Offshore Wind Planning in the New York Bight:

Birds and Bats Study

NEW YORK STATE | NYSERDA New York State Energy Research and Development Authority

NYSERDA Report 25-08
February 2025

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Offshore Wind Planning in the New York Bight: Birds and Bats Study

Final Report

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Abstract

This study compiles and analyzes existing data on the presence of bird and bat species in regional waters greater than 60 meters deep off the coast of New York State that may be sensitive to offshore wind development. As part of this study, a spatial risk assessment was conducted to calculate exposure and vulnerability to different phases of offshore wind development in the Area of Analysis (AoA). This assessment used species densities that varied spatially and temporally, as well as took into consideration collision, displacement, and population sensitivity. Risk scores were scaled up or down based on life history traits such as bird flight heights, attraction, and avoidance of offshore wind energy facilities. The spatial risk assessment combined scores across species that used the AoA to produce an overall risk map and reveal areas of uncertainty that corresponded to areas of no boat-based or aerial survey effort, where tracking data was used to fill many of these data gaps. The findings suggest that the AoA is beyond the range of many breeding terrestrial and coastal bird and bat species but is frequented by several species of offshore migrants and pelagics, including some listed as threatened or endangered. Further monitoring could address knowledge gaps and evaluate the most appropriate mitigation of impacts from stressors on birds and bats within the region.

Keywords

avoidance, birds, bats, collision, displacement, exposure, impact-producing factors, minimization, mitigation, offshore wind, population, rotor swept zone, stressors, vulnerability

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Acronyms and Abbreviations

ADLS	Aircraft Detection Lighting Systems
AoA	Area of Analysis
BGEPA	Bald and Golden Eagle Protection Act
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CEQ	Council on Environmental Quality
COP	Construction and Operations Plan
CV	collision vulnerability
DBBMM	dynamic Brownian Bridge Movement Model
DFA	diurnal flight activity
DV	displacement vulnerability
EIS	Environmental Impact Statement
ESA	Endangered Species Act
E-TWG	New York State Environmental Technical Working Group
F-TWG	New York State Fisheries Technical Working Group
FAA	Federal Aviation Administration
GBIF	Global Biodiversity Information Facility
GPS	Global Positioning System
Master Plan	New York State Offshore Master Plan

MDAT	Marine-Life Data and Analysis Team
MBTA	Migratory Bird Treaty Act
MMP	Mitigation and Monitoring Practices
MW	megawatt
NCCOS	National Centers for Coastal Ocean Science
NEPA	National Environmental Policy Act
NFA	nocturnal flight activity
NOAA	National Oceanographic and Atmospheric Administration
NYSDEC	New York Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
NWASC	Northwest Atlantic Seabird Catalog
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OSS	offshore substation
OSW	offshore wind development
PAC	Project Advisory Committee
POP	regional population score
PTT	platform terminal transmitters
PV	population vulnerability
QA/QC	quality assurance and quality control
RSZ	rotor swept zone
SDJV	Sea Duck Joint Venture
SGCN	Species of Greatest Conservation Need
U.S.C.	United States Code
USCG	U.S. Coast Guard
USFWS	United States Fish & Wildlife Service
WTG	wind turbine generator

Executive Summary

In 2019, New York's historic Climate Leadership and Community Protection Act (Climate Act) was signed into law, requiring the State to achieve 100% zero-emission electricity by 2040 and to reduce greenhouse gas emissions 85% below 1990 levels by 2050. The law specifically mandates the development of 9,000 megawatts (MW) of offshore wind energy by 2035, building upon its previous goal of 2,400 MW of offshore wind energy by 2030. The New York State Energy Research and Development Authority (NYSERDA) is charged with advancing these goals.

Since the early 2000s, offshore wind development off New York's coast has advanced in relatively shallow areas in the New York Bight, on the Outer Continental Shelf (OCS). As offshore wind (OSW) development continues to mature and offshore wind leases are developed in deeper waters, the size and type of the offshore wind components are likewise expected to grow, and the project footprint will change as the use of floating OSW technology begins to be deployed. This may result in more changes in the types of potential effects and interactions seen to date for fixed-bottom offshore wind projects. NYSERDA is conducting studies to investigate the implications of developing floating offshore wind in deeper waters. Findings from the studies will be used to support the identification of areas that present the greatest opportunities and least risk for siting deepwater offshore wind projects, and other workstreams designed to help assure the continued responsible siting and development of offshore wind energy.

Five environmental desktop studies compile and analyze existing data on resources in the Area of Analysis (AoA) that may be sensitive to OSW development. Three zones comprise the AoA: Zone 1 is on the continental shelf (60 to 150 meters deep), Zone 2 is at the shelf break and slope (150 to 2,000 meters deep), and Zone 3 overlaps the continental rise (2,000 to 3,000 meters deep). This study develops a risk layer to inform the fifth report, an environmental sensitivity analysis, which combines marine birds with other marine resources into an overall risk map of environmental sensitivity. The sensitivity analysis ultimately identifies areas of greatest concern to environmental resources within the AoA in siting deepwater offshore floating wind projects.

This study includes a literature and data review, as well as a spatial risk assessment to describe stressors from all phases of OSW, and their effects on collision or displacement vulnerability. Stressors correspond to negative impact-producing factors during pre-construction, construction, post-construction (operation), and decommissioning. Collision, displacement, and population sensitivity comprise a vulnerability analysis that scores risk, based on life history traits. Life history traits include bird and bat behaviors,

such as flight heights, attraction, and avoidance of OSW. The vulnerability assessment also integrates an exposure analysis, which ranks species densities within the AoA from low to high. Calculations from version 2 of the Marine-Life Data and Analysis Team (MDAT) models generate exposure scores for 47 marine bird species that use the Atlantic Outer Continental Shelf. Exposure scores scale up or down based on collision, displacement, and population vulnerability, and produce an overall risk map when combined across species that use the AoA.

The spatial risk assessment synthesizes information on species and areas of high risk to OSW infrastructure, while revealing key knowledge gaps and uncertainties. For example, findings suggest that the AoA is beyond the range of many breeding terrestrial and coastal bird and bat species but is frequented by several species of offshore migrants and pelagics. However, the MDAT models used in the exposure assessment are based on boat and aerial survey data, which have effort gaps in the deepest zones of the AoA (Zones 2 and 3). These effort gaps result in risk uncertainty that could be resolved by gathering and analyzing additional tracking data. Automated radiotelemetry of smaller-bodied birds, satellite tagging of larger-bodied birds, and passive acoustic monitoring of bats could be conducted to address existing data gaps. Additional monitoring is also necessary to address knowledge gaps and evaluate the most appropriate mitigation of impacts on birds and bats in the region.

1 Introduction

For more than a decade, New York State has been conducting research, analysis, and outreach to evaluate the potential for offshore wind energy. New York State Energy Research and Development Authority (NYSERDA) led the development of the New York State Offshore Wind Master Plan (Master Plan), a comprehensive roadmap and suite of more than 20 studies for the first 2,400 megawatts (MW) of offshore wind energy. The Master Plan encourages the development of offshore wind in a manner that is sensitive to environmental, maritime, economic, and social issues while addressing market barriers and aiming to lower costs. The Master Plan included spatial studies to inform siting of offshore wind energy areas. Now, NYSERDA is undertaking new spatial studies to review the feasible potential for deepwater offshore wind development at or exceeding depths of 60 meters in the New York Bight.

Planning processes considering the development of offshore wind in the deepwater areas examined in each of NYSERDA's spatial studies must consider these studies in the context of one another. Decision making must additionally consider different stakeholders and uses and will require further adjusted approaches and offshore wind technologies to ensure the best outcome. Globally, deepwater wind technology is less mature and primarily concentrated on floating designs at the depth ranges being assessed through these spatial studies, while deepwater fixed foundations are at their upper technical limit within the Area of Analysis (AoA). Therefore, floating designs were predominantly considered since most, if not all, of the AoA would likely feature floating offshore wind. NYSERDA, along with other state and federal agencies, is developing the research and analysis necessary to take advantage of opportunities afforded by deepwater offshore wind energy by assessing available and emerging technologies and characterizing the cost drivers, benefits, and risks of floating offshore wind. Findings from these studies and available datasets will be used to support the identification of areas that present the greatest opportunities and least risk for siting deepwater offshore wind projects.

Offshore wind energy development is being introduced into a highly dynamic and human-influenced system. These reports seek to better understand the potential interaction of offshore wind development and marine wildlife and habitats; however, it is important to consider these within the broader context of climate change and existing land-based and marine activities. The State will continue to conduct research through its established Technical Working Groups (TWGs) concerning the key subjects of fishing, maritime commerce, the environment, environmental justice, jobs, and the supply chain. These

TWGs were designed to inject expert views and the most recent information into decision making. Taken together, the information assembled in these spatial studies will help empower New York State and its partners to take the informed steps needed to capitalize on the unique opportunity presented by offshore wind energy.

1.1 Spatial Studies to Inform Lease Siting

- Benthic Habitat Study
- Birds and Bats Study
- Deepwater Wind Technologies – Technical Concepts Study
- Environmental Sensitivity Analysis
- Fish and Fisheries Data Aggregation Study
- Marine Mammals and Sea Turtles Study
- Maritime Assessment – Commercial and Recreational Uses Study
- Offshore Wind Resource Assessment Study Zones 1 and 3
- Technology Assessment and Cost Considerations Study

Each of the studies was prepared in support of a larger planning effort and shared with relevant experts and stakeholders for feedback. The State addressed comments and incorporated feedback received into the studies. Feedback from these diverse groups helps to strengthen the studies, and also helps ensure that these work products will have broader applicability and a comprehensive view. Please note that assumptions have been made to estimate offshore wind potential and impacts in various methodologies across the studies. NYSERDA does not necessarily endorse any underlying assumptions in the studies regarding technology and geography including but not limited to turbine location, turbine layout, project capacity, foundation type, and point of interconnection.

The Energy Policy Act of 2005 amended Section 8 of the Outer Continental Shelf Lands Act (OCSLA) to give BOEM the authority to identify offshore wind development sites within the Outer Continental Shelf (OCS) and to issue leases on the OCS for activities that are not otherwise authorized by the OCSLA, including wind development. The State recognizes that all development in the OCS is subject to review processes and decision-making by BOEM and other federal and State agencies. This collection of spatial studies is not intended to replace the BOEM Wind Energy Area (WEA) identification process and does not commit the State or any other agency or entity to any specific course of action with respect to OSW energy development. Rather, the State's intent is to facilitate the principled planning of future offshore development off the New York State coast, provide a resource for the various stakeholders, and encourage the achievement of the State's offshore wind energy goals.

1.2 Study Area

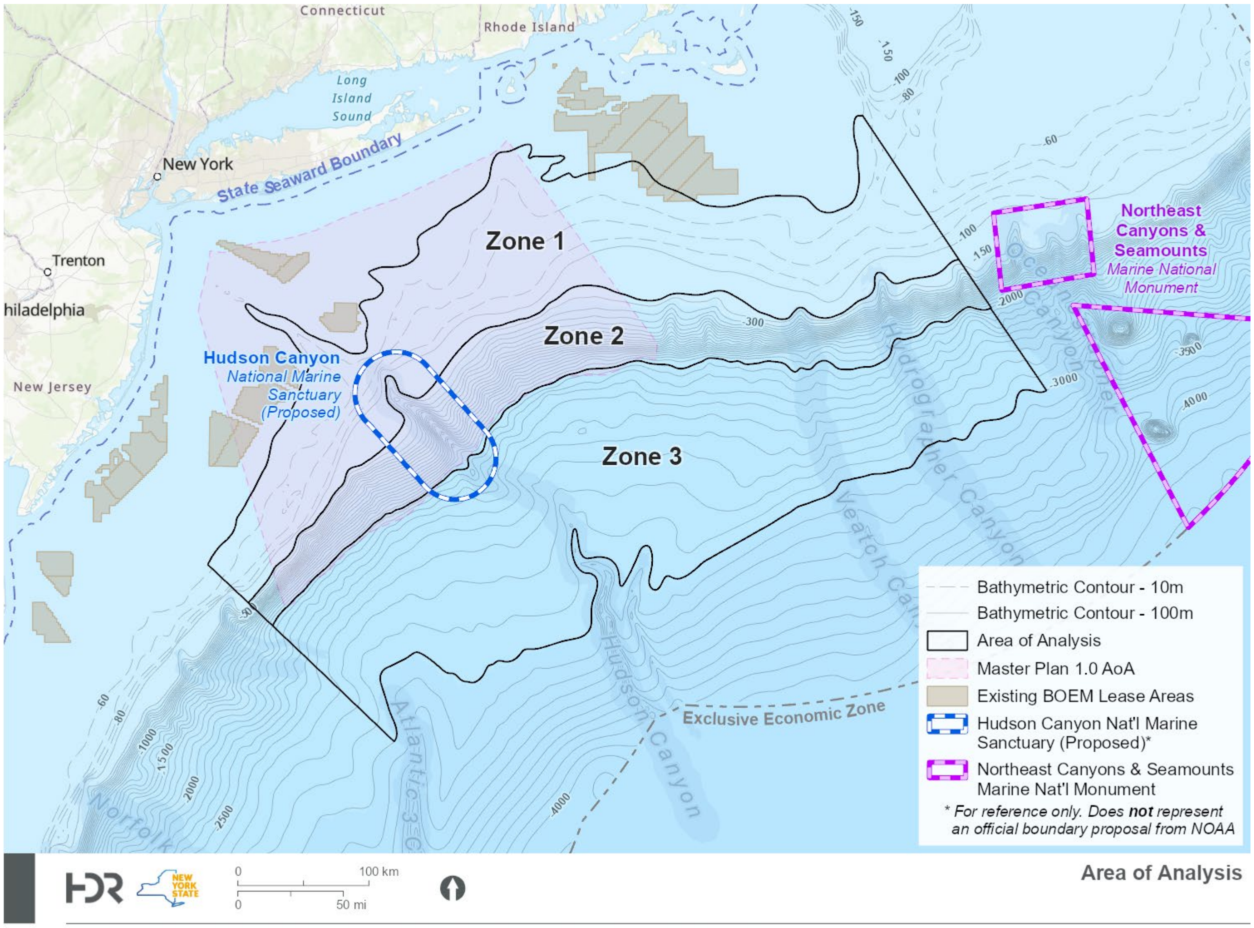
The spatial studies will evaluate potential areas for deepwater offshore wind development within a specific geographic Area of Analysis of approximately 35,670 square miles of ocean area extending from the coast of Cape Cod south to the southern end of New Jersey (Figure 1). It includes three zones extending outward from the 60-meter depth contour, which ranges between 15 and 50 nautical miles from shore to the 3,000-meter contour, which ranges from 140 to 160 nautical miles from shore.

The eastern edge of the AoA avoids Nantucket Shoals and portions of Georges Bank, since those areas are well known to be biologically and ecologically important for fish and wildlife, fisheries, and maritime activity. The AoA does include areas such as the Hudson Canyon, which is under consideration to be designated as a National Marine Sanctuary, and thus unlikely to be suitable for BOEM site leases. While offshore wind infrastructure will not be built across the entire AoA, the spatial studies analyze this broad expanse to provide a regional context for these resources and ocean uses.

- Zone 1 is closest to shore and includes a portion of the Outer Continental Shelf. It extends from the 60-meter contour out to the continental shelf break (60 meters [197 feet] to 150 meters [492 feet] deep). Zone 1 is approximately 12,040 square miles.
- Zone 2 spans the steeply sloped continental shelf break, with unique canyon geology and habitats (150 meters [492 feet] to 2,000 meters [6,561 feet] deep). Zone 2 is approximately 6,830 square miles.
- Zone 3 extends from the continental shelf break out to 3,000 meters (9,842 feet) depth. Zone 3 is approximately 16,800 square miles.

Zone 2, stretching across the steeply sloped continental shelf break with its distinctive canyon geology and unique habitats, is unlikely to host offshore wind turbines, but is still likely to be impacted by offshore wind development activities through maritime traffic and/or cabling and was therefore included in this study. The underwater canyons in this region are distinctive and ecologically significant, making Zone 2 an area of particular interest for scientific research, conservation efforts, and fish and benthic habitats. Another crucial factor prompting this analysis is the presence of electrical cabling in the area, which can have several environmental implications, including electromagnetic fields that might disrupt marine life and the physical disturbance of the seafloor during installation. Lastly, maritime vessel activities throughout the zone could involve shipping traffic, fishing, and other recreational activities related to the sea, which can introduce pollutants, noise, and physical disturbances such as vessel strikes that may have adverse effects on the surrounding environment.

Figure 1. Area of Analysis



CREDITS: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS, Esri, USGS, HDR Inc., BOEM, NYSERDA, NOAA Office of National Marine Sanctuaries

1.3 Study Objectives

The objectives of the Birds and Bats Study were:

1. Compile and synthesize the best available data and literature on bird and bat presence in the AoA (section 2).
2. Review and summarize the potential stressors associated with each phase of deepwater OSW and how they may affect birds and bats (section 3).
3. Assess the potential for risk of adverse impacts to birds and bats from OSW stressors in the AoA (section 4).
4. Describe the data gaps and uncertainties, including potential cumulative effects (section 5).
5. Provide guidance on current practices for avoiding, minimizing, and mitigating impacts to birds and bats from deepwater OSW (section 6).
6. Provide recommendations on areas and OSW activities of greatest risk to birds and bats and considerations for future research to better understand bird and bat presence and potential interactions with deepwater OSW (section 7).

This study is one of a series of environmental desktop studies that synthesize available and relevant existing data sets on four key resources groups: marine mammals and sea turtles, birds and bats, fish and fisheries, and benthic habitats. Each of these studies leverages information developed for the New York State Offshore Wind Master Plan (the Master Plan) and expands on the type of habitat and species within the AoA that are found in deep water and identifies potential stressors from different phases of OSW to each resource group, with a focus on deepwater technology. A fifth study builds upon and compiles the results from the four studies into a single environmental sensitivity analysis and presents a series of maps showing areas of greatest risk from OSW.

1.4 Agency and Stakeholder Engagement

The State is committed to engaging with stakeholders and incorporating stakeholder feedback into offshore wind planning processes. There were no stakeholder comments on the Birds and Bats Study from the Master Plan to incorporate into this study. State agency partners were engaged in development and review, and two stakeholder groups were consulted. A Project Advisory Committee (PAC), including subject matter experts, helped identify data sources and sensitivity receptor and rankings, and provided comments on the draft and final reports. Prior to the development of this report, the Birds and Bats PAC participated in conference calls to share technical details of the study content, including data and ranking criteria for the Environmental Sensitivity Analysis (NYSERDA, 2025). Conference call dates for the Birds and Bats PAC were on May 25, 2023, and June 27, 2023.

Additionally, NYSERDA's Environmental Technical Working Group (E-TWG) contributed to a preliminary list of data sources used in the development of this report and provided comments on the draft report. A kickoff call with the E-TWG was held on March 9, 2023, the study team was introduced to the E-TWG and the approach for each study was presented. Comments from the PAC and E-TWG were addressed in coordination with a second E-TWG meeting held on June 11, 2023, and, as practical, incorporated into the final report.

The State provided a first draft of this study for review to State and federal regulators, Technical Working Groups, and other stakeholders on August 7, 2023, and afforded these stakeholders the opportunity to submit written comments on the draft's contents. In addition, the E-TWG and F-TWG hosted meetings in September 2023, in which the study authors gave an overview of the document and fielded questions and concerns from participating organizations. In total, the State received 186 written and verbal comments from industry, the State, and non-governmental organizations.

One of the major comments addressed included the suggestion for inclusion of offshore eBird data (despite its limitations), which was added for the AoA, including 15 more bird species. Other comments reflected uncertainty, which was addressed by adding text to clarify how high uncertainty may accompany low-expected exposure or vulnerability of species to OSW. Additional figures were also included to address this point; for example, on historical observations of bats within the AoA. Prey quality/quantity was suggested as another stressor; however, this stressor was incorporated into the effects from bottom disturbance and new structures.

1.5 Regulatory Framework

The Outer Continental Shelf Lands Act (OCSLA; 43 United States Code [U.S.C.] §1331 et seq.) defined submerged lands under federal jurisdiction as the outer continental shelf and assigned authority for leasing to the Secretary of the Interior. In 2005, the Energy Policy Act (42 U.S.C. §13201 et seq.) amended the OCSLA to clarify uncertainties about offshore wind and granted development authority to the Secretary of the Interior. The BOEM Office of Renewable Energy Programs facilitates the responsible development of renewable energy resources on the OCS. These regulations provide a framework for issuing leases, easements, and rights-of-way for OCS activities that support production and transmission of energy from sources other than oil and natural gas. BOEM is currently in the planning and analysis phase of identifying deepwater wind energy areas off of New York State and New Jersey. This phase is to collect information, reduce potential conflicts of use, and identify areas that are potentially suitable for lease sale. BOEM conducts an environmental assessment once the wind energy areas are established.

Several federal statutes, regulations, and policies are pertinent to the future development of offshore wind facilities in the AoA. Specifically, those statutes relevant to the protection of birds and bats include the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Bald and Golden Eagle Protection Act (BGEPA), and the Migratory Bird Treaty Act of 1918 (MBTA). As part of the NEPA process, consultation with the United States Fish & Wildlife Service (USFWS) is required under Section 7 of the ESA for listed species. In 2021, the USFWS announced a proposed rulemaking to consider a permitting process for incidental take of migratory birds from offshore wind energy development.[1] With respect to project-specific guidance on data collection for site characterization, BOEM's Avian Survey Guidelines[2] provide recommendations for avian survey information required under BOEM's renewable energy regulations (30 CFR Part 585 Subpart F). In addition to issuing and managing leases, BOEM is responsible for conducting NEPA analyses and approving or disapproving most project-level plans, whereas the Bureau of Safety and Environmental Enforcement (BSEE) is generally responsible for enforcing operational safety. Although the AoA falls under federal jurisdiction, this study also takes into account species listed as threatened and endangered (e.g., New York Codes, Rules and Regulations Part 182), and/or as high priority Species of Greatest Conservation Need (SGCN), by the New York Department of Environmental Conservation (NYSDEC) and other neighboring State agencies.

2 Description of Birds and Bats in Area of Analysis

2.1 Data Sources

To describe bird and bat presence and use of the AoA, primary and secondary literature and data sources were compiled and reviewed based on PAC and E-TWG guidance, as well as precedent set in the United States NEPA process. This included Construction and Operations Plans (COPs), Environmental Impact Statements (EISs), Records of Decision, and Section 7 consultations under the ESA. The data review identified 24 sources for a spatial risk assessment (Table 1). Data were requested from providers who had tracked species offshore that were tagged in states neighboring the AoA (e.g., Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Rhode Island, and Virginia).

Data sources identified where, when, and how species were using the AoA. They included data from boat-based and aerial surveys, including passive acoustics, as well as tagging efforts (appendix A-B). The survey data provided information on bird and bat species densities, spatial extent, and seasonal occurrence.

Boat survey data documented the occurrence of birds and bats along the Atlantic Outer Continental Shelf. Passive acoustics deployed from boats in the New York Bight identified the presence of vocal bat species outside the AoA. For example, the Empire Wind project proposed in the New York Bight deployed passive acoustic bat detectors aboard vessels in 2018 (Tetra Tech 2022), and the University of Maryland Center for Environmental Science Acoustic Surveys deployed passive acoustic bat detectors (Anabat II) aboard five ships (research, fishing, and oceanic survey) operating during various time periods along the mid-Atlantic coast (Sjollema et al. 2014). Bat presence within the AoA from historical observations was obtained from peer-reviewed literature (Solick and Newman 2021). Community science observations from boat-based pelagic trips were used to identify bird species present within the AoA (Sullivan et al. 2009). Data from 2012–2023 within the general AoA were procured from the eBird Observational Dataset made available through the Global Biodiversity Information Facility (GBIF.org [26 September 2023] GBIF Occurrence Download[3]). Due to the unsystematic and unverifiable nature of community science data collection, pelagic seabirds with less than 10 observations were excluded from analysis.

Boat and aerial survey data used in Marine-Life Data and Analysis Team (MDAT) models produced seasonal predictions of bird density. These models were developed by the National Oceanic and Atmospheric Administration (NOAA), National Centers for Coastal Ocean Science (NCCOS), for BOEM to support Atlantic marine renewable energy planning. Version 2 of these models was available from Duke University's Marine Geospatial Ecology Lab.[4] The MDAT analysis integrated survey data (1978 to 2016) from the Northwest Atlantic Seabird Catalog (NWASC) with a range of environmental variables to produce long-term average annual and seasonal models. The MDAT models (Winship et al. 2018; Curtice et al. 2016) used boat-based and aerial survey data to predict the relative densities of 47 seabird species across the Atlantic Outer Continental Shelf, including the AoA (appendix B). The products of these models were the primary source used to inform the spatial risk assessment, due to their spatial coverage of the AoA, despite areas of no effort (see section 5.1.2.1).

NYSERDA collected digital aerial survey data on 76 bird species over 12 surveys, during four seasons across 3 years from 2016–2019 in the Master Plan study area (appendix B; NYSERDA 2021). While the NYSERDA digital aerial surveys did not identify any bat species, one bat species was detected during seven high-definition video aerial surveys and eight visual boat-based surveys of wildlife conducted in 2012 (Mid-Atlantic Baseline Study; Hatch et al. 2013).

Tagging efforts generated tracking data using the Motus Wildlife Network[5] (automated radiotelemetry for small-bodied birds) or Movebank[6] (geolocators and satellite transmitters for larger-bodied birds). Tracking data identified bird species distribution, use, and seasonal occurrence, and addressed data gaps in the survey data. Data were requested directly from contributors, except for the MDAT models, Jodice et al. 2015, and Spiegel et al. 2017, which were available on the Northeast Ocean Data Portal. While literature was reviewed to incorporate published regional tracking data, priority was placed on procuring unpublished data sources that used recently developed technologies (e.g., new high-resolution tags for small-bodied birds). Some data sets were requested, though not yet available publicly nor received in time for report release (e.g., for gull species). Despite thorough communications with subject matter experts to gather the best available data, the potential for missing data sources is acknowledged (see section 5). The tracking data procured for this Bird and Bat Study varied in effort (i.e., seasonal occurrence, number of individuals and years tagged), as well as tagging technology used. This resulted in variable spatiotemporal precision and accuracy that ranged from relatively low (e.g., automated radiotelemetry) to medium (e.g., geolocators) and high (satellite transmitters).

The USFWS compiled a Colonial Waterbird Database[7] containing two separate historic data sets on the locations and sizes of waterbird colonies. Colony data have been used in avian risk assessments to conduct foraging range analyses, where maximum foraging distances from colonies overlap with the study area (Stepanuk et al. 2022). However, the combination of the need for QA/QC and the distance of the deepwater AoA from known colonies rendered the Colonial Waterbird Database inutile for the purposes of characterizing the AoA. In some cases, the historic data sets overlapped, whereas in others they complemented each other. For example, one major colony was missing from one data set in one year, and another major colony was missing from the other data set in a different year, for key species (e.g., roseate terns). Such missing data are necessary to conduct a foraging range analysis of historic colony locations where colony sizes differentiate between major and minor colonies; however, this is not possible with inconsistent colony counts among each data set. Therefore, these data should undergo QA/QC by authoritative sources like colony managers to be reliably incorporated into future analyses (see section 7). Nevertheless, the deepwater AoA is beyond the foraging range of most breeders from major colonies (including roseate terns), and the few pelagic breeders that use the AoA nest in burrows within cryptic colony locations that are not well-documented. Without more comprehensive and reliable colony data, future foraging range analyses of the AoA are low priority.

Table 1. Summary of Data Sources Used in the Spatial Risk Assessment

Data	Source[a]	Species[b]
Acoustics	Solick and Newman 2021	Eastern Red and Silver-haired Bat
Acoustics	Tetra Tech 2022	Eastern Red, Big Brown, Hoary, Silver-haired Bat
Acoustics	Sjollema et al. 2014	Multiple Bat Spp.
Aerial Survey	Hatch et al. 2013	Eastern Red Bat
Boat Survey	Northwest Atlantic Seabird Catalog	Flight heights of 47 Marine Bird Species
Boat-based and Aerial Survey	Winship et al. 2018	Models of 47 Marine Bird Species
Boat-based pelagic trips	Sullivan et al. 2009	Multiple bird species
Aerial Survey	NYSERDA 2021	76 bird species
Tracking	Loring et al. 2020	12 Shorebird Species, including Red Knot
Tracking	Loring et al. 2019	Piping Plover, Roseate Tern, Common Tern

Table 1 continued

Data	Source[a]	Species[b]
Tracking	Jodice et al. 2015, Satgé et al. 2023	Black-Capped Petrel
Tracking	Raine et al. 2021, Campioni 2023	Bermuda Petrel
Tracking	Baran et al. 2022	Atlantic Puffin
Tracking	Yakola 2022	Leach's Storm-Petrel
Tracking	Powers et al. 2020	Great Shearwater
Tracking	Spiegel et al. 2017, Stenhouse et al. 2020	North Gannet, Red-Throated Loon, Surf Scoter
Tracking	Sea Duck Joint Venture	Surf, Black and White-Winged Scoter, Long-Tailed Duck, Common Eider
Tracking	Maine Department of Inland Fisheries & Wildlife	Great Blue Heron
Tracking	Bierregaard 2019	Osprey
Tracking	DeSorbo et al. 2015, 2022	Peregrine Falcon, Merlin

[a] Note: Identifies where, when, and how species are using AoA. Survey data feed into risk maps for Environmental Sensitivity Analysis (NYSERDA, 2024 24-01j). Tracking data address gaps in survey data.

[b] For scientific names of species, see Table 2 and Table 3.

2.2 Species Presence

This study identified the presence of four bat species in the New York Bight that potentially occur in the AoA (Table 2), as well as 78 bird species known to be present within the AoA, including those protected under the ESA and MBTA (Table 3). For comparison, the Master Plan discussed eight species of bats and 39 species of marine birds that regularly occur in the New York Bight (western portions of Zones 1 and 2 of this study's AoA; NYSERDA 2017). Later, digital aerial survey data identified 76 bird species in the Master Plan study area (NYSERDA 2021); those species included the marine birds discussed in the Master Plan, as well as species less common in the offshore environment such as waterfowl, raptors, shorebirds, and passerines. Species recorded in the NYSERDA digital aerial surveys but not expected in this study's AoA included nearshore swan, duck, waterbird, shorebird, raptor, and passerine species. A single passerine species was identified in the NYSERDA digital aerial surveys, and due to the unsystematic and incidental nature of community science data, eBird records on passerines were not included in this assessment. Species documented in this study's AoA but not in the NYSERDA digital aerial surveys were primarily pelagic seabirds. This study assessed which of those species are most likely to use Zones 1-3 of the AoA as a migratory corridor or as ecological habitat (e.g., for important functions like foraging and resting).

The spatial risk assessment (section 4) analyzed bats and a subset of birds known to be present within the AoA, focusing on 47 marine bird species that regularly use the AoA (Table 3). Marine birds frequently use marine habitat to forage for marine invertebrates and fish resources, unlike non-marine birds and bats, which only frequent offshore areas during transit or migration. The marine bird species incorporated into the spatial risk assessment were identified in survey data and analyzed in the MDAT models, including one federally listed seabird species (roseate tern, ESA endangered).

The 31 other bird species and nine bat species considered in this study, but not incorporated into the data layer products of the spatial risk assessment due to lack of data and confidence, included both listed and unlisted species. They were not identified in surveys but identified in eBird or tracked with either radiotelemetry or satellite tags through or near the AoA. Two ESA-listed shorebird species migrate across the AoA: red knots and piping plovers are federally listed as threatened.

Table 2. Bat Species Present in the Vicinity of the Area of Analysis, Conservation Status, and Federal Endangered Species Act Listing Status

Source: New York Department of Environmental Conservation [NYSDEC] 2019a

Common Name	Scientific Name	Type [a]	NY State Status	Federal Status	Where Recorded[b]
Eastern small-footed bat	*Myotis leibii*	Cave-Hibernating Bat	SC		
Little brown bat	*Myotis lucifugus*	Cave-Hibernating Bat	SGCN	Under Review	
Northern long-eared bat	*Myotis septentrionalis*	Cave-Hibernating Bat	E	E	
Indiana bat	*Myotis sodalis*	Cave-Hibernating Bat	E	E	
Tri-colored bat	*Perimyotis subflavus*	Cave-Hibernating Bat	SGCN	*P*	
Big brown bat	*Eptesicus fuscus*	Cave-Hibernating Bat			NY Bight
Eastern red bat	*Lasiurus borealis*	Migratory Tree-Roosting Bat			AoA
Hoary bat	*Lasiurus cinereus*	Migratory Tree-Roosting Bat			NY Bight
Silver-haired bat	*Lasionycteris noctivigans*	Migratory Tree-Roosting Bat			AoA

[a] Note: Identifies where, when, and how species are using AoA. Survey data feed into risk maps for Environmental Sensitivity Analysis (NYSERDA, 2025). Tracking data address gaps in survey data.

[b] NY Bight refers to the Master Plan study area (where bats were recorded in the vicinity of, but not within, the AoA).

Table 3. Bird Species Present in the Area of Analysis and Federal Endangered Species Act Listing Status

Common Name	Group	Order	Family	Subfamily[a]	*Genus species*	ESA Status[b]	MDAT	Use of AoA[d]
Long-tailed Duck	Sea ducks	Anseriformes	Anatidae	Anatinae	*Clangula hyemalis*	—	Yes	Marine
Black Scoter	Sea ducks	Anseriformes	Anatidae	Anatinae	*Melanitta americana*	—	Yes	Marine
White-winged Scoter	Sea ducks	Anseriformes	Anatidae	Anatinae	*Melanitta deglandi*	—	Yes	Marine
Surf Scoter	Sea ducks	Anseriformes	Anatidae	Anatinae	*Melanitta perspicillata*	—	Yes	Marine
Red-breasted Merganser	Sea ducks	Anseriformes	Anatidae	Anatinae	*Mergus serrator*	—	Yes	Marine
Common Eider	Sea ducks	Anseriformes	Anatidae	Anatinae	*Somateria mollissima*	—	Yes	Marine
Brant	Geese	Anseriformes	Anatidae	Anserinae	*Branta bernicla*	—	No	Migrant
Canada Goose	Geese	Anseriformes	Anatidae	Anserinae	*Branta canadensis*	—	No	Migrant
Razorbill	Auks	Charadriiformes	Alcidae	n/a	*Alca torda*	—	Yes	Marine
Dovekie	Auks	Charadriiformes	Alcidae	n/a	*Alle alle*	—	Yes	Marine
Black Guillemot	Auks	Charadriiformes	Alcidae	n/a	*Cepphus grylle*	—	Yes	Marine
Atlantic Puffin	Auks	Charadriiformes	Alcidae	n/a	*Fratercula arctica*	—	Yes	Marine
Common Murre	Auks	Charadriiformes	Alcidae	n/a	*Uria aalge*	—	Yes	Marine
Thick-billed Murre	Auks	Charadriiformes	Alcidae	n/a	*Uria lomvia*	—	Yes	Marine
Black Tern	Terns	Charadriiformes	Laridae	Sterninae	*Chlidonias niger*	—	No	Migrant
Bridled Tern	Terns	Charadriiformes	Laridae	Sterninae	*Onychoprion anaethetus*	—	Yes	Marine
Sooty Tern	Terns	Charadriiformes	Laridae	Sterninae	*Onychoprion fuscatus*	—	Yes	Marine
Roseate Tern	Terns	Charadriiformes	Laridae	Sterninae	*Sterna dougallii*	Endangered	Yes	Marine
Forster's Tern	Terns	Charadriiformes	Laridae	Sterninae	*Sterna forsteri*	—	No	Marine
Common Tern	Terns	Charadriiformes	Laridae	Sterninae	*Sterna hirundo*	—	Yes	Marine
Arctic Tern	Terns	Charadriiformes	Laridae	Sterninae	*Sterna paradisaea*	—	Yes	Marine
Least Tern	Terns	Charadriiformes	Laridae	Sterninae	*Sternula antillarum*	—	Yes	Marine
Royal Tern	Terns	Charadriiformes	Laridae	Sterninae	*Thalasseus maximus*	—	Yes	Marine
Bonaparte's Gull	Gulls	Charadriiformes	Laridae	Larinae	*Chroicocephalus philadelphia*	—	Yes	Marine
Herring Gull	Gulls	Charadriiformes	Laridae	Larinae	*Larus argentatus*	—	Yes	Marine
Ring-billed Gull	Gulls	Charadriiformes	Laridae	Larinae	*Larus delawarensis*	—	Yes	Marine
Lesser Black-backed Gull	Gulls	Charadriiformes	Laridae	Larinae	*Larus fuscus*	—	No	Marine
Iceland Gull	Gulls	Charadriiformes	Laridae	Larinae	*Larus glaucoides*	—	No	Marine
Glaucous Gull	Gulls	Charadriiformes	Laridae	Larinae	*Larus hyperboreus*	—	No	Marine
Great Black-backed Gull	Gulls	Charadriiformes	Laridae	Larinae	*Larus marinus*	—	Yes	Marine
Laughing Gull	Gulls	Charadriiformes	Laridae	Larinae	*Leucophaeus atricilla*	—	Yes	Marine
Black-legged Kittiwake	Gulls	Charadriiformes	Laridae	Larinae	*Rissa tridactyla*	—	Yes	Marine
Long-tailed Jaeger	Jaegers	Charadriiformes	Stercorariidae	n/a	*Stercorarius longicaudus*	—	No	Marine
Parasitic Jaeger	Jaegers	Charadriiformes	Stercorariidae	n/a	*Stercorarius parasiticus*	—	Yes	Marine
Pomarine Jaeger	Jaegers	Charadriiformes	Stercorariidae	n/a	*Stercorarius pomarinus*	—	Yes	Marine

Table 3 (continued)

Common Name	Group	Order	Family	Subfamily[a]	*Genus species*	ESA Status[b]	MDAT[c]	Use of AoA[d]
South Polar Skua	Skuas	Charadriiformes	Stercorariidae	n/a	*Stercorarius maccormicki*	—	Yes	Marine
Great Skua	Skuas	Charadriiformes	Stercorariidae	n/a	*Stercorarius skua*	—	Yes	Marine
Common Loon	Loons	Gaviiformes	Gaviidae	n/a	*Gavia immer*	—	Yes	Marine
Red-throated Loon	Loons	Gaviiformes	Gaviidae	n/a	*Gavia stellata*	—	Yes	Marine
Great Shearwater	Shearwaters	Procellariiformes	Procellariidae	n/a	*Ardenna gravis*	—	Yes	Marine
Sooty Shearwater	Shearwaters	Procellariiformes	Procellariidae	n/a	*Ardenna grisea*	—	Yes	Marine
Cory’s Shearwater	Shearwaters	Procellariiformes	Procellariidae	n/a	*Calonectris diomedea*	—	Yes	Marine
Audubon’s Shearwater	Shearwaters	Procellariiformes	Procellariidae	n/a	*Puffinus lherminieri*	—	Yes	Marine
Manx Shearwater	Shearwaters	Procellariiformes	Procellariidae	n/a	*Puffinus puffinus*	—	Yes	Marine
Northern Fulmar	Fulmars	Procellariiformes	Procellariidae	n/a	*Fulmarus glacialis*	—	Yes	Marine
Trindade Petrel	Petrels	Procellariiformes	Procellariidae	n/a	*Pterodroma arminjoniana*	—	No	Marine
Bermuda Petrel	Petrels	Procellariiformes	Procellariidae	n/a	*Pterodroma cahow*	Endangered	No	Marine
Fea's Petrel	Petrels	Procellariiformes	Procellariidae	n/a	*Pterodroma feae*	—	No	Marine
Black-capped Petrel	Petrels	Procellariiformes	Procellariidae	n/a	*Pterodroma hasitata*	Threatened (proposed)	Yes	Marine
Band-rumped Storm-petrel	Storm-petrels	Procellariiformes	Hydrobatidae	n/a	*Hydrobates castro*	—	Yes	Marine
Leach’s Storm-petrel	Storm-petrels	Procellariiformes	Hydrobatidae	n/a	*Hydrobates leucorhous*	—	Yes	Marine
Wilson’s Storm-petrel	Storm-petrels	Procellariiformes	Oceanitidae	n/a	*Oceanites oceanicus*	—	Yes	Marine
White-faced Storm-Petrel	Storm-petrels	Procellariiformes	Oceanitidae	n/a	*Pelagodroma marina*	—	No	Marine
Northern Gannet	Gannets	Suliformes	Sulidae	n/a	*Morus bassanus*	—	Yes	Marine
Masked Booby	Boobies	Suliformes	Sulidae	n/a	*Sula dactylatra*	—	No	Marine
Brown Booby	Boobies	Suliformes	Sulidae	n/a	*Sula leucogaster*	—	No	Marine
Double-crested Cormorant	Cormorants	Suliformes	Phalacrocoracidae	n/a	*Nannopterum auritum*	—	Yes	Marine
Great Cormorant	Cormorants	Suliformes	Phalacrocoracidae	n/a	*Phalacrocorax carbo*	—	No	Marine
Brown Pelican	Pelicans	Pelecaniformes	Pelecanidae	n/a	*Pelecanus occidentalis*	—	Yes	Marine
Horned Grebe	Grebes	Podicipediformes	Podicipedidae	n/a	*Podiceps auritus*	—	Yes	Marine
Red Phalarope	Phalaropes	Charadriiformes	Scolopacidae	Tringinae	*Phalaropus fulicarius*	—	Yes	Marine
Red-necked Phalarope	Phalaropes	Charadriiformes	Scolopacidae	Tringinae	*Phalaropus lobatus*	—	Yes	Marine
Red Knot	Shorebirds	Charadriiformes	Scolopacidae	Arenariinae	Calidris canutus	Threatened	No	Migrant
Piping Plover	Shorebirds	Charadriiformes	Charadriidae	Charadriinae	Charadrius melodus	Threatened	No	Migrant
Semipalmated Plover	Shorebirds	Charadriiformes	Charadriidae	n/a	Charadrius semipalmatus	—	No	Migrant
Semipalmated Sandpiper	Shorebirds	Charadriiformes	Charadriidae	n/a	Calidris pusilla	—	No	Migrant

Table 3 (continued)

Common Name	Group	Order	Family	Subfamily[a]	*Genus species*	ESA Status[b]	MDAT[c]	Use of AoA[d]
White-rumped Sandpiper	Shorebirds	Charadriiformes	Charadriidae	n/a	*Calidris fuscicollis*	—	No	Migrant
Pectoral Sandpiper	Shorebirds	Charadriiformes	Charadriidae	n/a	*Calidris melanotos*	—	No	Migrant
Sanderling	Shorebirds	Charadriiformes	Charadriidae	n/a	*Calidris alba*	—	No	Migrant
Dunlin	Shorebirds	Charadriiformes	Charadriidae	n/a	*Calidris alpina*	—	No	Migrant
Ruddy Turnstone	Shorebirds	Charadriiformes	Charadriidae	n/a	*Arenaria interpres*	—	No	Migrant
Whimbrel	Shorebirds	Charadriiformes	Charadriidae	n/a	*Numenius phaeopus*	—	No	Migrant
Black-bellied Plover	Shorebirds	Charadriiformes	Charadriidae	n/a	*Pluvialis squatarola*	—	No	Migrant
Lesser Yellowlegs	Shorebirds	Charadriiformes	Charadriidae	n/a	*Tringa flavipes*	—	No	Migrant
Great Blue Heron	Wading Birds	Pelecaniformes	Ardeidae	n/a	*Ardea herodias*	—	No	Migrant
Osprey	Raptors	Accipitriformes	Pandionidae	n/a	*Pandion haliaetus*	—	No	Migrant/ Marine
Peregrine Falcon	Raptors	Falconiformes	Falconidae	n/a	*Falco peregrinus*	—	No	Migrant
Merlin	Raptors	Falconiformes	Falconidae	n/a	*Falco columbarius*	—	No	Migrant

[a] "n/a" conveys that Subfamily is not applicable.

[b] "—" conveys that the Endangered Species Act (ESA) does not list the ESA Status.

[c] Marine-Life Data and Analysis Team (MDAT) species were marine birds analyzed in the spatial risk assessment (section 4); non-MDAT species were included in this table based on other studies.

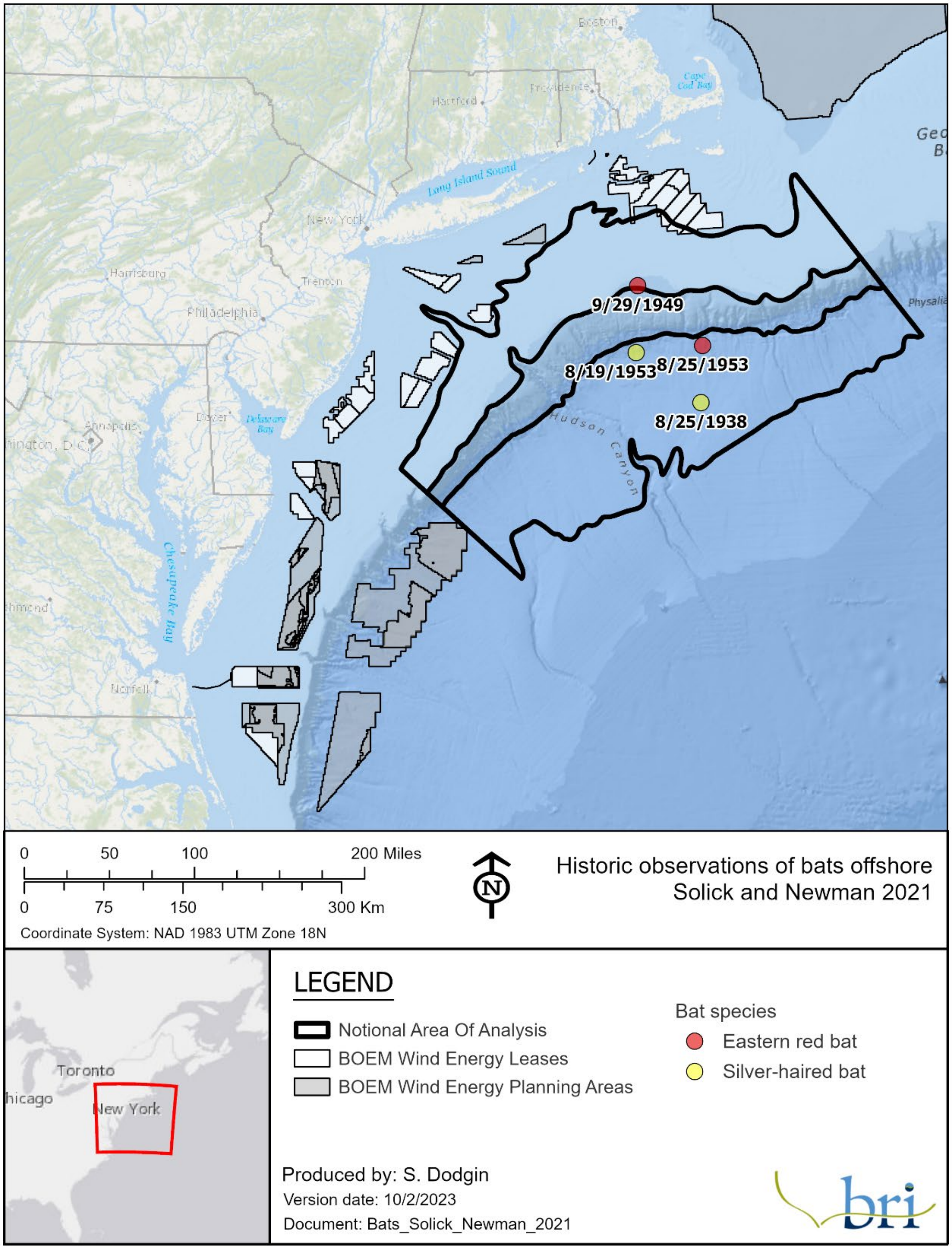
[d] Marine birds frequently use marine habitat to forage for marine invertebrates and fish resources, unlike bird and bat migrants, which only frequent offshore areas during transit or migration.

2.3 Overview of Bats in the Area of Analysis

A relatively low level of bat activity has been recorded in the AoA because of its distance from shore. In general, bats are not expected to regularly forage in the AoA, but some may be present during migration, particularly in the fall (Tetra Tech 2022; Environmental Design and Research 2021; Hein et al. 2021; Bureau of Ocean Energy Management 2012). Migratory tree-roosting bats are more likely to be found offshore than cave-hibernating bats, and do not include federal and/or state-listed species of concern (unlike cave-hibernating bats).

Bats have been documented in the marine environment in the U.S. (Grady and Olson 2006; Cryan and Brown 2007; J. B. Johnson, Gates, and Zegre 2011; Hatch et al. 2013; Pelletier et al. 2013; Stantec 2016; Z. R. Dowling and O'Dell 2018), and in Europe (Boshamer and Bekker 2008; Ahlén et al. 2009; Lagerveld et al. 2015). They have been observed to temporarily roost on structures on nearshore islands, such as lighthouses (Dowling et al. 2017), and there is evidence of bats, particularly eastern red bats, migrating offshore in the Atlantic (Hatch et al. 2013). Evidence exists of bats visiting wind turbines offshore (2.5 to 42.9 miles [4 to 69 kilometers]) in the Baltic and North Seas (Ahlén, Baagøe, and Bach 2009; Rydell and Wickman 2015; Lagerveld et al. 2017). All recorded instances of North American bats flying over open ocean have occurred in the Atlantic region between Nova Scotia and North Carolina, with visual observations occurring between 1.6 and 507 miles (2.6 to 817 kilometers) from the nearest land (Solick and Newman 2021; Figure 2). Historical records of a single Eastern red and silver-haired bat occurred in Zone 3 in August 1939 and 1953. In September 1949, an observation "estimated at about 200" of Eastern red bats occurred in Zone 1. It is unknown whether such historical records remain incidental, due to the lack of more recent data in the AoA.

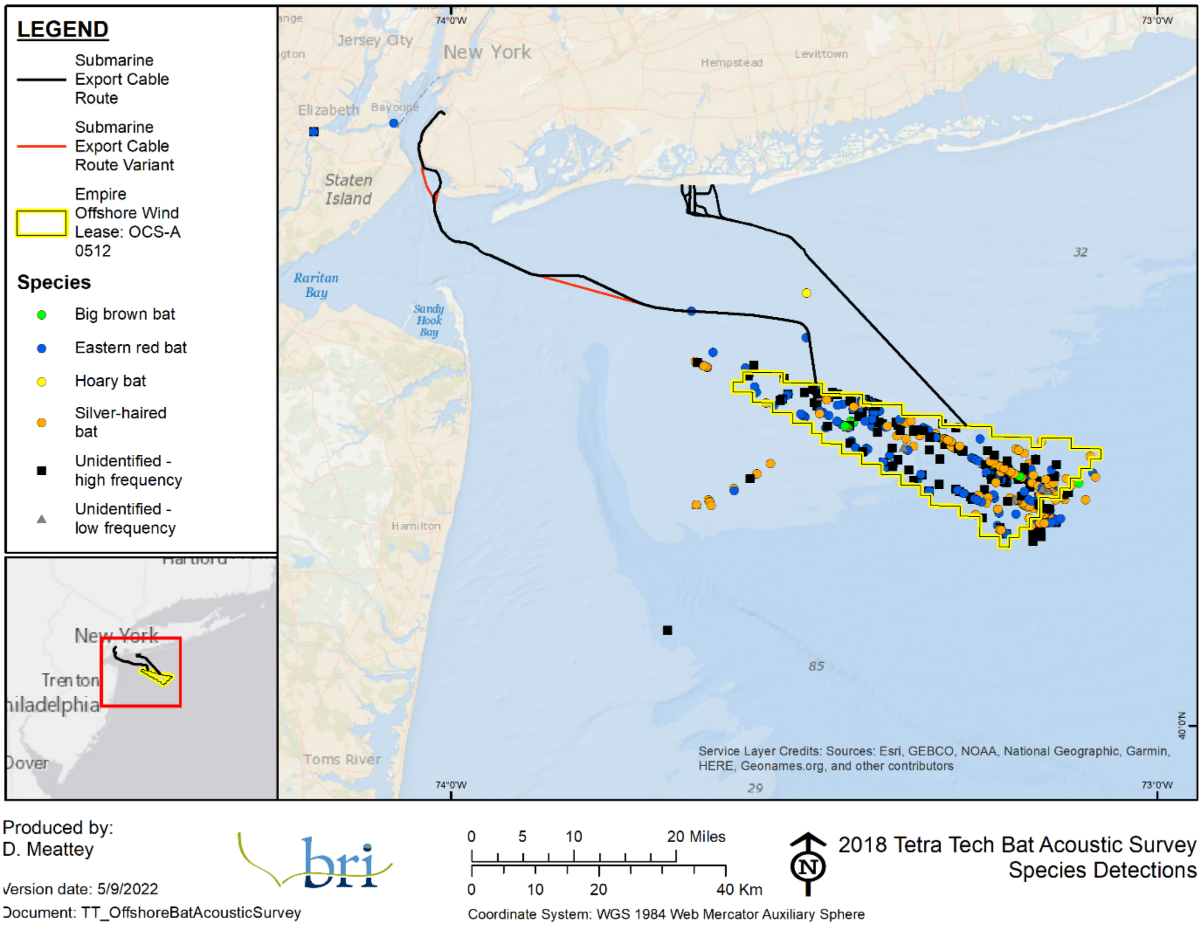
Figure 2. Historical Observations of Bats in the Area of Analysis



While there remain data gaps on offshore bat movements, available data indicate that bat activity levels are generally lower offshore than onshore or nearshore (Hein et al. 2021). 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 13.6 miles (21.9 kilometers), and the mean distance was 5.2 miles (8.4 kilometers, n = 166 bat detections; Sjollema et al. 2014). In Maine, bats were detected on islands up to 25.8 miles (41.6 kilometers) from the mainland (Peterson et al. 2014). New Jersey Department of Environmental Protection Environmental Baseline Surveys have identified bat activity as far as 15.5 miles (25 kilometers) offshore of New Jersey. Bird and bat monitoring (August 2021 to November 2021) for Dominion Energy's Coastal Virginia Offshore Wind project, 27 miles off the coast of Virginia Beach, Virginia, detected Eastern red, silver-haired and hoary bats (Normandeau Associates 2022a). Data from NYSERDA metocean buoys deployed within the New York Bight recorded only 10 calls (nine identified silver-haired bats and one unknown low-frequency call [i.e., non-*Myotis* species]) from August 2019 to June 2022, all of which occurred between August and October (Normandeau Associates 2022b). The Empire Wind project in the New York Bight (Tetra Tech 2022) detected four bat species within the lease area in 2018 (17-229 passes from June to November; Figure 3). However, this lease area is located outside the AoA, approximately 15 miles (25 kilometers) offshore, and approximately 20 miles (30 kilometers) north of the Hudson Shelf Valley extension of the AoA in Zone 1. Acoustic bat detectors deployed aboard research vessels at sea have detected bat activity in the vicinity of the AoA (near Zone 1), up to 81 miles (130 kilometers) east of New Jersey and 68 miles (110 km) south of Long Island (Stantec 2016); these included two detections identified as either big brown or silver-haired bats and three detections identified as eastern red bats.

Figure 3. Eastern Red, Big Brown, Hoary, and Silver-Haired Bats Observed during Acoustic Surveys Aboard Boats in the New York Bight

Source Tetra Tech 2022, Appendix R.



2.3.1 Cave-Hibernating Bats

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 migratory tree-roosting bats (Sjollema et al. 2014), with offshore movements primarily during the fall (Peterson et al. 2014; Stantec 2016). Acoustic studies generally indicate lower use of the offshore environment by cave-hibernating bats as compared to tree-roosting species.

In a Mid-Atlantic study, the maximum distance *Myotis* species were detected offshore was 7 miles (11.5 kilometers; Sjollema et al. 2014). A nano-tracking study on Martha's Vineyard recorded little brown bat (n = 3) movements off the island in late August and early September, with one individual flying 4 to 9 miles (6.4 to 14.5 kilometers) from Martha's Vineyard to Cape Cod (Dowling et al. 2017). Big brown bats (n = 2) were also detected migrating from Martha's Vineyard later in the year (October–November; Dowling et al. 2017). Peterson et al. (2014) deployed acoustic detectors on islands and buoys in the Gulf of Maine and detected the largest percentage of migration activity along the coastline as a migratory pathway for cave-hibernating bats between July and October. However, cave-hibernating bats can use the offshore environment for foraging and even roosting at considerable distances from shore. Fishermen in the Gulf of Maine reported *Myotis* bats (unknown species, though likely little brown bats) roosting on their fishing ship and long-line buoys 68 miles (110 kilometers) from the nearest land (Thompson et al. 2015). This rare event occurred during calm weather conditions, suggesting that these bats were not blown off course or lost.

While significant uncertainty remains about bat use in the AoA, based on the literature, bat use of the AoA by cave-hibernating bats is unlikely. This is supported by BOEM's analysis of Ocean Wind 1 and other U.S. offshore wind farms that found that cave-hibernating bats do not typically occur offshore (Bureau of Ocean Energy Management 2023).

2.3.2 Migratory Tree-Roosting Bats

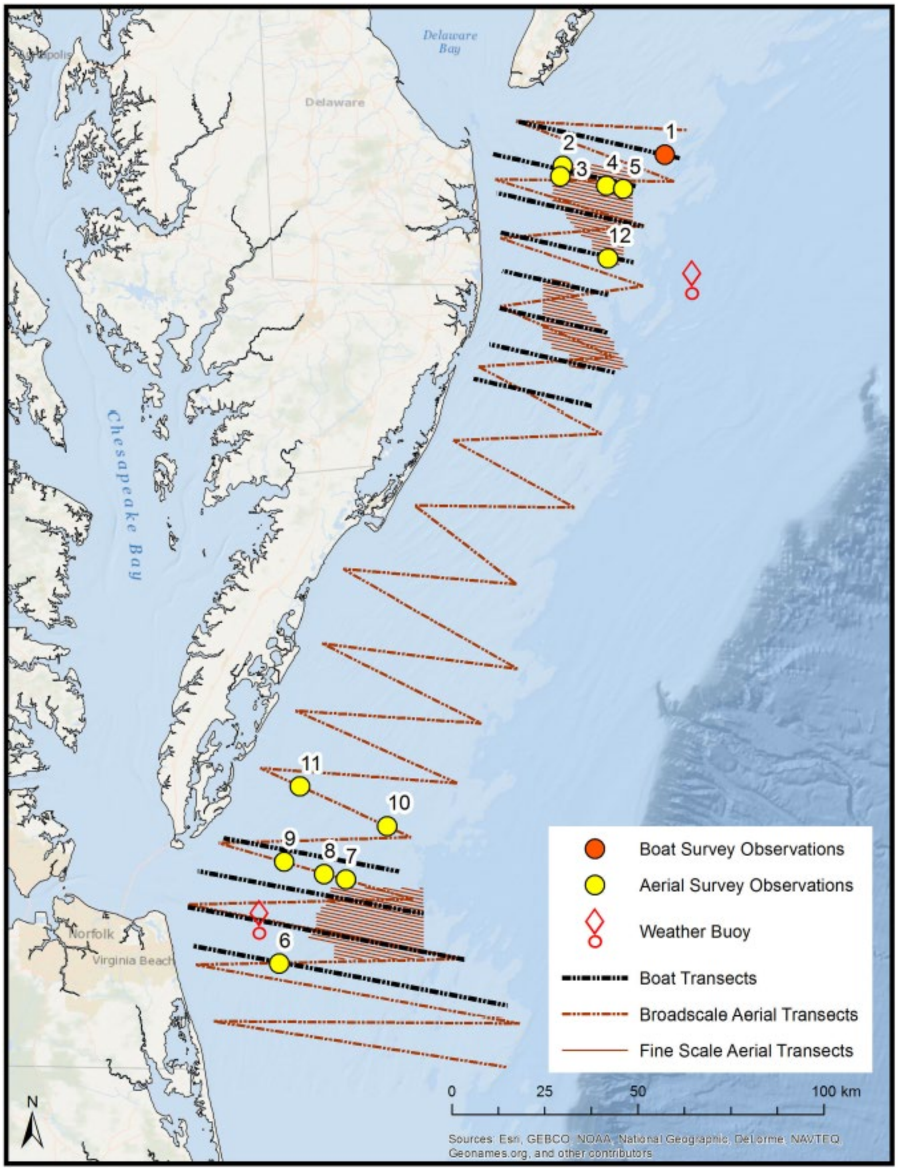
Migratory tree-roosting bats generally migrate from northeastern U.S. to southwestern and southern parts of the U.S. to overwinter (Cryan 2003; Wieringa et al. 2021). Rhode Island Acoustic Studies deployed acoustic bat detectors at seven locations within the Rhode Island National Wildlife Refuge Complex in southern Rhode Island (Smith and McWilliams 2016). The most commonly identified calls belonged to eastern red bats and silver-haired bats from 47,611 bat detections recorded across 775 detector nights. Eastern red bats were detected in the Mid-Atlantic outside of the AoA, up to 26 miles (41.8 kilometers) offshore by high-resolution digital video aerial surveys in September 2012 (Figure 4; Hatch et al. 2013). These bats were all observed in September off 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, indicating that individuals of this species can travel at least 280 miles (450 kilometers) over water in a single night (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).

As with cave-hibernating bats, there is significant uncertainty about offshore movements, though migratory tree-roosting bats have been documented in the offshore environment (Hatch et al. 2013; True et al. 2021). Based on the literature and recognizing the uncertainty, if tree bats occur in the AoA it is likely limited to migration period (late summer/early fall); although their use of the AoA is expected to be limited because of the distance from shore (Bureau of Ocean Energy Management 2023).

Figure 4. Eastern Red Bats Observed from Aerial Survey Data

The transects shown are outside the AoA, and the lease areas shown are, from north to south, OCS-A 0482 (Garden State Offshore Energy I, LLC), OCS-A 0519 (Skipjack Offshore Energy, LLC), OCS-A 0490 (US Wind Inc.), and OCS-A 0483 (Virginia Electric and Power Company).

Source: Hatch et al. 2013



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

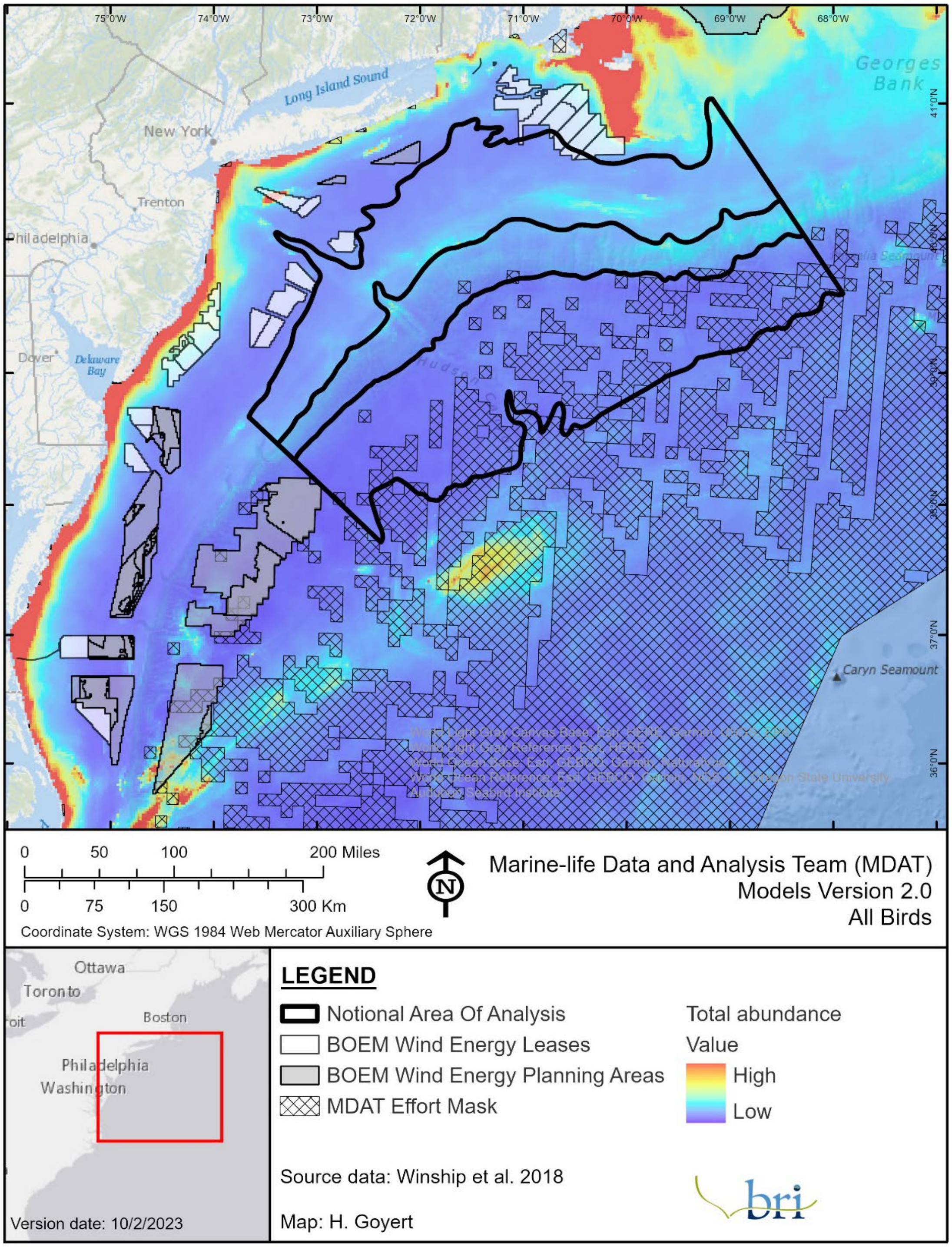
2.4 Overview of Birds in the Area of Analysis

Pelagic birds (i.e., open ocean inhabitants) and offshore migrants are the bird species most often recorded in the AoA. Pelagic birds use the AoA for foraging and include some species of auks, terns, gulls, jaegers, skuas, shearwaters, fulmars, petrels, storm-petrels, gannets, and phalaropes. Offshore migrants include some seabirds (e.g., terns), shorebirds, wading birds, raptors, and passerines (songbirds). ESA listed species that use the AoA include two threatened shorebird species (red knot, *Calidris canutus* and piping plover, *Charadrius melodus*), one endangered seabird species (roseate tern, *Sterna dougallii*), and one candidate threatened pelagic seabird species (Black-capped Petrel, *Pterodroma hasitata*).

Data on birds using the AoA were derived from surveys and tracking data of species tagged in states neighboring the AoA (e.g., Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Rhode Island, and Virginia). Tagging data were presented in map figures as either raw tracks or derived form, depending on the nature of data sharing agreements. For those data allowing analysis beyond the reproduction of tracks, dynamic Brownian Bridge Movement Models (DBBMMs) were used to derive species core use areas. DBBMMs generated individual-level utilization distribution (UD) surfaces for each species (Kranstauber et al. 2012) using package Move for R (Kranstauber and Smolla 2016). DBBMM maps displayed core use areas at utilization contour levels of 50%, 75%, and 95%. These were calculated for the mean UD surface, then cropped to the 95% contour (Spiegel et al. 2017). In contrast, maps derived from survey data (e.g., Figure 5, appendix B) represented the relative densities of seabirds using the AoA. Tracking data were used to describe bird use of the AoA, and survey data were used to further characterize the risk of OSW to marine birds using the AoA (section 4).

Figure 5. Marine-Life Data and Analysis Team Predictive Models of Relative Seabird Species Density

MDAT models predicted the relative densities of 47 seabird species across the Atlantic Outer Continental Shelf, using boat-based and aerial survey data (Winship et al. 2018; Curtice et al. 2016). Areas of no effort are indicated by the annual MDAT effort mask (across all four seasons).



2.4.1 Listed Species

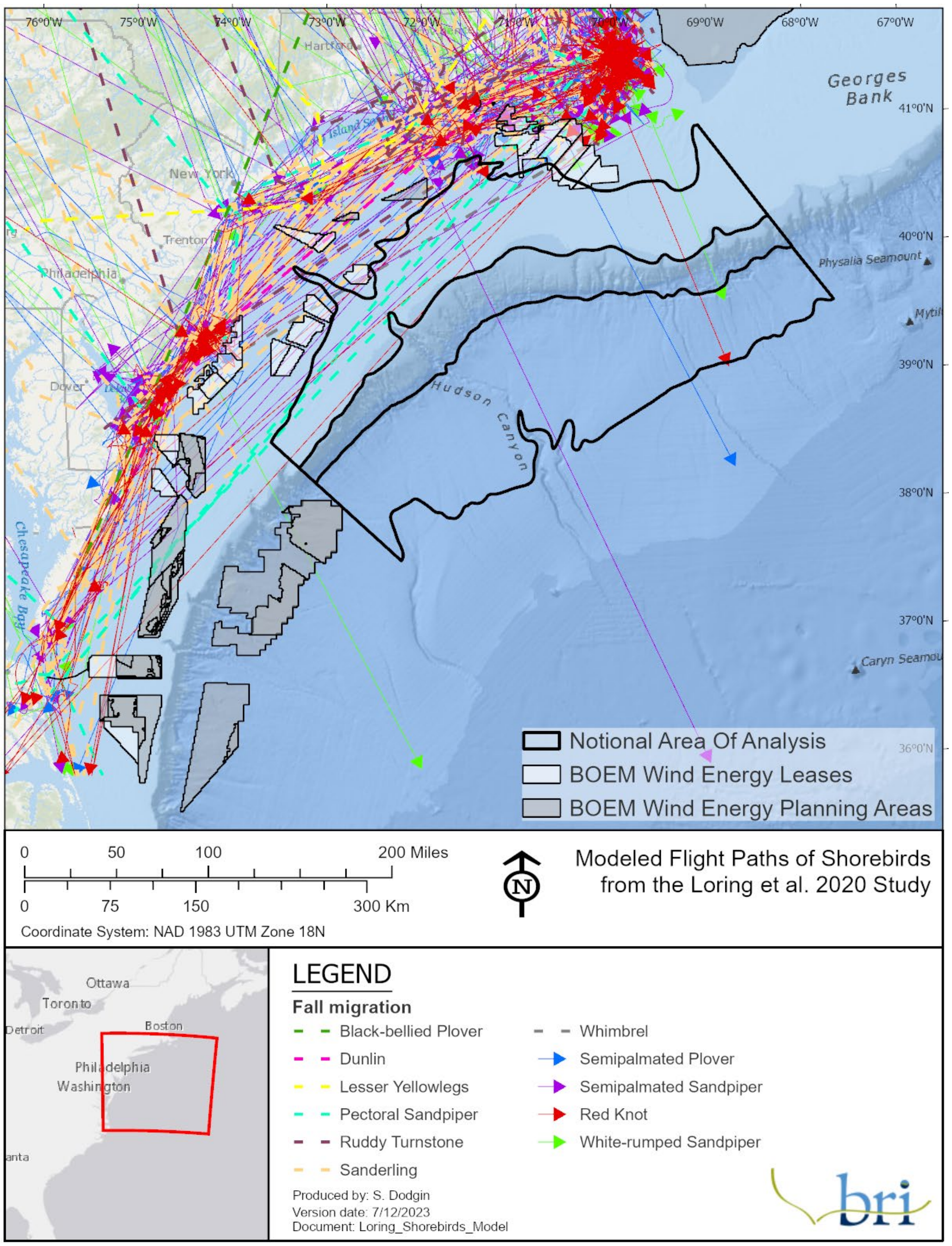
2.4.1.1 Threatened Shorebirds

Threatened shorebirds (red knot and piping plover) were tracked during migration using automated radiotelemetry via the Motus Wildlife Tracking Network (P. H. Loring et al. 2020; 2019). Red knots likely migrated through the AoA (in a southeasterly direction, transecting multiple Zones 1-3, Figure 6), and piping plovers likely migrated across the AoA during fall (in a southwesterly direction, remaining within Zones 1-2, Figure 7). Additionally, other shorebirds not listed under the ESA likely migrated through (e.g., semipalmated plovers, semipalmated sandpipers, and white-rumped sandpipers), across (pectoral sandpipers, ruddy turnstones, sanderlings, whimbrels, dunlin), or near (black-bellied plover, lesser yellowlegs) the AoA during fall (P. H. Loring et al. 2020). These data were limited by the lack of direct coverage of the AoA from the Motus Network, because receiving stations were all located onshore, not at sea; shorebirds were tagged in North and South America. Therefore, track lines were drawn between two detection points, and in cases where two detection points were distant in space and especially far apart in time, actual trajectories may be more sinuous than straight and deviate off the lines shown (Figure 6 and Figure 7).

Red Knot

Figure 6. Red Knots Movement Tracking

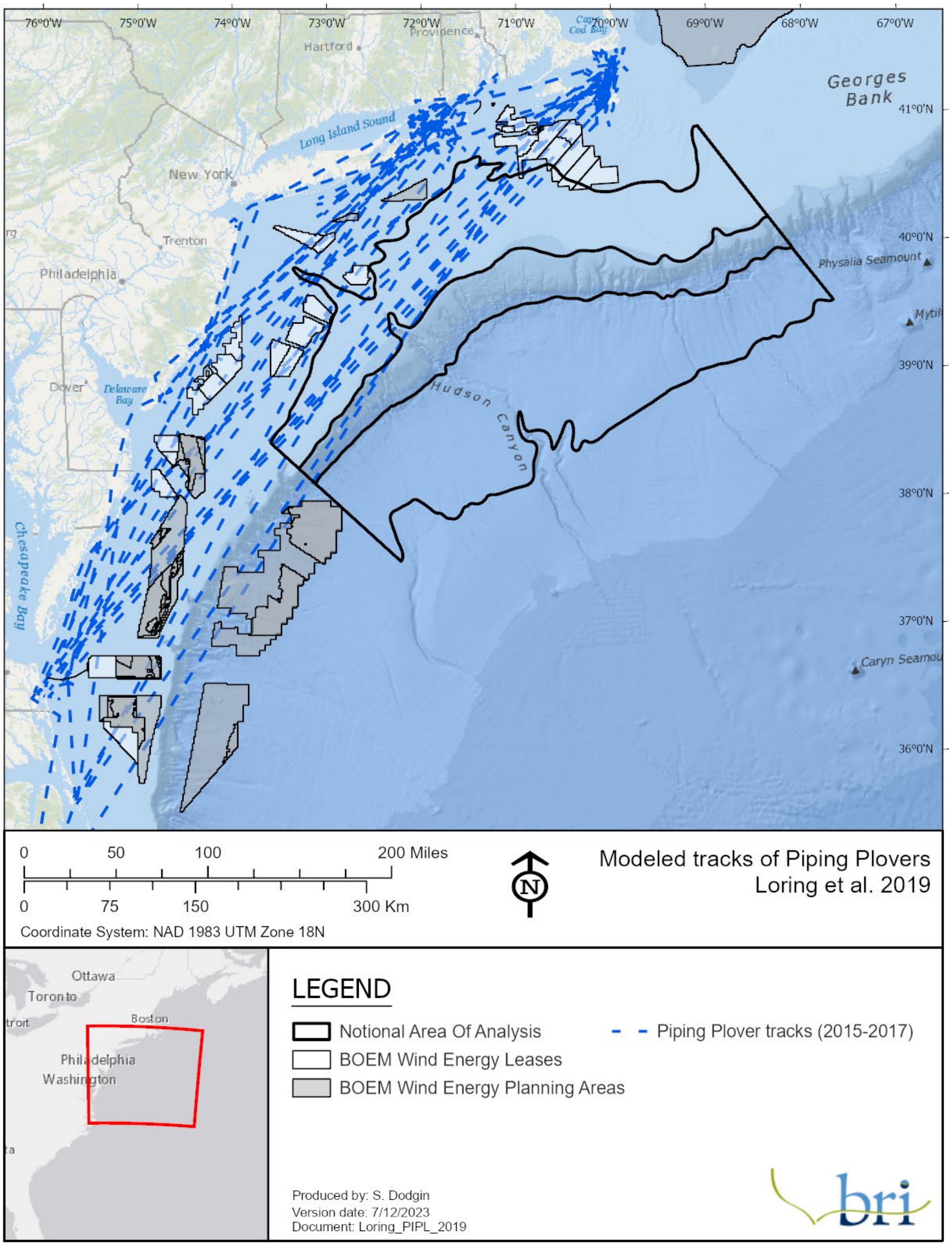
Dashed lines represent modeled tracks estimated between land-based detection points (n = 146 individuals tracked in fall with automated radiotelemetry). Solid lines with arrows represent modeled tracks estimated to depart offshore from the last detected flight direction and location (P. H. Loring et al. 2020).



Piping Plover

Figure 7. Piping Plovers Movement Tracking

Dashed lines represent modeled tracks estimated between land-based detection points (n = 70 individuals tagged in Massachusetts and Rhode Island and tracked in fall with automated radiotelemetry).



2.4.1.2 Threatened and Endangered Seabirds

Roseate Tern

Roseate terns are a small-bodied endangered seabird species tracked during the breeding and post-breeding seasons using automated radiotelemetry via the Motus Wildlife Tracking Network. Roseate terns tagged in Massachusetts and New York State did not appear to enter the AoA during the breeding or post-breeding season from 2015 to 2017 (Figure 8), though data were limited by the lack of direct coverage of the AoA from the Motus Network, because receiving stations were all located onshore, not at sea (P. H. Loring et al. 2019). This sampling bias from Motus data is highlighted by the 20 roseate tern observations in Zones 1-2 of the AoA (Figure 9; see Appendix B for relative density maps), as recorded in historical boat-based surveys from the NWASC and the NYSERDA digital aerial surveys during spring, summer and fall (NYSERDA 2021).

Black-Capped Petrel

Black-capped petrels are pelagic seabirds under review for ESA listing. In addition to surveys (see appendix B for relative density maps), they were tracked using Argos satellite tags during the nonbreeding season and used Zones 2–3 of the AoA (Jodice et al. 2015; Satgé et al. 2023; Figure 10).

Bermuda Petrel

Bermuda petrels are pelagic seabirds listed as Endangered under the ESA. They were tagged in Bermuda and tracked using satellite tags during the breeding season and used Zone 3, as well as the southeast portion of Zones 1–2 in the AoA (Raine et al. 2021 and Campioni 2023, unpublished data; Figures 11-13).

Figure 8. Roseate Terns Movement Tracking

Track lines were drawn between two detection points, and in cases where two detection points were distant in space and especially far apart in time, actual trajectories may be more sinuous than straight and deviate off the lines shown (n = 150 post/breeding individuals tracked with automated radiotelemetry).

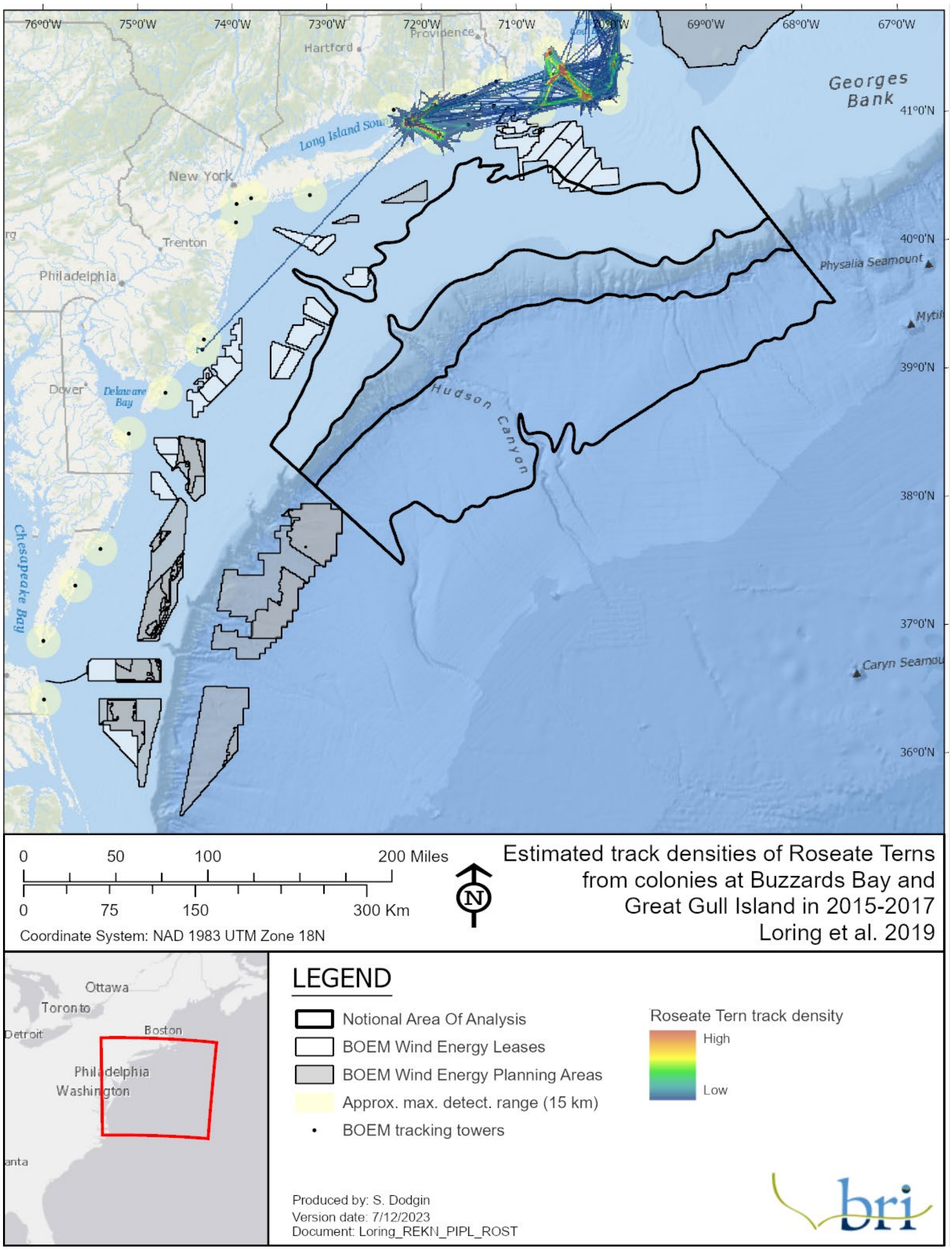


Figure 9. Roseate Terns Observed in Boat-Based and Aerial Surveys

Observations of roseate terns during spring, summer, and fall historical boat-based (NWASC) and digital aerial (NYSERDA) surveys (n=20 individuals).

Sources: Northwest Atlantic Seabird Catalog and NYSERDA digital aerial surveys (NYSERDA 2021)

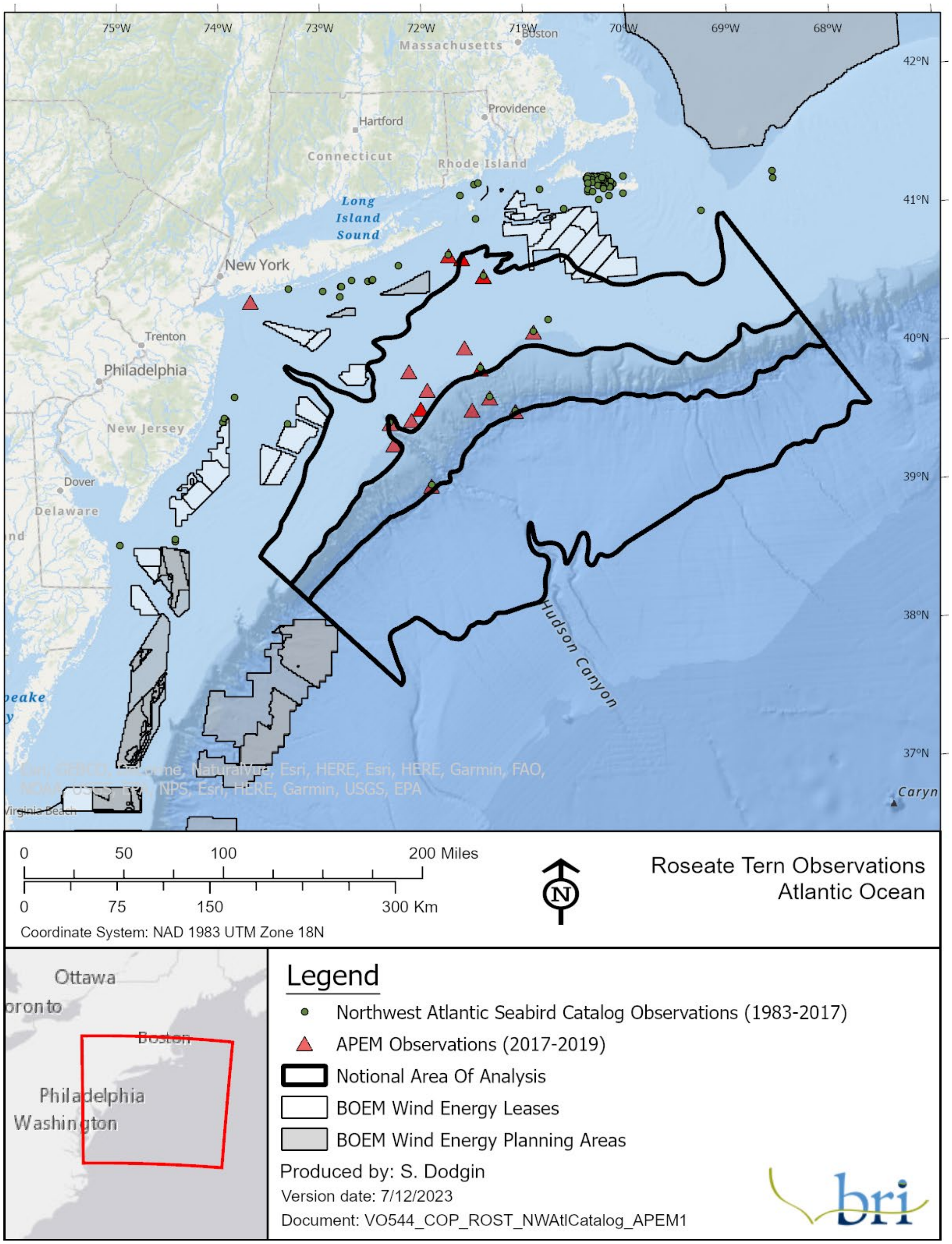


Figure 10. Black-Capped Petrels Movement Tracking on the Northeast Ocean Data Portal (a)

Data from satellite tags were available from two different data repositories: (a) Northeast Ocean Data Portal (n = 3 individuals).

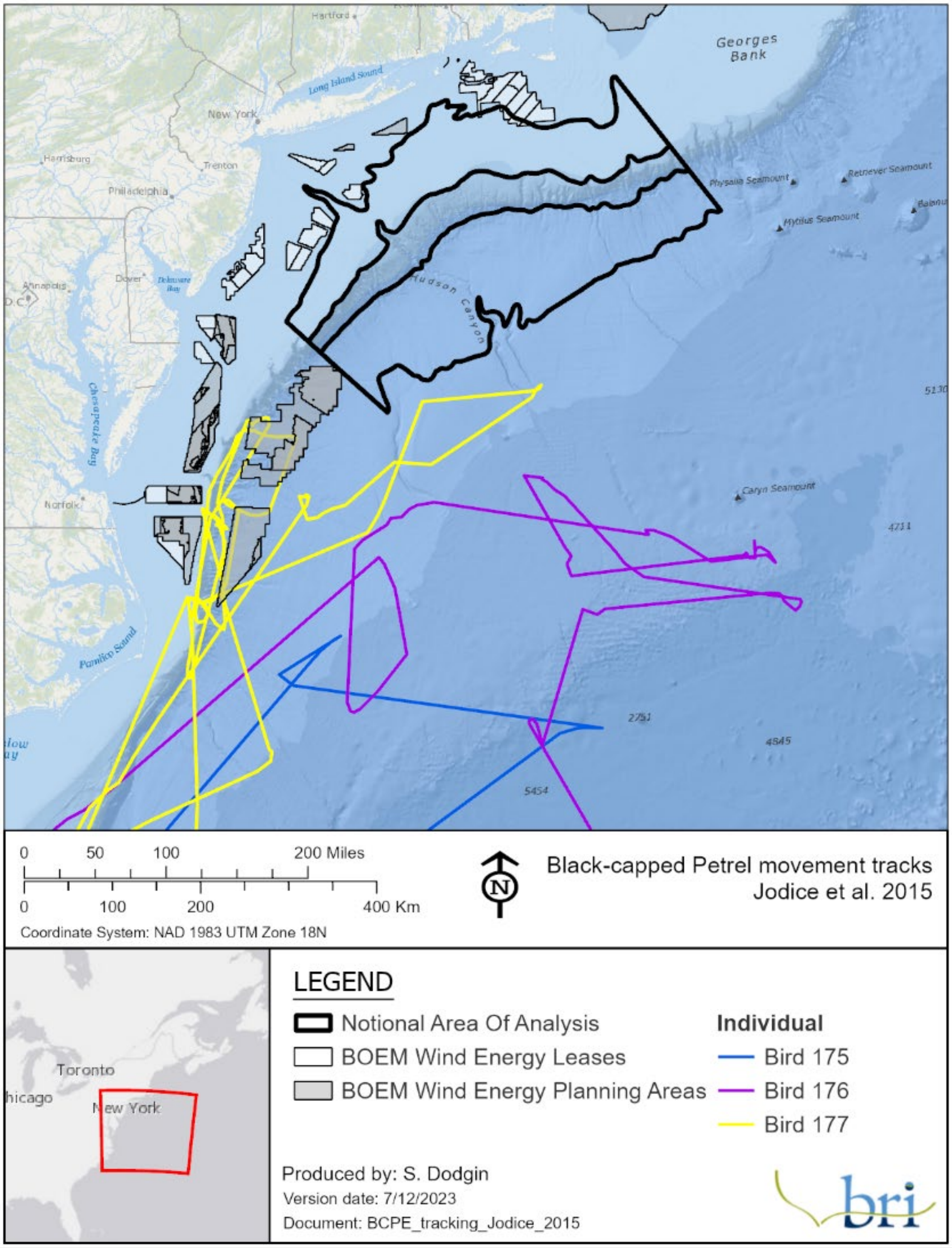


Figure 11. Black-Capped Petrels Movement Tracking on Movebank (b)

Data from satellite tags were available from two different data repositories: (b) Movebank, representing 50%, 75%, and 95% core use from DBBMM utilization distributions (n = 10 individuals during the nonbreeding season).

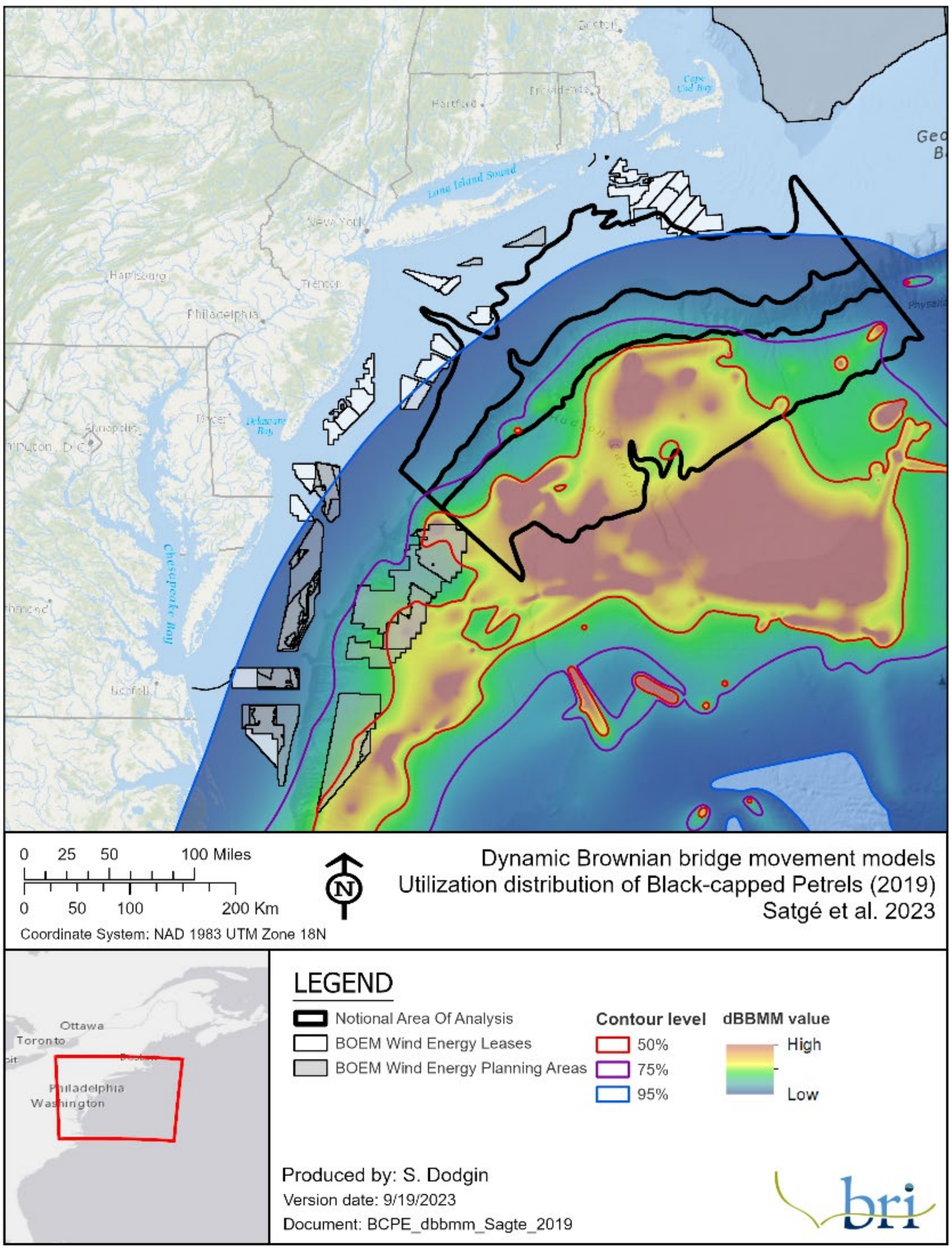


Figure 12. Bermuda Petrel Movement Tracking (a)

Raw track data from satellite tags during the breeding season were available from two different sources: (a) Carina Gjerdrum, Canadian Wildlife Service, Environment and Climate Change Canada, and André Raine, Archipelago Research and Conservation (n=5 chick-rearing adults in 2019).

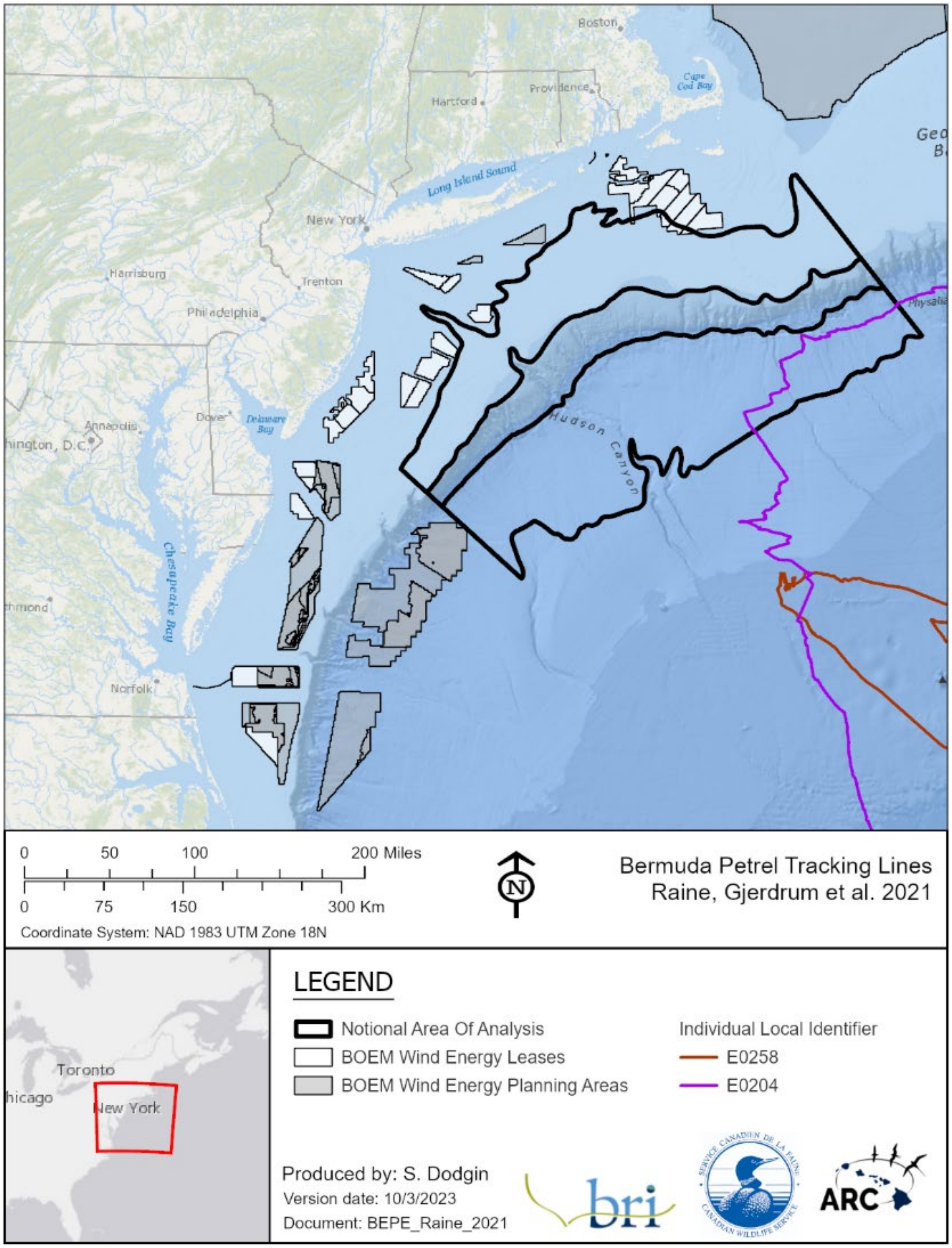
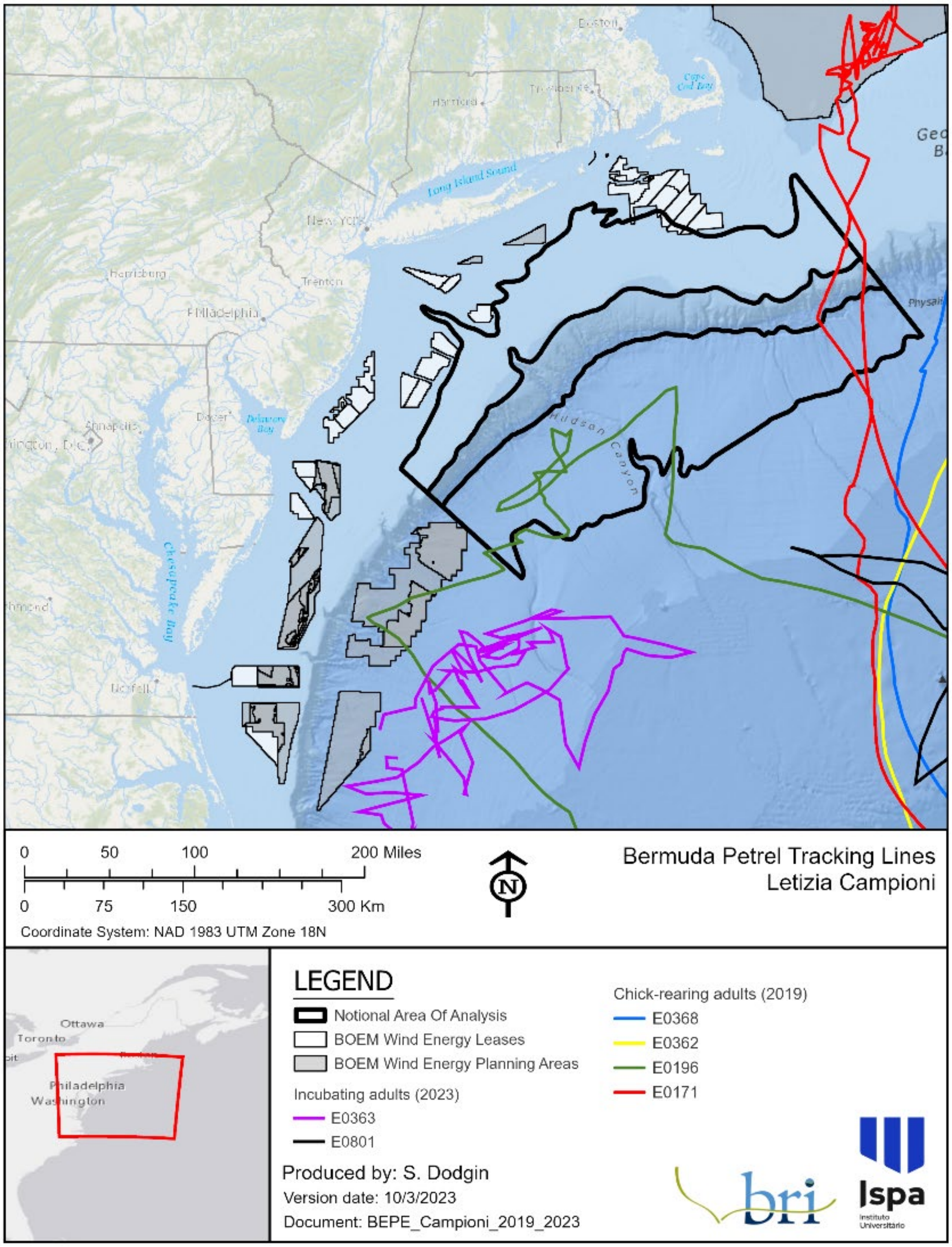


Figure 13. Bermuda Petrel Movement Tracking (b)

Raw track data from satellite tags during the breeding season were available from two different sources: (b) Marine and Environmental Sciences Centre, Instituto Superior de Psicologia Aplicada (ISPA): Instituto Universitário de Ciências Psicológicas, Sociais e da Vida, Portugal (n=9 chick-rearing adults in 2019 and 9 incubating adults in 2023).



2.4.2 Non-Listed Species

2.4.2.1 Migratory Waterbirds

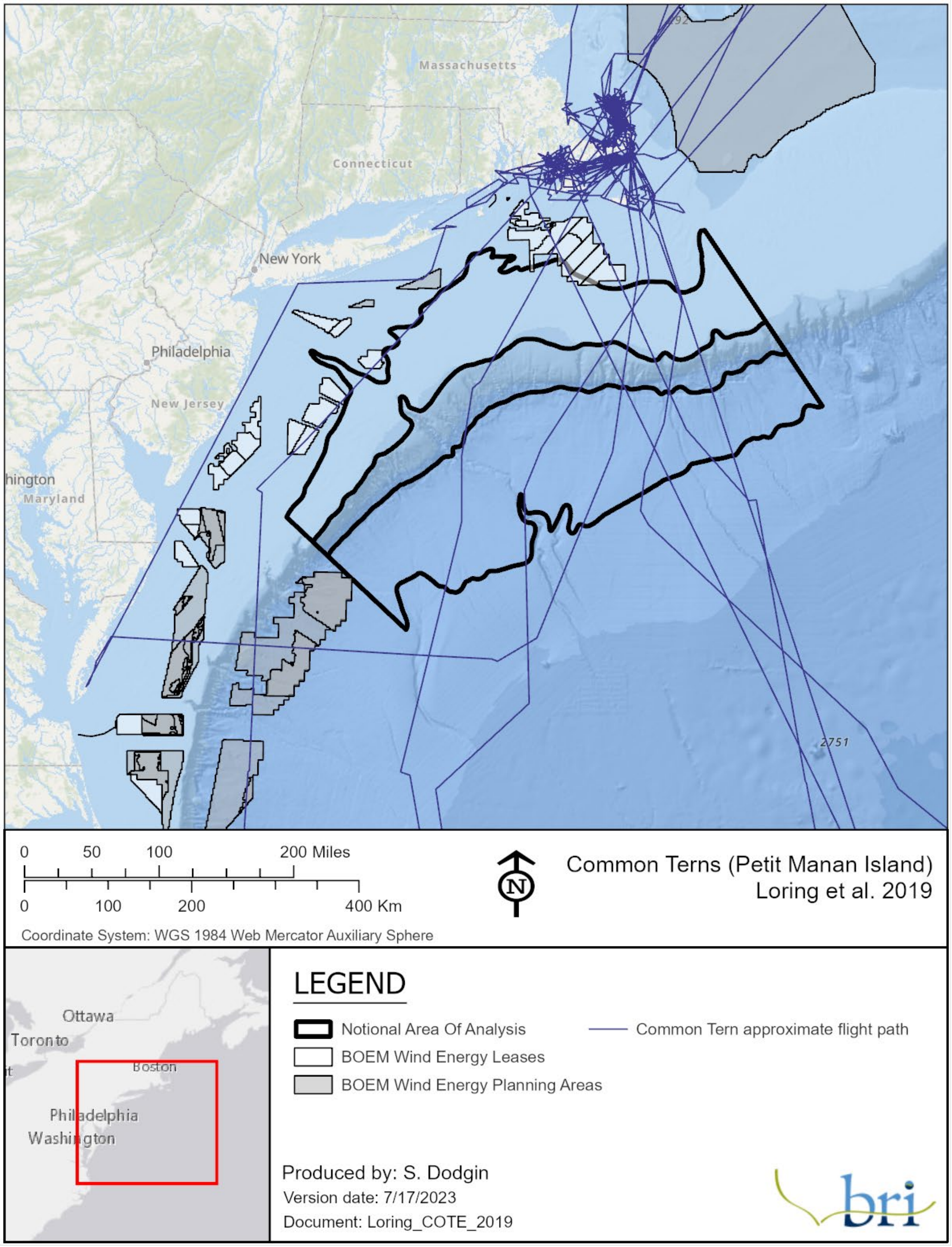
Migratory seabirds identified during surveys in the AoA included gulls, jaegers, skuas, terns, cormorants, pelicans, and grebes (Table 3, see appendix B for relative density maps). Additional tracking data were also available for common terns, as a surrogate for roseate terns that are sensitive to tagging (Paton et al. 2020).

Common Tern

Supplementary to surveys (see appendix B for relative density maps), common terns were tagged in fall 2017 using satellite transmitters, and traveled through the eastern portion of Zones 1–3 of the AoA during fall, and the western portion of Zones 1–3 during spring migration (see Loring et al. 2019 for more detail; Figure 14.

Figure 14. Common Terns Movement Tracking

Platform terminal transmitters (PTTs) tagged common terns during fall and spring migration (n = 3 individuals tagged in the Gulf of Maine and tracked with satellite tags).



2.4.2.2 Pelagic Seabirds

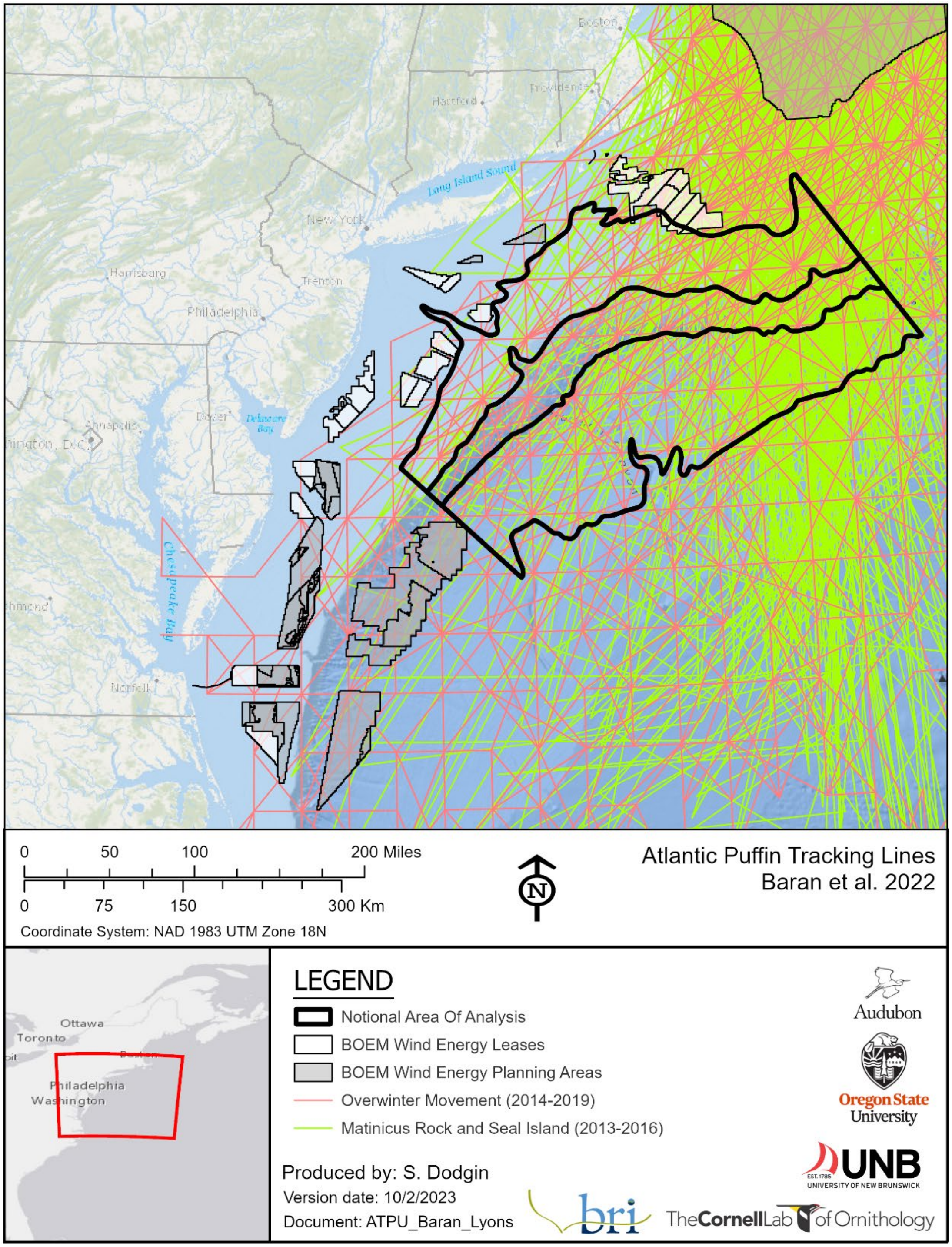
Pelagic seabirds identified during surveys in the AoA included auks, shearwaters, fulmars, petrels, storm-petrels, and pelagic shorebirds included phalaropes (Table 3, see appendix B for relative density maps). Additional tracking data were also available for Leach's storm-petrel and great shearwater.

Atlantic Puffin

Supplementary to surveys (see appendix B for relative density maps), Atlantic puffins were tagged from burrows at breeding colonies within the Gulf of Maine. They were tracked over winter from 2014 to 2019 using geolocators, and foraged throughout the AoA, particularly in eastern Zones 1a3 (Baran et al. 2022, Figure 15).

Figure 15. Atlantic Puffins Movement Tracking

Raw tracks of overwintering adults tagged in the Gulf of Maine with geolocators from 2014 to 2019 (n = 63 individuals).

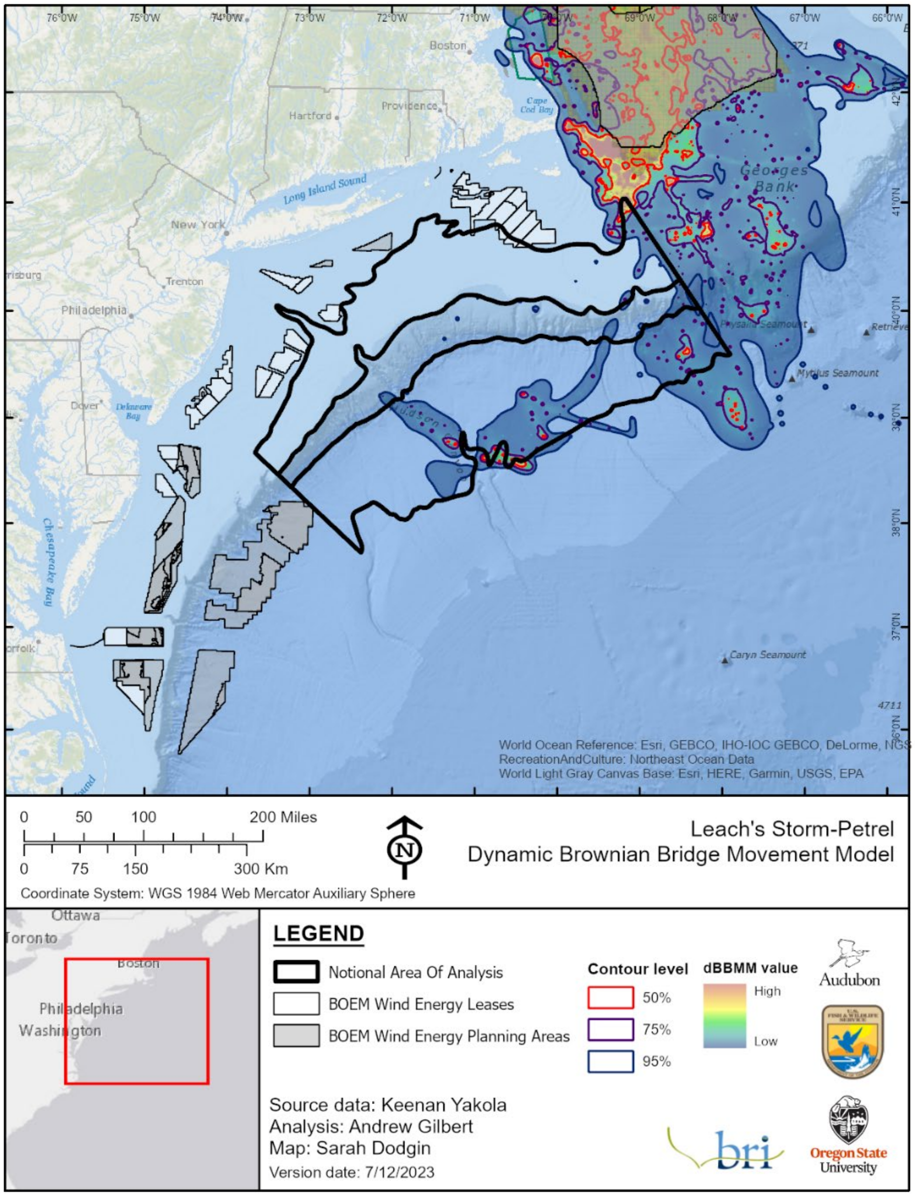


Leach’s Storm-Petrel

Supplementary to surveys (see appendix B for relative density maps), Leach’s storm-petrels were tagged from burrows at breeding colonies within the Gulf of Maine. They were tracked in 2022 using Global Positioning System (GPS)—Pathtrack tags, and foraged primarily in Zone 3 of the AoA, over the Hudson Canyon during the breeding season (Yakola 2022, unpublished data; Figure 16).

Figure 16. Leach’s Storm-Petrels Movement Tracking

50%, 75%, and 95% core use from DBBMM utilization distributions (n = 33 individuals tagged in the Gulf of Maine and tracked during the breeding season with GPS tags).

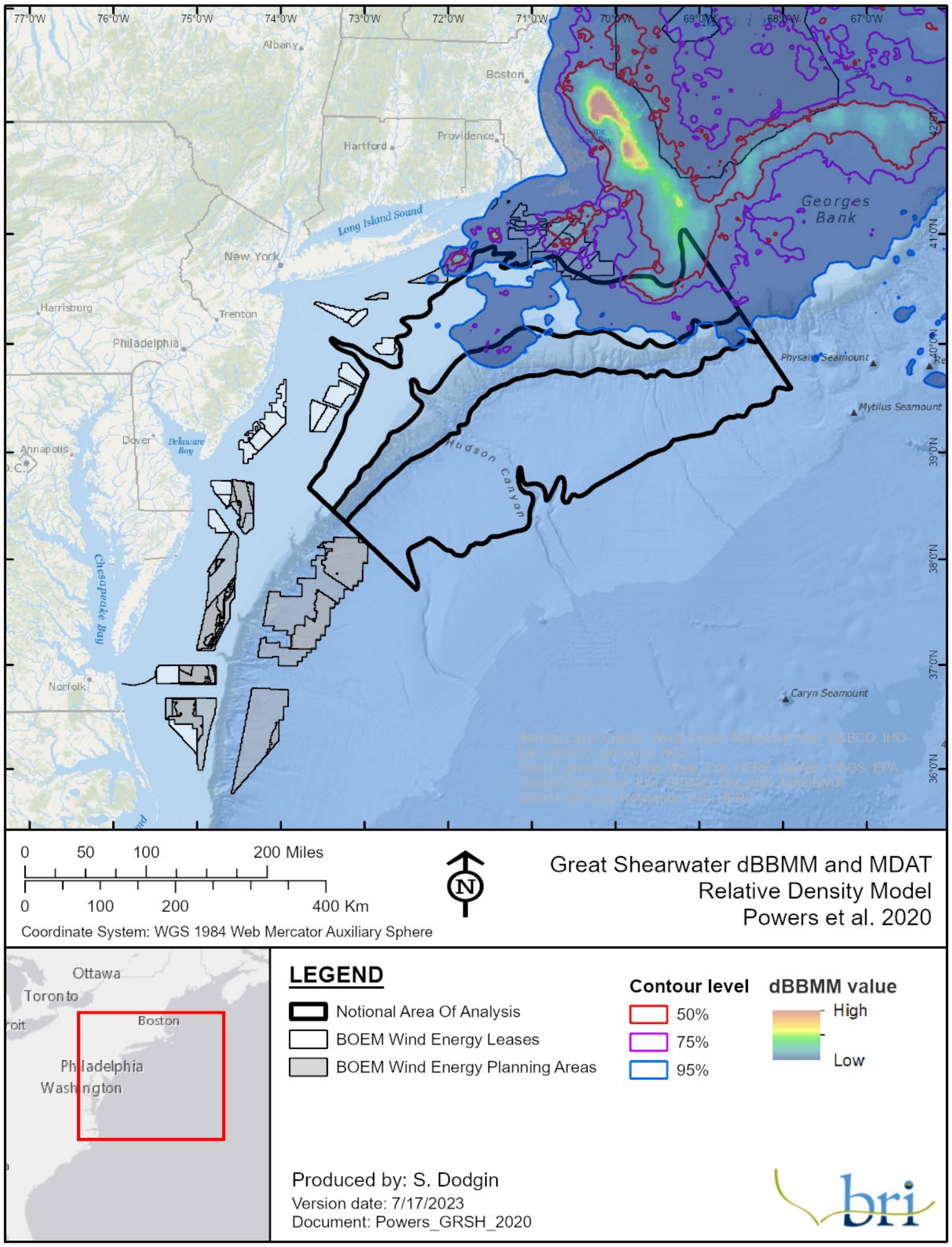


Great Shearwater

Supplementary to surveys (see appendix B for relative density maps), great shearwaters were tagged with PTTs (satellite) while overwintering from 2013 to 2018, and primarily used Zone 1 of the AoA (Powers et al. 2020; Figure 17).

Figure 17. Great Shearwaters Movement Tracking

50%, 75%, and 95% core use from DBBMM utilization distributions (n = 59 overwintering individuals tracked with satellite tags and tagged at Stellwagen National Marine Sanctuary north of Cape Cod Bay, Massachusetts).



2.4.2.3 Marine Diving Birds

Marine diving birds identified during surveys in the AoA included sea ducks, loons, and gannets (Table 3, see appendix B for relative density maps). Additional satellite telemetry tracking data were also available for these species groups from the Sea Duck Joint Venture (SDJV) Atlantic and Great Lakes Sea Duck Migration Study (Lamb et al. 2020), and the BOEM Marine Diving Bird Study (Spiegel et al. 2017; Stenhouse et al. 2020). Study objectives were to determine fine-scale use and movement patterns of marine diving birds during migration and winter. Nearly 400 northern gannets, red-throated loons and surf scoters were tracked using satellite transmitters, Argos PTTs, over the course of five years (2012 to 2016; Stenhouse et al. 2020). SDJV also tracked black scoters, white-winged scoters, and long-tailed ducks (Lamb et al. 2020). The diving bird study (Spiegel et al. 2017; Stenhouse et al. 2020) calculated separate DBBMM surfaces for each of two winters with at least five days of data. These surfaces were combined into a weighted mean surface per animal, as a percentage of the total number of days represented (minimum 30 total combined days). For the migratory periods, only five days per year and seven total days per period were required as a minimum threshold, since migration duration often occurred over a much shorter time period. Similar methods were used to derive the DBBMM surfaces for other species.

Nearshore areas outside the AoA were key habitat sites for sea ducks (Figure 22), however other marine diving birds present in the AoA used Zones 1–2 (Figure 23). Zone 1 was used in spring (April, May), winter (December, January, February, March) and fall (September, October, November), and Zone 2 was primarily used during spring migration (Figure 23). Northern gannets primarily used Zones 1–2 in spring and Zone 2 in fall (Figure 22), whereas red-throated loons used Zone 1 in spring (Figure 23). Sea ducks were generally concentrated in nearshore waters outside of the AoA, though surf and black scoters occurred in Zones 1–3, white-winged scoters occurred in Zones 1–2 (particularly in spring), and long-tailed ducks occurred in Zone 1 (Figure 24 through Figure 32).

Figure 18. Key Habitat Sites of Sea Ducks

Key habitat sites of sea ducks, derived from expert elicitation.

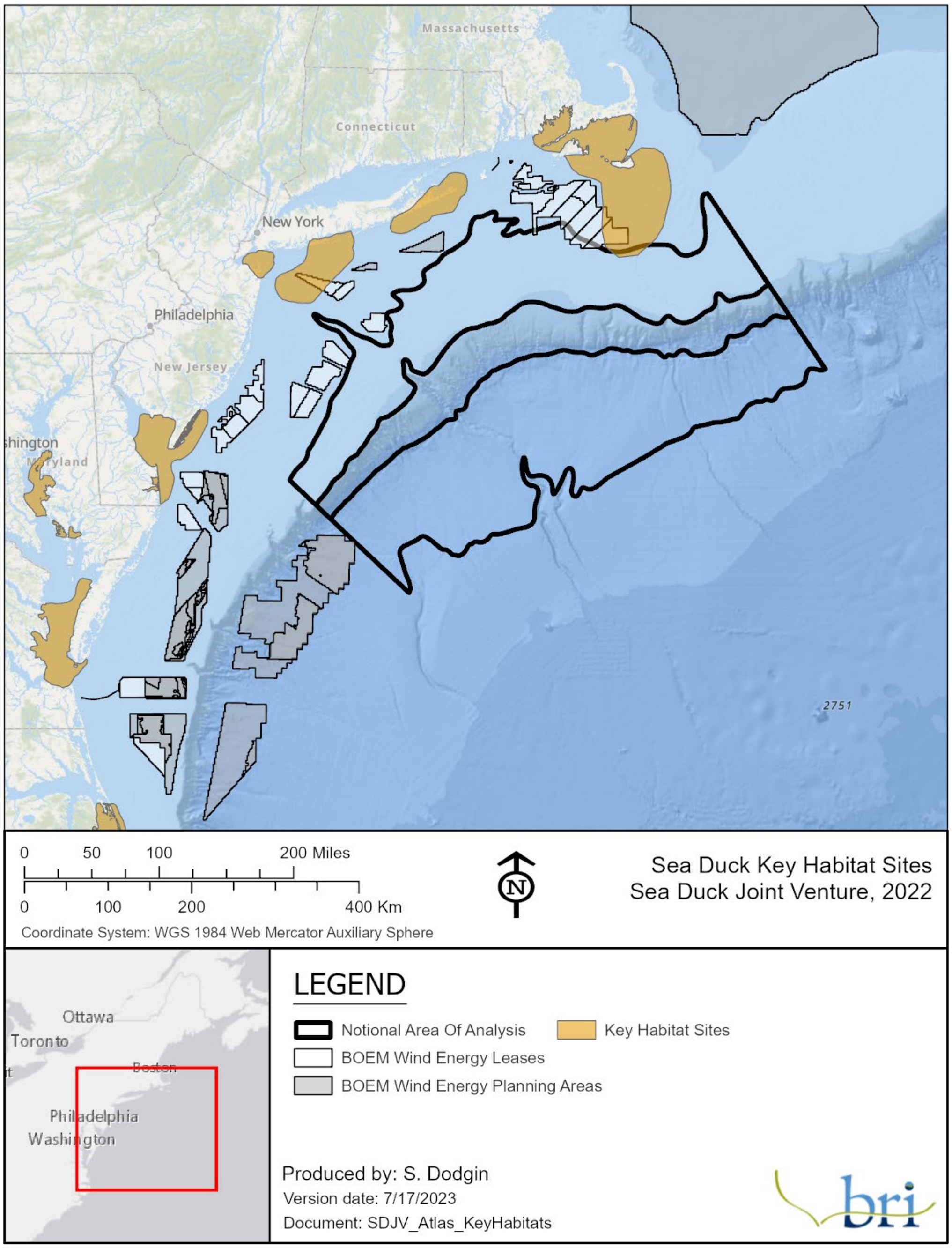


Figure 19. Winter Migration Utilization Distributions of Marine Diving Birds (a)

50%, 75%, and 95% core use from DBBMM utilization distributions in (a) winter (n = 34 northern gannets, n=46 red-throated loons, n = 78 surf scoters, n = 61 black scoters, n = 66 white-winged scoters, n = 49 long-tailed ducks tracked with satellite tags).

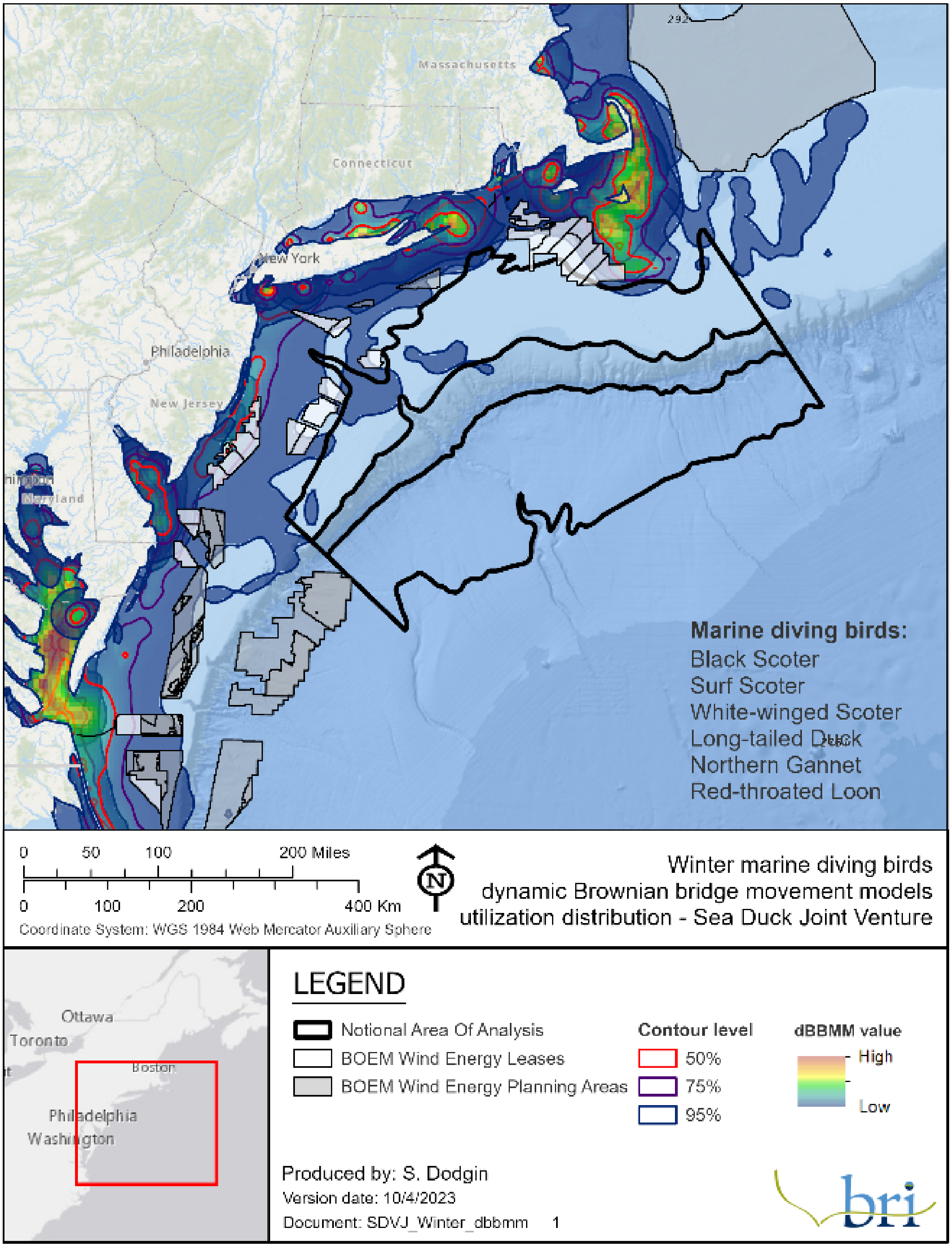


Figure 20. Spring Migration Utilization Distributions of Marine Diving Birds (b)

50%, 75%, and 95% core use from DBBMM utilization distributions in (b) spring (n = 35 northern gannets, n=46 red-throated loons, n = 87 surf scoters, n = 76 black scoters, n = 45 white-winged scoters, n = 60 long-tailed ducks tracked with satellite tags).

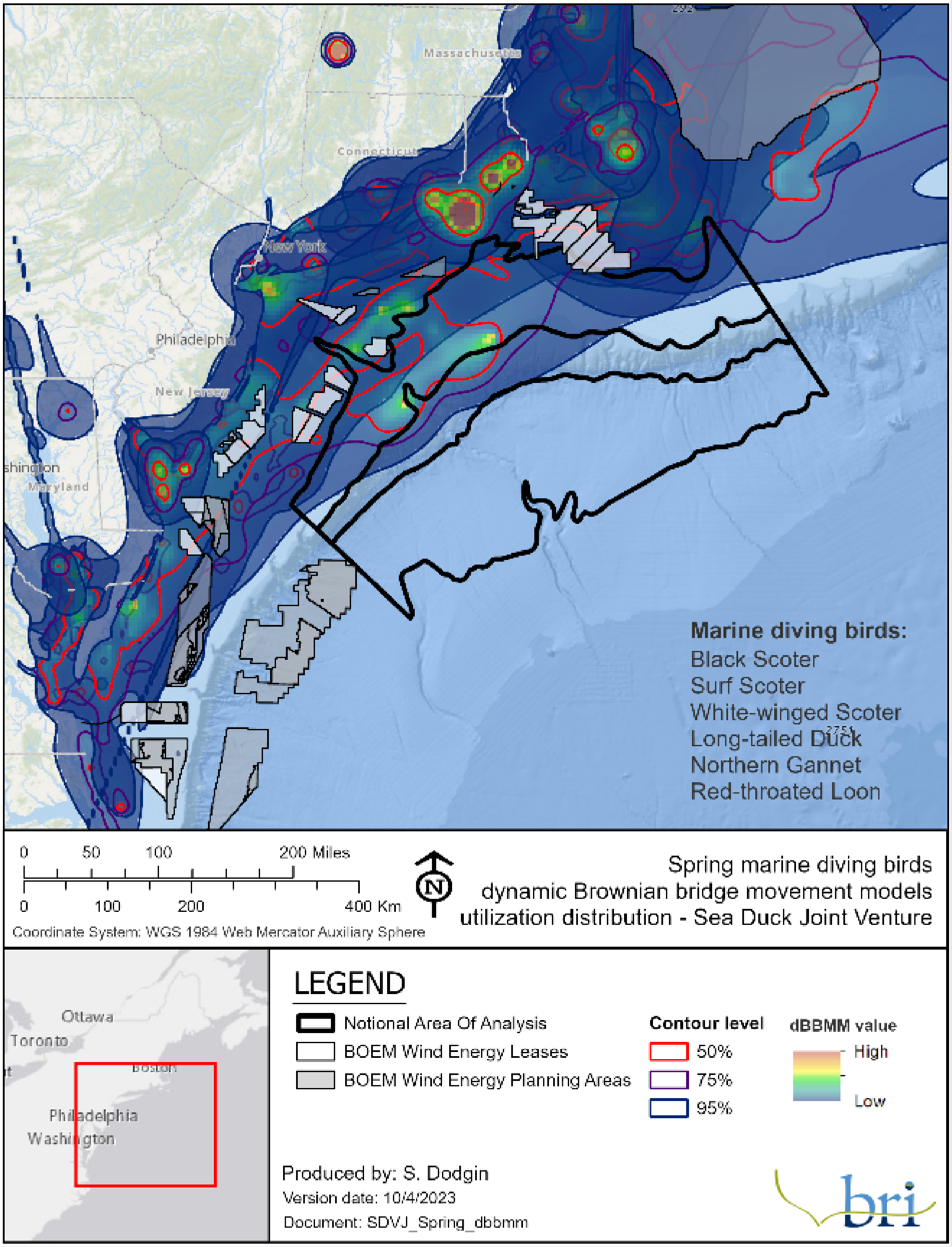
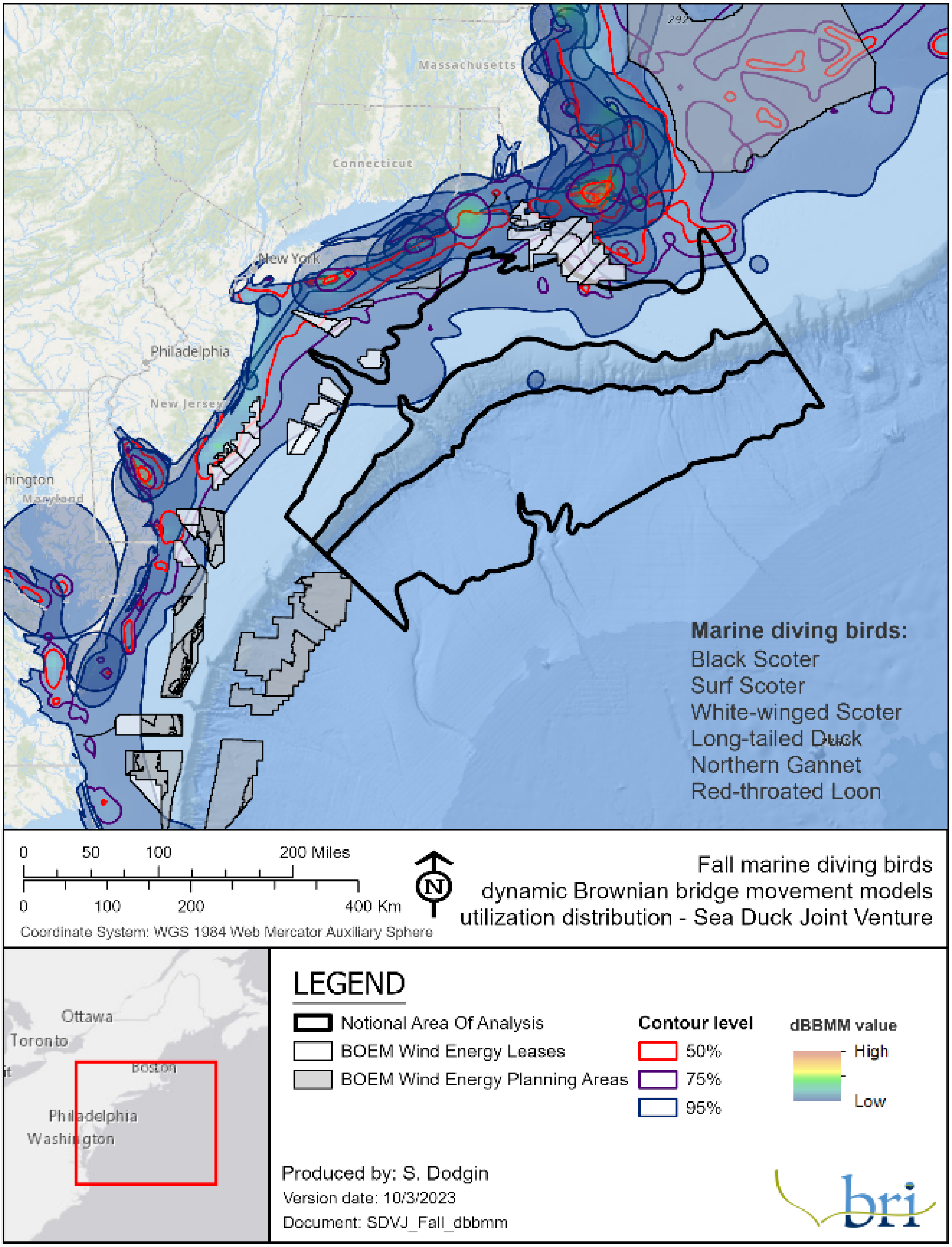


Figure 21. Fall Migration Utilization Distributions of Marine Diving Birds (c)

50%, 75%, and 95% core use from DBBMM utilization distributions in (c) fall (n = 36 northern gannets, n=31 red-throated loons, n = 83 surf scoters, n = 80 black scoters, n = 62 white-winged scoters, n = 37 long-tailed ducks tracked with satellite tags).



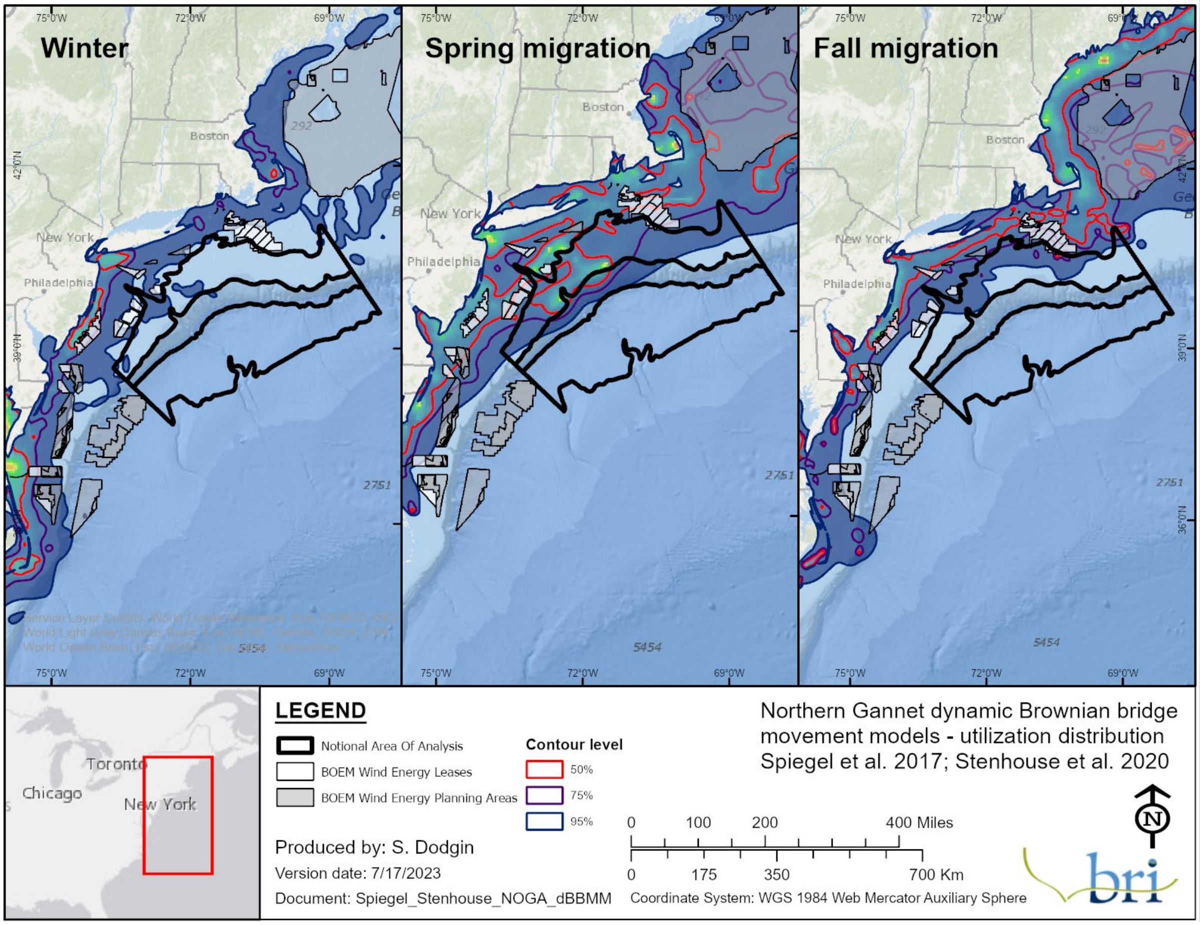
Northern Gannet

Northern gannets used Zone 1 in spring, winter, and fall, as well as Zone 2 during spring migration (Figure 22).

Figure 22. Winter, Spring, and Fall Migration Utilization Distributions of Northern Gannets

50%, 75%, and 95% core use from DBBMM utilization distributions in winter (n = 34 individuals), spring (n = 35 individuals) and fall (n = 36 individuals), tracked with satellite tags.

Sources: Spiegel et al. 2017; Stenhouse et al. 2020



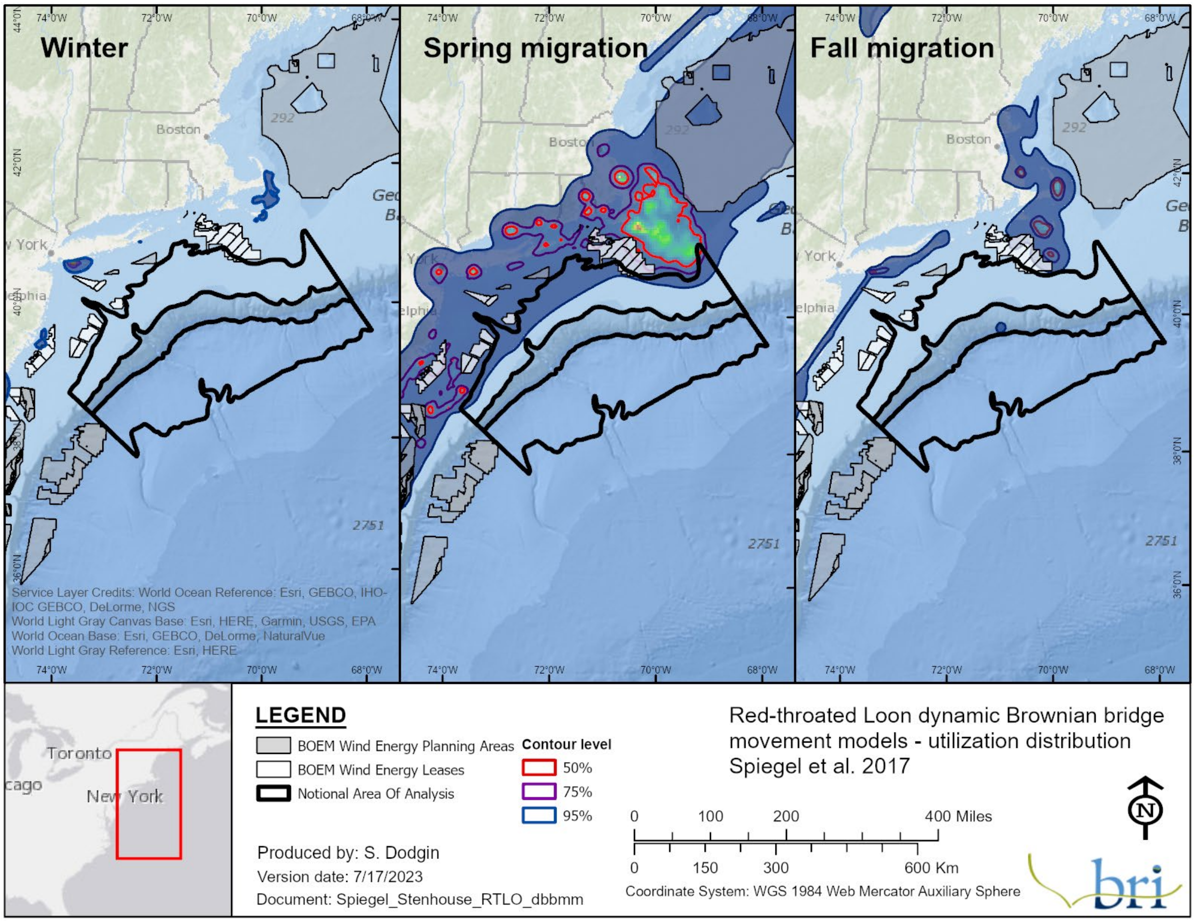
Red-Throated Loon

Red-throated loons used Zone 1 during spring migration, and were otherwise outside of the AoA, except for sparse evidence of use in Zone 2 during fall migration (Figure 23).

Figure 23. Winter, Spring, and Fall Migration Utilization Distributions of Red-Throated Loons

50%, 75%, and 95% core use from DBBMM utilization distributions in winter (n = 46 individuals), spring (n = 46 individuals) and fall (n = 31 individuals), tracked with satellite tags.

Sources: Spiegel et al. 2017; Stenhouse et al. 2020



Surf Scoter

Surf scoters were concentrated in nearshore areas outside of the AoA, but otherwise occurred in Zones 1–3 (Figure 24, Figure 25).

Figure 24. Winter, Spring, and Fall Migration Utilization Distributions of Surf Scoters

50%, 75%, and 95% core use from DBBMM utilization distributions in winter (n = 78 individuals), spring (n = 87 individuals) and fall (n = 83 individuals), tracked with satellite tags.

Sources: Spiegel et al. 2017; Stenhouse et al. 2020

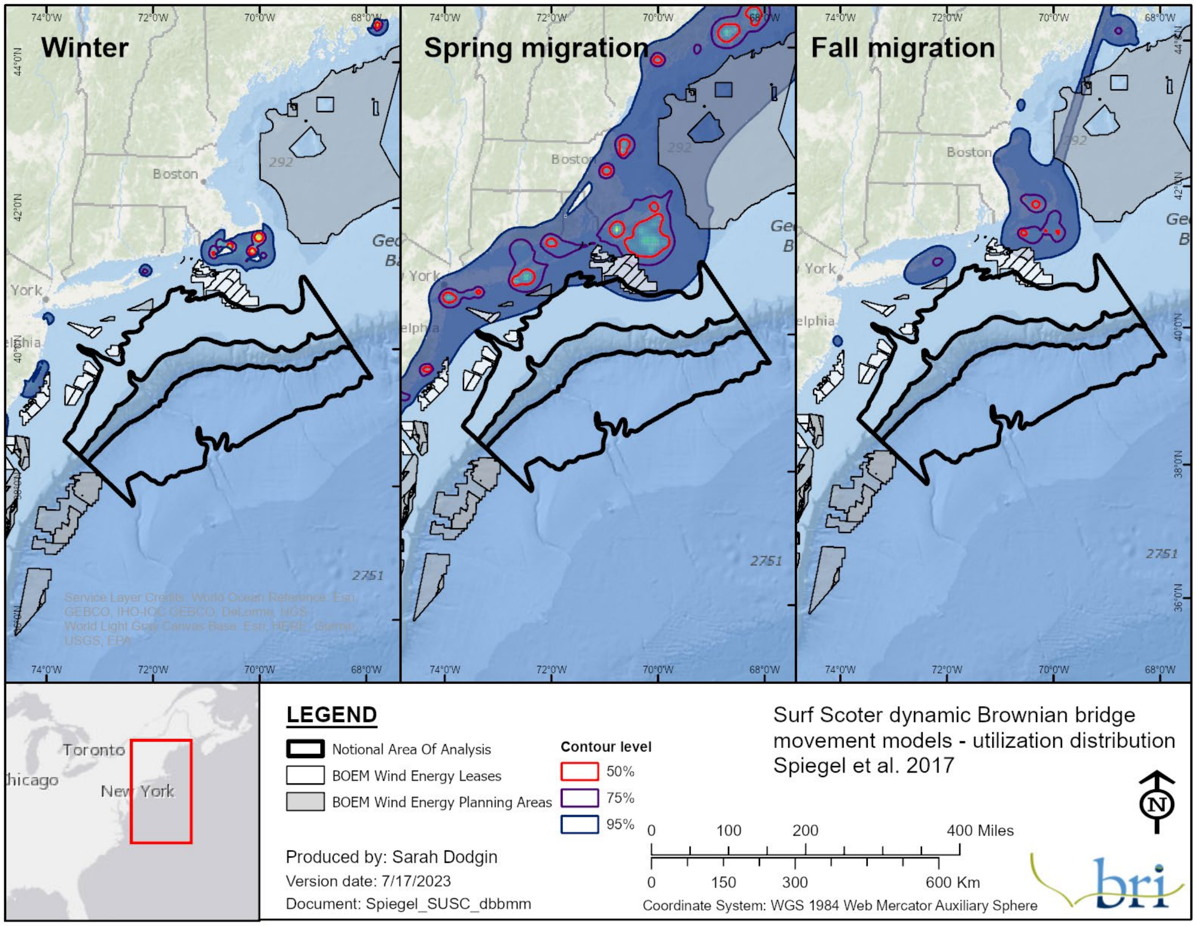
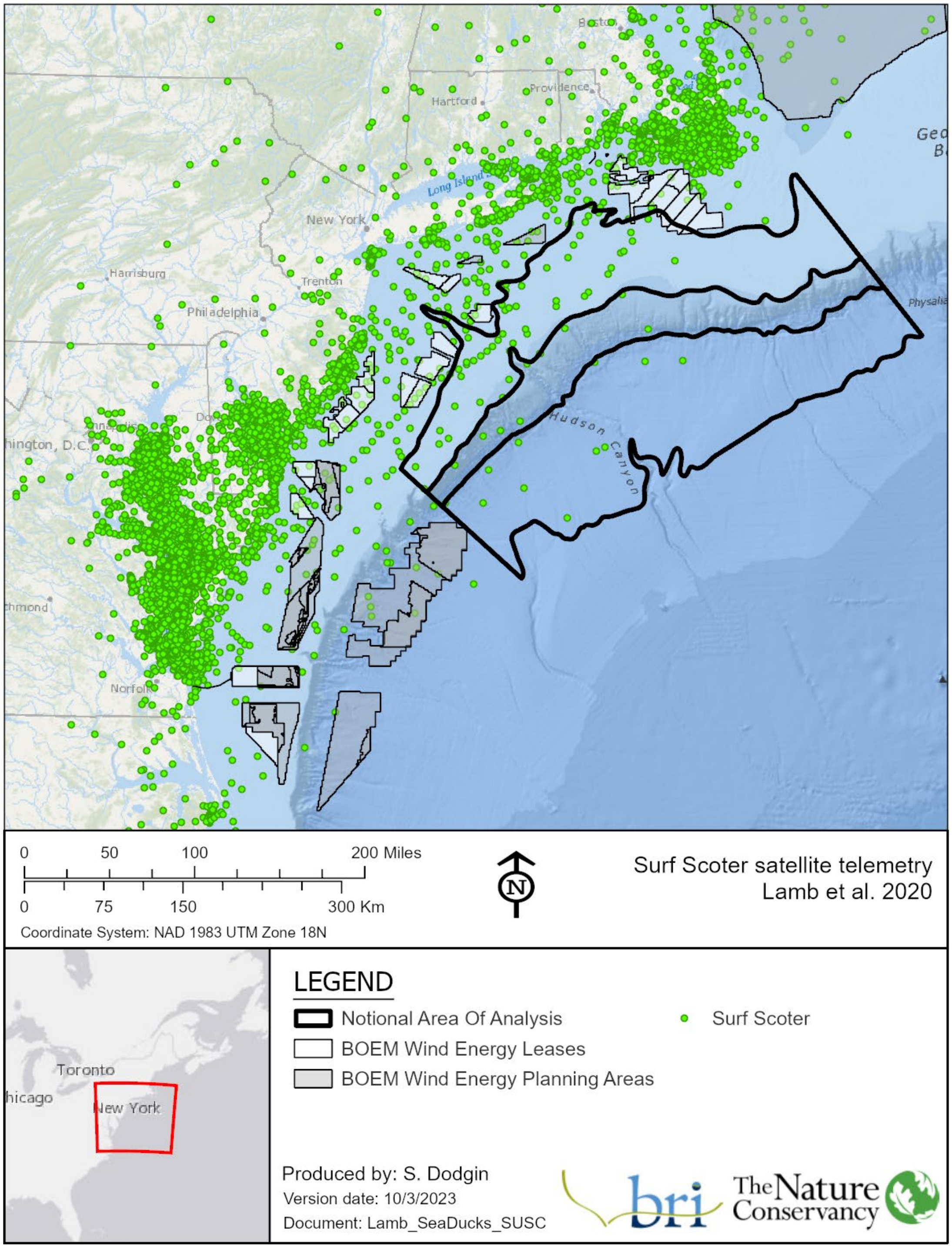


Figure 25. Model-Derived Locations of Surf Scoters

Model-derived locations during molting, staging and winter (August-March) 2002-2017 (n = 135 individuals tracked with satellite tags).



Black Scoter

Black scoters were concentrated in nearshore areas outside of the AoA, but otherwise occurred in Zones 1–3 (Figure 26, Figure 27).

Figure 26. Winter, Spring, and Fall Migration Utilization Distributions of Black Scoters

50%, 75%, and 95% core use from DBBMM utilization distributions in winter (n = 61 individuals), spring (n = 76 individuals) and fall (n = 80 individuals), tracked with satellite tags.

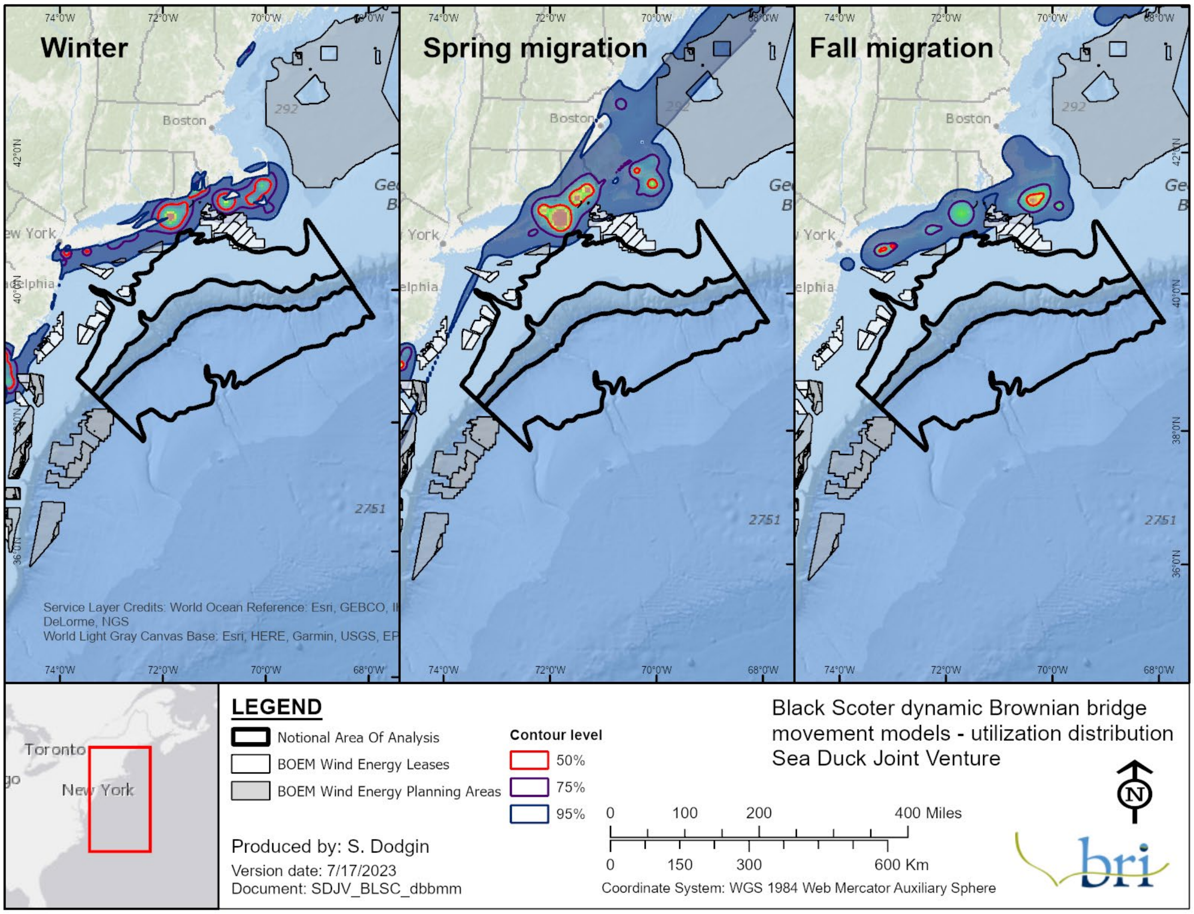
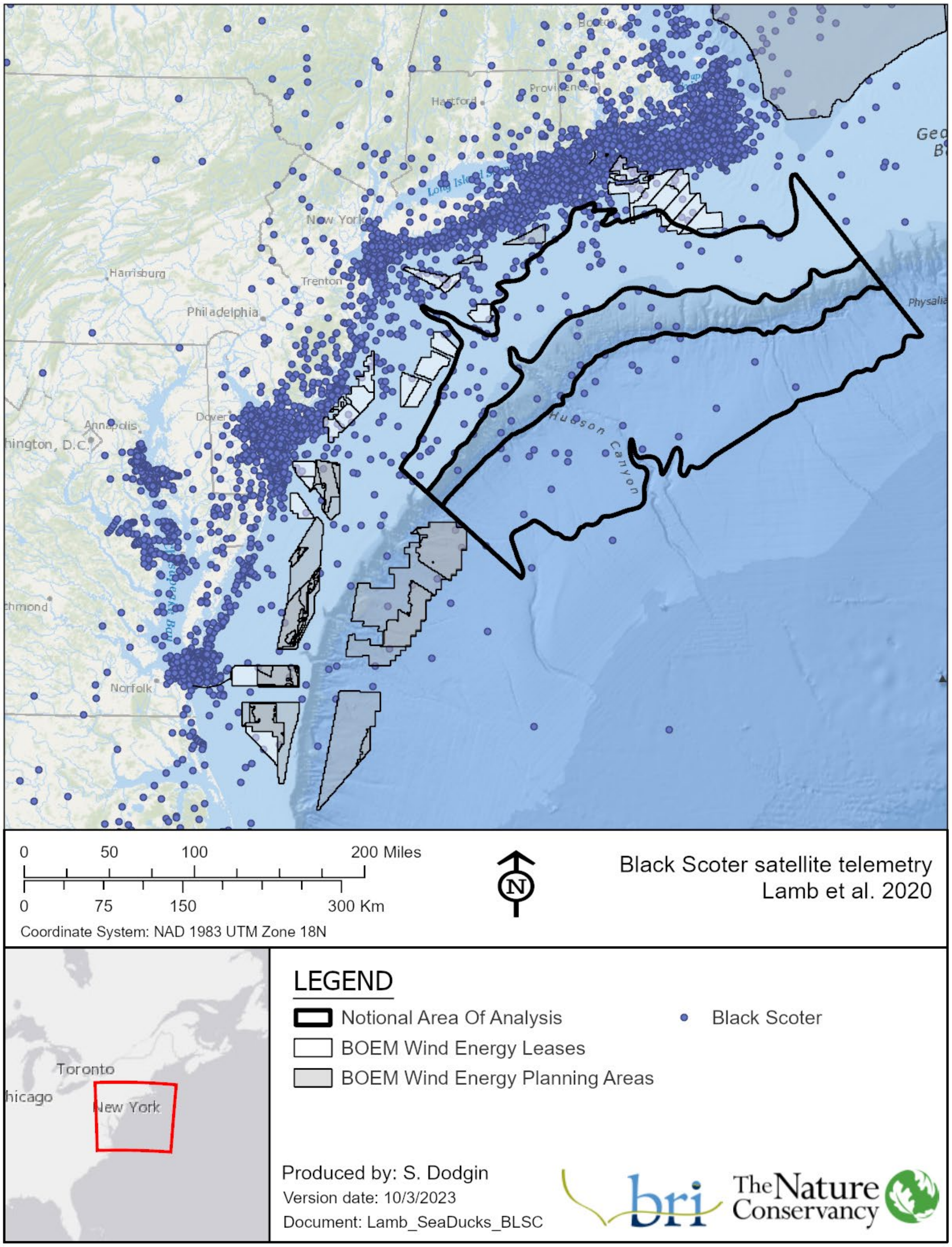


Figure 27. Model-Derived Locations of Black Scoters

Model-derived locations during molting, staging and winter (August-March) 2002-2017 (n = 86 individuals tracked with satellite tags).



White-Winged Scoter

White-winged scoters used the northeast part of Zone 1 during spring migration, the northeast edge of Zone 1 in winter, and occasionally Zone 2, but were otherwise outside of the AoA (Figure 28, Figure 29).

Figure 28. Winter, Spring, and Fall Migration Utilization Distributions of White-Winged Scoters

50%, 75%, and 95% core use from DBBMM utilization distributions in winter (n = 66 individuals), spring (n = 45 individuals) and fall (n = 62 individuals), tracked with satellite tags.

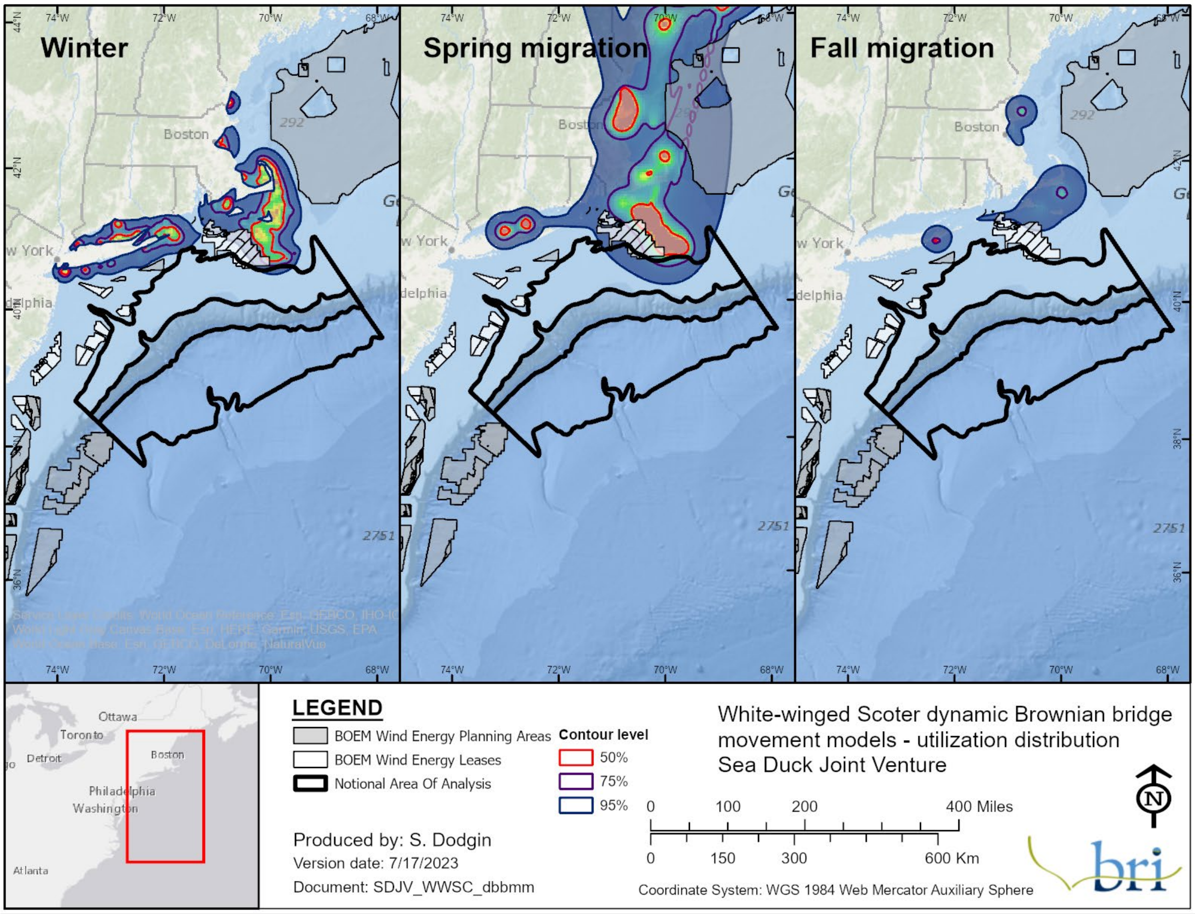
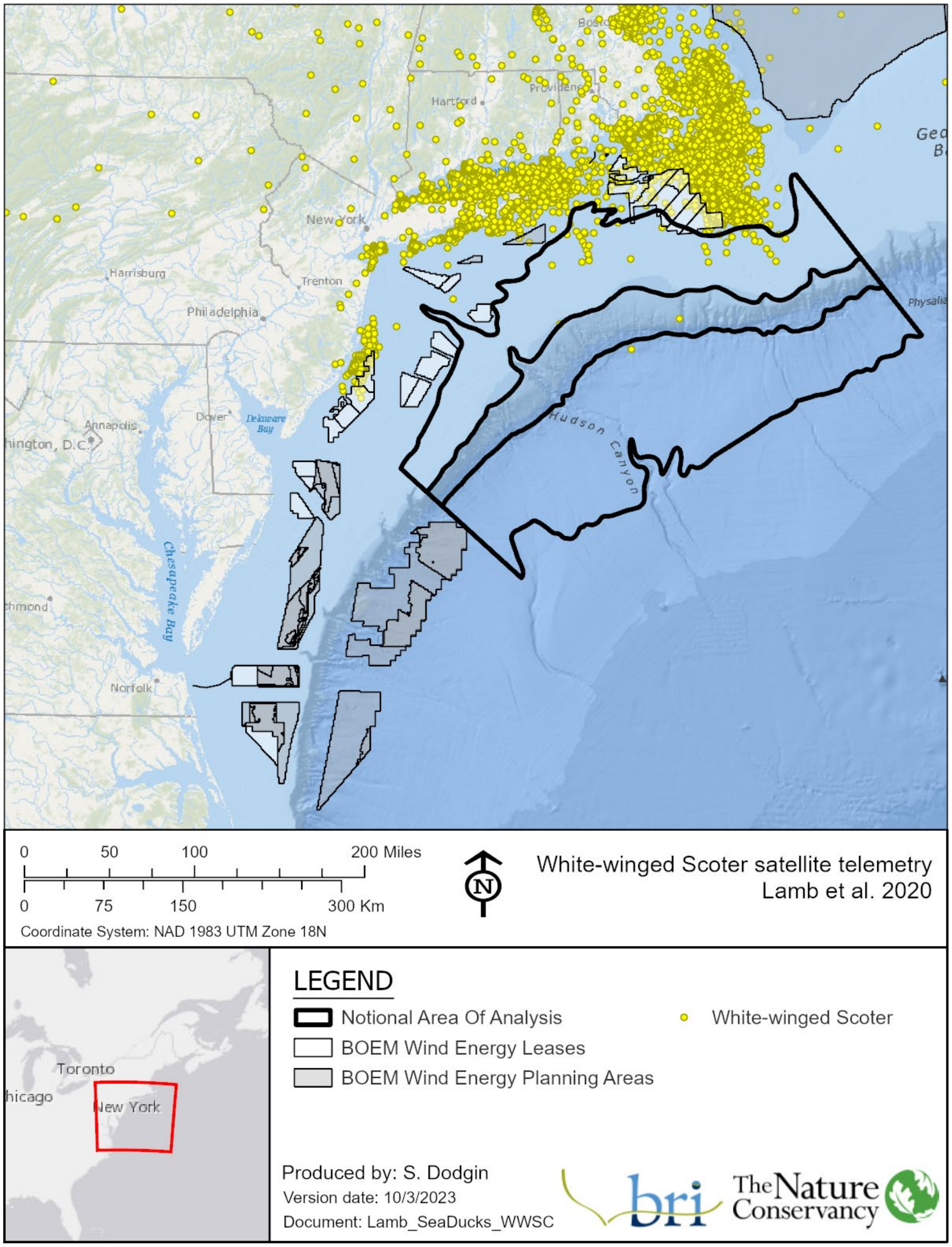


Figure 29. Model-Derived Locations of White-Winged Scoters

Model-derived locations during molting, staging and winter (August-March) 2002-2017 (n = 83 individuals tracked with satellite tags).



Long-Tailed Duck

Long-tailed ducks used the northeast portion of Zone 1, but were otherwise outside of the AoA during winter and migration (Figure 30, Figure 31).

Figure 30. Winter, Spring, and Fall Migration Utilization Distributions of Long-Tailed Ducks

50%, 75%, and 95% core use from DBBMM utilization distributions in winter (n = 49 individuals), spring (n = 60 individuals) and fall (n = 37 individuals), tracked with satellite tags.

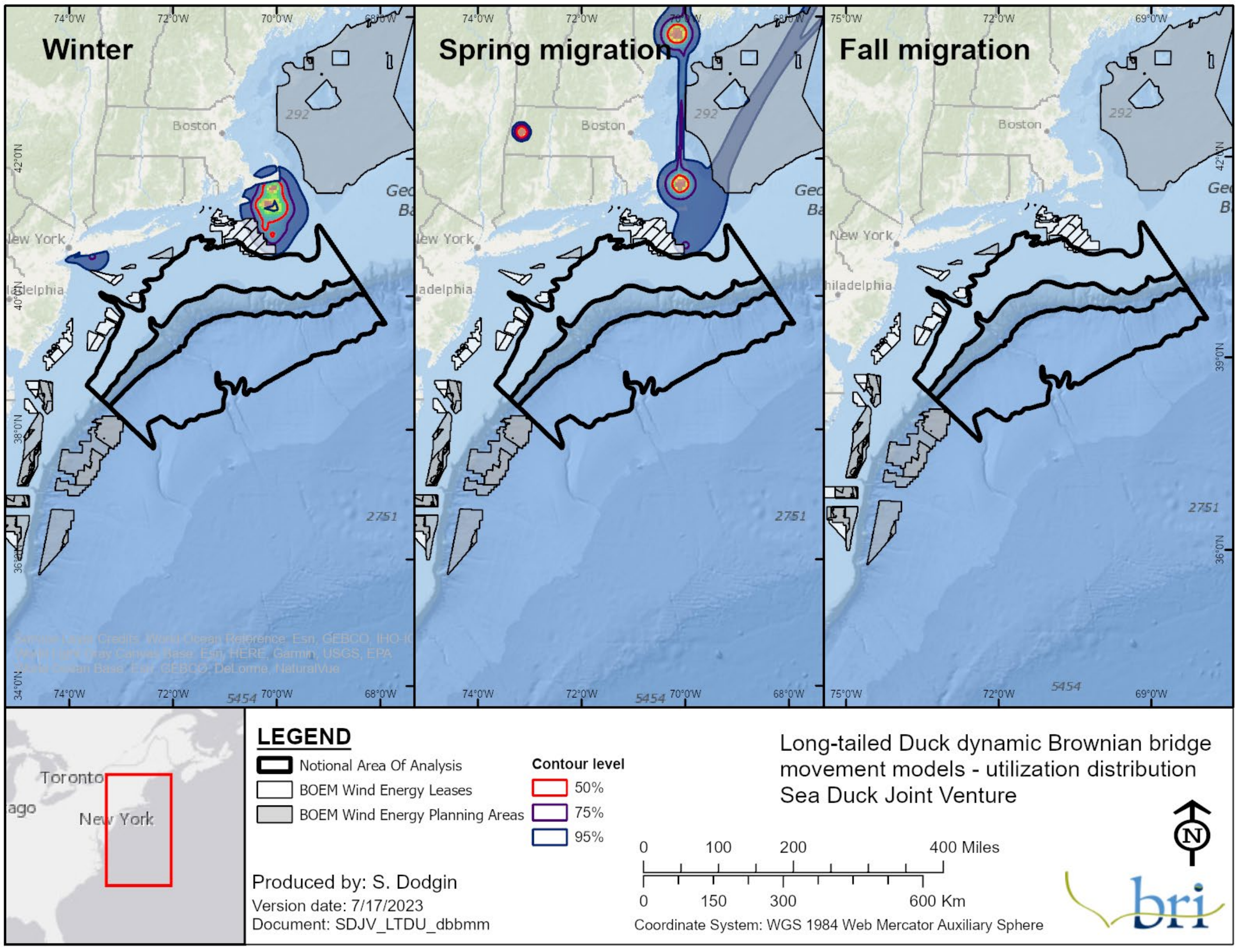
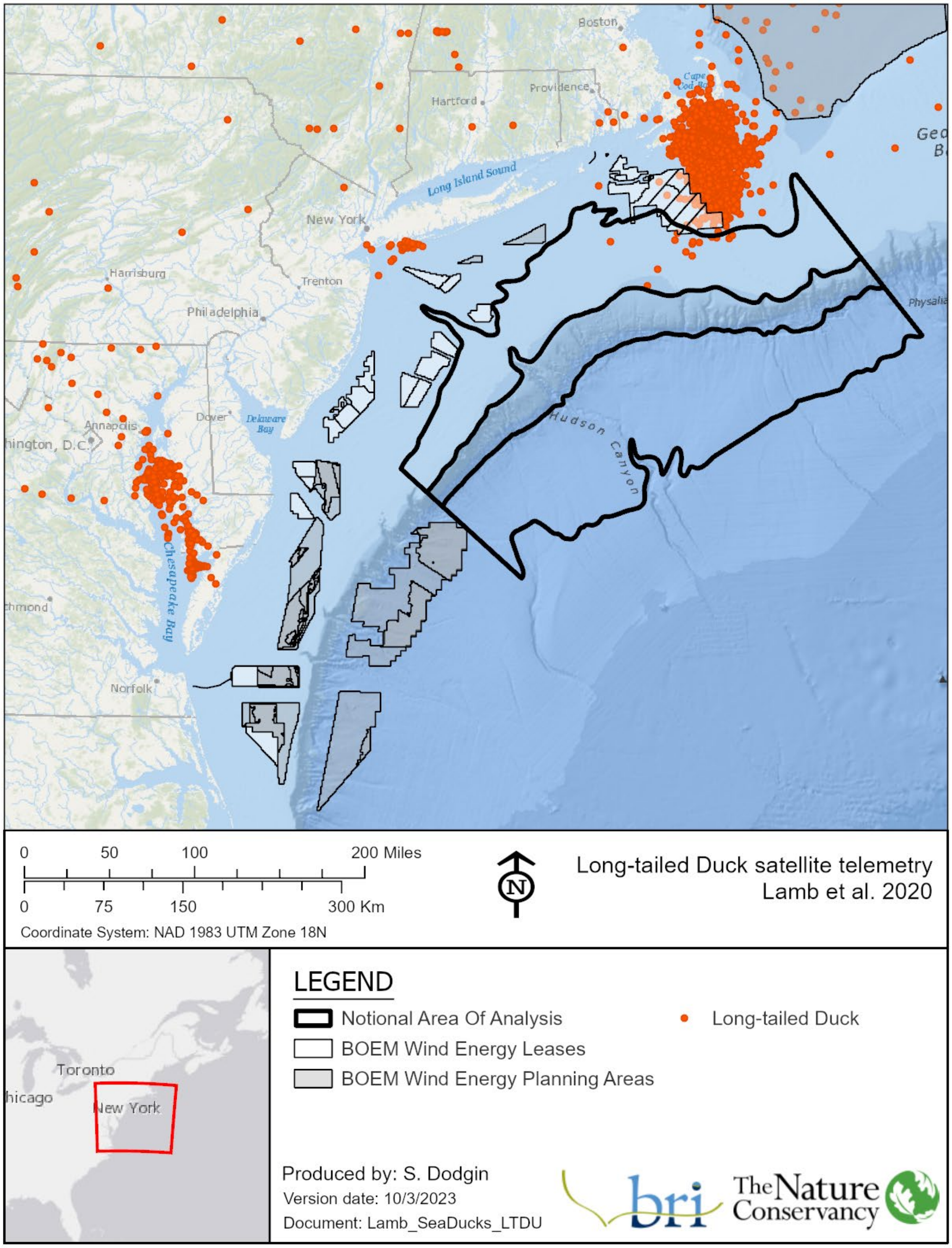


Figure 31. Model-Derived Locations of Long-Tailed Ducks

Model-derived locations during molting, staging and winter (August-March) 2002-2017 (n = 89 individuals tracked with satellite tags).

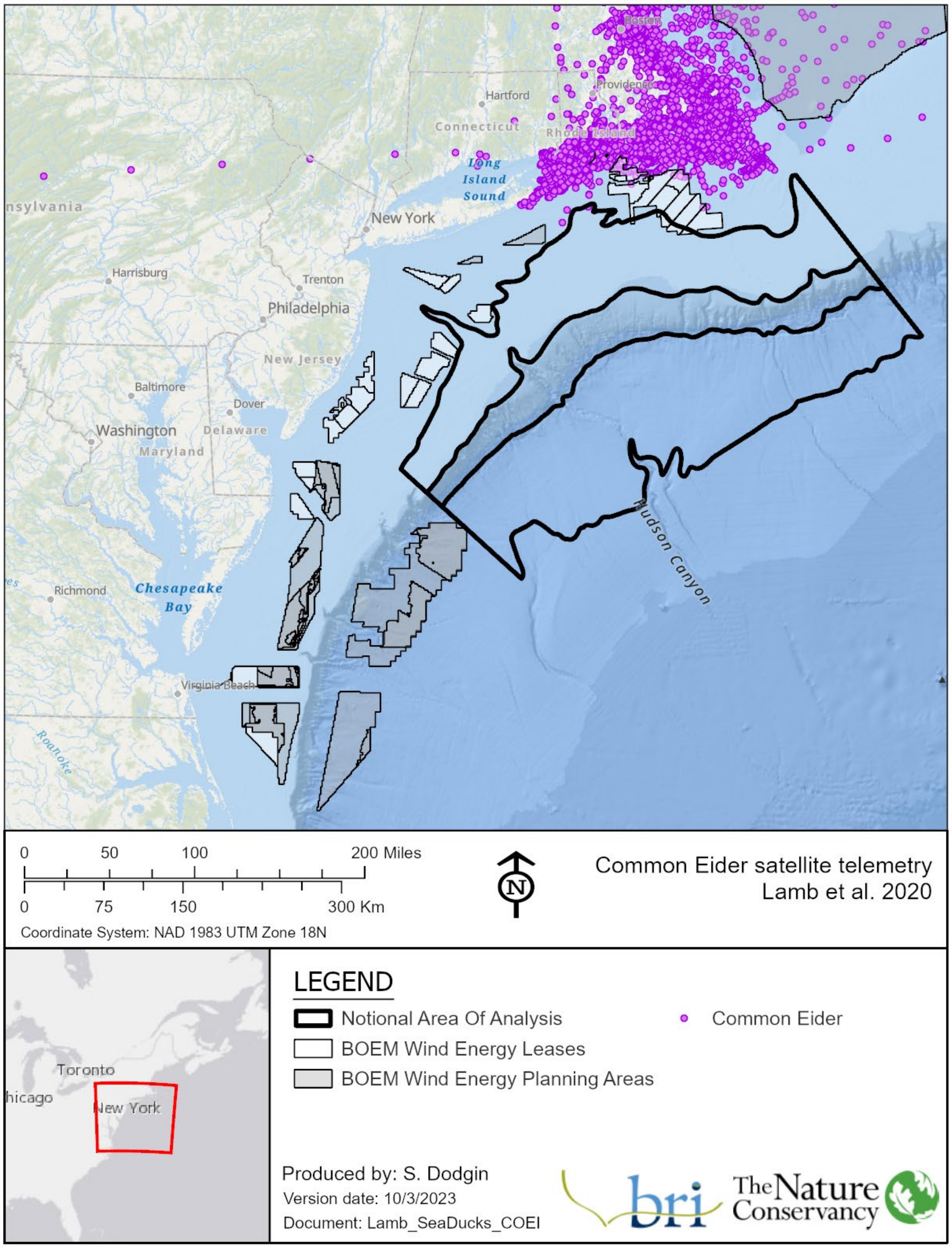


Common Eider

Common Eiders did not enter the AoA during molting, staging or winter (Figure 32).

Figure 32. Model-Derived Locations of Common Eiders

Model-derived locations during molting, staging and winter (August-March) 2002-2017 (n = 76 individuals tracked with satellite tags).



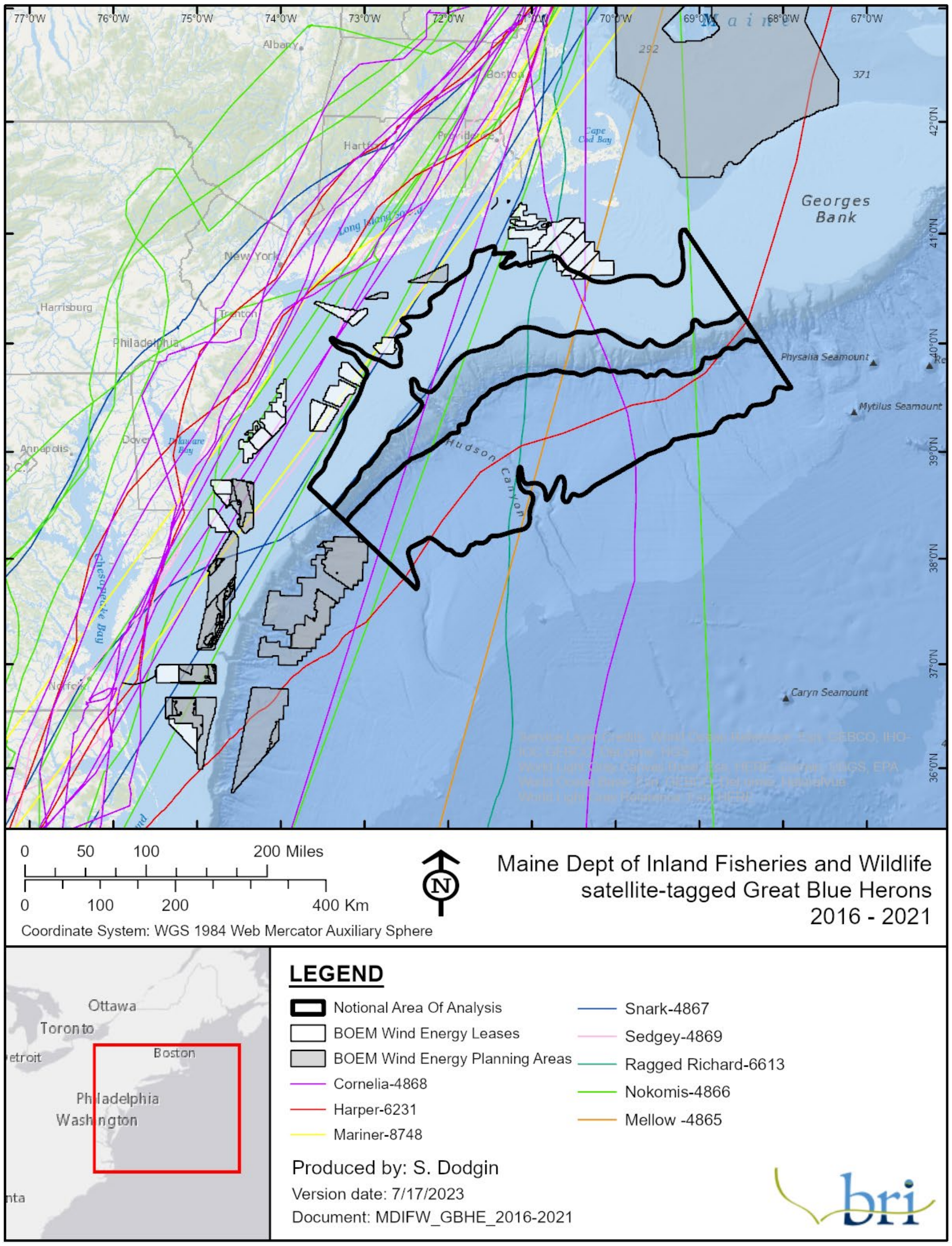
2.4.2.4 Wading Birds

Great Blue Heron

Great blue herons tracked with satellite tags by the Maine Department of Inland Fisheries and Wildlife traveled through Zones 1–3 of the AoA in spring and fall (Figure 33).

Figure 33. Great Blue Herons Movement Tracking

PTT tagged great blue herons in spring and fall (n = 8 individuals tracked with satellite tags).



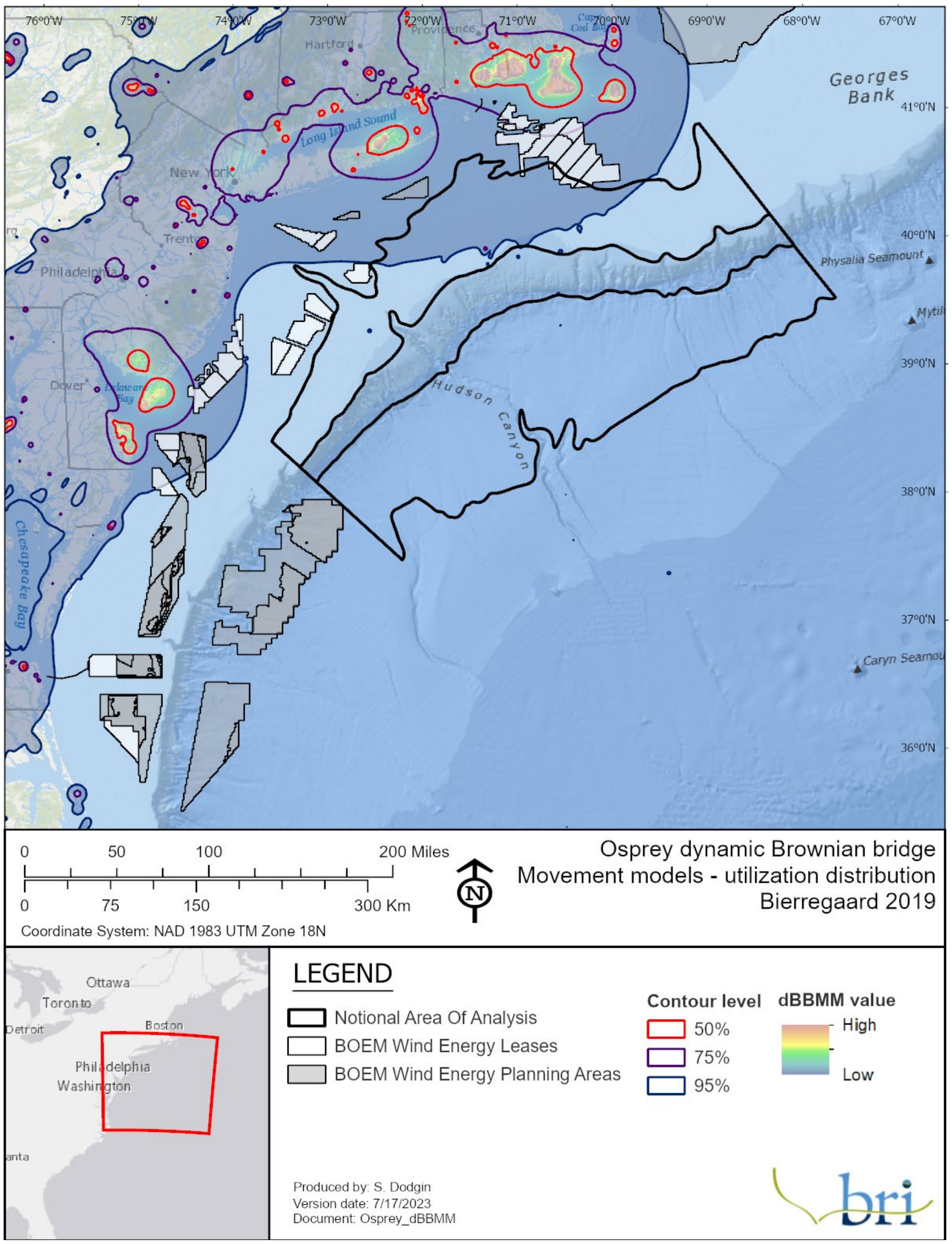
2.4.2.5 Raptors

Raptor migrations were tracked with Argos GPS tags within Zone 1 (Figure 34), through Zones 1–3 (Figure 35), and outside the AoA (Figure 36).

Osprey

Figure 34. Osprey Movement Tracking

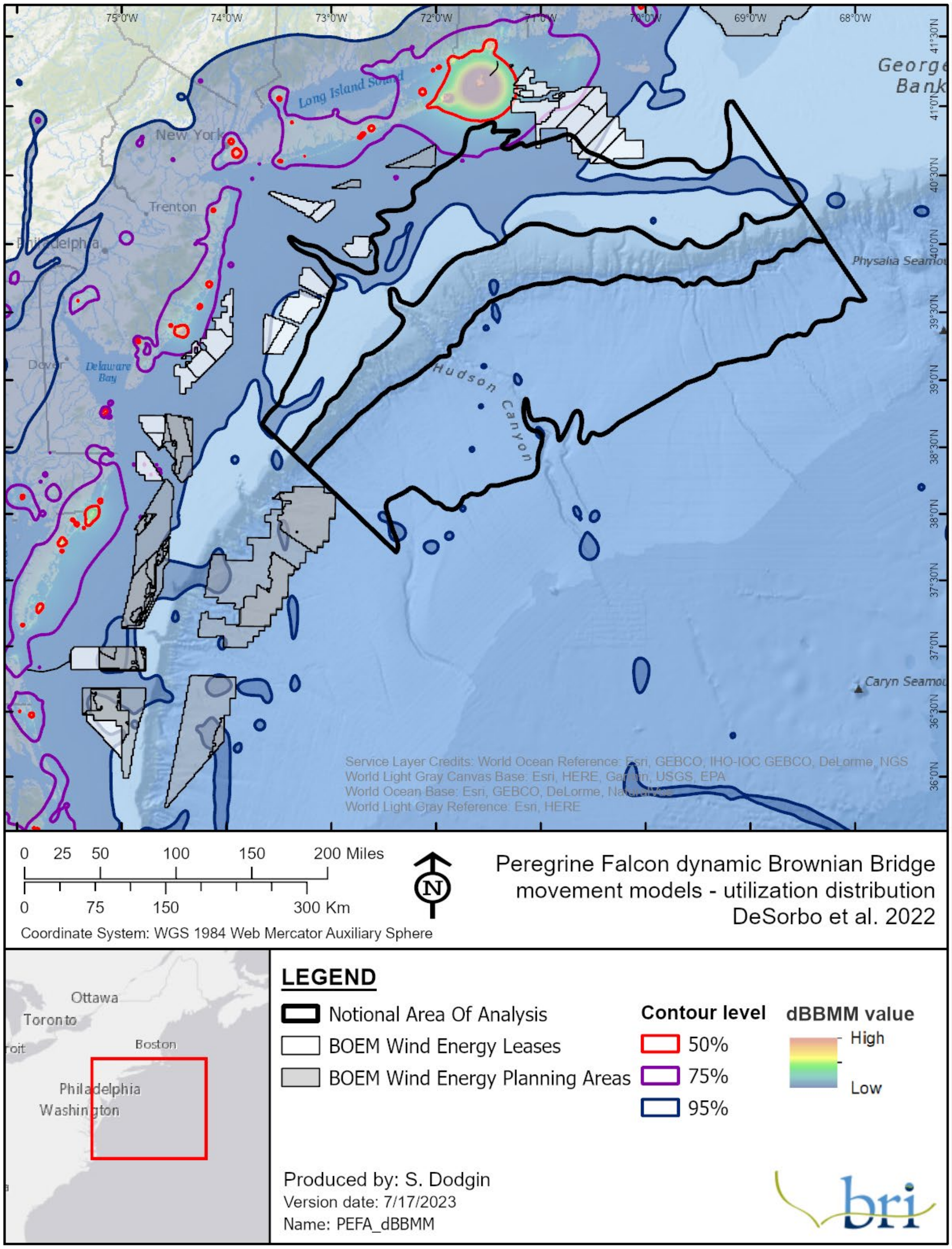
50%, 75%, and 95% core use from DBBMM utilization distributions (n = 96 individuals) in spring and fall, tracked with satellite tags.



Peregrine Falcon

Figure 35. Peregrine Falcon Movement Tracking

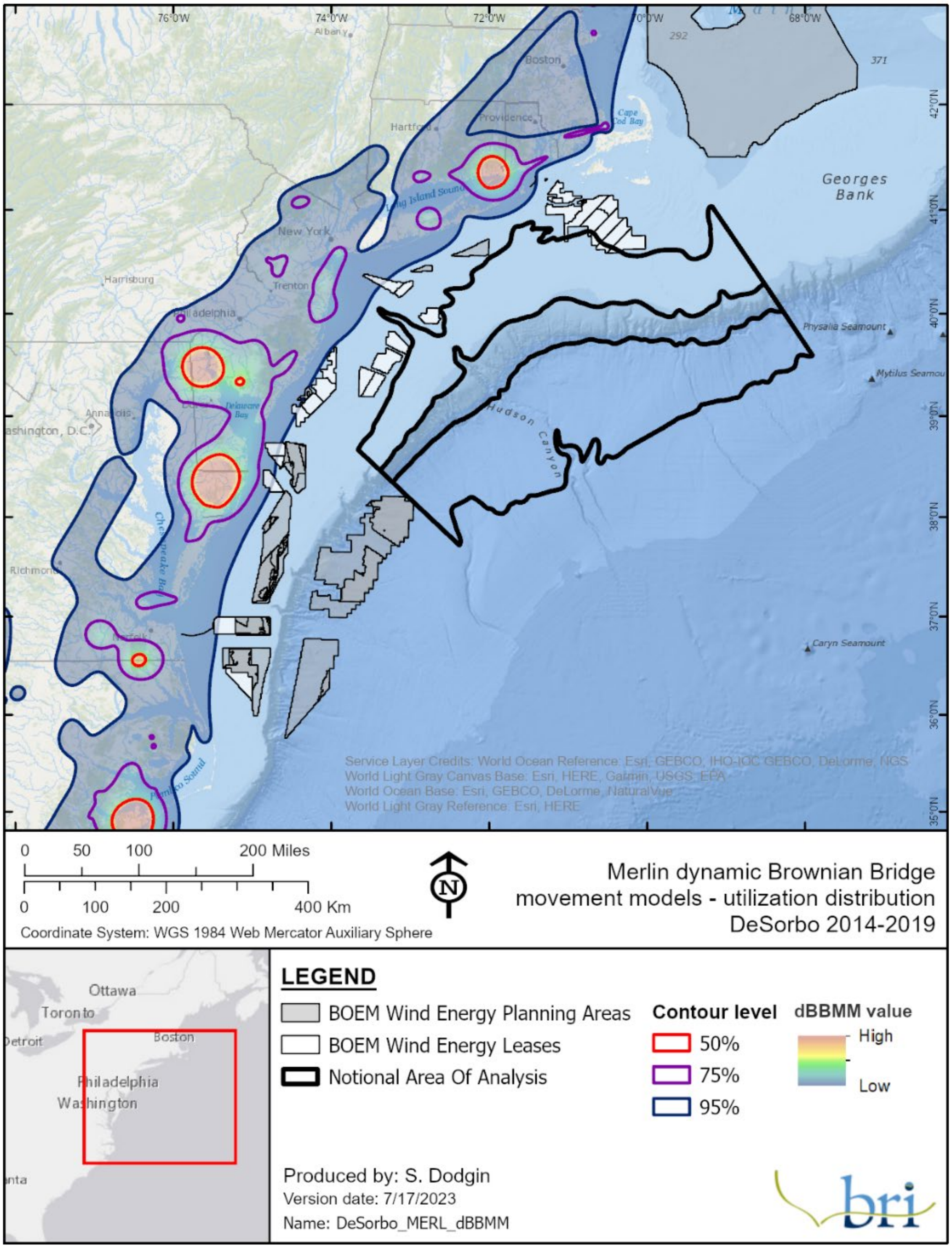
50%, 75%, and 95% core use from DBBMM utilization distributions (n = 49 individuals) in spring and fall, tracked with satellite tags (DeSorbo et al. 2015).



Merlin

Figure 36. Merlin Movement Tracking

50%, 75%, and 95% core use from DBBMM utilization distributions (n = 12 individuals) in spring and fall, tracked with satellite tags (DeSorbo et al. 2022).



3 Potential Stressors Associated with Each Phase of Deepwater Offshore Wind Development

This section identifies potential stressors and impact-producing factors associated with birds and bats from future OSW in the AoA (Table 4). Stressors are defined as effects of activities from OSW that may cause harm to receptors (in this case birds and bats), and/or the habitats and ecosystem processes on which they rely.[8] Similarly, impact-producing factors are defined by how offshore wind energy activities affect biological resources (Bureau of Ocean Energy Management 2019). Therefore, stressors are expected to impact birds and bats negatively, though some impact-producing factors may also affect birds and bats positively.

The level of risk that birds and bats encounter from stressors can vary both spatially and temporally. Exposure risk describes where and when bird populations are at risk of encountering proposed OSW. Spatial exposure to development may occur over the horizontal plane; for example, within foraging habitats, or along the vertical plane, depending on flight altitudes and rotor swept zone (RSZs). Temporal exposure varies with life cycle, including the breeding, staging (pre-migratory), migrating, stopover, and wintering seasons. Vulnerability characterizes how sensitive populations are to potentially adverse effects and negative impacts from development. This varies with life history traits, where collision vulnerability may increase when bird populations are attracted to development, and displacement vulnerability increases when populations avoid development.

The stressors that may affect birds from OSW are expected to impact populations directly, via collision risk, or indirectly, via displacement sensitivity. To be at risk of collision or displacement, bird populations must be both exposed to OSW and vulnerable to collision or displacement (Goodale and Stenhouse 2016). The primary concern for birds and bats is collisions that may result in injury or fatality, or potential indirect impacts, via displacement-induced habitat loss. The stressors identified in Table 4 that may affect birds and bats via collision or displacement are discussed in the sub-sections below. Some stressors may additionally affect populations through injury or sublethal fitness-level consequences that do not result directly from collision or displacement, though evidence is lacking and discussed in further detail below (e.g., see the potential effects of underwater noise in section 3.2.2).

Potential stressors expected to affect birds and bats from deepwater OSW are shown in Table 4. They were compiled using information from the Master Plan, impact-producing factors identified in BOEM Environmental Assessments, input from the PAC, E-TWG and F-TWG, and a literature review.

Construction and post-construction periods are expected to have greater impacts on birds and bats than pre-construction and decommissioning (sections 3.1.1 and 3.2). Advances in decommissioning methods and technologies are expected to occur throughout the operations phases of future projects over 25–30 years. Adaptive management incorporated into decommissioning plans would ideally be designed to re-evaluate impacts at the time that BOEM approves a full decommissioning plan prior to any decommissioning activities. The risk to birds and bats from all identified stressors and phases is further evaluated through a spatial risk assessment (section 4).

Table 4. List of Potential Stressors to Birds and Bats for Each Phase of Development

Pre-Construction	Construction	Post-Construction (Operation)	Decommissioning[a]
Vessel Traffic	Vessel Traffic	Vessel Traffic	Vessel Traffic
Noise	Noise	Noise	Noise
Bottom Disturbance	Bottom Disturbance	Bottom Disturbance	TBD
n/a	Artificial Lighting	Artificial Lighting	Artificial Lighting
n/a	n/a	New Structures	TBD
n/a	Changes in Water Quality	Changes in Water Quality	Changes in Water Quality
n/a	n/a	Changes to Atmospheric/ Oceanographic Dynamics	TBD

[a] TBD = to be determined (based on approval of decommissioning plans)

3.1 Bats

The lack of data on bats offshore contributes to high uncertainty in the AoA (Solick and Newman 2021); therefore, analysis of the impacts of stressors on bats is based on data from onshore and nearshore sources. There is some evidence to suggest that bats are attracted to wind turbines, particularly in onshore environments containing forested patches or singular trees (Smallwood and Bell 2020; Cryan et al. 2014). Displacement is not well-documented in onshore studies of bats; therefore, the risk for displacement is uncertain and warrants additional consideration in future studies. Given the current available data, the stressors reviewed during this study are expected to contribute to collision risk for bats, rather than displacement risk.

3.1.1 Attraction and Collision Risk

During pre-construction, construction, and post-construction activities, bats may be attracted to vessels. Vessels may provide roosting opportunities offshore for rest (Carter 1950; Norton 1930; Nichols 1920). Bats are known to use islands, ships, and other offshore structures as stopover points during travel (Pelletier et al. 2013). However, vessels and stationary objects are not generally considered a collision risk for bats (BOEM 2012) because of bats' use of echolocation (Johnson et al. 2004; Horn et al. 2008; Arnett et al. 2008).

While bat responses to offshore construction noise are poorly understood, research suggests that some species of bats will avoid foraging in onshore areas with increased noise (Schaub et al. 2008). However, uncertainty remains about how bats would respond to the dual stimulus of noise, perhaps causing some avoidance behavior, and the structure of the wind turbines, which could cause attraction as a potential roosting platform. Noise may temporarily occur during all four phases of development. For example, from vessel traffic, construction activities, operation, and decommissioning; however, it is unlikely to substantially impact bats given its attenuation and limited propagation (Guest et al. 2022).

Lighting on wind turbine decks, offshore substations, and construction or maintenance vessels may serve as an attractant to bats, though significant uncertainty remains about bat use far offshore. Some turbines may be lit with aviation lighting; however, aviation lighting has not been found to influence bat collision risk at onshore facilities in North America (Arnett et al. 2008). There is some evidence from Europe to suggest that bats foraging over the surface of the ocean increase their altitude when foraging around obstacles such as lighthouses and wind turbines (Ahlén et al. 2009). However, lighting sources on the turbine decks and offshore substation may serve as an attractant to bats as they navigate, or bats may potentially be indirectly attracted to insect prey drawn to the lights (Stantec 2016). They may also investigate the turbines for potential roosting opportunities or use lighting on structures for navigational purposes while migrating. If bats are present in the AoA, bats may more likely be attracted to wind turbines rather than displaced due to the presence of lighting.

During operations and maintenance of the wind turbines and the offshore substations, injury, or mortality from collision with new structures (turbines) represents the greatest potential risk to bats. At terrestrial wind farms in the U.S., bat fatalities from collisions with rotating blades have been well-documented (Cryan and Barclay 2009; Hayes 2013; Smallwood 2013; Martin et al. 2017; Pettit and O'Keefe 2017). These fatalities are predominantly represented by migratory tree-roosting bats (Kunz et al. 2007), which may be attracted to wind turbines in forested areas (Cryan 2008). Bats appear to be attracted to turbines for reasons that remain poorly understood, which could significantly increase risk even if number of bats offshore remains low (Guest et al. 2022). Acoustic studies indicate that migratory tree-roosting bats are the most common species group to be found offshore and available data indicate little to no use by cave hibernating bats (Tetra Tech 2022; Environmental Design and Research 2021a). Therefore, if bats occur in the AoA, they are expected to be migratory tree-roosting bats and are unlikely to be cave-hibernating bats. Migratory tree-roosting bats do not include federally- or state-listed species of concern (Table 2).

3.2 Birds

The siting of floating wind far offshore in the AoA may decrease risk to birds that use only coastal and nearshore environments, as compared to comparable wind facilities closer to shore (Garthe and Hüppop 2004; Farr et al. 2021).

3.2.1 Attraction and Collision Risk

Avian species may be attracted to construction equipment, new structures, and/or artificial lighting, during construction, operation, and decommissioning (Croll et al. 2022). Above water, attraction to lighting during nighttime construction or vessel activities could temporarily increase collision risk or mortality resulting from exhaustion associated with light entrapment (Fox and Petersen 2019; Montevecchi 2006; Maxwell et al. 2022). The attraction of seabirds to light that results from their disorientation (i.e., "phototaxis"), can inflate collision rates when flux densities increase within the RSZ (Rodríguez et al. 2017; Deakin et al. 2022). Additionally, under poor visibility conditions (e.g., at night or during fog and adverse weather), collision risk increases for some species, including protected species. Endangered seabird species and threatened shorebirds are thought to generally fly outside the 25–300 meter RSZ of current turbines with nameplate capacities of 10–16 megawatts: roseate terns below, red knot and piping plover above the RSZ (Loring et al. 2018; 2019). However, 17–20 megawatt prototype turbines span beyond this RSZ, both above and below, encroaching on the migratory and foraging altitudes of some protected species (e.g., Bureau of Ocean Energy Management 2023; AECOM 2023).

Below water, discharge from routine maintenance (i.e., fuel spills) or increased vessel activity may result in changes in water quality, resulting in fouling of birds (Bejarano et al. 2013). Entanglement of birds with marine debris may also occur from the accumulation of derelict gear around new structures such as floating wind cables (Benjamins et al. 2014; Farr et al. 2021). These below-water stressors potentially have negative effects on birds, though they are not well-documented and may be outweighed by positive effects.

Positive effects may occur from new structures that serve as artificial reefs or that increase productivity from oceanographic mixing (i.e., changes in dynamics from wind wake), if this improves foraging habitat (Fabi et al. 2004; Farr et al. 2021; Lieber, Langrock, and Nimmo-Smith 2021; Maxwell et al. 2022). However, if increased attraction to wind facilities generates increased use of a developed area, it could alternately heighten collision risk (Everaert and Stienen 2007). These potential impacts remain speculative, until tested offshore. Evaluation of such tradeoffs during all four phases of development would help determine whether new structures should be removed or remain in place during decommissioning, for conversion to artificial reefs (Callahan and Jackson 2014). Similarly, it remains unclear whether increased perching opportunities for birds on offshore structures increases their risk of collision from use of wind energy areas, or whether there is a benefit of resting locations in reducing energy expenditure (Ronconi et al. 2015; Maxwell et al. 2022). However, new above-water structures remain the primary direct stressor at risk of negatively affecting birds via collision with turbines (Maxwell et al. 2022) and questions remain on if offshore wind infrastructure serves as a demographic sink (Delibes et al. 2001)—i.e., birds are attracted for an apparent advantage, but the attraction leads to higher fatality rates.

3.2.2 Avoidance and Displacement Risk

Some species avoid wind energy facilities, which reduces collision risk but can lead to displacement from foraging areas (Mendel et al. 2019). Avian species may be displaced from construction activities and new structures, during construction and operation (Croll et al. 2022). Migratory seabirds and shorebirds may be displaced by offshore wind facilities under good visibility conditions, including some species listed as threatened and endangered under the ESA. Displacement has the potential to cause delayed but long-term indirect population impacts through habitat loss and/or increased energetic demands from diverting around facilities (Maxwell et al. 2022). Recent studies have suggested that shorebirds adjust their flight altitudes at sea, in some cases within the RSZ (Loring et al. 2021; Environmental Design and Research 2021b) and in others to avoid the RSZ (Schwemmer et al. 2023). Furthermore, higher wind speeds far offshore may increase bird flight heights, including species that might otherwise fly below the RSZ (Ainley et al. 2015). Lack of confidence in avoidance rates (Skov et al. 2018), and how bird flight heights respond to changes in wind speed or increased movement of floating turbines (as compared to fixed structures; Maxwell et al. 2022) all contribute to uncertainty in the likelihood and severity of these stressors.

Increased vessel traffic during all four phases of offshore wind energy development, particularly during high volume construction activity, presents a risk of temporary displacement for rafting birds from foraging areas, such as loons and sea ducks (Schwemmer et al. 2011; Kelsey et al. 2018). Temporary bottom disturbance of sediment during the installation of cables and infrastructure may additionally temporarily decrease the access of marine birds to their displaced prey (Staudinger et al. 2020).

Underwater noise could also potentially play a role in acoustic disturbance and displacement (McGrew et al. 2022). While the depths of floating offshore wind are beyond the foraging ranges of many marine diving birds (less than 60 meters deep, Sea Duck Joint Venture), evidence suggests that some sea ducks and alcids can dive up to 180 meters (Piatt and Nettleship 1985; Robertson, G. J. and J.P.L. Savard 2020). While hearing abilities are not well-measured in seabirds, their auditory physiology efficiently conducts underwater sound, and thresholds have been measured within frequency bands analogous to some marine mammals (Ketten et al. 1999; Dooling 2002; Hansen et al. 2017; Anderson Hansen et al. 2020; Johansen et al. 2016; Larsen et al. 2020). However, noise from the detonation of unexploded ordnance on the seafloor is short-term, and noise from construction activity of floating structures is less than the pile-driving required for fixed structures (Maxwell et al. 2022). Therefore, sound propagation from floating offshore wind activities may not substantially affect birds. Should fixed structures be considered for development in the AoA, then a reanalysis of potential auditory sensitivities is warranted. Given the temporary nature of these stressors, new above-water structures remain the primary indirect stressor expected to affect birds negatively via displacement from foraging habitats (Maxwell et al. 2022).

4 Spatial Risk Assessment

A spatial risk assessment for birds and bats was used to identify the exposure and vulnerability of birds and bats from the stressors, as identified in section 2. Spatial risk assessments are routinely prepared for project-specific COPs, to document the potential impacts of stressors from OSW on birds and bats. They characterize the sensitivity of birds and bats to impact-producing factors. Due to lack of data on bats in the AoA, a qualitative assessment was conducted for bats, based on a literature and data review. A quantitative spatial risk assessment was conducted for marine birds (n = 47), and also informed the Environmental Sensitivity Analysis, a separate spatial study (NYSERDA 2025). Bats were excluded from the Environmental Sensitivity Analysis due to lack of data offshore. This spatial risk assessment produced three spatial data layers for mapping: population, collision, and displacement vulnerability of birds in the AoA. The Environmental Sensitivity Analysis synthesized these bird data layers with the other environmental resources in the AoA (e.g., marine mammals, sea turtles, fish and fisheries, and benthic habitats) to produce a single overall environmental risk map.

4.1 Methods

4.1.1 Bats

The spatial risk assessment used a weight-of-evidence approach by evaluating (a) the likelihood bats will occur within the AoA (i.e., exposure) and (b) the known vulnerability of bats to collisions with wind turbines (offshore) and habitat modification (based on studies onshore). The likely presence of bat species was categorized based on criteria presented in the AoA, using the best available data, literature, and information on geographic range and habitat requirements (Table 5). Vulnerability for each species or group was based upon behavior, habitat requirements, seasonality of use, and known impacts associated with construction, operations, and decommissioning of standard project infrastructure. Due to lack of data on bats offshore, bats were not included in the data layers generated from the spatial risk assessment for the Environmental Sensitivity Analysis.

Table 5. Exposure Risk Definition

Exposure risk was determined based upon available data, existing literature, and species accounts.

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

4.1.2 Birds

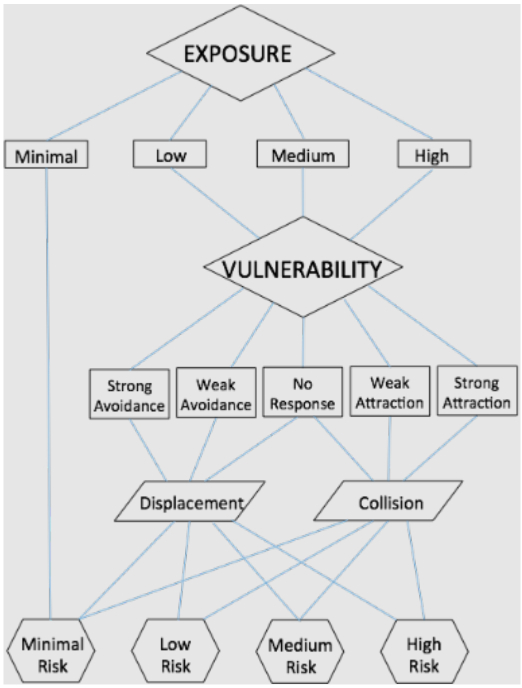
Based on avian risk assessments conducted for the Gulf of Maine and project-based COPs (e.g., Empire Wind in the New York Bight), the spatial risk assessment described risks to bird species from all phases of OSW: collision with turbines, avoidance, displacement, and attraction. Risk layers derived from MDAT models were based on boat and aerial survey data (Table 1). Therefore, these map layers represent the risk of 47 marine bird species to OSW in the AoA, and do not include the other 16 non-marine bird or nine bat species discussed in this study.

Tracking data (section 2) were used to qualitatively adjust risk scores, but the spatial risk map layers were based on survey data only. Tracking data (section 2) were not integrated quantitatively with the survey data in the spatial risk maps because they were presence-only, unlike survey data, which included observed absences (effort data). Whereas observed absences from survey data are more likely to translate to areas of low exposure to birds, tracks indicate only where individual animals have visited during the tag period (i.e., potentially high exposure areas). Given the influence of tag location on tracking data, large sample sizes across the full-annual cycle would be needed to infer low-population exposure from individual movement data. Despite this sampling bias, tracking data can effectively fill sampling gaps in survey data; for example, by providing information on movements overnight, or during poor weather (e.g., high wind), when surveys don’t operate due to safety concerns. Therefore, tracking and survey data provide imperfect but complementary information on population exposure to OSW. To account for sampling biases and properly integrate tracking with survey data, the development of advanced model-based methods is a research need (Matthiopoulos et al. 2022; see section 7).

The spatial risk assessment included an exposure and vulnerability assessment to produce a set of maps on marine birds using Version 2 of the MDAT data (appendix B). Exposure was calculated using quantiles of species densities within the AoA. Exposure scores scaled up or down based on population vulnerability (PV), collision vulnerability (CV), and displacement vulnerability (DV) for species believed to use the AoA. Population vulnerability is defined as the sensitivity of species to population decline, based on threat ranking and demographic factors such as population size, growth rates and survival (Willmott et al. 2013). Collision vulnerability refers to the sensitivity of species to injury or mortality from colliding with turbines, using data such as flight heights from the NWASC and rankings based on time spent in the RSZ or avoidance rates (Kelsey et al. 2018). NWASC flight height data were the best available in the region, though they were likely biased low due to measurement error, platform effects, and sampling conditions, and therefore may bias vulnerability estimates low (Johnston et al. 2014; Glennie et al. 2015; Johnston and Cook 2016; Borkenhagen et al. 2018; Harwood et al. 2018). Displacement vulnerability is defined as the sensitivity of species to displacement-induced habitat loss as a result of factors such as macro avoidance of wind facilities, disturbance ranking, and habitat flexibility (Willmott et al. 2013; Kelsey et al. 2018). While risk may be site-specific, season-specific, species-specific, and sometimes even specific to sex or individual behaviors (Stienen et al. 2008; Peschko, Mercker, and Garthe 2020), this assessment focuses on population-level exposure and vulnerability. Final calculations resulted in an overall risk score that was then combined across species (Figure 37).

Figure 37. Risk Assessment Framework

Exposure scores were calculated using the MDAT models, then incorporated into vulnerability scores that were multiplied by species density proportions to quantify risk.



4.1.2.1 Exposure Framework

To assess bird exposure at the regional scale, the study team compared the AoA to similarly sized areas in the Atlantic Outer Continental Shelf, for each season and species, then combined the results into an annual score. Data were analyzed at the resolution of BOEM lease blocks (2304 hectares or 23 square kilometers per standard block). Using the MDAT data, masked to remove zero-effort predicted grid cells, the predicted seasonal density surface for a given species was aggregated into a series of rectangles that were approximately the same size as the AoA, and the mean density estimate of each rectangle was calculated. This process compiled a data set of density estimates for all species surveyed, within areas the same size as the AoA. The 25th, 50th, and 75th weighted quartiles of this data set were calculated, and the quartile comprising the density estimate for the AoA was identified for a given species and season combination. These quartiles were weighted using the proportion of the total density across the entire modeled area that each sample represented. Thus, quartile breaks represented proportions of the total modeled seabird density rather than proportions of the raw data. A categorical score was assigned to the AoA for each season-species: 0 (minimal) was assigned when the density estimate for the AoA was in the bottom 25%; 1 (low) when it was between 25% and 50%; 2 (medium) when it was between 50% and 75%; and 3 (high) when it was in the top quartile (>75%).

All the seasonal scores were summed by species to obtain a total annual exposure score that represented species use of the study area. This annual regional exposure score for each species population (POP) represented seasonally integrated risk across the annual cycle and ranged from 1–5, categorized as absent (1), minimal (2), low (3), medium (4), and high (5). The final annual exposure scores for each species should be interpreted as a measure of the relative importance of the AoA for a species, as compared to other surveyed areas in the Northwest Atlantic Outer Continental Shelf. They do not indicate the absolute number of individuals likely to be exposed to offshore wind energy development. Rather, the exposure scores attempt 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 AoA 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 AoA than in other locations. A minimal exposure score should not be interpreted to suggest no individuals of that species in the AoA. In some cases, common species may have received a minimal exposure score even with substantial numbers of individuals in the AoA, so long as their predicted densities *outside* were comparatively higher.

4.1.2.2 Vulnerability Framework

Maps were created to convey spatial avian risk across three categories: PV, CV, and DV, using Version 2 of the MDAT marine bird relative density and distribution models (Curtice et al. 2016; Winship et al. 2018). Vulnerability rankings PV, CV, and DV were evaluated independently for all possible species where data were available to support estimates (Table 6). These combined ordinal scores across a range of key variables, consistent with research in Europe and the U.S. on the vulnerability of birds to offshore wind facilities and general disturbance (Willmott et al. 2013; Furness et al. 2013; Wade et al. 2016; Fliessbach et al. 2019). The purpose of these indices was to prioritize species in environmental assessments (Desholm 2009) and provide a relative rank of vulnerability (Willmott et al. 2013).

To calculate the PV, four factors were summed (Equation 1) and rescaled to a 0–1 score:

- a Partners in Flight “continental combined score” (*CCSmax*).
- a “state status” (*SSmax*) using the maximum of state threatened and endangered status and “Species of Greatest Conservation Need” (SGCN) scores for states neighboring the AoA (Connecticut, Maryland, Massachusetts, New Jersey, New York, Rhode Island, and Virginia).
- an adult survival score (*AS*).
- a *POP* representing species use of the study area.

Equation 1 $$PV = CCS_{max} + SS_{max} + AS + POP$$

CCSmax was derived by Partners in Flight to indicate global population health, using global population status, global breeding distribution, continental threats, and continental population trend (Panjabi et al. 2019). *Ssmax* incorporated state conservation status, which was not included in *CCSmax*. *AS* accounted for species with higher adult survival rates that are more sensitive to increases in adult mortality. The POP component used exposure to quantify population use of the AoA relative to the rest of the Atlantic Outer Continental Shelf, based on MDAT model relative density estimates (Kelsey et al. 2018; Fliessbach et al. 2019).

The CV assessment included scores for nocturnal flight activity (NFA), diurnal flight activity (DFA), avoidance, proportion of time within the RSZ, maneuverability in flight, and percentage of time flying (Willmott et al. 2013; Furness et al. 2013; Kelsey et al. 2018). The assessment process conducted here followed Kelsey et al. (2018) and included proportion of time within the RSZ (*RSZt*), a measure of avoidance (*Mac*), and flight activity (*NFA* and *DFA*). All factors were summed (Equation 2) and rescaled to 0–1.

Equation 2 $$CV = RSZt + MAc + \frac{NFA+DFA}{2}$$

RSZt accounted for the probability that a bird may fly through the RSZ. The proportion of animals within the RSZ was modeled using a smooth spline of flight heights from the NWASC and integrated across the height range to estimate the proportion of the animals using the RSZ (Johnston et al. 2014). The RSZ was assigned the values 25 to 300 meters based on recent example turbine configurations (Bureau of Ocean Energy Management 2021a; 2021b; 2023). *Mac* accounted for macro-avoidance rates that decrease collision risk. The scores used in the assessment were based on Willmott et al. (2013), but updated to reflect recent empirical studies (Krijgsveld et al. 2011; Cook et al. 2012; 2018; Vanermen et al. 2015; Skov et al. 2018), and indices (Garthe and Hüppop 2004; Furnesset al. 2013; Bradbury et al. 2014; Adams et al. 2016; Wade et al. 2016; Kelsey et al. 2018). More recent avoidance rates have been published (Ozsanlav-Harris et al. 2022), but are not directly comparable due to several factors including species, technology used, and scale of analysis, therefore support for an updated vulnerability analysis has been identified as a research need. (see section 7).

NFA and *DFA* represented estimated percentages of time spent flying (as opposed to resting on the sea surface) at night (*NFA*) and during the day (*DFA*), based on the assumption that more time spent flying increases collision risk. The NFA scores were taken directly from Willmott et al. (2013). The *DFA* scores were calculated from behavioral observations in the NWASC. Although recent studies have demonstrated high micro-avoidance of turbines during daylight hours, suggesting that nocturnal flight activity may contribute more heavily to collision risk (Tjørnløv et al. 2023), the *NFA* and *DFA* scores were equally weighted and averaged consistent with previous studies (Kelsey et al. 2018).

The DV assessment incorporated 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). These factors were summed (Equation 3) and rescaled to 0–1.

Equation 3 $$\boldsymbol{DV = MAd + HF}$$

MAd accounted for behavioral responses from birds that lead to macro-avoidance of wind facilities and have the potential to cause effective habitat loss if 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; Aonghais S C P Cook et al. 2012; 2018; Vanermen et al. 2015; Skov et al. 2018), and indices (Garthe and Hüppop 2004; Furness et al. 2013; Bradbury et al. 2014; Adams et al. 2016; Wade et al. 2016; Kelsey et al. 2018). The *MAd* scores were the same as the *Mac* scores described above, though inverted, following Kelsey et al. (2018). *HF* accounted 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). Generalists were assumed to be less affected by displacement or experience temporary displacement, whereas specialists were assumed to be more affected (Kelsey et al. 2018). The values for *HF* used in this assessment were taken from Willmott et al. (2013).

Table 6. Data Sources and Scoring 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
Population Vulnerability (PV)	SSmax	State status from states adjacent to project; Adams et al. 2016.	1 = No Ranking* 2 = State/Federal Special Concern 3 = State/Federal Threatened (T) 4 = State/Federal Endangered (E) 5 = State & Federal T and/or E
Population Vulnerability (PV)	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
Population Vulnerability (PV)	POP	Annual population use of the study area from the Marine-Life Data and Analysis Team (MDAT) models.	1 = 0 2 > 0 to 25% (inclusive) 3 > 25% to 50% (inclusive) 4 > 50% to 75% (inclusive) 5 >75%
Collision Vulnerability (CV)	RSZt	Turbine-specific percentage of flight heights in rotor swept zone (RSZ). Flight heights modeled from Northwest Atlantic Seabird Catalog (NWASC). Categories from Kelsey et al. 2018.	1 = < 5% in RSZ 3 = 5–20% in RSZ 5 = > 20% in RSZ
Collision Vulnerability (CV)	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
Collision Vulnerability (CV)	NFA & DFA	Nocturnal Flight Activity (NFA) and Diurnal Flight Activity (DFA). NFA scores were taken from Willmott 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
Displacement Vulnerability (DV)	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). Habitat flexibility (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. 2-4 = 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.

Vulnerability categories (PV, CV, DV) were used to weight annual MDAT modeled species density estimates to estimate total annual avian risk across the AoA. Annual MDAT density models were first standardized to generate a total density of one (1) for each species, then weighted per species by the vulnerability metric (0 to 1). These spatial layers were summed across all 47 species to yield a final total risk score by vulnerability category for birds. The quartiles of the PV, CV, DV-weighted densities were added together to give a total score ranging from 3 to 12, with higher values representing greater species density of vulnerable species.

4.2 Results

4.2.1 Bats

4.2.1.1 Exposure Risk to Bats in the Area of Analysis

While data gaps remain about offshore bat movements, available data suggested that bat activity, and therefore exposure risk, is generally low in the AoA, particularly as compared to the onshore or nearshore environments (Hein et al, 2021). This is supported by data from Europe suggesting that acoustic detections at nearshore and onshore sites on the North Sea can be up to 24 times higher compared to offshore locations (Brabant et al. 2021).

4.2.2 Birds

4.2.2.1 Exposure Risk to Birds in the Area of Analysis

Available data suggest that bird exposure to wind energy development in the AoA is generally low relative to the rest of the Atlantic Outer Continental Shelf, with some exceptions (see section 4.2.2.2). These exceptions include pelagics and offshore migrants. For example, recent data on ESA-listed pelagic seabirds, the endangered Bermuda petrels and candidate threatened black-capped petrels, suggest that they frequent the AOA (Raine et al. 2021; Satgé et al. 2023; Campioni 2023, unpublished data). Threatened shorebirds (red knots and piping plovers) and endangered seabirds (roseate terns) have been documented in the AoA (NWASC and NYSERDA digital aerial surveys; Loring et al. 2019; 2020), though their small body sizes limit the ability to track these species in the AOA, or identify them in offshore surveys. Additionally, offshore bird movement data is lacking, particularly in Zone 3.

4.2.2.2 Risk Sensitivity Rankings

The AoA is beyond the range of many breeding terrestrial and coastal bird species but it is frequented by offshore migrants and pelagics, some with high exposure and/or vulnerability scores (Table 7). In the MDAT models, Wilson's storm-petrel had the highest overall exposure, though their vulnerability was medium due to low-flight heights. Species with medium exposure in the MDAT models included dovekie, parasitic jaeger, Manx shearwater, and red-necked phalarope, and these species also resulted in low-medium vulnerability. A few species that appeared better represented in the NYSERDA digital aerial surveys (NYSERDA 2021) than the MDAT models included: red-throated loon, northern fulmar, black-capped petrel, and great shearwater (appendix B). Low exposure scores in Zone 3 of the AoA may, in part, be due to lack of survey data in the region (low MDAT coverage and high associated uncertainty; see section 5). Therefore, risk sensitivity rankings may change with updated MDAT 3.0 models, which incorporate the NYSERDA surveys and are scheduled for release in 2024. For species with minimal exposure scores (generated from the MDAT models) that indicated use of the AoA in tracking data shown in section 4.2.2.1 (Atlantic puffins, black-capped petrels, common terns, and Leach's storm petrels), their exposure scores were qualitatively increased to minimal-low in Table 7.

Vulnerability scores generally ranked higher than exposure in the AoA, particularly due to the potential for displacement of birds from deepwater OSW. Species with high displacement vulnerability included sea ducks (long-tailed duck, black scoter, white-winged scoter, common eider), auks (razorbill, black guillemot, Atlantic puffin, common murre), terns (bridled, roseate, common, and Arctic), and loons (common and red-throated). Taxa with medium overall displacement vulnerability included sea ducks, auks, gulls, terns, pelicans, petrels, shearwaters, fulmars, gannets, and phalaropes. The combination of exposure with medium to high collision, displacement and/or population vulnerability resulted in high risk across some regions of the AoA, particularly in eastern Zones 1–2 at the continental shelf break and slope (see section 4.2.2.3).

Table 7. Summary of Exposure and Vulnerability Scores for Marine Bird Species Analyzed in Risk Assessment

Common Name	Seasons	Exposure[b]	CV[c]	DV[c]	PV[c]
Long-tailed Duck	3	min.	low (0.30)	high (0.9)	low (0.35)
Black Scoter	3	min.	NA	high (0.9)	low (0.45)
White-winged Scoter	3	min.	low (0.33)	high (0.8)	med. (0.55)
Surf Scoter	3	min.	low (0.40)	high (0.9)	med. (0.55)
Red-breasted Merganser	2	min.	NA	med. (0.5)	low (0.25)
Common Eider	4	low	low (0.40)	high (0.9)	low (0.45)
Razorbill	4	low	min. (0.20)	high (0.8)	med. (0.55)
Dovekie	4	med.	Low (0.30)	med. (0.7)	low (0.45)
Black Guillemot	1	min.	NA	high (0.9)	low (0.35)

Table 7 continued

Common Name	Seasons	Exposure[b]	CV[c]	DV[c]	PV[c]
Atlantic Puffin	4	**min.-low**	min. (0.20)	high (0.8)	low (0.45)
Common Murre	2	min.	low (0.27)	high (0.8)	low (0.35)
Thick-billed Murre	2	min.	NA	NA	min. (0.05)
Bridled Tern	2	min.	low (0.40)	high (0.8)	low (0.45)
Sooty Tern	2	min.	med. (0.60)	med. (0.7)	low (0.40)
Roseate Tern	3	low	low (0.33)	high (0.8)	high (0.75)
Common Tern	3	**min.-low**	low (0.33)	high (0.8)	med. (0.55)
Arctic Tern	1	min.	low (0.33)	high (0.8)	med. (0.55)
Least Tern	2	min.	NA	NA	min. (0.05)
Royal Tern	3	min.	med. (0.57)	med. (0.5)	med. (0.60)
Bonaparte’s Gull	3	min.	med. (0.50)	med. (0.5)	low (0.30)
Herring Gull	4	low	med. (0.73)	med. (0.5)	med. (0.50)
Ring-billed Gull	4	min.	NA	low (0.4)	low (0.30)
Great Black-backed Gull	4	low	med. (0.67)	med. (0.7)	low (0.25)
Laughing Gull	4	min.	med. (0.60)	med. (0.5)	low (0.40)
Black-legged Kittiwake	3	low	med. (0.60)	med. (0.6)	low (0.45)
Parasitic Jaeger	3	med.	Med. (0.60)	low (0.3)	low (0.45)
Pomarine Jaeger	3	low	med. (0.73)	low (0.3)	low (0.40)
South Polar Skua	2	low	med. (0.73)	low (0.3)	med. (0.50)
Great Skua	1	min.	NA	NA	min. (0.05)
Common Loon	4	min.	med. (0.60)	high (0.8)	med. (0.50)
Red-throated Loon	3	min.	low (0.37)	high (0.9)	low (0.45)
Audubon’s Shearwater	4	min.	low (0.30)	med. (0.6)	med. (0.65)
Manx Shearwater	3	med.	Low (0.37)	med. (0.6)	med. (0.55)
Great Shearwater	4	low	low (0.40)	med. (0.6)	med. (0.60)
Sooty Shearwater	3	low	low (0.37)	med. (0.6)	med. (0.50)
Cory’s Shearwater	3	low	low (0.37)	med. (0.6)	med. (0.65)
Northern Fulmar	4	min.	low (0.43)	med. (0.6)	low (0.40)
Black-capped Petrel	4	**min.-low**	low (0.40)	med. (0.6)	med. (0.55)
Band-rumped Storm-petrel	1	min.	NA	NA	min. (0.05)
Leach’s Storm-Petrel	3	**min.-low**	low (0.40)	med. (0.6)	med. (0.50)
Wilson’s Storm-Petrel	3	high	low (0.40)	med. (0.6)	med. (0.50)
Northern Gannet	4	low	med. (0.50)	med. (0.6)	med. (0.55)
Double-crested Cormorant	4	min.	NA	low (0.4)	min. (0.15)
Brown Pelican	4	min.	NA	med. (0.5)	low (0.45)
Horned Grebe	1	min.	NA	NA	min. (0.05)
Red Phalarope	3	low	low (0.47)	med. (0.5)	low (0.40)
Red-necked Phalarope	3	med.	Low (0.43)	med. (0.5)	low (0.45)

[a] Number of seasons occurred in MDAT models; NA = Not Applicable (missing data); min. = minimal, med.= medium.

[b] Exposure Scores: 0–2 = minimal (green), 4-8 = low (yellow), 10-12 = medium (orange), and 14-16 = high (red); Exposure Scores were qualitatively increased to show a range in bold for species with substantial tracking data in the AoA (e.g., min.-low).

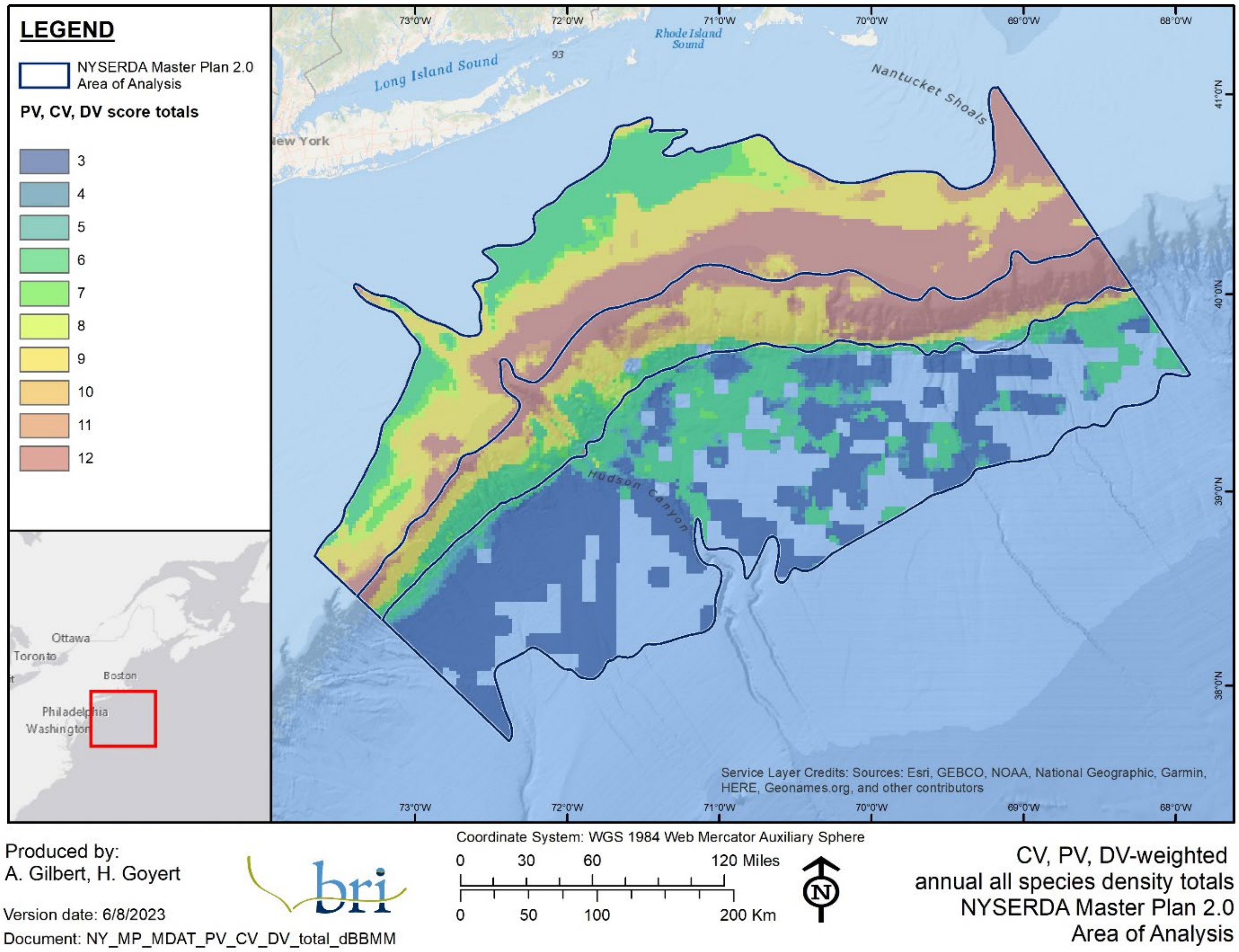
[c] Vulnerability Scores: [0-0.2] = minimal (green), (0.2-0.5) = low (yellow), [0.5-0.8) = medium (orange), [0.8-1.0] = high (red), where brackets include the (closed) interval endpoint(s) and parentheses exclude the (open) interval endpoint(s); CV=Collision Vulnerability, DV=Displacement Vulnerability, PV=Population Vulnerability.

4.2.2.3 Summary of Rankings

The highest overall risk to birds in the AoA is in Zones 1 and 2, on the continental shelf and at the shelf break (Figure 38). The eastern portions of these zones were primarily used by skuas and jaegers, auks (dovekie, Atlantic puffin), gulls (black-legged kittiwake, herring and black-backed gulls), terns (roseate and common), loons (red-throated and common), petrels (Wilson's and Leach's storm-petrel, black-capped petrel), northern fulmars, shearwaters (Cory's, sooty, great, Manx, and Audubon's shearwater), northern gannets, and phalaropes. Though not surprising, it remains undetermined why high densities of birds occurred at the shelf break. Such geographic features can lead to upwelling, and persistent fronts can lead to oceanographic mixing; for example, from the confluence of the Gulf Stream and Labrador Current in the AoA. This improves primary and secondary productivity, and therefore foraging habitat to marine birds (Haney 1986; Hunt and Schneider 1987; Shealer 2002). Further studies are needed to refine distributional estimates of marine birds at the continental shelf break in the AOA, ascertain the mechanisms explaining them, and close gaps in survey effort beyond the shelf break.

Figure 38. Species Risk Sensitivity Rankings

Species risk density proportions from the MDAT models were multiplied by population, collision, and displacement vulnerability (PV, CV, DV respectively) scores, then summed to yield total risk across the AoA; higher values represent greater species density (Winship et al. 2018) of vulnerable species. Lack of score indicates missing data (lack of survey effort) in zones 2 and 3.



5 Data Gaps and Uncertainties in Spatial Risk Assessment

5.1 Data Gaps, Deficiencies, and Confidence

In the bird and bat spatial risk assessment (section 4), uncertainty arose from both the exposure and vulnerability analysis, in terms of predicted bird and bat densities (exposure) and existing knowledge about how birds and bats interact with wind turbines (vulnerability). Broadly defined, uncertainty is incomplete information about a subject (Masden et al. 2015) or a deviation from absolute determinism (Walker et al. 2003). In other words, uncertainty results from lack of data, as well as lack of confidence in existing data. For example, high variability in data leads to large confidence intervals, and therefore high uncertainty around expectations (whether predicted risk is low or high). The category ranges for each of the exposure, vulnerability, and population scores calculated in this spatial risk assessment implicitly harbored uncertainty. 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). Therefore, uncertainty is broadly recognized as a key factor in the process of assessing risk to birds and bats from OSW.

5.1.1 Bats

High uncertainty surrounds the expected exposure and vulnerability of bats to potential floating OSW projects in the AoA, which leads to low confidence in the assessment results. While research has demonstrated bat use offshore, particularly by migratory tree-roosting bats, there is little to no information on bat use as far offshore as the AoA. Despite the detectability of bats in digital aerial surveys (Hatch et al. 2013), the NYSERDA digital aerial surveys did not identify any bat species. This suggests bat use of that northwest portion of the AoA is low, though sparse historical observations of bats have been recorded near and within the AoA (Solick and Newman 2021; Figure 2). Given the detection of bats near the AoA via passive acoustics (Tetra Tech 2022; Figure 3), this method would need to be deployed in the AoA to reduce uncertainties. Regarding vulnerability, there have been many studies demonstrating that bats are at risk of collision and can be attracted to wind turbines. The response of bats to turbines in the offshore environment is not well-documented (Brabant et al. 2019), though post-construction monitoring on offshore wind projects currently permitted in the U.S. may provide more information. Little information exists on displacement of bats offshore, but it is assumed that any avoidance behavior would not displace bats from foraging areas nor act as a barrier; although, to date, tracking technology has not allowed for the movement studies needed to understand avoidance responses in bats.

5.1.2 Birds

5.1.2.1 Exposure Uncertainty

Low to ***high*** uncertainty surrounds the expected exposure of birds to potential floating OSW projects in the AoA, with the highest uncertainty in Zone 3, which overall leads to varying confidence in the assessment results. Uncertainty surrounding exposure risk is attributable to low sample size, or lack of effort data, and high variability, which leads to large confidence intervals (i.e., high uncertainty) around the results (Winship et al. 2018). The AoA contains significant data gaps for transatlantic migrants and pelagic birds, particularly in Zone 3 (Figure 39). In the AoA, 18.3 percent of the MDAT data were missing survey data, primarily in Zone 3, as identified in the risk maps (Table 8). Therefore, tracking data were synthesized to fill in these data gaps, or areas of high uncertainty.

Figure 39. Digital Aerial and Boat-Based Survey Effort

Purple lines depict NYSERDA digital aerial survey transects during the third year (2018-2019), and gray polygons represent effort gaps in the boat-based and aerial surveys included in the MDAT models.

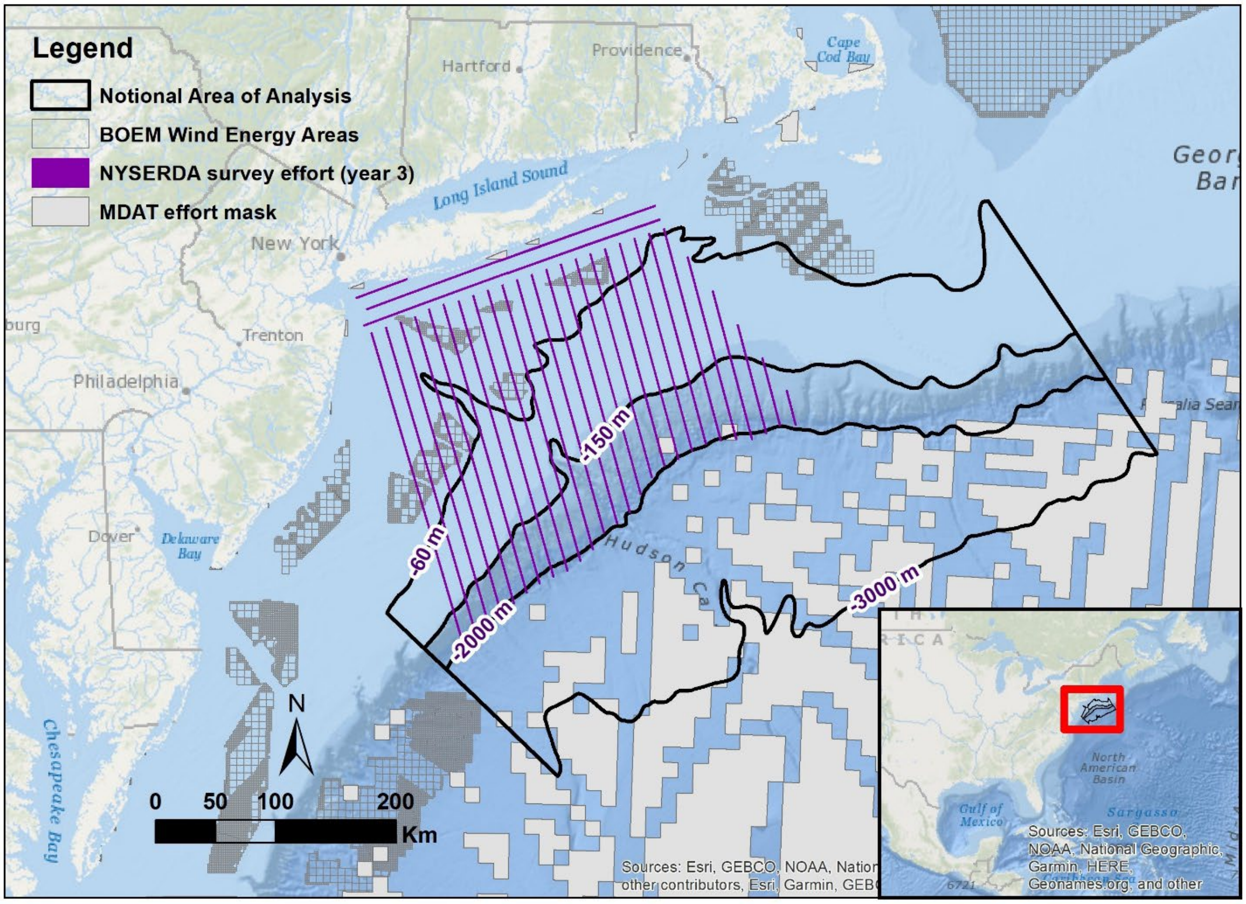


Table 8. Lack of Survey Data Effort Contributing to Uncertainty in the Areas of Analysis

Resource	Receptor	Zone 1	Zone 2	Zone 3	Total
Birds & Bats [a]	Birds	0.0%	3.6%	37.5%	18.3%

[a] No bats were detected during offshore surveys in the AoA.

To further characterize uncertainty levels in the exposure assessments for each Zone of the AoA, each taxonomic group or listed species (see Table 3) was scored qualitatively by the number of significant data sources available, those used in the exposure assessment itself, and those that provided support for the result of the assessment. All species/group assessments started with information gleaned from available literature, including species accounts, published studies, incidental observations, and expert knowledge. Each species/group was then given a score of 0.5–1 for each additional data source, based on spatial coverage of the AoA (local baseline data, a regional database or distribution model, and spatial data from tracking studies), plus data sources that supported the assessment (site-specific surveys), each of which was weighted equally (Table 9). Given that the NYSERDA survey effort only covered approximately 50% of Zone 1 and Zone 2 (Figure 39), the baseline score was 0.5; there were no site-specific data across all Zones. Scores were then tallied, and the more resources contributing to or supporting the assessment, the higher the score, the greater the confidence in the exposure assessment, and the lower the uncertainty, which ranged from minimal to high. Each of the three zones in the AoA were then scored, resulting in uncertainty levels for each group or listed species (Table 10). Zone 1 had the least uncertainty, due to full coverage of the zone by MDAT, partial coverage by the NYSERDA digital aerial surveys (NYSERDA 2021) and some tracking data; Zone 2 had higher uncertainty for many species with Motus tag data due to little to no receiver stations to the southwest of the zone; and Zone 3 had relatively high uncertainty for all species groups due to a lack of survey data, MDAT model coverage, and no utility of Motus data (Table 10).

Table 9. Description of Data Sources and their Contribution to Uncertainty Scores

Scores (rounded): 0-1 = High, 2 = Medium, 3 = Low, 4 = Minimal

Data Source	Description	Added to score
Literature	Species accounts, published studies, incidental observations, expert opinion	•
MDAT	Modeled spatial distributions and predicted relative densities across time	0.5–1
Baseline	Regional ecological baseline data, either historical (>10 years) or recent	0.5–1
Site-specific	Local baseline data that specifically overlaps the development area (recent)	1
Tracking	Spatial data from tracking studies, including VHF (Motus), GPS, or satellite	0.5–1

Table 10. Data Sources Available, Uncertainty Scores, and Uncertainty Levels in Exposure Assessments

Taxa	Zone 1: Uncertainty[c]	Zone 2: Uncertainty[c]	Zone 3: Uncertainty[c]
Roseate Tern[a]	low	medium	high
Red Knot[a,b]	high[b]	high[b]	high[b]
Piping Plover[a,b]	high[b]	high[b]	high[b]
Black-capped Petrel[a]	low	low	medium
Sea ducks	low	low	medium
Auks	medium	medium	high
Gulls, Jaegers, Skuas	medium	medium	high
Terns	low	low	medium
Loons	low	low	medium
Shearwaters, Fulmars, Petrels, Storm-Petrels	medium	medium	high
Gannets	low	low	medium
Cormorants and Pelicans	medium	medium	high
Grebes	medium	medium	high
Phalaropes	medium	medium	high
Shorebirds[b]	high[b]	high[b]	high[b]
Wading birds	medium	medium	high
Raptors[d]	medium	medium	high
Songbirds[b]	high[b]	high[b]	high[b]

[a] ESA listed/candidate.

[b] Shorebirds and songbirds were not given a score for Baseline or Site-specific data in recognition of the limitations of the NYSERDA APEM digital aerial survey data in detecting shorebirds (due to their small size and the likely timing of their migratory flights at night when daytime surveys will not detect them). The same reasoning holds for the two listed shorebird species, Piping Plover and Red Knot.

[c] Uncertainty Scores: 0-1 = high (red), 2 = medium (orange), 3 = low (yellow), 4 = minimal (green).

[d] Eagles are not included in the assessment because they require thermal updrafts for flight and the BOEM NOI checklist indicates that "neither species use the OCS."

5.1.2.2 Vulnerability Uncertainty

Low to high uncertainty surrounds the expected vulnerability of birds to potential floating OSW projects in the AoA—with the highest uncertainty for listed species, grebes, phalaropes, and songbirds—which overall leads to varying confidence in the assessment results. The difficulty of acquiring data on bird movements within the vicinity of turbines contributed to uncertainty in characterizing the vulnerability of birds to offshore wind energy development, particularly during poor visibility conditions (nocturnally or during adverse weather). The quality of the best available data has improved substantially in recent years, through improved technology (Skov et al. 2018; Tjørnløv et al. 2023), updated survey efforts (e.g., digital aerial surveys), predictive methods (e.g., MDAT models), and individual tracking studies (e.g., of small-bodied birds). The spatial risk assessment relied on vulnerability scores derived from empirical studies to identify such key uncertainties (Kelsey et al. 2018; Wade et al. 2016; Willmott et al. 2013).

Three species listed under the ESA (roseate tern, piping plover, and red knot), and one candidate species (black-capped petrel) have the potential to occur in the AoA. Based on tracking studies, endangered roseate terns are generally thought to fly under 25 meters, therefore beneath the RSZ (P. H. Loring et al. 2019), but there is a lot of uncertainty around these estimates and more research is needed, particularly tracking birds through storms where flight height can increase in high (following) winds (Ainley et al. 2015). On the other hand, threatened shorebirds (piping plovers and red knots) are often thought to migrate above 300 meters. Nameplate capacities of current 10–16 megawatt turbines may fall within this RSZ of 25–300 meters, however, prototype turbines greater than 16 megawatts are planned to surpass this RSZ, both above and below. There also exists a lot of uncertainty around flight heights and avoidance rates, which exacerbates lack of confidence in collision risk models under development by the USFWS and BOEM. For offshore wind energy it is the difficulty in quantifying bird mortalities from collision, because bodies fall into the water and disappear; although emerging technologies to detect collisions using cameras and vibration sensors are currently under development or undergoing testing in the offshore realm.[9]

A simple scoring approach categorized general knowledge around collision and displacement vulnerability, consistent with the assessment of exposure uncertainty. Expert judgement was used to categorize if there was high-quality or low-quality (i.e., little to no) information available for each component of the vulnerability assessment (Table 11). Overall, there was higher uncertainty about the vulnerability of non-marine migratory birds because their flight behavior offshore and avoidance rates are poorly studied. For marine birds, there was overall lower uncertainty due to extensive studies in Europe, however, it is important to recognize that these studies were conducted on smaller turbines spaced closer together than would be used in the AoA. For listed species there was generally higher uncertainty because it is relatively unknown how these species will respond to wind turbines.

Table 11. Uncertainty in the Vulnerability Assessment

Each component of collision vulnerability (CV) and displacement vulnerability (DV) is scored for the quality of the information available to assess vulnerability. 0 = low-quality information (or none) available; 1 = high-quality information available.

Taxa	CV component			CV uncertainty[b]	DV component		DV uncertainty [b]
	Time spent in rotor swept zone	Avoidance	Flight activity		Avoidance	Habitat flexibility	
Roseate Tern[a]	1	0	1	medium	0	1	medium
Red Knot[a]	1	0	1	medium	0	1	medium
Piping Plover[a]	1	0	1	medium	0	1	medium
Black-capped Petrel[a]	1	0	1	medium	0	1	medium
Sea ducks	1	1	1	low	1	1	low
Auks	1	1	1	low	1	1	low
Terns	1	0	1	medium	0	1	medium
Gulls, Jaegers, Skuas	1	1	1	low	1	1	low
Loons	1	1	1	low	1	1	low
Shearwaters, Fulmars, Petrels, Storm-petrels	1	0	1	medium	0	1	medium
Gannets	1	1	1	low	1	1	low
Cormorants	1	1	1	low	1	1	low
Pelicans	1	0	1	medium	0	1	medium
Grebes	0	1	0	high	1	1	low
Phalaropes	1	0	0	high	0	0	high
Shorebirds	1	0	1	medium	0	1	medium
Wading Birds	1	0	1	medium	0	1	medium
Raptors[c]	1	1	1	low	1	1	low
Songbirds	0	0	0	high	0	1	medium

[a] ESA listed/candidate.

[b] CV Uncertainty Scores: 0-1 = high (red); 2 = medium (orange); and 3 = low (red). DV Uncertainty Scores: 0 = high (red); 1 = medium (orange); and 2 = low (yellow).

[c] Eagles are not included in the assessment because they require thermal updrafts for flight and the BOEM NOI checklist indicates that “neither species use the OCS.”

5.2 Cumulative Effects

Risk to birds and bats from offshore wind energy facilities, combined with the rapid succession of offshore wind energy development in U.S. waters, has led to recent concerns over cumulative effects and associated uncertainties. Aggressive permitting timelines across multiple projects have resulted from the commitment by the Biden-Harris administration to deploy 30 gigawatts of offshore wind energy by the year 2030 and 15 gigawatts of floating offshore wind capacity by 2035.[10] As of mid-2023, there existed two demonstration-scale OSW projects operating in federal and state U.S. waters (offshore Virginia and Rhode Island), and four utility-scale projects in federal waters approved by BOEM (offshore Massachusetts, Rhode Island, New York and New Jersey). With recent offshore wind energy auctions, over two dozen lease areas are now planned for the Atlantic. This unprecedented advancement has led BOEM to prepare its first draft Programmatic Environmental Impact Statement (EIS) for the six awarded lease areas in the New York Bight. A focused, regional cumulative analysis is part of this Programmatic EIS and will likely be central to future regional planning processes.

To address cumulative impacts, EISs for utility-scale projects approved by BOEM have assessed the potential impacts of projects together with other regional planned actions. For example, the Vineyard Wind Final Environmental Impact Statement assessed “impacts that could result from the incremental impact of the Proposed Action and action alternatives when combined with past, present, or reasonably foreseeable activities, including other future offshore wind activities” (Bureau of Ocean Energy Management 2021b). The Record of Decision indicated that project impacts to birds would be “negligible to minor and potentially minor beneficial,” whereas impacts from planned actions were expected to be moderate. Cumulative impact analyses for New York State projects have also been performed for other EISs, such as the Empire Wind EIS (2023).

The proportion of the population overlapping with future OSW was calculated for each of the 47 seabird species analyzed in the Spatial Risk Assessment of this Bird and Bat study (based on MDAT data). For common eiders, 0.6% of the population was expected to overlap with OSW in winter, resulting in a predicted number of 56 annual collision fatalities (0–465 95% confidence interval). For common terns, 3.0% of the population was expected to overlap with OSW in summer, resulting in a predicted number of 11 annual collision fatalities (329 95% confidence interval). Common terns are often considered a surrogate for roseate terns, for which 0.6% of the population was expected to overlap with OSW in spring. These projections did not take into account the potential for OSW in the AoA, which would need to be incorporated into future cumulative analyses.

Accompanying the cumulative effects of development comes a high level of uncertainty generated from incomplete information in the past, present, and future. Here, uncertainty arises from lack of confidence in results often due to missing data and unreliable information, low sample sizes, or high variability (Masden et al. 2015; Walker et al. 2003). A cumulative impact assessment addresses uncertainty by filling in data gaps (Goodale and Milman 2016). Therefore, to inform future efforts, this study provides recommendations on how to address data gaps that contribute to uncertainty, in section 7.

6 Existing Guidance for Avoiding, Minimizing, and Mitigating Impacts

The mitigation hierarchy is the process by which environmental assessments, or impact statements, document how to reduce impacts of stressors on receptors. The Council on Environmental Quality (CEQ) defines mitigation in NEPA regulations (40 CFR 1508.1) as “measures that avoid, minimize, or compensate for effects caused by a proposed action or alternatives as described in an environmental document or record of decision and that have a nexus to those effects.” Effective in 2022, the CEQ amended the definition of “effects” (or impacts) to include direct, indirect, and cumulative effects. Thorough planning (i.e., avoidance through siting) and selection of appropriate installation methods throughout the project lifetime may mitigate some of the impacts that OSW imposes on birds and bats (NYSERDA 2017).

Avoidance, through siting of OSW, is the first step and most important conservation measure of the mitigation hierarchy. It involves the siting of facilities away from biological hotspots or areas of high use to avoid risk to birds and bats. For this reason, the identification of low-risk wind energy areas in the AoA is an important priority in the planning process. Key considerations specific to the AoA are distance from shore and the shelf break. In general terms, areas further offshore will have lower bird and bat species richness, thus broadly avoiding exposure for many species. However, the shelf break represents a significant oceanographic feature associated with marked shifts in the patterns of bird communities. Therefore, distance from shore is just one factor that should be considered in siting, among the broader oceanography of the AoA. As a first step, the spatial risk assessment (section 4) identifies areas of higher risk and data gaps that are recommended to be filled, in support of siting decisions.

Where impacts are unavoidable, the second step is to minimize risk; for example, through best management practices used in existing and emerging technologies.[11] However, currently, effective minimization measures for birds and bats have not been well-tested for efficacy. Furthermore, many of these existing and emerging technologies are developed onshore but not yet verified for use offshore. For birds and bats there are few minimization measures that have been demonstrated to be effective offshore, except for lighting reduction, because some marine birds, such as shearwaters, are attracted to light (Deakin et al. 2022) as are nocturnal migrants (Hüppop et al. 2006). Some measures, such as changing turbine blade coloration (May et al. 2020) or turbine stoppage (curtailment; Smallwood and Bell 2020), have been raised as possible minimization methods, but the evidence for onshore effectiveness is limited (McClure et al. 2021; Huso and Dalthorp 2023), and they have not been tested offshore (Croll et al. 2022). Turbine stoppage has only been shown to be effective for some terrestrial raptors and bats at onshore wind facilities and has not been shown to reduce fatalities for most bird species (Smallwood and Bell 2020). In fact, turbine operation may increase avoidance rates for some species (Cook et al. 2018), leading to a decrease in collision risk.

Due to the lack of effective minimization measures, compensatory mitigation is now being introduced as a potential mitigation measure for offshore wind (Croll et al. 2022) and is being implemented for ESA listed species (Bureau of Ocean Energy Management 2023). Conventionally, compensation has been achieved through a mitigation fund, restoration project, or habitat acquisition that offsets losses. While compensating for potential impacts is an option for projects sited in the AoA, basic research needs to be conducted first that supports siting to avoid impacts, identifies the species that are most likely to be at risk, and considers the unique qualities of floating offshore wind around the shelf break.

Critical to all mitigation strategies is monitoring. Pre- and post-construction monitoring data are needed to gauge the need for mitigation and to verify the effectiveness of mitigation measures. Below is a discussion on current approaches to mitigation that have been presented in offshore wind Environmental Impact Statements and Records of Decision within the U.S.

6.1 Current Guidance

During the NEPA and ESA Section 7 processes, BOEM and USFWS have developed a series of what are becoming standard practices of minimization, monitoring, and compensation (only for ESA species) for birds and bats. Measures have primarily focused on birds, with only the minimization of lighting and development of a monitoring plan applicable to bats. These are detailed below based on the measures identified in the Ocean Wind 1 Final EIS (BOEM 2023) and are like measures detailed in the Vineyard Wind 1 Final EIS (BOEM 2021b) and South Fork Final EIS (BOEM 2021a). Some of these measures are included in lease stipulations for survey activities supportive of COPs. Not included are incidental measures targeting other resources that may have positive effects on birds (e.g., removal of marine debris). Importantly, aside from minimizing lighting, there have been no field studies to indicate if measures such as perching deterrents will minimize collision risk (Maxwell et al. 2022), resulting in a significant need to support efforts that study minimization strategies. Current practices are as follows:

6.1.1 Minimization

- **Increase airgap:** Maximize wind turbine generator (WTG) air gaps (minimum blade tip elevation to the sea surface) to minimize collision risk to marine birds that fly close to the ocean surface (Degraer et al. 2022). The air gap assumed in the spatial risk assessment conducted in this Bird and Bat Study was 25 m, however these measures require testing to provide evidence of effectiveness.
- **Install bird perching deterrents:** To minimize attracting birds to operating turbines, perching-deterrent devices must be installed where such devices can be safely deployed on WTGs and offshore substations (OSSs).
- **Minimize lighting:** Use lighting technology that minimizes impacts on avian and bat species to the extent practicable, including:
    - Aircraft Detection Lighting Systems (ADLS), which will activate the hazard lighting only when an aircraft is in the vicinity of the wind facility.
    - Light for mariners at each WTG and OSS in a manner that is visible in a 360-degree arc around the WTG and OSS. To minimize the potential of attracting migratory birds, the top of each light shall be shielded to minimize upward illumination (Conditional on USCG approval)[12]. Upon approval of a lighting plan the agencies will work together to determine the color, intensity, and duration of any light from maritime lanterns that is likely to reach the typical flight heights of listed birds and will assess the degree to which the lighting is likely to attract or disorient birds.
- **Develop an ESA Minimization Report:** If the ESA Section 7 process determines there is potential for take, then there will be a periodic review of current technologies and methods for minimizing collision risk of listed birds. BOEM will then require the implementation of those technologies and methods deemed reasonable and prudent.

6.1.2 Monitoring

- **Monitoring Plan:** Develop and implement an Avian and Bat Post-Construction Monitoring Plan listed and non-listed species in coordination with BOEM, USFWS, and other relevant regulatory agencies. Prior to or concurrent with offshore construction activities, the plan must be submitted to BOEM and USFWS for review. Annual monitoring reports will be used to determine the need for adjustments to monitoring approaches, consideration of new monitoring technologies, and/or additional periods of monitoring.
- **Mortality Reporting:** An annual report covering each calendar year must be submitted to BOEM documenting any dead (or injured) birds or bats found on vessels and structures during construction, operations, and decommissioning. However, since carcasses are unlikely to fall on structures, supplementary methods are important to document and report mortality, including visual observations and automated collision detection systems.

6.1.3 Compensation for Endangered Species Act Listed Species with Estimated Take

- **Compensatory mitigation:** To minimize population-level effects on listed birds, provide appropriate compensatory mitigation as needed to offset projected levels of take of listed birds from WTG collision. BOEM commits to continued funding and development of Stochastic Collision Risk Assessment for Movement (SCRAM), used to estimate the risk of take from WTG operation, due to collision mortality. Under the ESA, "the term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Compensatory mitigation will be consistent with the conservation needs of listed species as identified in service documents including, but not limited to, listing documents, species status assessments, recovery plans, recovery implementation strategies, and five-year reviews.

7 Future Considerations

The highest overall risk to birds in the AoA was on the continental shelf and at the shelf break (in Zones 1 and 2), due to high exposure and/or vulnerability; however, the greatest uncertainty occurred beyond, on the continental rise (Zone 3), due to lack of data far offshore (particularly survey data; Figure 5). This uncertainty also applied to bats throughout the AoA, due to lack of data on bats far offshore. For birds, offshore migrants and pelagics were the most vulnerable taxa exposed to OSW in the AoA, as well as some of the most data-poor taxa. Federally threatened shorebirds (red knot, piping plover) and endangered or threatened seabird species (roseate tern, black-capped petrel, Bermuda petrel) were five of the most data-poor species that use that AoA during migration. This is because they are rare, and not easily identified in surveys. Additionally, red knots, piping plovers, and roseate terns are not well-suited for the heavy weight of satellite transmitters, due to their small body size. The medium to high displacement and population vulnerability of these rare, protected species places them at risk of impacts from OSW in the AoA. Additionally, the combination of increased turbine size and wind speeds in the AoA poses the potential for increased collision risk relative to other regions (Farr et al. 2021; Maxwell et al. 2022). With high levels of uncertainty for both bats and some birds, the first three considerations below highlight the value of filling data gaps.

1. **Incorporate updated MDAT models to include NYSERDA digital aerial survey data in the assessment of risk within the AoA.** Data poor species were often characterized by gaps in the survey effort data used in the MDAT 2.0 models, though tracking data on ESA-listed and migratory bird species filled in some of these data gaps. MDAT 3.0 models will incorporate the NYSERDA digital aerial survey data that cover the western portions of Zones 1 and 2 in the AoA. NCCOS is in the process of updating MDAT models to incorporate the NYSERDA digital aerial survey data. Since MDAT 3.0 models were not available for use in this study, future risk maps could be updated once the MDAT 3.0 models become available.

2. **Increase coverage of tracking data in the AoA.** A second priority is to support tracking advancements that quantify the movements of offshore pelagics and the flux of transiting migrants, including bats and passerines. The expansion of tracking studies would improve data coverage for these species and resolve associated uncertainties. The Motus Wildlife Network uses automated radiotelemetry to track small-bodied birds (including those listed under the ESA), though existing receiving stations are mostly located onshore. While some receiving stations are being deployed by developers on offshore buoys and/or towers (e.g., AECOM 2023), detections of birds offshore are either (a) not yet publicly available, (b) constrained due to lack of tagging efforts, or (c) unavailable due to technological limitations. The deployment of Motus stations offshore should be combined with support for associated tagging efforts—without an adequate sample size of tagged birds, detections of species using the AoA are not possible (for guidelines on sample sizes for Motus studies, see Loring et al. 2023; Lamb et al. 2023). To address further data limitations, technology advancements should aim for the following:

  - deploy automated telemetry receivers in the AoA.
  - deploy radar in the AoA.
  - miniaturize satellite tags for small-bodied birds and bats.

  Innovation in offshore radiotelemetry and radar will be needed to minimize marine noise. Radar combined with cameras may be deployed on fixed infrastructure to identify large flocks of migrants, including shorebirds and passerines; however, refinement of these technologies for use on floating platforms is under development.[13] Pathtrack tags show promising advancements in the miniaturization of satellite tags (Figure 16), though remain at the frontier of testing on sensitive species such as roseate terns. Exploration and improvement in new tracking technology (e.g., drones) will be key to reducing uncertainty surrounding the exposure and vulnerability of birds and bats to stressors from OSW.

3. **Increase survey coverage in the AoA**. Until improvements in tracking technology become feasible and verifiable, increased offshore survey effort is the most reliable source of reducing uncertainties in Zone 3 of the AoA. This is illustrated by observations of roseate terns during boat-based and digital aerial surveys (Figure 9), which were not captured in Motus detections (Figure 8). While updating the risk maps with the MDAT 3.0 models is an immediate need (consideration 1), this will only help to resolve uncertainty in the vicinity of western Zone 1 and 2. Though tracking data fill in some of the survey effort gaps for Zone 3 (consideration 2), regional survey data will inevitably be necessary to calculate risk using comparable methods to Zones 1 and 2. Survey imagery technology will also need advancement to achieve high rates of identification for small-bodied species, particularly those threatened and endangered. Further regional survey data collection will provide a multi-species perspective of habitat use in the AoA to complement individual movement-level information from tracking data.

The considerations listed below address how to leverage the utility of available data.

1. **Support research to better understand the distribution of seabird communities in the vicinity of the continental shelf break within the AoA.** The continental shelf break (Zones 1-2) represents a significant, highly productive oceanographic feature in the AoA that concentrates marine bird communities. Following the previous consideration, increased survey effort in this region, including special attention to the shelf-break canyons (e.g., Hudson Canyon), should aim to characterize the mechanisms explaining such aggregations, identify the species that are most likely to be at risk of OSW in Zones 2-3, and inform the siting of wind facilities to avoid impacts.

2. **Develop advanced model-based methods to integrate tracking and survey data, for improved exposure and vulnerability certainty in the AoA.** Novel methods may be needed to update exposure and vulnerability assessments of avian risk for OSW, despite existing efforts (Regional Wildlife Science Collaborative, Bird and Bat Subcommittee meeting minutes). A model-based approach to integrate tracking data with survey data is needed for exposure analyses, and data standardization of recent avoidance rate data is needed for vulnerability analyses. The inherent statistical challenge of combining "presence-only" tracking data with "presence-absence" survey data will require ample time and support to resolve data gaps in exposure assessments (Matthiopoulos et al. 2022). The standardization of recent avoidance data from Europe (2018 and later) across factors such as species, technology, and scale of analysis, is already underway to improve vulnerability assessments (e.g., BRI and Normandeau Associates, personal communication). The development and adoption of these new methods would provide greater certainty in the estimation of both exposure and vulnerability.

3. **Improve the utility of existing colony data for foraging range analyses of the AoA.** Updated tracking and survey data may inform not only exposure and vulnerability analyses, but also a foraging range analysis of the AoA. A foraging range analysis of species that breed in the Northeast and mid-Atlantic U.S. may help to refine risk estimates in the AoA, particularly in Zones 1 and 2, though it would be limited by a couple factors. First, such an analysis involves only breeders, not nonbreeders, and relies on complete survey and tracking data to identify maximum foraging range during the breeding season. Many species that use the AoA are nonbreeders (e.g., great shearwater, black-capped petrel, Atlantic puffin), and the AoA is beyond the foraging ranges of most breeders from major colonies (e.g., roseate and common tern, Atlantic puffin), except for some pelagic breeders with cryptic colony locations that are not well-documented (e.g., Leach's storm-petrel and Bermuda petrel). Second, colony data requires quality assurance and quality control (QA/QC) by authoritative sources such as colony managers to be reliably incorporated into future analyses. Due to the distance of the deepwater AoA from known colonies, a foraging range analysis is low priority without more comprehensive and reliable colony data and would provide limited information on the few pelagic species with large foraging ranges that are entering the AoA during the breeding season.

The aforementioned considerations aim to improve data coverage in the AoA to reduce uncertainties surrounding the exposure and vulnerability of birds and bats to offshore wind energy development. Reducing uncertainty in the distribution of birds and bats offshore will require time to fill research gaps with newly collected monitoring data. Until then, the mitigation hierarchy will play an important role in avoiding and minimizing potential impacts from those stressors. The following consideration aims to guide OSW energy planning in the AoA, based on only existing data and the mitigation hierarchy (see section 6 for more details).

1. **Test and verify mitigation measures offshore, to apply to the AoA.** The Mitigation and Monitoring Practices (MMP) Tool,[14] developed with support from NYSERDA, identifies avoidance, minimization, and mitigation measures suggested for use by the onshore wind industry and oil and gas sectors. The MMP tool is a comprehensive catalog of suggested measures, though few of these have been tested or verified, particularly offshore. Additionally, in the several years since the MMP tool was published, BOEM has released multiple Environmental Impact Statements and Records of Decision outlining industry-standard approaches to avoidance, minimization, and mitigation. Standard monitoring and mitigation practices (including those identified in the MMP tool) are recommended to reflect measures that are feasible, practical, and effective for the offshore wind energy industry. Emerging technologies that have not yet been verified in the offshore realm[15] should additionally be tested for their effectiveness at measuring and implementing the mitigation hierarchy.

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Appendix A. Data Sources

Table A-1. Data Sources

Data	Source [a]	Species	Description	Type	Purpose
Acoustics	Solick and Newman 2021	Eastern Red and Silver-haired Bat	Contains historical records of species occurrence within the AoA	Spatial	Documents species within the AoA
Acoustics	Tetra Tech and BRI 2019	Eastern Red, Big Brown, Hoary, Silver-Haired Bat	Contains species occurrence to identify proximity to the AoA	Spatial	Documents proximity of species to AoA
Acoustics	Sjollema et al. 2014	Multiple Bat Spp.	Contains species occurrence to identify proximity to the AoA	Spatial	Documents proximity of species to AoA
Acoustics	Smith and McWilliams 2016	Multiple Bat Spp.	Contains onshore species occurrence to identify proximity to the AoA	Spatial	Documents proximity of species to AoA
Aerial Survey	Hatch et al. 2013	Eastern Red Bat	Contains species occurrence to identify proximity to the AoA	Spatial	Documents proximity of species to AoA
Boat Survey	Northwest Atlantic Seabird Catalog	Flight heights of 47 Marine Bird Species	Contains species flight heights to identify collision vulnerability within the AoA	Spatial	Feeds into vulnerability assessment for risk map and sensitivity analysis
Boat-based and Aerial Survey	Winship et al. 2018	MDAT Models of 47 Marine Bird Species	Contains species densities, distribution, and seasonal occurrence to identify where and when species are using AoA	Spatial	Feeds into exposure assessment for risk map and sensitivity analysis
Boat-based pelagic trips	Sullivan et al. 2009	Multiple bird species	Contains species occurrence within the AoA from community science (eBird)	Spatial	Addresses data gaps from MDAT models
Aerial Survey	NYSERDA 2021	76 bird species	Contains species occurrence within part of the AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Loring et al. 2020	12 Shorebird Species, including Red Knot	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models

Table A-1 continued

Data	Source [a]	Species	Description	Type	Purpose
Tracking	Loring et al. 2019	Piping Plover, Roseate Tern, Common Tern	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Jodice et al. 2015, Satgé et al. 2023	Black-capped Petrel	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Raine et al. 2021, Campioni 2023	Bermuda Petrel	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Baran et al. 2022	Atlantic Puffin	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Yakola 2022	Leach's Storm-Petrel	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Powers et al. 2020	Great Shearwater	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Spiegel et al. 2017	North Gannet, Red-Throated Loon, Surf Scoter	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Sea Duck Joint Venture	Surf, Black and White-Winged Scoter, Long-Tailed Duck, Common Eider	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Maine Department of Inland Fisheries & Wildlife	Great Blue Heron	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Tracking	Bierregaard 2019	Osprey	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models

Table A-1 continued

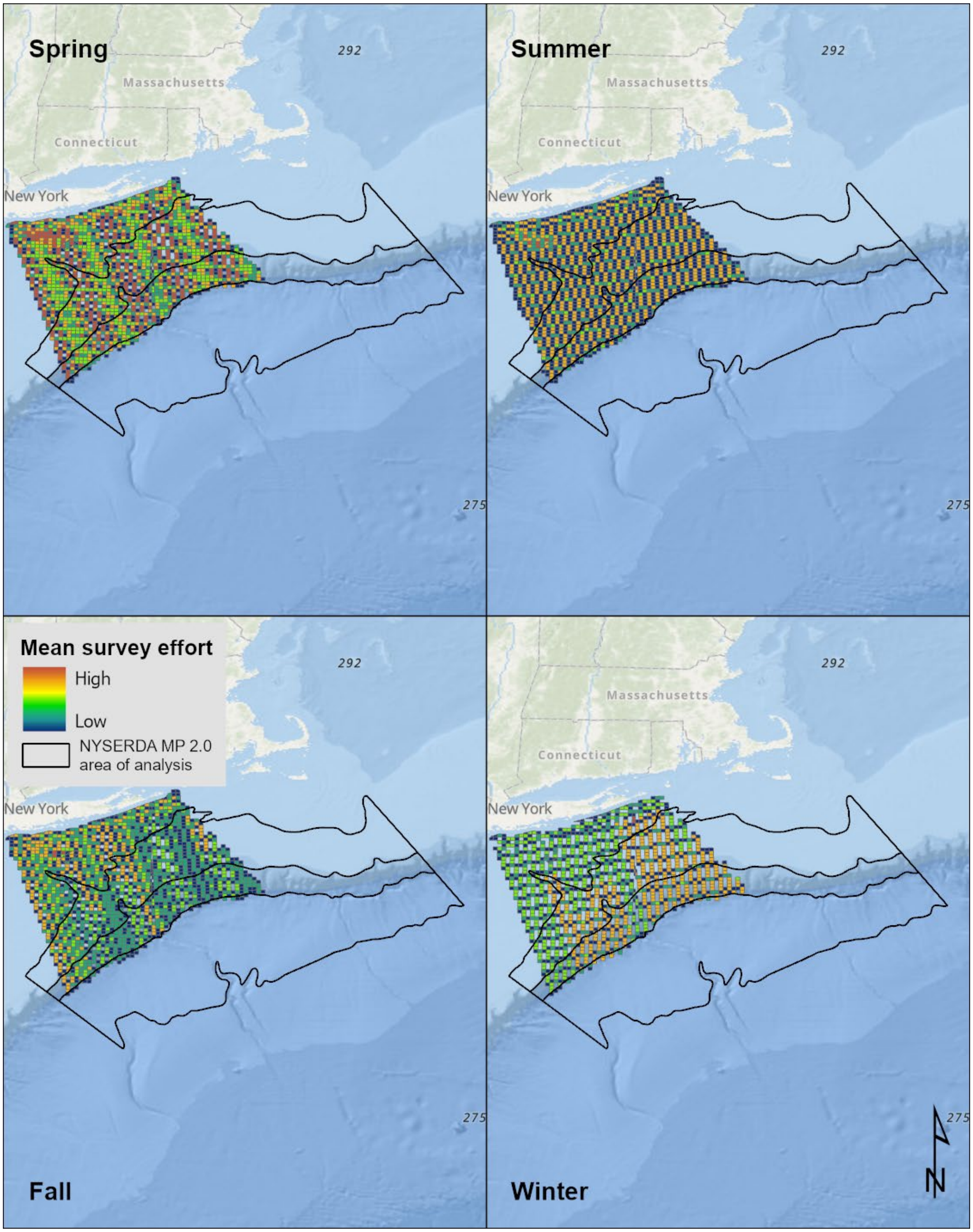
Data	Source [a]	Species	Description	Type	Purpose
Tracking	DeSorbo et al. 2015, 2022	Peregrine Falcon, Merlin	Contains individual occurrence to identify where and when species are concentrated and/or using AoA	Spatial	Addresses data gaps from MDAT models
Colony data	Avian Knowledge Network	Various Breeding Bird Species	Contains species colony sites onshore (outside of the AoA), though data require QA/QC	Spatial	Documents proximity of species to AoA
Report	Stepanuk, et al. 2022	14 Marine Bird Species	Contains methods of documenting important use areas to inform offshore wind energy siting in the Gulf of Maine	Non-spatial	Provides methods for sensitivity analysis and risk map
Report	Willmott et al. 2013	177 bird species known to use the Atlantic OCS	Provides guidance on risk ratings	Non-spatial	Risk rating guidance
Report	NYSERDA. 2017	39 species of marine birds, eight species of bats	Identifies potential use conflicts, stressors associated with OSW, and associated impacts	Non-spatial	Guidance on stressors associated with OSW and associated impacts
Database	NYSERDA Mitigation and Monitoring Practices Tool (MMP Tool)	n/a	NYSERDA developed a Mitigation and Monitoring Practices (MMP) Tool that is publicly available for use by environmental and fisheries stakeholders. It houses a searchable database of MMPs extracted from agency reports, environmental assessments, scientific literature, technical guidance documents, and other sources.	Non-spatial	Desribes avoidance, minimization, and mitigation practices
Database	TEHYS Wind Energy Monitoring and Mitigation Technologies Tool	n/a	As part of its mission to support the global deployment of wind energy through a better understanding of environmental issues, WREN has created a free, online tool to catalog monitoring and mitigating technologies developed to assess and reduce potential wildlife impacts resulting from land-based and offshore wind energy development. WREN will continuously maintain and update the research status of technologies to ensure the international community has access to current, publicly available information on monitoring and mitigation solutions, their state of development, and related research on their effectiveness.	Non-spatial	Describes emerging technologies used in avoidance, minimization, and mitigation practices

Appendix B. Exposure Maps of Marine Birds for the Area of Analysis

B.1 List of Maps

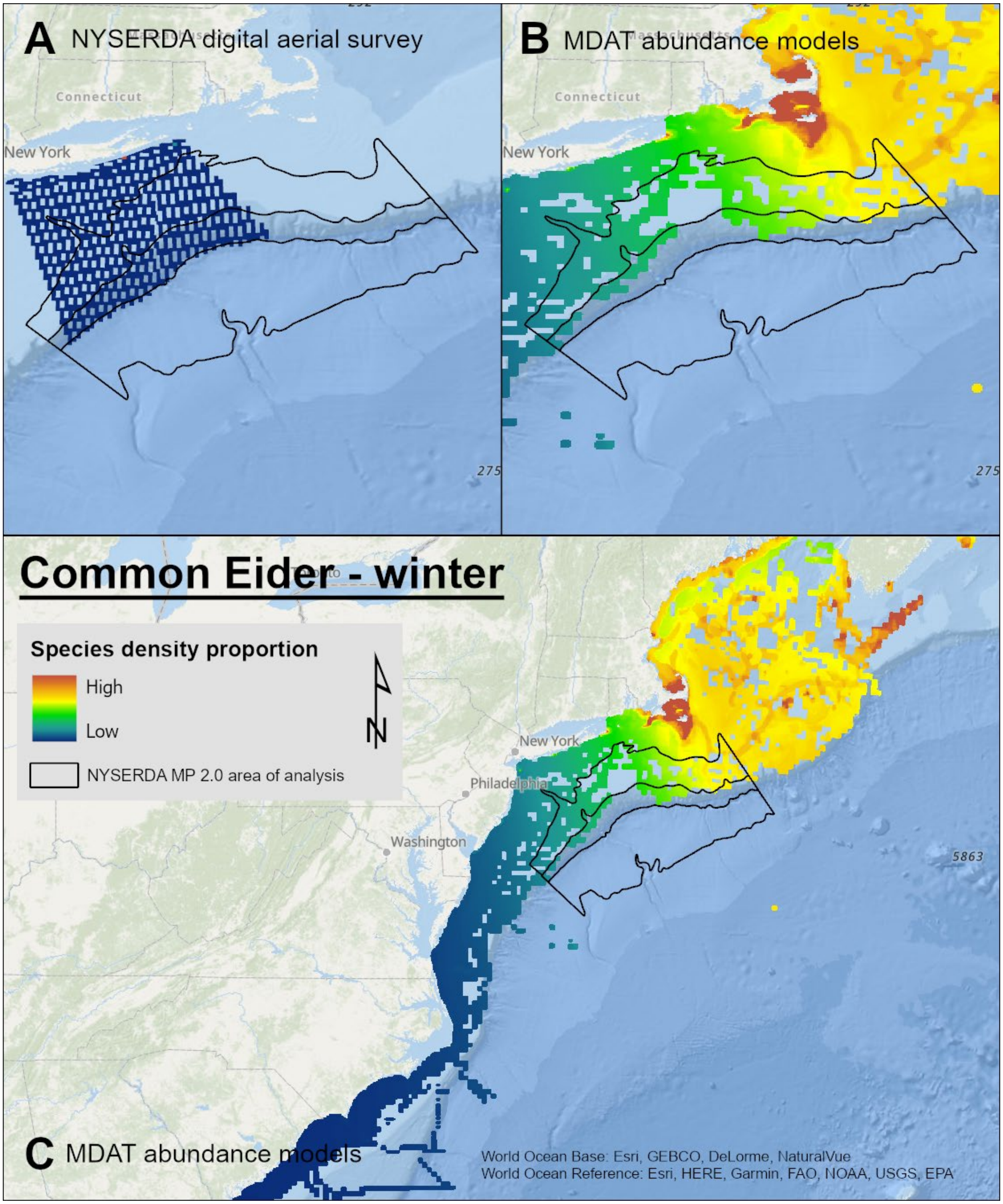
Map B-1. NYSERDA APEM High Resolution Digital Aerial Seasonal Survey Effort Error! Bookmark not defined.

This map compilation shows the NYSERDA APEM high resolution digital aerial seasonal survey effort. The four maps show data for spring, summer, fall and winter. The mean survey effort is in square kilometers by lease block.



Map B-2. Winter Common Eider Density Proportions

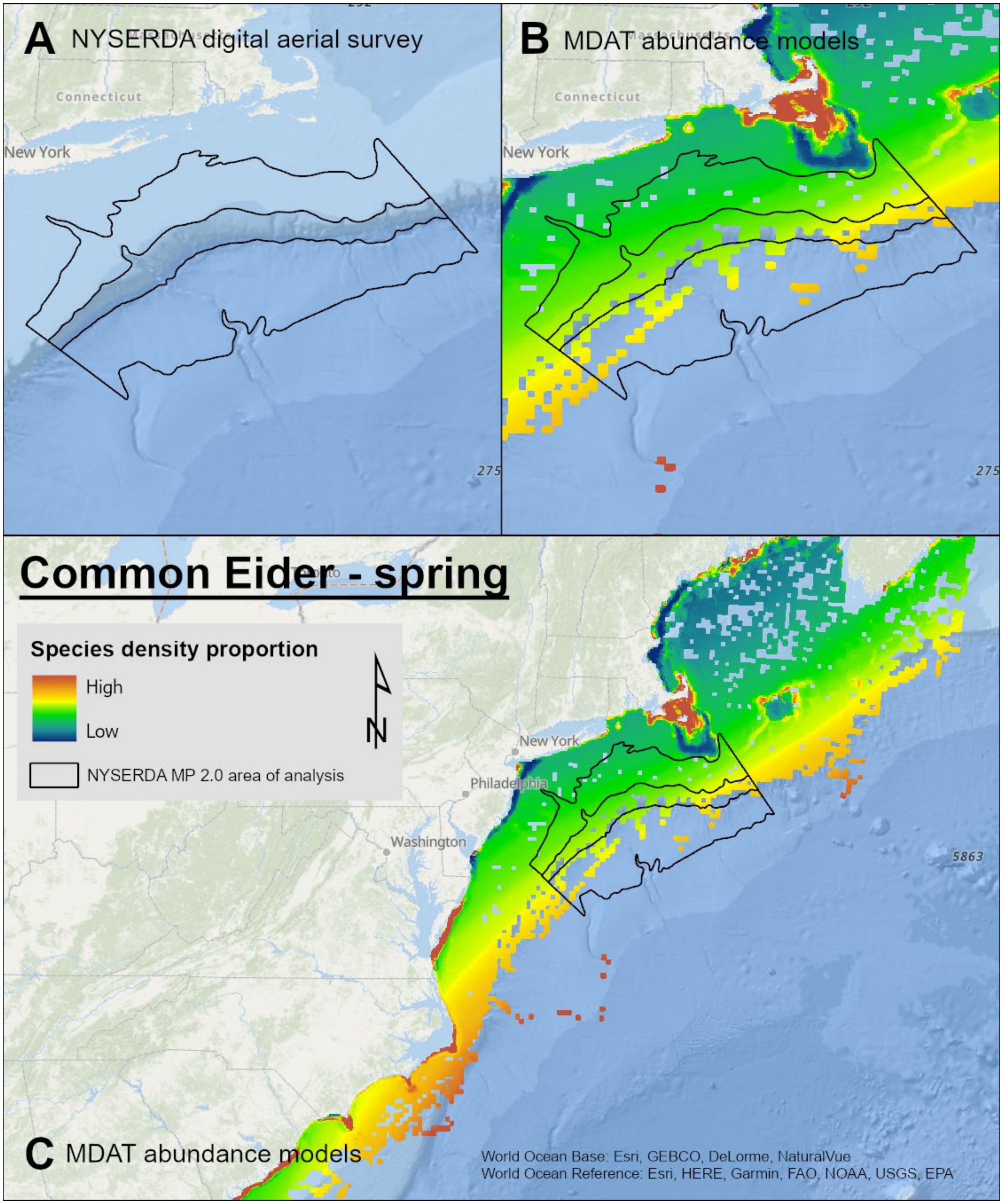
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

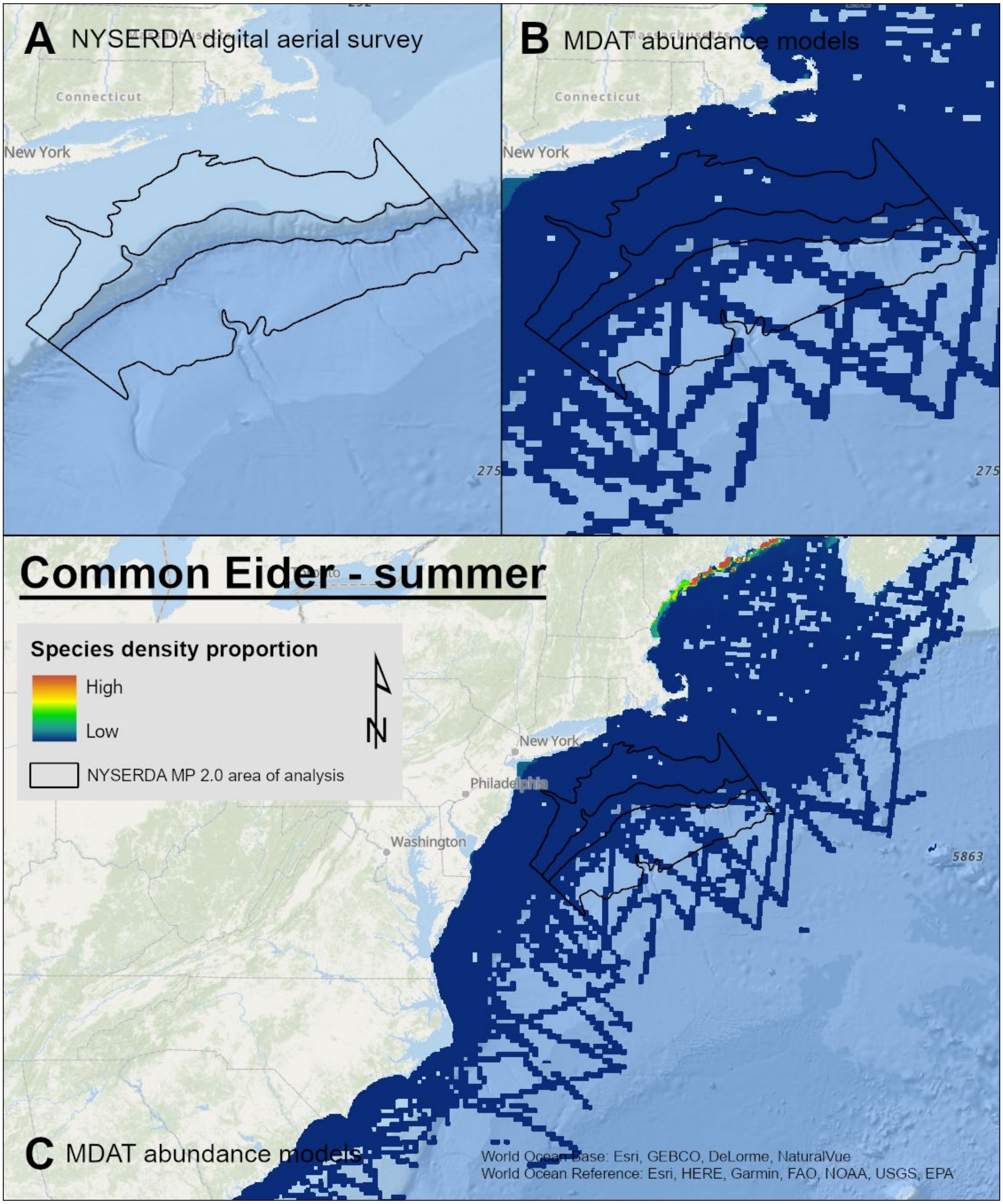
Map B-3. Spring Common Eider Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



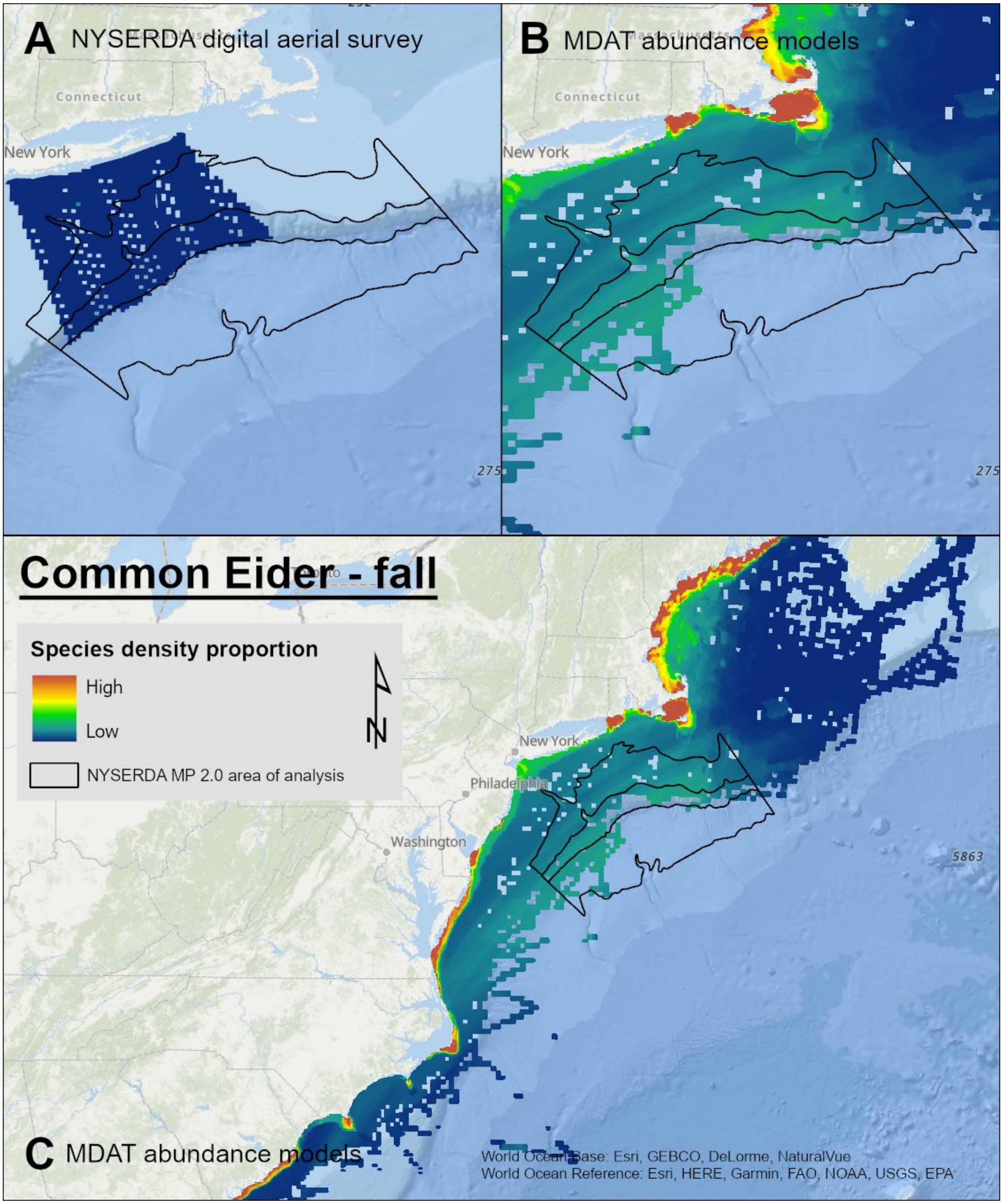
Map B-4. Summer Common Eider Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



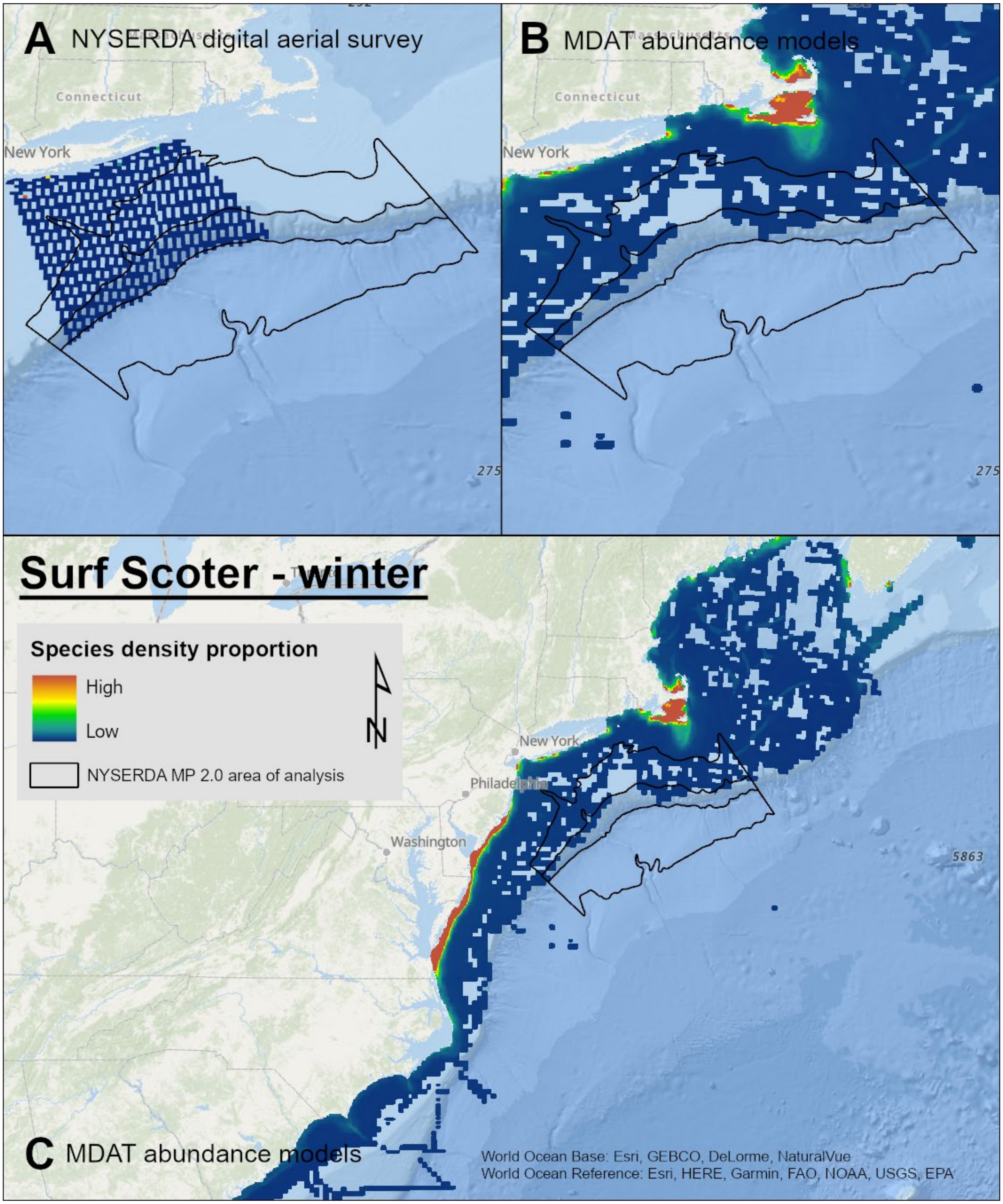
Map B-5. Fall Common Eider Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



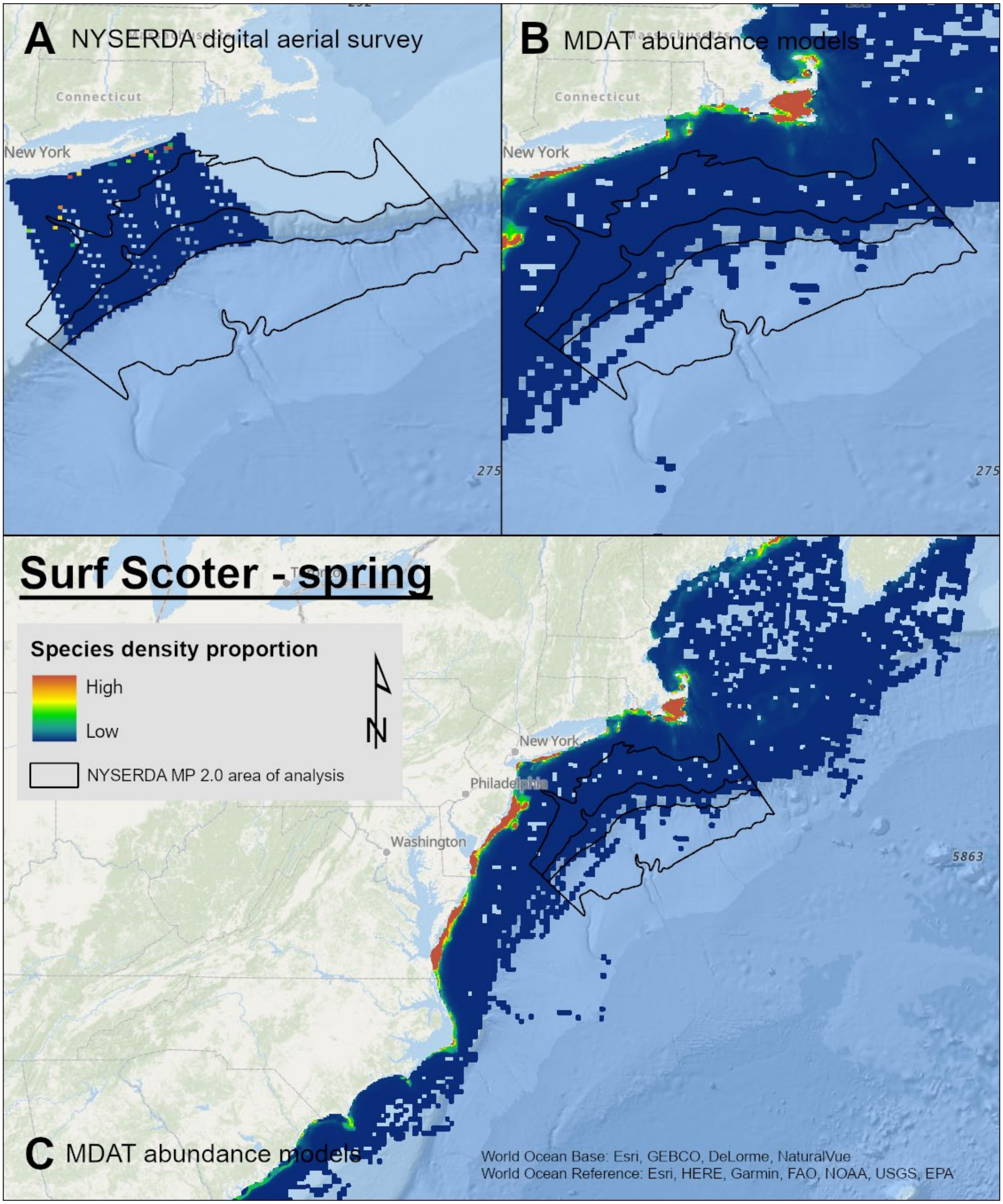
Map B-6. Winter Surf Scoter Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



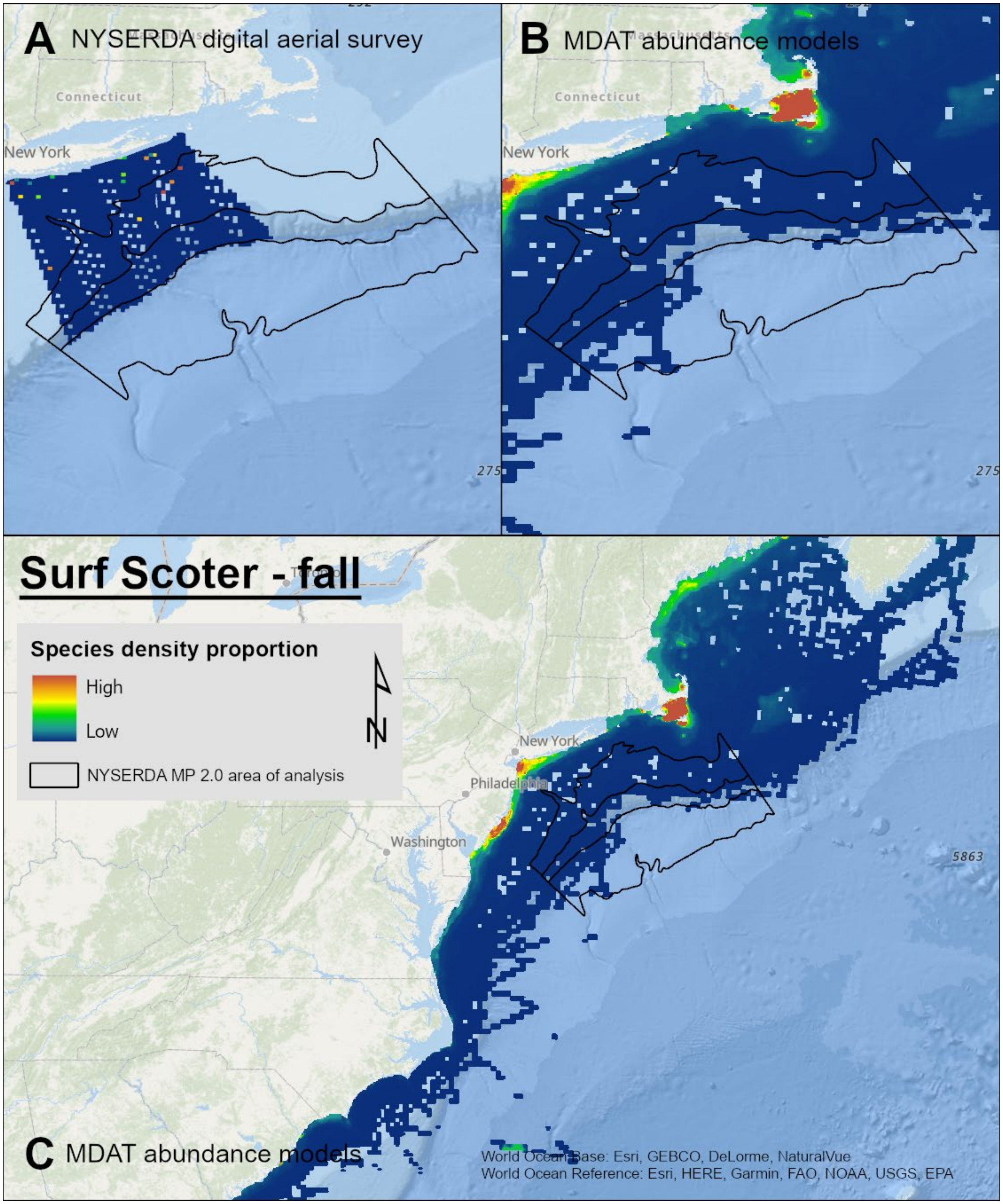
Map B-7. Spring Surf Scoter Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



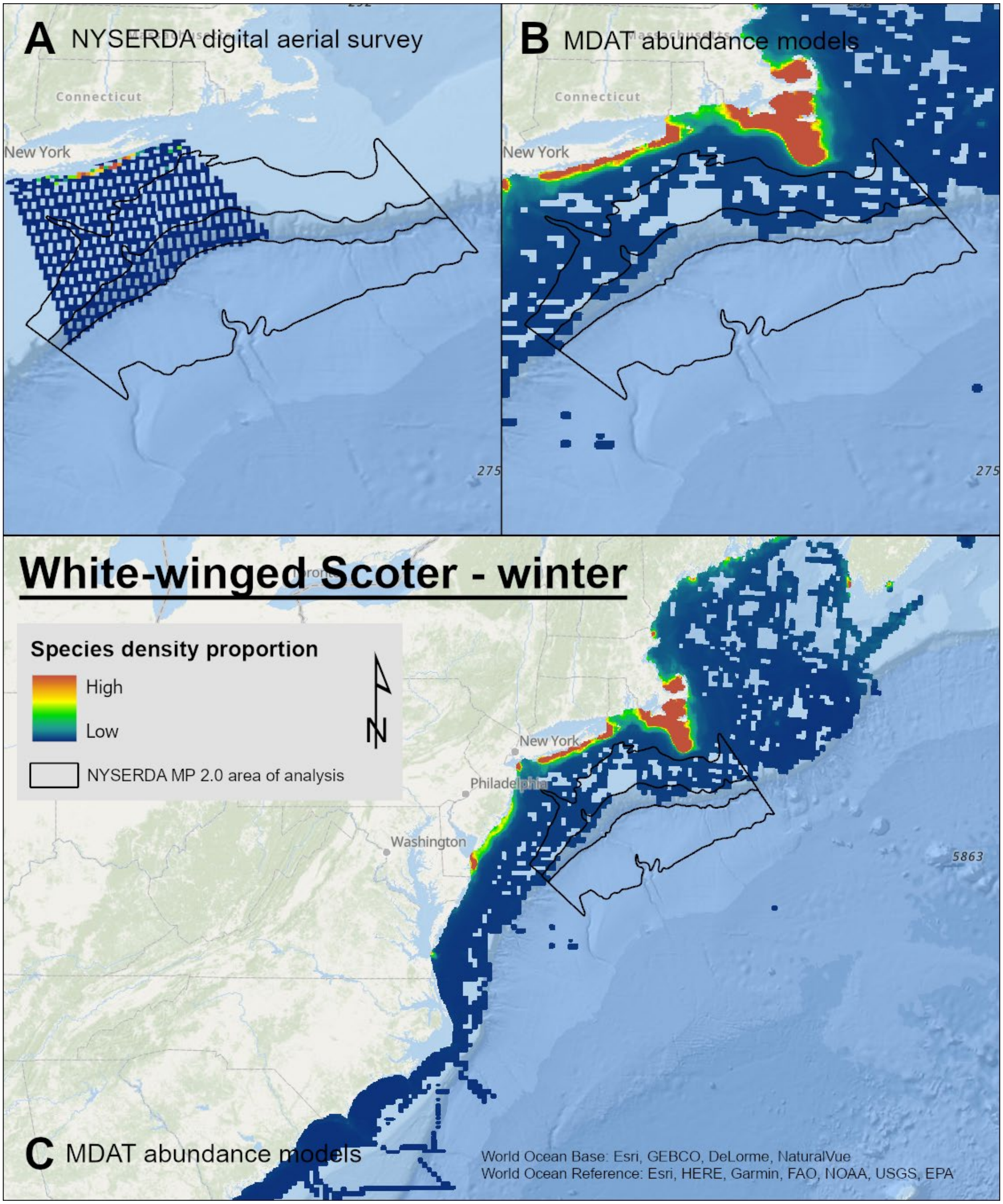
Map B-8. Fall Surf Scoter Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-9. Winter White-Winged Scoter Density Proportions

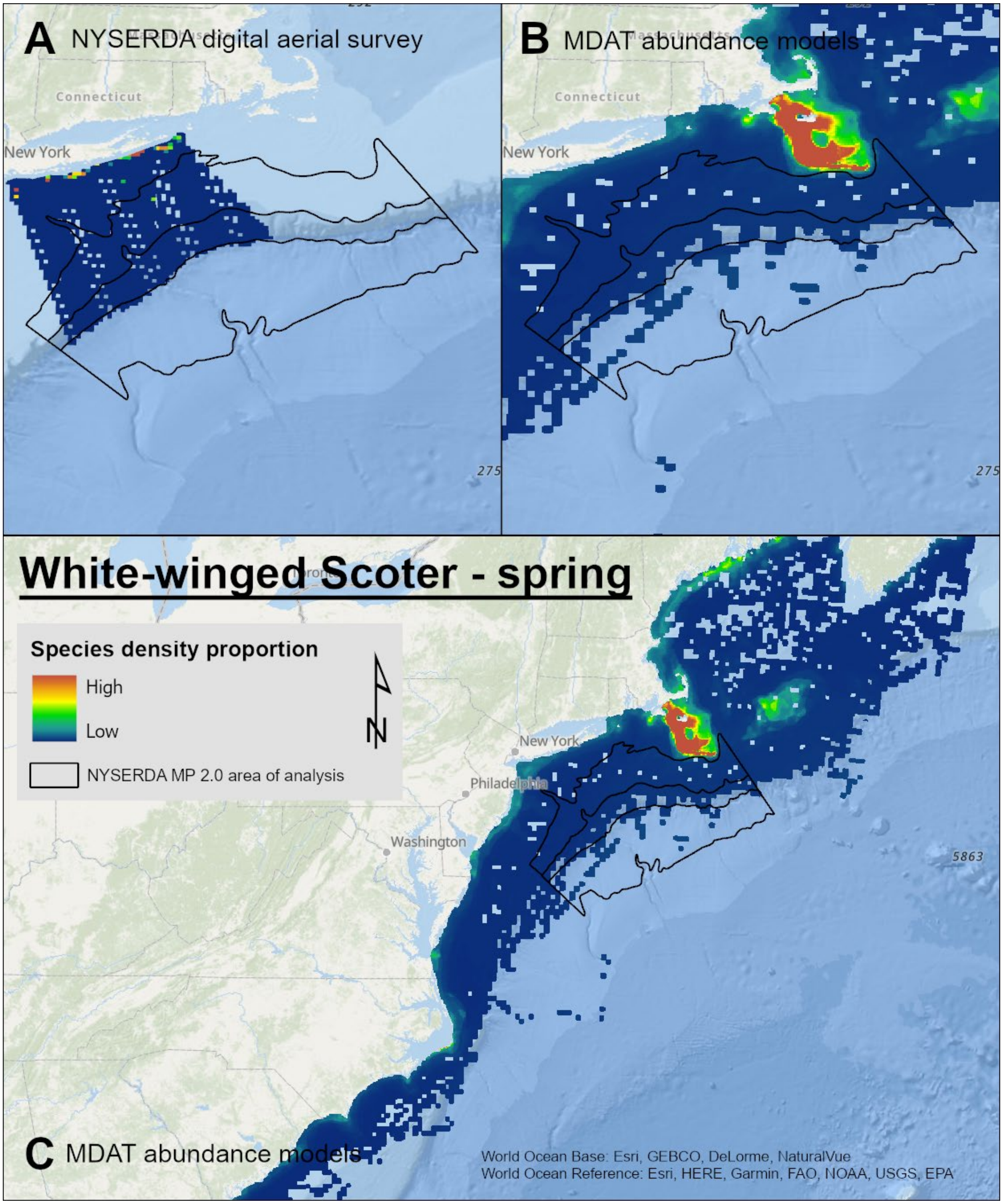
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

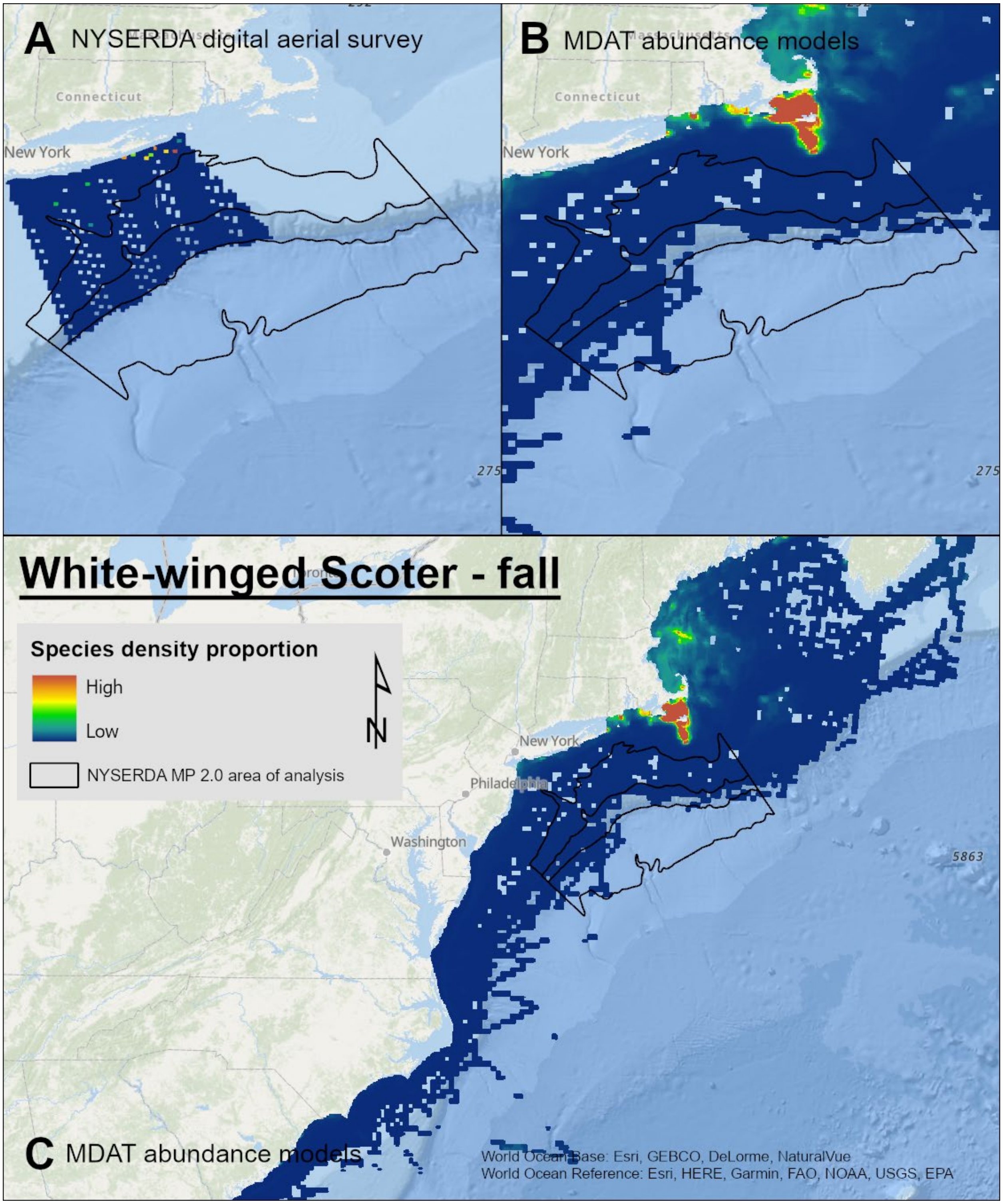
Map B-10. Spring White-Winged Scoter Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



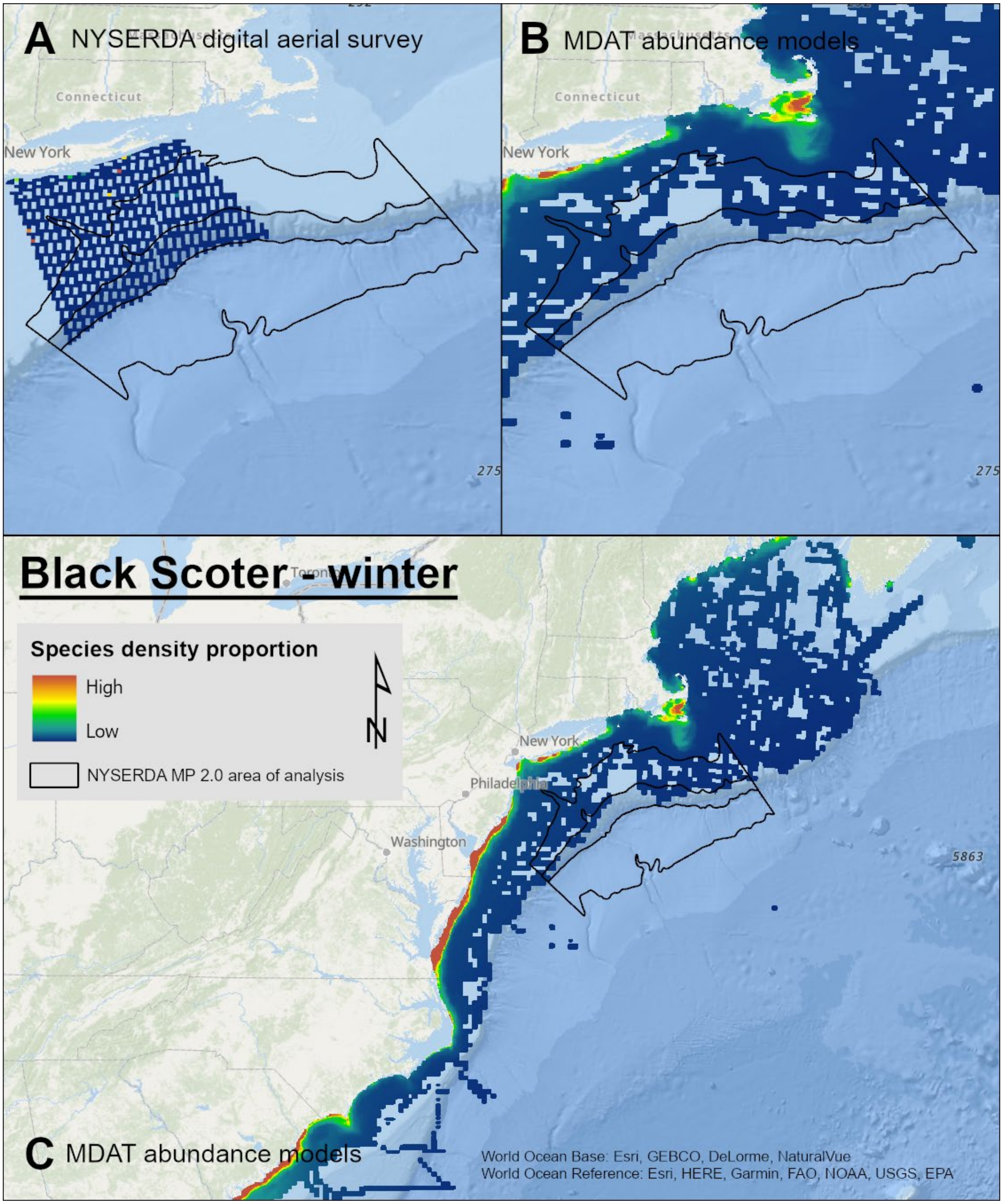
Map B-11. Fall White-Winged Scoter Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



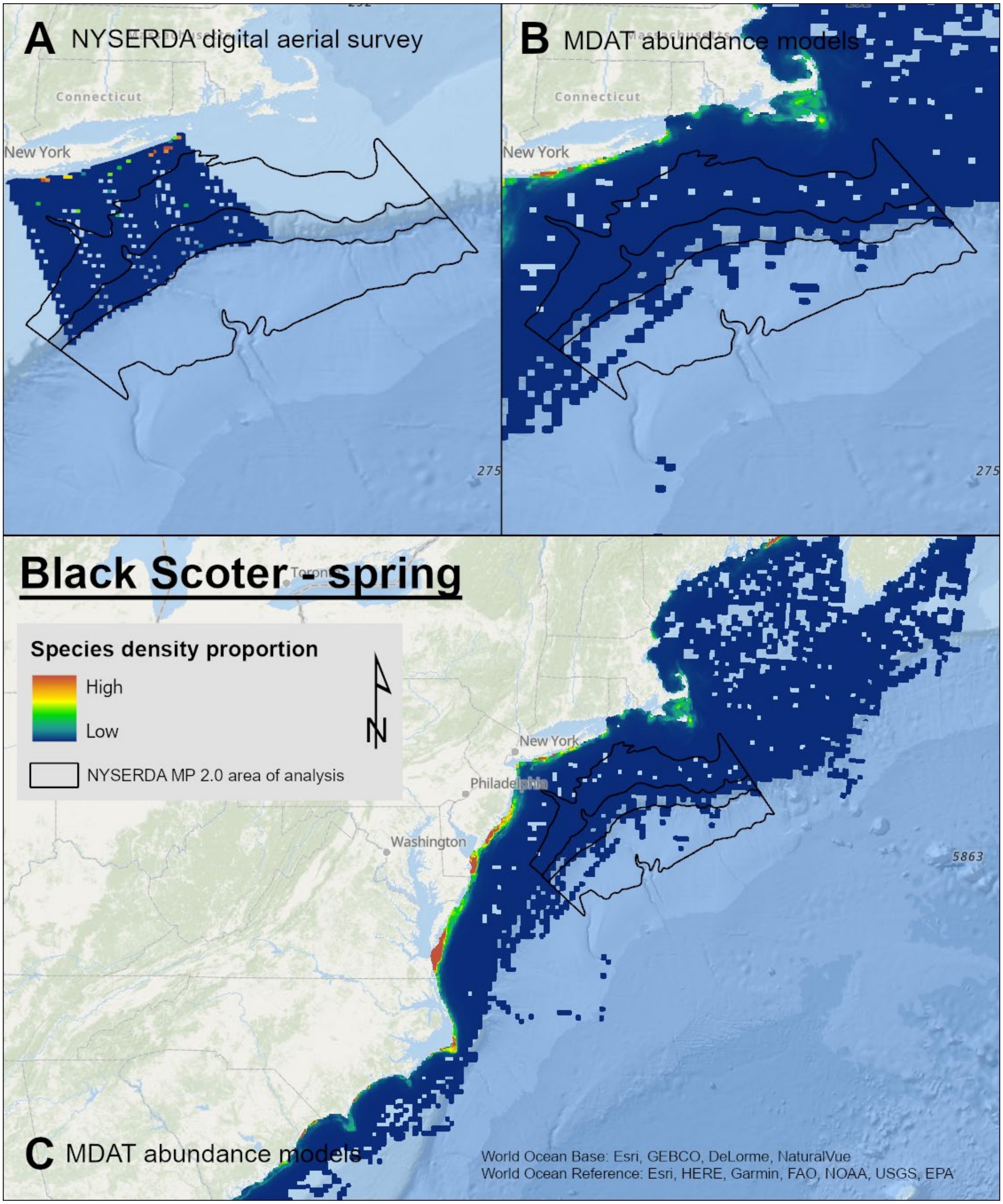
Map B-12. Winter Black Scoter Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



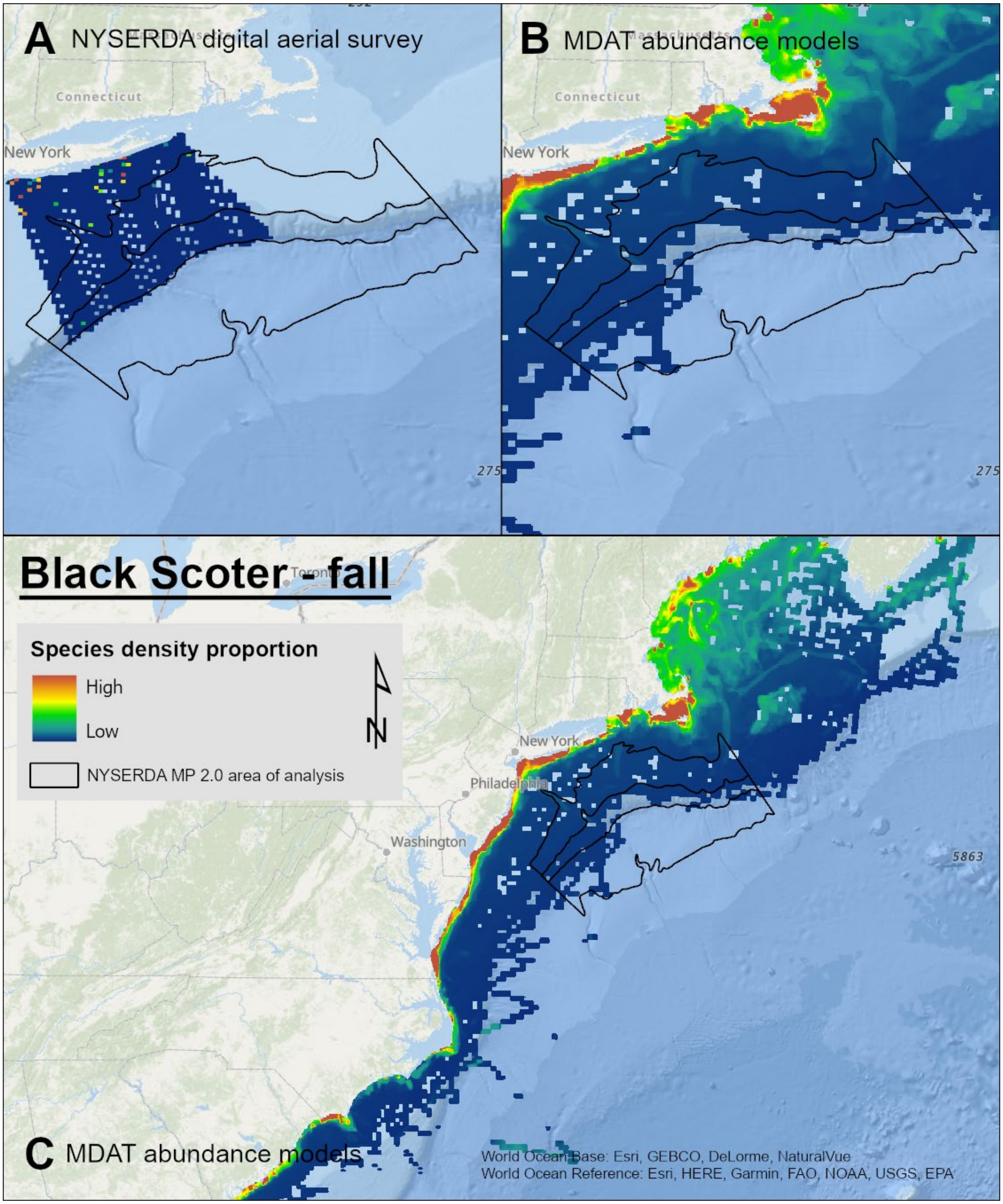
Map B-13. Spring Black Scoter Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-14. Fall Black Scoter Density Proportions

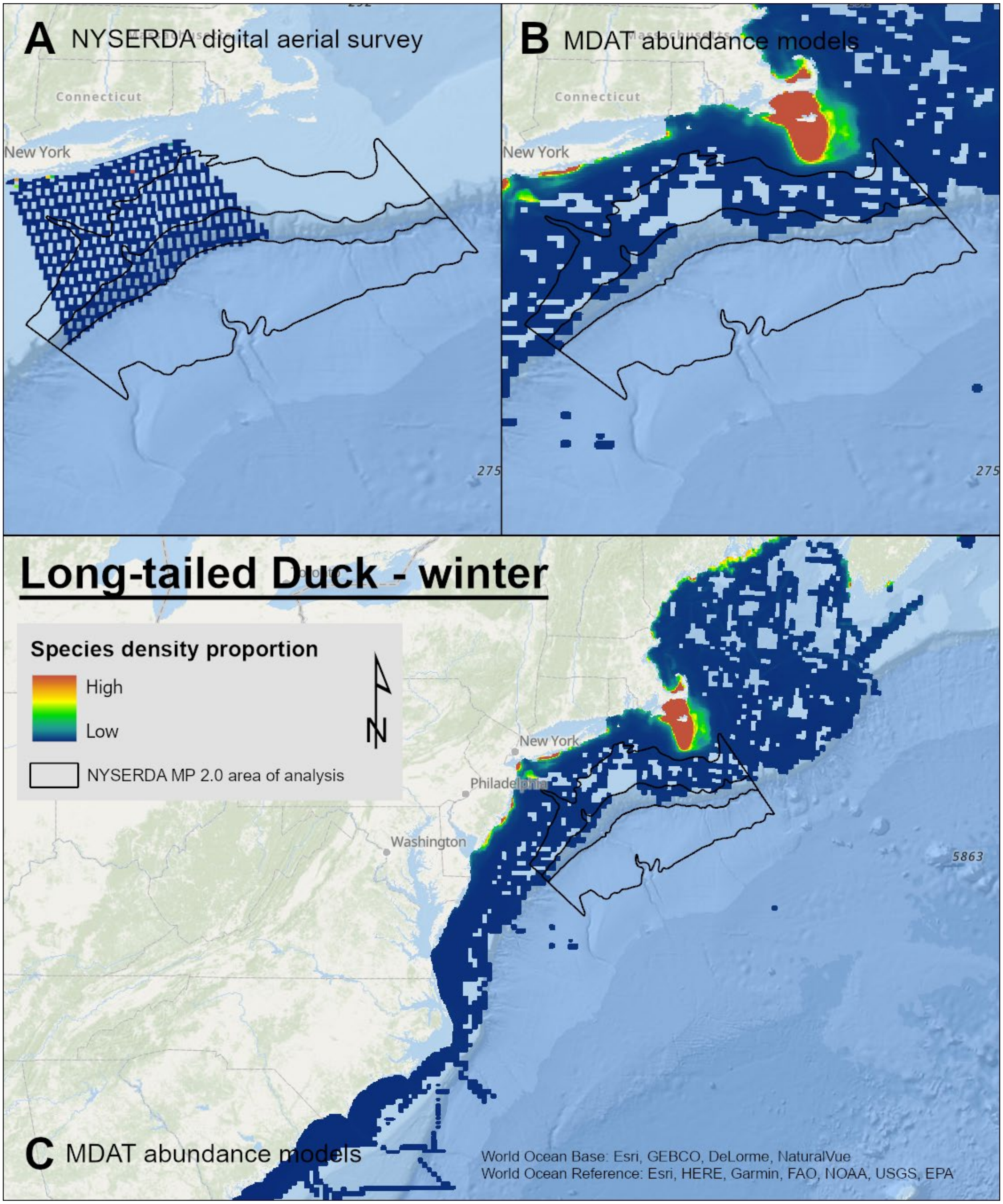
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

Map B-15. Winter Long-tailed Duck Density Proportions

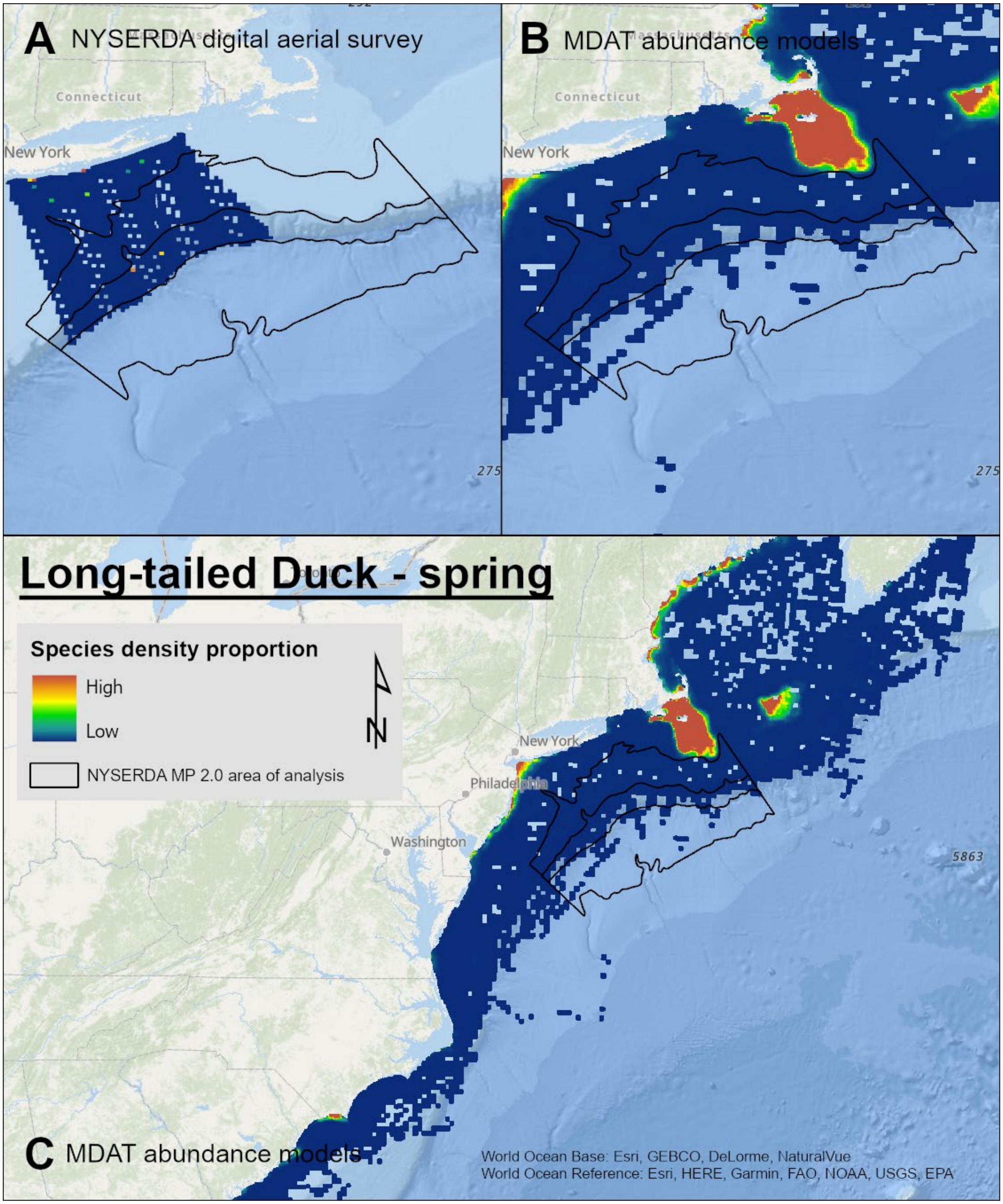
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

Map B-16. Spring Long-tailed Duck Density Proportions

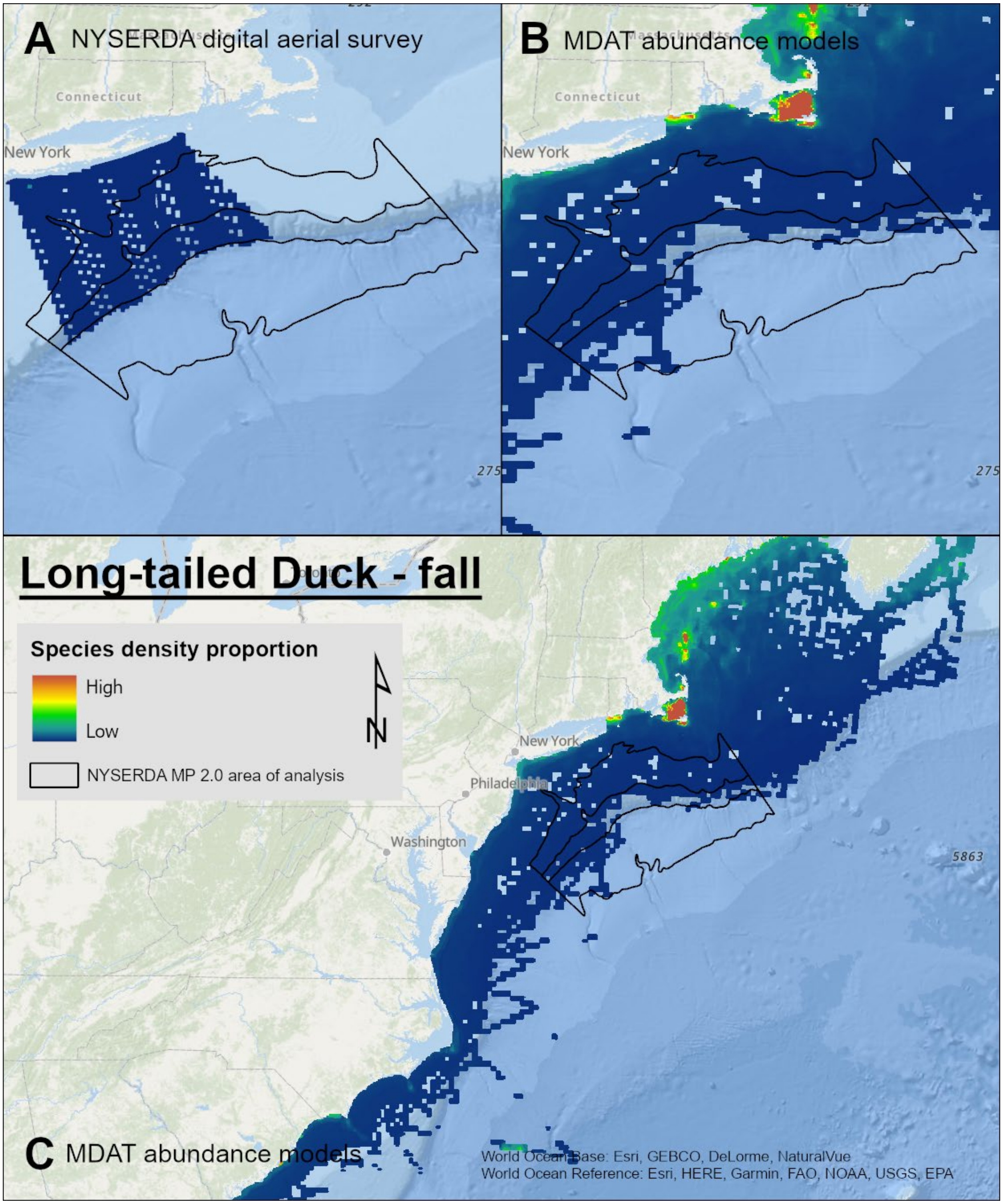
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

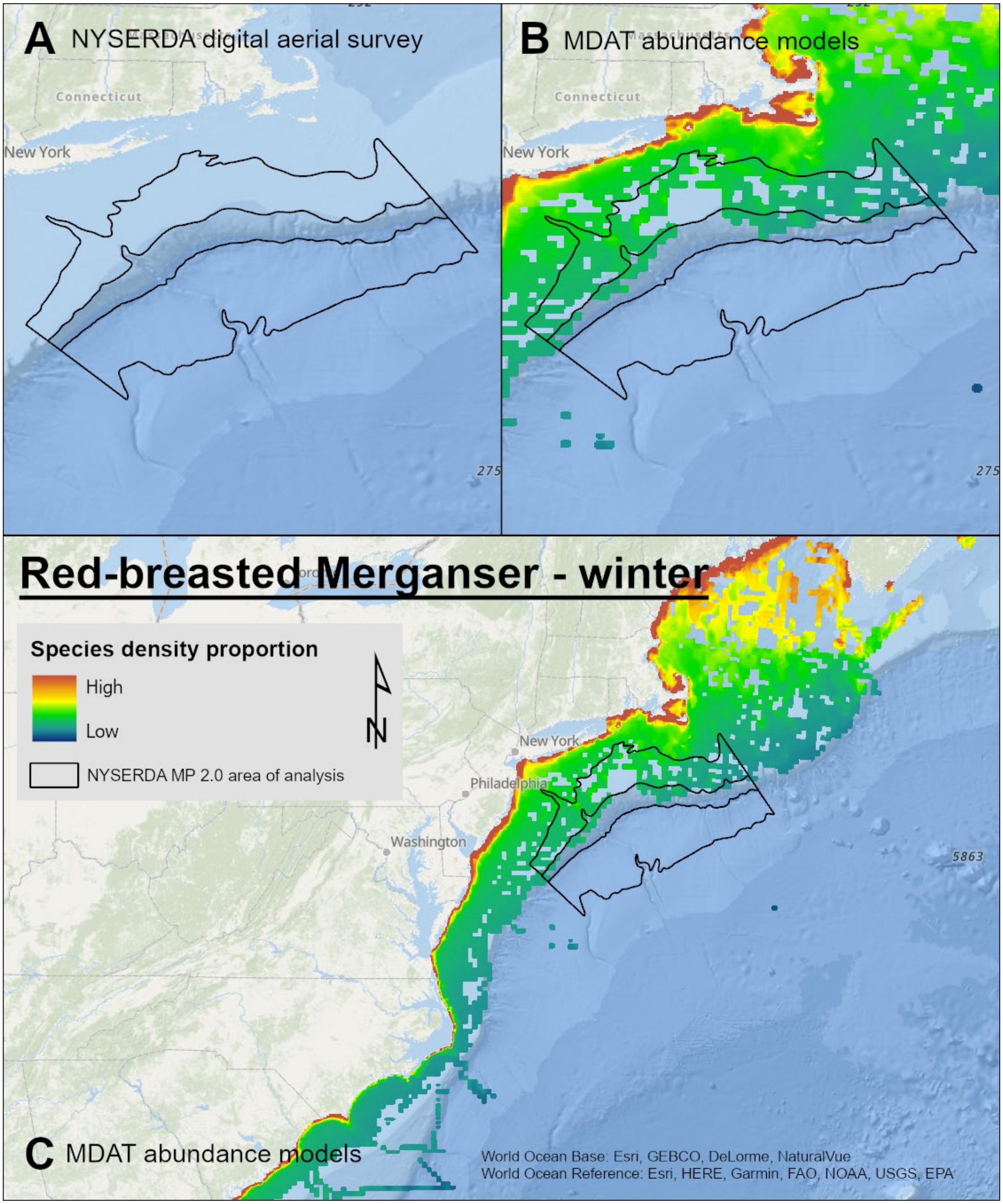
Map B-17. Fall Long-Tailed Duck Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



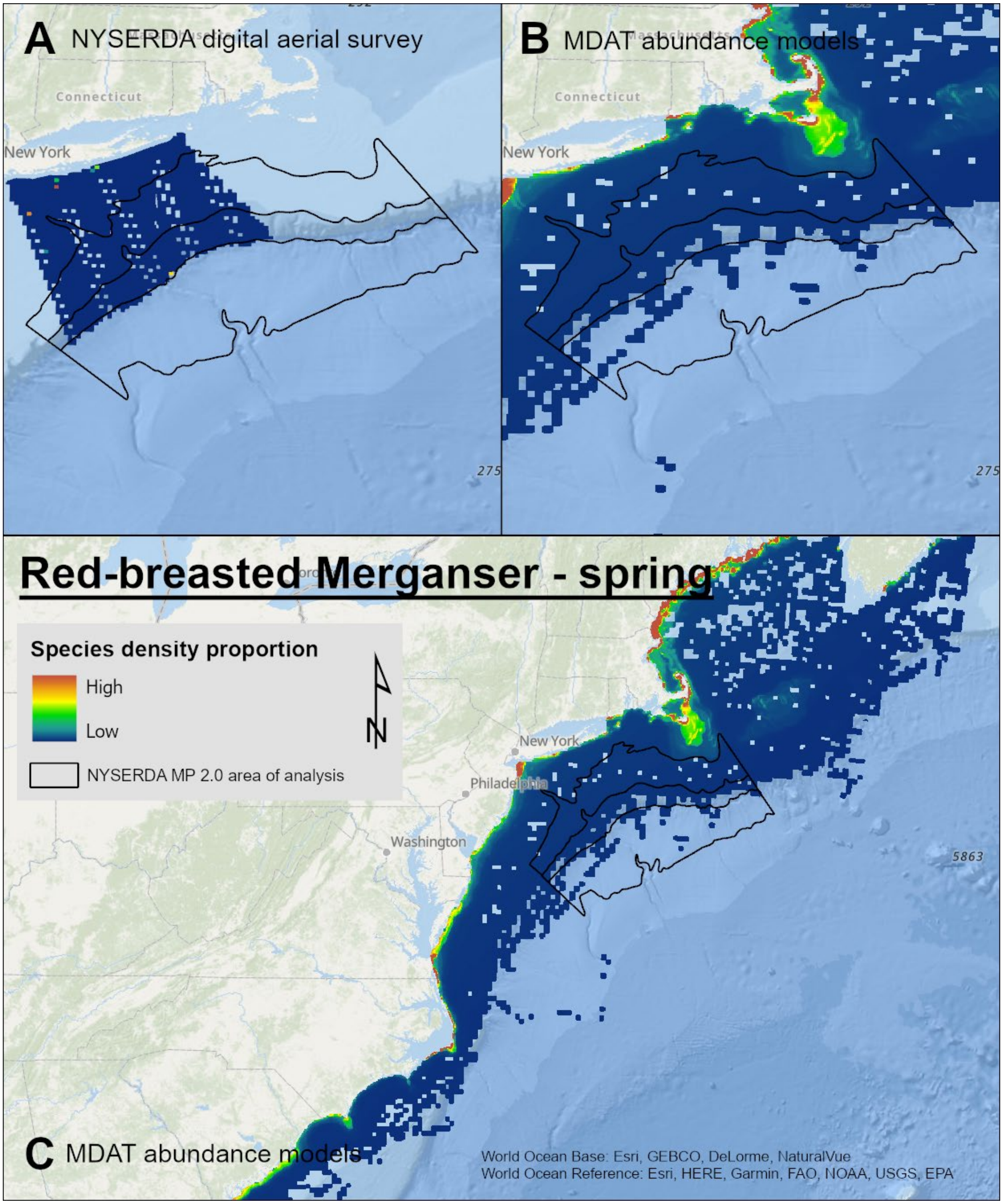
Map B-18. Winter Red-Breasted Merganser Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



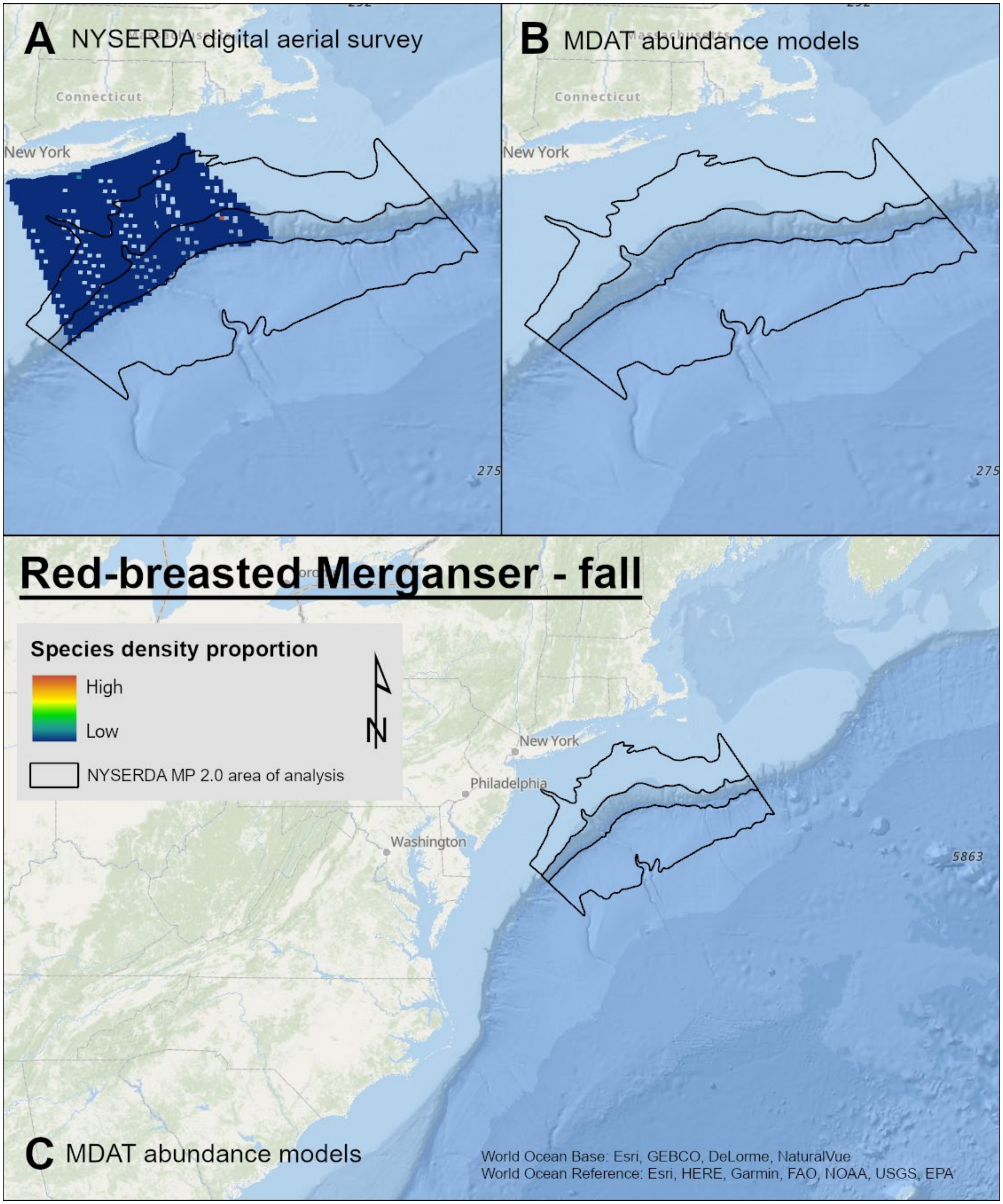
Map B-19. Spring Red-Breasted Merganser Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



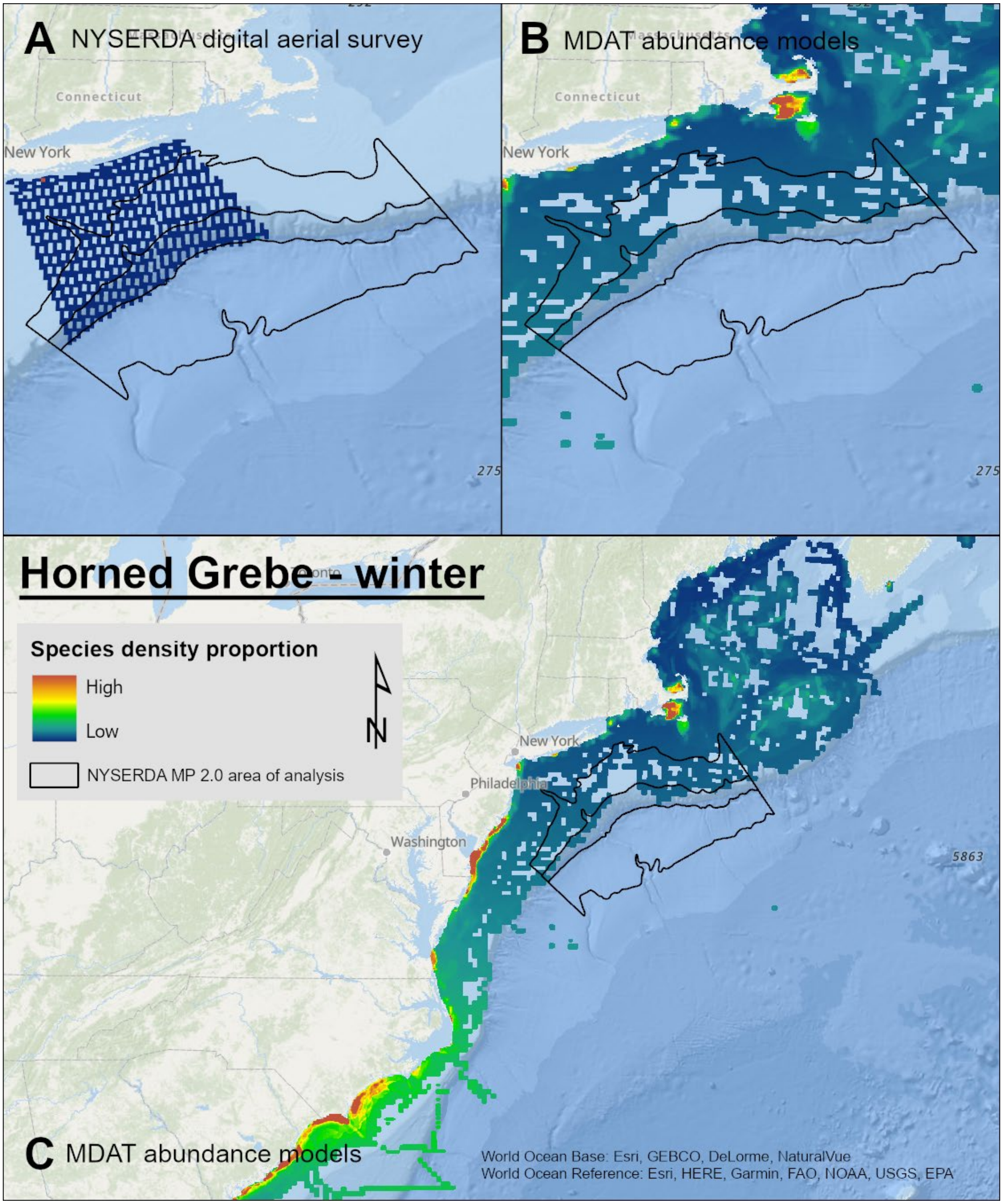
Map B-20. Fall Red-Breasted Merganser Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-21. Winter Horned Grebe Density Proportions

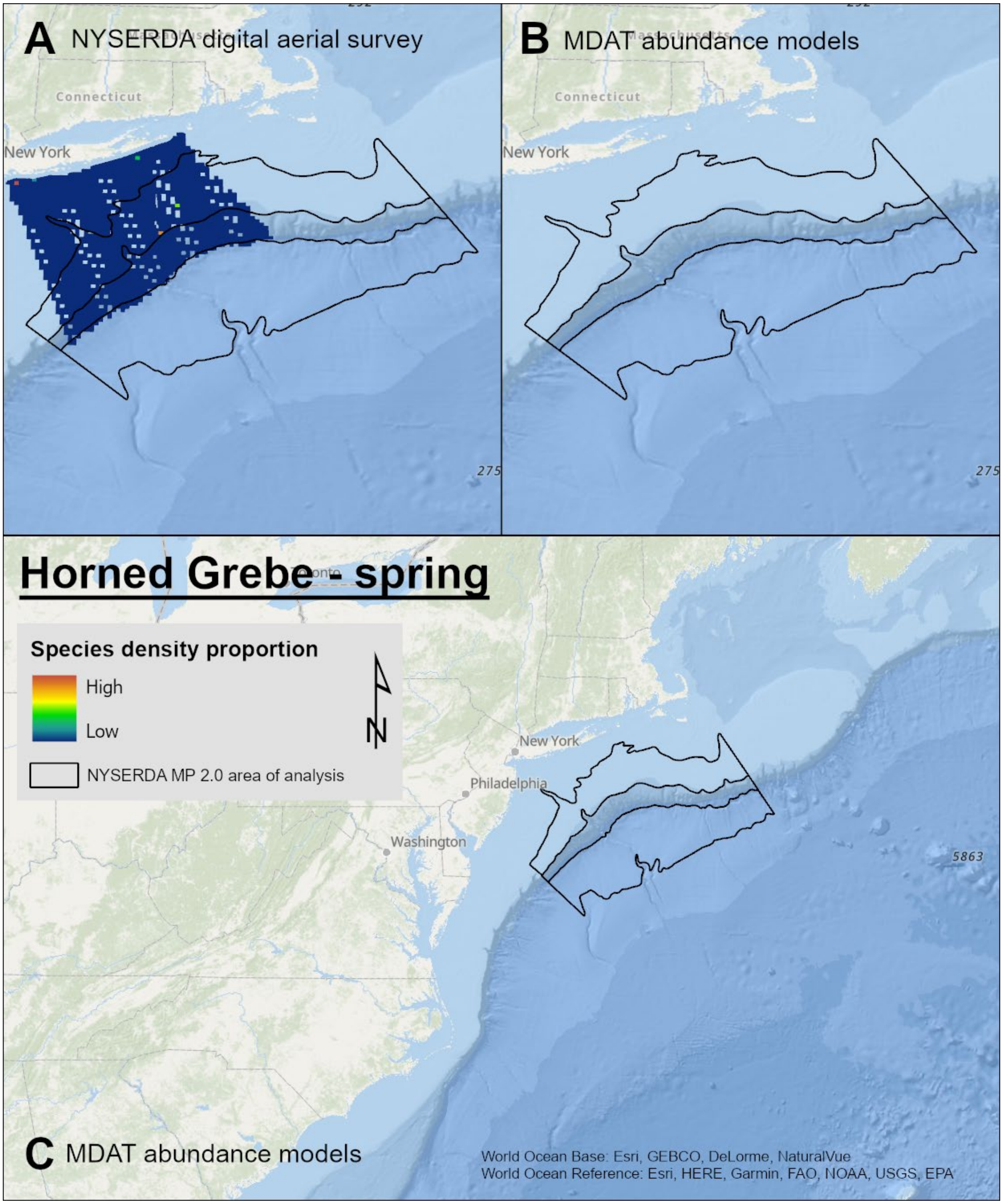
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

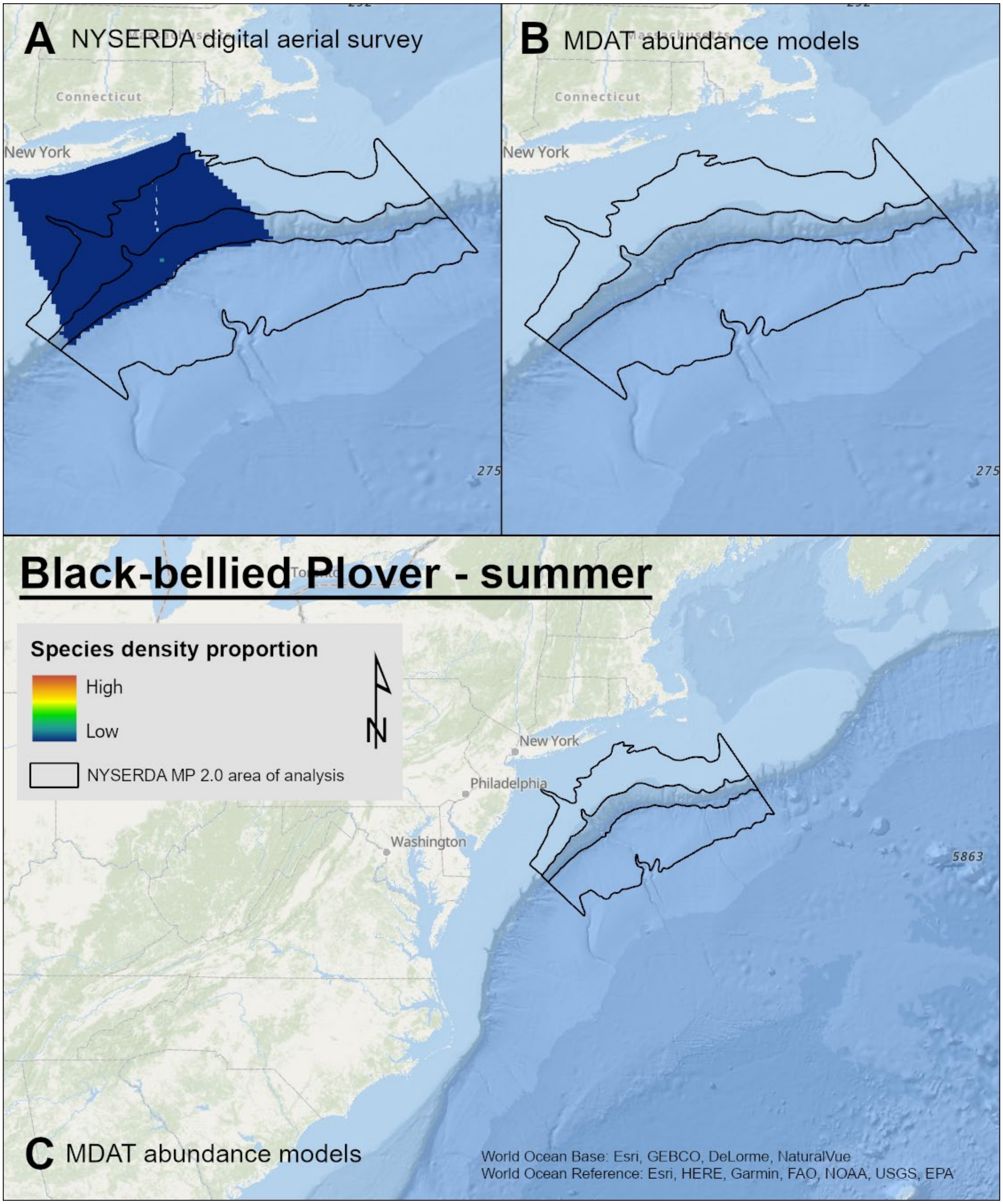
Map B-22. Spring Horned Grebe Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



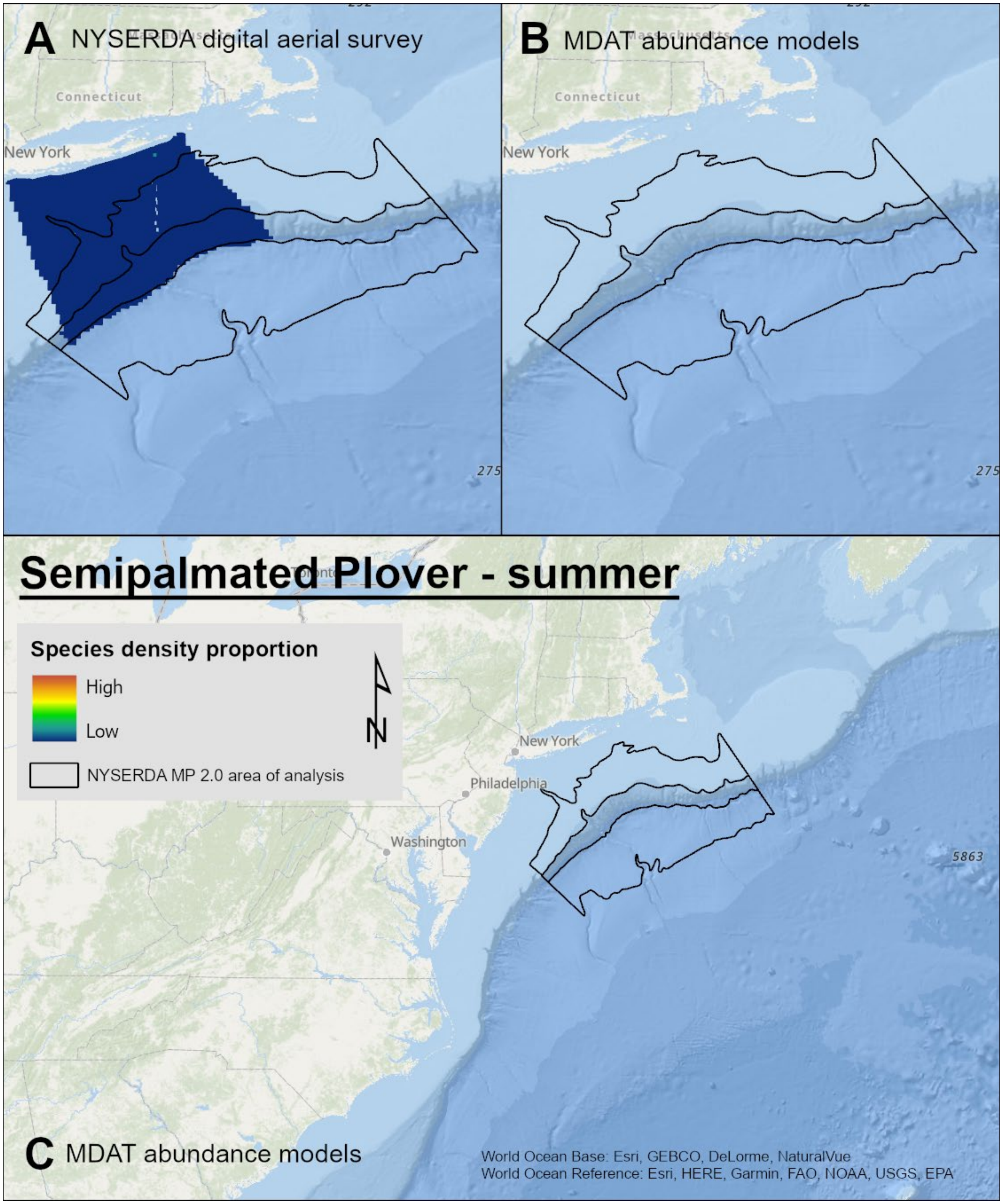
Map B-23. Summer Black-Bellied Plover Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



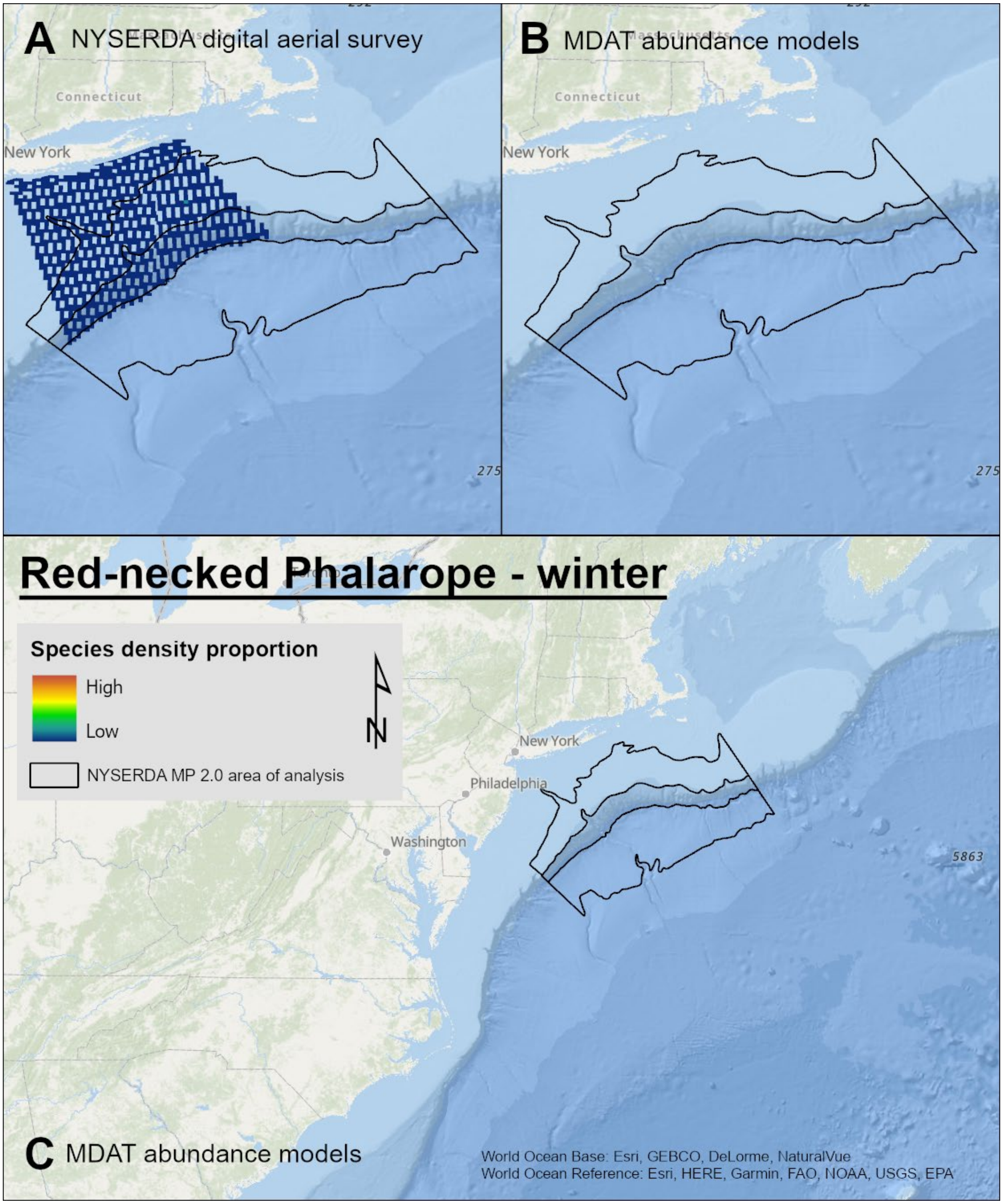
Map B-24. Summer Semipalmated Plover Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-25. Winter Red-Necked Phalarope Density Proportions

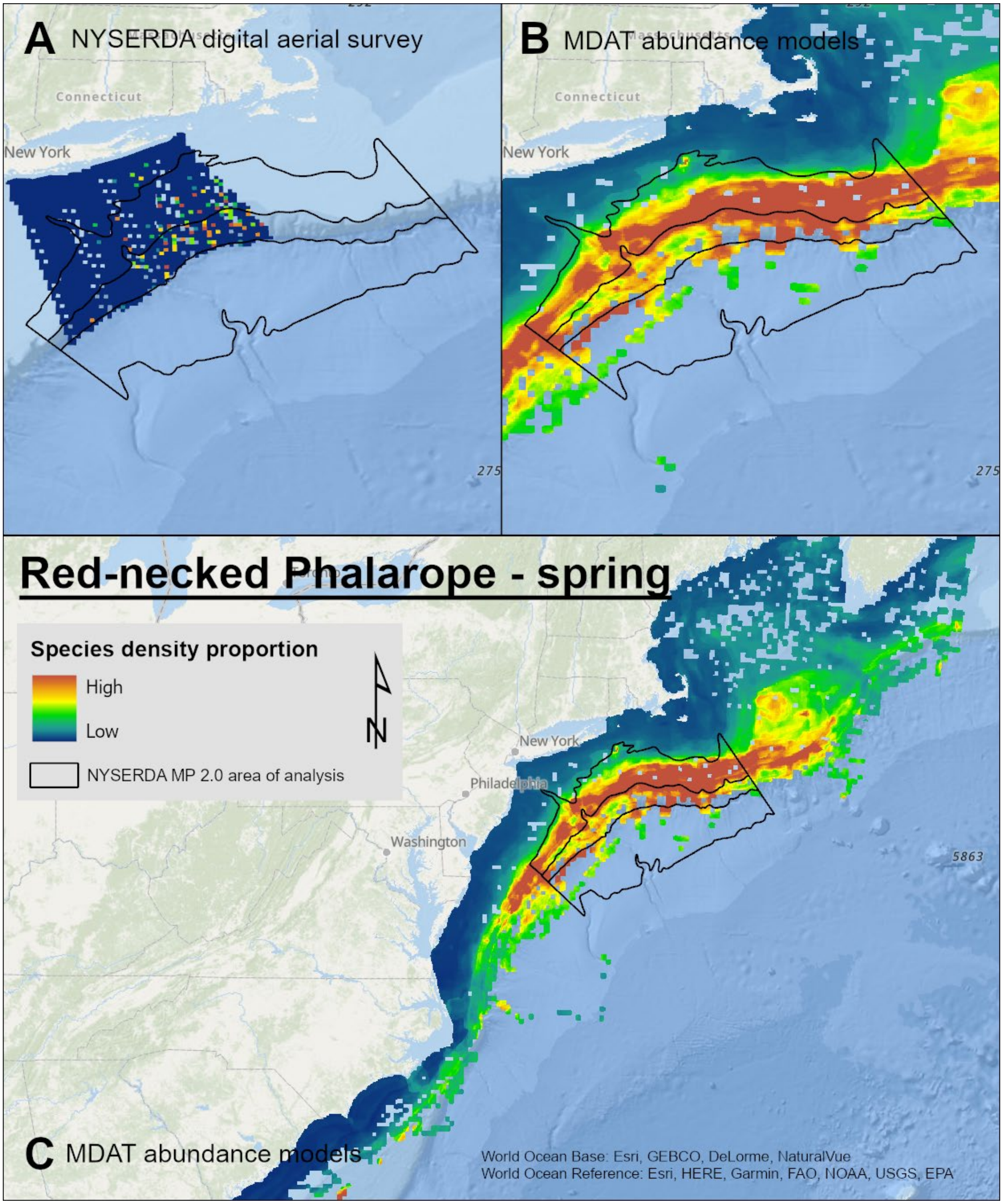
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

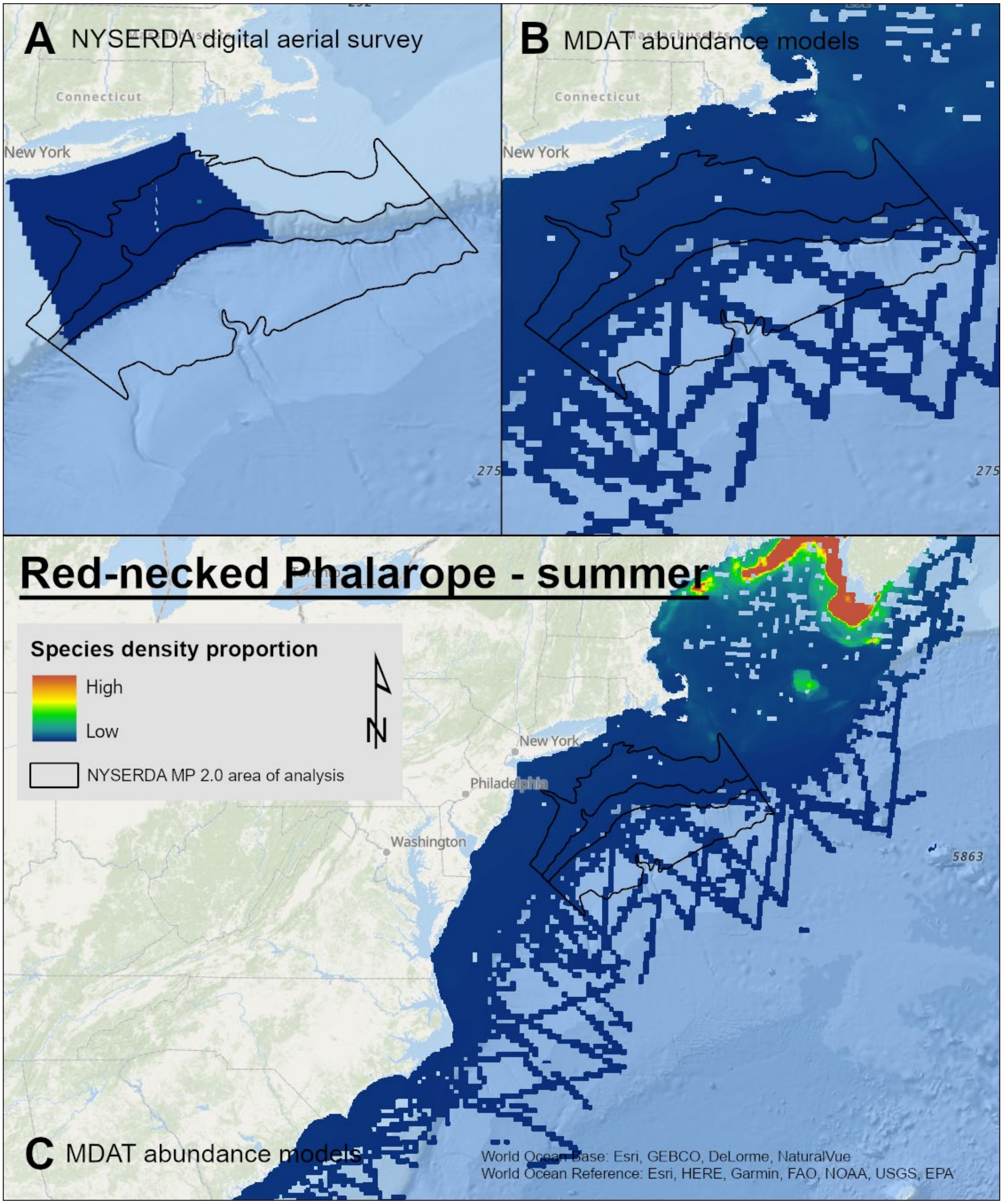
Map B-26. Spring Red-Necked Phalarope Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



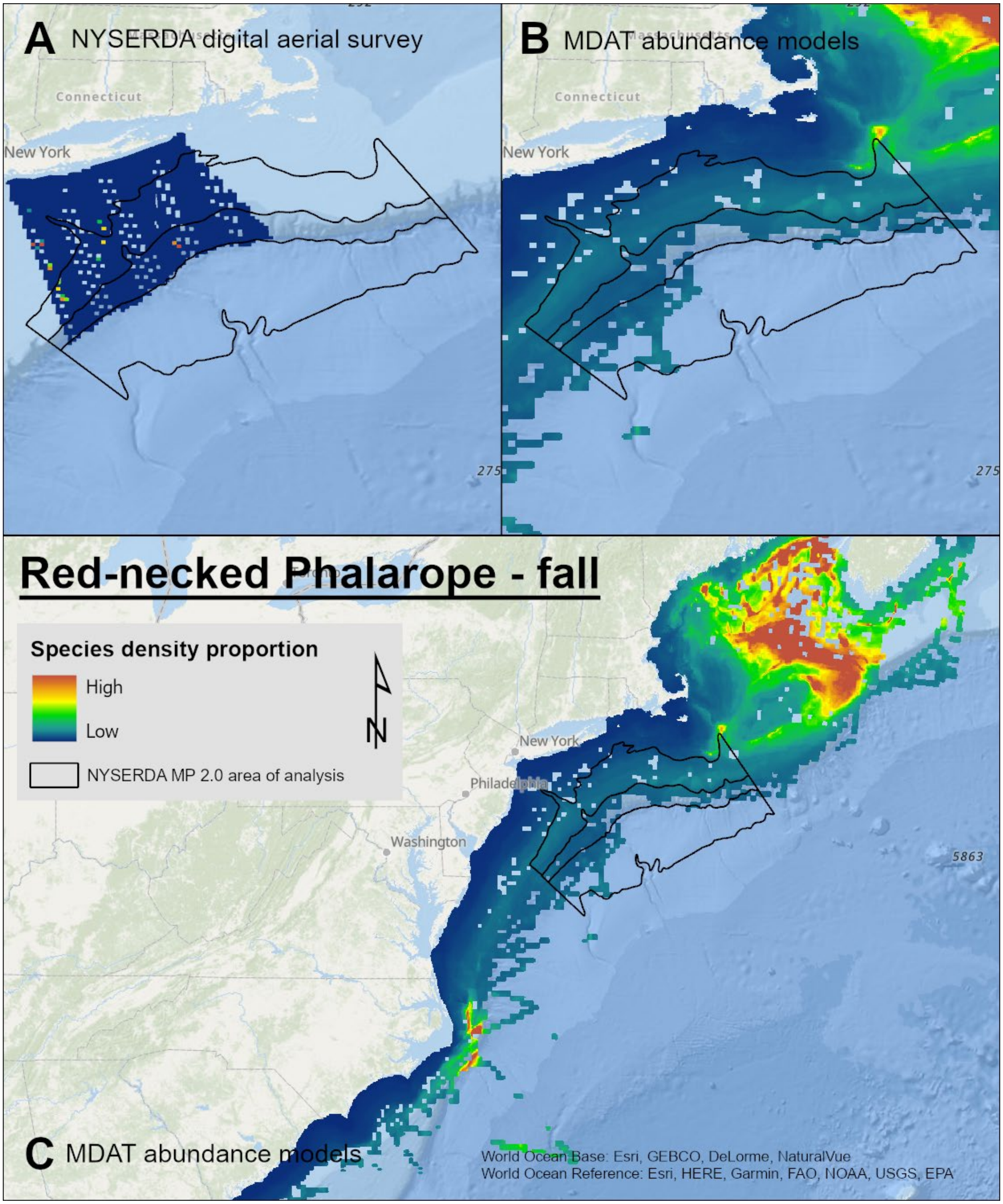
Map B-27. Summer Red-Necked Phalarope Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



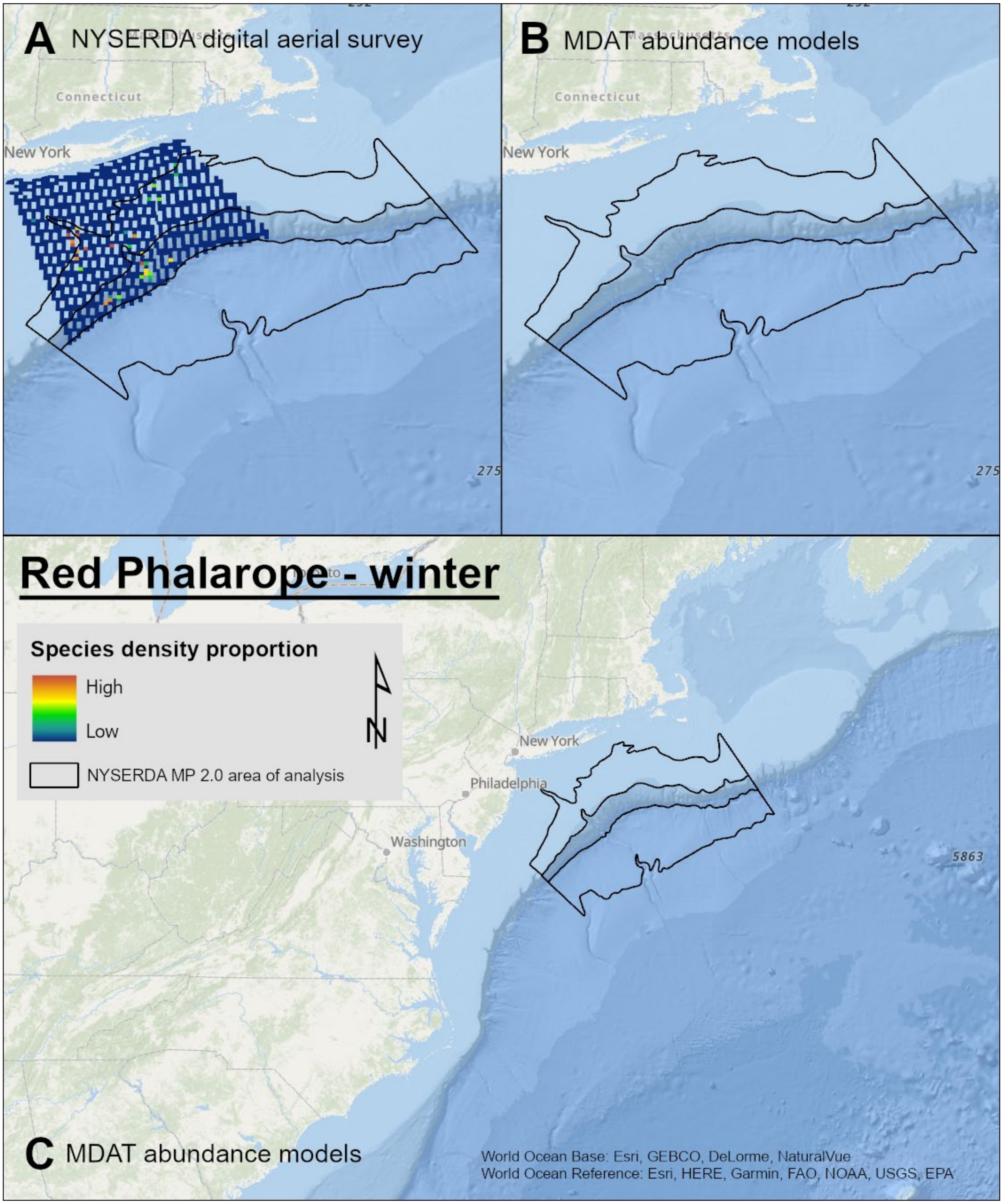
Map B-28. Fall Red-Necked Phalarope Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



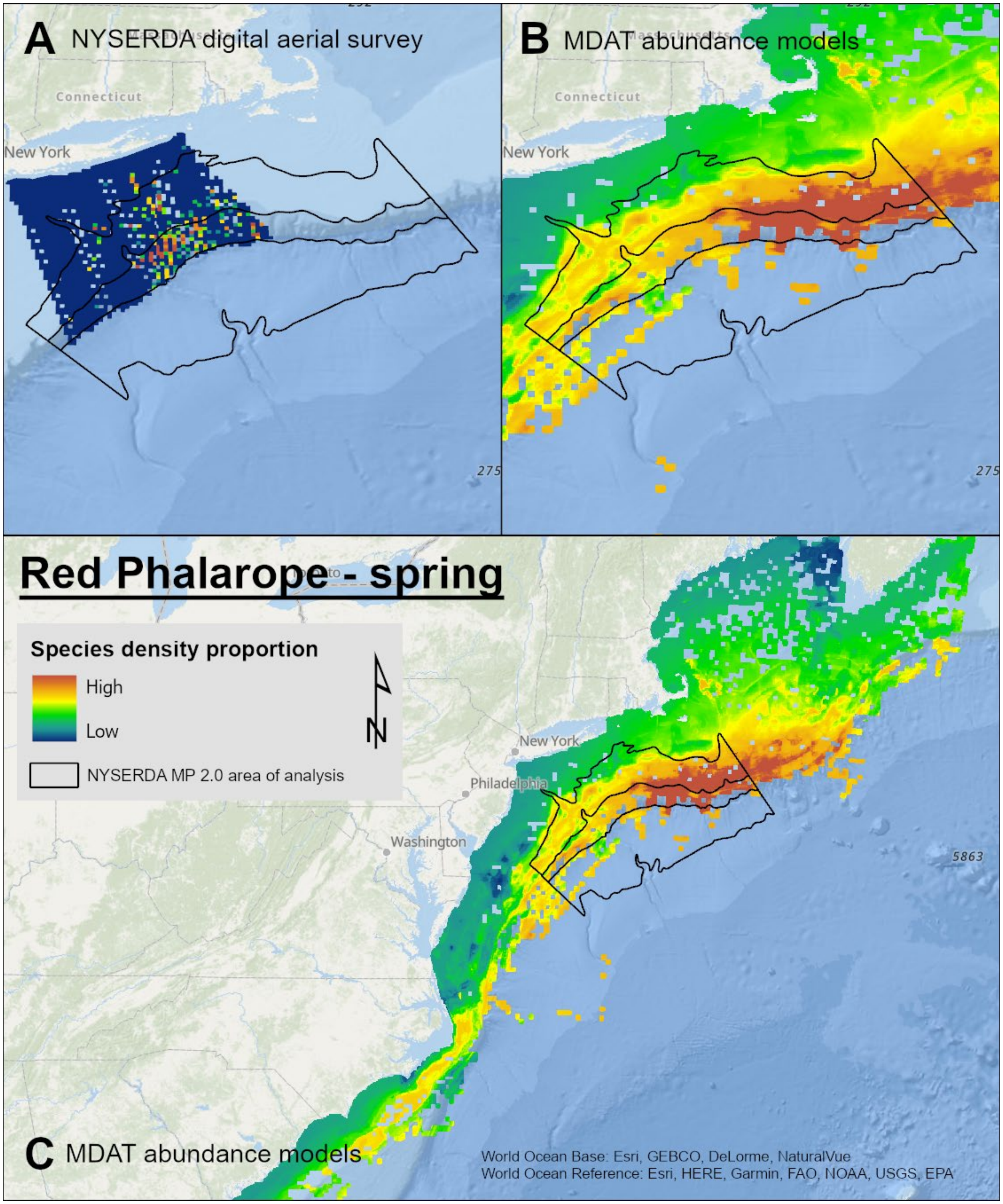
Map B-29. Winter Red Phalarope Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



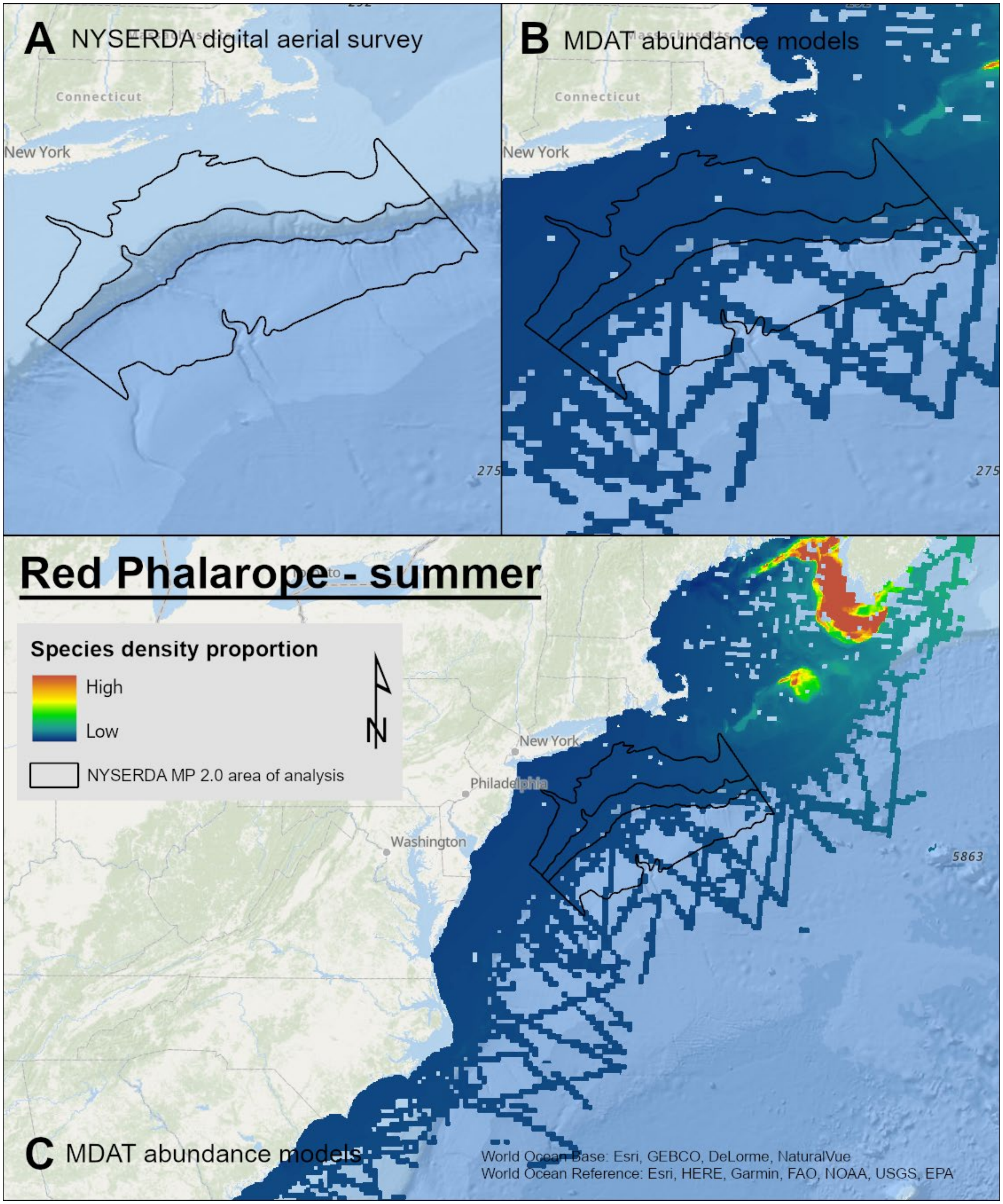
Map B-30. Spring Red Phalarope Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



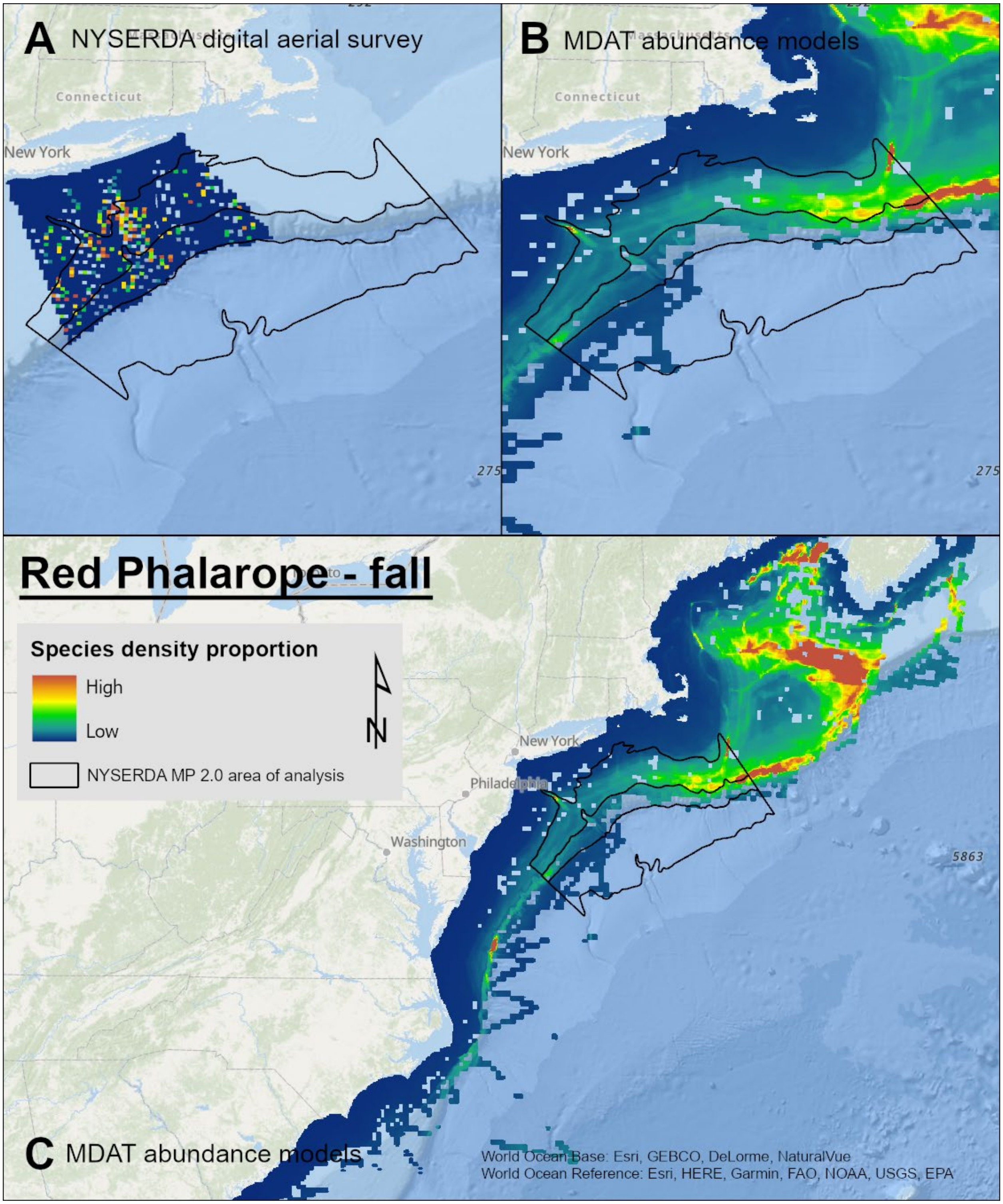
Map B-31. Summer Red Phalarope Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



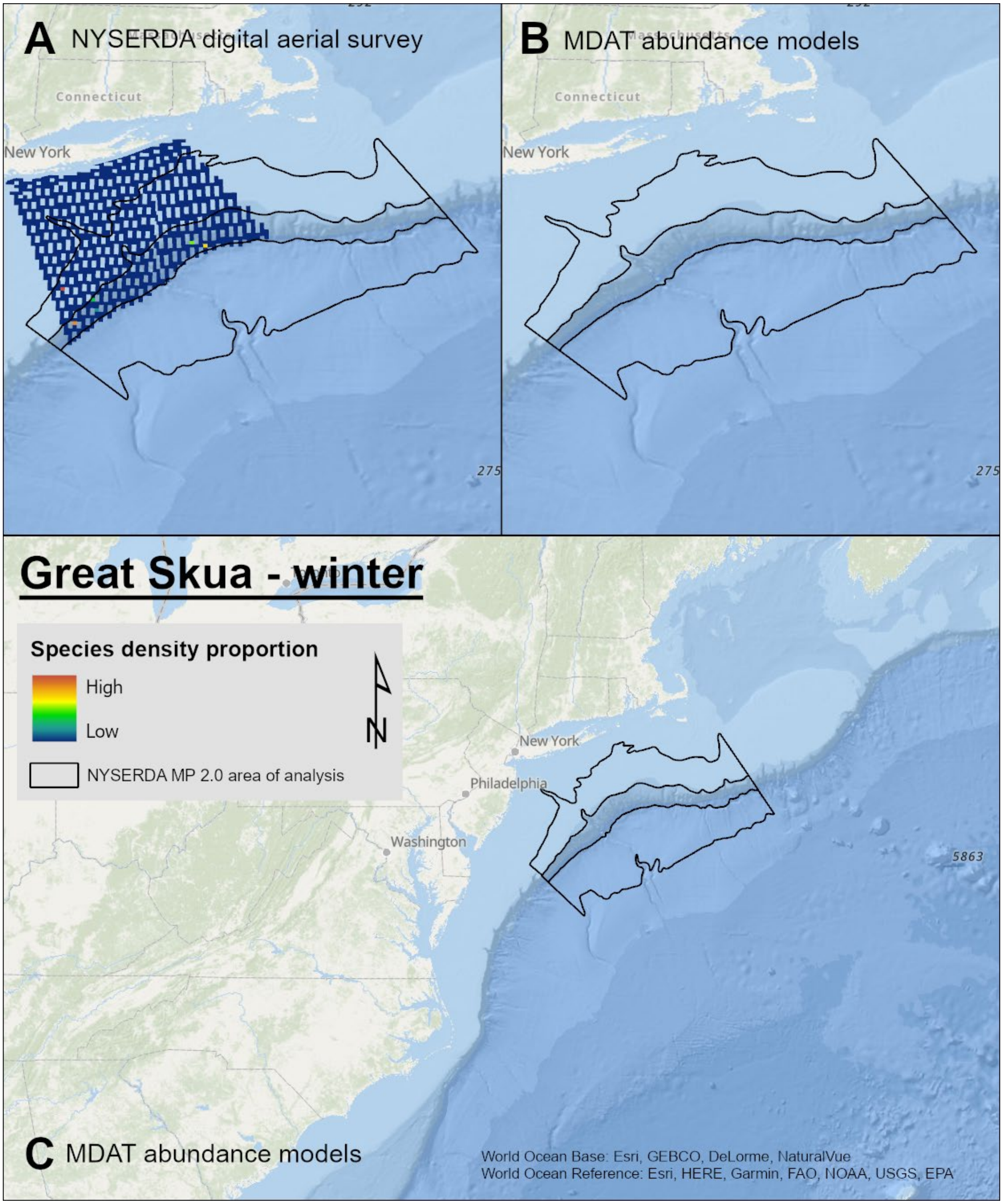
Map B-32. Fall Red Phalarope Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



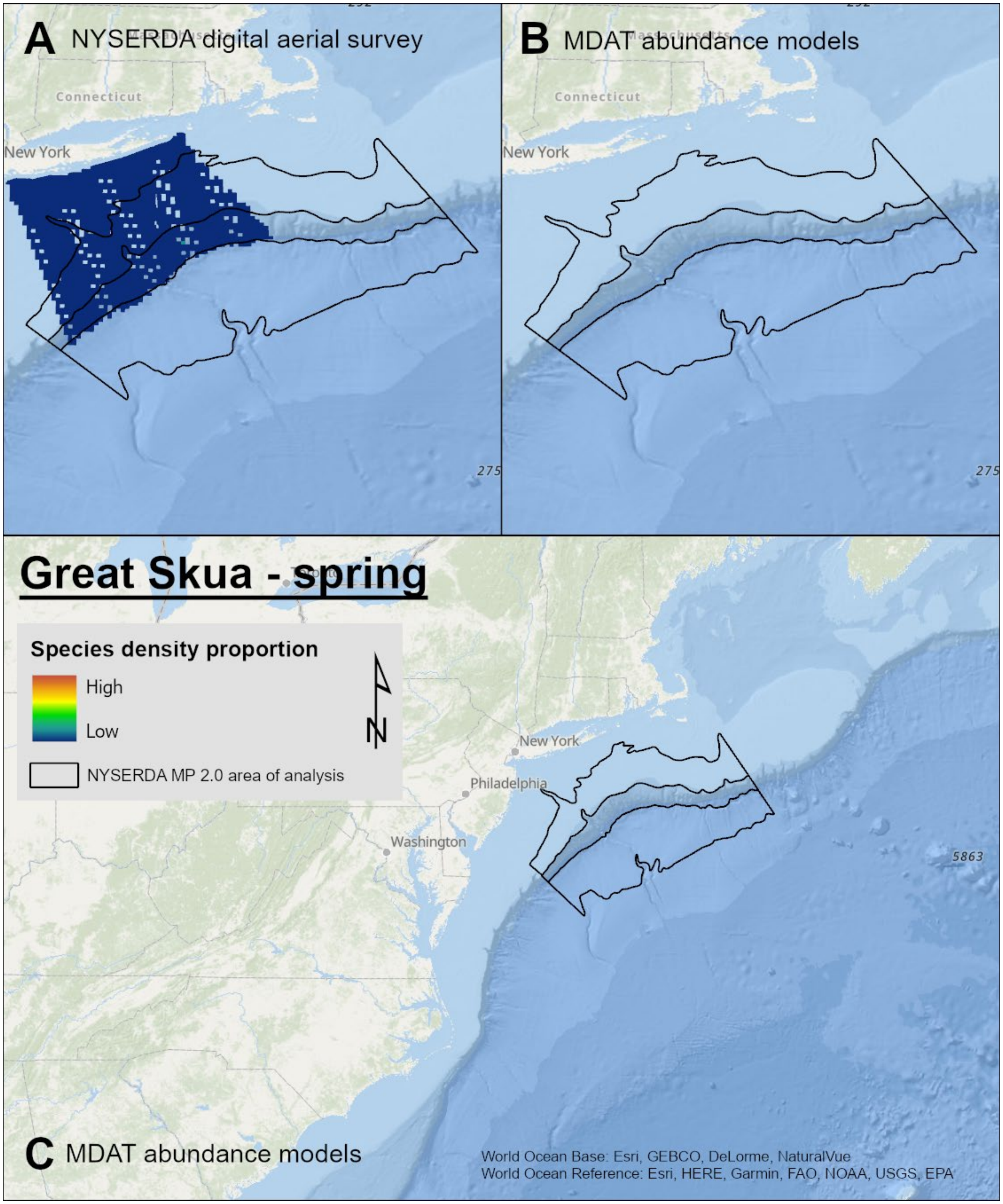
Map B-33. Winter Great Skua Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



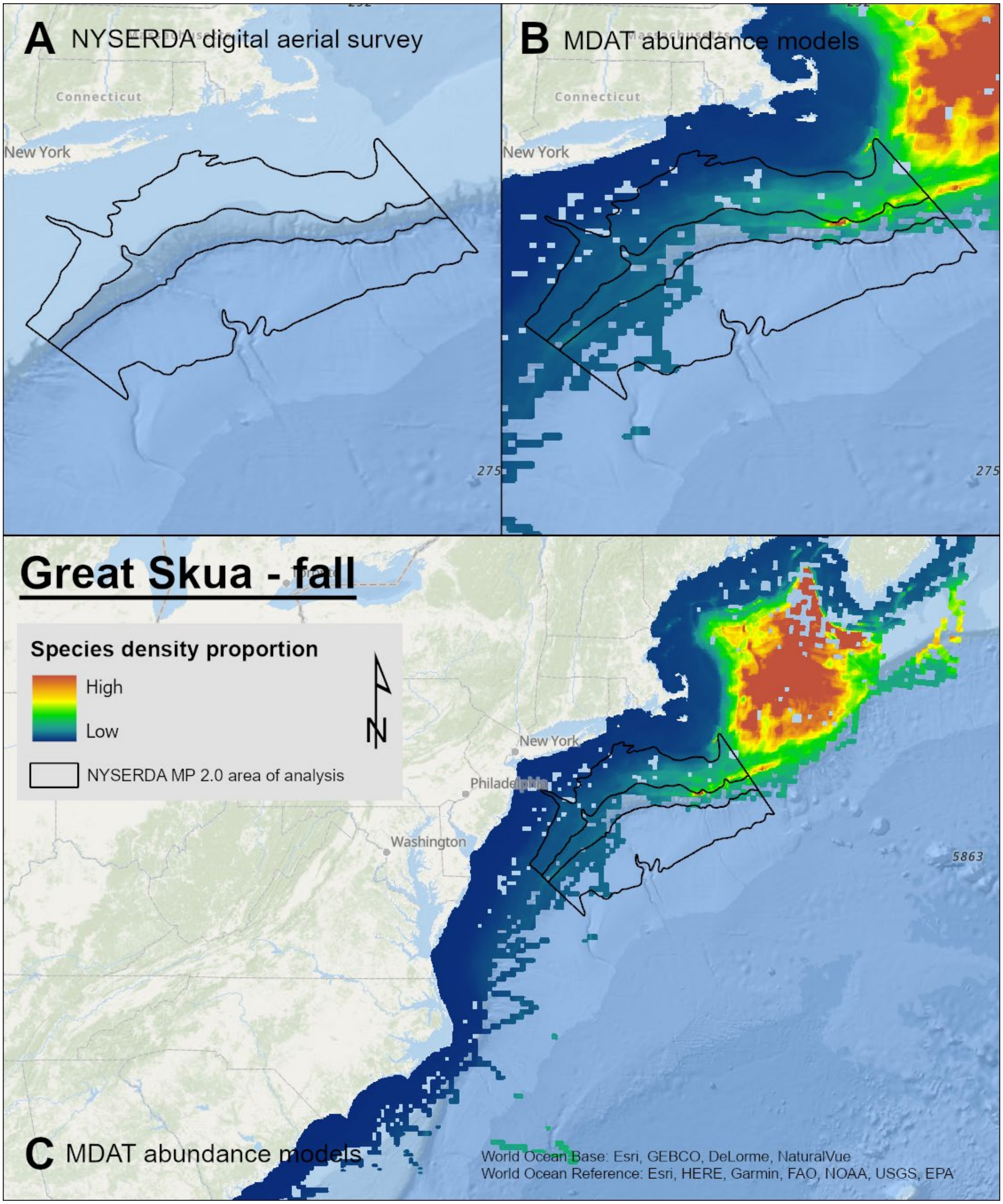
Map B-34. Spring Great Skua Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



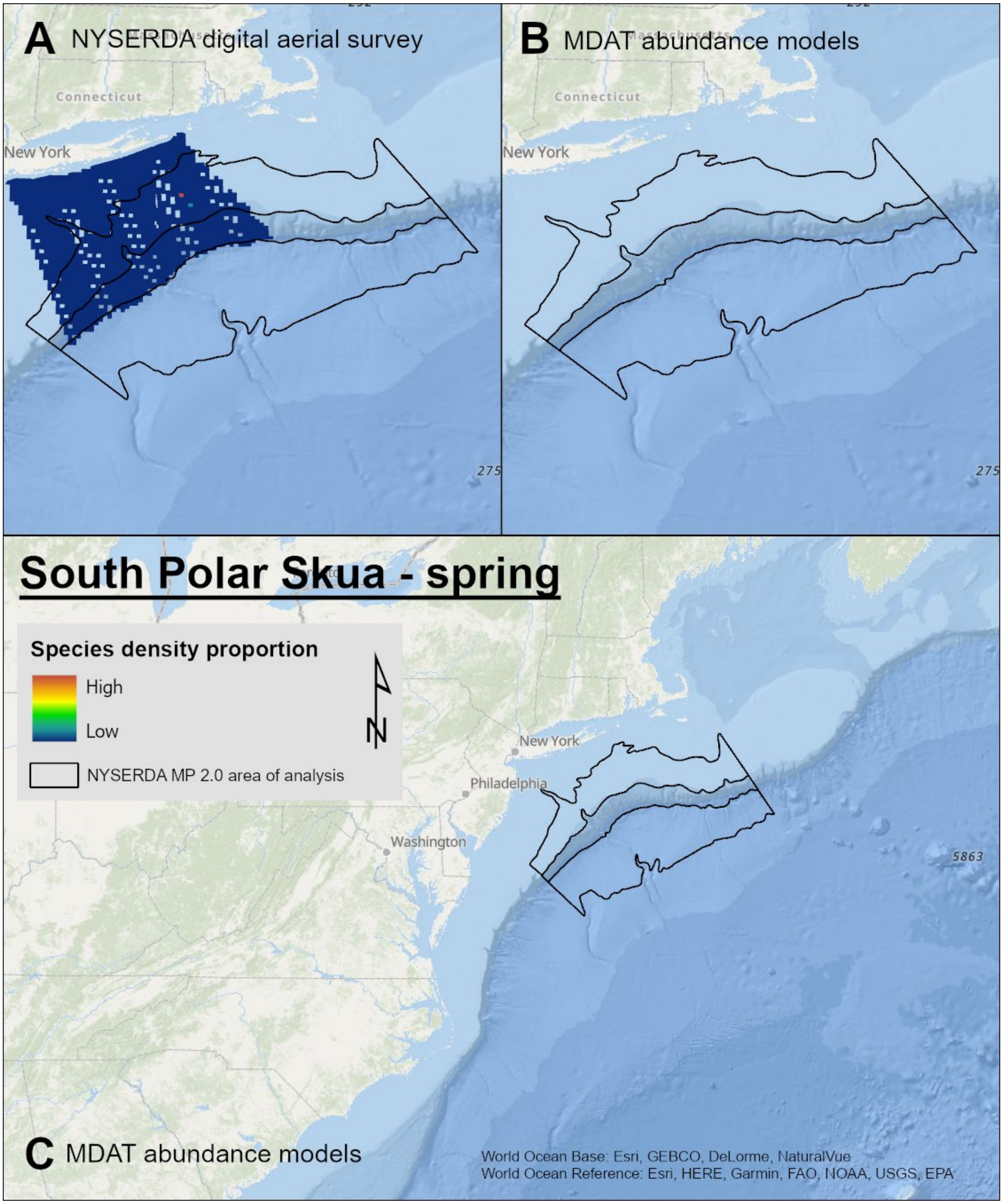
Map B-35. Fall Great Skua Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



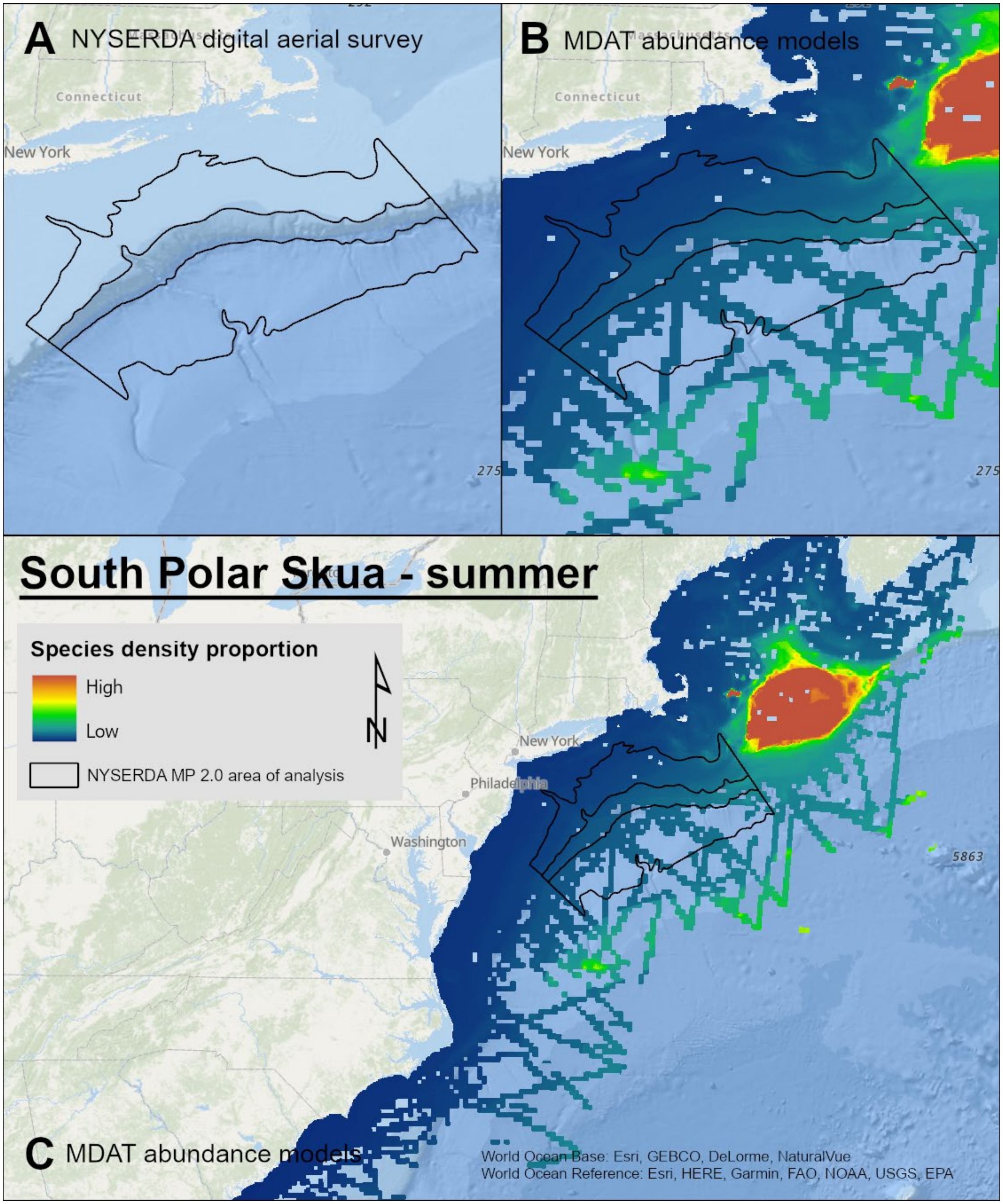
Map B-36. Spring South Polar Skua Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



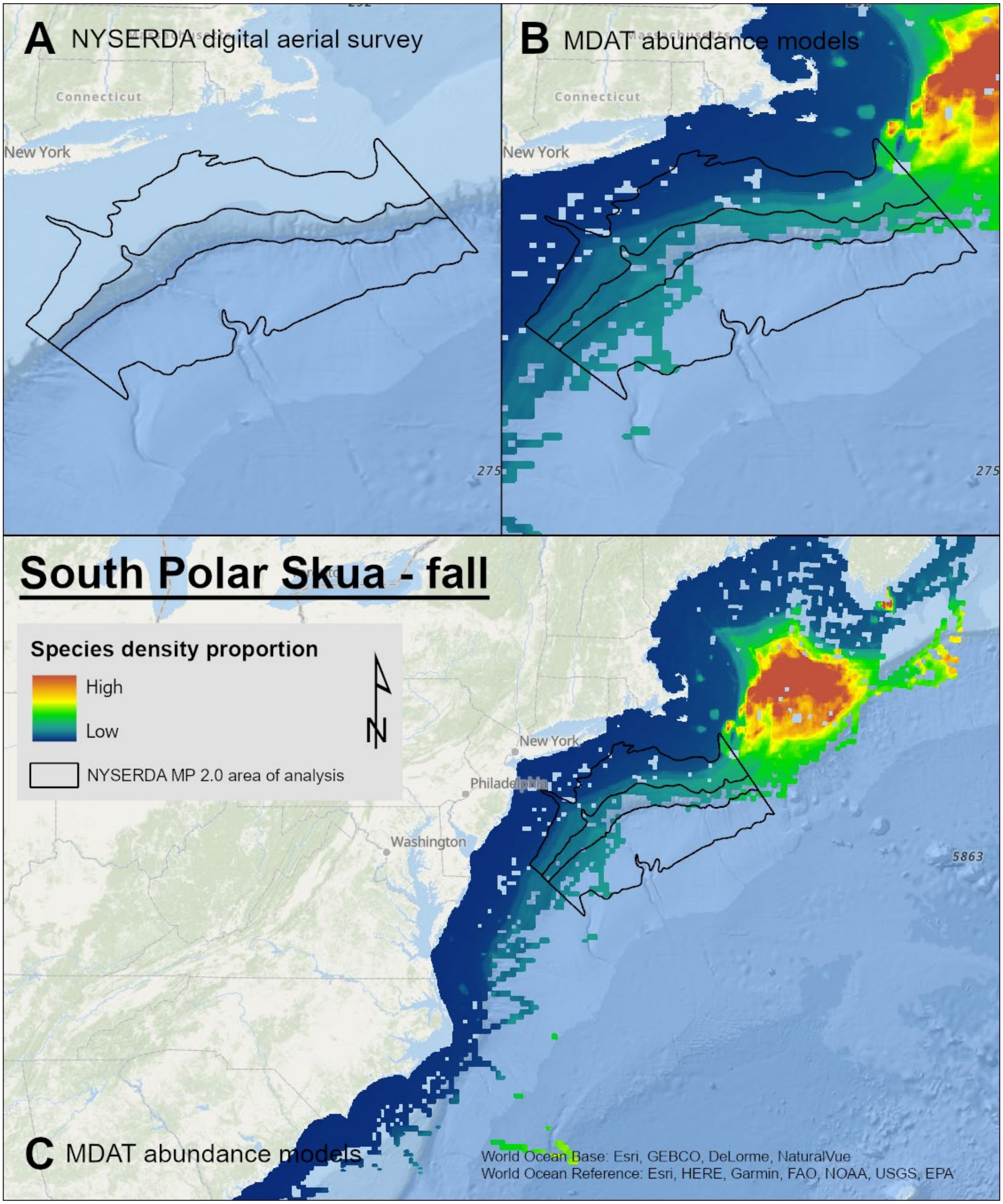
Map B-37. Summer South Polar Skua Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-38. Fall South Polar Skua Density Proportions

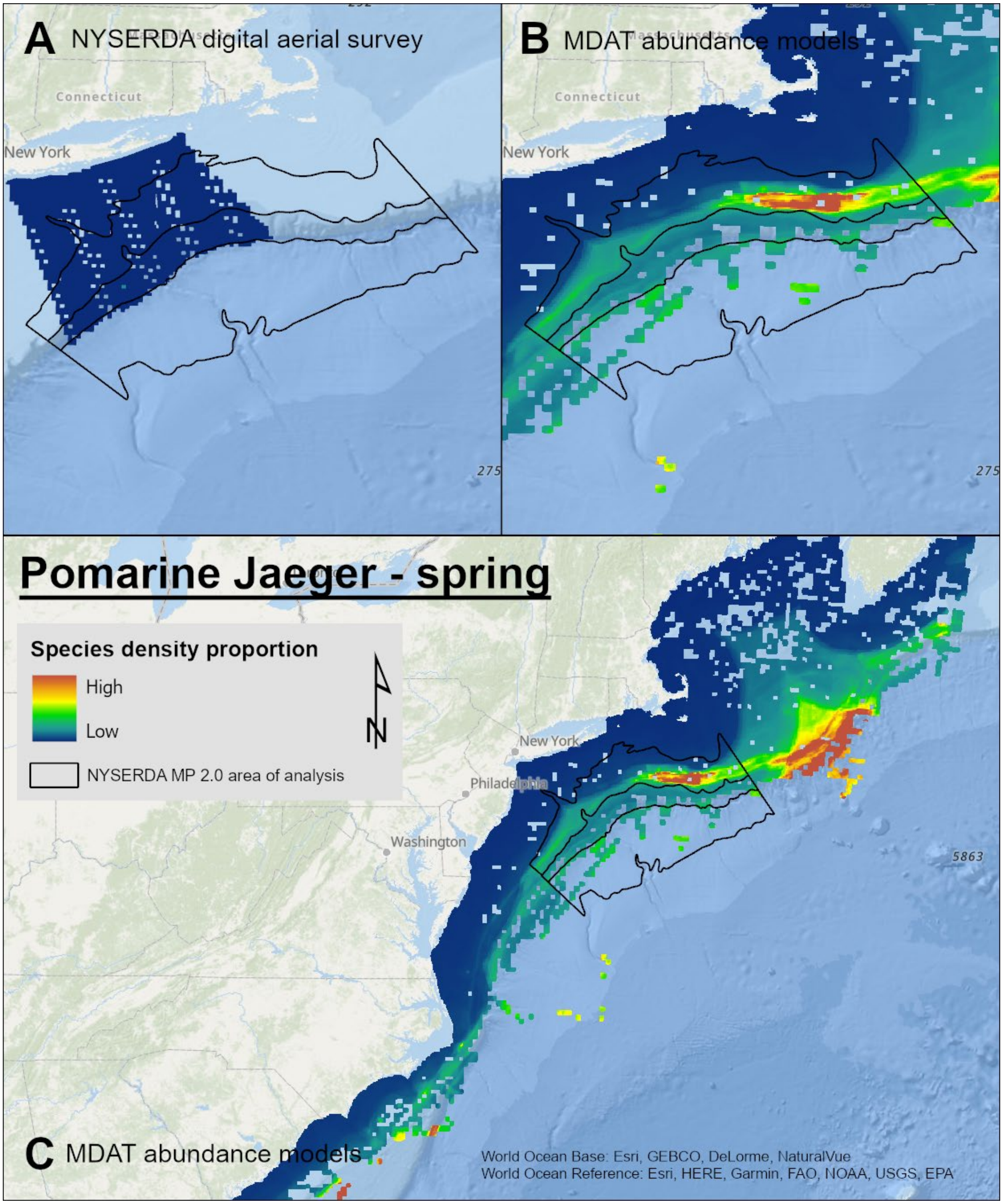
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

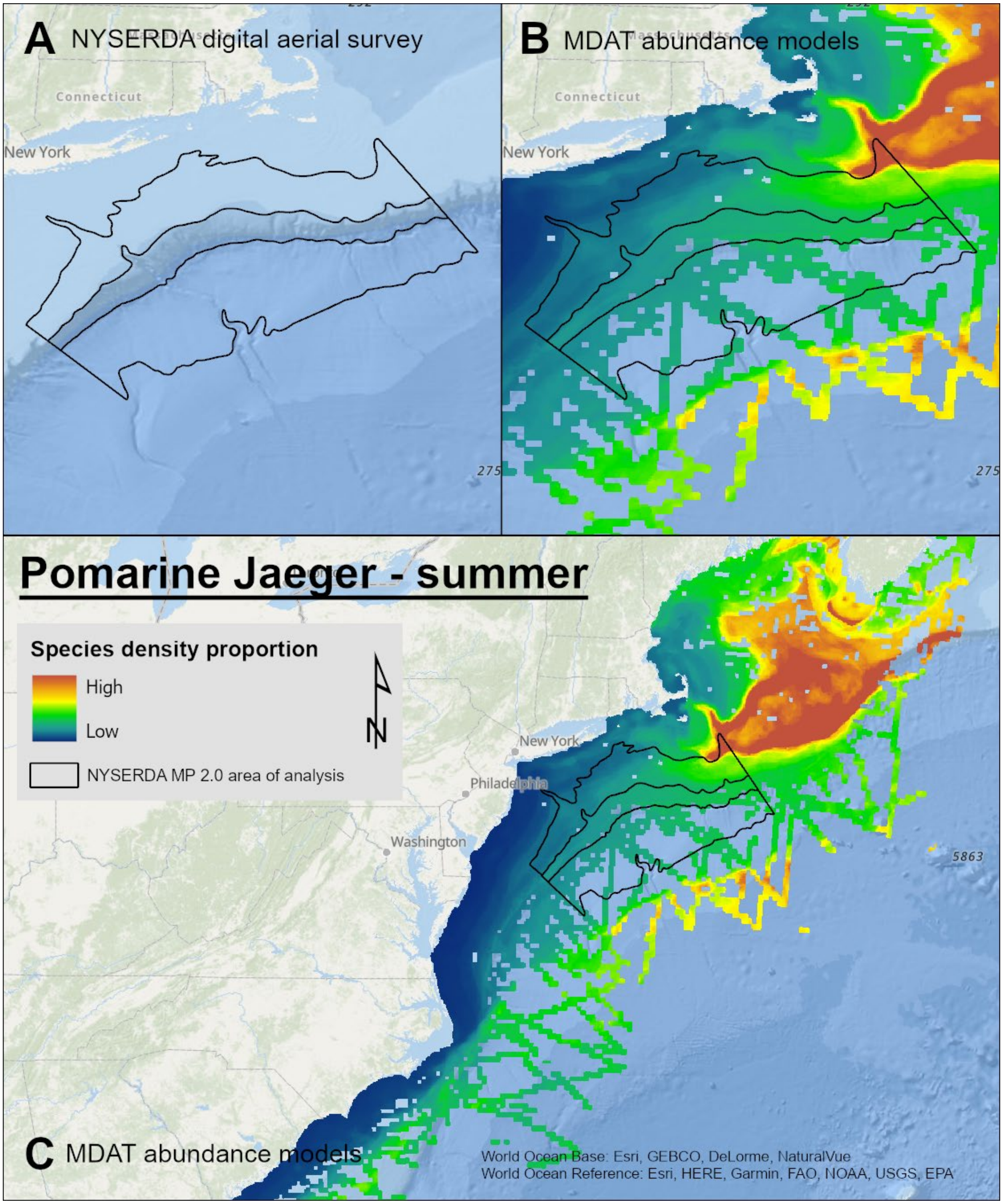
Map B-39. Spring Pomarine Jaeger Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



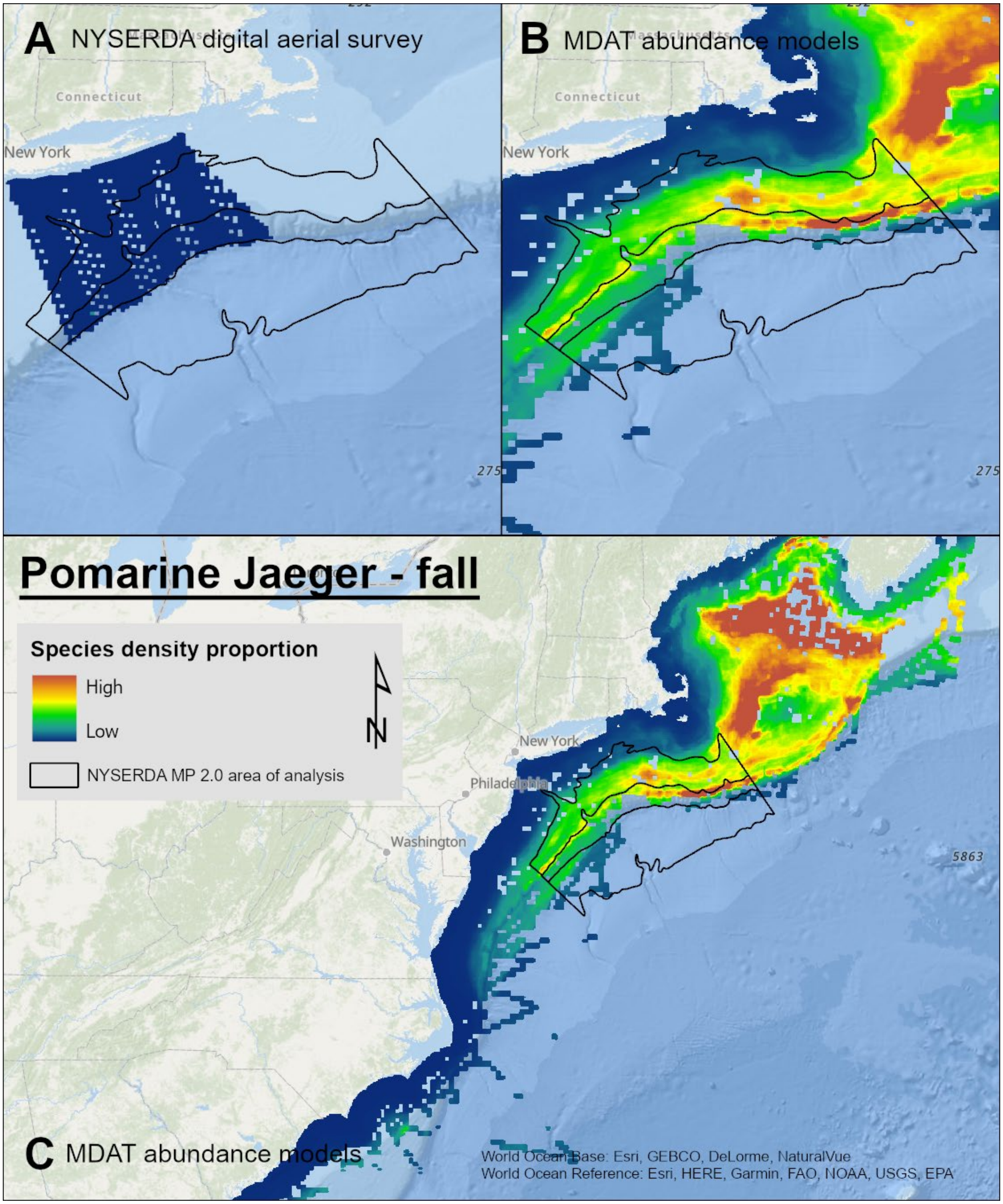
Map B-40. Summer Pomarine Jaeger Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



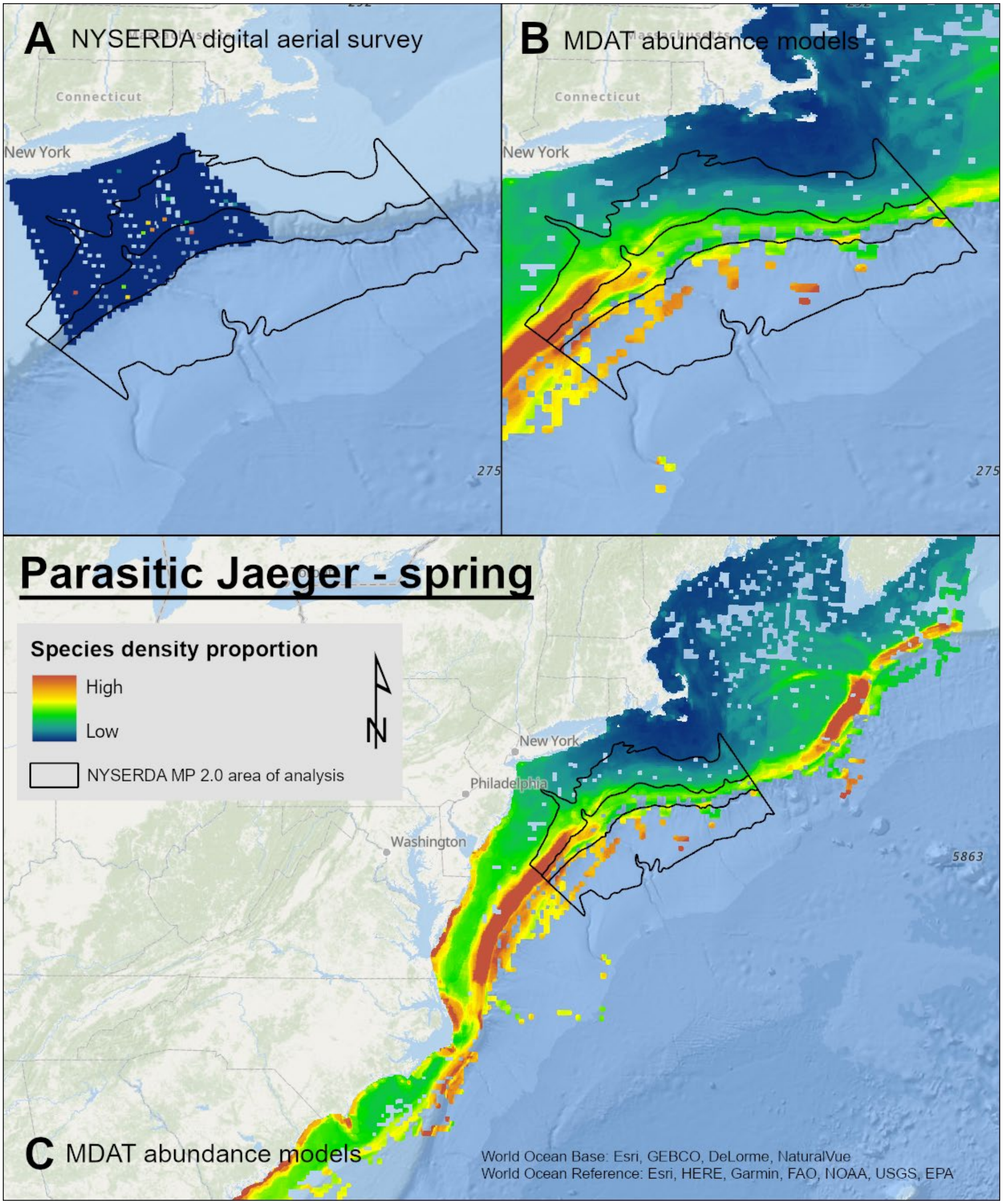
Map B-41. Fall Pomarine Jaeger Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



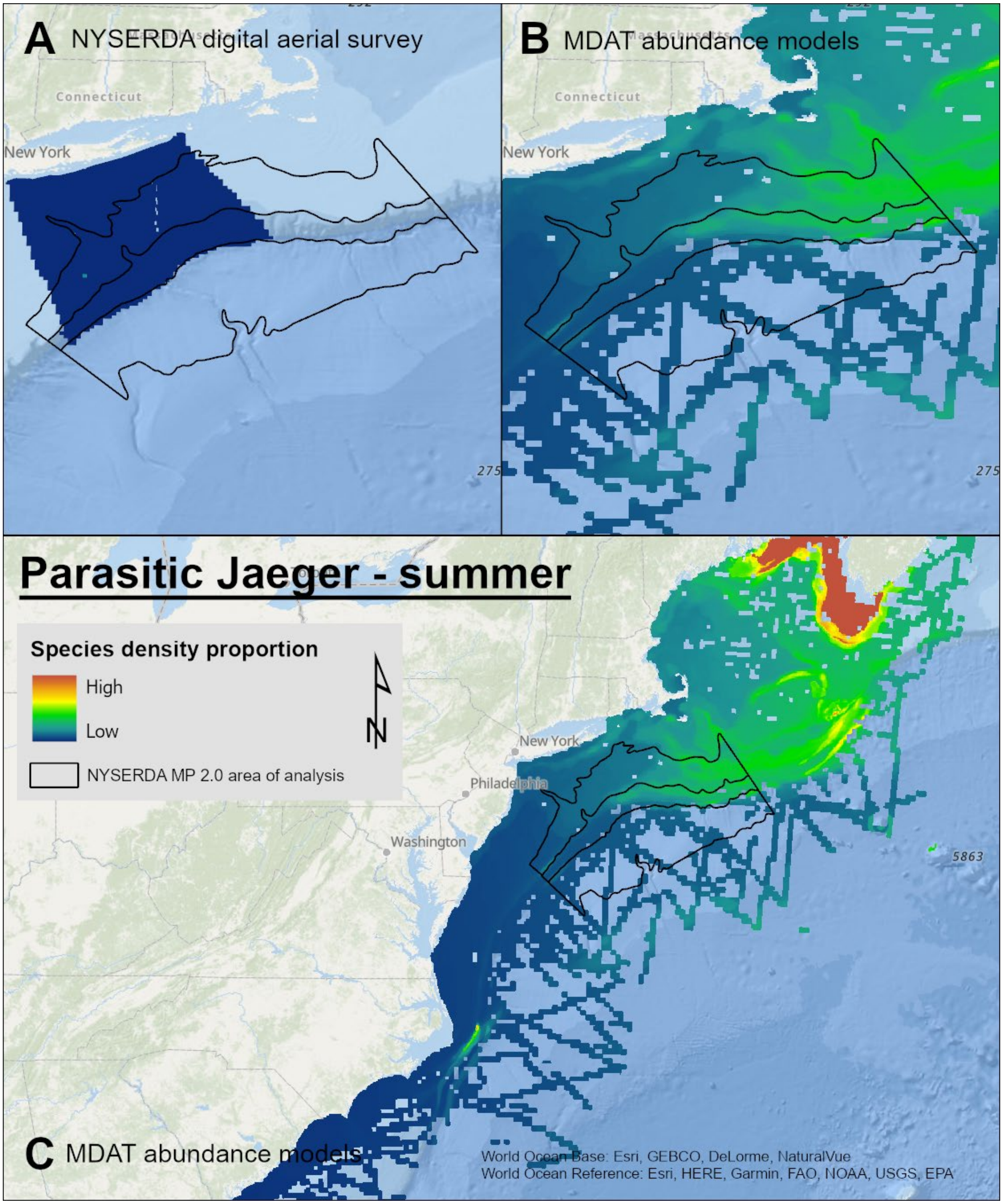
Map B-42. Spring Parasitic Jaeger Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



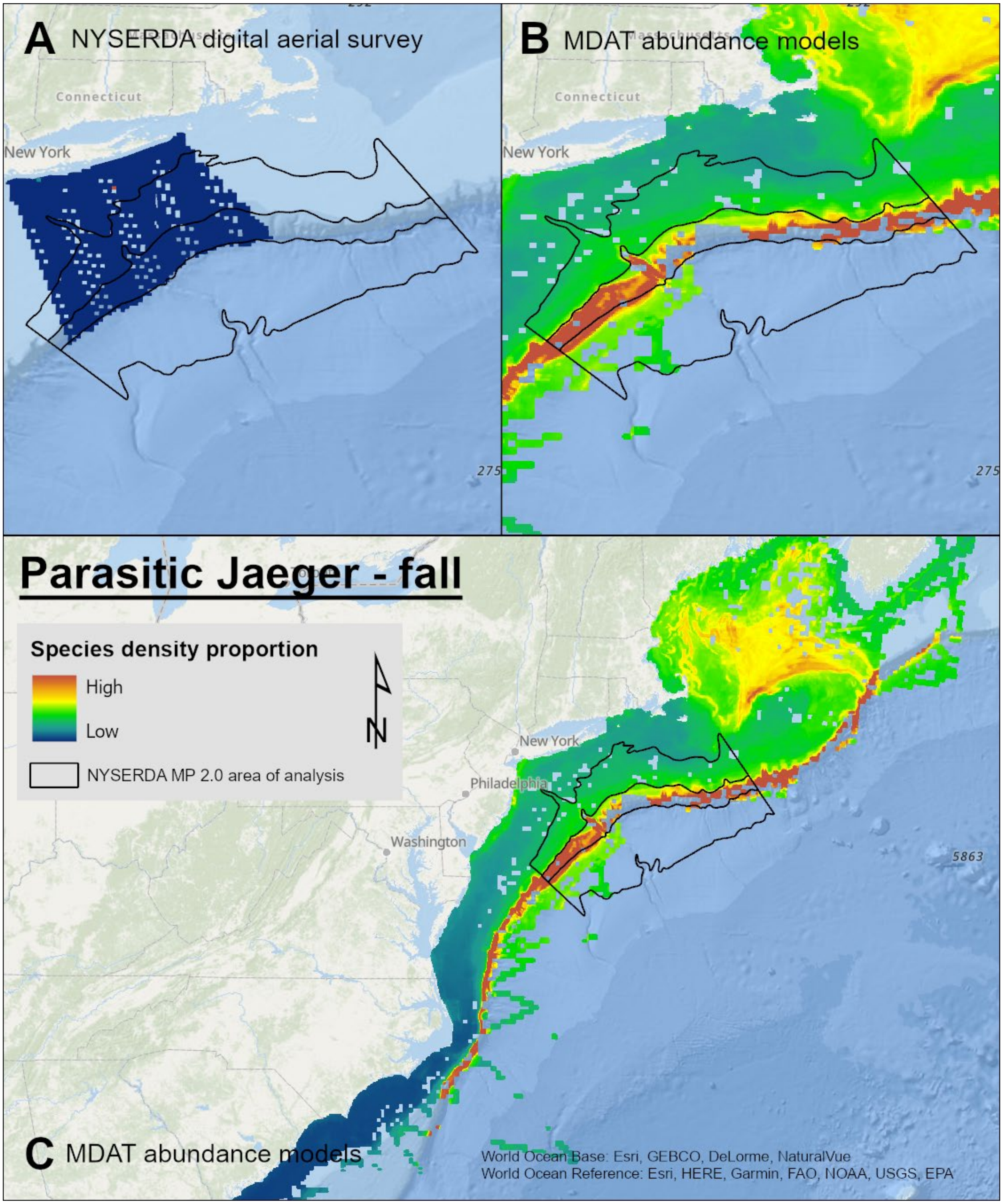
Map B-43. Summer Parasitic Jaeger Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



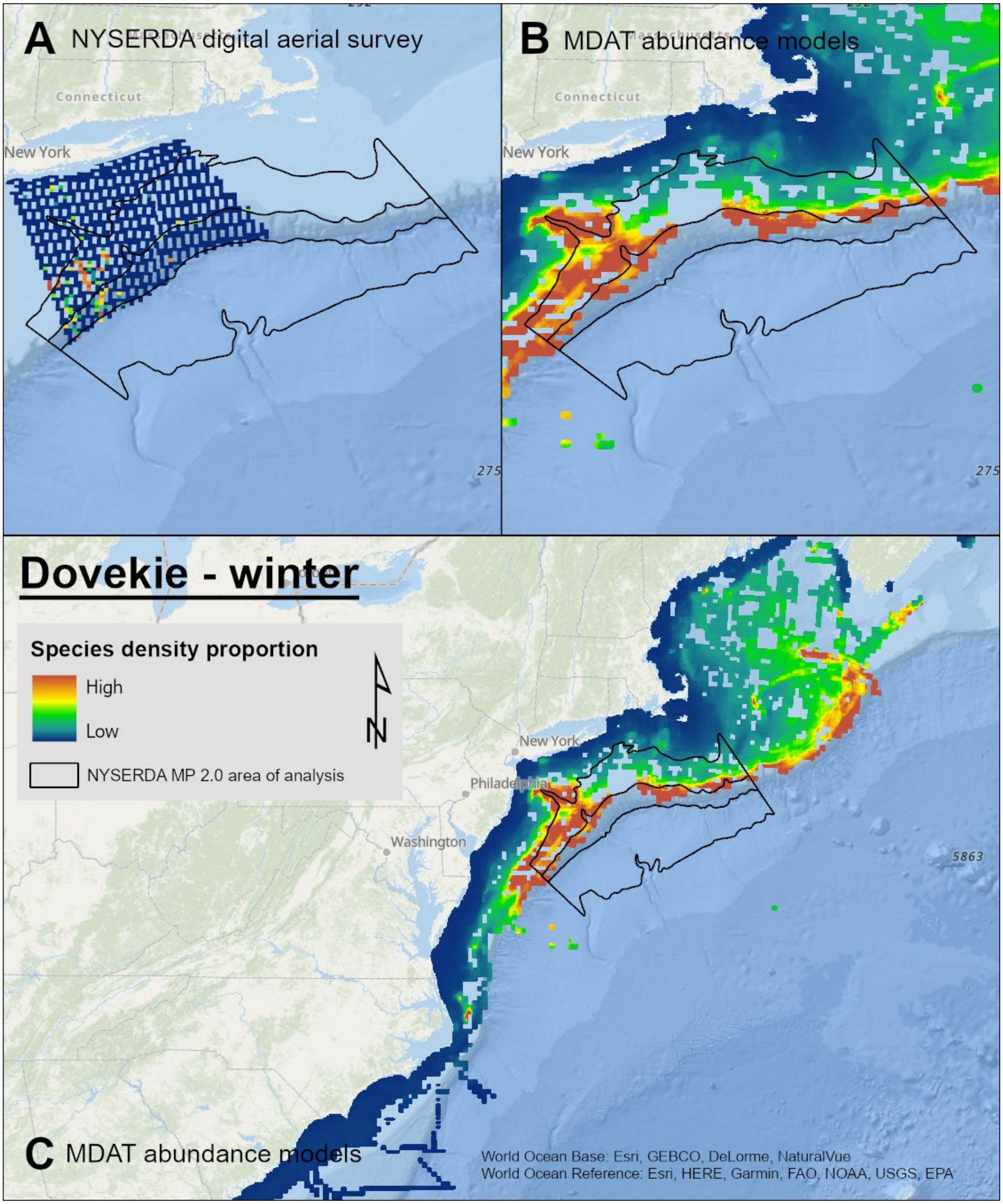
Map B-44. Fall Parasitic Jaeger Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



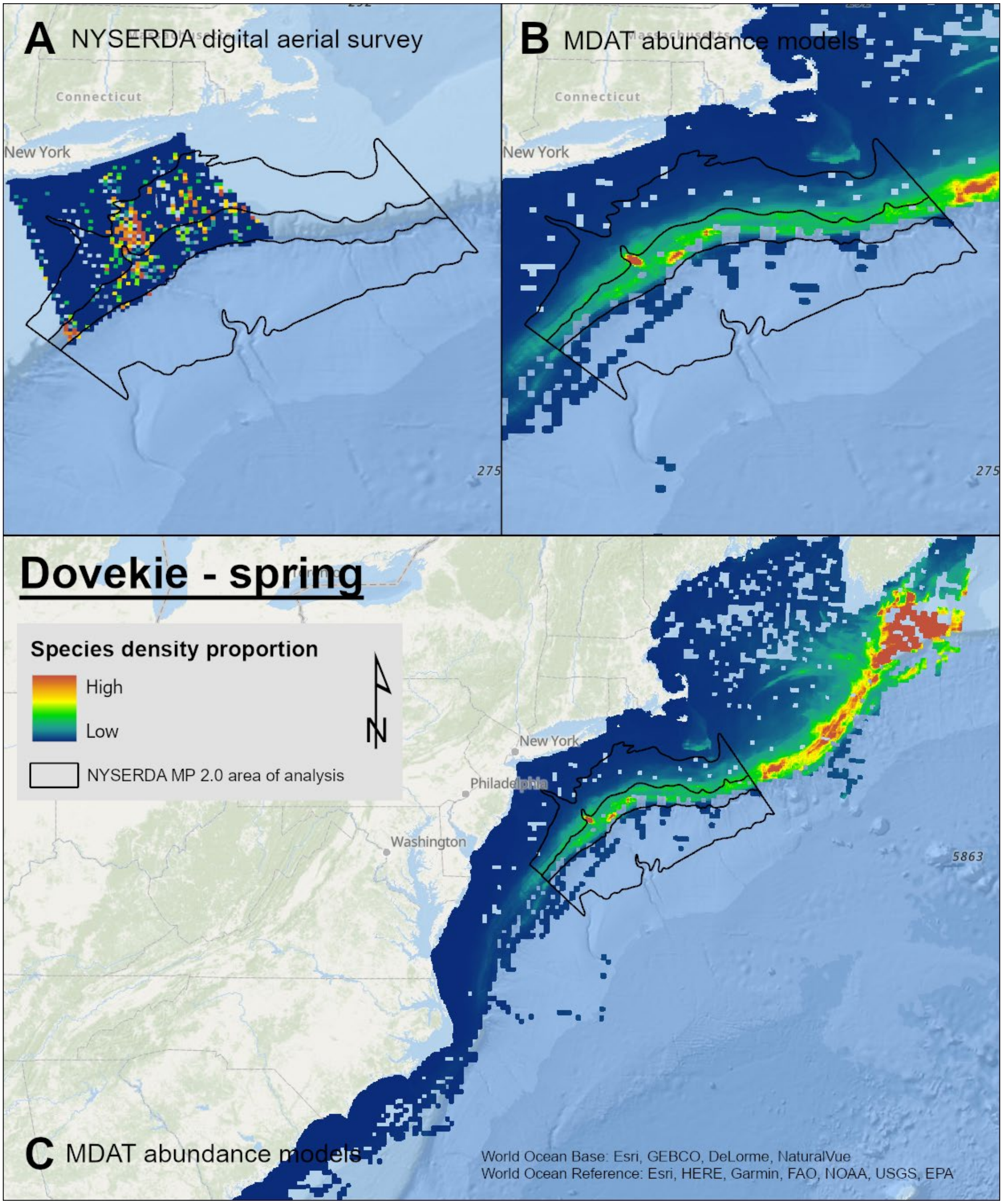
Map B-45. Winter Dovekie Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



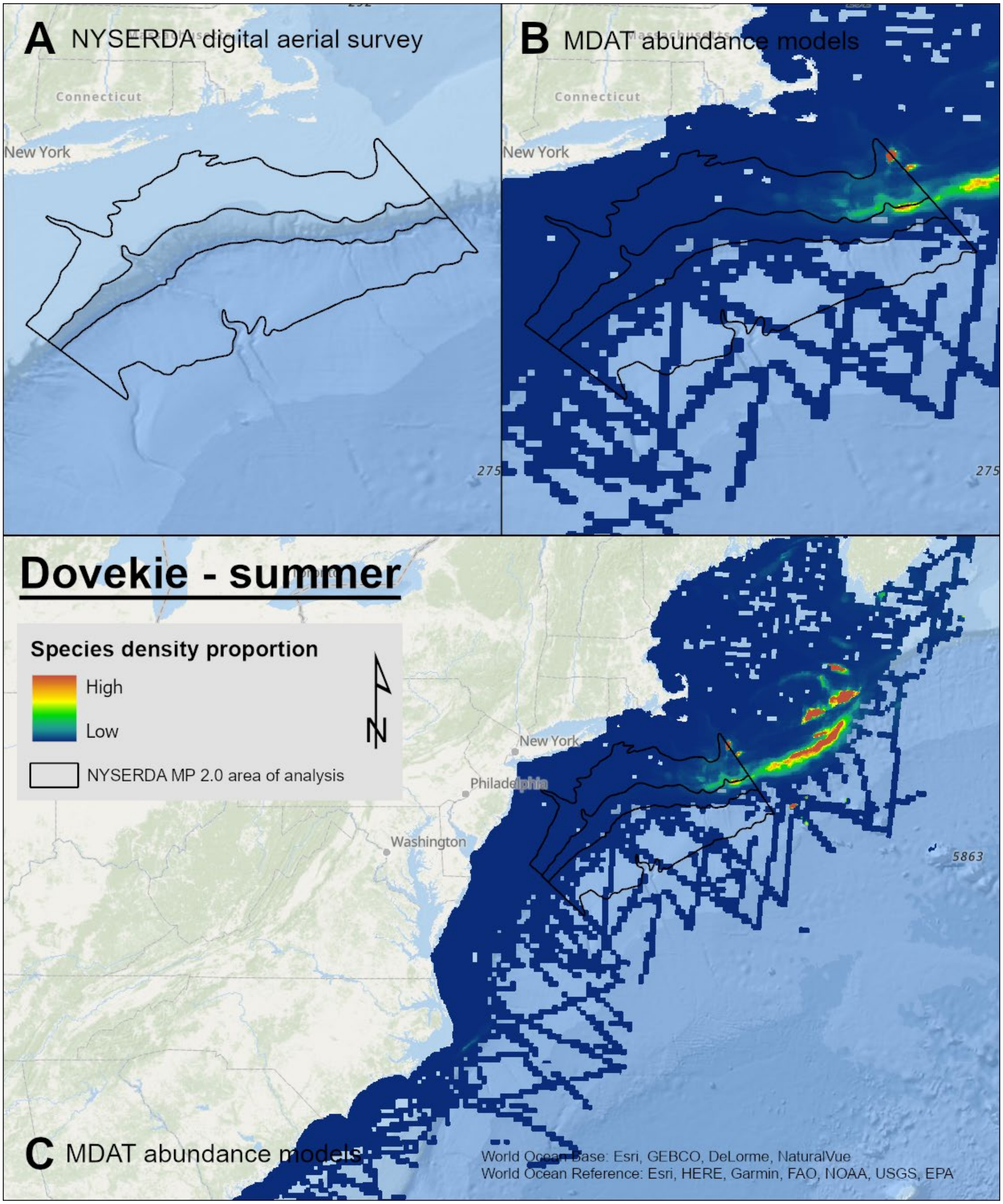
Map B-46. Spring Dovekie Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



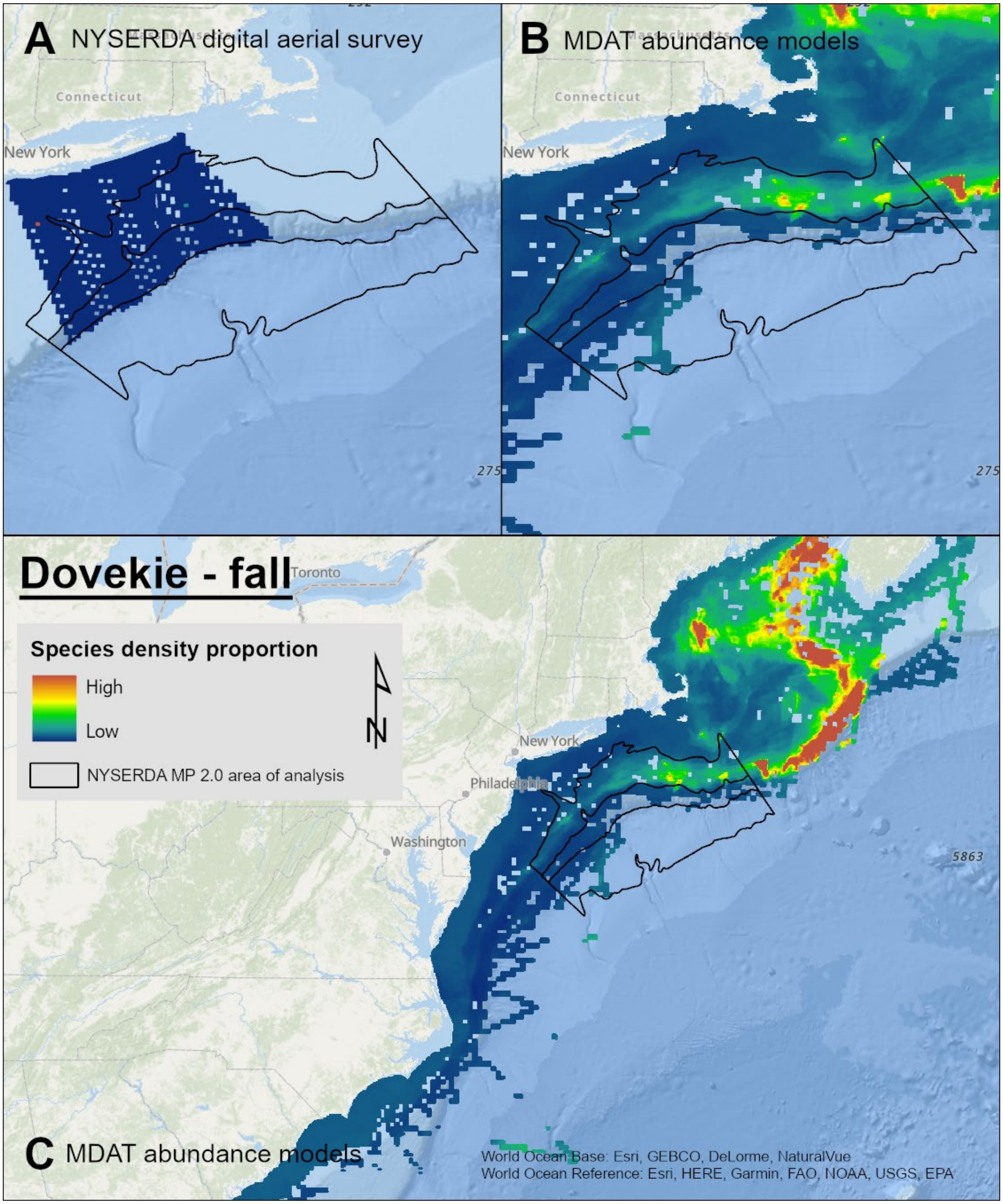
Map B-47. Summer Dovekie Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



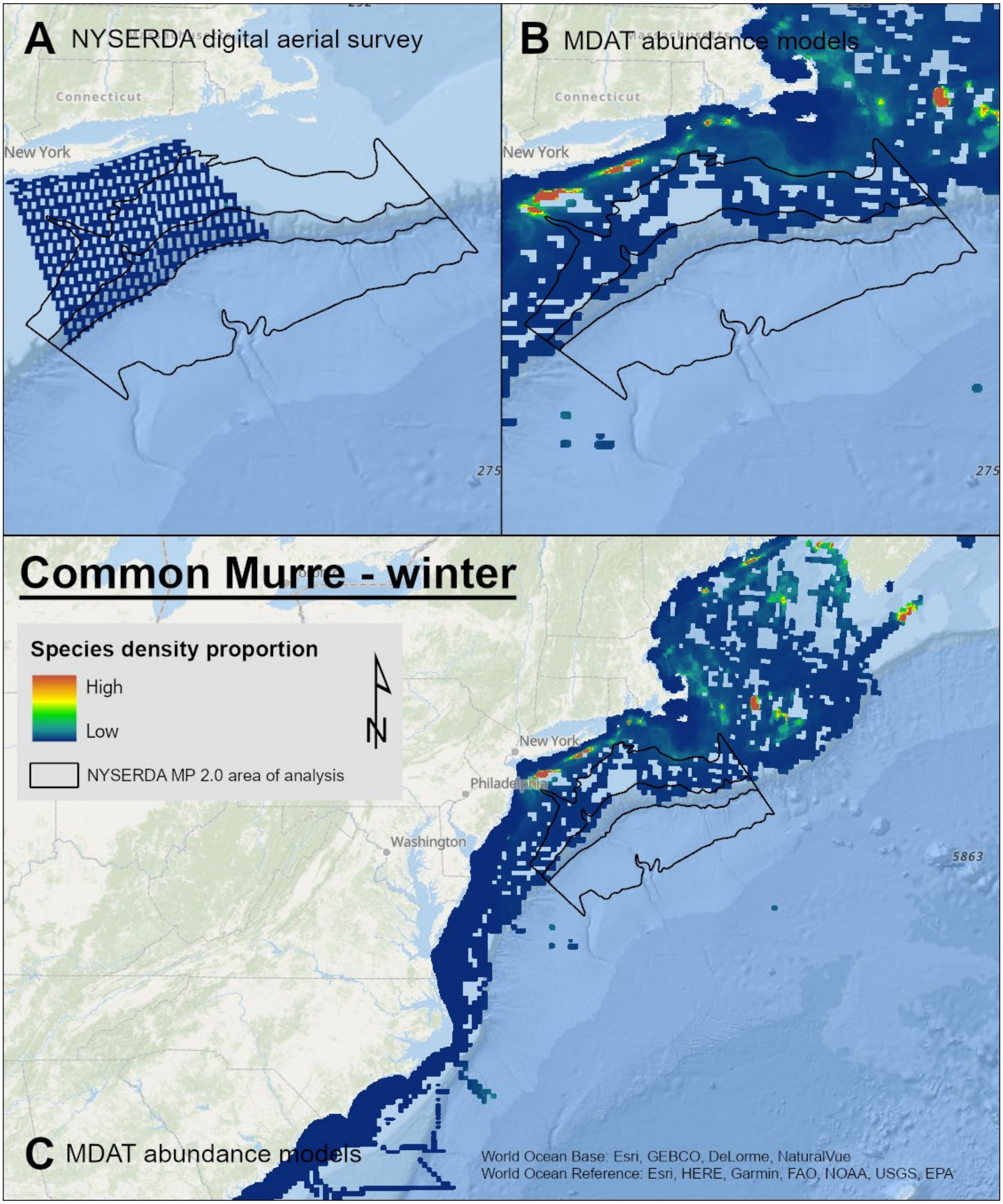
Map B-48. Fall Dovekie Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



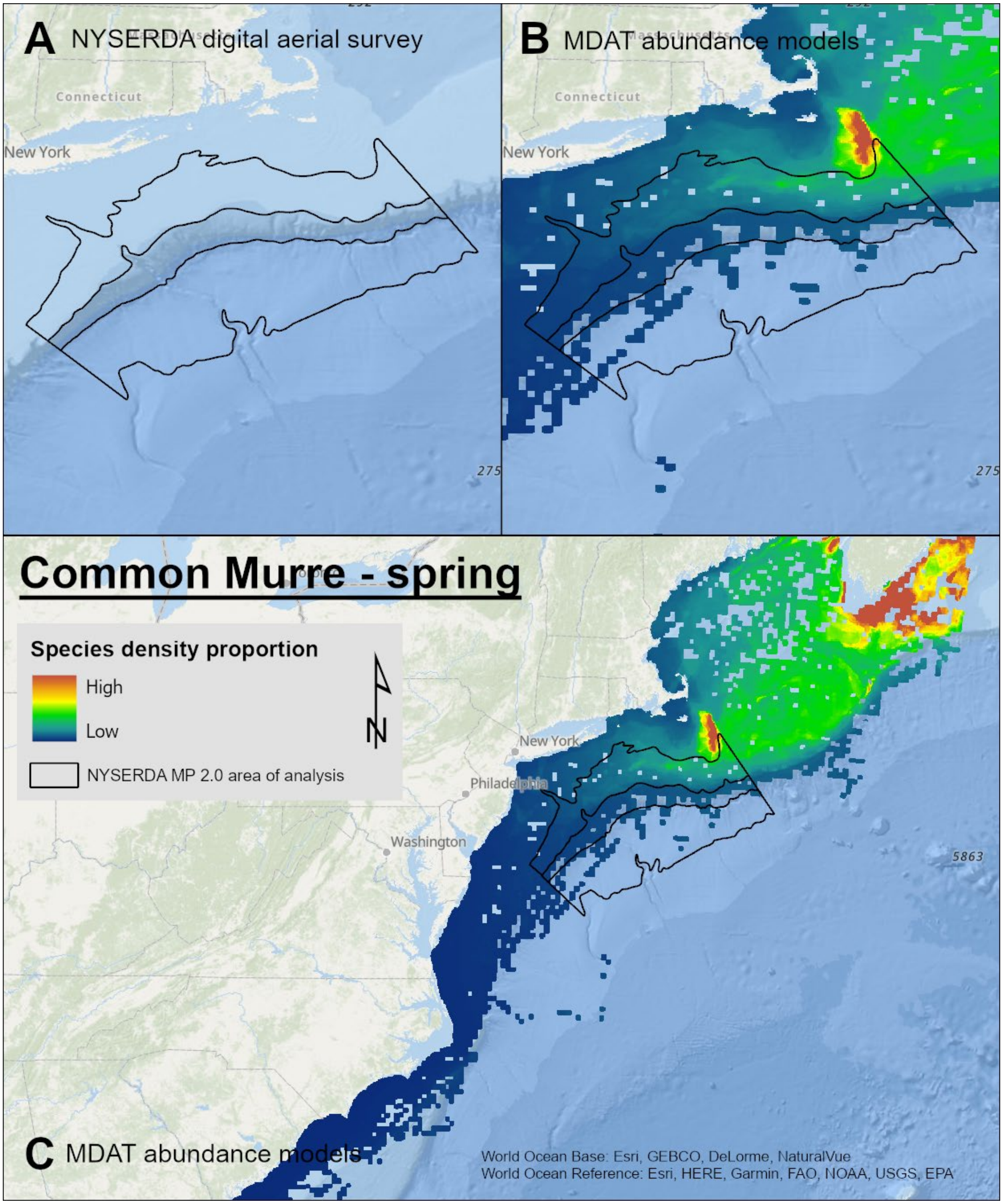
Map B-49. Winter Common Murre Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



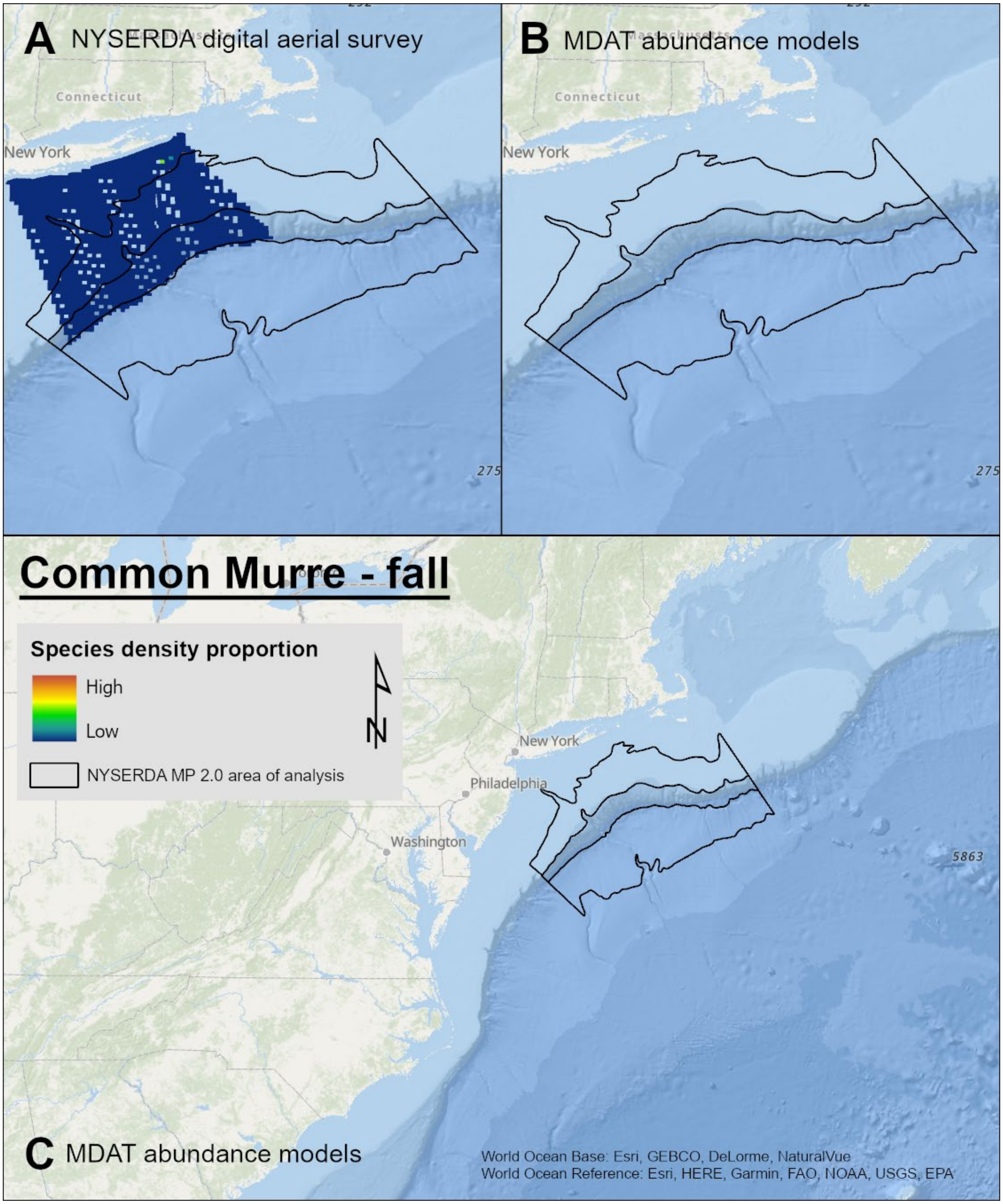
Map B-50. Spring Common Murre Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



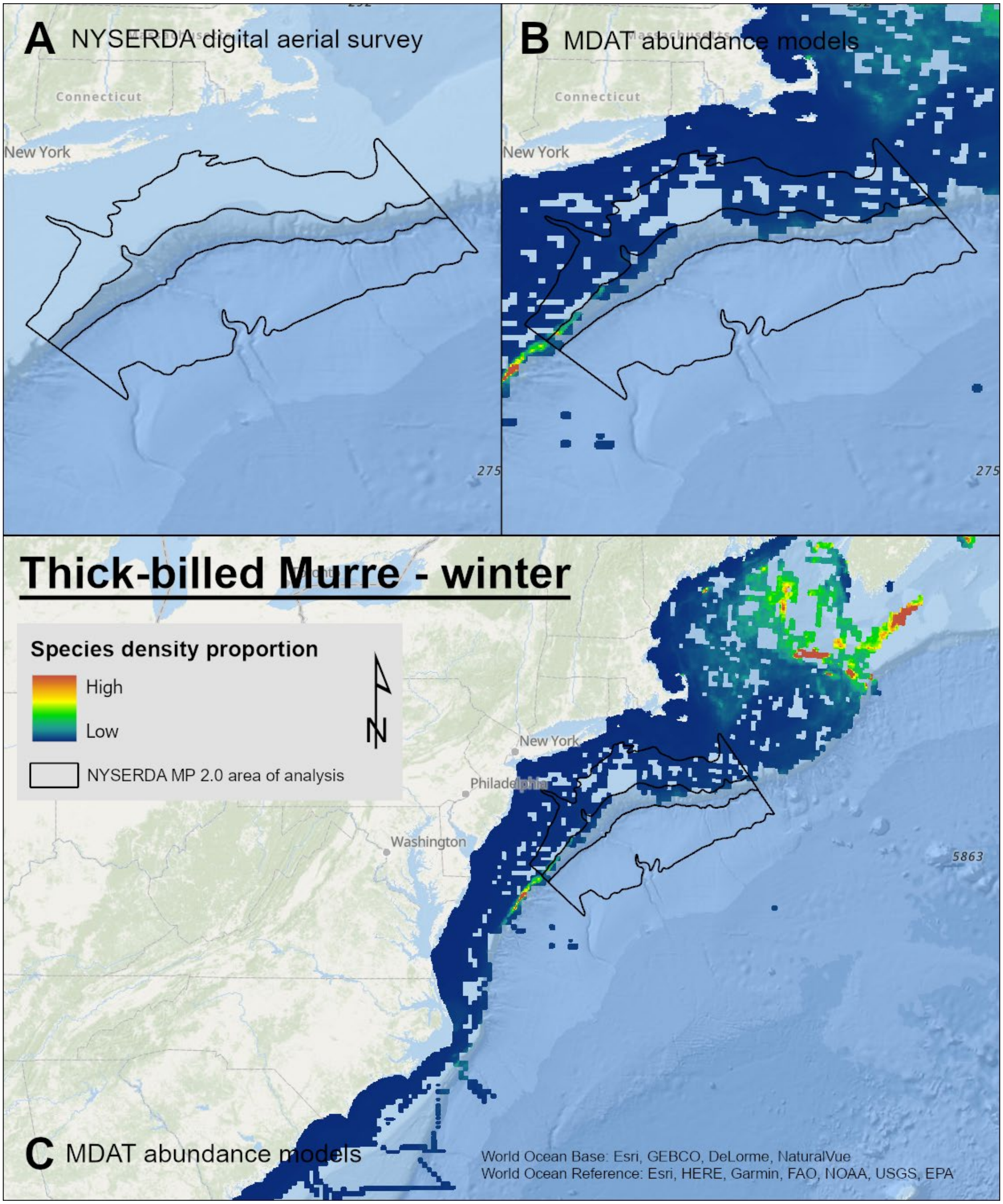
Map B-51. Fall Common Murre Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-52. Winter Thick-Billed Murre Density Proportions

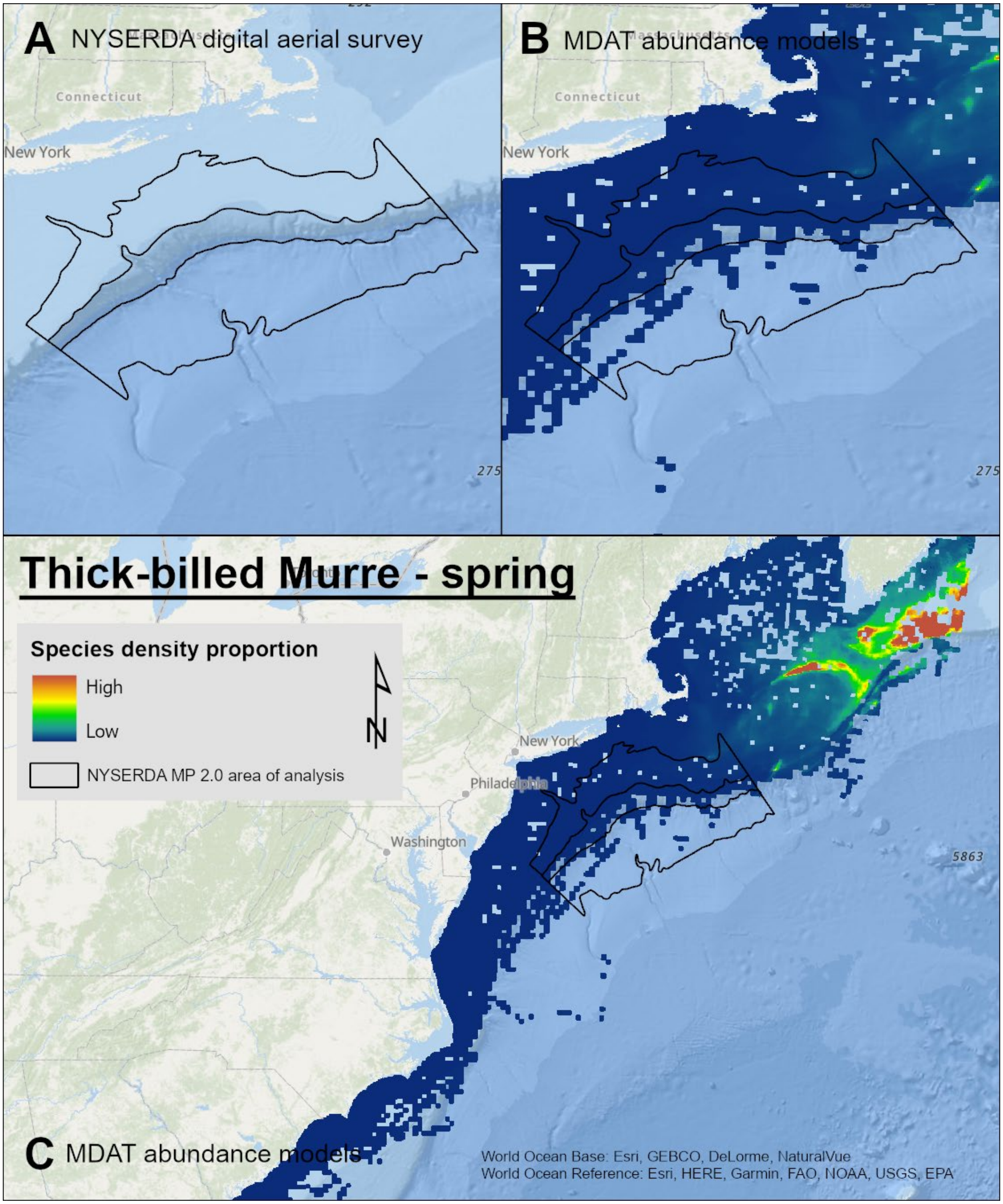
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

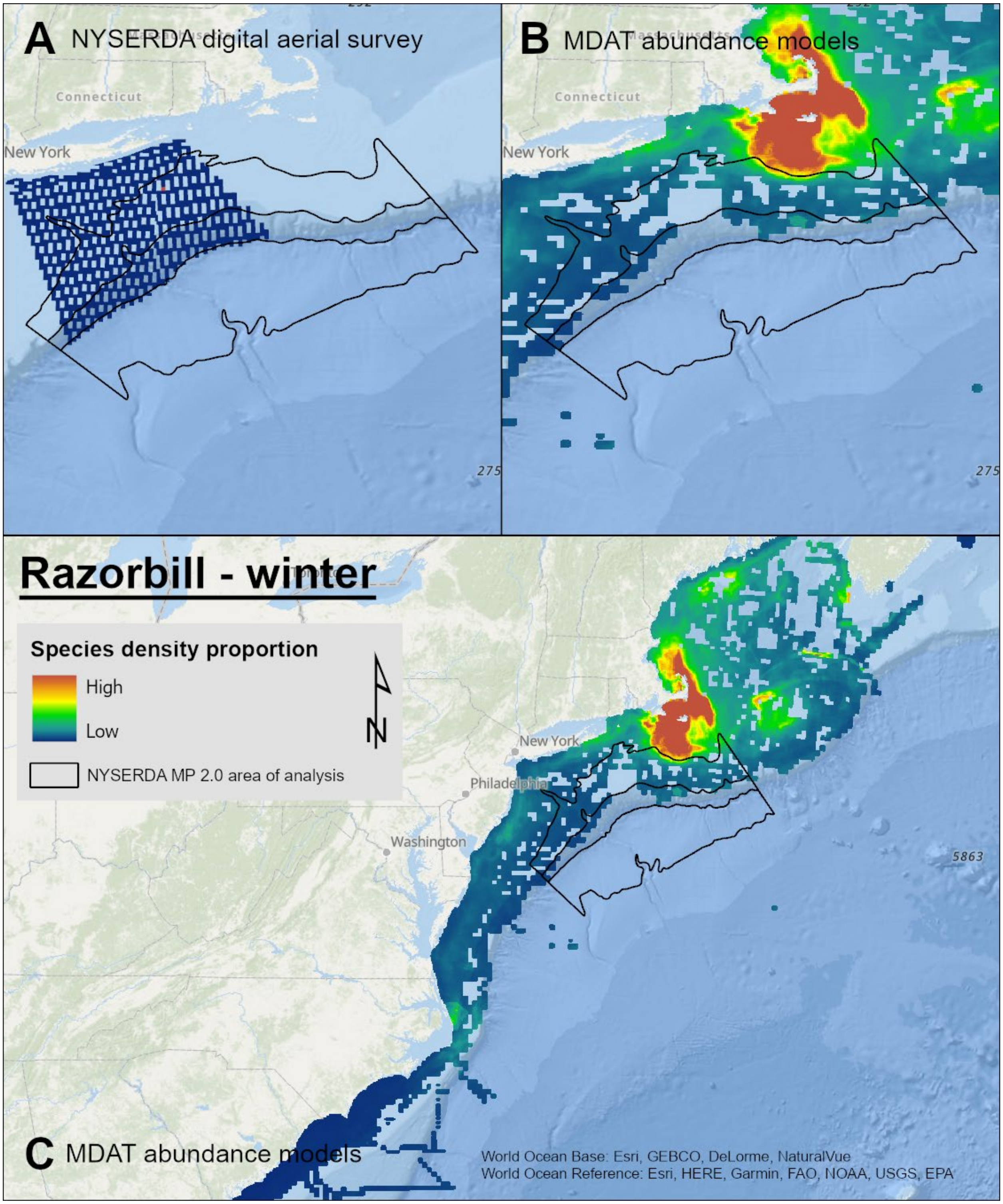
Map B-53. Spring Thick-Billed Murre Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



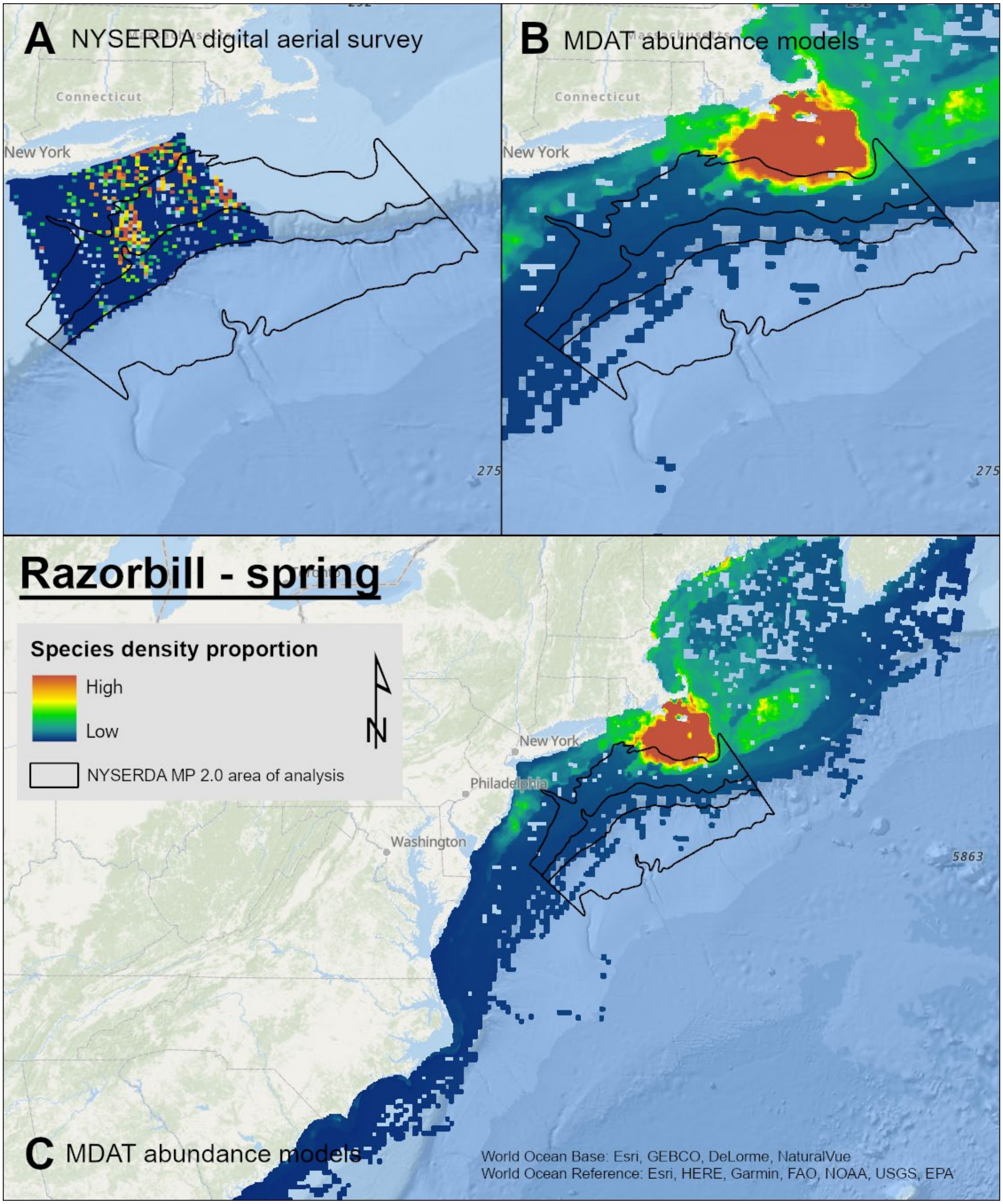
Map B-54. Winter Razorbill Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



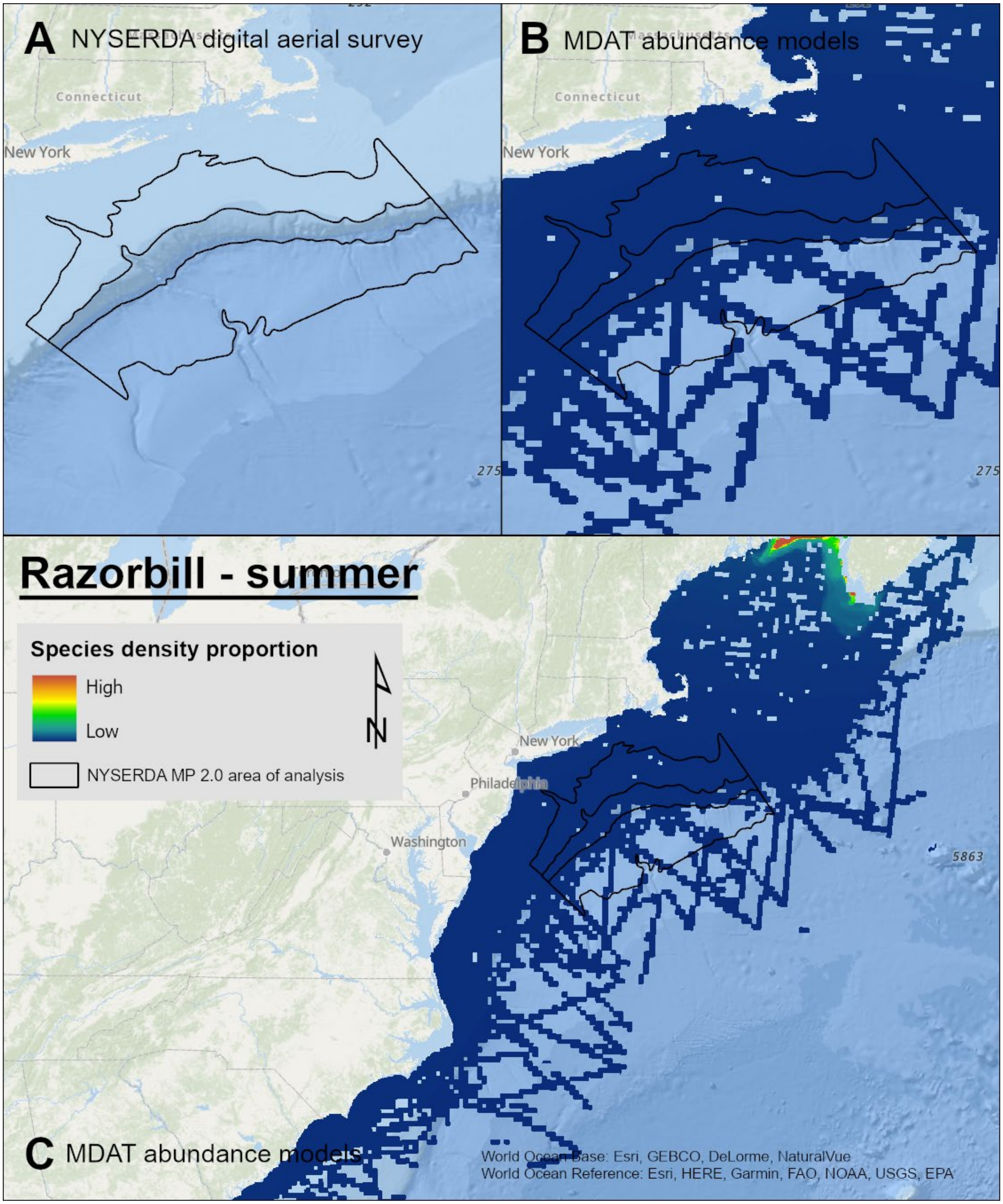
Map B-55. Spring Razorbill Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



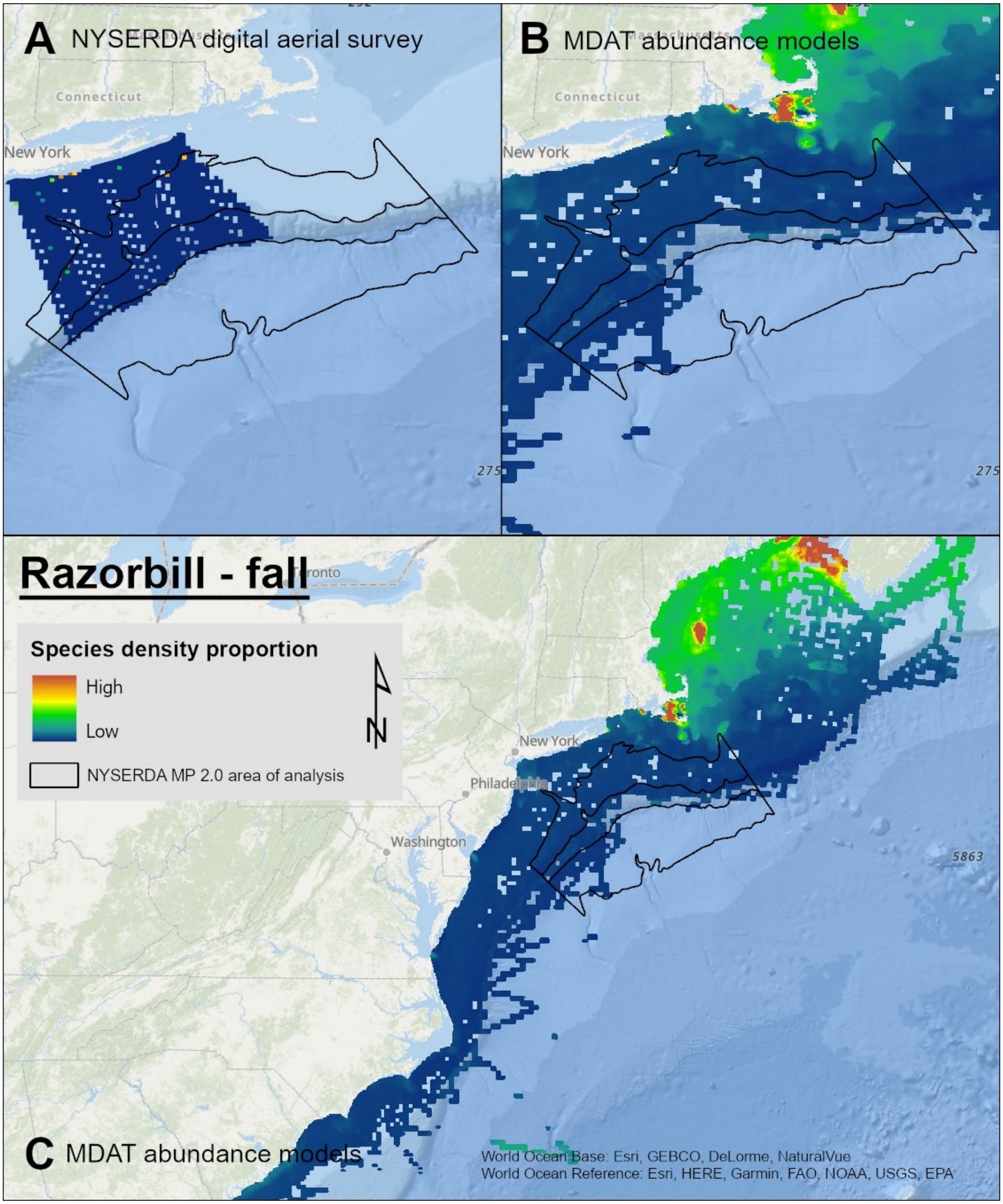
Map B-56. Summer Razorbill Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



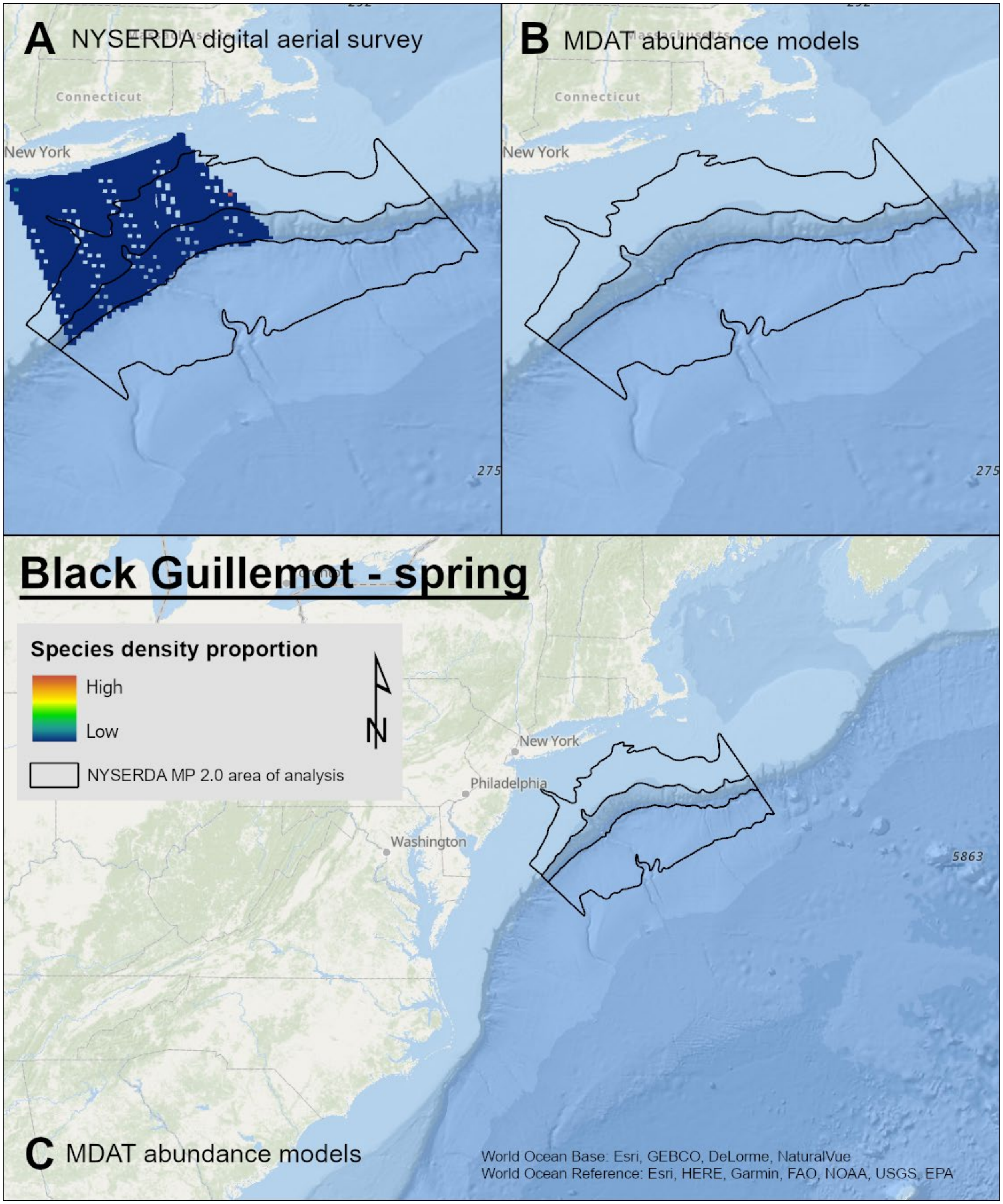
Map B-57. Fall Razorbill Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



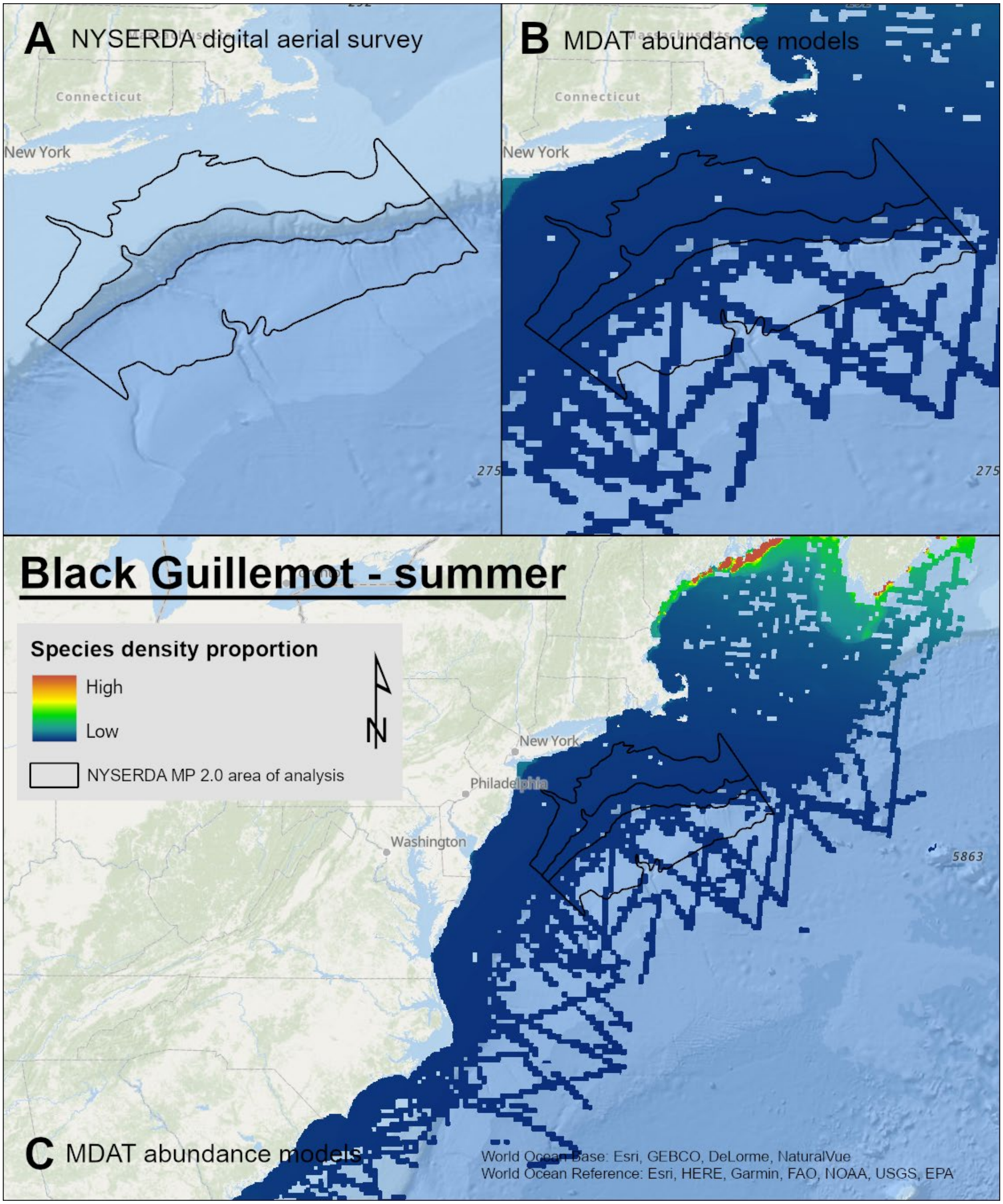
Map B-58. Spring Black Guillemot Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



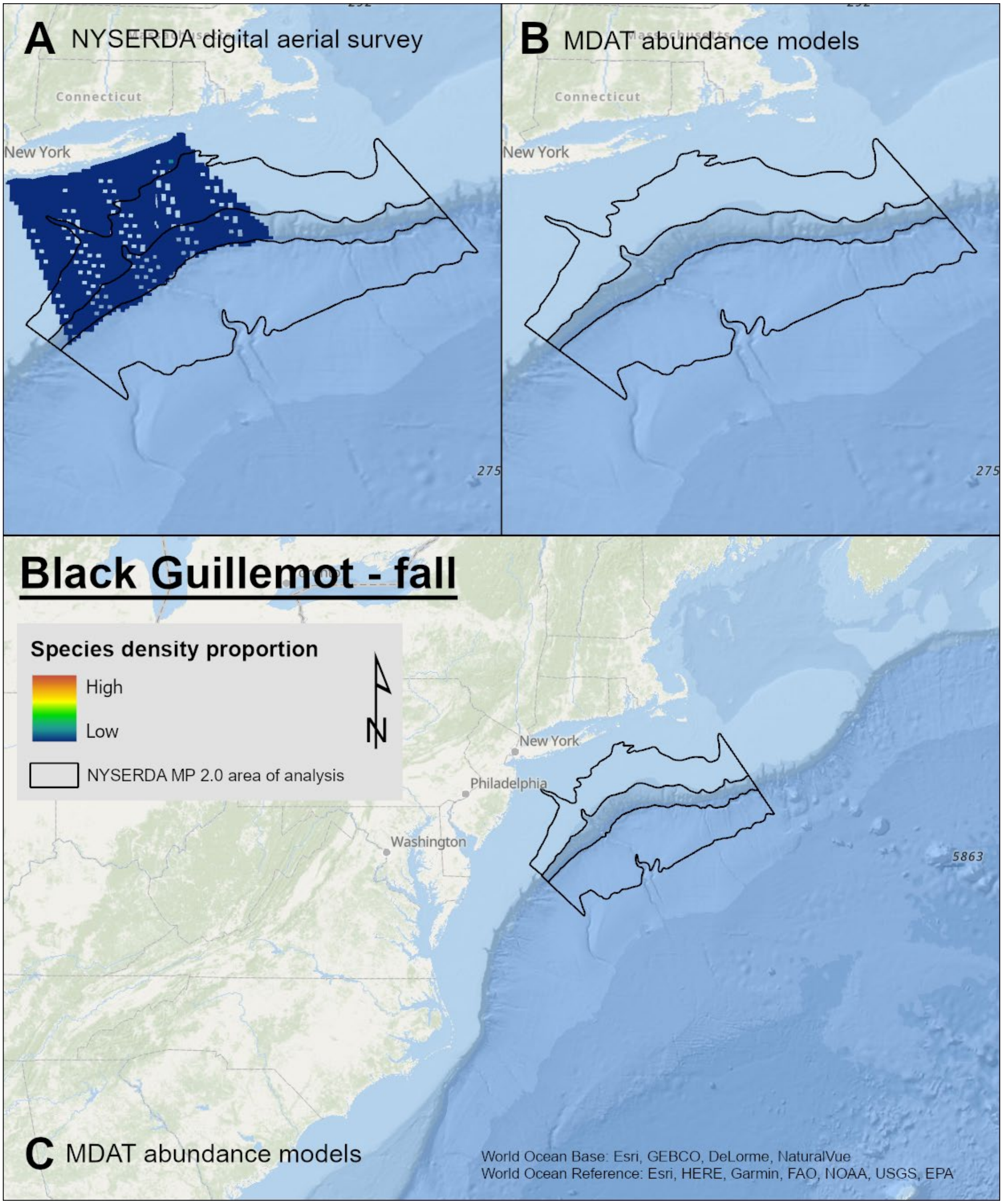
Map B-59. Summer Black Guillemot Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



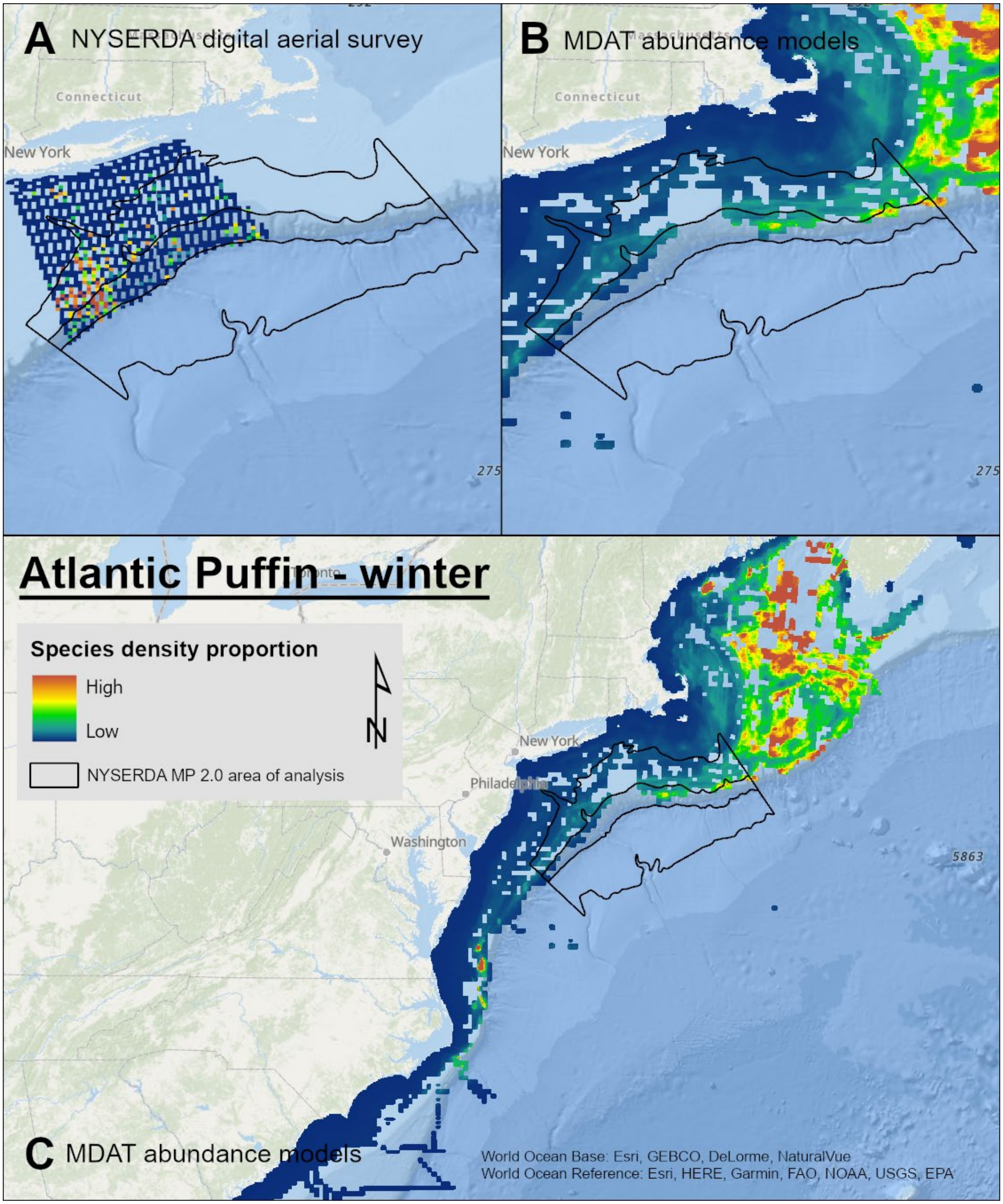
Map B-60. Fall Black Guillemot Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



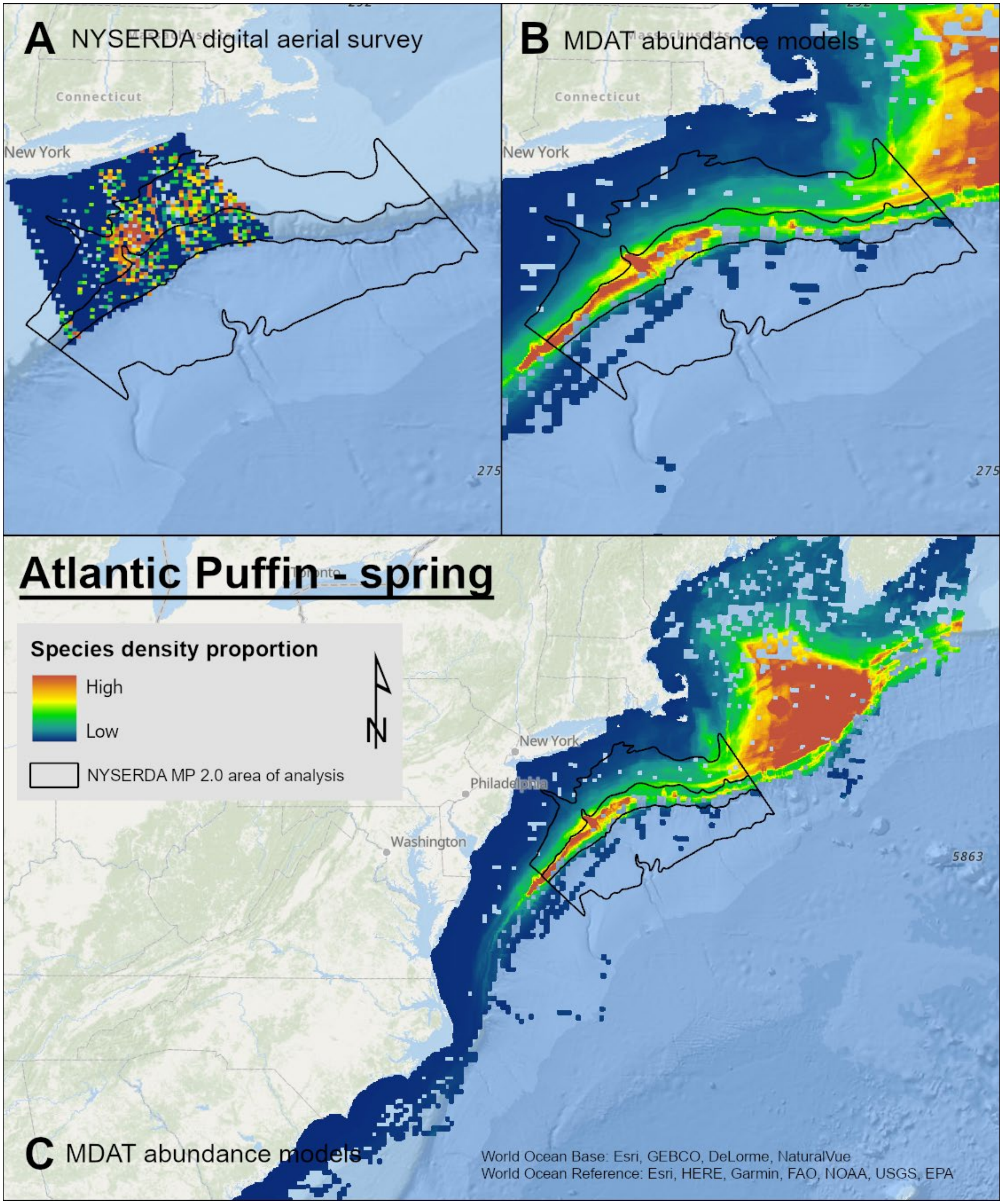
Map B-61. Winter Atlantic Puffin Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



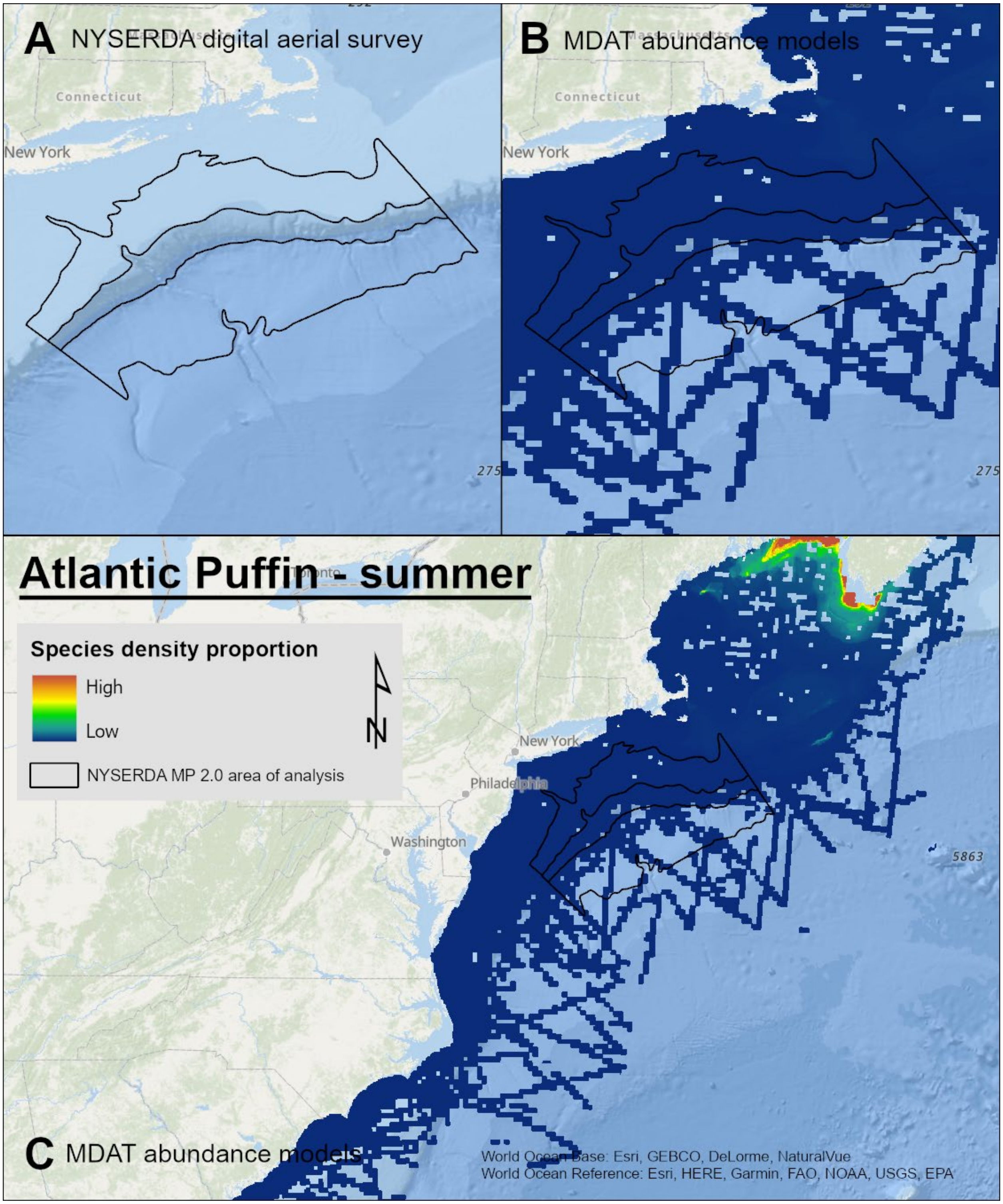
Map B-62. Spring Atlantic Puffin Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



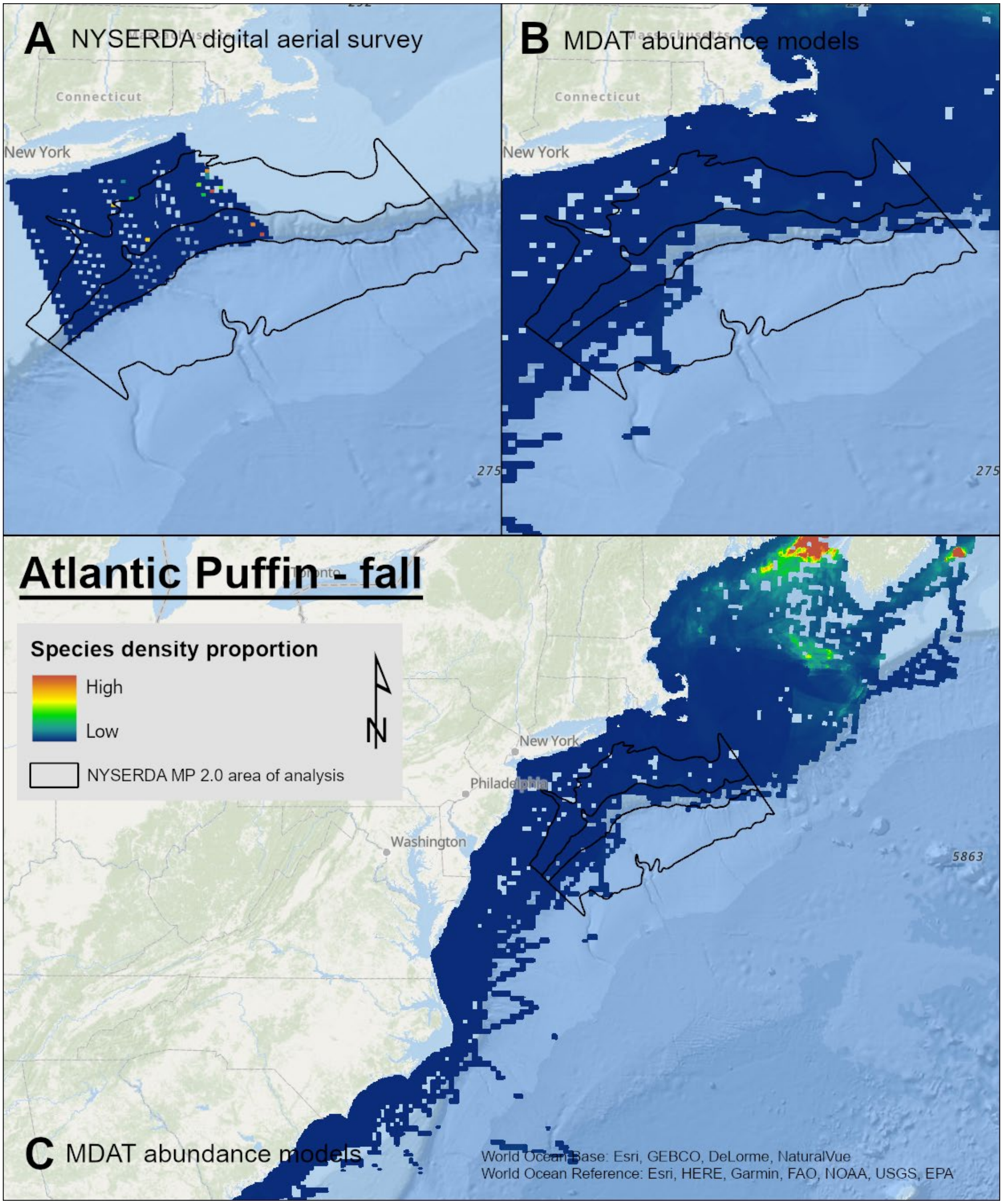
Map B-63. Summer Atlantic Puffin Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



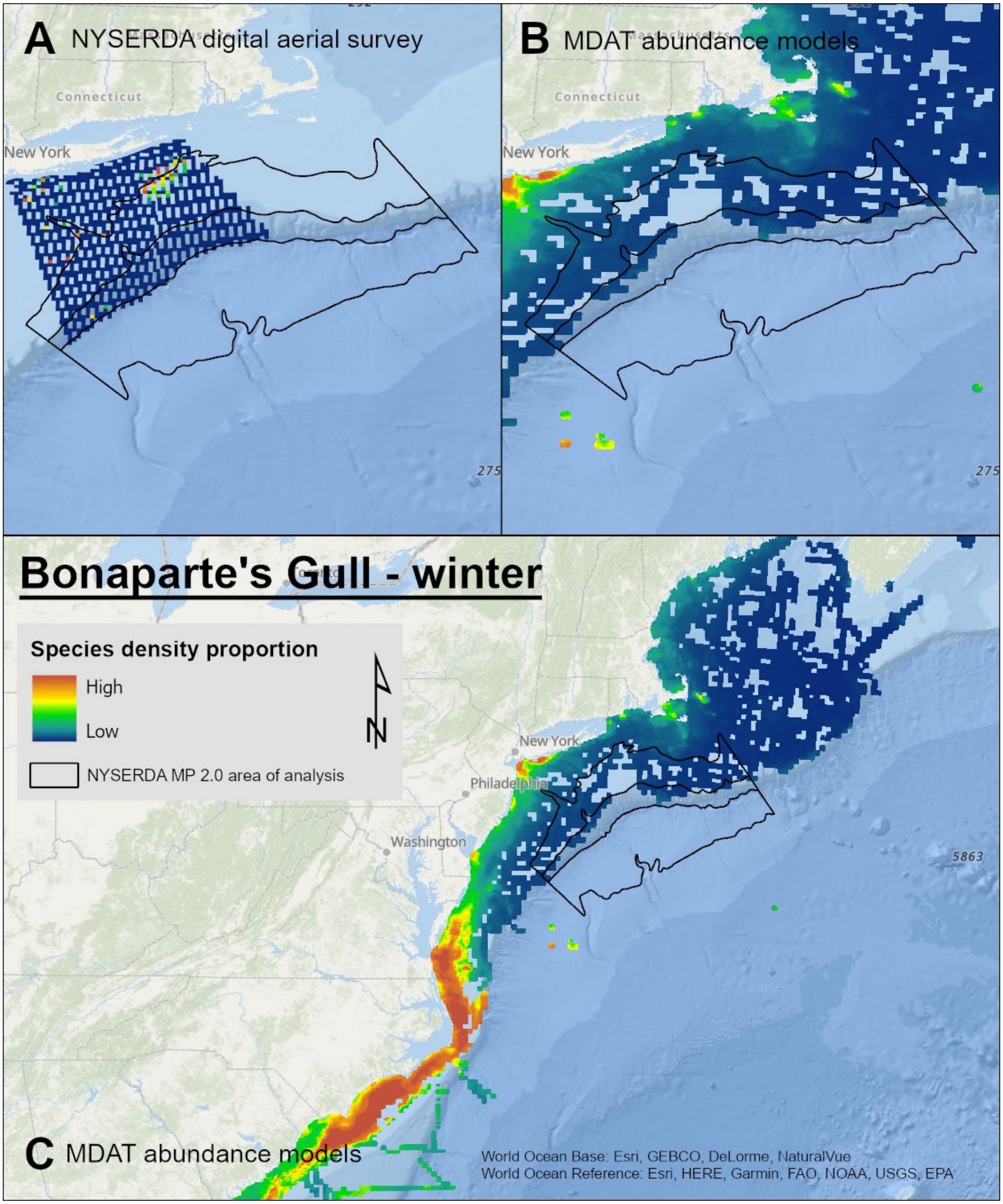
Map B-64. Fall Atlantic Puffin Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



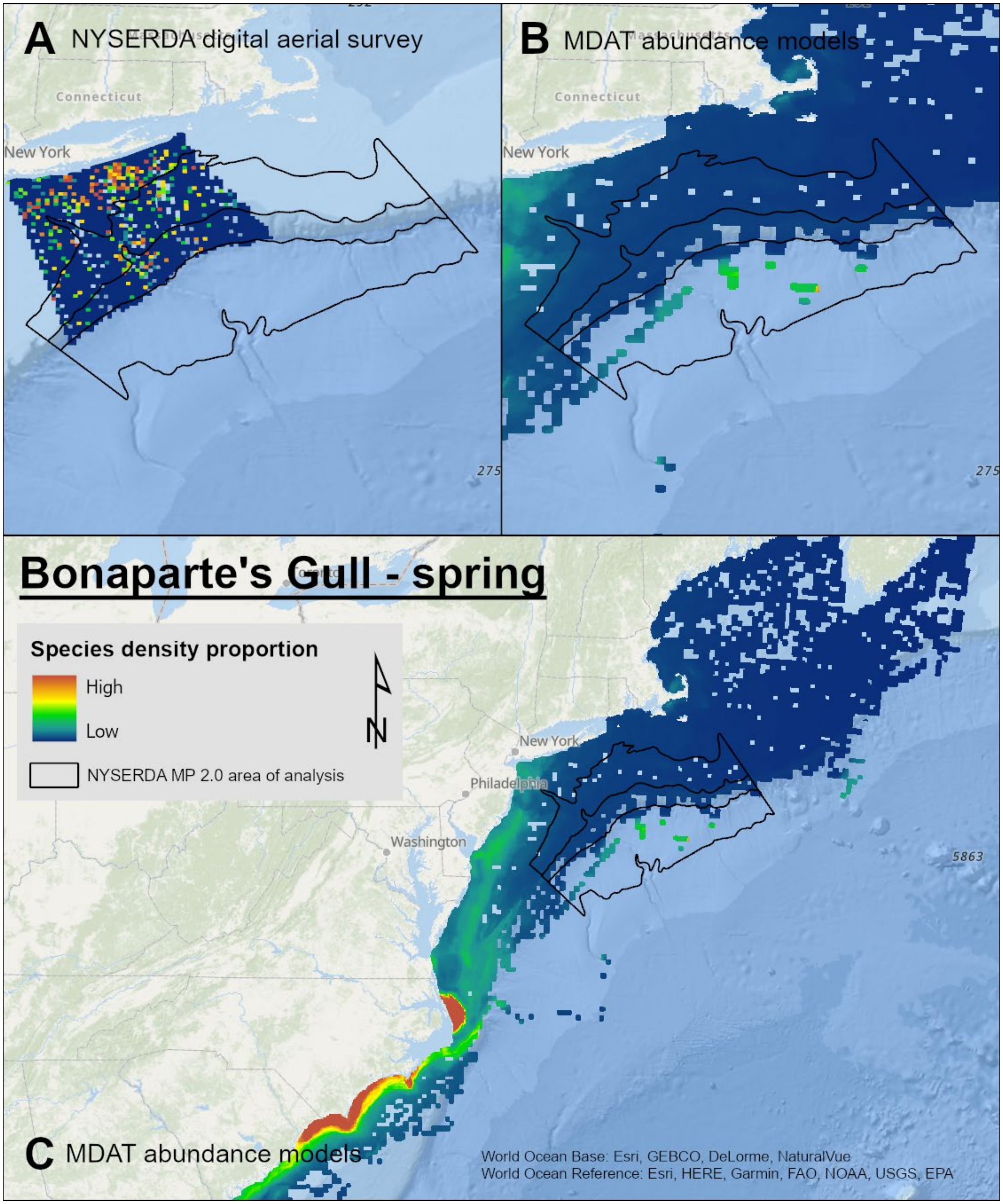
Map B-65. Winter Bonaparte's Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



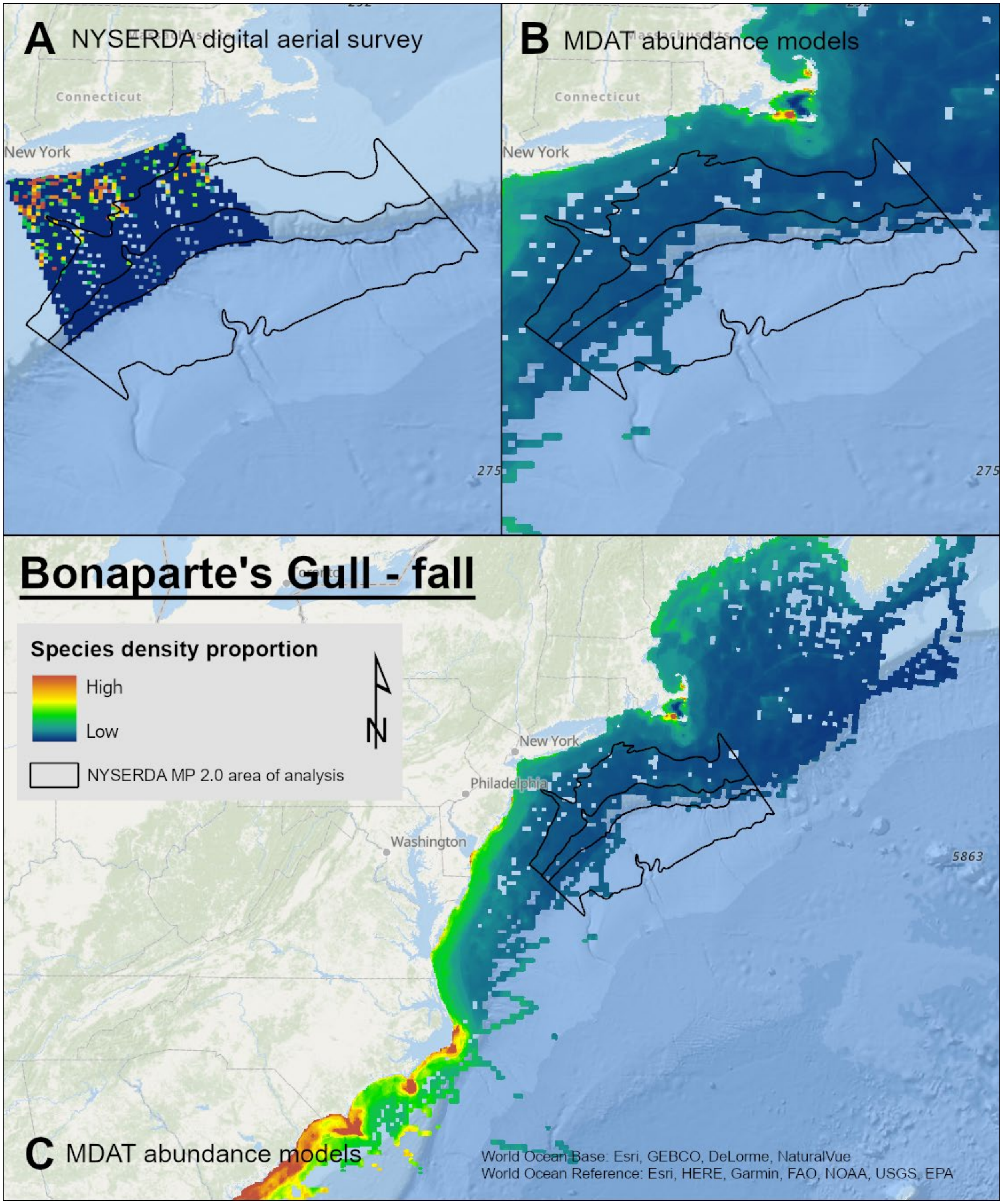
Map B-66. Spring Bonaparte's Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



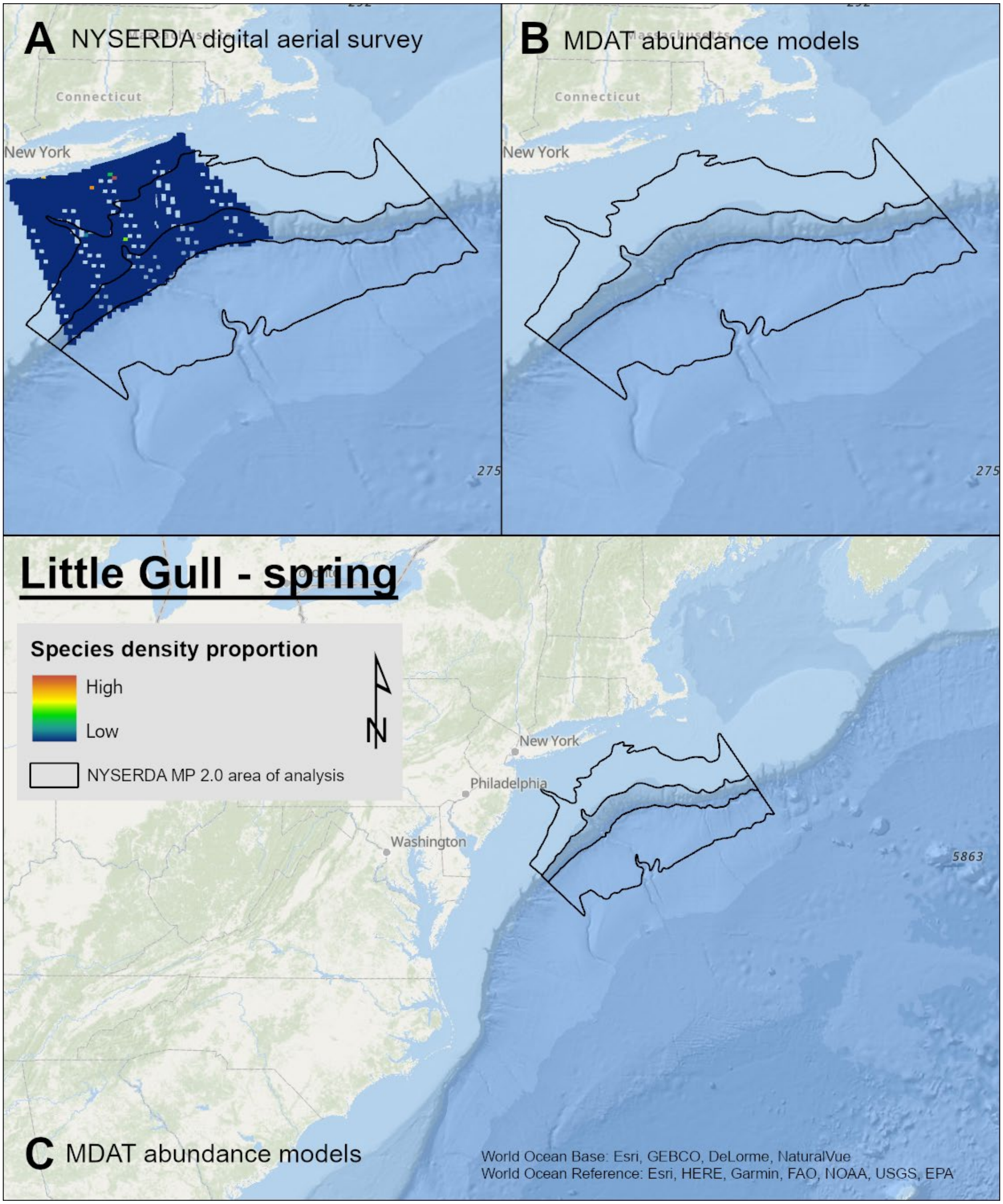
Map B-67. Fall Bonaparte's Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



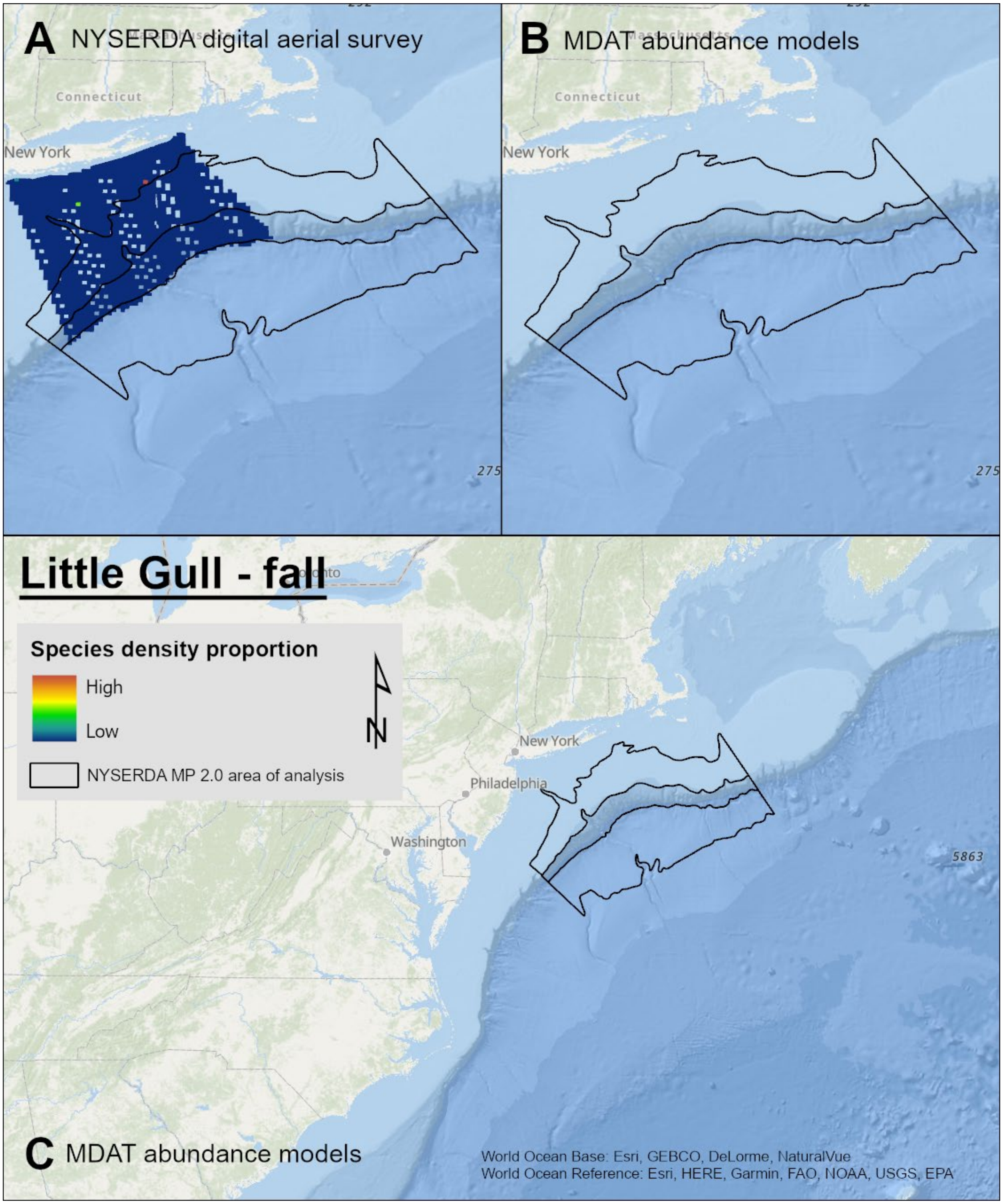
Map B-68. Spring Little Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



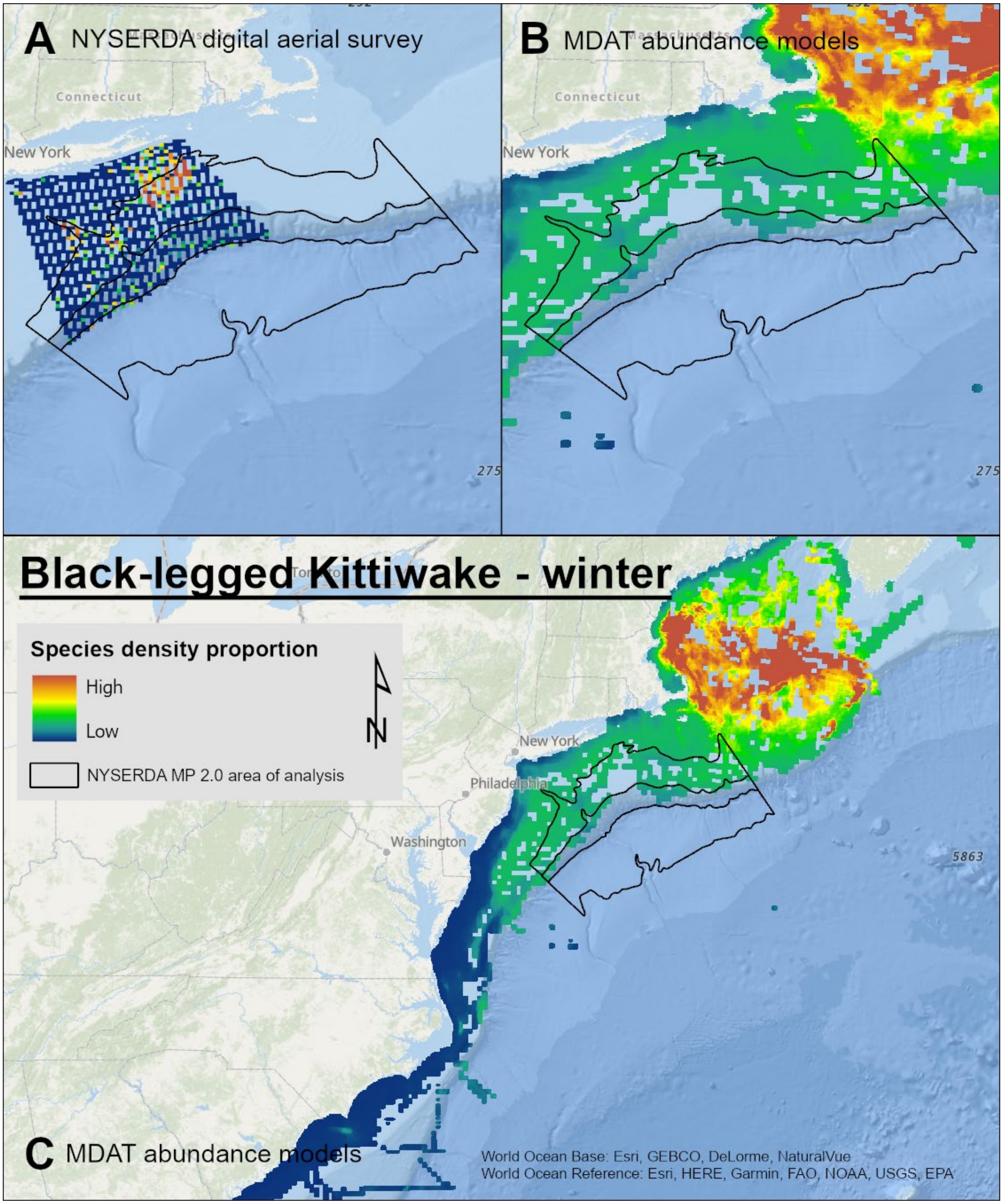
Map B-69. Fall Little Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



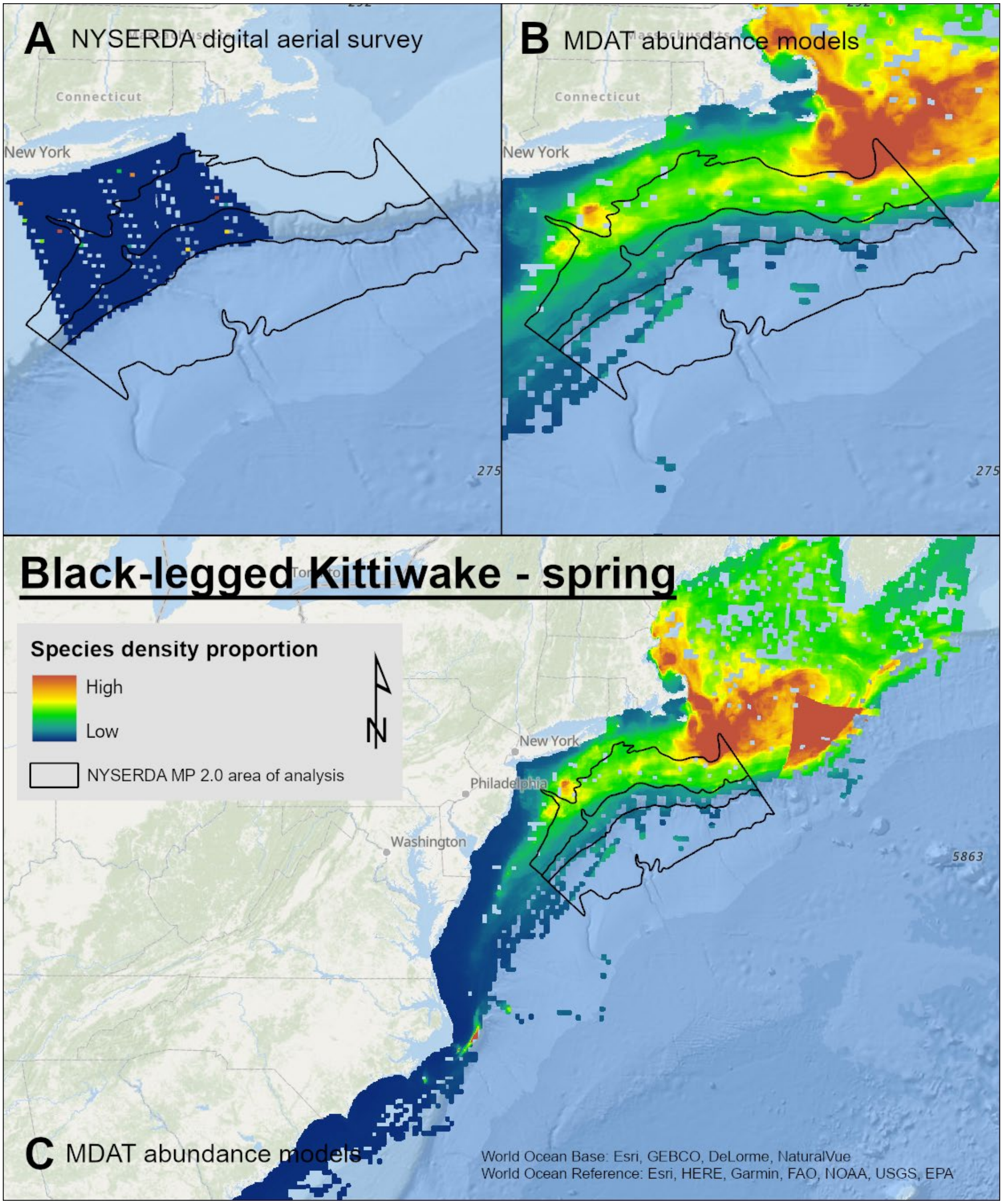
Map B-70. Winter Black-Legged Kittiwake Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



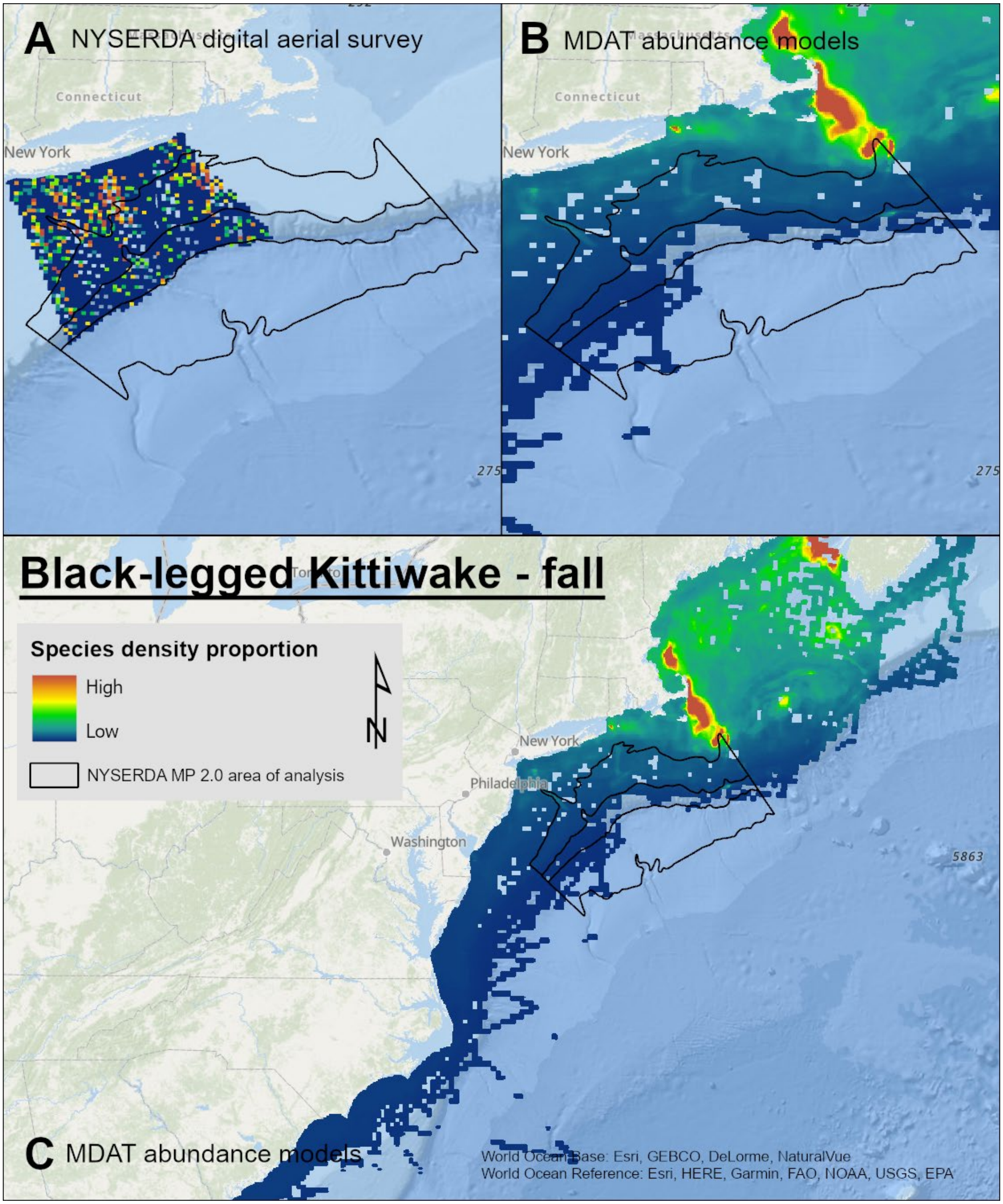
Map B-71. Spring Black-Legged Kittiwake Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



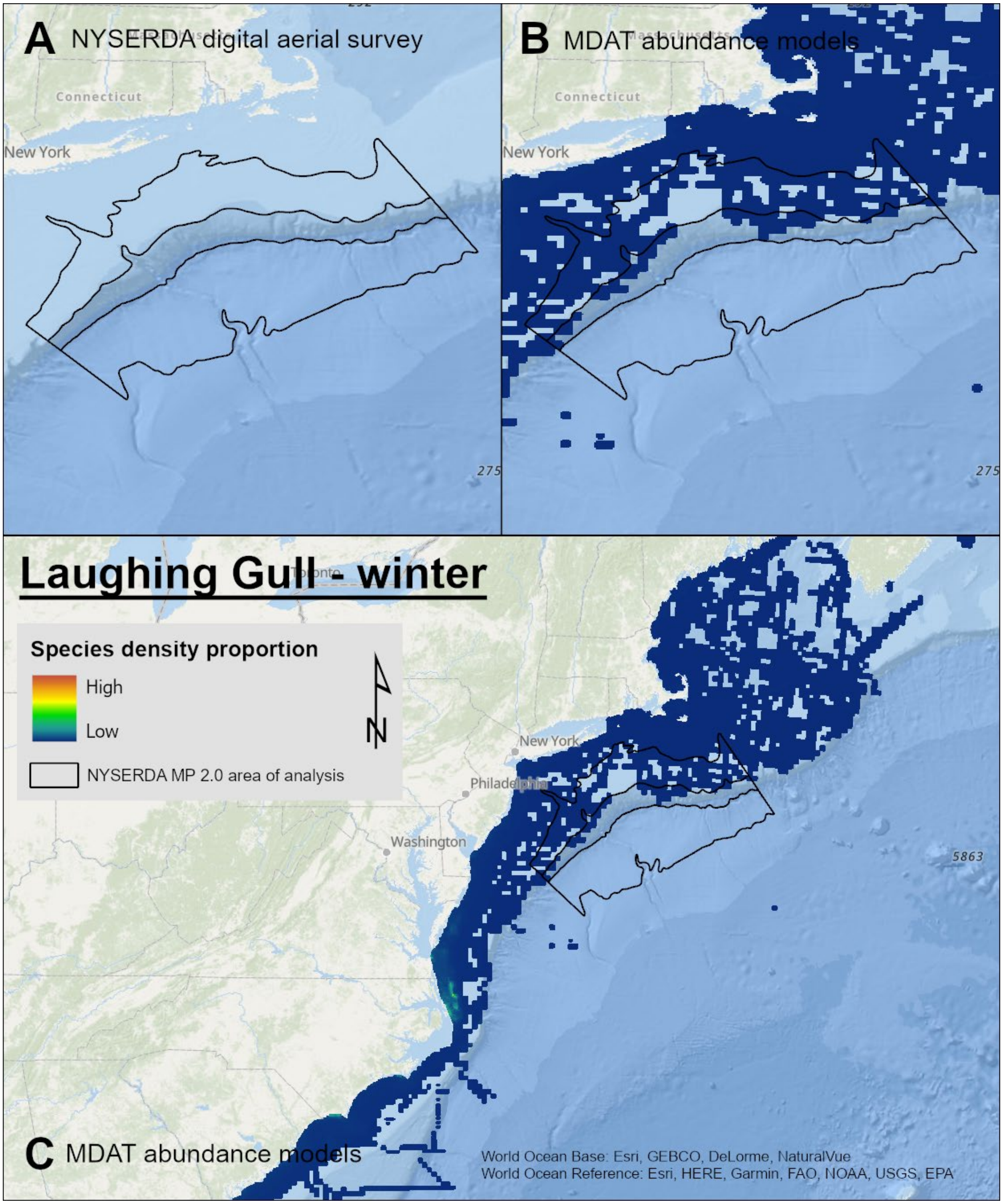
Map B-72. Fall Black-Legged Kittiwake Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



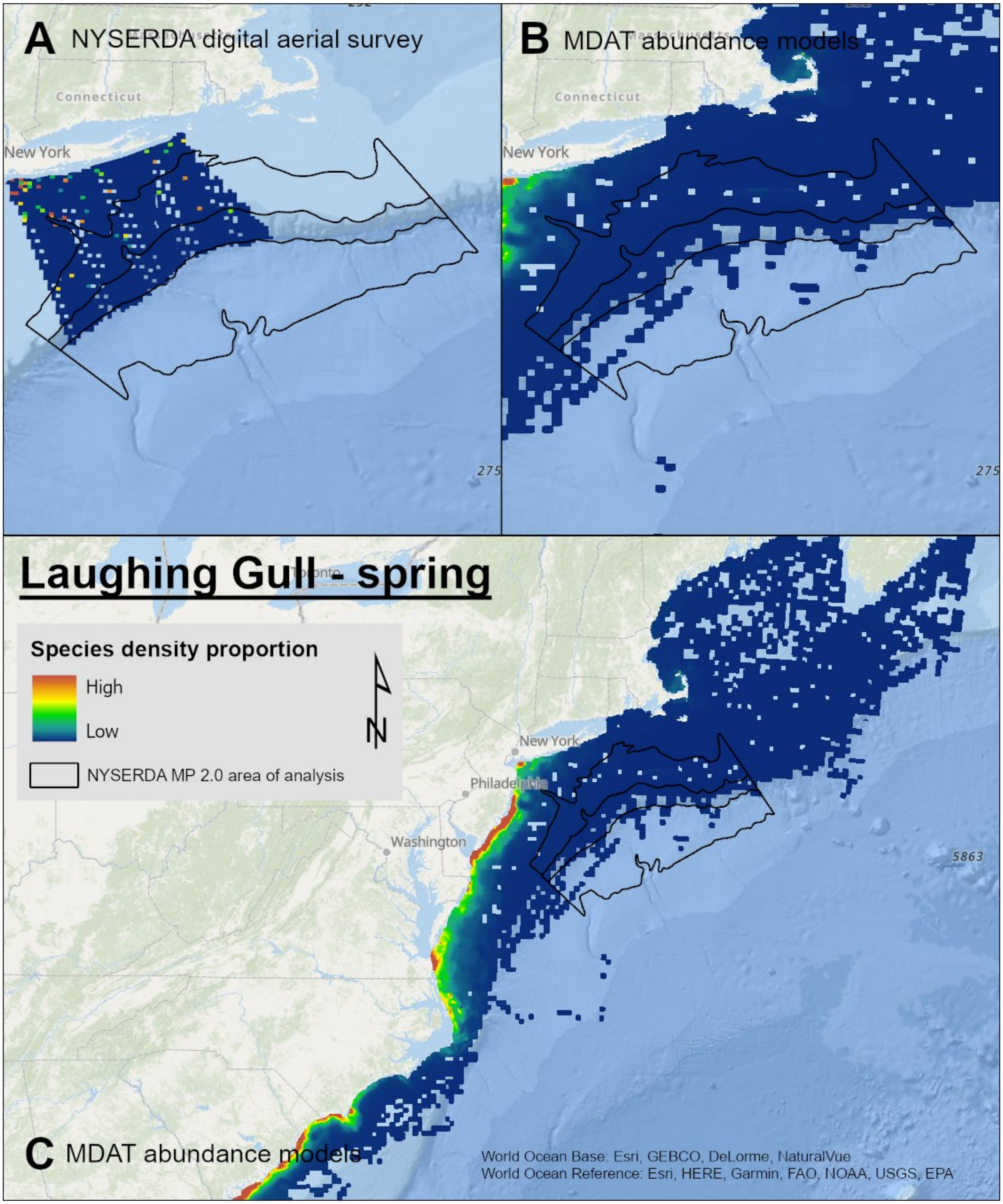
Map B-73. Winter Laughing Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



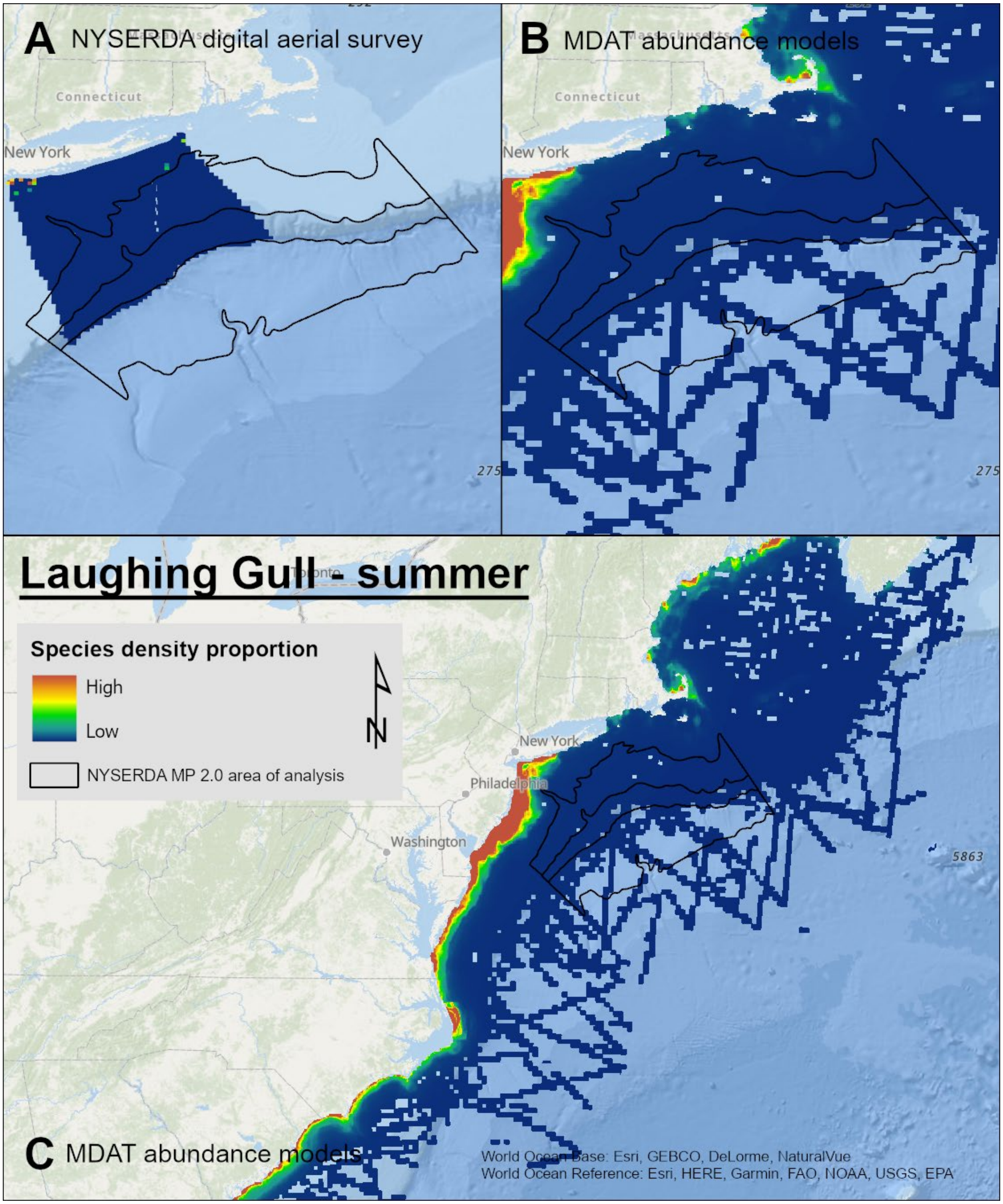
Map B-74. Spring Laughing Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



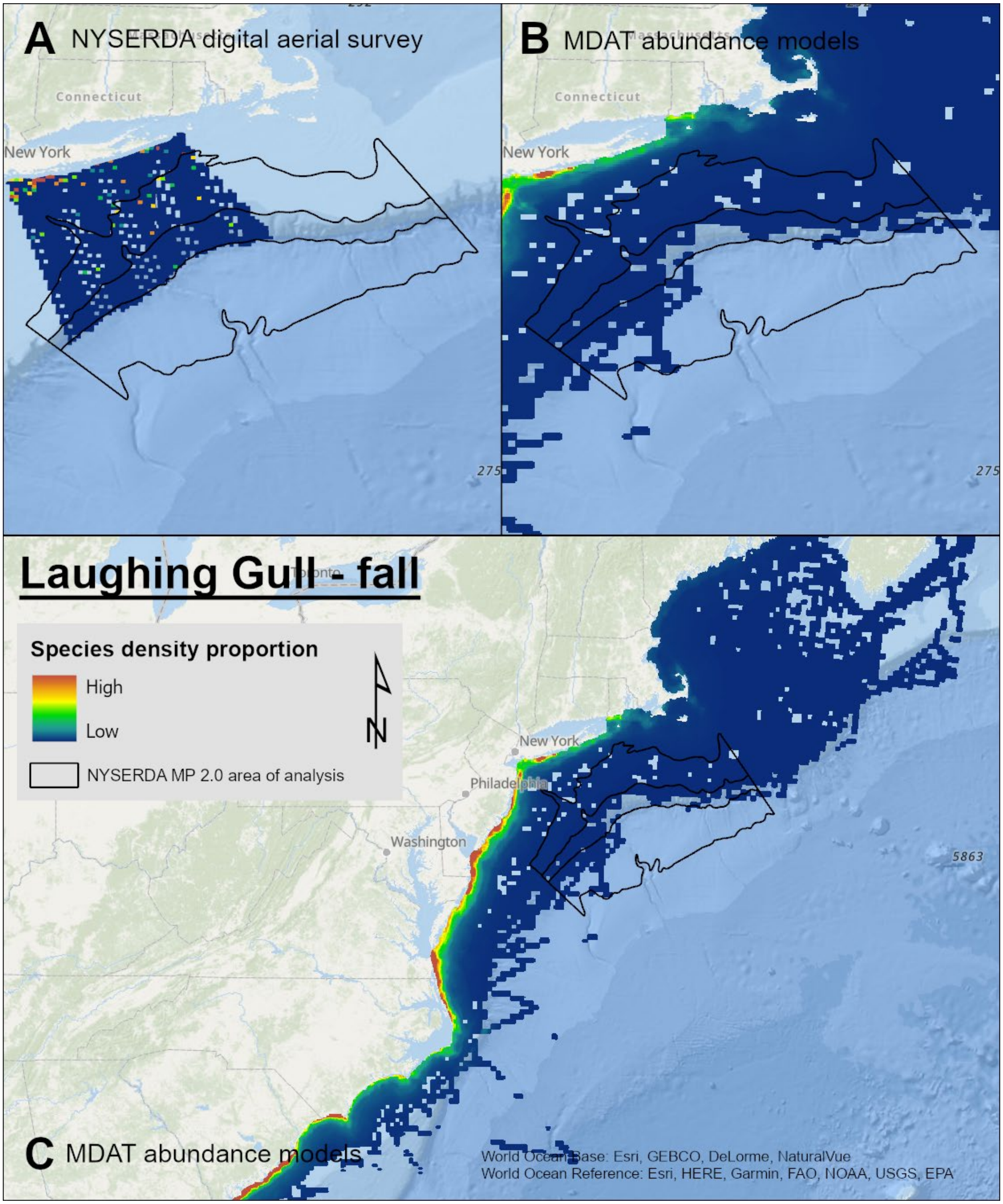
Map B-75. Summer Laughing Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



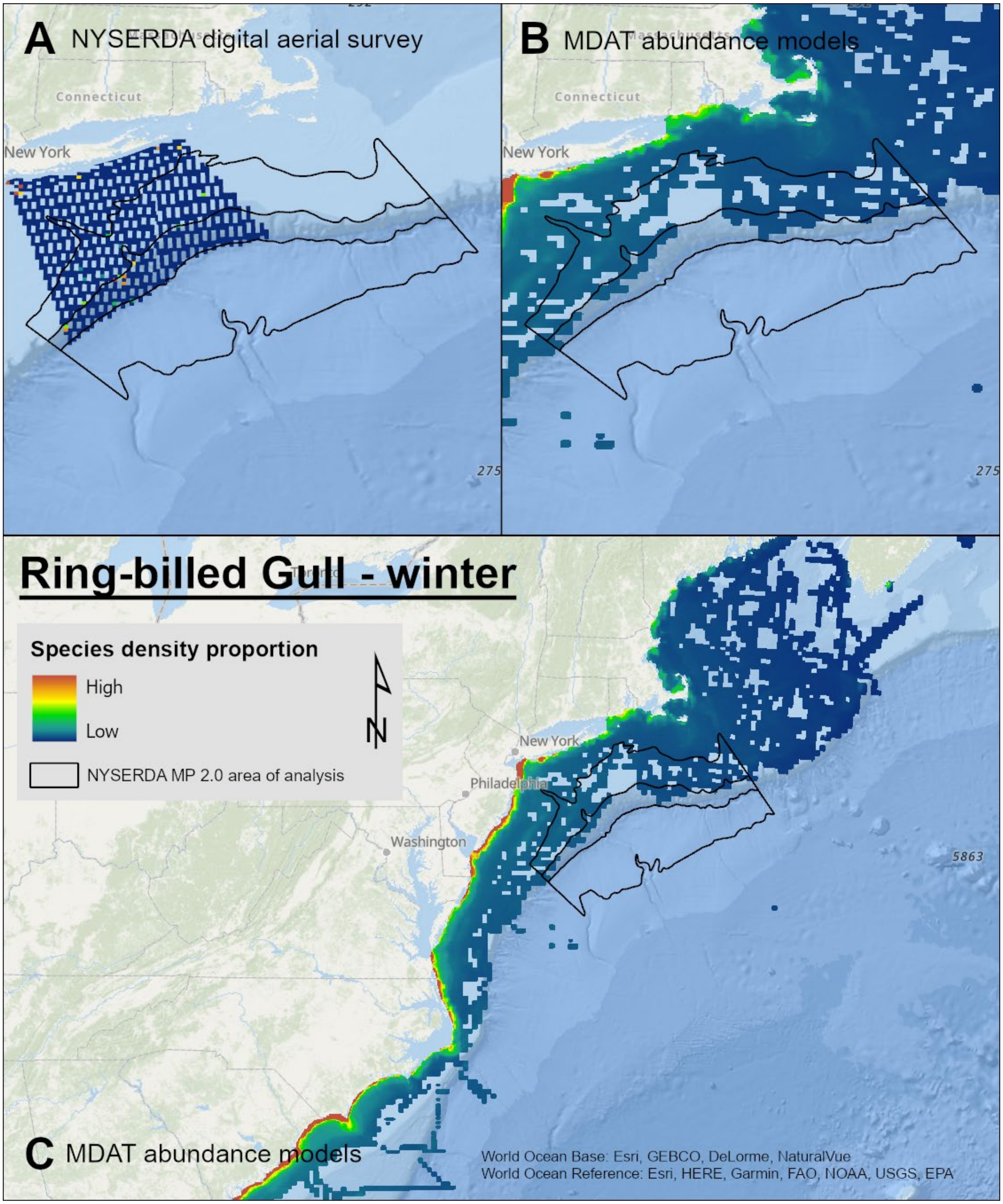
Map B-76. Fall Laughing Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



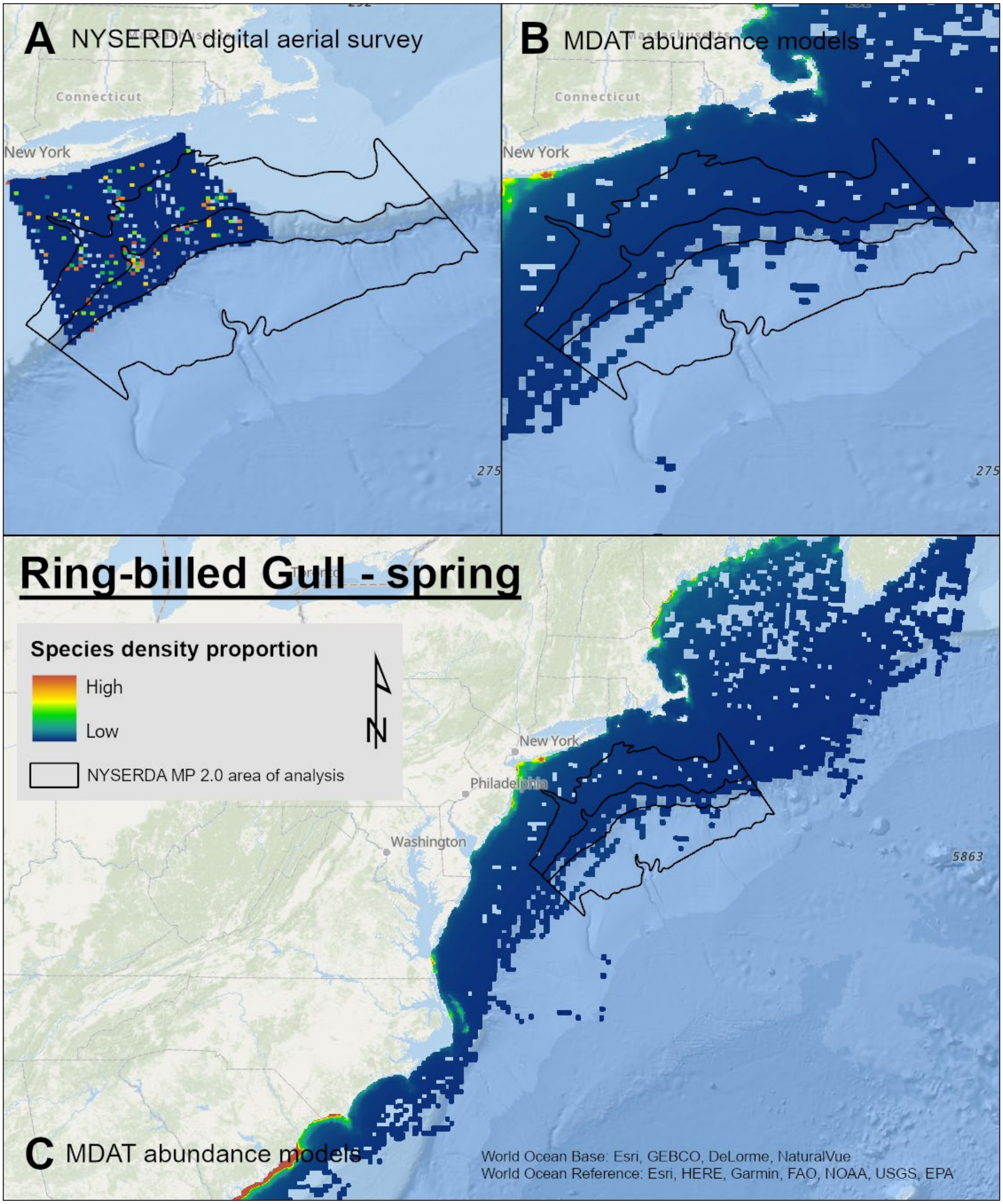
Map B-77. Winter Ring-Billed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



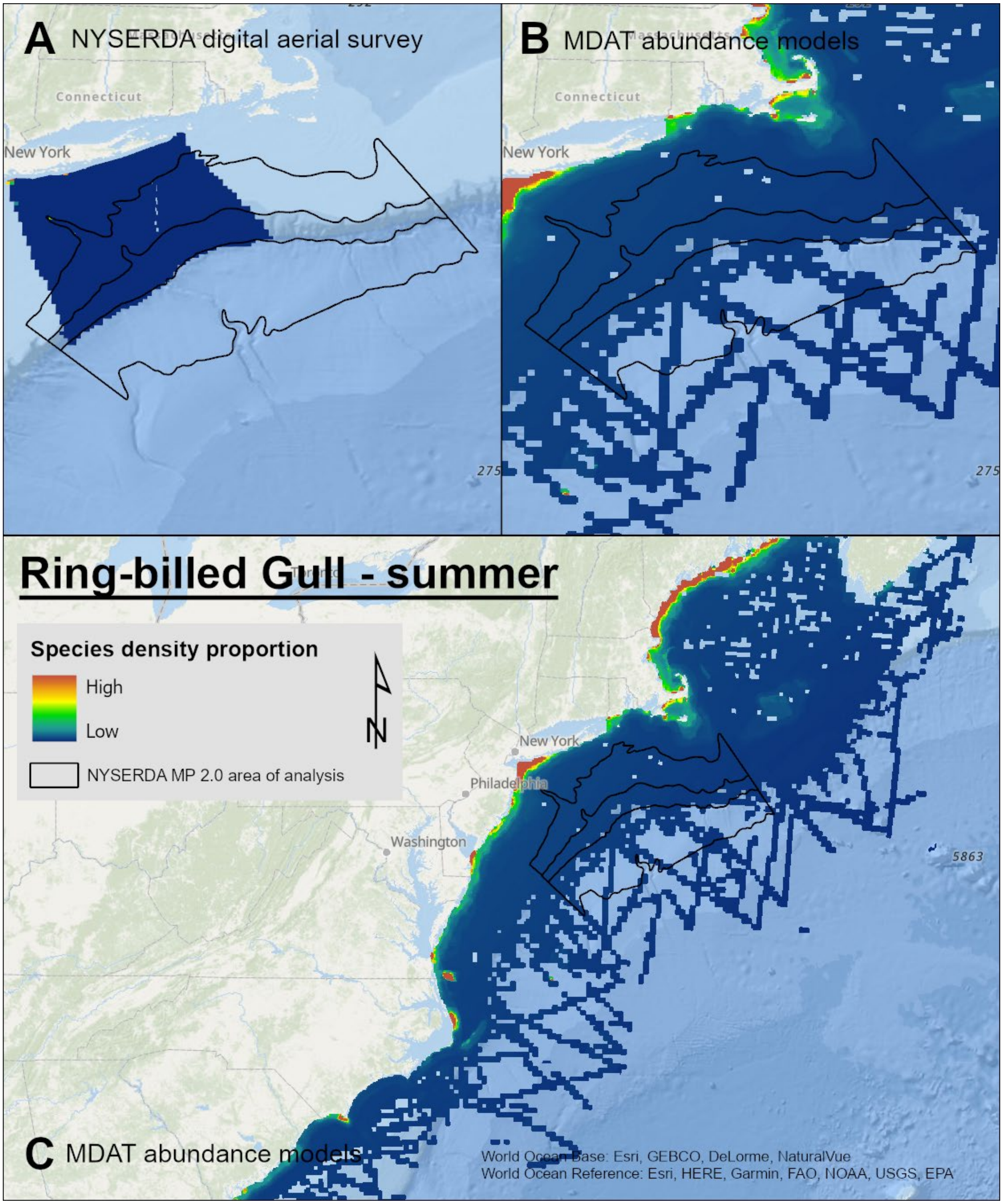
Map B-78. Spring Ring-Billed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



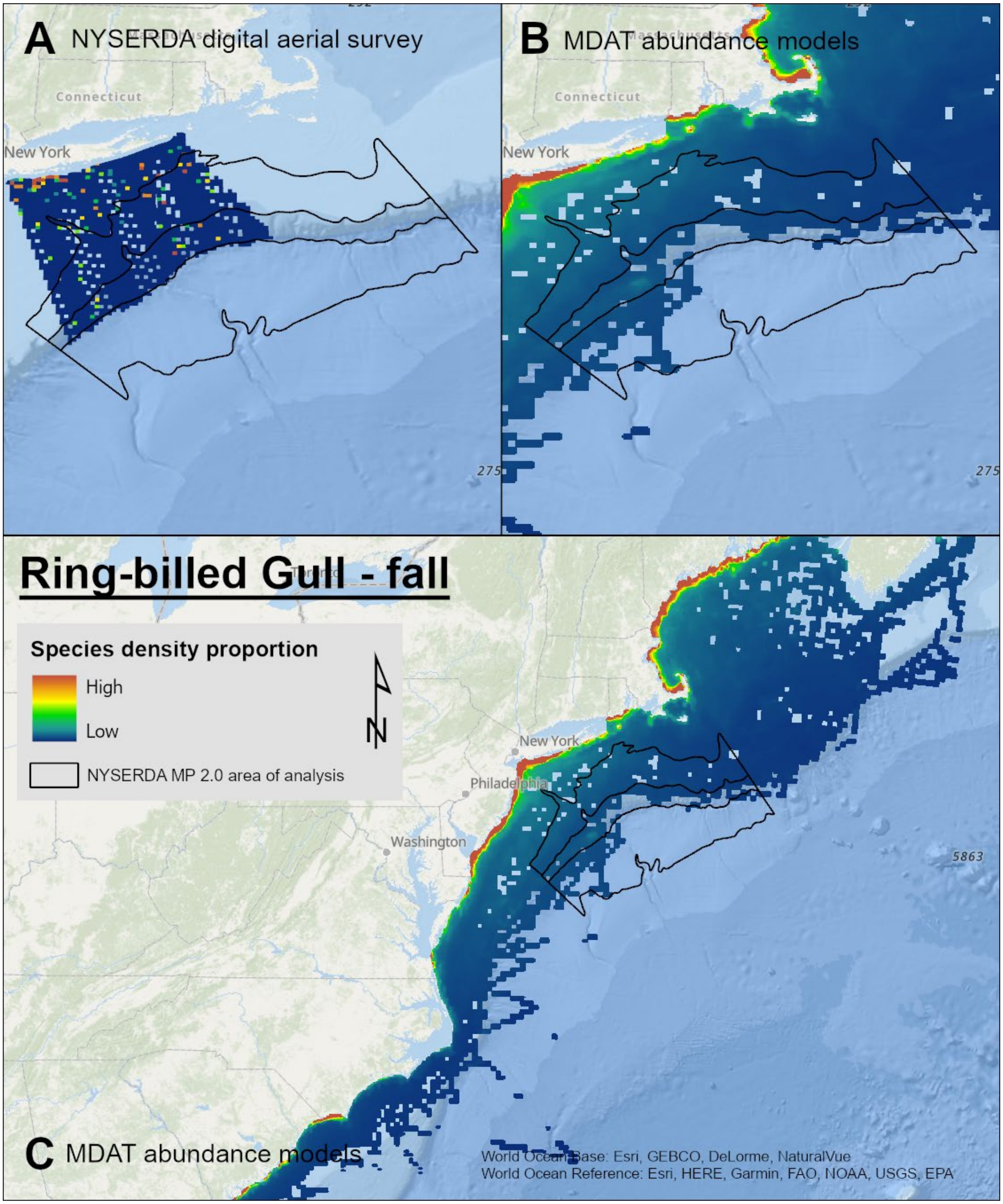
Map B-79. Summer Ring-Billed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



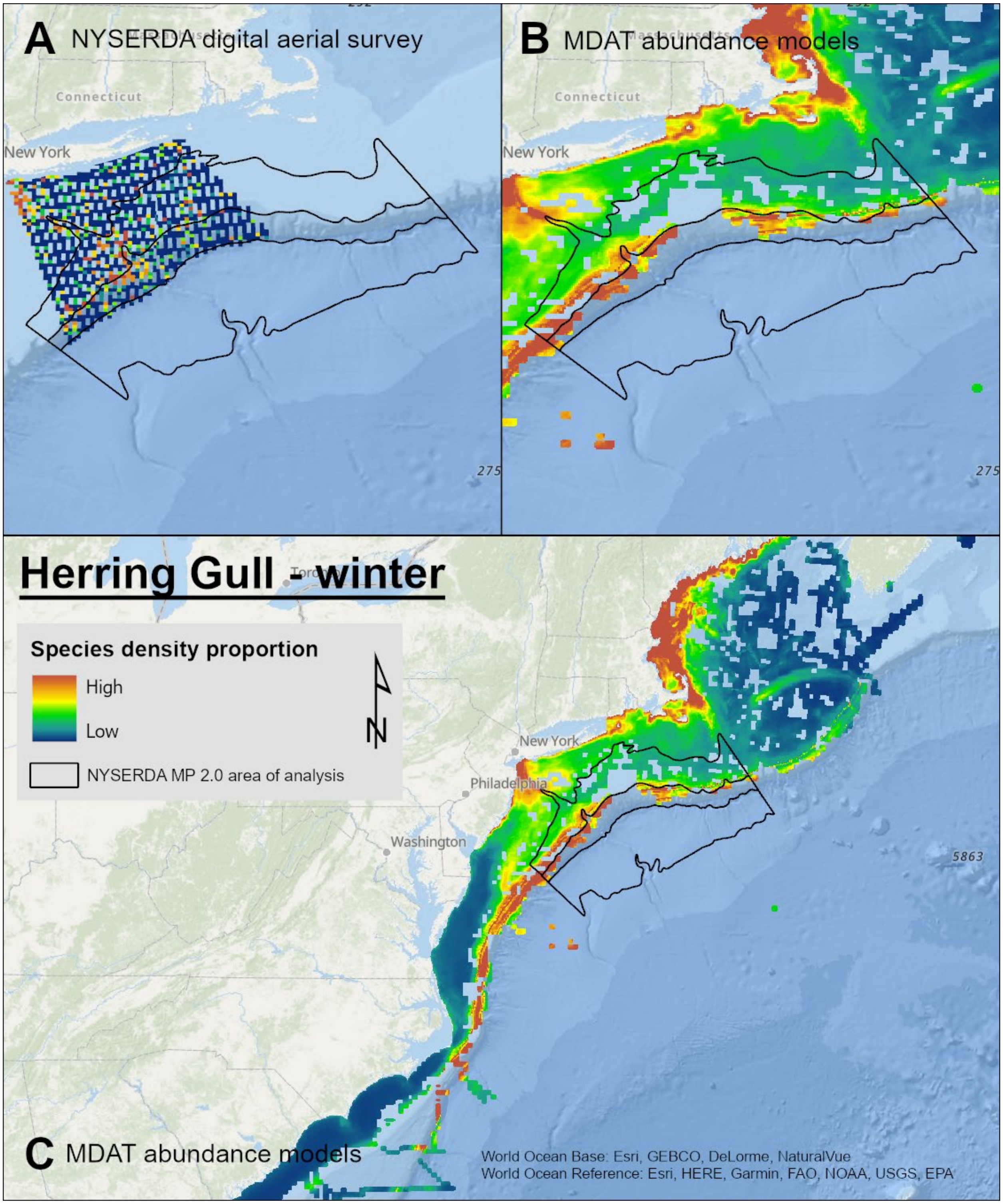
Map B-80. Fall Ring-Billed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



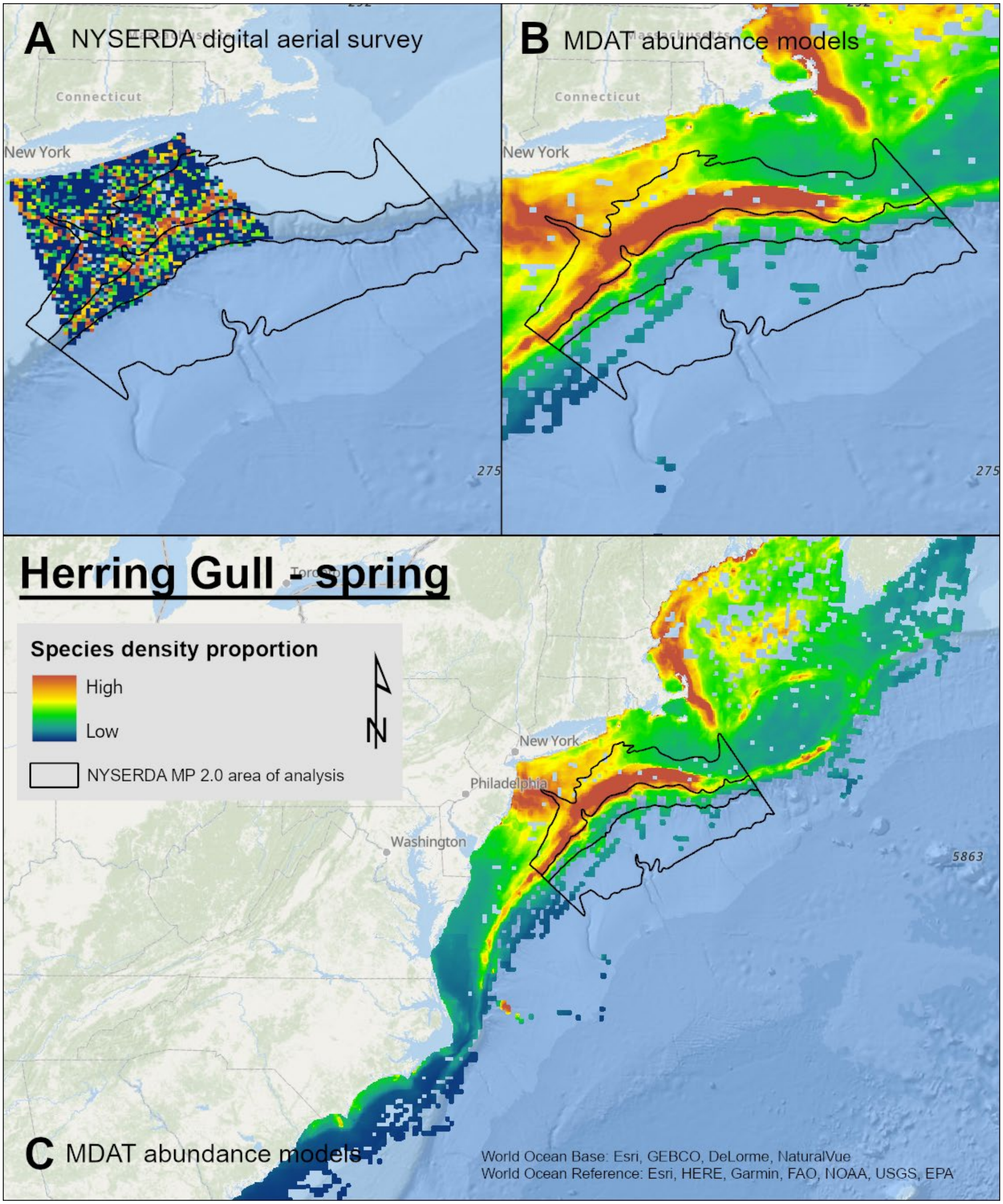
Map B-81. Winter Herring Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



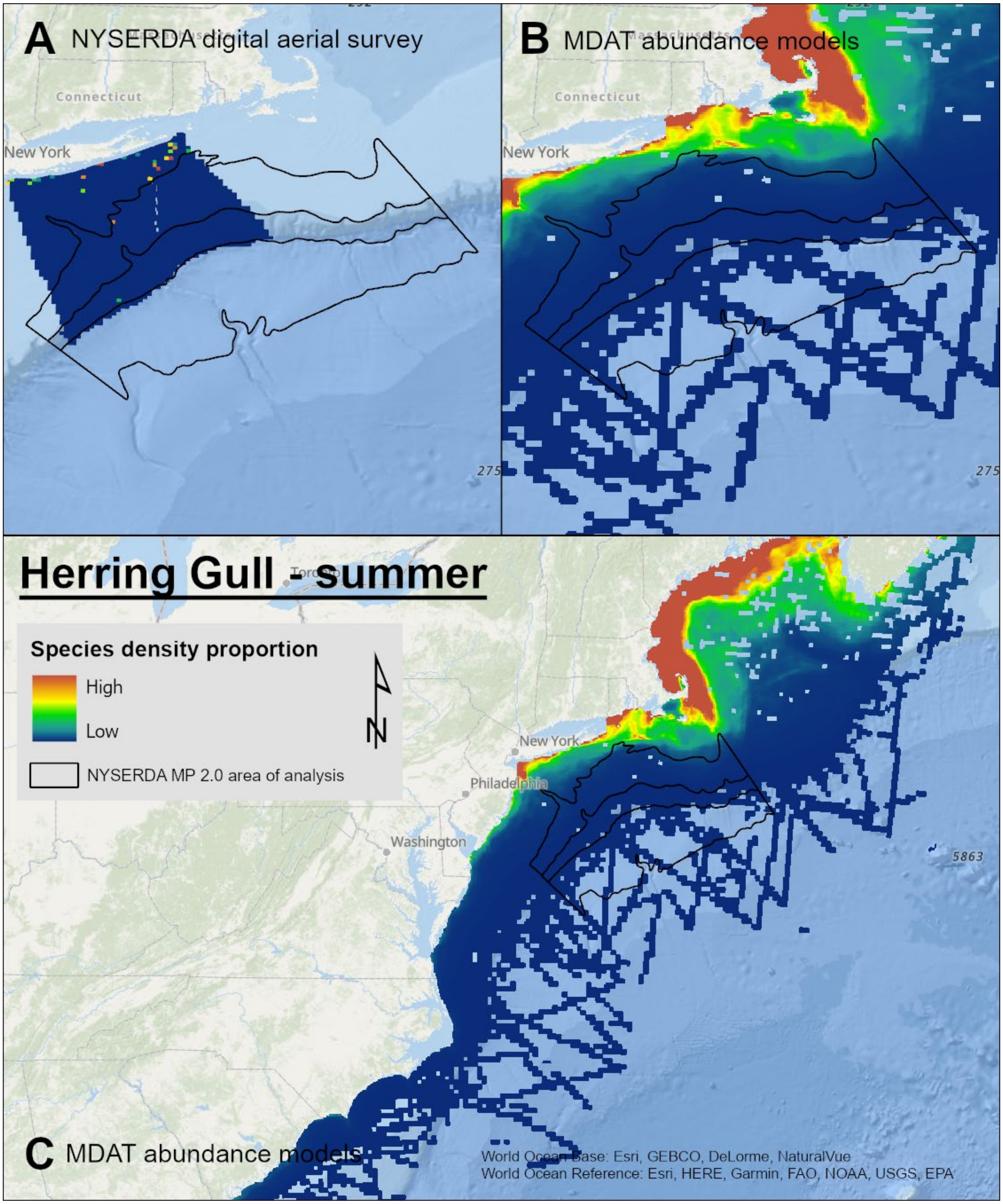
Map B-82. Spring Herring Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



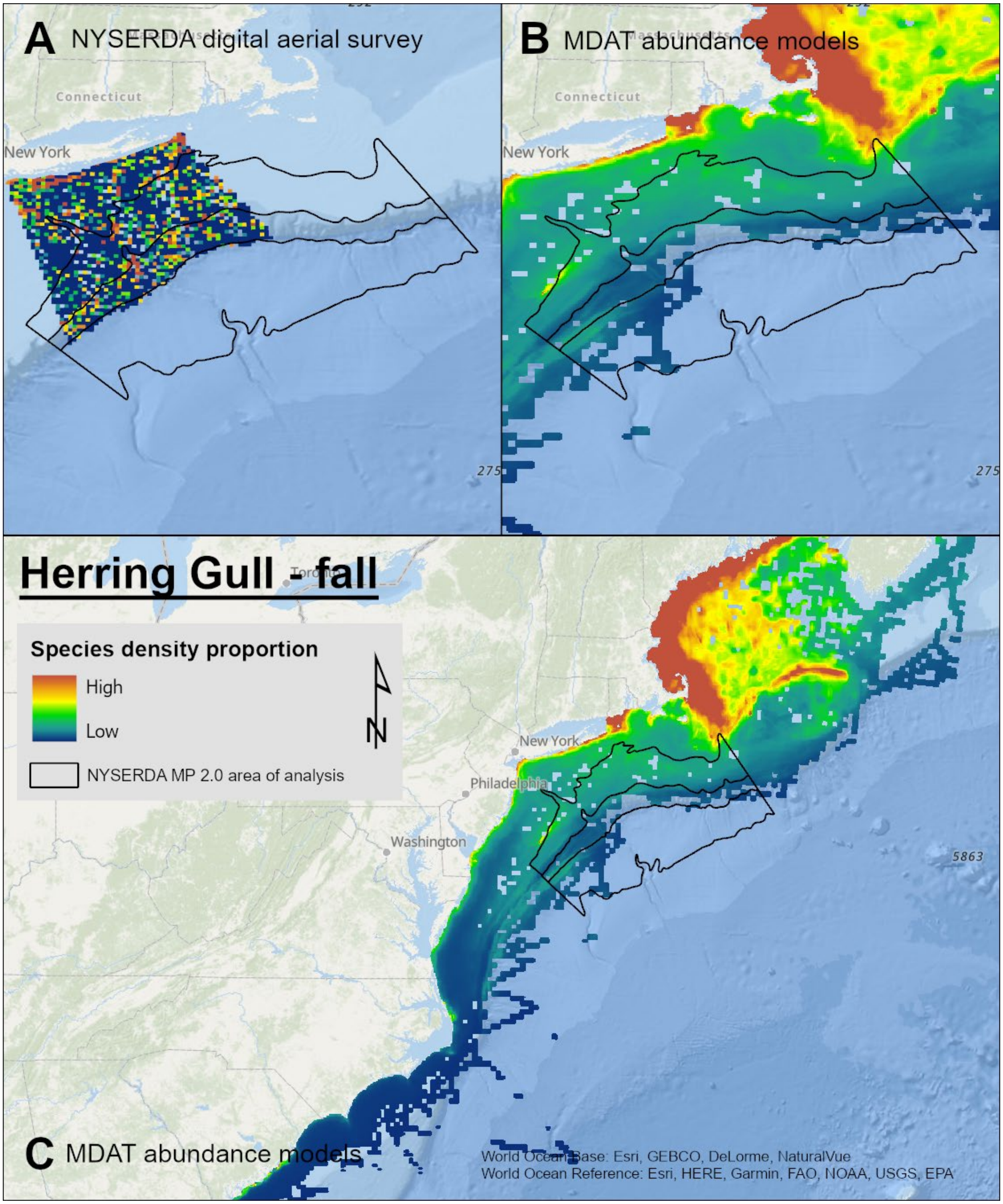
Map B-83. Summer Herring Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



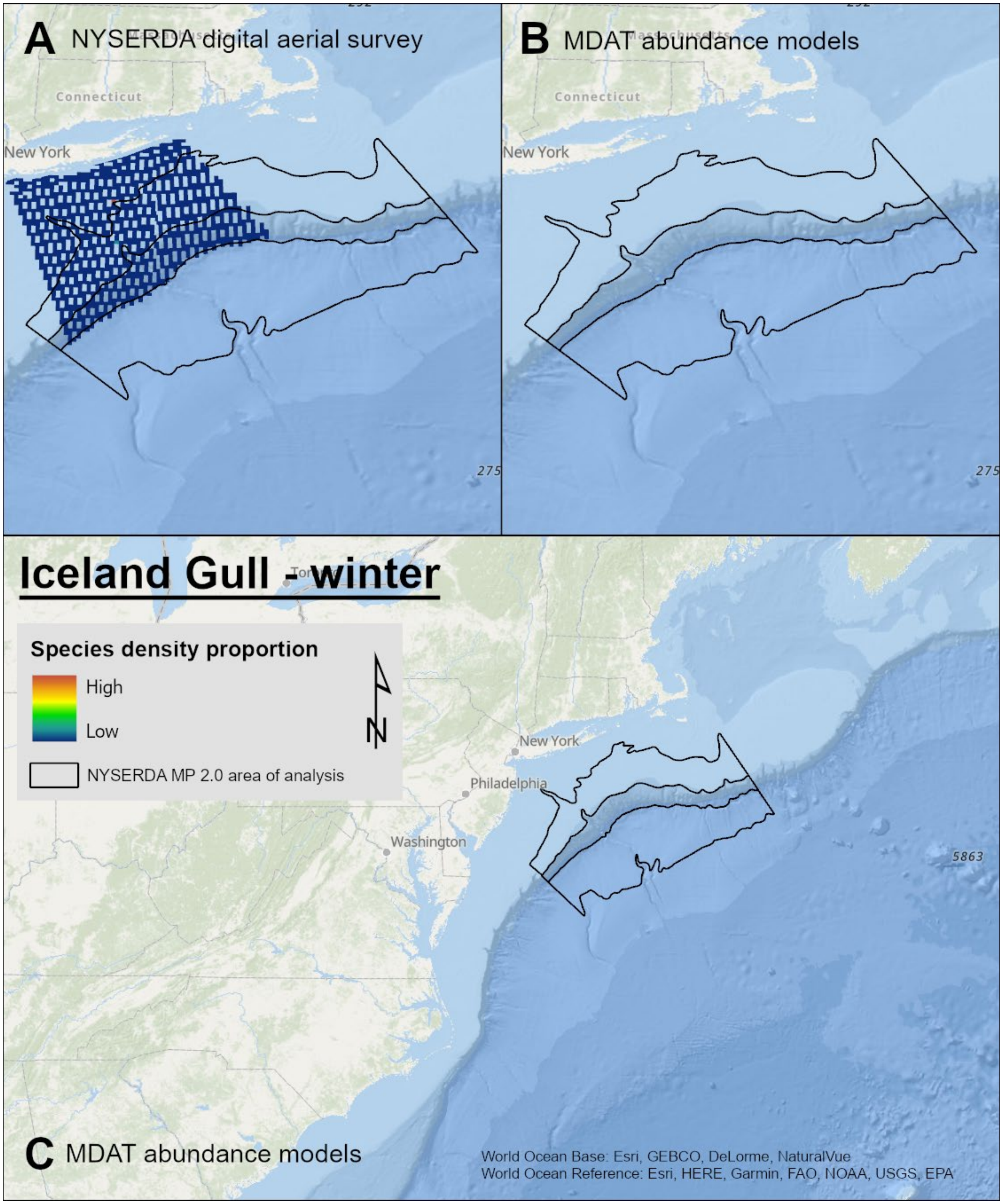
Map B-84. Fall Herring Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



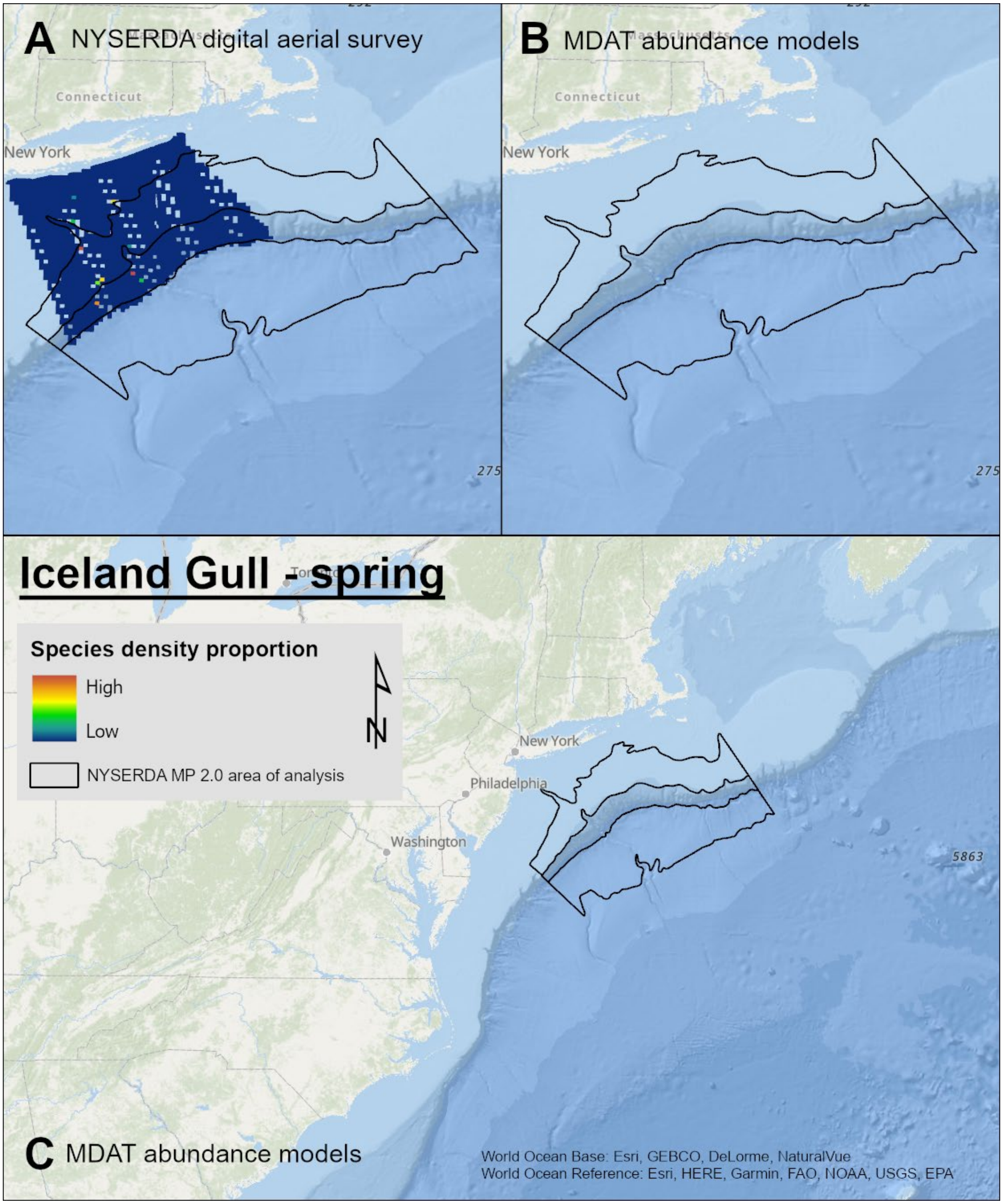
Map B-85. Winter Iceland Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



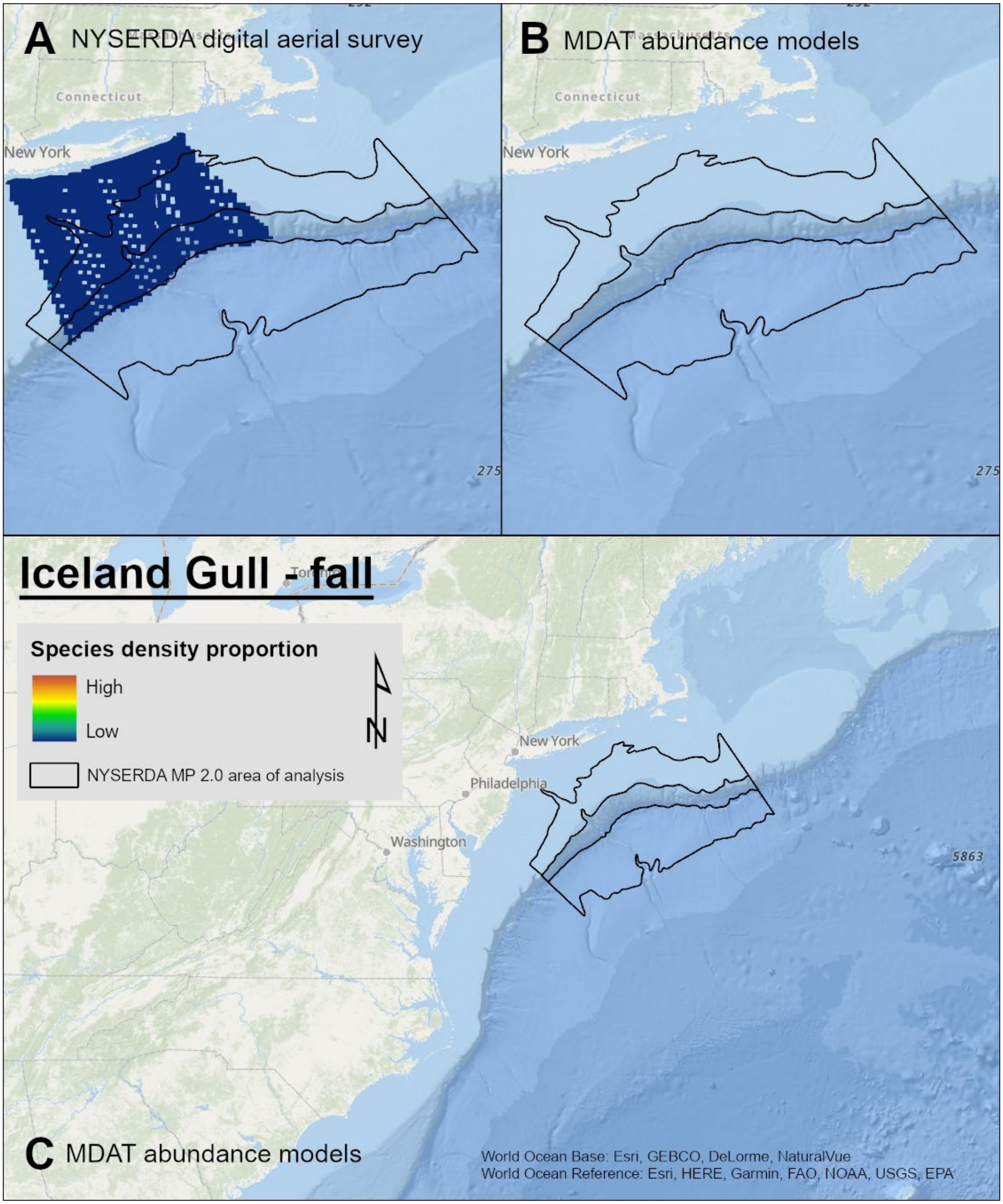
Map B-86. Spring Iceland Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



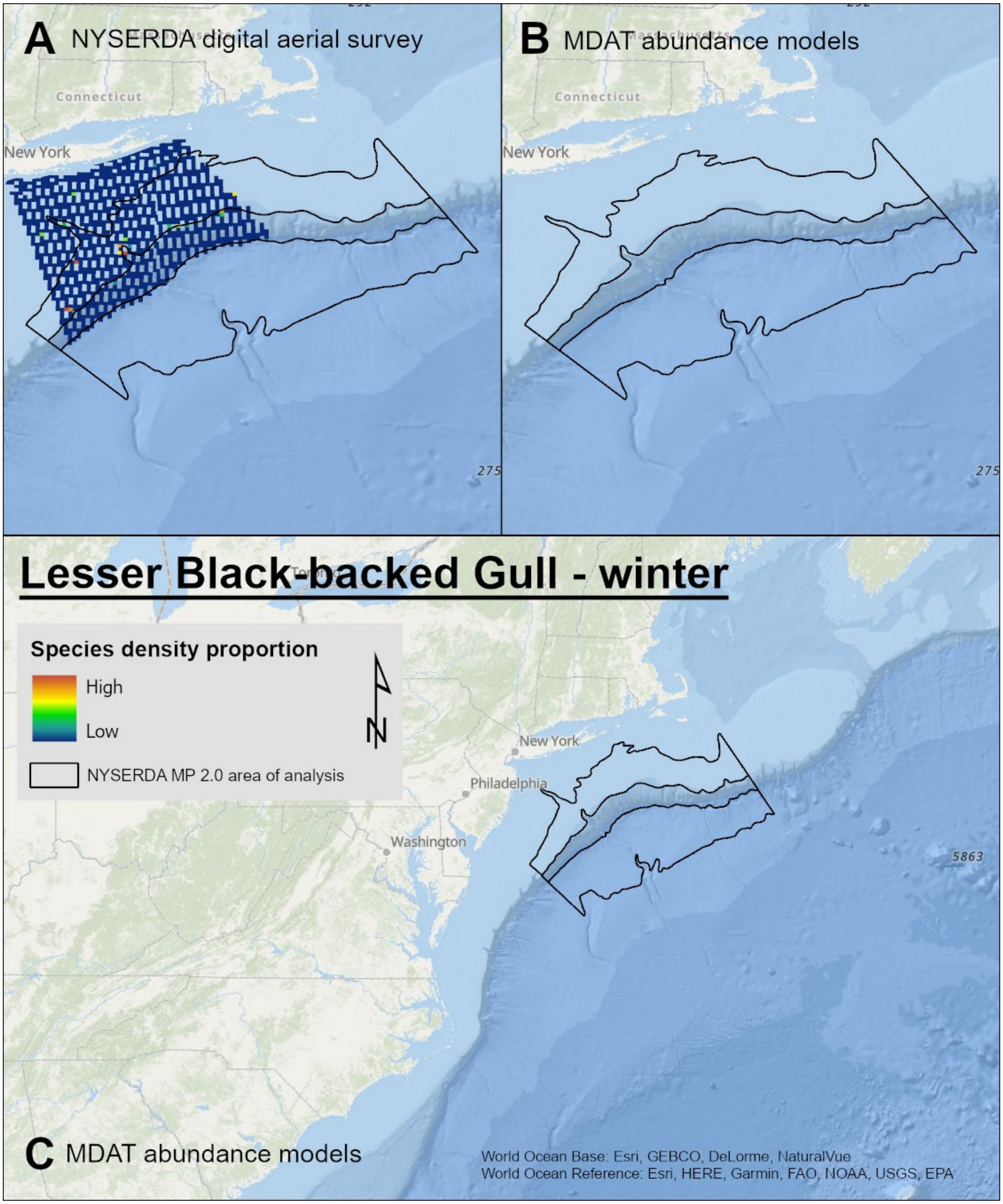
Map B-87. Fall Iceland Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-88. Winter Lesser Black-Backed Gull Density Proportions

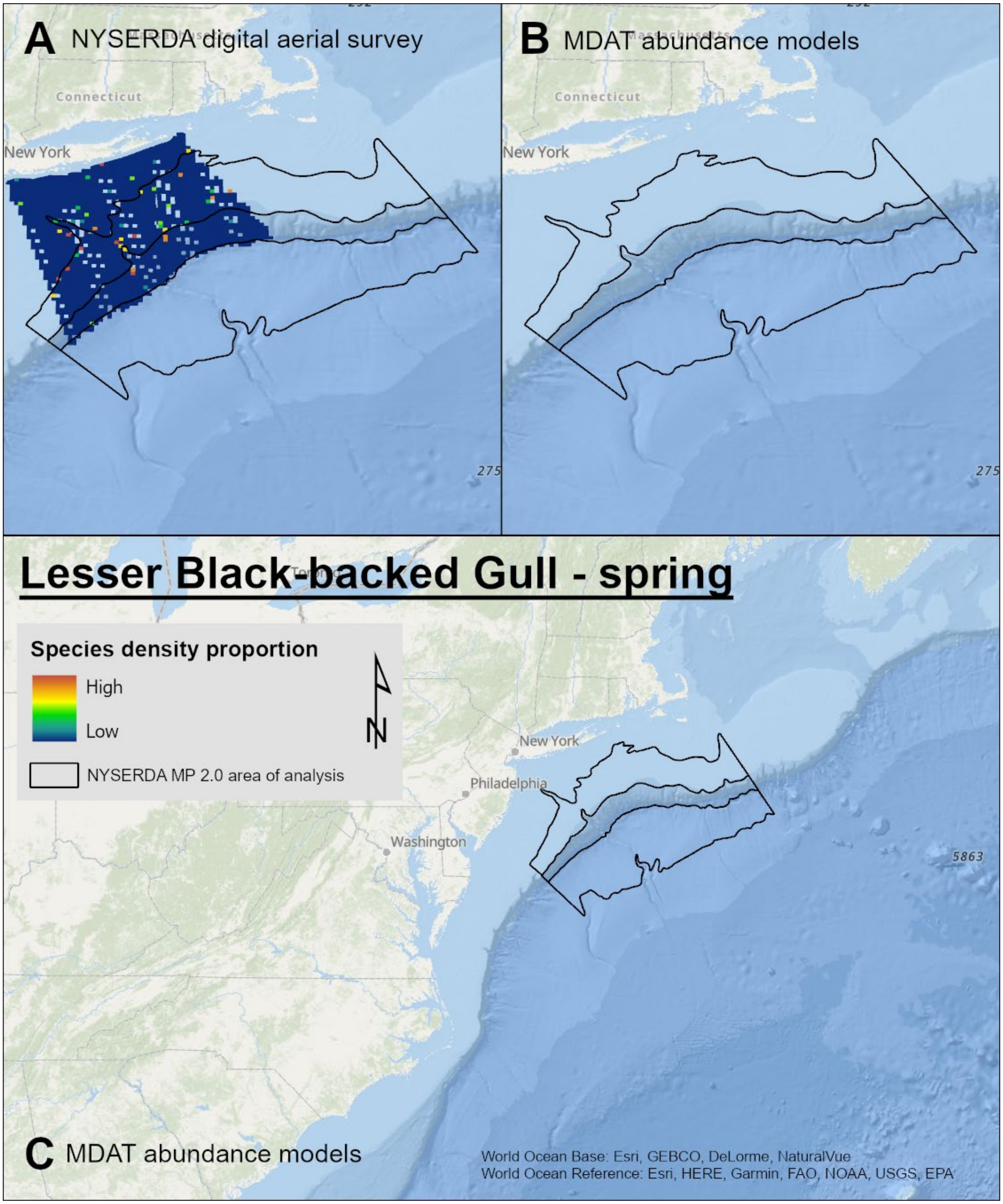
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

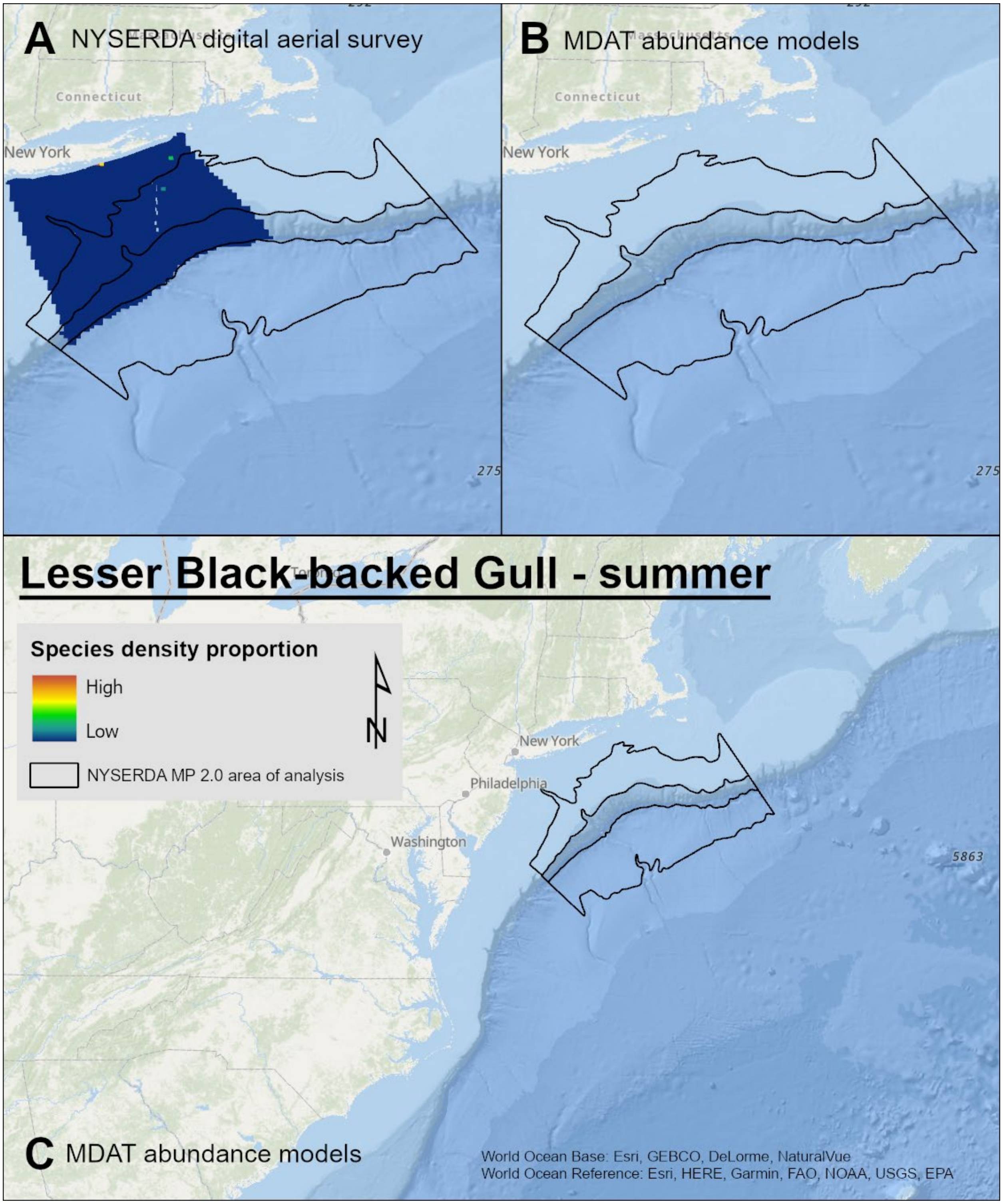
Map B-89. Spring Lesser Black-Backed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



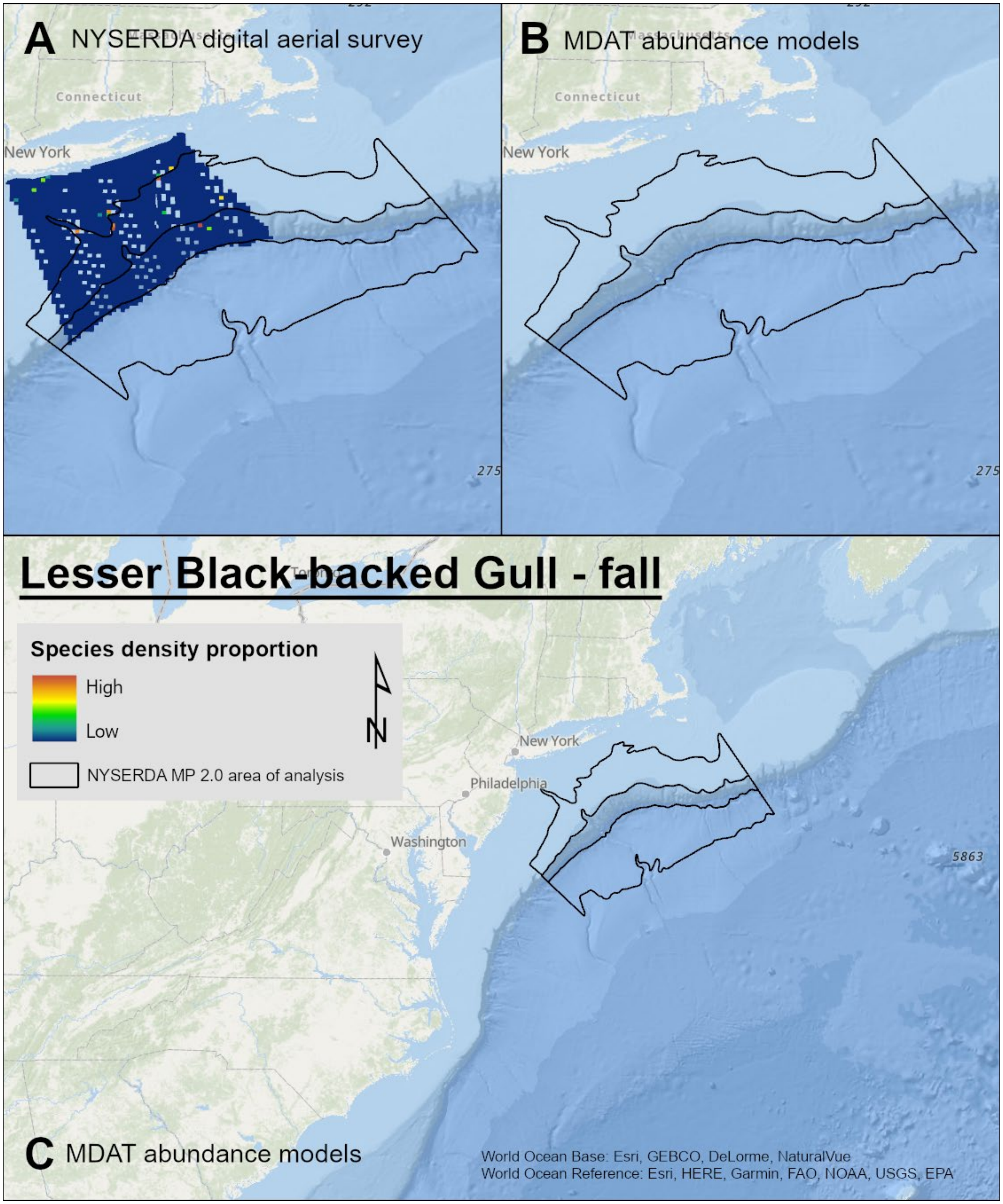
Map B-90. Summer Lesser Black-Backed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-91. Fall Lesser Black-Backed Gull Density Proportions

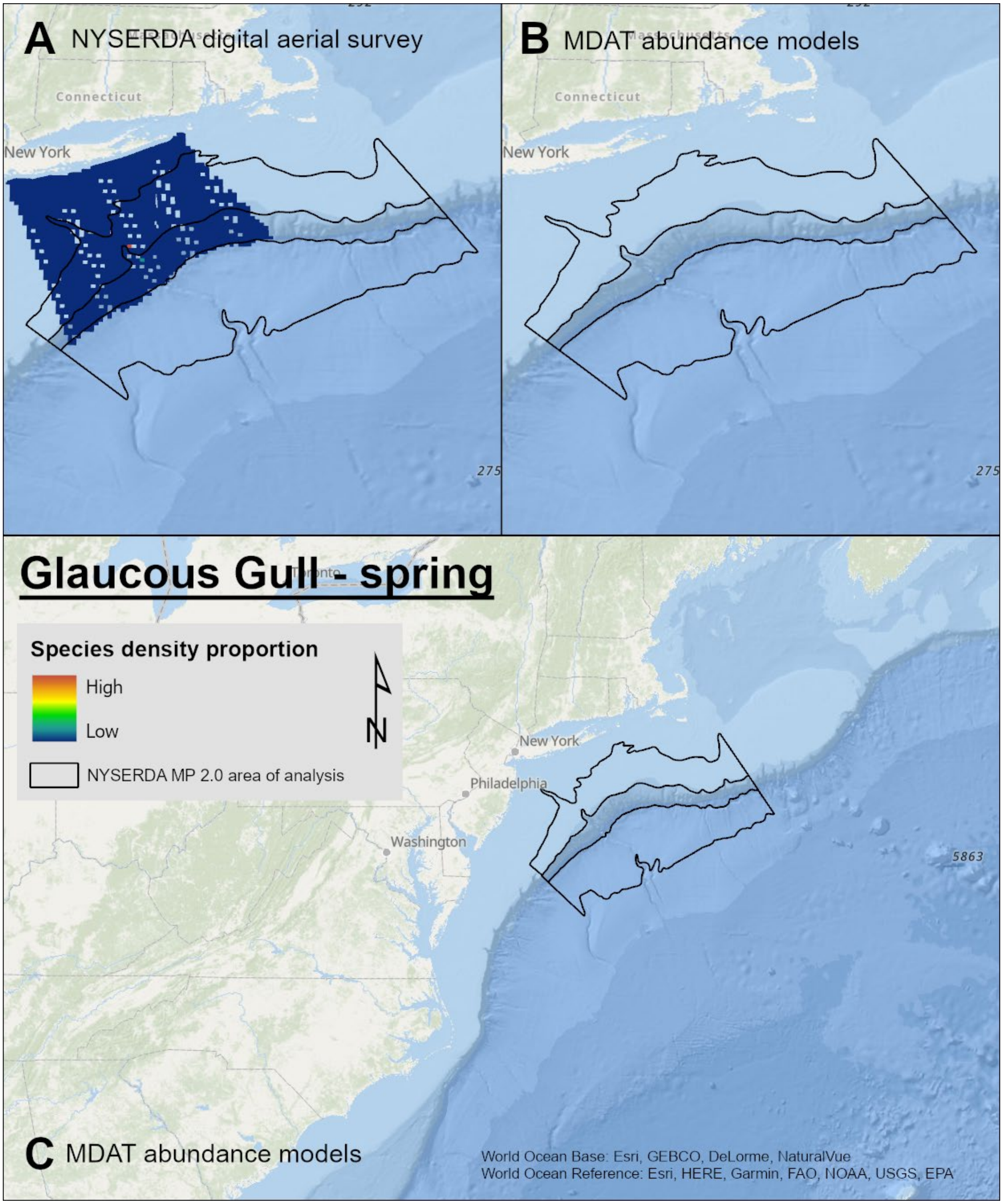
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

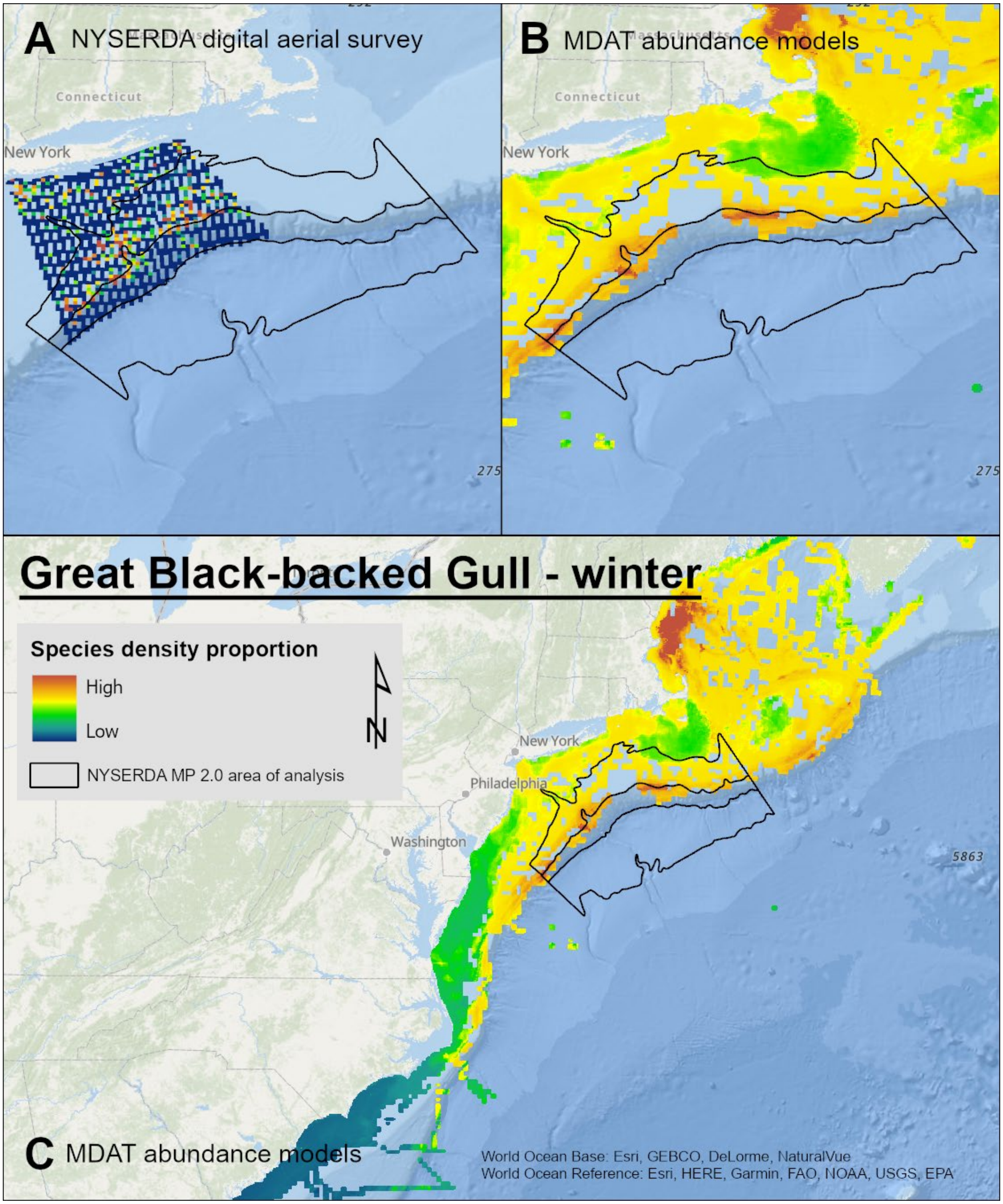
Map B-92. Spring Glaucous Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



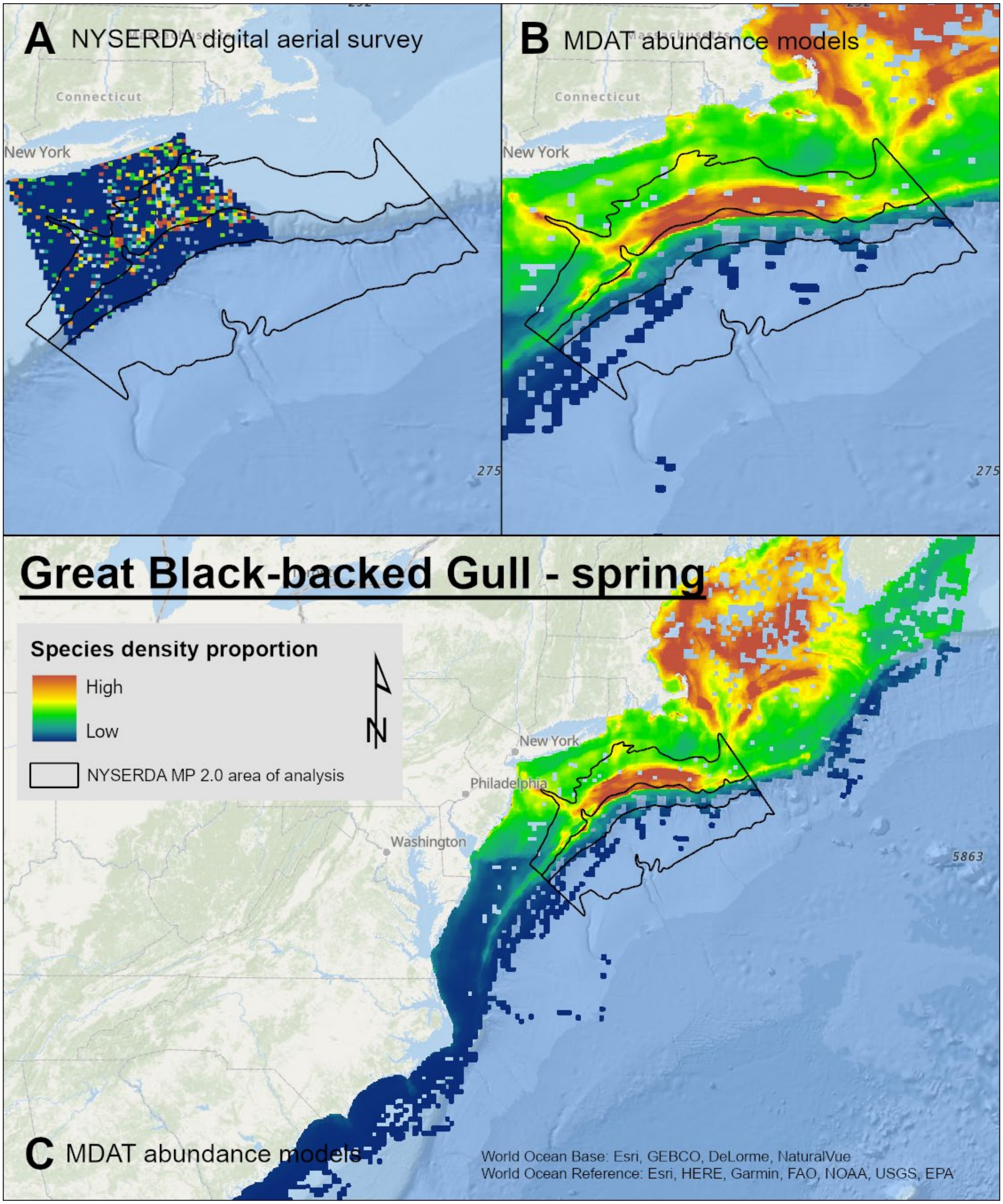
Map B-93. Winter Great Black-Backed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



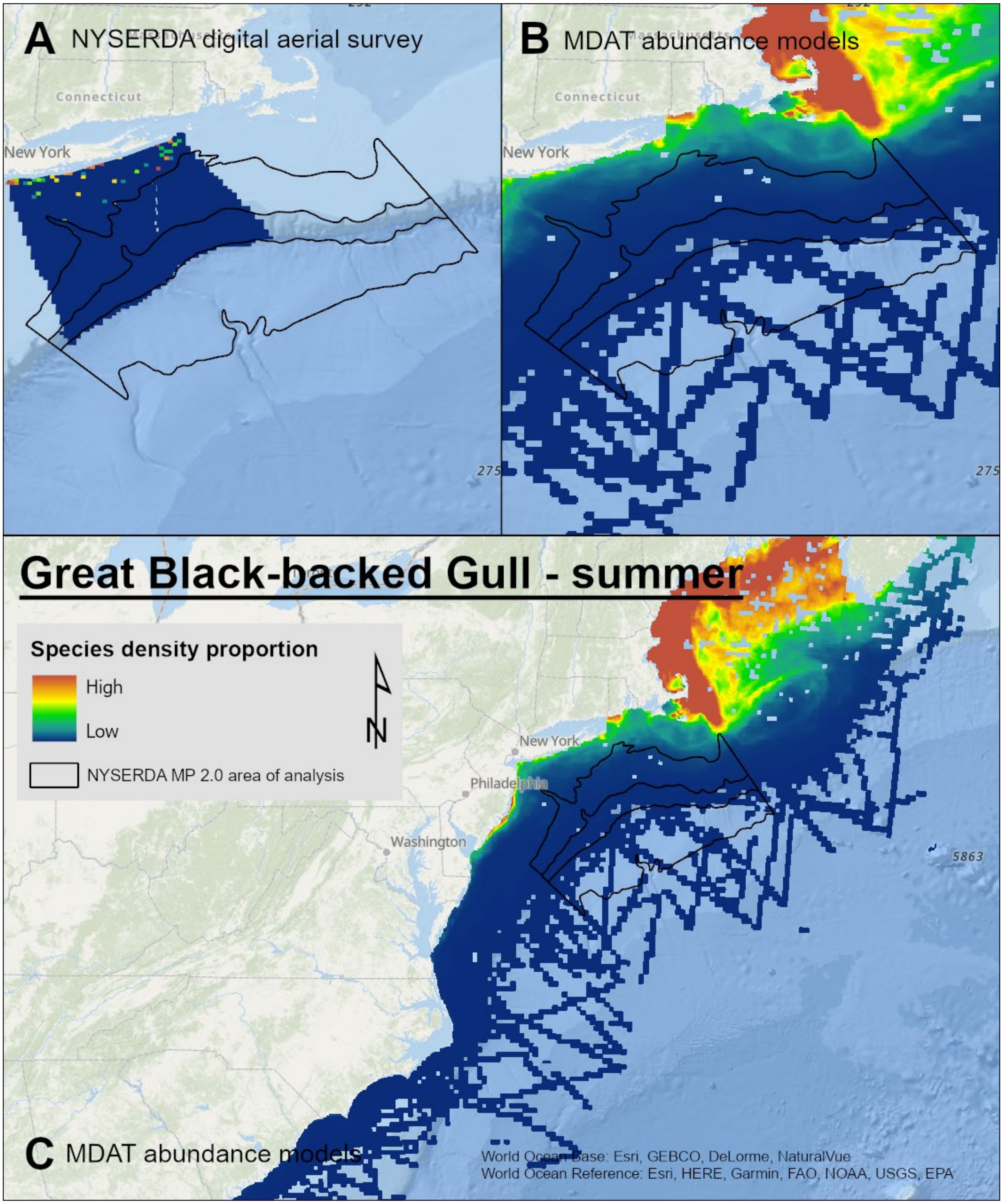
Map B-94. Spring Great Black-Backed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



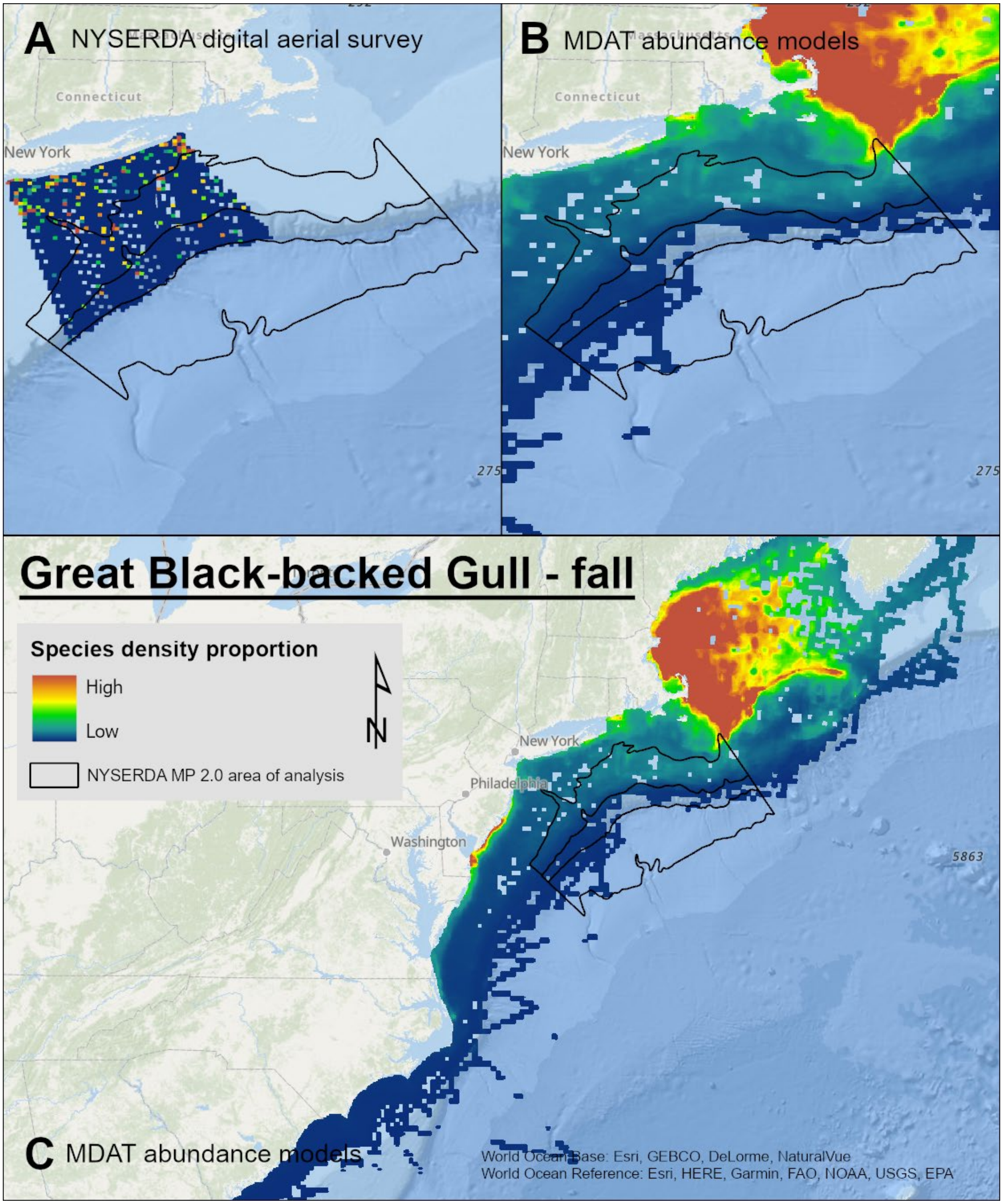
Map B-95. Summer Great Black-Backed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



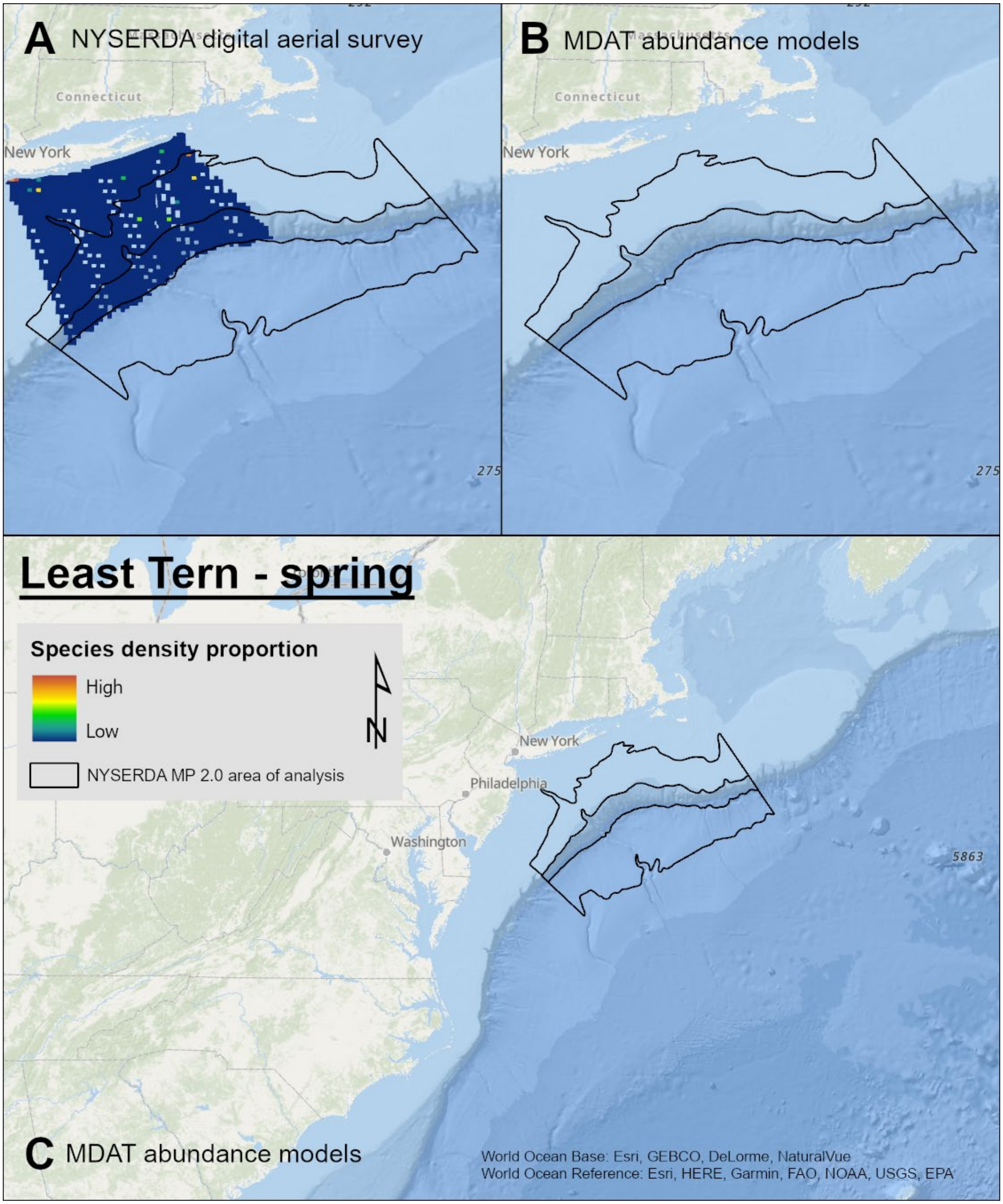
Map B-96. Fall Great Black-Backed Gull Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



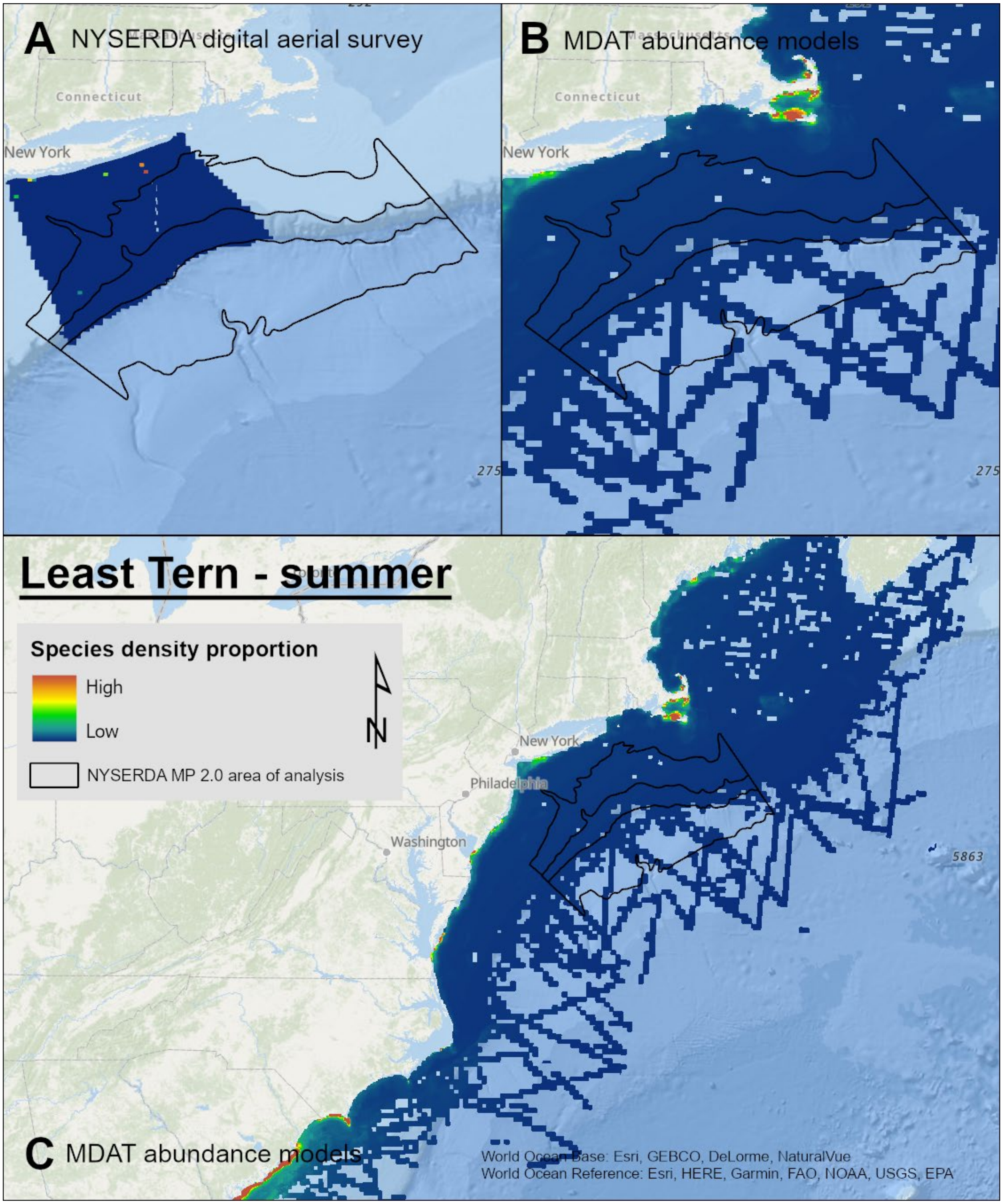
Map B-97. Spring Least Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



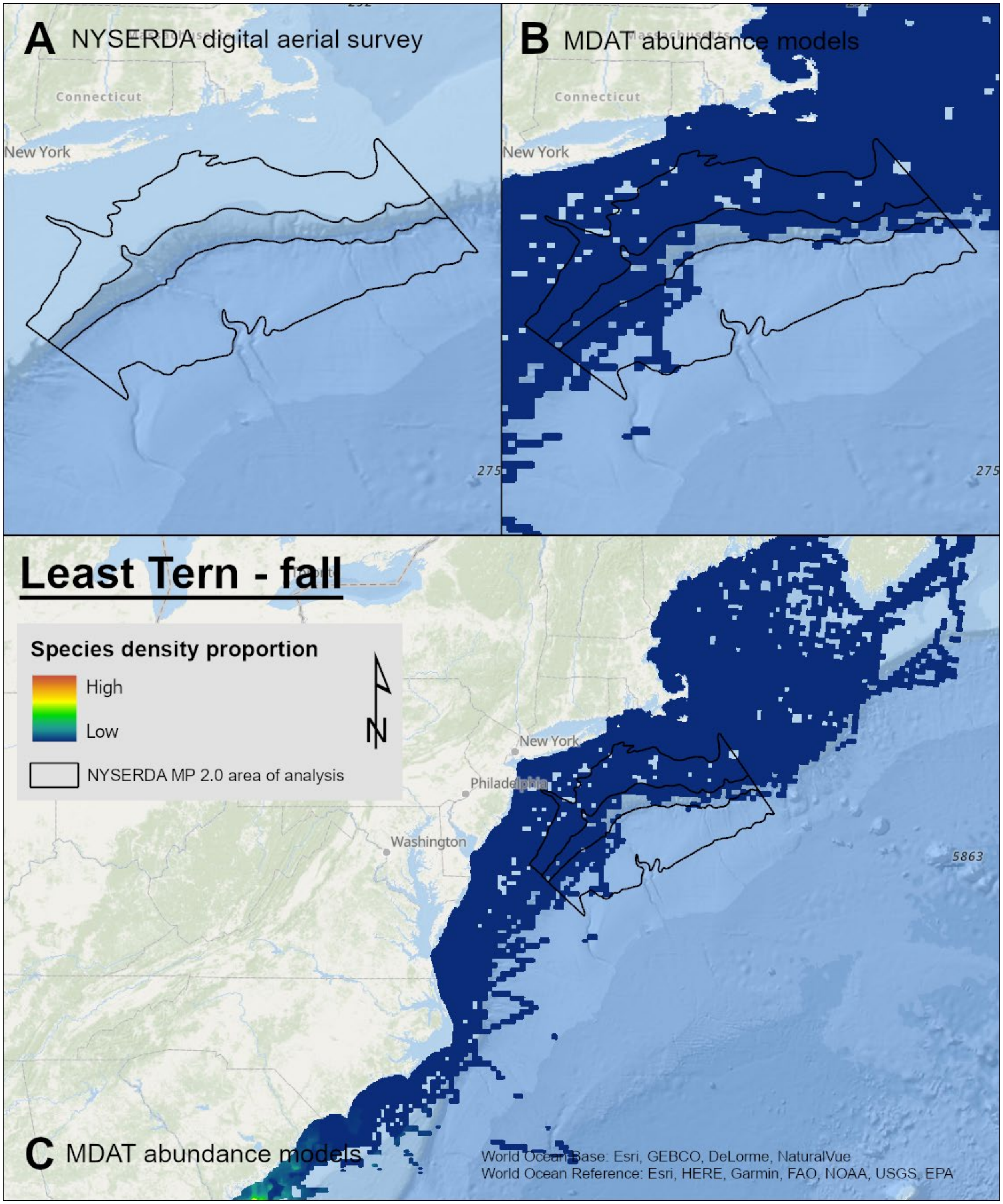
Map B-98. Summer Least Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



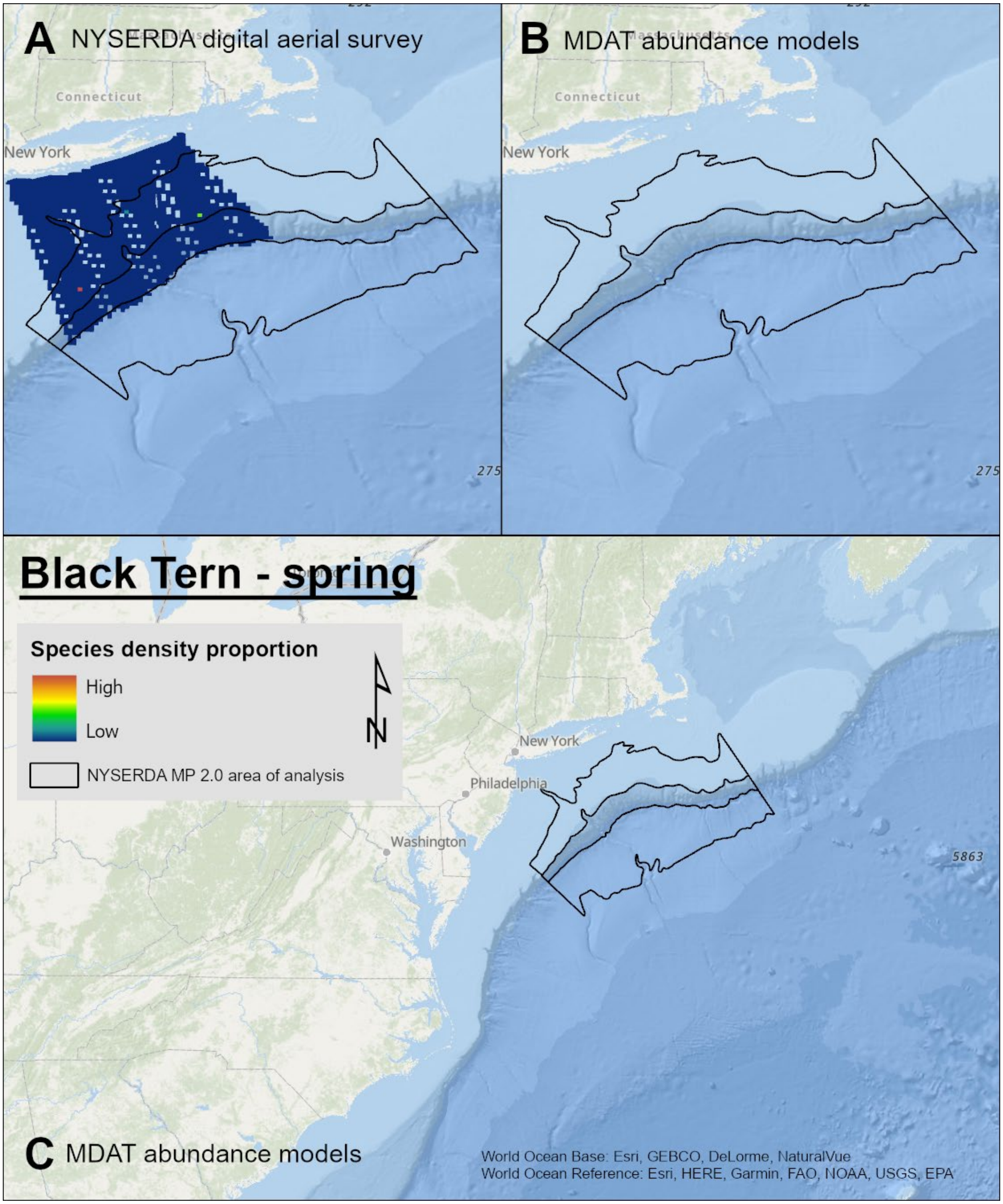
Map B-99. Fall Least Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



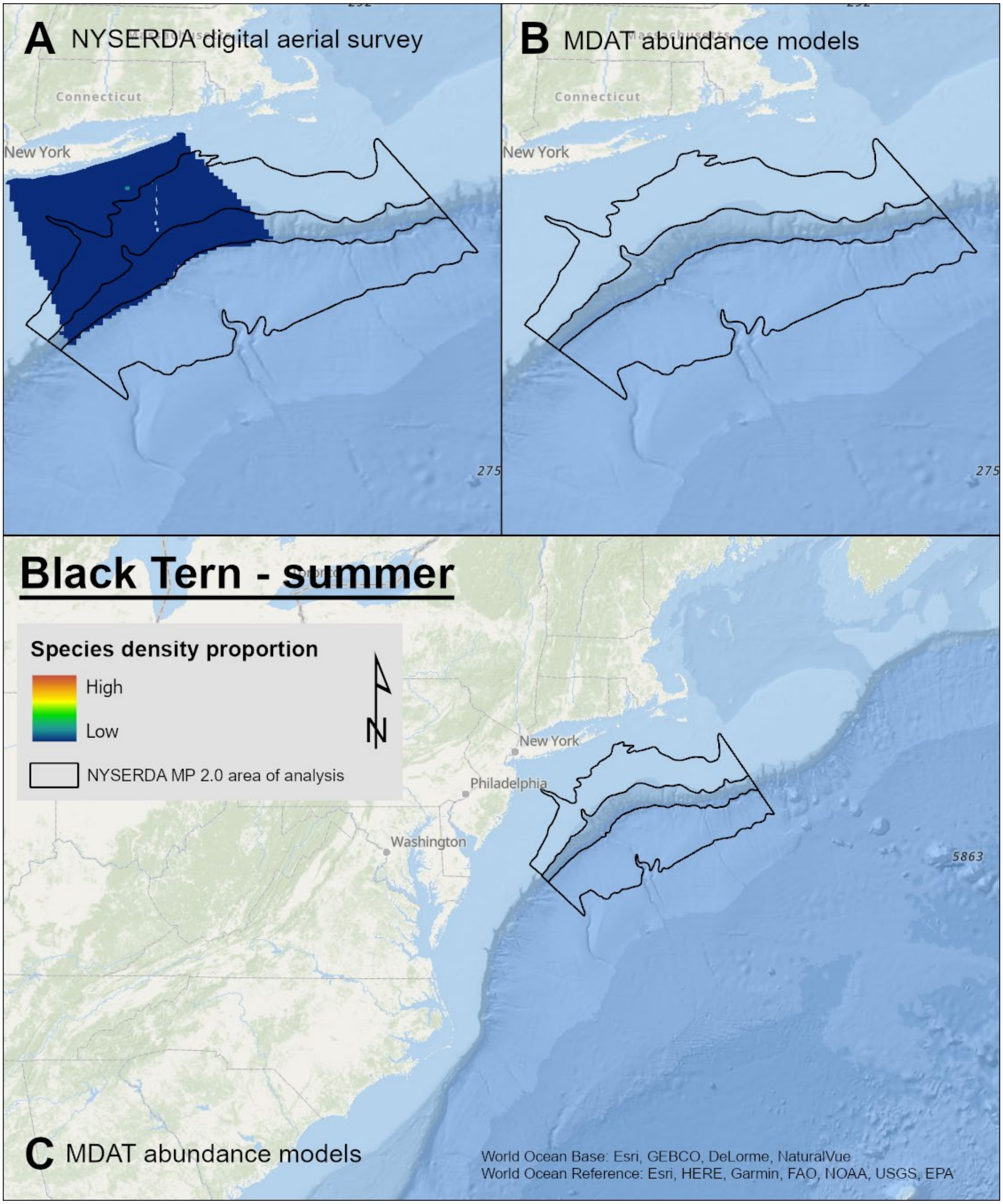
Map B-100. Spring Black Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



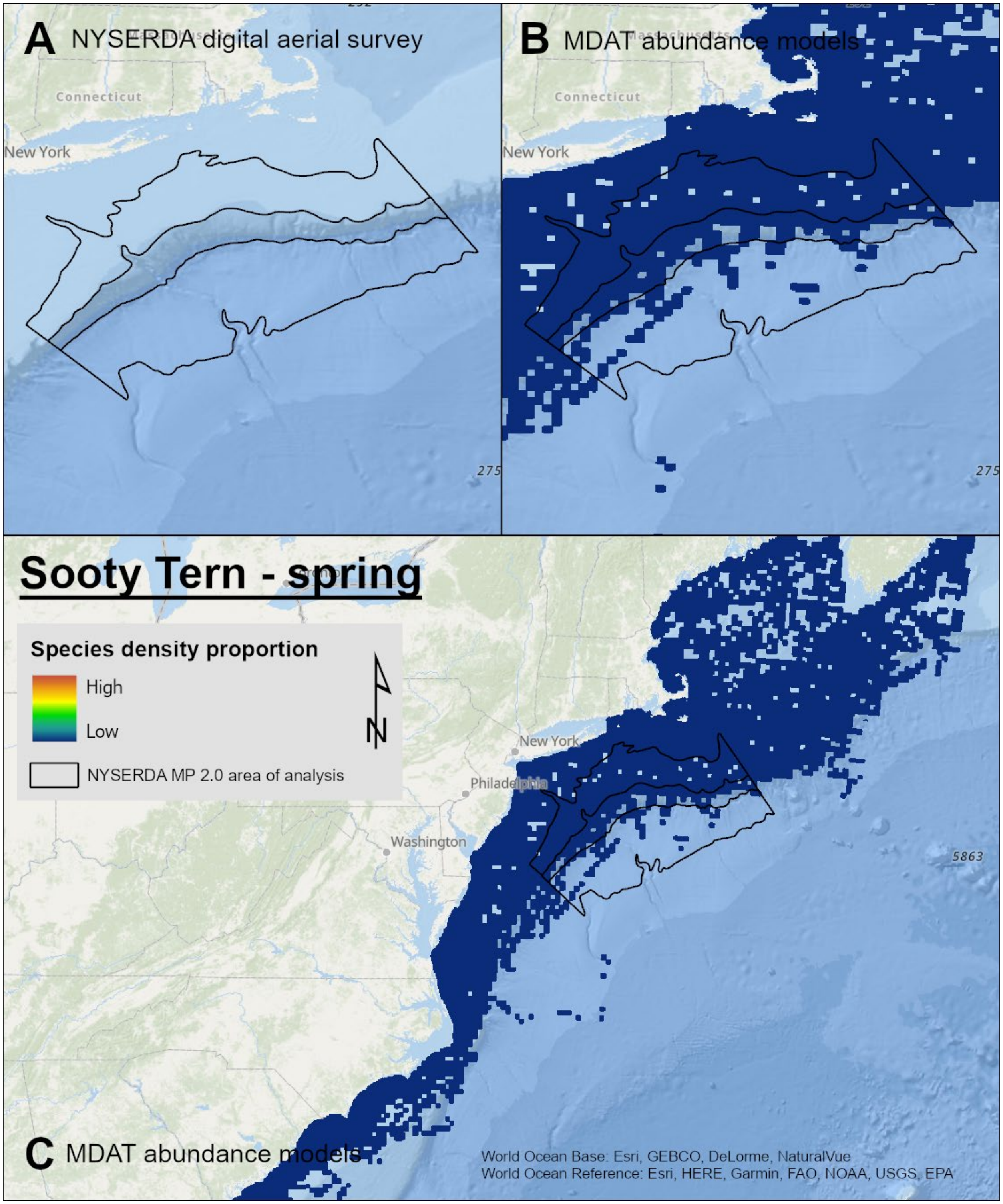
Map B-101. Summer Black Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



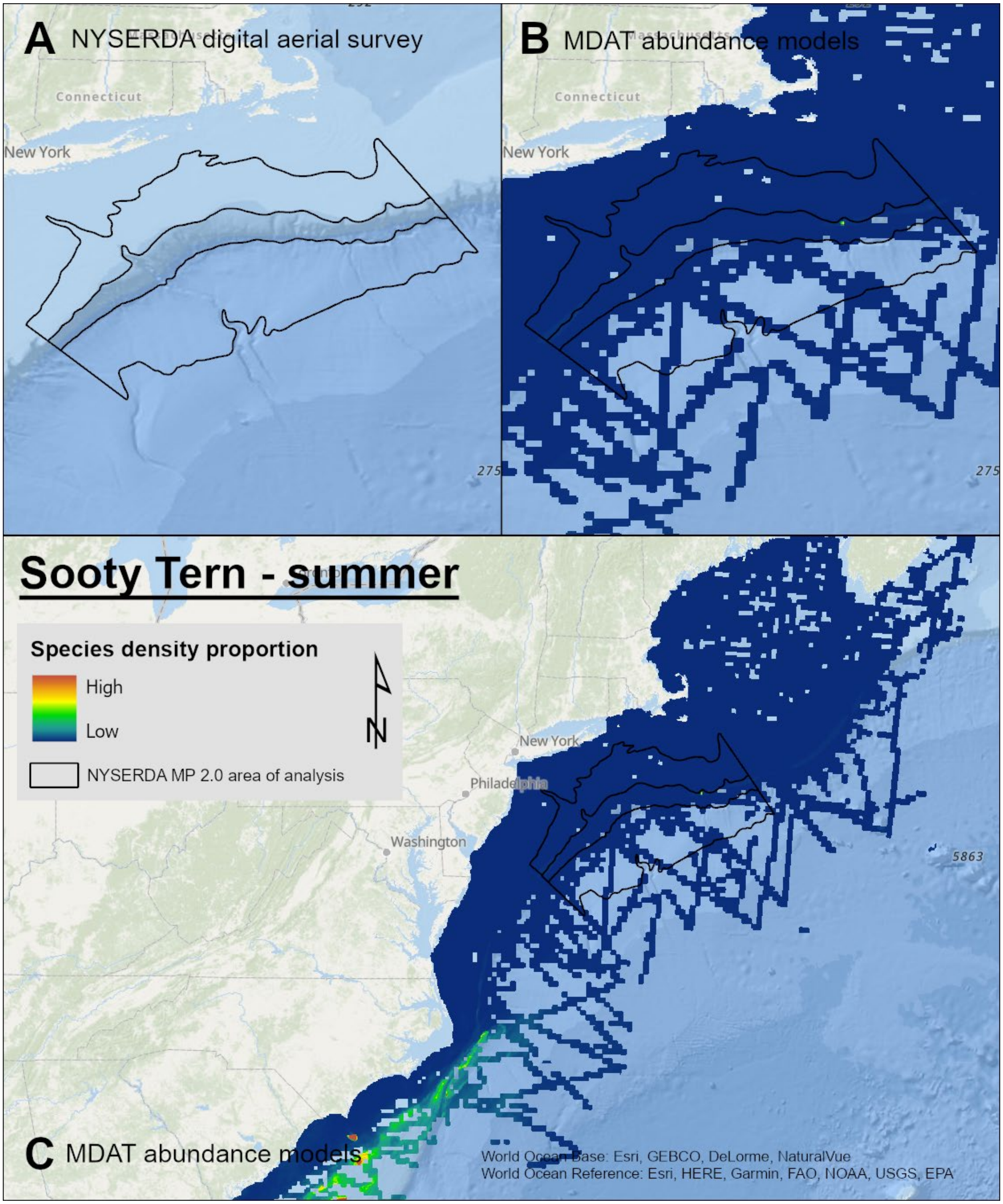
Map B-102. Spring Sooty Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-103. Summer Sooty Tern Density Proportions

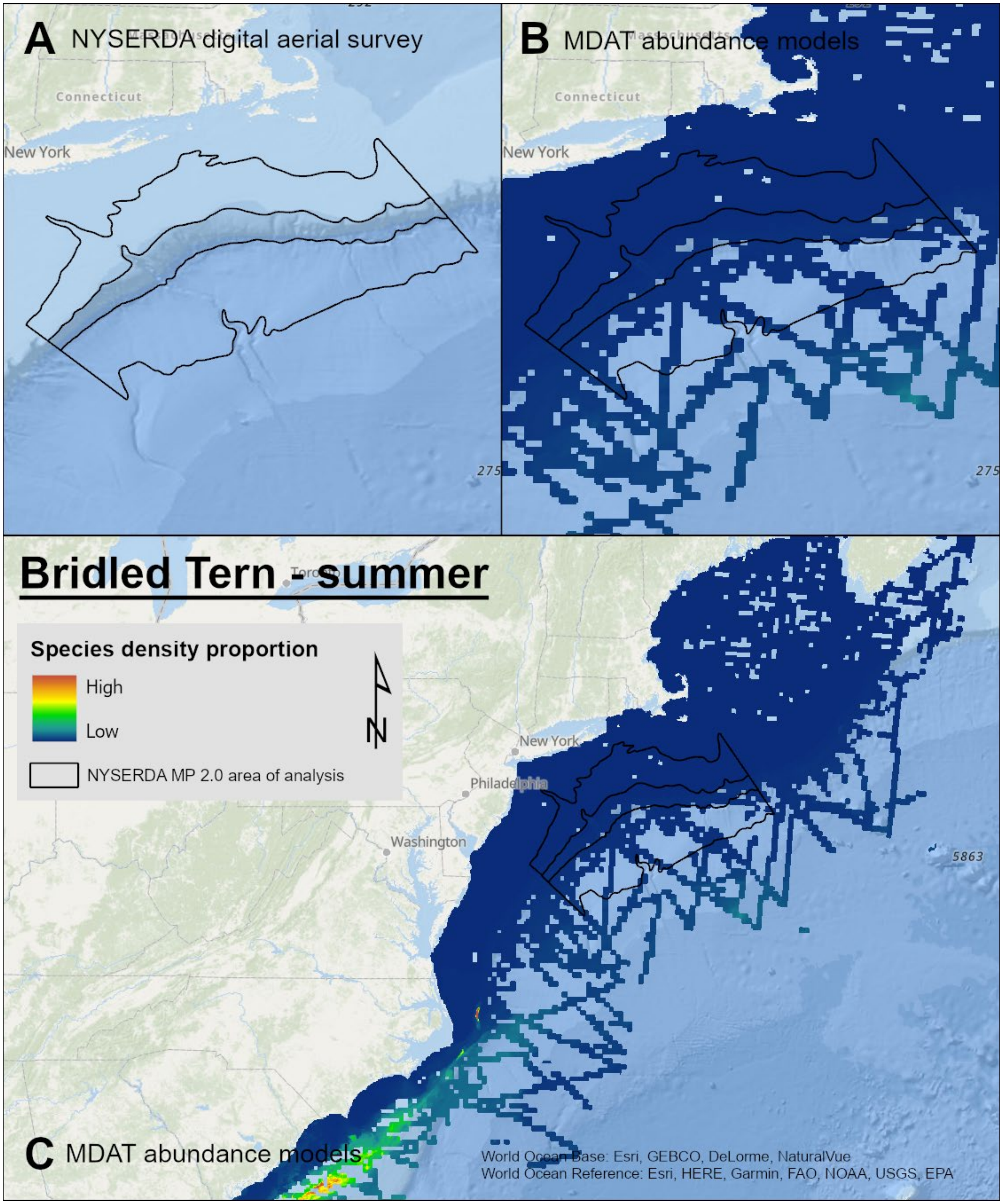
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

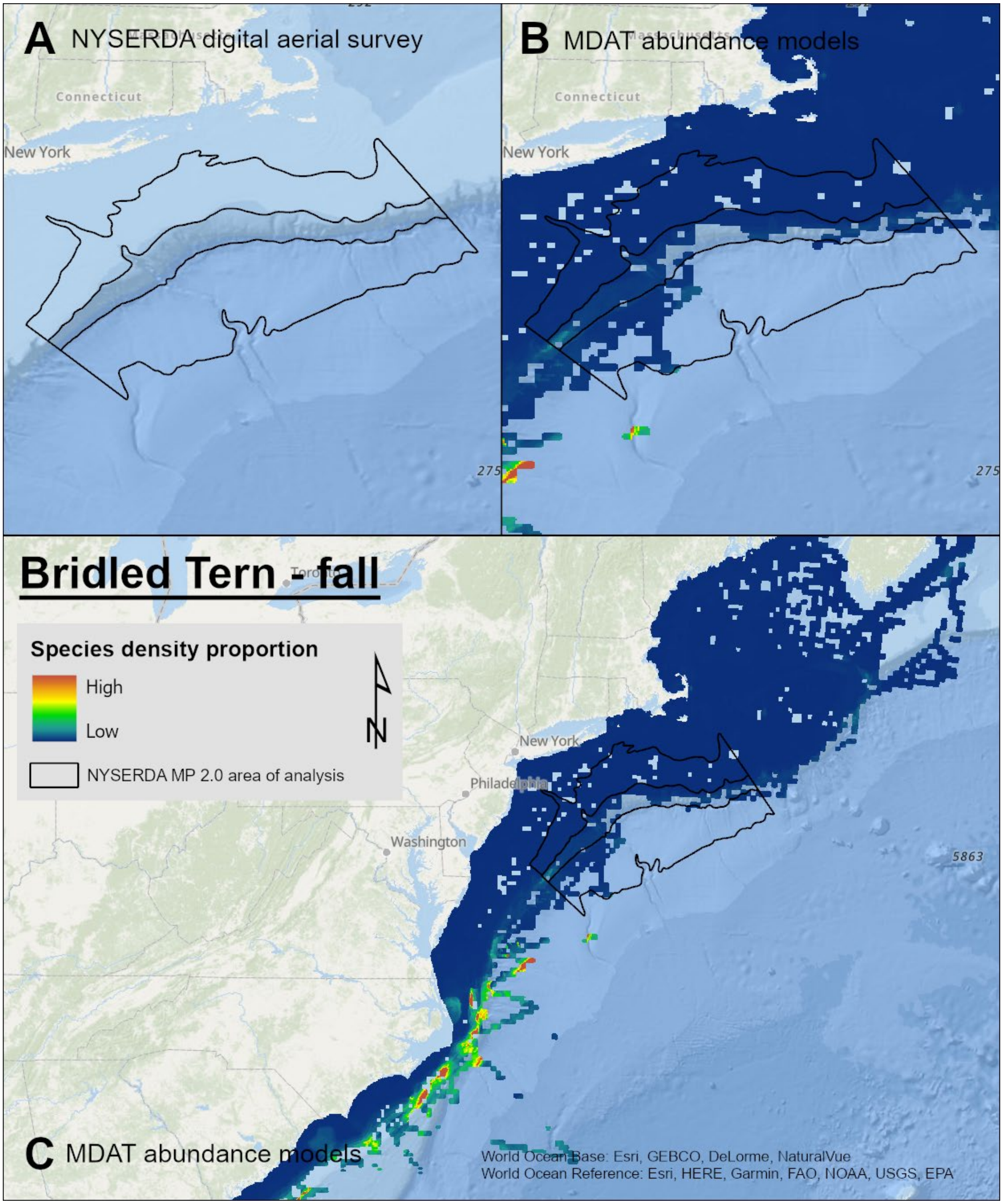
Map B-104. Summer Bridled Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



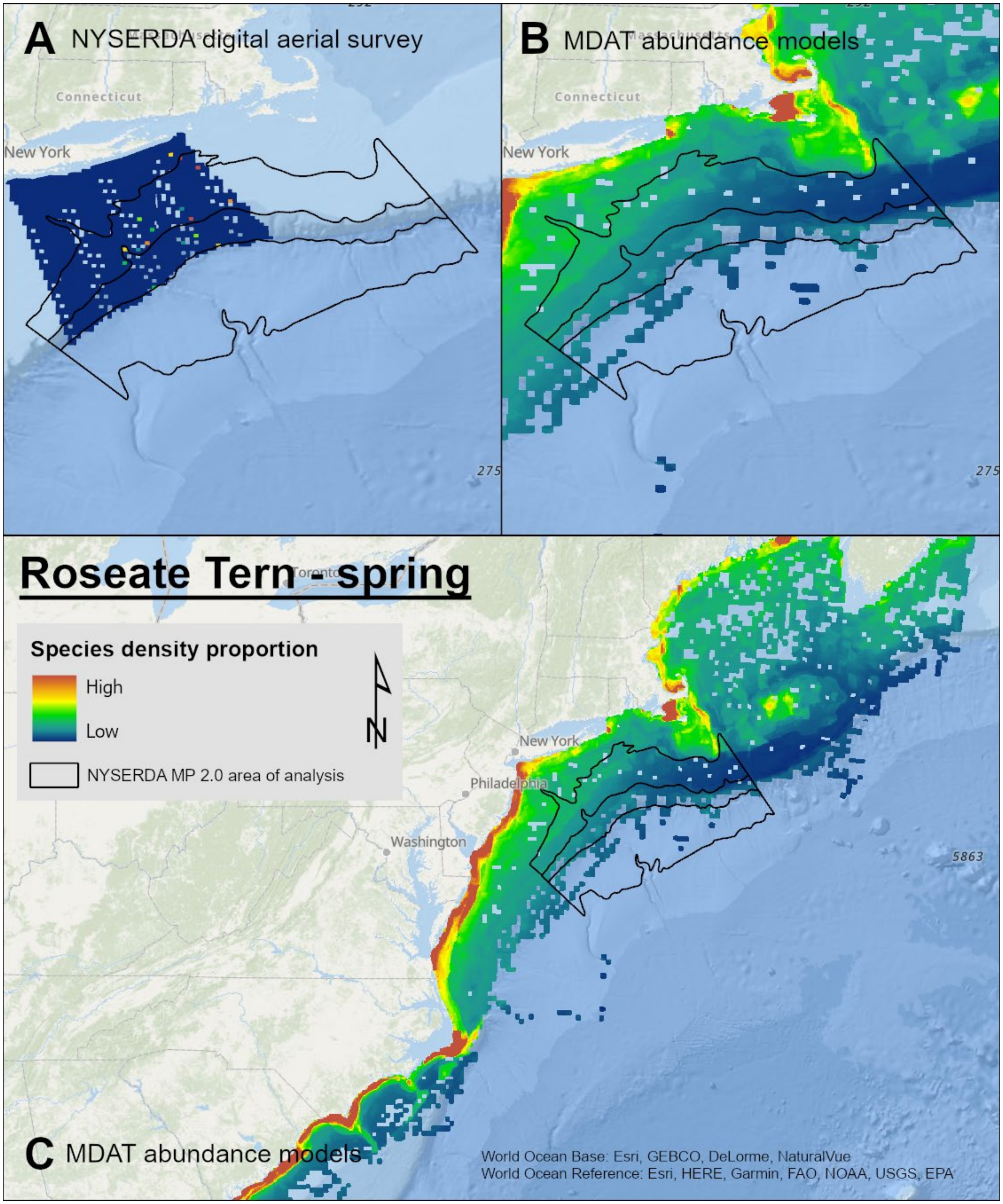
Map B-105. Fall Bridled Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



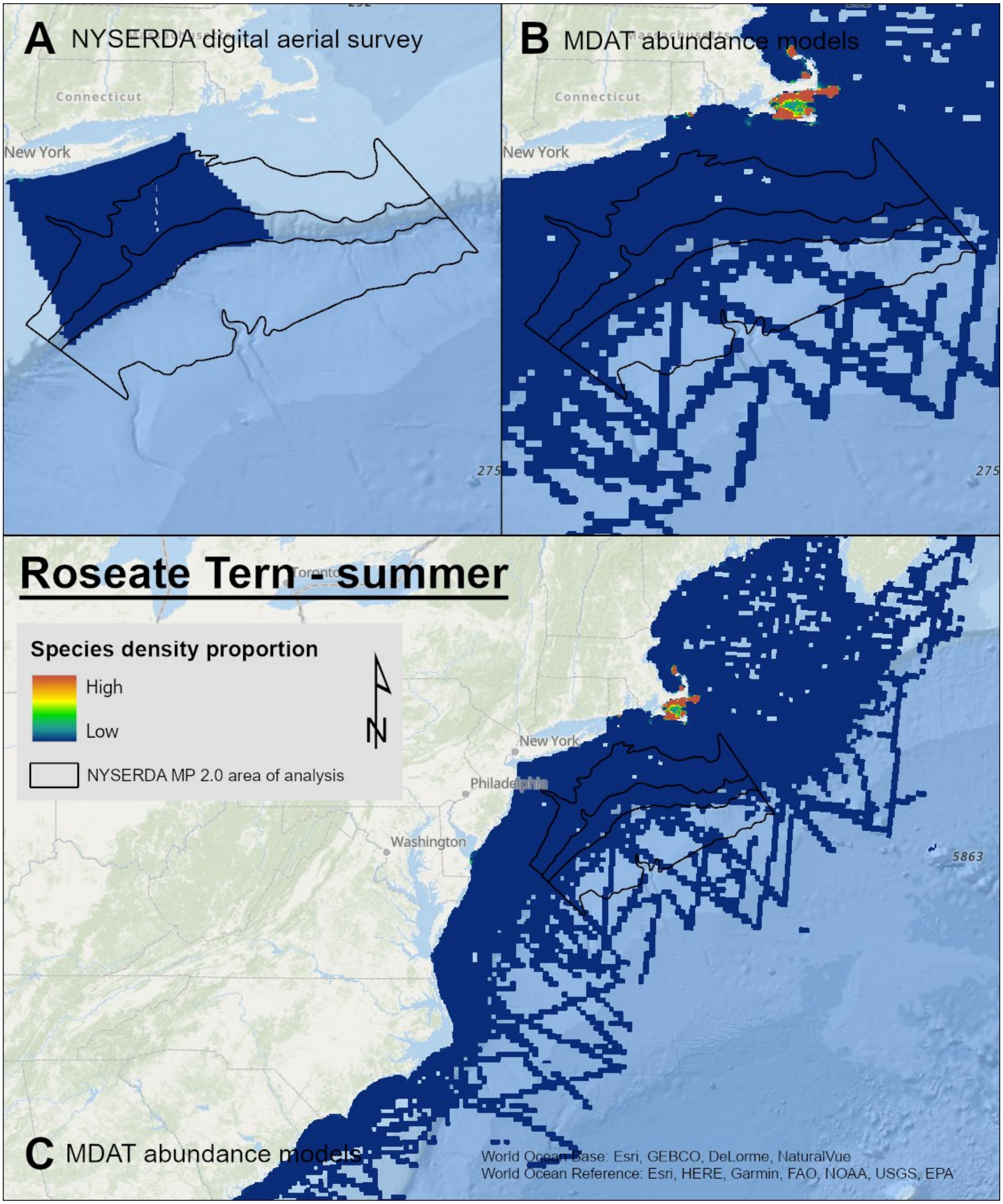
Map B-106. Spring Roseate Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



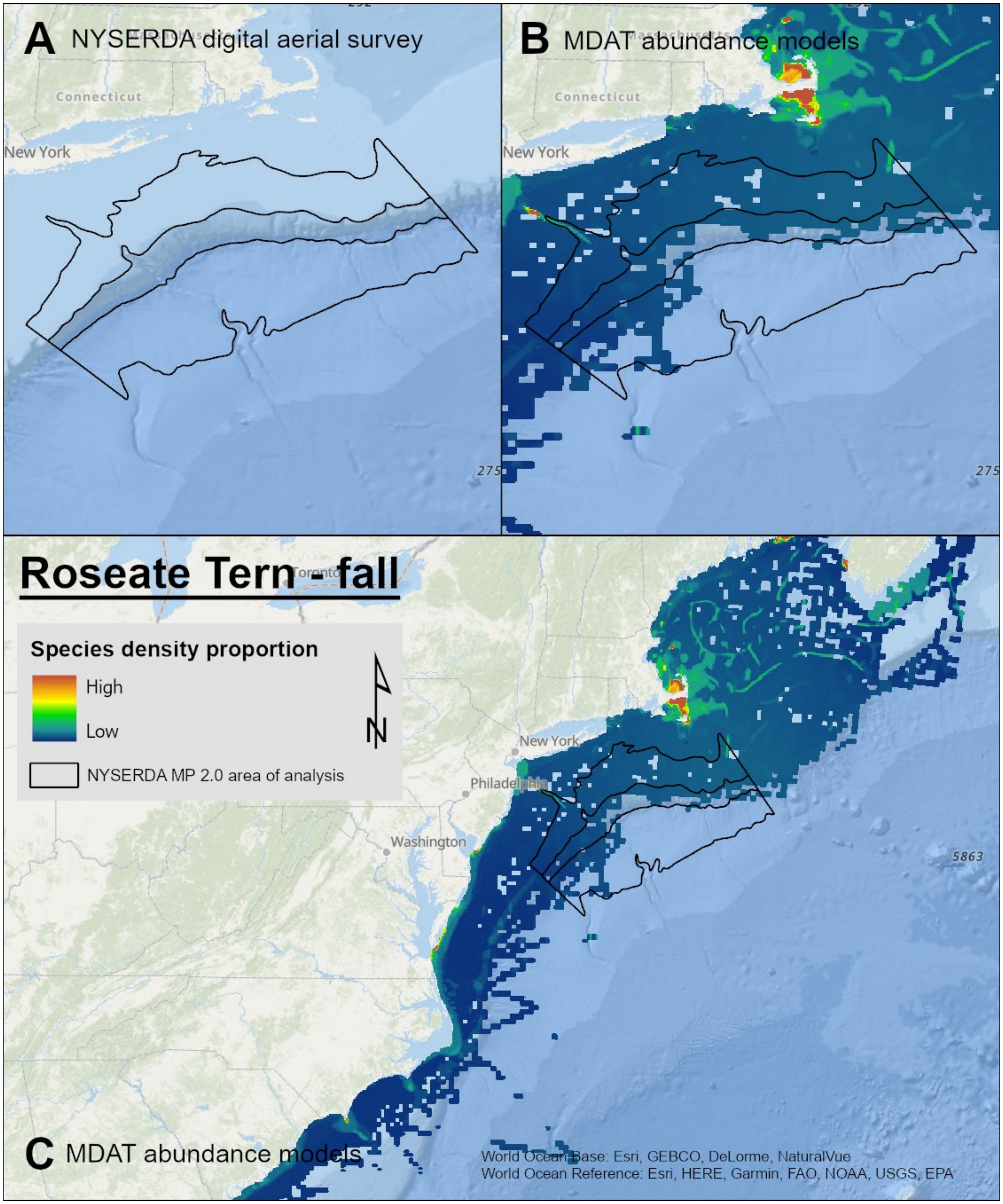
Map B-107. Summer Roseate Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



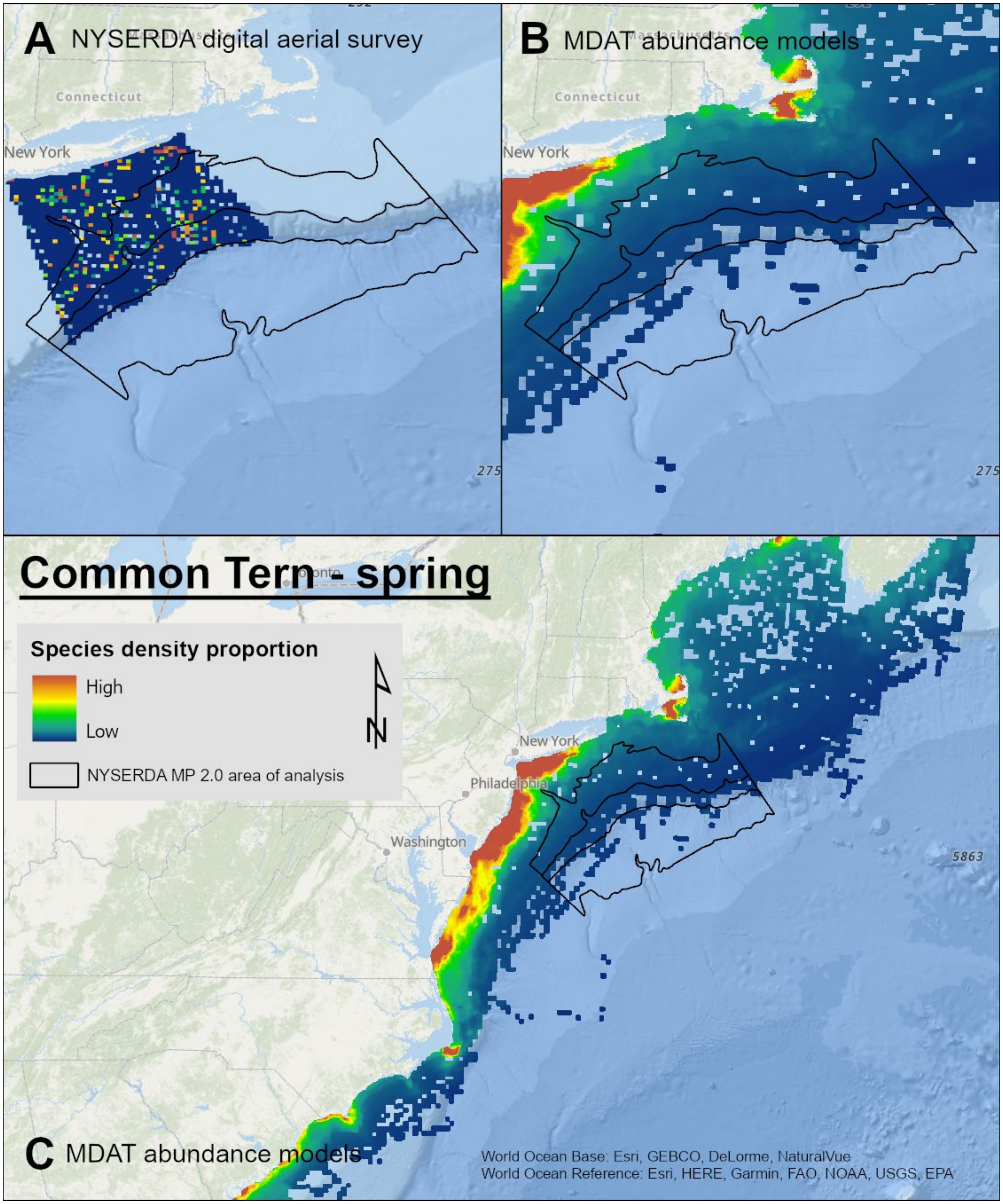
Map B-108. Fall Roseate Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



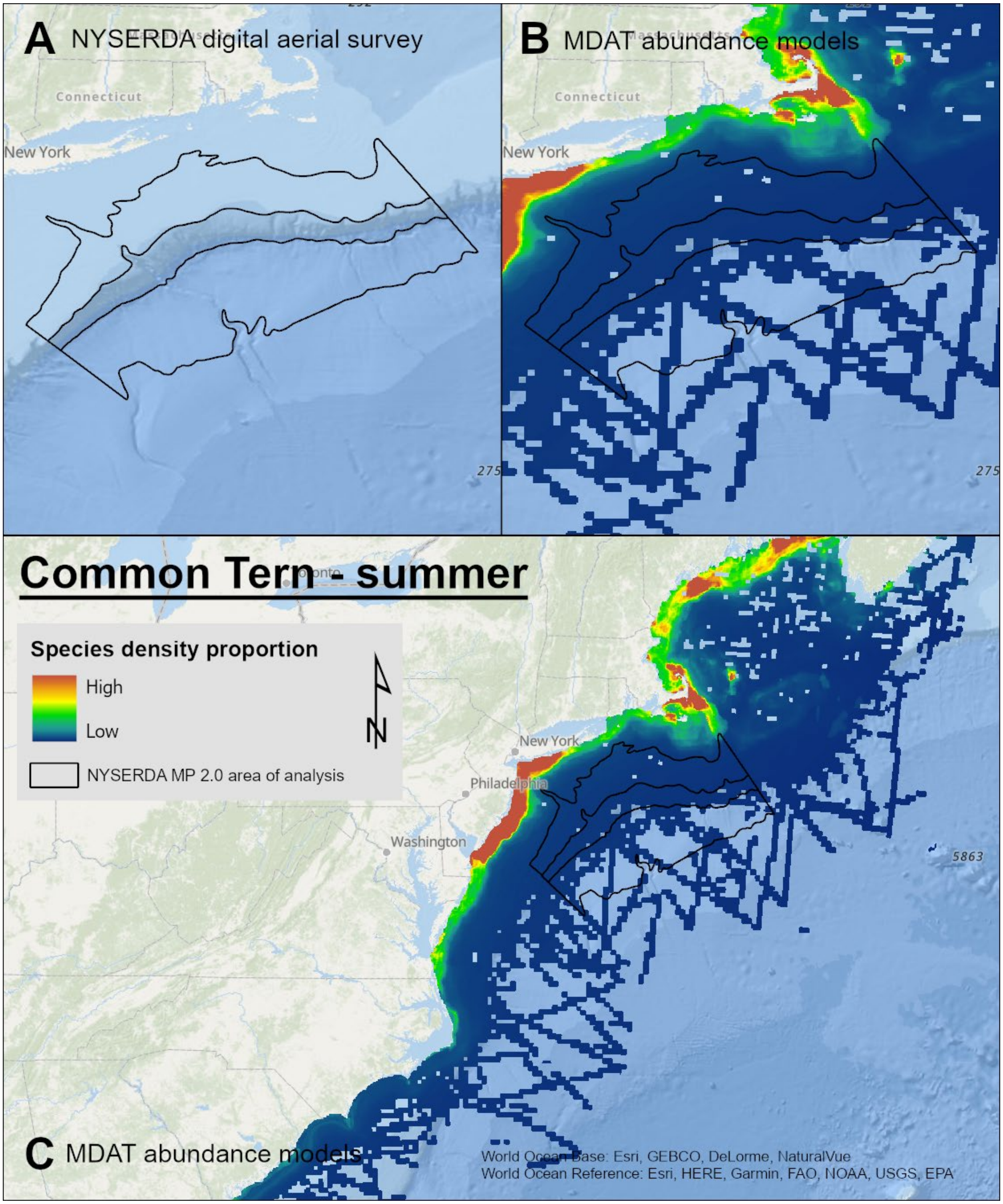
Map B-109. Spring Common Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



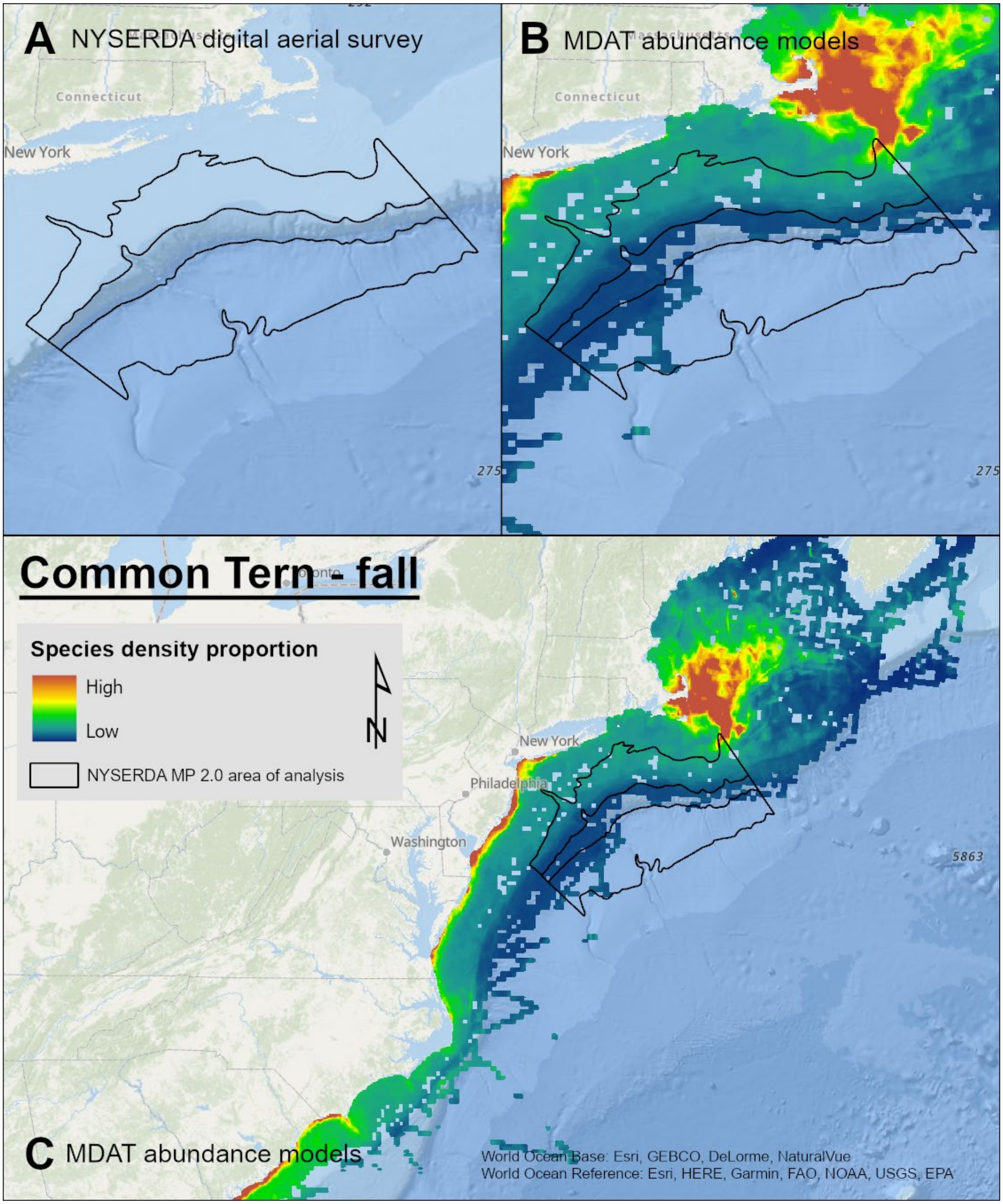
Map B-110. Summer Common Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



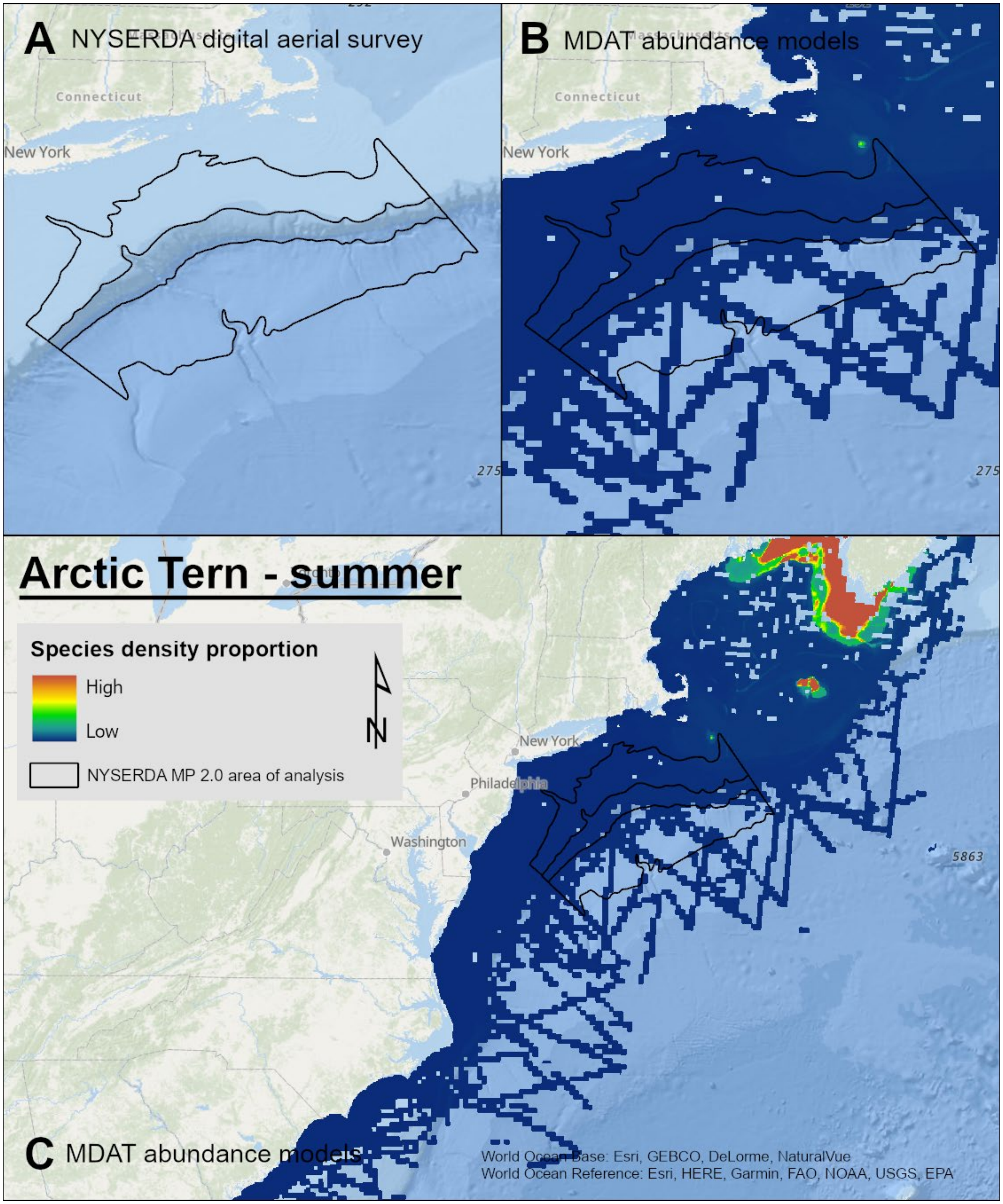
Map B-111. Fall Common Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



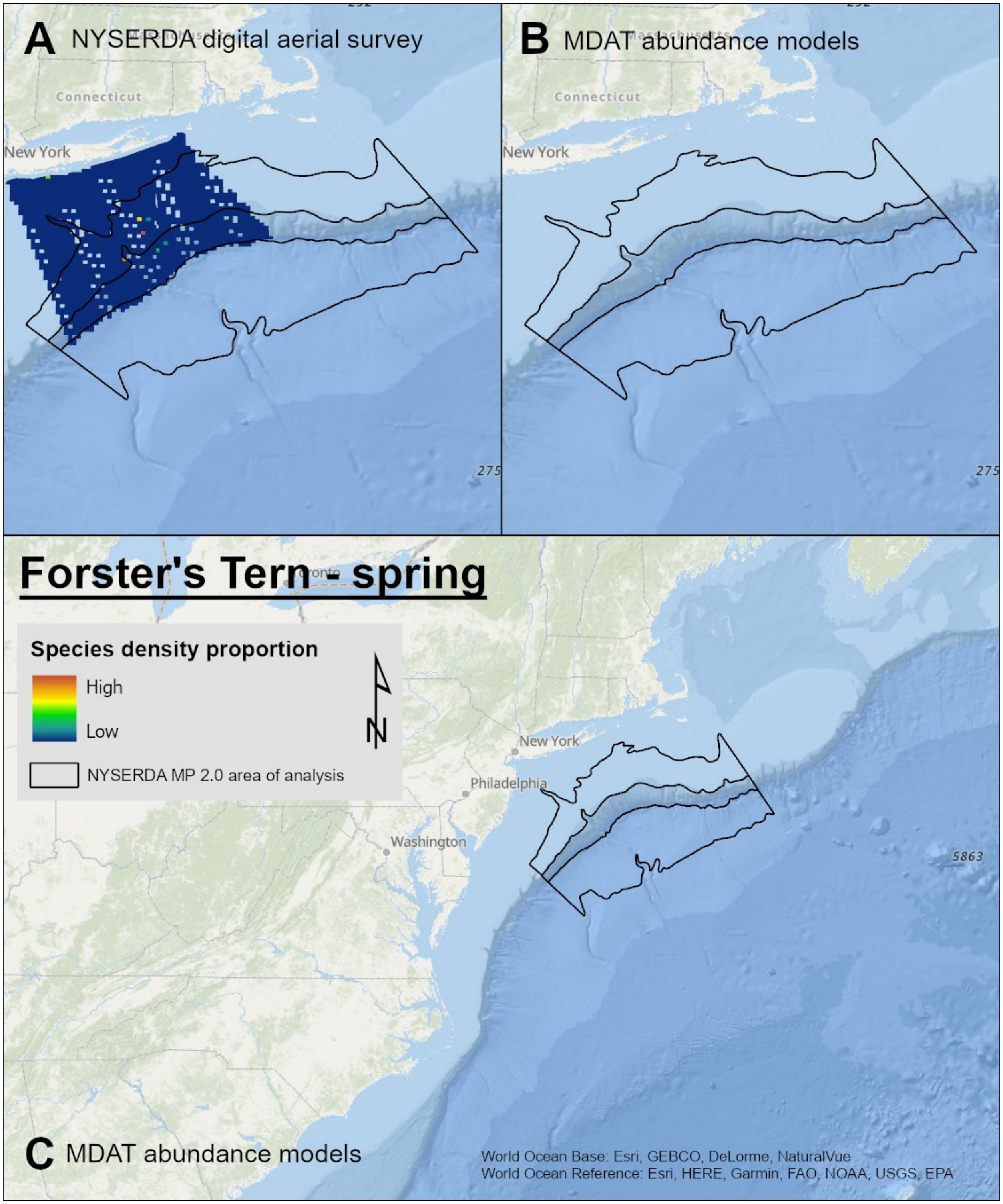
Map B-112. Summer Arctic Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-113. Spring Forster's Tern Density Proportions

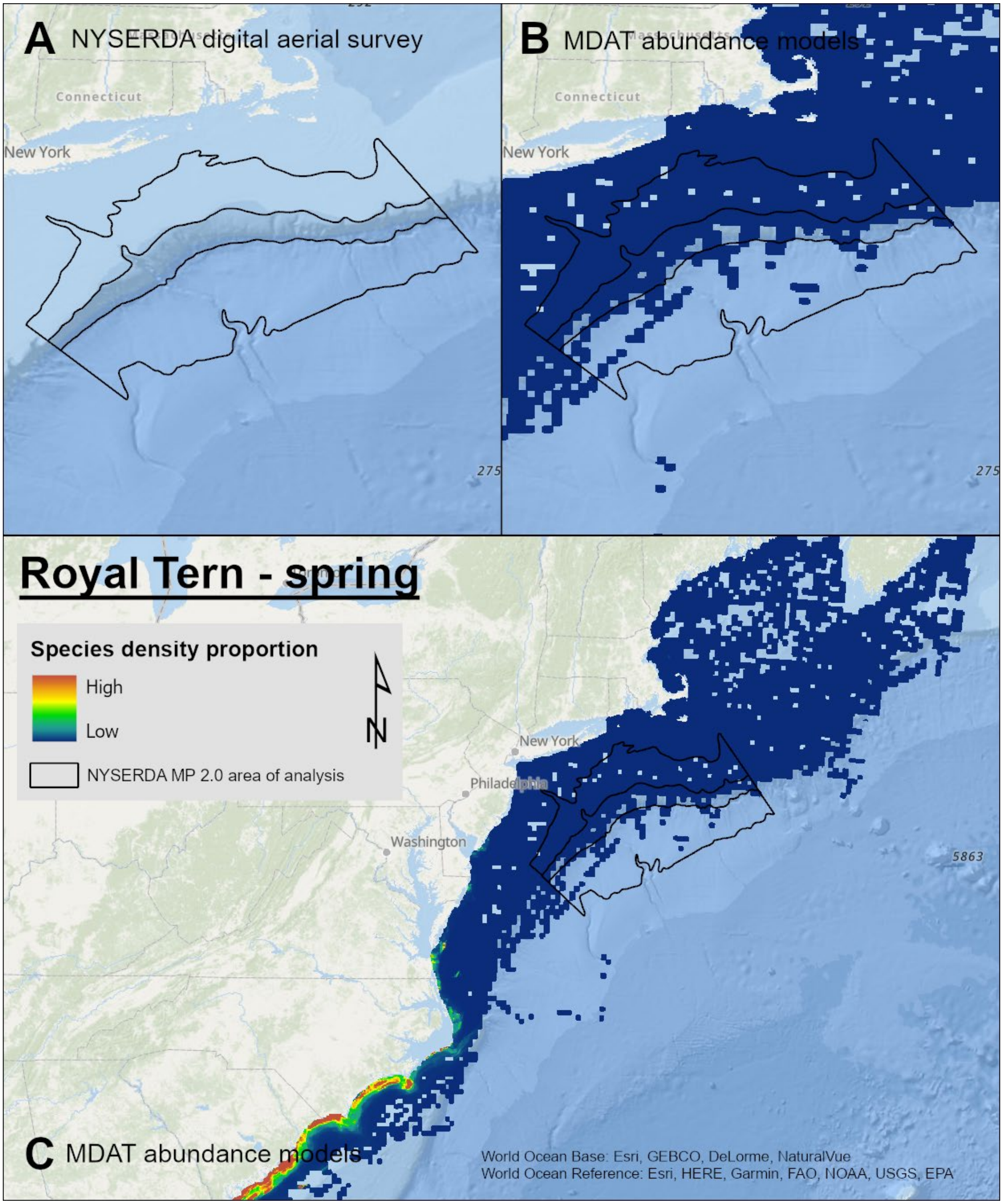
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

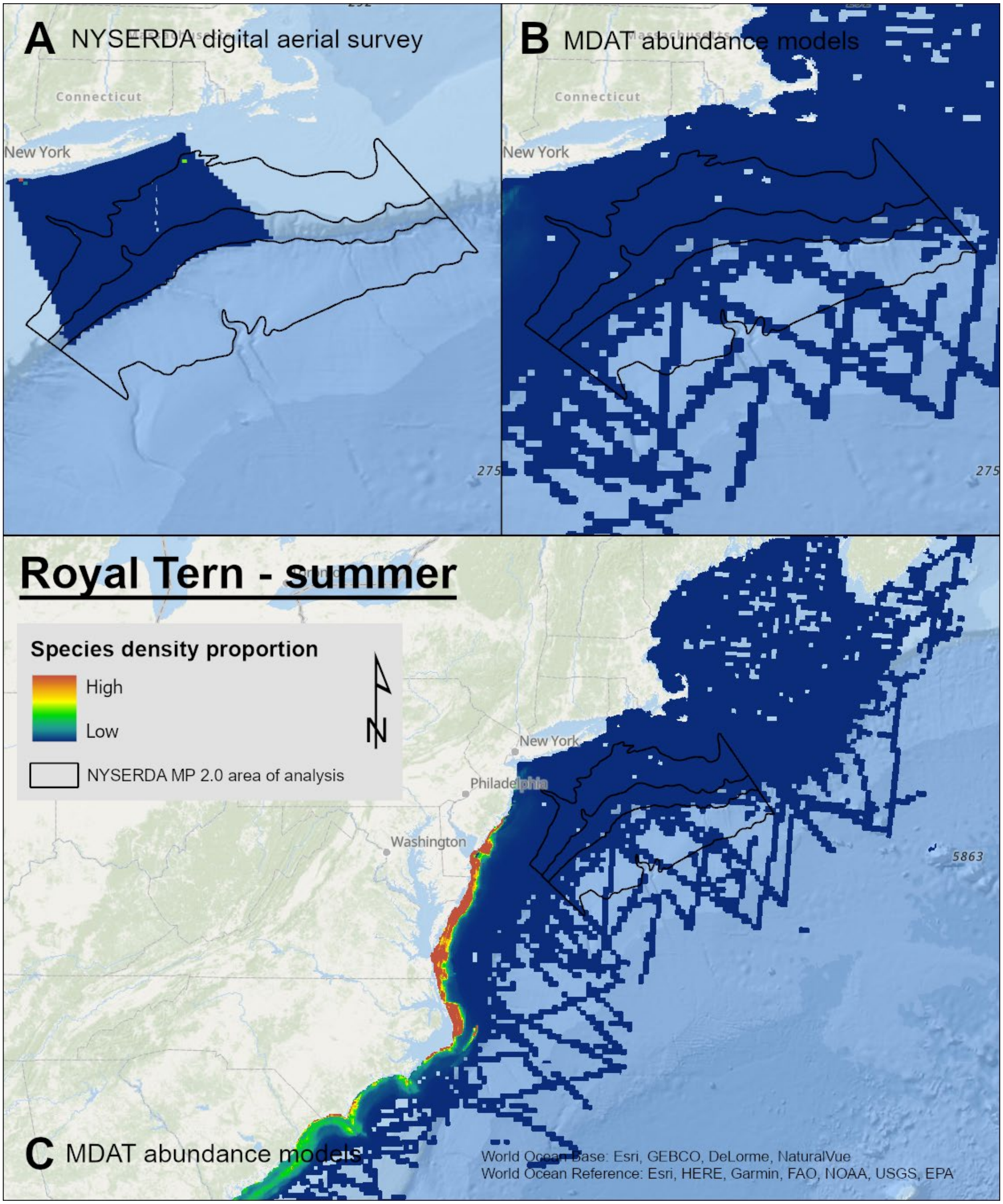
Map B-114. Spring Royal Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



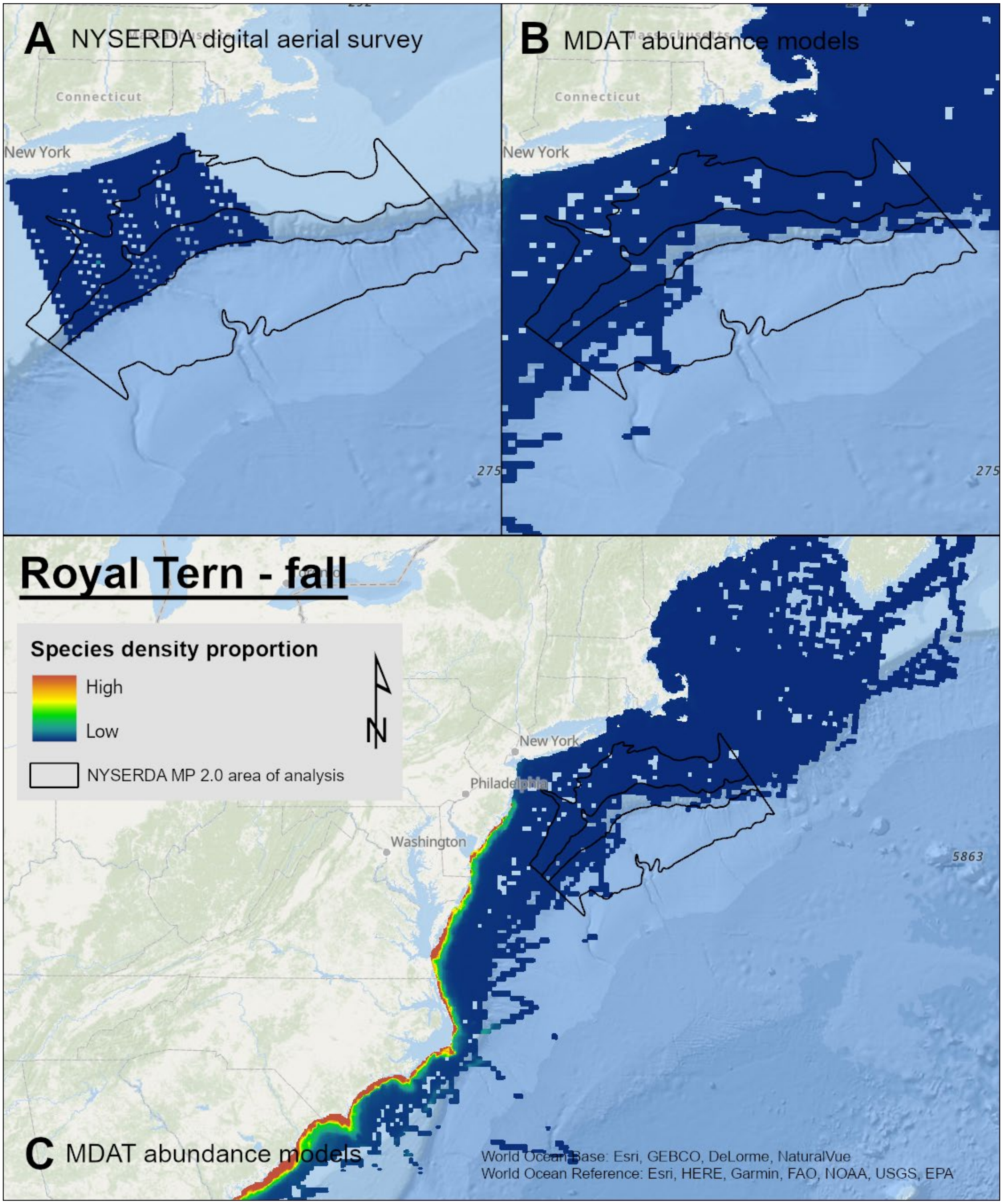
Map B-115. Summer Royal Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



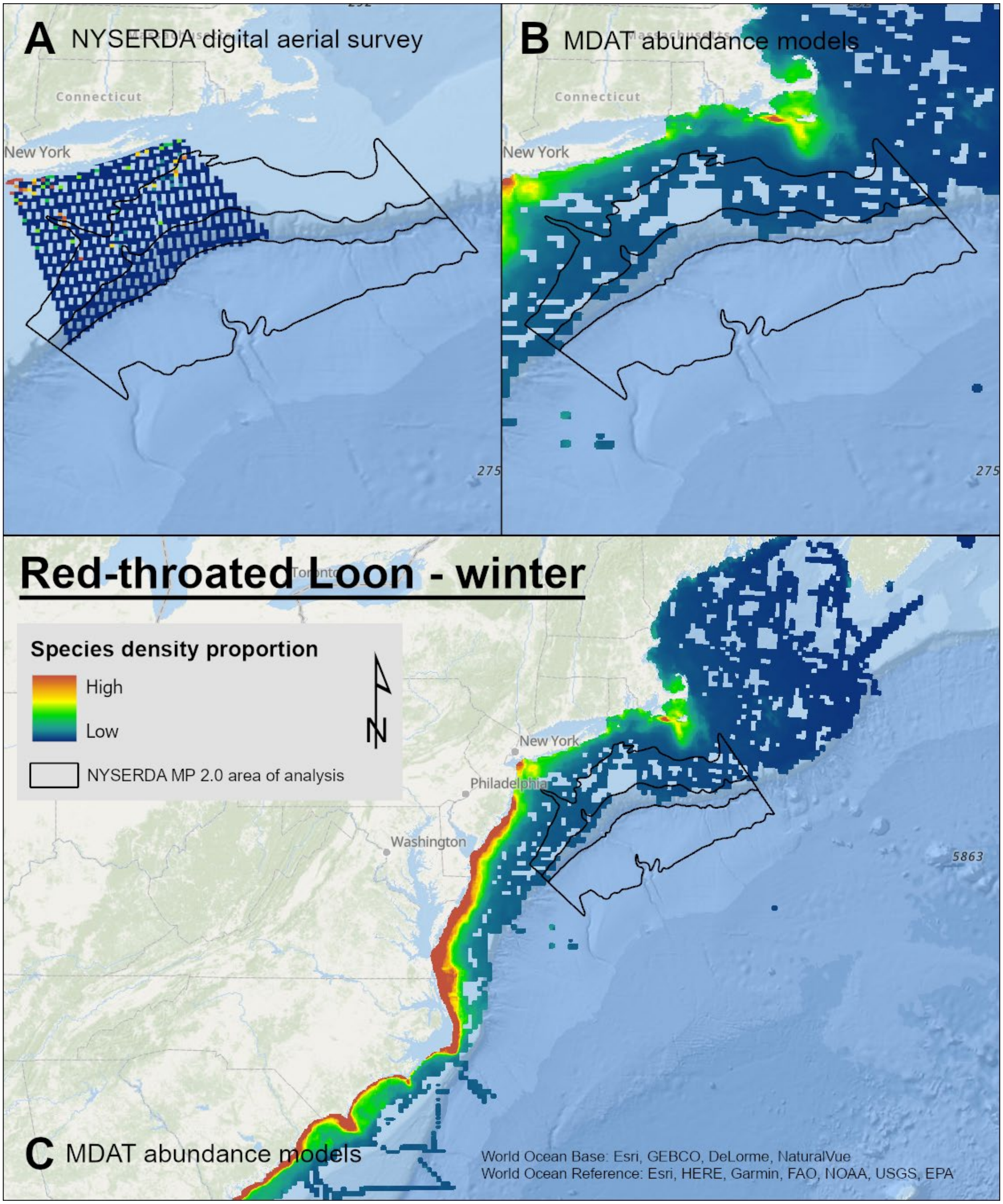
Map B-116. Fall Royal Tern Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



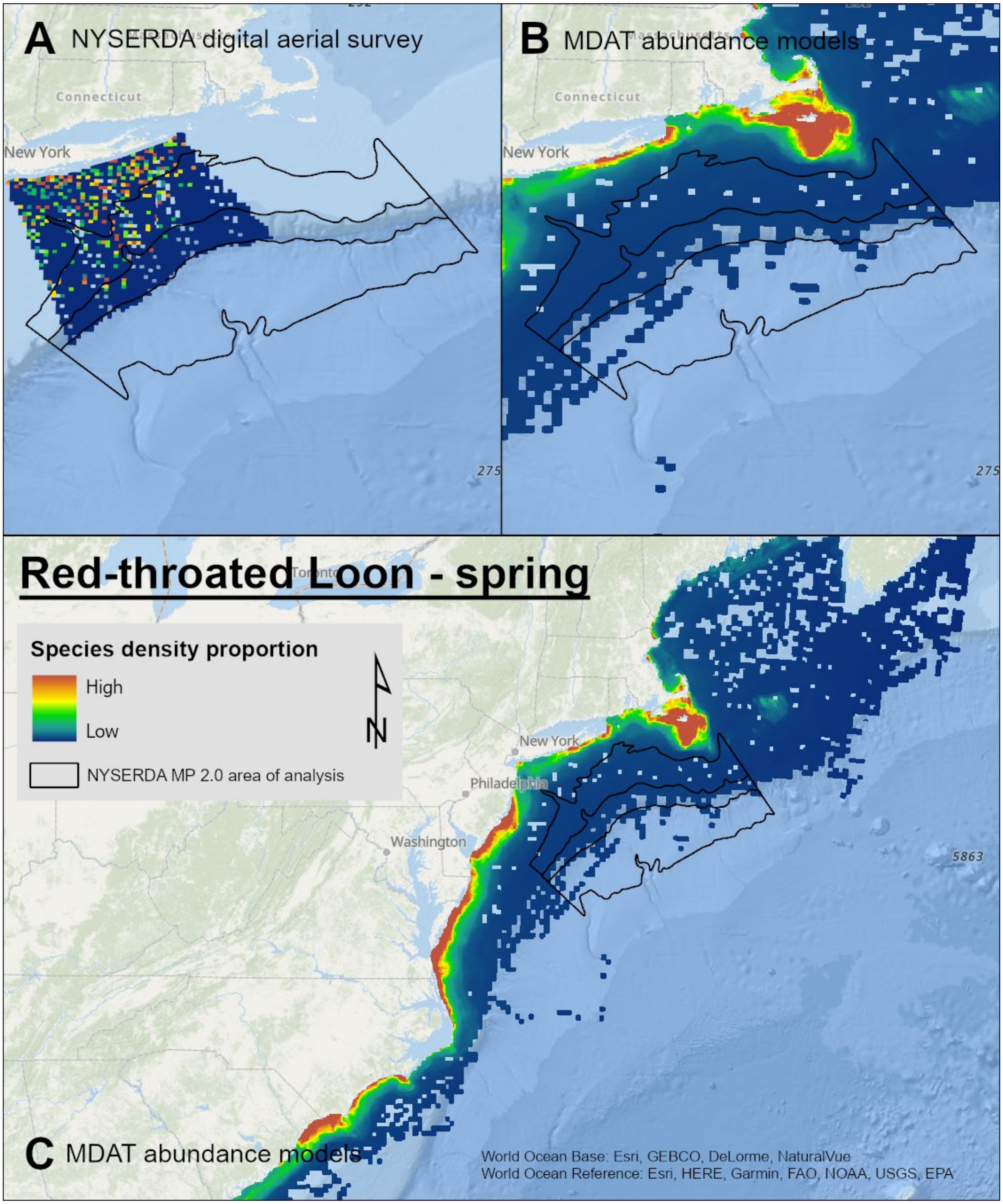
Map B-117. Winter Red-Throated Loon Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



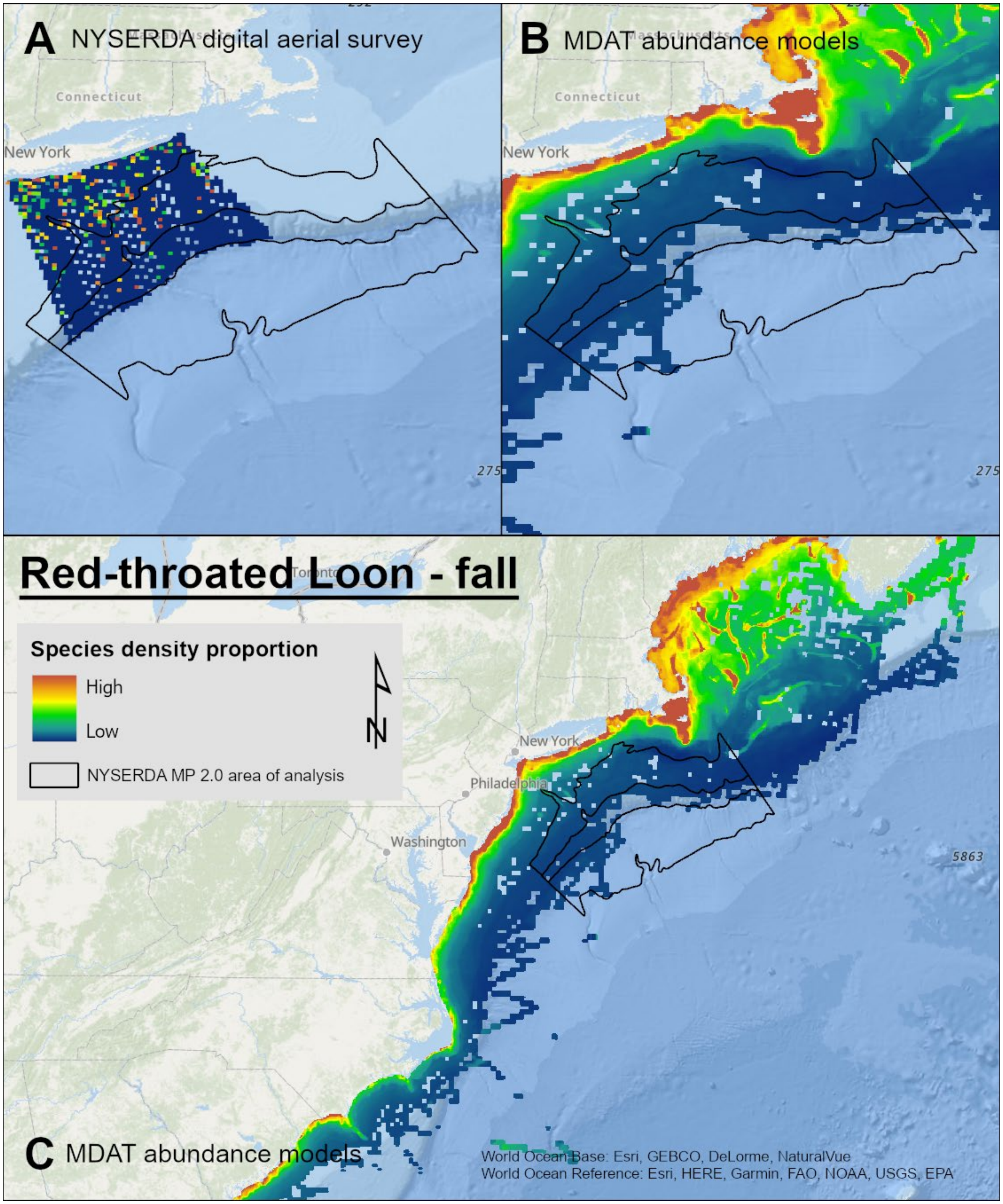
Map B-118. Spring Red-Throated Loon Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



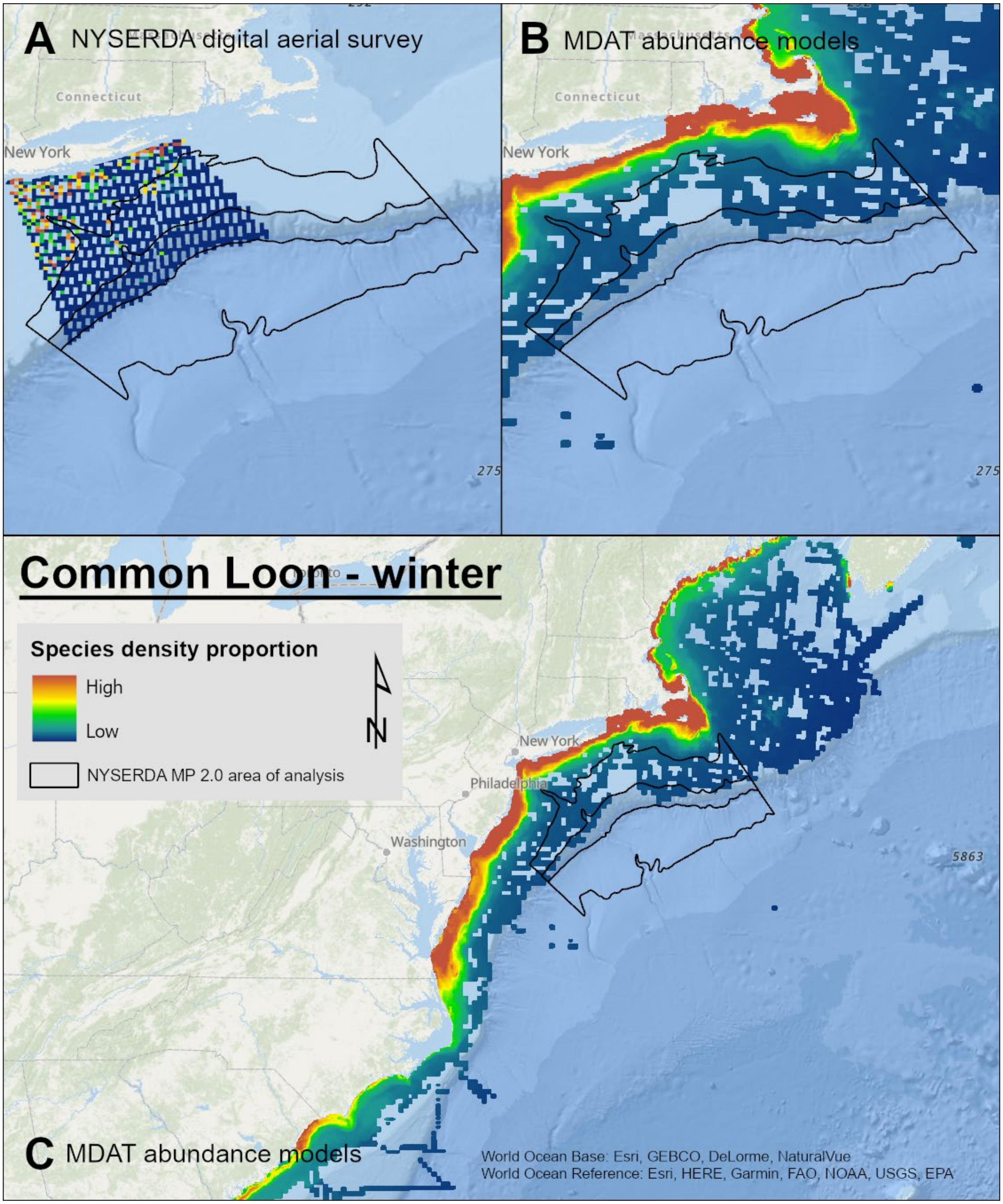
Map B-119. Fall Red-Throated Loon Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



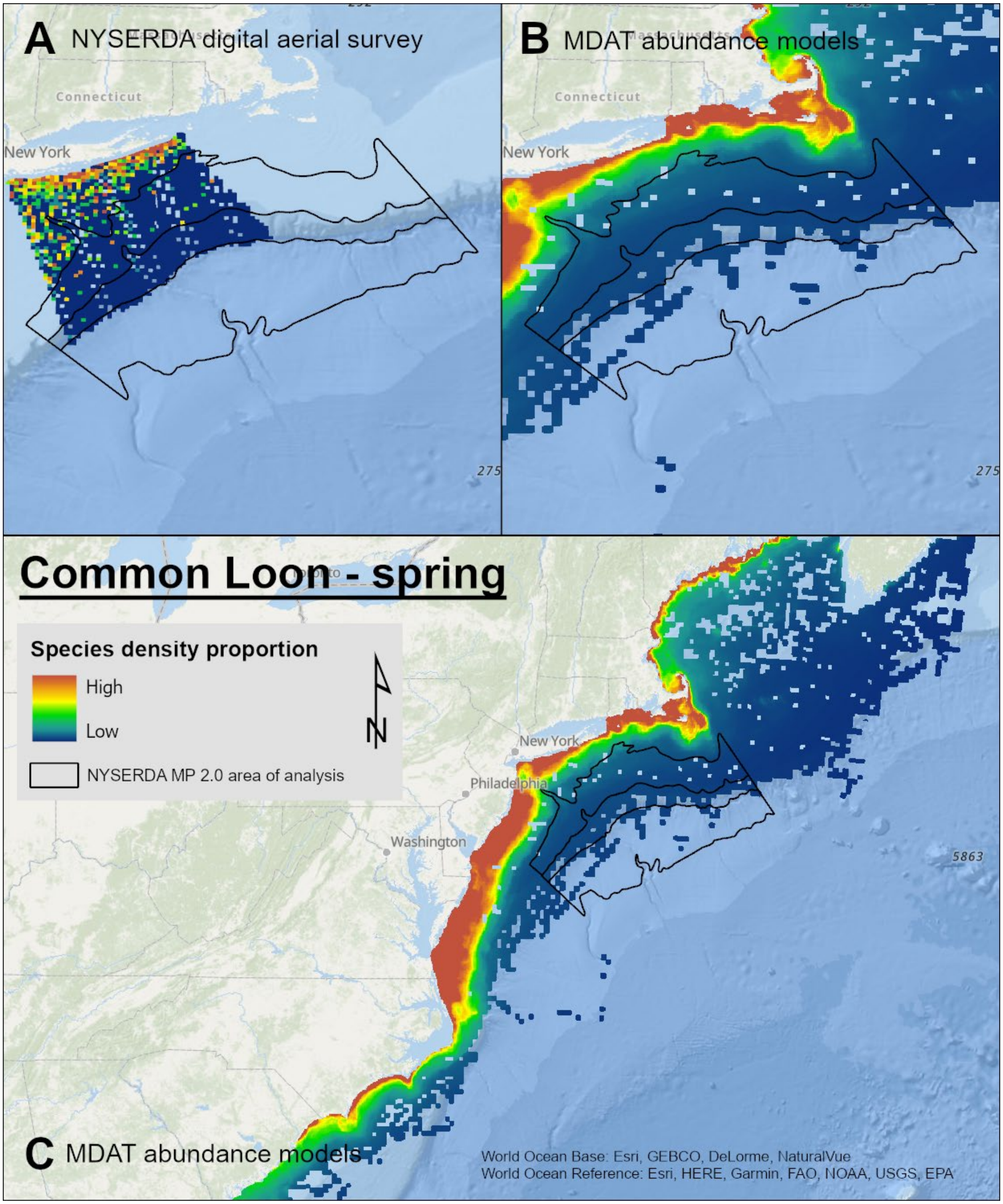
Map B-120. Winter Common Loon Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



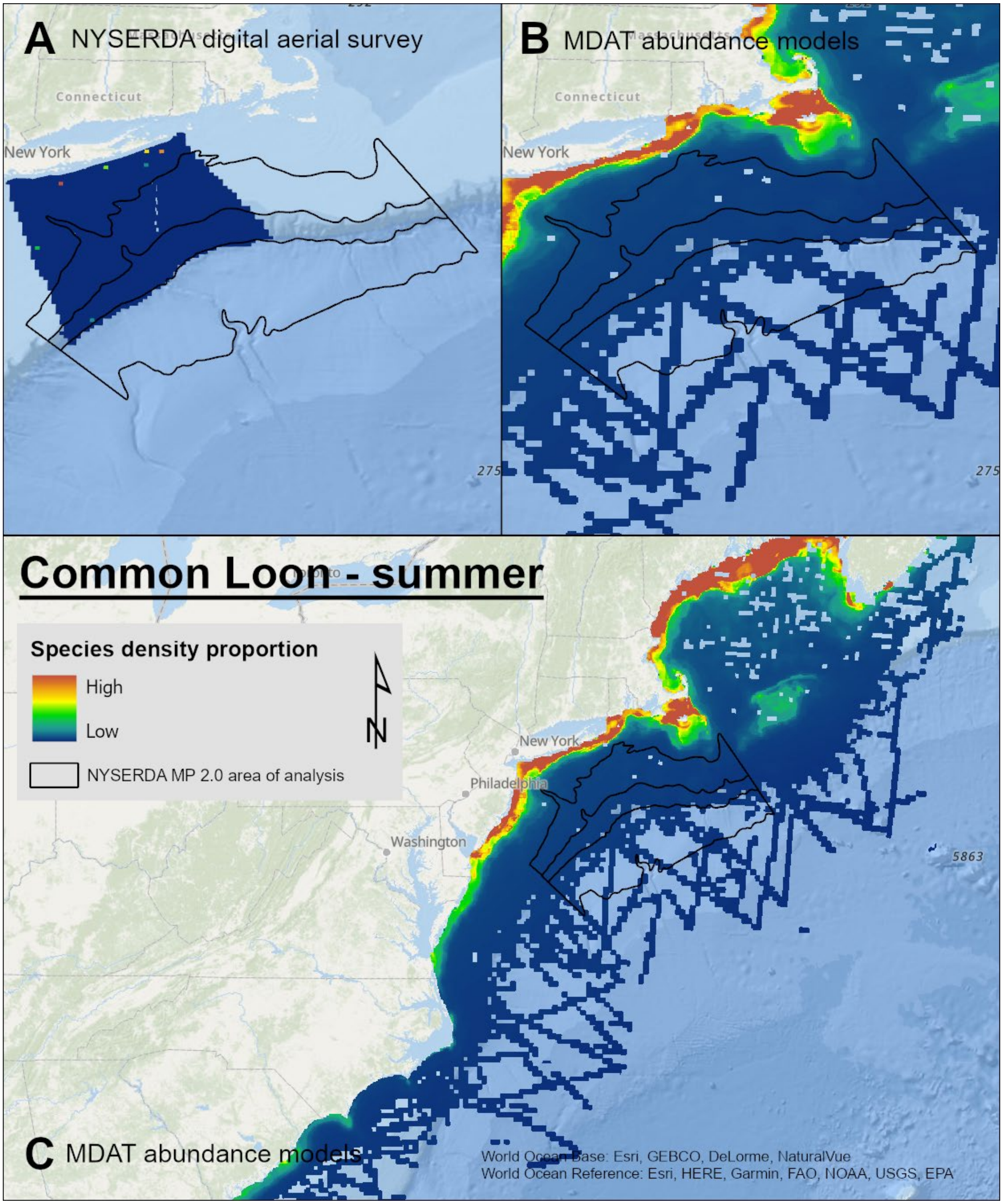
Map B-121. Spring Common Loon Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



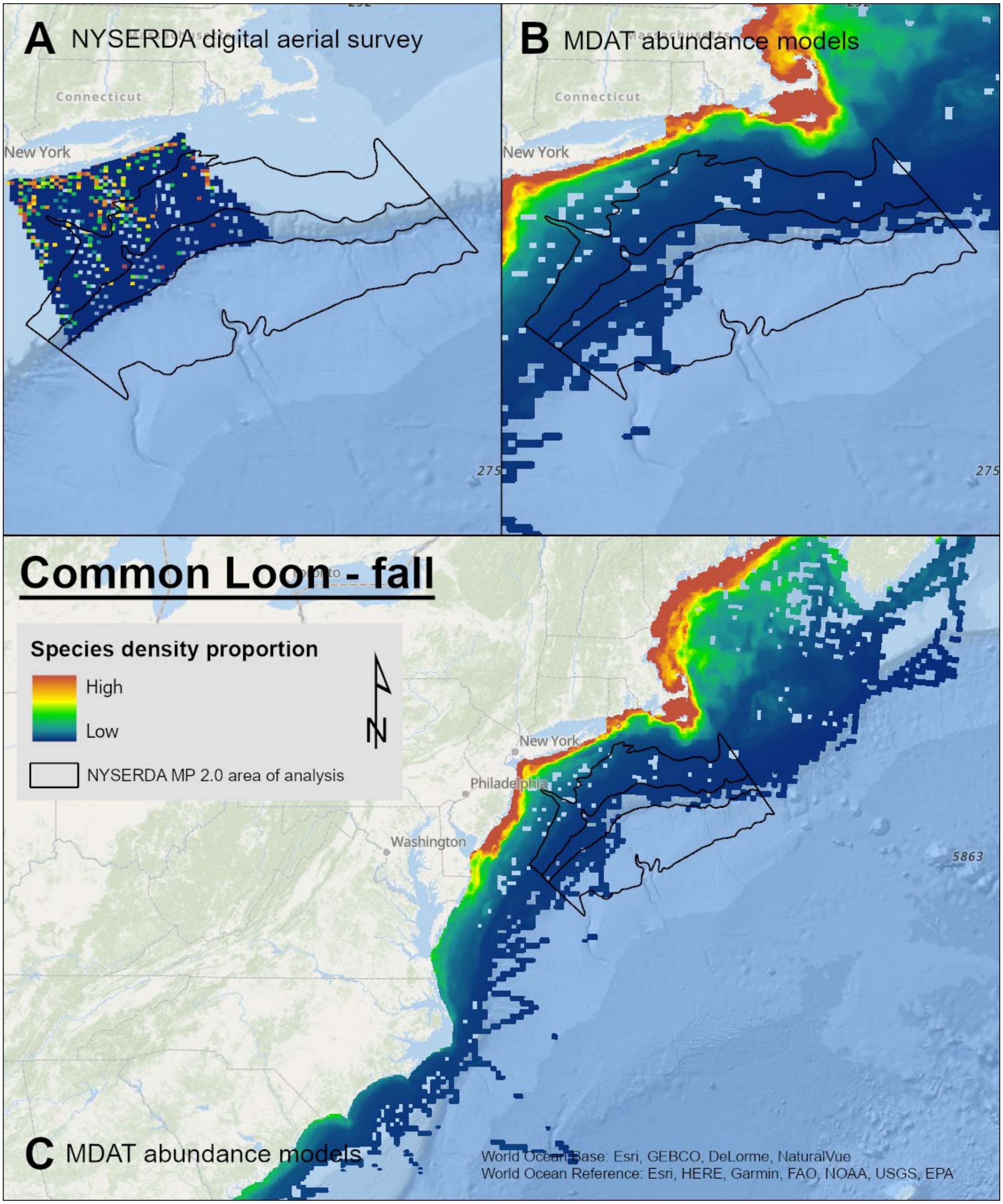
Map B-122. Summer Common Loon Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



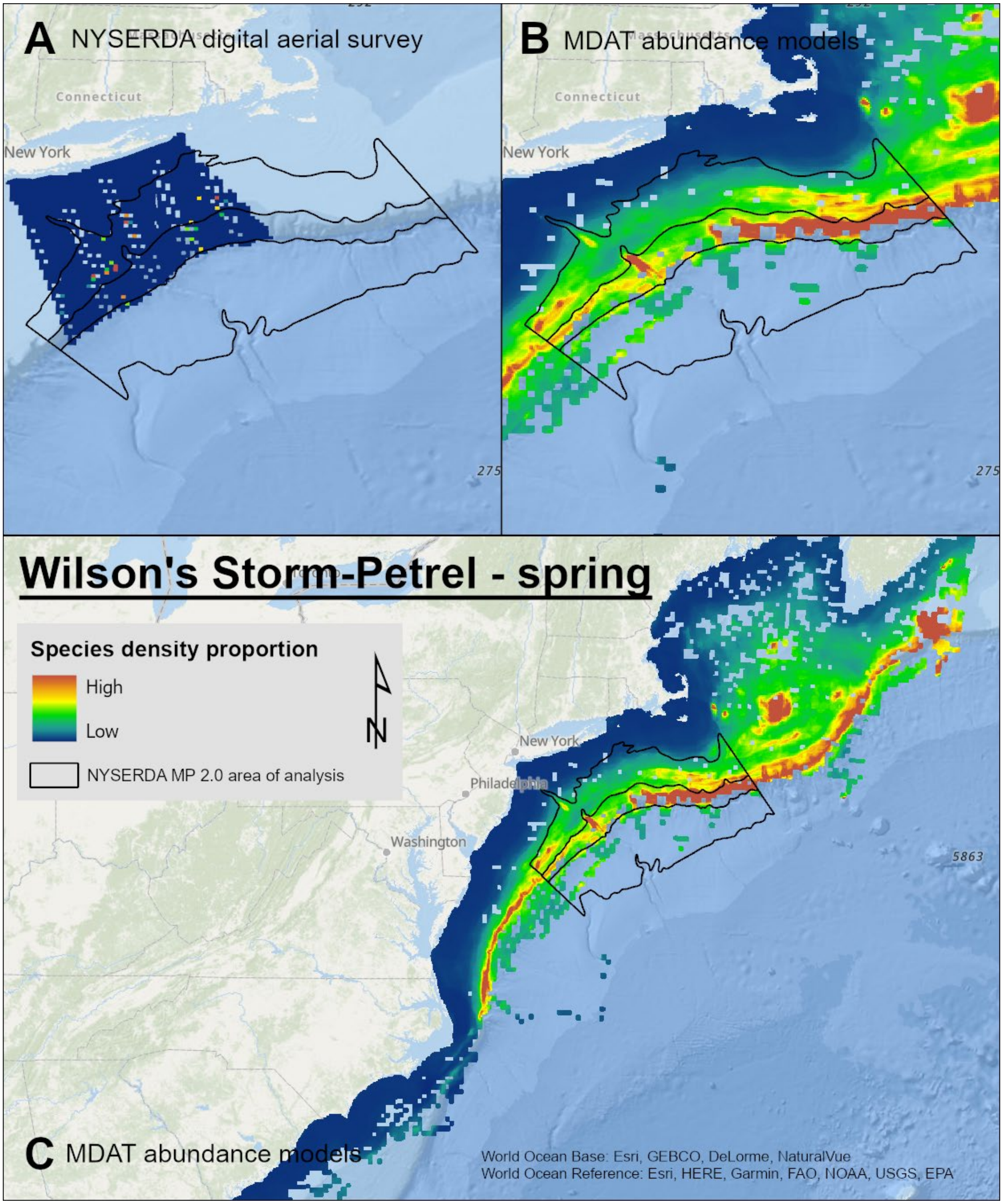
Map B-123. Fall Common Loon Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



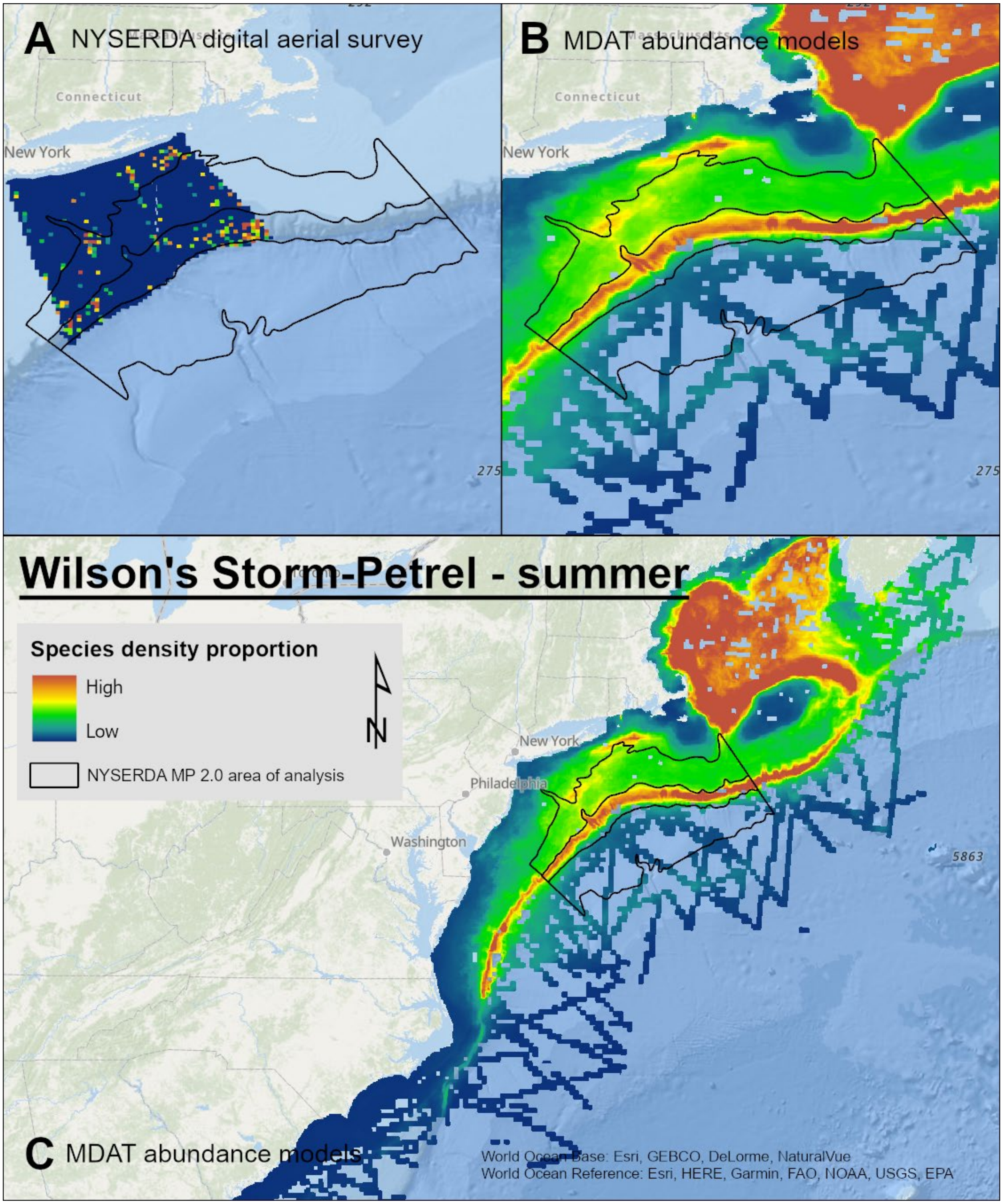
Map B- 124. Spring Wilson's Storm-Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



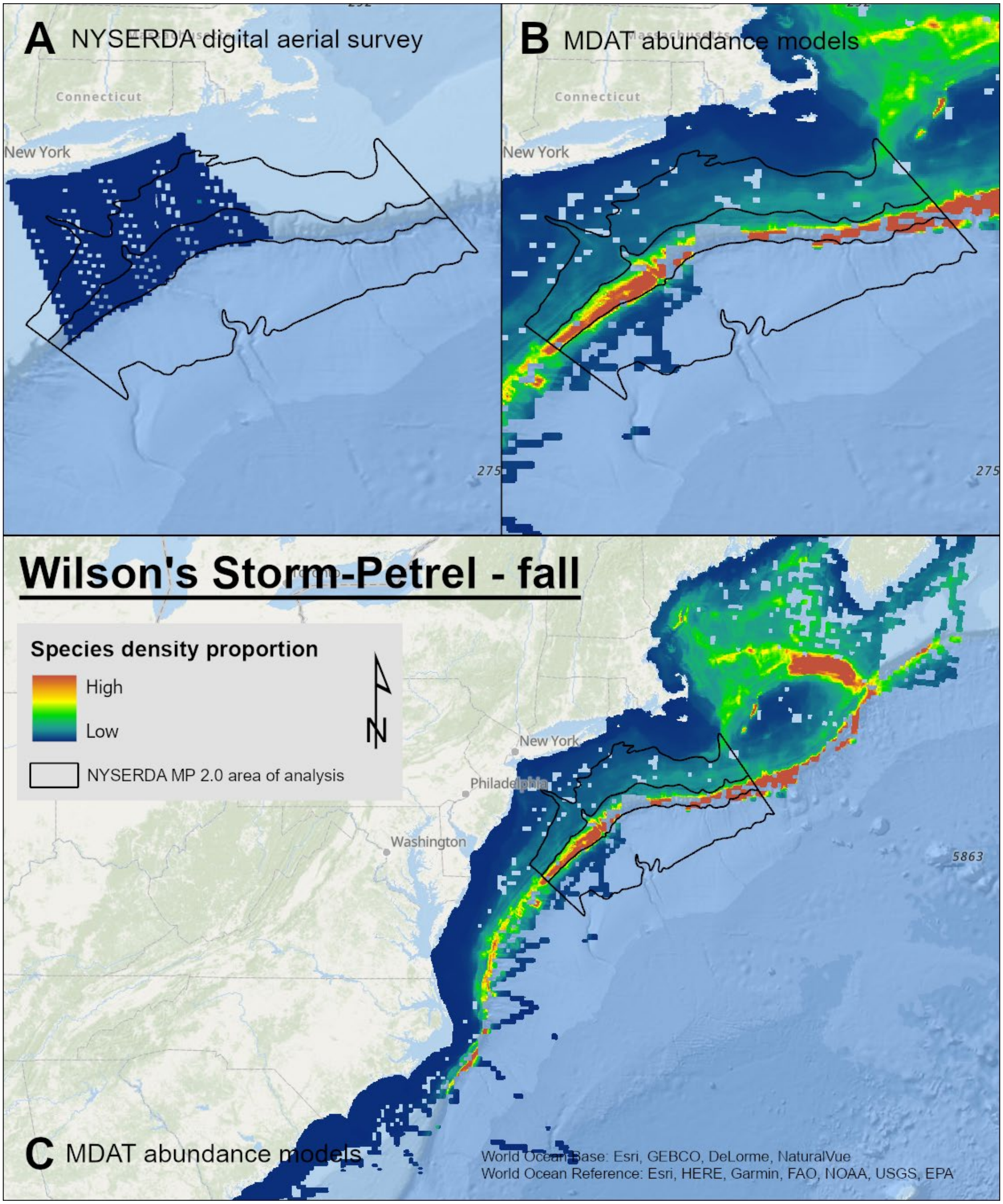
Map B-125. Summer Wilson's Storm-Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



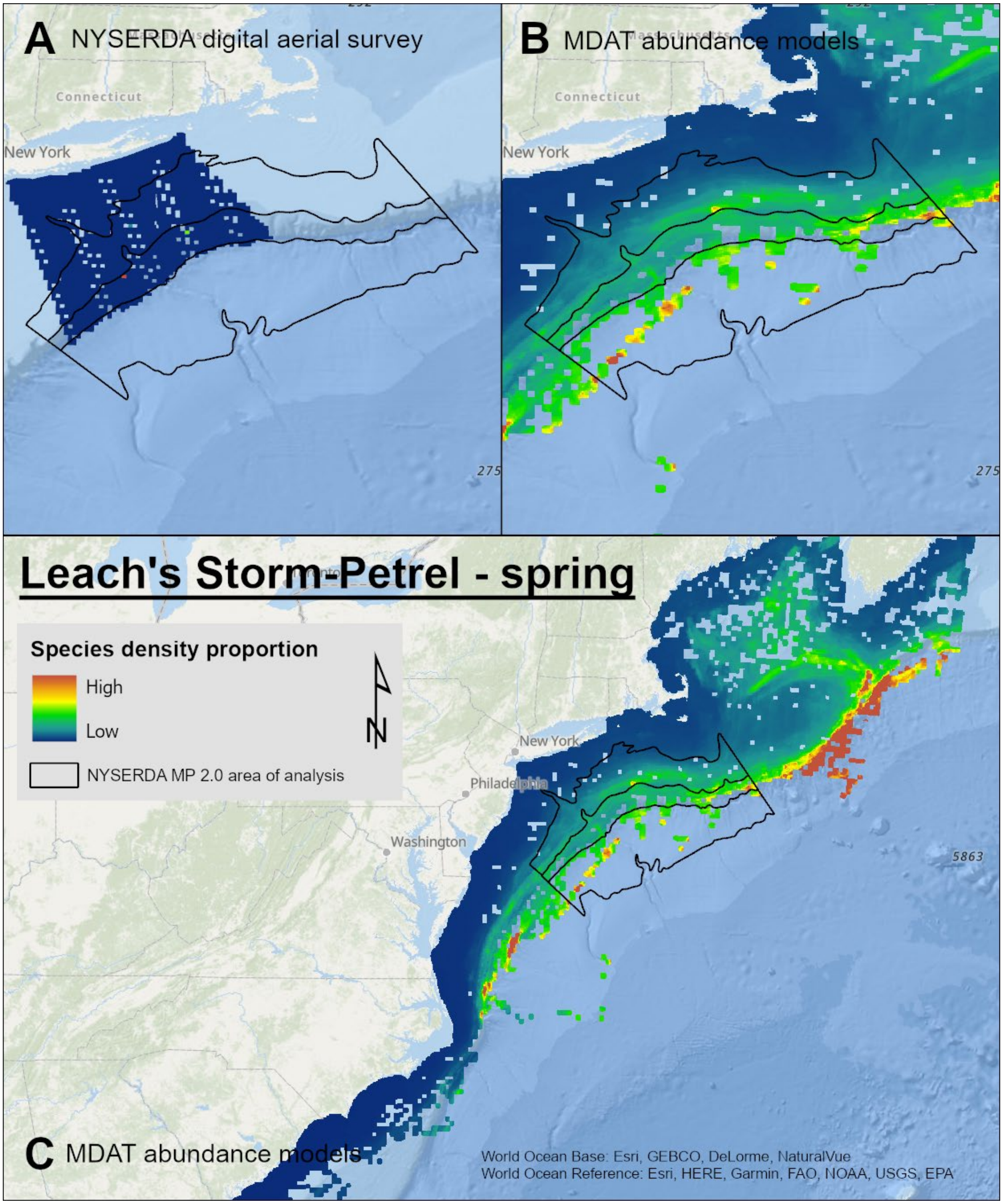
Map B-126. Fall Wilson's Storm-Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



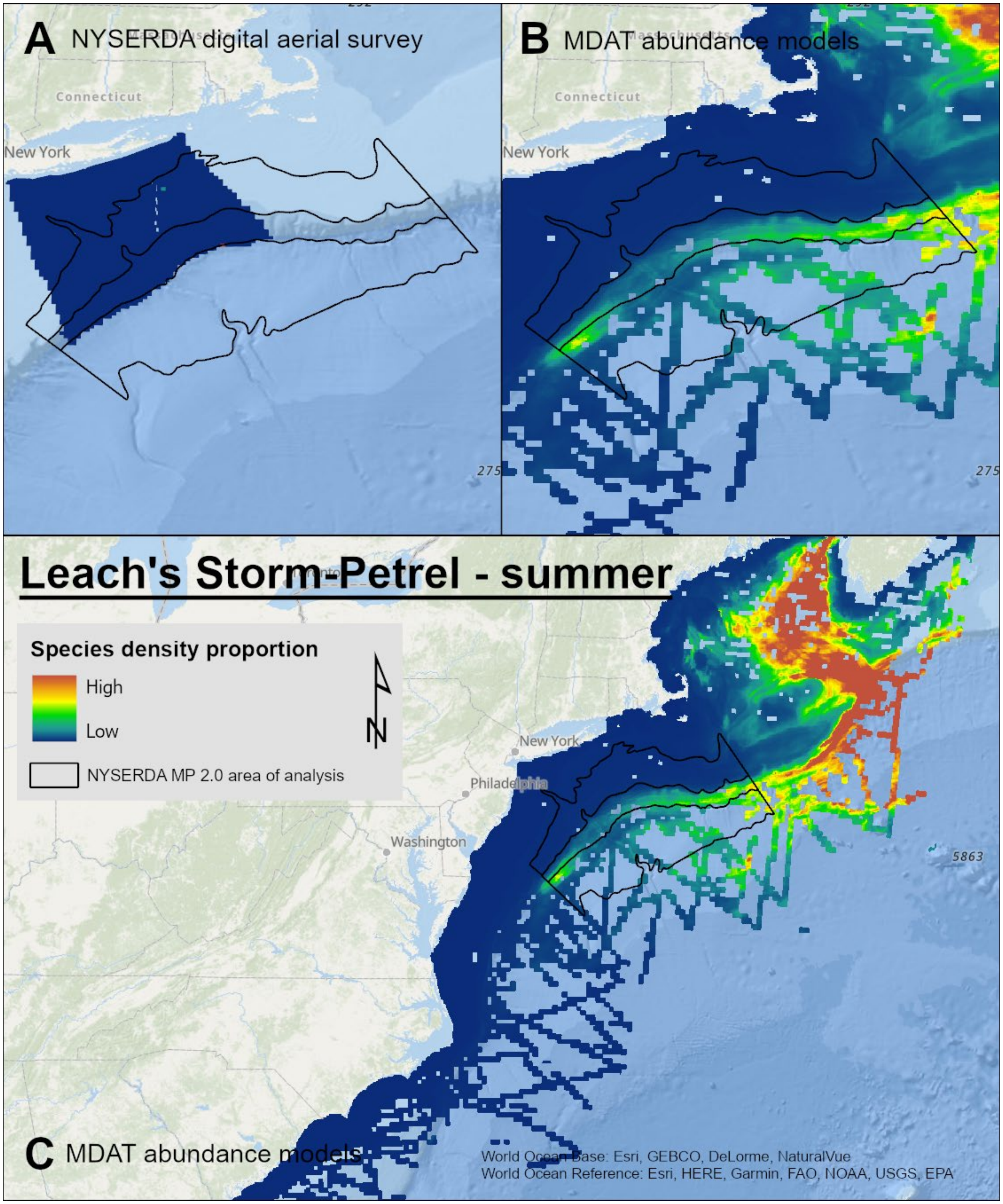
Map B-127. Spring Leach's Storm-Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



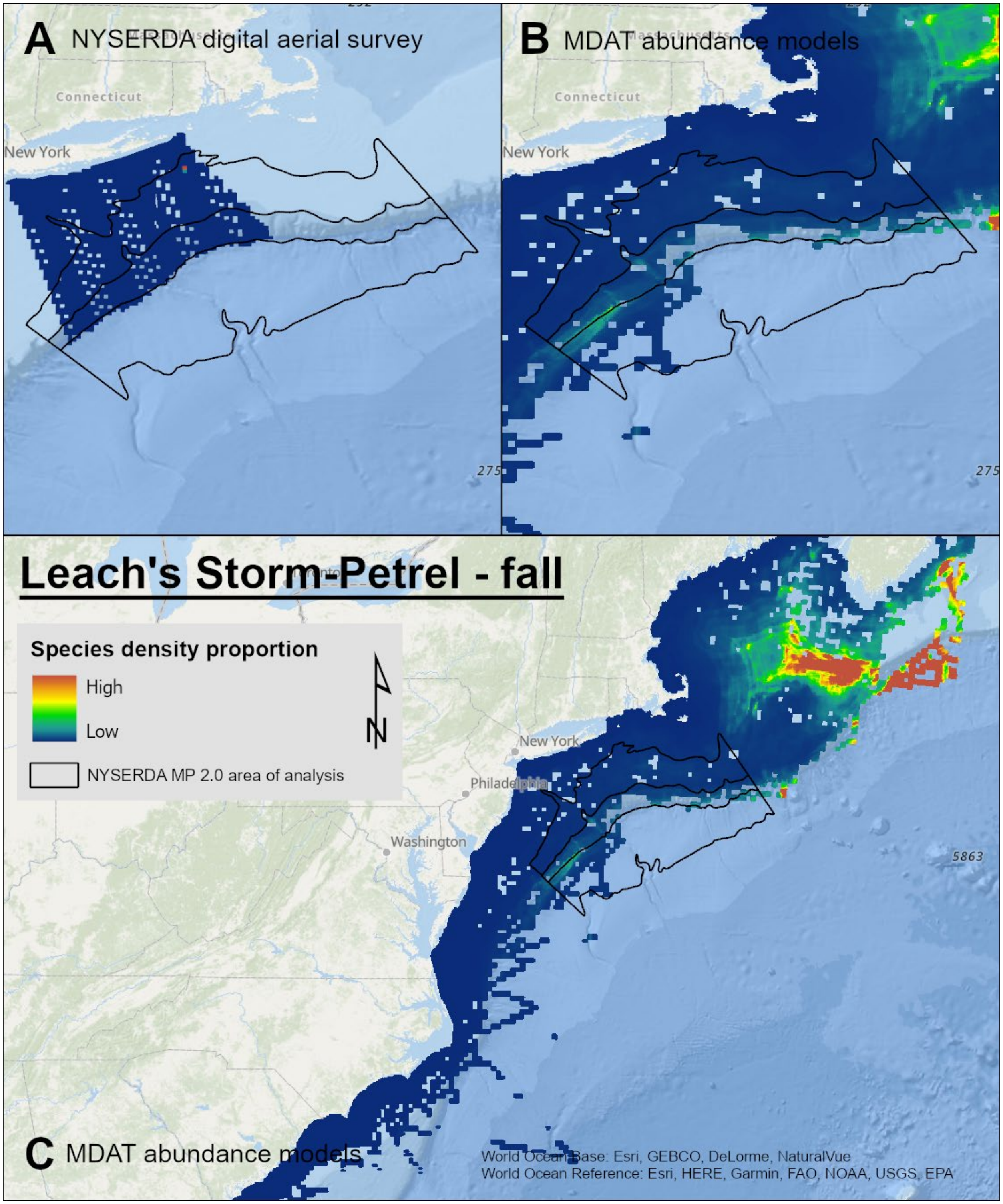
Map B-128. Summer Leach's Storm-Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



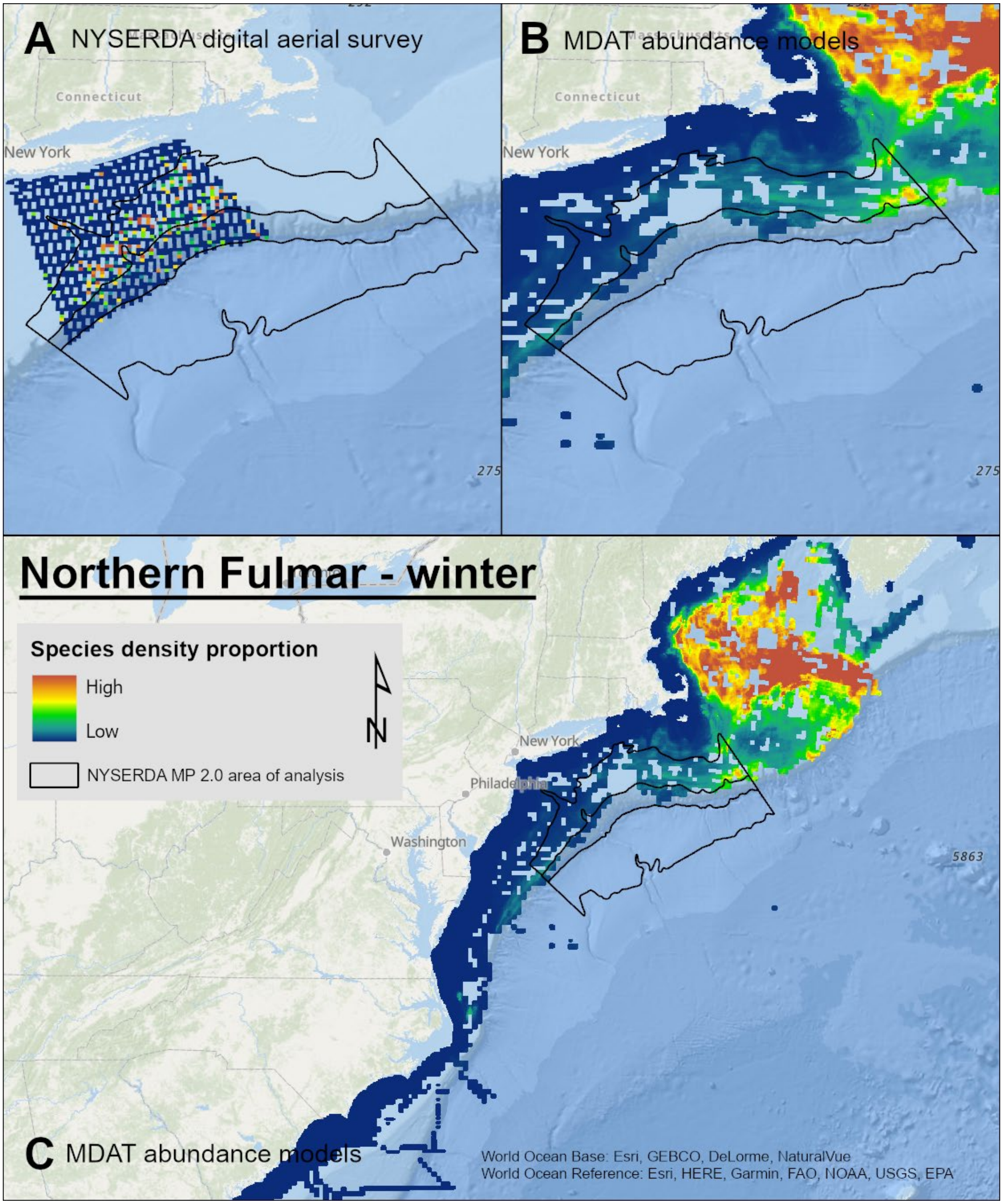
Map B-129. Fall Leach's Storm-Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



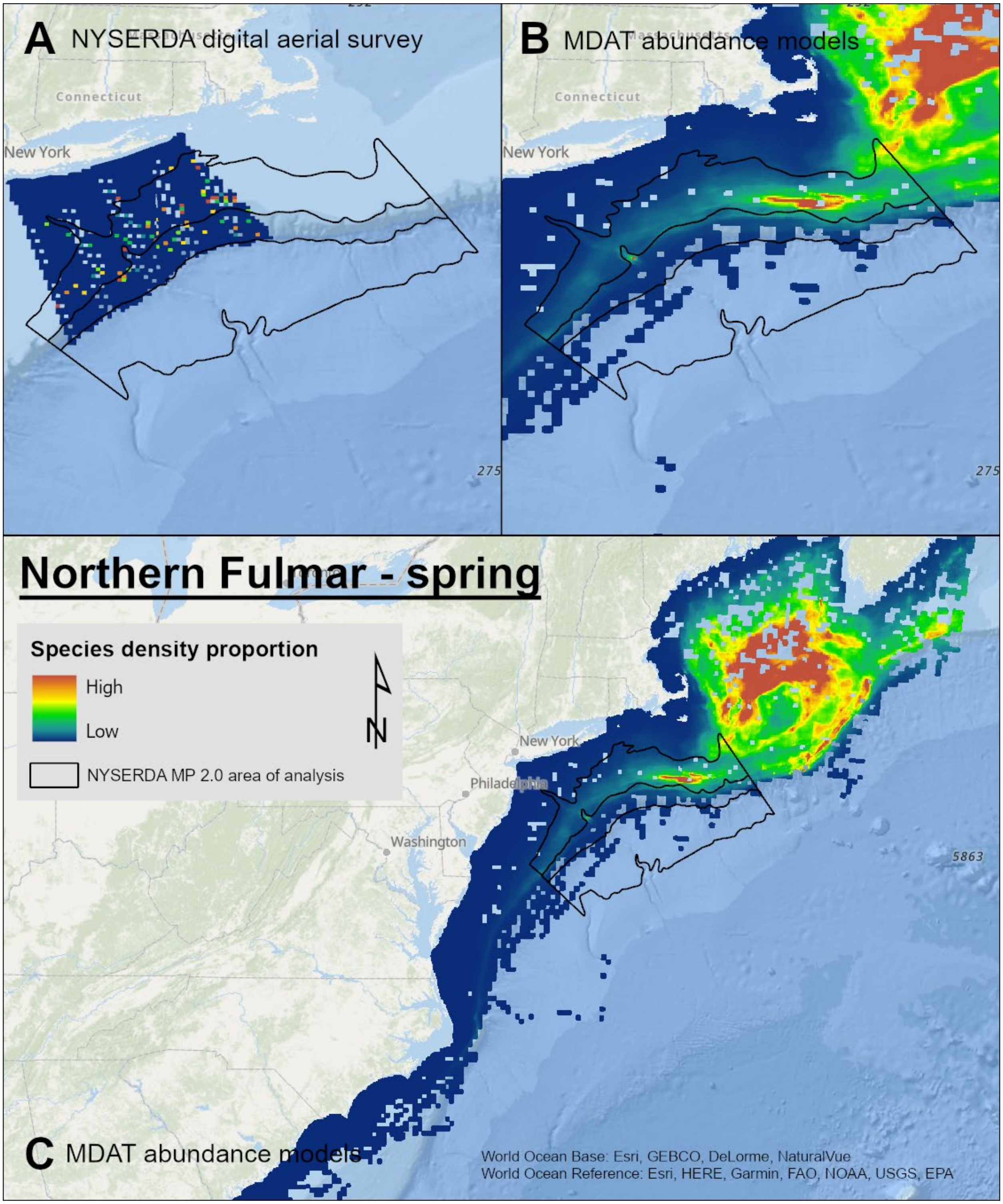
Map B-130. Winter Northern Fulmar Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



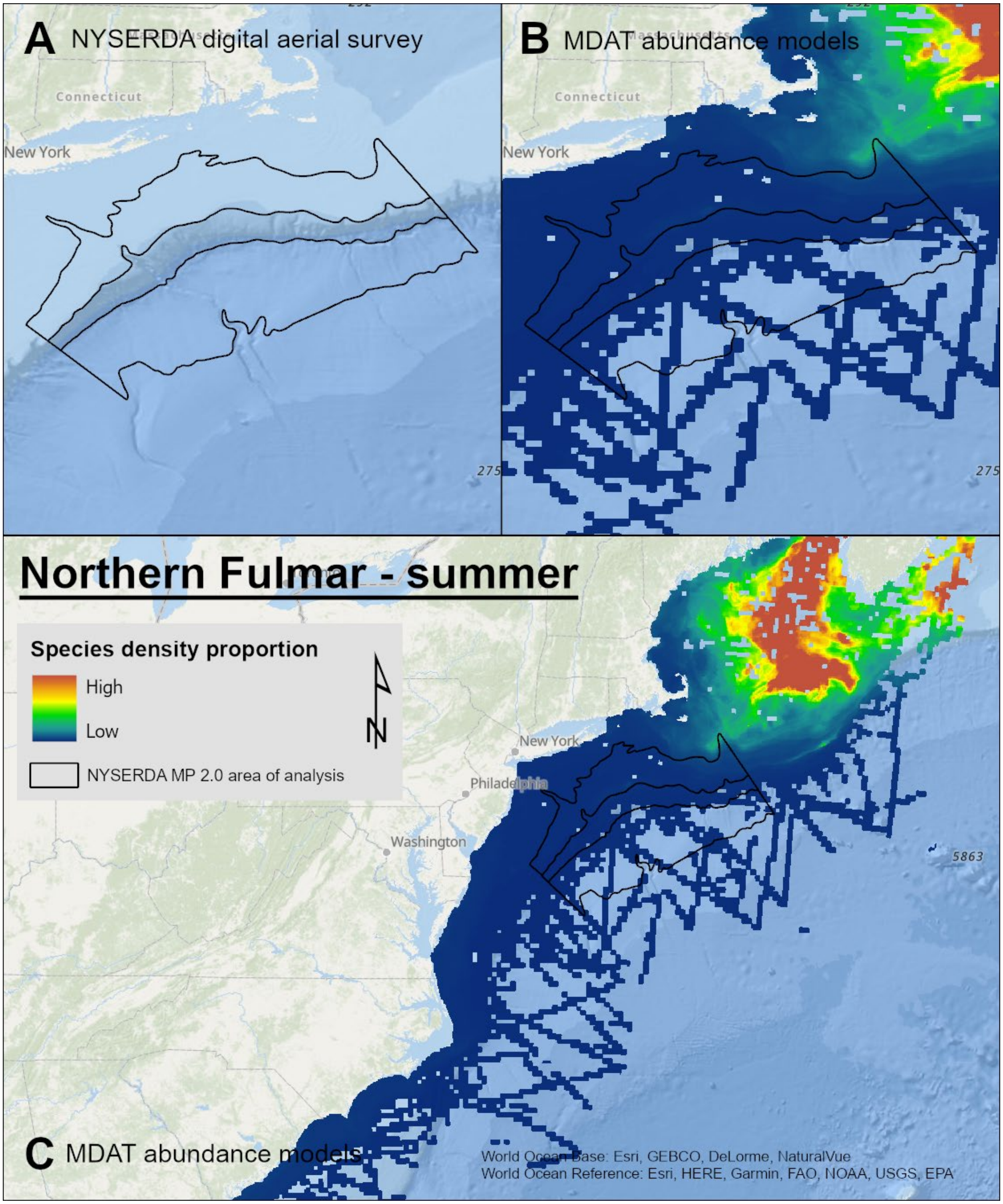
Map B-131. Spring Northern Fulmar Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



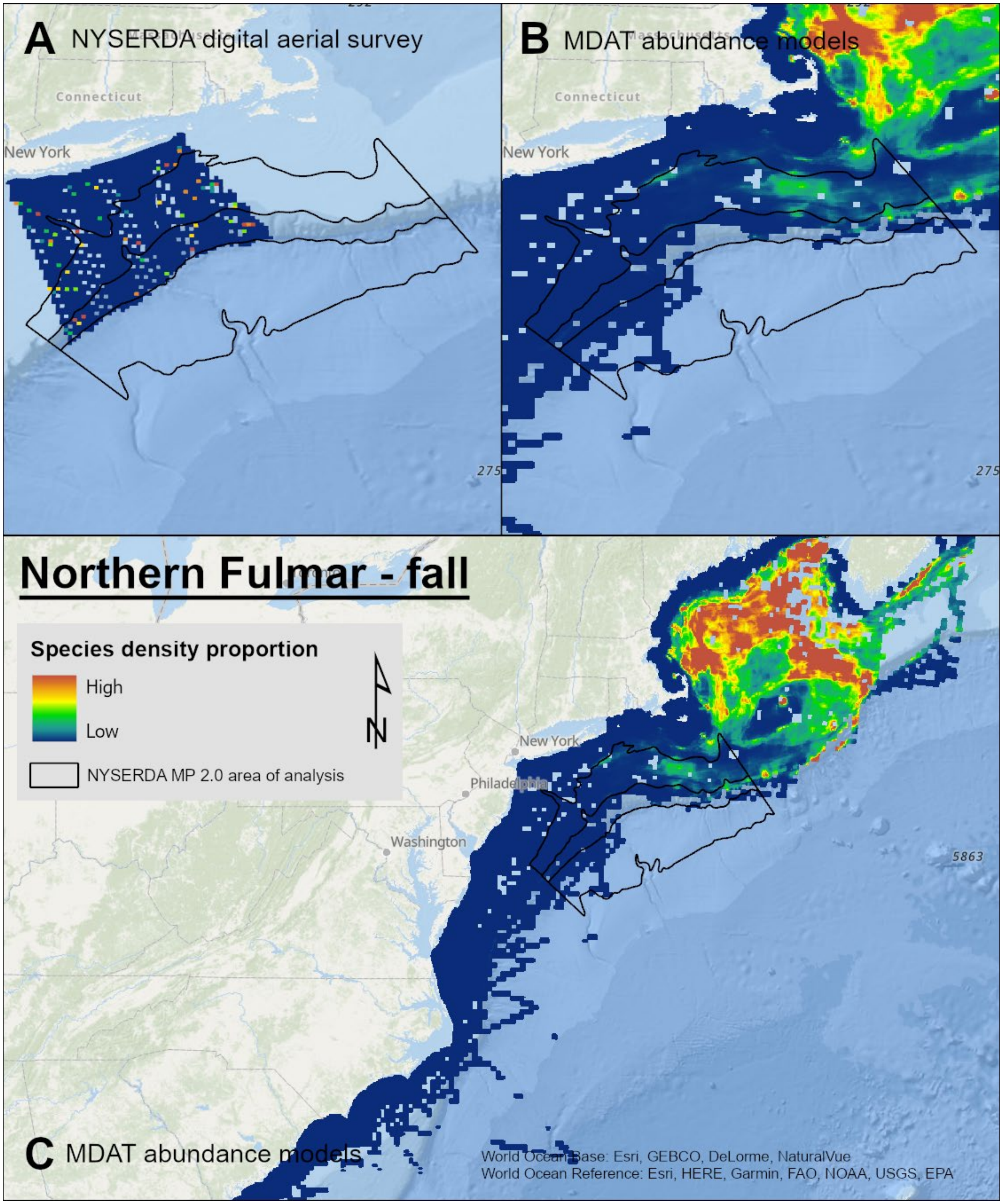
Map B-132. Summer Northern Fulmar Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



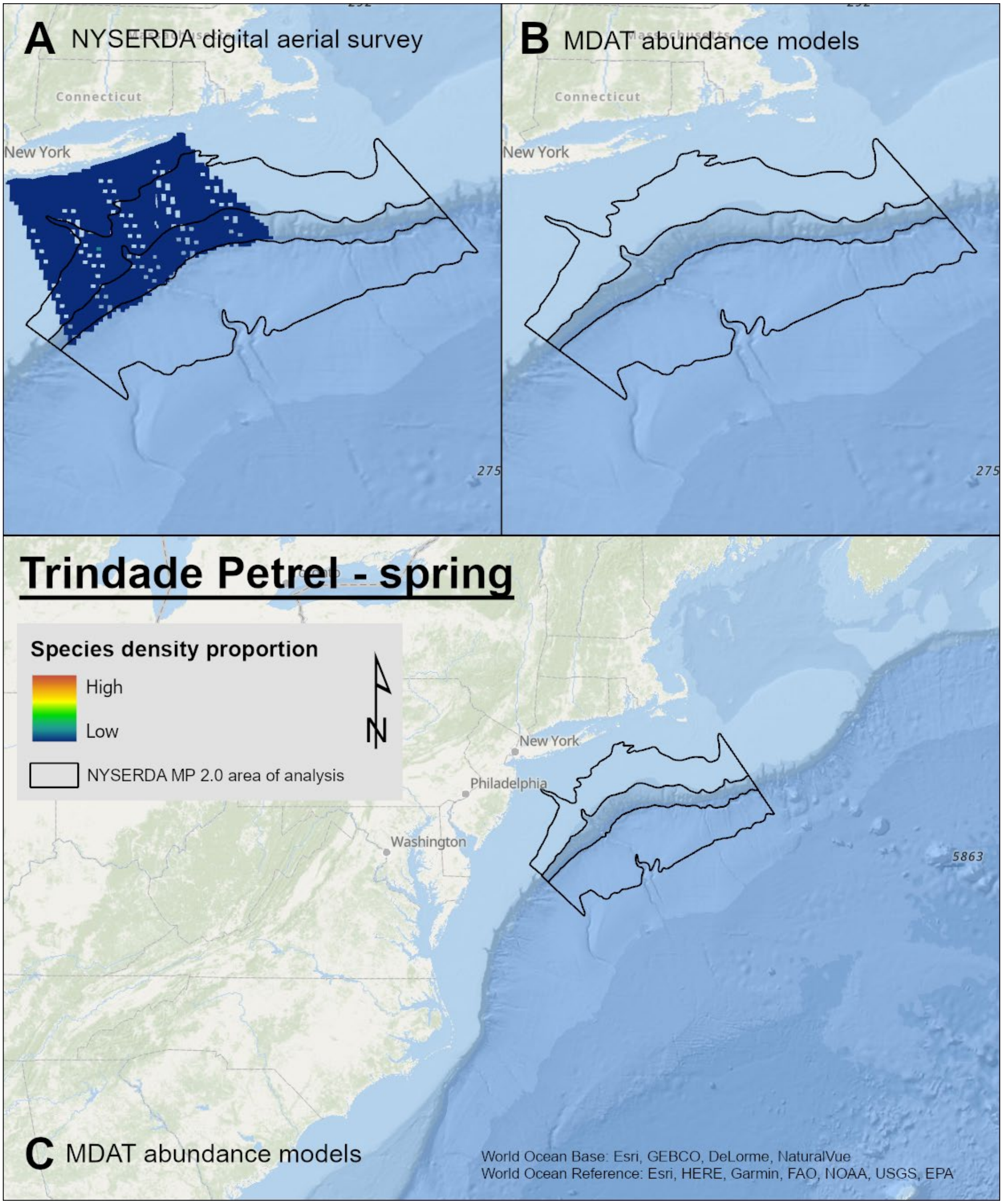
Map B-133. Fall Northern Fulmar Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



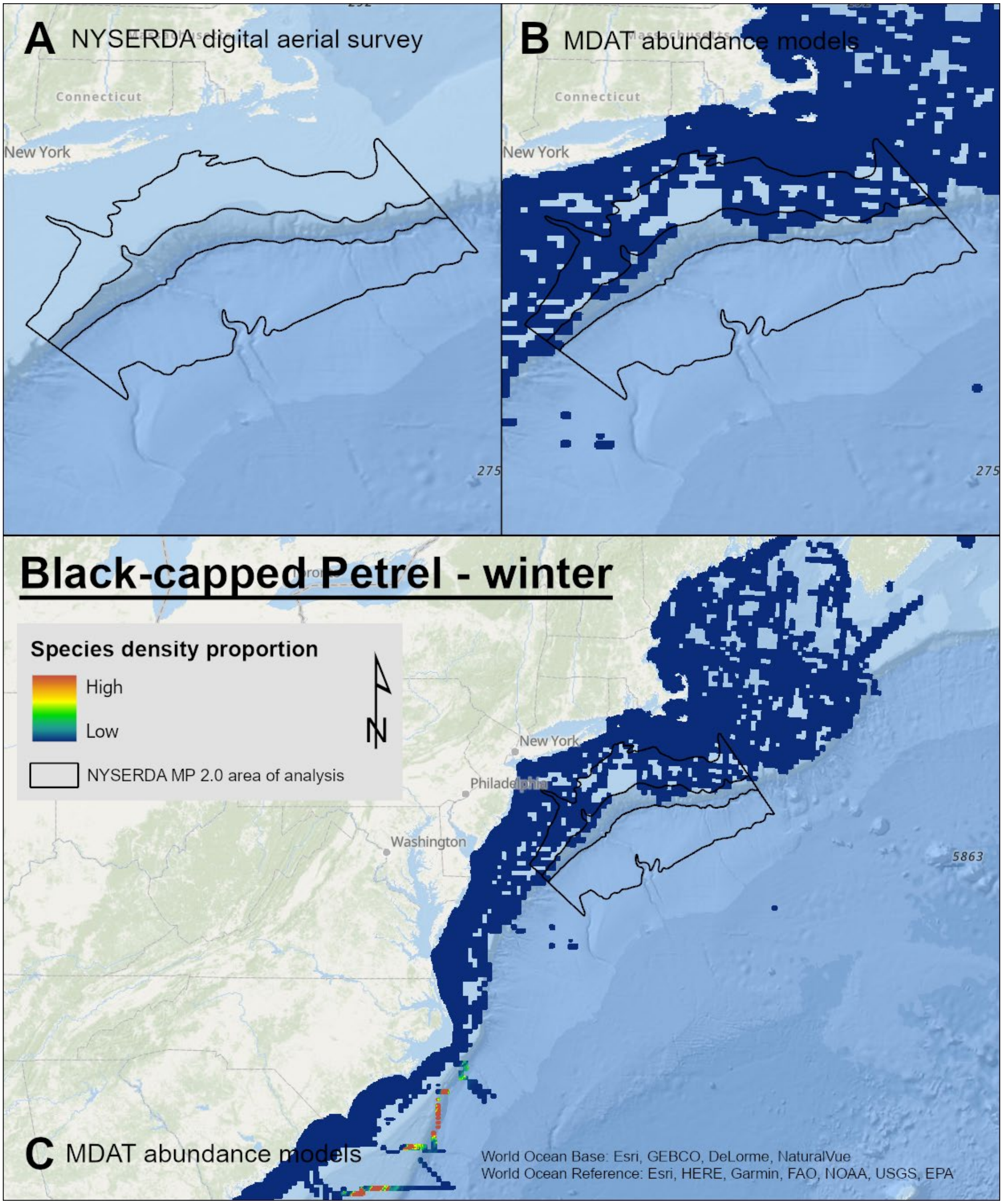
Map B-134. Spring Trindade Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-135. Winter Black-Capped Petrel Density Proportions i

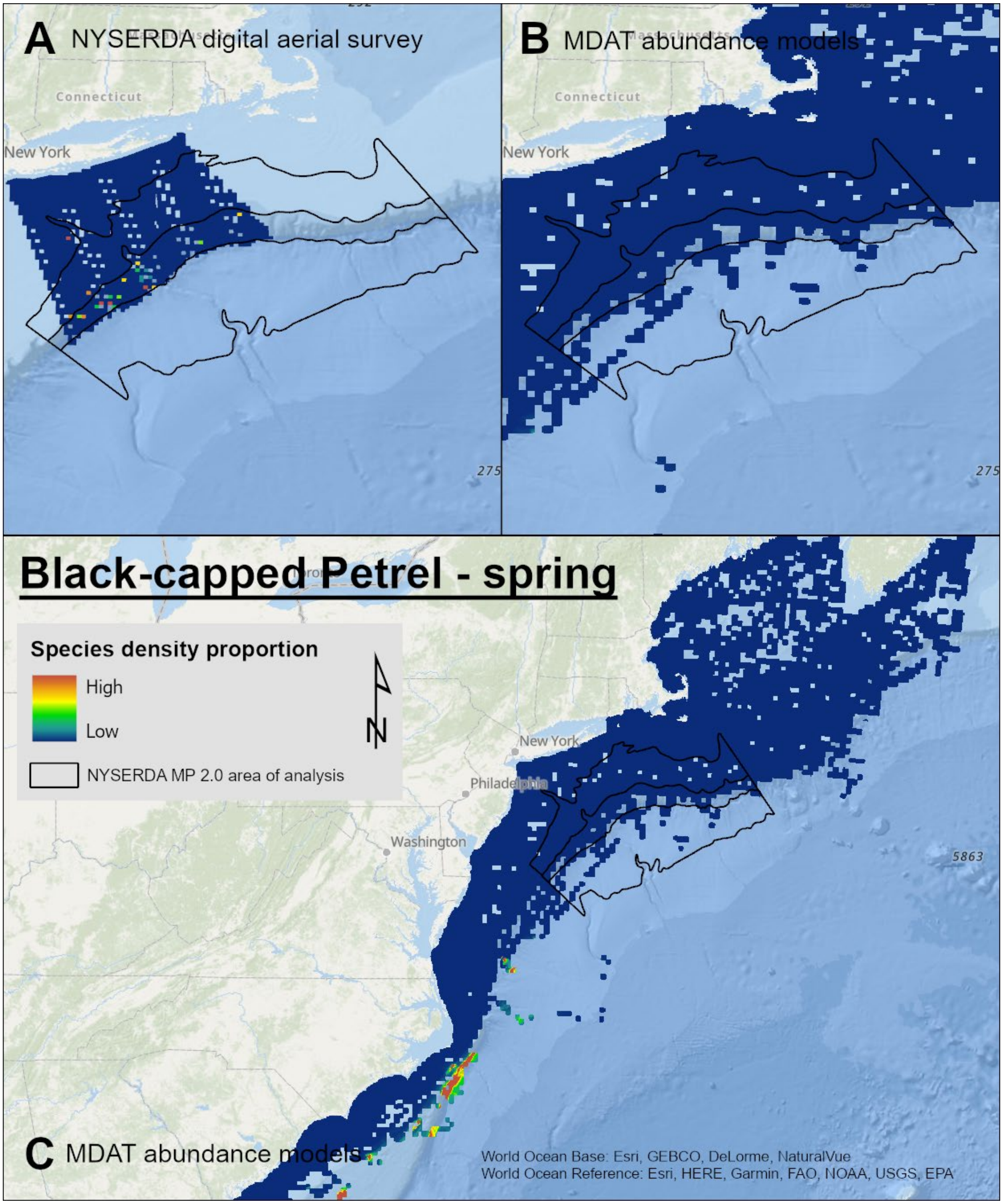
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

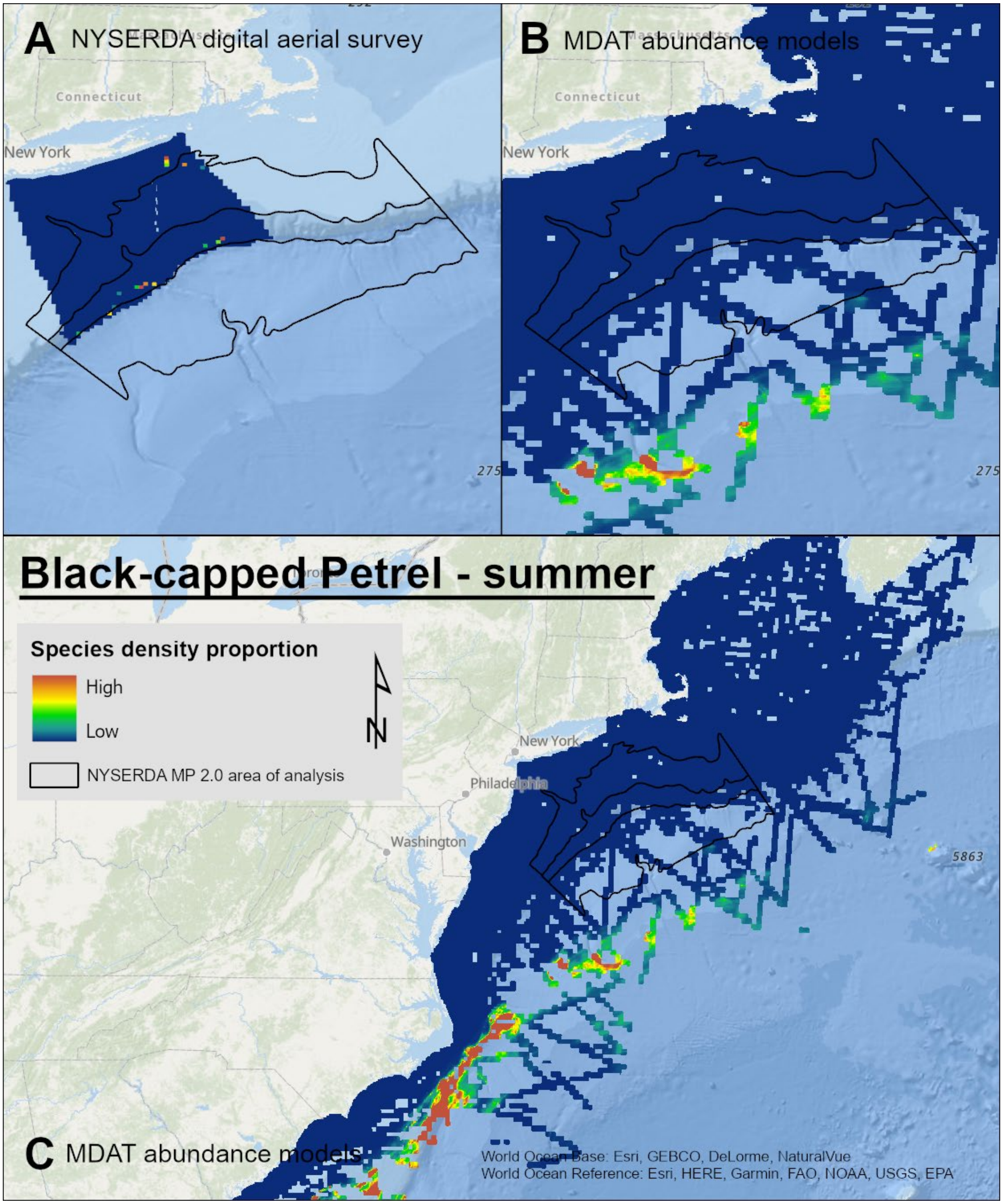
Map B-136. Spring Black-Capped Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



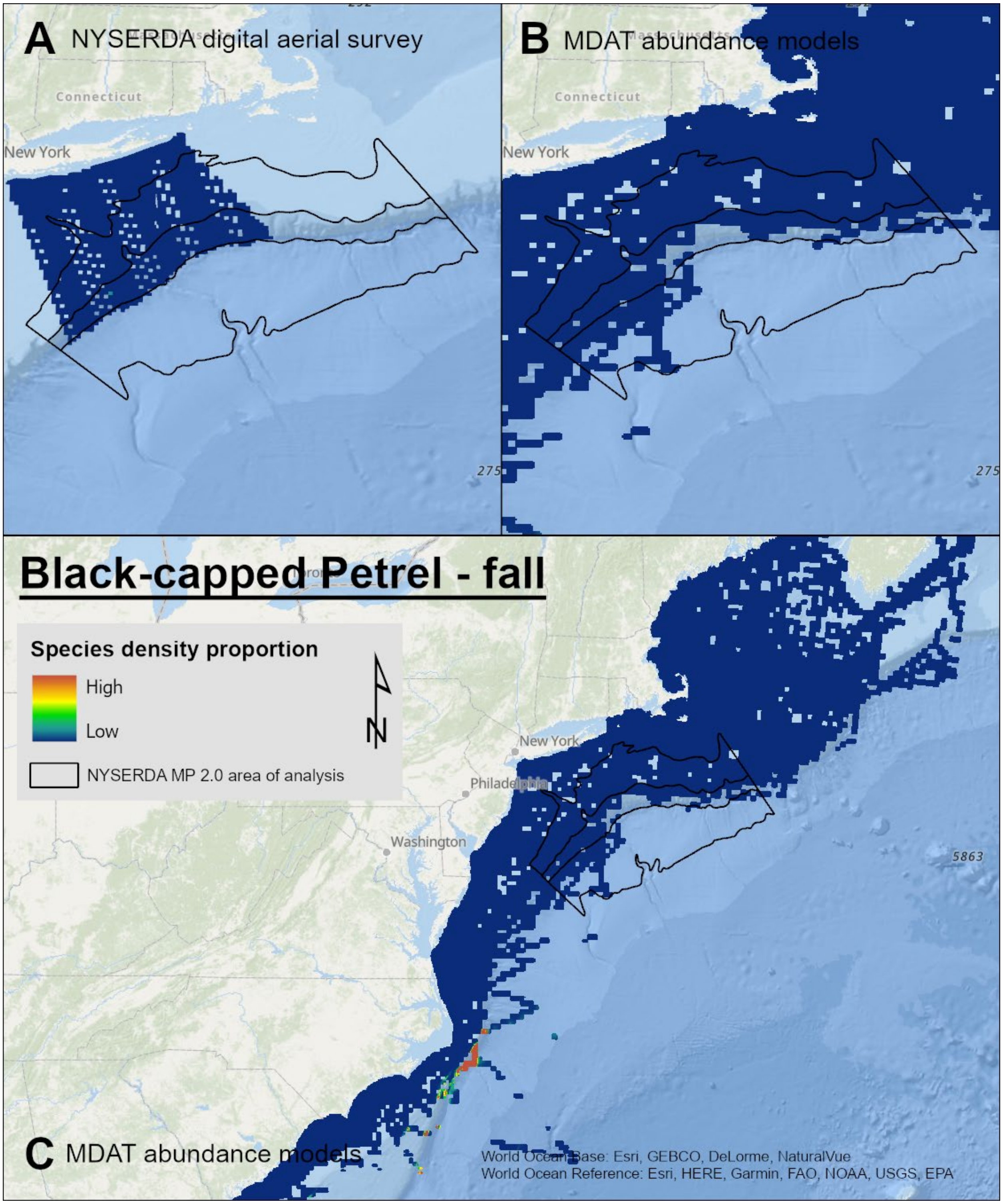
Map B-137. Summer Black-Capped Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



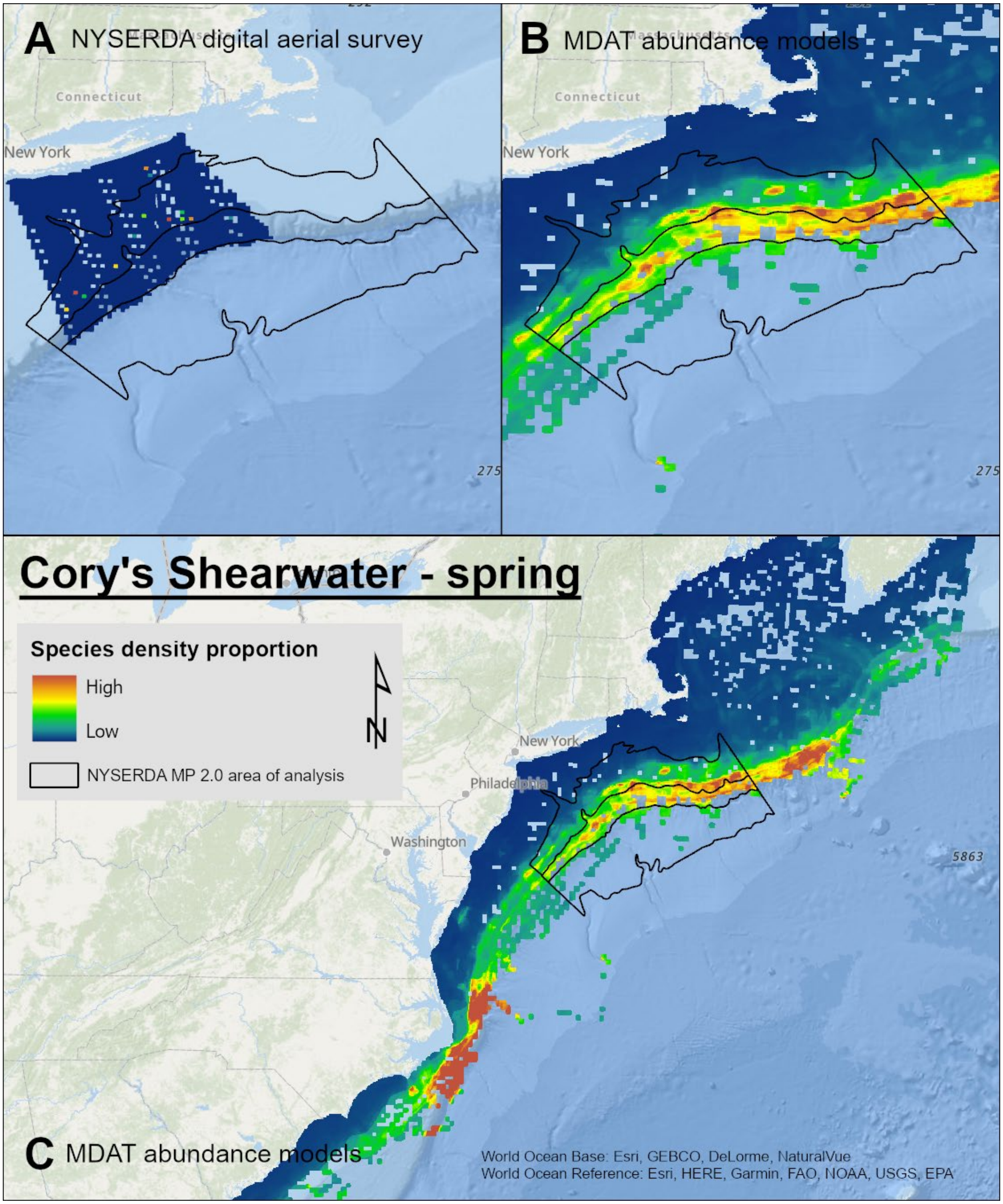
Map B-138. Fall Black-Capped Petrel Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



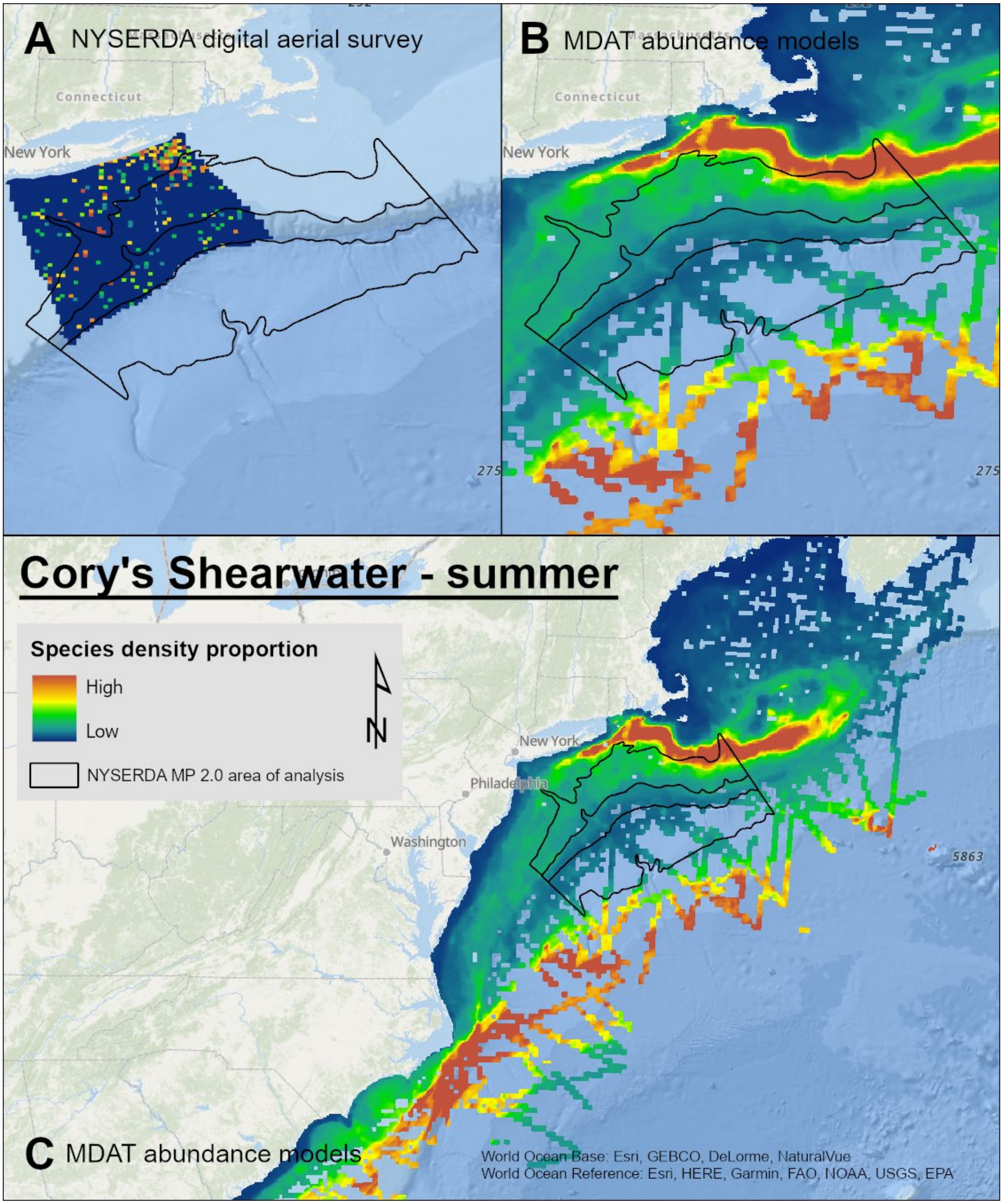
Map B-139. Spring Cory's Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



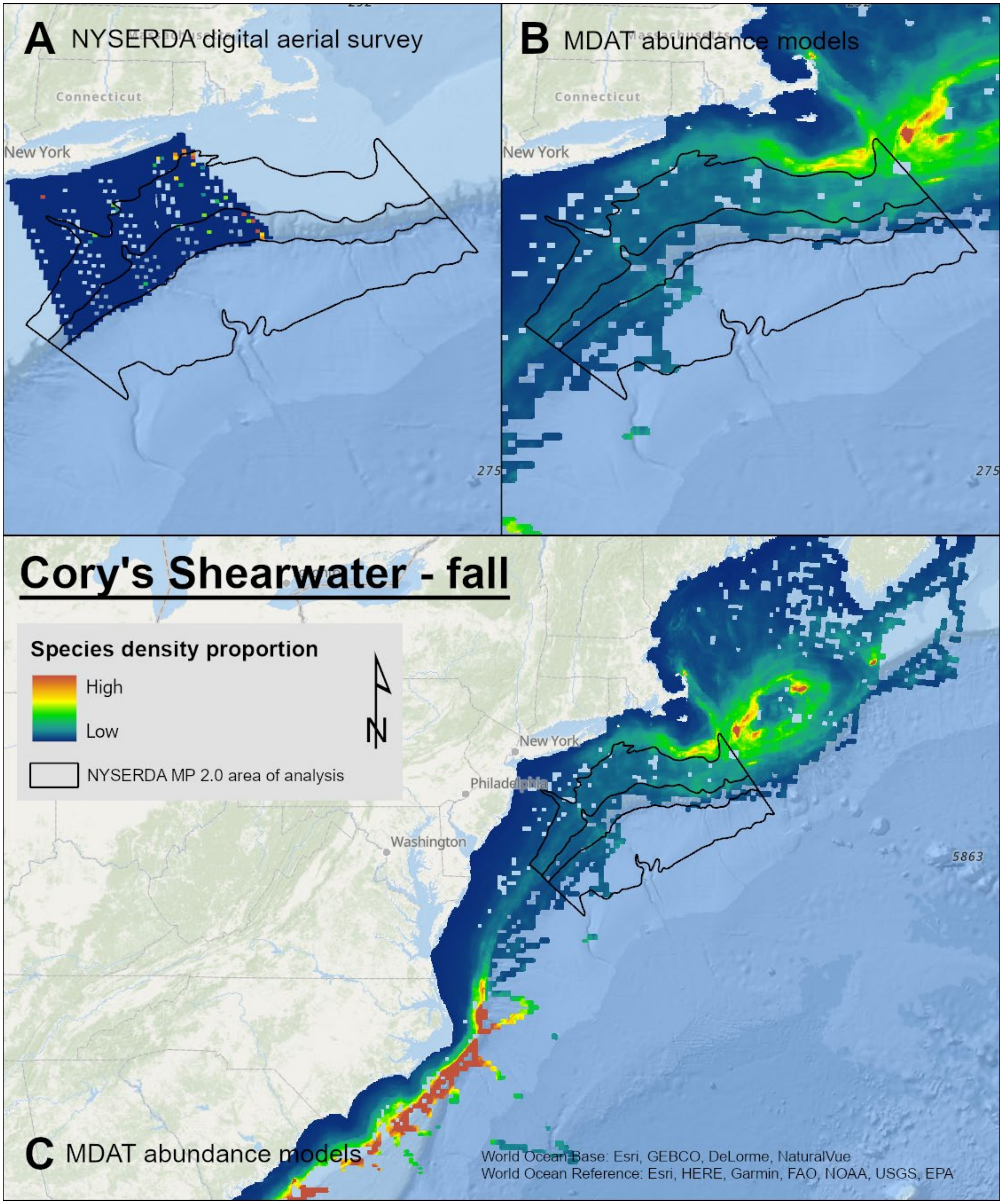
Map B-140. Summer Cory's Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



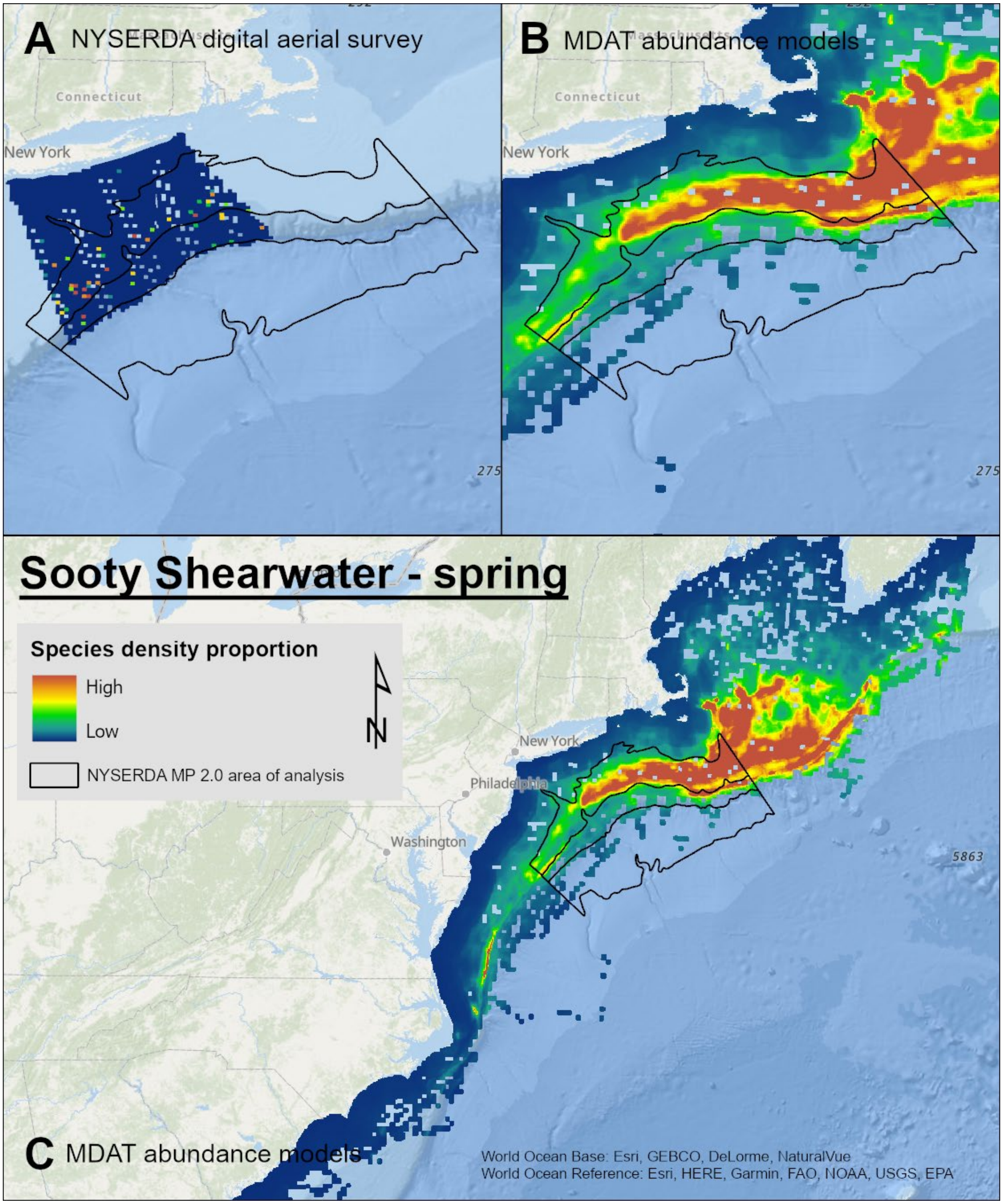
Map B-141. Fall Cory's Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



Map B-142. Spring Sooty Shearwater Density Proportions

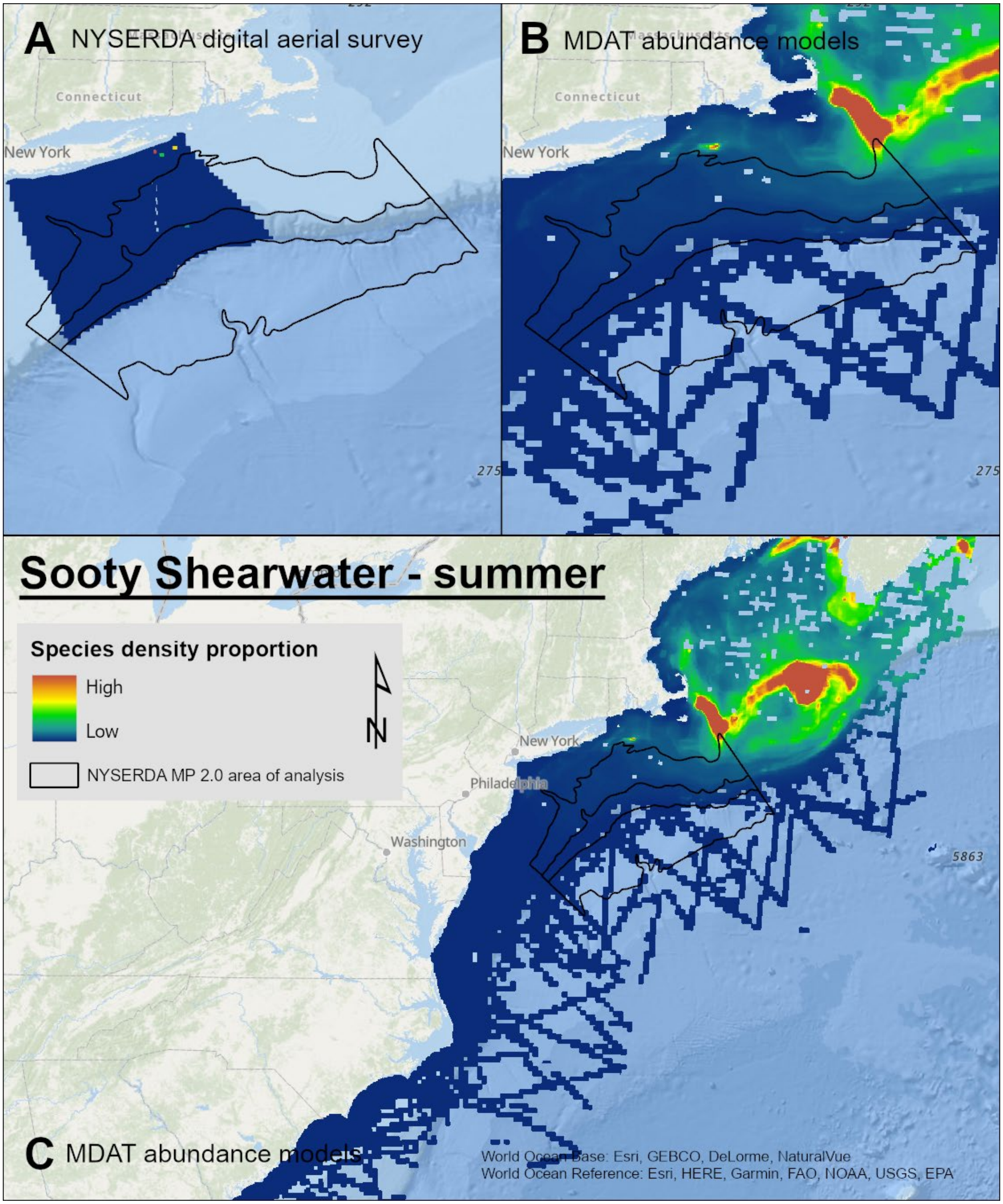
NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



World Ocean Base: Esri, GEBCO, DeLorme, NaturalVue
World Ocean Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

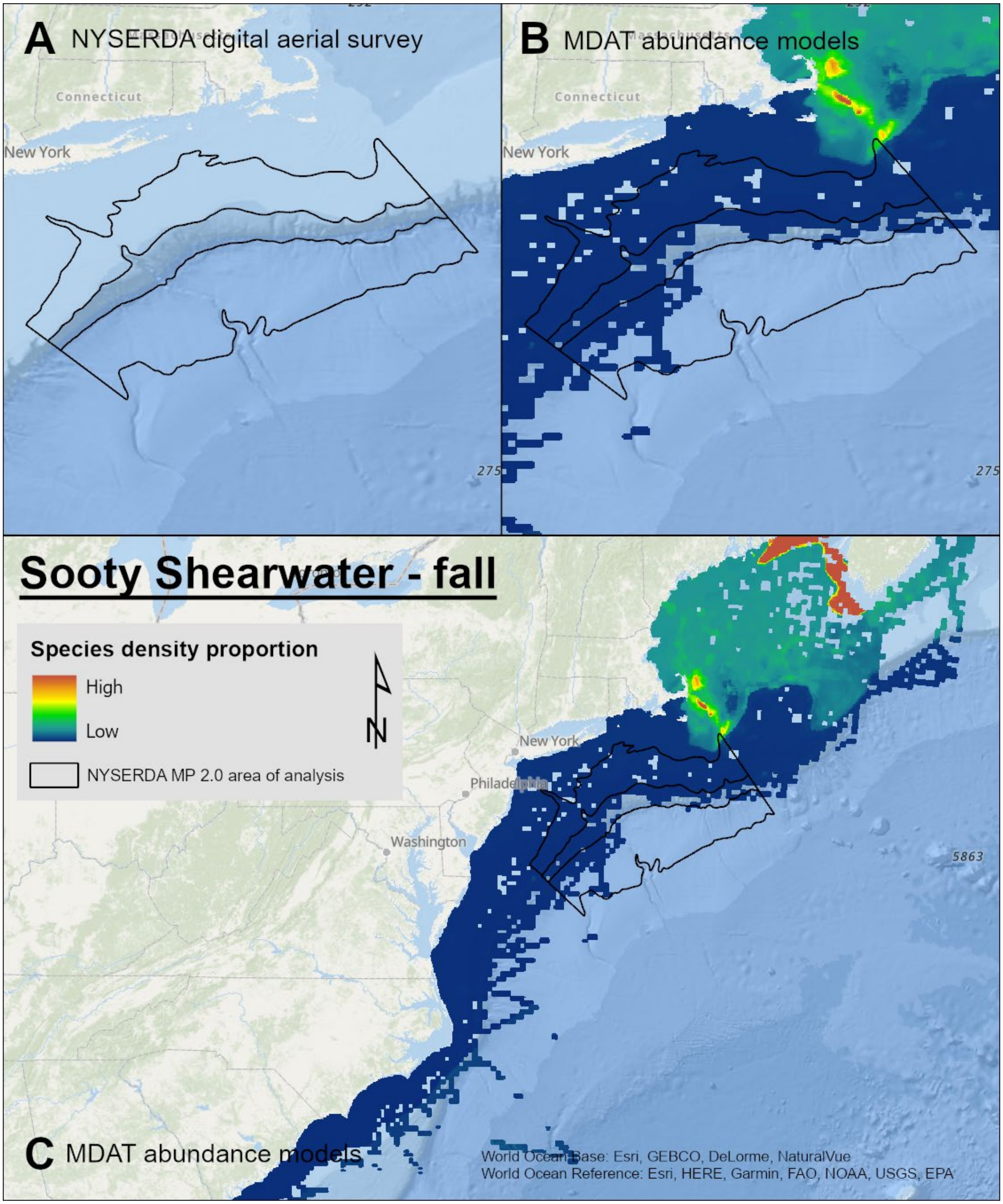
Map B-143. Summer Sooty Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



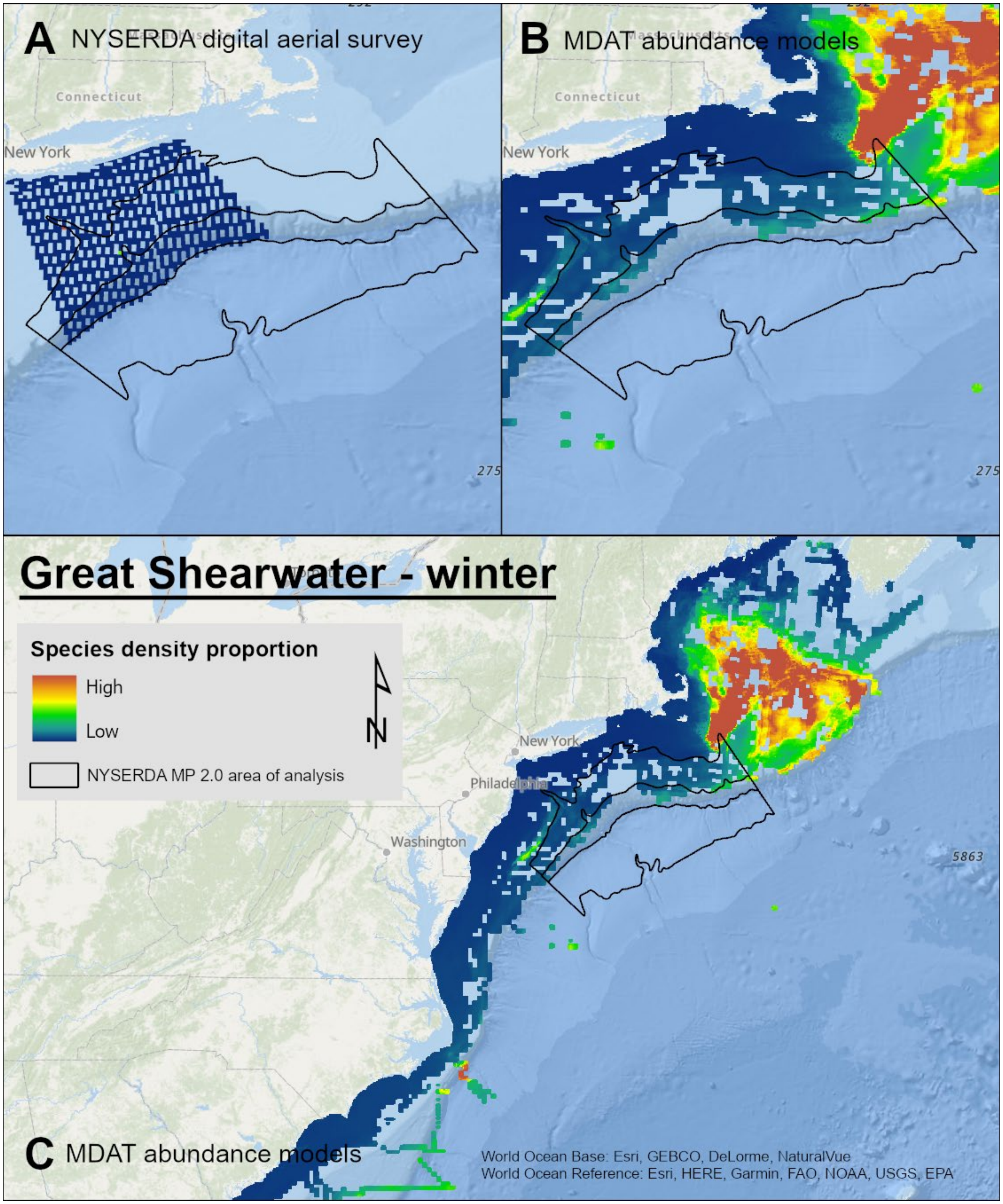
Map B-144. Fall Sooty Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



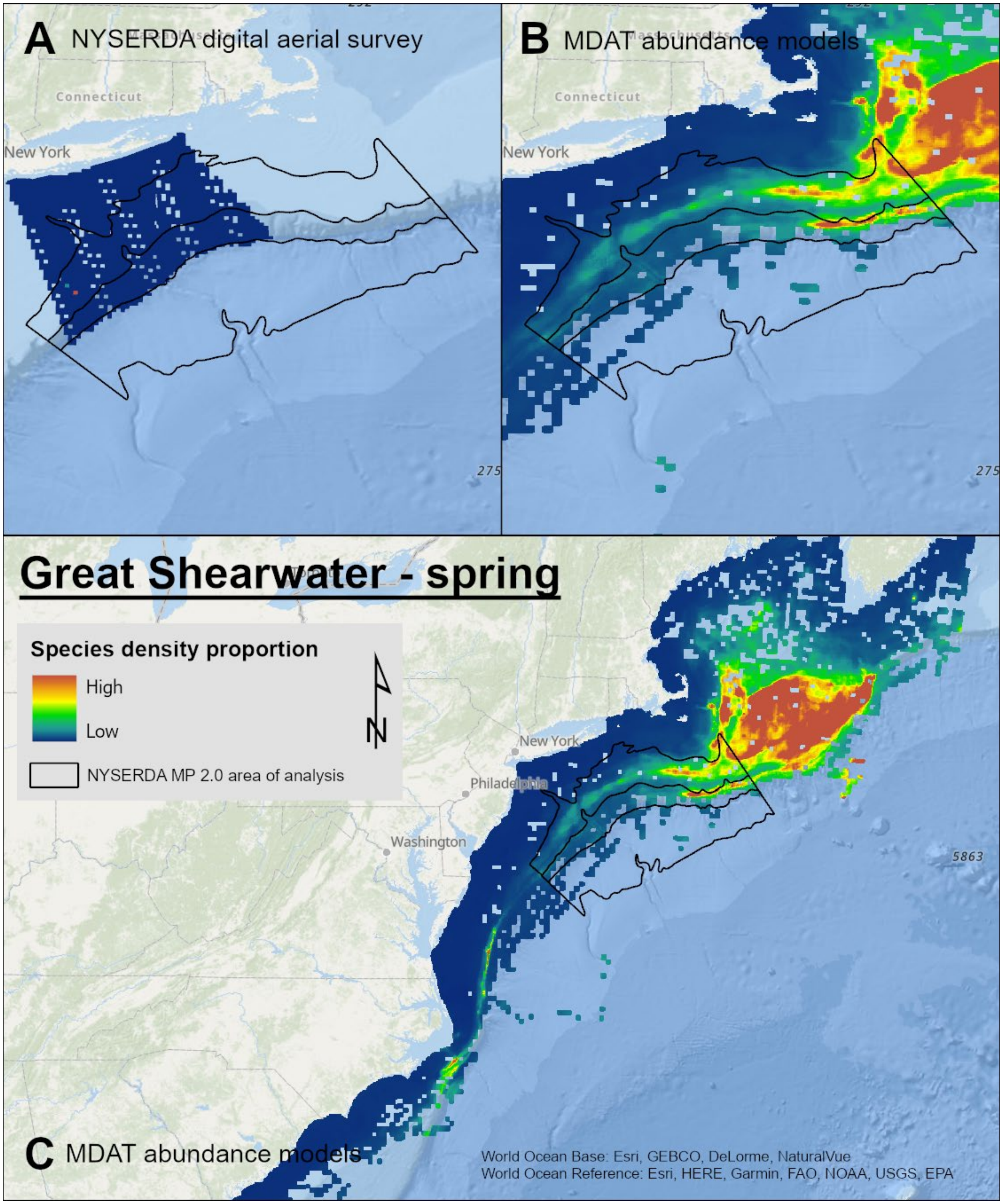
Map B-145. Winter Great Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



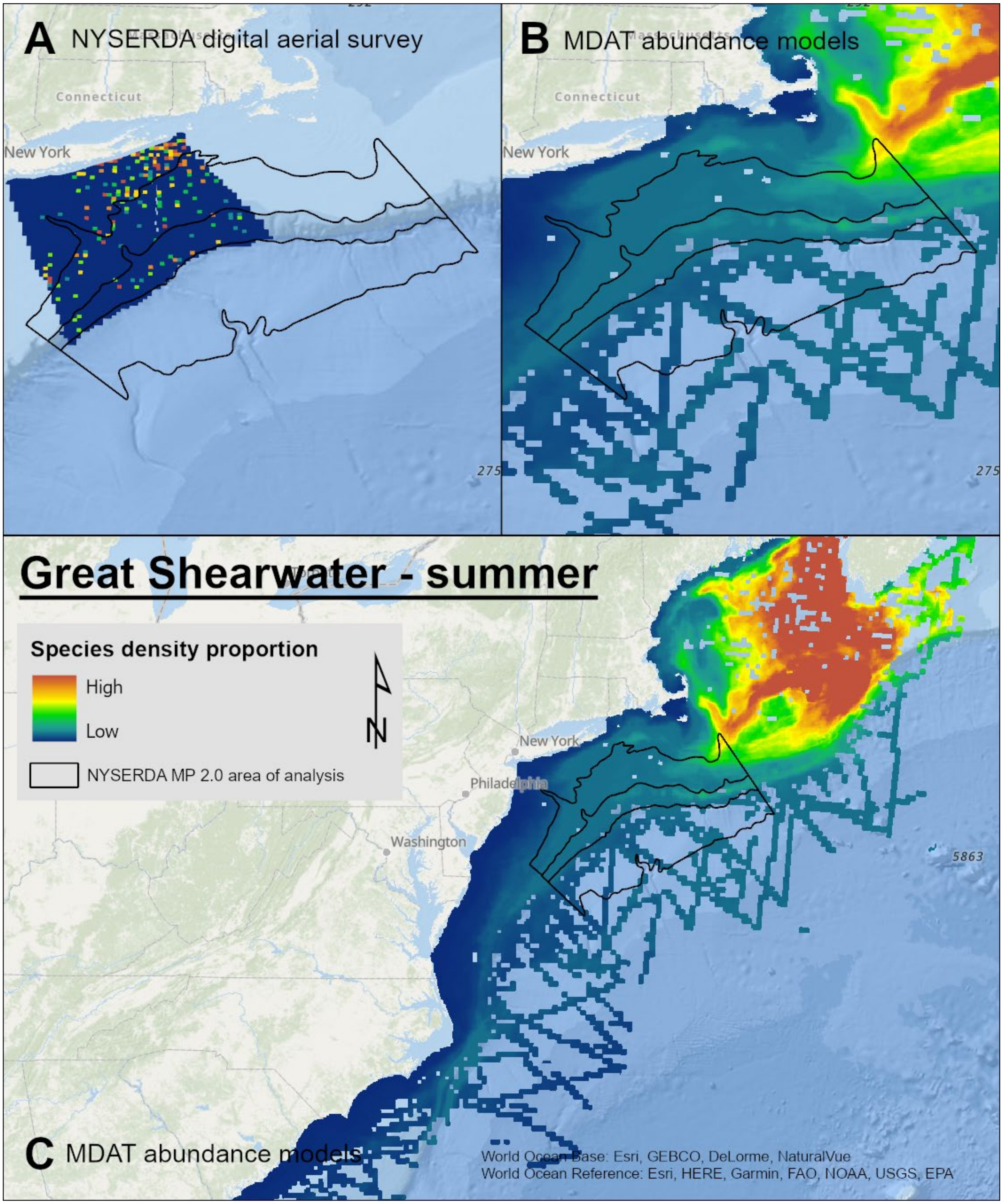
Map B-146. Spring Great Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



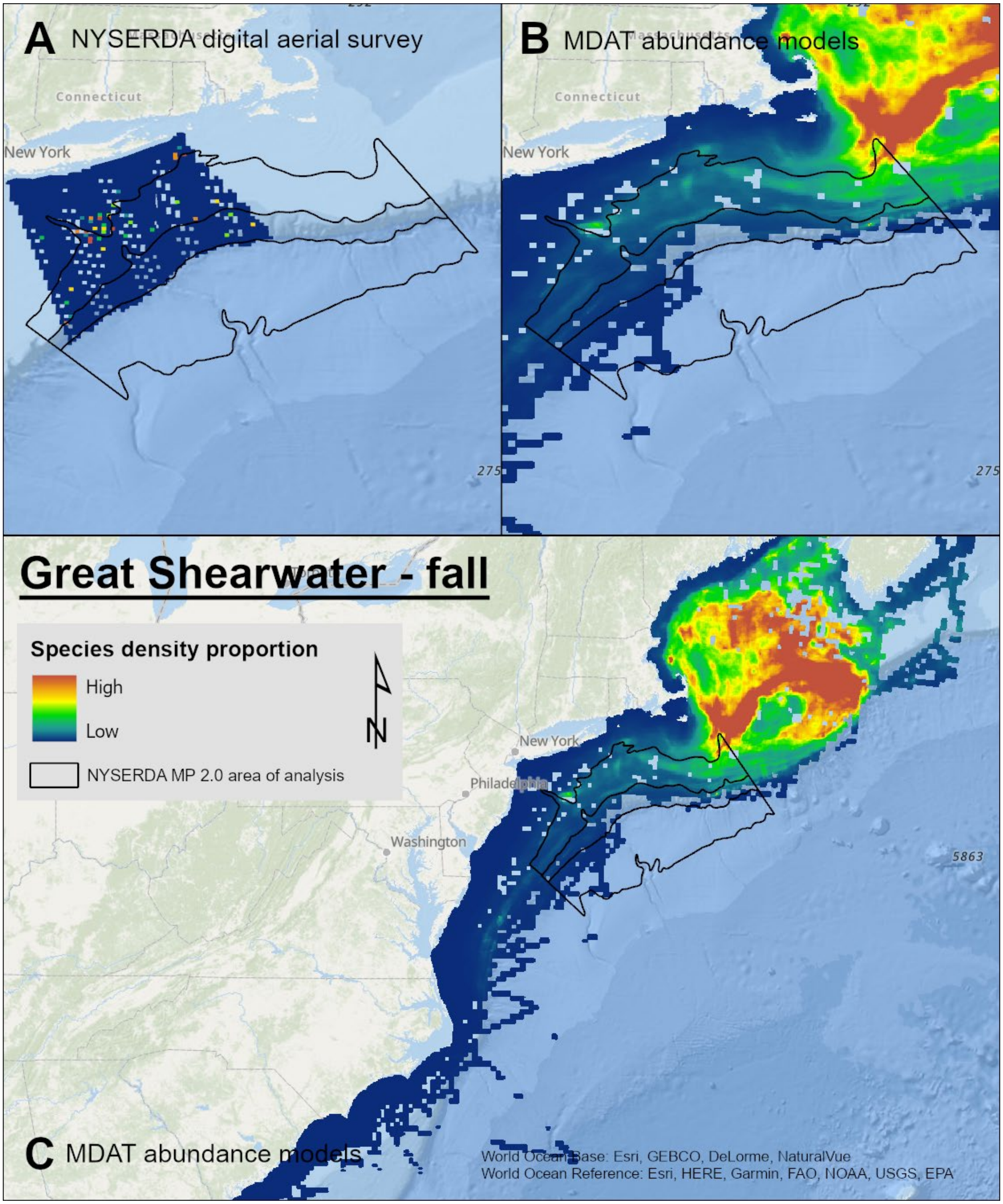
Map B-147. Summer Great Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



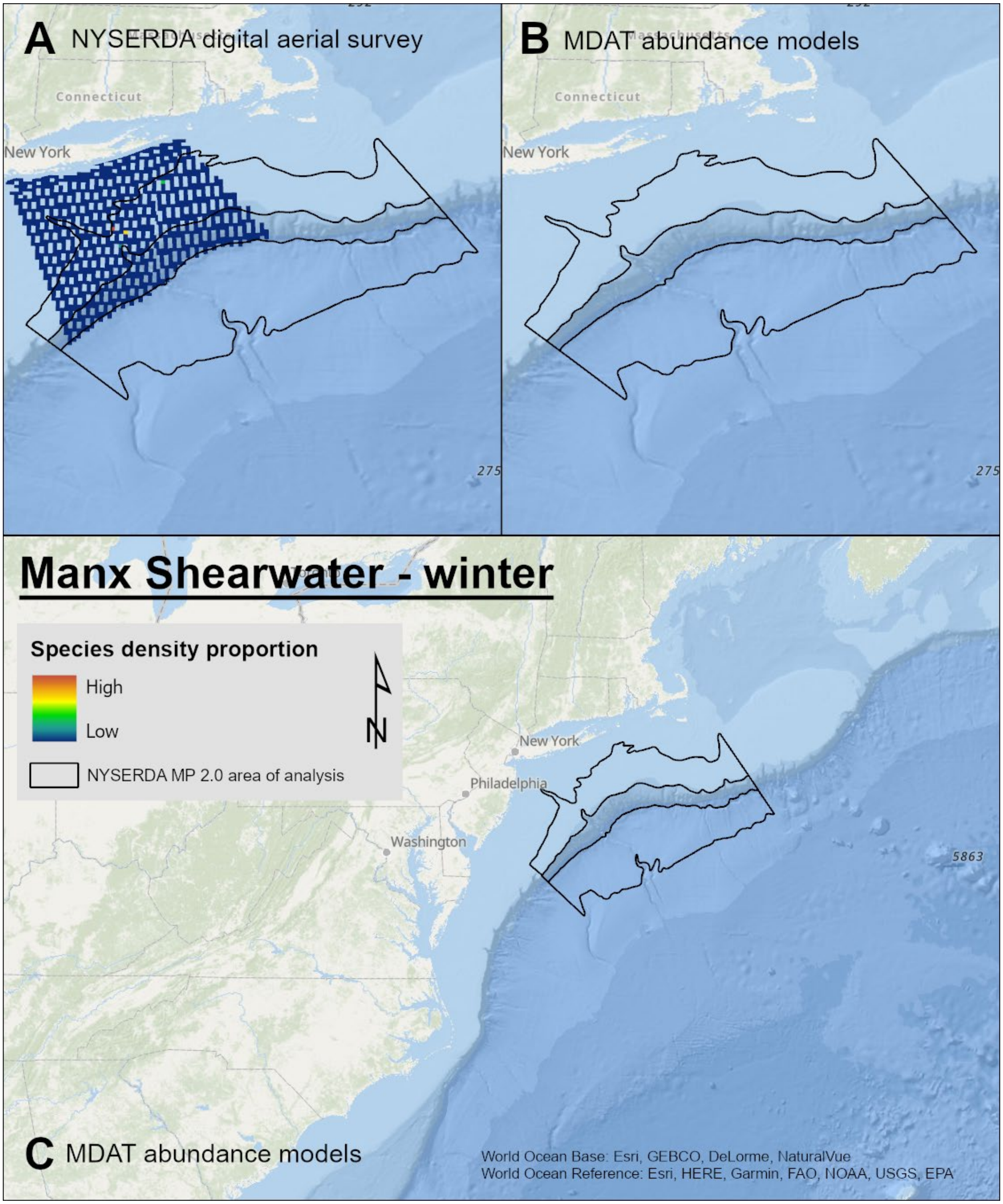
Map B-148. Fall Great Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



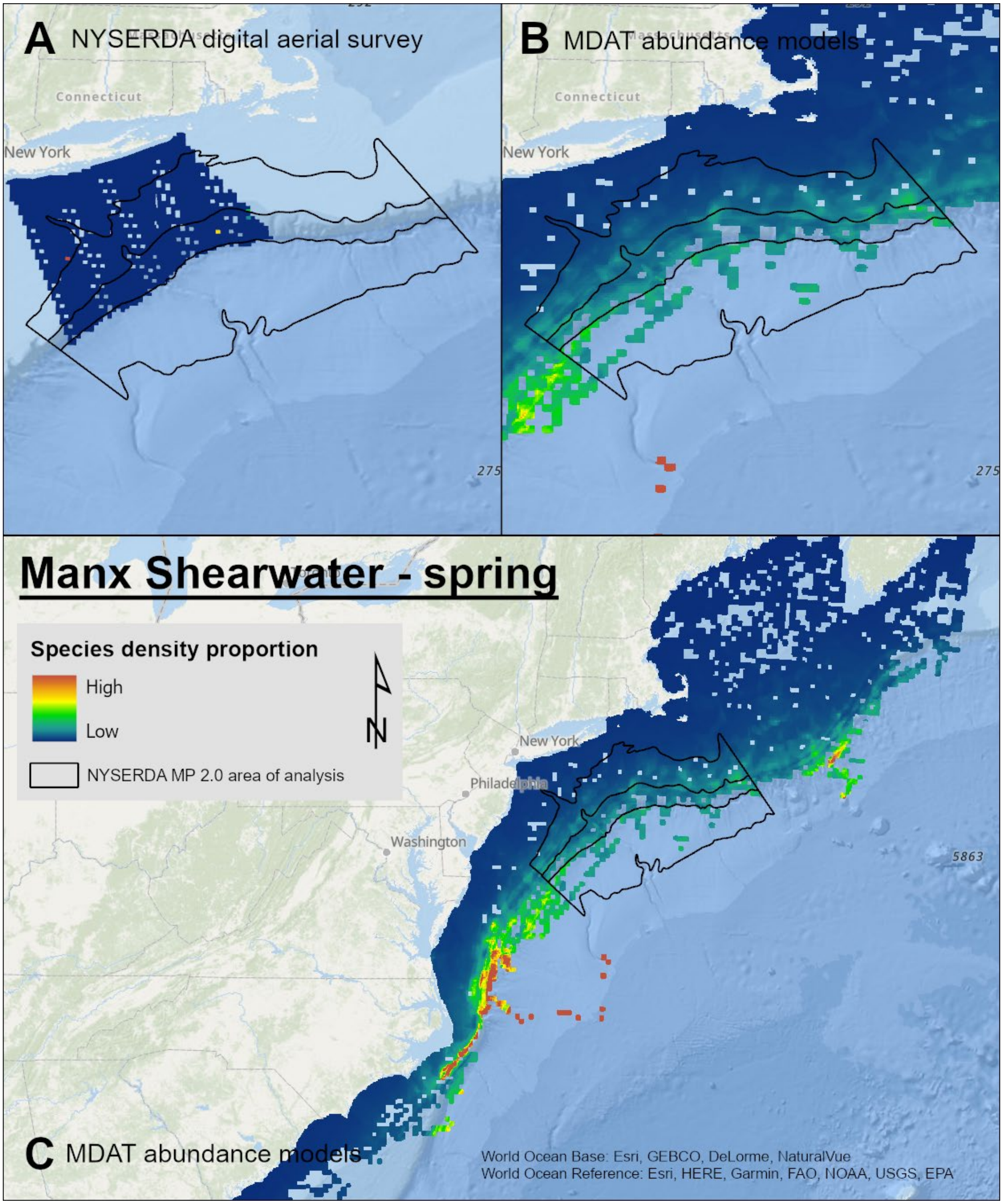
Map B-149. Winter Manx Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



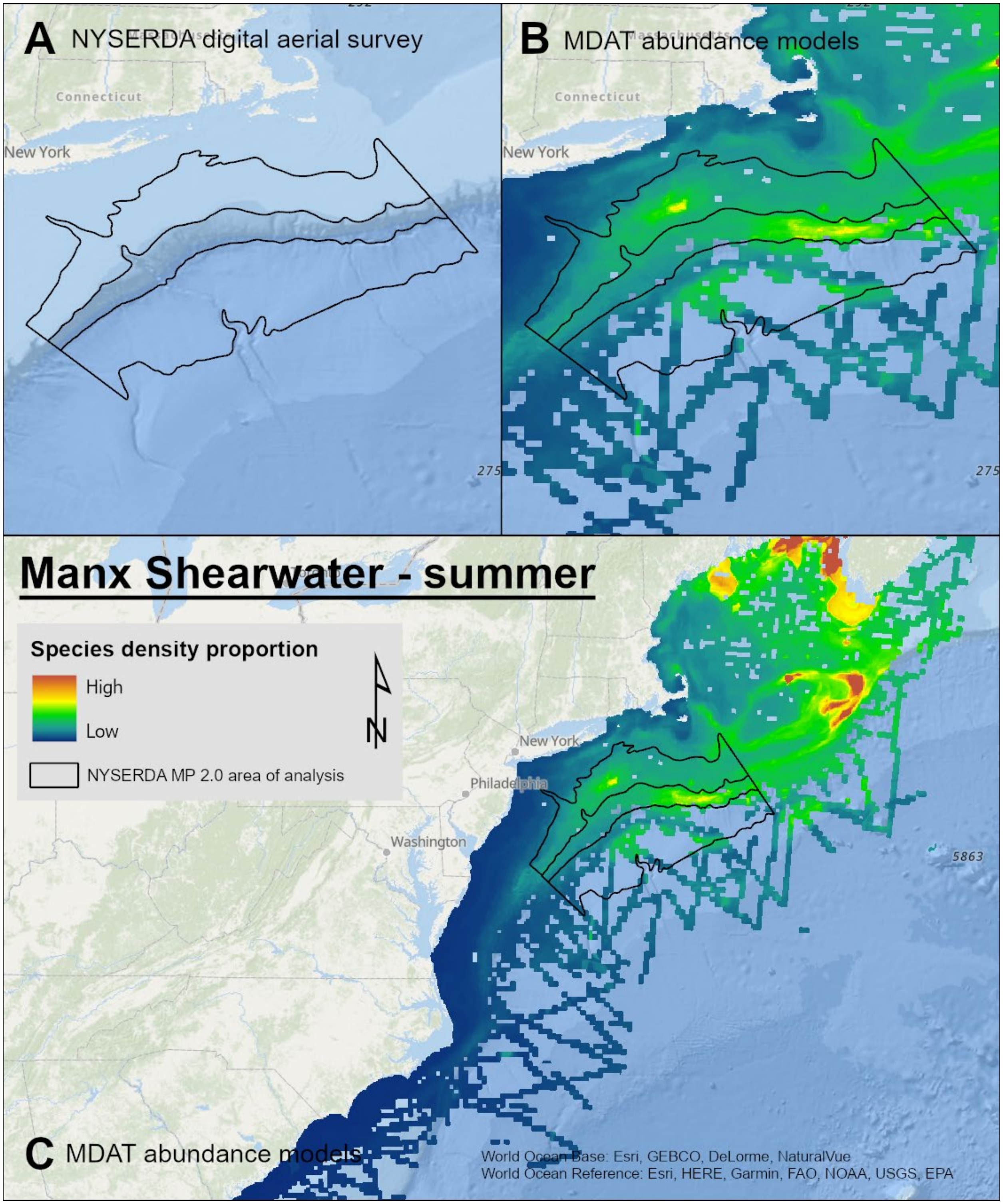
Map B-150. Spring Manx Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



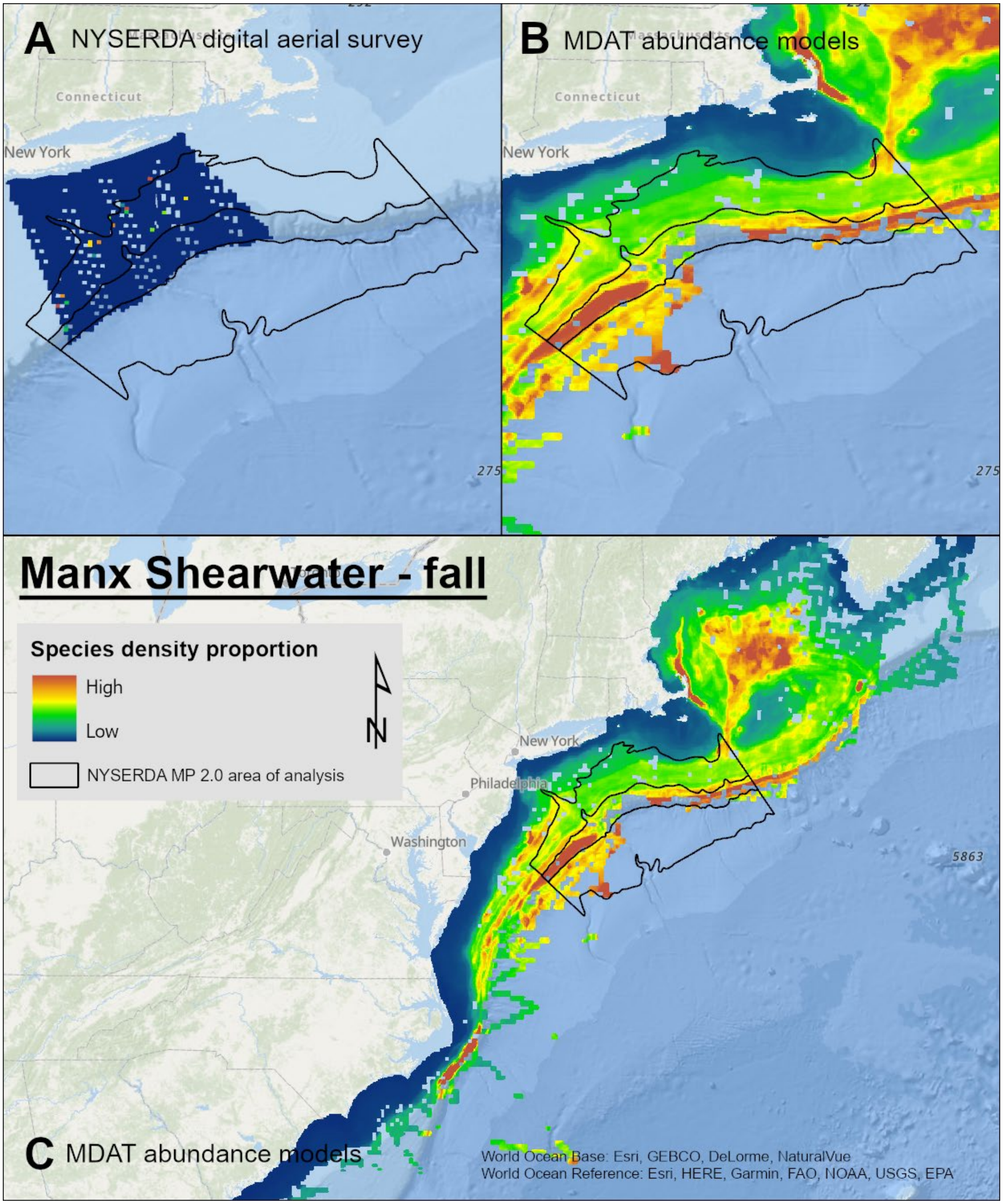
Map B-151. Summer Manx Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



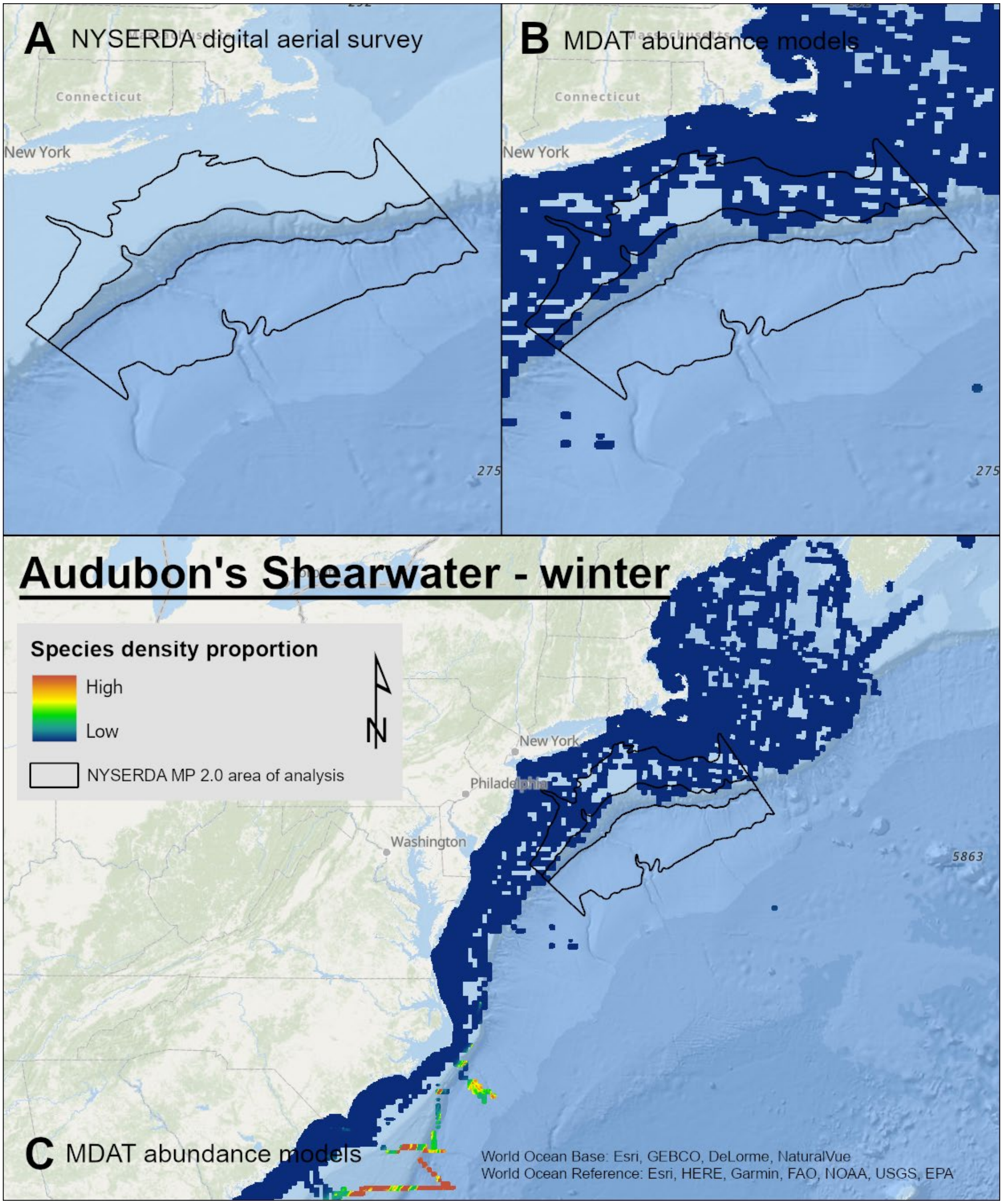
Map B-152. Fall Manx Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



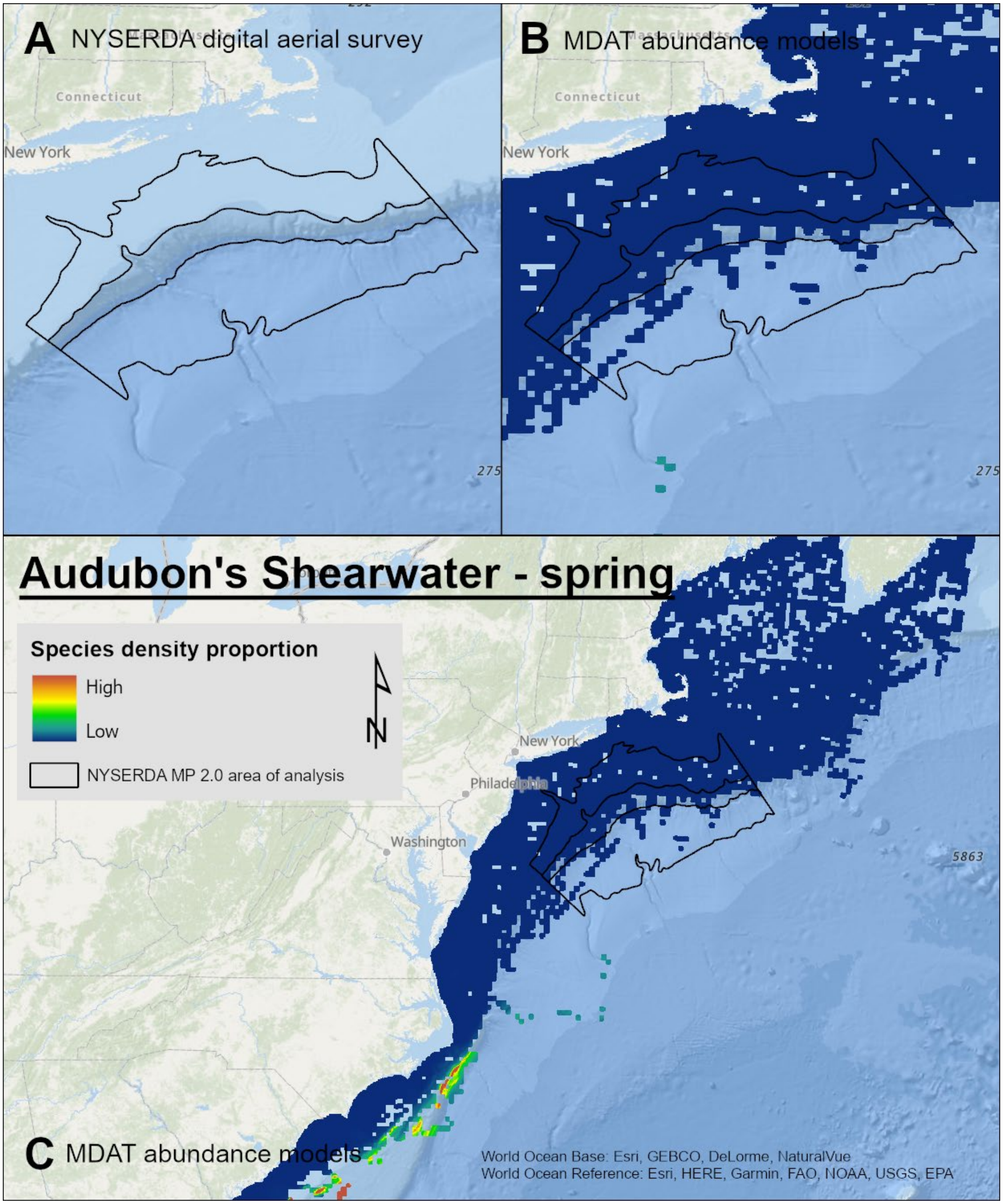
Map B-153. Winter Audubon's Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



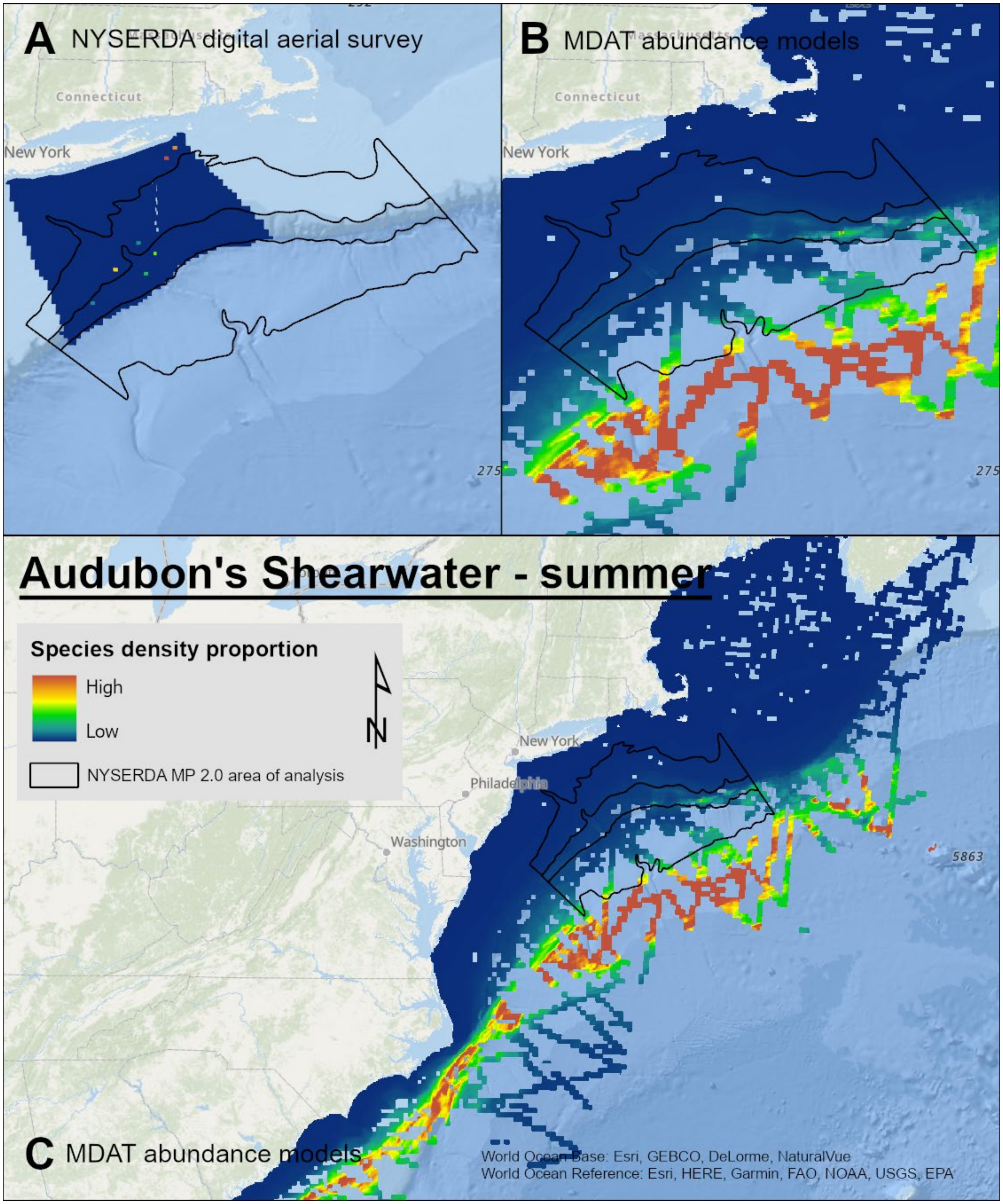
Map B-154. Spring Audubon's Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



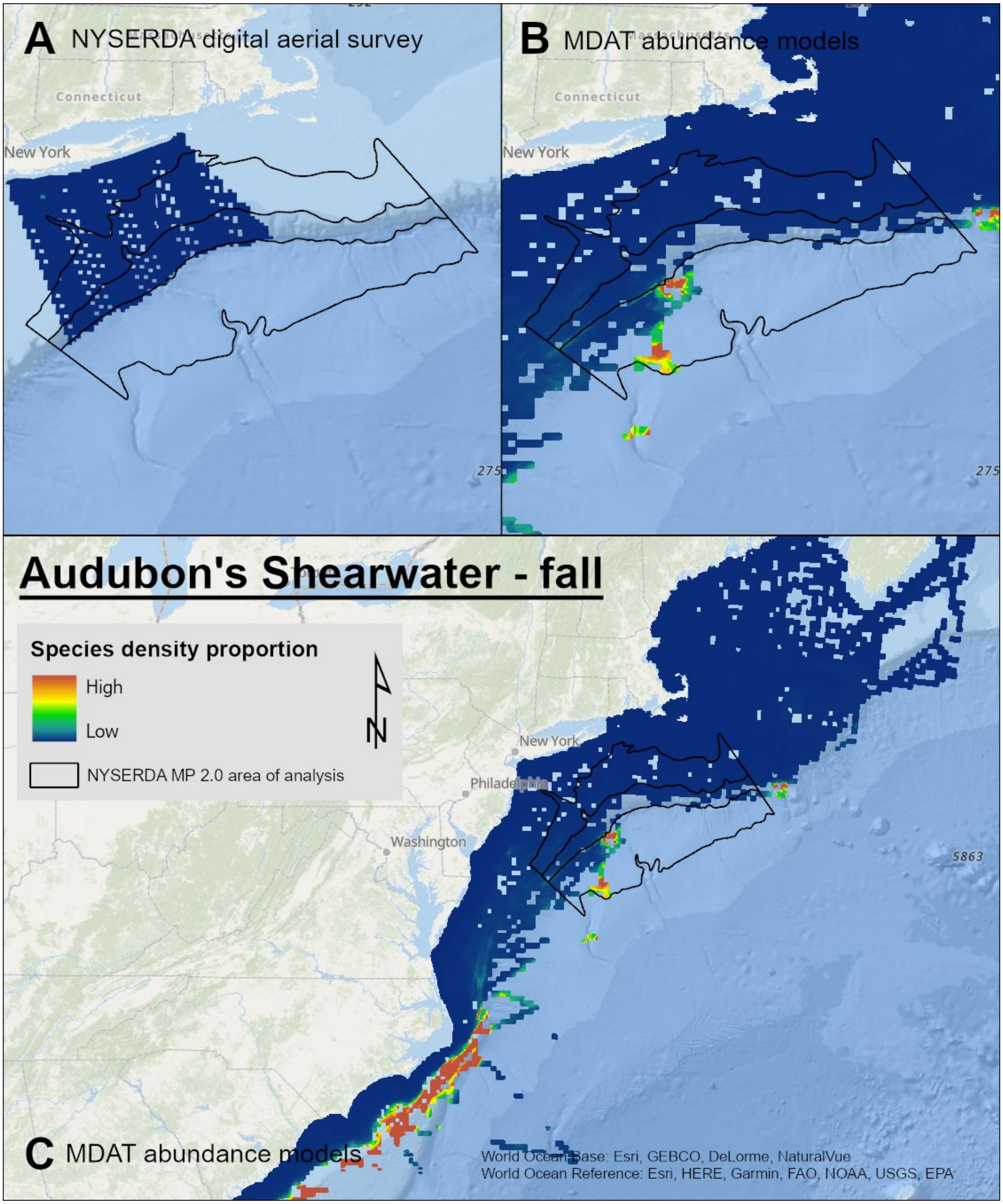
Map B-155. Summer Audubon's Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



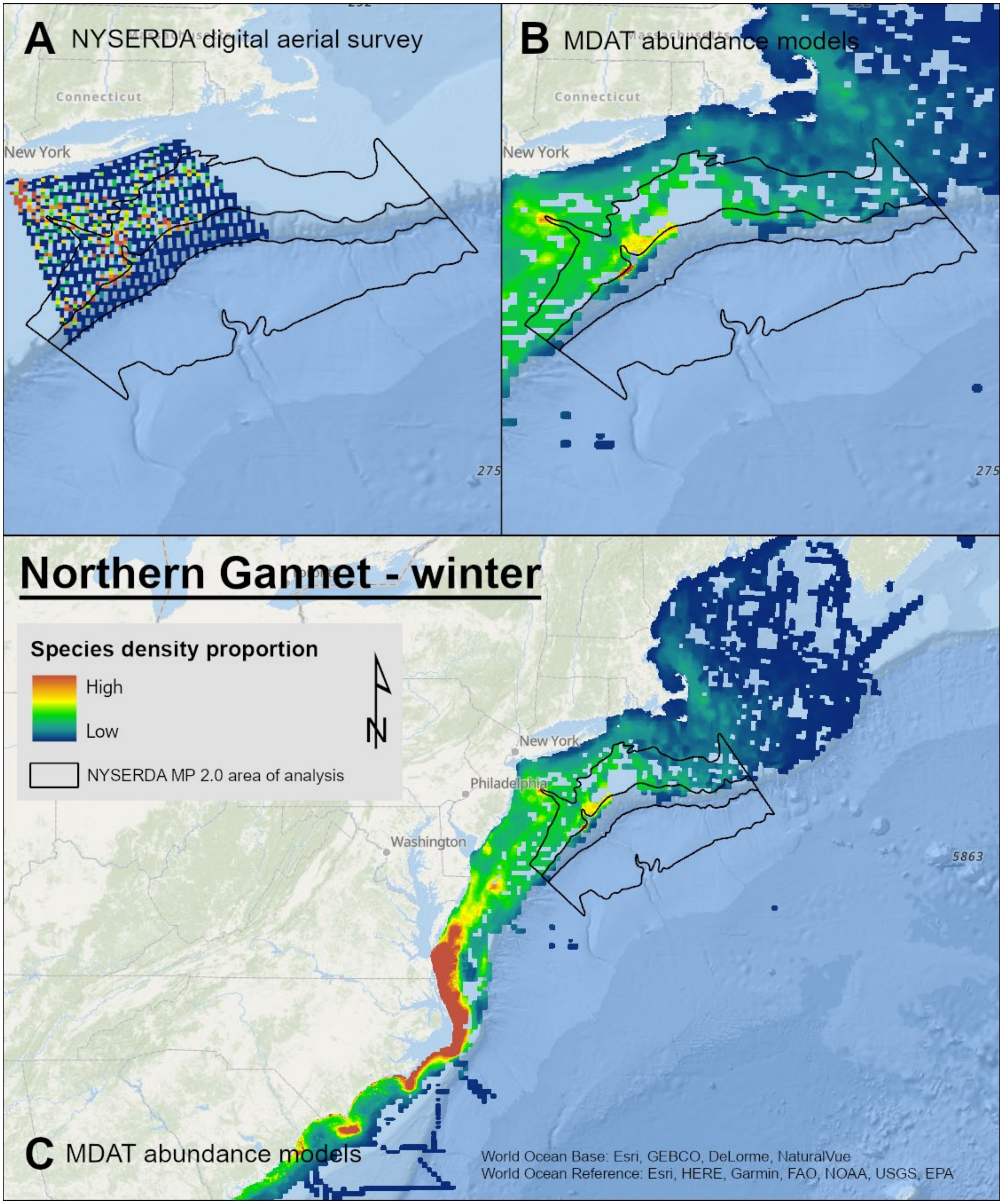
Map B-156. Fall Audubon's Shearwater Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



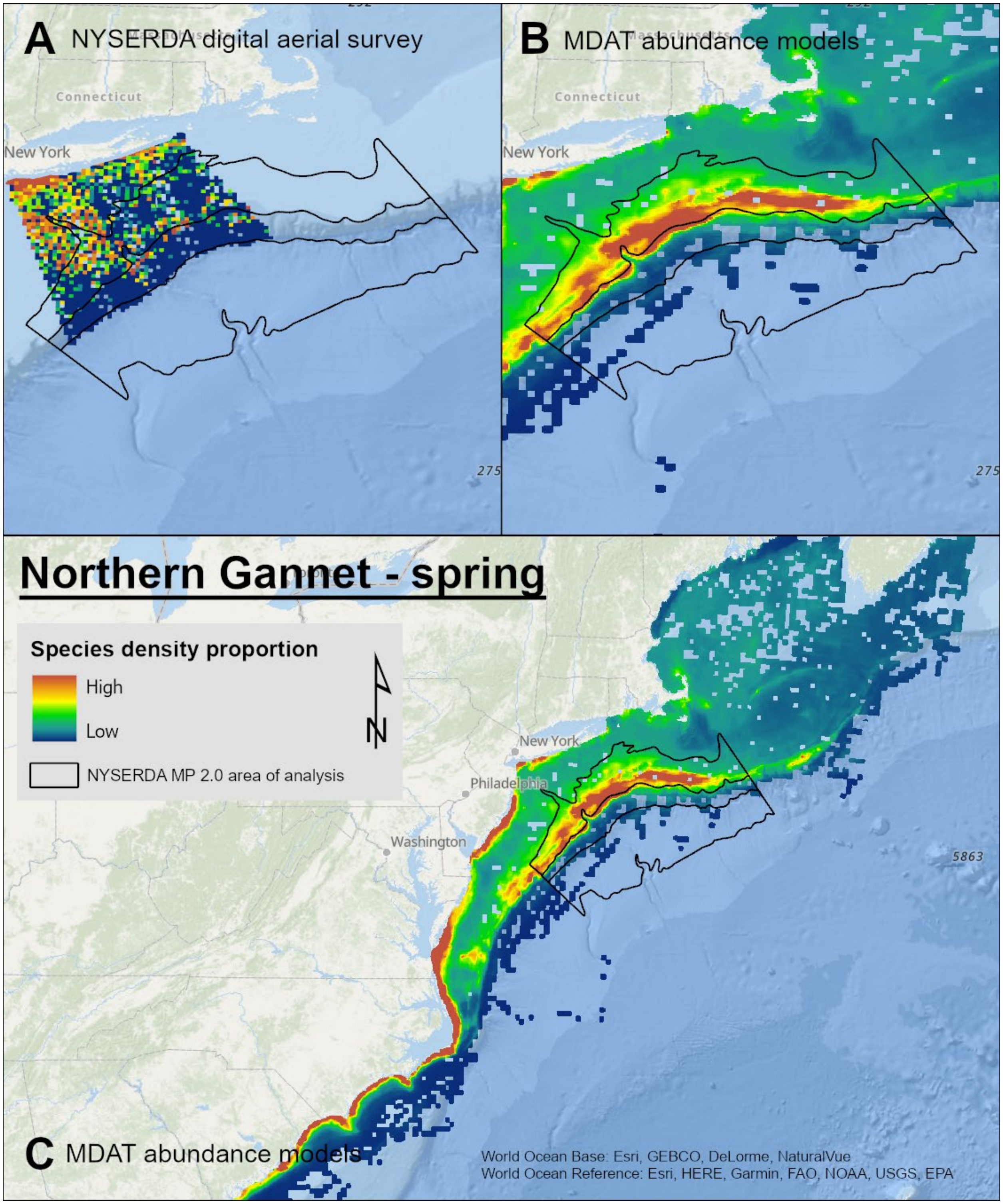
Map B-157. Winter Northern Gannet Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



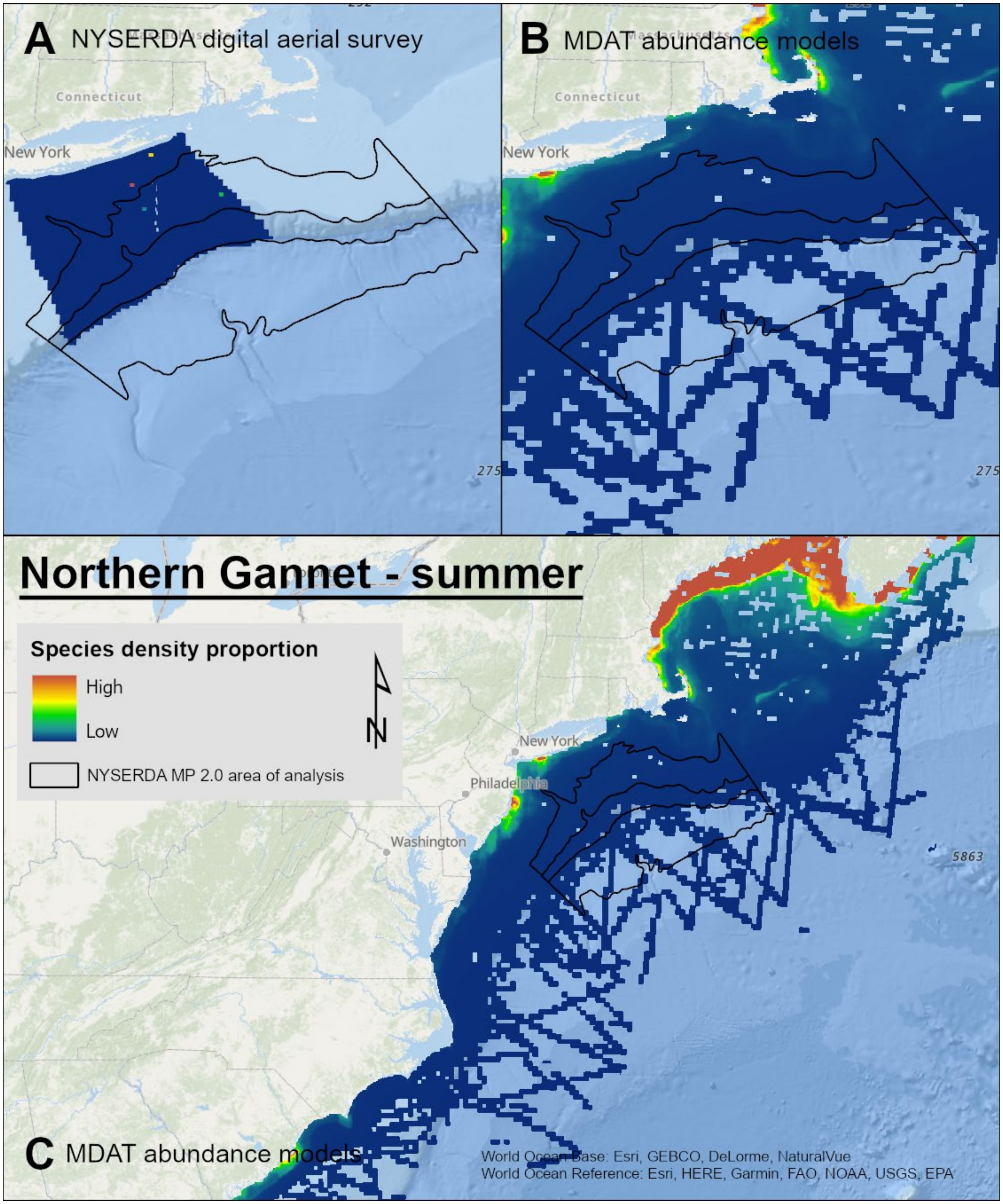
Map B-158. Spring Northern Gannet Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



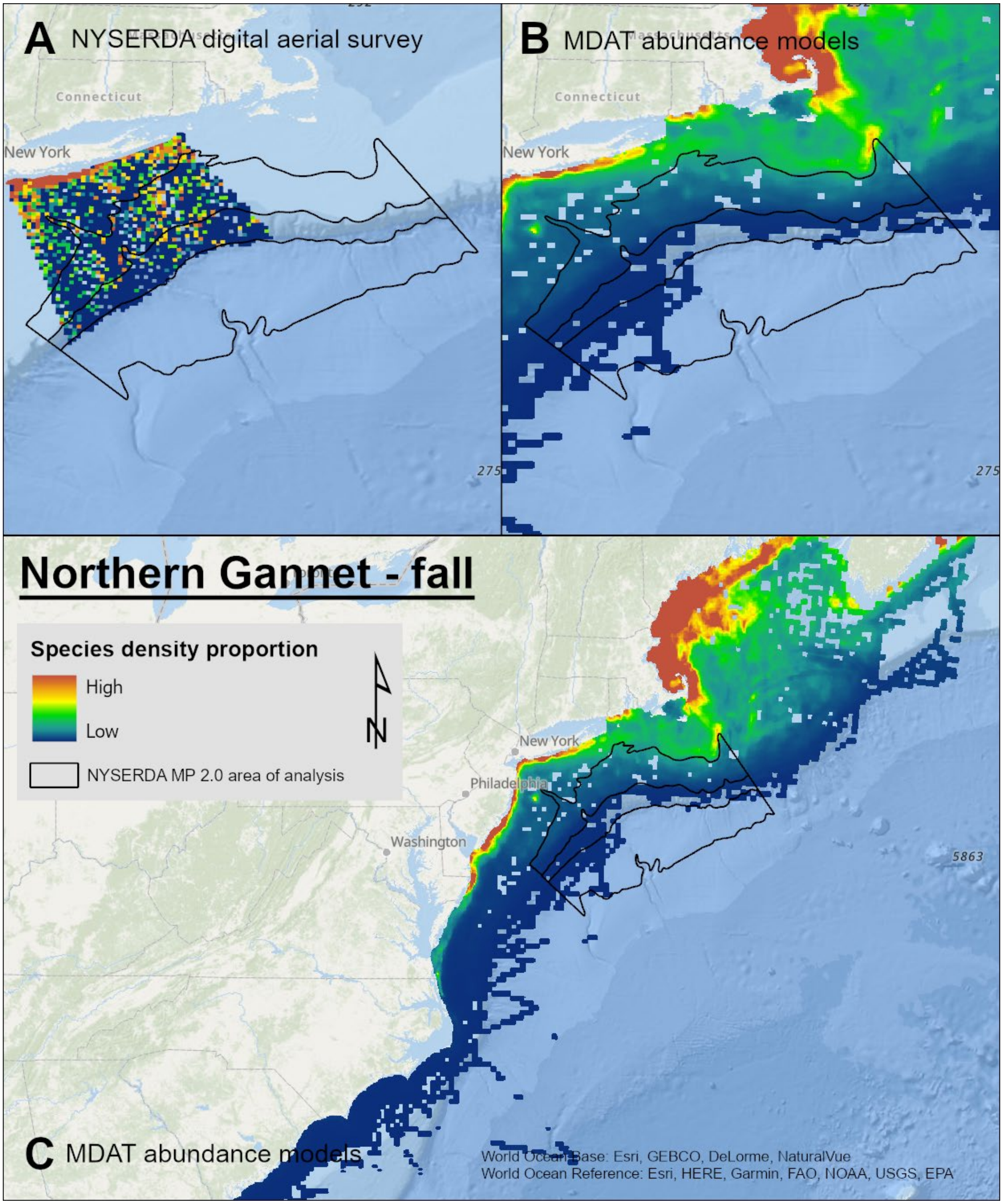
Map B-159. Summer Northern Gannet Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



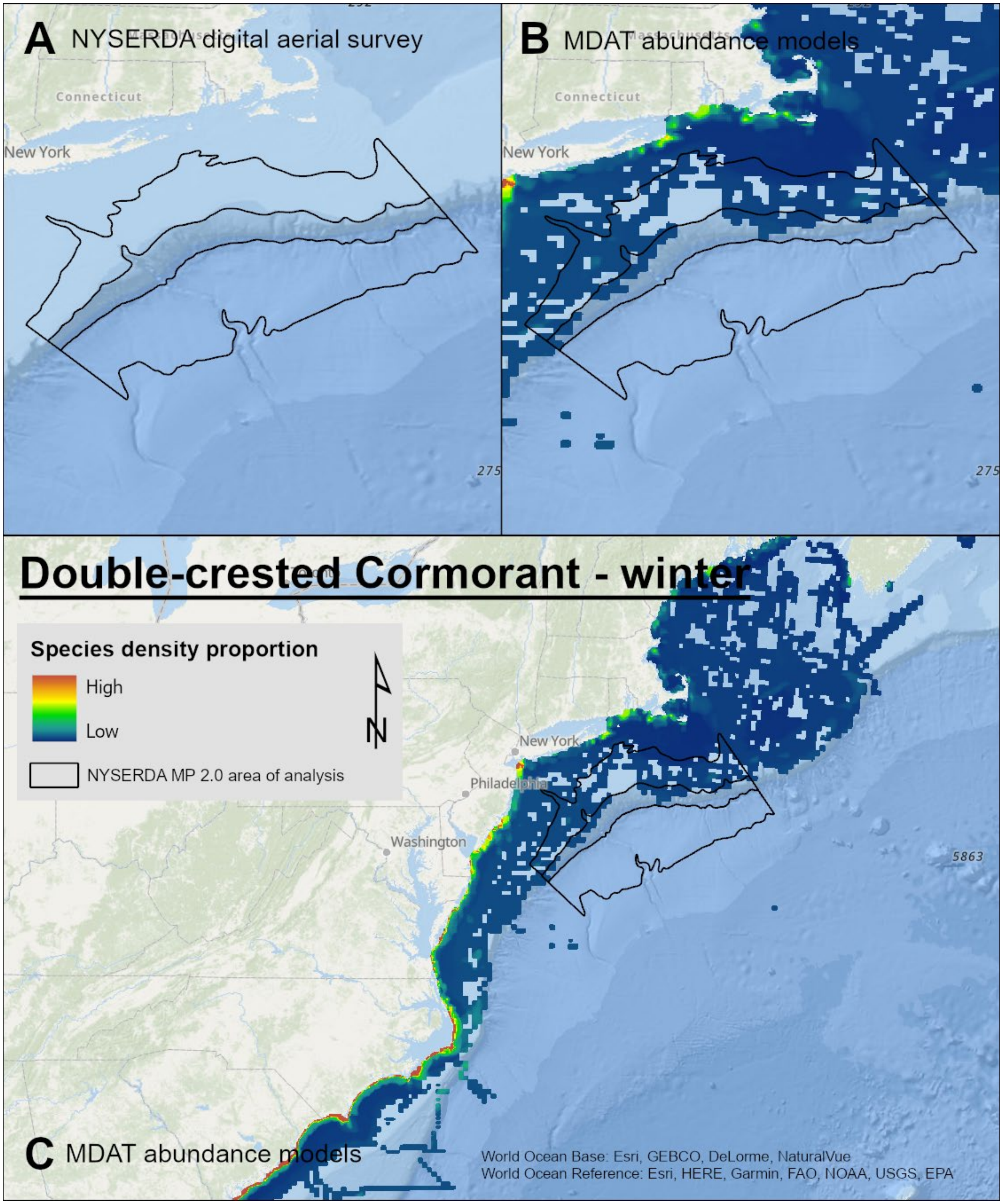
Map B-160. Fall Northern Gannet Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



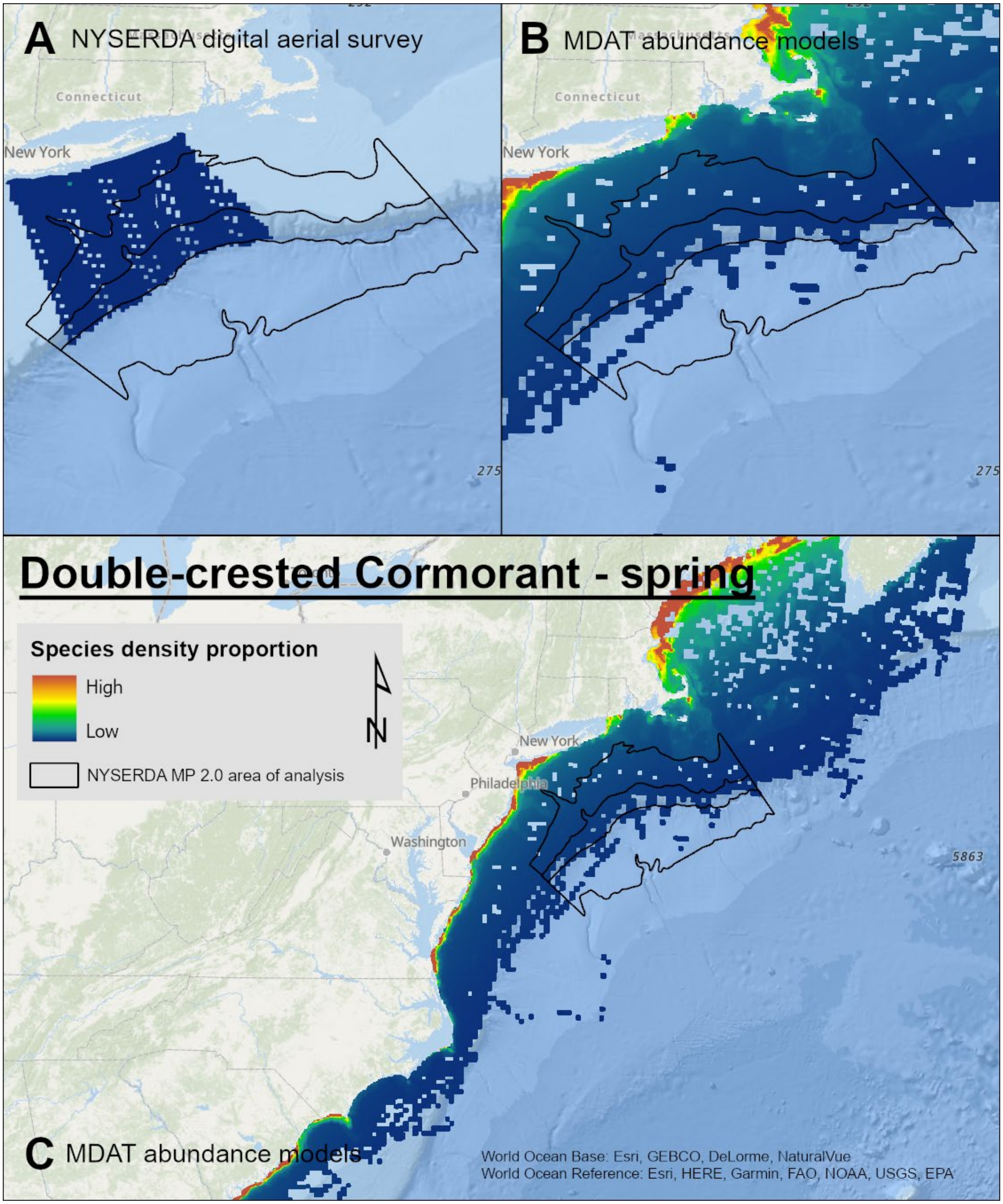
Map B-161. Winter Double-Crested Cormorant Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



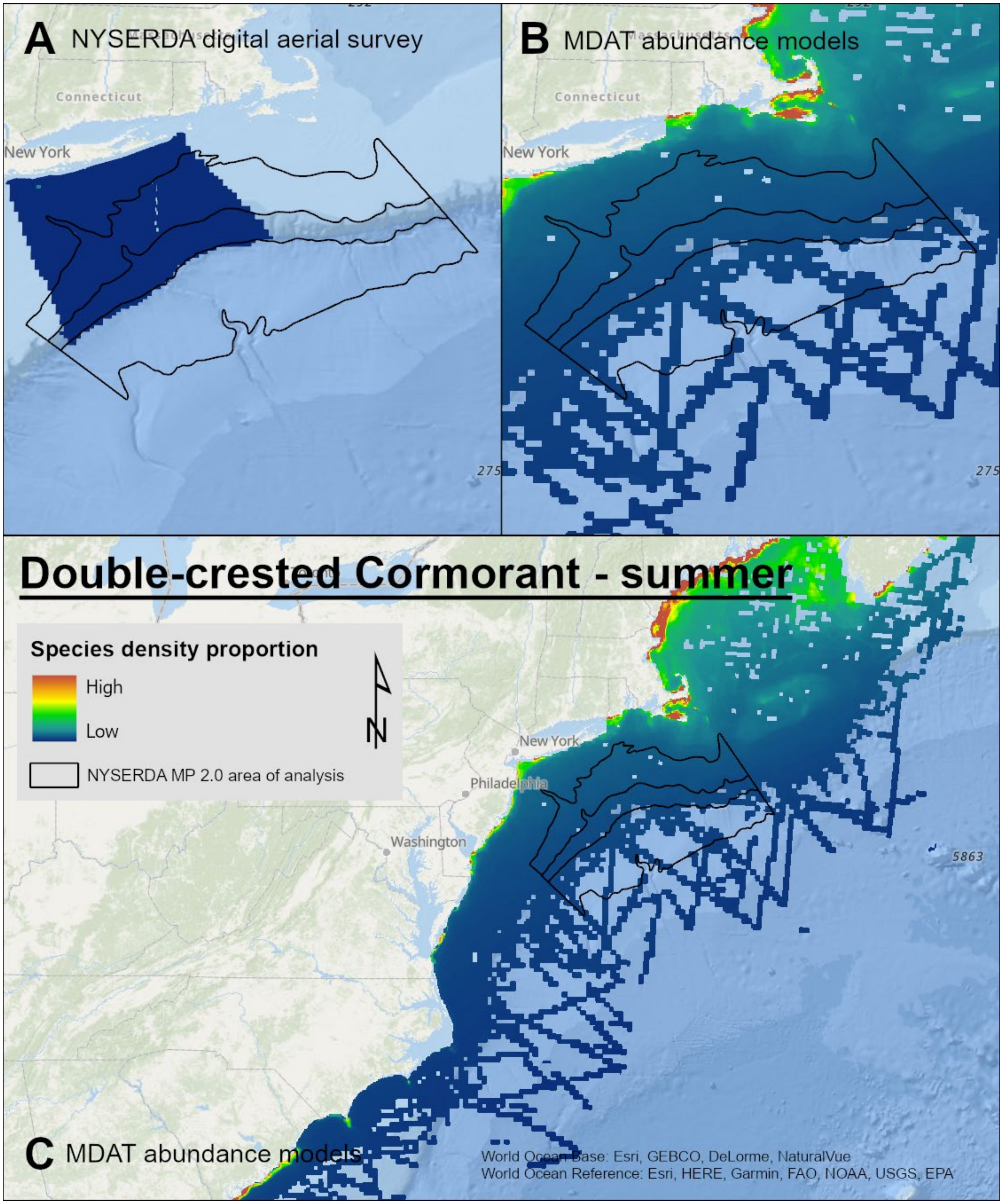
Map B-162. Spring Double-Crested Cormorant Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



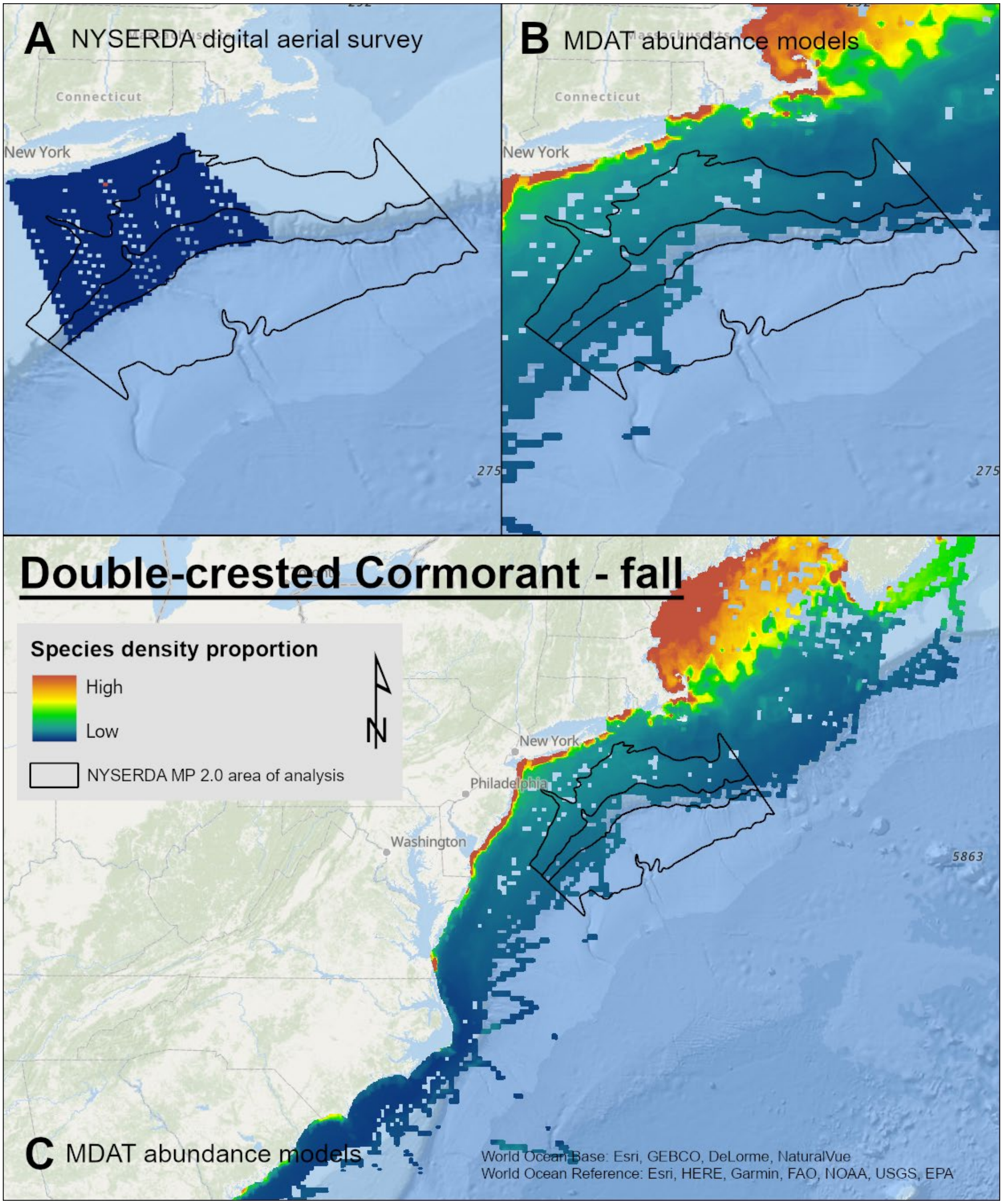
Map B-163. Summer Double-Crested Cormorant Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



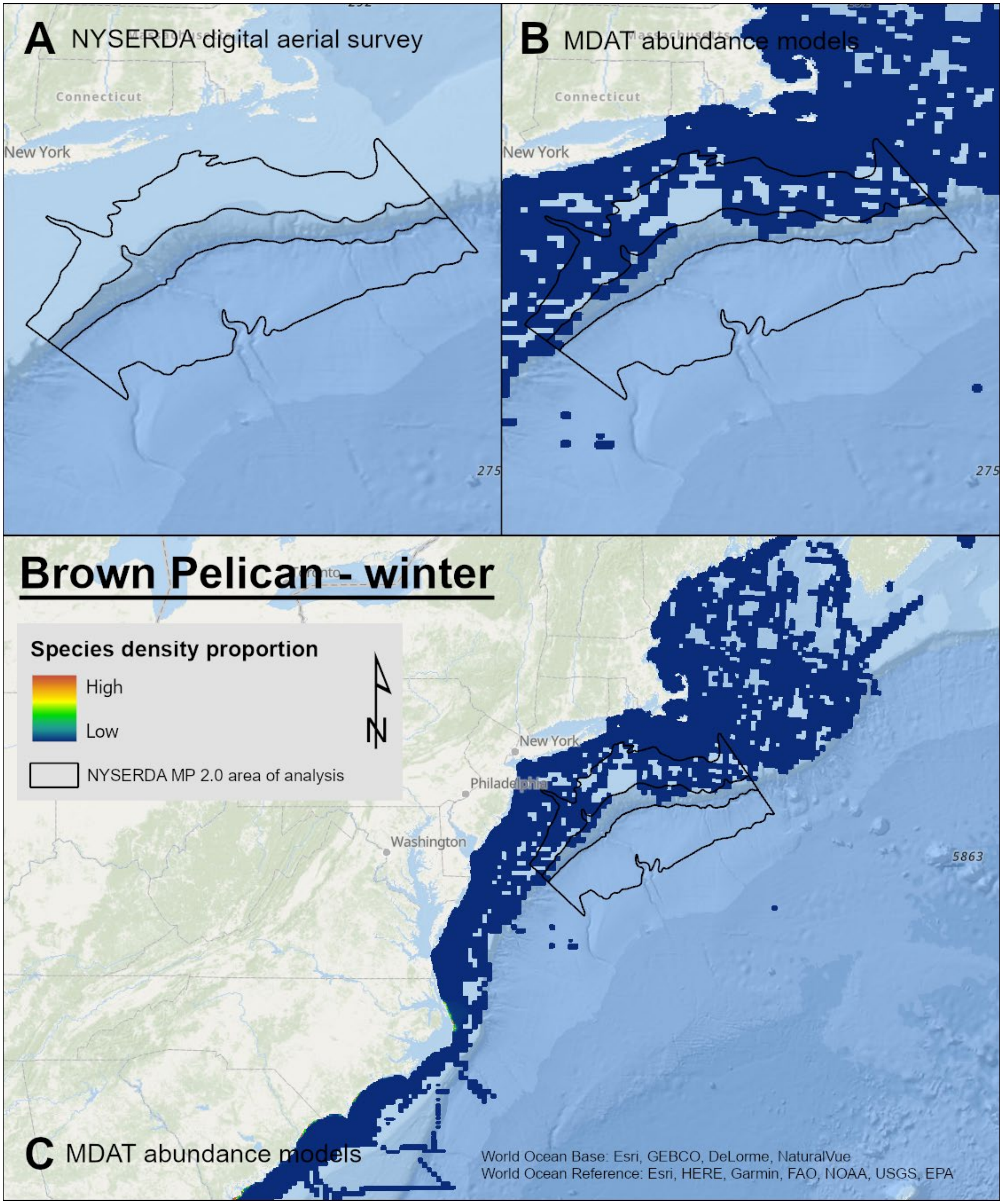
Map B-164. Fall Double-Crested Cormorant Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



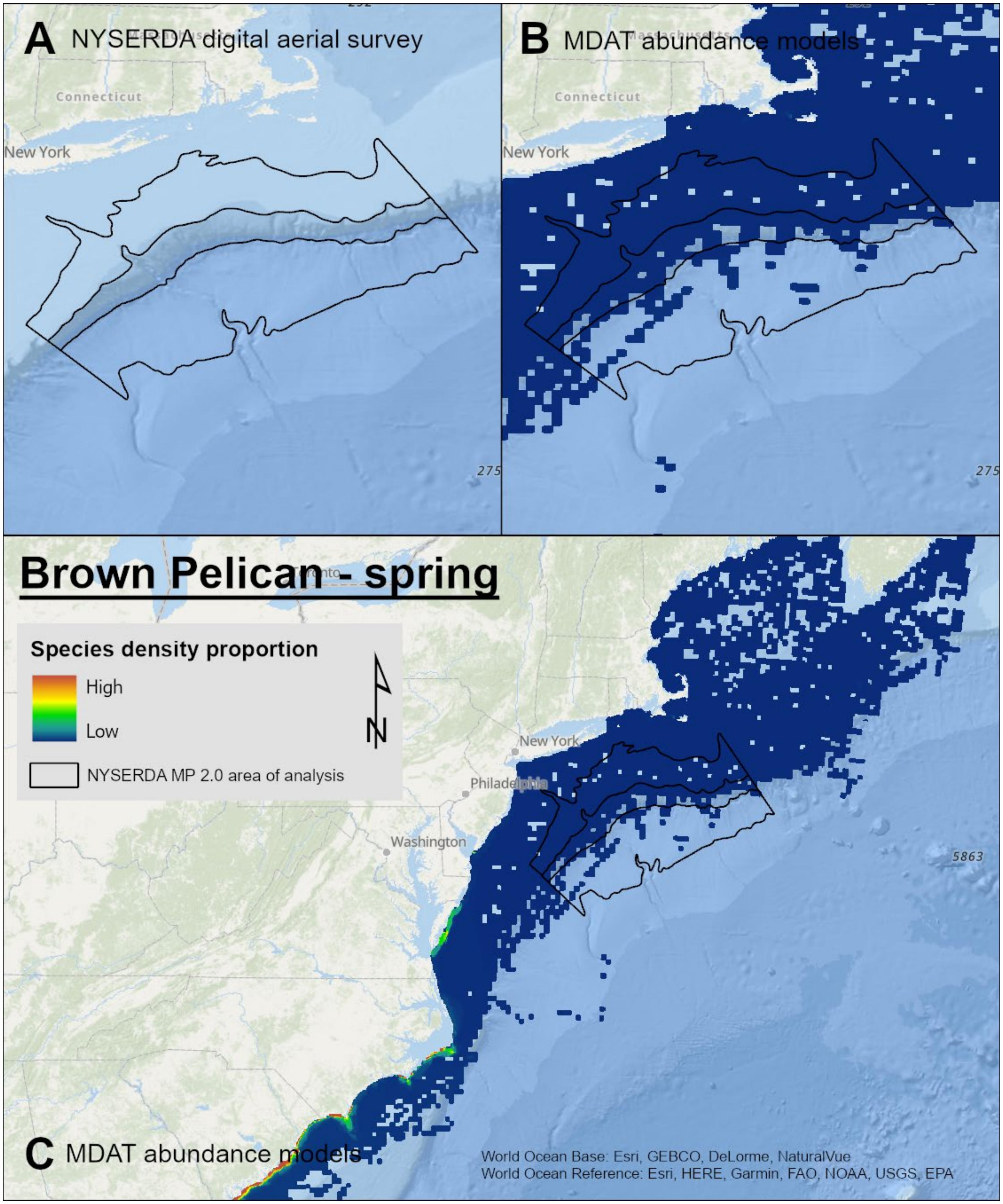
Map B-165. Winter Brown Pelican Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



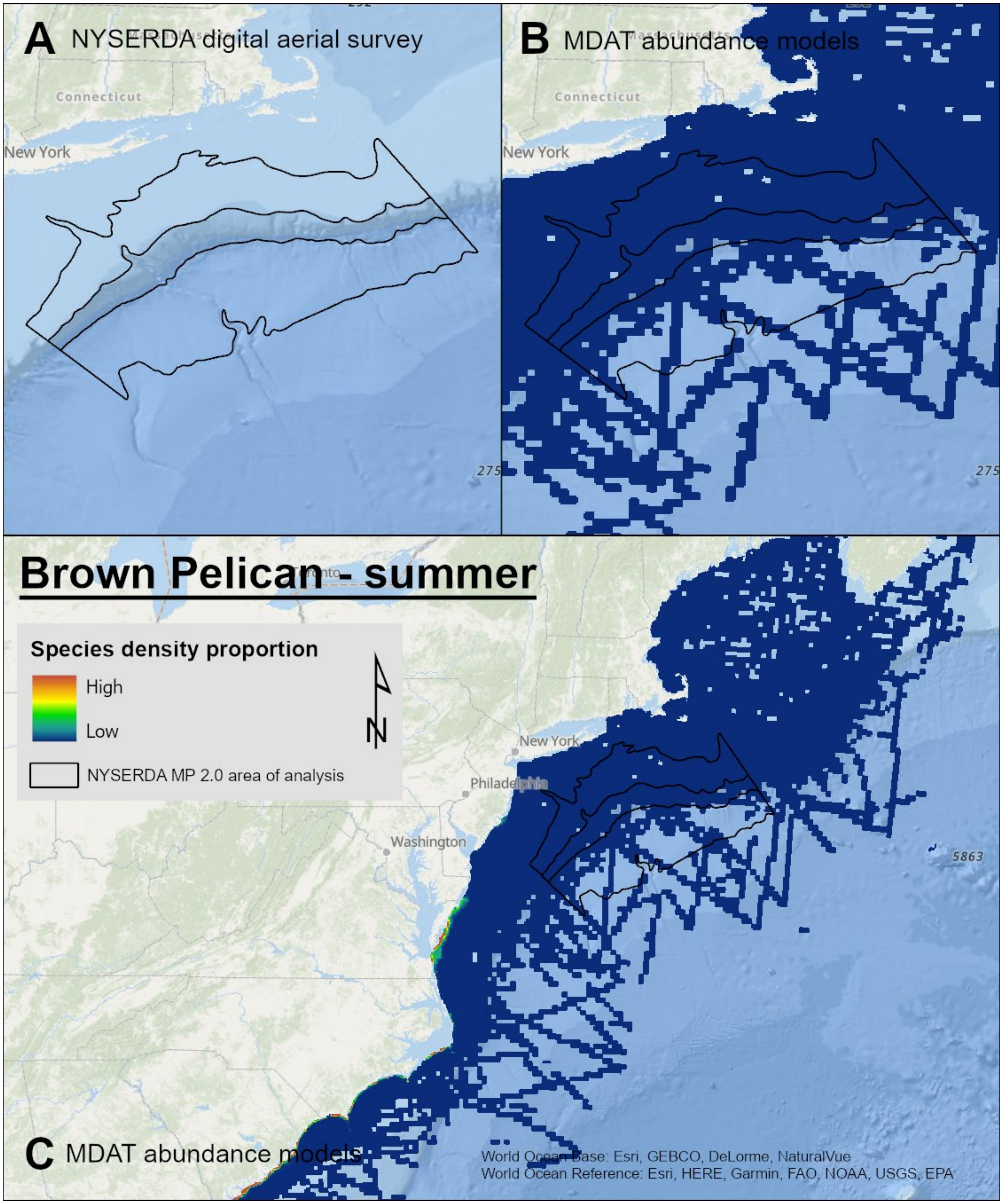
Map B-166. Spring Brown Pelican Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.



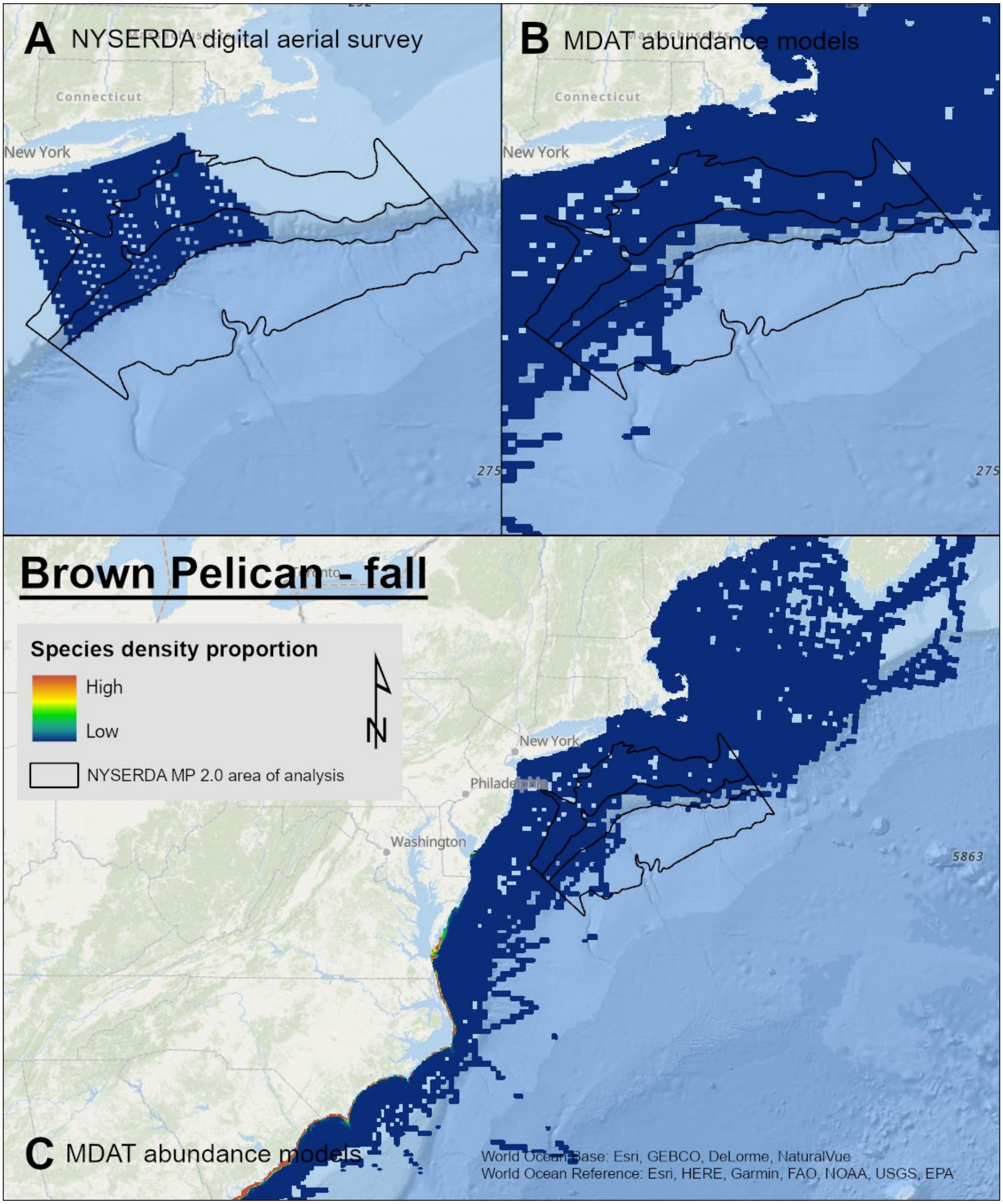
Map B-167. Summer Brown Pelican Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



Map B-168. Fall Brown Pelican Density Proportions

NYSERDA APEM high resolution digital aerial survey data (A) and the MDAT data at local (B) and regional scales (C). The scale for all maps is representative of relative spatial variation in the sites within the season for each data source.Error! Bookmark not defined.



Endnotes

[1] Proposed rule by the Fish and Wildlife Service in 2021: https://www.federalregister.gov/documents/2021/10/04/2021-21474/migratory-bird-permits-authorizing-the-incidental-take-of-migratory-birds.

[2] Guidelines for providing avian survey information for renewable energy development on the Outer Continental Shelf: https://www.boem.gov/sites/default/files/documents/newsroom/Avian%20Survey%20Guidelines.pdf

[3] eBird data utilized: https://doi.org/10.15468/dl.msqyya

[4] Marine-life Data and Analysis Team (MDAT) Marine-life data to support regional ocean planning and management: http://seamap.env.duke.edu/models/mdat/

[5] Motus Wildlife Tracking System (Motus) as an international collaborative research network that utilizes coordinated automated radio telemetry: https://motus.org/

[6] Animal tracking data: https://www.movebank.org

[7] Colonial waterbird databases: https://data.pointblue.org/apps/data_catalog/dataset/historiccwb#
https://data.pointblue.org/apps/data_catalog/dataset/colonial_waterbird_atlantic#
https://visualizebirds.shinyapps.io/shinyApp/

[8] Wind Energy Monitoring and Mitigation Technologies Tool which lists, but is not limited to, stressors, technologies, and research summaries: https://tethys.pnnl.gov/wind-energy-monitoring-mitigation-technologies-tool

[9] Wind Energy Monitoring and Mitigation Technologies Tool which lists, but is not limited to, stressors, technologies, and research summaries: https://tethys.pnnl.gov/wind-energy-monitoring-mitigation-technologies-tool

[10] Biden-Harris Administration announcement of new actions that would expand U.S. Offshore Wind Energy: https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/15/fact-sheet-biden-harris-administration-announces-new-actions-to-expand-u-s-offshore-wind-energy/

[11] Wind Energy Monitoring and Mitigation Technologies Tool which lists, but is not limited to, stressors, technologies, and research summaries: https://tethys.pnnl.gov/wind-energy-monitoring-mitigation-technologies-tool

[12] Guidelines for lighting and marking of structures supporting renewable energy development: https://www.boem.gov/sites/default/files/documents/renewable-energy/2021-Lighting-and-Marking-Guidelines.pdf

[13] A multi-scale approach to understanding migratory landbird habitat use of functional stopover habitat types and management efforts: https://www.usgs.gov/centers/wetland-and-aquatic-research-center/science/a-multiscale-approach-understanding-migratory

[14] Mitigation and Monitoring Practices Tool that is available for public use: https://www.nyftwg.com/mmp-tool/

[15] Wind Energy Monitoring and Mitigation Technologies Tool which lists, but is not limited to, stressors, technologies, and research summaries: https://tethys.pnnl.gov/wind-energy-monitoring-mitigation-technologies-tool

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