Kitty Hawk Wind

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Construction and Operations Plan

Appendix U - Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds

September 30, 2022

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Appendix U – Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats and Birds

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Assessment of the Potential Effects of the Kitty Hawk Offshore Wind Project on Bats & Birds

– Lease Area OCS-A 0508 –

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Executive Summary

Kitty Hawk Wind, LLC (the Company) is proposing to develop offshore wind power in the northwest portion of the OCS-A 0508 Lease Area, hereafter referred to as the "Wind Development Area". The Wind Development Area is located 44 km offshore of Corolla, North Carolina, in the portion of the Lease Area closest to shore. The offshore components of the Project, including the wind turbine generators (WTGs), an electrical service platform (ESP), and inter-array cables, will be located in federal waters within the Wind Development Area, while the export cable corridor will pass through federal and state waters landing in Virginia Beach, VA.

The Company initiated an assessment of potential effects on birds and bats from offshore components of the Project to support the Construction and Operations Plan (COP). The goal of the assessment is to provide a detailed analysis of the bird and bat species that may be exposed to each of the Project components, and to describe potential impacts to those species at the population and, where necessary, species or individual level. This assessment was developed to meet COP guidance, provide information for National Environmental Policy Act (NEPA) review, and support cooperating agency consultations. For each development phase, the assessment first described impact-producing factors, the species that would potentially be exposed to the impact-producing factors, and the vulnerability of the species exposed.

The offshore components of the Project are unlikely to impact bat populations. While some individual cave-hibernating bats may occur within the Wind Development Area during operation of the Project, and will be vulnerable to collision with operating WTGs, the exposure of cave-hibernating bats (including northern long-eared bat and state-listed species) to operating WTGs is expected to be minimal to low given their distance from shore. Migratory tree bats may occur in the Wind Development Area; however, this is expected to include low numbers of individuals given the Wind Development Area's distance from shore.

Construction, operations, and decommissioning activities occurring in the Wind Development Area are unlikely to significantly impact populations of coastal or marine birds because of the low levels of exposure. While coastal birds may forage in the Wind Development Area occasionally or pass through on their spring and/or fall migrations, the Wind Development Area is generally far enough offshore as to be beyond the range of most breeding terrestrial or coastal bird species. The Project largely avoids areas of high marine bird abundance because it is located between coastal and offshore concentration areas. Overall, listed or candidate species are also expected to have limited exposure to the Wind Development Area. Piping Plover and Red Knot flights within the Wind Development Area are likely limited to few individuals during migration, and they are generally expected to fly above the Project's rotor-swept zone (RSZ). There are no records of Roseate Terns within the Wind Development Area, and if individuals fly through the area during migration, they are likely to fly below the RSZ. There are historical records of Black-capped Petrel to the east of the Wind Development Area, but they were not detected in surveys. Finally, eagles are not expected as far offshore as the Wind Development Area and they were not detected in any surveys.

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List of Acronyms and Abbreviations

AC	alternating current
BGEPA	Bald and Golden Eagle Protection Act
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
Company	Kitty Hawk Wind, LLC
COP	Construction and Operations Plan
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESP	electrical service platform
km	kilometer
Lease Area	BOEM Lease Area OCS-A 0508
m	meter
MBTA	Migratory Bird Treaty Act
MDAT	Marine-life Data and Analysis Team
NEPA	National Environmental Policy Act
NOAA	National Oceanic & Atmospheric Administration
OCS	Outer Continental Shelf
Project	Kitty Hawk Offshore Wind Project
RSZ	rotor swept zone
USFWS	United States Fish & Wildlife Service
WEA	Wind Energy Area
WNS	white-nose syndrome
WTG	wind turbine generator

1 Part I: Introduction and Background

1.1 Project Description

Kitty Hawk Wind, LLC (the Company) is proposing to develop offshore wind power in the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area). The Company is proposing to develop the northwest portion of the Lease Area, hereafter referred to as the "Wind Development Area". The Wind Development Area is located 44 km offshore of Corolla, North Carolina, in the portion of the Lease Area closest to shore. The offshore components of the Project, including the wind turbine generators (WTGs), electrical service platform (ESP), and inter-array cables, will be located in federal waters within the Lease Area, while the export cable corridor will traverse both federal and state territorial waters of Virginia.

The Lease Area is located approximately 44 kilometers (km) offshore of Corolla, North Carolina. This area is within the Mid-Atlantic Bight, which is an oceanic region that spans coastal and offshore waters from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina, and is characterized by a broad expanse of gently sloping, sandy-bottomed continental shelf. In this area, the shelf extends up to 150 km offshore, where the waters reach to about 200 meters (m) deep. The Company's proposal is pursuant to Bureau of Ocean Management (BOEM) requirements for the commercial lease of submerged lands for renewable energy development on the Atlantic Outer Continental Shelf (Atlantic OCS).

Overall, the offshore portion of the Project consists of two major development components. The first component is the Wind Development Area, which is located within the Lease Area. This component includes the offshore WTGs, inter-array cables, ESP, and portions of the offshore export cables. The second component is the installation corridor for the offshore export cables. This area encompasses the portion of the offshore export cables that run from the Wind Development Area to the cable landfall. The offshore installation corridor includes the actual width of the corridor for cable installation and additional area that will be temporarily disturbed during installation activities. For the purpose of this assessment, the Project Area is comprised of the Wind Development Area (Figure 1-1). Installation and operation of the proposed offshore export cables (within the offshore installation corridor) are not expected to cause impacts to birds and bats (Bureau of Ocean Energy Management 2020c). For this reason, this assessment places primary focus on the offshore development within the Wind Development Area.

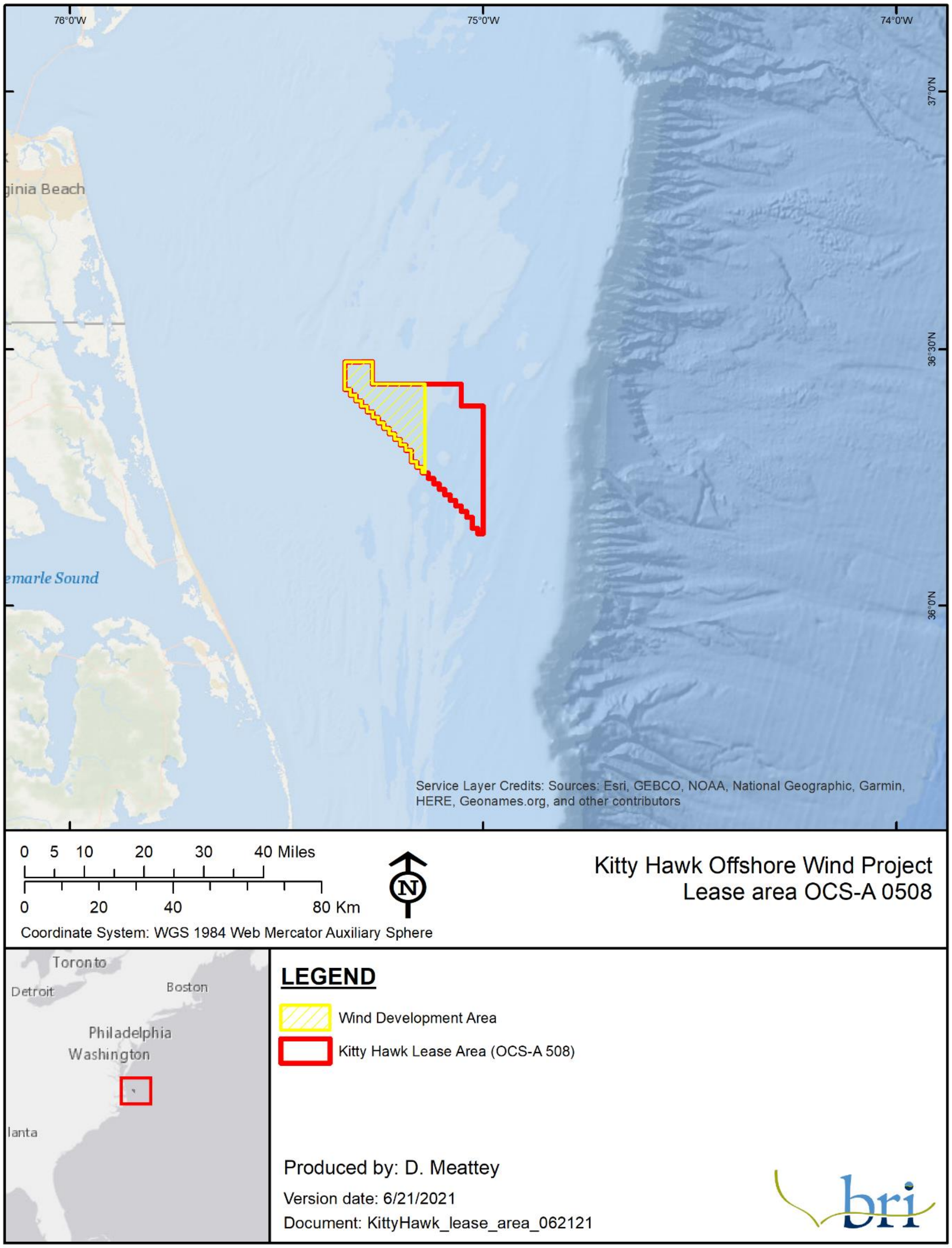

Figure 1-1. Overview of the Wind Development Area.

While a range of WTG models from various suppliers may be considered to allow for flexibility within the Wind Development Area, all WTGs for the Project are expected to follow the traditional offshore WTG design with three blades and a horizontal rotor axis. Specifically, the blades will be connected to a central hub, forming a rotor which turns a shaft connected gearbox (if required) and generator. The generator and gearbox will be located within a structure, known as the nacelle, and situated adjacent to the rotor hub. The nacelle will be supported by a tower structure affixed to the foundation. The nacelle will be able to rotate or "yaw" on the vertical axis in order to face the oncoming wind. Figure 1-2 shows a conceptual rendering of the WTG with the Project proposed representative dimensions.

For the purpose of the assessments presented within the COP and within this assessment, the WTG design envelope has been defined by maximum parameters (Table 1-1) which are representative of the WTGs expected to become available in time to be used for the Project.

Table 1-1: Potential Wind Turbine Generator (WTG) parameters

WTG Parameter	
Hub Height above mean sea level (MSL)	175 m
Upper Blade Tip above MSL	317.5 m
Lower Blade Tip above highest astronomical tide (HAT)	27-33 m
Rotor Diameter	285 m

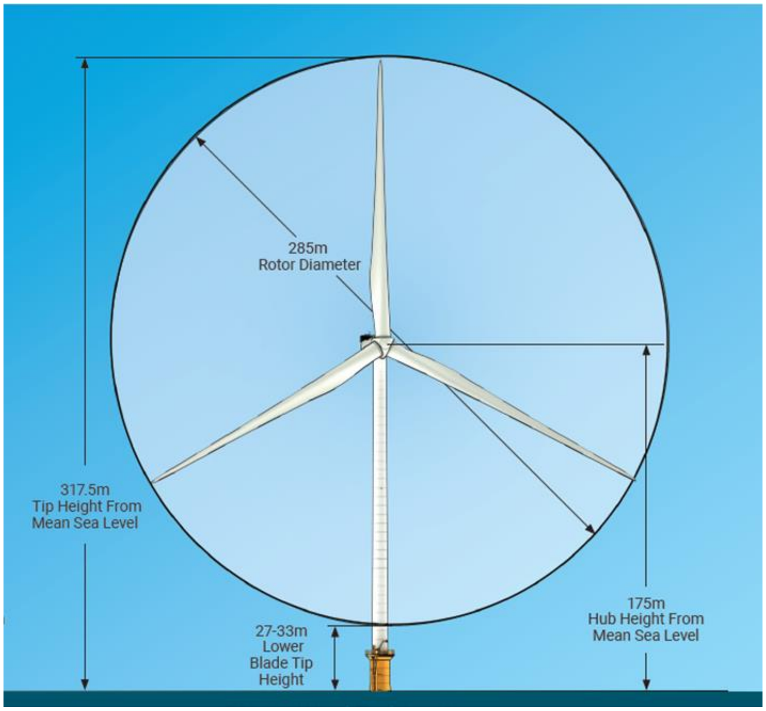

Figure 1-2: The maximum size turbine has a maximum blade tip height of 317.5 m relative to mean sea level (MSL). The minimum distance between the bottom of the blade and the water surface is 27 m.

1.2 Regulatory Background

Impacts to birds and bats are regulated under three federal laws: the Endangered Species Act (ESA) applies to birds and bats, while the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) apply only to birds. In addition, the National Environmental Policy Act (NEPA) requires that federal agencies evaluate environmental consequences of major federal actions. Major federal actions include issuance of federal permits that have the potential to affect the natural and human environments. Impacts to biological resources, including birds and bats, must therefore be identified and evaluated as part of the environmental review process for the Project. This assessment was developed to meet COP requirements (30 CFR 585.626), be aligned with BOEM’s 2020 Avian Guidelines (BOEM 2020b), provide information for NEPA review, and support agency consultations.

1.3 Assessment Approach

This assessment provides an overview of the bird and bat species that have the potential to be affected by the proposed offshore activities, with separate detailed sections on federally listed species. The potential direct and indirect impacts were evaluated for each phase of the Project (construction, operations, and decommissioning) for both collision and displacement.

For this assessment, a semi-quantitative approach was taken that first described impact-producing factors (e.g., presence of WTGs), the species that would potentially be exposed to the impact-producing factors, and the vulnerability of the species exposed. The assessment process was as follows:

- *Impact-producing Factors* – The first step in the assessment was to describe the impact-producing factors, which are the activities or components of the Project that have the potential to pose a hazard to birds or bats.

- *Exposure* – The next step in this 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 Project footprint. For species where site-specific data was available, a semi-quantitative exposure assessment was conducted. The exposure of birds and bats to the Wind Development Area was assessed using multiple datasets, species accounts, and the literature. This assessment of exposure was focused exclusively on the horizontal, or two-dimensional, likelihood that a species would use the Wind Development Area.

- *Relative Vulnerability* – Potential effects were then assessed qualitatively by combining the exposure assessment with the best information available on behavioral vulnerability to offshore wind. For the purposes of this analysis, 'behavioral vulnerability' is defined as the degree to which a species is expected to be affected by the Project, based on known effects at similar offshore developments. This assessment of behavioral vulnerability was done using a quantitative scoring process for marine birds, and qualitatively for non-marine migratory birds and bats using information on avoidance behaviors, flight heights, and collision risks published in the literature.

- *Risk* – The likelihood that the Project would impact birds or bats was then evaluated using a weight-of-evidence approach, based upon the exposure and vulnerability assessments described above. Recognizing that there is uncertainty in any risk assessment, impacts were determined by considering the likelihood that the viability of the resource (i.e. birds and bats) would be threatened by the impact-producing factor. For non-listed species, the assessment provides information for BOEM to make their impact determination at a population level, as has been done for assessments of Wind Energy Areas (WEA; BOEM 2016) and project specific Environmental Impact Statements (EIS; BOEM 2018). For federally listed species, this assessment provides information on an individual level because the loss of one individual from the breeding population has a greater likelihood of affecting a population than non-listed species.

2 Part II: Bats

This assessment provides an overview of the bat community that has the potential to be exposed to the proposed offshore Project activities, with separate sections on federally listed species.

2.1 Methods

The impact assessment was conducted using a weight-of-evidence approach by evaluating (a) the likelihood that bats will occur in the Wind Development Area (i.e., exposure), and (b) the known vulnerability of bats to collisions with WTGs (offshore). The likely presence of bat species was categorized based on criteria presented below using the best available data and information on geographic range and habitat requirements (Table 2-1). Literature was used to determine vulnerability for each species or group based on behavior, habitat requirements, seasonality of use, and known impacts associated with construction, operations, and decommissioning of proposed Project infrastructure.

Table 2-1: Exposure categories and definitions.

Exposure category	Exposure definition
Minimal	Not likely to be present, and little to no evidence of use of the offshore environment for breeding, or wintering, and minor predicted use during migration.
Low	Little evidence of the use of the offshore environment and a low proportion of the population exposed.
Medium	Moderate evidence of the use of the offshore environment and a moderate proportion of the population is exposed.
High	Strong evidence of the use of the offshore environment, the environment is primary habitat, and a high proportion of the population is exposed.

2.1.1 Data sources

2.1.1.1 Offshore Observations of Eastern Red Bats (Lasiurus borealis) in the Mid-Atlantic United States Using Multiple Survey Methods

Aerial and boat-based surveys of wildlife in the Mid-Atlantic (an area from Virginia to Delaware just to the north of the Wind Development Area) detected a possible migration event of eastern red bats (*Lasiurus borealis*) in September 2012 (Hatch *et al.* 2013). Eleven bats were observed offshore between 16.9 km and 41.8 km east of New Jersey. This study provides additional information about Eastern Red Bat distribution in the vicinity of the Wind Development Area to support the COP.

2.1.1.2 Bat Acoustic Surveys Conducted Within the Lease Area

A bat acoustic detector was deployed on a Terrasond Limited survey vessel from 8 May through 16 Nov 2020 as the vessel completed surveys across the Wind Development Area and traveled to and from port. Preliminary results including survey dates from 8 May through 7 Oct 2020 show no listed species were recorded in the Wind Development Area. A total of 48 bat passes were recorded in the Wind Development Area including eastern red bats (six bat passes), unidentified high frequency bats (40 bat passes), and unidentified low frequency bats (two bat passes). Bats were recorded over seven calendar nights and highest activity was recorded during the fall. A bat was observed roosting on the vessel within the Wind Development Area on 24 through 28 Sep 2020, but a definitive species confirmation was not possible. Bat passes during that time period suggest an eastern red bat.

2.1.1.3 Digital Aerial Surveys in the Lease Area and South Atlantic Bight

High resolution digital aerial surveys were conducted for BOEM in the South Atlantic Bight by Normandeau Associates, Inc. and APEM Inc. in 2018 and 2019 within an area defined by the coasts of North and South Carolina from state territorial waters out to the 30 m isobath and including Kitty Hawk, Wilmington East, Wilmington West Wind Energy Areas, and South Carolina–Grand Strand Call Area (only the 2018 data was available for the assessment). The primary survey area was covered by a minimum of 5 percent and the wind energy and call areas at 10 percent. Ground spatial resolution was 1.5 cm. Four quarterly surveys were intended, and while four surveys were completed in 2018, temporal coverage was not spread evenly across seasons and as such were used to provide annual exposure risk instead of seasonal exposure (See Table A-1 in Appendix A).

The Company contracted Normandeau Associates, Inc. and APEM Inc. to complete high resolution aerial surveys monthly in 2019 across the Lease Area (Lease Area OCS-A 0508) plus a 4 km buffer, which resulted in >10 percent coverage at 1.5 cm ground spatial resolution. Each survey required a single day to complete.

2.1.1.4 Offshore Activity of Bats along the Mid-Atlantic Coast

During March-October 2009, Angela Sjollema of the University of Maryland Center for Environmental Science conducted shipboard bat surveys using Anabat II detectors in an area north of the Wind Development Area (Sjollema *et al.* 2014). The goal of this project was to study offshore occurrence of bats along the Delmarva Peninsula. Acoustic monitoring of bats off the Atlantic Coast (from Massachusetts to North Carolina) was also conducted for 86 nights from March 2009 to August 2010 in spring (March–beginning of June) and fall (August–October). A total of 166 bat detections were recorded over 898 hours of recording time. Maximum detection distance from shore was 21.9 km and mean distance was 8.4 km. While not directly in the Wind Development Area, this study does describe the existing conditions of bat distribution in the region to support the COP.

2.1.1.5 Autumn Coastal Bat Migration Relative to Atmospheric Conditions: Implications for Wind Energy Development

Acoustic monitoring for bats was completed along the Atlantic Coast of southern New England during fall (range August–October) 2010-2012 (Smith & McWilliams 2016). These data support understanding of bat movement in the Wind Development Area, because they provide information on how weather affects offshore bat movement patterns. A total of 47,611 bat detections were recorded over 775 detector nights. The most commonly identified calls belonged to eastern red bats and silver-haired bats (*Lasionycteris noctivagans*). Bat activity varied with regional wind conditions, indicative of cold fronts and was strongly associated with various aspects of temperature.

2.2 Results

2.2.1 Overview of bats in North Carolina and Virginia

There are 17 species of bats known to occur in the states of North Carolina and Virginia (Table 2-2). These species can be divided into two major groups based on their wintering strategy: cave-hibernating bats and migratory tree bats (Fleming 2019). Both groups of bats are nocturnal insectivores that use a variety of forested and open habitats for foraging during the summer (Barbour & Davis 1969). Cave-hibernating bats are generally not observed offshore (Dowling & O'Dell 2018); in the fall, these bats migrate from summer habitat to winter hibernacula in the mountain and foothill regions of the state (LeGrand, Gatens, *et al.* 2020). In contrast, migratory tree bats generally fly to southern parts of the U.S. to overwinter (Cryan 2003), with some present year-round in North Carolina and Virginia (LeGrand, Gatens, *et al.* 2020, Timpone *et al.* 2011), and have been observed offshore during migration (Hatch *et al.* 2013).

Table 2-2. Bat species present in North Carolina and Virginia, and their conservation status (NCWRC 2015, Virginia Department of Game and Inland Fisheries 2018).

Common Name	Scientific Name	Type	NC State Status	VA State Status	Federal Status
Eastern small-footed bat	*Myotis leibii*	Cave-Hibernating Bat	SC		
Little brown bat	*Myotis lucifugus*	Cave-Hibernating Bat		E	
Northern long-eared bat	*Myotis septentrionalis*	Cave-Hibernating Bat	T	T	T
Indiana bat*	*Myotis sodalis*	Cave-Hibernating Bat	E	E	E
Gray bat*	*Myotis grisescens*	Cave-Hibernating Bat	E	E	E
Southeastern myotis	*Myotis austroriparius*	Cave-Hibernating Bat	SC		
Tri-colored bat	*Perimyotis subflavus*	Cave-Hibernating Bat		E	
Big brown bat	*Eptesicus fuscus*	Cave-Hibernating Bat			
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	Cave-Hibernating Bat		E	
Virginia big-eared bat*	*Corynorhinus townsendii virginianus*	Cave-Hibernating Bat	E	E	E
Brazilian free-tailed bat	*Tadarida brasiliensis*	Cave-Hibernating Bat			
Evening bat	*Nycticeius humeralis*	Migratory Tree Bat			
Eastern red bat	*Lasiurus borealis*	Migratory Tree Bat			
Seminole bat	*Lasiurus seminolus*	Migratory Tree Bat			
Hoary bat	*Lasiurus cinereus*	Migratory Tree Bat			

Common Name	Scientific Name	Type	NC State Status	VA State Status	Federal Status
Silver-haired bat	*Lasionycteris noctivigans*	Migratory Tree Bat			
Northern yellow bat	*Lasiurus intermedius*	Migratory Tree Bat	SC		
*Range does not indicate presence along the coast of VA/NC. E=endangered; T=threatened; SC=special concern.					

Four federally listed bat species are present in North Carolina and Virginia: the Indiana bat, gray bat, Virginia big-eared bat, and northern long-eared bat. The northern long-eared bat has a distinct, bimodal distribution in North Carolina, found primarily in the mountains and coastal plain, with very few records in the Piedmont region, though it is generally uncommon in both areas due to population declines resulting from the fungal disease known as white-nose syndrome (WNS) (Morris *et al.* 2009, LeGrand, Gatens, *et al.* 2020). The northern long-eared bat is found throughout the Commonwealth of Virginia, while the ranges of the Indiana bat, gray bat, and Virginia big-eared bat are not thought to include the eastern part of the state (Timpone *et al.* 2011, VDGIF 2020a, VDGIF 2020b, VDGIF 2020c). Historical records indicate the presence of these three species closer to the state's western border (LeGrand, Gatens, *et al.* 2020). Published literature suggests that summer colonies of gray bats are limited to primarily bachelor colonies (five caves) and one known maternity colony on the Virginia/Tennessee border (Powers *et al.* 2016, Timpone *et al.* 2011). The summer range of Indiana bats in the state is also likely minimal outside the western portion of the state, although a maternity colony was recently discovered in Caroline County, a first record in the Virginia coastal plain (St. Germain *et al.* 2017). Virginia big-eared bats are likewise limited to the west and southwest of the state during summer, with only one known maternity colony in Tazewell County (Timpone *et al.* 2011). Based on this information, the northern long-eared bat is the only federally protected bat species with the potential to occur in or near the Wind Development Area and is, therefore, the only federally listed bat species which will be included in this assessment.

The Northern long-eared bat is an insectivorous species that hibernates in caves, mines, and other locations (possibly talus slopes) in winter and spends the remainder of the year in forested habitats. The species' range includes most of the eastern and mid-western U.S. and southern Canada. Due to impacts from WNS, the species has declined by 90–100 percent in most locations where the disease has occurred. Declines are expected to continue as WNS spreads throughout the remainder of the species' range (USFWS 2016). As a result, the northern long-eared bat was listed as threatened under the ESA in 2015.

Northern long-eared bats are active throughout early spring to late fall (March-November) (Brooks & Ford 2005, Pettit & O'Keefe 2017). At summer roosting locations, they form maternity colonies (aggregations of females and juveniles) where females give birth to young in mid-June. These maternity colonies are moved every 2–14 days by the females carrying their pups; colonies can consist of 1–30 female bats with pups (Menzel *et al.* 2002). Juveniles are flightless until mid-July (Carter & Feldhamer 2005). Adult females and volant juveniles remain in maternity colonies until mid-August, at which time the colonies begin to break up and bats begin migrating to their hibernation sites (Menzel *et al.* 2002). Bats forage around the hibernation site and mating occurs prior to entering hibernation in a period known as the “fall swarm” (Broders & Forbes 2004, Brooks & Ford 2005). During breeding and in the summer, northern long-eared bats have small home ranges (less than 10 hectares; Silvis *et al.* 2016 in Dowling *et al.* 2017) and migratory movements can be up to 275 km (Griffin 1945 in Dowling *et al.* 2017).

2.2.2 Exposure

This section discusses the species of bats that may be exposed to construction, operations, and decommissioning of the Project’s offshore facilities. While there remain data gaps on offshore bat movements, bats have been documented in the marine environment in the U.S. (Grady & Olson 2006, Cryan & Brown 2007, Johnson, Gates, *et al.* 2011, Hatch *et al.* 2013, Pelletier *et al.* 2013, Dowling & O’Dell 2018, Stantec 2016) and in Europe (Boshamer & Bekker 2008, Ahlén *et al.* 2009, Lagerveld *et al.* 2015). Bats have been observed to temporarily roost on structures on nearshore islands, such as lighthouses (Dowling *et al.* 2017), and there is historical evidence of bats, particularly eastern red bats, migrating offshore in the Atlantic (Hatch *et al.* 2013). In a mid-Atlantic bat acoustic study conducted during the spring and fall of 2009 and 2010 (86 nights), the maximum distance that bats were detected from shore was 21.9 km, and the mean distance was 8.4 km (Sjollema et al. 2014). In Maine, bats were detected on islands up to 41.6 km from the mainland (Peterson *et al.* 2014). In the mid-Atlantic acoustic study, eastern red bats comprised 78 percent of all bat detections offshore (166 bat detections during 898 monitoring hours) and bat activity decreased as wind speed increased (Sjollema *et al.* 2014). In addition, eastern red bats were detected in the mid-Atlantic up to 44 km offshore during boat-based surveys, and up to 41.8 km offshore during high resolution digital aerial surveys (Hatch *et al.* 2013). Acoustic bat detectors deployed aboard research vessels at sea have detected bat activity up to 130 km from shore (Stantec 2016).

Several studies outside of North Carolina and Virginia have also highlighted the relationship between bat activity and weather conditions. In general, bat activity has been found to occur primarily during nights with warmer temperatures and low wind speeds (Fiedler 2004, Reynolds 2006, Cryan *et al.* 2014, Gorresen *et al.* 2020, Stantec Consulting Services Inc. 2016). Smith and McWilliams (2016) developed predictive models of regional nightly bat activity using continuous acoustic monitoring at several locations in coastal Rhode Island. Bat activity was found to steadily decrease with decreasing temperatures, and departures from seasonally normal temperatures increasingly inhibited bat activity later in the season (September–October). Although Smith and McWilliams (2016) found no association with wind speed and activity of migratory bats (primarily eastern red bats and silver-haired bats), they demonstrate a strong relationship with “wind profit”, a variable indicating combinations of wind speeds and directions that would likely induce coastal flight paths.

<u>Cave-hibernating bats</u>: Cave-hibernating bats hibernate regionally in caves, mines, and other structures, and feed primarily on insects in terrestrial and fresh-water habitats. These species

generally exhibit lower activity in the offshore environment than the migratory tree bats (Sjollema *et al.* 2014), with movements primarily during the fall (Stantec 2016, Peterson *et al.* 2014). In the mid-Atlantic study, the maximum distance *Myotis* species were detected offshore was 11.5 km (Sjollema et al. 2014). As shown by these studies, and acoustic surveys within the Lease Area (Figure 2-1), the use of coastline as a migratory pathway by cave-hibernating bats is likely limited to the fall migration period. Furthermore, acoustic studies generally indicate lower use of the offshore environment by cave-hibernating bats (as compared to tree-roosting species). In addition, cave-hibernating bats do not regularly feed on insects over the ocean. For these reasons, exposure to the Wind Development Area is considered ***minimal*** to ***low*** for cave-hibernating bats in general. This finding is supported by the Environmental Assessment for North Carolina, which found that, while rare, bat use offshore will primarily involve migratory tree bats (Bureau of Ocean Energy Management 2015), and the cumulative impacts analysis in the Supplemental EIS for the Vineyard Wind 1 (VW1 SEIS) finds that cave-hibernating bats do not typically occur offshore (BOEM 2020c). Due to their ESA listing status, northern-long-eared bats are discussed in greater depth below.

Northern long-eared bats are not expected in the Wind Development Area, because they were not detected in acoustic surveys within the Lease Area, and like other cave-hibernating bats, they do not regularly use the offshore environment for foraging or migrating (BOEM 2020c). Since research on the movements of these bats in the marine environment is limited, there remains uncertainty on whether this species travels offshore. If northern long-eared bats were to migrate over water, movements would likely be close to the coast. In a New England study, a nanotag tracking project on Martha's Vineyard (*n* = 8; July–October 2016) did not record offshore movements of northern long-eared bats (Dowling *et al.* 2017), suggesting that in general these species do not fly offshore. While in a different region, the Biological Assessment for Vineyard Wind 1 found that there are no records of northern long-eared bats on the Atlantic OCS, and concluded it was "extremely unlikely" that this species would pass over offshore portions of that project (BOEM 2019b). No bats were detected in the BOEM SAB or Kitty Hawk APEM digital aerial surveys conducted in the Wind Development Area. Given that there is little evidence of use of the offshore environment by northern long-eared bats, exposure is expected to be ***minimal***.

<u>Migratory tree bats</u>: Tree bats generally migrate to southwestern and southern parts of the U.S. to overwinter (Cryan 2003, Cryan, Stricker, *et al.* 2014), including North Carolina and Virginia (LeGrand, Gatens, *et al.* 2020), and have been documented in the offshore environment (Hatch *et al.* 2013). Eastern red bats were detected in the mid-Atlantic up to 41.8 km offshore by high resolution digital video aerial surveys (Hatch *et al.* 2013). These bats were all observed in September, to the north of the Wind Development Area off of Delaware and Maryland. Eastern red bats have been detected migrating from Martha's Vineyard late in the fall, and one bat was tracked as far south as Maryland (Dowling *et al.* 2017). These results are supported by historical observations of eastern red bats offshore, as well as acoustic and survey results (Hatch *et al.* 2013, Peterson *et al.* 2014, Sjollema *et al.* 2014). Eastern red bats were the only confirmed species recorded during acoustic surveys in the Lease Area (Figure 2-1). Tree bats are most likely

to pass through the Wind Development Area during the migration period (late summer/early fall), but their use of the Wind Development Area would "likely be rare" (Bureau of Ocean Energy Management 2015). No bats were detected in the BOEM SAB or Kitty Hawk APEM digital aerial surveys conducted in the Wind Development Area. Furthermore, in the VW1 SEIS, BOEM determined that offshore use by tree bats is expected to be "very low and limited to spring and fall migration periods" and "under very specific conditions like low wind and high temperatures" (BOEM 2020c). Because bat movement offshore is generally limited to fall migration, exposure is expected to be ***low***.

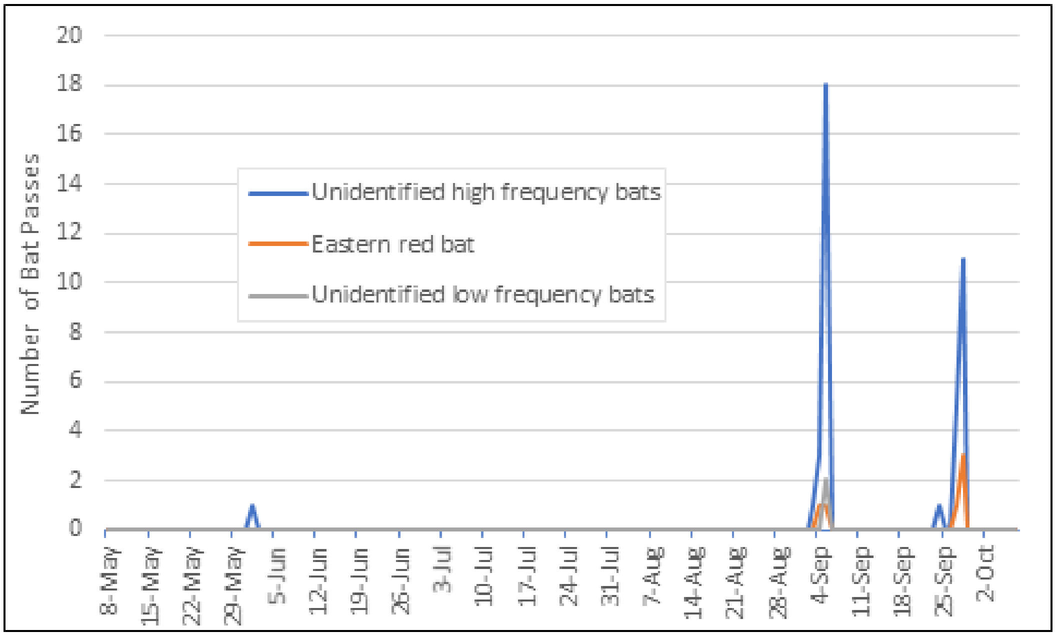

Figure 2-1: Number of recorded bat passes, by species, documented during acoustic surveys within the Lease Area.

2.2.3 Impacts

2.2.3.1 Impact Producing Factors

Offshore, the primary hazards bats may be exposed to are construction and maintenance vessels and WTGs. For the analysis below, the maximum turbine size that may be used for the Project is considered (Table 1-1, Figure 1-2) and it is also assumed that foundation type will not significantly change the hazards during construction.

2.2.3.2 Construction and Installation

Bats may be attracted to the offshore construction areas, including lighted vessels as they are moving throughout the Wind Development Area. Bats at onshore wind facilities have been documented showing higher attraction and more frequent approaches to turbines when the blades are not spinning (Cryan, Gorresen, *et al.* 2014), so attraction may be stronger during the construction period prior to commissioning of turbines. However, stationary objects are not generally considered a collision risk for bats (BOEM 2014) because of their use of echolocation (Johnson *et al.* 2004, Horn *et al.* 2008) and as such, individual bats are unlikely to collide with construction equipment or offshore facility structures during construction. BOEM determined that noise from pile-driving is short-term, temporary, and highly localized; is not expected to cause direct impacts (i.e., hearing loss); and, while bats may avoid offshore construction areas, indirect effects (and direct effects) are expected to be negligible (BOEM 2020c). Given the limited potential for individual impacts, combined with the temporary nature of exposure, population level impacts as a result of construction related activities are considered unlikely.

2.2.3.3 Operation and Maintenance

During migration, bats may be attracted to the Wind Development Area by lighted maintenance vessels, WTGs, and the ESP. The primary potential impact of the operational offshore components of the Project to bats is mortality or injury resulting from collision with WTGs. Based on collision mortalities documented at terrestrial wind facilities, all bats with potential to occur within the Wind Development Area are potentially vulnerable to collision. At terrestrial wind facilities in the U.S., bat mortality has been documented (Martin *et al.* 2017, Cryan & Barclay 2009, Hayes 2013, Smallwood 2013, Pettit & O’Keefe 2017), predominantly impacting migratory tree-roosting bats (Kunz *et al.* 2007). The highest proportion of bat fatalities tends to occur in late summer and early fall (Cryan 2008, Măntoiu *et al.* 2020), coinciding with the fall migration period.

In Europe, there is some evidence to suggest that bats forage over the surface of the ocean and when foraging around obstacles (i.e., lighthouses and WTGs) increase their altitude (Ahlén *et al.* 2009). In addition to foraging behavior, fatality risk in the offshore environment may also be influenced by flight height during migration. Bats migrating over the Baltic Sea have been observed frequently flying below 10 m (Ahlén et al. 2009) and bats observed during ship-based surveys in the North Sea flew at heights between 5–20 m (Lagerveld et al. 2014). Brabant *et al.* (2018) reported that offshore acoustic bat activity recorded at nacelle height is significantly less than at lower heights, though high altitude flight offshore (particularly during migration) has been reported in the eastern U.S. (Hatch *et al.* 2013), and is likely a common occurrence elsewhere (Hüppop & Hill 2016).

Fatality risk to offshore wind infrastructure may also be influenced by exploratory behavior around WTGs (Ahlén *et al.* 2009), attraction to red aviation lighting (Voigt *et al.* 2018), and daytime roosting opportunities (Lagerveld *et al.* 2017). Several studies have investigated the impacts of different lighting methods on attraction and avoidance behaviors in bats. Red aviation lights on WTG towers have been considered to be a potential source of interest to bats (Voigt *et al.* 2018); however, studies have shown that mortality at land-based towers with aviation lights is similar to or even less than mortality at towers without aviation lights (Arnett *et al.* 2008, Bennett & Hale 2014). Bennett and Hale (2014) reported higher eastern red bat fatalities at unlit WTGs in comparison with those lit with red aviation lights. Bats may also be attracted to maintenance vessels servicing WTGs and ESPs, particularly if insects are drawn to the lights of the vessels.

Based on available information, bats are more likely to be attracted to wind facility structures rather than displaced by them (Cryan *et al.* 2014). Limited research suggests that terrestrial wind facilities can contribute to habitat loss and reduced foraging activity (Millon *et al.* 2018), though it is unlikely similar patterns would be observed in the offshore environment where bat activity is already scarce.

Bats are not expected to regularly forage in the Wind Development Area but may be present during migration (BOEM 2015, BOEM 2020c). As discussed above, the exposure of cave-hibernating bats to the Wind Development Area is expected to be minimal to low because they are rarely encountered offshore and would only occur on rare occasions during migration. Therefore, population level impacts to cave hibernating bats are unlikely during operations of the offshore portions of the Project. Furthermore, the Project is expected to pose little to no to risk to individual northern long-eared bats, because this species is highly unlikely to forage or migrate offshore.

Migratory tree bats have the potential to pass through the Wind Development Area, but overall a small number of bats are expected in the Wind Development Area (BOEM 2020c) given its distance from shore (BOEM 2015). While there is evidence of bats visiting WTGs close to shore (4–7 km) in the Baltic Sea (enclosed by land; Ahlén et al. 2009, Rydell and Wickman 2015), and bats are demonstrated to be vulnerable to collisions, bats entering the Wind Development Area are expected to occur in low numbers (relative to the population), which will be primarily during late summer/fall migration. Therefore, population-level impacts are unlikely. While in a different region, this finding is consistent with the VW1 SEIS, which found that the direct and indirect impacts of the project would be “negligible to minor”, and that the cumulative impacts of the project combined with other proposed projects along the Atlantic OCS would be “minor” (BOEM 2020c).

2.2.3.4 Decommissioning

In general, decommissioning activities are expected to resemble construction activities and will involve removal of some portions, or all, of the Project infrastructure. Thus, the potential impact to bats from decommissioning is expected to be equal to or less than impacts from construction. For these reasons, decommissioning of the offshore portion of the Project is unlikely to impact populations of bats of any species.

2.3 Summary and Conclusions

Overall, the proposed Project is unlikely to impact bat populations. While some individual cave-hibernating bats may occur within the Wind Development Area during construction, operations, and decommissioning of the Project, and will be vulnerable to collision with operating turbines, the exposure of cave-hibernating bats (including northern long-eared bat and state-listed species) to operating turbines will be limited given their distance from shore. Small numbers of migratory tree bats are expected to occur in the Wind Development Area during construction, operations, and decommissioning; however, this is expected to include low numbers of individuals (BOEM 2020c) given the Wind Development Area's distance from shore and tree bat activity is expected to be concentrated during a small portion of the year (i.e., fall migration; August to October; (BOEM 2015, BOEM 2012)). Due to low exposure of bats to the Wind Development Area, the offshore components of the Project are unlikely to have population level impacts for any species of bats. In addition, individual federal and state-level listed bat species are unlikely to be affected.

These findings are consistent with BOEM's cumulative impacts assessment conducted for VW1, which encompasses all offshore wind projects along the Atlantic coast of the U.S., including the Project. BOEM determined that the cumulative impacts for all offshore wind projects, along with the impact-producing factors of climate change and ongoing onshore habitat loss, would result only in minor impacts and "none of the [impact-producing factors] associated with future offshore wind activities that occur offshore would be expected to appreciably contribute to overall impacts on bats" (BOEM 2020c).

3 Part III: Birds – Offshore

This avian assessment considered the potential effects of the offshore Project components during construction, operation, and decommissioning phases within the Wind Development Area. Spatially, bird exposure to the Wind Development Area will be similar during all phases. However, exposure to all construction and decommissioning activities are considered to be temporary. Birds are expected to have the same basic behavioral vulnerability to all phases (i.e., interacting with or being displaced by construction vessels or operating WTGs) and, thus, bird vulnerability was not assessed by specific phase. The foundation type is not expected to change the assessment. Below are provided an overview of methods and results.

3.1 Methods

3.1.1 Impact-producing factors

Hazards (i.e., impact-producing factors) are defined as the changes to the environment caused by Project activities during each offshore wind development phase (BOEM 2012, Goodale & Milman 2016). For birds, the primary impact-producing factors for the offshore component of the Project are above water and include vessels, lighting, WTGs, and the ESP (Table 3-1). Below water Project activities, including but not limited to foundation installation, are not expected to be a long-term hazard for birds (BOEM 2018) and are not discussed in detail. Low probability events, such as spills, are discussed in Section 7.12 of the COP.

Table 3-1: Potential effects on birds from offshore activities and the Project phases for which they are assessed.

Impact-Producing Factor(s)	Potential Effect	Description	Construction & Decommissioning*	Operations
Vessels, lighting, WTGs, ESP	Collision	Mortality and injury caused by collision with Project structures	✓	✓
Vessels, noise from pile-driving, WTGs, ESP	Displacement (Temporary)	Temporary disturbance by Project activities resulting in effective habitat loss	✓	
WTGs, ESP	Displacement (Long-term)	Long-term avoidance and/or displacement from habitat		✓

*Effects of decommissioning are expected to be less than or equal to construction activities.

3.1.2 Overview of potential effects by construction phase

Construction and Installation: Birds can be displaced by construction activities or collide with construction equipment when they interact with construction vessels or WTGs being installed. Spatially, bird exposure to the Wind Development Area will be similar during all development phases, but exposure to construction activities are considered to be temporary. During construction, lighting of construction vessels may temporarily attract birds and increase collision risk (Fox *et al.* 2006), but can be minimized by using best management practices, such as low-intensity strobe lights (BOEM 2020c). Lighting is not discussed in detail as an individual hazard, but as a factor that could increase collision risk and is discussed further within species group assessments below. Since the main impact-producing factor for birds is the presence of turbines, construction and operation are assessed together.

Operations and Maintenance: During operations, the potential effects of offshore wind facilities on birds are habitat loss due to displacement, and mortality due to collision (Drewitt & Langston 2006, Fox *et al.* 2006, Goodale & Milman 2016). The lighting associated with WTGs and the electrical service platform may result in attraction of birds and increased risk of collision (Montevecchi 2006). These effects are variable by taxonomic group, but can be minimized by using best management practices, such as low-intensity strobe lights (BOEM 2020c). Lighting is not discussed in detail as an individual hazard but considered a factor that could increase collision risk. The presence of maintenance vessels and associated activities may temporarily displace birds, but are not expected to cause adverse effects (BOEM 2018).

Decommissioning: While the specifics of decommissioning activities are not fully known at this time, the effects from decommissioning are expected to be the same or less than construction activities (Fox & Petersen 2019); thus, the potential impacts from decommissioning are not assessed independently.

The following section provides a brief overview of the methods used to assess exposure, assess vulnerability, and the how the exposure and vulnerability assessments were combined to assess potential effects. Detailed methods are provided in Attachment A.

3.1.3 Risk Framework

The potential effects associated with the proposed project were evaluated qualitatively using a risk assessment framework. This framework was presented to Bureau of Ocean Energy Management (BOEM), U.S. Fish and Wildlife Service (USFWS), Virginia Department of Environmental Quality (VDEQ), and Virginia Department of Wildlife Resources (VDWR) on 14 JUL 2020. The framework uses a weight-of-evidence approach and combines an assessment of exposure and behavioral vulnerability within the context of the literature to establish potential risk (Figure 3-1). Exposure has both spatial and temporal components. Spatially, birds are exposed on the horizontal (i.e., habitat area) and vertical planes (i.e., flight altitude); temporally, bird exposure is dictated by a species' life history and may be limited to breeding, staging, migrating, or wintering. Therefore, to be at risk of potential effects, a bird must be both *exposed* to an offshore wind development (i.e., overlapping in distribution) **and** be *vulnerable* to either displacement or collision (Goodale & Stenhouse 2016).

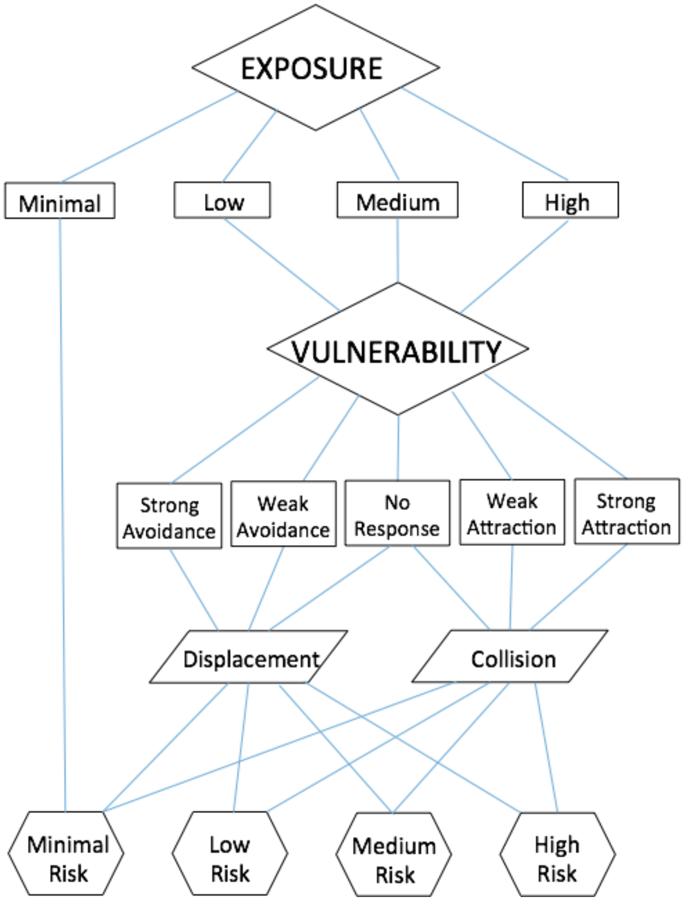

Figure 3-1: Risk assessment framework. First exposure was assessed, second vulnerability was assessed, and then, using a weight of evidence approach, the risk was evaluated.

Exposure was evaluated based upon (1) the seasonal BOEM South Atlantic Bight high-resolution digital aerial surveys (hereafter BOEM SAB surveys) conducted four times in 2018; (2) the project-specific Kitty Hawk APEM monthly high-resolution digital aerial surveys (hereafter Kitty Hawk APEM surveys) conducted in 2019; (3) version 2 of the Marine-life Data and Analysis Team (MDAT) marine bird relative density and distribution models (hereafter MDAT models; Curtice et al. 2016); (4) individual tracking studies; and (5) records in the Northwest Atlantic Seabird Catalog. Details on each of the data sets and detailed methods used in the exposure assessment are found in Attachment A. Due to gaps in knowledge on the relationship between the number of turbines and risk, this assessment analyzes the exposure of birds to the total area of development rather than to a specific number of turbines.[1]

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[1] Risk may not increase in a linear manner as the number of turbines increases because birds' avoidance response may increase as the numbers of turbines increases. Risk is also likely affected by the size and spacing of turbines: larger turbines have fewer revolutions than smaller turbines, may have a greater airgap between the water and the

Behavioral vulnerability was evaluated based the literature (Furness *et al.* 2013, Wade *et al.* 2016), and vulnerability score for the WTG design envelope parameters (lower blade tip height 27 m; upper blade tip height 317.5 m). See section A.2 (p. 142) in Attachment A for details on the vulnerability assessment.

Individual risk was assessed for listed species, while population level risk was assessed for non-listed species (Table 3-2). Population vulnerability was considered in assigning a final risk category, where a risk score was adjusted up or down based on the overall conservation status of the population (discussed in detail in section A.2 [p. 142] of Attachment A).

Table 3-2: Final risk evaluation matrix. CV = collision vulnerability; DV = displacement vulnerability, and PV = population vulnerability. An initial risk determination is made based upon vulnerability and exposure, and then the PV score is used to either keep the score the same, adjust the score up or down, or with a risk range eliminate the lower or upper portion of the range.

	Vulnerability (CV & DV)				
Exposure	*Minimal*	*Low*	*Medium*	*High*	*PV*
Minimal	Minimal	Minimal	Minimal	Minimal	↕
Low	Minimal	Low	Low	Low	
Medium	Minimal	Low	Medium	Medium	
High	Minimal	Low	Medium	High	
PV	↔				

3.2 Results

3.2.1 Overview

A diverse range of bird species may pass through the Wind Development Area, including migrant landbirds (such as raptors and songbirds), coastal birds (such as shorebirds, waterfowl, and waders), and marine birds (such as seabirds and sea ducks; Table 3-3). A high diversity of marine birds may use the Wind Development Area because it is located at the southern end of the Mid-Atlantic Bight, an area of overlap between northern and southern species assemblages. This assessment follows the taxonomic order presented in the most recent checklist produced by the North American Classification and Nomenclature Committee of the American Ornithological Society (Chesser *et al.* 2019).

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lowest blade position, and may be spaced much further apart. Thus, fewer larger turbines may pose a lower risk than many smaller turbines (Johnston *et al.* 2014).

Table 3-3. Avian species recorded offshore of North Carolina in the Kitty Hawk APEM monthly digital aerial survey and BOEM South Atlantic Bight digital aerial baseline survey, cross referenced with USFWS IPaC database (https://ecos.fws.gov/ipac/). • = present in the dataset.

Taxonomic Group	Species	IPaC
Ducks, geese, and swans		
American Black Duck	*Anas rubripes*	
Coastal diving ducks		
Greater Scaup	*Aythya marila*	
Lesser Scaup	*Aythya affinis*	
Sea ducks		
Black Scoter	*Melanitta americana*	
Long-tailed Duck	*Clangula hyemalis*	
Red-breasted Merganser	*Mergus serrator*	
Surf Scoter	*Melanitta perspicillata*	
White-winged Scoter	*Melanitta fusca*	
Grebes		
Horned Grebe	*Podiceps auritus*	
Shorebirds		
Black-bellied Plover	*Pluvialis squatarola*	
Dunlin	*Calidris alpina*	
Phalaropes		
Red Phalarope	*Phalaropus fulicarius*	
Red-necked Phalarope	*Phalaropus lobatus*	•
Skuas and jaegers		
Great Skua	*Stercorarius skua*	
Parasitic Jaeger	*Stercorarius parasiticus*	
Pomarine Jaeger	*Stercorarius pomarinus*	
Auks		
Atlantic Puffin	*Fratercula arctica*	
Dovekie	*Alle alle*	
Razorbill	*Alca torda*	
Small gulls		
Bonaparte's Gull	*Chroicocephalus philadelphia*	
Little Gull	*Hydrocoloeus minutus*	
Medium gulls		
Black-legged Kittiwake	*Rissa tridactyla*	•
Laughing Gull	*Leucophaeus atricilla*	
Ring-billed Gull	*Larus delawarensis*	
Large gulls		
Great Black-backed Gull	*Larus marinus*	•
Glaucous Gull	*Larus hyperboreus*	
Herring Gull	*Larus argentatus*	•
Iceland Gull	*Larus glaucoides*	
Lesser Black-backed Gull	*Larus fuscus*	
Small terns		
Black Tern	*Chlidonias niger*	
Least Tern	*Sternula antillarum*	
Medium terns		
Bridled Tern	*Onychoprion anaethetus*	
Common Tern	*Sterna hirundo*	
Forster's Tern	*Sterna forsteri*	
Gull-billed Tern	*Gelochelidon nilotica*	

Taxonomic Group	Species	IPaC
Royal Tern	*Thalasseus maximus*	
Sandwich Tern	*Thalasseus sandvicensis*	
Large terns		
Caspian Tern	*Hydroprogne caspia*	
Loons		
Common Loon	*Gavia immer*	•
Red-throated Loon	*Gavia stellata*	
Shearwaters and petrels		
Audubon's Shearwater	*Puffinus lherminieri*	
Black-capped Petrel	*Pterodroma hasitata*	
Cory's Shearwater	*Calonectris diomedea*	•
Great Shearwater	*Ardenna gravis*	•
Manx Shearwater	*Puffinus puffinus*	
Northern Fulmar	*Fulmarus glacialis*	•
Sooty Shearwater	*Ardenna grisea*	
Gannet		
Northern Gannet	*Morus bassanus*	•
Cormorants		
Double-crested Cormorant	*Phalacrocorax auritus*	
Pelicans		
American White Pelican	*Pelecanus erythrorhynchos*	
Brown Pelican	*Pelecanus occidentalis*	
Heron and egrets		
Great Blue Heron	*Ardea herodias*	
Great Egret	*Ardea alba*	
Green Heron	*Butorides virescens*	
Snowy Egret	*Egretta thula*	
Raptors		
Peregrine Falcon	*Falco peregrinus*	

The Mid-Atlantic Bight is an oceanic region that spans an area from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina, and is characterized by a broad expanse of gently sloping, sandy-bottomed continental shelf. This shelf extends up to 150 km offshore, where the waters reach about 200 m deep. Beyond the shelf edge, the continental slope descends rapidly to around 3,000 m. Most of this mid-Atlantic coastal region is bathed in cool Arctic waters introduced by the Labrador Current. At the southern end of this region, around Cape Hatteras, these cool waters collide with the warmer waters of the Gulf Stream. The mid-Atlantic region exhibits a strong seasonal cycle in temperature, with sea surface temperatures spanning 3–30 °C (Williams et al. 2015).

The Wind Development Area is located within one of four major North American north-south migration routes (known as “flyways”) for many species of seabirds, shorebirds, waterfowl, raptors, and songbirds (Menza *et al.* 2012). The Atlantic Flyway essentially runs along the Atlantic coast of North America and includes U.S. states and Canadian provinces that span the route from Canada to Central America, South America, and the Caribbean. Coastal and marine environments along the Atlantic Flyway provide important habitat and food resources for hundreds of avian species at stop-over sites, breeding locations, and wintering areas (Menza *et al.* 2012).

Migrant terrestrial and coastal species may follow the coastline during migration or choose more direct routes over expanses of open water. Many marine birds also make annual migrations or seasonal movements up and down the Atlantic coast (e.g., gannets, loons, and sea ducks), taking them directly through the mid-Atlantic region, particularly in spring and fall. The mid-Atlantic region also supports large populations of birds in summer, some of which breed in the area, such as coastal gulls and terns. Other summer residents, such as shearwaters and one storm-petrel species, visit from the Southern Hemisphere (where they breed during the austral summer/boreal winter). In the fall, many of the summer residents leave the area and migrate south to warmer regions and are replaced by species that breed further north and winter in the mid-Atlantic region. This results in a complex ecosystem where the avian community composition shifts regularly, and temporal and geographic patterns are highly variable. Overall, the MDAT models indicate that avian abundance is greatest closer to shore and further to the south than the Wind Development Area (Figure 3-2).

Three avian species listed under the ESA are present in the region: the Piping Plover (*Charadrius melodus*), Red Knot (*Calidris canutus rufa*), and Roseate Tern (*Sterna dougallii*). North Carolina is the only state on the Atlantic coast of the U.S. where the Piping Plover breeding and wintering ranges overlap. Red Knots winter in parts of North Carolina, as well as pass through the region during migration in transit to far northern breeding sites, using some stopover areas in the mid-Atlantic region, including Chesapeake Bay and North Carolina, to rest and forage along the way. Roseate Terns formerly bred in Virginia and historically were only rarely recorded breeding along the coast of North Carolina. They no longer breed in the region and typically only pass through on their way north to breeding sites in New York and New England states. Other federally-recognized species include the Black-capped Petrel, currently proposed for listing under the ESA, and the Bald Eagle and Golden Eagle, both protected under the BGEPA.

The assessment, below, includes the following for each species group: a description of the spatiotemporal context of exposure, exposure assessment, relative behavioral vulnerability assessment including flight height data, and a final risk determination. Marine birds are further divided into family groups. Species listed under the BGEPA and the ESA are assessed individually. A summary table is provided at the end of the assessment.

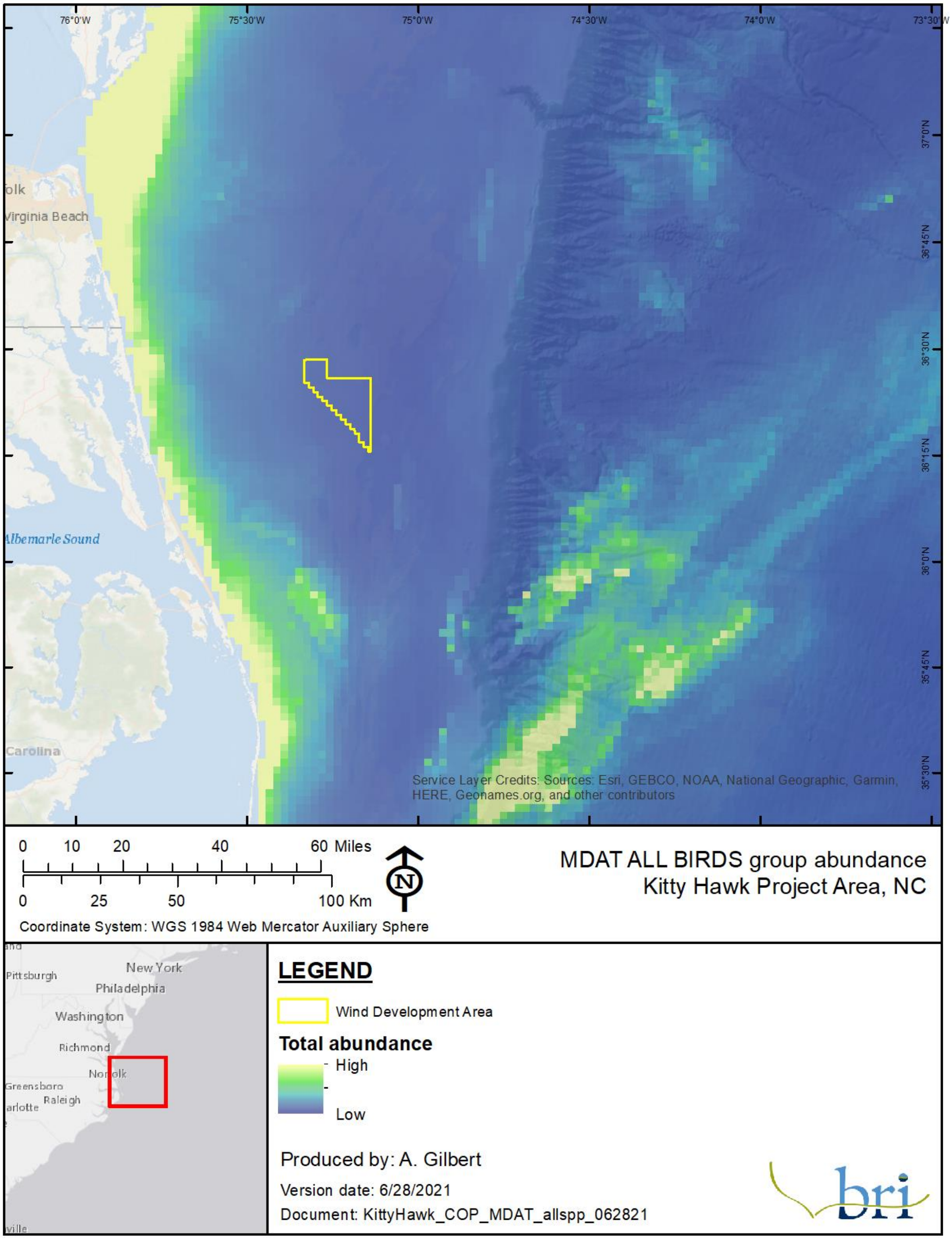

Figure 3-2: Bird abundance estimates (all birds) from the MDAT models.

3.2.2 Coastal Waterbirds

3.2.2.1 Spatiotemporal Context

Coastal waterbirds use terrestrial or coastal wetland habitats and rarely use the marine offshore environment. In this group, aquatic species are included that are generally restricted to freshwater or that use saltmarshes, beaches and other strictly coastal habitats, and that are not captured in other groupings (e.g., grebes and waterfowl). Some grebe species migrate to and winter on saltwater, where they generally stay inshore in relatively shallow and/or sheltered coastal waters, but may also be found offshore in shallower regions or over shoals (Stout & Nuechterlein 2020). Waterfowl comprises a broad group of geese and ducks, most of which spend much of the year in terrestrial or coastal wetland habitats (Baldassarre & Bolen 2006). The diving ducks generally winter on open freshwater, as well as brackish or saltwater. Some species regularly winter on saltwater, including mergansers, scaup, and goldeneyes, but they usually restrict their distributions to shallow, very nearshore waters (Owen & Black 1990). The IPaC database did not identify any coastal waterbird species in the Wind Development Area or surrounding waters.

A subset of the diving ducks, however, have an exceptionally strong affinity for saltwater, either year-round (e.g. eiders) or outside of the breeding season (e.g. scoters); these species are known as 'sea ducks' and are described in detail in the marine bird section (below).

3.2.2.2 Exposure Assessment

Exposure for coastal waterbirds was assessed using species accounts, baseline survey data, and literature. Exposure is considered to be ***minimal*** because most coastal waterbirds spend a majority of the year in freshwater aquatic systems and near-shore marine systems, and there is little to no use of the Wind Development Area during any season (Figure 3-3 and Figure 3-4). Due to the minimal exposure rating, a vulnerability and risk assessment was not conducted.

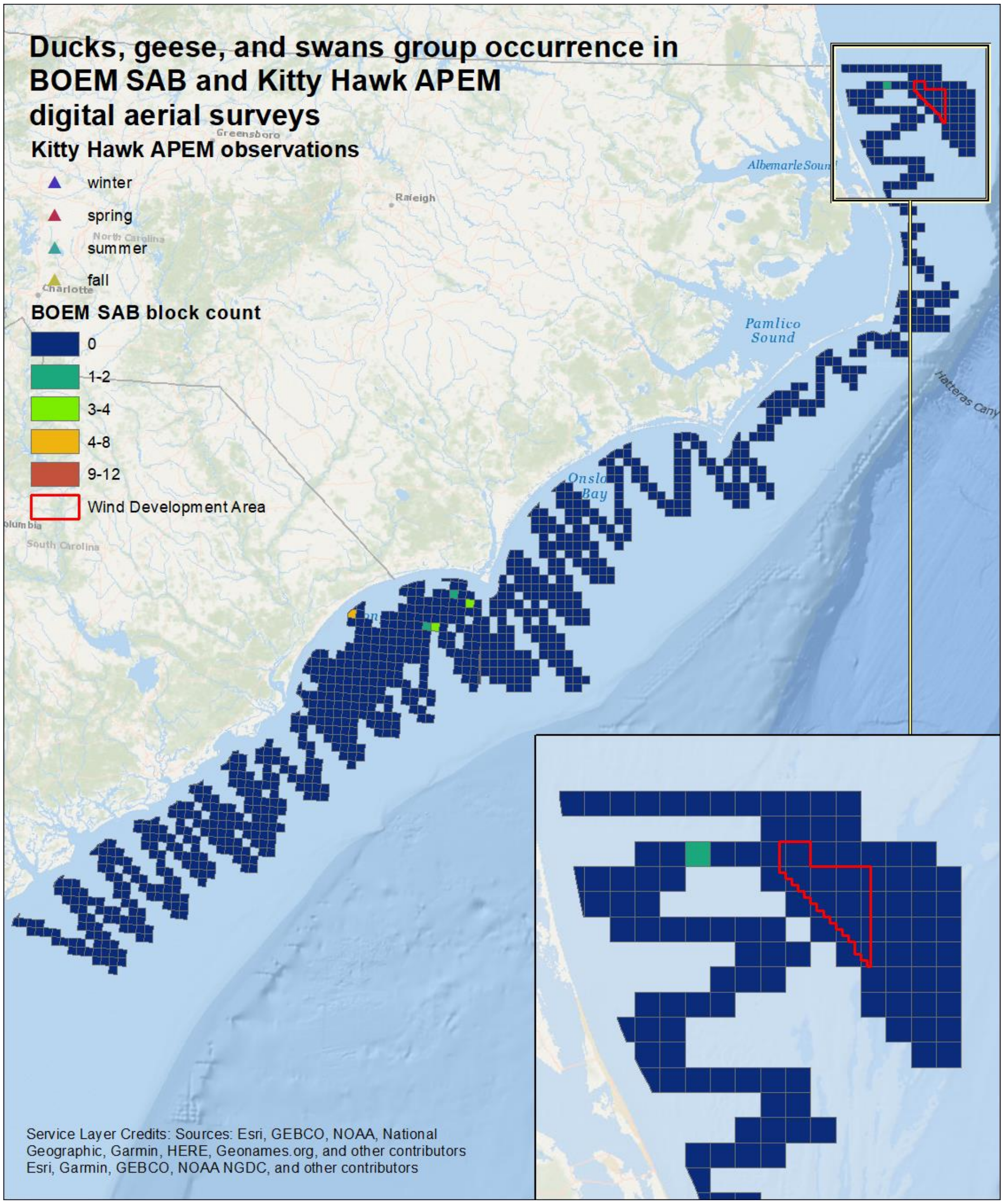

Figure 3-3: Coastal ducks, geese, and swans observed, by season, during the BOEM SAB and Kitty Hawk APEM surveys.

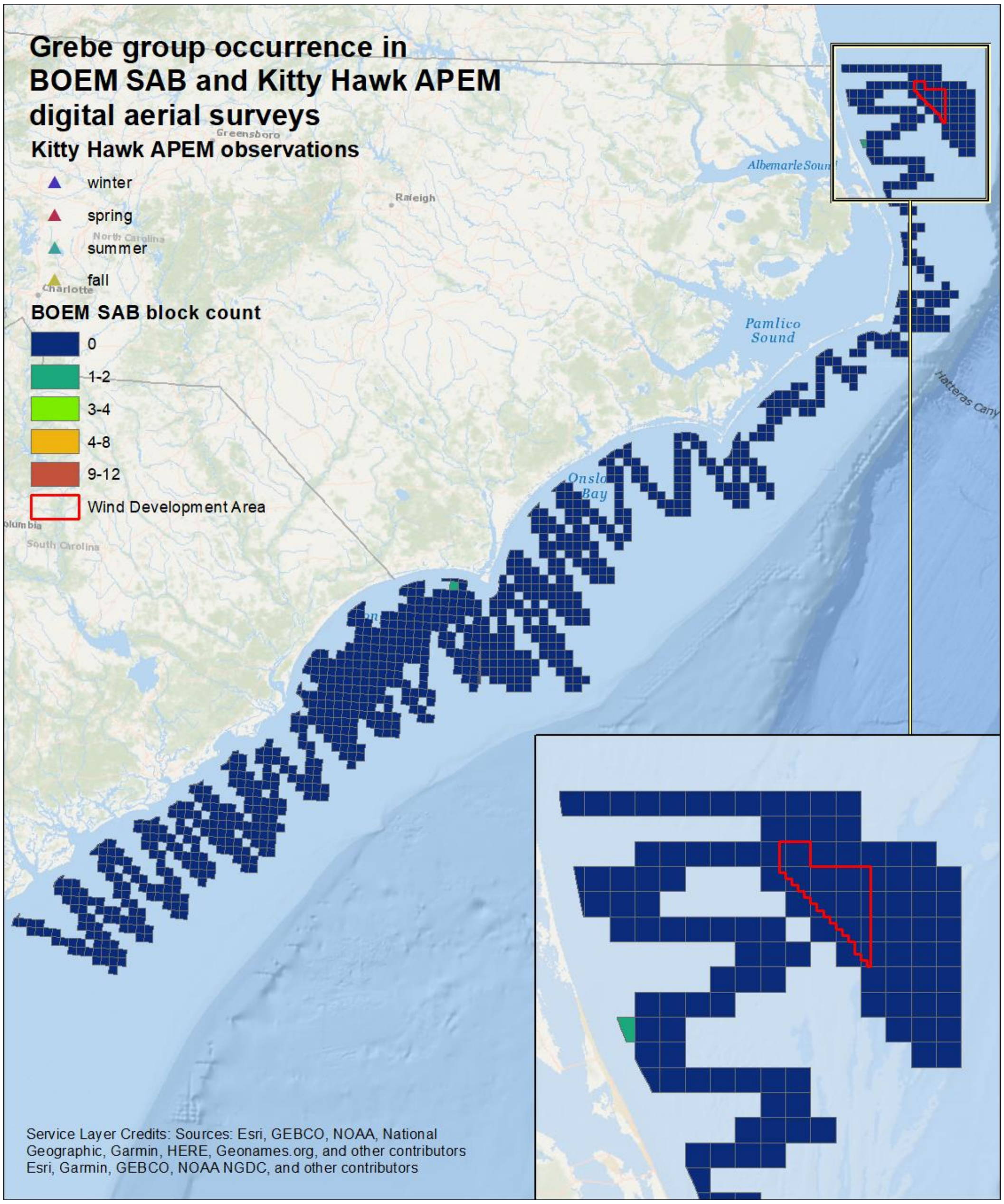

Figure 3-4: Grebes observed, by season, during the BOEM SAB and Kitty Hawk APEM surveys.

3.2.3 Shorebirds

3.2.3.1 Spatiotemporal Context

Shorebirds are coastal breeders and foragers and generally avoid straying out over deep waters during breeding. Few shorebird species breed locally on the U.S. Atlantic coast; most shorebirds that pass through the region are northern or Arctic breeders that migrate along the coast on their way to and from wintering areas in the Caribbean islands, or Central or South America. Of the shorebirds, only the two phalaropes (Red Phalarope [*Phalaropus fulicarius*] and Red-necked Phalarope [*P. lobatus*]) are generally considered marine species (Rubega *et al.* 2020, Tracy *et al.* 2020). Very little is known regarding the migratory movements of these species, although they are known to travel well offshore. Two shorebird species that are federally protected under the ESA occur in the region – the Piping Plover and the Red Knot – and these are addressed in detail below (Table 3-4).

Table 3-4: Shorebirds of federal conservation concern occurring in North Carolina and Virginia, and their conservation status (E = Endangered; T = Threatened.

Common Name	Scientific Name	NC State Status	VA State Status	Federal Status
Red Knot	*Calidris canutus rufa*	T	T	T
Piping Plover	*Charadrius melodus*	T	T	T

3.2.3.2 Exposure Assessment

Exposure was assessed using species accounts and baseline survey data. Spatial and temporal exposure to construction and operation is considered to be ***minimal*** because few were observed offshore and none in the Wind Development Area (Figure 3-5). While Red Phalaropes were detected in relatively high numbers in the BOEM SAB digital aerial surveys, there were few detections within the Wind Development Area and most of the birds were well to the south (see maps 23–29 in Attachment B). In general, phalaropes are associated with areas of coastal and offshore upwelling and winter well south of the Wind Development Area. Red Phalaropes are thought to overwinter at the inner edge of the Gulf Stream from about North Carolina south to Florida and beyond to the Caribbean islands (Tracy *et al.* 2020), while the current wintering area of Red-necked Phalaropes on the Atlantic OCS is largely unknown (Rubega *et al.* 2020).

A recent tracking study conducted in inland Canada indicates that shorebirds need 2–14 km to climb above a 165 m turbine (Howell *et al.* 2019) and are expected to fly at high altitudes during migration (see discussion for Piping Plover and Red Knot for additional detail). Since the closest portion of the Wind Development Area is approximately 44 km from the coast, shorebirds migrating during fair weather conditions are likely flying above the Project's WTGs, which would reduce collision risk. The birds may reduce flight height during periods of poor visibility. Due to the minimal exposure, a vulnerability and risk assessment was not conducted for non-ESA shorebird species.

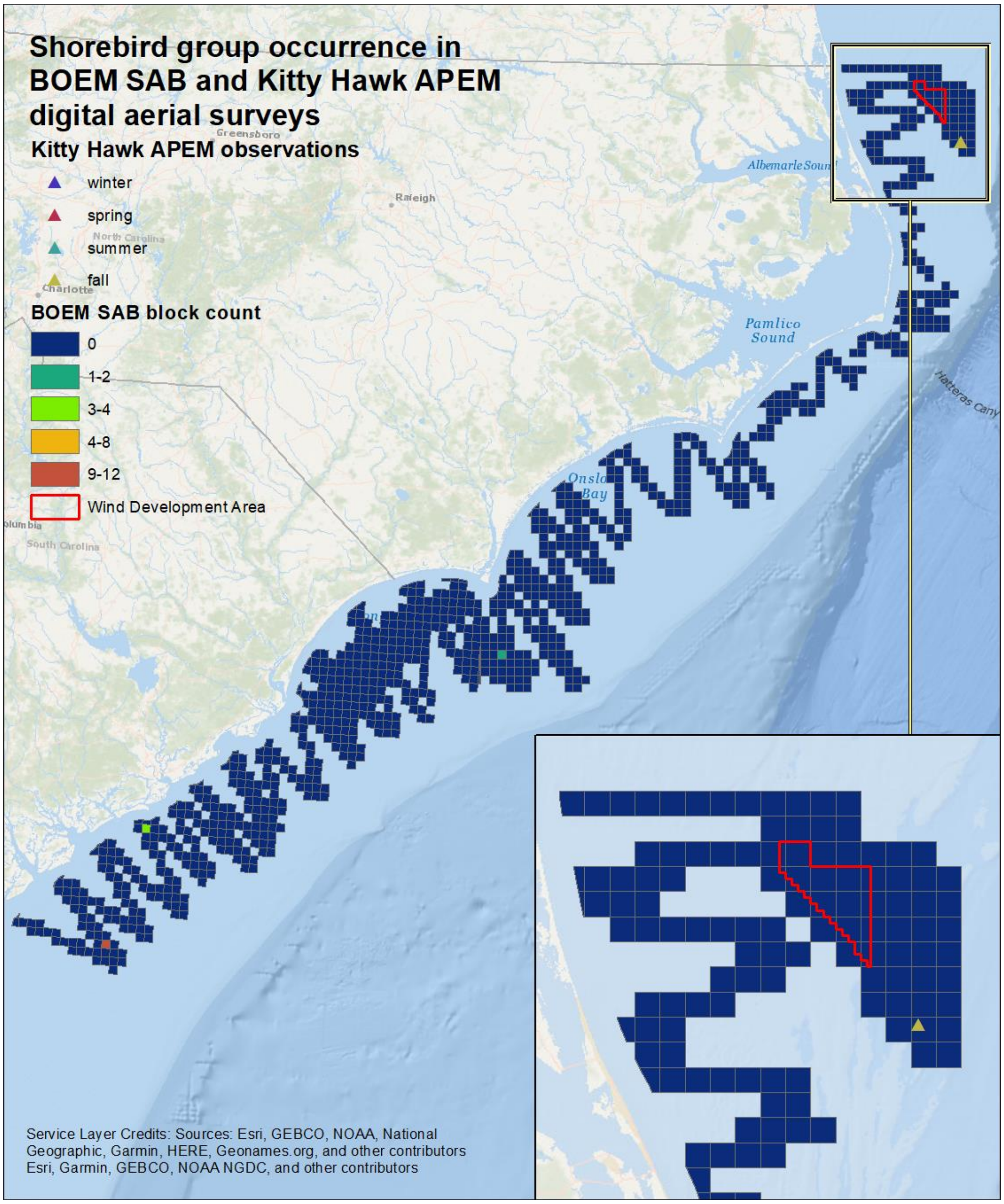

Figure 3-5: Shorebirds observed during the BOEM SAB and Kitty Hawk APEM surveys.

3.2.3.3 Endangered Shorebird Species

3.2.3.3.1 Piping Plover

3.2.3.3.1.1 Spatiotemporal context

The Piping Plover (*Charadrius melodus*) is a small shorebird that nests on beaches and wetlands along the Atlantic coast of North America, the Great Lakes, and in the Midwestern plains (Elliott-Smith & Haig 2020). The species winters in the coastal southeastern U.S., including North

Carolina (Cohen *et al.* 2008, Gratto-Trevor *et al.* 2012), and Caribbean (USFWS 2009b, Elliott-Smith & Haig 2020, BOEM 2014). Due to a number of threats, the Atlantic subspecies (*C. m. melodus*) is listed as threatened under the ESA[2], and is heavily managed on the breeding grounds to promote population recovery (Elliott-Smith & Haig 2020). Despite being listed more than 30 years ago, Atlantic Piping Plover populations have not met recovery goals in much of their range (Weithman *et al.* 2019). The winter range of the species is imperfectly understood, particularly for U.S. Atlantic breeders and for wintering locations outside the U.S., but the Atlantic subpopulation appears to primarily winter along the southern Atlantic coast and the Gulf coast of Florida (Burger *et al.* 2011, Elliott-Smith & Haig 2020, USFWS 2009b, Cohen *et al.* 2008, Gratto-Trevor *et al.* 2012).

Piping Plovers breed locally in coastal Virginia (Boettcher *et al.* 2007). Observations peak in May as local breeders arrive and spring migrants pass through on their way north and increase again in August during fall migration (Figure 3-6). Piping Plovers are present year-round in North Carolina (LeGrand, Haire, *et al.* 2020, Cohen *et al.* 2008). Observations increase from March through May and peak in August (Figure 3-6). Coastal areas of North Carolina, such as the Outer Banks, may provide important stopover habitat during migration, as larger numbers of birds are often seen during the fall than in the breeding season or winter (Elliott-Smith & Haig 2020).

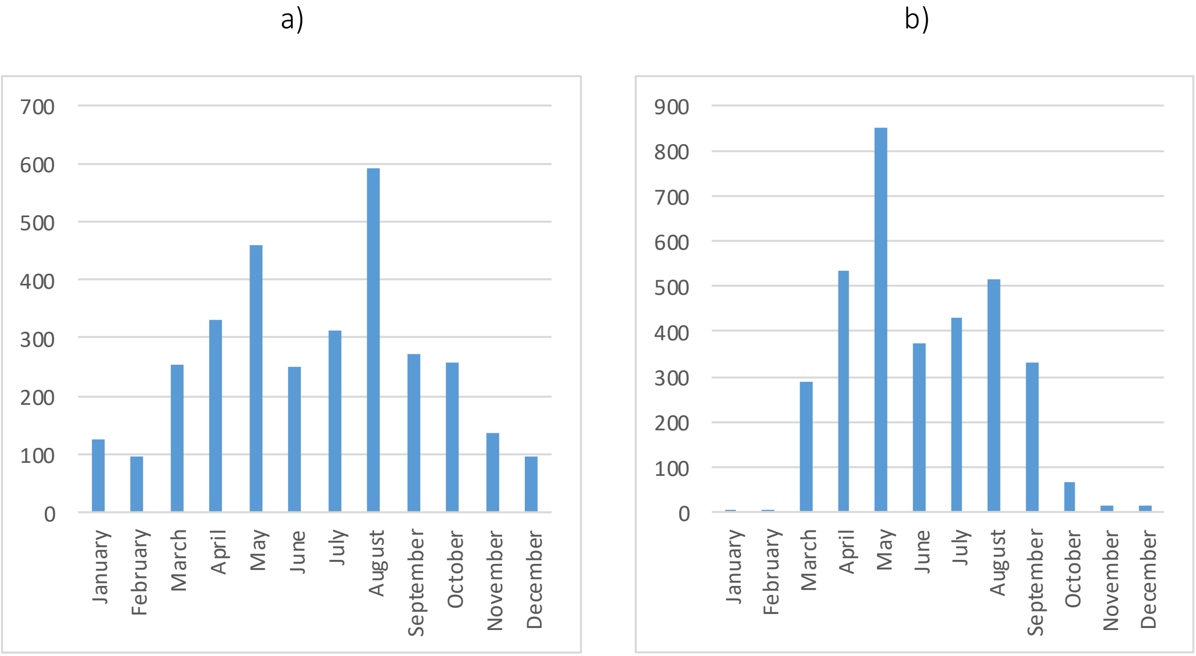

Figure 3-6: eBird records of Piping Plover in (a) North Carolina and (b) Virginia.

Piping Plovers make nonstop long-distance migratory flights (Normandeau Associates Inc. 2011, Loring *et al.* 2020), or offshore migratory “hops” between coastal areas (Loring *et al.* 2017). Based on recent tracking studies, at least some individuals of this species likely traverse the Wind Development Area during migration, as the birds favored more direct ocean crossings as

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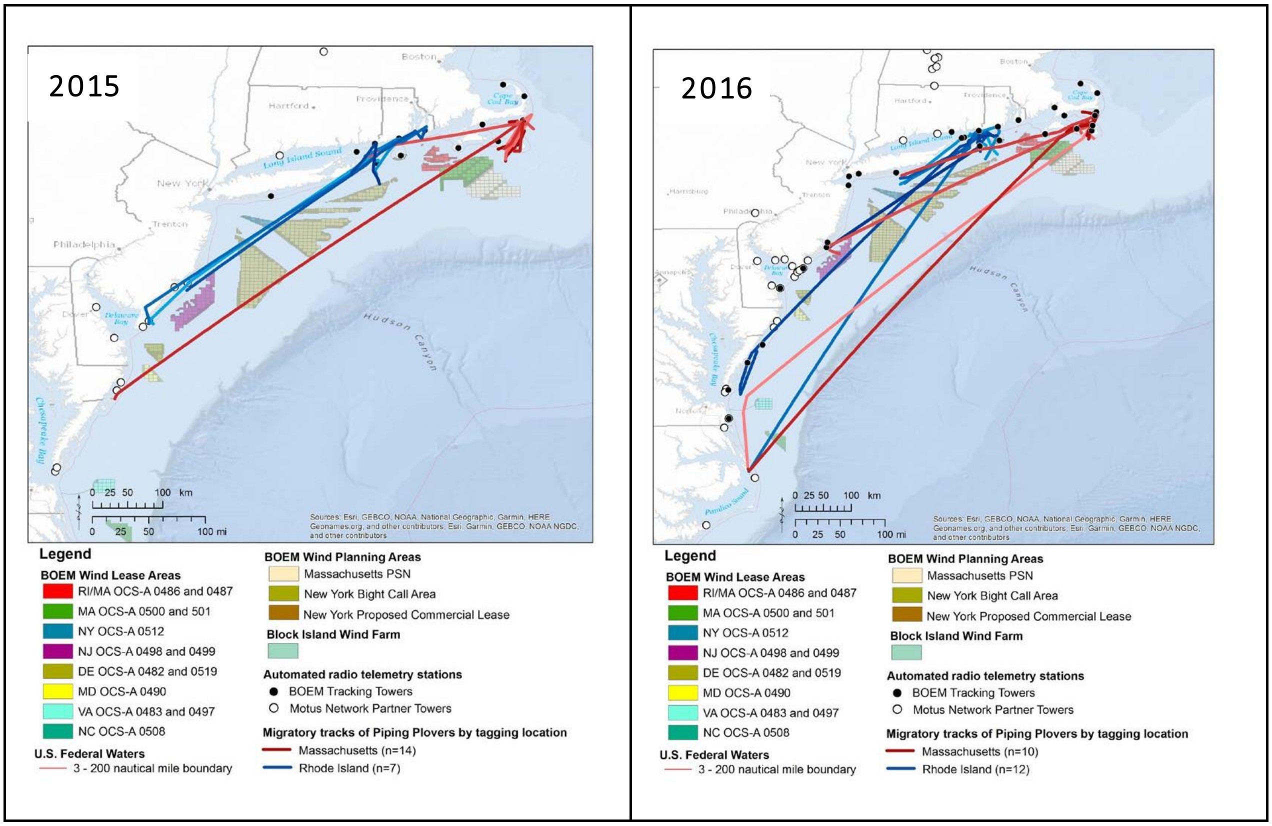
[2] https://www.fws.gov/northeast/pipingplover/

opposed to coastal hops (Figure 3-7; Loring et al. 2019, 2020). Migration occurs primarily during nocturnal periods, with the average takeoff time appearing to be within 3 hours of local sunset (Loring *et al.* 2017, Loring *et al.* 2019, Loring *et al.* 2020).

3.2.3.3.1.2 Exposure Assessment

Exposure was assessed using species accounts and the results of individual tracking studies. Due to their proximity to shore during breeding, Piping Plover exposure to the Project is limited to migration. Recent nanotag studies tracked migrating Piping Plovers captured in Massachusetts and Rhode Island from 2015–2017 and found that some birds likely passed through the Lease Area during direct offshore migratory flights from New England breeding areas (Figure 3-7) (Loring *et al.* 2019, Loring *et al.* 2020). The exposure estimates are considered a minimum estimate because of lost tags and incomplete coverage of the offshore environment by land-based receivers. There were no records in the Seabird Catalog of Piping Plovers in the vicinity of the Wind Development Area. Overall, there is no habitat for the species in the Wind Development Area, and the expected exposure to individuals of this species is limited to migration. As such, exposure is considered ***low***.



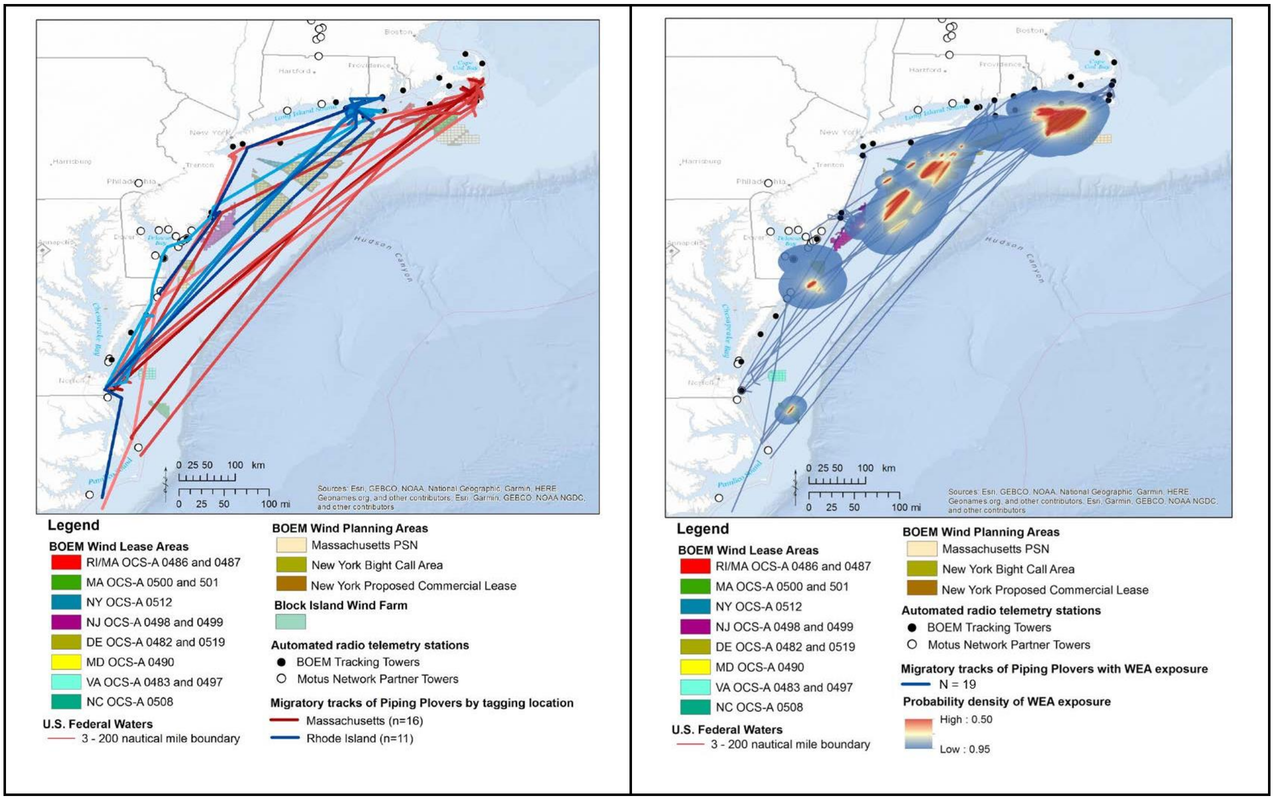


Figure 3-7: Modeled migratory track of Piping Plovers by year and composite probability density across Wind Energy Areas for all years of the study (Loring *et al.* 2019).

3.2.3.3.1.3 Relative Behavioral Vulnerability Assessment

The migratory flight height of Piping Plovers tagged with nanotags were generally above 250 m, with 15.2 percent of birds flying through Wind Energy Areas being between 25–250 m (Loring et al. 2019). Offshore radar studies have recorded shorebirds flying at 1,000–2,000 m (Richardson 1976, Williams and Williams 1990 *in* Loring et al. 2019), while nearshore radar studies have recorded lower flight heights of 100 m. A recent tracking study found that Piping Plovers flew at a mean of 288 m during offshore migratory flights (Loring *et al.* 2020). Flight heights can vary with weather; during times of poor visibility birds may fly lower (Dirksen et al. 2000 *in* Loring et al. 2019). Since plovers generally are expected to migrate at flight heights above the WTGs, potential exposure to collisions with turbines, construction equipment, or other structures is reduced. They also have good visual acuity and maneuverability in the air (Burger *et al.* 2011), and there is no evidence to suggest that they are particularly vulnerable to collisions. The Final Vineyard Wind 1 Biological Assessment prepared by BOEM for USFWS estimated that Piping Plover mortality from collision would be zero and that the likelihood of collision fatalities would be "insignificant and discountable" (BOEM 2019a). For these reasons, Piping Plovers have ***minimal*** to ***low*** vulnerability to collision with construction equipment and WTGs.

While there is little data on displacement for this species, avoidance behavior is not likely to lead to habitat loss offshore; thus, Piping Plovers are considered to have ***minimal*** vulnerability to displacement during turbine construction and operations, and are unlikely to be significantly affected by offshore Project activities, including boat traffic, unless that boat traffic occurs very near beaches or intertidal feeding areas.

3.2.3.3.1.4 Risk

The exposure of Piping Plovers to the Wind Development Area will be limited to migration, they have minimal to low vulnerability to collision, and minimal vulnerability to displacement; for these reasons, individual level impacts during construction and operation are expected to be ***minimal*** to ***low***. While these birds are federally and state listed, they received a medium population vulnerability score because they have a low rank in adult survival. Therefore, the final risk score was not adjusted.

3.2.3.3.2 Red Knot

3.2.3.3.2.1 Spatiotemporal context

The Red Knot (*Calidris canutus*) is a medium-sized shorebird with one of the longest migrations in the world, undertaking non-stop flights of up to 8,000 km on their circumpolar travels (Baker *et al.* 2020). The Atlantic Flyway subspecies (*C. c. rufa*) is listed as threatened under the ESA, primarily because this population decreased by approximately 70 percent from 1981 to 2012, to less than 30,000 individuals (Burger et al. 2011, Baker et al. 2013)[3]. The Red Knot is listed as threatened in North Carolina. This species breeds in the High Arctic, wintering in the southeastern U.S. and Caribbean, Northern Brazil, and Tierra del Fuego–Argentina (Baker *et al.* 2020). These populations share several key migration stopover areas along the U.S. Atlantic coast, particularly in Delaware Bay and coastal islands of Virginia (Burger *et al.* 2011). Population status is thought to be strongly influenced by adult survival and recruitment rates, as well as food availability on stopover sites, and conditions on the breeding grounds (Baker *et al.* 2020).

Based on a recent telemetry study, Red Knots would be present in the Wind Development Area only during migratory periods (Loring *et al.* 2018, BOEM 2016). Red Knots utilize the North Carolina and Virginia coasts as stopover locations particularly on spring migration. Observations in both states peak in May as migrants stop to rest and forage before continuing on to breeding sites in the arctic (Figure 3-8). The fall migration period is generally July–October, but birds may pass through as late as November (Loring *et al.* 2018). In Virginia observations again increase in August and September (Figure 3-8). Migration routes appear to be highly diverse, with some individuals flying out over the open ocean from the northeastern U.S. directly to stopover/wintering sites in the Caribbean and South America, while others make the ocean "jump" from farther south, or follow the U.S. Atlantic coast for the duration of migration (Baker *et al.* 2020). Of the birds that winter on the southeast U.S. coast and/or the Caribbean (considered short-distance migrants), a small proportion may pass through the Wind Development Area during migration, and are thus at higher likelihood of exposure than the

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[3] https://www.fws.gov/verobeach/StatusoftheSpecies.html

segment of the population wintering in South America, for example, that set out further north and make longer migrations flights (Loring *et al.* 2018). While at stopover locations, Red Knots make local movements (e.g., commuting flights between foraging locations related to tidal changes), but are thought to remain within 5 km (3 miles) of shore (Burger *et al.* 2011).

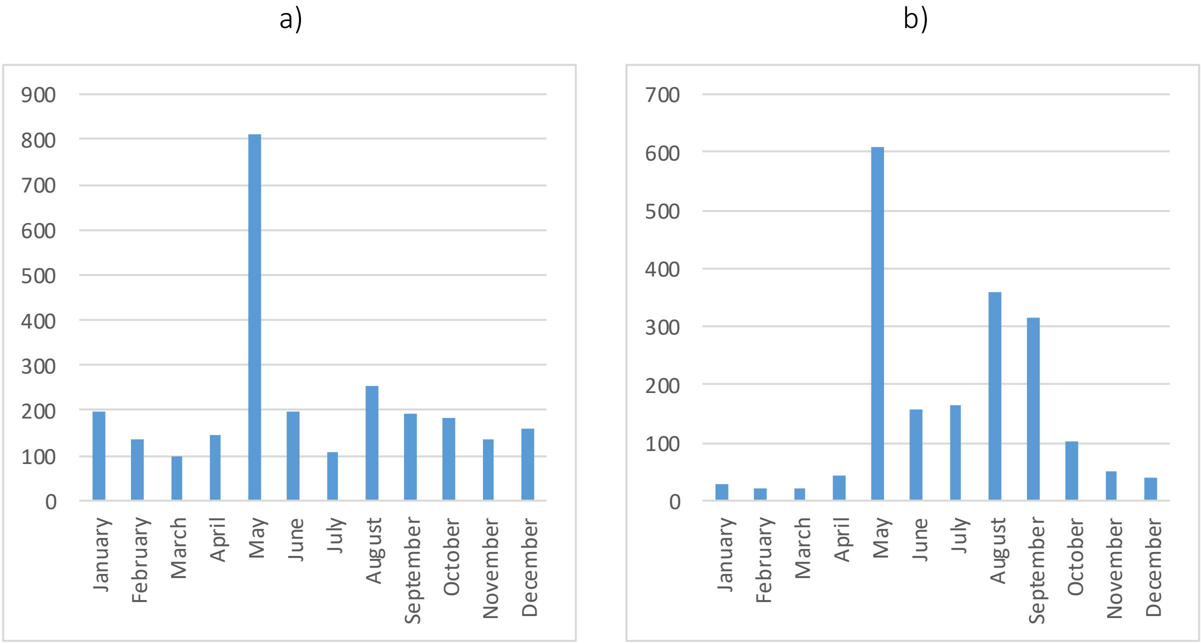

Figure 3-8: eBird records of Red Knot in (a) North Carolina and (b) Virginia.

3.2.3.3.2.2 *Exposure Assessment*

Exposure was assessed using species accounts and individual tracking data. Red Knot exposure to the Wind Development Area is limited to migration. The Seabird Catalog did not have any records of Red Knots in the vicinity of the Wind Development Area. In the telemetry study with receivers to the north of the Wind Development Area, few of the tagged Red Knots were estimated to pass through the lease area in Virginia (Loring *et al.* 2018). Migration flights are generally undertaken at night, but in fair weather conditions, which may reduce risk of collision (Loring *et al.* 2018). Overall, there is no habitat for the species in the Wind Development Area, and the expected exposure to individuals of this species is ***minimal*** to ***low***.

3.2.3.3.2.3 *Relative Behavioral Vulnerability Assessment*

During long-distance flights, Red Knots are generally considered to migrate at flight heights well above the RSZ (Burger *et al.* 2012), reducing exposure to collisions with turbines, construction equipment, or other structures. Flight heights during long-distance migrations are thought to normally be 1,000–3,000 m, except during takeoff and landing at terrestrial locations (Burger *et al.* 2011); however, Red Knots likely adjust their altitude to take advantage of local weather conditions, including flying at lower altitudes in headwinds (Baker *et al.* 2020), or during periods of poor weather and high winds (Burger *et al.* 2011). Flight heights during migration are thought to be well above the RSZ for the group of Red Knots that are long-distance migrants, but there is potential for exposure to collision for shorter-distance migrants that may traverse the Project vicinity within the RSZ, particularly during the fall (Loring *et al.* 2018). During shorter coastal migration flights, Red Knots are more likely to fly within the RSZ (Loring *et al.* 2018), but they have good visual acuity and maneuverability in the air, and there is no evidence to suggest that they are particularly vulnerable to collisions. The Final Vineyard Wind 1 Biological Assessment prepared by BOEM for USFWS estimated that Red Knot mortality from collision would be zero and that the likelihood of collision fatalities would be "insignificant and discountable" (BOEM 2019a). For these reasons, Red Knots have ***low*** vulnerability to collision with construction equipment or turbines.

While there is little data on displacement for this species, avoidance behavior offshore is not likely to lead to habitat loss; thus, Red Knots are considered to have ***minimal*** vulnerability to displacement during turbine construction and operation and are unlikely to be significantly affected by Project activities, including boat traffic, unless that boat traffic occurs very near beaches or stopover feeding areas.

3.2.3.3.2.4 Risk

Given that Red Knot exposure will be limited to migration and that these birds have minimal to low vulnerability, individual level impacts during construction and operation are expected to be ***minimal*** to ***low***. While these birds are federally and state listed, they received a medium population vulnerability score because of low score in adult survival. Therefore, the final risk score was not adjusted.

3.2.4 Wading Birds

3.2.4.1 Spatiotemporal Context

Most long-legged wading birds (such as herons and egrets) breed and migrate in coastal and inland areas. Like the smaller shorebirds, wading birds are coastal breeders and foragers and generally avoid straying out over deep waters (Kushlan & Hafner 2000). Most long-legged waders breeding along the U.S. Atlantic coast migrate south to the Gulf coast, the Caribbean islands, or Central or South America, thus they are capable of crossing large areas of ocean and may traverse the Wind Development Area during spring and fall migration periods. The IPaC database did not indicate any wading birds in the Wind Development Area or adjacent waters.

3.2.4.2 Exposure Assessment

Exposure was assessed using species accounts and baseline survey data. Exposure to construction and operation is considered to be ***minimal*** because wading birds spend a majority of the year in freshwater aquatic systems and near-shore marine systems; furthermore, the BOEM SAB and Kitty Hawk APEM aerial surveys reported no wading bird observations in the Wind Development Area. In addition, there were few observations of species within this group offshore during all seasons (Figure 3-9). Due to the assessment of minimal exposure, a vulnerability and risk assessment was not conducted.

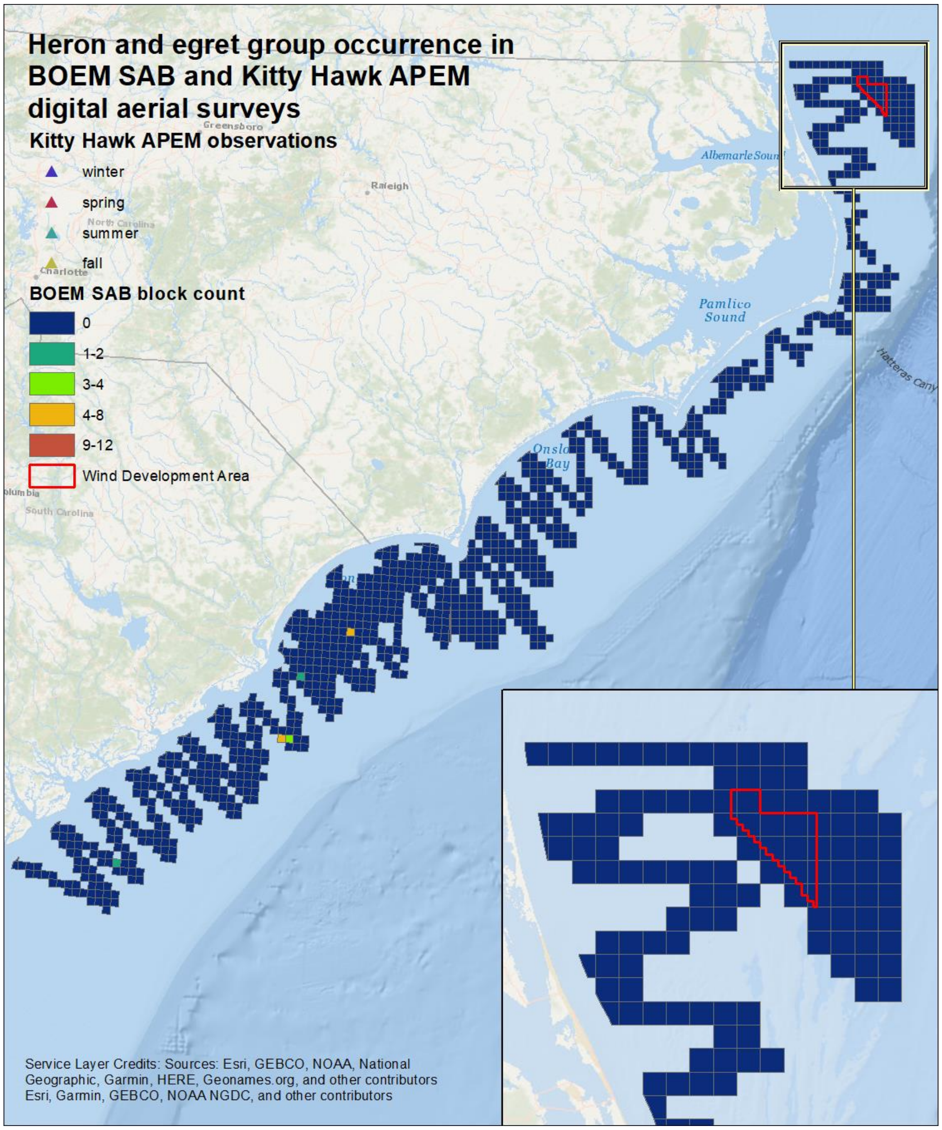

Figure 3-9: Herons and egrets observed during the BOEM SAB and Kitty Hawk APEM surveys.

3.2.5 Raptors

3.2.5.1 Spatiotemporal Context

Limited data exists documenting the use of offshore habitats by diurnal and nocturnal raptors in North America. The degree to which raptors might occur offshore will be dictated in large part by their morphology and flight strategy (i.e., flapping vs. soaring), which influences species' ability or willingness to cross large expanses of open water where thermal formation is poor (Kerlinger 1985). Interactions between raptors and offshore structures are likely to be predominantly limited to migration. Of the raptors in eastern North America, the eagles, *Buteo* hawks, and large *Accipiter* hawks (i.e., Northern Goshawks [*Accipiter gentilis*]) are rarely observed offshore (DeSorbo *et al.* 2012, DeSorbo, Persico, *et al.* 2018). The Sharp-shinned Hawk (*A. striatus*), Cooper's Hawk (*A. cooperii*), Northern Harrier (*Circus hudsonius*), American Kestrel (*Falco sparverius*), and Osprey (*Pandion haliaetus*) have all been observed at offshore islands regularly during migration, but generally in low numbers (DeSorbo *et al.* 2012, DeSorbo, Persico, *et al.* 2018). Of the common owl species, the larger species (Barred Owl [*Strix varia*] and Great-horned Owl [*Bubo virginianus*]) are generally considered to avoid the offshore environment. Northern Saw-whet Owls (*Aeqolius acadicus*) have been documented at coastal islands in Maine and Rhode Island during migration (DeSorbo et al. 2012), and winter in the mid-Atlantic (Rasmussen et al. 2008). Long-eared Owls (*Asio otus*) also migrate along the coast and winter in the mid-Atlantic (Marks et al. 1994).

Among raptors, falcons are the most likely to be encountered in offshore settings (Cochran 1985, DeSorbo *et al.* 2012, DeSorbo, Persico, *et al.* 2018). Merlins (*Falco columbarius*) are the most abundant diurnal raptor observed at offshore islands during fall migration (DeSorbo *et al.* 2012, DeSorbo, Persico, *et al.* 2018). Peregrine Falcons (*F. peregrinus*) fly hundreds of kilometers offshore during migration, and have been observed on vessels and oil drilling platforms considerable distances from shore (McGrady *et al.* 2006, Johnson, Storrer, *et al.* 2011, Voous 1961, DeSorbo *et al.* 2015). Recent individual tracking studies in the eastern U.S. indicate that migrating Peregrine Falcons (predominantly hatching year birds), likely originating from breeding areas in the Canadian Arctic and Greenland, commonly use offshore habitats during fall migration (Figure 3-11; DeSorbo et al. 2015, 2018c), while breeding adults from New Hampshire either used inland migration routes or were non-migratory (DeSorbo, Martin, *et al.* 2018).

Ospreys exhibit a wing morphology that enables open water crossings (Kerlinger 1985) and some individuals birds will fly offshore (Bierregaard 2019); however, satellite telemetry data from Ospreys breeding in New England and the mid-Atlantic suggest these birds generally follow coastal or inland migration routes and are unlikely to be exposed the Wind Development Area (Figure 3-12). Bald Eagles (*Haliaeetus leucocephalus*) are federally protected under the BGEPA and are addressed separately in detail below.

3.2.5.2 Exposure Assessment

Exposure for raptors was assessed using species accounts, baseline survey data, and individual tracking data. Only one unidentified hawk was reported during the Kitty Hawk APEM surveys, outside the northwest corner of the Wind Development Area (Figure 3-10). However, individual tracking data and species accounts indicate that falcons fly within the vicinity of the Wind Development Area. Therefore, the exposure is considered ***low*** for falcons because tracking data indicates they may pass through offshore waters in North Carolina and Virginia, and there is potential that falcons could be exposed to the Wind Development Area. Falcons may be attracted to turbines as offshore perching and hunting sites, which may increase temporal exposure during migration.

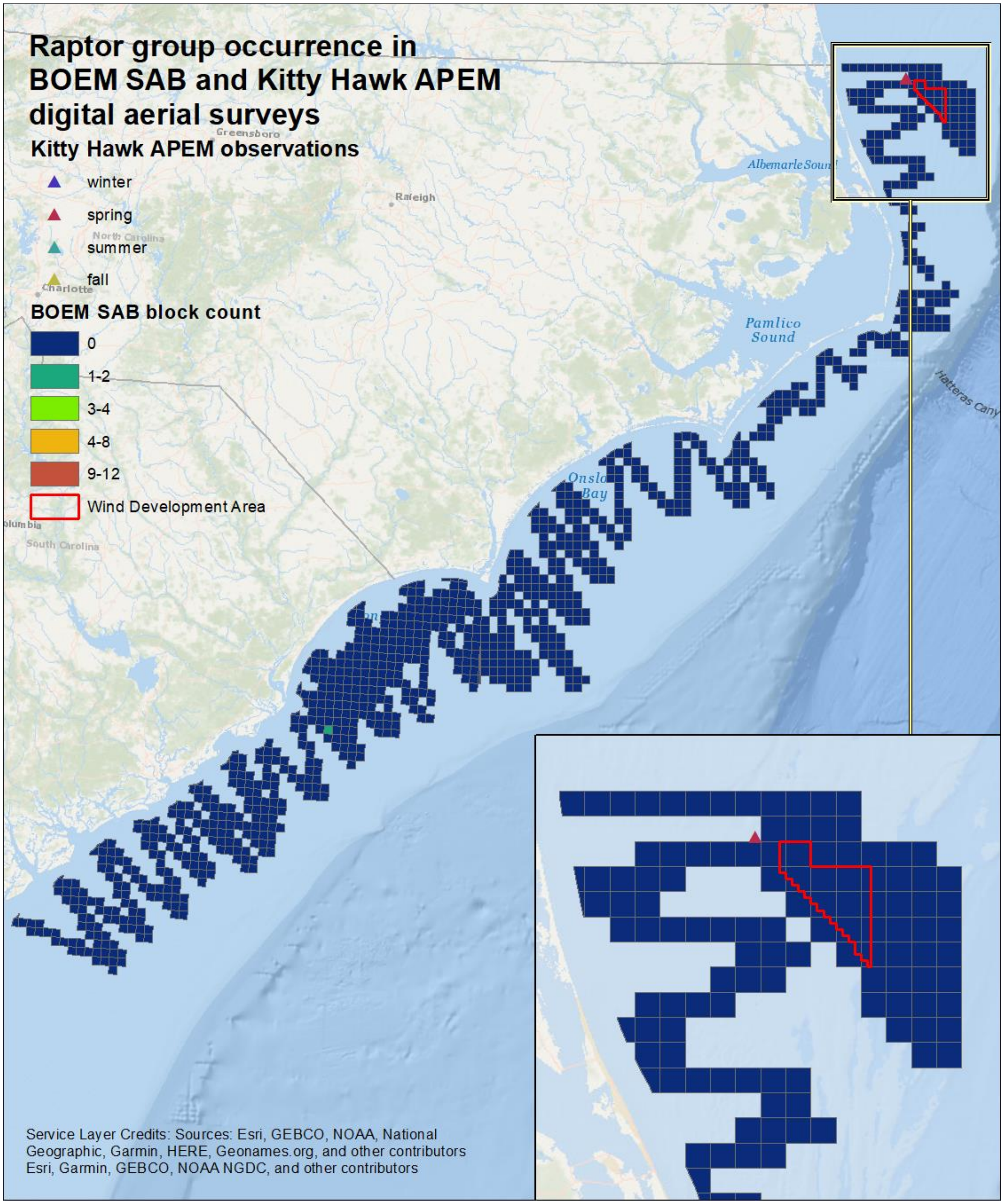

Figure 3-10: Raptors observed during the BOEM SAB and Kitty Hawk APEM surveys.

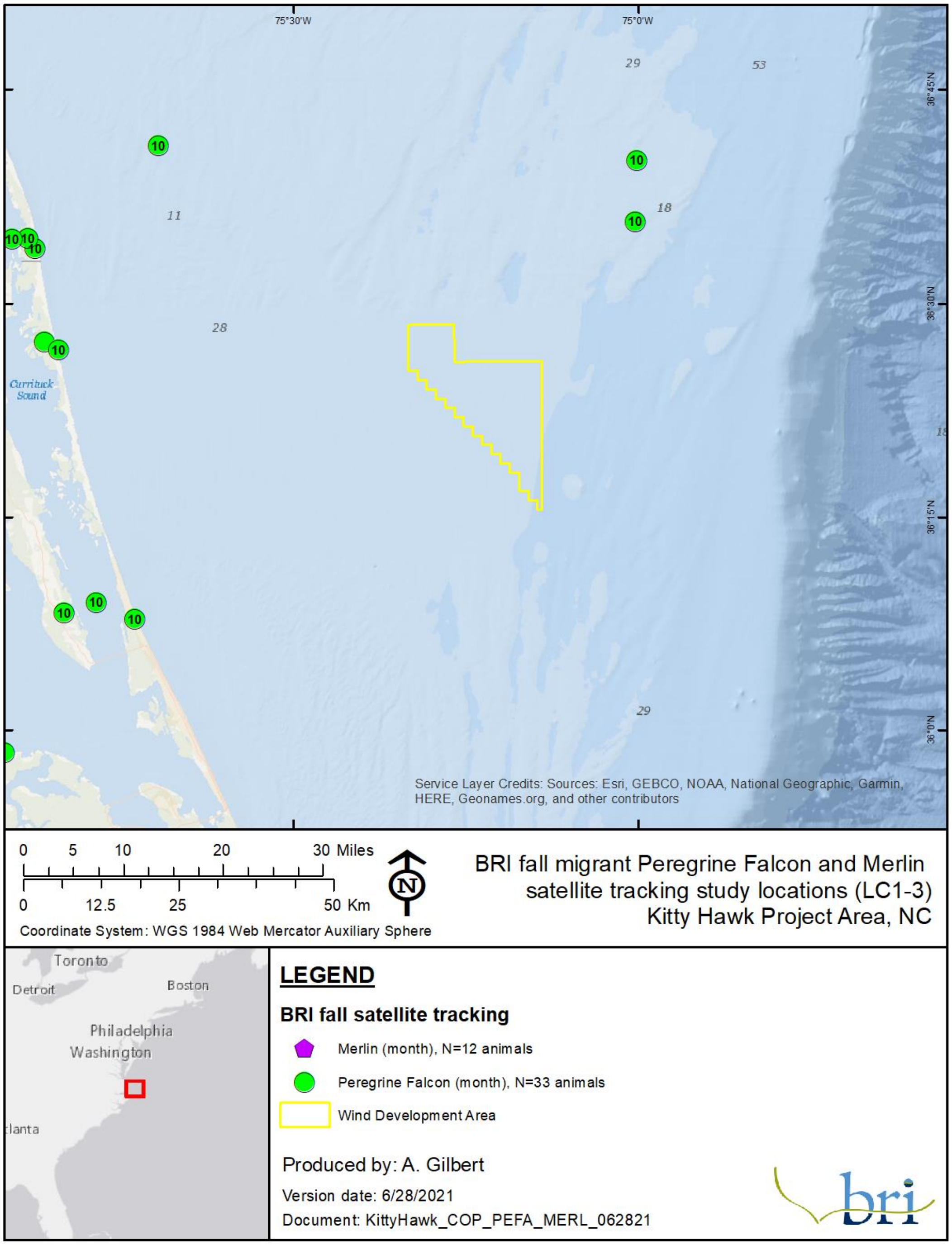

Figure 3-11: Location estimates from satellite transmitters instrumented to Peregrine Falcons and Merlins tracked from three raptor research stations along the Atlantic coast, 2010 – 2018. Research stations include Block Island, Rhode Island, Monhegan Island, Maine and Cutler, Maine. The number shown in points represents the month in which the location estimate was fixed.

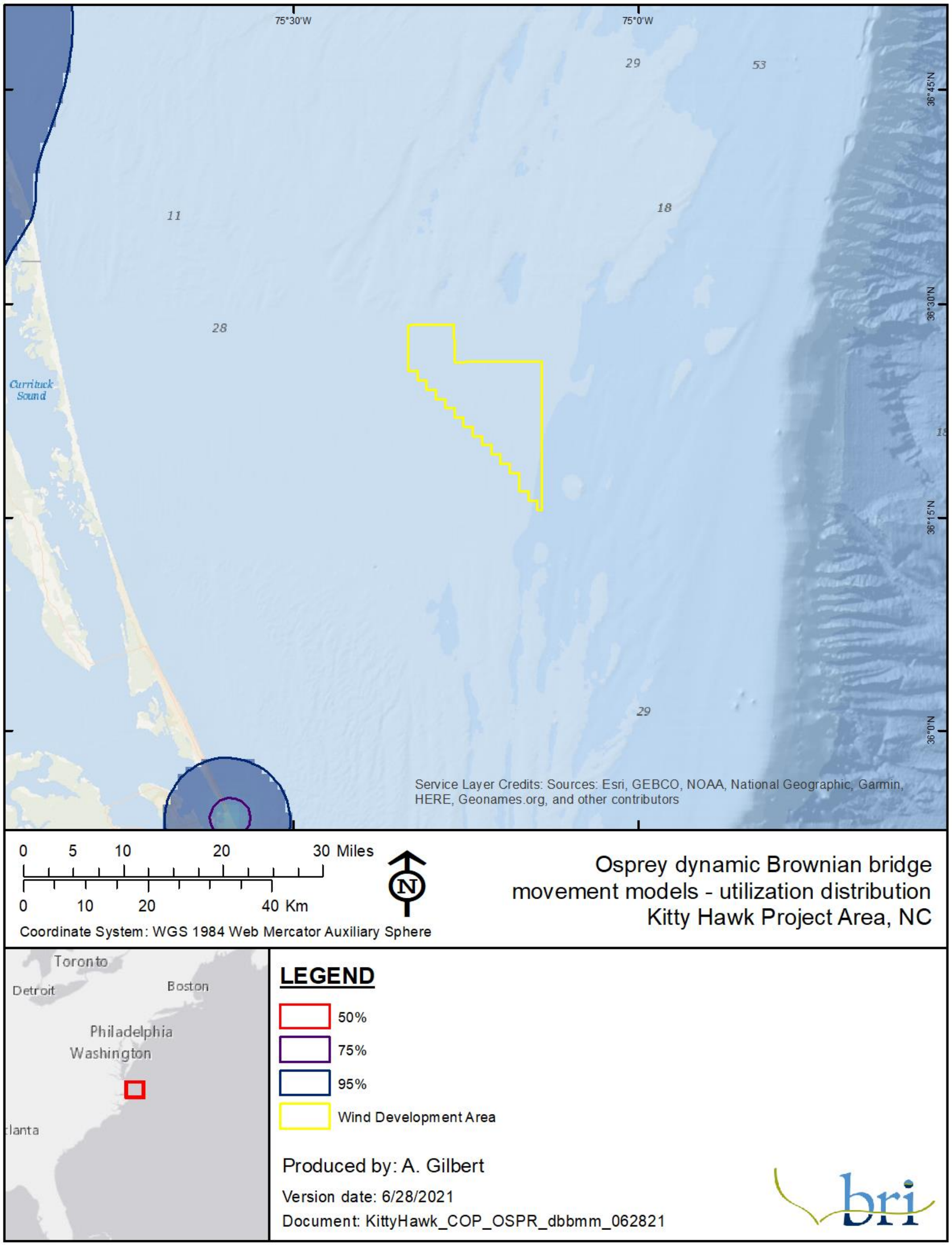

Figure 3-12: Dynamic Brownian bridge movement models for Osprey (n=127) that were tracked with satellite transmitters; the contours represent the percentage of the use area across the UD surface and represent various levels of use from 50 (core use) to 95 percent (home range).

3.2.5.3 Relative Behavioral Vulnerability Assessment

Raptors are commonly attracted to high perches for resting, roosting, or vantage points to survey for potential prey. A radar and laser rangefinder study found evidence that multiple migrating raptor species were attracted to offshore WTGs in Denmark (Skov *et al.* 2016), and falcons were observed regularly hunting and perching at an offshore wind facility in the Netherlands (Krijgsveld *et al.* 2011). Peregrine Falcons and Common Kestrels (*Falco tinnunculus*) have been observed landing on the platform deck of offshore WTGs (Skov *et al.* 2016, Hill *et al.* 2014); however, Peregrine Falcon mortalities have not been documented at European offshore wind developments. There are accounts of Peregrine Falcon mortalities associated with terrestrial-based WTGs in Europe (Hötker *et al.* 2006, Meek *et al.* 1993, Dürr 2011) and the U.S. (Mizrahi et al. 2009; T. French, MassWildlife, personal communication). However, carcasses were not detected in post-construction mortality studies at several projects with falcon activity (Bull *et al.* 2013, DiGaudio & Geupel 2014, Hein *et al.* 2013). Evidence of nocturnal soaring, perching, and feeding under lighted structures in terrestrial and offshore settings has been noted in Peregrine Falcons (Cochran, 1975; Johnson et al., 2011; Kettel et al., 2016; Voous, 1961), and these behaviors increase the exposure risk in this species. However, observations of raptors at the Anholt Offshore Wind Farm in the Baltic Sea (20 km from the coast) indicate avoidance behavior (13–59 percent of birds observed depending on the species), which has the potential to cause a barrier for migrants in some locations, but also may reduce collision risk. The percentage of Merlins and American Kestrels showing macro/meso avoidance behavior was 14/36 percent and 46/50 percent, respectively (Jacobsen *et al.* 2019).

Based on the above evidence, falcon vulnerability to collision during construction and operation is considered to be ***low*** to ***medium***, and vulnerability to displacement is ***minimal*** to ***low***. Since there is little data available on raptor response during construction, the behavioral vulnerability is considered the same for each development phase.

3.2.5.4 Risk Analysis

Risk of potential impacts to non-falcon raptor populations is considered ***minimal*** due to their ***minimal*** exposure. Risk of population level impacts to falcons is considered ***low*** because falcons have low exposure and low to medium vulnerability. For this species group, a population vulnerability assessment was not conducted. However, considerable uncertainty exists about what the proportion of migrating falcons, particularly Peregrine Falcons, might be attracted to offshore wind energy projects for perching, roosting and foraging, and the extent to which individuals might avoid turbines or collide with them.

3.2.6 Eagles

3.2.6.1 Spatiotemporal Context

Both Bald Eagles and Golden Eagles are federally protected under the BGEPA. The Bald Eagle is broadly distributed across North America. This species generally nests and perches in association with water (lakes, rivers, bays) in both freshwater and marine habitats, often remaining within roughly 500 m of the shoreline (Buehler 2020). Bald Eagles are year-round residents in both Virginia and North Carolina (Watts *et al.* 2007, LeGrand, Haire, *et al.* 2020). Bald Eagles were rarely observed in digital aerial surveys of the mid-Atlantic offshore region (all observations 6 km from shore; Williams et al. 2015b), and no eagles were observed during the baseline surveys.

The Golden Eagle (*Aquila chrysaetos*) is generally associated with open habitats, particularly in the western U.S., but satellite-tracked individuals wintering in the eastern U.S. have also been documented to heavily utilize forested regions (Katzner *et al.* 2012). Golden Eagles commonly winter in the southern Appalachians and are regularly observed in the mid-Atlantic U.S., spanning coastal plain habitat in Virginia, Delaware, North Carolina, South Carolina, and other southeastern states.

The general morphology of both Bald Eagles and Golden Eagles dissuades long-distance movements in offshore settings (Kerlinger 1985). These two species generally rely upon thermal formation, which develop poorly over the open ocean, during long-distance movements.

3.2.6.2 Exposure

Exposure was assessed using species accounts, tracking studies, and knowledge of eagle wing morphology. Golden Eagle exposure to the Wind Development Area is expected to be ***minimal*** due to their limited distribution in the eastern U.S., and reliance on terrestrial habitats. Bald Eagle exposure to the Wind Development Area is also expected to be ***minimal*** because the Wind Development Area is not located along any likely or known Bald Eagle migration route, and they tend not to fly over large waterbodies. No eagles were observed during the BOEM SAB and Kitty Hawk APEM surveys.

3.2.6.3 Relative Behavioral Vulnerability Assessment

Although there is little research on eagle interactions with offshore developments, eagles are expected to have ***minimal*** vulnerability to collision and displacement to offshore wind facilities. Bald Eagles and Golden Eagles are not expected to forage over the Wind Development Area or use the area during migration.

3.2.6.4 Risk Analysis

Since exposure is expected to be minimal for both eagle species, the individual level impacts during construction and operation are expected to be ***minimal***. A population vulnerability assessment was not done for eagles because they have minimal exposure and vulnerability and no mortality or displacement is anticipated.

3.2.7 Songbirds

3.2.7.1 Spatiotemporal Context

Songbirds almost exclusively use terrestrial, freshwater, and coastal habitats, and do not use the offshore marine system except during migration. Many North American breeding songbirds migrate to tropical regions. On their migrations, these neotropical migrants generally travel at night and at high altitudes where favorable winds can aid them along their trip.

Landbird migration may occur across broad geographic areas, rather than in narrow flyways as have been described for some waterbirds (Faaborg *et al.* 2010). Evidence for a variety of species suggests that overwater migration in the Atlantic is much more common in fall (than in spring), when the frequency of overwater flights increases perhaps due to consistent tailwinds (e.g. see Morris et al. 1994, Hatch et al. 2013, Adams et al. 2015, DeLuca et al. 2015).

Songbirds regularly cross large bodies of water (Bruderer & Lietchi 1999, Gauthreaux & Belser 1999), and there is some evidence that species migrate over large areas of the Northwestern Atlantic (Adams *et al.* 2015). Some birds may briefly fly over the water, while others, like the Blackpoll Warbler (*Setophaga striata*), can migrate over vast expanses of ocean (Faaborg *et al.* 2010, DeLuca *et al.* 2015).

Migrating songbirds have been detected at or in the vicinity of smaller offshore wind developments in Europe (Kahlert *et al.* 2004, Krijgsveld *et al.* 2011, Pettersson & Fågelvind 2011) and may have greater passage rates during the middle of the night (Huppop & Hilgerloh 2012). While the IPaC database did not indicate any songbirds in the Wind Development Area or adjacent waters, evidence from the literature indicates some songbirds migrate offshore in Virginia and North Carolina.

3.2.7.2 Exposure Assessment

Exposure for songbirds was assessed using species accounts, baseline survey data, and literature. Exposure to construction and operation is considered to be ***minimal*** to ***low*** because songbirds have limited spatial and temporal exposure, they do not use the offshore marine system as habitat, and there is little evidence of songbird use of the Wind Development Area outside of the migratory periods. While not designed specifically to detect small songbirds, the BOEM SAB and Kitty Hawk APEM surveys had few detections of passerines, and none in the Wind Development Area (Figure 3-13).

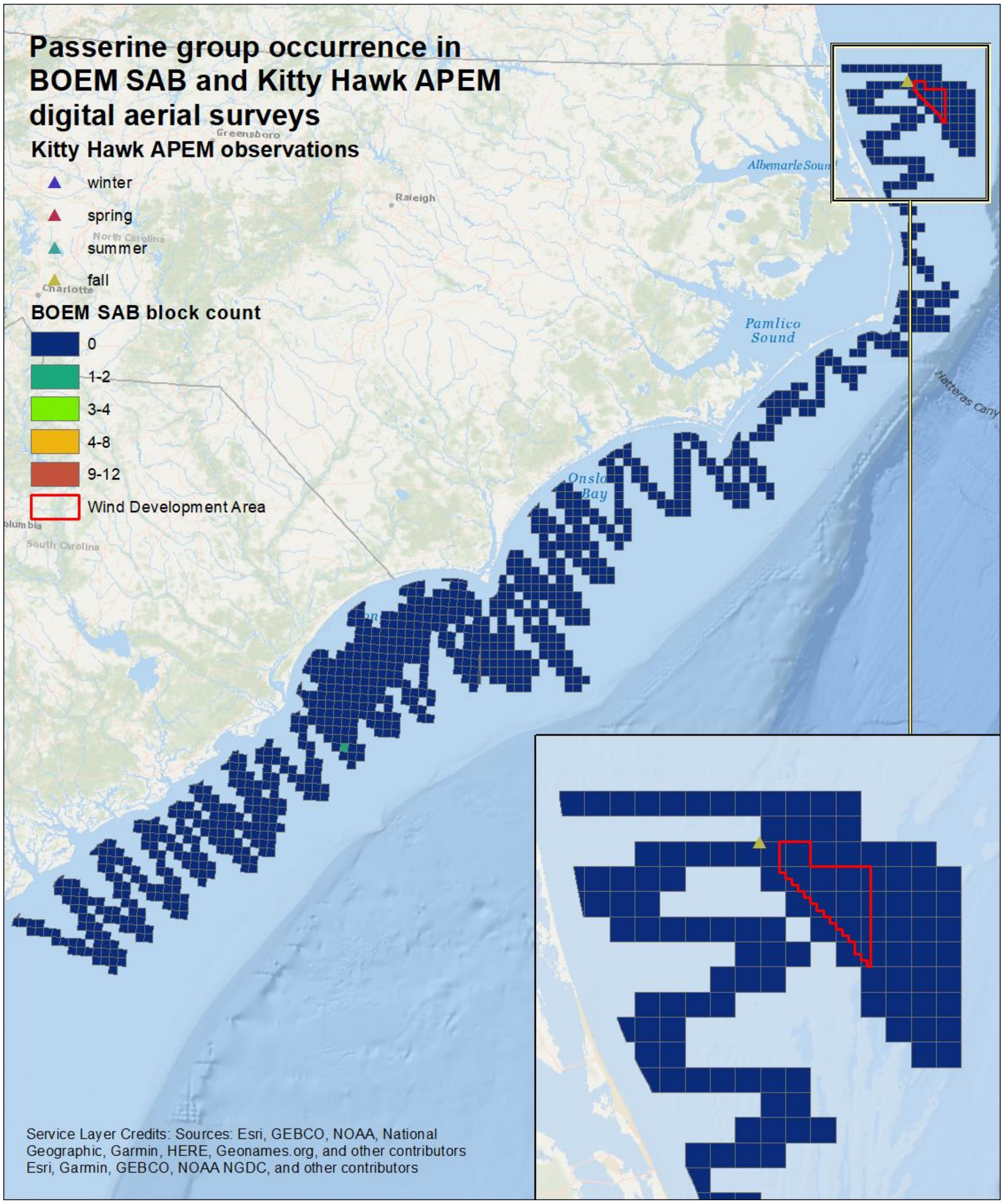

Figure 3-13: Songbirds (passerines) observed during the Kitty Hawk APEM surveys.

3.2.7.3 Relative Behavioral Vulnerability Assessment

If exposed to offshore WTGs, some songbirds may be vulnerable to collision. In some instances, songbirds may be able to avoid colliding with offshore WTGs (Petersen *et al.* 2006), but they are known to collide with illuminated terrestrial and marine structures (Fox *et al.* 2006). Movement during low visibility periods creates the highest collision risk conditions (Hüppop *et al.* 2006).

While terrestrial avian fatality rates range from 3–6 birds per megawatt per year (Allison *et al.* 2019), direct comparisons between mortality rates recorded at terrestrial and offshore wind developments should be made with caution because collisions with offshore WTGs could be lower either due to differing behaviors or lower exposure (NYSERDA 2015). At Nysted, Denmark, in 2,400 hours of monitoring with an infrared video camera, only one collision of an unidentified small bird was detected (Petersen *et al.* 2006). At the Thanet Offshore Wind Farm, thermal imaging did not detect any songbird collisions (Skov *et al.* 2018).

Songbirds typically migrate at heights between 90–600 m (NYSERDA 2010), but can fly lower during inclement weather or when there are headwinds. In a study in Sweden, nocturnal migrating songbirds flew on average at 330 m above the ocean during the fall and 529 m during the spring (Pettersson 2005). Based on the above evidence, the risk to songbirds is limited to collision with WTGs, and songbird vulnerability to collision during construction and operation is considered to be ***low*** to ***medium***.

3.2.7.4 Risk Analysis

This analysis suggests that the potential population-level impacts to songbirds is ***minimal*** to ***low*** because, while these birds have low to medium vulnerability to collision, they have minimal to low exposure, both spatially and temporally. Despite this recognized vulnerability, and for overall context, the mortality of songbirds from all terrestrial WTGs in the U.S. and Canada combined is predicted to have only a small effect on passerine populations (Erickson *et al.* 2014).

3.2.8 Marine Birds

Marine bird distributions are generally more pelagic and widespread than coastal birds. A total of 83 marine bird species are known to regularly occur off the Atlantic coast of the U.S. (Nisbet *et al.* 2013). Many of these marine bird species use the Wind Development Area during multiple time periods, either seasonally or year-round, including loons, storm-petrels and shearwaters, gannets, gulls, terns, and auks. The IPaC database indicated that Common Loon (*Gavia immer*), Northern Gannet (*Morus bassanus*), Audubon's Shearwater (*Puffinus lherminieri*), Cory's Shearwater (*Calonectris diomedea*), Great Shearwater (*Ardenna gravis*), Manx Shearwater (*Puffinus puffinus*), Northern Fulmar (*Fulmarus glacialis*), Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Wilson's Storm-Petrel (*Oceanites oceanicus*), Black-legged Kittiwake (*Rissa tridactyla*), Bonaparte's Gull (*Chroicocephalus philadelphia*), Great Black-backed Gull (*Larus marinus*), Herring Gull (*L. argentatus*), Ring-billed Gull (*L. delawarensis*), Dovekie (*Alle alle*), Red Phalarope, and Red-necked Phalarope may be present in the Wind Development Area and adjacent waters.

In the following sections, the assessments for major taxonomic groups of marine birds are reviewed, including discussions of their exposure (summarized in Table 3-5) and their vulnerability (summarized in Table 3-6. At the end of this offshore section, Table 3-28 shows the species-specific densities by season as a supplement.

Table 3-5: Annual exposure scores for each marine bird species in each taxonomic grouping.

Species Name	Scientific Name	Annual Species Exposure Score
Sea Ducks		
Black Scoter	*Melanitta americana*	0
Common Eider	*Somateria mollissima*	4
Long-tailed Duck	*Clangula hyemalis*	0
Red-breasted Merganser	*Mergus serrator*	0
Surf Scoter	*Melanitta perspicillata*	1
White-winged Scoter	*Melanitta fusca*	0
Skuas and Jaegers		
Great Skua	*Stercorarius skua*	0
Parasitic Jaeger	*Stercorarius parasiticus*	2
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*	0
Dovekie	*Alle alle*	0
Razorbill	*Alca torda*	0
Thick-billed Murre	*Uria lomvia*	0
Small Gulls		
Bonaparte's Gull	*Chroicocephalus philadelphia*	4
Little Gull	*Hydrocoloeus minutus*	0
Medium Gulls		
Black-legged Kittiwake	*Rissa tridactyla*	0
Laughing Gull	*Leucophaeus atricilla*	0
Ring-billed Gull	*Larus delawarensis*	1
Large Gulls		
Glaucous Gull	*Larus hyperboreus*	0
Great Black-backed Gull	*Larus marinus*	0
Herring Gull	*Larus argentatus*	0
Iceland Gull	*Larus glaucoides*	0
Lesser Black-backed Gull	*Larus fuscus*	0
Small Terns		
Black Tern	*Chlidonias niger*	0
Least Tern	*Sternula antillarum*	0
Medium Terns		
Arctic Tern	*Sterna paradisaea*	0
Bridled Tern	*Onychoprion anaethetus*	1
Common Tern	*Sterna hirundo*	2
Forster's Tern	*Sterna forsteri*	0
Gull-billed Tern	*Gelochelidon nilotica*	0
Roseate Tern	*Sterna dougallii*	2
Royal Tern	*Thalasseus maximus*	0
Sandwich Tern	*Thalasseus sandvicensis*	0
Sooty Tern	*Onychoprion fuscatus*	0
Large Terns		
Caspian Tern	*Hydroprogne caspia*	0

Species Name	Scientific Name	Annual Species Exposure Score
Loons		
Common Loon	*Gavia immer*	6
Red-throated Loon	*Gavia stellata*	1
Storm-Petrels		
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	0
Wilson's Storm-Petrel	*Oceanites oceanicus*	0
Shearwaters and Petrels		
Audubon's Shearwater	*Puffinus lherminieri*	0
Black-capped Petrel	*Pterodroma hasitata*	0
Cory's Shearwater	*Calonectris diomedea*	1
Great Shearwater	*Ardenna gravis*	0
Manx Shearwater	*Puffinus puffinus*	0
Northern Fulmar	*Fulmarus glacialis*	0
Sooty Shearwater	*Ardenna grisea*	0
Gannet		
Northern Gannet	*Morus bassanus*	2
Cormorants		
Double-crested Cormorant	*Phalacrocorax auritus*	1
Pelicans		
American White Pelican	*Pelecanus erythrorhynchos*	0
Brown Pelican	*Pelecanus occidentalis*	0

[1] Minimal = 0–2, Low = 3–5, Medium = 6–8, and High = 9–12.

Table 3-6: Vulnerability assessment rankings by species within each broad taxonomic grouping.

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Sea Ducks			
Surf Scoter	low (0.3)	high (0.9)	medium (0.67)
White-winged Scoter	low (0.37)	high (0.8)	medium (0.67)
Black Scoter	low (0.27)	high (0.9)	low (0.47)
Long-tailed Duck	low (0.33)	high (0.9)	low (0.4)
Red-breasted Merganser	medium (0.53)	medium (0.5)	low (0.27)
Skuas and Jaegers			
Pomarine Jaeger	medium (0.6)	low (0.3)	low (0.4)
Parasitic Jaeger	medium (0.6)	low (0.3)	low (0.4)
Auks			
Dovekie	low (0.27)	medium (0.7)	low (0.4)
Razorbill	low (0.27)	high (0.8)	medium (0.6)
Atlantic Puffin	minimal (0.2)	high (0.8)	medium (0.53)
Small Gulls			
Bonaparte's Gull	low (0.47)	medium (0.5)	low (0.33)
Medium Gulls			
Black-legged Kittiwake	low (0.43)	medium (0.6)	low (0.4)
Laughing Gull	low (0.47)	medium (0.5)	low (0.47)
Ring-billed Gull	medium (0.67)	low (0.4)	low (0.33)
Large Gulls			
Herring Gull	medium (0.7)	medium (0.5)	medium (0.53)
Great Black-backed Gull	medium (0.63)	medium (0.7)	minimal (0.2)
Medium Terns			
Roseate Tern	· (·)	high (0.8)	medium (0.73)

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Common Tern	low (0.3)	high (0.8)	medium (0.6)
Forster's Tern	low (0.43)	medium (0.5)	medium (0.53)
Royal Tern	low (0.43)	medium (0.5)	medium (0.67)
Loons			
Red-throated Loon	low (0.47)	high (0.9)	medium (0.53)
Common Loon	low (0.33)	high (0.8)	medium (0.53)
Shearwaters and Petrels			
Northern Fulmar	low (0.43)	medium (0.6)	low (0.47)
Black-capped Petrel	· (·)	medium (0.6)	medium (0.67)
Cory's Shearwater	low (0.4)	medium (0.6)	medium (0.67)
Sooty Shearwater	low (0.33)	medium (0.6)	medium (0.53)
Great Shearwater	low (0.37)	medium (0.6)	medium (0.67)
Manx Shearwater	low (0.37)	medium (0.6)	medium (0.53)
Audubon's Shearwater	low (0.4)	medium (0.6)	medium (0.6)
Gannet			
Northern Gannet	low (0.43)	medium (0.6)	medium (0.6)
Cormorants			
Double-crested Cormorant	medium (0.73)	low (0.4)	minimal (0.13)
Pelicans			
Brown Pelican	low (0.4)	medium (0.5)	medium (0.53)

3.2.8.1 Sea Ducks

3.2.8.1.1 Spatiotemporal Context

Sea ducks are northern or Arctic breeders that use Atlantic OCS waters heavily in winter (Silverman *et al.* 2013). Most sea ducks forage on mussels and/or other benthic invertebrates, and generally winter in shallow inshore waters or out over large offshore shoals where they can access prey. Sea ducks tracked with satellite transmitters were found primarily inshore of the Wind Development Area (Figure 3-14 to Figure 3-17).

3.2.8.1.2 Exposure Assessment

Exposure was assessed using species accounts, tracking data, baseline survey data, and MDAT models. Exposure is considered to be ***minimal*** to ***low*** based on sea duck annual exposure scores (Table 3-7), the average counts of sea ducks in the Kitty Hawk APEM surveys were generally the same as the BOEM SAB surveys (Table 3-27), and the literature indicates that sea duck exposure will be primarily limited to migration or travel between wintering sites. Note that Common Eider (*Somateria mollissima*) was the only sea duck to have a low exposure rank, which results from the MDAT models that may not be entirely accurate for this species, particularly during the spring (map 3 in Attachment B). No eiders were detected in either the BOEM SAB or Kitty Hawk APEM surveys.

Table 3-7: Seasonal exposure rankings for the sea duck group.

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

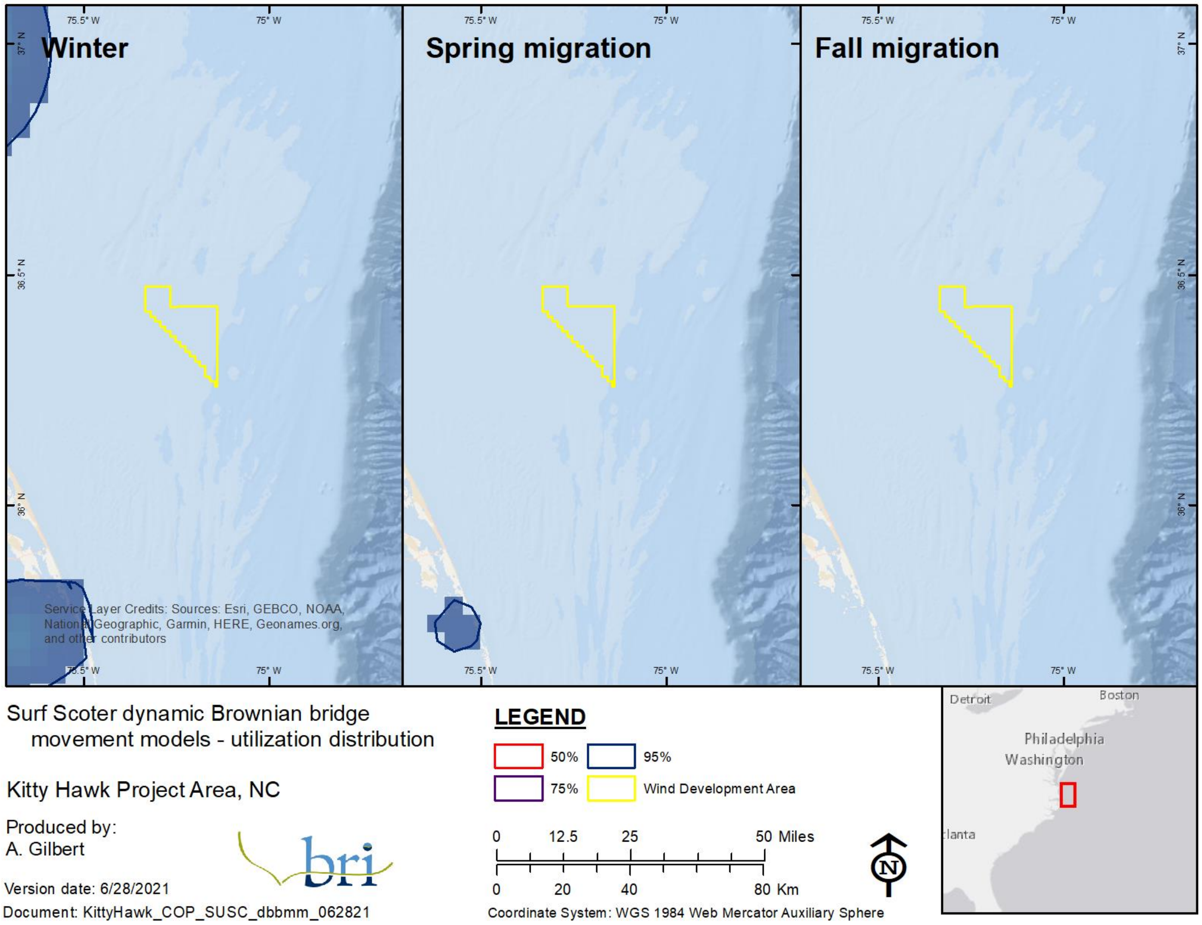

Figure 3-14: Dynamic Brownian bridge movement models for Surf Scoter (n = 78, 87, 83 [winter, spring, fall]) that were tracked with satellite transmitters. Utilization contour levels (50, 75, 95 percent) were calculated for the mean utilization distribution (UD) surface; a probability density surface showing the relative use of an area by the population of animals in this study over the period of study. 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 percent (home range). Data provided by BOEM: see section A.1.1.3.2 (p. 133).

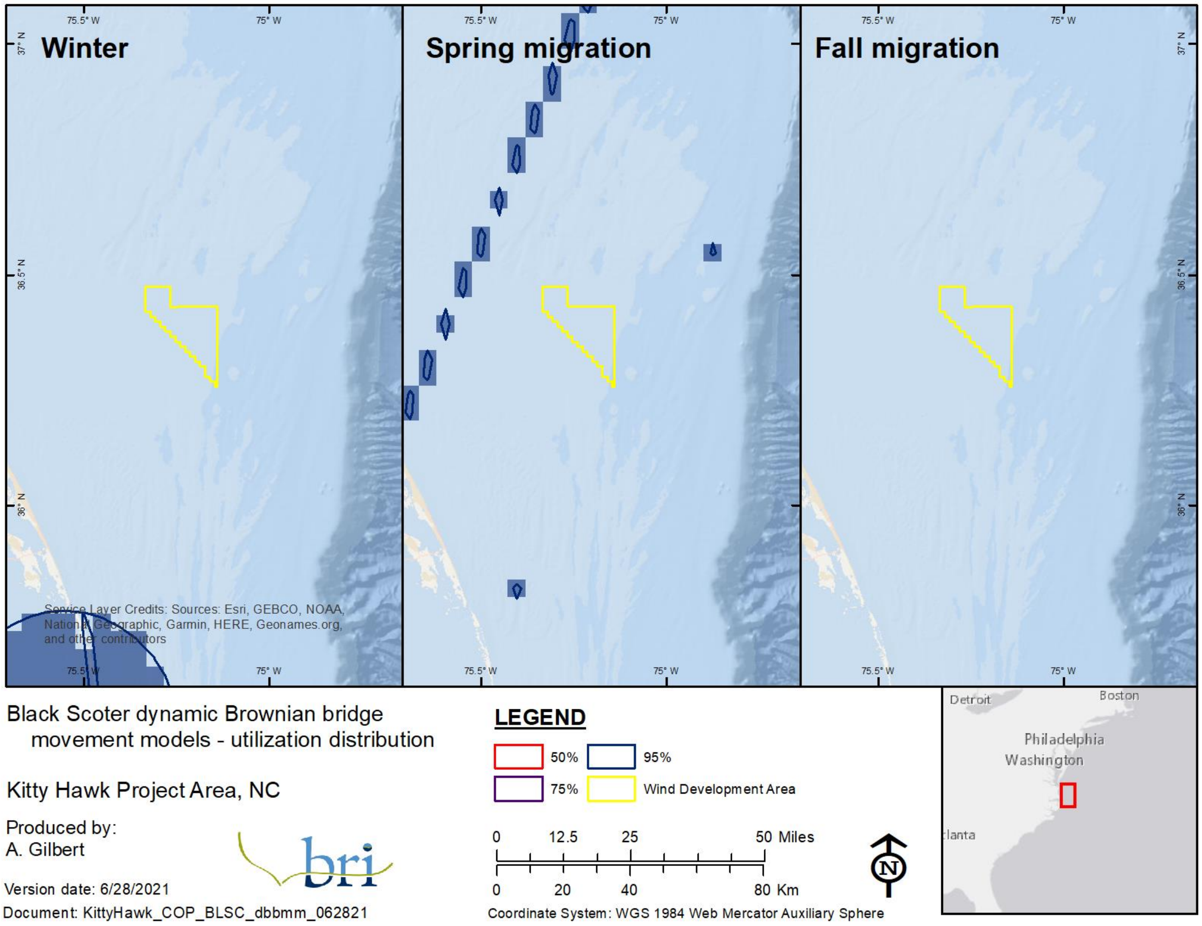

Figure 3-15: Dynamic Brownian bridge movement models for Black Scoter (n = 61, 76, 80 [winter, spring, fall]) that were tracked with satellite transmitters. Utilization contour levels (50, 75, 95 percent) were calculated for the mean utilization distribution (UD) surface; a probability density surface showing the relative use of an area by the population of animals in this study over the period of study. 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 percent (home range). Data provided by multiple sea duck researchers: see section A.1.1.3.6 (p. 135).

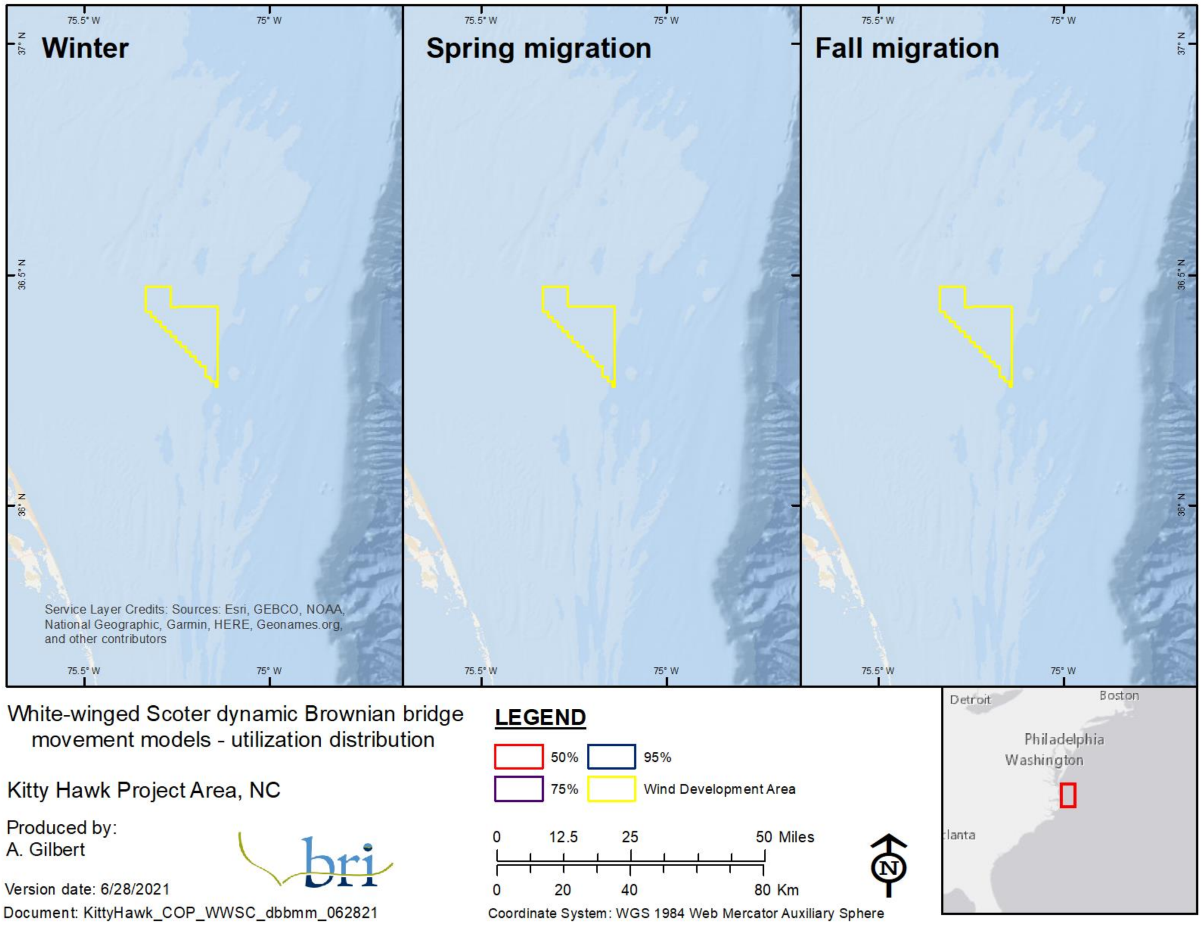

Figure 3-16: Dynamic Brownian bridge movement models for White-winged Scoter (n = 66, 45, 62 [winter, spring, fall]) that were tracked with satellite transmitters. Utilization contour levels (50, 75, 95 percent) were calculated for the mean utilization distribution (UD) surface; a probability density surface showing the relative use of an area by the population of animals in this study over the period of study. 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 percent (home range). Data provided by multiple sea duck researchers: see section A.1.1.3.6 (p. 135).

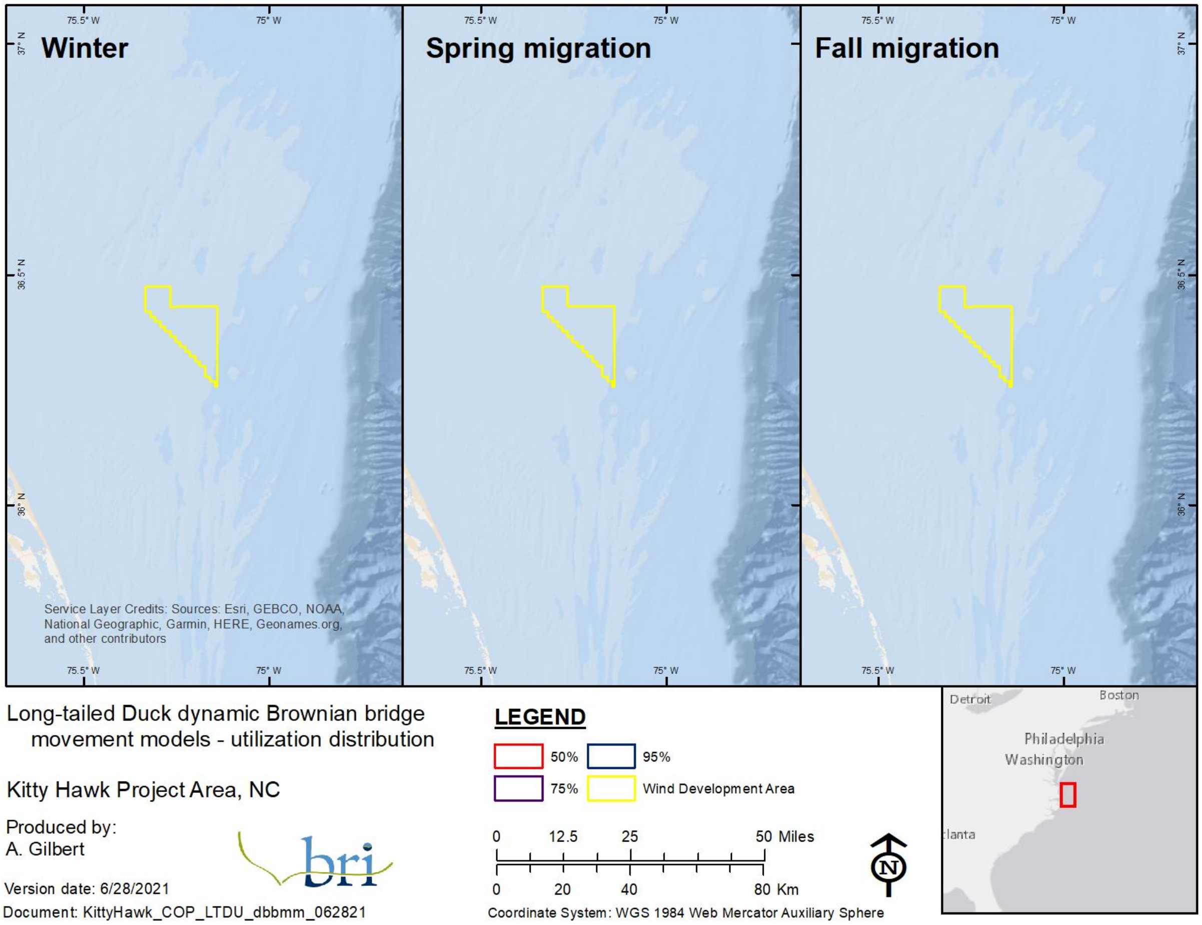

Figure 3-17: Dynamic Brownian bridge movement models for Long-tailed Duck (n = 49, 60, 37 [winter, spring, fall]) that were tracked with satellite transmitters. Utilization contour levels (50, 75, 95 percent) were calculated for the mean utilization distribution (UD) surface; a probability density surface showing the relative use of an area by the population of animals in this study over the period of study. 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 percent (home range). Data provided by multiple sea duck researchers: see section A.1.1.3.6 (p. 135).

3.2.8.1.3 Relative Behavioral Vulnerability Assessment

Sea ducks, particularly scoters, have been identified as being vulnerable to displacement (MMO 2018). Sea ducks are generally not considered vulnerable to collision (Furness *et al.* 2013), remaining primarily below the RSZ (during the day sea ducks were estimated to fly 0.2–8 percent of the time within the RSZ, depending on species; Figure 3-18). Avoidance behavior has been documented for Black Scoter (*Melanitta americana*) and Common Eider (Desholm & Kahlert 2005, Larsen & Guillemette 2007). Avoidance behavior of wind projects can lead to permanent or semi-permanent displacement, resulting in effective habitat loss (Petersen & Fox 2007, Percival 2010, Langston 2013). The high vulnerability of displacement, coupled with extensive use of the Atlantic coast during migration and wintering increases the potential for cumulative habitat loss for sea ducks (Goodale et al. 2019). However, for some species this displacement may cease several years after construction as food resources, behavioral responses, or other factors change (Petersen & Fox 2007, Leonhard *et al.* 2013).

Based on the above evidence, the risk to sea ducks is primarily displacement. From the literature, sea duck vulnerability to temporary displacement is considered to be medium to high during construction and initial operation because sea ducks are known to display a strong avoidance to offshore wind developments, and the displacement score was also ***medium*** to ***high*** (Table 3-8). However, since there is evidence of birds returning to wind facilities once they become operational, vulnerability to long-term displacement will vary by species and a lower range is added to displacement vulnerability. Since sea ducks generally fly below the RSZ and have strong avoidance behavior, collision vulnerability is ***low*** (Table 3-8).

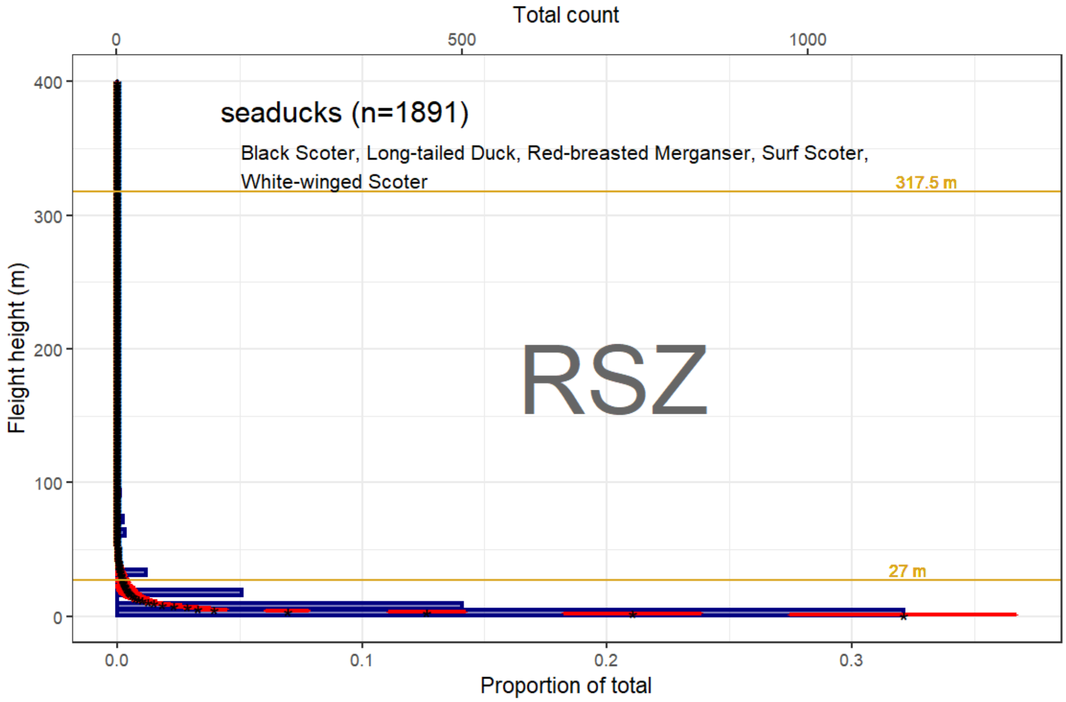

Figure 3-18: Flight heights of sea ducks (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

Table 3-8: Summary of sea duck vulnerability. Based on 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	Displacement Vulnerability	Population Vulnerability
Surf Scoter	low (0.3)	medium - high (0.9)	medium (0.67)
White-winged Scoter	low (0.37)	medium - high (0.8)	medium (0.67)
Black Scoter	low (0.27)	medium - high (0.9)	low (0.47)
Long-tailed Duck	low (0.33)	medium - high (0.9)	low (0.4)
Red-breasted Merganser	medium (0.53)	low - medium (0.5)	low (0.27)

3.2.8.1.4 Risk Analysis

This analysis suggests that the potential impacts to sea duck populations is ***minimal*** to ***low*** because, while these birds have medium to high vulnerability to displacement due to avoidance behaviors, overall, they have minimal to low exposure, both spatially and temporally. In addition, displacement from individual wind facilities is unlikely to affect populations because relatively few individuals are affected (Fox & Petersen 2019). Since sea ducks were assessed to have a low to medium population vulnerability score, the final risk score was not adjusted.

3.2.8.2 Auks

3.2.8.2.1 Spatiotemporal Context

The auk species present in the region of the proposed Project are generally northern or Arctic-breeders that winter along the U.S. Atlantic OCS. The annual abundance and distribution of auks along the U.S. Atlantic coast in winter is erratic, and is dependent upon broad climatic conditions and the availability of prey (Gaston & Jones 1998). In winters with prolonged harsh weather, which may prevent foraging for extended periods, these generally pelagic species often move inshore, or are driven considerably further south than usual. The MDAT abundance models show that auks are concentrated offshore and south of Nova Scotia (see maps in Attachment B).

3.2.8.2.2 Exposure Assessment

Exposure was assessed using species accounts, baseline survey data, and MDAT models. Exposure is considered to be ***minimal*** to ***low*** based on annual exposure scores for auks. Counts of unidentified auks were higher in the Kitty Hawk APEM surveys than the BOEM SAB surveys (Table 3-27). Based on compared bootstrap mean and 95 percent confidence intervals of count densities from the Kitty Hawk APEM and BOEM SAB digital aerial surveys (Table 3-27; see Attachment A for detailed methods), exposure was adjusted to include a higher range limit in winter and spring for Razorbill and Atlantic Puffin.

Table 3-9: Seasonal exposure rankings for auks. Based on compared bootstrap mean and 95 percent confidence intervals (CI) for densities (count/sq. km) from Kitty Hawk APEM and BOEM SAB digital aerial surveys, seasonal exposure was adjusted to include a higher range limit (orange).

Auks	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
Dovekie	Fall	0	0	0	minimal
	Summer	0	0	0	minimal
	Winter	0	0	0	minimal
	Spring	0	0	0	minimal
Common Murre	Fall	0	·	0	minimal
	Winter	0	0	0	minimal
	Spring	0	0	0	minimal
	Summer	0	·	0	minimal
Thick-billed Murre	Fall	0	·	0	minimal
	Winter	0	0	0	minimal
	Spring	0	0	0	minimal
	Summer	0	·	0	minimal
Razorbill	Summer	0	0	0	minimal
	Fall	0	0	0	minimal
	Winter	0	0	0	minimal - low
	Spring	0	0	0	minimal - low
Black Guillemot	Fall	0	·	0	minimal
	Winter	0	·	0	minimal
	Spring	0	·	0	minimal
	Summer	0	0	0	minimal
Atlantic Puffin	Spring	0	0	0	minimal - low
	Fall	0	0	0	minimal
	Summer	0	0	0	minimal
	Winter	0	0	0	minimal - low

3.2.8.2.3 Relative Behavioral Vulnerability Assessment

Auks are considered to be vulnerable to displacement, but not collision. Due to a sensitivity to disturbance from boat traffic and a high habitat specialization, many auks rank high in displacement vulnerability assessments (Furness *et al.* 2013, Wade *et al.* 2016, Dierschke *et al.* 2016). Studies in Europe have documented varying levels of displacement with rates ranging from no apparent displacement to 70 percent (Ørsted 2018). Auks have a 45–68 percent macro-avoidance rate and a 99.2 percent total avoidance rate (Cook *et al.* 2012). For turbines smaller (20-150 m) than are being considered, Atlantic Puffins are estimated to fly 0.1 percent of the time at RSZ, Razorbills 0.4 percent, and Common Murres 0.01 percent (Cook *et al.* 2012). Common Murres decrease in abundance in the area of offshore wind developments by 71 percent, and Razorbills by 64 percent (Vanermen *et al.* 2015). A recent telemetry study on Common Murre in Europe found a 63 percent reduction in resource selection at offshore wind facility areas compared to surrounding areas, with avoidance behavior increasing to 75 percent when turbine blades were rotating (Peschko *et al.* 2020). Auk flight heights from the Seabird Catalog indicate these birds are flying within the RSZ 0–0.1 percent of the time during the day

(Figure 3-19). The collision vulnerability for all species was defined as ***minimal*** to ***low***; the displacement vulnerability score ranged from ***medium*** to ***high*** depending on the species (Table 3-10).

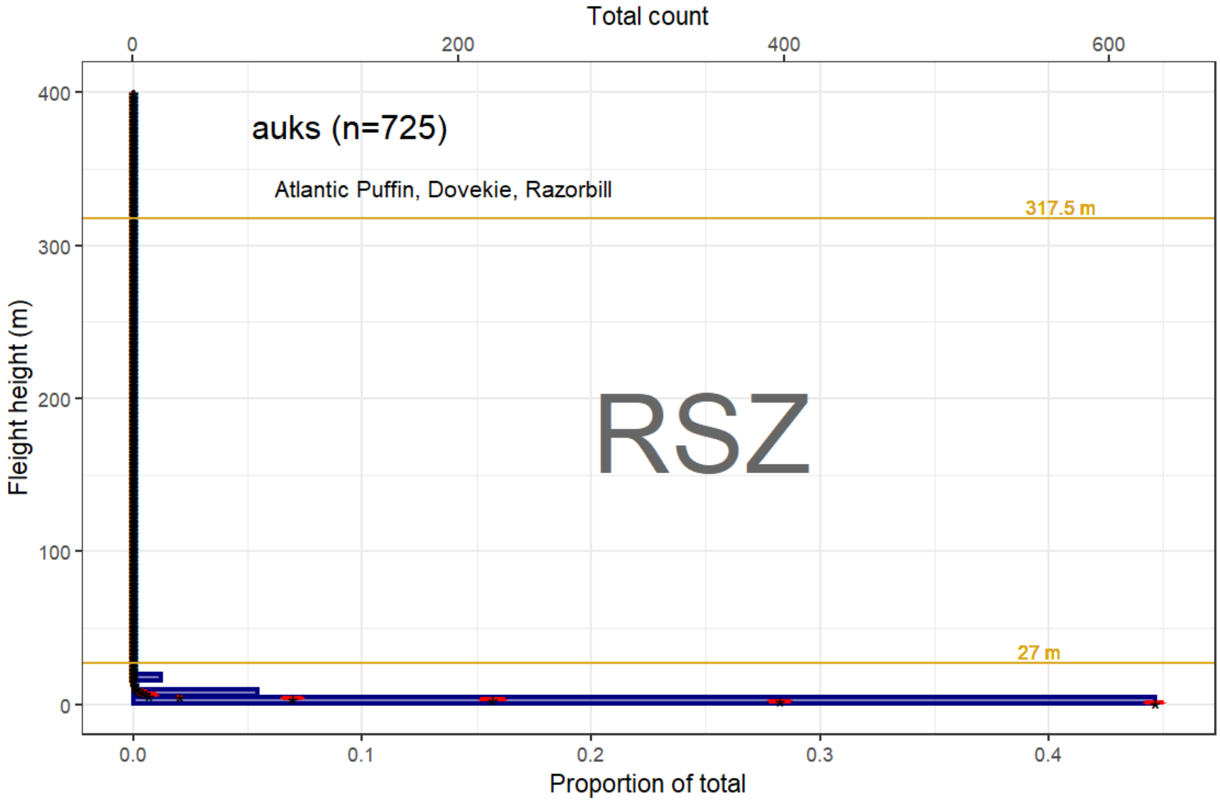

Figure 3-19. Flight heights of auks (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

Table 3-10: Summary of auk vulnerability.

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Dovekie	low (0.27)	medium (0.7)	low (0.4)
Razorbill	low (0.27)	high (0.8)	medium (0.6)
Atlantic Puffin	minimal (0.2)	high (0.8)	medium (0.53)

3.2.8.2.4 Risk Analysis

This analysis suggests that potential impacts to auk populations is ***minimal*** to ***low*** because, the birds have minimal to low exposure temporally and spatially. Since auks had a low to medium population vulnerability score, and the final risk score was not adjusted.

3.2.8.3 Gulls, Skuas, and Jaegers

3.2.8.3.1 Spatiotemporal Context

There are multiple gull species that could potentially pass through the Wind Development Area. The regional MDAT abundance models show that these birds have a wide distribution ranging from near shore (gulls) to offshore (jaegers). The jaegers are all Arctic breeders that regularly migrate through the western North Atlantic region. Parasitic Jaegers (*Stercorarius parasiticus*) are often observed closer to shore during migration than the others species (Wiley & Lee 2020) and Great Skuas (*S. skua*) may pass along the Atlantic OCS outside the breeding season.

3.2.8.3.2 Exposure Assessment

Exposure was assessed using species accounts, baseline survey data, and MDAT models. Exposure is considered to be ***minimal*** to ***low*** depending upon the species (Table 3-11). With the exception of Black-legged Kittiwake, which was slightly higher in the Wind Development Area, the average counts for gulls within the Wind Development Area were similar to those in the BOEM SAB survey area (Table 3-28). Based on compared bootstrap mean and 95 percent confidence intervals of count densities from the Kitty Hawk APEM and BOEM SAB digital aerial surveys (Table 3-27; see Attachment A for detailed methods), exposure was adjusted to include a lower range limit in fall, winter, and spring for Bonaparte's Gull.

Table 3-11: Seasonal exposure rankings for gull, skuas, and jaegers. Based on compared bootstrap mean and 95 percent confidence intervals (CI) for densities (count/sq. km) from Kitty Hawk APEM and BOEM SAB digital aerial surveys, seasonal exposure was adjusted to include a lower range limit (green).

Gulls, Skuas, and Jaegers	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
Great Skua	Summer	0	·	0	minimal
	Fall	0	0	0	minimal
	Spring	0	·	0	minimal
	Winter	0	·	0	minimal
South Polar Skua	Fall	0	0	0	minimal
	Summer	0	0	0	minimal
	Winter	0	·	0	minimal
	Spring	0	·	0	minimal
Pomarine Jaeger	Winter	0	·	0	minimal
	Spring	0	0	0	minimal
	Fall	0	0	0	minimal
	Summer	0	0	0	minimal
Parasitic Jaeger	Fall	0	0	0	minimal
	Spring	0	2	2	low

Gulls, Skuas, and Jaegers	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
	Summer	0	0	0	minimal
	Winter	0	·	0	minimal
Bonaparte's Gull	Fall	0	1	1	minimal - low
	Winter	0	2	2	minimal - low
	Spring	0	1	1	minimal - low
	Summer	0	·	0	minimal
Little Gull	Fall	0	·	0	minimal
	Spring	0	·	0	minimal
	Winter	0	·	0	minimal
	Summer	0	·	0	minimal
Black-legged Kittiwake	Fall	0	0	0	minimal
	Spring	0	0	0	minimal
	Winter	0	0	0	minimal
	Summer	0	·	0	minimal
Laughing Gull	Spring	0	0	0	minimal
	Fall	0	0	0	minimal
	Winter	0	0	0	minimal
	Summer	0	0	0	minimal
Ring-billed Gull	Fall	0	0	0	minimal
	Winter	0	0	0	minimal
	Summer	0	1	1	low
	Spring	0	0	0	minimal
Herring Gull	Winter	0	0	0	minimal
	Fall	0	0	0	minimal
	Spring	0	0	0	minimal
	Summer	0	0	0	minimal
Iceland Gull	Summer	0	·	0	minimal
	Spring	0	·	0	minimal
	Fall	0	·	0	minimal
	Winter	0	·	0	minimal
Lesser Black-backed Gull	Winter	0	·	0	minimal
	Spring	0	·	0	minimal
	Summer	0	·	0	minimal
	Fall	0	·	0	minimal
Glaucous Gull	Spring	0	·	0	minimal
	Summer	0	·	0	minimal
	Fall	0	·	0	minimal
	Winter	0	·	0	minimal
Great Black-backed Gull	Fall	0	0	0	minimal
	Winter	0	0	0	minimal
	Spring	0	0	0	minimal
	Summer	0	0	0	minimal

3.2.8.3.3 Relative Behavioral Vulnerability Assessment

Jaegers and gulls are considered to be vulnerable to collision, but rank low in vulnerability to displacement assessments (Furness *et al.* 2013) since there is no evidence in the literature that they are displaced from offshore wind developments (Krijgsveld *et al.* 2011, Lindeboom *et al.* 2011).

Little is known about how jaegers will respond to offshore WTGs, but these birds generally fly below the potential RSZ (0–10 m above the sea surface) although they could fly higher during kleptoparasitic chases (Wiley and Lee 1999). Gulls ranks at the top of collision vulnerability assessments because they can fly within the RSZ (Johnston *et al.* 2014), have been document to be attracted to turbines (Vanermen *et al.* 2015), and individual birds have been documented to collide with turbines (Skov *et al.* 2018).

The flight height of gulls, skuas, and jaegers in the Seabird Catalog indicated that birds in this group fly within the RSZ 1.2–22.6 percent of the time depending on species (small gulls = 1.2%, medium gulls = 2.5–5%, large gulls =22.2–22.6%; skuas and jaegers = 1.5–4.2% Figure 3-20). While the collision risk is thought to be greater for gulls, total avoidance rates are estimated to be 98 percent (Cook *et al.* 2012). At European offshore wind developments, gulls have been documented to be attracted to WTGs, which may be due to an attraction to increased boat traffic, new food resources, or new loafing habitat (i.e., perching areas; Fox et al. 2006, Vanermen et al. 2015), but interaction with offshore wind developments varies by season (Thaxter *et al.* 2015). Recent research suggests that some gull species may not exhibit macro-avoidance of wind facilities, but will preferentially fly between turbines, suggesting meso-avoidance that would reduce overall collision risk (Thaxter *et al.* 2018). The collision vulnerability scores for these groups were ***low*** to ***medium***. The displacement vulnerability score for all species was ***low*** to ***medium*** (Table 3-12).

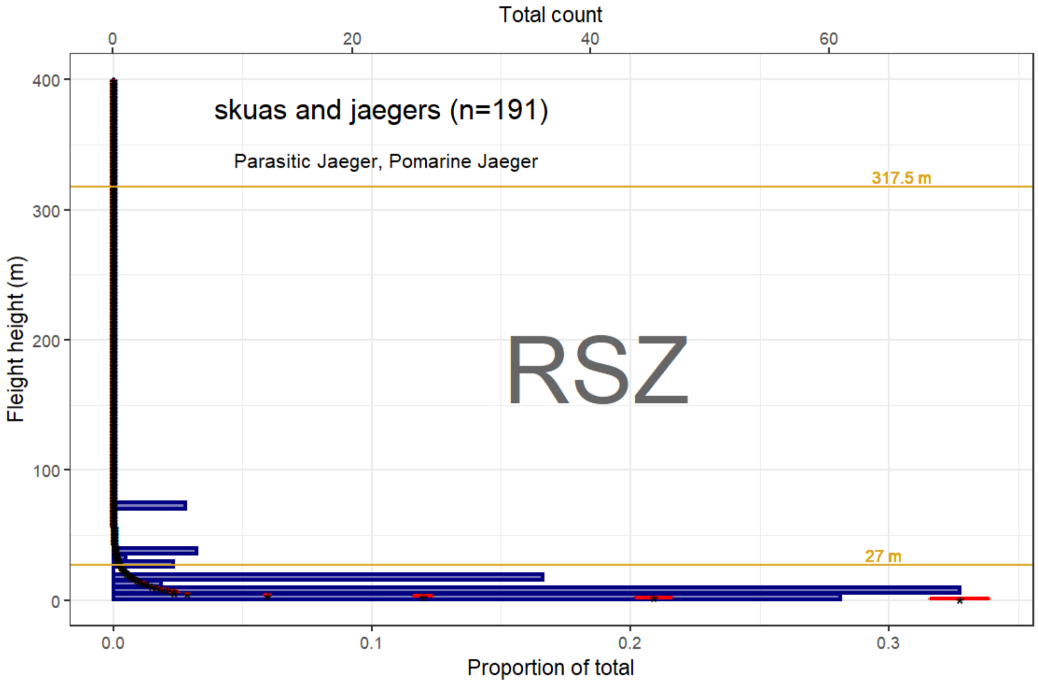

Figure 3-20: Flight heights of skuas and jaegers (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

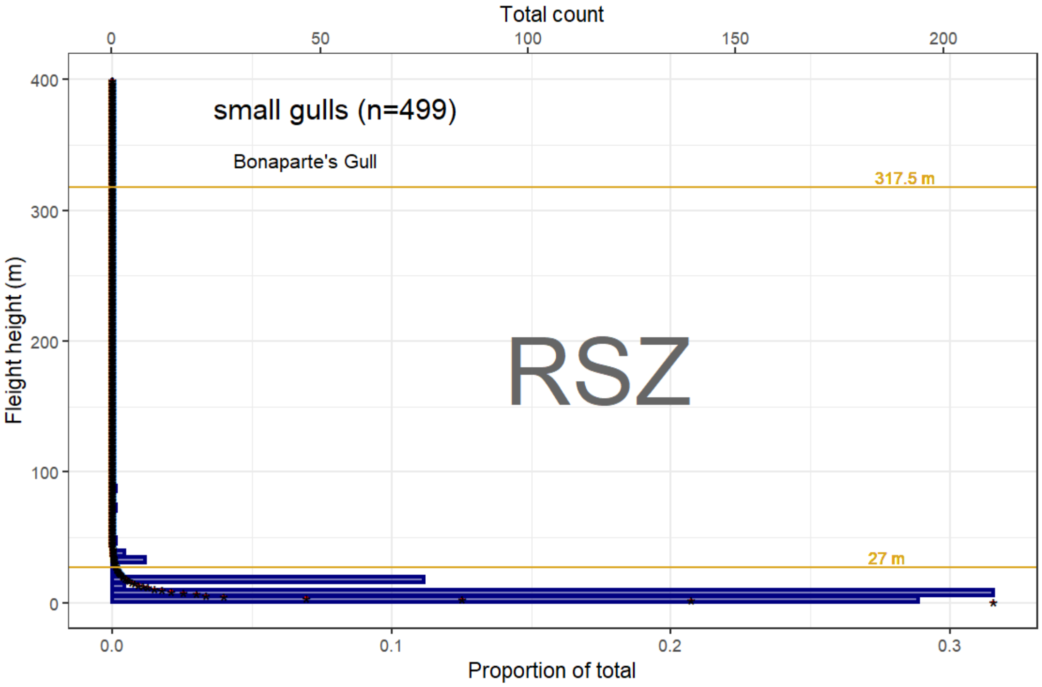

Figure 3-21. Flight heights of small gulls (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

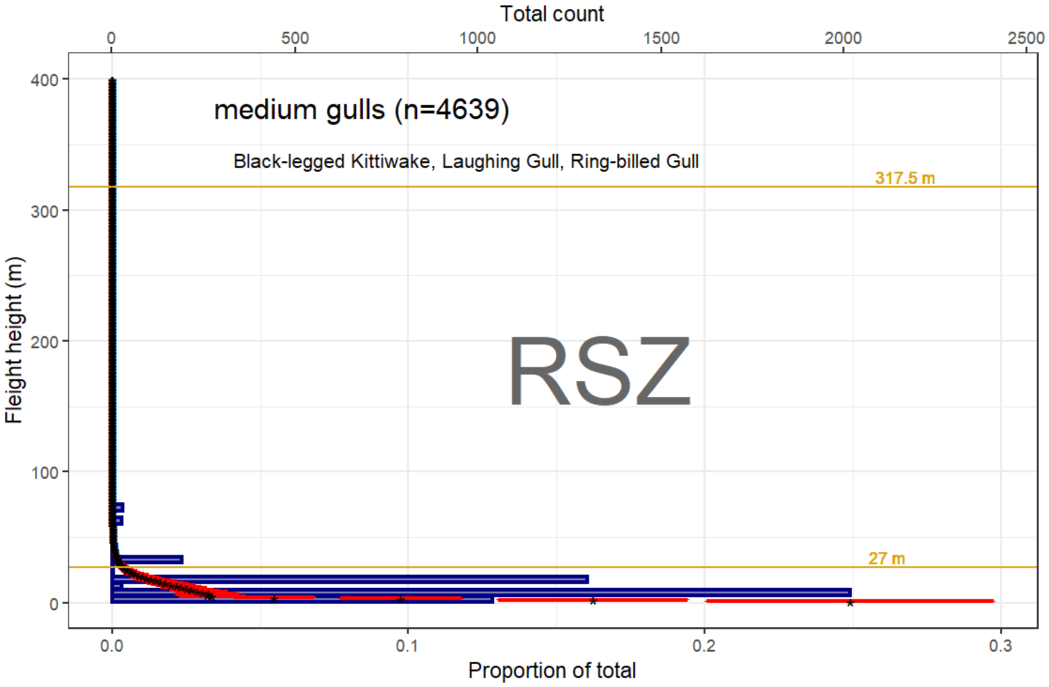

Figure 3-22. Flight heights of medium gulls (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

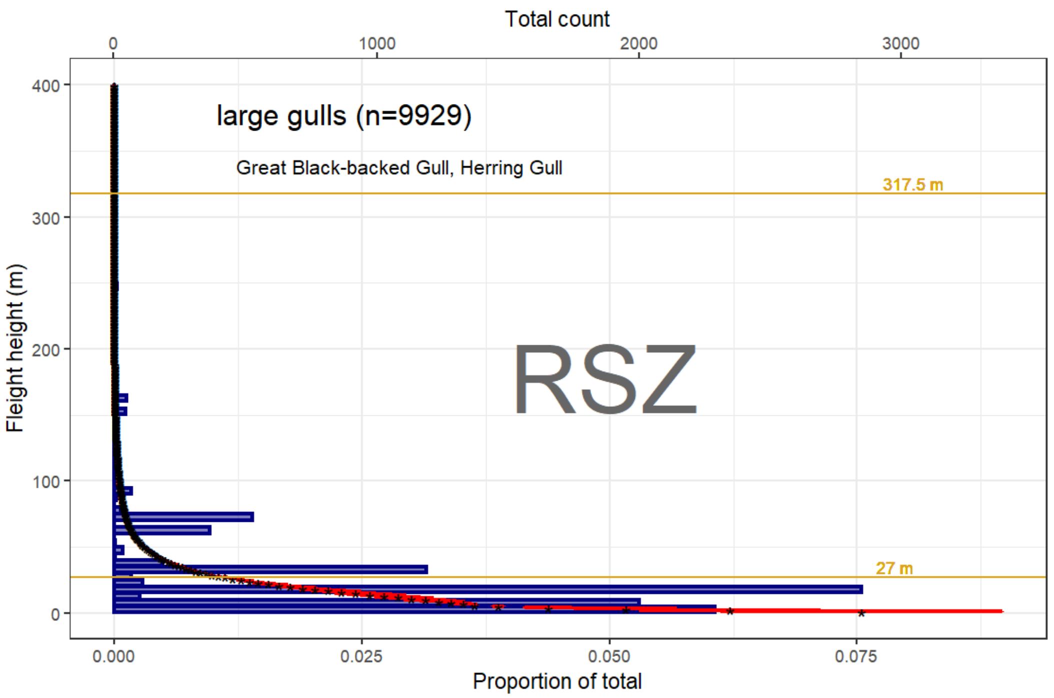

Figure 3-23. Flight heights of large gulls (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

Table 3-12: Summary of gull and jaeger vulnerability.

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Bonaparte's Gull	low (0.47)	medium (0.5)	low (0.33)
Black-legged Kittiwake	low (0.43)	medium (0.6)	low (0.4)
Laughing Gull	low (0.47)	medium (0.5)	low (0.47)
Ring-billed Gull	medium (0.67)	low (0.4)	low (0.33)
Herring Gull	medium (0.7)	medium (0.5)	medium (0.53)
Great Black-backed Gull	medium (0.63)	medium (0.7)	minimal (0.2)
Pomarine Jaeger	medium (0.6)	low (0.3)	low (0.4)
Parasitic Jaeger	medium (0.6)	low (0.3)	low (0.4)

3.2.8.3.4 Risk Analysis

This analysis suggests that potential impacts to gull populations is ***minimal*** to ***low*** depending on the species. Overall these birds have minimal to low exposure and low to medium vulnerability to collision, but recent research does suggests that they may exhibit meso-avoidance, and resident gull populations are robust and generally show high reproductive success (Pollet *et al.* 2020, Burger 2020, Good 2020, Weseloh *et al.* 2020). Since the gulls, jaegers, and skuas had a minimal to medium population vulnerability scores, the final risk score was not adjusted. Great-black Backed Gulls (*Larus marinus*) did have a minimal population vulnerability score, so the final risk level for this species is reduced to minimal.

3.2.8.4 Terns

3.2.8.4.1 Spatiotemporal Context

The Least Tern (*Sternula antillarum*) and Forster's Tern (*Sterna forsteri*) were observed in the Kitty Hawk APEM surveys. "Commic" terns (a term jointly encompassing Common Terns [*Sterna hirundo*] and Arctic Terns [*Sterna paradisaea*]) were also reported. Terns generally restrict themselves to coastal waters during breeding, although they may pass through the Wind Development Area during migration. Because Roseate Terns are listed at both state and federal levels, this species is addressed in detail below.

Table 3-13: Federal and state listing status of terns.

Common Name	Scientific Name	NC State Status	VA State Status	Federal Status
Roseate Tern	*Sterna dougallii*	E	E	E
Common Tern	*Sterna hirundo*	SC		
Gull-billed Tern	*Gelochelidon nilotica*		T	
Least Tern	*Sternula antillarum*	SC		

3.2.8.4.2 Exposure Assessment

Exposure was assessed using species accounts, baseline survey data, and MDAT models. A recent study used nanotags to track Common Terns tagged in New York and Massachusetts. While the movement models are not representative of the entire breeding and post-breeding period for many individuals, due to incomplete spatial coverage of the receiving stations and tag loss, two of the 257 birds tracked were estimated to pass through the Lease Area (Loring *et al.* 2019). Exposure is considered to be ***minimal*** to ***low*** depending on species and season (Table 3-14) and the average counts within the Wind Development Area were slightly lower than in the entire baseline survey area (Table 3-28).

Table 3-14: Seasonal exposure rankings for terns.

Small Terns	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
Least Tern	Winter	0	·	0	minimal
	Fall	0	0	0	minimal
	Spring	0	·	0	minimal
	Summer	0	0	0	minimal
Black Tern	Fall	0	·	0	minimal
	Winter	0	·	0	minimal
	Spring	0	·	0	minimal
	Summer	0	·	0	minimal
Sooty Tern	Spring	0	0	0	minimal
	Winter	0	·	0	minimal
	Fall	0	·	0	minimal
	Summer	0	0	0	minimal
Bridled Tern	Fall	0	1	1	low
	Summer	0	0	0	minimal
	Winter	0	·	0	minimal
	Spring	0	·	0	minimal
Gull-billed Tern	Spring	0	·	0	minimal
	Winter	0	·	0	minimal
	Summer	0	·	0	minimal
	Fall	0	·	0	minimal
Roseate Tern	Winter	0	·	0	minimal
	Summer	0	0	0	minimal
	Fall	0	0	0	minimal
	Spring	0	2	2	low
Common Tern	Summer	0	0	0	minimal
	Spring	0	1	1	low
	Winter	0	·	0	minimal
	Fall	0	1	1	low
Arctic Tern	Spring	0	·	0	minimal
	Summer	0	0	0	minimal
	Winter	0	·	0	minimal
	Fall	0	·	0	minimal
Forster's Tern	Fall	0	·	0	minimal
	Winter	0	·	0	minimal
	Summer	0	·	0	minimal
	Spring	0	·	0	minimal
Royal Tern	Spring	0	0	0	minimal
	Summer	0	0	0	minimal
	Winter	0	·	0	minimal
	Fall	0	0	0	minimal
Sandwich Tern	Fall	0	·	0	minimal
	Spring	0	·	0	minimal
	Summer	0	·	0	minimal
	Winter	0	·	0	minimal
Caspian Tern	Spring	0	·	0	minimal
	Summer	0	·	0	minimal
	Fall	0	·	0	minimal
	Winter	0	·	0	minimal

3.2.8.4.3 Relative Behavioral Vulnerability Assessment

Terns are considered to have some vulnerability to collision and rank in the middle of collision vulnerability assessments (Garthe & Hüppop 2004, Furness *et al.* 2013). Tern flight heights recorded in the Seabird Catalog indicate that during the day terns fly within the RSZ of the turbines being considered 0.7–1.7 percent of the time (Figure 3-24). A recent nanotag study estimated that Common Terns primarily flew below the RSZ (25 m) and that the frequency of Common Terns flying offshore within the RSZ (25–250 m) ranged from 0.9–9.8 percent (Loring *et al.* 2019). While the nanotag flight height estimated birds flying below 50 m, radar and observational studies provide evidence that terns in some instances can initiate migration at higher altitudes of 1,000–3,000 m (Loring et al. 2019). The probability of tern mortality as a result of collision with WTGs is predicted to decline as the distance between colonies and the turbines increases (Cranmer *et al.* 2017).

Common Terns and Roseate Terns tended to avoid the airspace around a small 660 kilowatt turbine (Massachusetts Maritime Academy in the U.S.) when the turbine was rotating and usually avoided the RSZ (Vlietstra 2007). This finding is corroborated by mortality monitoring of small turbines (200 and 600 kilowatt) in Europe, where tern mortality rates rapidly declined with distance from their colony (Everaert *et al.* 2007). Most observed tern mortalities in Europe have occurred at turbines <30 m from nests (Burger *et al.* 2011). Furthermore, the Final Vineyard Wind 1 Biological Assessment prepared by BOEM for USFWS estimated that Roseate Tern mortality from collision would be zero and that the likelihood of collision fatalities would be "insignificant and discountable" (BOEM 2019a).

The collision vulnerability score for terns is ***low***; the displacement score ranges from ***medium*** to ***high*** depending on the species. Terns fall into the high (5) category for macro avoidance because of a 69.5 percent avoidance rate determined at Horns Rev (Cook *et al.* 2012), which had small turbines (2 megawatt; Petersen et al. 2006), and Willmott et al. (2013) categorized tern avoidance as greater than 40 percent. Wade et al. (2016) determined "high" and "very high" uncertainty for flight heights and displacement for Roseate Terns. A lower range was added to the displacement vulnerability (DV) score for the following reasons: terns receive a low disturbance score in Wade et al. (2016); terns were determined to have a 30 percent macro avoidance of turbines at Egmond aan Zee (Cook *et al.* 2012); terns have high uncertainty scores; and displacement in terns has not been well studied (Table 3-15).

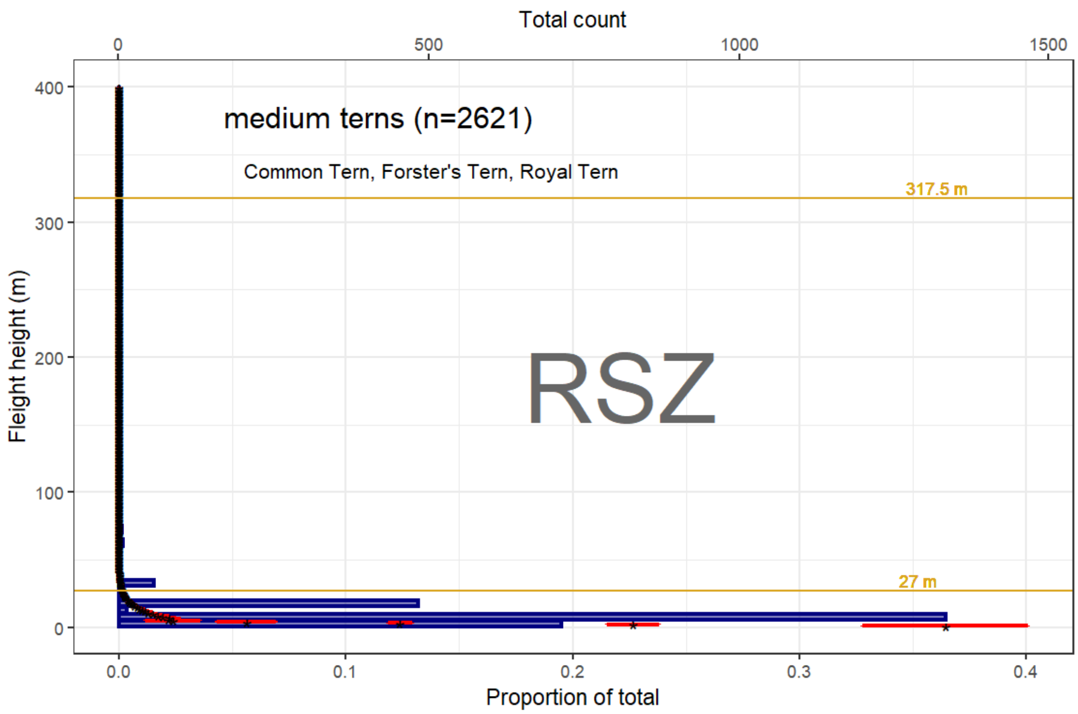

Figure 3-24. Flight heights of terns (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27–317.5 m).

Table 3-15: Summary of tern vulnerability. Based on the literature on terns, displacement vulnerability was adjusted to include a lower range limit (green).

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Roseate Tern	· (·)	medium - high (0.8)	high (0.87)
Common Tern	low (0.3)	medium - high (0.8)	medium (0.6)
Forster's Tern	low (0.43)	low - medium (0.5)	medium (0.53)
Royal Tern	low (0.43)	low - medium (0.5)	medium (0.67)

3.2.8.4.4 Risk Analysis

This analysis suggests that the risk of potential effects to tern populations is ***minimal*** to ***low***, depending upon the species, because these birds have minimal to low exposure, both spatially and temporally. All tern species had a medium population vulnerability score, and the final risk score was not adjusted.

3.2.8.5 Federally Endangered Tern Species: Roseate Tern

3.2.8.5.1.1 Spatiotemporal context

The Roseate Tern (*Sterna dougallii*) is a small seabird that breeds colonially on coastal islands. The Northwest Atlantic population has been federally listed as *Endangered* under the ESA since 1987, and is listed as *Endangered* in Virginia North Carolina. This population breeds in northeastern states and Atlantic Canada, and winters in South America, primarily eastern Brazil (USFWS 2010, Gochfeld & Burger 2020). Roseate Terns formerly bred in Virginia, and historically were rarely documented in North Carolina during breeding (Gochfeld & Burger 2020, LeGrand, Haire, *et al.* 2020). Declines have been largely attributed to low productivity, partially related to predators, habitat loss and degradation, and unusually low adult survival rates for a tern species (USFWS 2010). Over 90 percent of remaining individuals breed at just three colony locations in Massachusetts (Bird Island, Ram Island, and Penikese Island in Buzzards Bay) and one colony in New York (Great Gull Island, near the entrance to Long Island Sound; Nisbet et al. 2014, Loring et al. 2017). There are no longer any breeding colonies farther south.

Roseate Terns generally migrate through the mid-Atlantic region and arrive at their Northwest Atlantic breeding colonies in late April to late May, with nesting occurring between roughly mid-May and late July. Following the breeding season, adult and hatch year Roseate Terns move to post-breeding coastal staging areas from approximately late July to mid-September (USFWS 2010). Foraging activity during the staging period is known to occur up to 16 km from the coast, though most foraging activity occurs much closer to shore (Burger *et al.* 2011).

Roseate Tern migration routes are poorly understood, but they appear to migrate primarily well offshore (Nisbet 1984, USFWS 2010, Burger et al. 2011, Mostello et al. 2014, Nisbet et al. 2014). During migration periods, few Roseate Terns are predicted to occur within the Wind Development Area according to the MDAT models (Winship *et al.* 2018), and supported by the baseline surveys, Seabird Catalog data, and nanotag telemetry studies (Loring *et al.* 2019). The regional MDAT models show that Roseate Terns are generally concentrated closer to shore during spring migration and have low exposure in North Carolina offshore waters during the summer and fall. Roseate Terns were not observed during the Kitty Hawk APEM surveys, and the Seabird Catalog includes only one historical observation of Roseate Terns in the region (Figure 3-25).

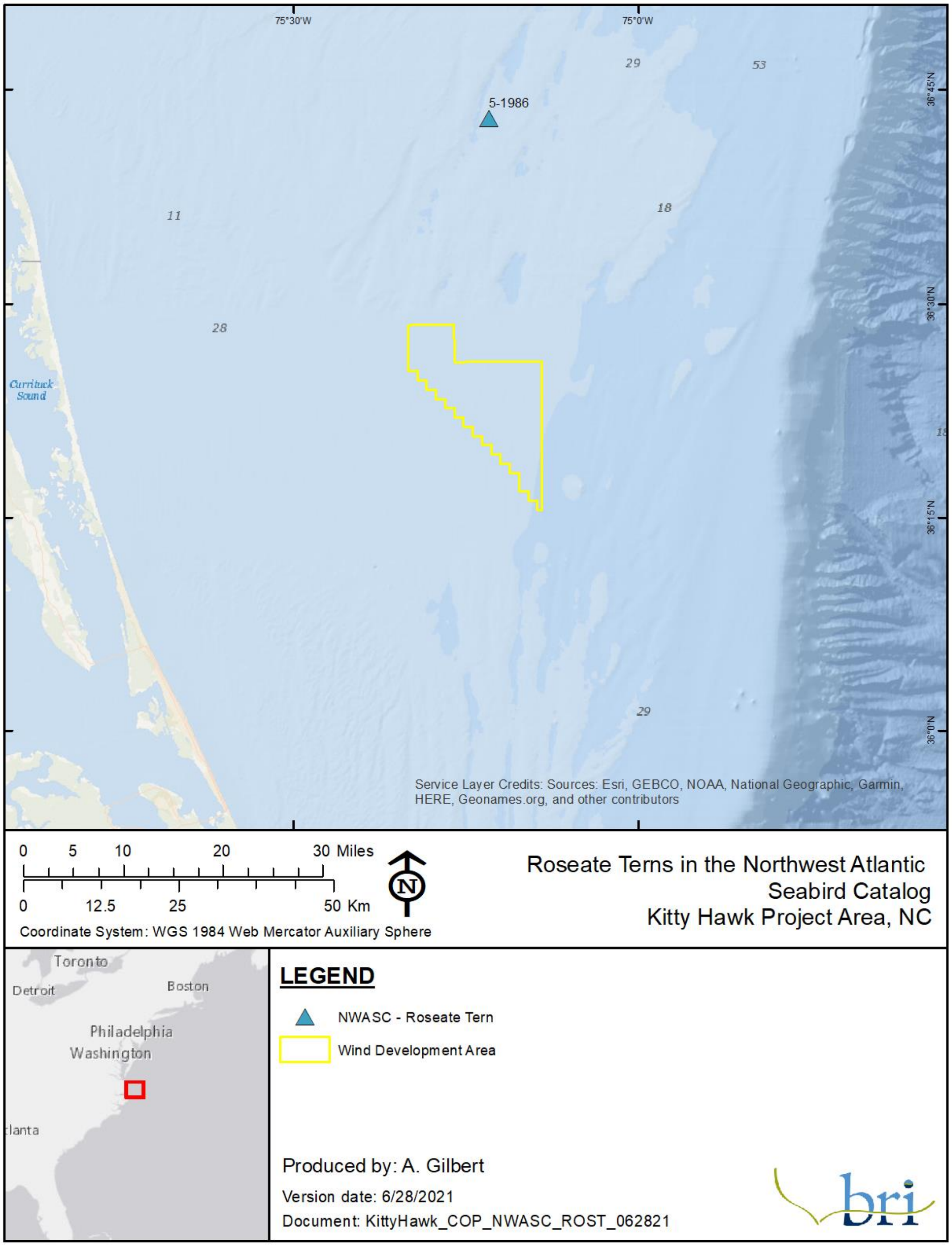

Figure 3-25: Roseate Tern observations from the Northwest Atlantic Seabird Catalog.

3.2.8.5.1.2 Exposure Assessment

Exposure for Roseate Terns was assessed using species accounts, tracking studies, baseline survey data, and MDAT models. The available information on foraging habits, migration, and distance from breeding sites, all indicate minimal exposure of Roseate Terns to the Wind Development Area. Roseate Terns have not been confirmed in the Wind Development Area.

A recent study used nanotags to track Roseate Terns and Common Terns tagged in New York and Massachusetts. The study, conducted to the north of the Wind Development Area, estimated that two of the Common Terns may have flown through the Wind Development Area, but none of the Roseate Terns (Loring et al. 2019). The specific flight paths of these birds is not known, however, due to the lack of receivers offshore and overall receiver coverage around the Wind Development Area. The movement models are not representative of the entire breeding and posting period for many individuals due to incomplete spatial coverage of the receiving stations and tag loss (Loring *et al.* 2019). Overall, Roseate Terns display limited spatial and temporal exposure to the Wind Development Area, and the expected exposure of Roseate Terns to the Wind Development Area is ***minimal*** and is limited to migration.

3.2.8.5.1.3 Relative Behavioral Vulnerability Assessment

Terns rank in the middle of collision vulnerability assessments (Furness *et al.* 2013). Terns have also been documented to lower their flight altitude when approaching a wind development to avoid the RSZ (Krijgsveld *et al.* 2011). A two-year study of a small 600 kilowatt onshore turbine in Buzzard's Bay, Massachusetts found no tern mortalities, though Common Terns regularly flew within 50 m of the turbine (Vlietstra 2007). Terns may detect turbine blades during operation, both visually and acoustically and have been observed to avoid flying between turbine rotors while they are in motion (Vlietstra 2007, MMS 2008).

Tern flight height during foraging is typically low, and European studies of related tern species at turbines that are smaller than those being considered, have suggested that approximately 4–10 percent of birds may fly at rotor height (20–150 m above sea level) during local flights (Jongbloed 2016). A recent nanotag study estimated that terns primarily flew below the RSZ (25 m) and that Roseate Terns flying offshore only occasionally flew within the lower portion of a RSZ ranging from 25–250 m (federal waters, 6.4 percent; Wind Energy Areas, 0 percent; Figure 3-26; Loring et al. 2019). There were too few Roseate Tern observations in the Seabird Catalog to estimate flight heights, but during the day Common Terns are estimated to fly within the RSZ 0.7 percent of time for the turbines being considered.

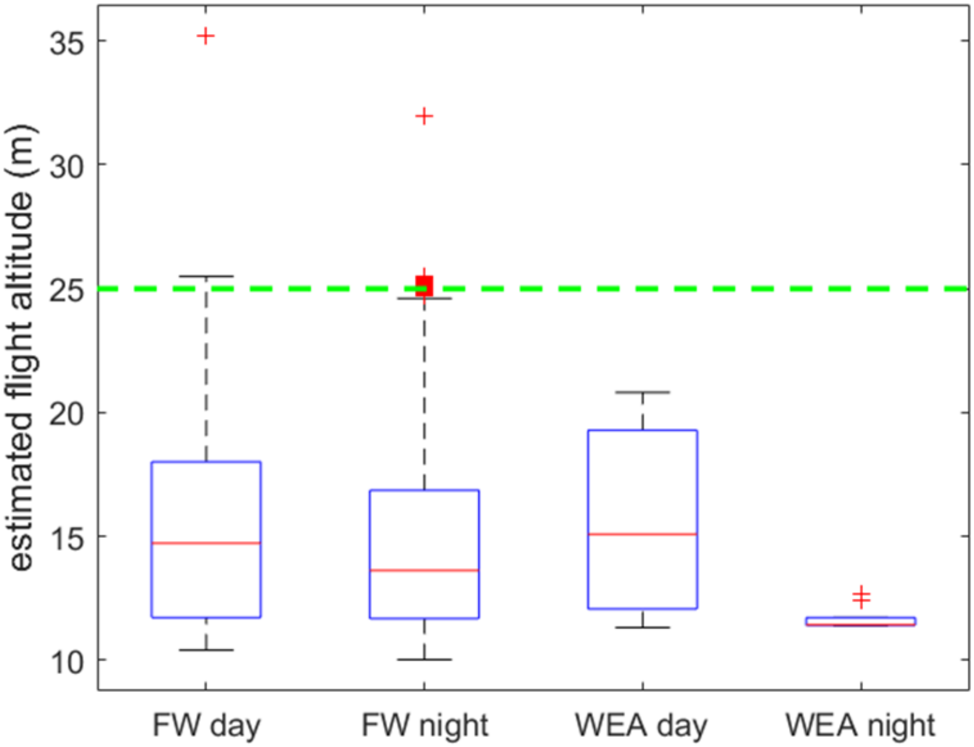

Figure 3-26: Model-estimated flight altitude ranges (m) of Roseate Terns. During exposure to Federal waters (FW) and Wind Energy Areas (WEAs) during day and night. The green-dashed line represents the lower limit of the RSZ (25 m). Taken from Loring et al. (2019).

Since there is little data on Roseate Tern flight height and proportion of time flying, data for the Common Tern was used as a surrogate. Common Tern received a collision vulnerability score of ***low***; and a displacement vulnerability score of ***high*** (Table 3-15; see tern discussion above for further details). A lower range was added to the displacement scores because the estimates of tern avoidance are primary based upon two studies of wind facilities with small turbines (2 megawatt; see section 3.2.8.4). In addition, Wade et al. (2016) determined “high” and “very high” uncertainty for flight heights and displacement for Roseate Terns. Their collision vulnerability may even be lower than these scores, because the modeled survey and nanotag data indicated terns generally fly below the RSZ and potentially avoid rotating turbines.

3.2.8.5.1.4 Risk

This analysis suggests that the potential impacts to individual Roseate Terns is ***minimal***, because these birds have minimal exposure, both spatially and temporally. Since Roseate Terns have a high population vulnerability score, the final risk score was adjusted up to ***low***.

3.2.8.6 Loons

3.2.8.6.1 Spatiotemporal Context

The Common Loon (*Gavia immer*) and Red-throated Loon (*G. stellata*) breed on inland freshwater lakes and ponds during the summer, but both species use the U.S. Atlantic OCS during winter, with migration periods in the spring and fall. Analysis of satellite-tracked Red-throated Loons, captured and tagged in the mid-Atlantic area, found their winter distributions to be coastal or inshore relative to the Wind Development Area (Gray *et al.* 2016). In the mid-Atlantic, Common Loons generally show a broader and more dispersed winter distribution than Red-throated Loons (Williams et al. 2015). As expected, based on the summer breeding habitat of loons, the BOEM SAB and Kitty Hawk APEM surveys, as well as MDAT models show lower use of the Wind Development Area by loons in the summer than other seasons. Based on band re-sightings and satellite telemetry studies, the wintering population in coastal North Carolina may include more individuals from Midwestern and Canadian breeding populations than birds breeding in New England (Evers *et al.* 2020). Band recoveries and re-sightings from North Carolina have included loons originally banded in Florida, Maine, Michigan, Minnesota, New York, Ontario, and Quebec (BRI unpublished data). This wintering area may be particularly important, as some Canadian breeding populations have experienced long-term declines in productivity (Bianchini *et al.* 2020).

3.2.8.6.2 Exposure Assessment

Exposure for loons was assessed using species accounts, tracking data, baseline survey data, and MDAT models. Exposure is considered to be ***minimal*** to ***low*** because loons may pass through the Wind Development Area during spring and fall migration, and are estimated to have low relative exposure during the winter (Table 3-16). Since Red-throated Loons migrate to far northern inland lakes to breed, density estimates indicate close to no use of the Wind Development Area during the summer. Similarly, Common Loon density was lower during the summer/spring than in other seasons, because adults migrate to inland lakes to breed. Red-throated Loons had lower counts within the Wind Development Area compared to the entire BOEM SAB survey area. Common Loon counts were higher in the Wind Development Area during the Kitty Hawk APEM surveys than in the BOEM SAB surveys (Table 3-28). In addition, tracking data indicate that Red-throated Loons largely pass through the area only during spring migration (Figure 3-27).

Table 3-16: Seasonal exposure rankings for the loon group.

Loons	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
Red-throated Loon	Spring	0	0	0	minimal
	Summer	0	·	0	minimal
	Fall	0	0	0	minimal
	Winter	0	1	1	low
Common Loon	Winter	1	1	2	low
	Fall	1	0	1	low
	Spring	1	1	2	low
	Summer	1	0	1	low

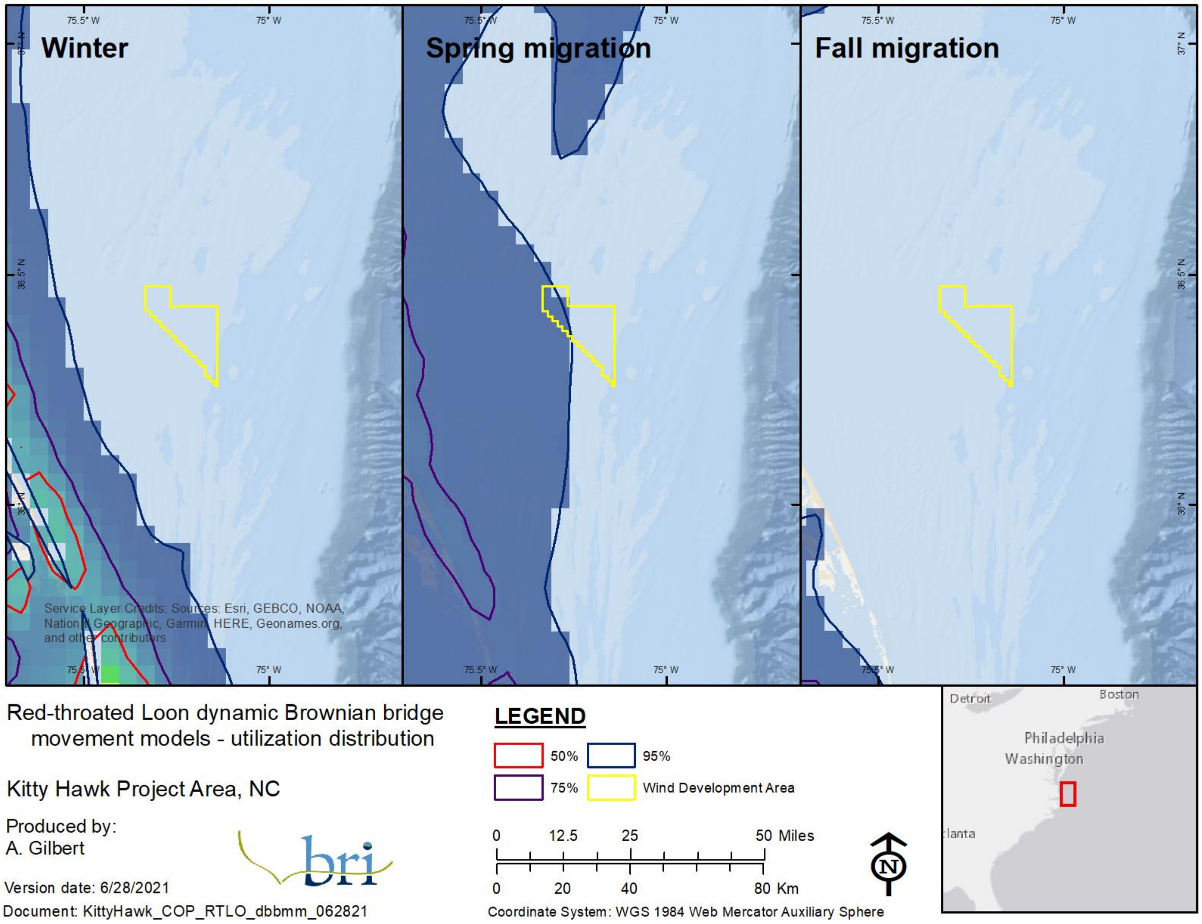

Figure 3-27: Dynamic Brownian bridge movement models for Red-throated Loons (n = 46, 46, 31 [winter, spring, fall]) that were tracked with satellite transmitters. Utilization contour levels (50, 75, 95 percent) were calculated for the mean utilization distribution (UD) surface; a probability density surface showing the relative use of an area by the population of animals in this study over the period of study. 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 percent (home range).

3.2.8.6.3 Relative Behavioral Vulnerability Assessment

Loons are consistently identified as being vulnerable to displacement (MMO 2018, Garthe & Hüppop 2004, Furness *et al.* 2013). Red-throated Loons have been documented to avoid offshore wind developments, which can lead to displacement (Dierschke *et al.* 2016). In addition to displacement caused by WTG, Red-throated Loons have also been shown to be negatively affected by increased boat traffic associated with construction and maintenance (Mendel *et al.* 2019). This high vulnerability to displacement, coupled with extensive use of the Atlantic OCS during migration and wintering increases the potential for cumulative habitat loss for loons (Goodale et al. 2019). However, there is some evidence that Red-throated Loons may return to wind facility areas after construction has been completed (APEM 2016). While data is lacking (because there are few Common Loons present at European wind facilities), Common Loons are expected to have a similar avoidance response.

Based on the above evidence, the risk to loons is primarily displacement from wind developments during construction and operation. From the literature, displacement vulnerability is considered to be high for loons during all phases, because they are known to display a strong avoidance to offshore wind developments, and the displacement score is ***high*** for both species (Table 3-17). There is little evidence in the literature that loons are vulnerable to collision, although they have the potential to fly through the lower portion of the RSZ (during the day loons fly approximately 6–13 percent of the time within the RSZ regardless of species) if they do not avoid the wind facility; thus, loons received a ***low*** collision risk score (Figure 3-28). Based on the literature, a lower range is added to collision vulnerability because loons have such a strong avoidance response.

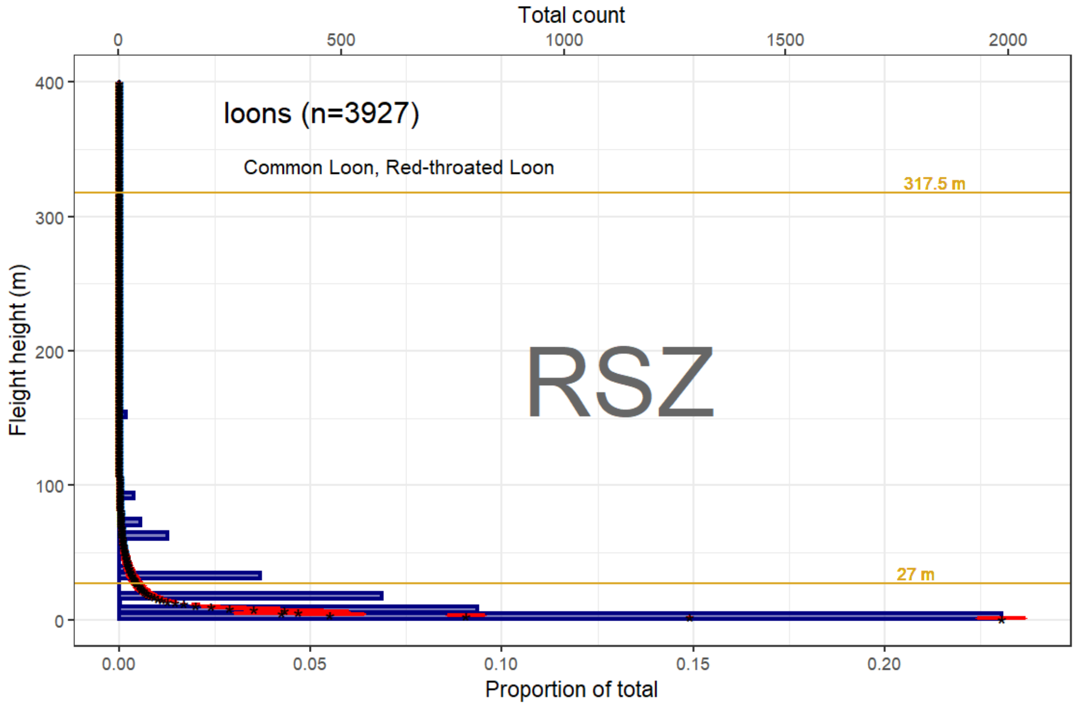

Figure 3-28: Flight heights of loons (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

Table 3-17: Summary of loon vulnerability. Based on the literature, collision vulnerability was adjusted to include a lower range limit (green).

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Red-throated Loon	minimal - low (0.47)	high (0.9)	medium (0.53)
Common Loon	minimal - low (0.33)	high (0.8)	medium (0.53)

3.2.8.6.4 Risk Analysis

This analysis suggests that the risk of potential impacts to loon populations is ***minimal*** to ***low*** because, overall, these birds are considered to have minimal to low exposure, both spatially and temporally. While these birds are vulnerable to displacement, there is uncertainty about how displacement will affect individual fitness (e.g. changes in energy expenditure due to avoidance) and effective methodologies for assessing population-level displacement effects are lacking (Mendel *et al.* 2019, Fox & Petersen 2019). Loons do have the potential to fly through the lower portion of the RSZ, but their strong avoidance behavior most likely significantly reduces their collision vulnerability to low levels. Since loons have a medium population vulnerability score, the final risk score was not adjusted.

3.2.8.7 Petrels, Shearwaters, and Storm-Petrels

3.2.8.7.1 Spatiotemporal Context

Few species in the petrels, shearwaters, and storm-petrels group breed in the northern hemisphere; these include the Northern Fulmar, which has a largely Arctic and subarctic breeding range, the Leach's Storm-Petrel, which breeds largely in Atlantic Canada and as far south as the Gulf of Maine, and a handful of Manx Shearwaters, that breed in Newfoundland, Canada. Of these, only the Northern Fulmar is likely to winter along the U.S. Atlantic OCS. A number of species in this group that breed in the southern hemisphere, however, visit the northern hemisphere during the austral winter in high numbers (Nisbet *et al.* 2013). Several of these species (e.g., Cory's Shearwater, Wilson's Storm-Petrel) are found in high densities across the broader region, concentrating beyond the outer continental shelf and in the Gulf of Maine, as indicated in the MDAT avian abundance models (Winship et al. 2018; see Attachment B).

3.2.8.7.2 Exposure Assessment

Exposure was assessed using species accounts, baseline survey data, and MDAT models. Overall, exposure score was minimal to low (Table 3-18) because, while the petrel group is commonly observed throughout the region during the summer month, they are typically found much further offshore than the Wind Development Area (see maps in Attachment B). For this reason, the annual exposure score is ***minimal***.

Table 3-18: Seasonal exposure rankings for the shearwaters, petrels, and storm-petrels.

Shearwaters, Petrels, & Storm-Petrels	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
Northern Fulmar	Spring	0	0	0	minimal
	Winter	0	0	0	minimal
	Fall	0	0	0	minimal
	Summer	0	0	0	minimal
Black-capped Petrel	Fall	0	0	0	minimal
	Winter	0	0	0	minimal
	Spring	0	0	0	minimal
	Summer	0	0	0	minimal
Cory's Shearwater	Spring	0	1	1	low
	Winter	0	·	0	minimal
	Summer	0	0	0	minimal
	Fall	0	0	0	minimal
Sooty Shearwater	Summer	0	0	0	minimal
	Winter	0	·	0	minimal
	Spring	0	0	0	minimal
	Fall	0	0	0	minimal
Great Shearwater	Fall	0	0	0	minimal
	Summer	0	0	0	minimal
	Spring	0	0	0	minimal
	Winter	0	0	0	minimal
Manx Shearwater	Winter	0	·	0	minimal

Shearwaters, Petrels, & Storm-Petrels	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
	Spring	0	0	0	minimal
	Fall	0	0	0	minimal
	Summer	0	0	0	minimal
Audubon's Shearwater	Summer	0	0	0	minimal
	Spring	0	0	0	minimal
	Winter	0	0	0	minimal
	Fall	0	0	0	minimal
Wilson’s Storm-Petrel	Summer	0	0	0	minimal
	Winter	0	·	0	minimal
	Spring	0	0	0	minimal
	Fall	0	0	0	minimal
Leach’s Storm-Petrel	Winter	0	·	0	minimal
	Spring	0	0	0	minimal
	Summer	0	0	0	minimal
	Fall	0	0	0	minimal

3.2.8.7.3 Relative Behavioral Vulnerability Assessment

Petrels, shearwaters, and storm-petrels rank at the bottom of displacement vulnerability assessments (Furness *et al.* 2013), and the flight height data indicates the birds have limited exposure to the RSZ (birds flew <0.1 percent of the time within the RSZ; Figure 3-29). Species within this group forage at night on bioluminescent aquatic prey and are instinctively attracted to artificial light sources (Imber 1975, Montevecchi 2006), which could increase collision risk during poor weather. Existing studies indicate that light-induced mass mortality events are primarily a land-based issue that involves juvenile birds, specifically fledging birds leaving their colonies at night (Le Corre *et al.* 2002, Rodríguez *et al.* 2014, Rodríguez *et al.* 2015, Rodríguez *et al.* 2017). Response to intermittent LED lights, which are the type likely to be used at offshore wind facilities, is largely unknown.

The collision vulnerability score is ***low*** for this group (Table 3-19). Displacement has not been well studied for this taxonomic group, but Furness et al. (2013) ranked species in this group as having the lowest displacement rank. A study at Egmond aan Zee, Netherlands, found that 50 percent (n =10) of tube-nosed species passed through the wind facility, which results in the birds receiving a displacement vulnerability score of 5 and thus a ***medium*** vulnerability (Table 3-19). Wade et al. (2016) described uncertainty on displacement vulnerability for these species as “very high”. Based upon the evidence in the literature, and identified uncertainty, a lower range has been added.

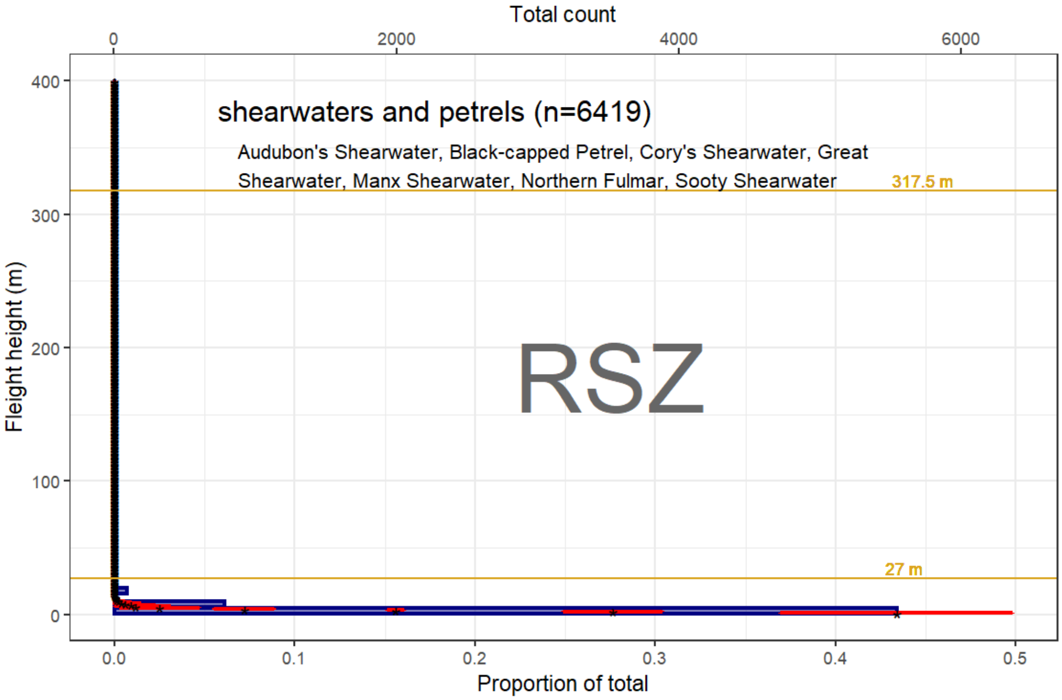

Figure 3-29: Flight heights of shearwaters and petrels (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

Table 3-19: Summary of petrel and shearwater vulnerability. Based on the literature, displacement vulnerability was adjusted to include a lower range limit (green).

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Northern Fulmar	low (0.43)	low - medium (0.6)	low (0.47)
Black-capped Petrel	· (·)	low - medium (0.6)	medium (0.67)
Cory's Shearwater	low (0.4)	low - medium (0.6)	medium (0.67)
Sooty Shearwater	low (0.33)	low - medium (0.6)	medium (0.53)
Great Shearwater	low (0.37)	low - medium (0.6)	medium (0.67)
Manx Shearwater	low (0.37)	low - medium (0.6)	medium (0.53)
Audubon's Shearwater	low (0.4)	low - medium (0.6)	medium (0.6)

3.2.8.7.4 Risk Analysis

This analysis suggests that the potential population level impacts to the petrel group is ***minimal*** because, overall, these birds have minimal exposure. Since the petrel group had a low to medium population vulnerability score, the final risk score was not adjusted. Due to the listing status of Black-capped Petrel (*Pterodroma hasitata*), this species is individually assessed below.

3.2.8.7.5 Candidate Petrel Species: Black-capped Petrel

The Black-capped Petrel is a pelagic seabird that breeds in small colonies on remote forested mountainsides of Caribbean islands, although breeding is now thought to be mostly restricted to the islands of Hispaniola (Haiti and the Dominican Republic) and possibly Cuba (Simons *et al.* 2013). During their breeding season (January-June), Black-capped Petrels travel long distances to forage over the deeper waters (200–2,000 m) of the southwestern North Atlantic, the Caribbean basin, and the southern Gulf of Mexico (Simons *et al.* 2013). Outside the breeding season, they regularly spend time in U.S. Atlantic waters, along the shelf edge of the South Atlantic Bight, commonly as far north as Cape Hatteras and occasionally beyond (Jodice *et al.* 2015).

The small, declining global population is likely less than 2,000 breeding pairs, and has been listed as Endangered on the IUCN Red List since 1994 (BirdLife International 2018) and is currently proposed for federal listing as *Threatened* in the U.S. (USFWS 2018b) due to its heavy use of the Gulf Stream within U.S. waters (USFWS 2018a) The Black-capped Petrel was pushed to the edge of extinction in the late 1800s due to hunting and harvest for food (Simons *et al.* 2013). Predation of adults and eggs by invasive mammals, and breeding habitat loss and degradation remain major threats to their existence; in addition, the effects of climate change on the biology of the species and its prey are largely unknown (Goetz *et al.* 2012). An increase in the frequency and intensity of hurricanes is expected to drastically increase mortality in breeding Black-capped Petrels (Hass *et al.* 2012). Given the small size of the breeding population, the species' resiliency (the ability to withstand normal environmental variation and stochastic disturbances over time) is considered to be low (USFWS 2018b).

3.2.8.7.5.1 Exposure Assessment

The Black-capped Petrel is extremely uncommon in areas not directly influenced by the warmer waters of the Gulf Stream (Haney 1987), and thought to be found in Atlantic coastal waters of the U.S. only as a result of tropical storms (Lee 2000). The Seabird Catalog contains ~5000 individual observations of Black-capped Petrels at sea (1979–2006; O'Connell et al. 2009, Simons et al. 2013), none of which are found in shelf waters north of Virginia. While no observations occur within the Wind Development Area, several observations have been documented between the eastern border of the Wind Development Area and the shelf break (Figure 3-31). Recent satellite tracking of a few birds, however, suggests possibly greater use of shelf waters than previously known, especially in the South Atlantic Bight (Jodice *et al.* 2015). The closest sightings reported in the Seabird Catalog are from just outside the eastern edge of the Wind Development Area (Figure 3-31). Recent tracking of Black-capped Petrels with satellite transmitters confirms that the birds are primarily using areas beyond the shelf break (Figure 3-30; Atlantic Seabirds 2019). Since there is a potential for the birds to pass through the Wind Development Area, although likely in few numbers, exposure is considered to be ***minimal*** to ***low***.

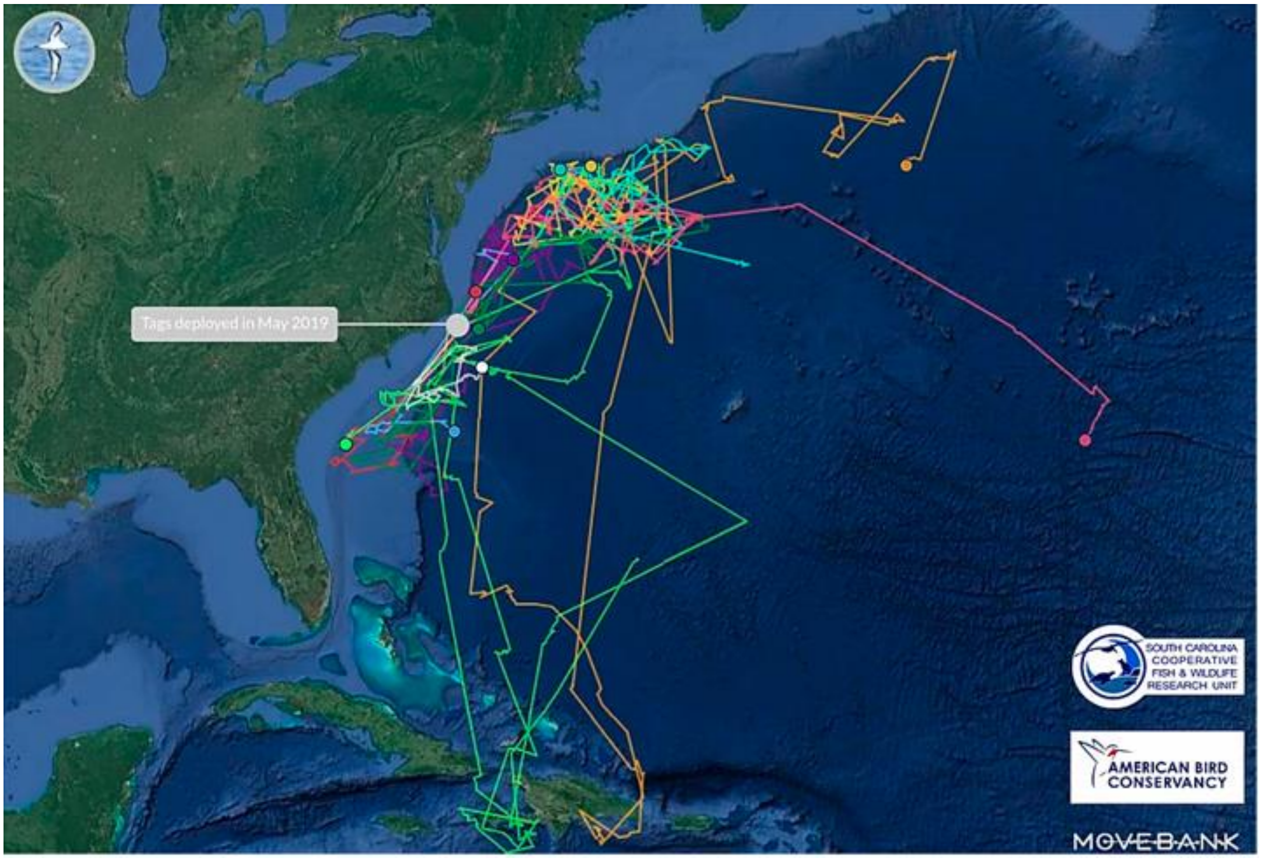

Figure 3-30: Track lines of Black-capped Petrels tagged with satellite transmitters (Atlantic Seabirds 2019).

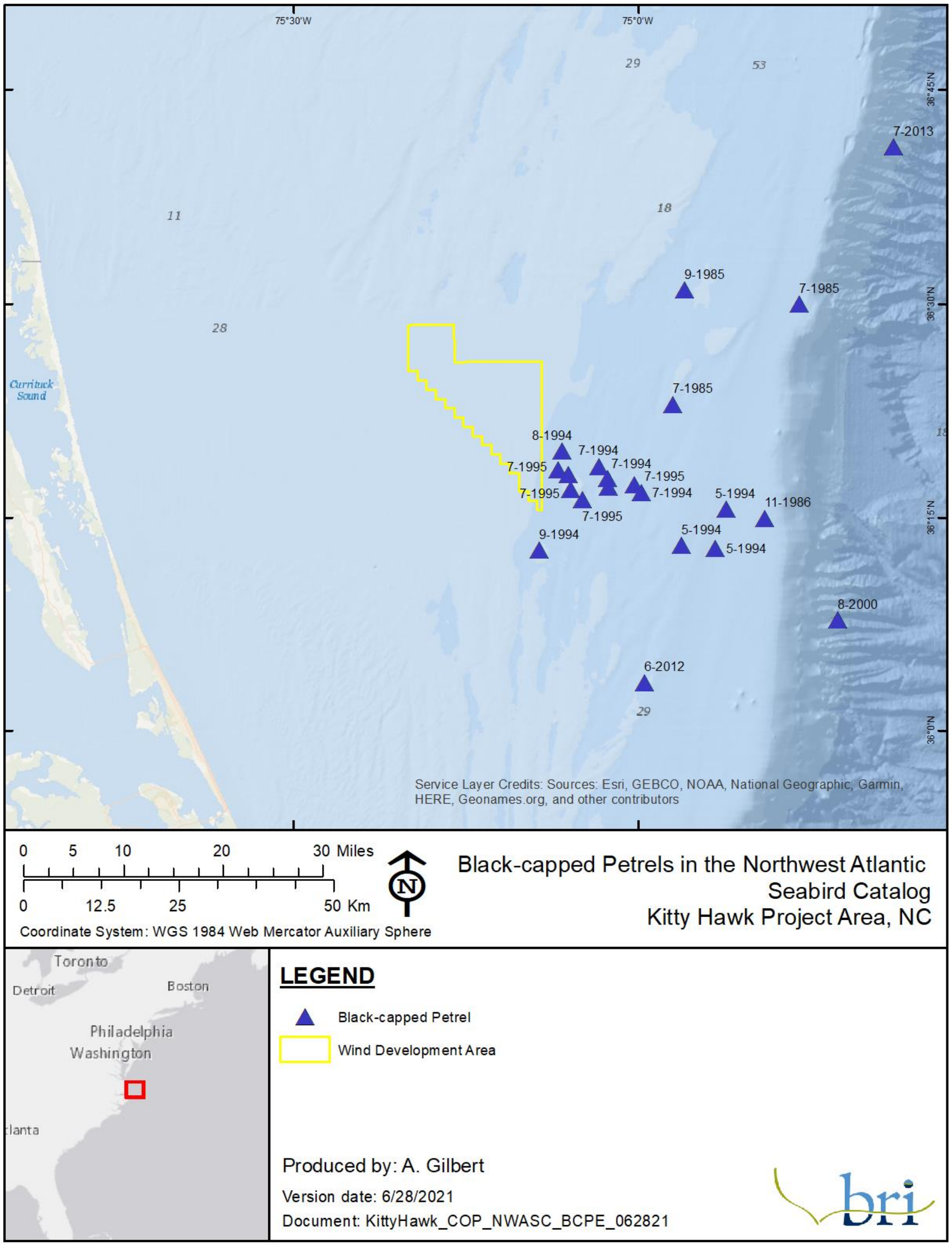

Figure 3-31: Black-capped Petrel observations from the Northwest Atlantic Seabird Catalog.

3.2.8.7.5.2 Relative Behavioral Vulnerability Assessment

Like most petrels, this species is attracted to lights, and is known to collide with lighted telecommunication towers on breeding islands (Goetz et al. 2012). This behavior could make Black-capped Petrels vulnerable to collision with lighted offshore vessels and structures. Despite some concern about the potential effects of wind facilities on Black-capped Petrels at sea, the highly pelagic nature of this species and its near absence from continental shelf waters of the southeastern U.S., led Simons et al. (2013) to conclude it unlikely that wind facilities will be detrimental to this species. Due to a lack of data, however, a vulnerability score was not developed for this species, and the vulnerability range for the other petrel species is used as a proxy.

3.2.8.7.5.3 Risk Analysis

This analysis suggests that the potential impacts to the Black-capped Petrel is ***minimal*** to **low** because, overall, these birds have minimal to low spatial and temporal exposure, and, based on the analysis for other petrel species (above), have low to medium vulnerability. Since Black-capped Petrels are not state listed, they have a medium population vulnerability score; as such, the final risk score was not adjusted.

3.2.8.8 Gannets, Cormorants, and Pelicans

3.2.8.8.1 Gannets

3.2.8.8.1.1 Spatiotemporal Context

The Northern Gannet uses the U.S. Atlantic OCS during winter and migration. They breed in southeastern Canada and winter along coasts of the mid-Atlantic region and the Gulf of Mexico. Based on analysis of satellite-tracked Northern Gannets captured and tagged in the mid-Atlantic region, these birds show a preference for shallow, productive waters and are mostly found inshore of the mid-Atlantic Wind Energy Areas in winter (Stenhouse *et al.* 2017). Northern Gannets are opportunistic foragers, capable of long-distance oceanic movements, and generally migrate on a broad front, all of which may increase their exposure to offshore wind facilities in some seasons, compared with species that are truly restricted to inshore habitats (Stenhouse *et al.* 2017).

3.2.8.8.1.2 Exposure Assessment

Exposure was assessed using species accounts, tracking data, baseline survey data, and MDAT models. Exposure is considered to be ***low*** for Northern Gannets (Table 3-20) and average counts of Northern Gannets within the Wind Development Area were lower than in the entire baseline survey area (Table 3-28). In addition, while individual tracking data indicates that the Wind Development Area is within a portion of the 95 percent utilization distribution, high use areas were closer to shore (Figure 3-32).

Table 3-20: Seasonal exposure rankings for Northern Gannets.

Gannet	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
Northern Gannet	Summer	0	0	0	minimal
	Spring	0	1	1	low
	Fall	0	0	0	minimal
	Winter	0	1	1	low

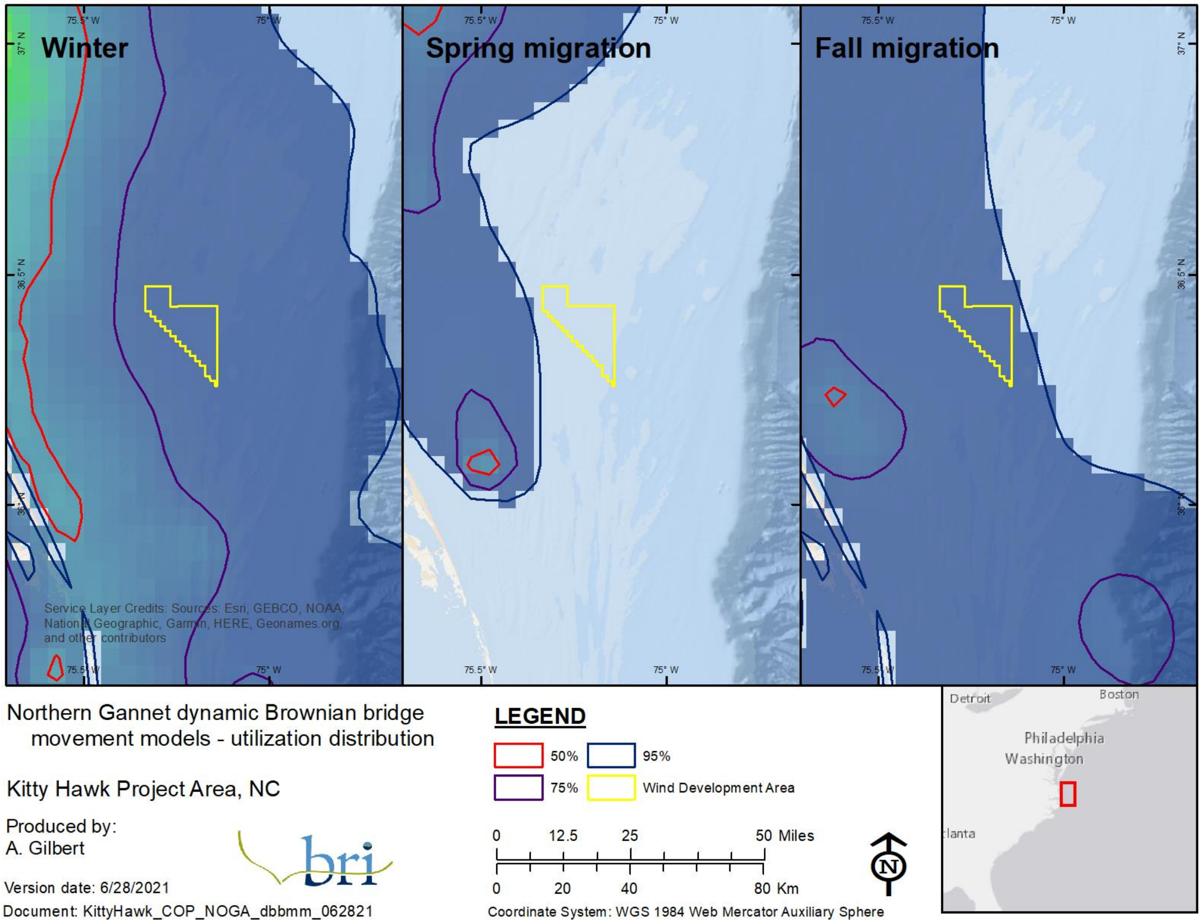

Figure 3-32: Dynamic Brownian bridge movement models for Northern Gannets (n = 34, 35, 36 [winter, spring, fall]) that were tracked with satellite transmitters. Utilization contour levels (50, 75, 95 percent) were calculated for the mean utilization distribution (UD) surface; a probability density surface showing the relative use of an area by the population of animals in this study over the period of study. 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 percent (home range).

3.2.8.8.1.3 Relative Behavioral Vulnerability Assessment

The Northern Gannet is identified as being vulnerable to both displacement and collision. They are considered to be vulnerable to displacement from habitat because studies indicate Northern Gannets strongly avoid offshore wind developments (Hartman *et al.* 2012, Garthe *et al.* 2017, Vanermen *et al.* 2015, Cook *et al.* 2012, Dierschke *et al.* 2016, Krijgsveld *et al.* 2011). Satellite tracking studies indicate near complete avoidance of active wind developments (Garthe *et al.* 2017), and avoidance rates are estimated to be 64–84 percent (macro) and a 99.1 percent (total) rate (Krijgsveld *et al.* 2011, Vanermen *et al.* 2015, Skov *et al.* 2018, Cook *et al.* 2012). However, there is little information suggesting this avoidance behavior leads to permanent displacement. Since Northern Gannets feed on highly mobile surface-fish and follow their prey throughout the Atlantic OCS (Mowbray 2020), avoidance of the Wind Development Area is unlikely to lead to habitat loss. Within a wind development, however, Northern Gannets may be vulnerable to collision because they have the potential to fly within the RSZ (Garthe *et al.* 2014, Cleasby *et al.* 2015, Furness *et al.* 2013). When they enter an offshore wind development, Northern Gannets fly in the RSZ 9.6 percent of the time (Cook *et al.* 2012) and models indicate that the proportion of birds at risk height is 0.07 (Johnston *et al.* 2014). Flight height data from the Seabird Catalog shows that during the day Northern Gannets fly within the RSZ 5.4 percent of the time (Figure 3-33).

Based on the above evidence, the risk of offshore developments to Northern Gannets is collision and displacement. The vulnerability of Northern Gannet to collision is considered to be ***low*** during construction and operation, and the collision vulnerability score was low. Recent studies indicate strong avoidance behavior (Garthe *et al.* 2017), which will likely reduce collision risk. Vulnerability to displacement is considered ***medium*** because Northern Gannets are known to avoid offshore wind developments (Table 3-21).

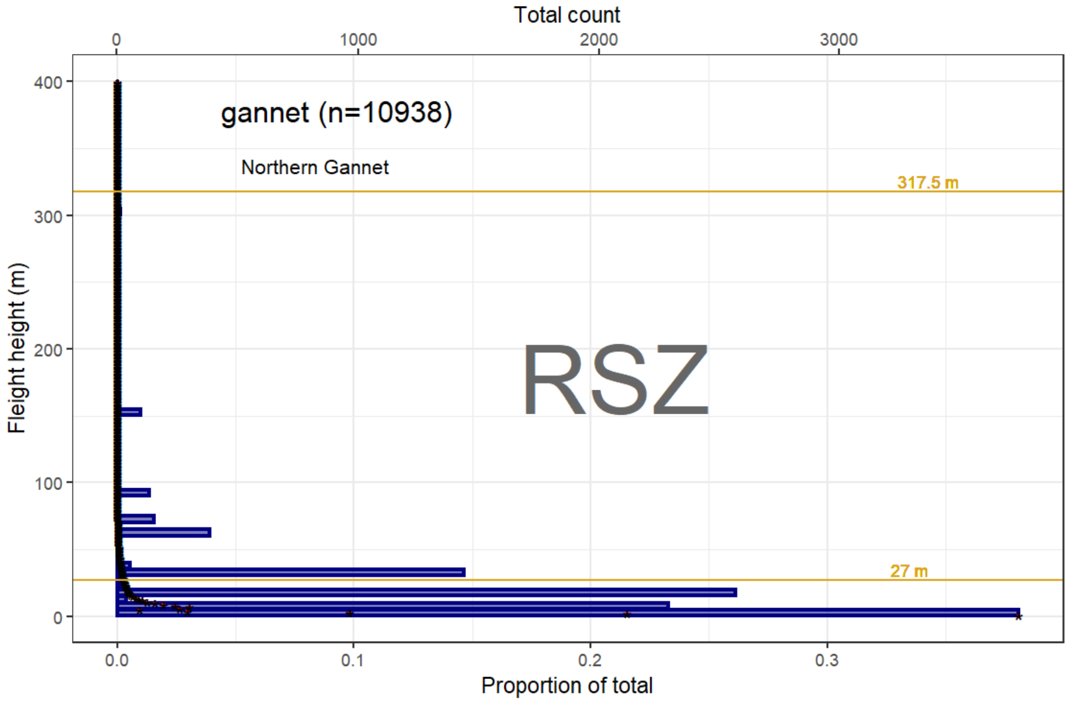

Figure 3-33: Flight heights of Northern Gannet (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

Table 3-21: Summary of gannet vulnerability.

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Northern Gannet	low (0.43)	medium (0.6)	medium (0.6)

3.2.8.8.1.4 *Risk Analysis*

This analysis suggests that the potential impacts to the Northern Gannet population is ***low*** because, overall, these birds have low exposure, both spatially and temporally, and low to medium vulnerability. However, there is uncertainty about how displacement will affect individual fitness (e.g., will it increase energy expenditure due to avoidance) and foraging opportunities (Fox & Petersen 2019). Since the Northern Gannet has a medium population vulnerability score, the final risk score was not adjusted.

3.2.8.8.2 Cormorants

3.2.8.8.2.1 *Spatiotemporal Context*

The Double-crested Cormorant (*Phalacrocorax auritus*) is the most likely species of cormorant to be exposed to the Wind Development Area. Great Cormorants (*P. carbo*) are regularly found on the Atlantic OCS as far south as the Carolinas, so could possibly pass through the Wind Development Area during the non-breeding season, but they usually remain in coastal waters (Hatch *et al.* 2020); no Great Cormorants were identified during the baseline surveys. Although much more common in the area, Double-crested Cormorants also tend to forage and roost close to shore. The regional MDAT abundance models show that cormorants are concentrated close to shore and are not commonly encountered offshore. This aligns with the literature, which indicates these birds rarely use the offshore environment (Dorr *et al.* 2020).

3.2.8.8.2.2 Exposure Assessment

Exposure was assessed using species accounts, baseline survey data, and MDAT models. Exposure is considered to be ***minimal*** for cormorants (Table 3-22) because the exposure score is minimal, and few cormorants were observed within the Wind Development Area during the baseline surveys (Table 3-28).

Table 3-22: Seasonal exposure rankings for the cormorant group.

Cormorants	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
Double-crested Cormorant	Summer	0	0	0	minimal
	Fall	0	0	0	minimal
	Spring	0	0	0	minimal
	Winter	0	1	1	low

3.2.8.8.2.3 Relative Behavioral Vulnerability Assessment

Cormorants have been documented to be attracted to WTGs (Lindeboom *et al.* 2011, Krijgsveld *et al.* 2011), may fly through the RSZ (30 percent of the time; Figure 3-34), rank in the middle of collision vulnerability assessments (Furness *et al.* 2013), and received a ***medium*** collision vulnerability score (Table 3-23). Based upon the evidence, the risk to cormorants is from collision; there is little evidence to suggest they will be displaced by offshore wind facilities and cormorants received a ***low*** displacement vulnerability score (Table 3-23).

Table 3-23: Summary of cormorant vulnerability.

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Double-crested Cormorant	medium (0.73)	low (0.4)	minimal (0.13)

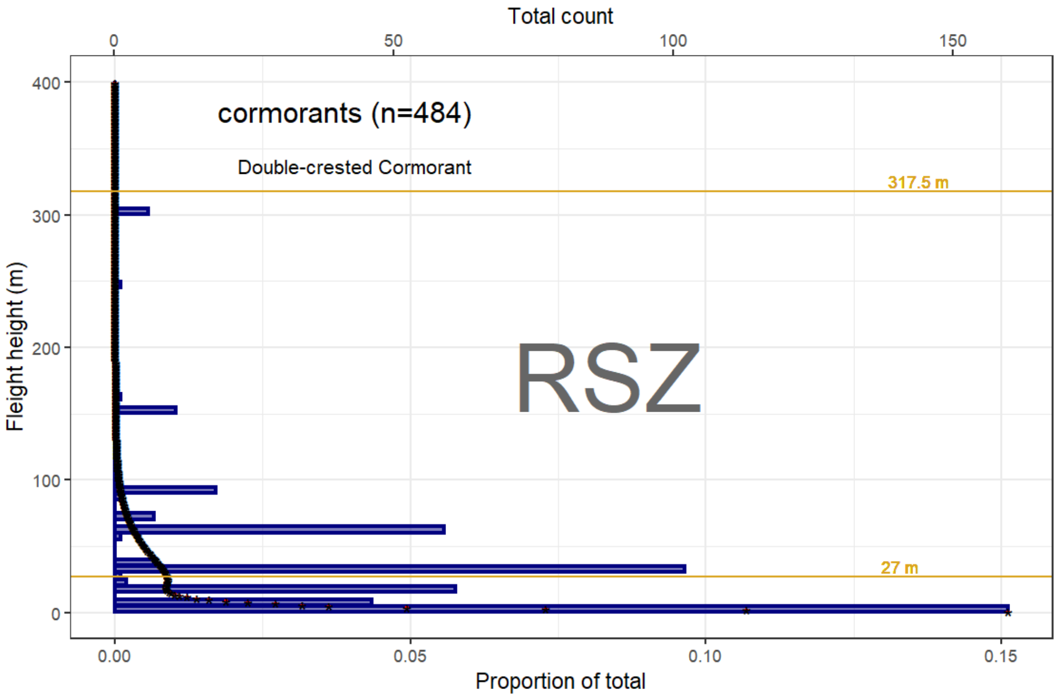

Figure 3-34: Flight heights of Double-crested Cormorant (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27-317.5 m).

3.2.8.8.2.4 Risk Analysis

This analysis suggests that the potential impacts to cormorant is ***minimal*** because these birds have minimal exposure, both spatially and temporally. Double-crested Cormorant also had a minimal population vulnerability score, but the final risk score could not be adjusted down because the birds already were in the lowest risk category.

3.2.8.8.3 Pelicans

3.2.8.8.3.1 Spatiotemporal Context

The Brown Pelican (*Pelecanus occidentalis*) breeds along both the Atlantic and Pacific coasts of the U.S., as well as the Gulf of Mexico (Shields 2020). Atlantic breeding colonies span coastal areas from Maryland to Florida, with colonies documented in both Virginia (Watts *et al.* 2018) and North Carolina (LeGrand, Haire, *et al.* 2020). Most pelicans breeding in Virginia and North Carolina likely migrate further south during winter (Schreiber & Mock 1988, Iliff 1999), though year-round presence has also been documented (LeGrand, Haire, *et al.* 2020, Wilkinson *et al.* 1994). These birds show a preference for relatively shallow (<150 m), productive waters, typically within 20 km of shore (Shields 2020, Lamb *et al.* 2019). American White Pelicans (*P. erythrorhynchos*) are an occasional migrant and uncommon (though increasing) winter visitor

(LeGrand, Haire, *et al.* 2020). A vulnerability assessment was not conducted for the American White Pelican.

3.2.8.8.3.2 Exposure Assessment

Exposure was assessed using species accounts, baseline survey data, and MDAT models. Exposure is considered to be minimal for the Brown Pelican (Table 3-24), because the exposure score is ***minimal*** for all seasons, and few pelicans were observed within the Wind Development Area during the baseline surveys (Table 3-28).

Table 3-24: Seasonal exposure rankings for the pelican group.

Pelicans	Season	Local Rank	Regional Rank	Total Rank	Exposure Score
American White Pelican	Fall	0	·	0	minimal
	Summer	0	·	0	minimal
	Spring	0	·	0	minimal
	Winter	0	·	0	minimal
Brown Pelican	Winter	0	0	0	minimal
	Summer	0	0	0	minimal
	Spring	0	0	0	minimal
	Fall	0	0	0	minimal

3.2.8.8.3.3 Relative Behavioral Vulnerability Assessment

Once listed under the ESA, the Brown Pelican made a strong recovery and the Atlantic and Gulf coast population was removed from the list in the 1985 (USFWS 2009a). They generally forage in warm, relatively shallow coastal waters, but commonly roost on offshore artificial structures (Shields 2020), occasionally fly through the RSZ (4.6 percent of the time; Figure 3-35), and have ranked highly in at least one collision vulnerability assessments (Kelsey et al. 2018). However, in our assessment, they received a ***low*** collision vulnerability score (Table 3-25). They may be attracted to areas of higher fish density and increased foraging opportunities around WTGs, and there is little to suggest they will be displaced by offshore wind facilities although they received a ***medium*** displacement vulnerability score. Based on the evidence, the risk to pelicans is from collision, but that is likely minor since their exposure is minimal and they do not fly within the RSZ often.

Table 3-25: Summary of pelican vulnerability.

Species	Collision Vulnerability	Displacement Vulnerability	Population Vulnerability
Brown Pelican	low (0.4)	medium (0.5)	medium (0.53)

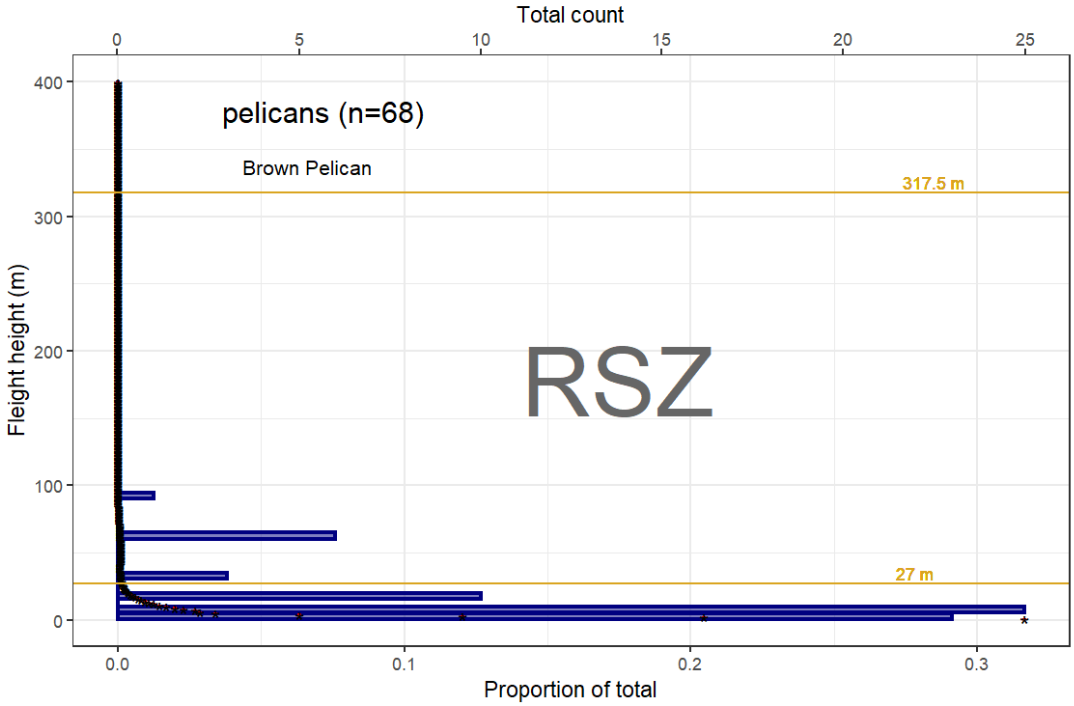

Figure 3-35: Flight heights of Brown Pelican (m) derived from the Northwest Atlantic Seabird Catalog, showing the actual number of birds in 5 m intervals (blue bars), and the modeled average flight height in 1 m intervals (asterisk) and the standard deviation (red lines), in relation to the upper and lower limits of the Rotor Swept Zone (RSZ) (gold; 27–317.5 m).

3.2.8.8.3.4 Risk Analysis

This analysis suggests that the potential impact to Brown Pelicans is ***minimal*** because these birds have minimal exposure, both spatially and temporally. Since the Brown Pelican had a medium population vulnerability score, the final risk score was not adjusted.

3.3 Mitigation

Exposure of bird populations to the Project has been avoided by siting the WTGs offshore, in a WEA designated by BOEM. The Company will construct and operate the Project in compliance with Federal Aviation Administration and United States Coast Guard requirements for lighting, while using lighting technology that minimize impacts on avian species to the extent practicable. Any dead or injured birds found on Project vessels or structures during construction, operation, or decommissioning will be documented in an annual report submitted to BOEM and USFWS (any birds found with federal bands will be reported to the United States Geological Survey Bird Band Laboratory).

3.4 Summary and Conclusions

This offshore avian assessment considered the potential impacts of the Project on birds during construction, operations, and decommissioning within the Wind Development Area in Lease

Area OCS-A 0508. Overall, Project activities occurring in the Wind Development Area are unlikely to impact populations of coastal or marine birds because of their minimal to low exposure (Table 3-26). While coastal birds may occasionally forage in the Wind Development Area, or pass through on their spring and/or fall migrations, the Wind Development Area is generally far enough offshore as to be beyond the range of most breeding terrestrial or coastal bird species. All marine birds are expected to have minimal to low exposure. The Project largely avoids areas of high marine bird abundance because it is located between coastal and offshore concentration areas and is not adjacent to any major bays or estuaries. Overall, listed species are also expected to have minimal to low exposure to the Wind Development Area. While there remains uncertainty on the offshore movements of Piping Plovers and Red Knots, flights within the Wind Development Area are likely limited to few individuals during migration, and they generally are expected to be flying above the WTGs. There are no records of Roseate Terns within the Wind Development Area, and if individuals fly through the area during migration, they are likely flying below the WTGs. There are some historical records of Black-capped Petrel to the east of the Wind Development Area, but none were detected in digital aerial surveys. Finally, eagles are not expected as far offshore as the Wind Development Area and they were not detected in any surveys. In summary, the Project is unlikely to impact populations of non-listed species or individual listed species.

Table 3-26: Overall summary of the assessment of potential effects on birds. Categories that are adjusted up due to population vulnerability are highlighted in orange (none were adjusted down).

Group	Exposure	Relative Vulnerability to				Collision Risk	Displacement Risk
		Collision	Displacement		Population		
			Temporary	Long-term			
Coastal Waterbirds	min	.	.	.	.	.	.
Shorebirds	min.	.	.	.	.	.	.
Piping Plover	low	min–low	min	min	med	min–low	min
Red Knot	min–low	low	min	min	med	min–low	min
Wading Birds	min	.	.	.	.	.	.
Raptors (falcons)[1]	low	low–med	min–low	min–low	.	low	min–low
Eagles	min	min	min	min	.	min	min
Songbirds	min–low	low–med	min	min		min–low	min
Marine Birds							
Sea Ducks[2]	min–low	low	high	med	low–med	min–low	min–low
Auks	min–low	min–low	med–high	med–high	low–med	min–low	min–low
Gulls, Jaegers & Skuas	min–low	low–med	low–med	low–med	min–med	min–low	min–low
Terns (excluding Roseate Tern)	min–low	low	low–high	low–high	med	min–low	min–low
Roseate Tern	min	low	med–high	med–high	high	low	low
Loons	min–low	min–low	high	high	med	min–low	min–low
Shearwaters, Petrels & Storm-Petrels	min	low	low–med	low–med	med	min	min
Black-capped Petrel	min–low	low	low–med	low–med	med	min–low	min–low
Gannets, Cormorants, Pelicans							
Northern Gannet	low	low	med	med	med	low	low
Double-crested Cormorant	min	med	low	low	min	min	min
Brown Pelican	min	low	med	med	med	min	min

[1] Almost exclusively Peregrine Falcon and Merlin. Non-falcon raptors have limited use of the offshore environment. [2] Excluding Red-breasted Merganser.

3.5 Supplemental Information

Table 3-27: Compared bootstrap mean and 95 percent confidence intervals (CI) for densities (count/sq. km) from Kitty Hawk APEM and BOEM SAB digital aerial surveys (methods detailed in Attachment A).

Taxonomic Group (Species)	Kitty Hawk density (CI)	BOEM SAB density (CI)	Density CI comparison
Phalaropes			
Red Phalarope	0.023 (0-0.06)	0 (0-0)	·
Auks			
Razorbill	0.44 (0.139-0.843)	0.058 (0-0.129)	KH CI above BOEM SAB CI
Atlantic Puffin	0.057 (0.014-0.121)	0 (0-0)	KH CI above BOEM SAB CI
Small Gulls			
Bonaparte's Gull	0.026 (0.007-0.048)	1.609 (0.723-2.768)	KH CI below BOEM SAB CI
Medium Gulls			
Black-legged Kittiwake	0.007 (0-0.02)	0.534 (0.116-1.096)	KH CI below BOEM SAB CI
Laughing Gull	0.004 (0-0.013)	0.027 (0-0.077)	·
Ring-billed Gull	0 (0-0)	0.01 (0-0.025)	·
Large Gulls			
Herring Gull	0.009 (0-0.02)	0 (0-0)	·
Great Black-backed Gull	0.008 (0-0.019)	0.056 (0-0.142)	·
Medium Terns			
Forster's Tern	0 (0-0)	0.005 (0-0.014)	·
Loons			
Red-throated Loon	0.003 (0-0.01)	0.01 (0-0.033)	·
Common Loon	0.911 (0.461-1.479)	0.502 (0.201-0.928)	·
Shearwaters and Petrels			
Northern Fulmar	0 (0-0)	0.016 (0-0.049)	·
Cory's Shearwater	0 (0-0)	0.013 (0-0.04)	·
Gannet			
Northern Gannet	0.14 (0.057-0.262)	0.266 (0.076-0.398)	·

Table 3-28: Mean seasonal and annual species densities (count/sq. km) derived from the Kitty Hawk APEM digital aerial survey area for the Kitty Hawk Project Area compared to annual species densities (count/sq. km) derived from the BOEM South Atlantic Bight digital aerial survey area within the Kitty Hawk project area and across the entire survey area.

Species	Mean density (total count/sq. km)						
	Kitty Hawk APEM					BOEM SAB	
	winter – project	spring – project	summer – project	fall – project	annual – project	annual – project	annual – SAB
Ducks, Geese, and Swans							
American Black Duck	0	0	0	0	0	0	<0.001
Unidentified duck	0	0	0	0	0	0	0.001
Coastal Diving Ducks							
Greater Scaup	0	0	0	0	0	0	0.002
Lesser Scaup	0	0	0	0	0	0	<0.001
Grebes							
Horned Grebe	0	0	0	0	0	0	<0.001
Shorebirds							
Black-bellied Plover	0	0	0	0.004	0	0	0
Dunlin	0	0	0	0	0	0	<0.001
Unidentified shorebird	0	0	0	0	0	0	<0.001
Phalaropes							
Red-necked Phalarope	0	0	0	0	0	0	0.002
Red Phalarope	0.091	0	0	0	0.023	0	1.248
Unidentified phalarope	0	0	0	0.086	0.026	0	0.282
Heron and Egrets							
Great Blue Heron	0	0	0	0	0	0	0.003
Great Egret	0	0	0	0	0	0	<0.001
Snowy Egret	0	0	0	0	0	0	<0.001
Green Heron	0	0	0	0	0	0	<0.001
Raptors							
Peregrine Falcon	0	0	0	0	0	0	<0.001
Passerines							

Species	Mean density (total count/sq. km)						
	Kitty Hawk APEM					BOEM SAB	
	winter – project	spring – project	summer – project	fall – project	annual – project	annual – project	annual – SAB
Unidentified passerine (perching birds, songbirds)	0	0	0	0.003	0	0	<0.001
Sea Ducks							
Surf Scoter	0	0	0	0	0	0	<0.001
White-winged Scoter	0	0	0	0	0	0	0.003
Black Scoter	0	0	0	0	0	0	0.140
Long-tailed Duck	0	0	0	0	0	0	<0.001
Red-breasted Merganser	0	0	0	0	0	0	<0.001
Unidentified scoter	0	0	0	0	0	0	<0.001
Skuas and Jaegers							
Great Skua	0.003	0	0	0	0	0	<0.001
Pomarine Jaeger	0	0	0	0	0	0	<0.001
Parasitic Jaeger	0	0	0	0	0	0	0.001
Unidentified skua	0	0	0	0	0	0	0.002
Auks							
Dovekie	0.008	0	0	0	0	0	<0.001
Razorbill	1.114	0.035	0	0	0.440	0.058	1.122
Atlantic Puffin	1.190	0.005	0	0	0.057	0	0.003
Unidentified auk	0	0	0	0	0	0	0.007
Unidentified large auk (Razorbill or Murre)	1.776	0.015	0	0	0.343	0.039	0.021
Unidentified murre	0.029	0	0	0	0.007	0	<0.001
Small Gulls							
Bonaparte's Gull	0.034	0.024	0	0.004	0.026	1.609	1.423
Little Gull	0	0	0	0	0	0	<0.001
Unidentified small gull	0.052	0.009	0	0.252	0.017	1.450	0.209
Medium Gulls							
Black-legged Kittiwake	0.042	0	0	0	0.007	0.534	0.131
Laughing Gull	0.003	0.008	0.002	0.035	0.004	0.027	0.077
Ring-billed Gull	0	0	0	0	0	0.010	0.014
Large Gulls							
Herring Gull	0.058	0.011	0	0.009	0.009	0	0.359

Species	Mean density (total count/sq. km)						
	Kitty Hawk APEM					BOEM SAB	
	winter – project	spring – project	summer – project	fall – project	annual – project	annual – project	annual – SAB
Iceland Gull	0	0	0	0	0	0	<0.001
Lesser Black-backed Gull	0	0.003	0	0	0	0	0.012
Glaucous Gull	0	0	0	0	0	0	<0.001
Great Black-backed Gull	0.217	0	0	0.006	0.008	0.056	0.050
Unidentified large gull	0.003	0	0	0.002	0.009	0.014	0.017
All Gulls							
Unidentified gull	0.003	0	0	0.005	0	0	<0.001
Small Terns							
Least Tern	0	0.003	0	0	0	0	0
Black Tern	0	0	0	0	0	0	0.003
Medium Terns							
Bridled Tern	0	0	0	0	0	0	<0.001
Gull-billed Tern	0	0	0	0	0	0	0.001
Common Tern	0	0	0	0	0	0	0.012
Forster's Tern	0	0.002	0	0	0	0.005	0.127
Royal Tern	0	0	0	0	0	0	0.023
Sandwich Tern	0	0	0	0	0	0	0.008
Common or Arctic Tern	0	0	0	0	0	0	<0.001
Large Terns							
Caspian Tern	0	0	0	0	0	0	0.002
Unidentified large tern	0	0	0	0	0	0	0.010
All Terns							
Unidentified tern	0	0.012	0.002	0.017	0.002	0	0.104
Loons							
Red-throated Loon	0.006	0.002	0	0	0.003	0.011	1.456
Common Loon	0.684	0.892	0	0.006	0.911	0.502	0.581
Unidentified loon	0	0	0	0	0	0	0.013
Storm-Petrels							
Unidentified storm-petrel	0	0.012	1.519	0	0	0	<0.001
Shearwaters and Petrels							
Northern Fulmar	0	0.002	0	0	0	0.016	0.005
Black-capped Petrel	0	0	0	0	0	0	<0.001

Species	Mean density (total count/sq. km)						
	Kitty Hawk APEM					BOEM SAB	
	winter – project	spring – project	summer – project	fall – project	annual – project	annual – project	annual – SAB
Cory's Shearwater	0	0	0.010	0	0	0.013	0.006
Sooty Shearwater	0	0	0	0.002	0	0	<0.001
Great Shearwater	0.003	0	0	0	0	0	0.001
Manx Shearwater	0.007	0.040	0	0	0	0	0.038
Audubon's Shearwater	0	0	0	0.002	0	0	0
Unidentified petrel	0	0	0	0	0	0	<0.001
Unidentified large shearwater	0	0	0	0	0	0	0.004
Unidentified small shearwater (Audubon's, Manx, or Little)	0	0	0	0	0	0	<0.001
Gannets							
Northern Gannet	0.276	0.088	0	0.006	0.140	0.226	1.204
Cormorants							
Double-crested Cormorant	0	0	0	0	0	0	0.001
Unidentified cormorant	0.006	0	0	0	0.007	0	0.002
Pelicans							
American White Pelican	0	0	0	0	0	0	<0.001
Brown Pelican	0	0	0	0	0	0	0.007

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A Attachment A: Detailed Avian Assessment Methods

A.1 Exposure Framework

Exposure has both a horizontal and vertical component. The assessment of exposure 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. For all birds, exposure was considered both in the context of the proportion of the population predicted to be exposed to the Wind Development Area as well as absolute numbers of individuals. The following sections introduce (1) the data sources used in the analysis, (2) the methods used to map species exposure, assign an exposure metric, and aggregate scores to year and taxonomic group, and (3) an interpretation of exposure scores.

A.1.1 Exposure Assessment Data Sources and Coverage

To assess the proportion of marine bird populations exposed to the Wind Development Area, three data sources were used to evaluate local and regional marine bird use: (1) the seasonal BOEM South Atlantic Bight high-resolution digital aerial surveys (hereafter BOEM SAB surveys) conducted in 2018, (2) the project-specific Kitty Hawk APEM monthly high-resolution digital aerial surveys (hereafter Kitty Hawk APEM surveys) conducted in 2019, and (3) version 2 of the Marine-life Data and Analysis Team (MDAT) marine bird relative density and distribution models (hereafter MDAT models; Curtice et al. 2016). The BOEM SAB surveys provide local coverage of both the Lease Area and surrounding waters on a seasonal basis. The Kitty Hawk APEM surveys provided better temporal granularity to the seasonal BOEM SAB survey data within the Lease Area and buffer. The MDAT models are modeled abundance data providing a large regional context for the Lease Area but are built from offshore survey data collected from 1978–2016. The BOEM SAB survey data were not included in the MDAT models. 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 avian survey guidelines, and the goals detailed above and described below. However, at the time of analysis, only a single year of BOEM SAB data was available to provide the local context and the seasonal coverage spatially did not exactly align with our defined seasons: winter (Dec, Jan, Feb), spring (Mar, Apr, May), summer (Jun, Jul, Aug), and Fall (Sep, Oct, Nov). Thus, we evaluated local exposure at an annual scale and used Kitty Hawk APEM survey data to provide seasonal context for exposure relative to the BOEM SAB surveys.

A.1.1.1 Baseline Survey Description

BOEM SAB high resolution digital aerial surveys were conducted by Normandeau Associates, Inc. and APEM Inc. in 2018 and 2019 within an area defined by the coasts of North and South Carolina from state territorial waters out to the 30 m isobath and including Kitty Hawk, Wilmington East, Wilmington West Wind Energy Areas, and South Carolina–Grand Strand Call Area. The primary survey area was covered by a minimum of 5 percent and the wind energy and call areas at 10 percent. Ground spatial resolution was 1.5 cm. Four quarterly surveys were intended, and while four surveys were completed in 2018, temporal coverage was not spread evenly across seasons and as such were used to provide annual exposure risk instead of seasonal exposure.

Table A-1: Survey dates for the seasonal BOEM South Atlantic Bight high-resolution digital aerial survey, year 1, conducted in 2018.

Season	Reference Month	Date Started	Date Completed	Days to Complete
Winter	Dec, Jan, Feb	31 Jan 2018	22 Dec 2018	12
Spring/summer	May, Jun	27 May 2018	16 Jun 2018	6
Fall	Sep, Oct, Nov	8 Sep 2018	11 Nov 2018	9

Kitty Hawk high resolution aerial surveys were conducted monthly in 2019 by Normandeau Associates, Inc. and APEM Inc. across the Lease Area (Lease Area OCS-A 0508) plus a 4 km buffer, which resulted in >10 percent coverage at 1.5 cm ground spatial resolution. Each survey required a single day to complete.

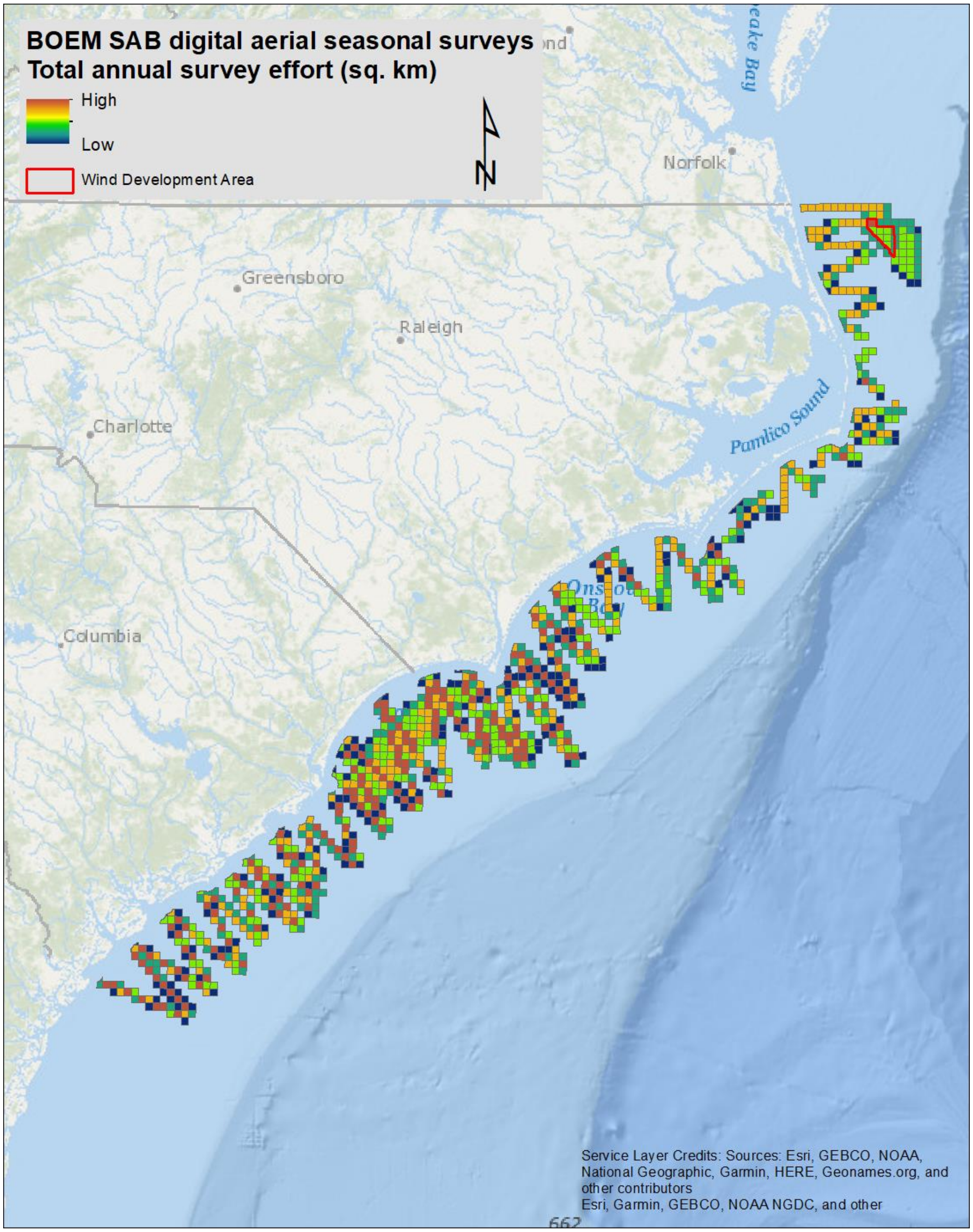

Figure A-1: BOEM SAB digital aerial seasonal surveys. Total annual survey effort (sq. km).

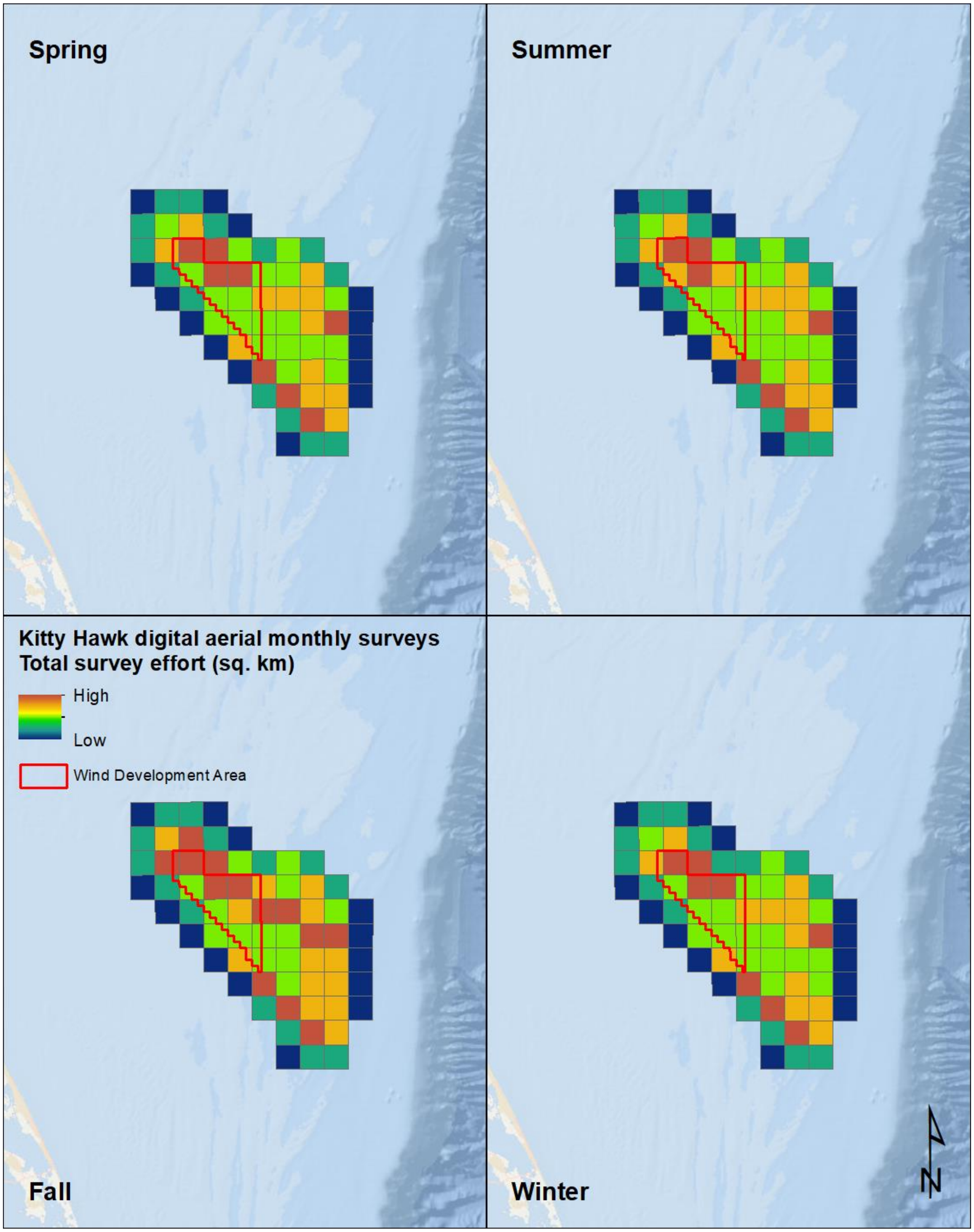

Figure A-2: Kitty Hawk APEM digital aerial monthly surveys. Total survey effort (sq. km).

A.1.1.2 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 (Curtice *et al.* 2016, Winship *et al.* 2018), 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[4]. The MDAT analysis integrated survey data (1978–2016) from the Atlantic Offshore Seabird Dataset Catalog[5] with a range of environmental variables to produce long-term average annual and seasonal models (Figure A-3). These models were specifically developed to support marine spatial planning on the Atlantic OCS. In Version 2 (used here), relative abundance and distribution models were produced for 47 avian species using U.S. Atlantic waters from Maine to Florida; this resource thus provides an excellent broad scale, regional context for the local relative densities estimated from digital aerial surveys.

The MDAT models as well as the BOEM SAB and Kitty Hawk APEM surveys each have strengths and weaknesses. The BOEM SAB and Kitty Hawk 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 Wind Development Area 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 means that individual observations (or lack of observations, for rare species) may in some cases carry substantial weight in determining exposure.

The MDAT models, in contrast to baseline surveys, 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 Wind Development Area to marine birds relative to other available locations in the Northwest Atlantic and is 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.

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[4] http://seamap.env.duke.edu/models/mdat/

[5] https://coast.noaa.gov/digitalcoast/data/atloffshoreseabird.html

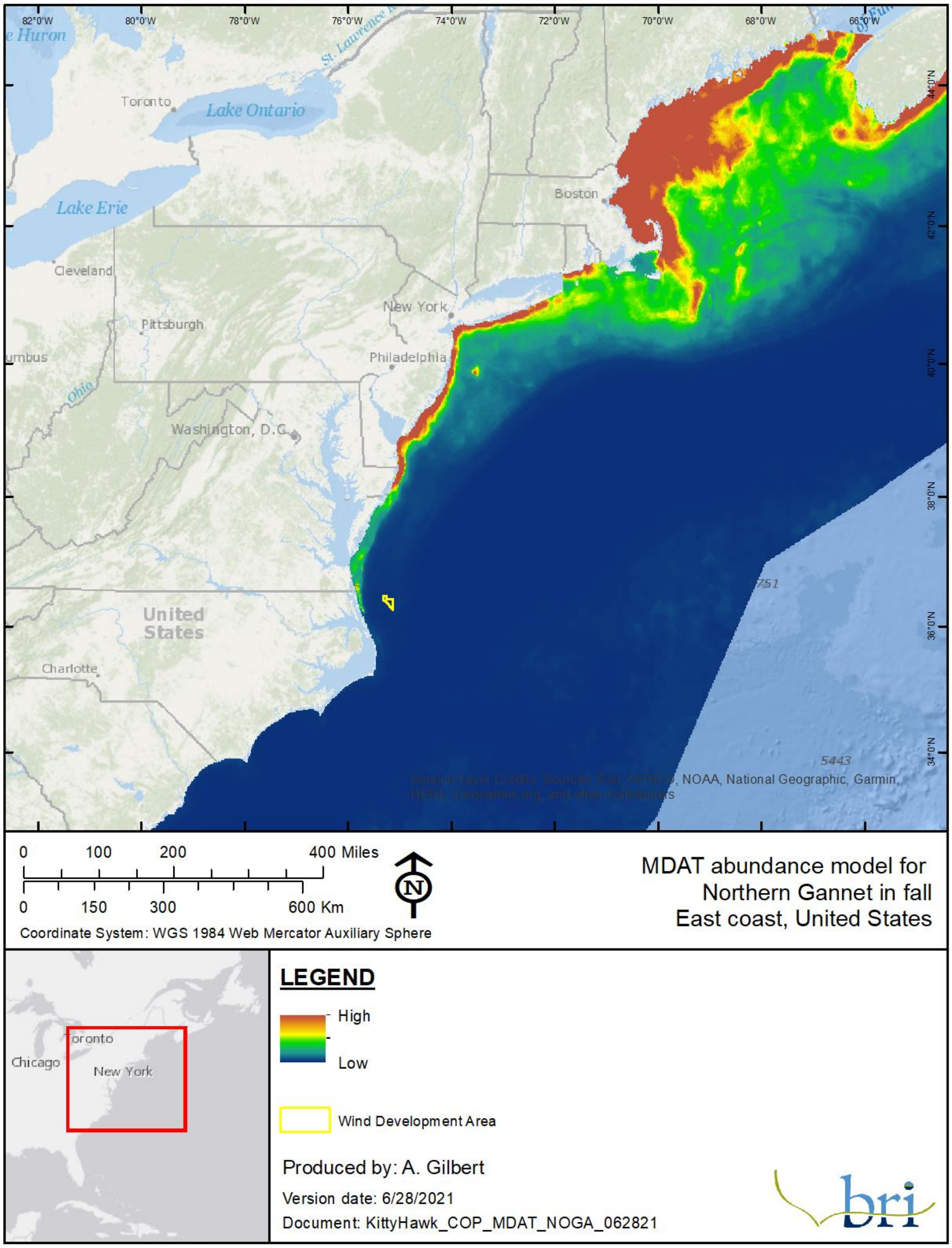

Figure A-3: Example Marine-life Data and Analysis Team (MDAT) abundance model for Northern Gannet in fall.

A.1.1.3 Secondary Sources

A.1.1.3.1 Northwest Atlantic Seabird Catalog

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

A.1.1.3.2 Mid-Atlantic Diving Bird Tracking Study

A satellite telemetry tracking study in the mid-Atlantic was developed and supported by BOEM and the USFWS with the objective of determining the 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 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 partners[6]. Results provide a better understanding of how these diving birds use offshore areas of the mid-Atlantic OCS and beyond.

A.1.1.3.3 Migrant Raptor Studies

Peregrine Falcon and Merlin

To facilitate research efforts on migrant raptors (i.e., migration routes, stopover sites, space use relative to WEAs, wintering/summer range, origins, contaminant exposure), BRI has deployed satellite transmitters on fall migrating raptors at three different raptor migration research stations along the Atlantic coast (DeSorbo et al. 2012, 2018c, 2018a). Research stations are located at Block Island, Rhode Island, Monhegan Island, Maine, and Cutler, Maine.

Satellite-tagged Peregrine Falcons (*Falco peregrinus*; *n*=41) and Merlins (*F. columbarius*; *n*=16) 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[7] where these data are stored. A

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

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

request for data use was made to Chris DeSorbo, the Raptor Program Director at BRI, who provided permission to use 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 United States (U.S.) and Canada between 1995 and 2001 (Martell & Douglas 2019, Martell *et al.* 2001). This data has been used to delineate both fall and spring migratory routes used by ospreys breeding in the U.S. 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, Utilization Distributions (UD) were generated for individual animals using a dynamic Brownian Bridge Movement Model (dBBMM; Kranstauber et al. 2012). Both Argos satellite data and GPS-derived positional data were used from the two different telemetry datasets from 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 U.S. 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 U.S. 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.

A.1.1.3.4 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 and an array of automated VHF 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, they 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 ESA-listed Piping Plovers (*Charadrius melodus*) and Roseate Terns (*Sterna dougallii*). This study provided new information on the offshore movements and flight altitudes for these species primarily to the north of the Wind Development Area gathered from a total of 33 automated telemetry stations, including areas of Massachusetts, New York, New Jersey, Delaware, and Virginia (Loring *et al.* 2019).

A.1.1.3.5 Tracking movements of *rufa* Red Knots in U.S. Atlantic Outer Continental Shelf Waters

The eastern North American population of the Red Knot (*Calidris canutus*) is designated as a subspecies (*C. c. rufa*). 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 U.S. Atlantic coast. Individuals were tracked utilizing radio telemetry stations within the study area that extended to an area north of the Wind Development Area from Cape Cod, Massachusetts, to Back Bay, Virginia. Modeling techniques were developed to describe the frequency and offshore movements over federal waters and specific WEAs within the study area. The primary study objectives were to (1) develop models related to offshore movements for *rufa* Red Knots, (2) assess the exposure to each WEA during southbound migration, and (3) examine WEA exposure and migratory departure movements in relation to various meteorological conditions (Loring *et al.* 2018).

A.1.1.3.6 Sea Duck Tracking Studies

The Atlantic and Great Lakes Sea Duck Migration Study, a multi-partner collaboration, was initiated by the Sea Duck Joint Venture (SDJV) in 2009 with the goals of (1) fully describing full annual cycle migration patterns for four species of sea ducks (the Surf Scoter, Black Scoter [*Melanitta americana*], White-winged Scoter [*M. 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 near-shore 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, the Canadian Wildlife Service, USGS Patuxent Wildlife Research Center, University of Rhode Island, Rhode Island Department of Environmental Management, U.S. Fish and Wildlife Service, Sea Duck Joint Venture, 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, Meattey *et al.* 2018, Meattey *et al.* 2019, SDJV 2015).

In addition, BOEM and USFWS partnered with the 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).

A.1.2 Exposure Mapping

Maps were developed to display local and regional context for exposure assessments. A three-panel map was created for each species-season combination that includes MDAT and/or local BOEM SAB survey (BOEM SAB and Kitty Hawk APEM surveys, see Attachment B). 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 winter is provided below to aid in discussion (Figure A-4).

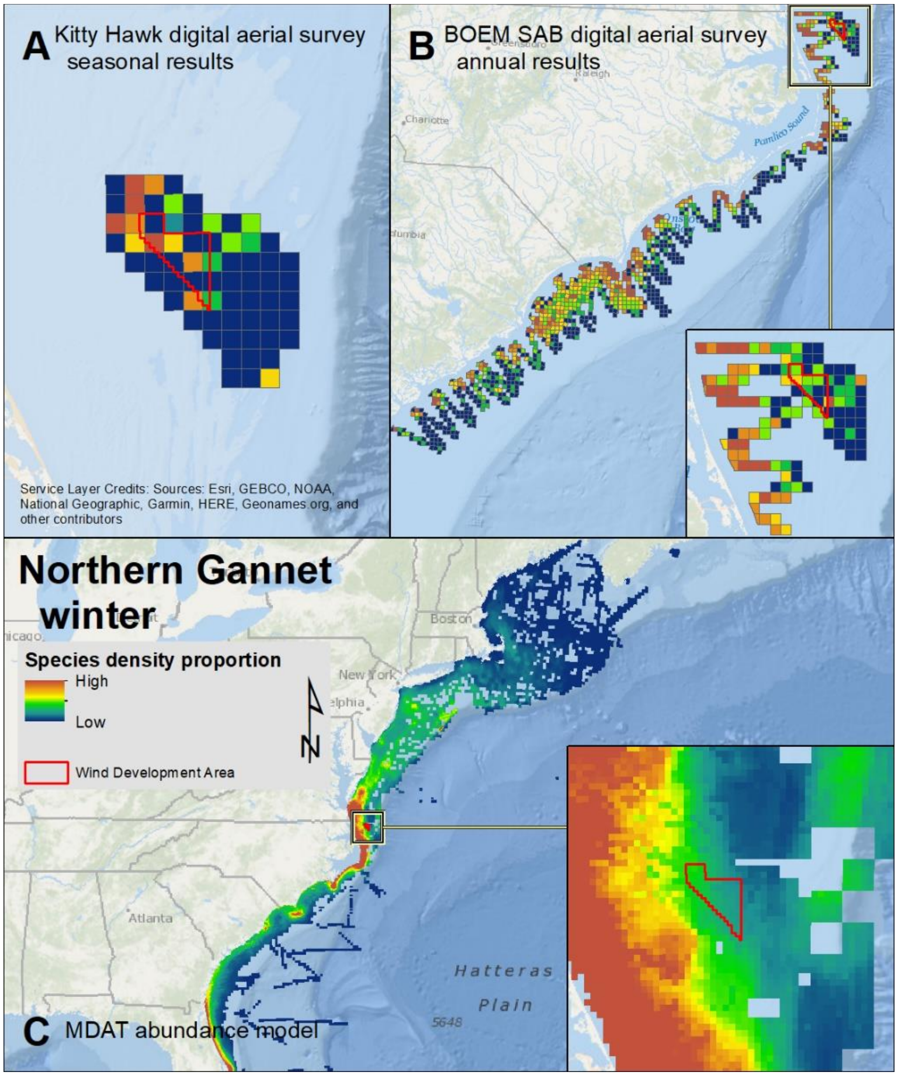

Figure A-4: Example species map of relative density proportions locally and regionally. Panel (A) presents the seasonal Kitty Hawk APEM data as proportions of total effort-corrected counts. Panel B includes the annual BOEM South Atlantic Bight Survey data as proportions of total effort-corrected counts for the entire survey area with an inset of the Wind Development Area. Panel C includes data from MDAT models presented at different scales: baseline survey data and the entire northwest Atlantic.

The first map panel (A) presents the Kitty Hawk APEM data as proportions of total effort-corrected counts within a season. The proportion of the total effort-corrected counts (total counts per square km) was calculated for each BOEM designated OCS[8] Lease Block[9], 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. The second map panel (B) presents the annual BOEM SAB data as proportions of total effort-corrected counts. The proportion of the total effort-corrected counts (total counts per square km) was calculated as for Kitty Hawk surveys, but mean annual exposure is presented due to lack of correspondent seasonal surveys. Exposure was ranked from low-to-high for each species based on weighted quantiles of these count proportions based on BOEM SAB survey data aggregated annually. 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 4 weighted quantiles.

The last map panels (C) include data from MDAT models presented for the entire Northwest Atlantic, with an inset at the project area scale. Density data are scaled in a similar way to the BOEM SAB 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, except that we added in zero-effort prediction within the area surveyed for the Kitty Hawk APEM surveys. 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 taxonomic group densities and to strengthen the analysis. Furthermore, 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.

A.1.3 Exposure Assessment Metrics

To assess bird exposure at the local (i.e., South Atlantic Bight) and regional scales (i.e., U.S. Atlantic waters), the Wind Development Area was compared to other similarly sized areas in each dataset for each season and species. Using the MDAT data, masked to remove zero-effort predicted cells, the predicted seasonal density surface for a given species was aggregated into a

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[8] Outer Continental Shelf (OCS) is defined by the 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".

[9] 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.

series of rectangles that were approximately the same size as the Wind Development Area, 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 Wind Development Area. The 25th, 50th, and 75th weighted quantiles of this dataset were calculated, and the quantile into which the density estimate for the Wind Development Area 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 Wind Development Area for each season-species: 0 (Minimal) was assigned when the density estimate for the Wind Development Area was in the bottom 25 percent; 1 (Low) when it was between 25 and 50 percent; 2 (Medium) when it was between 50 and 75 percent; and 3 (High) when it was in the top quartile (>75 percent).

A similar process was used to categorize each species using the baseline survey data, but we aggregated data to the annual level because of the lack of consistent temporal coverage across seasons and only having four surveys over one year at the time of analysis. The mean relative density for the Wind Development Area (a collection of 22 partial or full OCS Lease Blocks) was calculated. To compare the Wind Development Area to other locations with the survey region, the nearest 22 OCS Lease Blocks to each OCS Lease Block surveyed in the BOEM SAB survey area were identified and the relative density of each 1,067 OCS Lease Block groups was calculated. Thus, a dataset of relative densities for all possible Wind Development Area-sized OCS Lease Block groups was generated within the BOEM SAB survey region using the BOEM SAB survey data. This data set was used to assign local scores to all species, based on the same quartile categories described for the MDAT models above. If a score for a species was not available using the BOEM SAB survey data (local assessment), and because the avian surveys made every effort to survey all species, then the local assessment score was assigned a 0, since no animals were sighted for that species.

A.1.4 Species Exposure Scoring

To determine the relative exposure for a given species and season in the Wind Development Area compared to all other areas, the seasonal MDAT quartile score and the annual BOEM SAB 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 Wind Development Area 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 (BOEM SAB 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 ***minimal*** (a combined score of 0), ***low*** (combined score of 1–2), ***medium*** (combined score of 3–4), or ***high*** (combined score of 5–6; Table A-2). In general terms, species-season combinations labeled as ***minimal*** had low densities at both the local and regional scales. ***Low*** exposure was assessed for species with below-average densities at both spatial scales, or above-average density at one of the two scales and low density at the other scale. ***Medium*** exposure describes several different combinations of densities; one or both scales must be at least above-average density, but this category can also include species-season combinations where density was high for one scale and low for another. ***High*** exposure is when both scales are high density, 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.

A.1.5 Comparison of the BOEM SAB and Kitty Hawk APEM surveys

The following methods were used to determine if exposure was over-estimated due to the limited temporal extent of the BOEM SAB survey data: mean annual densities from the Kitty Hawk APEM monthly surveys were compared with the mean annual densities from the BOEM SAB quarterly surveys in the Kitty Hawk Wind Development Area. To do so, due to non-normality in the data, the nonparametric bootstrap mean densities (1,000 resamples with replacement) and 95 percent confidence intervals (CI) were calculated using package Boot (Davison & Hinkley 1997, Canty & Ripley 2020) in R version 3.5.3 (R Core Team, 2019) for both the Kitty Hawk APEM and BOEM SAB survey data at the annual scale for the Kitty Hawk Project Area only. The confidence interval ranges were then compared. For species were the ranges of both data sets did not overlap, it was determined that mean densities were significantly different. These results were used to apply a correction to the overall exposure estimates, as derived from above, in the season that those species occurred (had non-zero density). For example, if the mean CI range for a species determined from Kitty Hawk APEM data was entirely below that of the CI range determined from BOEM SAB surveys for the project area, the mean density estimates were likely lower in the Kitty Hawk Project Area than portrayed by the BOEM SAB survey data. This is likely due to insufficient temporal coverage and the exposure level was adjusted to include a range with a lower estimate (e.g., low would become minimal-low).

Table A-2: Definitions of exposure levels developed for the COP for each taxonomic group and season. The listed scores represent the exposure scores from the local BOEM SAB and the regional MDAT on the left and right, respectively.

Exposure Level	Definition	Scores
Minimal	Wind Development Area densities at both local and regional scales are below the 25th percentile.	0, 0
Low	Wind Development Area local and/or regional density is between the 25th and 50th percentiles. OR Wind Development Area local density is between the 50th and 75th percentiles and regional density is below the 25th percentile, or vice versa.	1, 1 2, 0
Medium	Wind Development Area local or regional density is between the 50th and 75th percentiles. OR Wind Development Area local density is between the 50th and 75th percentiles and regional density between the 25th and 50th percentiles, or vice versa. OR Wind Development Area local density is greater than the 75th percentile and regional density is below the 25th percentile, or vice versa. OR Wind Development Area 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).	2, 2 2, 1 3, 0 3, 1
High	Wind Development Area densities at both local and regional scales are above the 75th percentile. OR Local densities are greater than the 75th percentile and regional densities are between the 50th and 75th percentiles, or vice versa.	3, 3 3, 2

A.1.6 Aggregated Annual Exposure Scores

To understand the total exposure across the annual cycle for each species, all the seasonal scores were summed to obtain an annual score from 0–12. These annual scores were mapped to exposure categories of ***minimal*** (0–2), ***low*** (3–5), ***medium*** (6–8), and ***high*** (9–12). The annual exposure category for a species represents the seasonally integrated risk across the annual cycle.

Finally, because these scores are all relative to seasonal distribution, estimates of effort-corrected count density were provided within the Wind Development Area and over the entire survey area for each species from the BOEM SAB survey data. Uncommon taxonomic groups with few detections in the Wind Development Area may be somewhat over-rated for exposure using this method, while common taxonomic groups with relatively few detections in the Wind Development Area may be effectively under-rated in terms of total exposure to the Project. Density estimates per square km are presented to provide context for the exposure scores.

A.1.7 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 Wind Development Area 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 ***high*** exposure score indicates that the observed and predicted densities of the species in the Wind Development Area were high *relative to densities of that species in other surveyed areas*. Conversely, a ***low*** or ***minimal*** exposure score means that the species was predicted to occur at lower densities in the Wind Development Area *than in other locations*. A ***minimal*** exposure score should not be interpreted to mean there are no individuals of that species in the Wind Development Area. In fact, common species may receive a ***minimal*** exposure score even if there are still substantial numbers of individuals in the Wind Development Area, so long as their predicted densities *outside* are comparatively higher. This 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).

A.1.8 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. For marine birds the quantitative assessment was primarily used for the final exposure score but was adjusted to include a range if other data sources (e.g., tracking studies) or the literature provided additional exposure information. For non-marine migratory birds, exposure was determined primarily from the literature. Final exposure level categories used in this assessment are described in Table A-3.

Table A-3. Assessment criteria used for assigning species to final exposure levels.

Final Exposure Level	Definition
Minimal	Minimal seasonal exposure scores in all seasons or minimal score in all but 1 season AND/OR Based upon the literature—and, if available, other locally available tracking or survey data—little to no evidence of use (e.g., no record in Project Area) of the offshore environment for breeding, wintering, or staging, and low predicted use during migration
Low	Low exposure scores in 2 or more seasons, or Medium exposure score in 1 season AND/OR Based upon the literature—and, if available, other locally available tracking or survey data— low evidence of use of the Wind Development Area or offshore environment during any season
Medium	Medium exposure scores in 2 or more seasons, or High exposure score in 1 season AND/OR Based upon the literature—and, if available, other locally available tracking or survey data—moderate evidence of the Wind Development Area or use of the offshore environment during any season
High	High exposure scores in 2 or more seasons AND/OR

Final Exposure Level	Definition
	Based upon the literature—and, if available, other locally available tracking or survey data—high evidence of use of the Wind Development Area or offshore environment, and the offshore environment is primary habitat during any season

A.2 Vulnerability Framework

Researchers in Europe and the U.S. have assessed the vulnerability of birds to offshore wind facilities and general disturbance by combining ordinal scores across a range of key variables (Furness *et al.* 2013, Wade *et al.* 2016, Fliessbach *et al.* 2019, Willmott *et al.* 2013). 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, the 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 facilities but should not be interpreted as an absolute determination that there will or will not be collision mortality or habitat loss. In addition, for many species there remains significant uncertainty (see discussion below) on critical inputs into vulnerability score (e.g., avoidance rates). Therefore, the results should be interpreted as a guide to species that have a higher likelihood of risk.

The existing vulnerability methods assess individual-level vulnerability to collision and displacement independently, 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 facility or certain turbine designs. Thus, there is a need to develop a *project-specific* vulnerability score for each species that is inclusive of both collision and displacement.

The scoring process in this assessment builds from the existing methods, incorporates the specifications of the turbine models being considered, 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 COP assessments. For species, or species groups, for which inputs are lacking, the literature is used to qualitatively determine a vulnerability ranking using expert judgment and the criteria in Table A-4.

Table A-4. Assessment criteria used for assigning species to each behavioral vulnerability level.

Behavioral Vulnerability Level	Definition
Minimal	0–0.25 ranking for collision or displacement risk in vulnerability scoring AND/OR No evidence of collisions or displacement in the literature. Unlikely to fly within the rotor-swept zone (RSZ).

Behavioral Vulnerability Level	Definition
Low	0.26–0.5 ranking for collision or displacement risk in vulnerability scoring AND/OR Little evidence of collisions or displacement in the literature. Rarely flies within the RSZ.
Medium	0.51–0.75 ranking for collision or displacement risk in vulnerability scoring AND/OR Evidence of collisions or displacement in the literature. Occasionally flies within the RSZ.
High	0.76–1.0 ranking for collision or displacement risk in vulnerability scoring AND/OR Significant evidence of collisions or displacement in the literature. Regularly flies within the RSZ.

A.2.1 Population Vulnerability (PV)

There are many factors that contribute to how sensitive a population is to mortality or habitat loss related to the presence of a wind facility; these include vital rates, existing population trends, and relative abundance of birds (Goodale & 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 score by using Partners in Flight (PiF) "continental combined score" (CCSmax), a local "state status" (SSmax), and adult survival score (AS; Equation 1). 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 A-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 A-4). Since using quartiles creates hard cut-off points and there is uncertainty present in all inputs (see discussion on uncertainty below), using only scores can potentially misrepresent vulnerability (e.g., a 0.545 PV score leading to a ***medium*** category). To account for these issues, 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 ***low***, but a published paper indicated a decreasing population, the score would be adjusted up to include a range of ***low–medium***.

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

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 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 (Desholm 2009, Adams *et al.* 2016). The five categories are based upon those used in several vulnerability assessments (Kelsey *et al.* 2018, Fliessbach *et al.* 2019, Willmott *et al.* 2013), and the species-specific values were used from Willmott et al. (2013).

Table A-5. Data sources and scoring of factors used in the vulnerability assessment

Vulnerability Component	Factor	Definition and Source	Scoring
Population Vulnerability (PV)	*CCSmax*	Partners in Flight continental combined score: http://pif.birdconservancy.org/ACAD/Database.aspx	1 = Minor population sensitivity 2 = Low population sensitivity 3 = Medium population sensitivity 4 = High population sensitivity 5 = Very-High population sensitivity
	SSmax	State status from states adjacent to project; Adams et al. 2016	1 = No Ranking* 2 = State/Federal Special Concern 3 = State/Federal Threatened 4 = State/Federal Endangered 5 = State & Federal End and/or Thr
	AS	Adult survival score: scores and categories taken from Willmott et al. 2013	1 = <0.75 2 = 0.75 to 0.80 3 = >0.80 to 0.85 4 = >0.85 to 0.90 5 = >0.90
Collision Vulnerability (CV)	*RSZt*	Turbine-specific percentage of flight heights in rotor swept zone (RSZ). Flight heights modeled from Seabird Catalog. Categories from Kelsey et al. 2018	1 = < 5% in RSZ 3 = 5–20% in RSZ 5 = > 20% in RSZ
	MAc	Avoidance rates and scoring categories from Willmott et al. 2013 and Kelsey et al. 2018	1 = >40% avoidance 2 = 30 to 40% avoidance 3 = 18 to 29% avoidance 4 = 6 to 17% avoidance 5 = 0 to 5% avoidance
	NFA & DFA	Nocturnal Flight Activity (NFA) and 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% 2 = 21–40% 3 = 41–60% 4 = 61–80% 5 = 81–100%
Displacement Vulnerability (DV)	*MAd*	Macro-avoidance rates that would decrease collision risk from Willmott et al. 2013 and Kelsey et al. 2018	1 = 0–5% avoidance 2 = 6–17% avoidance 3 = 18–29% avoidance 4 = 30–40% avoidance 5 = > 40% avoidance
	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 1 = species uses a wide range of habitats over a large area and usually has a wide range of prey available to them 2 to 4 = grades of behavior between scores 1 and 5 5 = species with habitat- and prey-specific requirements that do not have much flexibility in diving-depth or choice of prey species

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

A.2.2 Collision Vulnerability (CV)

Collision vulnerability 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, Kelsey *et al.* 2018, Willmott *et al.* 2013). 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). Each factor was weighted equally (following Kelsey et al. 2018) and given a categorical score of 1–5 (Table A-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 A-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.

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

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 Seabird Catalog. Flight heights calculated from digital aerial survey methods were excluded because the methods have yet to be 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).

  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 >X feet (or m) were capped at 300 m 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 15 m bins. The integration of the smooth spline model count within each 1 m increment was calculated and the mean and standard deviation of all 100 models were calculated across all 1 m increments. The proportion of animals within the RSZ was estimated by summing the 1 m count integrations, then values were converted to a 1–5 scale based upon the categories used by Kelsey et al. (2018; Table A-5). The RSZ was defined by the maximum turbine height being considered (317.5 m) and the minimum possible airgap (27 m; Table A-6). The analysis was conducted in R Version 3.5.3.[10] 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 turbines are present.

Table A-6: Turbine parameters used in the vulnerability analysis

Color in flight height figures	Lower blade tip height (m)	Upper blade tip height (m)
Gold	27	317.5

- 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 facility area (Kelsey *et al.* 2018), versus meso-avoidance (avoiding individual turbines), and micro-avoidance (avoiding turbine 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

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[10] 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 **A-5**. The MAc indicates that this factor is used in the CV versus the MAd, which was used in the 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, Cook *et al.* 2018, Vanermen *et al.* 2015, Skov *et al.* 2018), and indexes (Furness *et al.* 2013, Wade *et al.* 2016, Kelsey *et al.* 2018, Bradbury *et al.* 2014, Garthe & Hüppop 2004, Adams *et al.* 2016). 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. and Kelsey et al). 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 facilities with turbines much smaller than are proposed for the Project; 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 (NFA) and during the day (DFA) based on the assumption that more time spent flying would increase collision risk. The NFA scores were taken directly from the scores, based on literature review, from Willmott et al. 2013. The DFA score were calculated from the BOEM SAB 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.

A.2.3 Displacement Vulnerability (DV)

Rankings of displacement vulnerability account for two factors: 1) disturbance from ship/helicopter traffic and the wind facility structures (MAd); and 2) habitat flexibility (HF; Furness et al. 2013, Kelsey et al. 2018). This assessment combines these two factors, weights them equally (following Kelsey et al. 2018), and categorizes them from 1–5 (Equation 3; Table A-5). Note: while Furness et al. (2013) down-weighted 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, that avoidance behavior may change through time and that several years after projects have been built some individuals may forage within the wind facility. The taxonomic specific text indicates if 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 A-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.

$$DV = MAd + HF \quad \text{Equation 3}$$

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 facilities, 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, Skov *et al.* 2018, Cook *et al.* 2018), and indices (Furness *et al.* 2013, Wade *et al.* 2016, Kelsey *et al.* 2018, Garthe & Hüppop 2004, Adams *et al.* 2016, Bradbury *et al.* 2014). 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 (>40 percent) is scored as a 5. Since the >40 percent 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 on the Atlantic OCS.

A.2.4 Final Risk Determination

The CV, DV, and PV calculations are all used to make a final evaluation on population level risk (Table 3-2). First the CV and DV categories are combined with the exposure assessment to develop a preliminary risk determination. Rather than multiplying the CV and DV by PV score, as is done in some vulnerability assessments (Furness *et al.* 2013), the PV score is used to adjust the risk score up or down based on the following rules: ***minimal*** = adjustment down in risk; ***low*** to ***medium*** = no adjustment; and ***high*** = adjusted up. In the case of a risk range, an adjustment down would eliminate the high of the range and an adjustment up would eliminate the low end of the range. This approach down weights the influence of PV in the risk assessment to account for the broad uncertainty in understanding population dynamics.

A.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 on 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 the Project area and the region (i.e., exposure); and our understanding of how birds interact with turbines (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., Kitty Hawk APEM and BOEM SAB 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 facility area, then a range of exposure is provided (e.g., minimal–low) 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 (Kelsey *et al.* 2018, Willmott *et al.* 2013), or have developed separate stand-alone 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, but rather uses the uncertainty assessment conducted by Wade et al. (2016) as a guide (

Table A-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 A-7 From Wade et al. (2016): "Uncertainty inherent in data underlying the generation of four vulnerability factors for 38 seabird species. Uncertainty Scores equate to five Uncertainty Categories with greater scores indicating lower uncertainty: very high (score 1), high (score 2), moderate (score 3), low (score 4) and very low uncertainty (score 5). These categories and scores are on an ordinal scale where the numerical values have no significance beyond allowing a ranking to be established. Species rankings and scores were generated relative to data considered in each of the four vulnerability factors".

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

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B Attachment B: Maps of Exposure for Marine Birds for the Wind Development Area

Table of Maps

Map 1: Kitty Hawk APEM digital aerial seasonal survey effort; mean survey effort in sq. km by full or partial lease block inside and outside the Wind Development Area. 18

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Map 2: Winter Common Eider density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local 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. 20

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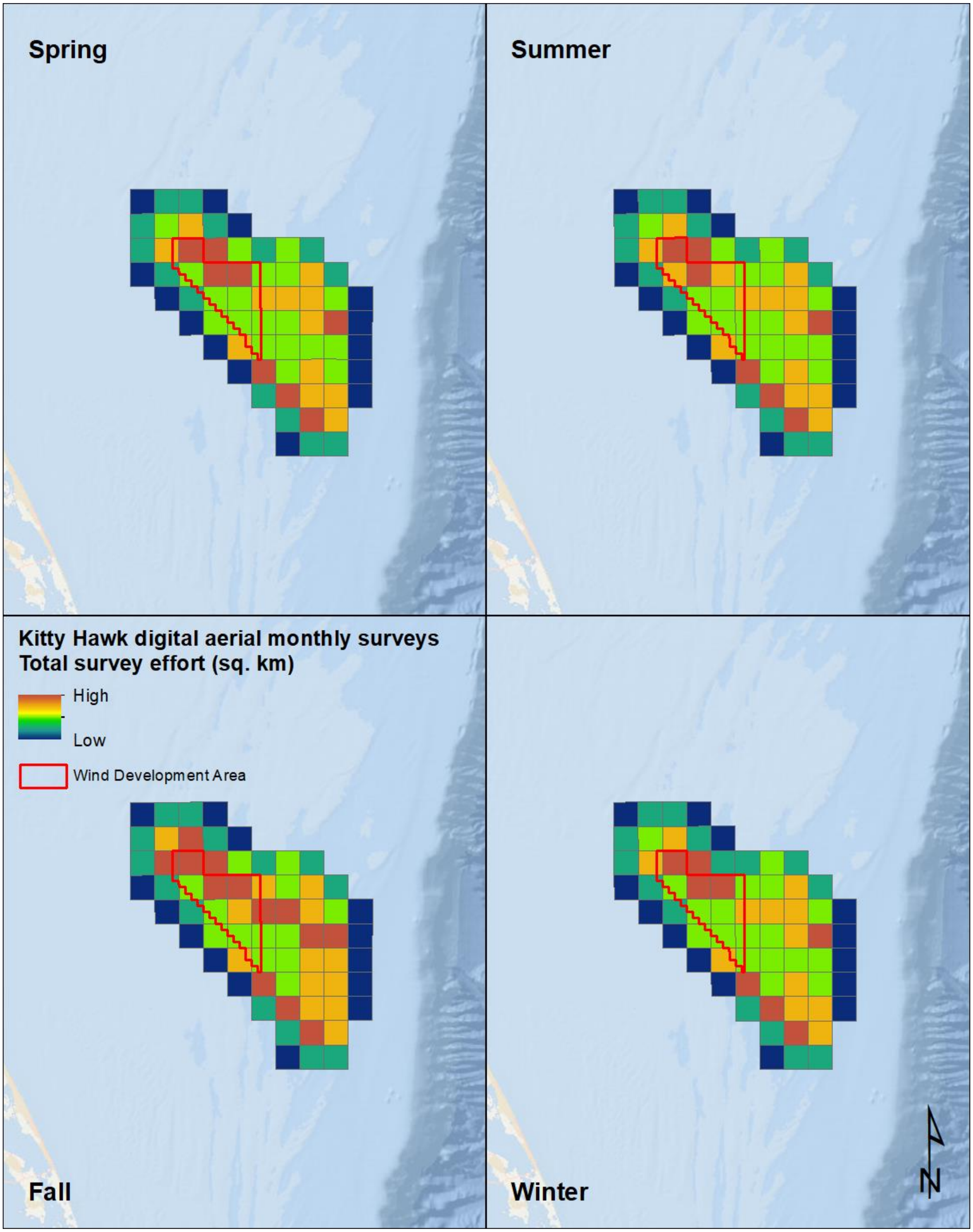
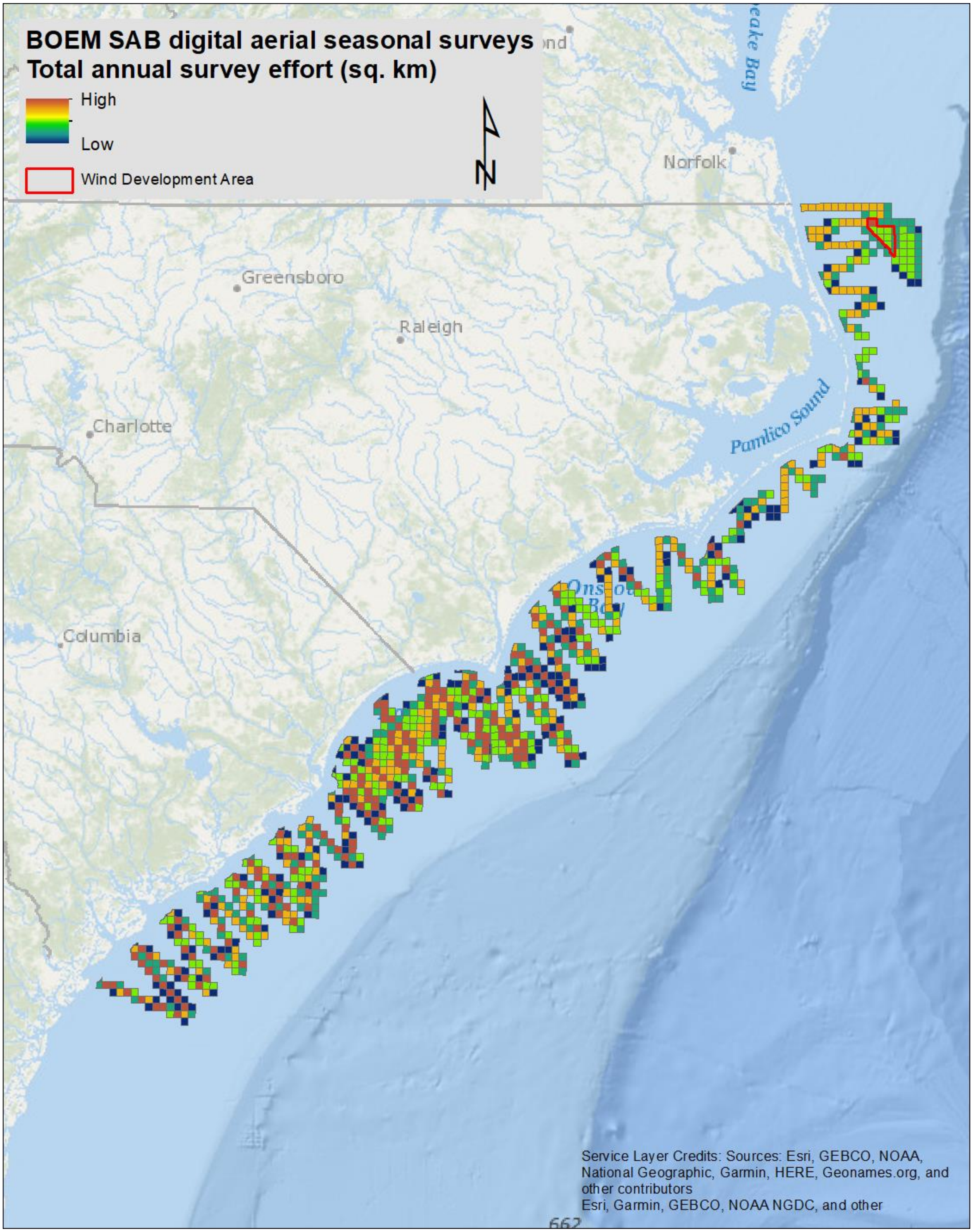
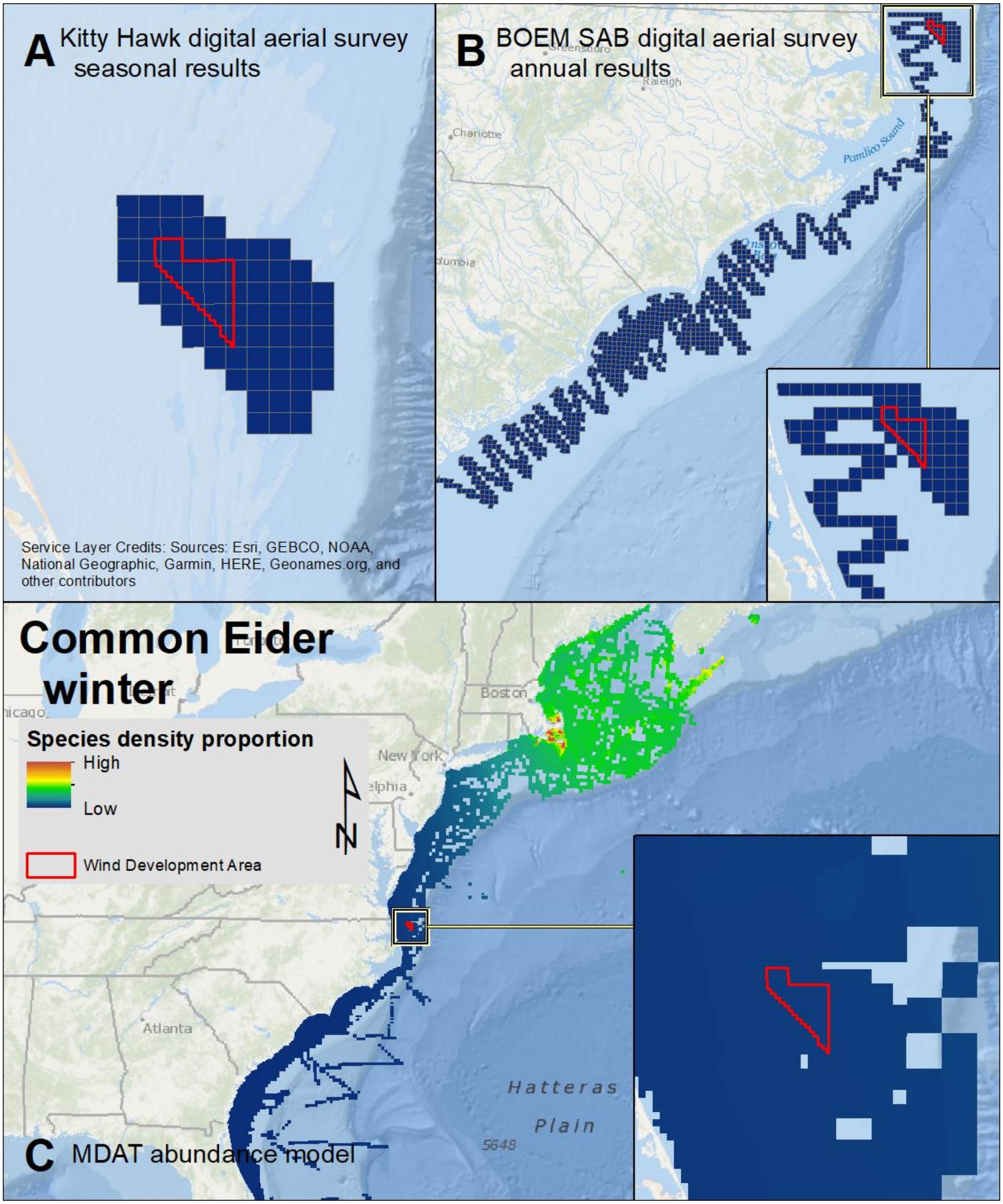


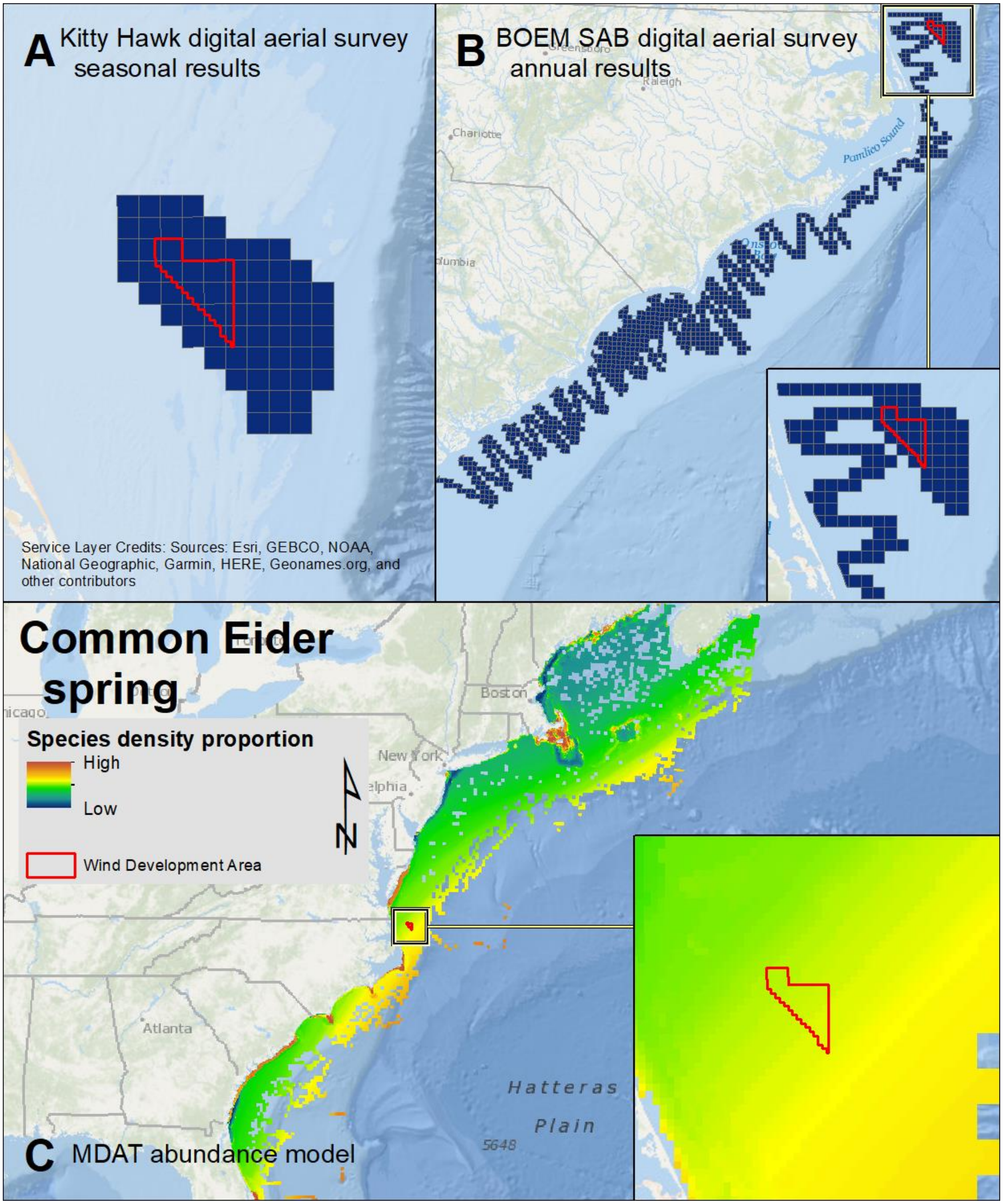
Map 1: Kitty Hawk APEM digital aerial seasonal survey effort; mean survey effort in sq. km by full or partial lease block inside and outside the Wind Development Area. Error! Bookmark not defined.



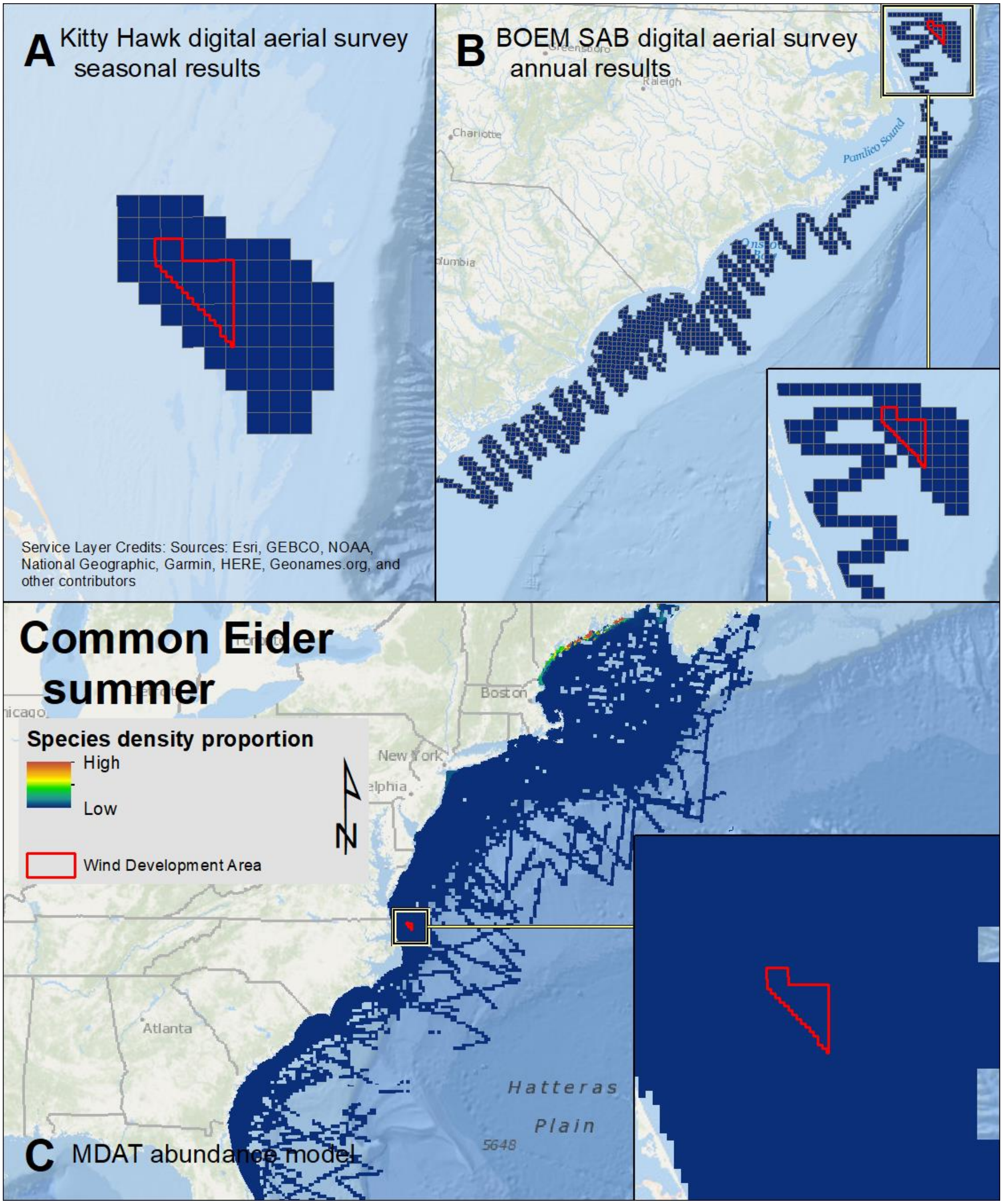
Map 2: BOEM SAB digital aerial baseline annual survey effort; mean survey effort in sq. km by full or partial lease block inside and outside the Wind Development Area. Error! Bookmark not defined.



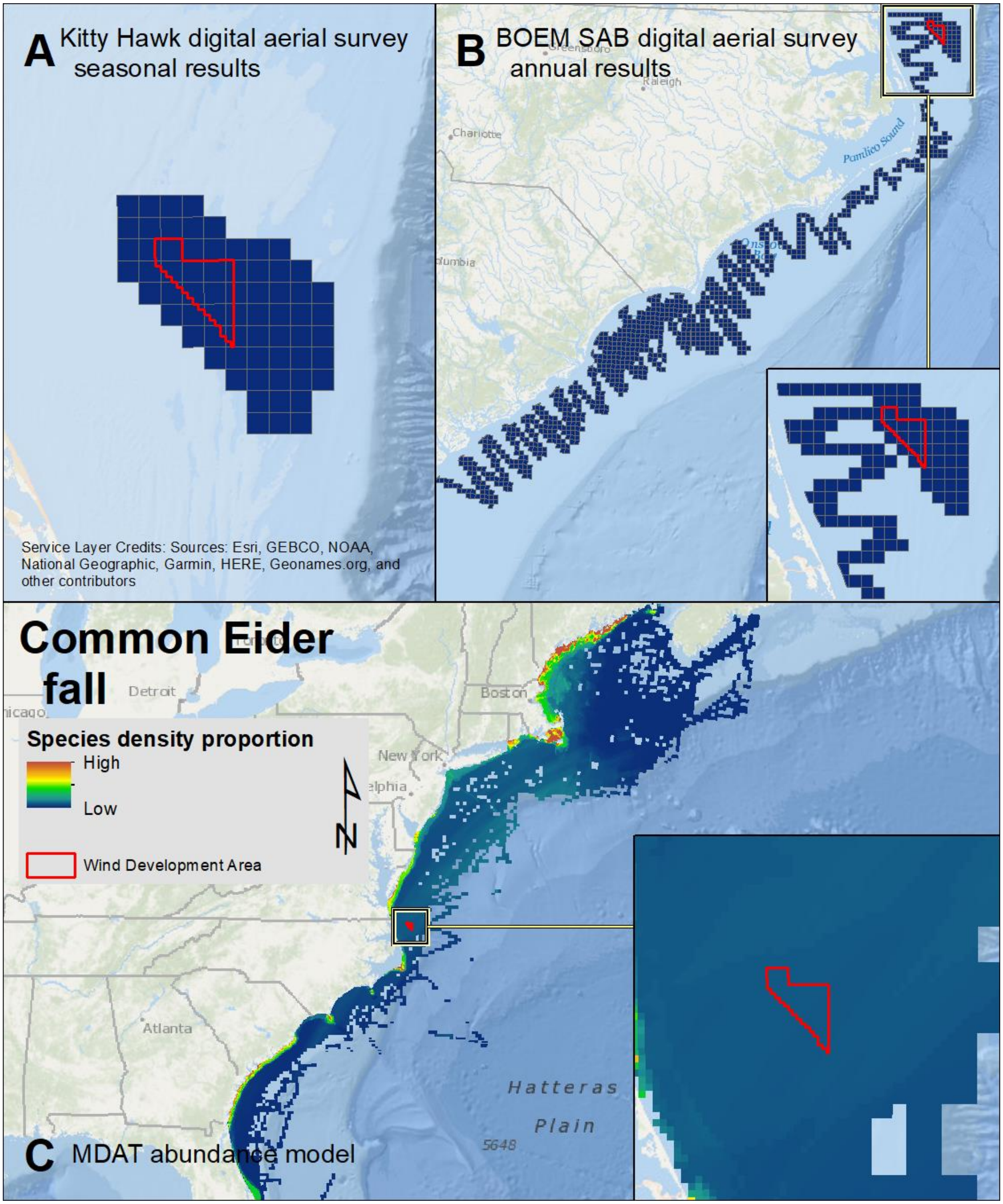
Map 2: Winter Common Eider density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



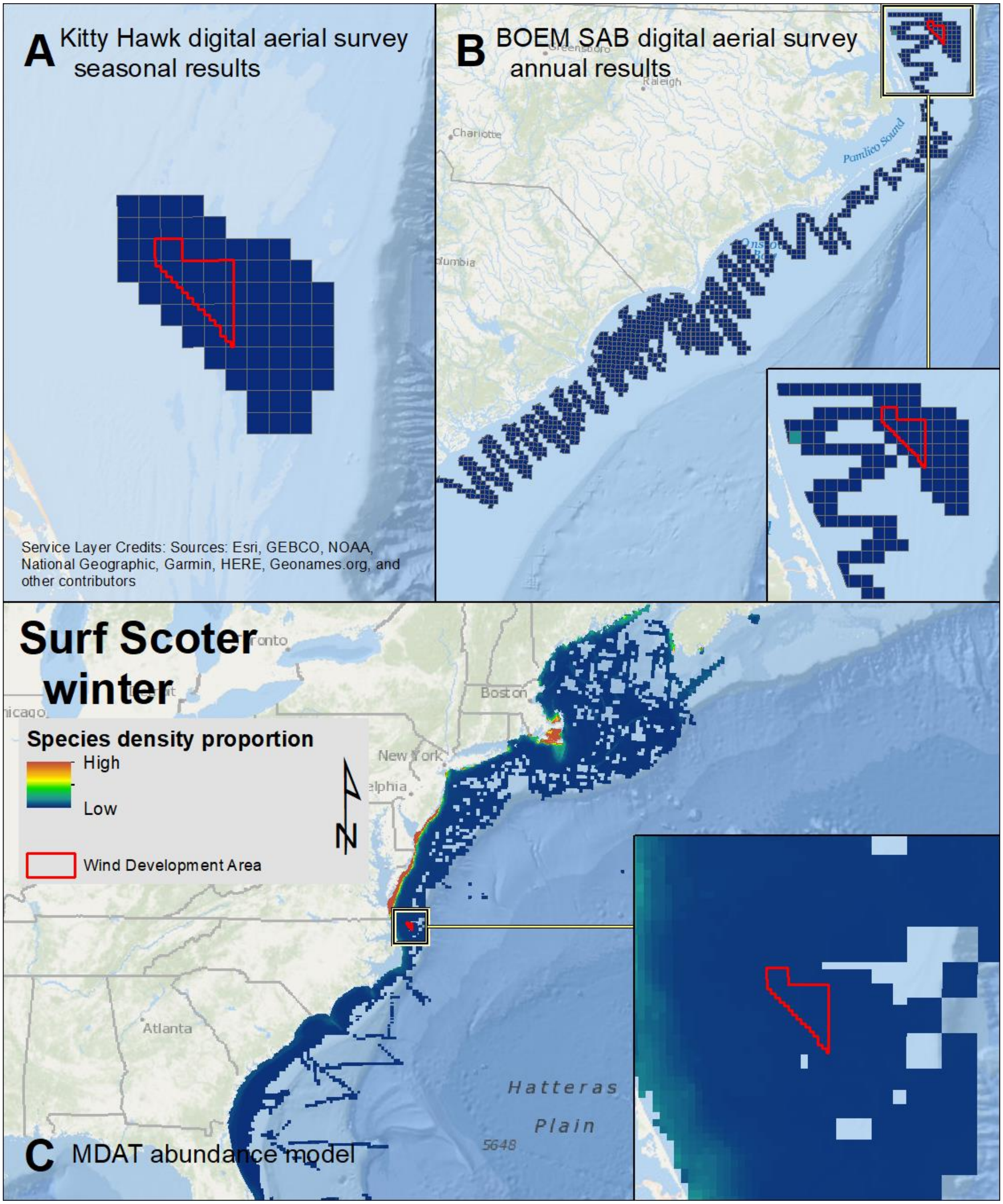
Map 3: Spring Common Eider density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



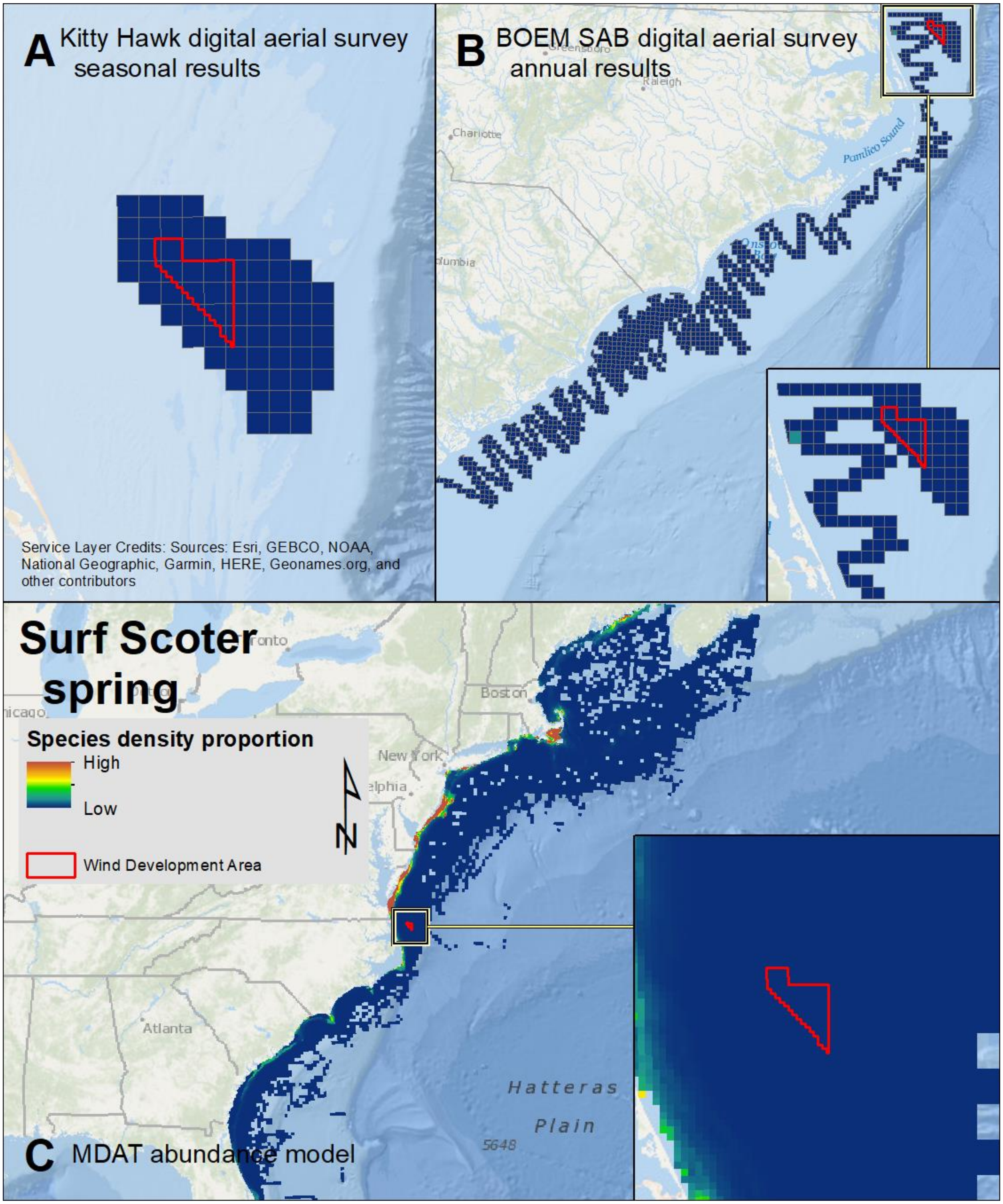
Map 4: Summer Common Eider density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



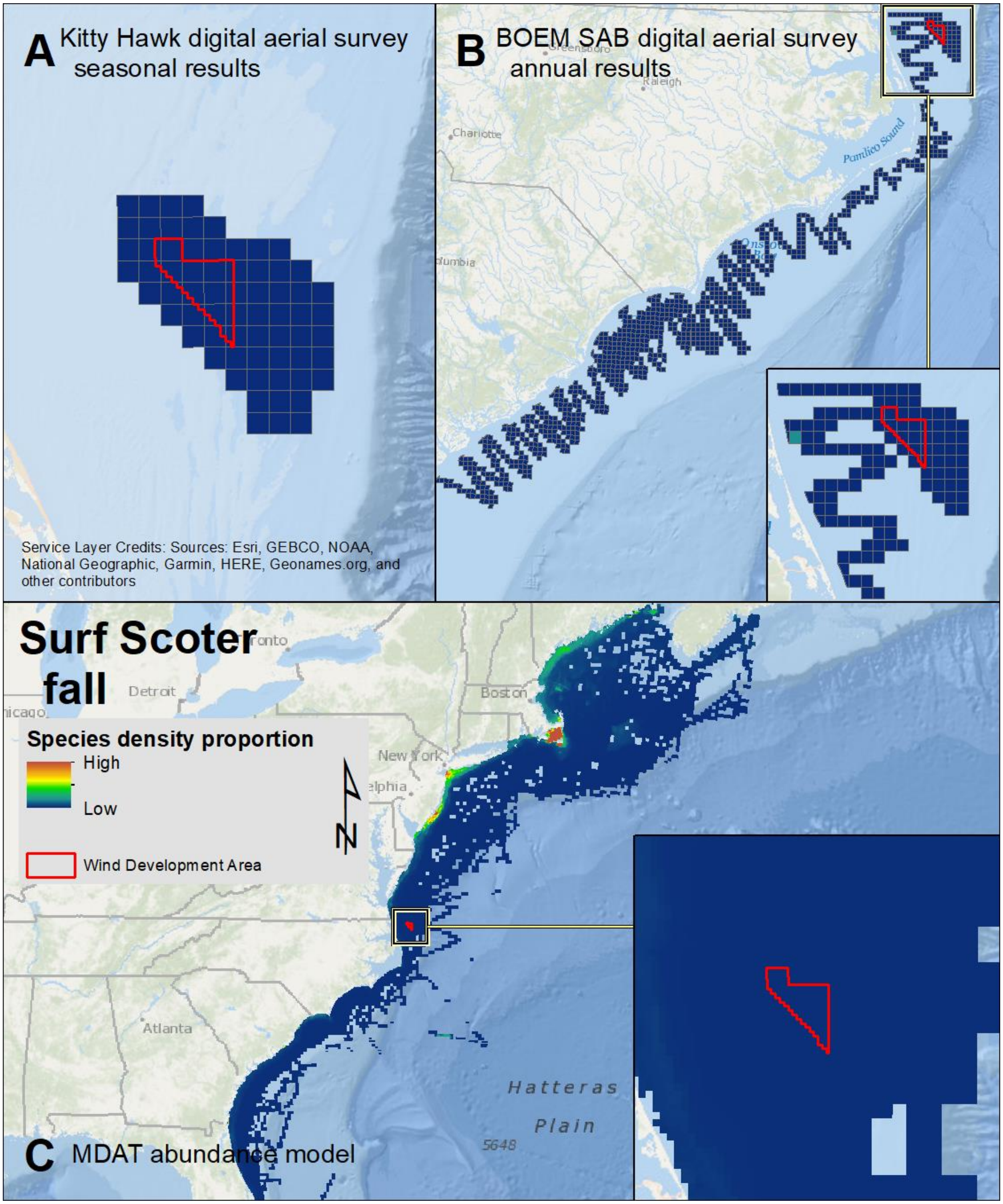
Map 5: Fall Common Eider density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



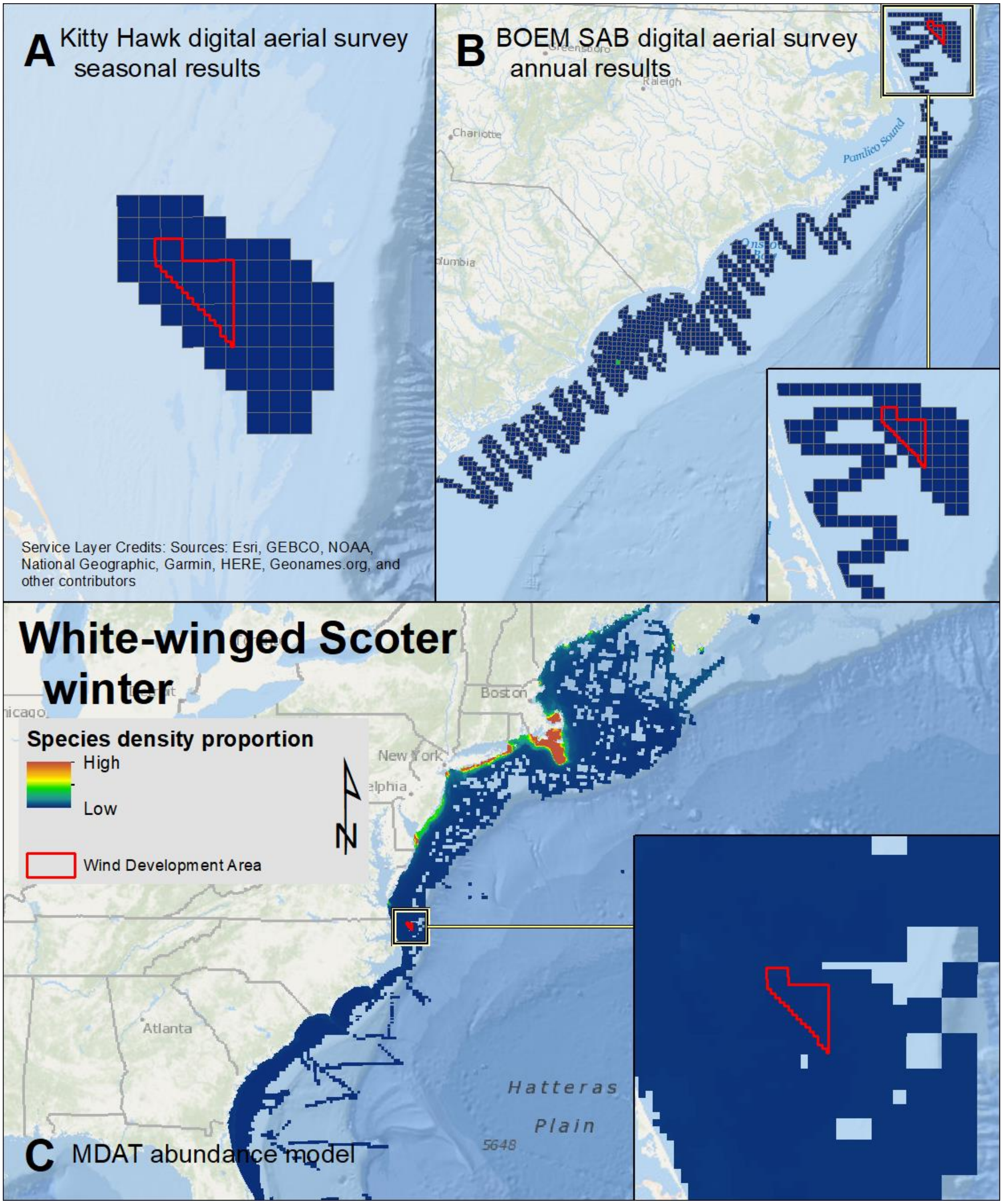
Map 6: Winter Surf Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



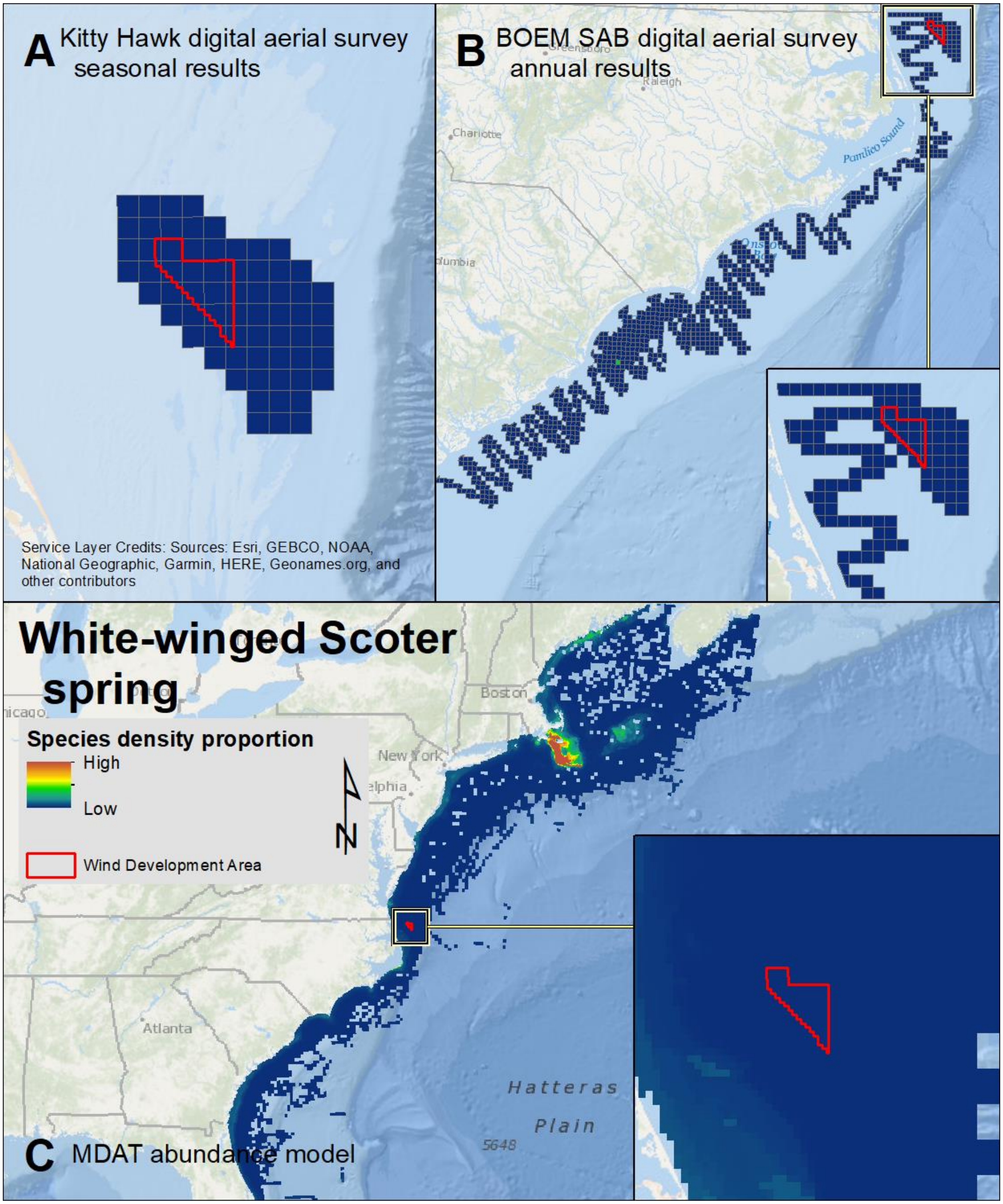
Map 7: Spring Surf Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



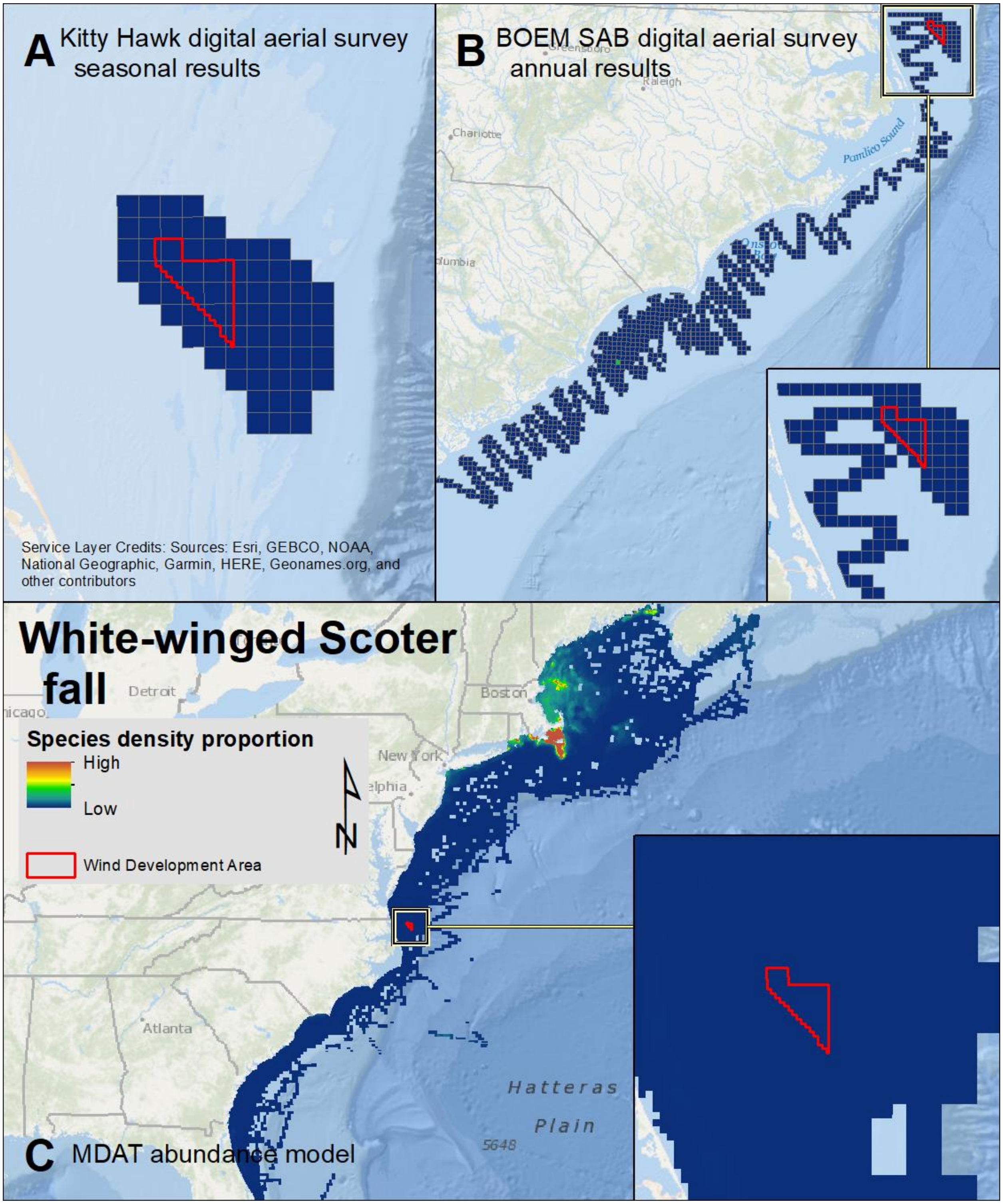
Map 8: Fall Surf Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



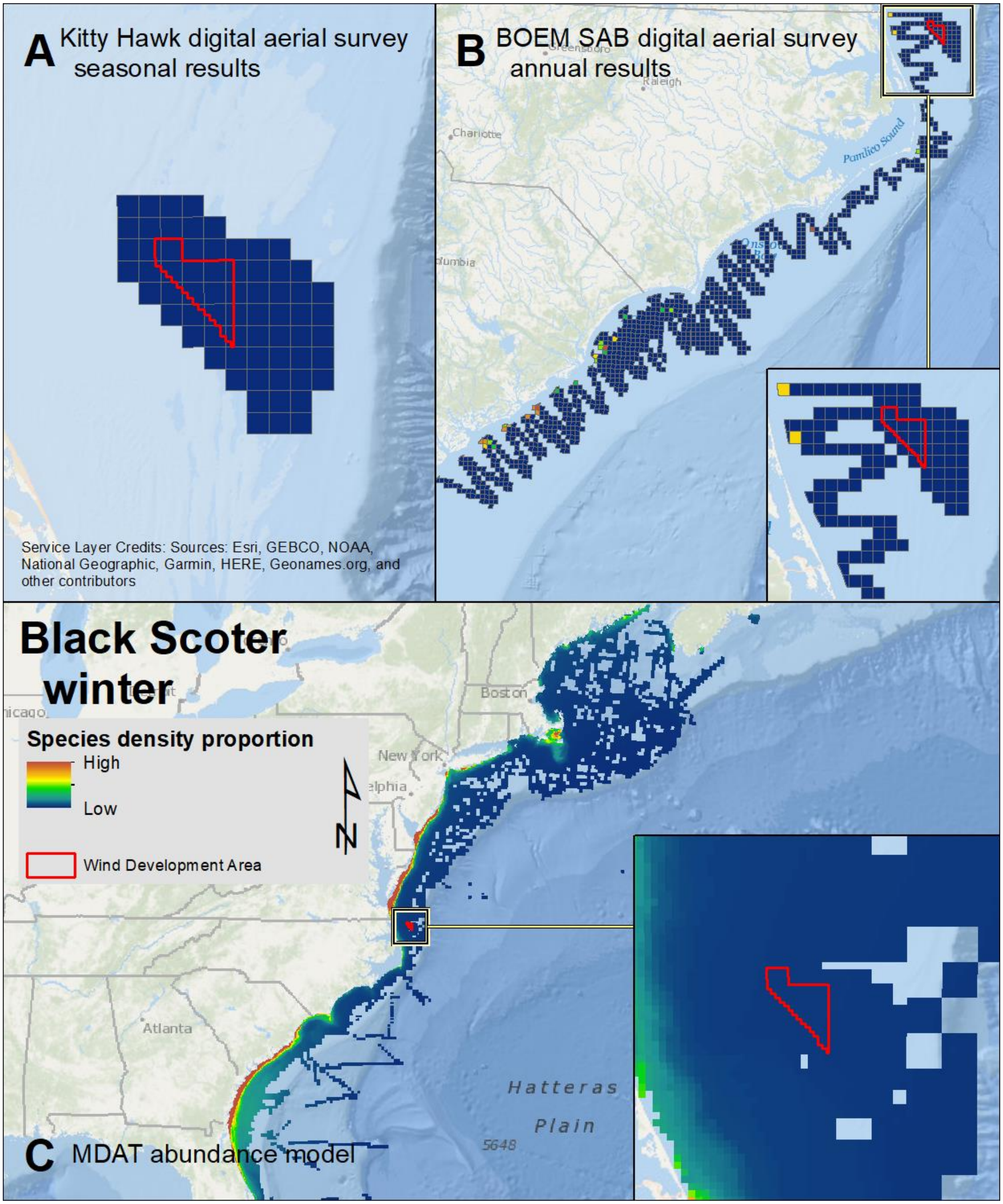
Map 9: Winter White-winged Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



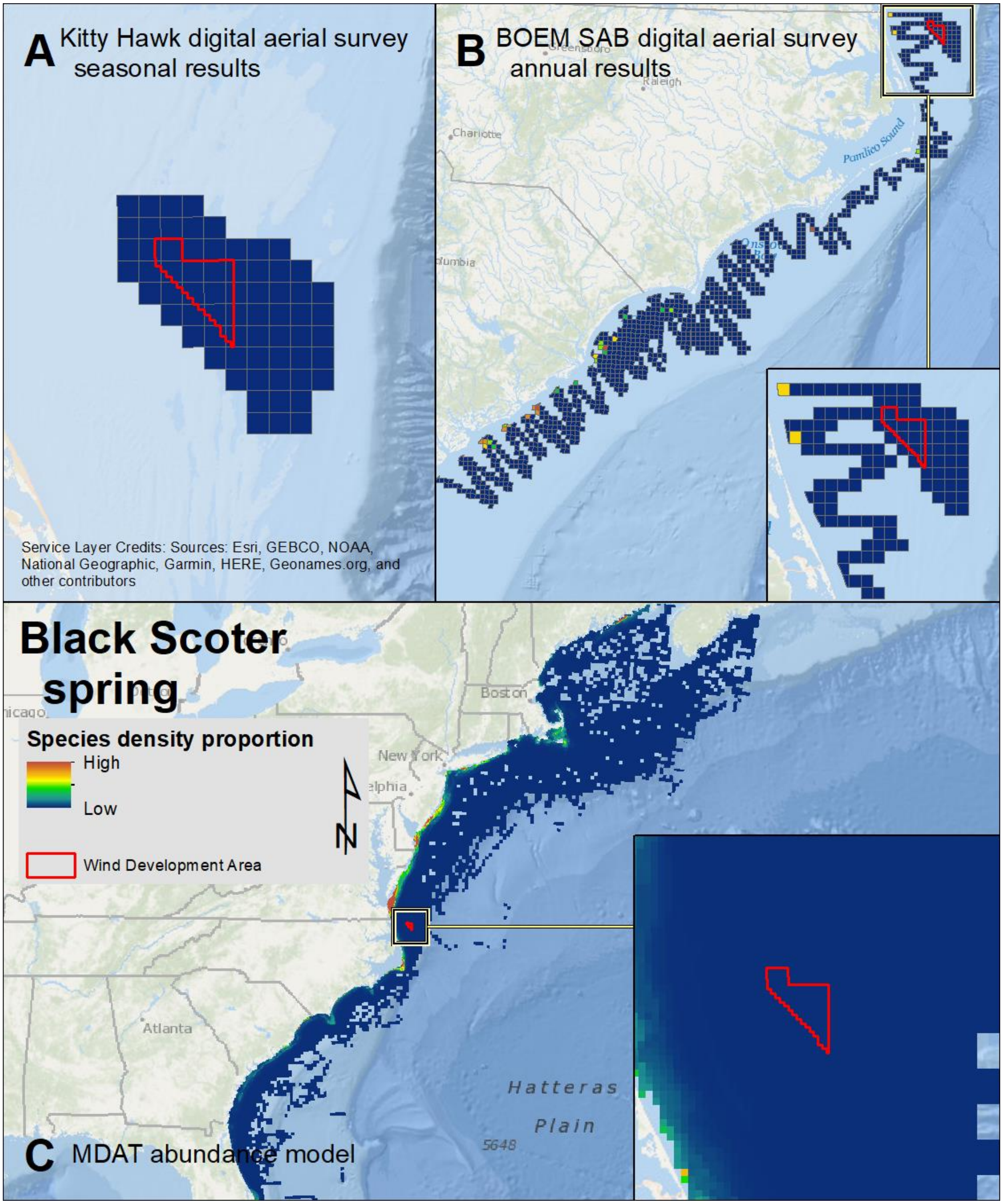
Map 10: Spring White-winged Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



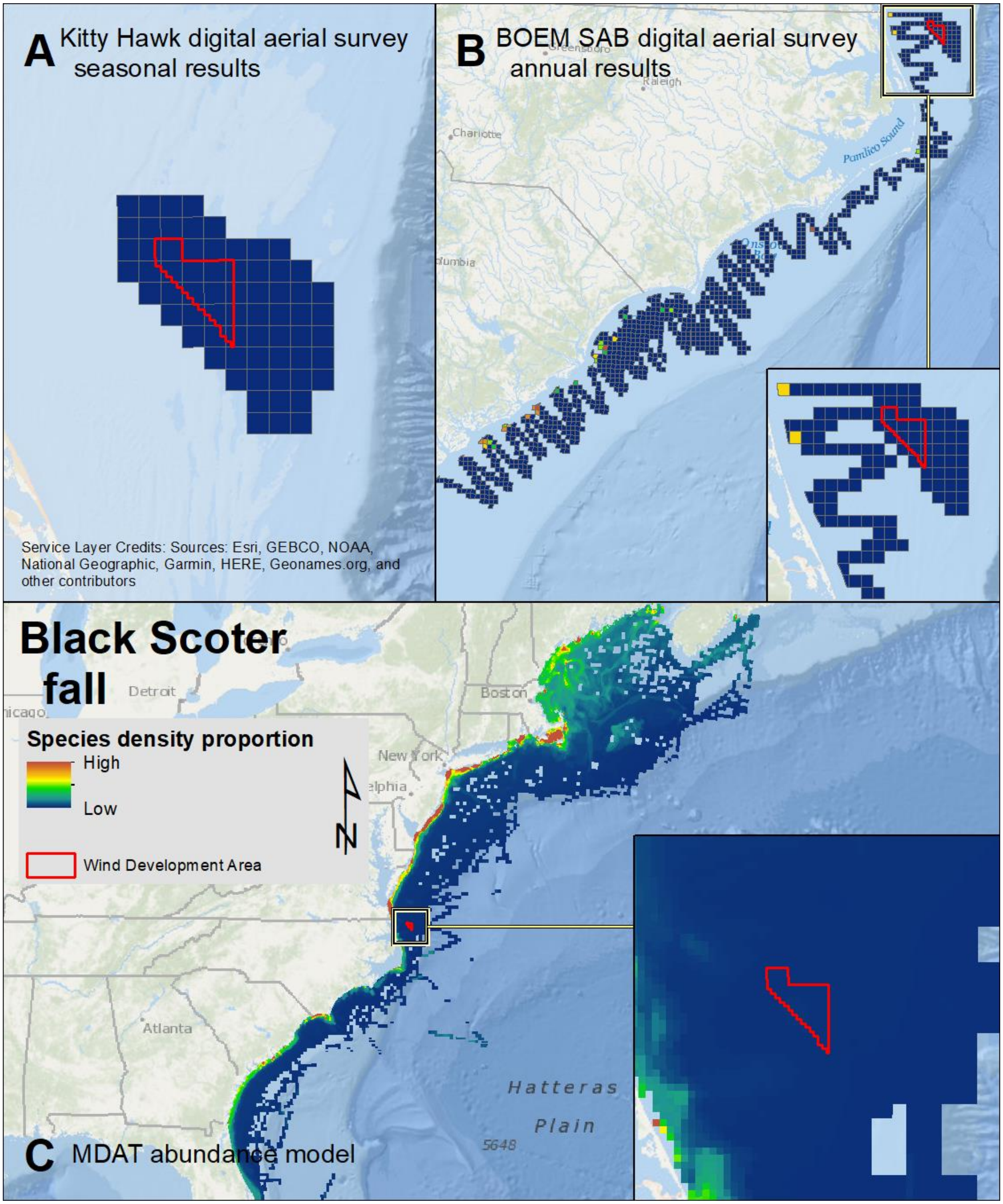
Map 11: Fall White-winged Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



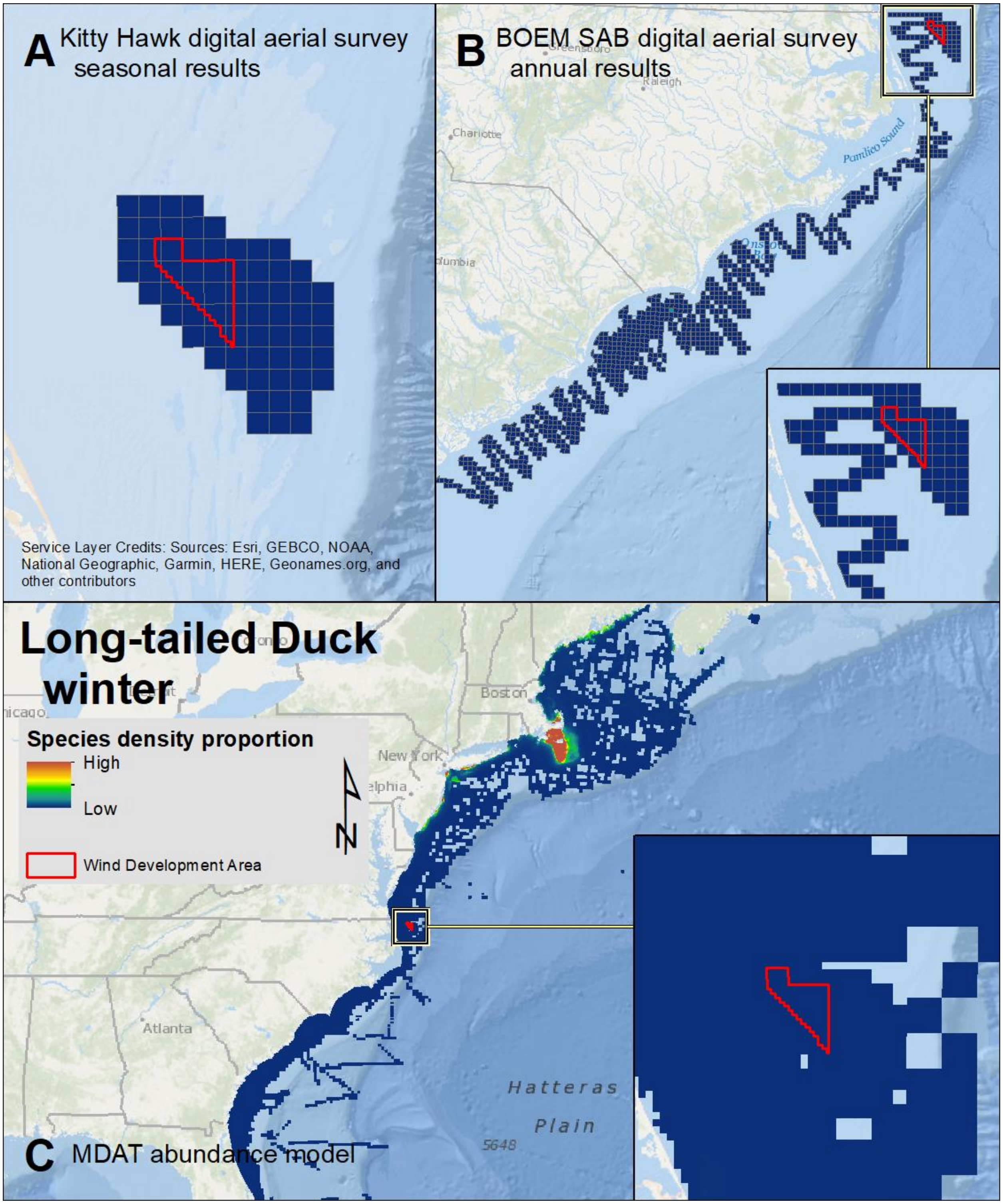
Map 12: Winter Black Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



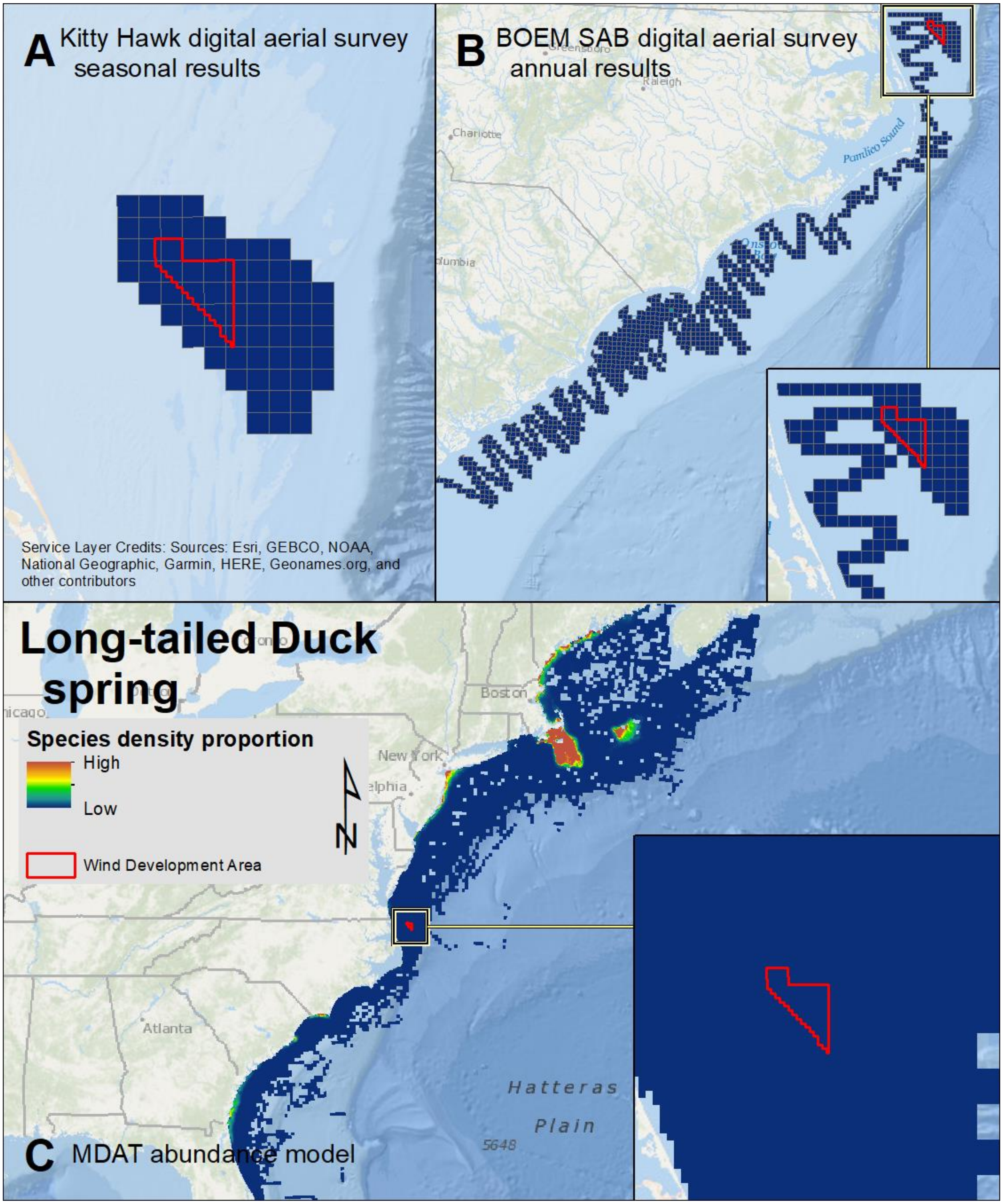
Map 13: Spring Black Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



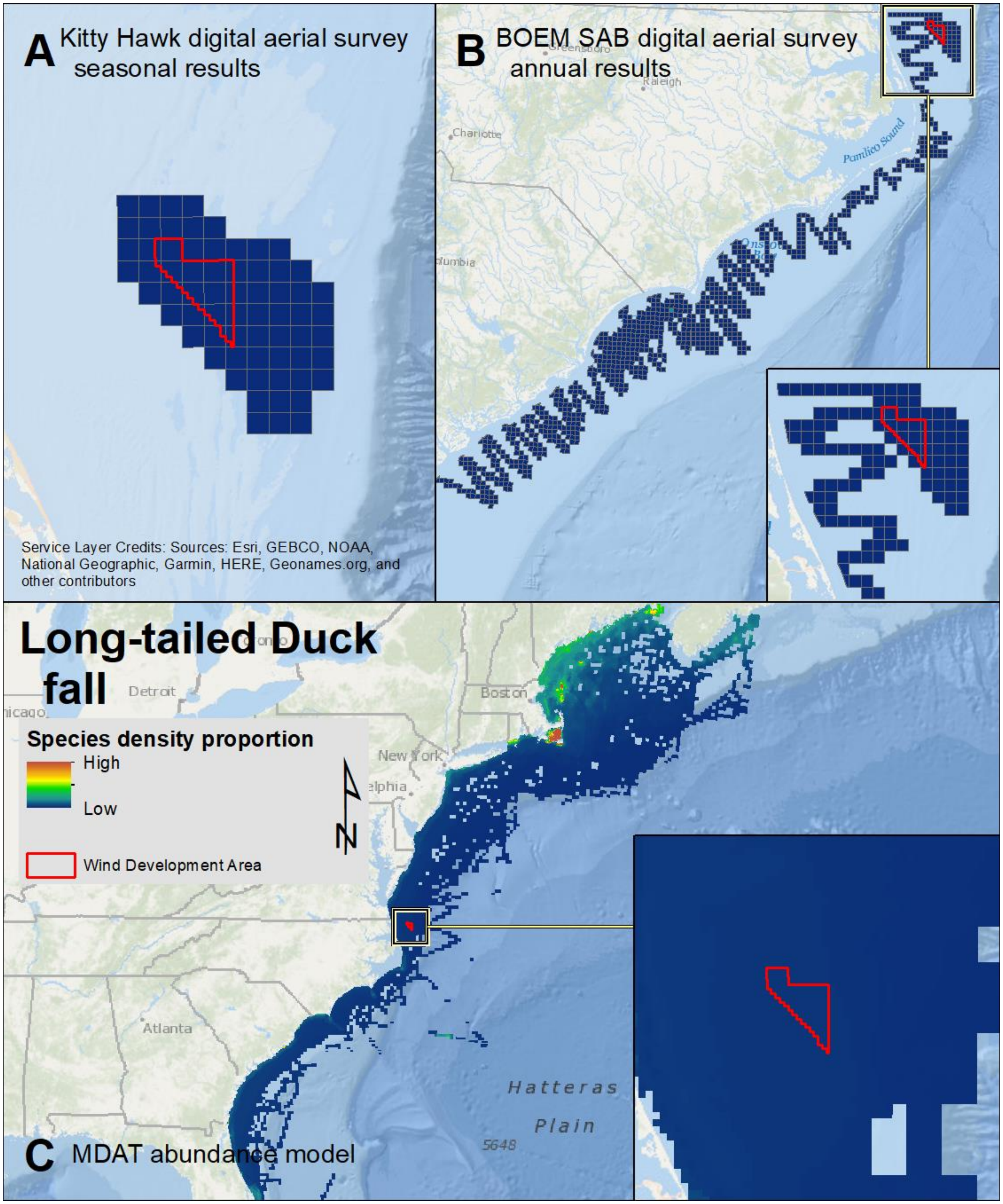
Map 14: Fall Black Scoter density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



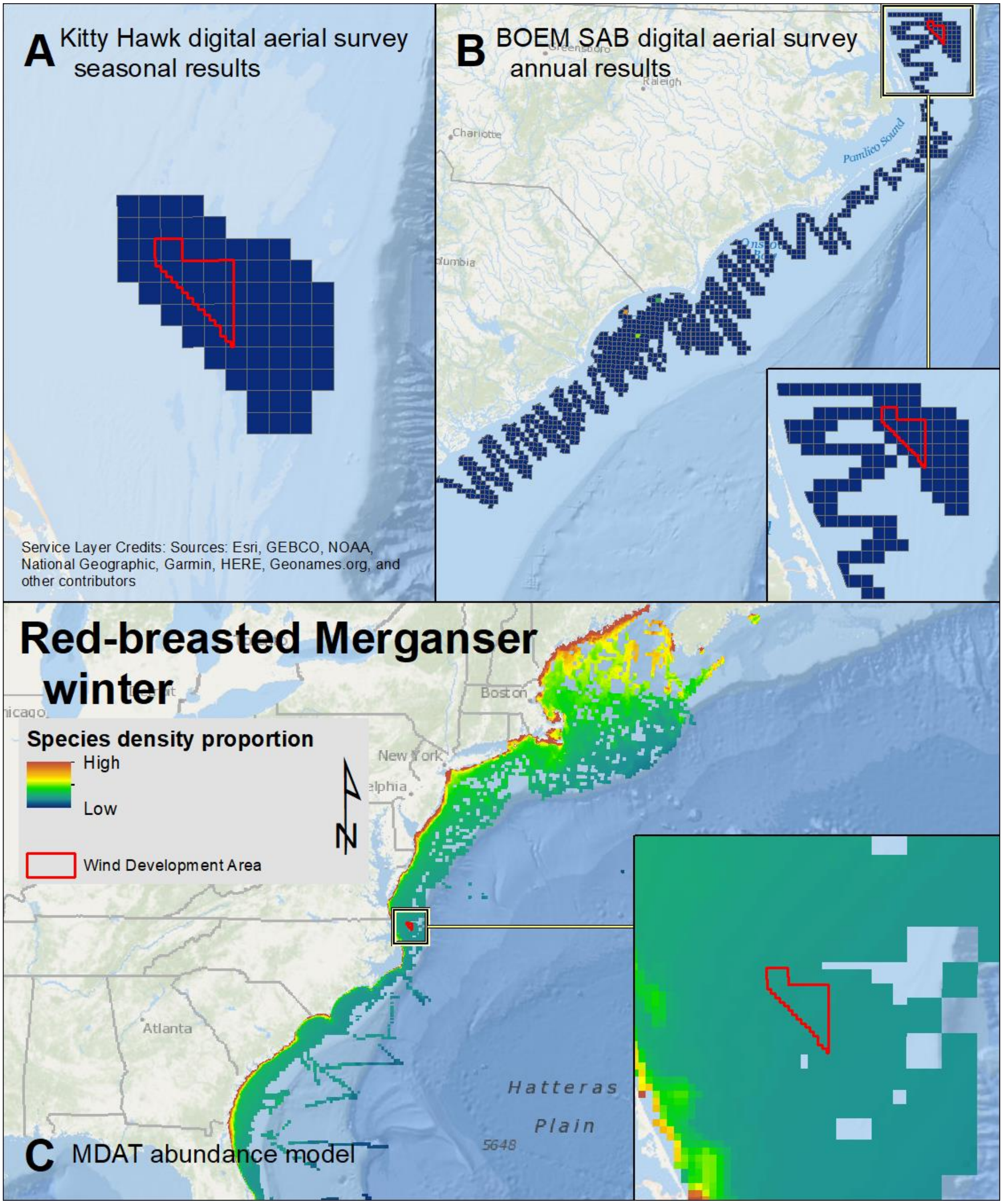
Map 15: Winter Long-tailed Duck density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



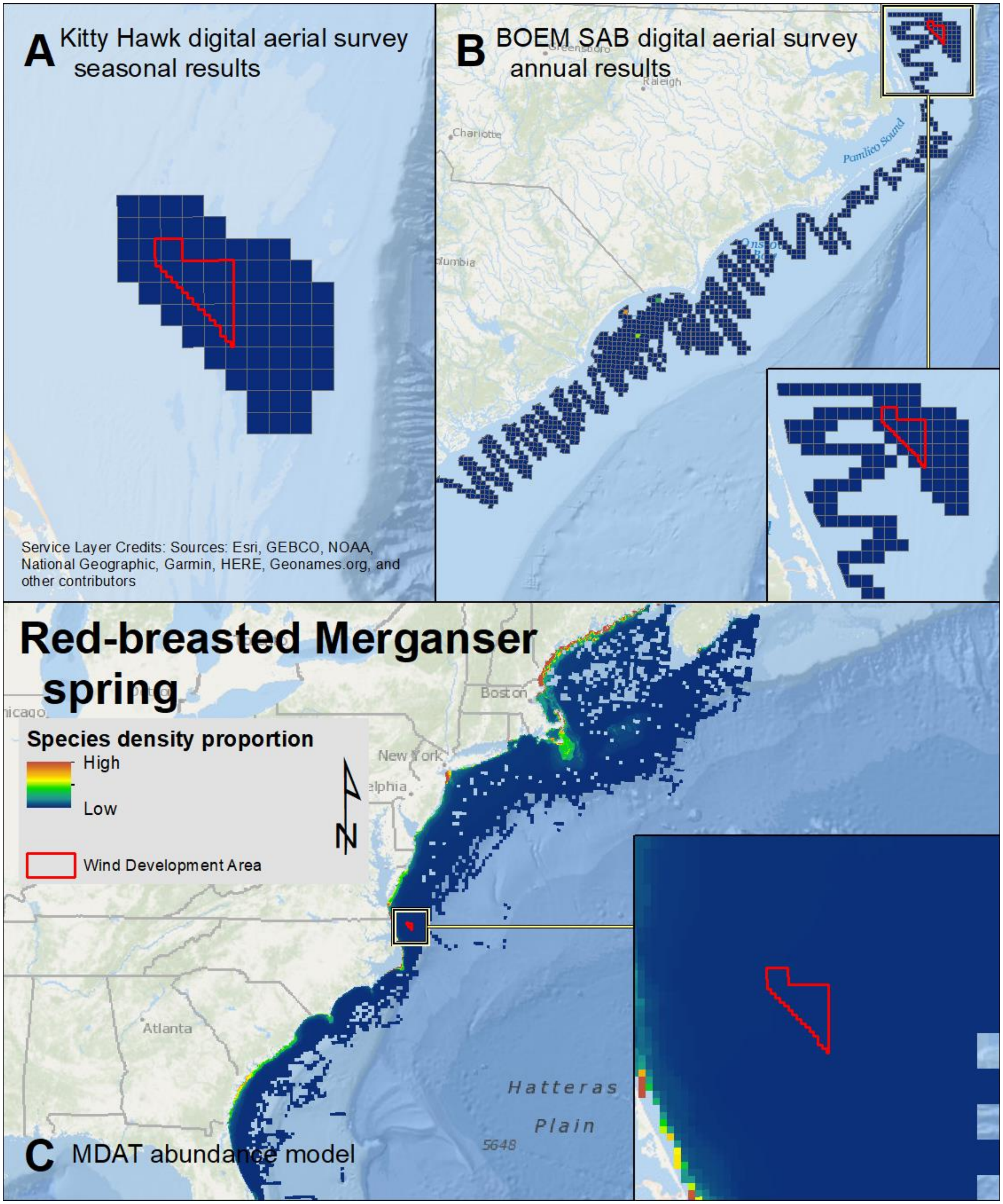
Map 16: Spring Long-tailed Duck density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



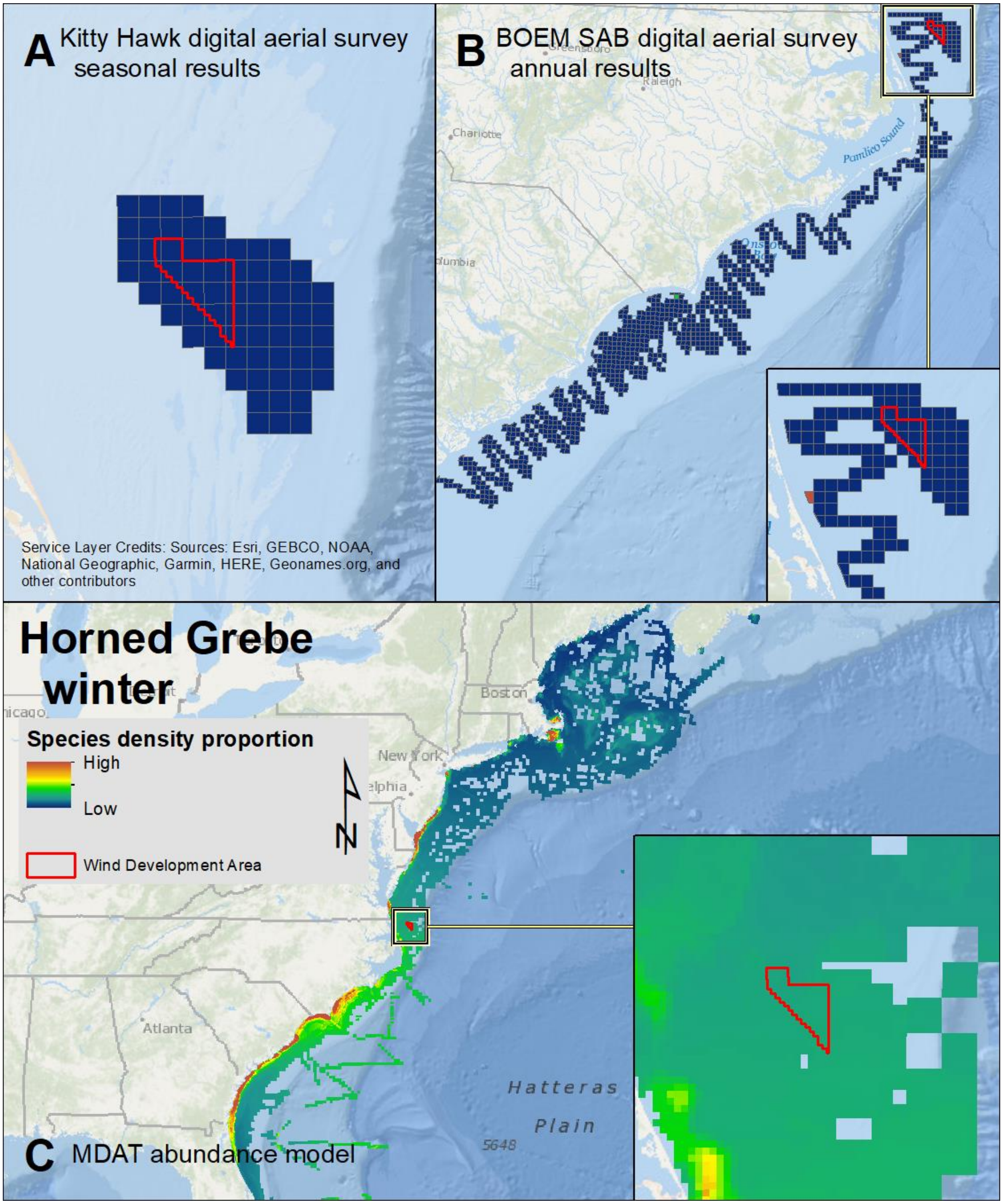
Map 17: Fall Long-tailed Duck density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



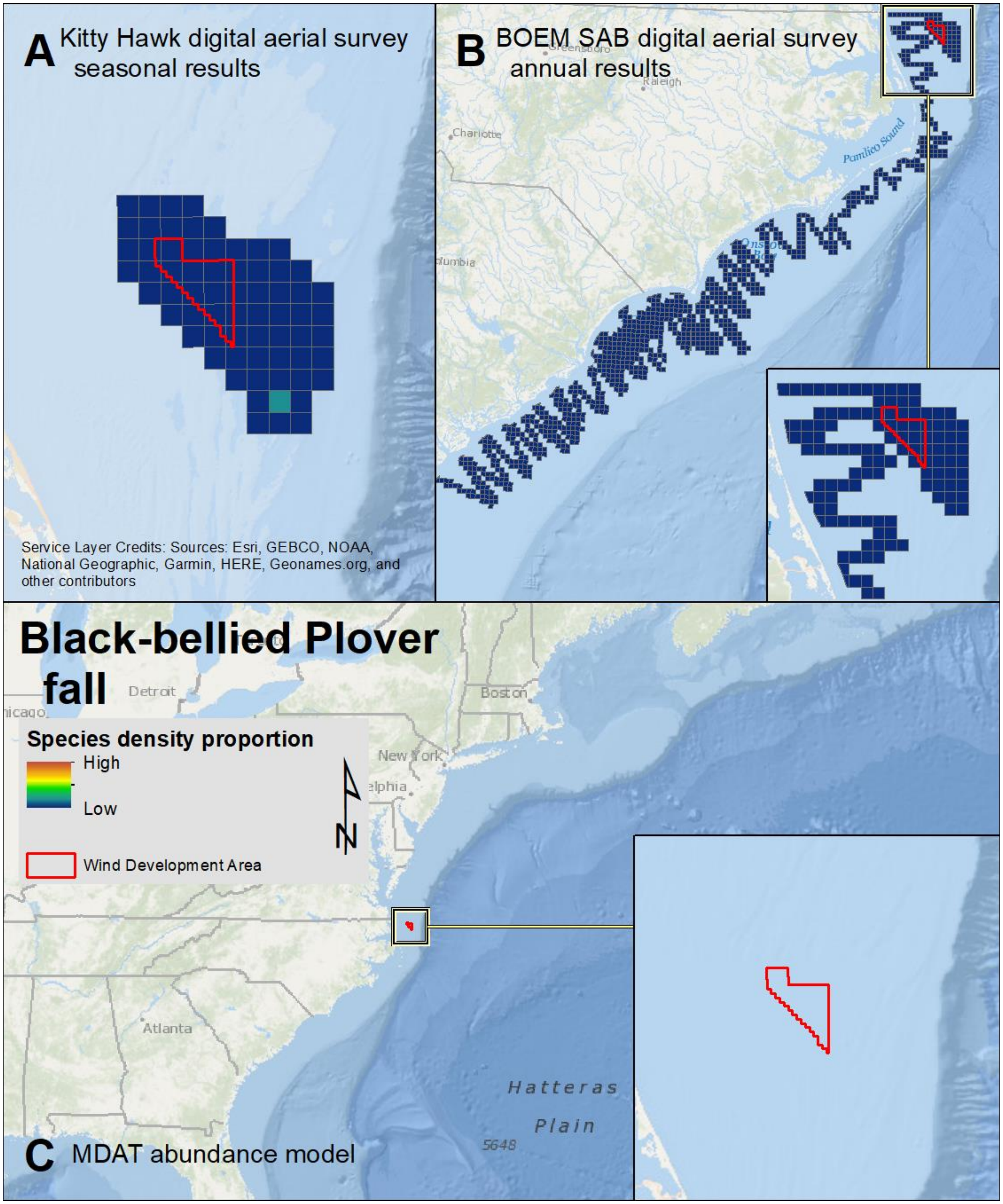
Map 18: Winter Red-breasted Merganser density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



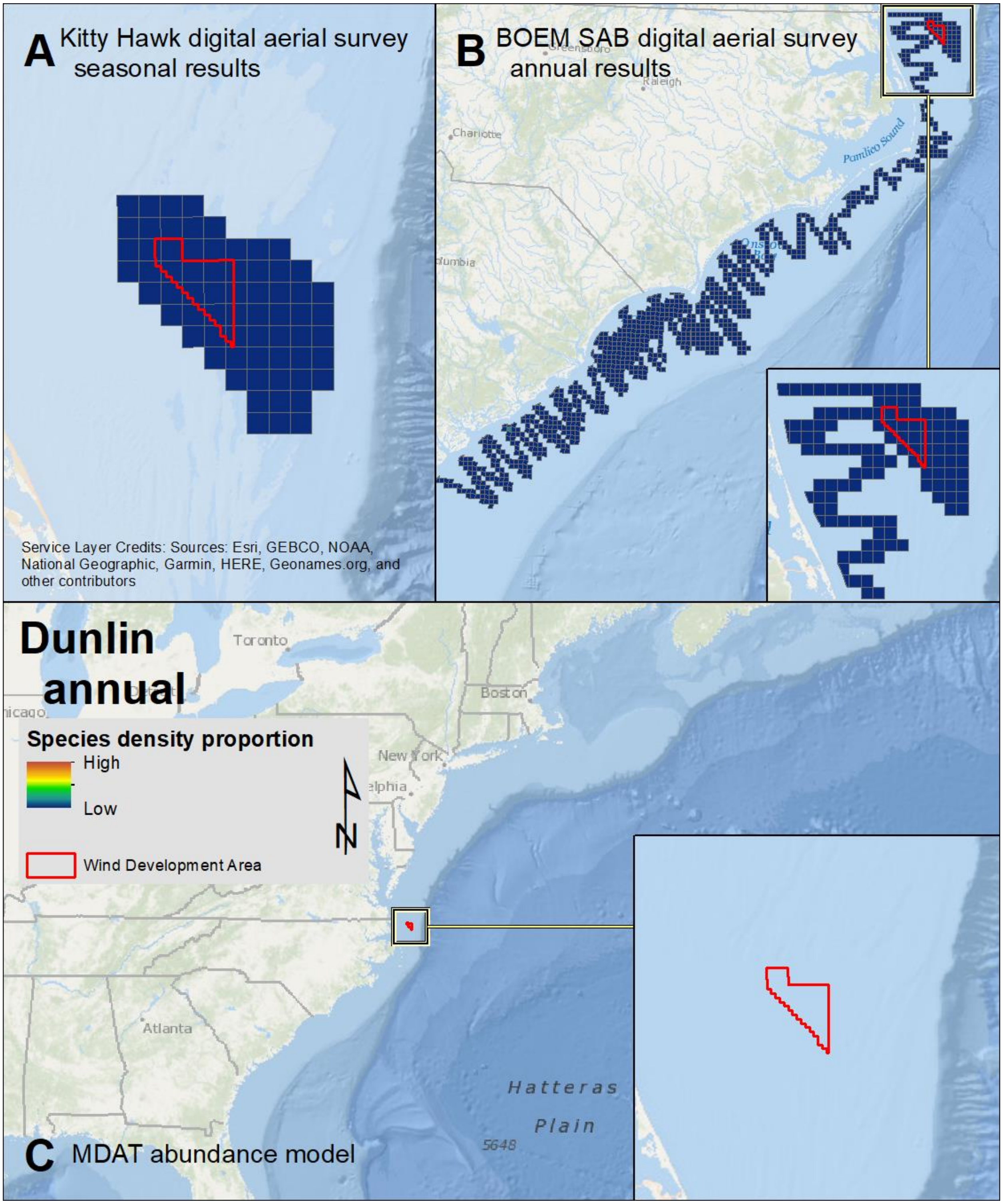
Map 19: Spring Red-breasted Merganser density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



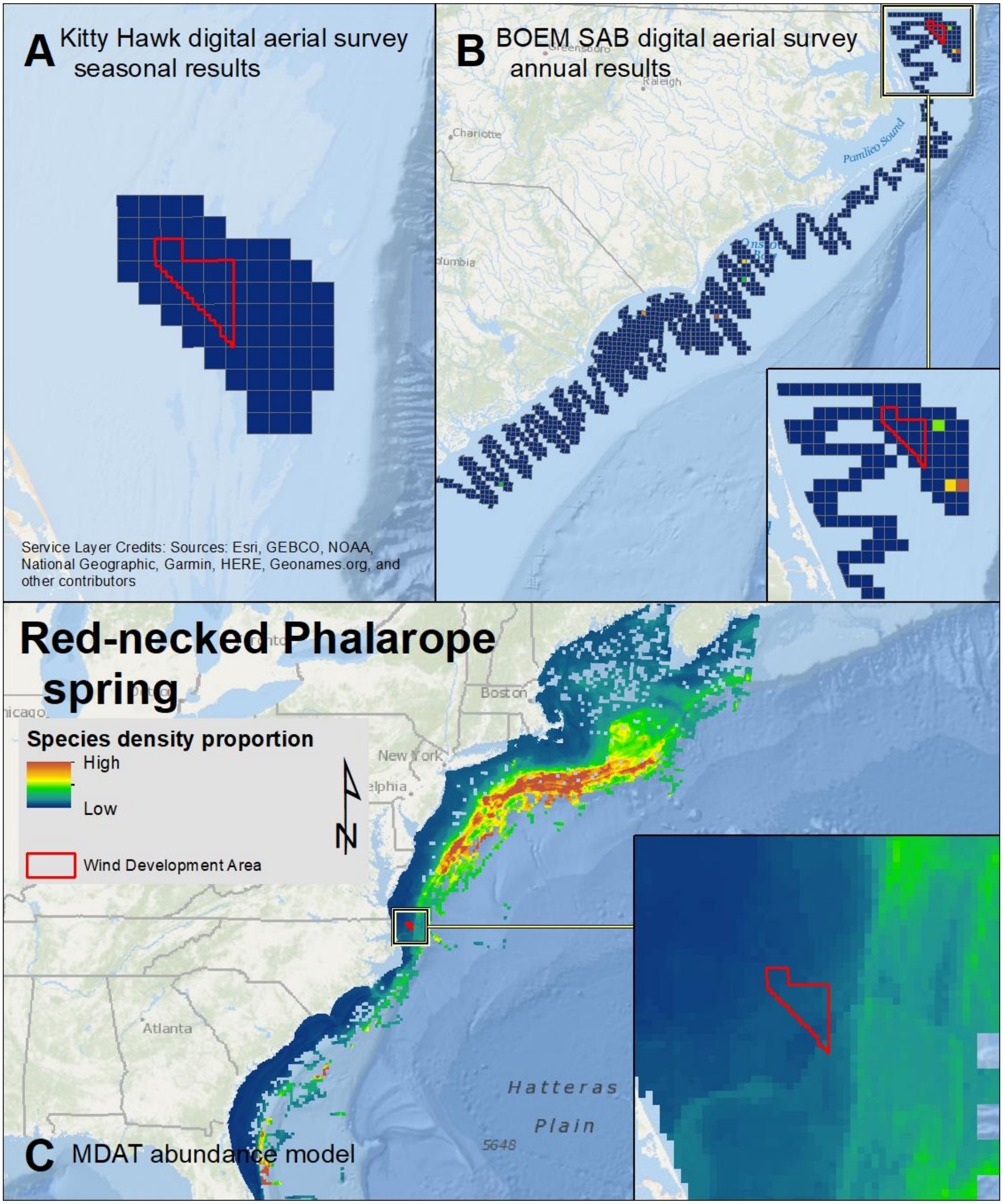
Map 20: Winter Horned Grebe density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



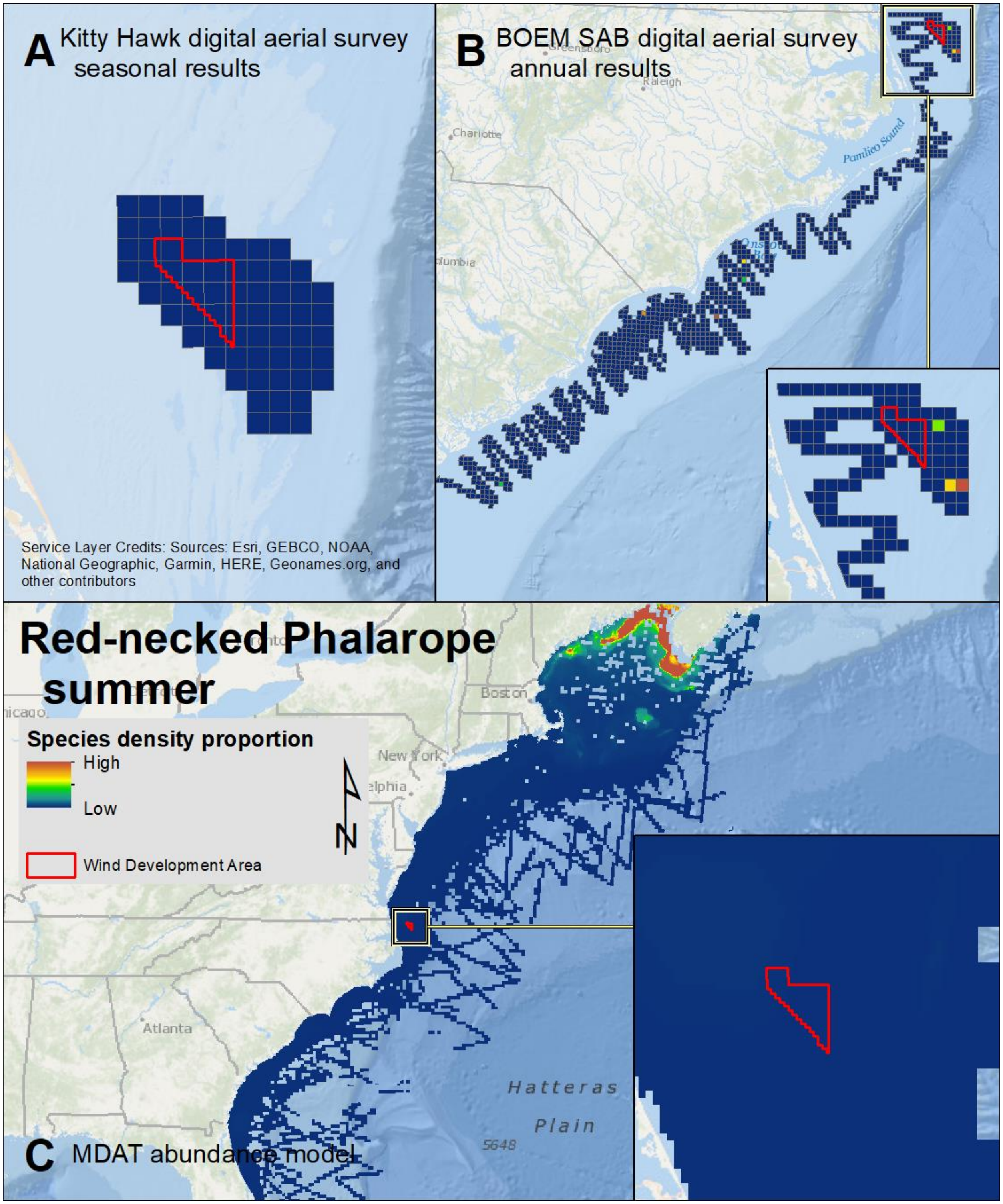
Map 21: Fall Black-bellied Plover density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



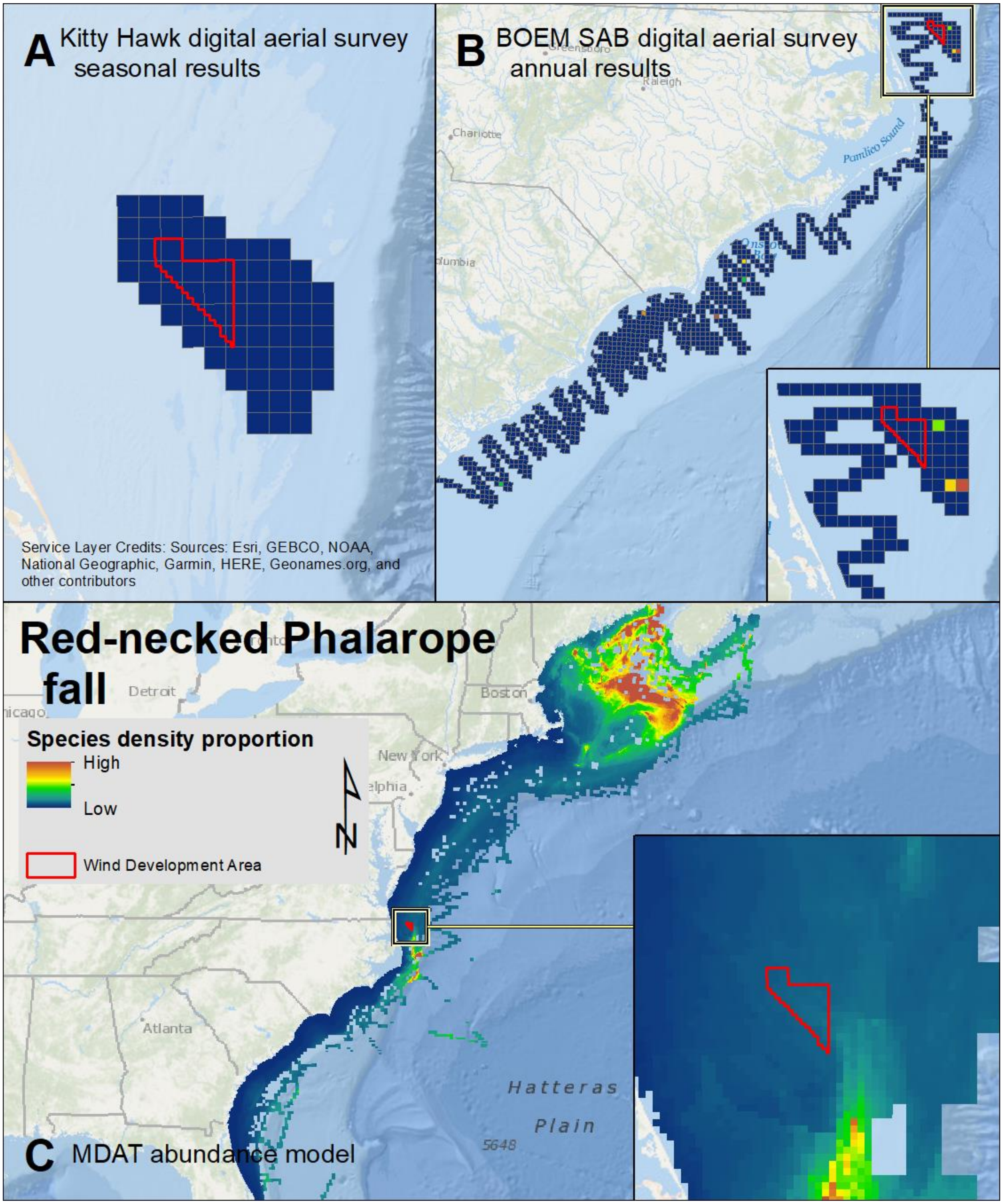
Map 22: Annual Dunlin density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



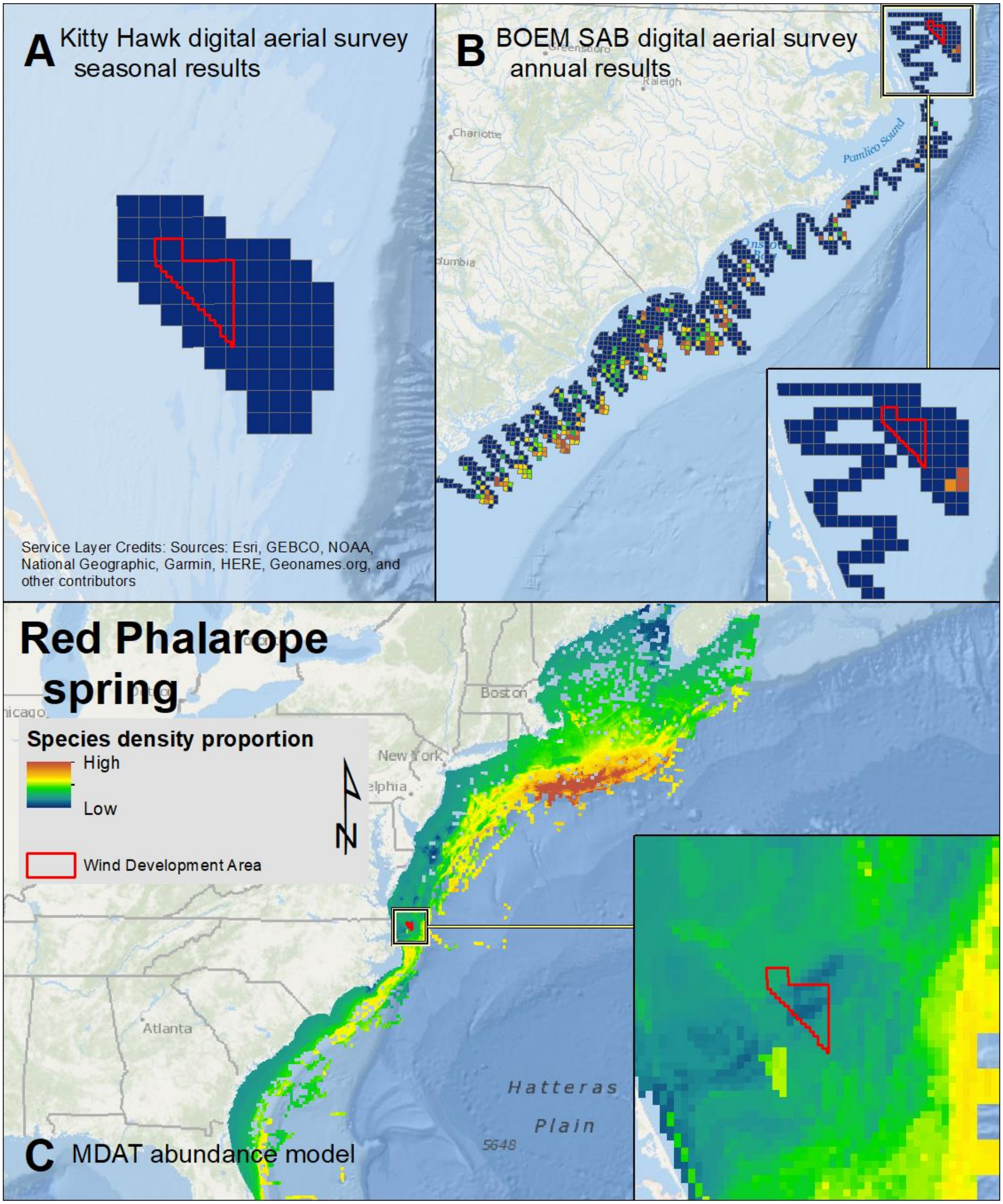
Map 23: Spring Red-necked Phalarope density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



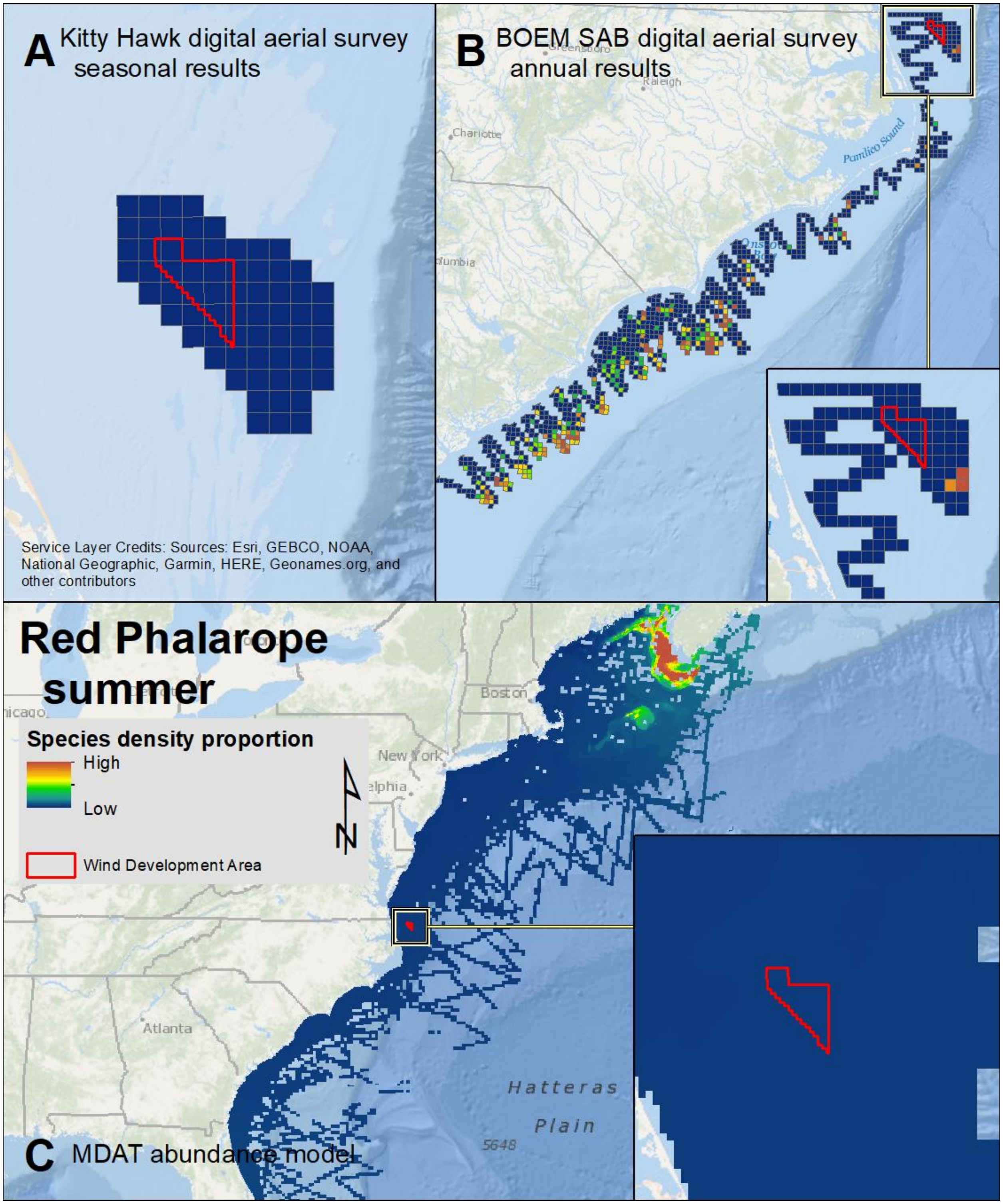
Map 24: Summer Red-necked Phalarope density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



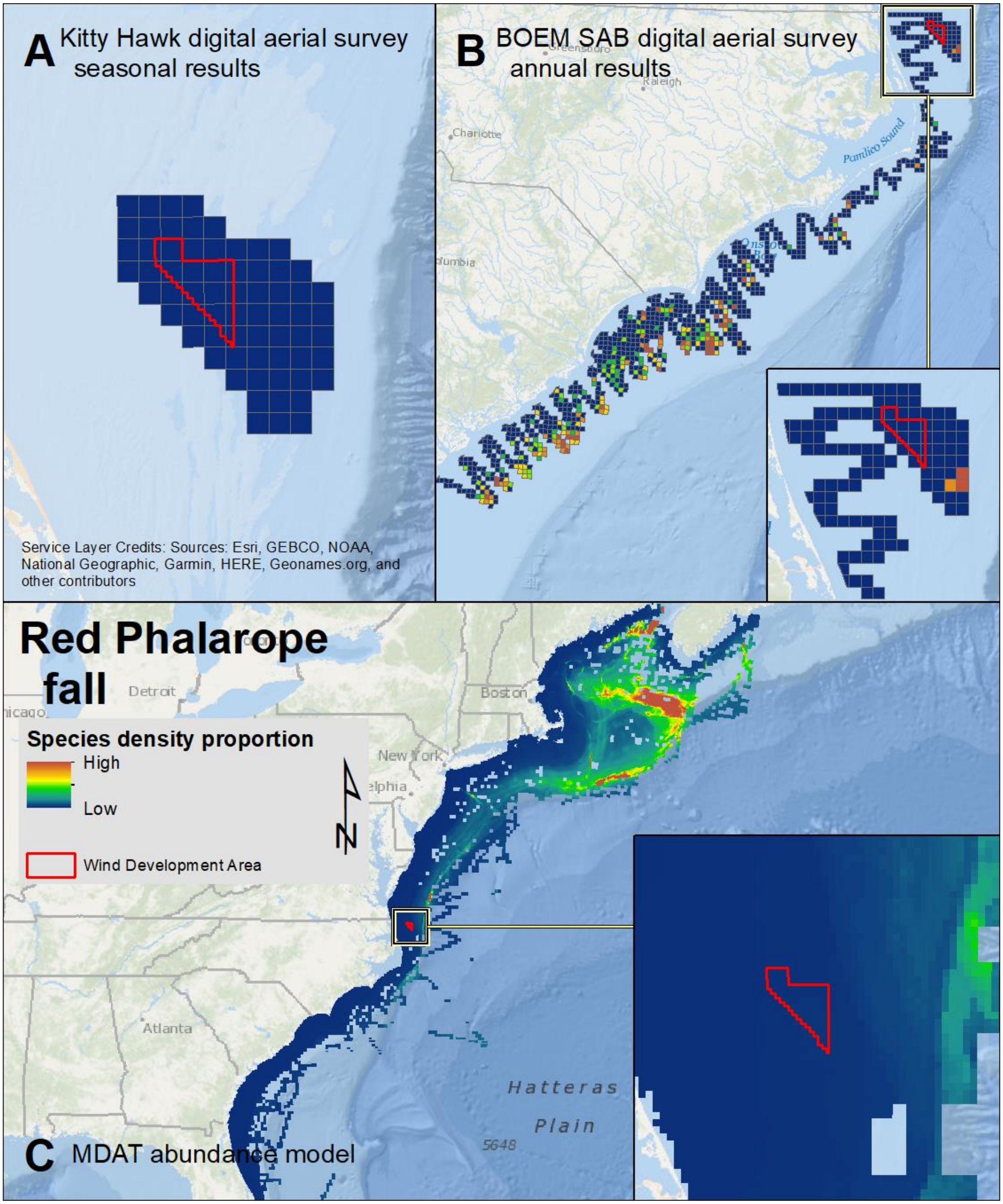
Map 25: Fall Red-necked Phalarope density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



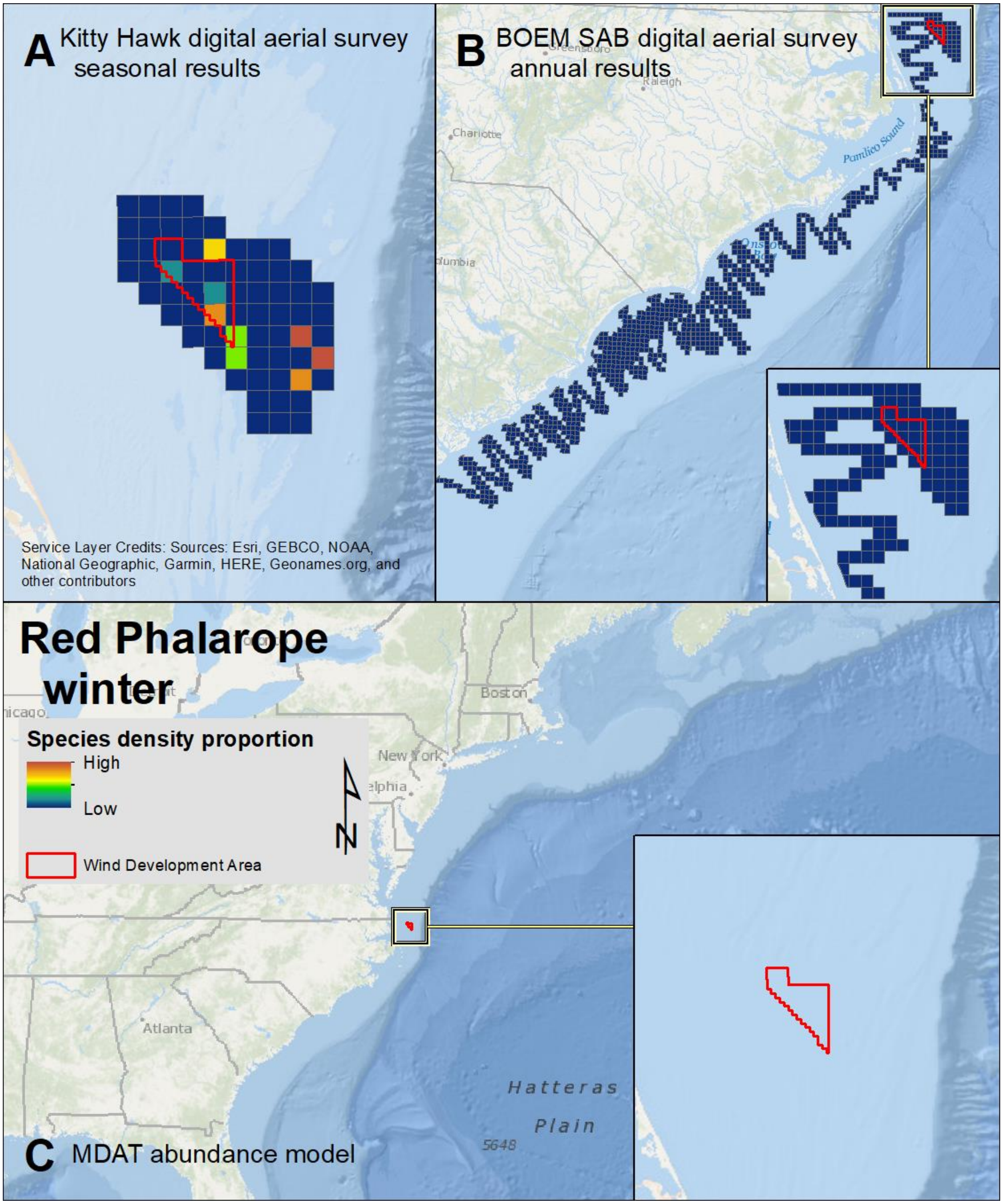
Map 26: Spring Red Phalarope density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



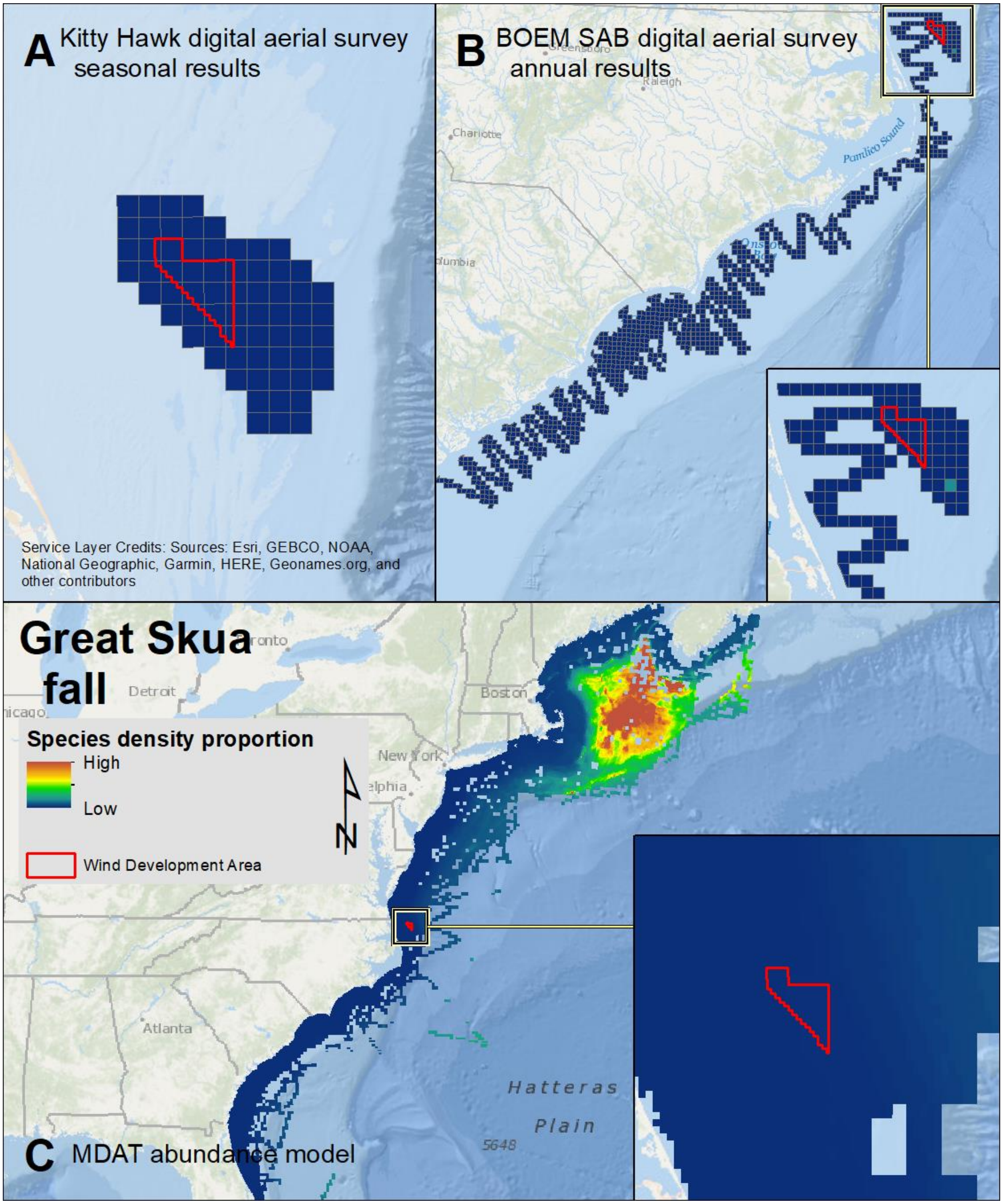
Map 27: Summer Red Phalarope density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



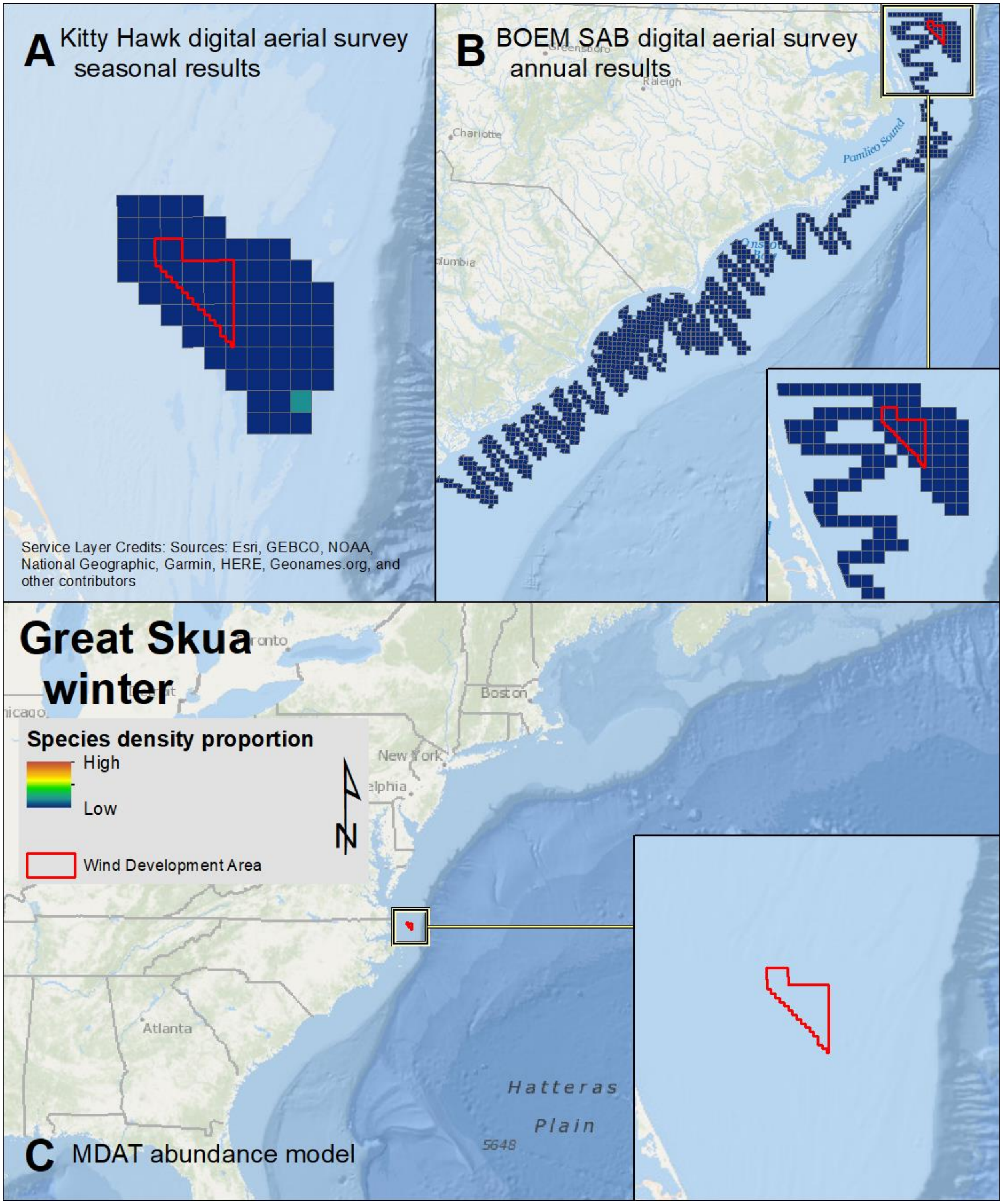
Map 28: Fall Red Phalarope density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



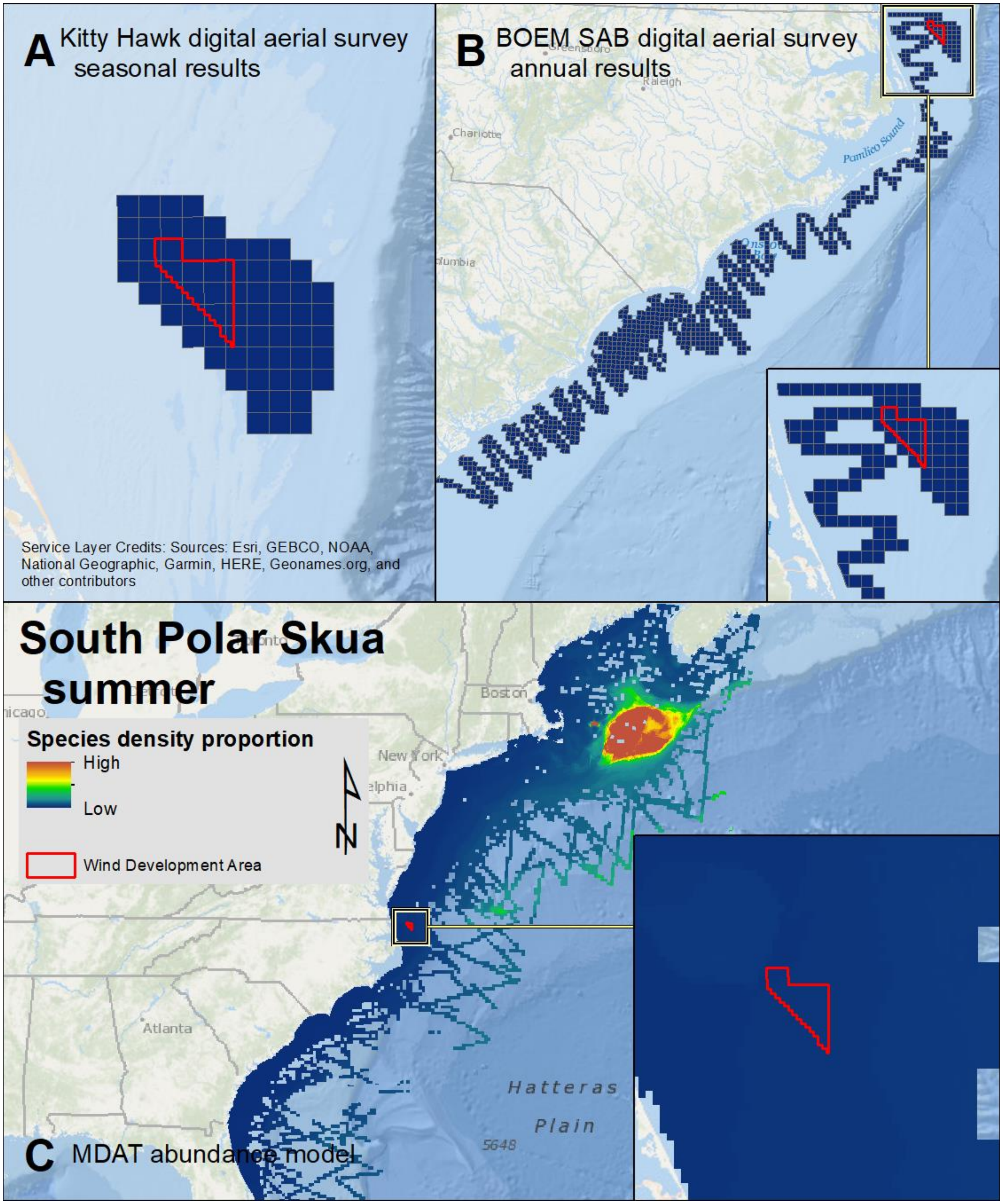
Map 29: Winter Red Phalarope density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



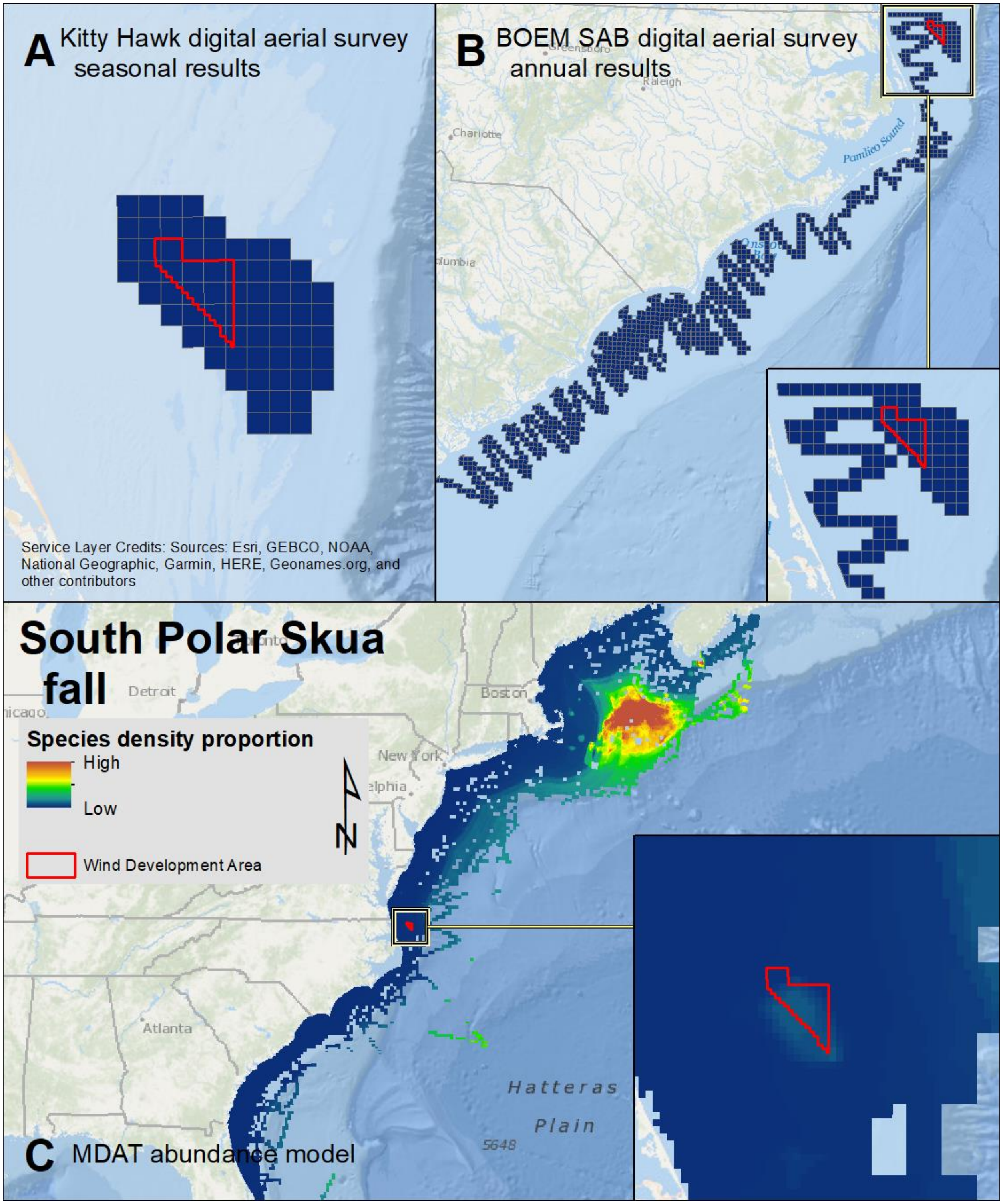
Map 30: Fall Great Skua density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



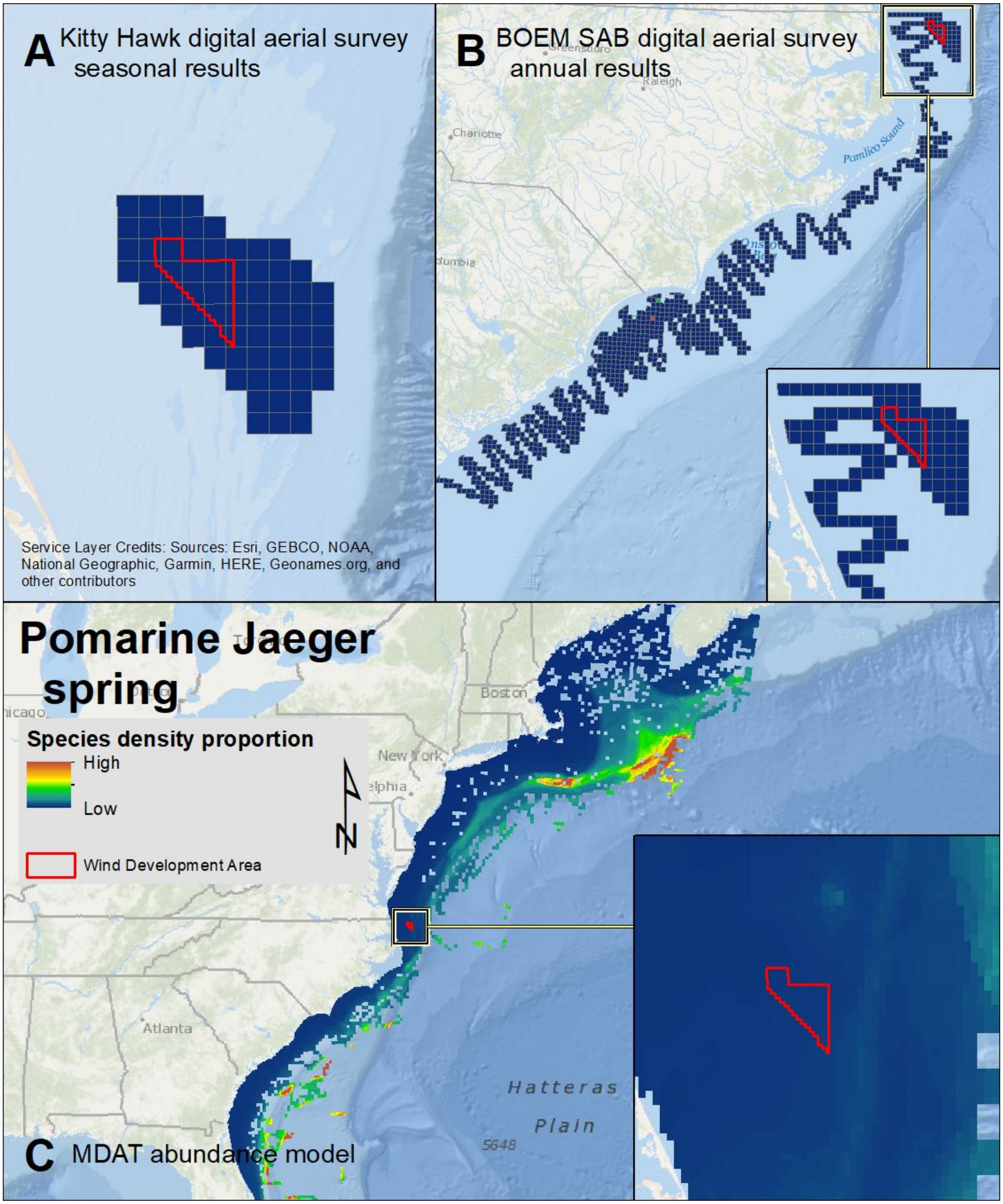
Map 31: Winter Great Skua density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



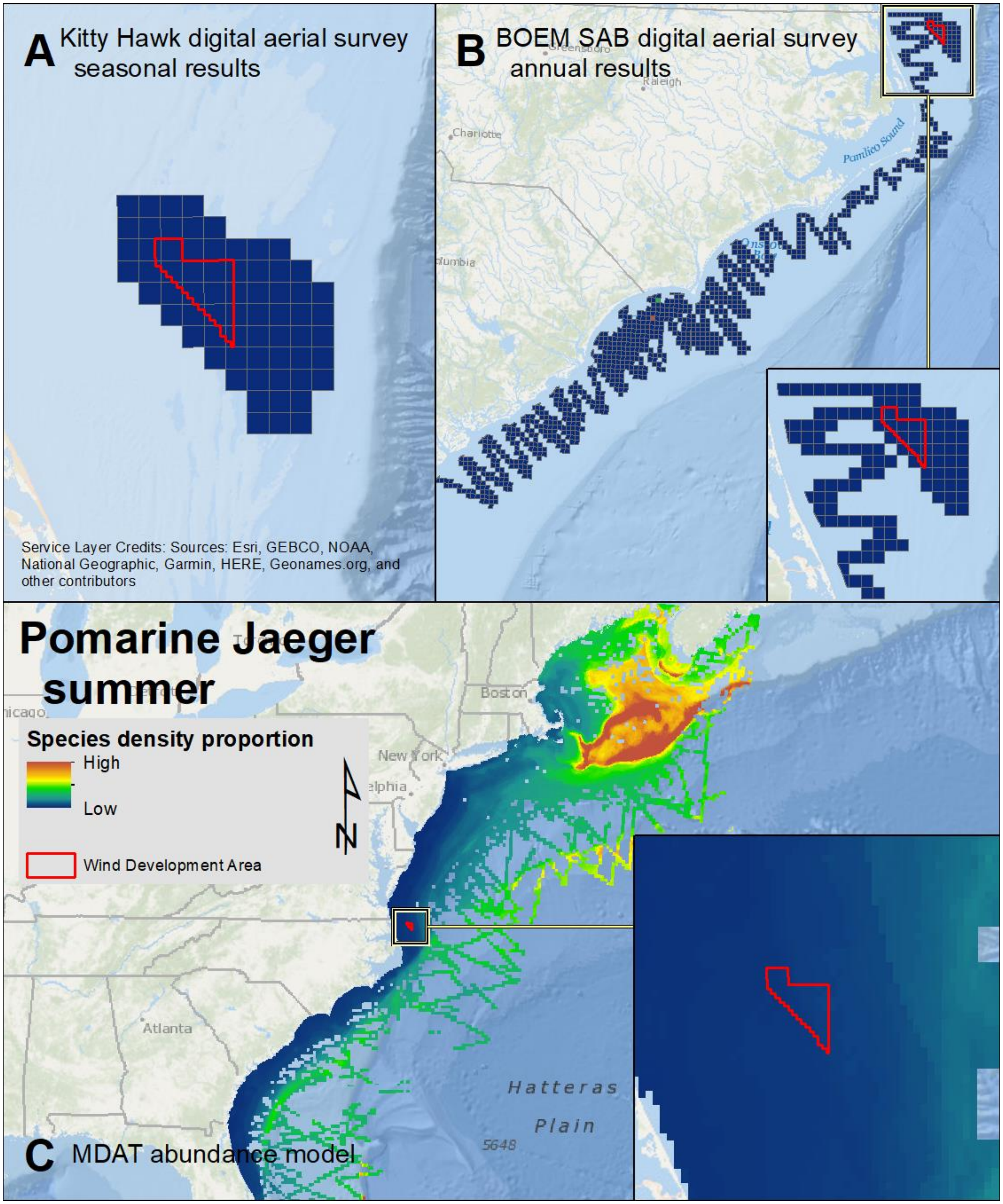
Map 32: Summer South Polar Skua density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



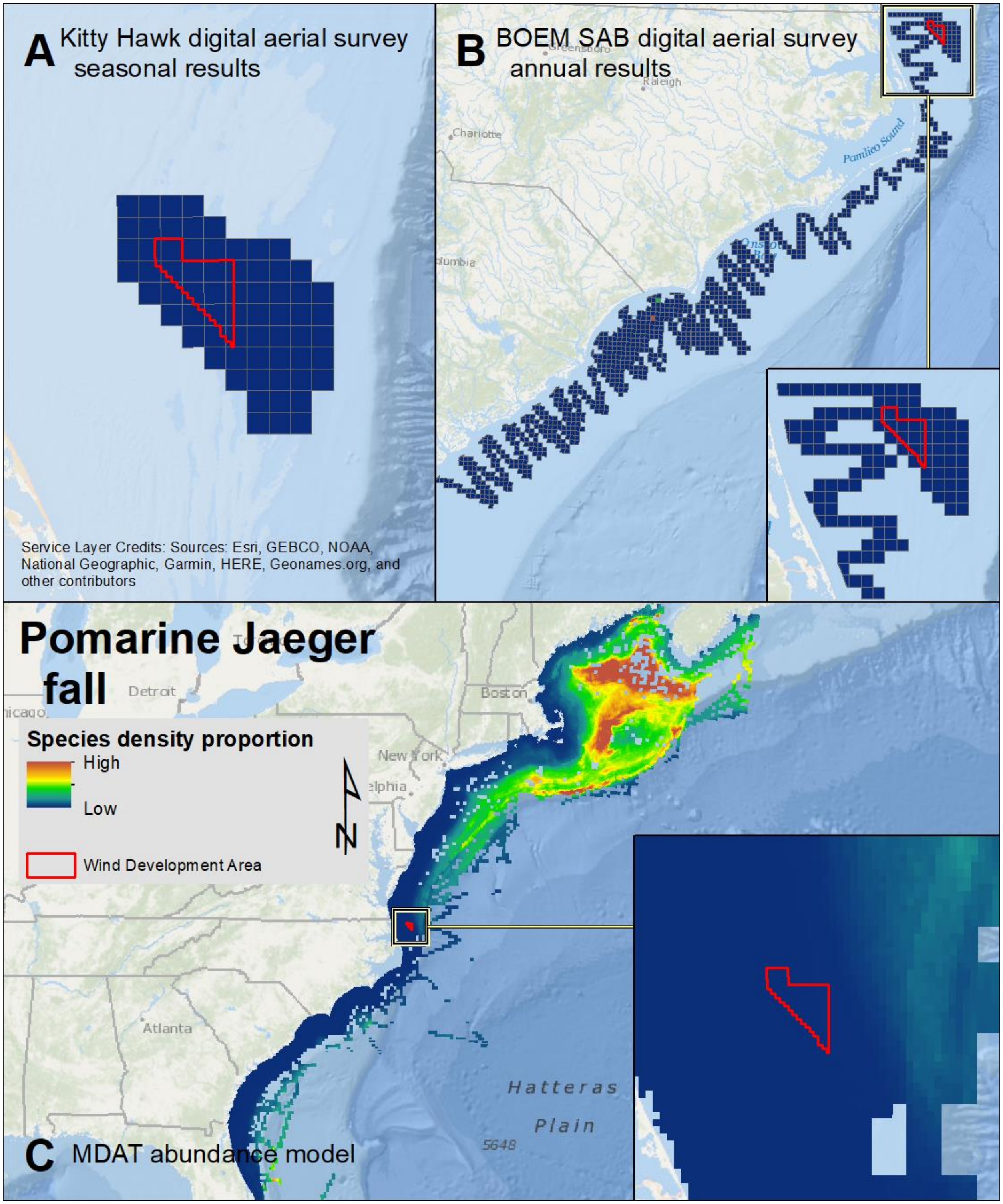
Map 33: Fall South Polar Skua density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



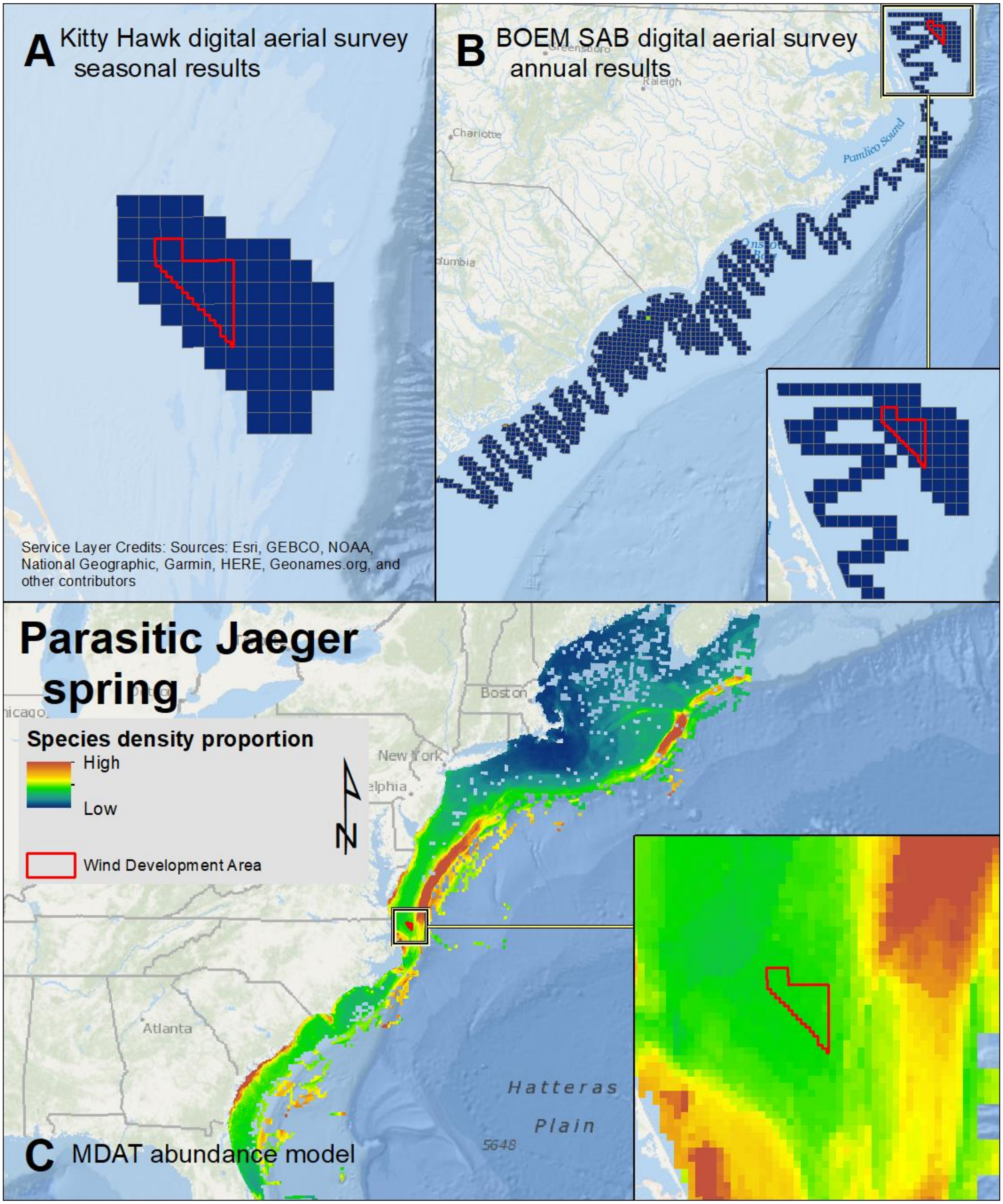
Map 34: Spring Pomarine Jaeger density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



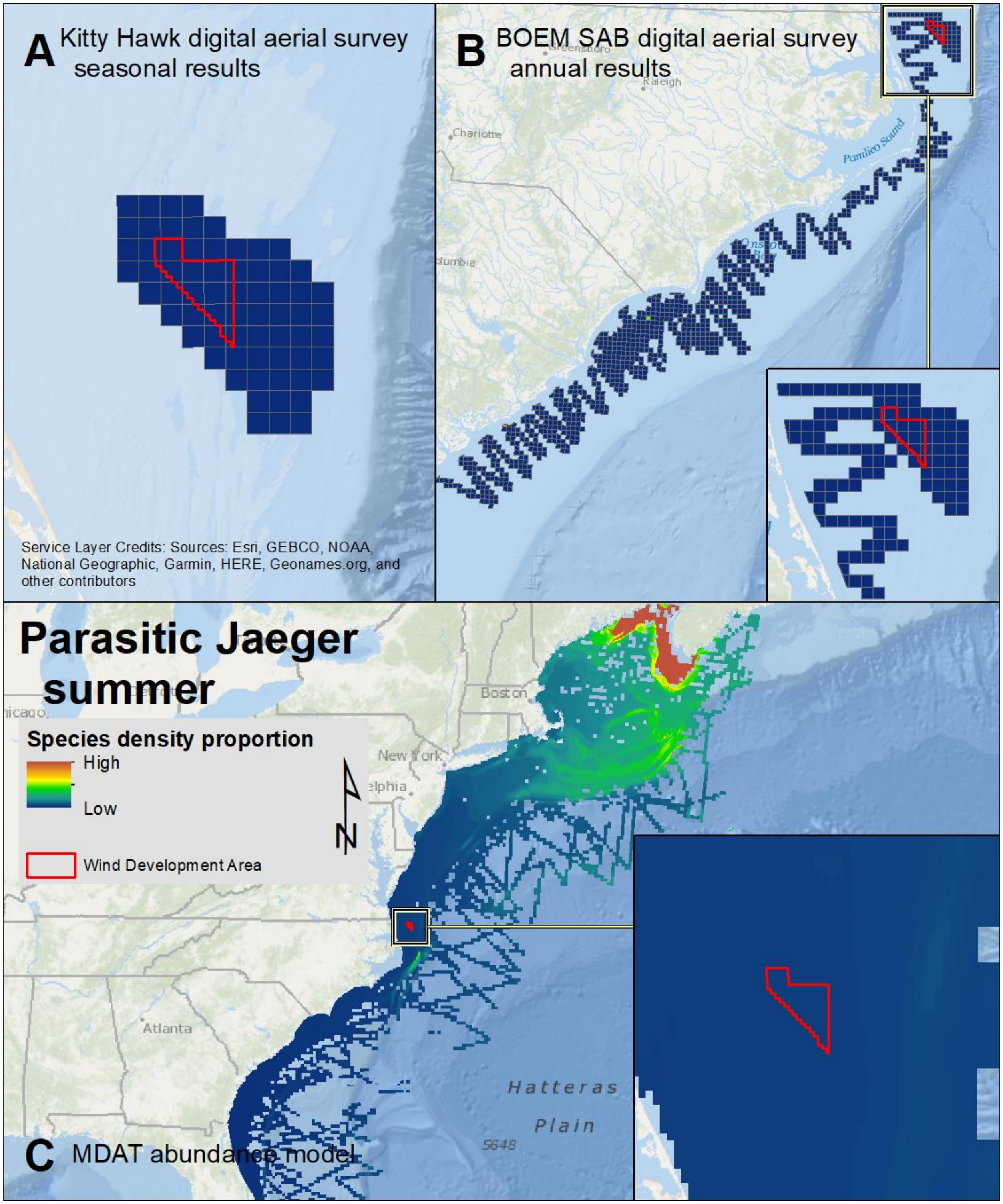
Map 35: Summer Pomarine Jaeger density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



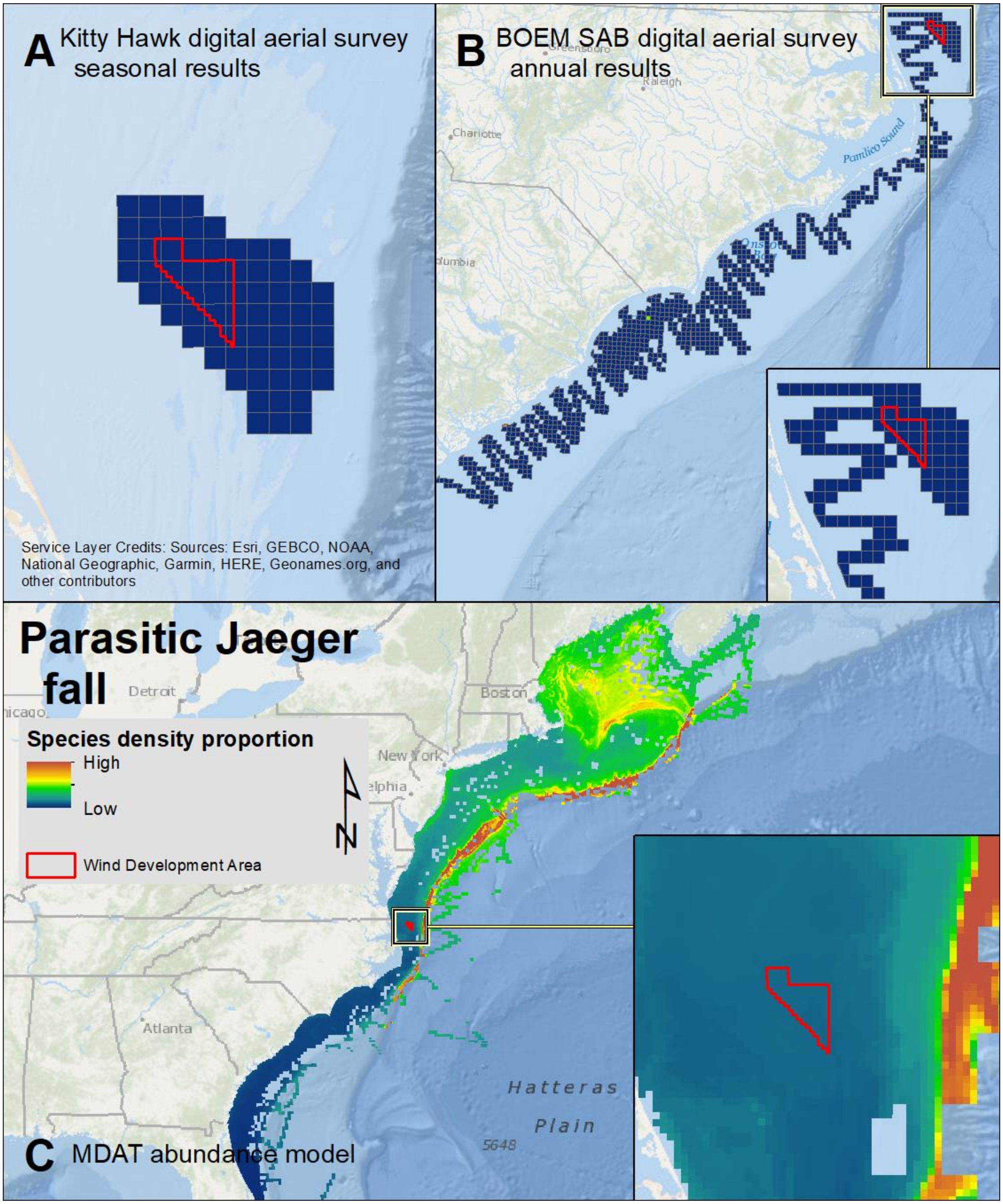
Map 36: Fall Pomarine Jaeger density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



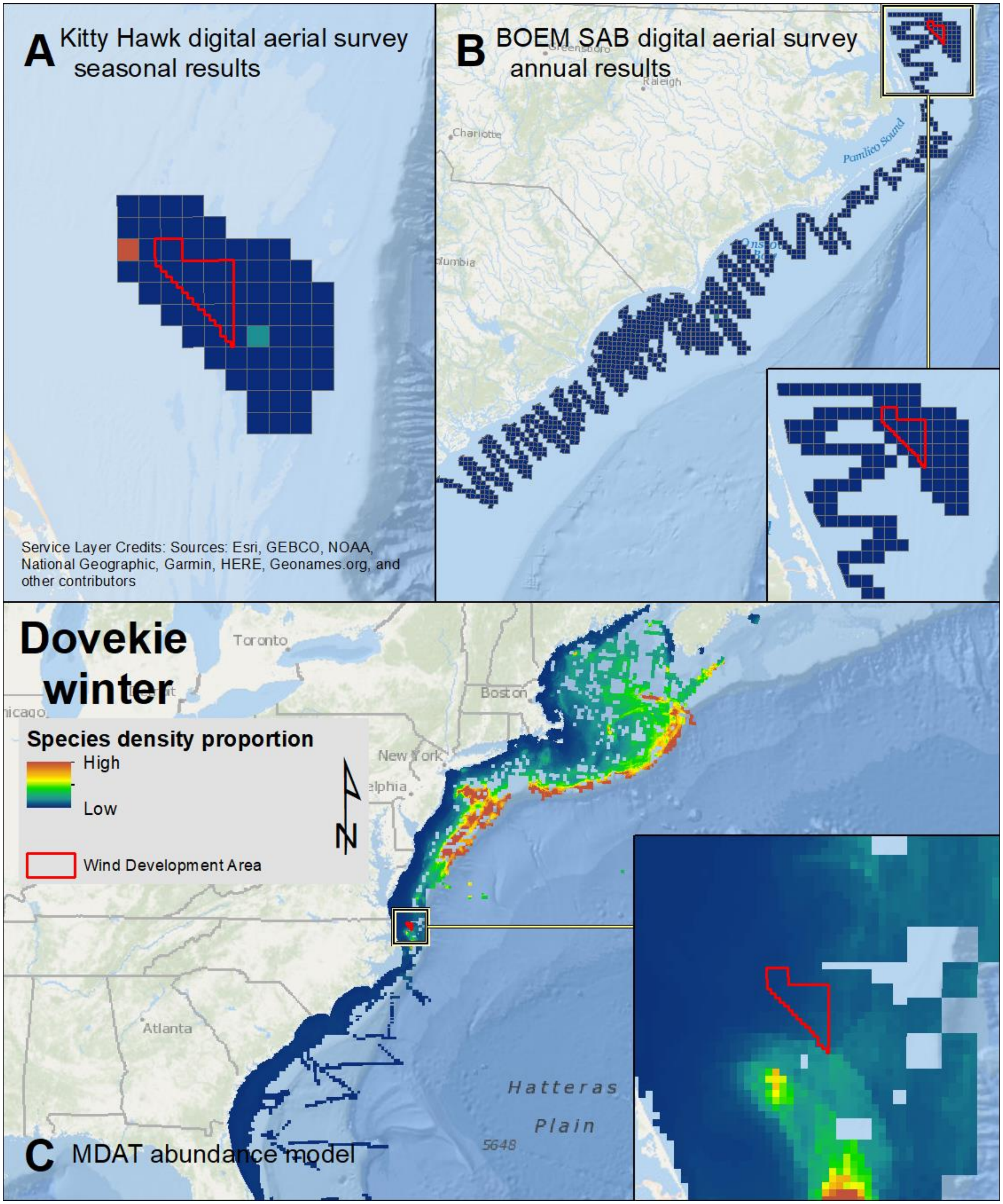
Map 37: Spring Parasitic Jaeger density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



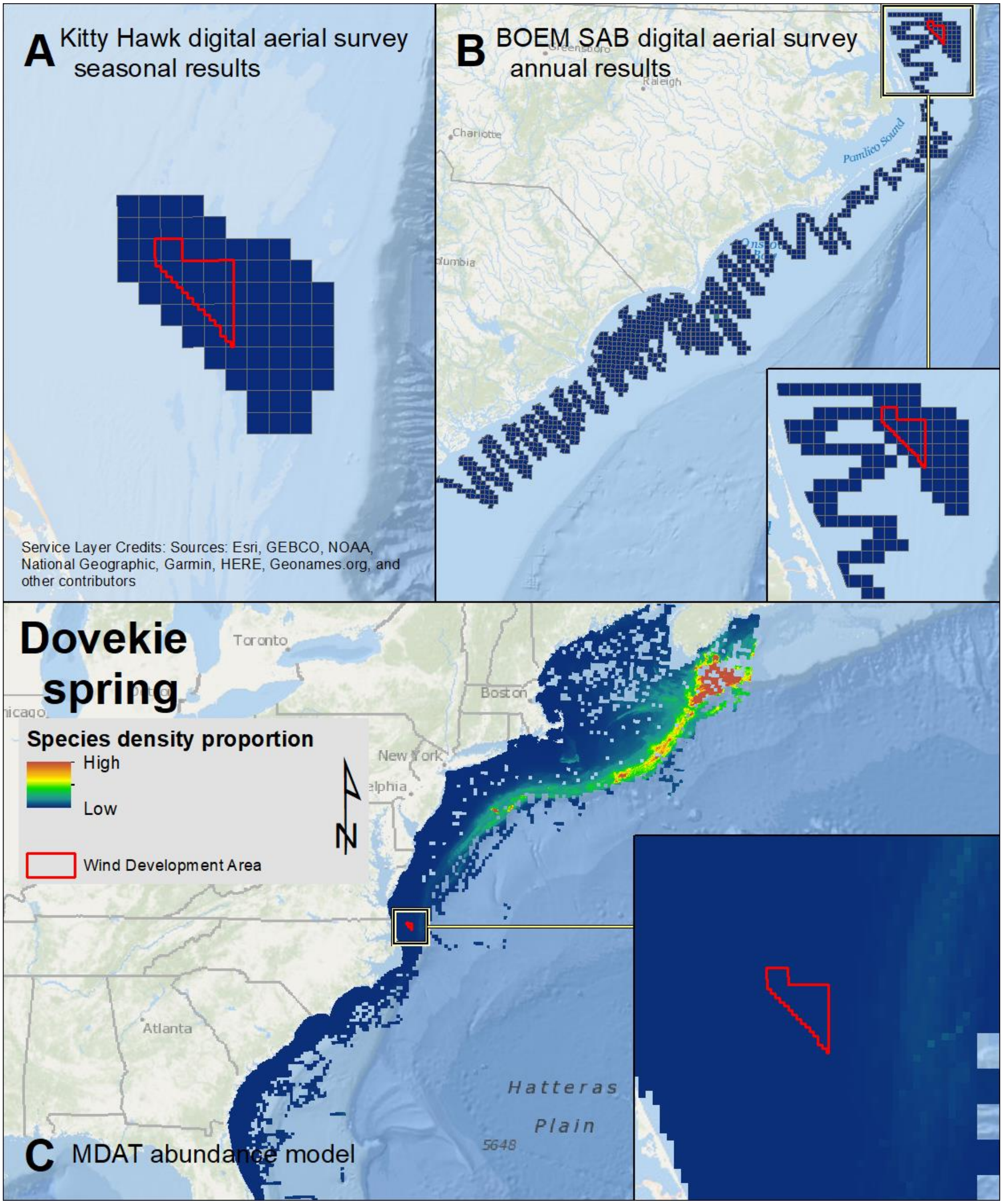
Map 38: Summer Parasitic Jaeger density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



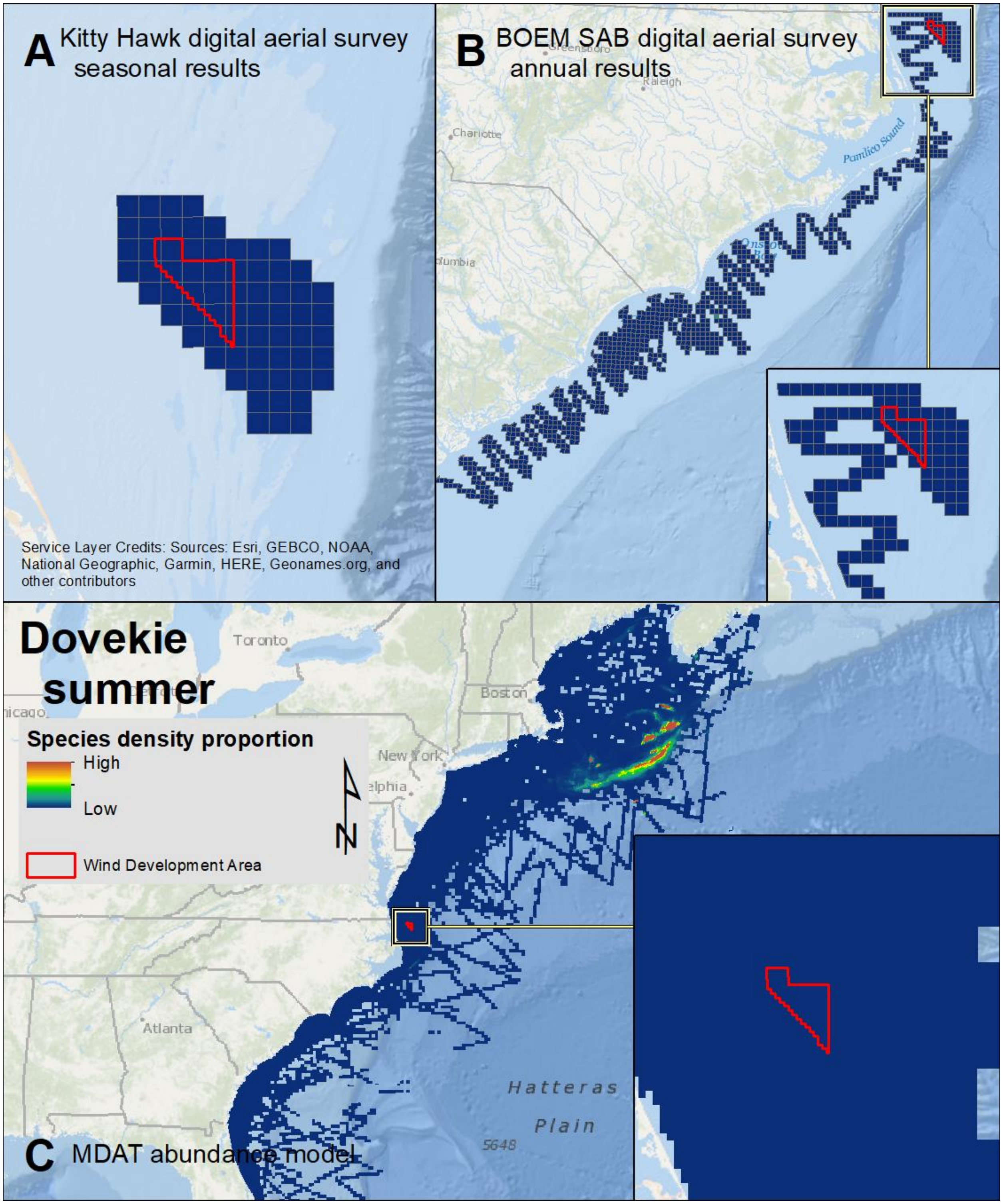
Map 39: Fall Parasitic Jaeger density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



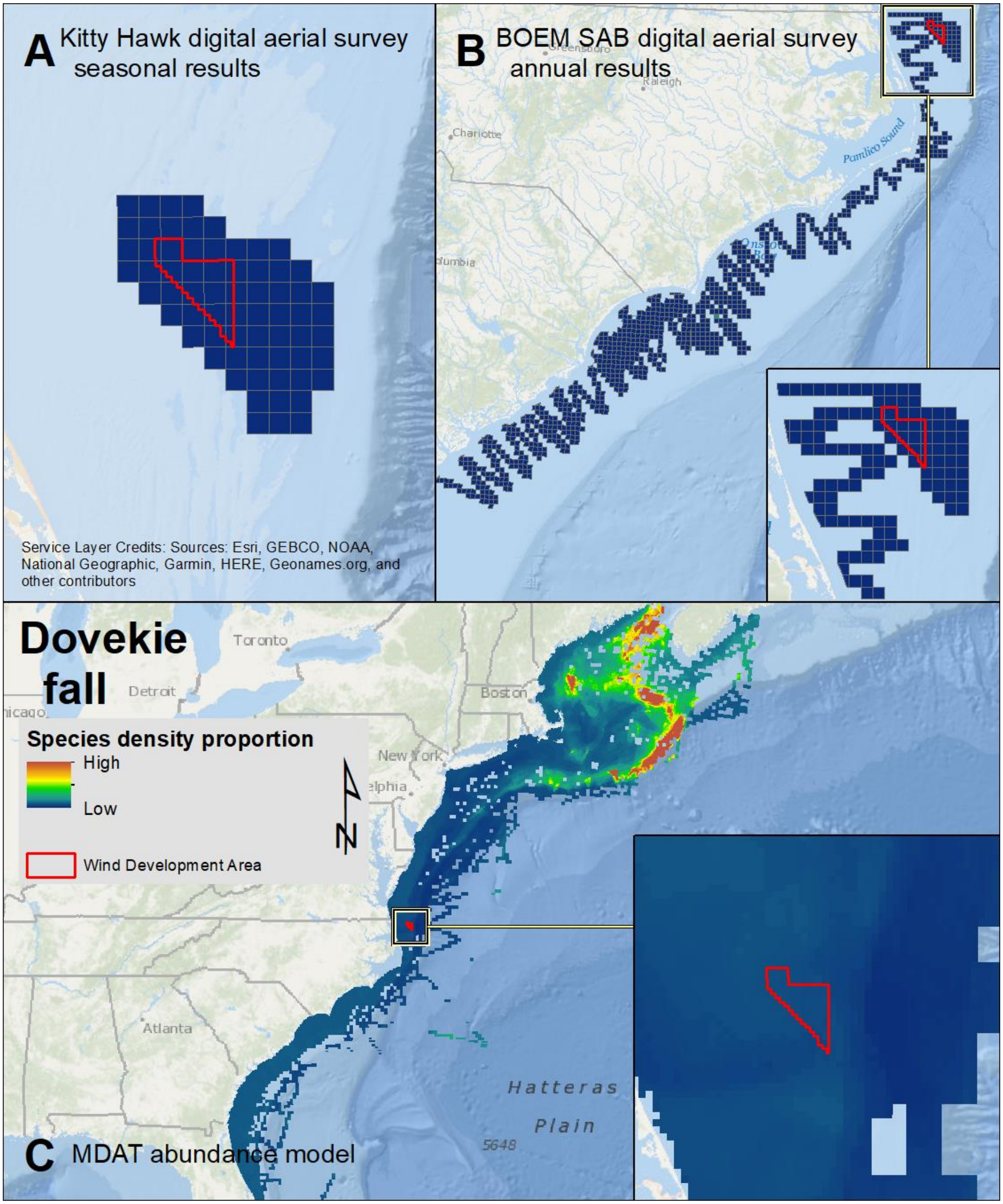
Map 40: Winter Dovekie density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



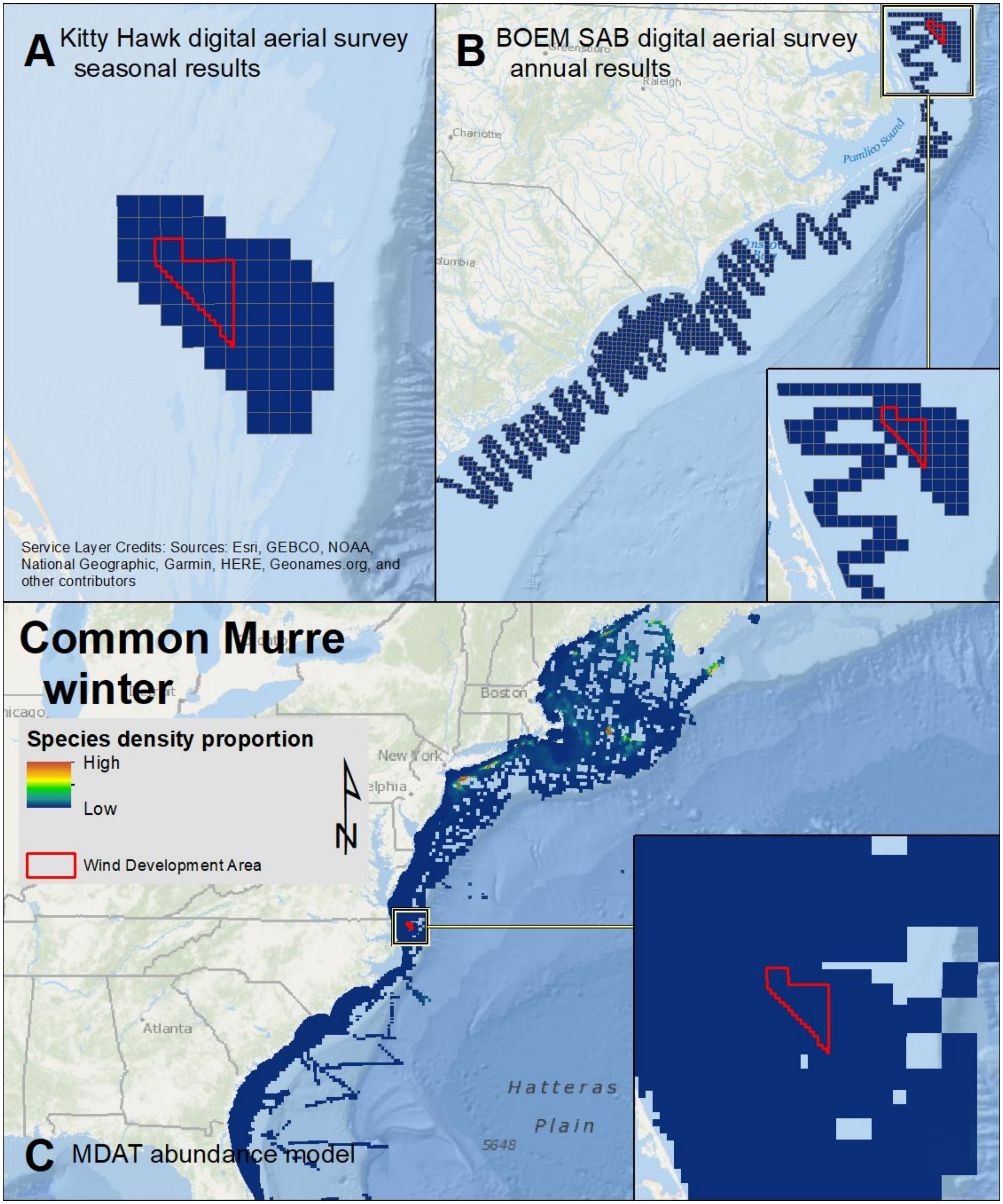
Map 41: Spring Dovekie density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



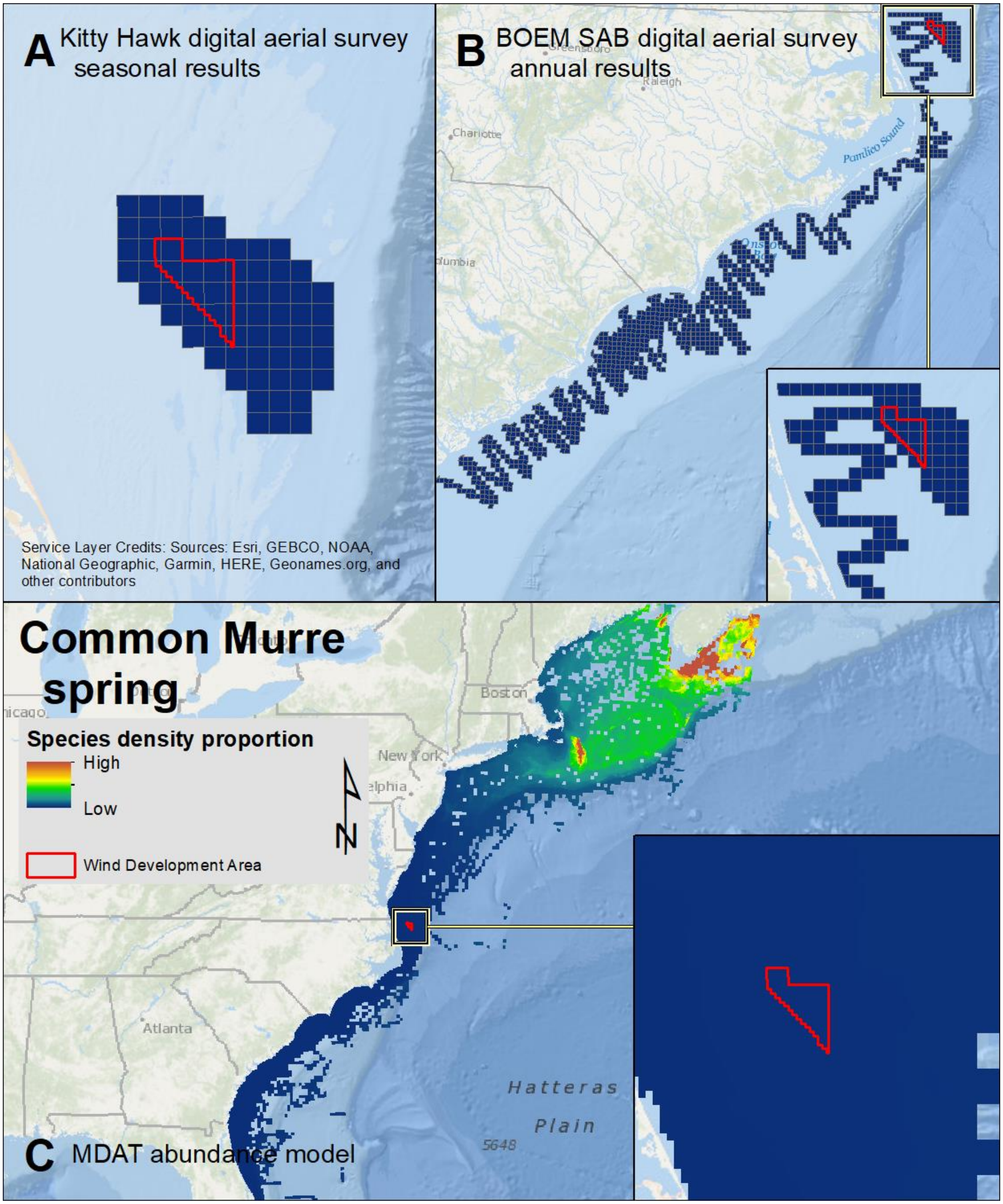
Map 42: Summer Dovekie density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



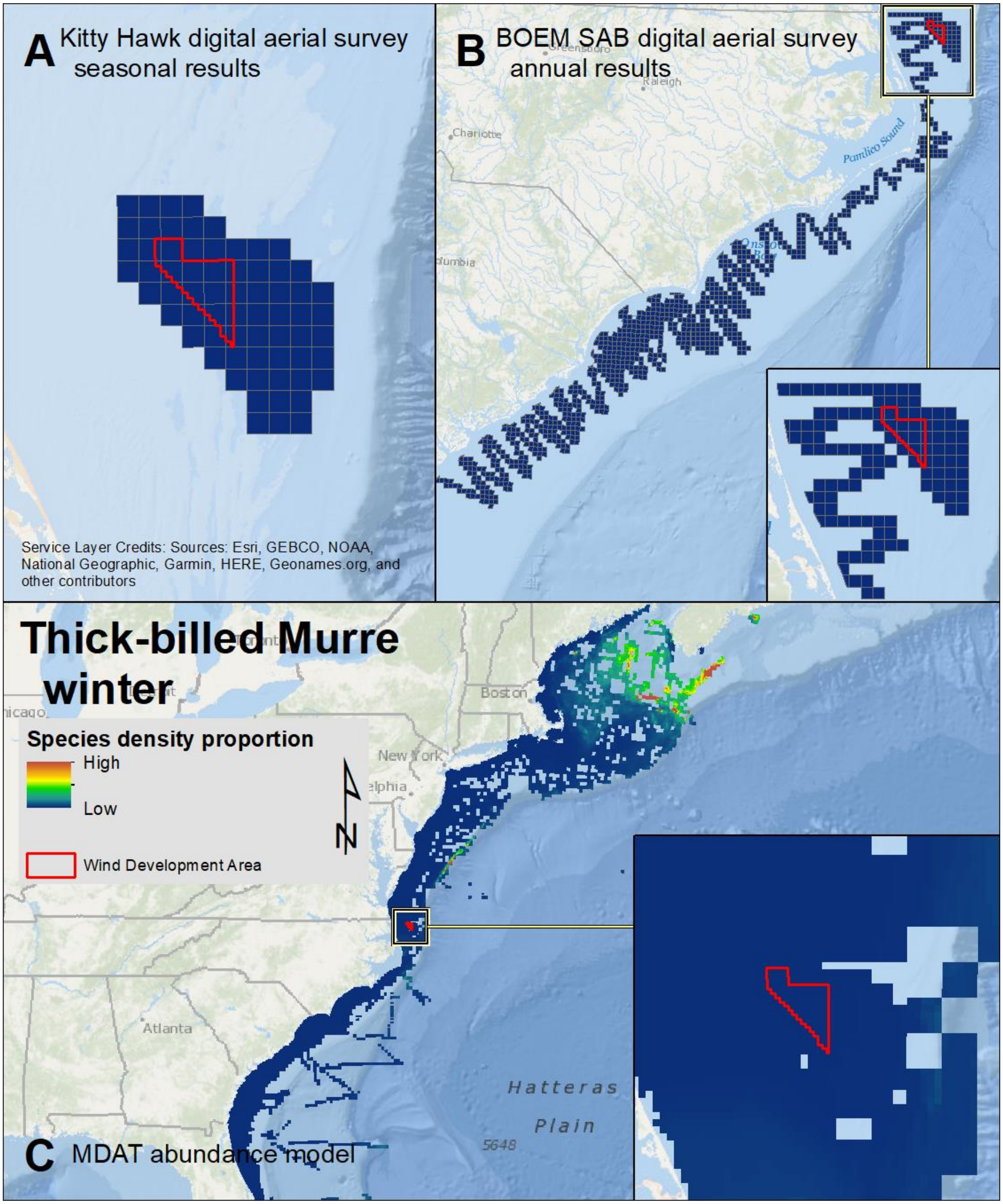
Map 43: Fall Dovekie density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



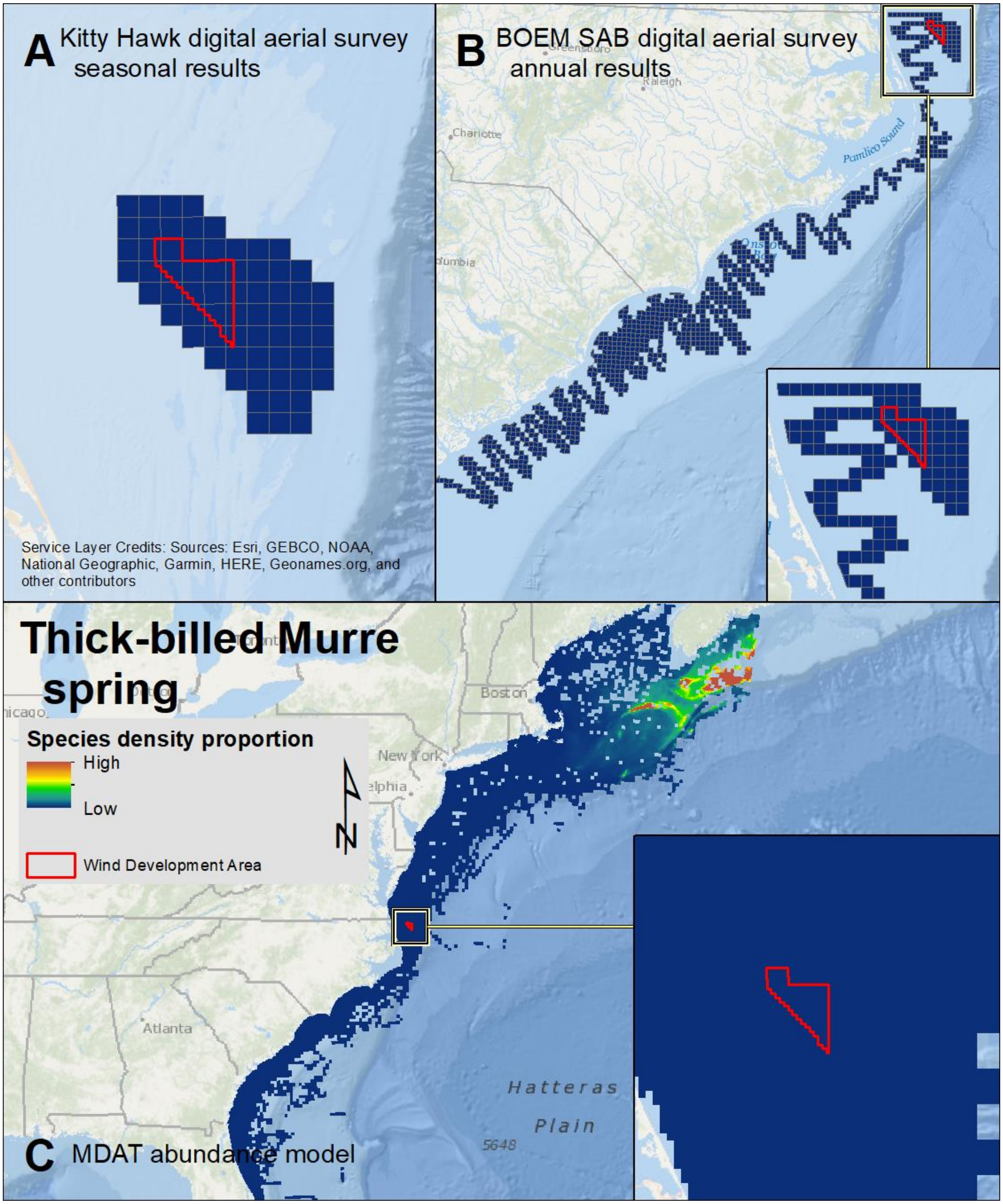
Map 44: Winter Common Murre density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



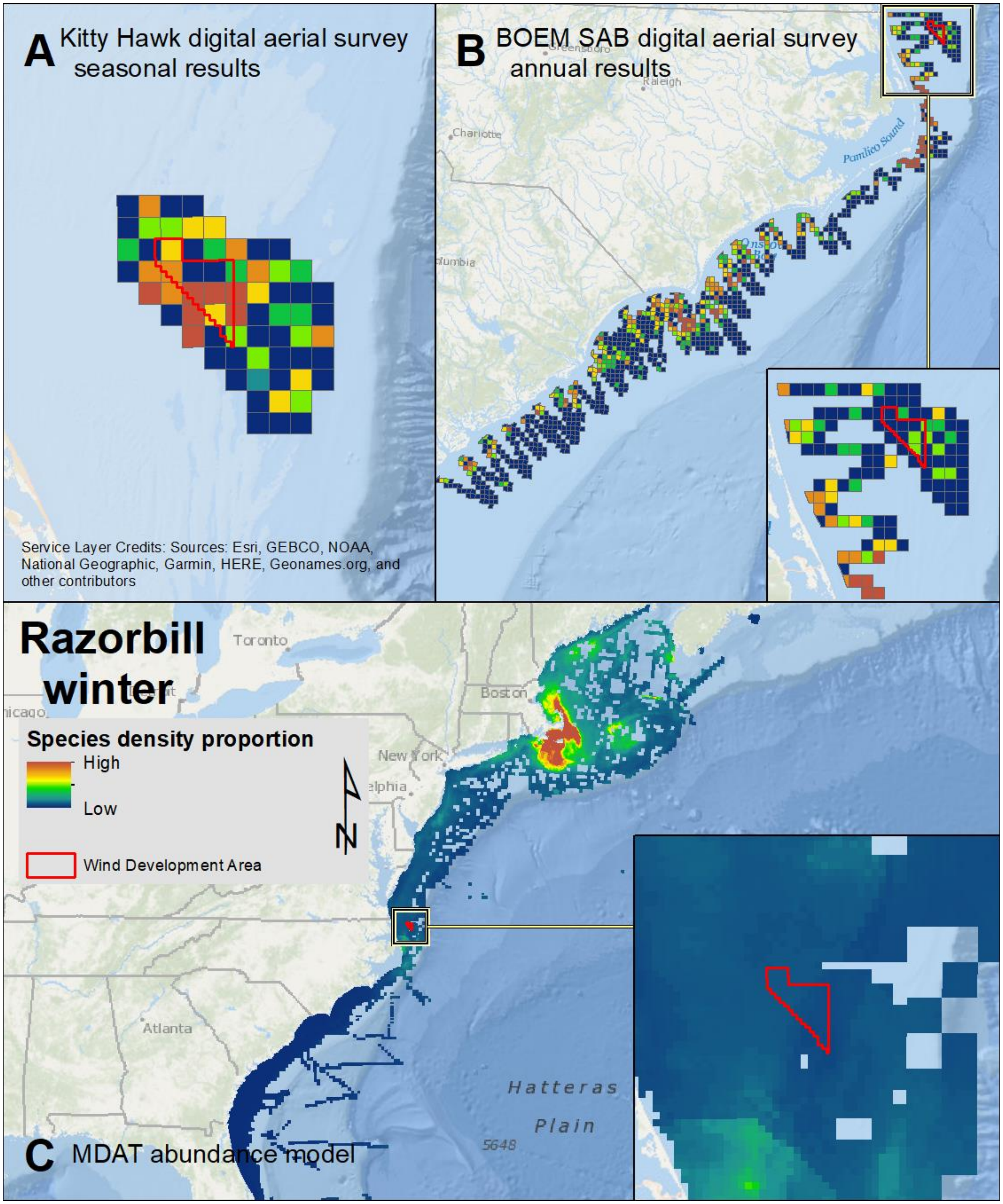
Map 45: Spring Common Murre density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



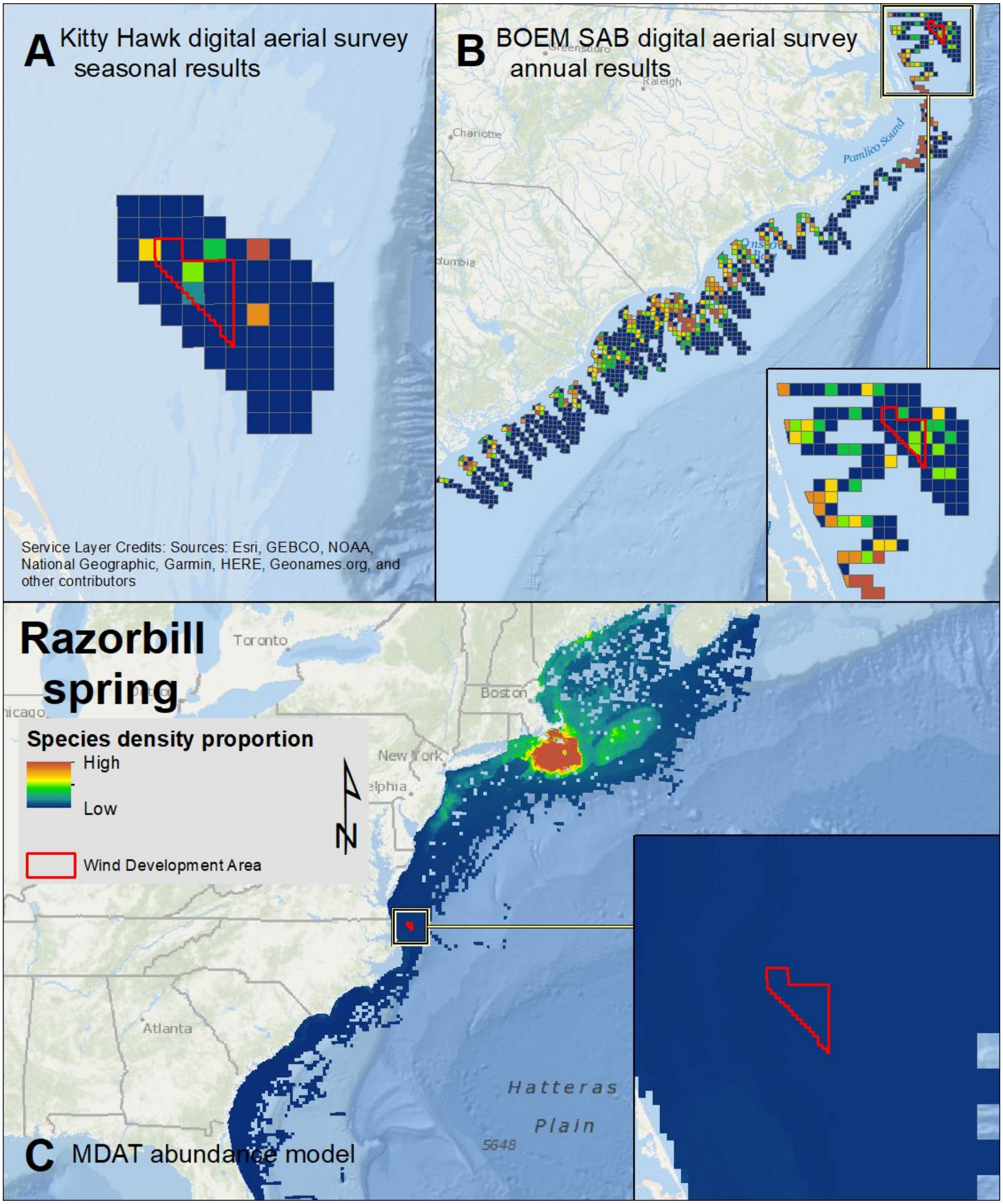
Map 46: Winter Thick-billed Murre density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



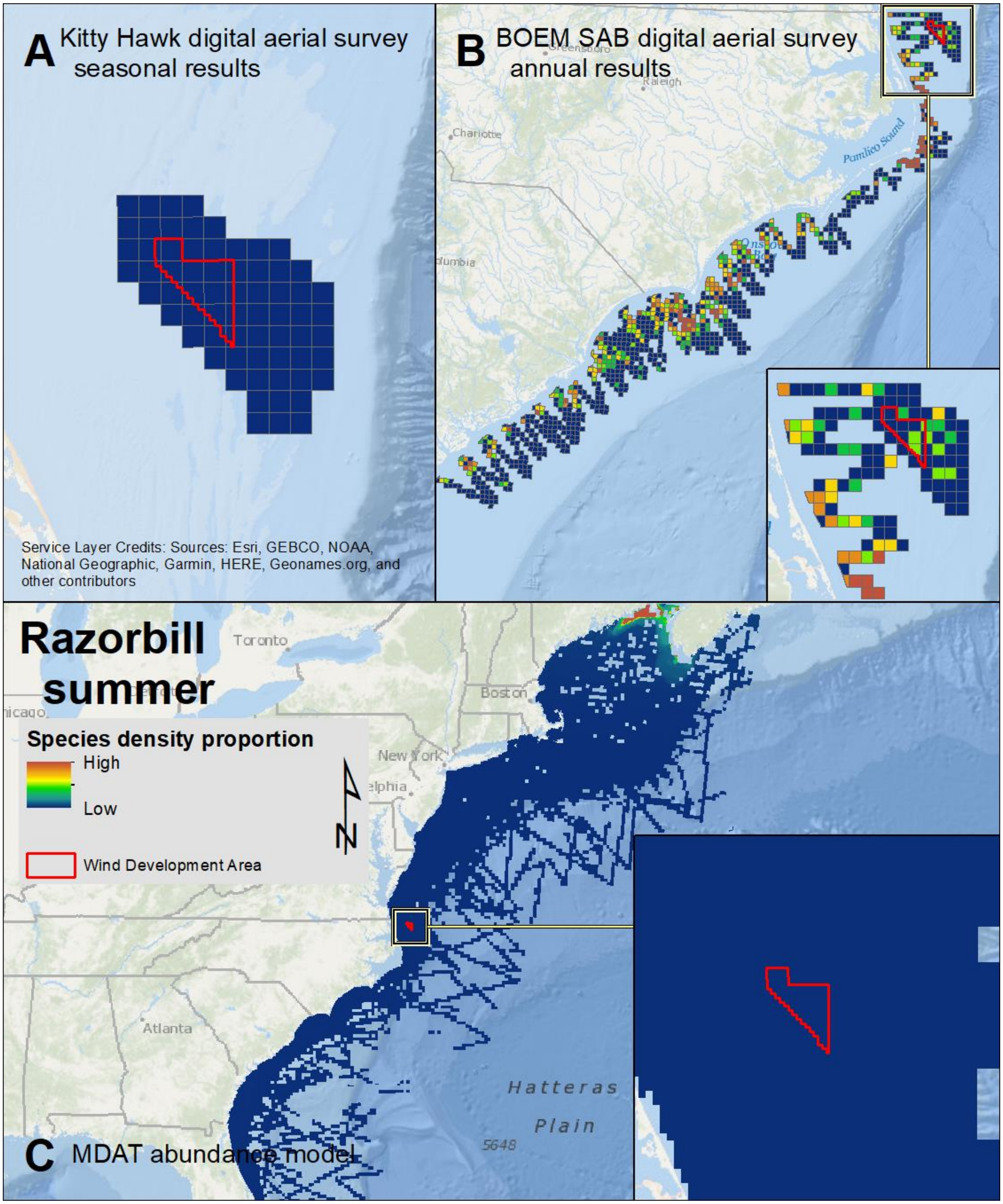
Map 47: Spring Thick-billed Murre density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



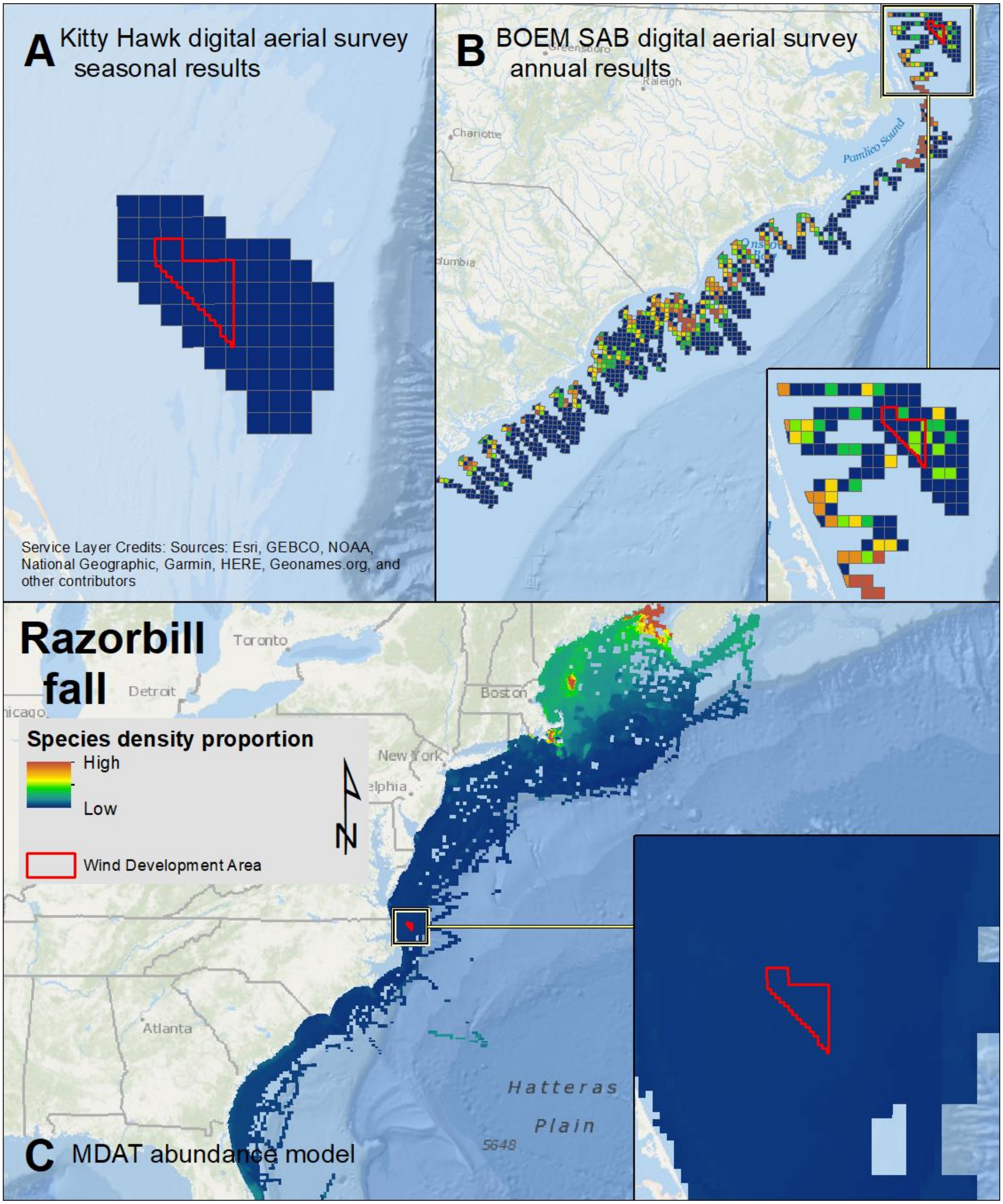
Map 48: Winter Razorbill density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



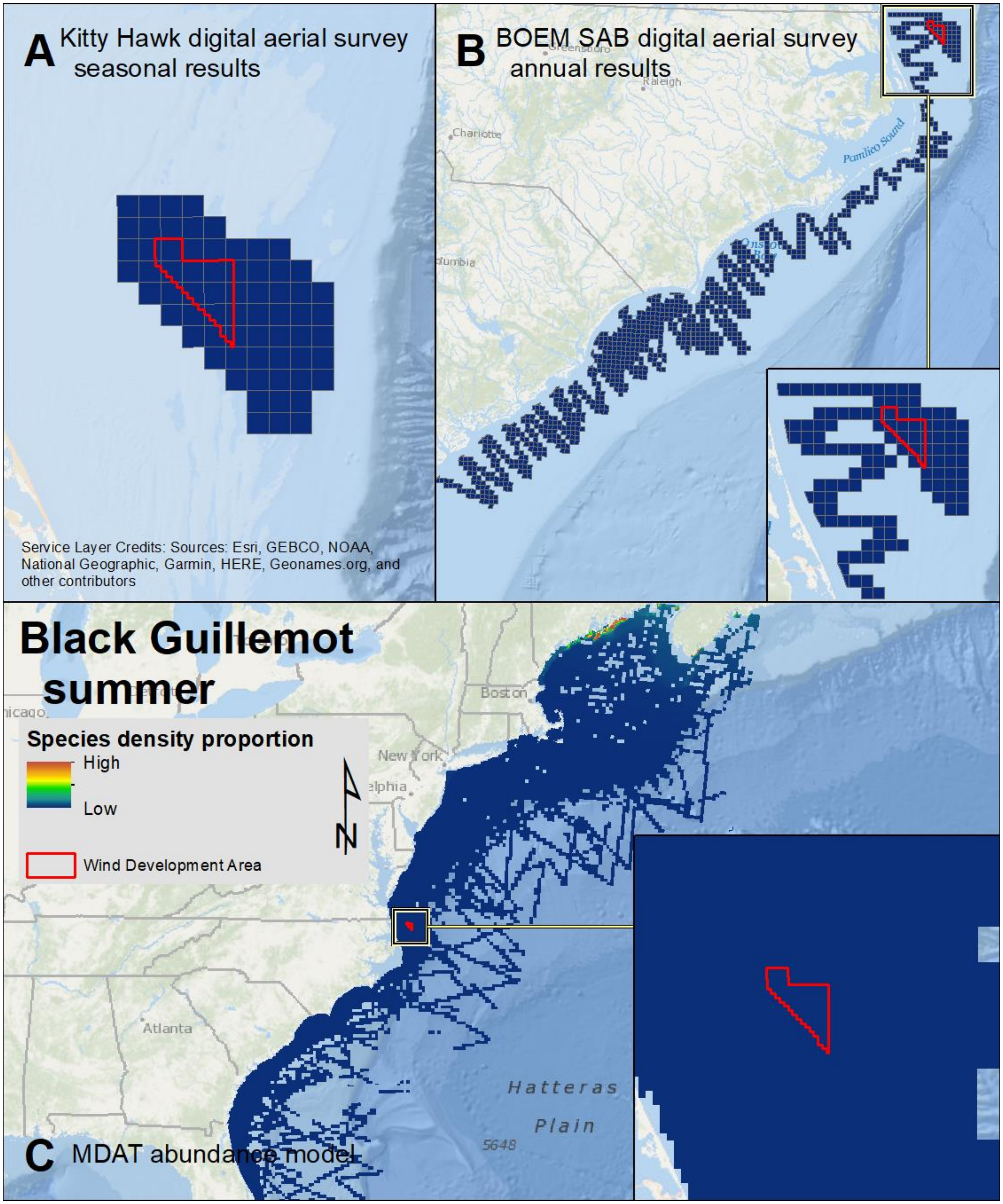
Map 49: Spring Razorbill density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



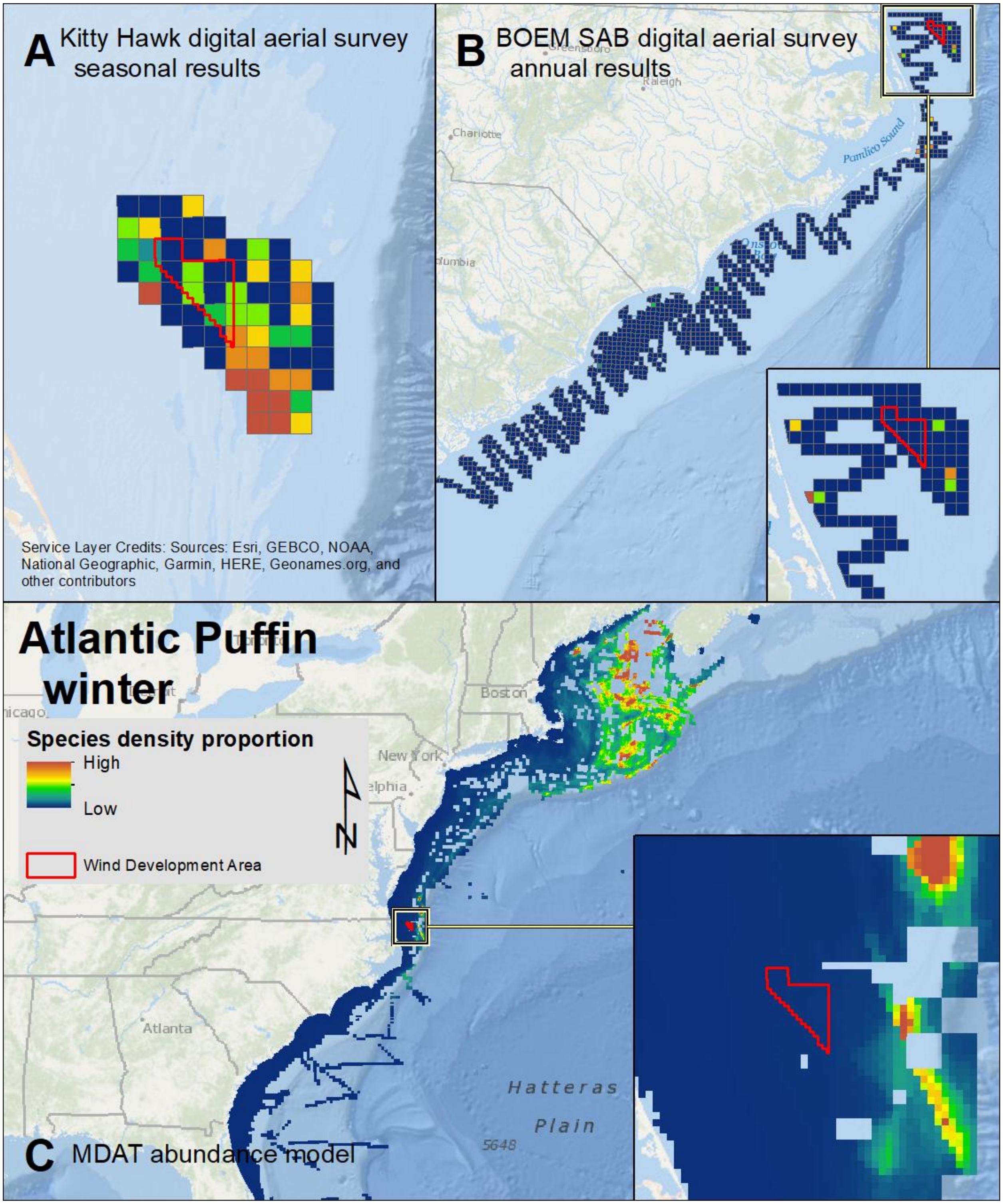
Map 50: Summer Razorbill density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



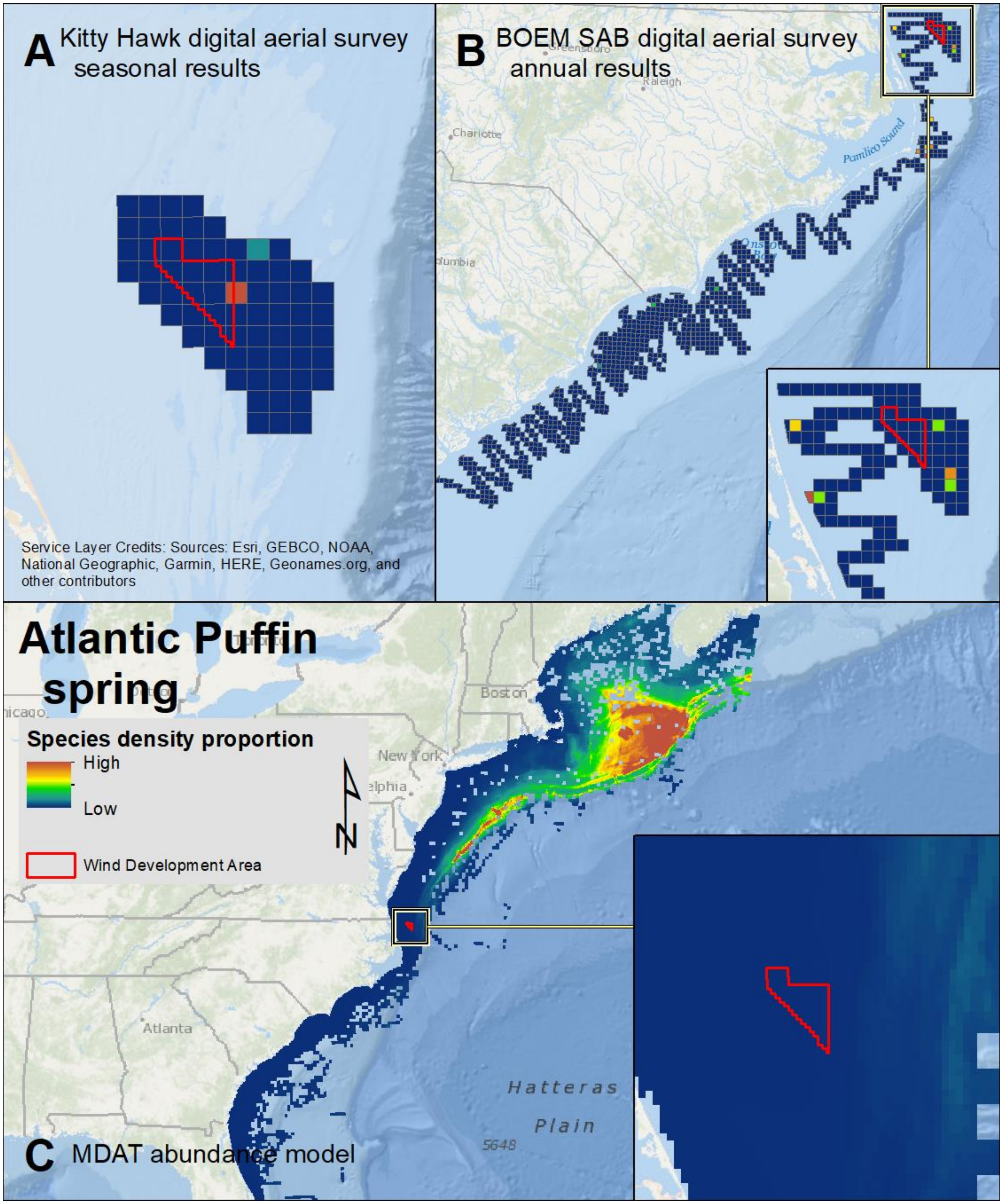
Map 51: Fall Razorbill density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



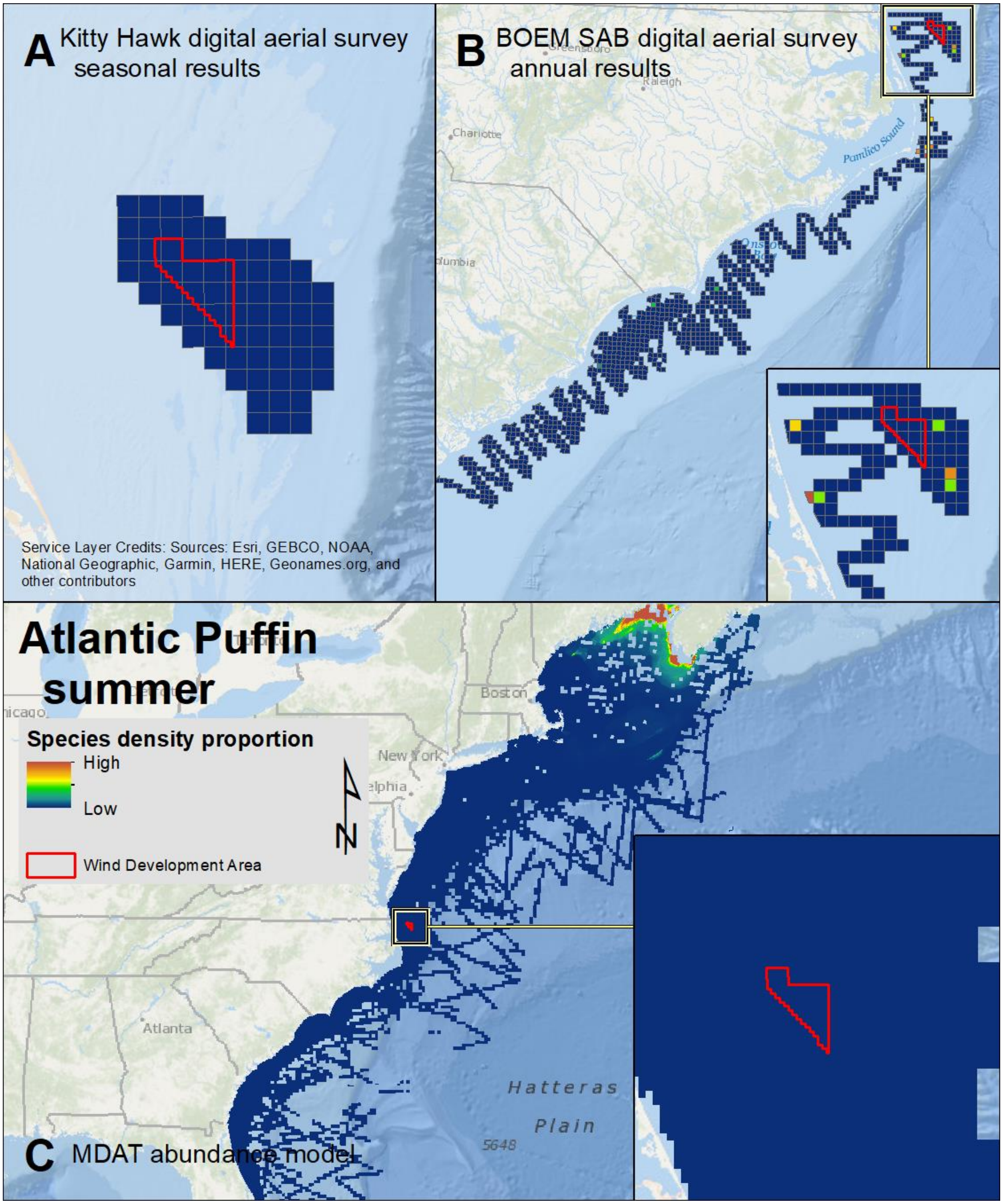
Map 52: Summer Black Guillemot density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



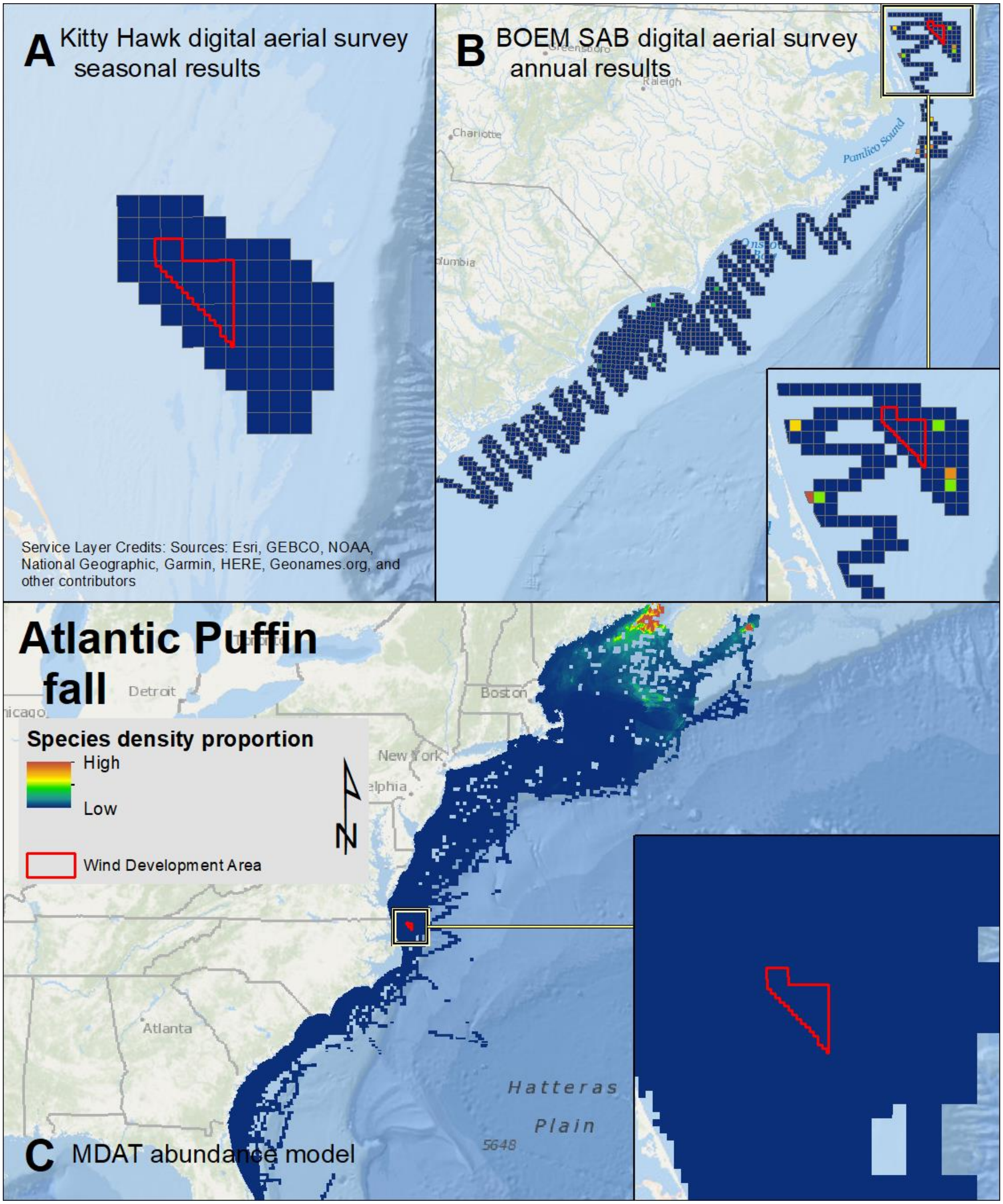
Map 53: Winter Atlantic Puffin density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



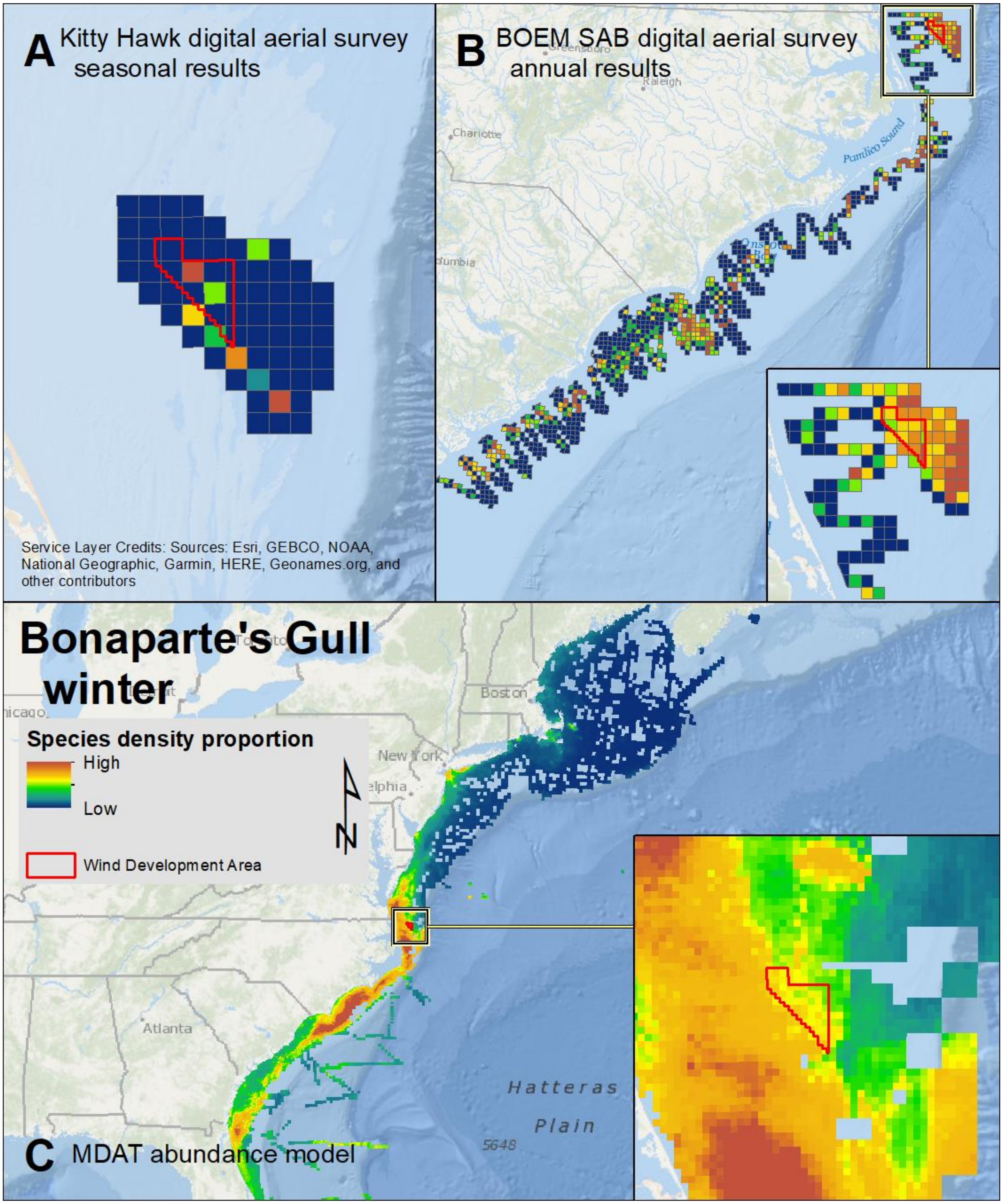
Map 54: Spring Atlantic Puffin density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



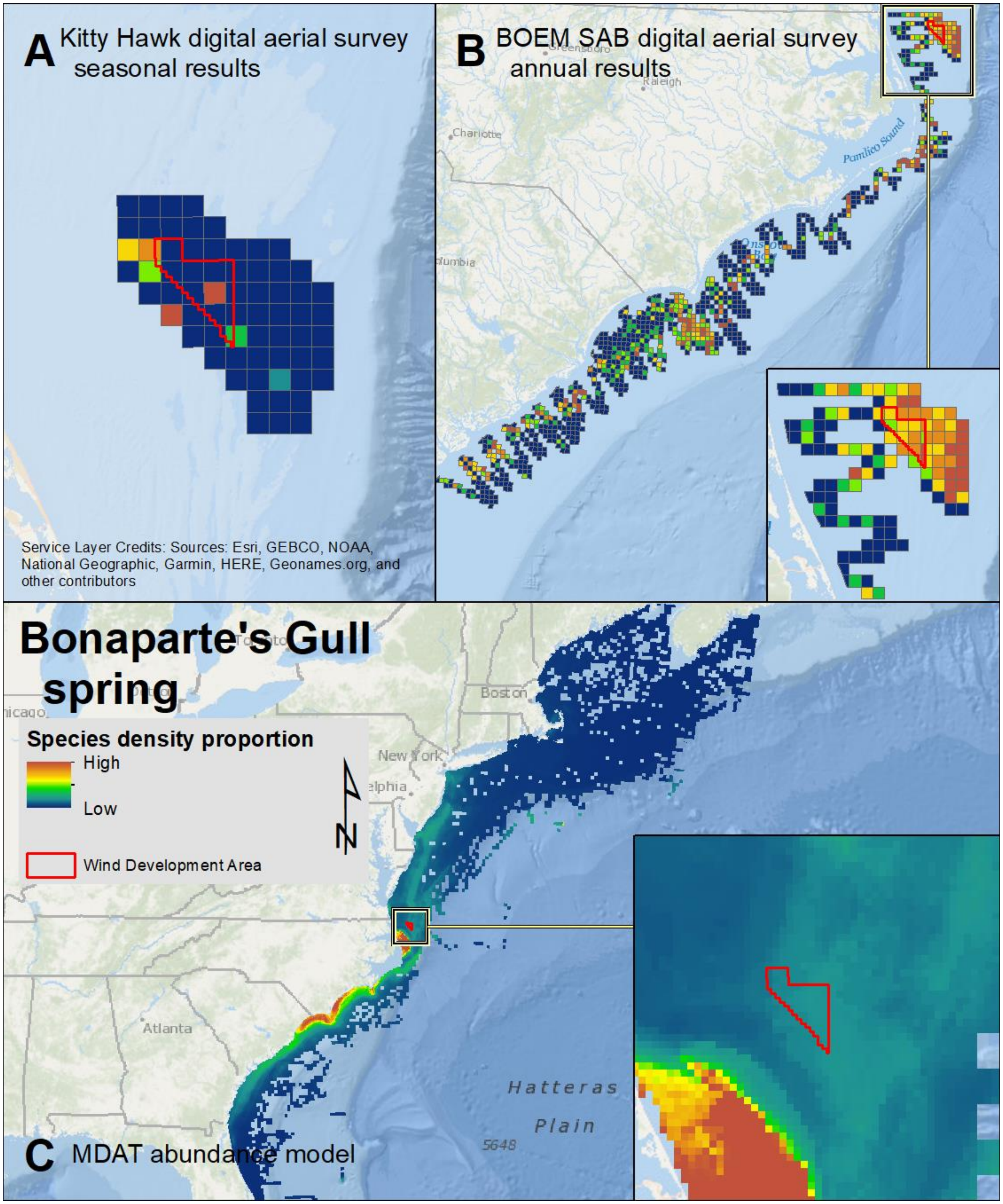
Map 55: Summer Atlantic Puffin density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



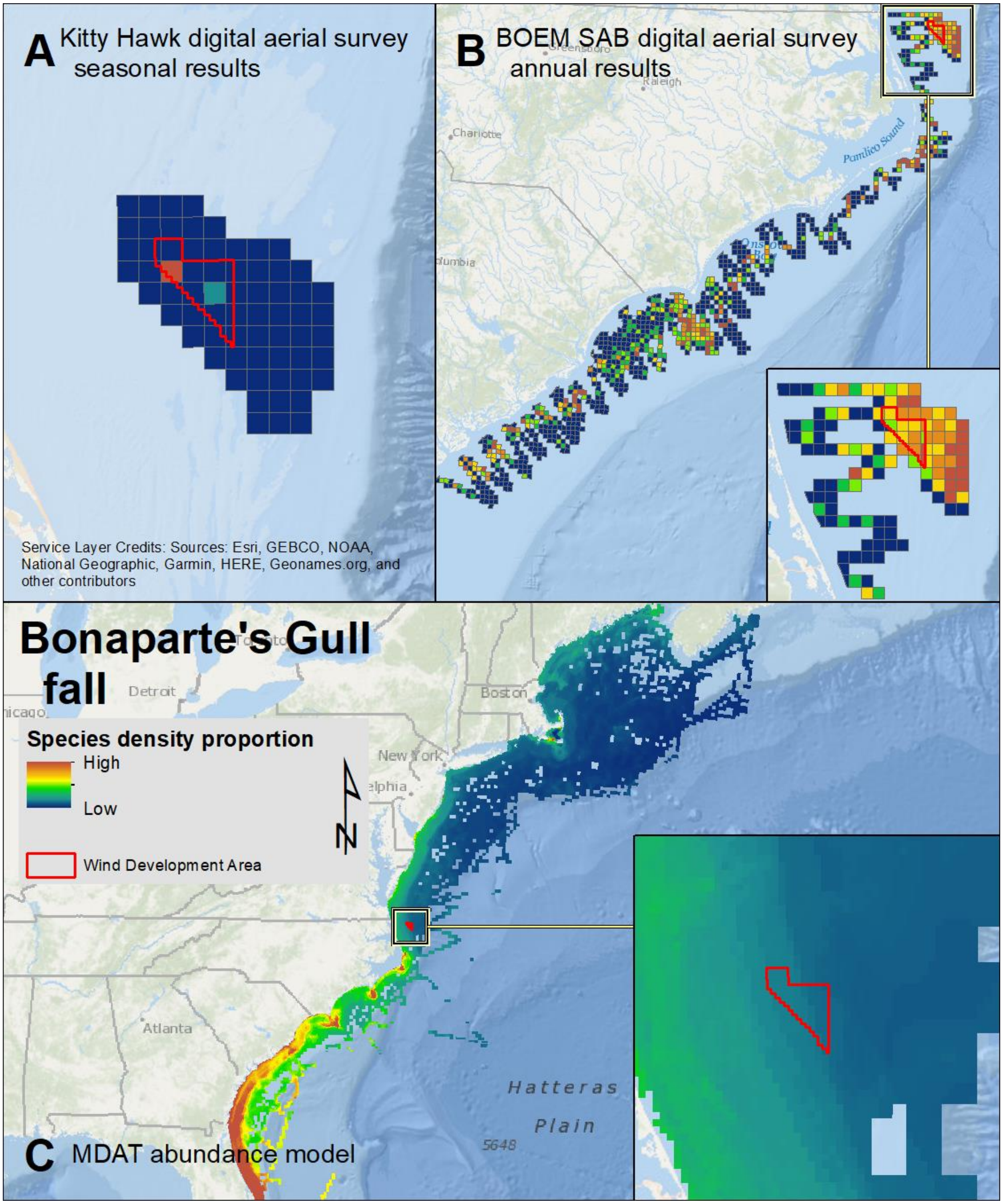
Map 56: Fall Atlantic Puffin density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



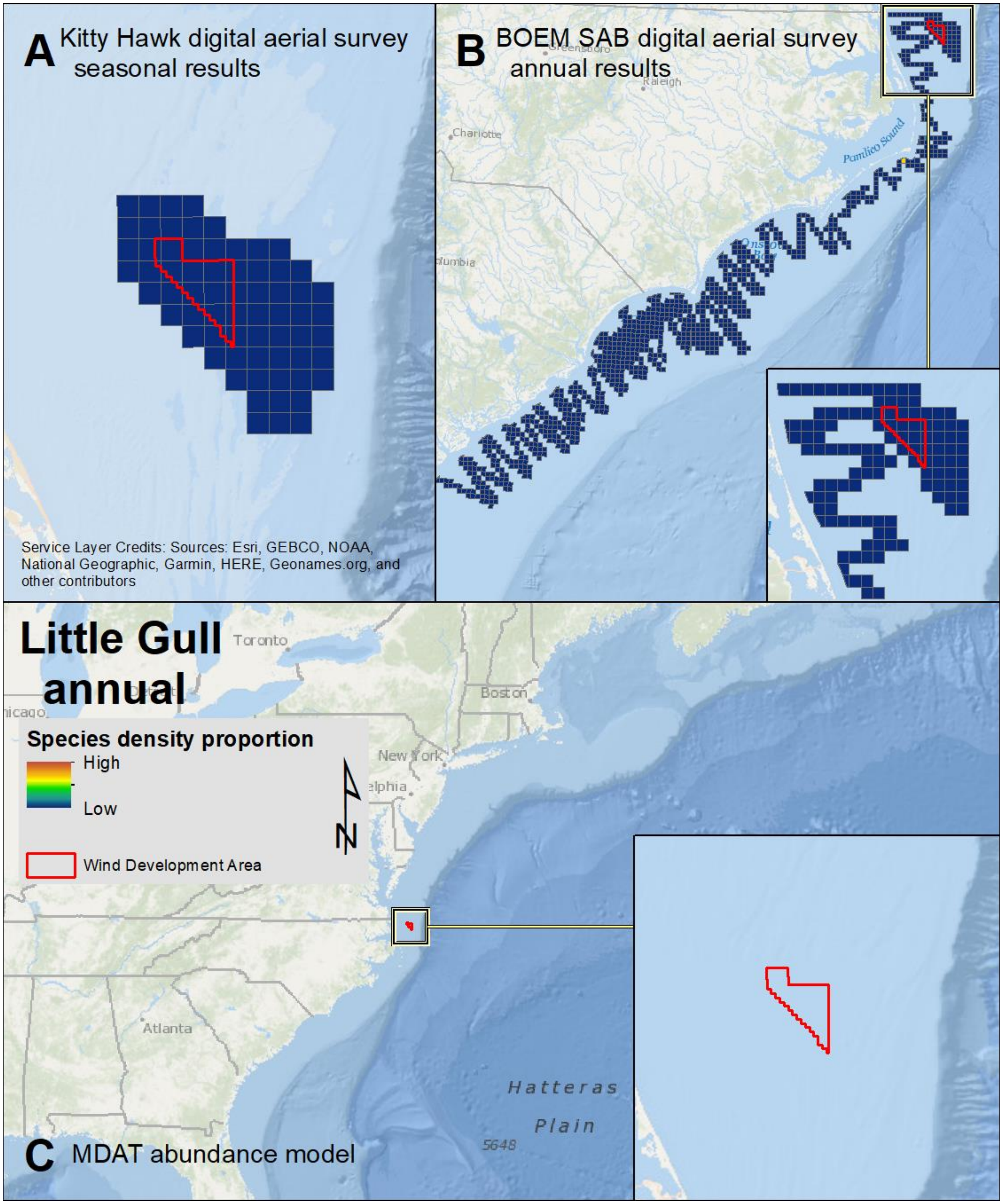
Map 57: Winter Bonaparte's Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



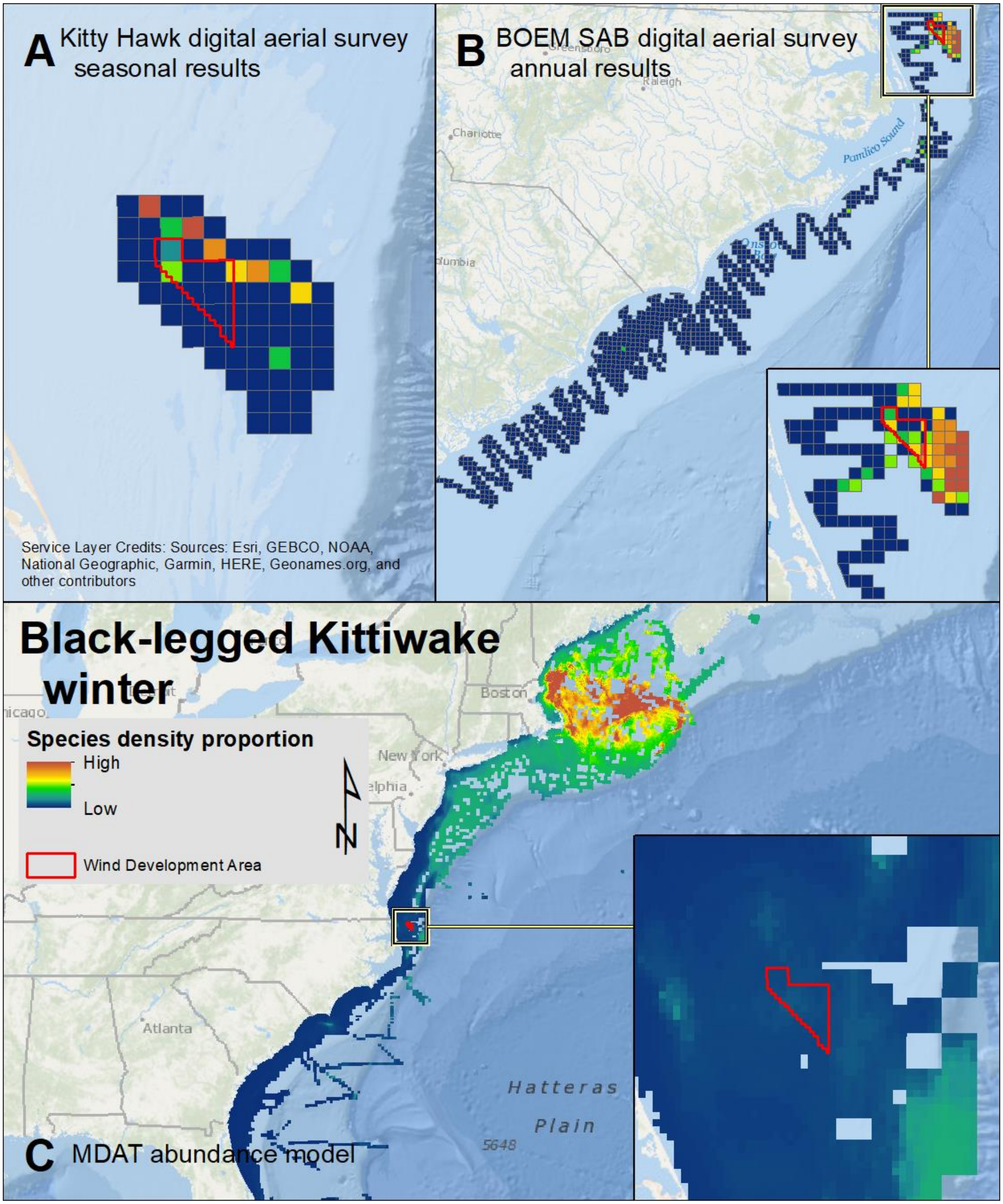
Map 58: Spring Bonaparte's Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



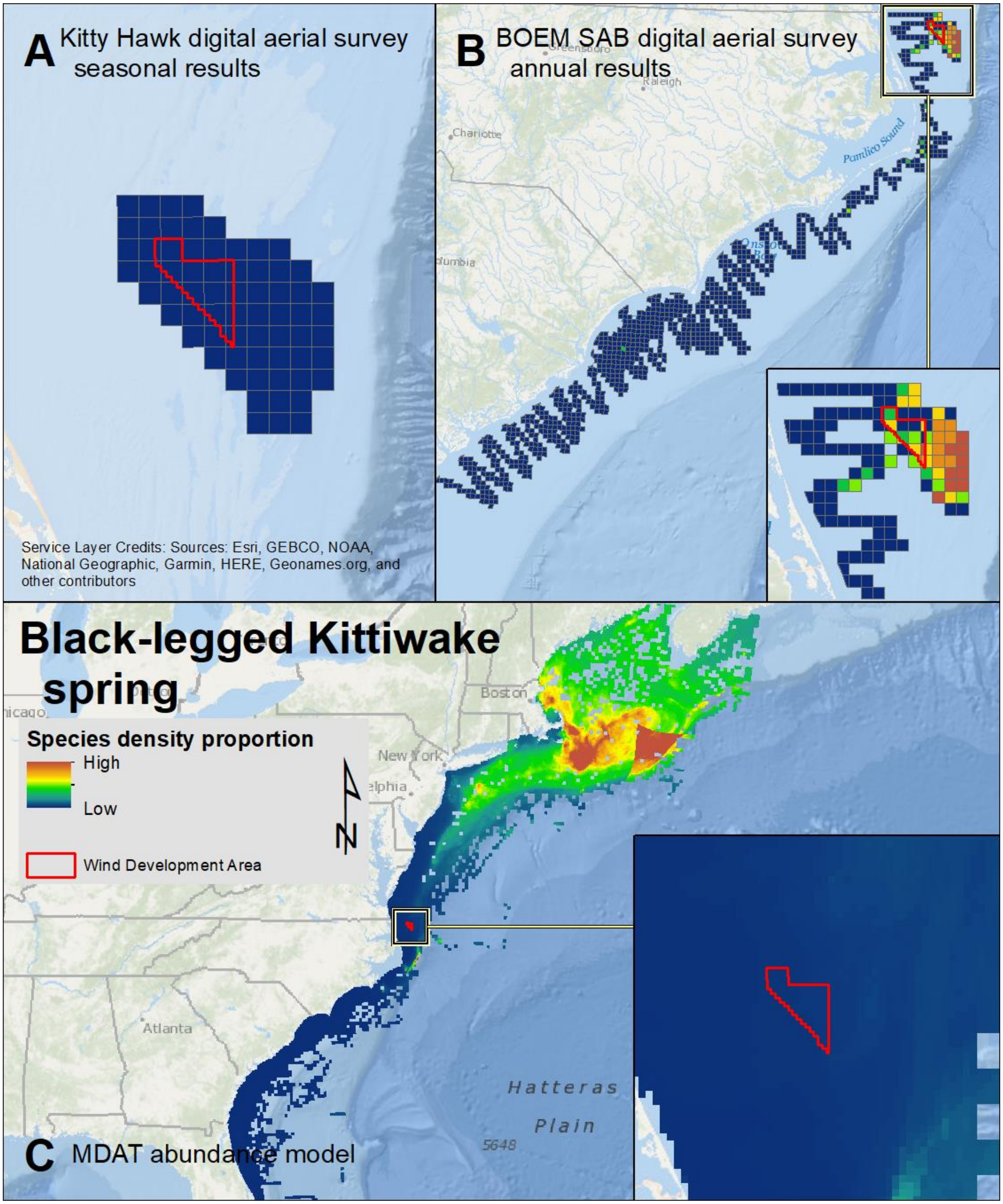
Map 59: Fall Bonaparte's Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



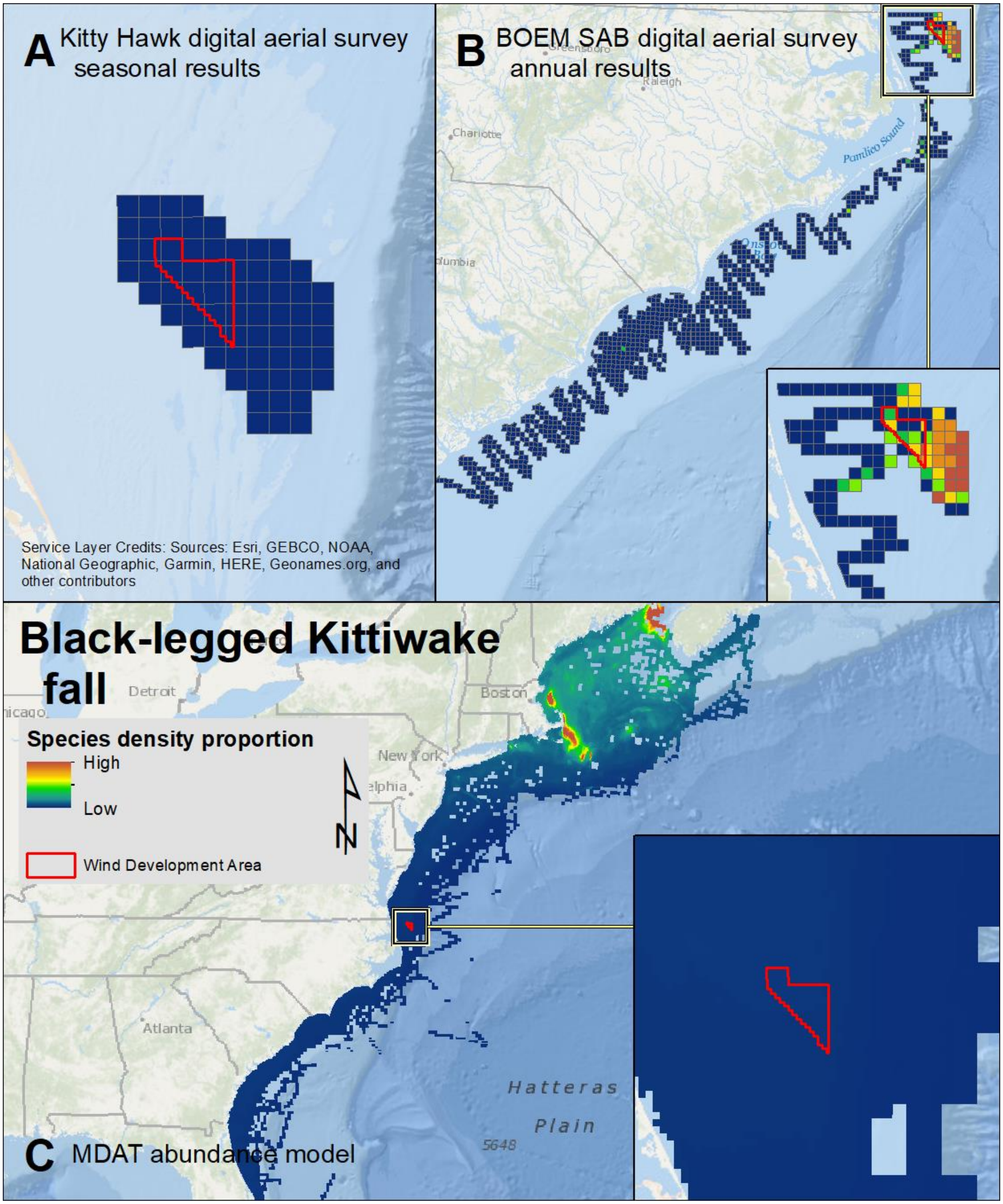
Map 60: Annual Little Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



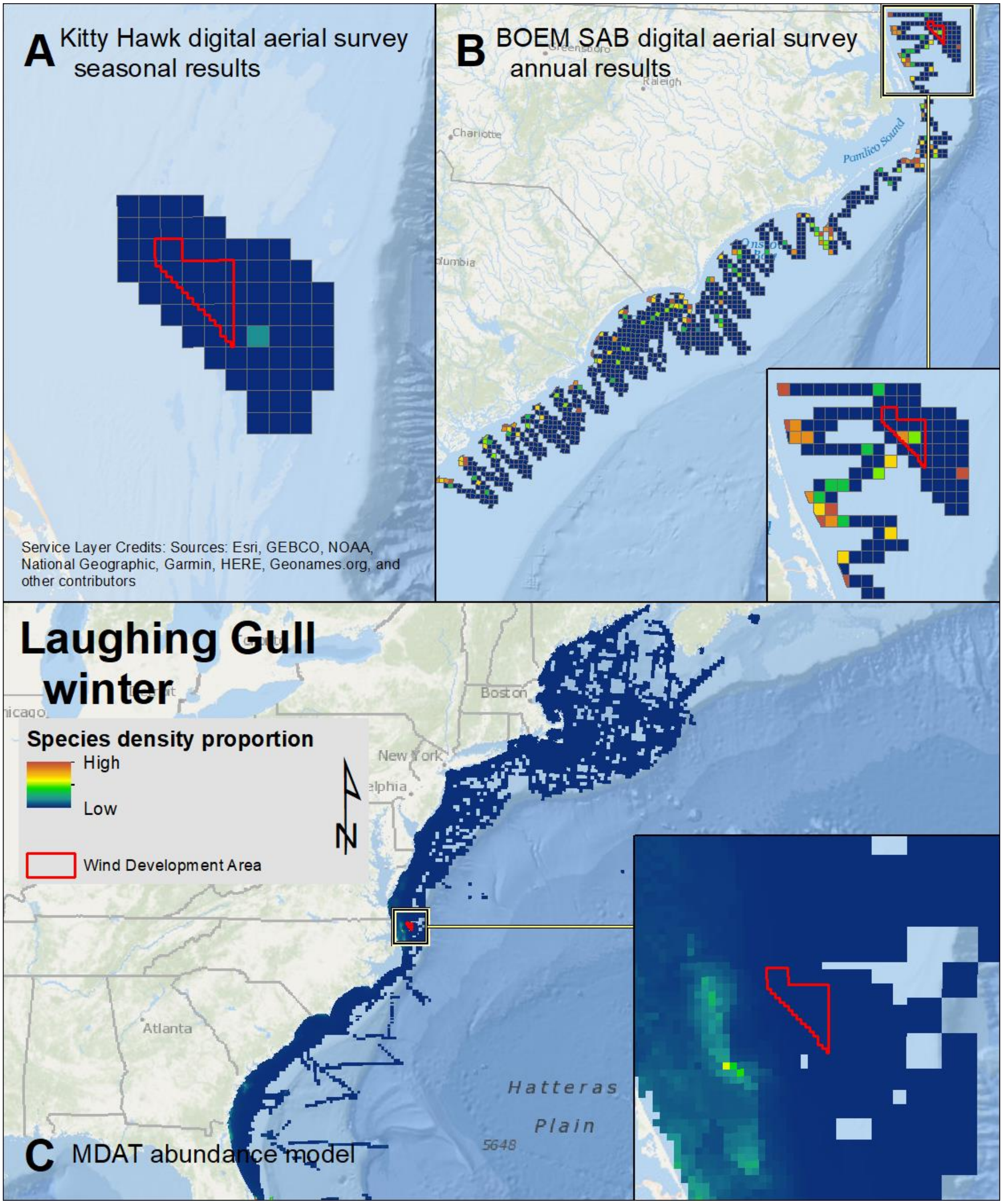
Map 61: Winter Black-legged Kittiwake density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



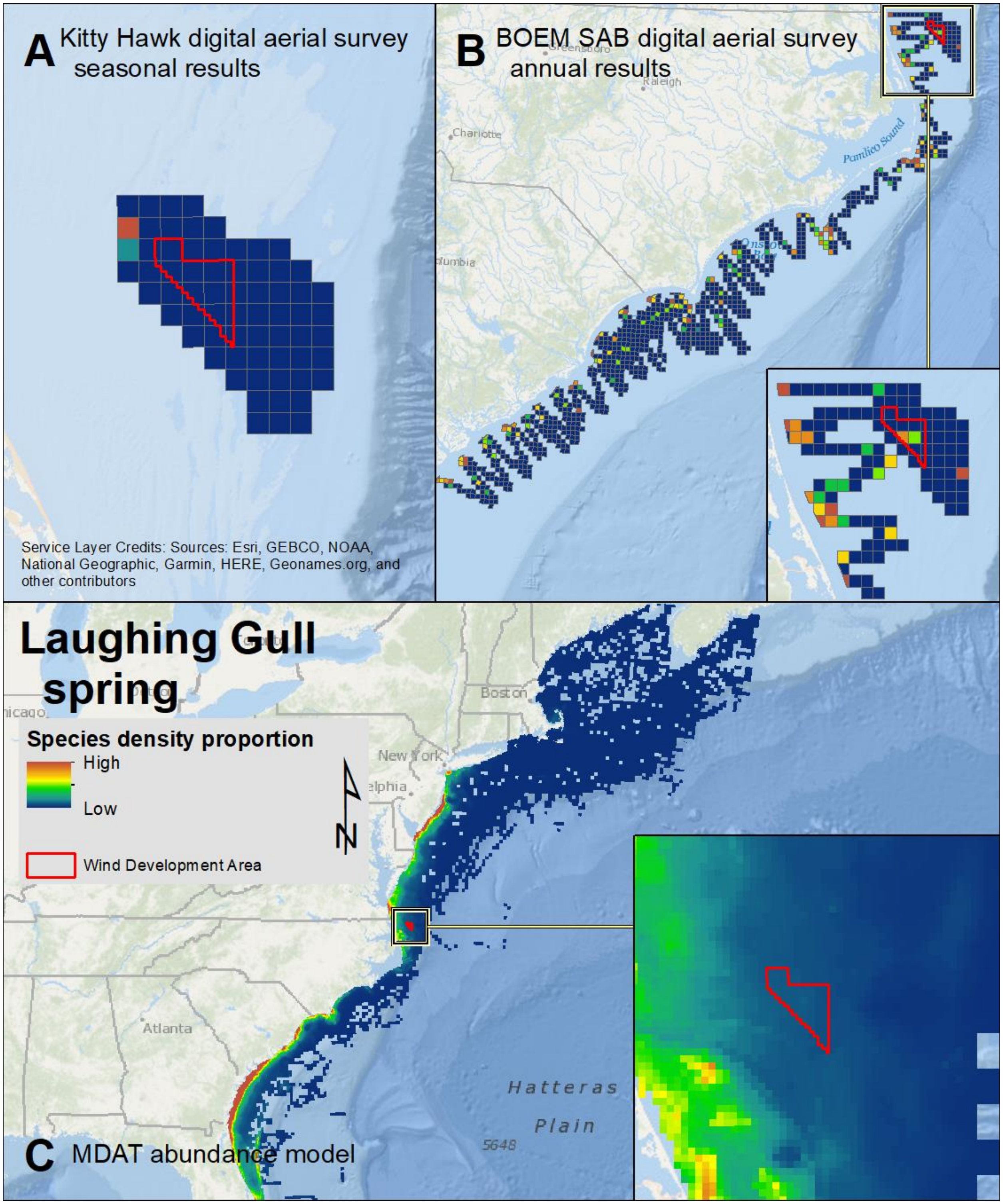
Map 62: Spring Black-legged Kittiwake density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



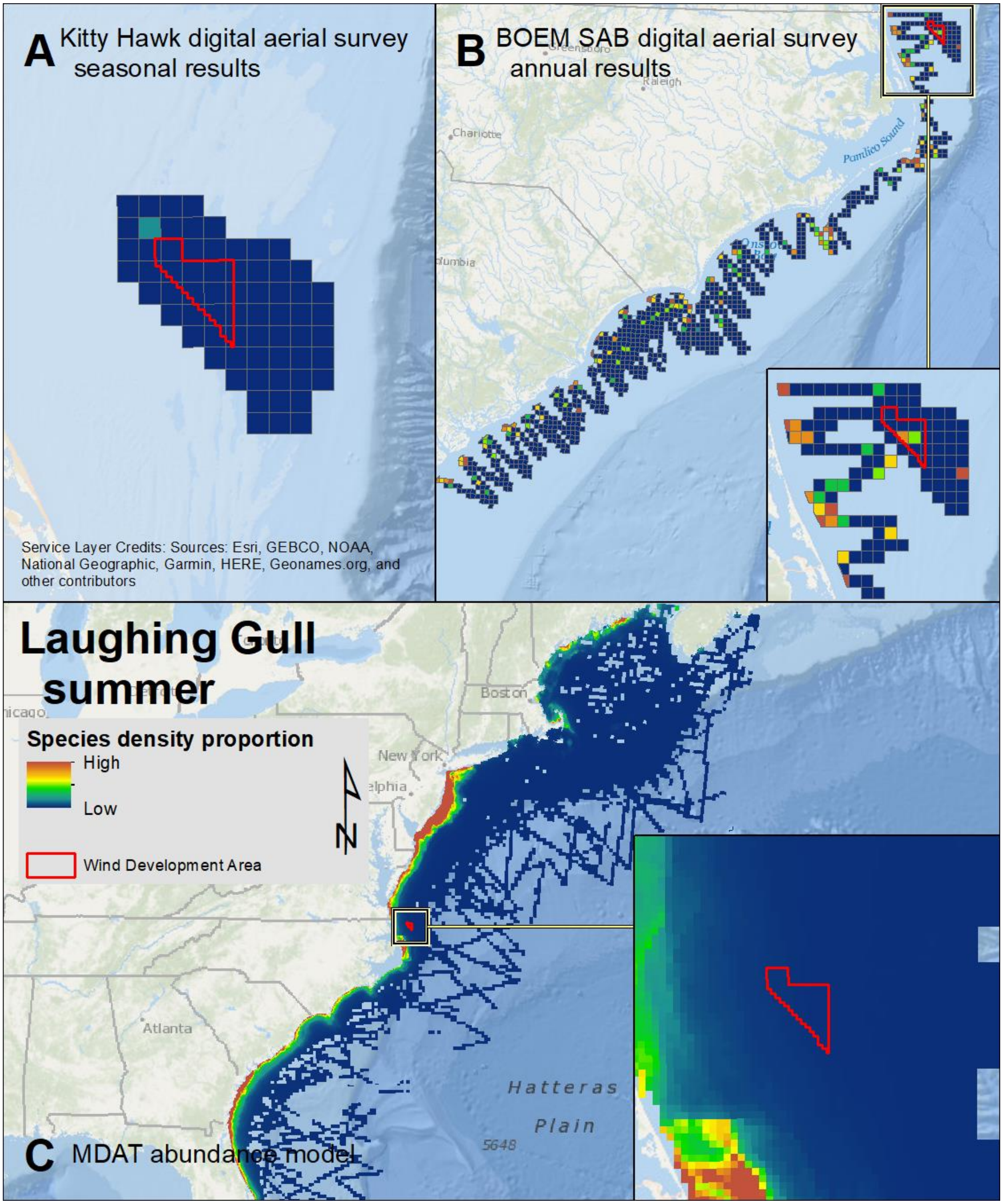
Map 63: Fall Black-legged Kittiwake density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



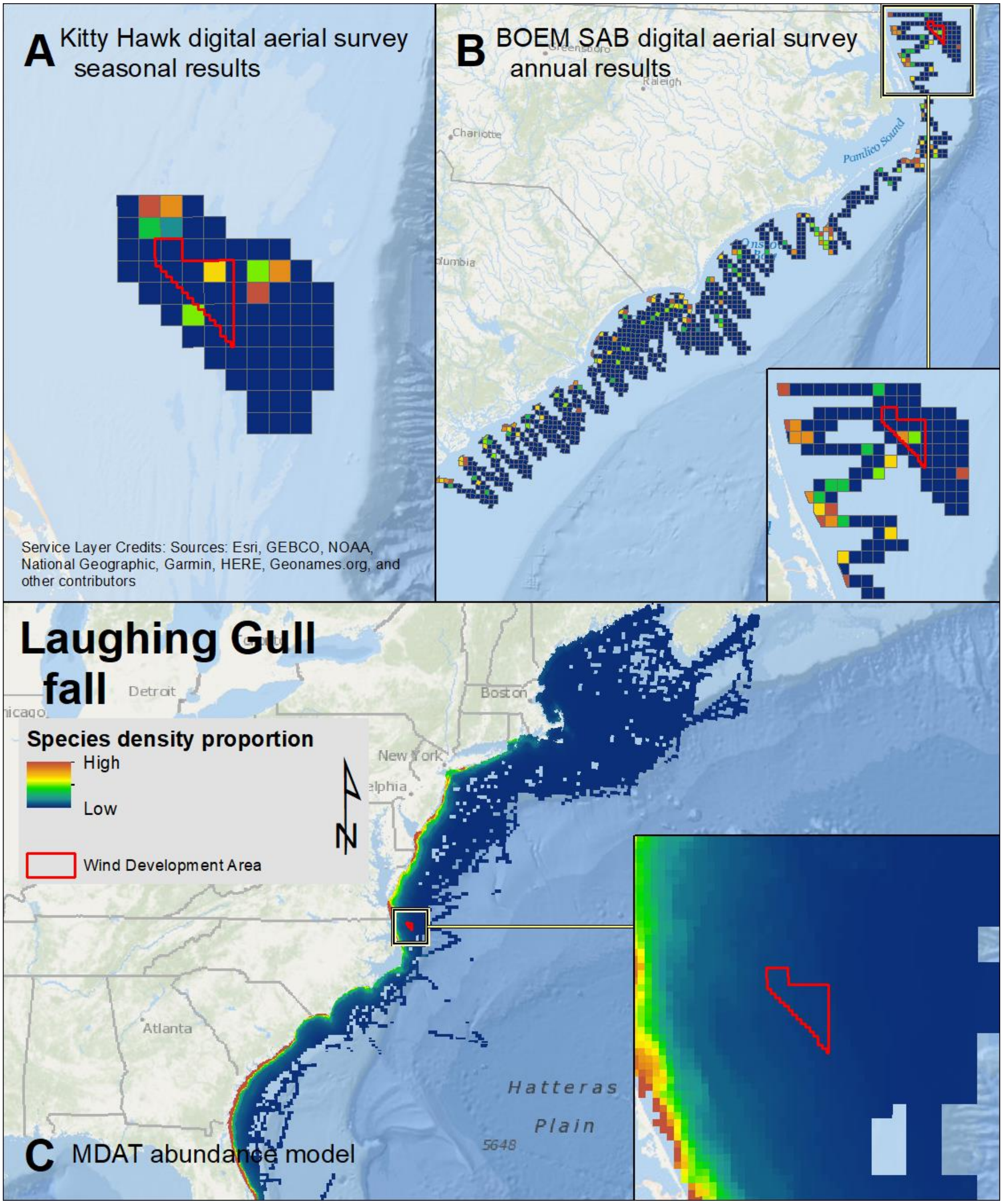
Map 64: Winter Laughing Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



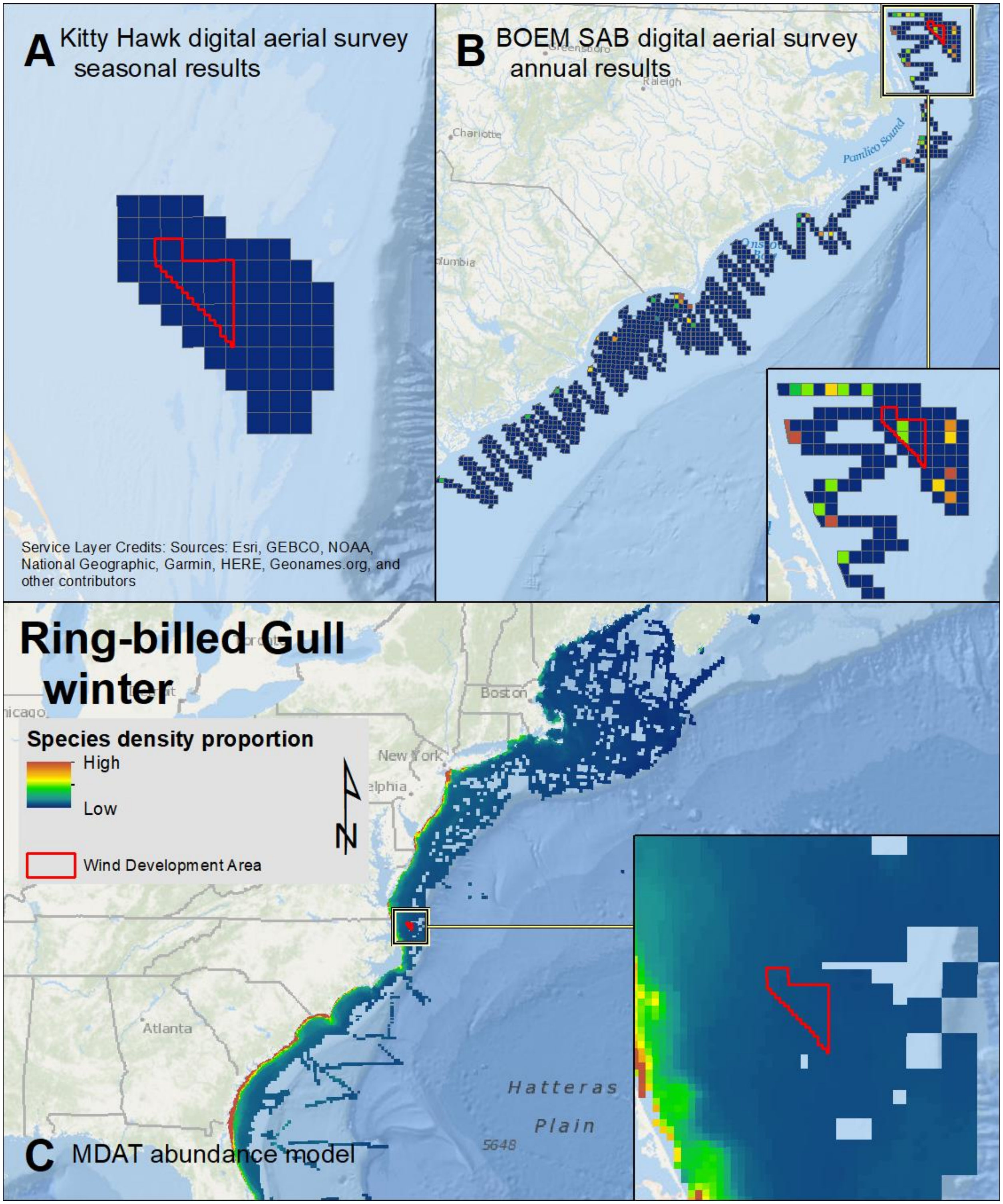
Map 65: Spring Laughing Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



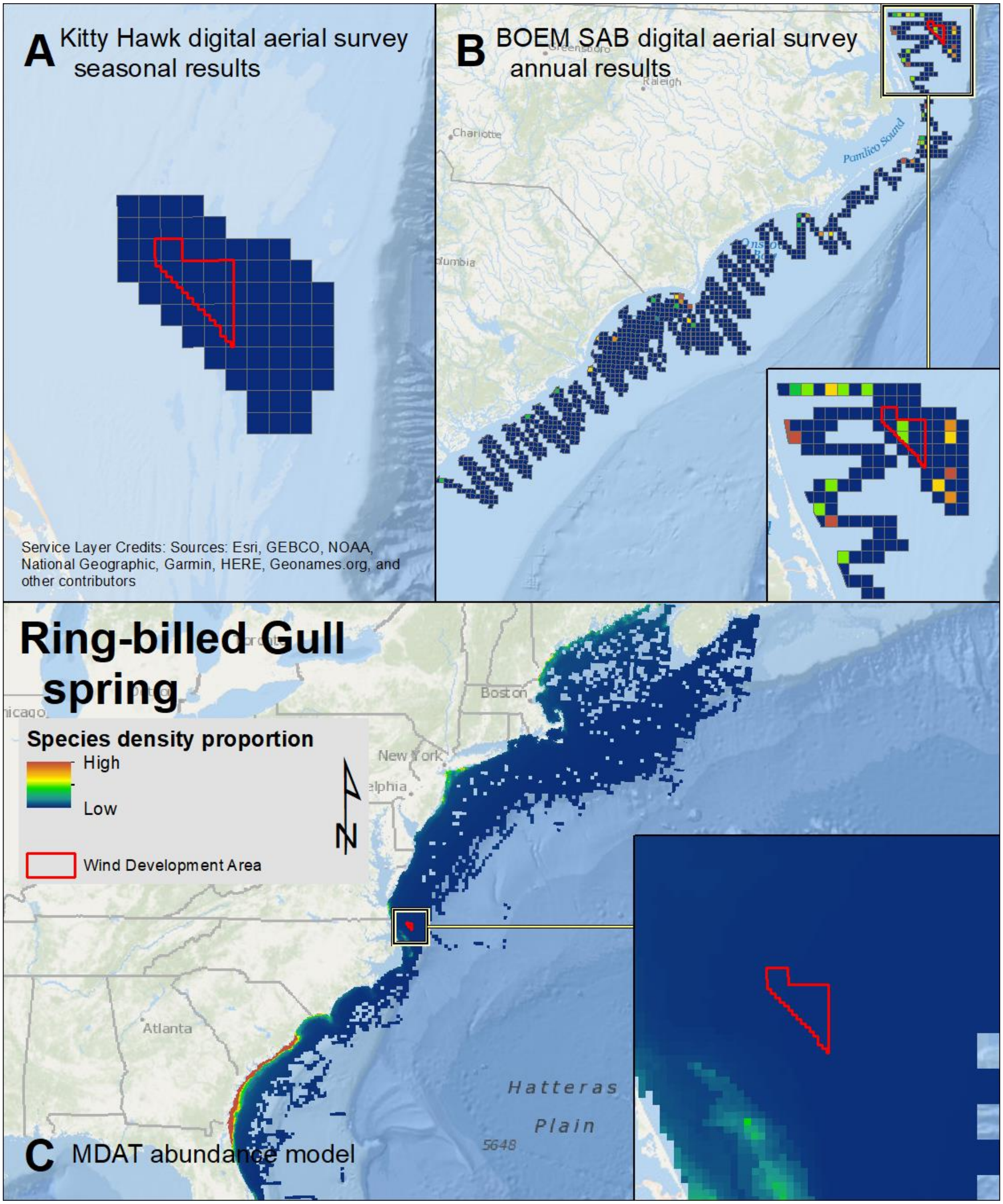
Map 66: Summer Laughing Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



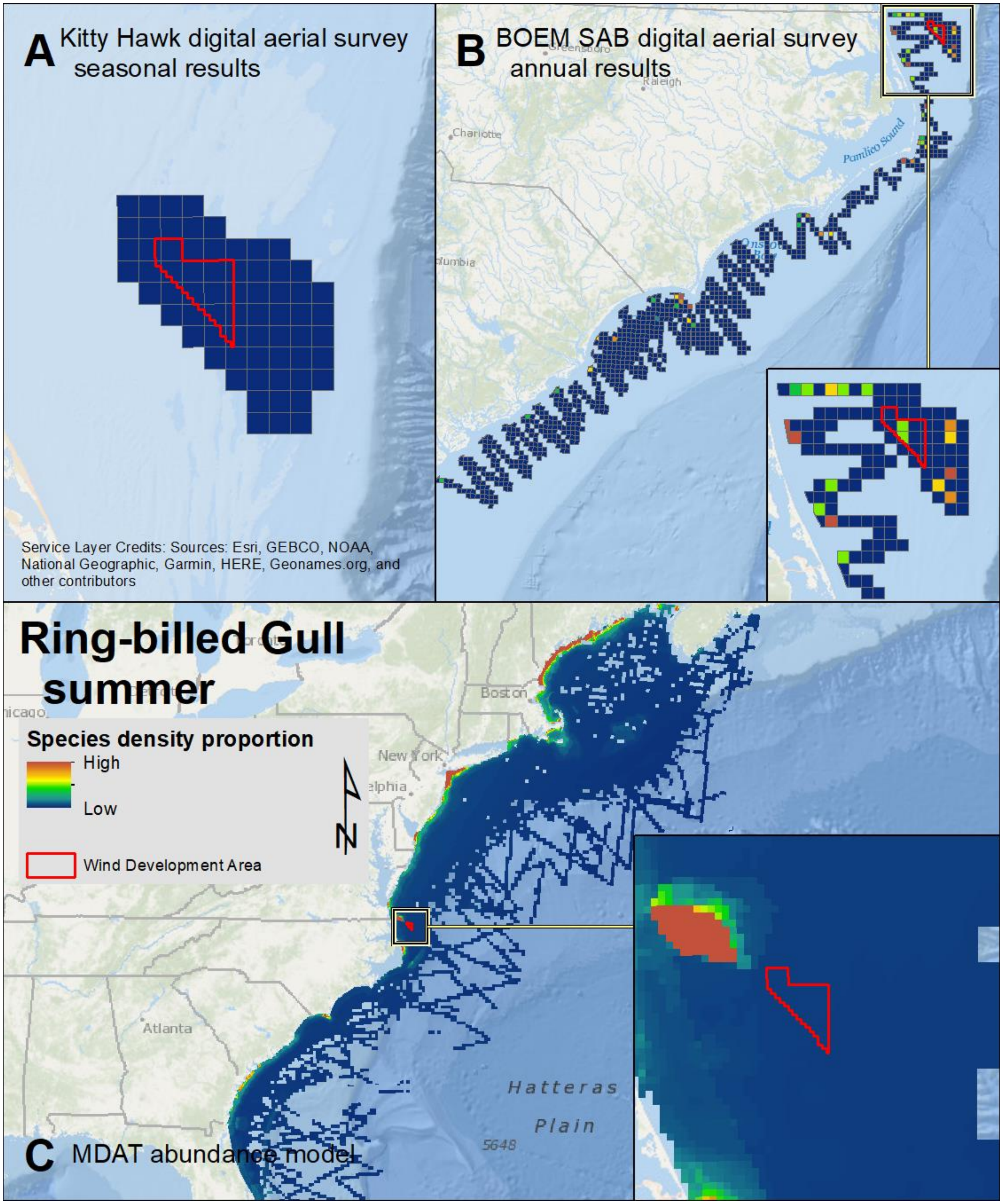
Map 67: Fall Laughing Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



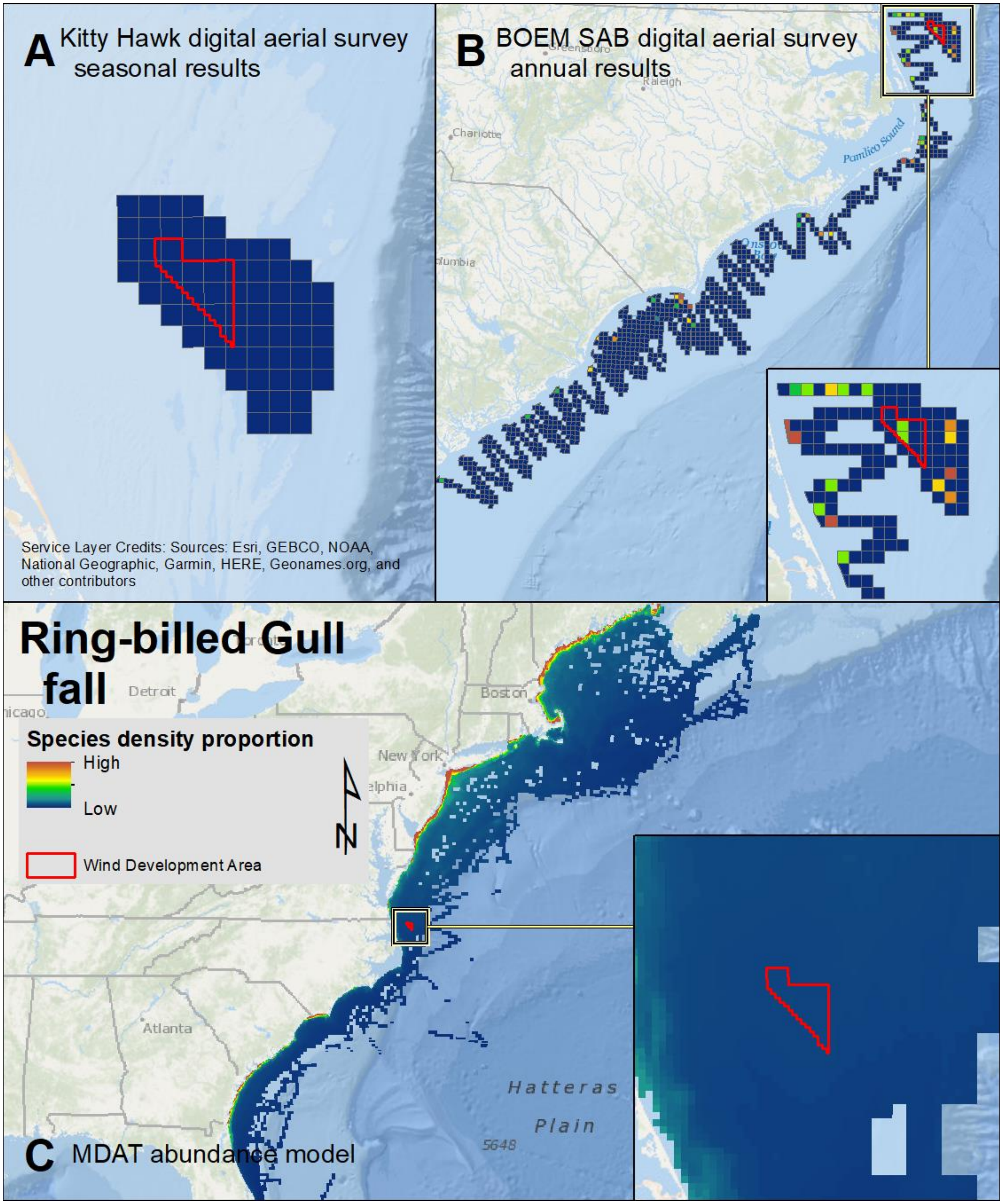
Map 68: Winter Ring-billed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



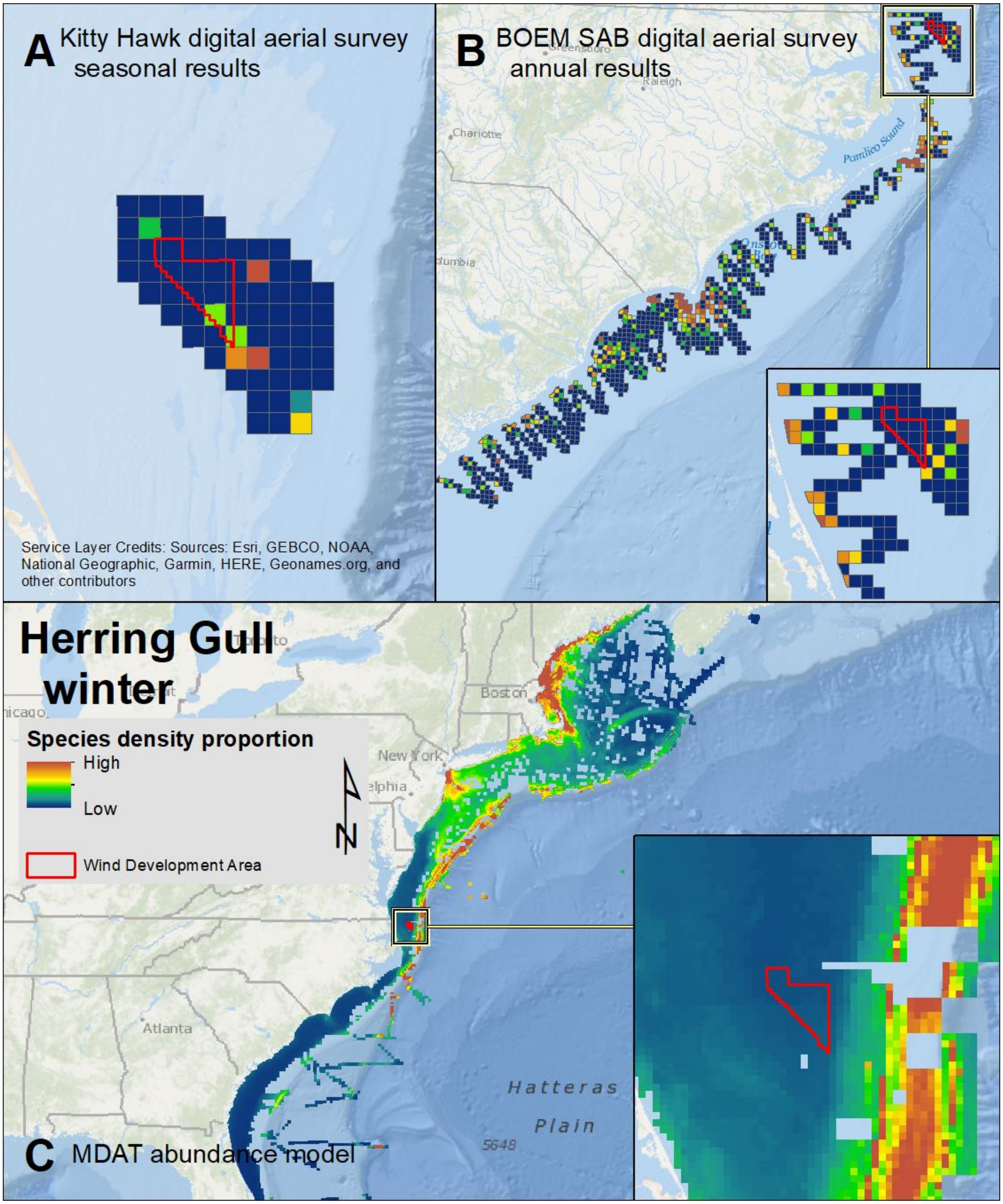
Map 69: Spring Ring-billed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



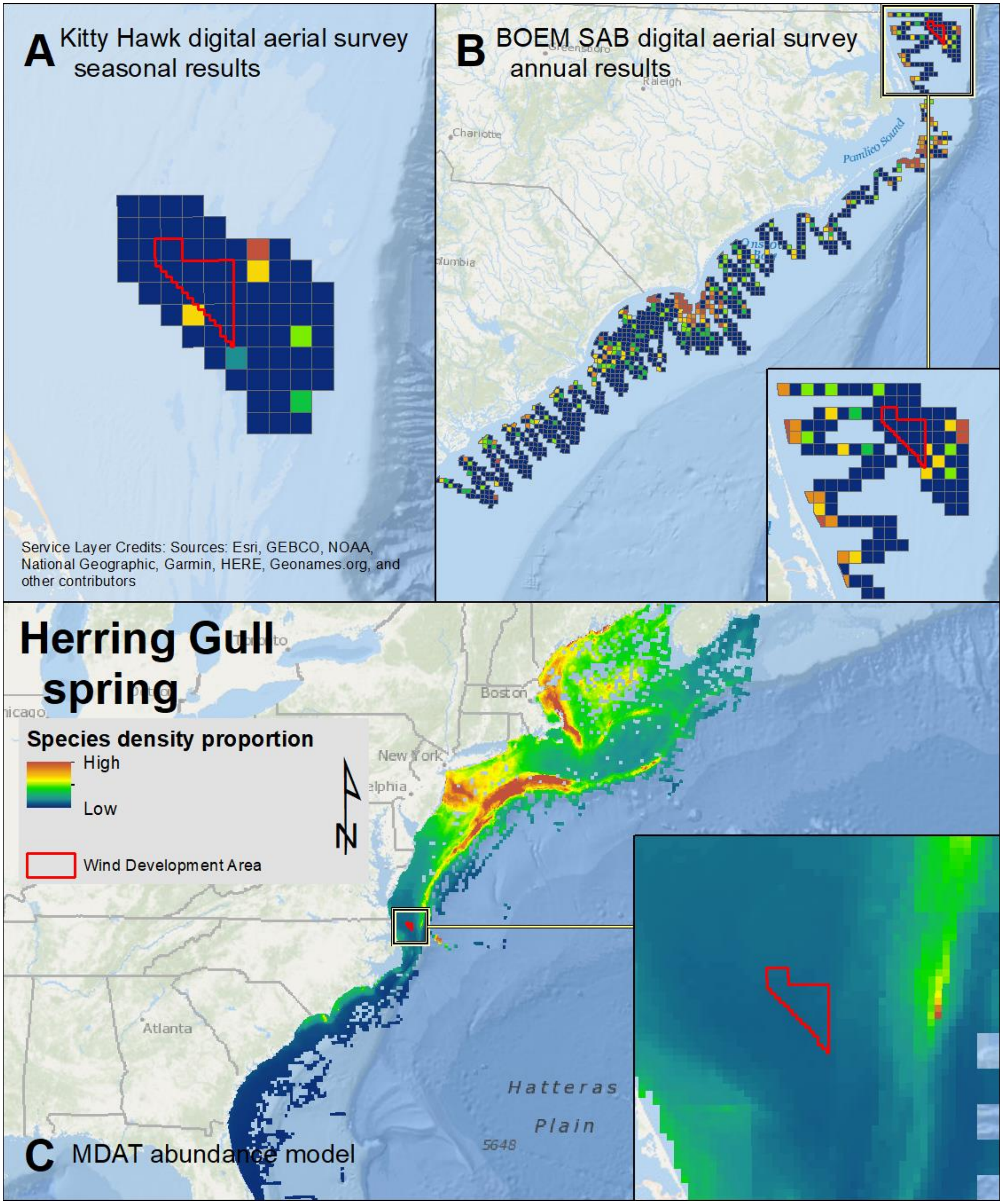
Map 70: Summer Ring-billed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



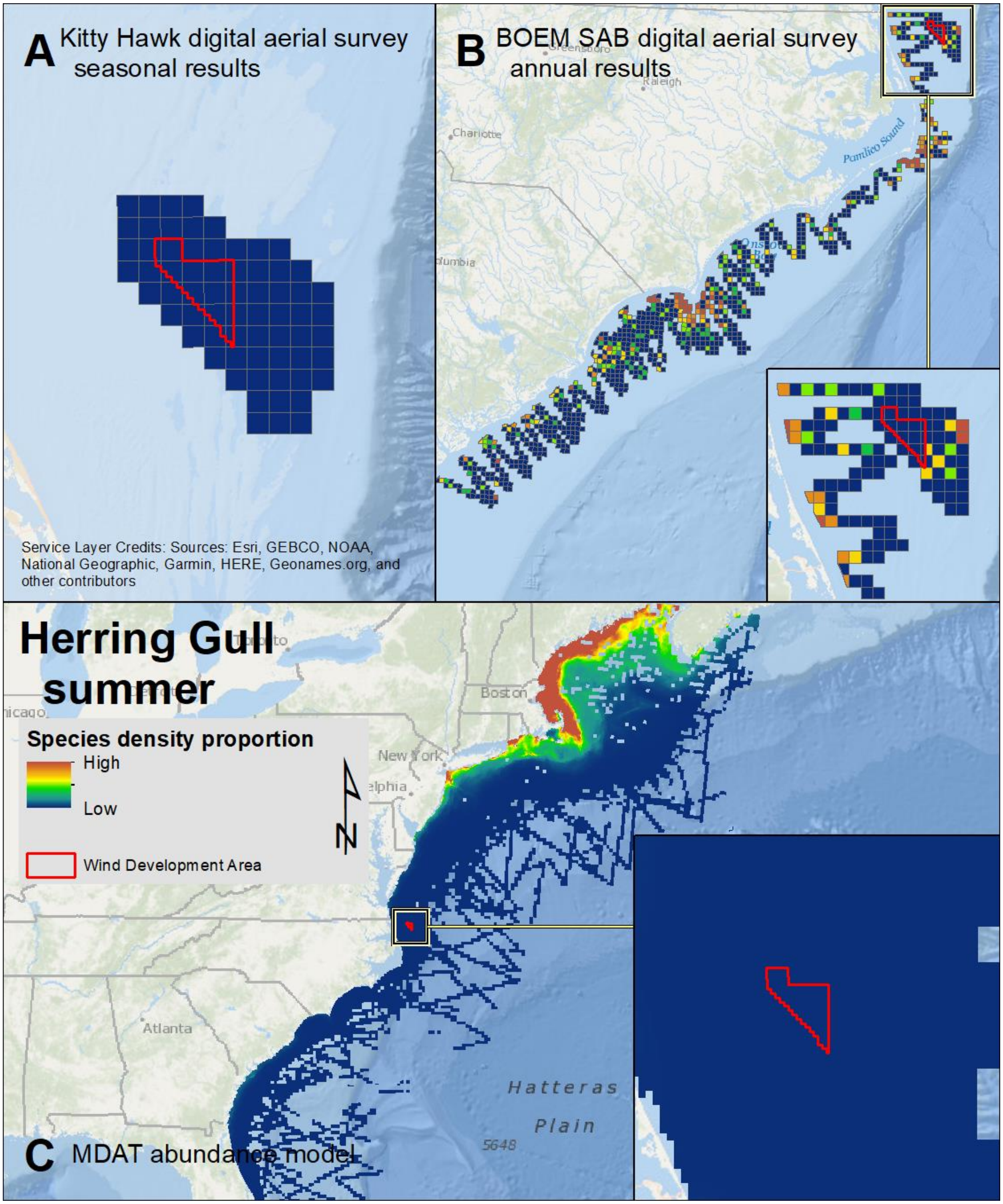
Map 71: Fall Ring-billed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



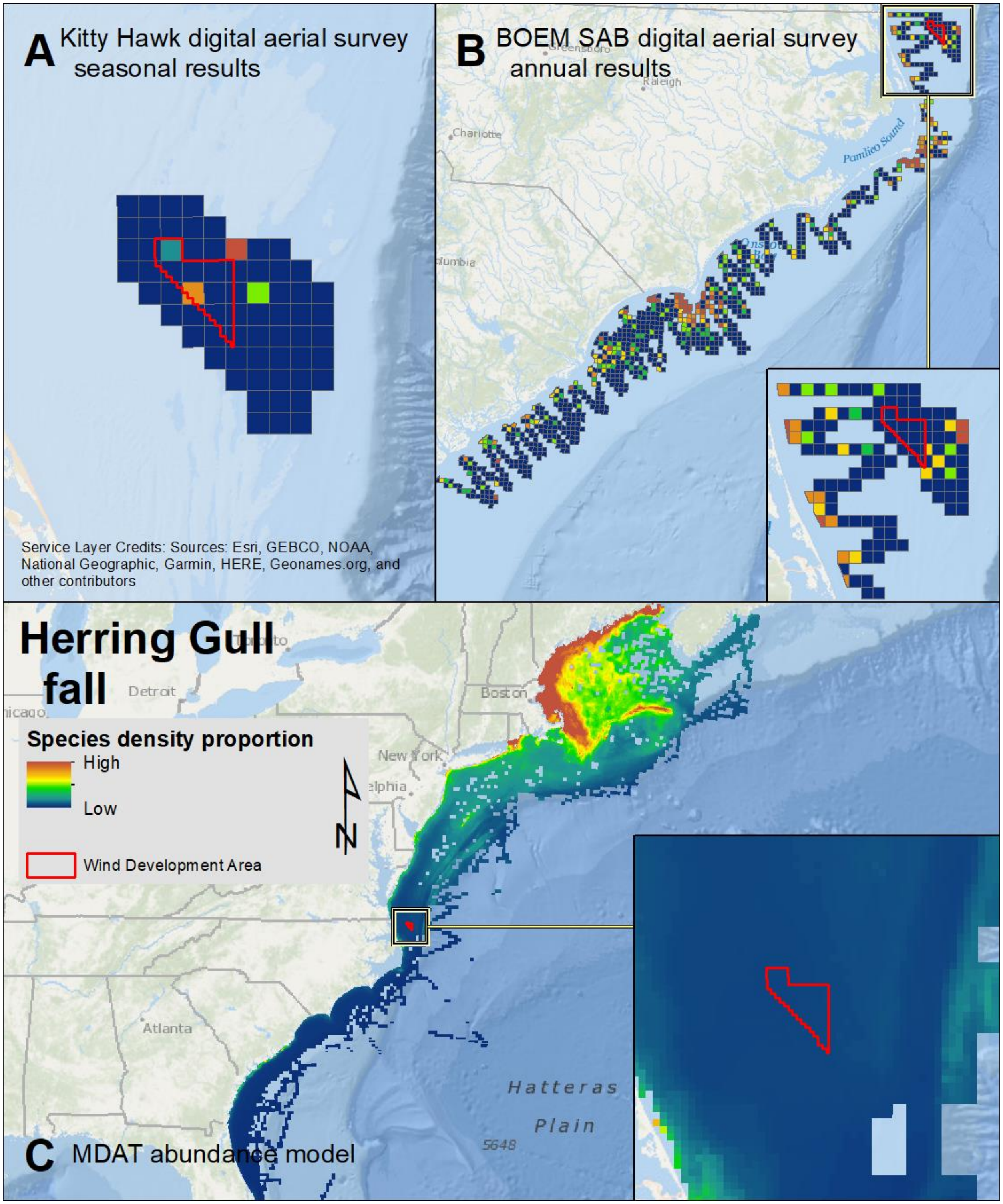
Map 72: Winter Herring Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



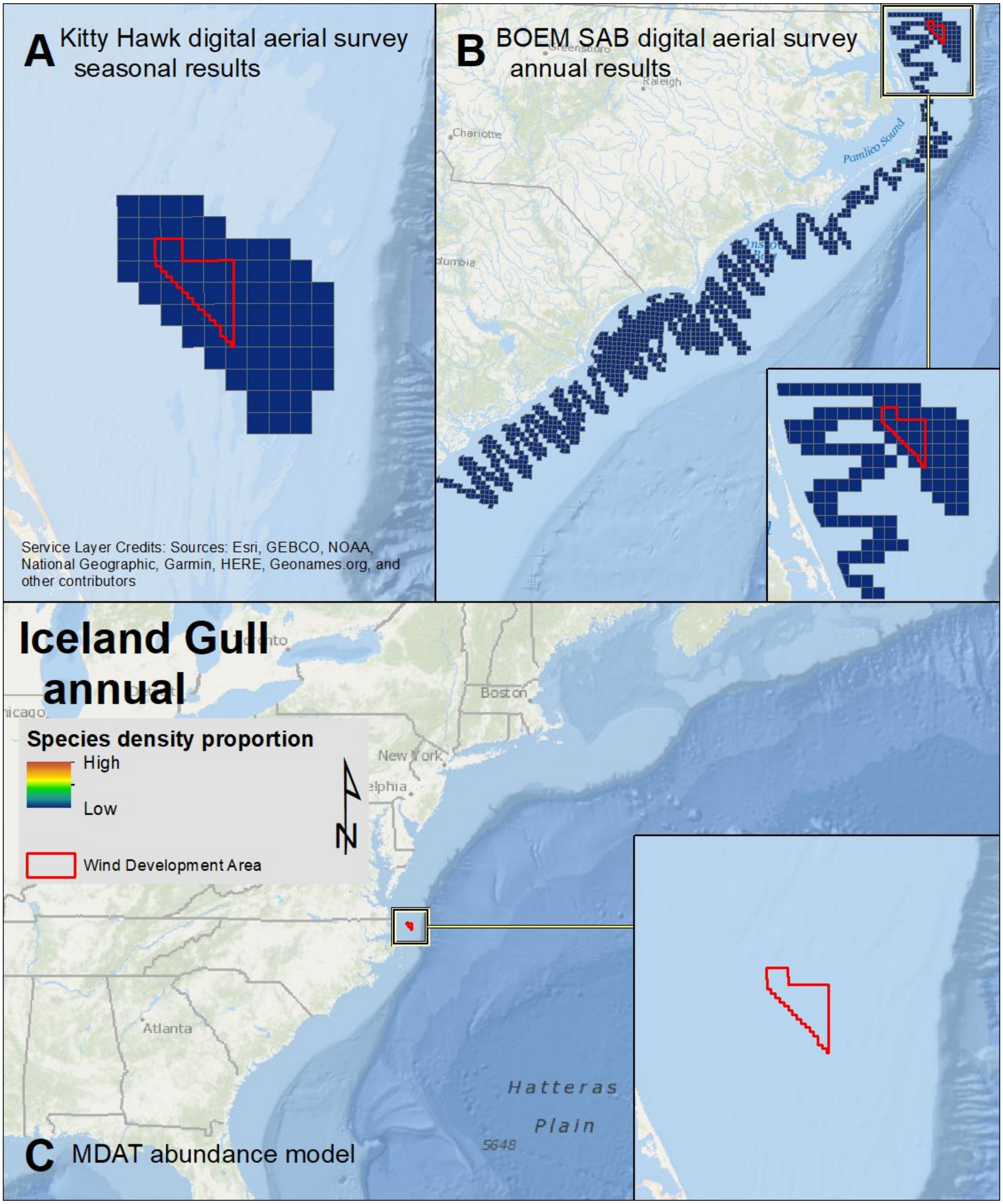
Map 73: Spring Herring Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



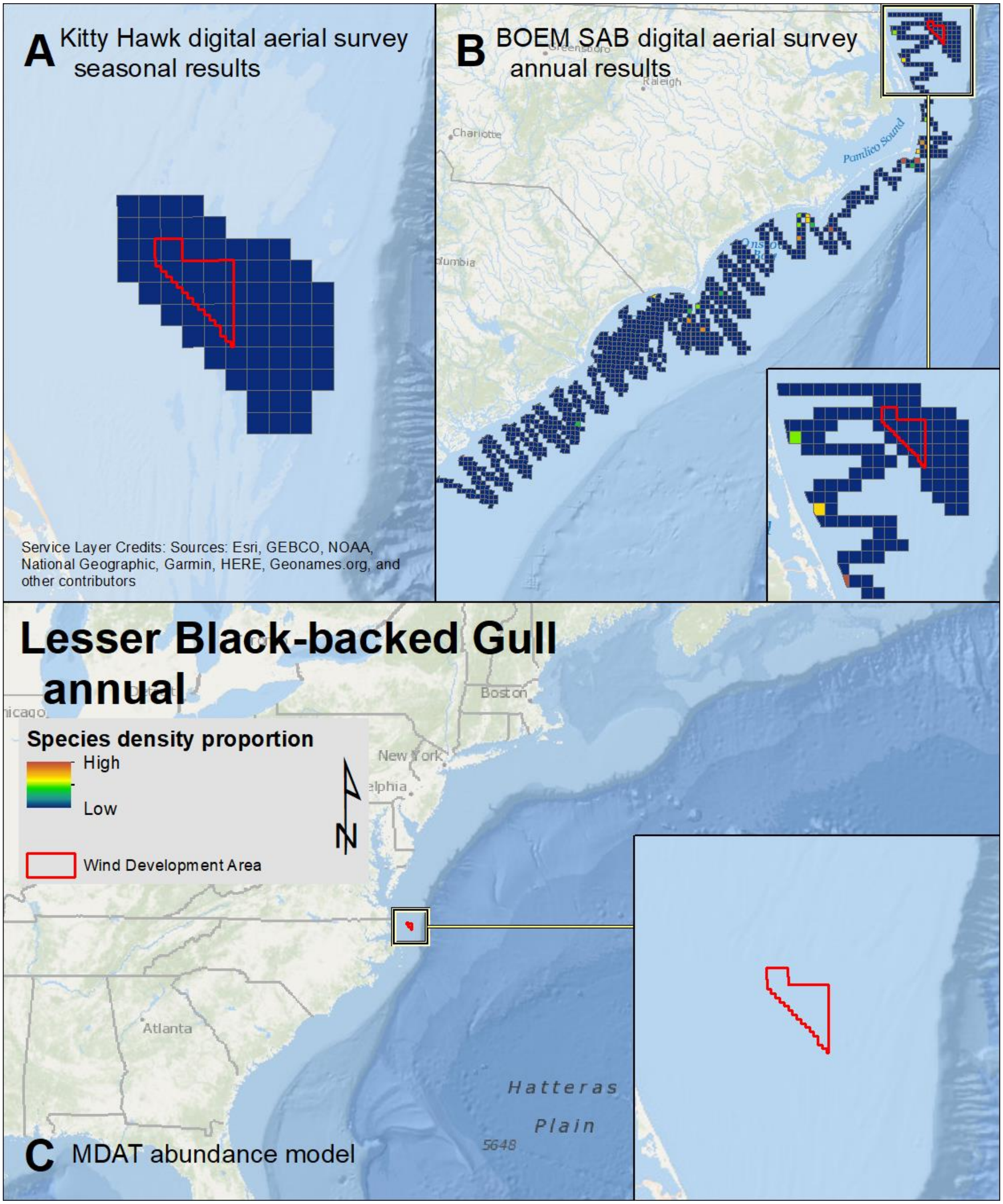
Map 74: Summer Herring Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



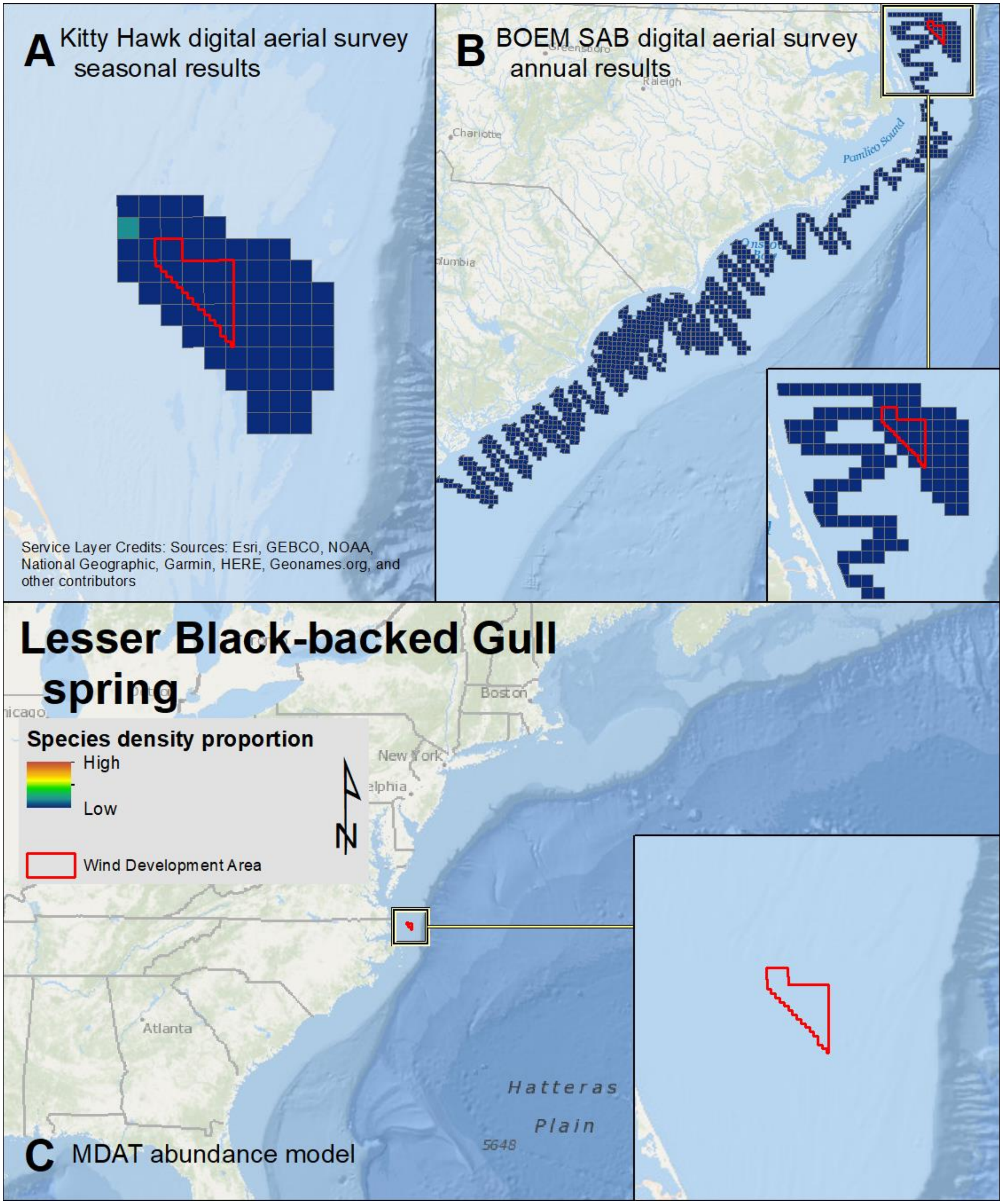
Map 75: Fall Herring Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



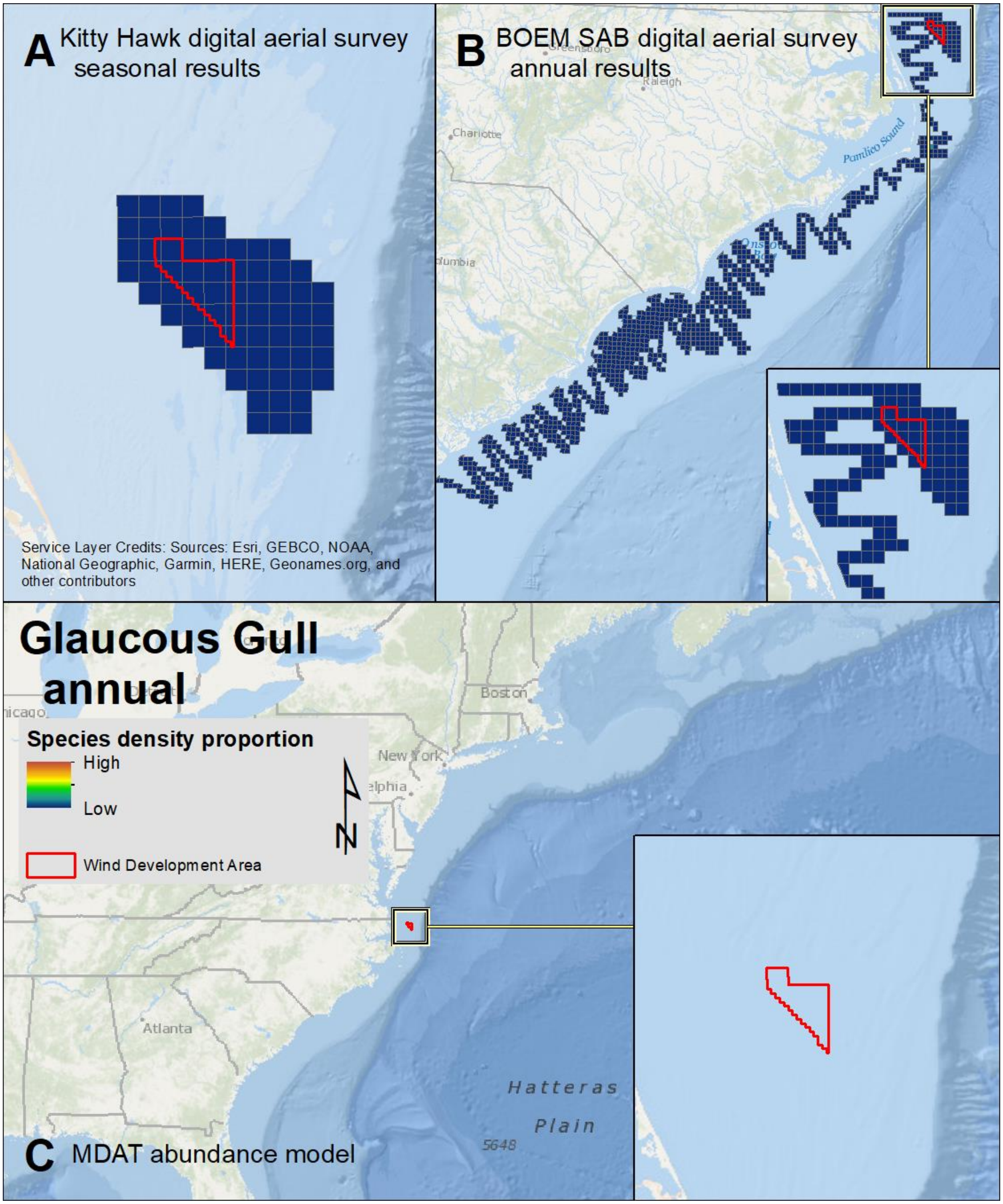
Map 76: Annual Iceland Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



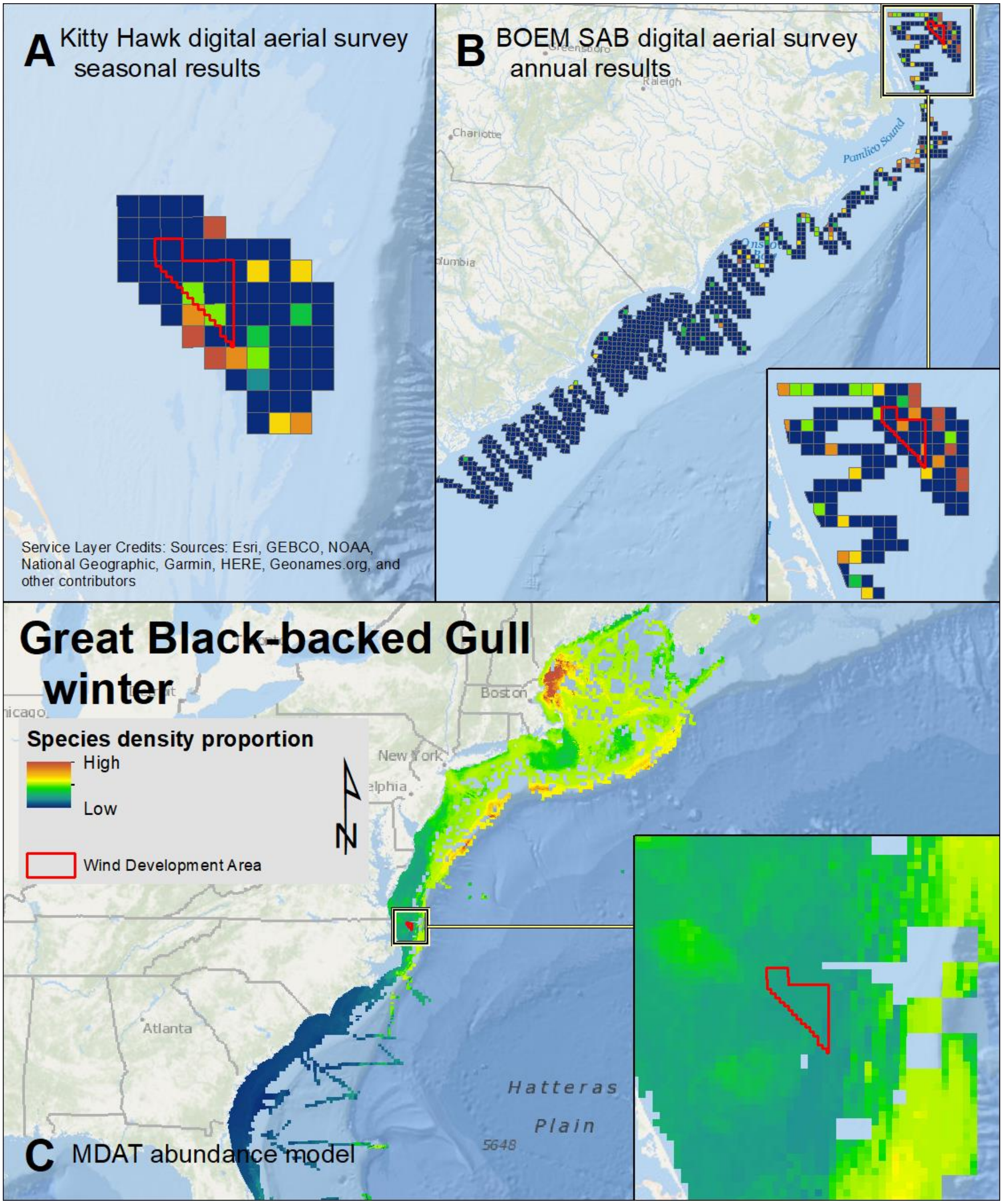
Map 77: Annual Lesser Black-backed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



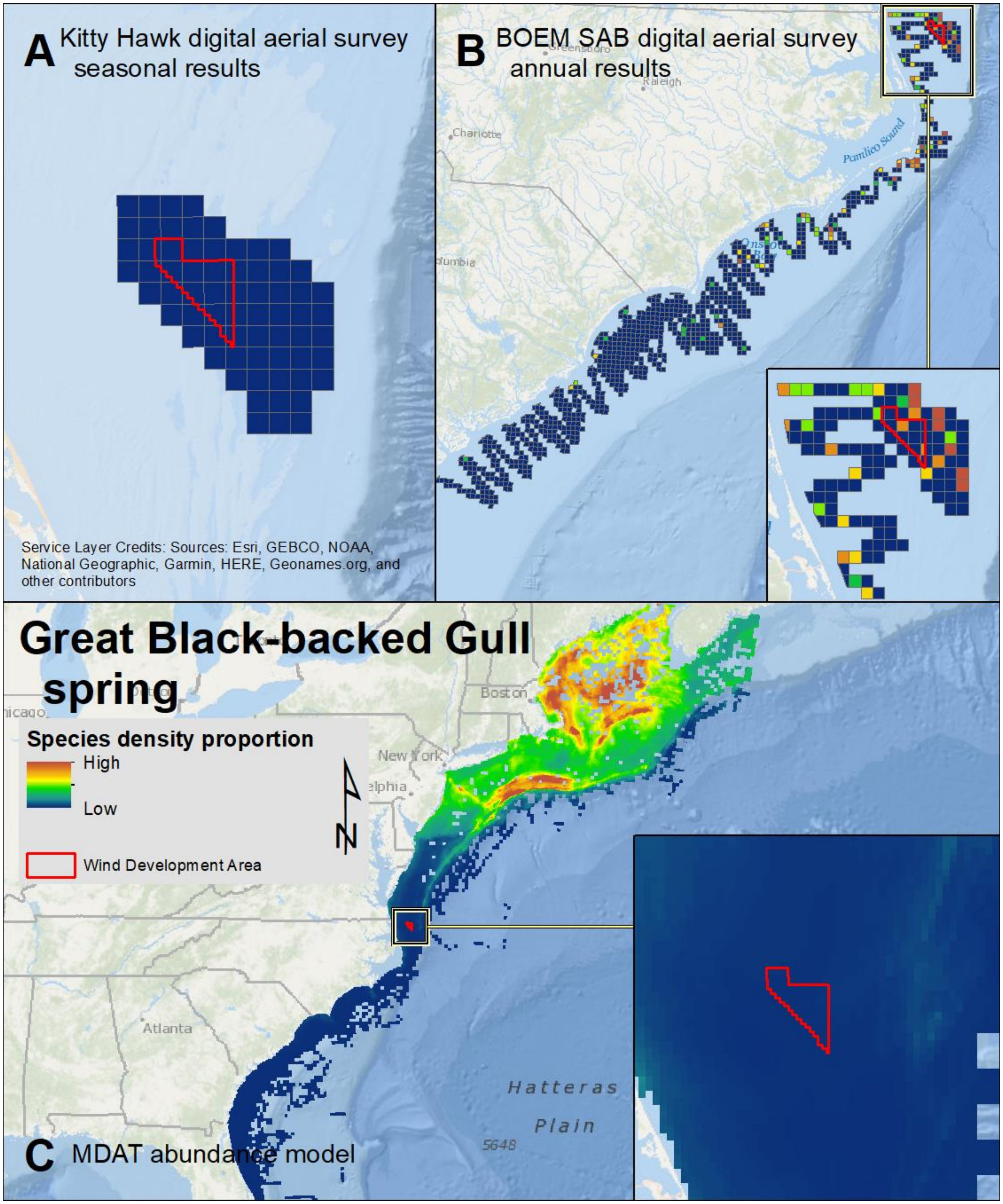
Map 78: Spring Lesser Black-backed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



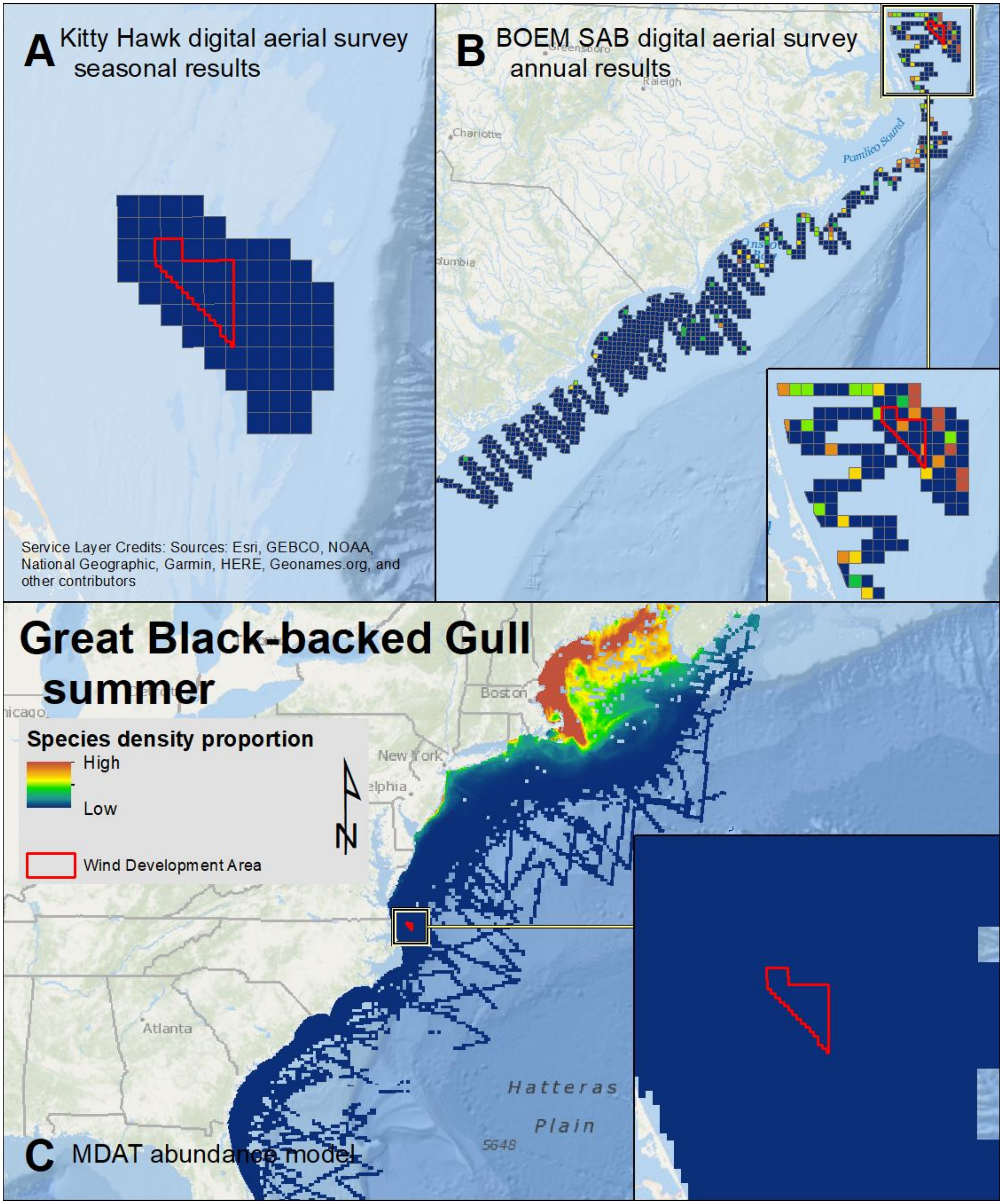
Map 79: Annual Glaucous Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



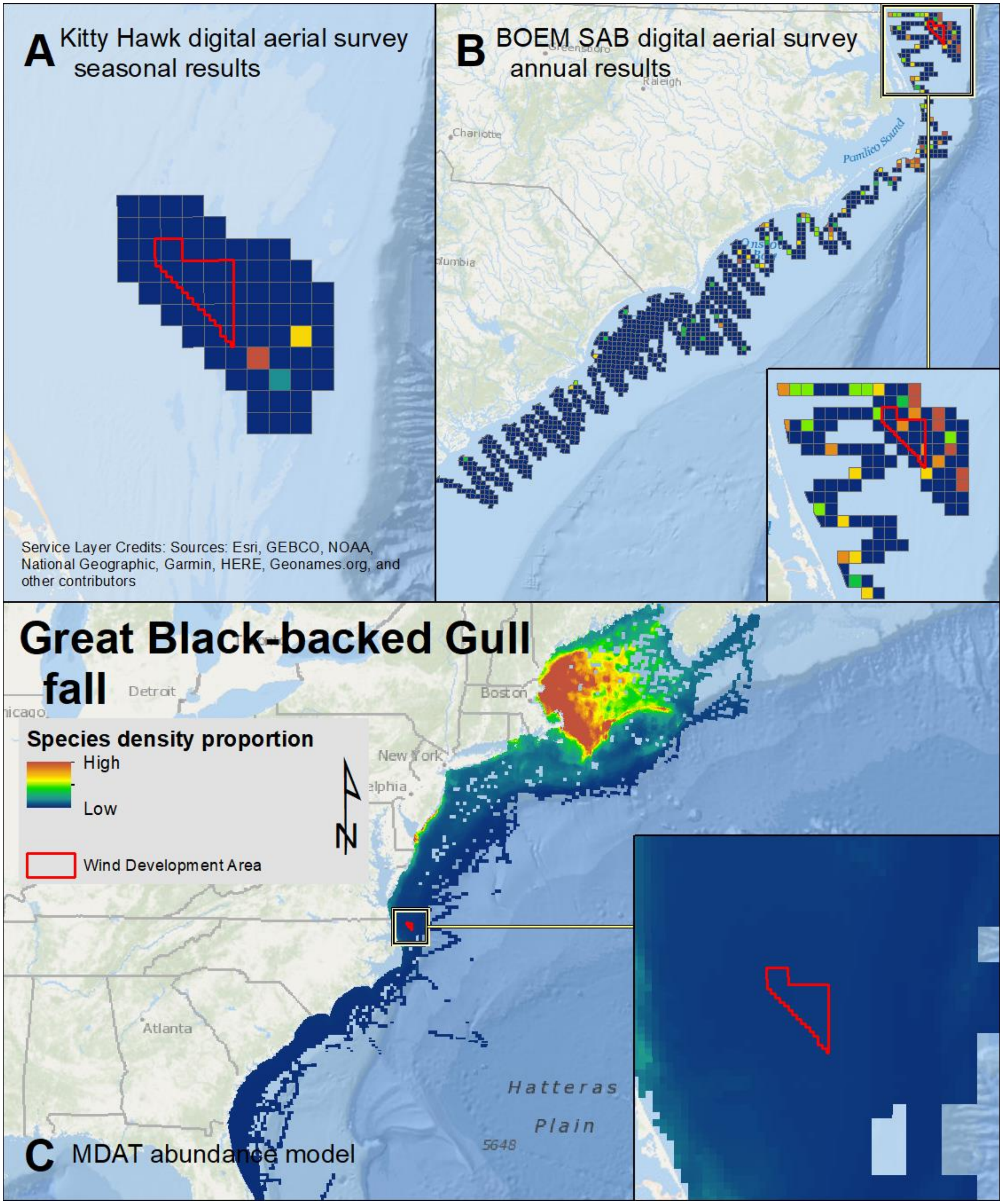
Map 80: Winter Great Black-backed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



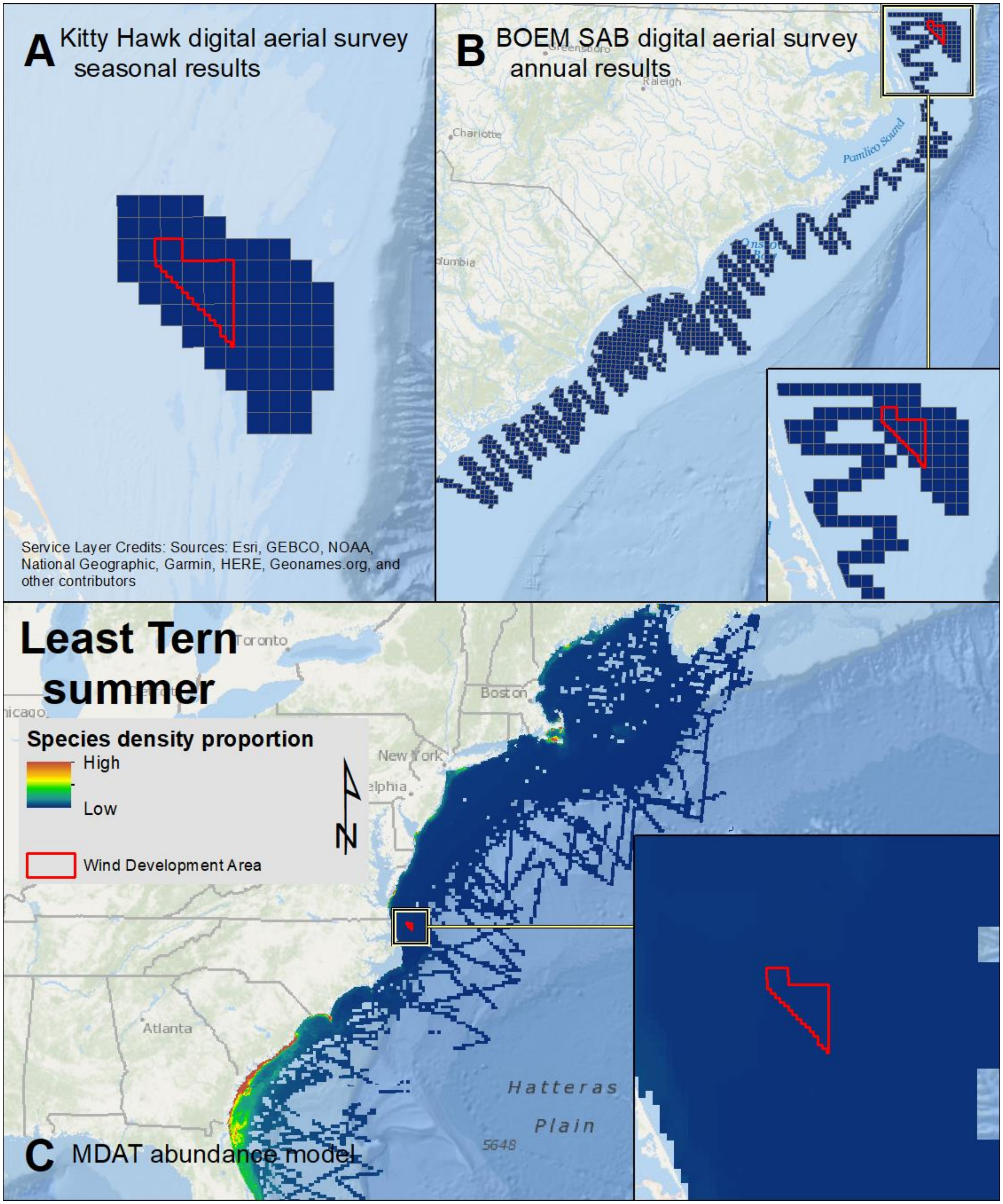
Map 81: Spring Great Black-backed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



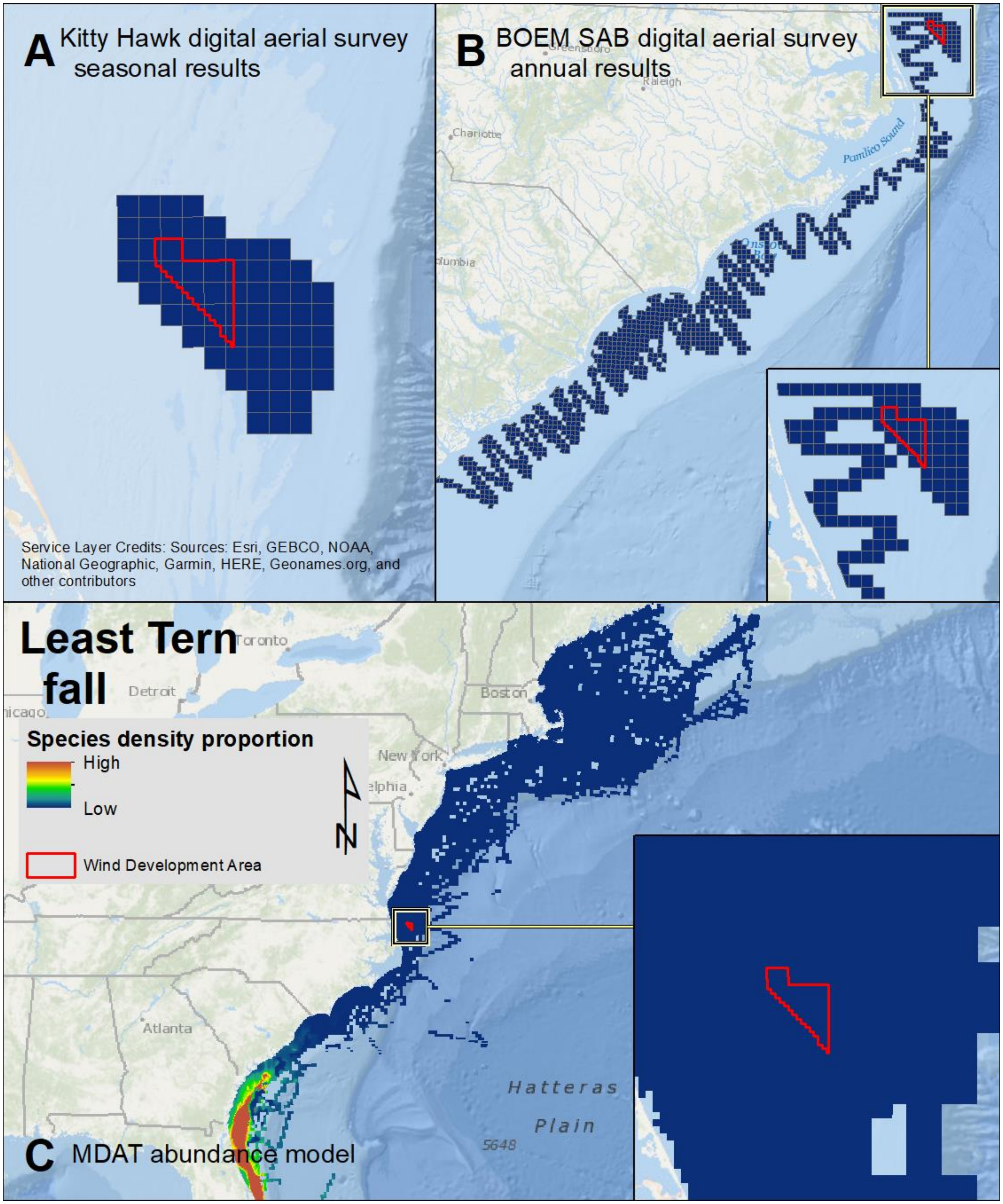
Map 82: Summer Great Black-backed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



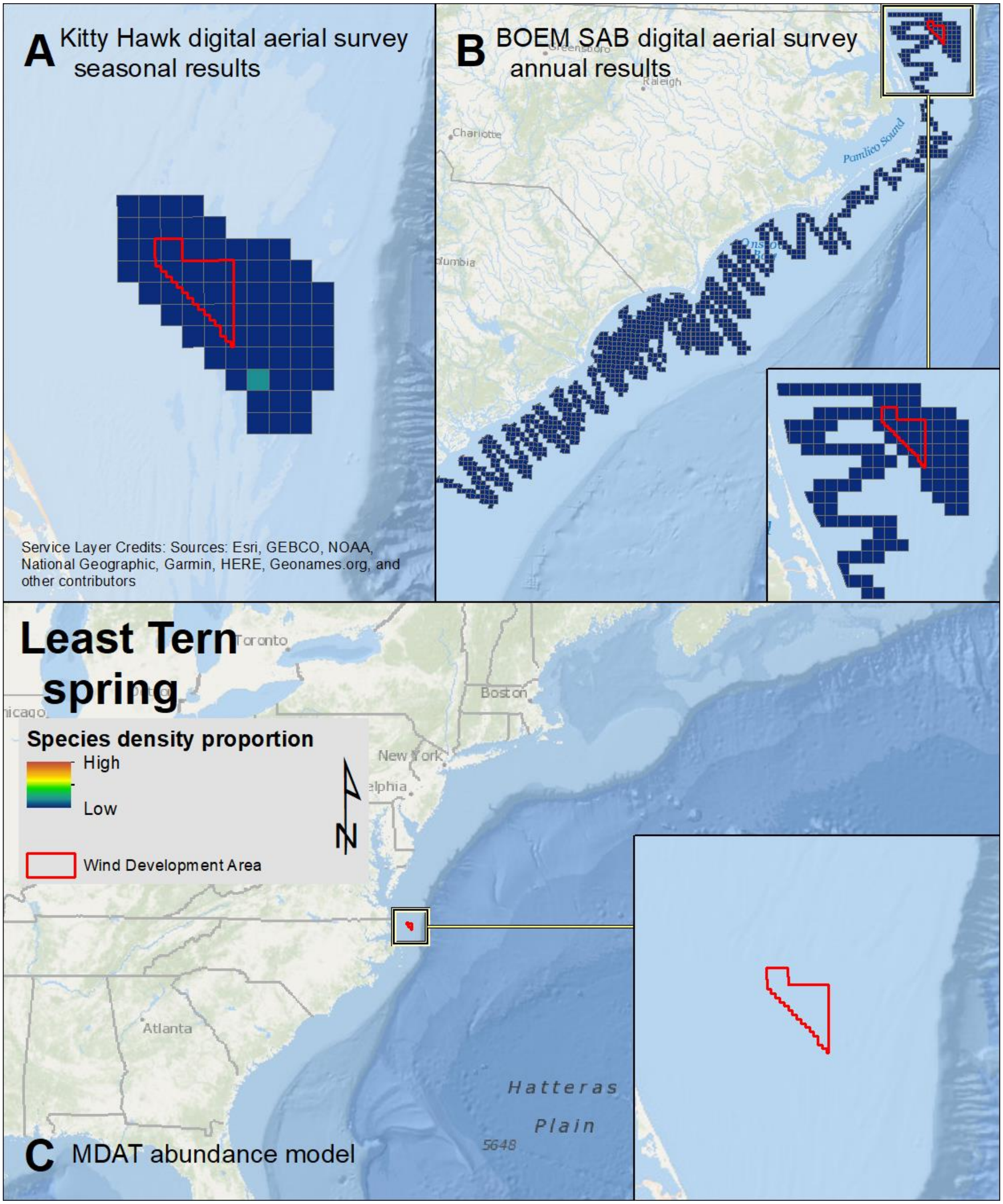
Map 83: Fall Great Black-backed Gull density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



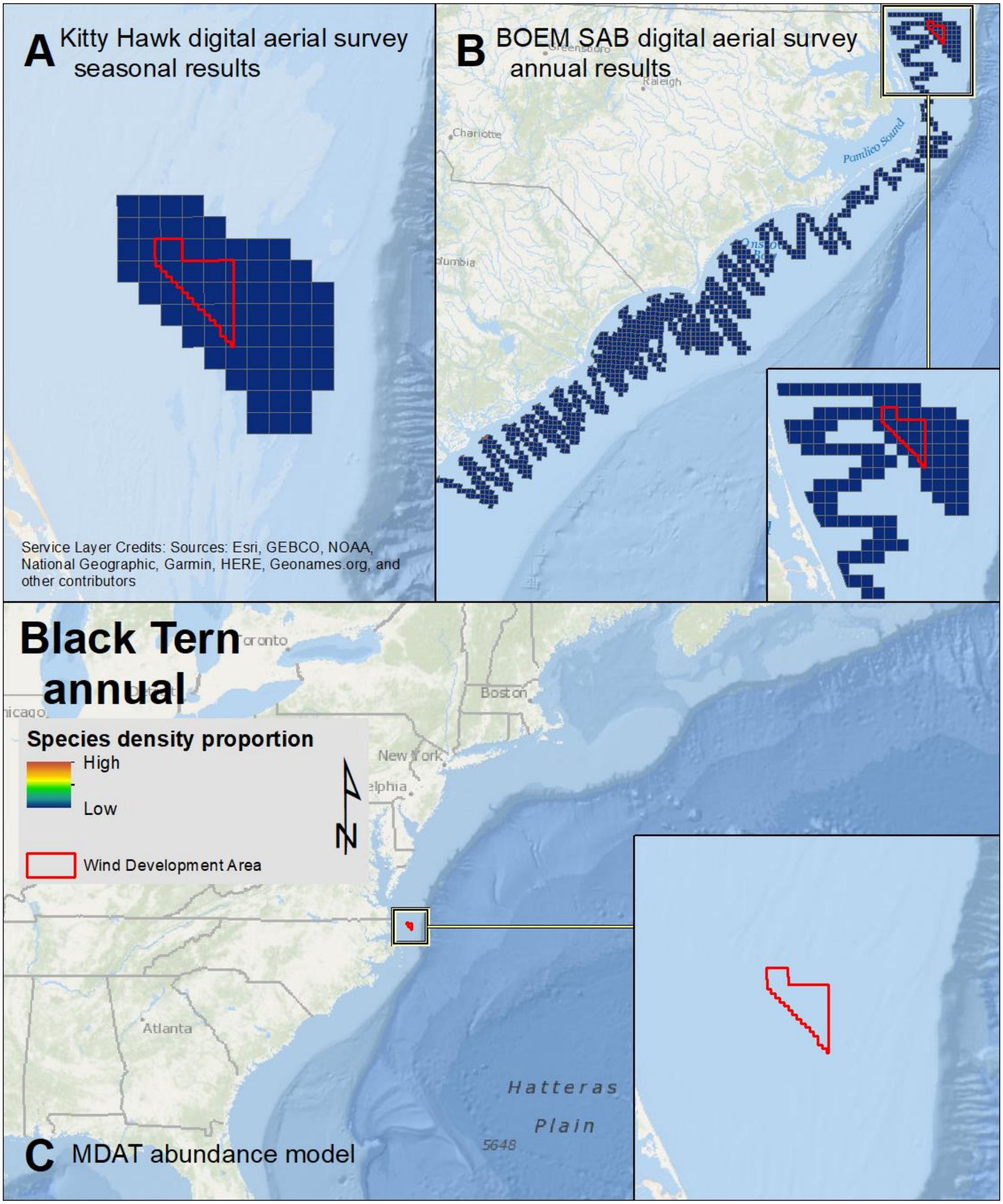
Map 84: Summer Least Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



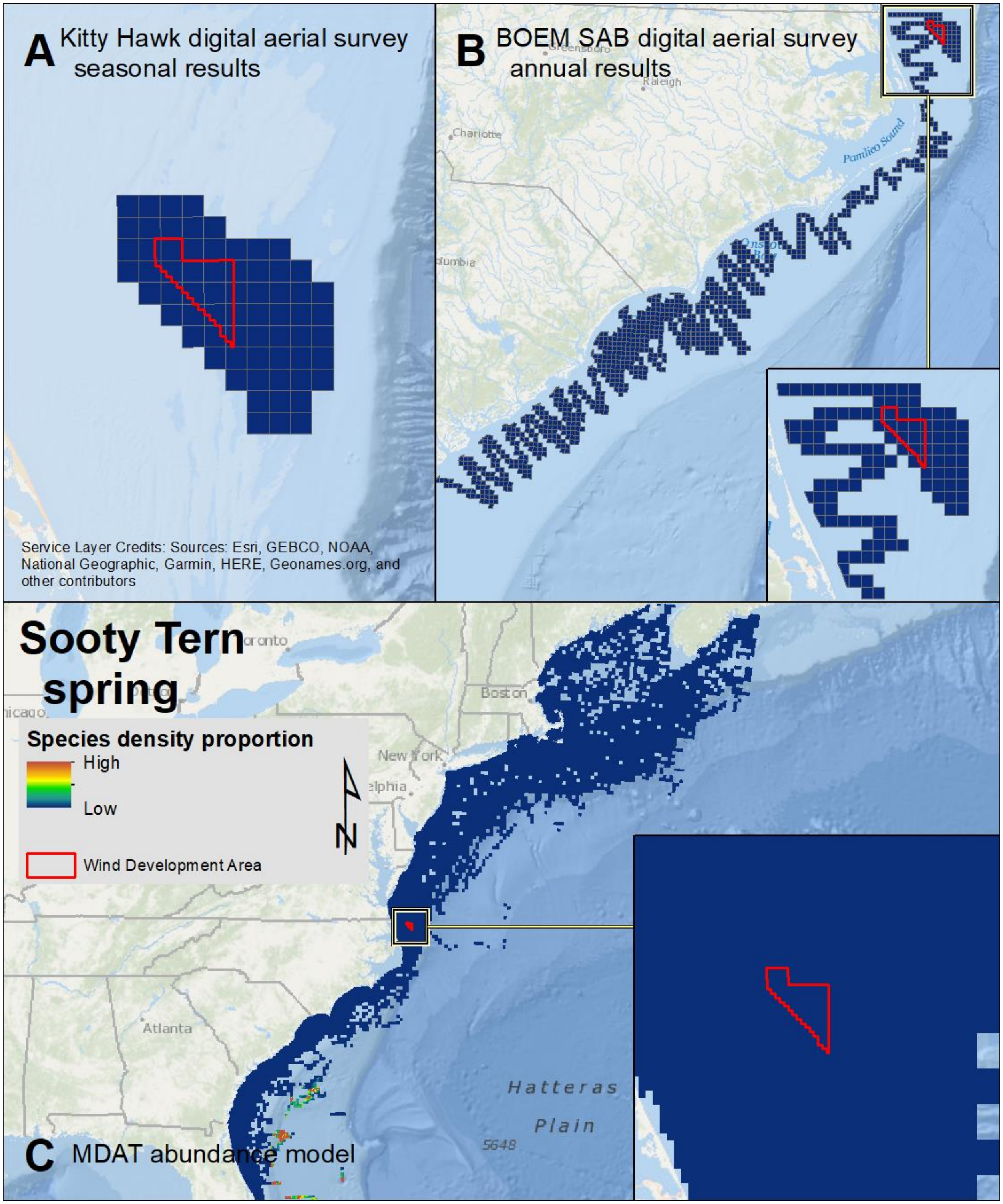
Map 85: Fall Least Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



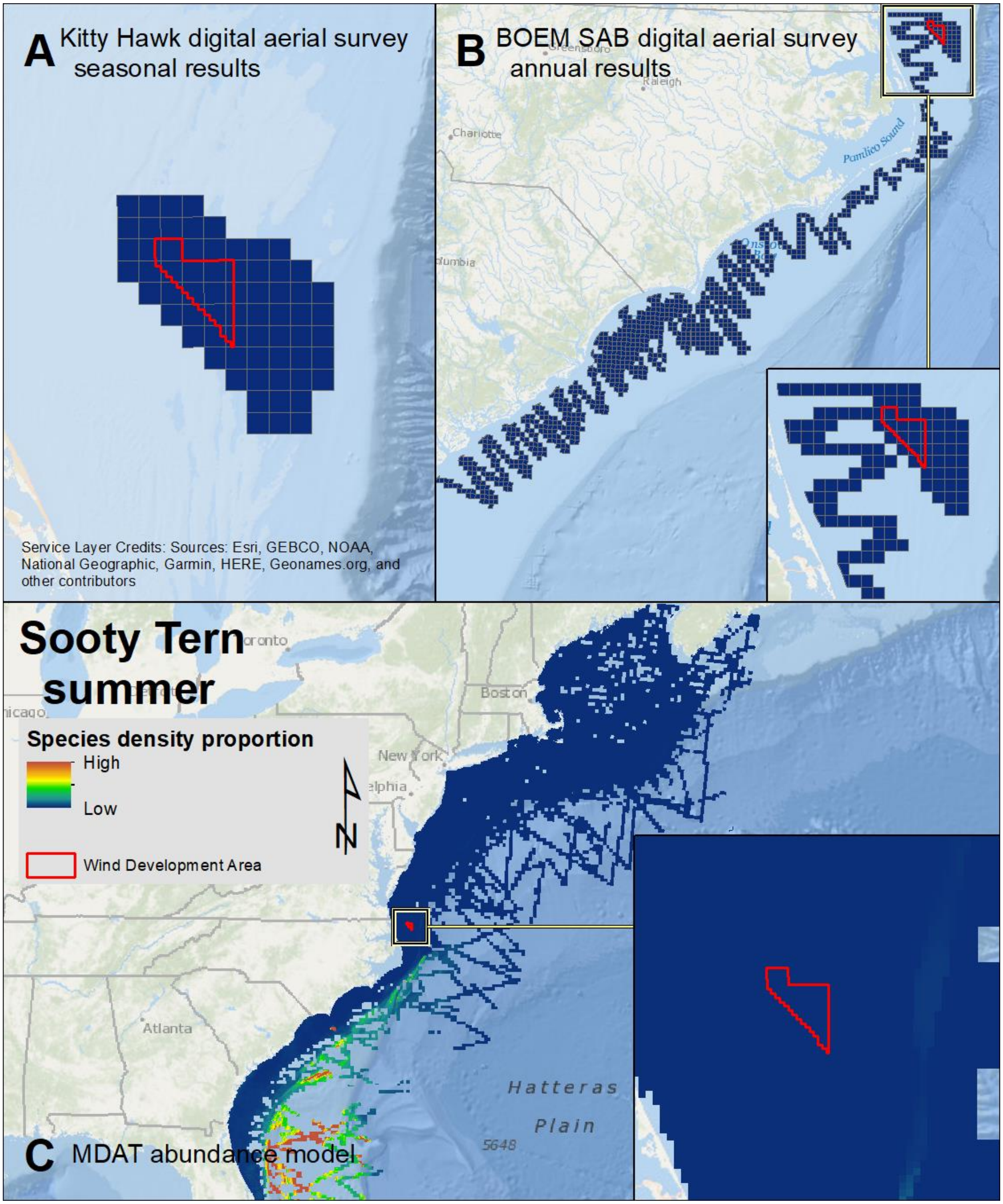
Map 86: Spring Least Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



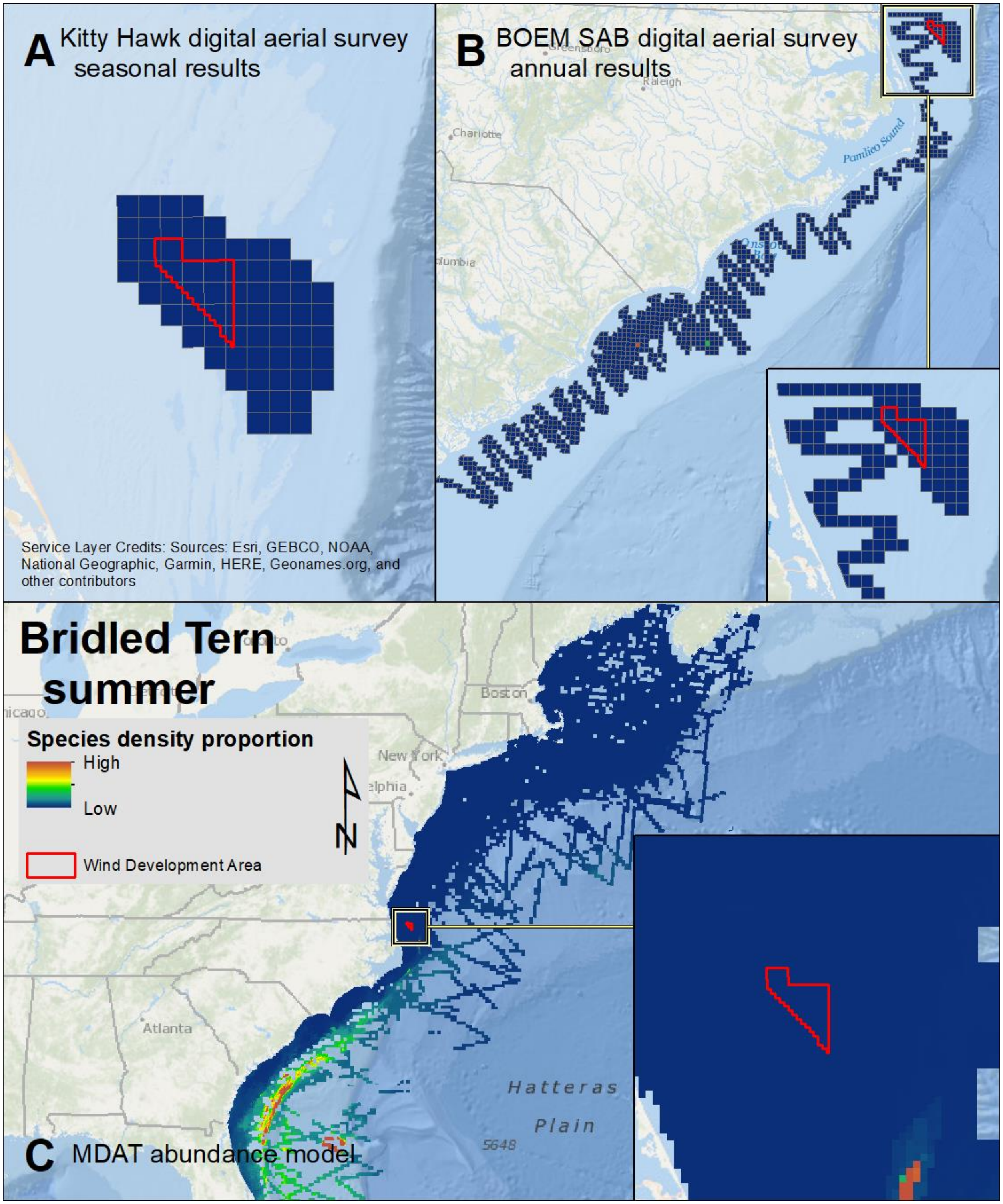
Map 87: Annual Black Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



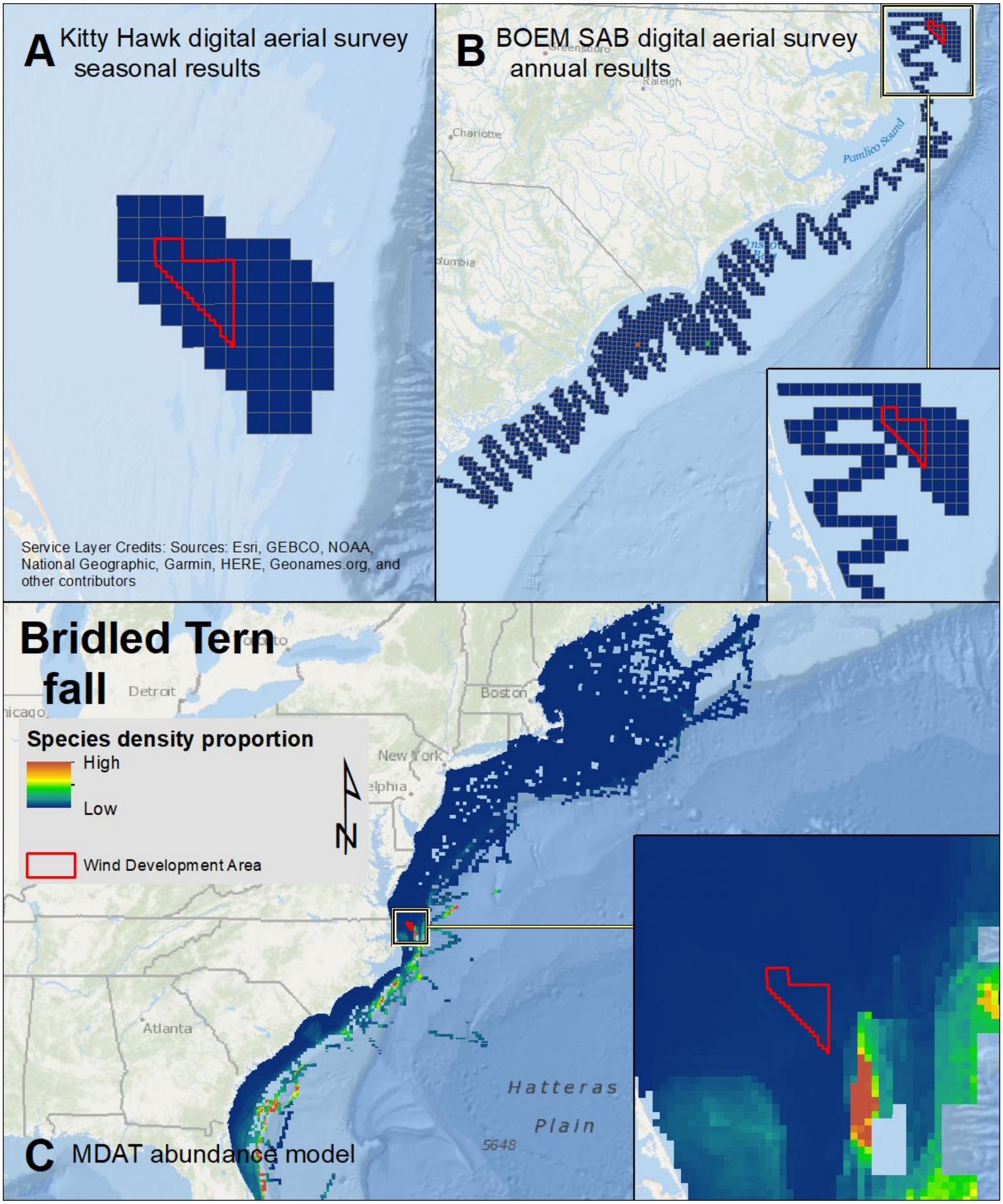
Map 88: Spring Sooty Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



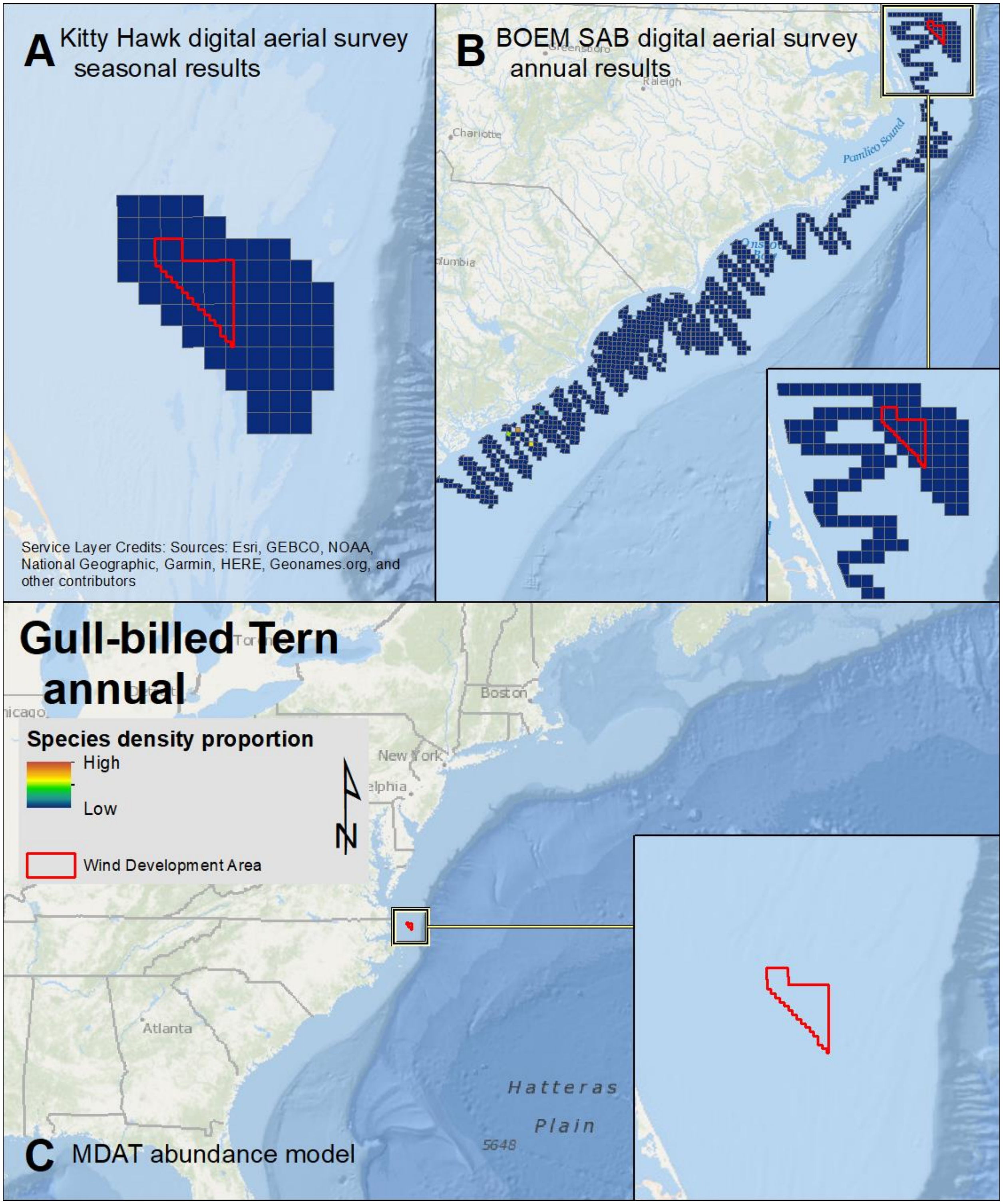
Map 89: Summer Sooty Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



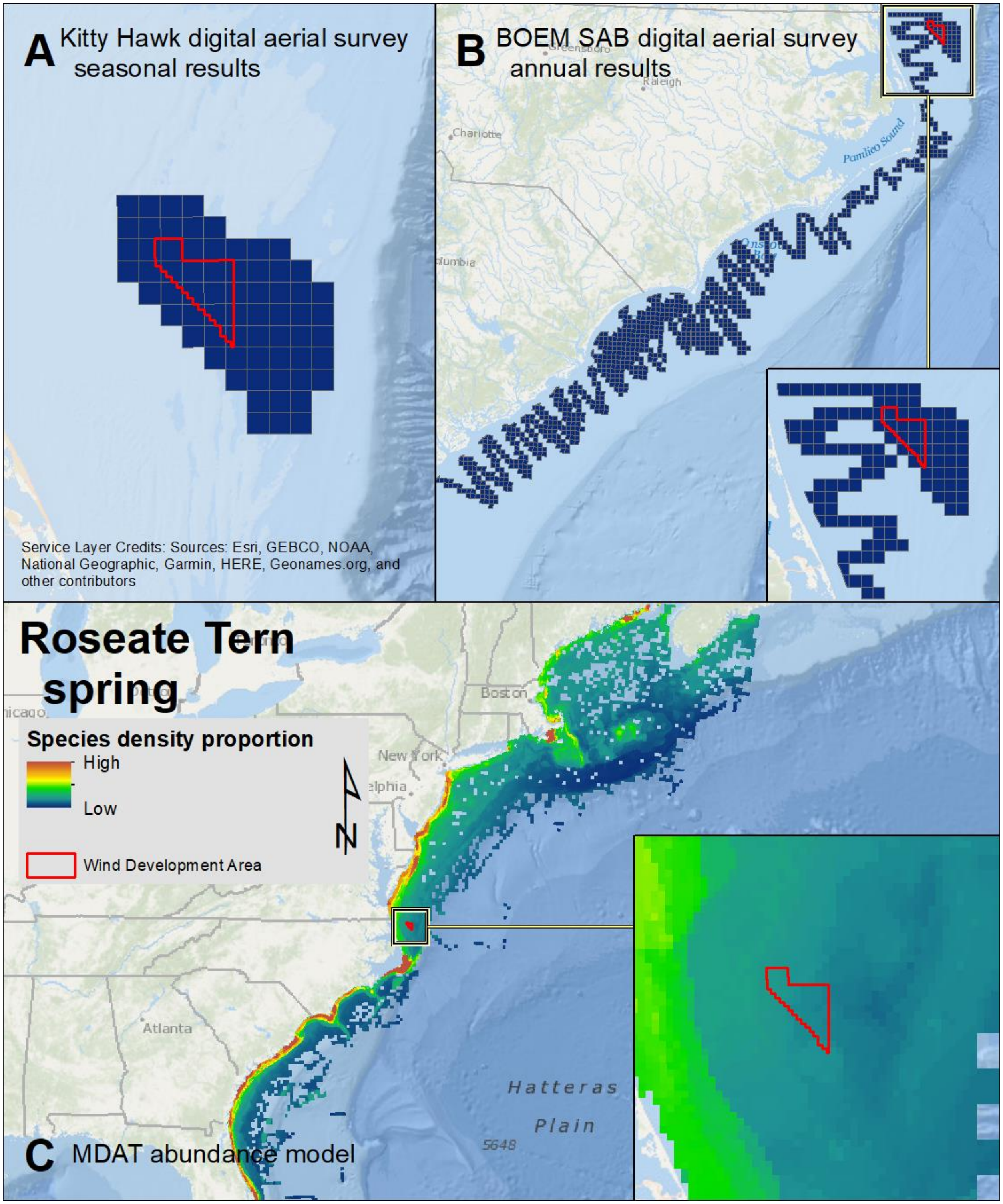
Map 90: Summer Bridled Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



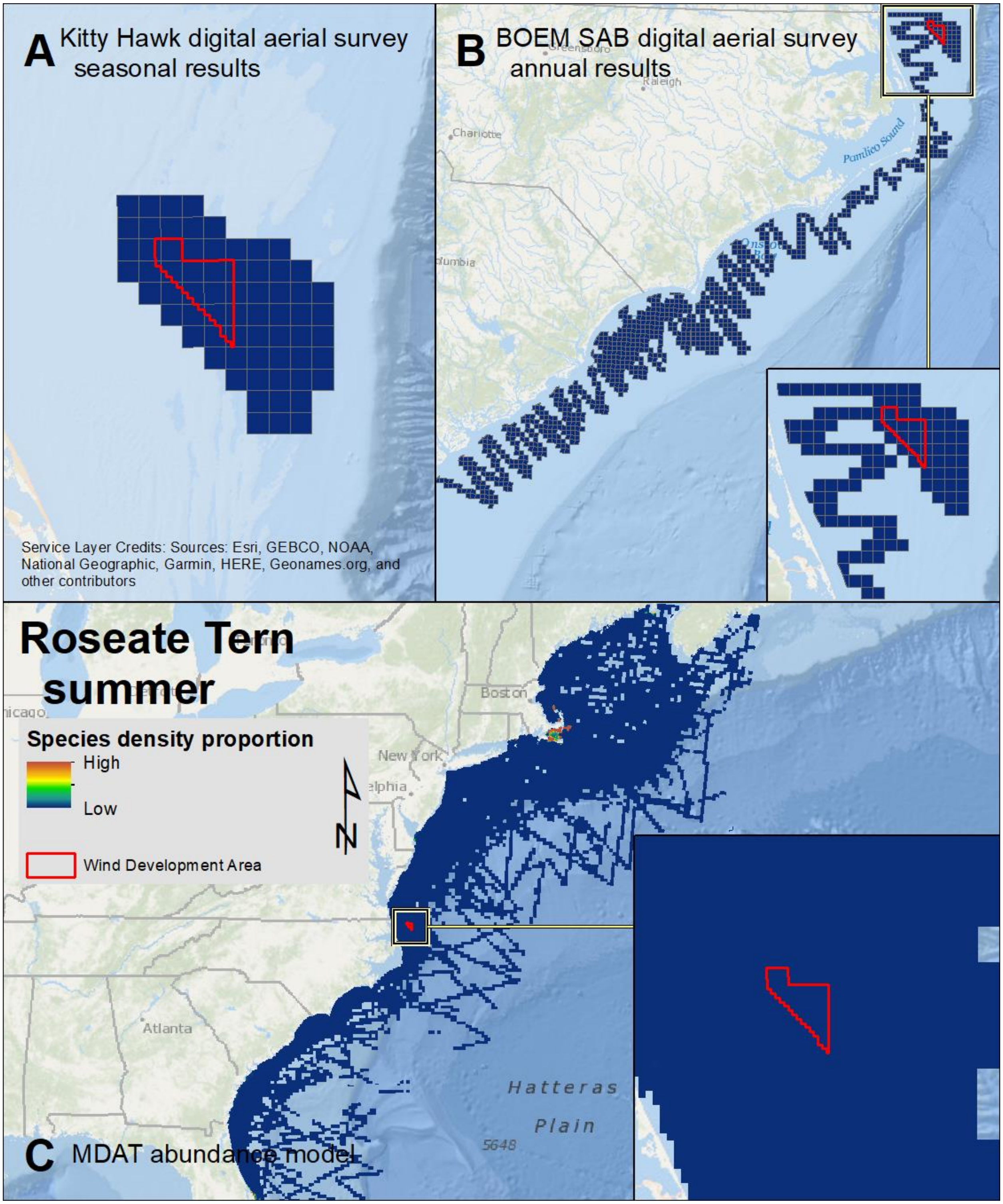
Map 91: Fall Bridled Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



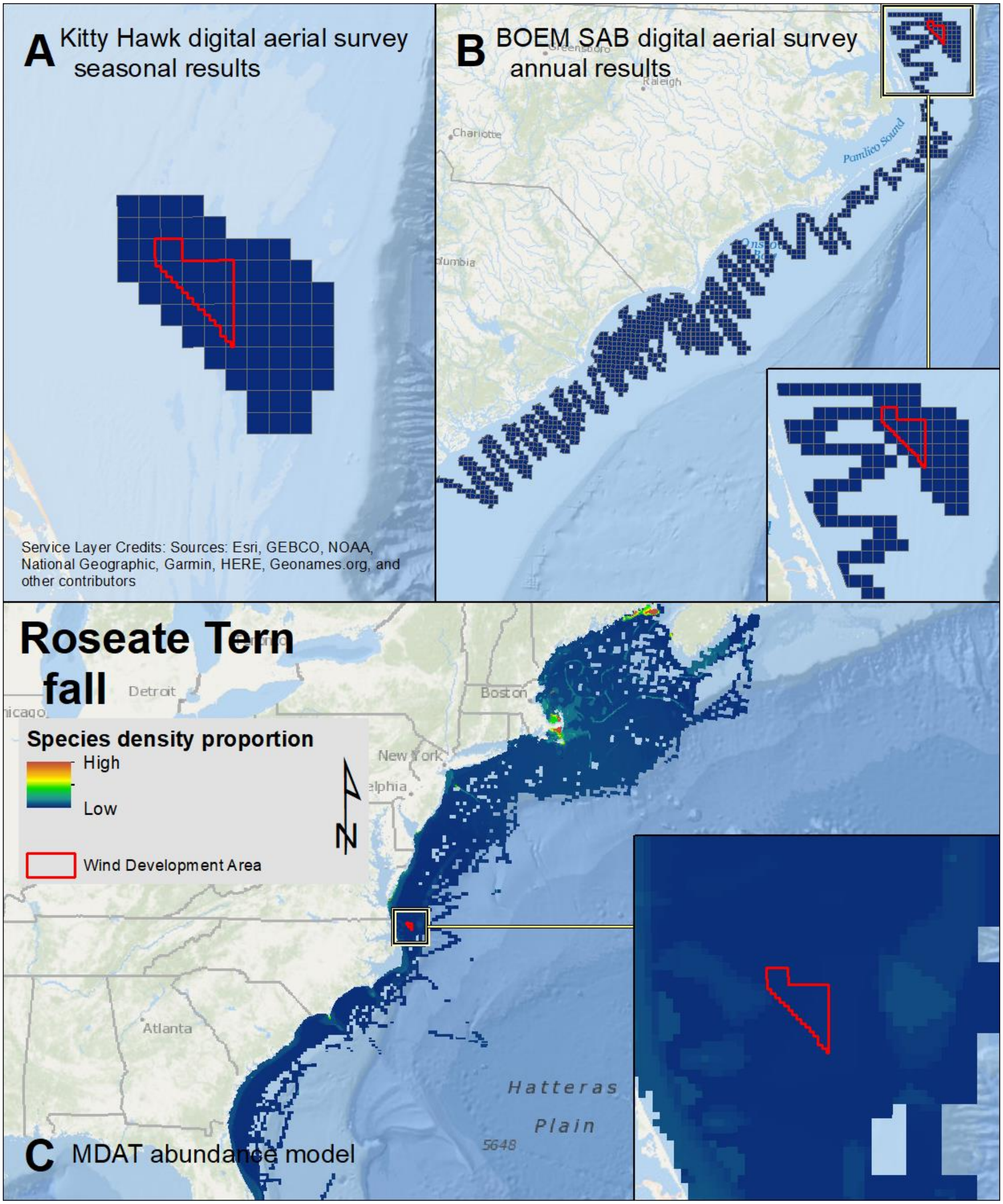
Map 92: Annual Gull-billed Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



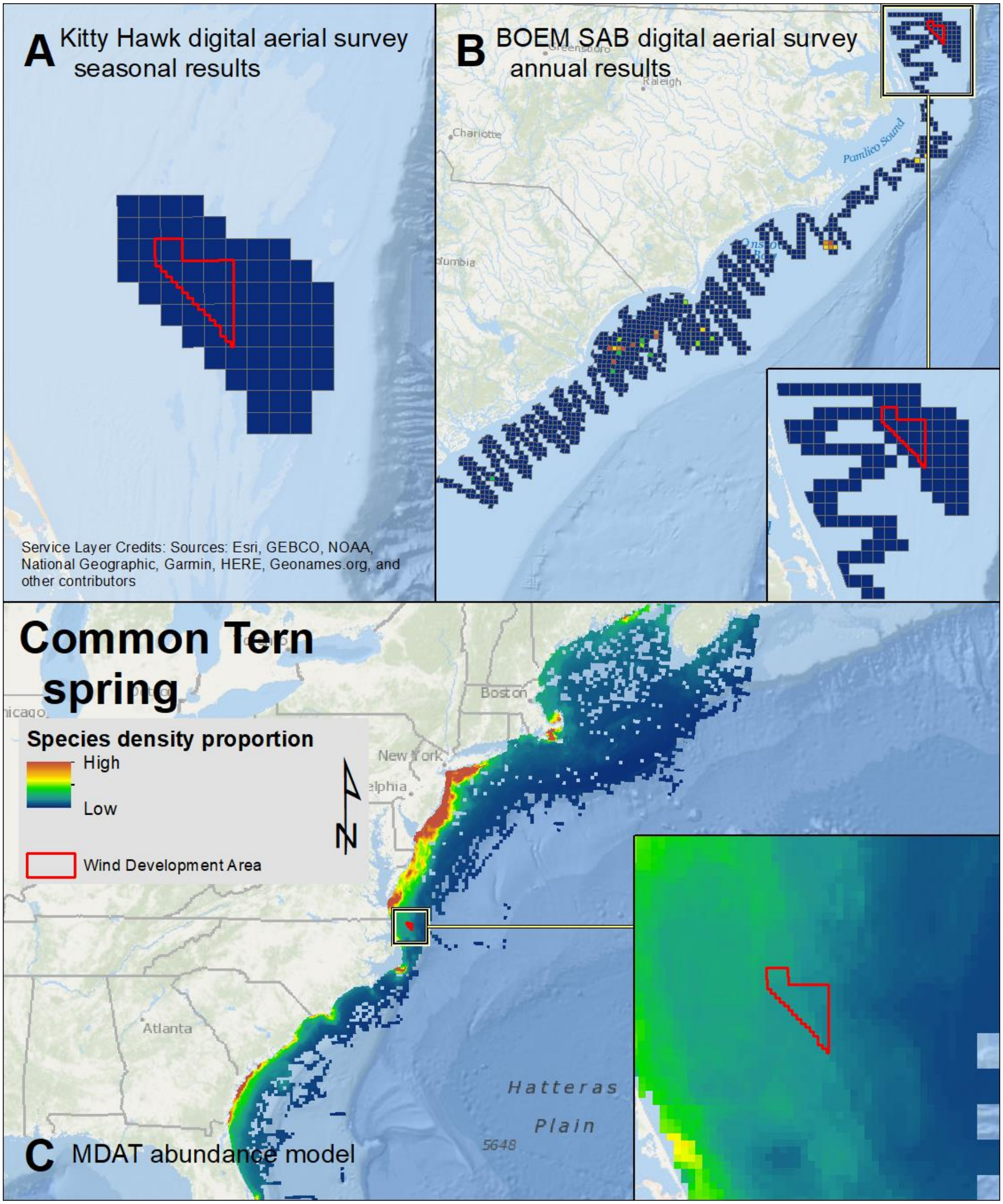
Map 93: Spring Roseate Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



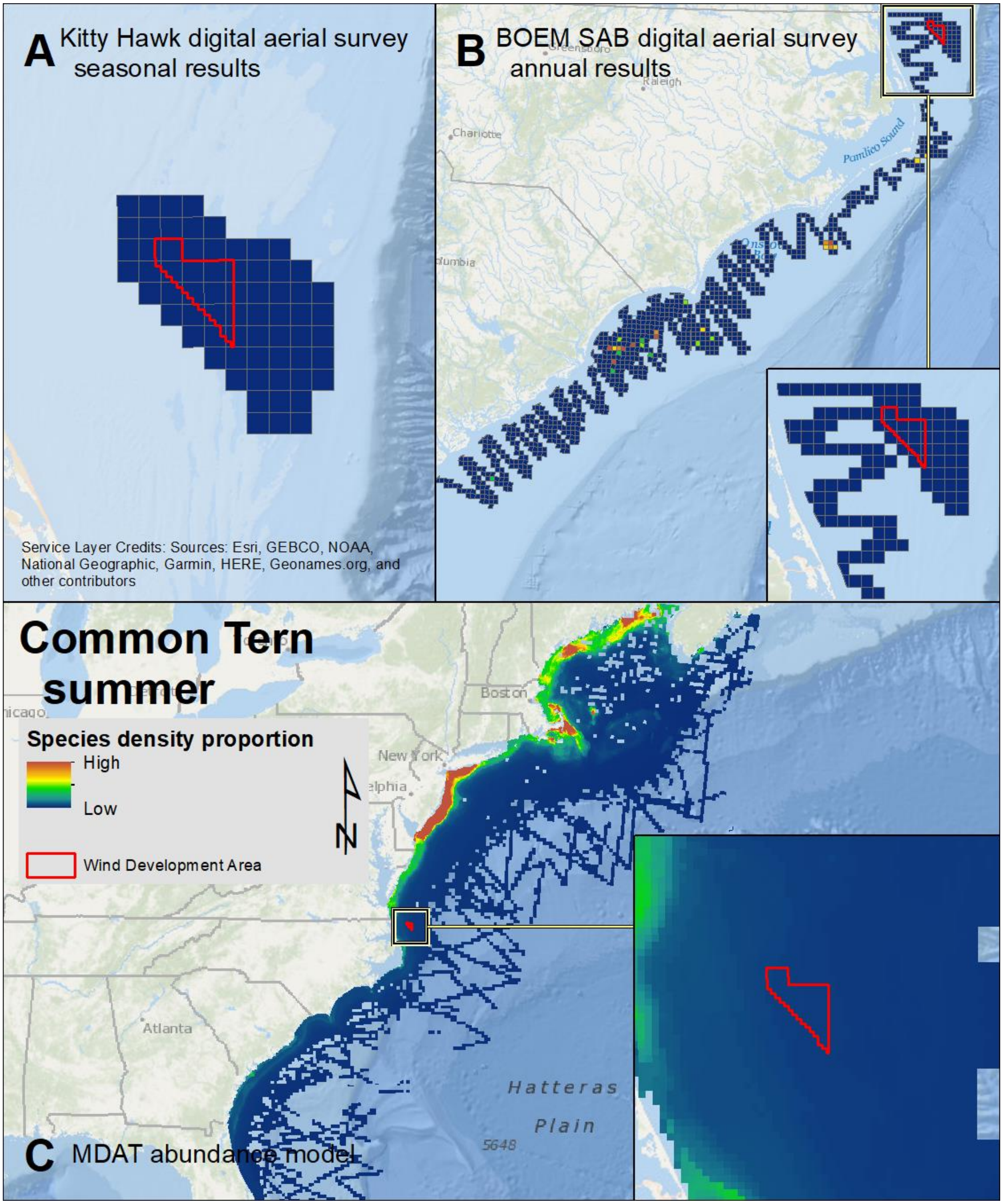
Map 94: Summer Roseate Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



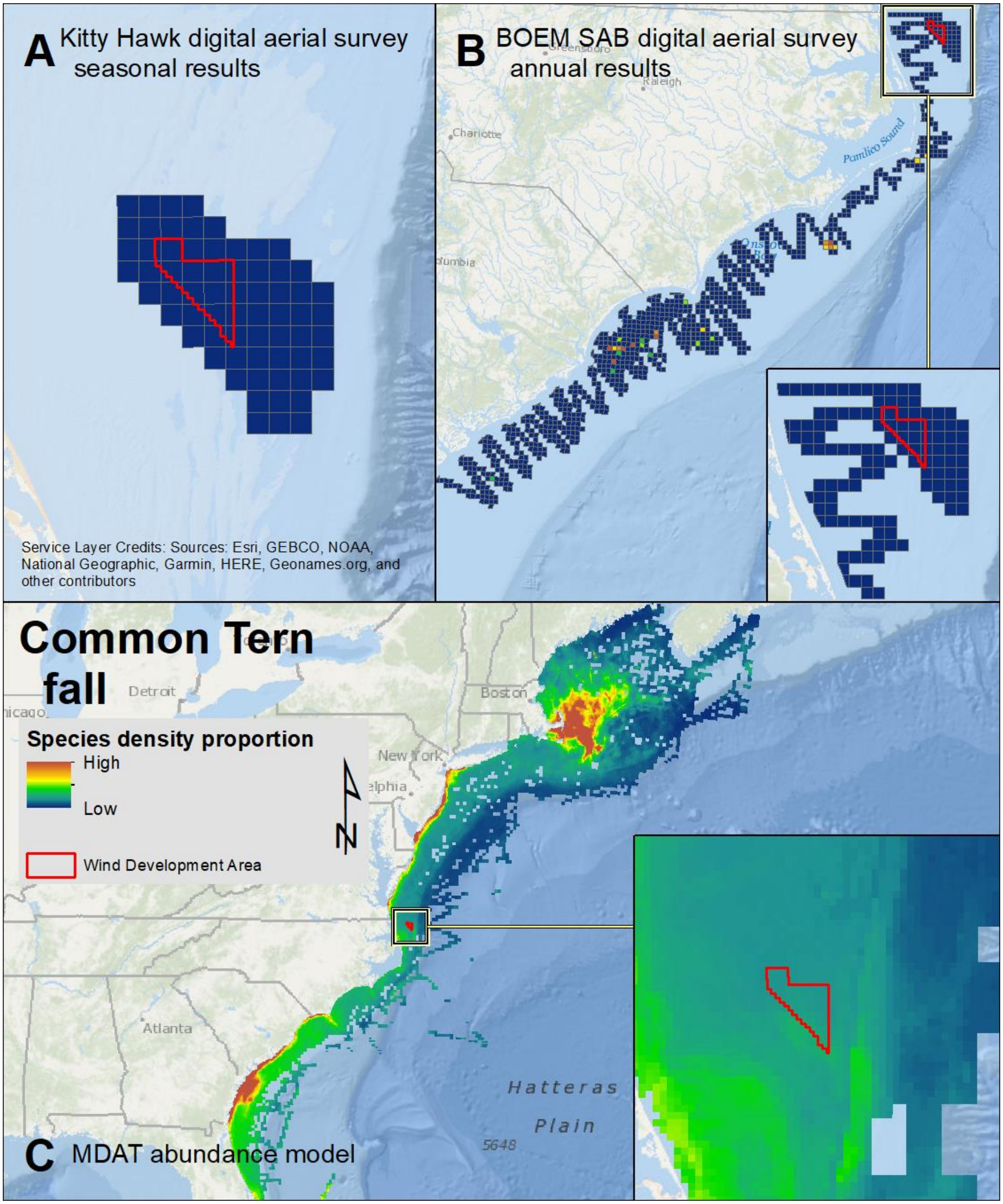
Map 95: Fall Roseate Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



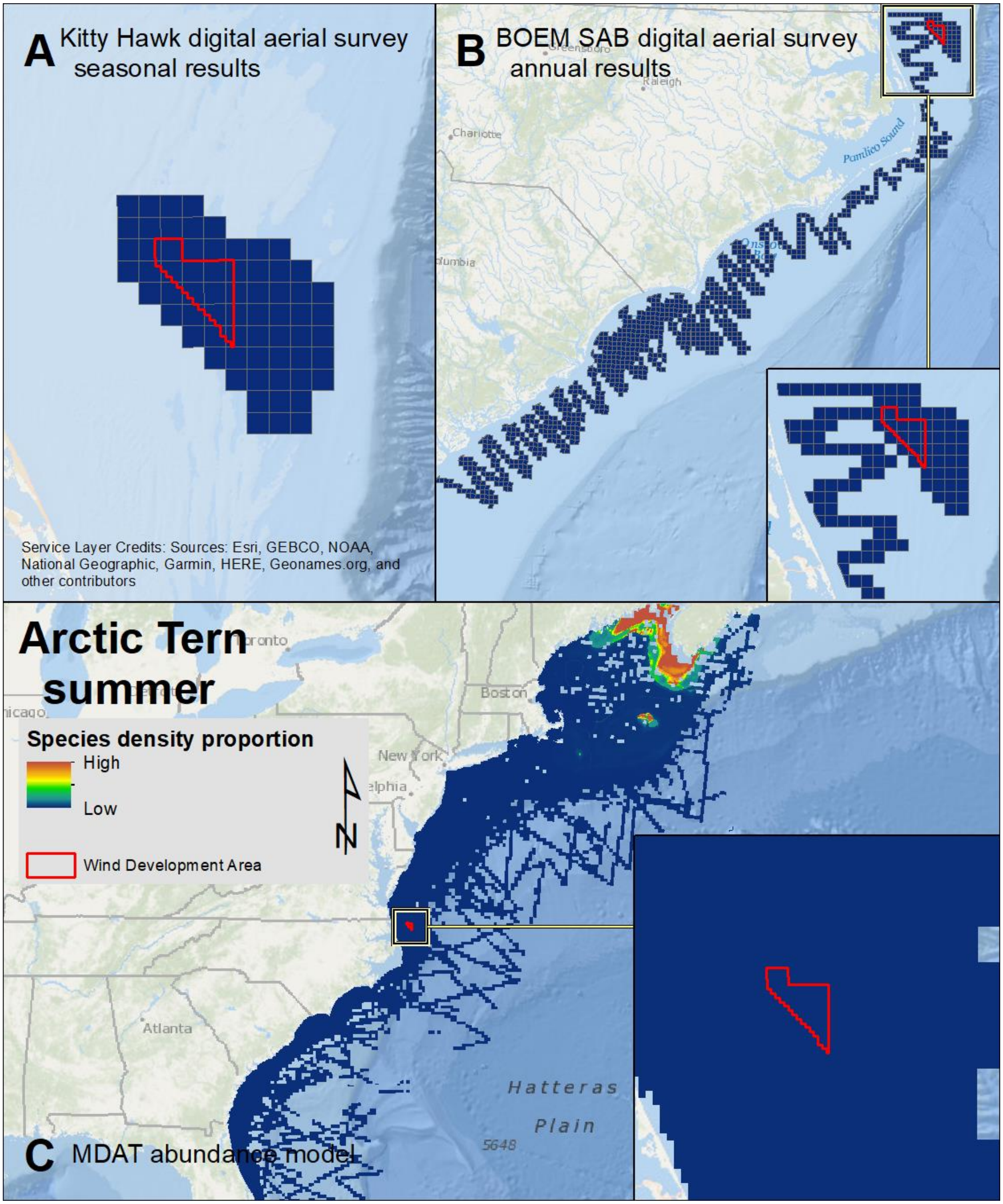
Map 96: Spring Common Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



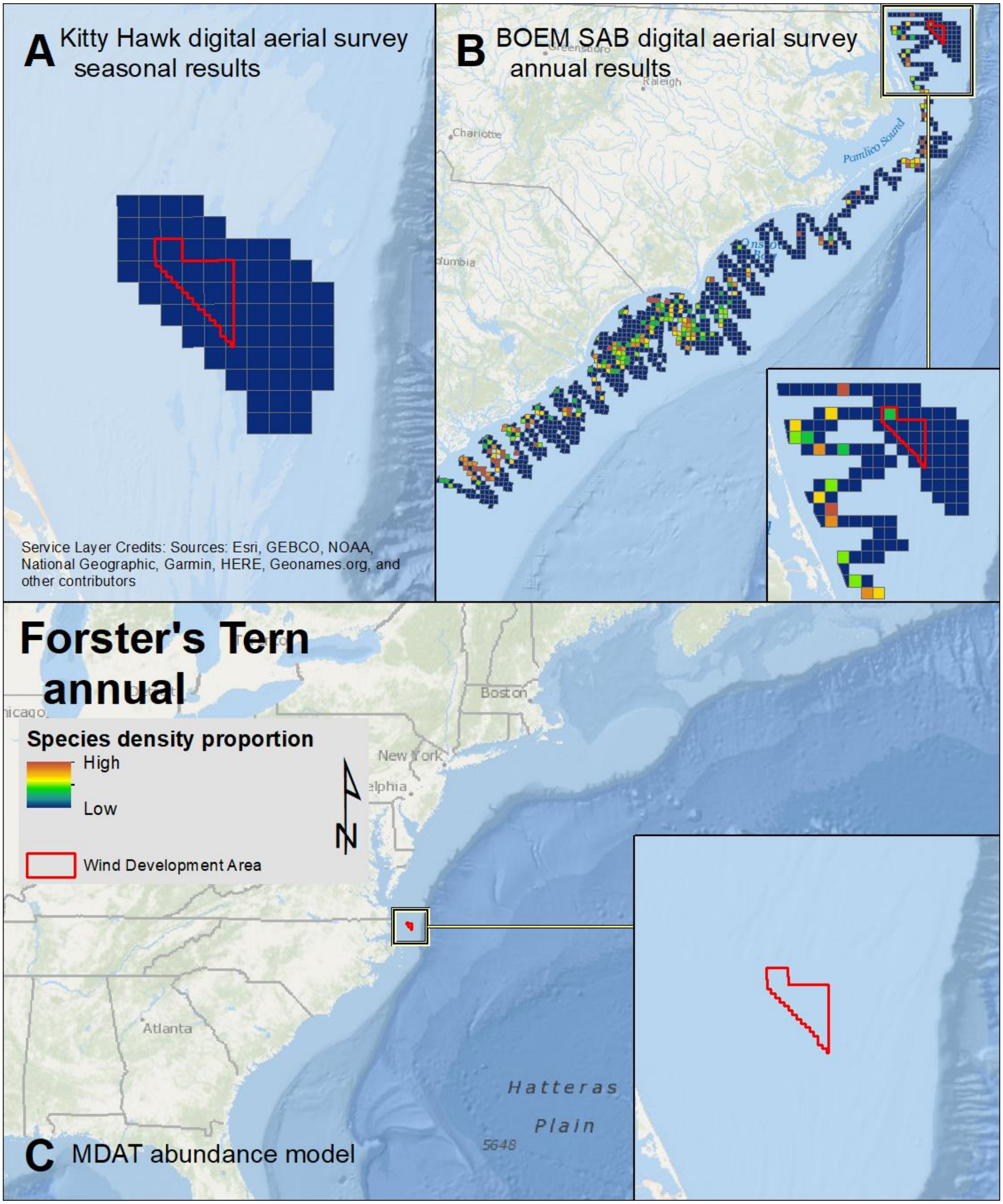
Map 97: Summer Common Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



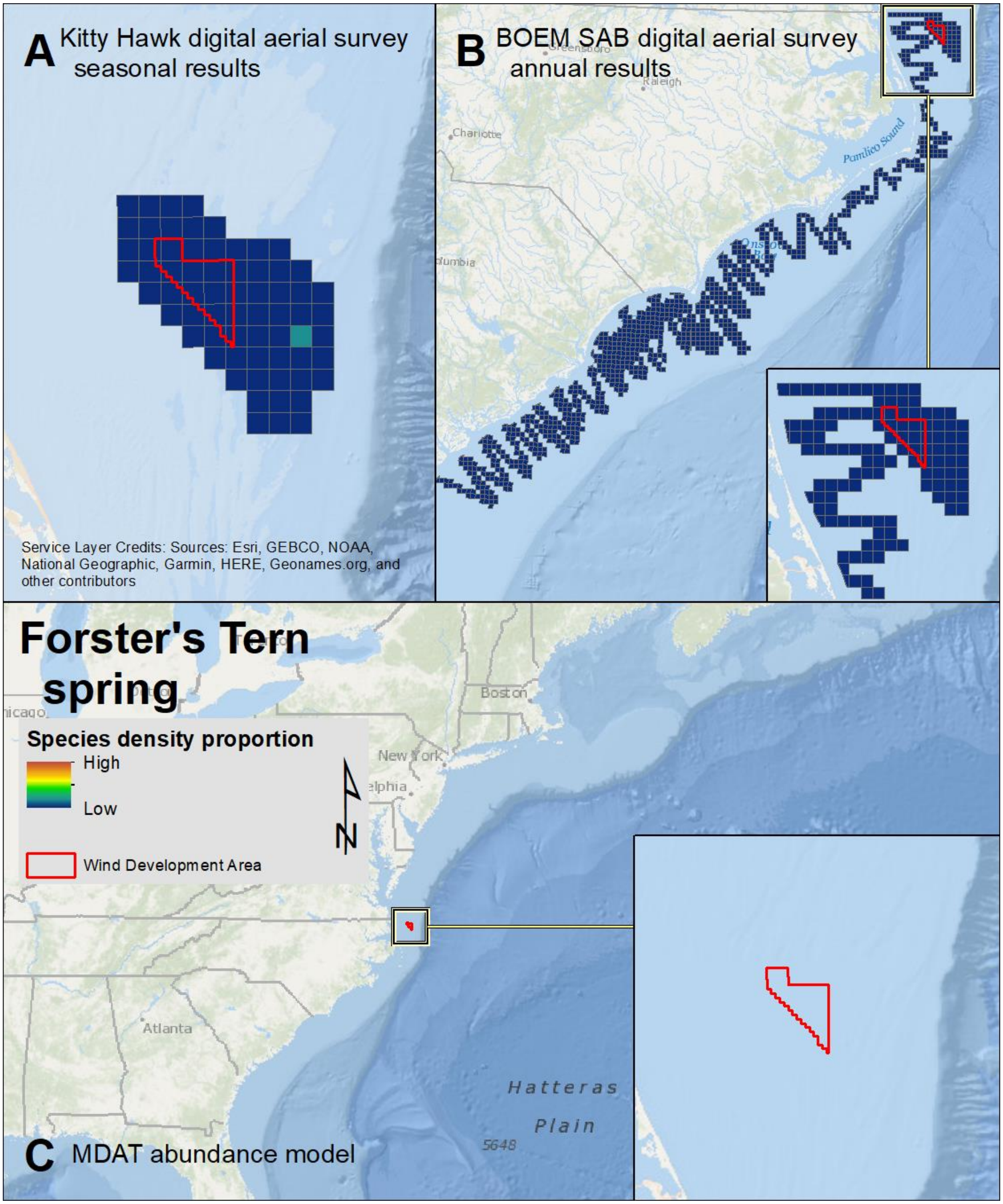
Map 98: Fall Common Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



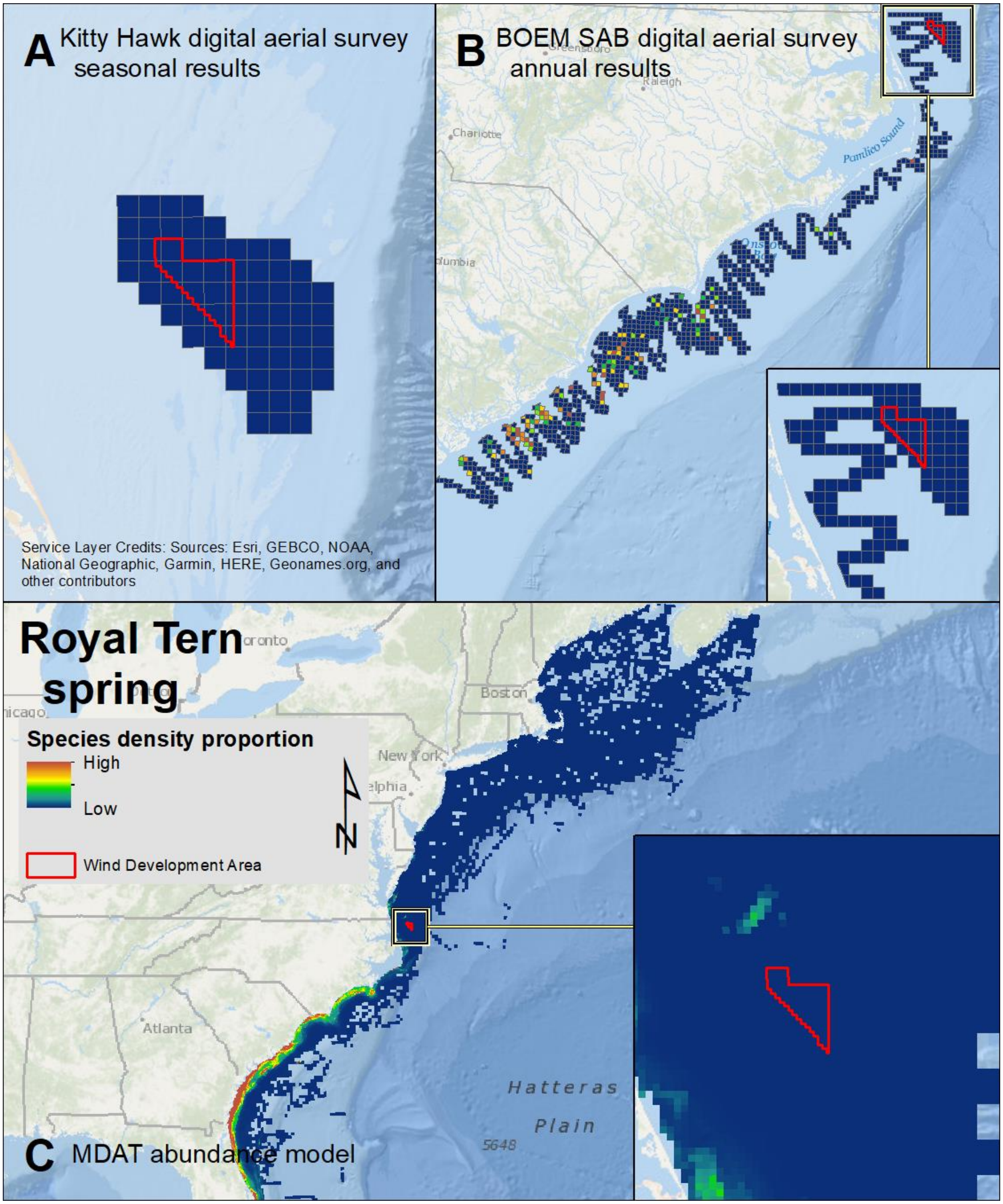
Map 99: Summer Arctic Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



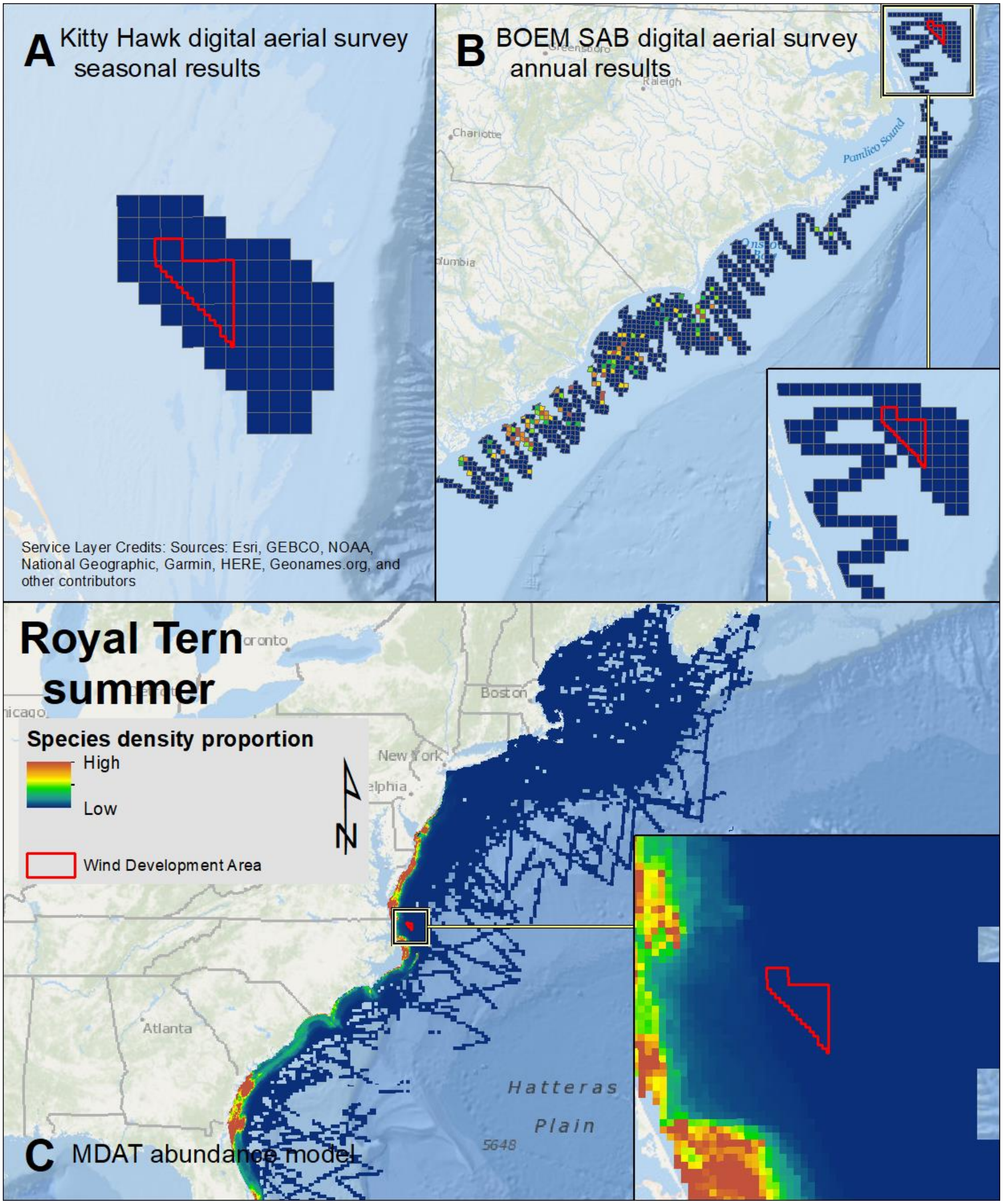
Map 100: Annual Forster's Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



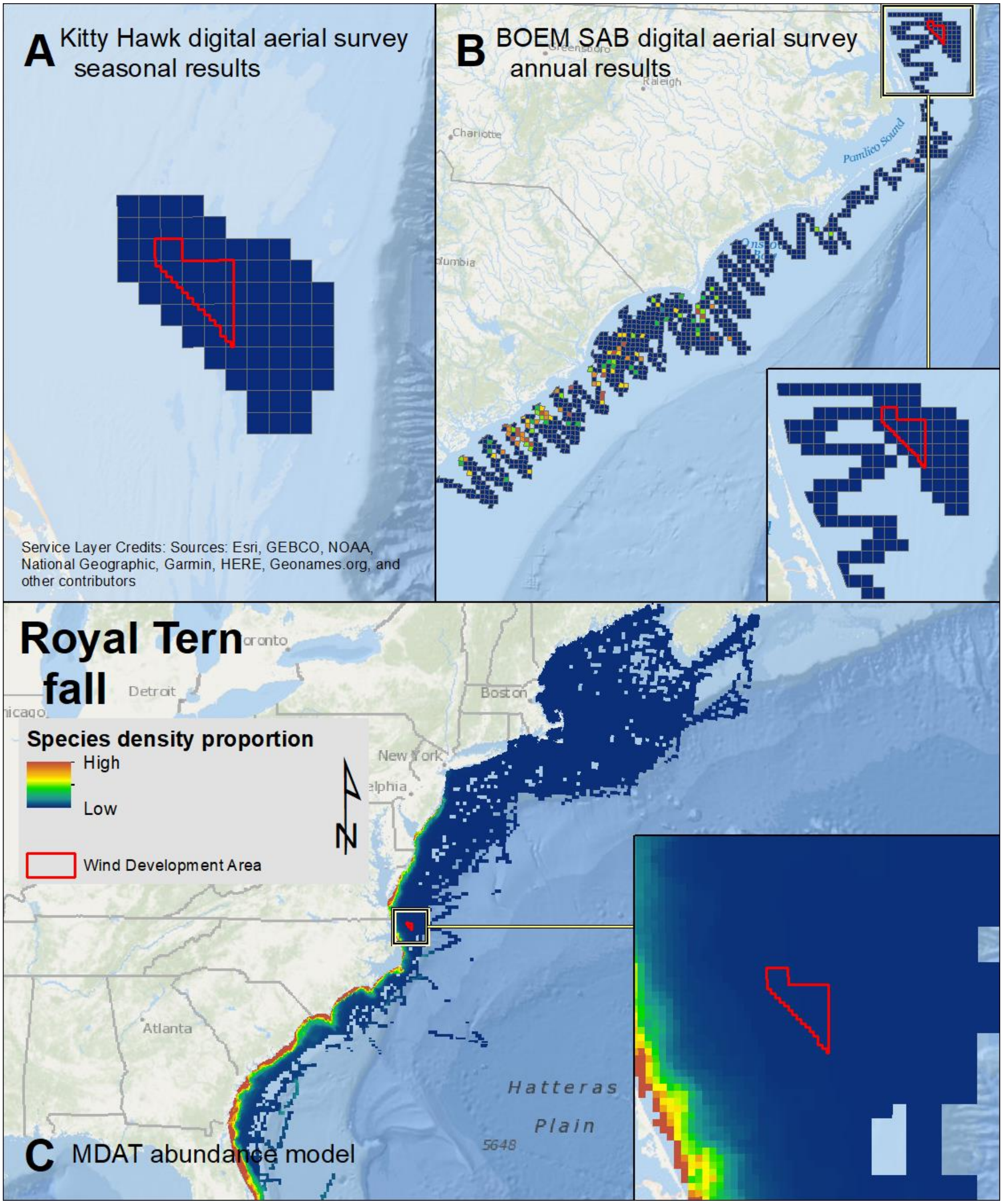
Map 101: Spring Forster's Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



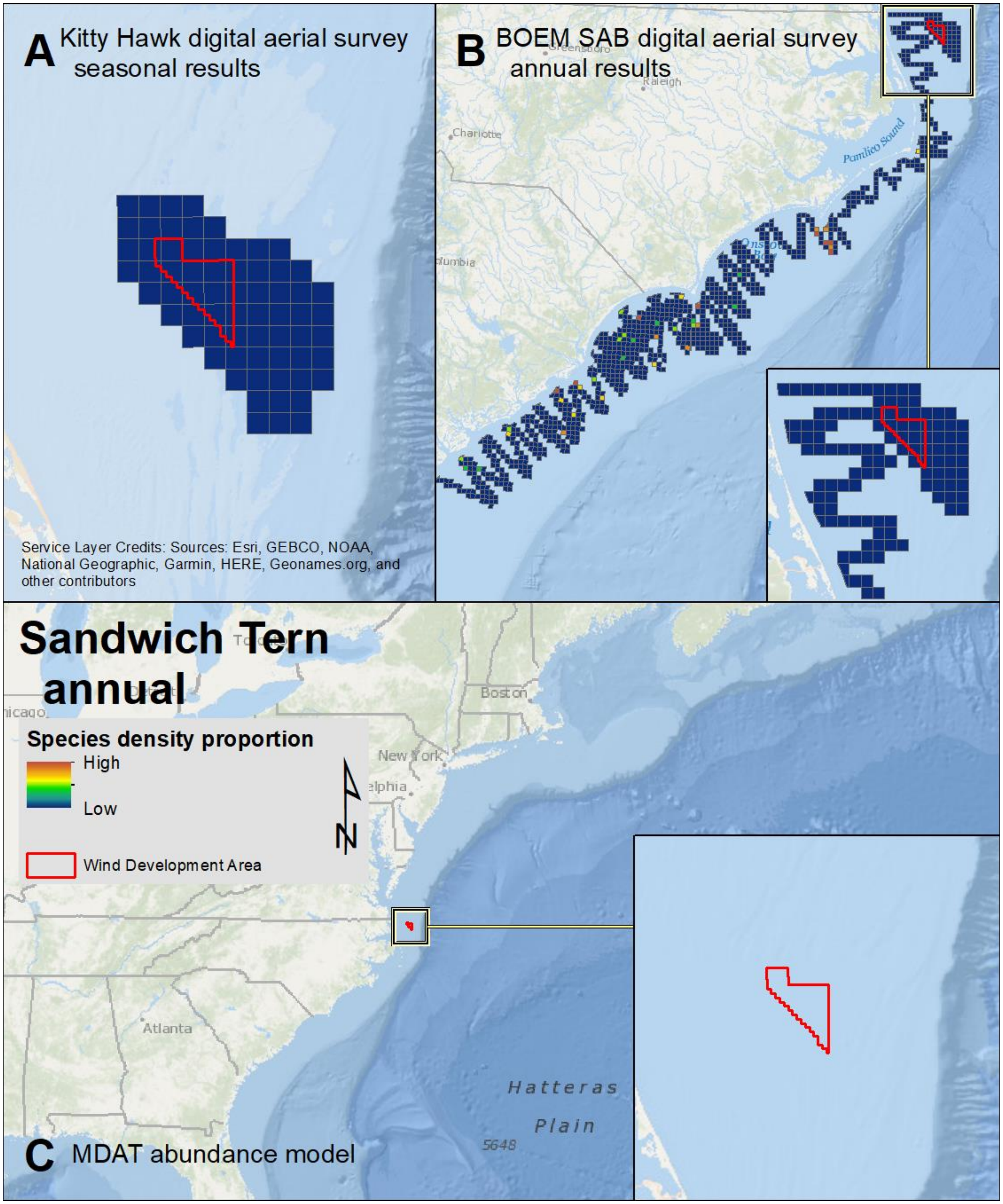
Map 102: Spring Royal Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



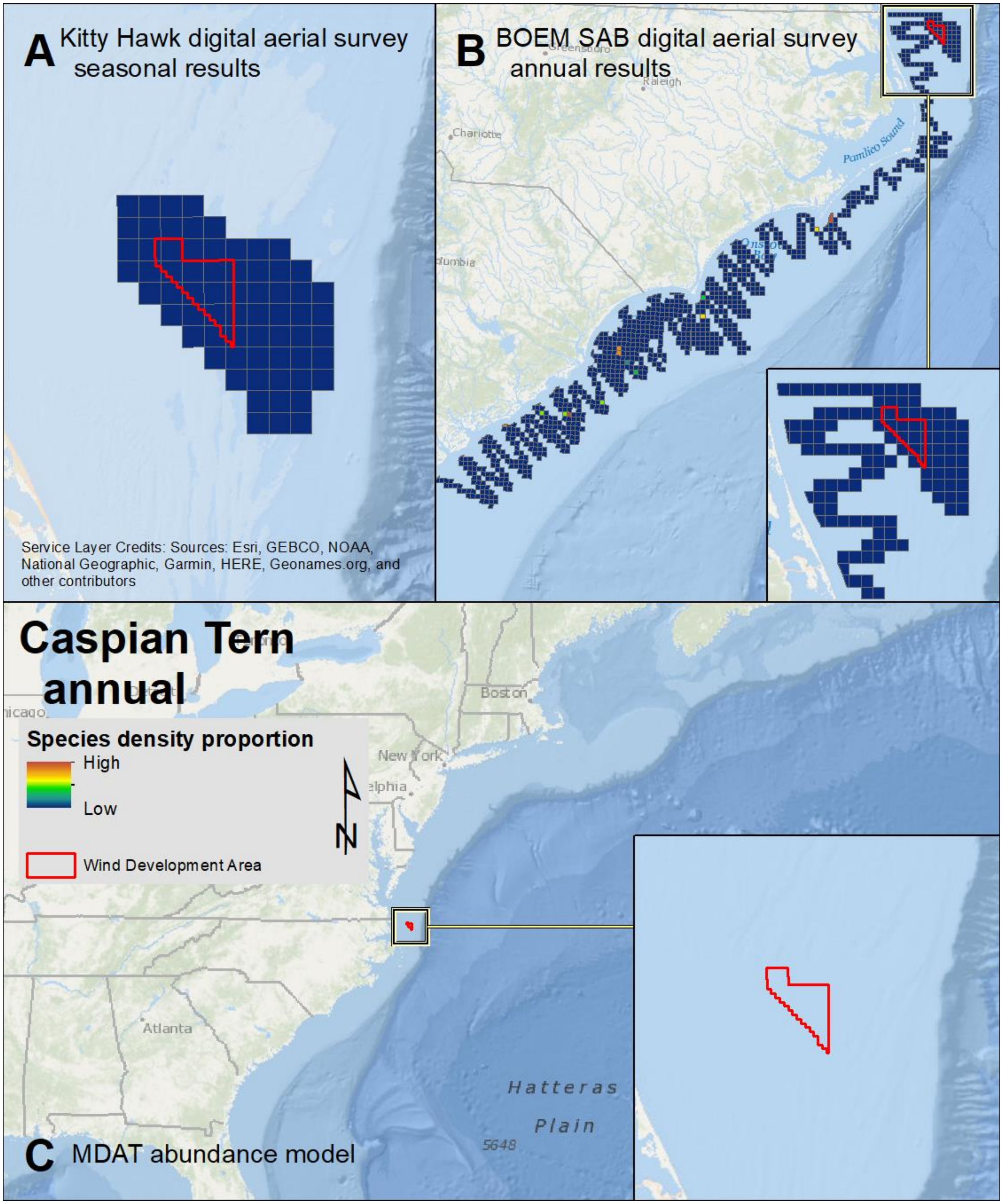
Map 103: Summer Royal Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



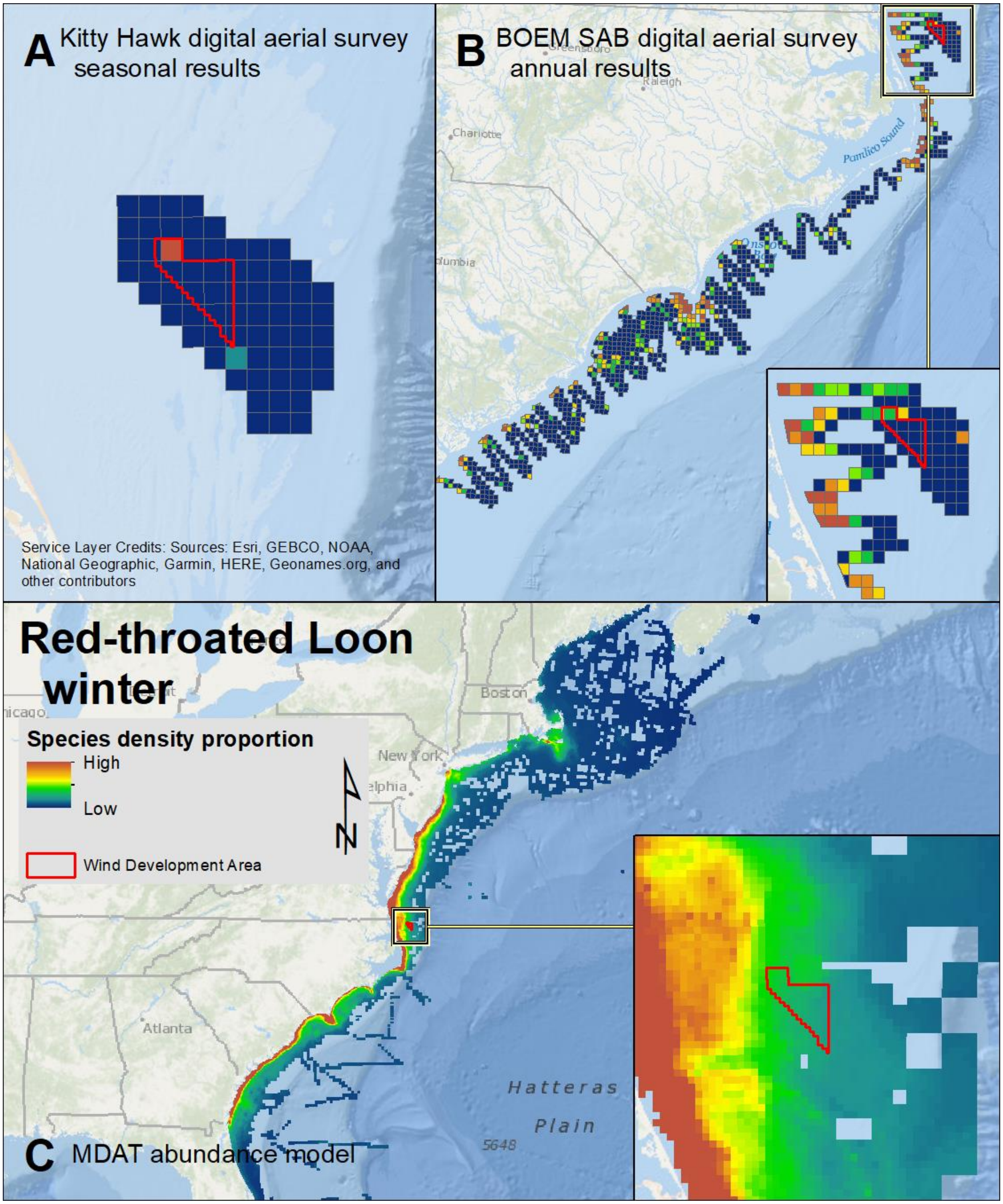
Map 104: Fall Royal Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



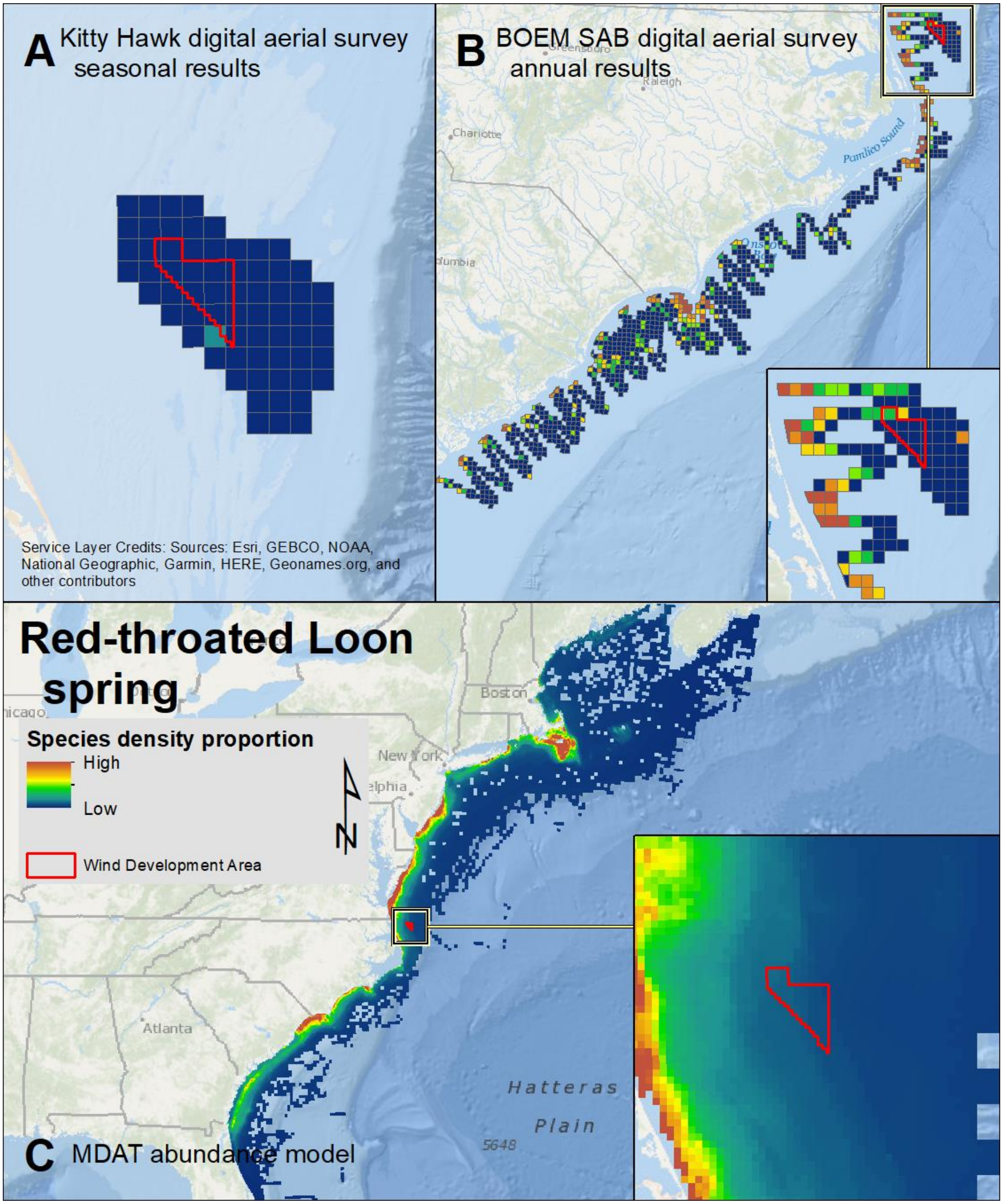
Map 105: Annual Sandwich Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



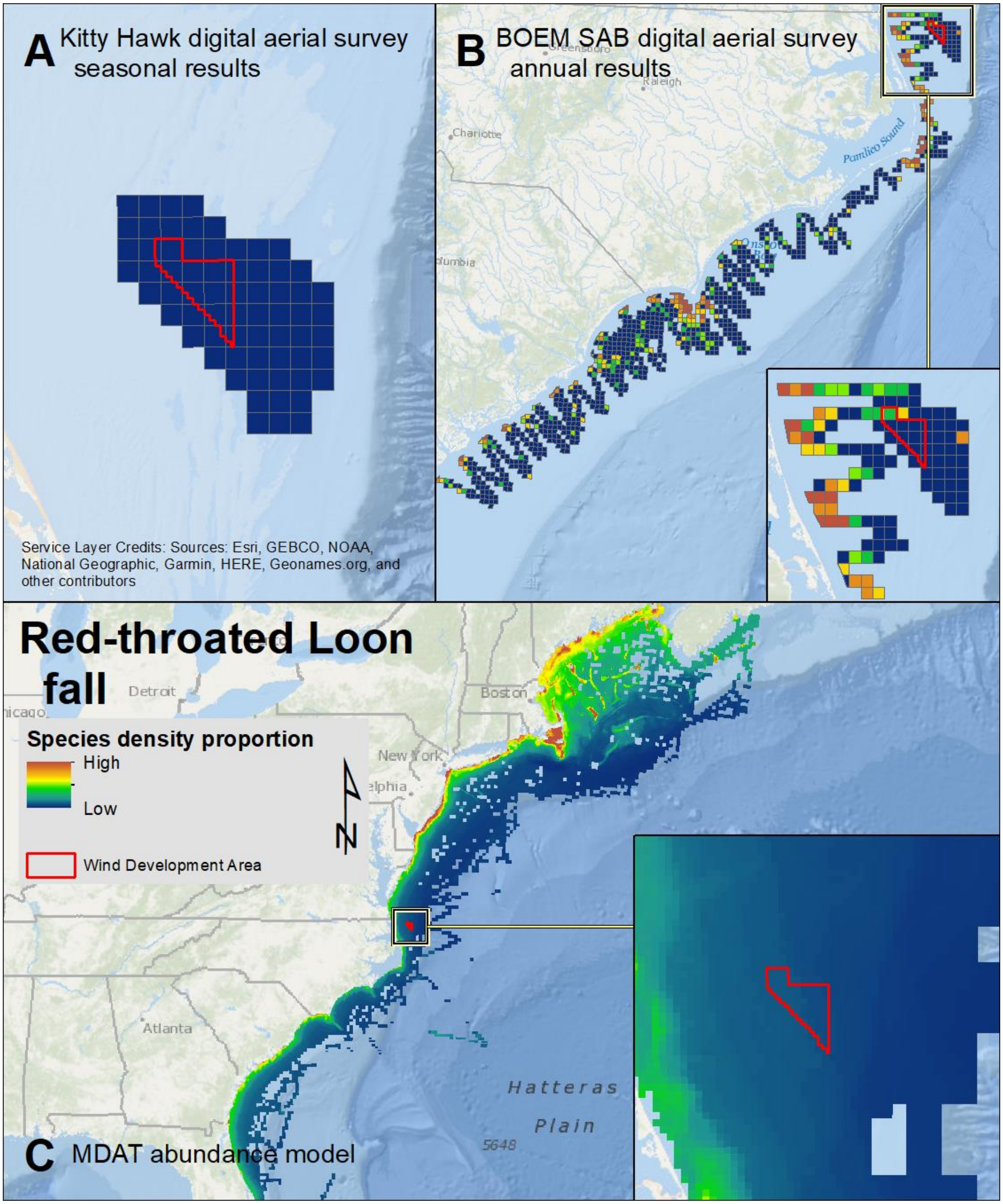
Map 106: Annual Caspian Tern density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



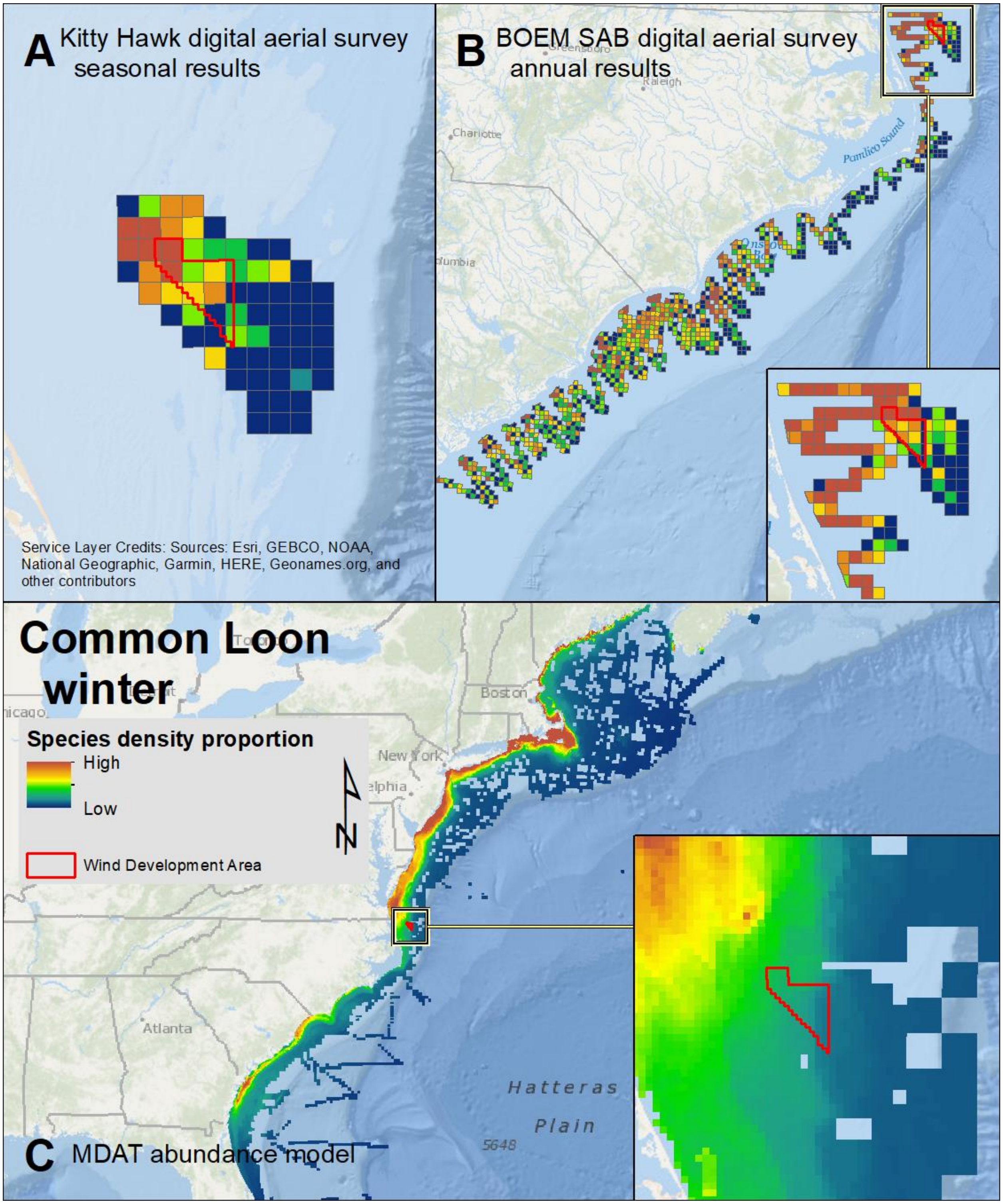
Map 107: Winter Red-throated Loon density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



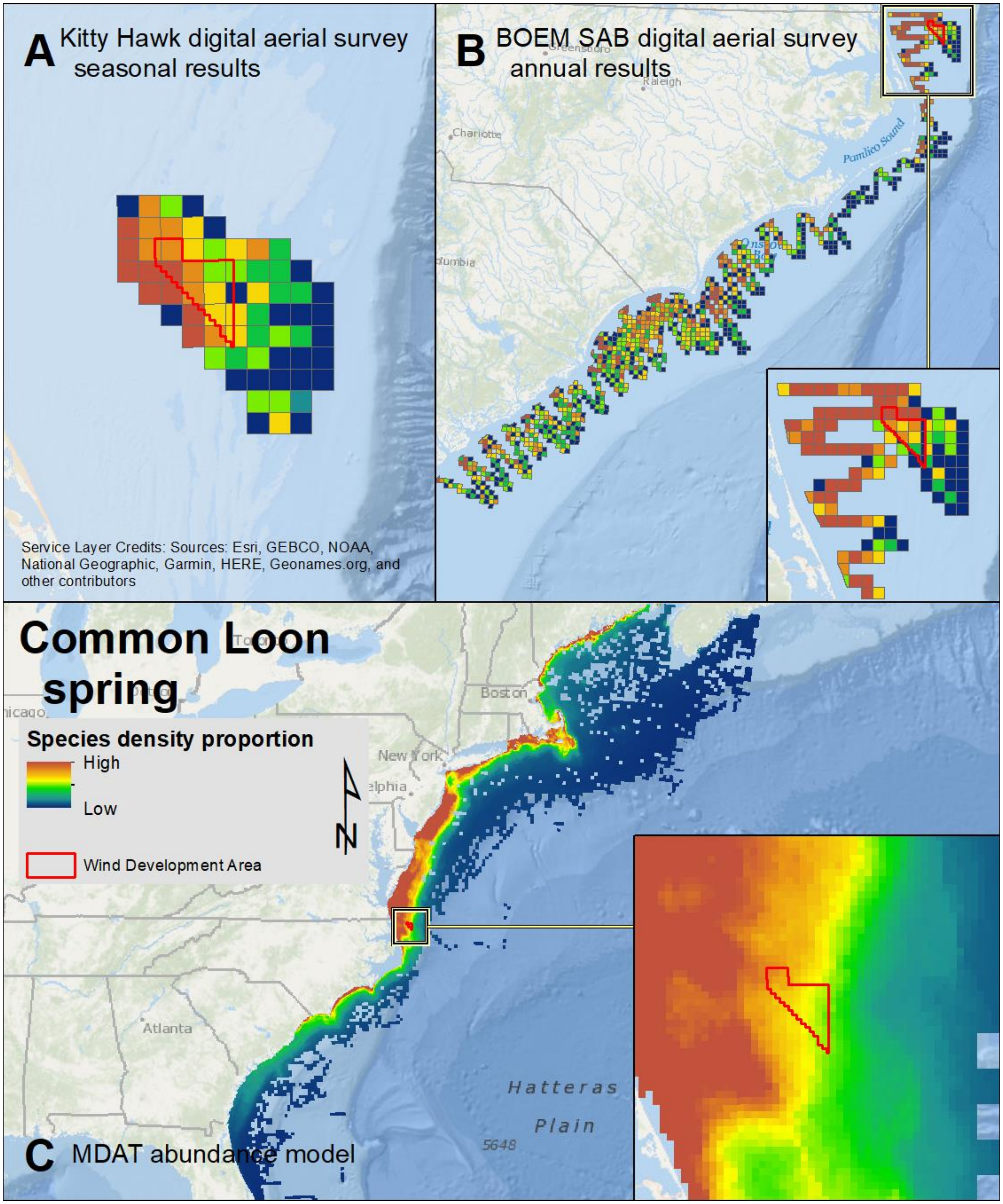
Map 108: Spring Red-throated Loon density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



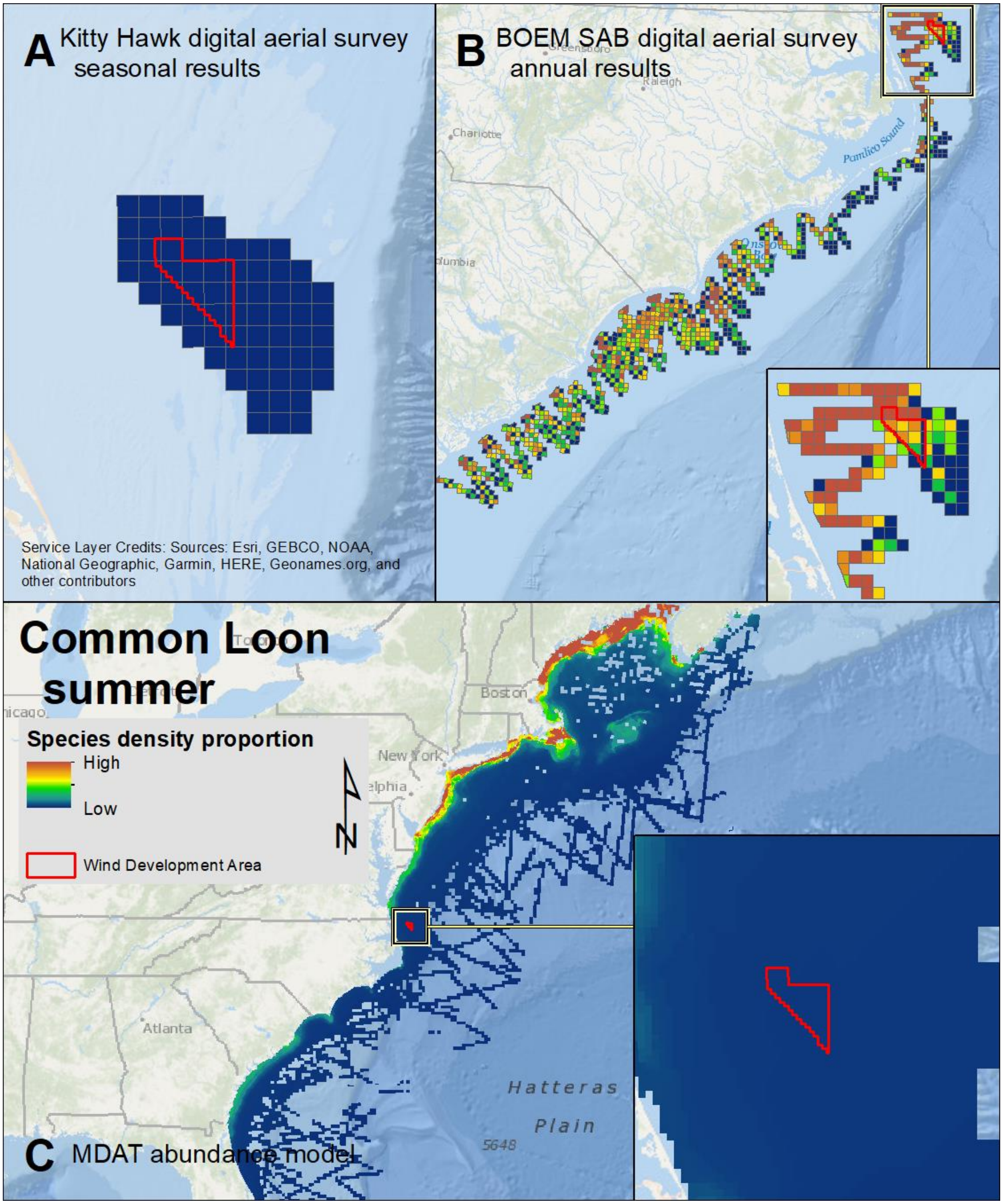
Map 109: Fall Red-throated Loon density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



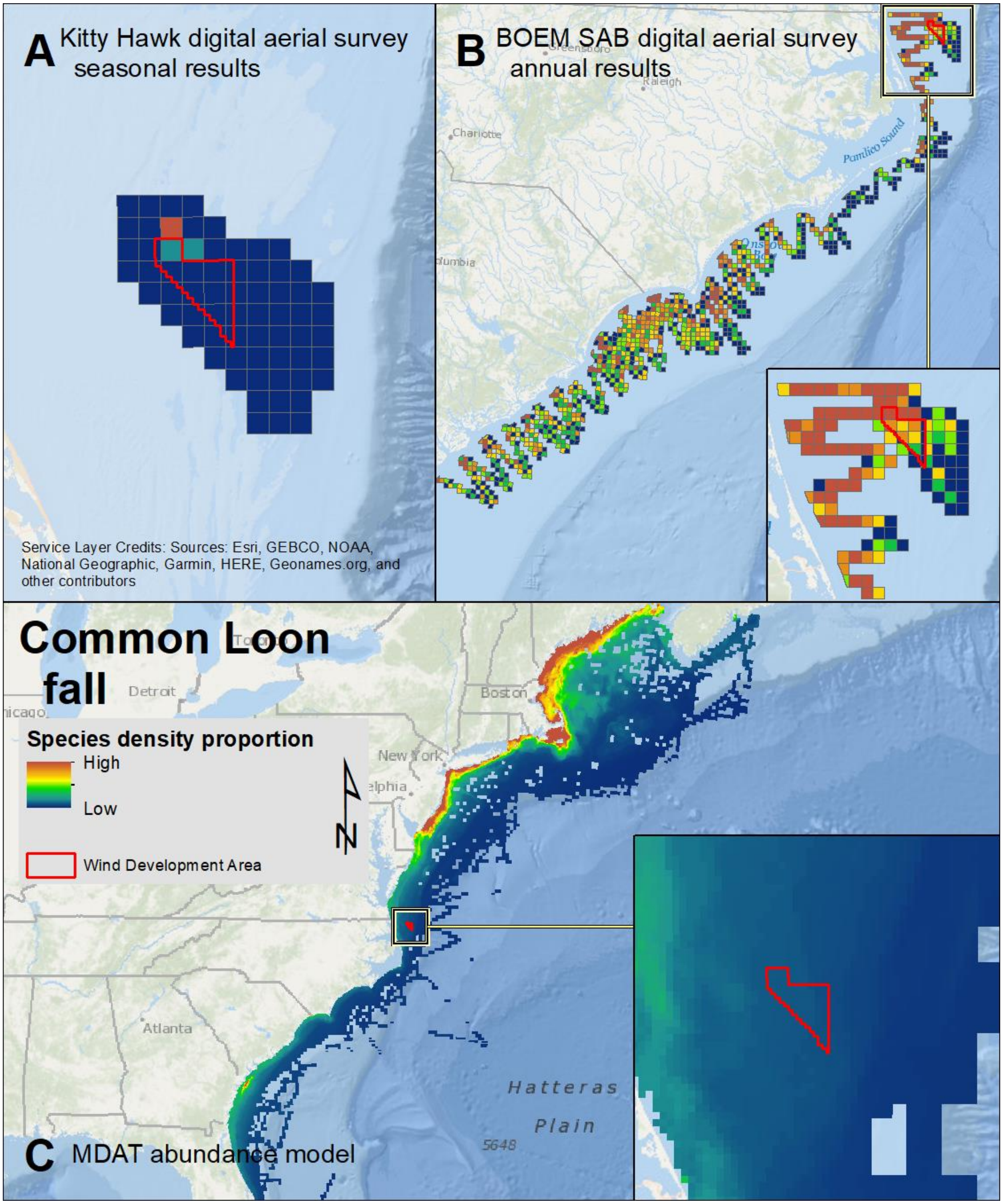
Map 110: Winter Common Loon density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



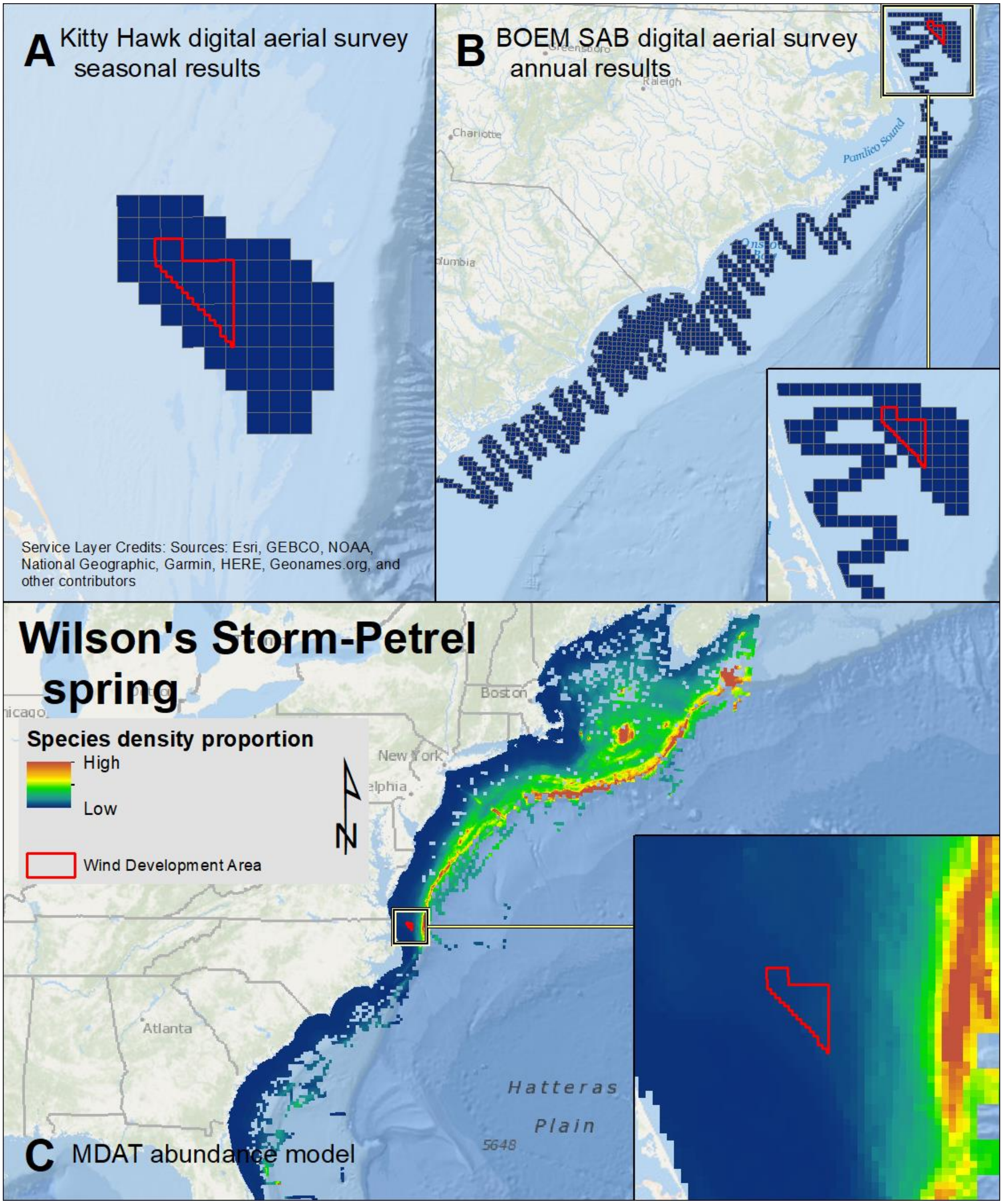
Map 111: Spring Common Loon density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



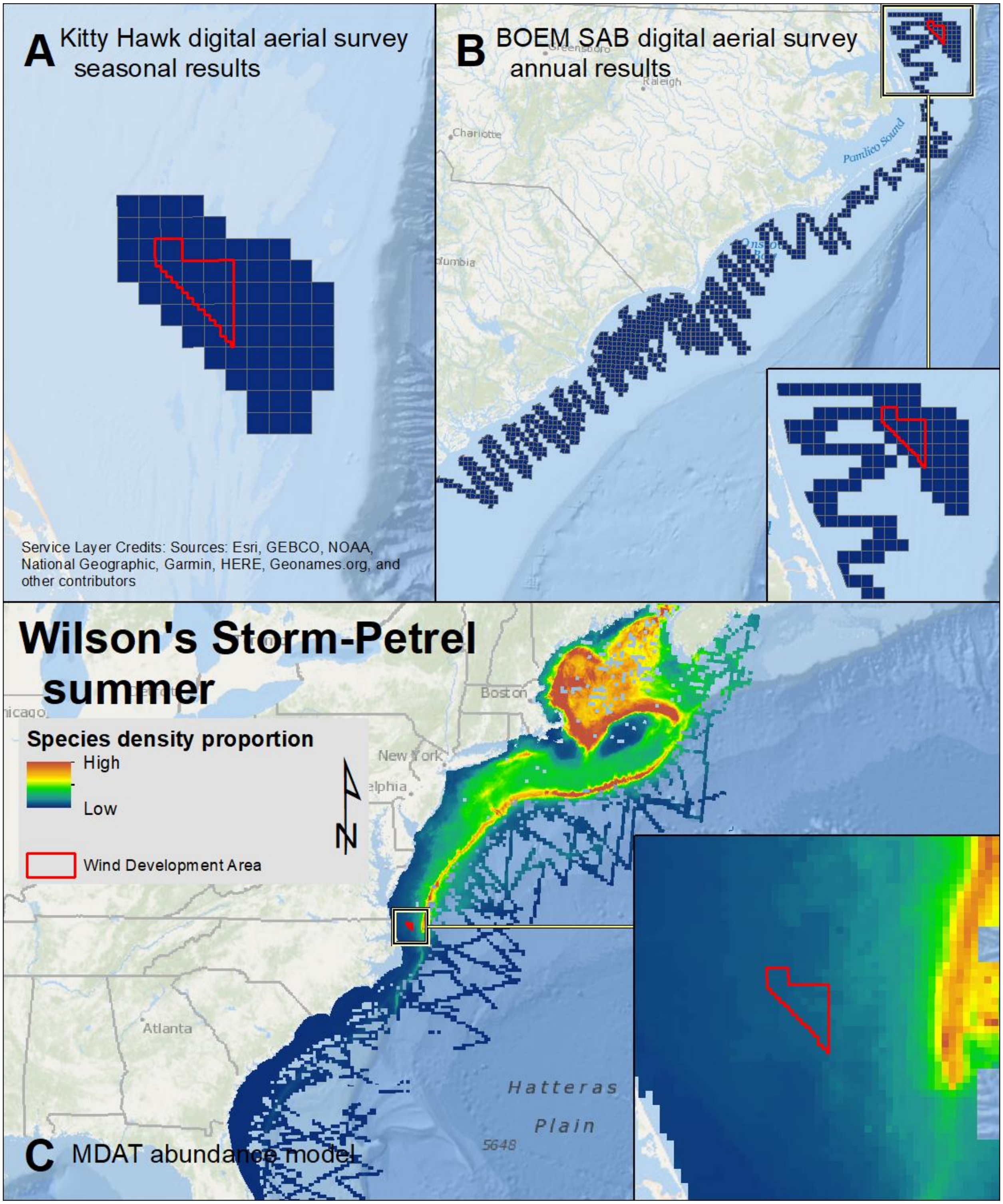
Map 112: Summer Common Loon density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



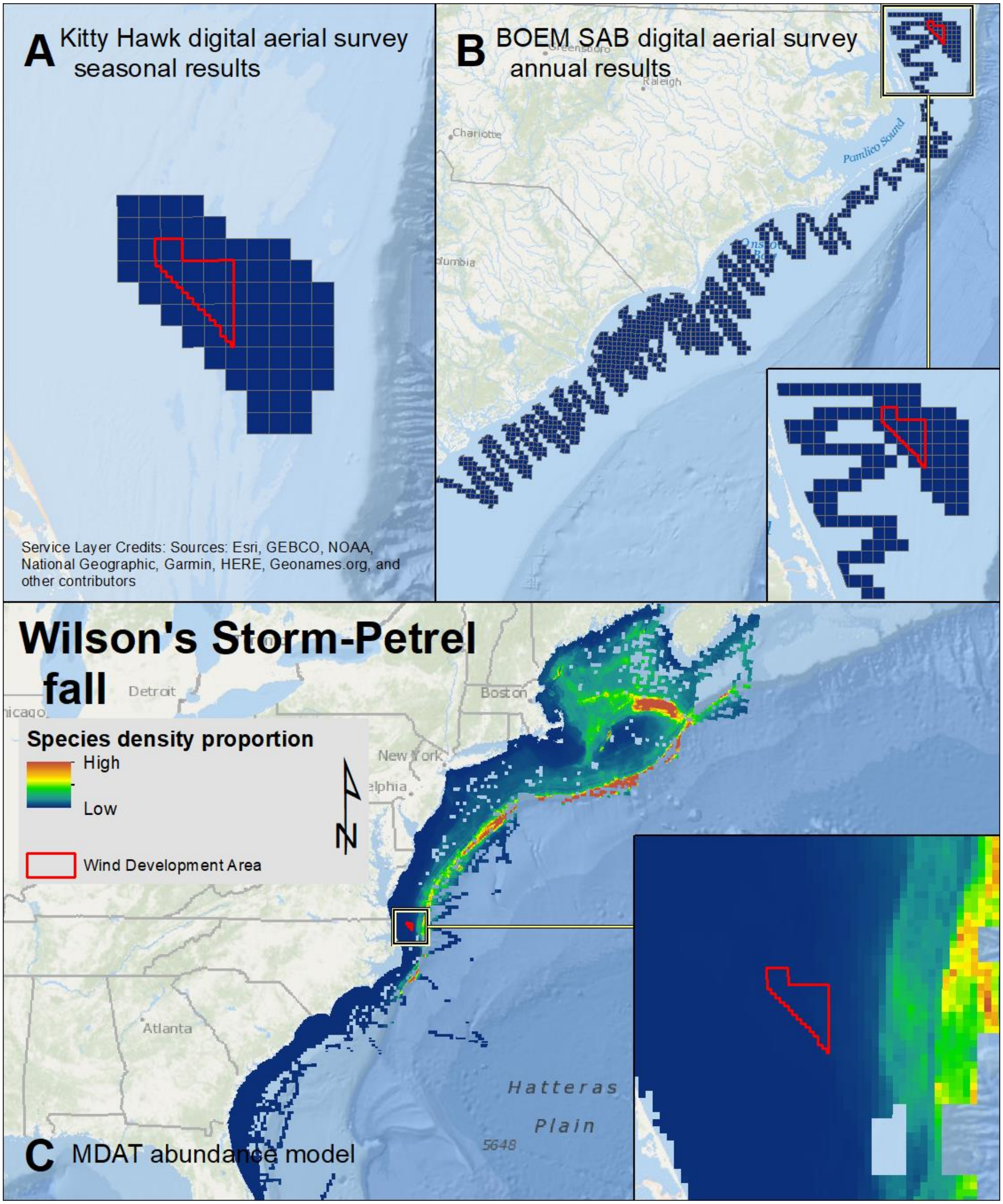
Map 113: Fall Common Loon density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



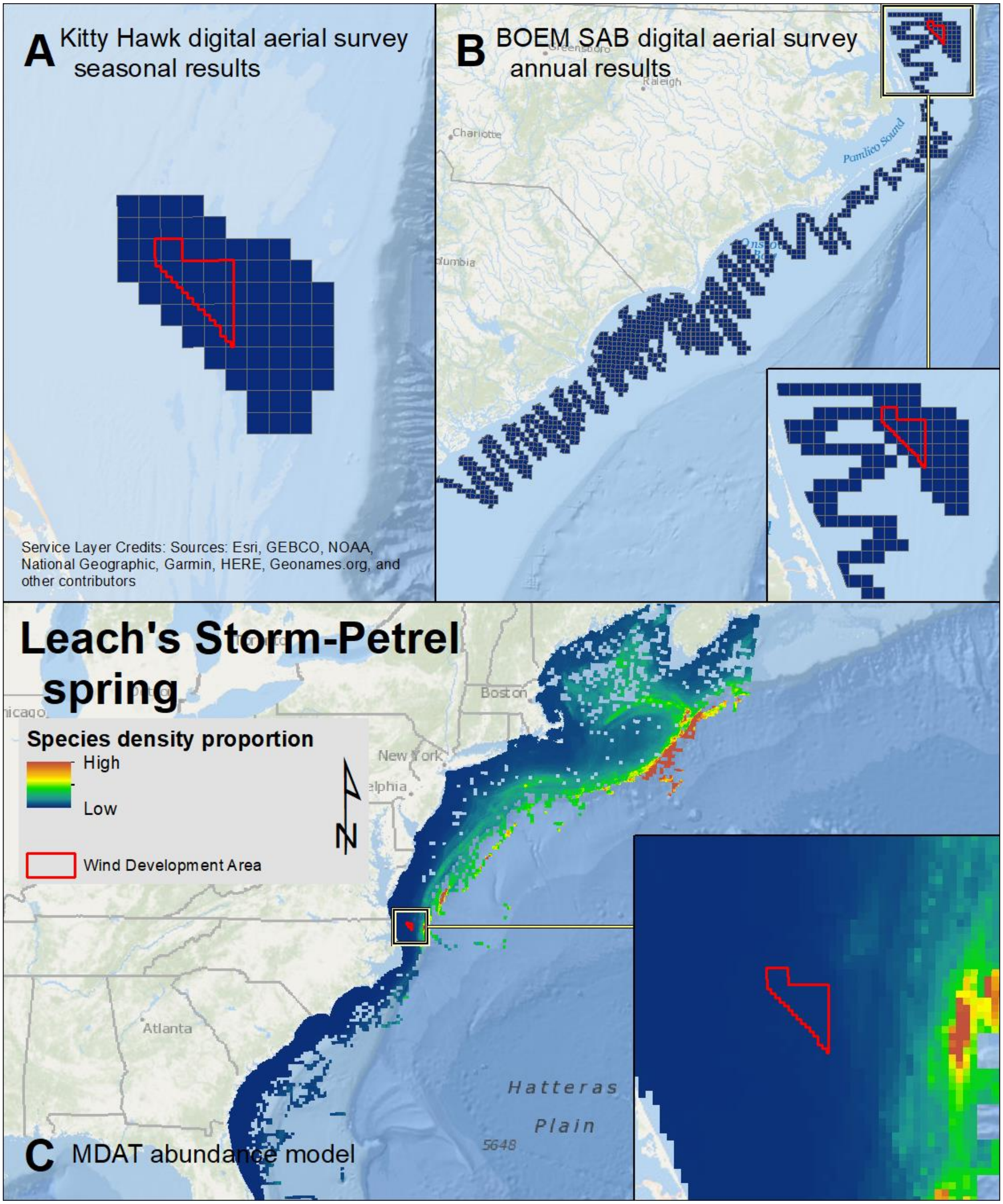
Map 114: Spring Wilson's Storm-Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



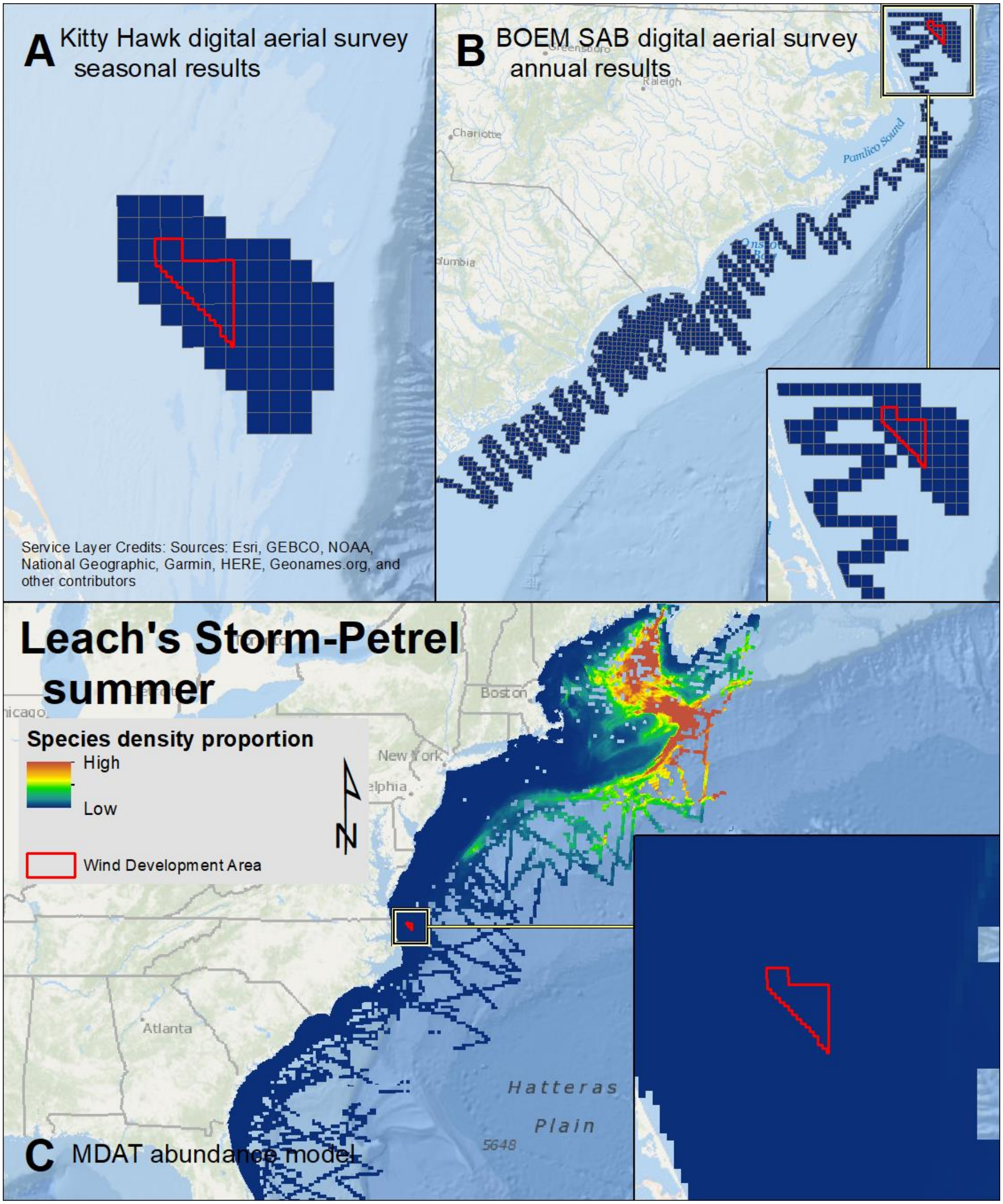
Map 115: Summer Wilson's Storm-Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



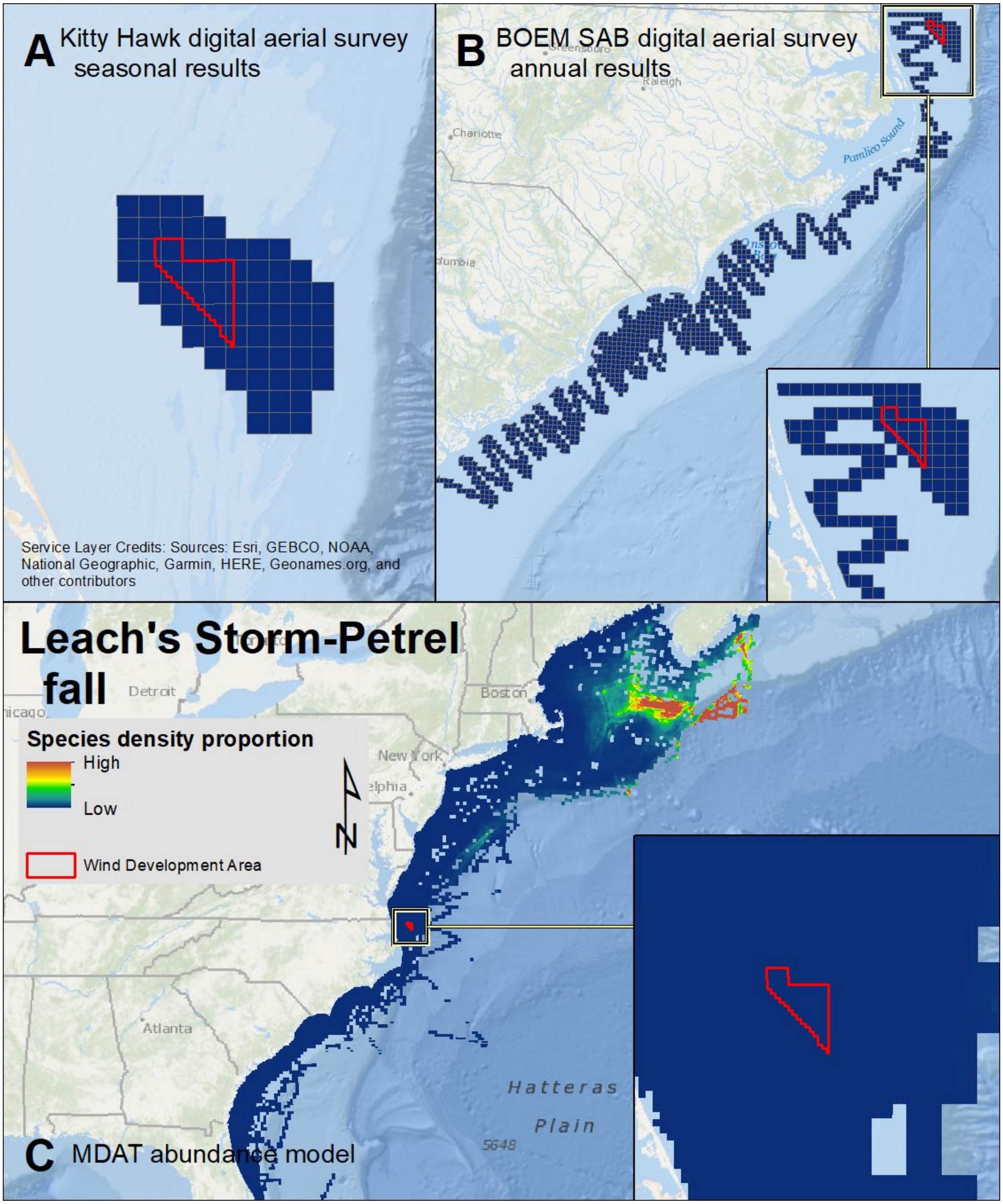
Map 116: Fall Wilson's Storm-Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



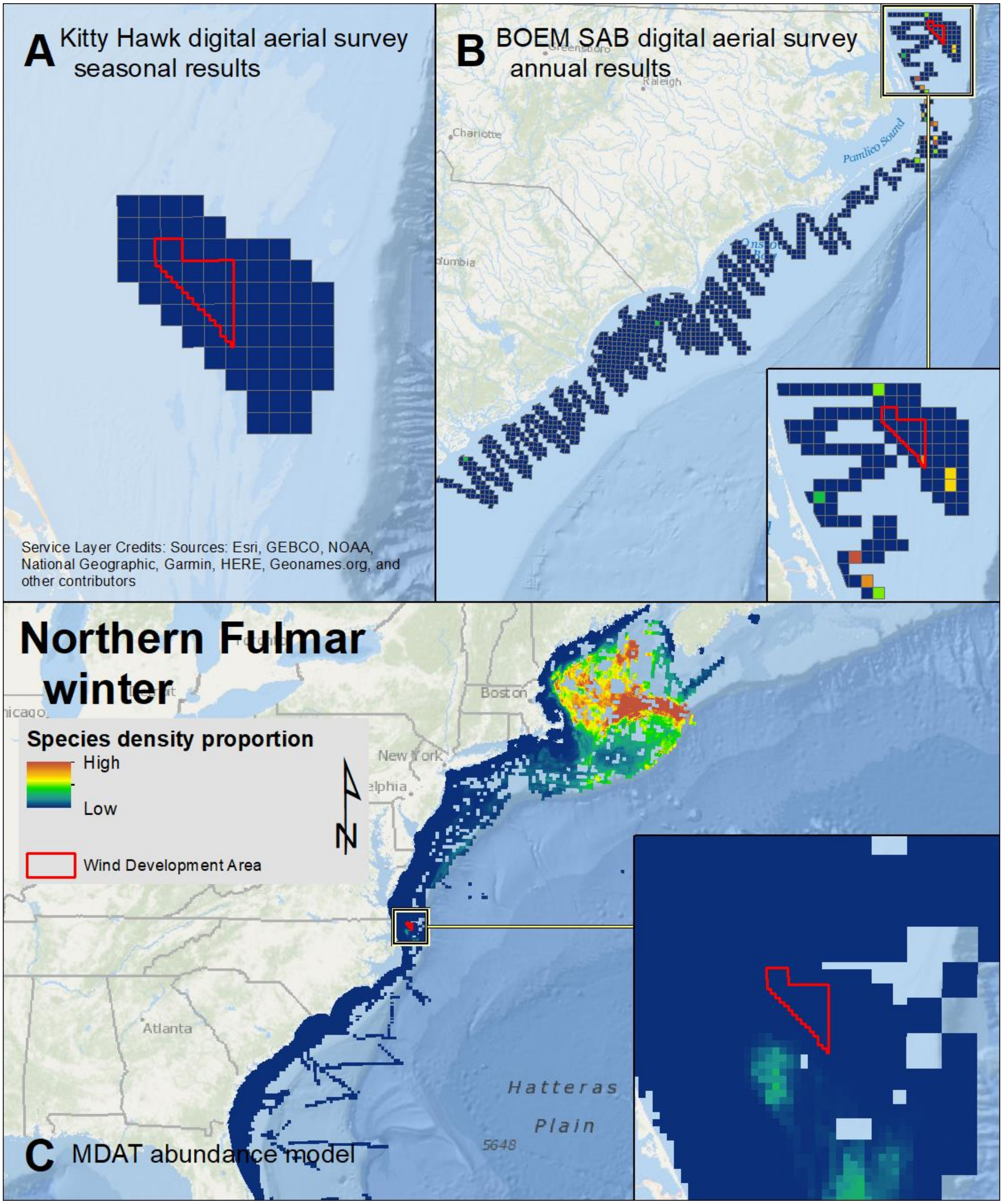
Map 117: Spring Leach's Storm-Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



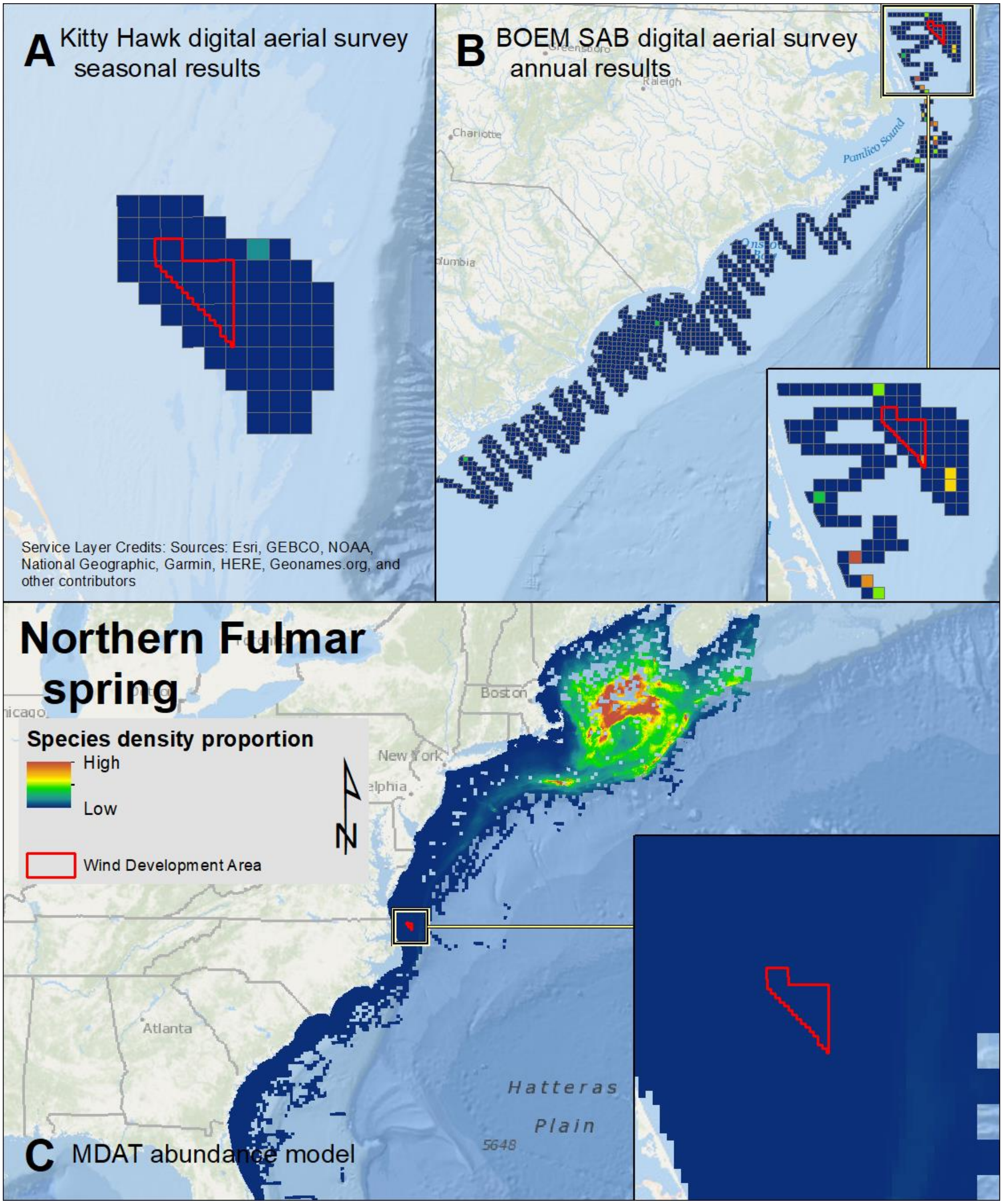
Map 118: Summer Leach's Storm-Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



Map 119: Fall Leach's Storm-Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local 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.Error! Bookmark not defined.



Map 120: Winter Northern Fulmar density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local 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.Error! Bookmark not defined.



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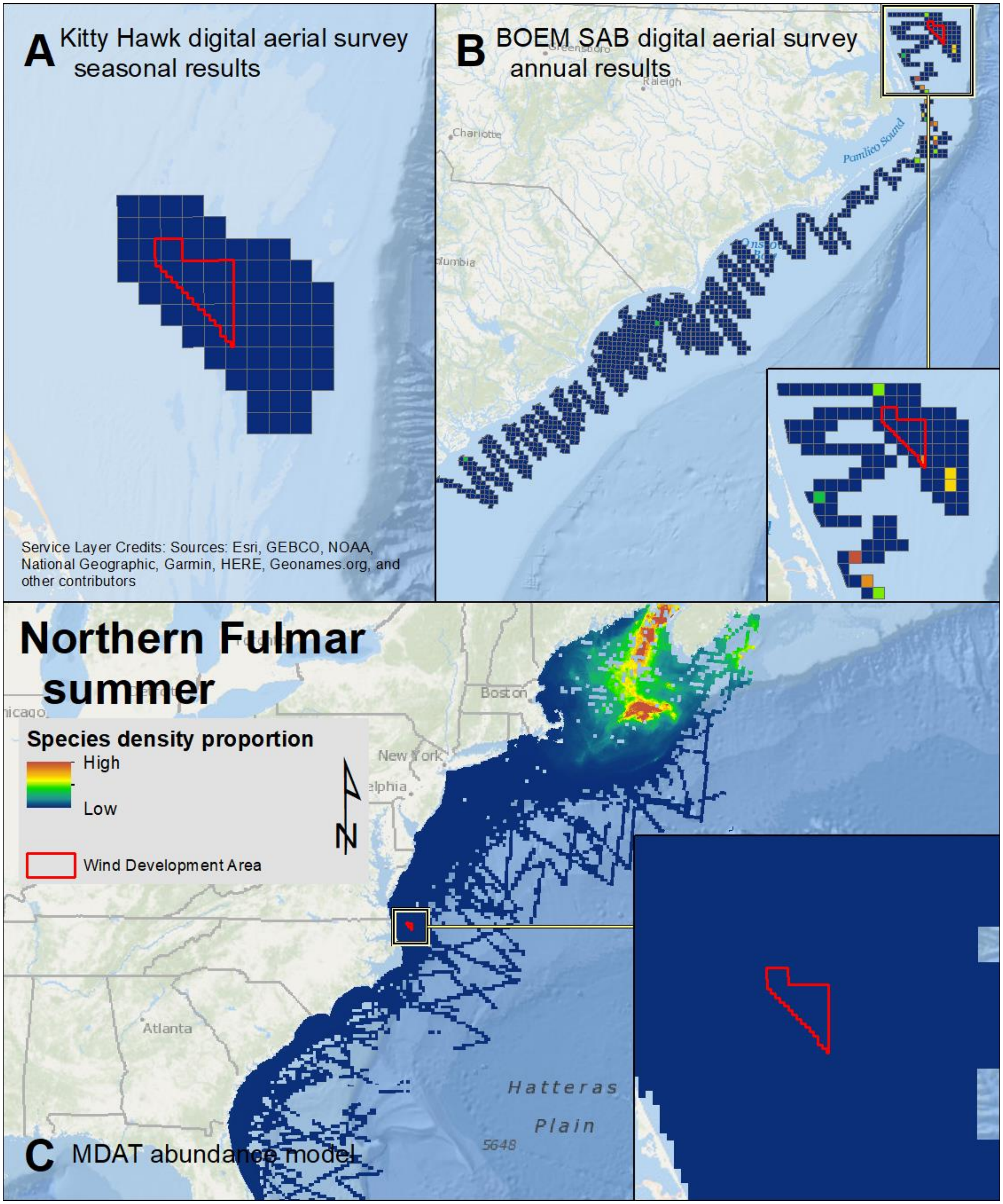
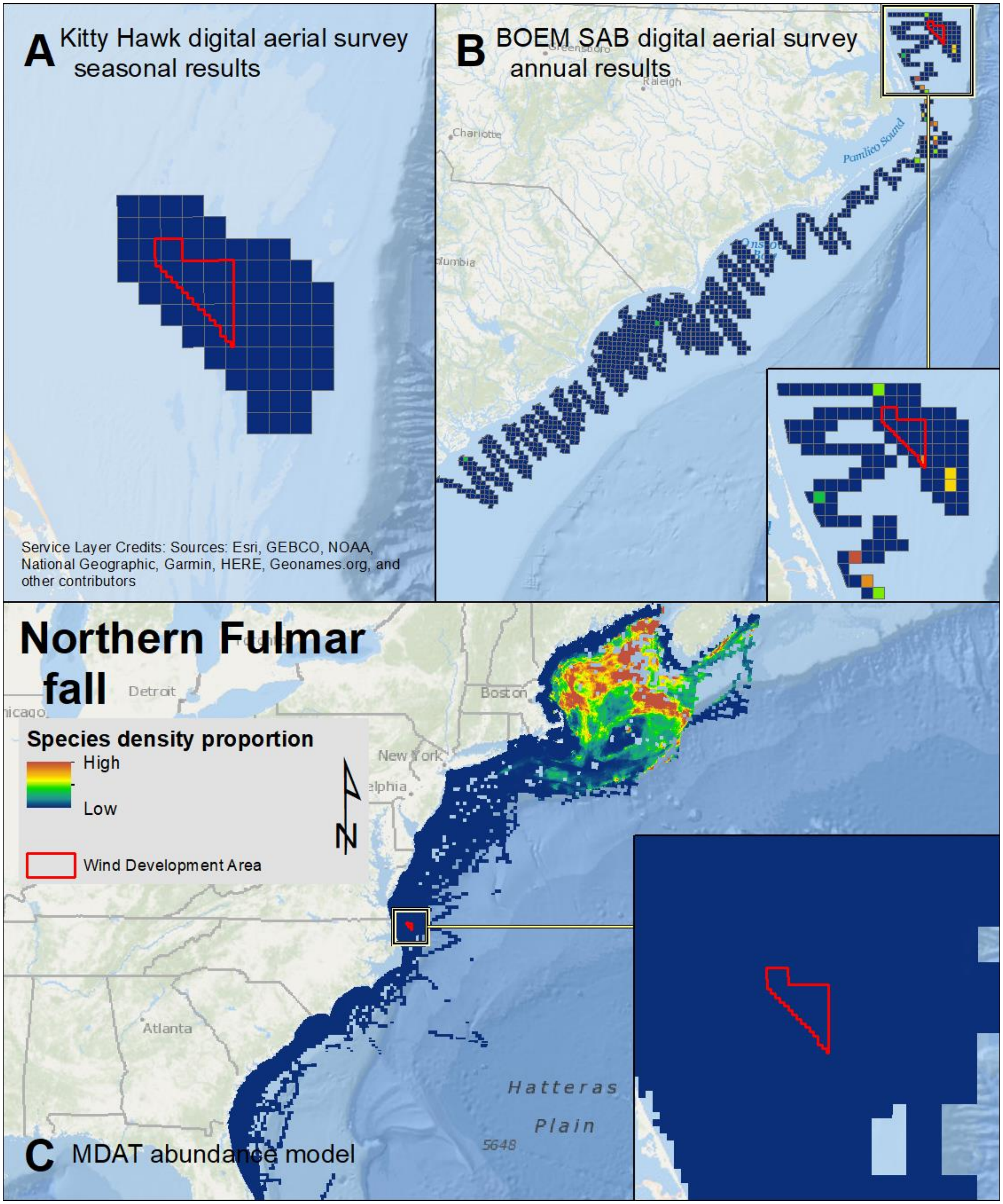
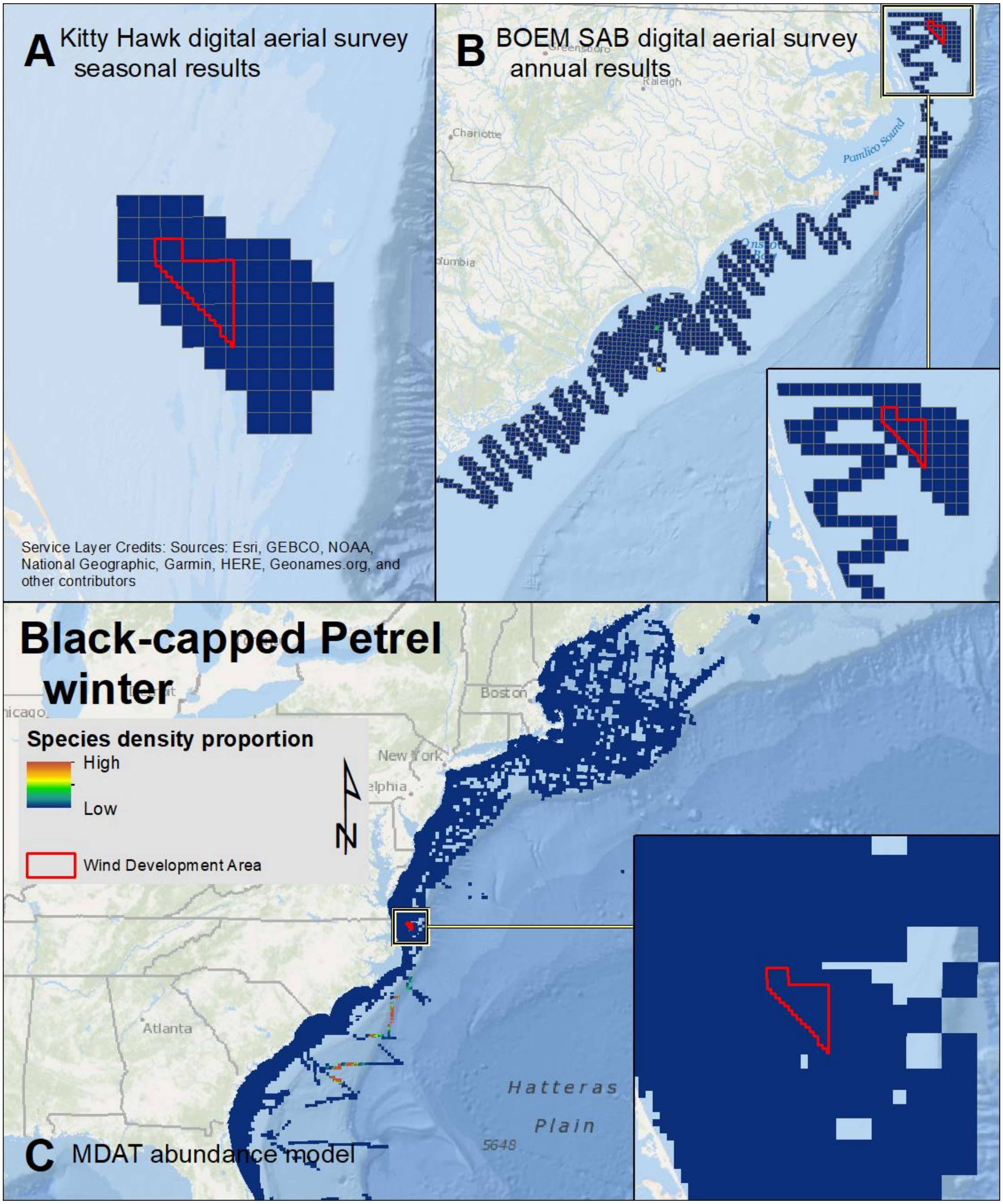
Map 121: Spring Northern Fulmar density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



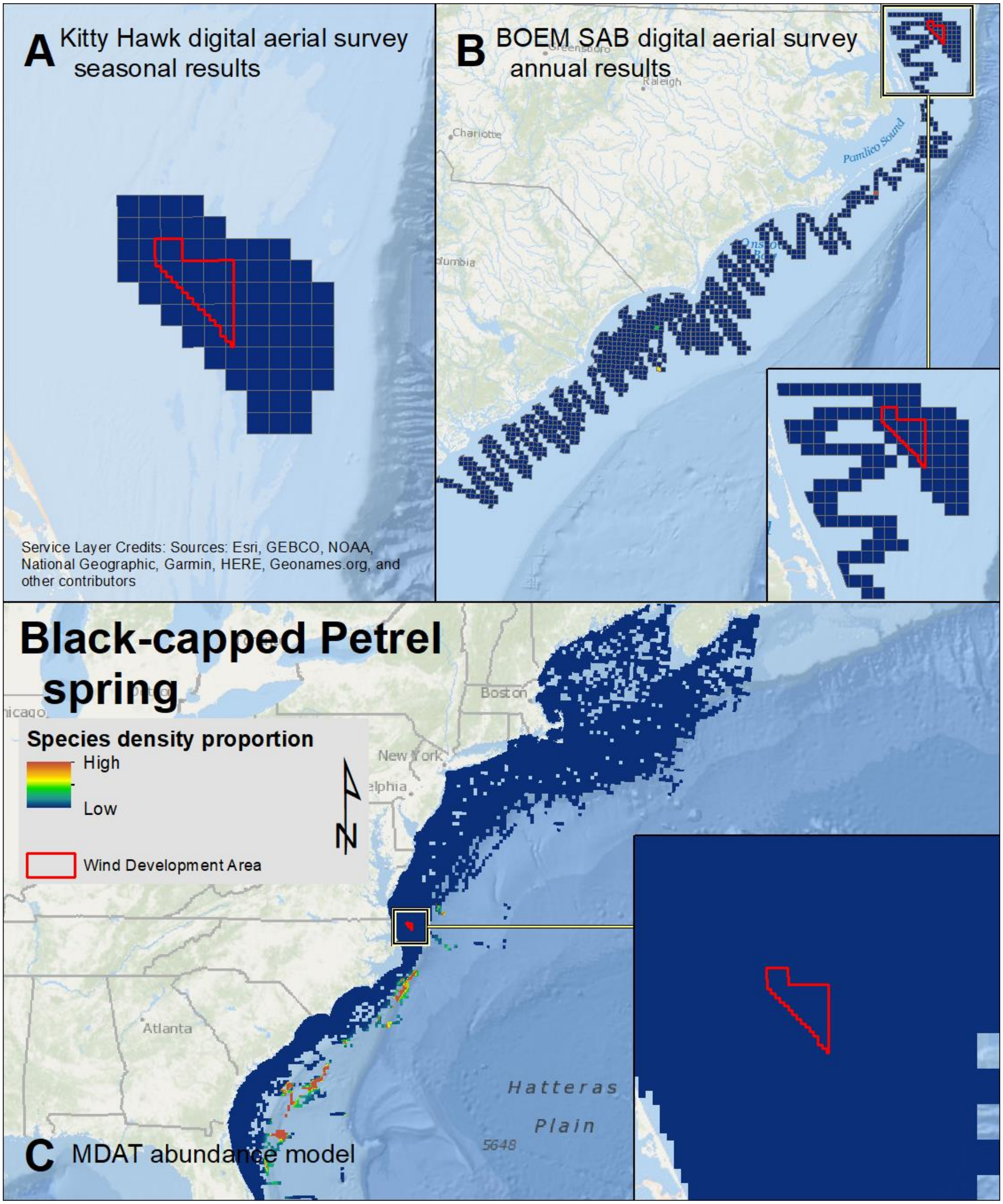
Map 122: Summer Northern Fulmar density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



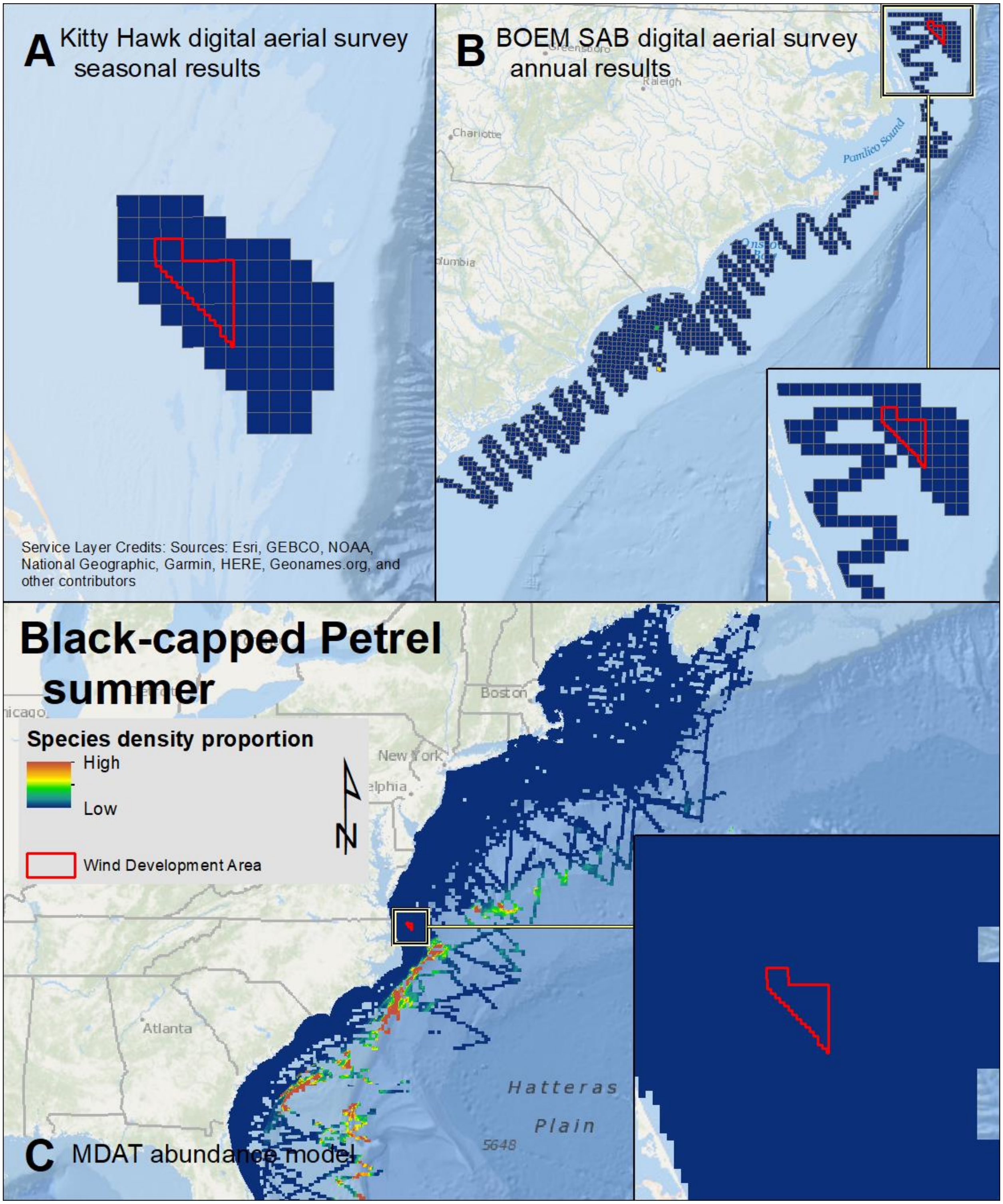
Map 123: Fall Northern Fulmar density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



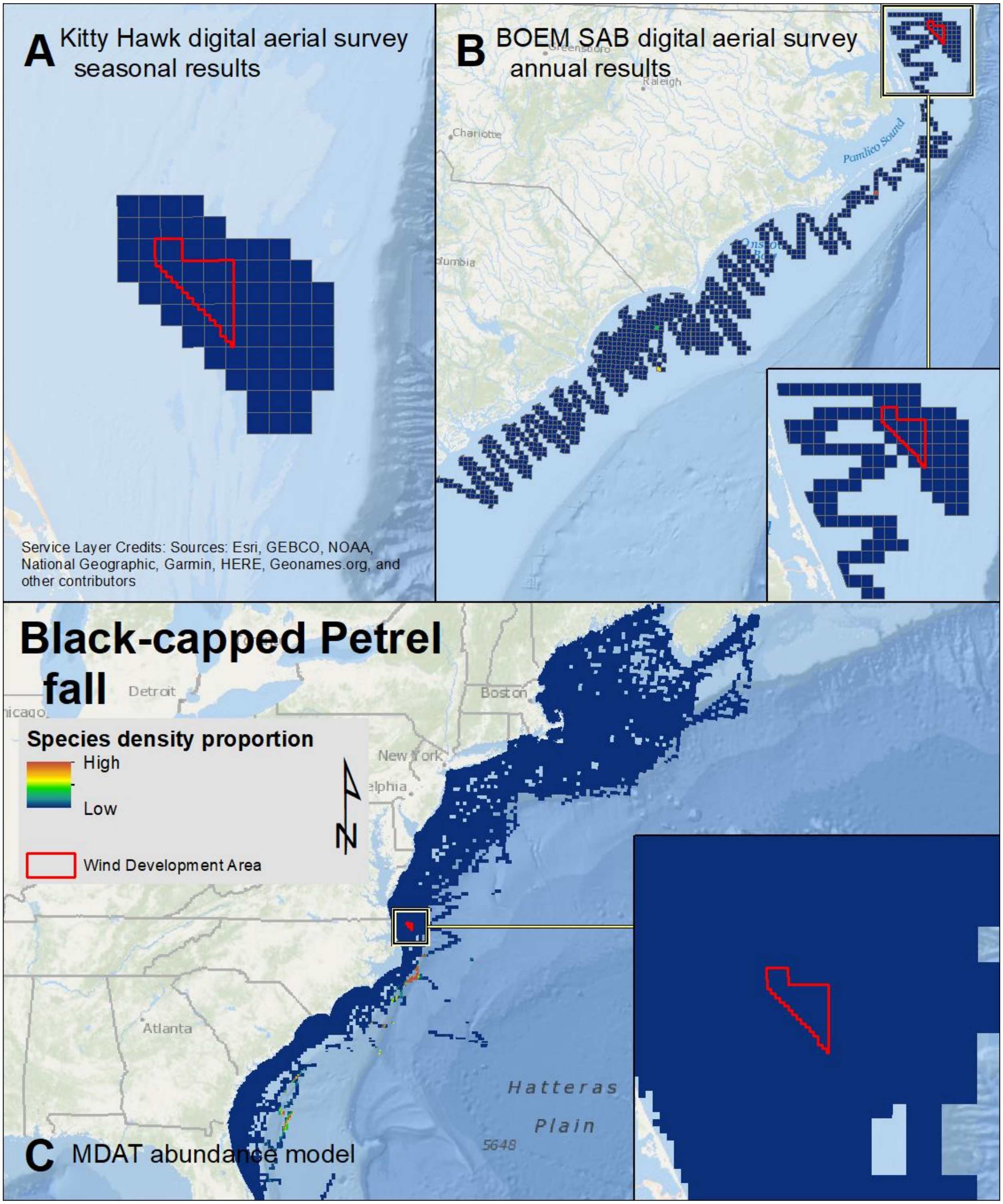
Map 124: Winter Black-capped Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



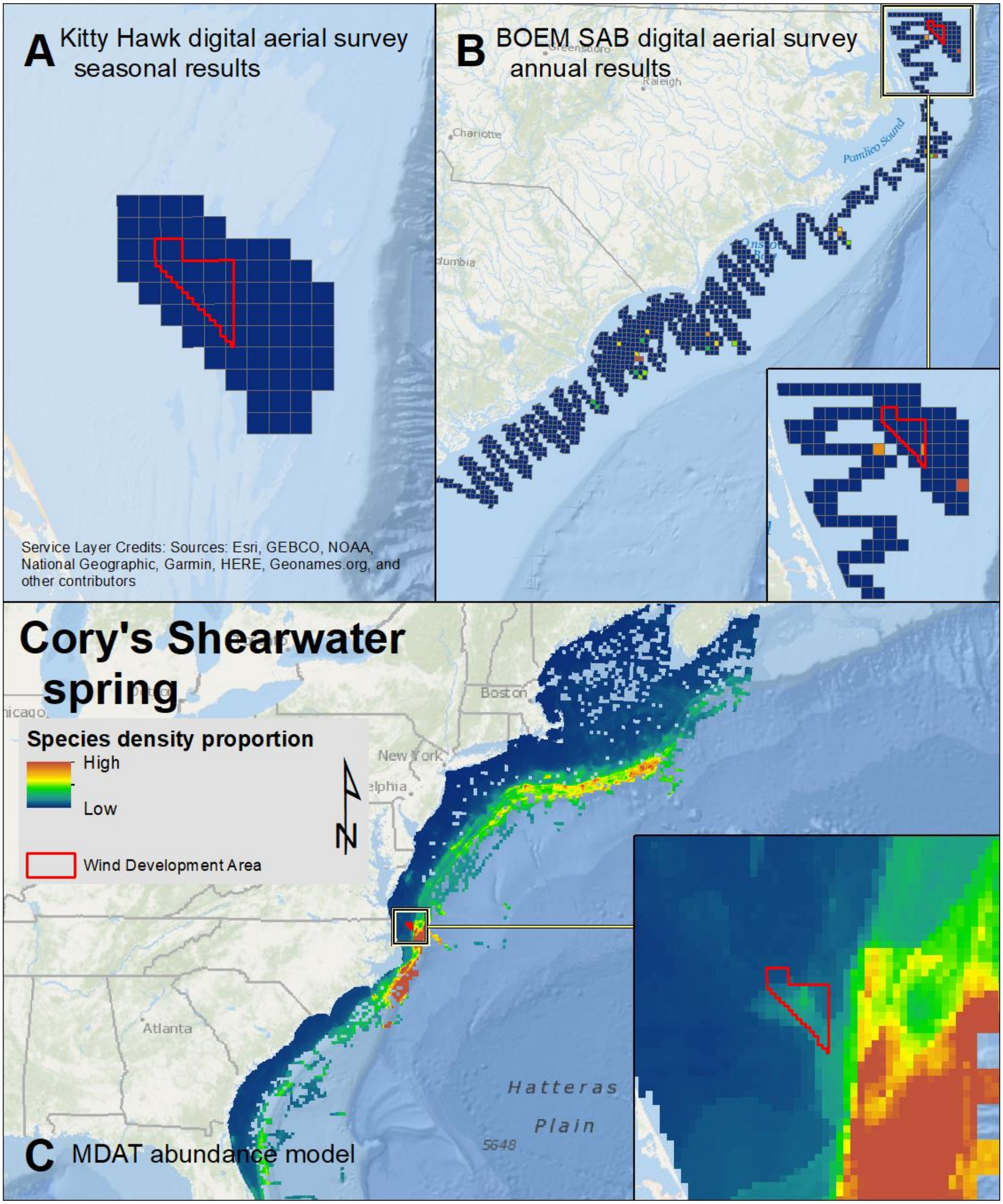
Map 125: Spring Black-capped Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



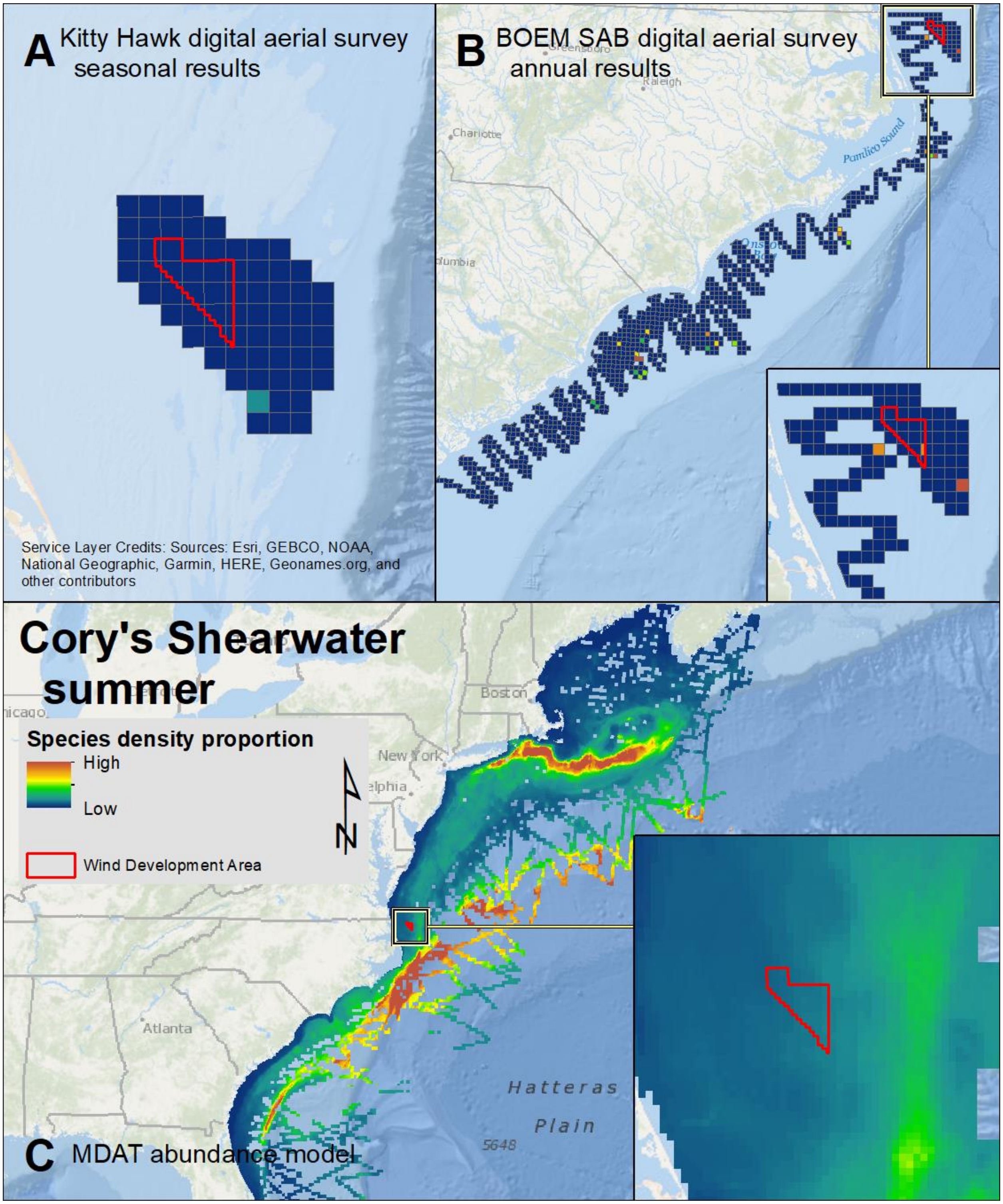
Map 126: Summer Black-capped Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



Map 127: Fall Black-capped Petrel density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local 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.Error! Bookmark not defined.



Map 128: Spring Cory's Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local 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.Error! Bookmark not defined.



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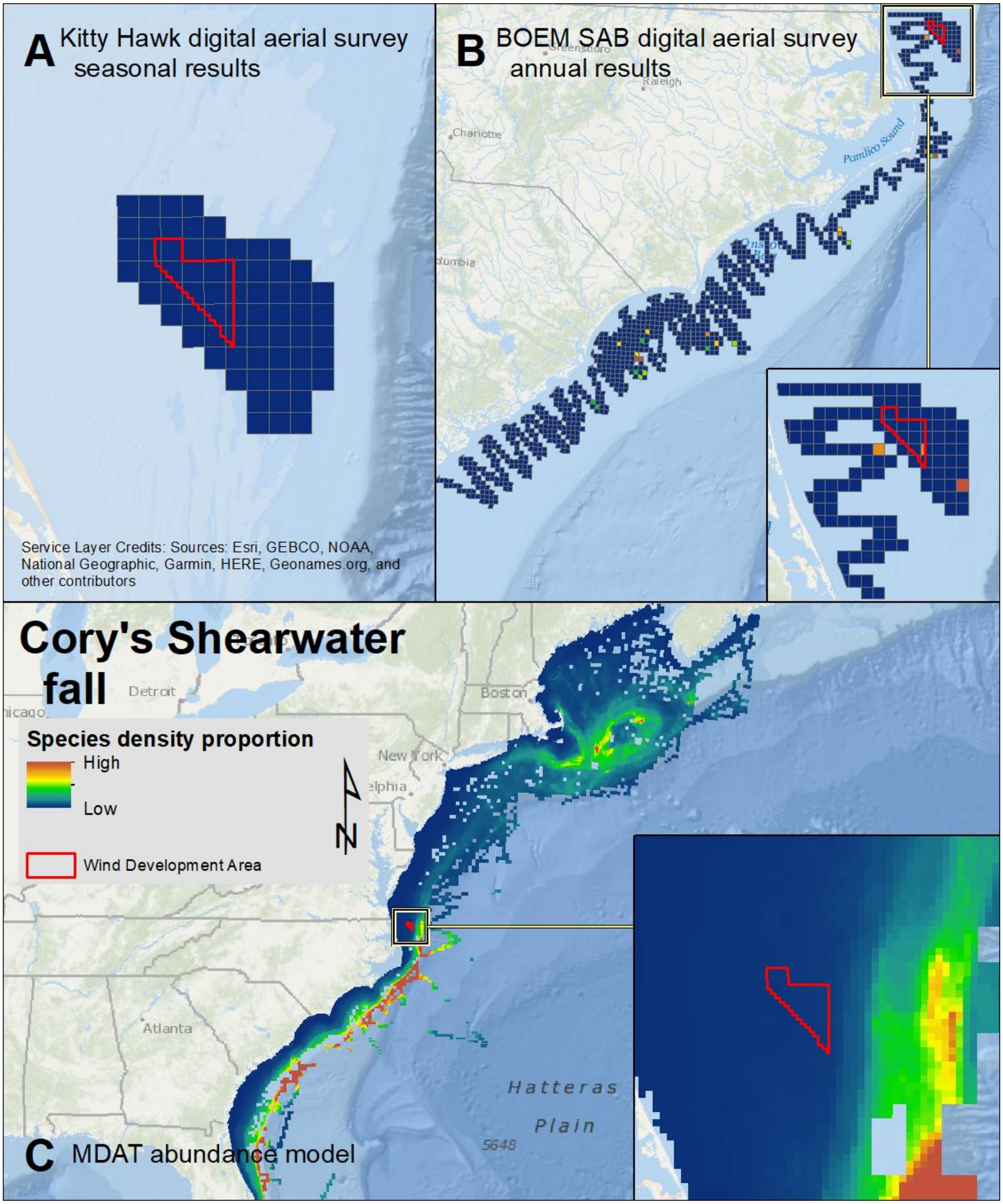
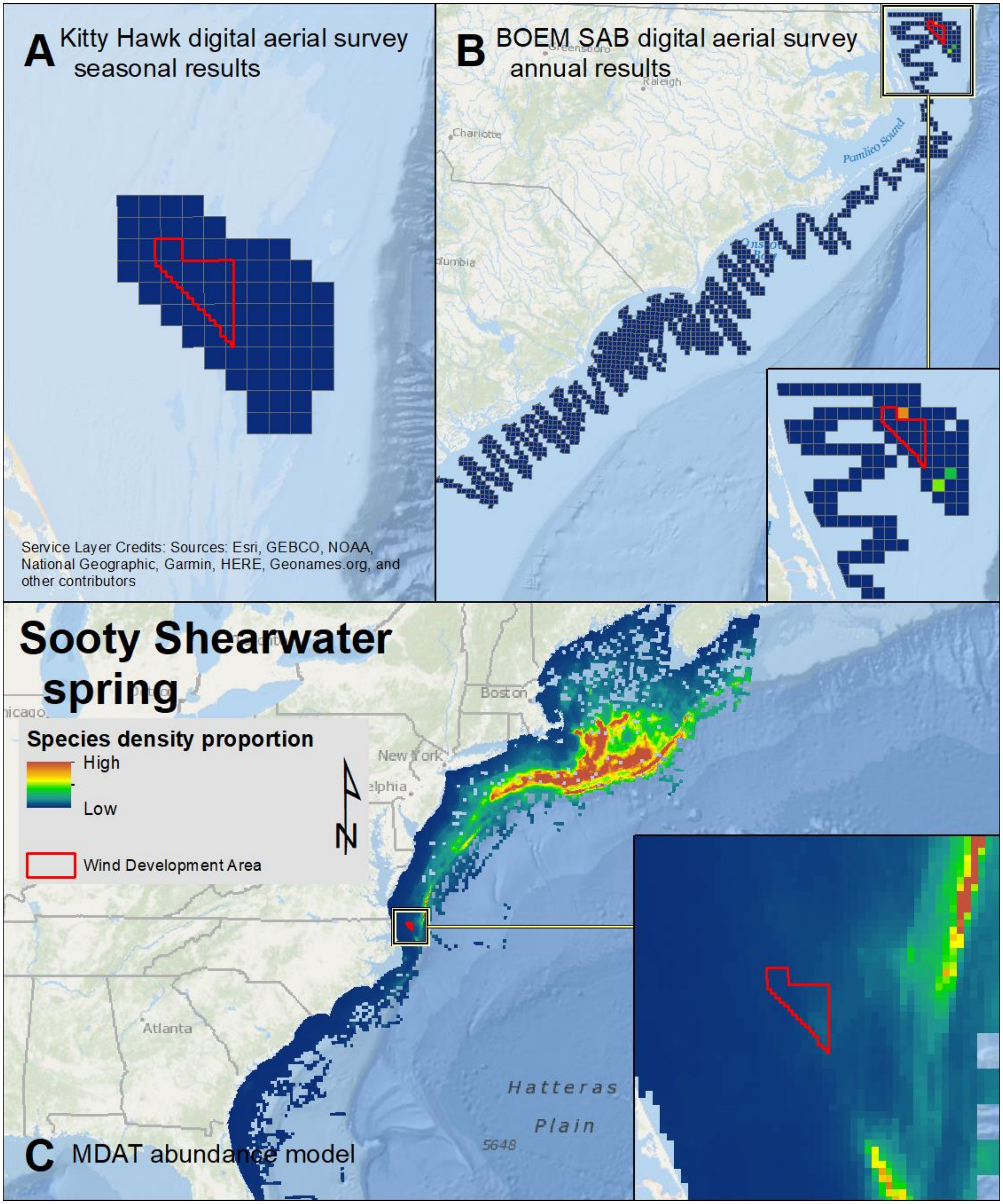
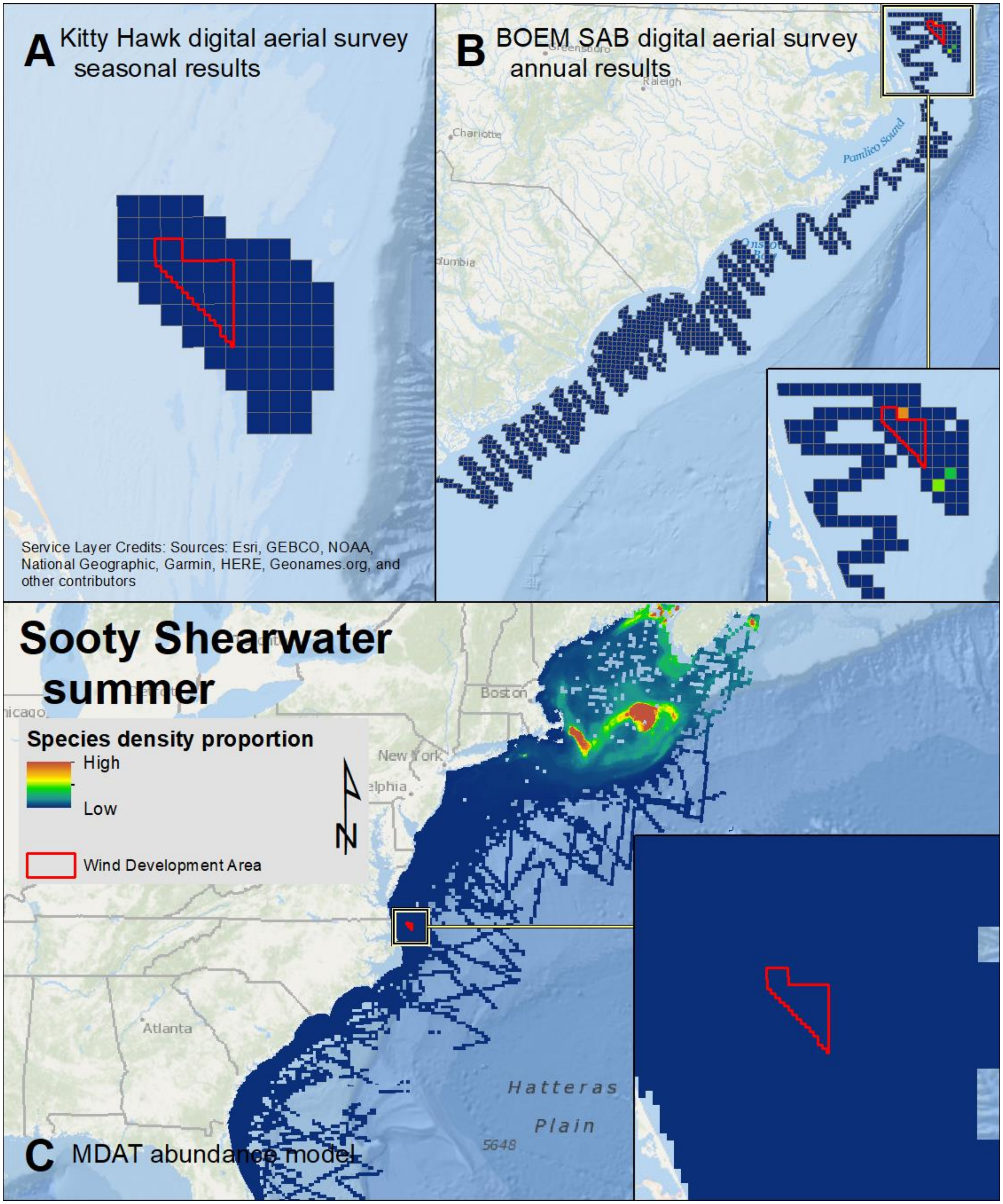
Map 129: Summer Cory's Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



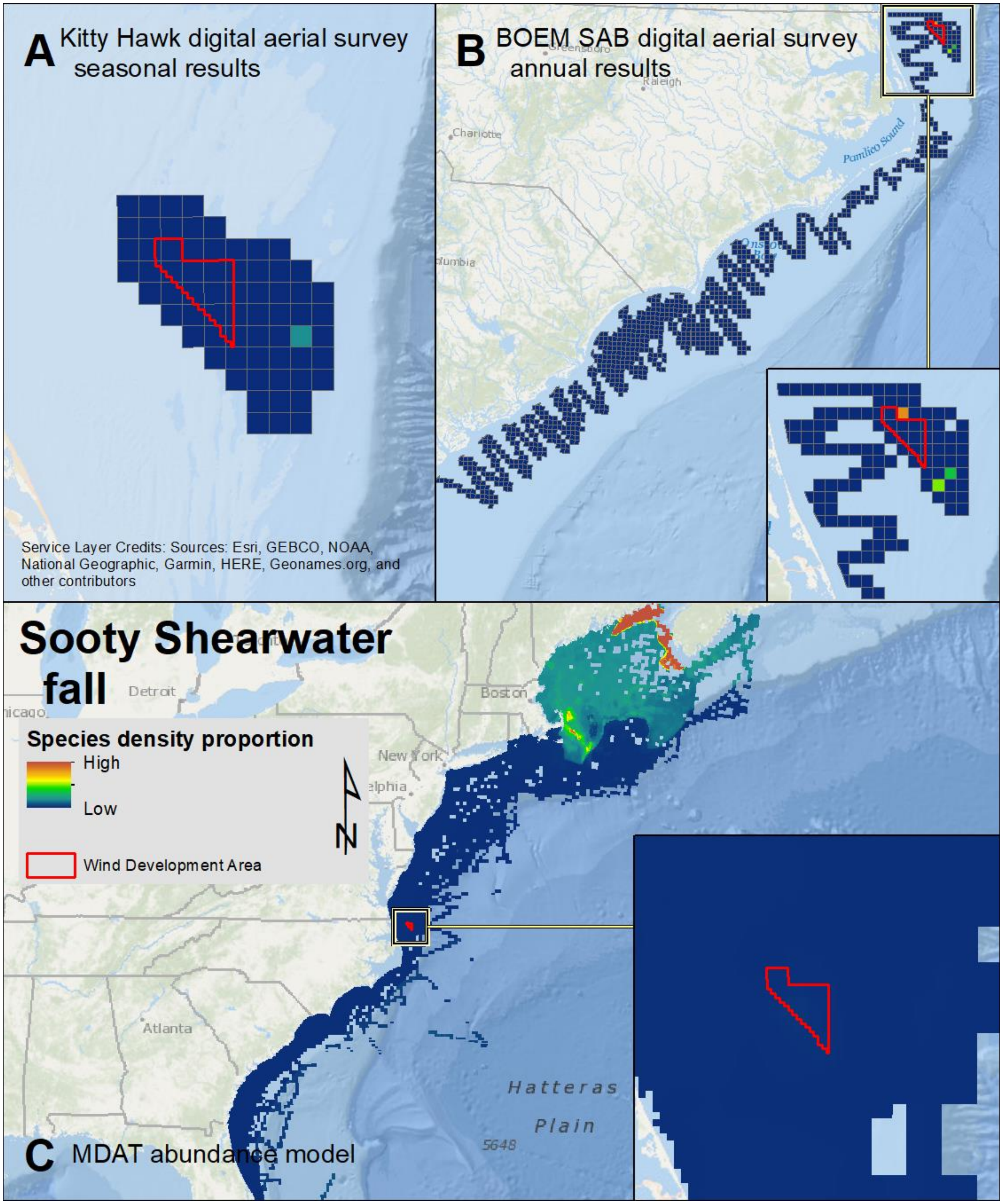
Map 130: Fall Cory's Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



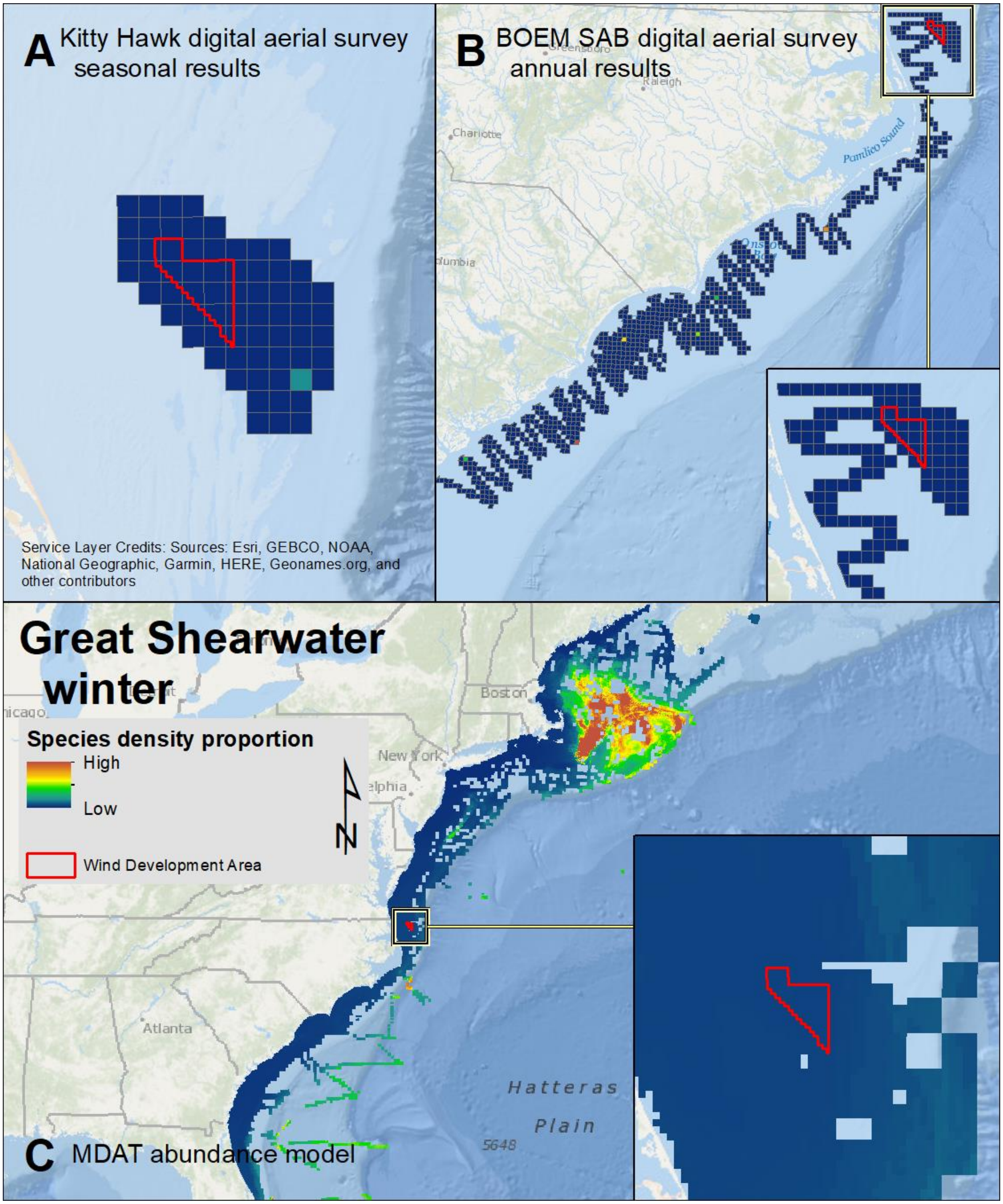
Map 131: Spring Sooty Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



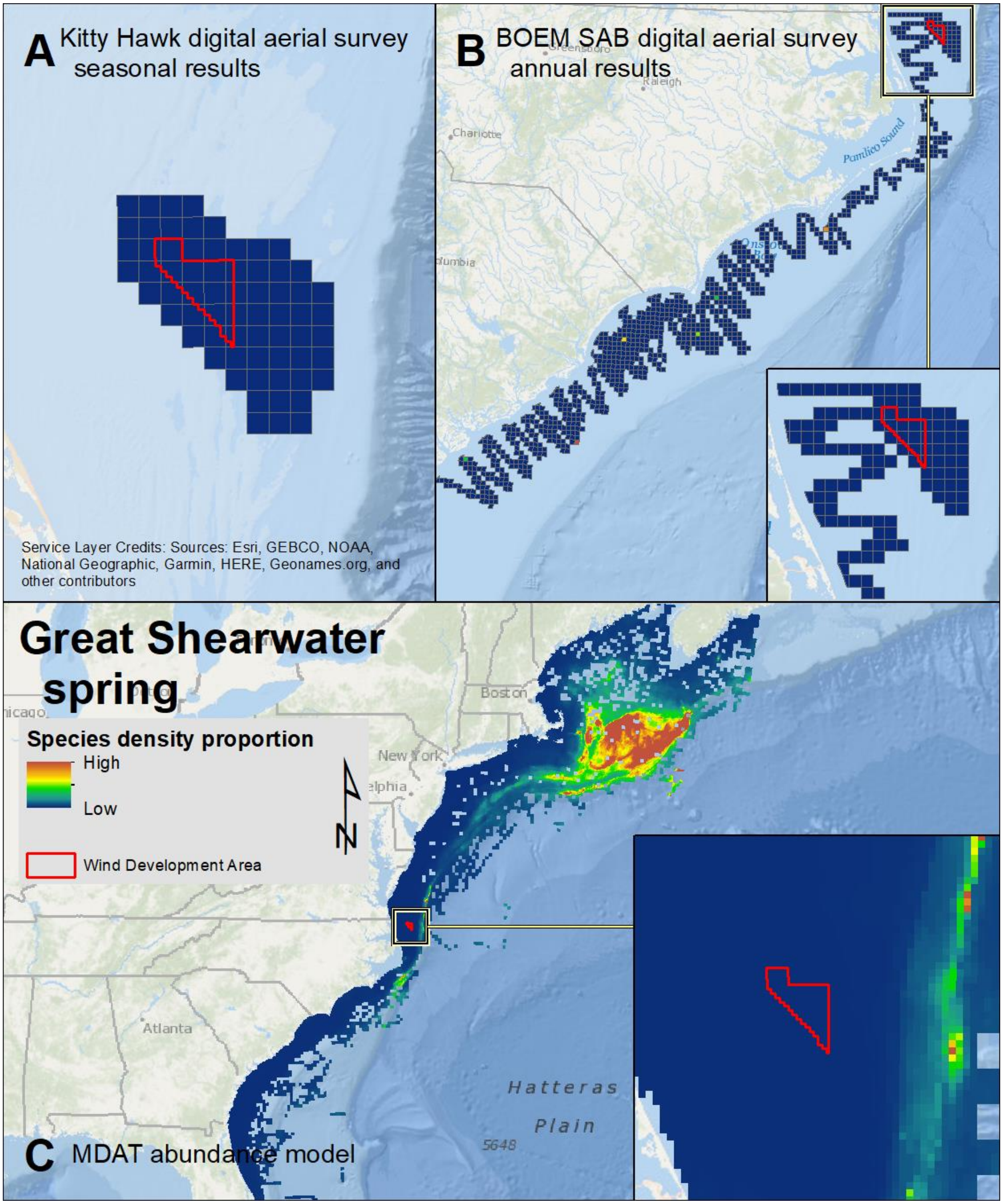
Map 132: Summer Sooty Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



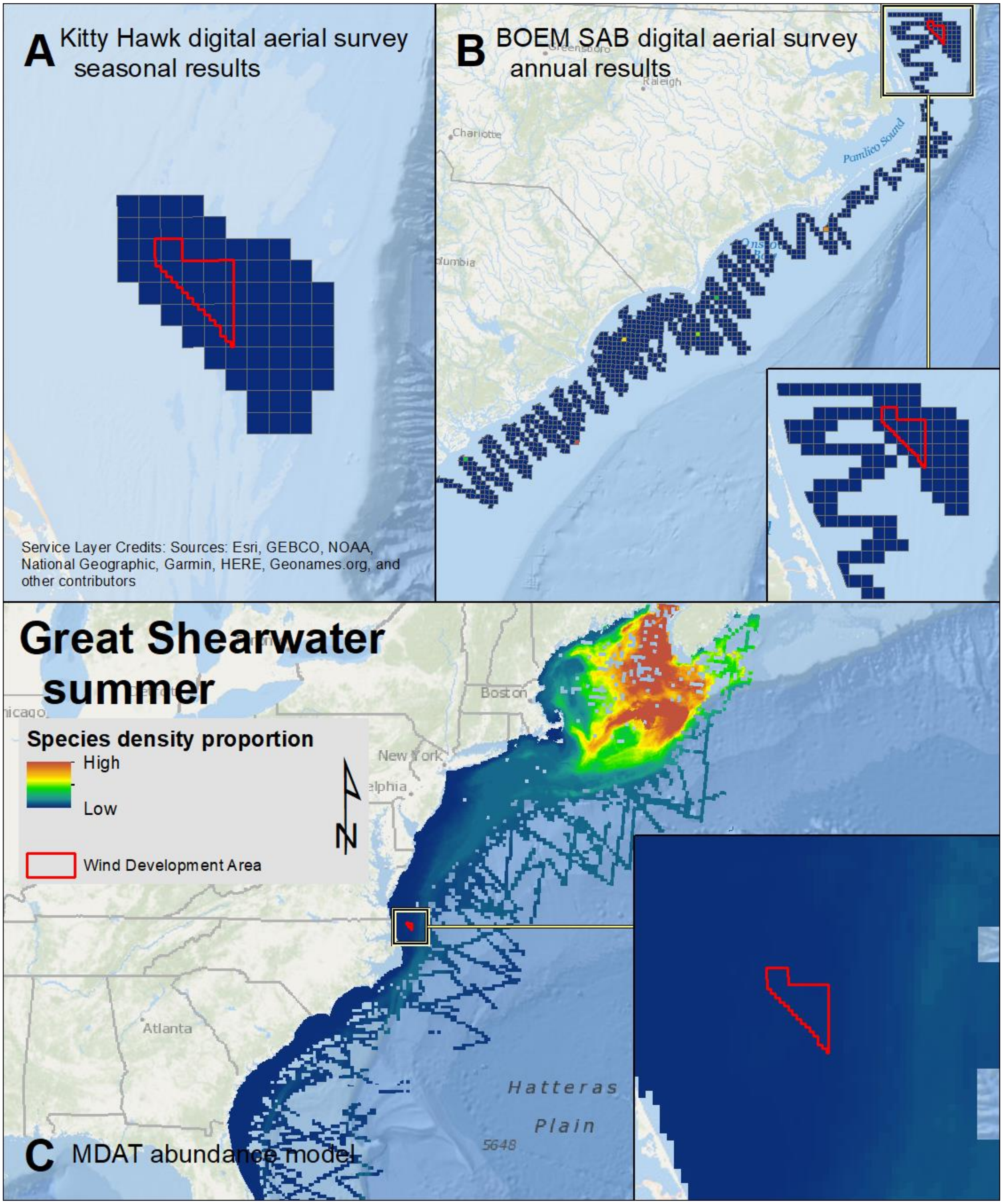
Map 133: Fall Sooty Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



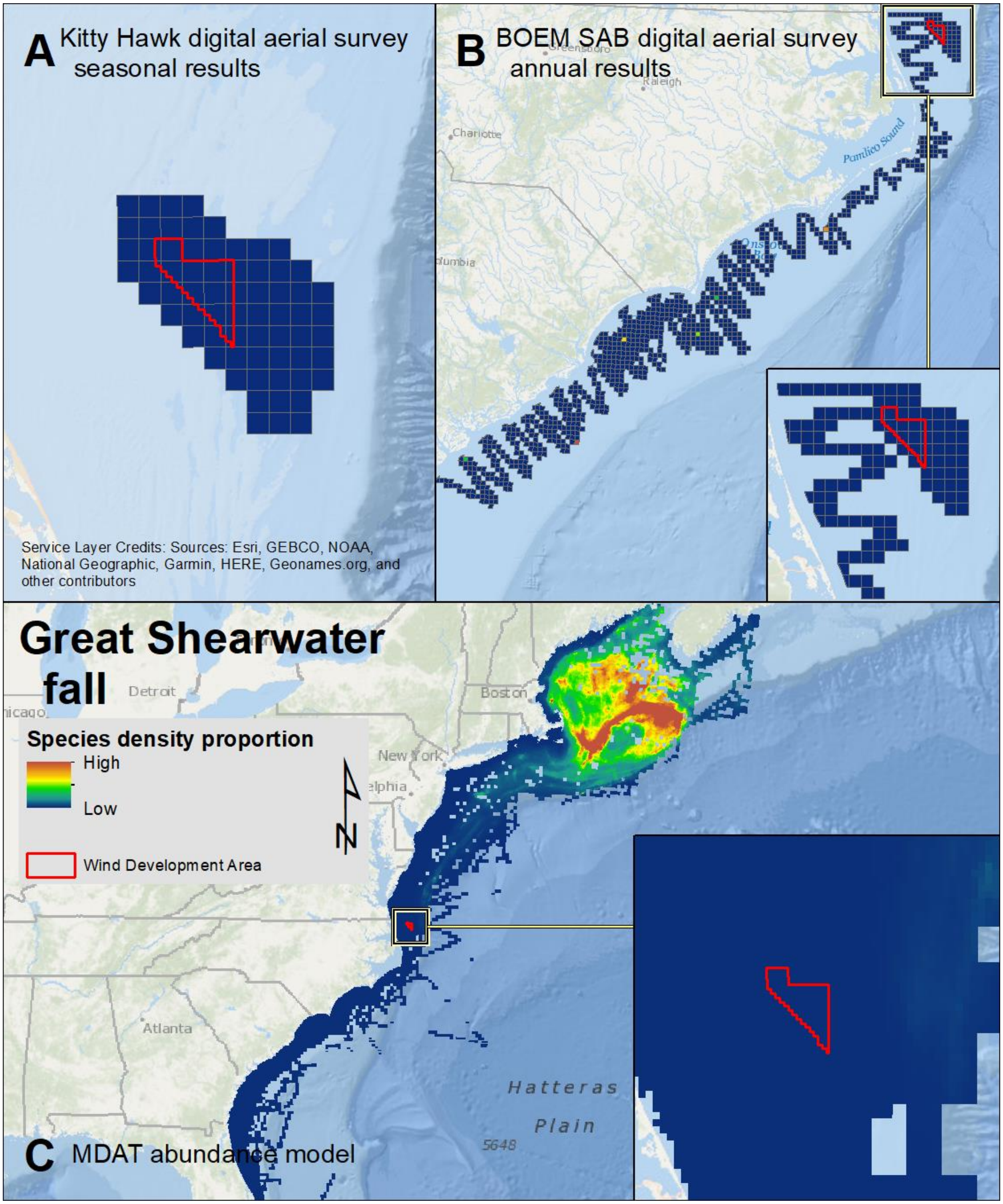
Map 134: Winter Great Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



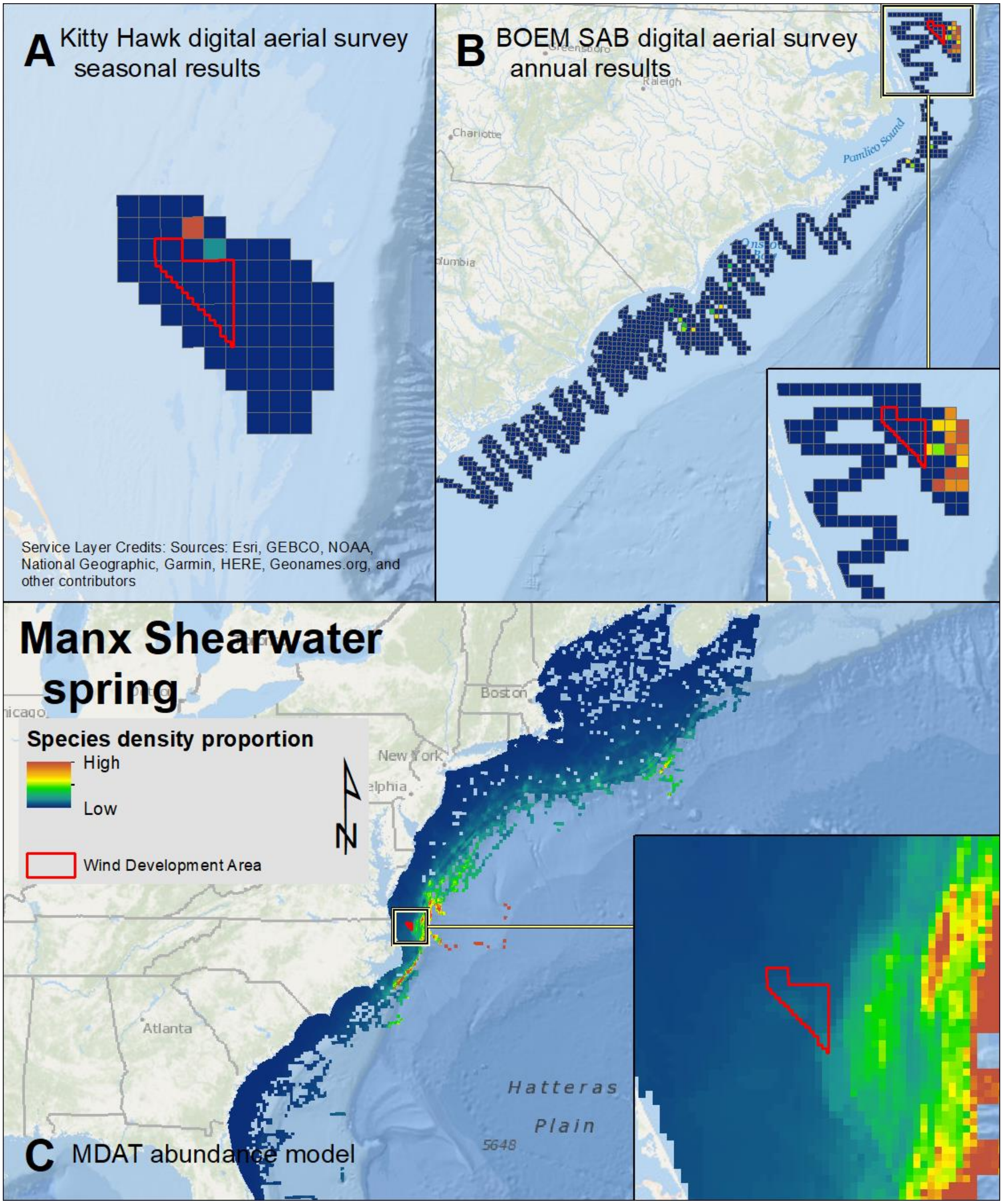
Map 135: Spring Great Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



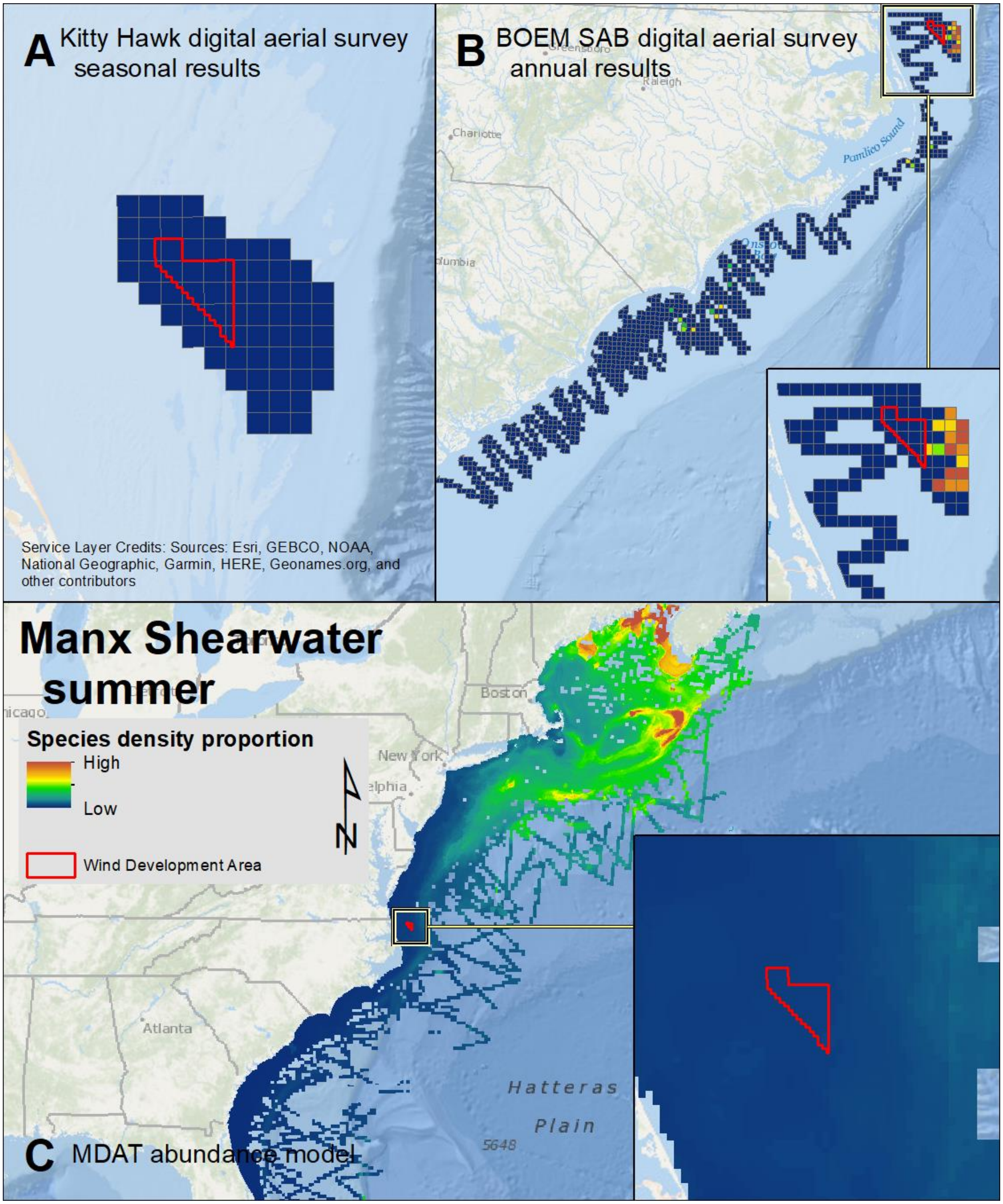
Map 136: Summer Great Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



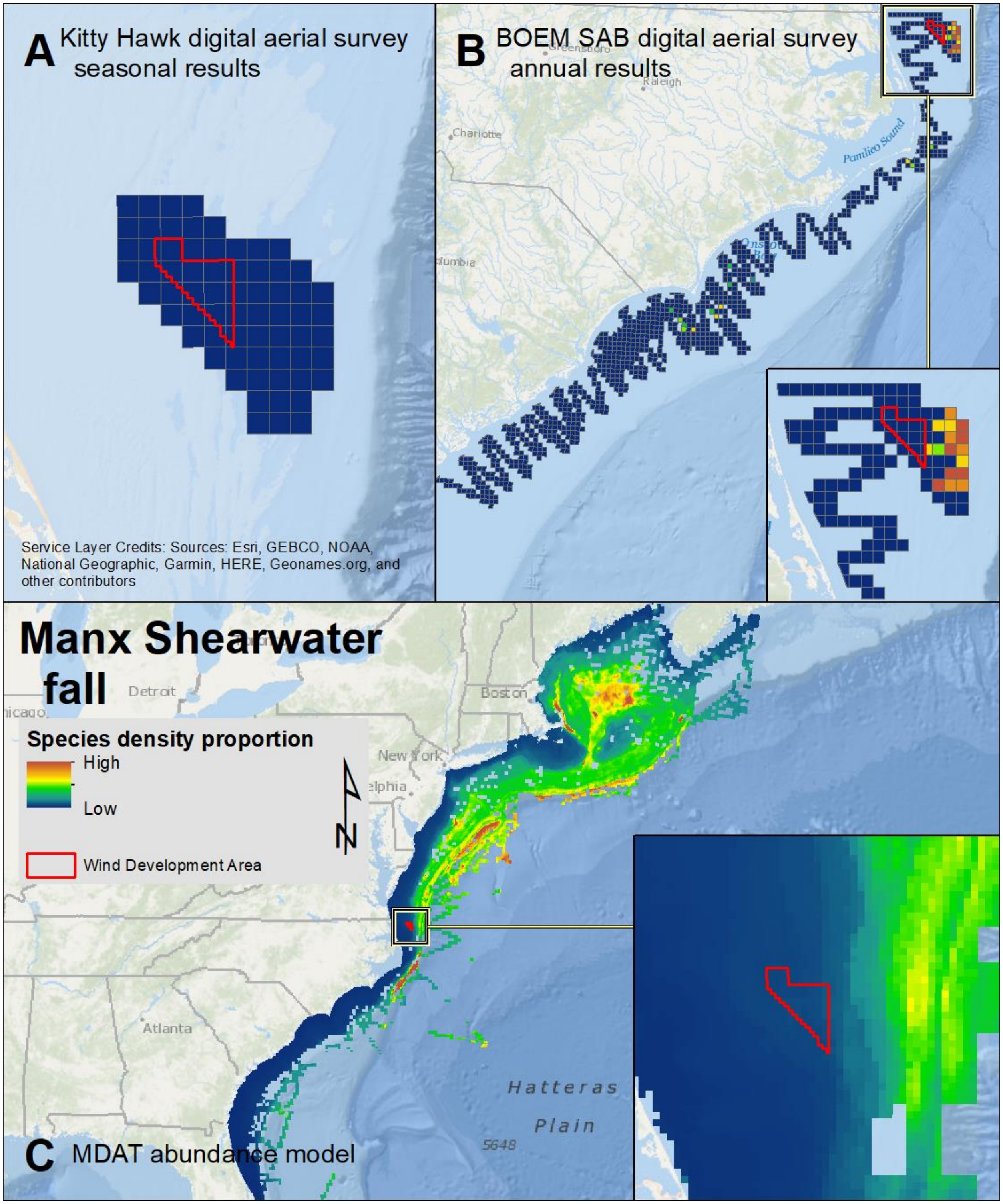
Map 137: Fall Great Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



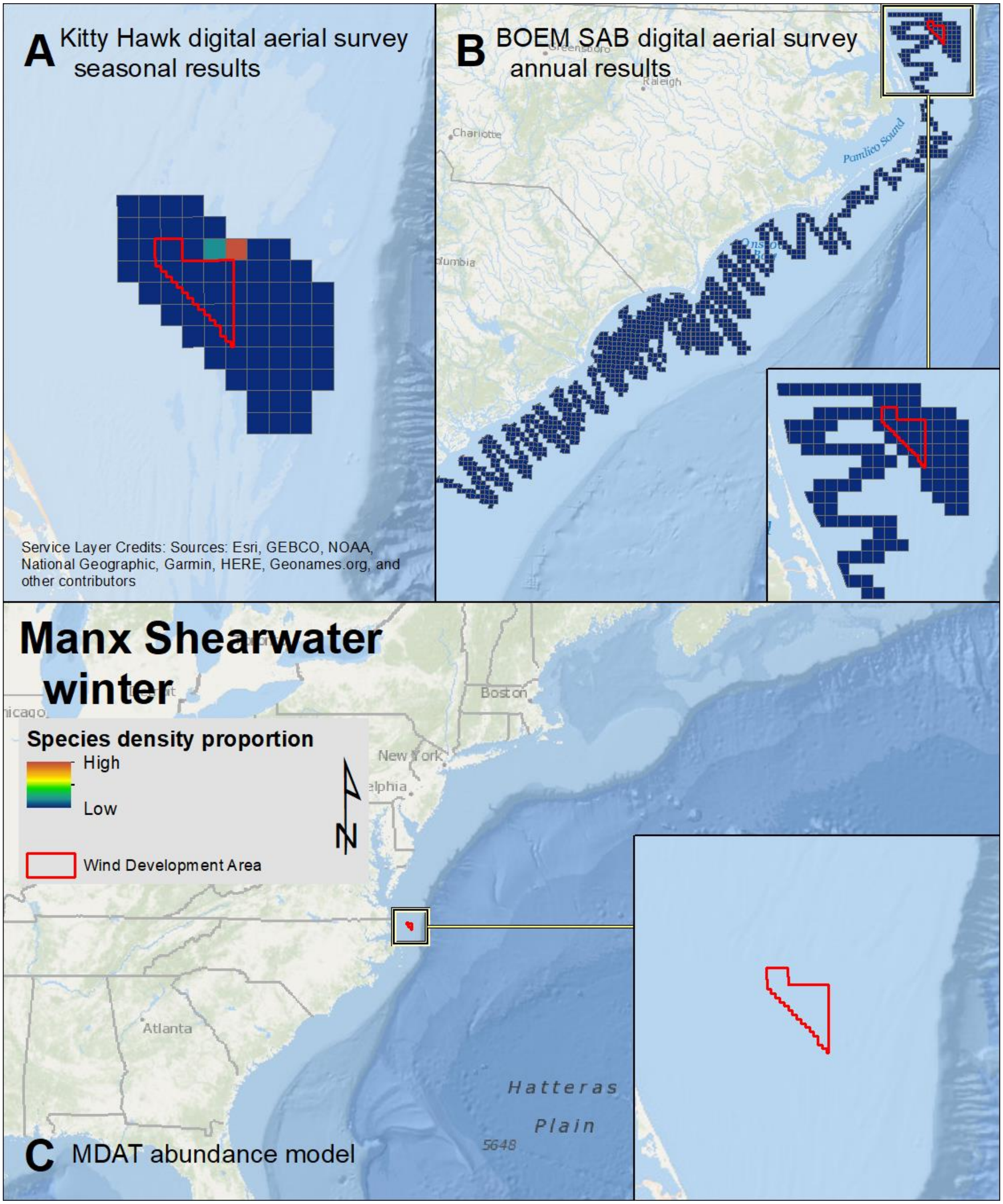
Map 138: Spring Manx Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



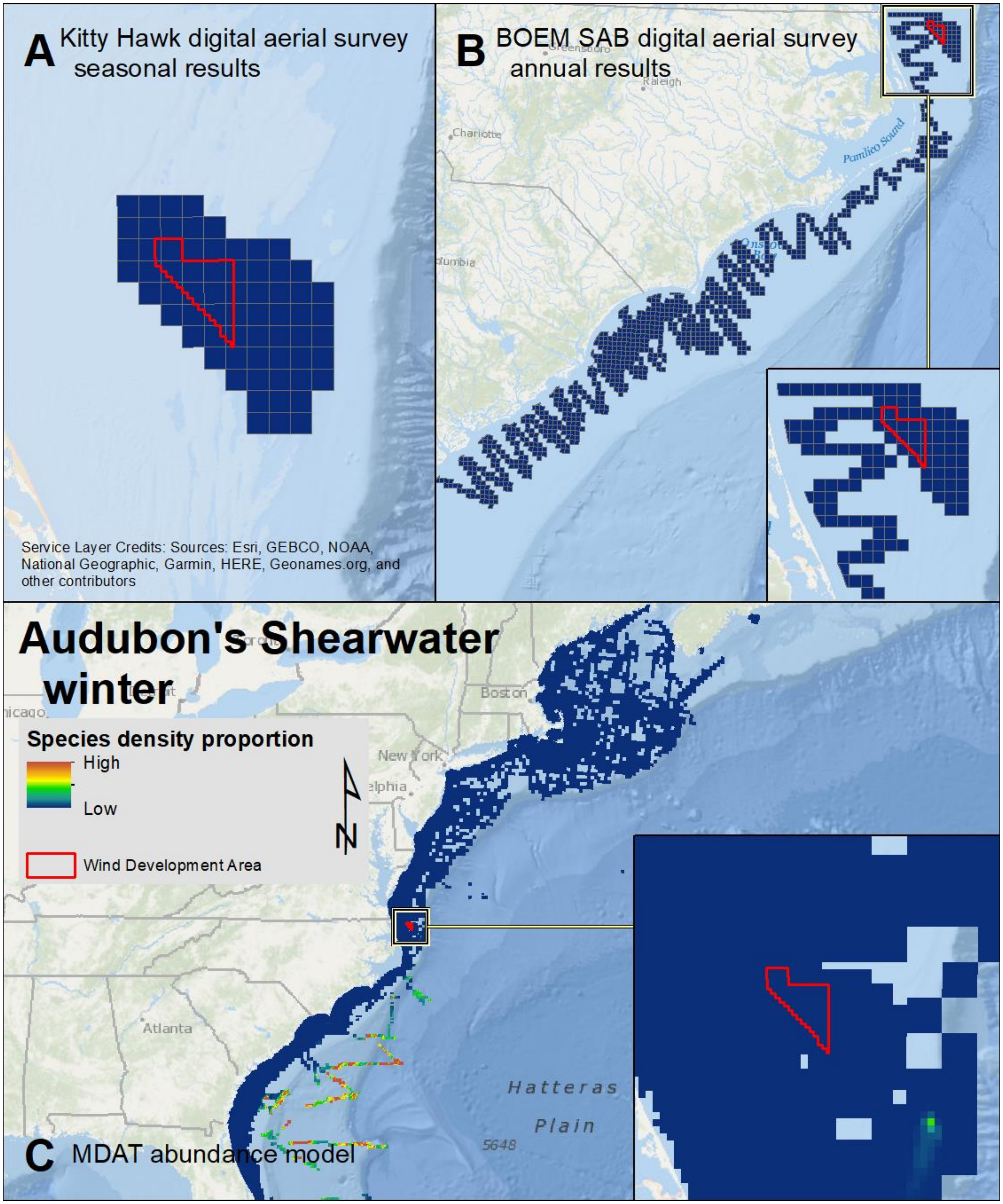
Map 139: Summer Manx Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



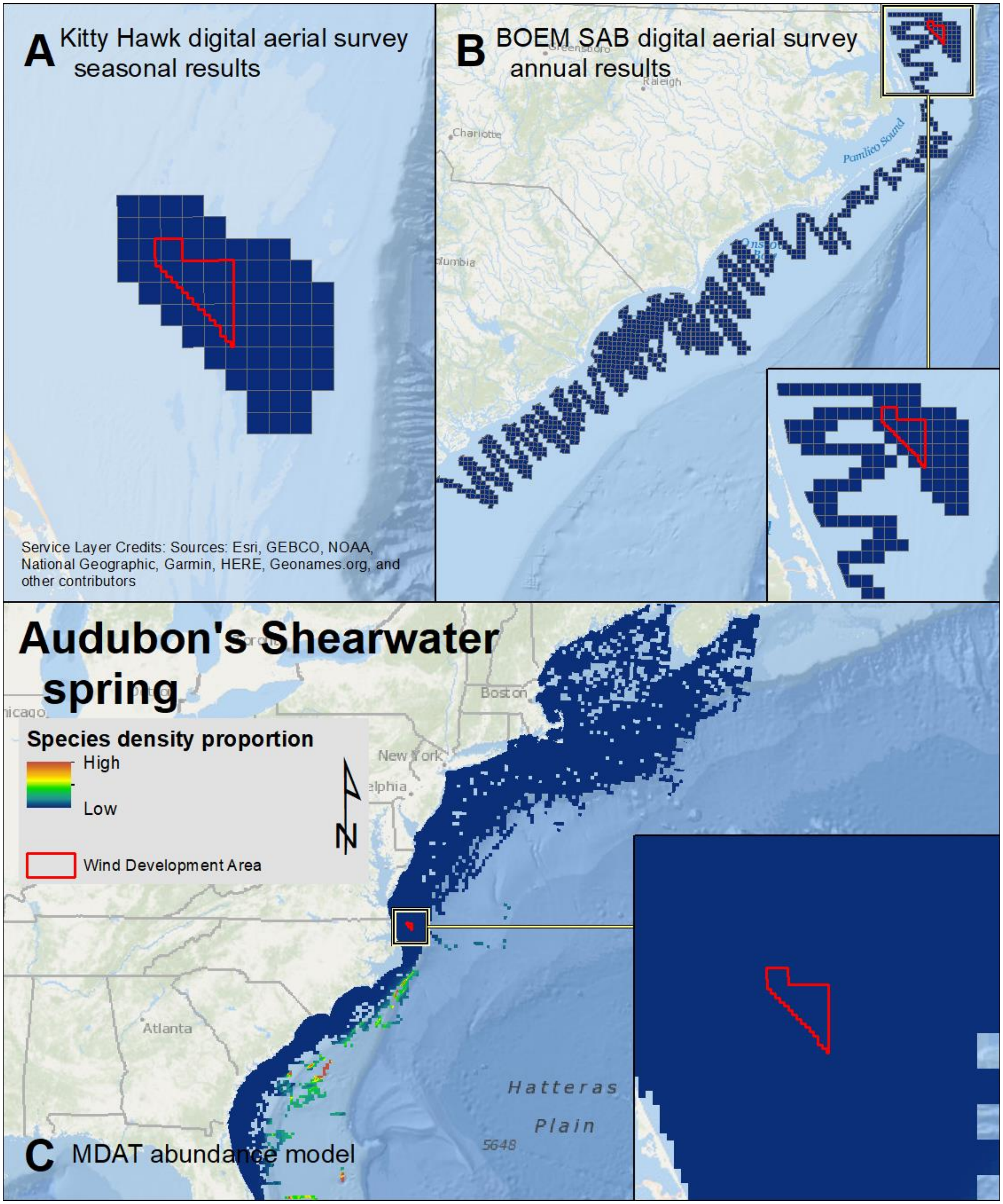
Map 140: Fall Manx Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



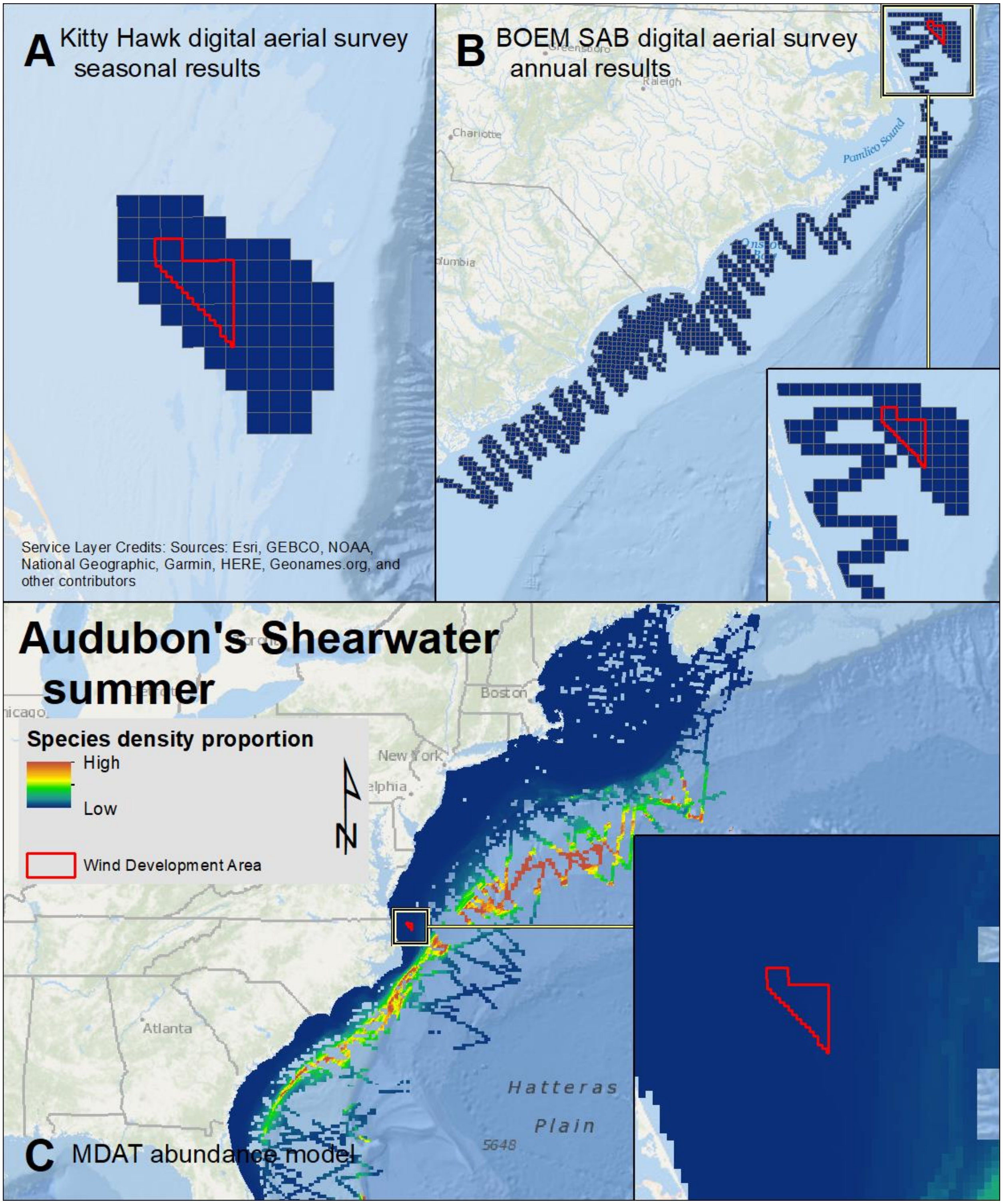
Map 141: Winter Manx Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



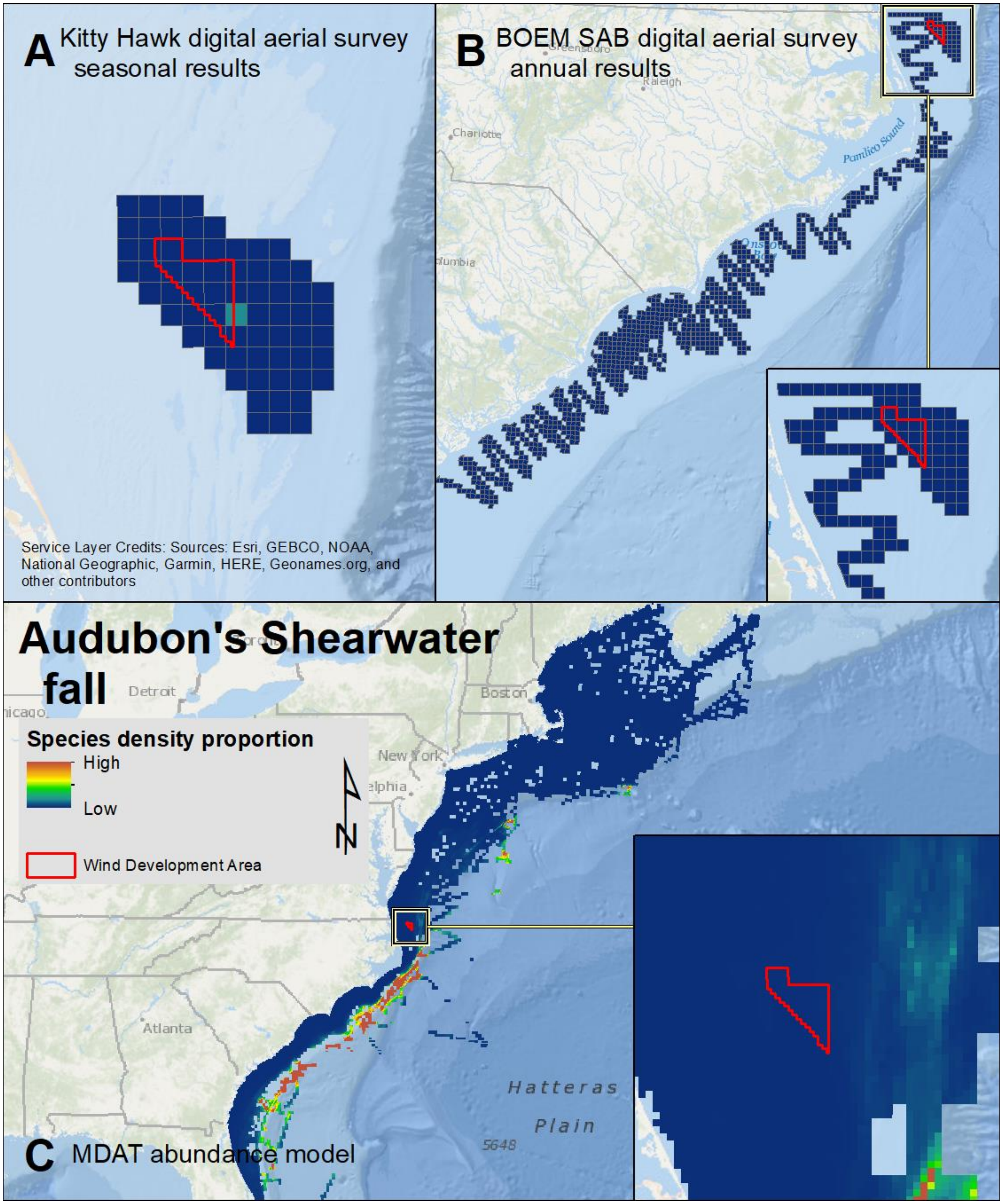
Map 142: Winter Audubon's Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



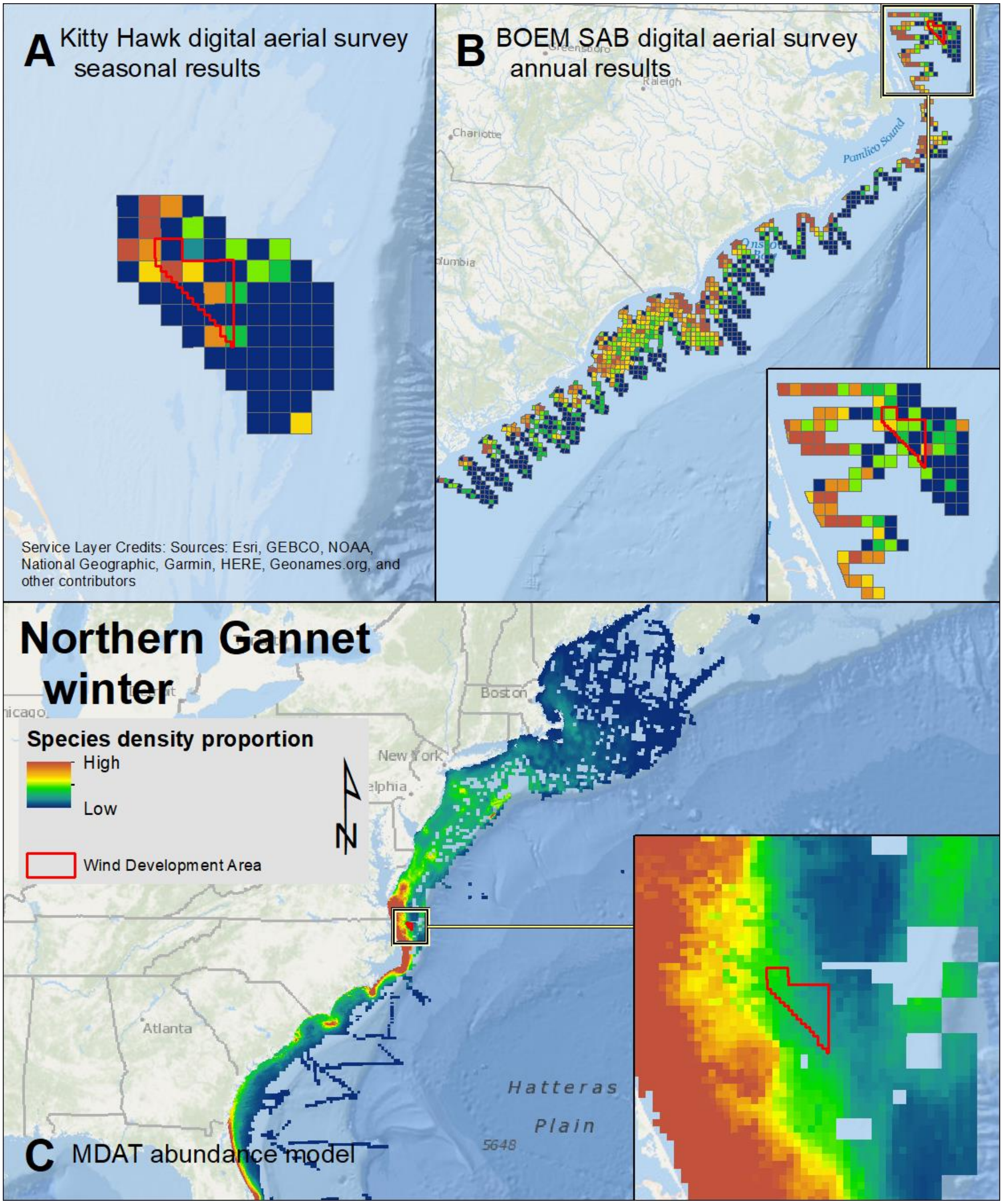
Map 143: Spring Audubon's Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



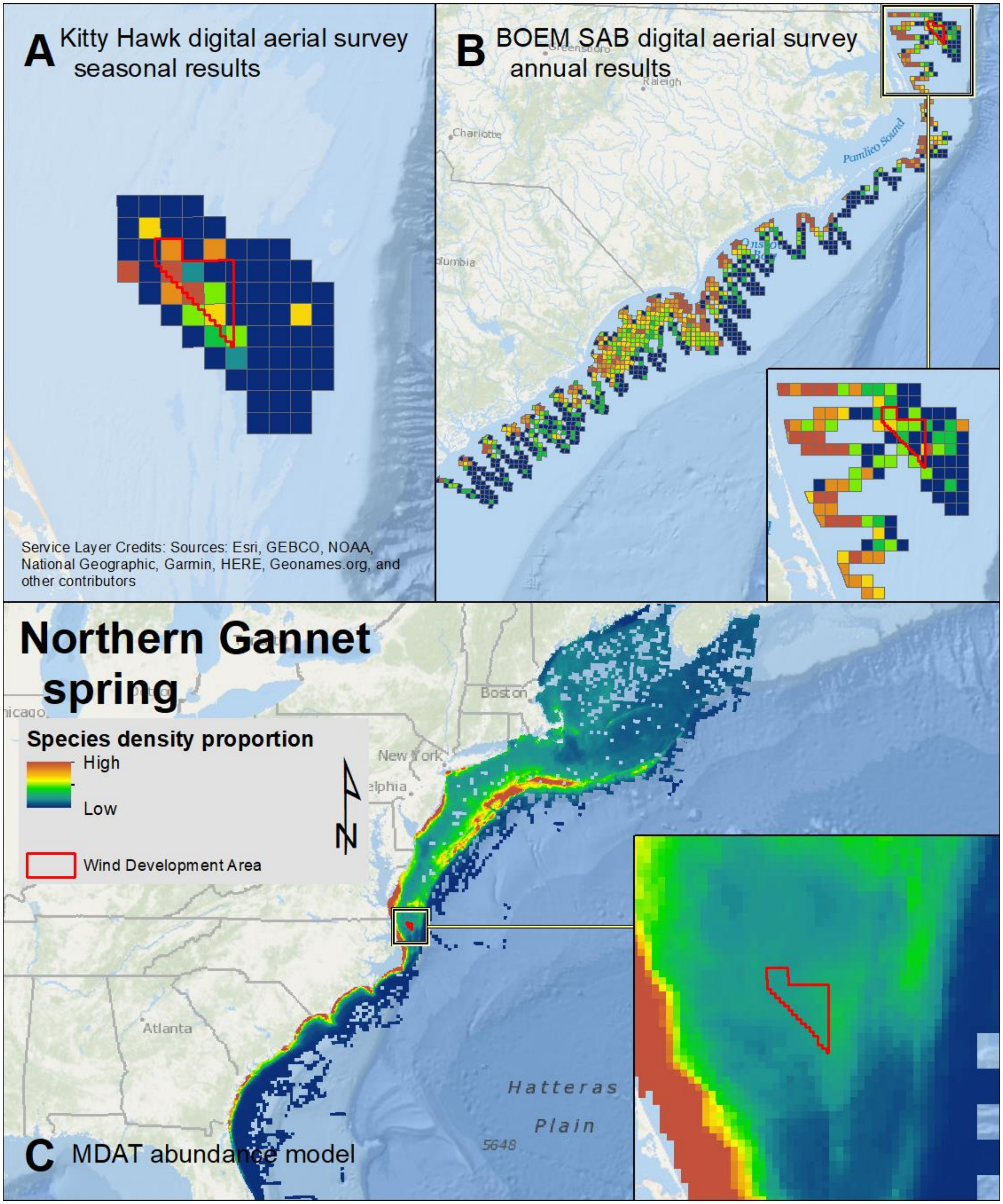
Map 144: Summer Audubon's Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



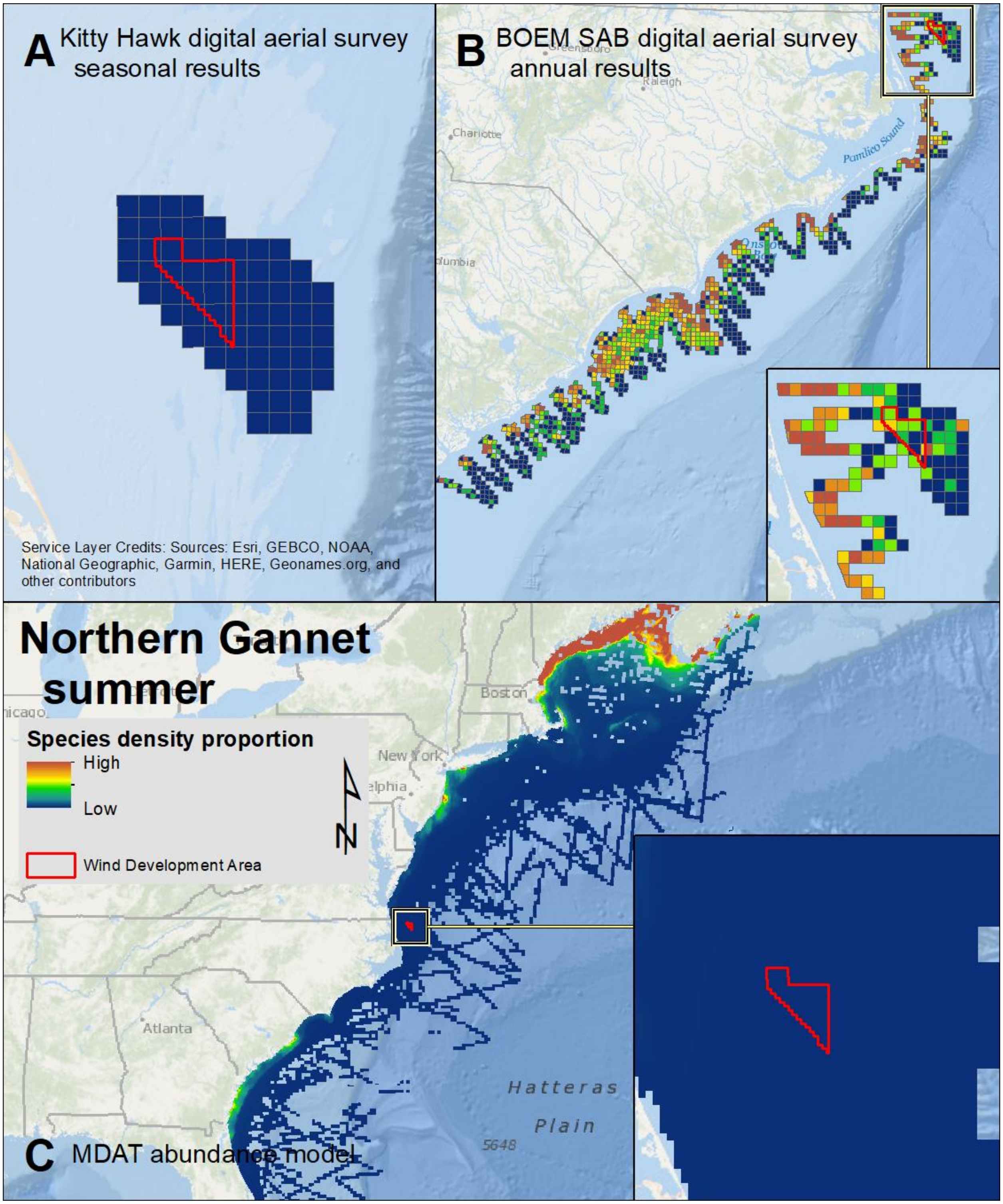
Map 145: Fall Audubon's Shearwater density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



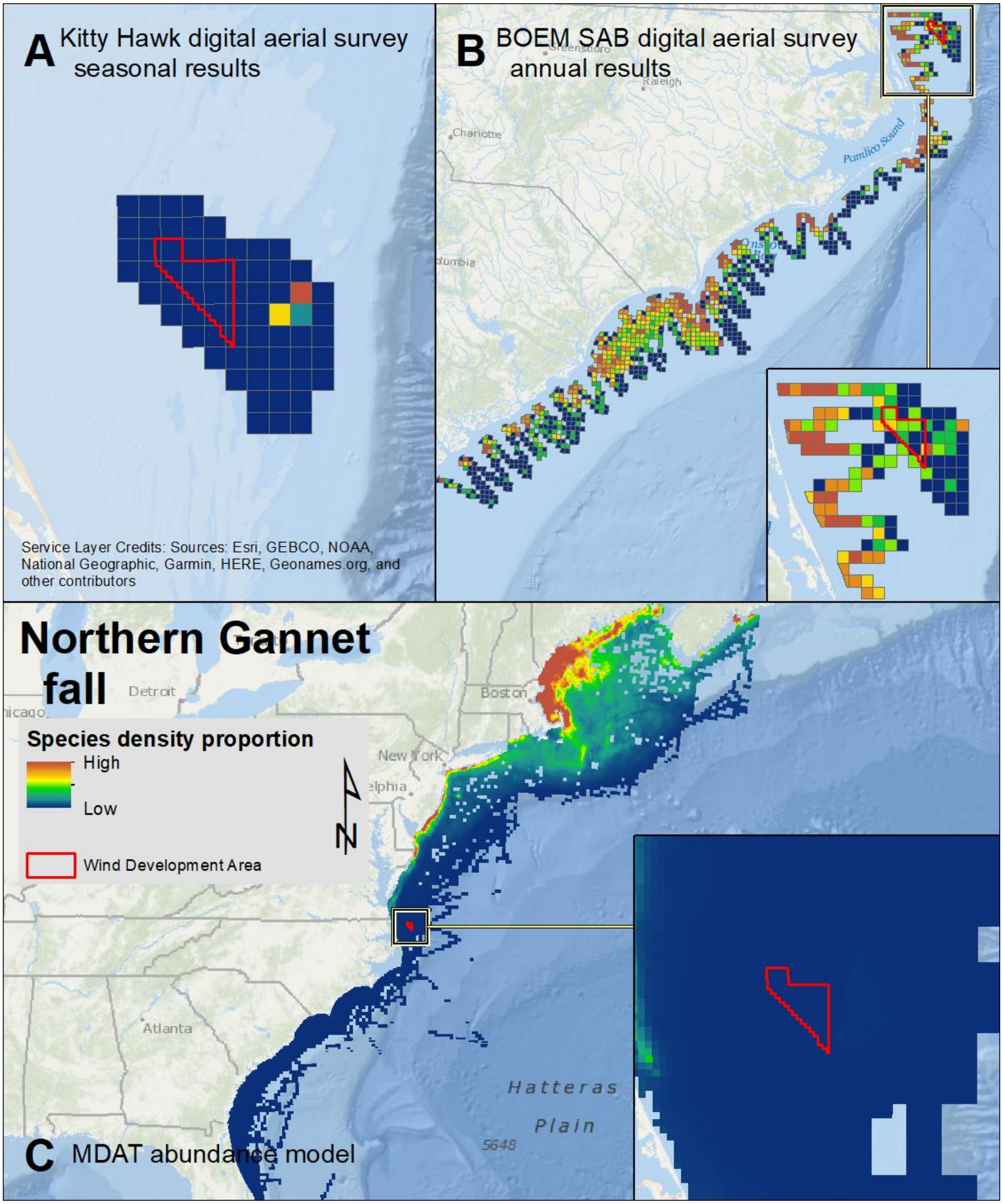
Map 146: Winter Northern Gannet density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



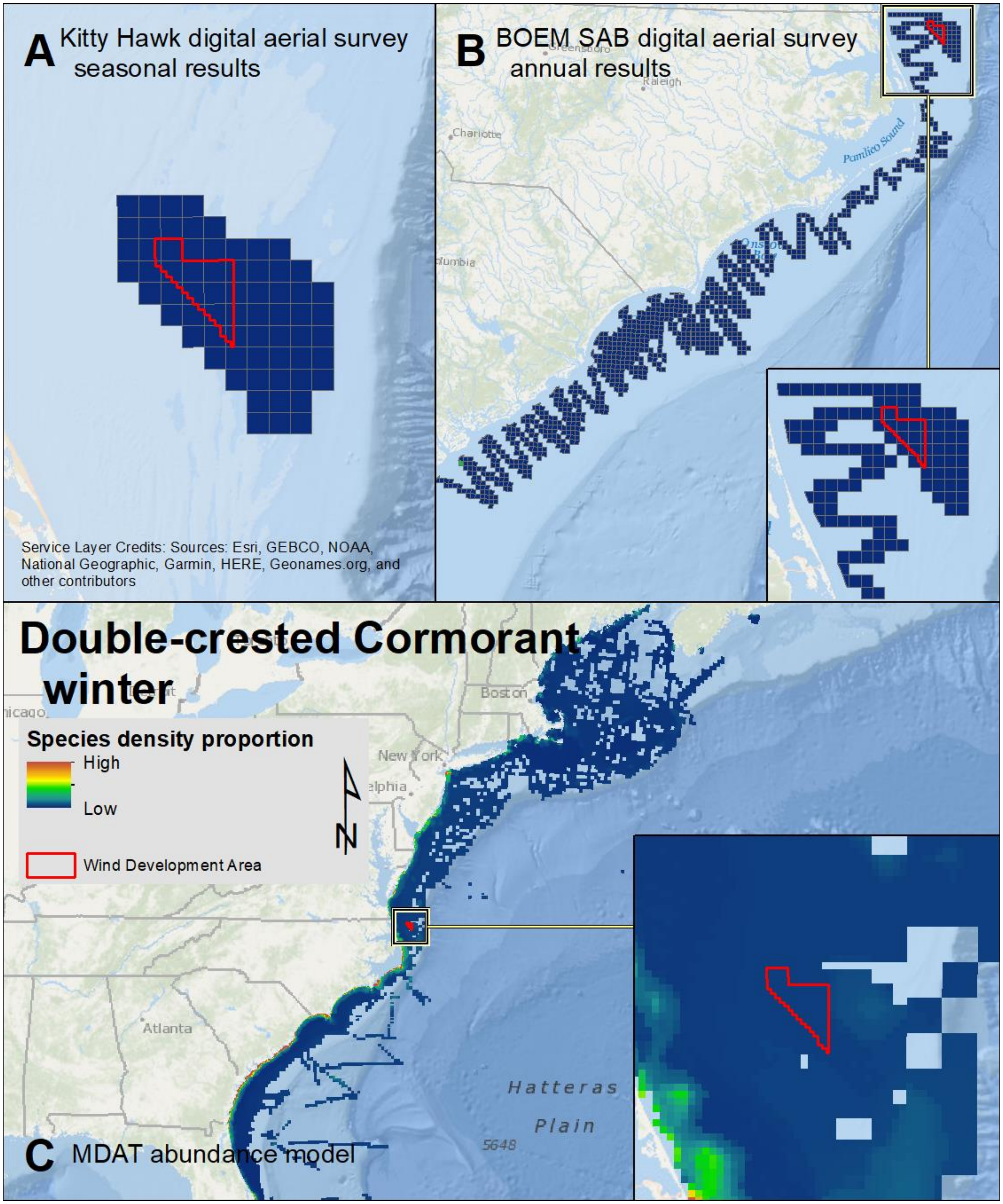
Map 147: Spring Northern Gannet density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



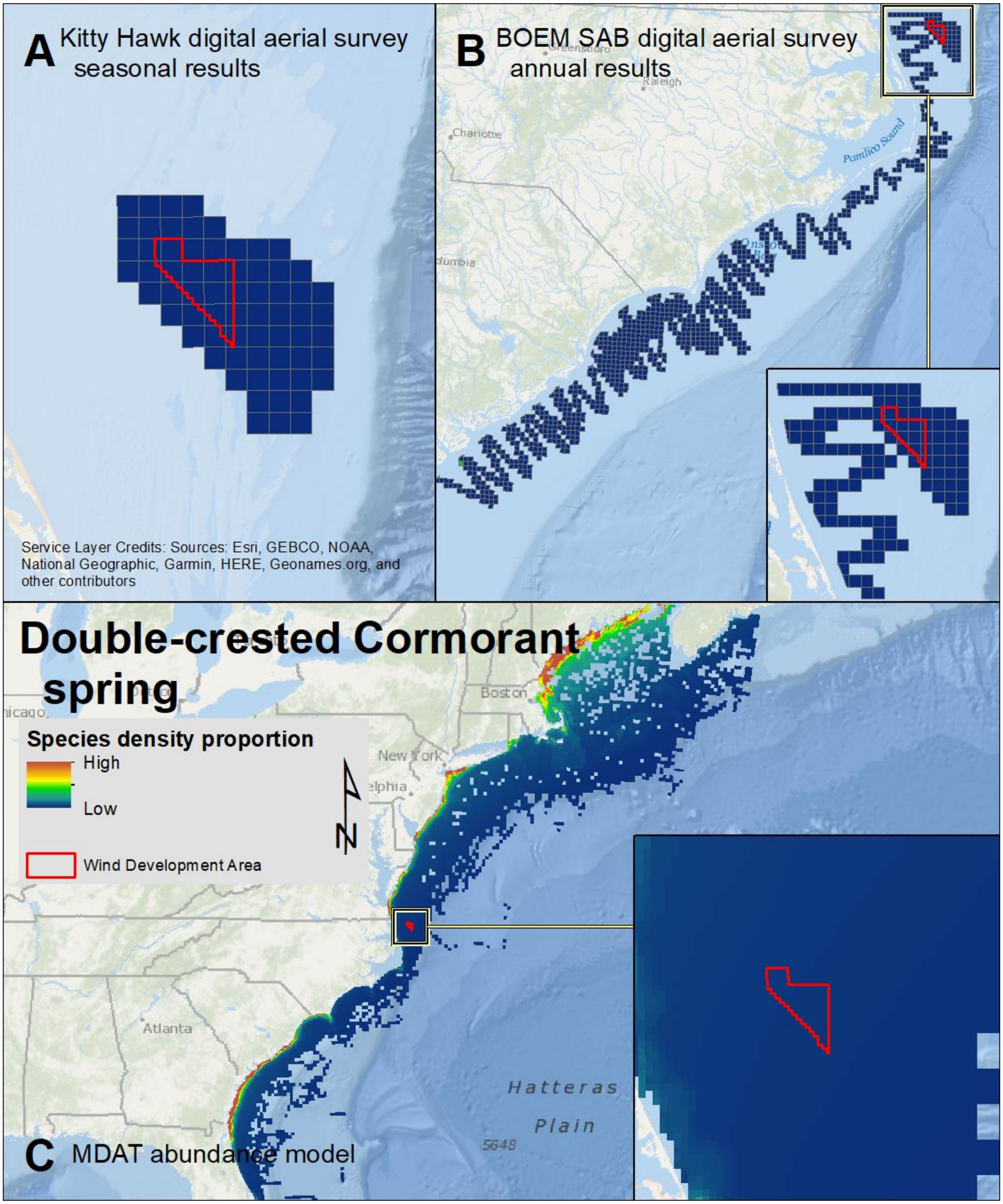
Map 148: Summer Northern Gannet density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



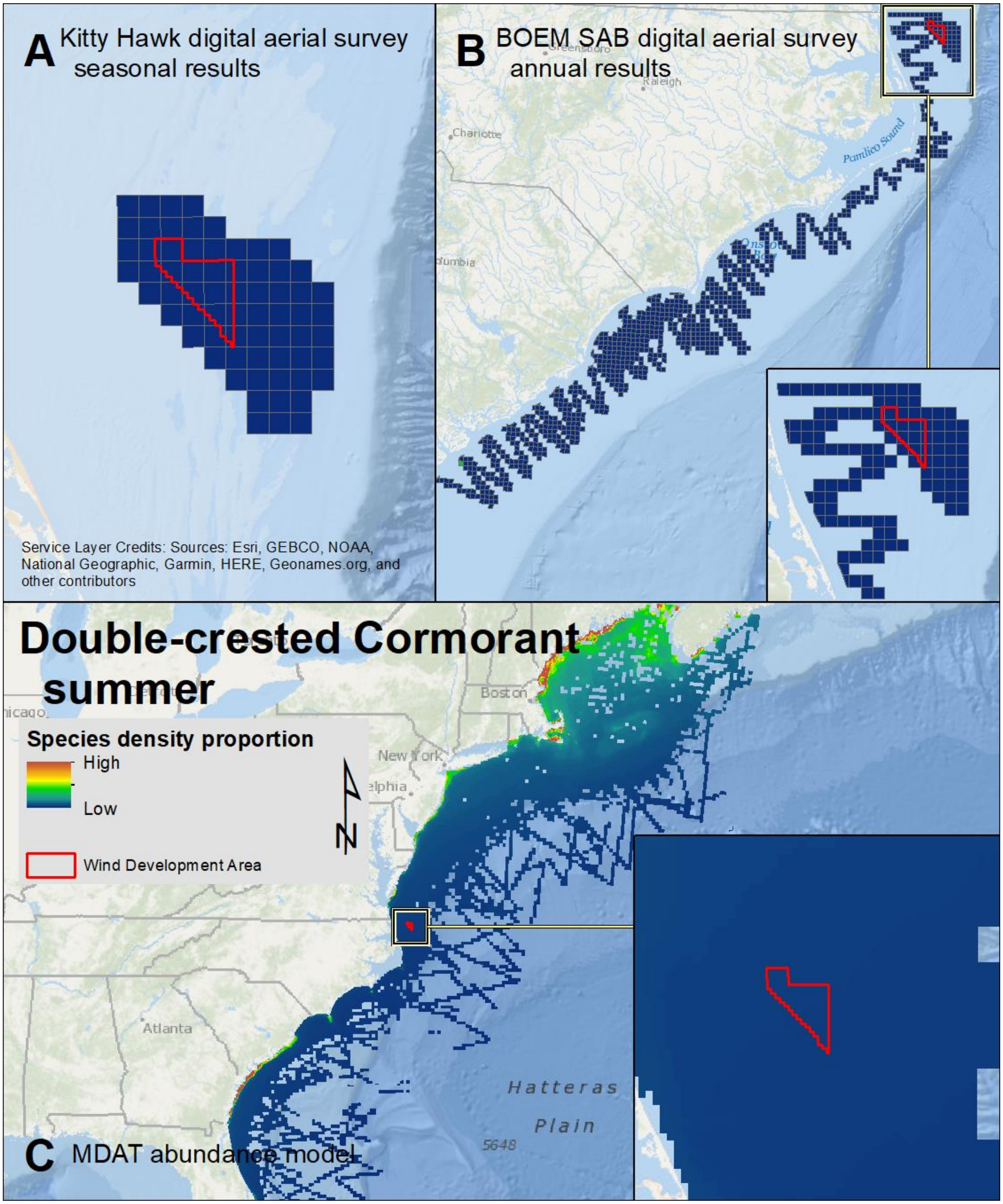
Map 149: Fall Northern Gannet density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



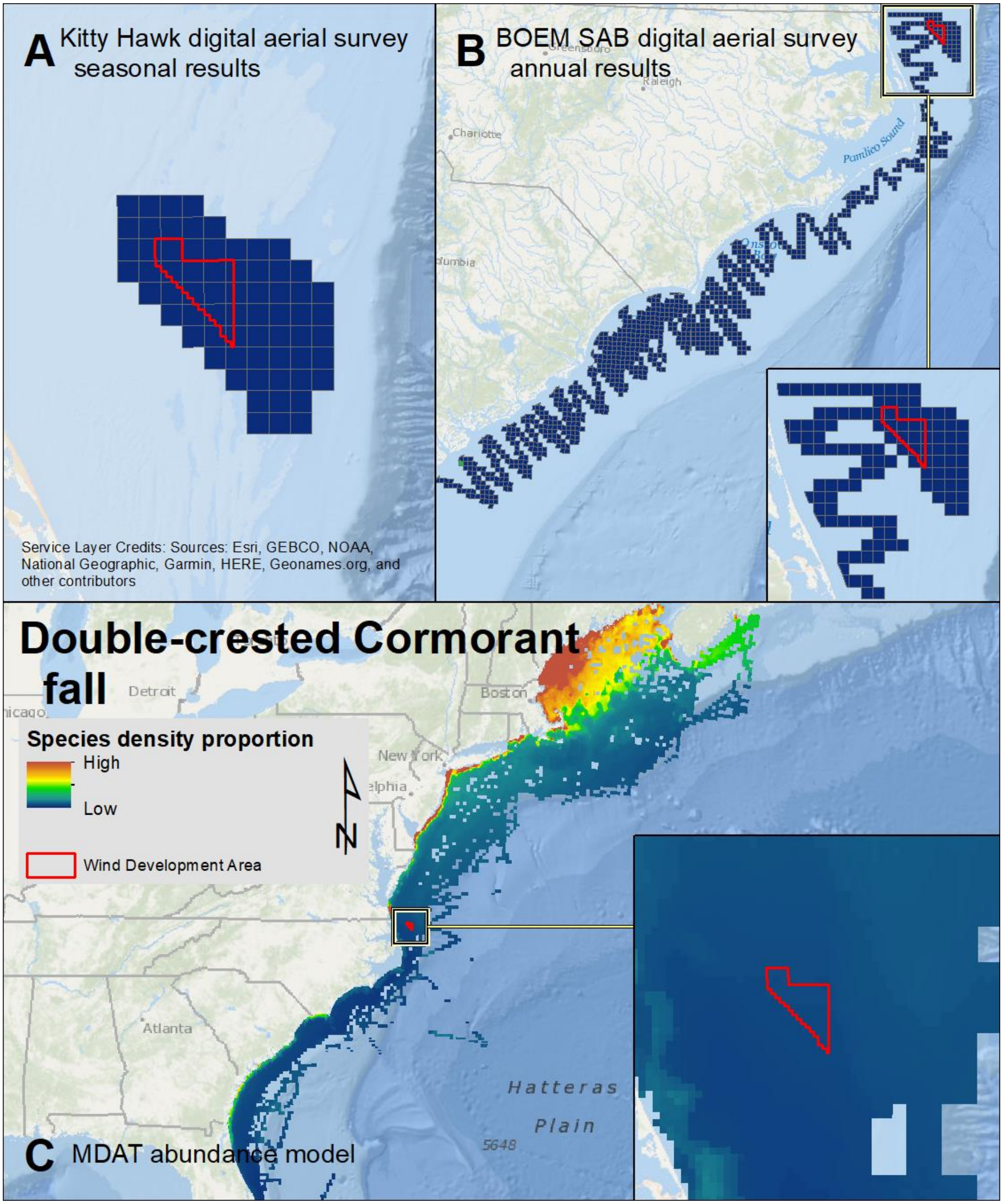
Map 150: Winter Double-crested Cormorant density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



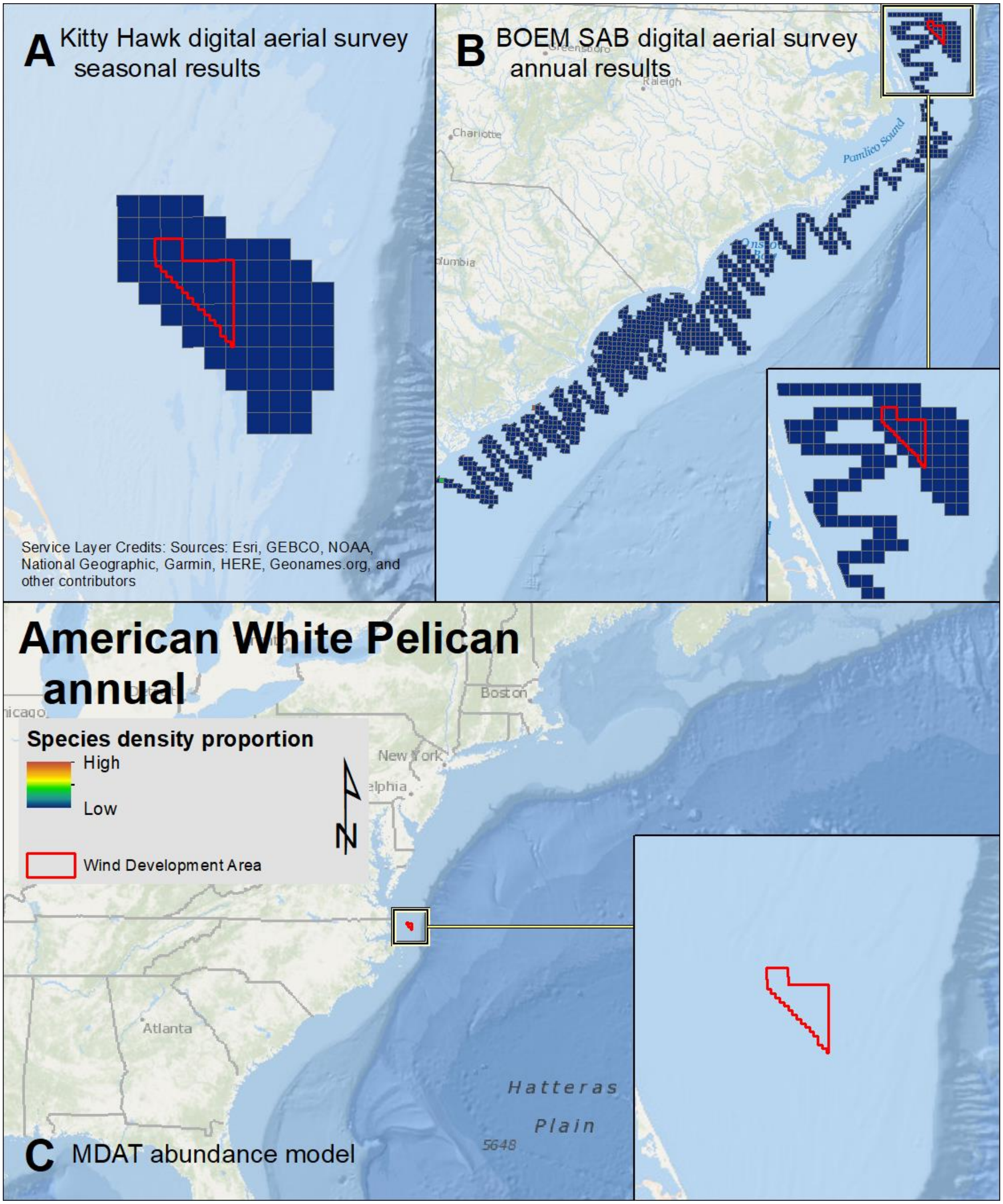
Map 151: Spring Double-crested Cormorant density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



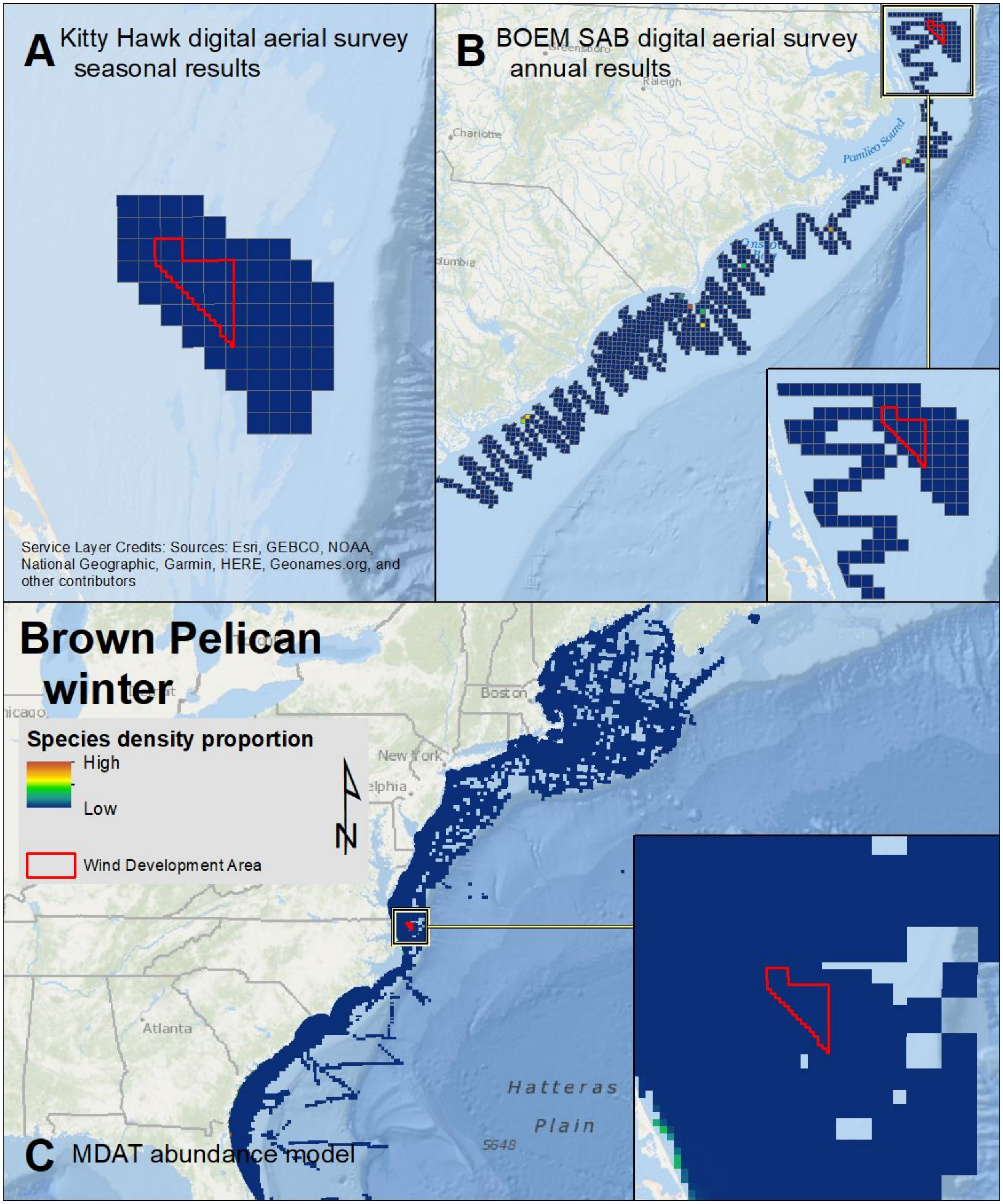
Map 152: Summer Double-crested Cormorant density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



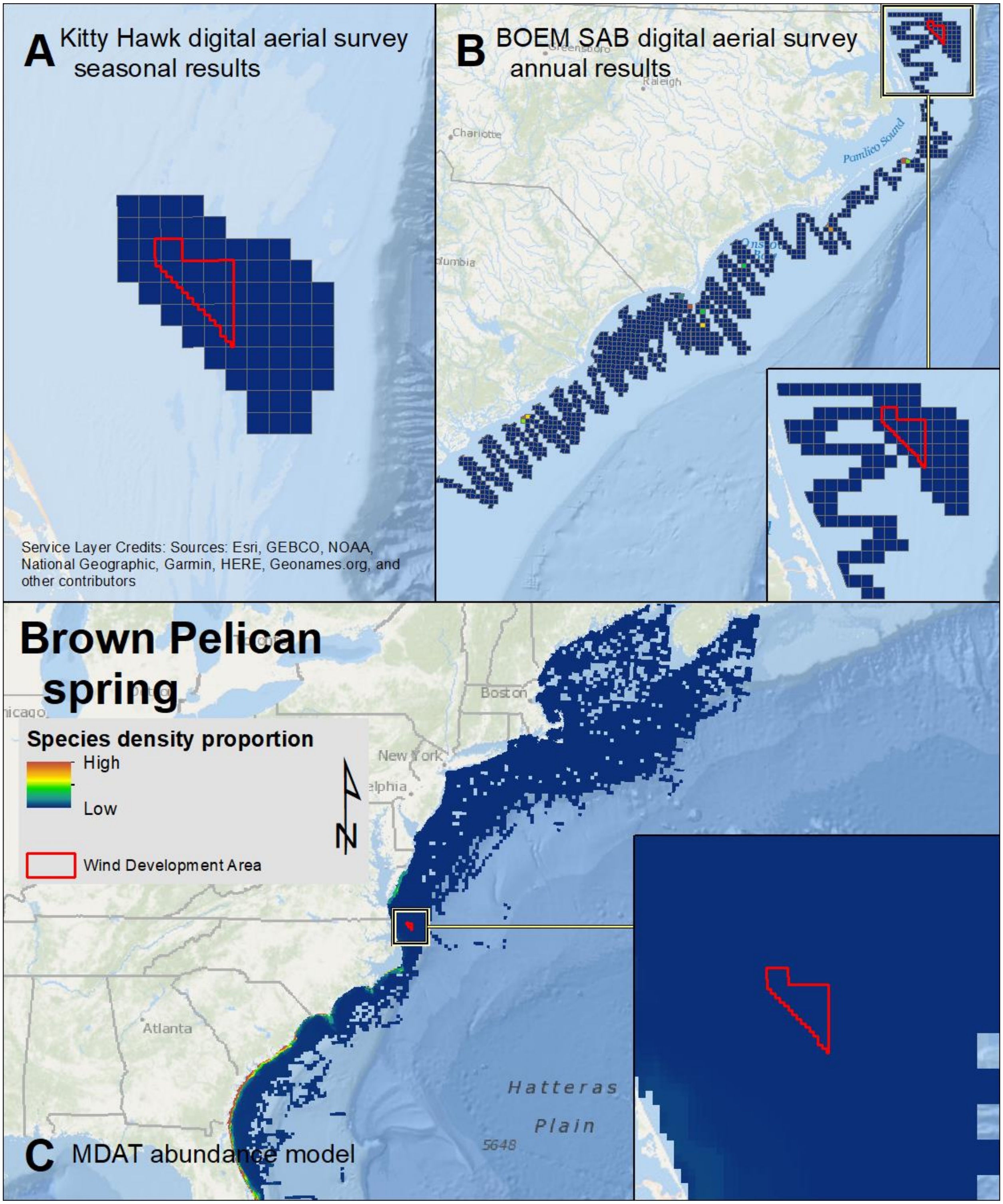
Map 153: Fall Double-crested Cormorant density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



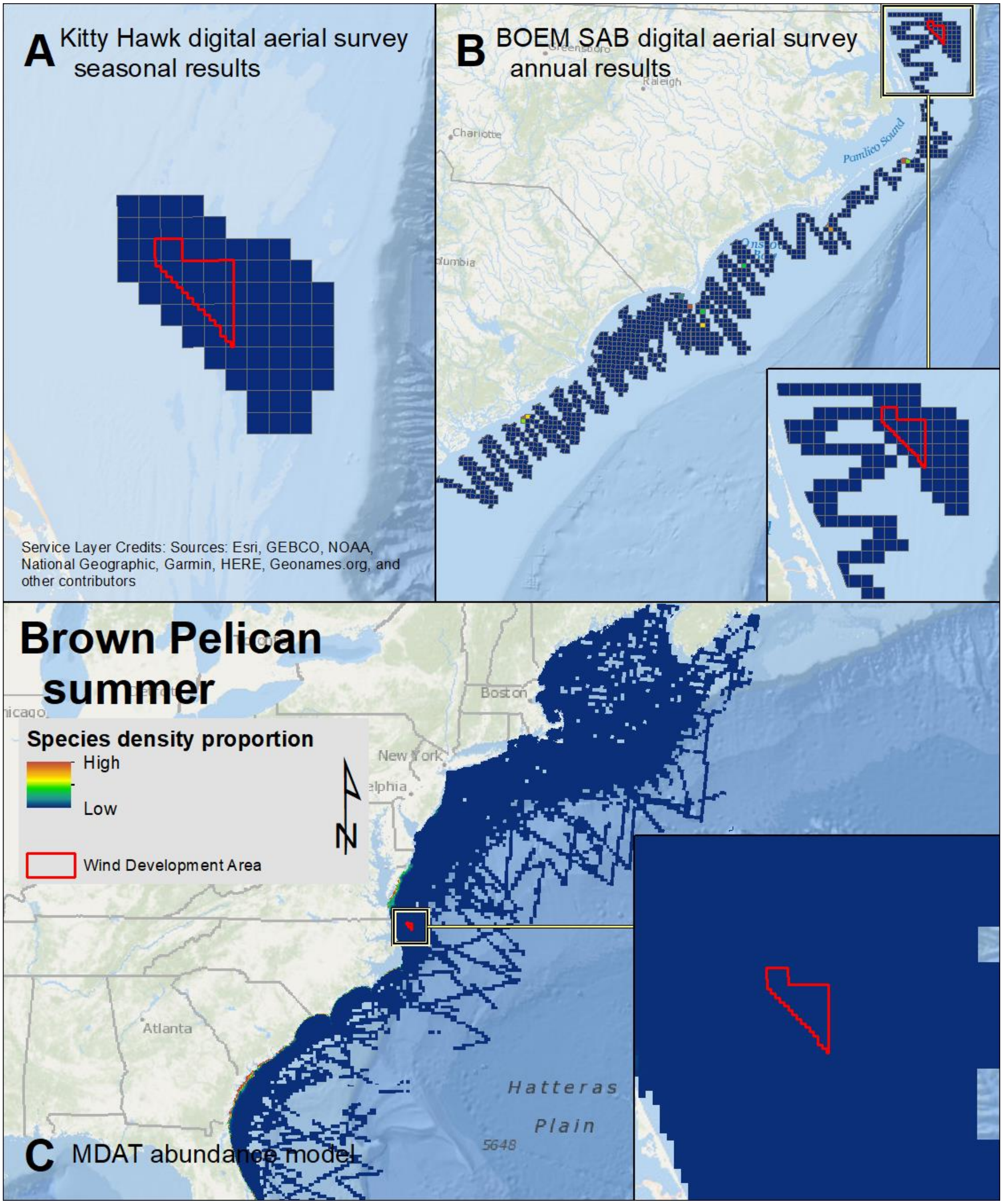
Map 154: Annual American White Pelican density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source. Error! Bookmark not defined.



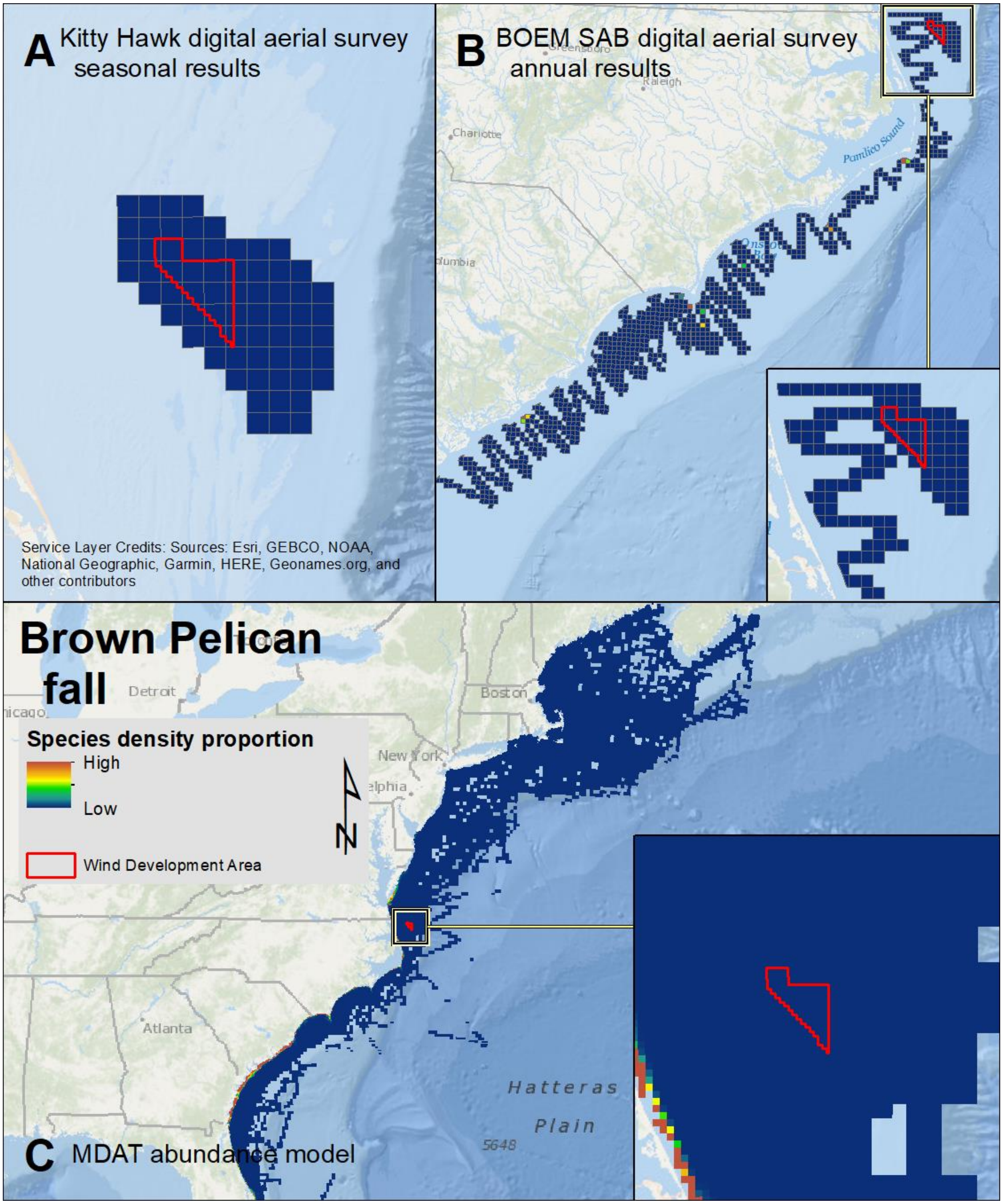
Map 155: Winter Brown Pelican density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



Map 156: Spring Brown Pelican density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local 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.Error! Bookmark not defined.



Map 157: Summer Brown Pelican density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local 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.Error! Bookmark not defined.



Map 158: Fall Brown Pelican density proportions in the Kitty Hawk APEM digital aerial surveys (A), annual density proportions in the BOEM SAB digital aerial baseline survey data (B), and seasonal density proportions in the MDAT data at local 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.Error! Bookmark not defined.