New England Wind

AVANGRID RENEWABLES

# Construction and Operations Plan

## Lease Area OCS-A 0534

## Volume III Appendices

February 2024

Submitted by
Park City Wind LLC

Submitted to
Bureau of Ocean Energy Management
45600 Woodland Rd
Sterling, VA 20166

Prepared by
Epsilon Associates, Inc.

Epsilon ASSOCIATES INC.

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BUREAU OF OCEAN ENERGY MANAGEMENT
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*Prepared by:*
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*In Association with:*

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February 2024

On April 29, 2022, modifications were made to the project design Envelope that involved changing the maximum wind turbine generator (WTG) and electrical service platform (ESP) topside parameters for Phase 1 (Park City Wind) to match those of Phase 2 (Commonwealth Wind) (see Table 1). As a result of this change, the potential minimum footprint of Phase 1 decreased, and correspondingly the potential maximum footprint of Phase 2 increased (see Table 2). Additionally, the maximum capacity in megawatts for both phases was eliminated to accommodate the rapid advancement in commercially available wind turbine generator size and technology.

**Table 1 Modifications to the Phase 1 WTG and ESP Parameters[1]**

| Maximum WTG Parameters | Previous Dimension | New Dimension[2] |
|---|---|---|
| Tip Height | 319 m (1,047 ft) | 357 (1,171 ft) |
| Top of the Nacelle Height | 199 m (653 ft) | 221 m (725 ft) |
| Hub Height | 192 m (630 ft) | 214 m (702 ft) |
| Rotor Diameter | 255 m (837 ft) | 285 m (935 ft) |
| Minimum Tip Clearance[3] | 27 m (89 ft) | 27 m (89 ft) |
| Blade Chord | 8 m (26 ft) | 9 m (30 ft) |
| Tower Diameter | 9 m (30 ft) | 10 m (33 ft)[4] |
| **Maximum ESP Parameters** | **Previous Dimension** | **New Dimension[2]** |
| Width | 45 m (148 ft) | 60 m (197 ft) |
| Length | 70 m (230 ft) | 100 m (328 ft) |
| Height | 38 m (125 ft) | No change |
| Height of Topside (above MLLW[5]) | 70 m (230 ft) | No change |

1. Maximum WTG dimensions are included in Table 3.2-1 and maximum ESP dimensions are included in Table 3.2-3 of COP Volume I
2. The new Phase 1 WTG and ESP maximum parameters were revised to match those of Phase 2
3. All parameters are maximum values except tip clearance, where the minimum tip clearance represents the maximum potential impact
4. To accommodate the slight increase in tower diameter, the maximum transition piece diameter/width for Phase 1 monopile foundations was also increased from 9 m (30 ft) to 10 m (33 ft) (see Table 3.2-2 of COP Volume I)
5. MLLW: Mean Lower Low Water

To accommodate the larger Phase 1 WTG dimensions and greater capacity range, the minimum footprint of Phase 1 decreased and the maximum footprint of Phase 2 increased, thus also adjusting the potential number of WTG/ESP positions within each Phase (see Table 2).

**Table 2 Modifications to the Phase 1 and Phase 2 Layout and Size**

| | | Previous Layout and Size | New Layout and Size |
|---|---|---|---|
| **Phase 1** | Number of WTGs | 50-62 | 41-62 |
| | Area | 182-231 km$^2$ (44,973-57,081 acres) | 150-231 km$^2$ (37,066-57,081 acres) |
| **Phase 2** | Number of WTGs | 64-79 | 64-88 |
| | Area | 222-271 km$^2$ (54,857-66,966 acres) | 222–303 km$^2$ (54,857–74,873 acres) |

Additionally, while the Project Design Envelope (PDE) previously included a total of four or five offshore export cables for New England Wind (two offshore export cables for Phase 1 and two or three offshore export cables for Phase 2), the Proponent has confirmed that there will be a total of five offshore export cables (two offshore export cables for Phase 1 and three offshore export cables for Phase 2).

These revisions remain within the maximum design scenario considered for this report and the maximum potential impacts are still representative considering these modifications. Therefore, this report was not updated to reflect these minor modifications, as the findings are not affected.

# Appendix III-C

## Supporting material for avian assessment: analysis methods and results

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| BOEM | Bureau of Ocean Energy Management |
| COP | Construction and Operations Plan |
| dBBMM | dynamic Brownian-bridge movement model |
| EIS | Environmental Impact Statement |
| ESA | Endangered Species Act |
| ft | feet |
| GPS | Global Positioning System |
| km | kilometer |
| m | meter |
| MDAT | Marine-life Data and Analysis Team |
| mi | miles |
| MLLW | Mean Lower Low Water |
| MW | megawatt |
| NM | nautical mile |
| NOAA | National Oceanic and Atmospheric Administration |
| OCS | Outer Continental Shelf |
| PTT | Argos platform terminal transmitter |
| RSZ | rotor swept zone |
| SDJV | Sea Duck Joint Venture |
| SWDA | Southern Wind Development Area |
| UD | Utilization distribution |
| USFWS | United States Fish and Wildlife Service |
| WEA | Wind Energy Area |
| WTG | Wind Turbine Generator |

# 1 Introduction

This Appendix provides support for the detailed avian assessment provided in Section 6.2 of COP Volume III. Section 1 of this Appendix provides a brief overview of assessment methods; section 2 provides detail on the methods used for the offshore assessment; section 3 focuses on birds in the offshore environment and includes details on seasonal densities of all birds exposed to the Southern Wind Development Area [SWDA]); and section 5 also provides seasonal exposure maps for marine birds. The SWDA is defined as all of Lease Area OCS-A 0534 and the southwest portion of Lease Area OCS-A 0501 (see Figure 1.1-1 of COP Volume I).

## 1.1 Project Description

Park City Wind LLC ("the Proponent") proposes to construct, operate, and decommission offshore renewable wind energy facilities in its Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0534 along with associated offshore and onshore cabling, onshore substations, and onshore operations and maintenance (O&M) facilities ("New England Wind"). New England Wind will occupy all of Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501 in the event that Vineyard Wind 1 does not develop "spare" or extra positions included in Lease Area OCS-A 0501 and Vineyard Wind 1 assigns those positions to Lease Area OCS-A 0534.

New England Wind will be developed in two Phases with a maximum of 130 wind turbine generator (WTG) and electrical service platform (ESP) positions. Four or five offshore export cables – two cables for Phase 1 and two or three cables for Phase 2 – will transmit electricity from the SWDA to onshore transmission systems in the Town of Barnstable, Massachusetts unless technical, logistical, grid interconnection, or other unforeseen issues arise. Each Phase of New England Wind will be developed using a Project Design Envelope (the "Envelope") that defines and brackets the characteristics of the facilities and activities for purposes of environmental review while maintaining a reasonable degree of flexibility with respect to the selection of key components (e.g. WTGs, ESP(s), foundations, submarine cables).

The SWDA may be 411–453 square kilometers ($km^2$) (101,590–111,939 acres) in size depending upon the final footprint of the Vineyard Wind 1 project. The SWDA (excluding the two separate aliquots that are closer to shore) is just over 32 kilometers (km) (20 miles [mi]) from the southwest corner of Martha's Vineyard and approximately 38 km (24 mi) from Nantucket.[1] The SWDA includes two separate aliquots, which are each 1/64$^{th}$ of a BOEM Outer Continental Shelf (OCS) Lease Block, located along the northeastern boundary of Lease Area OCS-A 0501. Although these aliquots are a part of the SWDA, at this time, the Proponent does not intend to develop the two "vacant" positions located in these separate aliquots as part of New England

[1] Within the SWDA, the closest WTG is approximately 34 km (21 mi) from Martha's Vineyard and 40 km (25 mi) from Nantucket.

Wind. The WTGs and ESP(s) will be oriented in fixed east-to-west rows and north-to-south columns with one nautical mile (1.85 km) spacing between positions.

## 1.2 Methods Overview

For each subject group addressed under this assessment, species occurrence and area use were identified and evaluated using multiple data sources, including but not limited to: MassCEC aerial surveys, boat-based surveys within the SWDA (hereafter "New England (NE) Wind boat survey"), National Oceanic and Atmospheric Administration (NOAA) Marine Bird Distribution Models, occurrence data, individual tracking data, relevant current literature, and species accounts.

Most species were assessed within general taxonomic groups (e.g. wading birds), however, species with federal listing status were individually assessed. Listed species, or candidate species, are piping plover (*Charadrius melodus*), red knot (*Calidris canutus rufa*), roseate tern (*Sterna dougallii*), and black-capped petrel (*Pterodroma hasitata*).

The results section of this Appendix addresses exposure and vulnerability of coastal birds and marine birds separately and includes maps, tables, and figures for each major taxonomic group. Exposure assessment maps, tables, and figures are presented for both coastal and marine birds based on the aforementioned data sources.

For the offshore assessment, a semi-quantitative approach was taken that first describes the species that would potentially be exposed to the SWDA, and the vulnerability of the species exposed. The assessment process was as follows:

- *Exposure* – The first step in the process was to assess exposure for each species and each taxonomic group, where 'exposure' is defined as the extent of overlap between a species' seasonal or annual distribution and the SWDA. For species where site-specific data was available, a semi-quantitative exposure assessment was conducted. This exposure assessment was focused exclusively on the horizontal, or two-dimensional, likelihood that a bird would use the SWDA.

- *Relative Vulnerability* – Potential vulnerability was then assessed for marine birds using a scoring process. For the purposes of this analysis, 'behavioral vulnerability' is defined as the degree to which a species is expected to be affected by WTGs in the SWDA based on known responses to similar offshore developments. This assessment of behavioral vulnerability focused on documented avoidance behaviors, estimated flight heights, and other factors. Flight heights used in the assessment were gathered from the NE Wind boat surveys (local) and the datasets in the Northwest Atlantic Seabird Catalog (regional).

# 2 Birds – Offshore: Methods

## 2.1.1 Exposure Framework

Exposure has both a horizontal and vertical component. The exposure assessment focused exclusively on the horizontal exposure of birds. Vertical exposure (i.e. flight height) was considered within the assessment of vulnerability. The exposure assessment was quantitative where site-specific survey data was available. For birds with no available site-specific data, species accounts and the literature were used to conduct a qualitative assessment (see text in Section 6.2 of COP Volume III). For all marine birds, exposure was considered both in the context of the proportion of the population predicted to be exposed to the SWDA as well as absolute numbers of individuals. The following sections introduce the data sources used in the analysis, the methods used to map species exposure, methods used to assign an exposure metric, methods to aggregate scores to year and taxonomic group, and interpretation of exposure scores.

### *2.1.1.1 Exposure Assessment Data Sources and Coverage*

To assess the proportion of marine bird populations exposed to the SWDA, three primary data sources were used to evaluate local and regional marine bird use: (1) the NE Wind boat-based surveys[2], (2) MassCEC aerial surveys, which cover the Massachusetts Wind Energy Area (MA WEA) (Veit et al. 2016), and (3) version 2 of the Marine-life Data and Analysis Team (MDAT) marine bird relative density and distribution model (Curtice et al. 2019). The NE Wind boat-based surveys provide the most current local coverage across the SWDA plus 1 NM buffer. The MassCEC aerial surveys provide local coverage of both the SWDA and surrounding waters. The MDAT models are modeled abundance data providing a large regional context for the SWDA but are built from offshore survey data collected from 1978–2016. Each of these primary sources is described in more detail below, along with additional data sources that inform the avian impact assessment. Data collected during these surveys are in general agreement with BOEM guidelines and the goals detailed above and described below.

#### 2.1.1.1.1 New England Wind Boat-Based Surveys

In October 2018, the Biodiversity Research Institute (BRI) was tasked with completing a year-round offshore boat-based avian survey of the southern portion of Lease Area OCS-A 0534. Surveys were completed as described in the Survey Plan submitted to BOEM on October 10, 2018, and approved by BOEM on October 23, 2018. The survey design followed BOEM's Avian

[2] The NE Wind boat survey was conducted prior to the segregation of Lease Area OCS-A 0501 into OCS-A 0501 and OCS-A 0534 and did not include the entire final SWDA footprint. Survey data were supplemented with the MassCEC aerial surveys, MDAT models, published literature, species accounts, and assessments conducted for Vineyard Wind 1.

Guidelines[3], and surveys were only conducted in suitable viewing conditions (sea state ≤4 on the Beaufort Scale[4]). Each survey covered 10.2% of the total survey area, including a 1.85 km (1 NM) buffer, with a total transect length of 158 km (85.4 NM) (Figure 2-1).
BRI conducted 16 offshore boat-based avian surveys in the SWDA between October of 2018 and September of 2019. These surveys focused on detecting birds and other wildlife, and also included observations of boats and fishing gear whenever possible. Surveys were conducted once per month, except during the spring (April and May) and fall (August and September), migration periods when the survey frequency increased to twice per month. The migration periods were determined based upon recent information on tern movements and migration (Loring et al. 2019). Throughout, the surveys used current, standardized at-sea avian survey methods. The survey protocol included the use of distance sampling, and data were recorded with the avian data survey collection application, *SeaScribe*[5].

A team of three experienced BRI staff members conducted surveys aboard the 30-meter (m) (100-foot [ft]) *FV Helen H*, a Cape Cod based vessel owned and operated by Helen H Deep Sea Fishing. On each one-day survey, the boat departed from Hyannis Harbor in the Town of Barnstable. Time spent on the water was approximately 18 hours each survey-day, including 8.5 hours of survey time within the SWDA and buffer. Throughout the survey trips, the Captain adhered to all applicable North Atlantic right whale (*Eubalaena glacialis*) vessel speed restrictions.

###### *2.1.1.1.1.1 Survey Protocol*

The surveys were conducted from the top deck wheel house of the *FV Helen H*. Observers always had a clear, unobstructed view in a bow to beam arc off one side of the vessel. While on transect, one surveyor (the primary observer) continuously scanned horizontally and vertically for birds (using the naked eye or binoculars). The second surveyor (the recorder) entered all observations into *SeaScribe* using a tablet computer. A third surveyor (the secondary observer) aided in spotting and photographing birds, and survey crew members rotated these roles throughout the day to reduce observer fatigue.

Location, date, and time were automatically recorded by *SeaScribe* several times per minute and all observations were individually georeferenced. At the beginning of each survey, the recorder entered data on sea state (Beaufort Scale), transect number, observer's initials, visibility, survey ID, station, and platform, and changed each throughout the survey, as needed. Observers also recorded sea state and visibility every 30 minutes or as conditions warranted. The data fields used are detailed in Table 2-1.

Surveys were conducted on one side of the vessel using distance sampling methods. Observers used the side of the boat with the best viewing conditions (least glare) and swapped sides as

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[3] https://www.boem.gov/Avian-Survey-Guidelines/
[4] https://en.wikipedia.org/wiki/Beaufort_scale
[5] http://www.briloon.org/seascribe

necessary during the survey to optimize viewing conditions. Observers recorded all birds sighted (species and number), and the distance (m) and angle (°) to each at first sighting, within a 90° arc between the bow and the port or starboard beam (depending on visibility conditions). Radial distance was estimated from the observer to the animal or the center of the group of animals, based on the first sighting. Distance estimates were calibrated between observers and estimated to the nearest tens of meters for birds closer to the boat, and to the nearest 20 or 50 m (65 or 164 ft) for birds farther from the boat. For birds observed in flight, the vertical flight height above the water at first sighting was estimated to the nearest meter along with their general direction of movement. Details of bird plumages (which provide information on age) and specific behaviors were recorded whenever possible, following codes provided in *SeaScribe*. The behavior and direction of movement were also recorded based on when the bird or group was first sighted. In addition, while in transit to and from the survey area, surveyors carried out casual observations for terns and other species during daylight hours, when possible.

Table 2-1: Dates of New England Wind boat-based surveys within the Southern Wind Development Area (SWDA) (hereafter "NE Wind boat surveys")

| Survey | Year | Month | Date |
|---|---|---|---|
| 1 | 2018 | October | 26 |
| 2 | | November | 30 |
| 3 | | December | 5 |
| 4 | 2019 | January | 13 |
| 5 | | February | 7 |
| 6 | | March | 9 |
| 7 | | April | 7 |
| 8 | | April | 25 |
| 9 | | May | 4 |
| 10 | | May | 16 |
| 11 | | June | 12 |
| 12 | | July | 3 |
| 13 | | August | 20 |
| 14 | | August | 24 |
| 15 | | September | 4 |
| 16 | | September | 20 |

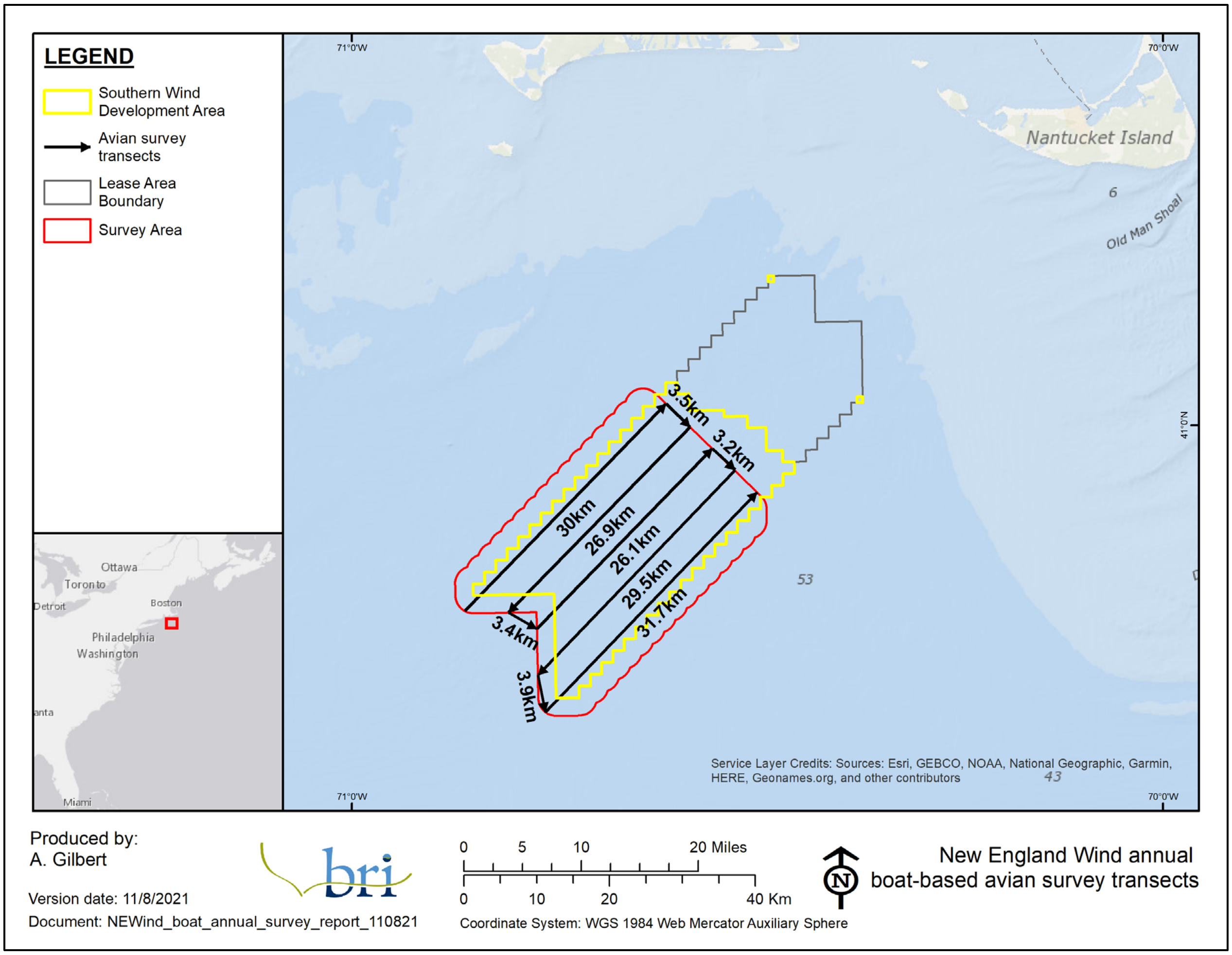


Figure 2-1: New England Wind boat surveys transect layout

### *2.1.1.1.1.2 Community Distance Modeling*

As described above, boat-based line transect surveys averaging 156 km (97 mi) long were conducted throughout the study area spaced 18.5 km (10 NM) apart and surveyed 16 times over the course of a year (2018–2019). A distance survey protocol was implemented during the survey (Buckland et al. 2001), with all detected animals recorded. Species were assigned a taxonomic group based on similarity among species ranging from auks to gannets.

To estimate detection probabilities for each taxonomic group, thus estimating the total population size of the group using the study area, a community distance model (CDM) was parameterized in JAGS (http://mcmc-jags.sourceforge.net/) within R (R Core Team 2019). This method allows detection probabilities to be estimated for all species in the sampled community, which improves the ability to correct abundance estimates even for uncommon species, such as terns, with too few observations to provide enough data to properly utilize traditional distance sampling methods.

The observed data were parsed into transects, truncated to those less than 500 m (0.27 NM) from the transect line, then placed in ten 50 m (164 ft) distance bins for use in this modeling effort. The core of the model is a distance detection model (Buckland et al. 2001) that uses a proportional hazard key function to describe the change in detection probability with distance from the transect line. A CDM generalizes this detection function across multiple species and assumes that each species has a similar functional relationship with detection probability (Sollmann et al. 2016). While Sollmann et al. (2016) used a half-normal detection function, here we use a hazard rate function:

$$p_{ijb} = 1 - \exp\left(-\left(-\frac{{d_b}^2}{\sigma_{ij}}\right)^{-\theta_j}\right)$$

Where, $\boldsymbol{p_{ijb}}$ is the detection probability of a given distance band for survey transect *i*, species *j*, and distance band *b*; $\boldsymbol{p_{ijb}}$ is the mean distance to the transect line, $\boldsymbol{d_b}$ is the distance from the middle of the distance band to the transect centerline, while $\boldsymbol{\sigma}$ and $\boldsymbol{\theta}$ are the shape and scale parameters that can vary by species and transect. These probabilities are then summed across all distance bands to determine the detection probability for a given species and transect. The general form of the model shares information across species using a random effects approach:

$$\log(\sigma_{ij}) = \alpha_j + \boldsymbol{\beta_{ij}X}$$

$$\alpha_{ij} \sim Normal(\mu_\alpha, \sigma_\alpha)$$

$$\boldsymbol{\beta_{ij}} \sim Normal(\boldsymbol{\mu_\beta}, \boldsymbol{\sigma_\beta})$$

Where $\boldsymbol{\alpha_j}$ is the species j intercept for the hazard rate function and $\boldsymbol{\beta_{ij}}$ is a vector of parameters that describe relationships to a vector of covariates ($\boldsymbol{X}$). Information can be shared among taxonomic groups can be shared in both the intercept and slope parameter estimates and facilitates estimation of detection probabilities even in species with small sample sizes. These data are used to calculate the detection probability for each distance band, which are then summed to estimate the detection probability for the entire survey. In this particular case, wind speed was the only covariate utilized. Thus, the detection probability can vary among surveys and transects via wind speed and among taxonomic groups.

Once the survey specific detection probability is estimated for each taxonomic group, then a Horvitz-Thompson estimator to estimate the total population size for each species on each survey:

$$\widehat{N}_{kj} = \frac{\bar{c}_{kj}A}{a}\left(\frac{y_{kj}}{p_{kj}}\right)$$

Where $\hat{N}_{kj}$ is the estimated total population size for survey *k* and species *j*, $p_{kj}$ is the detection probability, and $\bar{c}_{kj}$ is the average group size for survey *k* and species *j*. The ratio of the total study area (A) over the surveyed area (a) scales the estimate to the total study area. Note that if no individuals are found on the survey then this estimator cannot provide non-zero estimates of $\hat{N}_{kj}$. Density estimates were obtained by dividing $\hat{N}_{kj}$ by the study area (square kilometers).

Distance model fit was assessed by using a visual posterior predictive check as well as calculating Bayesian p-values in a comparison of a Freeman-Tukey statistic.

##### 2.1.1.1.2 MassCEC Aerial Surveys (Veit et al. 2016)

Data from 38 aerial surveys conducted between November 2011 and January 2015 for the Massachusetts Clean Energy Center (MassCEC) and BOEM were used to describe local-scale patterns of abundance (Figure 2-2 and Figure 2-3). These surveys provided baseline (pre-development) information on the distribution and abundance of marine birds in the MA WEA, which is located south of Martha's Vineyard and Nantucket, and includes the SWDA. The original count data were collected over three annual survey periods and occurred across all seasons. Seasons were chosen to describe broad changes in weather patterns in the offshore environment: spring (March–May), summer (June–August), fall (September–November), and winter (December–February).

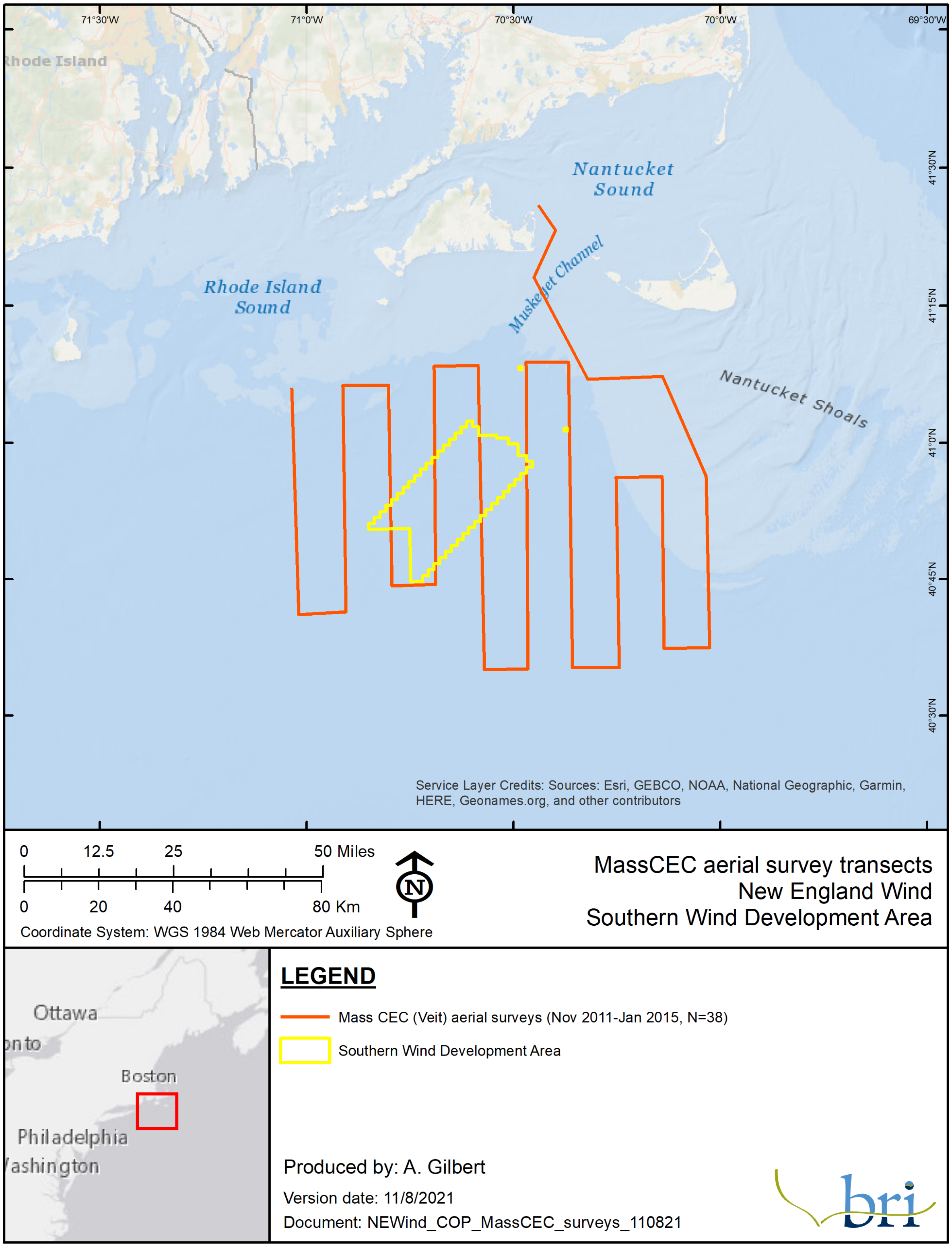


Figure 2-2: MassCEC aerial survey transects

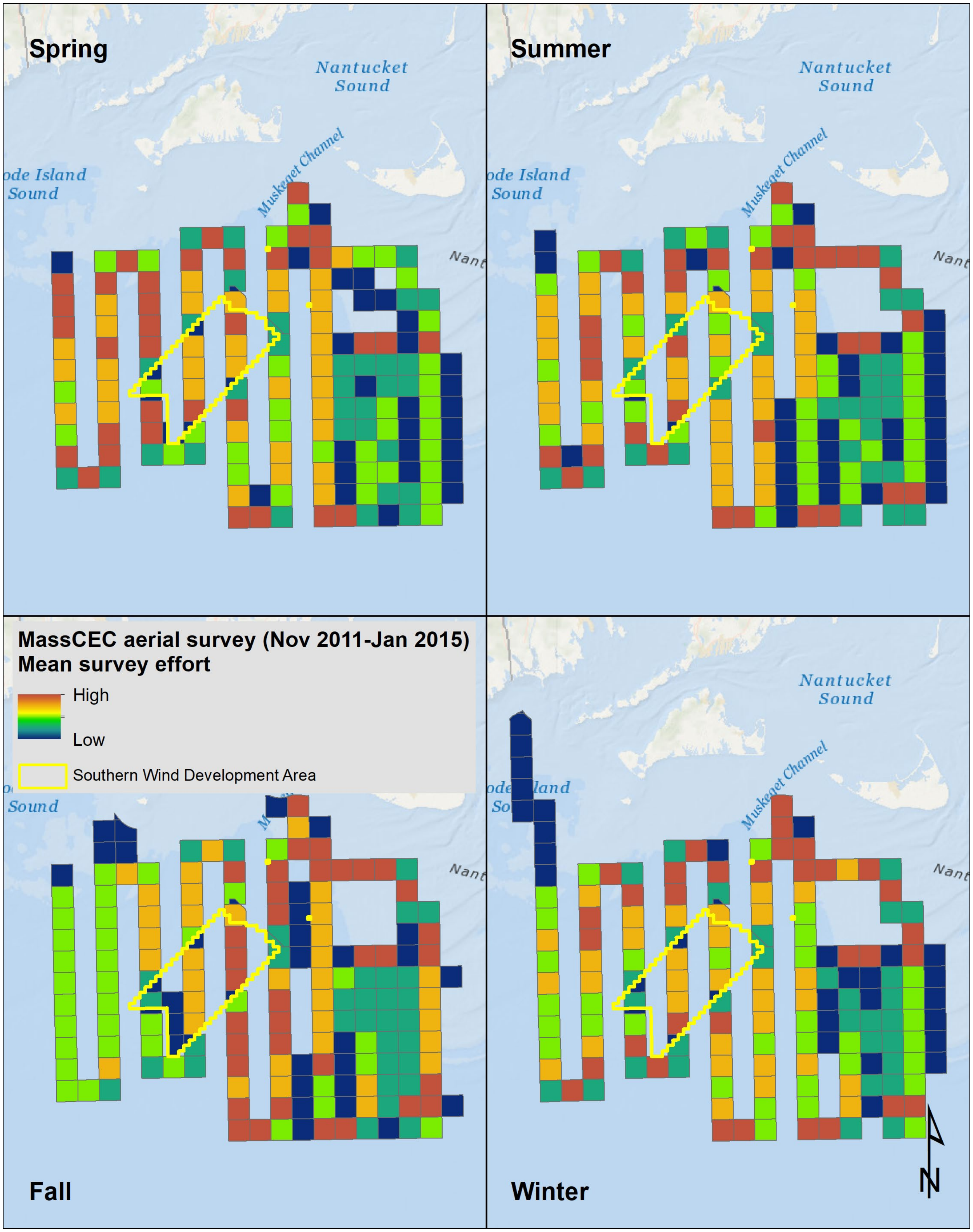


Figure 2-3: Seasonal mean survey effort from MassCEC aerial surveys

#### 2.1.1.1.3 The MDAT Marine Bird Abundance and Occurrence Models (Version 2)

Seasonal predictions of density were developed to support Atlantic marine renewable energy planning. Distributed as MDAT bird models (Winship et al. 2018; Curtice et al. 2019), they describe regional-scale patterns of abundance. Updates to these models (Version 2) are available directly from Duke University's Marine Geospatial Ecology Lab MDAT model web page[6]. The MDAT analysis integrated survey data (1978–2016) from the Atlantic Offshore Seabird Dataset Catalog[7] with a range of environmental variables to produce long-term average annual and seasonal models (Figure 2-4). These models were developed to support marine spatial planning in the Atlantic. In Version 2, relative abundance and distribution models were produced for 47 avian species using Atlantic waters in the United States (US) from Florida to Maine; this resource thus provides an excellent regional context for local relative densities estimated from digital aerial surveys.

The MDAT, MassCEC aerial survey, and NE Wind boat survey information sources each have strengths and weaknesses. The MassCEC aerial survey and NE Wind boat survey data were collected in a standardized, comprehensive way, and the data are on average more recent, so they describe recent distribution patterns in the SWDA and surrounding areas. However, these surveys covered a fairly small area relative to the Northwest Atlantic distribution of most marine bird species, and the limited number of surveys conducted in each season means that individual observations (or lack of observations, for rare species) may in some cases carry substantial weight in determining seasonal exposure. The MassCEC aerial surveys also produced "unidentified" observations (e.g. "unknown large gull" or "unknown small tern"), which prove difficult for evaluating species-specific exposures. For this reason, these data were analyzed at higher taxonomic groupings.

The MDAT models, in contrast to baseline surveys (MassCEC aerial survey and NE Wind boat survey), are based on data collected at much larger geographic and temporal scales. These data were also collected using a range of survey methods. The larger geographic scale is helpful for determining the importance of the SWDA to marine birds relative to other available locations in the Northwest Atlantic and is thus essential for determining overall exposure. However, these models are based on survey data from decades of surveys and long-term climatological averages of dynamic covariates; given changing climate conditions, these models may no longer accurately reflect current distribution patterns. Model outputs that incorporate environmental covariates to predict distributions across a broad spatial scale may also vary in the accuracy of those predictions at a local scale.

[6] http://seamap.env.duke.edu/models/mdat/
[7] https://coast.noaa.gov/digitalcoast/data/atloffshoreseabird.html

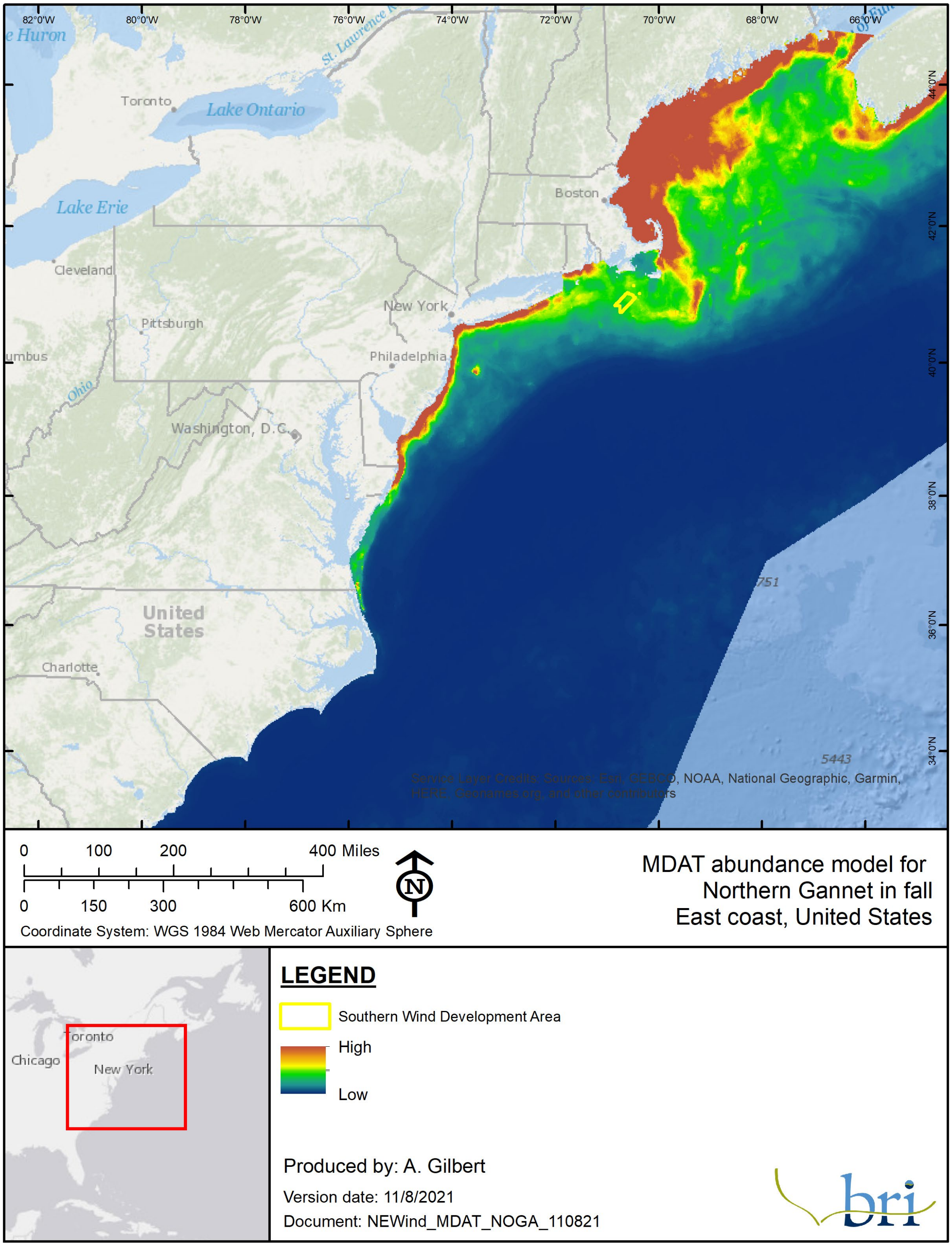


Figure 2-4: Example Marine-life Data and Analysis Team (MDAT) abundance model for northern gannet (*Morus bassanus*) in fall

#### 2.1.1.1.4 Secondary Sources

##### *2.1.1.1.4.1 Northwest Atlantic Seabird Catalog*

The Northwest Atlantic Seabird Catalog is the comprehensive database for the majority of offshore and coastal seabird surveys conducted in US Atlantic waters from Maine to Florida. The database contains records from 1938–2017, having more than 180 datasets and greater than 700,000 observation records along with associated effort information (K. Coleman, Pers. Comm., 31 Oct 2018). The database is currently being managed by Arliss Winship at NOAA. With BOEM's approval, NOAA provided the database to BRI to make queries for this assessment. All relevant data from the Northwest Atlantic Seabird Catalog were mapped to determine the occurrence of rare species within the SWDA.

##### *2.1.1.1.4.2 Mid-Atlantic Diving Bird Tracking Study*

A satellite telemetry tracking study in the mid-Atlantic was developed and supported by BOEM and the US Fish and Wildlife Service (USFWS) with objectives aimed at determining fine scale use and movement patterns of three species of marine diving birds during migration and winter (Spiegel et al. 2017). These species – the red-throated loon (*Gavia stellata*), surf scoter (*Melanitta perspicillata*), and northern gannet (*Morus bassana*) – are all considered species of conservation concern and exhibit various traits that make them vulnerable to offshore wind development. Nearly 400 individuals were tracked using satellite transmitters, Argos platform terminal transmitters (PTT), over the course of five years (2012–2016), including some tagged surf scoters as part of the Atlantic and Great Lakes Sea Duck Migration Study by Sea Duck Joint Venture (SDJV)[8]. Results provide a better understanding of how these diving birds use offshore areas of the mid-Atlantic Outer Continental Shelf (OCS) and beyond.

Utilization distributions (UDs) were determined for each species by calculating individual level dynamic Brownian-bridge movement model (dBBMM) surfaces (Kranstauber et al. 2012) using package Move for R (Kranstauber and Smolla 2016). Separate dBBMM surfaces were calculated for each of two winters with at least five days of data and combined into a weighted mean surface for each animal (as a percentage of the total number of days represented in the surface) with a minimum 30 total combined days of data. This method of combining multiple seasons was used for the migration periods as well, but with relaxed requirements for days of data, requiring only five days per year and seven total days per period since migration duration often occurred over a much shorter time period. Utilization contour levels of 50%, 75%, and 95% were calculated for the mean UD surface. The final UD was cropped to the 95% contour for mapping and further analyses (Spiegel et al. 2017).

[8] https://seaduckjv.org/science-resources/atlantic-and-great-lakes-sea-duck-migration-study/

### *2.1.1.1.4.3 Migrant Raptor Studies*

#### *Peregrine Falcon and Merlin*

To facilitate research efforts on migrant raptors [i.e. migration routes, stopover sites, space use relative to Atlantic OCS wintering/summer range, origins, contaminant exposure], BRI has deployed satellite transmitters on fall migrating raptors at three different raptor migration research stations along the north Atlantic coast (DeSorbo et al. 2012; DeSorbo, Persico, et al. 2018; DeSorbo, Gilpatrick, et al. 2018). Research stations include the Block Island Raptor Research Station at Block Island, Rhode Island (peregrines falcons [*Falco peregrinus]*: 3 adult [ad.] females, 18 hatch year [HY] females, 17 HY males; merlins [*Falco columbarius*]: 3 ad. females and 13 HY females [DeSorbo, Persico, et al. 2018]); Monhegan Island, Maine (peregrine falcons: 2 HY females); and Cutler, Maine (peregrine falcons: 1 ad. female).

Satellite-tagged peregrine falcons and merlins provided information on fall migration routes along the Atlantic flyway. Positional data was filtered to remove poor quality locations using the Douglas Argos Filtering tool (Douglas et al. 2012) available online on the Movebank data repository[9] where these data are stored and processed. A request for data use was made to Chris DeSorbo, Raptor Program Director at BRI, who provided permission to utilize the results of the migrant raptor studies.

#### *Osprey*

Between 2000 and 2019, 106 tracking devices were fitted to ospreys (*Pandion haliaetus*) predominantly spanning between Chesapeake Bay and northern New Hampshire (www.ospreytrax.com). This data set includes both adults and juveniles, but emphasized tagging juveniles prior to their first migration. It represents the first dedicated study of dispersal, mortality, and migration in juvenile osprey. Satellite transmitters were used in early years, but beginning in 2012, higher resolution cellular Global Positioning System (GPS) transmitters were deployed on adult males to better document their foraging behavior around nests and to provide additional details about migration (e.g. thermal soaring over land and dynamic soaring over water) (Horton et al. 2014).

Separately, satellite Argos satellite PTT tags were deployed on osprey in the US and Canada between 1995 and 2001 (Martell et al. 2001; Martell and Douglas 2019). This data has been used to delineate both fall and spring migratory routes used by ospreys breeding in the US. Tagging locations included areas in Oregon, Washington, Minnesota, New York, and New Jersey. Birds tagged in eastern states generally migrated along the Eastern Seaboard.

To characterize potential utilization of the offshore environment by osprey, UDs were generated for individual animals using a dBBMM (Kranstauber et al. 2012). Both Argos satellite data and GPS-derived positional data were used from the two different telemetry datasets from

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[9] https://www.movebank.org/

Movebank (as above). Both datasets were compiled together and a max speed filter by animal was applied, which excluded locations with instantaneous speeds greater than 100 kilometers per hour (62 miles per hour) and also filtered points outside of an extent including the eastern US and Atlantic Canada (including all offshore points for this region). Individual dBBMMs were generated for the last 365 consecutive days of available data per tag (or less if the tags provide less than 365 consecutive days), thus representing an annual cycle within the US. Models were composited into a weighted UD for the sampled population, weighting each animal's UD by the number of days data were available of the total number of days of all animals providing models.

###### *2.1.1.1.4.4 Tracking movements of vulnerable terns and shorebirds in the Northwest Atlantic using nanotags*

Since 2013, BOEM and the USFWS have supported a study using nanotags (coded VHF tags) and an array of automated very high frequency (VHF) radio telemetry stations to track the movements of vulnerable terns and shorebirds. The study was designed to assess the degree to which these species use offshore federal waters during breeding, pre-migratory staging periods, and on their migrations. In a pilot study in 2013, researchers attached nanotags to common terns (*Sterna hirundo*) and American oystercatchers (*Haematopus palliatus*) and set up eight automated sentry stations (Loring et al. 2017). Having proved the methods successful, the study was expanded to 16 automated stations in 2014, and from 2015–2017, tagging efforts included Endangered Species Act-listed piping plovers and roseate terns. This study provided new information on the offshore movements and flight altitudes for these species gathered from a total of 33 automated telemetry stations, including areas of Massachusetts, New York, New Jersey, Delaware, and Virginia (Loring et al. 2019).

###### *2.1.1.1.4.5 Tracking movements of rufa Red Knots in US Atlantic Outer Continental Shelf Waters*

Building from a previous tracking study, *rufa* red knots were fitted with digital VHF transmitters during their 2016 southbound migration at stopover locations in both Canada and along the US Atlantic coast. Individuals were tracked utilizing radio telemetry stations within the study area that extended from Cape Cod, Massachusetts to Back Bay, Virginia. Modeling techniques were developed to describe the frequency and offshore movements over Federal waters and specific Wind Energy Areas (WEAs) within the study area. The primary study objectives were to: develop models related to offshore movements for *rufa* red knots; assess the exposure to each WEA during southbound migration; and examine WEA exposure and migratory departure movements in relation to various meteorological conditions (Loring et al. 2018).

###### *2.1.1.1.4.6 Sea Duck Tracking Studies*

The Atlantic and Great Lakes Sea Duck Migration Study, a multi-partner collaboration, was initiated by SDJV in 2009 with the goals of: (1) fully describing full annual cycle migration patterns for four species of sea ducks (surf scoter, black scoter [*Melanitta americana*], white-winged scoter [*Melanitta deglandi*], and long-tailed duck [*Clangula hyemalis*]), (2) mapping local movements and estimating length-of-stay during winter for individual radio-marked ducks in areas proposed for placement of WTGs, (3) identifying nearshore and offshore habitats of high significance to sea ducks to help inform habitat conservation efforts, and (4) estimating rates of annual site fidelity to wintering areas, breeding areas, and molting areas for all four focal species in the Atlantic flyway. To date, over 500 transmitters have been deployed in the US and Canada by various project partners including BRI, Canadian Wildlife Service, US Geological Survey Patuxent Wildlife Research Center, University of Rhode Island, Rhode Island Department of Environmental Management, USFWS, SDJV, and the University of Montreal. These collective studies have led to increased understanding of annual cycle dynamics of sea ducks, as well as potential interactions with and impacts from offshore wind energy development (Loring et al. 2014; SDJV 2015; Meattey et al. 2018; Meattey et al. 2019).

Additionally, BOEM and USFWS partnered with SDJV during 2012–2016 to deploy transmitters in surf scoters as part of a satellite telemetry tracking study in the mid-Atlantic, with objectives aimed at determining fine scale use and movement patterns of three species of marine diving birds during migration and winter (Spiegel et al. 2017).

UDs were determined for each species by calculating individual level dBBMM surfaces (Kranstauber et al. 2012) using package Move for R (Kranstauber and Smolla 2016). Separate dBBMM surfaces were calculate for each of two winters with at least five days of data and combined into a weighted mean surface for each animal (as a percentage of the total number of days represented in the surface) with a minimum 30 total combined days of data. This method of combining multiple seasons was used for the migration periods as well, but with relaxed requirements for days of data, requiring only five days per year and seven total days per period since migration duration often occurred over a much shorter time period. Utilization contour levels of 50%, 75%, and 95% were calculated for the mean UD surface. The final UD was cropped to the 95% contour for mapping and further analyses (Spiegel et al. 2017).

#### *2.1.1.2 Exposure Mapping*

Maps were developed to display local and regional context for exposure assessments. A three-part map was created for each species-season (winter: December– February; spring: March–May; summer: June–August; and fall: September–November) combination that includes MDAT and/or baseline survey data (See section 5 of this Appendix). Any species-season combination which did not at least have either MDAT model or baseline survey data (i.e. blank maps) were left out of the final map set. An example map for northern gannet in fall is provided below to aid in discussion (Figure 2-5).

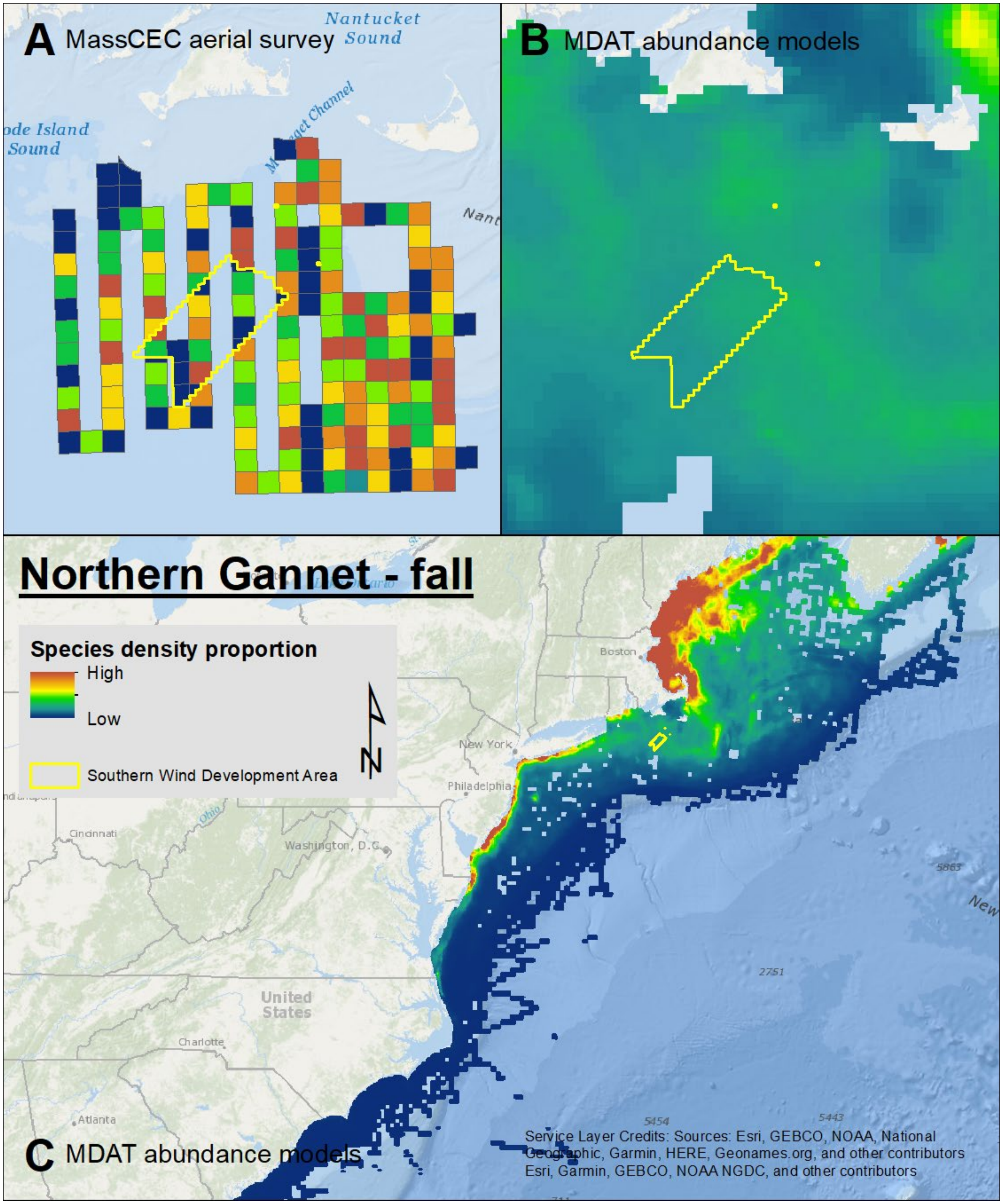


Figure 2-5: Example map of relative density proportions locally and regionally for northern gannet in fall

The first map panel (A) presents the MassCEC aerial survey data as proportions of total effort-corrected counts. The proportion of the total effort-corrected counts (total counts per square kilometer of survey area) was calculated for each BOEM designated OCS[10] Lease Block[11], across all surveys in a given season. This method was useful as it scaled all effort-corrected count data from 0–1 to standardize data visualizations among species. Exposure was ranked from low–high for each species based on weighted quantiles of these count proportions. Quantiles were weighted by the count proportions because data were skewed towards zero. OCS Lease Blocks with zero counts were always the lowest, and blocks with more than one observation were divided into four weighted quantiles.

The next two map panels (B and C) include data from MDAT models presented at different scales. Panel B shows the modeled densities in the same area as the baseline surveys while Panel C shows the density output over the entire Northwest Atlantic. Density data are scaled in a similar way to the baseline survey data, so that the low–high designation for density is similar for both datasets. However, there are no true zeroes in the model outputs, and thus no special category for them in the MDAT data. All MDAT models were masked to remove areas of zero effort within a season. These zero-effort areas do have density estimates, but generally are of low confidence, so they were excluded from mapping and analysis to reduce anomalies in predicted species densities and to strengthen the analysis. Additionally, while the color scale for the MDAT data is approximately matched to that used for the baseline survey data, the values that underlie them are different (the MDAT data are symbolized using an ArcMap default color scale, which uses standard deviations from the mean to determine the color scale rather than quantiles). Maps should be viewed in a broadly relative way between local and regional assessments and even across species.

#### *2.1.1.3 Exposure Assessment Metrics*

Avian exposure to the SWDA was assessed on an individual level by calculating densities using the NE Wind boat survey, on a local population level using the MassCEC aerial surveys, and on a regional population level using the MDAT models. The local and regional datasets were combined to create the species-specific exposure score (see next section). The exposure scores were developed from the MassCEC and MDAT models by comparing bird densities in the SWDA with all other possible SWDA-sized areas within the survey area for each dataset. For each species the mean densities were compiled for each SWDA-sized area, quantiles calculated for

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[10] The OCS is defined by the US Department of the Interior (https://www.bsee.gov/newsroom/library/glossary) as "All submerged lands seaward and outside the area of lands beneath navigable waters. Lands beneath navigable waters are interpreted as extending from the coastline 3 nautical miles into the Atlantic Ocean, the Pacific Ocean, the Arctic Ocean, and the Gulf of Mexico excluding the coastal waters off Texas and western Florida. Lands beneath navigable waters are interpreted as extending from the coastline 3 marine leagues into the Gulf of Mexico off Texas and western Florida."

[11] OCS Lease Blocks are defined (https://catalog.data.gov/dataset/outer-continental-shelf-lease-blocks-atlantic-region-nad83) as "small geographic areas within an Official Protraction Diagram (OPD) for leasing and administrative purposes. These blocks have been clipped along the Submerged Lands Act (SLA) boundary and along the Continental Shelf Boundaries. Additional details are available from: https://www.boem.gov/BOEM-Newsroom/Library/Publications/1999/99-0006-pdf.aspx"

the set of all SWDA-sized areas, and a categorical score was assigned to each quantile. If the SWDA was in the top quartile, a bird would get a high exposure score; if it was in the bottom, a minimal score. The analysis was done in the following two steps:

Step 1, assess regional exposure using MDAT models: Using the MDAT data, masked to remove zero-effort predicted cells, the predicted seasonal density surface for a given species was aggregated into a series of rectangles that were approximately the same size as the SWDA, and the mean density estimate of each rectangle was calculated. This process compiled a dataset of density estimates for all species surveyed, for areas the same size as the SWDA. The 25$^{th}$, 50$^{th}$, and 75$^{th}$ weighted quantiles of this dataset were calculated, and the quantile into which the density estimate for the SWDA fell for a given species and season combination was identified. Quantiles were weighted by using the proportion of the total density across the entire modeled area that each sample represented. Thus, quantile breaks represent proportions of the total seabird density rather than proportions of the raw data. A categorical score was assigned to the SWDA for each season-species: 0 (Minimal) was assigned when the density estimate for the SWDA was in the bottom 25%; 1 (Low) when it was between 25% and 50%; 2 (Medium) when it was between 50% and 75%; and 3 (High) when it was in the top quartile (greater than 75%). While a "high" score does suggest importance within a local or regional scale, these scores need to be considered in context of scores at each spatial scale when assessing overall importance to the species in a season.

Step 2, assess local exposure using the MassCEC aerial survey: A similar process was used to categorize each species-season combination using the baseline survey data. To compare the SWDA to other locations within the survey region, the nearest 19 OCS full or partial Lease Blocks to each OCS Lease Block surveyed in the MassCEC aerial survey area in each season (winter, $n$ = 166; spring, $n$ = 170; summer, $n$ = 173; and fall, $n$ = 175) were identified and the relative density of each OCS Lease Block group was calculated. Thus, a dataset of relative densities for all possible SWDA-sized OCS Lease Block groups was generated within the survey region using the baseline survey data. This data set was used to assign scores to all species-season combinations, based on the same quartile categories described for the MDAT models above. If a score for a species-season combination was not available using the baseline survey data (local assessment), and because the avian surveys made every effort to survey all species, then the local assessment score was assigned a zero since no animals were sighted for that species-season combination.

#### *2.1.1.4 Species Exposure Scoring*

To determine the relative exposure for a given species and season in the SWDA compared to all other areas, the MDAT quartile score and baseline survey data quartile score were added together to create a final exposure metric that ranged from 0 to 6. The density information at both spatial scales was equally weighed, and thus represent both the local and regional importance of the SWDA to a given species during a given season. However, if a species-season combination was not available for the MDAT regional assessment, then the score from the local assessment (baseline survey data) was accepted as the best available information for that species-season, and it was scaled to range from 0 to 6 (e.g. essentially doubled to match the final combined score).

The exposure score was categorized as ***insignificant*** (a combined score of 0), ***unlikely*** (combined score of 1–2), ***potential*** (combined score of 3–4), or ***likely*** (combined score of 5–6) (Table 2-2). In general terms, species-season combinations labeled as ***insignificant*** had low densities at both the local and regional spatial scales. ***Unlikely*** exposure was assessed for species with below-average densities at both spatial scales, or above-average density at one of the two spatial scales and low density at the other scale. ***Potential*** exposure describes several different combinations of densities; one or both spatial scales must be at least above-average density, but this category can also include species-season combinations where density was high for one spatial scale and low for another. ***Likely*** exposure is when density is high at both spatial scales, or one is high and the other is above average. Both local and regional exposure scores were viewed as equal in importance in the assessment of exposure. All exposure determinations are highlighted in bold throughout the text.

Table 2-2: Definitions of exposure levels developed for the avian assessment for each species and season; the listed scores represent the exposure scores from the local baseline survey data and the regional MDAT on the left and right, respectively

| Exposure Level | Definition | Scores |
|---|---|---|
| *Insignificant* | Densities at both local and regional scales are below the 25th percentile. | 0, 0 |
| *Unlikely* | Local and/or regional density is between the 25th and 50th percentiles. | 1, 1 |
| | **OR** | |
| | Local density is between the 50th and 75th percentiles and regional density is below the 25th percentile, or vice versa. | 2, 0 |
| *Potential* | Local or regional density is between the 50th and 75th percentiles. | 2, 2 |
| | **OR** | |
| | Local density is between the 50th and 75th percentiles and regional density between the 25th and 50th percentiles, or vice versa. | 2, 1 |
| | **OR** | |
| | Local density is greater than the 75th percentile and regional density is below the 25th percentile, or vice versa. | 3, 0 |
| | **OR** | |
| | Local density is greater than the 75th percentile of all densities and regional density is between the 25th and 50th percentiles of all densities (or vice versa). | 3, 1 |
| *Likely* | Densities at both local and regional scales are above the 75th percentile. | 3, 3 |
| | **OR** | |
| | Local densities are greater than the 75th percentile and regional densities are between the 50th and 75th percentiles, or vice versa. | 3, 2 |

### *2.1.1.5 Aggregated Annual Exposure Scores*

To understand the total exposure across the annual cycle for each species, seasonal scores were summed to obtain an annual score that ranged from 0–12. These annual scores were then mapped to exposure categories of ***insignificant*** (0–2), ***unlikely*** (3–5), ***potential*** (6–8), and ***likely*** (9–12). The annual exposure category for a species represents the seasonally integrated risk across the annual cycle.

Finally, because these scores are relative to seasonal distribution, estimates of count density were provided within the SWDA and over the entire survey area for each species from the baseline survey data. Uncommon species with few detections in the SWDA may be somewhat over-rated for exposure using this method, while common species with relatively few detections in the SWDA may be effectively under-rated in terms of total exposure to the SWDA. Density estimates (count per sq. km) are presented to provide context for the exposure scores.

#### *2.1.1.6 Interpreting Exposure Scores*

The final exposure scores for each species and season, as well as the aggregated annual scores, should be interpreted as a measure of the relative importance of the SWDA for a species, as compared to other surveyed areas in the region and in the Northwest Atlantic. It does not indicate the absolute number of individuals likely to be exposed. Rather, the exposure score attempts to provide regional and population-level context for each species.

A ***likely*** exposure score indicates that the observed and predicted densities of the species in the SWDA were high relative to densities of that species in other surveyed areas. Conversely, an ***unlikely*** or ***insignificant*** exposure score means that the species was predicted to occur at lower densities in the SWDA than in other locations. An ***insignificant*** exposure score should not be interpreted to mean there are no individuals of that species in the SWDA. In fact, common species may receive an ***insignificant*** exposure score even if there are substantial numbers of individuals in the SWDA, so long as their predicted densities *outside* the SWDA are comparatively higher. The quantitative annual exposure score was then considered with additional species-specific information, along with expert opinion, to place each species within a final exposure category (described below in section 2.1.1.7).

#### *2.1.1.7 Exposure Categories*

The quantitative assessment of exposure (described above), other locally available data, existing literature, and species accounts were utilized to develop a final qualitative exposure determination. Final exposure level categories used in this assessment are described in Table 2-3 below.

Table 2-3: Assessment criteria used for assigning species to final exposure levels

| Final Exposure Level | Definition |
|---|---|
| *Insignificant* | Insignificant seasonal exposure scores in all seasons or insignificant score in all but one season.<br><br>OR<br><br>Based upon the literature—and, if available, other locally available tracking or survey data—little to no evidence of use of the SWDA or offshore environment for breeding, wintering, or staging, and low predicted use during migration. |
| *Unlikely* | Unlikely exposure scores in two or more seasons, or Potential exposure score in one season.<br><br>OR |

| Final Exposure Level | Definition |
|---|---|
| | Based upon the literature—and, if available, other locally available tracking or survey data—low evidence of use of the SWDA or offshore environment during any season. |
| *Potential* | Potential exposure scores in two or more seasons, or Likely exposure score in one season.<br><br>OR<br><br>Based upon the literature—and, if available, other locally available tracking or survey data—moderate evidence of the SWDA or use of the offshore environment during any season. |
| *Likely* | Likely exposure scores in two or more seasons.<br><br>OR<br><br>Based upon the literature—and, if available, other locally available tracking or survey data—high evidence of use of the SWDA or offshore environment, and the offshore environment is primary habitat during any season. |

### 2.1.2 Vulnerability Framework

Researchers in Europe and the US have assessed the vulnerability of birds to offshore wind farms and general disturbance by combining ordinal scores across a range of key variables (Furness et al. 2013; Willmott et al. 2013; Wade et al. 2016; Kelsey et al. 2018; Fliessbach et al. 2019). The purpose of these indices was to prioritize species in environmental assessments (Desholm 2009), and provide a relative rank of vulnerability (Willmott et al. 2013). Importantly, past assessments and the one conducted here are intended to support decision-making by ranking the relative likelihood that a species will be sensitive to offshore wind farms but should not be interpreted as an absolute determination that there will or will not be collision mortality or habitat loss. Therefore, the results should be interpreted as a guide to species that have a higher likelihood of vulnerability.

The existing vulnerability methods assess individual-level vulnerability to collision and displacement independently and then incorporate population-level vulnerability to develop a final *species-specific* vulnerability score. These past efforts provide useful rankings across a region but are not designed to assess the vulnerability of birds to a particular wind farm or certain WTG designs. Collision risk models (e.g. Band 2012) do estimate site-specific mortality, but are substantially influenced by assumptions about avoidance rates (Chamberlain et al. 2006). Furthermore, collision risk models do not explicitly assess vulnerability to displacement; i.e., macro avoidance behaviors, leading to temporarily or permanently displacement from a wind farm area, which can cause effective habitat loss). Thus, there is a need to develop a *project-specific* vulnerability score for each species that is inclusive of both collision and displacement and has fewer assumptions.

The scoring process in this assessment builds from the existing methods, incorporates the specifications of the WTGs being considered by New England Wind, utilizes local bird conservation status, and limits the vulnerability score to the species observed in the local surveys. The results from this scoring method may differ for some species from the qualitative determinations made in other Construction and Operation Plan (COP) assessments because the input parameters use specific categorical definitions that in some cases are conservative (e.g., > 40% macro-avoidance receives the highest score; see below and Table 2-5). The literature is also used to interpret scoring results, and, if empirical studies indicate a lower or higher vulnerability, a range is added to the final score (see uncertainty discussion below). For species or species group for which inputs are lacking, the literature is used to qualitatively determine a vulnerability ranking using the criteria in Table 2-4. Below is a description of the scoring approach.

Table 2-4: Assessment criteria used for assigning species to each behavioral vulnerability level

| Behavioral Vulnerability Level | Definition |
|---|---|
| *Insignificant* | 0–0.25 ranking for collision or displacement risk in vulnerability scoring.<br>OR<br>No evidence of collisions or displacement in the literature. Unlikely to fly within the rotor-swept zone (RSZ). |
| *Unlikely* | 0.26–0.5 ranking for collision or displacement risk in vulnerability scoring.<br>OR<br>Little evidence of collisions or displacement in the literature. Rarely flies within the RSZ. |
| *Potential* | 0.51–0.75 ranking for collision or displacement risk in vulnerability scoring.<br>OR<br>Evidence of collisions or displacement in the literature. Occasionally flies within the RSZ. |
| *Likely* | 0.76–1.0 ranking for collision or displacement risk in vulnerability scoring.<br>OR<br>Significant evidence of collisions or displacement in the literature. Regularly flies within the RSZ. |

#### *2.1.2.1 Population Vulnerability*

Many factors contribute to how sensitive a population is to mortality or habitat loss related to the presence of a wind farm, including include vital rates, existing population trends, and relative abundance of birds (Goodale and Stenhouse 2016). In this avian risk assessment, the relative abundance of birds is accounted for by the exposure analysis described above. The vulnerability assessment creates a population vulnerability (PV) score by using Partners in Flight (PiF) "continental combined score" (CCSmax), a local "state status" (SSmax), and adult survival score (AS) (Equation 1 below). Survival is included as an independent variable that is not accounted for in the CCSmax. This approach is based upon methods used by Kelsey et al. (2018) and Fliessbach et al. (2019).

Each factor included in this assessment (CCSmax, SSmax, and AS) is weighted equally and receives a categorical score of 1–5 (Table 2-5). The final population level vulnerability scores are rescaled to a 0–1 scale, divided into quartiles, and are then translated into four final vulnerability categories (Table 2-4). Since using quartiles creates hard cut-off points and there is uncertainty present in all inputs (See discussion on uncertainty below), using scores alone can potentially misrepresent vulnerability (e.g. a 0.545 PV score leading to a ***potential*** category). To account for this, the scores are considered along with information in existing literature. If there is evidence in the literature that conflicts with the vulnerability score, then the score will be appropriately adjusted (up or down) according to documented empirical evidence. For example, if a PV score was assessed as ***unlikely***, but a paper indicated an increasing population, the score would be adjusted up to include a range of ***unlikely–potential***.

$$PV = CCSmax + SSmax + AS \qquad \text{Equation 1}$$

Specifics for each factor in PV are as follows:

- *CCSmax* is included in scoring because it integrates various factors PiF uses to indicate global population health. It represents the maximum value for breeding and non-breeding birds developed by PiF, and combines the scores for population size, distribution, global threat status, and population trend (Panjabi et al. 2019). The CCSmax score from PiF was rescaled to a 1–5 scale to achieve consistent scoring among factors.

- *SSmax* is included in scoring to account for local conservation status, which is not included in the CCSmax. Local conservations status is generally determined independently by states and accounts for the local population size, population trends, and stressors on a species within a particular state. It was developed following methods by Adams et al. (2016) in which the state conservation status for the relevant adjacent states is placed within five categories (1 = no ranking, to 5 = endangered), and then, for each species, the maximum state ranking is selected.

- *AS* is included in the scoring because species with higher adult survival rates are more sensitive to increases in adult mortality because they tend to be species that are also long-lived and have low annual reproductive success (e.g., K strategists) (Desholm 2009; Adams et al. 2016). The five categories are based upon those used in several vulnerability assessments (Willmott et al. 2013; Kelsey et al. 2018; Fliessbach et al. 2019), and the species-specific values were used from Willmott et al. (2013).

Table 2-5: Data sources and scoring of factors used in the vulnerability assessment

| Vulnerability Component | Factor | Definition and Source | Scoring |
|---|---|---|---|
| Population Vulnerability (PV) | continental combined score *(CCSmax)* | CCSmax is Partners in Flight continental combined score: pif.birdconservancy.org/ACAD/Database.aspx. | 1 = Minor population sensitivity<br>2 = Low population sensitivity<br>3 = Medium population sensitivity<br>4 = High population sensitivity<br>5 = Very-High population sensitivity |
| | state status *(SSmax)* | SSmax from states adjacent to New England Wind from Adams et al. (2016). | 1 = No Ranking[1]<br>2 = State/Federal Special Concern<br>3 = State/Federal Threatened<br>4 = State/Federal Endangered<br>5 = State & Federal End and/or Thr |
| | *adult survival (AS)* | AS score: scores and categories taken from Willmott et al. (2013). | 1 = <0.75<br>2 = 0.75 to 0.80<br>3 = >0.80 to 0.85<br>4 = >0.85 to 0.90<br>5 = >0.90 |
| Collision Vulnerability (CV) | *rotor swept zone (RSZt)* | Wind turbine generator (WTG)-specific percentage of flight heights in RSZ. Flight heights modeled from Northwest Atlantic Seabird Catalog. Categories from Kelsey et al. (2018). | 1 = < 5% in RSZ<br>3 = 5–20% in RSZ<br>5 = > 20% in RSZ |
| | *macro-avoidance (MAc)* | Avoidance rates and scoring categories from Willmott et al. (2013) and Kelsey et al. (2018). | 1 = >40% avoidance<br>2 = 30 to 40% avoidance<br>3 = 18 to 29% avoidance<br>4 = 6 to 17% avoidance<br>5 = 0 to 5% avoidance |
| | Nocturnal Flight Activity (NFA); Diurnal Flight Activity (DFA). | NFA scores were taken from Willmot et al. (2013); DFA was calculated using locally available aerial surveys that records if birds are sitting or flying. | 1 = 0–20%<br>2 = 21–40%<br>3 = 41–60%<br>4 = 61–80%<br>5 = 81–100% |
| Displacement Vulnerability (DV) | *MAd* | Macro-avoidance rates (MAd) that would decrease collision risk from Willmott et al. (2013) and Kelsey et al. (2018). | 1 = 0–5% avoidance<br>2 = 6–17% avoidance<br>3 = 18–29% avoidance<br>4 = 30–40% avoidance<br>5 = > 40% avoidance |

| Vulnerability Component | Factor | Definition and Source | Scoring |
|---|---|---|---|
| | *Habitat flexibility (HF)* | The degree to which a species is considered a habitat generalist (i.e. can forage in a variety of habitats) or a specialist (i.e. requires specific habitat and prey type). HF score and categories taken from Willmott et al. (2013). | 0 = species does not forage in the Atlantic Outer Continental Shelf<br>1 = species uses a wide range of habitats over a large area and usually has a wide range of prey available to them<br>2 to 4 = grades of behavior between scores 1 and 5<br>5 = species with habitat- and prey-specific requirements that do not have much flexibility in diving-depth or choice of prey species |

Notes:

1. Note actual definitions for state conservation ranking may be adjusted to follow individual state language.

#### *2.1.2.2 Collision Vulnerability*

Collision vulnerability (CV) assessments can include a variety of factors including nocturnal flight activity, diurnal flight activity, avoidance, proportion of time within the rotor swept zone (RSZ), maneuverability in flight, and percentage of time flying (Furness et al. 2013; Willmott et al. 2013; Kelsey et al. 2018). The assessment process conducted here follows Kelsey et al. (2018) and includes proportion of time within the RSZ (RSZt), a measure of avoidance (MAc), and flight activity (NFA and DFA) (Equation 2 below). Each factor was weighted equally and given a categorical score of 1–5 (Table 2-5). The final collision vulnerability scores were rescaled to a 0–1 scale, divided into quartiles, and then translated into four final vulnerability categories (Table 2-4). As described in the PV section, the score is then considered along with information available in existing literature; if there is sufficient evidence to deviate from the quantitative score, a CV categorical range is assigned for each species.

$$CV = RSZt + MAc + (NFA + DFA)/2 \qquad \text{Equation 2}$$

Specifics for each factor in CV are as follows:

- RSZt is included in the score to account for the probability that a bird may fly through the RSZ. Flight height data was selected from the Northwest Atlantic Seabird Catalog, with additional data added from the annual boat surveys and spring surveys in the Vineyard Wind 1 project area. Flight heights calculated from digital aerial survey methods were excluded because the methods has not been validated (Thaxter et al. 2015) and the standard flight height data used in European collision assessments (Masden 2019) is modeled primarily from boat-based survey (Johnston et al. 2014). Three additional boat-based datasets were excluded because there was low confidence in the data (collected by citizen science efforts, less standardized, and of lower quality) or estimated flight heights only included part of the air space below 300 m (984 ft).

Many of the boat-based datasets provided flight heights as categorical ranges for which the mid value of the range in meters were determined, as well as the lower and upper bounds of the category. Upper bounds that were given as greater than X m (or ft) were capped at 300 m (984 ft) to estimate upper bounds. A few datasets provided exact flight height estimates which resulted in upper and lower ranges being the same as the mid value. A total of 100 randomized datasets were generated per species using the uniform distribution to select possible flight height values between lower and upper flight height bounds. Similar to methods from Johnston et al. (2014), flight heights were modeled using a smooth spline of the square root of the binned counts in 10-m (32-ft) bins. The integration of the smooth spline model count within each 1 m (3 ft) increment was calculated and the mean and standard deviation of all 100 models were calculated across all 1 m (3 ft) increments. The proportion of animals within each RSZ was estimated by summing the 1 m (3 ft) count integrations and dividing by the total estimate count of animals across all RSZ zones, then values were converted to a 1–5 scale based upon the categories used by Kelsey et al. (2018) (Table 2-5). The RSZ was defined by minimum and maximum WTG options being considered for SWDA (two different power unit ranges at two different tower heights) (Table 2-6). The analysis was conducted in R Version 3.5.3.[12] Of note, there are several important uncertainties in flight height estimates: flight heights from boats can be skewed lower; flight heights are generally recorded during daylight and in fair weather; and flight heights may change when WTGs are present.

[12] R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Table 2-6: WTG options for Phase 1 and Phase 2 of SWDA used in the vulnerability analysis; mean Lower Low Water (MLLW) is the average height of the lowest tide recorded at a tide station each day during the recording period

| Phase 1 | |
|---|---|
| WTG Parameter | Envelope |
| WTG Capacity | 13–16 megawatts (MW) |
| Maximum tip height | 319 m (1,047 ft) MLLW |
| Maximum hub height | 192 m (630 ft) MLLW |
| Maximum rotor diameter | 255 m (837 ft) |
| Minimum tip clearance | 27 m (89 ft) MLLW |
| Maximum blade chord | 8 m (26.2 ft) |
| Maximum tower diameter | 9 m (29.5 ft) |
| Phase 2 | |
| WTG Parameter | Envelope |
| WTG Capacity | 13–19 MW |
| Maximum tip height | 357 m (1,171 ft) MLLW |
| Maximum hub height | 214 m (702 ft) MLLW |
| Maximum rotor diameter | 285 m (935 ft) |
| Minimum tip clearance | 27 m (89 ft) MLLW |
| Maximum blade chord | 9 m (29.5 ft) |
| Maximum tower diameter | 10 m (32.8 ft) |

- MAc is included in the score to account for macro-avoidance rates that would decrease collision risk. Macro-avoidance is defined as a bird's ability to change course to avoid the entire wind farm area (Kelsey et al. 2018), versus meso-avoidance (avoiding individual WTGs), and micro-avoidance (avoiding WTG blades) (Skov et al. 2018). The scores used in the assessment were based on Willmott et al. (2013), who conducted a literature review to determine known macro-avoidance rates and then converted them to a 1–5 score based upon the categories in Table 2-5. The MAc indicates that this factor is used in the CV versus the MAd, which was used in the displacement vulnerability (DV) score (described below). For the assessment conducted here, Willmott et al. (2013) avoidance rates were updated to reflect the most recent empirical studies (Krijgsveld et al. 2011; Cook et al. 2012; Vanermen et al. 2015; Cook et al. 2018), and indexes (Garthe and Hüppop 2004; Furness et al. 2013; Bradbury et al. 2014; Adams et al. 2016; Wade et al. 2016; Kelsey et al. 2018). For the empirical studies, the average avoidance was used when a range was provided in a paper. For the indices, the scores were converted to a continuous value using the median of a scores range; only one value was entered for related indices (e.g. Adams et al. 2016 and Kelsey et al. 2018). When multiple values were available for a species, the mean value was calculated. For some species, averaging the avoidance rates across both the empirical studies and indices led to some studies being counted multiple times. Indices were included to capture how the authors interpreted the avoidance studies and determined avoidance rates for species where data was not available. There are several important uncertainties in determining avoidances rates: the studies were all conducted in Europe; the studies were conducted at wind farms with

WTGs much smaller than are proposed for SWDA; the methods used to record avoidance rates varied and included surveys, radar, and observers; the analytical methods used to estimate avoidance rates also varied significantly between studies; and the avoidance rate for species where empirical data is not available were assumed to be similar to closely-related species.

- NFA and DFA include scores of estimate percentage of time spent flying at night and during the day based upon the assumption that more time spent flying would increase collision risk. The NFA scores were taken directly from the scores, based upon literature review, from Willmott et al. (2013). The DFA score were calculated from the baseline survey data that categorized if a bird was sitting or flying for each bird observation. Per Kelsey et al. (2018), the NFA and DFA scores were equally weighted and averaged.

#### *2.1.2.3 Displacement Vulnerability*

Rankings of DV account for two factors: (1) disturbance from ship/helicopter traffic and the wind farm structures (MAd), and (2) habitat flexibility (HF) (Furness et al. 2013; Kelsey et al. 2018). This assessment combines these two factors, weights them equally, and categorizes them from 1–5 (Equation 3 below) (Table 2-5). It's worth noting that while Furness et al. (2013) down-weighed the DV score by dividing by 10 (they assumed displacement would have lower impacts on the population), the assessment conducted here maintains the two scores on the same scale. Empirical studies indicate that for some species, particularly sea ducks, avoidance behavior may change through time and that several years after projects have been built some individuals may forage within the wind farm. The taxonomic specific text indicates whether there is evidence that displacement may be partially temporary. The final displacement vulnerability scores are rescaled to a 0–1 scale, divided into quartiles, and translated into four final vulnerability categories (Table 2-4). As described in the PV section, the score is then considered along with the literature; if there is sufficient evidence to deviate from the quantitative score, a DV categorical range is assigned for each species.

$$DV = MAd + HF \qquad \textit{Equation 3}$$

Specifics for each factor in DV are as follows:

- *MAd* is included to account for behavioral responses from birds that lead to macro-avoidance of wind farms, and that have the potential to cause effective habitat loss if the birds are permanently displaced (Fox et al. 2006). The MAd scores used in the assessment were based on Willmott et al. (2013), but updated to reflect the most recent empirical studies (Krijgsveld et al. 2011; Cook et al. 2012; Vanermen et al. 2015; Cook et al. 2018; Skov et al. 2018), and indexes (Garthe and Hüppop 2004; Furness et al. 2013; Bradbury et al. 2014; Adams et al. 2016; Wade et al. 2016; Kelsey et al. 2018). See MAc above for further details. The scores are the same as the MAc scores described above, but, following methods from Kelsey et al. (2018), are inverted so that a high avoidance rate (greater than 40%) is scored as a 5. Since the greater than 40% cutoff is a low threshold, many species can receive a high 5 score; there is a large range within this high category that includes species documented to have moderate avoidance rates (e.g. terns) and species with near complete avoidance (e.g. loons).

- *HF* accounts for the degree to which a species is considered a habitat generalist (i.e. can forage in a variety of habitats) or a specialist (i.e. requires specific habitat and prey type). The assumption is that generalists are less likely to be affected by displacement, whereas specialists are more likely to be affected (Kelsey et al. 2018). The values for HF used in this assessment were taken from Willmott et al. (2013). Note that Willmott et al. (2013) used a 1–5 scale plus a "0" to indicate that a species does not forage in the OCS.

### 2.1.3 Uncertainty

Uncertainty is recognized in this assessment for both exposure and vulnerability. Given the natural variability of ecosystems and recognized knowledge gaps, assessing how anthropogenic actions will affect the environment inherently involves a degree of uncertainty (Walker et al. 2003). Broadly defined, uncertainty is incomplete information about a subject (Masden et al. 2015) or a deviation from absolute determinism (Walker et al. 2003). In the risk assessment conducted here, uncertainty is broadly recognized as a factor in the process, and is accounted for by including, based upon the best available data, a range for the exposure, vulnerability, and population scores when appropriate.

For offshore wind avian assessments, uncertainty primarily arises from two sources: predictions of bird use of a project area and region (i.e. exposure); and our understanding of how birds interact with WTGs (i.e. vulnerability). While uncertainty will always be present in any assessment of offshore wind, and acquiring data on bird movements during hours of darkness and in poor weather is difficult, overall knowledge on bird use of the marine environment has improved substantially in recent years through local survey efforts (e.g. MassCEC aerial surveys), revised regional modeling efforts (i.e. MDAT models), and individual tracking studies (e.g. falcons, terns, piping plover, red knot, diving birds). For many species, multiple data sources may be available to make an exposure assessment, such as survey and individual tracking data. If the data sources show differing patterns in use of the wind farm area, then a range of exposure is provided (e.g. insignificant–unlikely) to account for all available data and to capture knowledge gaps and general uncertainty about bird movements.

Similarly, knowledge has been increasing on the vulnerability of birds to offshore wind facilities in Europe (e.g. Skov et al. 2018). Vulnerability assessments have either incorporated uncertainty into the scoring process to calculate a range of ranks (Willmott et al. 2013; Kelsey et al. 2018), or have developed separate standalone tables (Wade et al. 2016). In order to keep the scoring process as simple as possible, this assessment does not directly include uncertainty in the scoring, rather it uses the uncertainty assessment conducted by Wade et al. (2016) as a reference (Table 2-7) and references all available literature. Like exposure, if there is evidence in the literature, or from other data sources, that conflicts with the vulnerability score, the score will be adjusted up or down, as appropriate, to include a range that extends into the next category. This approach accounts for knowledge gaps and general uncertainty about vulnerability.

Table 2-7: Vulnerability uncertainty from Wade et al. (2016)

| Species | Uncertainty Level: % of time at altitudes overlapping with turbine blades | Uncertainty Score | Uncertainty Level: Displacement caused by structures | Uncertainty Score | Uncertainty Level: Displacement caused by vessels and/or helicopters | Uncertainty Score | Uncertainty Level: Use of tidal races | Uncertainty Score | Overall Uncertainty Score (max 20) |
|---|---|---|---|---|---|---|---|---|---|
| European storm-petrel | Very high | 1 | Very high | 1 | High | 2 | Very high | 1 | 5 |
| Leach's storm-petrel | Very high | 1 | Very high | 1 | High | 2 | Very high | 1 | 5 |
| Sooty shearwater | Very high | 1 | Very high | 1 | High | 2 | Very high | 1 | 5 |
| Arctic skua | Moderate | 3 | Very high | 1 | Very high | 1 | Very high | 1 | 6 |
| Common goldeneye | Very high | 1 | Very high | 1 | High | 2 | High | 2 | 6 |
| Greater scaup | Very high | 1 | Very high | 1 | High | 2 | High | 2 | 6 |
| Manx shearwater | High | 2 | Very high | 1 | High | 2 | Very high | 1 | 6 |
| Slavonian grebe | Very high | 1 | High | 2 | High | 2 | Very high | 1 | 6 |
| White-tailed eagle | Very high | 1 | High | 2 | High | 2 | Very high | 1 | 6 |
| Great-crested grebe | High | 2 | High | 2 | High | 2 | Very high | 1 | 7 |
| Long-tailed duck | Very high | 1 | High | 2 | High | 2 | High | 2 | 7 |
| Roseate tern | Very high | 1 | High | 2 | High | 2 | High | 2 | 7 |
| Great skua | Moderate | 3 | High | 2 | High | 2 | Very high | 1 | 8 |
| Little tern | Very high | 1 | Moderate | 3 | Very high | 1 | Moderate | 3 | 8 |
| Velvet scoter | High | 2 | Very high | 1 | Moderate | 3 | High | 2 | 8 |
| Black-headed gull | Moderate | 3 | Moderate | 3 | High | 2 | Very high | 1 | 9 |
| Northern fulmar | Low | 4 | High | 2 | High | 2 | Very high | 1 | 9 |
| Arctic tern | Moderate | 3 | Moderate | 3 | High | 2 | High | 2 | 10 |
| Great northern diver | High | 2 | High | 2 | Very high | 1 | Very low | 5 | 10 |
| Little auk | Very high | 1 | Low | 4 | Low | 4 | Very high | 1 | 10 |
| Black-throated diver | High | 2 | Moderate | 3 | High | 2 | Low | 4 | 11 |
| Common gull | Low | 4 | Low | 4 | High | 2 | Very high | 1 | 11 |
| Common eider | Moderate | 3 | Moderate | 3 | Moderate | 3 | Moderate | 3 | 12 |
| Sandwich tern | Low | 4 | Low | 4 | High | 2 | High | 2 | 12 |
| Black guillemot | Very high | 1 | High | 2 | Very low | 5 | Very low | 5 | 13 |
| European shag | High | 2 | Low | 4 | High | 2 | Very low | 5 | 13 |
| Great black-backed gull | Low | 4 | Very low | 5 | Moderate | 3 | Very high | 1 | 13 |
| Great cormorant | Moderate | 3 | Very low | 5 | High | 2 | Moderate | 3 | 13 |
| Black-legged kittiwake | Very low | 5 | Very low | 5 | High | 2 | High | 2 | 14 |
| Common tern | Very low | 5 | Low | 4 | High | 2 | Moderate | 3 | 14 |
| Herring gull | Very low | 5 | Very low | 5 | Moderate | 3 | Very high | 1 | 14 |
| Lesser black-backed gull | Very low | 5 | Very low | 5 | Moderate | 3 | Very high | 1 | 14 |
| Northern gannet | Very low | 5 | Very low | 5 | High | 2 | High | 2 | 14 |
| Red-throated diver | Low | 4 | Low | 4 | High | 2 | Low | 4 | 14 |
| Common scoter | Low | 4 | Very low | 5 | Low | 4 | High | 2 | 15 |
| Atlantic puffin | Moderate | 3 | Moderate | 3 | Very low | 5 | Very low | 5 | 16 |
| Razorbill | Low | 4 | Very low | 5 | Very low | 5 | Low | 4 | 18 |
| Common guillemot | Low | 4 | Very low | 5 | Very low | 5 | Very low | 5 | 19 |

# 3 Birds – Offshore: Results

Interpretation of the results are presented in the body of the COP (Volume III Section 6.2). The results provided below are organized by sections addressing exposure and vulnerability of coastal birds and marine birds separately and include maps, tables, and figures for each species or species group. Endangered Species Act listed and candidate species are assessed individually.

## 3.1 Coastal birds

The following section presents results of coastal bird exposure assessment. Exposure assessment maps, tables, and figures are presented based on numerous references and data sets, including, but not limited to, the NE Wind boat surveys, MassCEC aerial surveys, Northwest Atlantic Seabird Catalog data, occurrence data, individual tracking data, relevant literature, and species accounts. For coastal birds, the relative behavioral vulnerability assessment is discussed in the body of the COP (Volume III Section 6.2) is primarily based upon the literature and expert opinion.

### 3.1.1 Shorebirds

#### *3.1.1.1 Exposure Tables, Maps, and Figures*

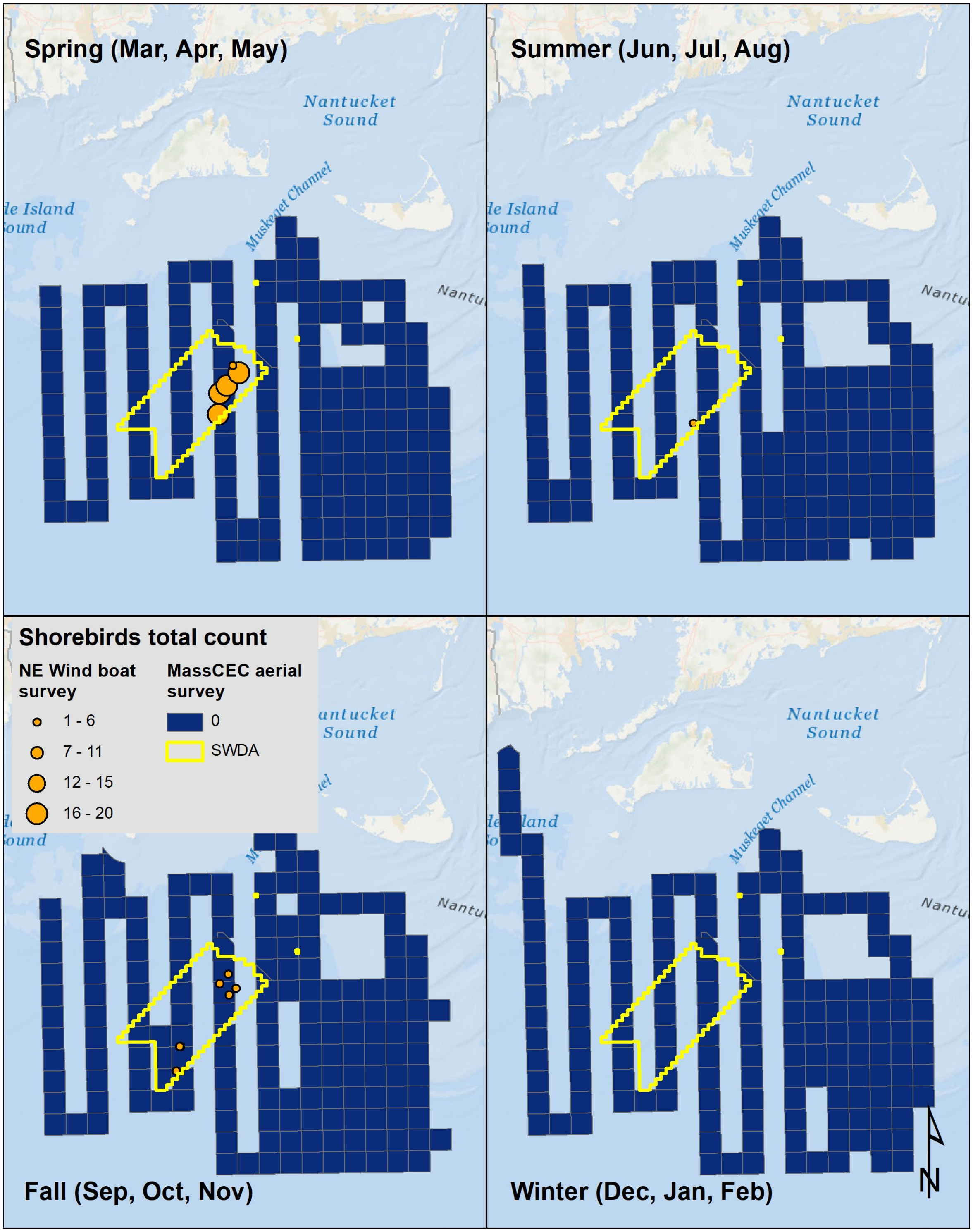



Figure 3-1: Shorebirds observed, by season, during the NE Wind boat surveys and MassCEC aerial surveys

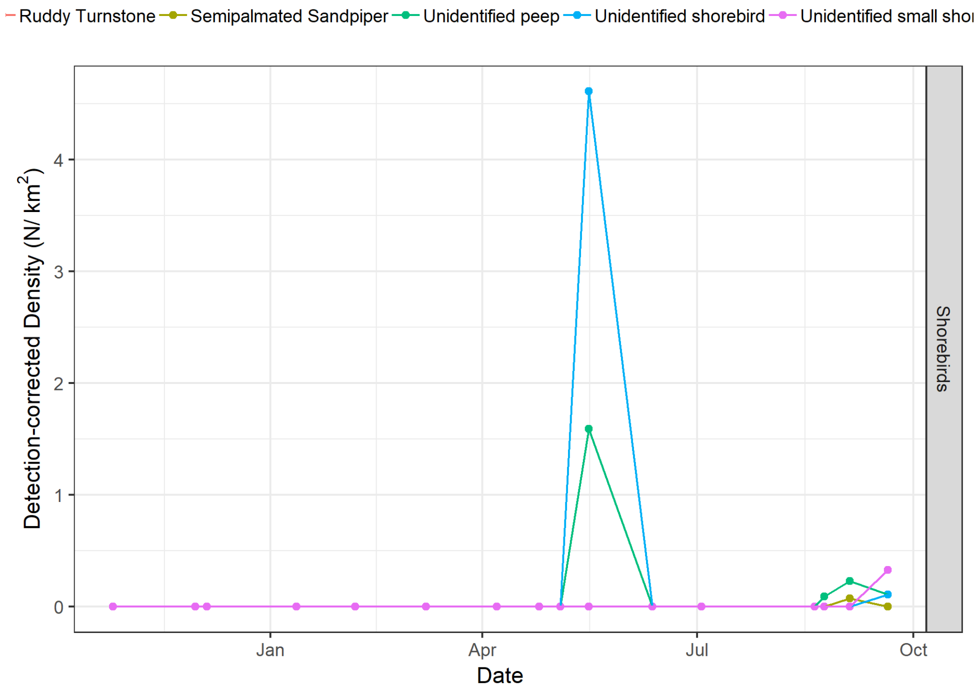



Figure 3-2: Detection-corrected density estimates from the NE Wind boat surveys for shorebirds in the study area

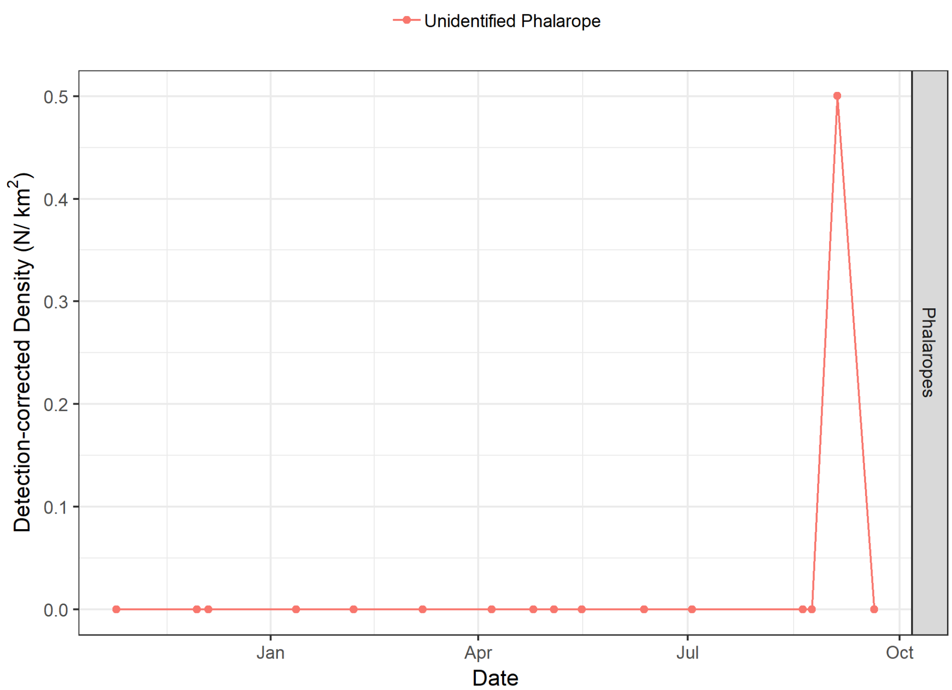



Figure 3-3: Detection-corrected density estimates from the NE Wind boat surveys for phalaropes in the study area

## 3.1.2 Endangered Shorebird Species

### *3.1.2.1 Piping Plover*

#### 3.1.2.1.1 Exposure Tables, Maps, and Figures

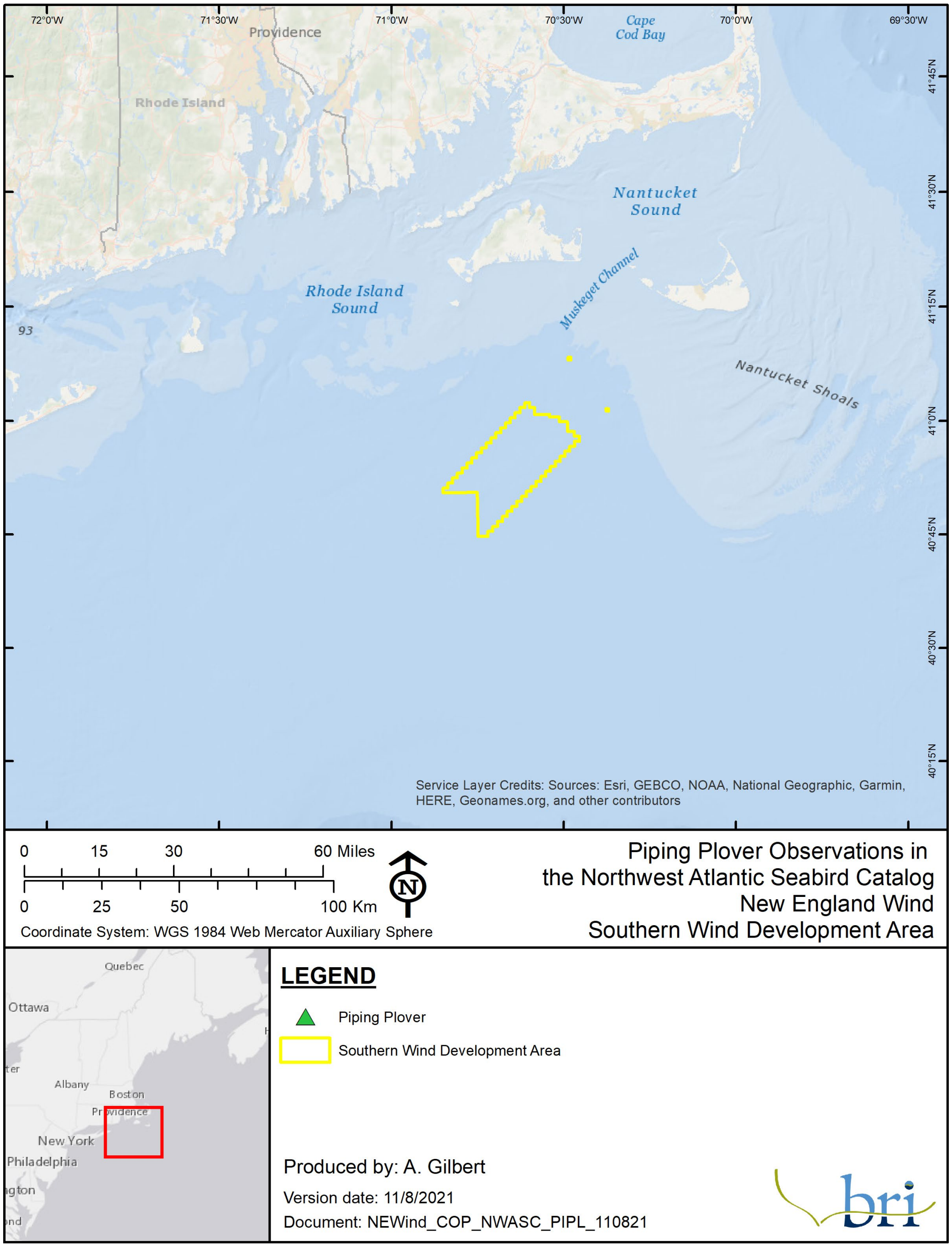
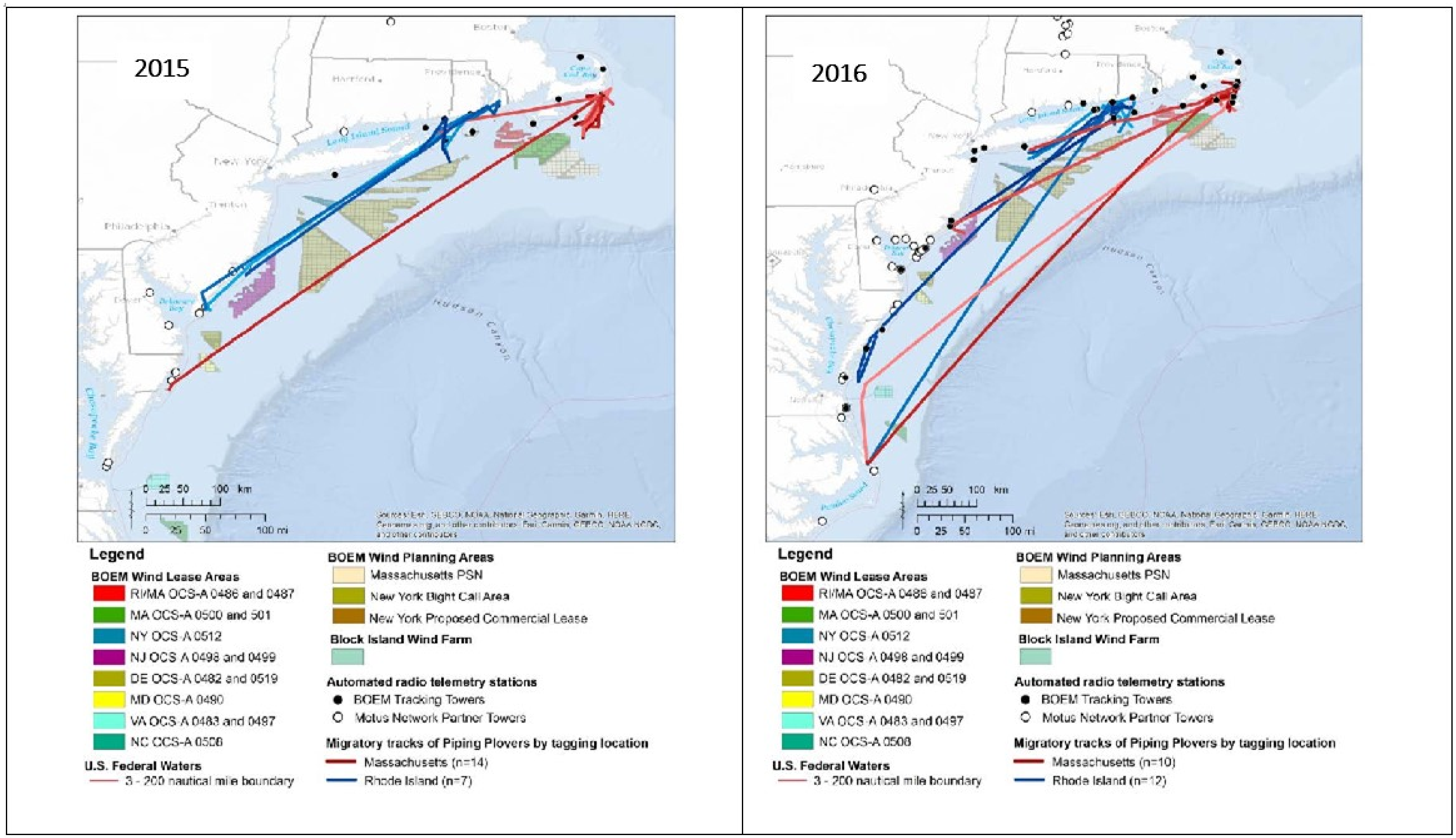



Figure 3-4. Piping plover (PIPL) observations from the Northwest Atlantic Seabird Catalog



2015
Boston
Hartford
Providence
Long Island Sound
New York
Trenton
Philadelphia
Delaware Bay
Hudson Canyon
0 25 50 100 km
0 25 50 100 mi
Legend
BOEM Wind Lease Areas
RI/MA OCS-A 0486 and 0487
MA OCS-A 0500 and 501
NY OCS-A 0512
NJ OCS-A 0498 and 0499
DE OCS-A 0482 and 0519
MD OCS-A 0490
VA OCS-A 0483 and 0497
NC OCS-A 0508
U.S. Federal Waters
3 - 200 nautical mile boundary
BOEM Wind Planning Areas
Massachusetts PSN
New York Bight Call Area
New York Proposed Commercial Lease
Block Island Wind Farm
Automated radio telemetry stations
BOEM Tracking Towers
Motus Network Partner Towers
Migratory tracks of Piping Plovers by tagging location
Massachusetts (n=14)
Rhode Island (n=7)
2016
Boston
Hartford
Providence
Long Island Sound
New York
Philadelphia
Hudson Canyon
0 25 50 100 km
0 25 50 100 mi
Legend
BOEM Wind Lease Areas
RI/MA OCS-A 0486 and 0487
MA OCS-A 0500 and 501
NY OCS-A 0512
NJ OCS-A 0498 and 0499
DE OCS-A 0482 and 0519
MD OCS-A 0490
VA OCS-A 0483 and 0497
NC OCS-A 0508
U.S. Federal Waters
3 - 200 nautical mile boundary
BOEM Wind Planning Areas
Massachusetts PSN
New York Bight Call Area
New York Proposed Commercial Lease
Block Island Wind Farm
Automated radio telemetry stations
BOEM Tracking Towers
Motus Network Partner Towers
Migratory tracks of Piping Plovers by tagging location
Massachusetts (n=10)
Rhode Island (n=12)

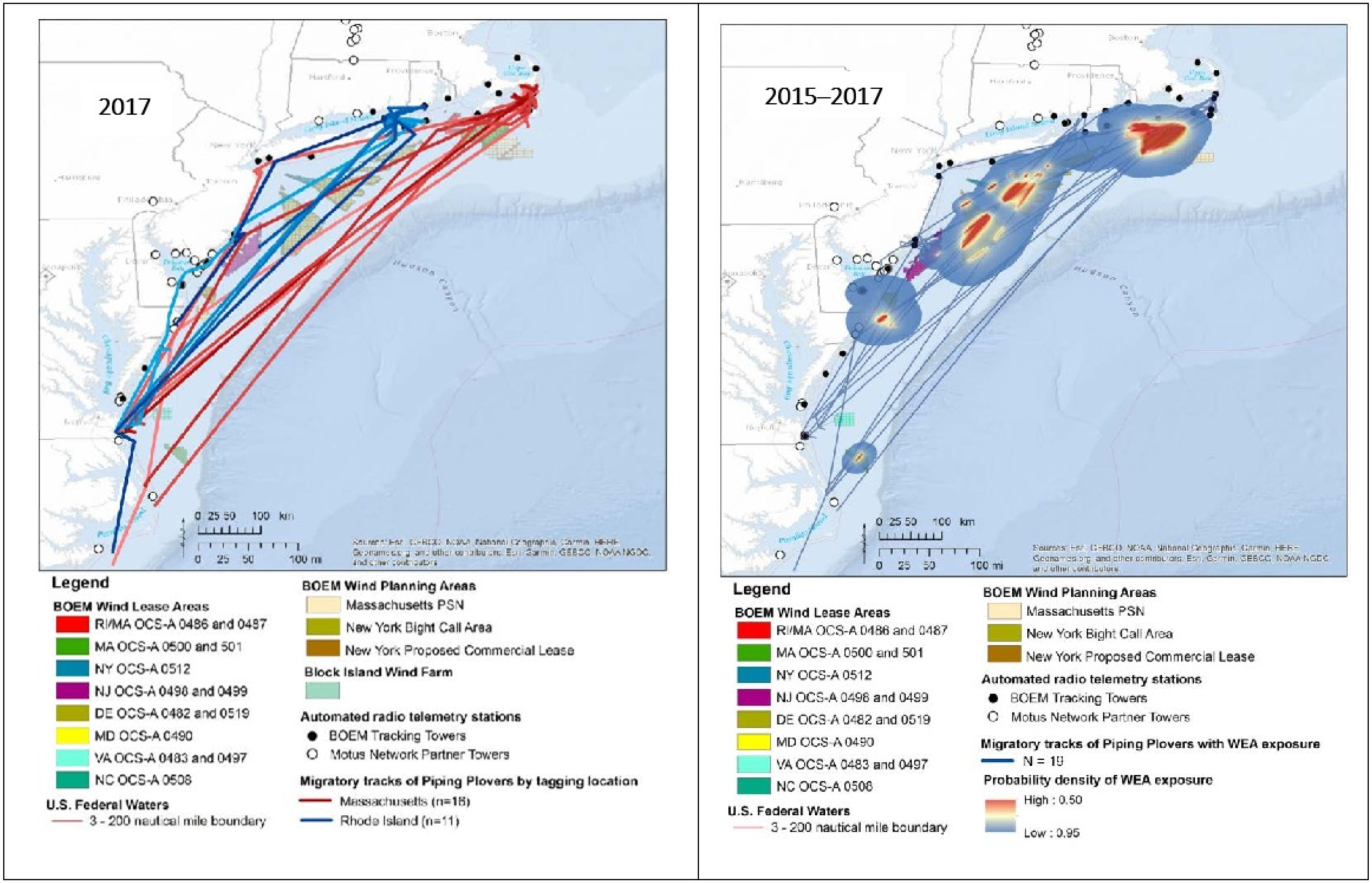



Figure 3-5: Modeled migratory track by year of piping plovers with nanotags and composite probability density across Atlantic OCS Wind Energy Areas for all years of the study; there is uncertainty in the actual offshore migratory tracks due to lack of receivers offshore and temporal gaps in the data (Loring et al. 2019)

### 3.1.2.2 Red Knot

#### 3.1.2.2.1 Exposure Tables, Maps, and Figures

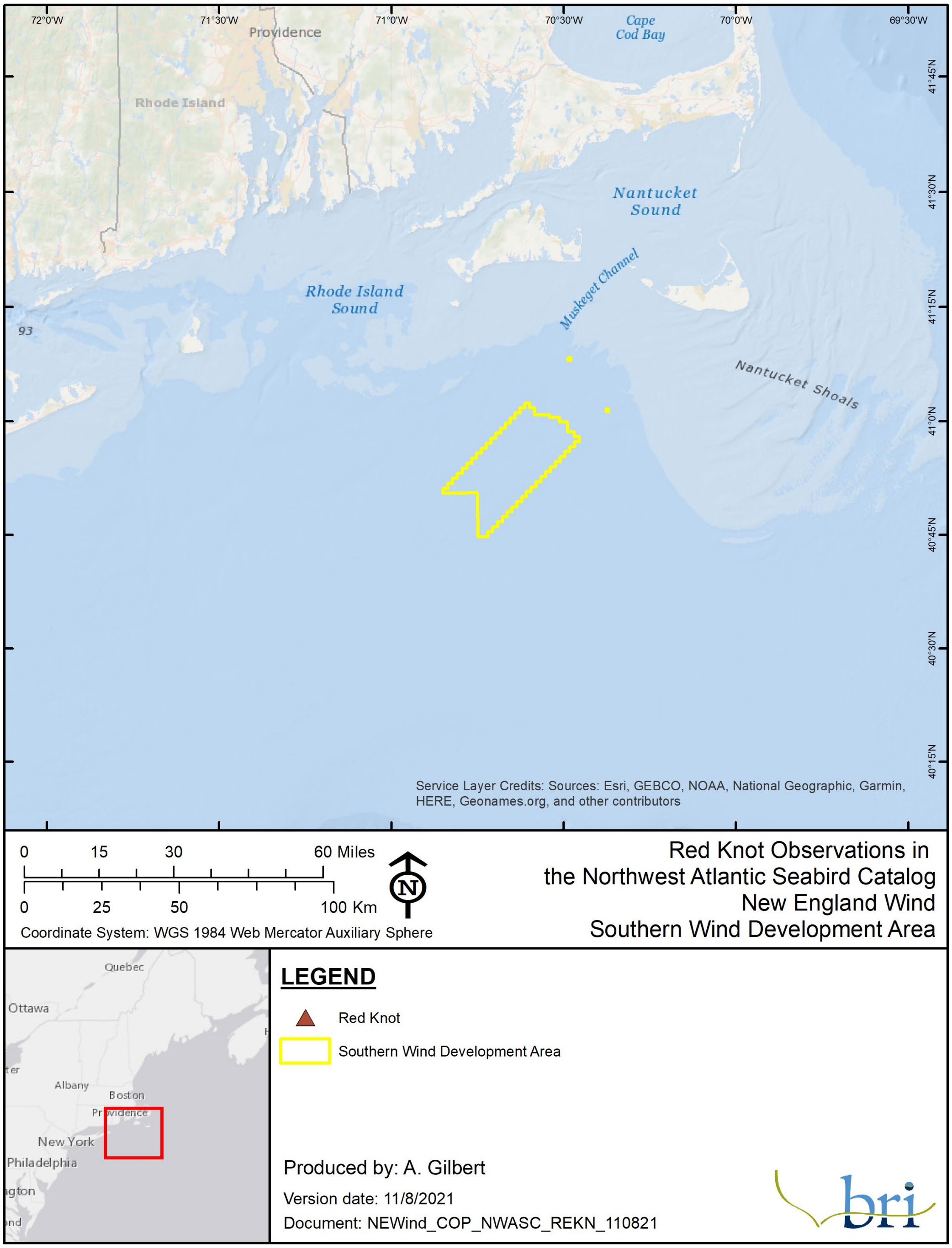



Figure 3-6: Red knot observations from the Northwest Atlantic Seabird Catalog

## 3.1.3 Wading Birds

### *3.1.3.1 Exposure Tables, Maps, and Figures*

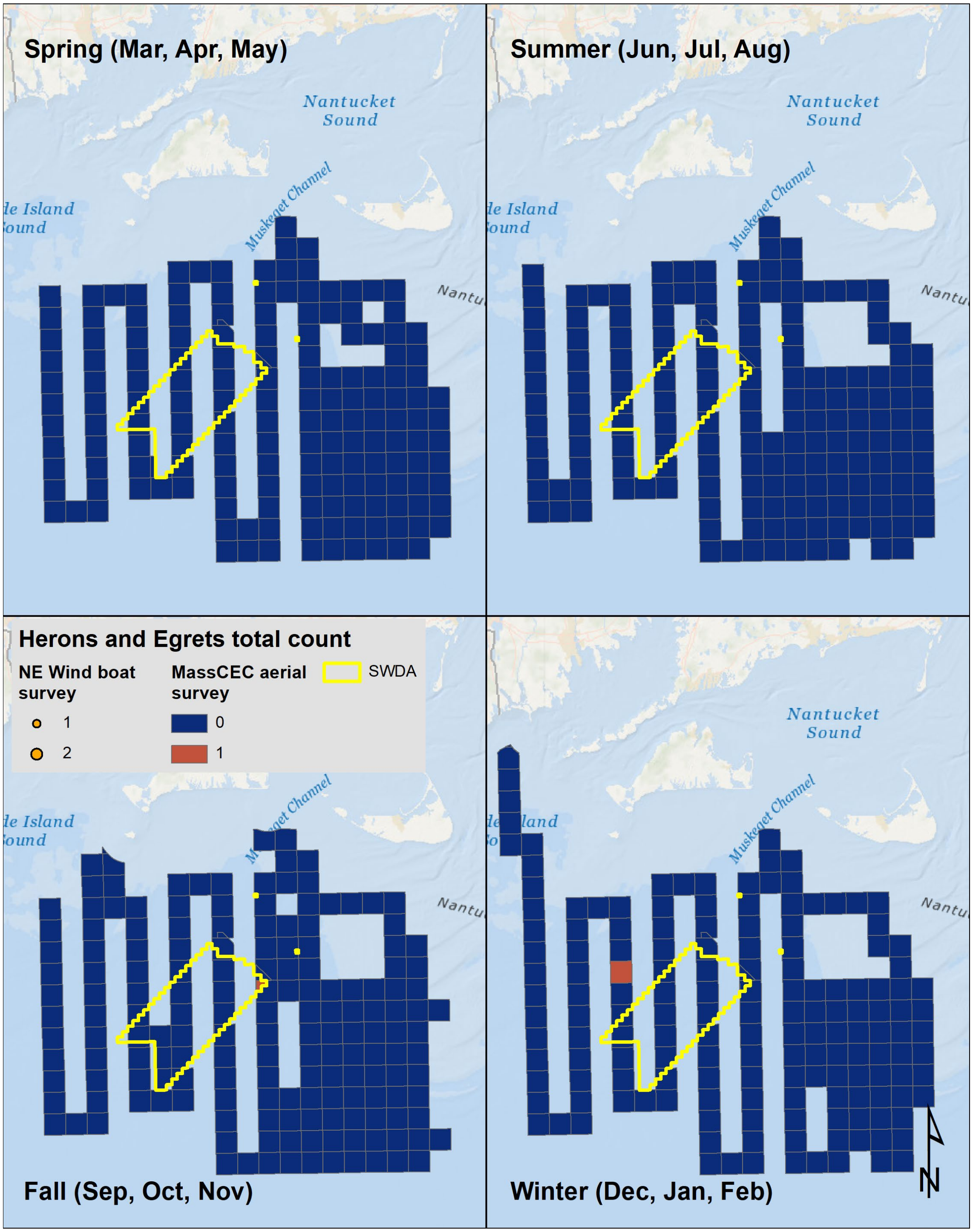



Figure 3-7: Herons and egrets observed, by season, during the NE Wind boat surveys and MassCEC aerial surveys

### 3.1.4 Raptors

#### *3.1.4.1 Exposure Tables, Maps, and Figures*

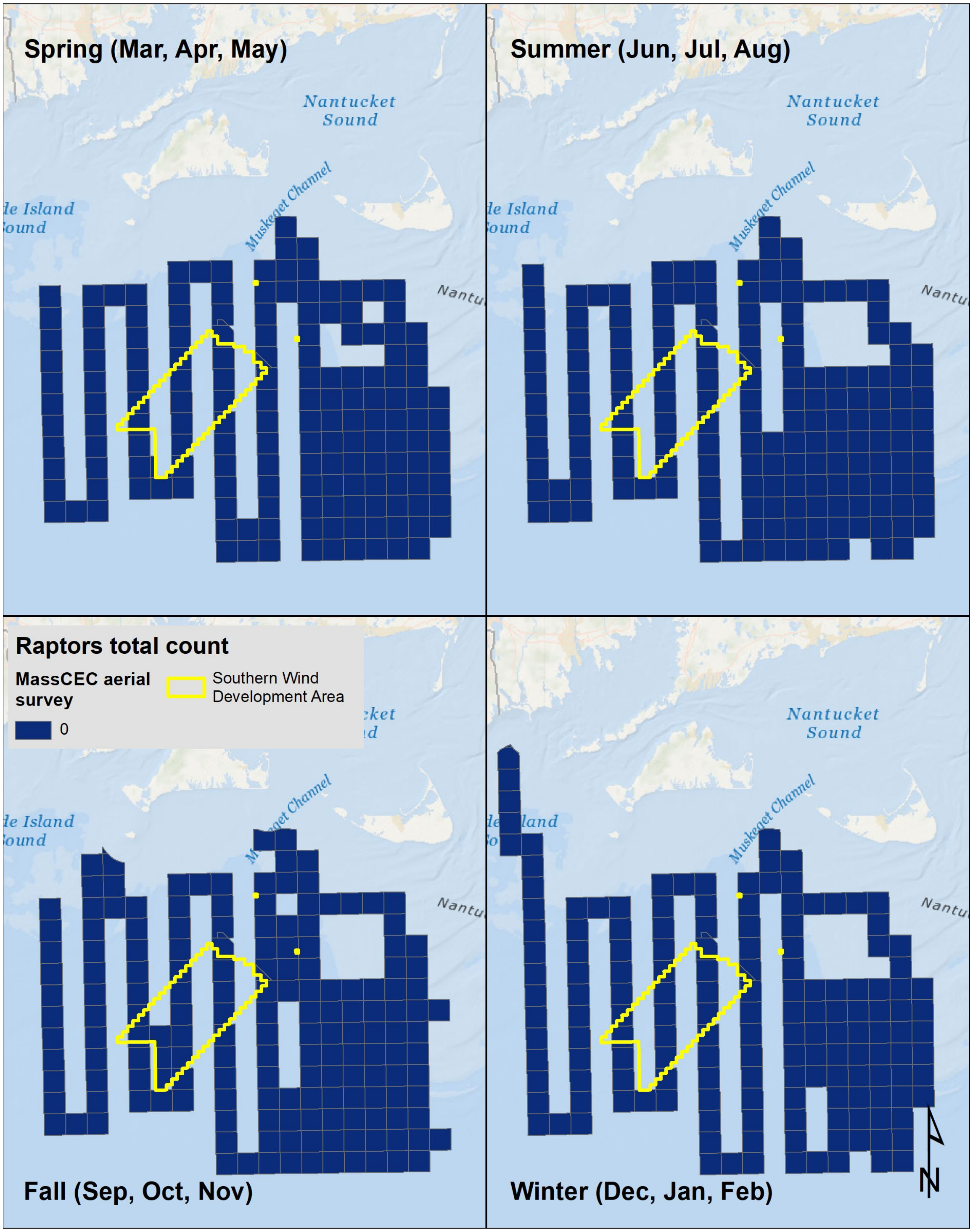



Figure 3-8: Raptors observed, by season, during the NE Wind boat surveys and MassCEC aerial surveys

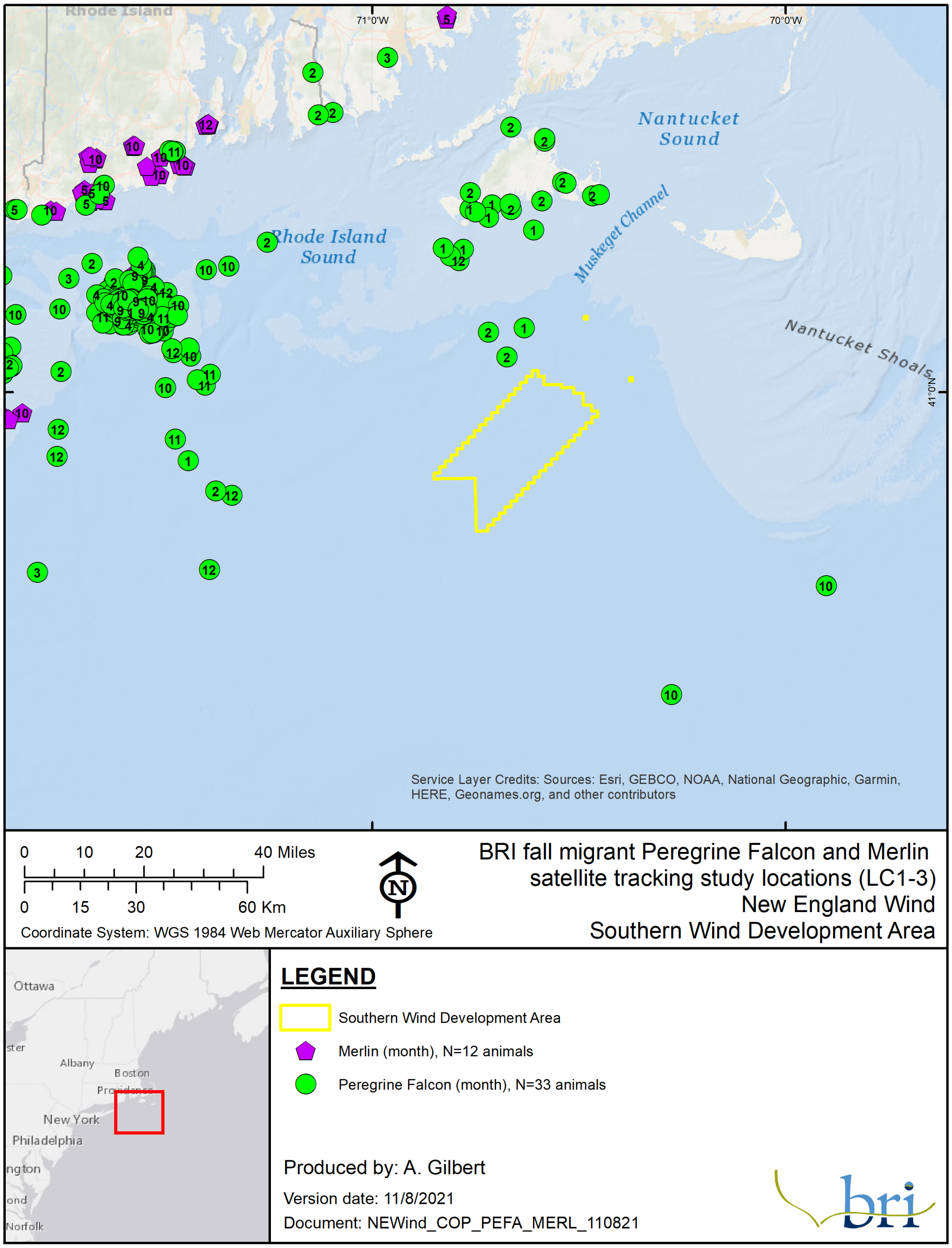



Figure 3-9: Location estimates from satellite transmitters instrumented to peregrine falcons and merlins tracked from three raptor research stations along the Atlantic coast, 2010 – 2018 (DeSorbo, Persico, et al. 2018).

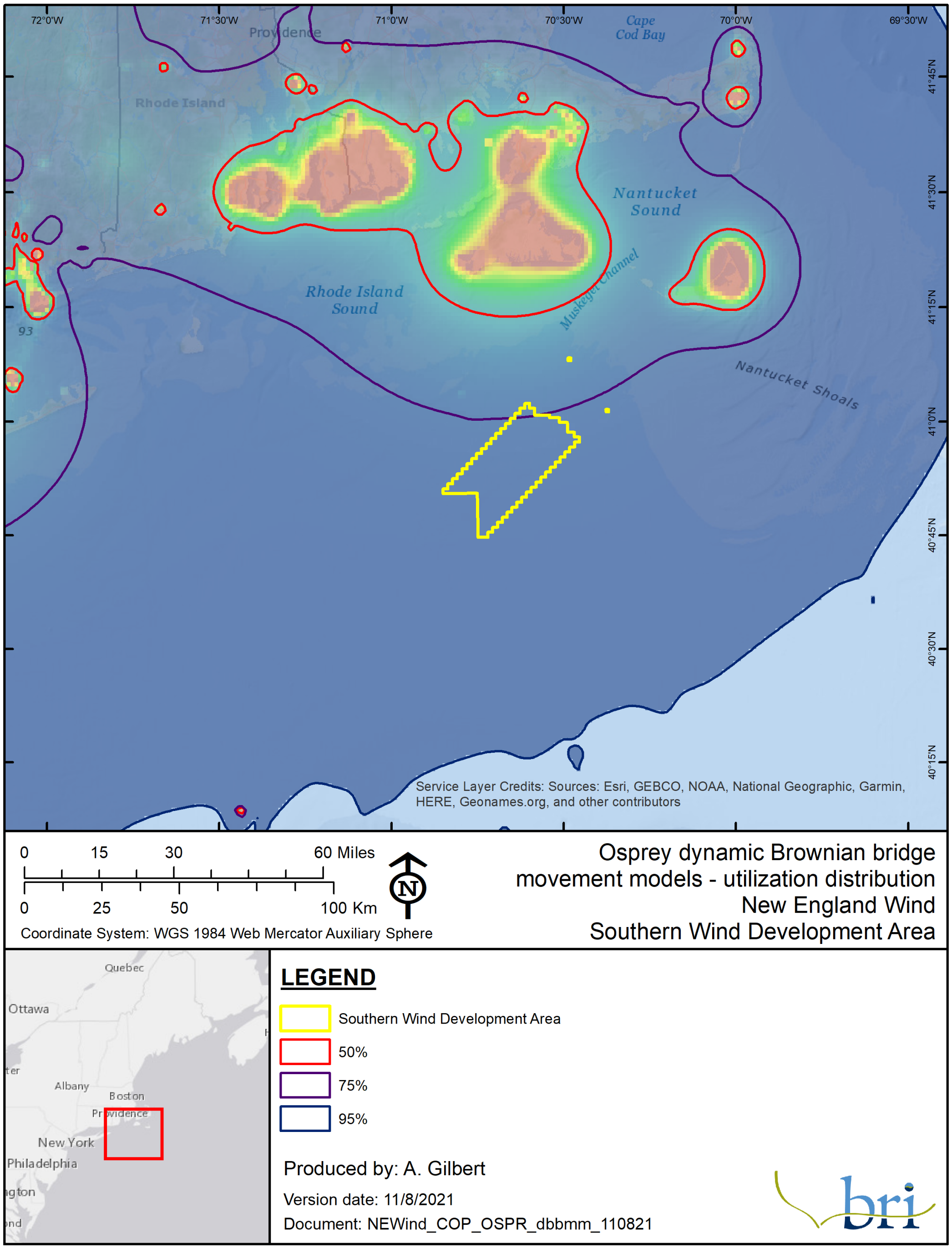



Figure 3-10: Dynamic Brownian bridge movement models for osprey (n = 127) that were tracked with satellite transmitters; the contours represent the percentage of the use area across the UD surface and represent various levels of use from 50% (core use) to 95% (home range)

### 3.1.5 Songbirds

#### 3.1.5.1 Exposure Tables, Maps, and Figures

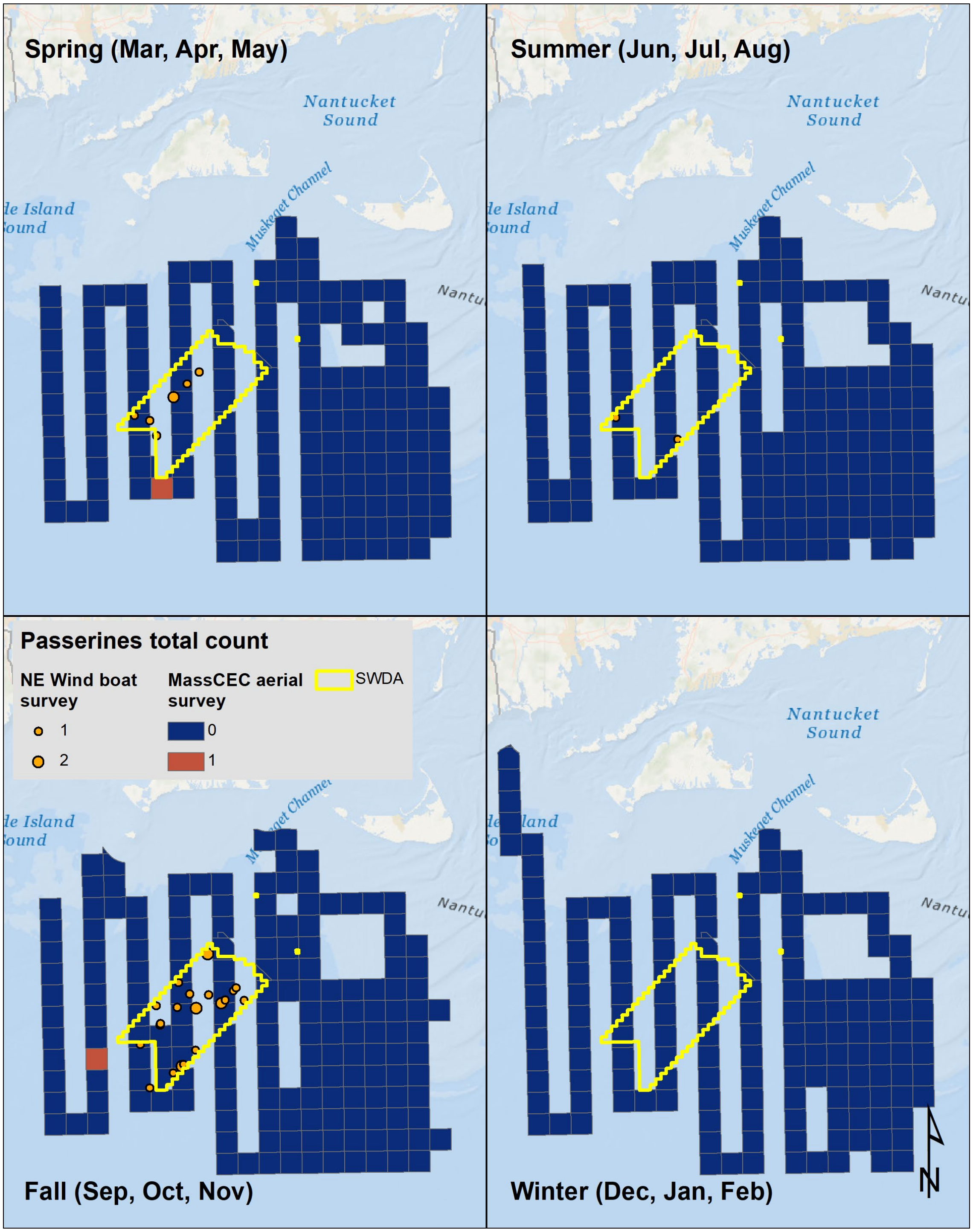



Figure 3-11: Songbirds (passerines) observed, by season, during the NE Wind boat surveys and MassCEC aerial surveys

### 3.1.6 Coastal Waterbirds (waterfowl)

#### *3.1.6.1 Exposure Tables, Maps, and Figures*

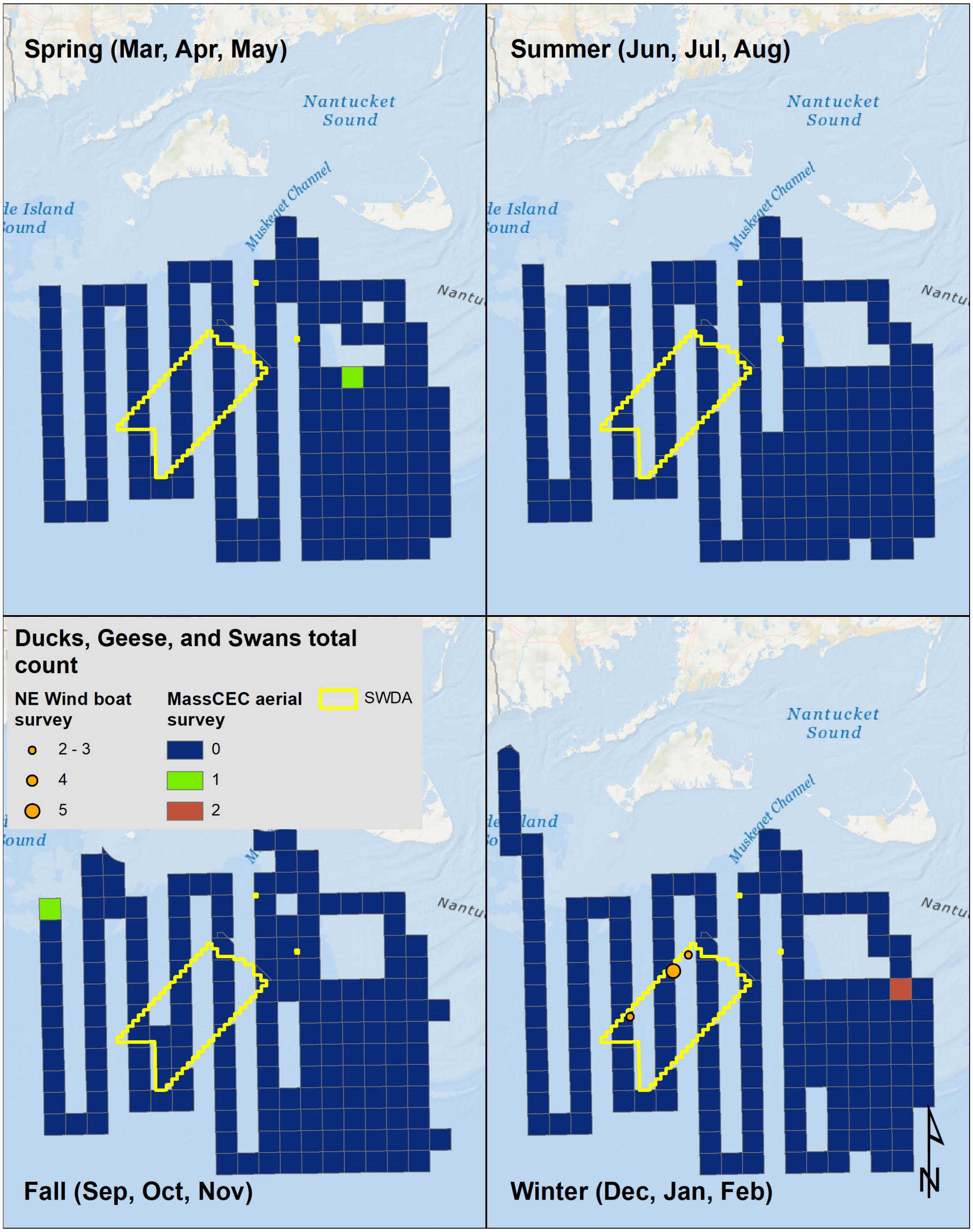



Figure 3-12: Coastal ducks, geese, and swans observed, by season, during the NE Wind boat surveys and MassCEC aerial surveys

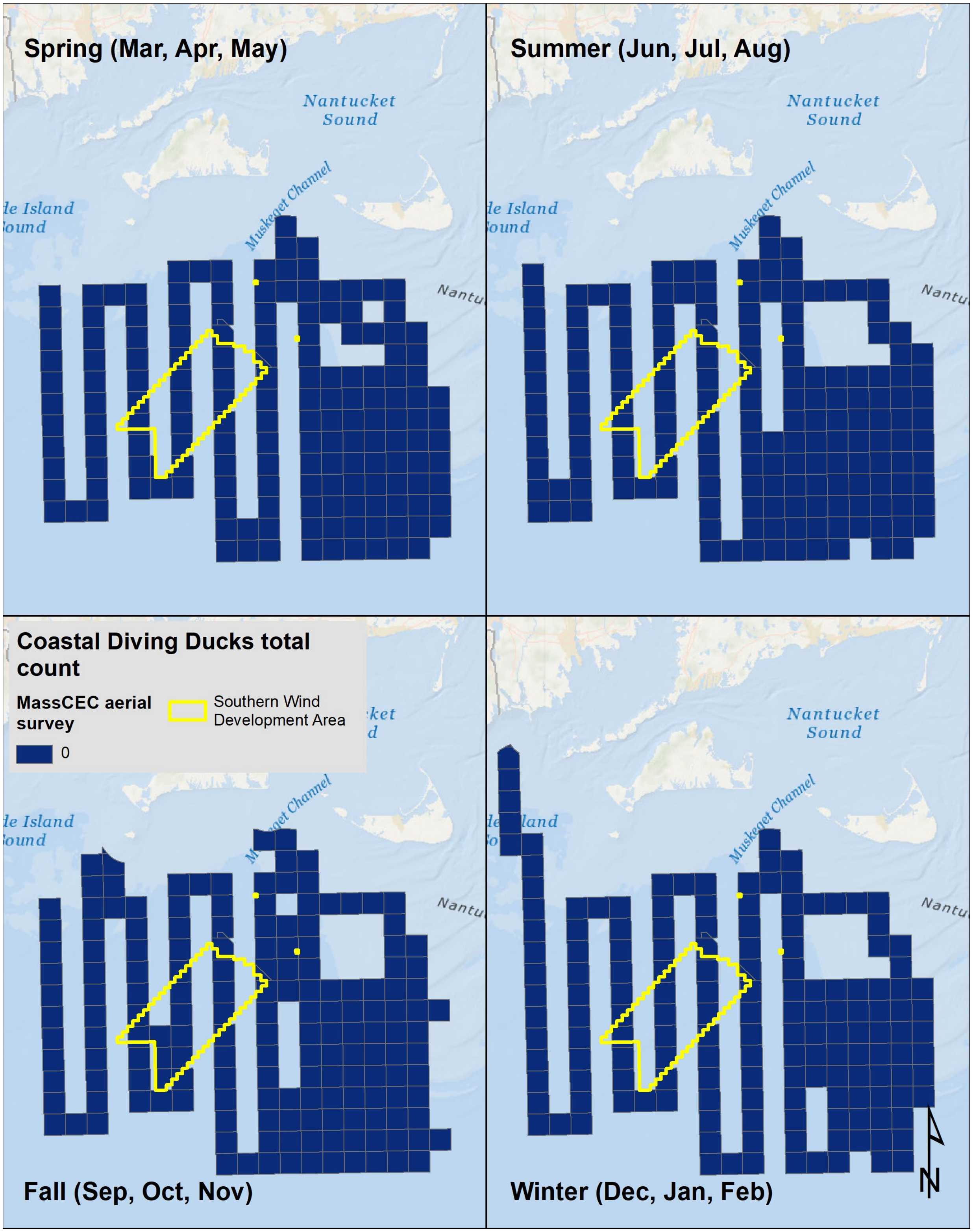



Figure 3-13: Coastal diving ducks observed, by season, during the NE Wind boat surveys and MassCEC aerial surveys

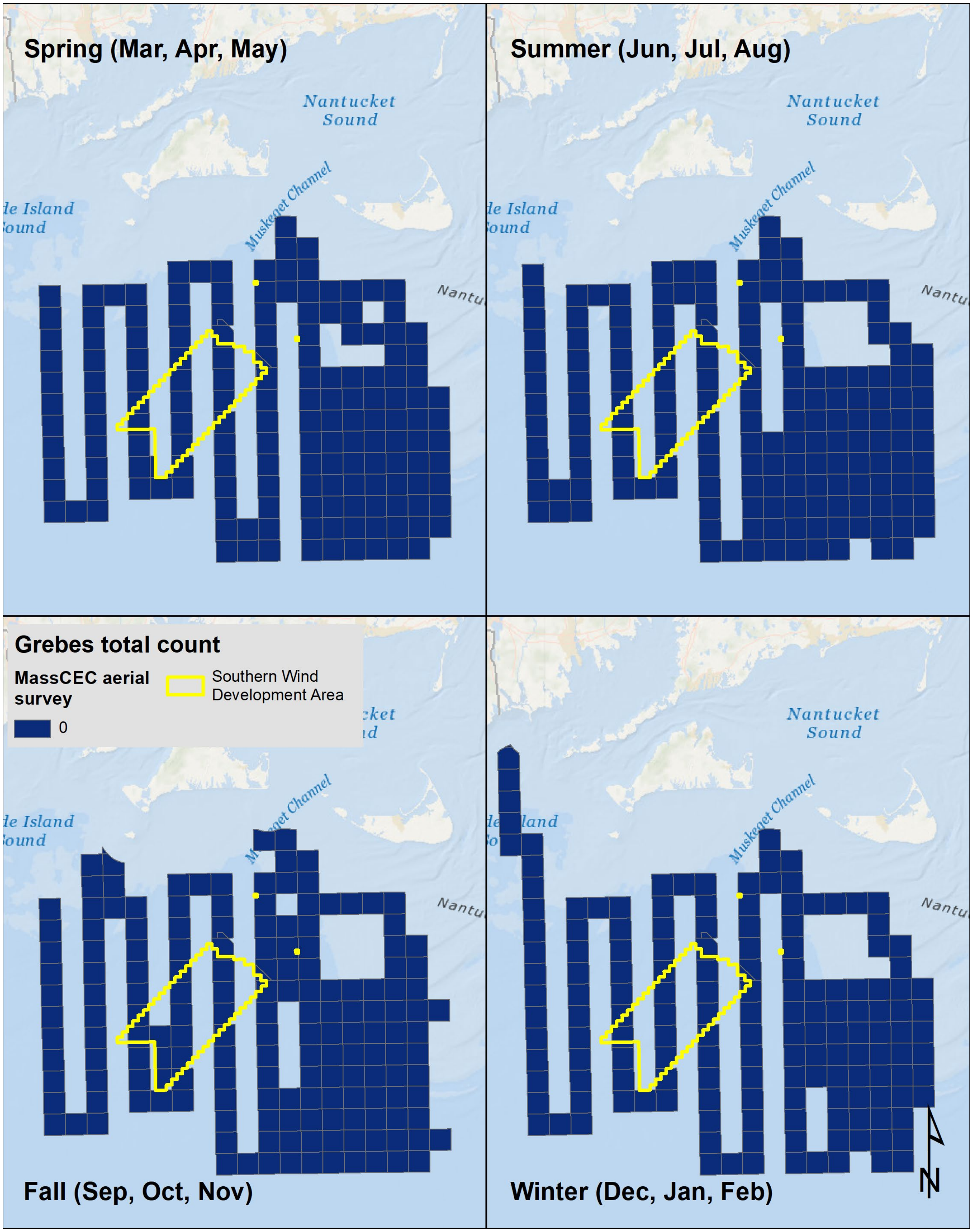



Figure 3-14: Grebes observed, by season, during the NE Wind boat surveys and MassCEC aerial surveys

## 3.2 Marine birds

The following section presents results of marine bird exposure and vulnerability assessments. Marine birds were assessed by species within each major taxonomic group (Table 3-1), which included loons, sea ducks, petrels and allies, gannets and allies, gulls and allies, terns, and auks. Exposure assessment maps, tables, and figures are presented based on numerous references and data sets including, but not limited to, the NE Wind boat surveys (Figure 3-16), MassCEC aerial surveys, NOAA MDAT (Figure 3-15), occurrence data, individual tracking data, relevant literature, and species accounts. Species occurrence is also quantified based on observed densities both within and outside the SWDA from the MassCEC aerial surveys community distance modelling based on the NE Wind boat survey (Table 3-2).

There are noticeable differences in the mean densities of animals detected within the SWDA when comparing values from MassCEC aerial surveys to the NE Wind boat surveys. A number of factors come into play that each contribute to these observed differences: temporal variation, platform (boat vs. aerial), and analysis. Species-specific density estimates are affected differently by each of these factors.

Temporal variability (seasonal and annual differences) in species density are prevalent, which is why surveys are ideally conducted for multiple seasons and over several years (Camphuysen et al. 2004). MassCEC aerial surveys were conducted in 2011–2015 (3+ yrs) and NE Wind boat surveys were conducted in 2018–2019 (1 yr). Temporal differences can be explained by variation in tides, weather patterns, prey distribution, population differences, timing of survey (i.e., when during the day or even month), and other factors (Camphuysen et al. 2004; Bolduc and Fifield 2017). These factors do not affect species the same, thus, temporal differences may be important (to a greater or lesser degree) in explaining differences between the two surveys, depending on the species.

Platform effects are well known and largely relate to differences in detectability of species from the different platforms, as well as disturbance or attraction effects of those platforms. Detectability issues can be corrected for, discussed below, but basically differs in that boat-based surveys allow more time for detection and identification to species than visual aerial surveys (Henkel et al. 2007). This is due largely to the much faster survey speeds of aerial (100 knots) vs. boats (10 knots). Also, the height of aerial surveys above the water (90 m, 300 ft) makes this method less effective in detecting smaller birds particularly close to the water surface (compared with the observer height on the boat used in these surveys, the *Helen H* [7 m, 21 ft]). Each platform also can result in differences due to disturbance of birds on the water surface or in the air, causing some birds to dive when the boat or aircraft approached and prior to detection, effectively removing the availability of those animals to be counted (Ronconi and Burger 2009), such as with loons (Briggs et al. 1985), although there is believed to be less disturbance for aerial surveys compared with boats (Buckland et al. 2012). This effect would vary with platform and even within platforms depending on the size of the platform, height, speed, and other factors presumably, such as engine noise and vibration. Some species may be attracted to boats, an effect particularly seen in species that are known to scavenge fishery discards, such as shearwaters, gulls, and gannets (Wahl and Heinemann 1979; Briggs et al. 1985; Skov and Durinck

2001; Bodey et al. 2014), which can result in elevated densities from boat surveys compared with aerial surveys.

Analytical differences are the easiest to account for between these two surveys. The aerial surveys used a strip transect method (Tasker et al. 1984) and did not record data that could be used to evaluate detection rates among species, so estimates of density are naïve (uncorrected) estimates. Whereas, the boat surveys employed line transect and distance sampling methods (Buckland et al. 2001), which allowed for the use of a modified Community Distance Model (Sollmann et al. 2015) to correct for imperfect detection, and thus provide corrected (absolute) density estimates. In all cases, the naïve estimate would be lower than the corrected estimate (within a survey effort), since we do not have perfect detection across all species (Ronconi and Burger 2009; Bolduc and Fifield 2017). For some large, prominent species (e.g., northern gannet) detection would be very high across the survey area so that naïve estimates would be closer to actual densities, but for some smaller species, especially those that fly low to the water (e.g., Wilson's storm-petrel), detection rates are much less (Spear et al. 2004) and actual densities would expected to be greater than naïve estimates.

For the exposure analysis for the SWDA, densities for MassCEC aerial surveys overall and within the SWDA are provided. The MassCEC data are used in the quantitative exposure scoring (see section 2.1.1.3) and are most valuable in comparing the relative density of species within the SWDA to surrounding areas. The boat-based surveys provide recent detection-corrected densities for the SWDA and are the primary data source for species-specific densities within the SWDA. An import note, as discussed above, is that density estimates for some species calculated from the boat-surveys may be biased higher because these birds are attracted to vessels. Conversely, detection rates for small species, such as Wilson's storm-petrel, are biased low in the aerial surveys because they are difficult to see from an aircraft. Taken together, the datasets provide the best possible information for understanding temporal (annual, seasonal) and species variation. Temporal differences are presented for each species group in Figure 3-16; annual densities for each survey are detailed in Table 3-2; species-specific monthly densities (boat-based survey) and relative exposure score (MassCEC surveys and MDAT models) are provided within each taxonomic group section; as supplemental data, seasonal and monthly densities are provided at the end of the Appendix in Table 3-20 and 3-21; and finally, interpretation of these results is found in Volume III Section 6.2 of the COP.

In the sections below, a relative behavioral vulnerability assessment, including flight height data relative to proposed WTG parameters, is presented for each species. Flight heights are presented at the taxonomic level for brevity, though species-specific flight heights are accounted for in each vulnerability assessment. Flight heights used in the assessment were gathered from the NE Wind boat surveys (local) and the datasets in the Northwest Atlantic Seabird Catalog (regional).

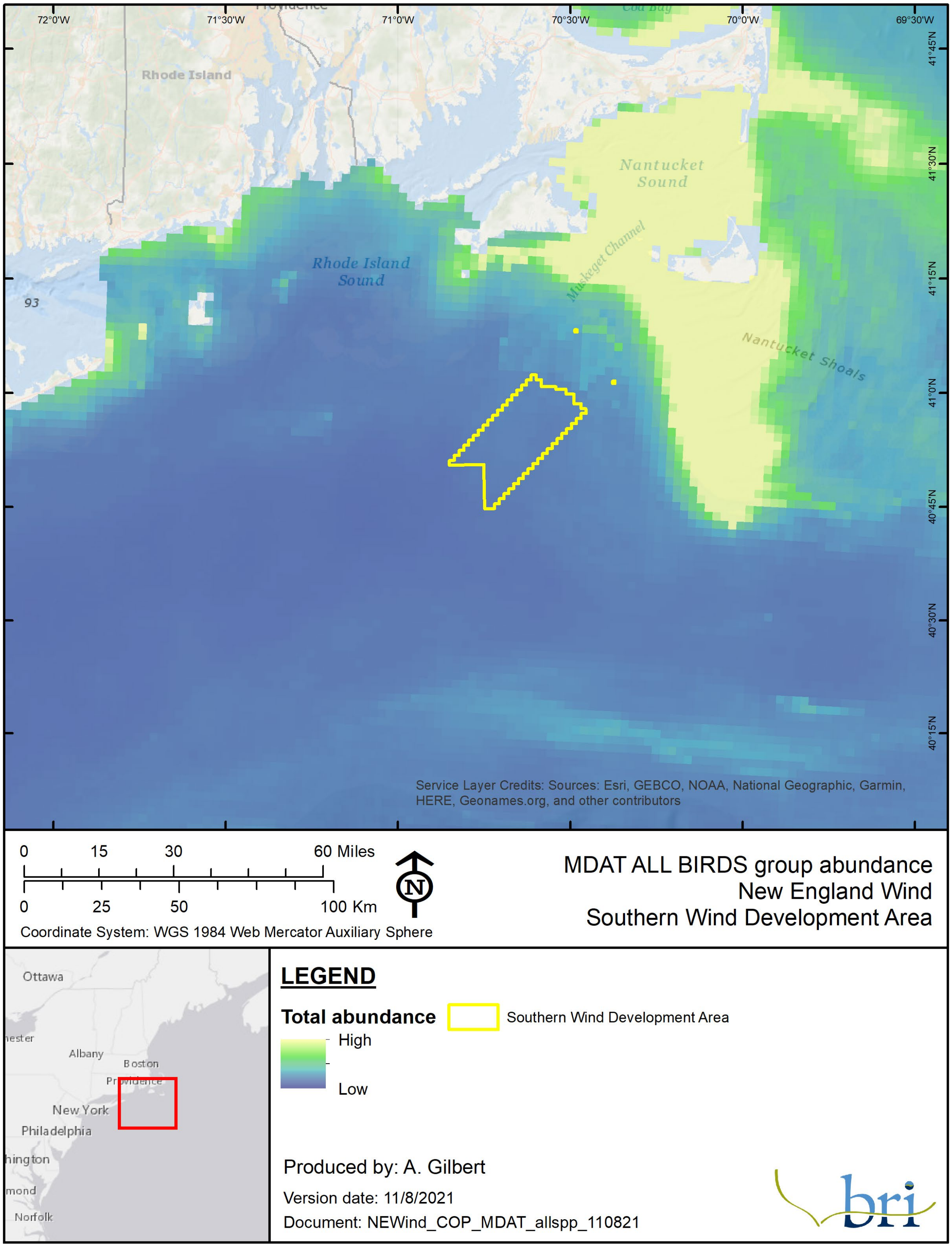



Figure 3-15: Bird abundance estimates from the MDAT models

Table 3-1: Annual exposure scores for each marine bird species in each taxonomic grouping

| Species | Annual Species Exposure Score | |
|---|---|---|
| Sea ducks | | |
| Black Scoter | *Melanitta americana* | 1 |
| Common Eider | *Somateria mollissima* | 1 |
| Long-tailed Duck | *Clangula hyemalis* | 0 |
| Red-breasted Merganser | *Mergus serrator* | 1 |
| Surf Scoter | *Melanitta perspicillata* | 0 |
| White-winged Scoter | *Melanitta fusca* | 3 |
| Grebes | | |
| Horned Grebe | *Podiceps auritus* | 0 |
| Phalaropes | | |
| Red Phalarope | *Phalaropus fulicarius* | 4 |
| Red-necked Phalarope | *Phalaropus lobatus* | 0 |
| Skuas and Jaegers | | |
| Great Skua | *Stercorarius skua* | 0 |
| Parasitic Jaeger | *Stercorarius parasiticus* | 1 |
| Pomarine Jaeger | *Stercorarius pomarinus* | 0 |
| South Polar Skua | *Stercorarius maccormicki* | 0 |
| Auks | | |
| Atlantic Puffin | *Fratercula arctica* | 0 |
| Black Guillemot | *Cepphus grylle* | 0 |
| Common Murre | *Uria aalge* | 2 |
| Dovekie | *Alle alle* | 1 |
| Razorbill | *Alca torda* | 6 |
| Thick-billed Murre | *Uria lomvia* | 0 |
| Small Gulls | | |
| Bonaparte's Gull | *Chroicocephalus philadelphia* | 1 |
| Medium Gulls | | |
| Black-legged Kittiwake | *Rissa tridactyla* | 6 |
| Laughing Gull | *Leucophaeus atricilla* | 1 |
| Ring-billed Gull | *Larus delawarensis* | 1 |
| Large Gulls | | |
| Great Black-backed Gull | *Larus marinus* | 1 |
| Herring Gull | *Larus argentatus* | 4 |
| Small Terns | | |
| Least Tern | *Sternula antillarum* | 0 |
| Medium Terns | | |
| Arctic Tern | *Sterna paradisaea* | 0 |
| Bridled Tern | *Onychoprion anaethetus* | 0 |
| Common Tern | *Sterna hirundo* | 1 |
| Roseate Tern | *Sterna dougallii* | 3 |
| Royal Tern | *Thalasseus maximus* | 0 |
| Sooty Tern | *Onychoprion fuscatus* | 0 |
| Loons | | |
| Common Loon | *Gavia immer* | 1 |
| Red-throated Loon | *Gavia stellata* | 0 |
| Storm-Petrels | | |
| Leach's Storm-Petrel | *Oceanodroma leucorhoa* | 0 |
| Wilson's Storm-Petrel | *Oceanites oceanicus* | 2 |

| Species | Annual Species Exposure Score | |
|---|---|---|
| Shearwaters and Petrels | | |
| Audubon's Shearwater | *Puffinus lherminieri* | 0 |
| Black-capped Petrel | *Pterodroma hasitata* | 0 |
| Cory's Shearwater | *Calonectris diomedea* | 5 |
| Great Shearwater | *Ardenna gravis* | 1 |
| Manx Shearwater | *Puffinus puffinus* | 1 |
| Northern Fulmar | *Fulmarus glacialis* | 3 |
| Sooty Shearwater | *Ardenna grisea* | 0 |
| Gannet | | |
| Northern Gannet | *Morus bassanus* | 4 |
| Cormorants | | |
| Double-crested Cormorant | *Phalacrocorax auritus* | 1 |
| Pelicans | | |
| Brown Pelican | *Pelecanus occidentalis* | 0 |

[1.] Annual Exposure Scores: Insignificant = 0–2, Unlikely = 3–5, Potential = 6–8, and Likely = 9–12.

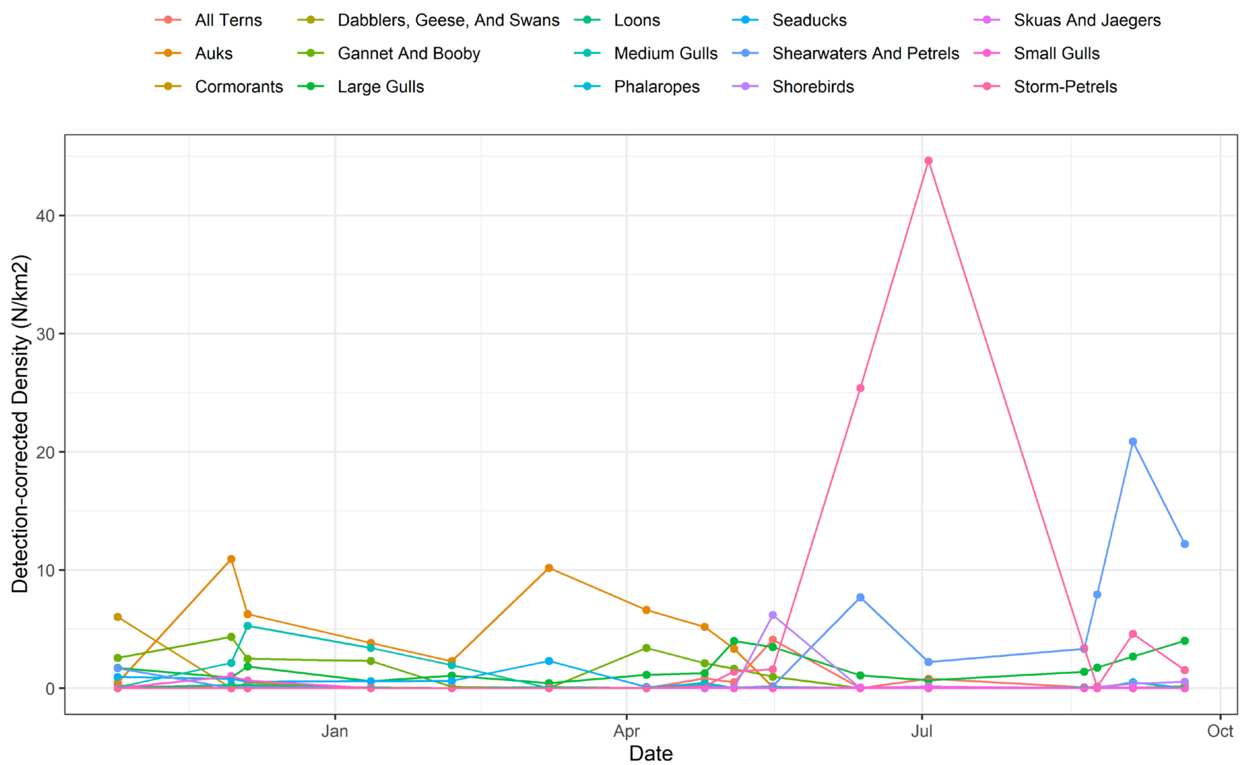



Figure 3-16: Mean species group densities from the NE Wind boat surveys

Table 3-2: Mean annual species densities (count/square km) in the MassCEC aerial survey area within the Atlantic Outer Continental Shelf (OCS) and the SWDA compared with the community distance model (CDM) detection-corrected densities and 95% confidence intervals (CI) for the NE Wind annual boat survey results.

| Species | MassCEC aerial survey | | NE Wind annual boat survey |
|---|---|---|---|
| | Density in the MassCEC aerial survey area | Density in the SWDA | CDM detection-corrected density (95% CI) |
| Ducks, Geese, and Swans | | | |
| Brant | <0.001 | 0 | · |
| Unidentified Duck | <0.001 | 0 | · |
| Unidentified Duck | · | · | 0.029 (0.016-0.055) |
| Sea Ducks | | | |
| Common Eider | 0.004 | 0 | · |
| Surf Scoter | 0.036 | 0 | · |
| White-winged Scoter | 2.390 | 0.002 | · |
| Black Scoter | 0.013 | 0 | · |
| Long-tailed Duck | 1.208 | 0.011 | · |
| Red-breasted Merganser | <0.001 | 0 | · |
| Common Eider | · | · | 0.041 (0.029-0.059) |
| Surf Scoter | · | · | 0.009 (0.006-0.013) |
| White-winged Scoter | · | · | 0.119 (0.080-0.177) |
| Black Scoter | · | · | 0.027 (0.019-0.040) |
| Long-tailed Duck | · | · | 0.121 (0.082-0.180) |

| Species | MassCEC aerial survey | | NE Wind annual boat survey |
|---|---|---|---|
| | Density in the MassCEC aerial survey area | Density in the SWDA | CDM detection-corrected density (95% CI) |
| Unidentified Dark scoter - black or surf | <0.001 | 0 | · |
| Unidentified Scoter | 0.090 | 0 | · |
| Unidentified Scoter | · | · | 0.071 (0.048-0.107) |
| Shorebirds | | | |
| Ruddy Turnstone | · | · | 0.005 (0.003-0.009) |
| Semipalmated Sandpiper | · | · | 0.005 (0.003-0.009) |
| Unidentified peep | · | · | 0.126 (0.078-0.314) |
| Unidentified shorebird | · | · | 0.295 (0.183-0.658) |
| Unidentified small shorebird | · | · | 0.020 (0.010-0.183) |
| Phalaropes | | | |
| Red Phalarope | 0.005 | <0.001 | · |
| Unidentified Phalarope | 0.059 | 0.222 | · |
| Unidentified Phalarope | · | · | 0.031 (0.014-0.080) |
| Skuas and Jaegers | | | |
| Pomarine Jaeger | <0.001 | 0 | · |
| Unidentified Jaeger | <0.001 | <0.001 | · |
| Unidentified Skua | <0.001 | 0 | · |
| Pomarine Jaeger | · | · | 0.004 (0.002-0.008) |
| Unidentified Jaeger | · | · | 0.013 (0.006-0.039) |
| Auks | | | |
| Dovekie | 0.002 | 0.002 | · |
| Common Murre | 0.002 | 0.002 | · |
| Razorbill | 0.671 | 0.505 | · |
| Unidentified Alcid | 0.003 | 0 | · |
| Unidentified large alcid (Razorbill or Murre) | 0.031 | 0.013 | · |
| Unidentified Murre | <0.001 | 0 | · |
| Unidentified small alcid (Puffin/Dovekie) | <0.001 | 0 | · |
| Dovekie | · | · | 0.095 (0.076-0.116) |
| Common Murre | · | · | 0.543 (0.467-0.627) |
| Razorbill | · | · | 0.322 (0.275-0.374) |
| Atlantic Puffin | · | · | 0.425 (0.370-0.487) |
| Unidentified Alcid | · | · | 0.062 (0.053-0.072) |
| Unidentified large alcid (Razorbill or Murre) | · | · | 1.458 (1.255-1.682) |
| Unidentified Murre | · | · | 0.155 (0.132-0.181) |
| Unidentified small alcid (Puffin/Dovekie) | · | · | 0.017 (0.015-0.020) |
| Small Gulls | | | |
| Bonaparte's Gull | 0.030 | 0.024 | · |
| Unidentified small gull | 0.015 | <0.001 | · |
| Sabine's Gull | · | · | 0.003 (0.002-0.005) |
| Bonaparte's Gull | · | · | 0.058 (0.034-0.099) |
| Unidentified small gull | · | · | 0.052 (0.031-0.089) |
| Medium Gulls | | | |

| Species | MassCEC aerial survey | | NE Wind annual boat survey |
|---|---|---|---|
| | Density in the MassCEC aerial survey area | Density in the SWDA | CDM detection-corrected density (95% CI) |
| Black-legged Kittiwake | 0.130 | 0.258 | · |
| Laughing Gull | <0.001 | <0.001 | · |
| Black-legged Kittiwake | · | · | 0.798 (0.630-0.992) |
| Laughing Gull | · | · | 0.041 (0.032-0.051) |
| Ring-billed Gull | · | · | 0.008 (0.006-0.010) |
| Large Gulls | | | |
| Herring Gull | 0.088 | 0.085 | · |
| Great Black-backed Gull | 0.028 | 0.010 | · |
| Unidentified Large Gull | 0.016 | 0.002 | · |
| Unidentified white winged gull (Ross's Gull, Ivory Gull, Iceland Gull, Glaucous-winged Gull and Glaucous Gull) | <0.001 | 0 | · |
| Herring Gull | · | · | 0.978 (0.836-1.215) |
| Great Black-backed Gull | · | · | 0.464 (0.401-0.553) |
| Unidentified Large Gull | · | · | 0.260 (0.216-0.350) |
| All Gulls | | | |
| Unidentified Gull | 0.029 | 0.008 | · |
| Unidentified Gull | · | · | 0.047 (0.041-0.057) |
| Small Terns | | | |
| Unidentified small Tern | 0.010 | 0.002 | · |
| Medium Terns | | | |
| Roseate Tern | <0.001 | 0 | · |
| Common Tern | 0.005 | 0 | · |
| Roseate Tern | · | · | 0.009 (0.006-0.013) |
| Common Tern | · | · | 0.288 (0.211-0.438) |
| All Terns | | | |
| Unidentified Tern | 0.031 | 0 | · |
| Unidentified Tern | · | · | 0.121 (0.090-0.179) |
| Loons | | | |
| Red-throated Loon | 0.060 | 0.012 | · |
| Common Loon | 0.026 | 0.054 | · |
| Unidentified Loon | 0.014 | 0.008 | · |
| Red-throated Loon | · | · | 0.043 (0.026-0.068) |
| Common Loon | · | · | 0.010 (0.006-0.015) |
| Unidentified Loon | · | · | 0.017 (0.010-0.029) |
| Storm-Petrels | | | |
| Wilson's Storm-Petrel | 0.034 | 0.059 | · |
| Unidentified Storm-petrel | 0.002 | 0.002 | · |
| Wilson's Storm-Petrel | · | · | 5.180 (4.522-6.691) |
| Shearwaters and Petrels | | | |
| Northern Fulmar | 0.044 | 0.069 | · |
| Cory's Shearwater | 0.110 | 0.126 | · |
| Sooty Shearwater | <0.001 | 0 | · |
| Great Shearwater | 0.027 | 0.010 | · |
| Manx Shearwater | 0.002 | <0.001 | · |
| Unidentified Large Shearwater | 0.003 | 0 | · |

| Species | MassCEC aerial survey | | NE Wind annual boat survey |
|---|---|---|---|
| | Density in the MassCEC aerial survey area | Density in the SWDA | CDM detection-corrected density (95% CI) |
| Unidentified Shearwater | 0.005 | 0.002 | · |
| Northern Fulmar | · | · | 0.035 (0.031-0.039) |
| Cory's Shearwater | · | · | 0.852 (0.765-0.946) |
| Sooty Shearwater | · | · | 0.088 (0.078-0.098) |
| Great Shearwater | · | · | 2.345 (2.086-2.632) |
| Manx Shearwater | · | · | 0.015 (0.014-0.017) |
| Unidentified Large Shearwater | · | · | 0.155 (0.137-0.175) |
| Unidentified Shearwater | · | · | 0.027 (0.024-0.029) |
| Gannet | | | |
| Northern Gannet | 0.160 | 0.206 | · |
| Northern Gannet | · | · | 1.266 (1.046-1.572) |
| Cormorants | | | |
| Double-crested Cormorant | <0.001 | <0.001 | · |
| Double-crested Cormorant | · | · | 0.003 (0.001-0.009) |
| Unidentified Cormorant | · | · | 0.377 (0.159-0.903) |
| Heron and Egrets | | | |
| Great Blue Heron | <0.001 | 0.002 | · |
| Passerines | | | |
| Unidentified Passerine (perching birds, songbirds) | <0.001 | 0 | · |

Table 3-3: Vulnerability assessment rankings by species within each broad taxonomic grouping; DV = displacement vulnerability, PV = population vulnerability

| Species | Collision Vulnerability (CV) | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Sea Ducks | | | | |
| Black Scoter | unlikely (0.27) | unlikely (0.27) | likely (0.9) | unlikely (0.4) |
| Common Eider | unlikely (0.27) | unlikely (0.27) | likely (0.9) | unlikely (0.47) |
| Long-tailed Duck | unlikely (0.3) | unlikely (0.3) | likely (0.9) | unlikely (0.27) |
| Red-breasted Merganser | potential (0.53) | potential (0.53) | potential (0.5) | unlikely (0.27) |
| Surf Scoter | unlikely (0.27) | unlikely (0.27) | likely (0.9) | potential (0.53) |
| White-winged Scoter | unlikely (0.27) | unlikely (0.27) | likely (0.8) | potential (0.53) |
| Shorebirds | | | | |
| Piping Plover | · (·) | · (·) | unlikely (0.3) | potential (0.67) |
| Red Knot | · (·) | · (·) | unlikely (0.3) | potential (0.53) |
| Phalaropes | | | | |
| Red Phalarope | unlikely (0.47) | unlikely (0.47) | potential (0.5) | unlikely (0.27) |
| Skuas and Jaegers | | | | |
| Pomarine Jaeger | potential (0.73) | potential (0.73) | unlikely (0.3) | unlikely (0.4) |
| Auks | | | | |
| Common Murre | insignificant (0.23) | insignificant (0.23) | likely (0.8) | unlikely (0.4) |
| Dovekie | unlikely (0.3) | unlikely (0.3) | potential (0.7) | unlikely (0.4) |

| Species | Collision Vulnerability (CV) | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Razorbill | insignificant (0.2) | insignificant (0.2) | likely (0.8) | potential (0.6) |
| Small Gulls | | | | |
| Bonaparte's Gull | potential (0.5) | potential (0.5) | potential (0.5) | unlikely (0.33) |
| Medium Gulls | | | | |
| Black-legged Kittiwake | unlikely (0.43) | unlikely (0.43) | potential (0.6) | unlikely (0.33) |
| Laughing Gull | unlikely (0.47) | unlikely (0.47) | potential (0.5) | unlikely (0.4) |
| Large Gulls | | | | |
| Great Black-backed Gull | potential (0.63) | potential (0.63) | potential (0.7) | insignificant (0.2) |
| Herring Gull | potential (0.7) | potential (0.7) | potential (0.5) | potential (0.53) |
| Medium Terns | | | | |
| Common Tern | unlikely (0.33) | unlikely (0.33) | likely (0.8) | potential (0.6) |
| Roseate Tern | · (·) | · (·) | likely (0.8) | likely (0.87) |
| Loons | | | | |
| Common Loon | unlikely (0.33) | unlikely (0.33) | likely (0.8) | potential (0.6) |
| Red-throated Loon | unlikely (0.33) | unlikely (0.33) | likely (0.9) | unlikely (0.47) |
| Storm-Petrels | | | | |
| Wilson's Storm-Petrel | unlikely (0.43) | unlikely (0.43) | potential (0.6) | unlikely (0.4) |
| Shearwaters and Petrels | | | | |
| Cory's Shearwater | unlikely (0.33) | unlikely (0.33) | potential (0.6) | potential (0.6) |
| Great Shearwater | unlikely (0.3) | unlikely (0.3) | potential (0.6) | potential (0.67) |
| Manx Shearwater | unlikely (0.37) | unlikely (0.37) | potential (0.6) | potential (0.53) |
| Northern Fulmar | unlikely (0.37) | unlikely (0.37) | potential (0.6) | unlikely (0.47) |
| Sooty Shearwater | unlikely (0.4) | unlikely (0.4) | potential (0.6) | potential (0.53) |
| Gannet | | | | |
| Northern Gannet | unlikely (0.3) | unlikely (0.3) | potential (0.6) | unlikely (0.47) |
| Cormorants | | | | |
| Double-crested Cormorant | potential (0.6) | potential (0.6) | unlikely (0.4) | insignificant (0.13) |

## 3.2.1 Loons

### *3.2.1.1 Exposure Tables, Maps, and Figures*

Table 3-4: Seasonal exposure rankings for the loons group

| Loons | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Common Loon | Spring | 0 | 0 | 0 | insignificant |
| | Winter | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 1 | 0 | 1 | unlikely |
| Red-throated Loon | Summer | 0 | · | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 1 | 1 | unlikely |
| | Winter | 0 | 0 | 0 | insignificant |

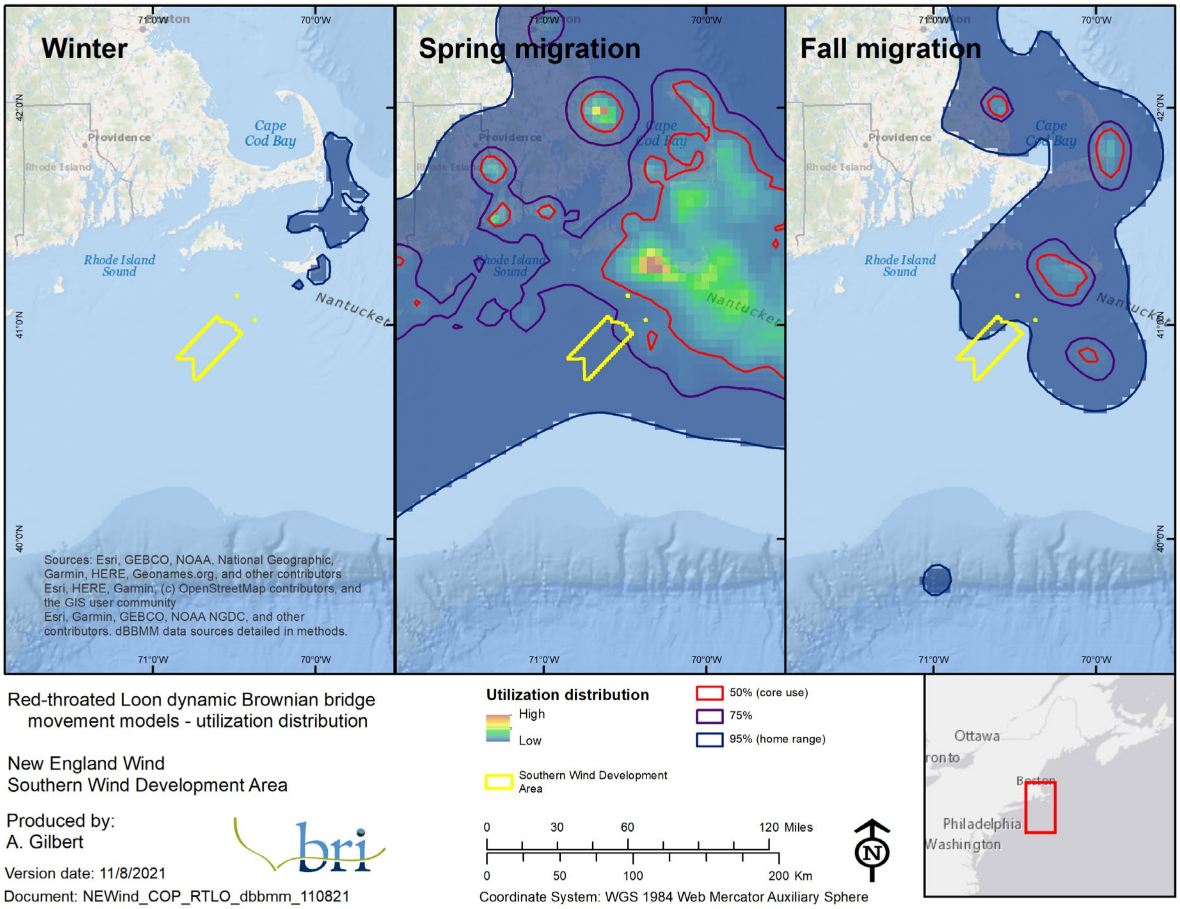



Figure 3-17: Dynamic Brownian bridge movement models for red-throated loons (n = 46, 46, 31 [winter, spring, fall]) that were tracked with satellite transmitters; the contours represent the percentage of the use area across the UD surface and represent various levels of use from 50% (core use) to 95% (home range)

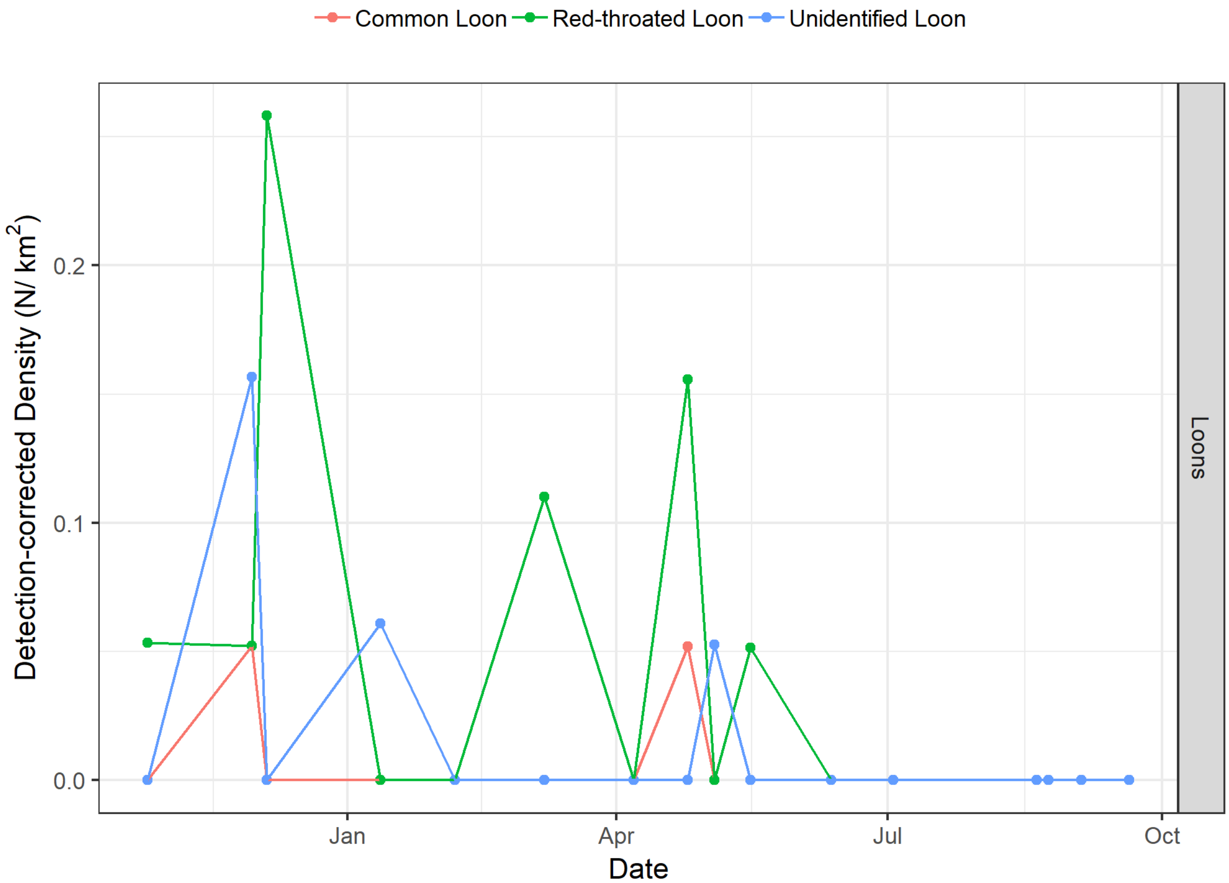



Figure 3-18: Detection-corrected density estimates from the NE Wind boat surveys for loons in the study area

### 3.2.1.2 Relative Behavioral Vulnerability Figures and Tables

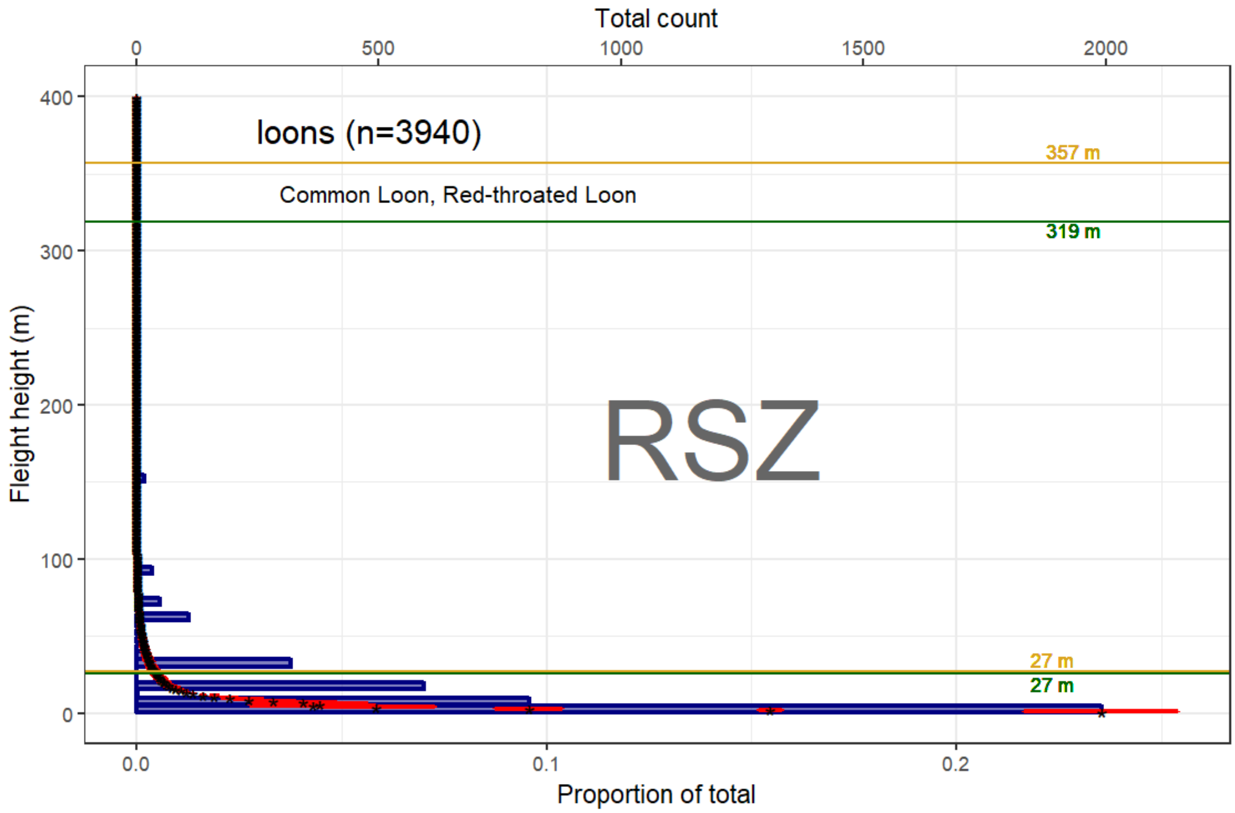



Figure 3-19: Flight heights of loons (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27-319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27-357 m [87-1171 ft])

Table 3-5: Vulnerability assessment rankings by species for the loons group. DV = displacement vulnerability; PV = population vulnerability. Based upon the literature, collision vulnerability was adjusted to include a lower range limit (green)

| Species | Collision Vulnerability | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Common Loon | insignificant - unlikely (0.33) | insignificant - unlikely (0.33) | likely (0.8) | potential (0.6) |
| Red-throated Loon | insignificant - unlikely (0.33) | insignificant - unlikely (0.33) | likely (0.9) | unlikely (0.47) |

## 3.2.2 Sea Ducks

### *3.2.2.1 Exposure Tables, Maps, and Figures*

Table 3-6: Seasonal exposure rankings for the sea ducks group

| Sea Ducks | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Black Scoter | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | · | 0 | insignificant |
| | Fall | 0 | 1 | 1 | unlikely |
| Common Eider | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 1 | 1 | unlikely |
| Long-tailed Duck | Summer | 0 | · | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| Red-breasted Merganser | Summer | 0 | · | 0 | insignificant |
| | Fall | 0 | · | 0 | insignificant |
| | Winter | 0 | 1 | 1 | unlikely |
| | Spring | 0 | 0 | 0 | insignificant |
| Surf Scoter | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | · | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| White-winged Scoter | Winter | 0 | 1 | 1 | unlikely |
| | Spring | 0 | 2 | 2 | unlikely |
| | Summer | 0 | · | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |

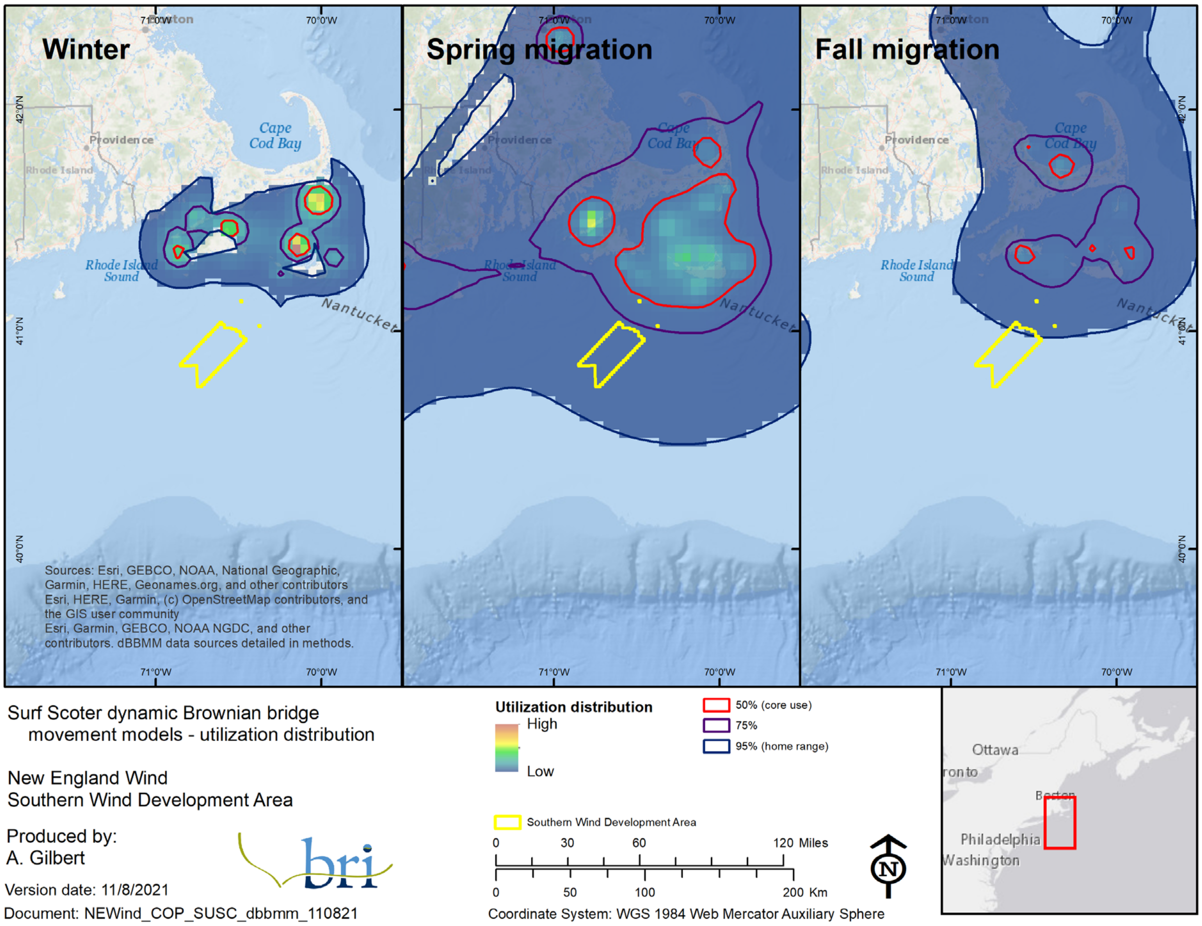



Figure 3-20: Dynamic Brownian bridge movement models for surf scoter (n = 78, 87, 83 [winter, spring, fall]) that were tracked with satellite transmitters; the contours represent the percentage of the use area across the UD surface and represent various levels of use from 50% (core use) to 95% (home range). Data provided by BOEM (See Section 2.1.1.1.4.2)

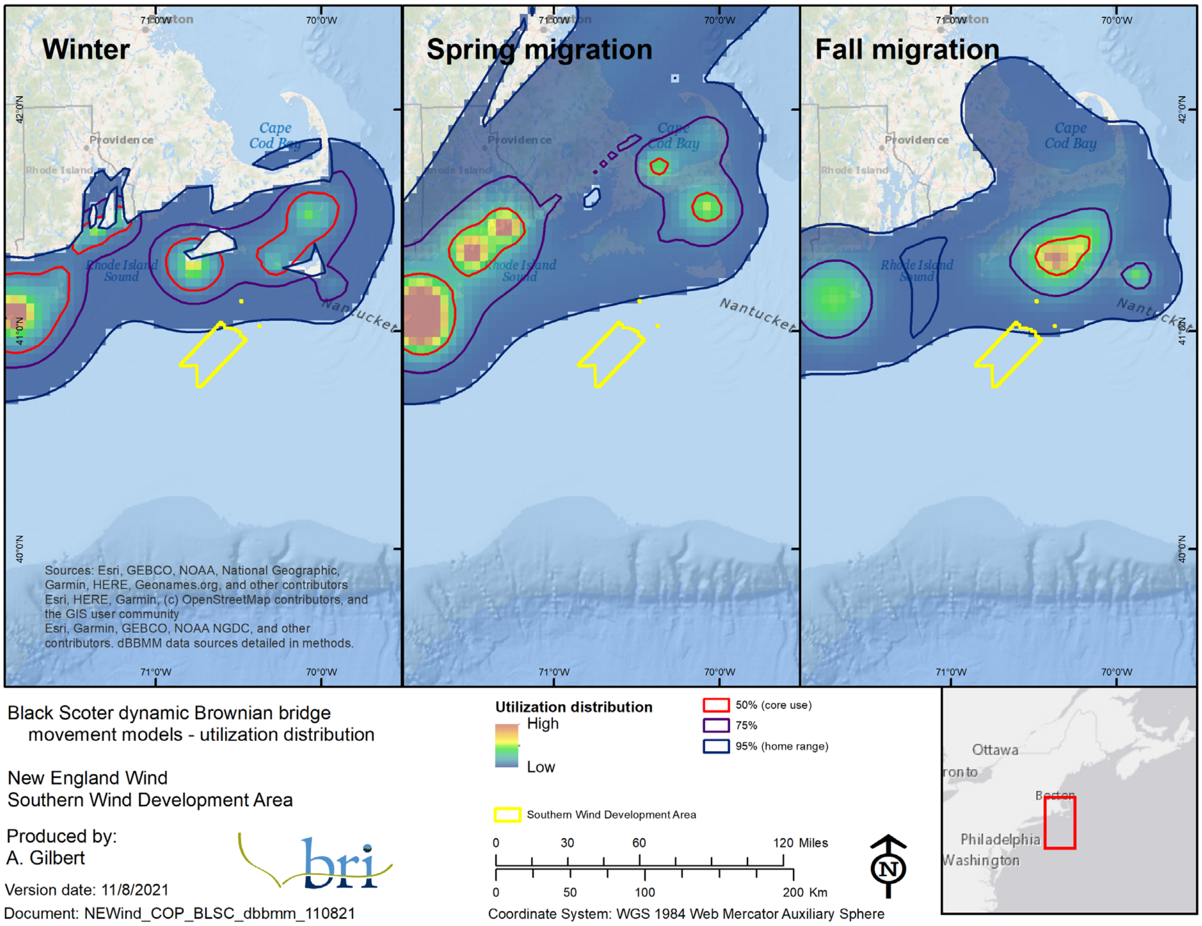



Figure 3-21: Dynamic Brownian bridge movement models for black scoter (n = 61, 76, 80 [winter, spring, fall]) that were tracked with satellite transmitters; the contours represent the percentage of the use area across the UD surface and represent various levels of use from 50% (core use) to 95% (home range). Data provided by multiple sea duck researchers (See Section 2.1.1.1.4.6)

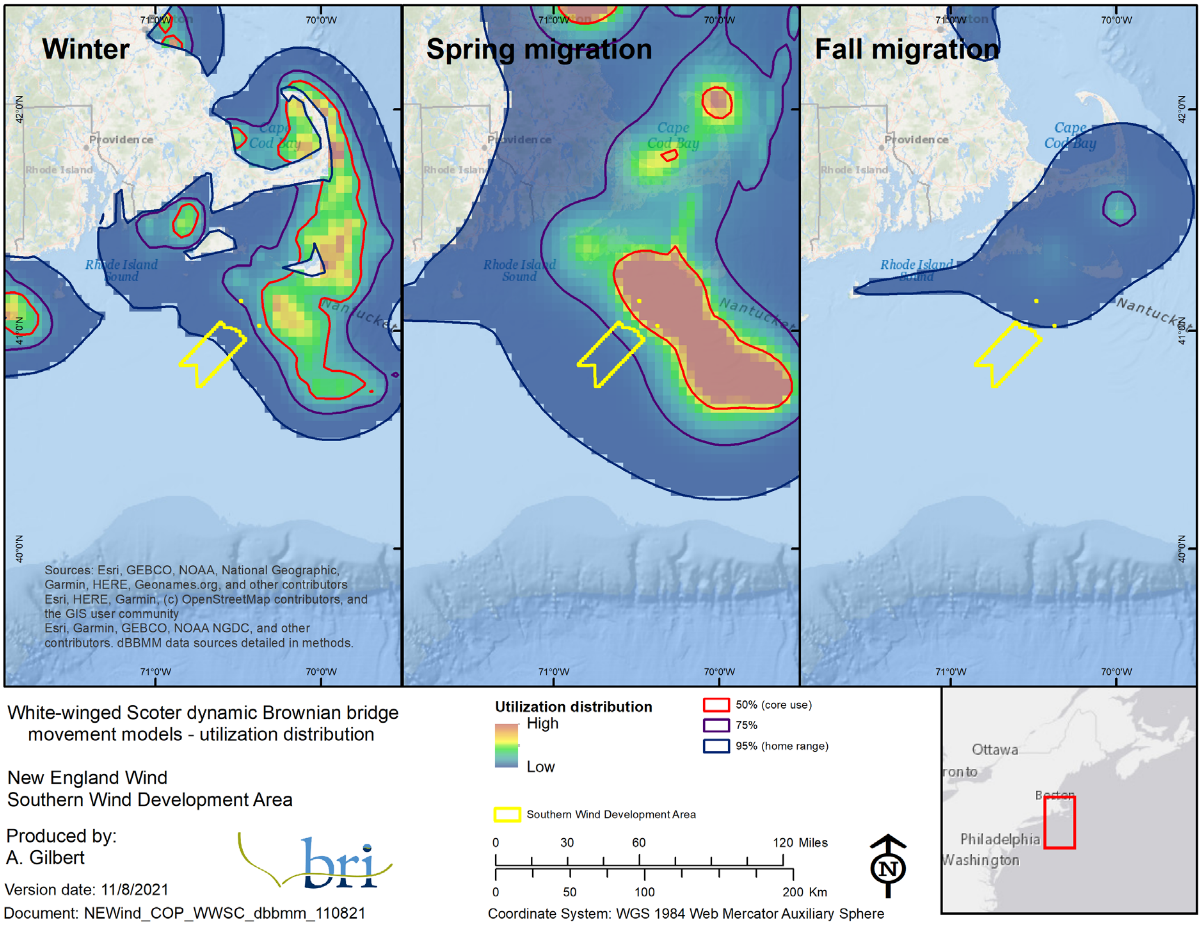



Figure 3-22: Dynamic Brownian bridge movement models for white-winged scoter (n = 66, 45, 62 [winter, spring, fall]) that were tracked with satellite transmitters: the contours represent the percentage of the use area across the UD surface and represent various levels of use from 50% (core use) to 95% (home range). Data provided by multiple sea duck researchers (See Section2.1.1.1.4.6)

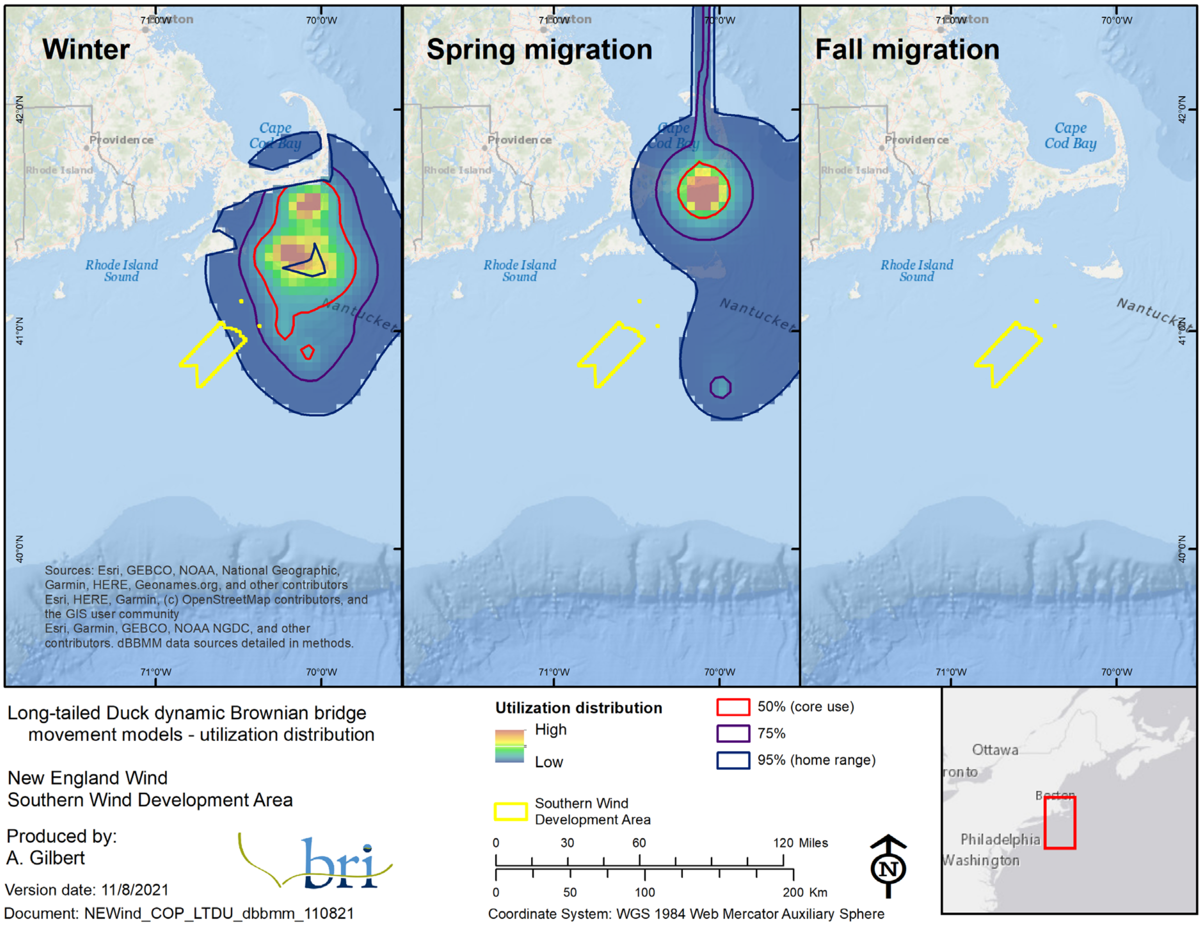



Figure 3-23: Dynamic Brownian bridge movement models for Long-tailed Duck (n = 49, 60, 37 [winter, spring, fall]) that were tracked with satellite transmitters; the contours represent the percentage of the use area across the UD surface and represent various levels of use from 50% (core use) to 95% (home range). Data provided by multiple sea duck researchers (See Section 2.1.1.1.4.6)

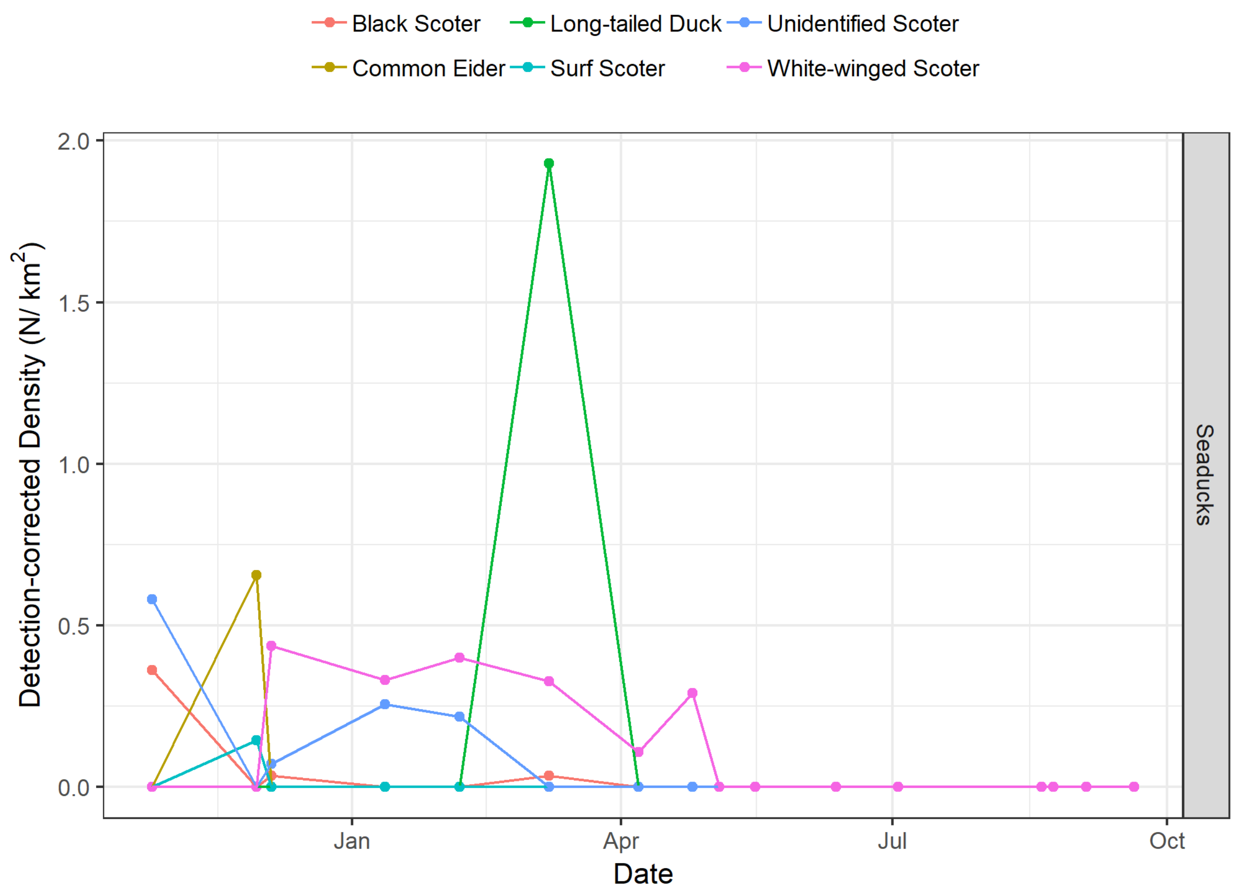



Figure 3-24: Detection-corrected density estimates from the NE Wind boat surveys for sea ducks in the study area

### 3.2.2.2 Relative Behavioral Vulnerability Figures and Tables

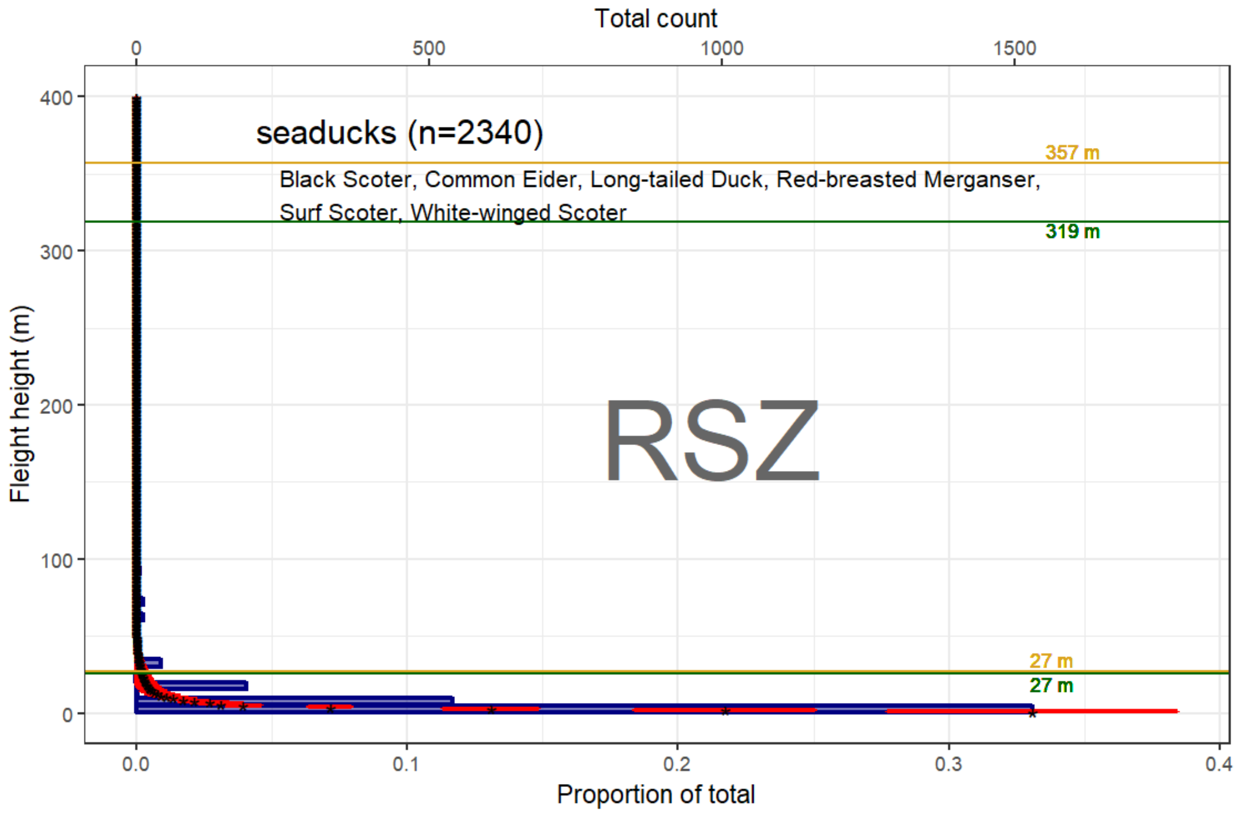



Figure 3-25: Flight heights of sea ducks (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27-319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27-357 m [87-1171 ft])

Table 3-7: Summary of sea duck vulnerability; based upon the literature, displacement vulnerability was adjusted to include a lower range limit (green) to account for macro-avoidance rates potentially decreasing with time

| Species | Collision Vulnerability | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Black Scoter | unlikely (0.27) | unlikely (0.27) | potential - likely (0.9) | unlikely (0.4) |
| Common Eider | unlikely (0.27) | unlikely (0.27) | potential - likely (0.9) | unlikely (0.47) |
| Long-tailed Duck | unlikely (0.3) | unlikely (0.3) | potential - likely (0.9) | unlikely (0.27) |
| Red-breasted Merganser | potential (0.53) | potential (0.53) | unlikely - potential (0.5) | unlikely (0.27) |
| Surf Scoter | unlikely (0.27) | unlikely (0.27) | potential - likely (0.9) | potential (0.53) |
| White-winged Scoter | unlikely (0.27) | unlikely (0.27) | potential - likely (0.8) | potential (0.53) |

### 3.2.3 Shearwaters, Petrels, and Storm-petrels

#### *3.2.3.1 Exposure Tables, Maps, and Figures*

Table 3-8: Seasonal exposure rankings for the shearwaters, petrels, and storm-petrels

| Shearwaters and Petrels | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Audubon's Shearwater | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Winter | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| Black-capped Petrel | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | 0 | 0 | insignificant |
| Cory's Shearwater | Summer | 0 | 2 | 2 | unlikely |
| | Fall | 2 | 1 | 3 | potential |
| | Spring | 0 | 0 | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| Great Shearwater | Winter | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 1 | 1 | unlikely |
| | Spring | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| Manx Shearwater | Winter | 0 | · | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 1 | 1 | unlikely |
| | Fall | 0 | 0 | 0 | insignificant |
| Northern Fulmar | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 3 | 0 | 3 | potential |
| Sooty Shearwater | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| | Spring | 0 | 0 | 0 | Insignificant |
| Leach's Storm-Petrel | Fall | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| | Spring | 0 | 0 | 0 | Insignificant |
| Wilson's Storm-Petrel | Winter | 0 | · | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 1 | 1 | 2 | unlikely |

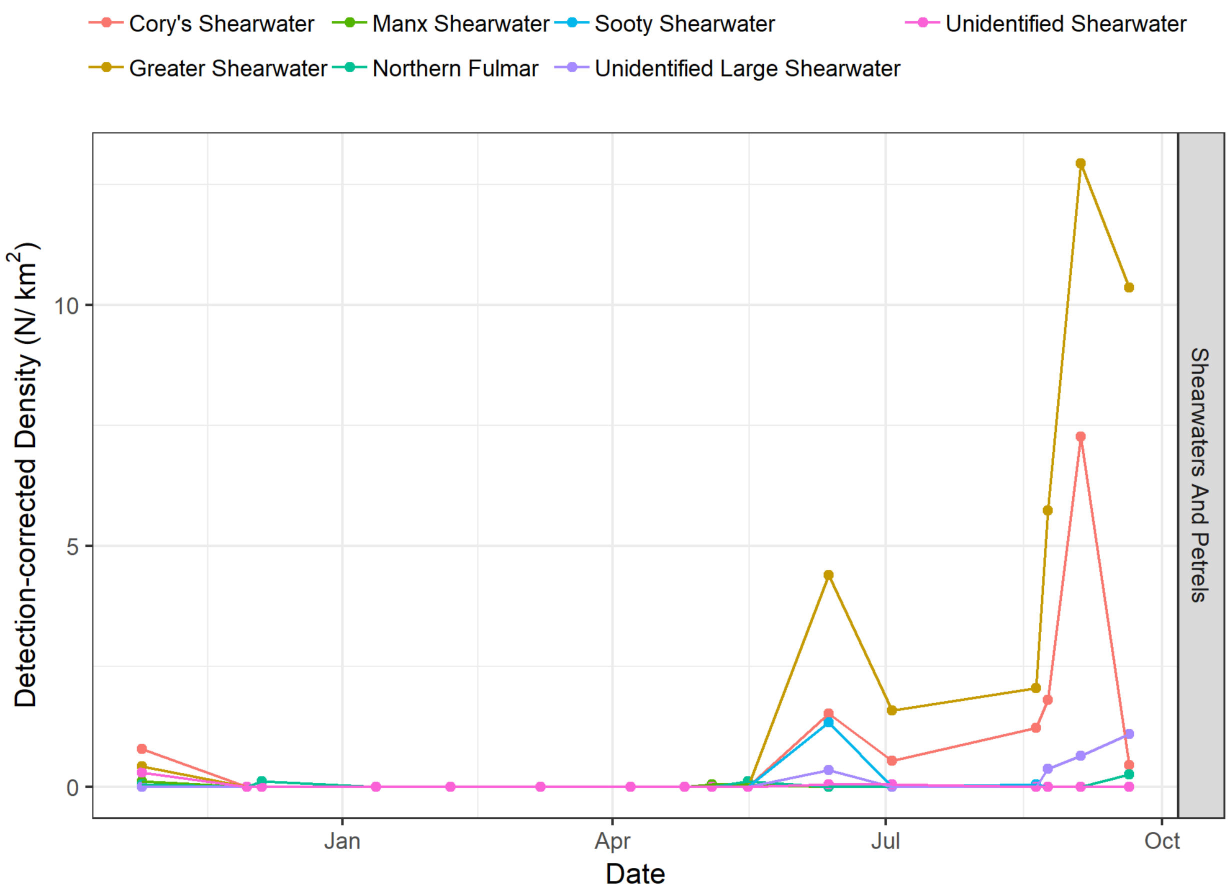



Figure 3-26: Detection-corrected density estimates from the NE Wind boat surveys for shearwaters and petrels in the study area

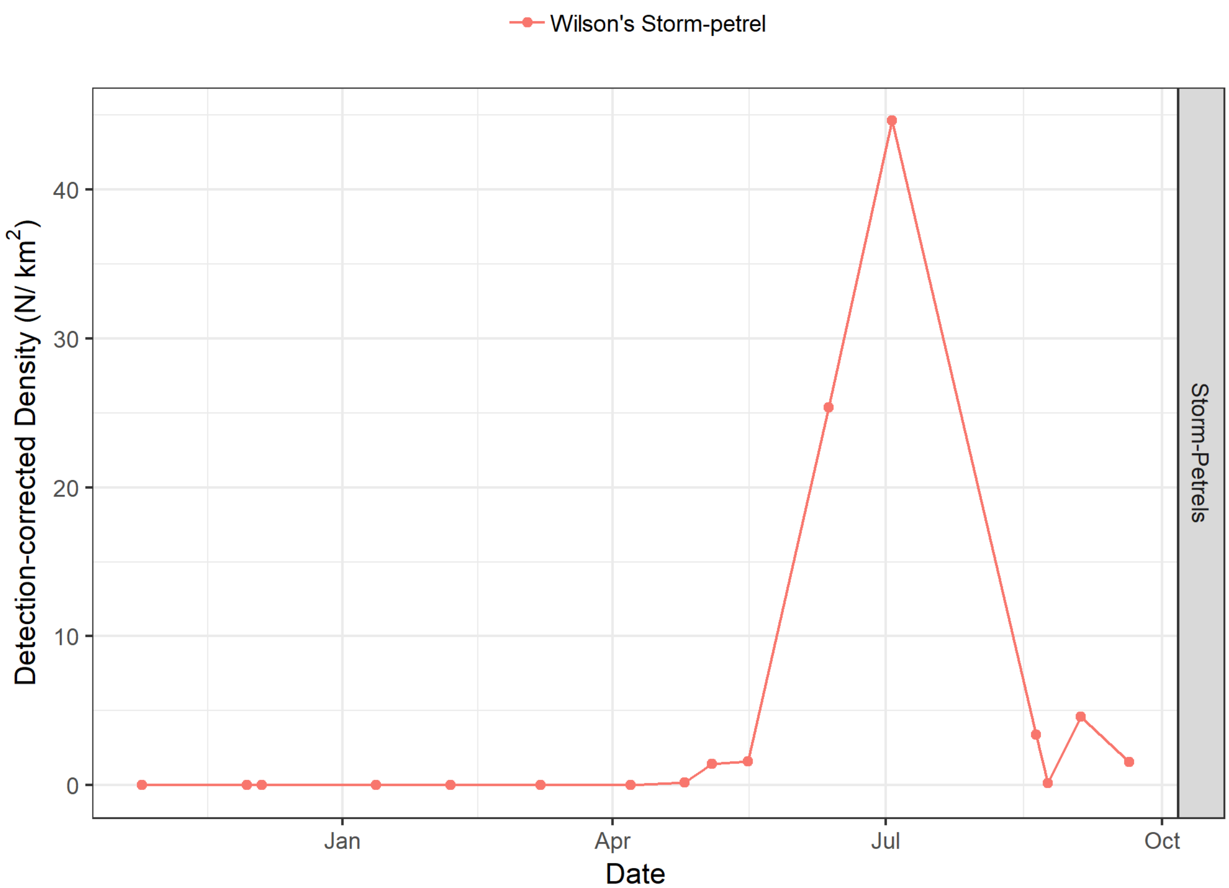
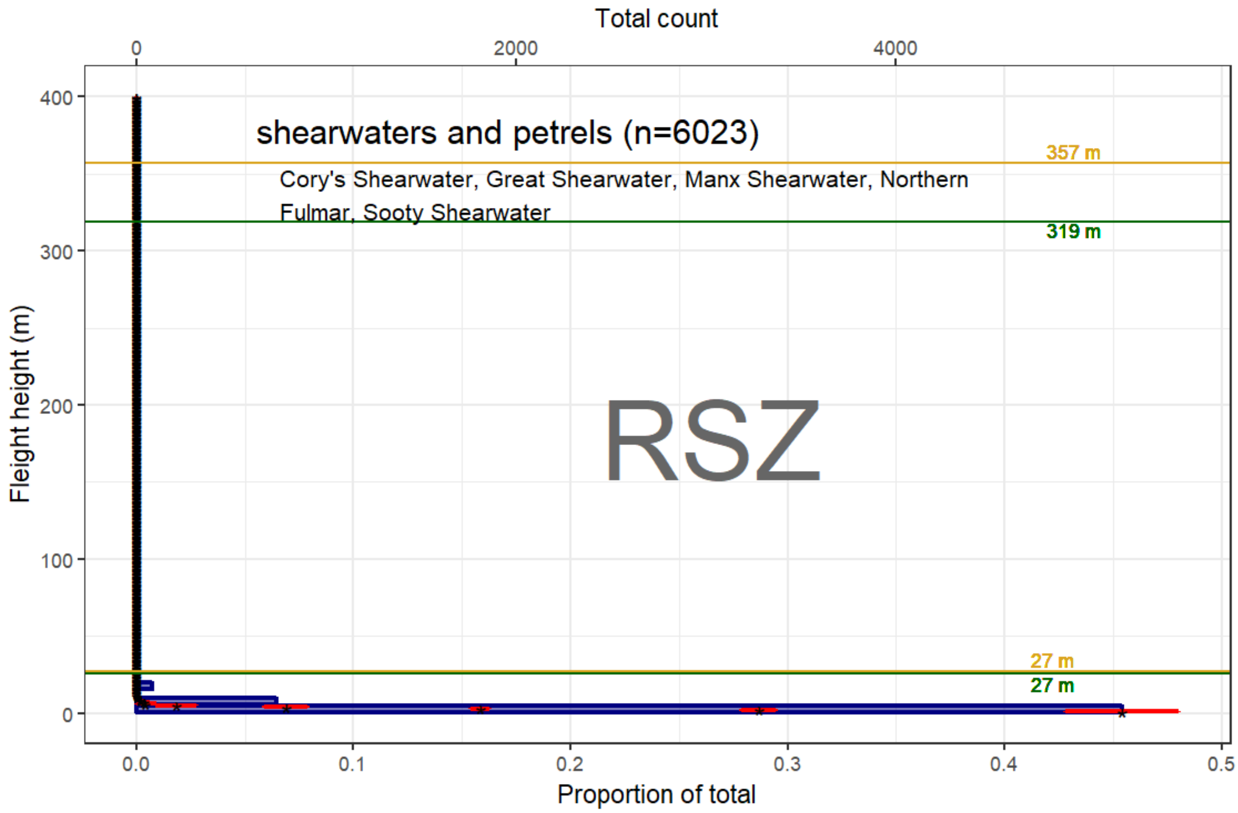



Figure 3-27: Detection-corrected density estimates from the NE Wind boat surveys for storm-petrels in the study area

### *3.2.3.2 Relative Behavioral Vulnerability Figures and Tables*



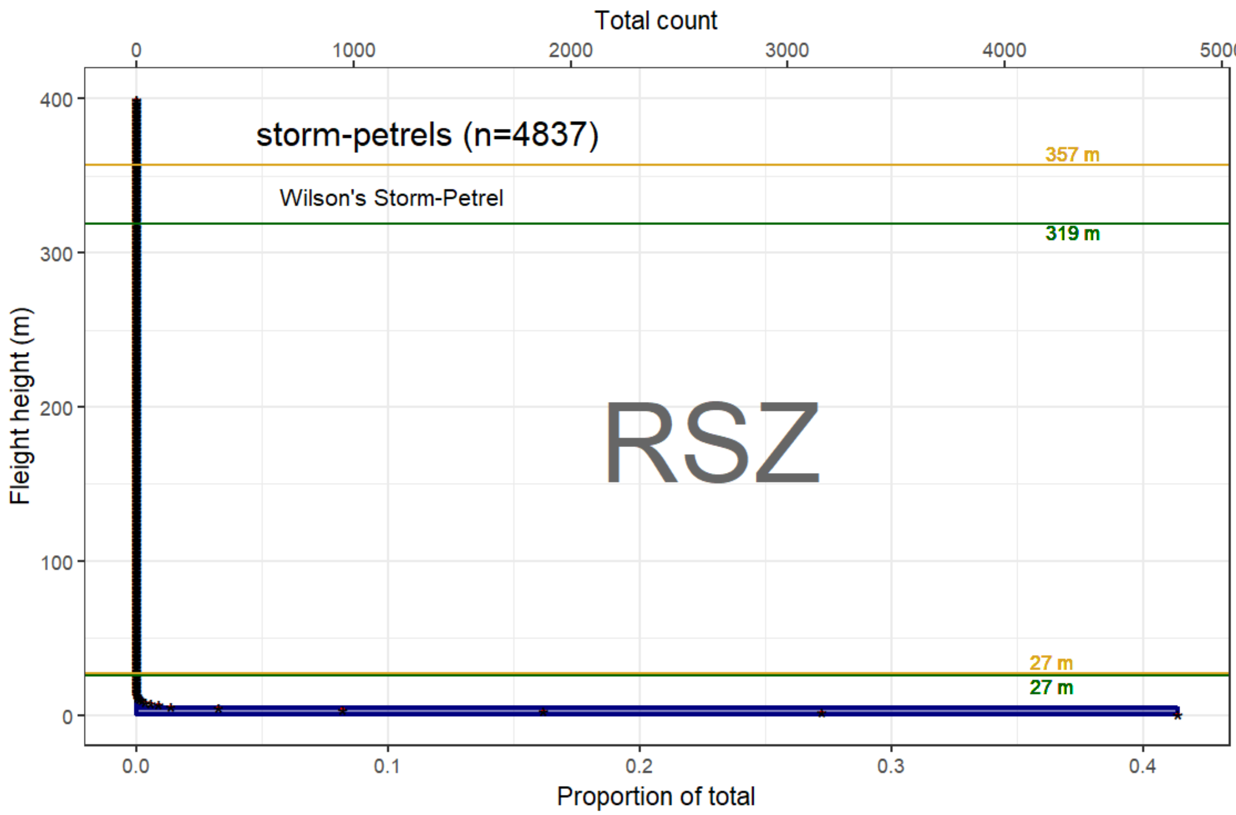



Figure 3-28: Flight heights of shearwaters, petrels, and storm-petrels (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27-319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27-357 m [87-1171 ft])

Table 3-9: Summary of petrel, shearwater, and storm-petrel vulnerability. Based upon the literature, displacement vulnerability was adjusted to include a lower range limit (green)

| Species | Collision Vulnerability | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Cory's Shearwater | unlikely (0.33) | unlikely (0.33) | unlikely - potential (0.6) | potential (0.6) |
| Great Shearwater | unlikely (0.3) | unlikely (0.3) | unlikely - potential (0.6) | potential (0.67) |
| Manx Shearwater | unlikely (0.37) | unlikely (0.37) | unlikely - potential (0.6) | potential (0.53) |
| Northern Fulmar | unlikely (0.37) | unlikely (0.37) | unlikely - potential (0.6) | unlikely (0.47) |
| Sooty Shearwater | unlikely (0.4) | unlikely (0.4) | unlikely - potential (0.6) | potential (0.53) |
| Wilson’s Storm-Petrel | unlikely (0.43) | unlikely (0.43) | unlikely - potential (0.6) | unlikely (0.4) |

### *3.2.3.3 Candidate Petrel Species*

#### 3.2.3.3.1 Black-capped Petrel

#### 3.2.3.3.2 Exposure Tables, Maps, and Figures

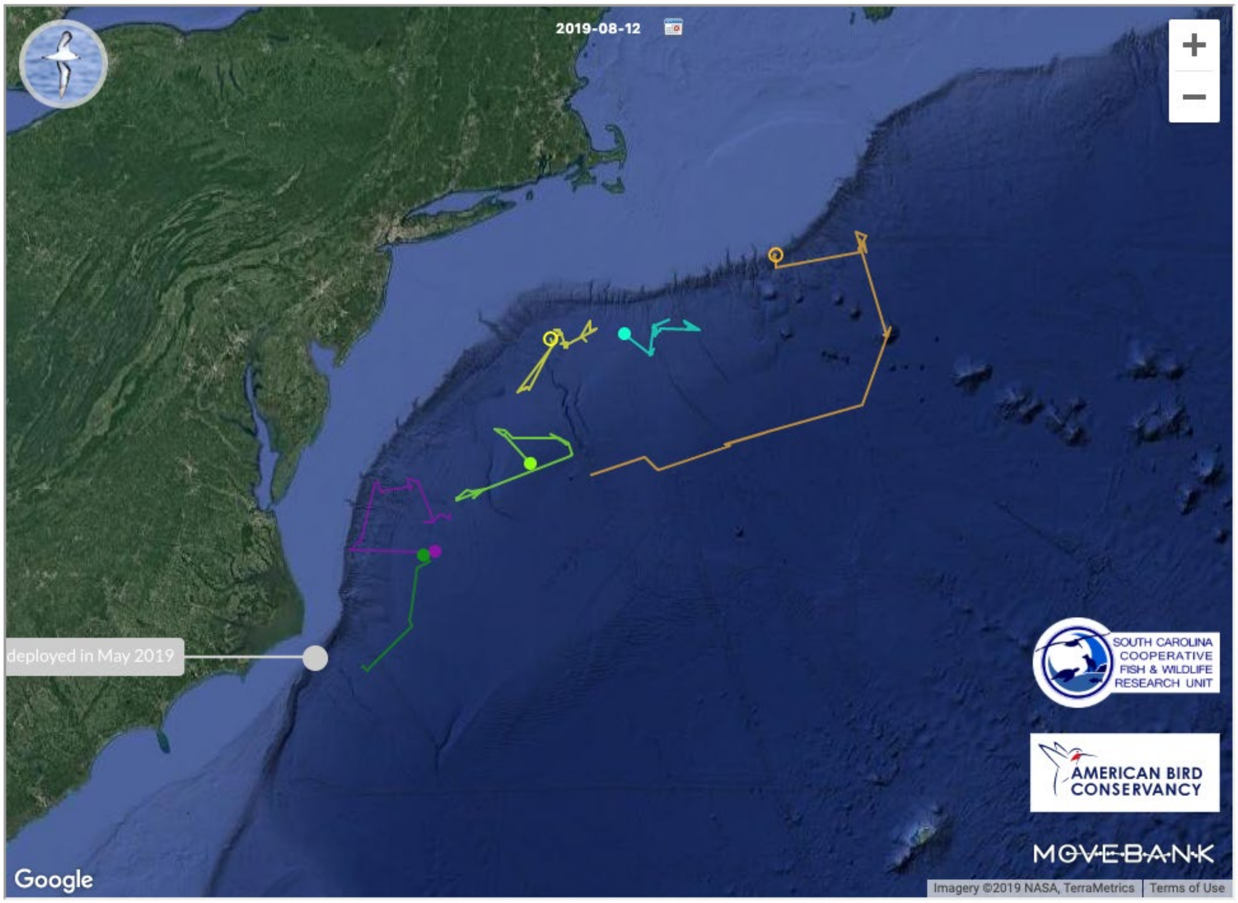



Figure 3-29: Track lines of black-capped petrels tagged with satellite transmitters (Atlantic Seabirds 2019)

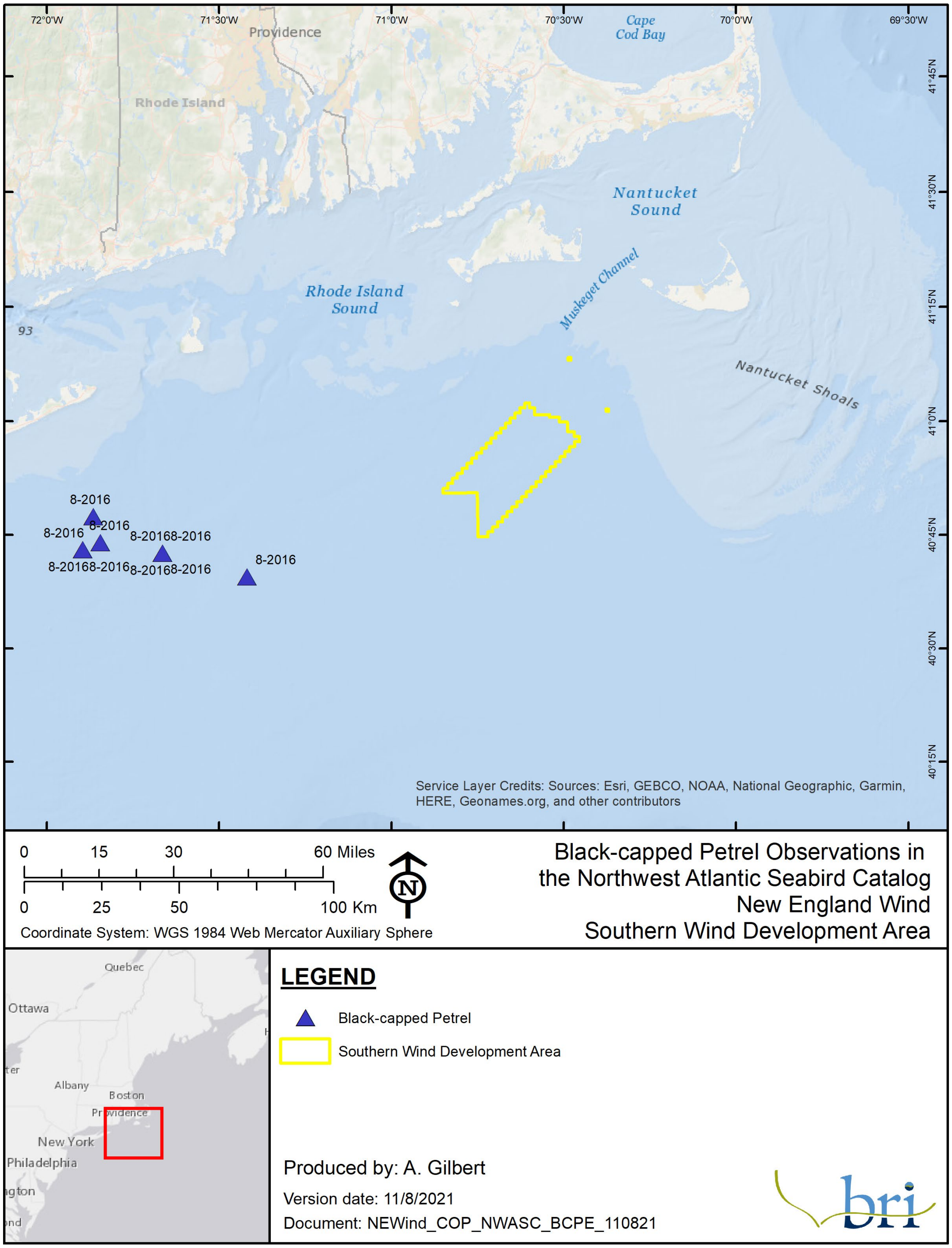



Figure 3-30. Black-capped petrel observations from the Northwest Atlantic Seabird Catalog and NE Wind boat surveys

### 3.2.4 Gannets, Cormorants, and Pelicans

#### *3.2.4.1 Gannets*

##### 3.2.4.1.1 Exposure Tables, Maps, and Figures

Table 3-10: Seasonal exposure rankings for northern gannets.

| Gannet | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Northern gannet | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 3 | 1 | 4 | potential |

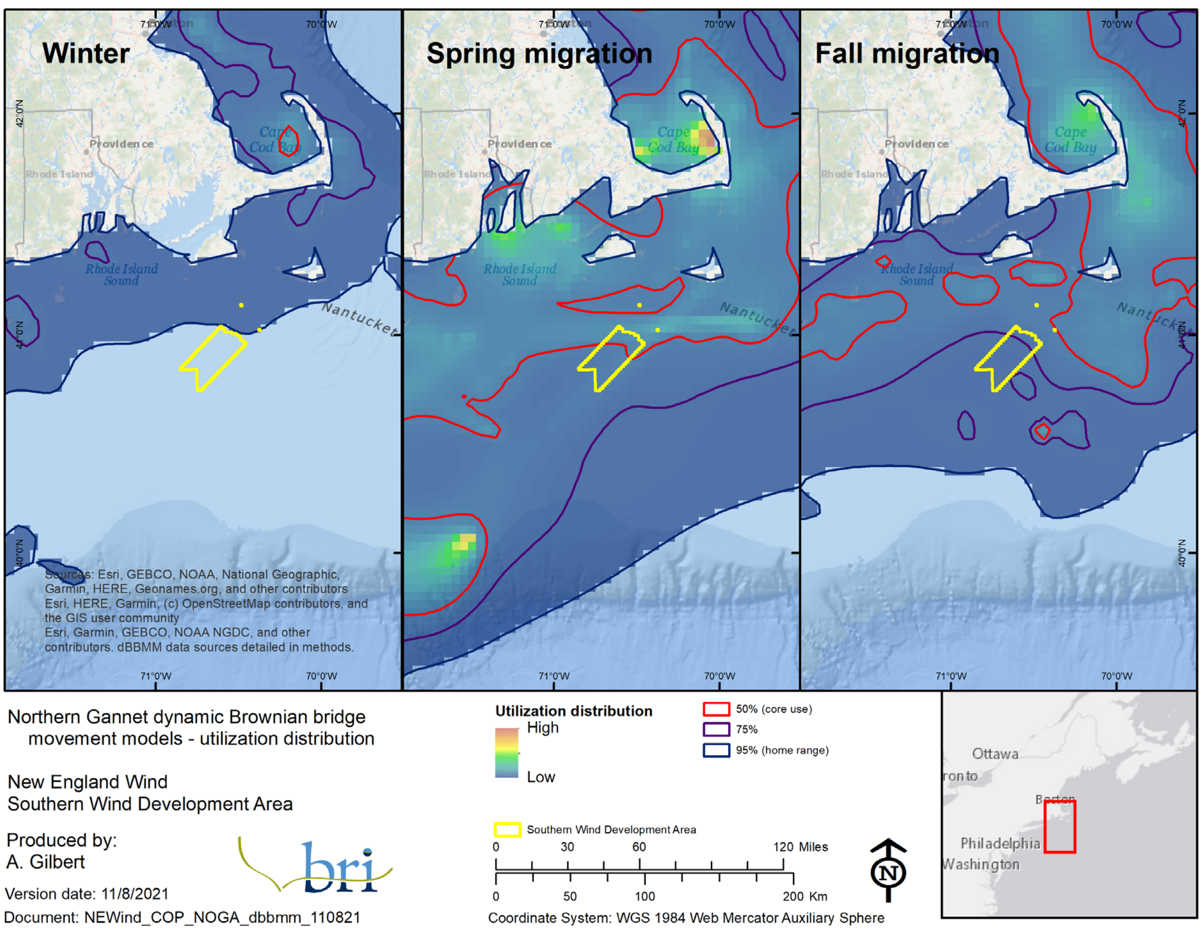



Figure 3-31: Dynamic Brownian bridge movement models for northern gannets (n = 34, 35, 36 [winter, spring, fall]) that were tracked with satellite transmitters; the contours represent the percentage of the use area across the UD surface and represent various levels of use from 50% (core use) to 95% (home range)

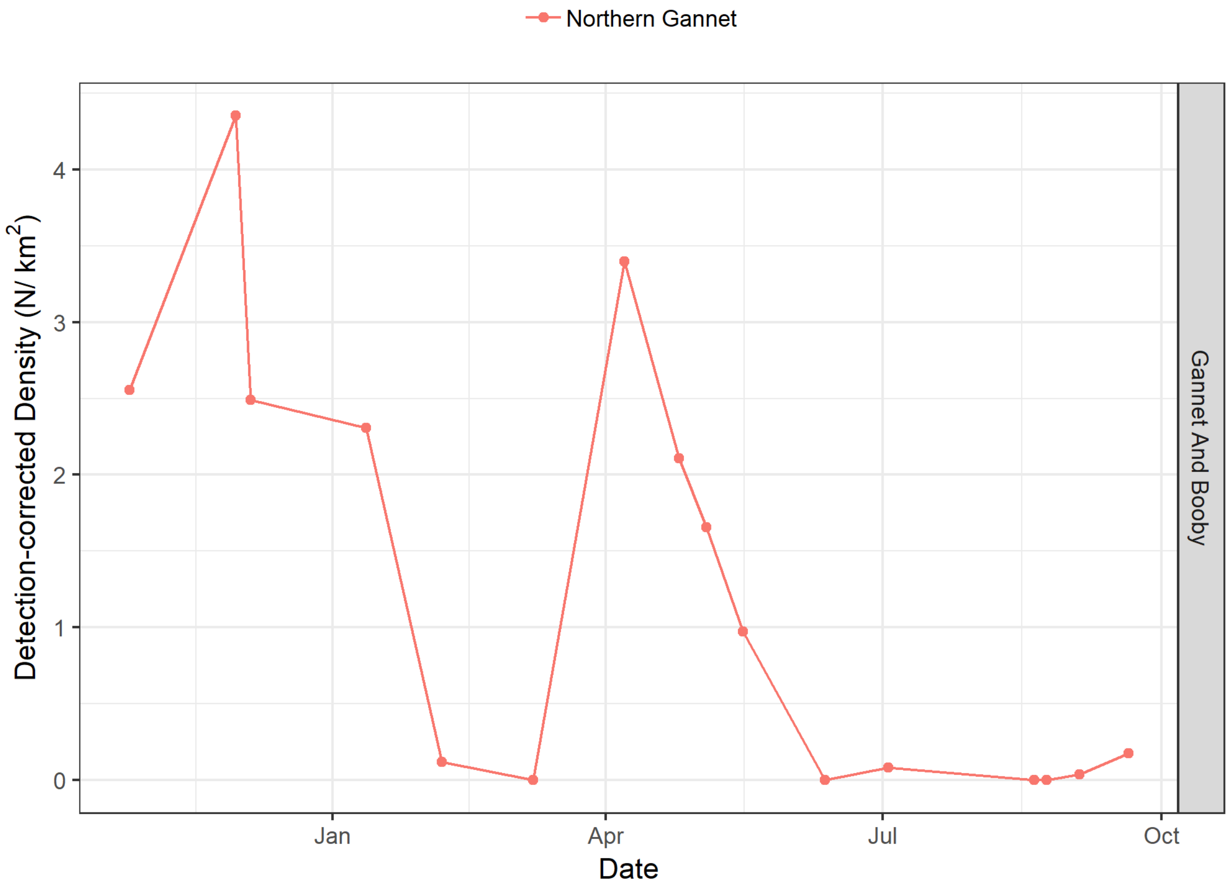



Figure 3-32: Detection-corrected density estimates from the NE Wind boat surveys for northern gannets in the study area

### 3.2.4.1.2 Relative Behavioral Vulnerability Figures and Tables

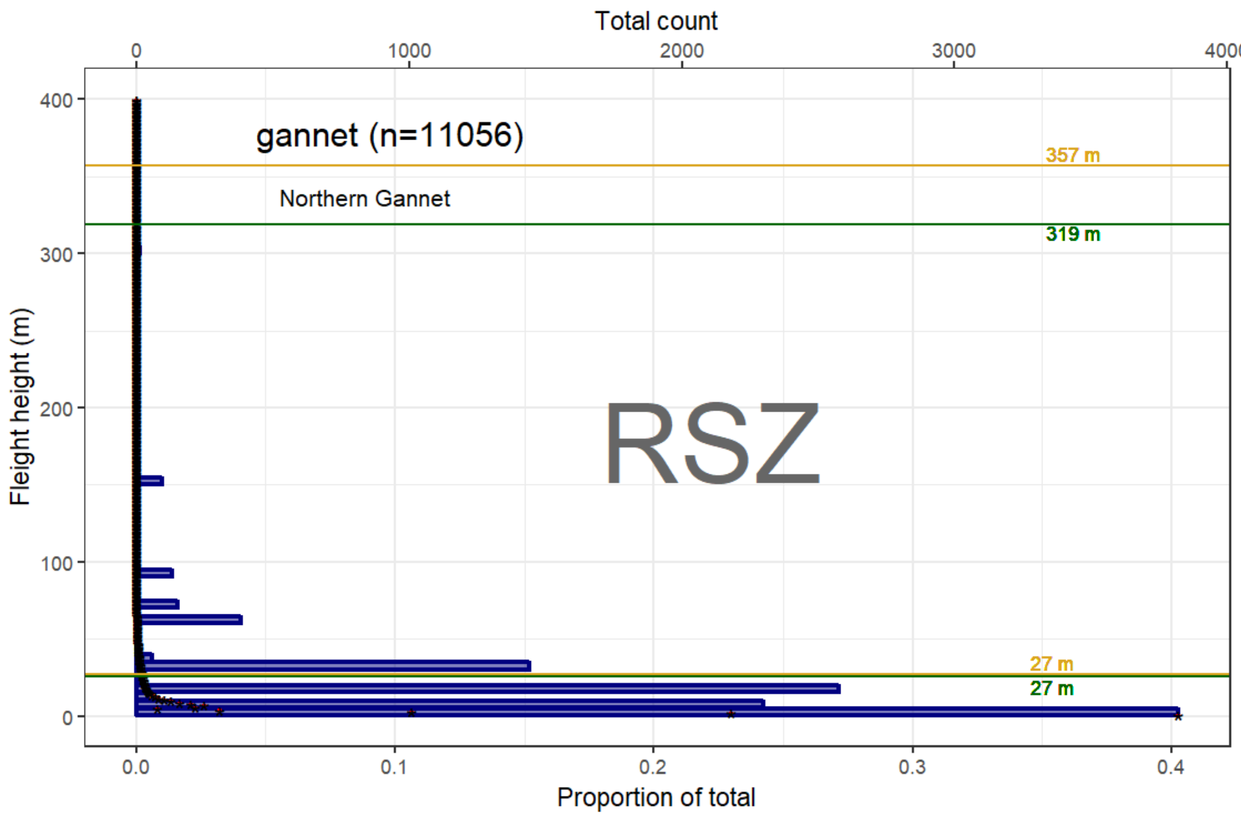



Figure 3-33: Flight heights of northern gannet (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27-319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27-357 m [87-1171 ft])

Table 3-11: Summary of northern gannet vulnerability

| Species | Collision Vulnerability | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Northern Gannet | unlikely (0.3) | unlikely (0.3) | potential (0.6) | unlikely (0.47) |

### *3.2.4.2 Cormorants*

#### 3.2.4.2.1 Exposure Tables, Maps, and Figures

Table 3-12: Seasonal exposure rankings for the cormorant group

| Cormorants | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Double-crested Cormorant | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 1 | 1 | unlikely |
| | Fall | 0 | 0 | 0 | insignificant |

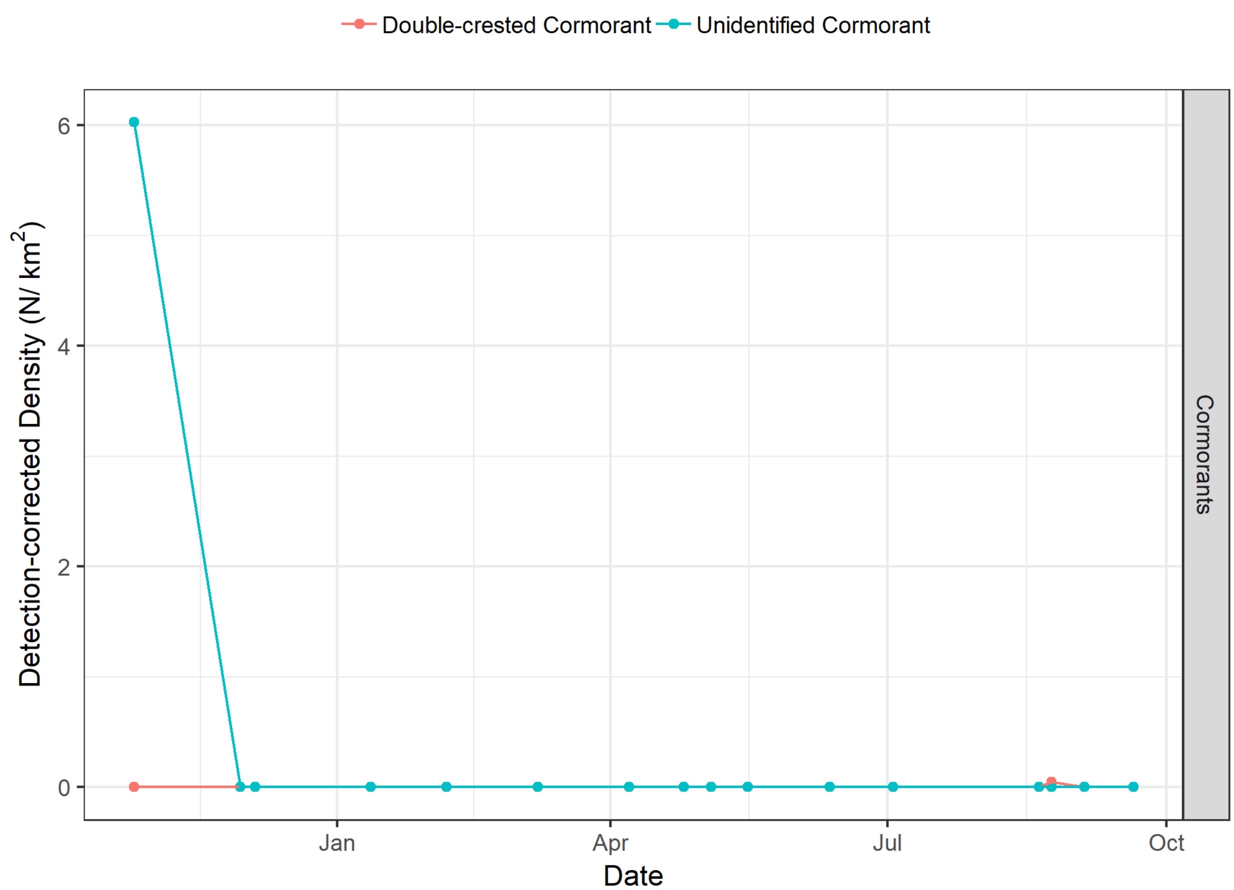



Figure 3-34: Detection-corrected density estimates from the NE Wind boat surveys for cormorants in the study area

### 3.2.4.2.2 Relative Behavioral Vulnerability Figures and Tables

Table 3-13: Summary of cormorant vulnerability

| Species | Collision Vulnerability | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Double-crested Cormorant | potential (0.6) | potential (0.6) | unlikely (0.4) | insignificant (0.13) |

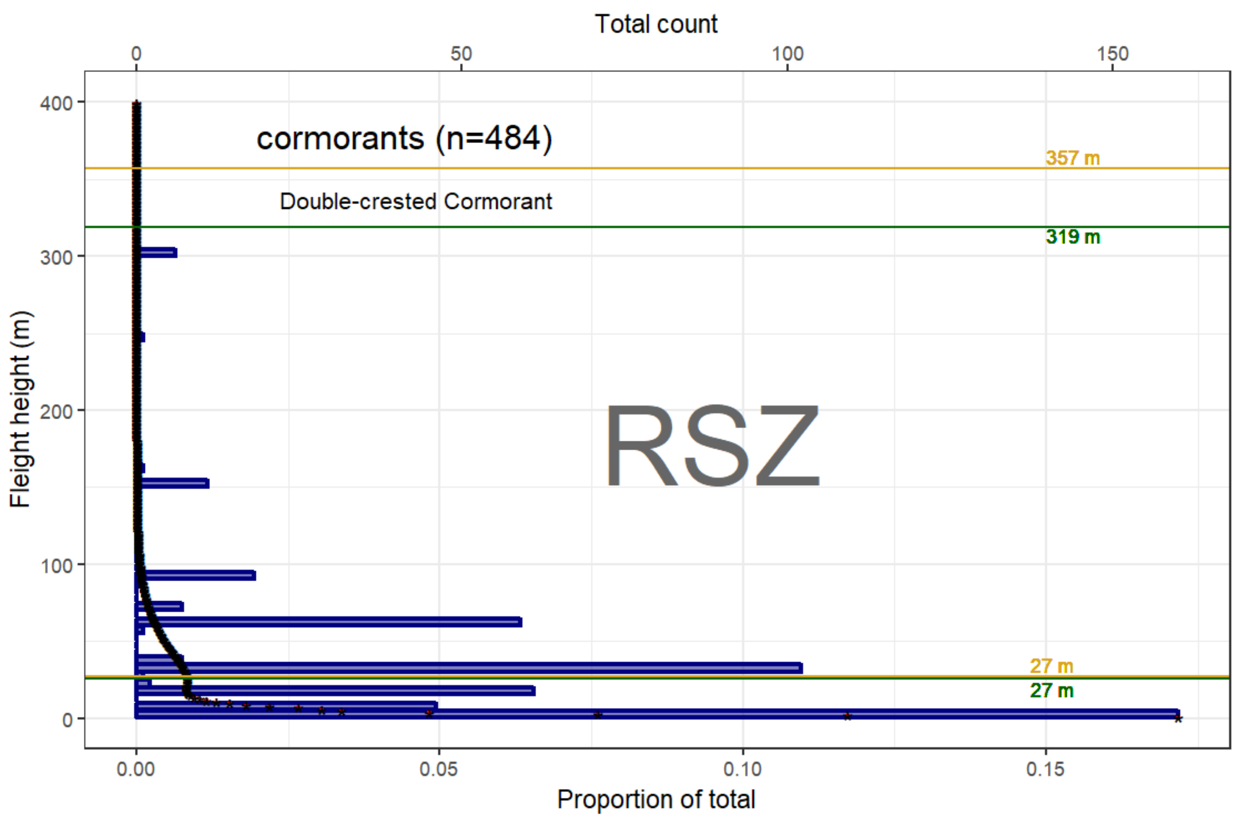



Figure 3-35: Flight heights of double-crested cormorant (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27–319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27–357 m [87-1171 ft])

## 3.2.5 Gulls, Skuas, and Jaegers

### *3.2.5.1 Exposure Tables, Maps, and Figures*

Table 3-14: Seasonal exposure rankings for gull, skuas, and jaegers

| Skuas and Jaegers | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Great Skua | Winter | 0 | · | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Spring | 0 | · | 0 | insignificant |
| | Summer | 0 | · | 0 | insignificant |
| Parasitic Jaeger | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 1 | 1 | unlikely |
| | Winter | 0 | · | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| Pomarine Jaeger | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| South Polar Skua | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Spring | 0 | · | 0 | insignificant |

| Small Gulls | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Bonaparte's Gull | Summer | 0 | · | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 1 | 0 | 1 | unlikely |

| Medium Gulls | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Black-legged Kittiwake | Summer | 0 | · | 0 | insignificant |
| | Fall | 3 | 0 | 3 | potential |
| | Winter | 0 | 1 | 1 | unlikely |
| | Spring | 1 | 1 | 2 | unlikely |
| Laughing Gull | Fall | 1 | 0 | 1 | unlikely |
| | Winter | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| Ring-billed Gull | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 1 | 1 | unlikely |

| Large Gulls | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Great Black-backed Gull | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | 1 | 1 | unlikely |
| Herring Gull | Summer | 2 | 0 | 2 | unlikely |
| | Spring | 0 | 1 | 1 | unlikely |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | 1 | 1 | unlikely |

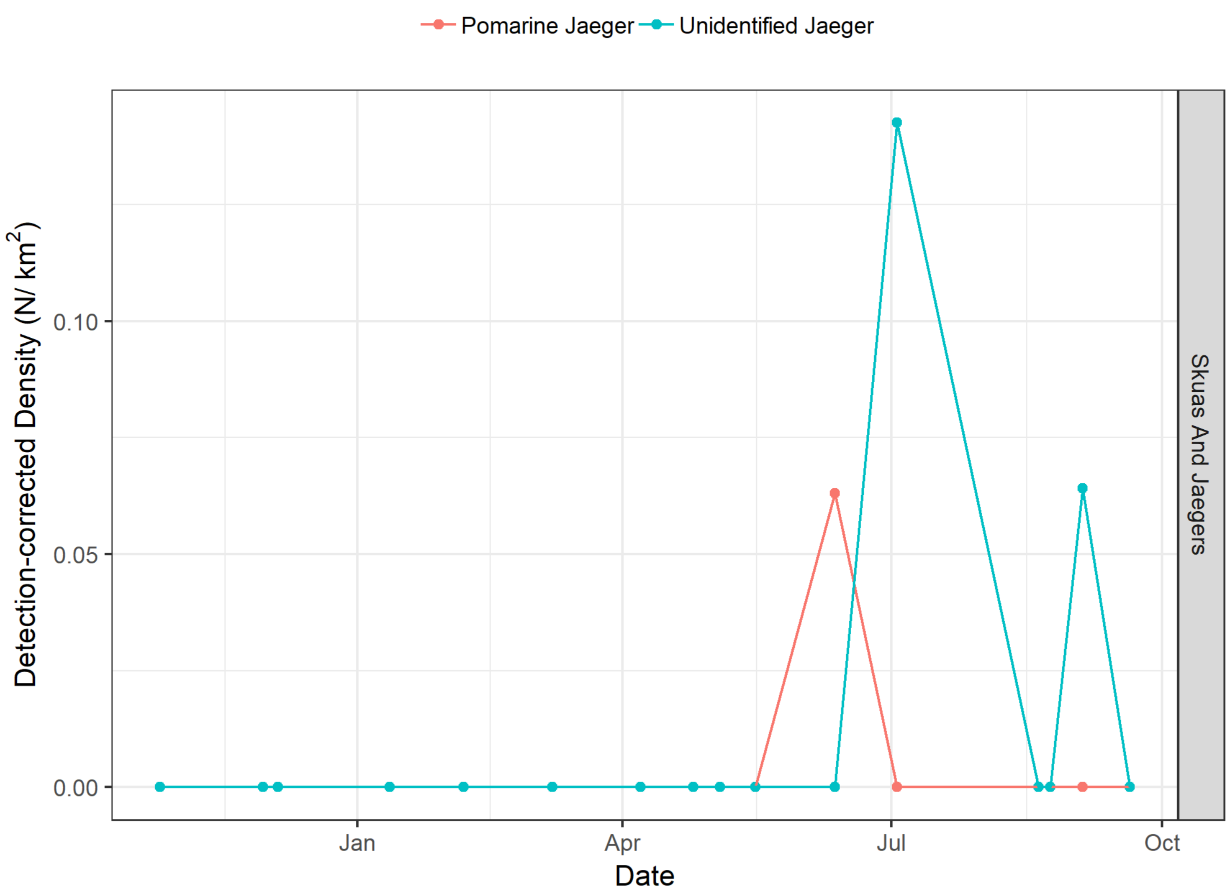



Figure 3-36: Detection-corrected density estimates from the NE Wind boat surveys for skuas and jaegers in the study area

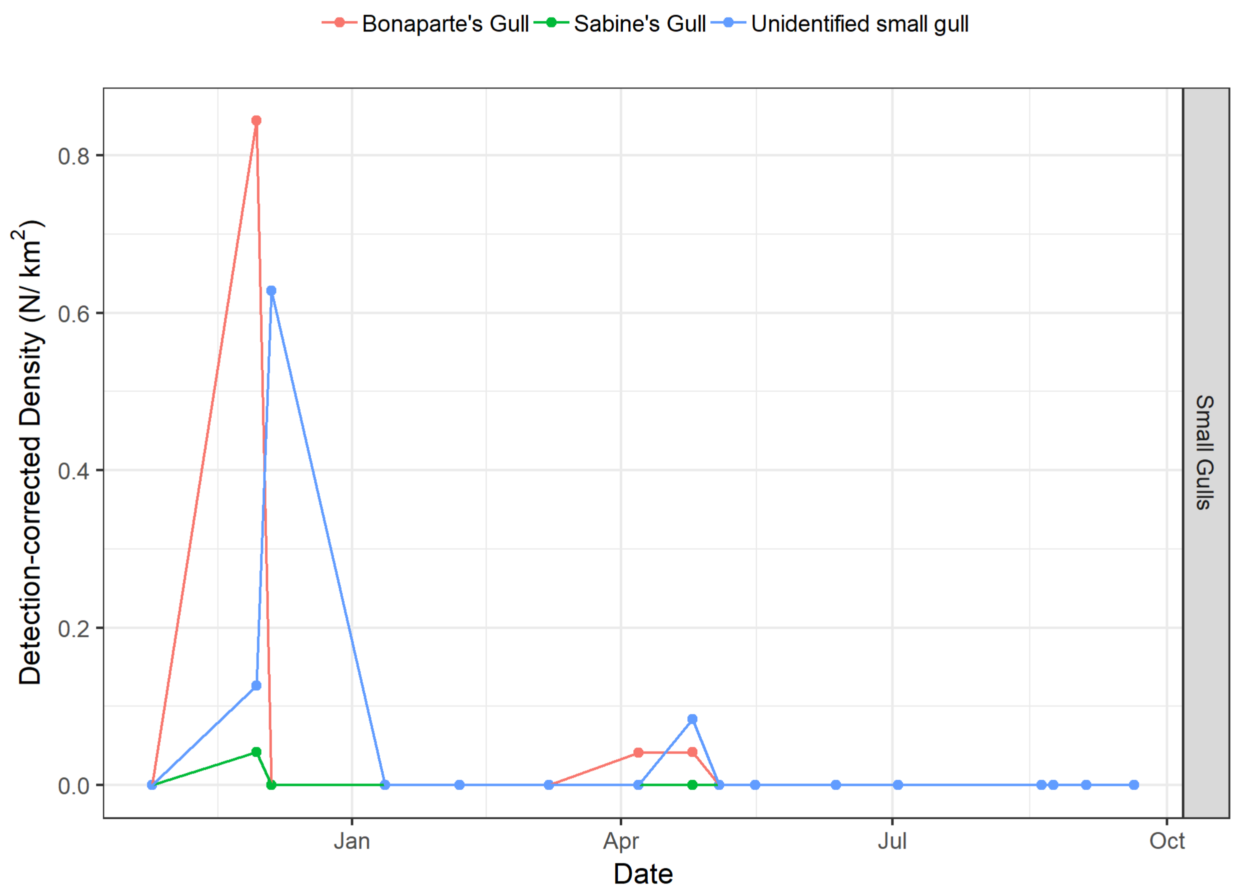



Figure 3-37: Detection-corrected density estimates from the NE Wind boat surveys for small gulls in the study area

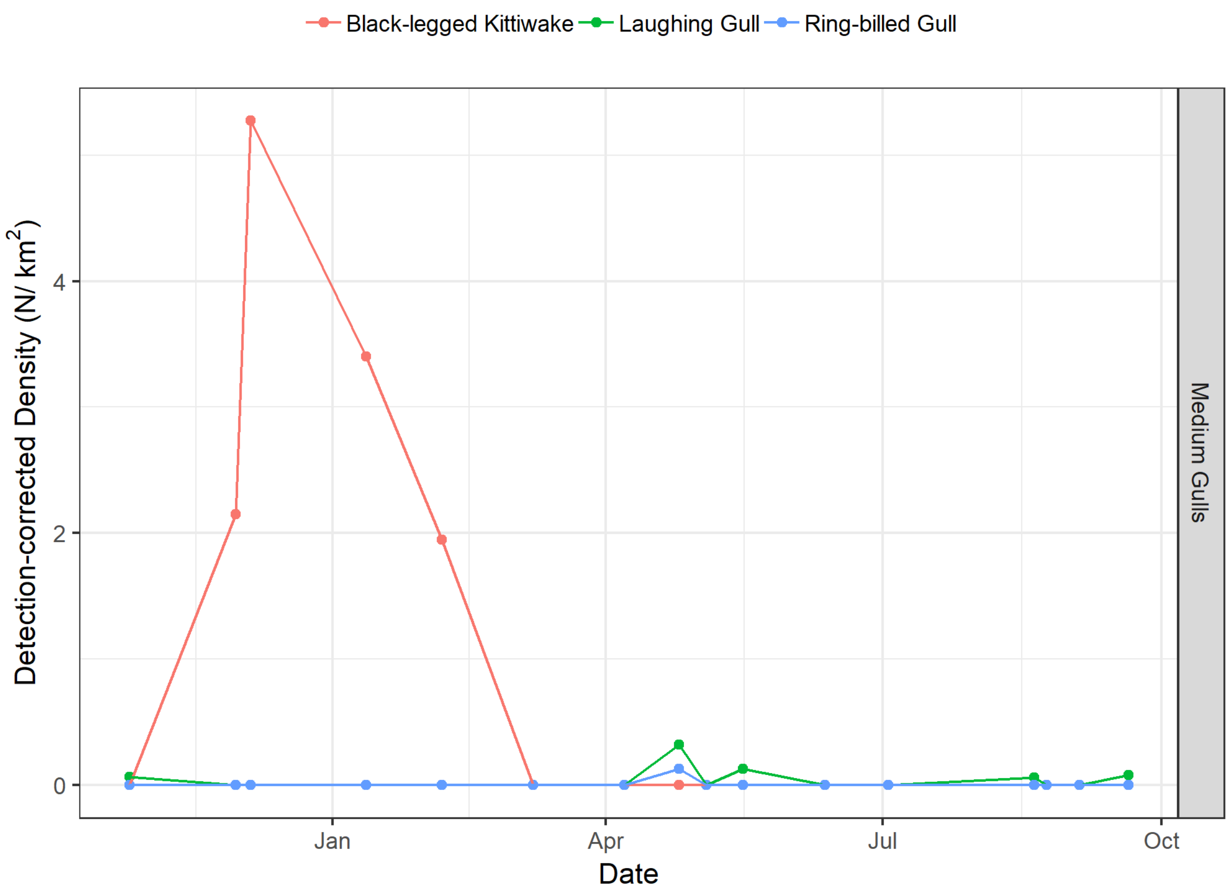



Figure 3-38: Detection-corrected density estimates from the NE Wind boat surveys for medium gulls in the study area

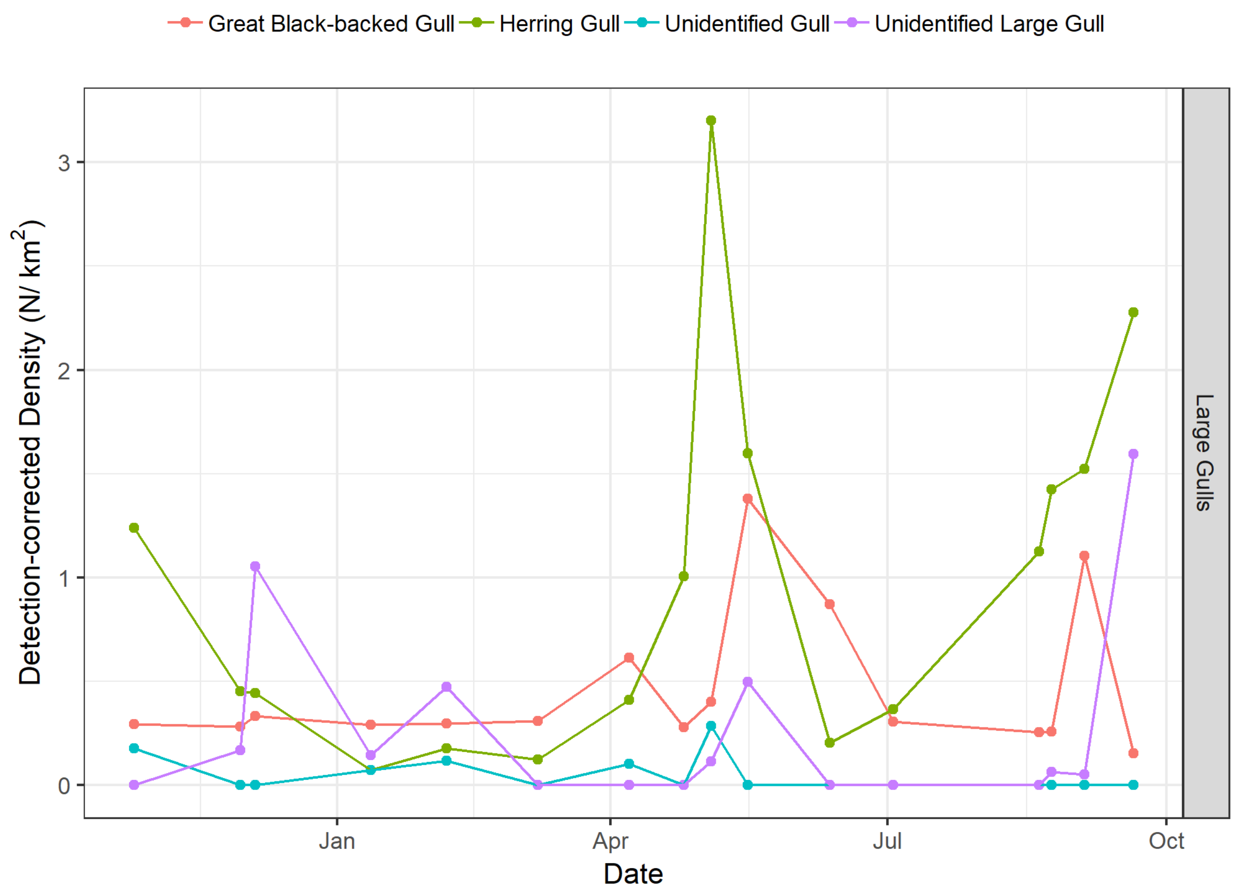



Figure 3-39: Detection-corrected density estimates from the NE Wind boat surveys for large gulls in the study area

### *3.2.5.2 Relative Behavioral Vulnerability Figures and Tables*

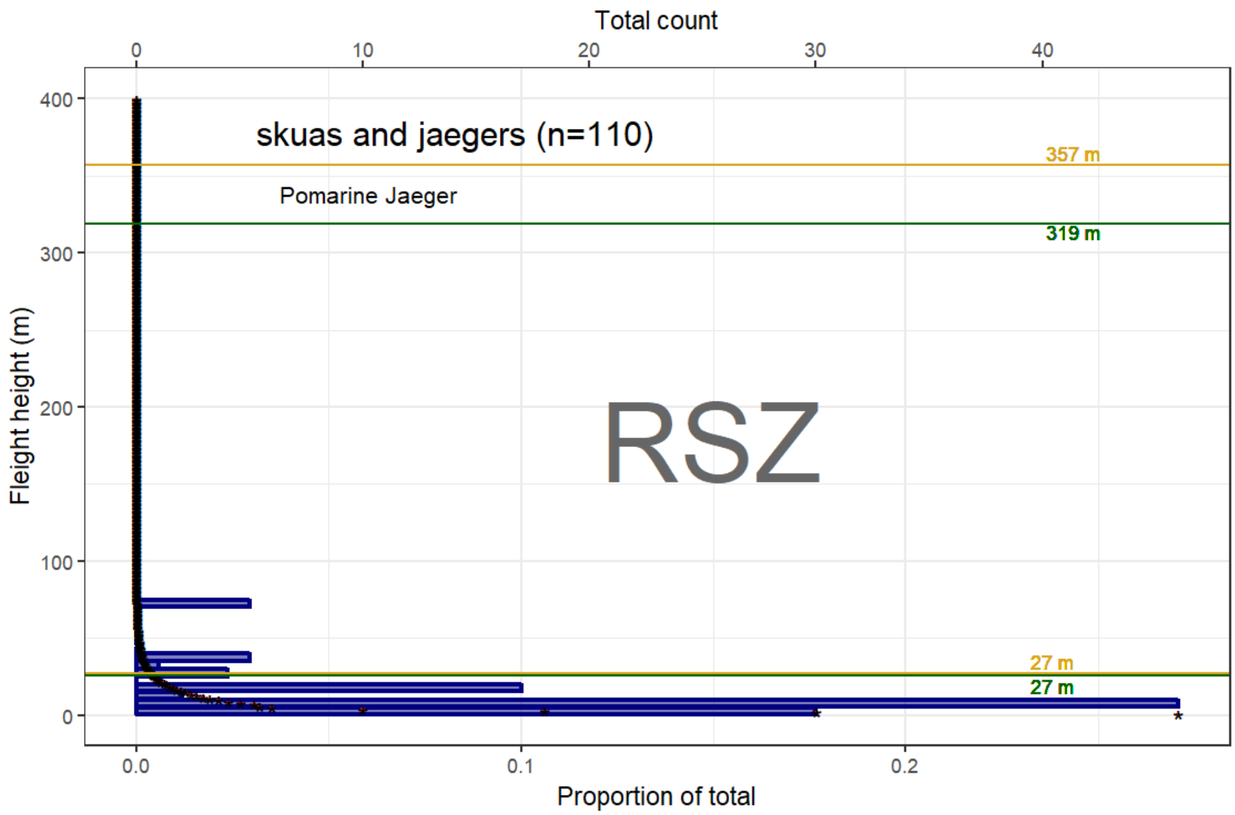



Figure 3-40: Flight heights of skuas and jaegers (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27–319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27–357 m [87-1171 ft])

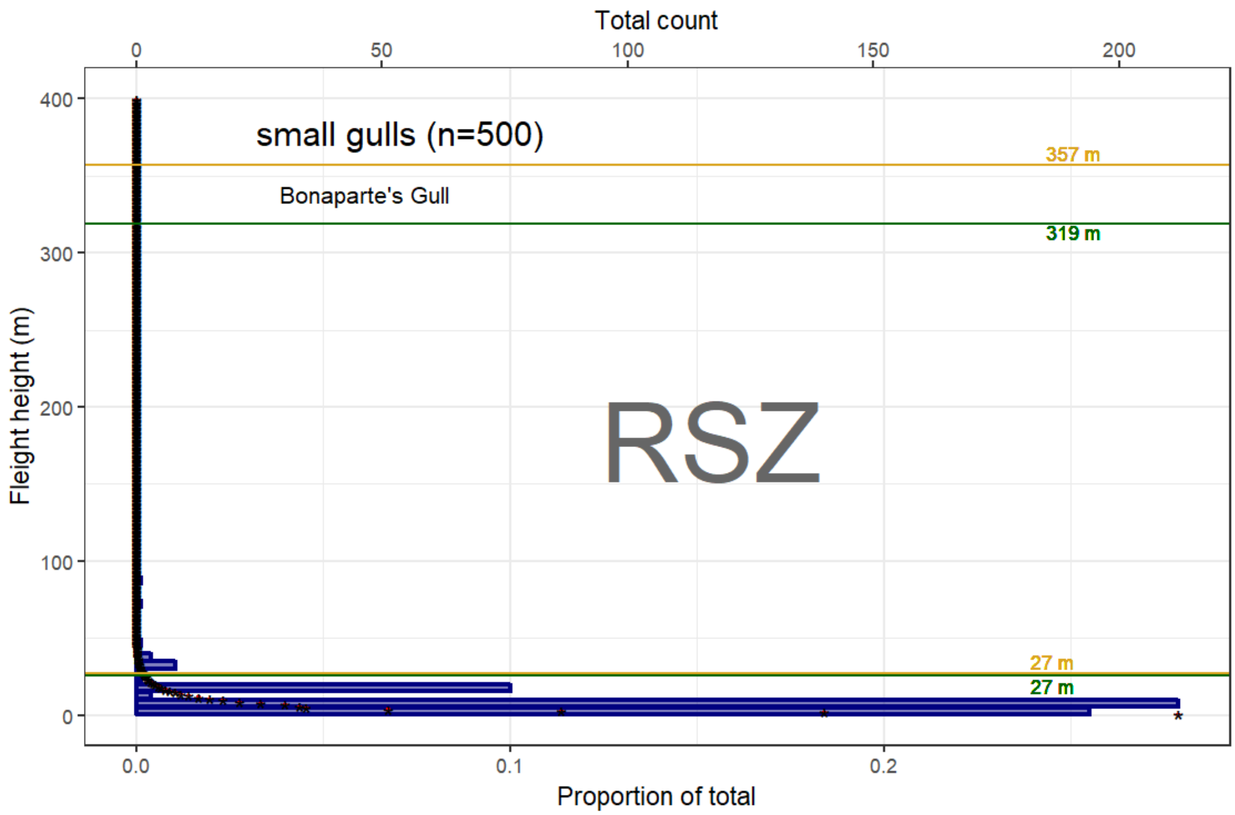



Figure 3-41: Flight heights of small gulls (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27–319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27–357 m [87-1171 ft])

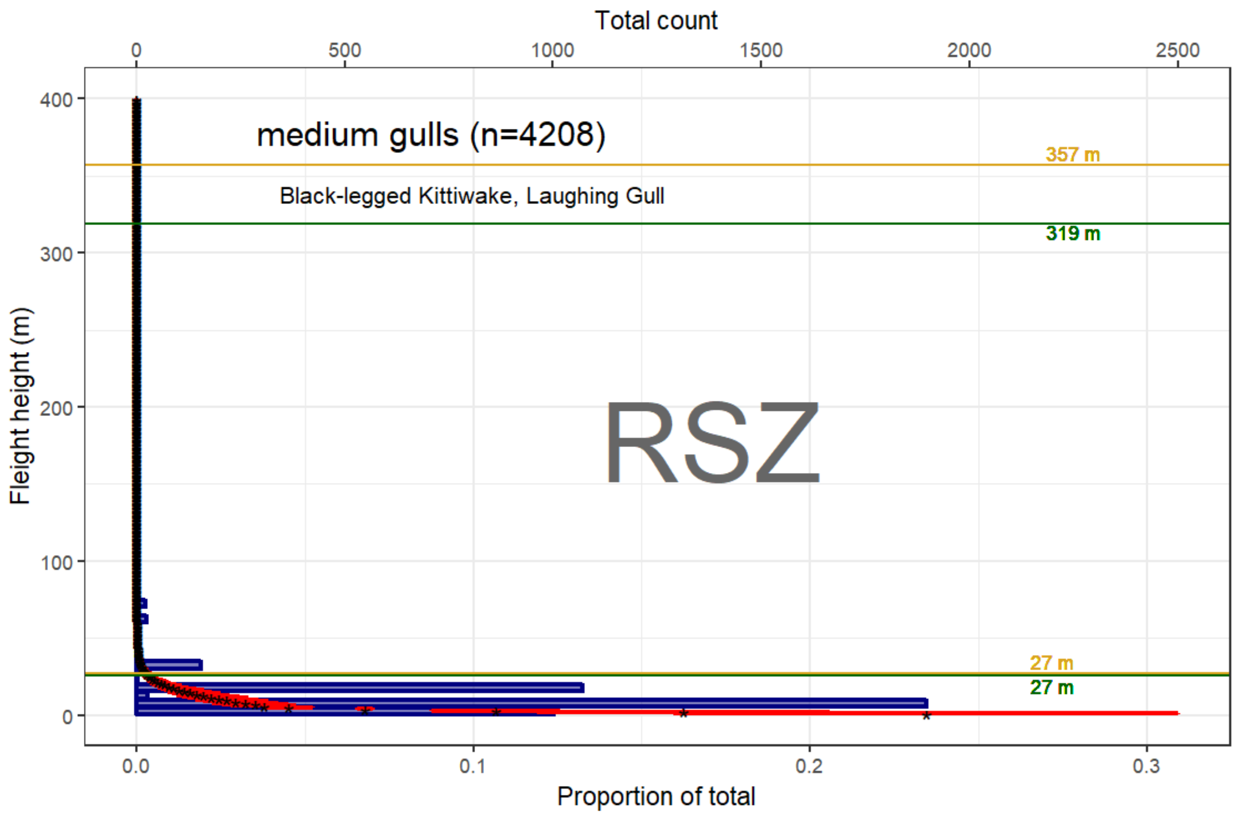



Figure 3-42: Flight heights of medium gulls (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27–319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27–357 m [87-1171 ft])

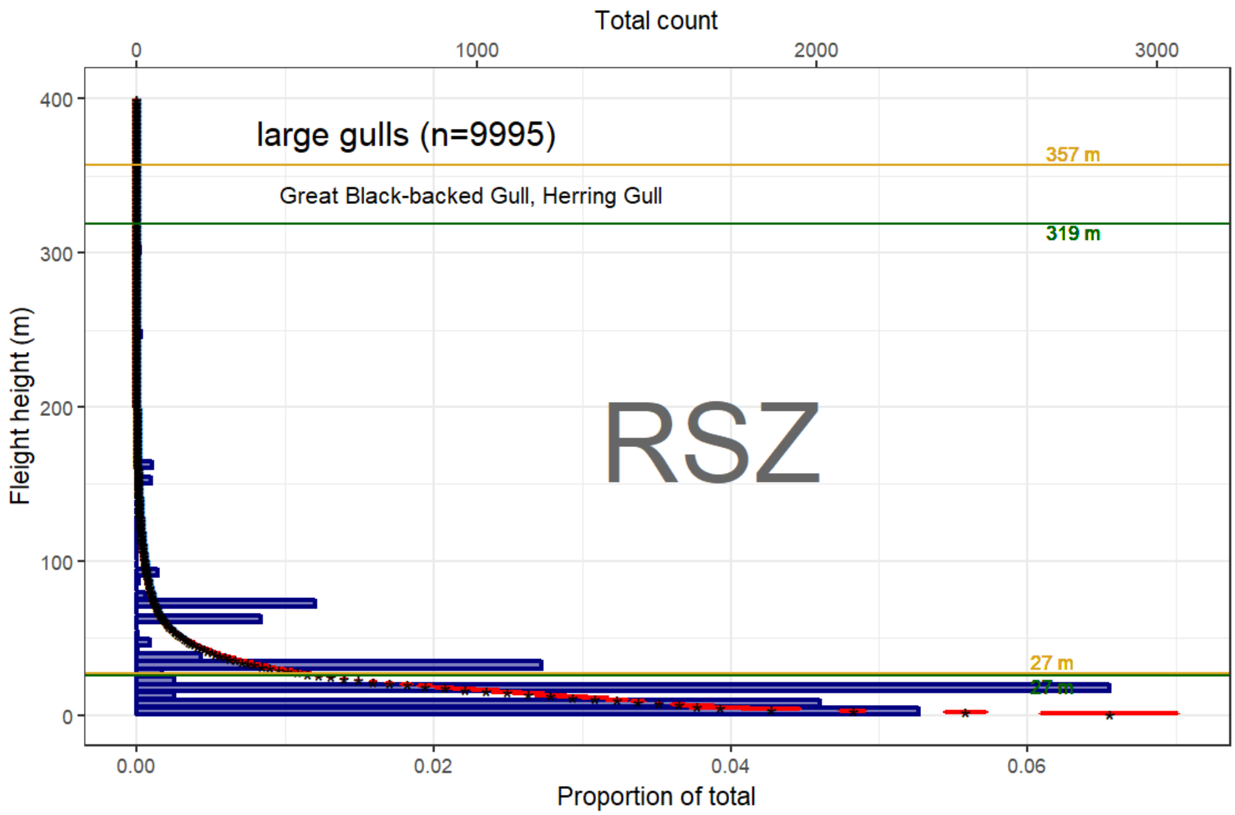



Figure 3-43: Flight heights of large gulls (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27–319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27–357 m [87-1171 ft])

Table 3-15: Summary of gull, skua, and jaeger vulnerability

| Species | Collision Vulnerability | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Pomarine Jaeger | potential (0.73) | potential (0.73) | unlikely (0.3) | unlikely (0.4) |
| Bonaparte's Gull | potential (0.5) | potential (0.5) | potential (0.5) | unlikely (0.33) |
| Black-legged Kittiwake | unlikely (0.43) | unlikely (0.43) | potential (0.6) | unlikely (0.33) |
| Laughing Gull | unlikely (0.47) | unlikely (0.47) | potential (0.5) | unlikely (0.4) |
| Great Black-backed Gull | potential (0.63) | potential (0.63) | potential (0.7) | insignificant (0.2) |
| Herring Gull | potential (0.7) | potential (0.7) | potential (0.5) | potential (0.53) |

### 3.2.6 Terns

#### *3.2.6.1 Exposure Tables, Maps, and Figures*

Table 3-16: Seasonal exposure rankings for tern

| Small Terns | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Least Tern | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| | Spring | 0 | · | 0 | insignificant |

| Medium Terns | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Arctic Tern | Fall | 0 | · | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Spring | 0 | · | 0 | insignificant |
| Bridled Tern | Spring | 0 | · | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| Common Tern | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 1 | 1 | unlikely |
| | Winter | 0 | · | 0 | insignificant |
| Roseate Tern | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 2 | 2 | unlikely |
| | Winter | 0 | · | 0 | insignificant |
| | Spring | 0 | 1 | 1 | unlikely |
| Royal Tern | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 0 | · | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| Sooty Tern | Winter | 0 | · | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | · | 0 | insignificant |

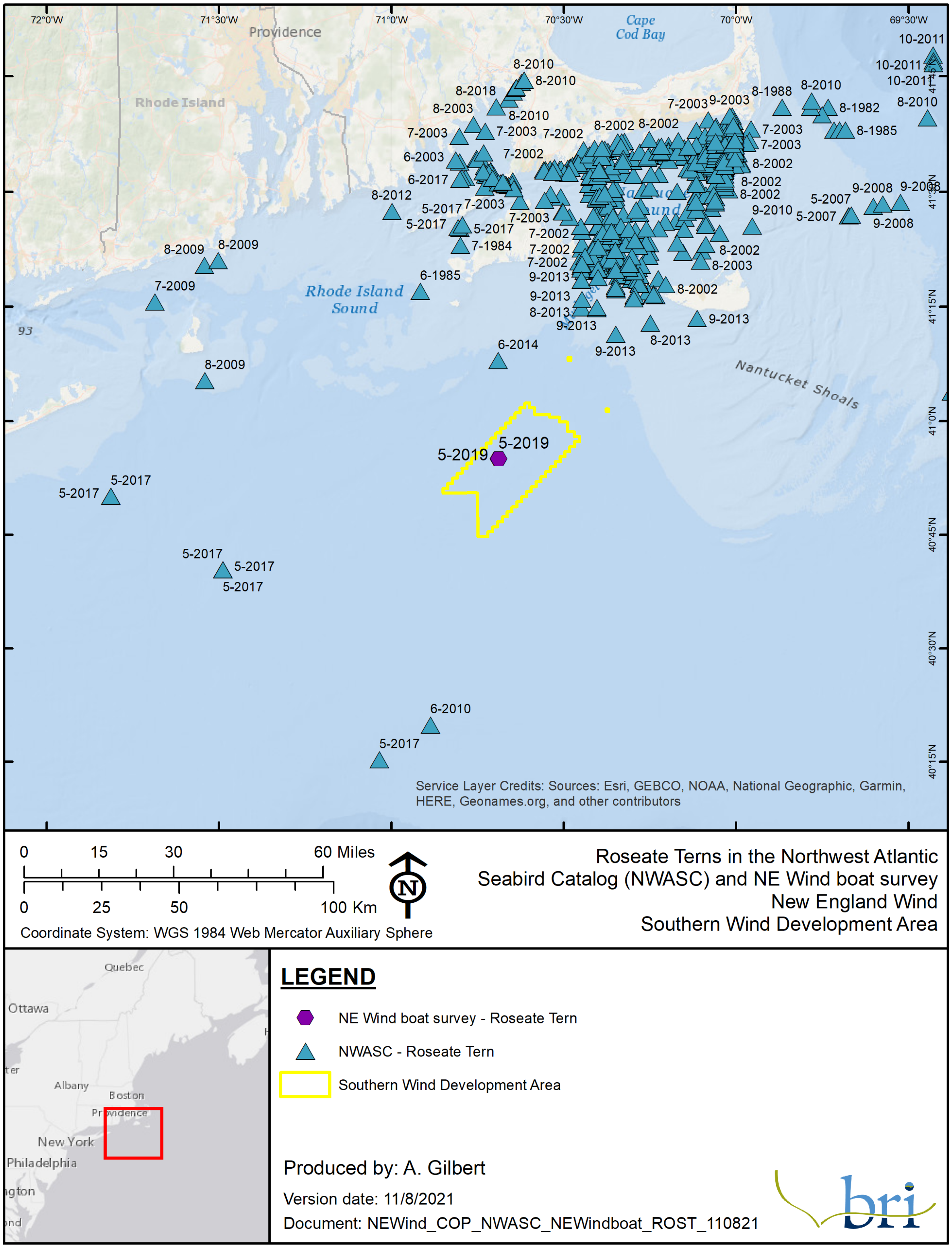



Figure 3-44: Roseate tern observations from the Northwest Atlantic Seabird Catalog and NE Wind boat surveys

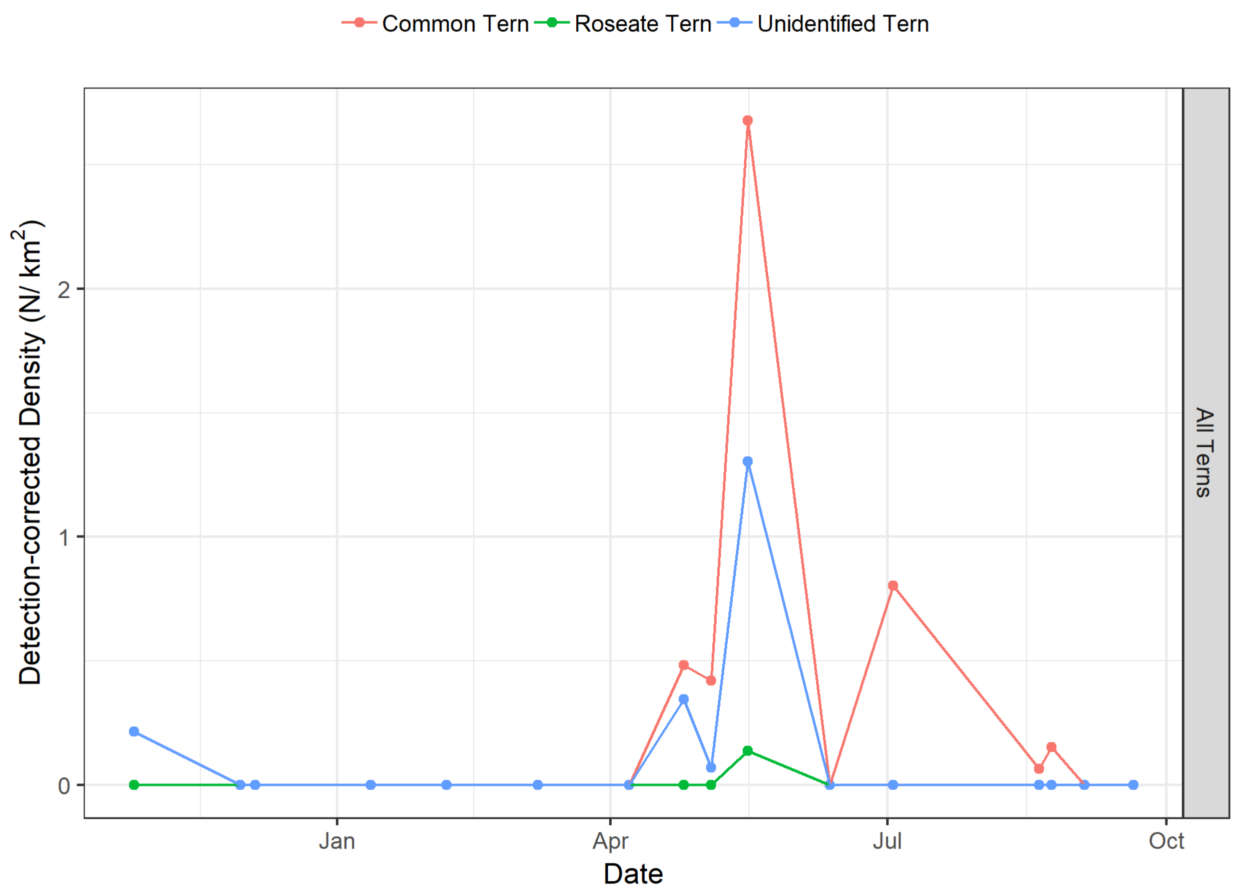



Figure 3-45: Detection-corrected density estimates from the NE Wind boat surveys for terns in the study area

### *3.2.6.2 Behavioral Vulnerability Figures and Tables*

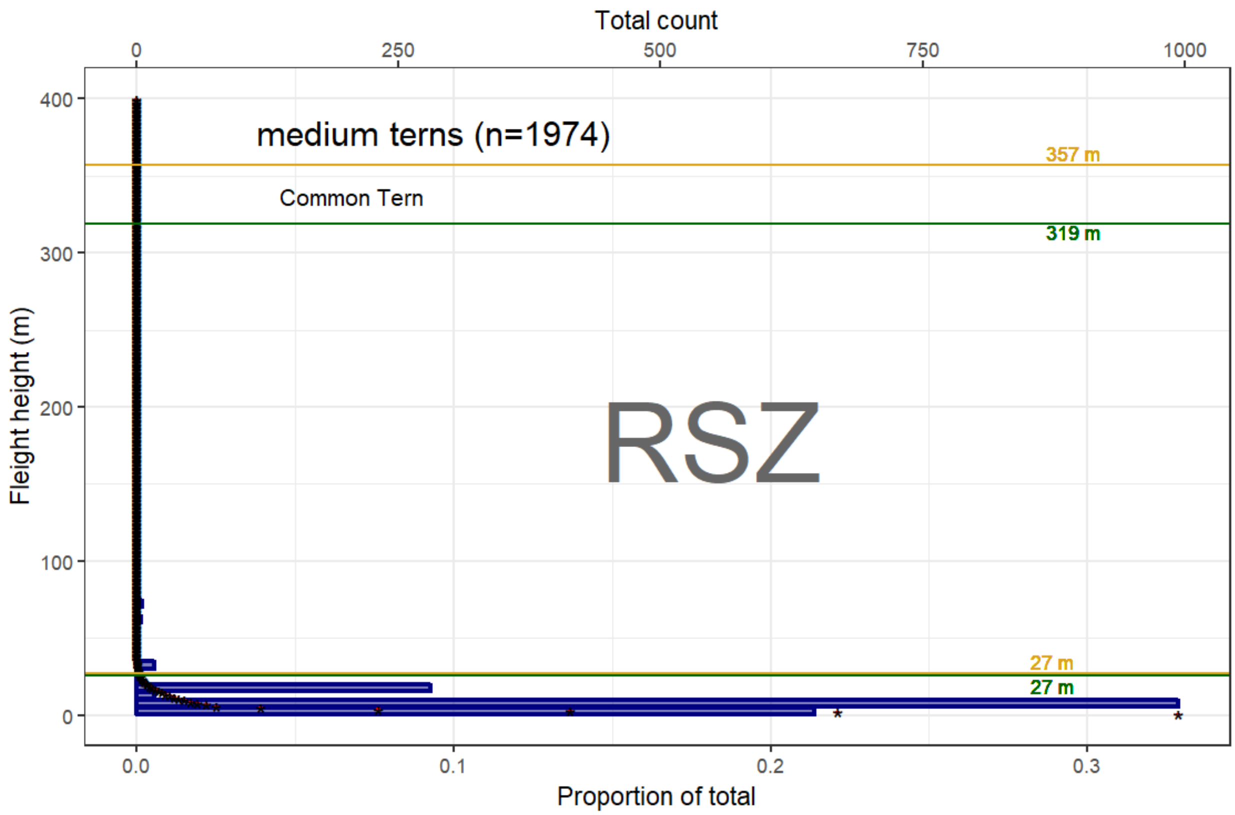



Figure 3-46: Flight heights of terns (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27–319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27–357 m [87-1171 ft])

Table 3-17: Summary of tern vulnerability; based upon the literature on terns, collision and displacement vulnerability were adjusted to include a lower range limit (green)

| Species | Collision Vulnerability | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Common Tern | unlikely (0.33) | unlikely (0.33) | potential - likely (0.8) | potential (0.6) |
| Roseate Tern | . | . | potential - likely (0.8) | likely (0.87) |

### 3.2.6.3 *Federally Endangered Tern Species*

#### 3.2.6.3.1 Roseate Tern

#### 3.2.6.3.2 Exposure Tables, Maps, and Figures

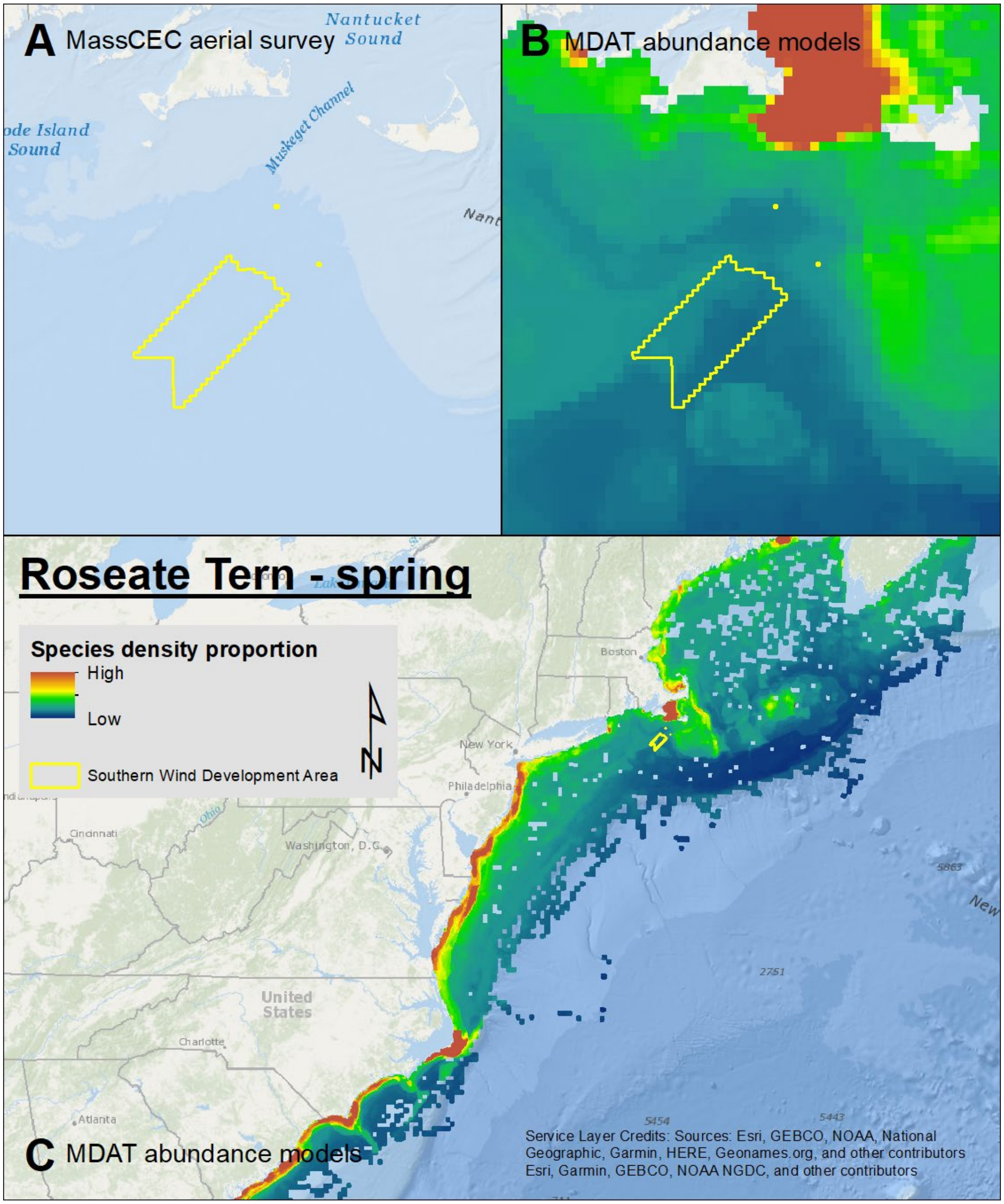



Figure 3-47: Spring roseate tern density proportions in the MassCEC aerial survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data source

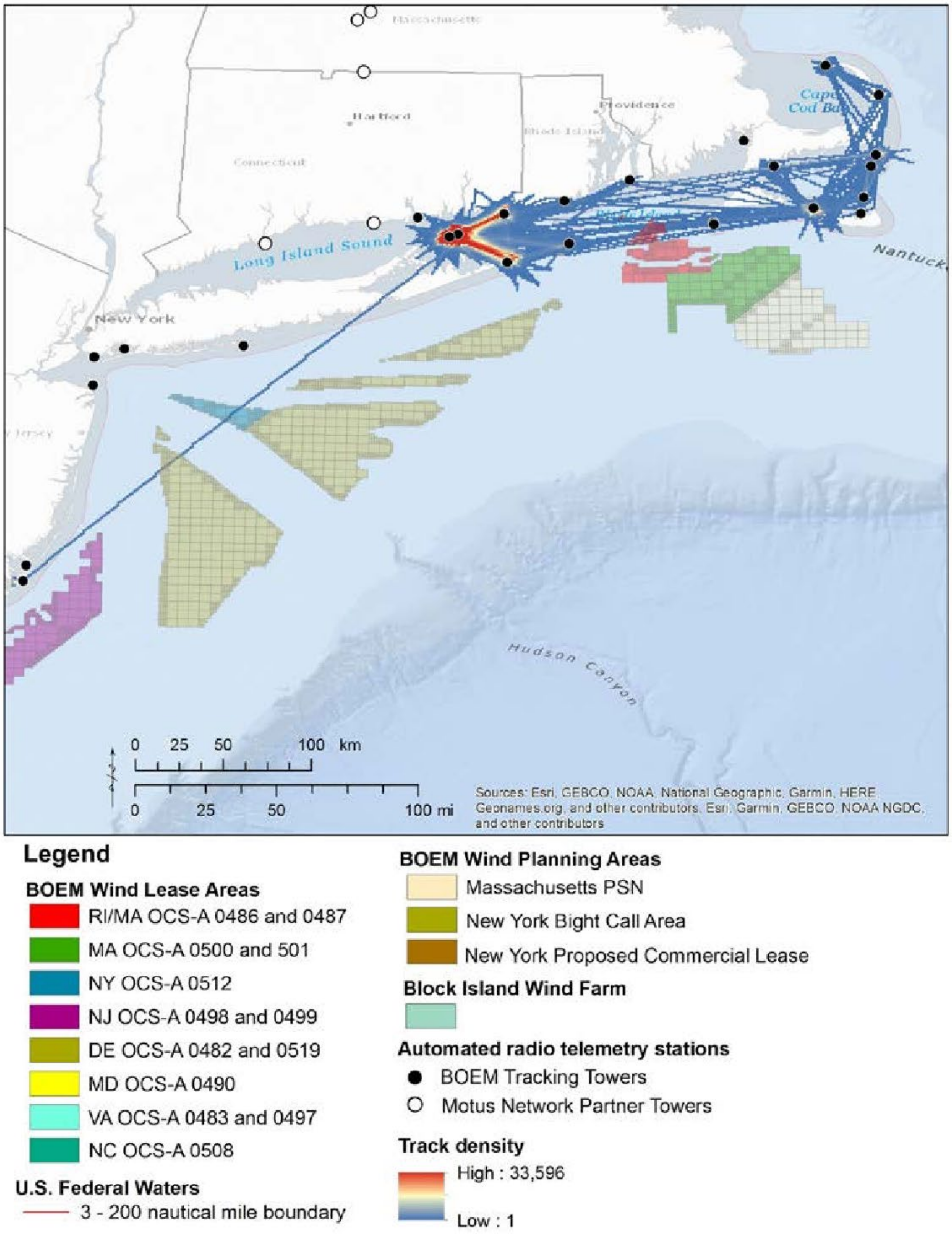



Figure 3-48: Track densities of roseate terns (n=90) tracked with nanotags from Great Gull Island during the breeding and post-breeding period from 2015–2017 (Loring et al. 2019)

### 3.2.6.3.3 Relative Behavioral Vulnerability Figures and Tables

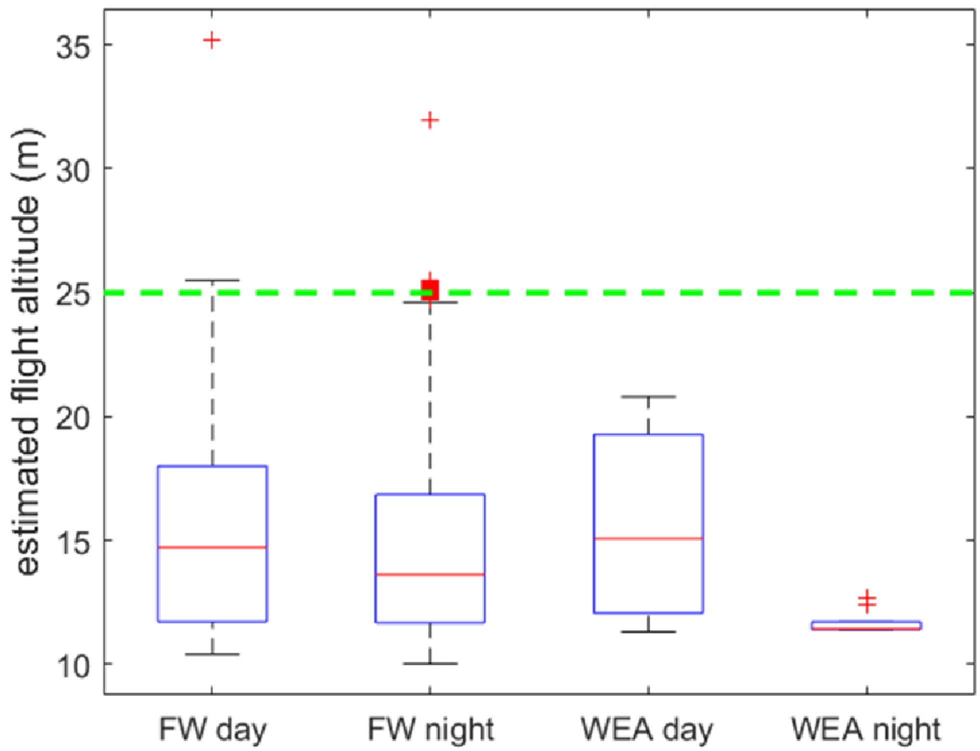



Figure 3-49: Model-estimated flight altitude ranges (m) of roseate terns. During exposure to Federal waters and Atlantic OCS WEAs during day and night. The green-dashed line represents the lower limit of the RSZ (25 m [82 ft]) (from Loring et al. [2019])

## 3.2.7 Auks

### *3.2.7.1 Exposure Tables, Maps, and Figures*

Table 3-18: Seasonal exposure rankings for auks

| Auks | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Atlantic Puffin | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| Black Guillemot | Winter | 0 | · | 0 | insignificant |
| | Spring | 0 | · | 0 | insignificant |
| | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | · | 0 | insignificant |
| Common Murre | Summer | 0 | · | 0 | insignificant |
| | Fall | 0 | · | 0 | insignificant |
| | Winter | 1 | 1 | 2 | unlikely |
| | Spring | 0 | 0 | 0 | insignificant |

| Auks | Season | Local Rank | Regional Rank | Total Rank | Exposure Score |
|---|---|---|---|---|---|
| Dovekie | Summer | 0 | 0 | 0 | insignificant |
| | Fall | 0 | 0 | 0 | insignificant |
| | Winter | 1 | 0 | 1 | unlikely |
| | Spring | 0 | 0 | 0 | insignificant |
| Razorbill | Fall | 0 | 1 | 1 | unlikely |
| | Winter | 0 | 2 | 2 | unlikely |
| | Spring | 0 | 3 | 3 | potential |
| | Summer | 0 | 0 | 0 | insignificant |
| Thick-billed Murre | Fall | 0 | · | 0 | insignificant |
| | Winter | 0 | 0 | 0 | insignificant |
| | Spring | 0 | 0 | 0 | insignificant |
| | Summer | 0 | · | 0 | insignificant |

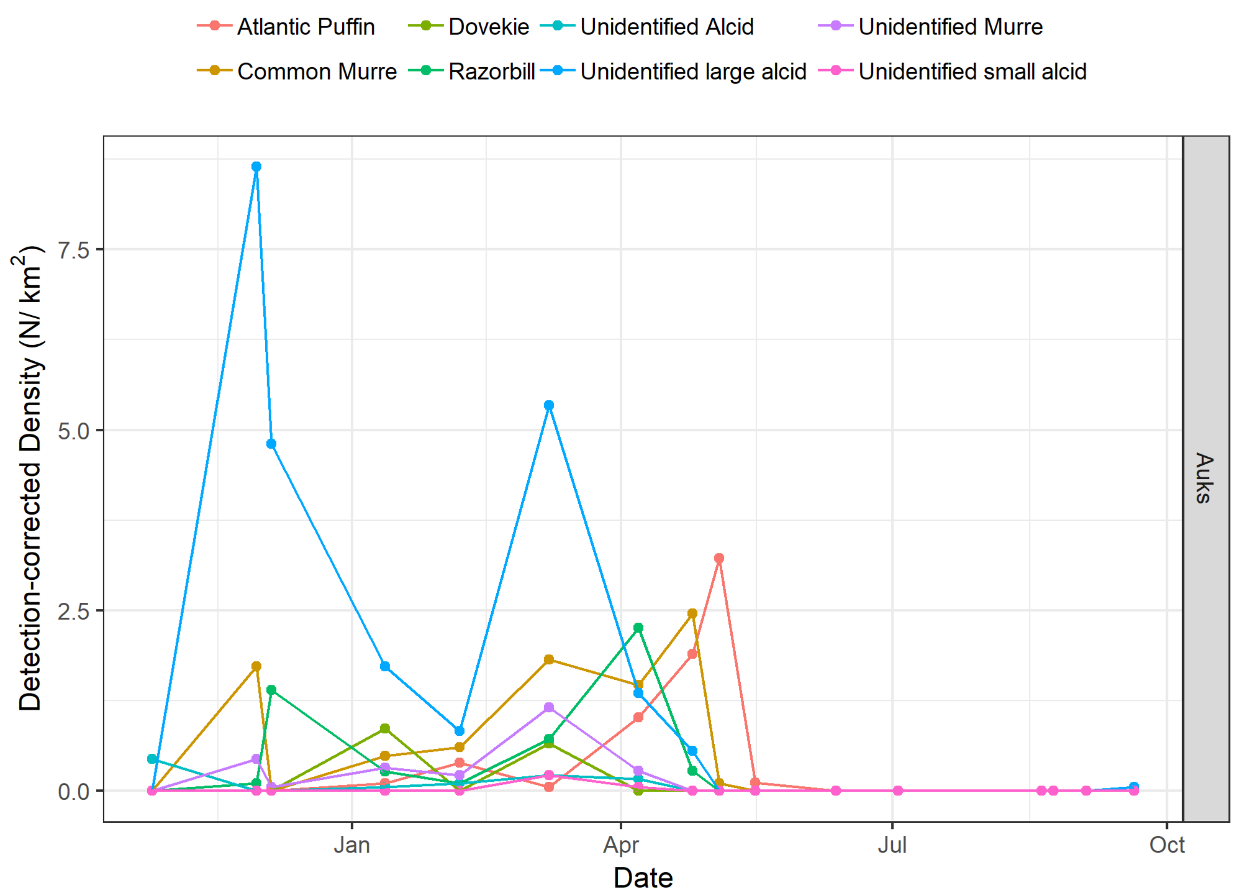



Figure 3-50: Detection-corrected density estimates from the NE Wind boat surveys for auks in the study area

### 3.2.7.2 Relative Behavioral Vulnerability Figures and Tables

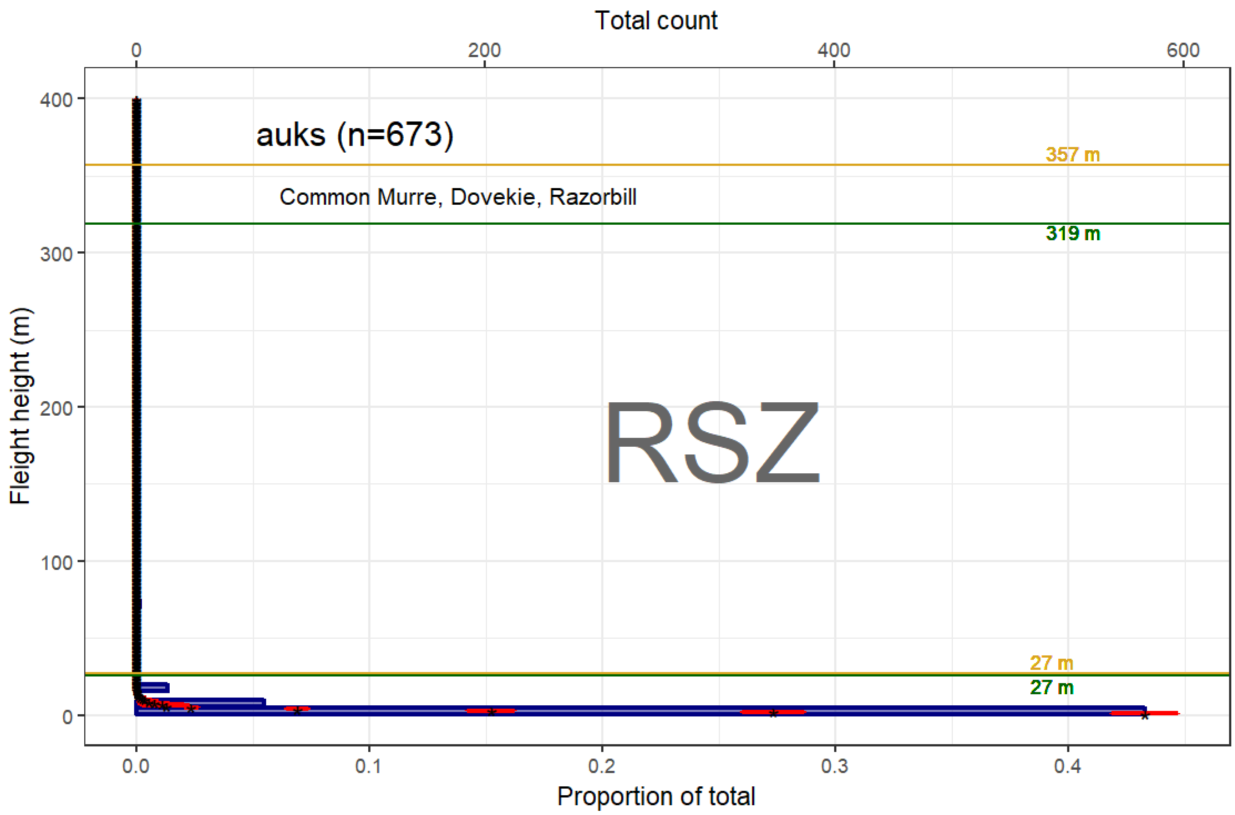



Figure 3-51: Flight heights of auks (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the RSZ for a 16 MW WTG (Phase 1, green: 27-319 m [87-1047 ft]) and a 19 MW WTG (Phase 2, gold: 27-357 m [87-1171 ft])

Table 3-19: Summary of auk vulnerability

| Species | Collision Vulnerability | | DV | PV |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | | |
| Common Murre | insignificant (0.23) | insignificant (0.23) | likely (0.8) | unlikely (0.4) |
| Dovekie | unlikely (0.3) | unlikely (0.3) | potential (0.7) | unlikely (0.4) |
| Razorbill | insignificant (0.2) | insignificant (0.2) | likely (0.8) | potential (0.6) |

Table 3-20: From the MassCEC aerial survey, seasonal species densities (total count/sq. km) in the SWDA and the entire MassCEC aerial survey area within the Atlantic OCS (these data are only for marine birds and are supplemental to the annual counts detailed in Part 3: Birds – Offshore)

| Species | Mean density (total count/sq. km) | | | | | | | | | | Total count |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Southern Wind Development Area | | | | | MassCEC aerial survey area | | | | | |
| | annual | winter | spring | summer | fall | annual | winter | spring | summer | fall | |
| Ducks, Geese, and Swans | | | | | | | | | | | |
| Brant | 0 | 0 | 0 | 0 | 0 | <0.001 | 0 | 0 | 0 | 0.002 | 1 |
| Unidentified Duck | 0 | 0 | 0 | 0 | 0 | <0.001 | <0.001 | <0.001 | 0 | 0 | 2 |
| Sea Ducks | | | | | | | | | | | |
| Common Eider | 0 | 0 | 0 | 0 | 0 | 0.004 | 0.017 | 0.005 | 0 | <0.001 | 14 |
| Surf Scoter | 0 | 0 | 0 | 0 | 0 | 0.036 | 0.140 | 0.028 | 0 | 0.011 | 17 |
| White-winged Scoter | 0.002 | 0.011 | 0 | 0 | 0 | 2.390 | 2.774 | 9.159 | 0 | 0.339 | 1043 |
| Black Scoter | 0 | 0 | 0 | 0 | 0 | 0.013 | 0.052 | 0 | 0 | 0.010 | 24 |
| Long-tailed Duck | 0.011 | 0 | 0.056 | 0 | 0 | 1.208 | 1.760 | 4.646 | 0 | 0.001 | 496 |
| Red-breasted Merganser | 0 | 0 | 0 | 0 | 0 | <0.001 | 0.001 | 0 | 0 | 0 | 1 |
| Common Eider | . | . | . | . | . | . | . | . | . | . | 14 |
| Surf Scoter | . | . | . | . | . | . | . | . | . | . | 17 |
| White-winged Scoter | . | . | . | . | . | . | . | . | . | . | 1043 |
| Black Scoter | . | . | . | . | . | . | . | . | . | . | 24 |
| Long-tailed Duck | . | . | . | . | . | . | . | . | . | . | 496 |
| Unidentified Dark scoter - black or surf | 0 | 0 | 0 | 0 | 0 | <0.001 | 0.002 | 0 | 0 | 0 | 1 |
| Unidentified Scoter | 0 | 0 | 0 | 0 | 0 | 0.090 | 0.413 | 0.018 | 0 | 0.009 | 44 |
| Unidentified Scoter | . | . | . | . | . | . | . | . | . | . | 44 |
| Shorebirds | | | | | | | | | | | |
| Ruddy Turnstone | . | . | . | . | . | . | . | . | . | . | . |
| Semipalmated Sandpiper | . | . | . | . | . | . | . | . | . | . | . |
| Unidentified peep | . | . | . | . | . | . | . | . | . | . | . |
| Unidentified shorebird | . | . | . | . | . | . | . | . | . | . | . |
| Unidentified small shorebird | . | . | . | . | . | . | . | . | . | . | . |

| Species | Mean density (total count/sq. km) | | | | | | | | | | Total count |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Southern Wind Development Area | | | | | MassCEC aerial survey area | | | | | |
| | annual | winter | spring | summer | fall | annual | winter | spring | summer | fall | |
| Phalaropes | | | | | | | | | | | |
| Red Phalarope | <0.001 | 0 | 0 | 0 | 0.003 | 0.005 | 0 | 0.027 | 0 | <0.001 | 6 |
| Unidentified Phalarope | 0.222 | 0 | 1.081 | 0.066 | 0 | 0.059 | 0.013 | 0.201 | 0.014 | 0.059 | 77 |
| Unidentified Phalarope | . | . | . | . | . | . | . | . | . | . | 77 |
| Skuas and Jaegers | | | | | | | | | | | |
| Pomarine Jaeger | 0 | 0 | 0 | 0 | 0 | <0.001 | 0 | 0 | 0 | <0.001 | 1 |
| Unidentified Jaeger | <0.001 | 0 | 0 | 0.004 | 0 | <0.001 | 0 | <0.001 | <0.001 | 0.001 | 4 |
| Unidentified Skua | 0 | 0 | 0 | 0 | 0 | <0.001 | 0 | <0.001 | 0 | 0 | 1 |
| Pomarine Jaeger | . | . | . | . | . | . | . | . | . | . | 1 |
| Unidentified Jaeger | . | . | . | . | . | . | . | . | . | . | 4 |
| Auks | | | | | | | | | | | |
| Dovekie | 0.002 | 0.010 | 0 | 0 | 0 | 0.002 | 0.005 | 0.002 | 0 | 0 | 16 |
| Common Murre | 0.002 | 0.012 | 0 | 0 | 0 | 0.002 | 0.007 | 0.002 | 0 | 0 | 19 |
| Razorbill | 0.505 | 1.925 | 0.863 | 0 | 0.003 | 0.671 | 1.910 | 1.333 | 0 | 0.015 | 1103 |
| Unidentified Alcid | 0 | 0 | 0 | 0 | 0 | 0.003 | 0.013 | 0.002 | 0 | 0 | 19 |
| Unidentified large alcid (Razorbill or Murre) | 0.013 | 0.031 | 0.029 | 0 | 0.003 | 0.031 | 0.041 | 0.119 | 0 | 0.002 | 130 |
| Unidentified Murre | 0 | 0 | 0 | 0 | 0 | <0.001 | 0.001 | 0 | 0 | 0 | 3 |
| Unidentified small alcid (Puffin/Dovekie) | 0 | 0 | 0 | 0 | 0 | <0.001 | <0.001 | 0.002 | 0 | 0 | 6 |
| Dovekie | . | . | . | . | . | . | . | . | . | . | 16 |
| Common Murre | . | . | . | . | . | . | . | . | . | . | 19 |
| Razorbill | . | . | . | . | . | . | . | . | . | . | 1103 |
| Atlantic Puffin | . | . | . | . | . | . | . | . | . | . | . |
| Unidentified Alcid | . | . | . | . | . | . | . | . | . | . | 19 |
| Unidentified large alcid (Razorbill or Murre) | . | . | . | . | . | . | . | . | . | . | 130 |
| Unidentified Murre | . | . | . | . | . | . | . | . | . | . | 3 |
| Unidentified small alcid (Puffin/Dovekie) | . | . | . | . | . | . | . | . | . | . | 6 |
| Small Gulls | | | | | | | | | | | |
| Bonaparte's Gull | 0.024 | 0.117 | 0 | 0 | 0 | 0.030 | 0.120 | 0.016 | 0 | 0.010 | 124 |

| Species | Mean density (total count/sq. km) | | | | | | | | | | Total count |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Southern Wind Development Area | | | | | MassCEC aerial survey area | | | | | |
| | annual | winter | spring | summer | fall | annual | winter | spring | summer | fall | |
| Unidentified small gull | <0.001 | 0 | 0.004 | 0 | 0 | 0.015 | 0.054 | 0.006 | 0 | 0.011 | 40 |
| Sabine's Gull | · | · | · | · | · | · | · | · | · | · | · |
| Bonaparte's Gull | · | · | · | · | · | · | · | · | · | · | 124 |
| Unidentified small gull | · | · | · | · | · | · | · | · | · | · | 40 |
| Medium Gulls | | | | | | | | | | | |
| Black-legged Kittiwake | 0.258 | 0.399 | 0.056 | 0 | 0.192 | 0.130 | 0.471 | 0.049 | 0 | 0.068 | 468 |
| Laughing Gull | <0.001 | 0 | 0 | 0 | 0.003 | <0.001 | 0 | 0 | <0.001 | <0.001 | 3 |
| Black-legged Kittiwake | · | · | · | · | · | · | · | · | · | · | 468 |
| Laughing Gull | · | · | · | · | · | · | · | · | · | · | 3 |
| Ring-billed Gull | · | · | · | · | · | · | · | · | · | · | · |
| Large Gulls | | | | | | | | | | | |
| Herring Gull | 0.085 | 0.033 | 0.066 | 0.275 | 0.024 | 0.088 | 0.183 | 0.140 | 0.055 | 0.047 | 429 |
| Great Black-backed Gull | 0.010 | 0.019 | 0.012 | 0.008 | 0.009 | 0.028 | 0.056 | 0.029 | 0.027 | 0.014 | 222 |

Table 3-21: Mean monthly detection-corrected densities and 95% CI calculated using the CDM for the NE Wind annual boat survey results.

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ducks, Geese, and Swans | | | | | | | | | | | | |
| Unidentified duck | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.470 |
| | . | . | . | . | . | . | . | . | . | . | . | (0.251-0.881) |
| Sea Ducks | | | | | | | | | | | | |
| Black Scoter | 0 | 0 | 0.036 | 0 | 0 | 0 | 0 | 0 | 0 | 0.363 | 0 | 0.036 |
| | . | . | (0.025-0.054) | . | . | . | . | . | . | (0.252-0.528) | . | (0.026-0.052) |
| Common Eider | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.656 | 0 |
| | . | . | . | . | . | . | . | . | . | . | (0.460-0.938) | . |
| Long-tailed Duck | 0 | 0 | 1.930 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | . | . | (1.318-2.873) | . | . | . | . | . | . | . | . | . |
| Surf Scoter | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.146 | 0 |
| | . | . | . | . | . | . | . | . | . | . | (0.102-0.208) | . |
| Unidentified scoter | 0.257 | 0.219 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.580 | 0 | 0.073 |
| | (0.153-0.442) | (0.153-0.318) | . | . | . | . | . | . | . | (0.404-0.845) | . | (0.051-0.104) |
| White-winged Scoter | 0.331 | 0.401 | 0.328 | 0.200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.437 |
| | (0.197-0.568) | (0.280-0.582) | (0.224-0.488) | (0.139-0.287) | . | . | . | . | . | . | . | (0.306-0.623) |
| Shorebirds | | | | | | | | | | | | |
| Ruddy Turnstone | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.038 | 0 | 0 | 0 |
| | . | . | . | . | . | . | . | . | (0.024-0.072) | . | . | . |
| Semipalmated Sandpiper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.038 | 0 | 0 | 0 |
| | . | . | . | . | . | . | . | . | (0.024-0.072) | . | . | . |
| Unidentified peep | 0 | 0 | 0 | 0 | 0.795 | 0 | 0 | 0.047 | 0.168 | 0 | 0 | 0 |
| | . | . | . | . | (0.495-1.646) | . | . | (0.027-0.165) | (0.098-0.704) | . | . | . |
| Unidentified shorebird | 0 | 0 | 0 | 0 | 2.305 | 0 | 0 | 0 | 0.054 | 0 | 0 | 0 |
| | . | . | . | . | (1.437-4.775) | . | . | . | (0.027-0.489) | . | . | . |
| Unidentified small shorebird | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.163 | 0 | 0 | 0 |

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | . | . | . | . | . | . | . | . | (0.082-1.467) | . | . | . |
| Phalaropes | | | | | | | | | | | | |
| Unidentified phalarope | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.250 | 0 | 0 | 0 |
| | . | . | . | . | . | . | . | . | (0.110-0.639) | . | . | . |
| Skuas and Jaegers | | | | | | | | | | | | |
| Pomarine Jaeger | 0 | 0 | 0 | 0 | 0 | 0.063 | 0 | 0 | 0 | 0 | 0 | 0 |
| | . | . | . | . | . | (0.032-0.135) | . | . | . | . | . | . |
| Unidentified jaeger | 0 | 0 | 0 | 0 | 0 | 0 | 0.143 | 0 | 0.032 | 0 | 0 | 0 |
| | . | . | . | . | . | . | (0.062-0.473) | . | (0.016-0.071) | . | . | . |
| Auks | | | | | | | | | | | | |
| Atlantic Puffin | 0.108 | 0.388 | 0.055 | 1.459 | 1.669 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | (0.082-0.137) | (0.339-0.443) | (0.047-0.064) | (1.264-1.677) | (1.461-1.896) | . | . | . | . | . | . | . |
| Common Murre | 0.486 | 0.610 | 1.817 | 1.964 | 0.056 | 0 | 0 | 0 | 0 | 0 | 1.730 | 0 |
| | (0.370-0.617) | (0.533-0.696) | (1.555-2.101) | (1.701-2.260) | (0.049-0.063) | . | . | . | . | . | (1.515-1.965) | . |
| Dovekie | 0.865 | 0 | 0.661 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | (0.658-1.096) | . | (0.565-0.764) | . | . | . | . | . | . | . | . | . |
| Razorbill | 0.270 | 0.111 | 0.716 | 1.271 | 0 | 0 | 0 | 0 | 0 | 0 | 0.112 | 1.398 |
| | (0.206-0.343) | (0.097-0.127) | (0.613-0.828) | (1.084-1.485) | . | . | . | . | . | . | (0.098-0.127) | (1.224-1.592) |
| Unidentified auk | 0.054 | 0.111 | 0.220 | 0.085 | 0 | 0 | 0 | 0 | 0 | 0.442 | 0 | 0 |
| | (0.041-0.069) | (0.097-0.127) | (0.188-0.255) | (0.072-0.099) | . | . | . | . | . | (0.384-0.506) | . | . |
| Unidentified large auk (Razorbill/murre) | 1.729 | 0.832 | 5.341 | 0.958 | 0 | 0 | 0 | 0 | 0.027 | 0 | 8.648 | 4.810 |
| | (1.316-2.192) | (0.727-0.949) | (4.571-6.175) | (0.821-1.114) | . | . | . | . | (0.020-0.035) | . | (7.577-9.824) | (4.211-5.476) |
| Unidentified murre | 0.324 | 0.222 | 1.156 | 0.141 | 0 | 0 | 0 | 0 | 0 | 0 | 0.446 | 0.056 |
| | (0.247-0.411) | (0.194-0.253) | (0.990-1.337) | (0.120-0.166) | . | . | . | . | . | . | (0.391-0.507) | (0.049-0.064) |
| Unidentified small auk (Puffin/Dovekie) | 0 | 0 | 0.220 | 0.028 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | . | . | (0.188-0.255) | (0.024-0.033) | . | . | . | . | . | . | . | . |

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Small Gulls | | | | | | | | | | | | |
| Bonaparte's Gull | 0 | 0 | 0 | 0.041 | 0 | 0 | 0 | 0 | 0 | 0 | 0.844 | 0 |
| | . | . | . | (0.025-0.069) | . | . | . | . | . | . | (0.492-1.450) | . |
| Sabine's Gull | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.042 | 0 |
| | . | . | . | . | . | . | . | . | . | . | (0.025-0.072) | . |
| Unidentified small gull | 0 | 0 | 0 | 0.042 | 0 | 0 | 0 | 0 | 0 | 0 | 0.127 | 0.628 |
| | . | . | . | (0.025-0.071) | . | . | . | . | . | . | (0.074-0.217) | (0.372-1.062) |
| Medium Gulls | | | | | | | | | | | | |
| Black-legged Kittiwake | 3.400 | 1.950 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.150 | 5.273 |
| | (2.586-4.481) | (1.586-2.345) | . | . | . | . | . | . | . | . | (1.724-2.607) | (4.192-6.442) |
| Laughing Gull | 0 | 0 | 0 | 0.162 | 0.064 | 0 | 0 | 0.030 | 0.040 | 0.067 | 0 | 0 |
| | . | . | . | (0.129-0.197) | (0.051-0.078) | . | . | (0.023-0.039) | (0.029-0.054) | (0.055-0.081) | . | . |
| Ring-billed Gull | 0 | 0 | 0 | 0.065 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | . | . | . | (0.052-0.079) | . | . | . | . | . | . | . | . |
| Large Gulls | | | | | | | | | | | | |
| Great Black-backed Gull | 0.291 | 0.295 | 0.308 | 0.447 | 0.889 | 0.870 | 0.305 | 0.258 | 0.628 | 0.295 | 0.282 | 0.332 |
| | (0.230-0.438) | (0.258-0.350) | (0.266-0.378) | (0.387-0.518) | (0.780-1.028) | (0.749-1.012) | (0.264-0.371) | (0.220-0.316) | (0.537-0.760) | (0.258-0.350) | (0.248-0.327) | (0.292-0.383) |
| Herring Gull | 0.073 | 0.177 | 0.123 | 0.707 | 2.400 | 0.205 | 0.366 | 1.276 | 1.900 | 1.240 | 0.452 | 0.443 |
| | (0.057-0.109) | (0.155-0.210) | (0.106-0.151) | (0.617-0.818) | (2.106-2.786) | (0.176-0.238) | (0.317-0.445) | (1.087-1.574) | (1.535-2.711) | (1.084-1.468) | (0.397-0.523) | (0.389-0.511) |
| Unidentified large gull | 0.146 | 0.473 | 0 | 0 | 0.305 | 0 | 0 | 0.032 | 0.823 | 0 | 0.169 | 1.053 |
| | (0.115-0.219) | (0.413-0.560) | . | . | (0.268-0.353) | . | . | (0.027-0.042) | (0.634-1.312) | . | (0.149-0.196) | (0.924-1.214) |
| All Gulls | | | | | | | | | | | | |
| Unidentified gull | 0.073 | 0.118 | 0 | 0.051 | 0.143 | 0 | 0 | 0 | 0 | 0.177 | 0 | 0 |
| | (0.057-0.109) | (0.103-0.140) | . | (0.044-0.060) | (0.125-0.166) | . | . | . | . | (0.155-0.210) | . | . |
| Medium Terns | | | | | | | | | | | | |
| Common Tern | 0 | 0 | 0 | 0.242 | 1.548 | 0 | 0.805 | 0.109 | 0 | 0 | 0 | 0 |
| | . | . | . | (0.180-0.357) | (1.153-2.276) | . | (0.564-1.355) | (0.073-0.192) | . | . | . | . |
| Roseate Tern | 0 | 0 | 0 | 0 | 0.069 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | . | . | . | . | (0.051-0.100) | . | . | . | . | . | . | . |
| All Terns | | | | | | | | | | | | |
| Unidentified tern | 0 | 0 | 0 | 0.173 | 0.687 | 0 | 0 | 0 | 0 | 0.214 | 0 | 0 |
| | . | . | . | (0.128-0.255) | (0.512-1.006) | . | . | . | . | (0.154-0.340) | . | . |
| Loons | | | | | | | | | | | | |
| Common Loon | 0 | 0 | 0 | 0.026 | 0.026 | 0 | 0 | 0 | 0 | 0 | 0.052 | 0 |
| | . | . | . | (0.016-0.041) | (0.016-0.040) | . | . | . | . | . | (0.033-0.083) | . |
| Red-throated Loon | 0 | 0 | 0.110 | 0.078 | 0.026 | 0 | 0 | 0 | 0 | 0.053 | 0.052 | 0.258 |
| | . | . | (0.064-0.189) | (0.049-0.123) | (0.016-0.040) | . | . | . | . | (0.032-0.087) | (0.033-0.083) | (0.163-0.406) |
| Unidentified loon | 0.061 | 0 | 0 | 0 | 0.026 | 0 | 0 | 0 | 0 | 0 | 0.157 | 0 |
| | (0.029-0.137) | . | . | . | (0.016-0.042) | . | . | . | . | . | (0.098-0.248) | . |
| Storm-Petrels | | | | | | | | | | | | |
| Wilson's Storm-Petrel | 0 | 0 | 0 | 0.090 | 1.508 | 25.389 | 44.635 | 1.761 | 3.071 | 0 | 0 | 0 |
| | . | . | . | (0.083-0.103) | (1.372-1.743) | (22.568-28.130) | (38.785-60.593) | (1.559-1.983) | (2.485-5.333) | . | . | . |
| Shearwaters and Petrels | | | | | | | | | | | | |
| Cory's Shearwater | 0 | 0 | 0 | 0 | 0 | 1.526 | 0.552 | 1.520 | 3.861 | 0.792 | 0 | 0 |
| | . | . | . | . | . | (1.359-1.705) | (0.504-0.603) | (1.368-1.686) | (3.458-4.294) | (0.724-0.864) | . | . |
| Great Shearwater | 0 | 0 | 0 | 0 | 0 | 4.402 | 1.595 | 3.895 | 11.656 | 0.426 | 0 | 0 |
| | . | . | . | . | . | (3.922-4.919) | (1.457-1.743) | (3.514-4.310) | (10.289-13.178) | (0.390-0.465) | . | . |
| Manx Shearwater | 0 | 0 | 0 | 0 | 0.060 | 0 | 0 | 0 | 0 | 0.122 | 0 | 0 |
| | . | . | . | . | (0.055-0.066) | . | . | . | . | (0.111-0.133) | . | . |
| Northern Fulmar | 0 | 0 | 0 | 0 | 0.060 | 0 | 0 | 0 | 0.130 | 0.061 | 0 | 0.120 |
| | . | . | . | . | (0.054-0.066) | . | . | . | (0.112-0.150) | (0.056-0.066) | . | (0.109-0.131) |
| Sooty Shearwater | 0 | 0 | 0 | 0 | 0 | 1.350 | 0 | 0.029 | 0 | 0 | 0 | 0 |
| | . | . | . | . | . | (1.203-1.509) | . | (0.026-0.033) | . | . | . | . |
| Unidentified large shearwater | 0 | 0 | 0 | 0 | 0 | 0.352 | 0 | 0.187 | 0.876 | 0 | 0 | 0 |
| | . | . | . | . | . | (0.314-0.394) | . | (0.170-0.206) | (0.768-0.998) | . | . | . |

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unidentified shearwater | 0 | 0 | 0 | 0 | 0 | 0.059 | 0.061 | 0 | 0 | 0.305 | 0 | 0 |
| | . | . | . | . | . | (0.052-0.066) | (0.056-0.067) | . | . | (0.278-0.332) | . | . |
| Gannet | | | | | | | | | | | | |
| Northern Gannet | 2.305 | 0.120 | 0 | 2.752 | 1.314 | 0 | 0.081 | 0 | 0.107 | 2.556 | 4.352 | 2.491 |
| | (1.695-3.312) | (0.100-0.147) | . | (2.299-3.341) | (1.106-1.592) | . | (0.067-0.101) | . | (0.079-0.156) | (2.135-3.145) | (3.666-5.270) | (2.099-3.006) |
| Cormorants | | | | | | | | | | | | |
| Double-crested Cormorant | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.024 | 0 | 0 | 0 | 0 |
| | . | . | . | . | . | . | . | (0.009-0.071) | . | . | . | . |
| Unidentified cormorant | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.028 | 0 | 0 |
| | . | . | . | . | . | . | . | . | . | (2.549-14.453) | . | . |

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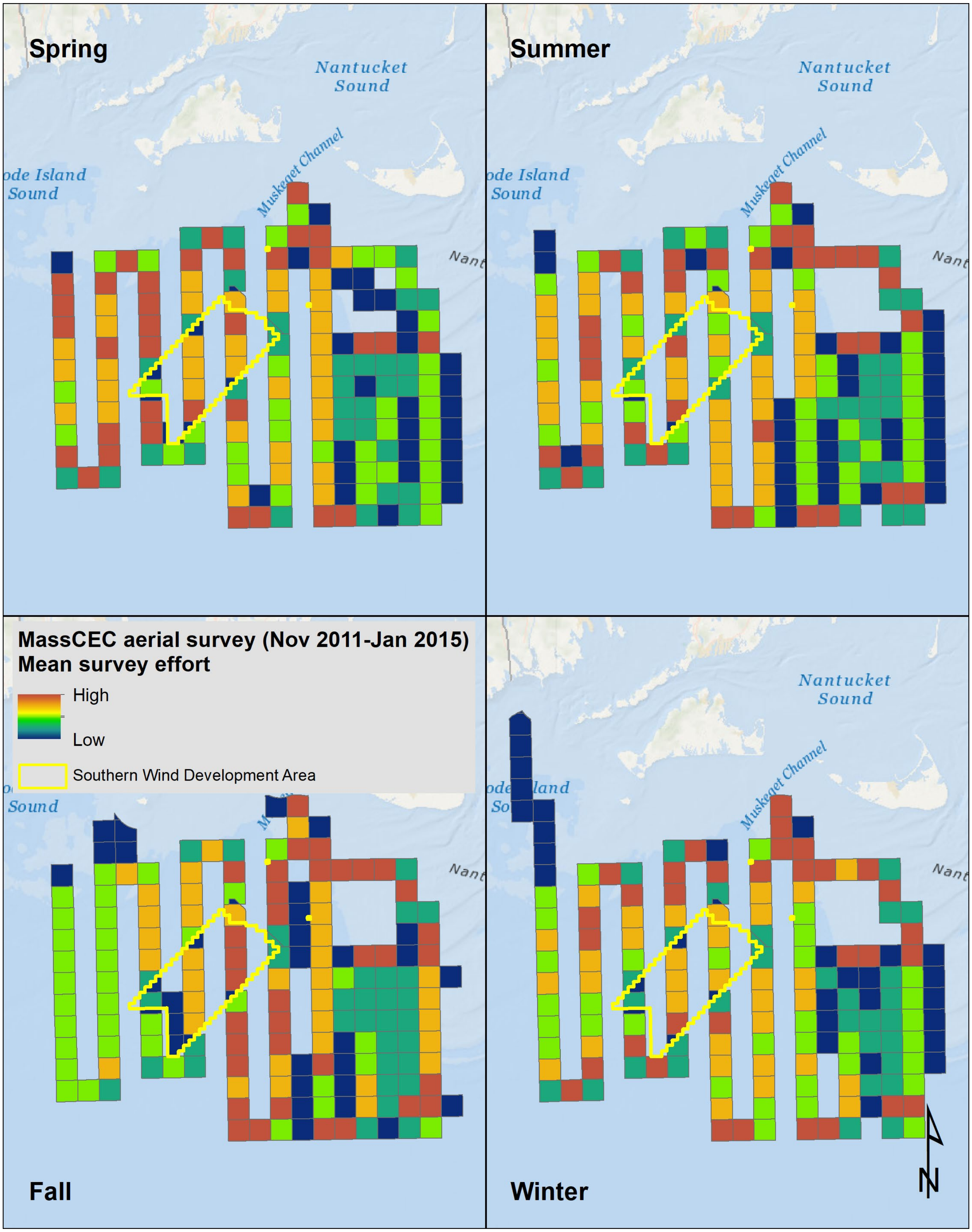
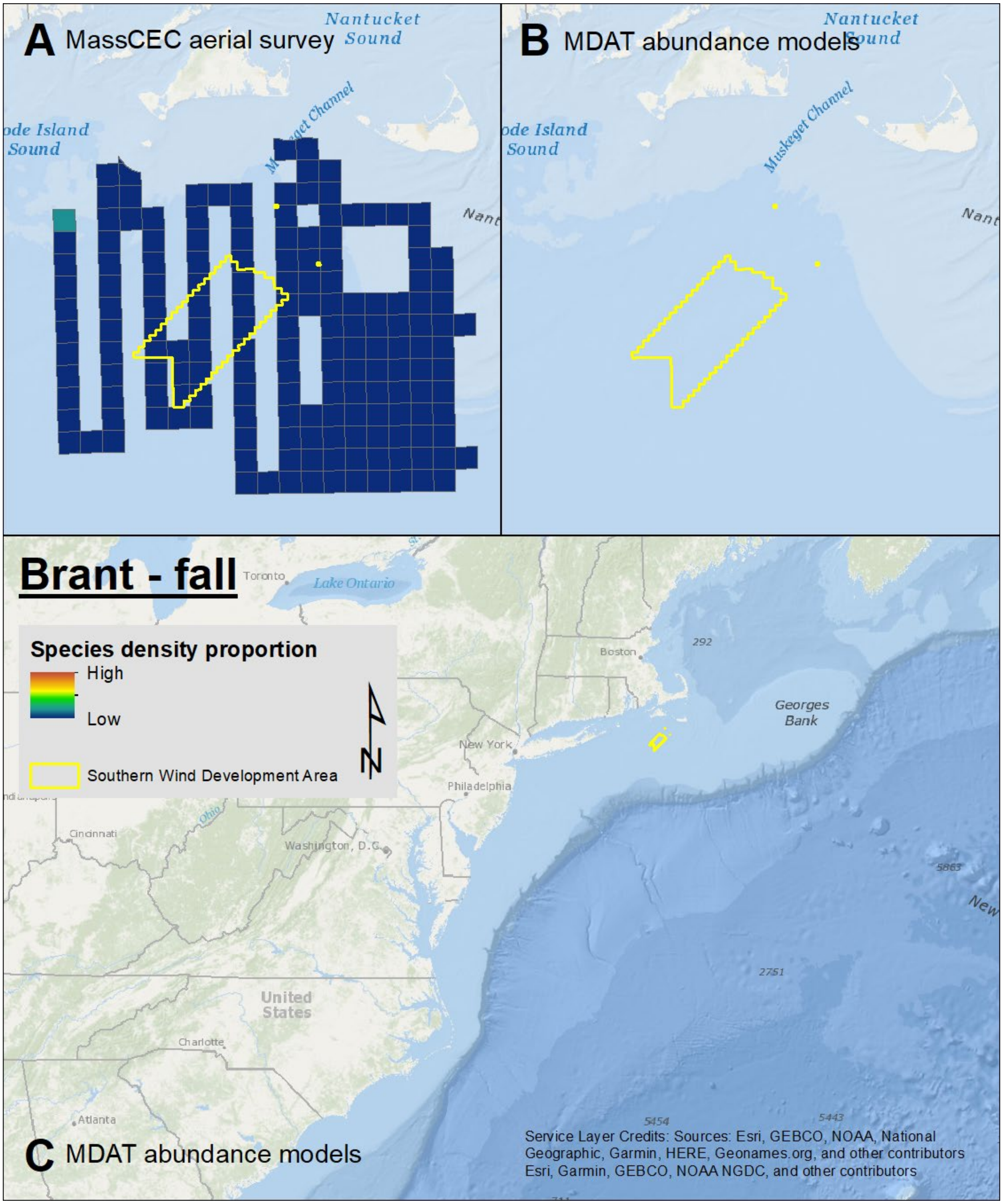
# 5 Birds – Offshore: Seasonal Maps

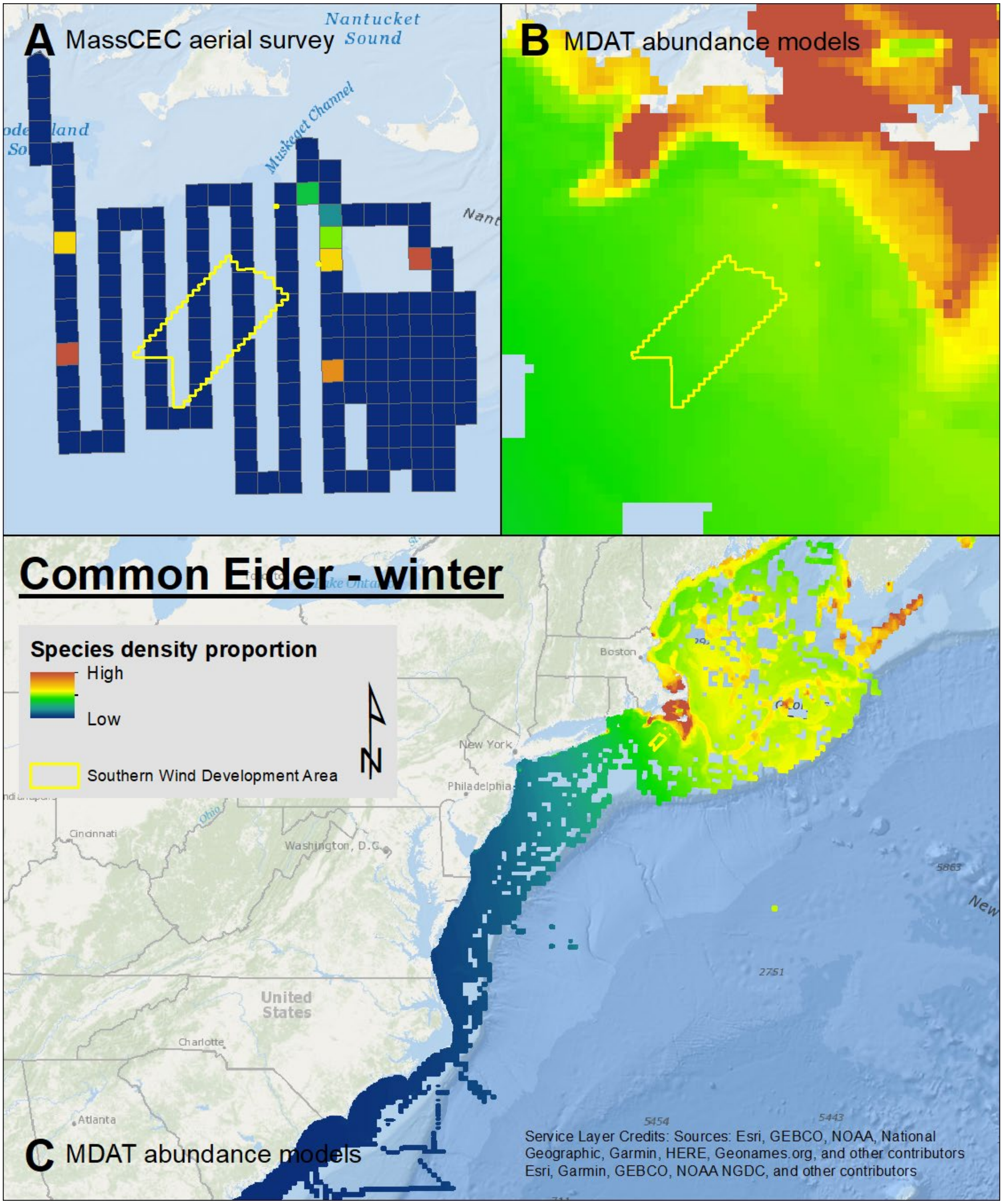
## 5.1 Table of Maps



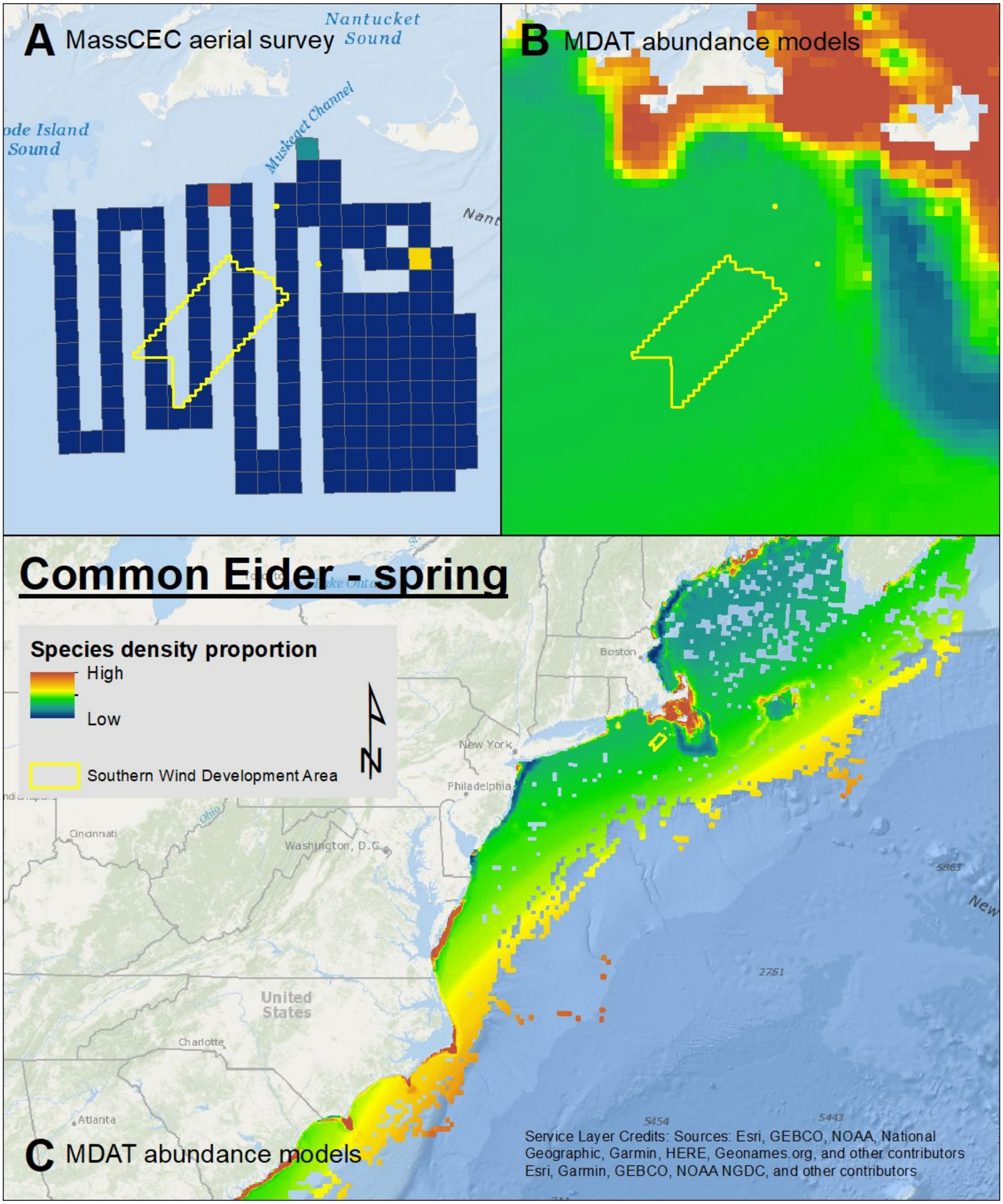

Map 1: MassCEC aerial baseline seasonal survey effort; mean survey effort in sq. km by full or partial lease block inside and outside the Southern Wind Development AreaError! Bookmark not defined.



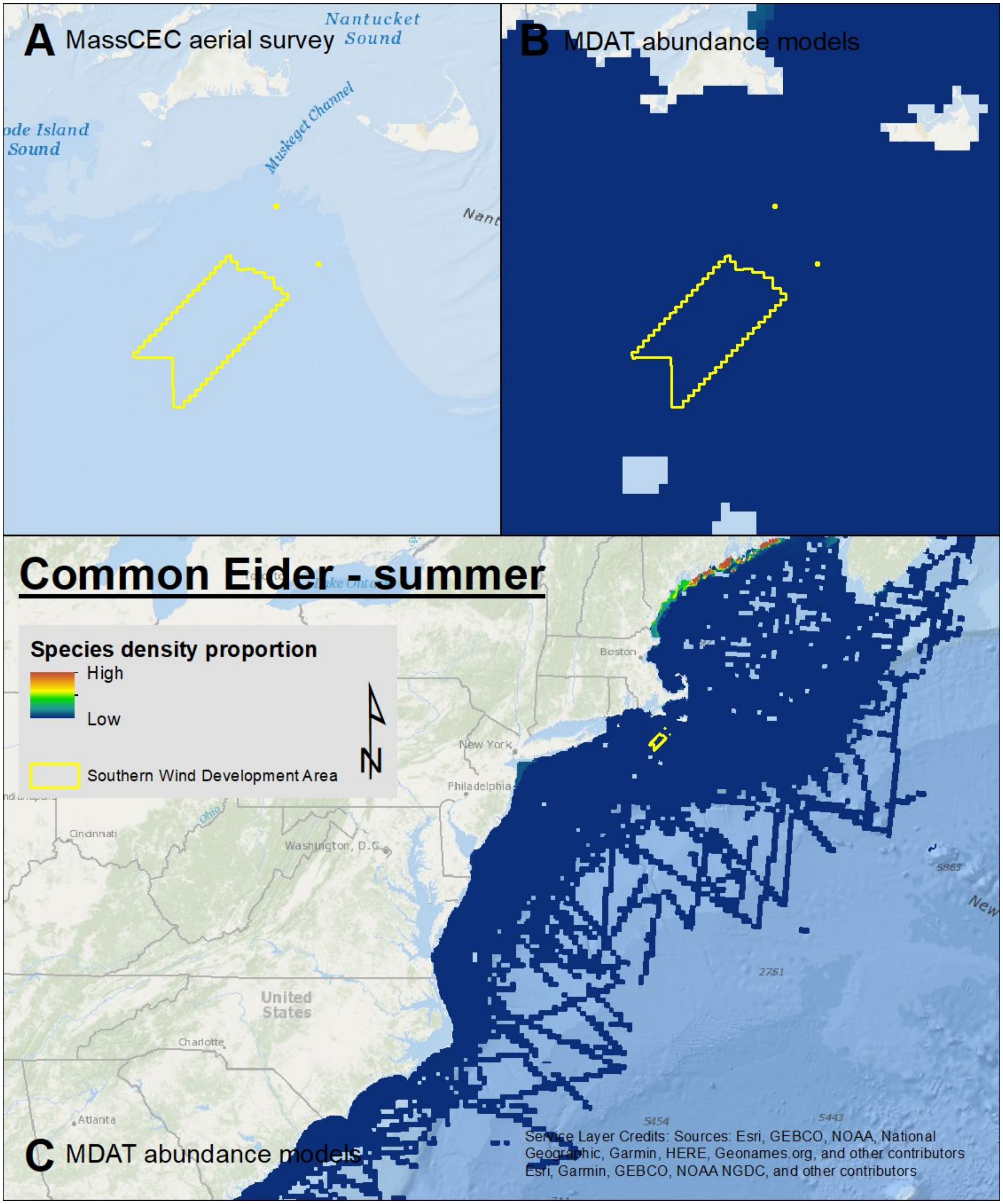

Map 2: Fall Brant density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



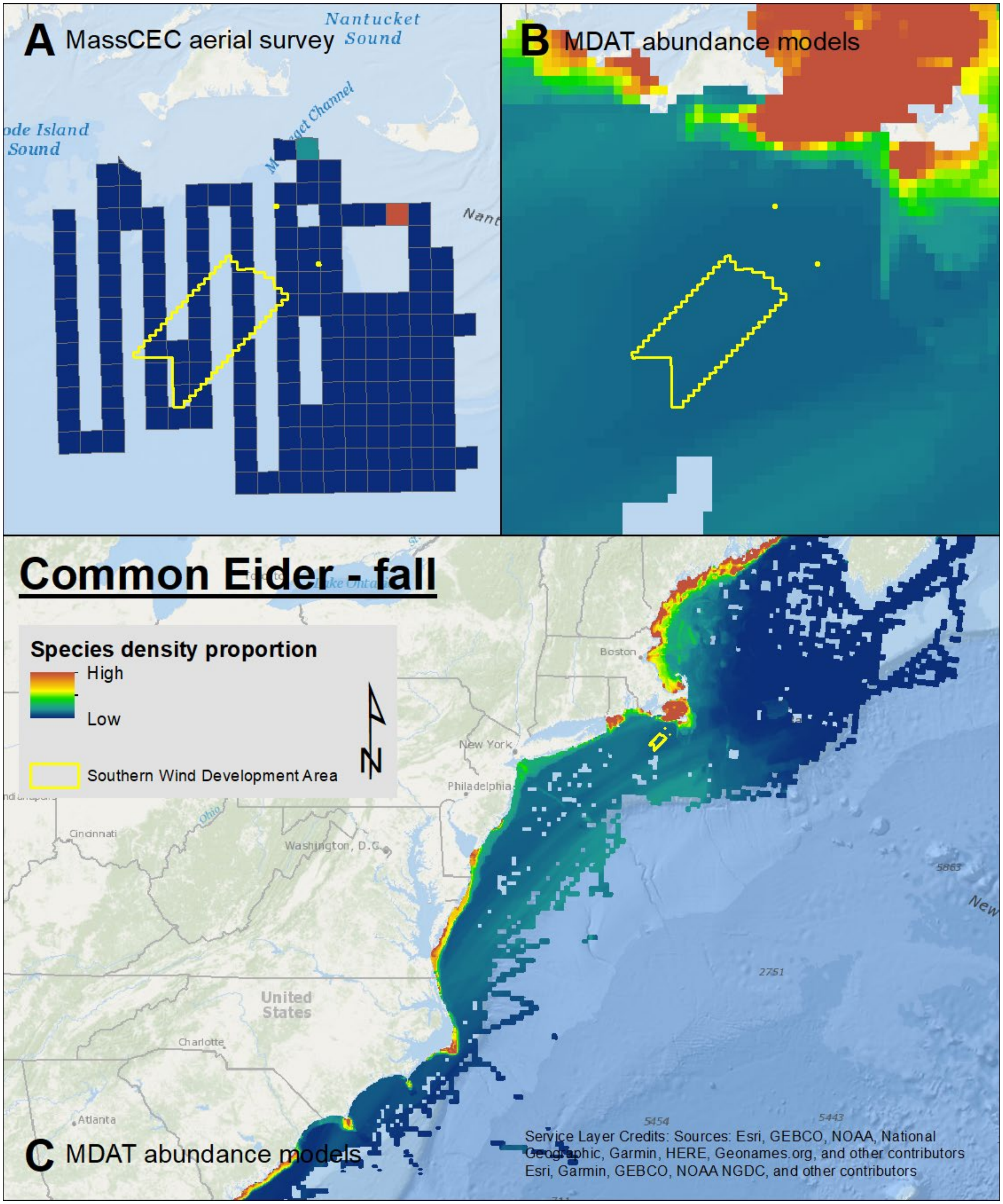

Map 3: Winter Common Eider density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



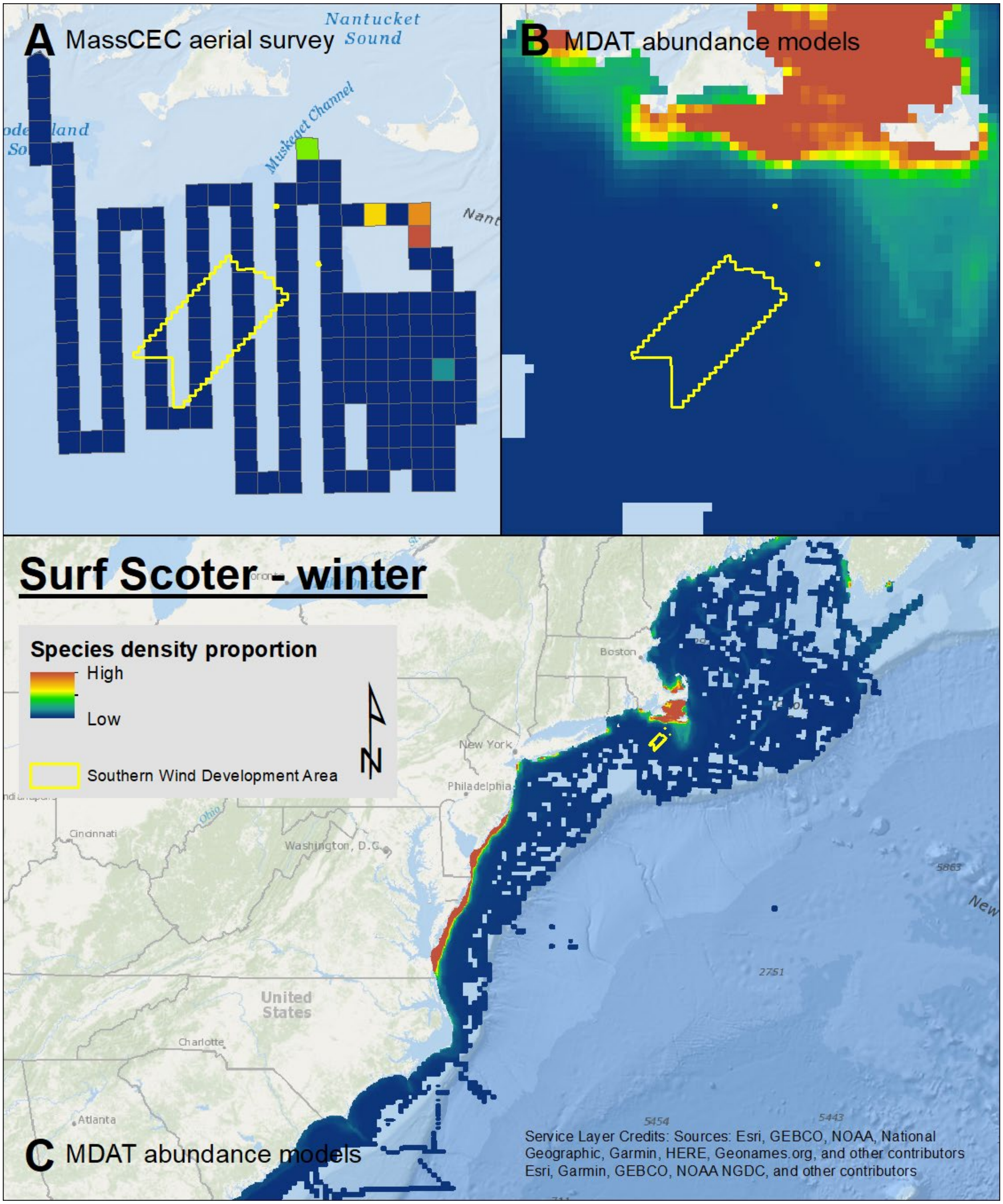

Map 4: Spring Common Eider density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



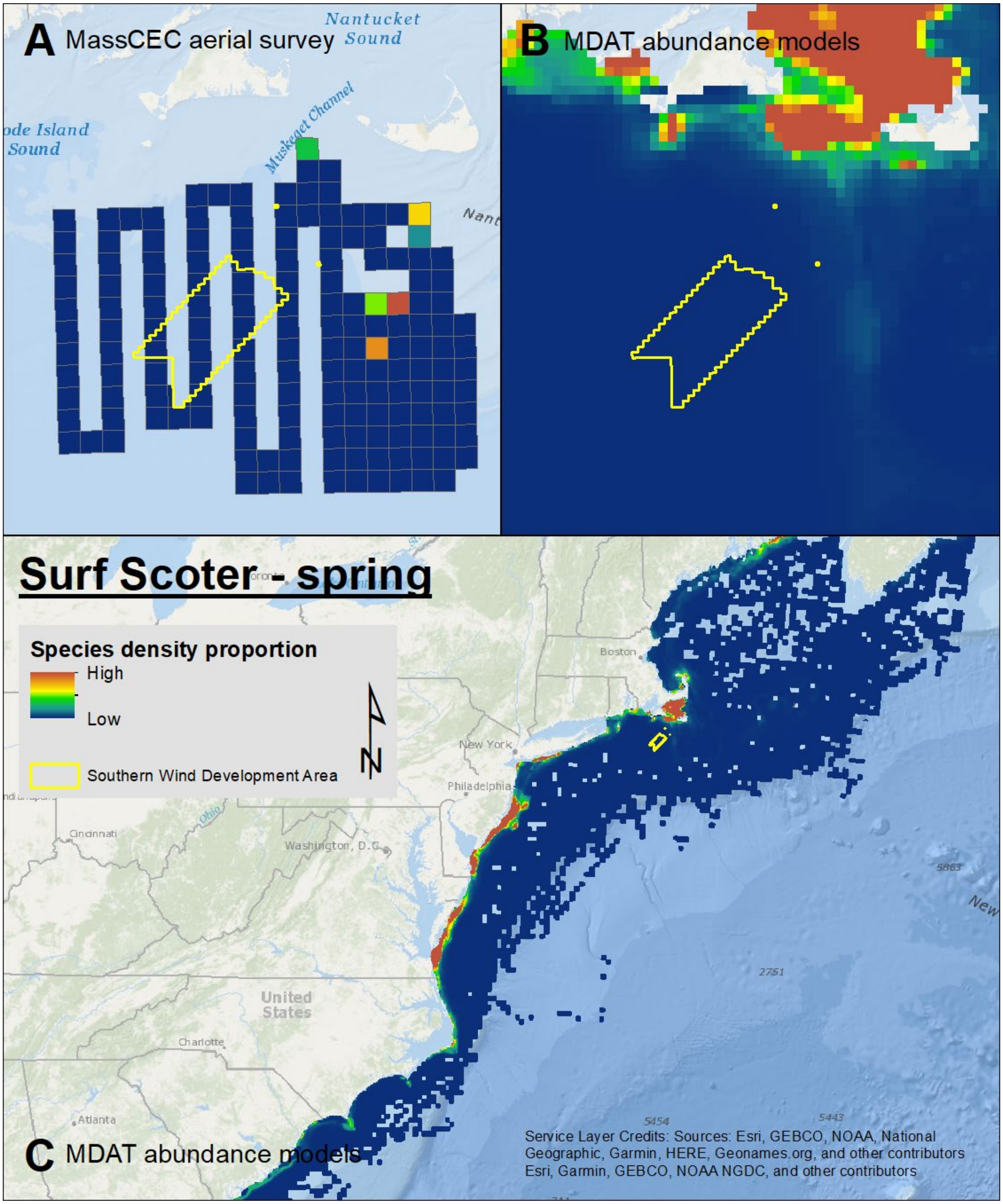

Map 5: Summer Common Eider density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



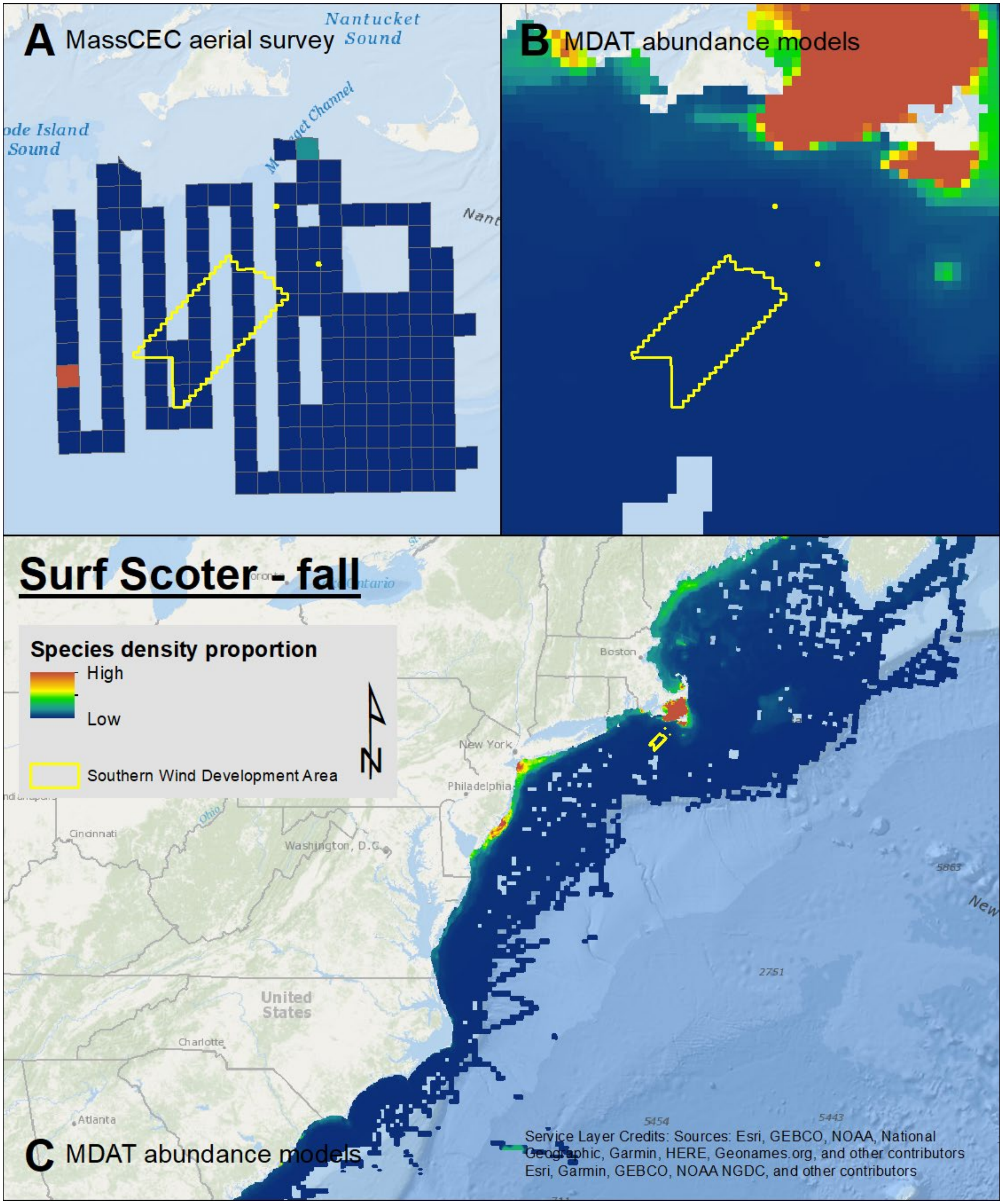

Map 6: Fall Common Eider density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



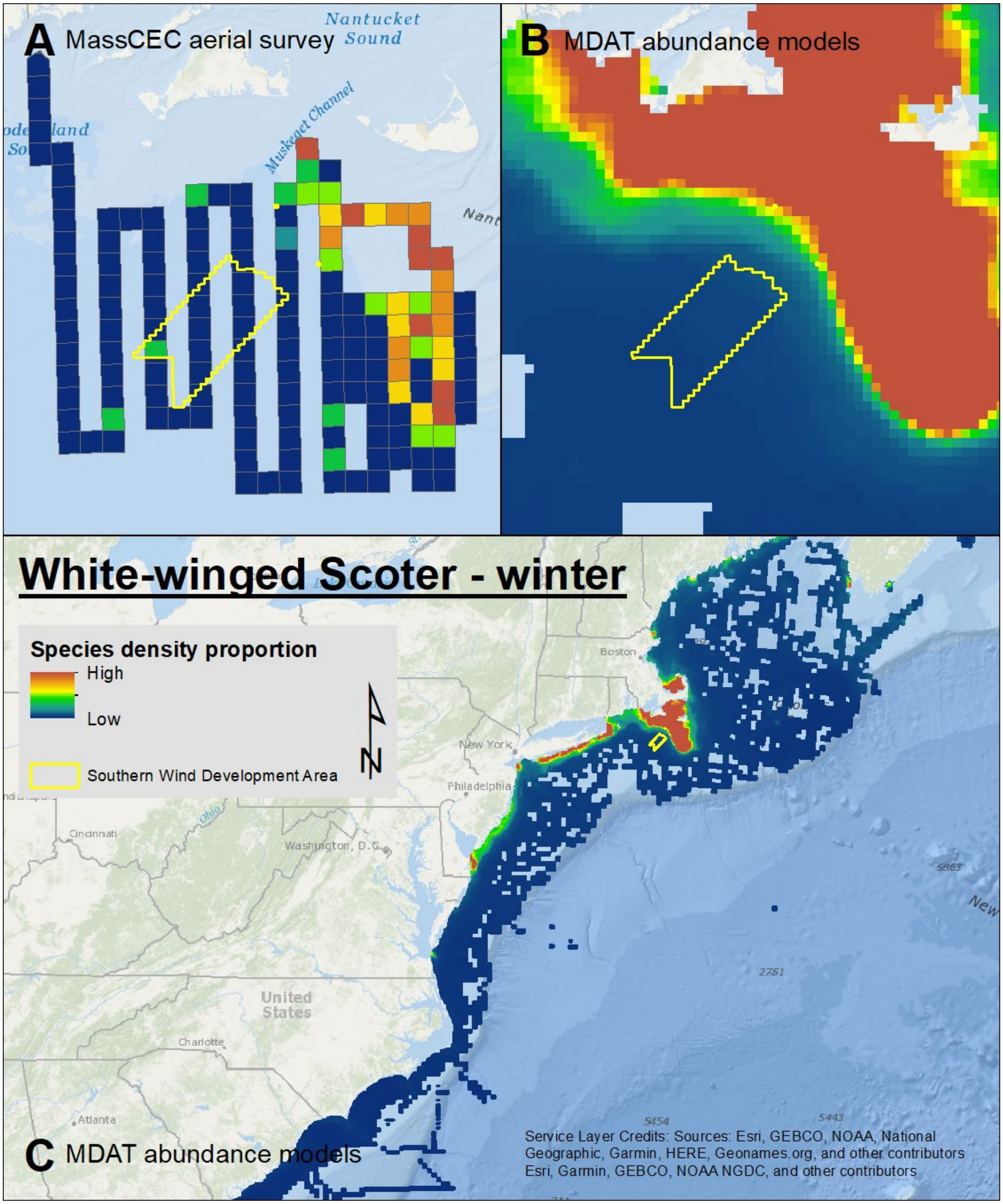

Map 7: Winter Surf Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



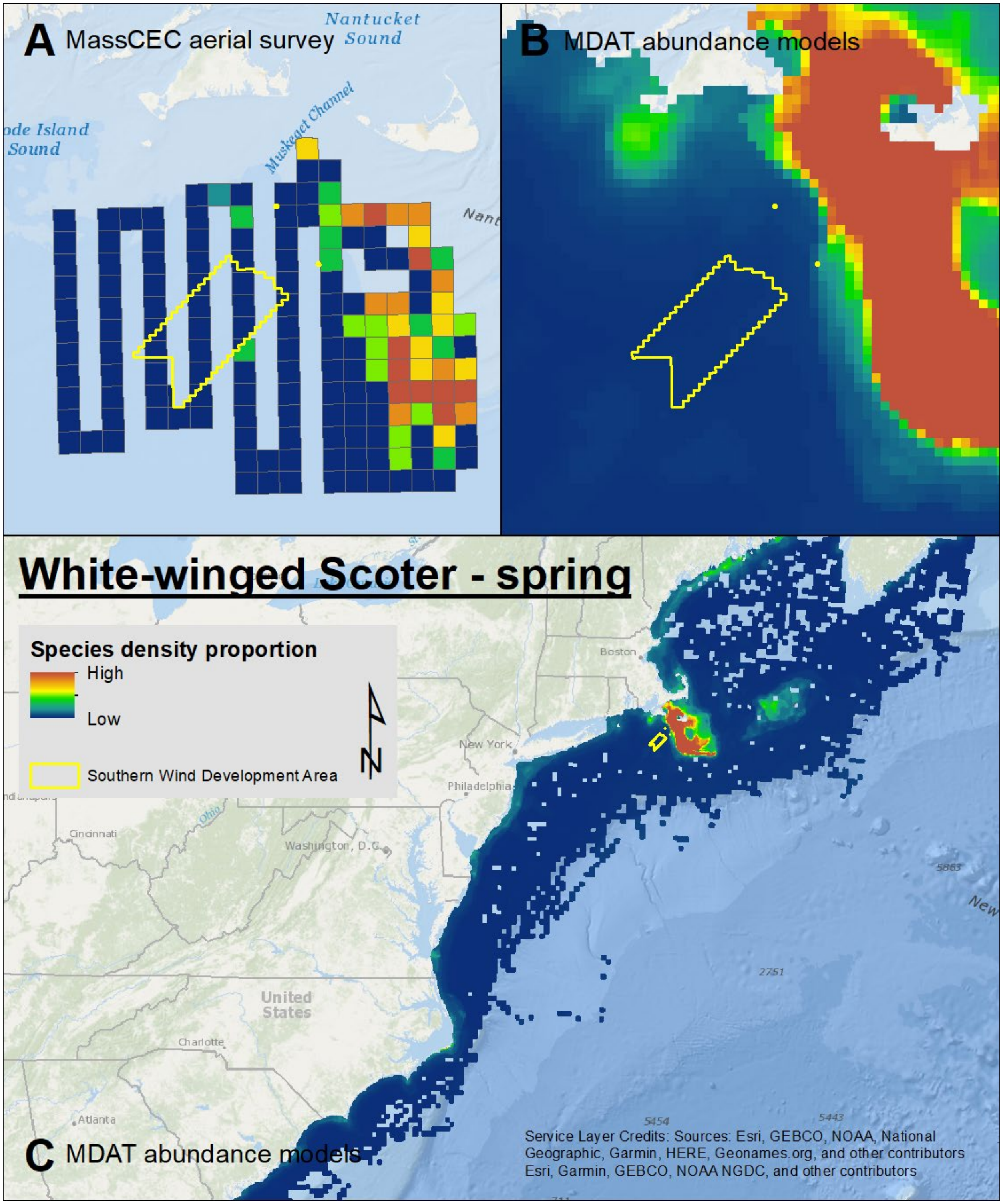

Map 8: Spring Surf Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



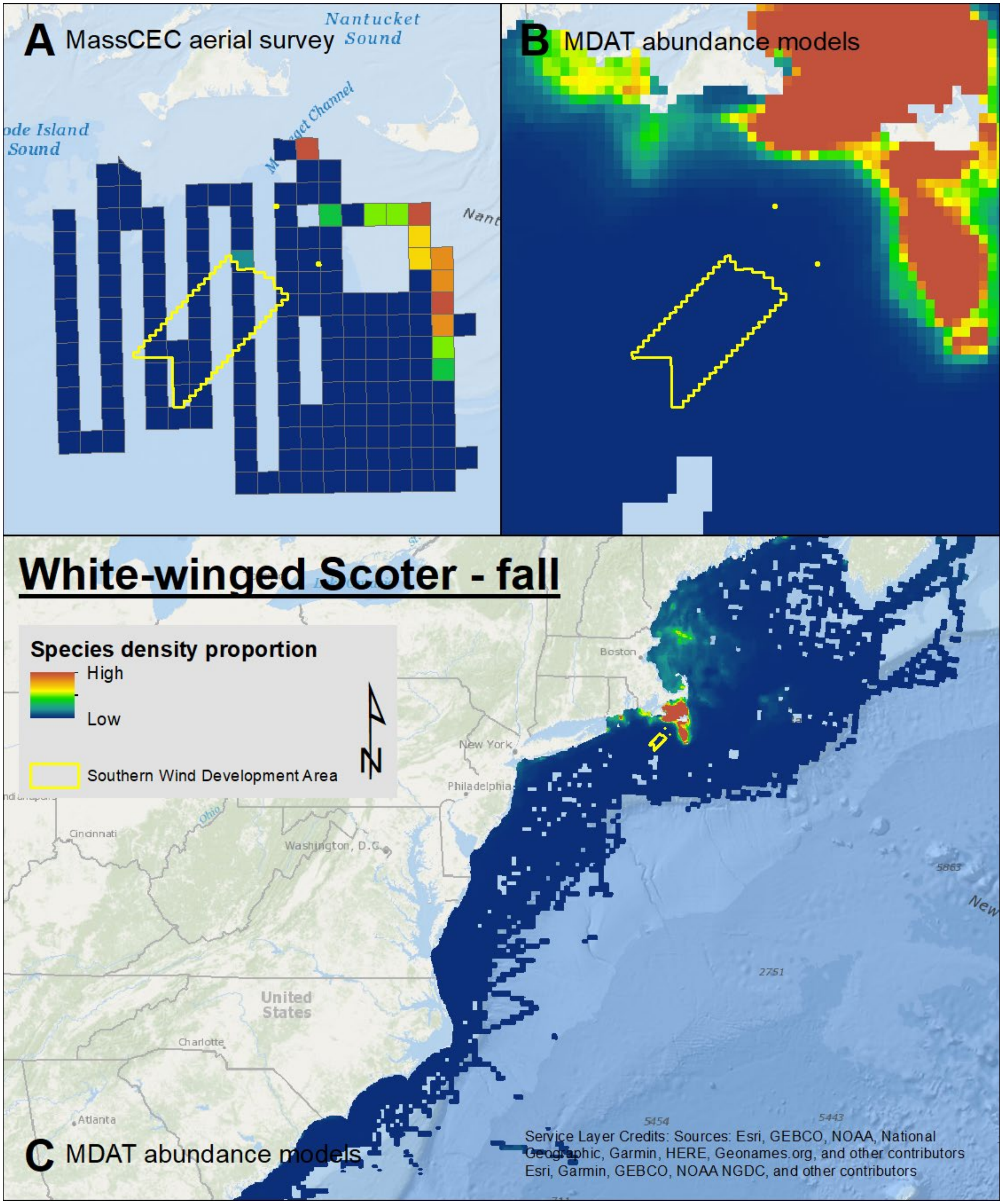

Map 9: Fall Surf Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



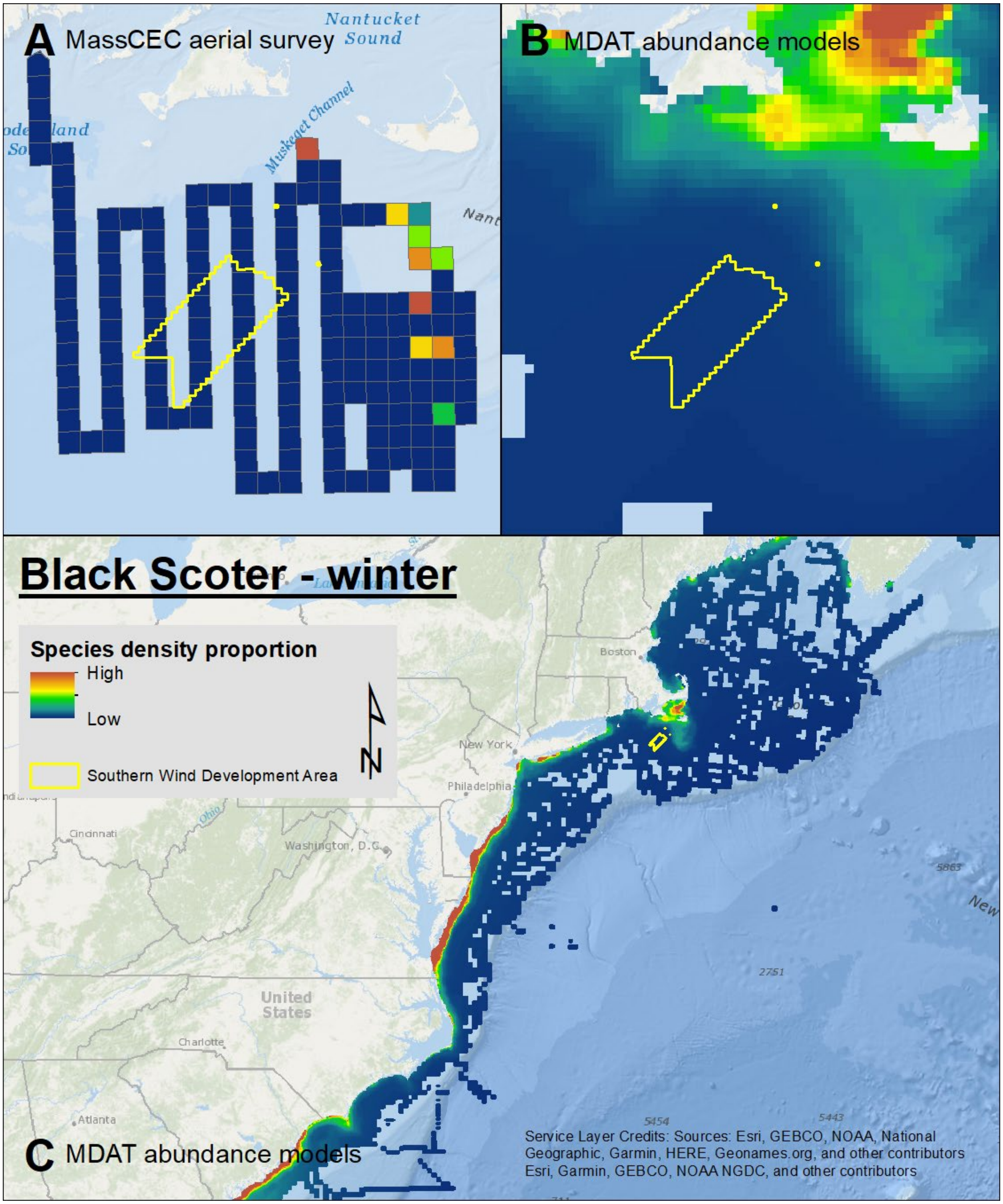

Map 10: Winter White-winged Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



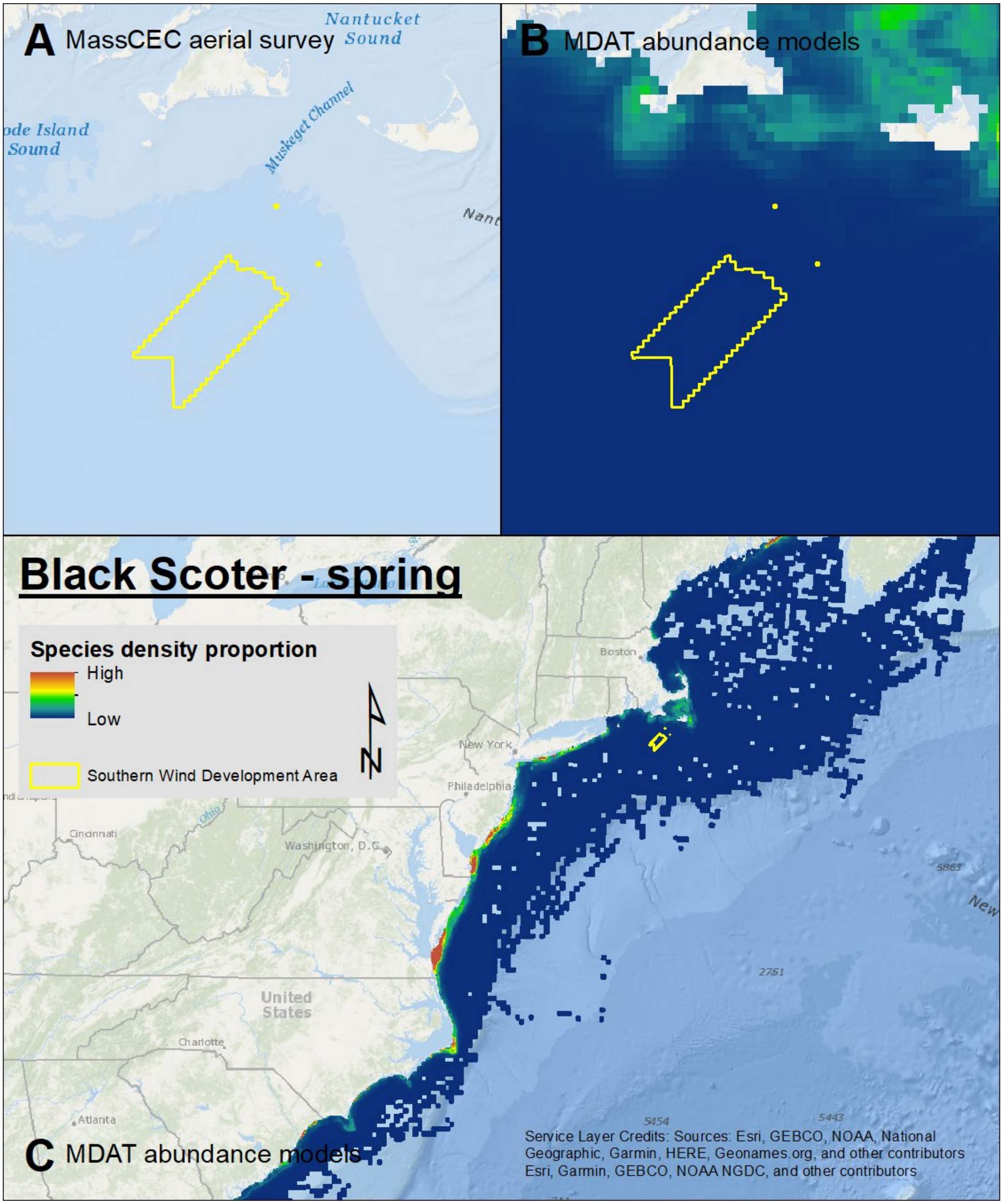

Map 11: Spring White-winged Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



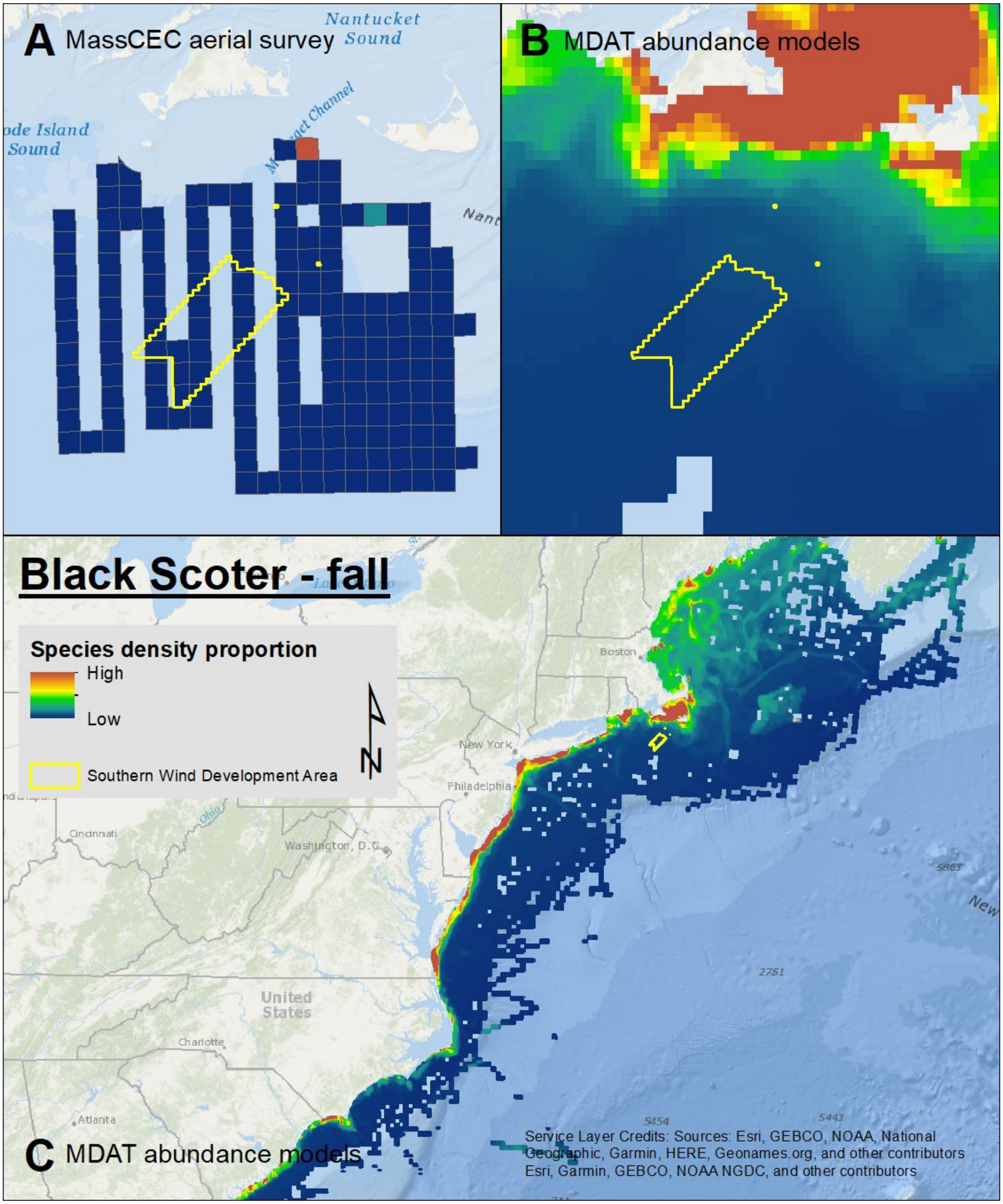

Map 12: Fall White-winged Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



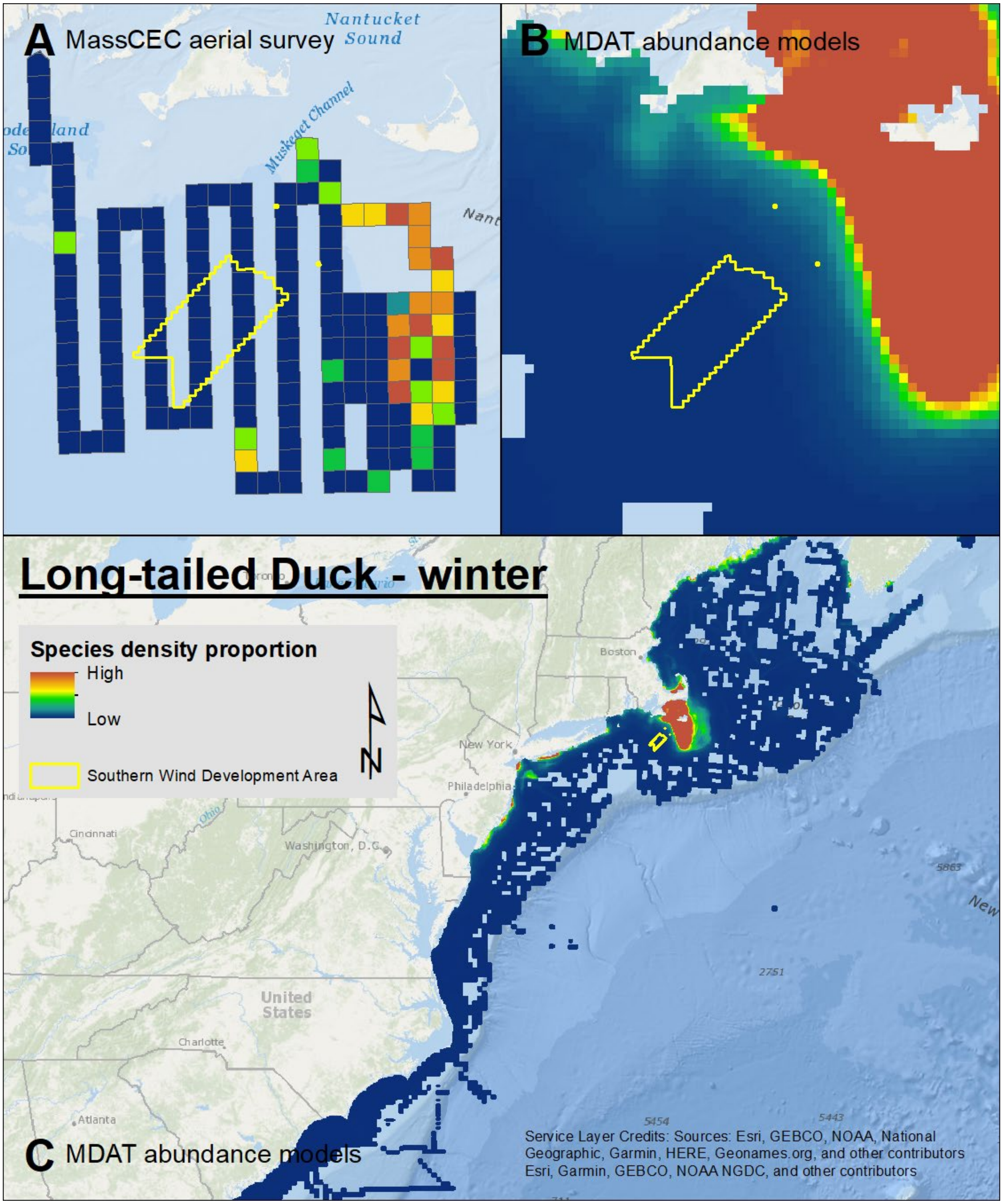

Map 13: Winter Black Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



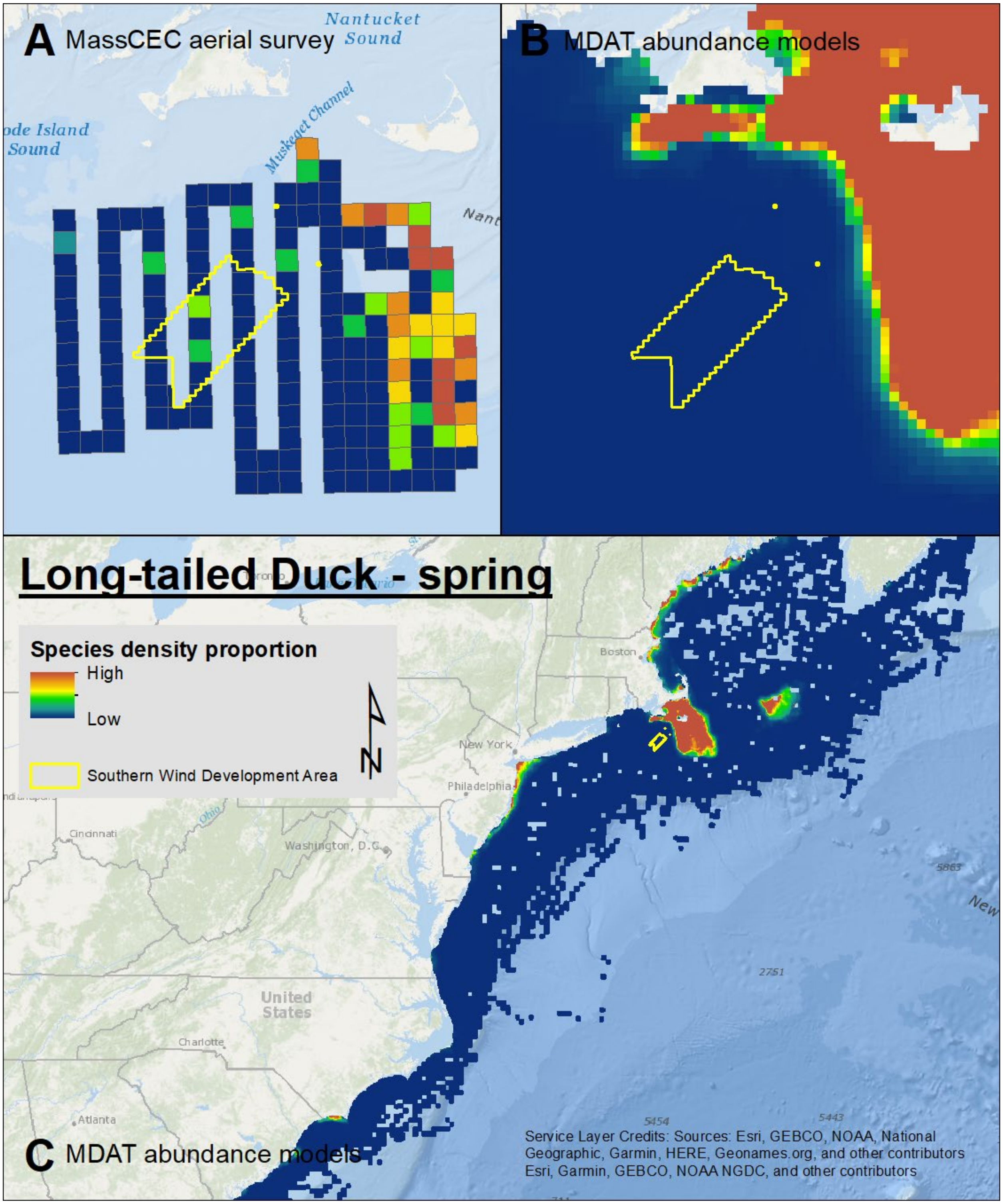

Map 14: Spring Black Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



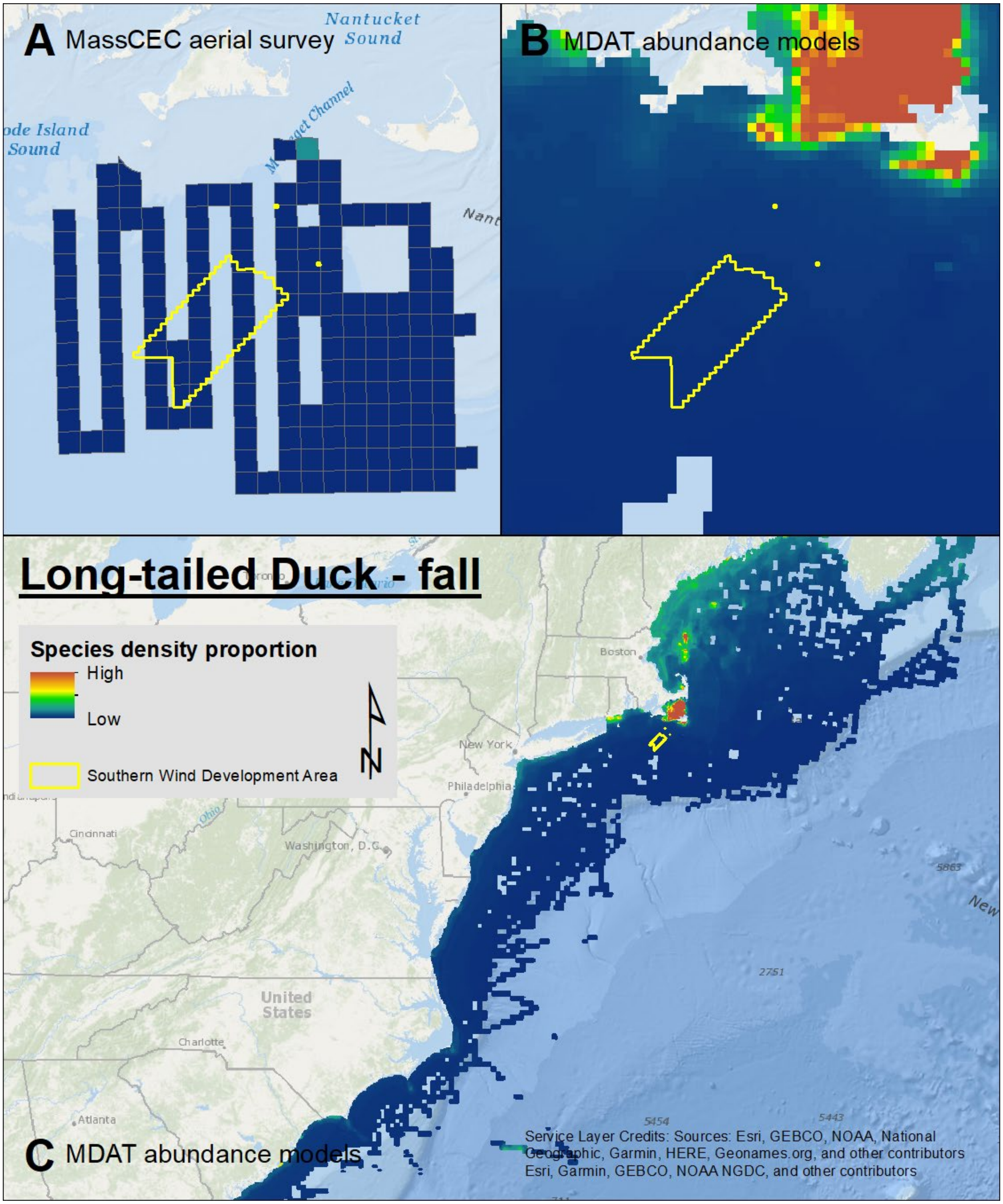

Map 15: Fall Black Scoter density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



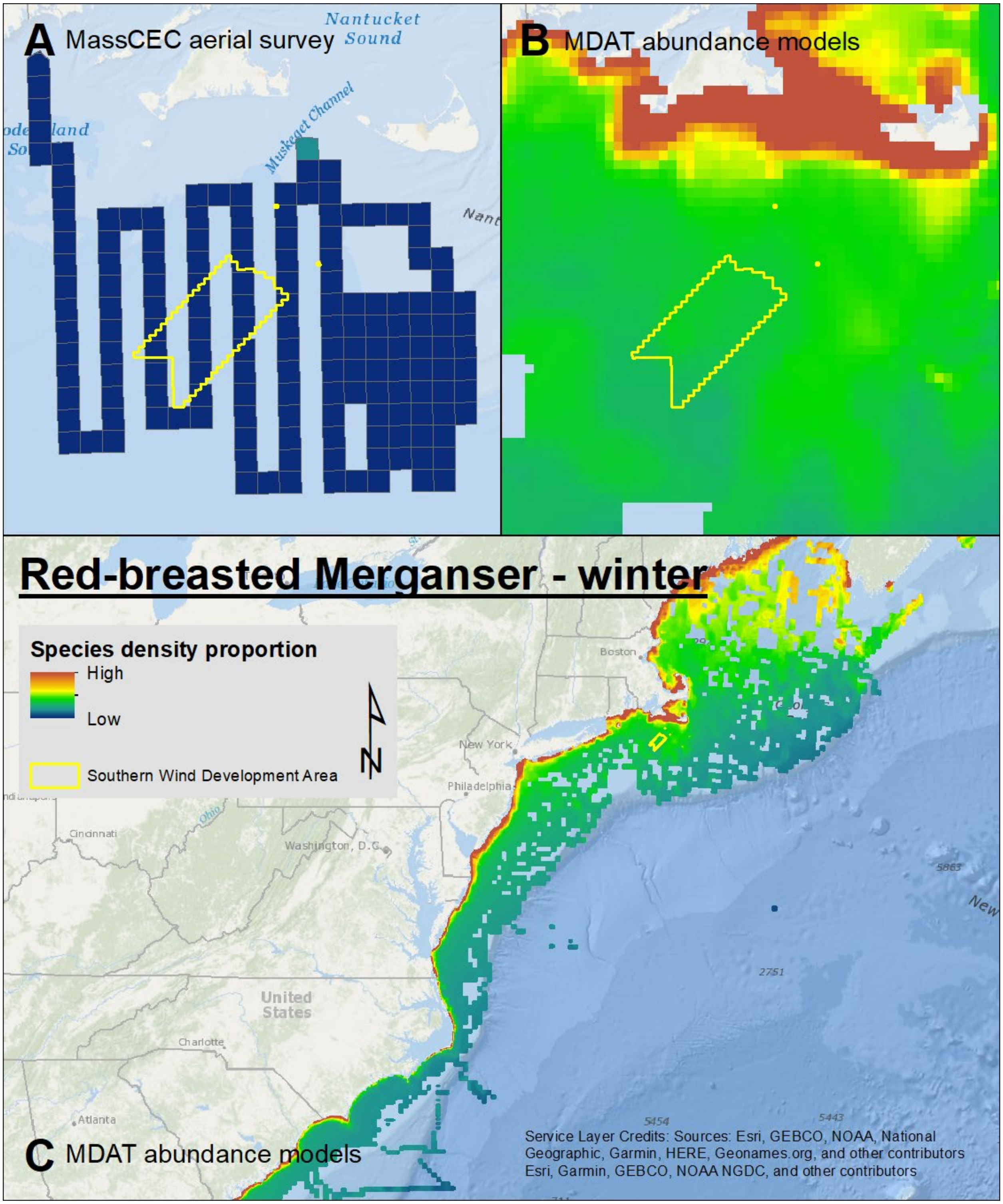

Map 16: Winter Long-tailed Duck density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



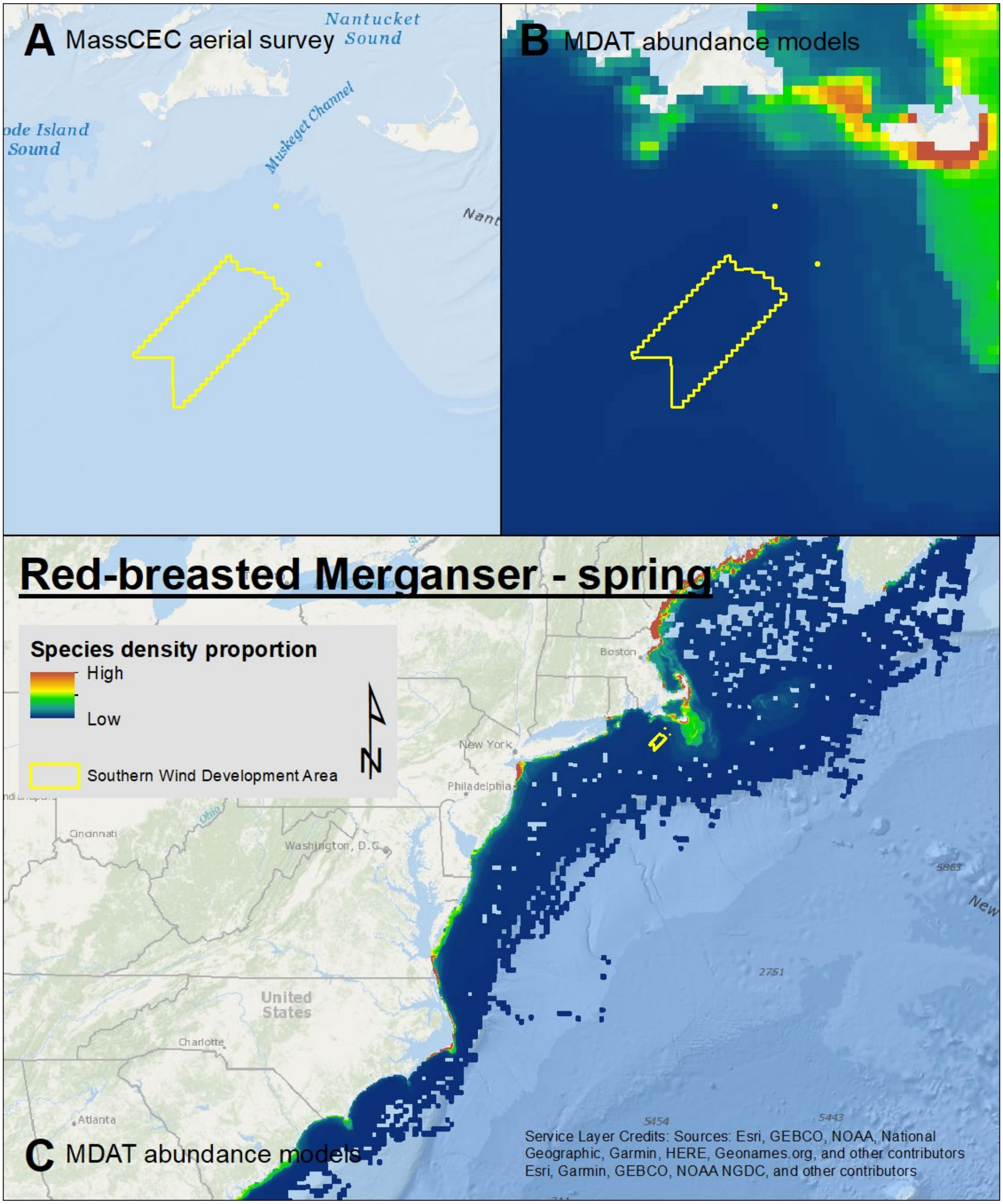

Map 17: Spring Long-tailed Duck density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



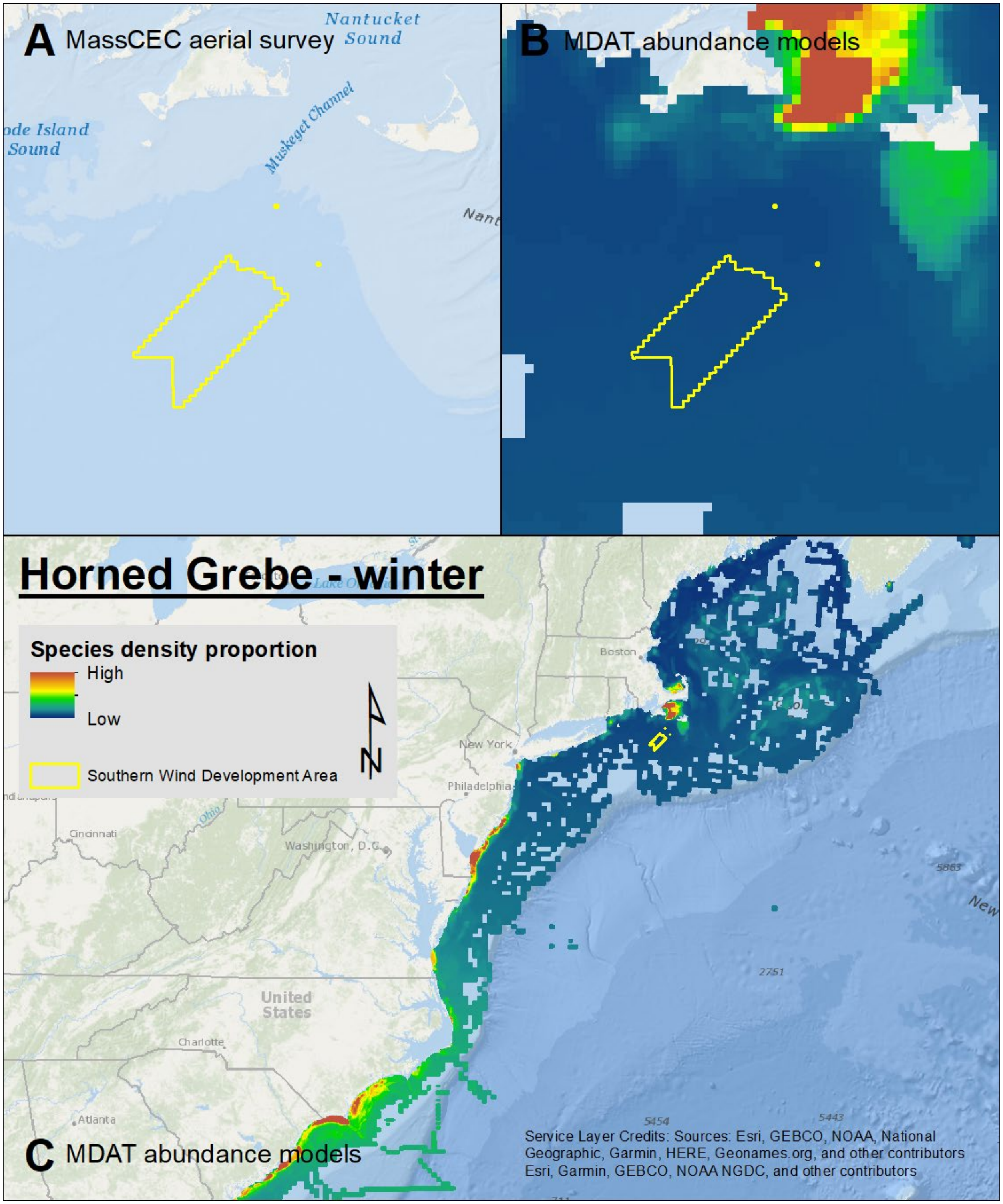

Map 18: Fall Long-tailed Duck density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



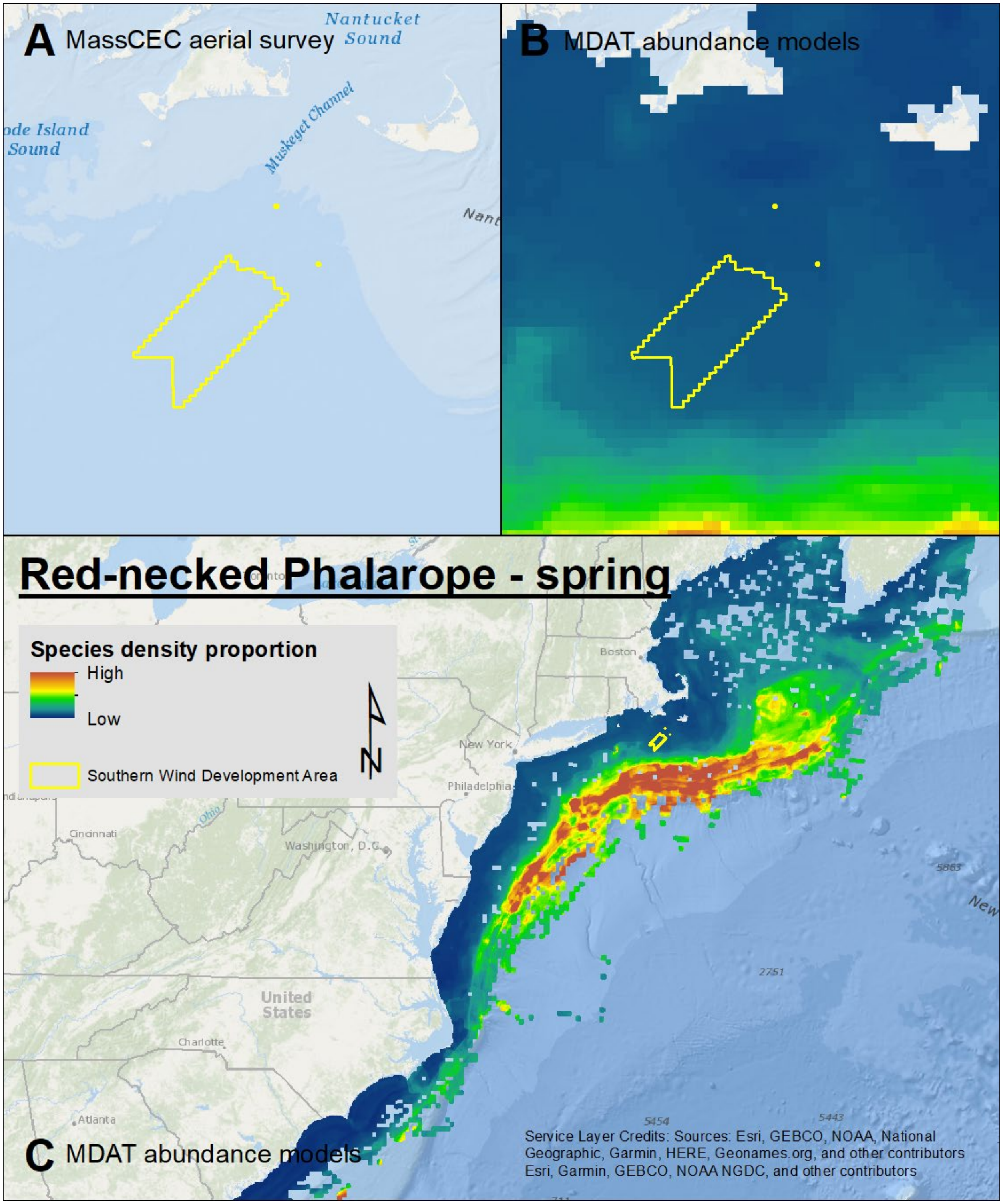

Map 19: Winter Red-breasted Merganser density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



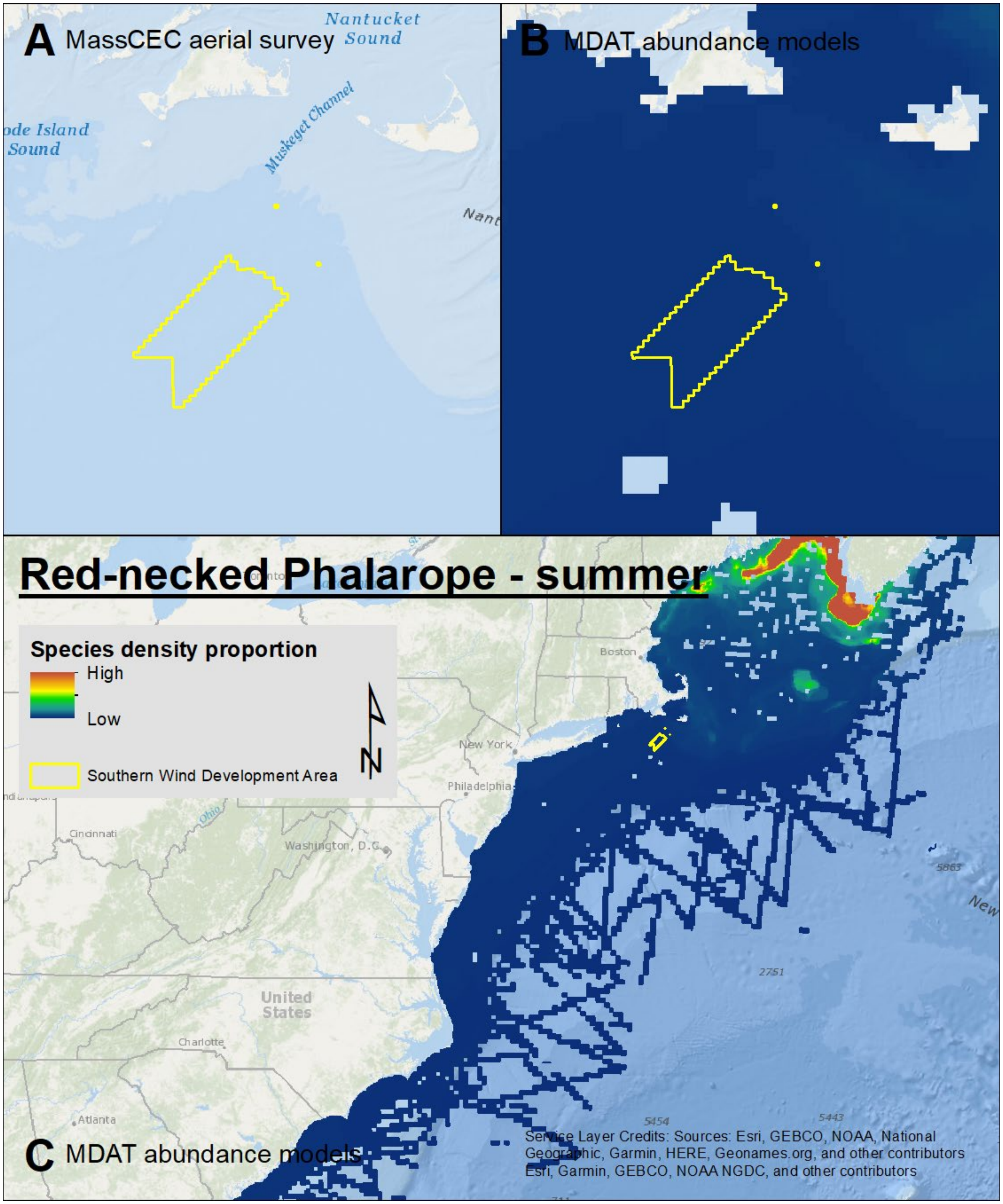

Map 20: Spring Red-breasted Merganser density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



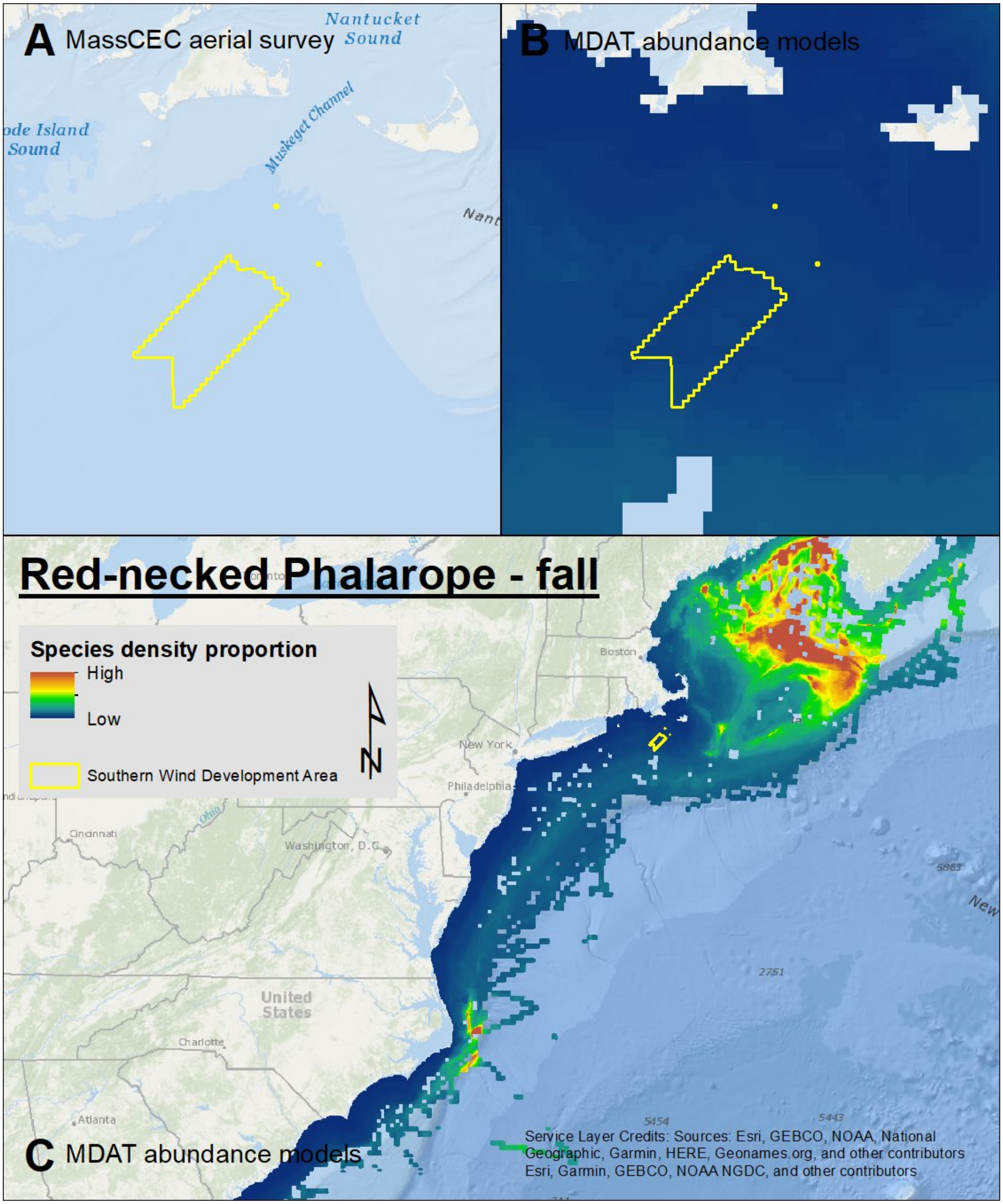

Map 21: Winter Horned Grebe density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



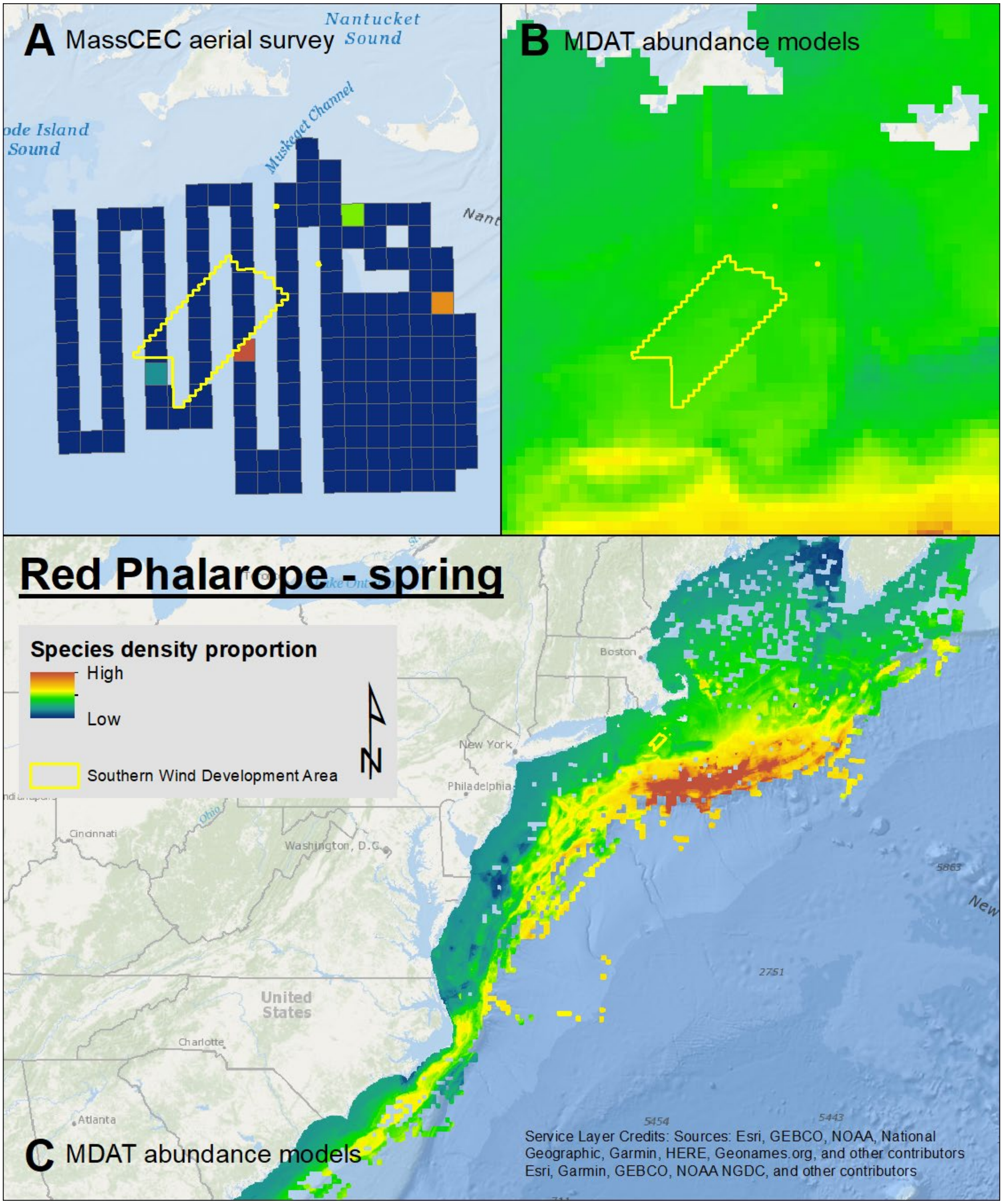

Map 22: Spring Red-necked Phalarope density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



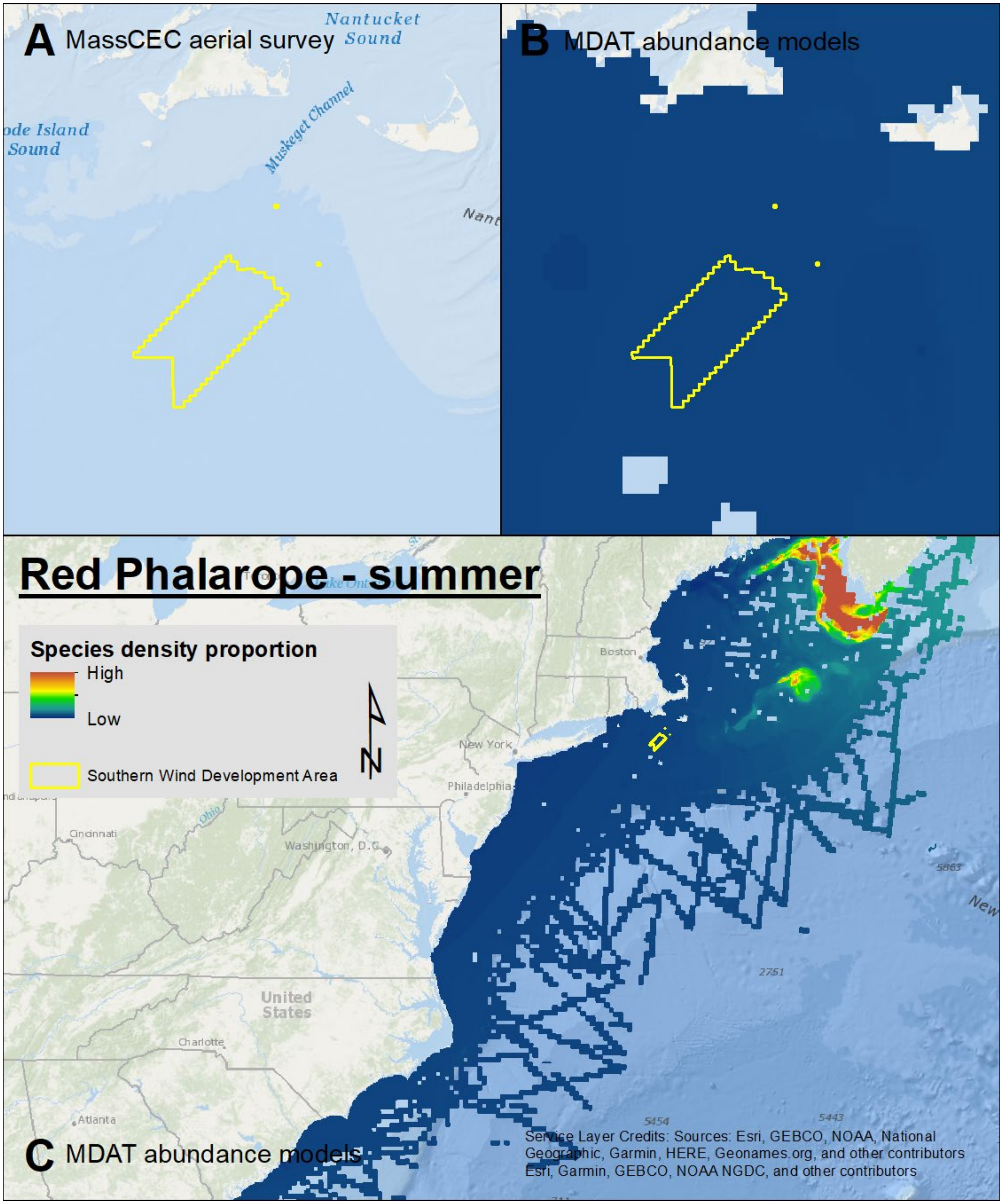

Map 23: Summer Red-necked Phalarope density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



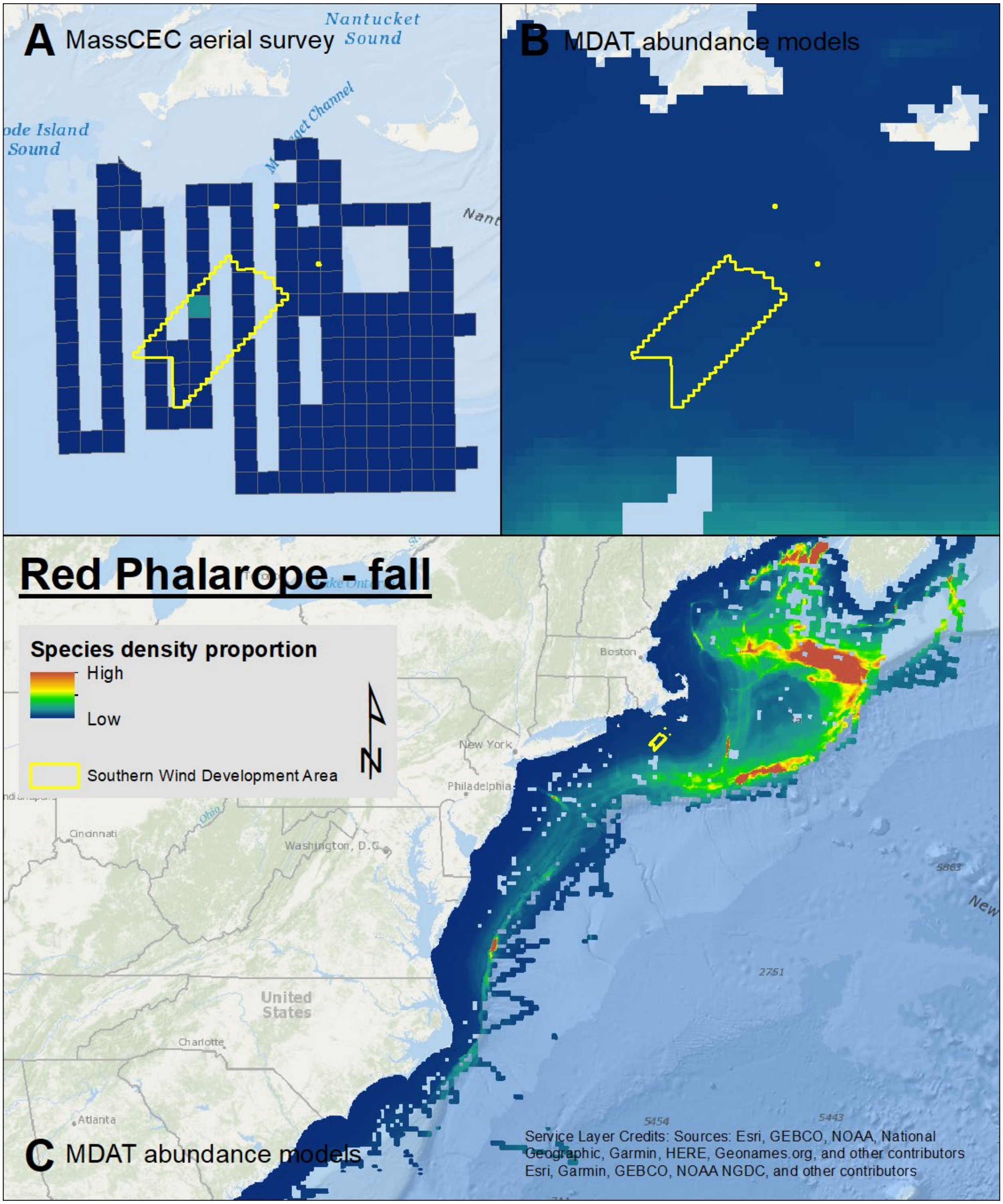

Map 24: Fall Red-necked Phalarope density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



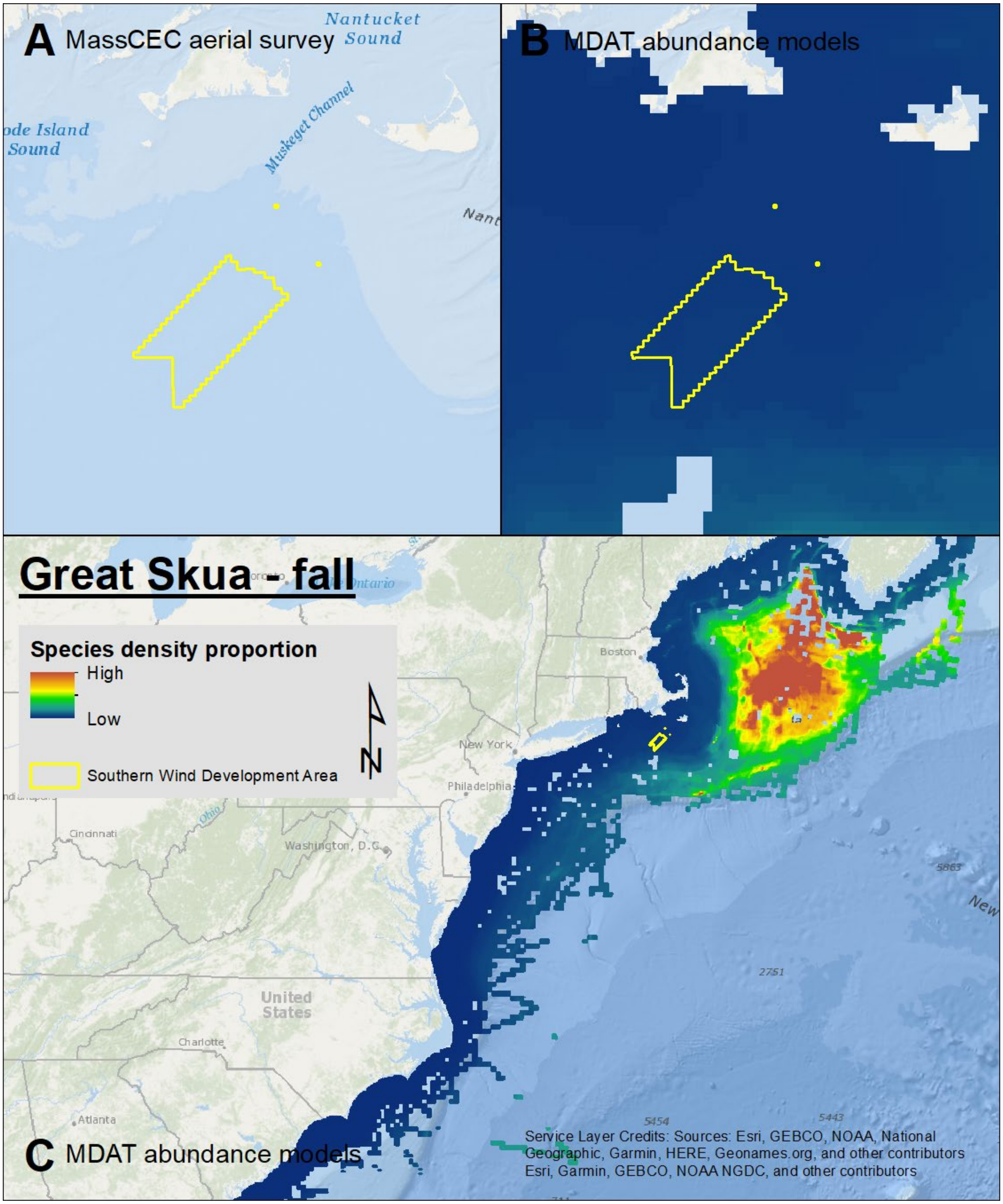

Map 25: Spring Red Phalarope density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



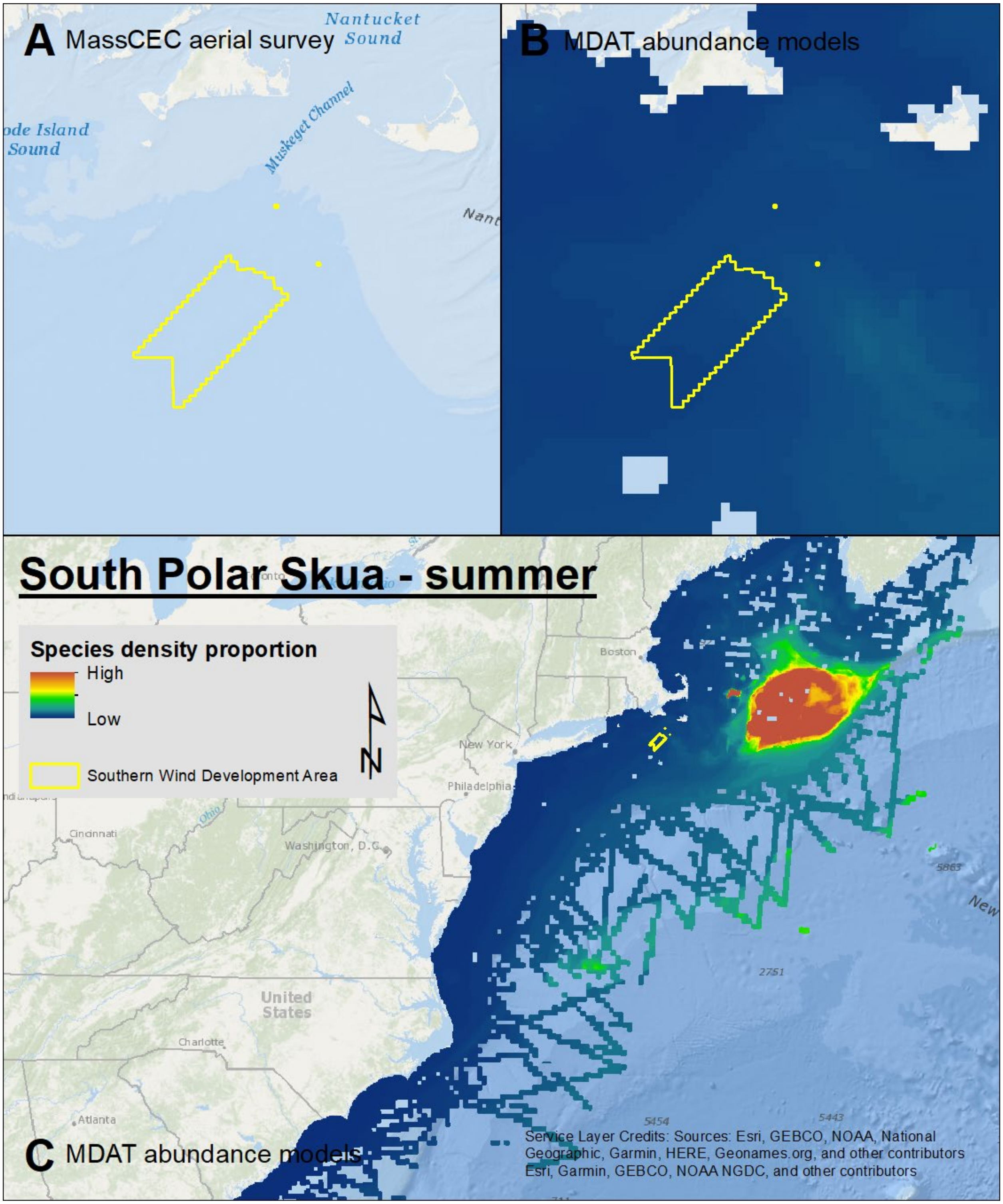

Map 26: Summer Red Phalarope density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



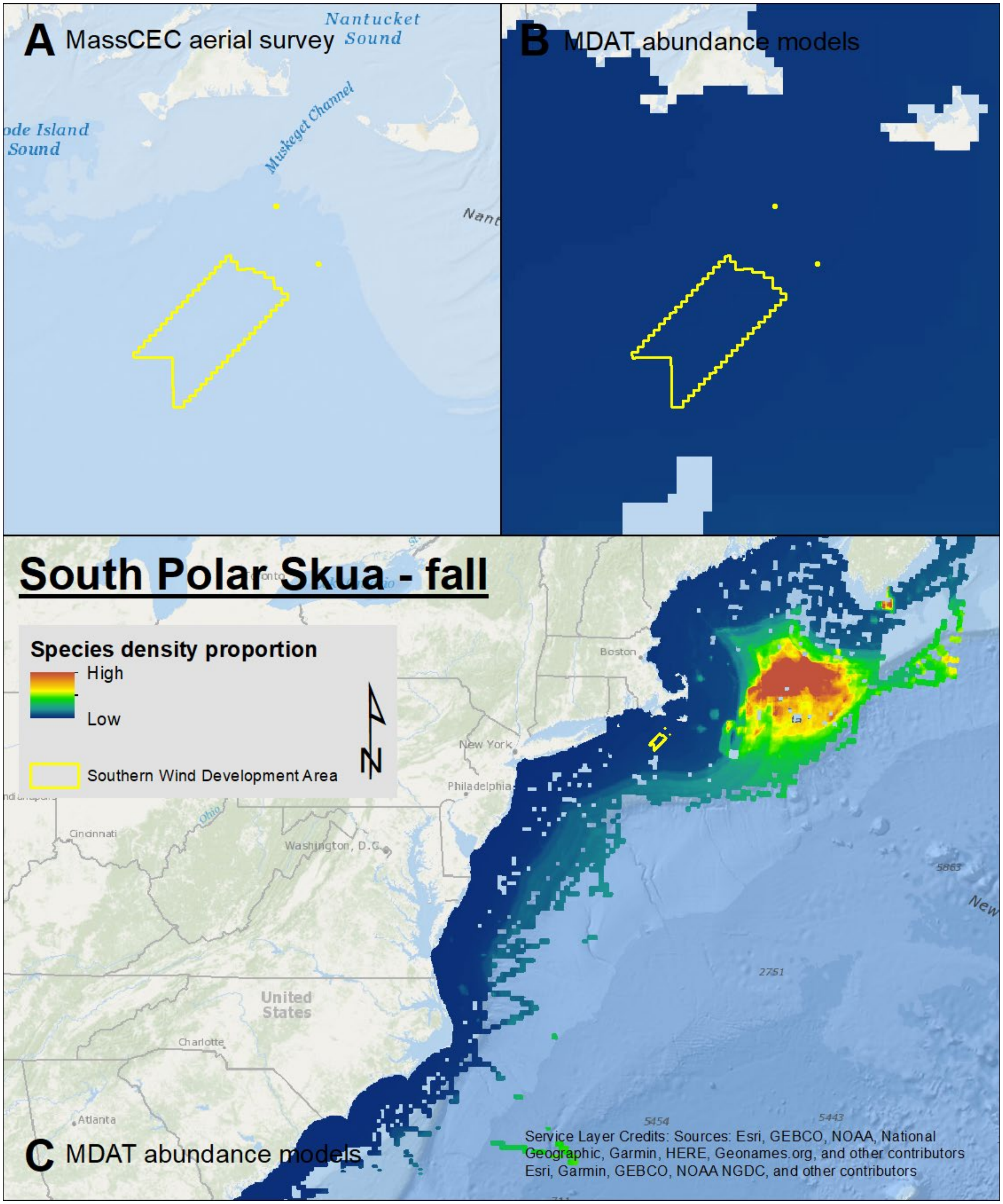

Map 27: Fall Red Phalarope density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



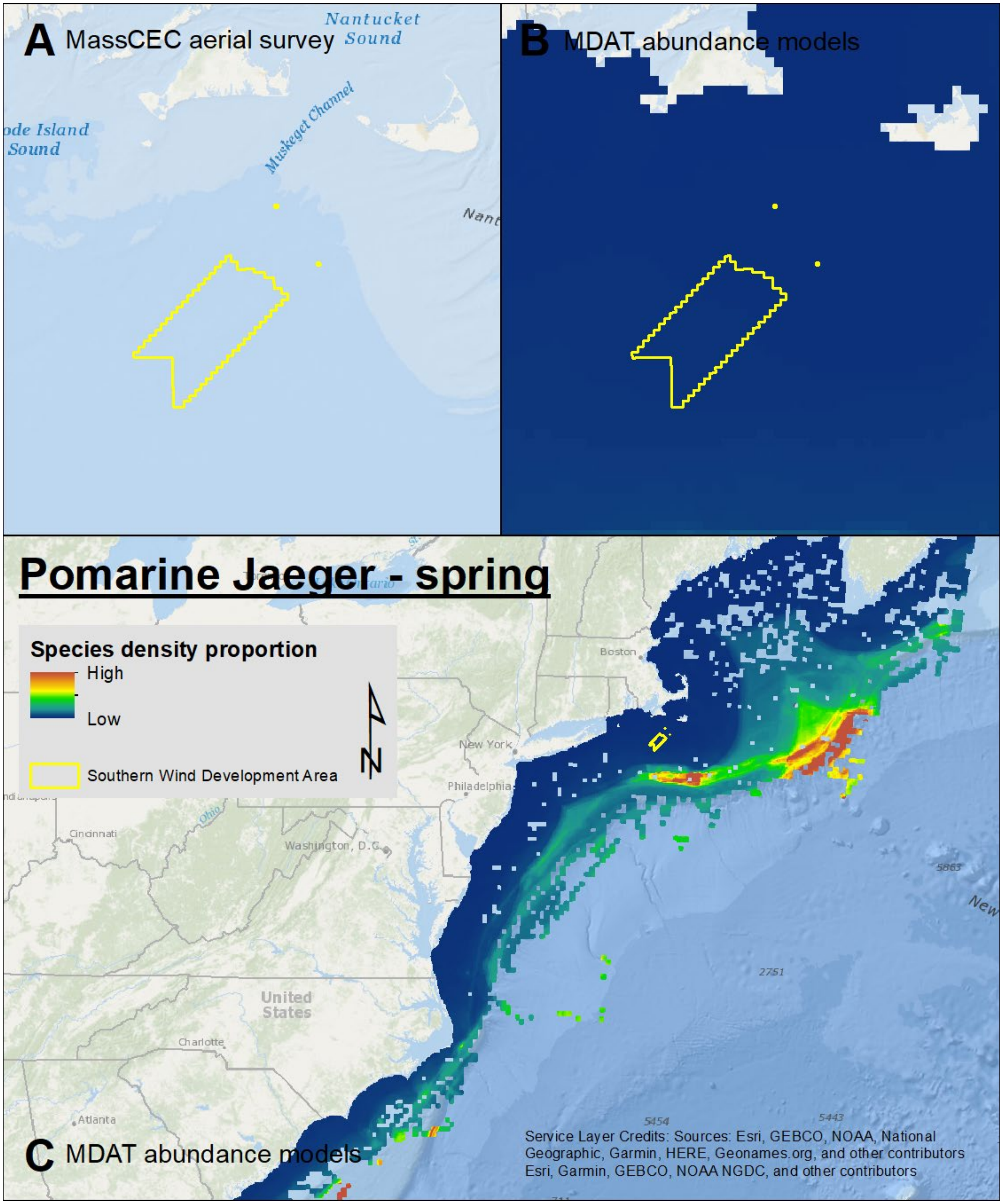

Map 28: Fall Great Skua density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



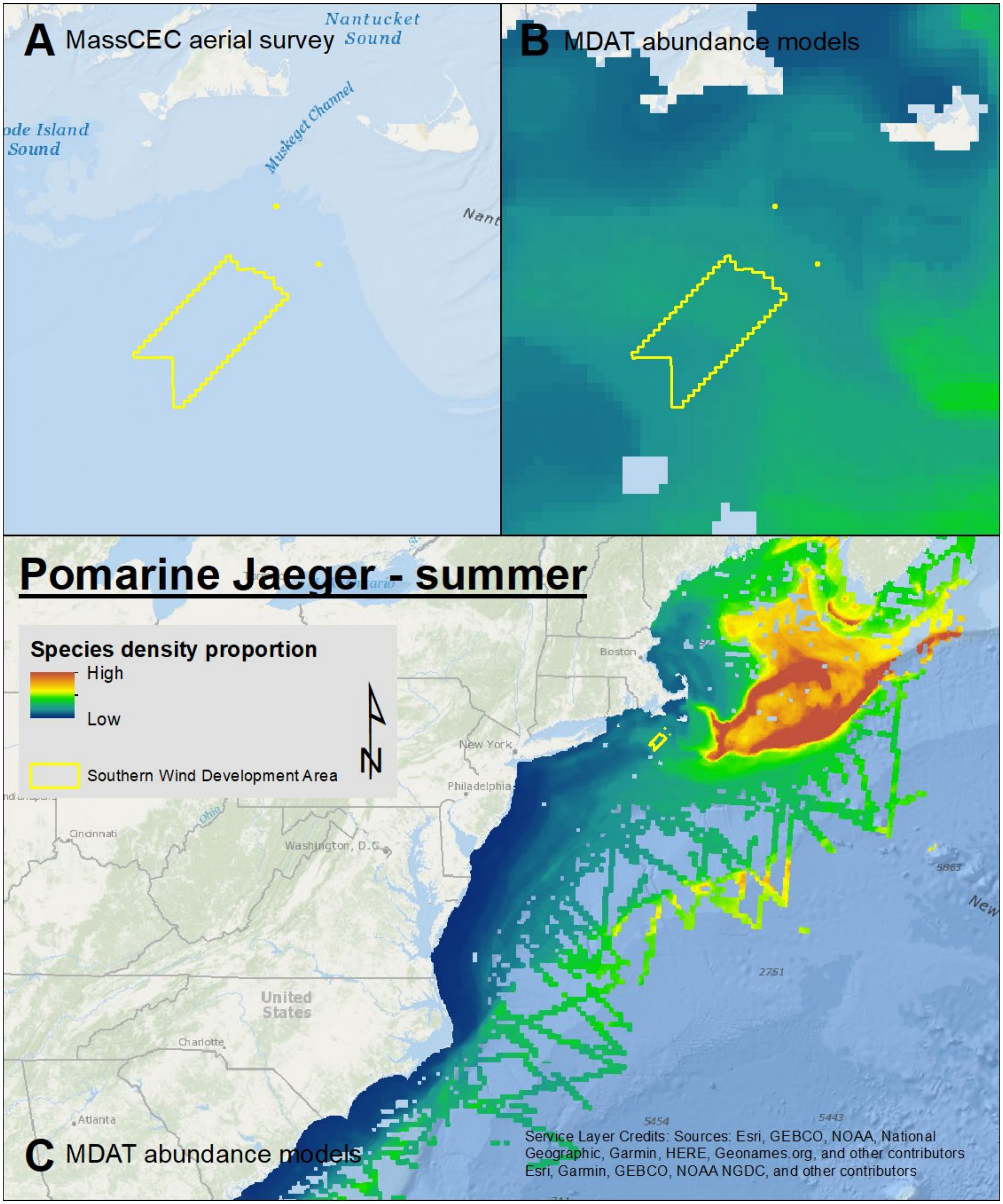

Map 29: Summer South Polar Skua density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



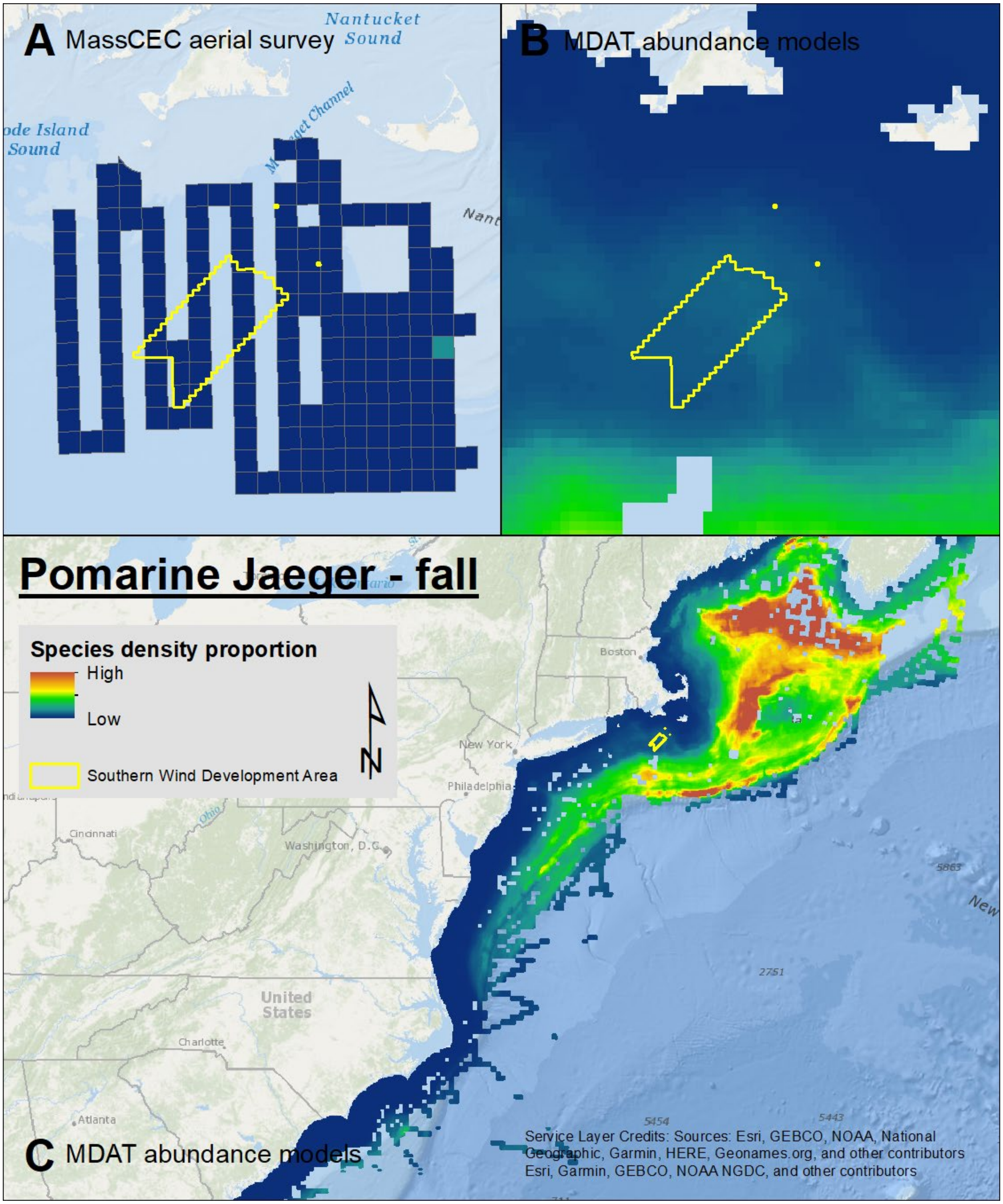

Map 30: Fall South Polar Skua density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



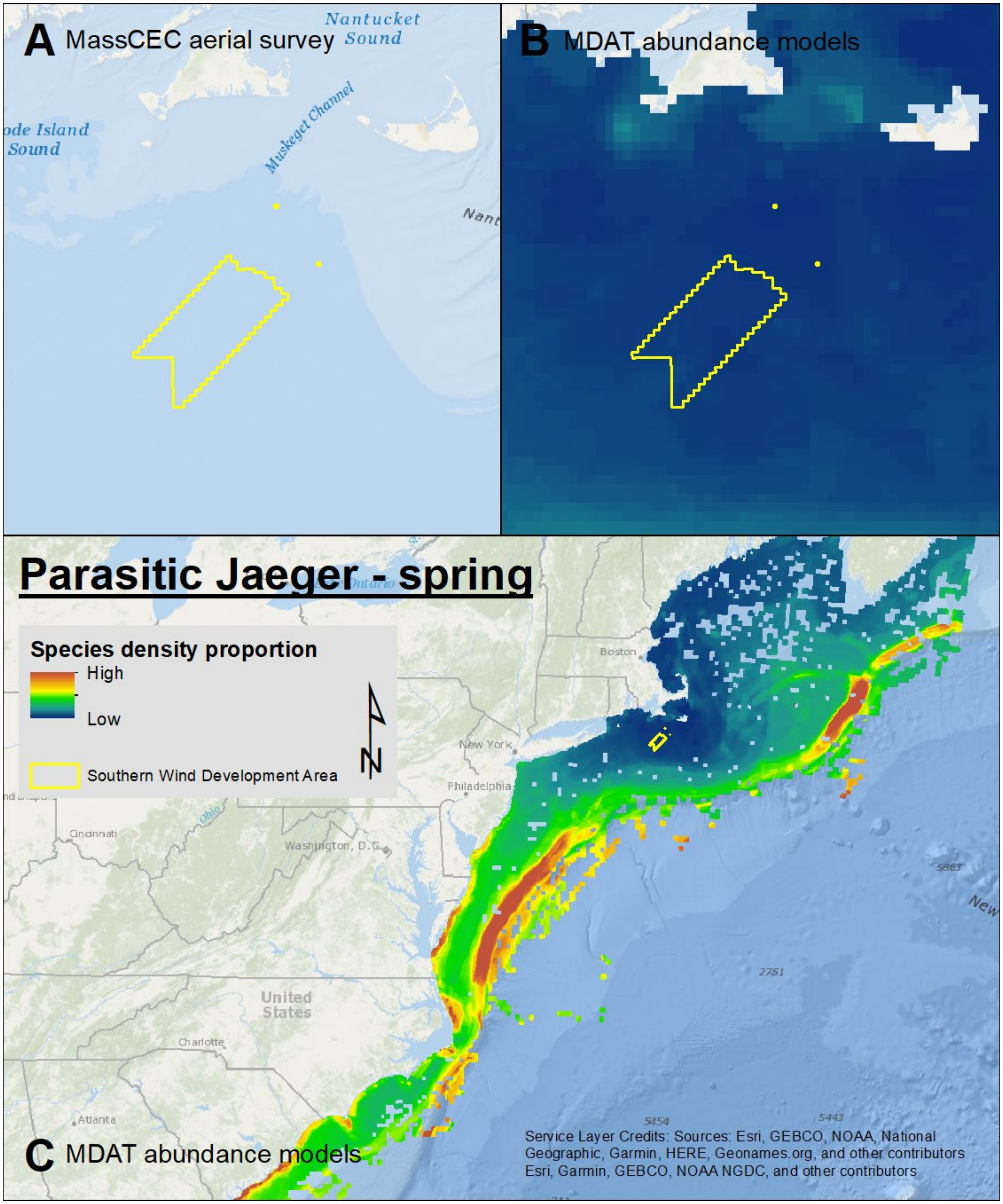

Map 31: Spring Pomarine Jaeger density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



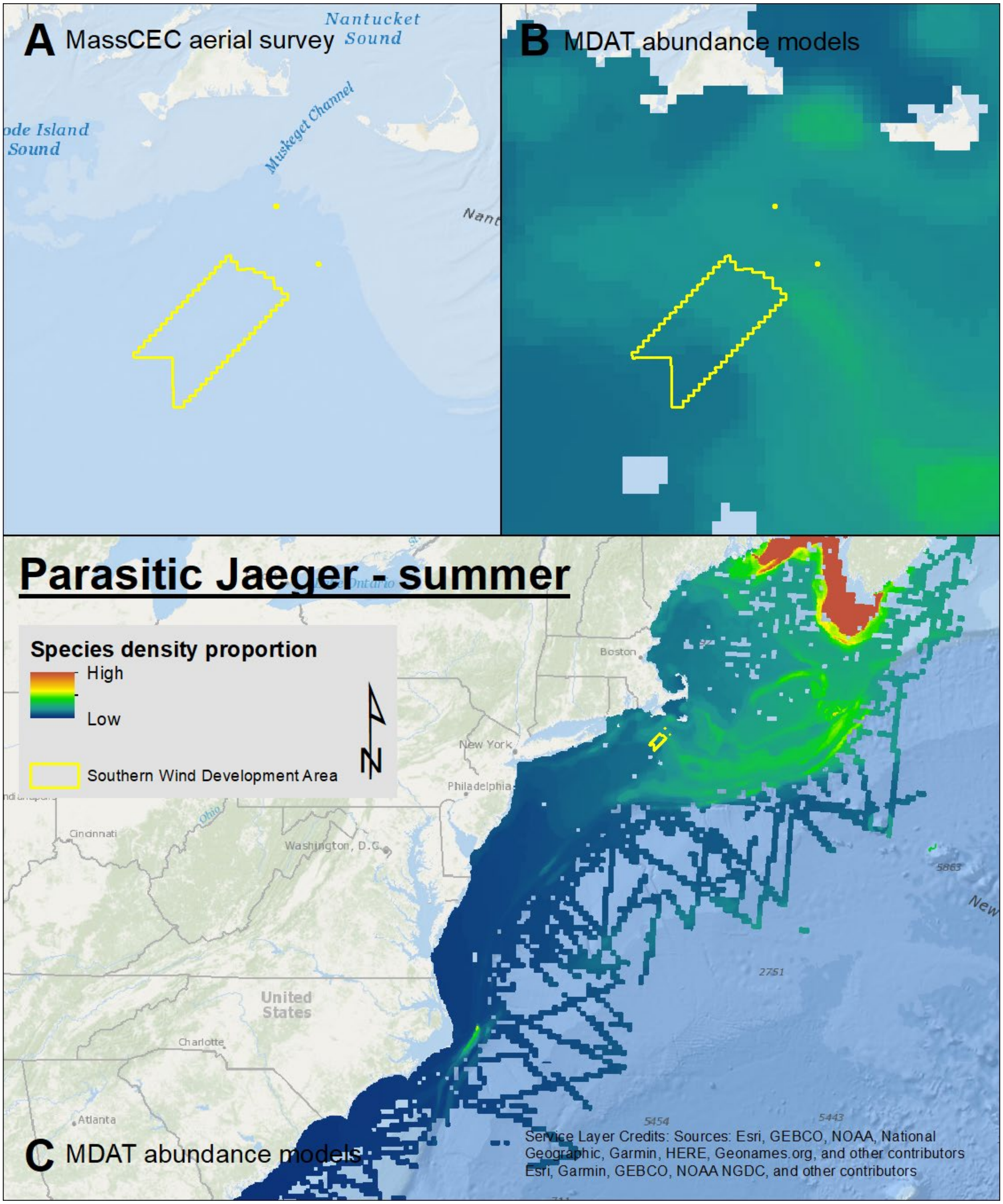

Map 32: Summer Pomarine Jaeger density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



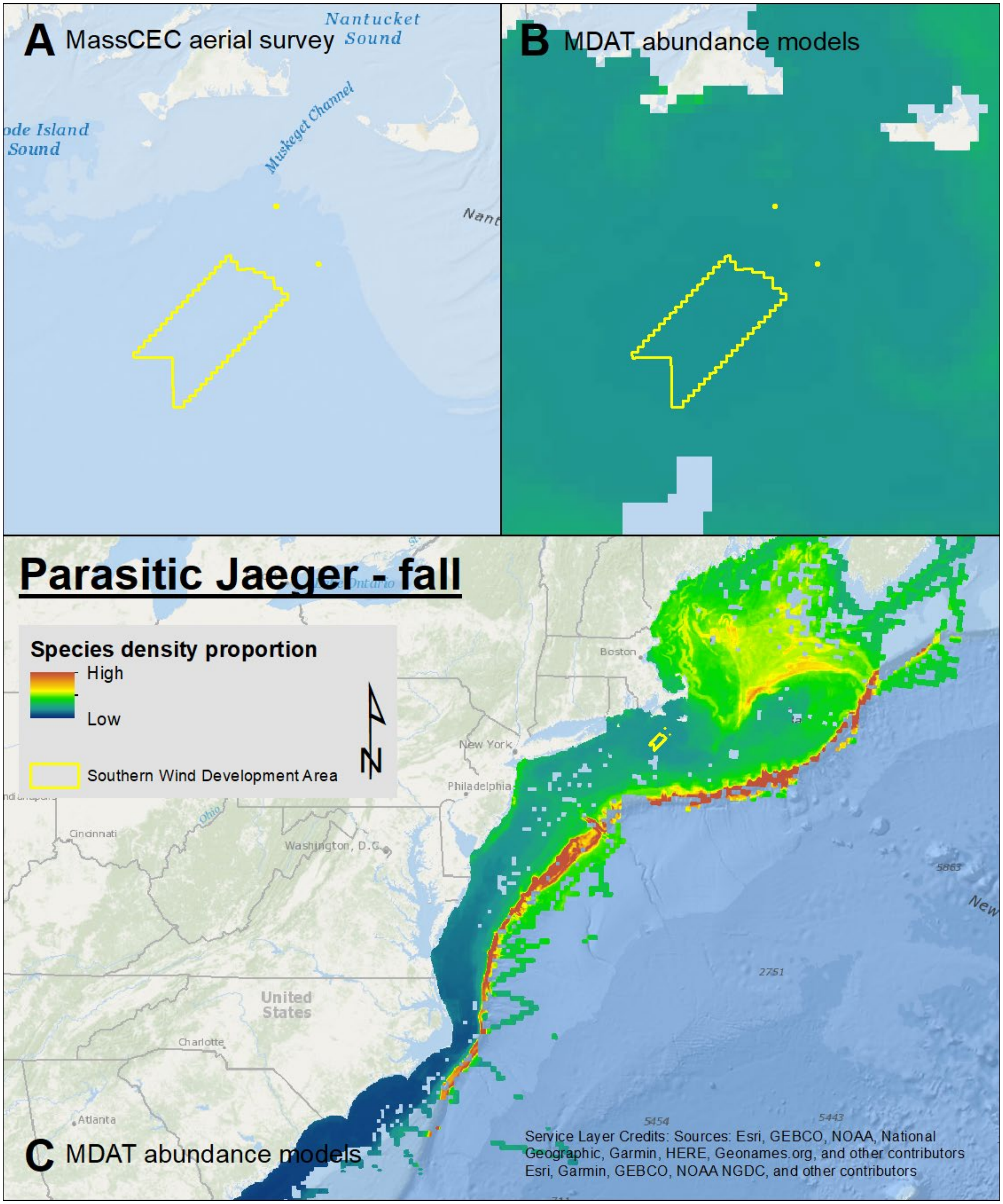

Map 33: Fall Pomarine Jaeger density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



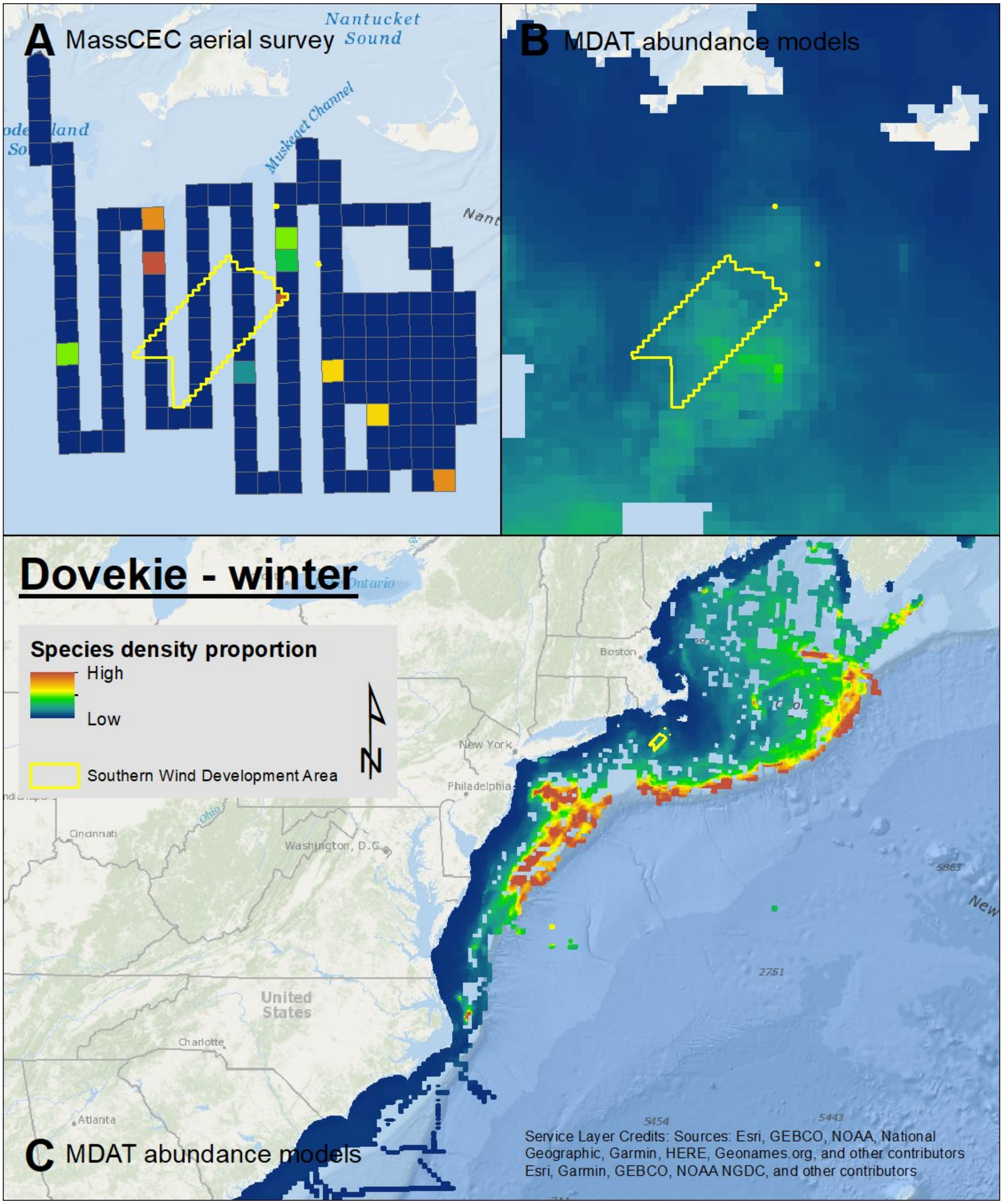

Map 34: Spring Parasitic Jaeger density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



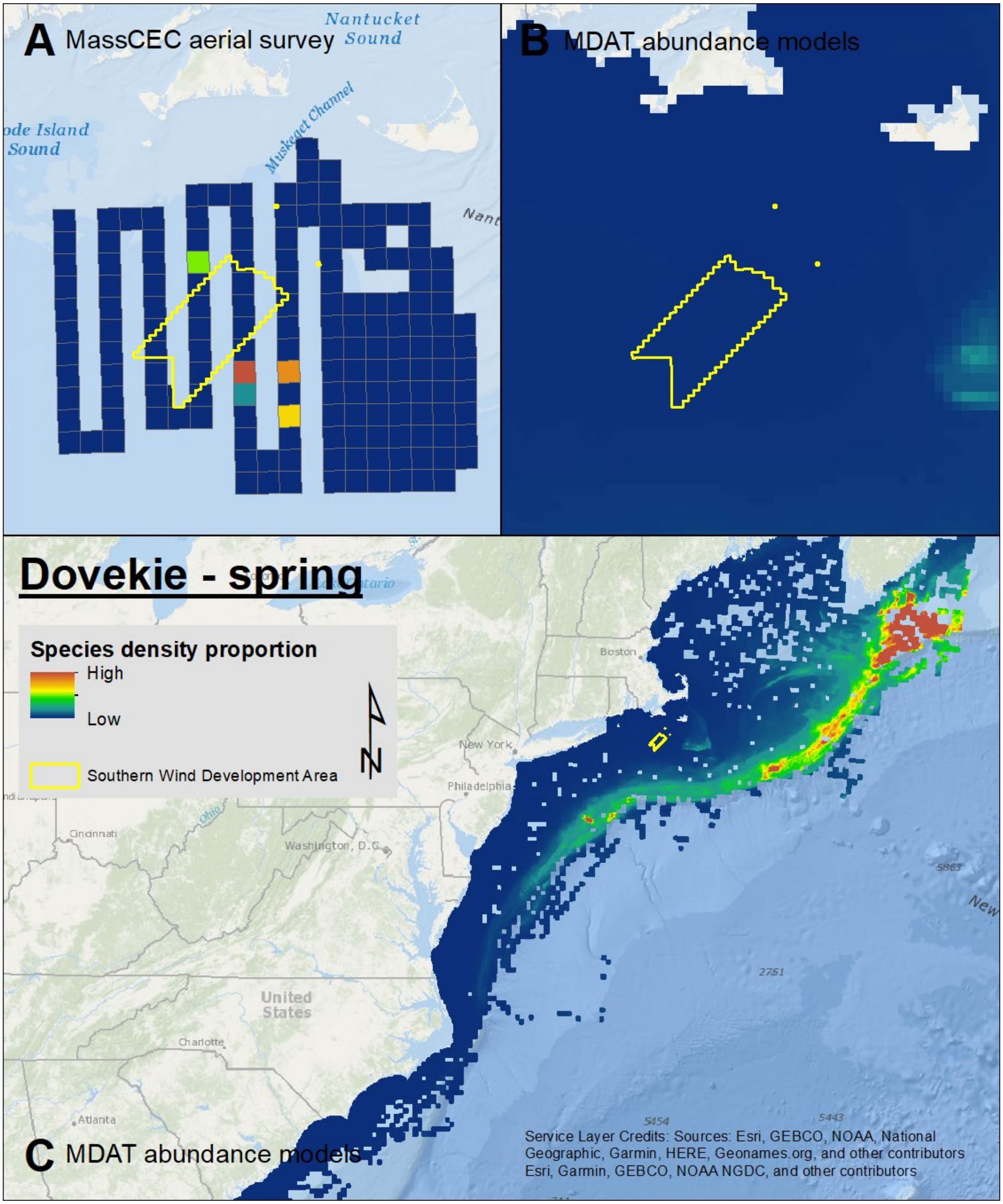

Map 35: Summer Parasitic Jaeger density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



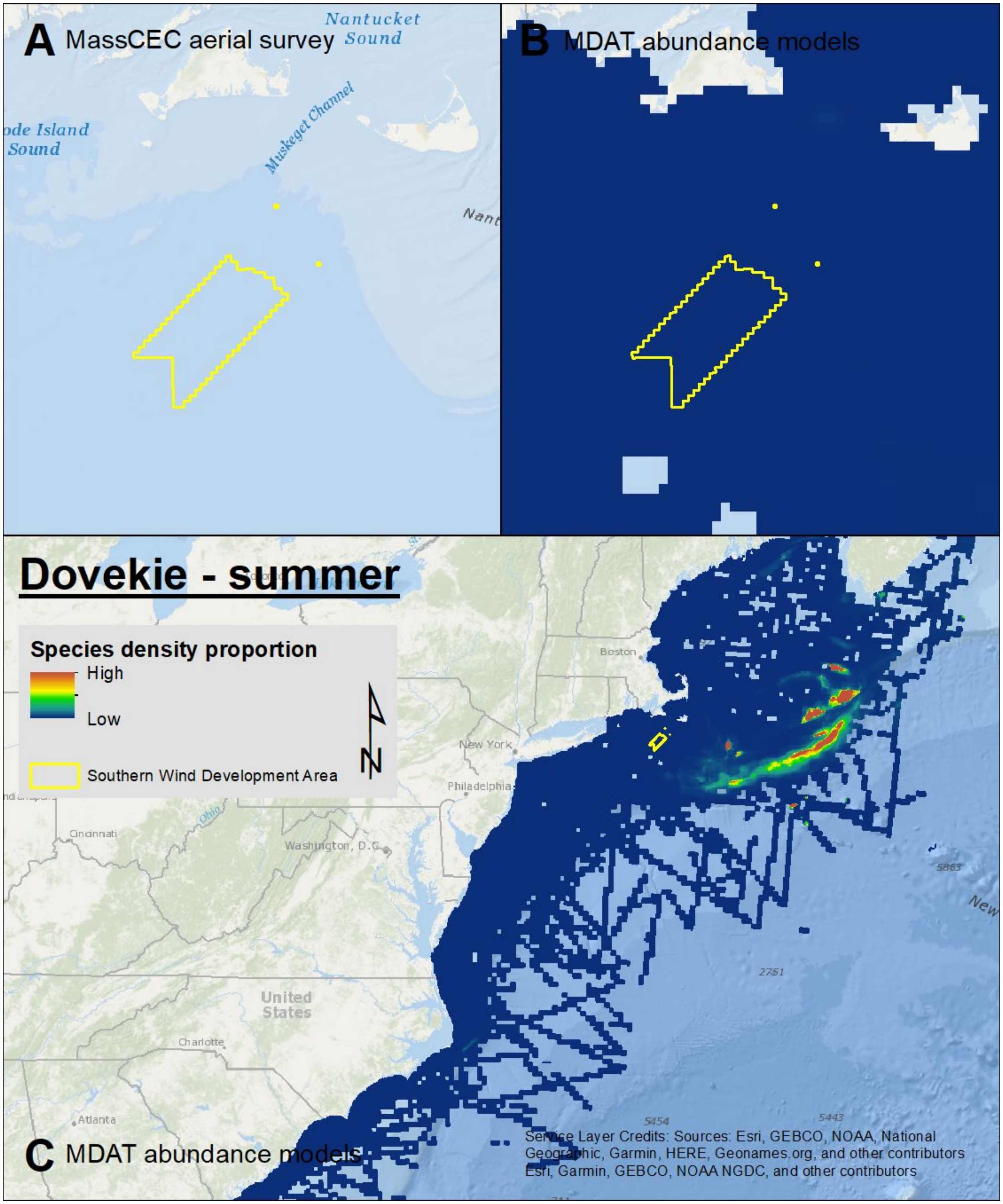

Map 36: Fall Parasitic Jaeger density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



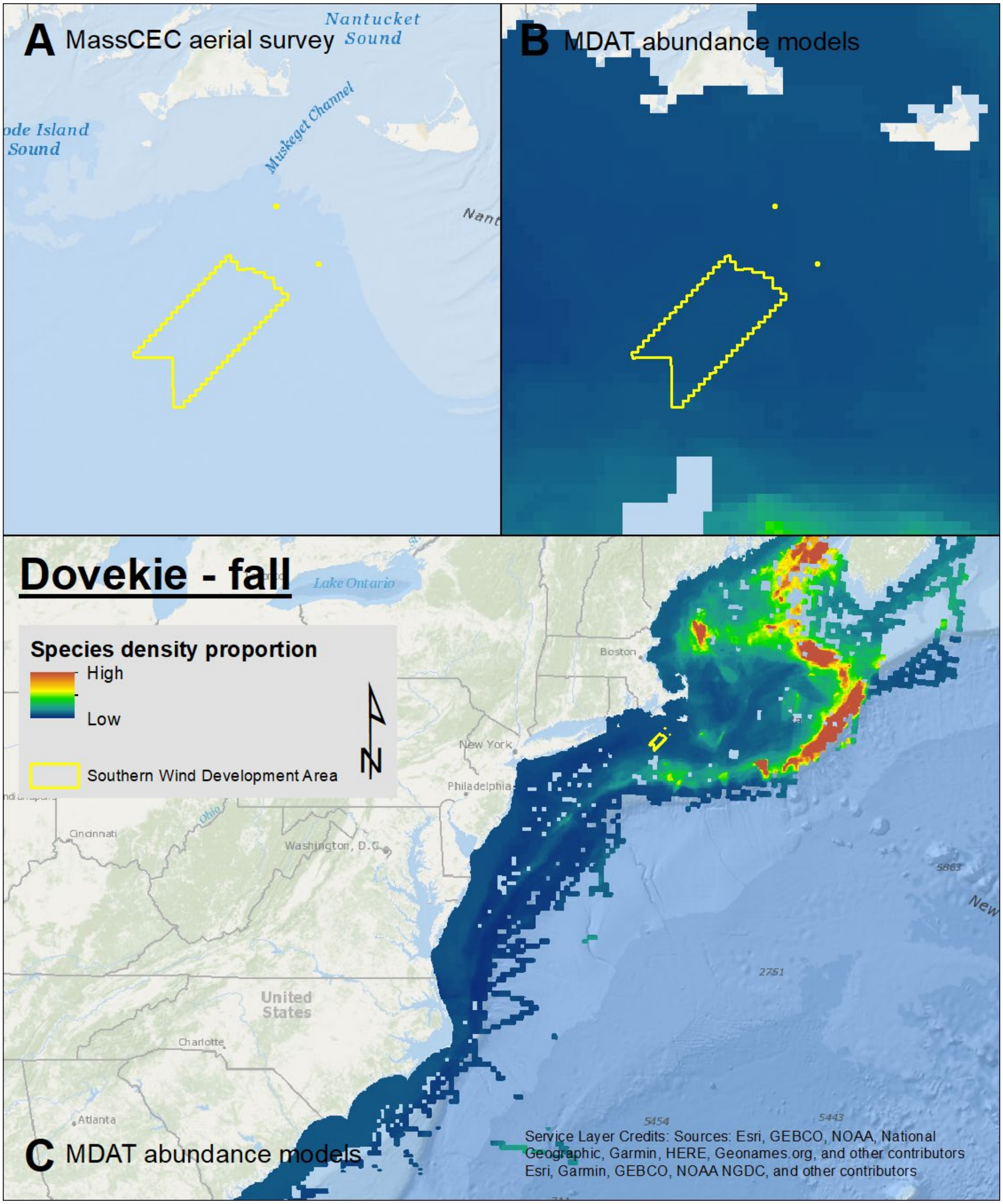

Map 37: Winter Dovekie density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



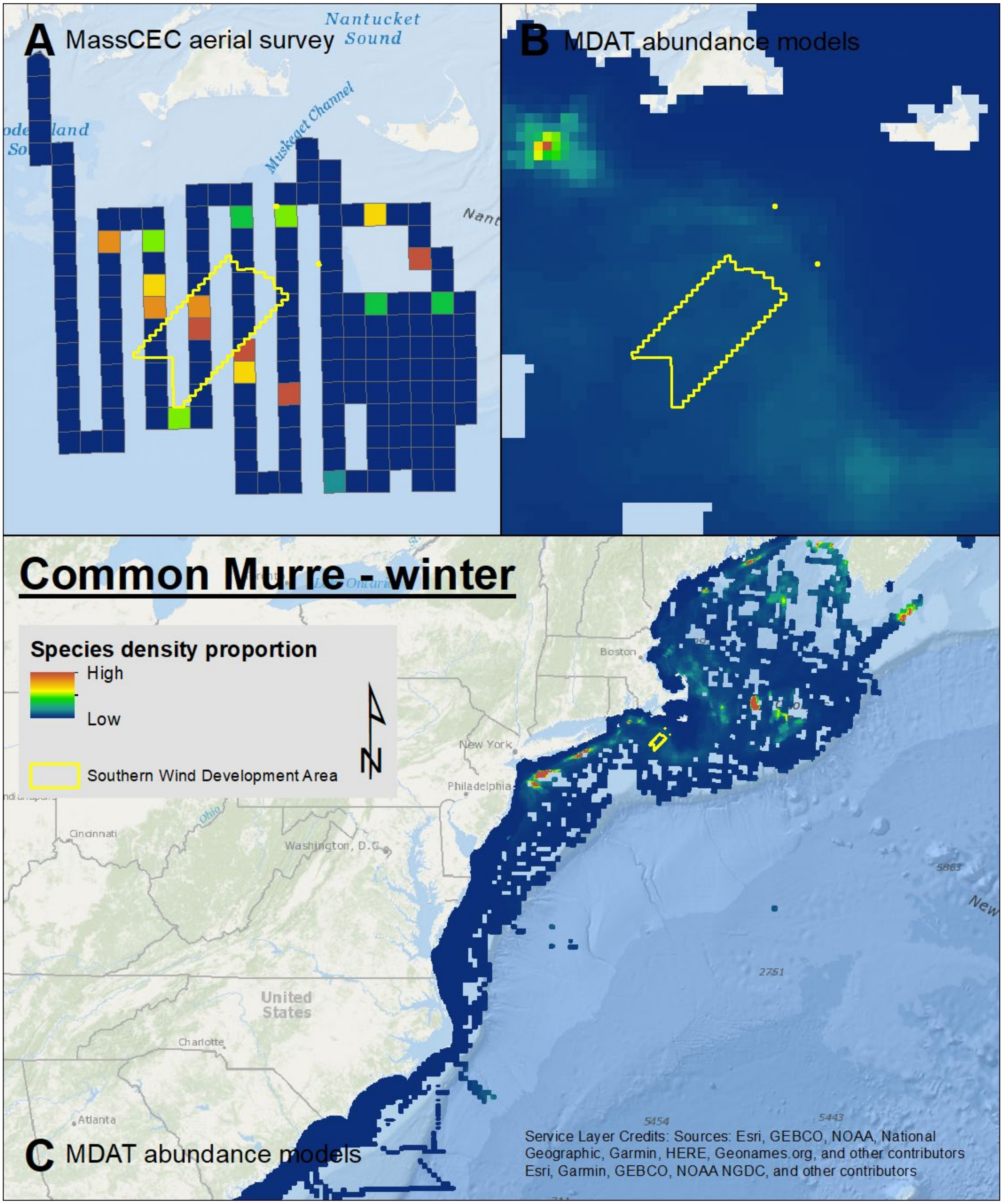

Map 38: Spring Dovekie density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



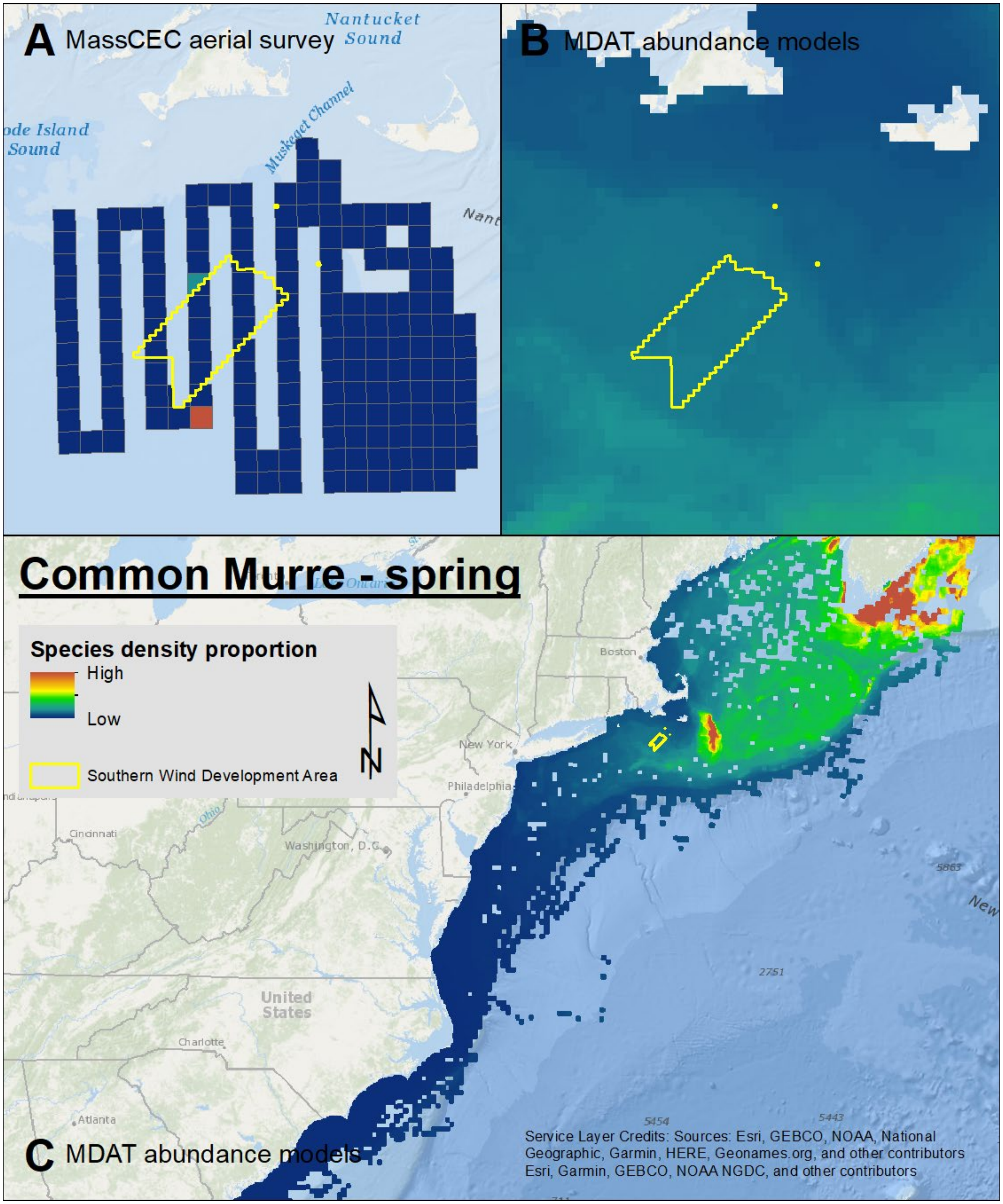

Map 39: Summer Dovekie density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



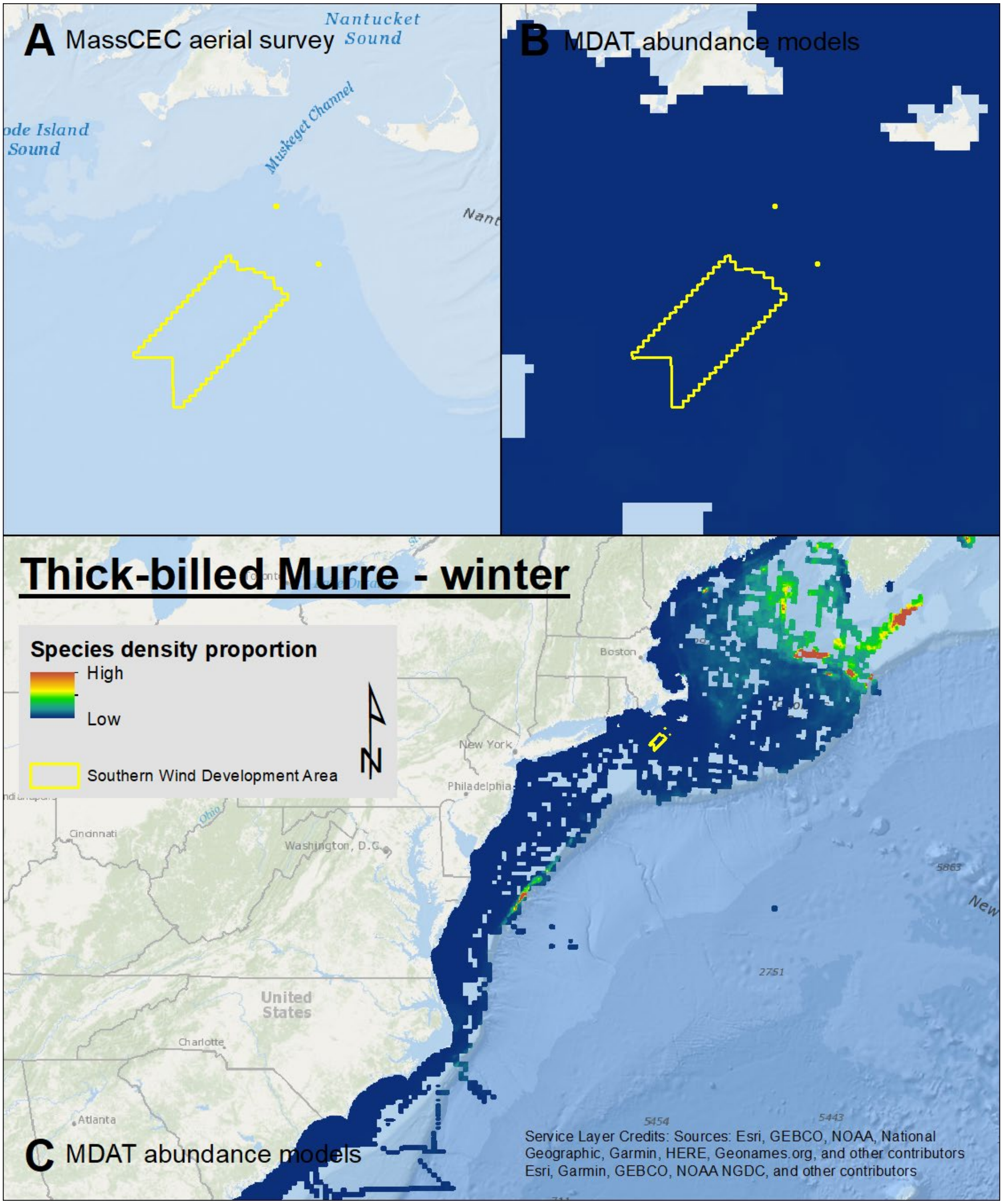

Map 40: Fall Dovekie density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



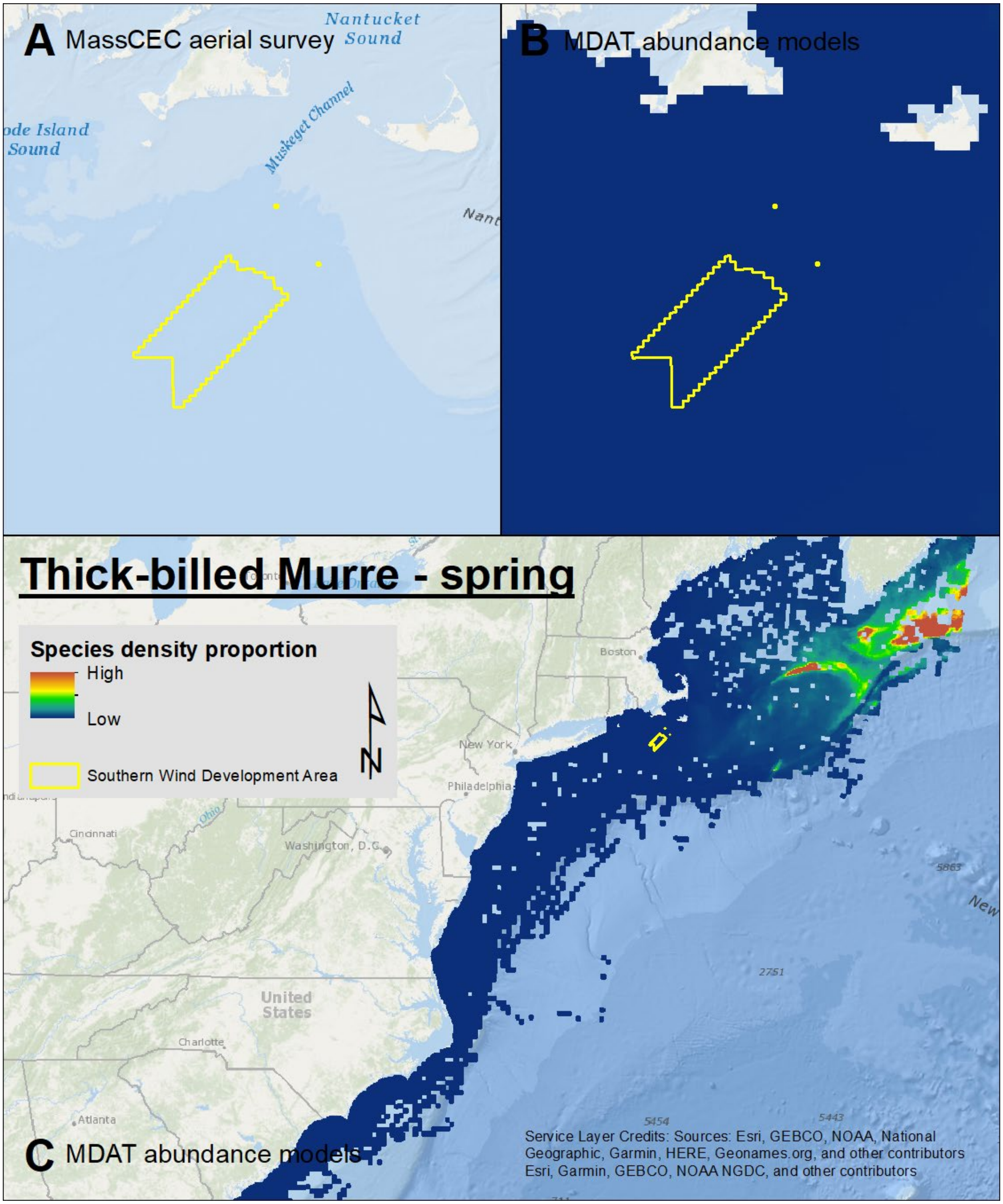

Map 41: Winter Common Murre density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



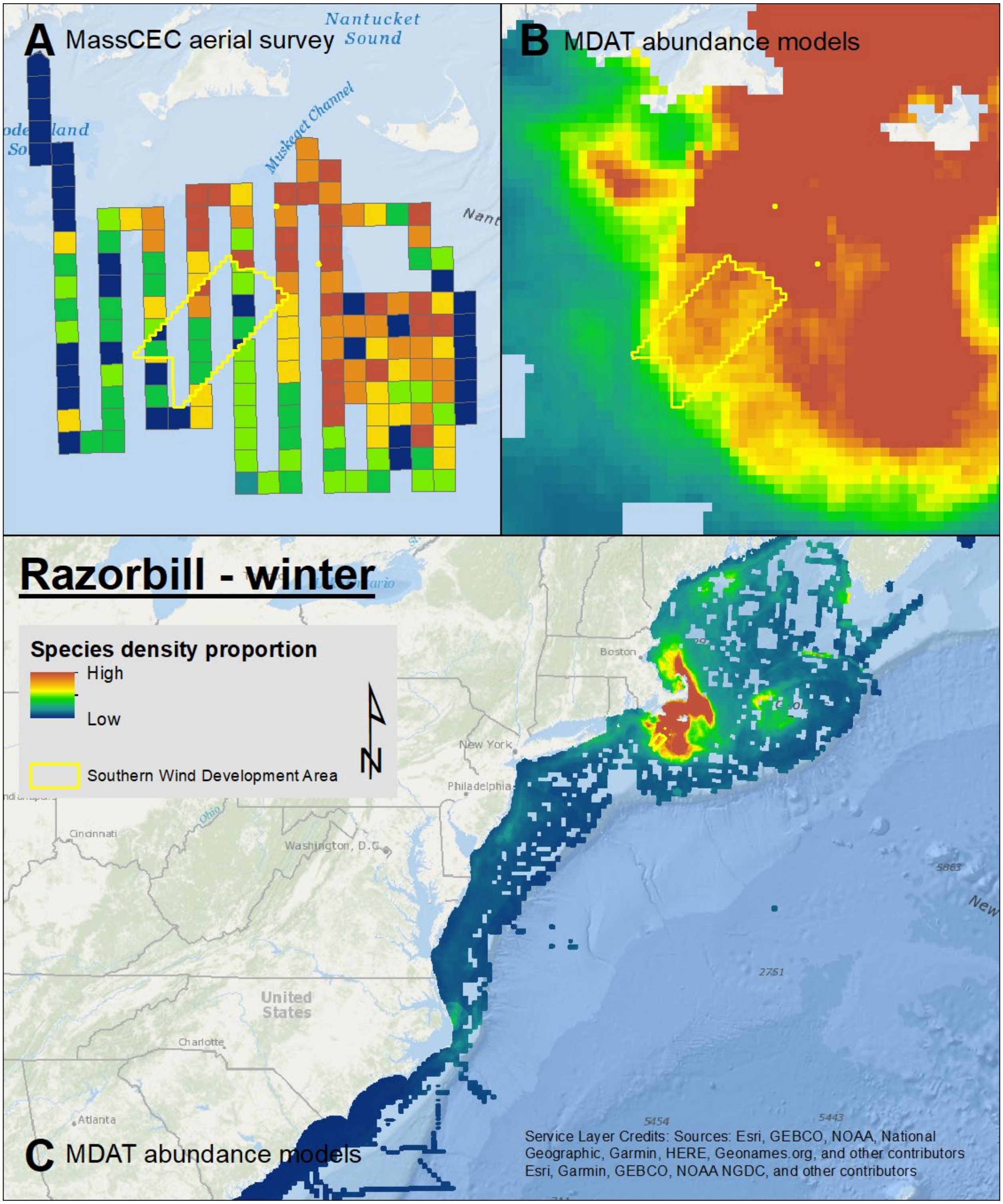

Map 42: Spring Common Murre density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



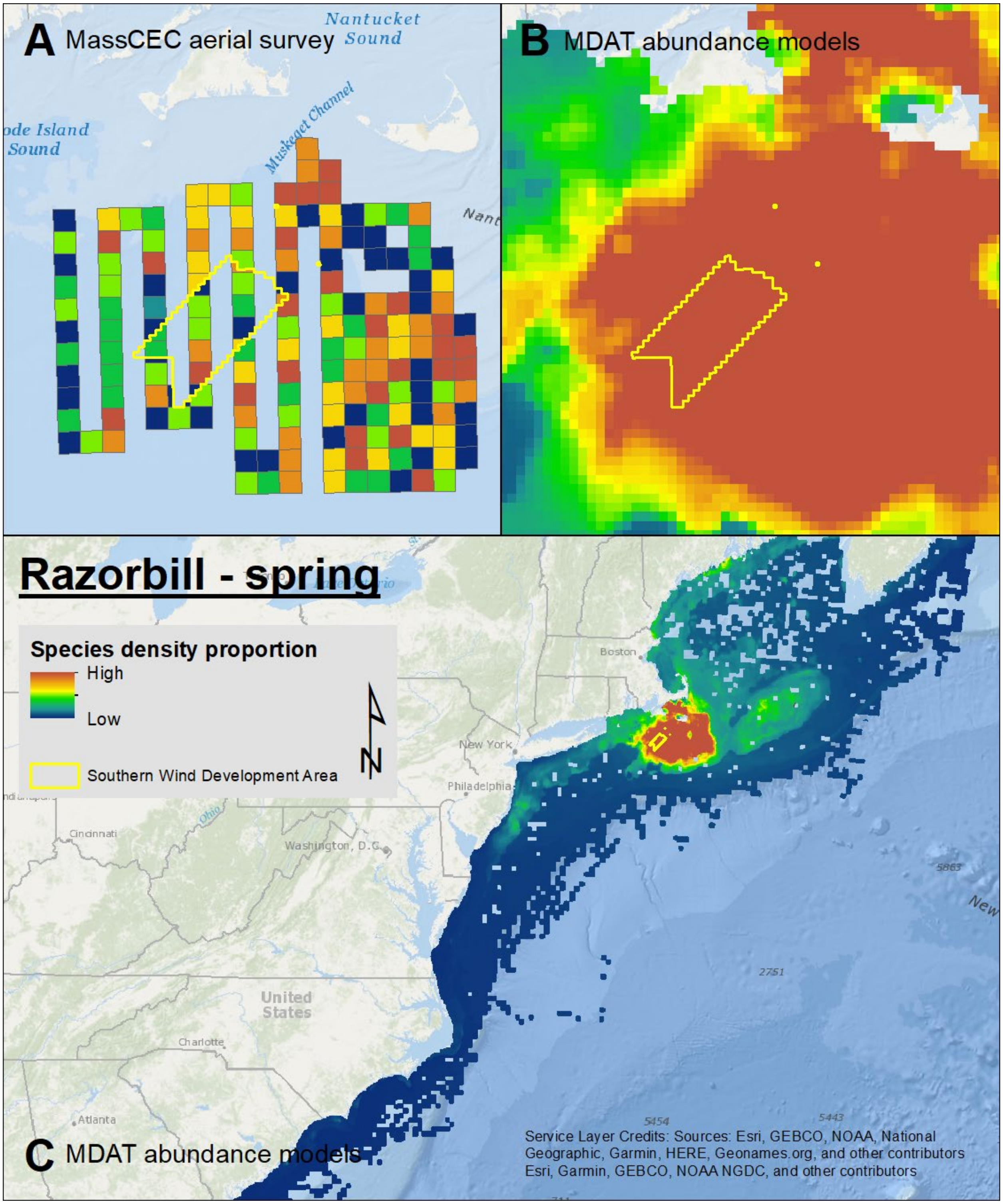

Map 43: Winter Thick-billed Murre density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



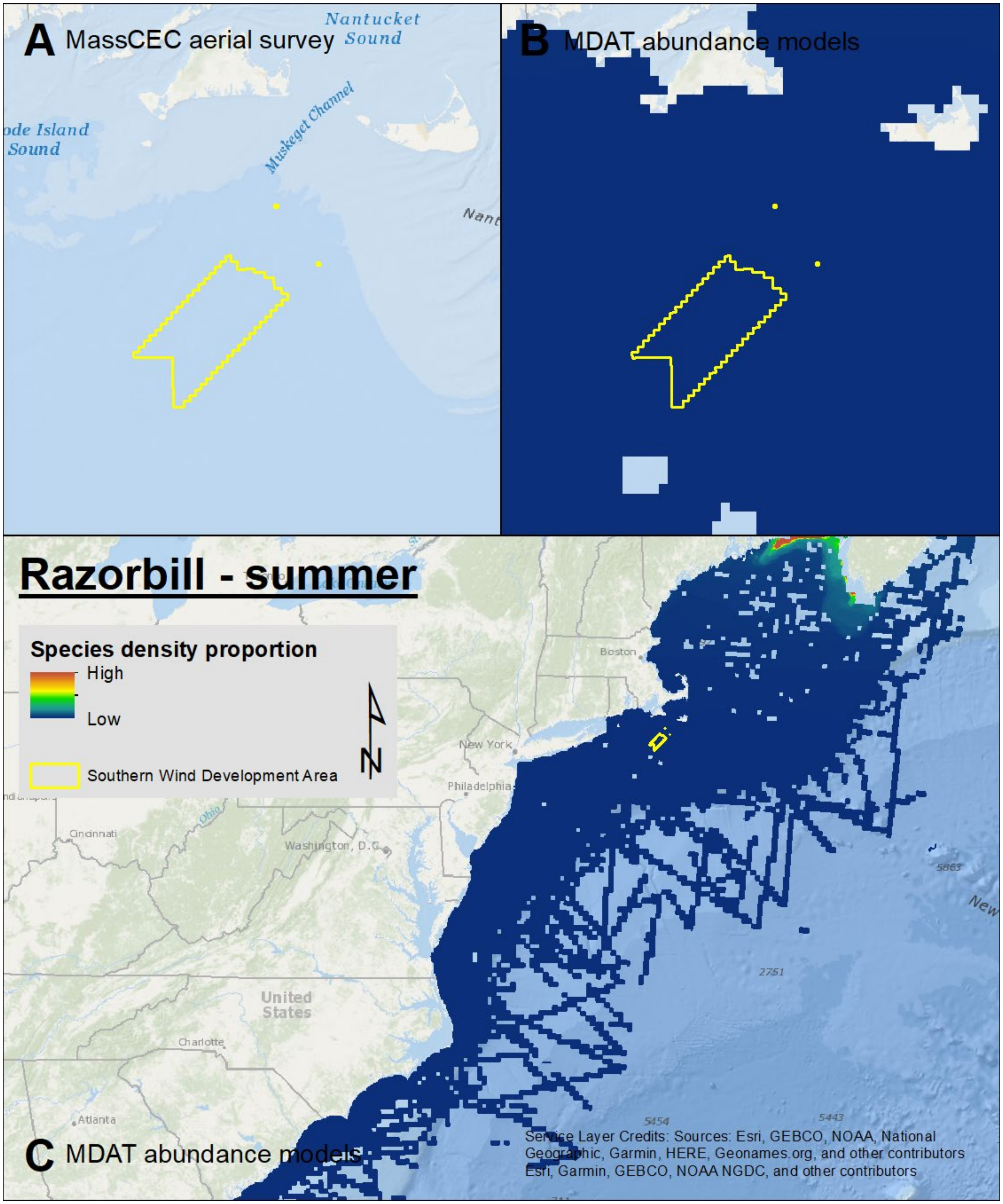

Map 44: Spring Thick-billed Murre density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



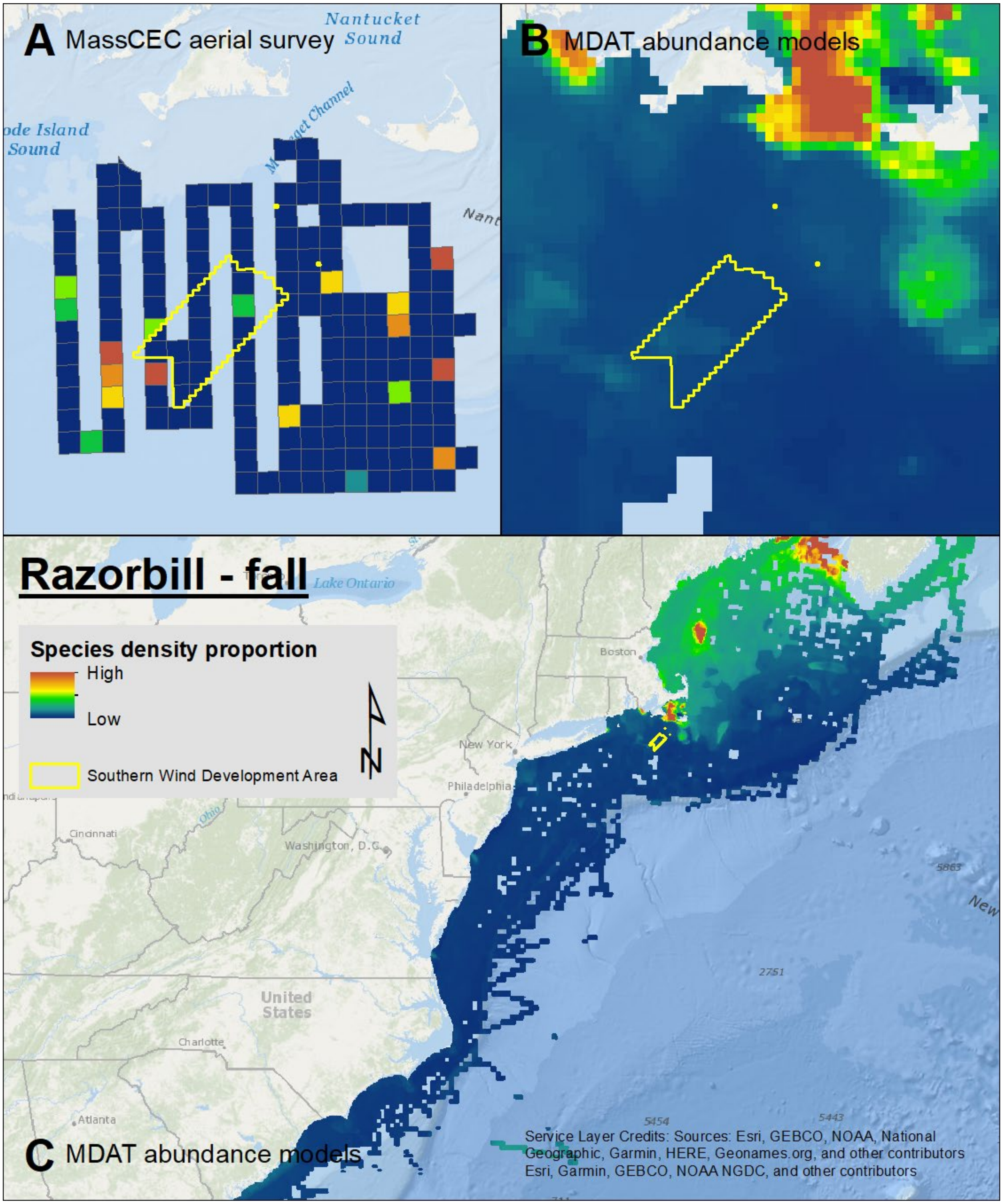

Map 45: Winter Razorbill density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



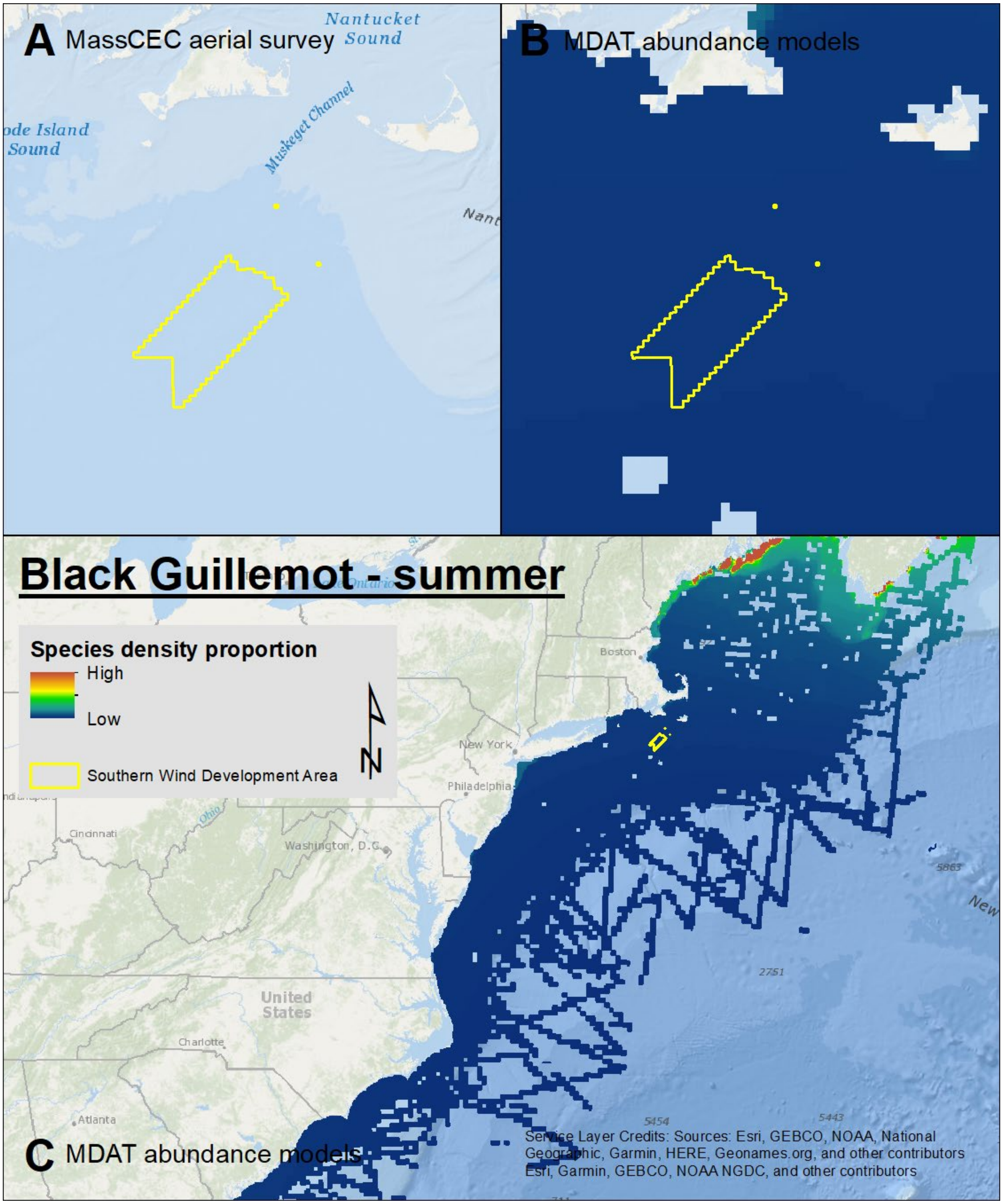

Map 46: Spring Razorbill density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



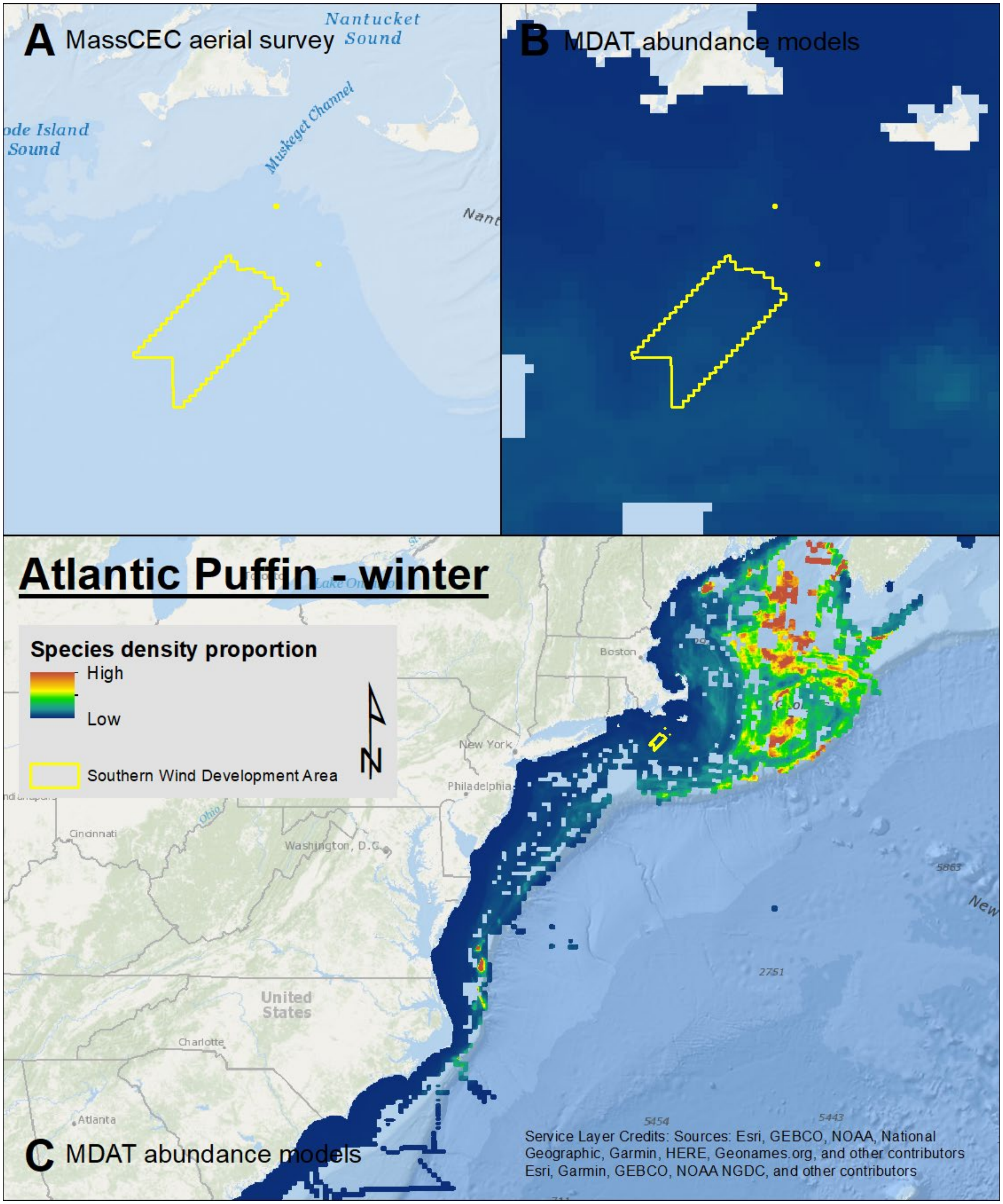

Map 47: Summer Razorbill density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



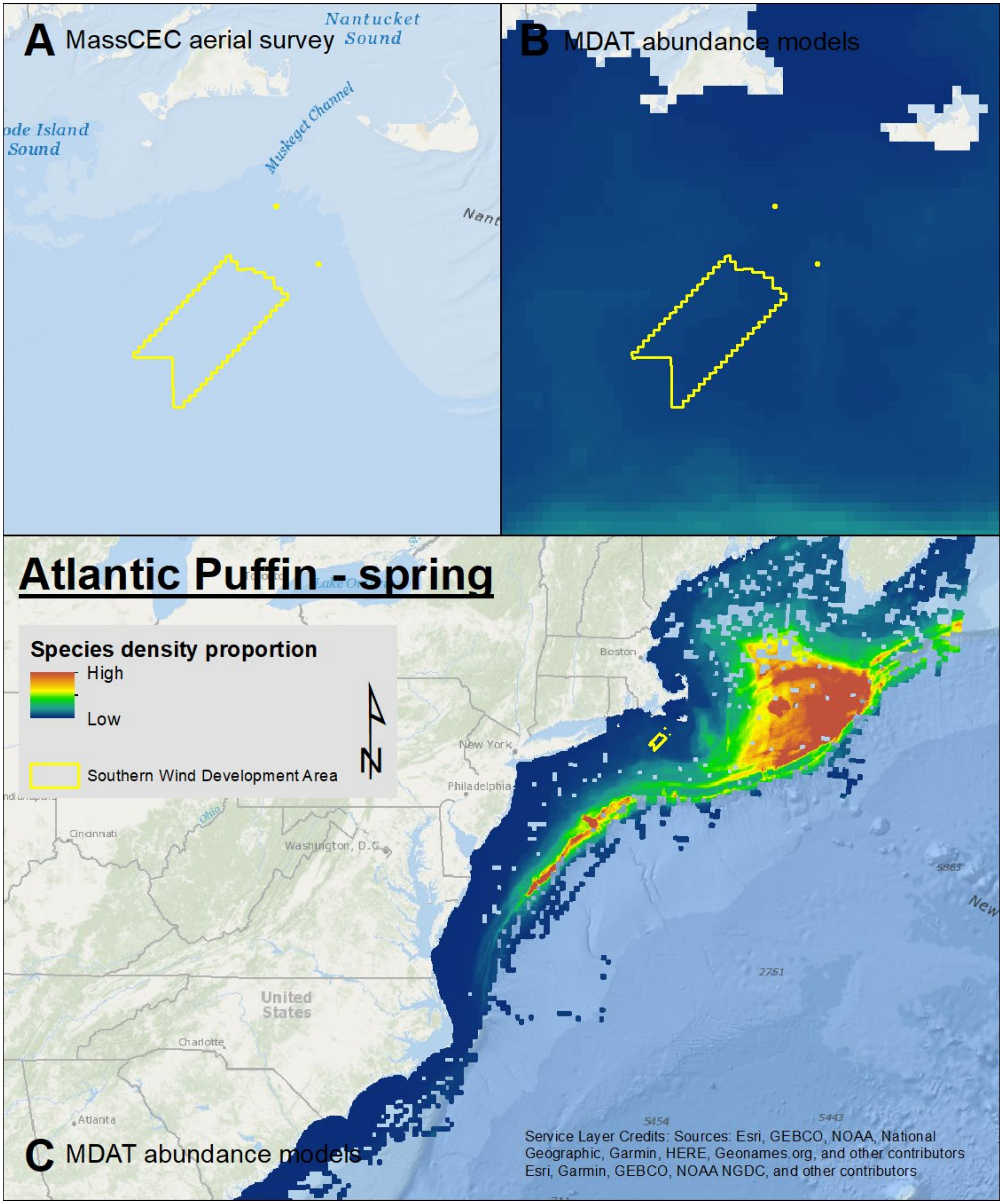

Map 48: Fall Razorbill density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



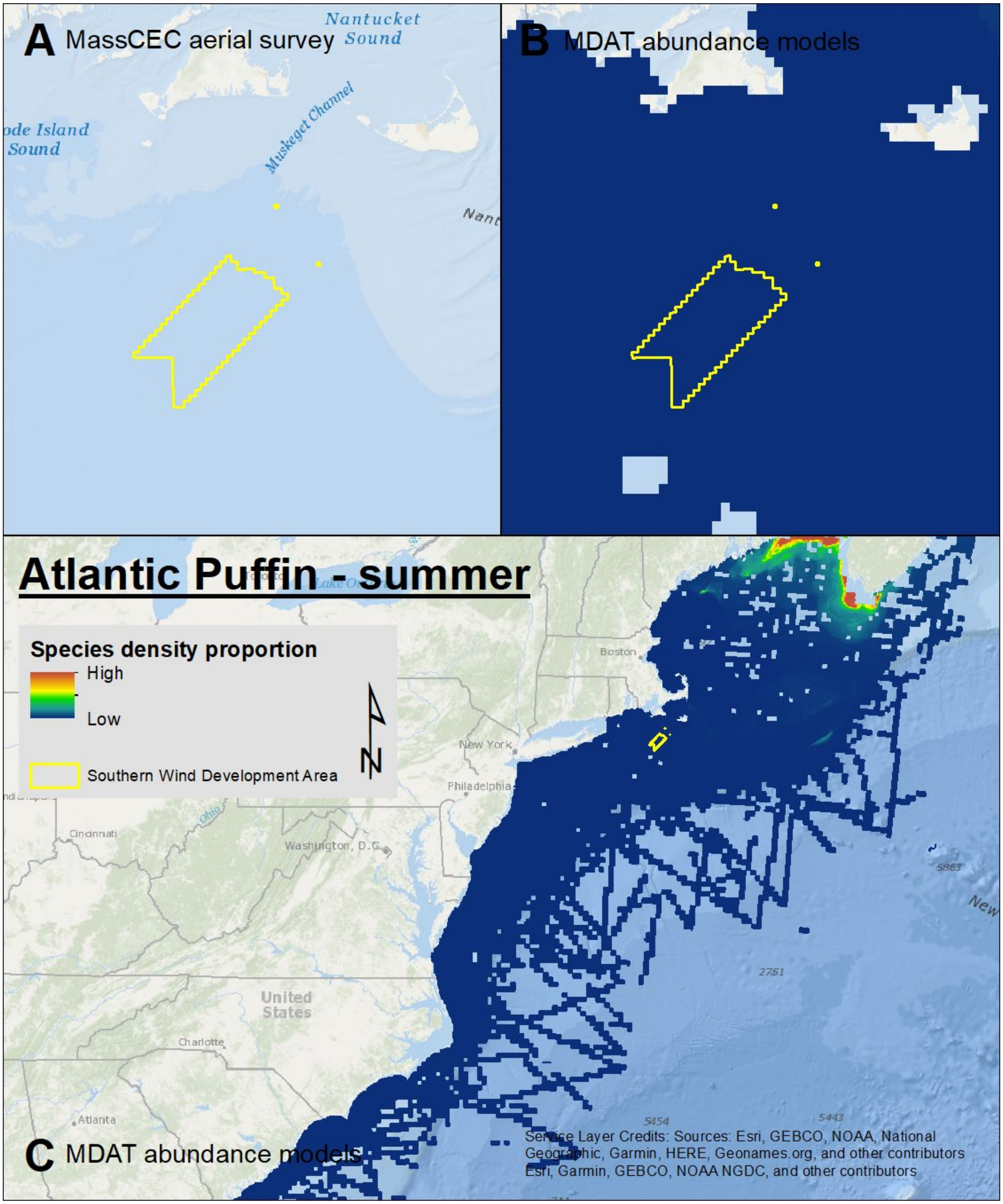

Map 49: Summer Black Guillemot density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



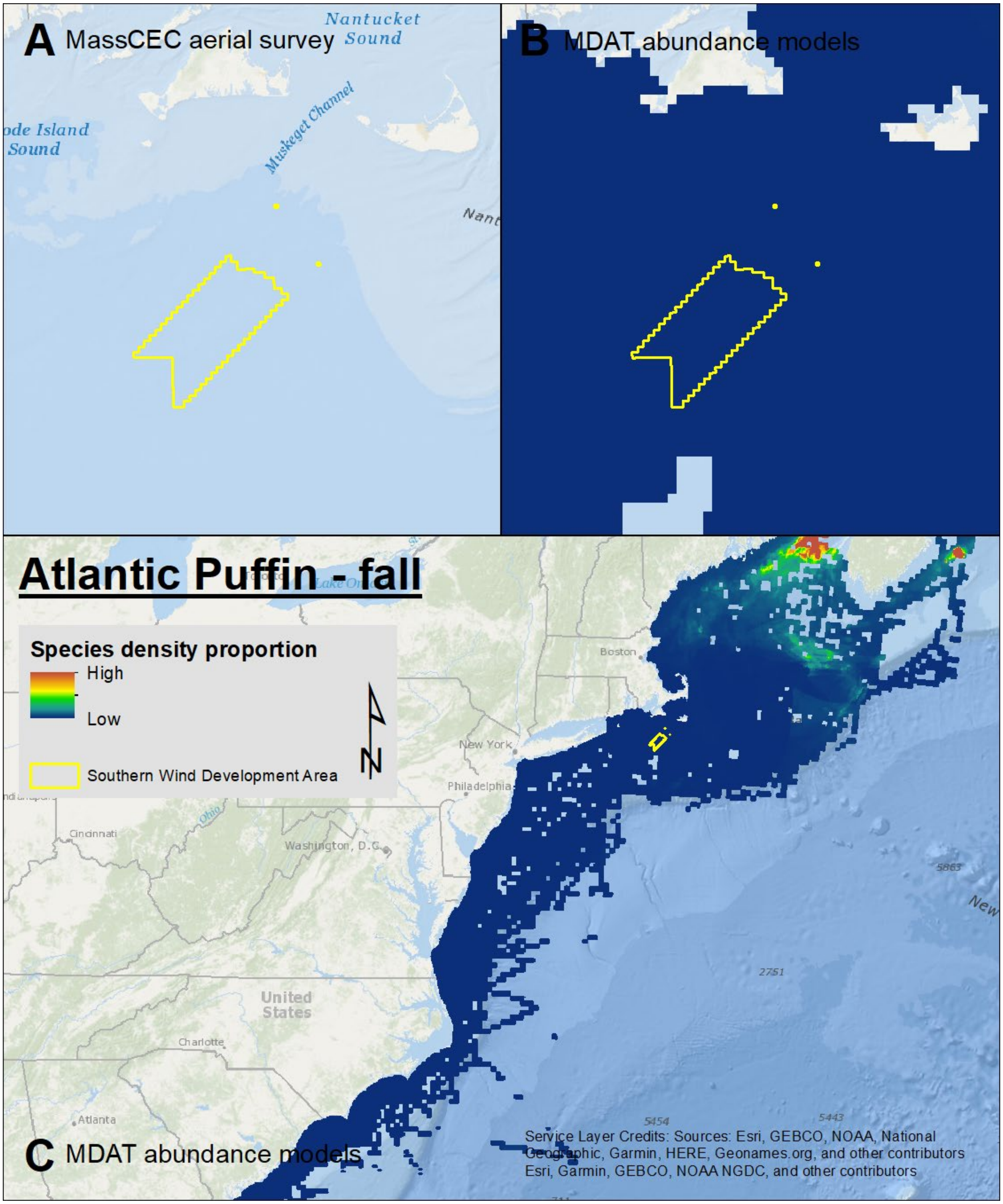

Map 50: Winter Atlantic Puffin density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



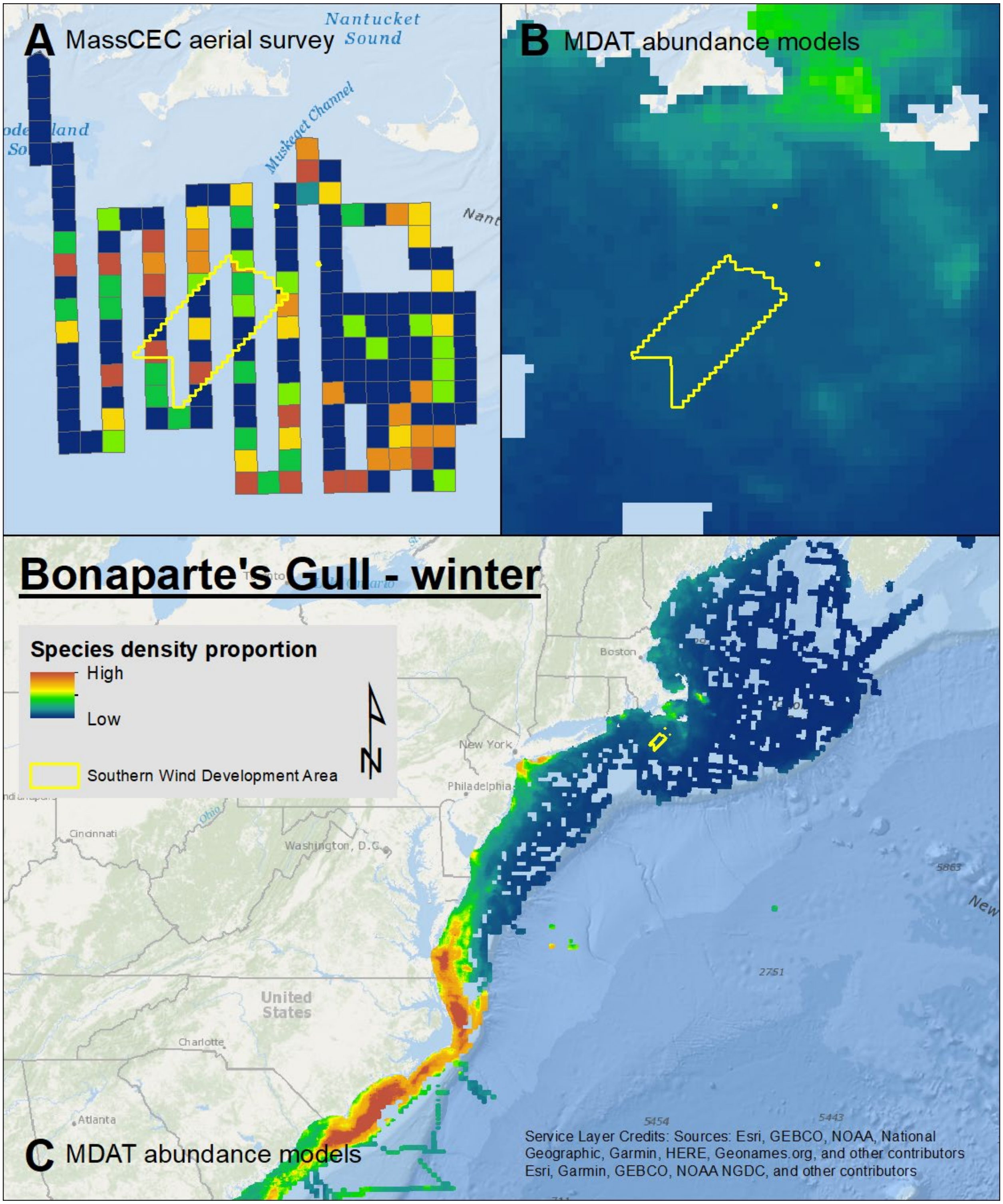

Map 51: Spring Atlantic Puffin density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



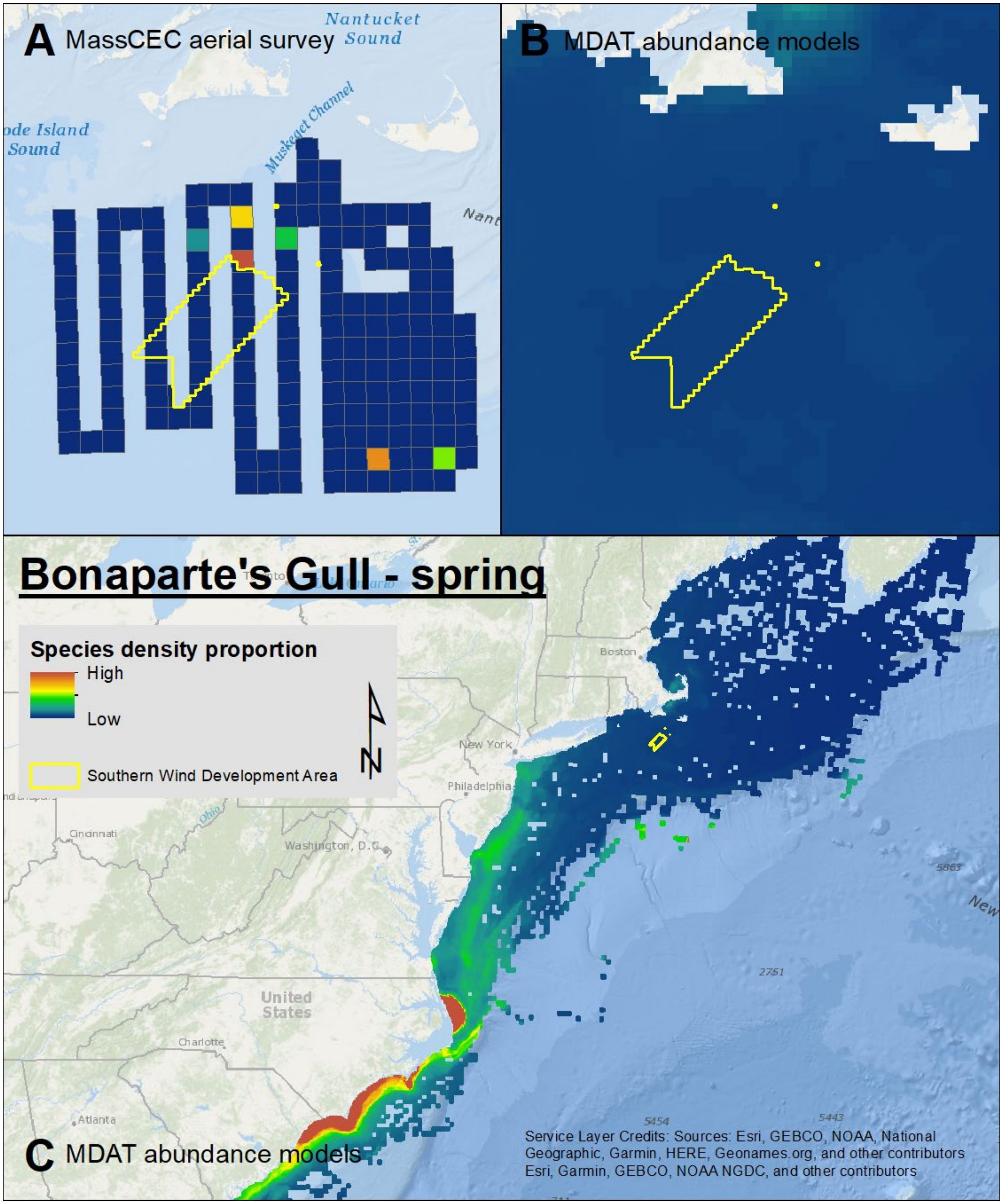

Map 52: Summer Atlantic Puffin density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



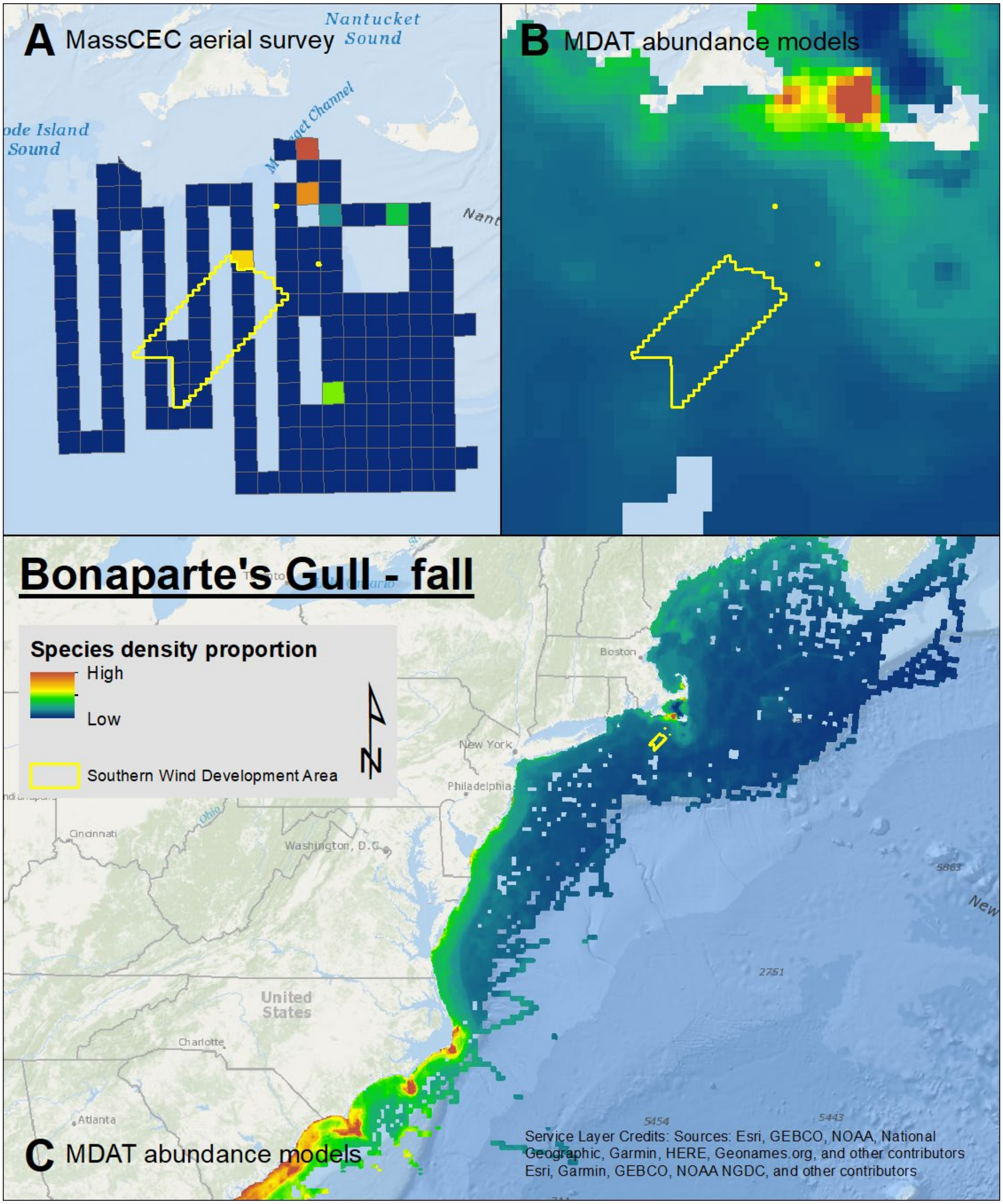

Map 53: Fall Atlantic Puffin density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



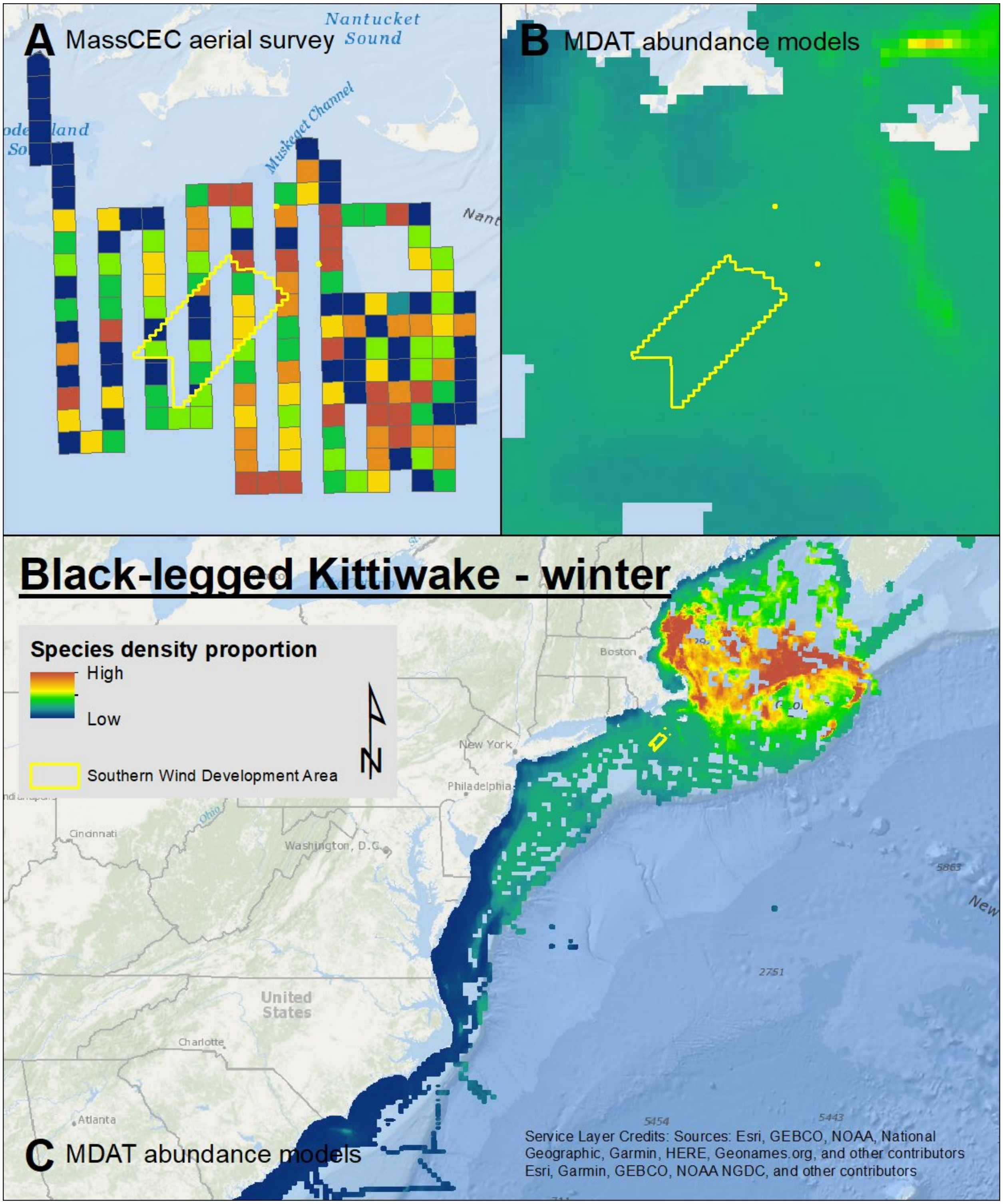

Map 54: Winter Bonaparte's Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



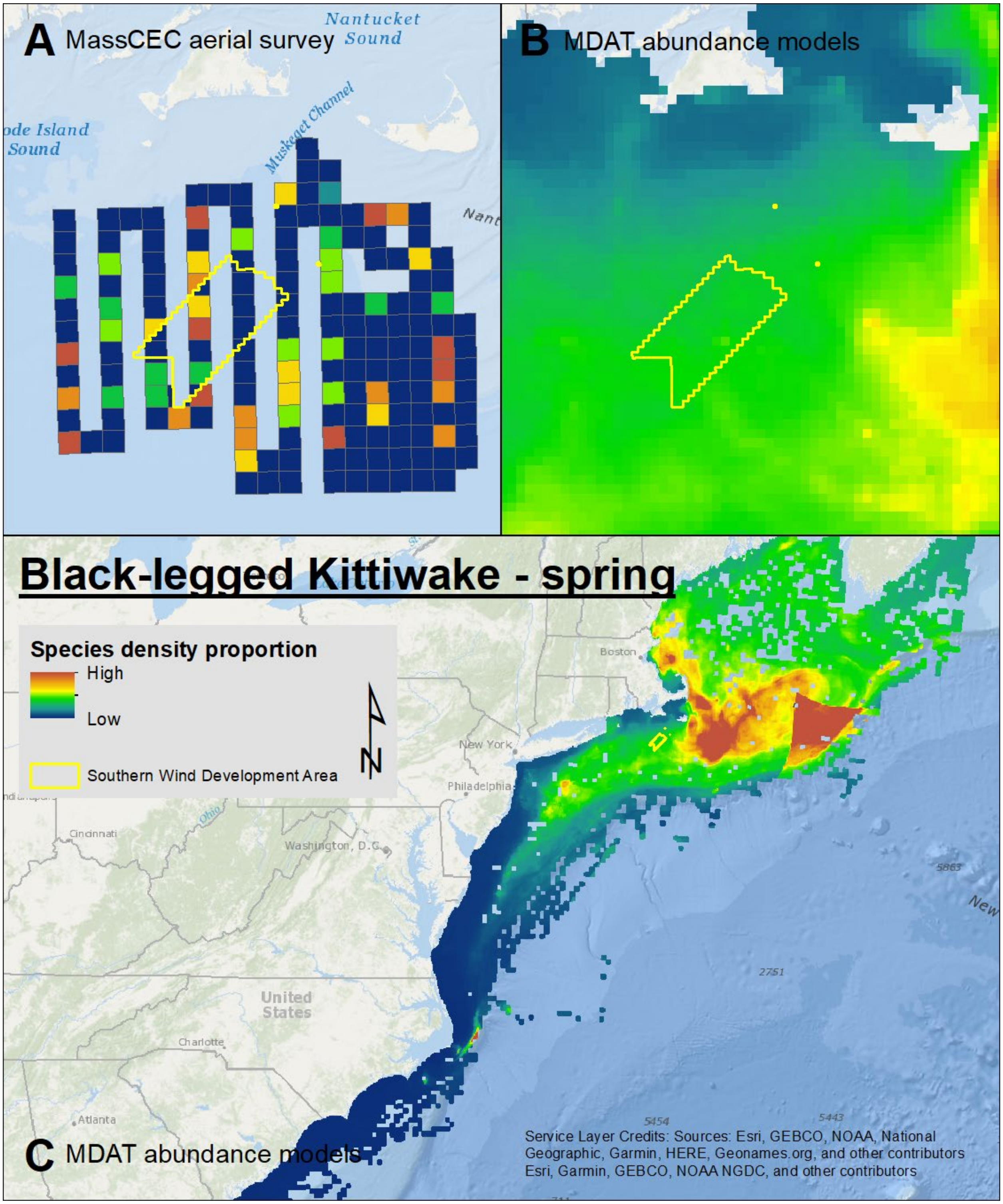

Map 55: Spring Bonaparte's Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



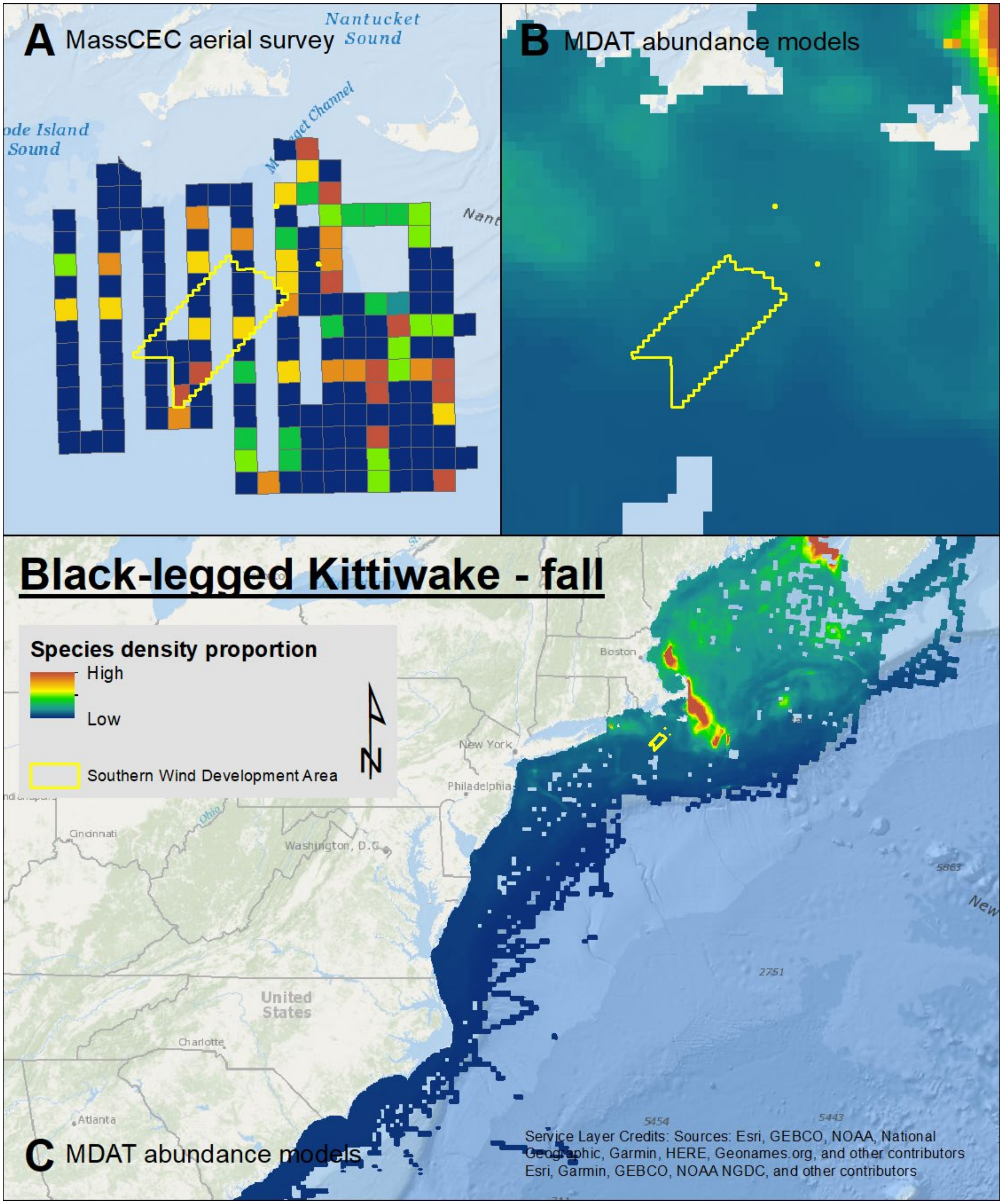

Map 56: Fall Bonaparte's Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



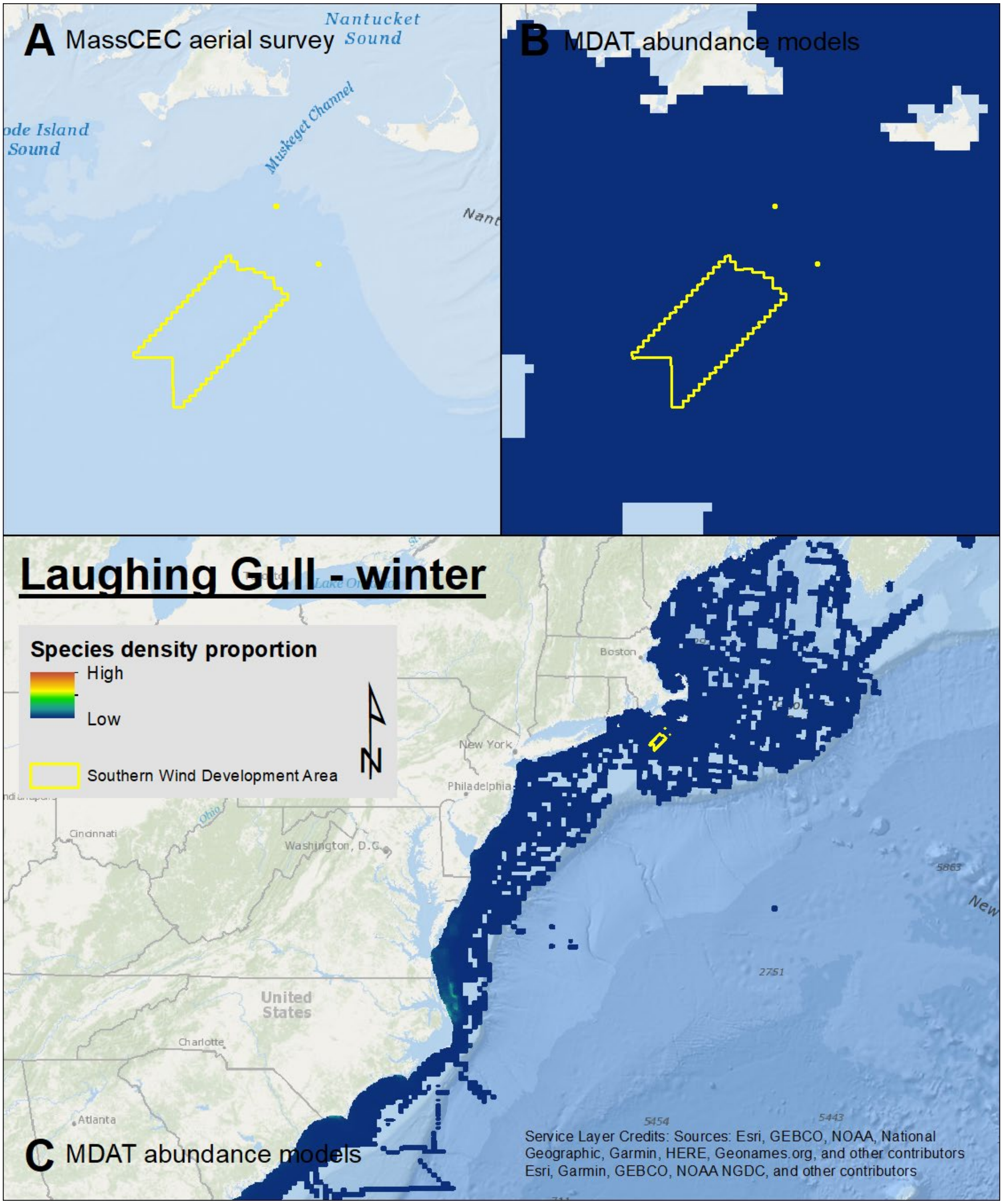

Map 57: Winter Black-legged Kittiwake density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



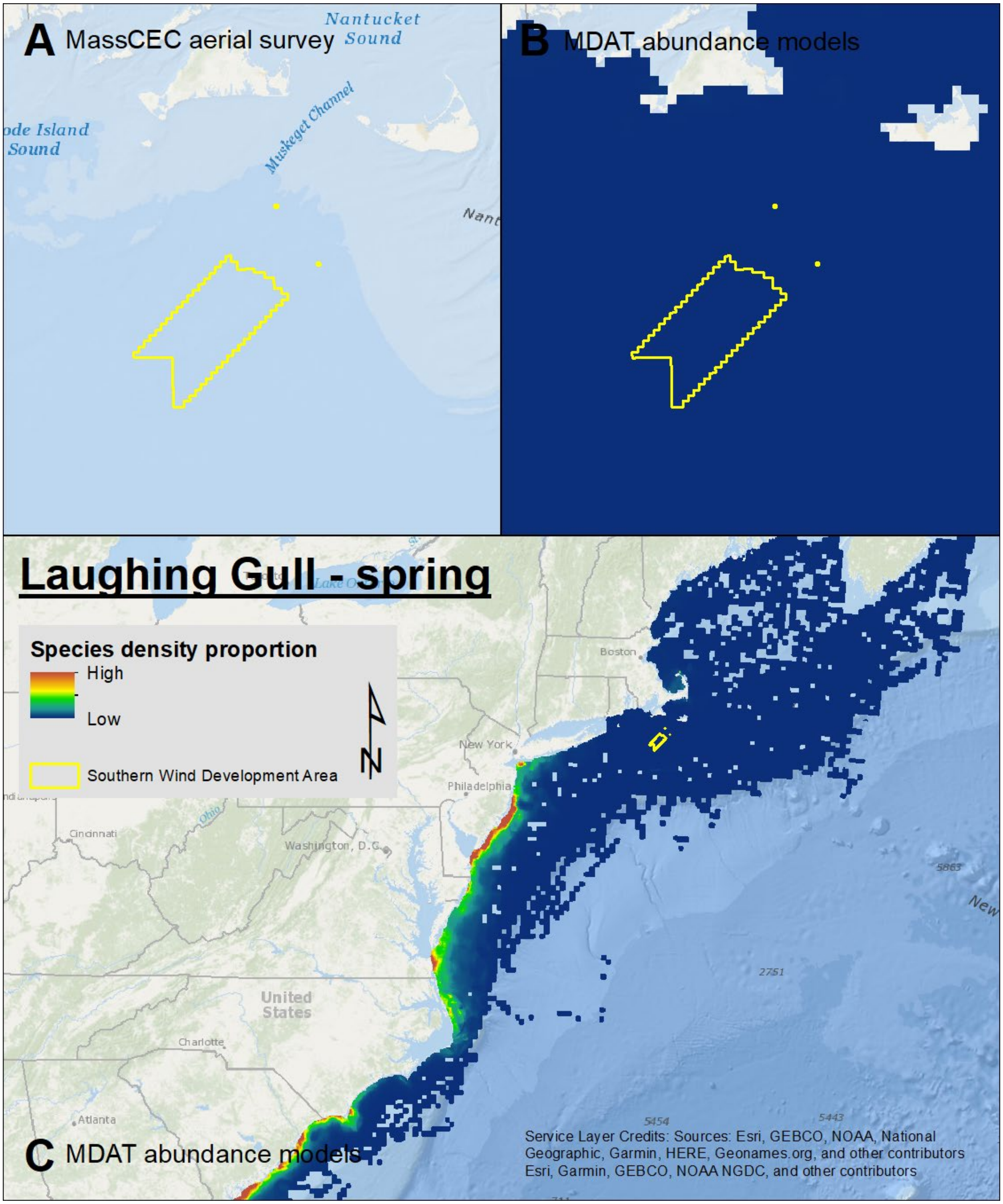

Map 58: Spring Black-legged Kittiwake density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



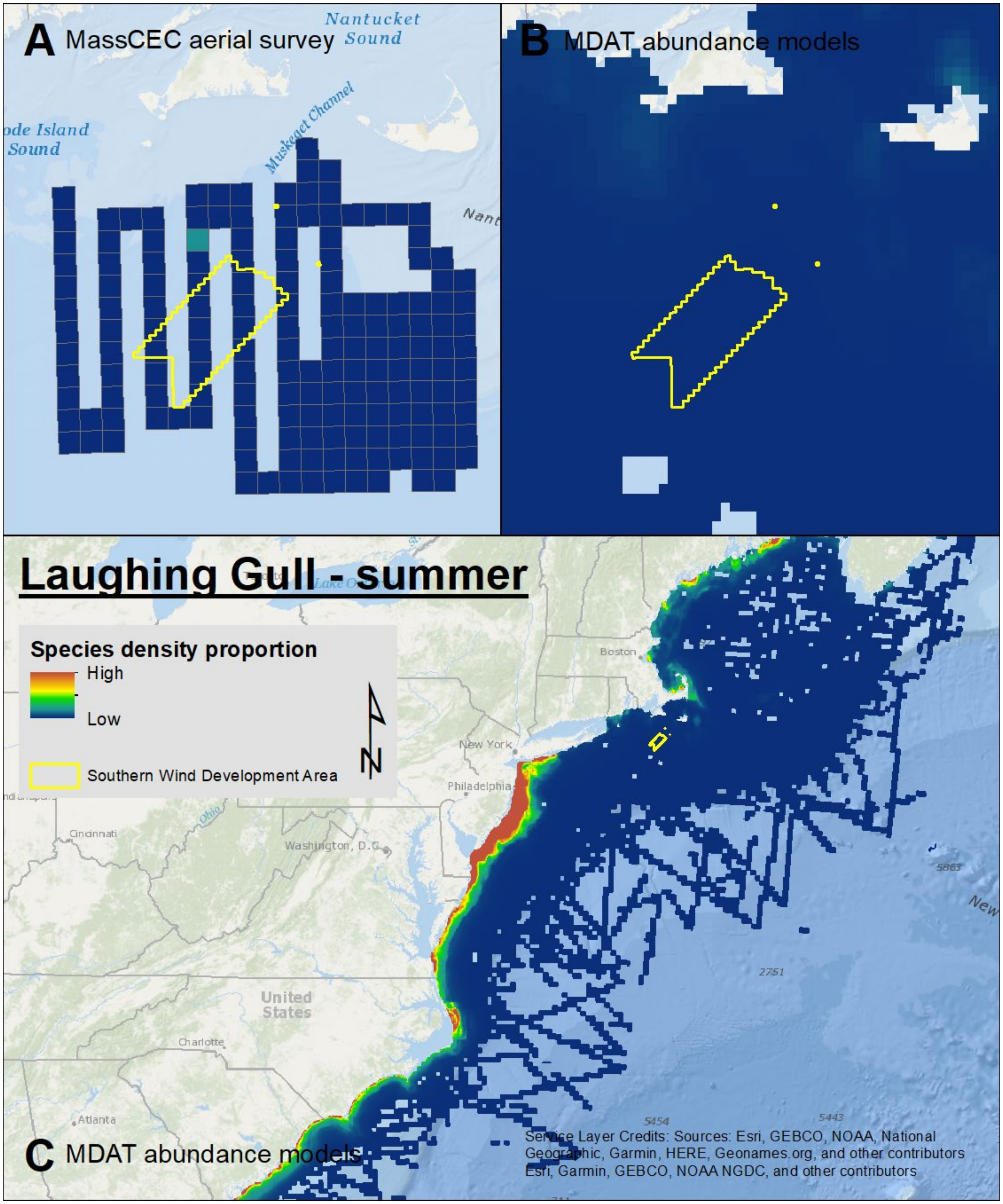

Map 59: Fall Black-legged Kittiwake density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



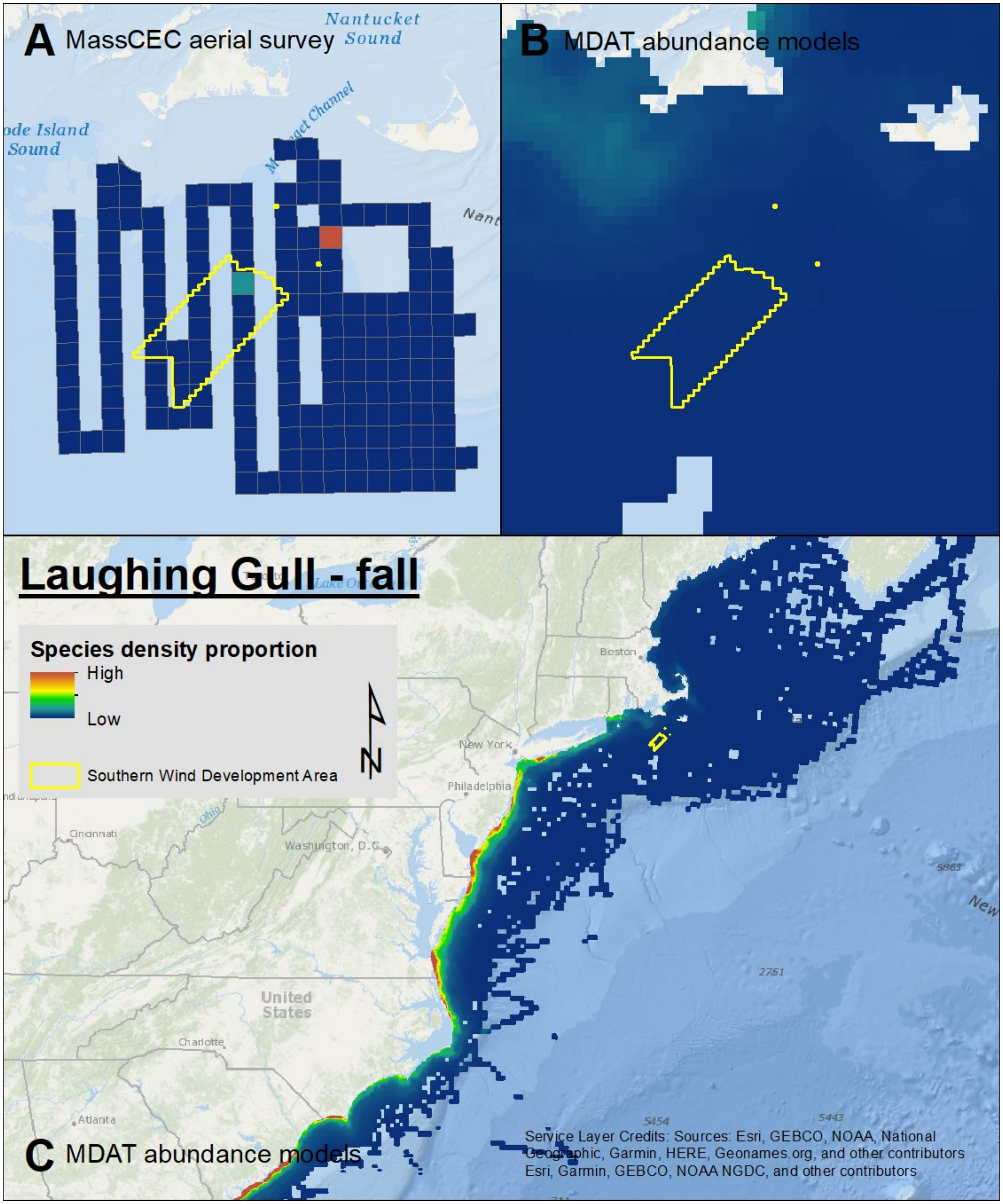

Map 60: Winter Laughing Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



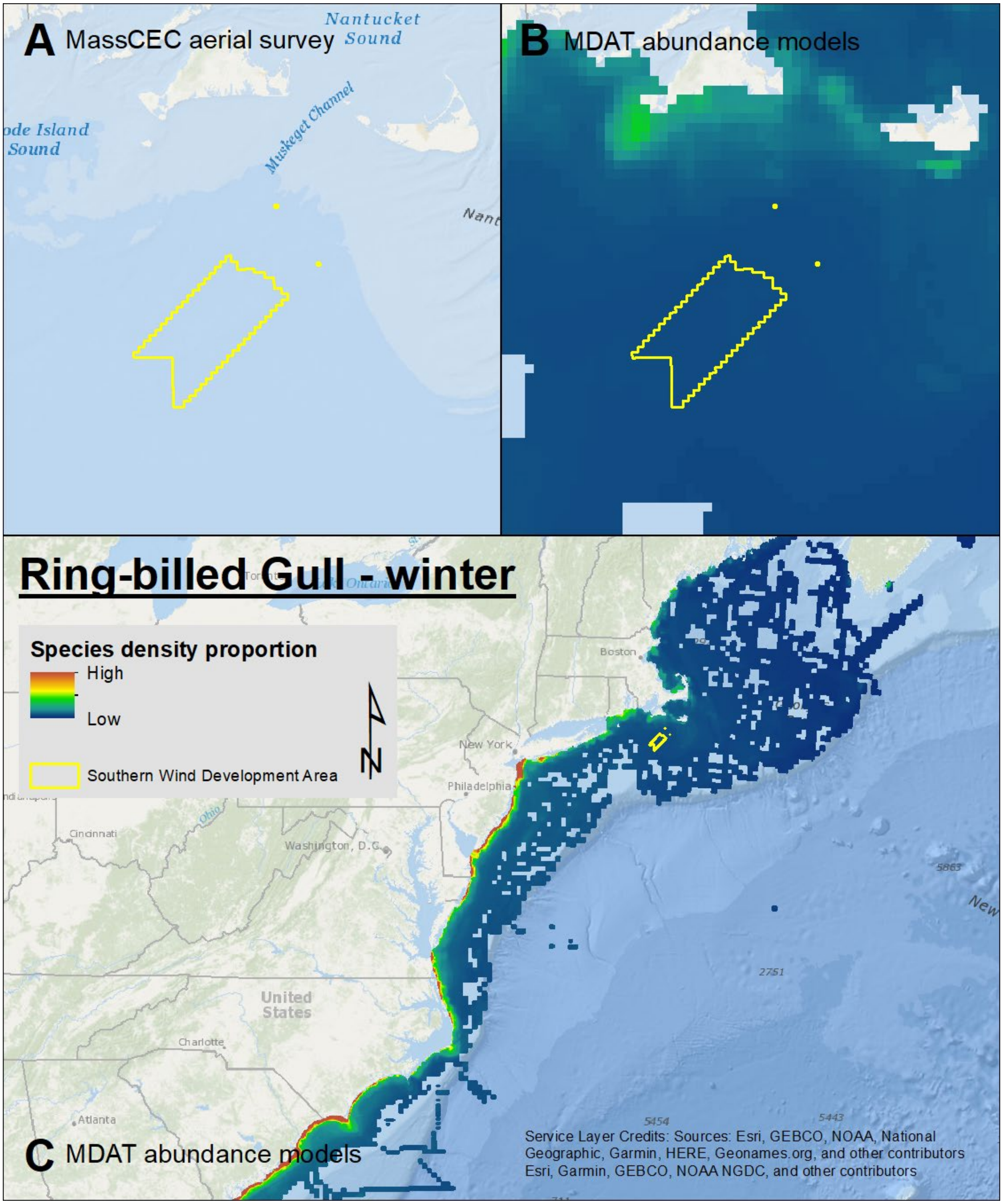

Map 61: Spring Laughing Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



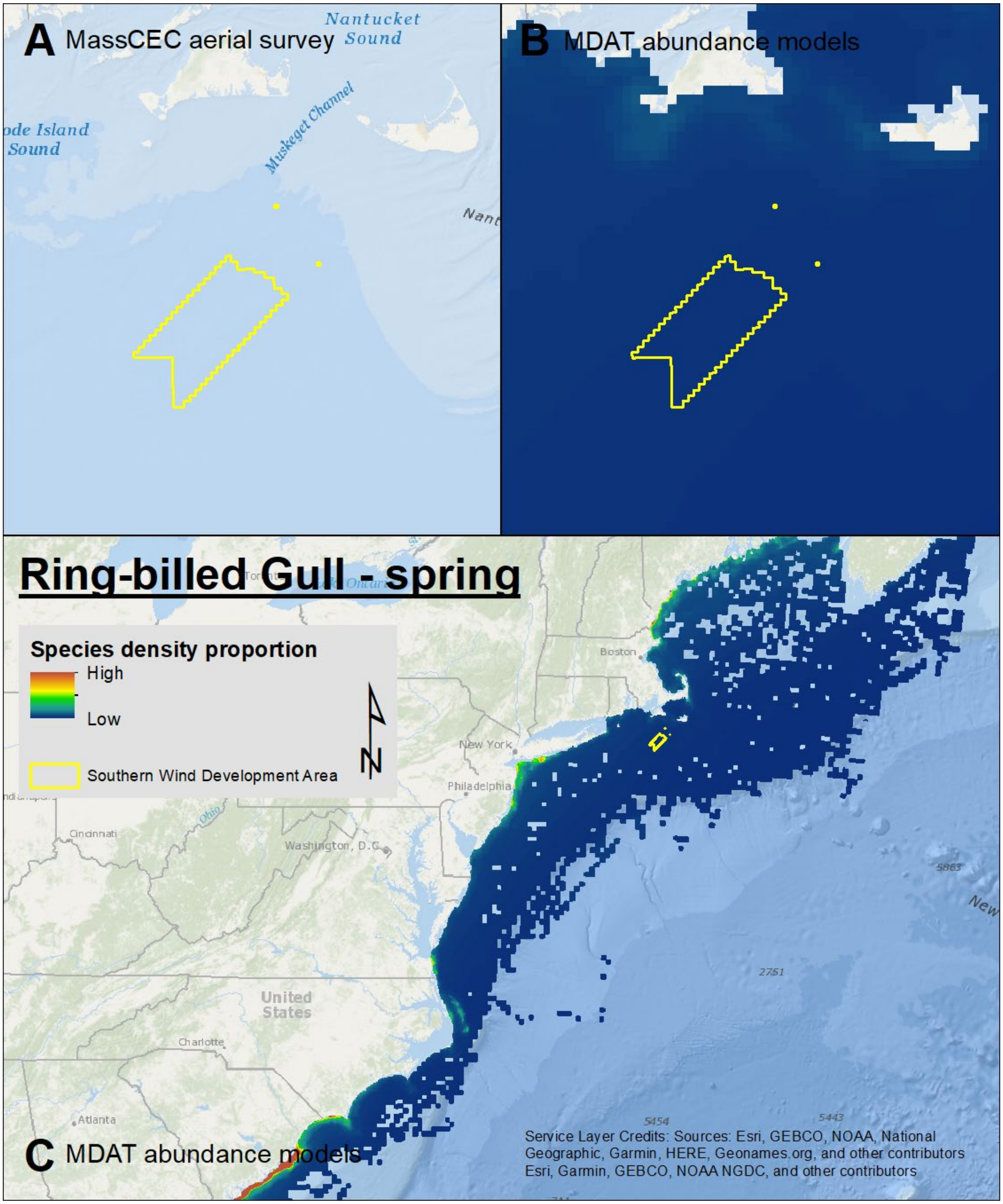

Map 62: Summer Laughing Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



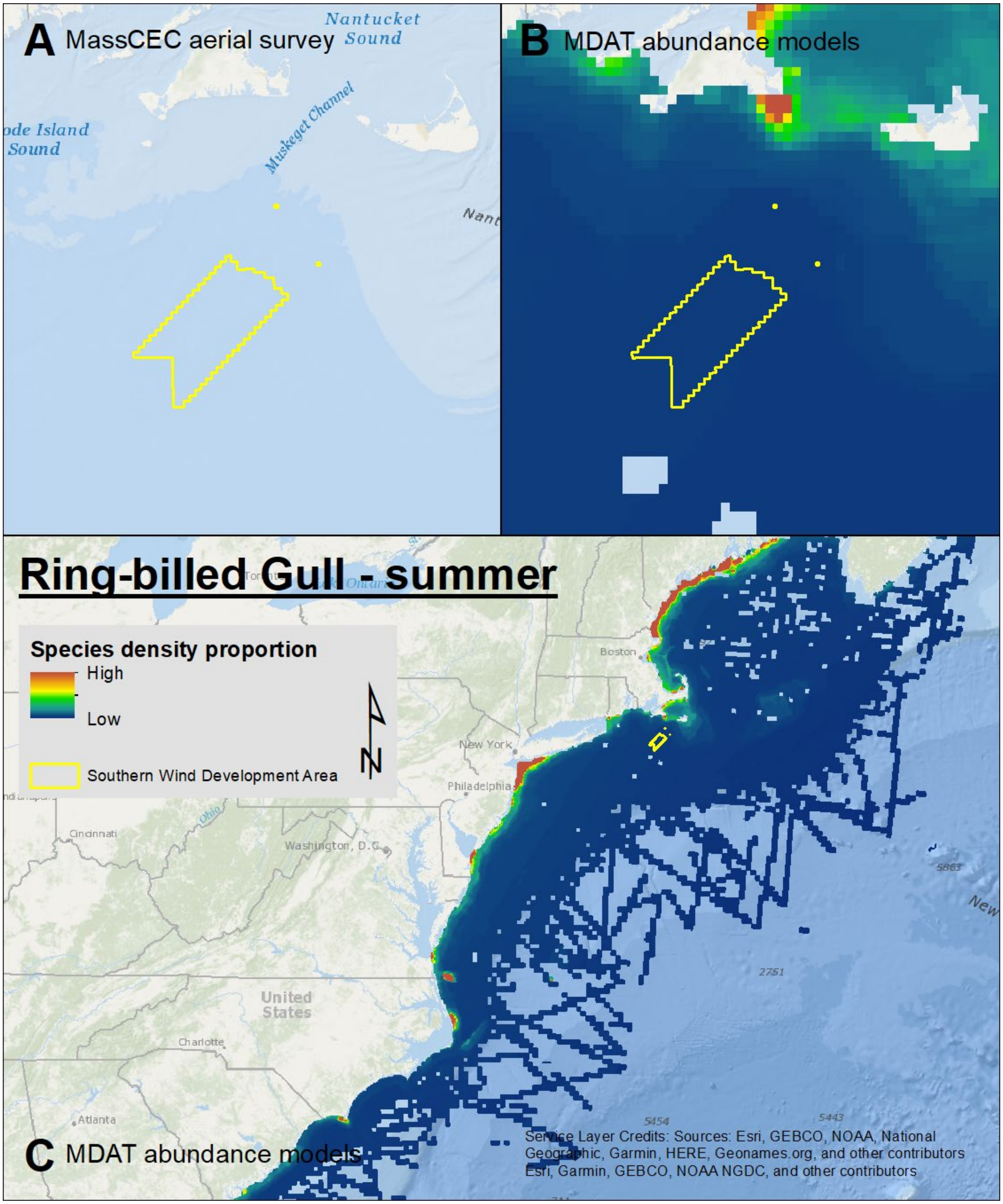

Map 63: Fall Laughing Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



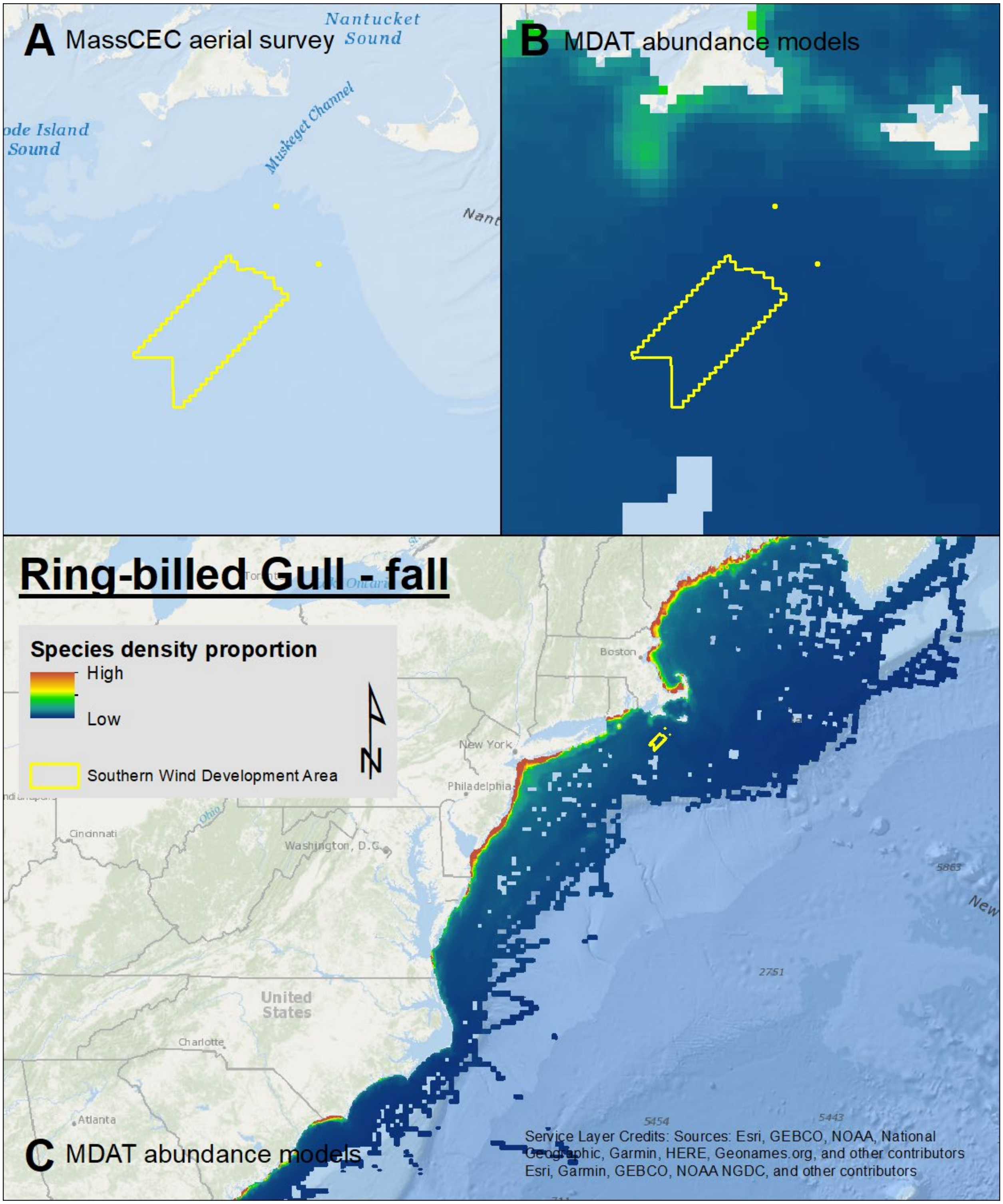

Map 64: Winter Ring-billed Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



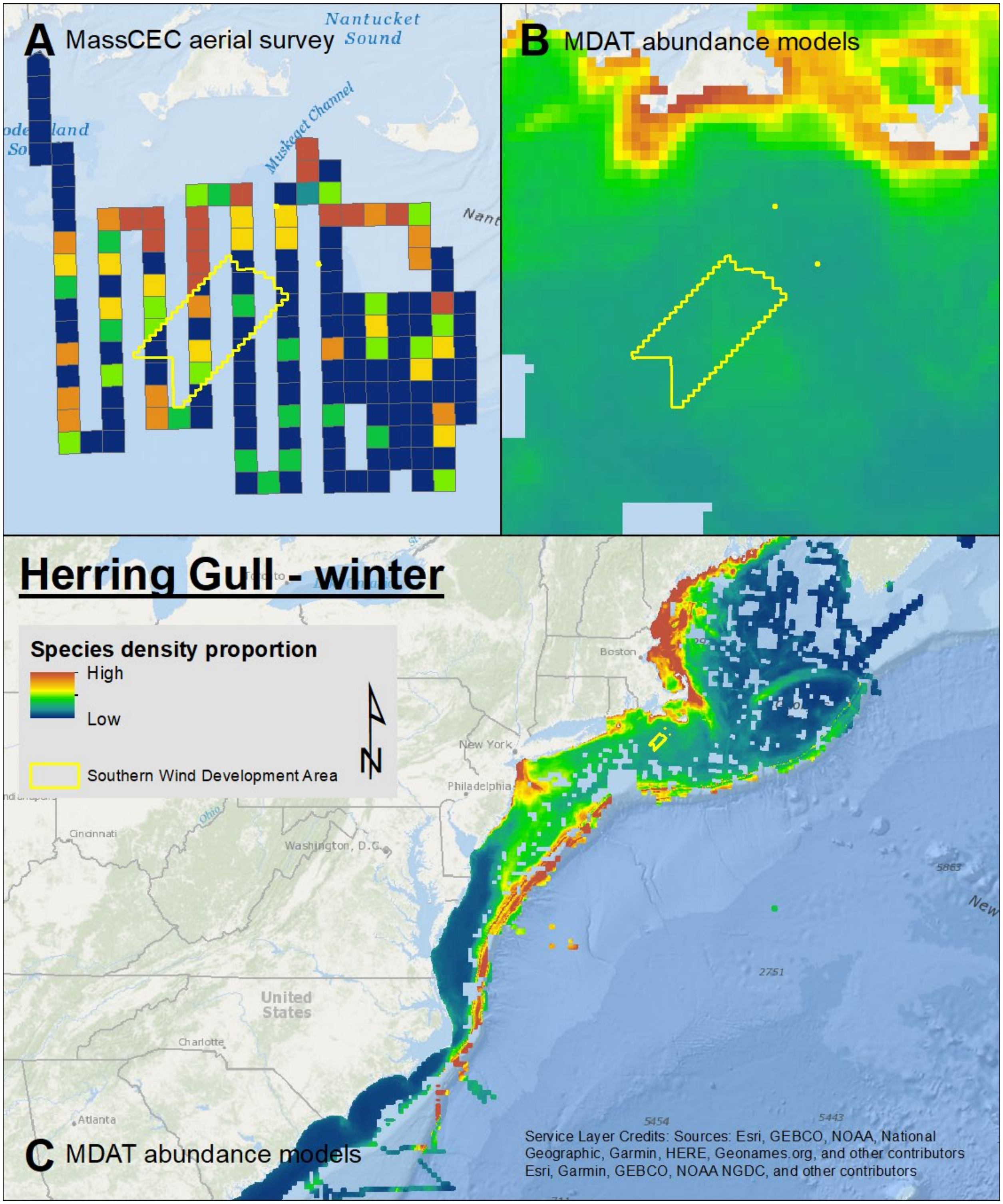

Map 65: Spring Ring-billed Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



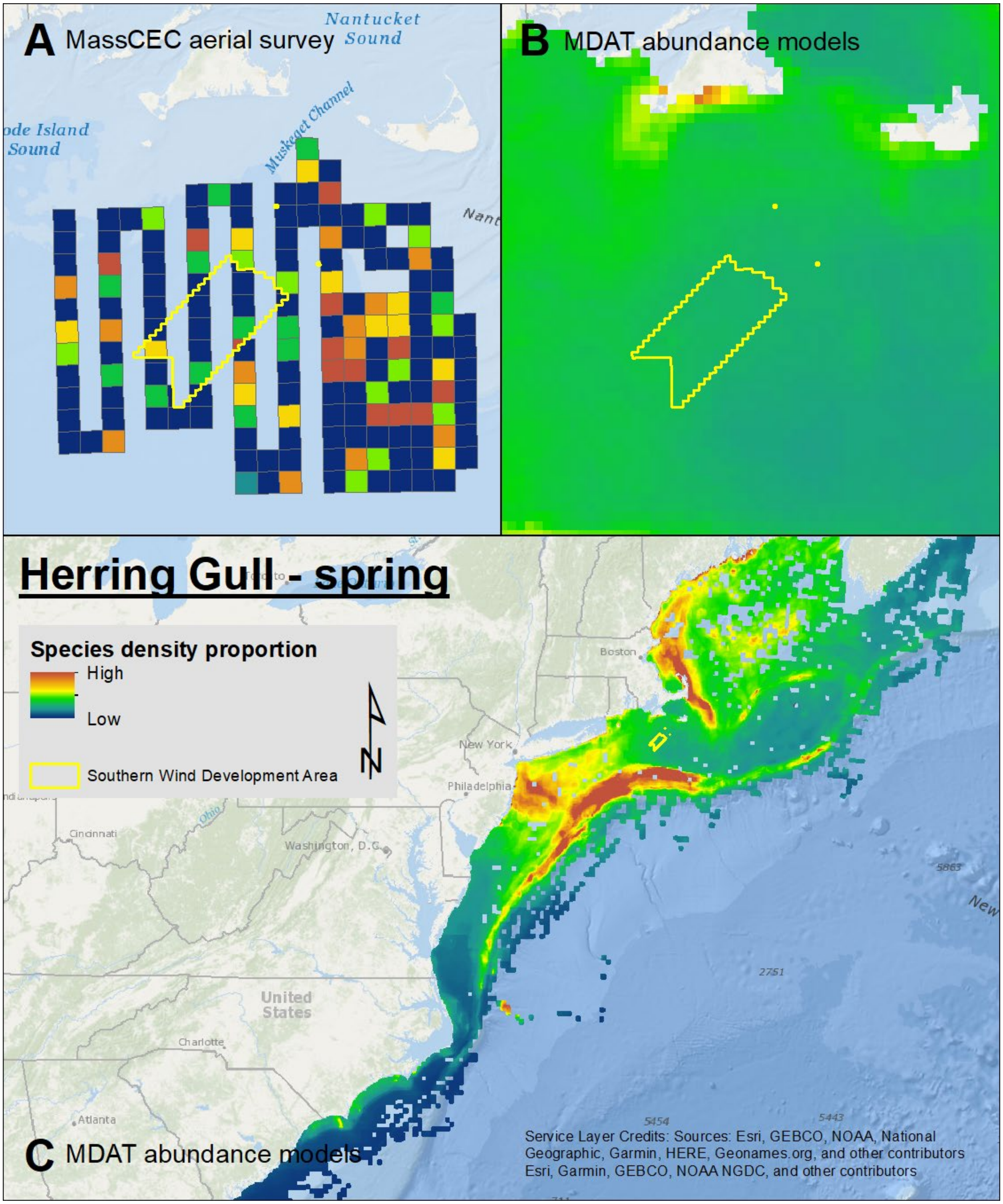

Map 66: Summer Ring-billed Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



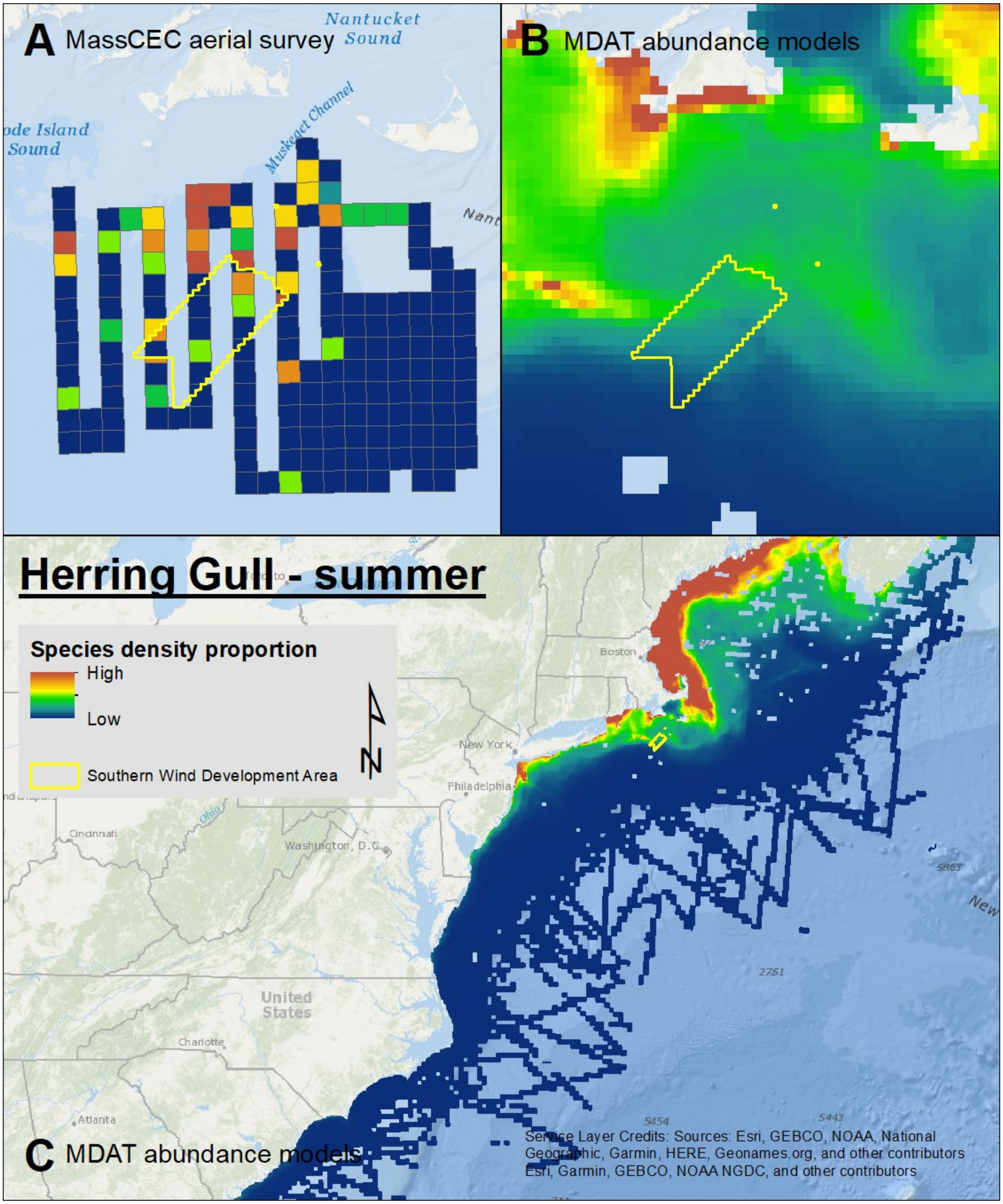

Map 67: Fall Ring-billed Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



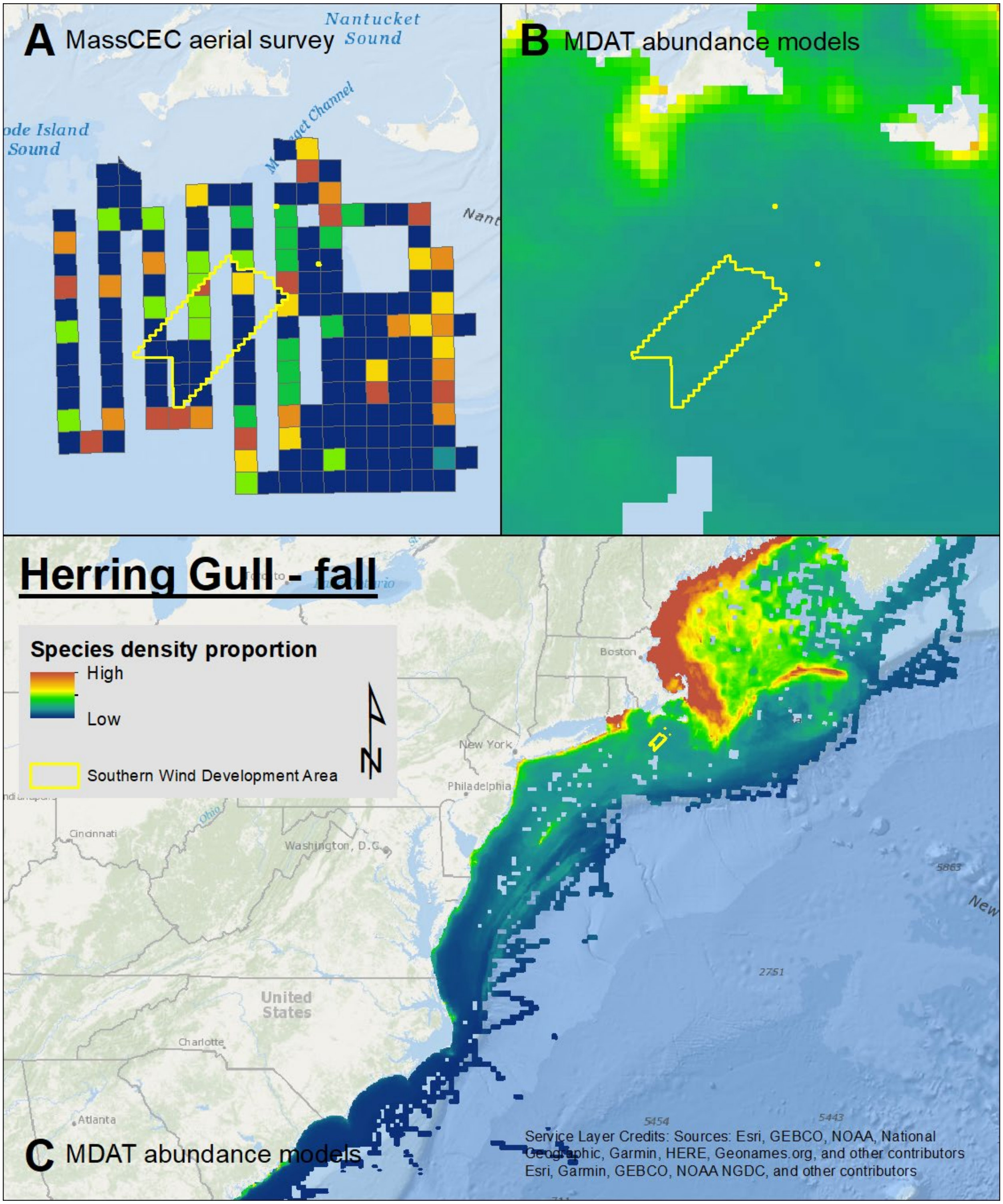

Map 68: Winter Herring Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



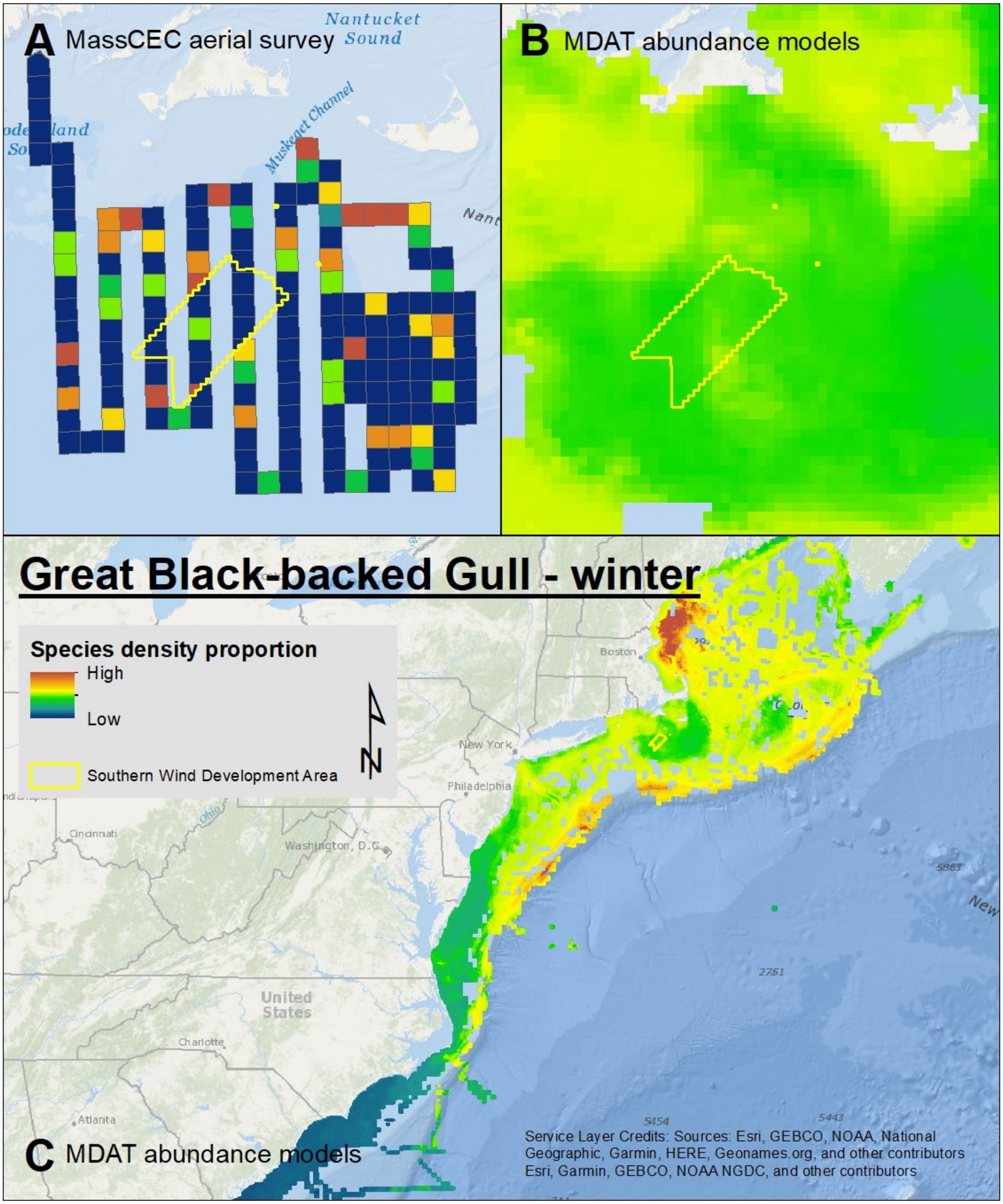

Map 69: Spring Herring Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



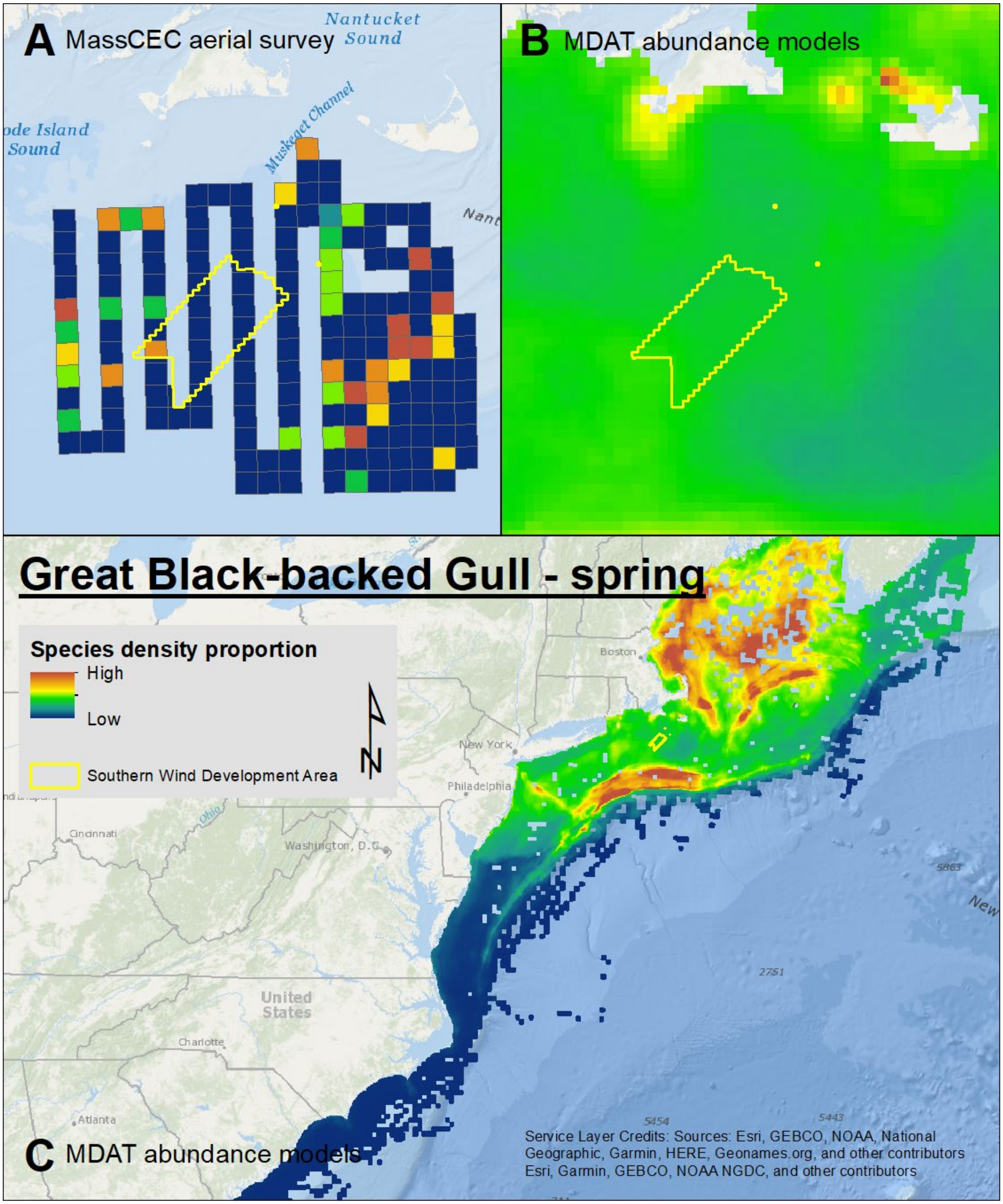

Map 70: Summer Herring Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



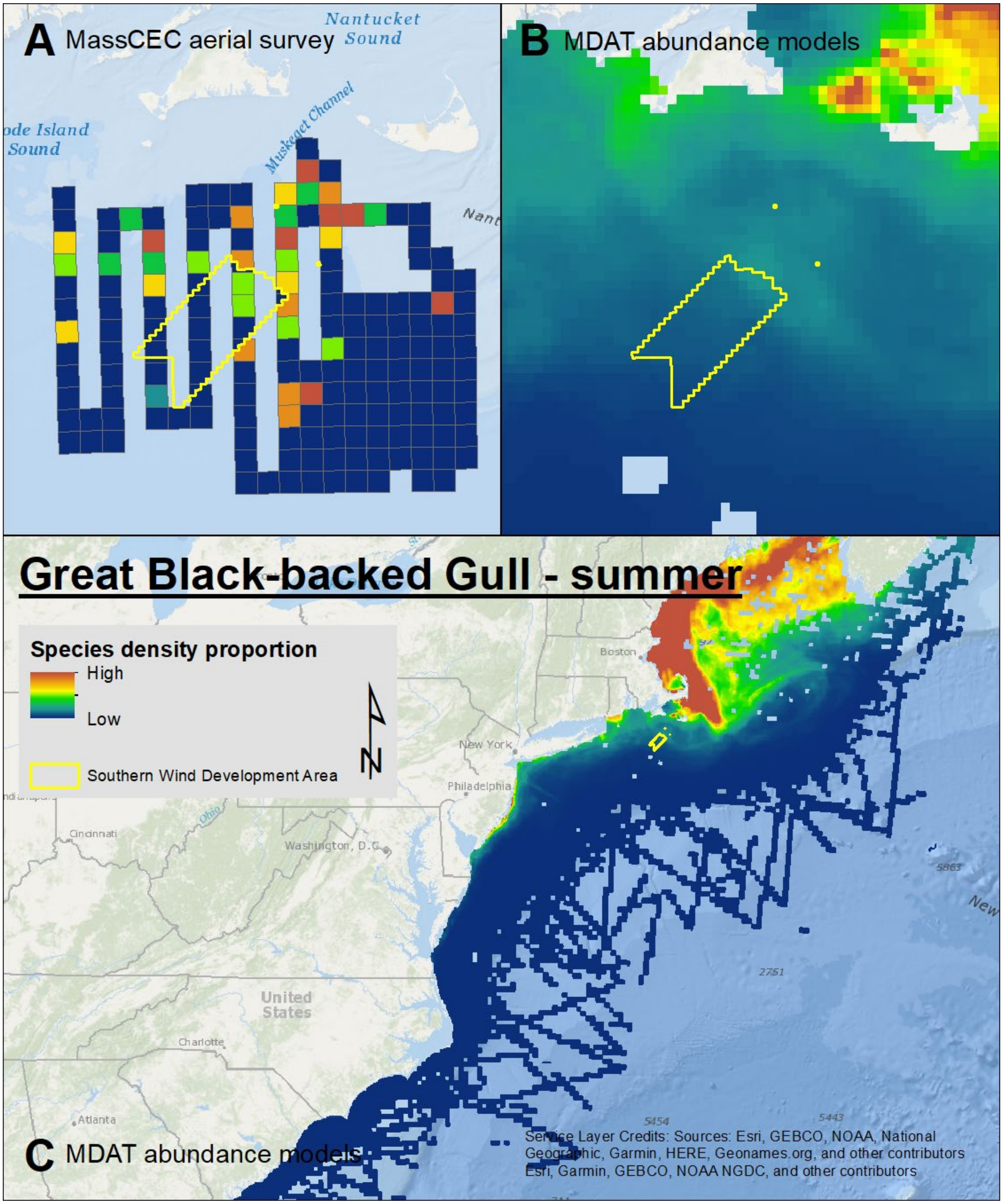

Map 71: Fall Herring Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



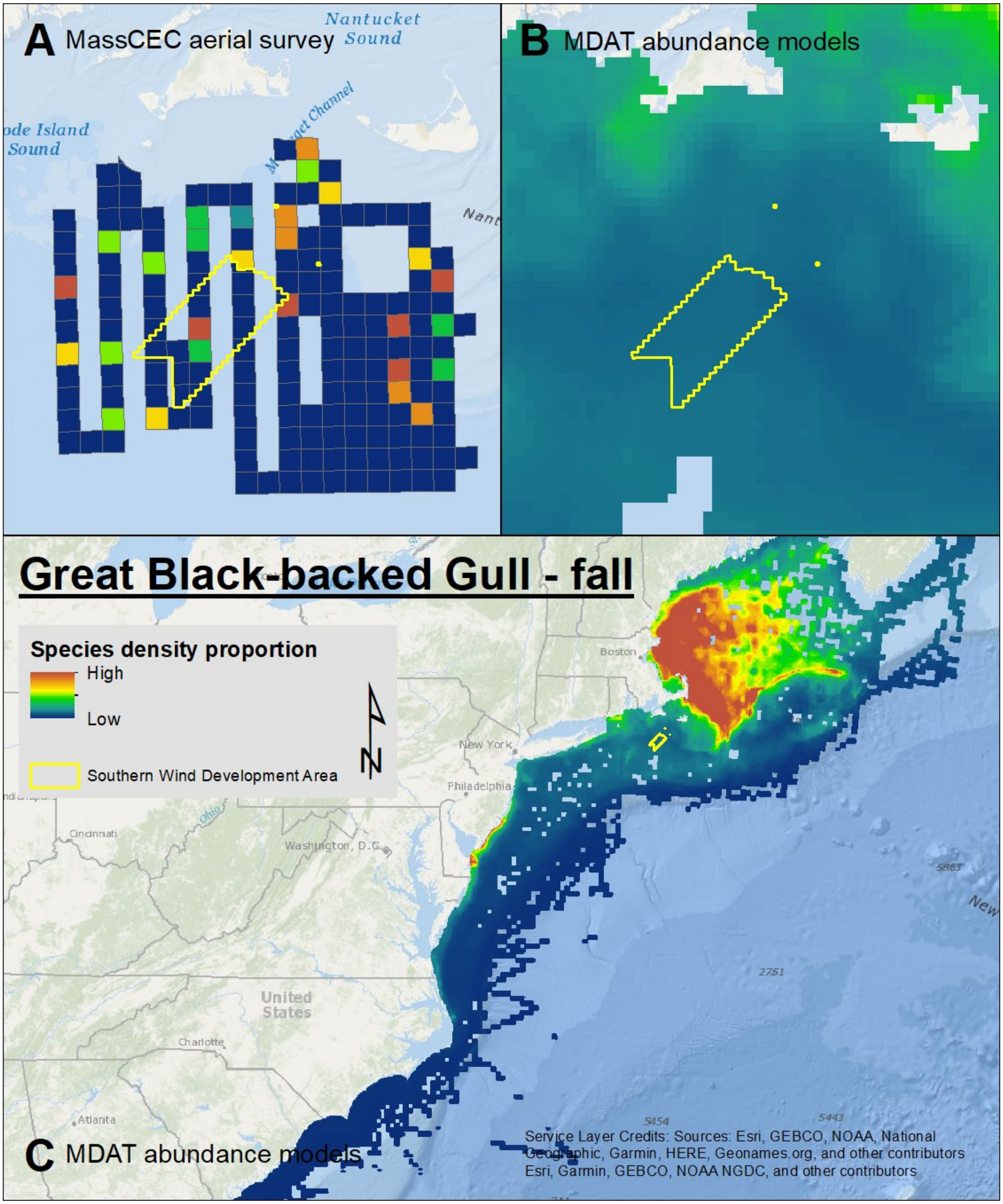

Map 72: Winter Great Black-backed Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



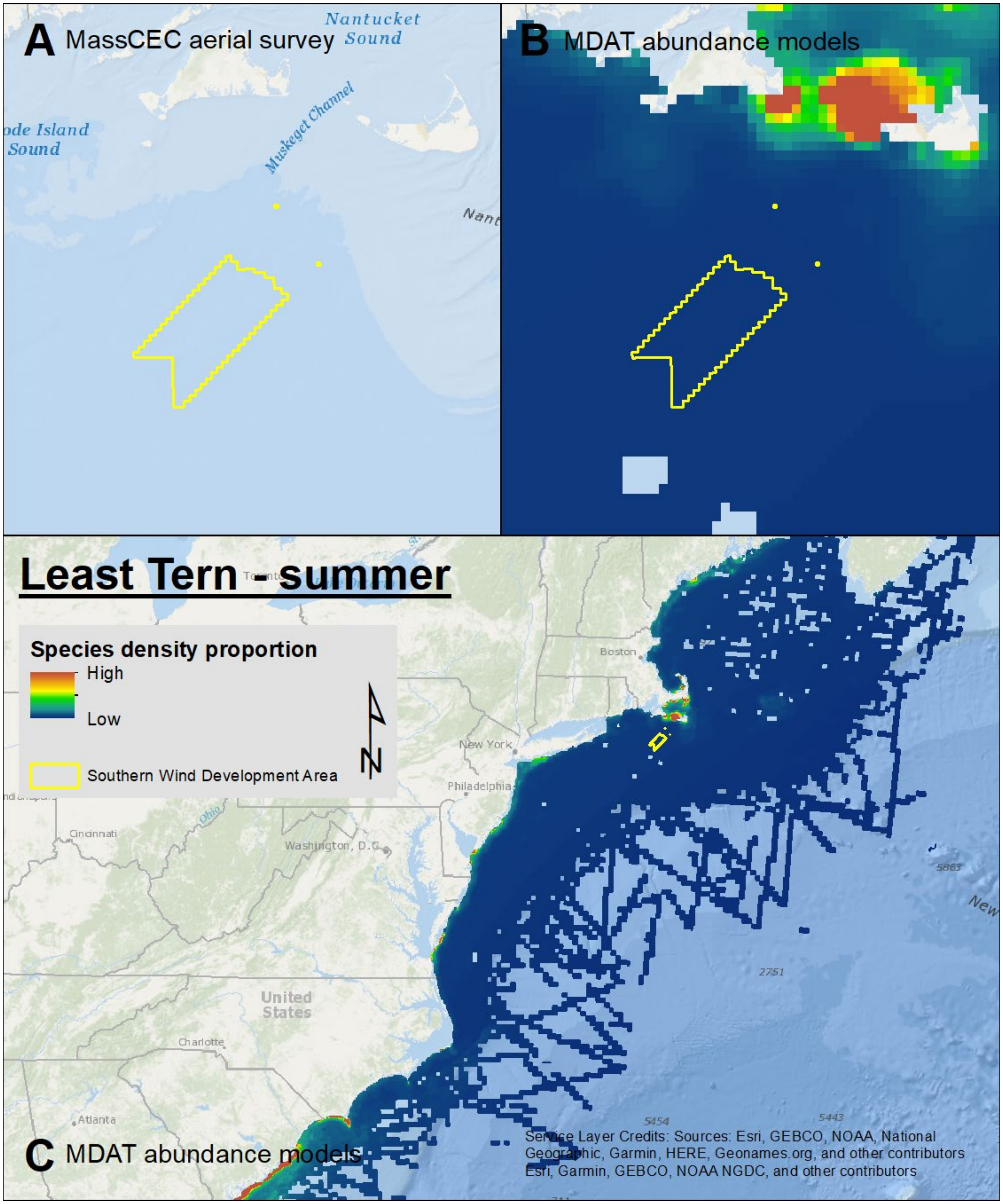

Map 73: Spring Great Black-backed Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



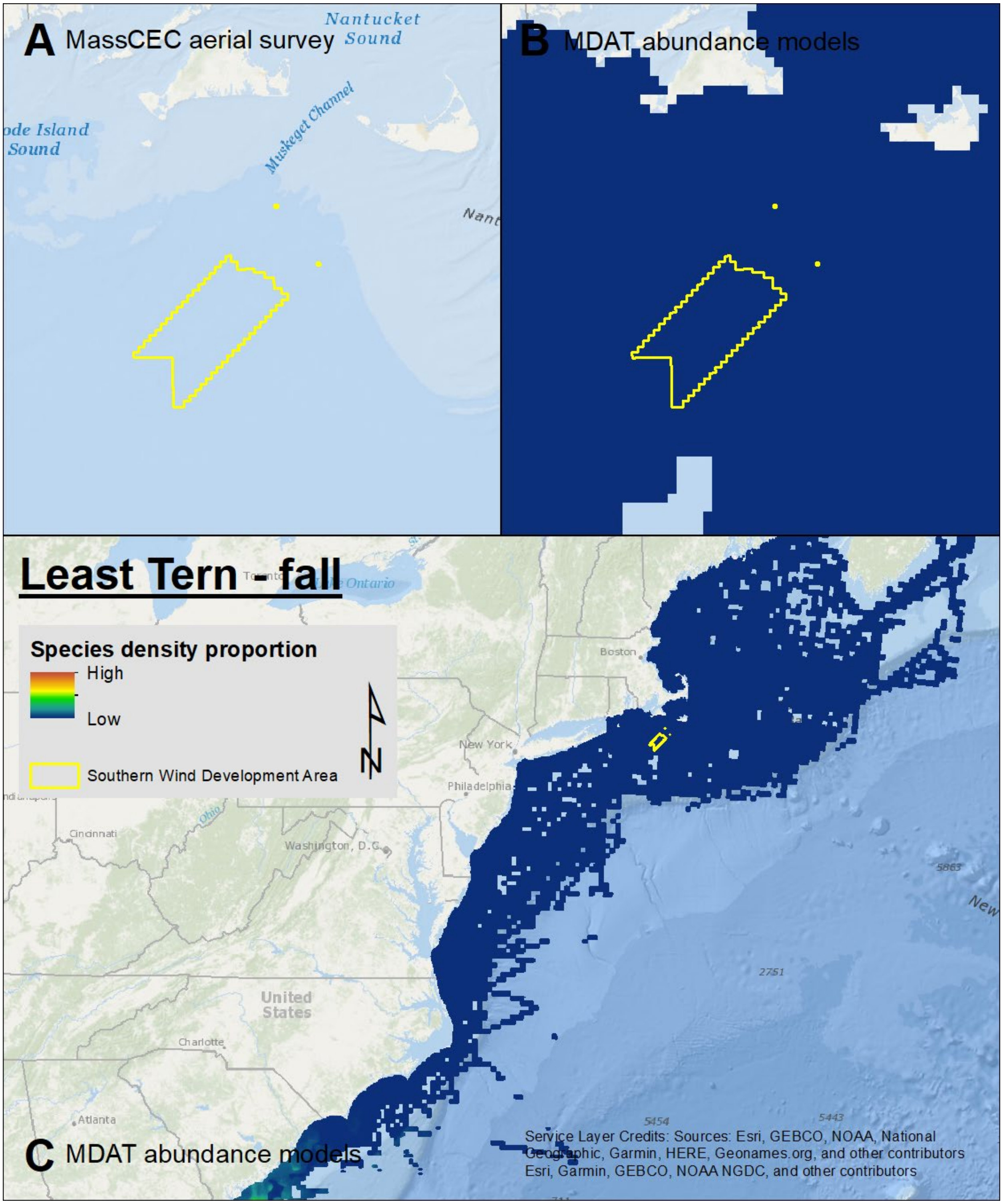

Map 74: Summer Great Black-backed Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



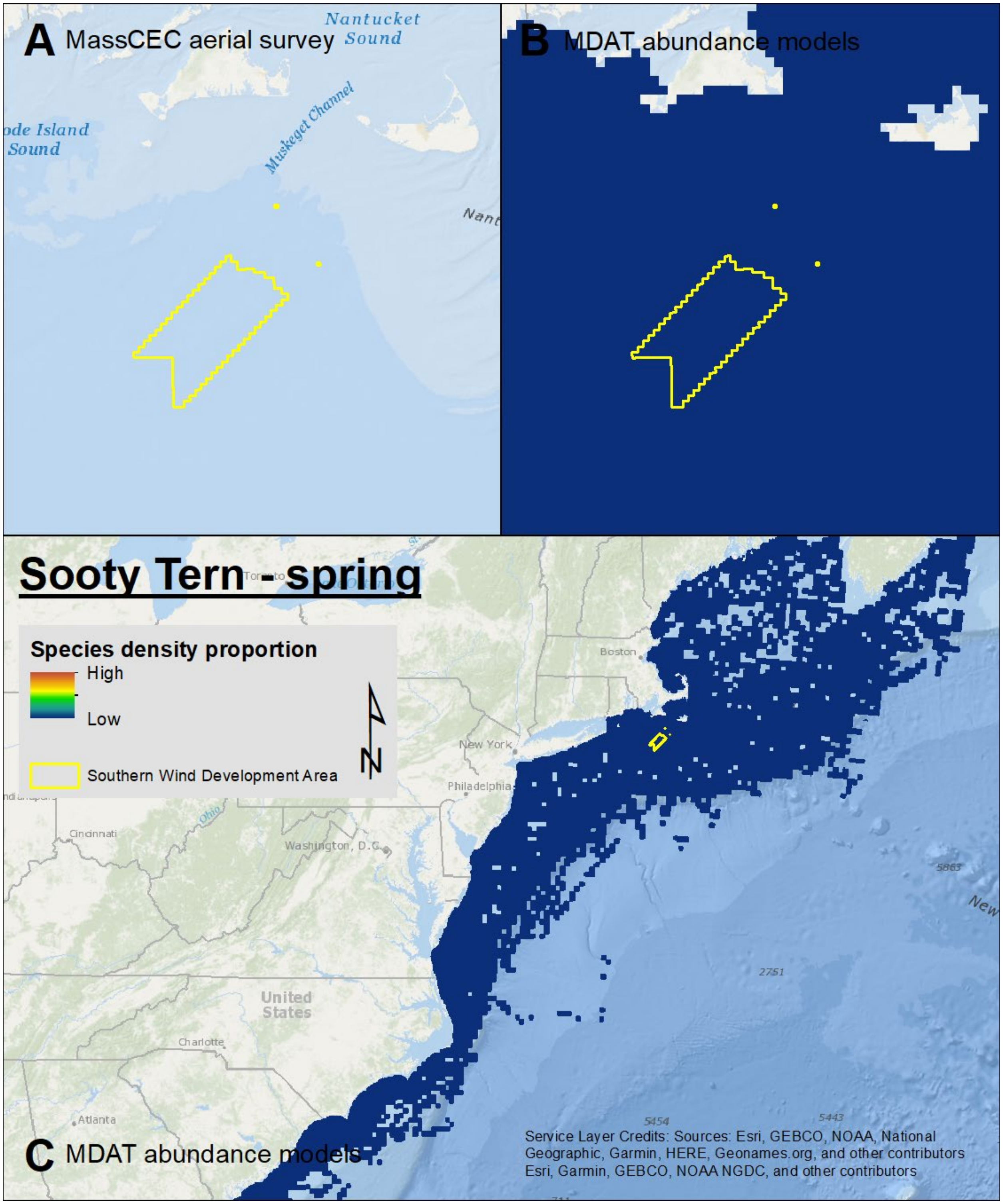

Map 75: Fall Great Black-backed Gull density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



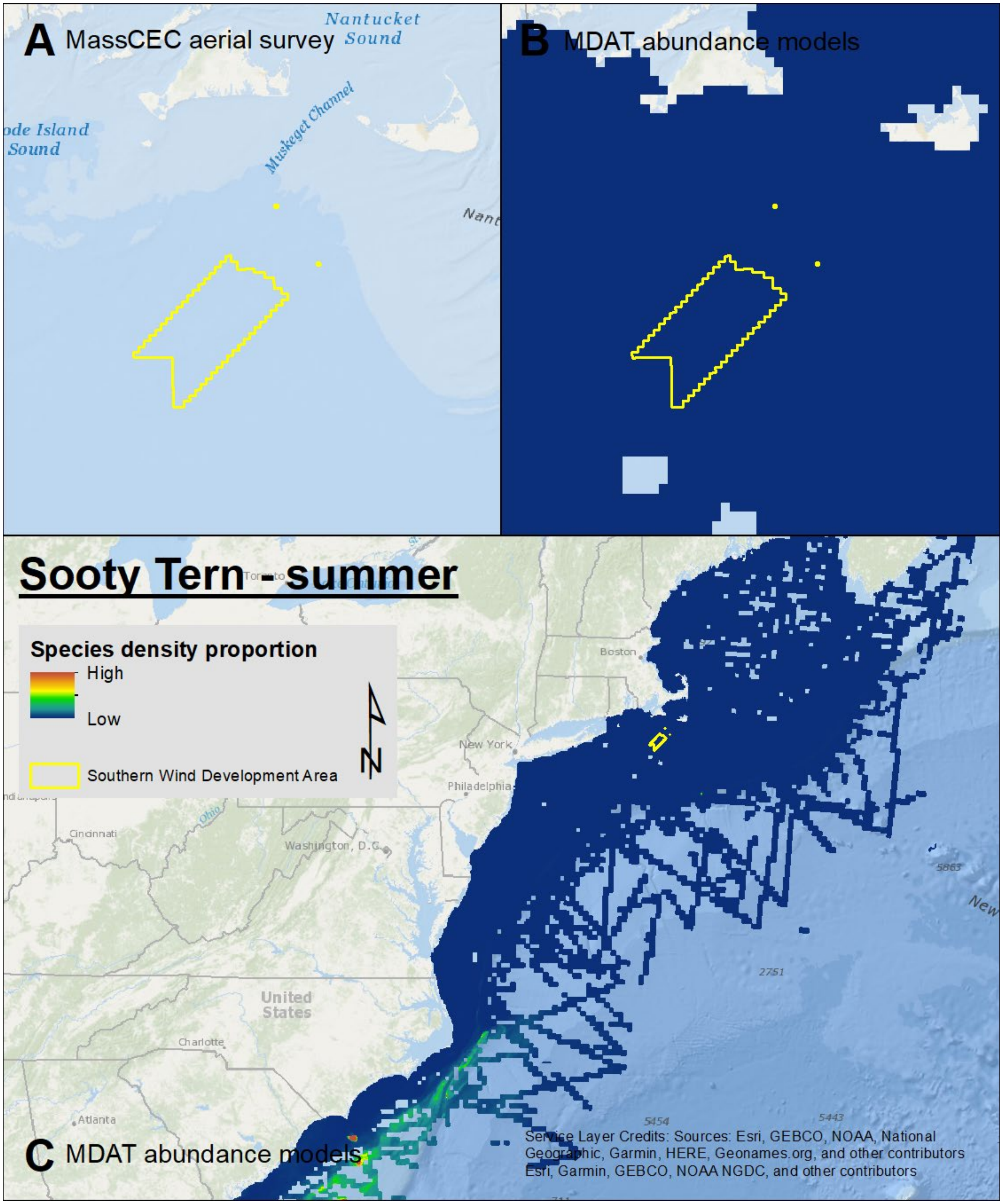

Map 76: Summer Least Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



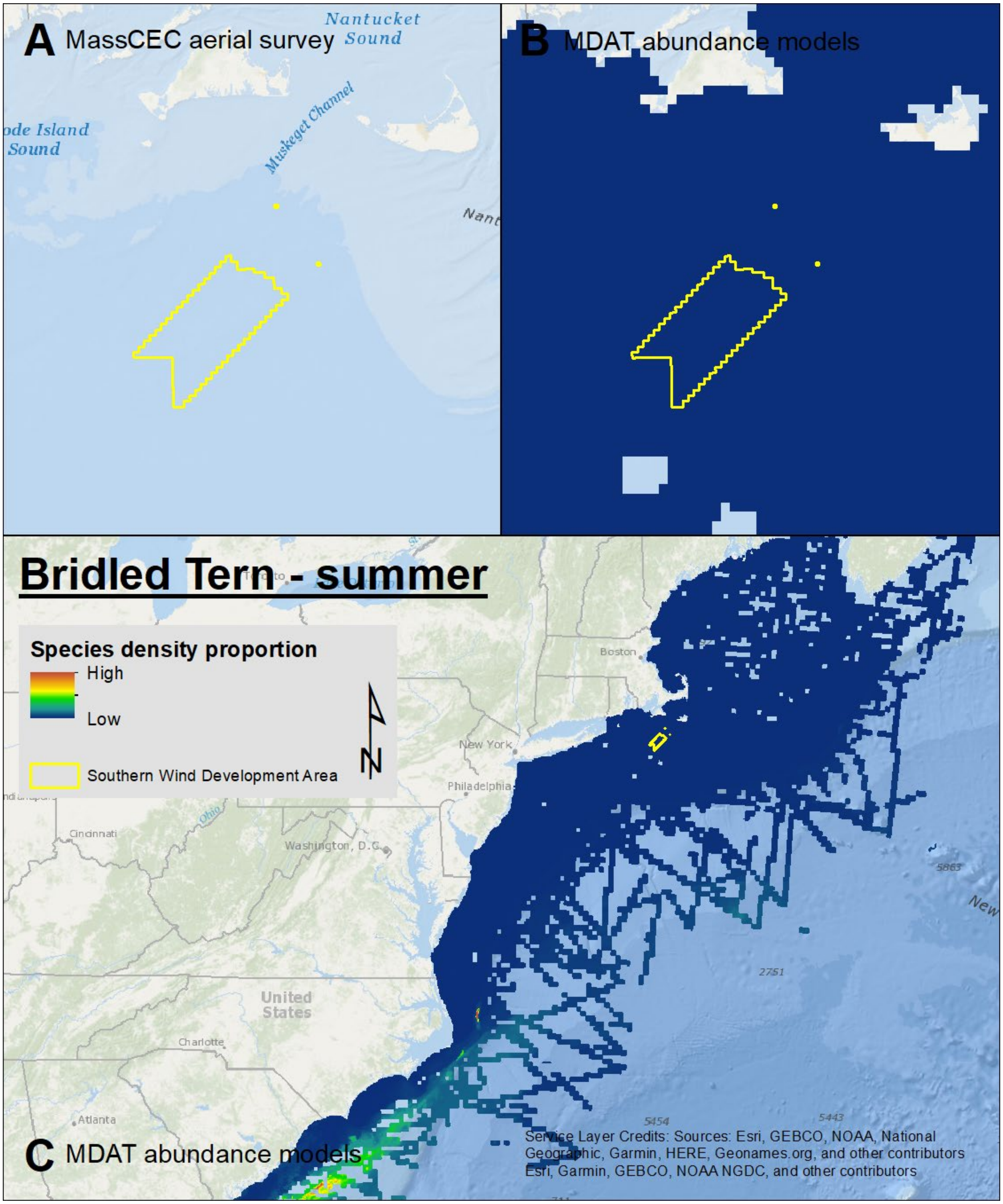

Map 77: Fall Least Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



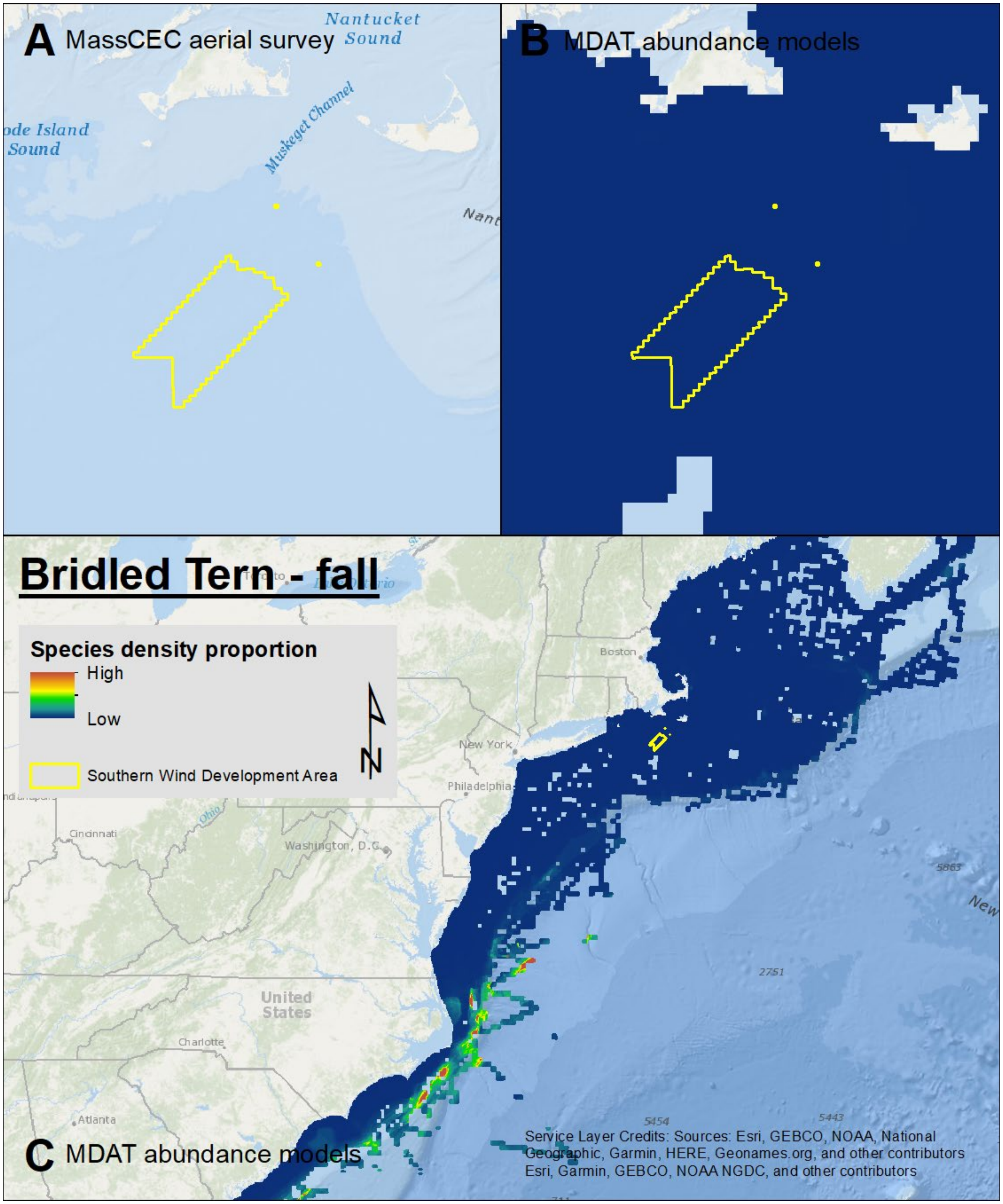

Map 78: Spring Sooty Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



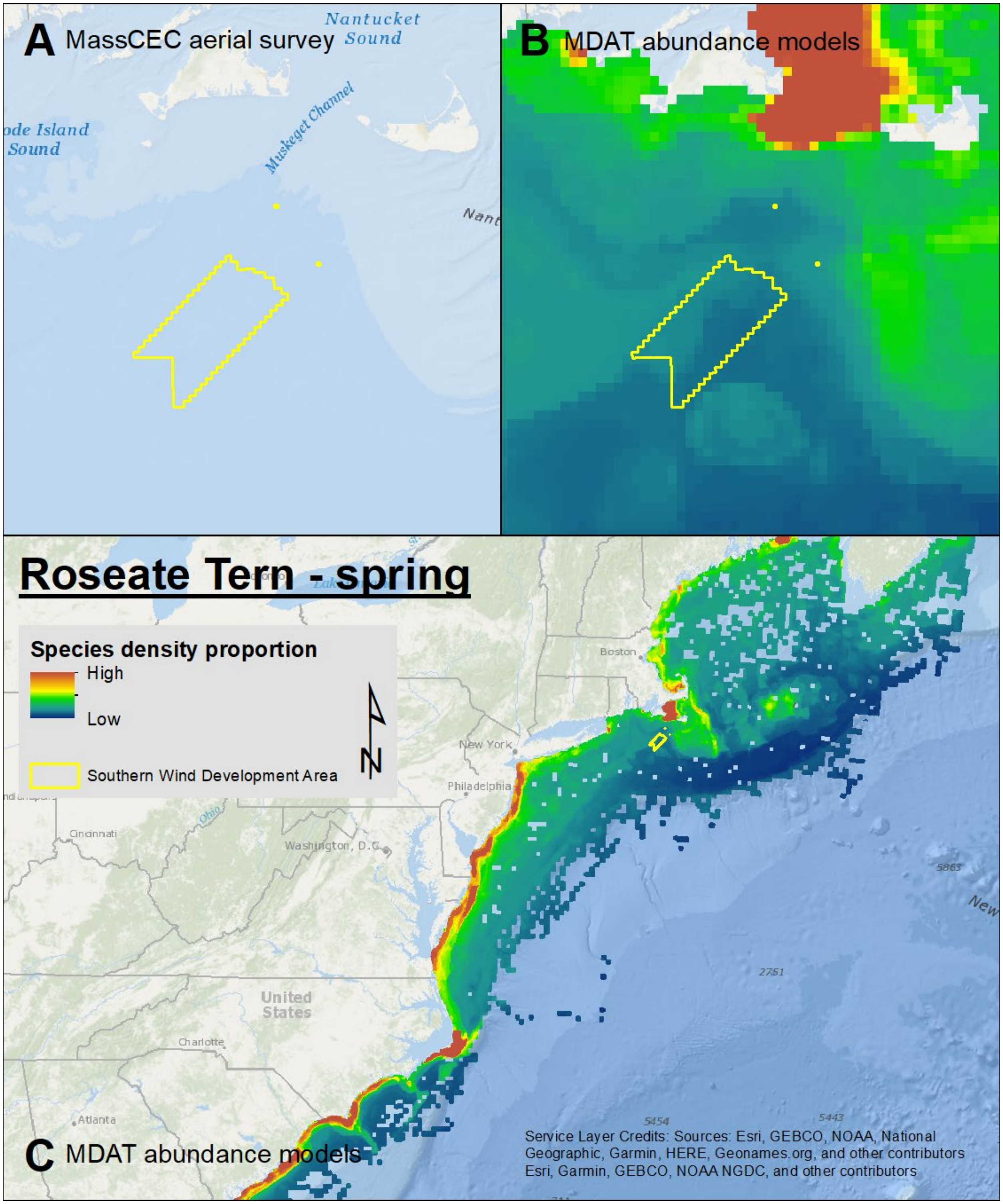

Map 79: Summer Sooty Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



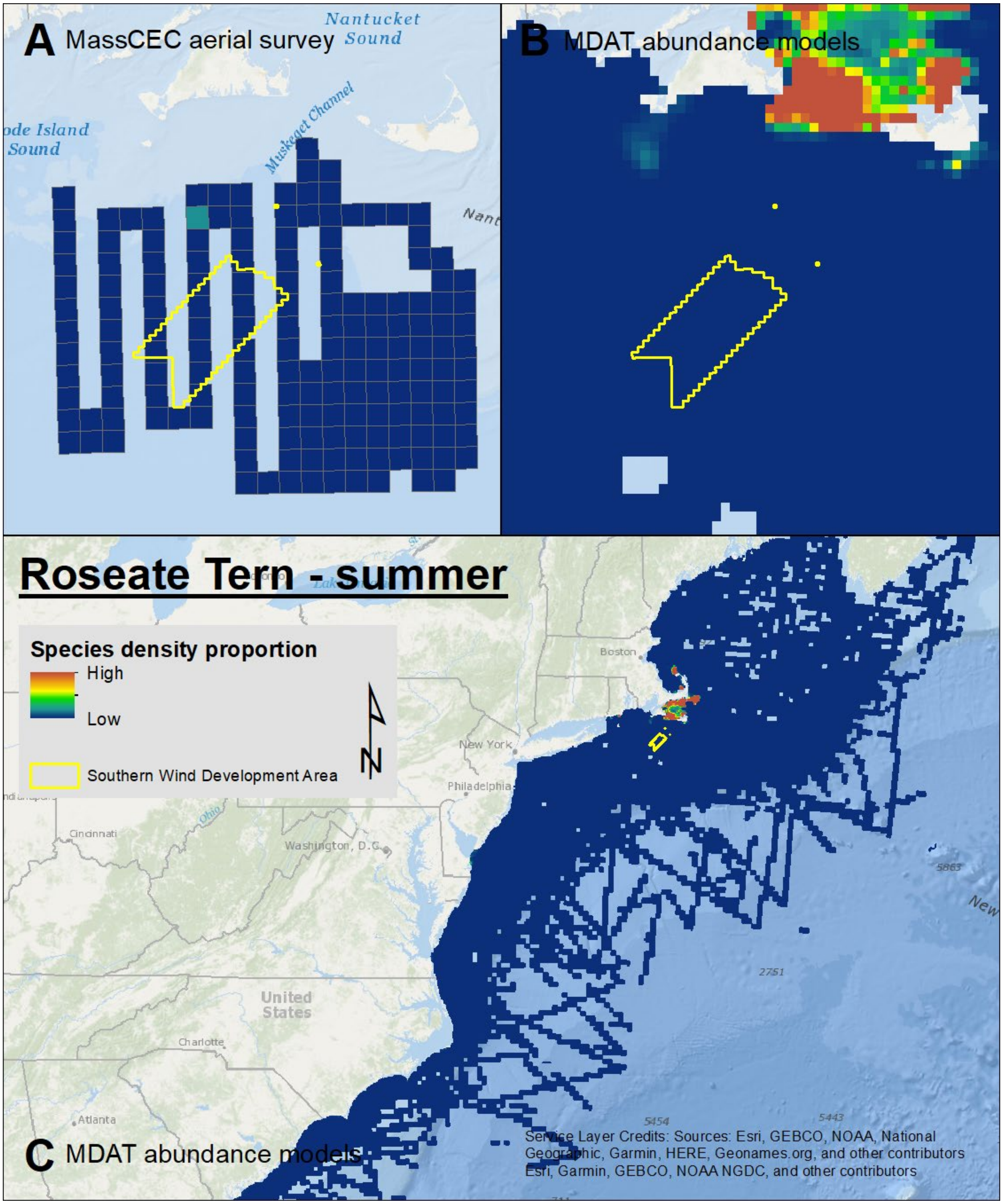

Map 80: Summer Bridled Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



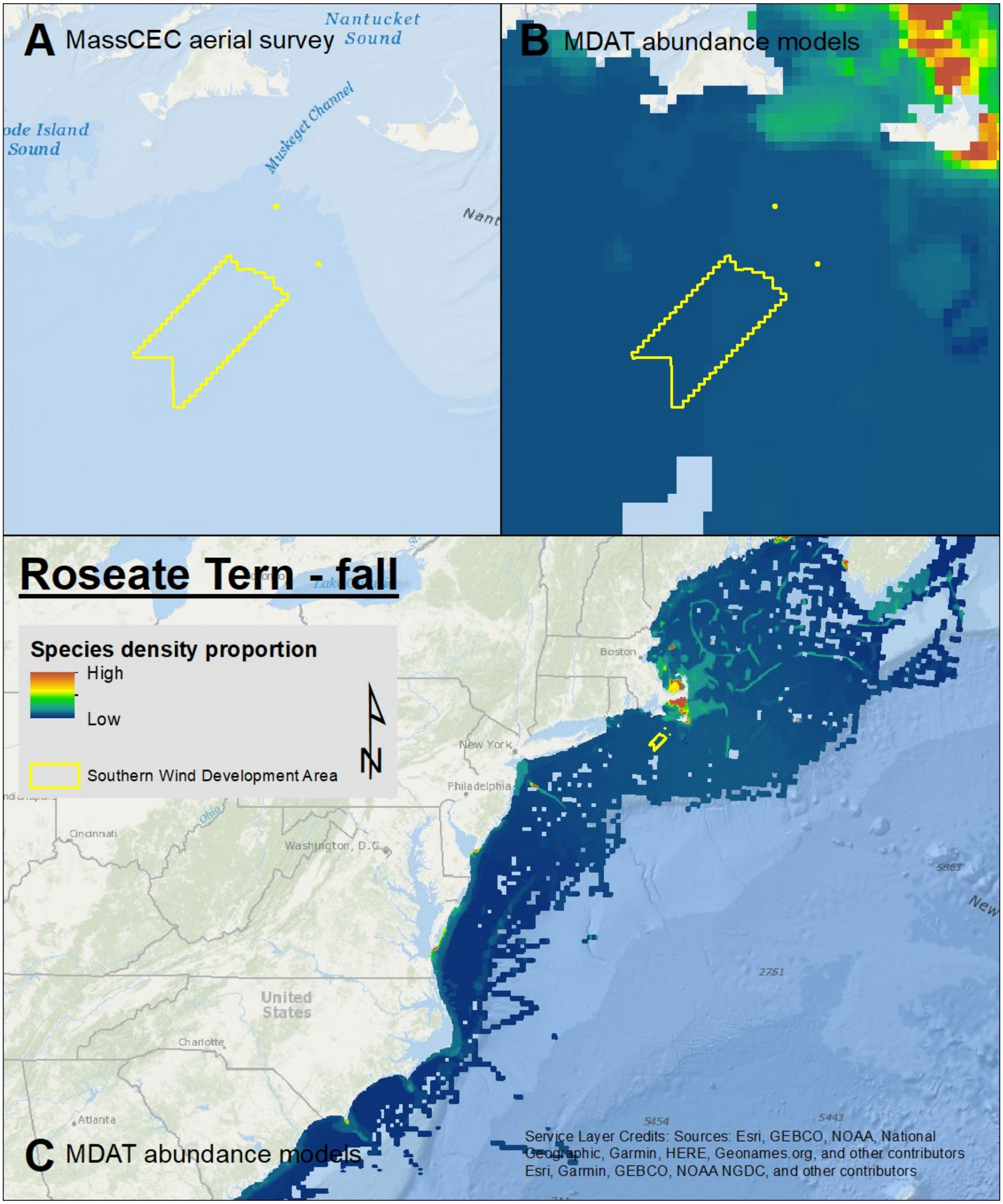

Map 81: Fall Bridled Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



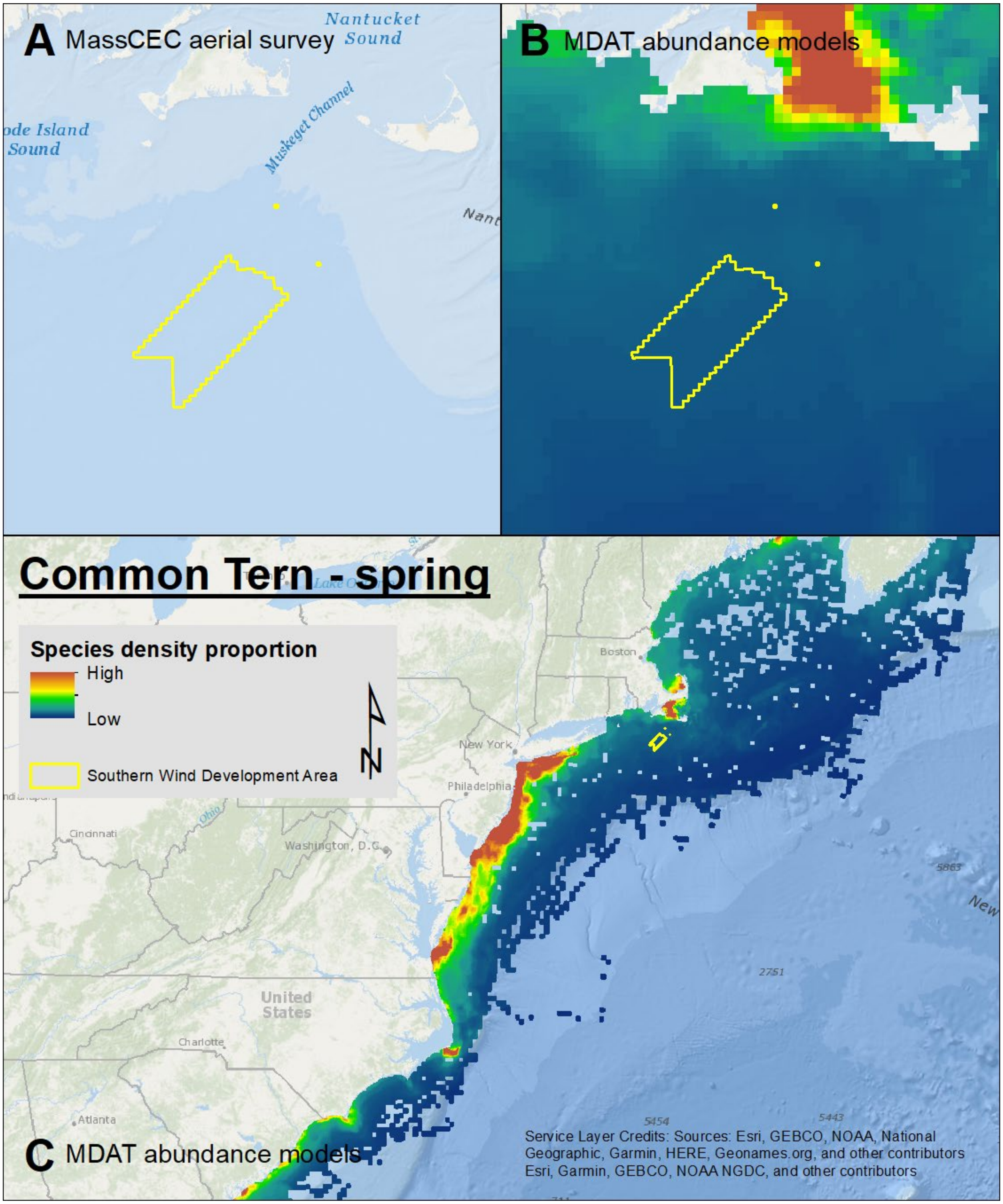

Map 82: Spring Roseate Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



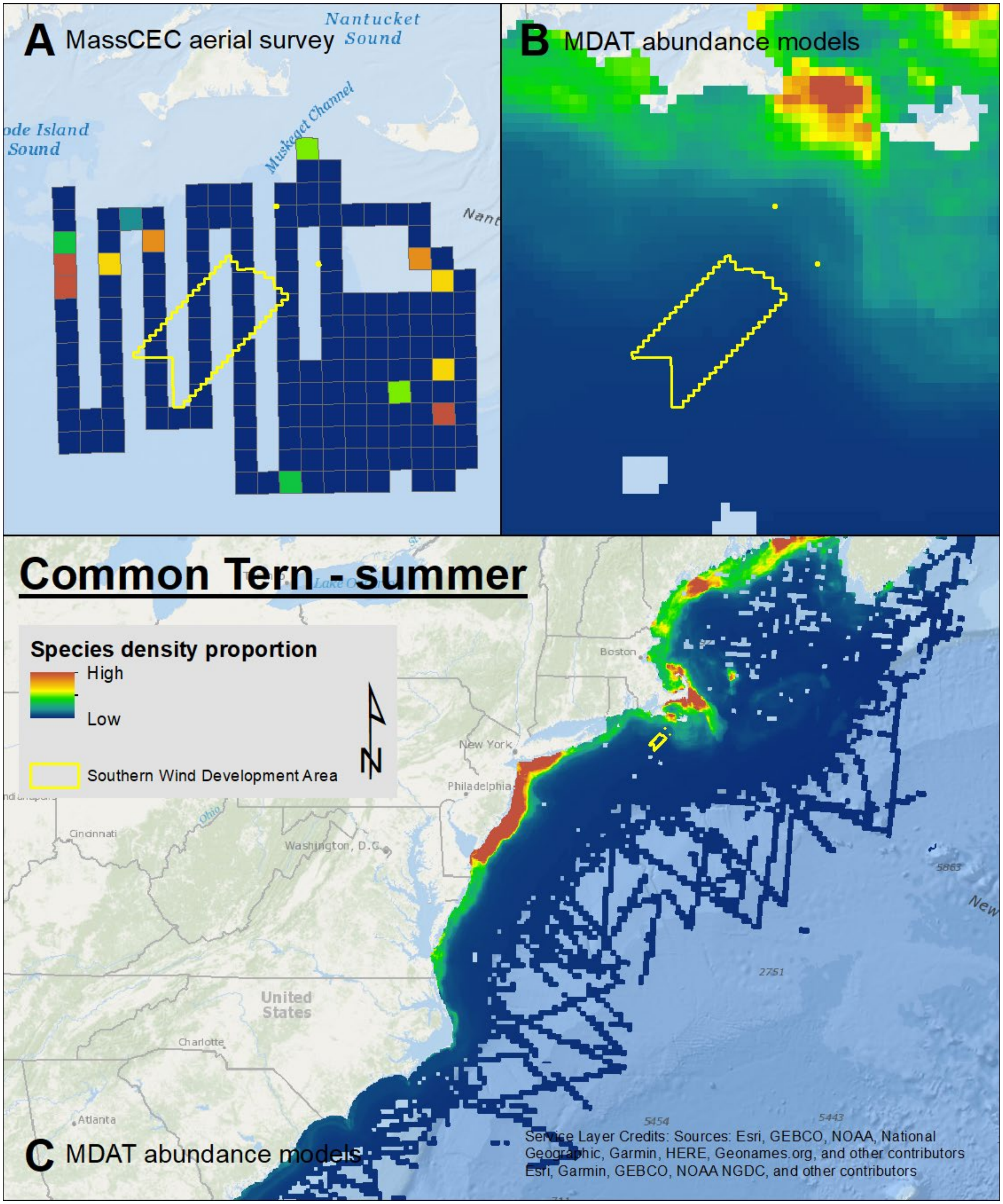

Map 83: Summer Roseate Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



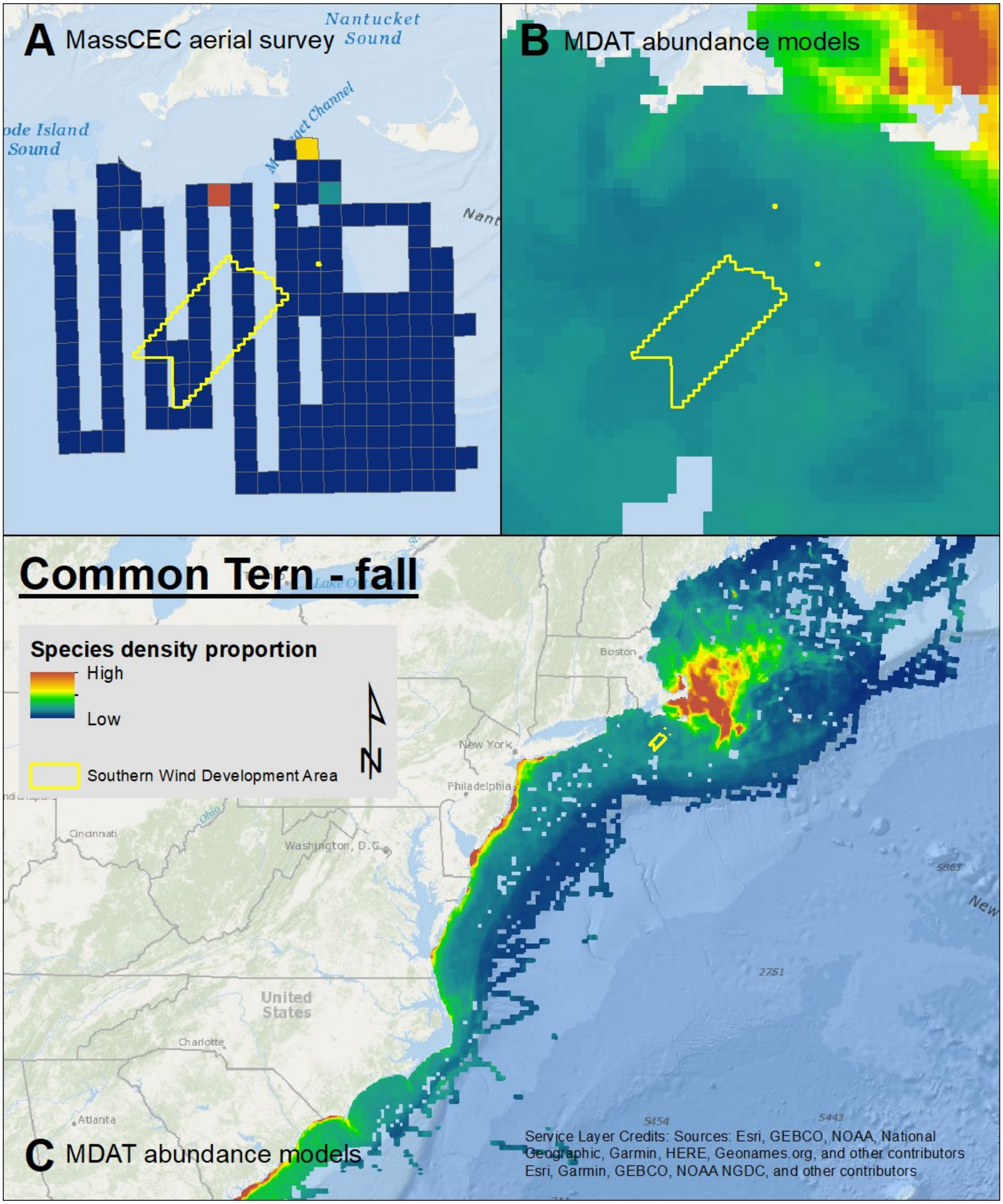

Map 84: Fall Roseate Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



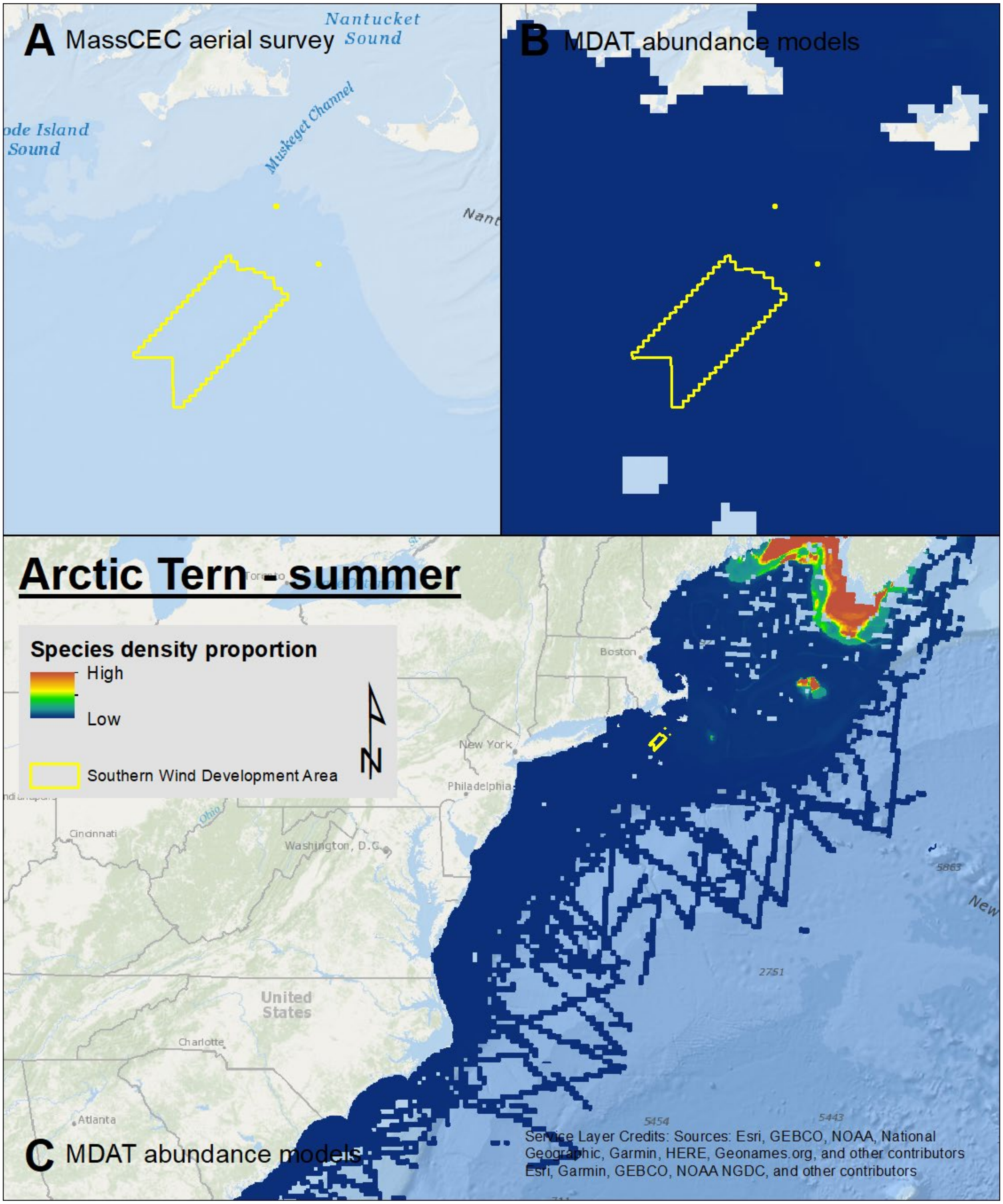

Map 85: Spring Common Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



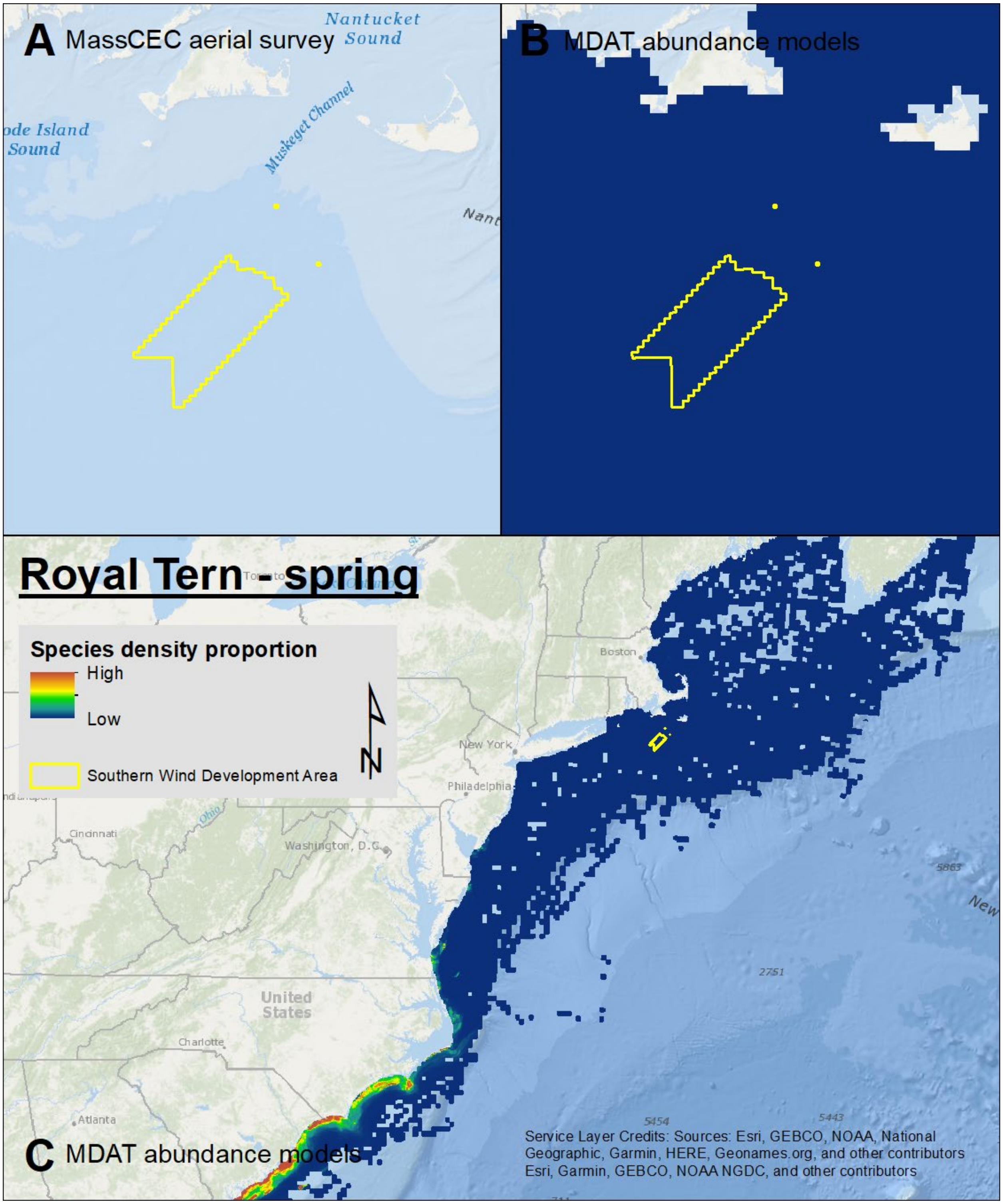

Map 86: Summer Common Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



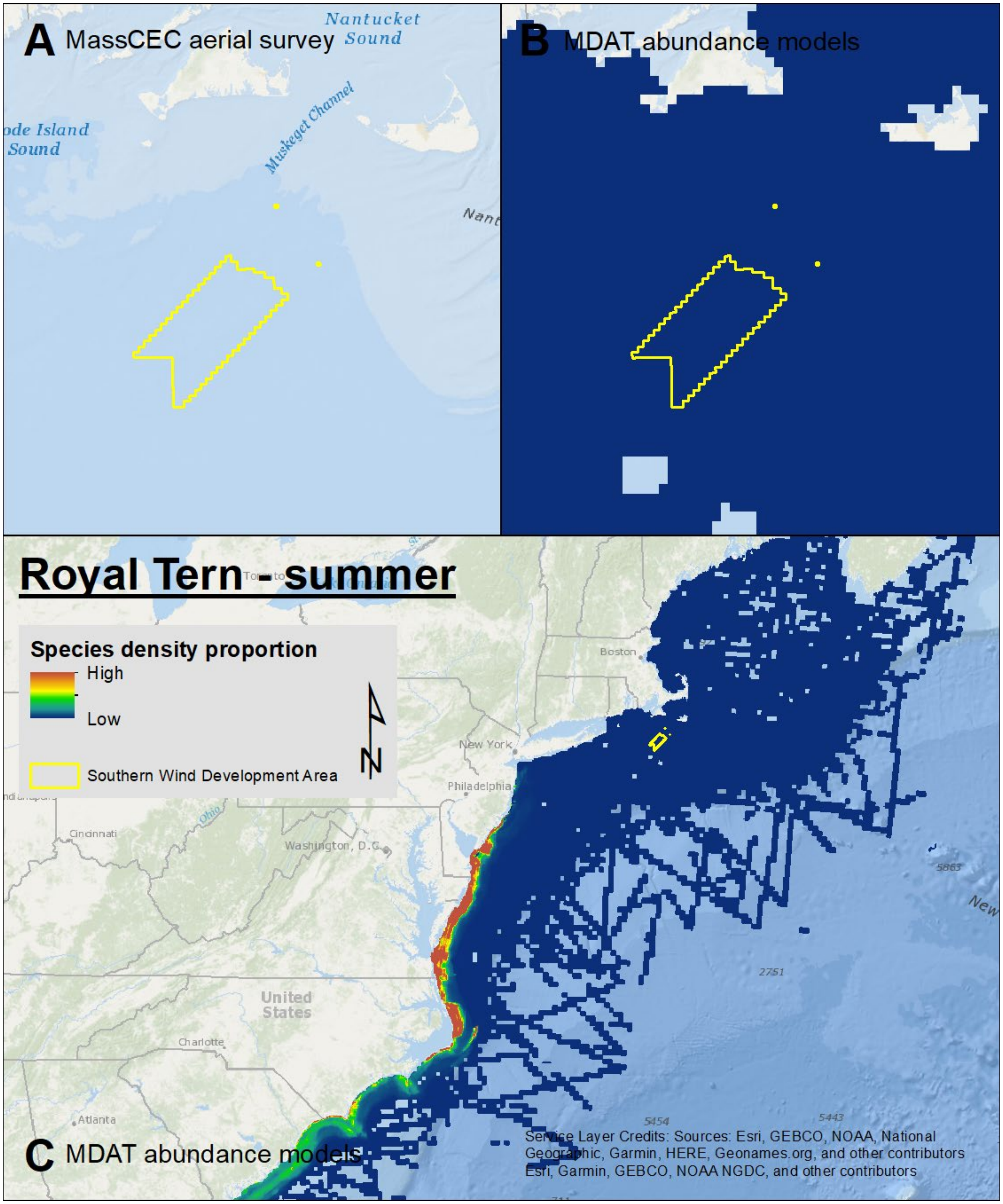

Map 87: Fall Common Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



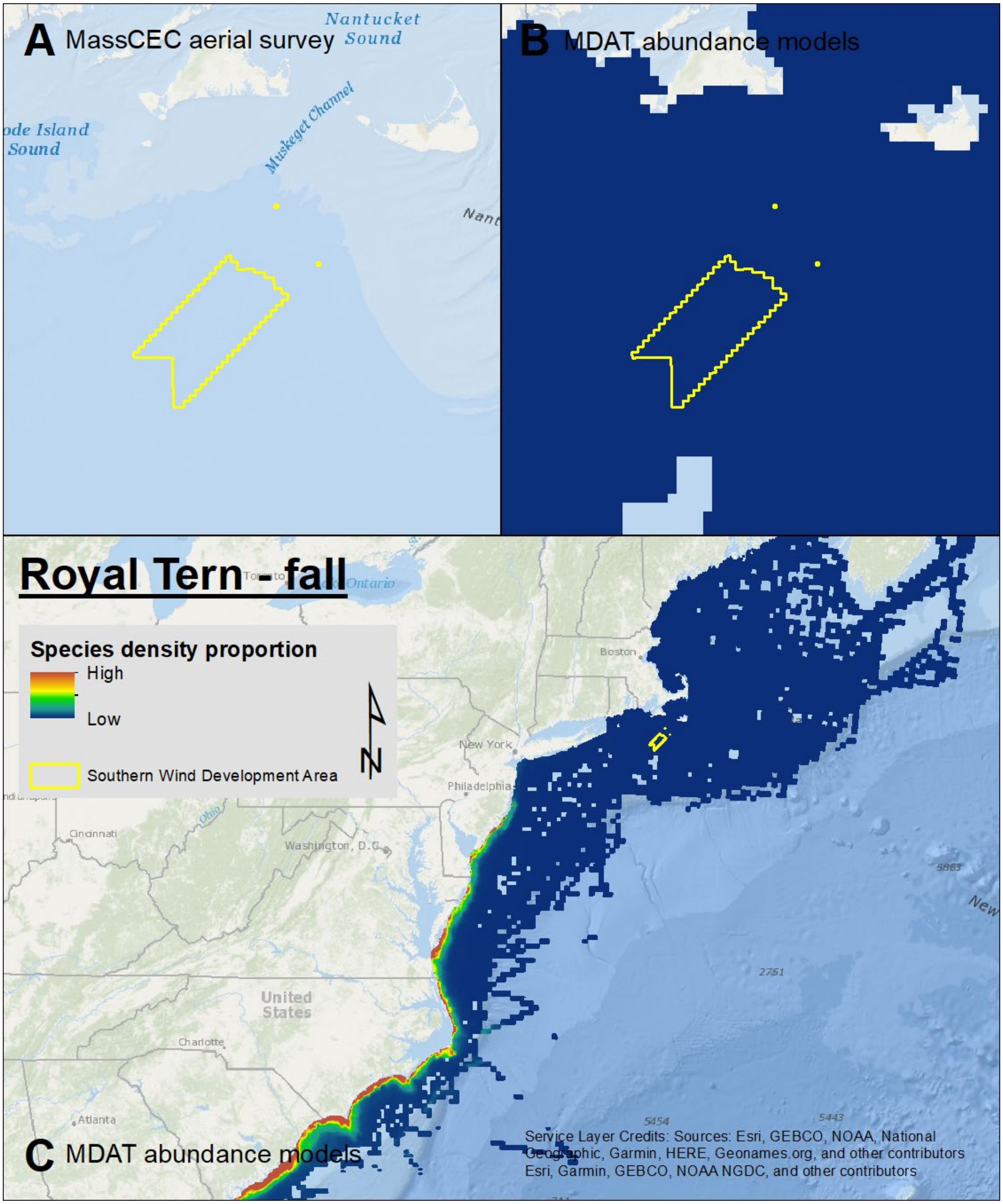

Map 88: Summer Arctic Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



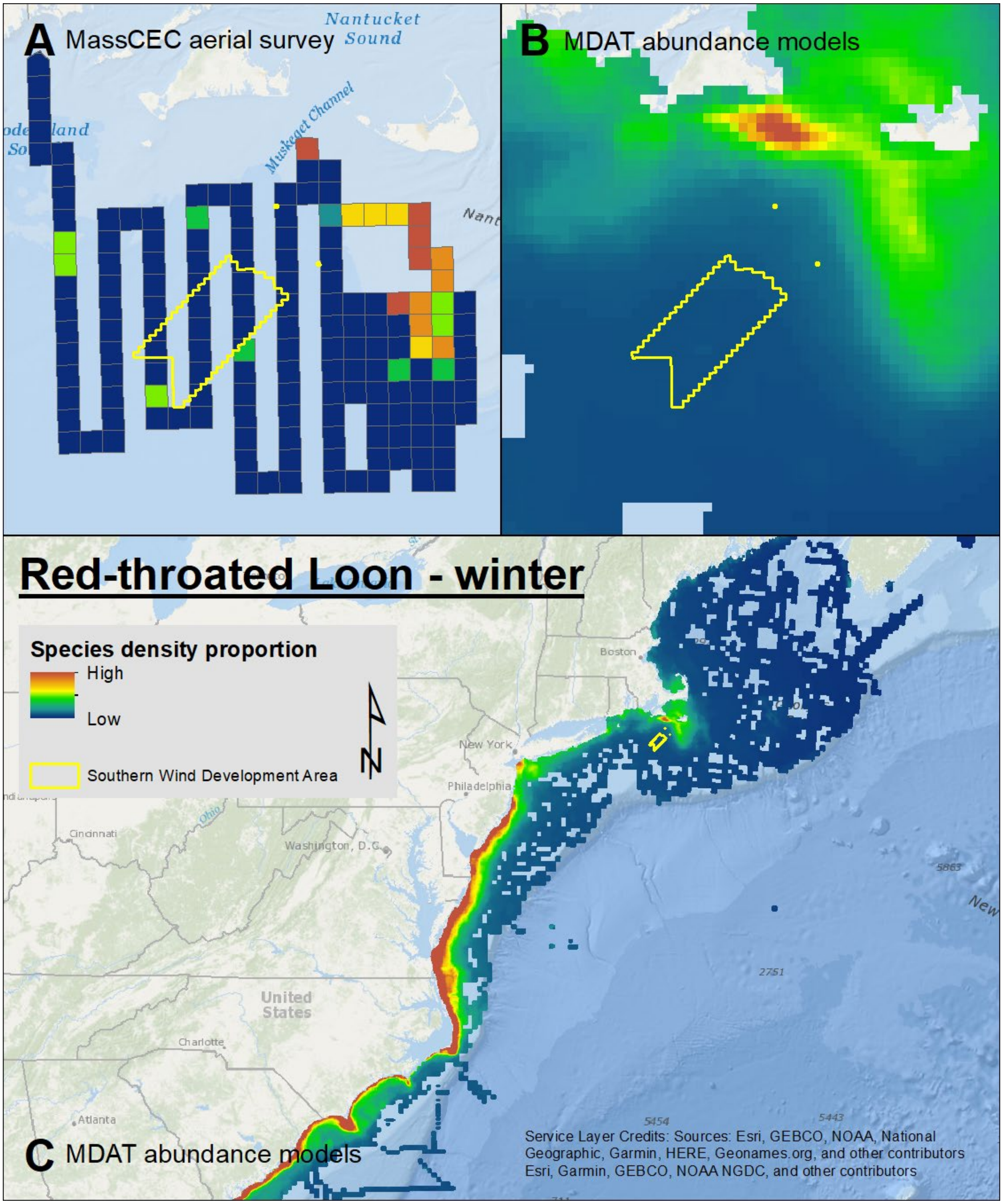

Map 89: Spring Royal Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



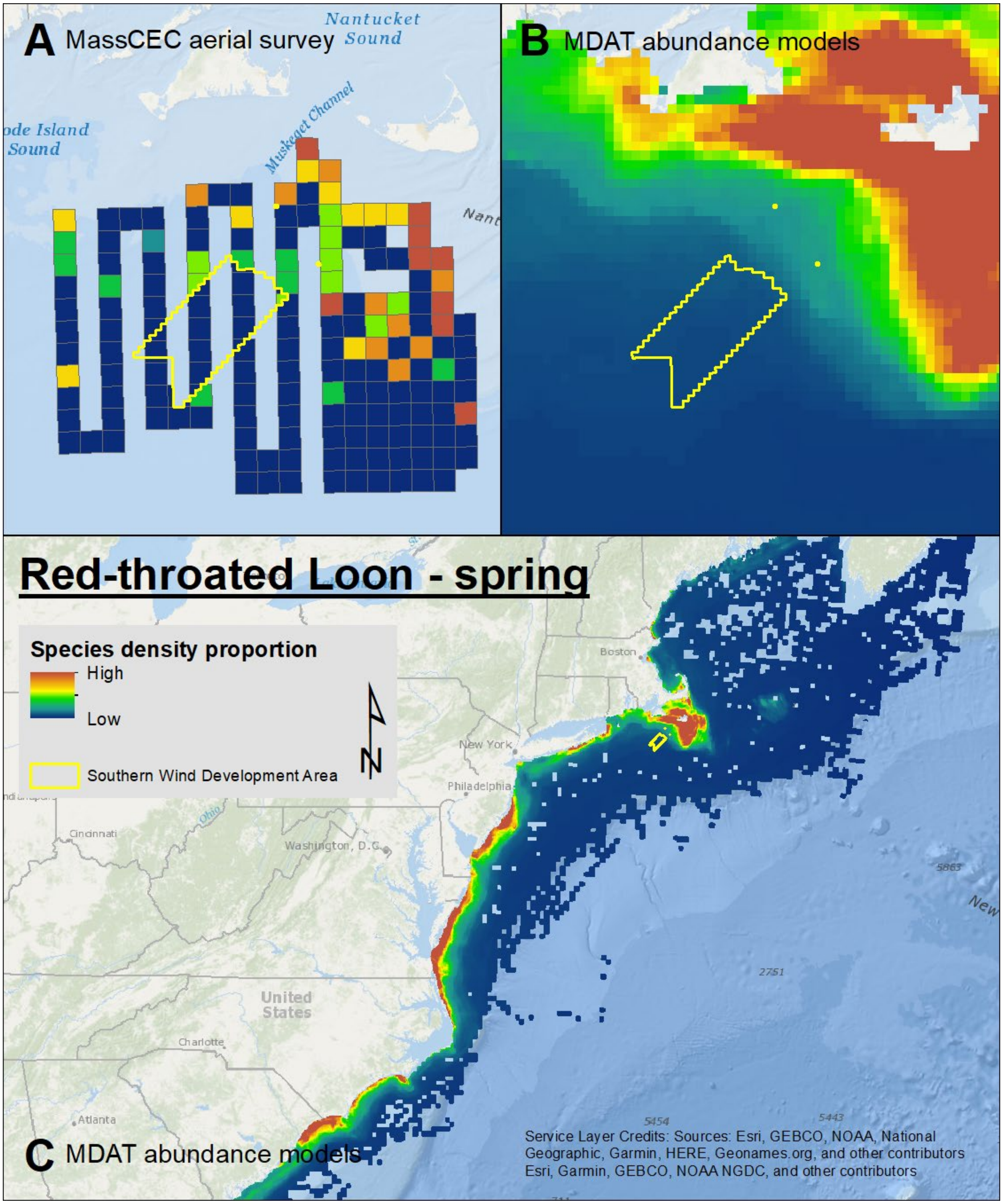

Map 90: Summer Royal Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



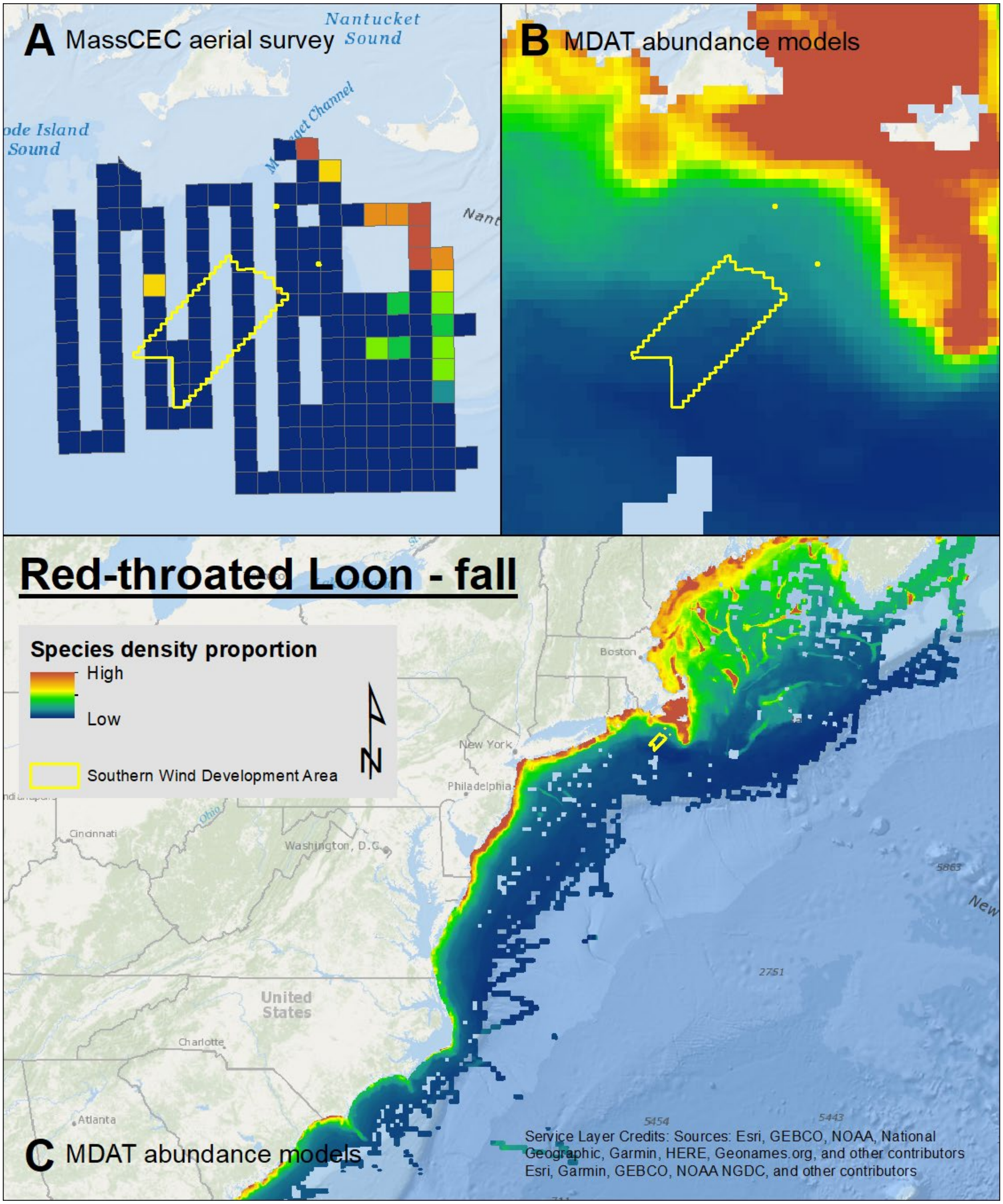

Map 91: Fall Royal Tern density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



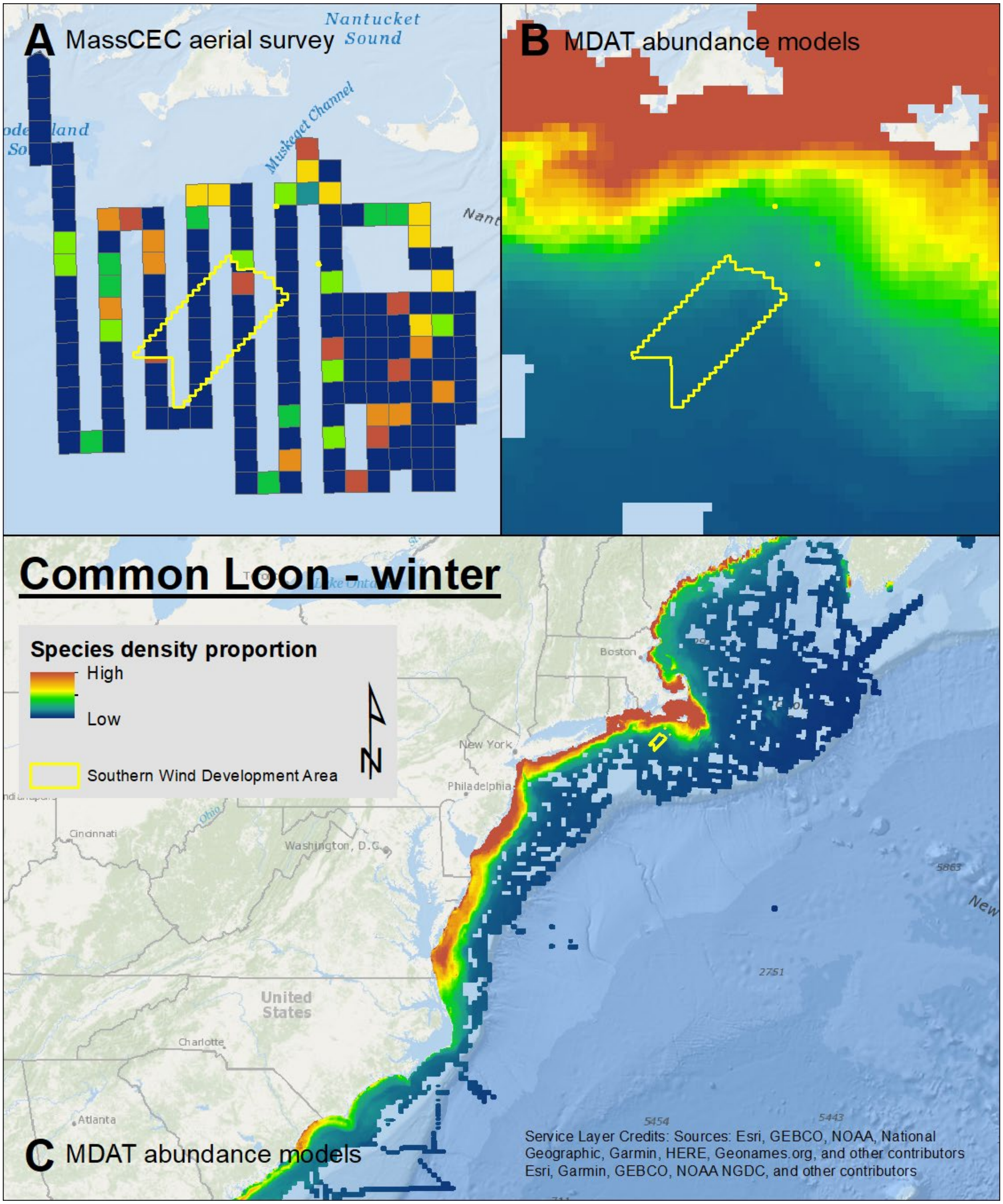

Map 92: Winter Red-throated Loon density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



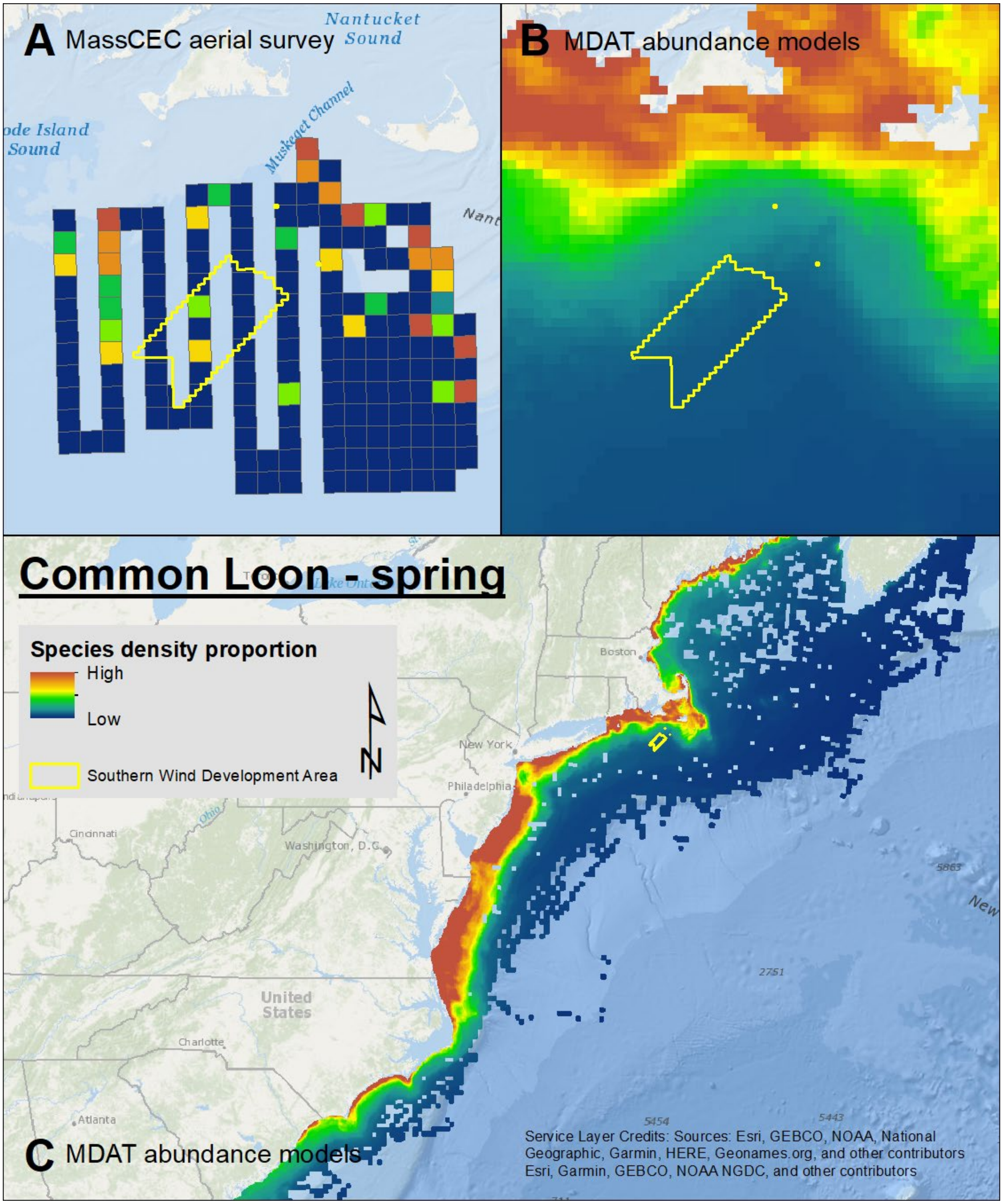

Map 93: Spring Red-throated Loon density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



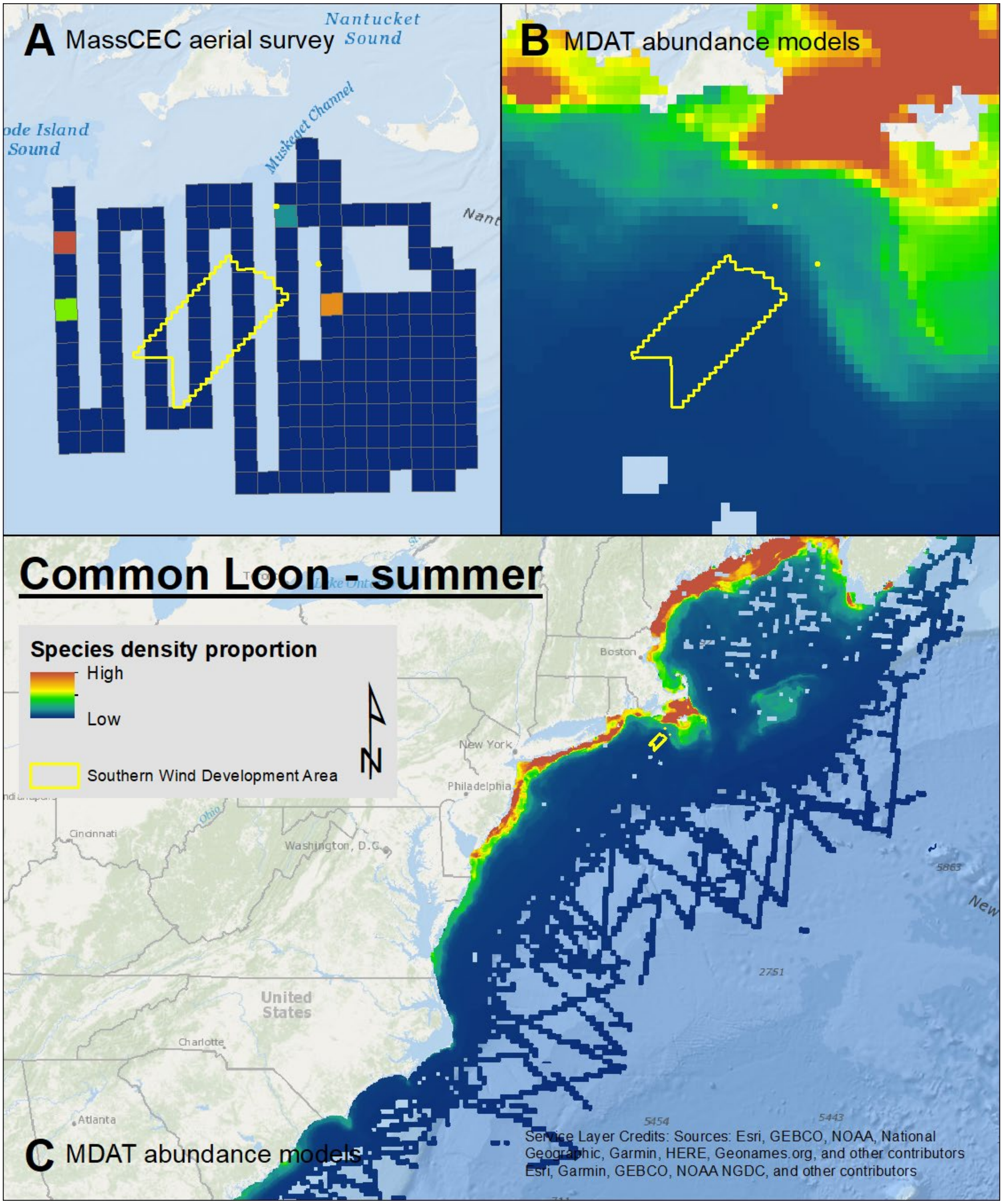

Map 94: Fall Red-throated Loon density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



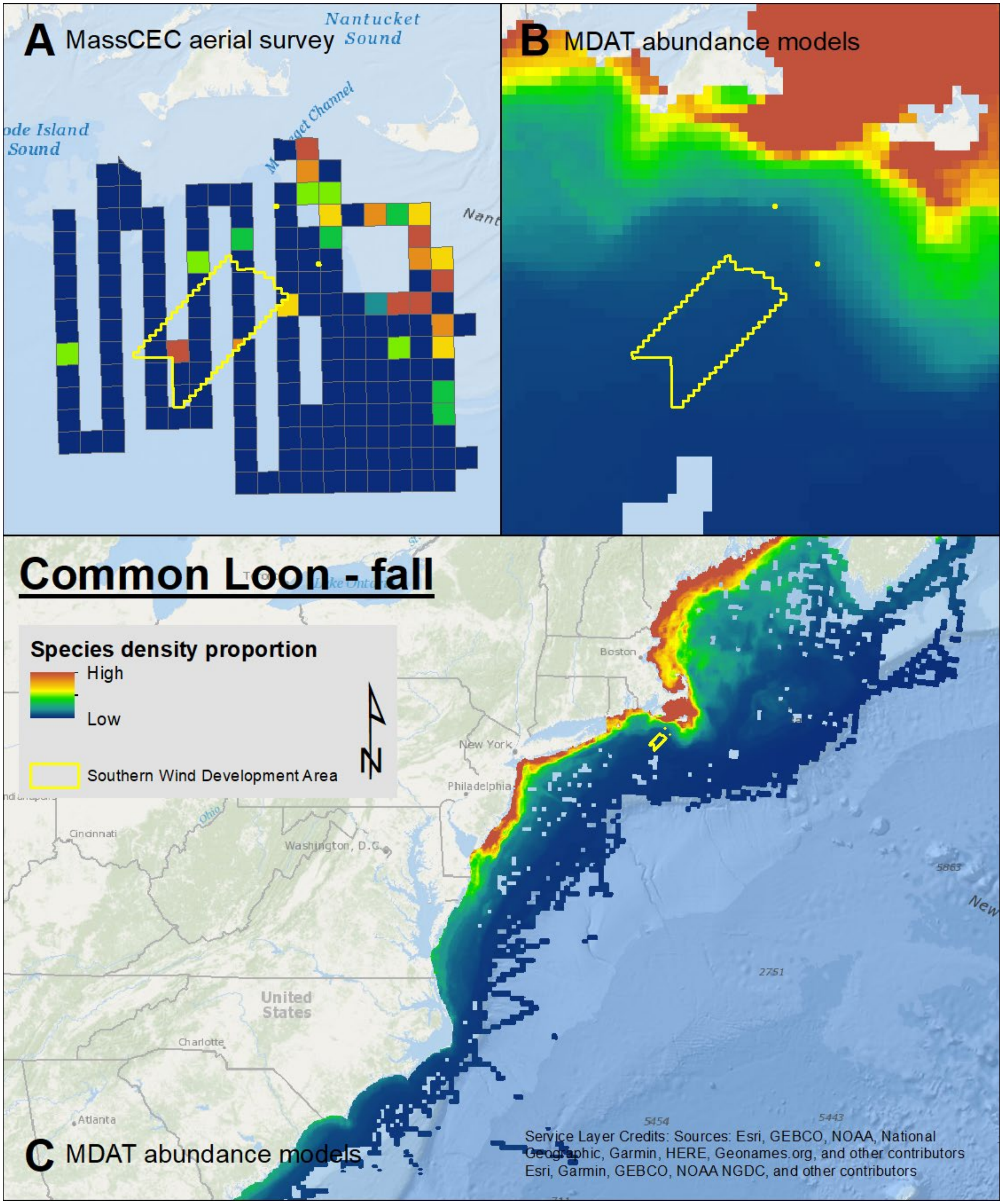

Map 95: Winter Common Loon density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



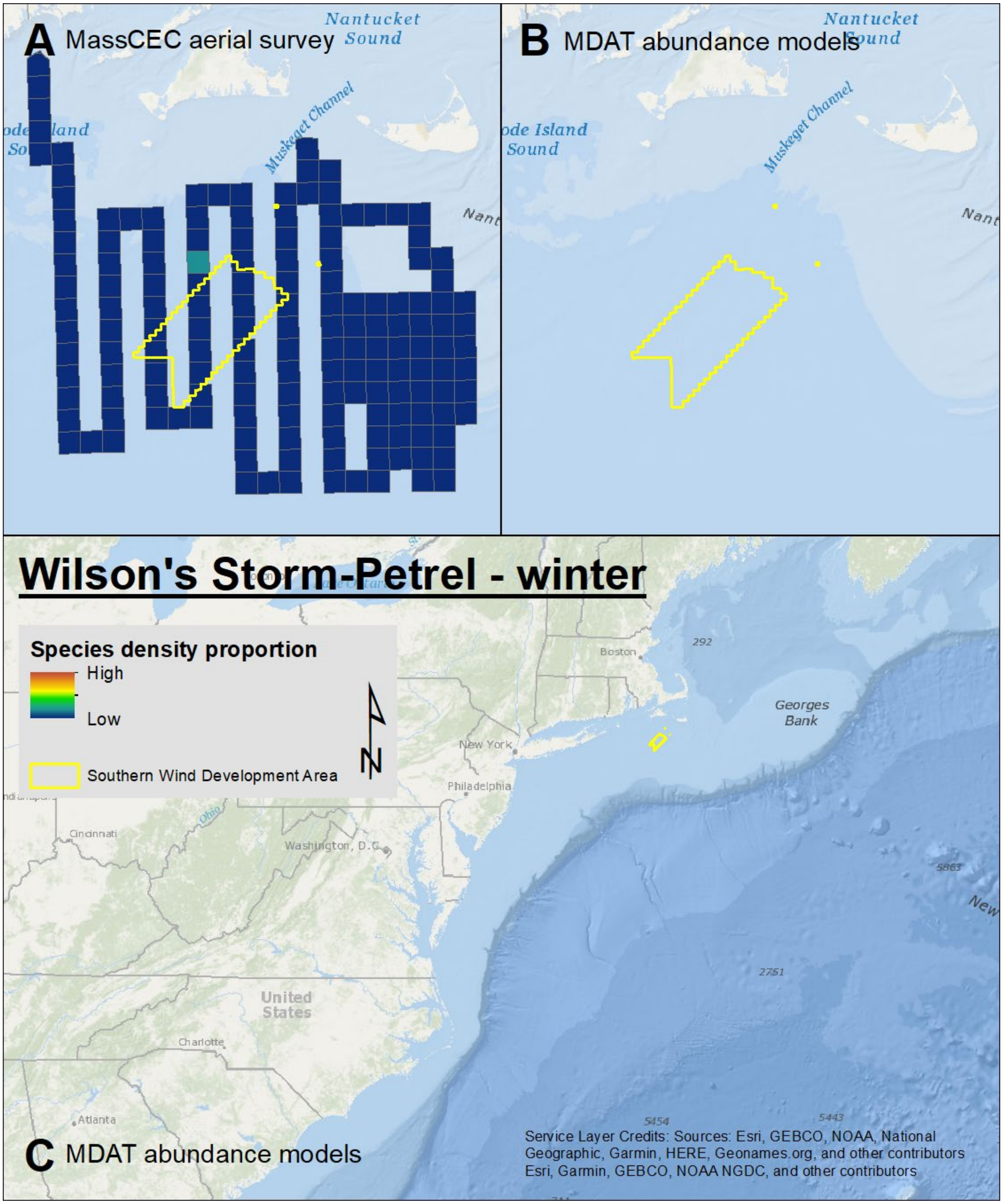

Map 96: Spring Common Loon density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



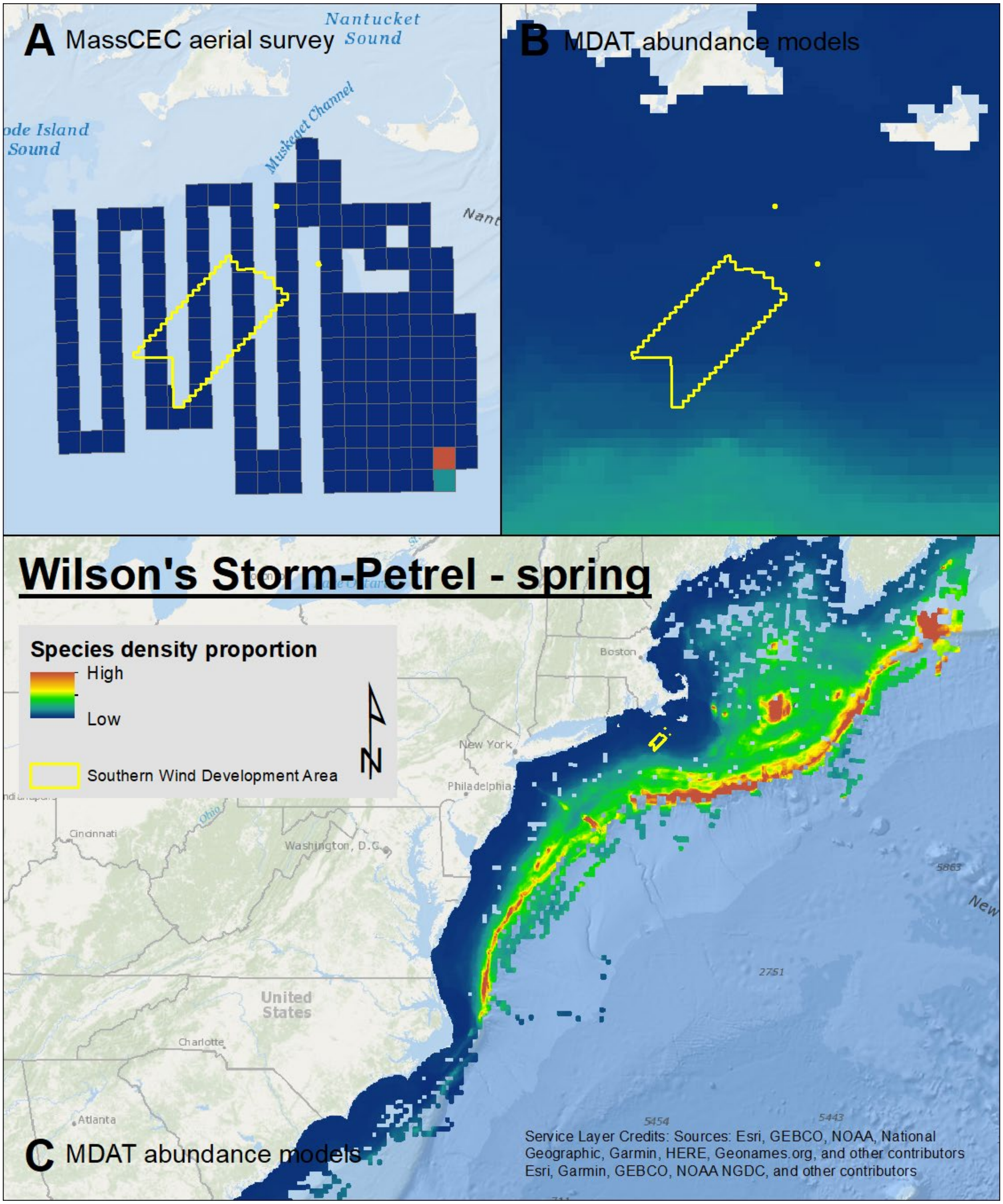

Map 97: Summer Common Loon density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



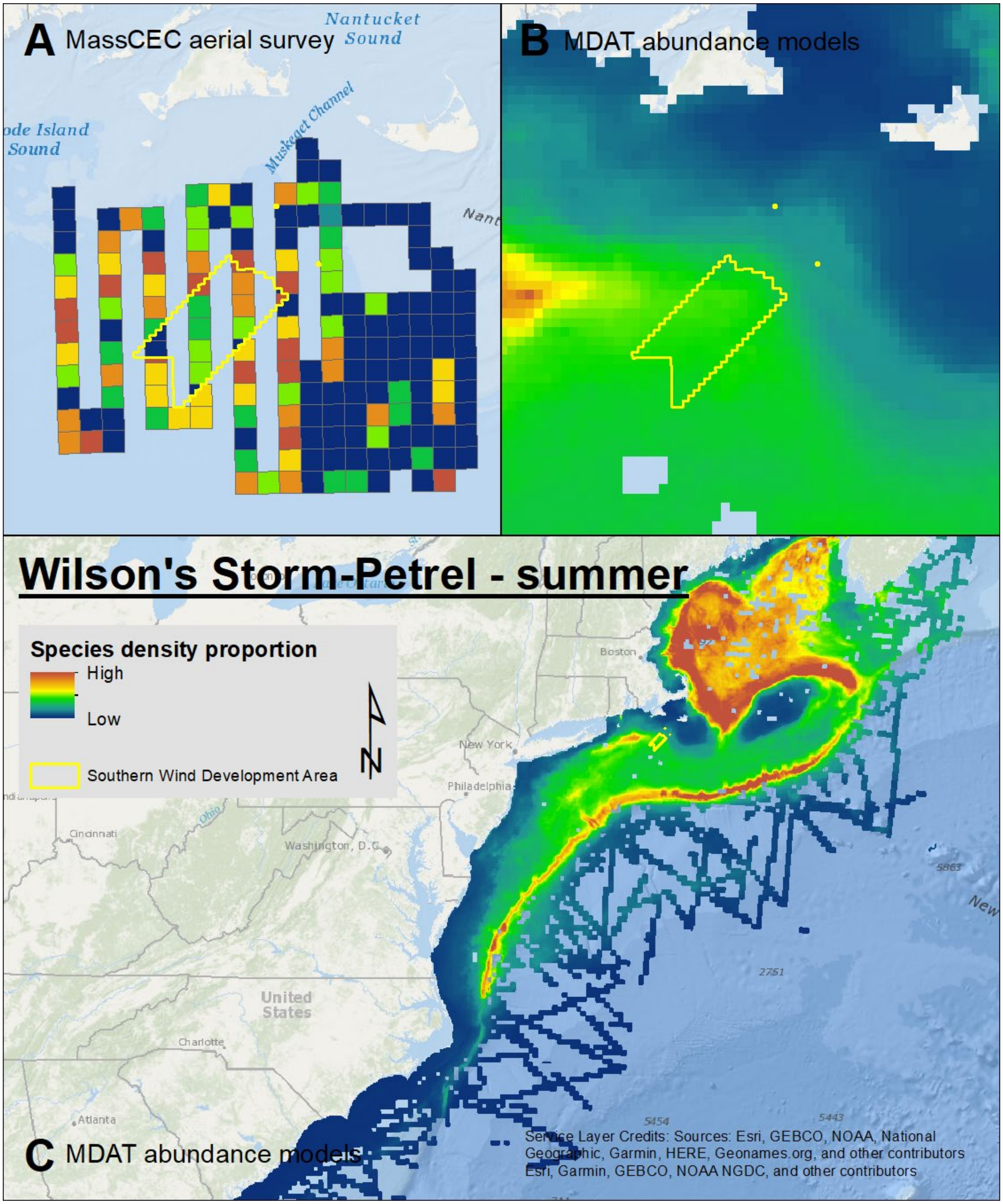

Map 98: Fall Common Loon density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



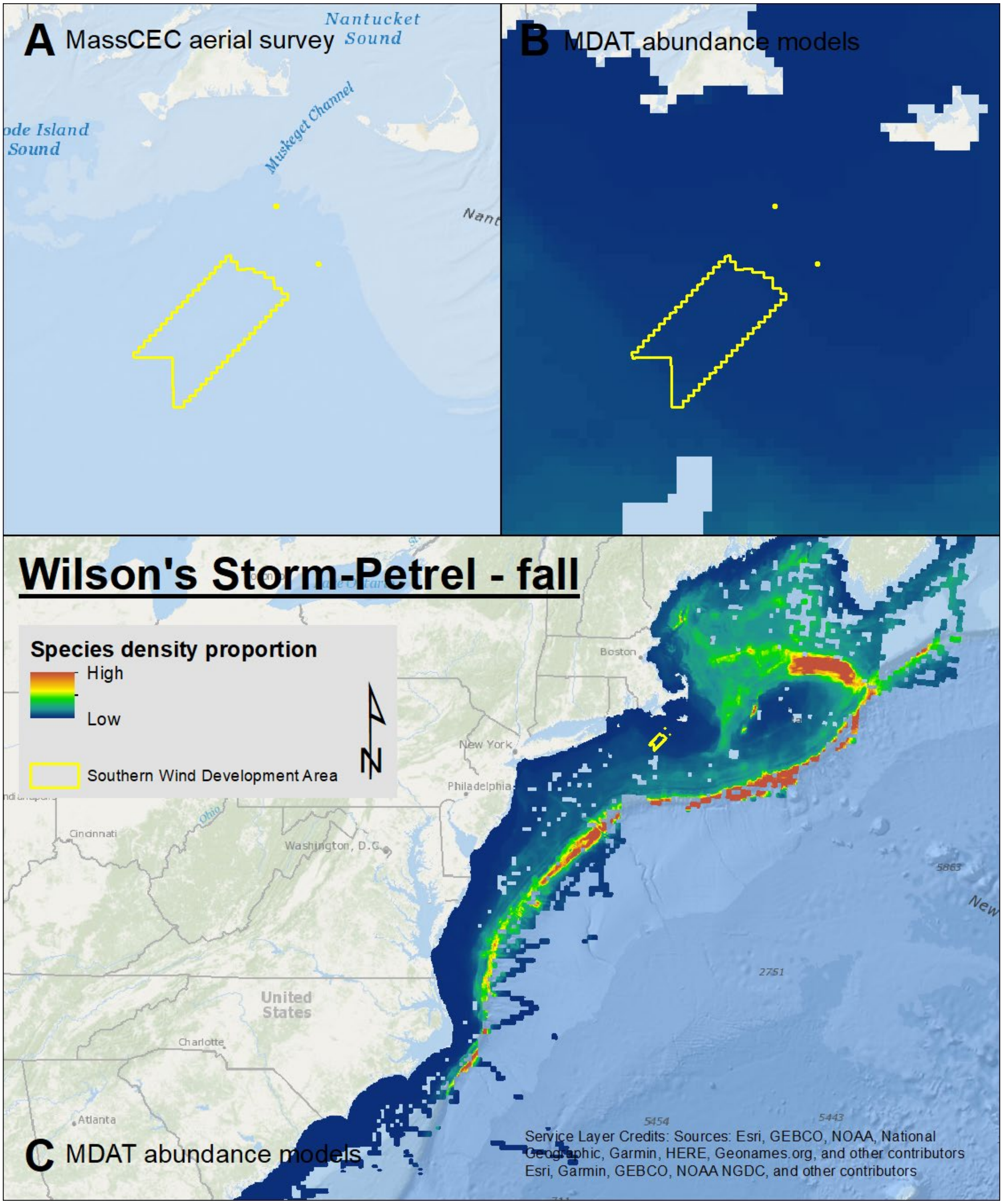

Map 99: Winter Wilson's Storm-Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



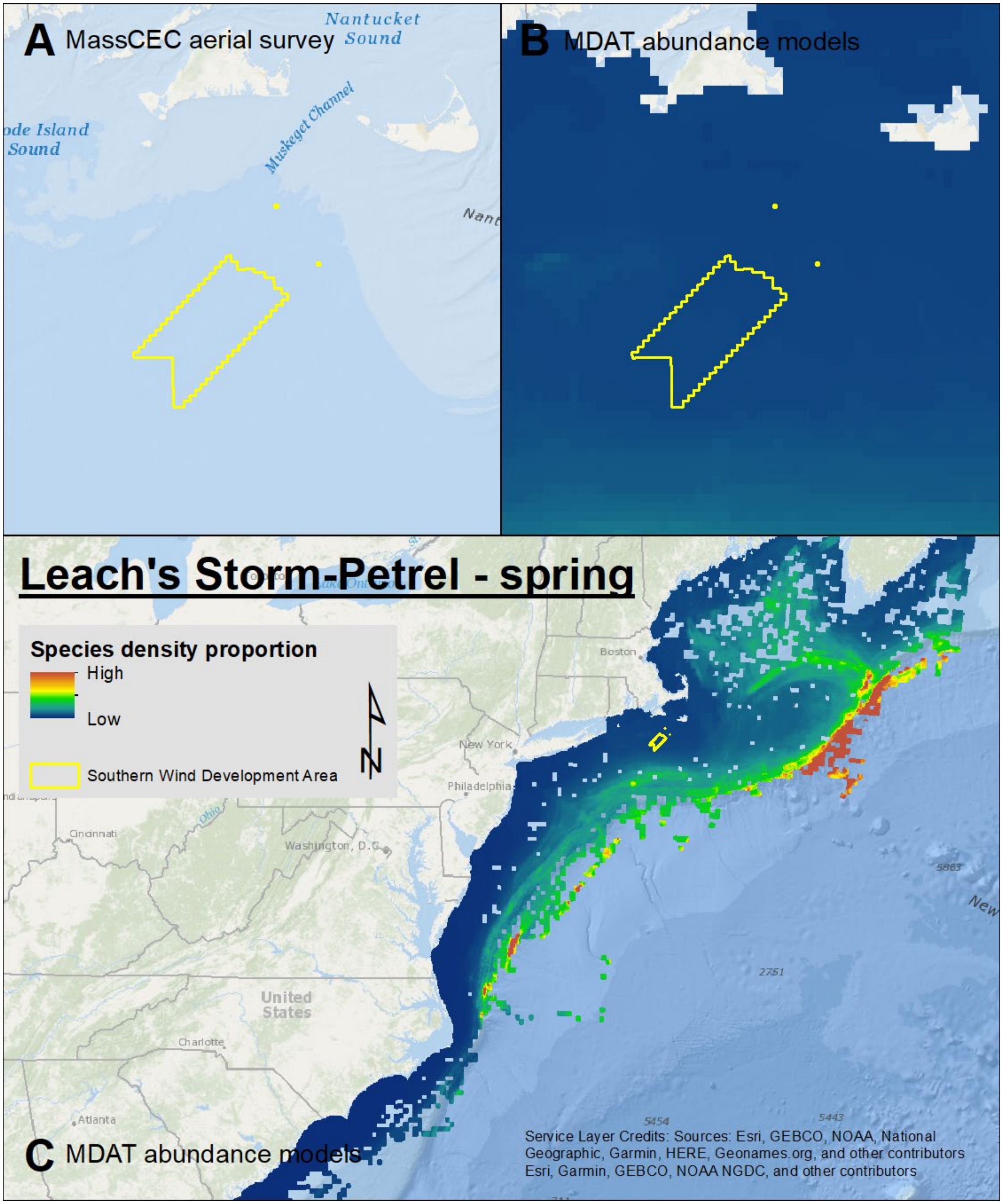

Map 100: Spring Wilson's Storm-Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



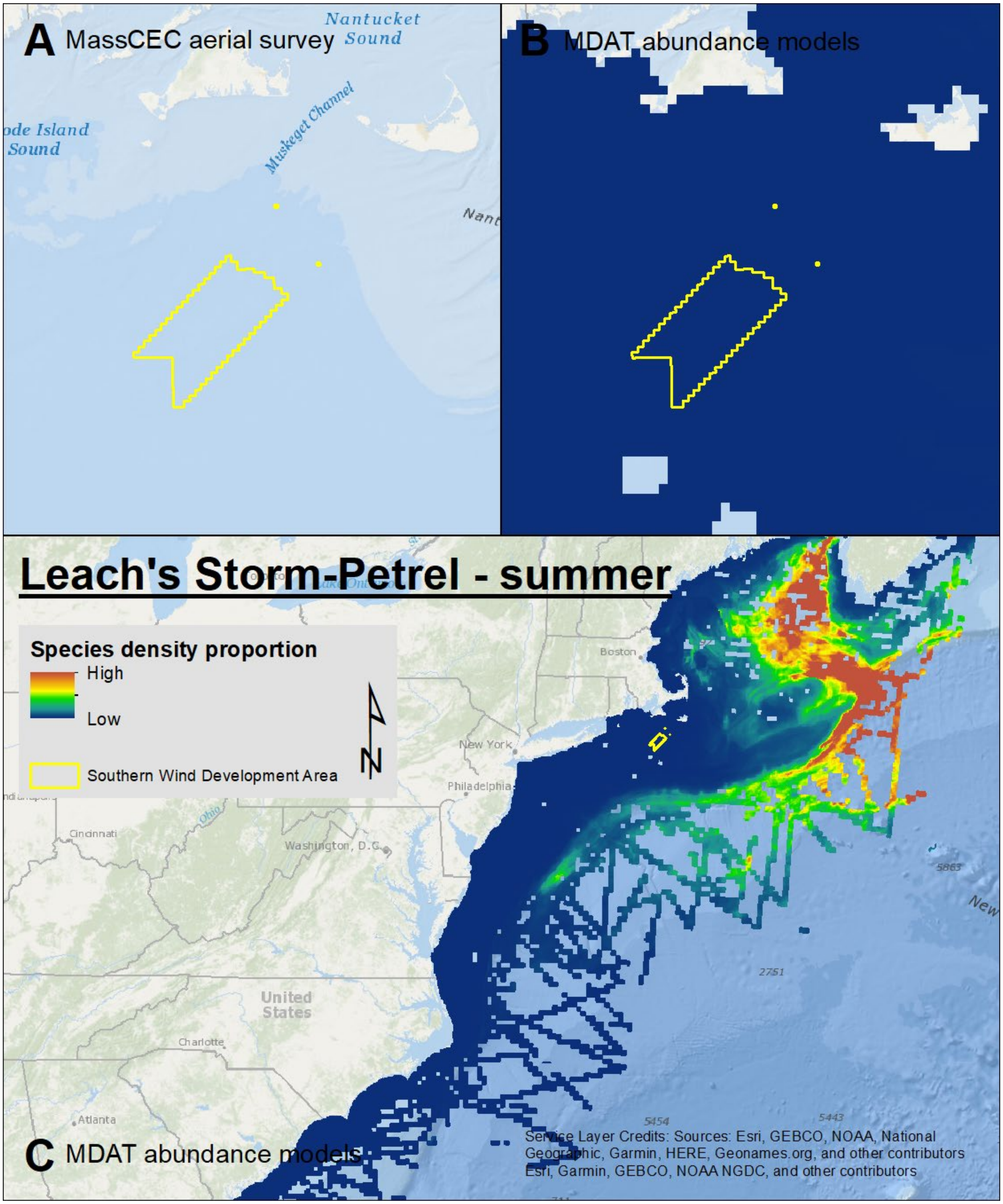

Map 101: Summer Wilson's Storm-Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



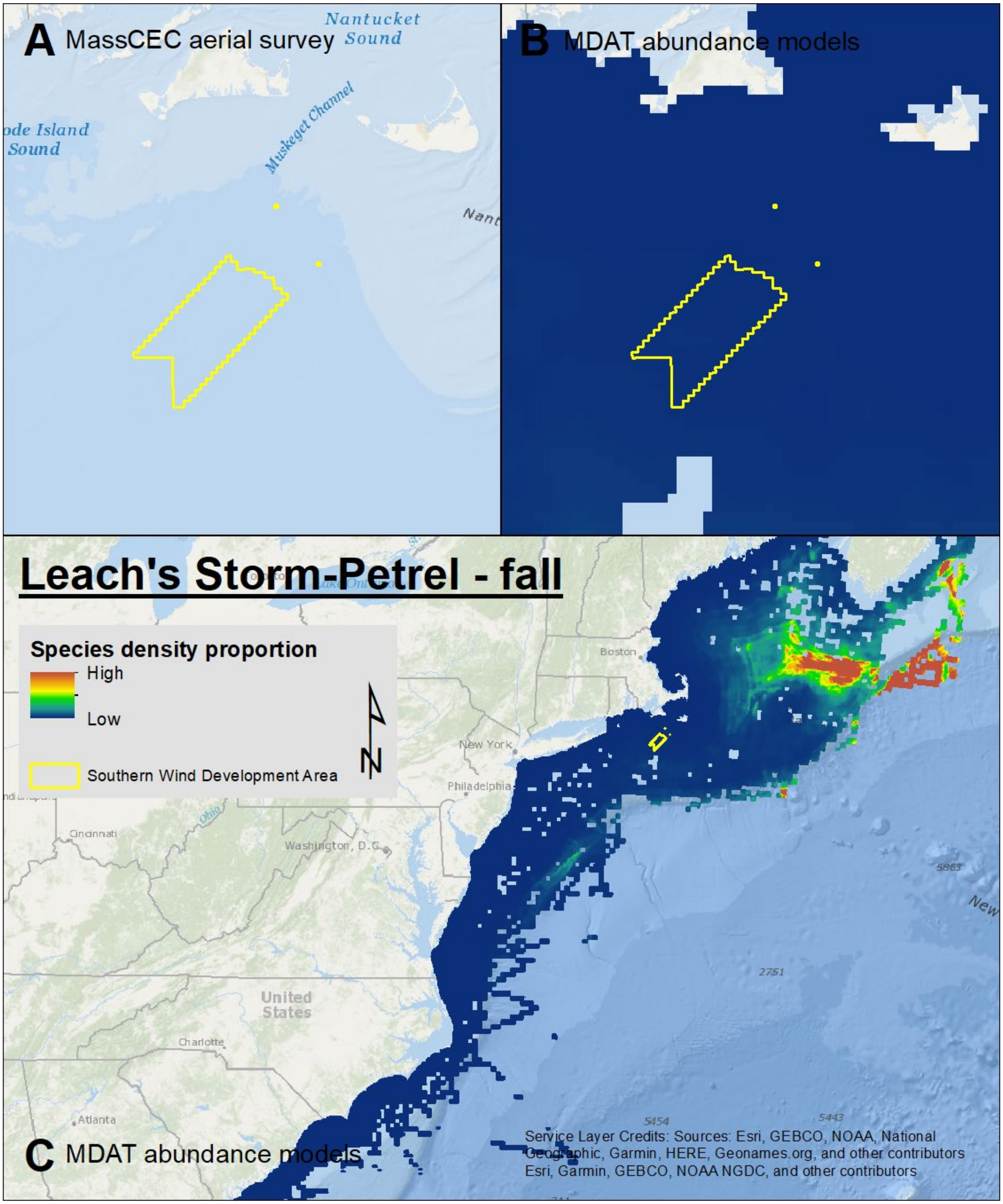

Map 102: Fall Wilson's Storm-Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



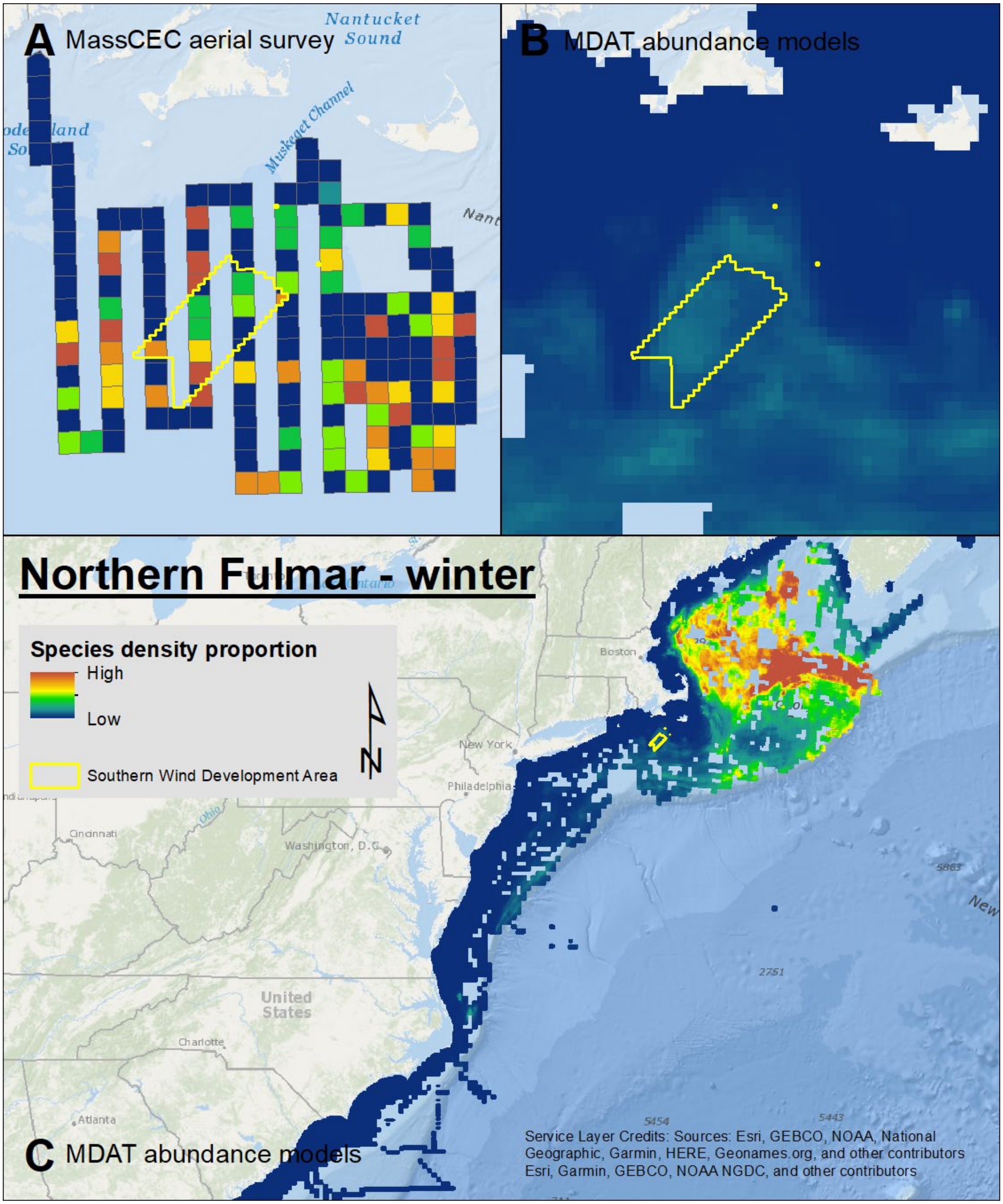

Map 103: Spring Leach's Storm-Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



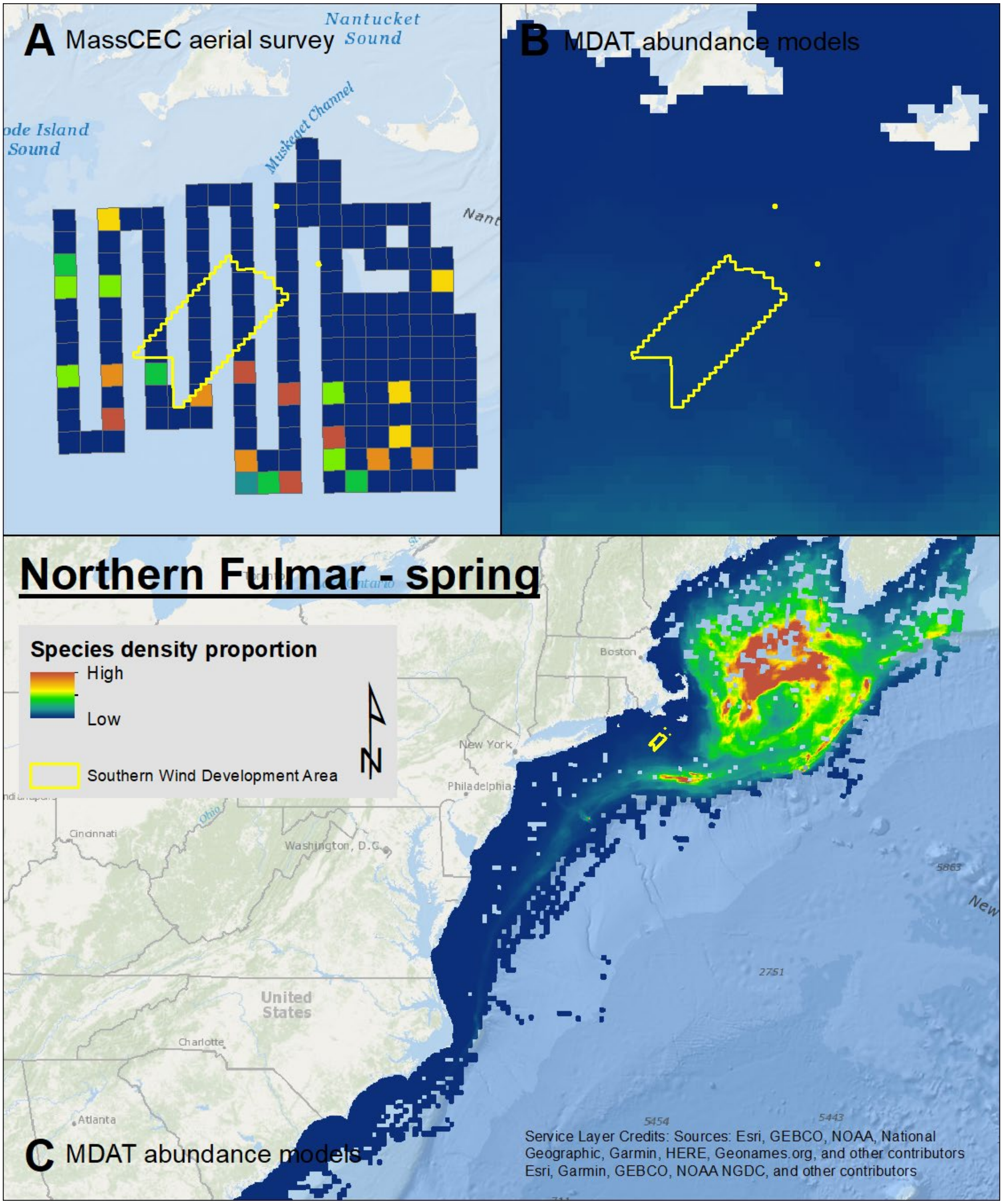

Map 104: Summer Leach's Storm-Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



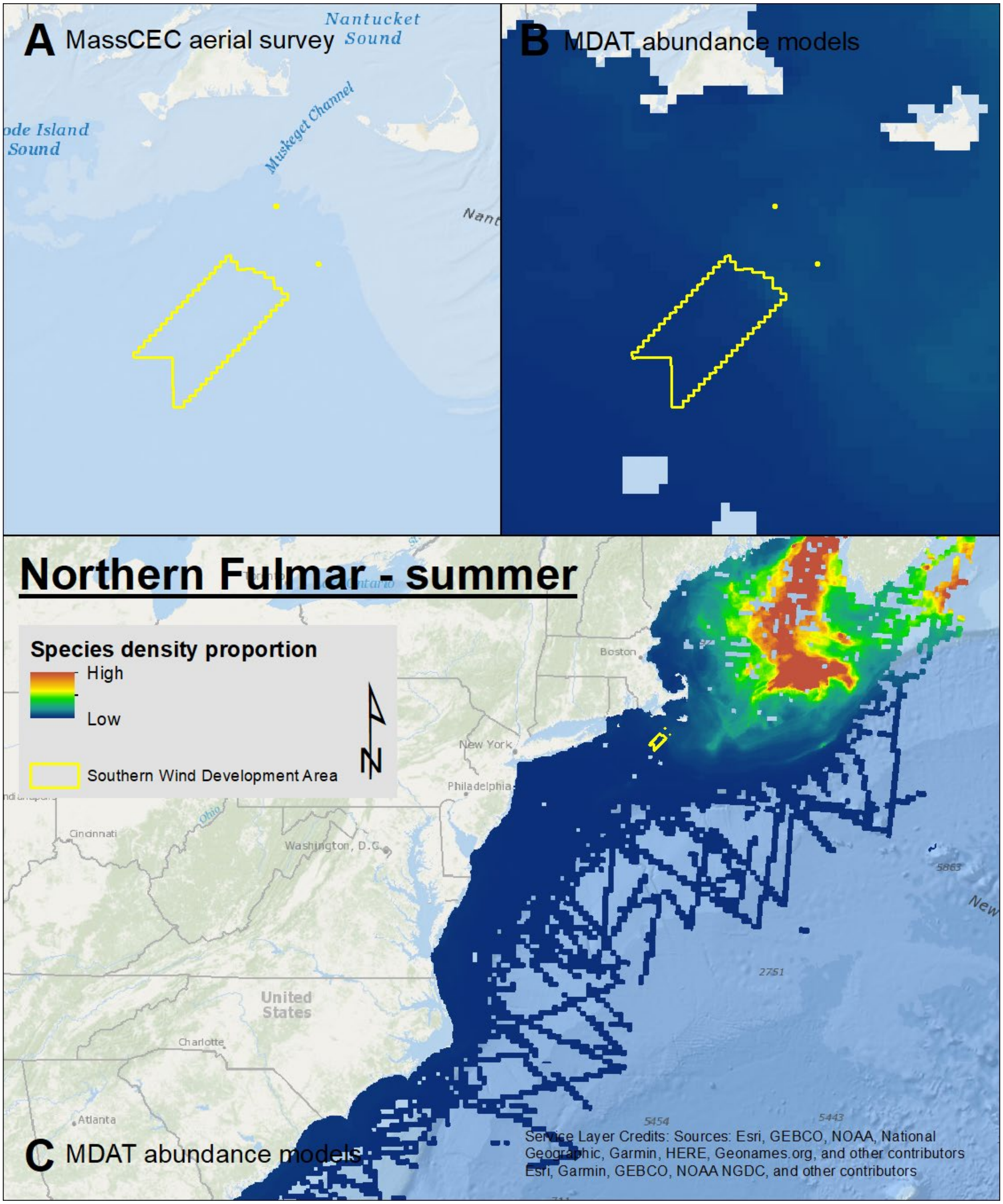

Map 105: Fall Leach's Storm-Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



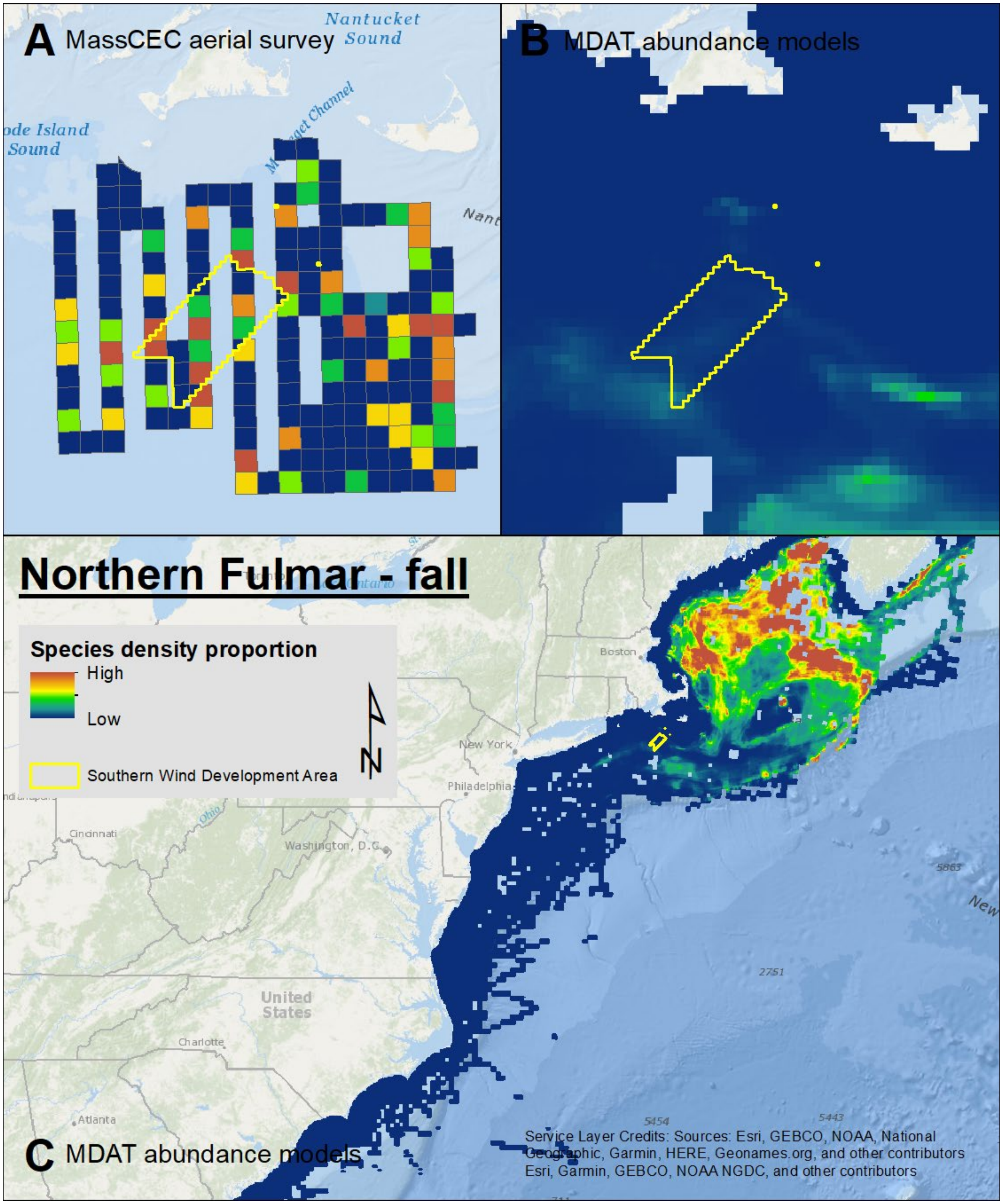

Map 106: Winter Northern Fulmar density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



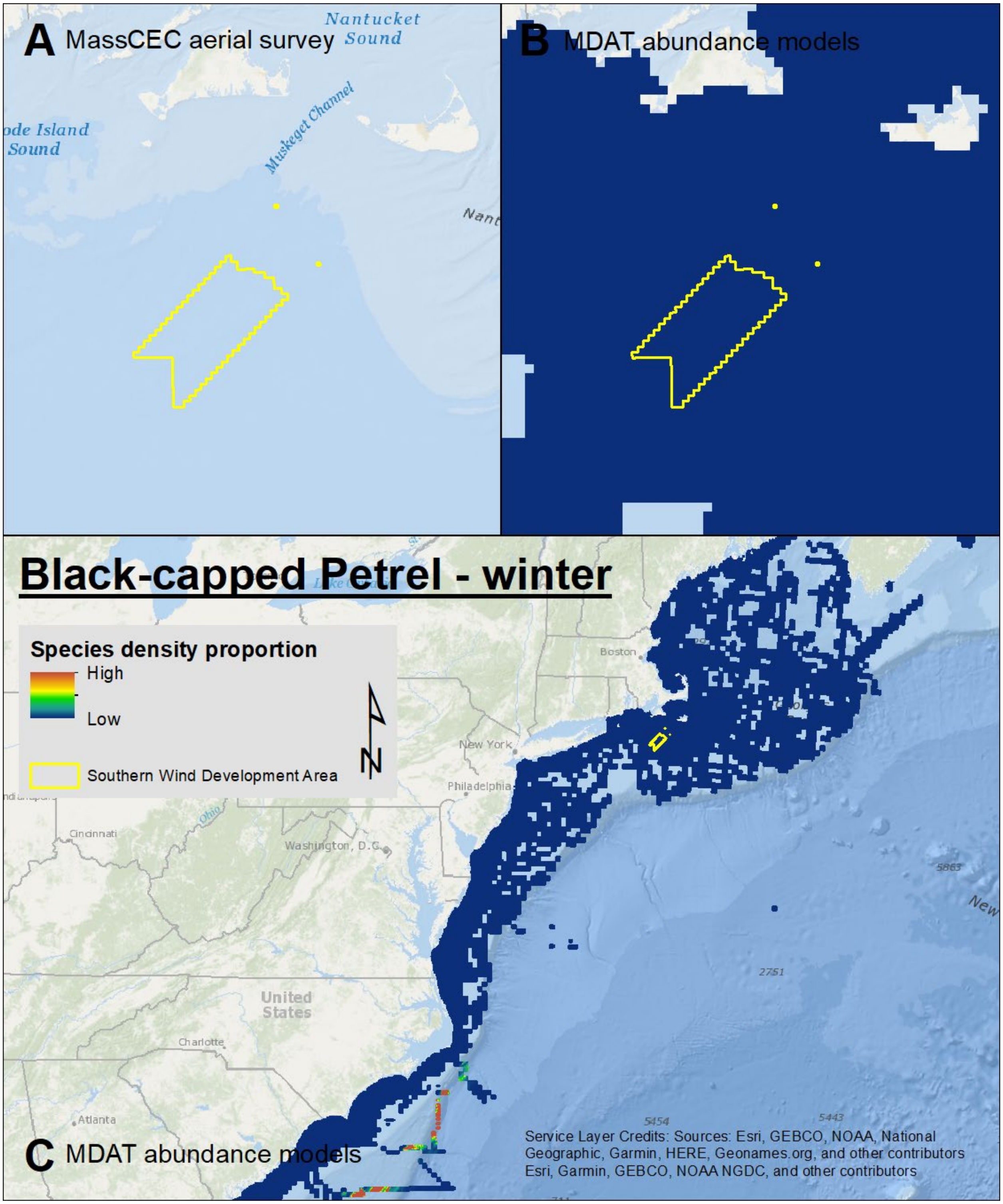

Map 107: Spring Northern Fulmar density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



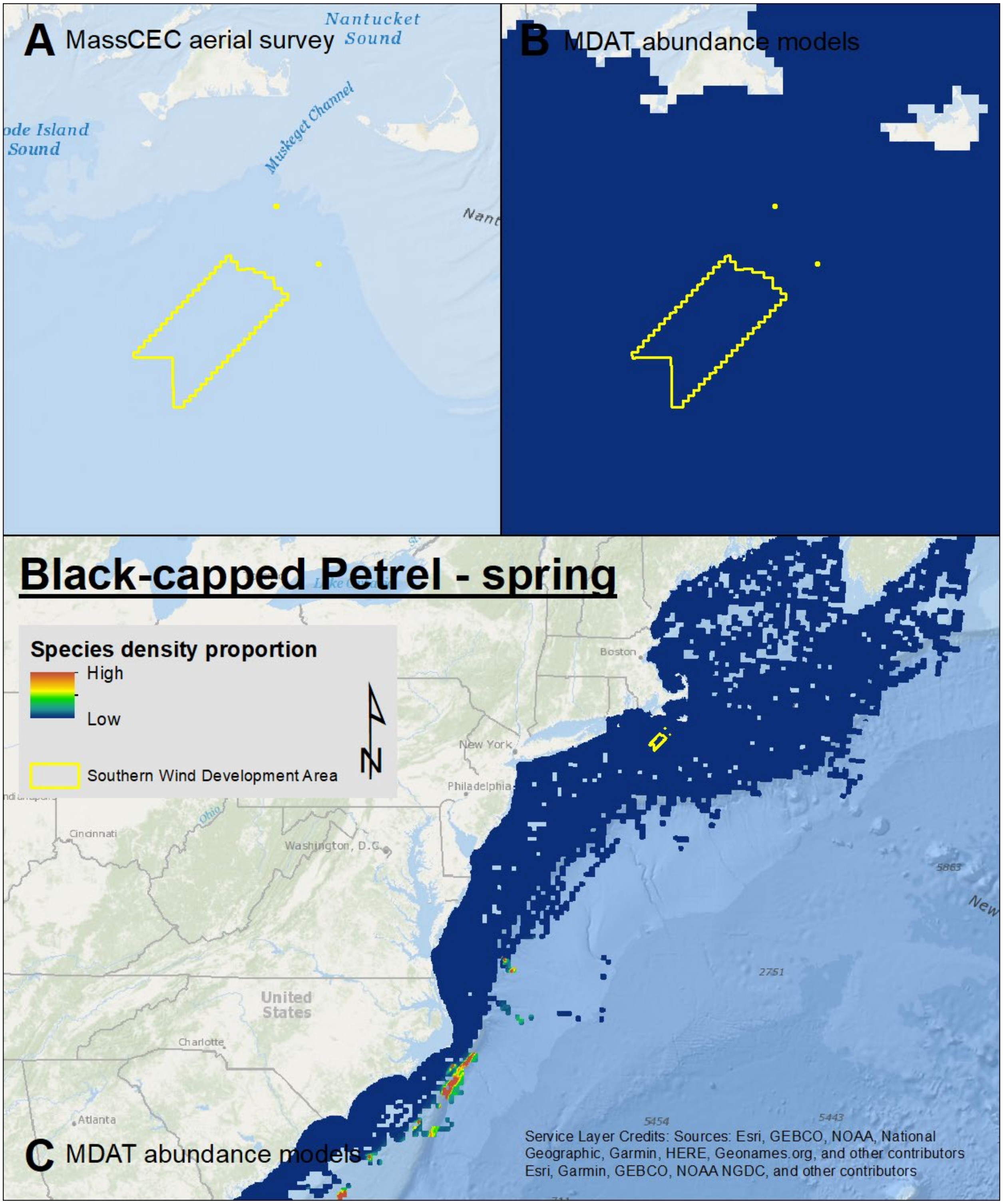

Map 108: Summer Northern Fulmar density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



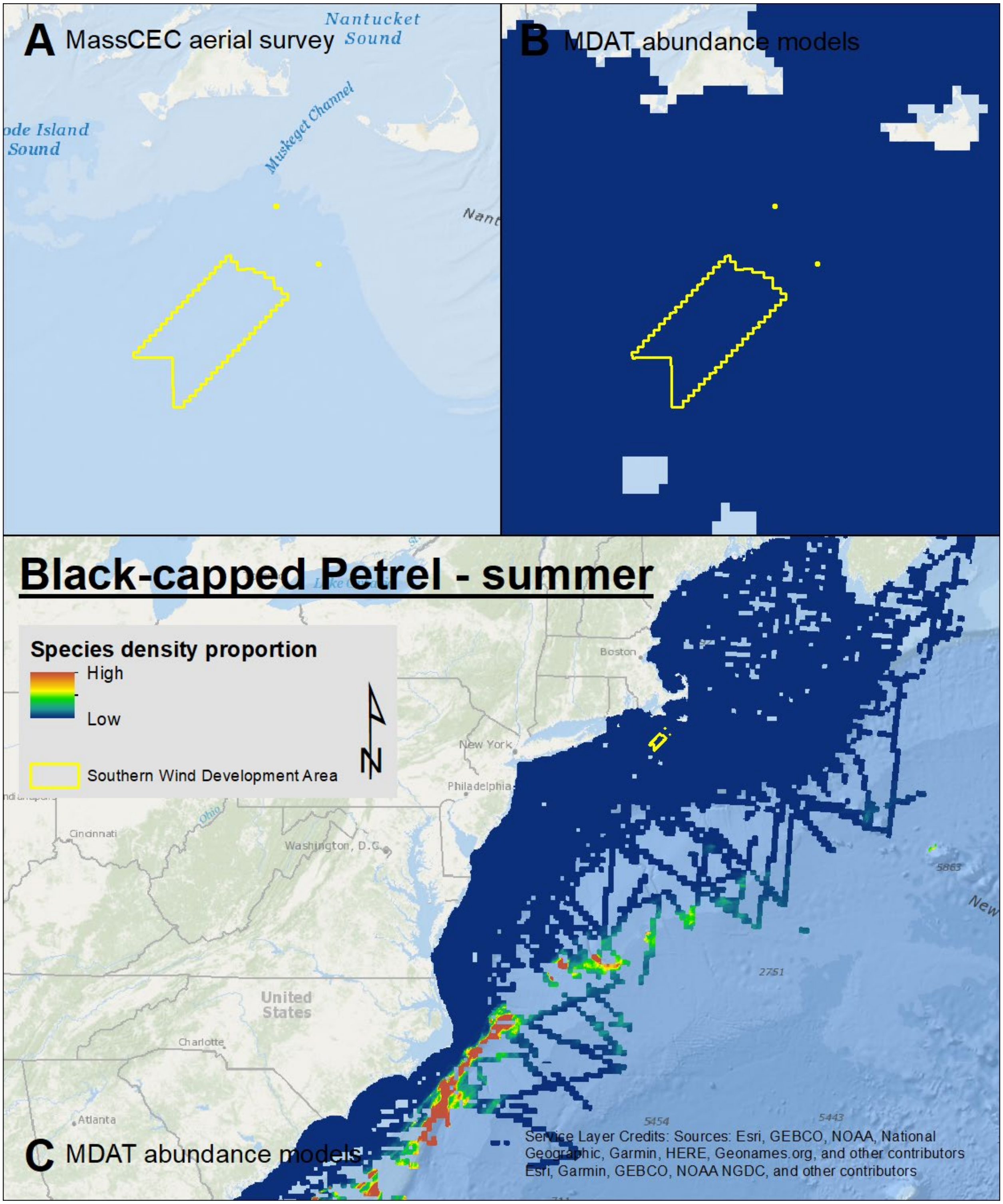

Map 109: Fall Northern Fulmar density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



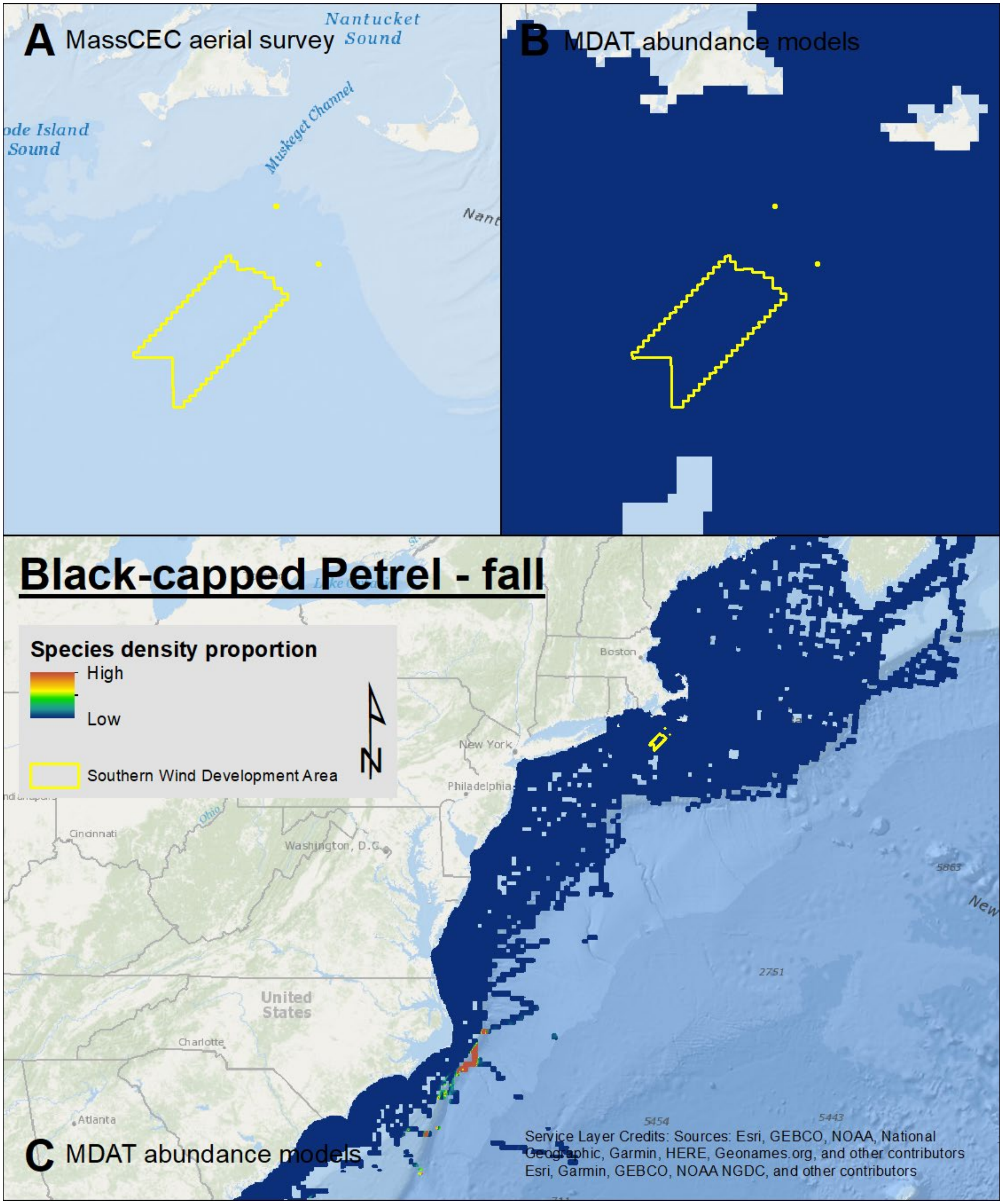

Map 110: Winter Black-capped Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



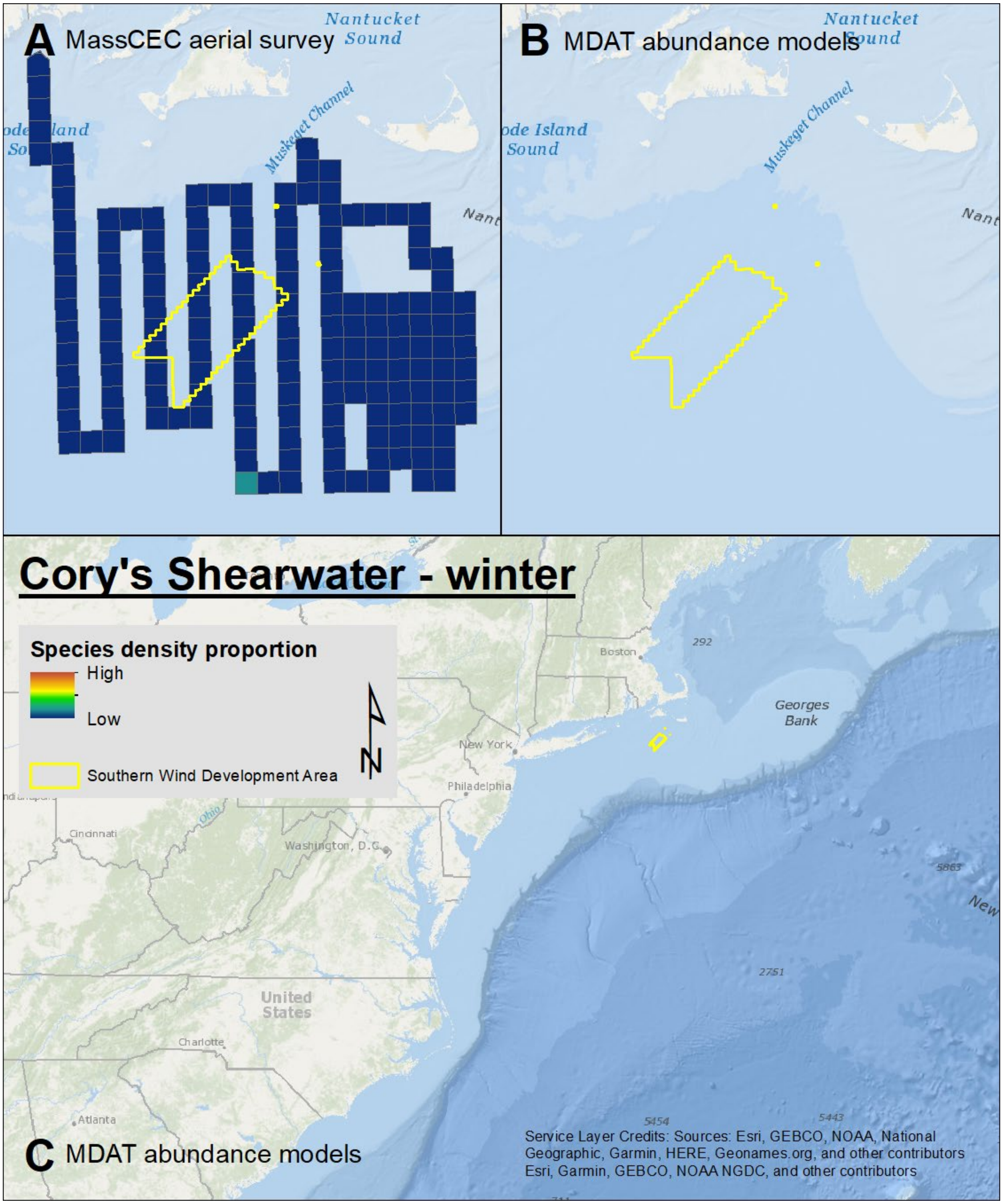

Map 111: Spring Black-capped Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



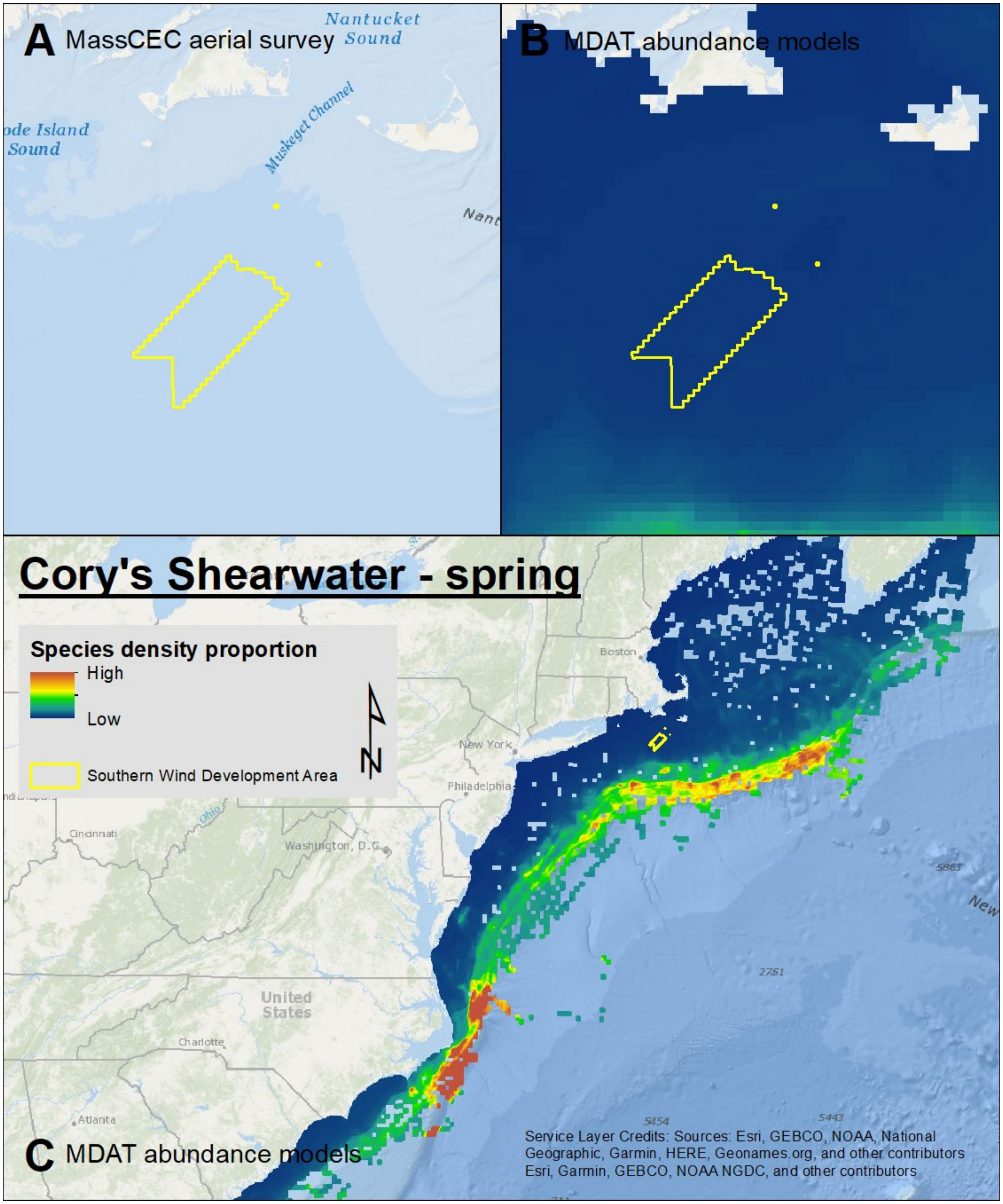

Map 112: Summer Black-capped Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



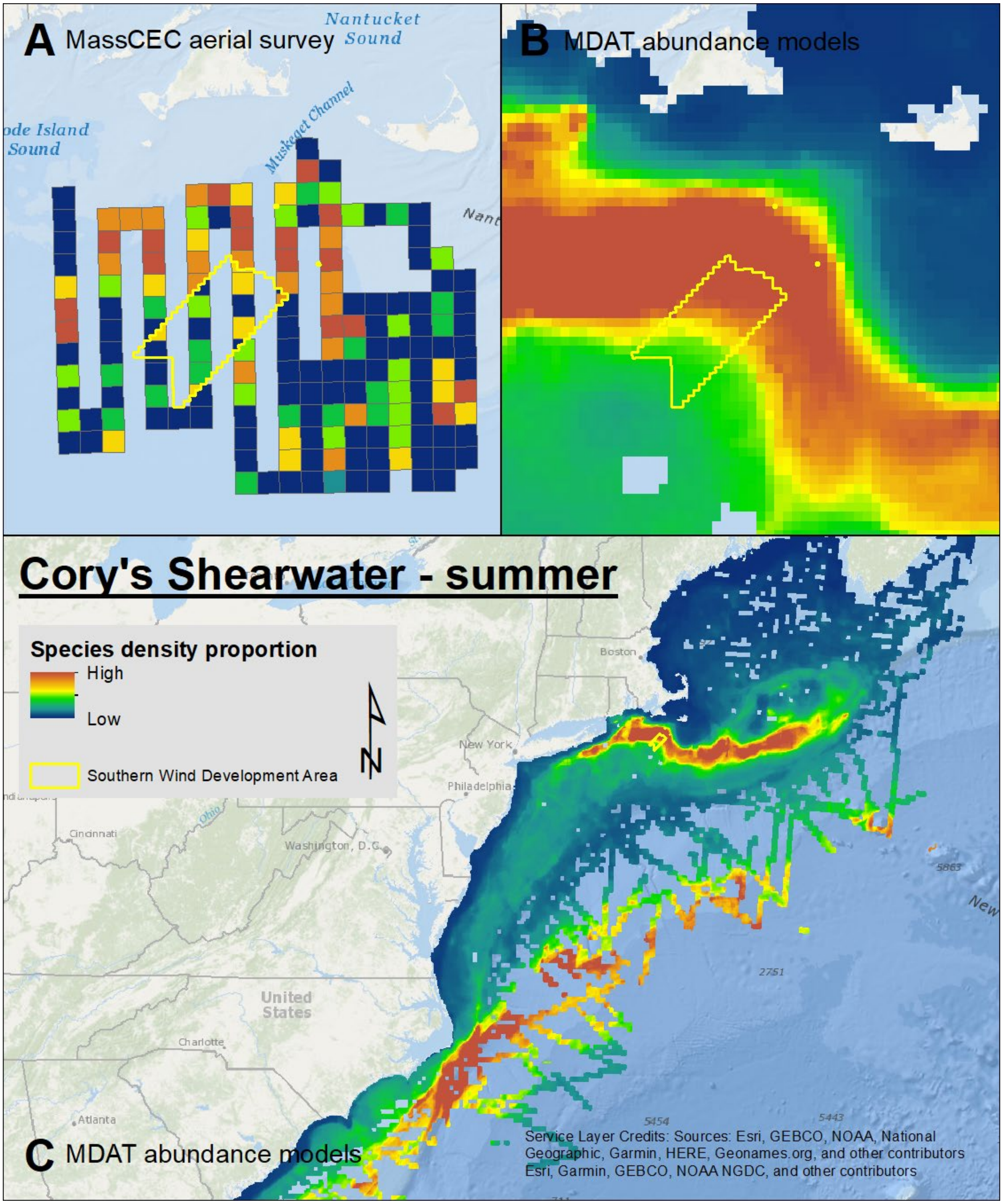

Map 113: Fall Black-capped Petrel density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



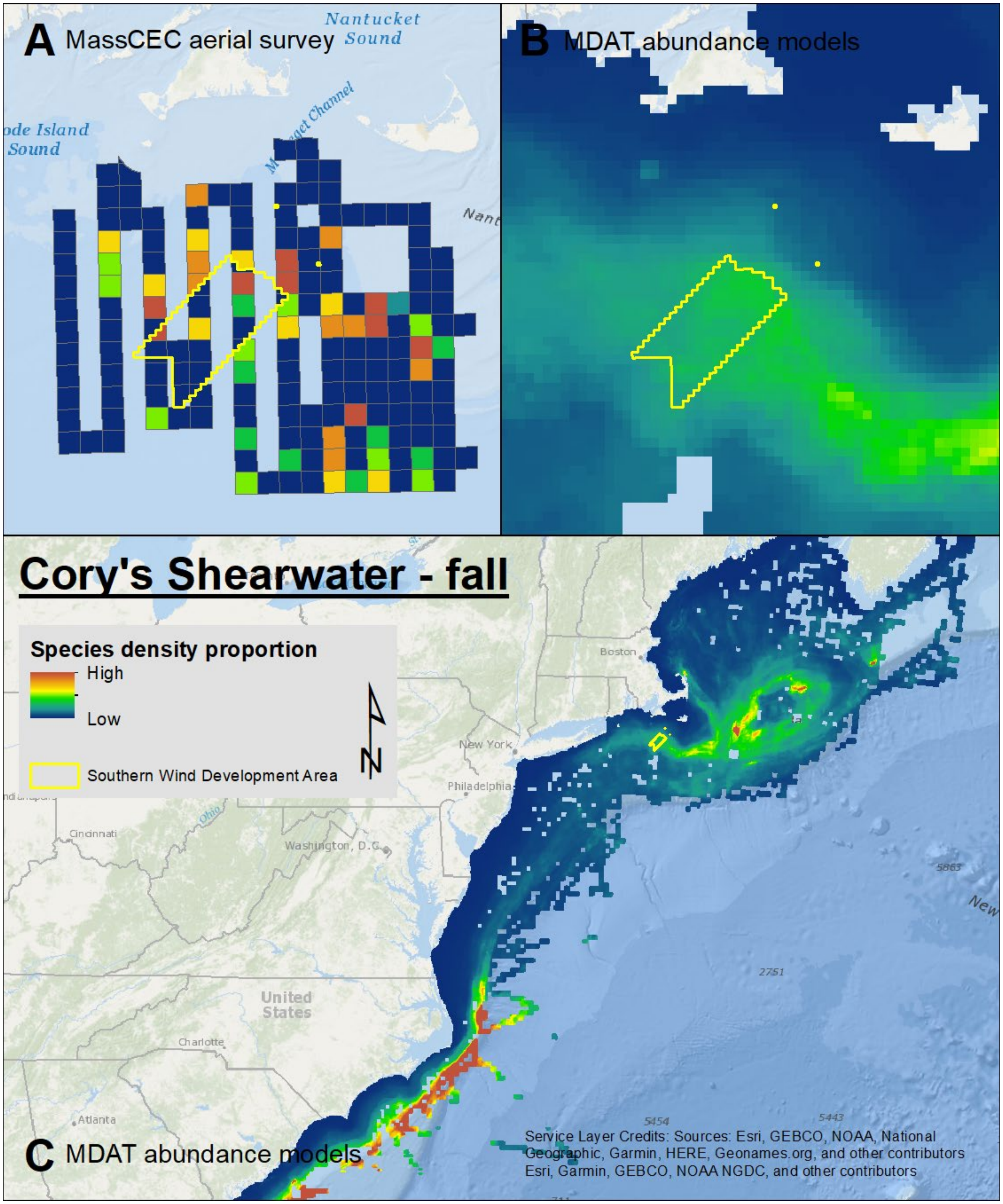

Map 114: Winter Cory's Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



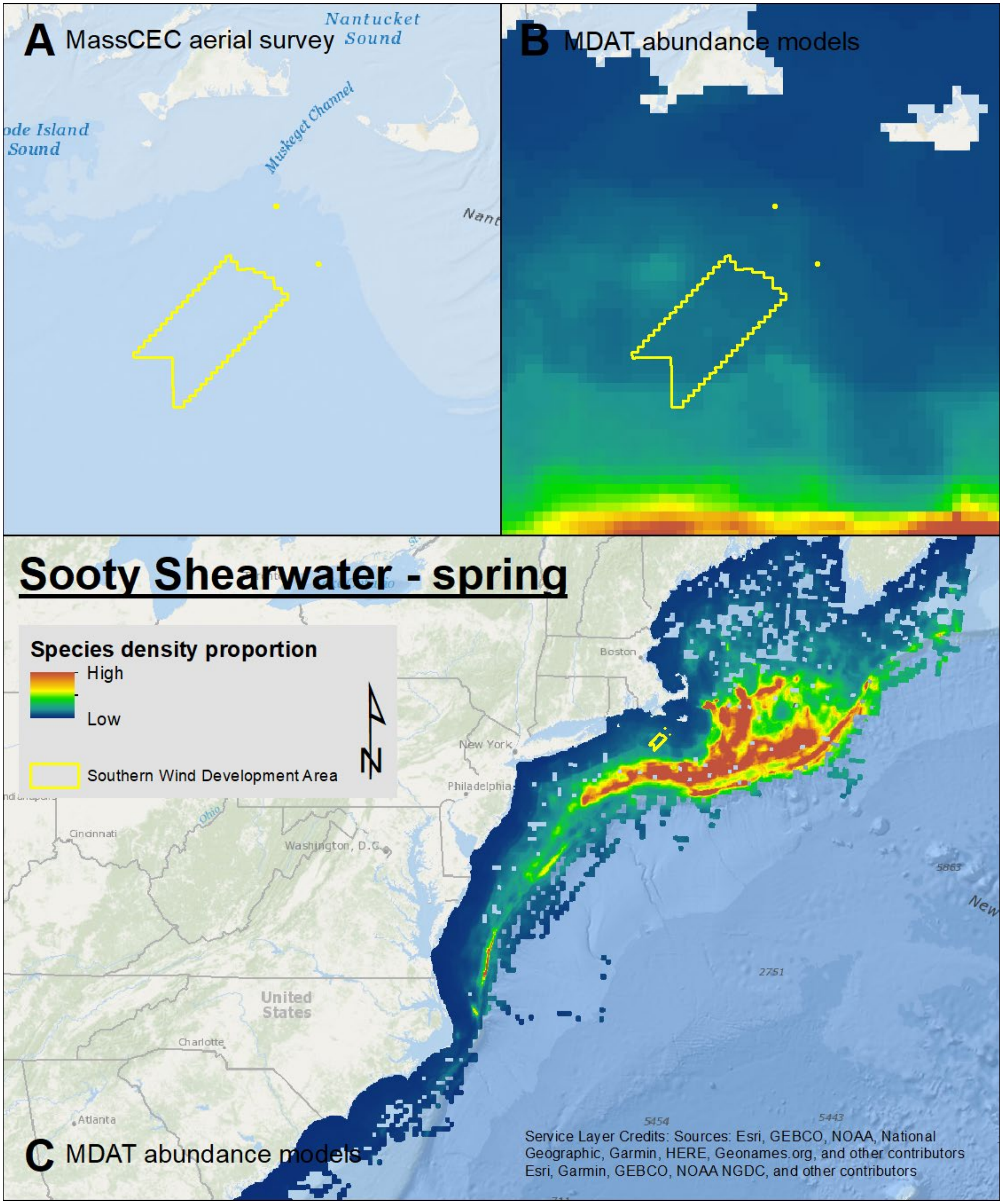

Map 115: Spring Cory's Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



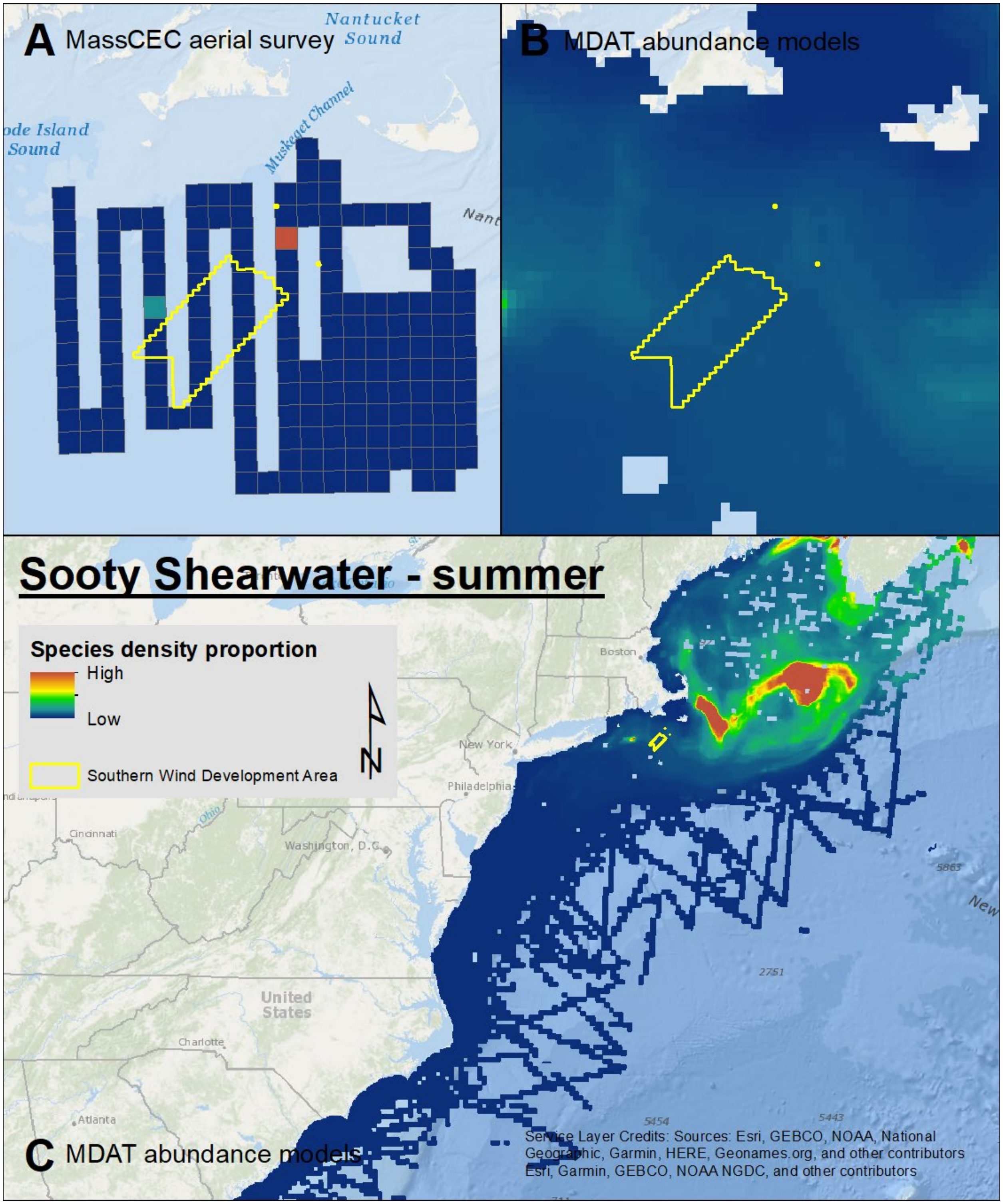

Map 116: Summer Cory's Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



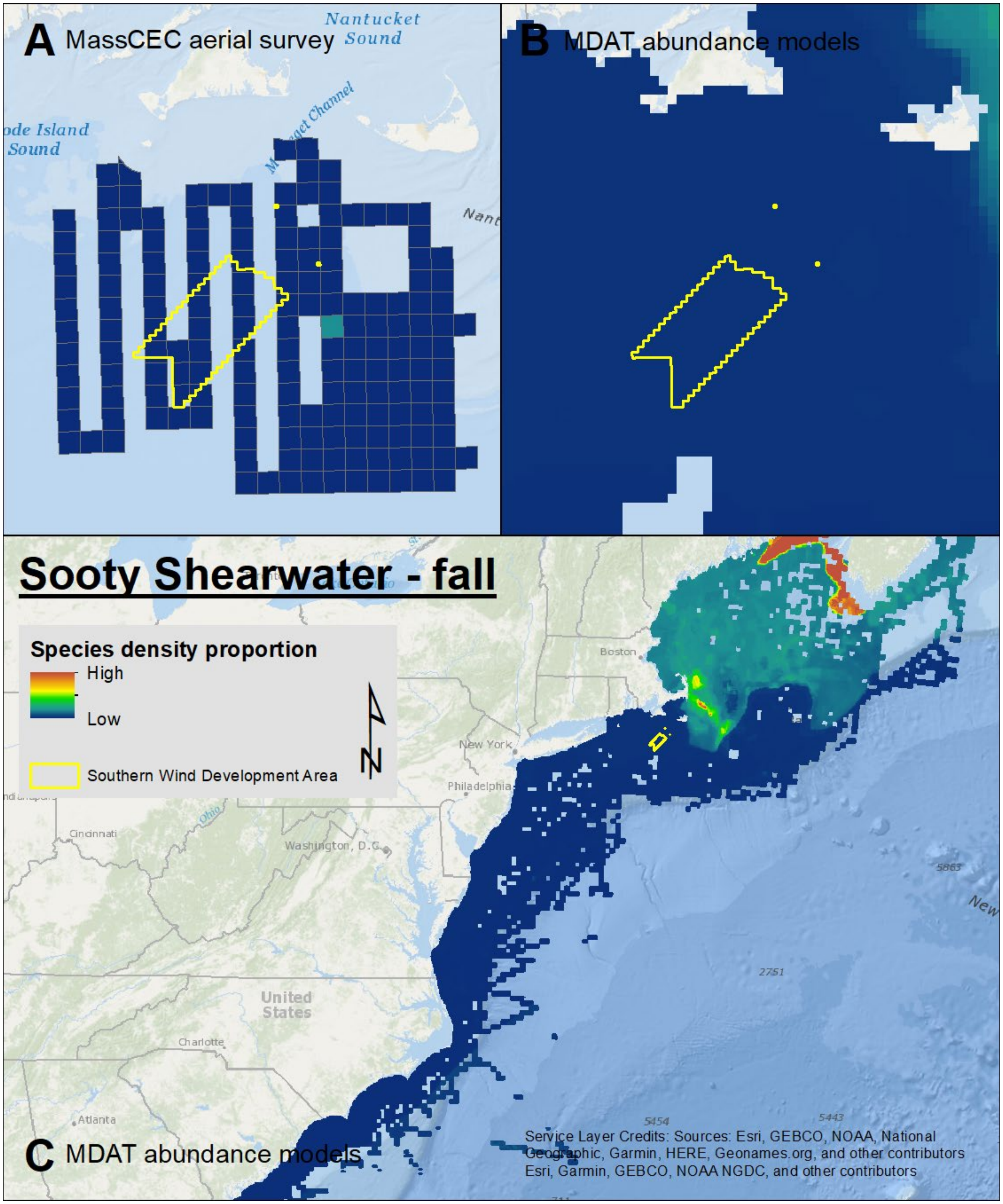

Map 117: Fall Cory's Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



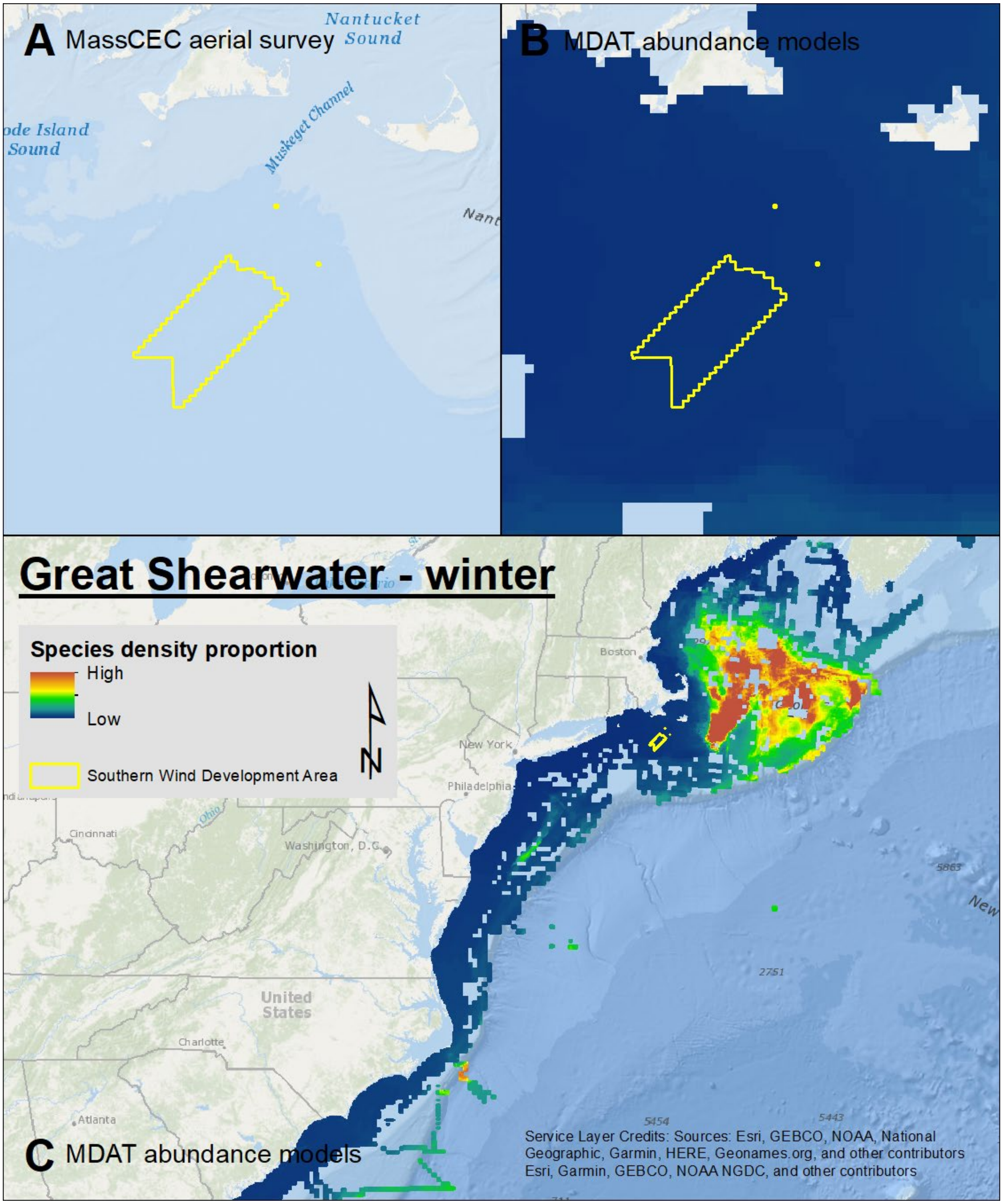

Map 118: Spring Sooty Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



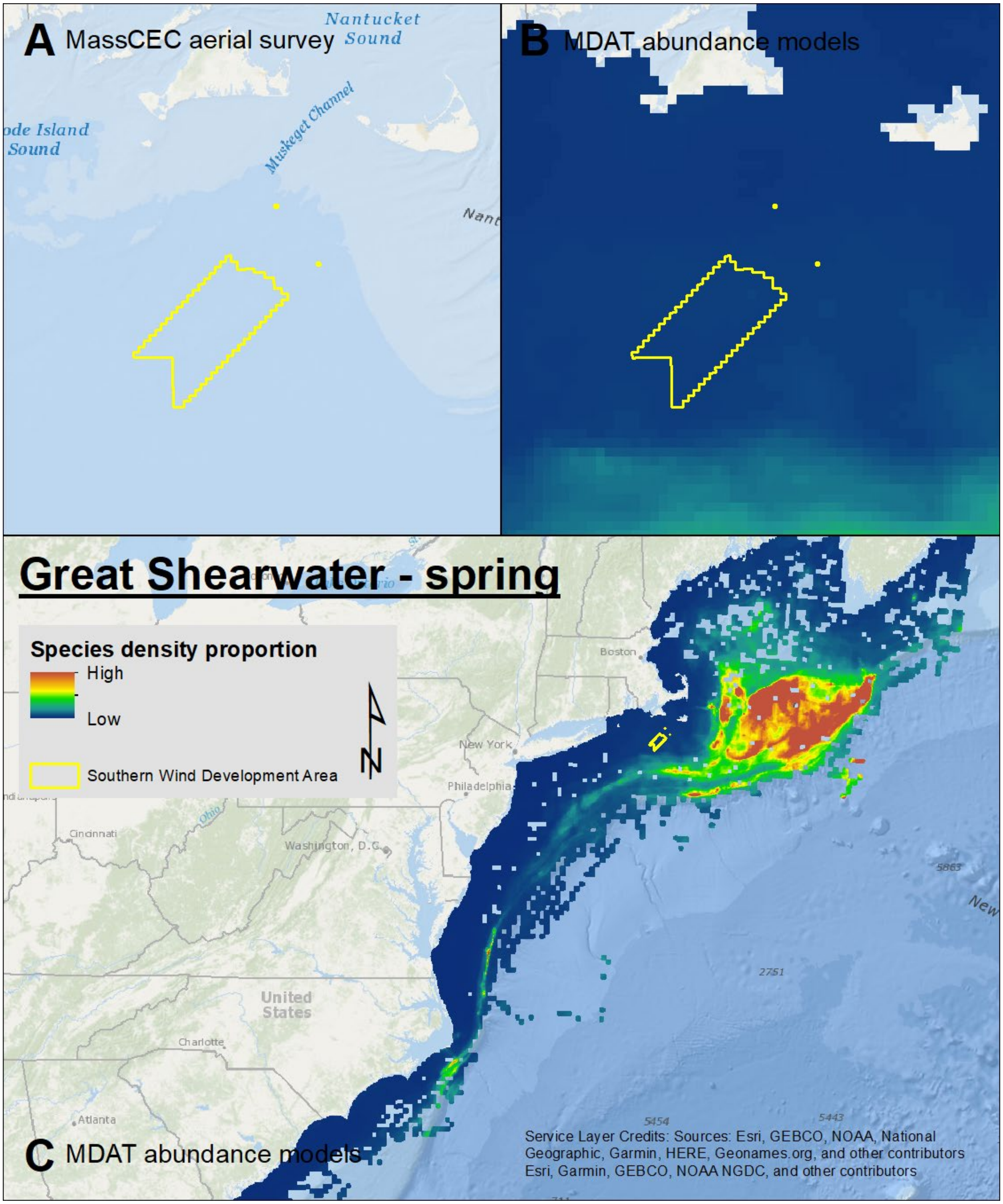

Map 119: Summer Sooty Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



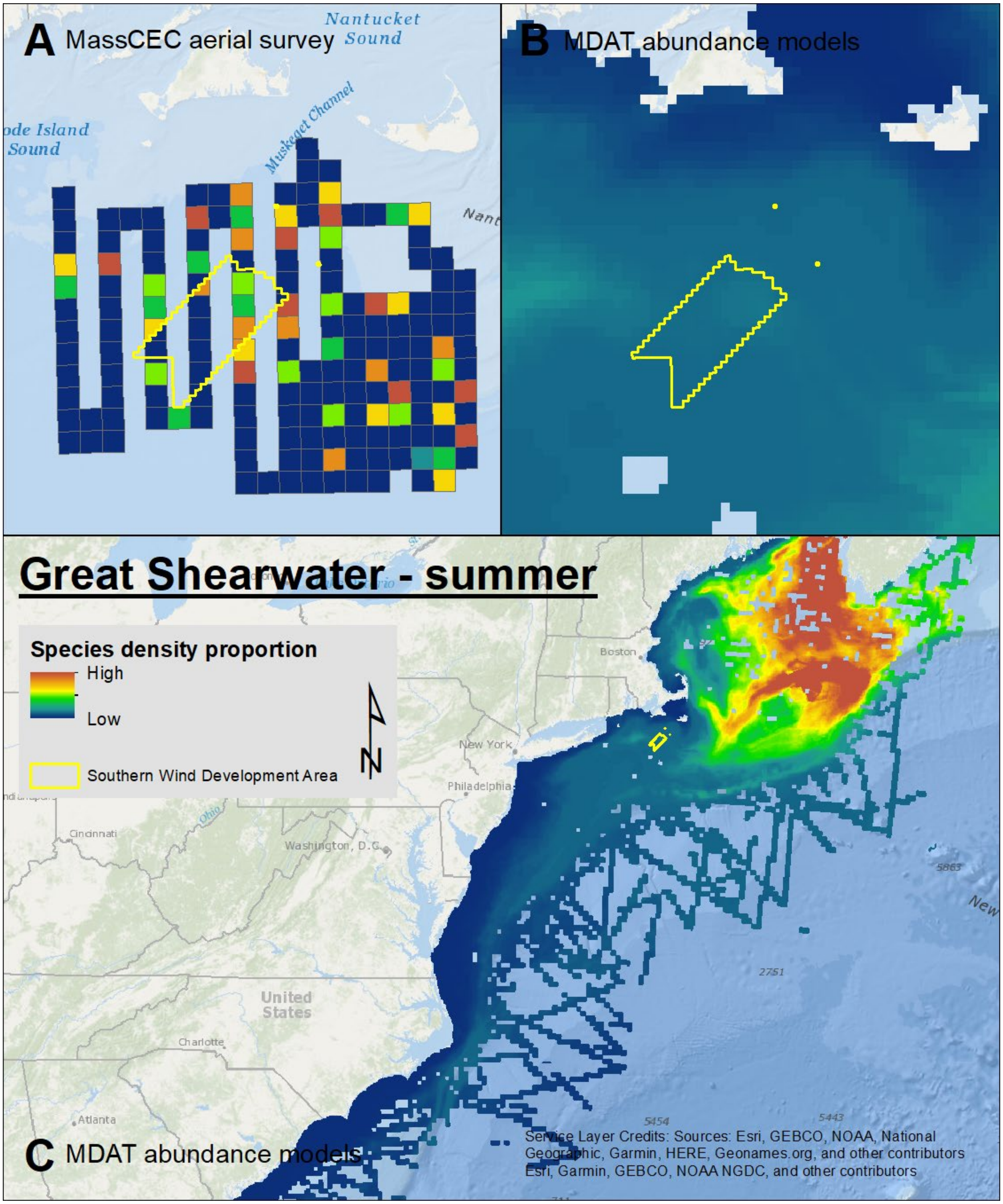

Map 120: Fall Sooty Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



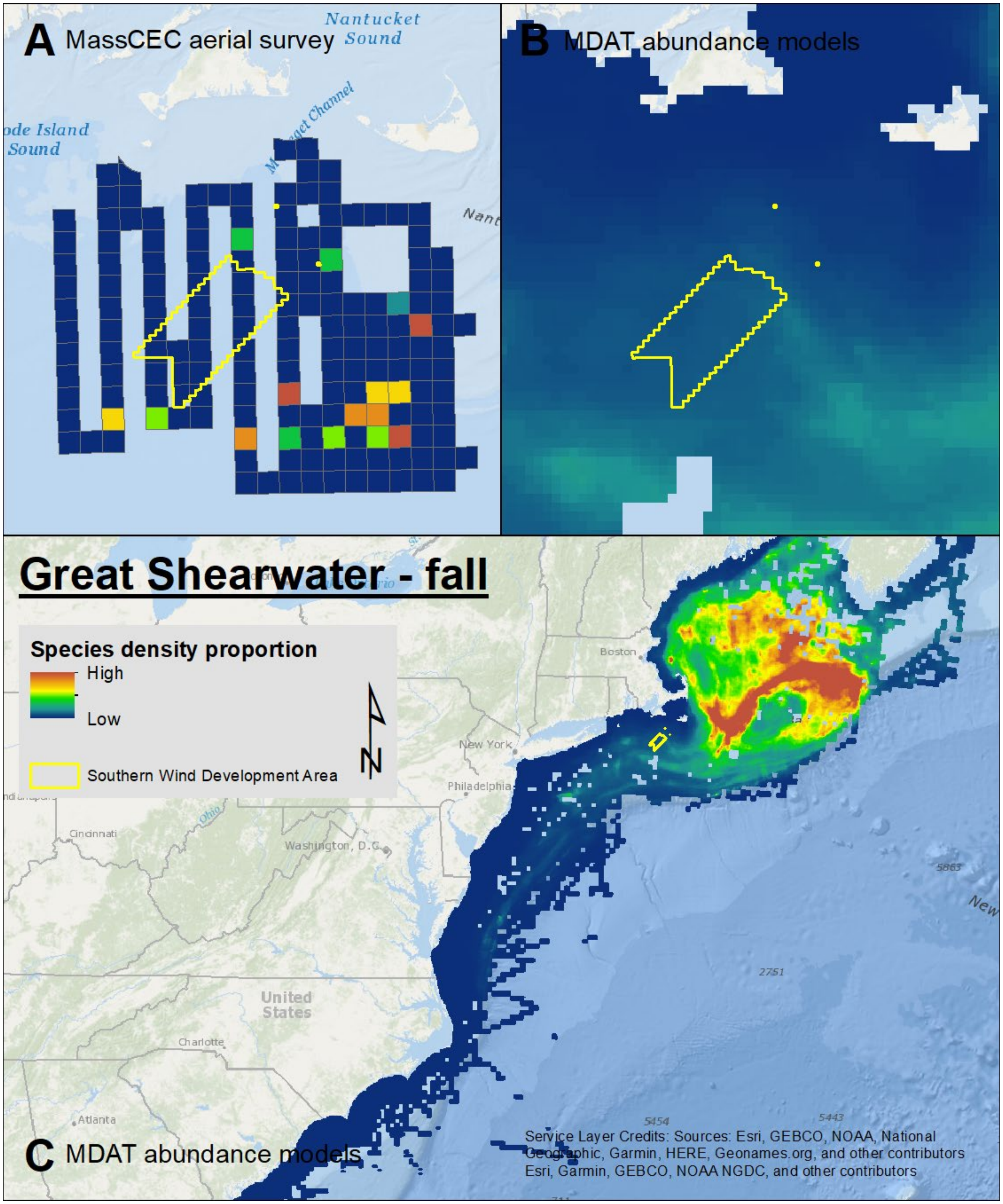

Map 121: Winter Great Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



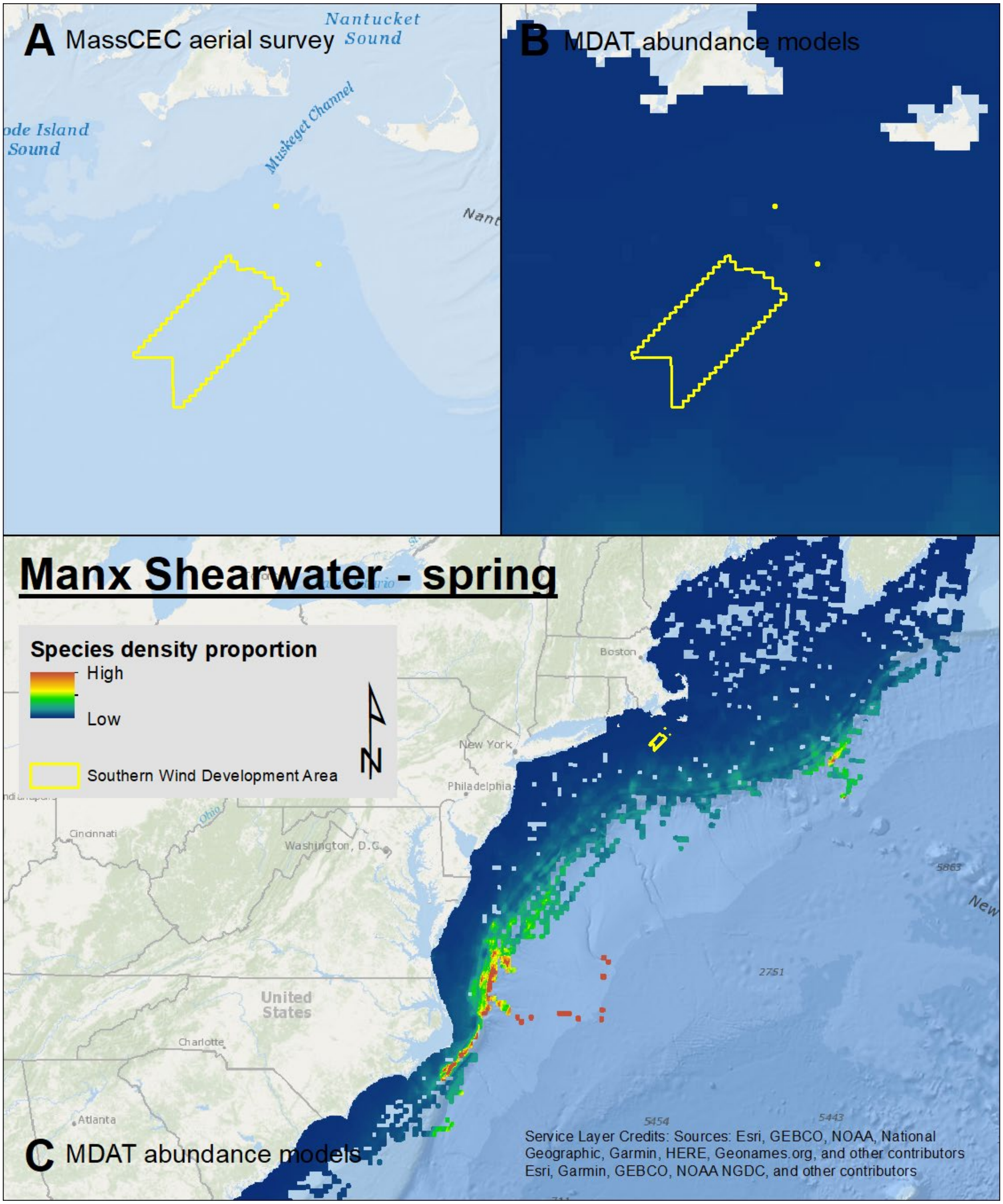

Map 122: Spring Great Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



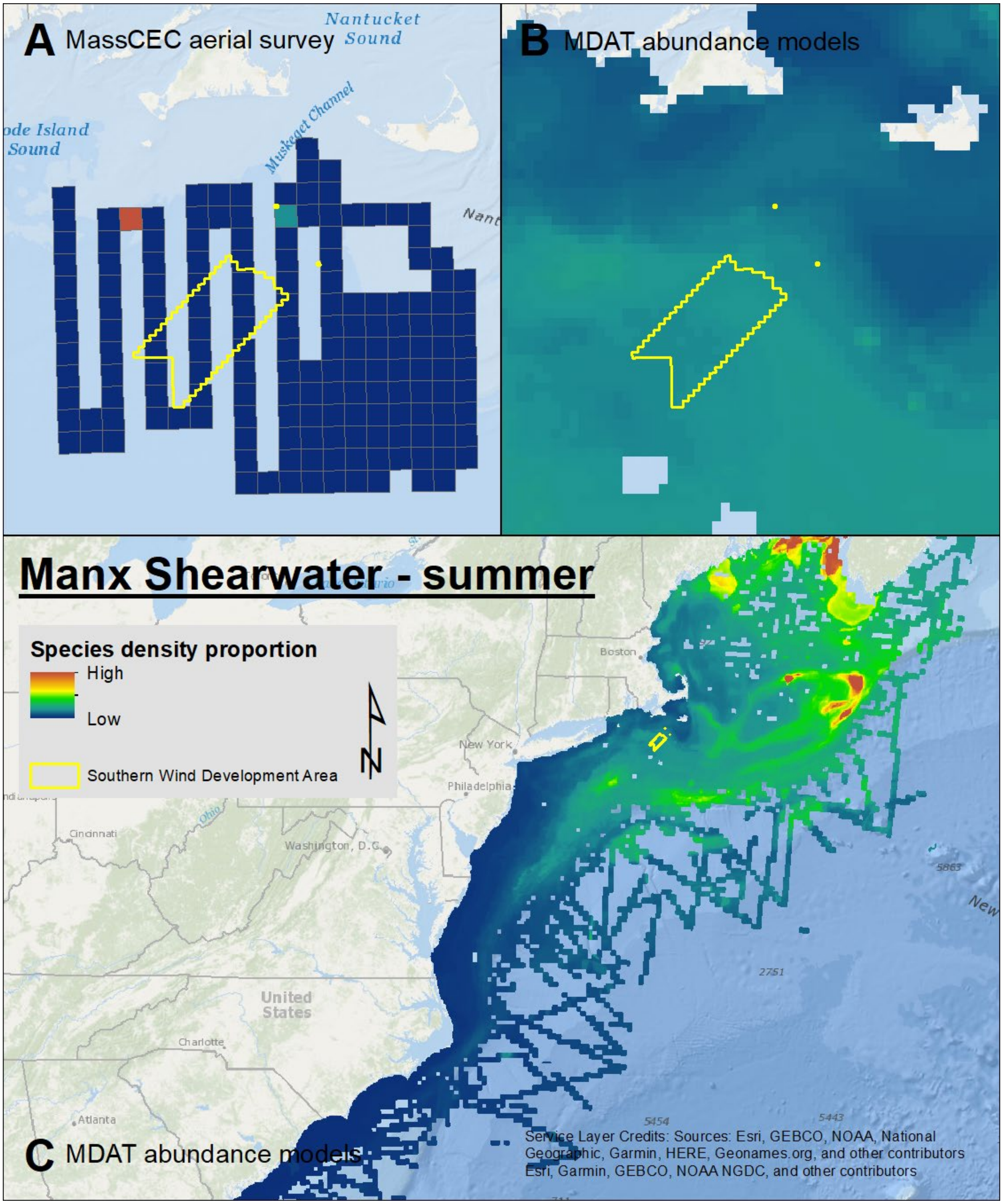

Map 123: Summer Great Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



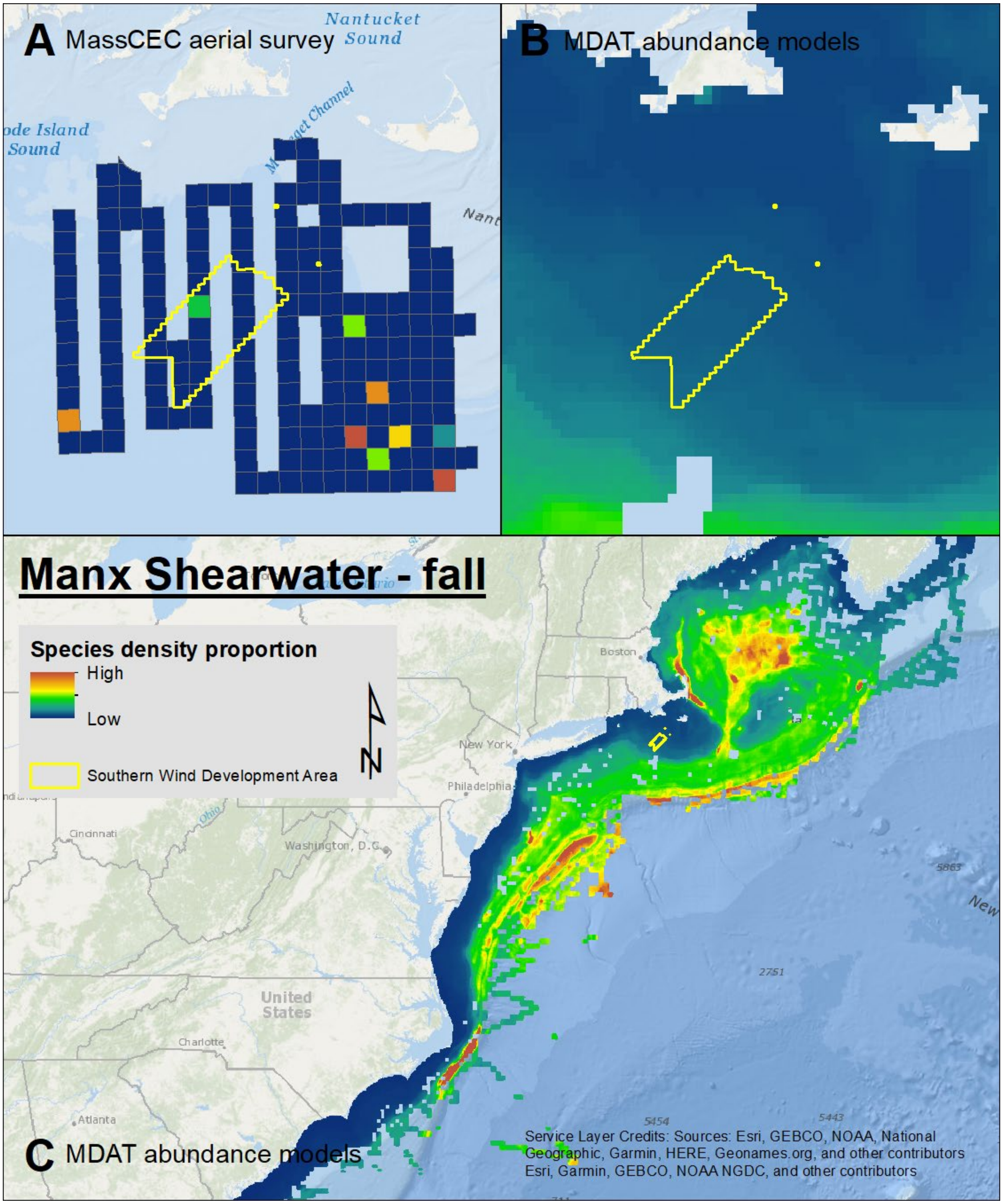

Map 124: Fall Great Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



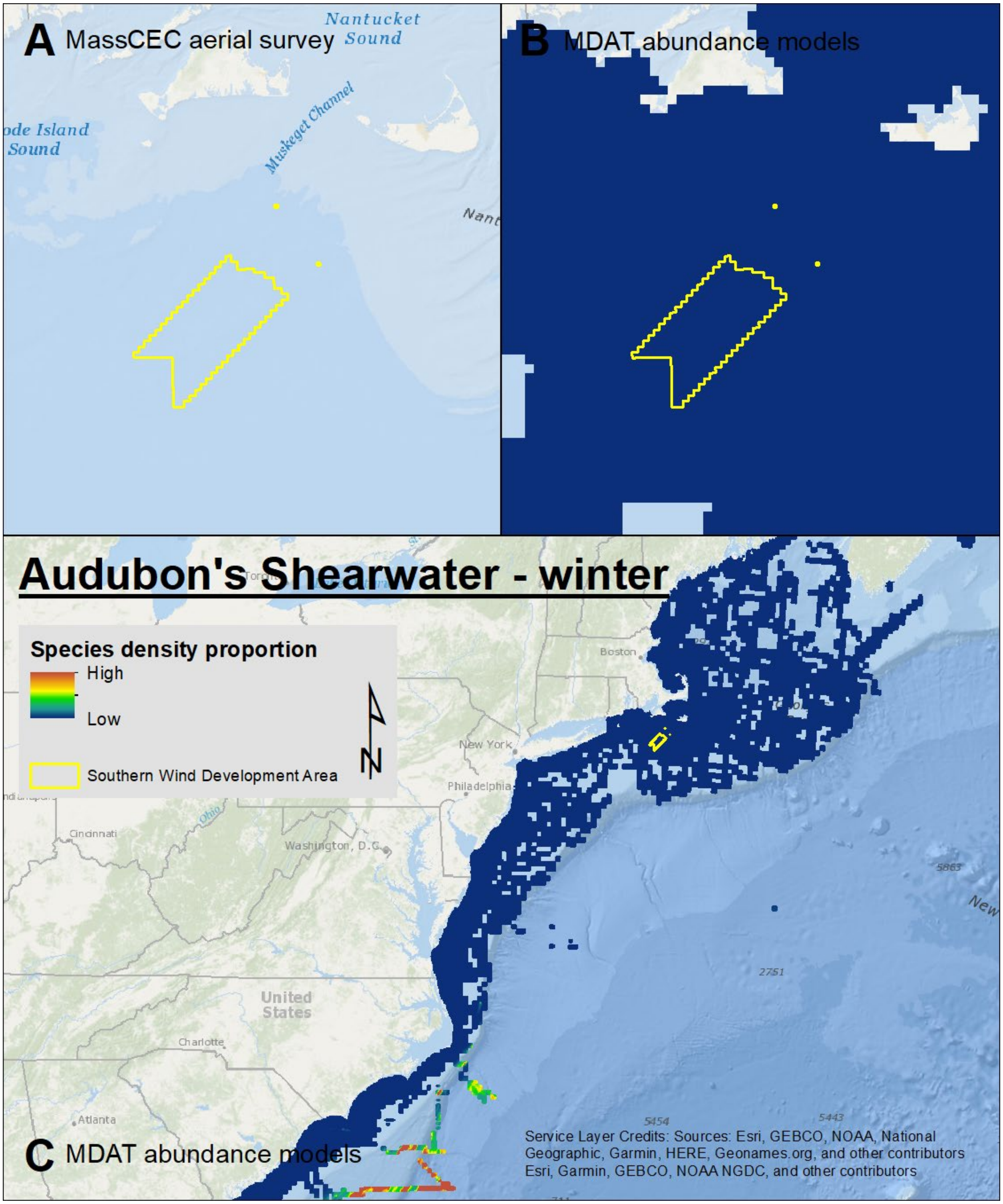

Map 125: Spring Manx Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



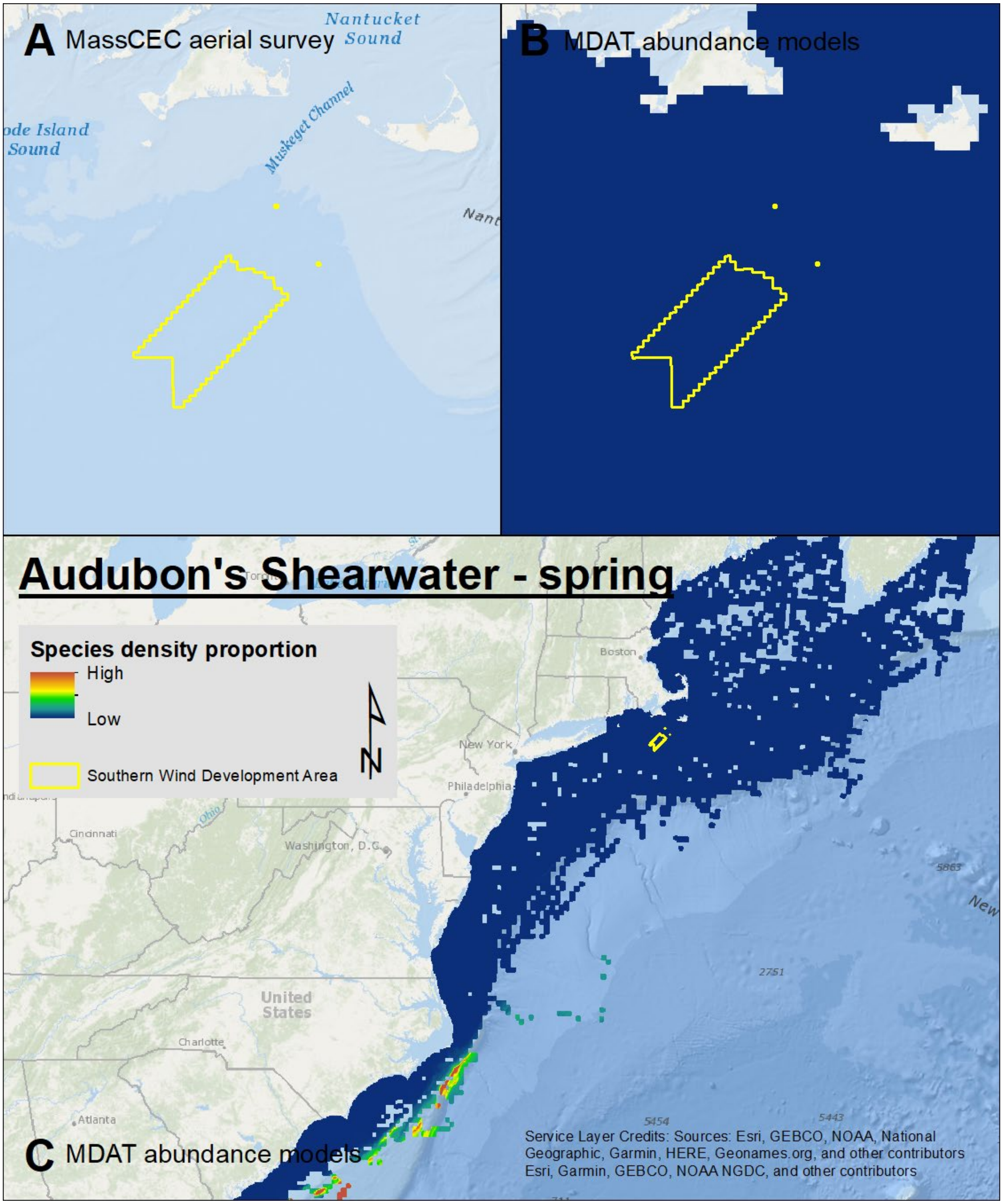

Map 126: Summer Manx Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



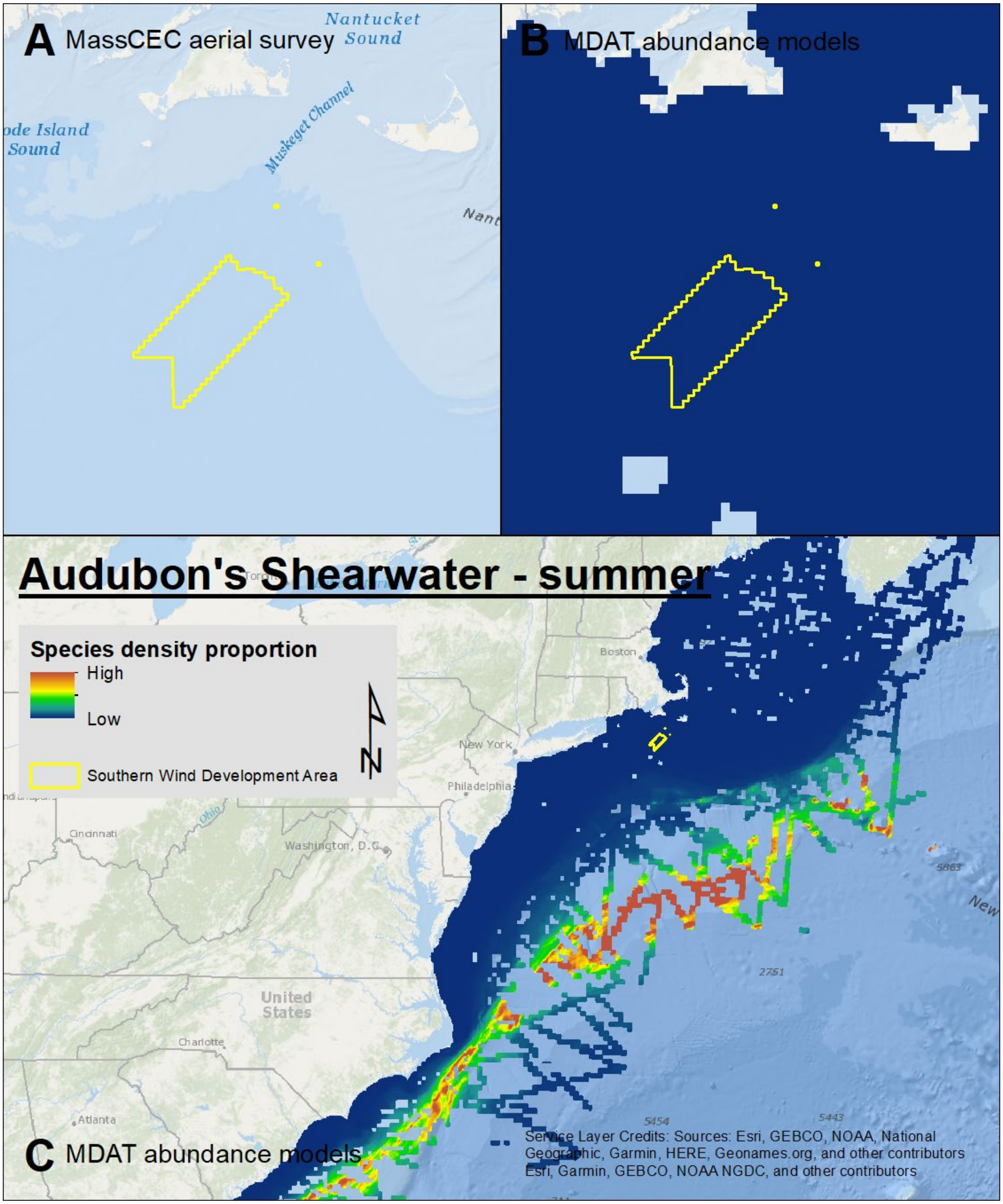

Map 127: Fall Manx Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



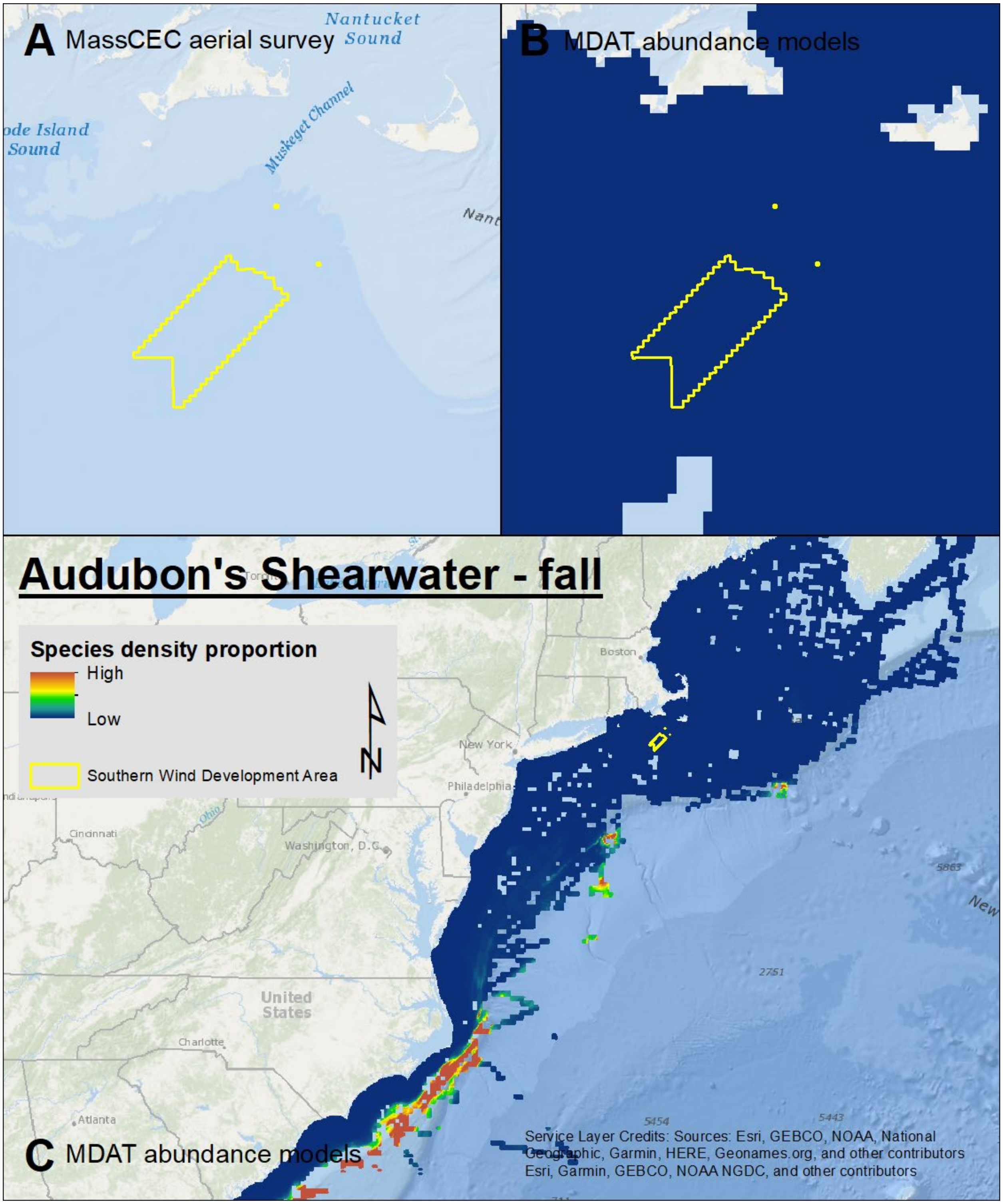

Map 128: Winter Audubon's Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



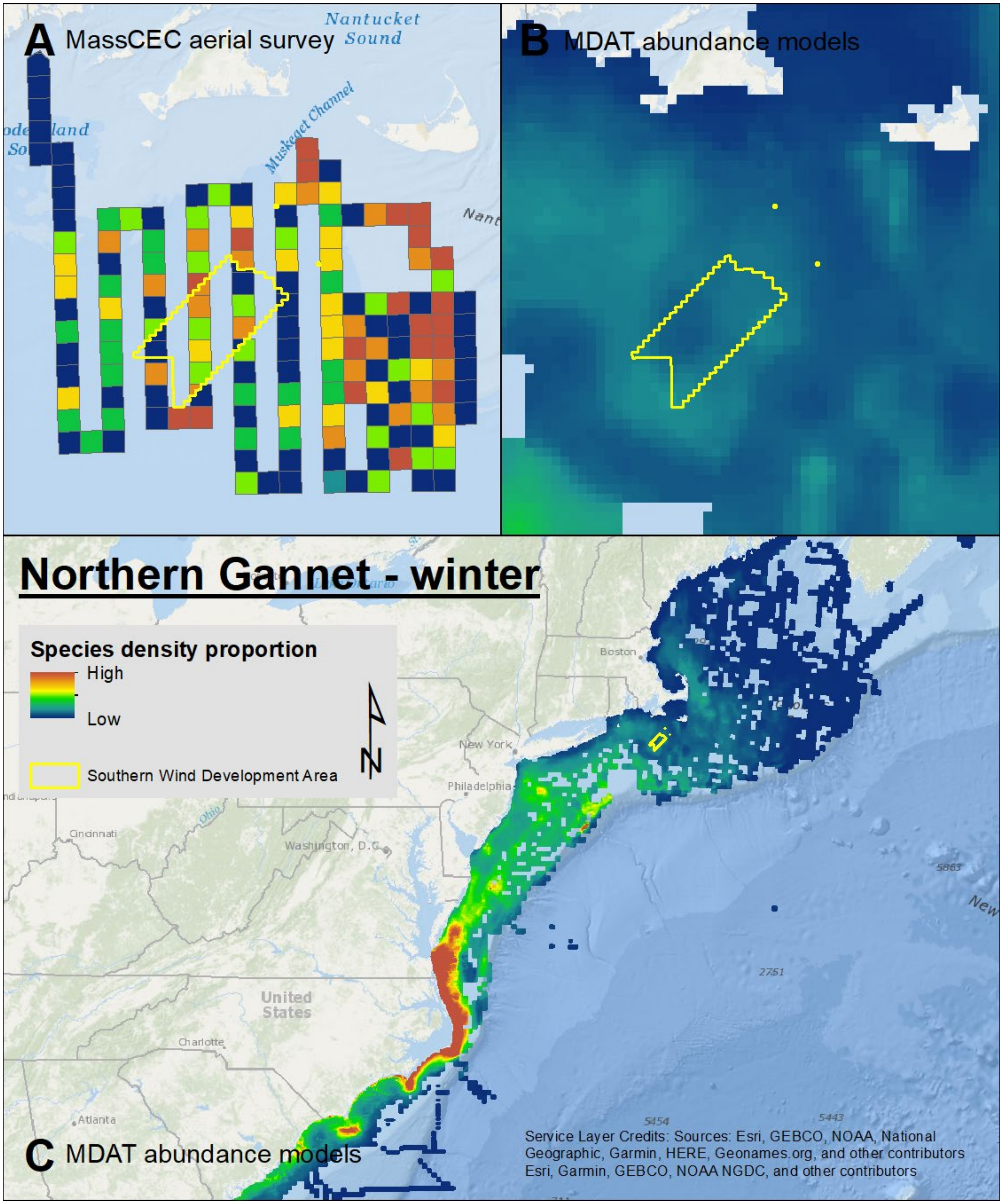

Map 129: Spring Audubon's Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



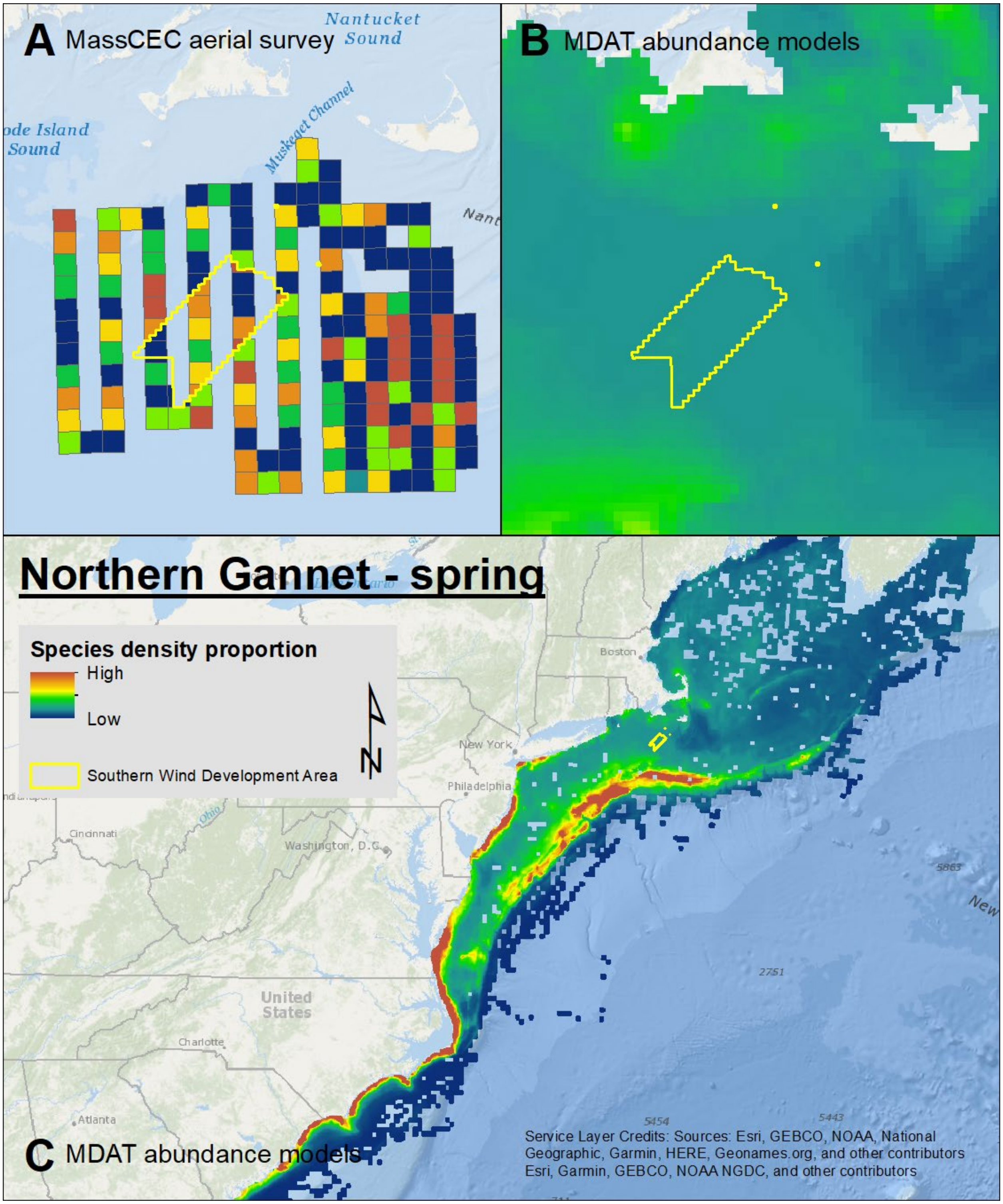

Map 130: Summer Audubon's Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



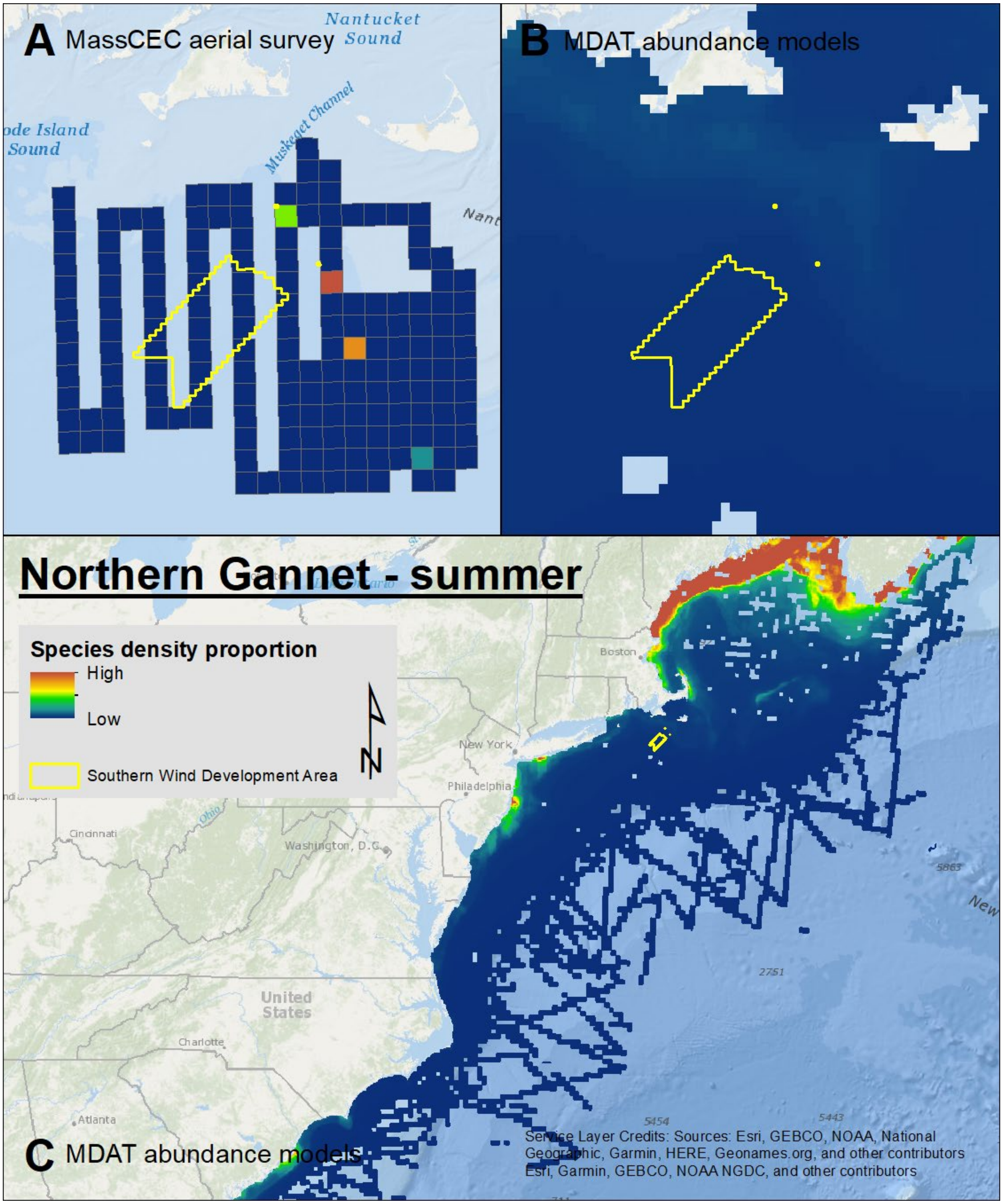

Map 131: Fall Audubon's Shearwater density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



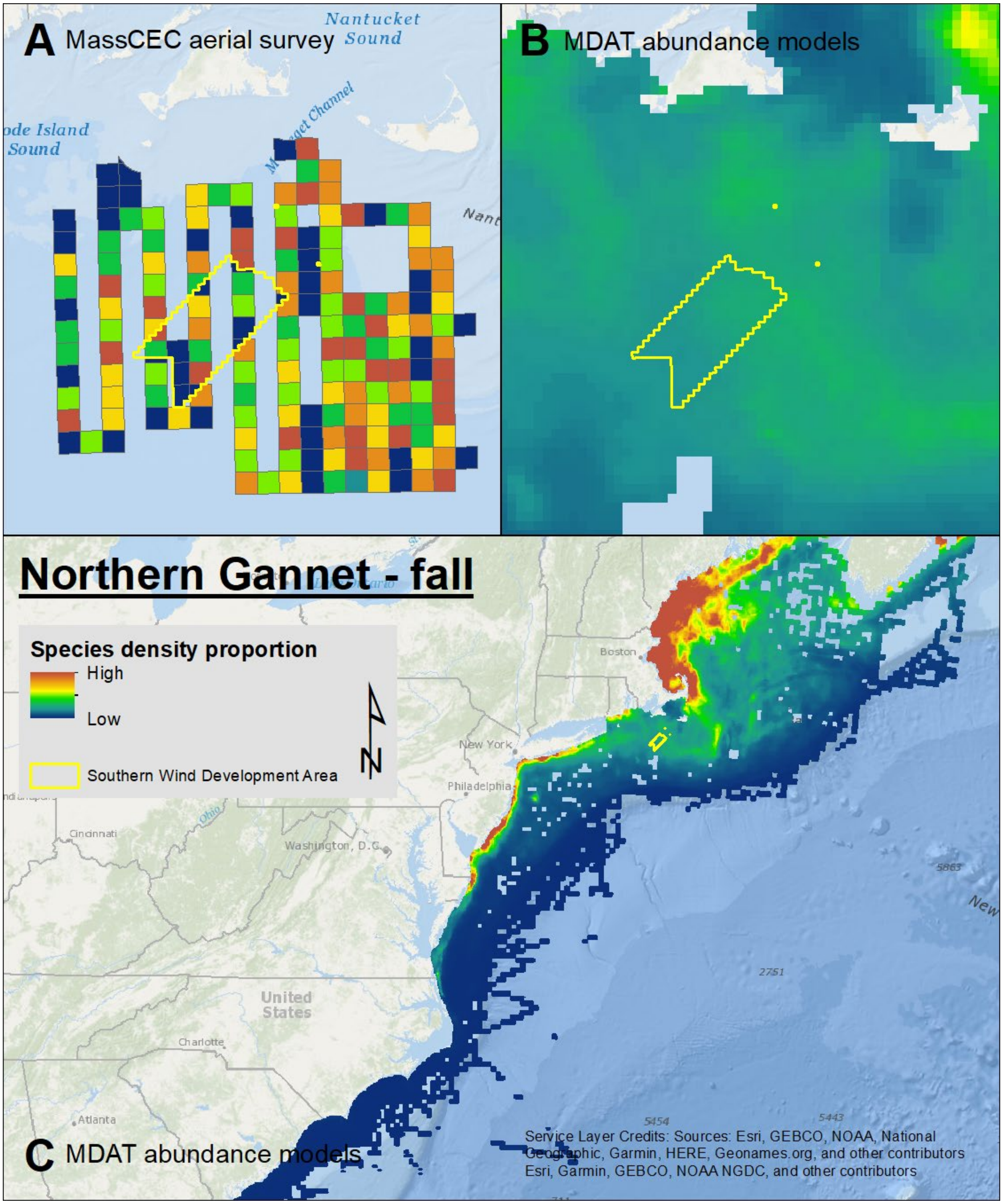

Map 132: Winter Northern Gannet density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



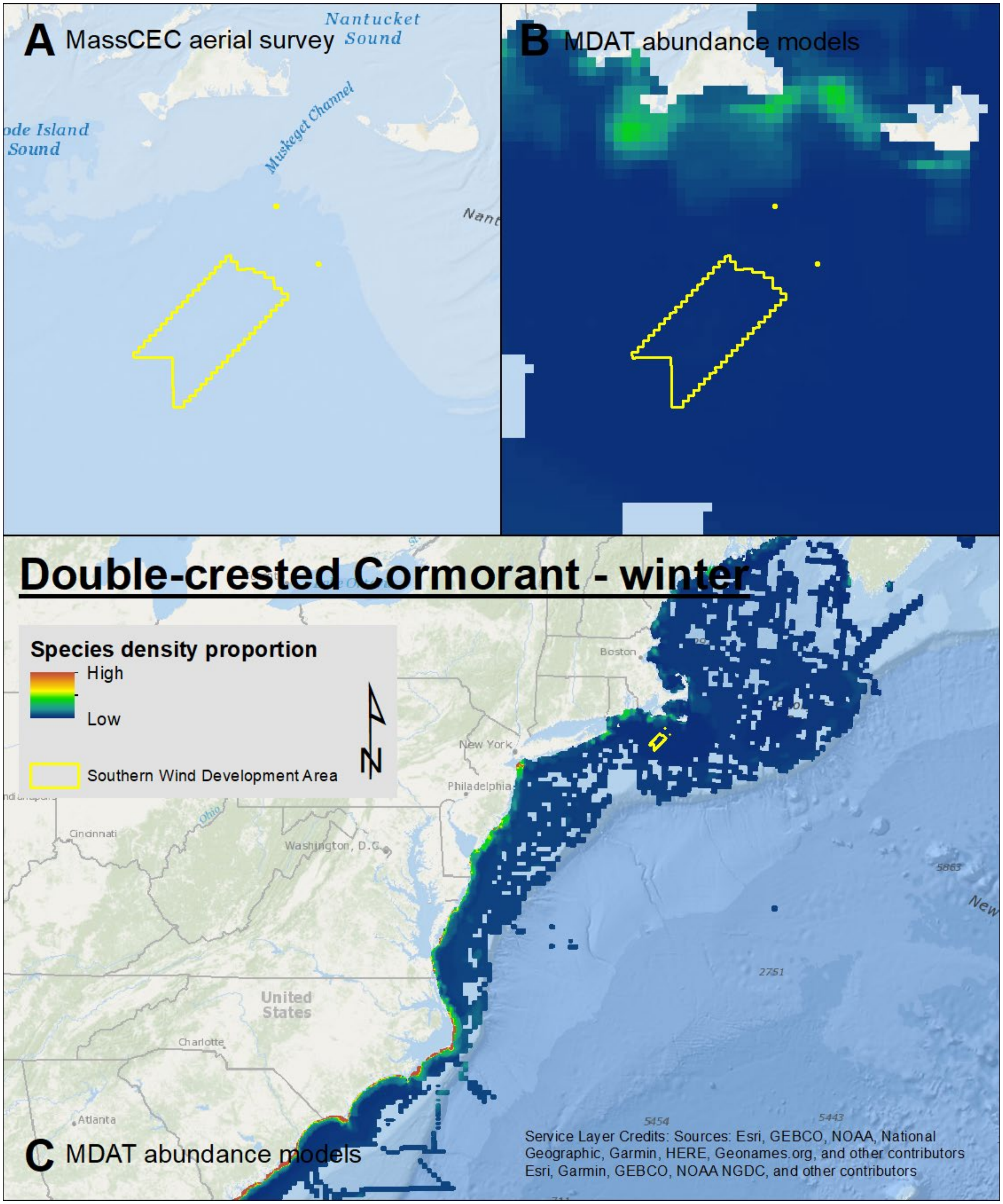

Map 133: Spring Northern Gannet density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



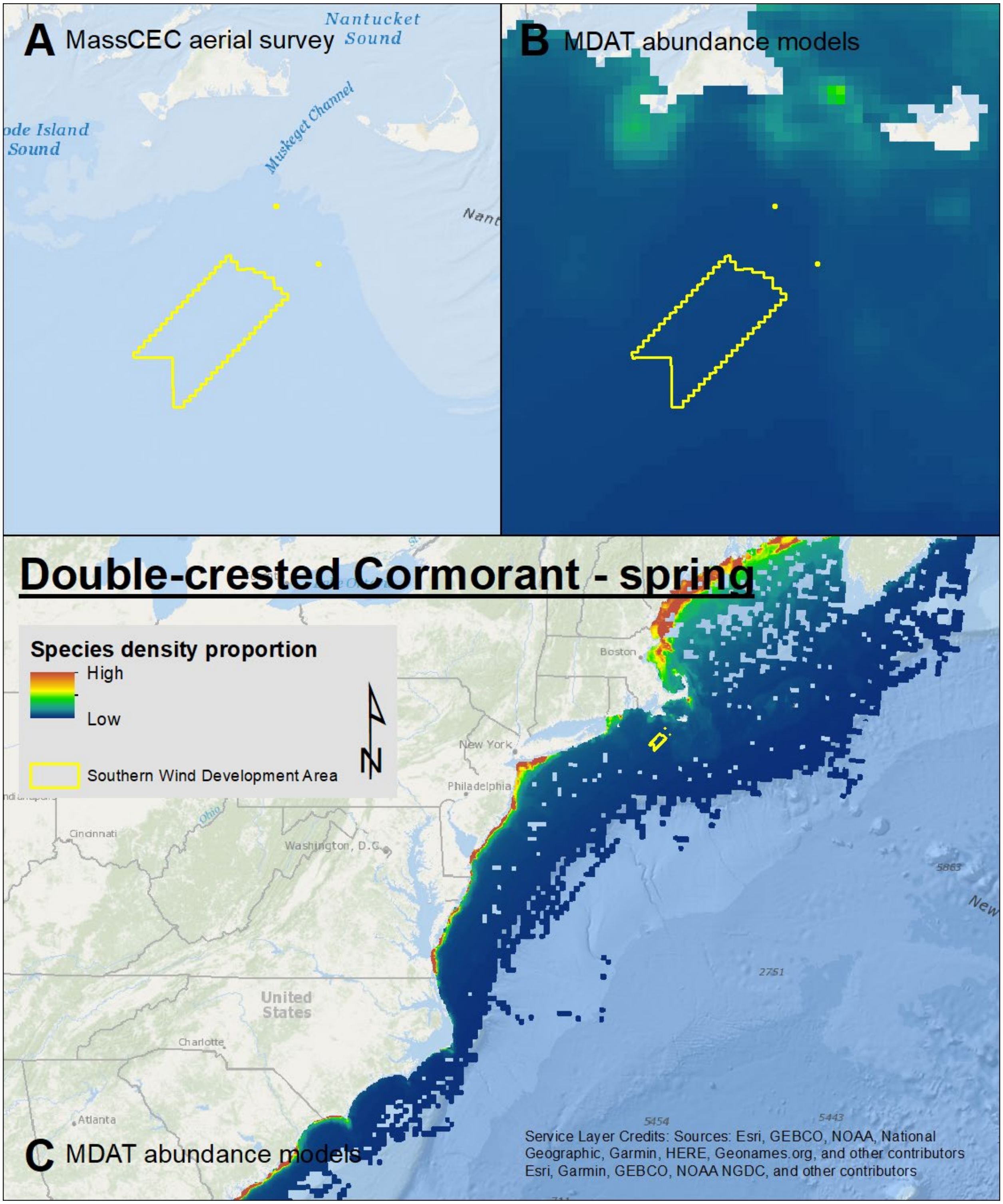

Map 134: Summer Northern Gannet density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



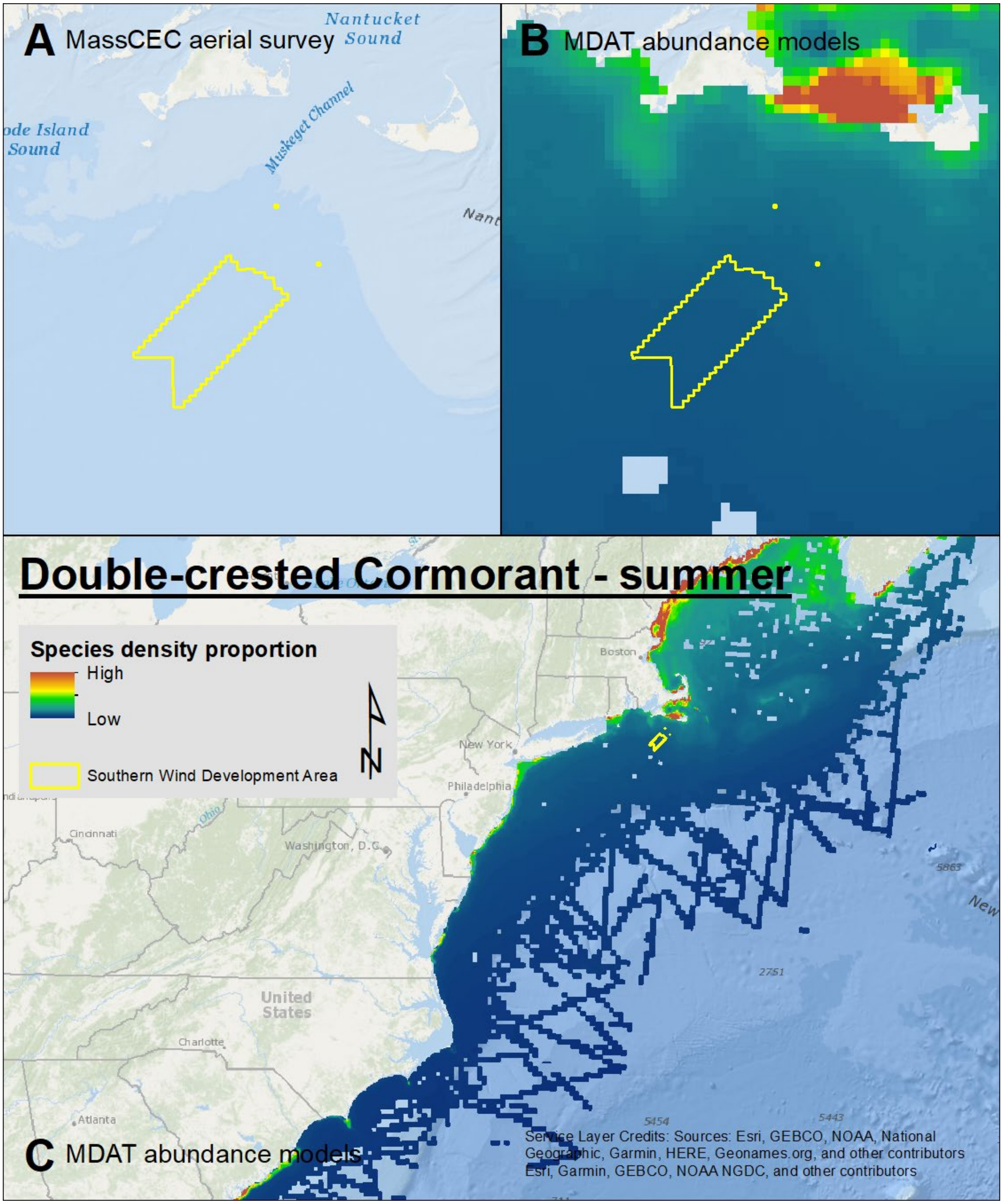

Map 135: Fall Northern Gannet density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



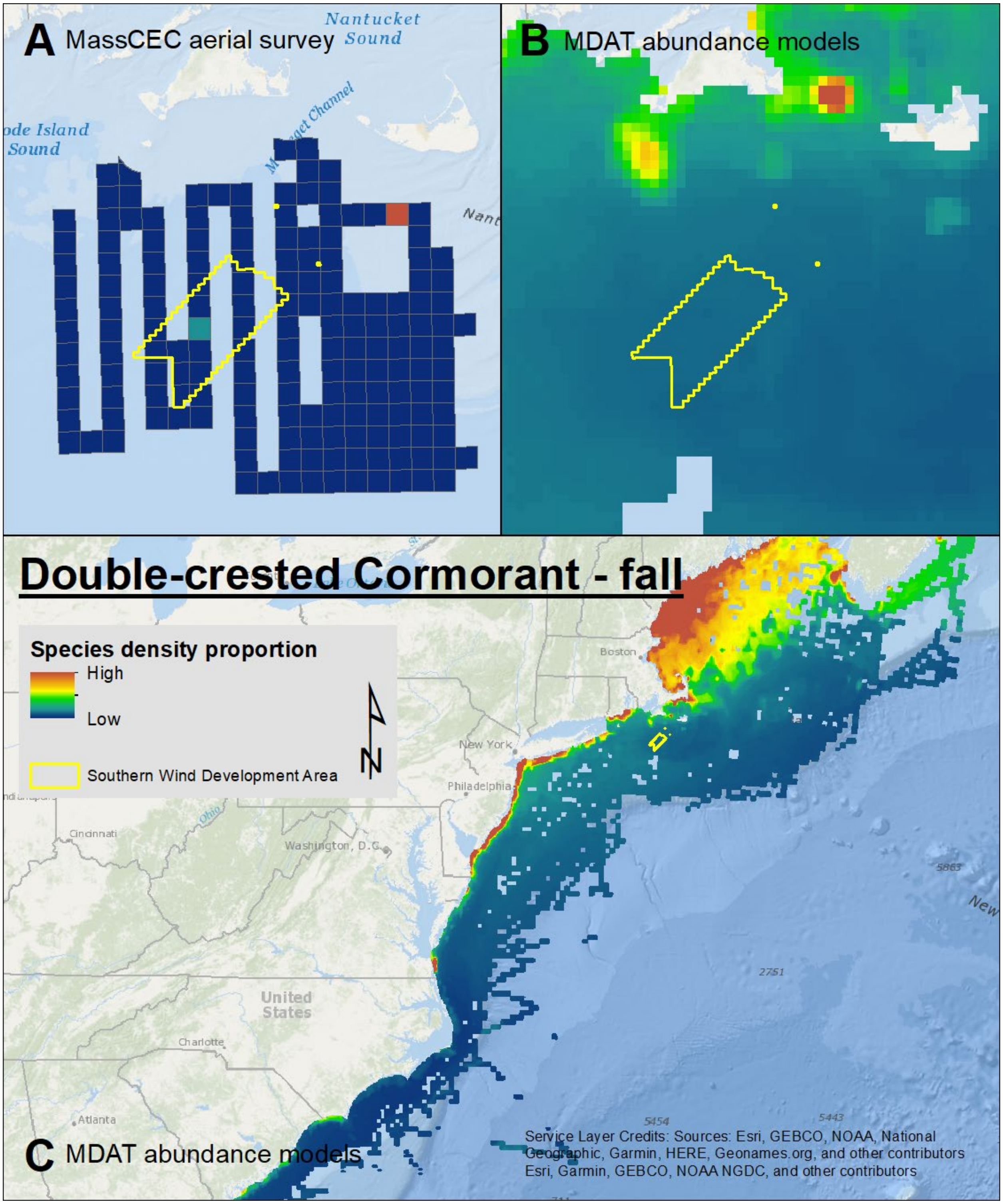

Map 136: Winter Double-crested Cormorant density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



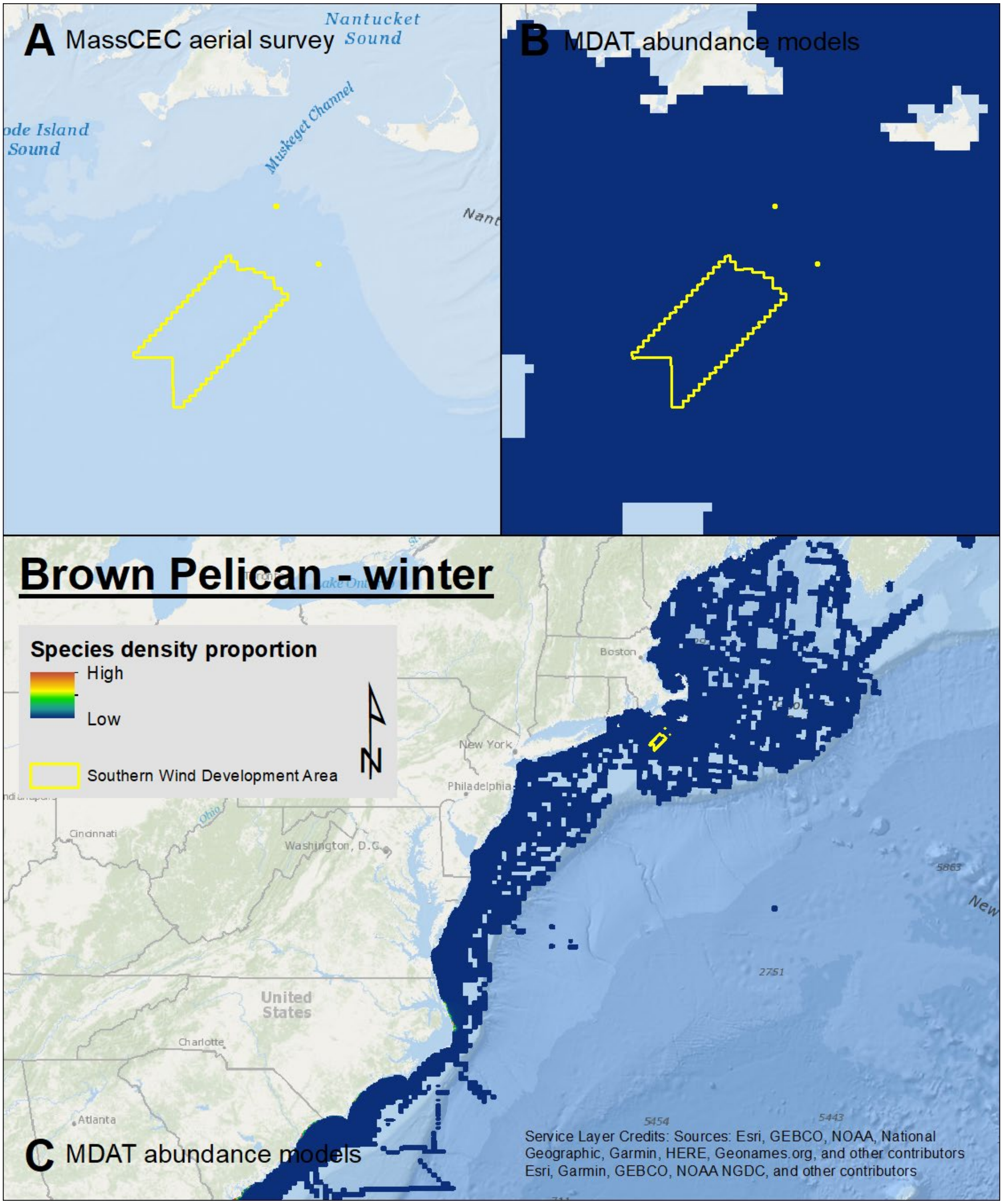

Map 137: Spring Double-crested Cormorant density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



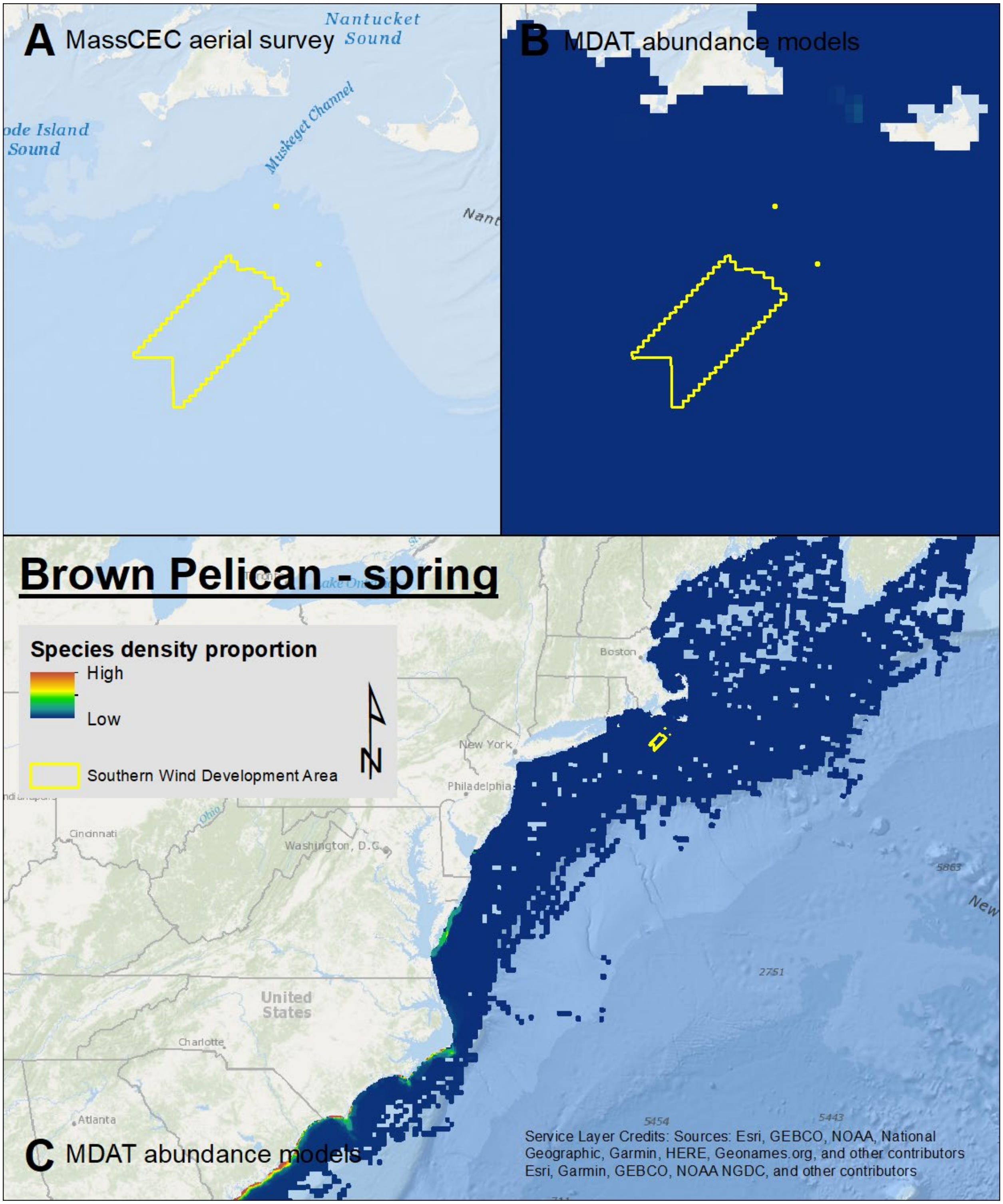

Map 138: Summer Double-crested Cormorant density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



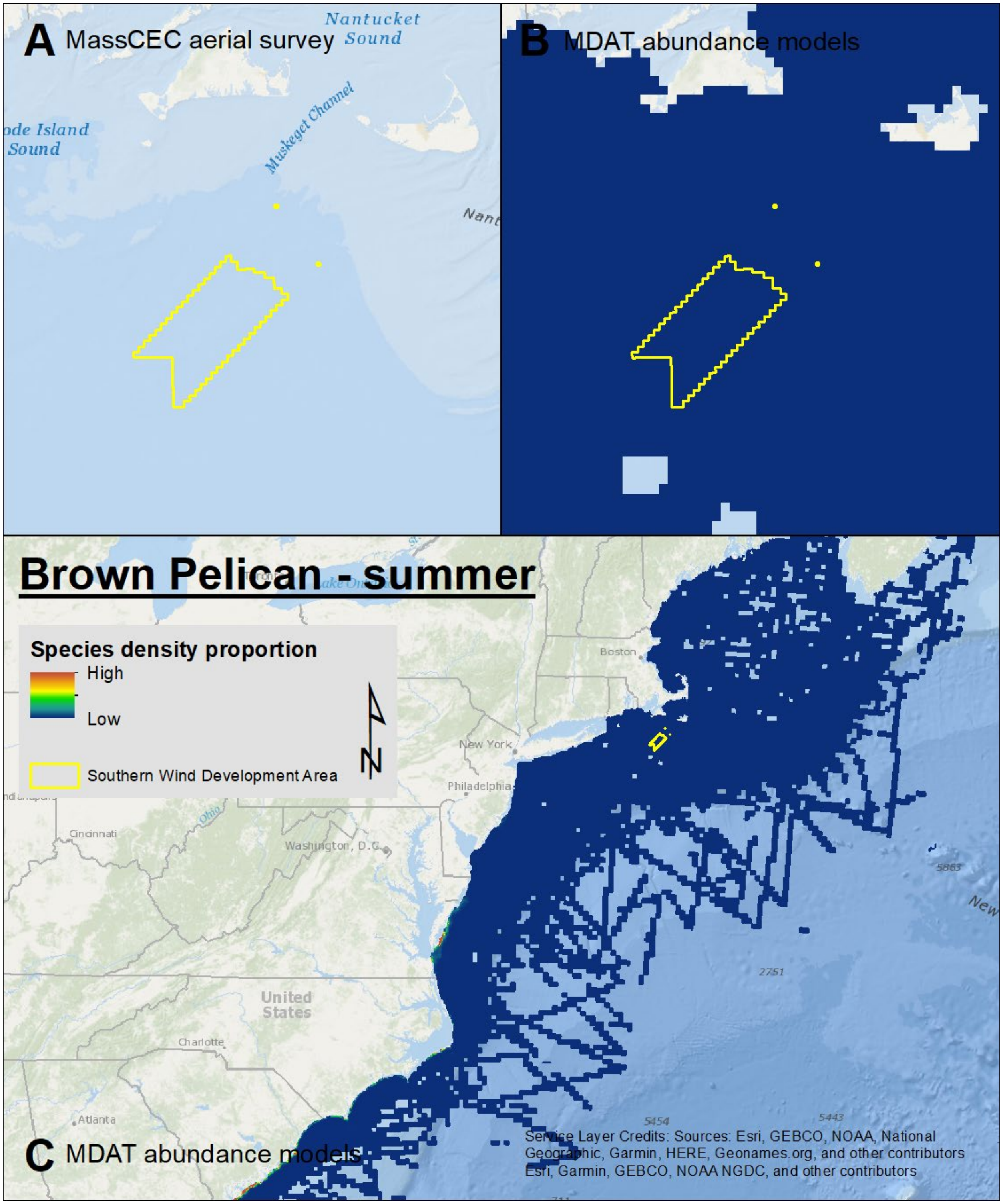

Map 139: Fall Double-crested Cormorant density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.



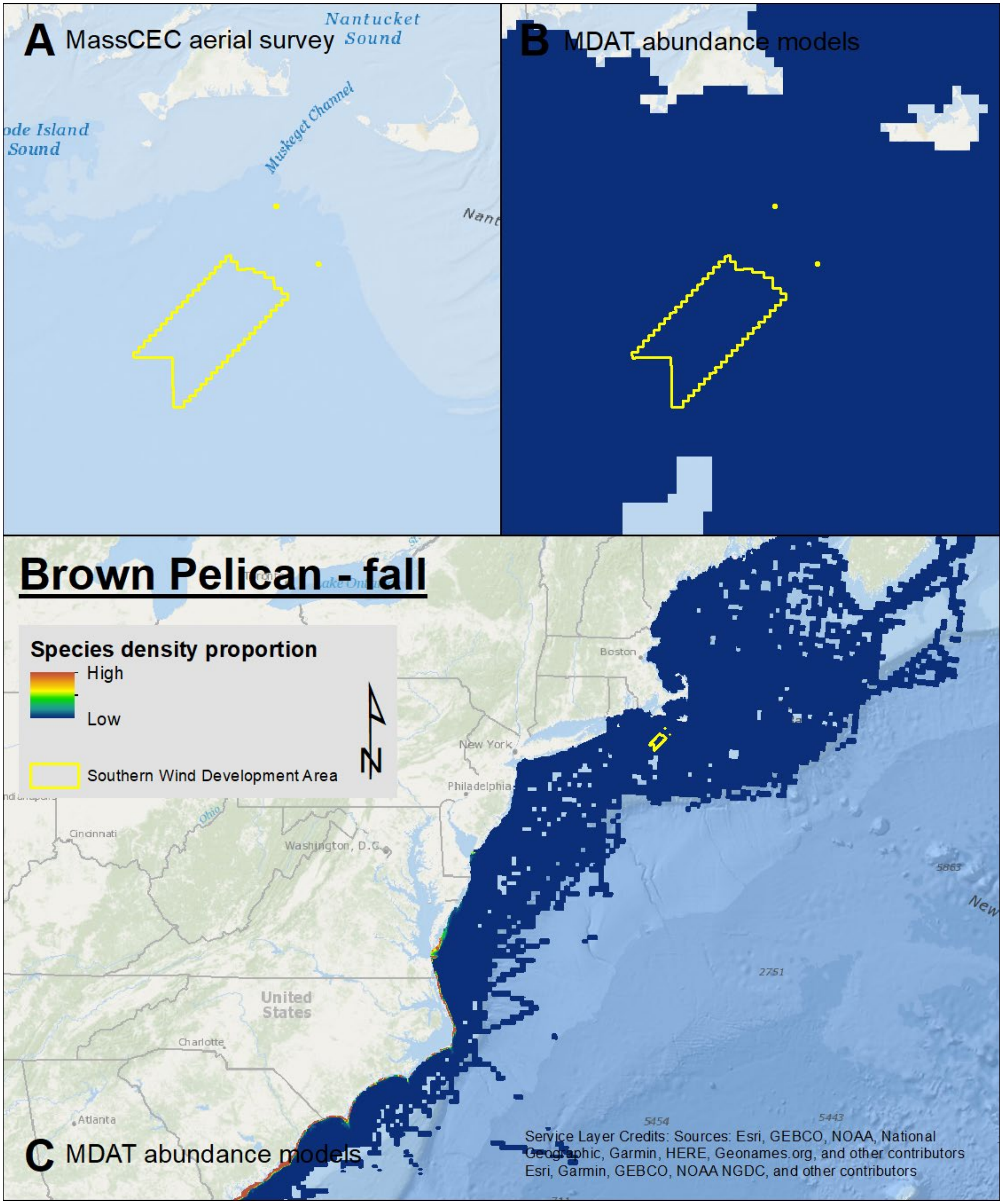

Map 140: Winter Brown Pelican density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.




Map 141: Spring Brown Pelican density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.




Map 142: Summer Brown Pelican density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.




Map 143: Fall Brown Pelican density proportions in the MassCEC aerial baseline survey data (A) and the MDAT data at local (B) and regional scales (C); the scale for all maps is representative of relative spatial variation in the sites within the season for each data sourceError! Bookmark not defined.