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Pelagic Seabirds off the East Coast of the United States 2008-2013

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ABOUT THE COVER

Cover photo (Northern Gannett) courtesy of David Pereksta (BOEM). Used with permission.

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Abstract:

We collected data on the distribution and abundance of seabirds on twenty-two research cruises over the shelf waters of the eastern United States between August 2008 and February 2013. We had two primary research objectives. The first of these was to identify "hotspots" of seabird abundance, where hotspots are intended to represent those areas characterized by elevated abundance of seabirds that persist through time, either seasonally or interannually. Our second objective was to contrast estimates of abundance made by us in 2008 to 2012 to those made by surveys of similar areas during 1975 to 1990 by the Manomet Bird Observatory. Having this knowledge in hand will allow us to determine changes in abundances and have greater ability to determine the factors influencing these changes--such as changing climates, changing prey bases, or the development of wind facilities.

Introduction

There is heightened interest in developing wind resources in the offshore waters of the Atlantic, and thus there is a need for information on the spatial and temporal movement and occupancy patterns of wildlife in offshore habitats. Agencies overseeing offshore permitting processes are investing resources in surveys to gather baseline information on the use of offshore habitats by wildlife to use for siting offshore developments. Ships of opportunity surveys, the results of which are the focus of this report, are one of many ongoing efforts to determine areas of significance to marine birds and other marine resources. Communities of seabirds inhabiting the pelagic waters off the U.S. East Coast are dominated by wintering nonbreeders, mainly shearwaters and storm-petrels that nest on remote islands in the southern hemisphere (Barrett, et al., 2006; Nisbet, et al., 2013). Because the nesting colonies of these birds are not generally accessible, shipboard surveys of the ocean are one of the best ways to quantify abundance of these seabirds in our area and to measure variability over time.

Our goal in this effort was to document areas of frequent use and aggregation by birds to inform planning of offshore developments. We identified seasonal distribution and abundance patterns, movement patterns, and habitat-abundance associations. We were also interested in the birds' response to changes in climate and fisheries activities, and perhaps other unknown factors.

Our primary objective was to determine current seabird distribution and abundance from Maine to Cape Hatteras, North Carolina. A secondary objective was to determine whether changes in distribution and abundance have occurred relative to historic records. A tertiary objective was to assess whether changes, if they have occurred, might be attributed to climate change or fisheries.

Methods

This report presents the results of 22 research cruises over the shelf waters of the eastern United States between August 2008 and February 2013, using NOAA research vessels as platforms. The purpose of these surveys was to establish baseline data on the seasonal abundance and distribution of pelagic bird species which could be used for determining where to site potential offshore development, as well as to draw comparisons with seabird data collected in the 1970s and 1980s. Our sampling was limited to the continental shelf, which extends to about 100 nautical miles off the northeastern United States.

Our results from 2008 and 2009 were summarized in Appendix I and those from 2010 in Appendix II. In 2011, we participated on three NOAA Ecomon cruises between February and November, and then a fourth in February 2012 (Table 1). We also collected data on a Herring Acoustic Survey in September 2011. In 2012-2013, we collected data on 4 Ecomon cruises between June 2012 and February 2013, and a Herring Acoustic Survey in September-October 2012.

All data are stored at the US Geological Survey's database in Patuxent, Maryland. We collected data on seabirds while the ship was underway during daylight hours. We discontinued sampling when the ship stopped to sample an oceanographic station. We used a combination of strip-transect and line-transects to quantify density. Our default method was to sample a 300 m wide strip transect situated on the side of the ship that offered the best visibility. When densities were not so high as to overwhelm the observer, we recorded distances and angles to all birds spotted, regardless of their distance from the ship (i.e. >> 300m). This ensured our ability to scale data collected within the 300 m strip on the basis of detectability of individual species of birds (Buckland et al. 2001).

Table 1: Cruises from Which Seabird Data Were Collected in 2011-2013

Cruise	Month andYear	Locations and Linear Distances
EcoMon	February 2011	Cape Hatteras to the Gulf of Maine (1318 km)
EcoMon	August 2011	Cancelled by NOAA
Herring Acoustic	September 2011	Georges Bank and Jeffries Ledge (1730 km)
EcoMon	November 2011	Cape Hatteras to the Gulf of Maine (897 km)
EcoMon	February 2012	Cape Hatteras to the Gulf of Maine (1200 km
EcoMon	June 2012	Cape Hatteras to Gulf of Maine (1120 km)
EcoMon	August 2012	Cape Hatteras to Gulf of Maine (1211 km)
Herring Acoustic	September-October 2012	Georges Bank and Jeffries Ledge (1411 km)
EcoMon	October-November 2012	Cape Hatteras to Gulf of Maine (798 km)
EcoMon	February 2013	Cape Hatteras to Gulf of Maine (729 km)

Results

We sampled three kinds of surveys: 1) Ecomon surveys, designed to monitor zooplankton on the continental shelf from Maine to Cape Hatteras, 2) Herring Acoustic surveys, designed to quantify spatial distribution of herring and their prey (copepods) using acoustics, on northern Georges Bank, and 3) a research cruise with Gareth Lawson and Peter Wiebe of the Woods Hole Oceanographic Institute designed to investigate the accumulation of zooplankton at hydrographic fronts on Georges Bank and surrounding waters. We present the data in Tables 2 throough 5 and Figures 1 through 10.

Table 2: Densities of dominant species recorded in 2010.

Species	February 2010	May 2010	August 2010	November 2010
Northern Fulmar	2.4[a] (7.5)[b]	1.6 (3.8)	0 (0)	8.5 (1.5)
Greater Shearwater	0 (0)	6.8 (1.5)	7.3 (2.75)	5.7 (7.5)
Wilson's Storm-petrel	0 (0)	4.4 (6.0)	3.9 (8.0)	1.59 (0.5)
Northern Gannet	1.4 (1.0)	0.28 (1.75)	0.29 (0.25)	6.3 (1.25)
Herring Gull	2.6 (3.75)	0.50 (1.5)	1.7 (0.75)	2.3 (8.5)
Dovekie	0.36 (1.0)	0.09 (1.0)	0 (0)	8.1 (0)

[a]Densities of dominant species recorded in 2010 (birds/km^2)

[b]Density estimates for 1970s-1980s (Powers, 1984) given in parentheses

Table 3: Densities of Dominant Seabird Species in 2011-2012

Species	EcoMon February 2011	EcoMon June 2011	Herring Acoustic September-October 2011	EcoMon October-November 2011
White-winged Scoter	1.0[a]	0	0.01	0.07
Northern Fulmar	0.6	0.6	0.2	1.5
Great Shearwater	0	4.3	6.2	4.1
Wilson's Storm-petrel	0	2.1	1.3	0.04
Northern Gannet	3.8	0.09	0.31	0.7
Great Black-backed Gull	1.1	0.5	0.9	0.4
Herring Gull	0.6	0.5	1.2	3.3
Common Tern	0	0.2	0.3	0
Red Phalarope	0	0	0.09	1.0
Razorbill	0.7	0.004	0.001	0.01
Dovekie	1.0	0.01	0	0.5

[a]Birds per km^2

Table 4: Densities of Dominant Seabird Species in 2012-2013

Species	EcoMon February 2012	EcoMon June 2012	EcoMon August 2012	Herring Sept-Oct 2012	EcoMon Oct-Nov 2012	EcoMon Feb 2013
Common Eider	0[a]	0	0.02	0.4	0.4	0
Cory's Shearwater	0	0.05	0.3	0.4	0.04	0
Great Shearwater	0.002	0.8	2.9	4.3	1.4	0
Sooty Shearwater	0	1.1	0.008	0.008	0.002	0
Wilson's Storm-Petrel	0	0.7	1.1	0.7	0.06	0
Leach's Storm-Petrel	0	0.4	0.4	0.03	0.002	0
Northern Gannet	0.4	0.007	0.1	1.3	0.8	1.6
Black-legged Kittiwake	0.4	0	0	0.003	0.1	0.4
Great Black-backed Gull	0.6	0.2	0.2	1.2	0.3	0.3
Herring Gull	0.9	0.2	0.07	0.6	1.9	0.3
Common Tern	0	0.02	0.07	0.2	0	0
All small *Sterna* terns	0	0.03	0.08	0.7	0	0
Phalarope, sp.	0	0.004	0.6	0.6	0.1	0.004
Razorbill	0.5	0	0	0.001	0.02	0.3
Dovekie	3.6	0.1	0	0	0.5	2.8

[a]Birds per km^2

Table 4: Abundance of seabirds, stratified by the same habitat designations as in Powers (1983) for 2011-2012 and 2012-2013.

Species	2011-2012[a]	2012-2013[a]
White-winged Scoter	GM 0.05 GB 0 SNE 0.1 MA 0.08	0.02 0 0.08 0.2
Northern Fulmar	GM 0.6 GB 0.004 SNE 0.04 MA 0.005	0.2 0.06 0.02 0.01
Great Shearwater	GM 1.6 GB 0.9 SNE 1.1 MA 0.4	1.1 0.5 0.2 0.01
Wilson's Storm-Petrel	GM 0.5 GB 0.2 SNE0.1 MA 0.1	0.3 0.1 0.04 0.06
Northern Gannet	GM 0.1 GB 0.01 SNE 0.2 MA 0.8	0.3 0.2 0.05 0.05
Great Black-backed Gull	GM 0.5 GB 0.03 SNE 0.2 MA 0.1	0.3 0.07 0.09 0.05

Species	2011-2012[a]	2012-2013[a]
Herring Gull	GM 0.5 GB 0.1 SNE 0.2 MA 0.6	0.2 0.2 0.1 0.1
Common Tern	GM 0.08 GB 0.01 SNE 0.06 MA 0.02	0.02 0.002 0.03 0.006
Red Phalarope	GM 0.04 GB 0.01 SNE 0.04 MA 0.2	0.07 0.004 0.002 0.007
Razorbill	GM 0.02 GB 0.003 SNE 0.1 MA 0.005	0.02 0.03 0.07 0.007
Dovekie	GM 0.1 GB 0.02 SNE 0.03 MA 0.2	0.15 0.4 0.1 0.4

[a] Mean birds per km^2

Note: Seabird abundance was stratified by the same habitat designations as in Powers (Powers, 1984) for 2011-2012 and 2012-2013

GM = Gulf of Maine; GB = Georges Bank; SNE = Southern New England; MA = Mid-Atlantic

Hotspots

We searched for Hotspots of abundance of single species of seabirds and of seabird diversity (Santora et al. 2012, Santora et al. 2011, Santora and Veit 2013). We defined a Hotspot of abundance as any rectangle (1/4 degree of latitude, squared) that harbored an abundance larger than 2 standard deviations (s.d) above the mean of all such squares surveyed, on 50% or more of of the cruises on which that rectangle was visited. We identified Hotspots using this definition to take account of many areas in the ocean that harbor very high abundance of birds for a short, but predictable portion of the year. For example, tens of thousands of Northern Gannets commonly feed very close to shore off Avalon, Cape May and Sandy Hook New Jersey on Menhaden and probably other species of schooling fishes during both spring and fall. They often are only present at any one of these places for a few days or weeks; for this reason, a ranking of overall average abundance would fail to identify such a place as a Hotspot, even if it was indeed "Hot" for a small portion of the year. We wanted our metric to pick up these places that were persistently hot from year to year for the same species.

We also sought to identify locations that were characterized by persistently elevated diversity of seabirds. To identify the "diversity hotspots", we used the same basic logic as for abundance hotspots, but used species number as the unit of measure. Cells that 50% of the time harbored > 2 standard deviations above the overall mean for species number were labeled as diversity hotspots. We conducted these calculations for the U.S. continental shelf between latitudes 40^{o} and 45^{o} N (From New York City north to the Canadian border).

We identified two primary Hotspots of abundance, one off southeastern Cape Cod and the other at the mouth of the Chesapeake Bay. These two areas were both Hotspots of abundance and species number; there was in addition a diversity hotspot off of northern New Jersey and in the New York Harbor area. All these Hotspots were heavily influenced by the abundance of sea ducks, terns, gulls and loons. That is, they were close enough to shore to record all these species, which do not occur in truly pelagic waters. This suggests that we need to recalculate Hotspots so as to be specific to habitats; we need, for example to identify what areas are hotspots for shearwaters and petrels, which do not appear in the areas identified as Hotspots above, except in small numbers. Apart from this issue, the Hotspots we identified are in accord with those identified by marine ornithologists in previous years (e.g. Powers 1983, Veit and Petersen 1993).

Table 5: Hotspots of Seabird Abundance in the Northwest Atlantic.

Hotspot Location	Species	Season	Detailed Location	Species Present Based on Other Surveys	Source
Northeast Peak Georges Bank	Northern Fulmar	October-June			Nisbet et al. 2013
North Edge Georges Bank	Great Shearwater	June-October		Northern Fulmar Sooty Shearwater Wilsons Storm-Petrel	Powers and van Os 1979; Veit and Petersen 1993
Jeffries Ledge	Wilsons's Storm-Petrel Great Black-backed Gull Herring Gull	Year-round	Off Portsmouth, NH	Great Shearwater Sooty Shearwater	Keith and Fox 2013
Cultivator Shoal	Wilson's Storm-Petrel	June-September			Powers 1983
Great South Channel	Great Shearwater Sooty Shearwater	June-October			Powers 1983
Provincetown and Stellwagen Bank	Great Shearwater Sooty Shearwater Great Black-backed Gull Herring Gull Common tern Roseate tern	June-October June-October September-May May-October May-September			Veit and Petersen 1993
Pollock Rip, east of Monomoy, MA	Great Black-backed Gull Razorbill	November-March			Veit and Petersen 1993

Hotspot Location	Species	Season	Detailed Location	Species Present Based on Other Surveys	Source
Nantucket Sound	Common Eider	October-March		Black Scoter Surf Scoter White-winged Scoter	Perkins et al. 2005
Nantucket Shoals	White-winged Scoter Long-tailed Duck	November-April November-April			White et al. 2009
Muskeget Channel	Roseate Tern Razorbill	May-Sept November-March			Perkins et al. 2005; Veit et al. 2013; Veit and Perkins 2014
Barnegat Inlet, NJ	Common Tern Forsters tern Royal tern	April-November			Boyle 2011
Cape Hatteras, NC	Northern Gannet	November-March			Patteson 2014
Continental Slope	Great Shearwater Wilson's Storm-Petrel Red Phalarope Great Black-backed Gull	June-October May-Sept October-May September-March	Off Virginia Off New Jersey Off Virginia Off Martha's Vineyard, New Jersey		Powers 1983; Nisbet et al. 2013

Changes in Abundance 1970s to Present

To compare recent (2008-2011) abundance to that 30 years ago (1975-1990) we summed bird abundance over the US continental shelf between Maine and Florida, with most effort concentrated in the Maryland-Maine sector (Figures 1-10). We partitioned the dataset to include the most heavily sampled areas; we thus used all cells north of 40° and south of 45°. Our conclusions about changes in abundance were the same within each partition.

We found that Northern Fulmars and Greater Shearwaters declined by roughly 50% during this time interval. These declines are likely due to changes in commercial fishing activity (Fogarty and Murawski 1998, Overholtz et al. 2000, Overholtz and Link 2007). During the late 1970's, the largest aggregations of seabirds off the eastern U.S. were associated with fleets of "factory trawlers" that fished silver hake and other groundfish around the perimeter of Georges Bank (Lear 1998). These fisheries were effectively excluded by the Magnuson Act in 1978, and the supply of discards for seabirds, especially shearwaters, fulmars and gannets, substantially declined. Adding to this decline was the collapse of the North Atlantic cod fishery in the 1990s and the consequent reduction in fishing and discards by the American fleets. These combined effects must have resulted in a reduced prey base for pelagic birds, especially those that scavenge at trawlers off the U.S, east Coast. Greater Shearwaters breed at Tristan da Cunha in the South Atlantic Ocean and Northern Fulmars in the Canadian arctic, and both are very difficult to census during the summer; at-sea censuses may be the most reliable indicators of population trends in these species (cf. gulls, below).

Gulls, especially Herring and Great Black-backed Gulls, declined by 30-50% in the waters surveyed since the 1970s. This decline is in accord with changes noted in the breeding colonies in North America (Nisbet, et al., 2013). The generally accepted explanation for the recent declines in these gull populations is the reduction in garbage available (due to changes in the way garbage is dumped, with no "open" dumping) and the reduction in bycatch from trawlers and shore-based fishery processing facilities.

Northern Gannets increased in our area by about 30%, which roughly corresponds to increases in the Newfoundland and Quebec colonies during the same time period (Montevecchi and Myers 1999). The reasons for this increase are not entirely clear, but are partly related to changes in fish populations and in climate (Fogarty and Murawski 1998, Overholtz and Link 2007). Interestingly, a shoreward shift in the distribution of gannets is clearly evident in our distributional maps. This indicates a shift from scavenging trawlers near the shelf break in the 1970s to more coastal foraging. Such a shoreward shift also occurred for Great Black-backed and Herring Gulls (Figures 5 and

6) and is almost certainly caused by the reduction in fisheries effort offshore and consequent decrease in availability of discards and offal during the intervening years.

Wintering Razorbills and Dovekies both increased substantially within the US continental shelf since the 1970s. Razorbill breeding colonies between Maine and Newfoundland have increased during this same time period, in part due to the cessation of gill net fisheries around Newfoundland in the early 1990s (Regular et al. 2013), but their southward push in winter in recent years is related to North Atlantic Oscillation (Hurrell, et al., 2013). they move further south in NAO positive years (Veit and Manne, undated). Dovekies nesting in underground burrows in the high arctic are almost impossible to census, but their numbers off the eastern USA have increased very dramatically since about 2000, and this increase is at least partly related to a series of strongly NAO-negative *y*ears.

Association with Tunas and Cetaceans

We (Goyert et al., 2014) found significant spatial association among Common and Roseate Terns (Sterna hirundo and S. dougalii) and tunas (Thunnus albacares and T. thynnus) and dolphins (Delphinus delphis, Lagenorhynchus acutus) on Georges Bank and surrounding waters. This association is important to document for a number of reasons. First, terns, dolphins and tunas are either declining, Endangered or both, so if foraging by terns depends on tuna and dolphin abundance, fast and nonlinear declines could be caused by the decline of one component species within the association. Second, foraging by terns during the post-breeding season (July to September) is largely unknown so establishing their foraging needs at this time of year is important to their conservation. Third, the concepts of “facilitation” and “local enhancement” (Bruno et al. 2003, Stachowicz 2001), in which seabirds use seabirds and other marine animals such as mammals and fishes as cues to the location of prey, are emerging as important processes structuring marine systems, and knowledge of these processes will be important in the design of marine reserves.

Association with Prey

We took advantage of the NOAA herring surveys conducted in August-October at the northern edge of Georges Bank to both survey where terns are likely to feed during the post breeding period and to quantify the spatial relationship between foraging seabirds and their fish prey. Spawning herring tend to aggregate at depths of 100m or more (M. Jech, pers comm) and nonspawning herring plus other fishes are likely to be present in these same areas. Using both echosounders and nets to sample fish, we found significant spatial association between foraging gannets and schools of herring (Martin 2012).

References

Barrett, RT, Chapdelaine, G, Anker-Nilssen, T, et al. 2006. Seabird Numbers and Prey Consumption in the North Atlantic. *ICES Journal of Marine Science* Volume 63, page(s) 1145-1158. DOI 1016/j.icesjms.2006.04.004.

Bruno, JF, Stachowicz, JJ and Bertness, MD. 2003. Inclusion of Facilitation into Ecological Theory. *Trends in Ecology and Evolution*.Volume 18, page(s) 119-125. DOI 10.1016/S0169-5347(02)00045-9.

Fogarty, MJ and Murawski, SA. 1998. Large-Scale Disturbance and the Structure of Marine Systems: Fishery Impacts on Georges Bank. *Ecological Applications*.Volume 5(1), page(s) S6-S22.

Goyert, HF, Manne, LL and RVeit, RR. 2014. Facultative Interactions among the Pelagic Community of Temperate Migratory Terns, Tunas and Dolphins. *Oikos*.Volume 123(11), page(s) 1400-1408. DOI 10.1111/oik.00814.

Hurrell, JW, Yochann, K, Ottersen, G, et al. eds. 2013. *The North Atlantic Oscillation: Climatic Significance and Environmental Impact* (American Geophysical Union, Washington DC), page(s) 279.

Lear, WH. 1998. History of Fisheries in the Northwest Atlantic: The 500 Year Perspective. *Journal of Northwest Atlantic Fisheries Science* Volume 23, page(s) 41-73.

Martin, MC. 2013. *Habitat Association and Spatial Distribution of Procellariiform Seabirds Along the Continental Shelf of the Northeast of the United States and the Southeastern Canada: Relationships to Prey and Other Top Predators* (City University of New York, NY NY).

Montevecchi, WA and Myers, RA. 1997. Centurial and Decadal Oceanographic Influences on Changes in Northern Gannet Populations and Diets in the North-West Atlantic: Implications for Climate Change. *ICES Journal of Marine Science* Volume 54, page(s) 608-614.

Nisbet, ICT, Veit, RR, Auer, TP, et al. 2013. *Marine Birds of the Eastern United States and Bay of Fundy: Distribution, Numbers, Trends, Threats and Management*. (Cambridge, MA), Nuttall Ornithological Monographs Volume 29, page(s) 188.

Overholtz, WJ, LINK, JS and Suslowicz, LE. 2000. Consumption of Important Pelagic Fish and Squid by Predatory Fish in the Northeastern USA Shelf Ecosystem with Some Fishery Comparisons. *ICES Journal of Marine Science,*.Volume 57, page(s) 1147-1159. DOI 10.1006/jmsc.2000.0802.

Overholtz, WJ and LINK, JS. 2007. Consumption Impacts by Marine Mammals, Fish and Seabirds on the Gulf of Maine- Georges Bank Atlantic Herring (*Clupea Harengus*) Complex During the Years 1977-2002. *ICES Journal of Marine Science* Volume 64(1), page(s) 83-96.

Powers, KD. 1984. *Pelagic Distributions of Marine Birds Off the Northeastern United States*. (Woods Hole, Massasschusetts), NOAA Technical Memorandum NMFS-F/Nec ; 27

Santora, JA, Ralston, S and Sydeman, WJ. 2011. Spatial Organization of Krill and Seabirds in the Central California Current. *ICES Journal of Marine Science* Volume 68(7), page(s) 1391-1402. DOI 10.1093/icesjms/fsr046.

Santora, JA, Sydeman, WJ, Schroeder, ID, et al. 2012. Krill Space: A Comparative Assessment of Mesoscale Structuring in Polar and Temperate Marine Ecosystems. *Journal of Marine Science*. DOI 10.1093/icesjms/fss048.

Santora, JA and Veit, RR. 2013. Spatio-Temporal Persistence of Top Predator Hotspots near the Antarctic Peninsula. *Marine Ecology Progress Series*.Volume 487, page(s) 287-304. DOI 10.3354/meps10350.

Stachowicz, JJ. 2001. Mutualism, Facilitation and Structure of Ecological Communities. *Bioscience*.Volume 51(3), page(s) 235-246. DOI 10.1641/0006-3568(2001)051[0235:MFATSO]2.0.CO;2.

Veit, RR and Petersen, WR. 1993. *Birds of Massachusetts*. (Massachusetts Audubon Society, Lincoln, Ma.

Veit, RR and Manne, LL. undated. Interannual Variability of Alcids Wintering Off Southern New England and Relation to the North Atlantic Oscillation. *Unpublised Material*(College of Staten Island, Department of Biology).

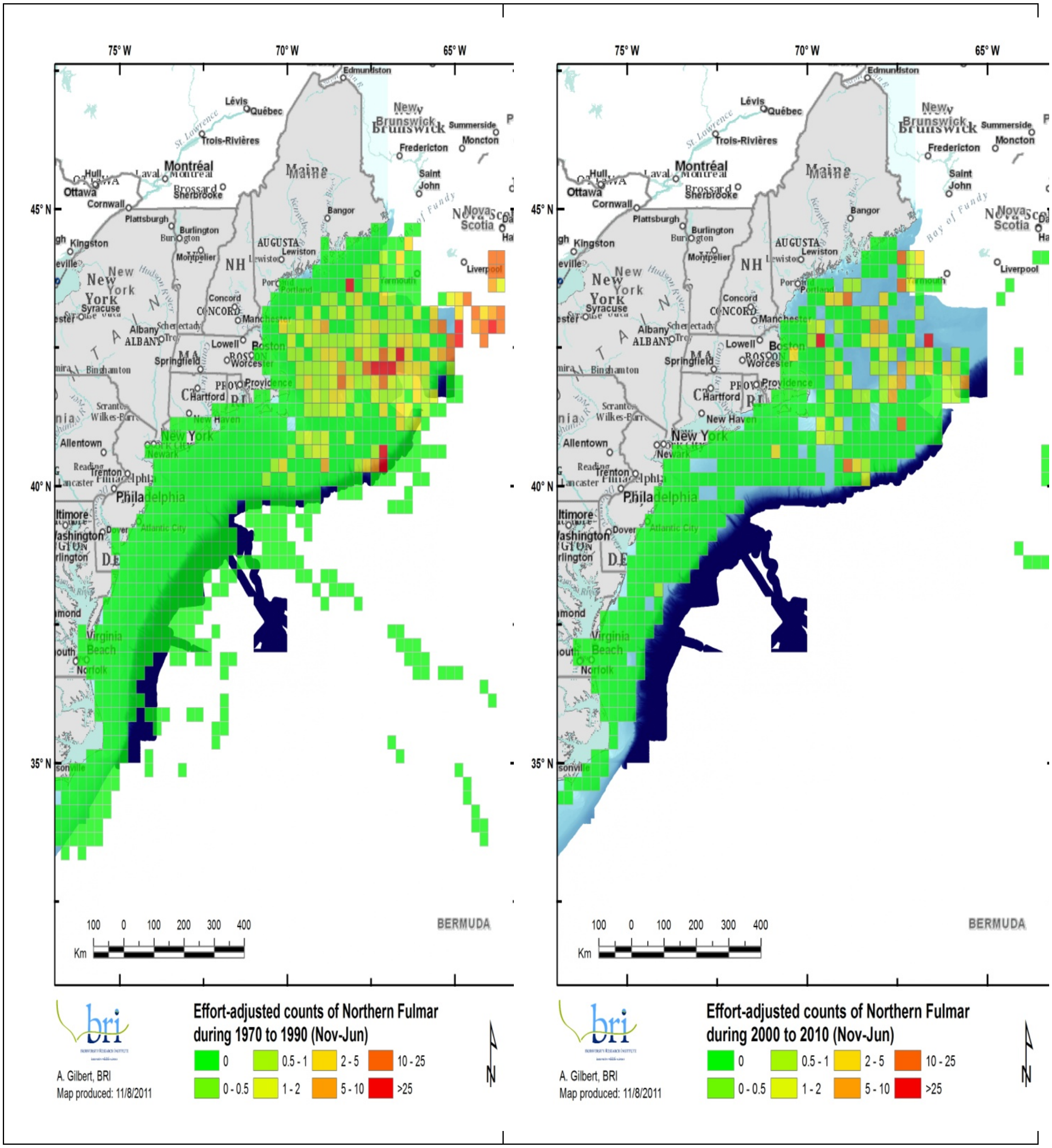


Figure 1: Comparison of Northern Fulmars between 1970-1990 (left) and 2000-2010 (right)

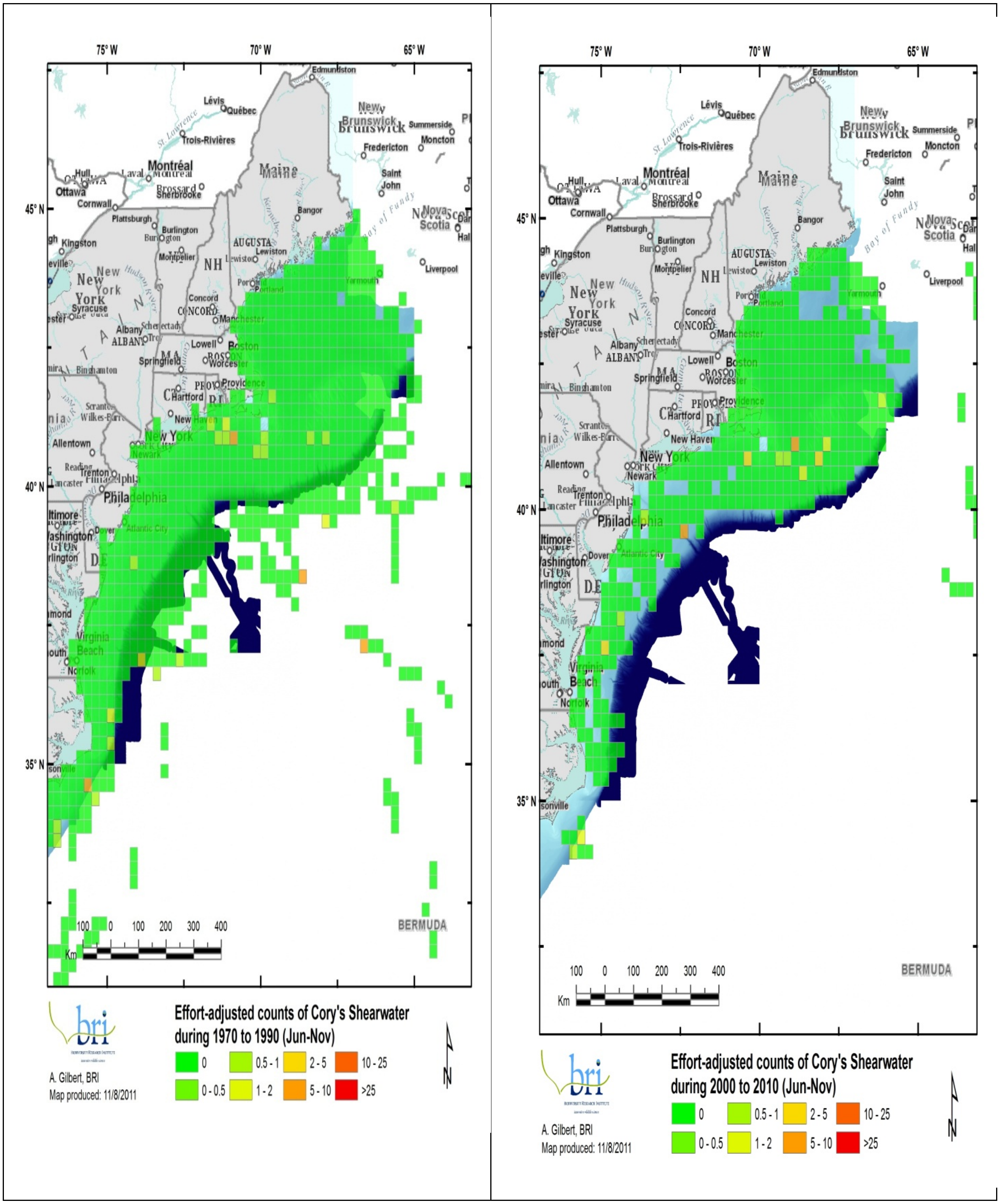


Figure 2: Comparison of Cory's Shearwater abundance, 1970-1990 (left) and 2000-2010 (right)

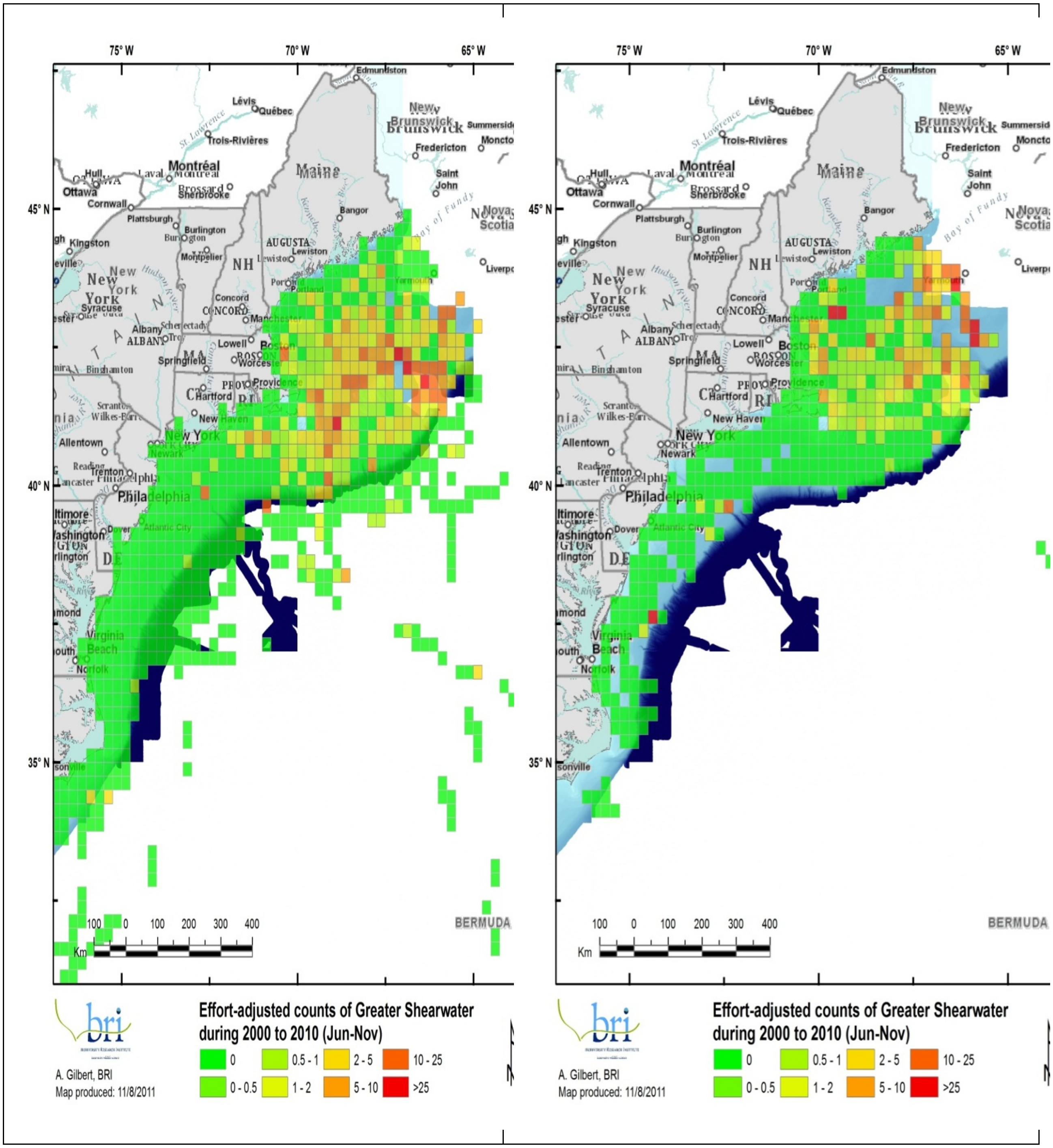


Figure 3: Comparison of Great Shearwater abundance 1970-1990 (left) and 2000-2010 (right)

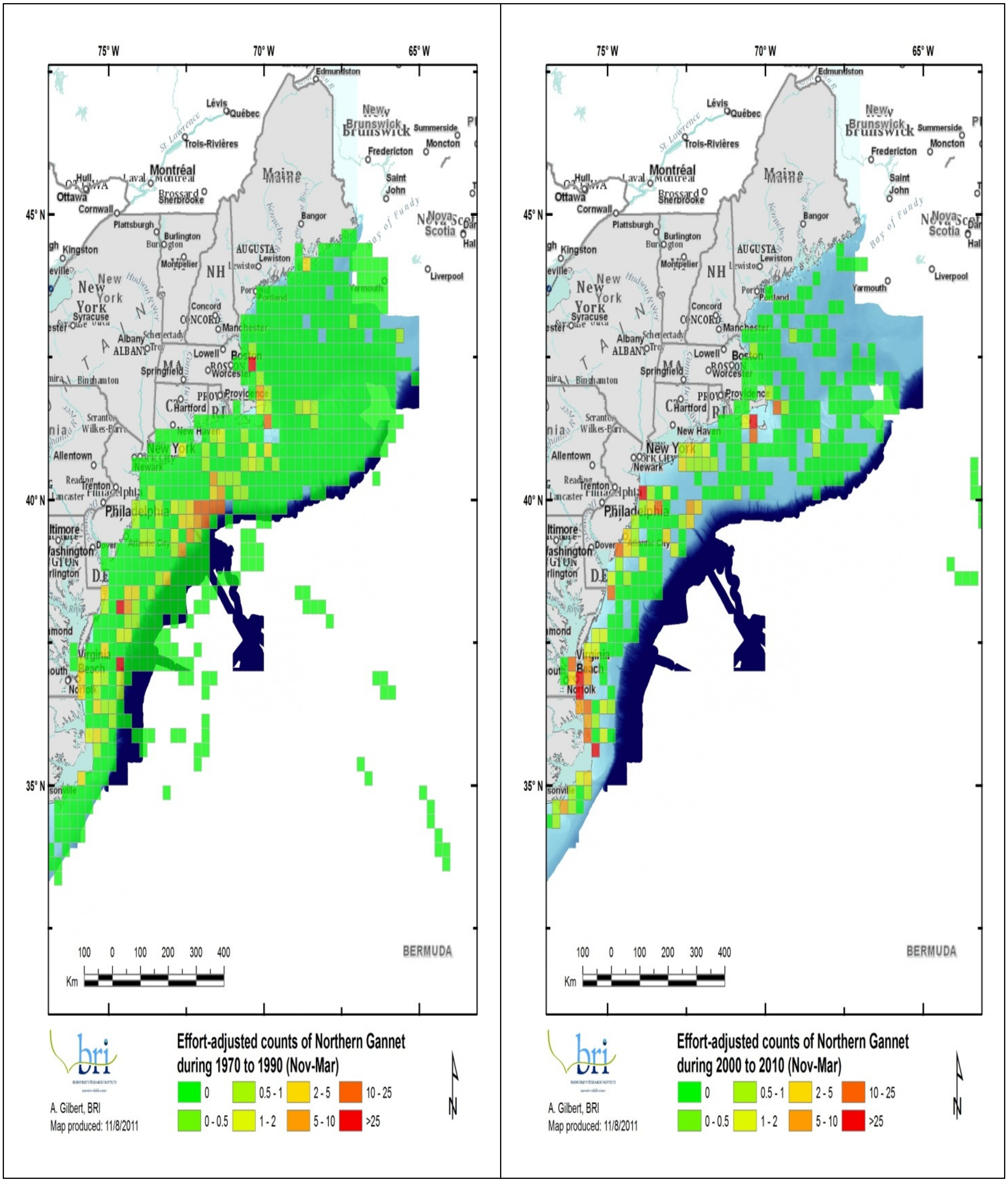


Figure 4: Comparison of Northern Gannet abundance 1970-1990 (left) and 2000-2010 (right)

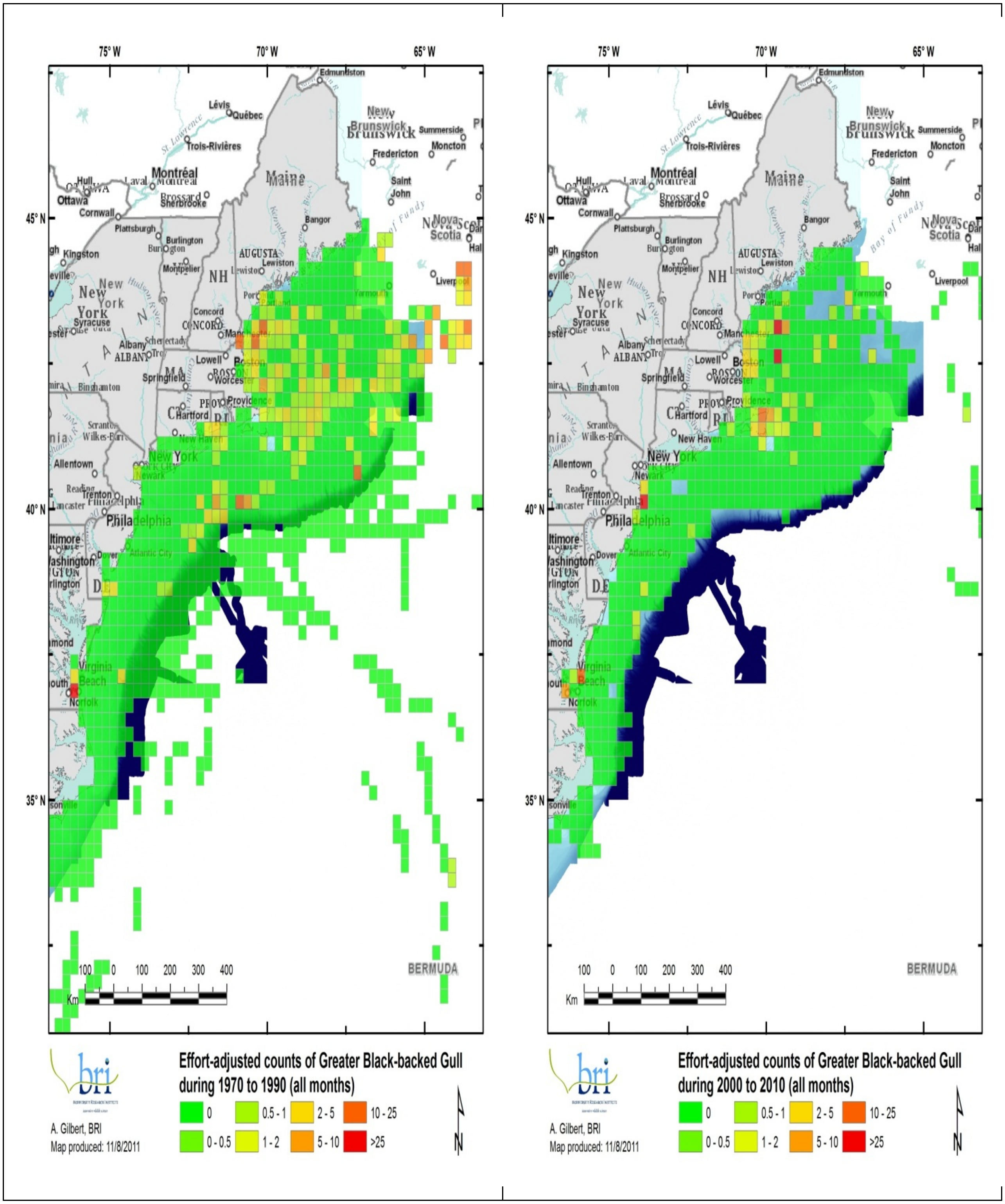


Figure 5: Comparison of Great Black-backed Gull abundance 1970-1990 (left) and 2000-2010 (right)

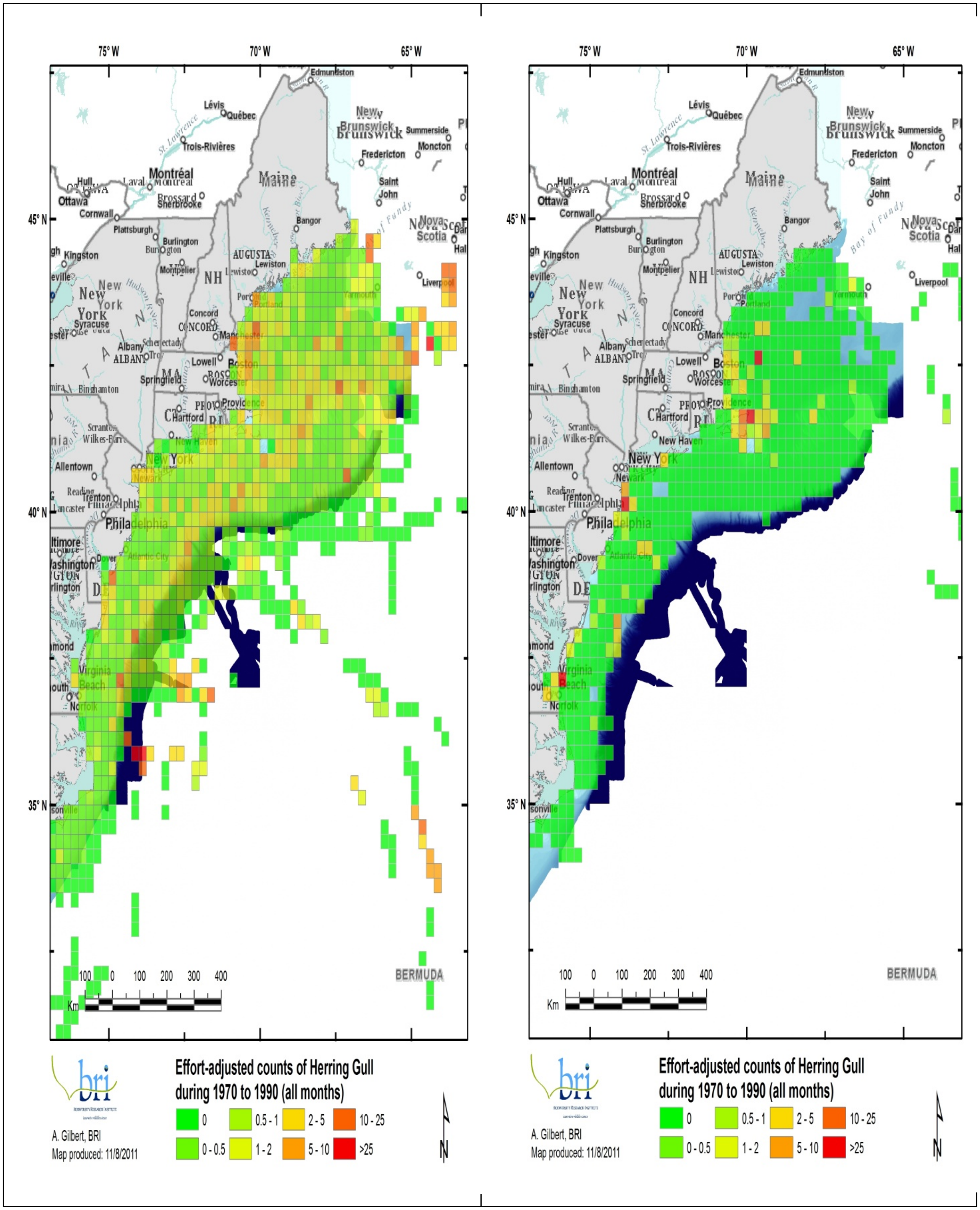


Figure 6: Comparison of Herring Gull abundance 1970-1990 (left) and 2000-2010 (right)

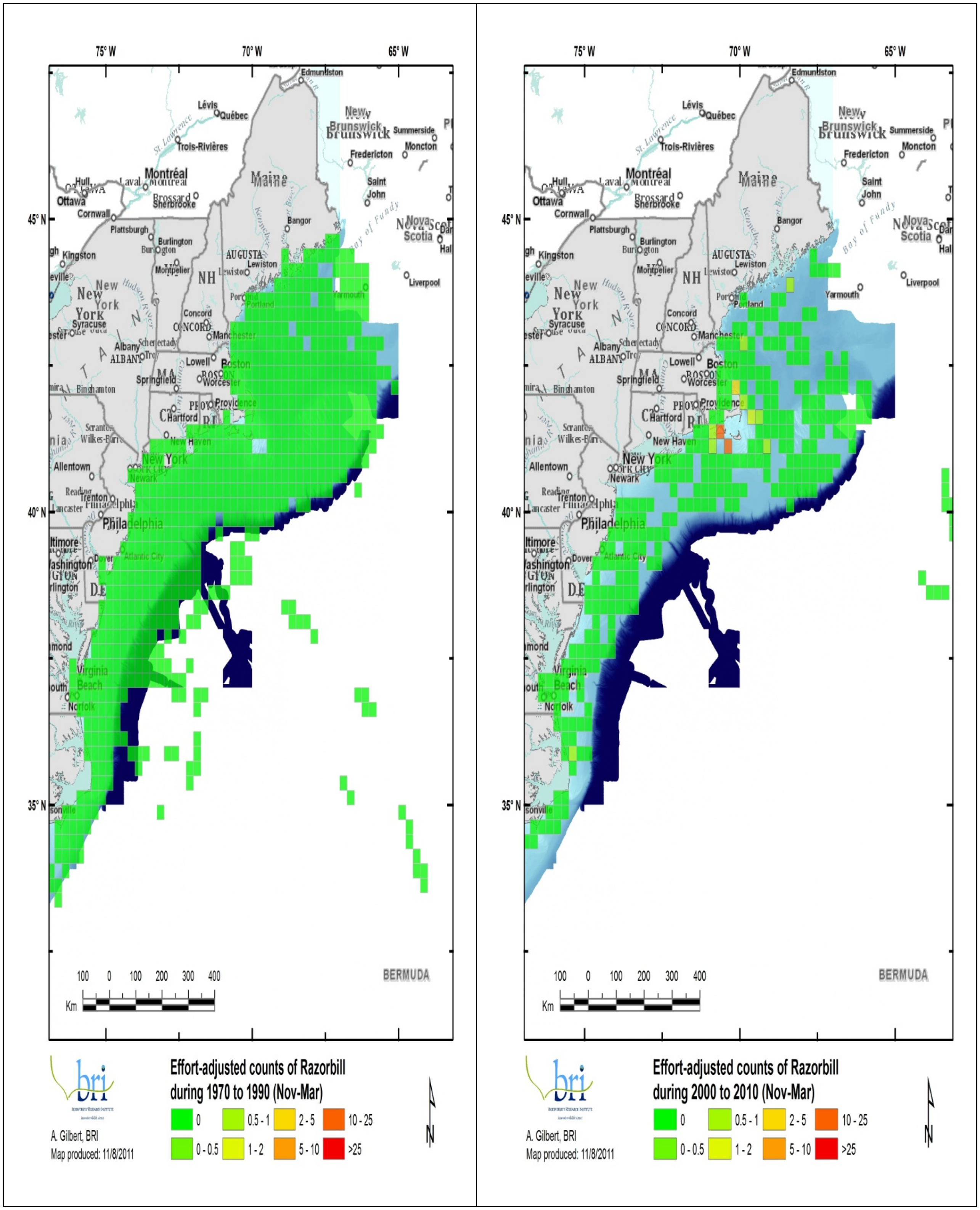


Figure 7: Comparison of Razorbill abundance 1970-1990 (left) and 2000-2010 (right)

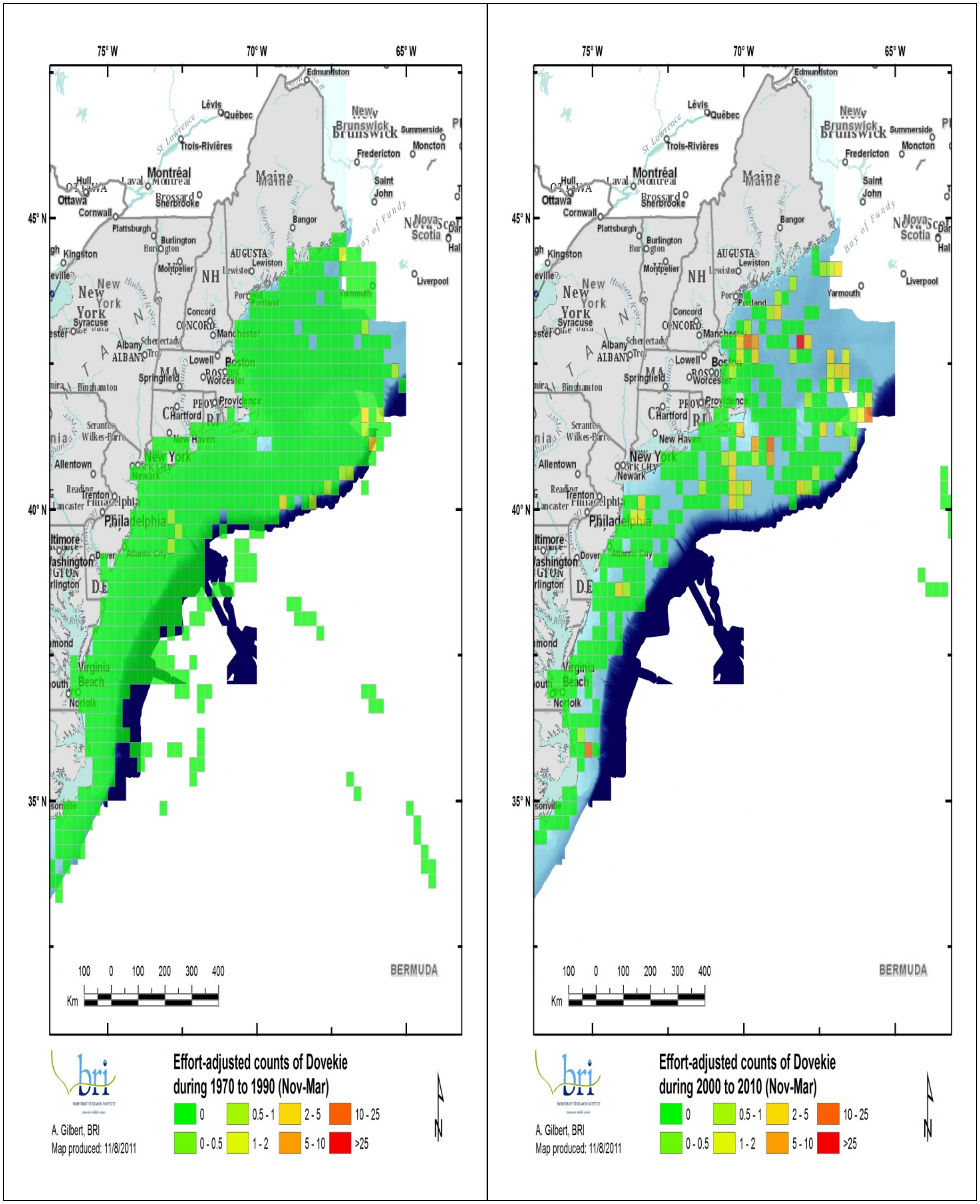


Figure 8: Comparison of Dovekie abundance 1970-1990 (left) and 2000-2010 (right)

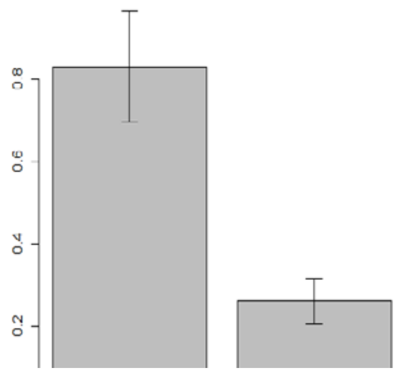
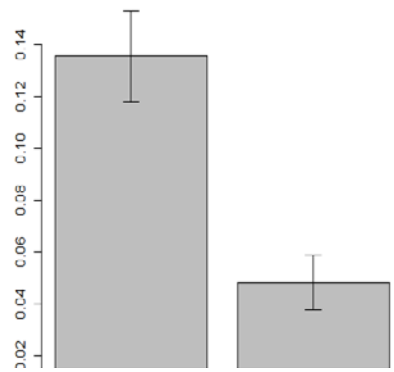
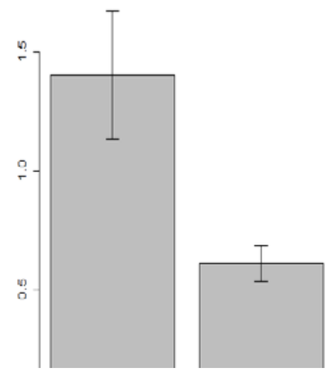
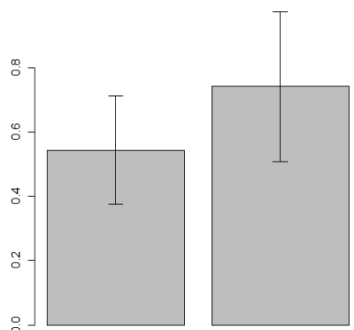
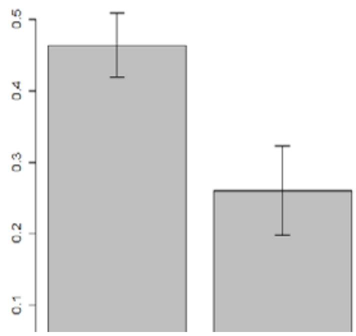
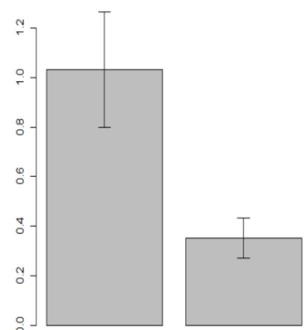
Northern Fulmar		Cory's Shearwater		Great Shearwater	
					
1970-1990	1990-2010	1970-1990	1990-2010	1970-1990	1990-2010
Northern Gannet		Great Black-backed Gull		Herring Gull	
					
1970-1990	1990-2010	1970-1990	1990-2010	1970-1990	1990-2010

Figure 9: Comparisons of seabird abundance 1970-1990 to 2000-2010

<table>
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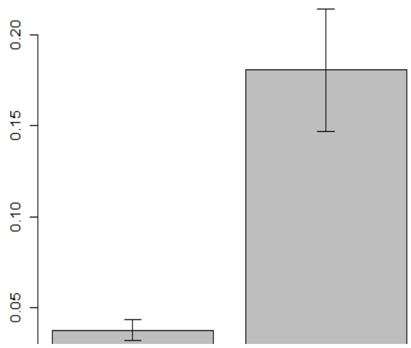
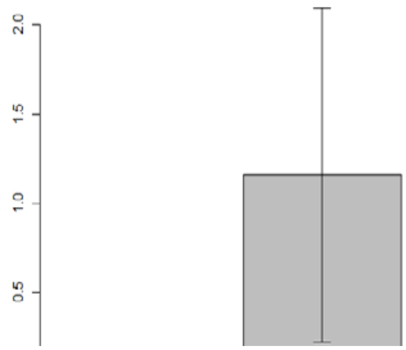
<tr><td colspan="2">
</td><td colspan="2">
</td></tr>
<tr><td>1970-1990</td><td>1990-2010</td><td>1970-1990</td><td>1990-2010</td></tr>
</table>

Figure 10: Comparisons of seabird abundance 1970-1990 vs 2000-2010, continued. Means +/- 1 sd

Appendix I

At-Sea Distributions of Pelagic Seabirds off the East Coast of the United States, 2008-2009

A Preliminary Report to the Minerals Management Services

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Introduction

Interest in developing wind resources in the offshore waters of the mid Atlantic and New England is increasing rapidly. Understanding how this activity might adversely affect wildlife resources is critical for development to move forward. Currently, information on the spatial and temporal movement and occupancy patterns of wildlife resources in offshore habitats is lacking for much of Minerals Management Service's north and mid Atlantic Planning Regions.

The pelagic waters off the U.S. East Coast are dominated by birds that do not breed in the area; prominent are shearwaters and storm-petrels that nest in the Antarctic and on Sub Antarctic islands during May-October as well as fulmars, alcids and gulls that nest in the Arctic during November-March (Barrett et al. 2006, Nisbet et al. *in press*). Because of the dominance by wintering nonbreeders, shipboard surveys are one of the best ways to quantify abundance and measure its variability through time.

Our goal in this effort is to document areas of frequent use and aggregation by birds, such that planning of offshore development can be properly informed as to the importance to birds of the pelagic habitats off our coast. In order to do this, we need to identify seasonal distribution and abundance patterns, movement patterns, and habitat-abundance associations. We are also interested in how the birds are responding to changes in climate and fisheries activities, and perhaps other unknown factors. It is increasingly evident that populations of seabirds have been impacted by changes in the earth's climate (Aebischer et al. 1990, Veit et al. 1997, Garthe 1997, Guinet et al. 1998, Thompson and Ollason 2001, Gjerdrum et al. 2003, Sandvik et al. 2005, Montevecchi and Myers 1997, Durant et al. 2003), but how these may have impacted seabird abundance off our coast is unknown.

The debate over whether fishing effort or climate is more to blame for changes in fish, bird and mammal populations has raged for close to 100 years (Volterra 1926, Beverton and Holt 1957, Thompson 2006.) Exploitation of fish populations has impacted the pelagic communities of the US continental shelf and these community changes have affected seabirds (Fogarty and Murawski 1998, Montevecchi 2002). Picking apart the effects of climate versus fisheries is difficult but recent progress has been made (Scott et al. 2006, Thompson 2006).

Our primary objective is to determine current seabird distribution and abundance from Maine to Cape Hatteras, North Carolina. A secondary objective is to determine whether changes in distribution and abundance have occurred relative to historic records. A tertiary objective is to assess whether changes, if they have occurred, might be attributed to climate change.

Methods

To establish baseline data on the seasonal abundance and distribution of pelagic bird species for determining where to site potential offshore development and to draw comparisons with seabird data collected in the 1970s and 1980s, we conducted surveys off the east coast of the United States from Cape Hatteras to Maine, using NOAA research vessels as platforms, from summer 2008 through fall 2009. Our sampling was limited to the continental shelf, which extends to about 100 nautical miles off the northeastern United States.

We participated on seven NOAA cruises between May 2008 and November 2009 (Table 1). All data have been stored with Andrew Gilbert at the USFWS database in Patuxent, Maryland. We collected data on seabirds while the ship was underway during daylight hours. Thus, we discontinued sampling when the ship stopped to sample an oceanographic station. We used a combination of strip-transect and line-transects to quantify density. Our default method was to sample a 300 m wide strip transect, situated on the side of the ship that offered the best visibility. When densities were not so high as to overwhelm the observer , we also recorded distances and angles to all birds spotted, regardless of their distance from the ship (i.e. >> 300m). This ensured our ability to scale data collected within the 300 m strip on the basis of detectability of individual species of birds (Buckland et al. 2001).

Table 1. Cruises from which seabird data were collected in 2008-2009.

Cruise	Month /Year	Area Surveyed
EcoMon	August 2008	Cape Hatteras to the Gulf of Maine (2413 km)
Herring Acoustic	Sept/Oct 2008	Georges Bank and Jeffrey's Ledge (3616 km)
EcoMon	Jan 2009	Cape Hatteras to the Gulf of Maine (1483 km)
EcoMon	May 2009	Cape Hatteras to the Gulf of Maine (2703 km)
EcoMon	Aug 2009	Cape Hatteras to the Gulf of Maine (2219 km)
Herring Acoustic	Sept/0ct 2009	Georges Bank and Jeffrey's Ledge (3079 km)
EcoMon	November 2009	Cape Hatteras to Gulf of Maine (1828 km)

Preliminary Results

We sampled two kinds of surveys: 1.) **EcoMon** surveys, designed to monitor zooplankton on the continental shelf from Maine to Cape Hatteras, and 2.) **Herring Acoustic** surveys, designed to quantify spatial distribution of herring and their prey (copepods) using acoustics, on northern Georges Bank.

The ECOMON surveys work on an established grid of oceanographic stations that are laid out in a rectangular grid in such a way as to sample all oceanographic habitats of the U.S. East Coast (Link et al. 2007). On each cruise, stations that are actually sampled are selected randomly within "strata" such that effort within each oceanographic habitat is standardized across cruises.

We recorded about 40 species of seabirds, close to the 44 species recorded by Powers (1983). We missed a few tropical species characteristic of the Gulf Stream (e.g. Black-capped Petrel, Bridled Tern) but did record Lesser Black-backed Gull, a European species that has dramatically increased in abundance since the 1980s and was not recorded at that time.

Although our quantitative analysis is very preliminary at this point we believe the following trends to be significant:

1.) Greater Shearwaters seem to have declined in the past 30 years (Table 3). This may reflect a true decline in population, or a decline in aggregation based on the decline of commercial fisheries on Georges Bank. That is, there are far fewer fishing boats discarding offal as in the past.
2.) There has been an increase in Cory's Shearwaters, a warm water species that breeds at the Azores and on other eastern Atlantic Islands, in 2008 and 2009. This may reflect climate change.
3.) There has been a recent (2008 and 2009) surge in abundance of Dovekies onto Georges Bank and surrounding waters. A recent analysis suggests this increase is correlated with the North Atlantic Oscillation (Veit and Guris 2009; Veit 2009).

We present some sample densities of the five most abundant species in 2008-2009 observed on each cruise in Table 2. In the maps, numbers reported are number per observation. Quantified densities (birds/km^2) for some species are presented in Table 2.

Table 2. Densities of dominant species recorded in 2008-2009 (birds/km^2).

	August 2008	September/ October 2008	January 2009	May/ June 2009	August 2009	September/ October 2009	November 2009
Northern Fulmar	0	0.01	1.31	0.07	0	0.10	0.90
Greater Shearwater	0.30	1.41	0	0.60	0.34	1.81	0.30
Wilson's Storm-petrel	0.47	0.11	0	1.59	1.8	0.16	0
Northern Gannet	0.002	0.02	2.59	0.12	0	0.15	0.59
Herring Gull	0.03	0.55	0.56	0.22	0.009	0.41	1.022
Dovekie	0	0	0.83	0	0	0	0.23

Table 3. Greater Shearwater abundance within four strata sampled both in the 1970s (Powers 1983) and 2008-2009 (this study).

		1970s (Powers 1983) Birds/km^2		2008-2009 Birds/km^2	
May	Gulf of Maine	2.0		3.7	
	Georges Bank	2.0		4.3	
	Southern New England	2.0		0.1	
	Mid Atlantic	0		4.1	
August	Gulf of Maine	8.0		3.0	
	Georges Bank	3.0		0.3	
	Southern New England	3.0		0.3	
	Mid Atlantic	0		0.1	
October	Gulf of Maine	30.0		4.4	
	Georges Bank	12.0		5.7	
	Southern New England	15.0		0.7	
	Mid Atlantic	2.0		0	

References Cited

Aebischer, N.J., J.C. Coulson and J.M. Colebrook. 1990. Parallel long-term trends across four marine trophic levels and weather. **Nature** 347: 753-755.

Barrett, R.T., G. Chapdelaine, T. Anker-Nilssen, A. Mosbech, W.A. Montevecchi, J.B. Reid and R.R. Veit. 2006. Seabird numbers and prey consumption in the North Atlantic. **ICES Journal of Marine Science** 63: 1145-1158.

Beverton, R.J.H. and S.J. Holt. 1957. On the Dynamics of Exploited Fish Populations. HMSO, London.Bordage, D., and J.L. Savard. 1995. Black Scoter (*Melanitta nigra*). In The Bird of North America, No. 177 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press.

Durant, J.M., T. Anker-Nilssen and N.C. Stenseth. 2003. Trophic interactions under climate fluctuations: the Atlantic Puffin as an example. **Proceedings of the Royal Society of London B** 270: 1461-1466.

Fogarty, M.J. and S.A. Murawski. 1998. Large-scale disturbance and the structure of marine systems: fishery impacts on Georges Bank. **Ecological Applications** 8 (1) Supplement: S6-S22.

Garthe, S. 1997. Influence of hydrography, fishing activity and colony location on summer seabird distribution in the southeastern North Sea. **ICES Journal of Marine Science** 54: 566-577.

Gjerdrum, C., A.M.J. Vallée, C.C. St. Clair, D.F. Bertram, J.L. Ryder and G.S. Blackburn. 2003. Tufted Puffin reproduction reveals ocean climate variability. **Proceedings of the National Academy of Sciences** 100: 9377-9382.

Guinet, C., O. Chastel, M. Koudil, J. Durbec and P. Jouventin. 1998. Effects of warm sea-surface temperature anomalies on the blue petrel at the Kerguelen Islands. **Proceedings of the Royal Society of London B** 265: 1001-1006.

Link, J., J. O'Reilly, M. Fogarty, D. Dow, J. Vitaliano, C. LeGault, W. Overholtz, J. Green, D. Palka, V. Guida, J. Brodziak E. Methratta, and W. T. Stockhausen. 2007. Energy Flow on Georges Bank Revisited: The Energy Modeling and Analysis eXercise

(EMAX) in Historical Context. **Journal of Northwest Atlantic Fisheries Science** 39: 83-101

Montevecchi, W.A. 2002. Interaction between fisheries and seabirds. Pages 527-558 *in* E.A. Schreiber and J. Burger (Eds) Biology of Marine Birds. CRC Press, Boca Raton, Florida.

Montevecchi, W.A. and R.A. Myers. 1997. Centurial and decadal oceanographic influences on changes in northern gannet populations and diets in the north-west Atlantic: implications for climate change. **ICES Journal of Marine Science** 54: 608-614.

Nisbet, I.C.T., R.R. Veit and S.A. Auer. *In press*. Marine birds of the Eastern USA and the Bay of Fundy: Distribution, numbers, trends, threats and management. **Nuttall Ornithological Monographs.**

Powers, K.D. 1983. Pelagic Distributions of Marine Birds off the Northeastern United States. NOAA technical memorandum NMFS-F/NEC-27

Sandvik, H., K.E. Erikstad, R.T. Barrett and N.G. Yoccoz. 2005. The effect of climate on adult survival in five species of North Atlantic seabirds**. Journal of Animal Ecology** 74: 817-831.

Scott, B.E., J. Sharples, S. Wanless, O.N. Ross, M. Frederiksen and F. Daunt. 2006. The use of biologically meaningful oceanographic indices to separate the effects of climate and fisheries on seabird breeding success. Pages 46-62 *in* Boyd, I., S. Wanless and C.J. Camphuysen (Eds). 2006. Top Predators in Marine Ecosystems: their Role in Monitoring and Management. Cambridge University Press.

Thompson, P.M. and J.C. Ollason. 2001. Lagged effects of ocean climate change on fulmar population dynamics. **Nature** 413: 417-420.

Thompson, P.M. 2006. Identifying drivers of change: Did fisheries play a role in the spread of North Atlantic fulmars? Pages 143-156 *in* Boyd, I., S. Wanless and C.J. Camphuysen (Eds). Top Predators in Marine Ecosystems: their Role in Monitoring and Management. Cambridge University Press

Veit, R.R. (*abstract*). 2009. Shift in winter range of alcids off the northeastern US coast and its relation to oceanic climate. 33rd Annual Meeting of the Waterbird Society, Cape May, New Jersey, 4-8 November 2009.

Veit, R.R. and P.A. Guris. 2009. Recent increases in alcid abundance in the New York Bight and New England Waters. **New Jersey Birds** 34: 83-87.

Veit, R.R., J.A. McGowan, D.G. Ainley, T.R. Wahl and P. Pyle. 1997. Apex predator declines ninety percent in association with changing oceanic climate. **Global Change Biology** 3: 23-28.

Volterra, V. 1926. Variazione fluttuazione del numero d'individui in specie animali conviventi. **Mem. Acad. Lincei**. 2: 31-113.

Appendix A. Distribution and Abundance Maps of Most Commonly Seen Species

Part 1- Ecosystem Monitoring survey August 2008

Seabird abundance and distribution

Most abundant species:

1) Wilson's Storm-petrel, 2) Greater Shearwater, 3) Leach's Storm-petrel,

4) Cory's Shearwater, 5) Red-necked Phalarope

Wilson storm petrel distribution
along the Northeastern Coast of USA -August 2008

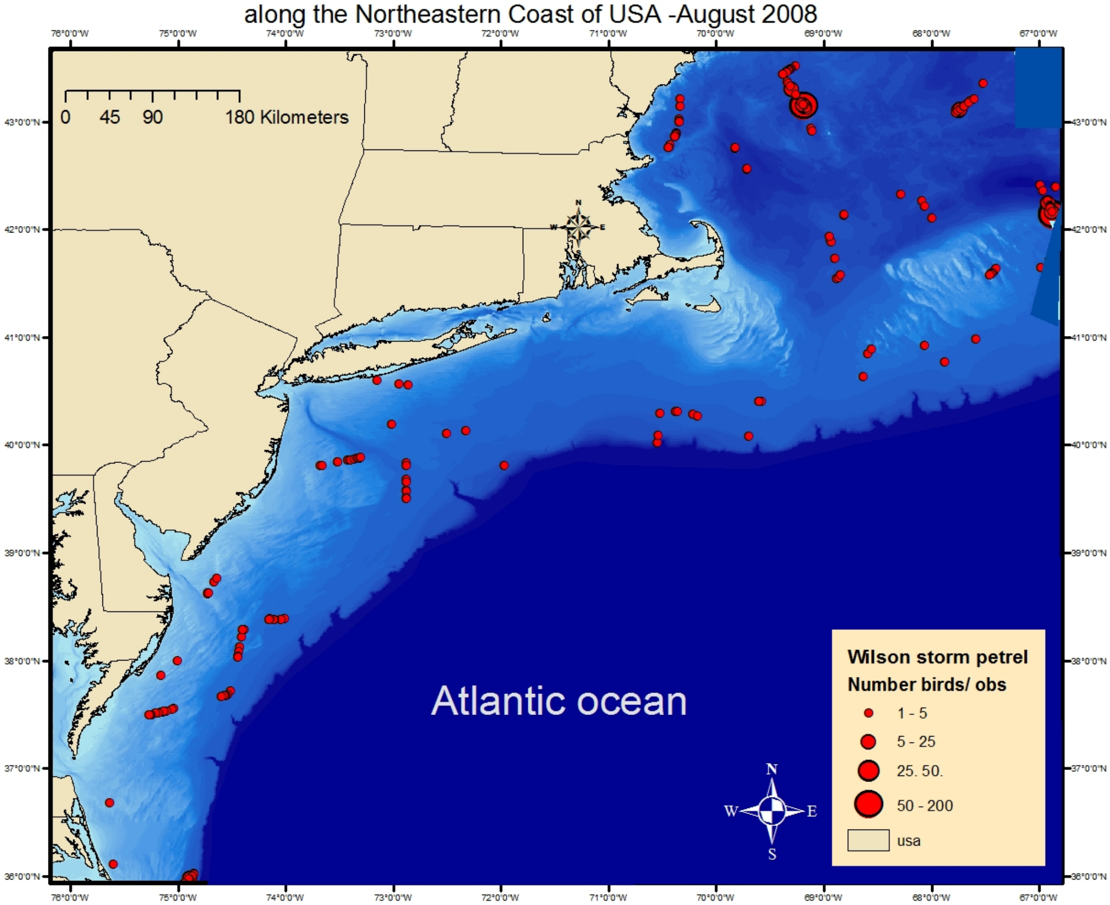


FIGURE 1.1: Wilson's Storm-petrel (N = 1146)

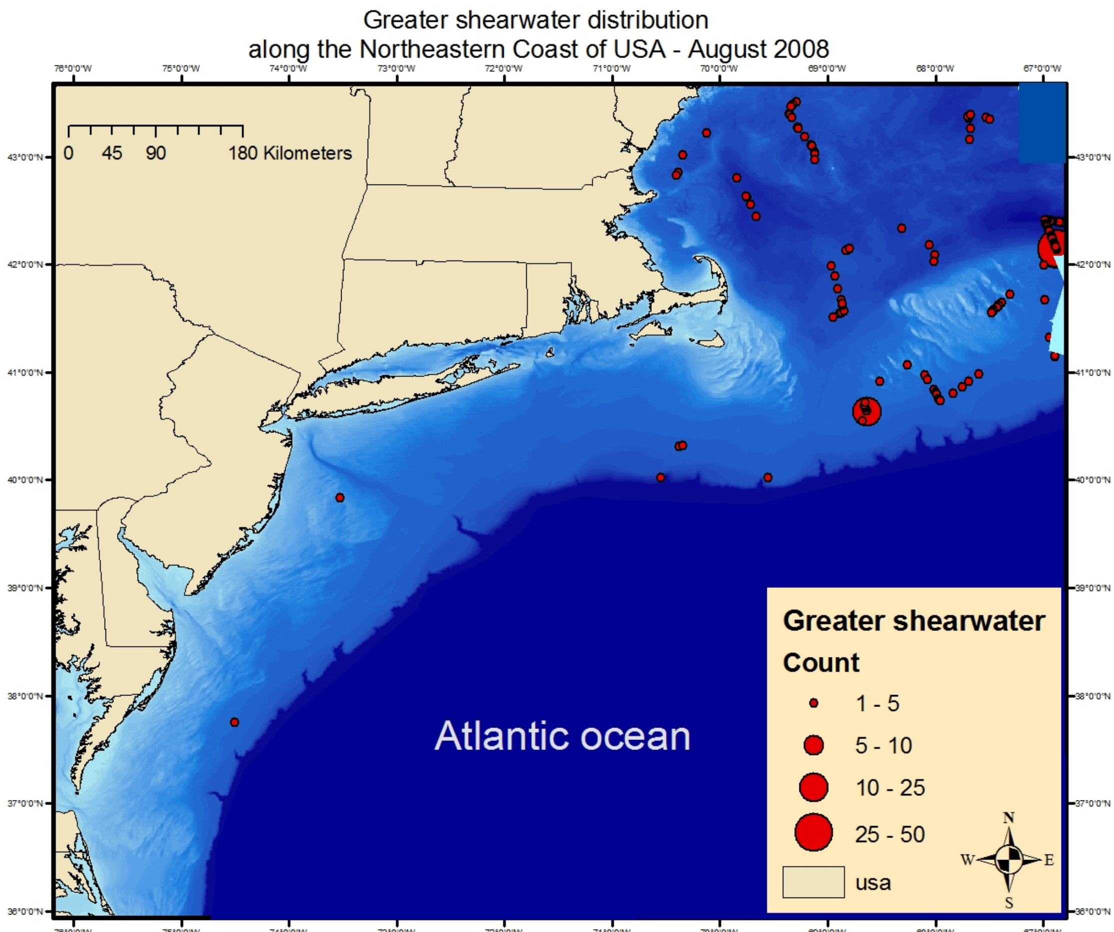


FIGURE 1.2: Greater Shearwater (N= 745)

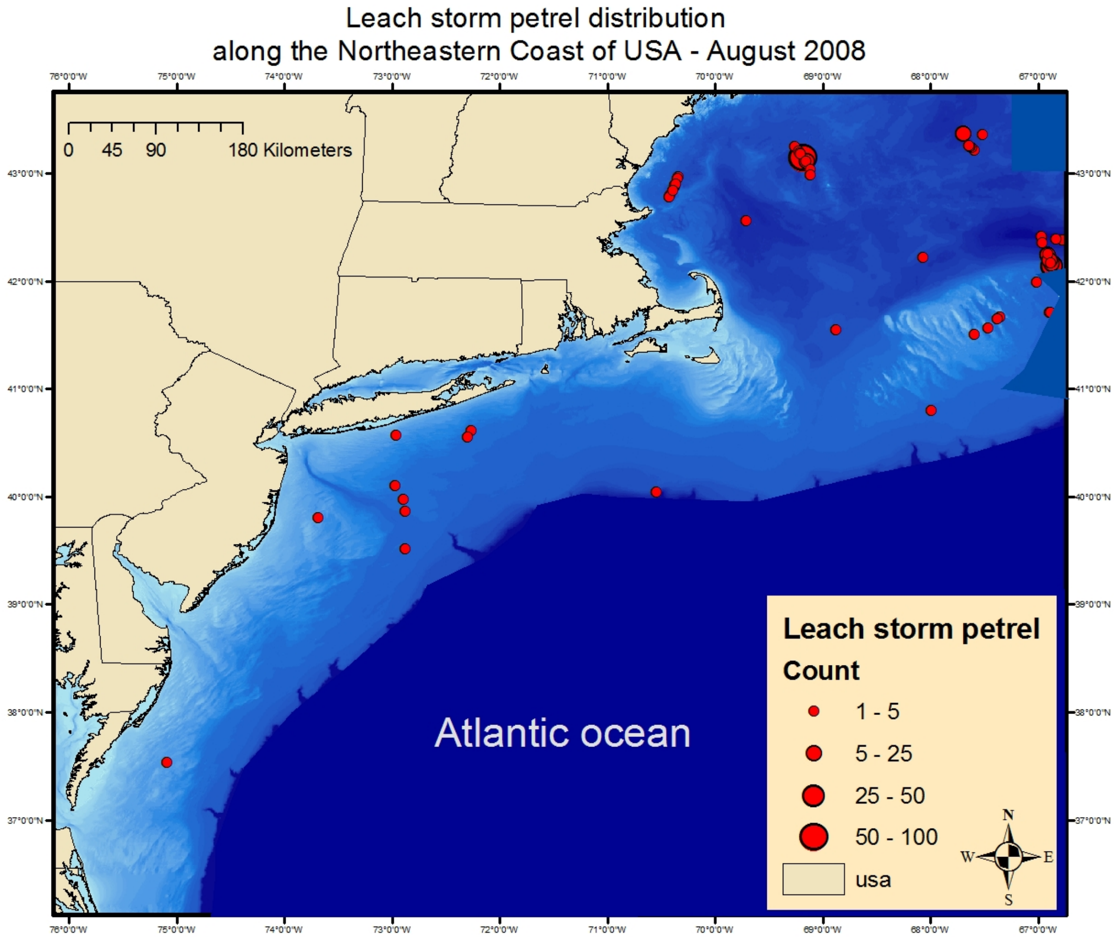


FIGURE 1.3: Leach's Storm-petrel (N = 532)

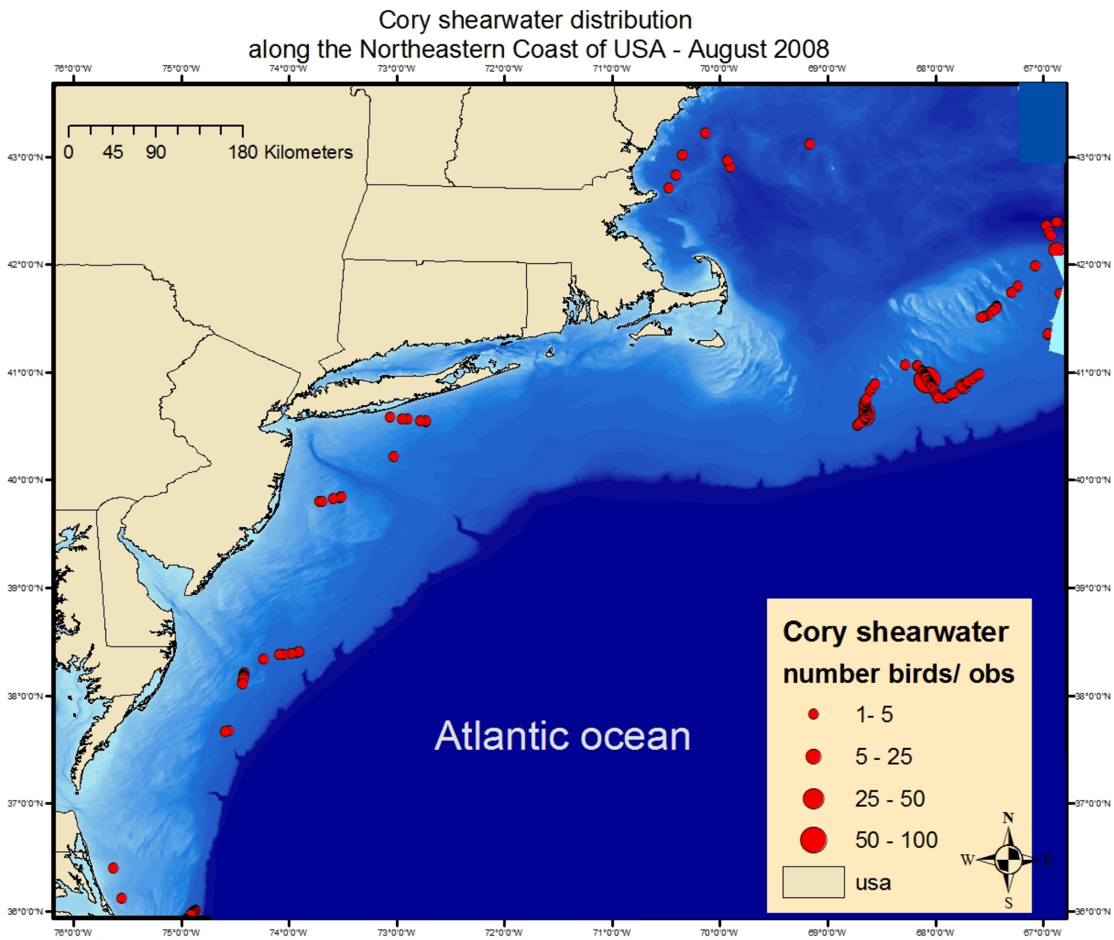


FIGURE 1.4: Cory's Shearwater (N= 455)

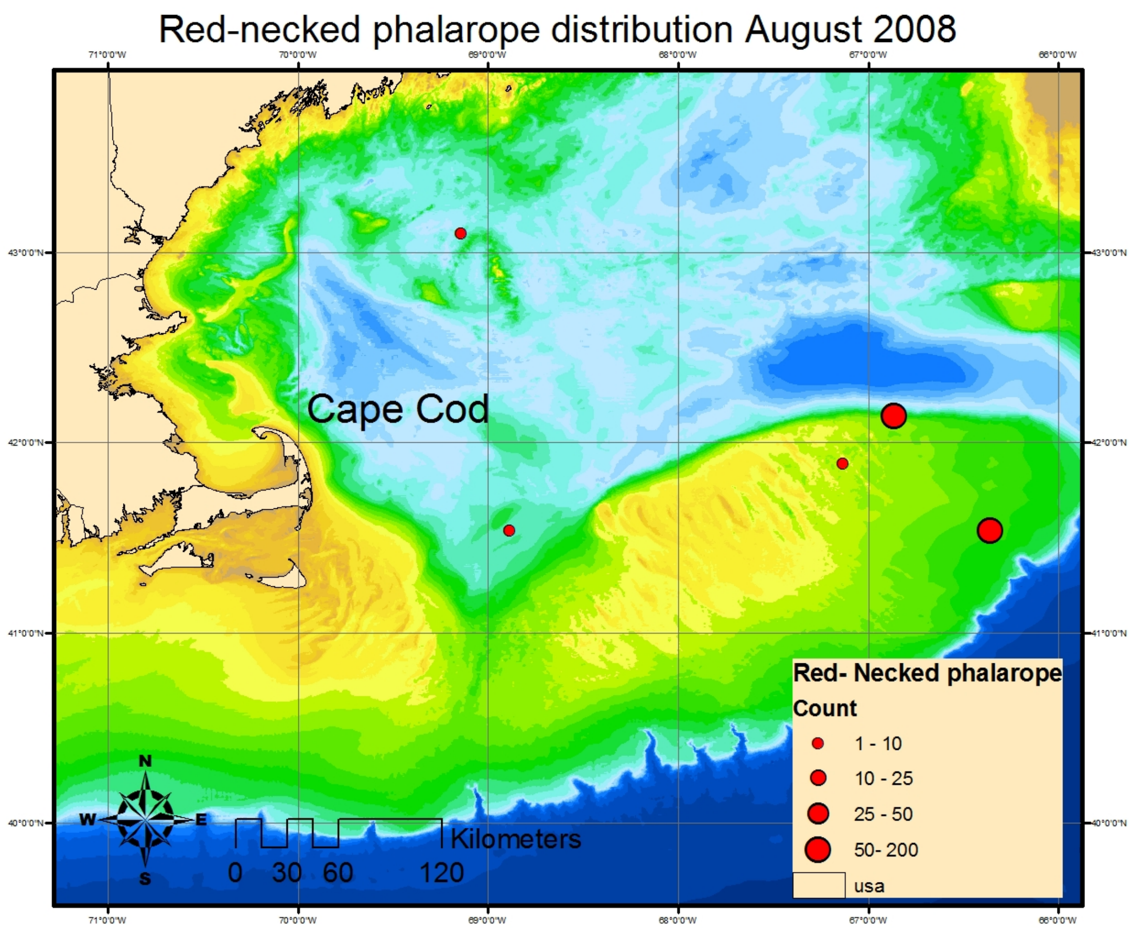


FIGURE 1.5: Red-necked Phalarope (N= 268)

Part 2: Atlantic Herring survey

September/ October 2008

Most abundant species: 1) Greater Shearwater, 2) Herring Gull, 3) Great Black-backed Gull, 3) Wilson's Storm-petrel, 4) Leach's Storm-petrel

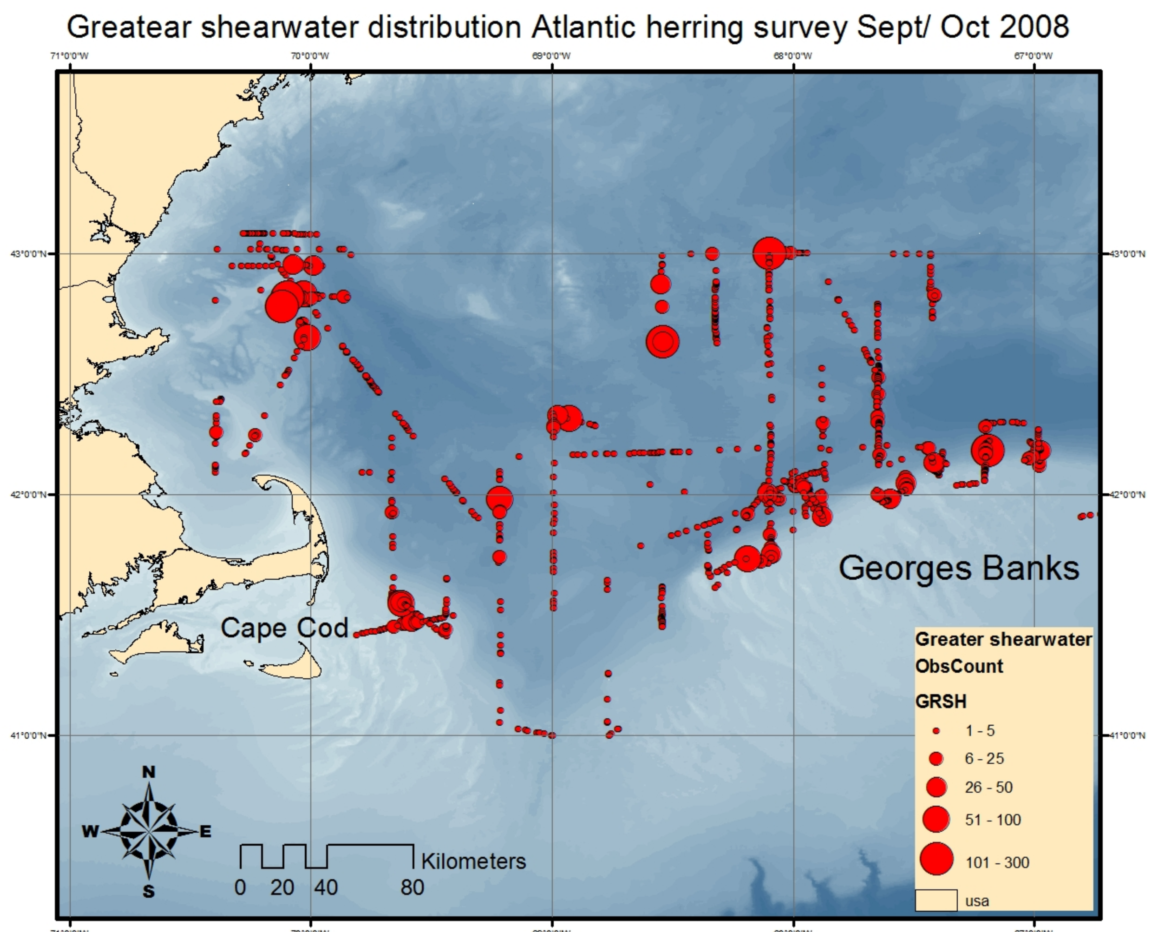


FIGURE 2.1: Greater shearwater

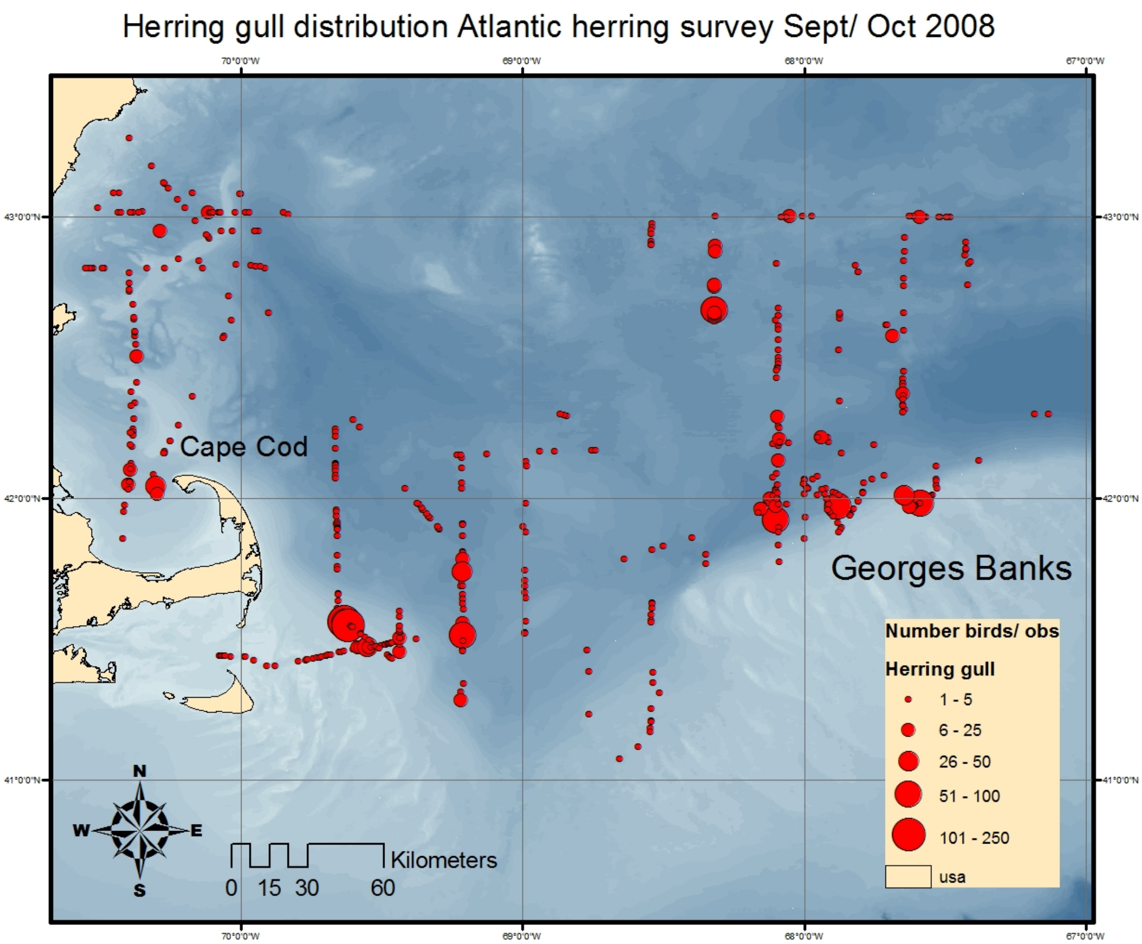


FIGURE 2.2: Herring Gull

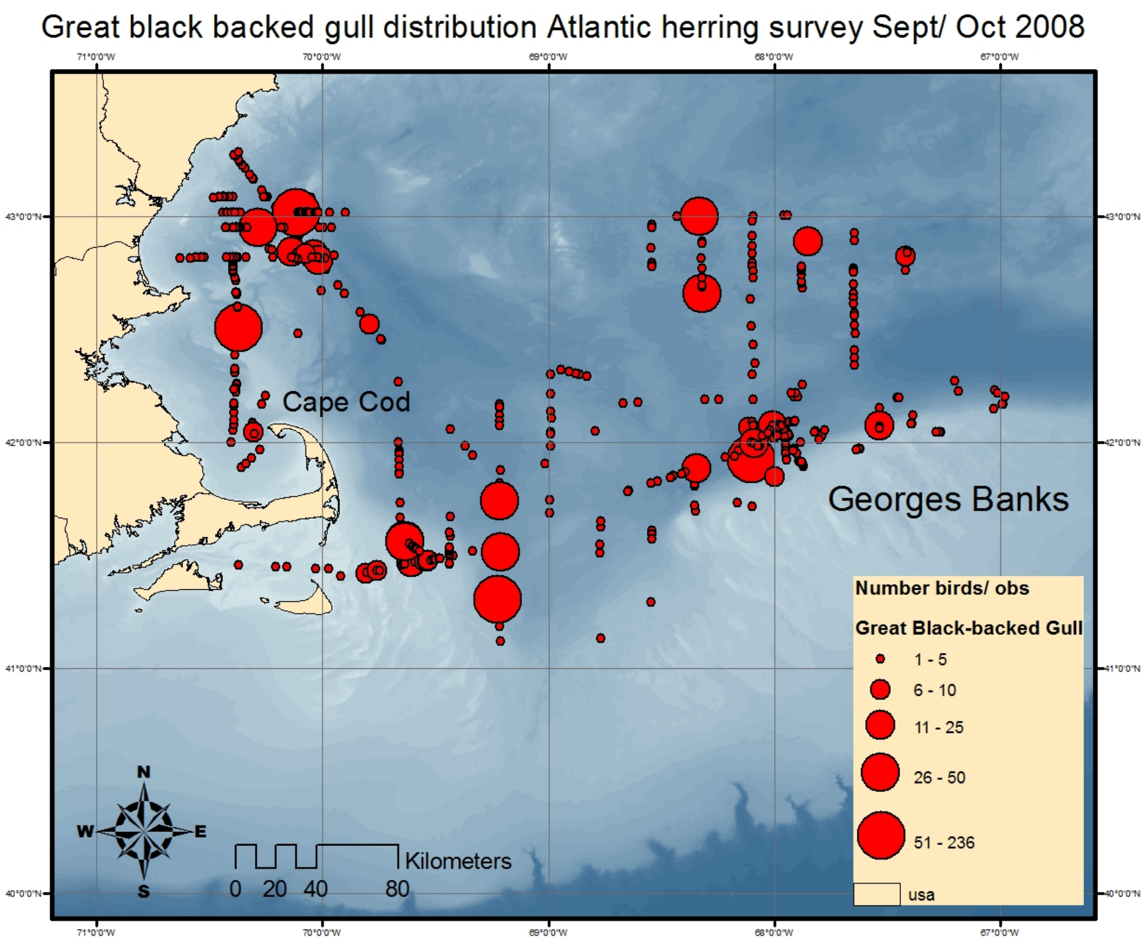


FIGURE 2.3: Great Black-backed Gull

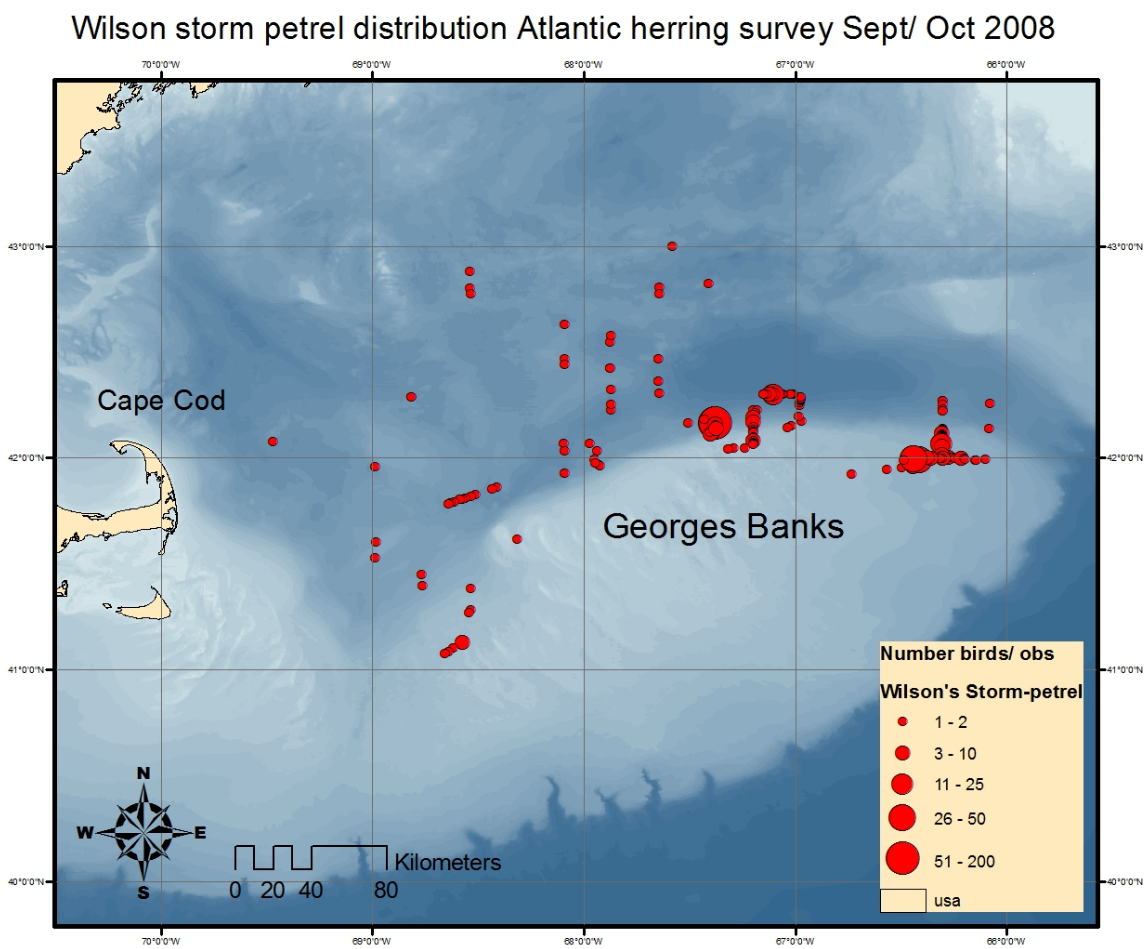


FIGURE 2.4: Wilson's Storm-petrel

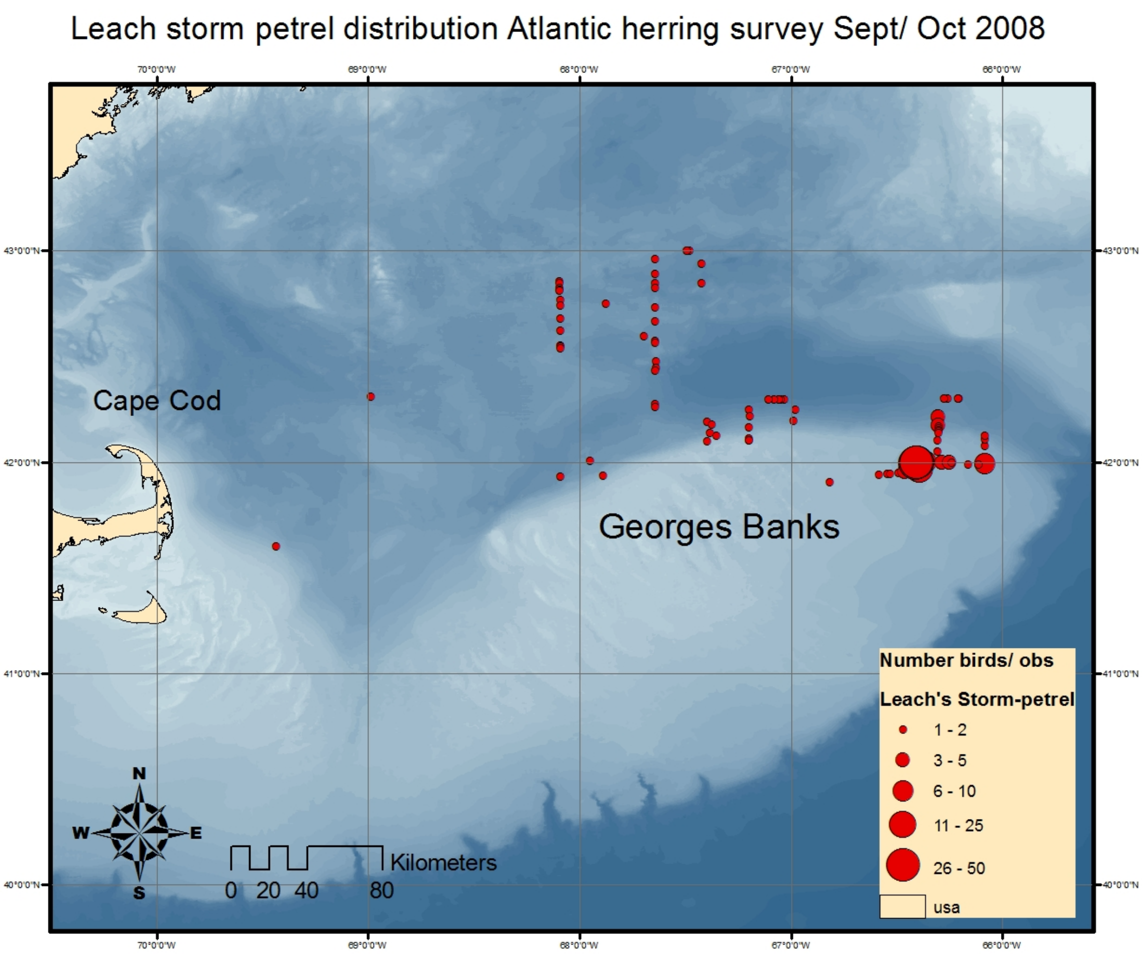
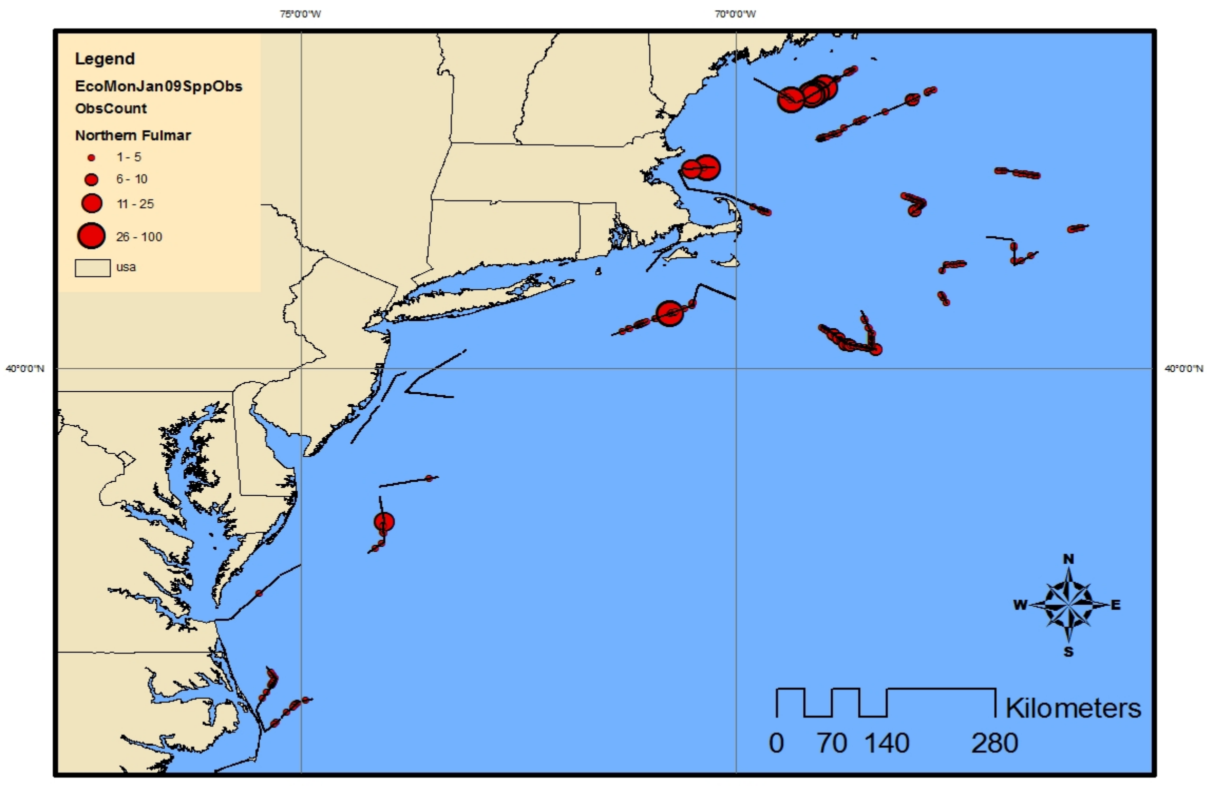


FIGURE 2.5: Leach's Storm-petrel

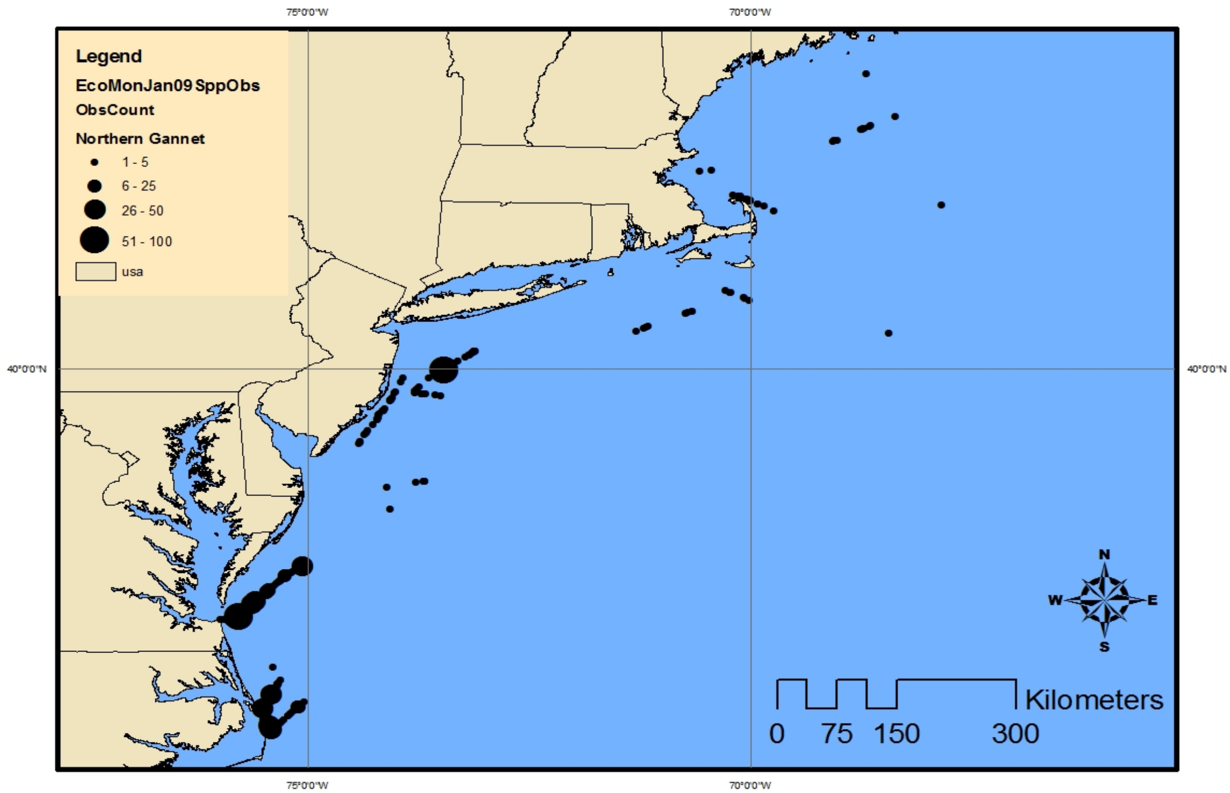
Part 3: Ecosystem Monitoring Survey January 2009

Most abundant species: 1) Northern Fulmar, 2) Northern Gannet, 3) Dovekie, 4) Herring Gull, 5) Great Black-backed Gull



Northern Fulmar distribution along the Eastern coast of United States- Atlantic Ocean - Ecomon Survey NOAA January 2009

FIGURE 3.1: Northern Fulmar



Northern gannet distribution along the Eastern coast of United States- Atlantic Ocean - Ecomon Survey NOAA January 2009

FIGURE 3.2: Northern Gannet

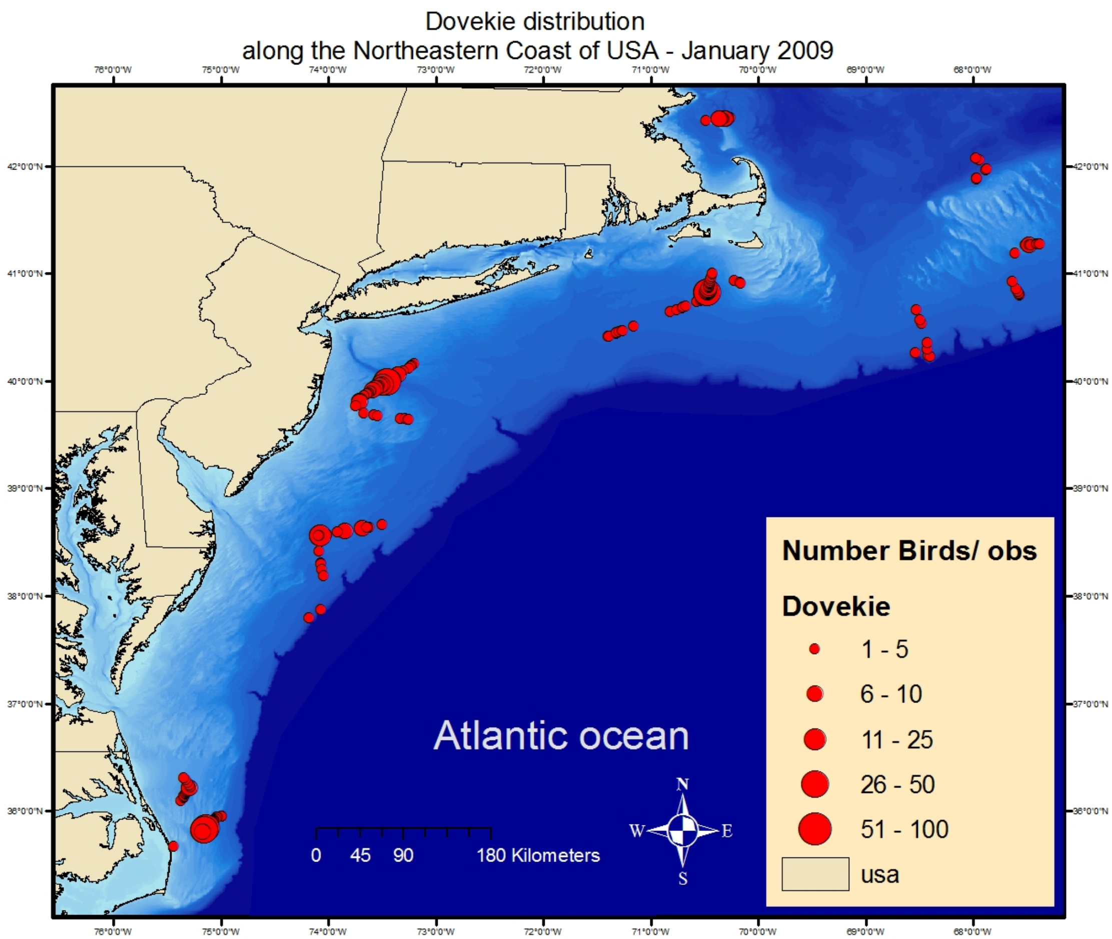


FIGURE 3.3: Dovekie

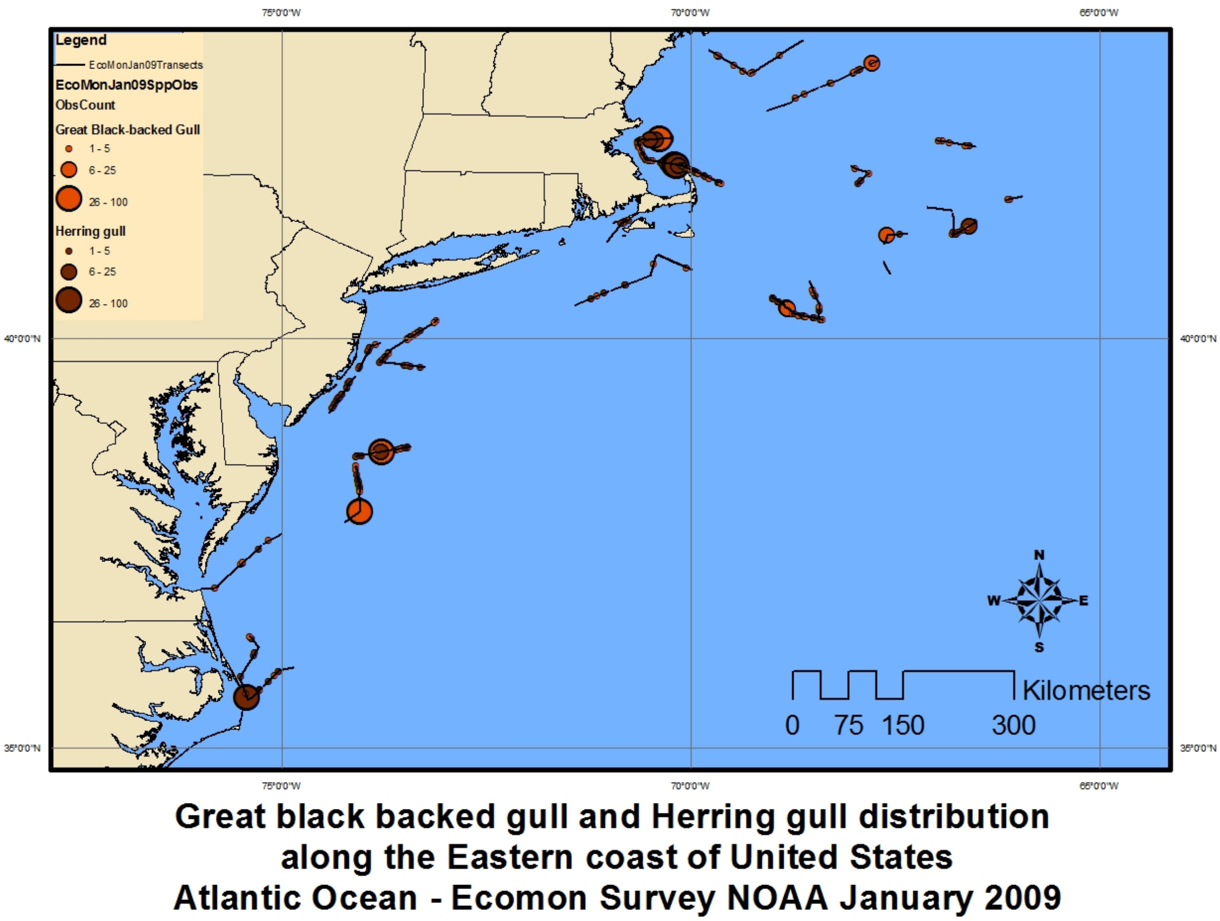


FIGURE 3.4: Herring Gull and Great Black-backed Gull

Part 4: Ecosystem monitoring survey May 2009

Most abundant species: 1) Greater Shearwater, 2) Leach's Storm-petrel, 3) Wilson's Storm-petrel, 4) Sooty Shearwater, 5) Northern Gannet

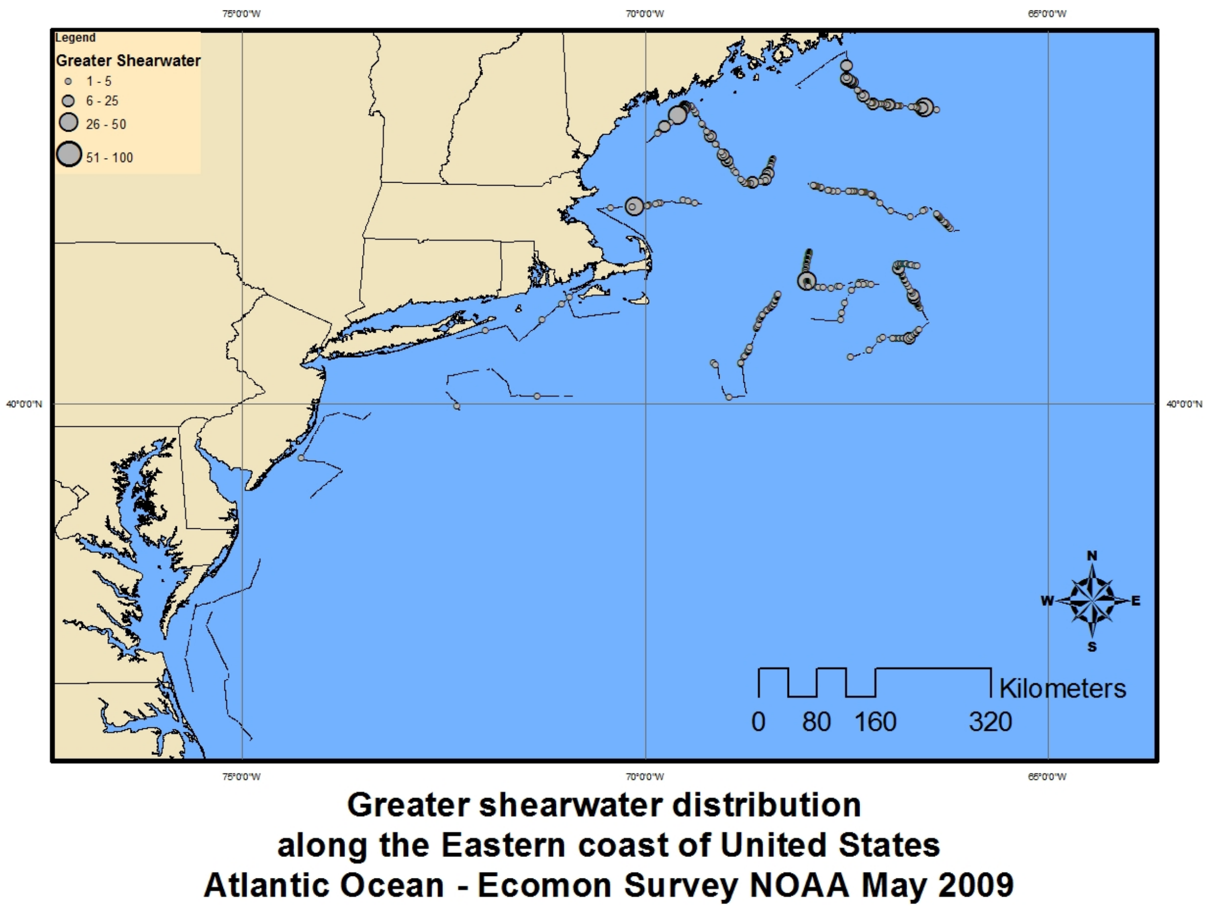


FIGURE 4.1: Greater Shearwater

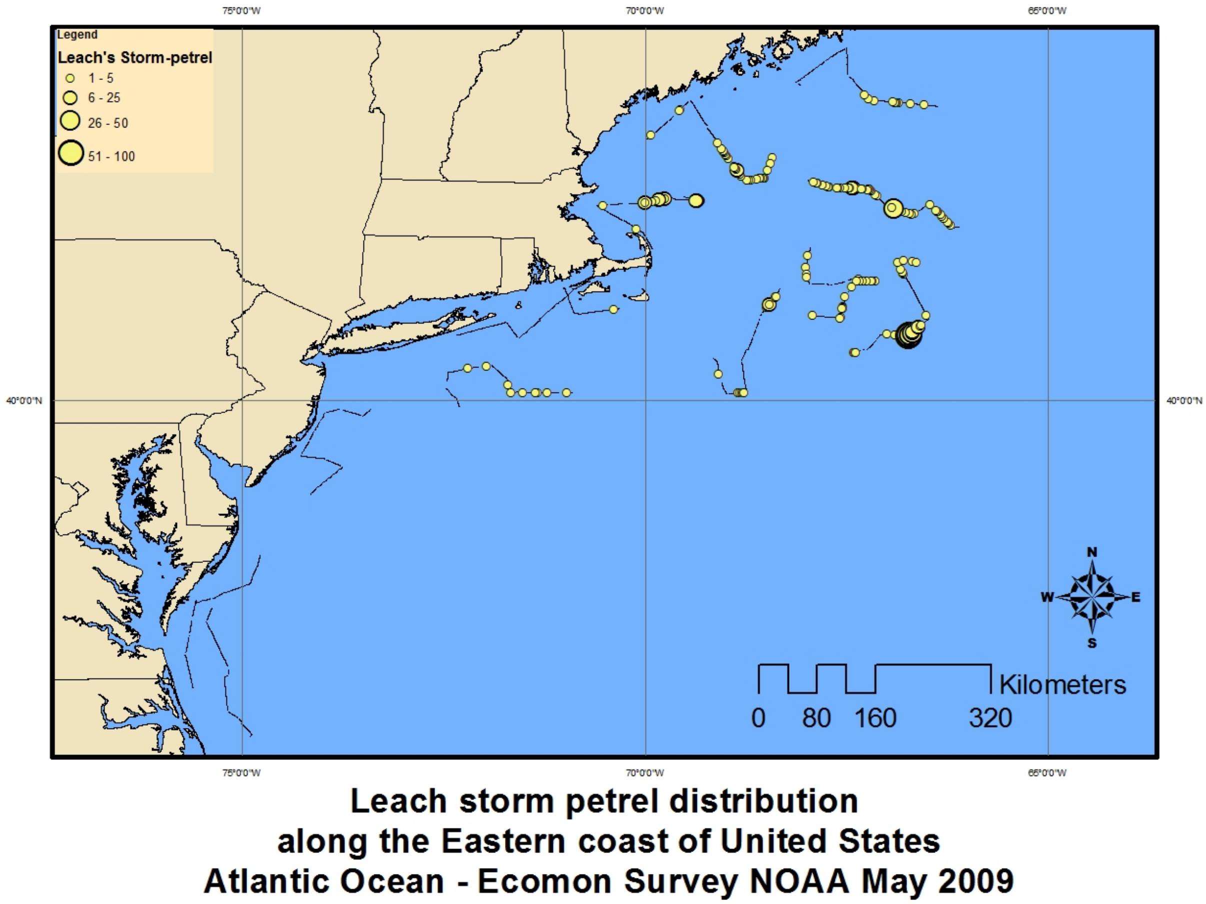


FIGURE 4.2: Leach’s Storm-petrel

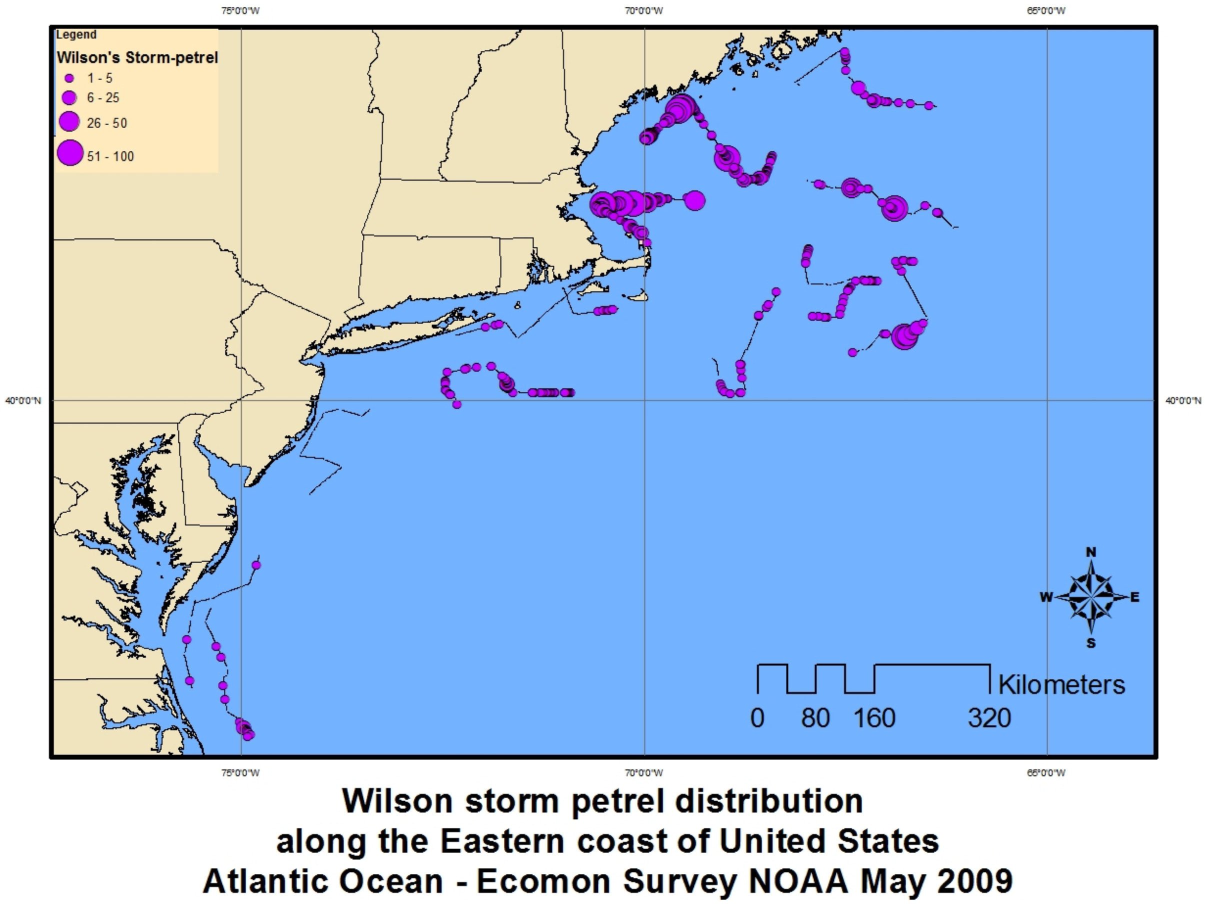


FIGURE 4.3: Wilson’s Storm-petrel

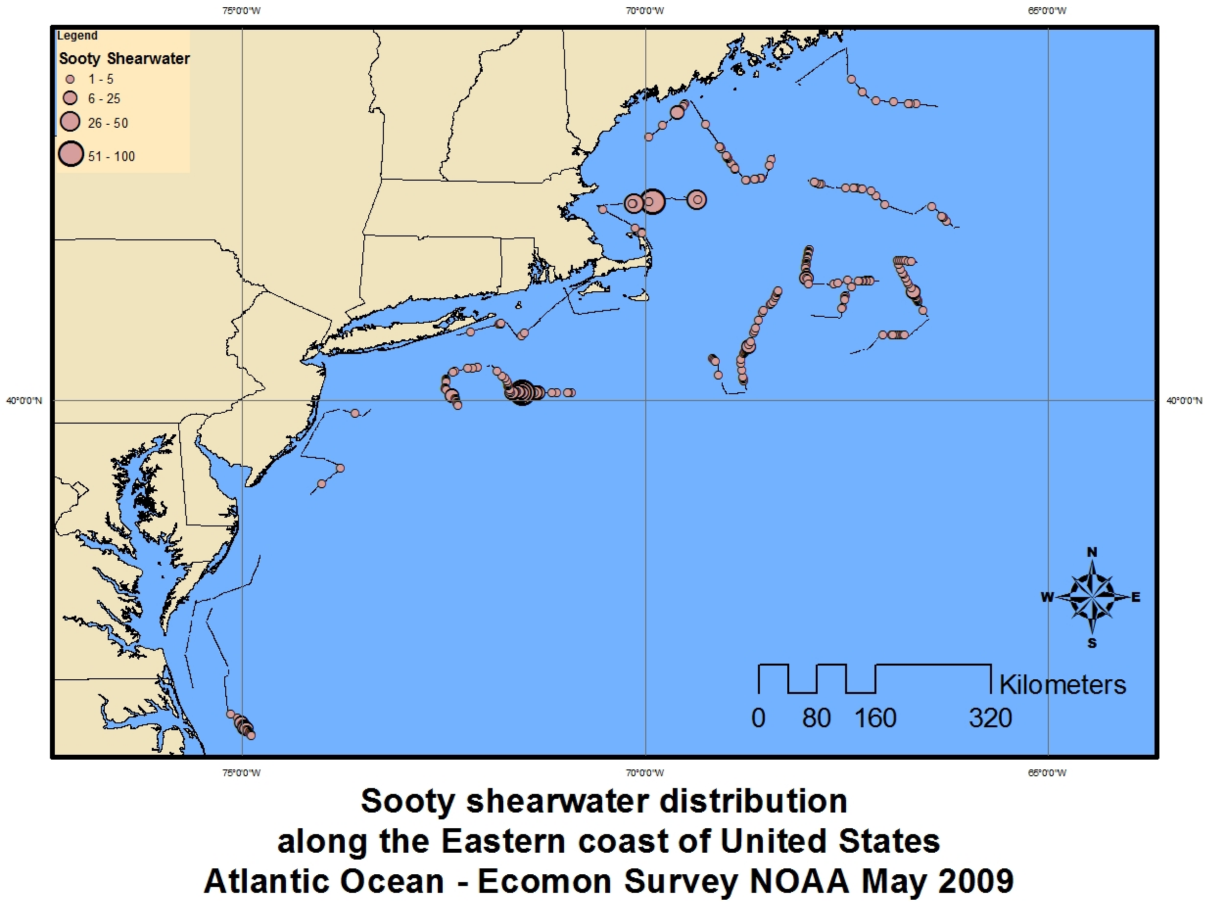


FIGURE 4.4: Sooty Shearwater

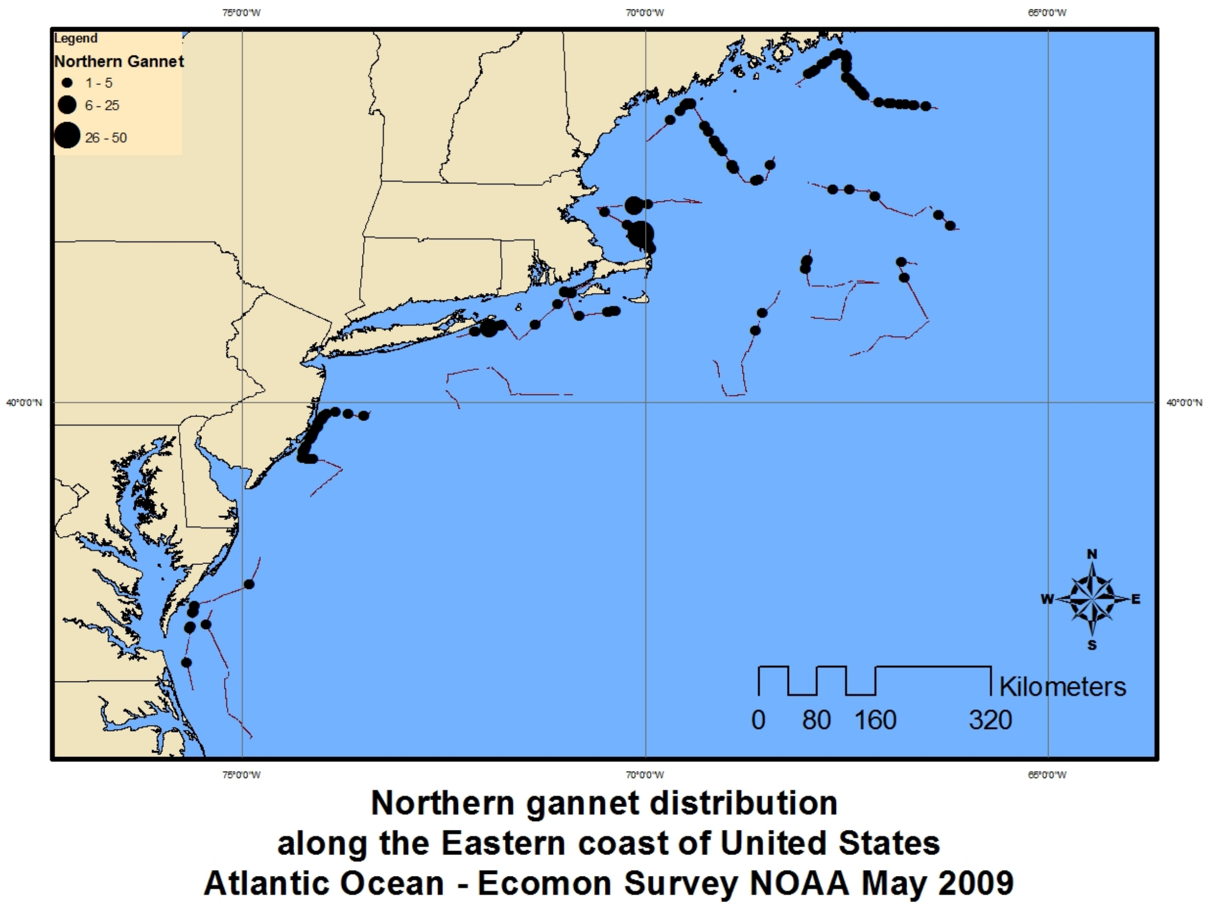


FIGURE 4.5: Northern Gannet

Part 5: Atlantic herring survey September/ October 2009

Most abundant species: 1) Greater Shearwater, 2) Great Black-backed Gull, 3) Cory's Shearwater, 4) Herring Gull, 5) Wilson's Storm-petrel, 6) Northern Gannet

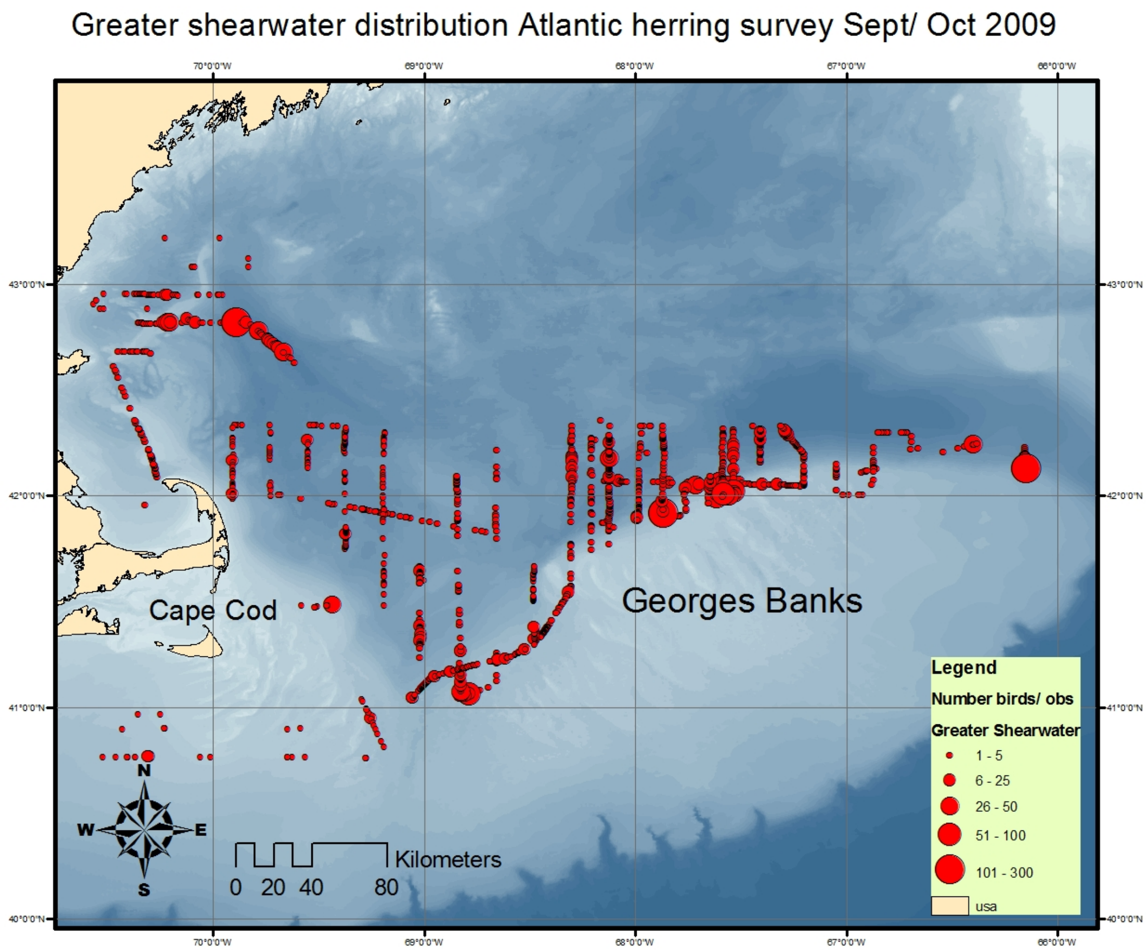


FIGURE 5.1: Greater Shearwater

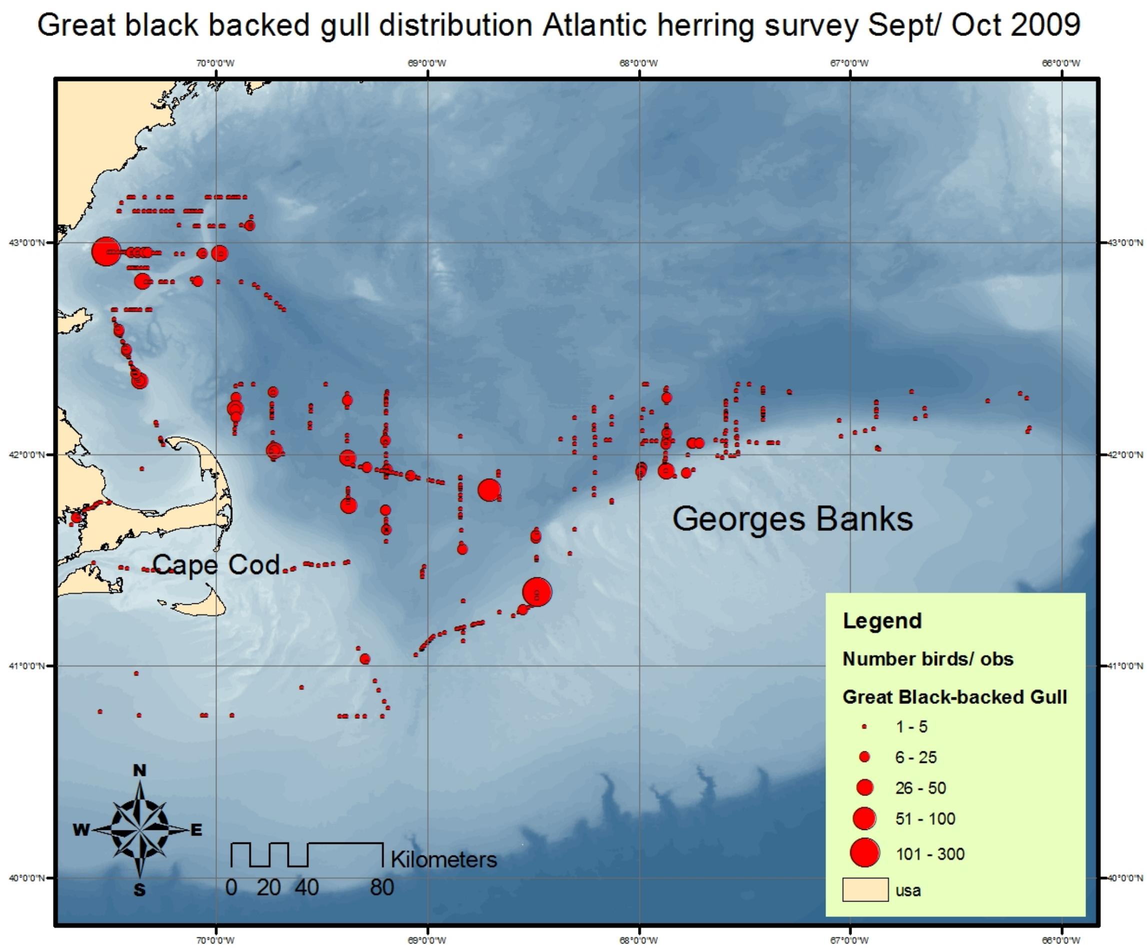


FIGURE 5.2: Great Black-backed Gull

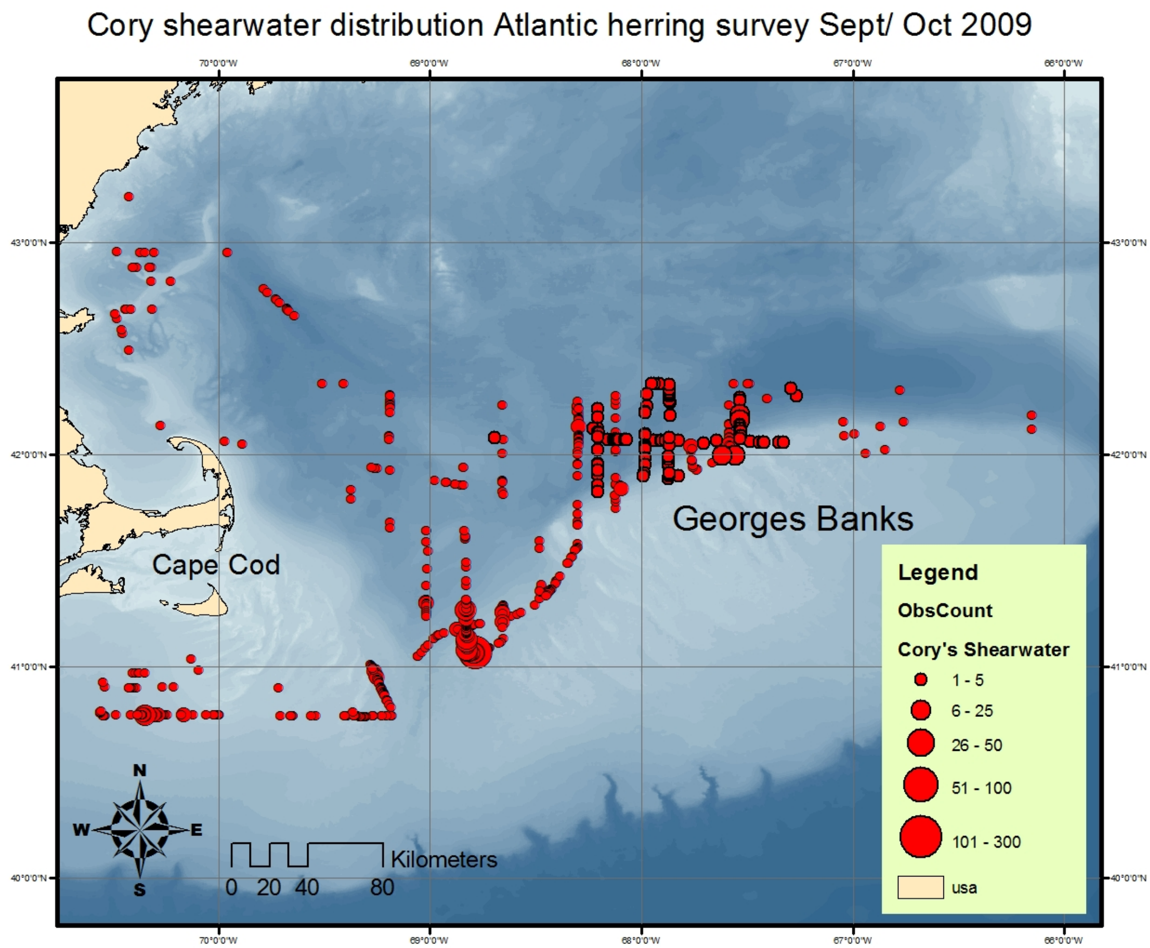


FIGURE 5.3: Cory's Shearwater

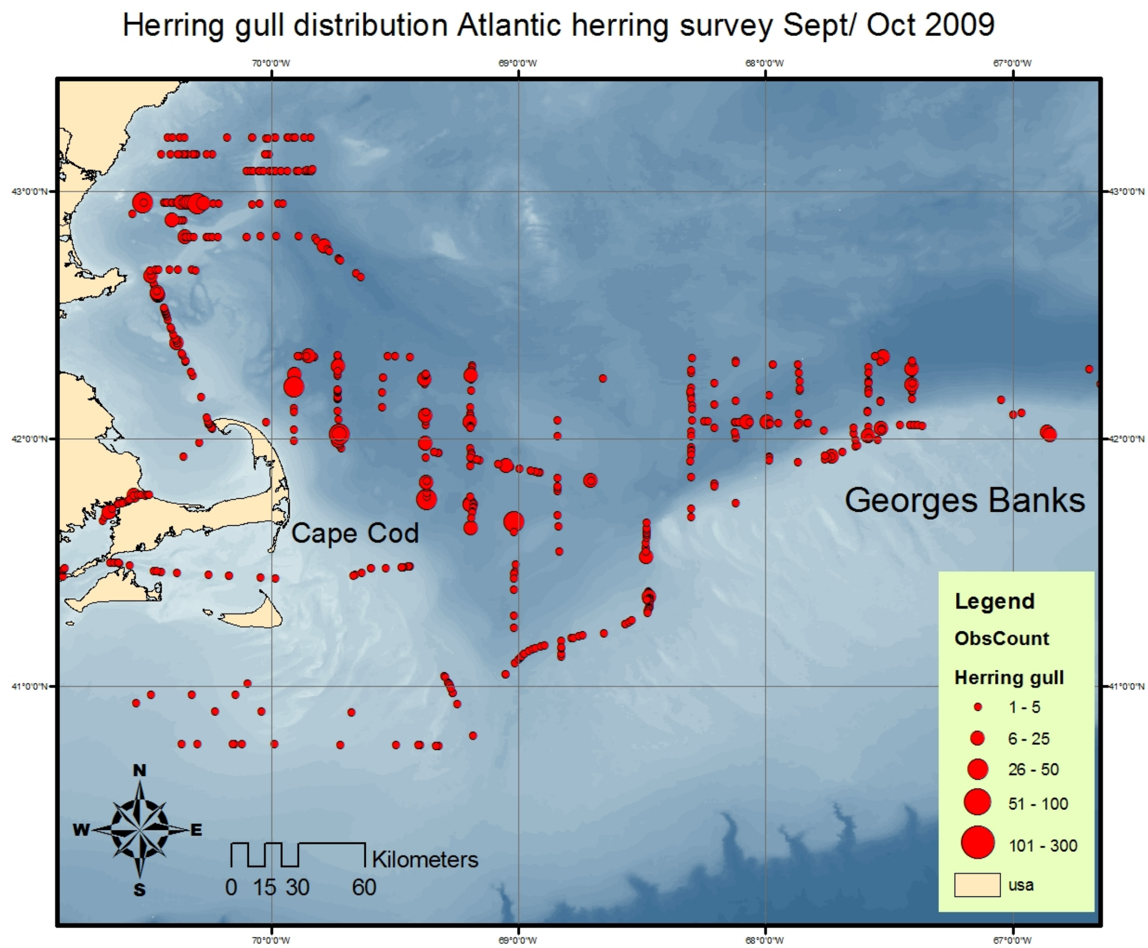


FIGURE 5.4: Herring Gull

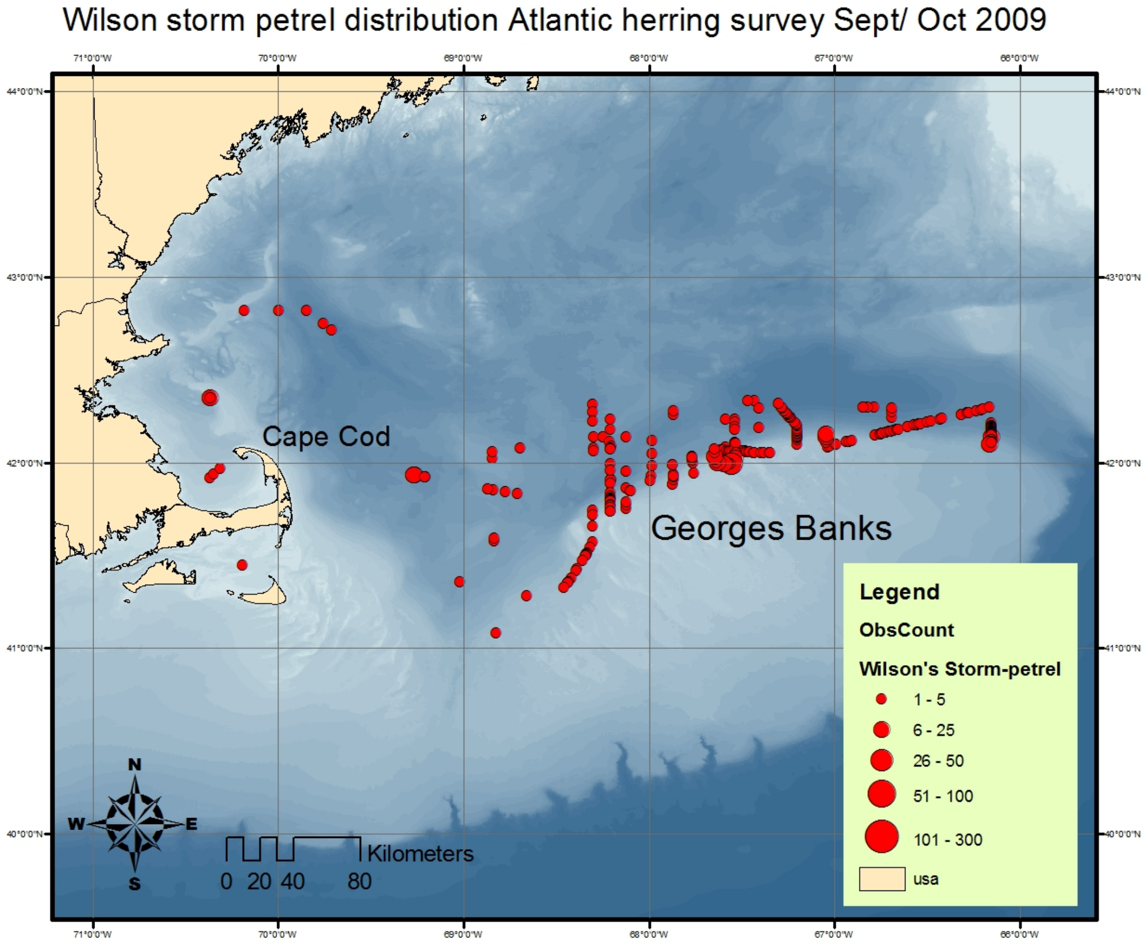


FIGURE 5.5: Wilson's Storm-petrel

Part 6: Ecosystem Monitoring survey November 2009

Most abundant species:

1) Herring Gull, 2) Northern Fulmar, 3) Black-legged Kittiwake, 4) Great Black-backed Gull, 5) Common Eider, and 6) Northern Gannet

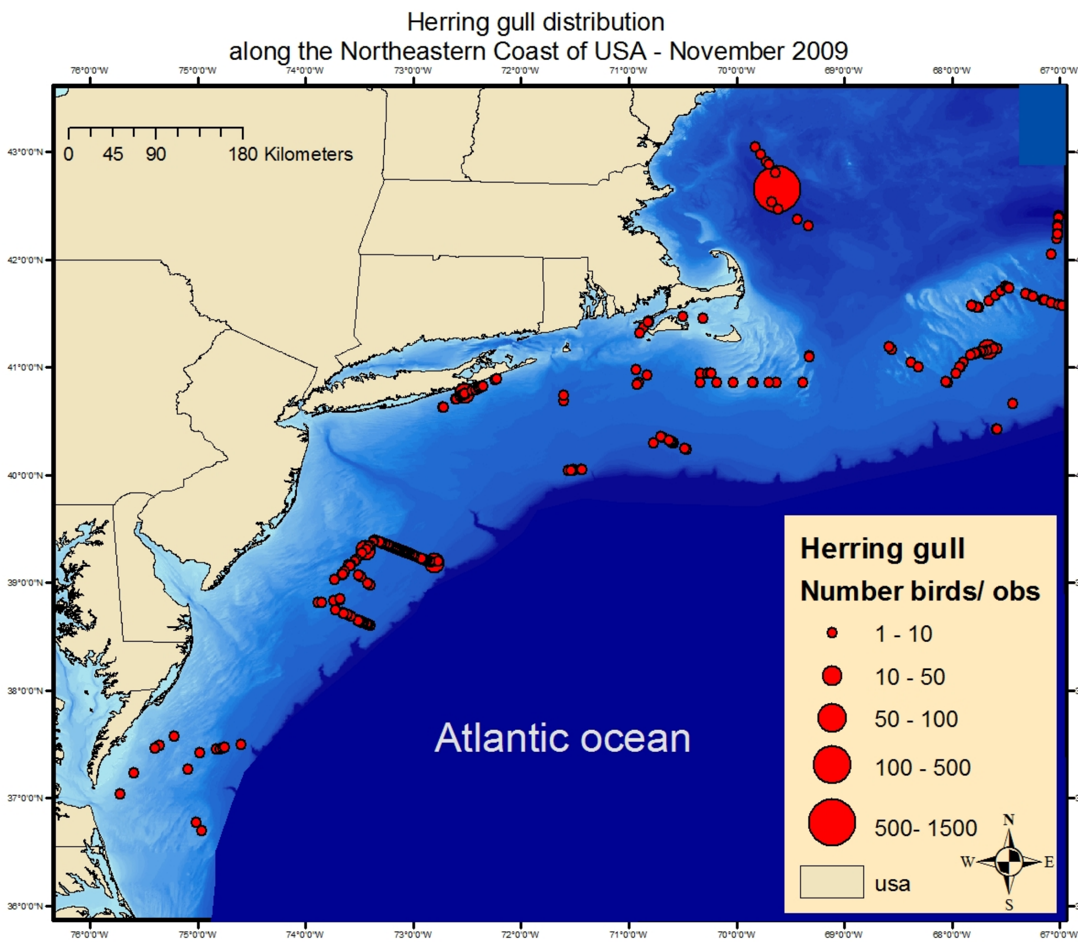


FIGURE 6.1: Herring Gull (N= 1870)

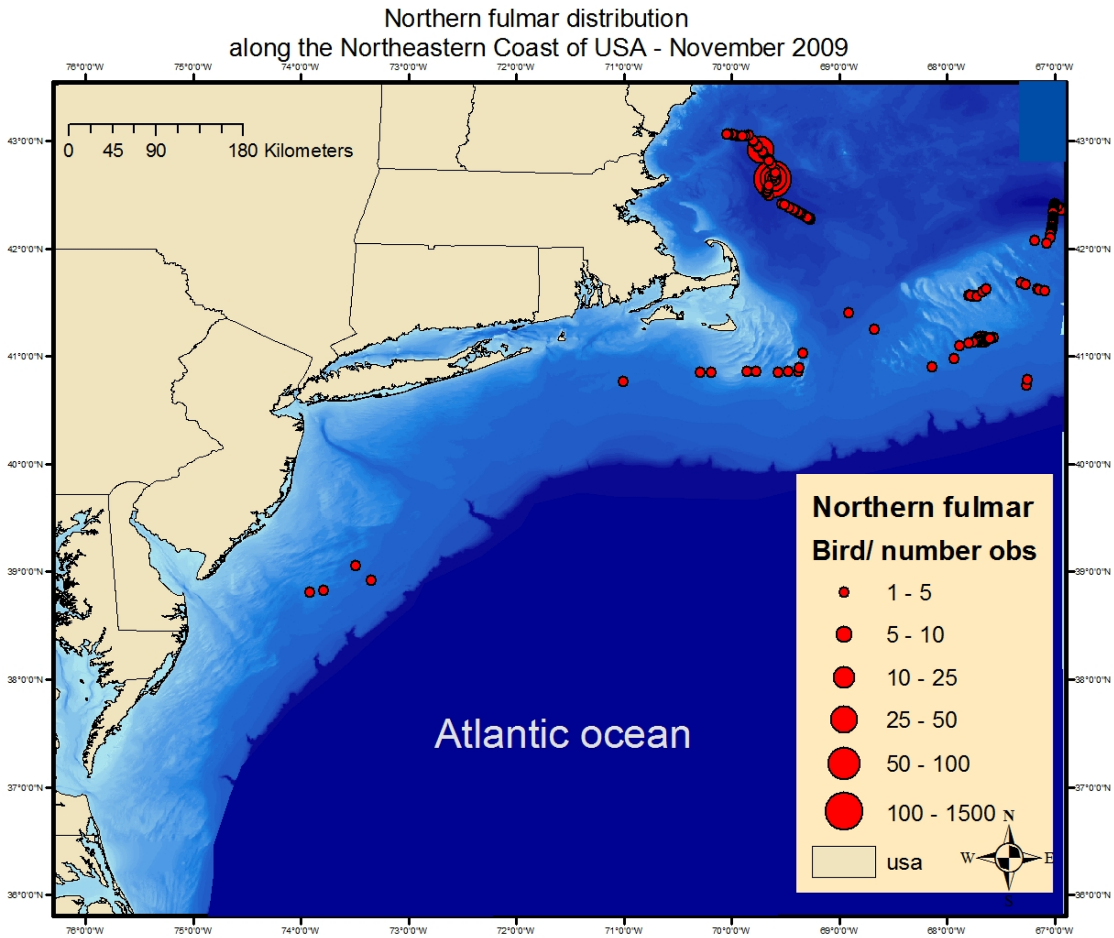


FIGURE 6.2: Northern Fulmar (N= 1646)

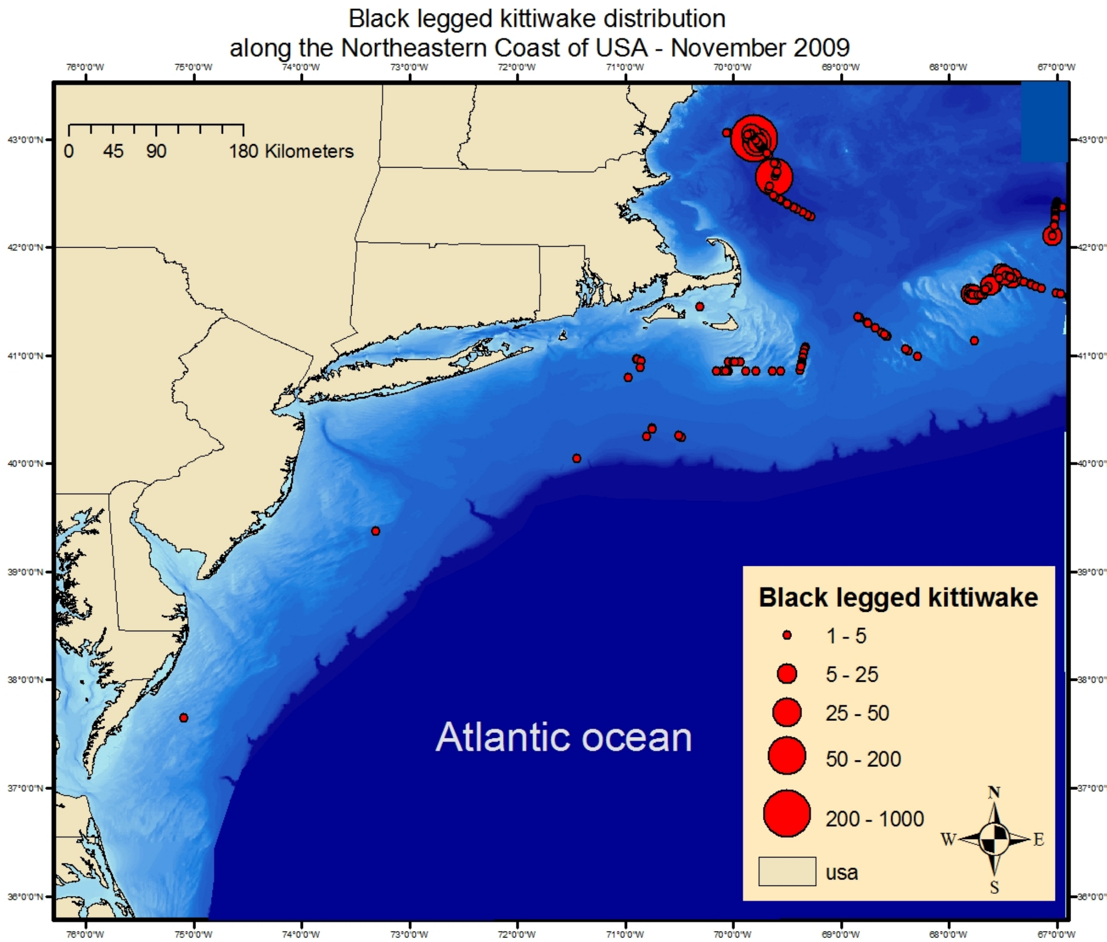


FIGURE 6.3: Black-legged Kittiwake (N= 1604)

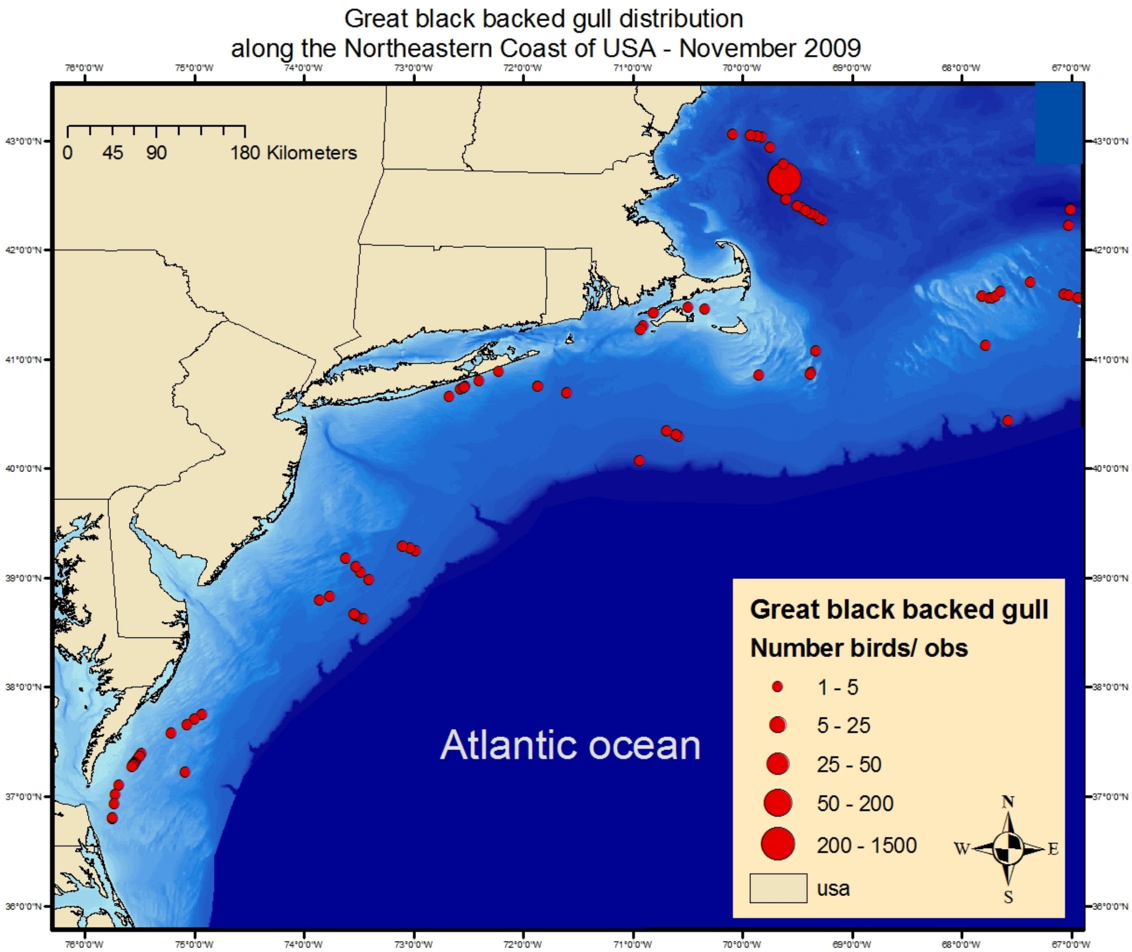


FIGURE 6.4: Great Black-backed gull (N= 1437)

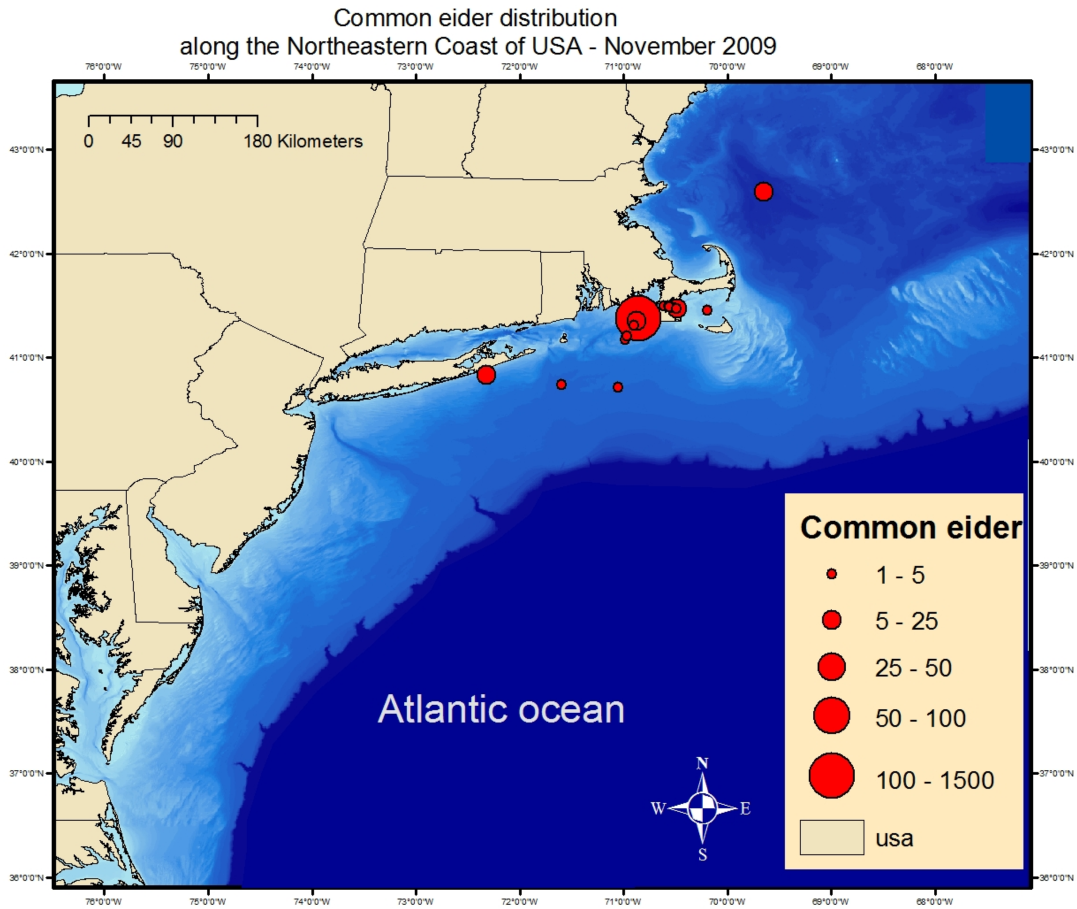


FIGURE 6.5: Common Eider (N= 1179)

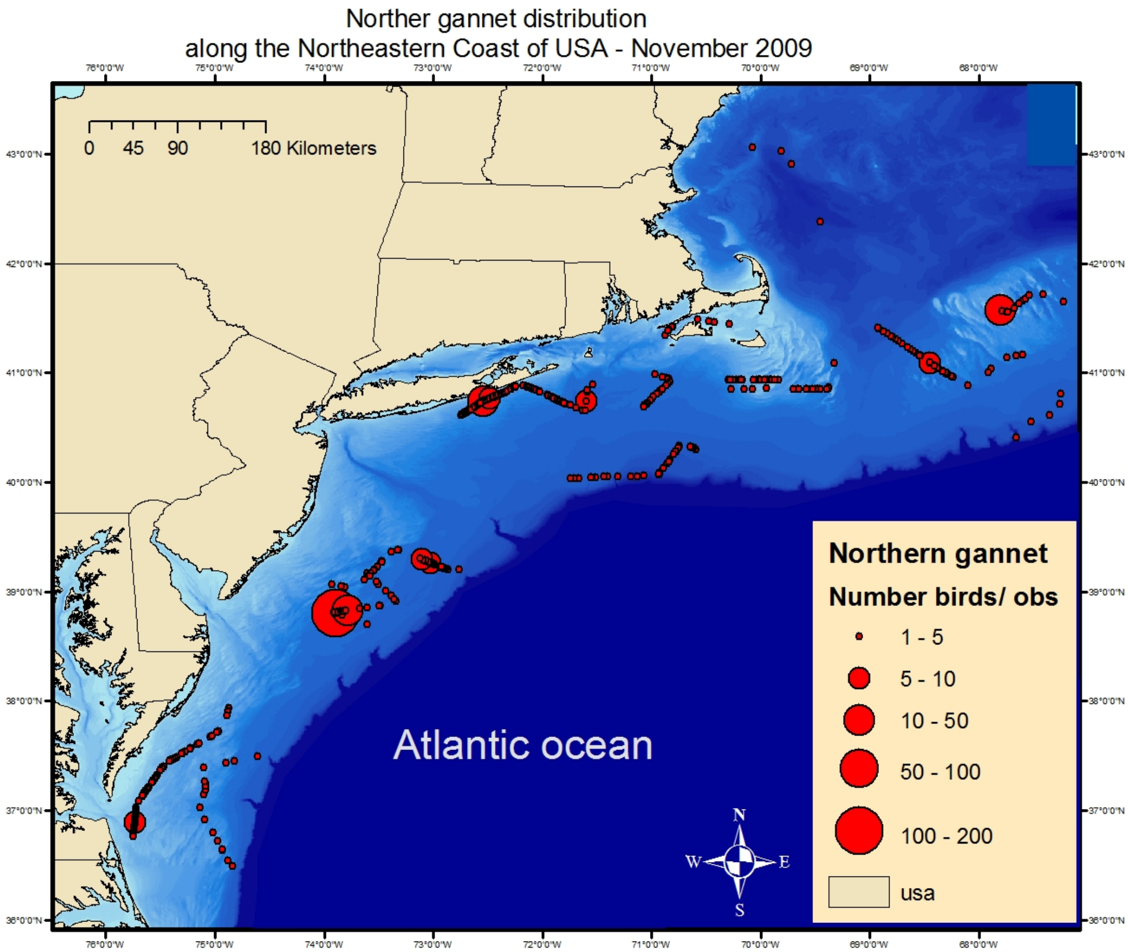


FIGURE 6.6: Northern Gannet (N= 1087)

Appendix II

At-Sea Distributions of Pelagic Seabirds off the East Coast of the United States, 2010

A Preliminary Report to BOEMRE

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Introduction

Interest in developing wind resources in the offshore waters of the mid Atlantic and New England is increasing rapidly. Understanding how this activity might adversely affect wildlife resources is critical for development to move forward. Currently, information on the spatial and temporal movement and occupancy patterns of wildlife resources in offshore habitats is lacking for much of BOEMRE's North and Mid-Atlantic Planning Regions.

The pelagic waters off the U.S. East Coast are dominated by birds that do not breed in the area; prominent are shearwaters and storm-petrels that nest in the Antarctic and on Sub Antarctic islands during May-October as well as fulmars, alcids and gulls that nest in the Arctic during November-March (Barrett et al. 2006, Nisbet et al. *in press*). Because of the dominance by wintering nonbreeders, shipboard surveys are one of the best ways to quantify abundance and measure its variability through time.

Our goal in this effort is to document areas of frequent use and aggregation by birds, such that planning of offshore development can be properly informed as to the importance to birds of the pelagic habitats off our coast. In order to do this, we need to identify seasonal distribution and abundance patterns, movement patterns, and habitat-abundance associations. We are also interested in how the birds are responding to changes in climate and fisheries activities, and perhaps other unknown factors. It is increasingly evident that populations of seabirds have been impacted by changes in the earth's climate (Aebischer et al. 1990, Veit et al. 1997, Garthe 1997, Guinet et al. 1998, Thompson and Ollason 2001, Gjerdrum et al. 2003, Sandvik et al. 2005, Montevecchi and Myers 1997, Durant et al. 2003), but how these may have impacted seabird abundance off our coast is unknown.

The debate over whether fishing effort or climate is more to blame for changes in fish, bird and mammal populations has raged for close to 100 years (Volterra 1926, Beverton and Holt 1957, Thompson 2006.) Exploitation of fish populations has impacted the pelagic communities of the US continental shelf and these community changes have affected seabirds (Fogarty and Murawski 1998, Montevecchi 2002). Picking apart the effects of climate versus fisheries is difficult but recent progress has been made (Scott et al. 2006, Thompson 2006).

Our primary objective is to determine current seabird distribution and abundance from Maine to Cape Hatteras, North Carolina. A secondary objective is to determine whether changes in distribution and abundance have occurred relative to historic records. A tertiary objective is to assess whether changes, if they have occurred, might be attributed to climate change.

2010 Methods

In 2010 we continued the same methodology that we used in 2008-2009. In this report, we present the results from four EcoMon cruises conducted in February, May, August and November. We also staffed the herring acoustic cruise in September, and a three cruises run by the Woods Hole Oceanographic Institute in (Table1). Due to reduced funding for Andrew Gilbert at USGS, who processed all bird data for us, we do not yet have completed results for these last two cruises. We will work this spring and summer to get the data processed and prepare another report summarizing the first two years of the project and including the data from these last four cruises by 31 August 2011.

We conducted surveys off the east coast of the United States from Cape Hatteras to Maine using NOAA research vessels as platforms from summer 2008 through fall 2010. The purpose of these surveys was to establish baseline data on the seasonal abundance and distribution of pelagic bird species which may be used for determining where to site potential offshore development, as well as to draw comparisons with seabird data collected in the 1970s and 1980s. Our sampling was limited to the continental shelf, which extends to about 100 nautical miles off the northeastern United States.

We participated on four NOAA EcoMon cruises between February and November 2010, one Herring Acoustic cruise and three research cruises with Drs. Gareth Lawson and Peter Wiebe of the Woods Hole Oceanographic Institute (Table 1). All data are stored at the US Geological Survey's database in Patuxent, Maryland. As we did in the past, we collected data on seabirds while the ship was underway during daylight hours. Thus, we discontinued sampling when the ship stopped to sample an oceanographic station. We used a combination of strip-transect and line-transects to quantify density. Our default method was to sample a 300 m wide strip transect situated on the side of the ship that offered the best visibility. When densities were not so high as to overwhelm the observer, we recorded distances and angles to all birds spotted, regardless of their distance from the ship (i.e. >> 300m). This ensured our ability to scale data collected within the 300 m strip on the basis of detectability of individual species of birds (Buckland et al. 2001).

Table 1. Cruises from which seabird data were collected in 2010.

Cruise	Month /Year	Linear Distance Surveyed
EcoMon	February 2010	Cape Hatteras to the Gulf of Maine (1352 km)
EcoMon	May 2010	Cape Hatteras to the Gulf of Maine (2061 km)
WHOI Georges Bank	July 2010	Georges Bank
EcoMon	August 2010	Cape Hatteras to the Gulf of Maine (2029 km)
WHOI Georges Bank	September 2010	Georges Bank
Herring Acoustic	September 2010	Georges Bank and Jeffries Ledge
WHOI Georges Bank	Oct-Nov 2010	Georges Bank
EcoMon	November 2010	Cape Hatteras to the Gulf of Maine (897 km)

Preliminary Results

We sampled three kinds of surveys: 1) EcoMon surveys, designed to monitor zooplankton on the continental shelf from Maine to Cape Hatteras, 2) Herring Acoustic surveys, designed to quantify spatial distribution of herring and their prey (copepods) using acoustics, on northern Georges Bank, and 3) three research cruises with Gareth Lawson and Peter Wiebe of the Woods Hole Oceanographic Institute designed to investigate the accumulation of zooplankton at hydrographic fronts on Georges Bank and surrounding waters. We present the data here from the EcoMon cruises. Our August 2011 summary report of the first two years of this project will include the additional data from the WHOI cruise, and those from the Herring acoustic cruise.

The winter of 2010-2011 has been characterized as having the largest negative anomaly of the North Atlantic Oscillation on record (since 1865; Hurrell et al. 2003). This highly unusual oceanographic condition may have impacted the abundance and diversity of bird species in our area substantially. The most obvious difference we noted was the exceptional abundance of Dovekies in November 2010 (Table 2). Dovekie abundance was at least 8 times higher than at any time in the 1970s-1980s (Powers 1983), and substantially higher than on any survey we have conducted since 2008. Veit and Guris (2009) and Veit (ms) have found, based on a fifty year time series (1955-present) of shore-based counts in Massachusetts, that southward incursions of Dovekies are associated with NAO- negative conditions. Dovekie abundance seems therefore to at least partly reflect the anomalous conditions of this winter (2010-2011); on the other hand, Dovekies have been steadily increasing in abundance of the US coast since about 1990, so there is also some unexplained component to this increase.

We also observed unusually high numbers of Northern Gannets and Northern Fulmars in November 2010 (Table 2). Northern Gannets have been steadily increasing in the NW Atlantic for 50 years or more (Montevecchi and Myers 1997), and the number we observed in November are consistent with this continued increase. The fulmar numbers were higher than any we have recorded since 2008, but not higher than what Powers (1983) recorded in the 1970s and 1980s. Thus our high totals for November may reflect the anomalous oceanographic conditions. Numbers of Herring Gulls have steadily declined in the NW Atlantic since the 1970s, and our data are consistent with this decline.

In 2010, abundance of Greater Shearwaters was higher in spring, but lower in fall, than what Powers recorded (Table 3). This pattern possibly reflects a different seasonal pattern of resource use than what was the case in the 1970s.
We present some sample densities of the five most abundant species in 2008-2009 observed on each cruise in Table 2. In the maps, numbers reported are number per observation. Quantified densities (birds/km^2) for some species are presented in Table 2**.**

Table 2. Densities of dominant species recorded in 2010 (birds/km^2). Density estimates for 1970s-1980s (from Powers 1983) given *in italics* below each value.

	February 2010	**May 2010**	**August 2010**	**November 2010**
Northern Fulmar	2.4 *(7.5)*	1.6 *(3.8)*	0 *(0)*	**8.5** ***(1.5)***
Greater Shearwater	0 (0)	6.8 *(1.5)*	7.3 *(2.75)*	5.7 *(7.5)*
Wilson's Storm-petrel	0 *(0)*	4.4 *(6.0)*	3.9 *(8.0)*	1.59 *(0.5)*
Northern Gannet	1.4 *(1.0)*	0.28 *(1.75)*	0.29 *(0.25)*	**6.3** ***(1.25)***
Herring Gull	2.6 *(3.75)*	0.50 *(1.5)*	1.7 *(0.75)*	2.3 *(8.5)*
Dovekie	0.36 *(1.0)*	0.09 *(1.0)*	0 *(0)*	**8.1** ***(0)***

Table 3. Greater Shearwater abundance within four strata sampled both in the 1970s (Powers 1983), 2008-2009 and 2010 (this study).

		1970s (Powers 1983) Birds/km^2		2008-2009 Birds/km^2		2010 Birds/km^2
May	Gulf of Maine	2.0		3.7		19.8
	Georges Bank	2.0		4.3		7.3
	Southern New England	2.0		0.1		0.2
	Mid Atlantic	0		4.1		0.05
August	Gulf of Maine	8.0		3.0		12.9
	Georges Bank	3.0		0.3		8.1
	Southern New England	3.0		0.3		1.0
	Mid Atlantic	0		0.1		0
October	Gulf of Maine	30.0		4.4		(Nov) 6.2
	Georges Bank	12.0		5.7		(Nov) 5.9
	Southern New England	15.0		0.7		(Nov) 2.8
	Mid Atlantic	2.0		0		(Nov) 8.0

References Cited

Aebischer, N.J., J.C. Coulson and J.M. Colebrook. 1990. Parallel long-term trends across four marine trophic levels and weather. **Nature** 347: 753-755.

Barrett, R.T., G. Chapdelaine, T. Anker-Nilssen, A. Mosbech, W.A. Montevecchi, J.B. Reid and R.R. Veit. 2006. Seabird numbers and prey consumption in the North Atlantic. **ICES Journal of Marine Science** 63: 1145-1158.

Beverton, R.J.H. and S.J. Holt. 1957. On the Dynamics of Exploited Fish Populations. HMSO, London.Bordage, D., and J.L. Savard. 1995. Black Scoter (*Melanitta nigra*). In The Bird of North America, No. 177 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press.

Durant, J.M., T. Anker-Nilssen and N.C. Stenseth. 2003. Trophic interactions under climate fluctuations: the Atlantic Puffin as an example. **Proceedings of the Royal Society of London B** 270: 1461-1466.

Fogarty, M.J. and S.A. Murawski. 1998. Large-scale disturbance and the structure of marine systems: fishery impacts on Georges Bank. **Ecological Applications** 8 (1) Supplement: S6-S22.

Garthe, S. 1997. Influence of hydrography, fishing activity and colony location on summer seabird distribution in the southeastern North Sea. **ICES Journal of Marine Science** 54: 566-577.

Gjerdrum, C., A.M.J. Vallée, C.C. St. Clair, D.F. Bertram, J.L. Ryder and G.S. Blackburn. 2003. Tufted Puffin reproduction reveals ocean climate variability. **Proceedings of the National Academy of Sciences** 100: 9377-9382.

Guinet, C., O. Chastel, M. Koudil, J. Durbec and P. Jouventin. 1998. Effects of warm sea-surface temperature anomalies on the blue petrel at the Kerguelen Islands. **Proceedings of the Royal Society of London B** 265: 1001-1006.

Hurrell, J.W., Y. Kushnir, G. Ottersen and M. Visbeck (Eds). 2003. The North Atlantic Oscillation: Climatic Significance and Environmental Impact. American geophysical Union, Washington, D.C.

Link, J., J. O'Reilly, M. Fogarty, D. Dow, J. Vitaliano, C. LeGault, W. Overholtz, J. Green, D. Palka, V. Guida, J. Brodziak E. Methratta, and W. T. Stockhausen. 2007. Energy Flow on Georges Bank Revisited: The Energy Modeling and Analysis eXercise (EMAX) in Historical Context. **Journal of Northwest Atlantic Fisheries Science** 39: 83-101

Montevecchi, W.A. 2002. Interaction between fisheries and seabirds. Pages 527-558 *in* E.A. Schreiber and J. Burger (Eds) Biology of Marine Birds. CRC Press, Boca Raton, Florida.

Montevecchi, W.A. and R.A. Myers. 1997. Centurial and decadal oceanographic influences on changes in northern gannet populations and diets in the north-west Atlantic: implications for climate change. **ICES Journal of Marine Science** 54: 608-614.

Nisbet, I.C.T., R.R. Veit and S.A. Auer. *In press*. Marine birds of the Eastern USA and the Bay of Fundy: Distribution, numbers, trends, threats and management. **Nuttall Ornithological Monographs.**

Powers, K.D. 1983. Pelagic Distributions of Marine Birds off the Northeastern United States. NOAA technical memorandum NMFS-F/NEC-27

Sandvik, H., K.E. Erikstad, R.T. Barrett and N.G. Yoccoz. 2005. The effect of climate on adult survival in five species of North Atlantic seabirds**. Journal of Animal Ecology** 74: 817-831.

Scott, B.E., J. Sharples, S. Wanless, O.N. Ross, M. Frederiksen and F. Daunt. 2006. The use of biologically meaningful oceanographic indices to separate the effects of climate and fisheries on seabird breeding success. Pages 46-62 *in* Boyd, I., S. Wanless and C.J. Camphuysen (Eds). 2006. Top Predators in Marine Ecosystems: their Role in Monitoring and Management. Cambridge University Press.

Thompson, P.M. and J.C. Ollason. 2001. Lagged effects of ocean climate change on fulmar population dynamics. **Nature** 413: 417-420.

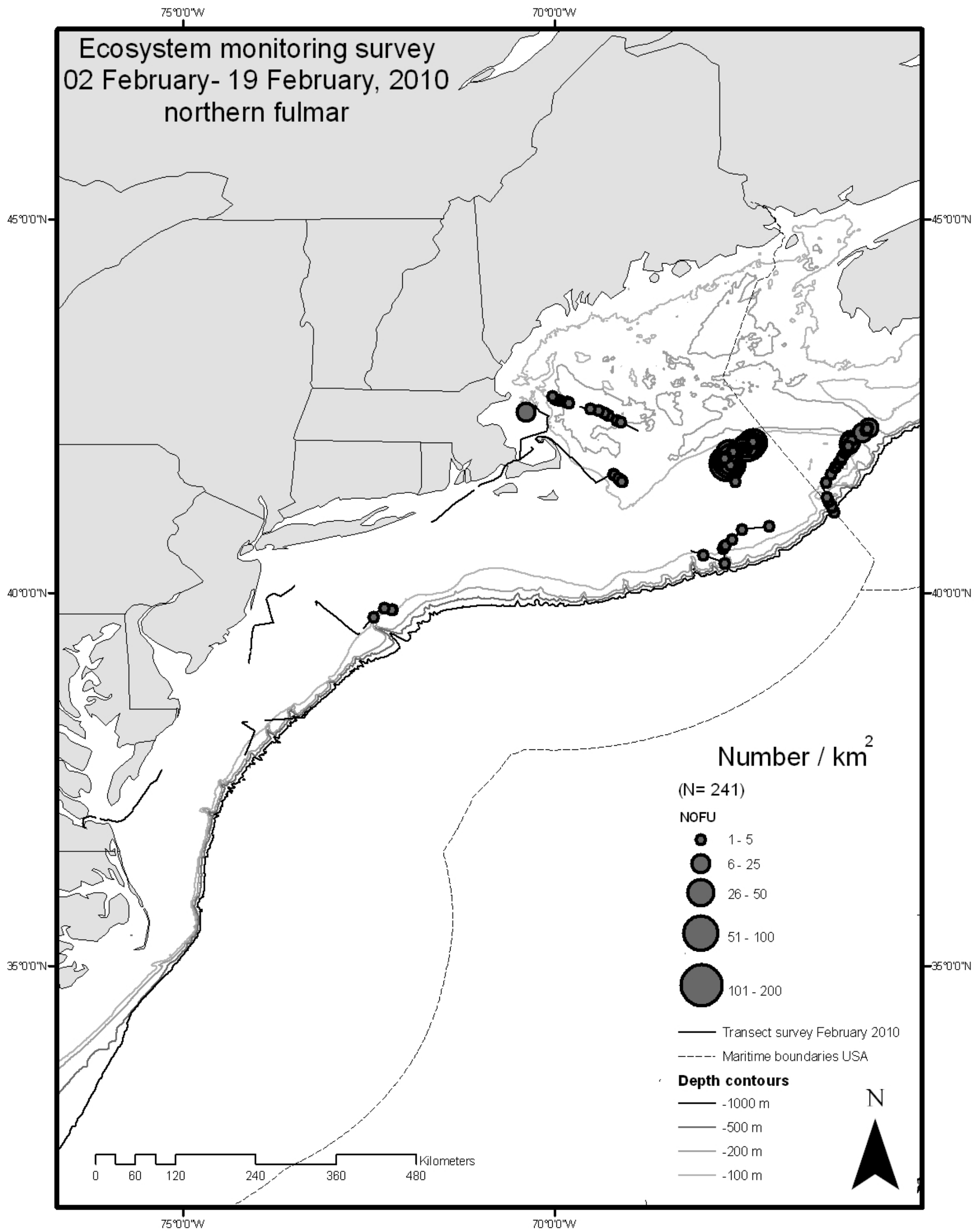
Veit, R.R. (*abstract*). 2009. Shift in winter range of alcids off the northeastern US coast and its relation to oceanic climate. 33rd Annual Meeting of the Waterbird Society, Cape May, New Jersey, 4-8 November 2009.

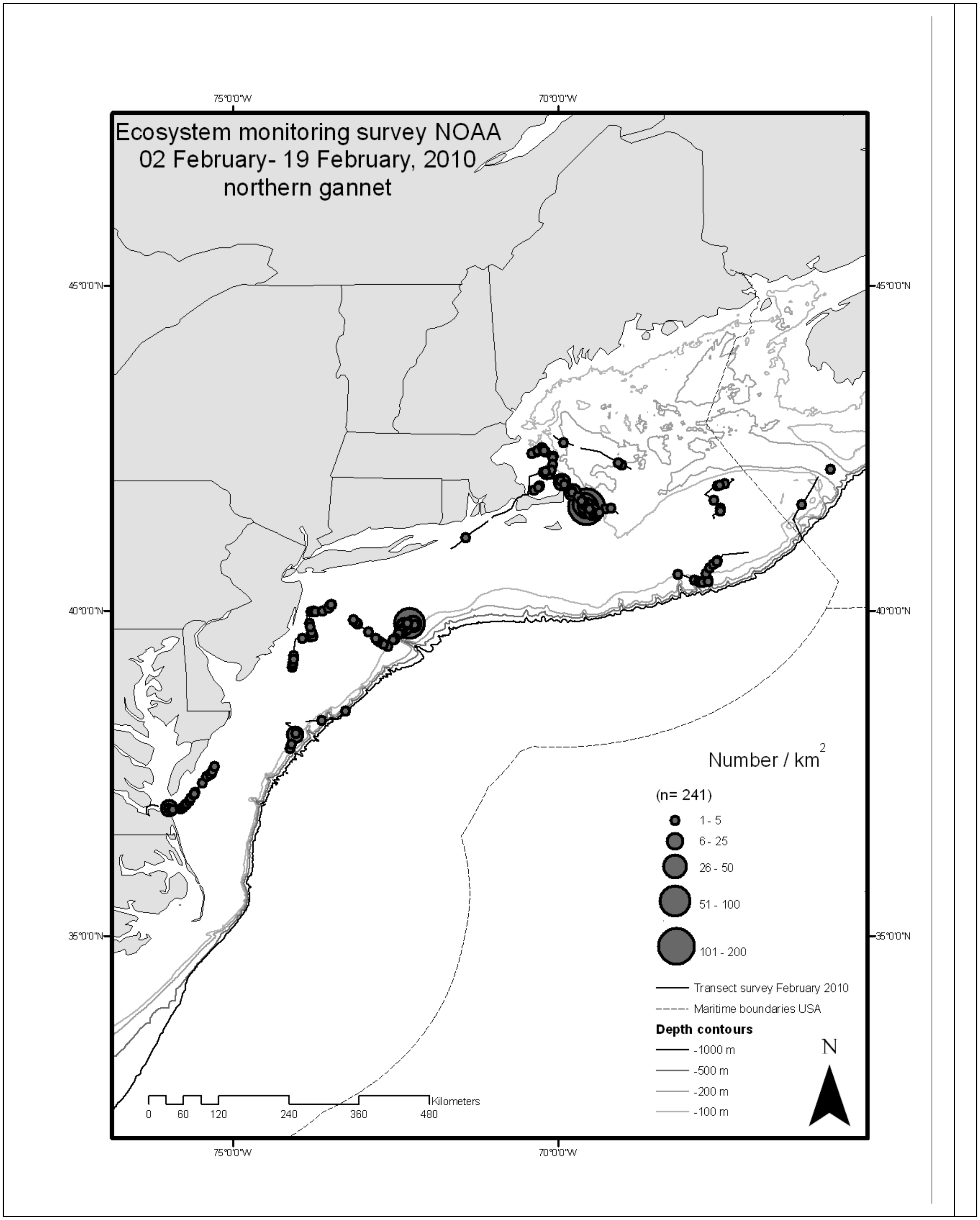
Veit, R.R. and P.A. Guris. 2009. Recent increases in alcid abundance in the New York Bight and New England Waters. **New Jersey Birds** 34: 83-87.

Veit, R.R., J.A. McGowan, D.G. Ainley, T.R. Wahl and P. Pyle. 1997. Apex predator declines ninety percent in association with changing oceanic climate. **Global Change Biology** 3: 23-28.

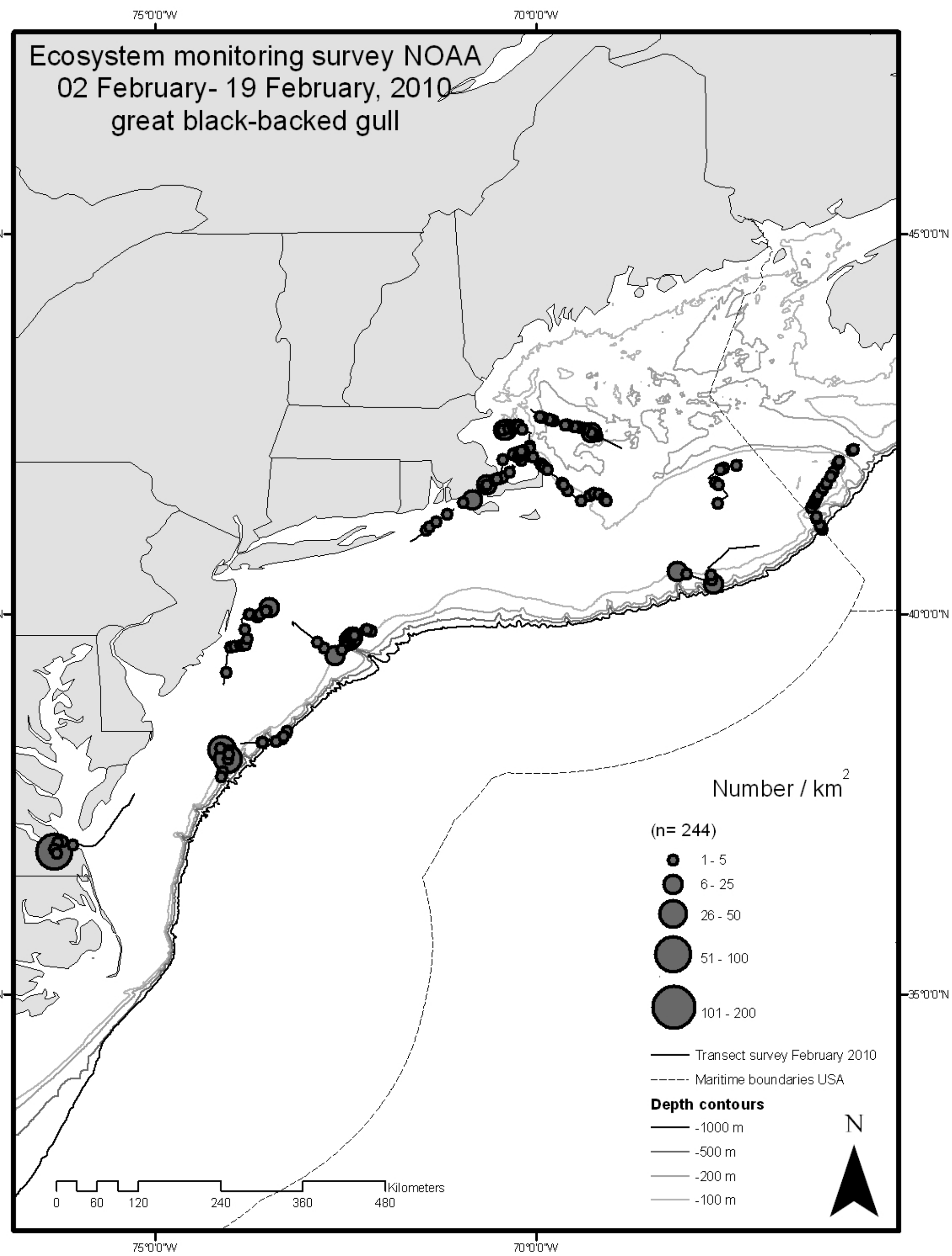
Volterra, V. 1926. Variazione fluttuazione del numero d'individui in specie animali conviventi. **Mem. Acad. Lincei**. 2: 31-113.

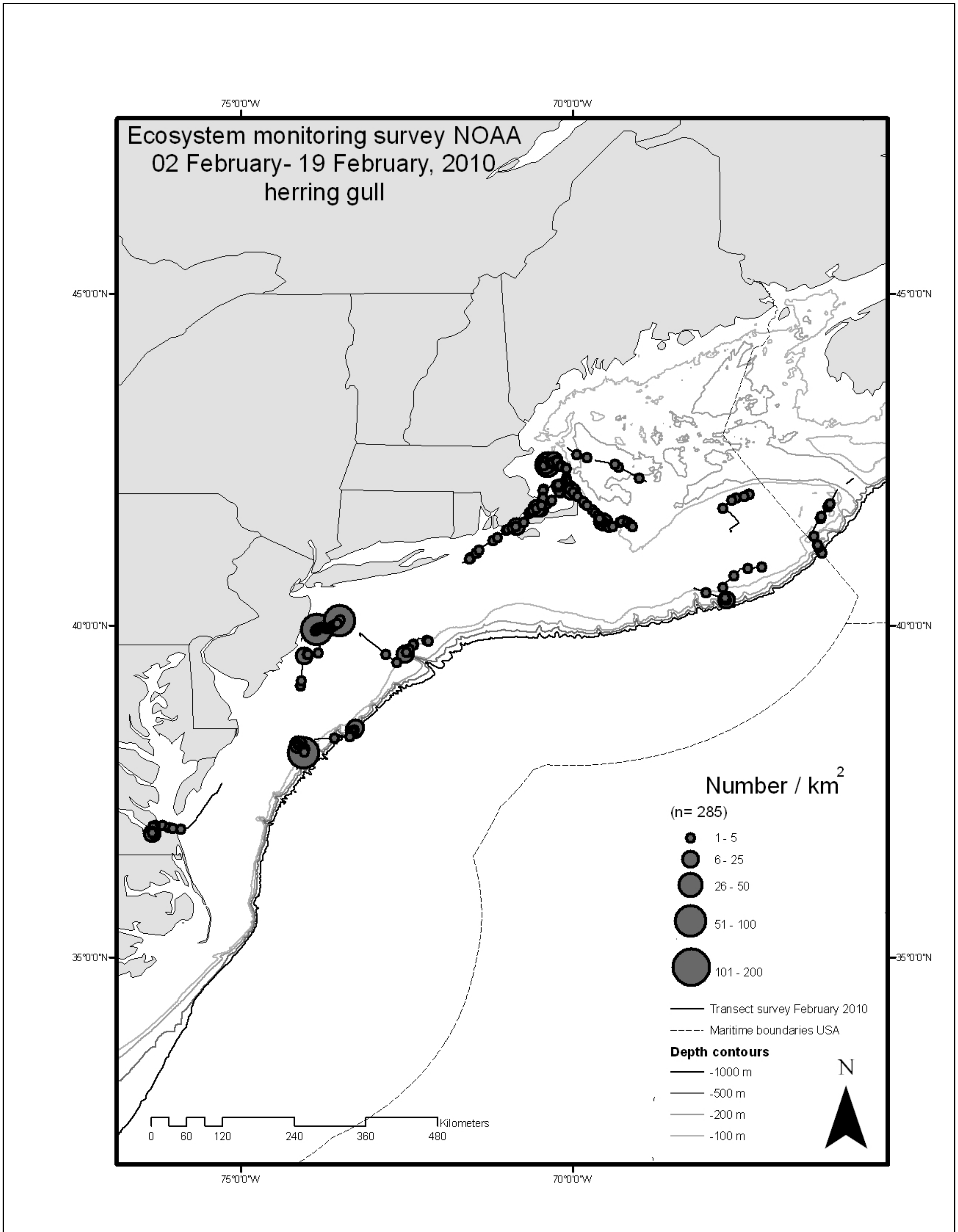
Appendix A. Distribution and Abundance Maps of Most Commonly Seen Species



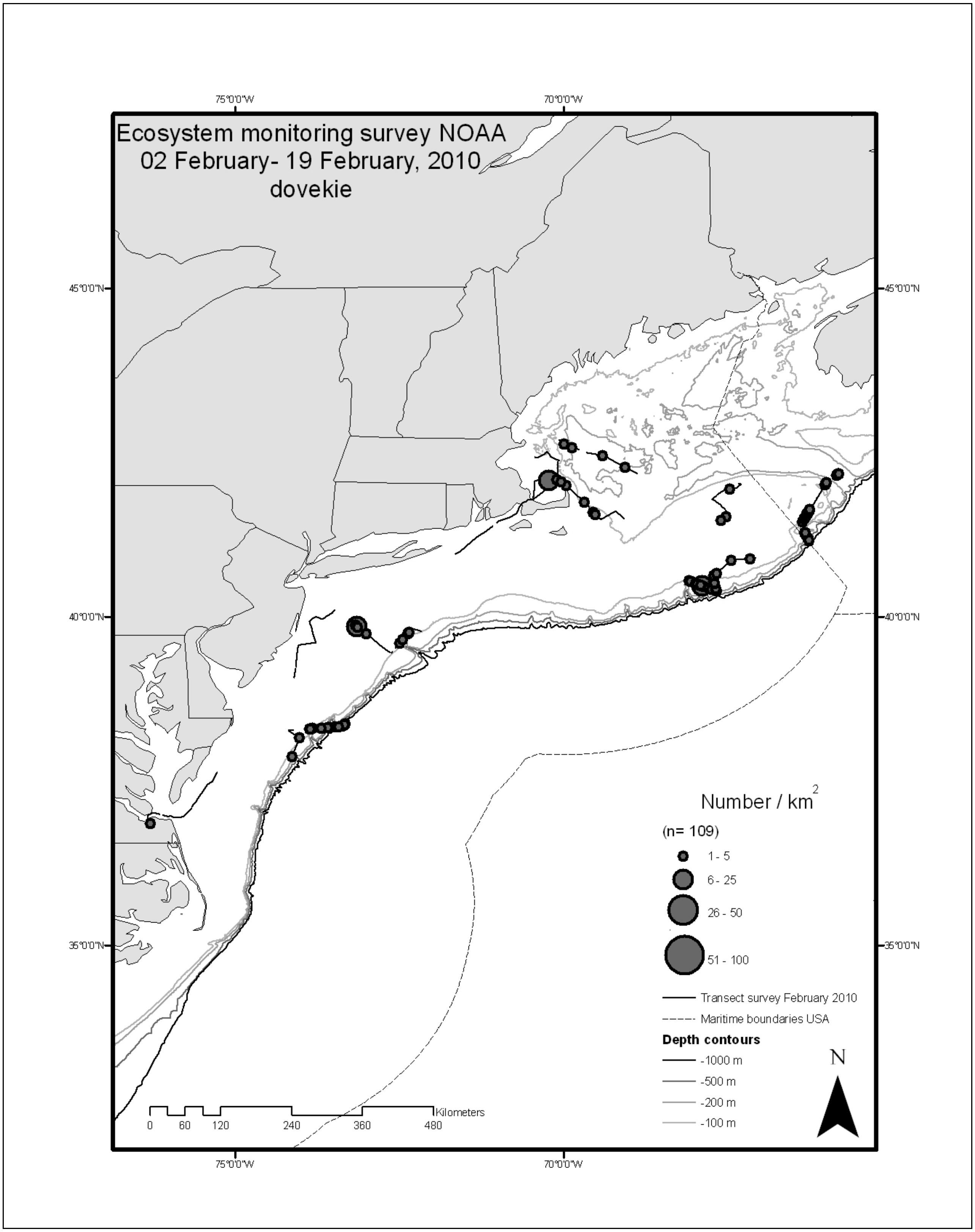


Ecosystem monitoring survey NOAA
02 February- 19 February, 2010
northern gannet
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 241)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect survey February 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0 60 120 240 360 480
Kilometers

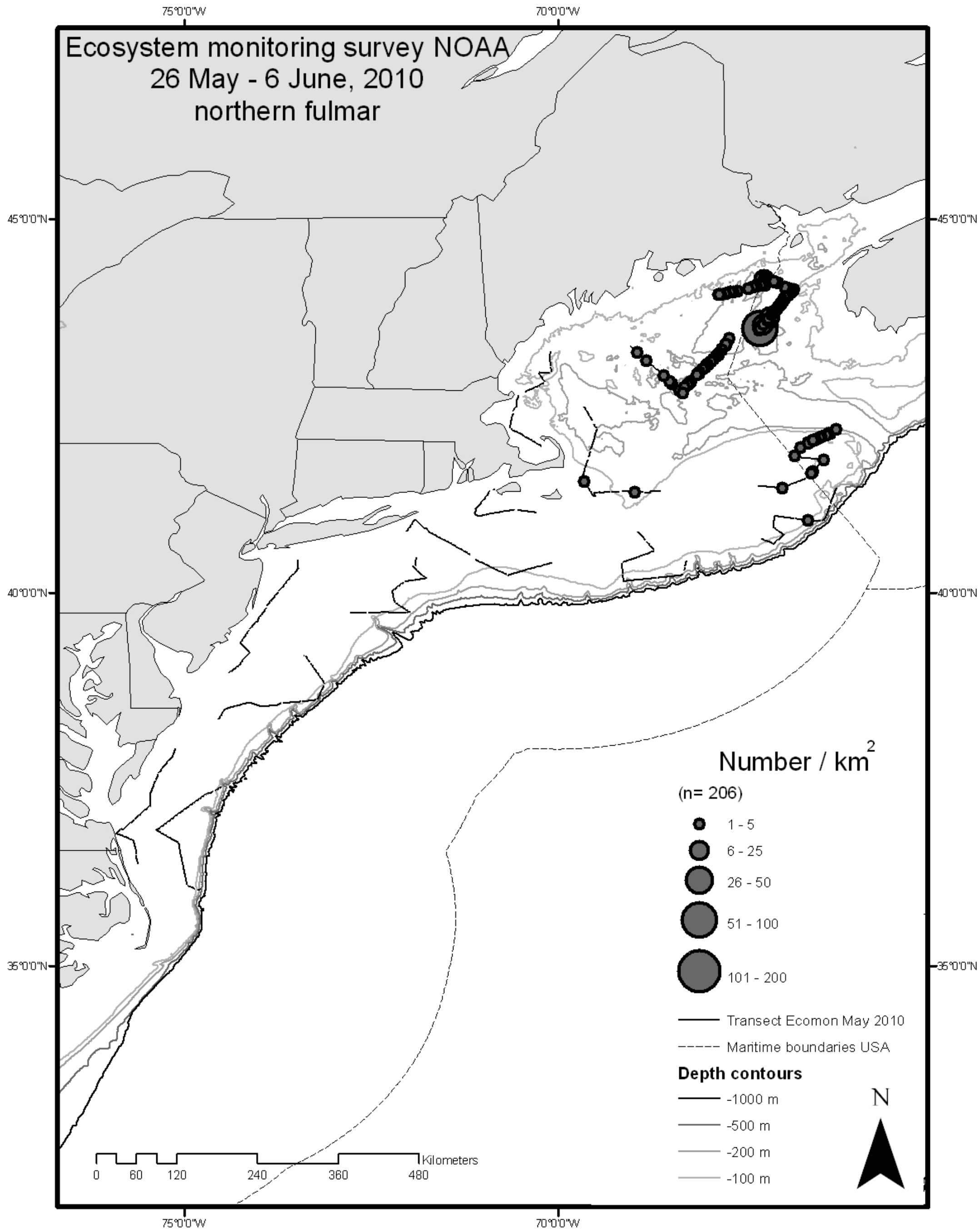

Ecosystem monitoring survey NOAA
02 February- 19 February, 2010
great black-backed gull
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 244)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect survey February 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers

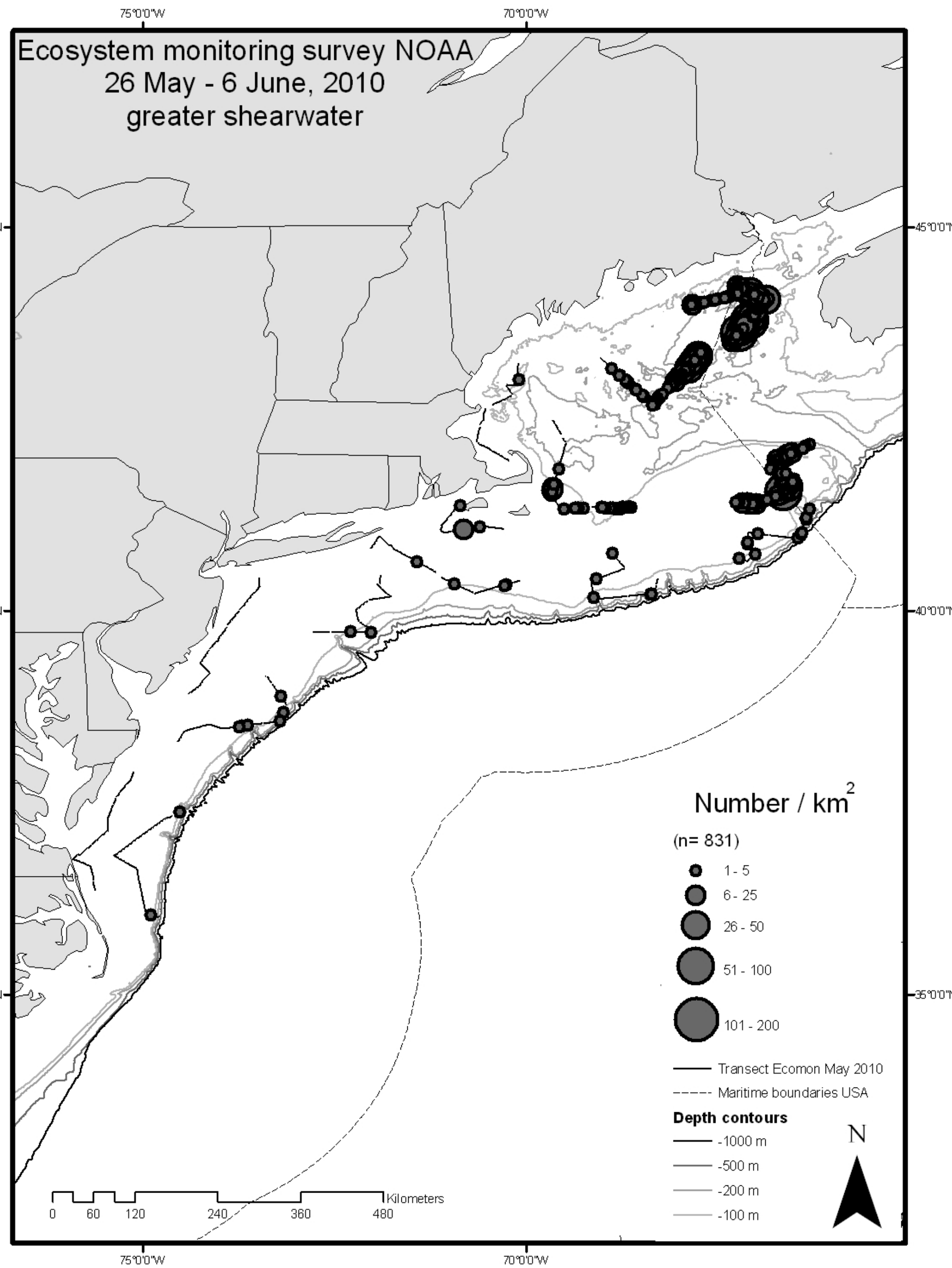


Ecosystem monitoring survey NOAA
02 February- 19 February, 2010
herring gull
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km²
(n= 285)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect survey February 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers

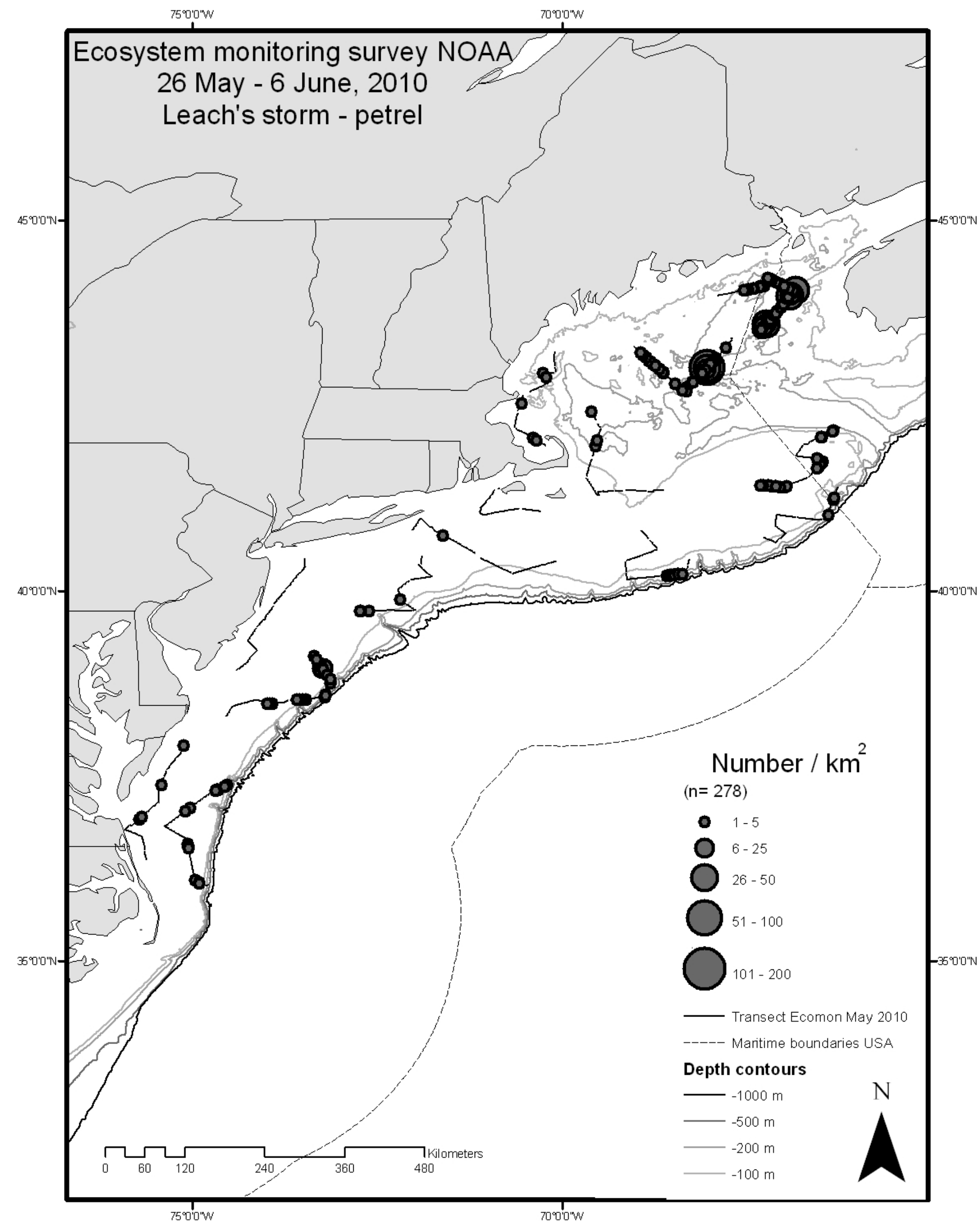


Ecosystem monitoring survey NOAA
02 February- 19 February, 2010
dovekie
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 109)
1 - 5
6 - 25
26 - 50
51 - 100
Transect survey February 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers

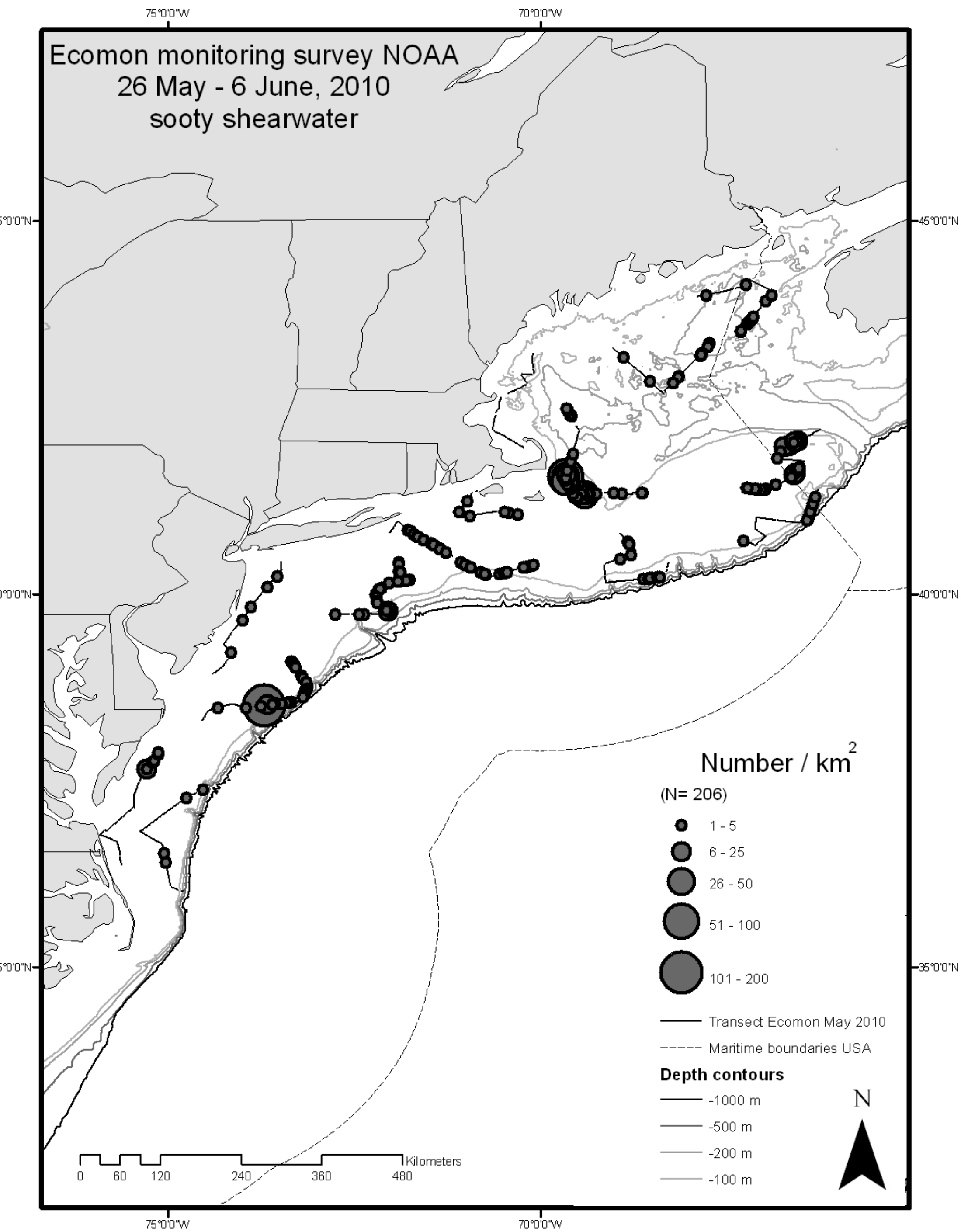

Ecosystem monitoring survey NOAA
26 May - 6 June, 2010
northern fulmar
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km²
(n= 206)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon May 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers

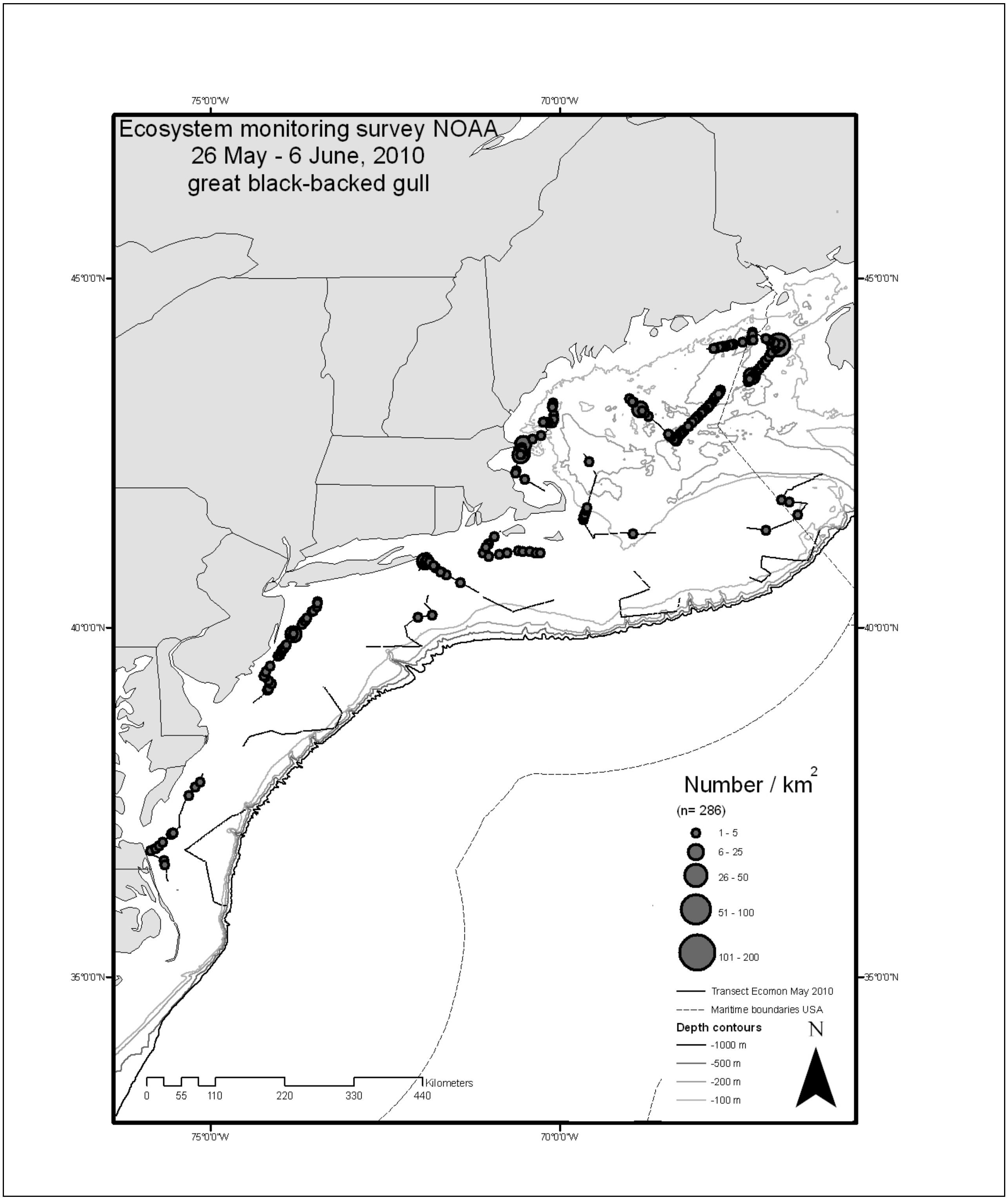


Ecosystem monitoring survey NOAA
26 May - 6 June, 2010
greater shearwater
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 831)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon May 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers

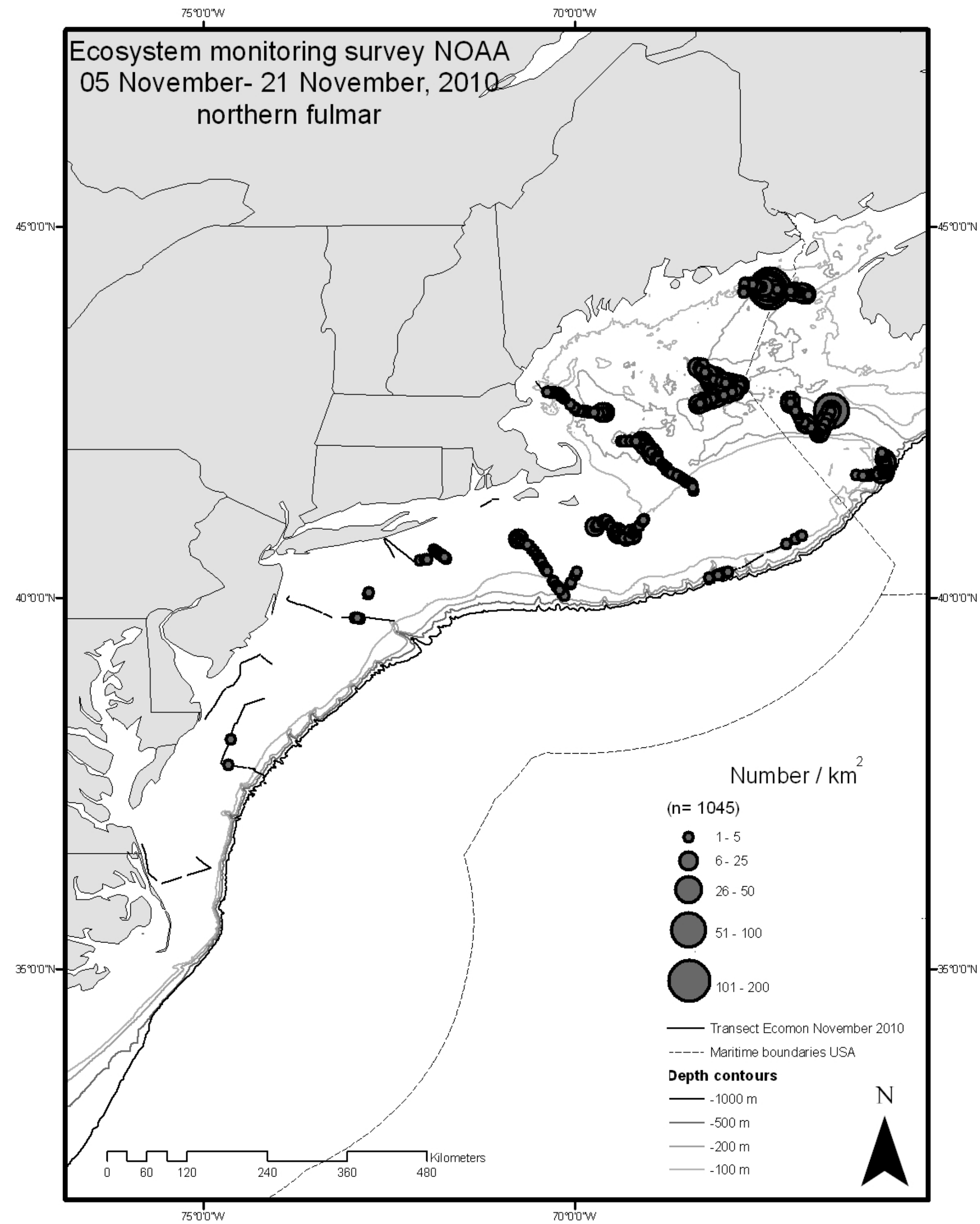


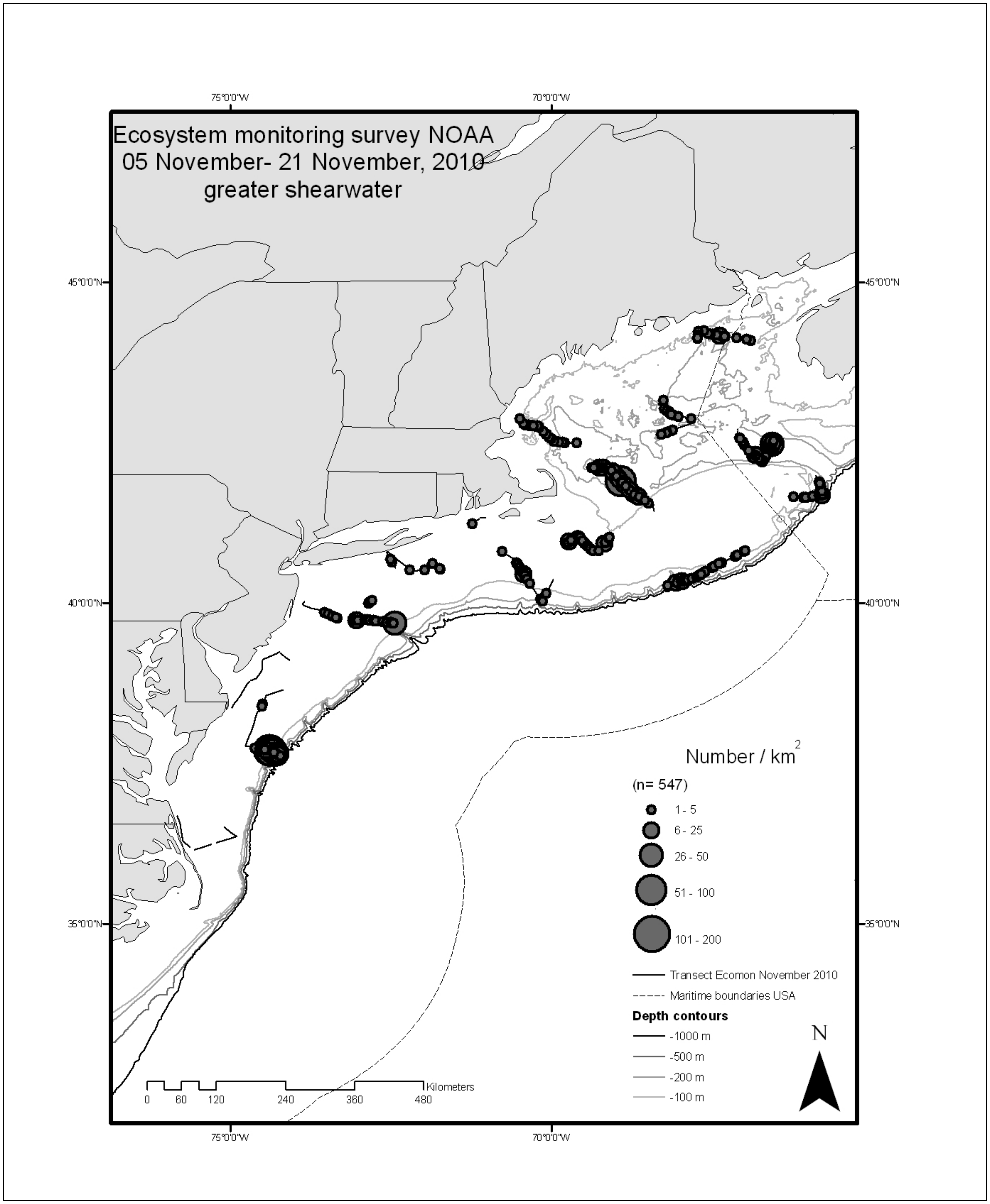
Ecosystem monitoring survey NOAA
26 May - 6 June, 2010
Leach's storm - petrel
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 278)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon May 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0 60 120 240 360 480
Kilometers


Ecomon monitoring survey NOAA
26 May - 6 June, 2010
sooty shearwater
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(N= 206)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon May 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers

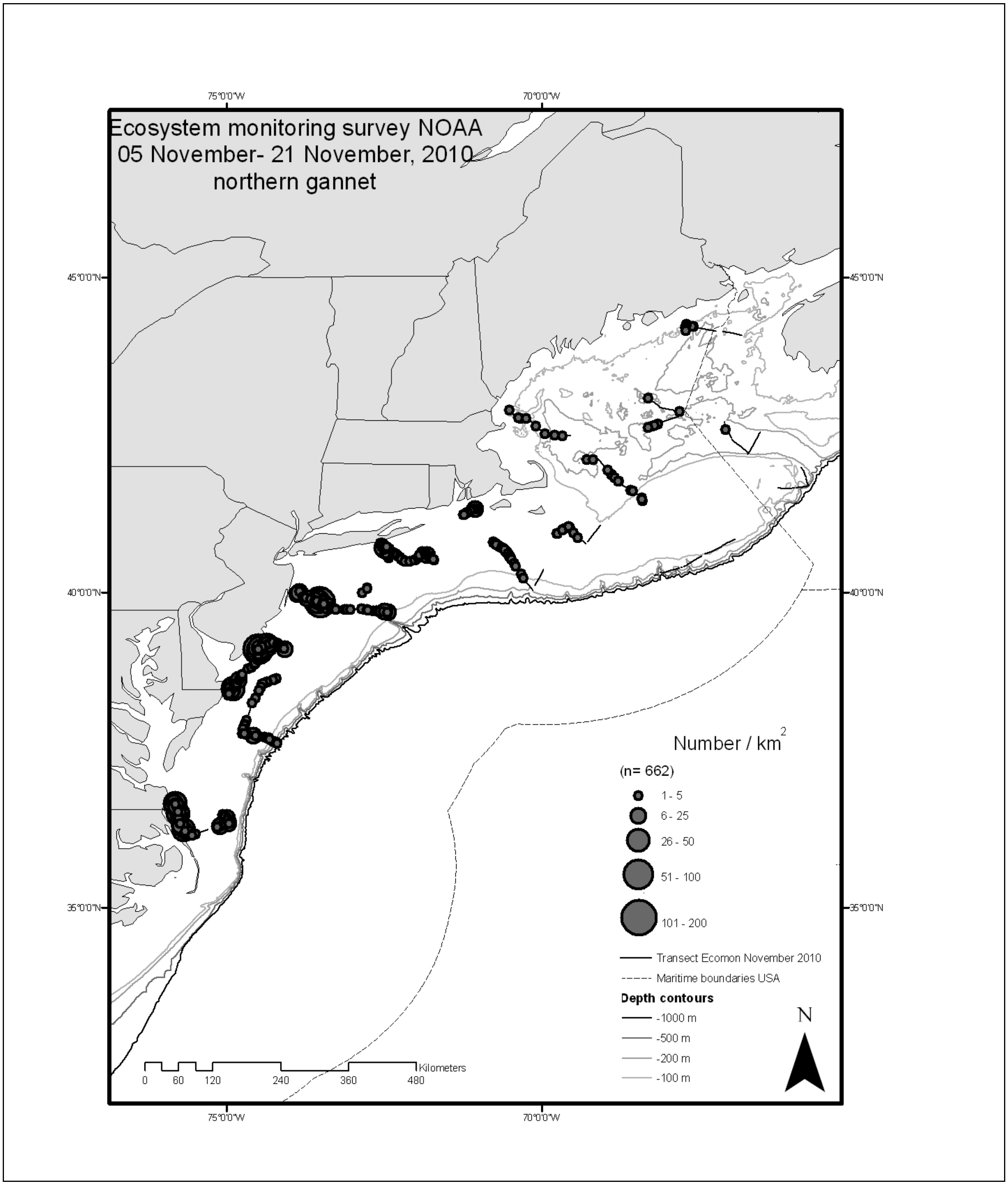


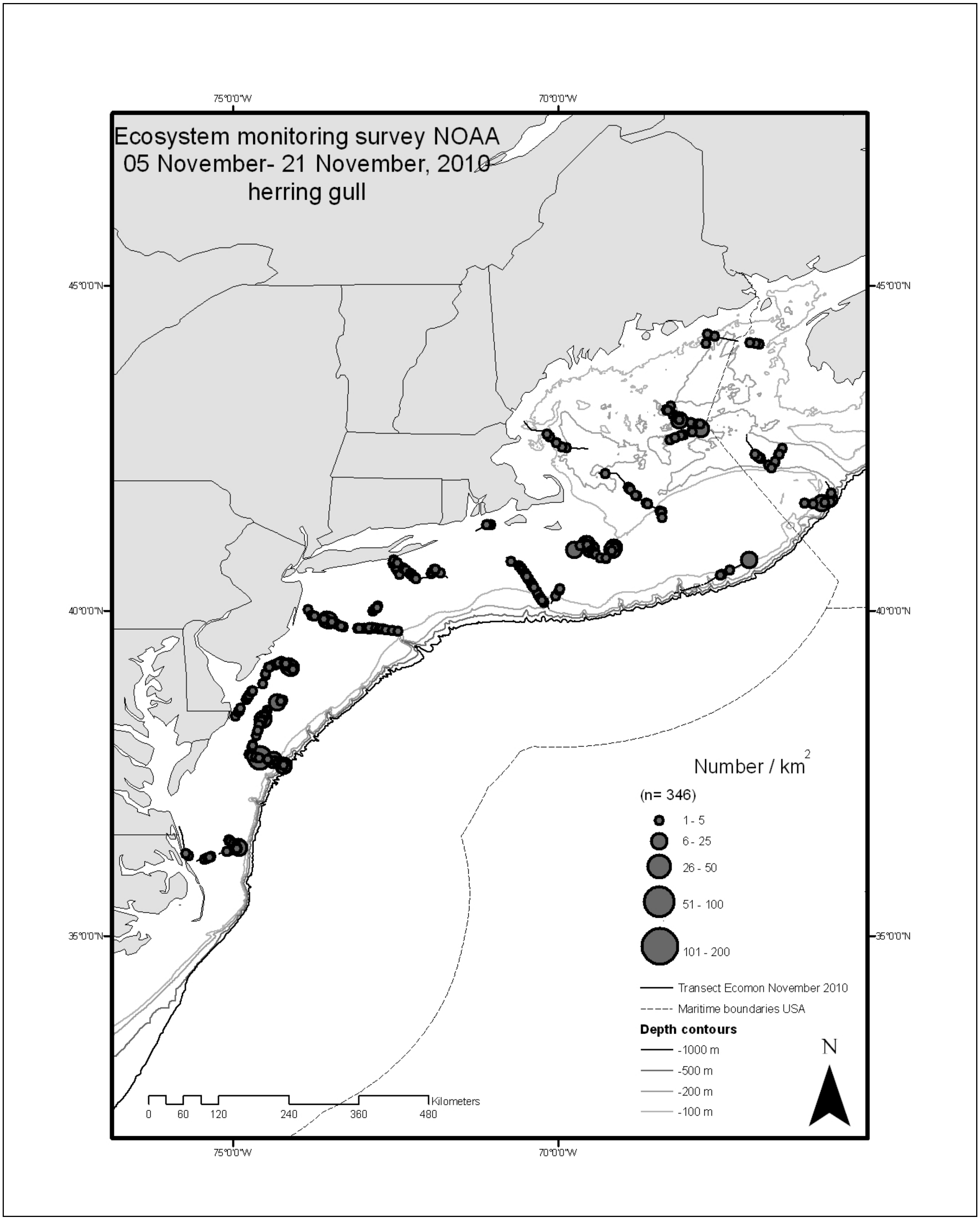
75°0'0"W
70°0'0"W
Ecosystem monitoring survey NOAA
26 May - 6 June, 2010
great black-backed gull
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 286)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon May 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
55
110
220
330
440
Kilometers


Ecosystem monitoring survey NOAA
05 November- 21 November, 2010
northern fulmar
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 1045)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon November 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0 60 120 240 360 480 Kilometers

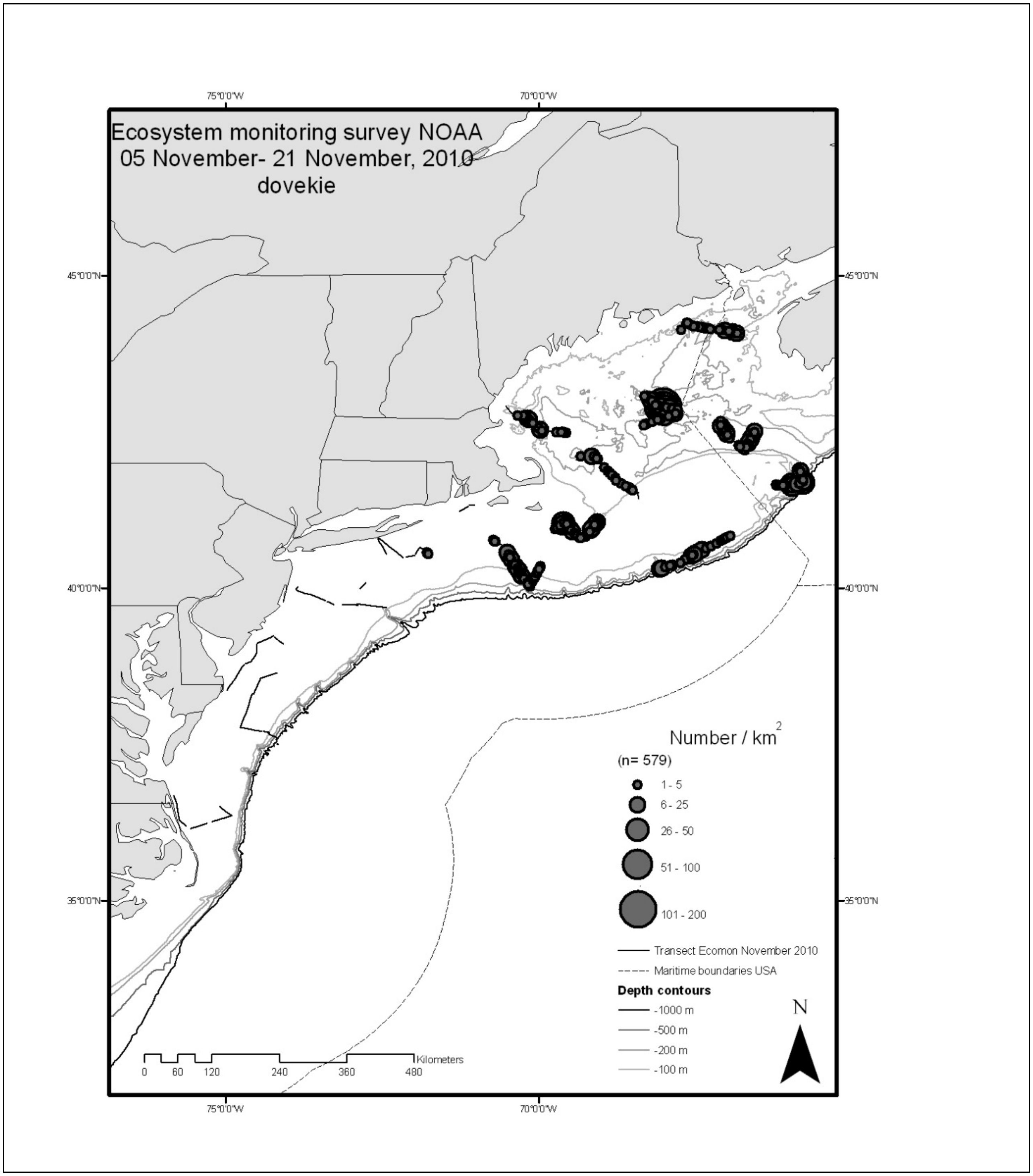


Ecosystem monitoring survey NOAA
05 November- 21 November, 2010
greater shearwater
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 547)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon November 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers


Ecosystem monitoring survey NOAA
05 November- 21 November, 2010
northern gannet
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 662)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon November 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers



Ecosystem monitoring survey NOAA
05 November- 21 November, 2010
herring gull
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km²
(n= 346)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon November 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0
60
120
240
360
480
Kilometers


Ecosystem monitoring survey NOAA
05 November- 21 November, 2010
dovekie
75°0'0"W
70°0'0"W
45°0'0"N
40°0'0"N
35°0'0"N
Number / km2
(n= 579)
1 - 5
6 - 25
26 - 50
51 - 100
101 - 200
Transect Ecomon November 2010
Maritime boundaries USA
Depth contours
-1000 m
-500 m
-200 m
-100 m
N
0 60 120 240 360 480
Kilometers

Appendix III

Pelagic Seabirds off the East Coast of the United States 2008-2011

Three-Year Report to Bureau of Ocean Energy Management

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Abstract: We collected data on distribution and abundance of seabirds on seventeen research cruises over the shelf waters of the eastern United States between August 2008 and January 2012. We had two primary research objectives. The first of these was to identify "Hotspots" of seabird abundance, where Hotspots are intended to represent those areas characterized by elevated abundance of seabirds that persist through time, either seasonally or interannually. Our second objective was to contrast estimates of abundance made by us in 2008-2012 to those made by surveys of similar areas during 1975-1990 by the Manomet Bird Observatory. Having this knowledge in hand will allow us to look at changes in abundances and have greater ability to determine the factors influencing these changes - such as changing climates, changing prey bases or the development of wind facilities.

Introduction

There is heightened interest in developing wind resources in the offshore waters of the Atlantic and therefore a need for information on the spatial and temporal movement and occupancy patterns of wildlife resources in offshore habitats. Agencies overseeing offshore permitting processes are investing resources in survey efforts to gather baseline information on the use of offshore habitats by marine resources to use for sighting offshore developments. Ships of Opportunity surveys, the results of which are the focus of this report, are one of a number of survey efforts underway to determine areas of significance to marine birds and other marine resources. Because of the dominance by wintering nonbreeders in the pelagic waters off the U.S. East Coast, shipboard surveys are one of the best ways to quantify abundance and measure its variability through time.

Our goal in this effort was to document areas of frequent use and aggregation by birds to inform planning of offshore developments. We identified seasonal distribution and abundance patterns, movement patterns, and habitat-abundance associations. We were also interested in the birds response to changes in climate and fisheries activities, and perhaps other unknown factors.

Our primary objective was to determine current seabird distribution and abundance from Maine to Cape Hatteras, North Carolina. A secondary objective was to determine whether changes in distribution and abundance have occurred relative to historic records. A tertiary objective was to assess whether changes, if they have occurred, might be attributed to climate change or fisheries.

Methods

This report presents the results of seventeen research cruises over the shelf waters of the eastern United States between August 2008 and January 2012, using NOAA research vessels as platforms from summer 2008 through fall 2011. The purpose of these surveys was to establish baseline data on the seasonal abundance and distribution of pelagic bird species which could be used for determining where to site potential offshore development, as well as to draw comparisons with seabird data collected in the 1970s and 1980s. Our sampling was limited to the continental shelf, which extends to about 100 nautical miles off the northeastern United States.

In 2011, we participated on 3 NOAA Ecomon cruises between February and November, and then a fourth in February 2012 (Table 1). All data are stored at the US Geological Survey's database in Patuxent, Maryland. We collected data on seabirds while the ship was underway during daylight hours. We discontinued sampling when the ship stopped to sample an oceanographic station. We used a combination of strip-transect and line-transects to quantify density. Our default method was to sample a 300 m wide strip transect situated on the side of the ship that offered the best visibility. When densities were not so high as to overwhelm the observer, we recorded distances and angles to all birds spotted, regardless of their distance from the ship (i.e. >> 300m). This ensured our ability to scale data collected within the 300 m strip on the basis of detectability of individual species of birds (Buckland et al. 2001).

Table 1. Cruises from which seabird data were collected in 2011-2012.

Cruise	Month /Year	Linear Distance Surveyed
EcoMon	February 2011	Cape Hatteras to the Gulf of Maine (1318 km)
EcoMon	August 2011	Cancelled by NOAA
Herring Acoustic	September 2011	Georges Bank and Jeffries Ledge
EcoMon	November 2011	Cape Hatteras to the Gulf of Maine (897 km)
Ecomon	February 2012	Cape Hatteras to the Gulf of Maine (1200 km)

Results

2011 Summary

We sampled three kinds of surveys: 1) Ecomon surveys, designed to monitor zooplankton on the continental shelf from Maine to Cape Hatteras, 2) Herring Acoustic surveys, designed to quantify spatial distribution of herring and their prey (copepods) using acoustics, on northern Georges Bank, and 3) a research cruise with Gareth Lawson and Peter Wiebe of the Woods Hole Oceanographic Institute designed to investigate the accumulation of zooplankton at hydrographic fronts on Georges Bank and surrounding waters. We present the data here from the Ecomon cruises.

Table 2. Densities of dominant species recorded in 2010 (birds/km²). Density estimates for 1970s-1980s (from Powers 1983) given *in italics* below each value.

	February 2010	**May 2010**	**August 2010**	**November 2010**
Northern Fulmar	2.4 *(7.5)*	1.6 *(3.8)*	0 *(0)*	**8.5** ***(1.5)***
Greater Shearwater	0 (0)	6.8 *(1.5)*	7.3 *(2.75)*	5.7 *(7.5)*
Wilson's Storm-petrel	0 *(0)*	4.4 *(6.0)*	3.9 *(8.0)*	1.59 *(0.5)*
Northern Gannet	1.4 *(1.0)*	0.28 *(1.75)*	0.29 *(0.25)*	**6.3** ***(1.25)***
Herring Gull	2.6 *(3.75)*	0.50 *(1.5)*	1.7 *(0.75)*	2.3 *(8.5)*
Dovekie	0.36 *(1.0)*	0.09 *(1.0)*	0 *(0)*	**8.1** ***(0)***

Three Year Summary

Hotspots

We searched for Hotspots of abundance of single species of seabirds and of seabird diversity (Santora et al. 2012, Santora et al. 2011, Santora and Veit 2013). We defined a Hotspot of abundance as any rectangle (1/4 degree of latitude, squared) that harbored an abundance larger than 2 standard deviations (s.d) above the mean of all such squares surveyed, on 50% or more of of the cruises on which that rectangle was visited. We identified Hotspots using this definition to take account of many areas in the ocean that harbor very high abundance of birds for a short, but predictable portion of the year. For example, tens of thousands of Northern Gannets commonly feed very close to shore off Avalon, Cape May and Sandy Hook New Jersey on Menhaden and probably other species of schooling fishes during both spring and fall. They often are only present at any one of these places for a few days or weeks; for this reason, a ranking of overall average abundance would fail to identify such a place as a Hotspot, even if it was indeed "Hot" for a small portion of the year. We wanted our metric to pick up these places that were persistently hot from year to year for the same species.

We also sought to identify locations that were characterized by persistently elevated diversity of seabirds. To identify the "diversity hotspots", we used the same basic logic as for abundance hotspots, but used species number as the unit of measure. Cells that 50% of the time harbored > 2 standard deviations above the overall mean for species number were labeled as diversity Hotspots. We conducted these calculations for the U.S. continental shelf between latitudes 40o and 45o N (From New York City north to the Canadian border).

We identified two primary Hotspots of abundance, one off southeastern Cape Cod and the other at the mouth of the Chesapeake Bay. These two areas were both Hotspots of abundance and species number; there was in addition a diversity hotspot off of northern New Jersey and in the New York Harbor area. All these Hotspots were heavily influenced by the abundance of sea ducks, terns, gulls and loons. That is, they were close enough to shore to record all these species, which do not occur in truly pelagic waters. This suggests that we need to recalculate Hotspots so as to be specific to habitats; we need, for example to identify what areas are hotspots for shearwaters and petrels, which do not appear in the areas identified as Hotspots above, except in small numbers. Apart from this issue, the Hotspots we identified are in accord with those identified by marine ornithologists in previous years (e.g. Powers 1983, Veit and Petersen 1993).

Changes in Abundance 1970s to Present

To compare recent (2008-2011) abundance to that 30 years ago (1975-1990) we summed bird abundance over the US continental shelf between Maine and Florida, with most effort concentrated in the Maryland-Maine sector (Figure 1). We partitioned the dataset to include the most heavily sampled areas; we thus used all cells north of 40° and south of 45°. Our conclusions about changes in abundance were the same within each partition.

We found that Northern Fulmars and Greater Shearwaters declined by roughly 50% during this time interval. These declines are likely due to changes in commercial fishing activity (Fogarty and Murawski 1998, Overholtz et al. 2000, Overholtz and Link 2007). During the late 1970's, the largest aggregations of seabirds off the eastern U.S. were associated with fleets of "factory trawlers" that fished silver hake and other groundfish around the perimeter of Georges Bank (Lear 1998). These fisheries were effectively excluded by the Magnuson Act in 1978, and the supply of discards for seabirds, especially shearwaters, fulmars and gannets, substantially declined. Adding to this decline was the collapse of the North Atlantic cod fishery in the 1990s and the consequent reduction in fishing and discards by the American fleets. These combined effects must have resulted in a reduced prey base for pelagic birds, especially those that scavenge at trawlers off the U.S, east Coast. Greater Shearwaters breed at Tristan da Cunha in the South Atlantic Ocean and Northern Fulmars in the Canadian arctic, and both are very difficult to census during the summer; at-sea censuses may be the most reliable indicators of population trends in these species (cf. gulls, below).

Gulls, especially Herring and Great Black-backed Gulls declined by 30-50% in the waters surveyed since the 1970s. This decline is in accord with changes noted in the breeding colonies in North America (Nisbet et al. 2011). The generally accepted explanation for the recent declines in these gull populations is the reduction in garbage available (due to changes in which the way garbage is dumped, with no "open" dumping) and the reduction in bycatch from trawlers and shore-based fishery processing facilities.

Northern Gannets increased in our area by about 30%, which roughly corresponds to increases in the Newfoundland and Quebec colonies during the same time period (Montevecchi and Myers 1999). The reasons for this increase are not entirely clear, but are partly related to changes in fish populations and in climate (Fogarty et al., Overholtz and Link). Interestingly, a shoreward shift in the distribution of gannets is clearly evident in our distributional maps. This indicates a shift from scavenging trawlers near the shelf break in the 1970s to more coastal foraging.

Wintering Razorbills and Dovekies both increased substantially within the US continental shelf since the 1970s. Razorbill breeding colonies between Maine and Newfoundland have increased during this same time period, in part due to the cessation of gill net fisheries around Newfoundland in the early 1990s (Regular et al. 2013), but their southward push in winter in recent years is related to (North Atlantic Oscillation (NAO; Hurrell et al. 2003) they move further south in NAO positive years (Veit and Manne ms). Dovekies nesting in underground burrows in the high arctic are almost impossible to census, but their numbers off the eastern USA have increased very dramatically since about 2000, and this increase is at least partly related to a series of strongly NAO-negative years.

Association with Tunas and Cetaceans

We (Goyert et al., ms) found significant spatial association among Common and Roseate Terns (Sterna hirundo and S. dougalii) and tunas (Thunnus albacares and T. thynnus) and dolphins (Delphinus delphis, Lagenorhynchus acutus) on Georges Bank and surrounding waters. This association is important to document for a number of reasons. First, terns, dolphins and tunas are either declining, Endangered or both, so if foraging by terns depends on tuna and dolphin abundance, fast and nonlinear declines could be caused by the decline of one component species within the association. Second, foraging by terns during the post-breeding season (July to September) is largely unknown so establishing their foraging needs at this time of year is important to their conservation. Third, the concepts of “facilitation” and “local enhancement” (Bruno et al. 2003, Stachowicz 2001), in which seabirds use seabirds and other marine animals such as mammals and fishes as cues to the location of prey, are emerging as important processes structuring marine systems, and knowledge of these processes will be important in the design of marine reserves.

Association with Prey

We took advantage of the NOAA herring surveys conducted in August-October at the northern edge of Georges Bank to both survey where terns are likely to feed during the post breeding period and to quantify the spatial relationship between foraging seabirds and their fish prey. Spawning herring tend to aggregate at depths of 100m or more (M. Jech, pers comm) and nonspawning herring plus other fishes are likely to be present in these same areas. Using both echosounders and nets to sample fish, we found significant spatial association between foraging gannets and schools of herring (Martin 2012).

We also collected acoustic data using the ADCP (Acoustic Doppler Current Profiler) on all Delaware II cruises after Fall 2010. These will be available to integrate with bird data collected simultaneously once transcribed which we expect to be completed by May 2013.

References

Bruno, J.F., J.J. Stachowicz, and M.D. Bertness. 2003. Inclusion of facilitation into ecological theory. Trends in Ecology and Evolution 18: 119-125.

Fogarty, M.J. and S.A. Murawski. 1998. Large-scale disturbance and the structure of marine systems: fishery impacts on Georges Bank. Ecological Applications S(1) Supplement: S6-S22.

Hurrell, J.W., Y. Kushmir, G. Ottersen, and M. Visbeck (eds). 2003. The North Atlantic Oscillation: Climatic significance and Environmental Impact. American Geophysical Union, Washington, D.C. 279 pp.

Lear, W.H. 1998. History of fisheries in the Northwest Atlantic: the 500 year perspective. Journal of Northwest Atlantic Fisheries Science 23: 41-73.

Martin, M.C. 2012. Habitat association and spatial distribution of procellariiform seabirds along the northeast continental shelf of the United States: Relation to prey and other top predators. Unpublished PhD thesis.

Overholtz, W.J., J.S. Link and L.E. Suslowicz. 2000. Consumption of important pelagic fish and squid by predatory fish in the northeastern USA shelf ecosystem with some fishery comparisons. ICES J. Marine Science 57: 1147-1159.

Overholtz, W.J. and J.S. Link. 2007. Consumption impacts by marine mammals, fish and seabirds on the Gulf of Maine- Georges Bank Atlantic herring (*Clupea harengus*) complex during the years 1977-2002. ICES J. Marine Science 64: 83-96.

Powers, K.D. 1983. Pelagic Distributions of Marine Birds Off the Northeastern United States. NOAA technical Memorandum NMFS-F/NEC-27

Regular, P., W. Montevecchi, A. Hedd, G. Robertson, and S. Wilhelm. 2013. Canadian fishery closures provide a large-scale test of the impact of gillnet bycatch on seabird populations. Biology letters 9 (4), 20130088.

Santora, J.A., S. Ralston and W.J. Sydeman. 2011. Spatial organization of krill and seabirds in the Central California Current. ICES Journal of Marine Science (2011), 68(7), 1391–1402. doi:10.1093/icesjms/fsr046

Santora, J.A., W.J. Sydeman, I.D. Schroeder, C.S. Reiss, B.K. Wells, J.C. Field, A.M. Cossio and V.J. Loeb. 2012. ICES Journal of Marine Science; doi:10.1093/icesjms/fss048

Santora, J.A. and R.R. Veit. 2013. Spatio-temporal persistence of top predator hotspots near the Antarctic Peninsula. Marine Ecology Progress Series 487: 287-304.

Shealer, D.A. 2001. Foraging behavior and food of seabirds. Pages 137-177. In E.A. Shreiber and J. Burger, Eds.. Biology of Marine Birds. CRC Marine Biology Series, CRC Press, New York,

Stachowicz, J.J. 2001. Mutualism, facilitation and structure of ecological communities. Bioscience 51: 235-246.

Veit, R.R. and L.L. Manne. ms. Interannual variability of alcids wintering off southern New England and relation to the North Atlantic Oscillation.

Veit, R.R. and W.R. Petersen. 1993. Birds of Massachusetts. Massachusetts Audubon Society, Lincoln, MA.

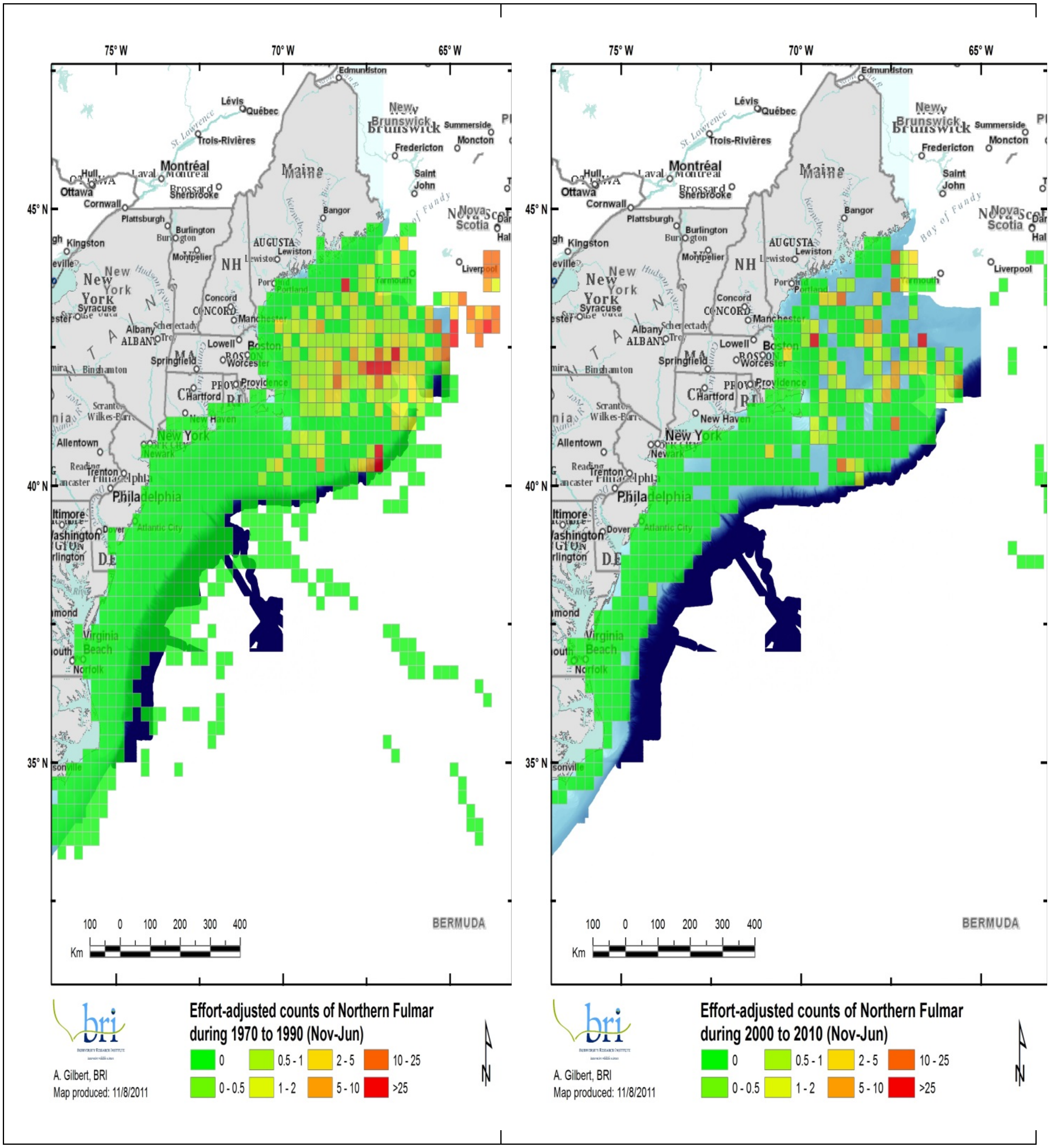


Figure 1. Comparison of Northern Fulmars between 1970-1990 (left) and 2000-2010 (right).

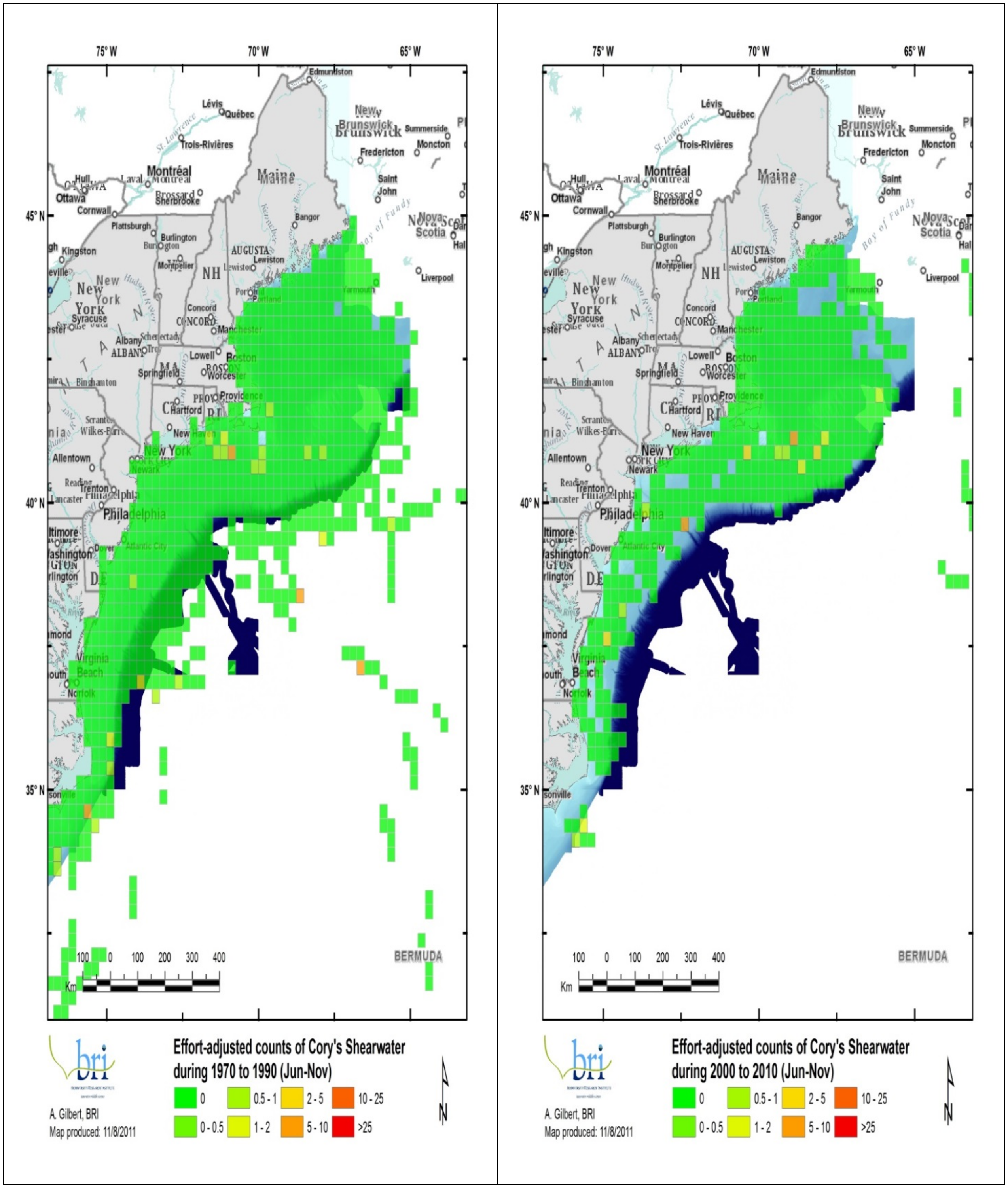


Figure 2. Comparison of Cory’s Shearwater abundance, 1970-1990 (right) and 2000-2010 (right).

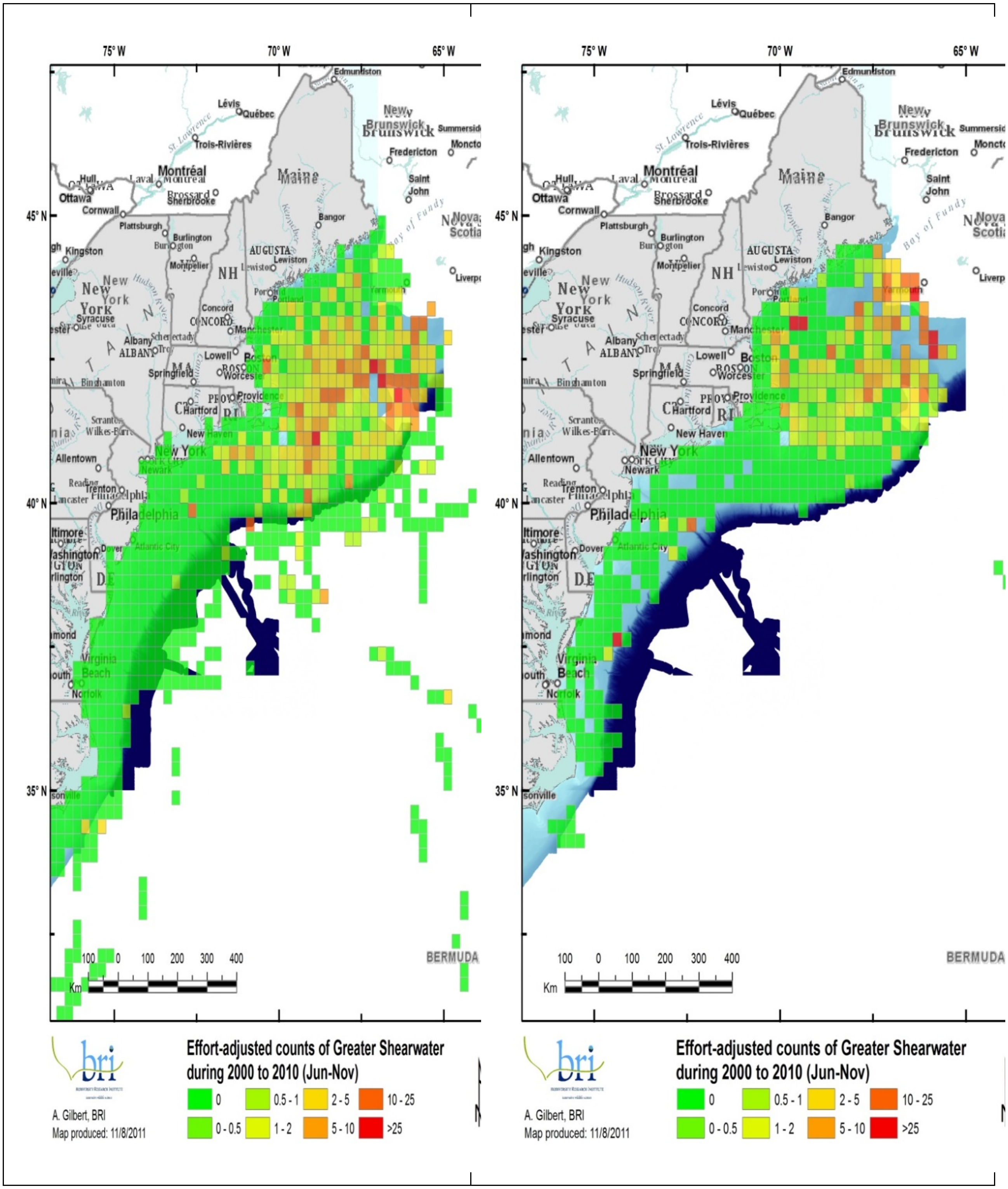


Figure 3. Comparison of Great Shearwater abundance 1970-1990 (left) and 2000-2010 (right).

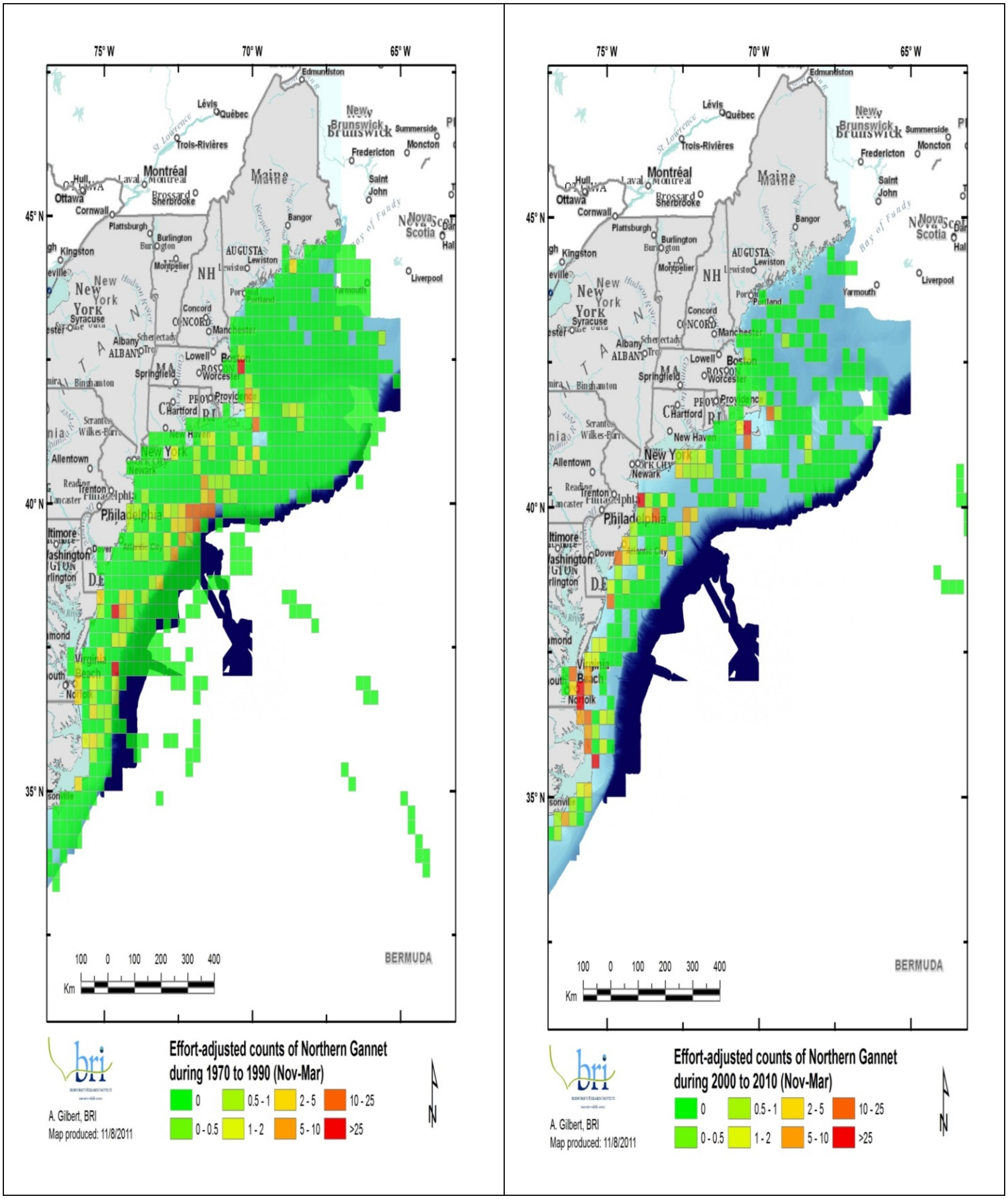


Figure 4. Comparison of Northern Gannet abundance 1970-1990 (left) and 2000-2010 (right).

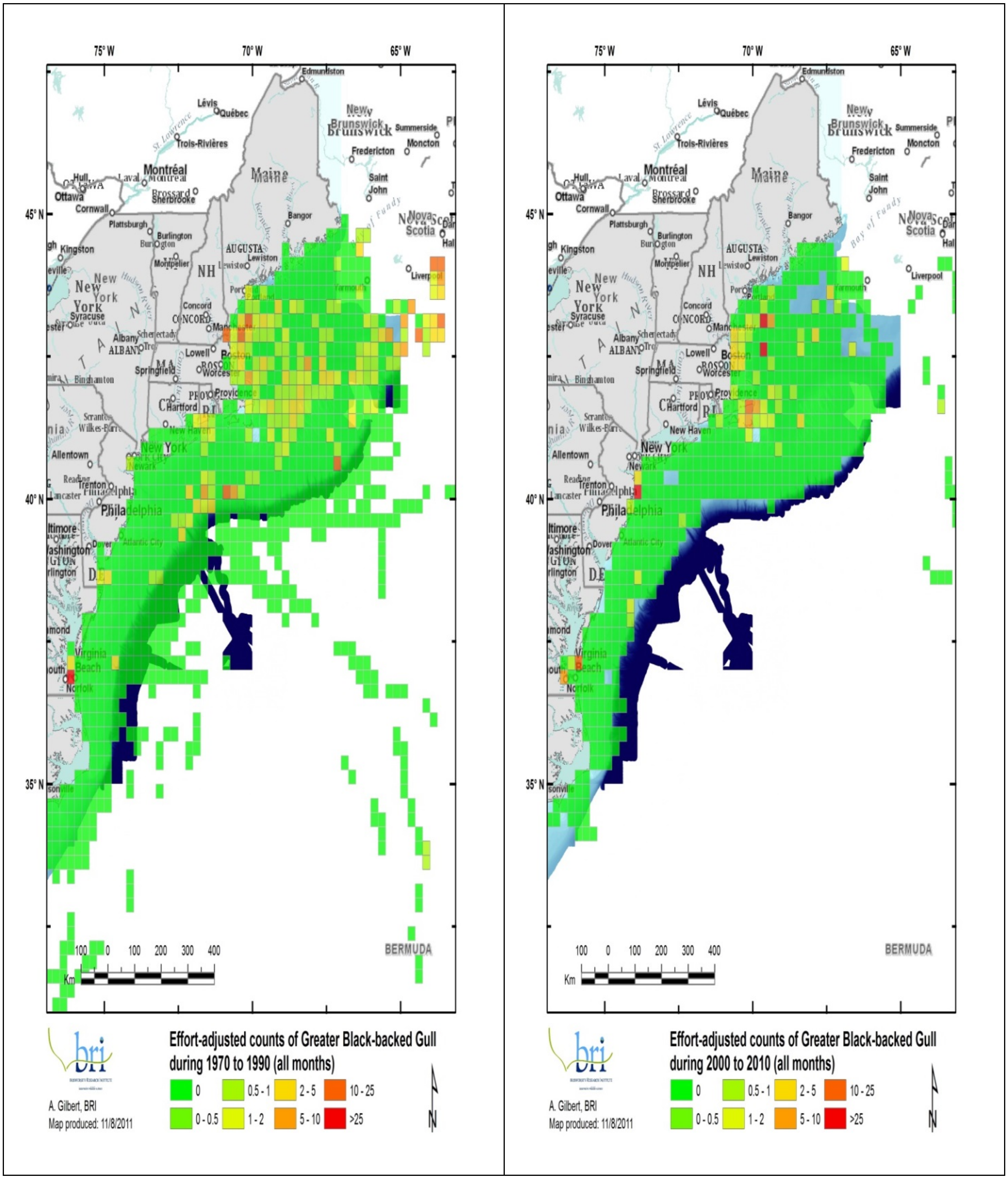


Figure 5. Comparison of Great Black-backed Gull abundance 1970-1990 (left) and 2000-2010 (right).

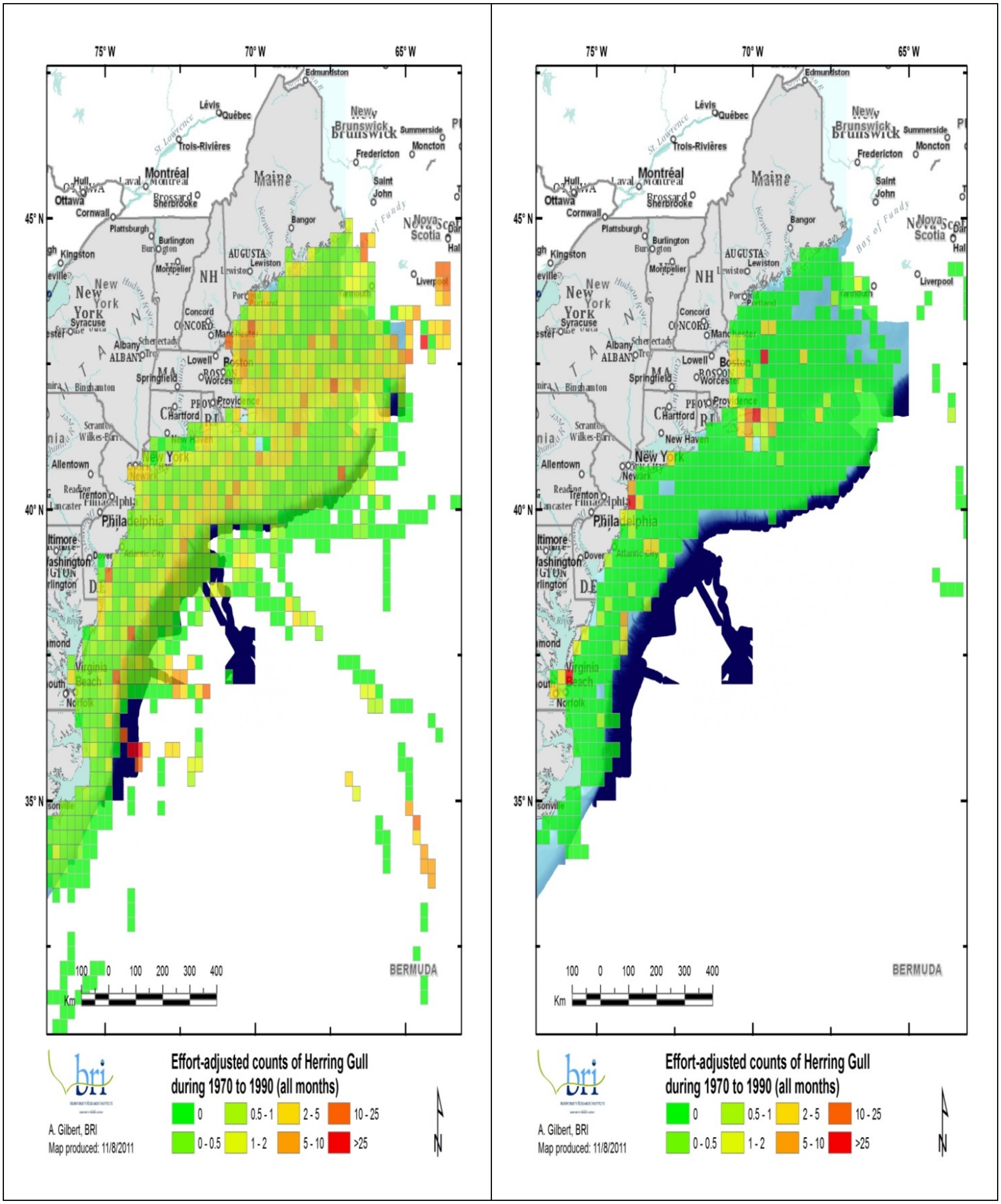


Figure 6. Comparison of Herring Gull abundance 1970-1990 (left) and 2000-2010 (right).

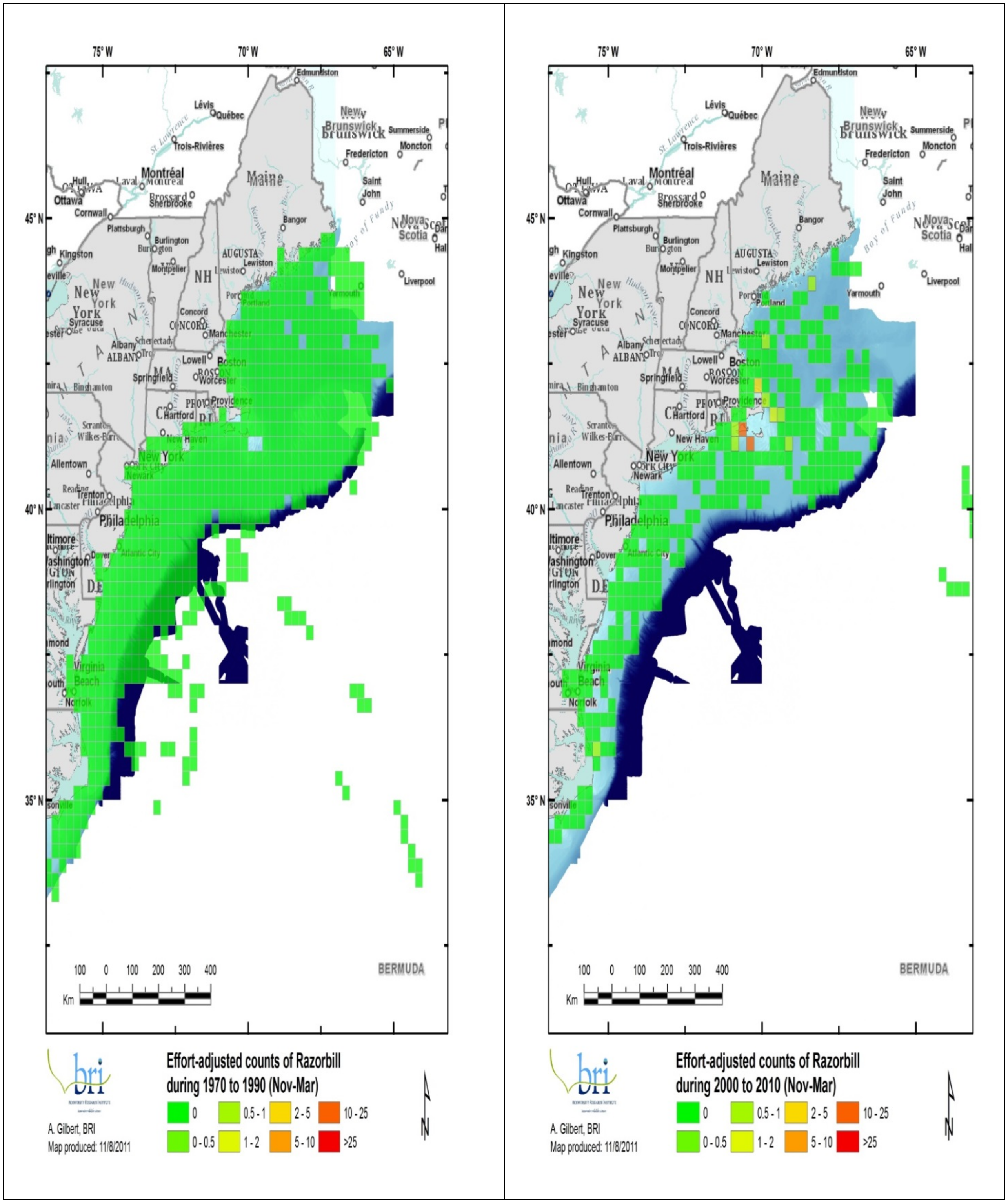


Figure 7. Comparison of Razorbill abundance 1970-1990 (left) and 2000-2010 (right).

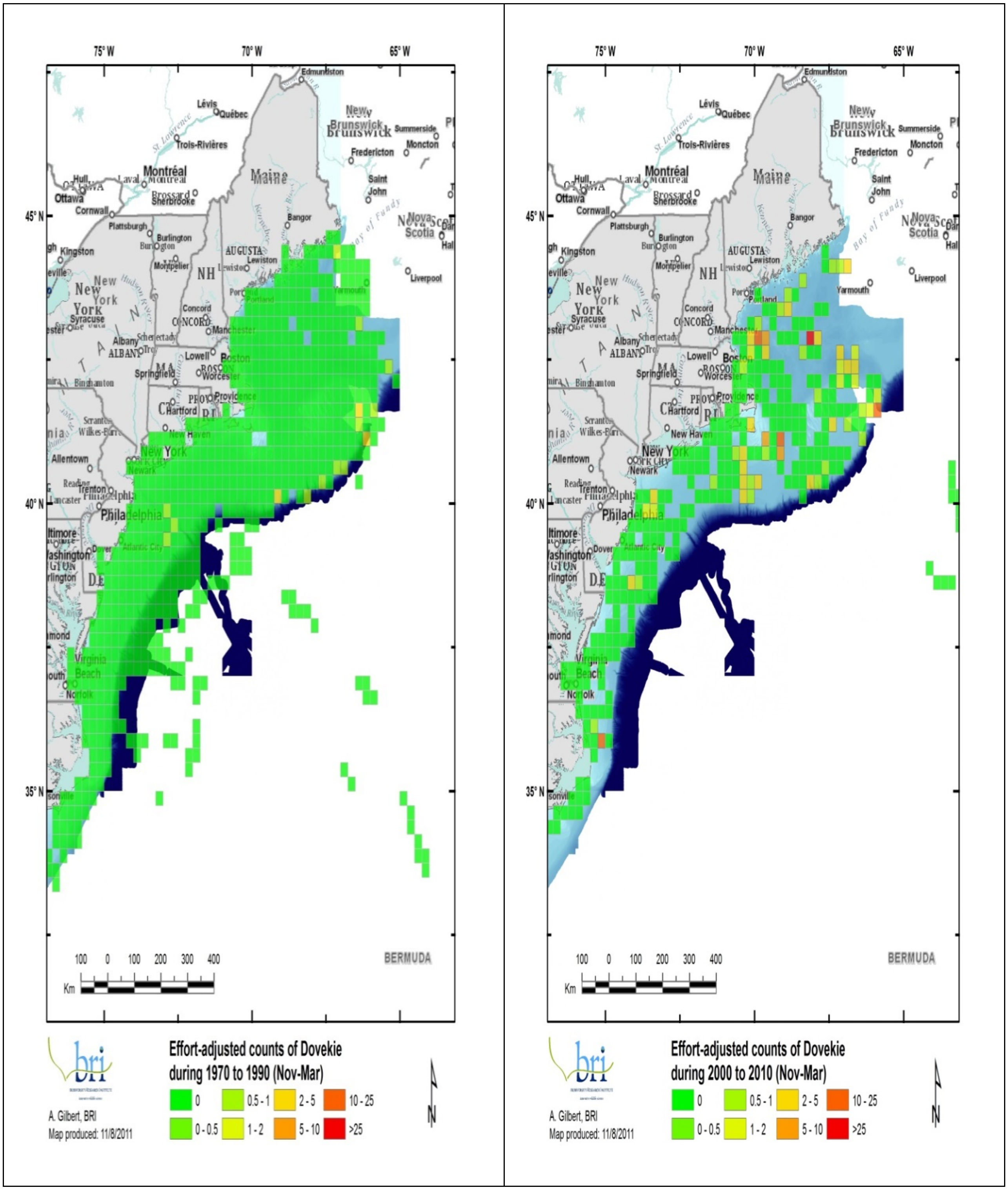


Figure 8. Comparison of Dovekie abundance 1970-1990 (left) and 2000-2010 (right).

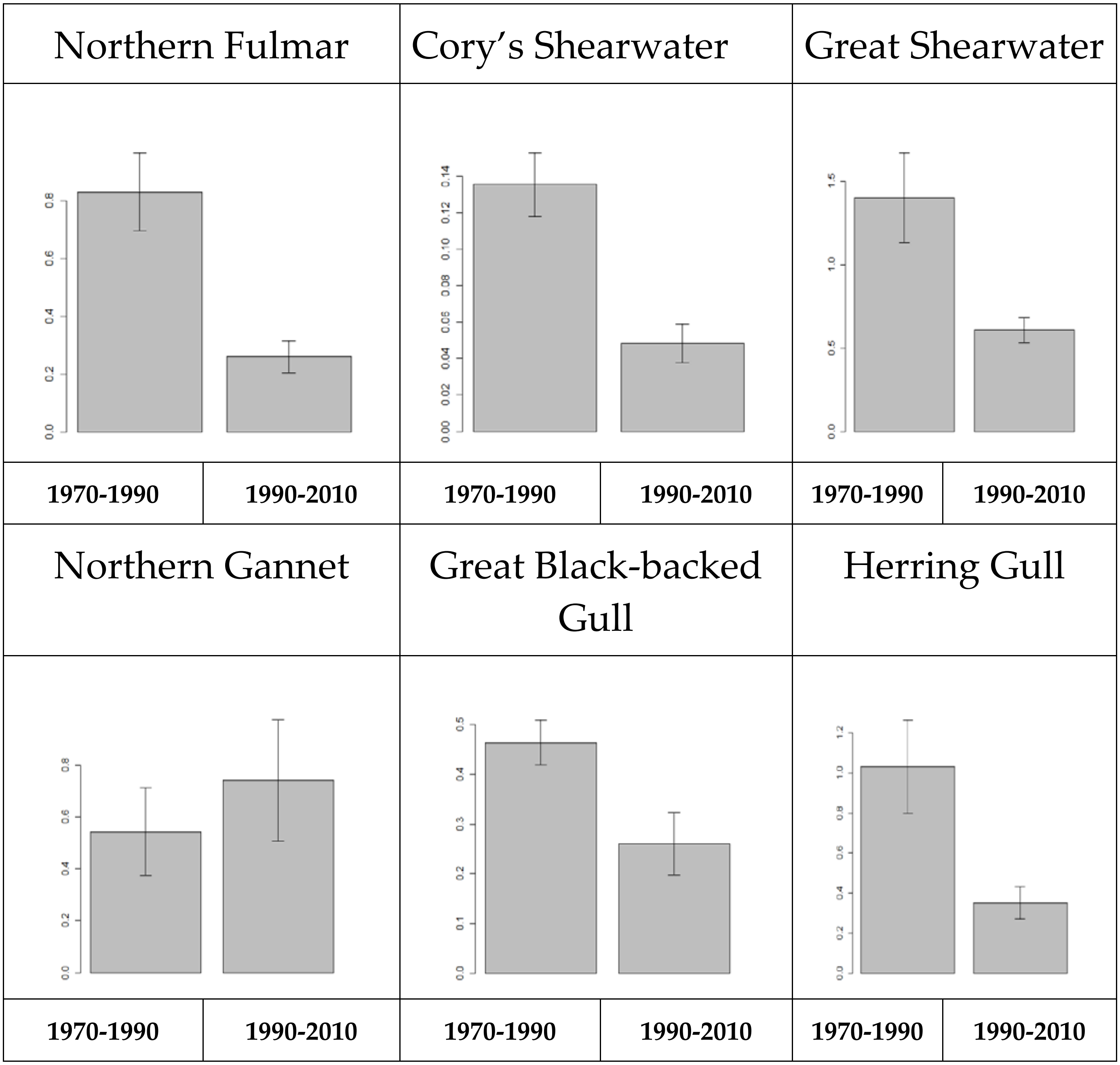


Figure 9. Comparisons of seabird abundance 1970-1990 to 2000-2010.

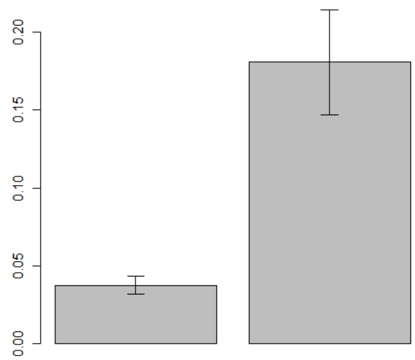
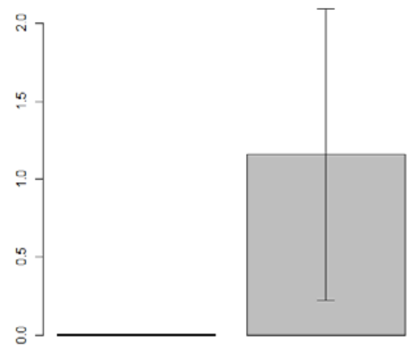
Dovekie		Razorbill	
			
1970-1990	1990-2010	1970-1990	1990-2010

Figure 9a. Comparsions of seabird abundance 1970-1990 vs 2000-2010, continued. Means +/- 1 sd.

Appendix 1. Cruise maps left out of earlier reports. Ecomon Cruise 1-11 February 2011.

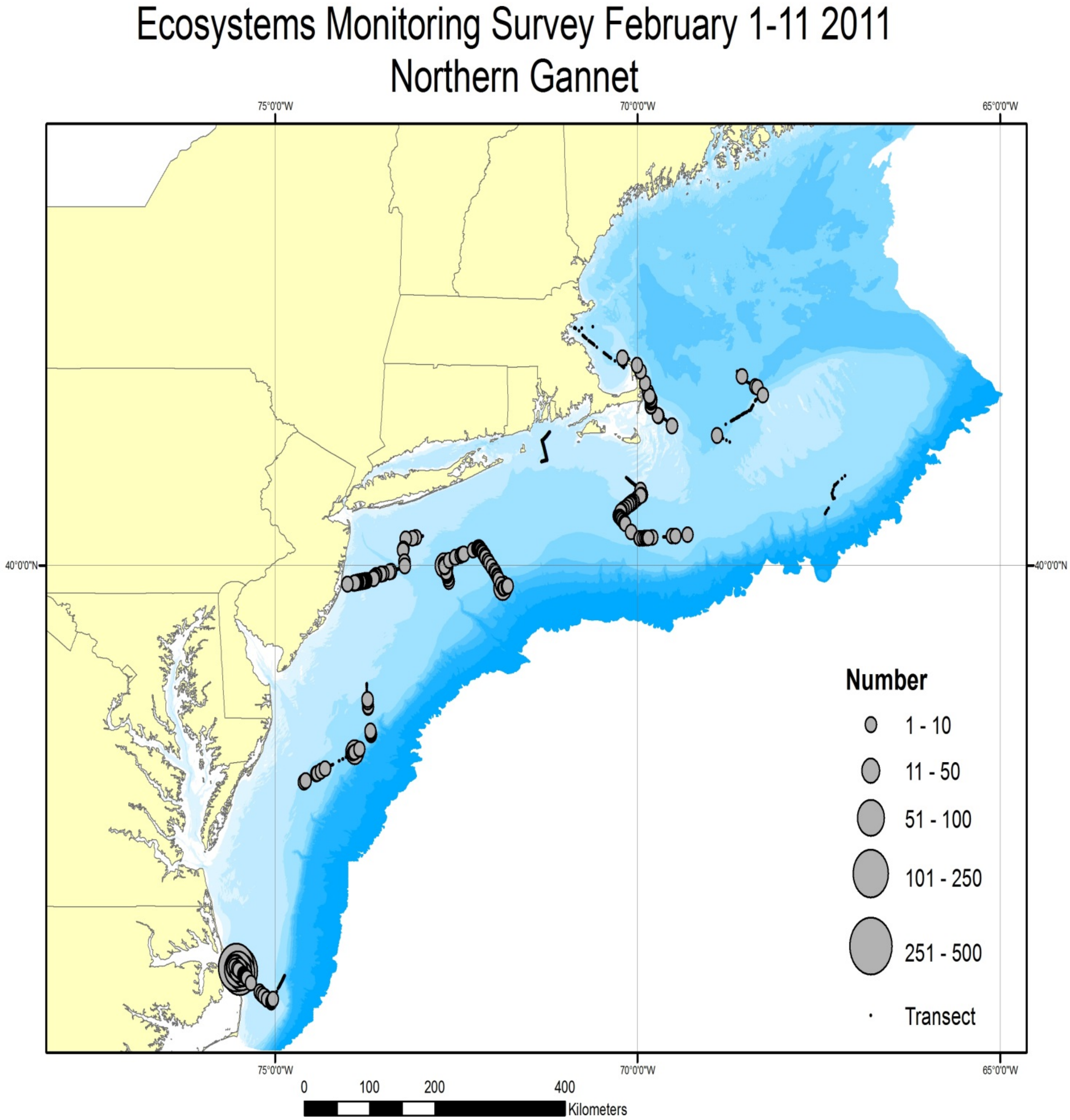


Figure A1. Distribution of Northern Gannets February 2011. Note concentration at Cape Hatteras.

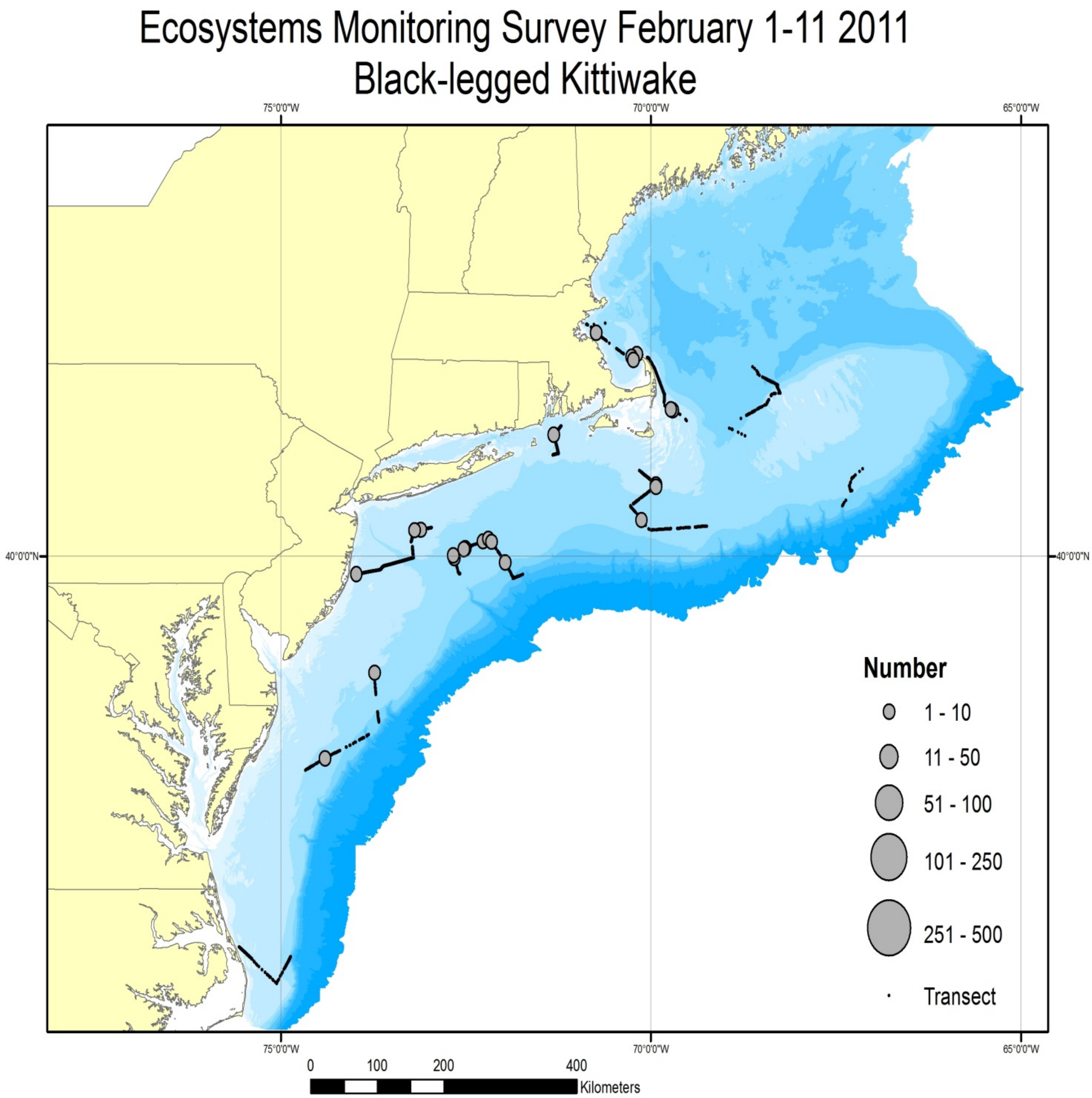


Figure A2. Distribution of Black-legged Kittiwakes February 2011.

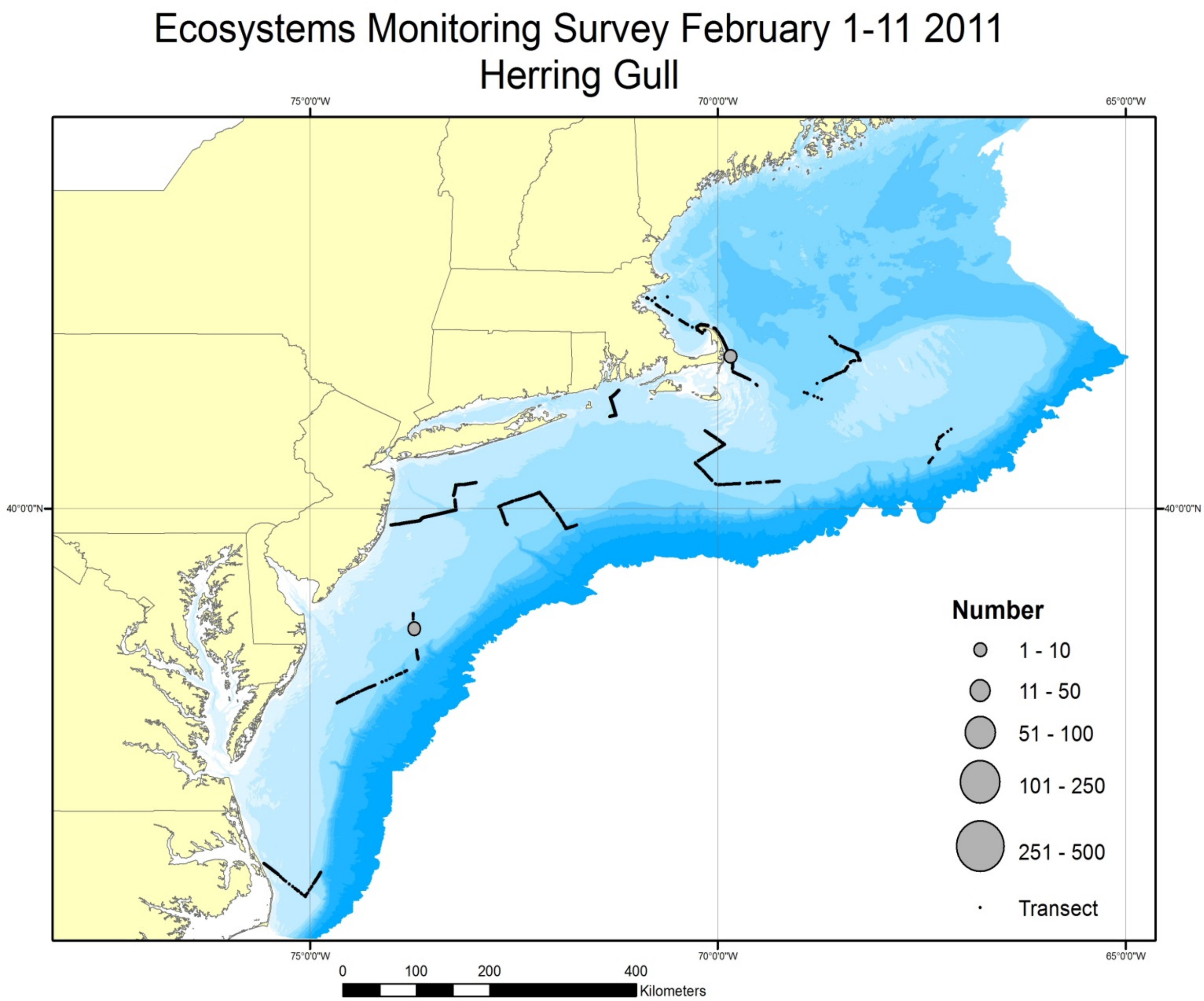


Figure A3. Distribution of Herring Gulls February 2011.

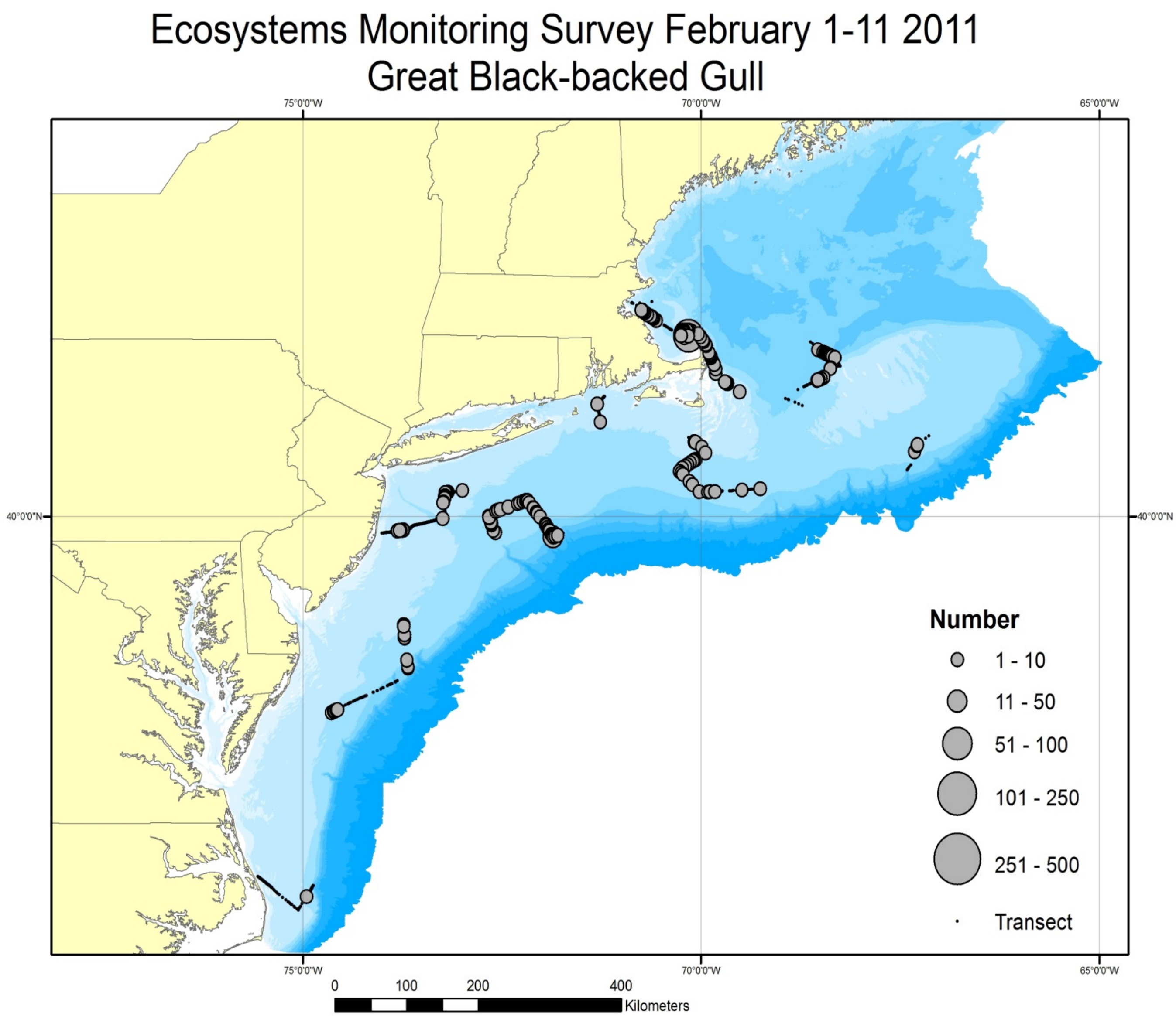


Figure A4. Distribution of Great Black-backed Gulls February 2011.

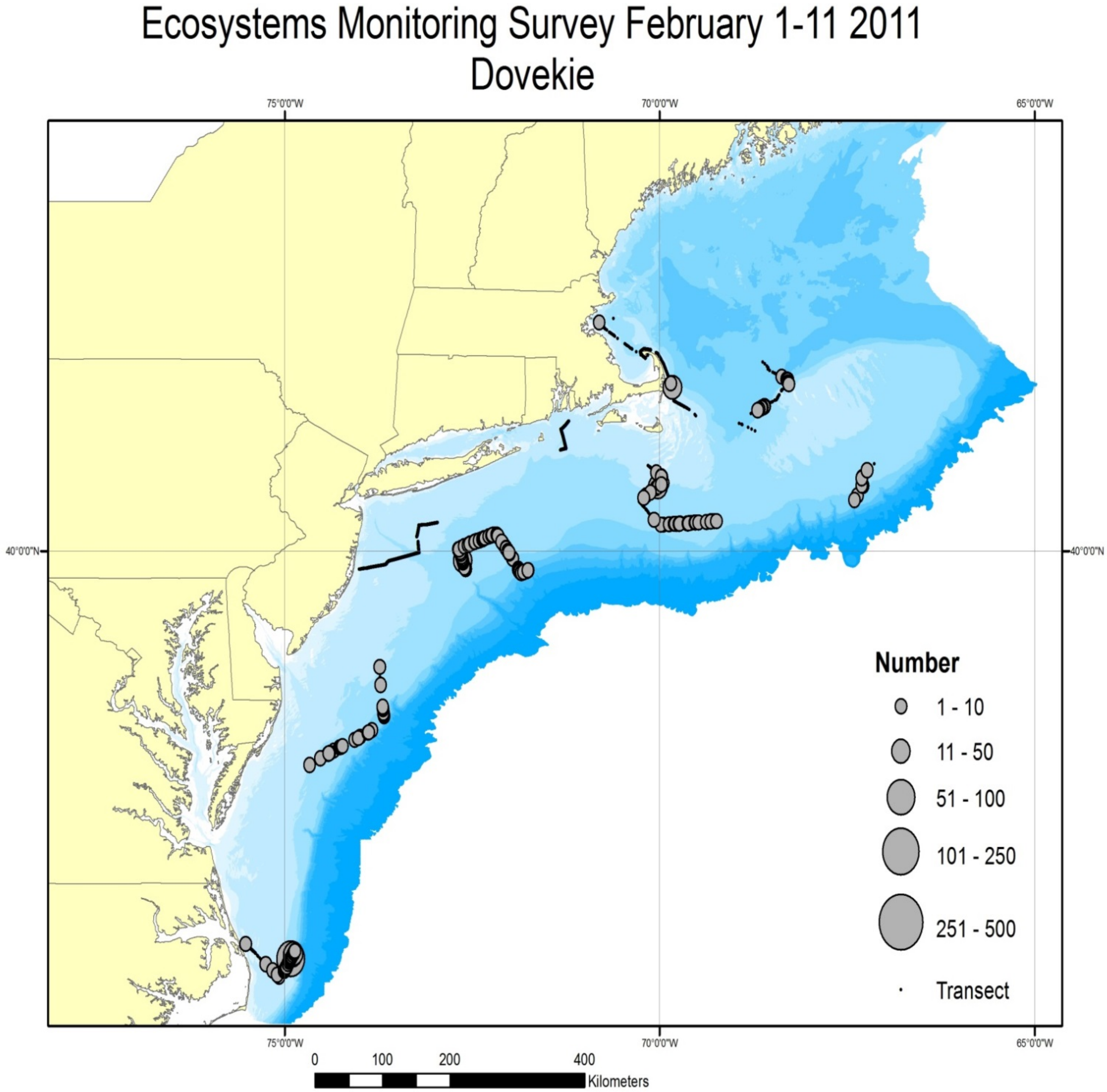


Figure A5. Distribution of Dovekies February 2011. Dovekies were unusually widespread, including substantial numbers off Cape Hatteras, and broadly distributed on midshelf waters, probably associated with a mid shelf front.

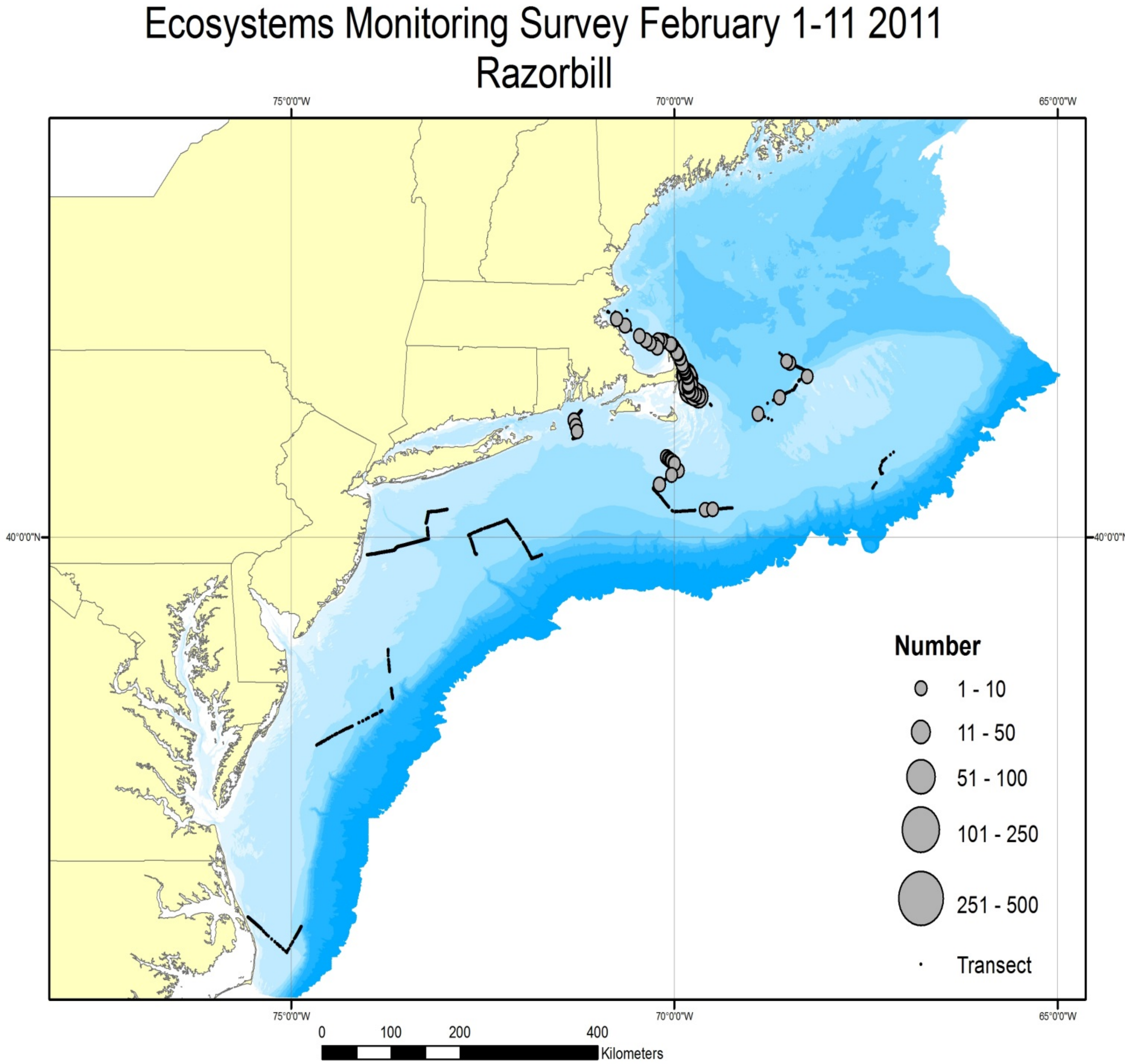


Figure A6. Distribution of Razorbills February 2011. Peak concentrations were east of outer Cape Cod.

Appendix IV

Cruise maps left out of earlier reports. EcoMon Cruise 1-11 February 2011.

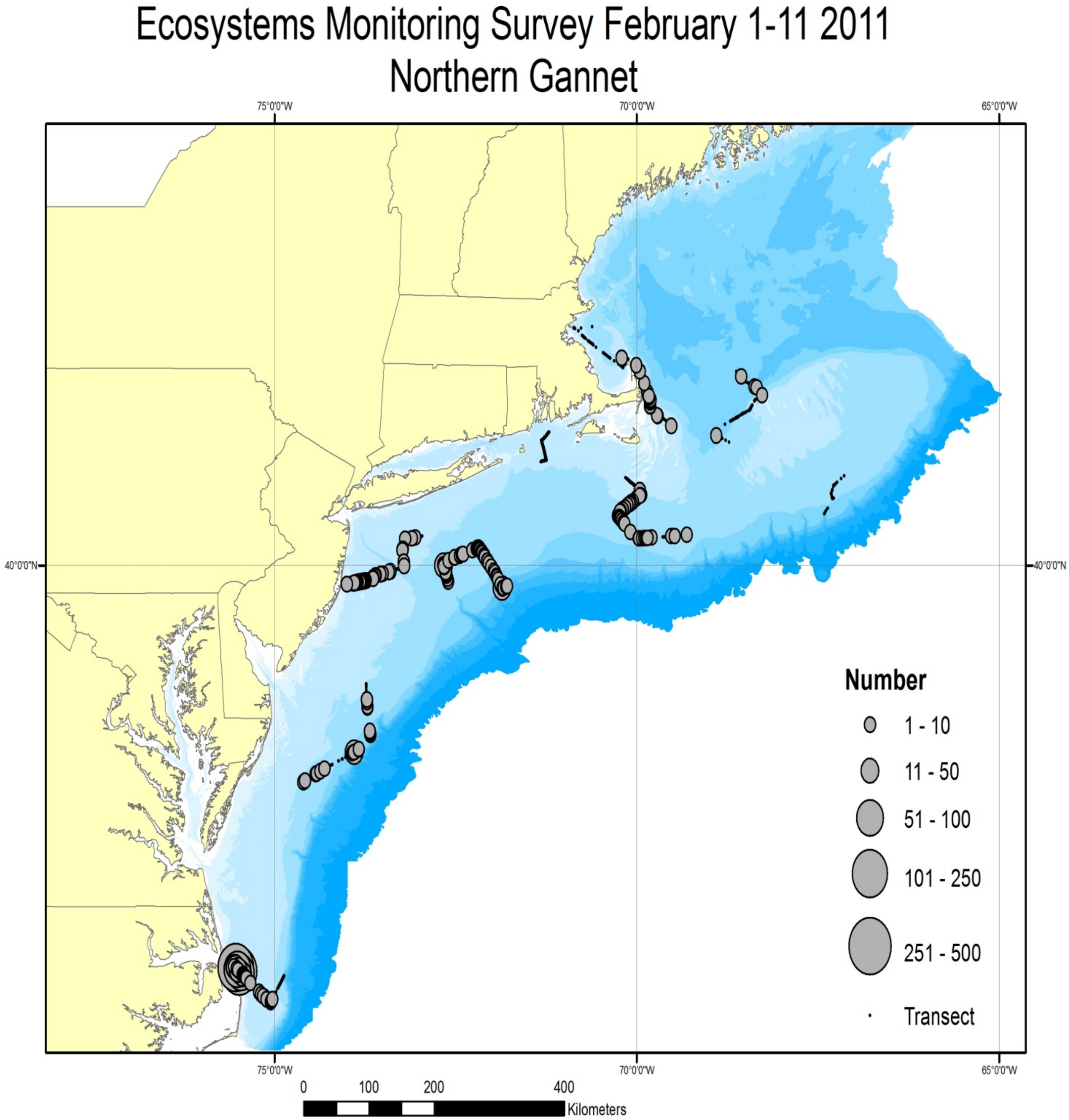


Figure A1. Distribution of Northern Gannets February 2011. Note concentration at Cape Hatteras.

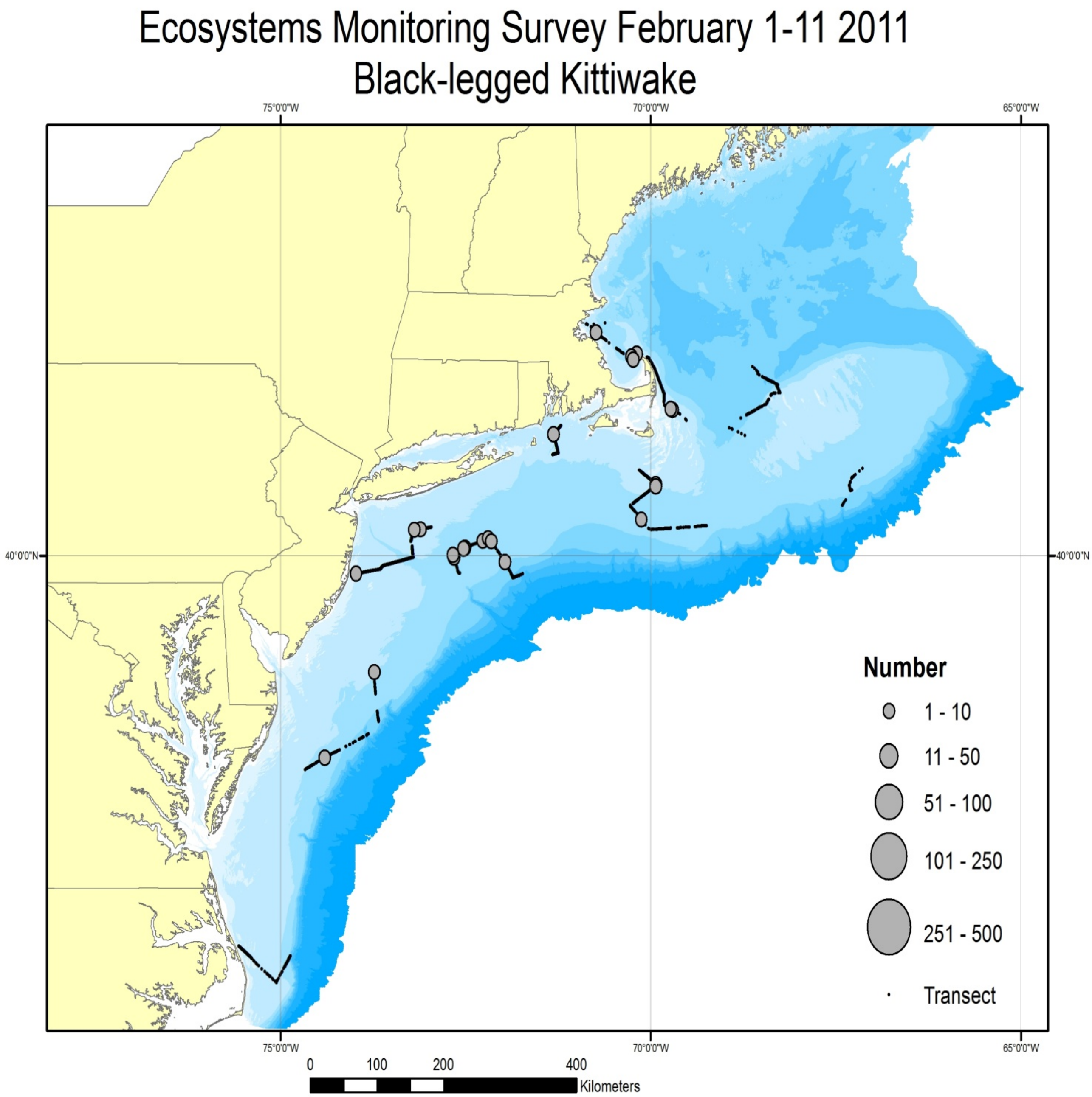


Figure A2 Distribution of Black-legged Kittiwakes February 2011.

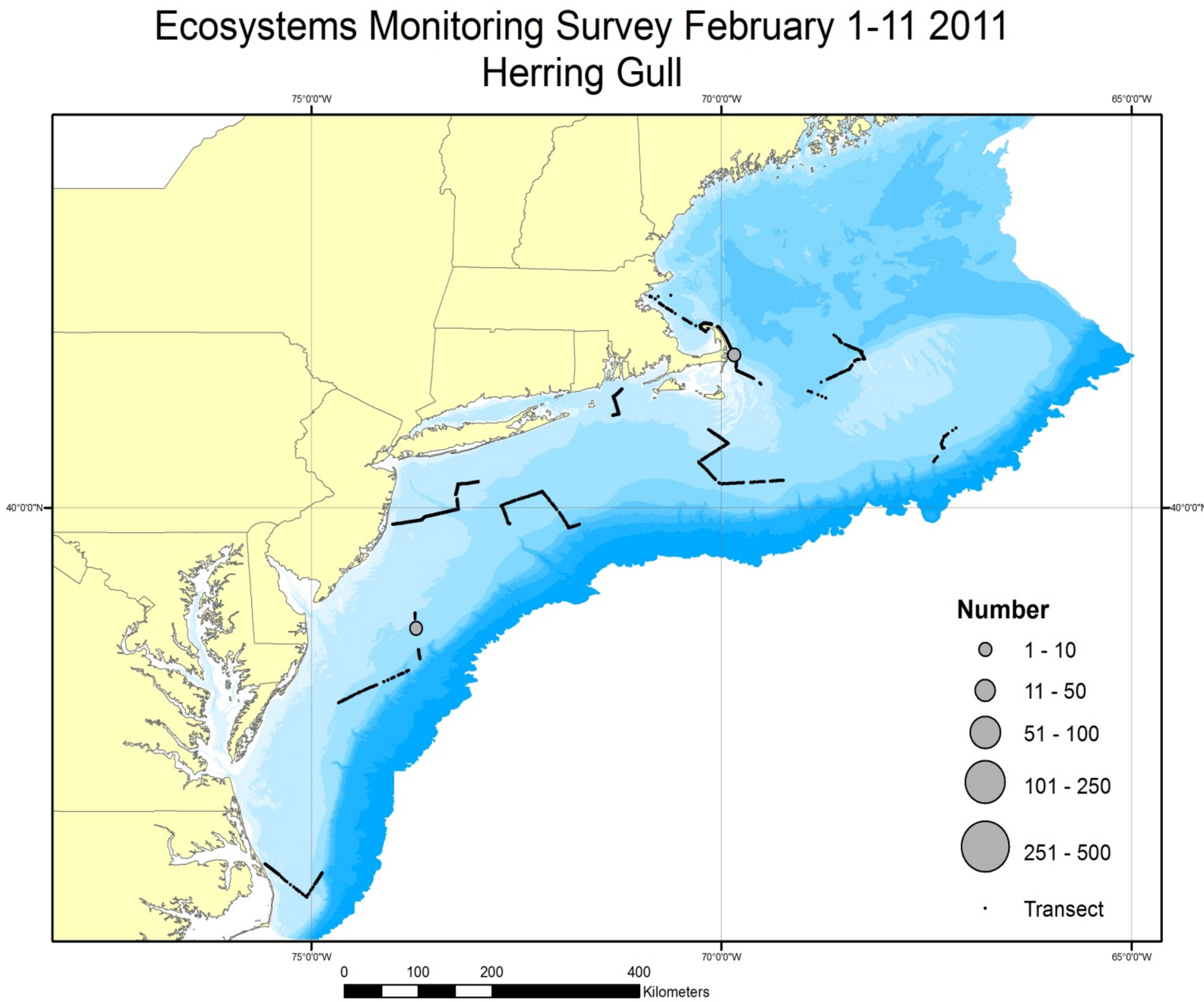


Figure A3. Distribution of Herring Gulls February 2011.

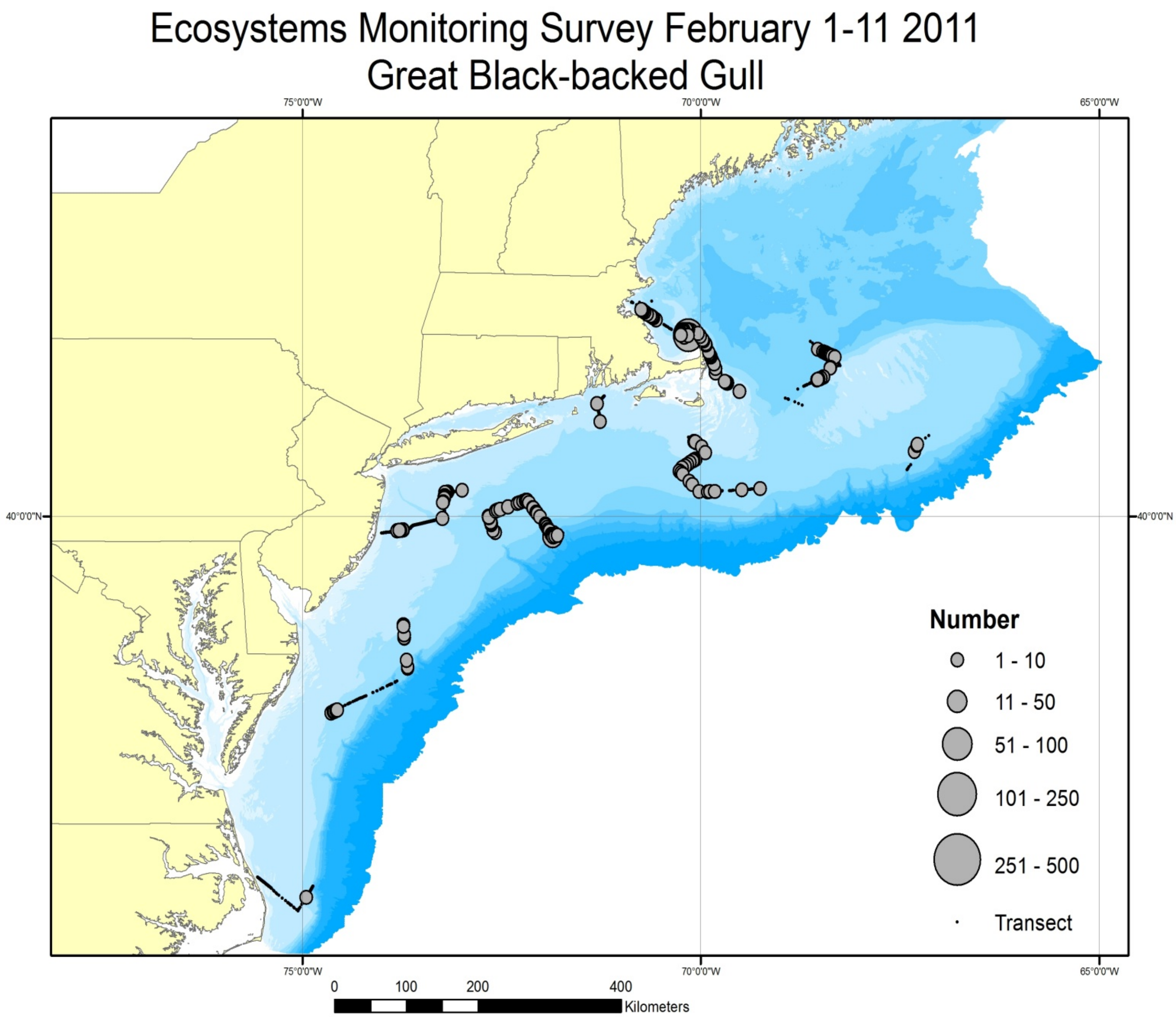


Figure A4. Distribution of Great Black-backed Gulls February 2011.

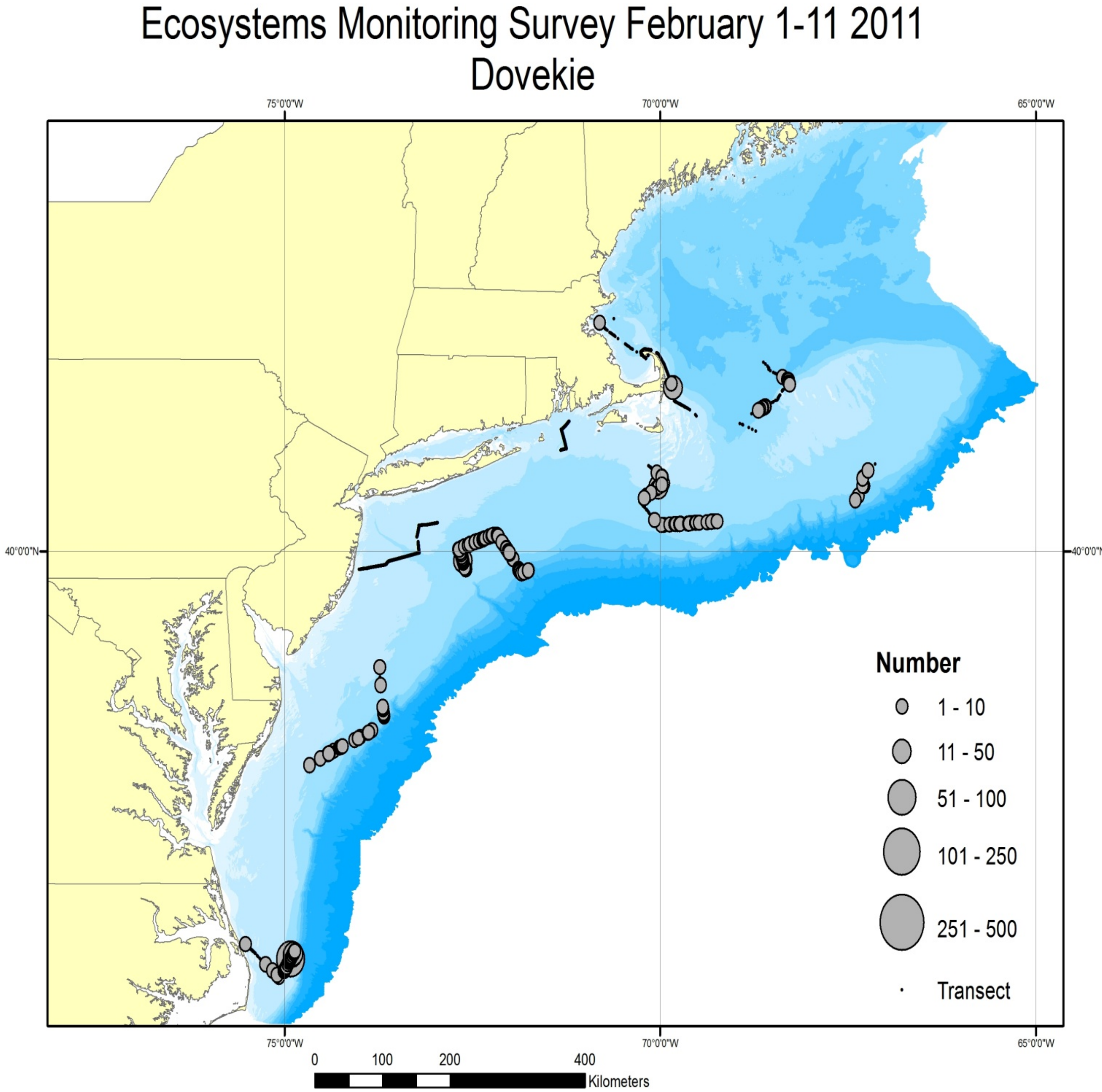


Figure A5. Distribution of Dovekies February 2011. Dovekies were unusually widespread, including substantial numbers off Cape Hatteras, and broadly distributed on midshelf waters, probably associated with a mid shelf front.

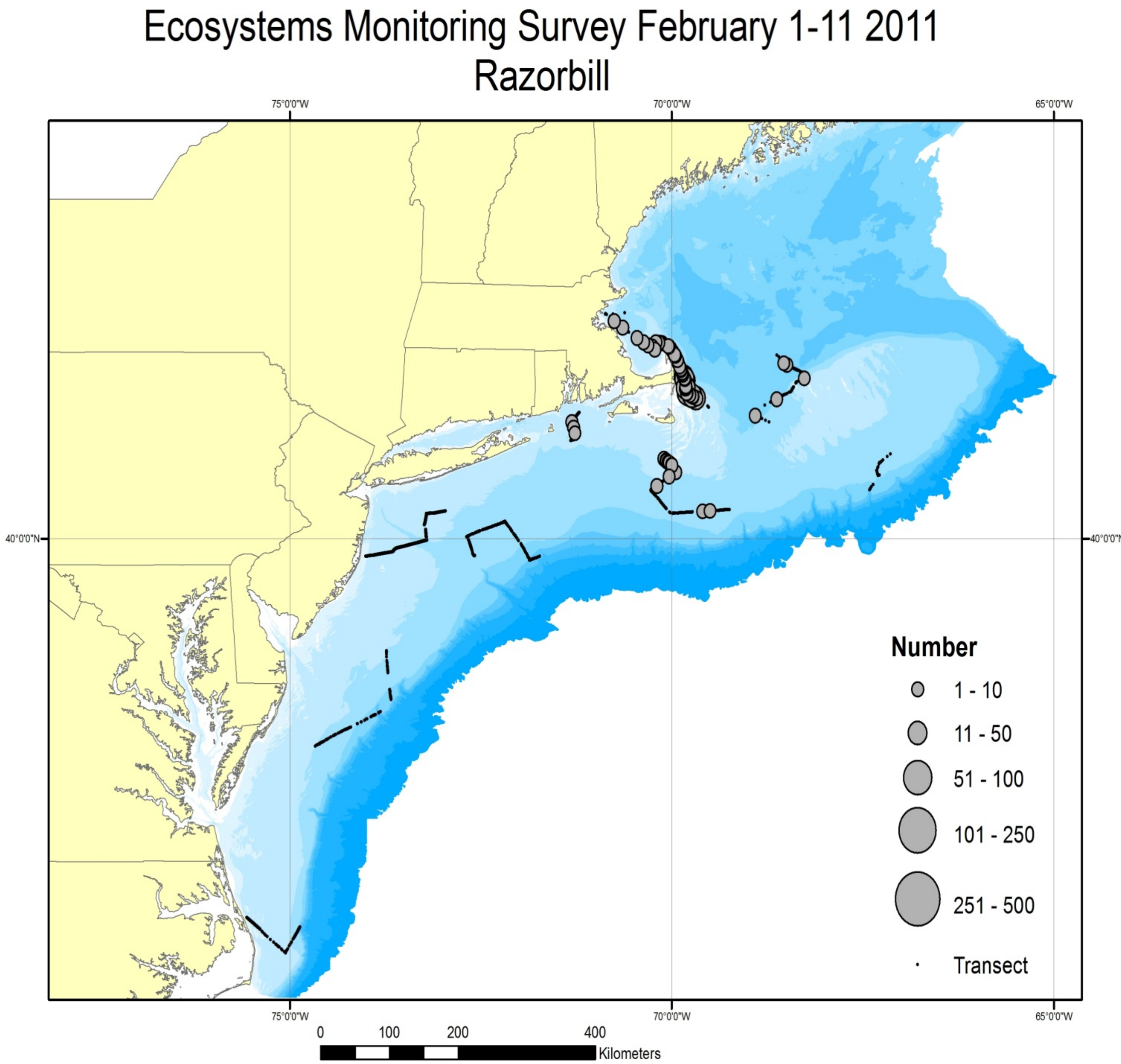
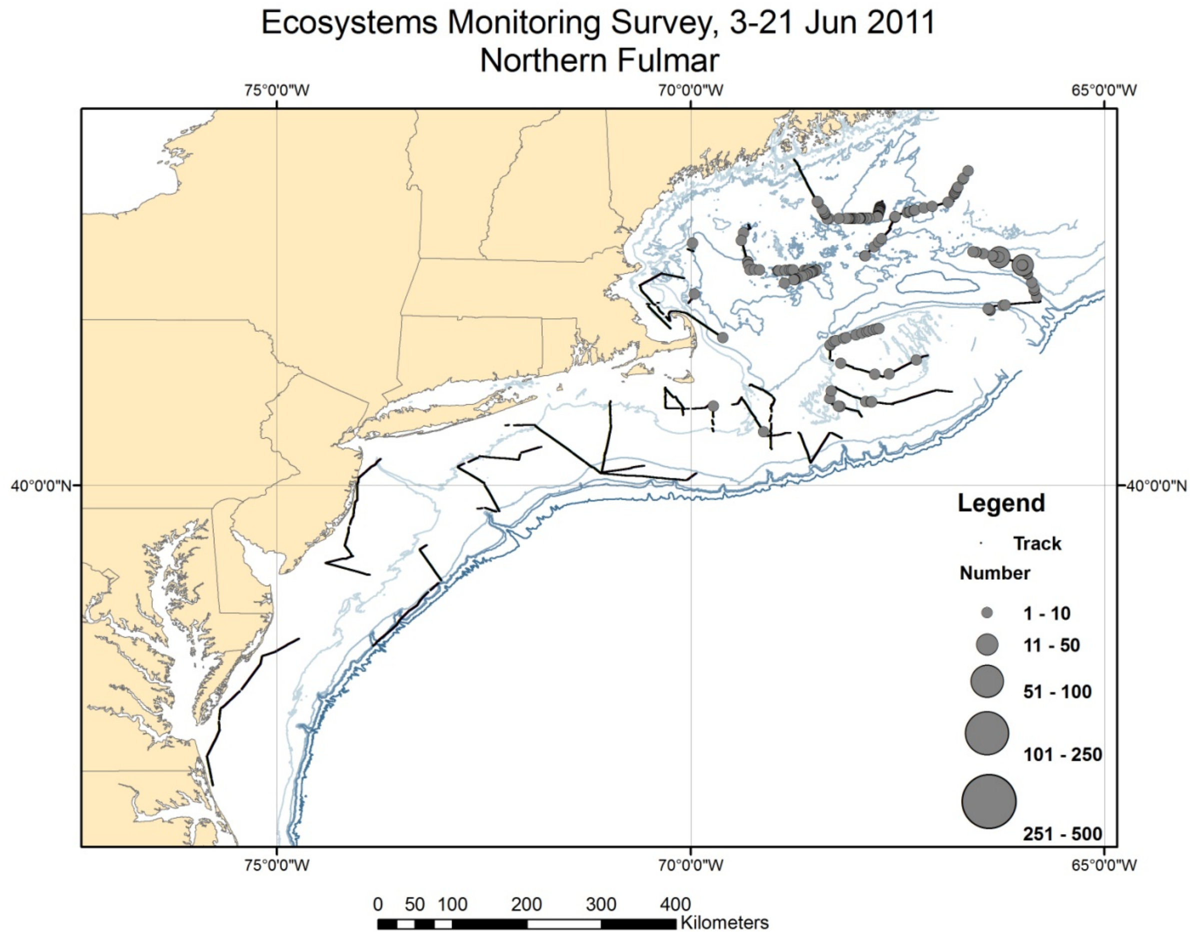
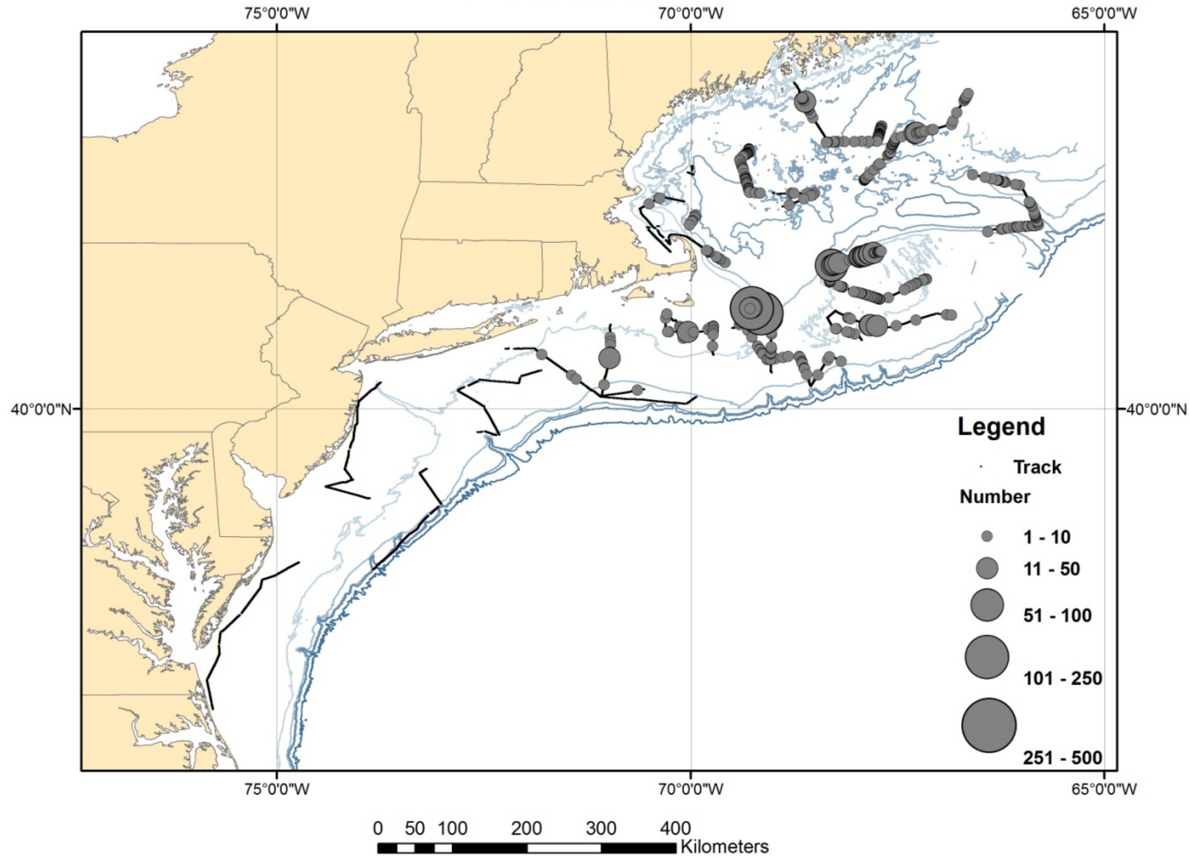
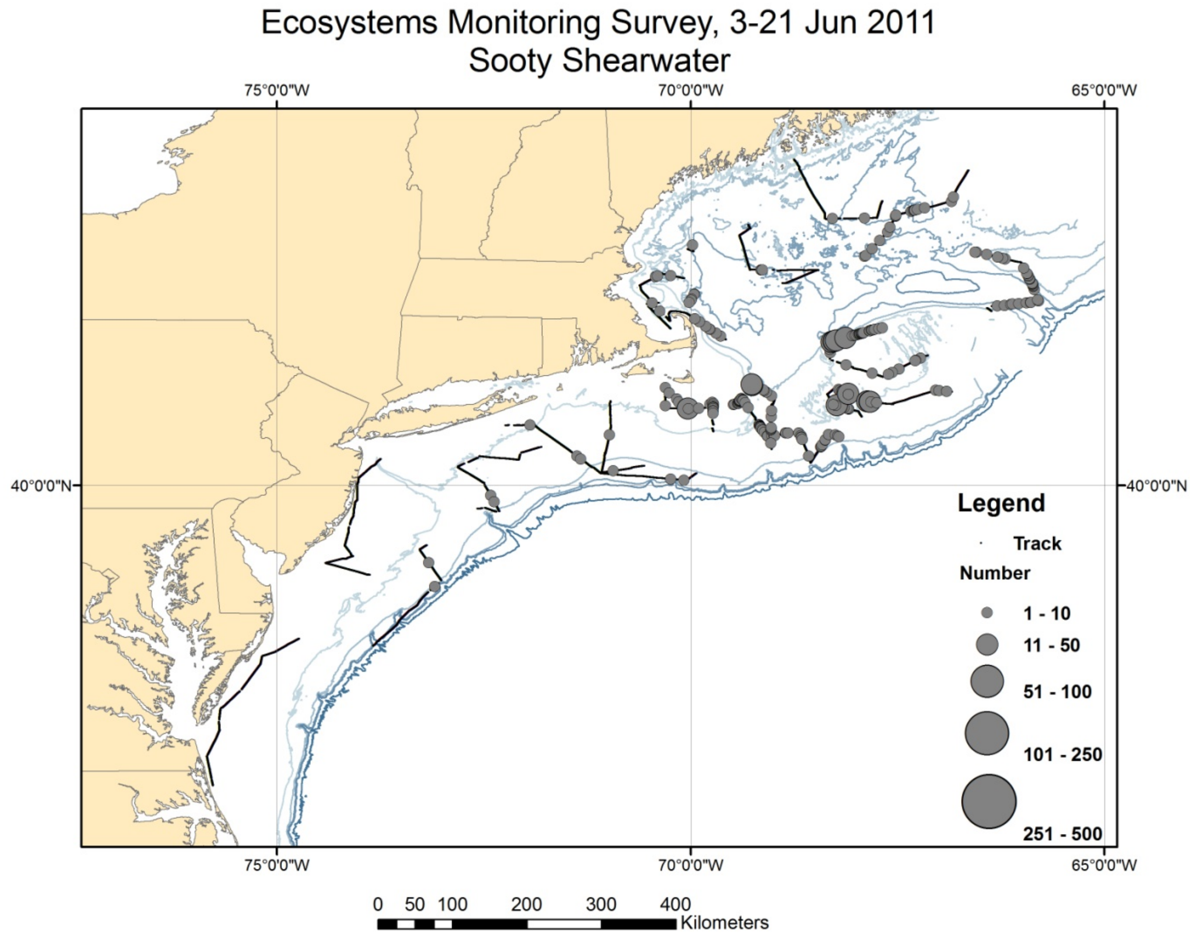


Figure A6. Distribution of Razorbills February 2011. Peak concentrations were east of outer Cape Cod.

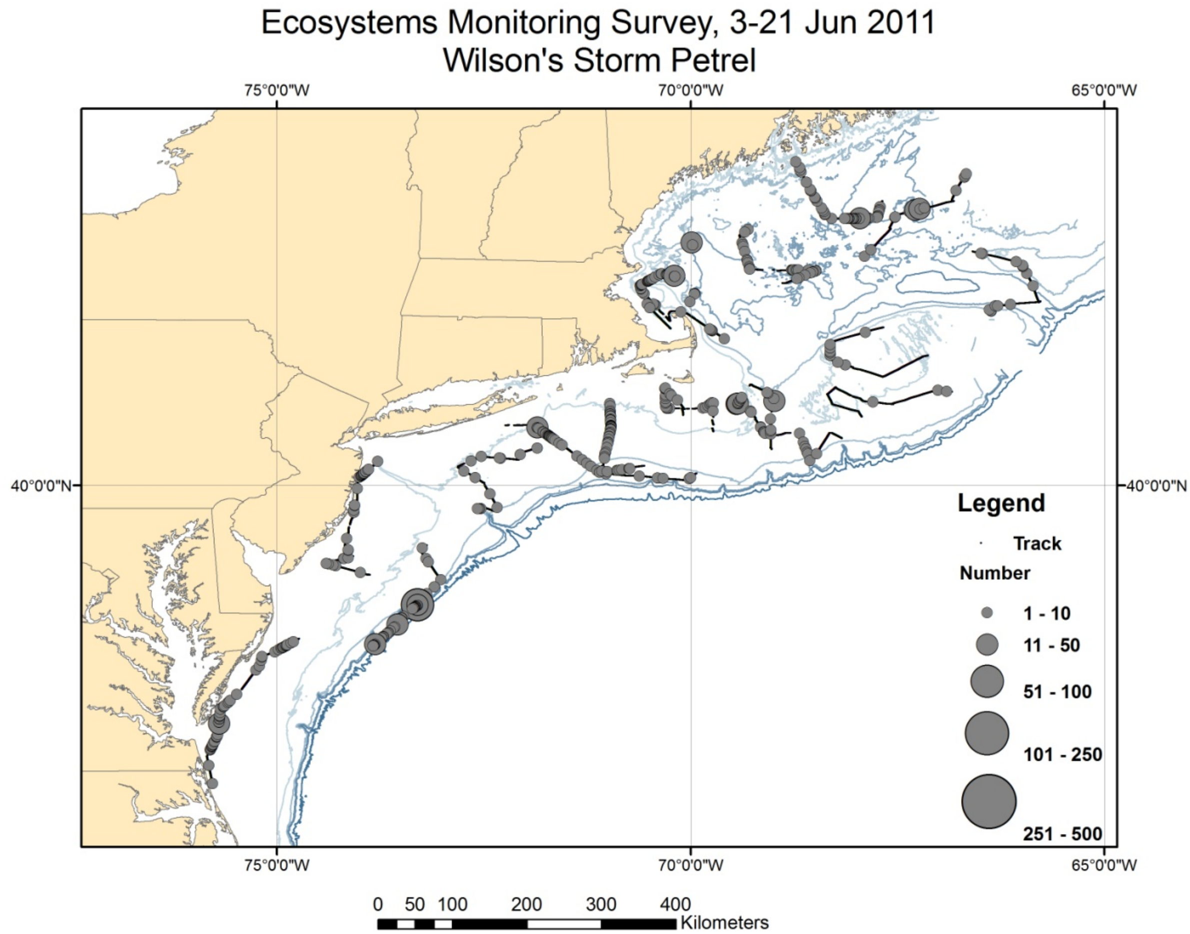

Ecosystems Monitoring Survey, 3-21 Jun 2011
Northern Fulmar
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

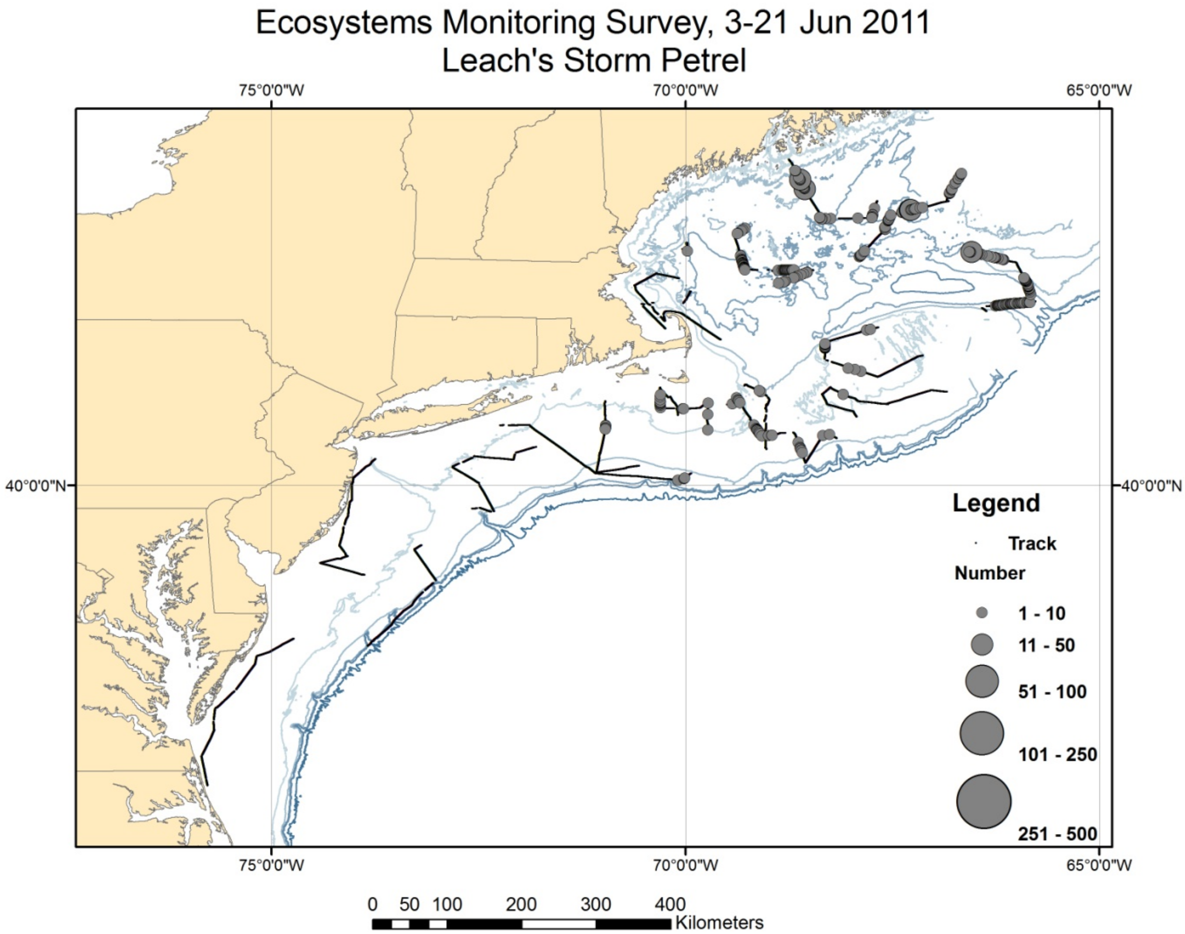
Ecosystems Monitoring Survey, 3-21 Jun 2011
Great Shearwater

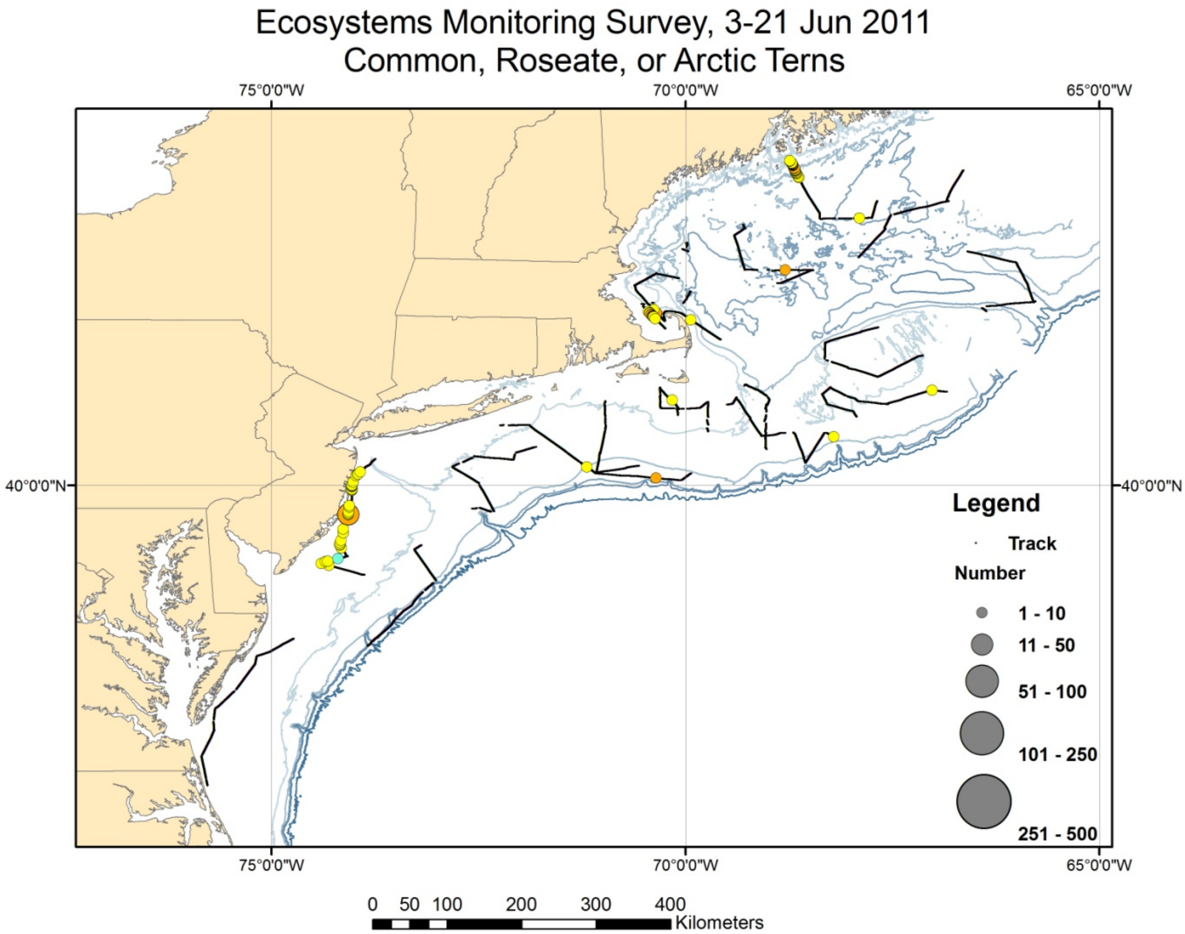




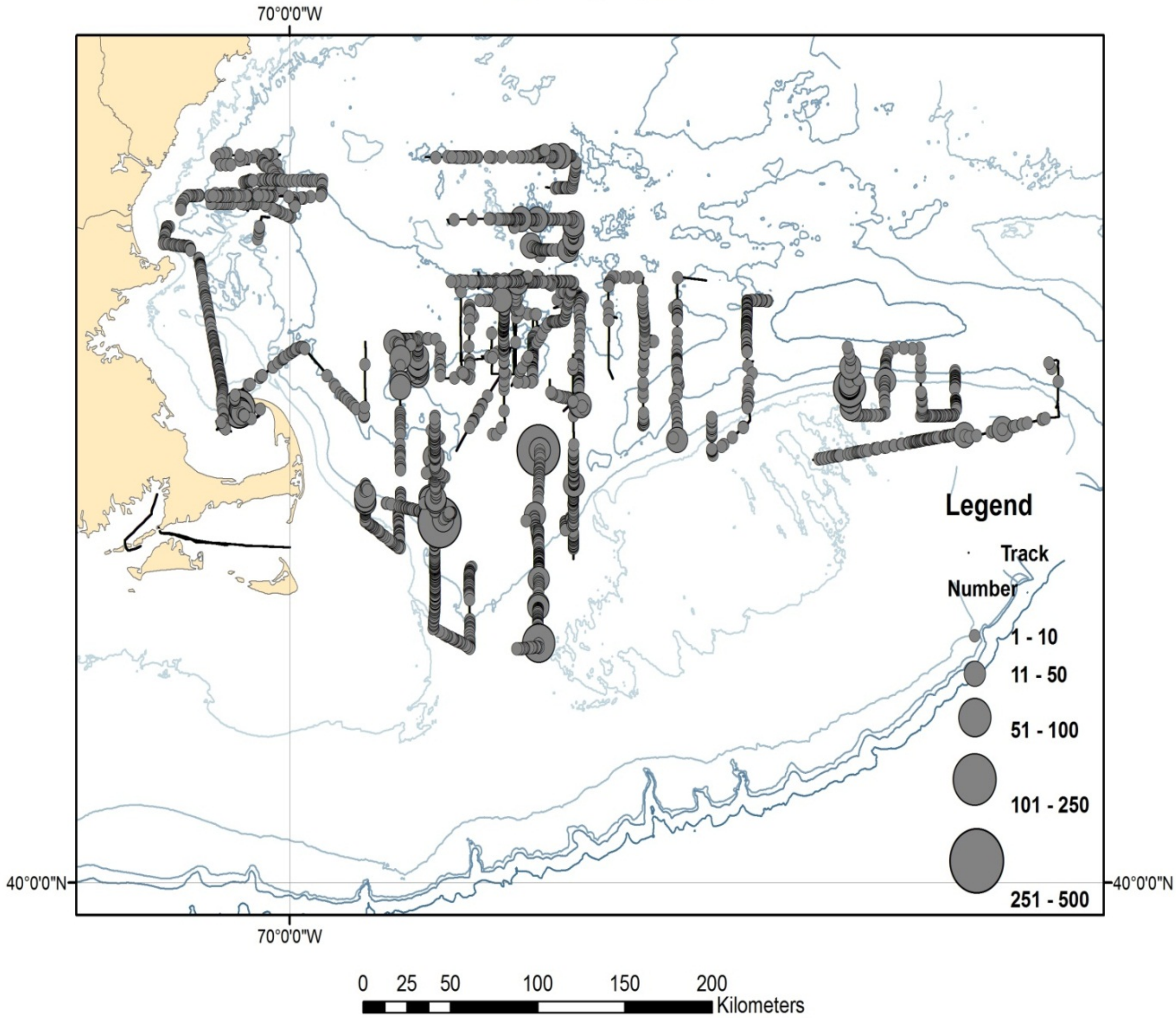
Ecosystems Monitoring Survey, 3-21 Jun 2011
Sooty Shearwater
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers


Ecosystems Monitoring Survey, 3-21 Jun 2011
Wilson's Storm Petrel
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

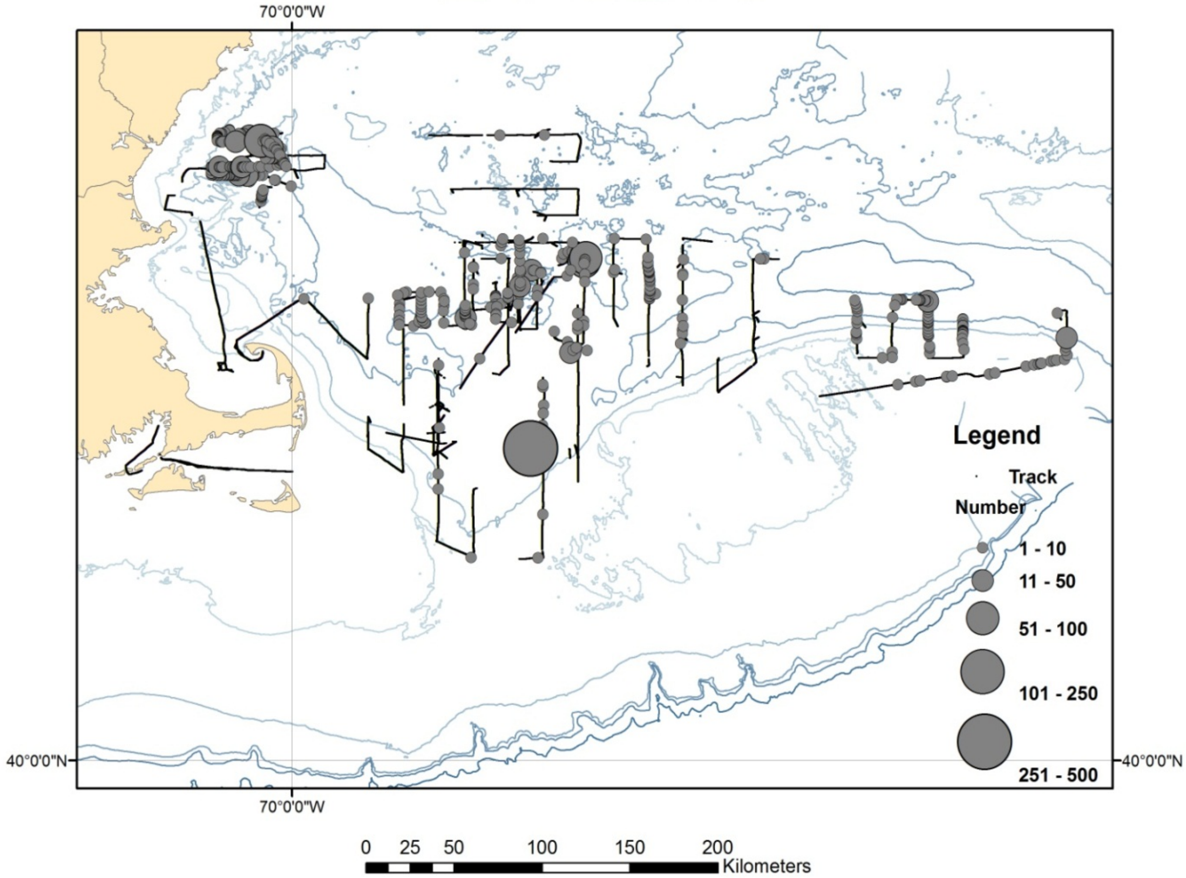

Ecosystems Monitoring Survey, 3-21 Jun 2011
Leach's Storm Petrel
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

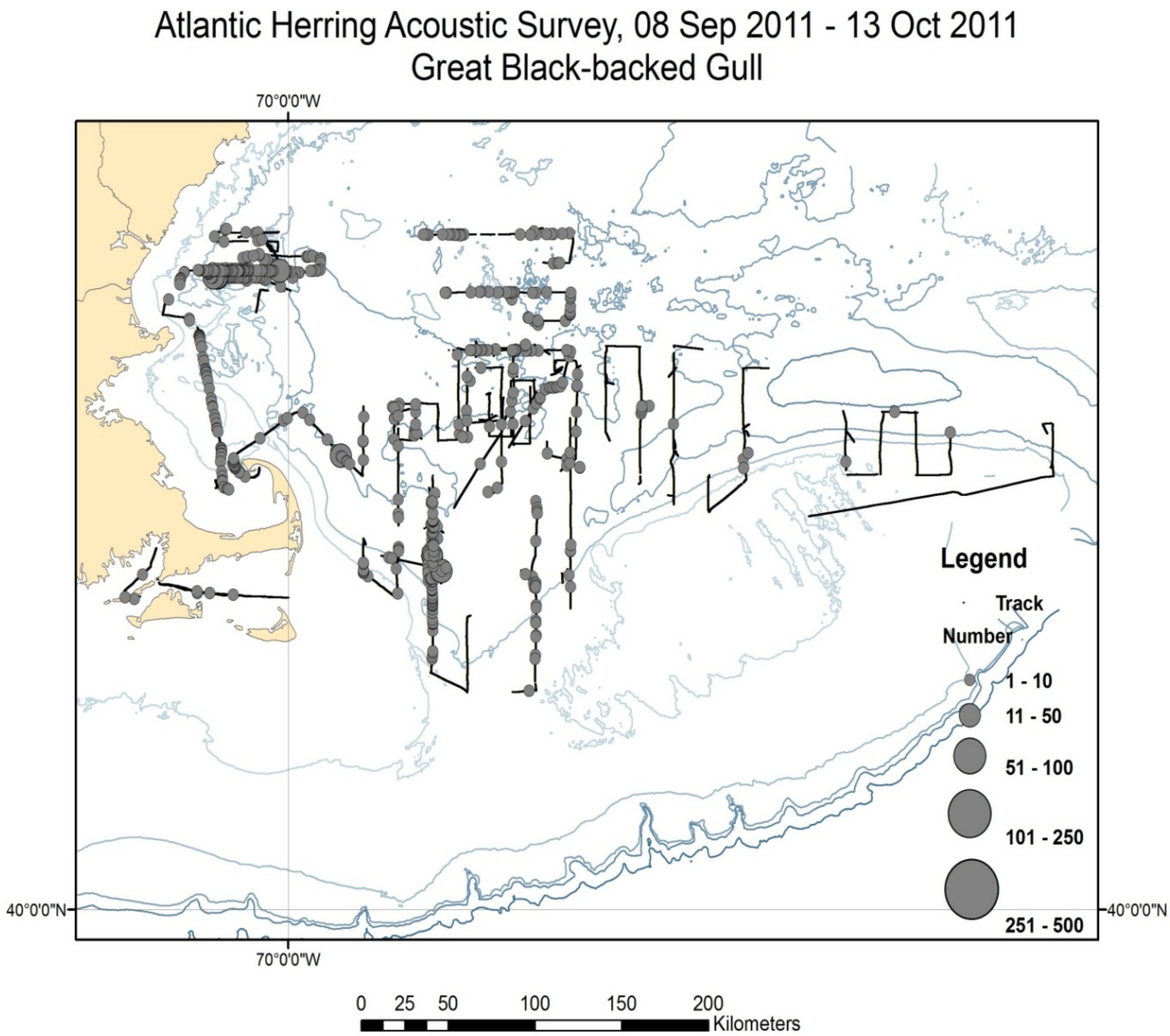

Ecosystems Monitoring Survey, 3-21 Jun 2011
Common, Roseate, or Arctic Terns
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

Atlantic Herring Acoustic Survey, 08 Sep 2011 - 13 Oct 2011
Greater Shearwater



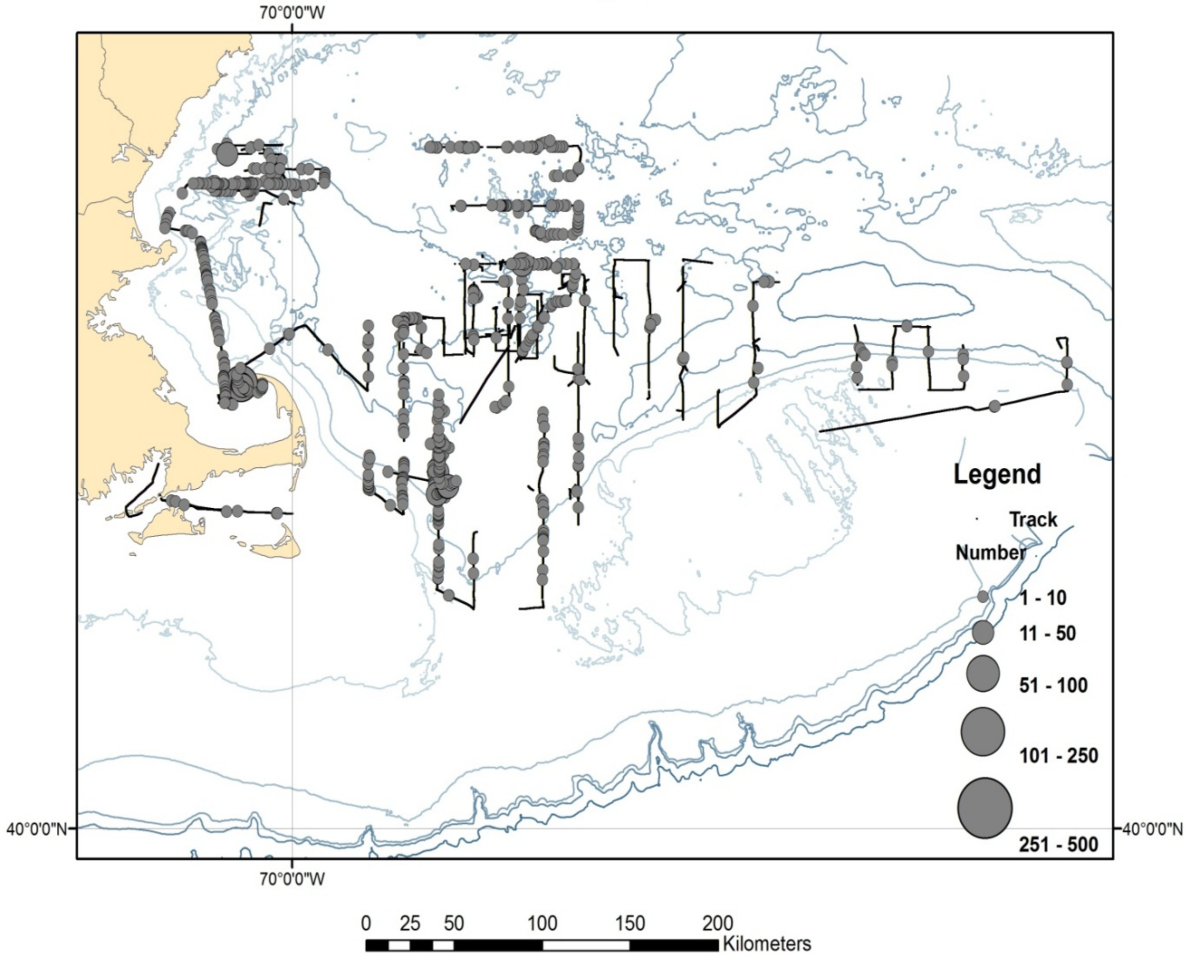
Atlantic Herring Acoustic Survey, 08 Sep 2011 - 13 Oct 2011
Wilson's Storm Petrel



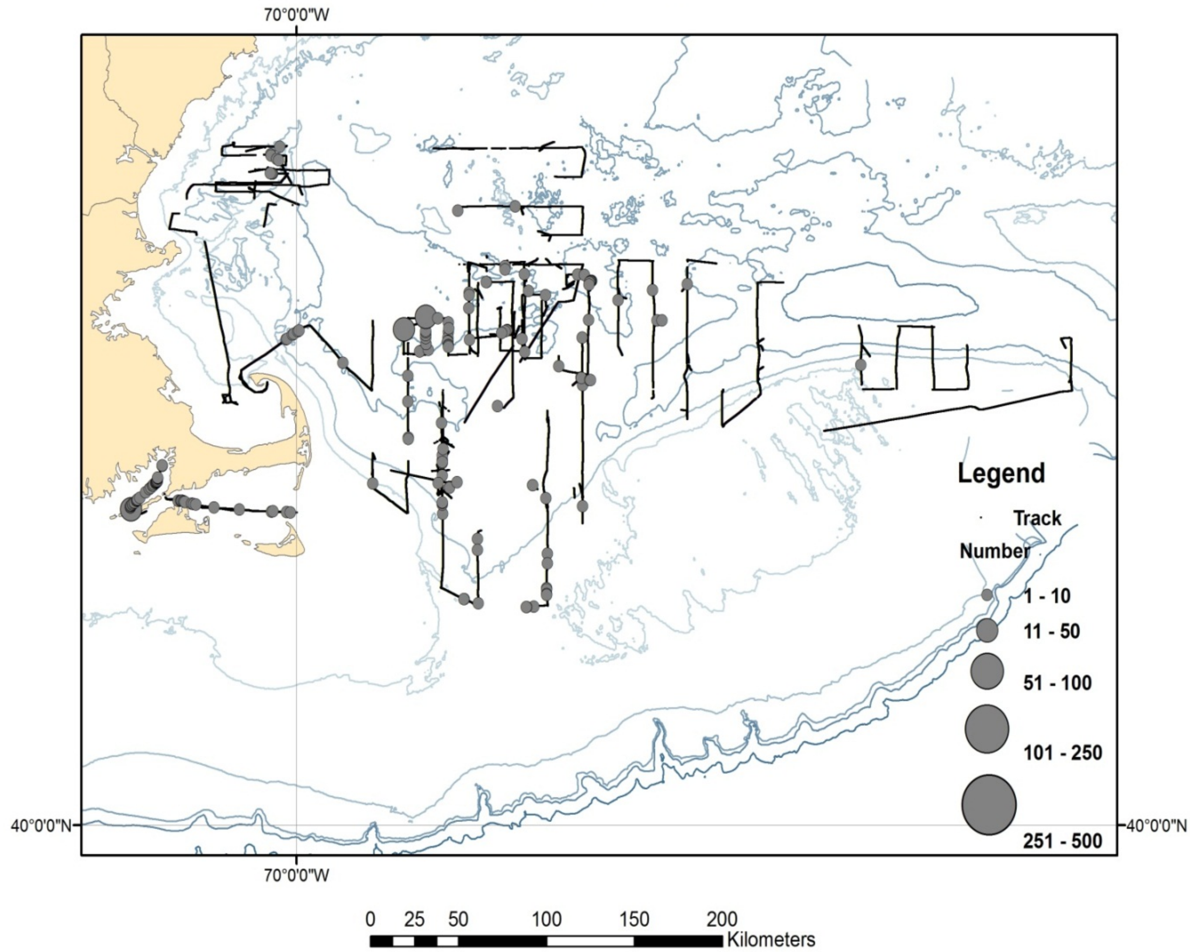


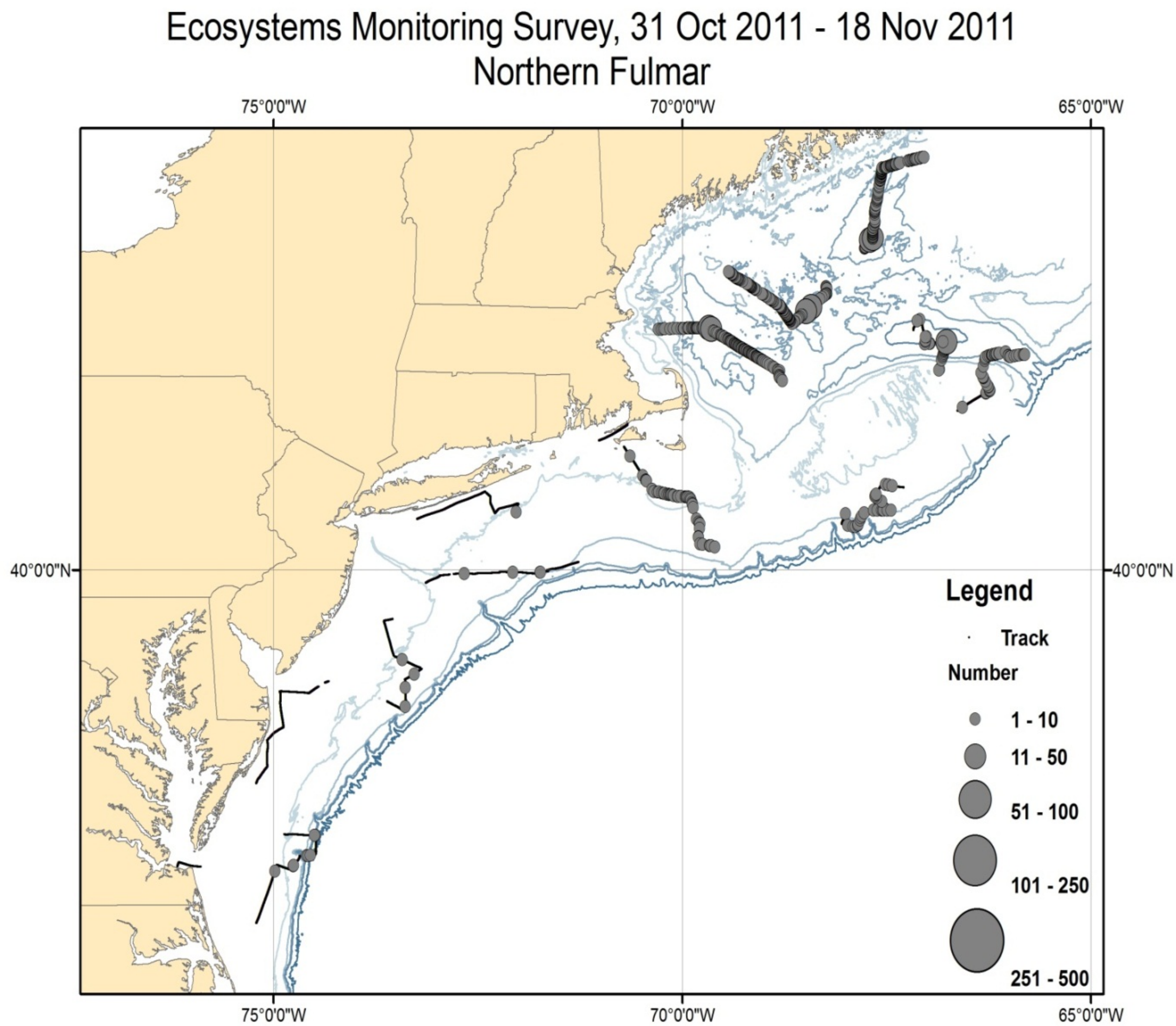
Atlantic Herring Acoustic Survey, 08 Sep 2011 - 13 Oct 2011
Great Black-backed Gull
70°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 25 50 100 150 200
Kilometers

Atlantic Herring Acoustic Survey, 08 Sep 2011 - 13 Oct 2011
Herring Gull

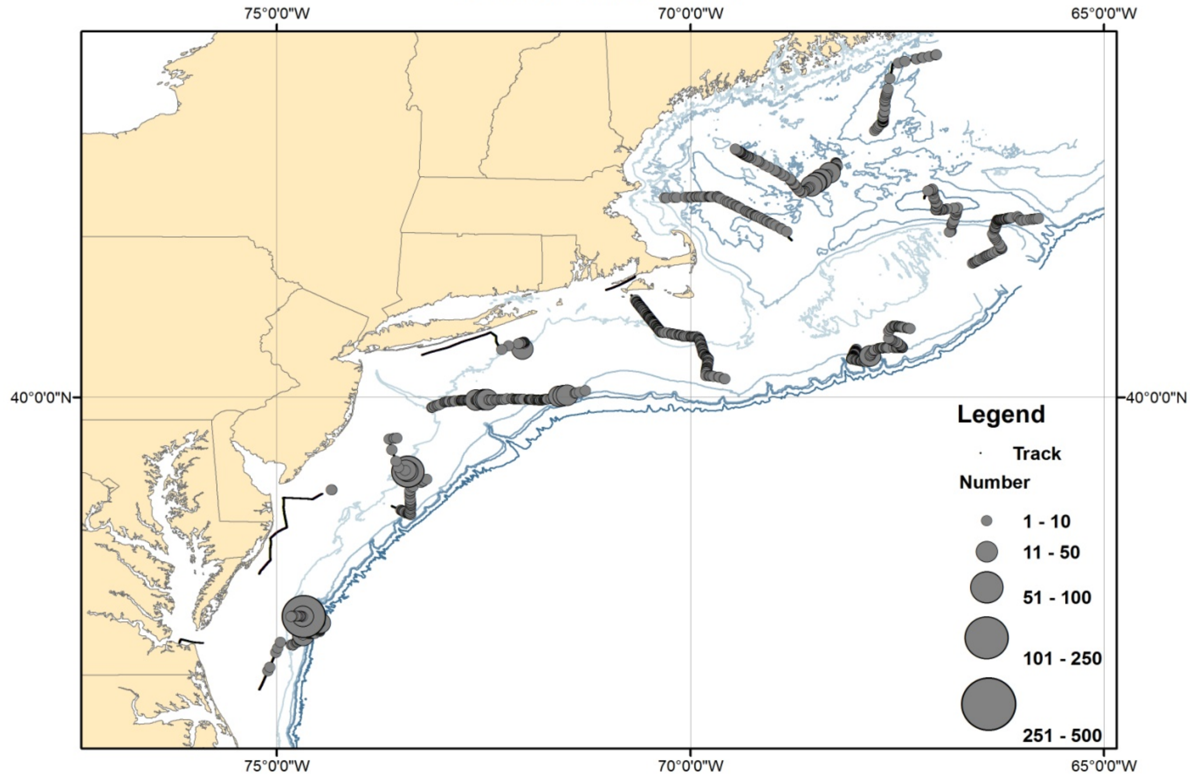


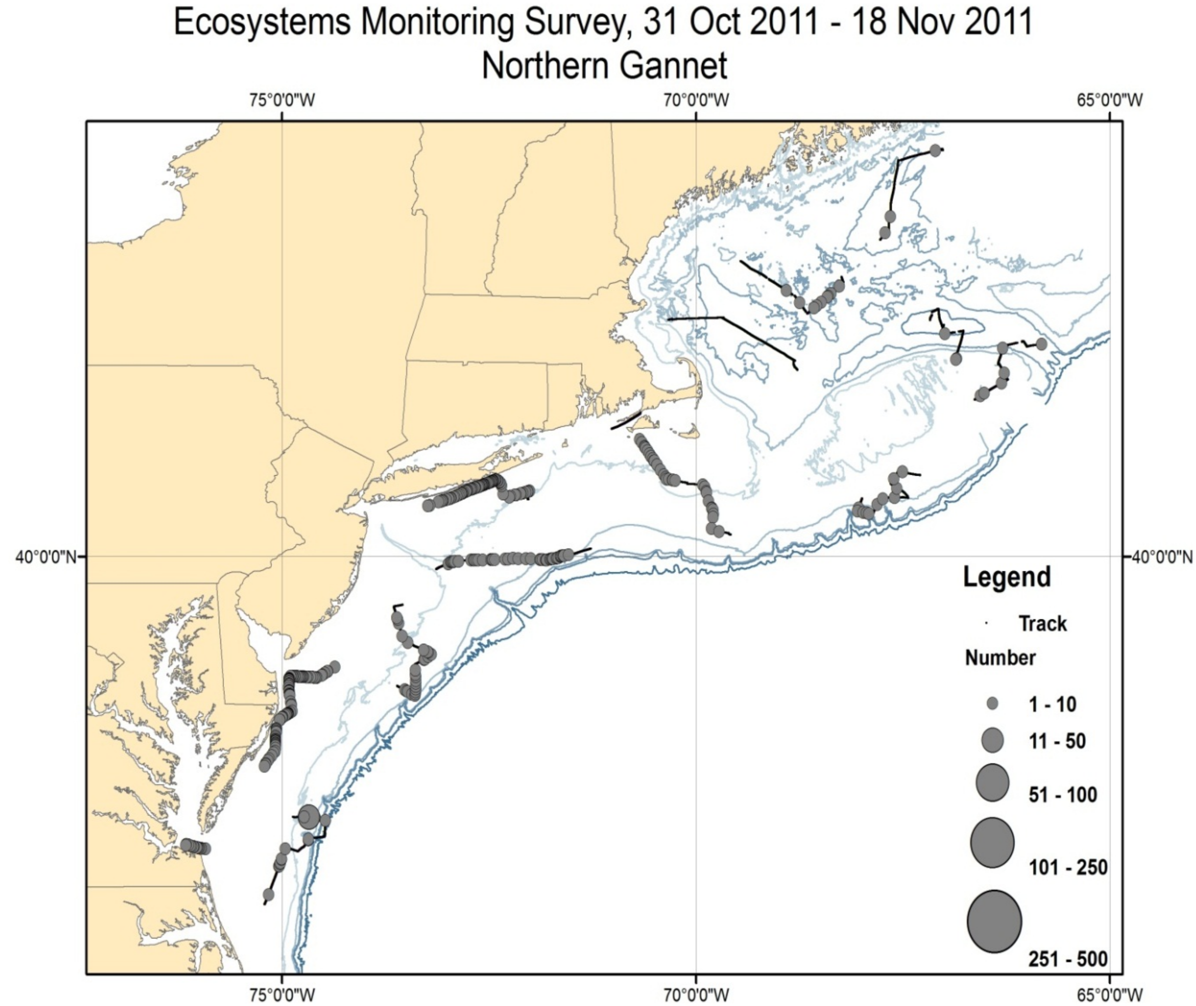
Atlantic Herring Acoustic Survey, 08 Sep 2011 - 13 Oct 2011
Common Tern



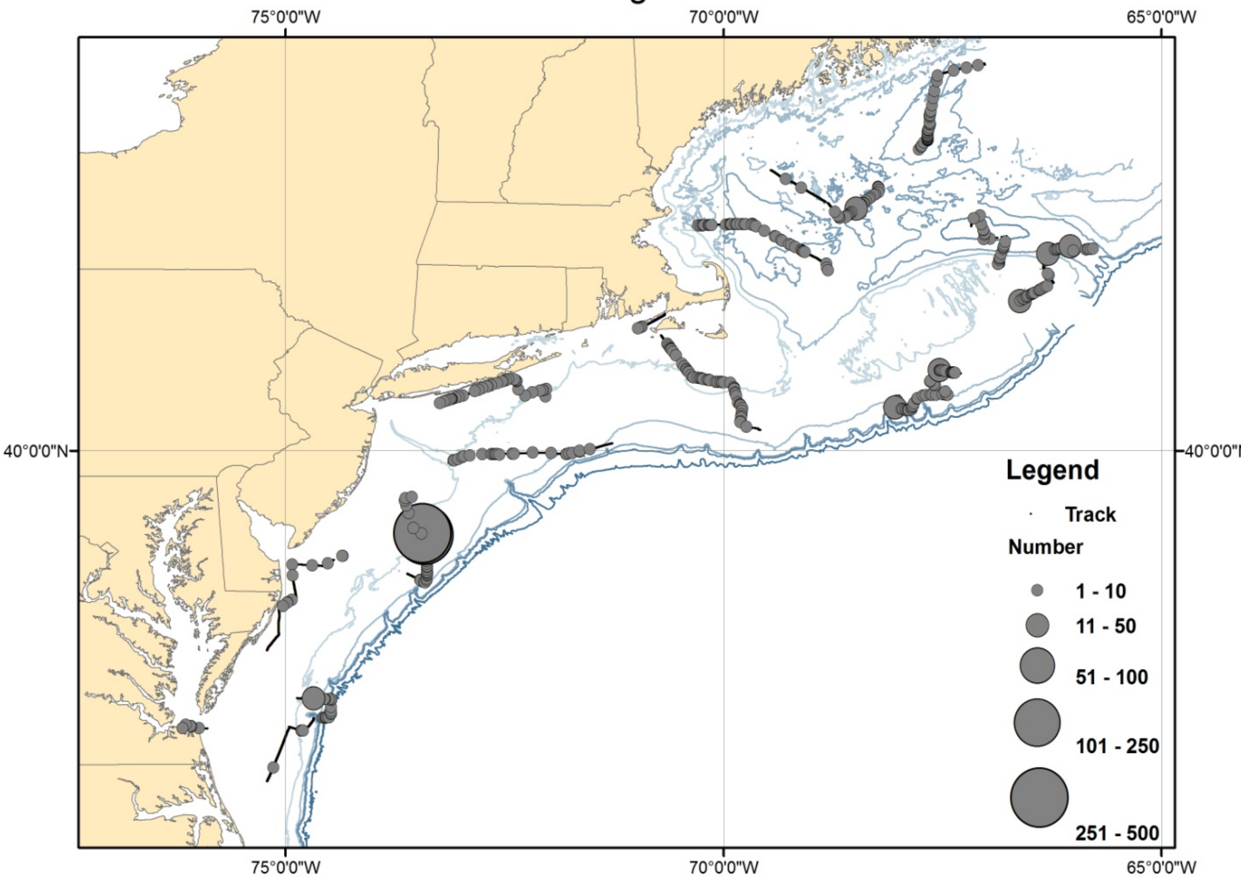

Ecosystems Monitoring Survey, 31 Oct 2011 - 18 Nov 2011
Northern Fulmar
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500

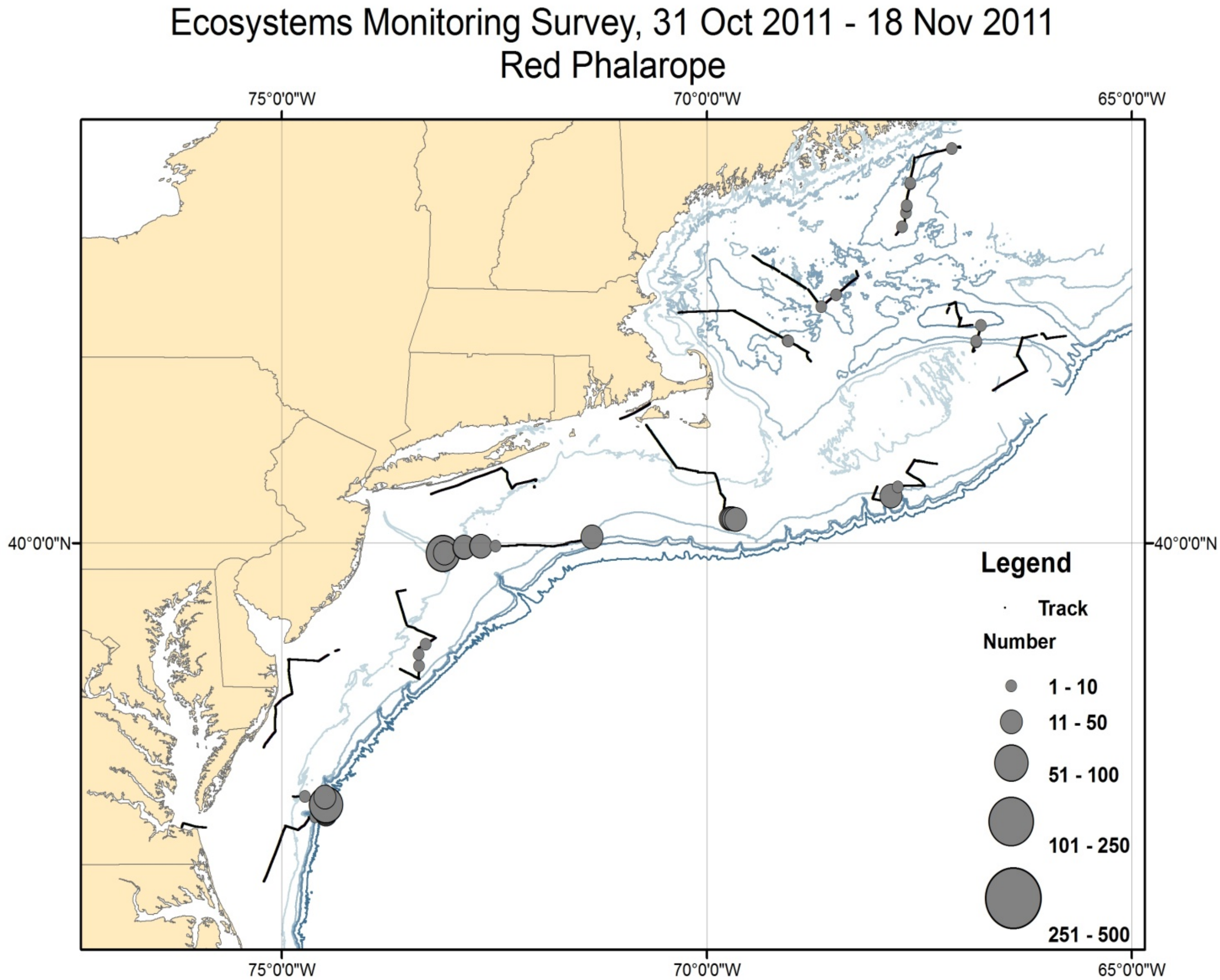
Ecosystems Monitoring Survey, 31 Oct 2011 - 18 Nov 2011
Greater Shearwater



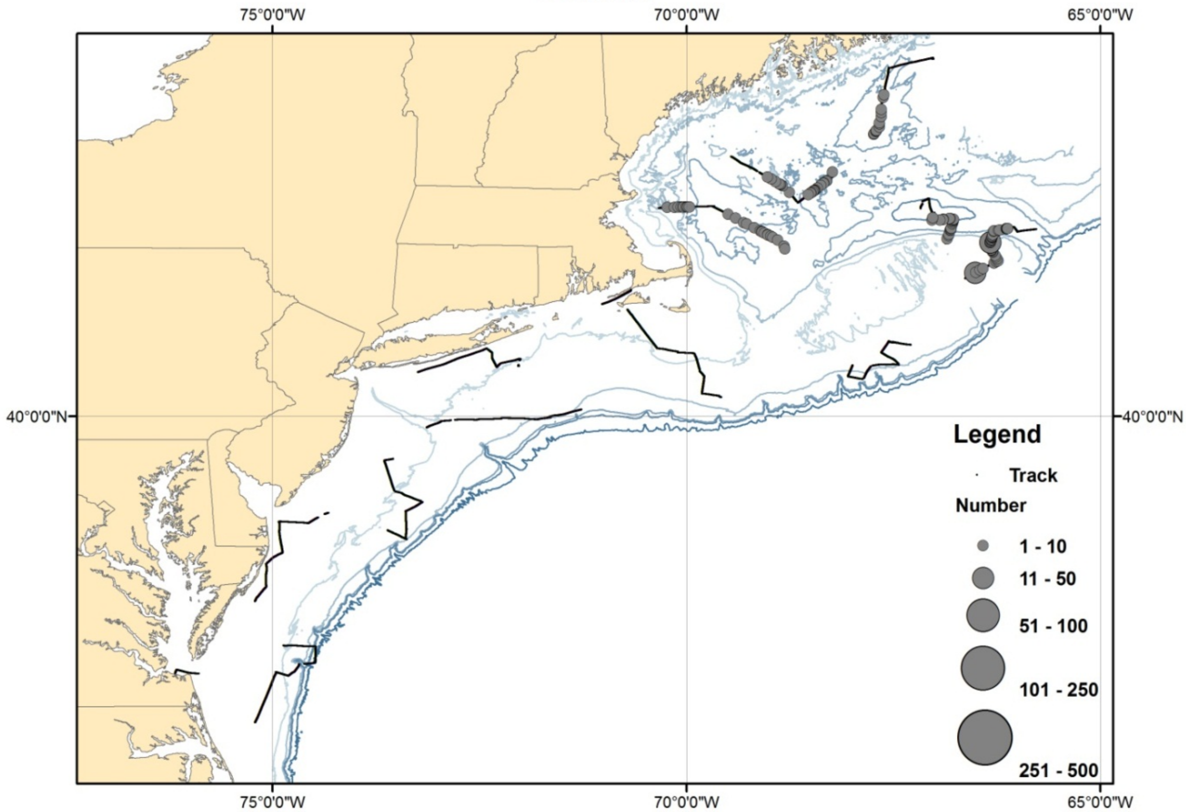

Ecosystems Monitoring Survey, 31 Oct 2011 - 18 Nov 2011
Northern Gannet
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500

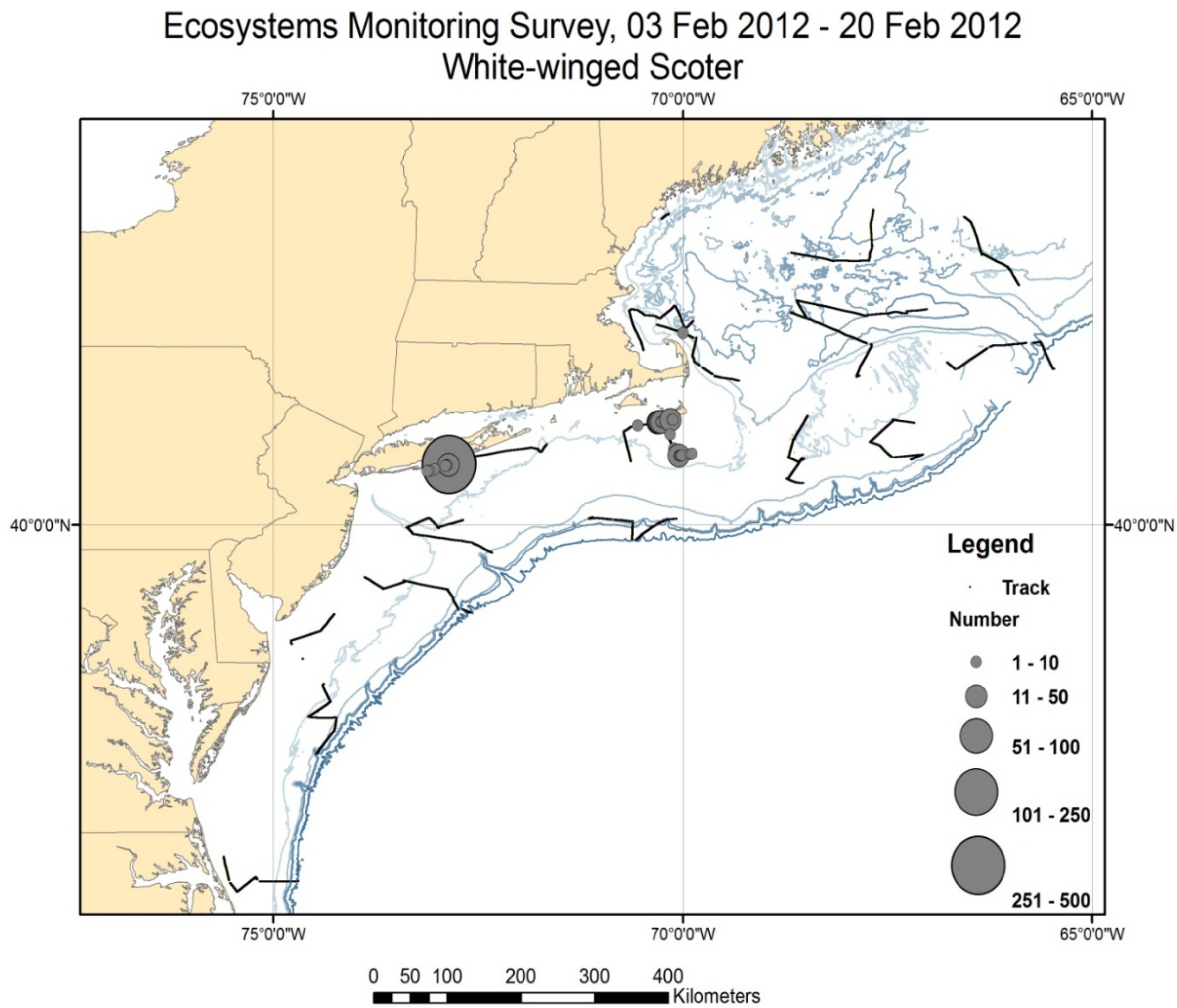
Ecosystems Monitoring Survey, 31 Oct 2011 - 18 Nov 2011
Herring Gull



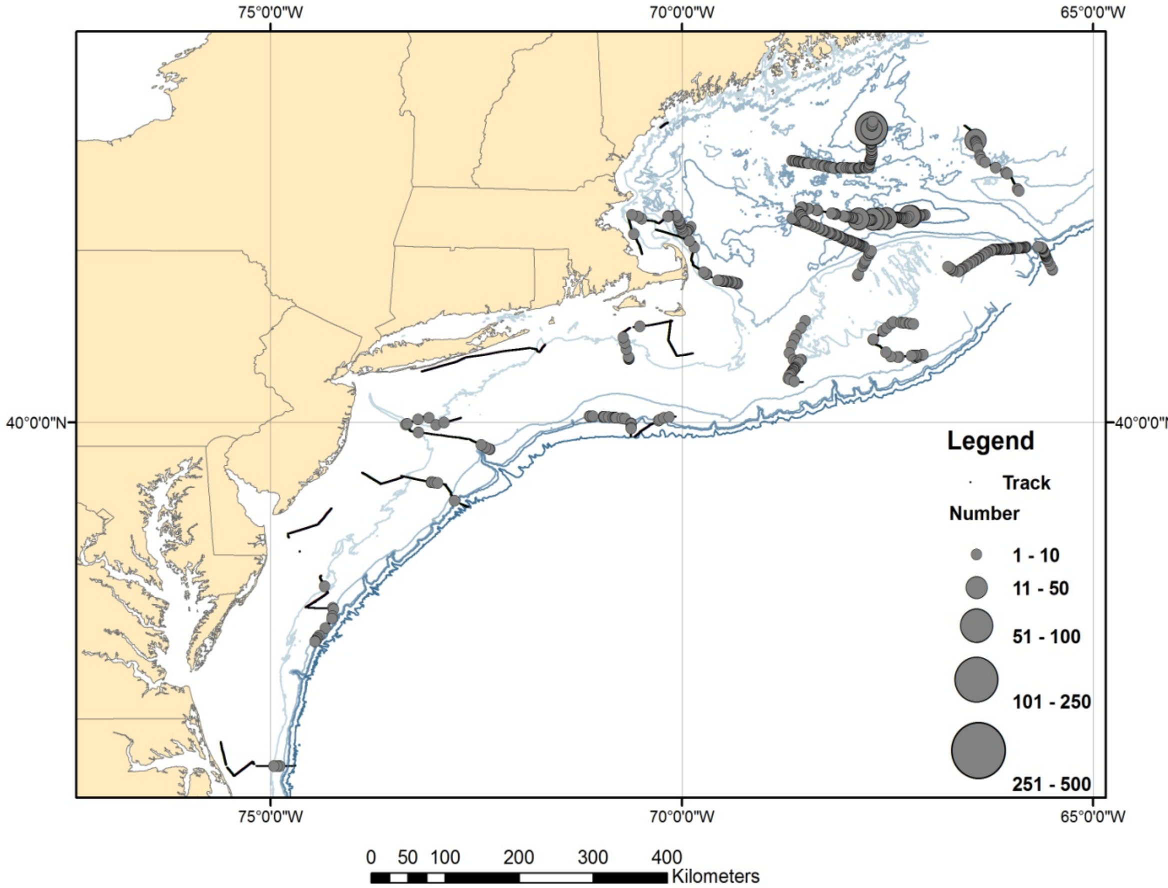

Ecosystems Monitoring Survey, 31 Oct 2011 - 18 Nov 2011
Red Phalarope
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500

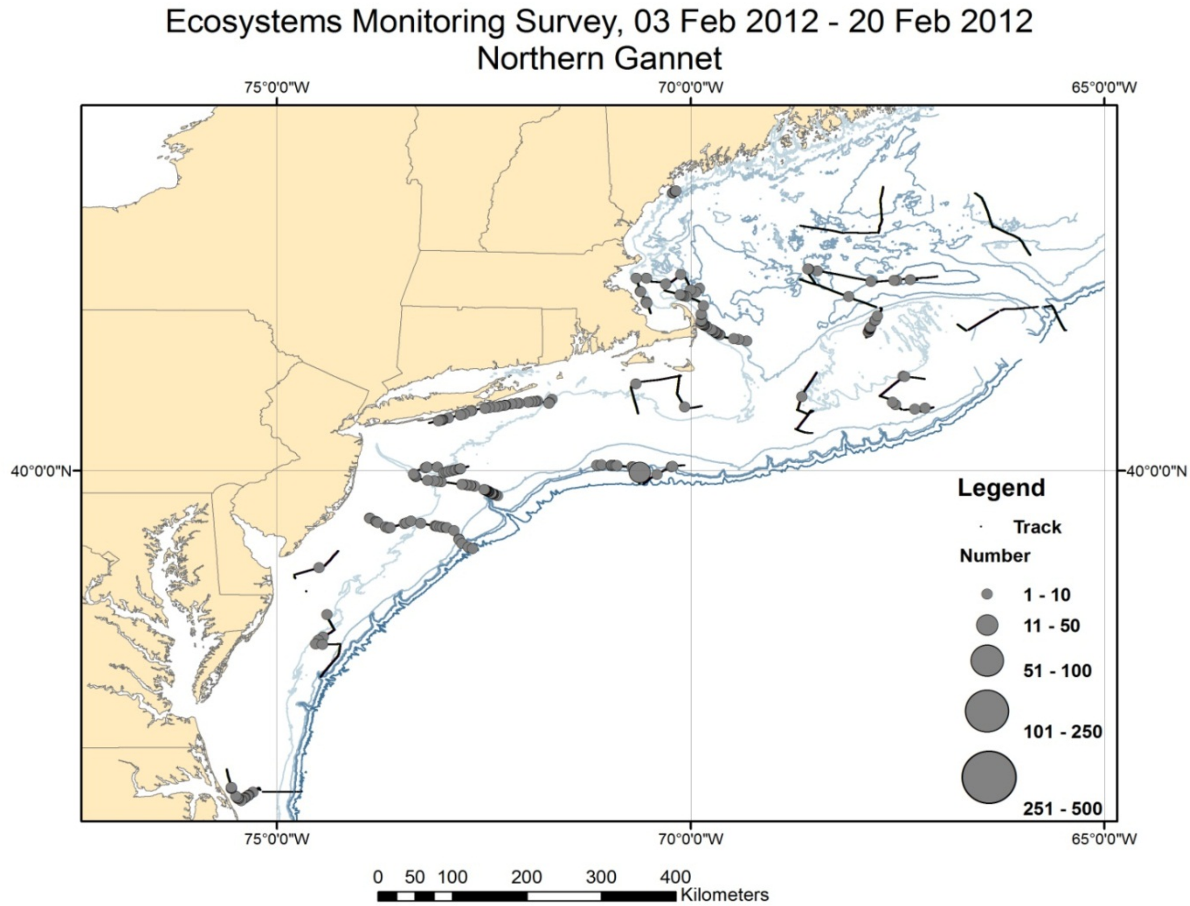
Ecosystems Monitoring Survey, 31 Oct 2011 - 18 Nov 2011
Dovekie

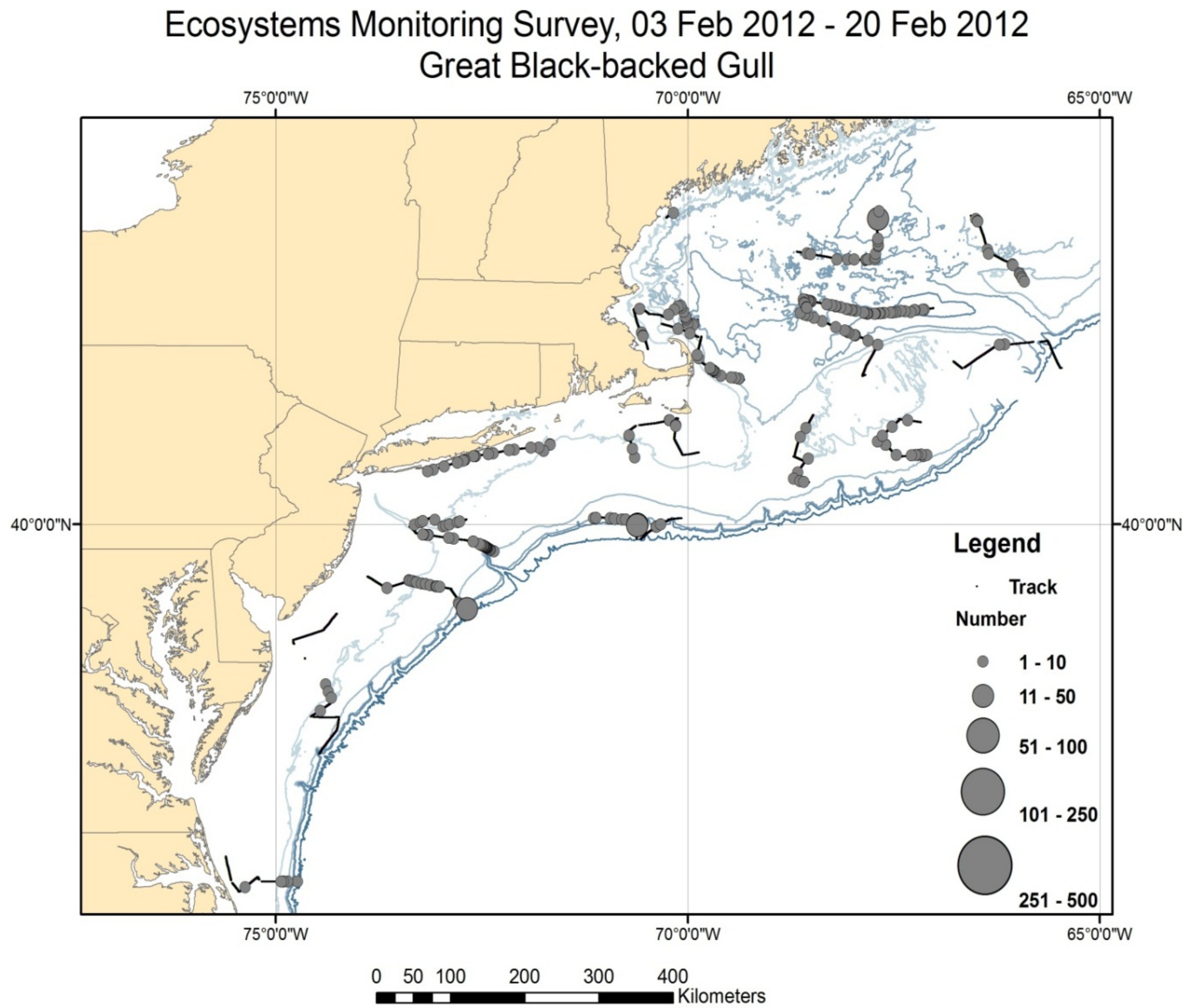



Ecosystems Monitoring Survey, 03 Feb 2012 - 20 Feb 2012
White-winged Scoter
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

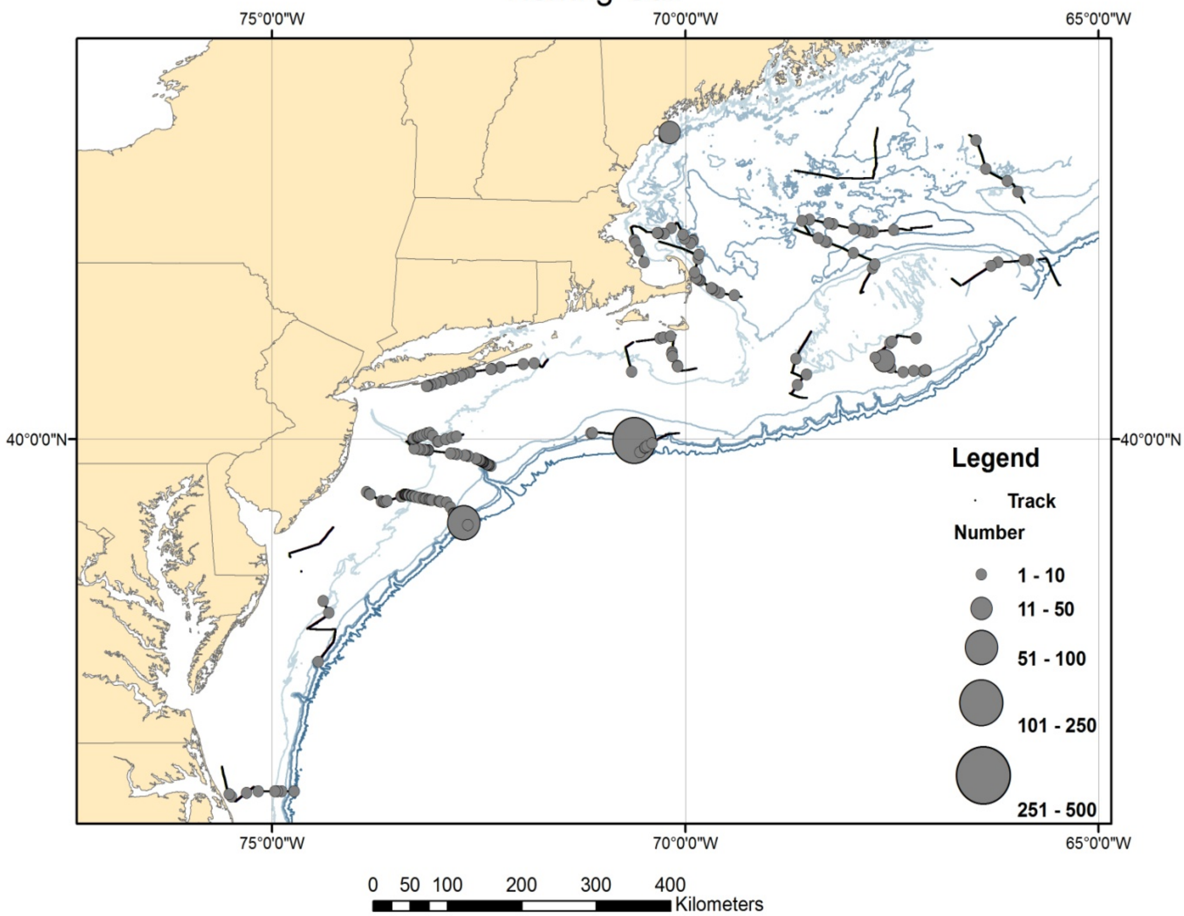
Ecosystems Monitoring Survey, 03 Feb 2012 - 20 Feb 2012
Northern Fulmar



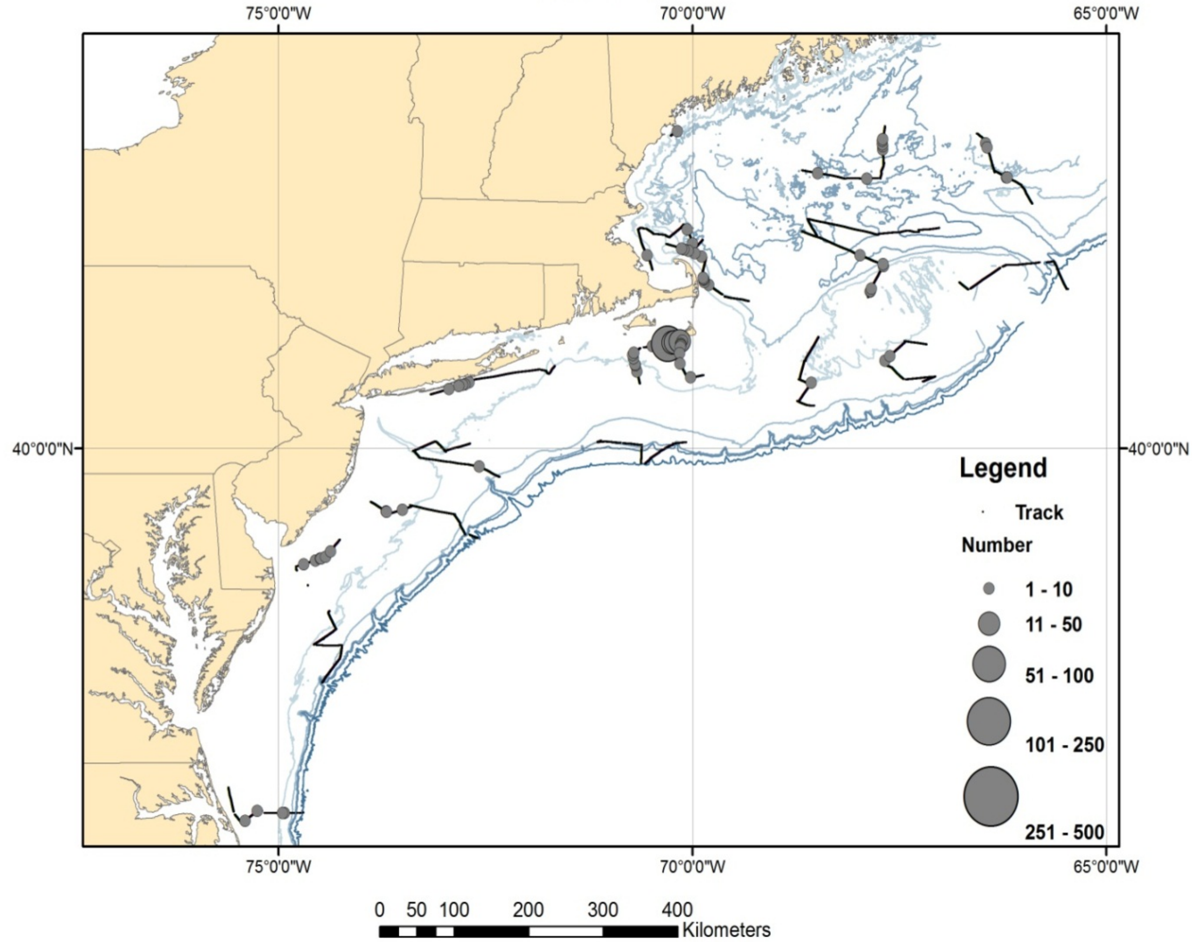

Ecosystems Monitoring Survey, 03 Feb 2012 - 20 Feb 2012
Northern Gannet
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers


Ecosystems Monitoring Survey, 03 Feb 2012 - 20 Feb 2012
Great Black-backed Gull
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

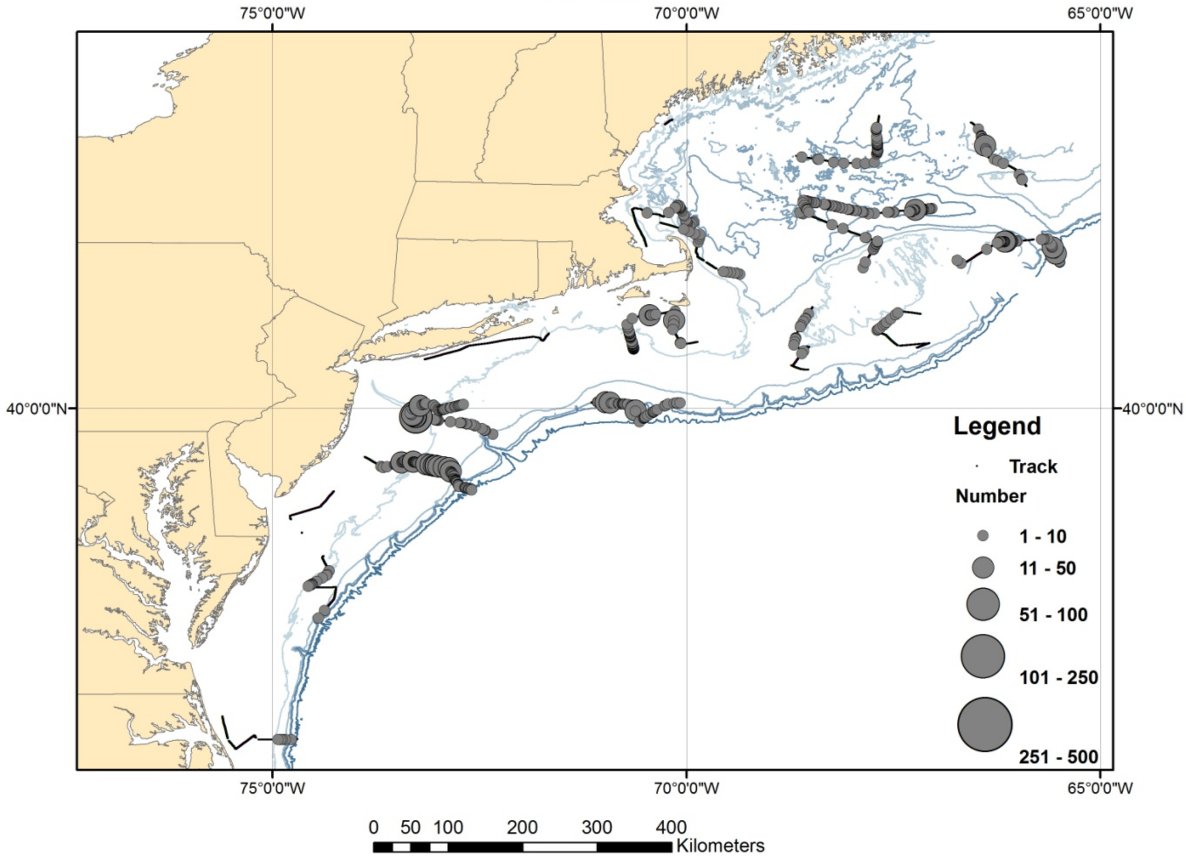
Ecosystems Monitoring Survey, 03 Feb 2012 - 20 Feb 2012
Herring Gull

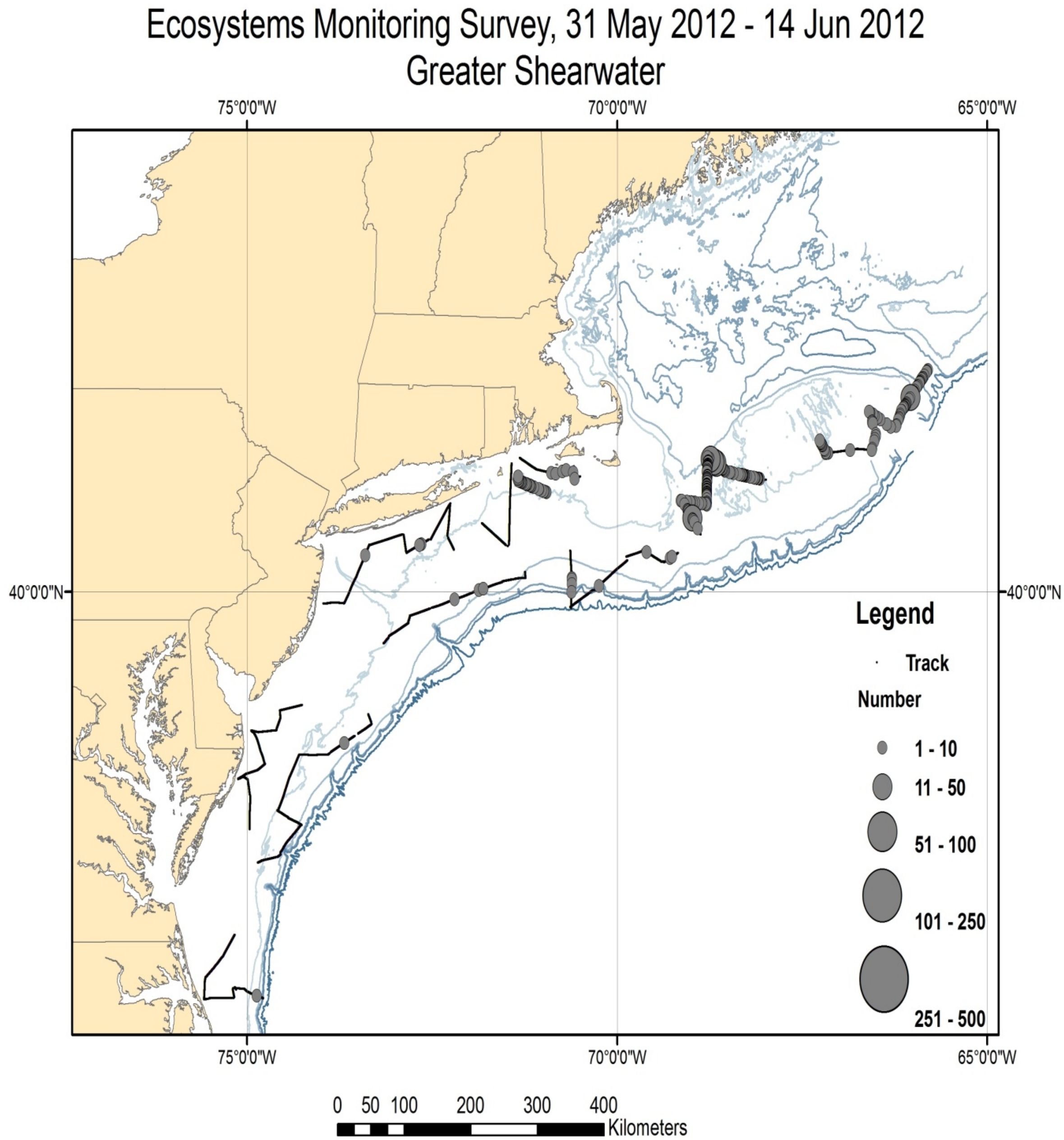


Ecosystems Monitoring Survey, 03 Feb 2012 - 20 Feb 2012
Razorbill

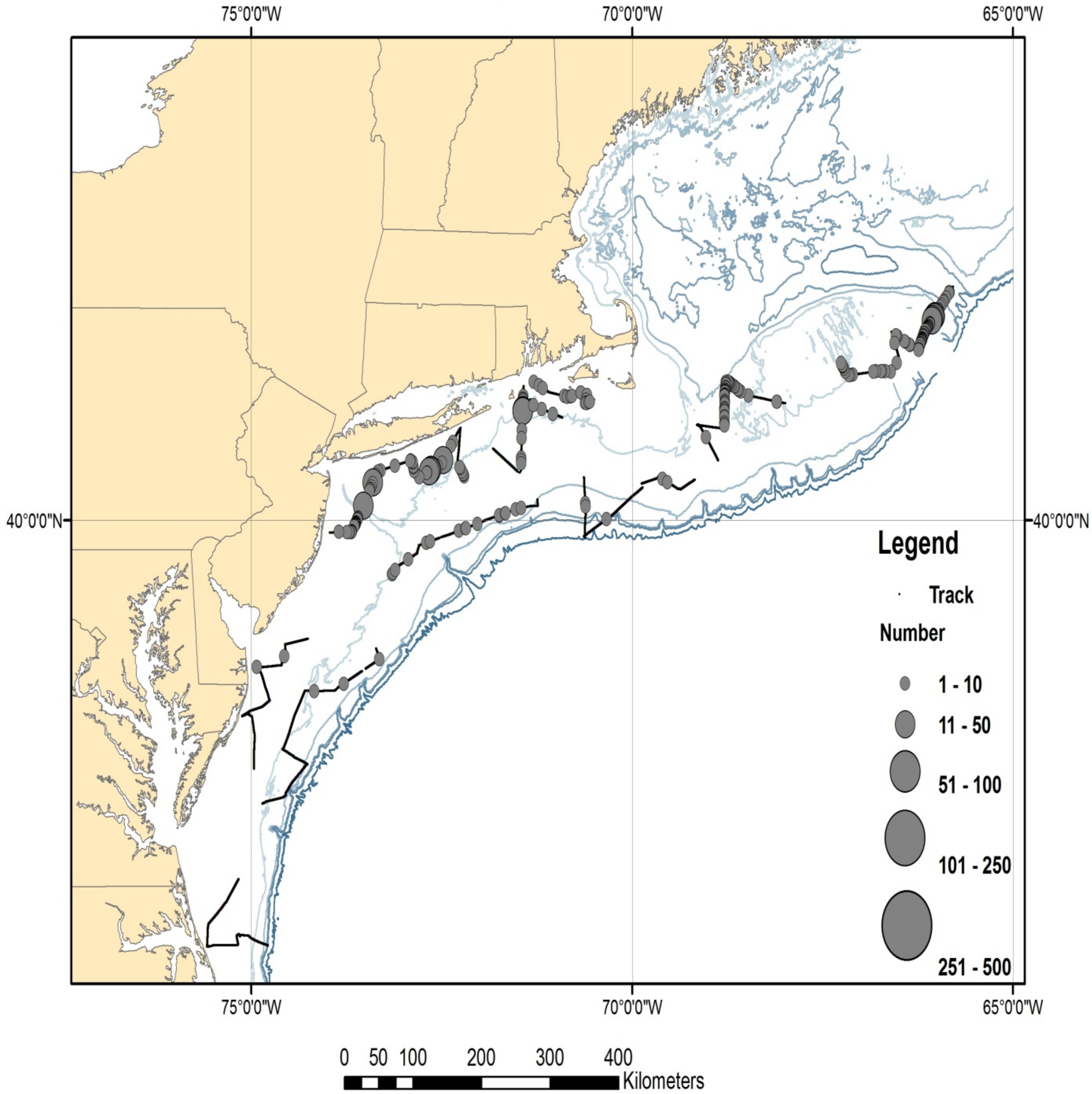


Ecosystems Monitoring Survey, 03 Feb 2012 - 20 Feb 2012
Dovekie

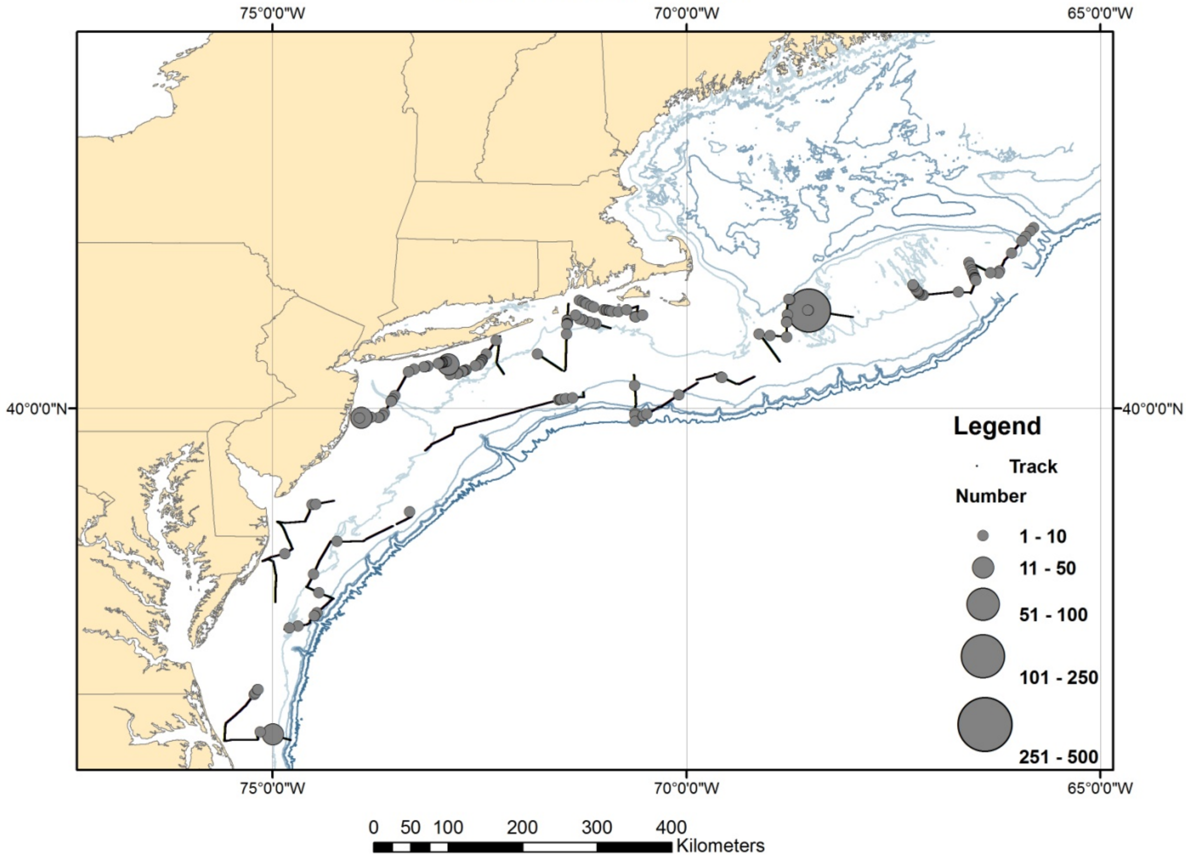



Ecosystems Monitoring Survey, 31 May 2012 - 14 Jun 2012
Greater Shearwater
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

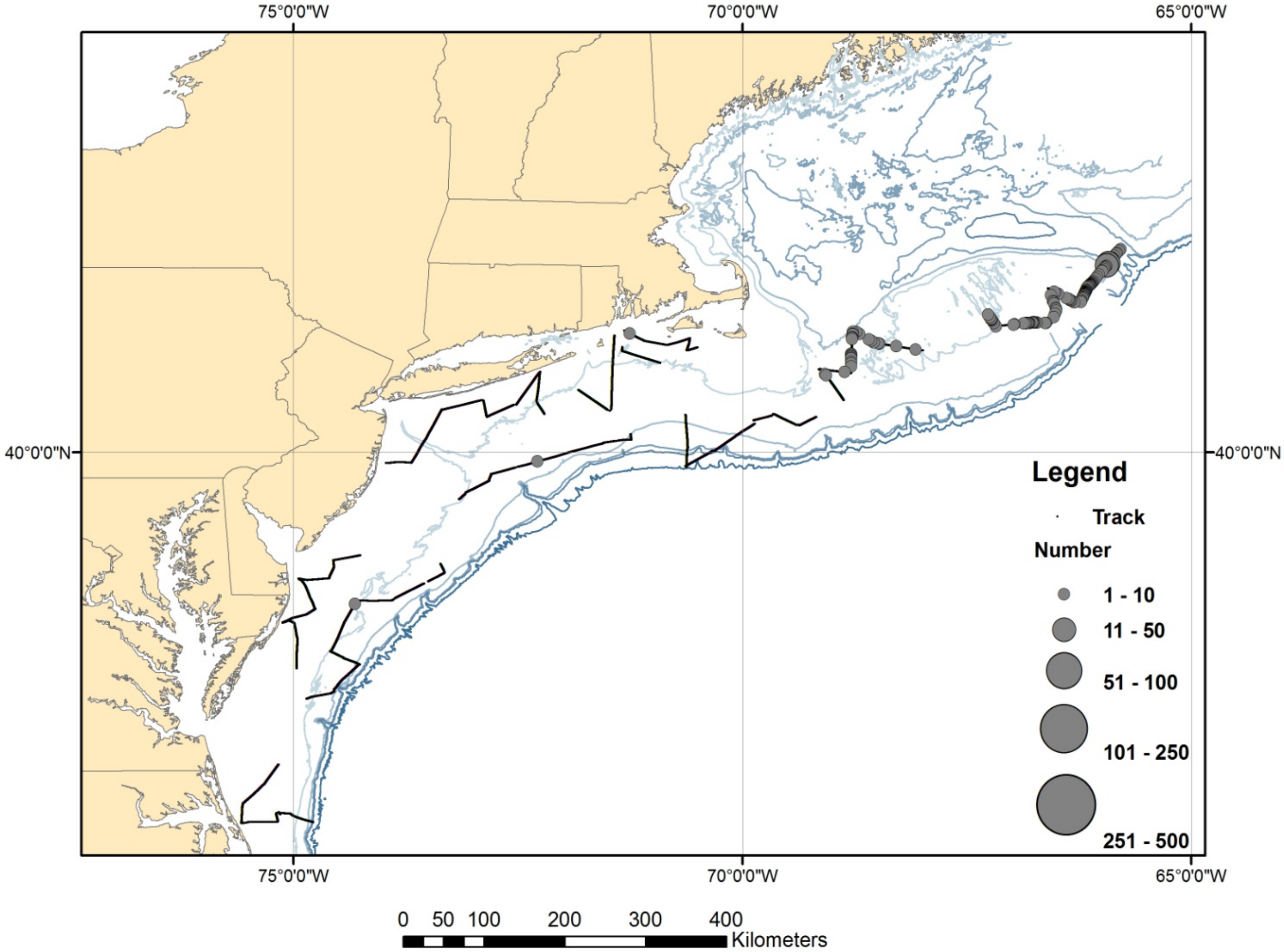
Ecosystems Monitoring Survey, 31 May 2012 - 14 Jun 2012
Sooty Shearwater

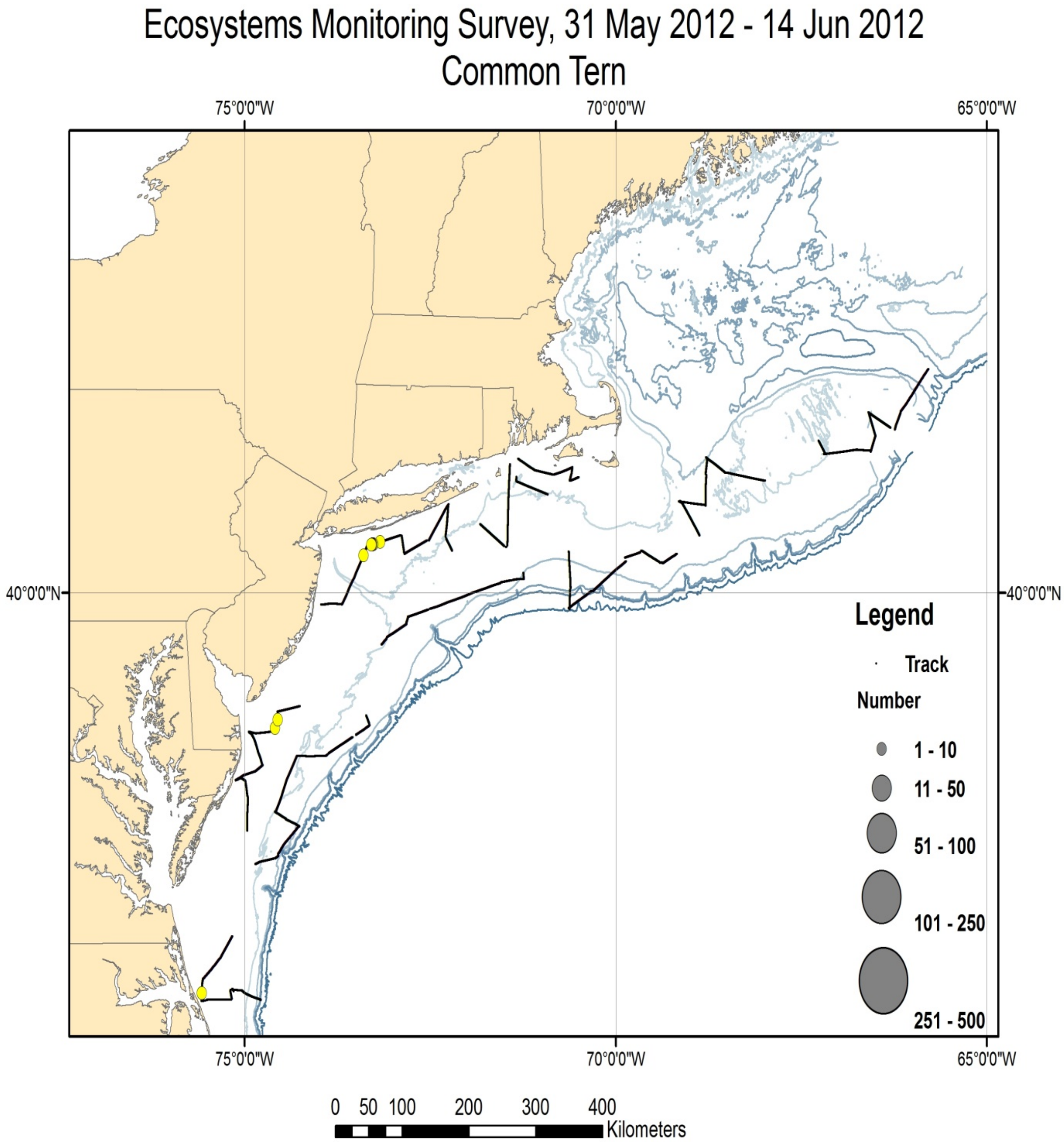


Ecosystems Monitoring Survey, 31 May 2012 - 14 Jun 2012
Wilson's Storm Petrel

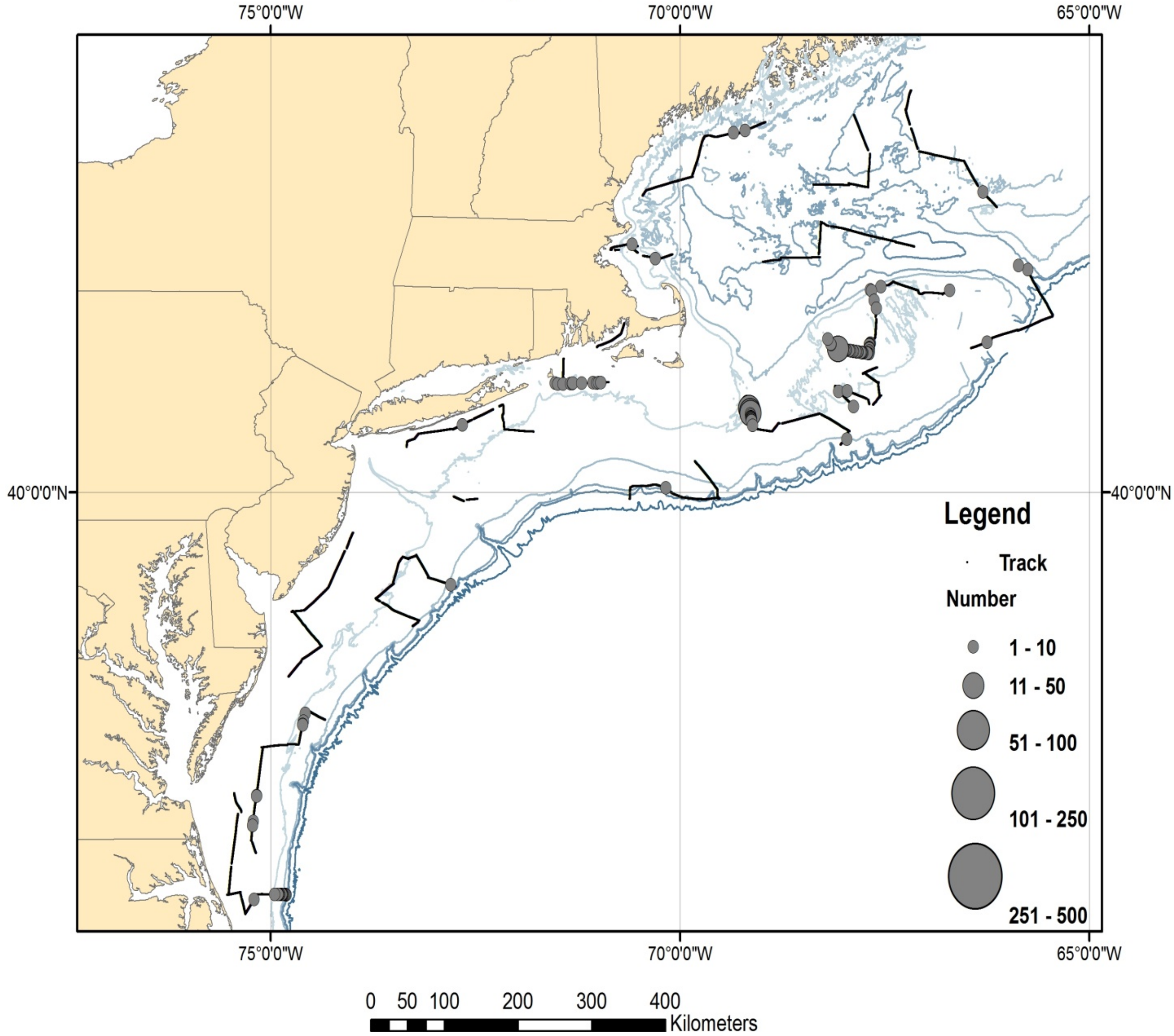


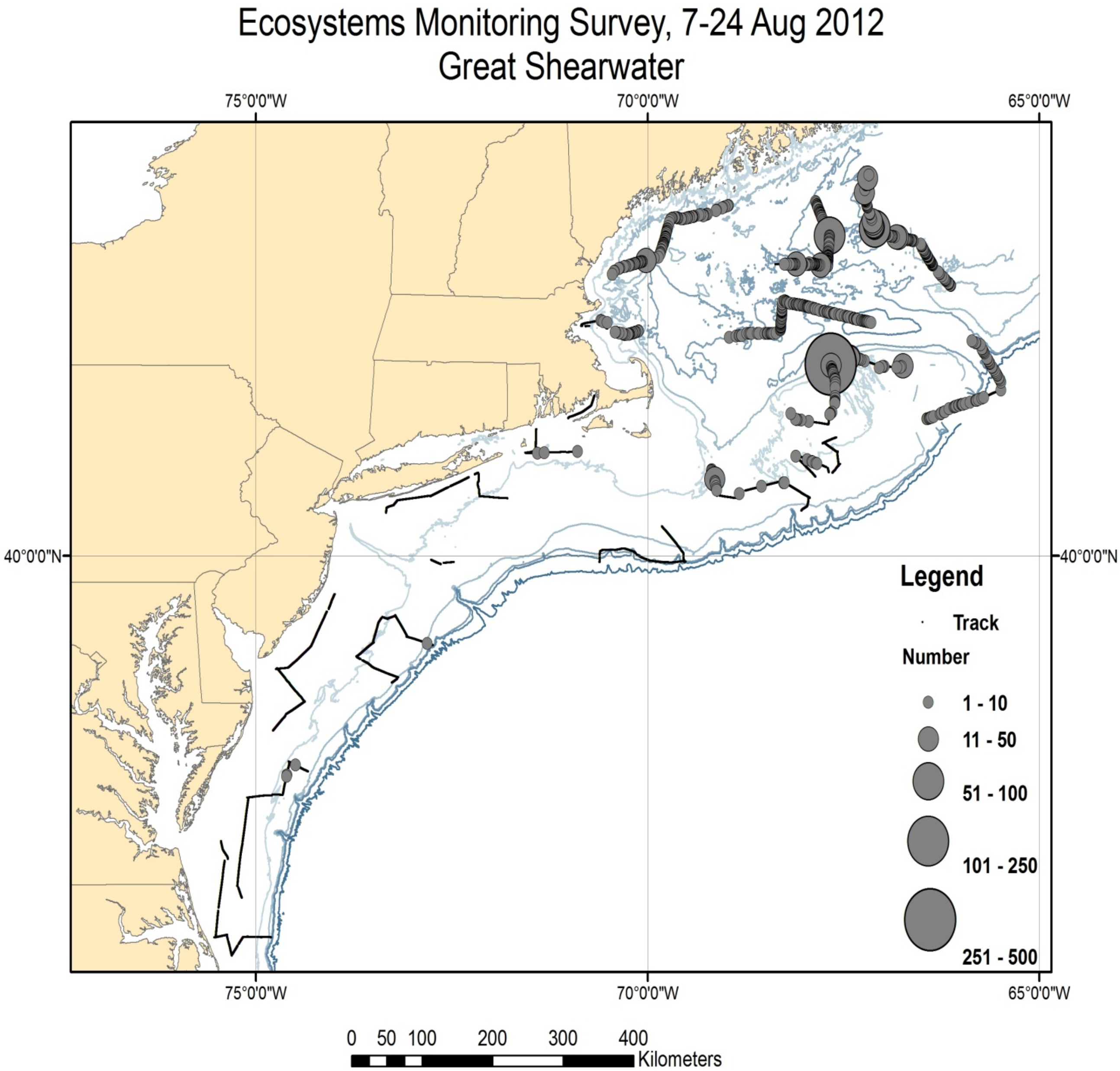
Ecosystems Monitoring Survey, 31 May 2012 - 14 Jun 2012
Leach's Storm Petrel



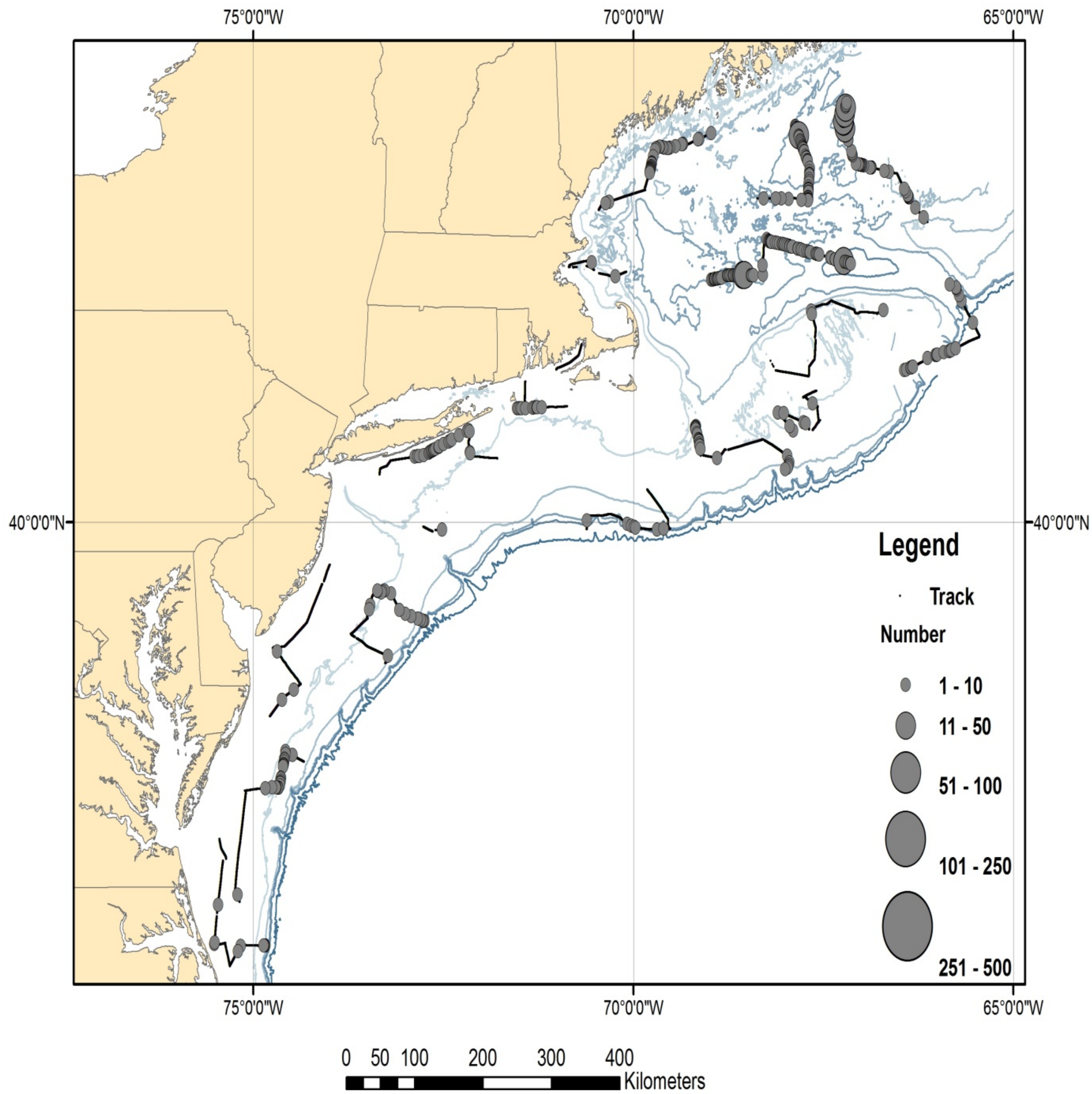

Ecosystems Monitoring Survey, 31 May 2012 - 14 Jun 2012
Common Tern
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
75°0'0"W
70°0'0"W
65°0'0"W
0 50 100 200 300 400
Kilometers

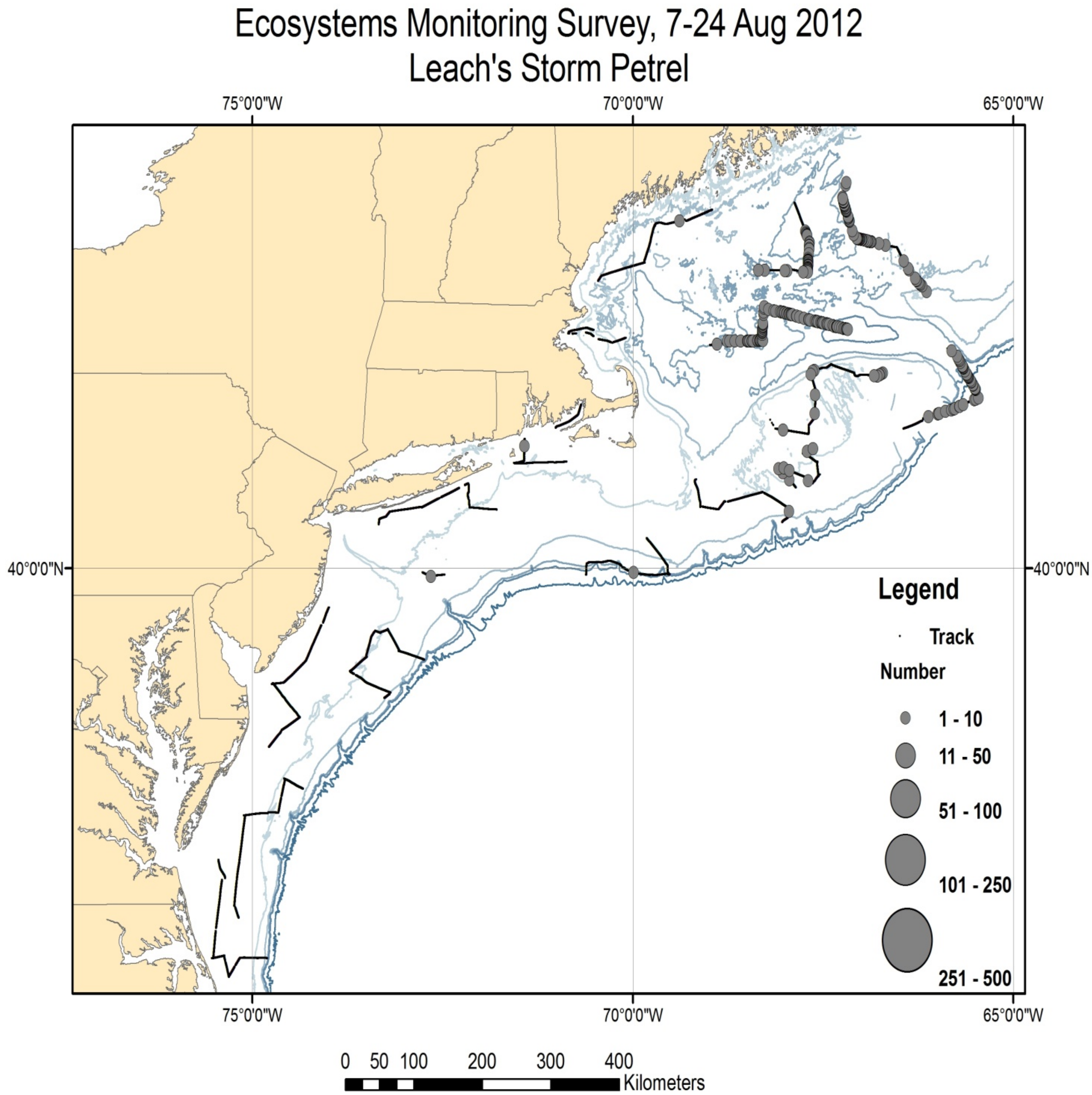
Ecosystems Monitoring Survey, 7-24 Aug 2012
Cory's Shearwater

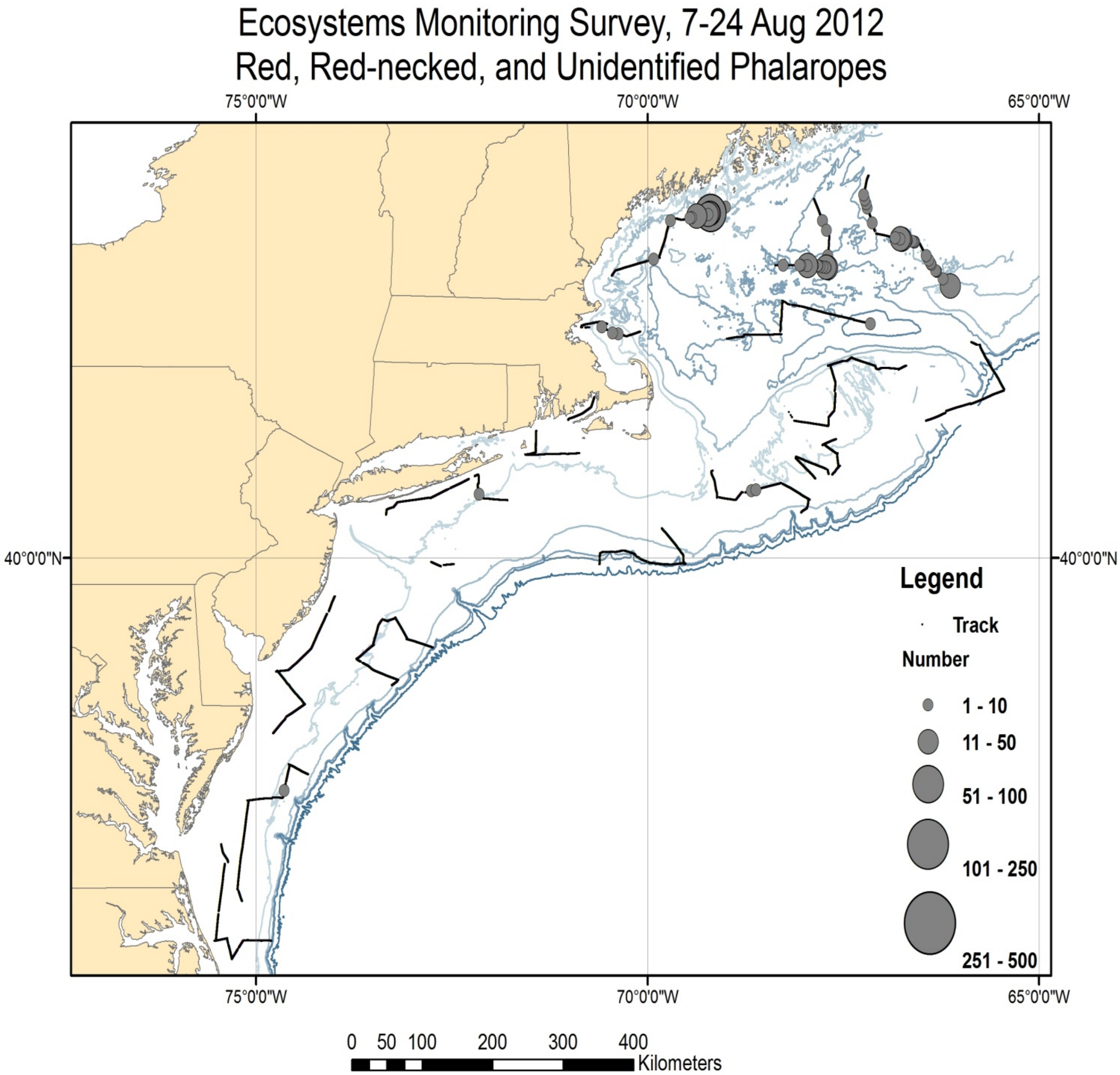


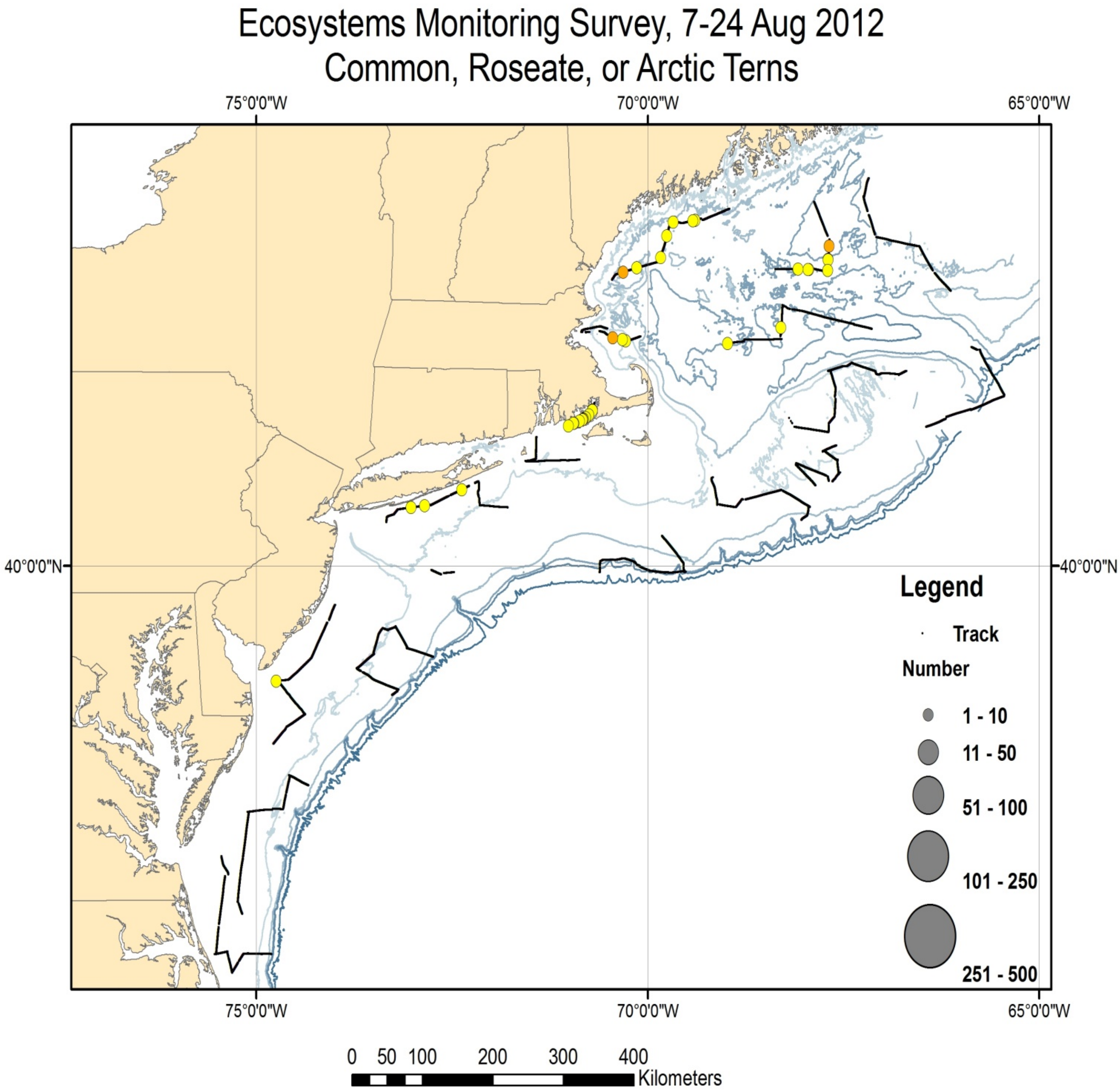

Ecosystems Monitoring Survey, 7-24 Aug 2012
Great Shearwater
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

Ecosystems Monitoring Survey, 7-24 Aug 2012
Wilson's Storm Petrel

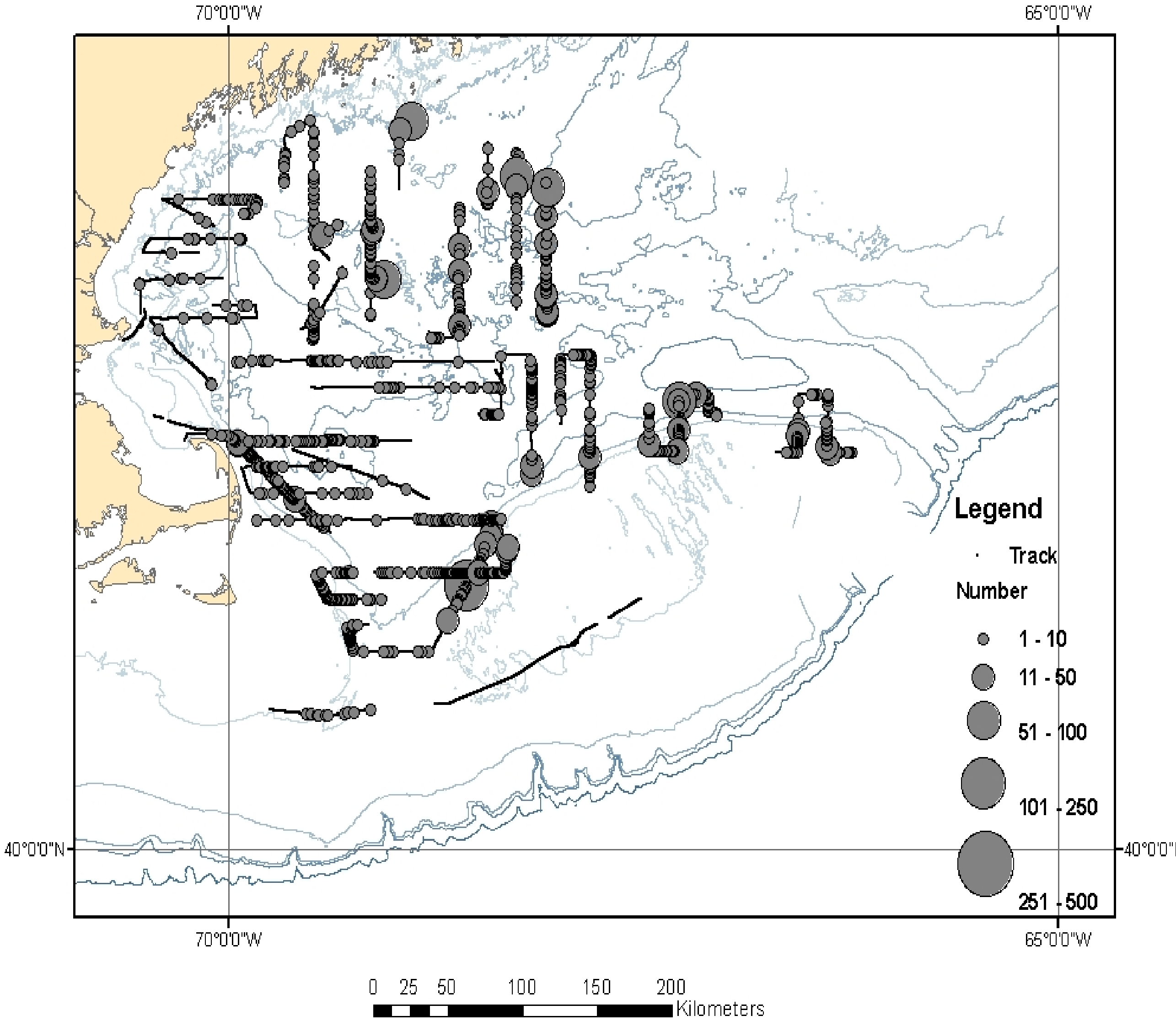


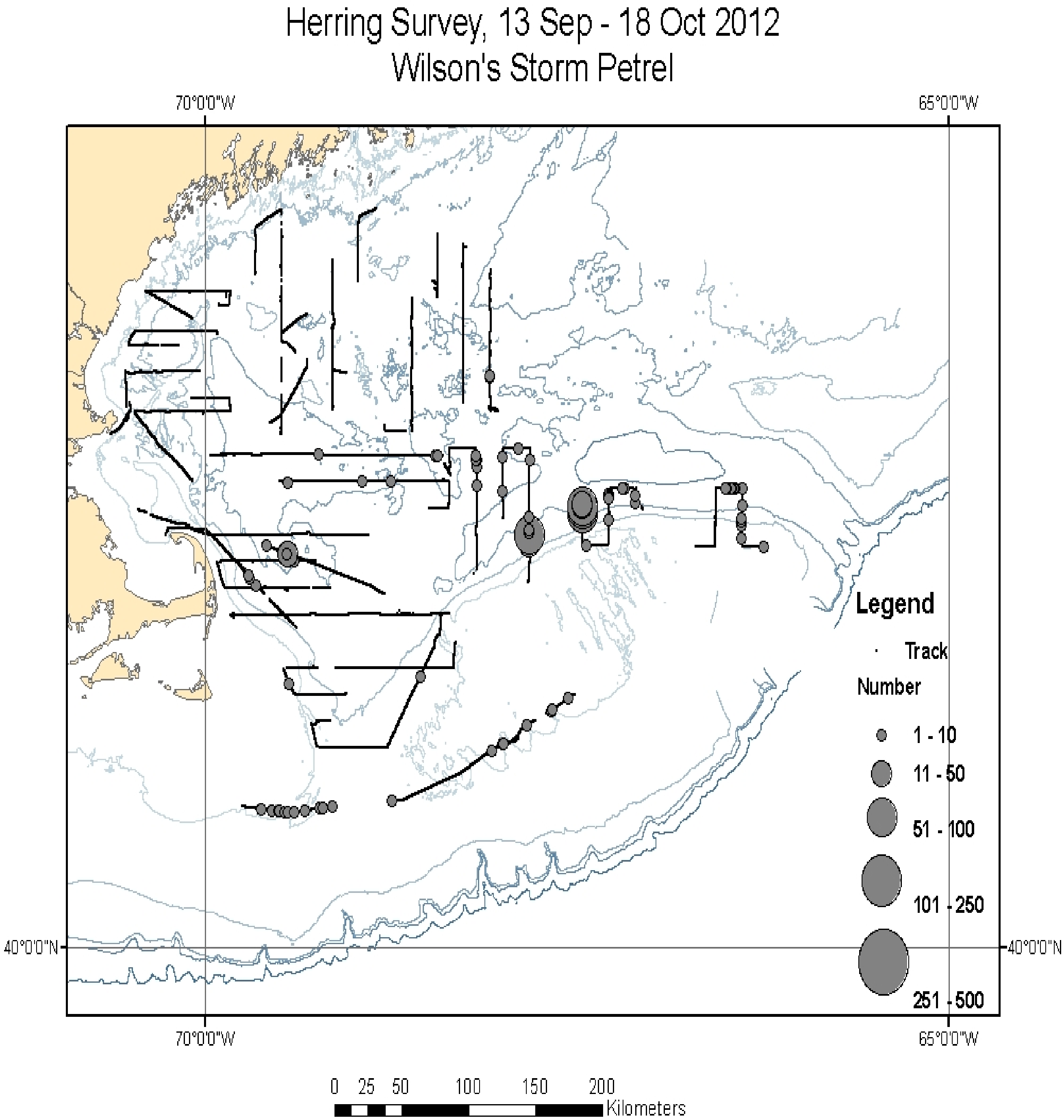

Ecosystems Monitoring Survey, 7-24 Aug 2012
Leach's Storm Petrel
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers


Ecosystems Monitoring Survey, 7-24 Aug 2012
Red, Red-necked, and Unidentified Phalaropes
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

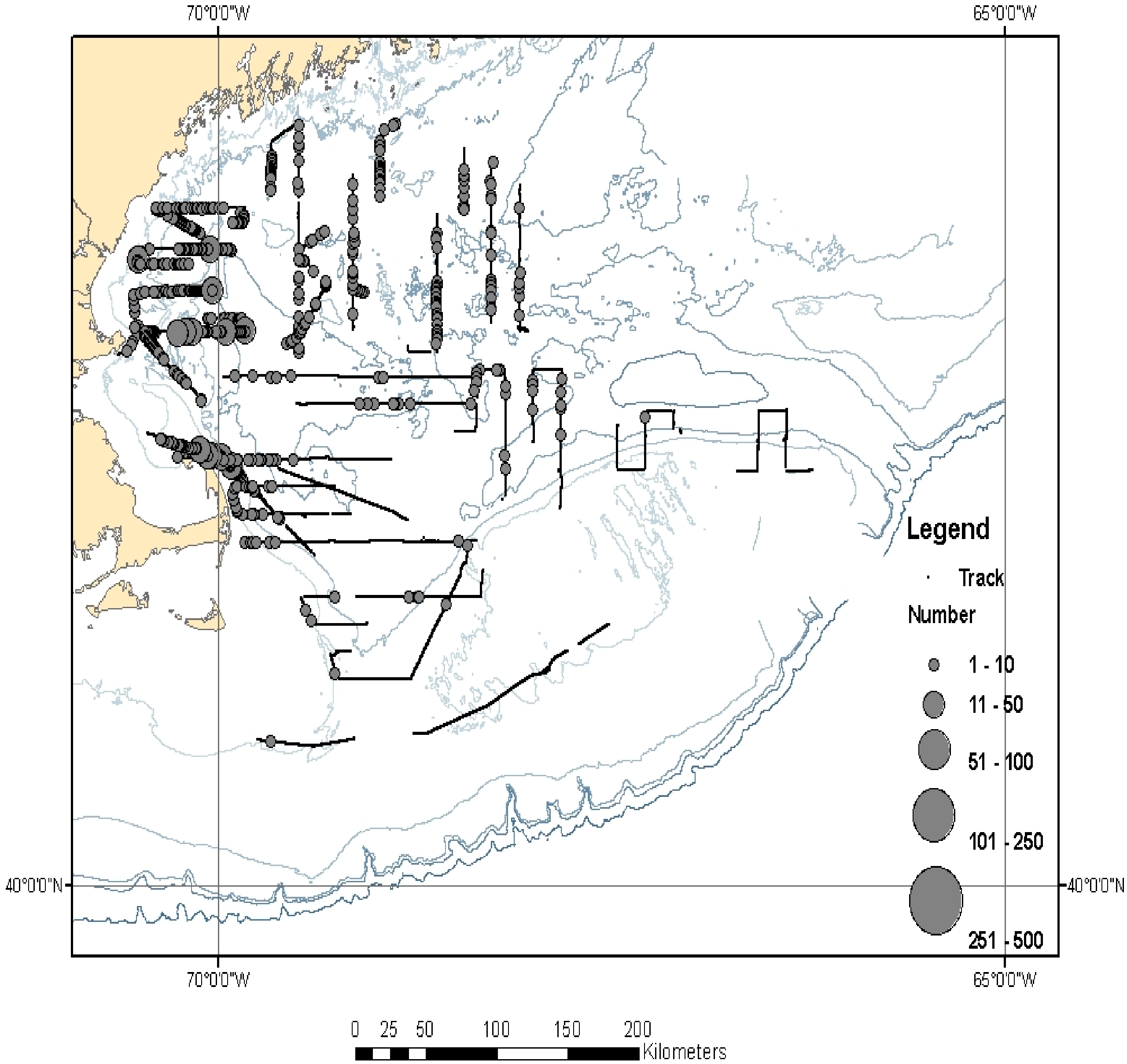

Ecosystems Monitoring Survey, 7-24 Aug 2012
Common, Roseate, or Arctic Terns
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

Herring Survey, 13 Sep - 18 Oct 2012
Great Shearwater

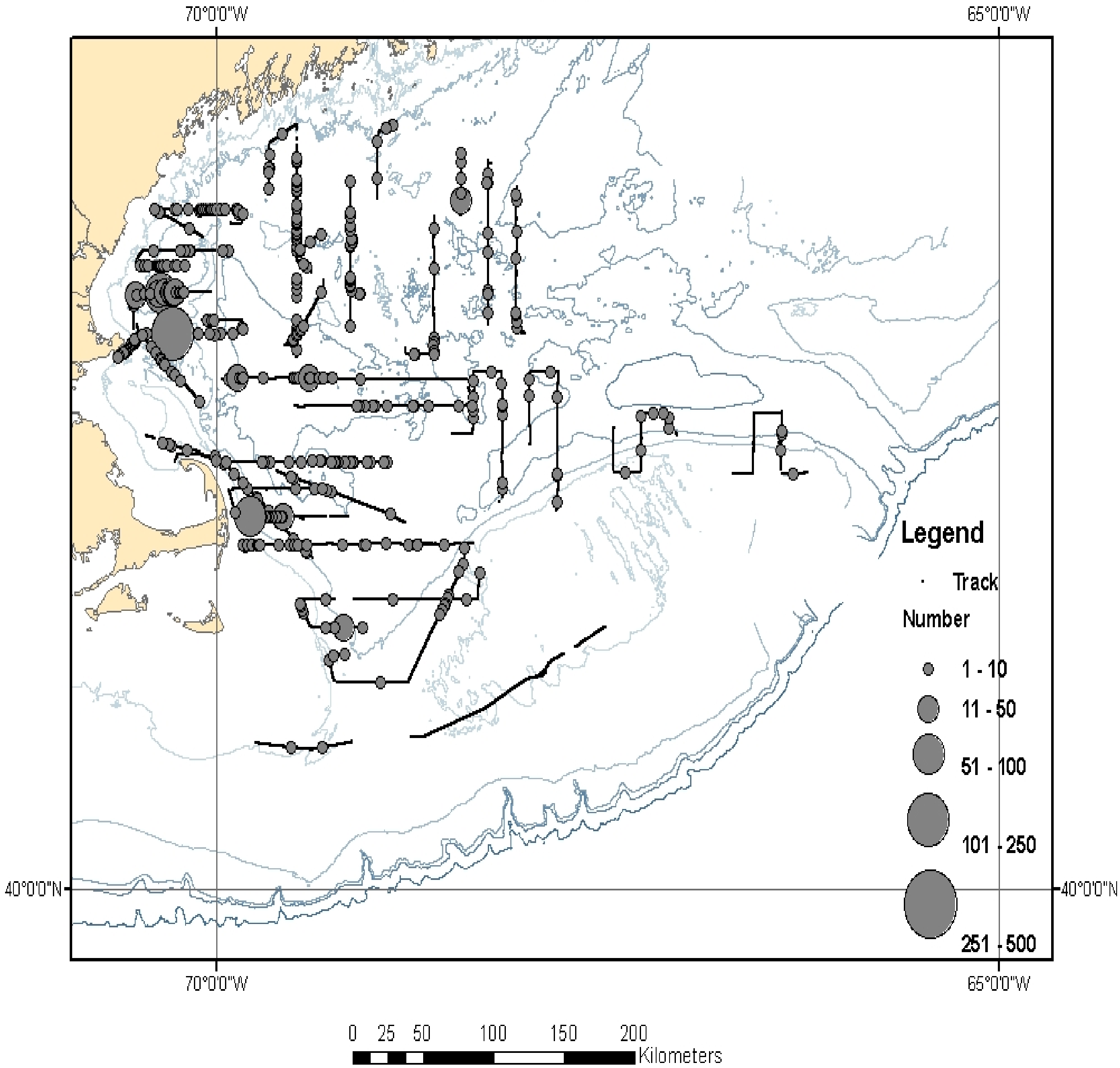


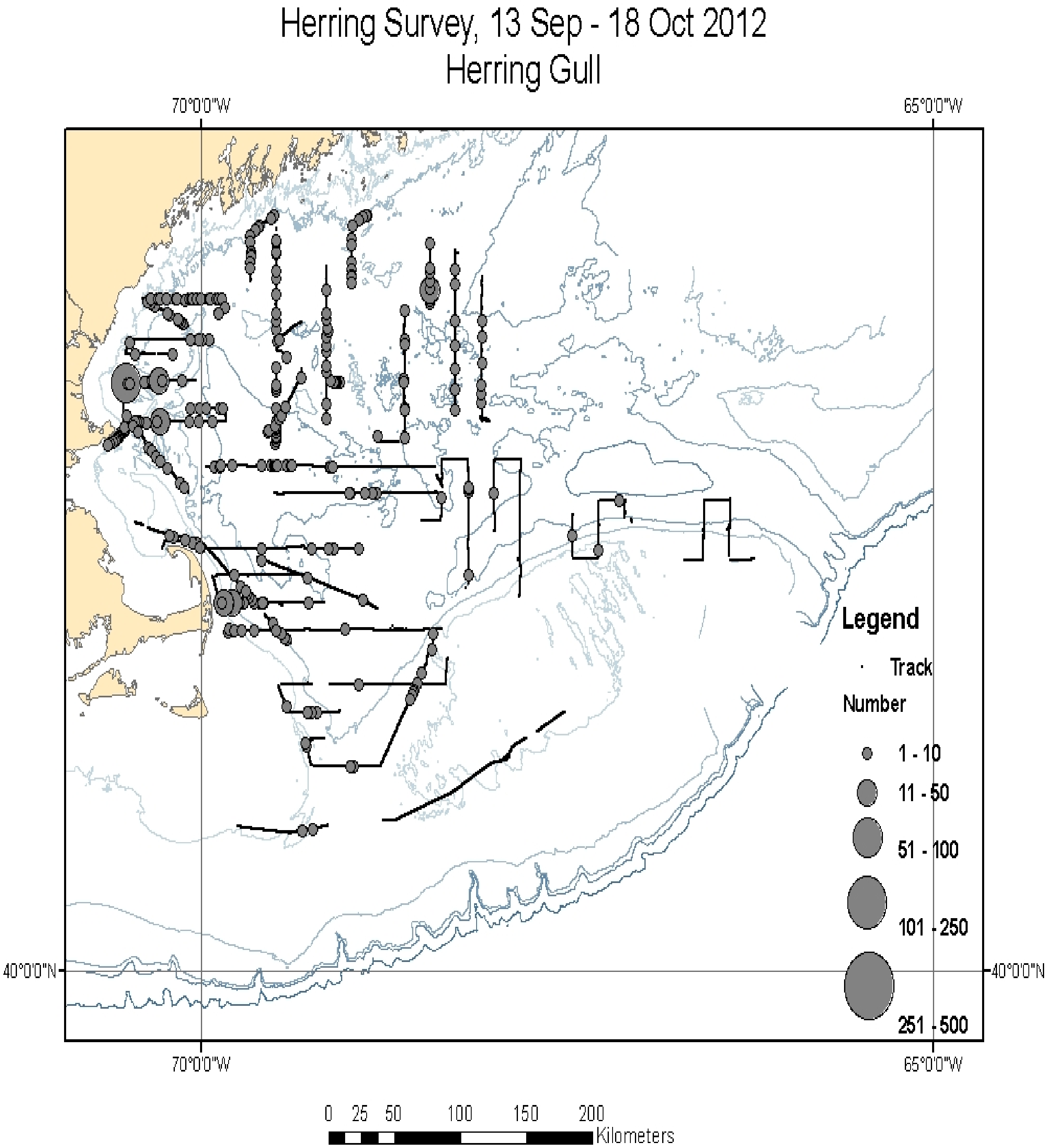

Herring Survey, 13 Sep - 18 Oct 2012
Wilson's Storm Petrel
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 25 50 100 150 200
Kilometers

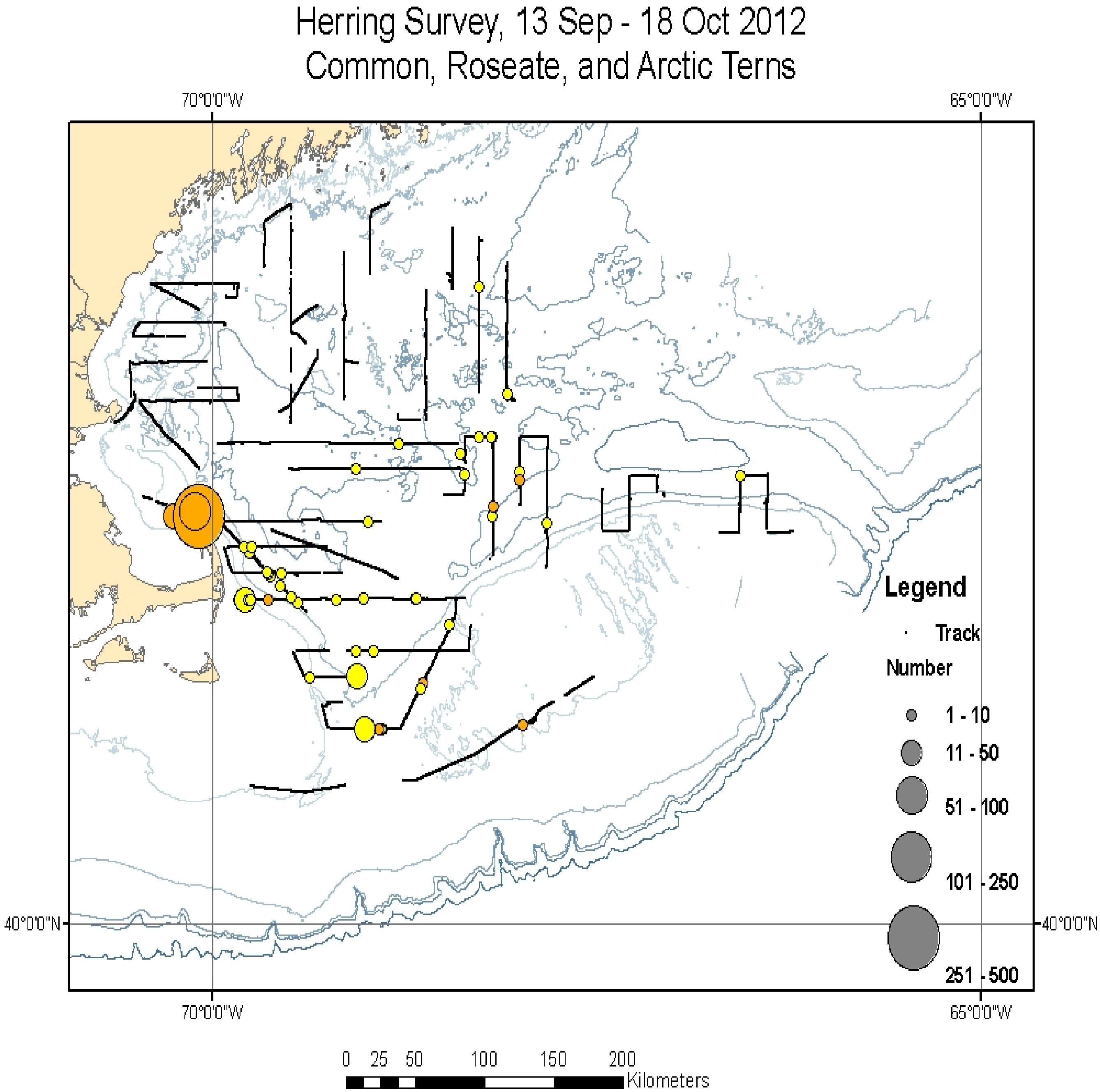
Herring Survey, 13 Sep - 18 Oct 2012
Northern Gannet

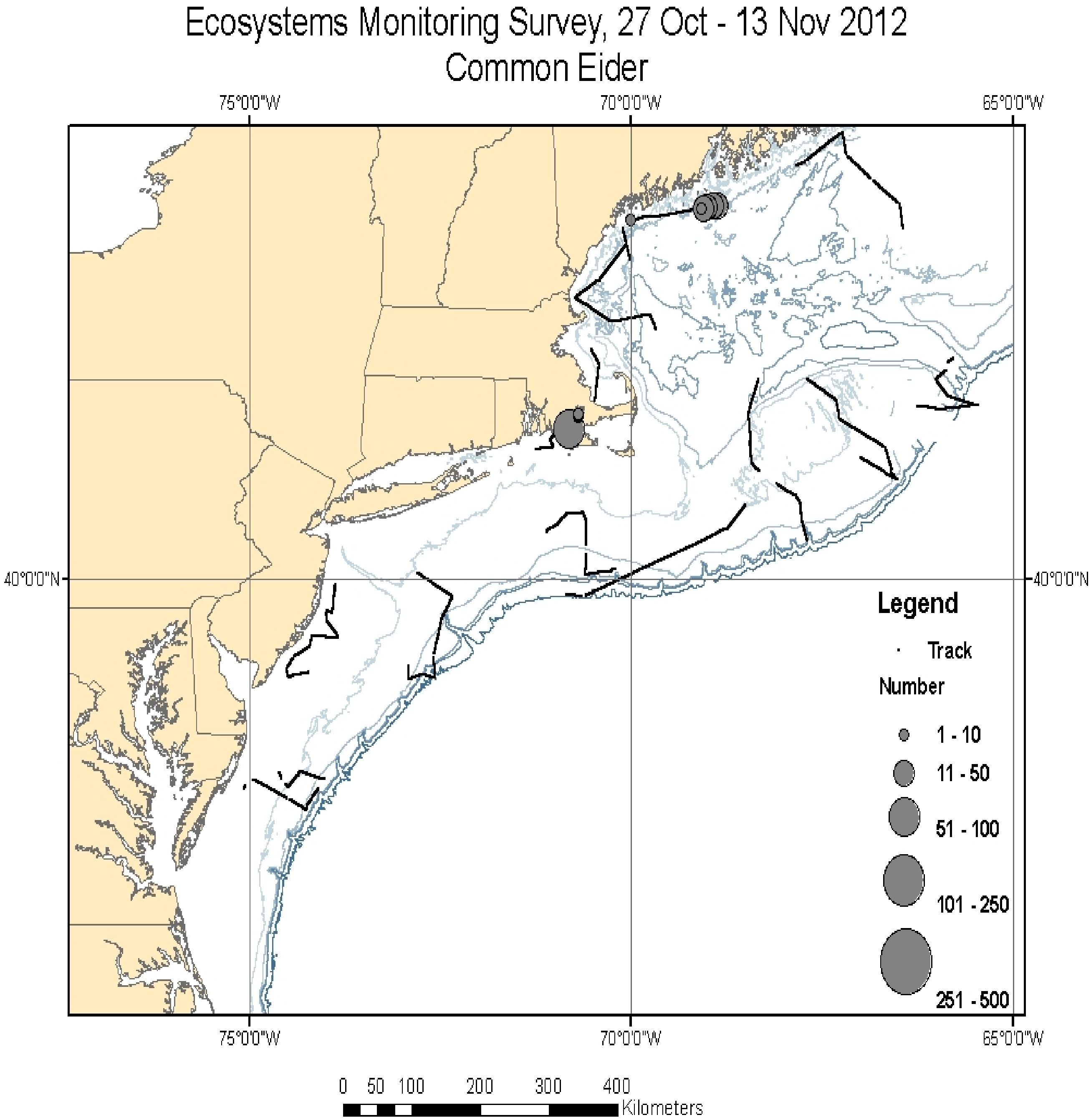


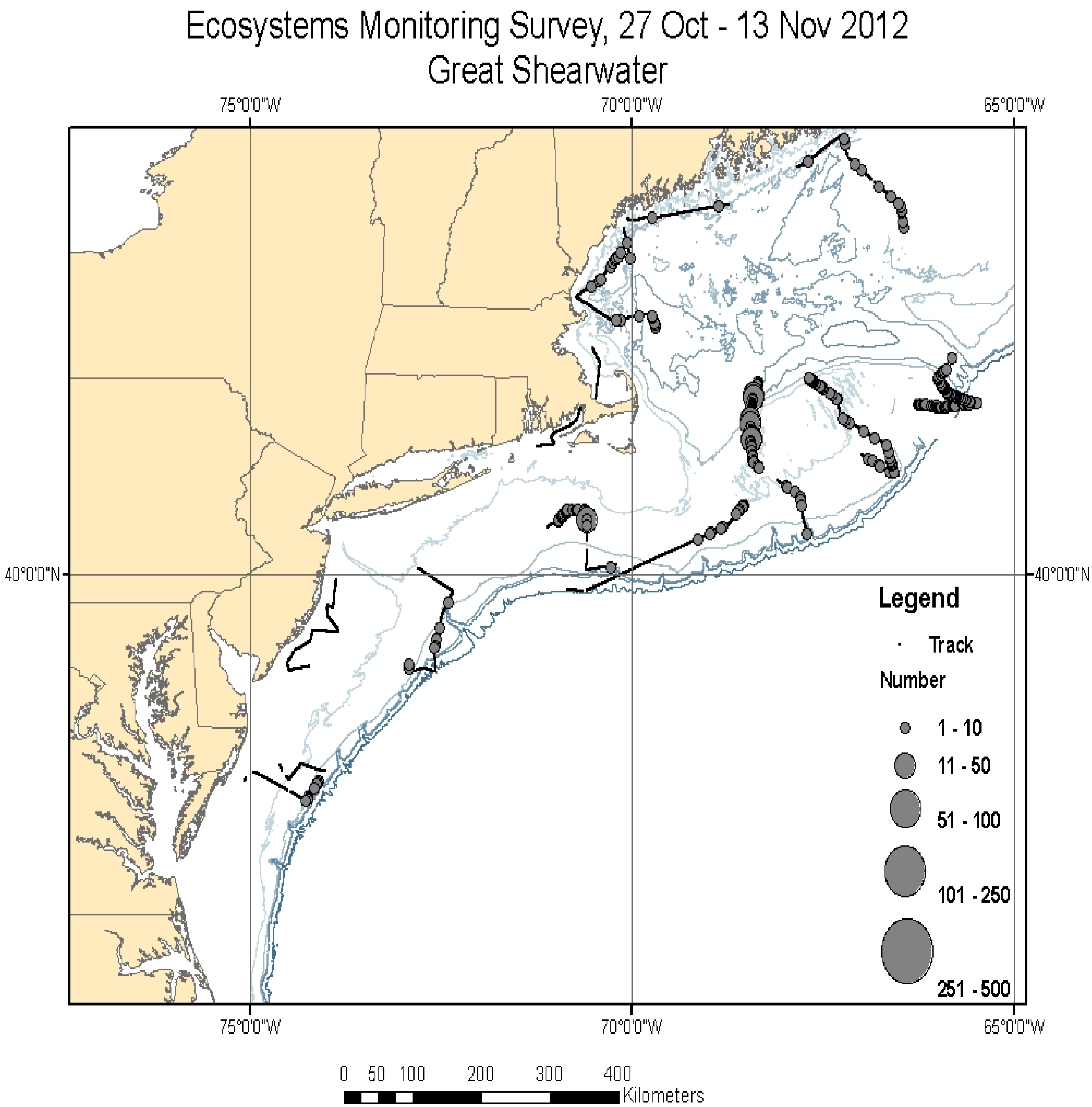
Herring Survey, 13 Sep - 18 Oct 2012
Great Black-backed Gull

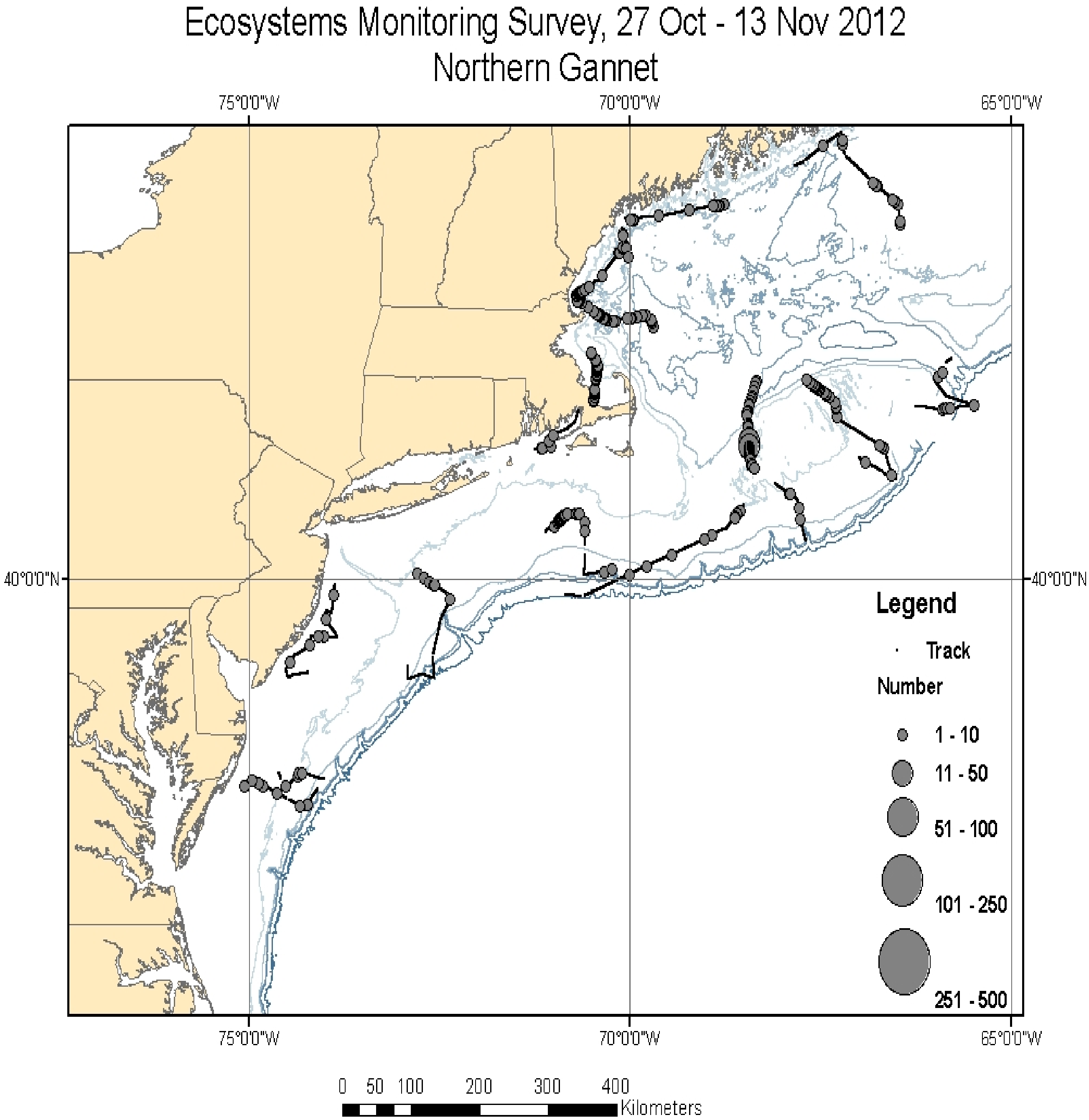


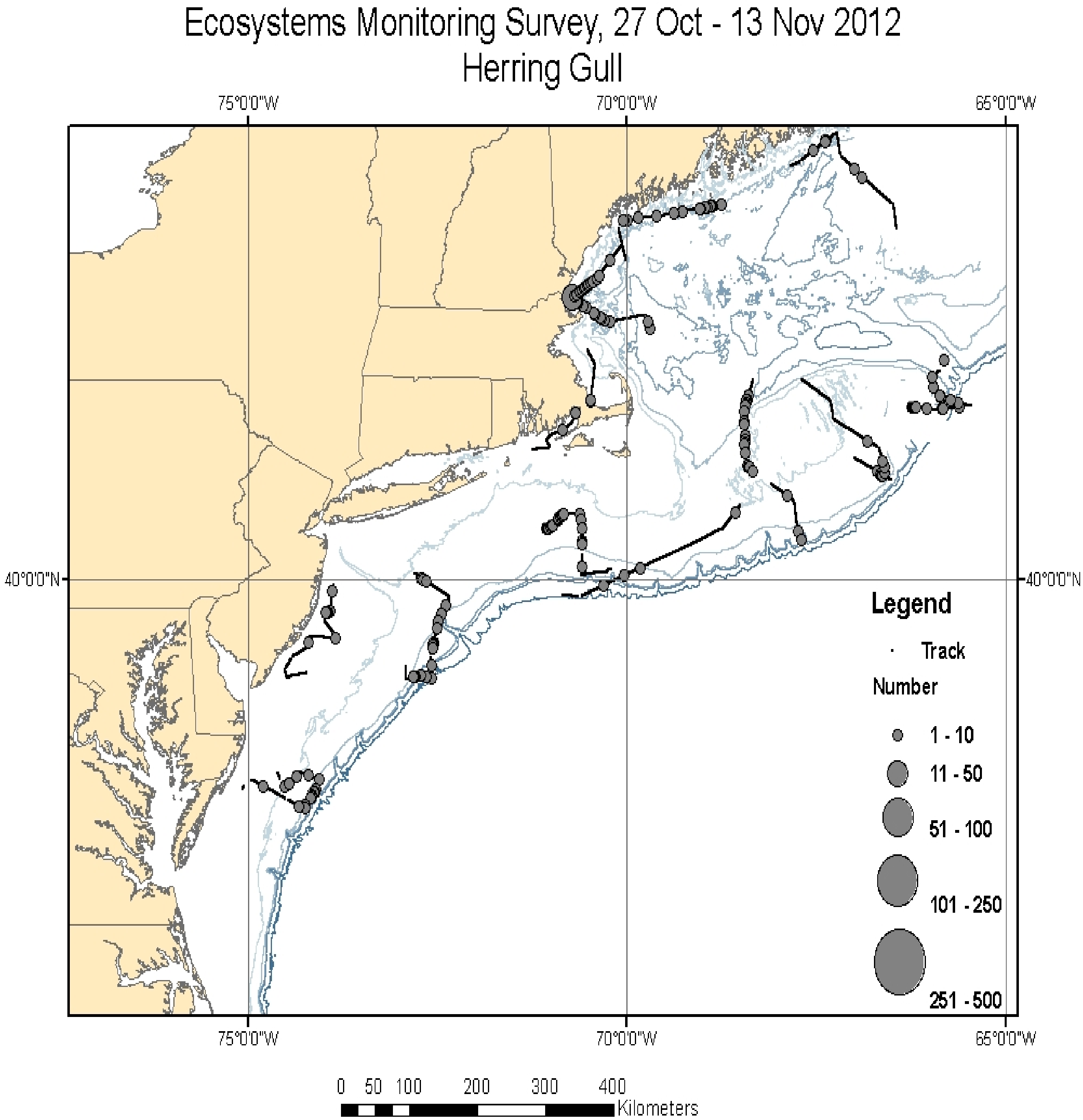

Herring Survey, 13 Sep - 18 Oct 2012
Herring Gull
70°0'0"W
65°0'0"W
40°0'0"N
40°0'0"N
70°0'0"W
65°0'0"W
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 25 50 100 150 200
Kilometers

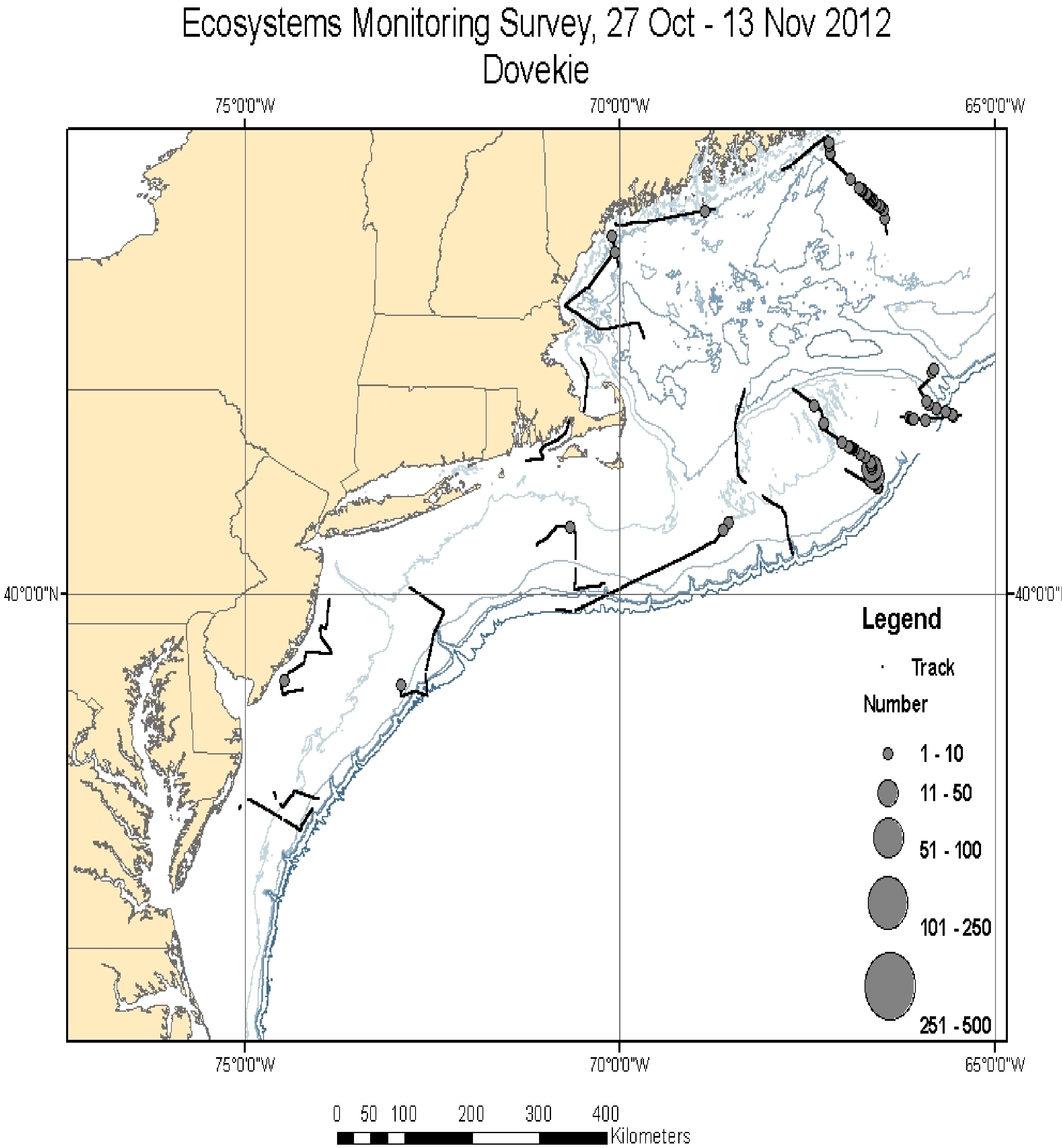

Herring Survey, 13 Sep - 18 Oct 2012
Common, Roseate, and Arctic Terns
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 25 50 100 150 200
Kilometers

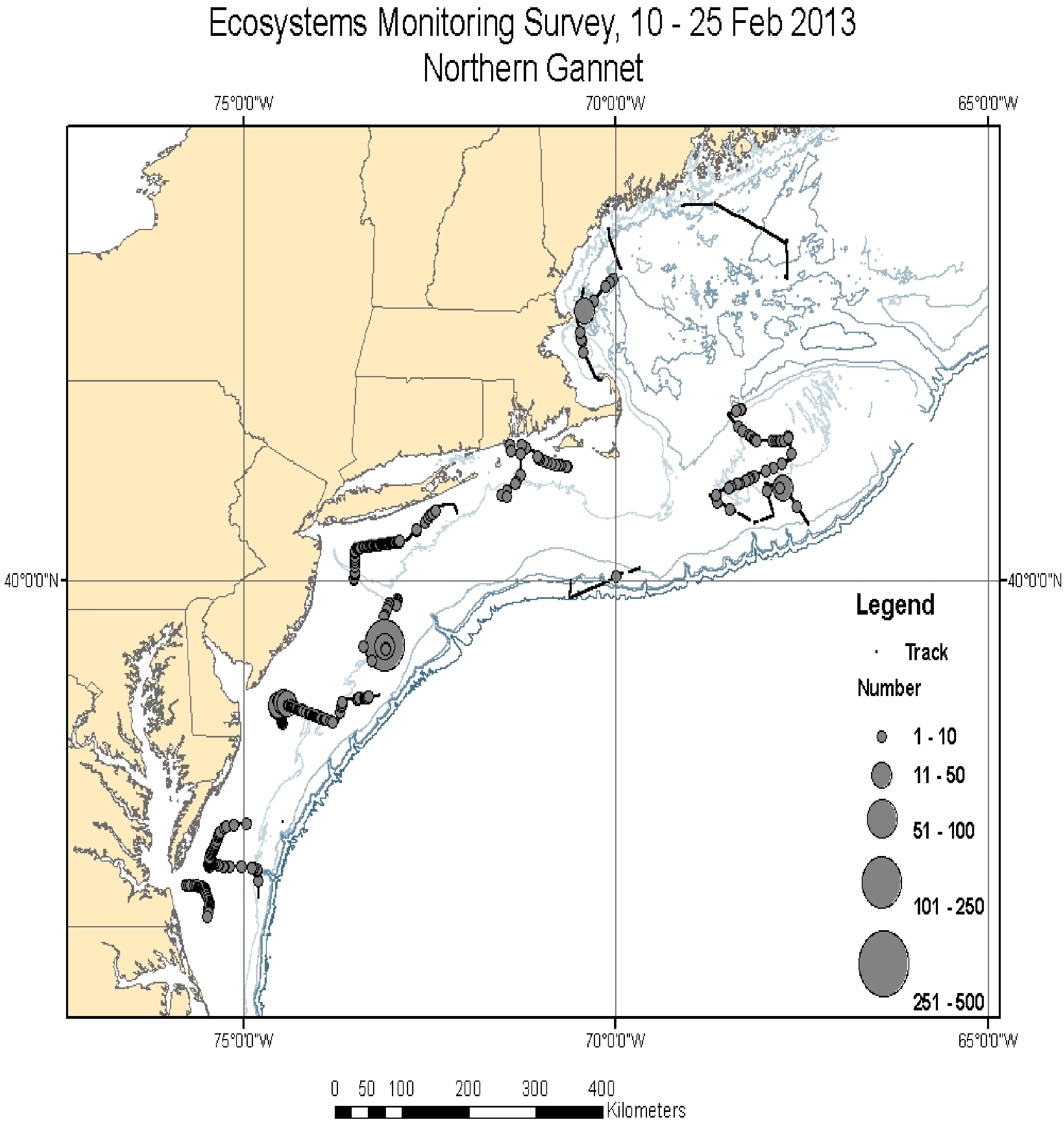

Ecosystems Monitoring Survey, 27 Oct - 13 Nov 2012
Common Eider
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
75°0'0"W
70°0'0"W
65°0'0"W
0 50 100 200 300 400
Kilometers

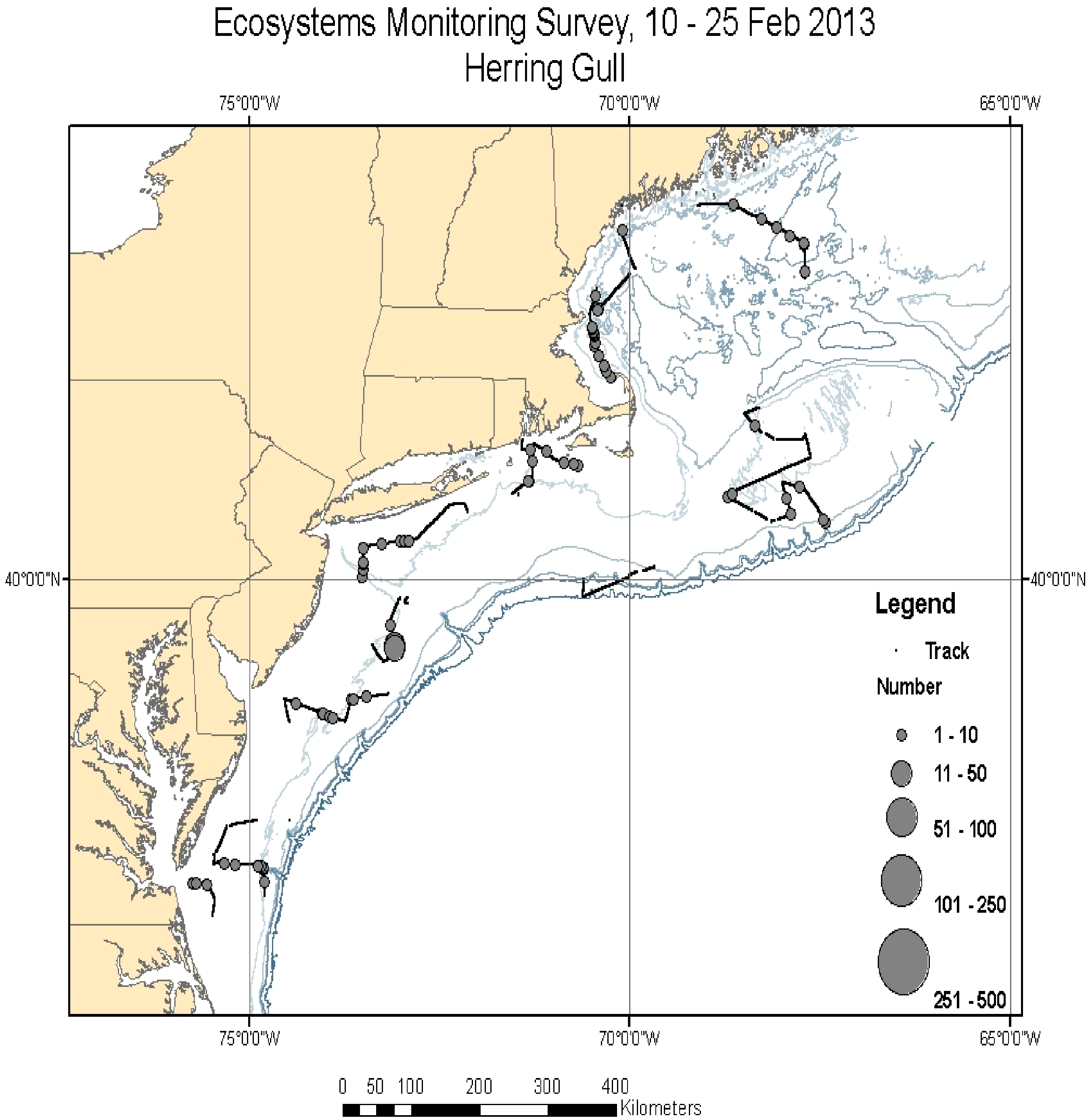

Ecosystems Monitoring Survey, 27 Oct - 13 Nov 2012
Great Shearwater
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers


Ecosystems Monitoring Survey, 27 Oct - 13 Nov 2012
Northern Gannet
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
75°0'0"W
70°0'0"W
65°0'0"W
0 50 100 200 300 400
Kilometers

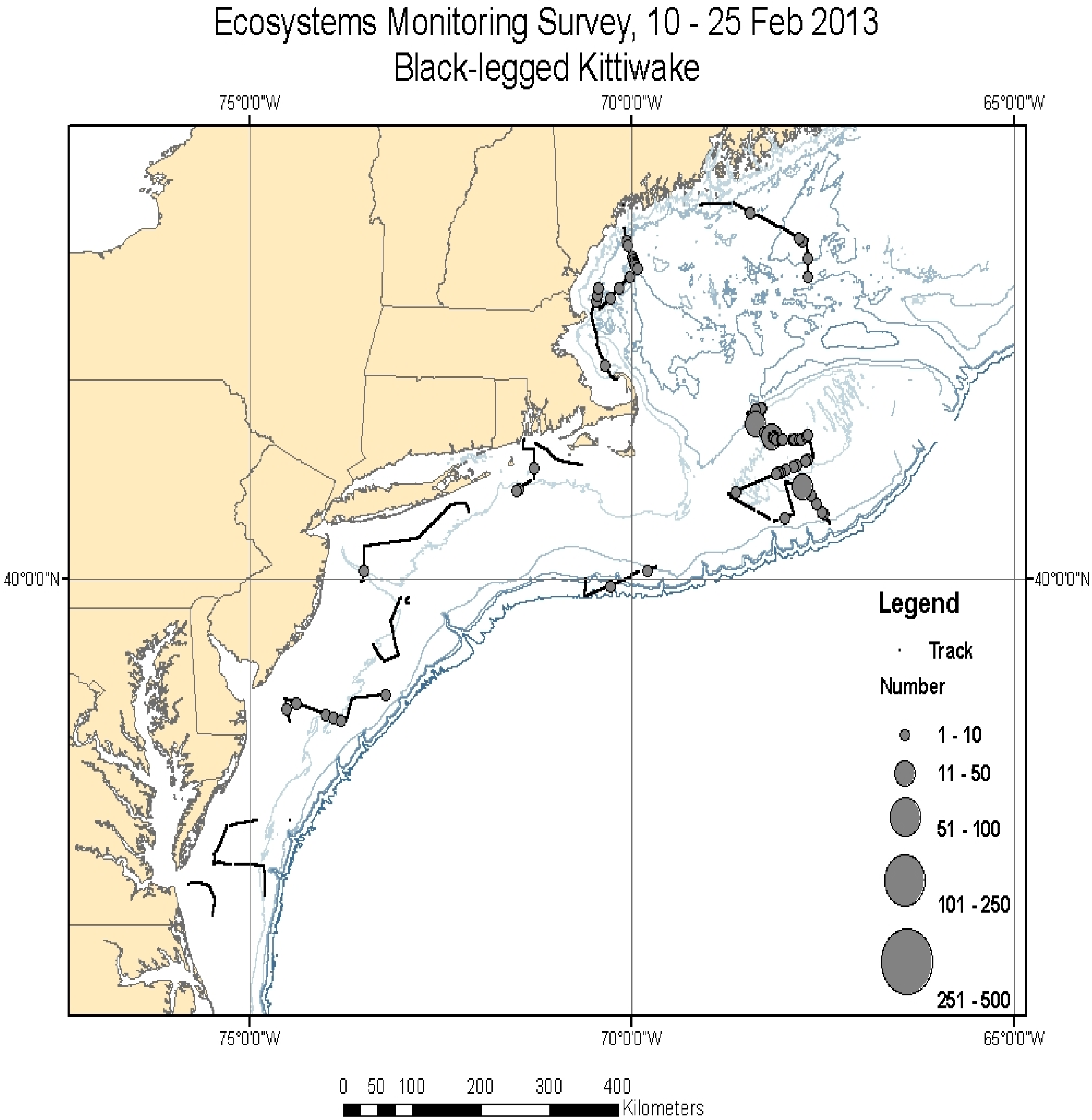

Ecosystems Monitoring Survey, 27 Oct - 13 Nov 2012
Herring Gull
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers


Ecosystems Monitoring Survey, 27 Oct - 13 Nov 2012
Dovekie
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

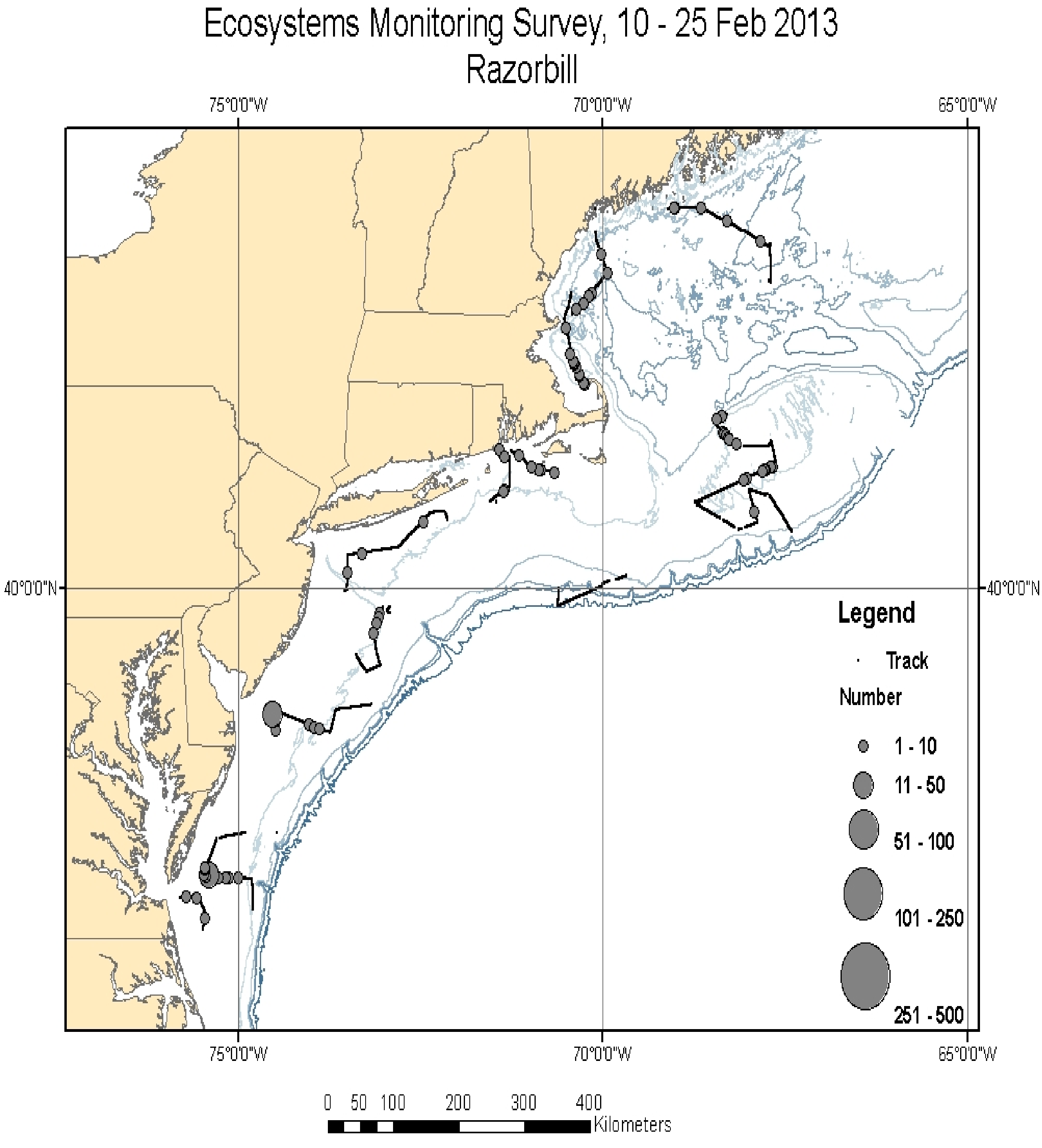

Ecosystems Monitoring Survey, 10 - 25 Feb 2013
Northern Gannet
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers



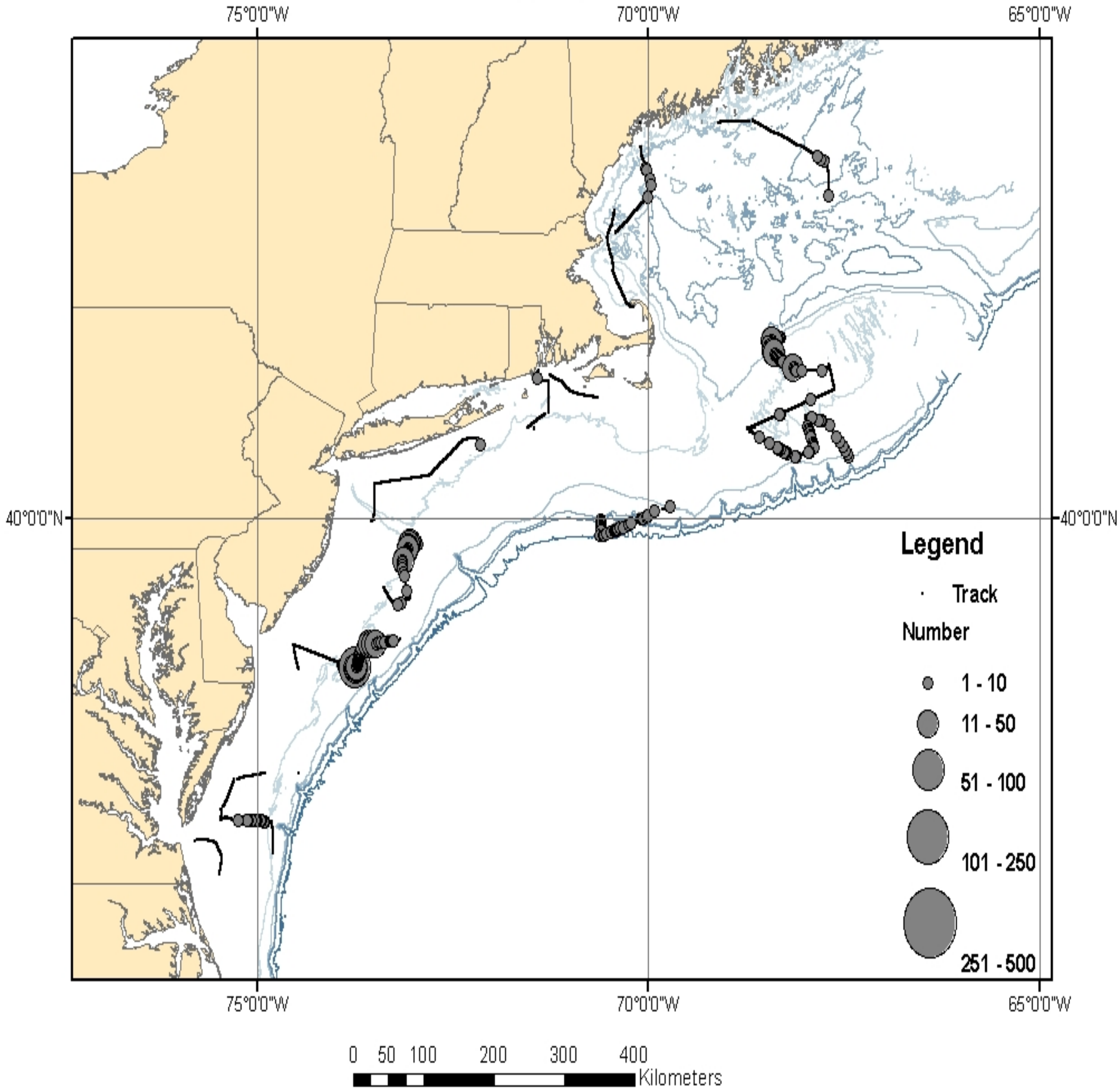
Ecosystems Monitoring Survey, 10 - 25 Feb 2013
Herring Gull
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
75°0'0"W
70°0'0"W
65°0'0"W
0 50 100 200 300 400
Kilometers



Ecosystems Monitoring Survey, 10 - 25 Feb 2013
Black-legged Kittiwake
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
75°0'0"W
70°0'0"W
65°0'0"W
0 50 100 200 300 400
Kilometers


Ecosystems Monitoring Survey, 10 - 25 Feb 2013
Razorbill
75°0'0"W
70°0'0"W
65°0'0"W
40°0'0"N
Legend
Track
Number
1 - 10
11 - 50
51 - 100
101 - 250
251 - 500
0 50 100 200 300 400
Kilometers

Ecosystems Monitoring Survey, 10 - 25 Feb 2013
Dovekie



The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under US administration.

The Bureau of Ocean Energy Management

As a bureau of the Department of the Interior, the Bureau of Ocean Energy (BOEM) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS) in an environmentally sound and safe manner.

The BOEM Environmental Studies Program

The mission of the Environmental Studies Program (ESP) is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments.