), large bony fish (n=142), turtles (n=12), shorebirds (n=7), and marine mammals (n=2).

    - The 13 turtles and 158 sharks recorded are listed as Endangered (Federally listed as Threatened or Endangered, and New York State and / or New Jersey listed as Endangered).

- Survey 2 – Fall 2016

    - The most abundant group recorded was ducks (n=34), followed by shearwaters (n=24), gulls (n=20), gannets (n=14), phalaropes (n=6), loons (n=5), sunfish (n=4), and turtles (n=1).

    - The Leatherback turtle recorded during the fall 2016 survey is listed as Endangered (Federally listed as Threatened or Endangered, and New York and / or New Jersey State listed as Endangered).

- Survey 3 – Winter 2016 / 2017

    - The most abundant group recorded was gannets (n=18), followed by gulls (n=9), loons (n=5), alcids (n=3), and sunfish (n=1).

- Survey 4 – Spring 2017

    - The most abundant group recorded was terns (n=96), followed by loons (n=29), marine mammals (n=7), gannets (n=6), fish (n=3), phalaropes (n=2), sharks (n=2), gulls (n=1), and storm petrels (n=1).

    - Sterna terns, shark species and Atlantic bluefin tuna were recorded during the spring 2017 survey. These are Listed Species (Federally listed as Threatened or Endangered, New York State and / or New Jersey listed as Endangered). Unidentified Sterna tern species have been grouped as Listed Species in order to cover the potential for the individuals to be roseate terns, which are Listed. However a process of unidentified species apportionment will be undertaken for the ornithology baseline technical report to separate individuals into positively identified species, and as such they all may not be apportioned to roseate tern during that process.

- A summary of the raw counts recorded by season, and the status of each species, are given in **Table 1**.

Table 1 Number of individuals recorded in each survey season and their Listed status

Species	Number of individuals (Season)				Listed
	Summer	Fall	Winter	Spring	
Black scoter		34			No
Red-throated loon		3	1		No
Common loon		2	4	29	No
Northern Gannet		14	18	6	No
Red / red-necked phalarope		6		2	No
Dovekie			1		No
Atlantic puffin			1		No
Razorbill			1		No
Bonaparte's gull		11	3		No
Ring-billed gull		1			No
Herring gull		8	2	1	No
Great black-backed gull			2		No
Species unknown – small gull			2		No
Common tern				79	No
Least tern				4	Yes [NJ]
Sterna tern species				13	Yes [NY/NJ]
Audubon's shearwater		4			No
Cory's shearwater		20			No
Species unknown – storm petrel				1	No
Species unknown - shorebird	7				No
Species unknown - dolphin	2			7	No
Loggerhead turtle	4				Yes
Leatherback turtle		1			Yes

Species	Number of individuals (Season)				Listed
	Summer	Fall	Winter	Spring	
Kemp's Ridley turtle	1				Yes
Species unknown - turtle	8				Yes
Basking shark				1	No
Species unknown - Carcharhinidae	17				No
Species unknown - hammerhead	1				Yes
Species unknown - shark	140			1	No
Cownose ray	15				No
Cownose / bullnose ray	28				No
Species unknown - ray	148				No
Ocean sunfish		3			No
Sharptail sunfish		1			No
Species unknown - sunfish			1		No
Mahi-mahi	1				No
Atlantic bluefin tuna				3	Yes
Cobia	139				No
Species unknown - fish	2				No

2. Introduction

Normandeau and APEM were contracted by NYSERDA to provide four quarterly aerial digital surveys over a single year of the site originally termed 'Wind Energy Area' (WEA). The four surveys were conducted between summer 2016 to spring 2017. The WEA site was subsequently leased by Equinor in March 2017 and is now referred to as Lease Area OCS-A 0512.

The aims and objectives of the work required by NYSERDA were to assess the abundance and distribution of primarily birds present in the WEA, and also to gather information on other marine fauna such as marine mammals, sharks, rays, and turtles. Equinor further contracted APEM to report on the findings of these four quarterly surveys in order to form the 'Year 1' data collection of Lease Area OCS-A 0512. APEM were contracted separately to undertake a further programme of monthly aerial digital surveys of Lease Area OCS-A 0512 from November 2017 to October 2018, which form the 'Year 2' data collection of Lease Area OCS-A 0512. The purpose of the Year 1 and Year 2 data sets is to provide the baseline information required for conducting impact assessments and will meet the U.S. Bureau of Ocean Energy Management's (BOEM's) regulatory requirements for environmental review.

The Lease Area OCS-A 0512 referred to herein comprises of the Lease Area OCS-A 0512 site (the proposed turbine array footprint) plus a 4 km (2.5 miles) buffer surrounding it. To meet the objectives of the project, images were captured using a grid-based aerial digital survey design with a 1.5 cm ground sampling distance (GSD). Digital still images were collected, processed and analyzed by APEM with species identification and quality control undertaken by Normandeau.

This 'Year 1' Annual Report summarizes the data collected following the completion of four quarterly aerial digital surveys of the 'WEA' completed between July 2016 and May 2017. A separate 'Year 2' Annual Report summarizes the data collected from the 12 monthly aerial digital surveys conducted on behalf of Equinor of Lease Area OCS-A 0512 between November 2017 and October 2018. These two years of data are to be combined and summarized in a separate offshore ornithology baseline technical report in support of the draft Construction and Operation Plan (COP).

The following information is provided in Section 3:

- The number of aerial digital surveys conducted;
- Survey dates, start and end times, and weather conditions;
- Aerial digital survey data collection and analysis methodology; and
- Health and safety issues encountered during the surveys.

The following information is provided in Section 4:

- The results of the design-based abundance estimates per species / taxonomic group;
- Spatial distribution maps presenting the location of birds and marine fauna; and
- Flight direction information of birds recorded.

Anecdotal information such as vessels recorded visually from the aircraft or captured in the digital imagery is provided in Section 5. Additionally, the locations of the vessels captured in the imagery are noted in figures in Section 4.

3. Survey and Analysis Methodologies

Summary of Aerial Digital Surveys

A programme of four seasonal aerial digital surveys were undertaken to cover the summer and fall in 2016 and the winter and spring in 2017.

APEM has a bespoke camera system, termed “Shearwater III,” customized by in-house specialists for surveying the offshore environment. Our camera system is integrated with custom flight planning software that allowed each survey transect to be accurately mapped out before the aircraft leaves the ground. Each image capture node was precisely defined, allowing the system to fire the camera exposures at exactly the right location. This ensured that each survey was flown with the same transect orientation and the camera was triggered at the same position along each transect within set tolerances. APEM’s planning systems enable tolerances on flight path along survey lines to be set automatically aborting survey lines that drift away from the aircraft’s planned flight line. APEM’s on-board camera technician continually monitored the imagery as it was collected to ensure the data collected was fit for purpose. The camera technician would make the decision to cease data collection should the conditions become unsuitable for surveying. The survey would then be resumed at the next earliest opportunity.

The aerial digital surveys captured images along 28 lines spaced approximately 0.8 km across-track and 0.6 km along-track between image nodes within the Lease Area OCS-A 0512 (**Figure 1**). Data collected were 1.5 cm GSD digital still images using a GPS-linked bespoke flight management system to ensure the tracks were flown with a high degree of accuracy. The aircraft’s internal GPS and IMU systems record to an accuracy of +/- 3 to 5 m as standard.

Imagery is captured in raw format and post-processed to ensure optimal quality for the subsequent stage of image analysis, to extract information on marine fauna or other notable occurrences. When a survey is completed, the data are checked to ensure the number of lines and the number of images collected is correct, and that the quality of the imagery is acceptable. Once the image analysis had been completed, further Quality Control (QC) processes took place (see Summary of Quality Control).

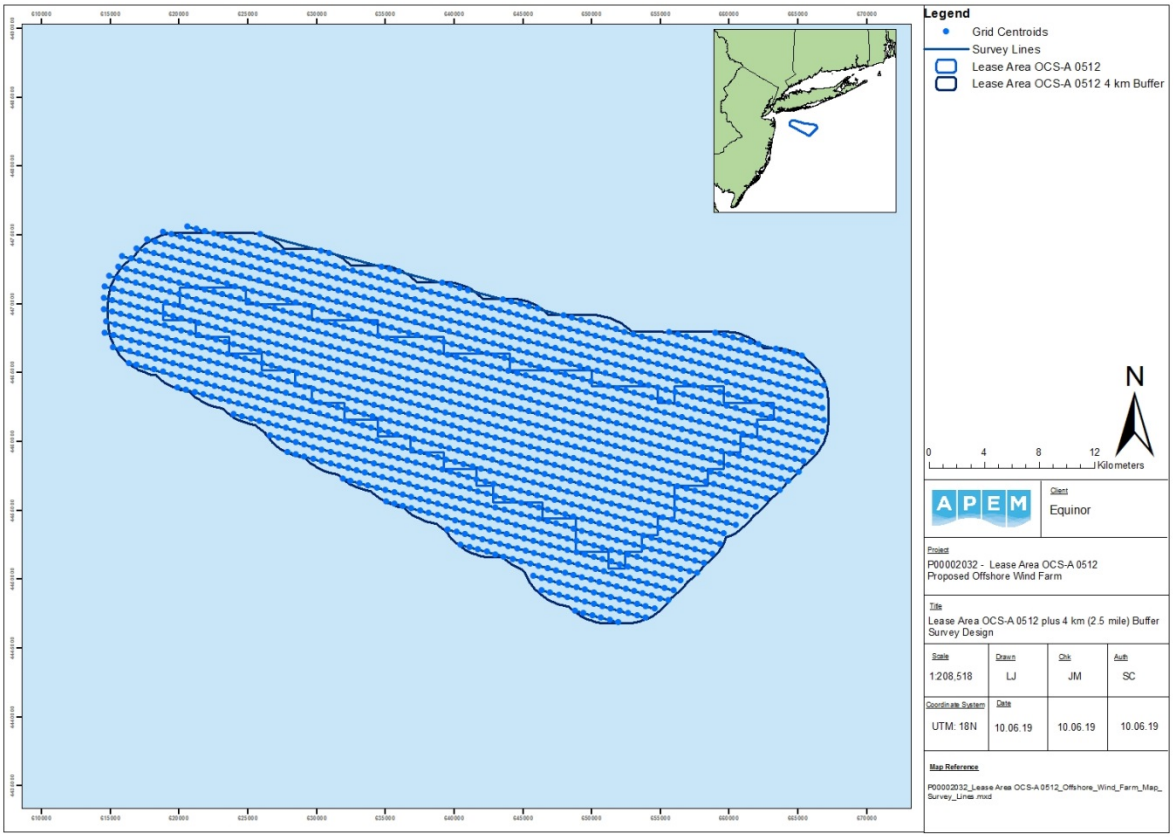


Figure 1 **Flight lines and image capture points of the aerial digital still imagery at Lease Area OCS-A 0512 plus 4 km (2.5 mile) buffer.**

No health or safety issues were reported during the surveys.

The date(s) start, and end times are provided for each aerial digital survey in **Table 2** with the corresponding weather conditions provided in **Table 3**. Weather conditions during all surveys were conducive to collecting and analyzing imagery for the purpose of providing data on the identification, distribution and abundance of bird species and marine fauna within the Lease Area OCS-A 0512 plus 4 km buffer. Favorable conditions for surveying are defined as there being no precipitation, a sea state of <4, wind speeds of <30 knots, visibility of >5 km, and sun angle of more than 5 degrees (depending on cloud cover and other environmental conditions). For safety reasons, no surveying took place in icing conditions. The weather criteria follow the BOEM guidelines for aerial digital surveys of birds for projects requiring a COP (BOEM, 2017). Measures were also taken to minimize glint and glare, such as avoiding midday when the sun angle has the greatest potential to impact image quality. Furthermore, additional coverage was collected to ensure that in the unlikely event imagery was affected by glint or glare, alternative data could be selected for analysis. The various weather conditions that the data were captured in would not affect the ability to detect marine fauna in the imagery.

The number of images and coverage collected per survey is presented in **Table 4**.

Table 2 **Date and start / end time (Coordinated Universal Time) for each flight for the 'Year 1' quarterly surveys.**

Survey	Date	Flight Number	UTC Start Time (HH:MM)	UTC End Time (HH:MM)
Survey 1	07-27	1	20:16	22:59
	07-28	2	13:01	13:30
		3	18:29	22:16
Survey 2	11-12	1	15:04	19:57
	11-13	2	16:21	19:15
Survey 3	03-23	1	12:18	15:37
		2	18:46	21:07
Survey 4	05-16	1	11:39	15:22
		2	19:12	22:23

Table 3 **Weather conditions recorded for 'Year 1' quarterly surveys.**

Survey	Date	Douglas Sea State[1]	Turbidity[2]	Wind Speed (knots) / Direction	Cloud Cover (%)[3]	Visibility (km)	Air Temp (°F)
Survey 1	07-27	1	1	5 / SW	0 - 5	> 10 km	82 - 84
	07-28	1	1	Calm	10	> 10 km	80
		1	1	8 / SW	5 – 100	> 10 km	80 - 83
Survey 2	11-12	2 - 3	1	13 – 17 / NW	0 - 5	> 10 km	40 - 41
	11-13	2 - 3	1	7 – 25 / W	0 - 10	> 10 km	42 - 44
Survey 3	03-23	2 - 3	1	20 – 30 / NNW	0	> 10 km	22 - 24
		2 - 3	1	20 – 30 / NW - WNW	0 - 3	> 10 km	29 - 37
Survey 4	05-16	1	1	25 / NNW	20 - 50	> 10 km	57 - 61
		1	1	20 / WNW	30 – 90	> 10 km	65 - 70

[1] 0 = Calm (Glassy), 1 = Calm (Rippled), 2 = Smooth, 3 = Slightly Moderate, 4 = Moderate
[2] 0 = Clear, 1 = Slightly Turbid, 2 = Moderately Turbid, 3 = Highly Turbid
[3] 0 = Clear, 1-10 = Few, 11-50 = Scattered, 51-95 = Broken, 96-100 = Overcast

Table 4 **Image number and survey coverage for 'Year 1' quarterly surveys.**

Survey	Image Number	Coverage (%)
Survey 1	10,587	12.13
Survey 2	10,996	11.14
Survey 3	13,837	13.25
Survey 4	12,683	15.69

Summary of Quality Control

Images were analyzed to enumerate birds to species level, and to enumerate any other non-avian marine fauna. Survey data was uploaded to APEM's partner Normandeau's ReMOTe website in 'real time' as soon as image analysis was completed. These data are publically accessible[1]. Normandeau provided QC of the data to check for missed animals in 10% of images recorded as empty and also quality assured 20% of the bird species identification undertaken by APEM (and 100% of Listed species). Normandeau identified 100% of the species of non-avian marine fauna including marine mammals, sharks, rays and turtles. Birds and marine fauna identified from the images were 'snagged' (i.e. located within the images) and categorized usually to species, but sometimes to the species grouping. The number of blank images and the number of images that were subject to QC are provided in **Table 5**. The agreement exceeded 99% for every survey which included the results from the wider area surveys of the Offshore Planning Area (Normandeau, 2018).

Table 5 The total number of blank images and the number of blank images that underwent QC.

Survey	Blank Images	Blank Images QC'd
Survey 1	10,166	430
Survey 2	10,944	1,118
Survey 3	13,779	1,378
Survey 4	12,582	1,258

Species Abundance Estimates

For each monthly aerial digital survey of the Lease Area OCS-A 0512 plus 4 km buffer, geo-referenced locations of marine fauna, contained within each individual digital still image were used to generate raw counts. Marine fauna locations contained within the boundaries of the two areas (Lease Area OCS-A 0512 and the 4 km buffer) were then extracted using ArcGIS, providing raw count data. These data are presented in this annual report for all species.

The raw counts were then divided by the number of images collected to give the mean number of animals per image (i). Population estimates (N) for each survey month were then generated by multiplying the mean number of animals per image by the total number of images required to cover the entire study area (A):

$$N = i\ A$$

Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. The statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values were taken as the variability of the statistic over the population (Efron & Tibshirani, 1993).

[1] https://remote.normandeau.com/ewind_overview.php

A measure of precision was calculated using a Poisson estimator, suitable for a pseudo-Poisson over-dispersed distribution. This produced a CV based on the relationship of the standard error to the mean.

Analysis to account for the availability bias of particular marine fauna species has not been taken into consideration here. Availability bias corrections for the relevant avian species will be presented in the ornithological baseline technical report.

All analysis and data manipulation carried out by APEM was conducted in the R programming language (R Development Core Team, 2012) and non-parametric 95% confidence intervals were generated using the 'boot' library of function (Canty & Ripley, 2010). This results in species-specific monthly abundance estimates being calculated from the raw count data, with upper and lower confidence limits. Where appropriate, a level of precision is also presented for each monthly abundance estimate. Dividing the monthly abundance estimates by the size of the Lease Area OCS-A 0512 or 4 km buffer sites calculates the density (e.g. bird per km^2) for any given species.

Species Distribution Maps

Observations comprised individual points for each recorded individual, geo-referenced to the actual spatial location at the time of survey. Seasonal relative density distribution maps were produced for total species using ArcGIS (version 9.2) by summing the number of individuals recorded in each image per season and then representing this sum of individuals as a dot on a map that was proportional to the number of individuals in that image; i.e. large numbers of individuals per image are represented by larger dots than smaller numbers of individuals per image.

Species Flight Direction Rose Diagrams

The direction of birds in flight was recorded from all digital still images. Bearings of bird directions were plotted using Oriana to summarize overall directions of movement. The mean angle and mean vector is used to describe directional preferences and extent of 'agreement'. A Rayleigh test that assumes a null hypothesis of uniformity (i.e. scattered orientation in all directions) has been used, where a significant test indicates directionality of movement.

4. Species Accounts

The following species accounts present the raw counts and design-based abundance estimates from the four aerial digital surveys of Lease Area OCS-A 0512 and a 4 km Buffer (The Lease Area OCS-A 0512). Behavioral and distribution data are also presented and discussed in each species account, where relevant.

4.1 Black Scoter

Thirty-four flying black scoters (20 females and 11 males were identified) were recorded in the fall survey (**Table 6**). All of the individuals were recorded flying in a single group in the north of the 4 km buffer (**Figure 2**). The single flock of black scoters was flying in a north-easterly direction (**Figure 3**).

Table 6 Raw counts and abundance and density estimates (No. estimated individuals per km^2) of black scoter in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.

a) Lease Area OCS-A 0512 plus 4 km Buffer							
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**	**Male**	**Female**
Summer	0	0	-	0	0	0	0
Fall	34	380	0.46	34	0	11	20
Winter	0	0	-	0	0	0	0
Spring	0	0	-	0	0	0	0
b) Lease Area OCS-A 0512							
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**	**Male**	**Female**
Summer	0	0	-	0	0	0	0
Fall	0	0	-	0	0	0	0
Winter	0	0	-	0	0	0	0
Spring	0	0	-	0	0	0	0
c) 4 km Buffer							
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**	**Male**	**Female**
Summer	0	0	-	0	0	0	0
Fall	34	361	0.72	34	0	11	20
Winter	0	0	-	0	0	0	0
Spring	0	0	-	0	0	0	0

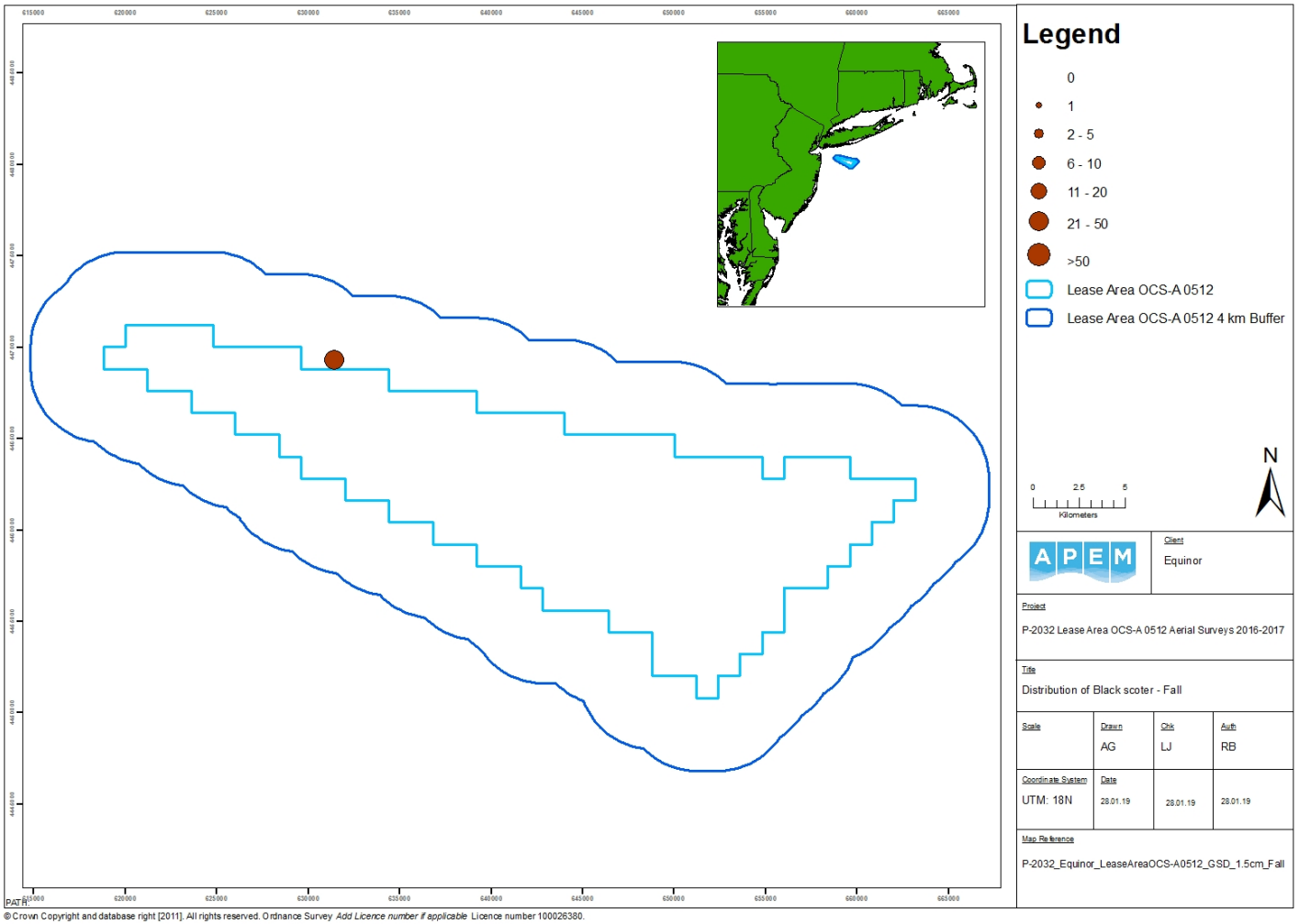
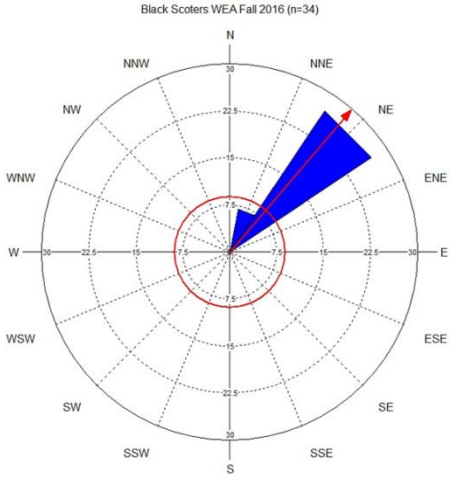


Figure 2 Distribution of black scoter recorded in the fall 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**34**
Mean Vector (μ)	**40.424**
Length of Mean Vector (r)	**0.987**
Rayleigh Test (Z)	**33.154**
Rayleigh Test (p)	**< 1E-12**

Figure 3 **Summary of flight direction of black scoters (n=34) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the fall survey.**

4.2 Red-throated Loon

During the fall survey, three red-throated loons were recorded in the Lease Area OCS-A 0512 (**Table 7, Figure 4**). Two were recorded in the Lease Area OCS-A 0512 site, whilst the third was recorded in the eastern 4 km buffer. In the winter survey, a single red-throated loon was recorded in the central region of the wind farm (**Figure 5**).

Two red-throated loons were recorded flying in the fall survey, and one recorded in the winter survey. Red-throated loons did not show a significant tendency to fly in any one direction in the fall (**Figure 6**), nor in the winter (**Figure 6**).

Table 7 Raw count and abundance and density estimates (No. estimated individuals per km^2) of red-throated loons in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	3	34	0.04	2	1
Winter	1	8	0.01	1	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	1	12	0.04	0	1
Winter	1	8	0.02	1	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	2	21	0.04	2	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

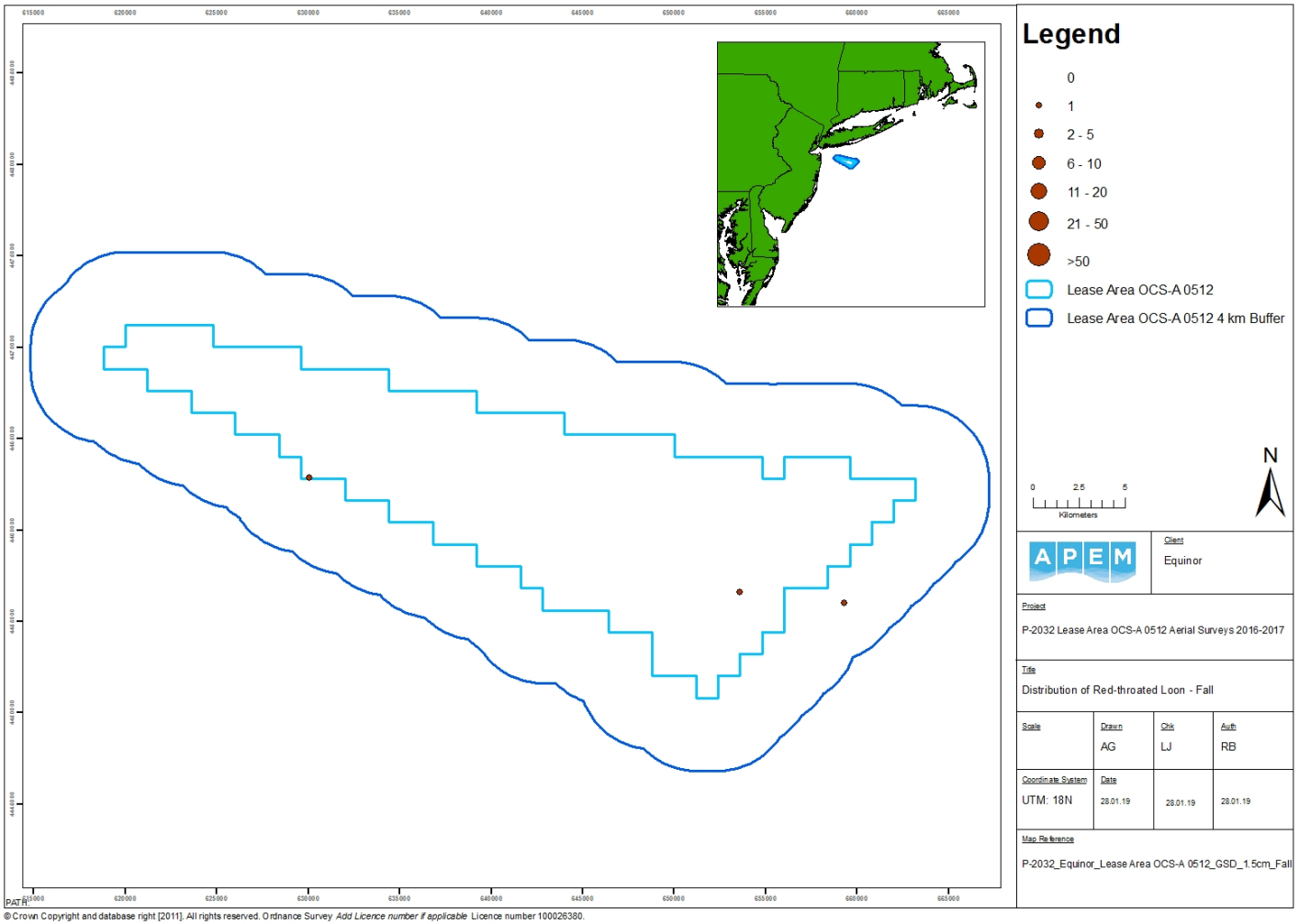


Figure 4 **Distribution of red-throated loons recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.**

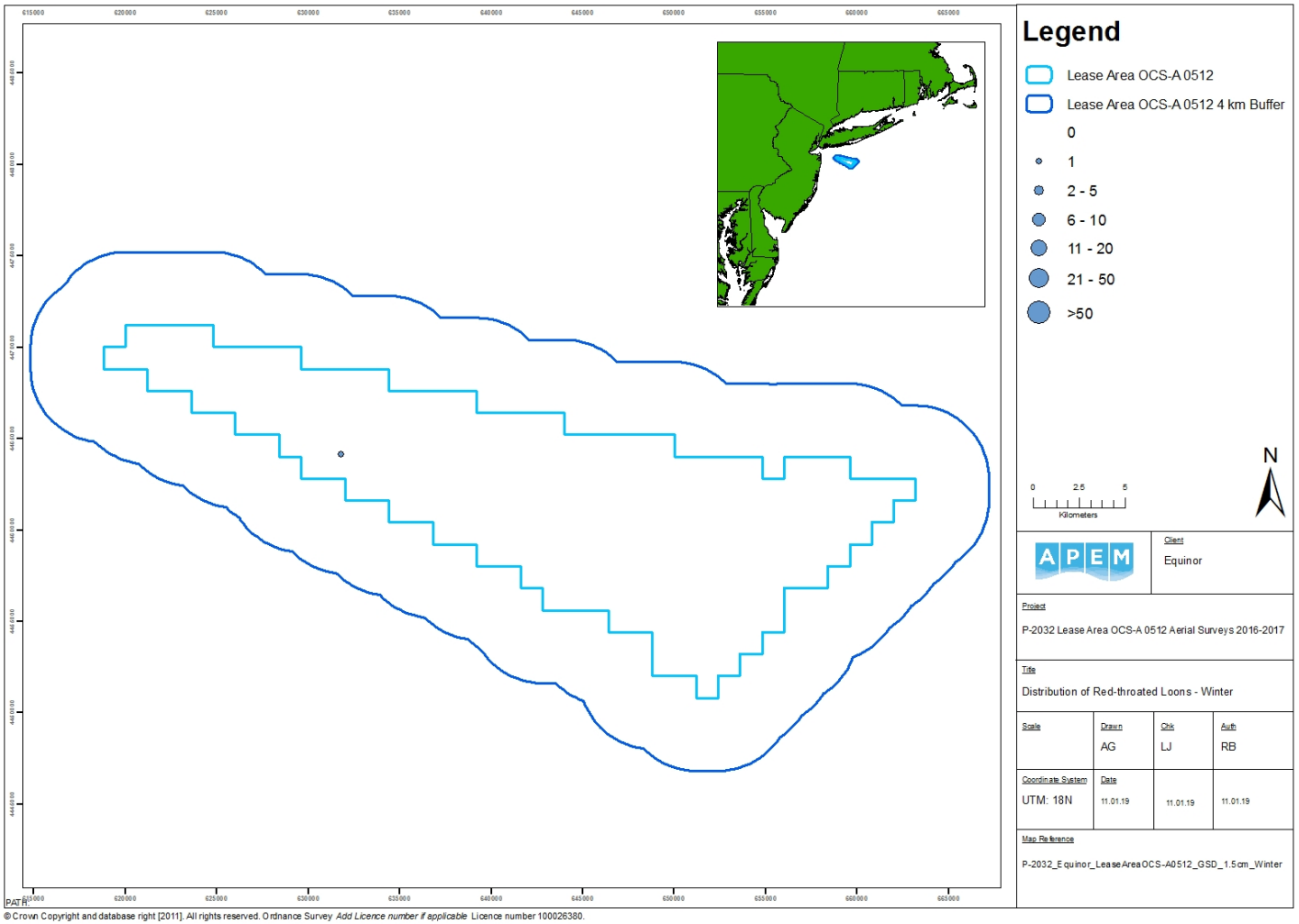


Figure 5 Distribution of red-throated loons recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

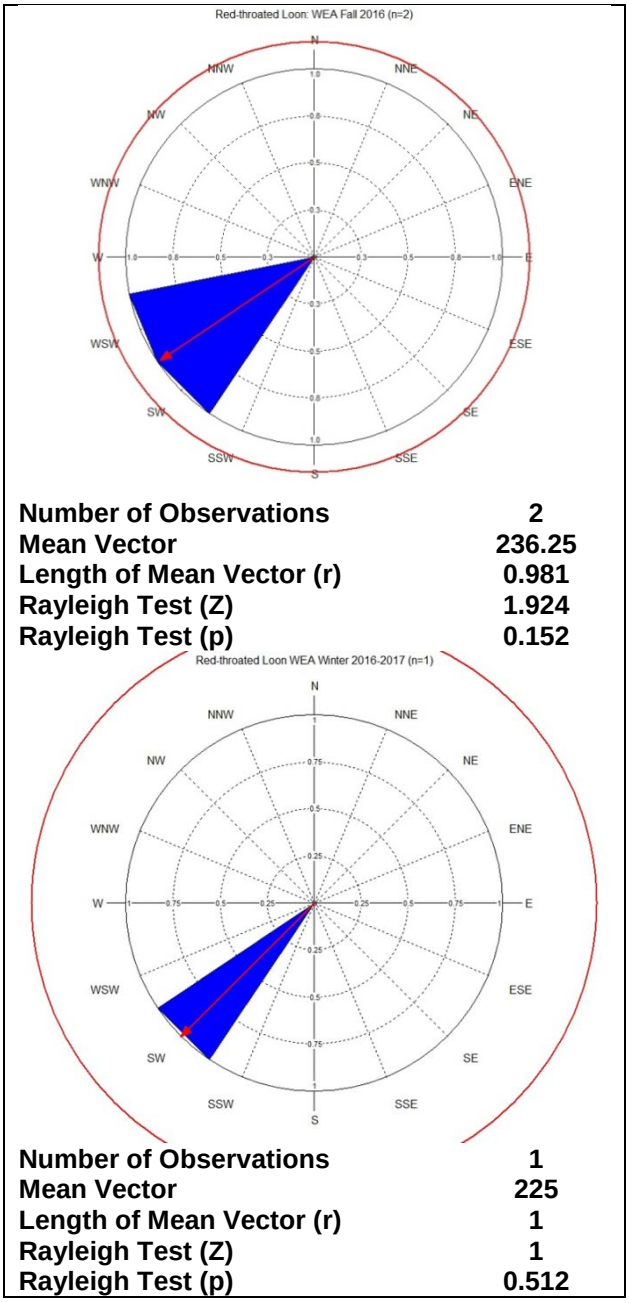


Figure 6 **Summary of flight direction of red-throated loons (n=3) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the fall and winter surveys.**

4.3 Common Loon

During the fall survey, two common loons were recorded in flight – one at the southern edge of the 4 km buffer, and the other within the Lease Area OCS-A 0512 site (**Table 8, Figure 7**). In the winter survey, four common loons were recorded in across the Lease Area OCS-A 0512 (**Figure 8**). In the spring survey, a total of 29 common loons were recorded, loosely distributed across the north of the Lease Area OCS-A 0512 (**Figure 9**).

Two common loons were recorded in flight in the fall, and did not show a significant tendency to fly in any one direction (**Figure 10**). One common loon was recorded in flight in both winter and spring (**Figure 10**).

Table 8 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of common loons in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	2	22	0.03	2	0
Winter	4	31	0.04	1	3
Spring	29	195	0.24	1	28
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	1	12	0.04	1	0
Winter	1	8	0.02	0	1
Spring	11	73	0.23	0	11
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	1	11	0.02	1	0
Winter	3	24	0.05	1	2
Spring	18	122	0.24	1	17

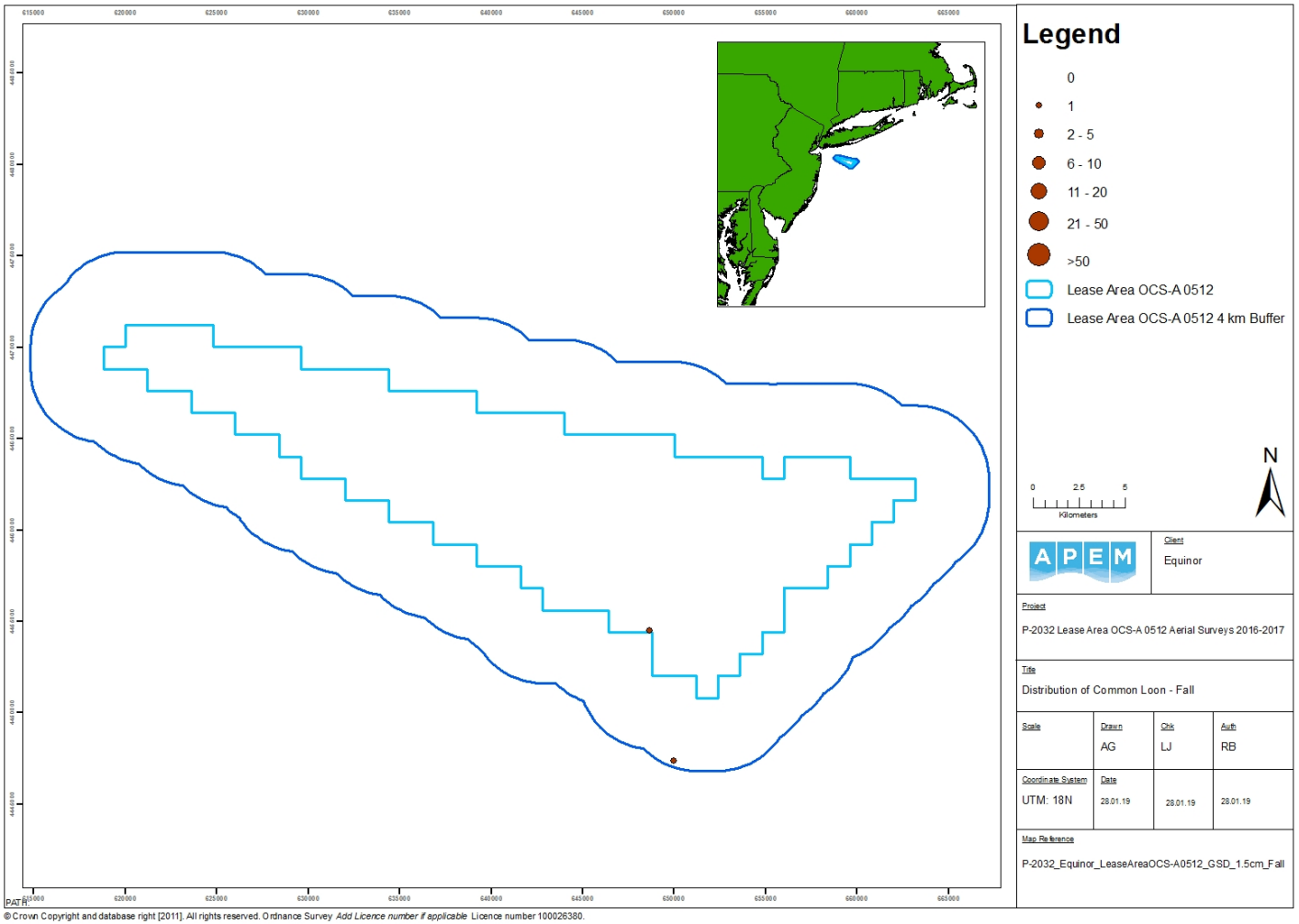


Figure 7 Distribution of common loons recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

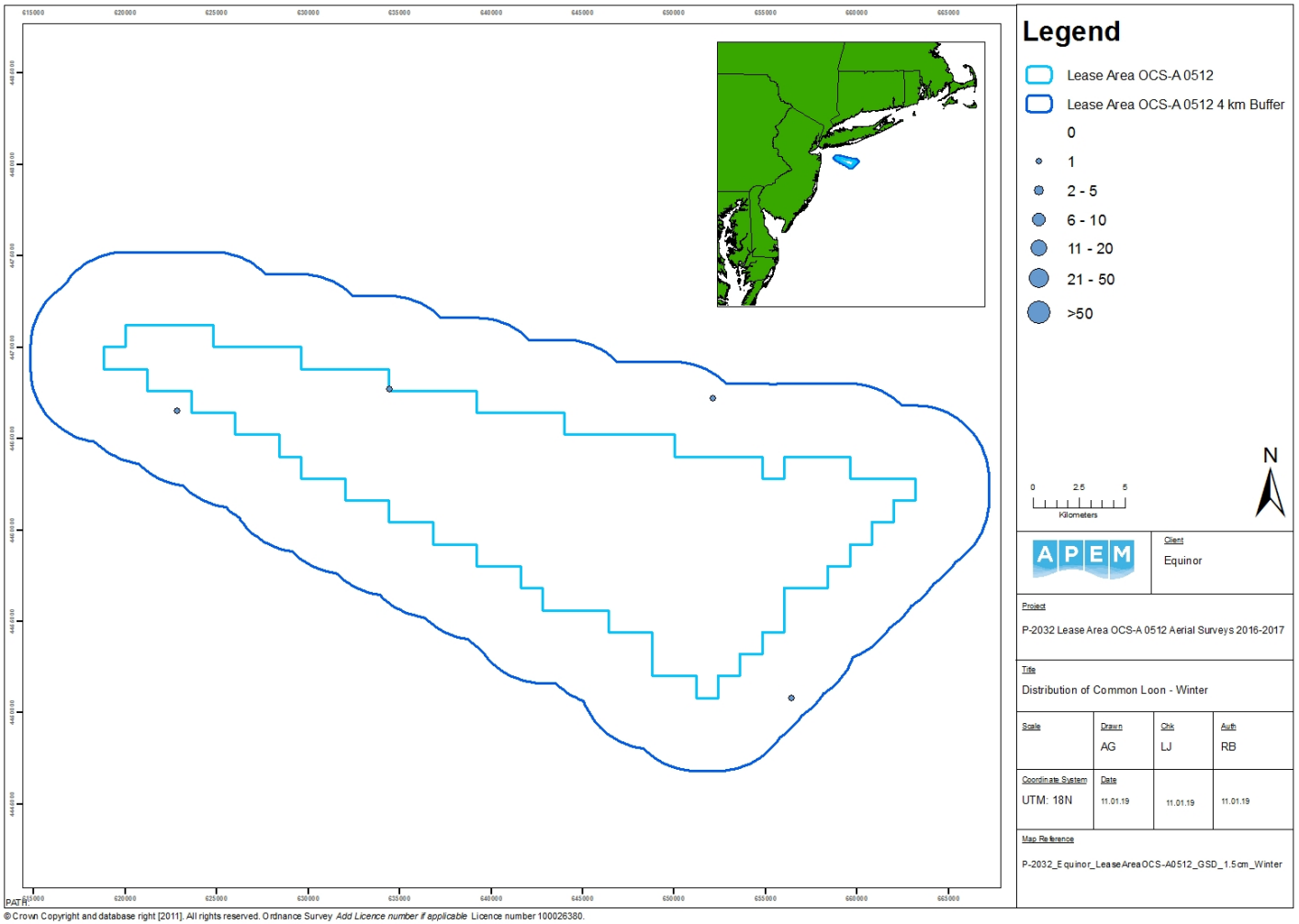


Figure 8 Distribution of common loons recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

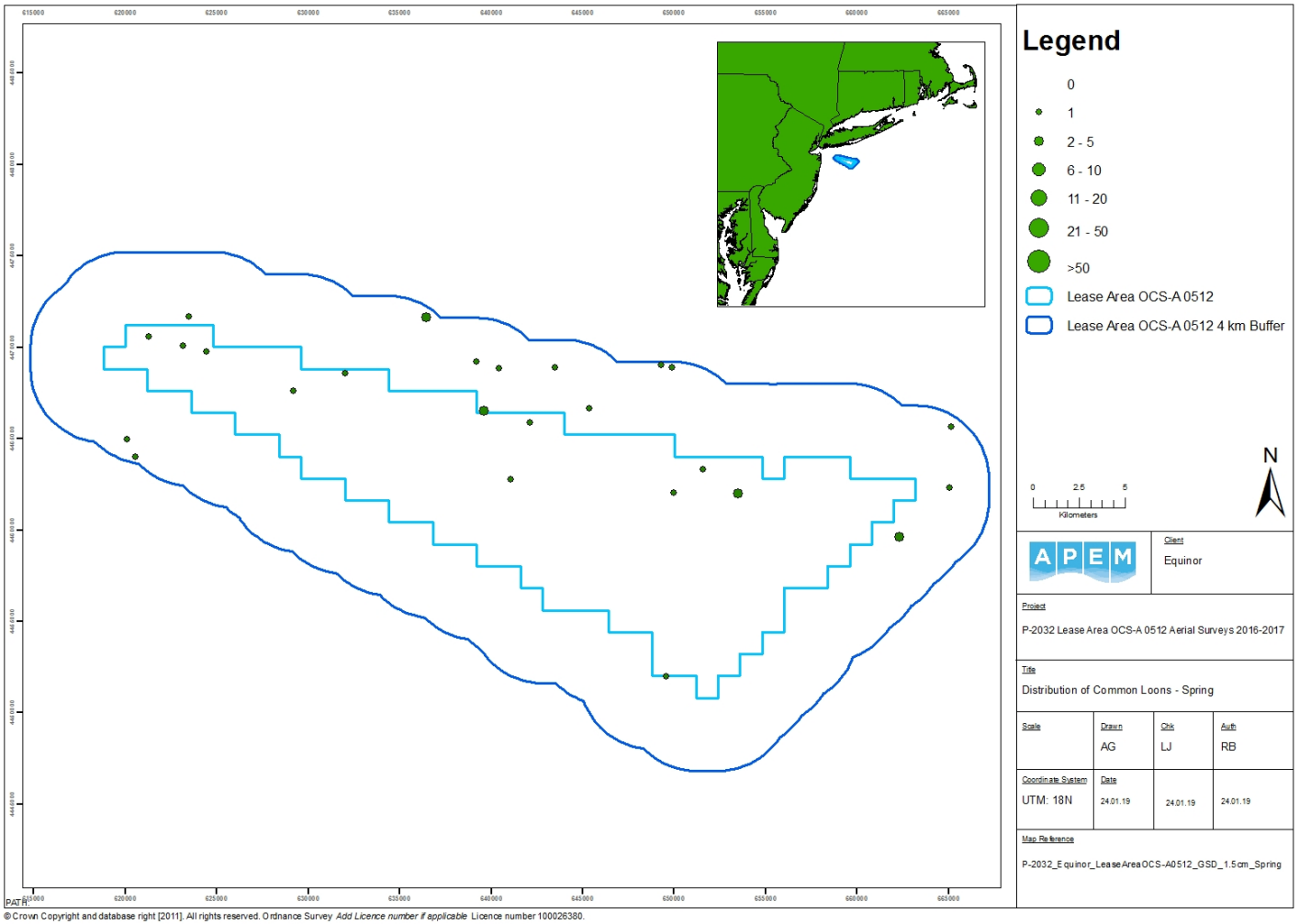
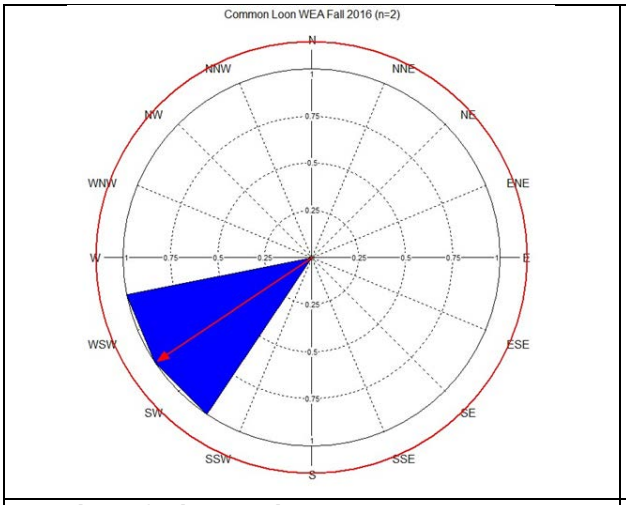
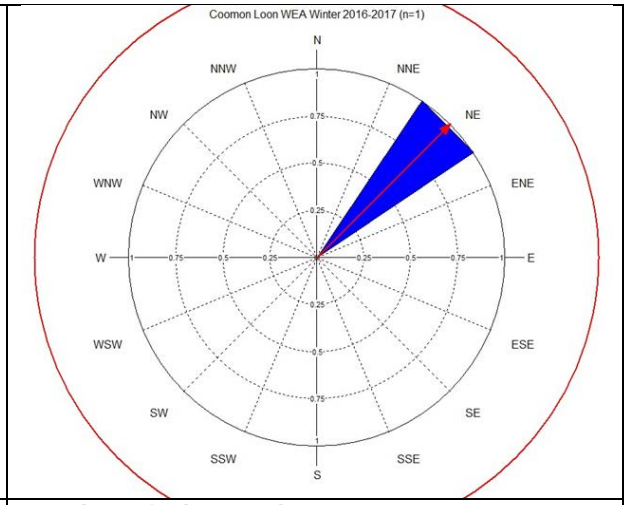


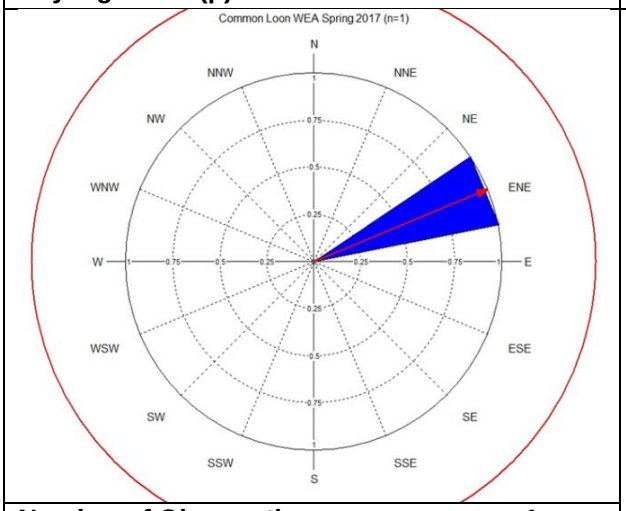
Figure 9 **Distribution of common loons recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.**



Number of Observations	**2**
Mean Vector	**236.25**
Length of Mean Vector (r)	**0.981**
Rayleigh Test (Z)	**1.924**
Rayleigh Test (p)	**0.152**



Number of Observations	**1**
Mean Vector	**45**
Length of Mean Vector (r)	**1**
Rayleigh Test (Z)	**1**
Rayleigh Test (p)	**0.512**



Number of Observations	**1**
Mean Vector	**67.5**
Length of Mean Vector (r)	**1**
Rayleigh Test (Z)	**1**
Rayleigh Test (p)	**0.512**

Figure 10 **Summary of flight direction of common loons (n=4) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the fall, winter and spring surveys.**

4.4 Northern Gannet

During the fall survey 14 northern gannets were recorded within the Lease Area OCS-A 0512, predominantly within the 4 km buffer (**Table 9**, **Figure 11**). In the winter survey 18 northern gannets were recorded across the Lease Area OCS-A 0512, with birds predominantly located in the 4 km buffer (**Figure 12**). In the spring survey six northern gannets were recorded within the Lease Area OCS-A 0512, with five in the 4 km buffer (**Figure 13**).

Of the northern gannets recorded the same amount were observed flying and sitting (n=19 or 50% each). Gannets were recorded flying mostly in either a north / northeast direction or southwest direction (**Figure 14**).

Table 9 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of northern gannets in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	14	156	0.19	5	9
Winter	18	141	0.17	12	6
Spring	6	40	0.05	2	4
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	3	37	0.12	0	3
Winter	4	31	0.1	4	0
Spring	1	7	0.02	0	1
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	11	117	0.23	5	6
Winter	14	110	0.22	8	6
Spring	5	34	0.07	2	3

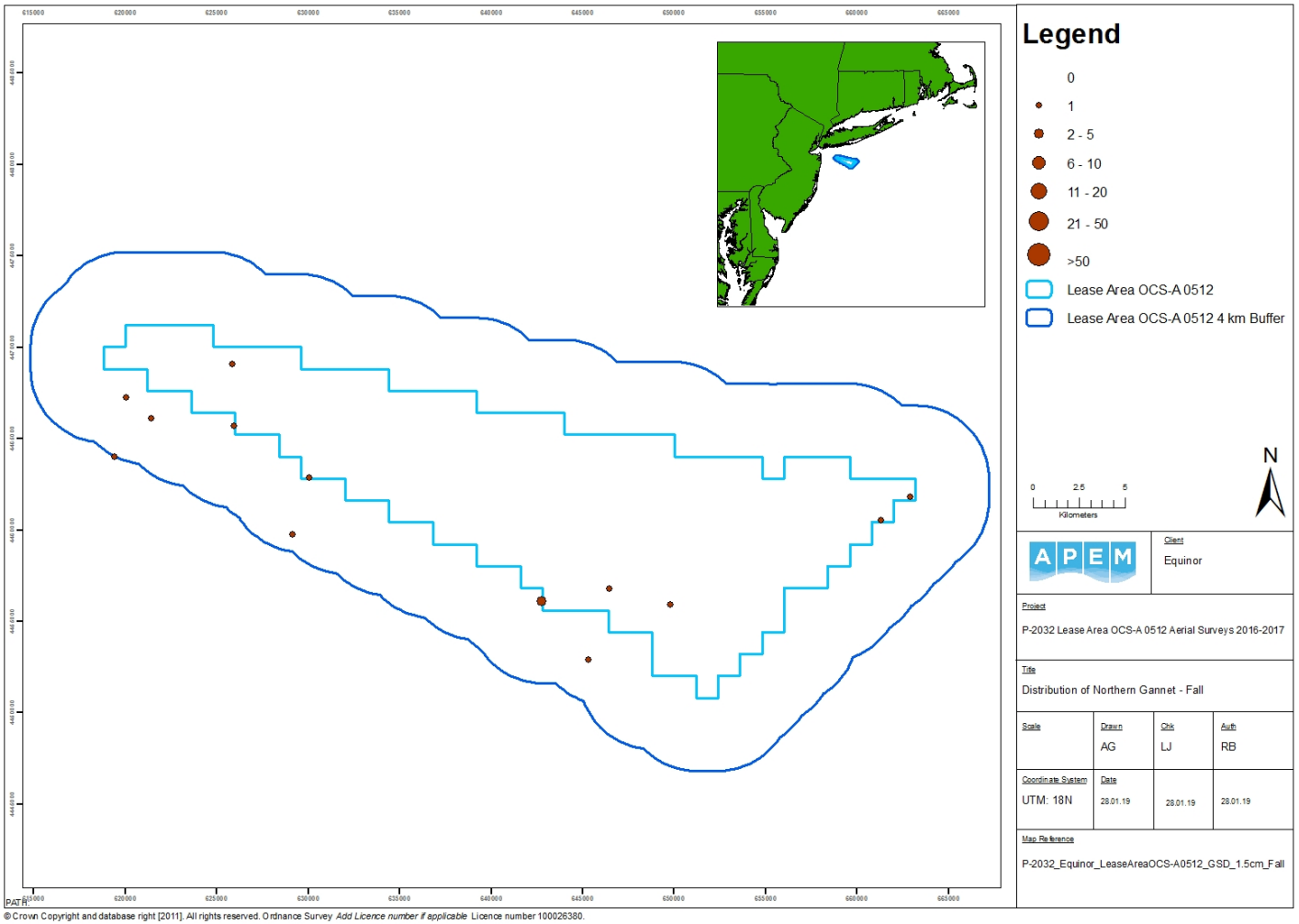


Figure 11 Distribution of northern gannets recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

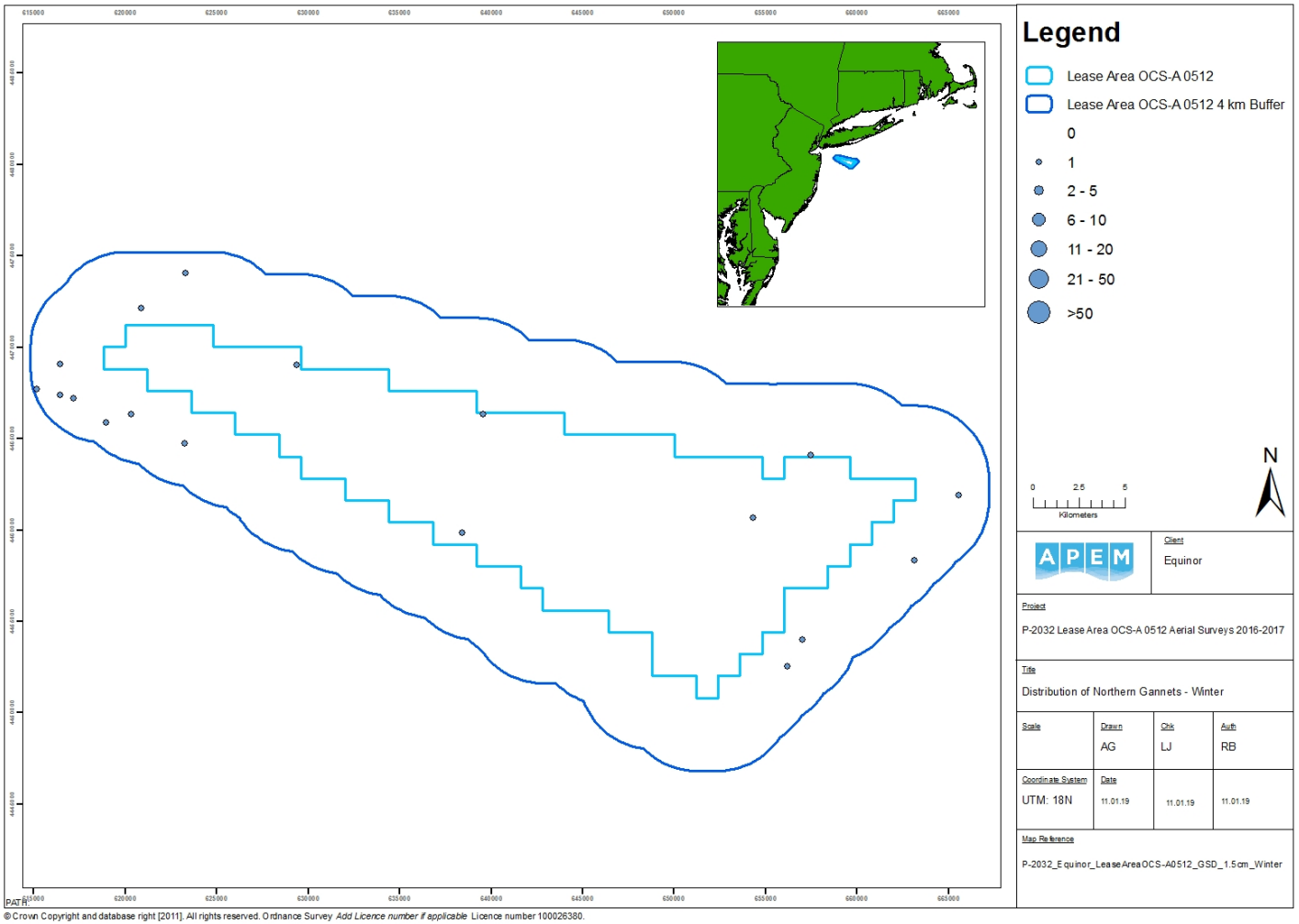


Figure 12 Distribution of northern gannets recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

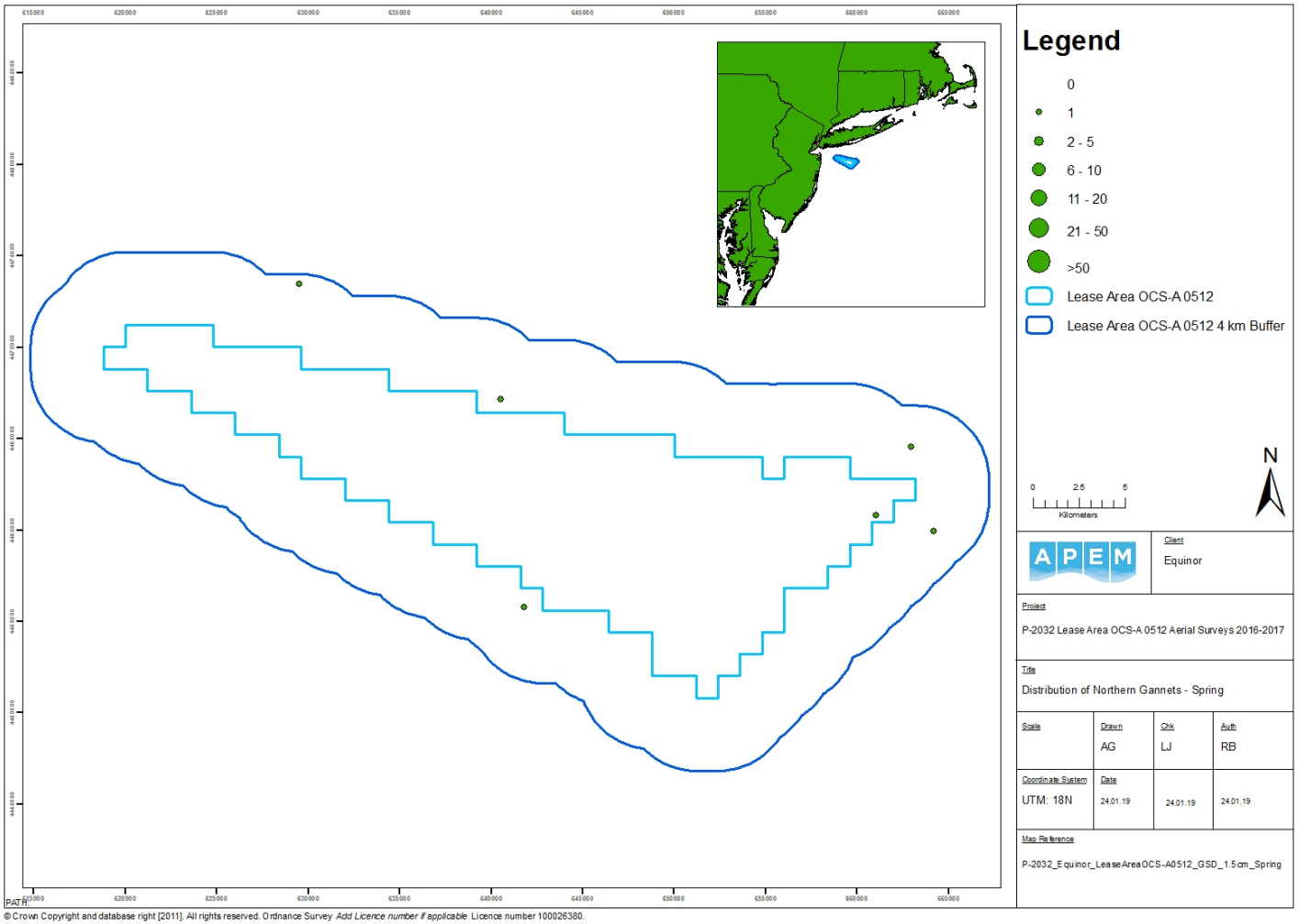
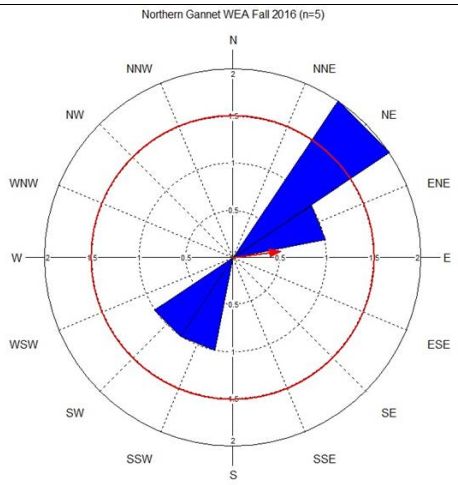
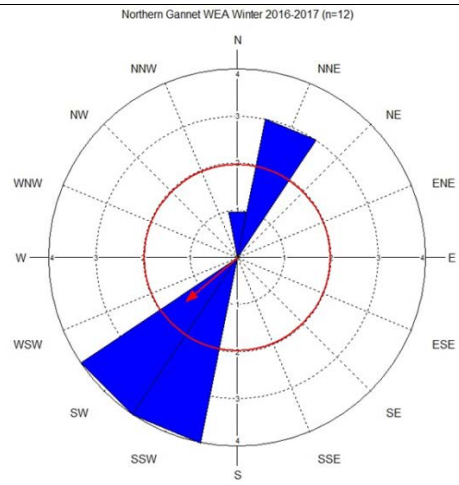


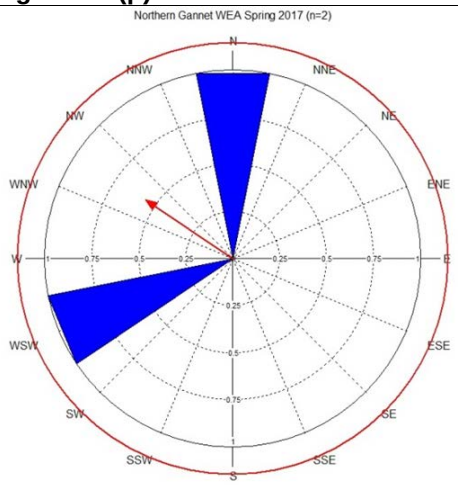
Figure 13 Distribution of Northern gannets recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**5**
Mean Vector	**82.429**
Length of Mean Vector (r)	**0.252**
Rayleigh Test (Z)	**0.317**
Rayleigh Test (p)	**0.748**



Number of Observations	**12**
Mean Vector	**229.399**
Length of Mean Vector (r)	**0.352**
Rayleigh Test (Z)	**1.491**
Rayleigh Test (p)	**0.229**



Number of Observations	**2**
Mean Vector	**303.75**
Length of Mean Vector (r)	**0.556**
Rayleigh Test (Z)	**0.617**
Rayleigh Test (p)	**0.606**

Figure 14 Summary of flight direction of northern gannets (n=19) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the fall, winter and spring surveys.

4.5 Red / Red-necked Phalarope

During the fall survey, six red / red-necked phalaropes were recorded, with two located within the Lease Area OCS-A 0512 site and four in the eastern 4 km buffer (**Table 10**, **Figure 15**). In the spring survey two birds were recorded in the north of the wind farm, close to the buffer boundary (**Figure 16**). One red / red-necked phalarope was recorded flying in a south-westerly direction in the fall survey (**Figure 17**).

Table 10 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of red / red-necked phalaropes in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	6	67	0.08	1	5
Winter	0	0	-	0	0
Spring	2	13	0.02	0	2
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	1	12	0.04	0	1
Winter	0	0	-	0	0
Spring	2	13	0.04	0	2
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	5	53	0.11	1	4
Winter	0	0	-	0	0
Spring	0	0	-	0	0

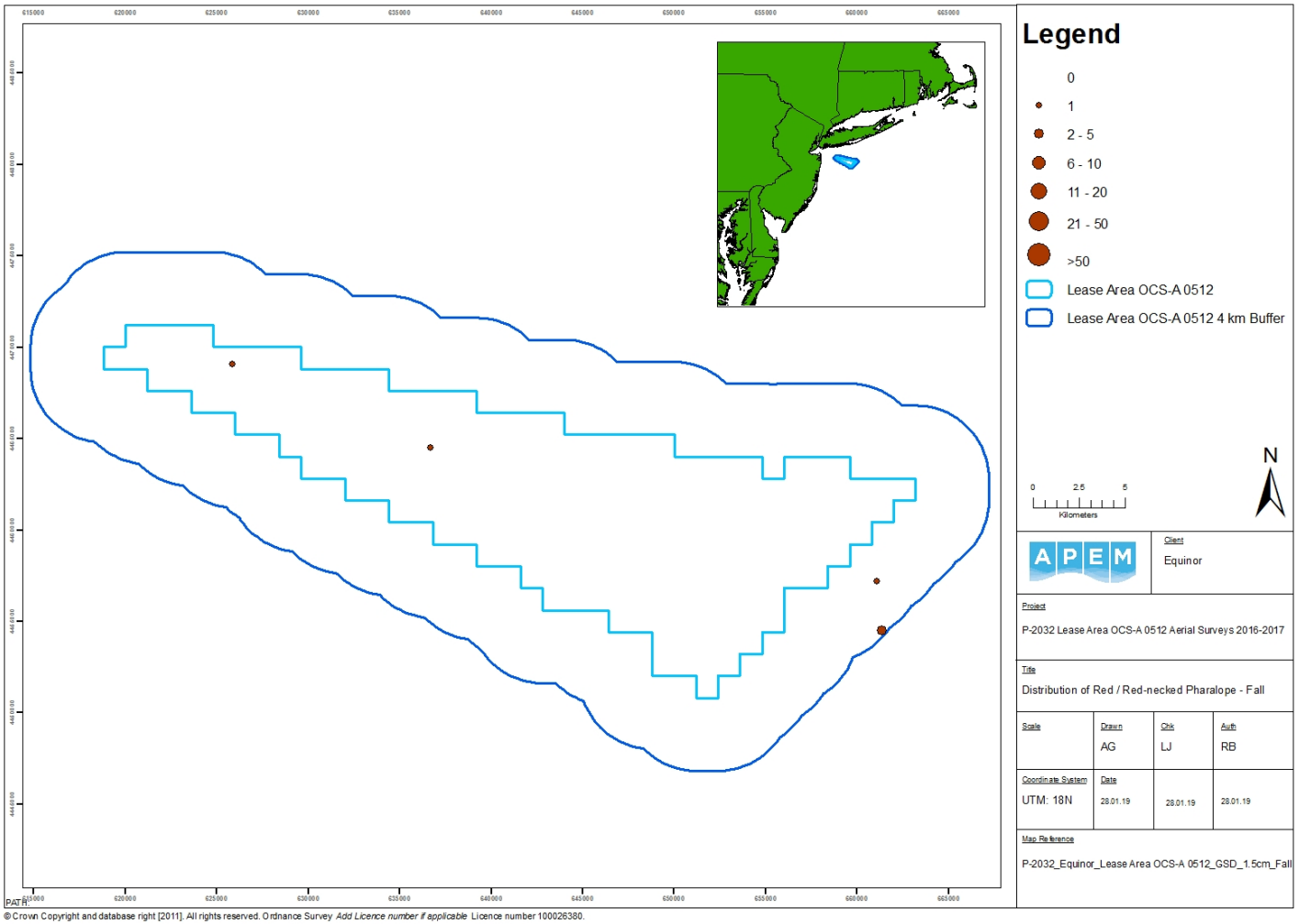


Figure 15 Distribution of red / red-necked phalaropes recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

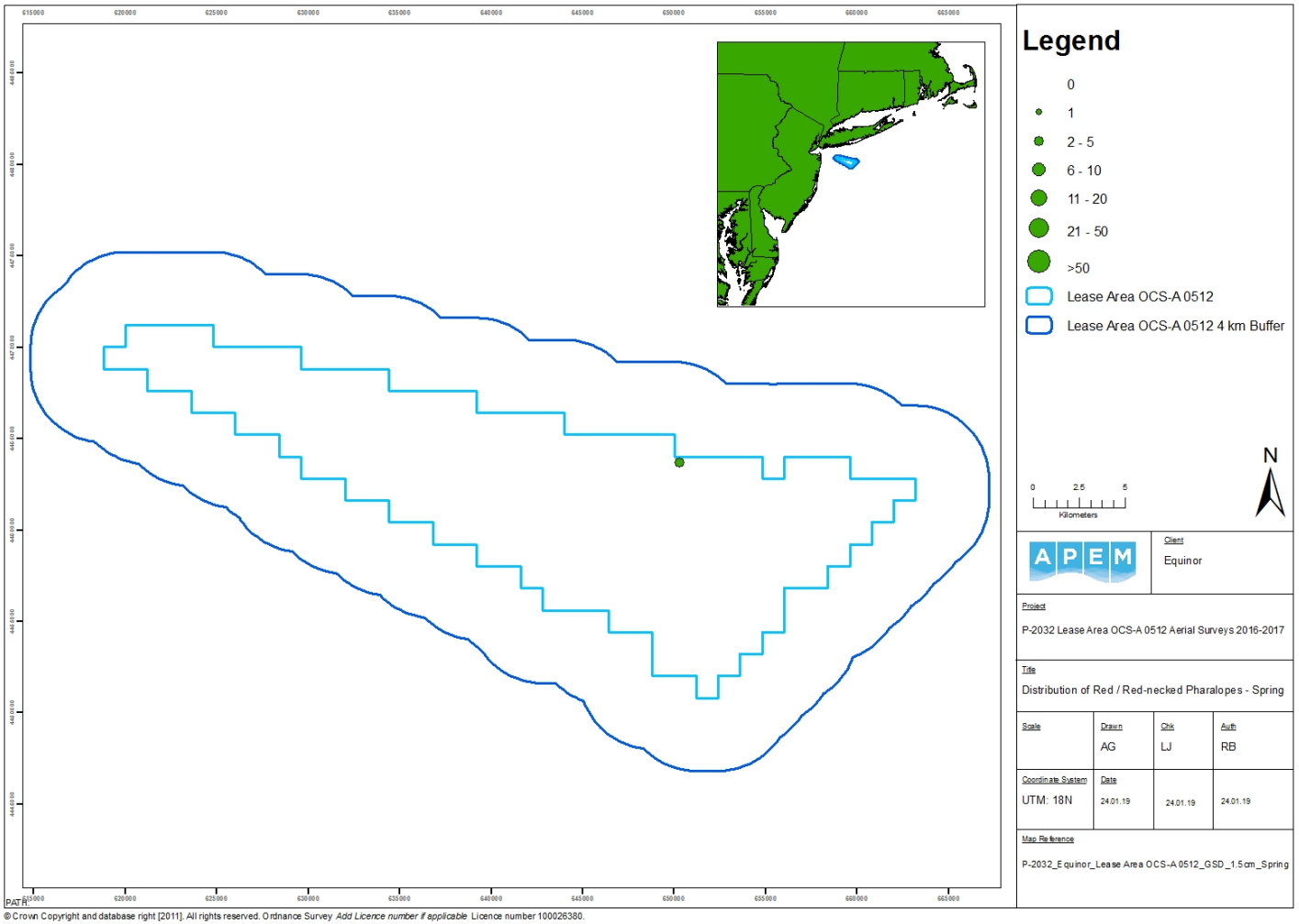
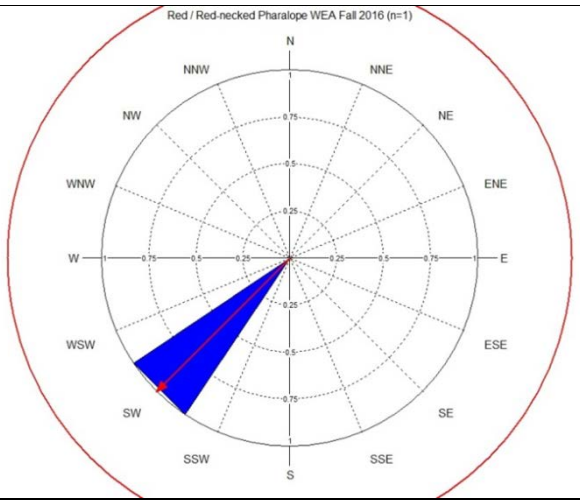


Figure 16 Distribution of red / red-necked phalaropes recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**1**
Mean Vector	**225**
Length of Mean Vector (r)	**1**
Rayleigh Test (Z)	**1**
Rayleigh Test (p)	**0.512**

Figure 17 Summary of flight direction of red / red-necked phalarope (n=1) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the fall survey.

4.6 Dovekie

During the winter 2016-2017, a single sitting dovekie was recorded the northern region of the wind farm (**Table 11**, **Figure 18**).

Table 11 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of dovekie in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	1	8	0.01	0	1
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	1	8	0.02	0	1
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

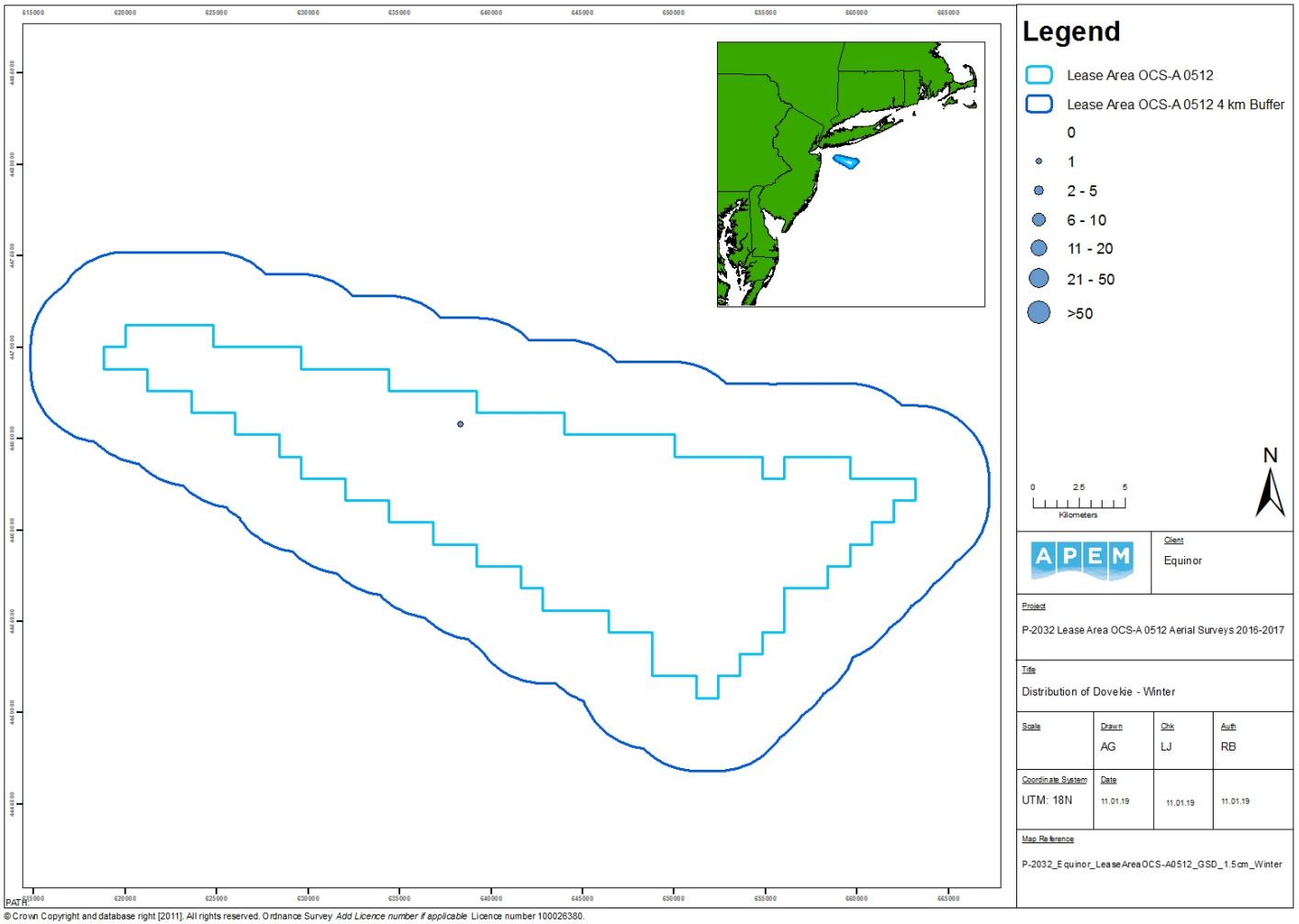


Figure 18 Distribution of dovekie recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.7 Atlantic Puffin

A single sitting Atlantic Puffin was recorded in the east of the Lease Area OCS-A 0512 site during the winter survey of Lease Area OCS-A 0512 (**Table 12**, **Figure 19**).

Table 12 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Atlantic puffins in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	1	8	0.01	0	1
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	1	8	0.02	0	1
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

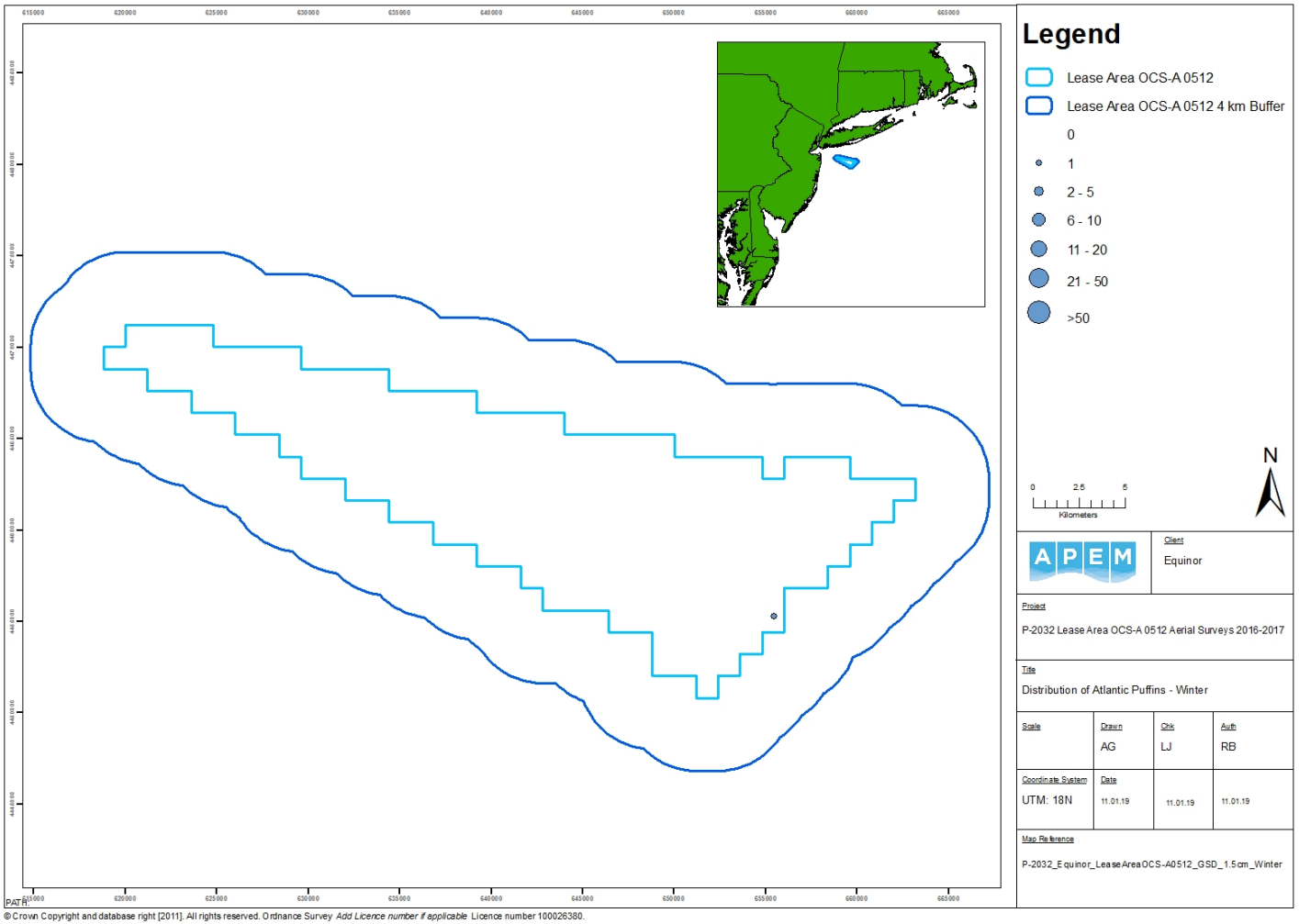


Figure 19 Distribution of Atlantic Puffins recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.8 Razorbill

During the winter survey, a single sitting razorbill was recorded in the eastern 4 km buffer (**Table 13**, **Figure 20**).

Table 13 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of razorbills in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	1	8	0.01	0	1
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	1	8	0.02	0	1
Spring	0	0	-	0	0

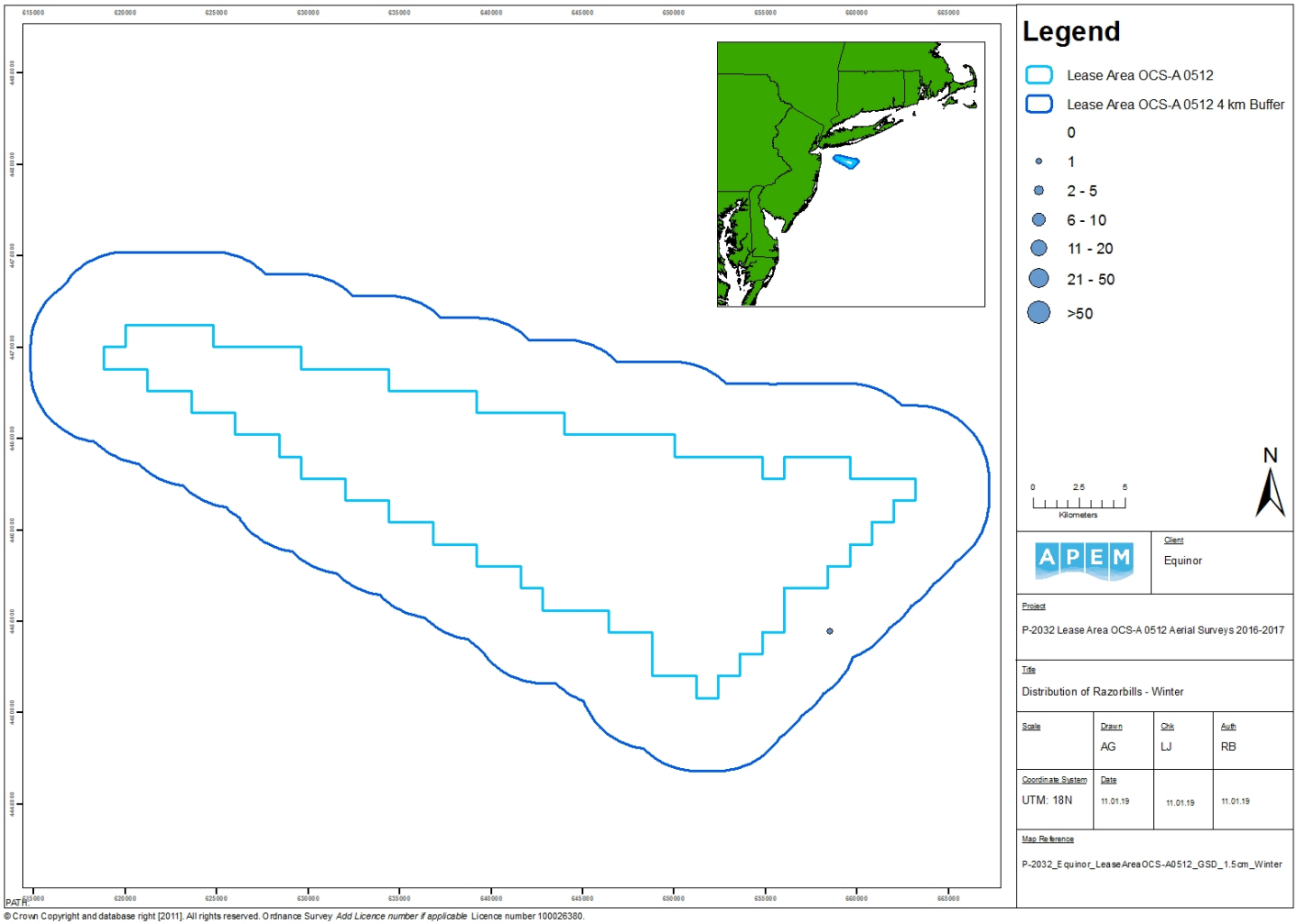


Figure 20 Distribution of razorbills recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.9 Bonaparte's Gull

In the fall survey, eleven Bonaparte's gulls were recorded in four groups (**Table 14**, **Figure 21**), with two groups in the Lease Area OCS-A 0512 site and two in the 4 km buffer zone. In the winter survey, three Bonaparte's gulls were recorded in a group in the eastern region of the 4 km buffer of the Lease Area OCS-A 0512 (**Table 14**, **Figure 22**).

A total of eight Bonaparte's gulls were recorded flying in the fall survey. Bonaparte's gulls showed a preference to fly in a south-westerly direction with a significant orientation around the mean of 219° (**Figure 23**).

Table 14 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Bonaparte's gulls in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	11	123	0.15	8	3
Winter	3	23	0.03	0	3
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	6	73	0.23	6	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	5	53	0.11	2	3
Winter	3	24	0.05	0	3
Spring	0	0	-	0	0

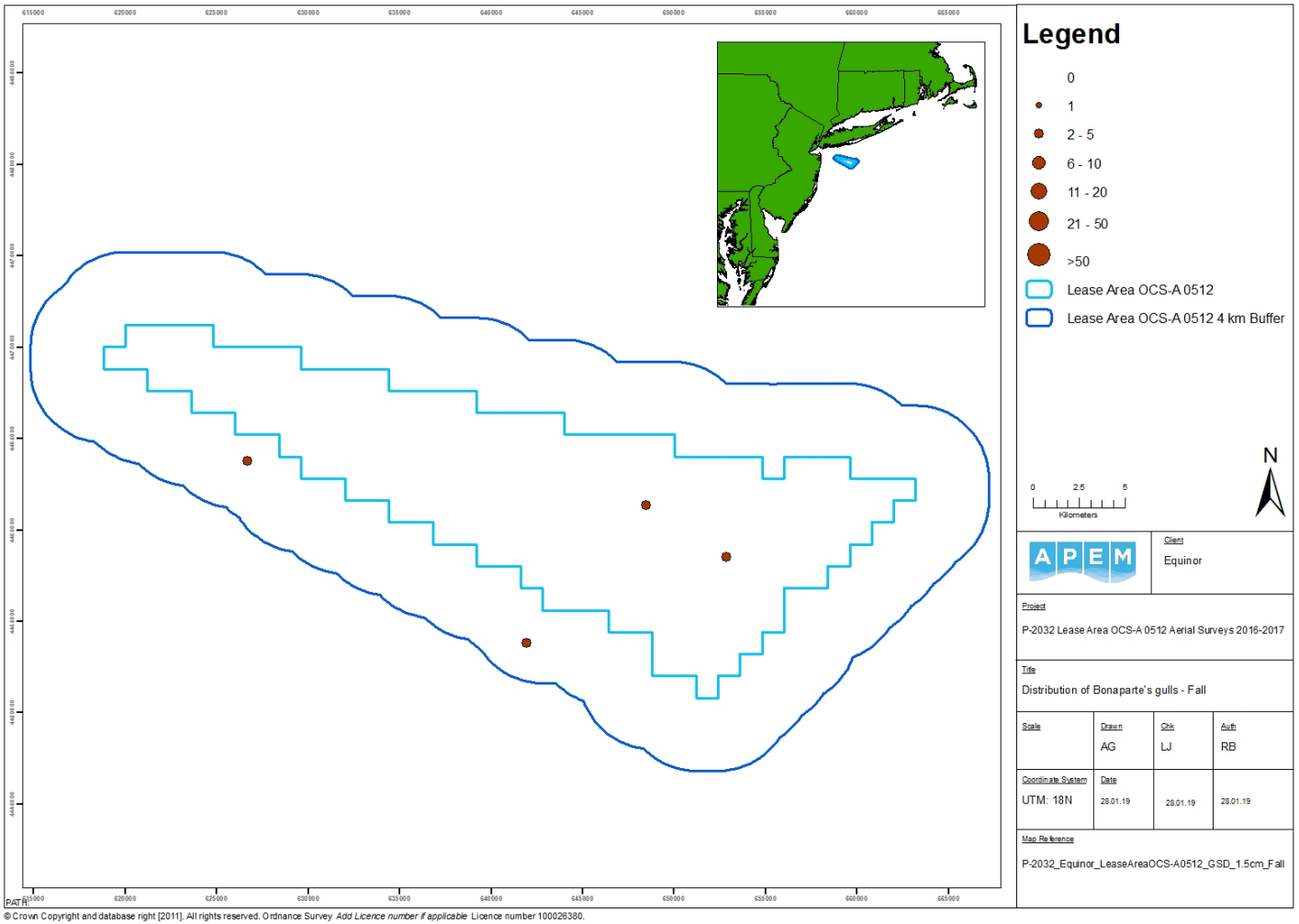


Figure 21 Distribution of Bonaparte's gulls recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

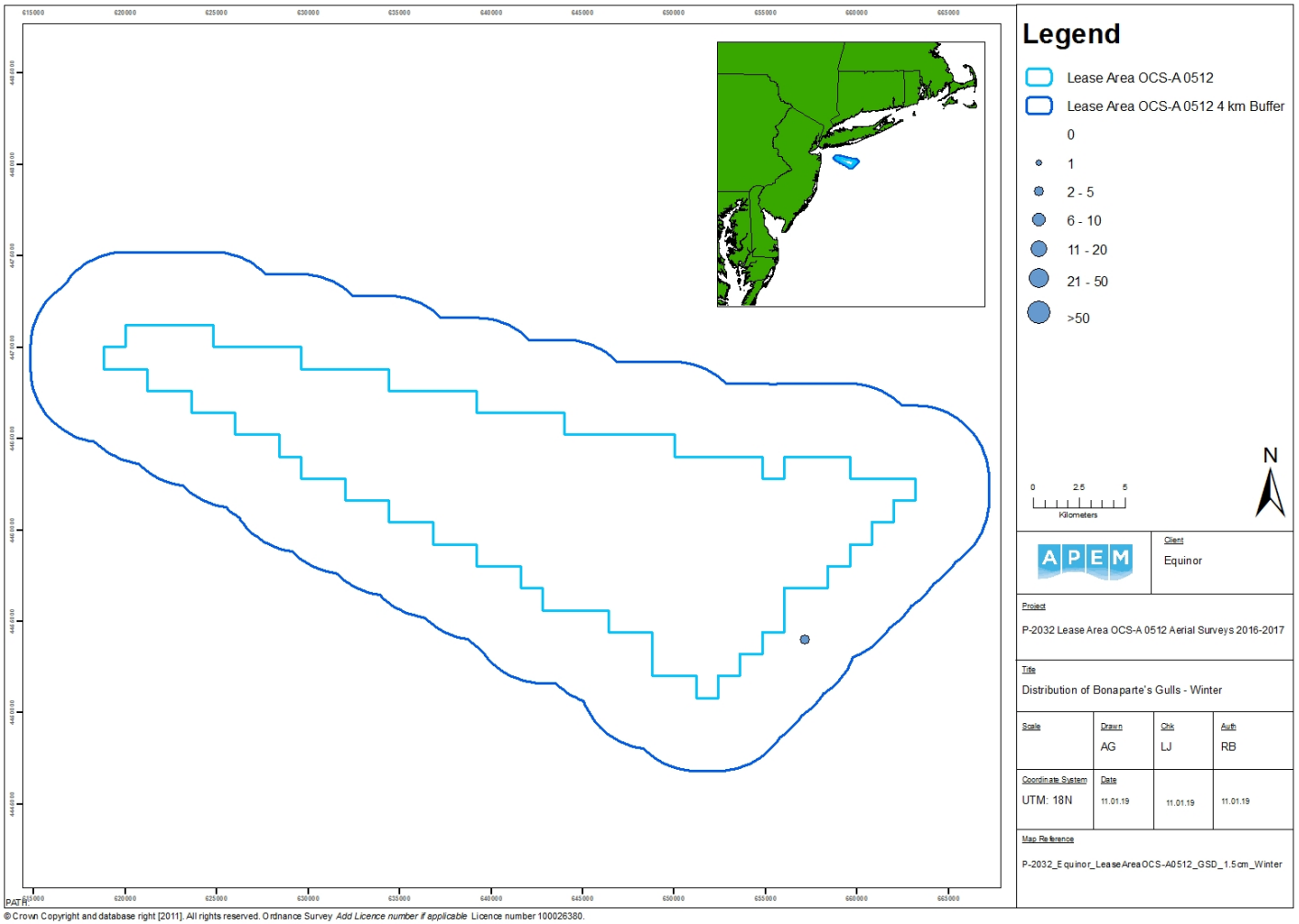
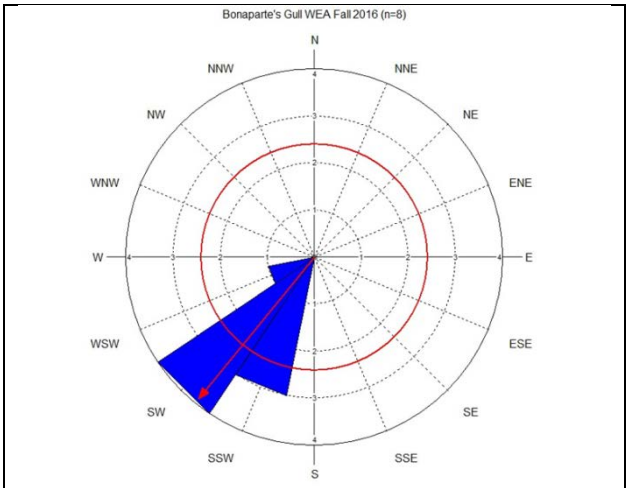


Figure 22 Distribution of Bonaparte's gulls recorded in the winter 2016-2017 survey of the Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**8**
Mean Vector	**219.32**
Length of Mean Vector (r)	**0.967**
Rayleigh Test (Z)	**7.476**
Rayleigh Test (p)	**< 1E-12**

Figure 23 Summary of flight direction of Bonaparte's gulls (n=8) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the fall survey.

4.10 Ring-billed Gull

In the fall survey, a single ring-billed gull was recorded flying in a south-south-westerly direction in the south of the 4 km buffer (**Table 15**, **Figure 24, Figure 25**).

Table 15 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of ring-billed gulls in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	1	11	0.01	1	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	1	11	0.02	1	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

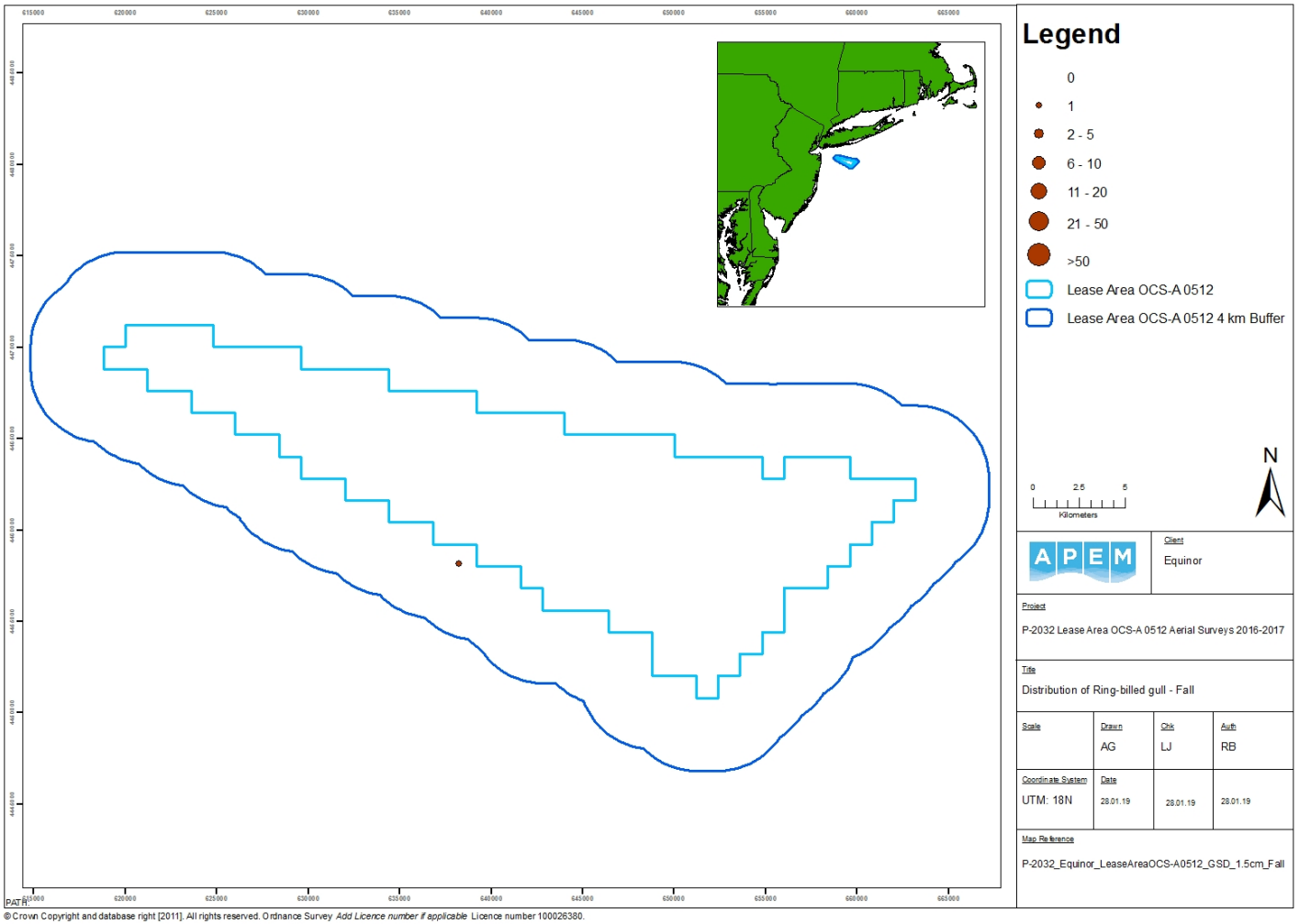
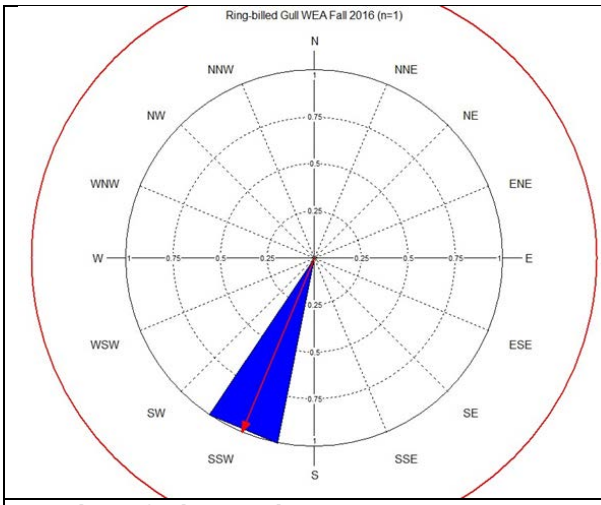


Figure 24 Distribution of ring-billed gulls recorded in the fall 2016 survey of the Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**1**
Mean Vector	**202.5**
Length of Mean Vector (r)	**1**
Rayleigh Test (Z)	**1**
Rayleigh Test (p)	**0.512**

Figure 25 Summary of flight direction of ring-billed gull (n=1) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the fall survey.

4.11 Herring Gull

In the fall survey, eight herring gulls were recorded distributed across the center of the Lease Area OCS-A 0512 (**Table 16**, **Figure 26**). In the winter survey, two herring gulls were recorded in the south of the 4 km buffer (**Table 16**, **Figure 27**). In the spring survey, a single herring gull was recorded in the north of the Lease Area OCS-A 0512 site (**Table 16**, **Figure 28**).

Eight herring gulls were recorded flying in the fall, with a further two in the winter and one in the spring. Herring gulls did not show a significant tendency to fly in any one direction (**Figure 29**).

Table 16 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of herring gulls in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	8	89	0.11	8	0
Winter	2	16	0.02	2	0
Spring	1	7	0.01	1	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	1	12	0.04	1	0
Winter	0	0	-	0	0
Spring	1	7	0.02	1	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	7	74	0.15	7	0
Winter	2	16	0.03	2	0
Spring	0	0	-	0	0

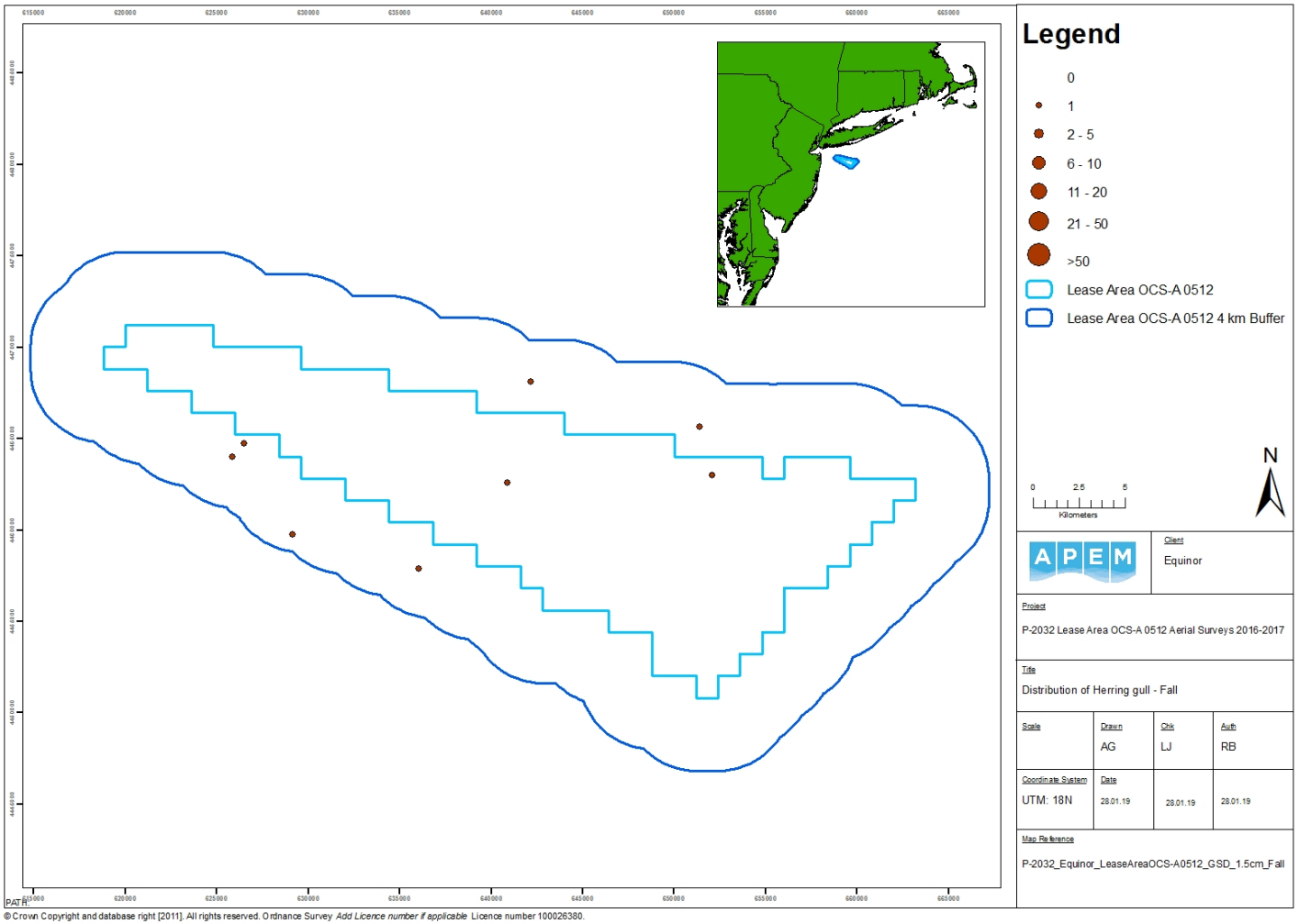


Figure 26 Distribution of herring gulls recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

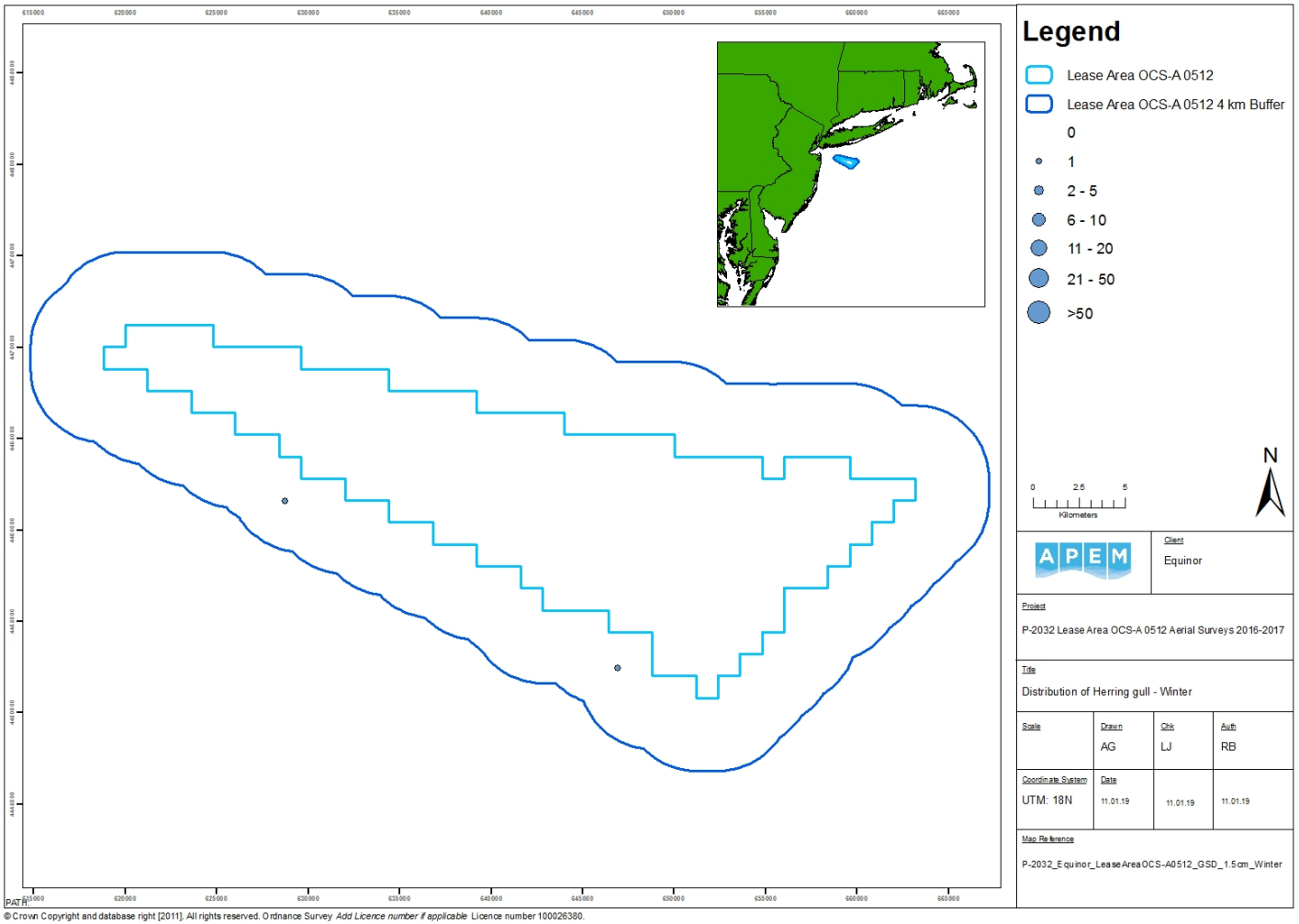


Figure 27 Distribution of herring gulls recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

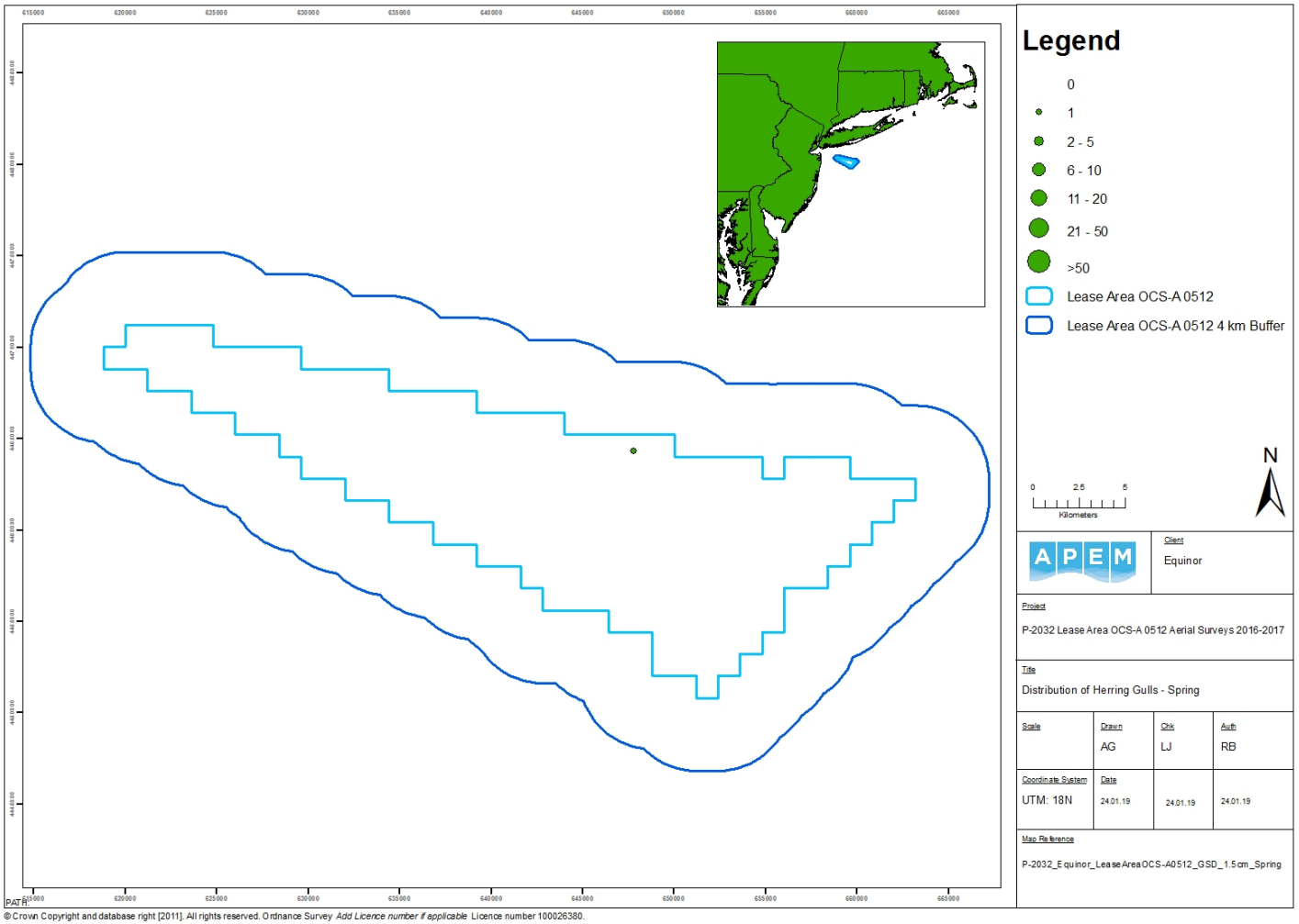
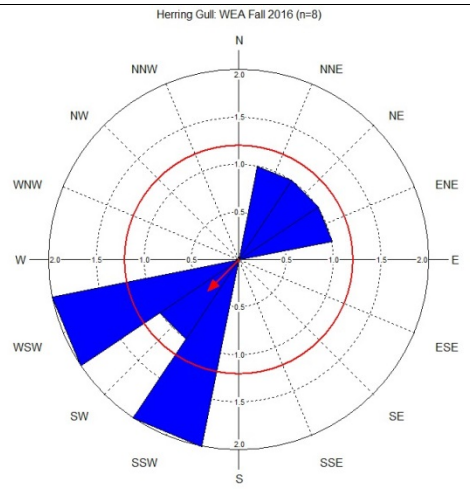
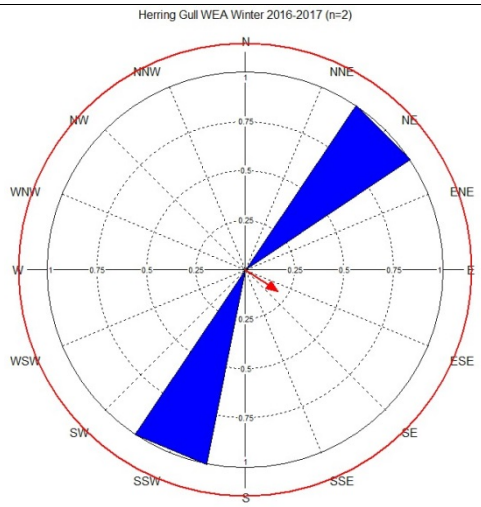


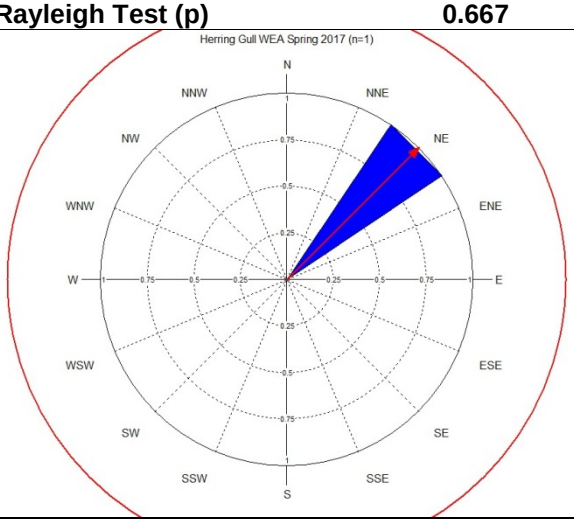
Figure 28 Distribution of herring gulls recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**8**
Mean Vector	**225**
Length of Mean Vector (r)	**0.231**
Rayleigh Test (Z)	**0.427**
Rayleigh Test (p)	**0.667**



Number of Observations	**2**
Mean Vector	**123.75**
Length of Mean Vector (r)	**0.195**
Rayleigh Test (Z)	**0.076**
Rayleigh Test (p)	**0.943**



Number of Observations	**1**
Mean Vector	**45**
Length of Mean Vector (r)	**1**
Rayleigh Test (Z)	**1**
Rayleigh Test (p)	**0.512**

Figure 29 Summary of flight direction of herring gulls (n=11) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the fall, winter and spring surveys.

4.12 Great Black-backed Gull

In the winter survey, two great black-backed gulls were recorded in the east of the 4 km buffer (**Table 17**, **Figure 30**). One individual was flying in a south-westerly direction and the other was flying in a southerly direction (**Figure 31**).

Table 17 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of great black-backed gulls in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	2	16	0.02	2	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	2	16	0.03	2	0
Spring	0	0	-	0	0

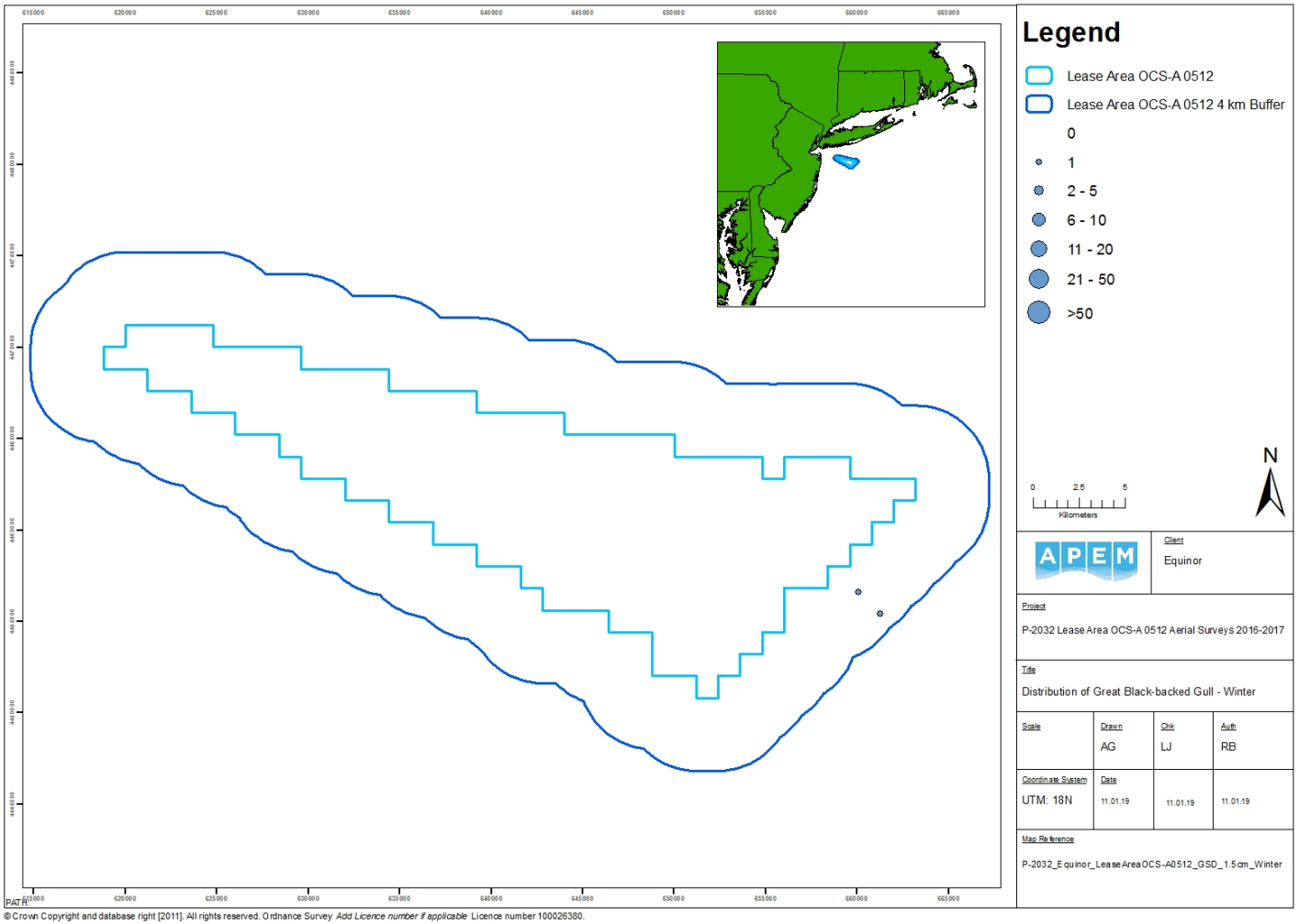
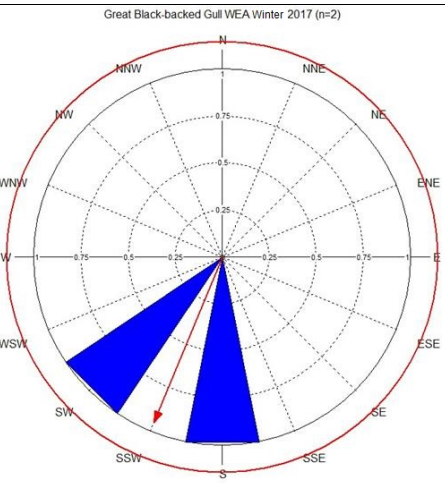


Figure 30 Distribution of great black-backed gulls recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**2**
Mean Vector	**202.5**
Length of Mean Vector (r)	**0.948**
Rayleigh Test (Z)	**1.798**
Rayleigh Test (p)	**0.178**

Figure 31 Summary of flight direction of great black-backed gulls (n=2) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the winter survey.

4.13 Species Unknown – Small Gull

In the winter survey, two unknown small gull species were recorded within the Lease Area OCS-A 0512 site (**Table 18**, **Figure 32**).

Table 18 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of small gull species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	2	16	0.02	0	2
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	2	15	0.05	0	2
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

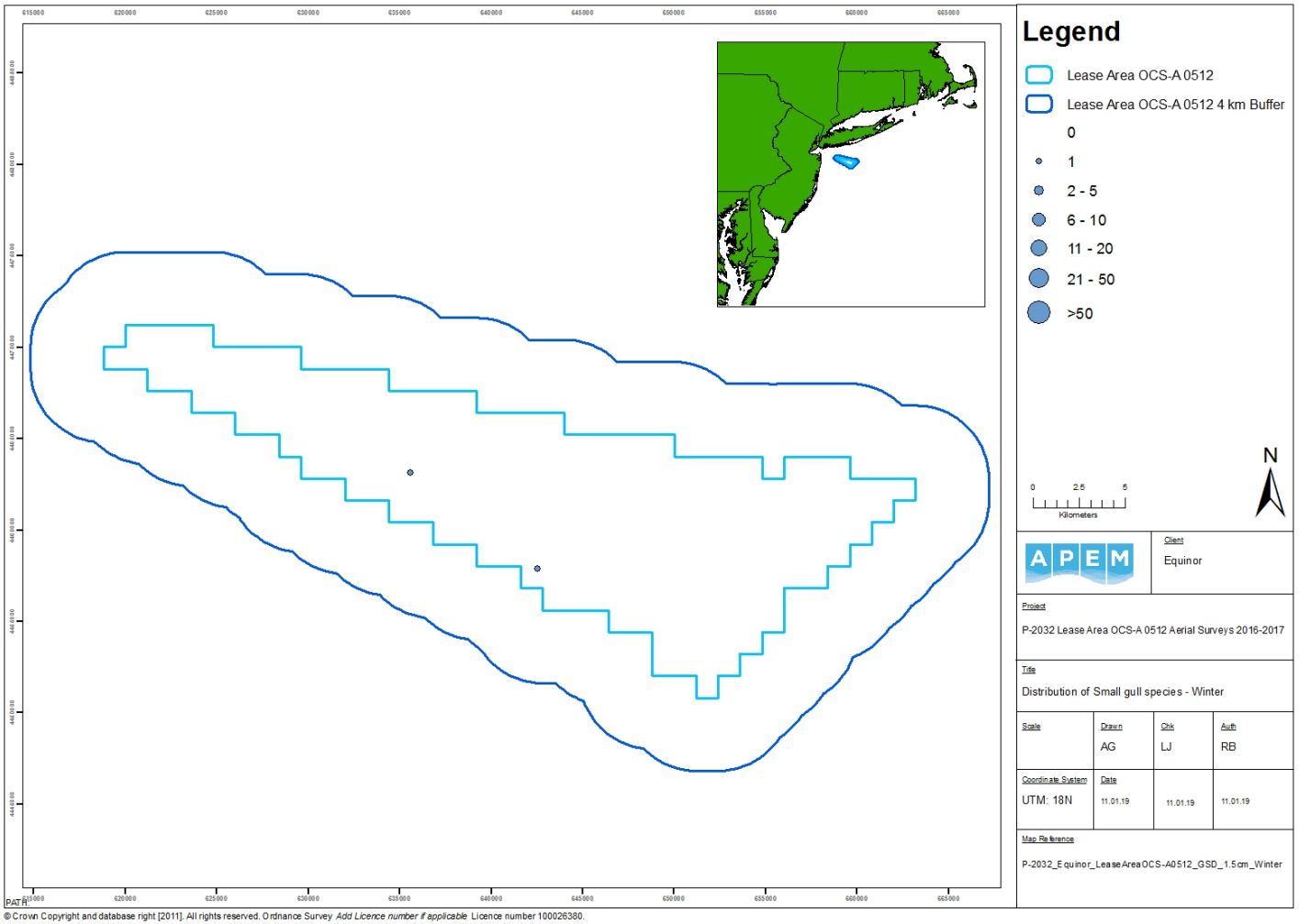


Figure 32 Distribution of unknown small gull species recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.14 Common Tern

In the spring survey, a total of 79 common terns were recorded in the Lease Area OCS-A 0512, with the largest concentration in the north-east (**Table 19**, **Figure 33**).

A total of 73 common terns were recorded in flight in the spring survey, with a preference to fly in a south-westerly direction with a significant orientation around the mean of 225° (**Figure 34**).

Table 19 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of common terns in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	79	532	0.65	73	6
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	49	325	1.01	44	5
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	30	204	0.41	29	1

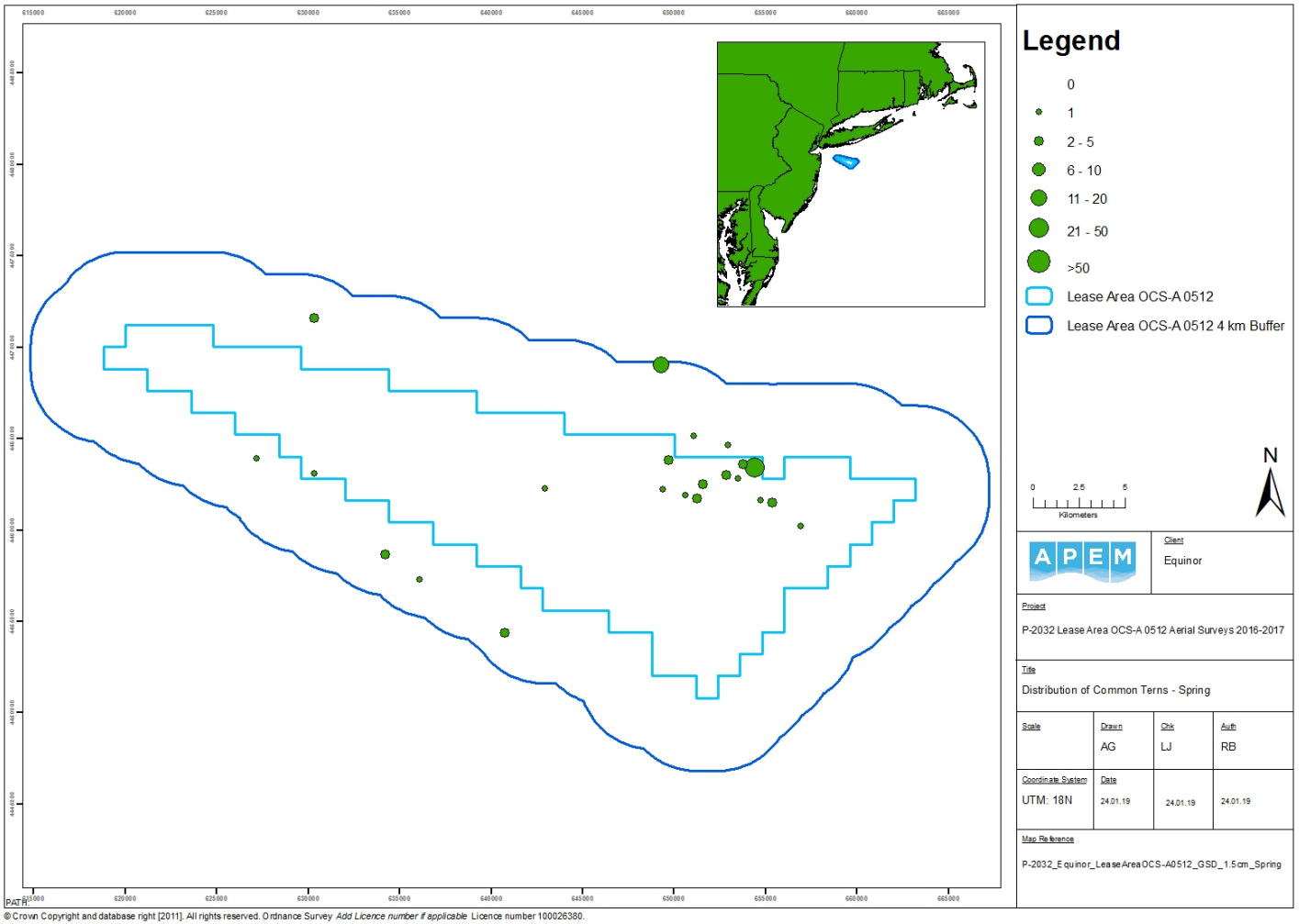
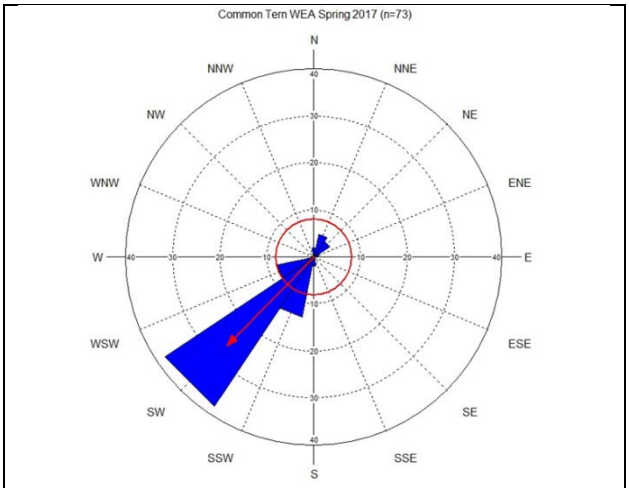


Figure 33 Distribution of common terns recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**73**
Mean Vector	**224.542**
Length of Mean Vector (r)	**0.656**
Rayleigh Test (Z)	**31.377**
Rayleigh Test (p)	**< 1E-12**

Figure 34 Summary of flight direction of common terns (n=73) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the spring survey.

4.15 Least Tern

In the spring survey, a total of four least terns were recorded in the west of the Lease Area OCS-A 0512, with three were recorded inside the Lease Area OCS-A 0512 site and one within the 4 km buffer (**Table 20**, **Figure 35**).

All four least terns were recorded in flight in the spring, with the majority flying in a southerly direction (**Figure 36**).

Table 20 Raw count and abundance and density estimates (No. estimated individuals per km^2) of least terns in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	4	27	0.03	4	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0

Winter	0	0	-	0	0
Spring	3	20	0.06	3	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	1	7	0.01	1	0

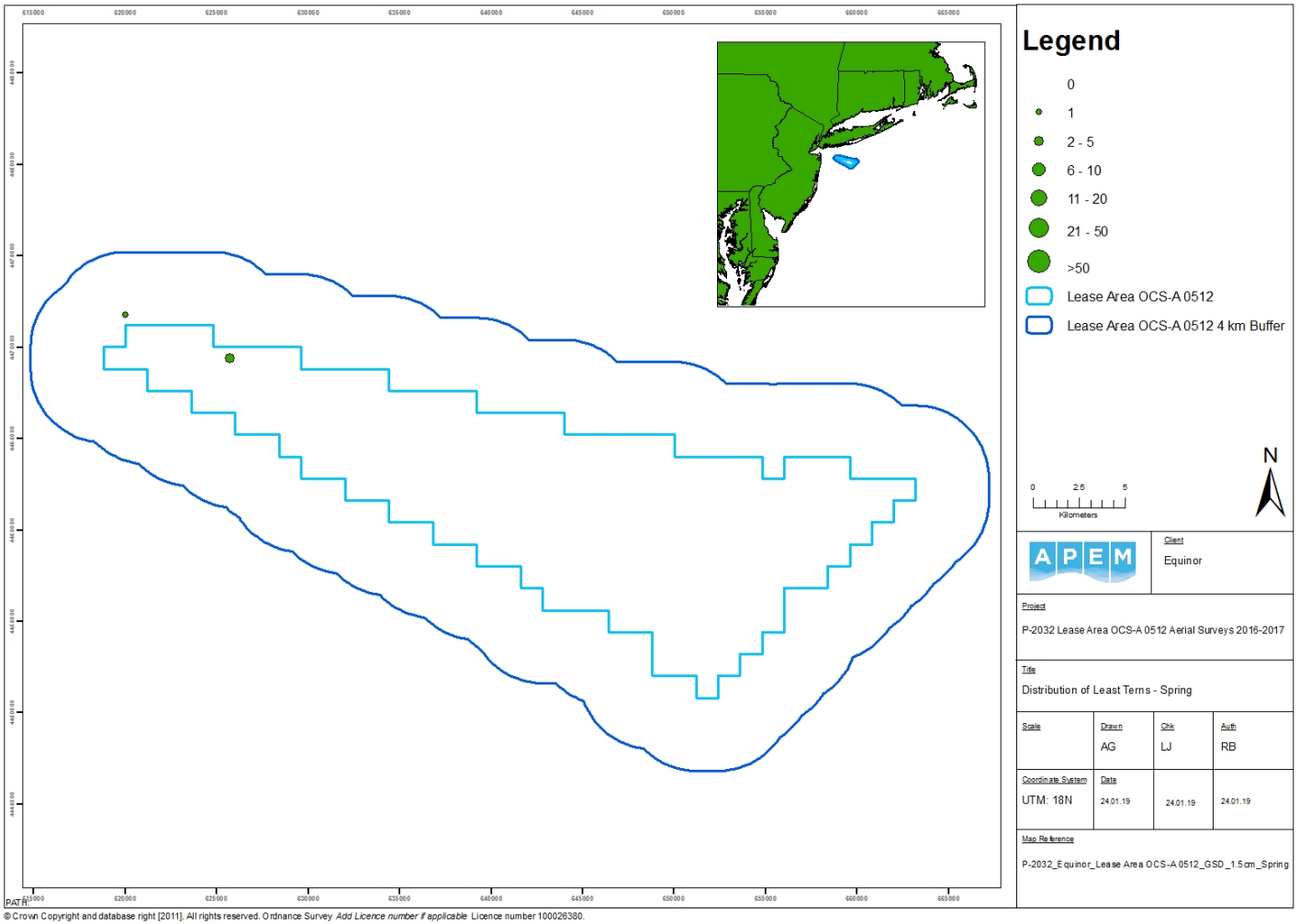
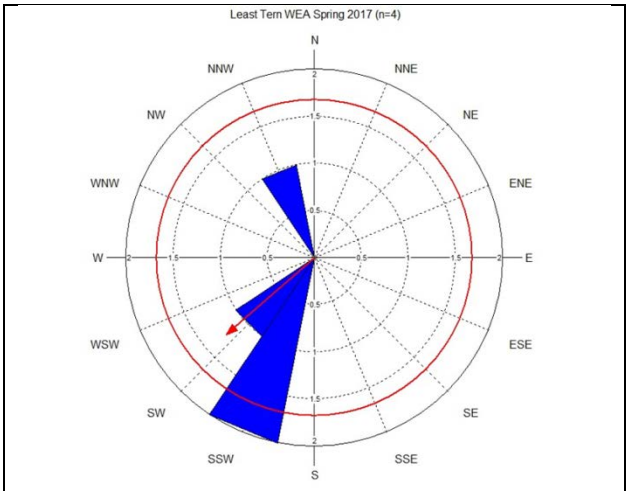


Figure 35 Distribution of least terns recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**4**
Mean Vector	**228.679**
Length of Mean Vector (r)	**0.618**
Rayleigh Test (Z)	**1.525**
Rayleigh Test (p)	**0.23**

Figure 36 Summary of flight direction of least terns (n=4) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the spring survey.

4.16 Sterna Tern Species

Thirteen unknown sterna tern species were recorded in the spring survey, which were concentrated in the north-east of the Lease Area OCS-A 0512 (**Table 21**, **Figure 37**).

A total of 12 unknown sterna tern species were recorded in flight in the spring and were mostly observed flying in a south-westerly direction, with a significant orientation around the mean of 214° (**Figure 38**).

Table 21 **Raw count and abundance and density estimates of (No. estimated individuals per km^2) Sterna tern species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	13	88	0.11	12	1
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	11	73	0.23	10	1
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	2	14	0.03	2	0

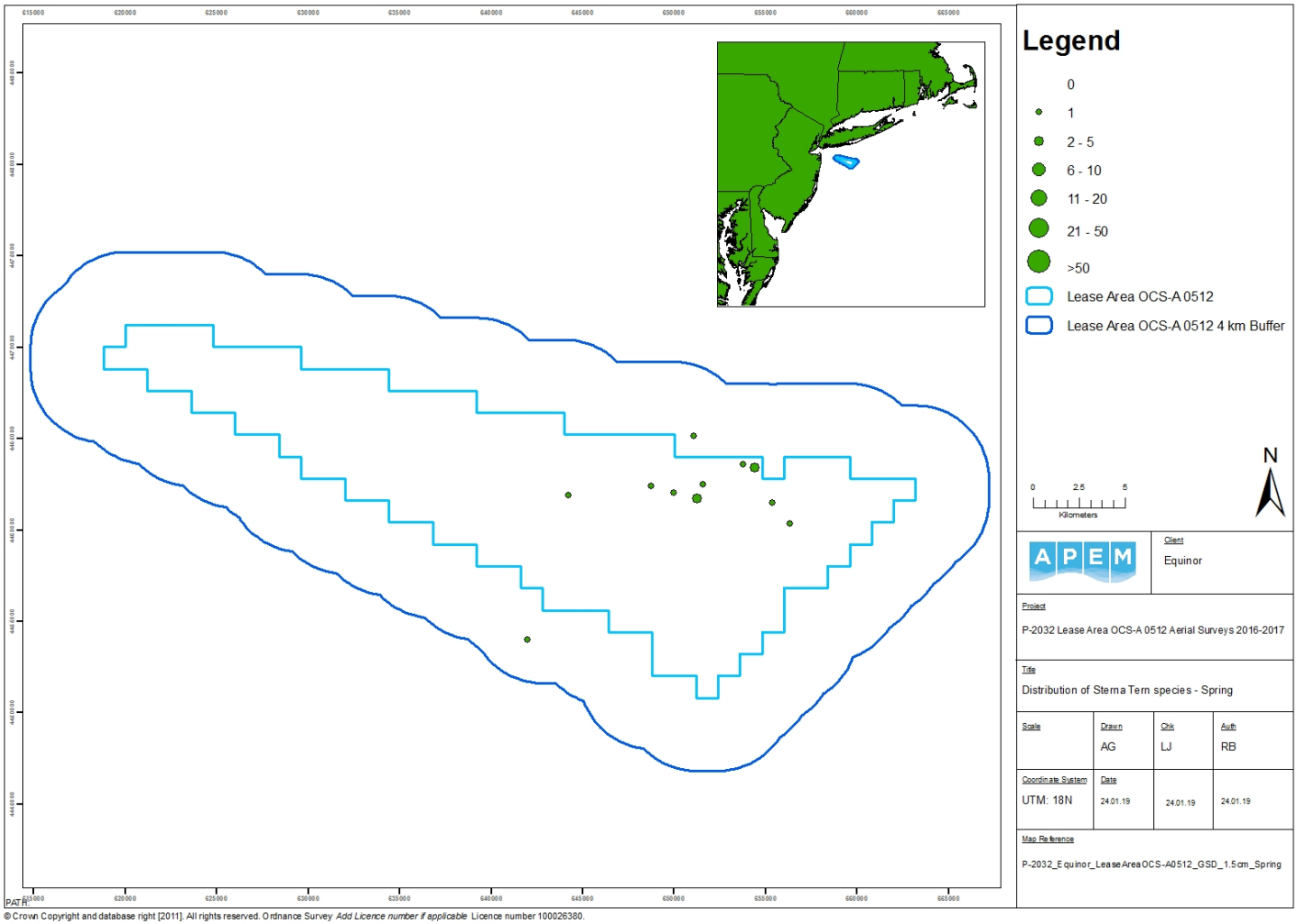
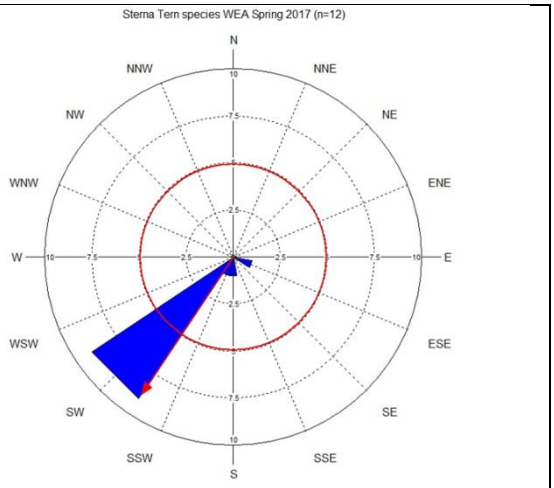


Figure 37 Distribution of Sterna tern species recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**12**
Mean Vector	**213.884**
Length of Mean Vector (r)	**0.87**
Rayleigh Test (Z)	**9.09**
Rayleigh Test (p)	**0.00000229**

Figure 38 Summary of the flight direction of Sterna tern species (n=12) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the spring survey.

4.17 Audubon's shearwater

Four Audubon's shearwaters were recorded in the 4 km buffer in the fall 2016 survey. All four were recorded sitting in a single group (**Table 22**, **Figure 39**).

Table 22 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Audubon's shearwater in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	4	45	0.05	0	4
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	4	42	0.08	0	4
Winter	0	0	-	0	0
Spring	0	0	-	0	0

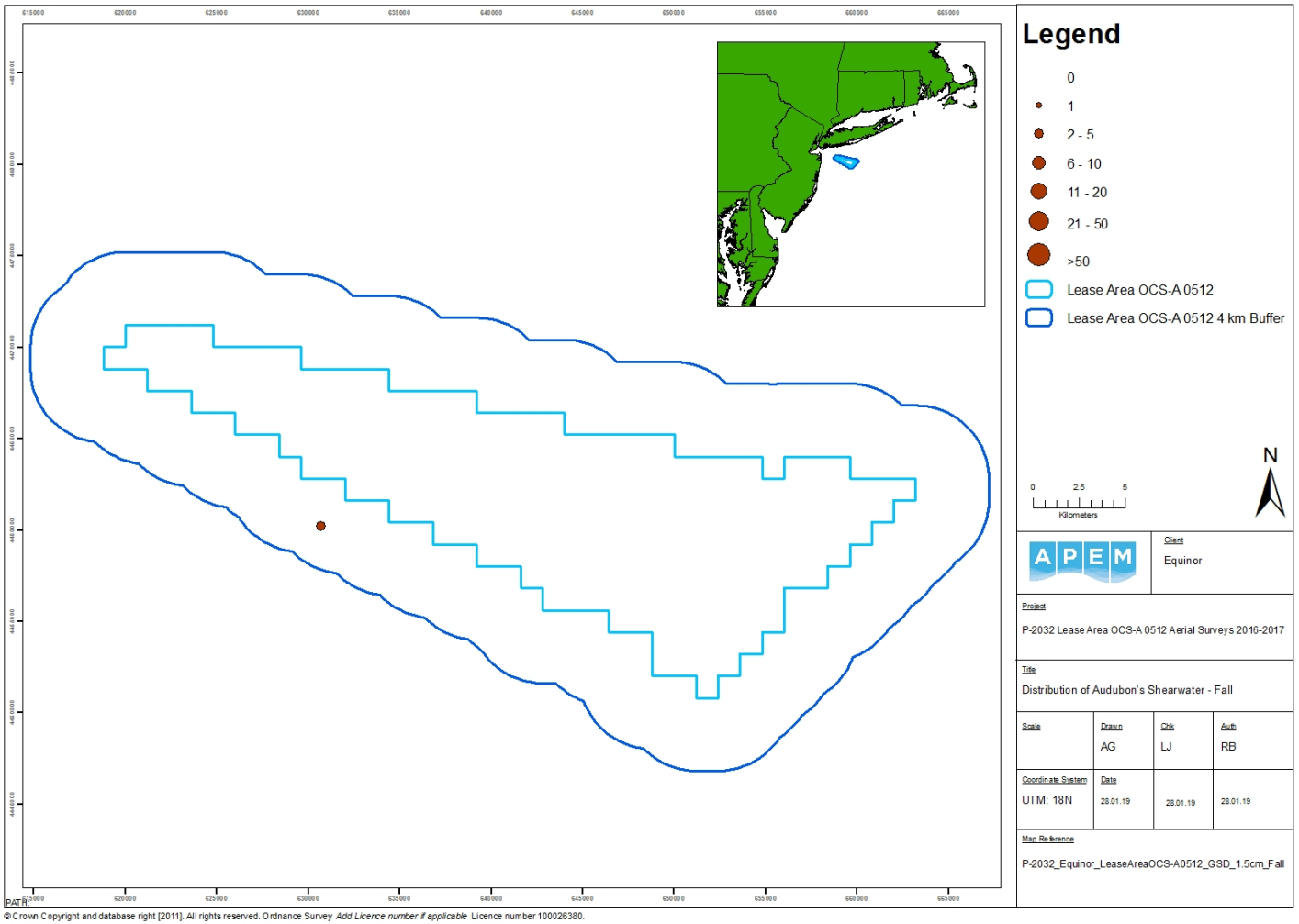


Figure 39 Distribution of Audubon's shearwater recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.18 Cory's Shearwater

A group of 20 Cory's shearwater were recorded sitting in the southern 4 km buffer in the fall survey of the Lease Area OCS-A 0512 (**Table 23**, **Figure 40**).

Table 23 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Cory's shearwater in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	20	224	0.27	0	20
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	20	212	0.43	0	20
Winter	0	0	-	0	0
Spring	0	0	-	0	0

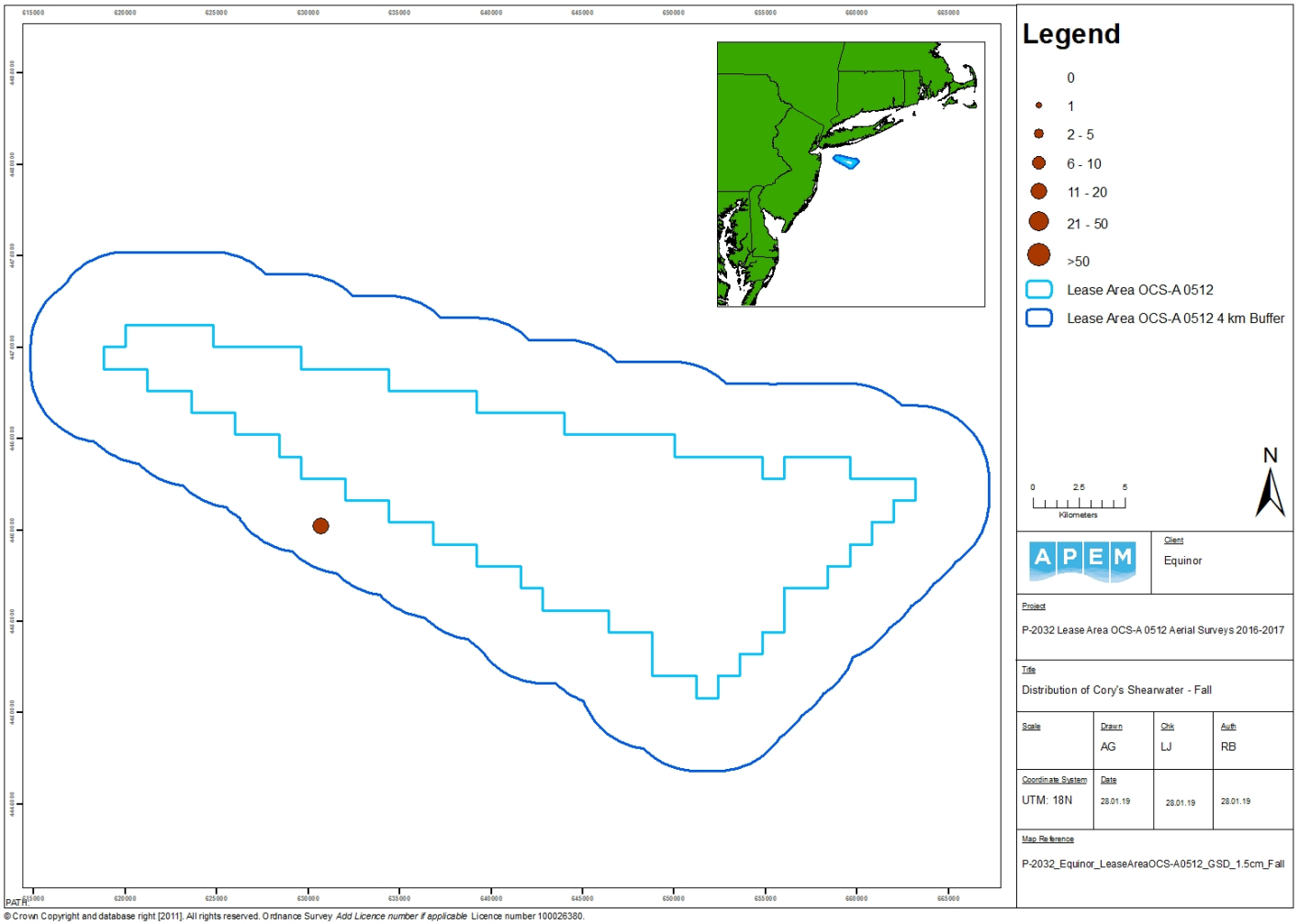


Figure 40 Distribution of Cory's shearwater recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.19 Species Unknown – Storm Petrel

A single unknown storm petrel species was recorded in the north-east of the Lease Area OCS-A 0512 in the spring survey (**Table 24**, **Figure 41**).

The single unknown storm petrel species was recorded in flight in the spring, flying in a south-south-westerly direction (**Figure 42**).

Table 24 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of storm petrel species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	1	7	0.01	1	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	0	0	0
Spring	1	7	0.02	1	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

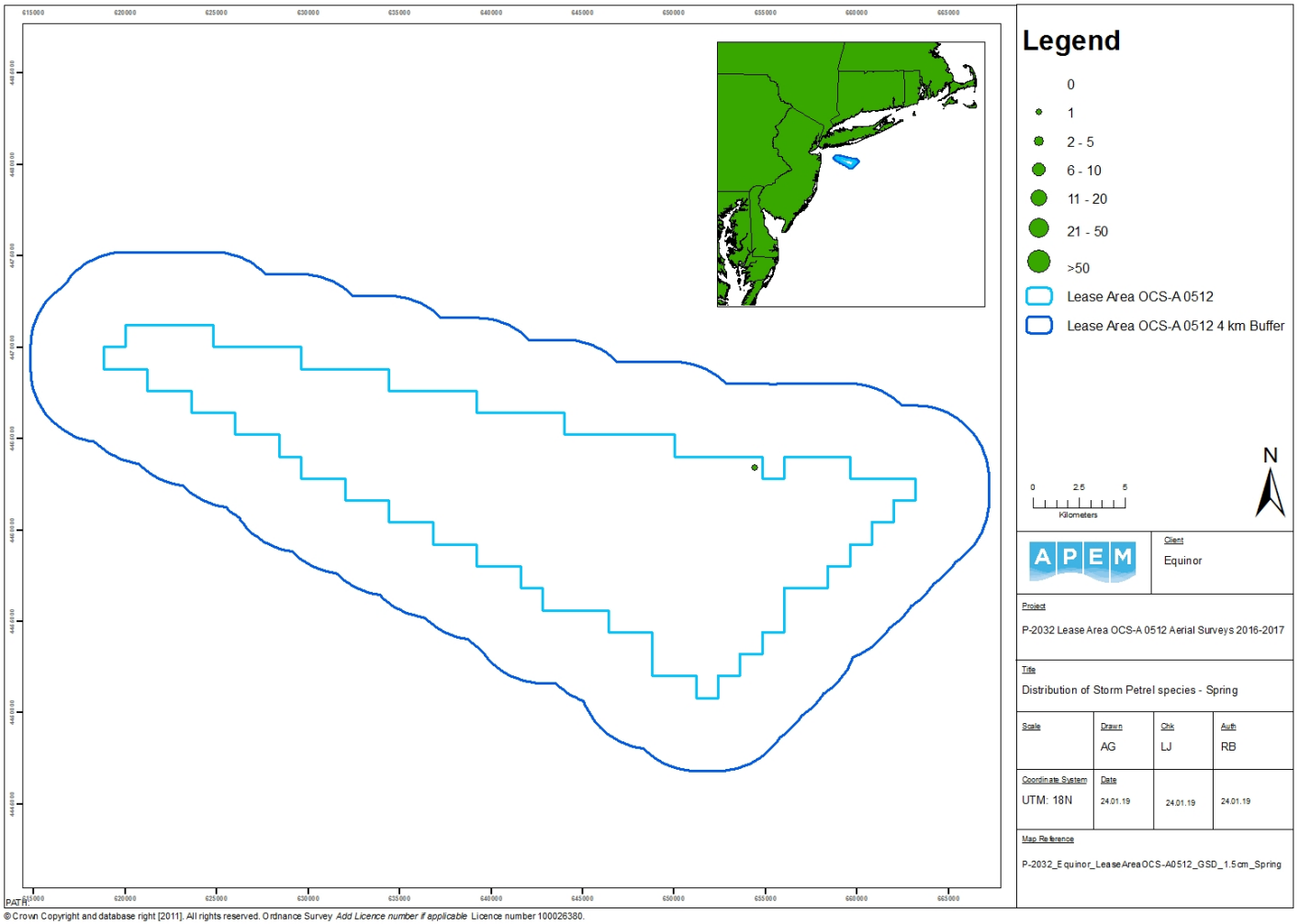
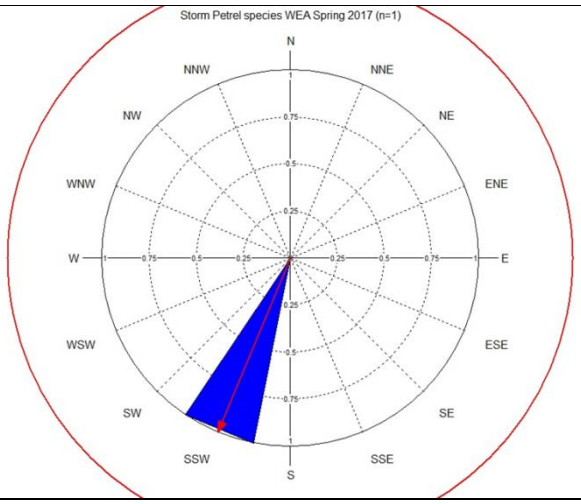


Figure 41 Distribution of unknown storm petrels recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**1**
Mean Vector	**202.5**
Length of Mean Vector (r)	**1**
Rayleigh Test (Z)	**1**
Rayleigh Test (p)	**0.512**

Figure 42 Summary of flight direction of storm petrel species (n=1) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the spring season.

4.20 Species Unknown - Shorebird

A group of seven unknown shorebird species was recorded in the west of the 4 km buffer of the Lease Area OCS-A 0512 in the summer survey (**Table 25**, **Figure 43**).

All seven unknown shorebird species were observed in flight in summer survey and were observed flying in a north-easterly direction around a mean orientation of 45° (**Figure 44**).

Table 25 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of shorebirds in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	7	57	0.07	7	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Flying**	**Sitting**
Summer	7	57	0.11	7	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

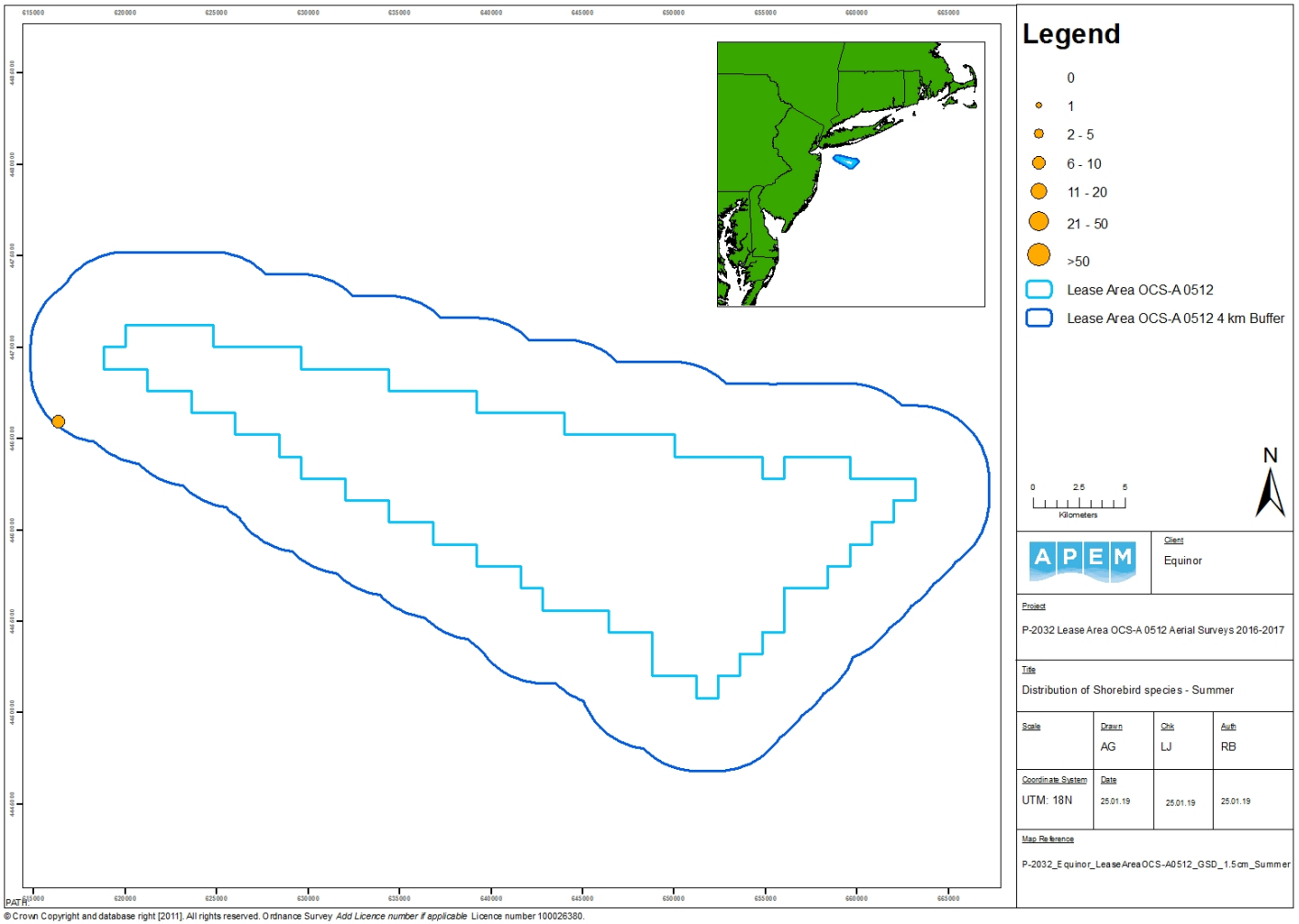
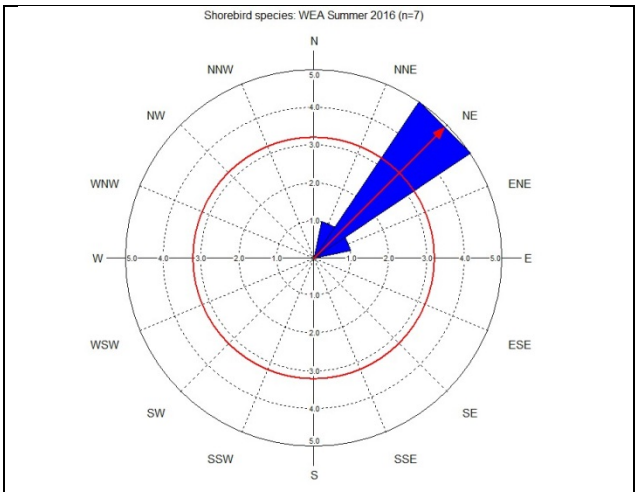


Figure 43 Distribution of unknown shorebirds recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.



Number of Observations	**7**
Mean Vector	**45**
Length of Mean Vector (r)	**0.978**
Rayleigh Test (Z)	**6.699**
Rayleigh Test (p)	**< 1E-12**

Figure 44 Summary of shorebird species (n=7) recorded in the Lease Area OCS-A 0512 plus 4 km buffer in the summer season.

4.21 Species Unknown – Dolphin

In the summer, a group of two unknown dolphin species were recorded in the west of the Lease Area OCS-A 0512 site (**Table 26**, **Figure 45**). In the spring, a group of seven individuals was recorded in the north eastern region of the wind farm (**Table 26**, **Figure 46**).

Table 26 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of dolphin species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	2	16	0.02	0	2
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	7	47	0.06	0	7
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	2	16	0.05	0	2
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	7	48	0.10	0	7

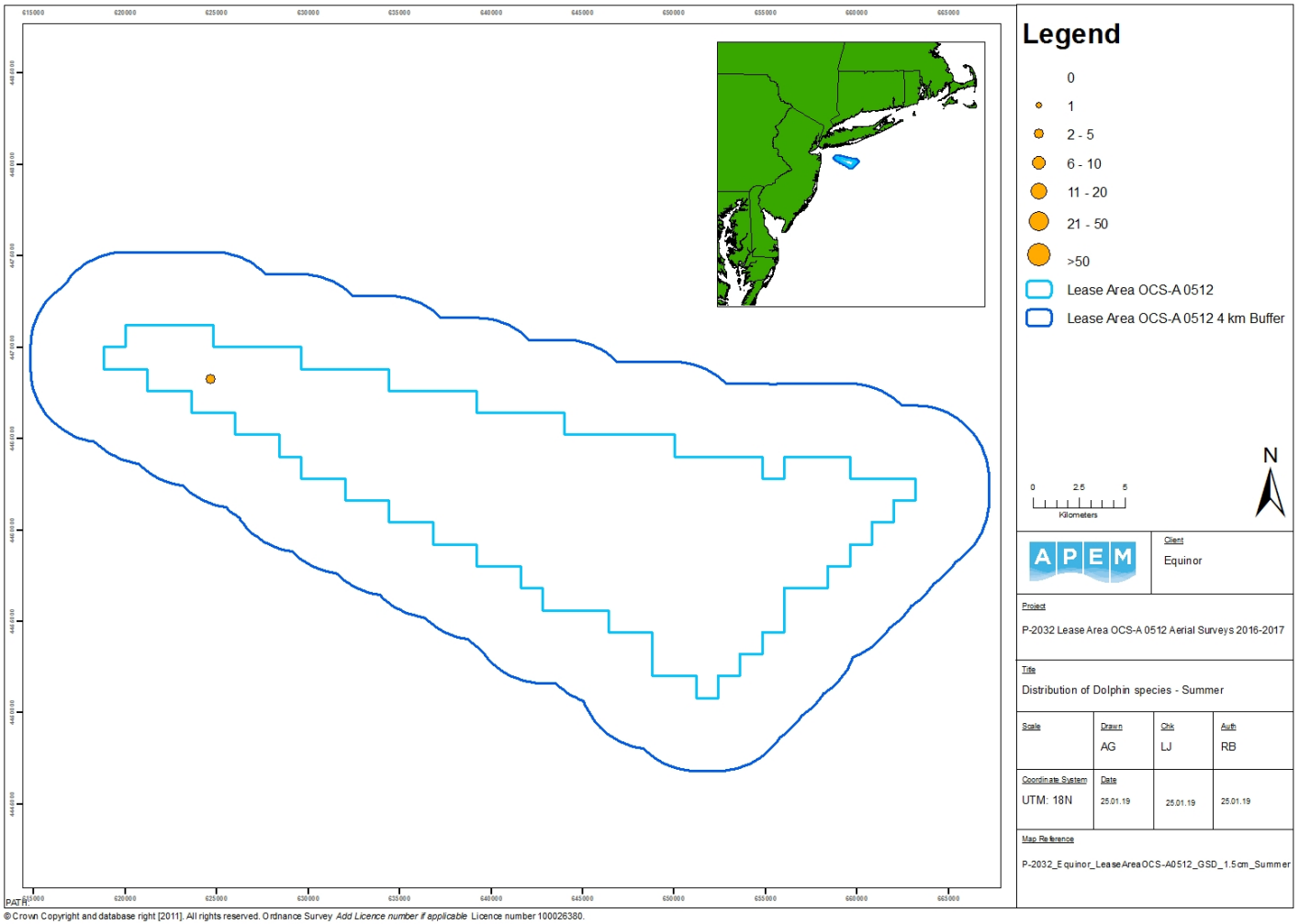


Figure 45 Distribution of unknown dolphin species recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

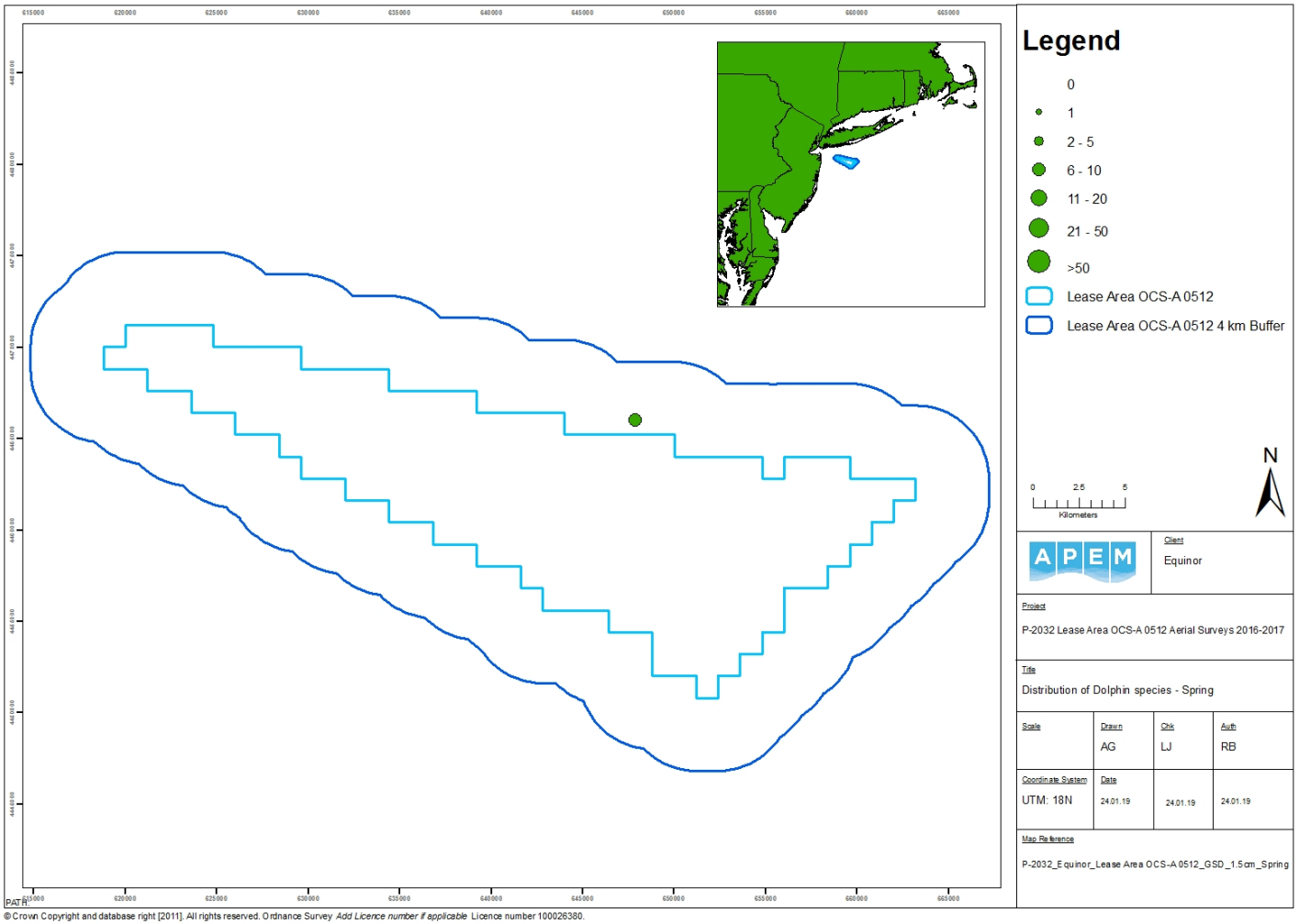


Figure 46 Distribution of unknown dolphin species recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.22 Loggerhead turtle

Four loggerhead turtles were recorded in the Lease Area OCS-A 0512 in the summer survey, with three being recorded in the 4 km buffer and one in the Lease Area OCS-A 0512 site (**Table 27**, **Figure 47**).

Table 27 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Loggerhead turtles in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	4	33	0.04	0	4
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.02	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	3	25	0.05	0	3
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

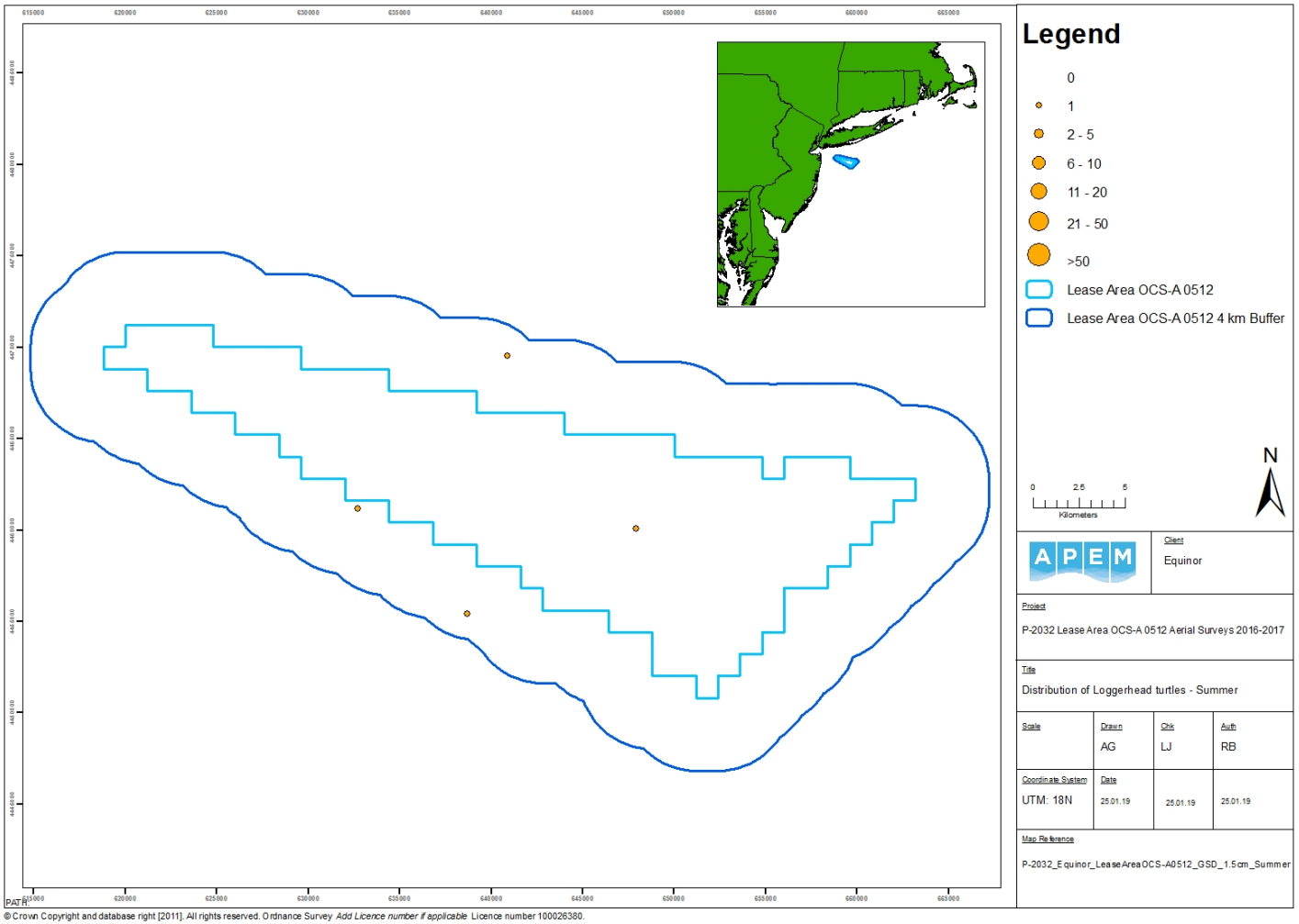


Figure 47 Distribution of Loggerhead turtles recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.23 Leatherback turtle

In the fall survey, a single Leatherback turtle in the south-east of the Lease Area OCS-A 0512 inside the 4 km buffer zone (**Table 28**, **Figure 48**).

Table 28 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Leatherback turtles in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	-
Fall	1	11	0.01	1	-
Winter	0	0	-	0	-
Spring	0	0	-	0	-
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	-
Fall	0	0	-	0	-
Winter	0	0	-	0	-
Spring	0	0	-	0	-
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	-
Fall	1	11	0.02	1	-
Winter	0	0	-	0	-
Spring	0	0	-	0	-

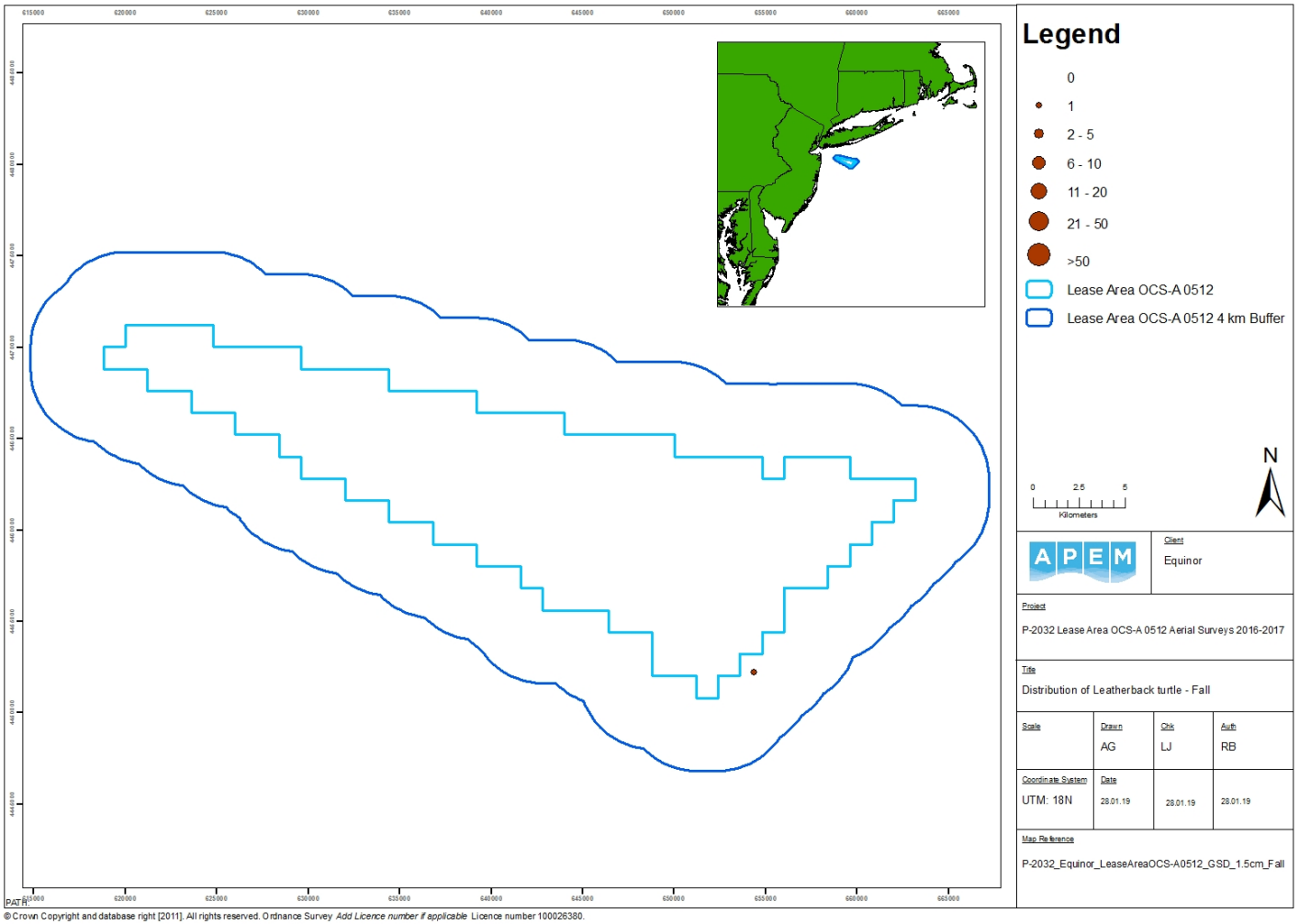


Figure 48 Distribution of Leatherback turtles recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.24 Kemp's Ridley Turtle

A single Kemp's Ridley turtle was recorded in the south of the Lease Area OCS-A 0512, in the 4 km buffer, in the summer survey (**Table 29**, **Figure 49**).

Table 29 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Kemp's Ridleys turtles in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.01	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.02	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

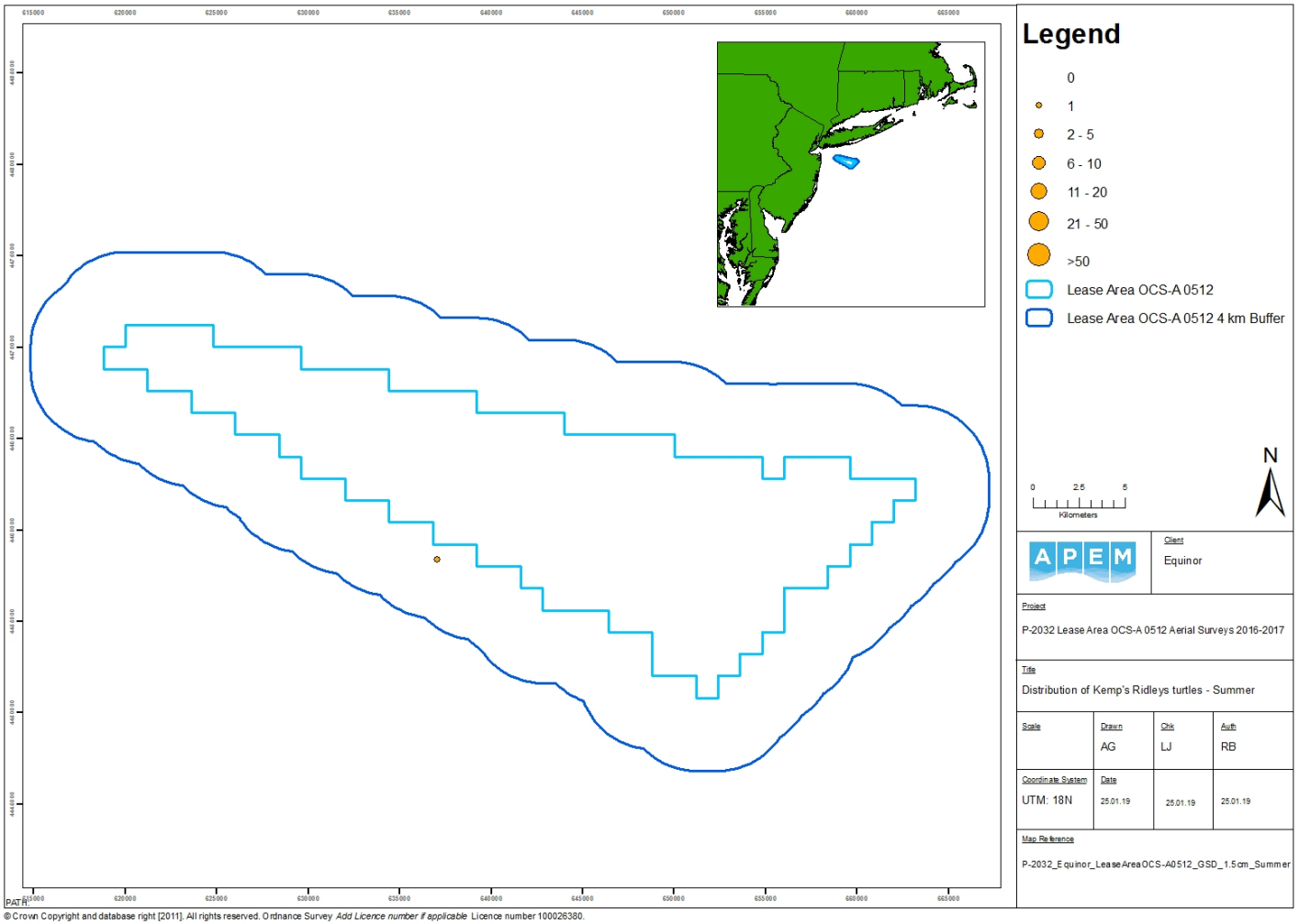


Figure 49 Distribution of Kemp's Ridley turtle recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.25 Species Unknown - Turtle

Eight individual unknown turtle species were recorded in the summer survey of Lease Area OCS-A 0512 (**Table 30**, **Figure 50**).

Table 30 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of turtle species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	8	65	0.08	0	8
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	4	32	0.1	0	4
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	4	33	0.07	0	4
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

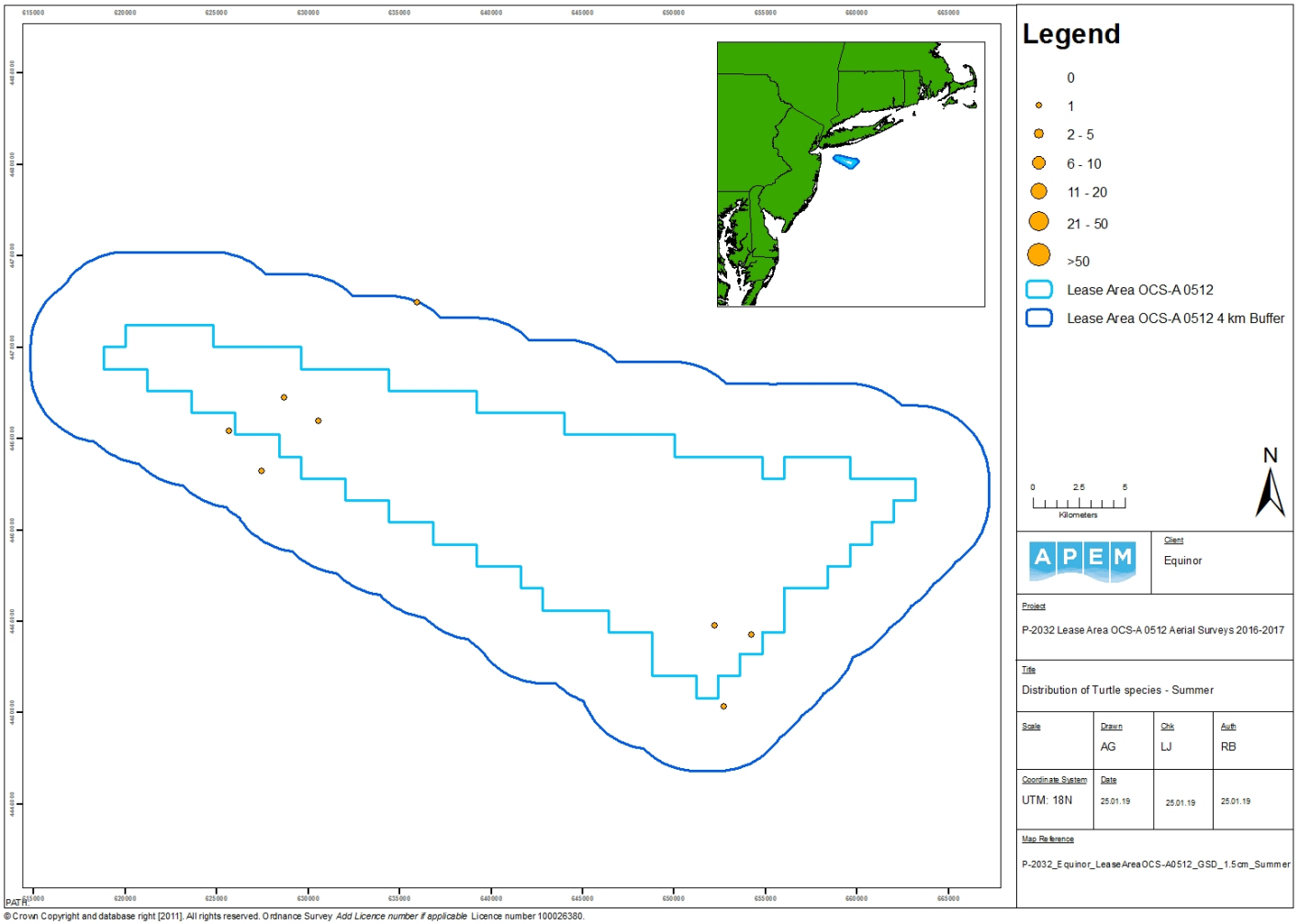


Figure 50 Distribution of unknown turtle species recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.26 Basking Shark

In the spring survey, a single basking shark was recorded in the north-east of the 4 km buffer of Lease Area OCS-A 0512 (**Table 31**, **Figure 51**).

Table 31 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of basking sharks in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	1	7	0.01	0	1
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	1	7	0.01	0	1

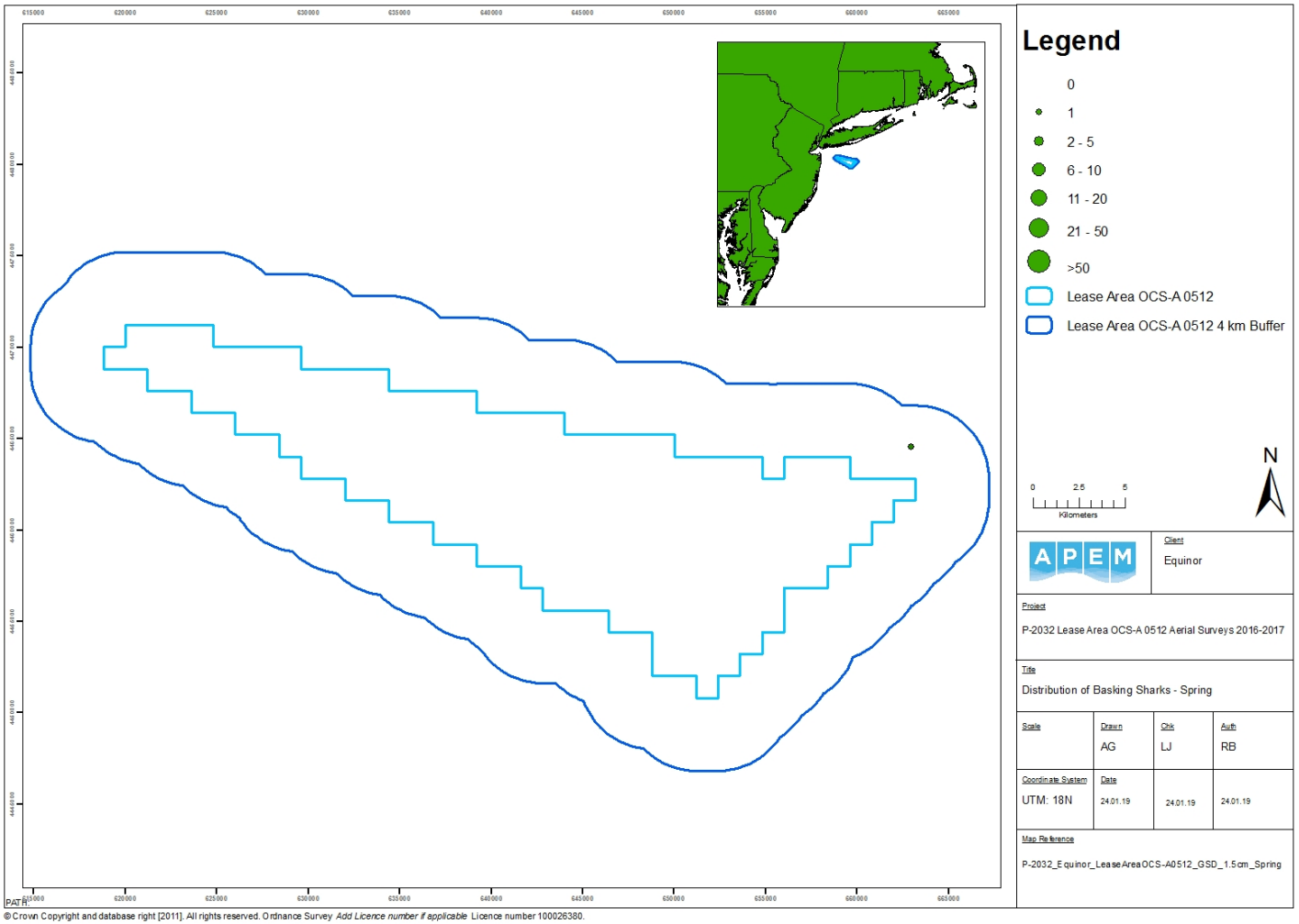


Figure 51 Distribution of basking sharks recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.27 Species Unknown - Carcharhinidae

In the summer survey, a total of 17 Carcharhinidae species were recorded loosely distributed around the Lease Area OCS-A 0512 (**Table 32**, **Figure 52**).

Table 32 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Carcharhinidae species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	17	139	0.17	0	17
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	4	32	0.10	0	4
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	13	107	0.21	0	13
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

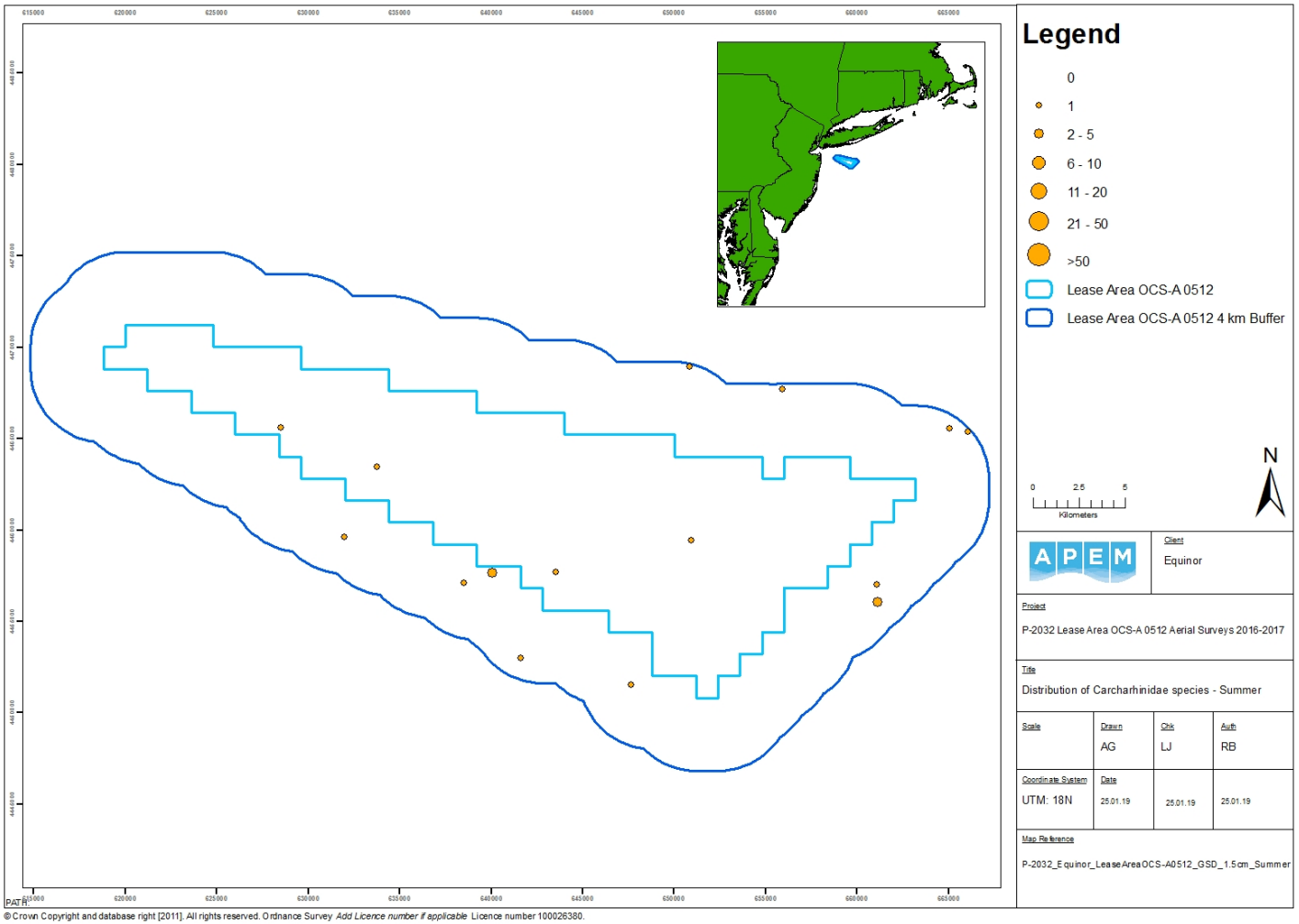


Figure 52 Distribution of Carcharhinidae species recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.28 Species Unknown - Hammerhead

In the summer survey, a single unknown hammerhead species was recorded in the east of the Lease Area OCS-A 0512 (**Table 33**, **Figure 53**).

Table 33 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of hammerhead species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.01	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.02	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

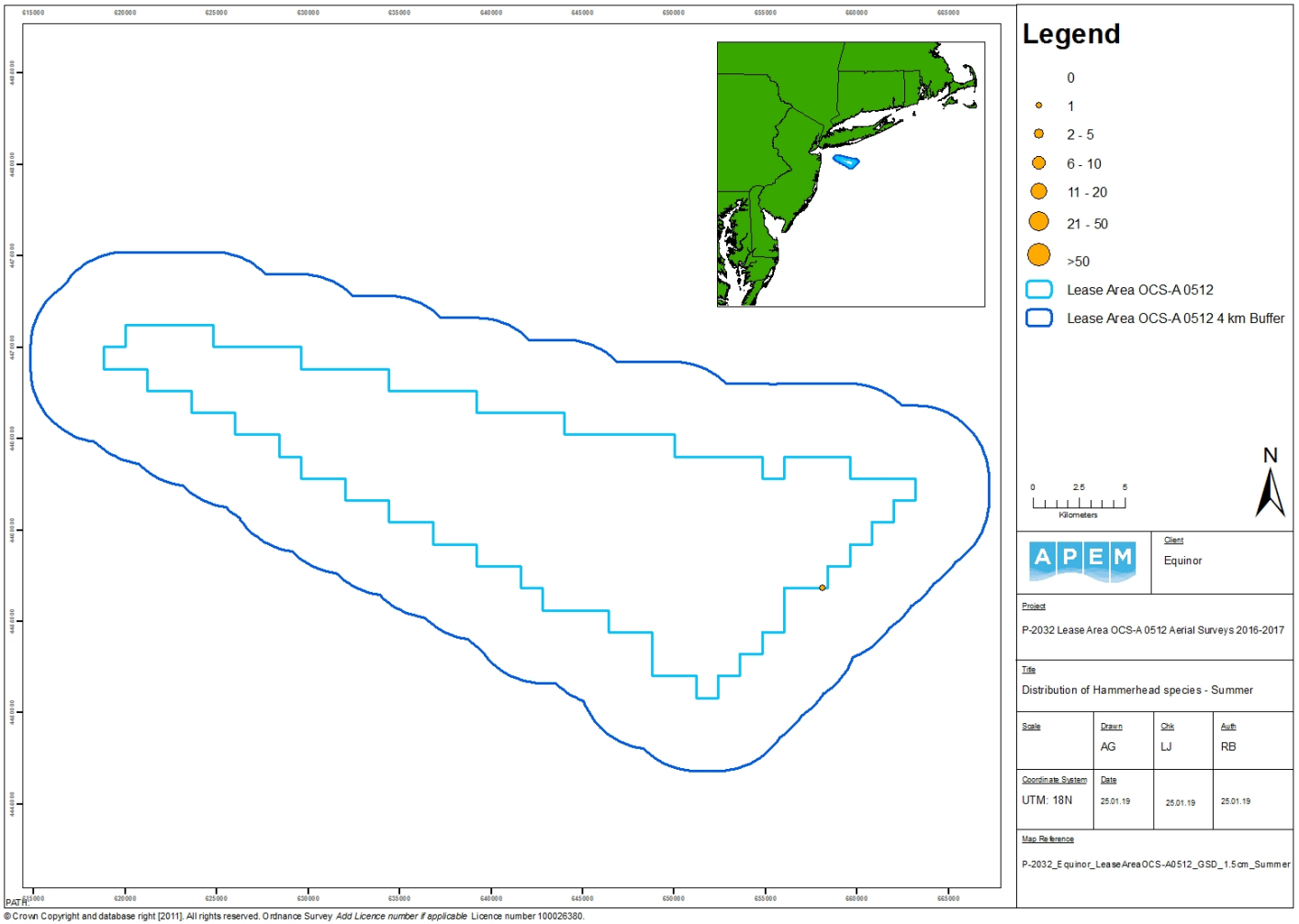


Figure 53 Distribution of unknown Hammerhead species recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.29 Species Unknown - Shark

In the summer survey, 140 unknown shark species were recorded in the Lease Area OCS-A 0512. Shark species were loosely distributed around the Lease Area OCS-A 0512 (**Table 34**, **Figure 54**). In the spring survey, a single unknown shark species was recorded in the westerly region of the 4 km buffer of the Lease Area OCS-A 0512 (**Table 34**, **Figure 55**).

Table 34 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of shark species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	140	1142	1.39	0	140
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	1	7	0.01	0	1
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	29	234	0.73	0	29
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	111	911	1.83	0	111
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	1	7	0.01	0	1

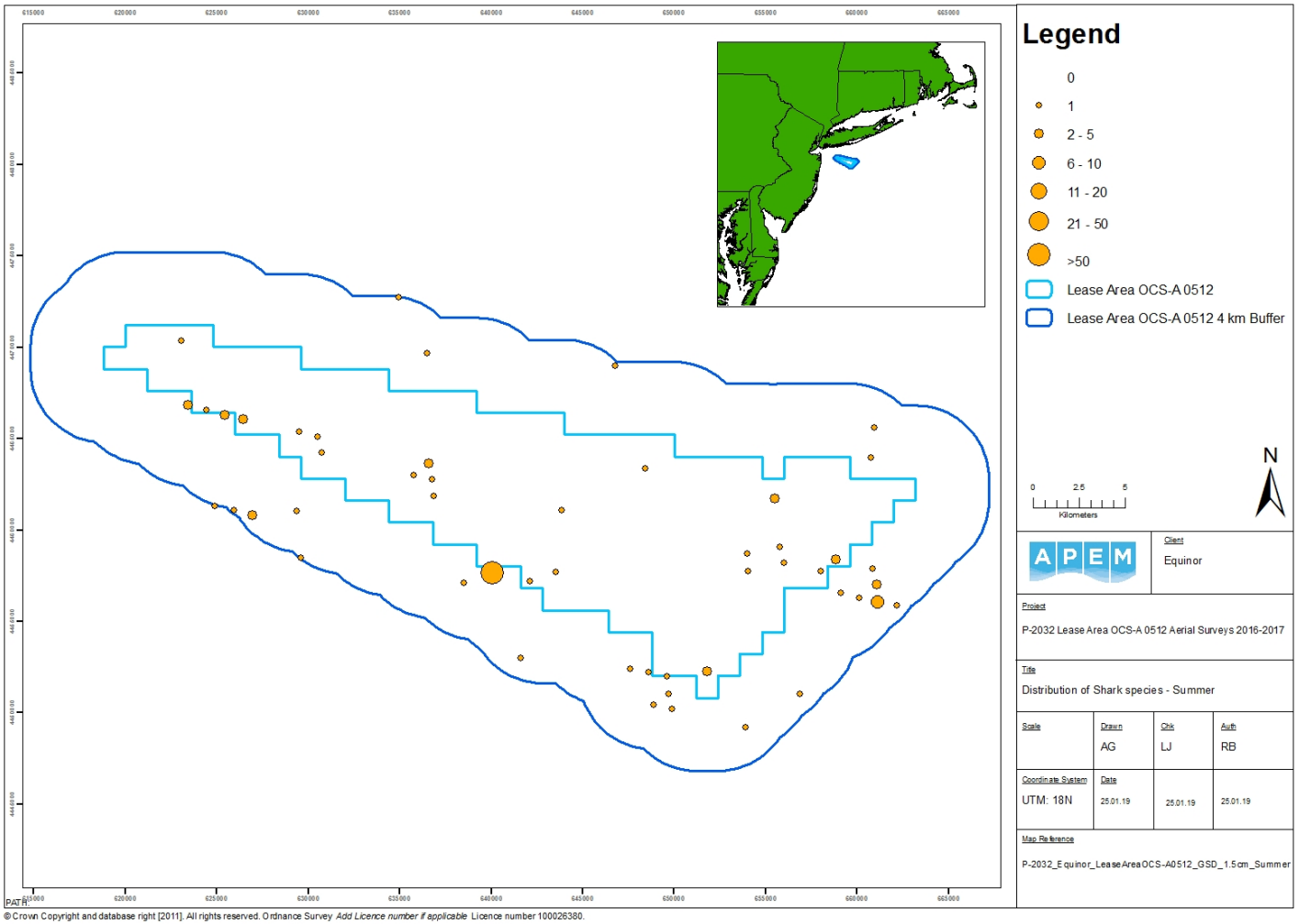


Figure 54 Distribution of unknown shark species sharks recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

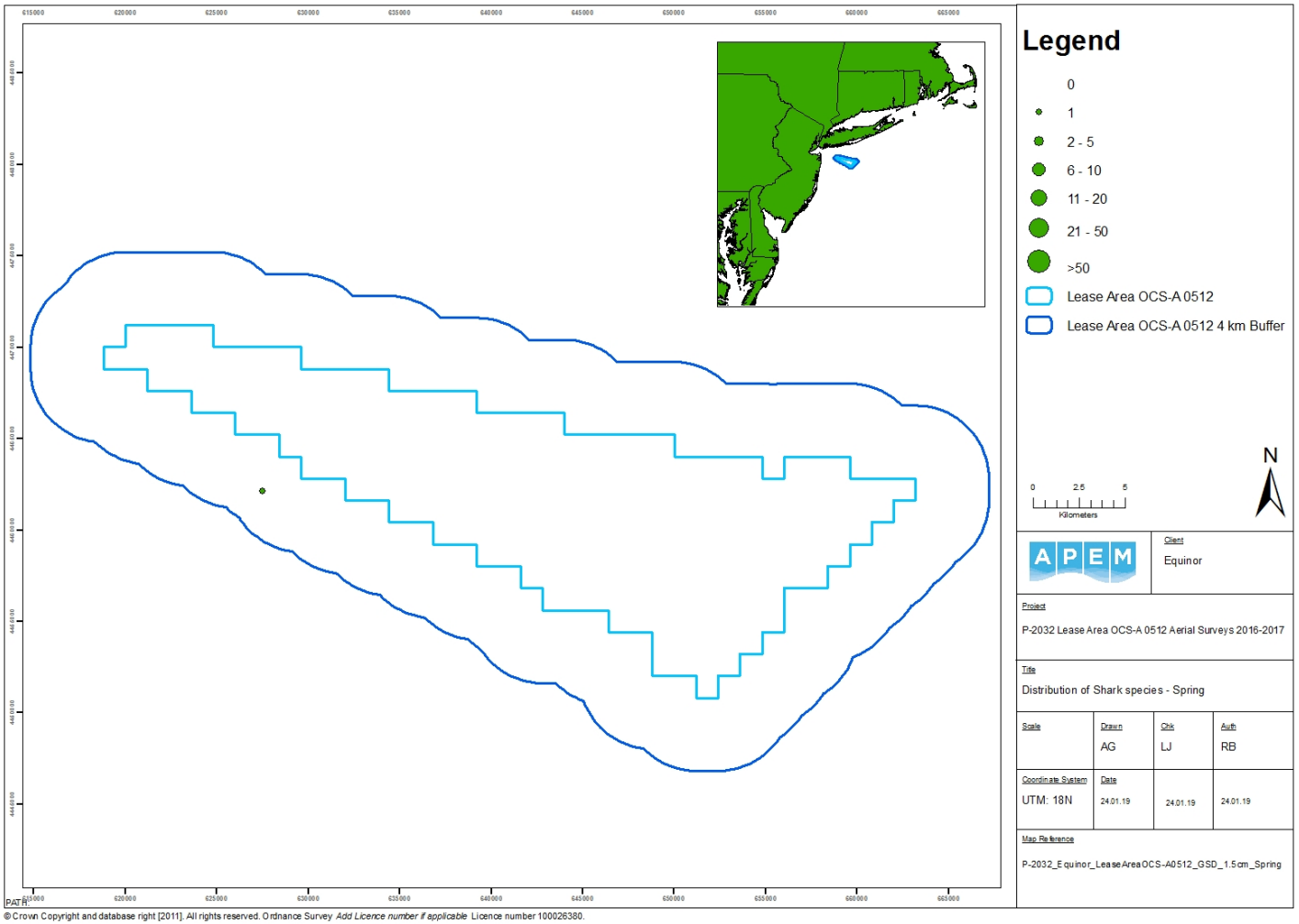


Figure 55 Distribution of unknown shark species recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.30 Cownose Ray

In the summer survey, 15 cownose rays were recorded in the Lease Area OCS-A 0512, located in the north-west region (**Table 35**, **Figure 56**).

Table 35 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of cownose rays in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	15	122	0.15	0	15
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	14	113	0.35	0	14
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.02	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

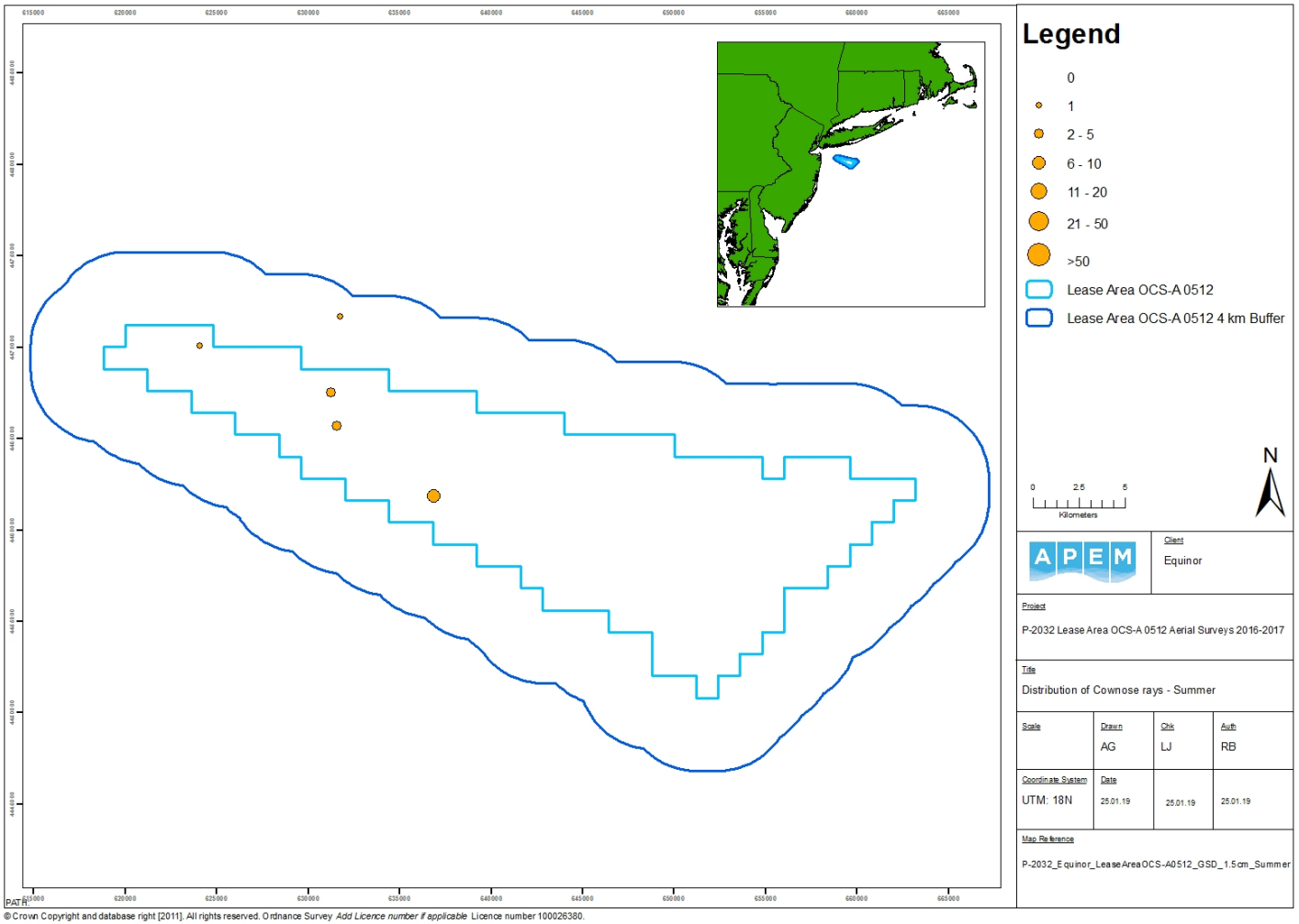


Figure 56 Distribution of cownose rays recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.31 Cownose / Bullnose Ray

Twenty-eight cownose / bullnose rays were recorded in the summer survey, entirely concentrated in the west of the Lease Area OCS-A 0512 (**Table 36, Figure 57**).

Table 36 **Raw count and abundance and density estimates of (No. estimated individuals per km^2) cownose / bullnose rays in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	28	228	0.28	0	28
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	6	48	0.15	0	6
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	22	181	0.36	0	22
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

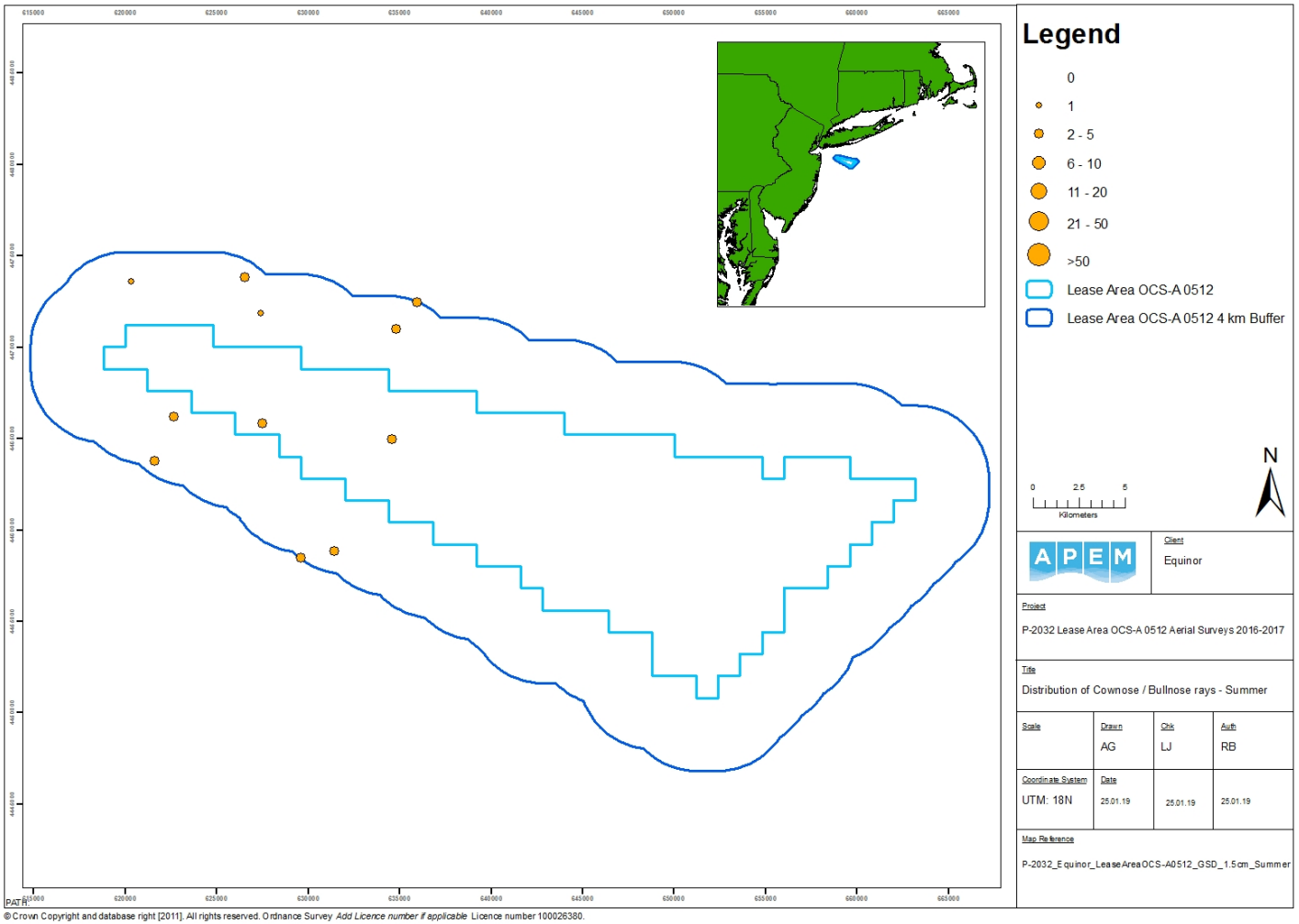


Figure 57 Distribution of cownose / bullnose rays recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.32 Species Unknown - Ray

A total of 148 unknown were species were recorded in the summer survey, predominately concentrated in the west of the Lease Area OCS-A 0512 (**Table 37**, **Figure 58**).

Table 37 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of unknown ray species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	148	1207	1.47	0	148
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	51	412	1.28	0	51
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	97	796	1.6	0	97
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

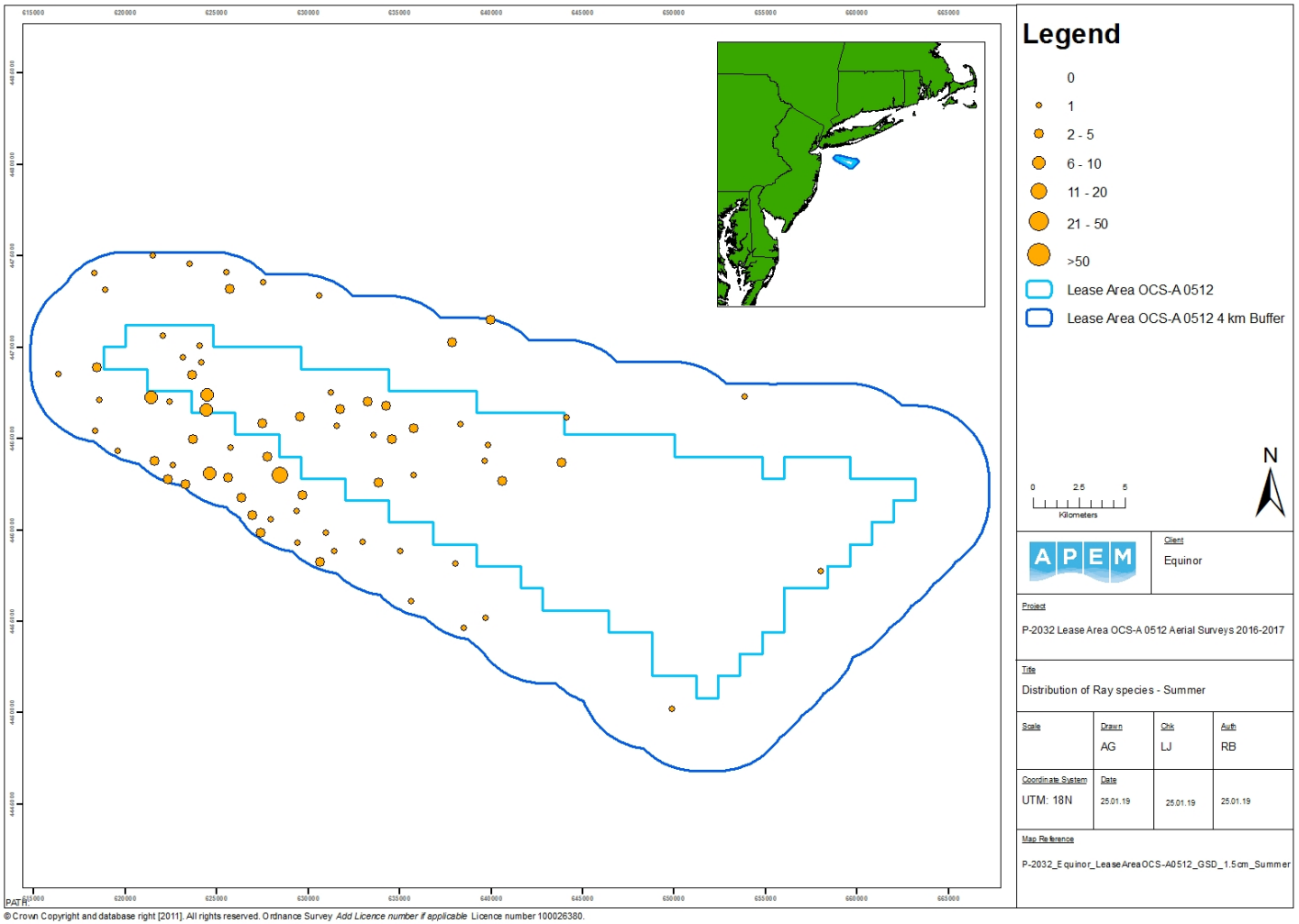


Figure 58 Distribution of unknown ray species recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.33 Ocean Sunfish

In the fall survey, three ocean sunfish were recorded in the Lease Area OCS-A 0512. Two were recorded in the Lease Area OCS-A 0512 site, and the third in the northern 4 km buffer (**Table 38**, **Figure 59**).

Table 38 **Raw count and abundance and density estimates of (No. estimated individuals per km^2) ocean sunfish in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	3	34	0.01	0	3
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	3	37	0.12	0	3
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

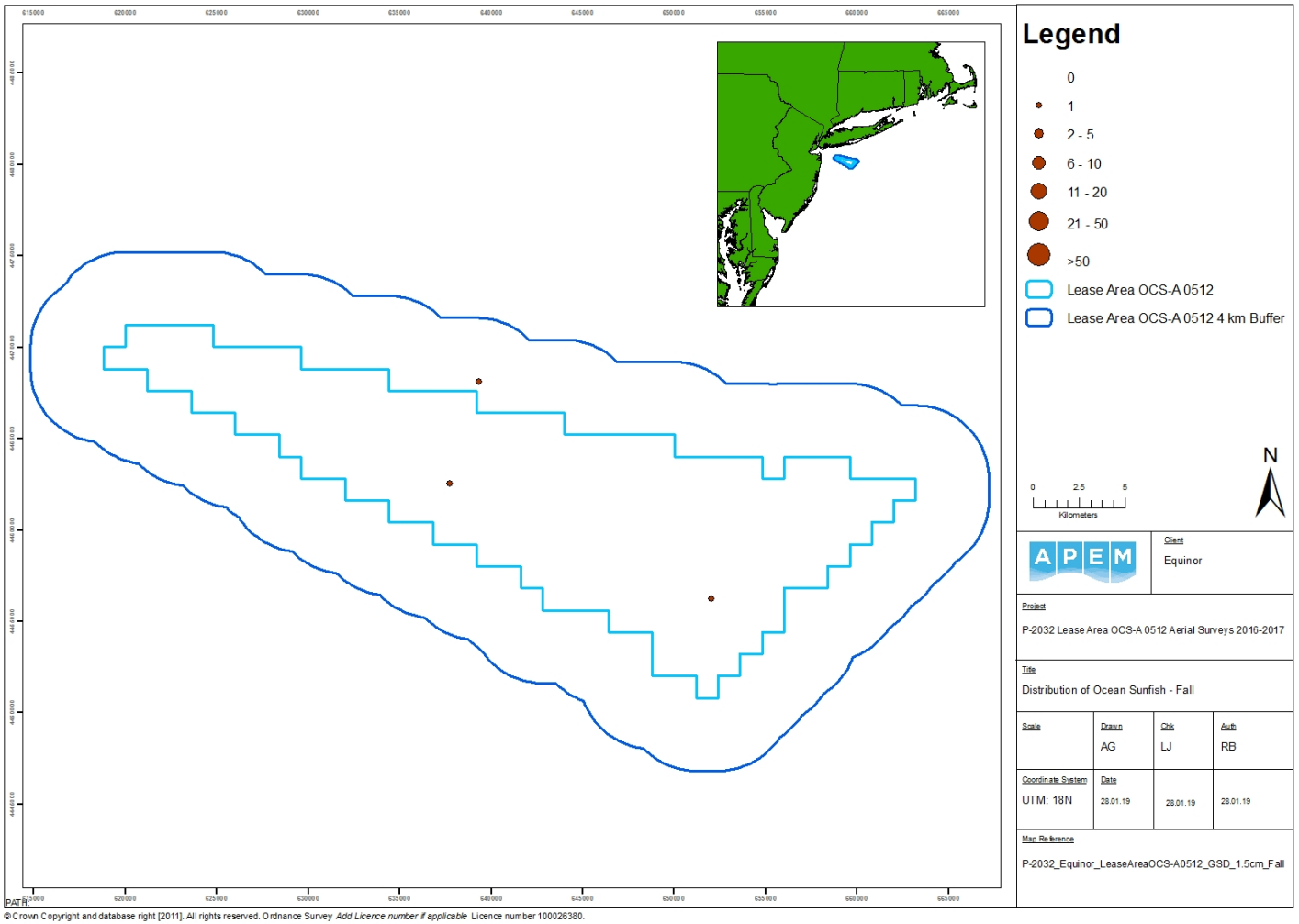


Figure 59 Distribution of ocean sunfish recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.34 Sharptail Sunfish

In the fall, a single sharptail sunfish was recorded in the north-west of the 4 km buffer zone (**Table 39**, **Figure 60**).

Table 39 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Sharptail sunfish in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	1	11	0.01	0	1
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	1	11	0.02	0	1
Winter	0	0	-	0	0
Spring	0	0	-	0	0

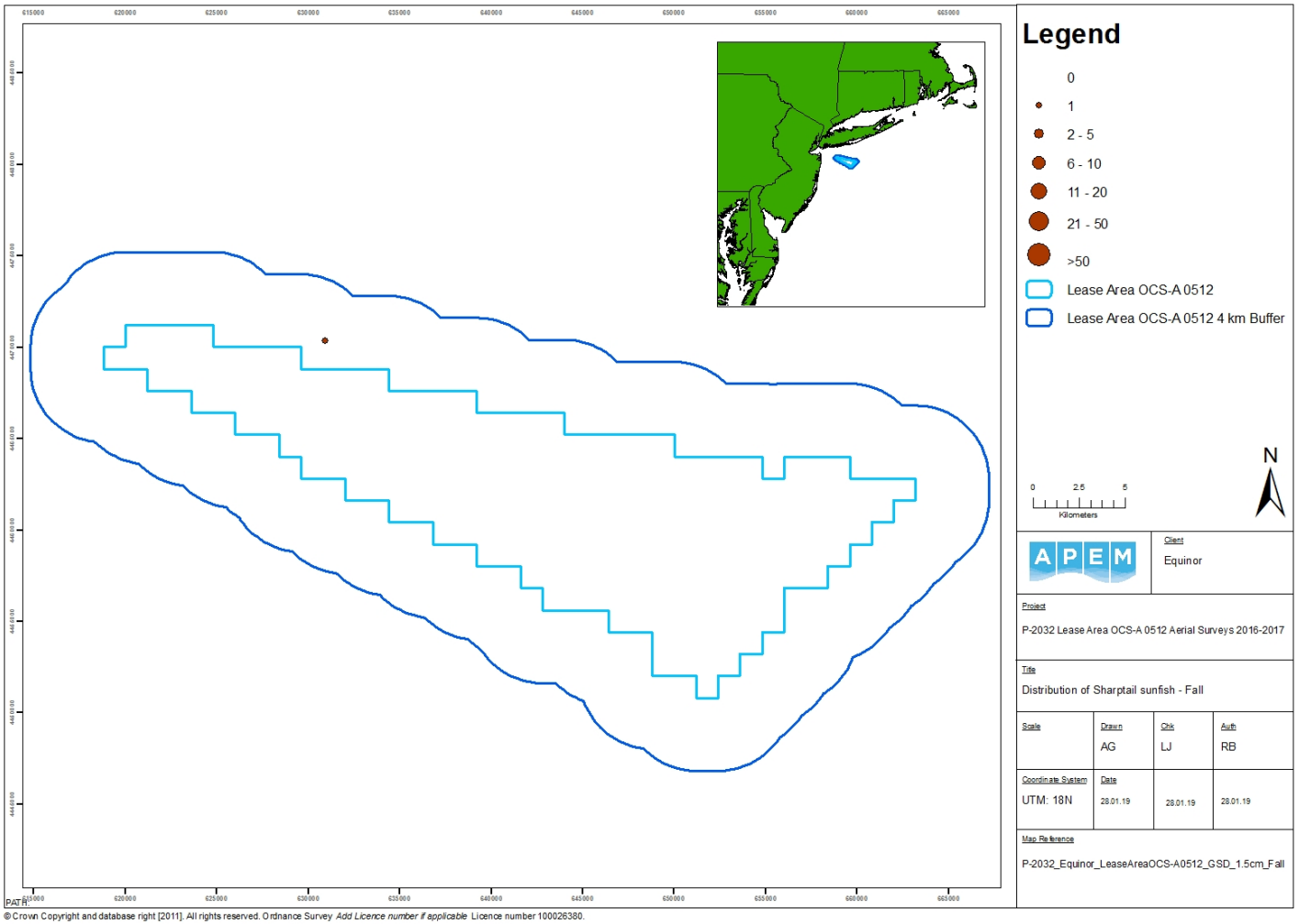


Figure 60 Distribution of Sharptail Sunfish recorded in the fall 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.35 Species Unknown - Sunfish

A single unknown sunfish species was recorded in the south-east of the Lease Area OCS-A 0512 in the 4 km buffer, in the winter survey (**Table 40**, **Figure 61**).

Table 40 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of unknown sunfish in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	1	8	0.01	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	1	8	0.02	0	1
Spring	0	0	-	0	0

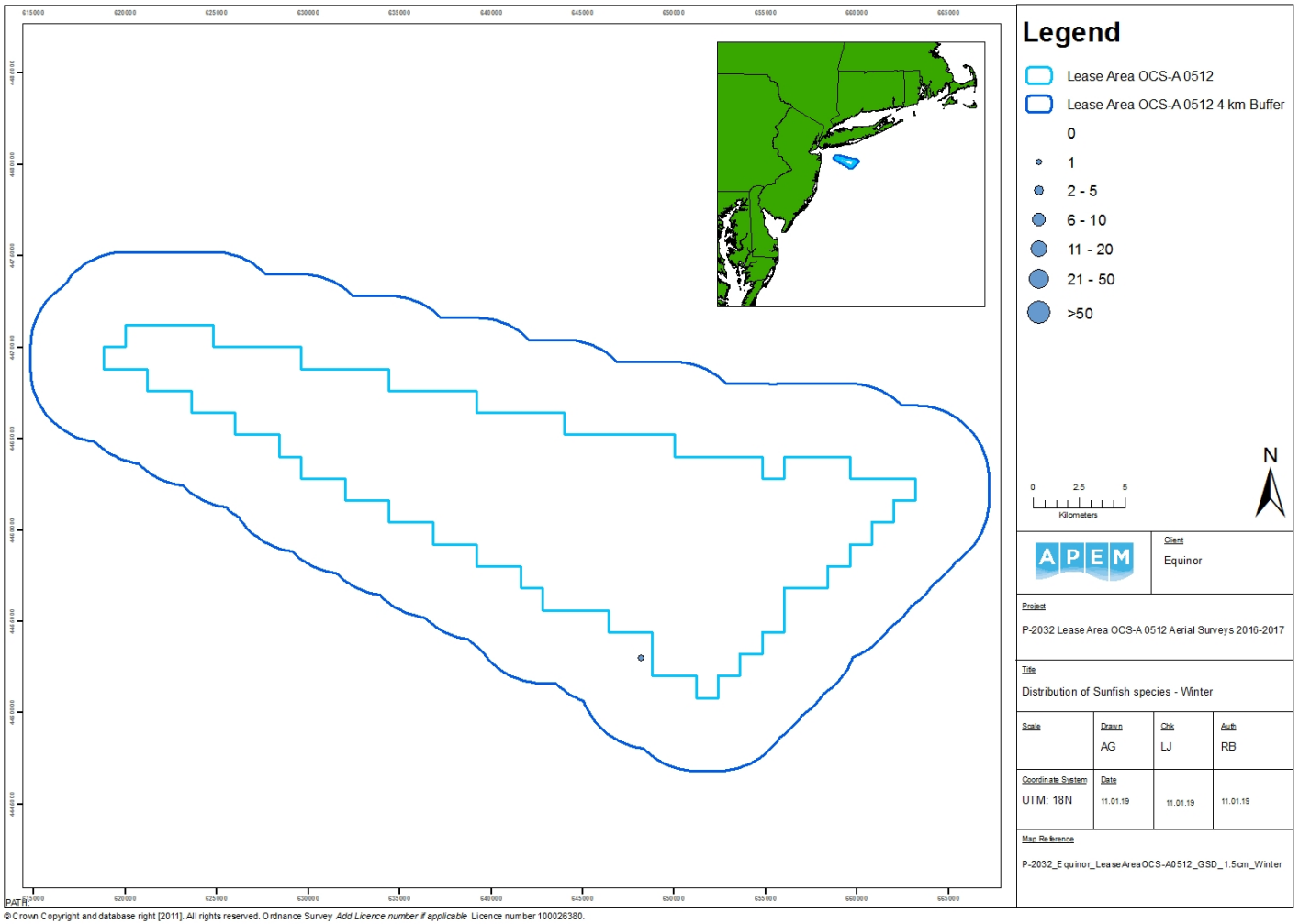


Figure 61 **Distribution of unknown sunfish species recorded in the winter 2016-2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.**

4.36 Mahi-mahi

A single mahi-mahi was recorded in the east of the Lease Area OCS-A 0512 in the 4 km buffer in the summer survey (**Table 41**, **Figure 62**).

Table 41 **Raw count and abundance and density estimates of (No. estimated individuals per km^2) mahi-mahi in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.01	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.02	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

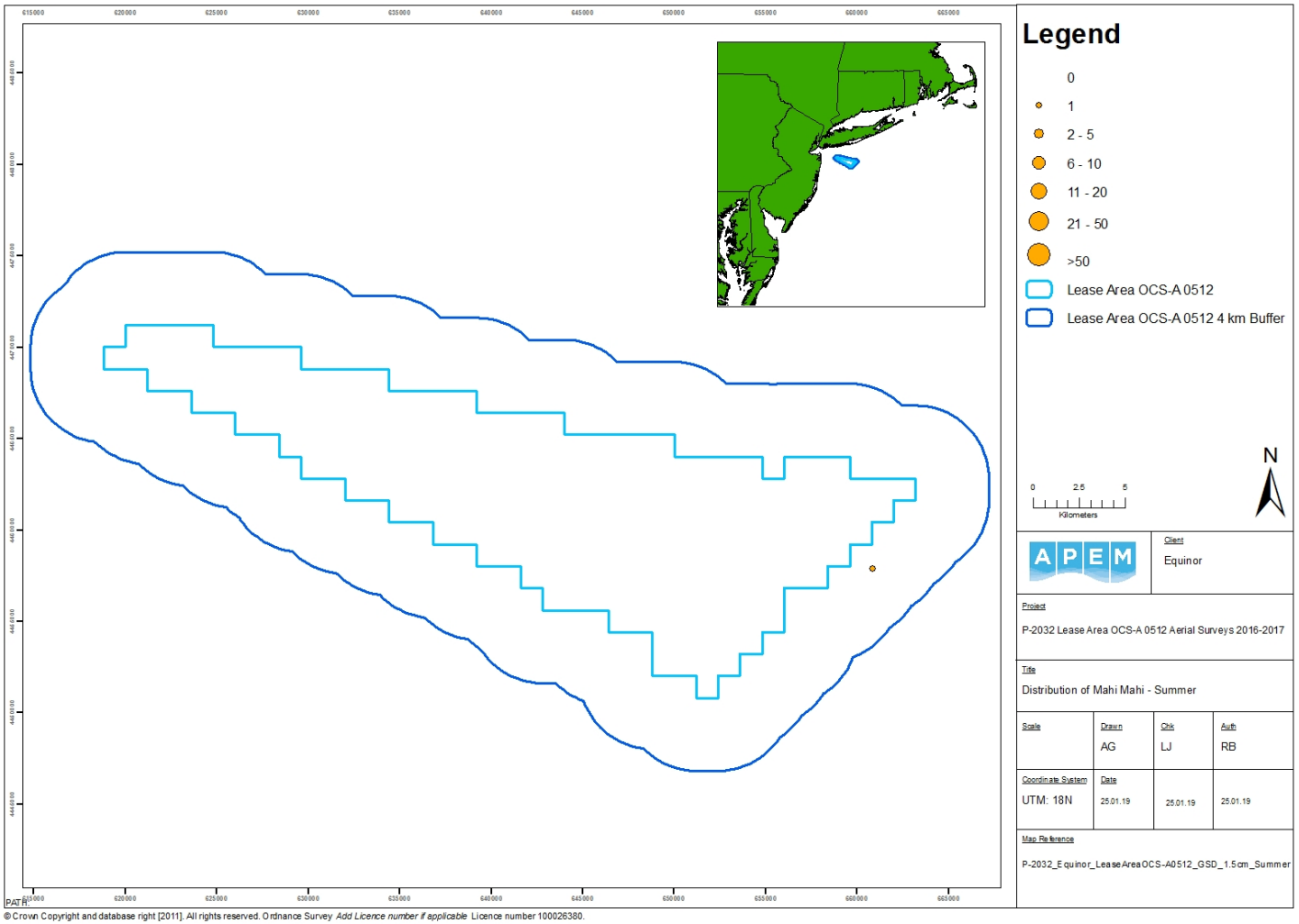


Figure 62 Distribution of Mahi Mahi recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.37 Atlantic Bluefin Tuna

Three Atlantic bluefin tuna were recorded in the south-west of the 4 km buffer in the spring survey (**Table 42**, **Figure 63**).

Table 42 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Atlantic bluefin species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	3	20	0.02	0	3
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	0	0	-	0	0
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	3	20	0.04	0	3

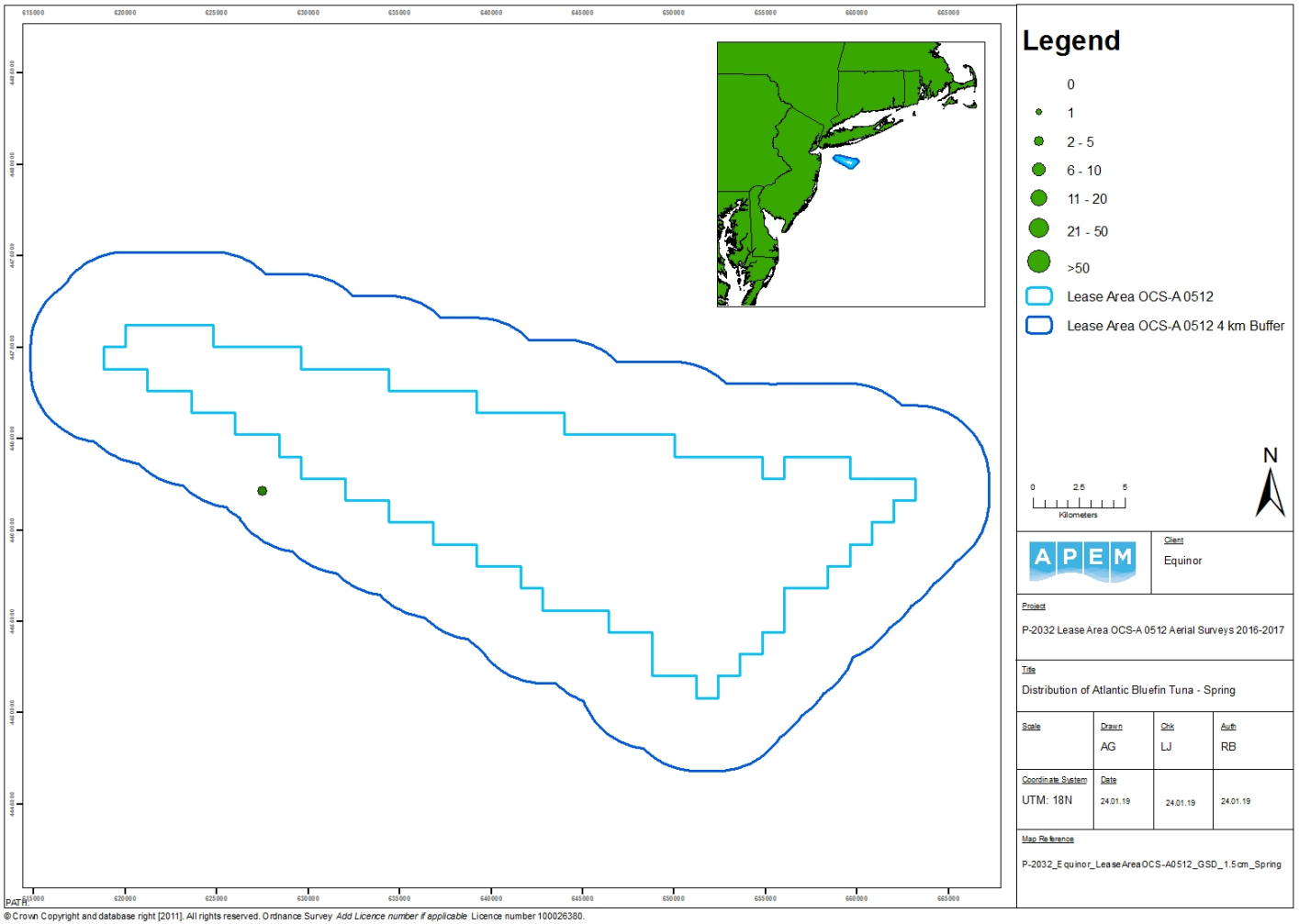


Figure 63 Distribution of Atlantic Bluefin tuna recorded in the spring 2017 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.38 Cobia

A total of 139 Cobia species were recorded in the summer survey, with a higher concentration in the east of the Lease Area OCS-A 0512 (**Table 43**, **Figure 64**).

Table 43 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of Cobia in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	139	1133	1.38	0	139
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	3	24	0.07	0	3
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	136	1116	2.24	0	136
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

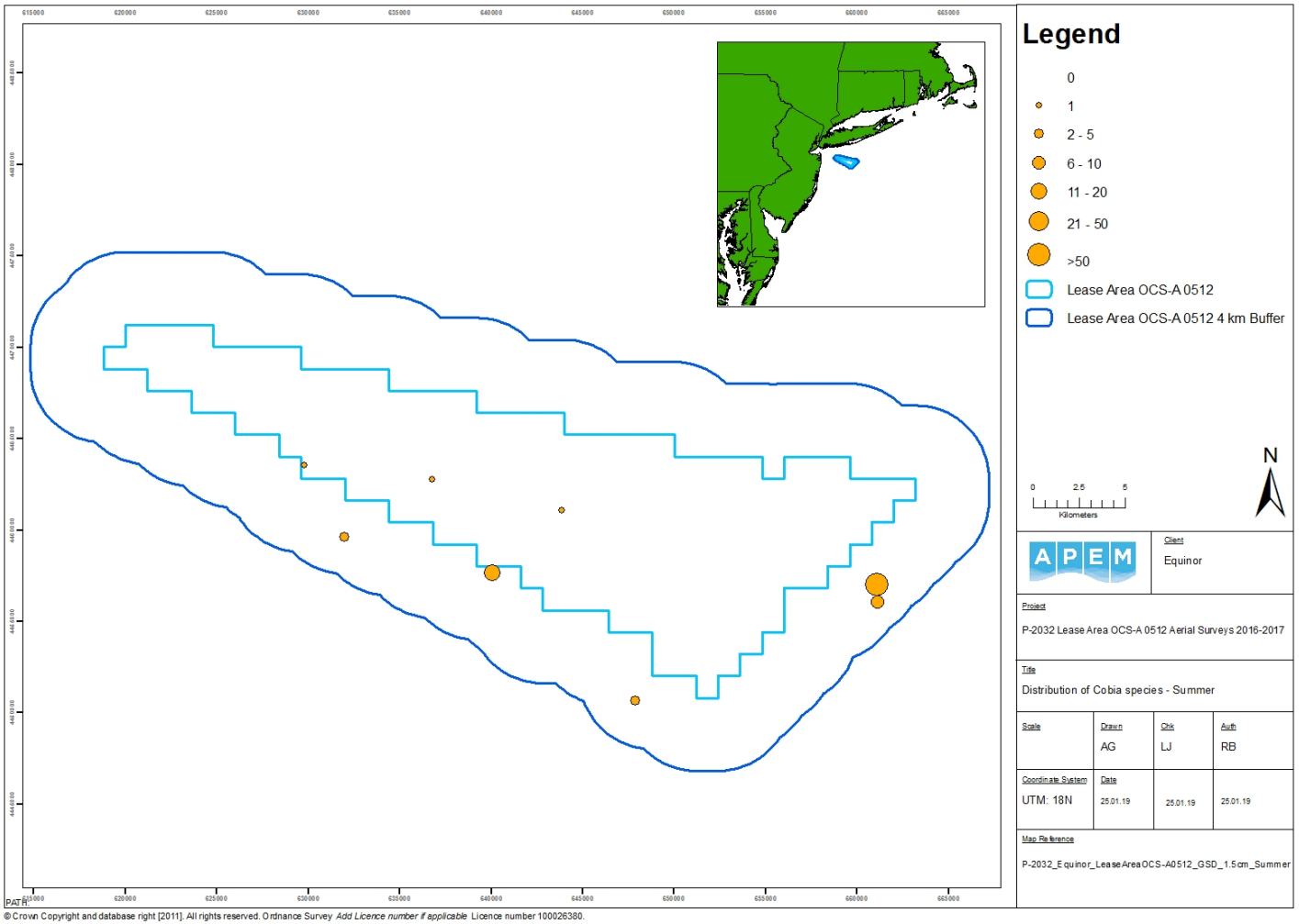


Figure 64 Distribution of Cobia recorded in the summer 2016 survey of Lease Area OCS-A 0512 plus 4 km buffer.

4.39 Species Unknown – Fish

In the summer survey, two unknown fish species were recorded. One was located in the easterly region of the 4 km buffer, and the other in the Lease Area OCS-A 0512 site (**Table 44**, **Figure 65**).

Table 44 **Raw count and abundance and density estimates (No. estimated individuals per km^2) of fish species in: a) Lease Area OCS-A 0512 plus 4 km buffer, b) Lease Area OCS-A 0512, and c) the Lease Area OCS-A 0512 4 km buffer only.**

a) Lease Area OCS-A 0512 plus 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	2	16	0.02	0	2
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
b) Lease Area OCS-A 0512					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.02	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0
c) 4 km Buffer					
Survey	**Raw Count**	**Abundance**	**Density**	**Surfacing**	**Submerged**
Summer	1	8	0.02	0	1
Fall	0	0	-	0	0
Winter	0	0	-	0	0
Spring	0	0	-	0	0

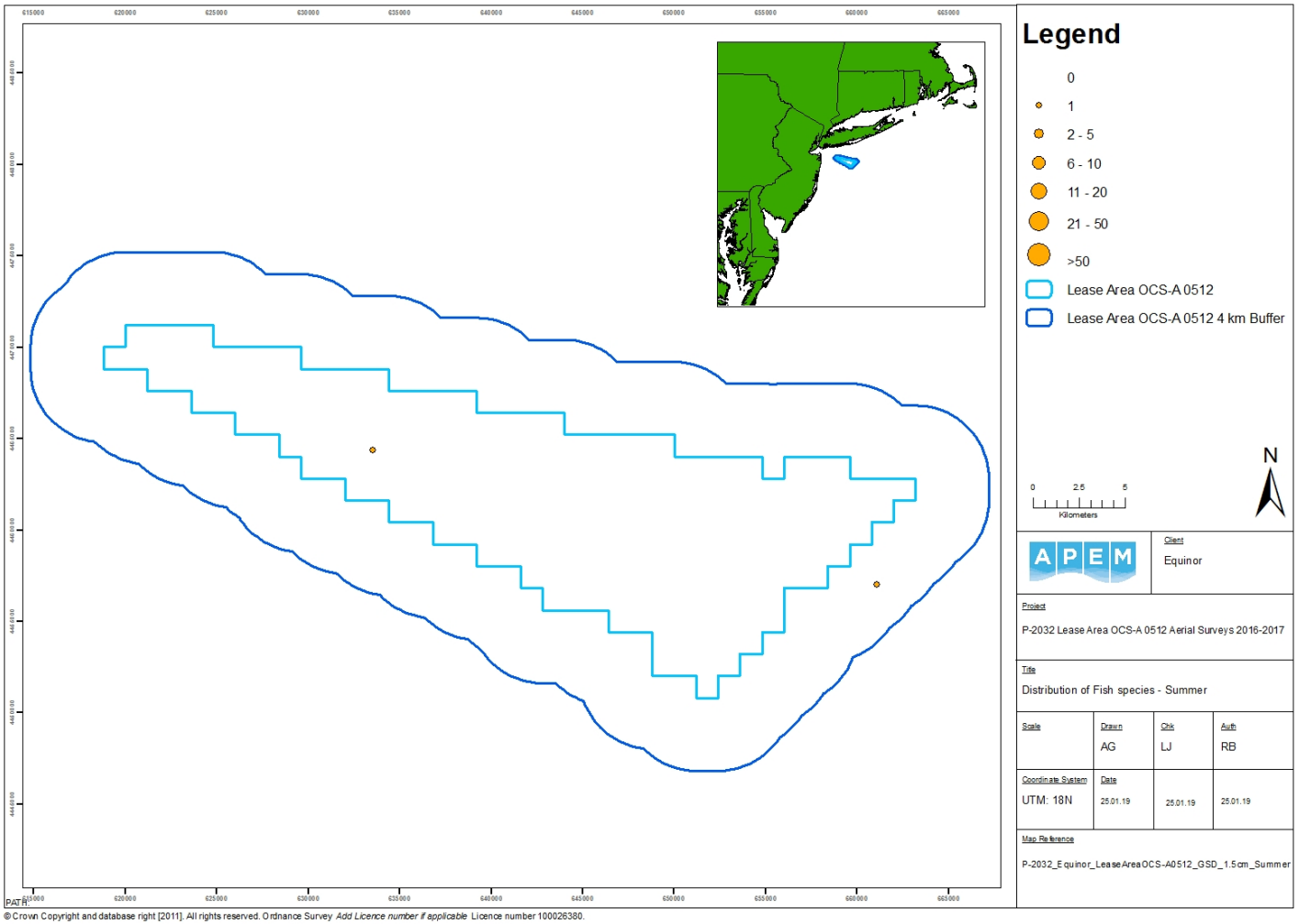


Figure 65 Distribution of unknown fish species recorded in the summer 2016 period surveys of Lease Area OCS-A 0512 plus 4 km buffer.

5. Shipping Observations

In the summer 2016 survey, one small fishing boat was seen on the 27th July. On the 28th July, one cargo vessel, one small fishing boat, two pleasure / fishing boats and an unknown vessel were sighted from the plane. A fishing vessel was also recorded in the images.

During the fall 2016 survey, four tankers and one cargo vessel were seen on 12th November, with two small fishing boats seen on the 13th November.

No vessels were seen from the plane during the winter 2016-2017 surveys.

During the spring 2017 survey, two pleasure boats and the wake from two fast boats were sighted on 16th May.

6. Discussion

6.1 Ducks

Ducks were recorded during the fall 2016 survey only, with black scoters (n=34) being recorded in flight in the north of the Lease Area OCS-A 0512, within the 4 km buffer zone, an abundance estimate of 380 birds.

6.2 Loons

Red-throated loons were recorded in the fall (n=3) and winter (n=1) surveys, whilst common loons were recorded in the fall (n= 2), winter (n=4) and spring (n=29). This suggests that there is a lower abundance of red-throated loons than common loons in the WEA, with a peak abundance estimate of 34 red-throated loon individuals in the fall and a peak abundance estimate of common loons of 195 in the spring.

For three out of four surveys loons did not show any particular distribution patterns; however, common loons in the spring survey were primarily distributed in the north of the Lease Area OCS-A 0512.

6.3 Gannets

Gannets were recorded in three out of four surveys, excluding the summer, survey, with a peak raw count in the winter survey (n=18), with an abundance estimate of 156 birds in the fall, 141 birds in the winter, and 40 birds in the spring.

In all three surveys in which gannets were recorded, the majority were observed inside the 4 km buffer zone. In the fall survey, the distribution was more southerly, whilst there was no noticeable distribution pattern in the other surveys.

6.4 Phalaropes

Red / red-necked phalaropes were recorded in the fall and spring surveys, with a peak count in the fall survey (n=6), with an abundance estimate of 67. There was no noticeable distribution patterns, in part owing to the low number of individuals recorded.

6.5 Alcids

Alcids were recorded in very low numbers in the winter survey only. In total, dovekie (n=1), Atlantic puffin (n=1) and murre / razorbill (n=1) were recorded, with only the murre / razorbill being recorded in the 4 km buffer zone. Each species had an abundance estimate of eight.

6.6 Small gulls

The most abundant small gull species recorded was Bonaparte's gulls, recorded in both the fall (n=11) and winter (n=3) surveys, giving a peak abundance estimate of 123 in the fall survey. Additionally, ring-billed gull (n=1) was recorded in the fall and two unknown small gull species were recorded in the winter survey, giving abundance estimates of 8 and 16, respectively. There was no clear distribution pattern for small gulls.

6.7 Large gulls

Two species of large gull were recorded in the surveys; herring gulls and great black-backed gulls. Herring gulls were recorded in three out of four surveys (excluding the summer), with a peak count in the fall survey (n=8), with an estimated abundance of 89. Great black-backed gulls were recorded in the winter survey only (n=2), with an abundance estimate of 16.

The majority of herring gulls were recorded in the 4 km buffer zone, as were all of the great black-backed gulls.

6.8 Terns

Terns were only recorded in the spring surveys. The most abundant species recorded was common tern (n=79), with an estimated abundance of 532. Least terns (n=4) and unknown sterna tern species (n=13) were also recorded, with estimated abundances of 27 and 88, respectively.

Common terns and unknown sterna tern species were primarily recorded in the north-east of the Lease Area OCS-A 0512, within the Lease Area OCS-A 0512 site, whilst the four least terns were located in the west of the Lease Area OCS-A 0512.

6.9 Shearwaters

Shearwaters were recorded in the fall survey only; Audubon's shearwater (n=4) and Cory's shearwater (n=20), giving abundance estimates of 45 and 224, respectively. All shearwaters were recorded in roughly the same location within the south of the 4 km buffer.

6.10 Storm petrels

An unknown storm petrel species (n=1) was recorded in flight in the north-east or the Lease Area OCS-A 0512 site in spring 2017, close to the 4 km buffer.

6.11 Shorebirds

An unknown shorebird species (n=7) was recorded in the west of the 4 km buffer in the summer survey. All individuals were recorded in flight. An estimated abundance of 57 was calculated.

6.12 Marine mammals

Marine mammals, recorded as unknown dolphin species (n=7), were recorded in the summer (n=2) and spring surveys (n=7), with a peak abundance estimate of 47 in the spring survey. All dolphins were recorded in single groups.

6.13 Turtles

All turtle species were recorded in the summer survey, with the exception of the single leatherback turtle that was recorded in the fall survey. Loggerhead turtles (n=4), leather back turtles (n=1), Kemp's Ridley turtles (n=1) and unknown turtle species (n=8) were all recorded. The majority of turtles were recorded inside the 4 km buffer.

6.14 Sharks

Sharks were recorded in the spring (n=2) and summer (n=158) surveys, with basking shark (n=1) and unknown shark species (n=1) in the spring and unknown shark species (n=140) in the summer survey. Sharks were loosely distributed across the Lease Area OCS-A 0512.

6.15 Rays

Rays were recorded in the summer survey only. Cownose rays (n=15), cownose / bullnose rays (n=28) and unknown ray species (n=148) were recorded. The vast majority of rays, regardless of species, were recorded in the north-west of the Lease Area OCS-A 0512.

6.16 Sunfish

Sunfish were recorded in fall (n=4) and winter (n=1) surveys. A peak abundance estimate of 34 ocean sunfish was recorded in the fall survey.

6.17 Large Bony Fish

Large bony fish, including mahi mahi, unknown fish species, Atlantic bluefin tuna and cobia, - were recorded during the spring (n=142) and summer (n=3) surveys. The peak count was of 139 cobia recorded in the spring, with an abundance estimate of 1,133.

Other than three cobia and one unknown fish species, all fish were recorded within the 4 km buffer zone.

7. Conclusions

Normandeau and APEM were contracted to provide a programme of four quarterly aerial digital surveys of the Equinor's Lease Area OCS-A 0512 site in the New York Bight between summer 2016 and spring 2017 on behalf of NYSERDA. The four surveys were completed

using APEM's high-resolution camera system, the Shearwater III, to capture digital still imagery. Equinor subsequently contracted APEM to report on these surveys in order to form the 'Year 1' data collection of the Lease Area OCS-A 0512 site.

- Survey 1 – Summer 2016

The most abundant group recorded in the summer survey was rays (n=191), followed by sharks (n=158), large bony fish (n=142), turtles (n=12), shorebirds (n=7), and marine mammals (n=2).

- Survey 2 – Fall 2016

The most abundant group recorded in the fall survey was ducks (n=34), followed by shearwaters (n=24), gulls (n=20), gannets (n=14), phalaropes (n=6), loons (n=5), sunfish (n=4), and turtles (n=1).

- Survey 3 – Winter 2016/2017

The most abundant group recorded in the winter survey was gannets (n=18), followed by gulls (n=9), loons (n=5), alcids (n=3), and sunfish (n=1).

- Survey 4 – Spring 2017

The most abundant group recorded in the spring survey was terns (n=96), followed by loons (n=29), marine mammals (n=7), gannets (n=6), fish (n=3), phalaropes (n=2), sharks (n=2), gulls (n=1), and storm petrels (n=1).

8. References

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Appendix I Scientific Names and Taxonomy of Marine Fauna

Common Name	Scientific Name	Family	Class
Mallard	*Anas platyrhynchos*	Anatidae	Aves
American Black Duck	*Anas rubripes*	Anatidae	Aves
Long-tailed Duck	*Clangula hyemalis*	Anatidae	Aves
Surf Scoter	*Melanitta perspicillata*	Anatidae	Aves
White-winged Scoter	*Melanitta fusca*	Anatidae	Aves
Black Scoter	*Melanitta americana*	Anatidae	Aves
Red-throated Loon	*Gavia stellata*	Gaviidae	Aves
Common Loon	*Gavia immer*	Gaviidae	Aves
Cory's shearwater	*Calonectris diomedea*	Procellariidae	Aves
Great shearwater	*Ardenna gravis*	Procellariidae	Aves
Sooty shearwater	*Ardenna grisea*	Procellariidae	Aves
Manx shearwater	*Puffinus puffinus*	Procellariidae	Aves
Northern Fulmar	*Fulmarus glacialis*	Procellariidae	Aves
Northern Gannet	*Morus bassanus*	Sulidae	Aves
Red Phalarope	*Phalaropus fulicarius*	Scolopacidae	Aves
Red-necked Phalarope	*Phalaropus lobatus*	Scolopacidae	Aves
Common Murre	*Uria aalge*	Alcidae	Aves
Thick-billed Murre	*Uria lomvia*	Alcidae	Aves
Dovekie	*Alle alle*	Alcidae	Aves
Atlantic puffin	*Fratercula arctica*	Alcidae	Aves
Razorbill	*Alca torda*	Alcidae	Aves
Black-legged Kittiwake	*Rissa tridactyla*	Laridae	Aves
Bonaparte's Gull	*Chroicocephalus philadelphia*	Laridae	Aves
Laughing gull	*Leucophaeus atricilla*	Laridae	Aves
Ring-billed Gull	*Larus delawarensis*	Laridae	Aves
Herring Gull	*Larus argentatus*	Laridae	Aves
Lesser black-backed gull	*Larus fuscus*	Laridae	Aves
Great Black-backed Gull	*Larus marinus*	Laridae	Aves
Common tern	*Sterna hirundo*	Laridae	Aves
Least tern	*Sternaula antillarum*	Laridae	Aves
Forster's tern	*Sterna forsteri*	Laridae	Aves
Black-capped petrel	*Pterodroma hasitata*	Procellariidae	Aves
Great blue heron	*Ardea herodias*	Ardeidae	Aves
Common Dolphin	*Delphinus delphis*	Delphinidae	Mammalia
Bottlenose Dolphin	*Tursiops truncates*	Delphinidae	Mammalia
Harbour Porpoise	*Phocoena phocoena*	Phocoenidae	Mammalia
Humpback whale	*Megaptera novaeangliae*	Balaenopteridae	Mammalia
Loggerhead turtle	*Caretta caretta*	Cheloniidae	Reptilia

Common Name	Scientific Name	Family	Class
Leatherback turtle	*Dermochelys coriacea*	Dermochelyidae	Reptilia
Kemp's Ridley turtle	*Lepidochelys kempii*	Cheloniidae	Reptilia
Mahi Mahi	*Coryphaena hippurus*	Coryphaenidae	Actinopterygii
Atlantic Bluefin tuna	*Thunnus thynnus*	Scombridae	Actinopterygii
Cobia	*Rachycentron canadum*	Rachycentridae	Actinopterygii
Ocean Sunfish	*Mola mola*	Molidae	Actinopterygii
Sharptail sunfish	*Masturus lanceolatus*	Molidae	Actinopterygii
Cownose Ray	*Rhinoptera bonasus*	Rhinopteridae	Chondrichthyes
Bullnose ray	*Myliobatis freminvilli*	Chondrichthyes	Myliobatidae
Blue Shark	*Prionace glauca*	Carcharhinidae	Chondrichthyes
Basking shark	*Cetorhinus maximus*	Cetorhinus	Chondrichthyes
Tiger shark	*Galeocerdo cuvier*	Carcharhinidae	Chondrichthyes
Great white shark	*Carcharodon carcharias*	Lamnidae	Chondrichthyes
Scalloped hammerhead	*Sphyrna lewini*	Sphyrnidae	Chondrichthyes