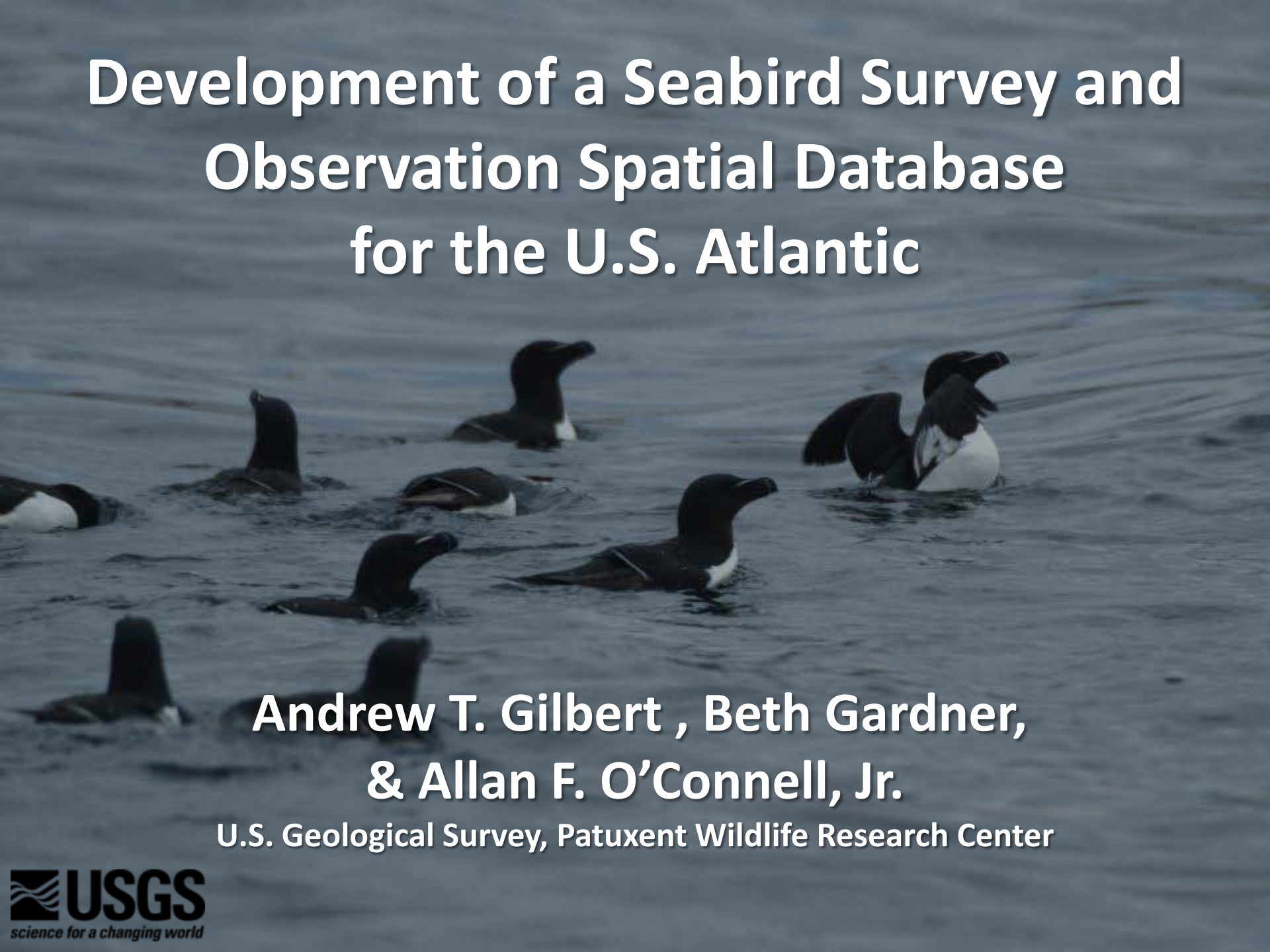
Development of a Seabird Survey and Observation Spatial Database for the U.S. Atlantic



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History of Seabird Database Project

- Need to evaluate seabird distribution for offshore proposals
- No centralized repository of seabird data for the U.S. Atlantic
- USFWS funded USGS to catalog seabird datasets in 2005
- USFWS further funded USGS to compile and standardize data into a single database in 2006
- BOEMRE added funds to continue work and add modeling component in 2008

Study Goal and Objectives

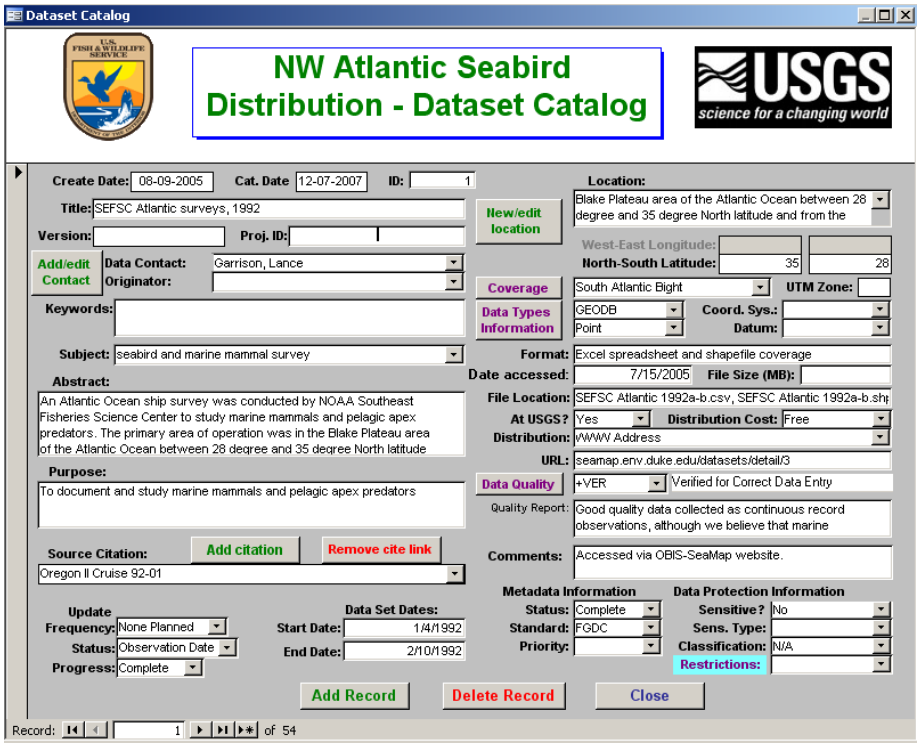
- Goal: To create a database of seabird observations and survey effort for the western North Atlantic between Florida and Maine and model the distribution of selected seabird species
  - Objective 1: gather seabird occurrence data along with other biotic and abiotic variables
  - Objective 2: develop biological distribution models for seabirds using available occurrence data and environmental variables.
  - Objective 3: generate seabird distribution maps for a suite of species that inhabit the continental shelf zone along the U.S. Atlantic coast from Florida to Maine

Overview of Methods

- Develop a catalog of seabird survey and observation datasets.
- Acquire seabird and biophysical data (e.g., bathymetry, SST, chlorophyll) for modeling
- Standardize seabird data for modeling
- Match seabird data with biophysical data
- Conduct hierarchical modeling
- Predict species distribution

Seabird Dataset Catalog

- Create a catalog of seabird datasets
- Record information about datasets and information they contain (metadata catalog)
  - Coverage area
  - Abstract
  - Dates
  - Data type (digital, analog, text file, GIS)
- Locate data and archive where possible



Example Seabird Surveys

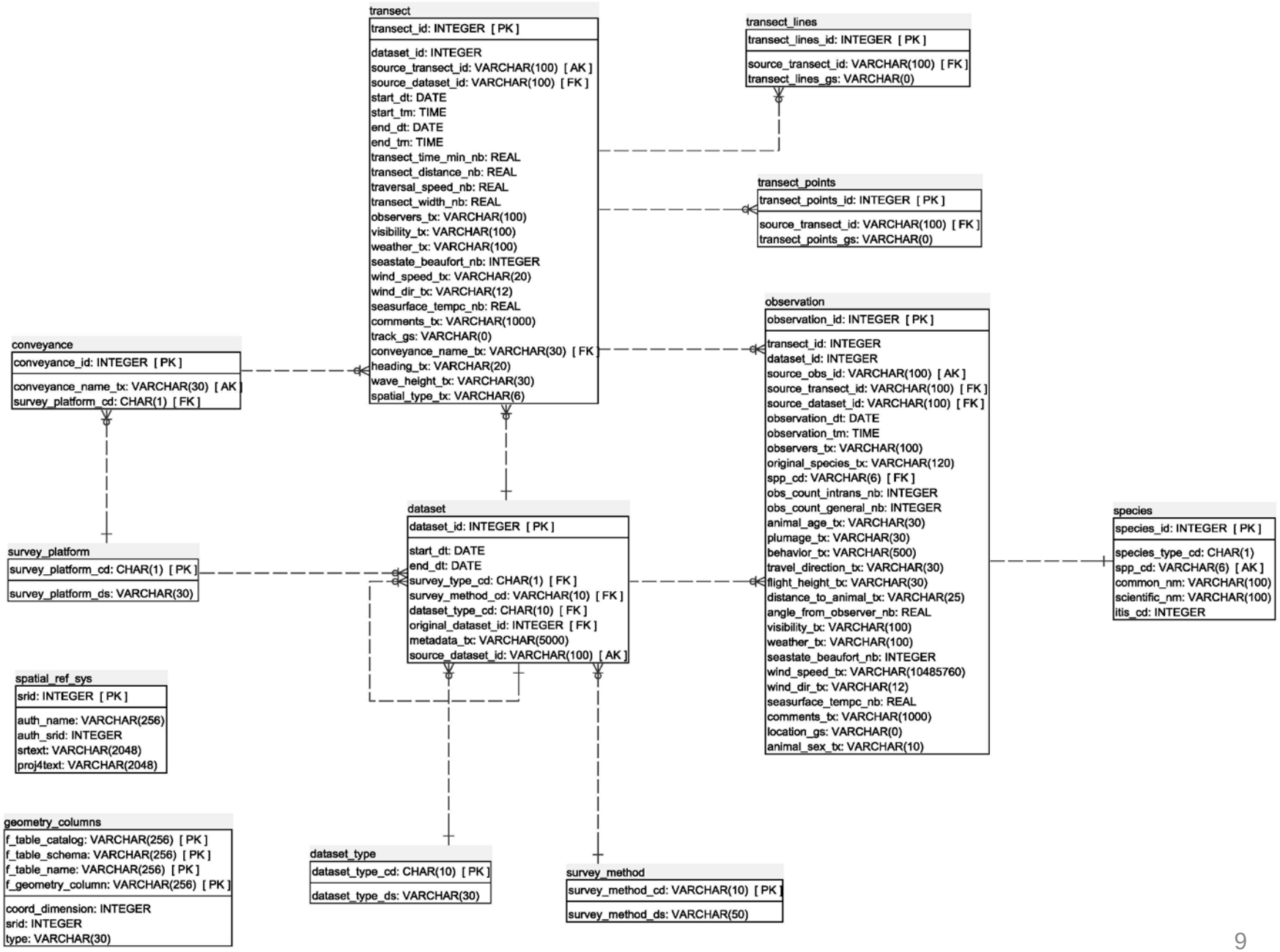
Dataset	Years of surveys	Region of survey
Manomet Center for Conservation Sciences	1978–1980	Gulf of Maine, Mid-Atlantic Bight
Cetacean and Seabird Assessment Program	1980–1988	Gulf of Maine, Mid-Atlantic Bight
Georgia pelagic surveys	1982–1985	South Atlantic Bight
Southeast Fisheries Science Center surveys	1992, 1998, 1999	South Atlantic Bight
Winter Survey of the Mid-Atlantic	2001–2003	Mid-Atlantic Bight
Cape Wind, Mass Audubon	2002–2006	Nantucket Sound
North Carolina Shelf — trophic predators	2004–2005	Offshore North Carolina
Bar Harbor whale watch	2005–2006	Offshore Mount Desert Island, ME
NOAA Ecosystem Monitoring Survey	2007–2010	Gulf of Maine, Mid-Atlantic Bight
NOAA Herring Acoustic Survey	2006–2010	Gulf of Maine, Mid-Atlantic Bight

Data Standardization

- Create master observation dataset
  - Create standard species lists
  - Create common data fields (date, time, observation ID, effort ID, etc.)
- Create effort dataset when possible and link to species observations
  - presence <u>AND</u> absence data
  - facilitates error detection

Relational Seabird Database

- Postgresql 8.4 (PostGIS) database
- Opensource, fully relational database with spatial querying features
- Very quick access and querying
- Geometry information can be stored directly in the database in open standards formats
- Allows complex geometry queries
- Can be mapped directly with some GIS products (not ArcGIS 9.3 but in 10 you can map, but not edit data directly from the db)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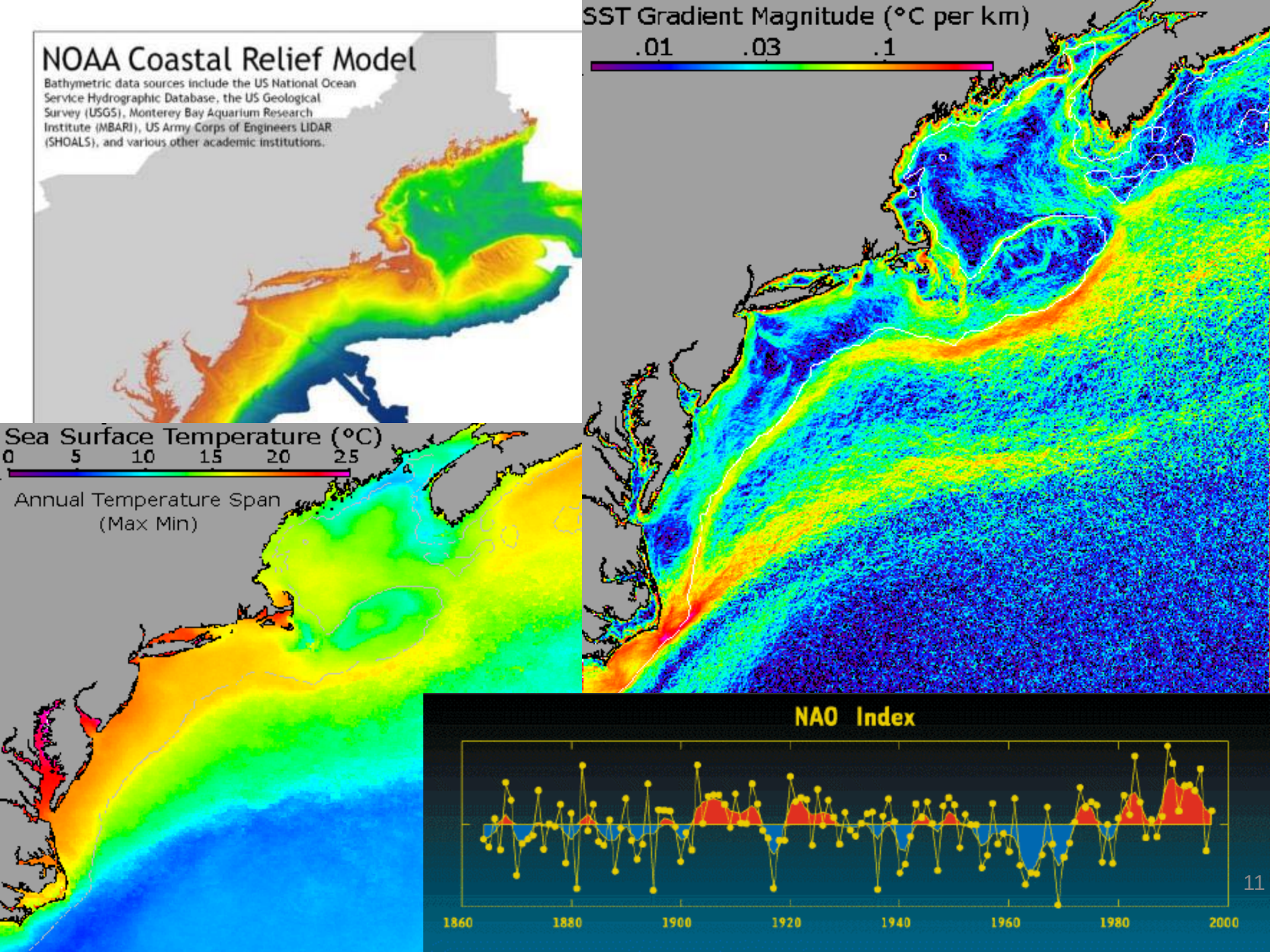
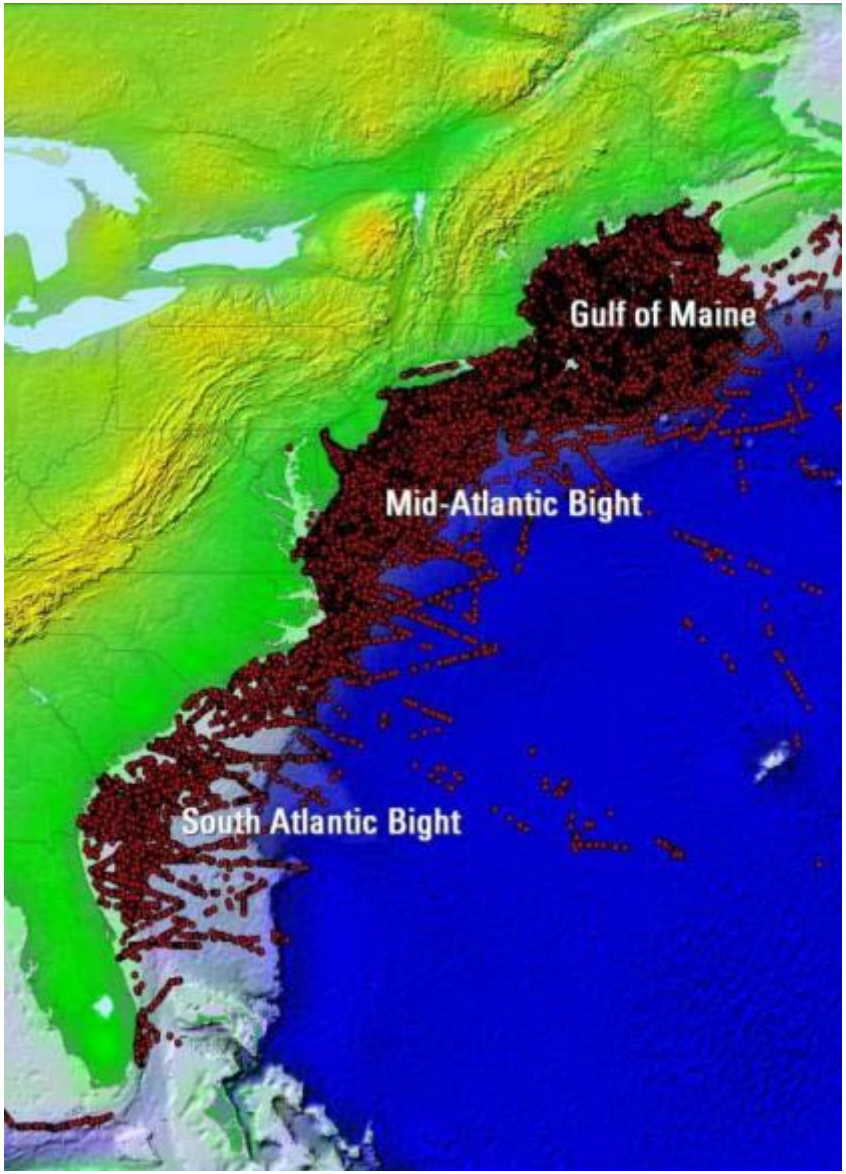
Environmental Data

- Created a ¼ degree grid based on smoothed SST data
- Summarized environmental data based on these ¼ degree grid cells
- SST, bathymetry, slope, chlorophyll, SST fronts, ocean winds, NAO


NOAA Coastal Relief Model
Bathymetric data sources include the US National Ocean Service Hydrographic Database, the US Geological Survey (USGS), Monterey Bay Aquarium Research Institute (MBARI), US Army Corps of Engineers LIDAR (SHOALS), and various other academic institutions.
SST Gradient Magnitude (°C per km)
.01 .03 .1
Sea Surface Temperature (°C)
0 5 10 15 20 25
Annual Temperature Span
(Max Min)
NAO Index
1860 1880 1900 1920 1940 1960 1980 2000

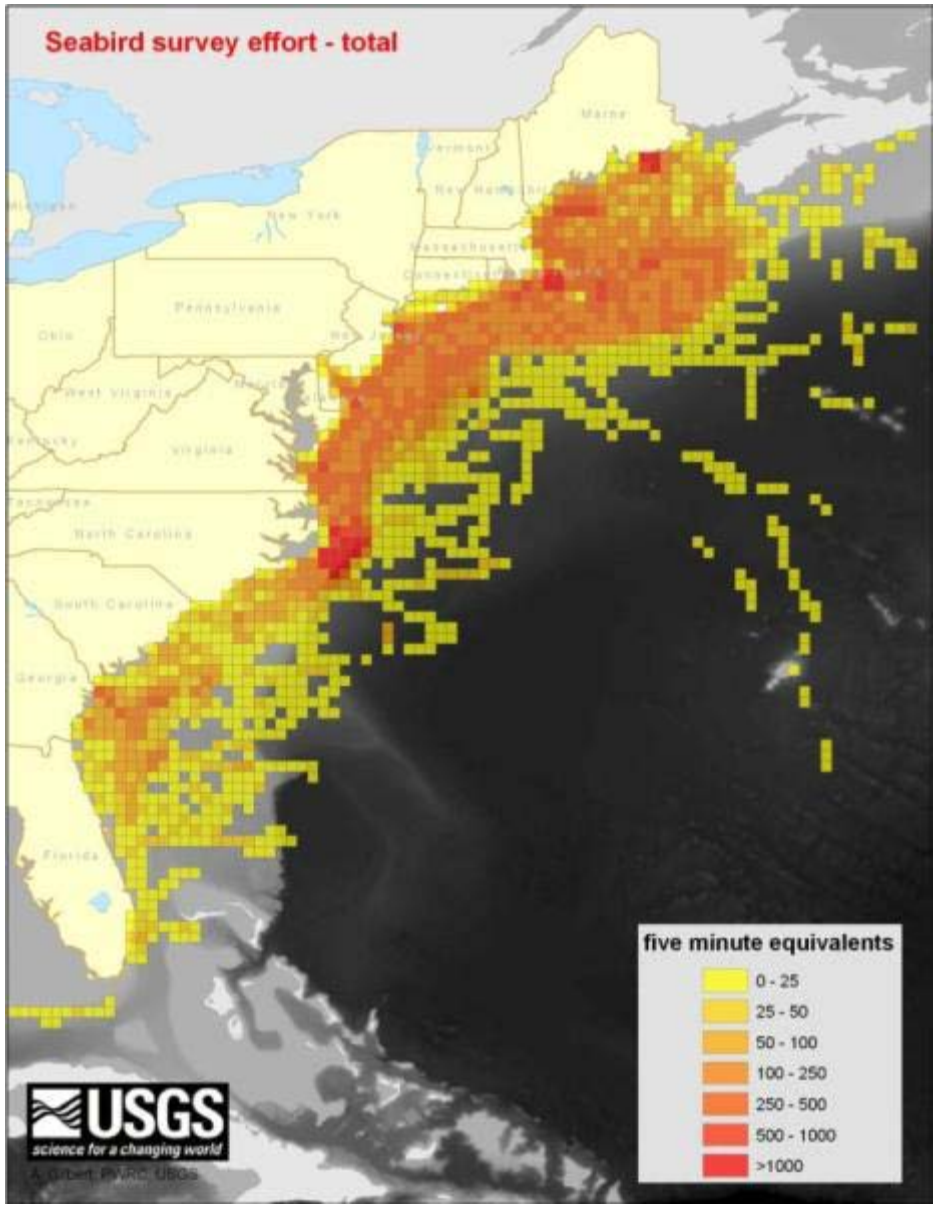
Seabird Occurrence Data

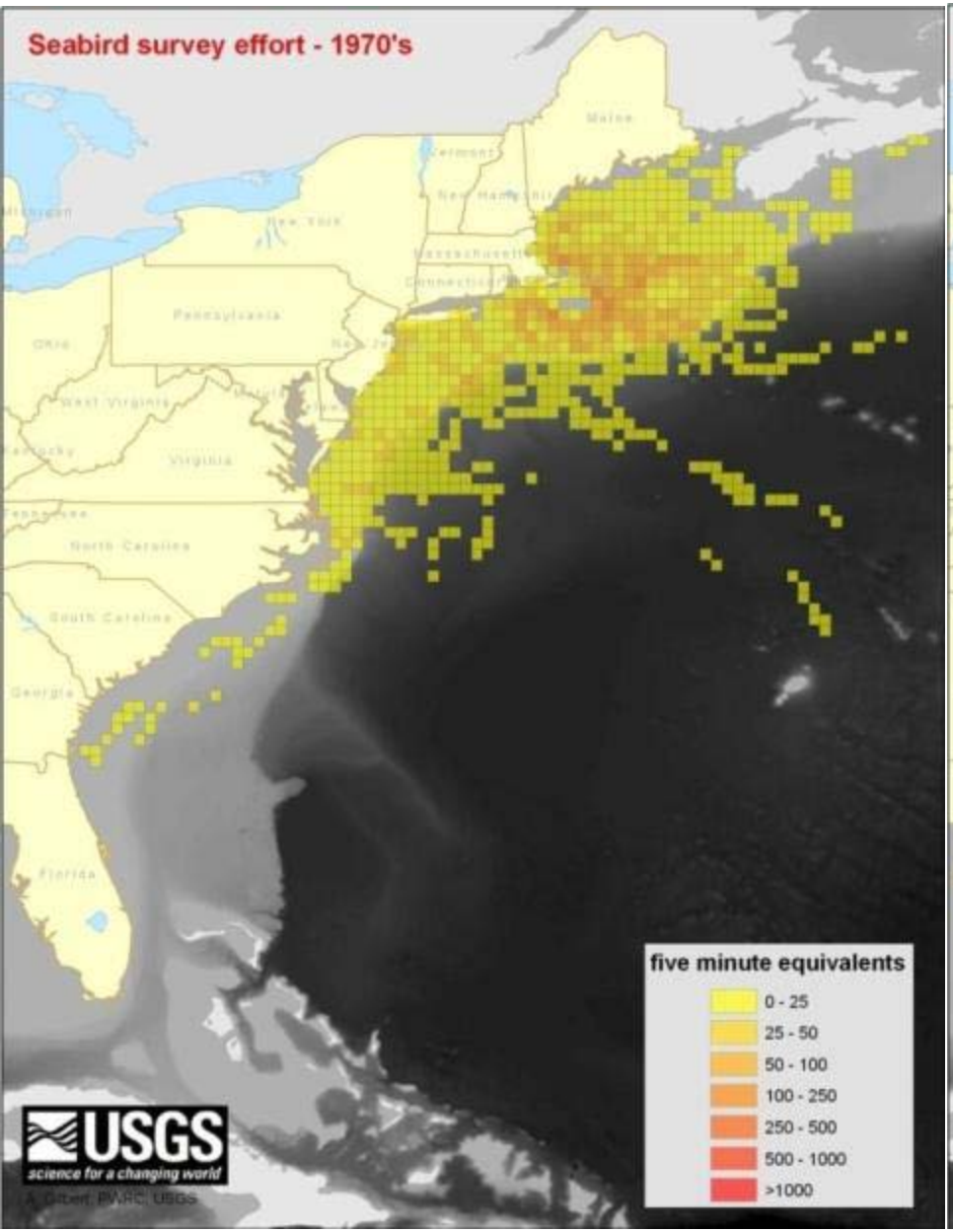
- >400,000 observations have been accumulated from 70 datasets
- >270,000 seabird observation from U.S. Atlantic waters (>100k from Canada in PIROP)
- >data spans the 1900s, most collected from 1978 through November 2010
- Data collected using a mix of scientific and non-scientific methods



Seabird Survey Effort

- In order to better document the spatial and temporal variability of seabirds surveys in the Atlantic OCS, we standardized survey effort to account for both discrete-time and continuous-strip surveys.
- Color schemes represent a standardized range of the number of surveys conducted in each grid cell in 5 minute equivalents.
  - Discrete time transects: 5 minute equivalents = # of 5 minute periods of survey
  - Continuous time transects: 5 minute equivalents = 0.8333 nautical mile survey segments (the distance traveled by a ship traveling 10 knots for 5 minutes)




Seabird survey effort - 1970's
Maine
Vermont
New Hampshire
New York
Massachusetts
Connecticut
Pennsylvania
Ohio
New Jersey
West Virginia
Virginia
Kentucky
Tennessee
North Carolina
South Carolina
Georgia
Florida
five minute equivalents
0 - 25
25 - 50
50 - 100
100 - 250
250 - 500
500 - 1000
>1000
USGS
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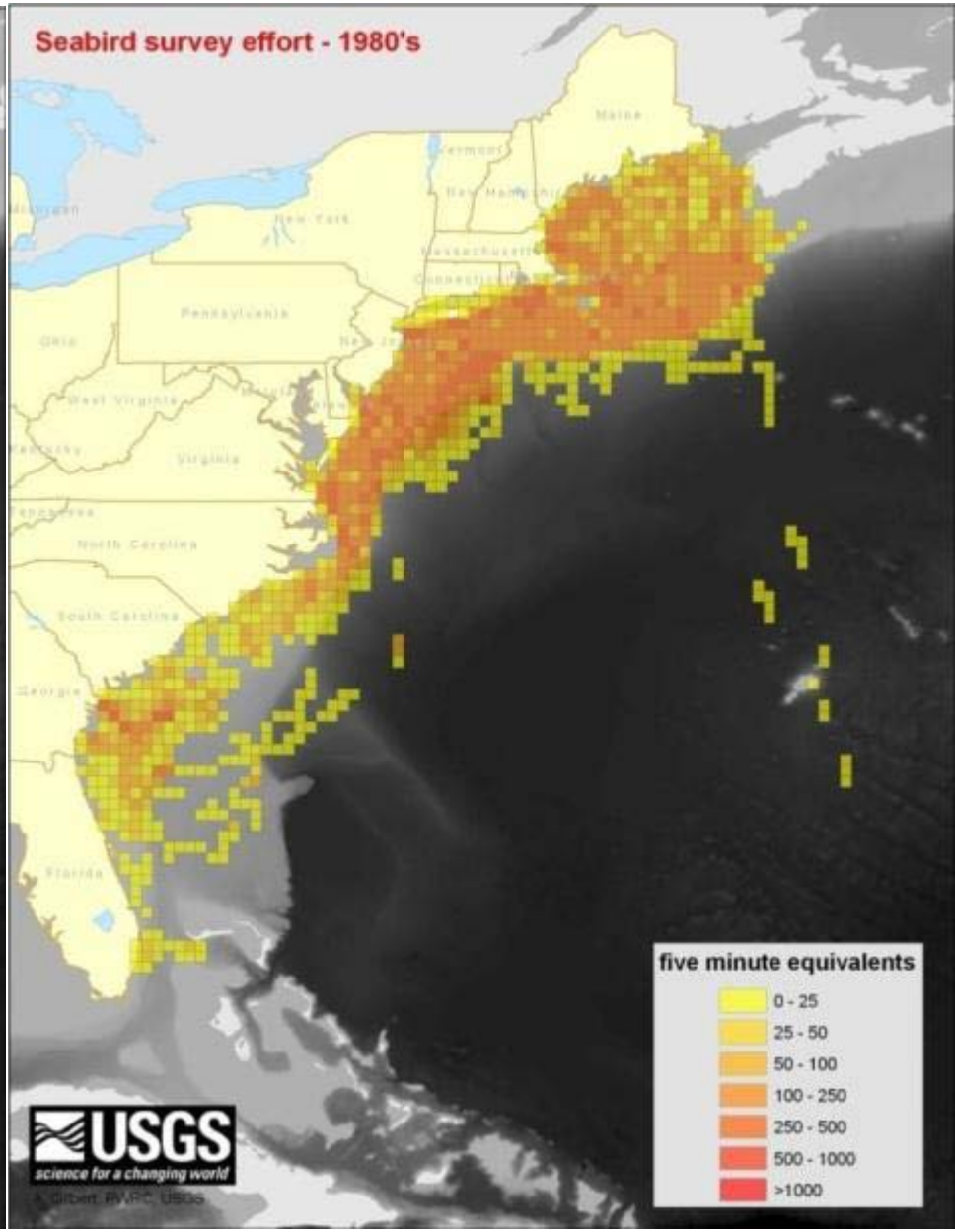
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Maine
Vermont
New Hampshire
New York
Massachusetts
Connecticut
Pennsylvania
Ohio
New Jersey
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Virginia
Kentucky
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North Carolina
South Carolina
Georgia
Florida
five minute equivalents
0 - 25
25 - 50
50 - 100
100 - 250
250 - 500
500 - 1000
>1000
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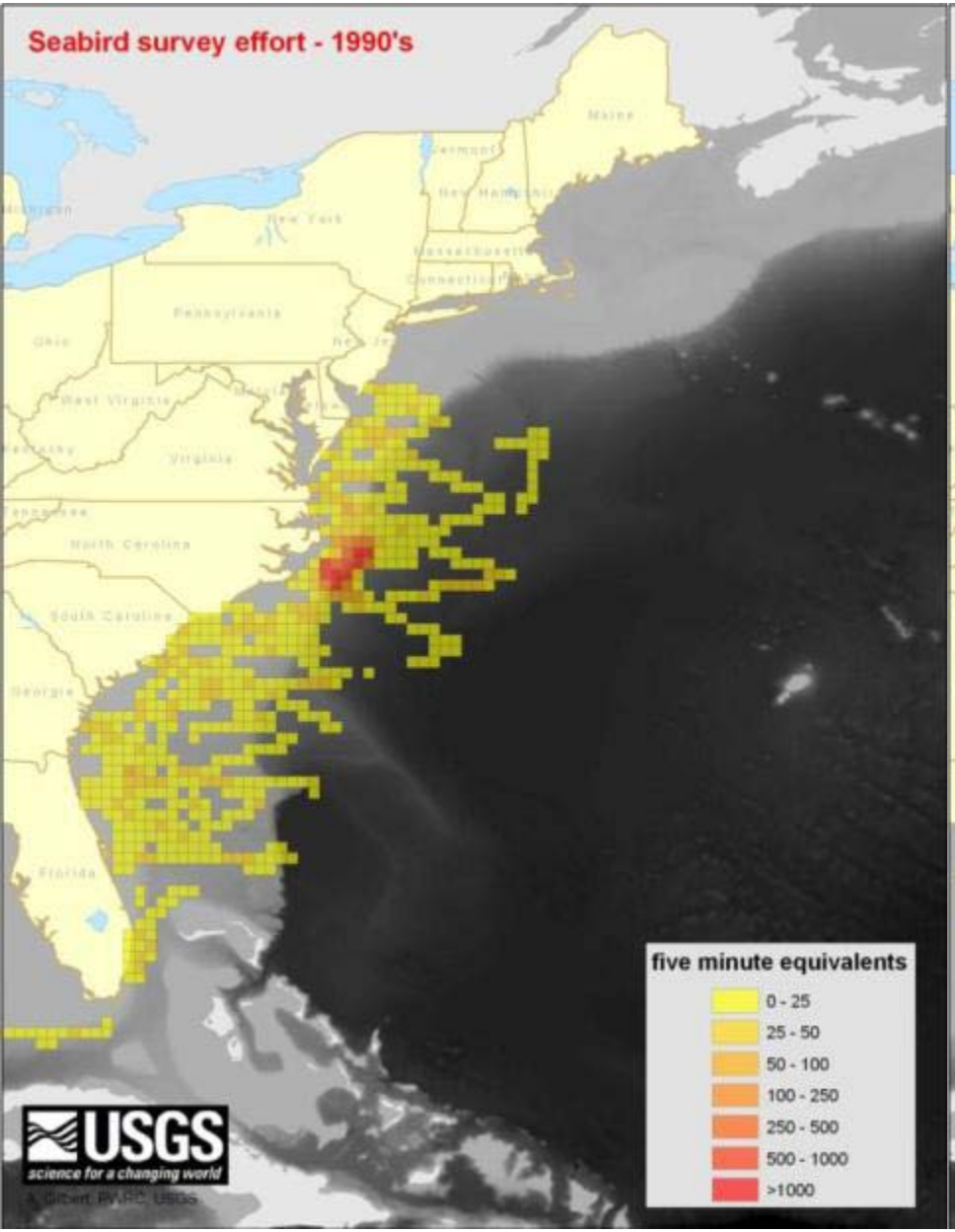
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Maine
Vermont
New Hampshire
New York
Massachusetts
Connecticut
Pennsylvania
Ohio
New Jersey
West Virginia
Virginia
Kentucky
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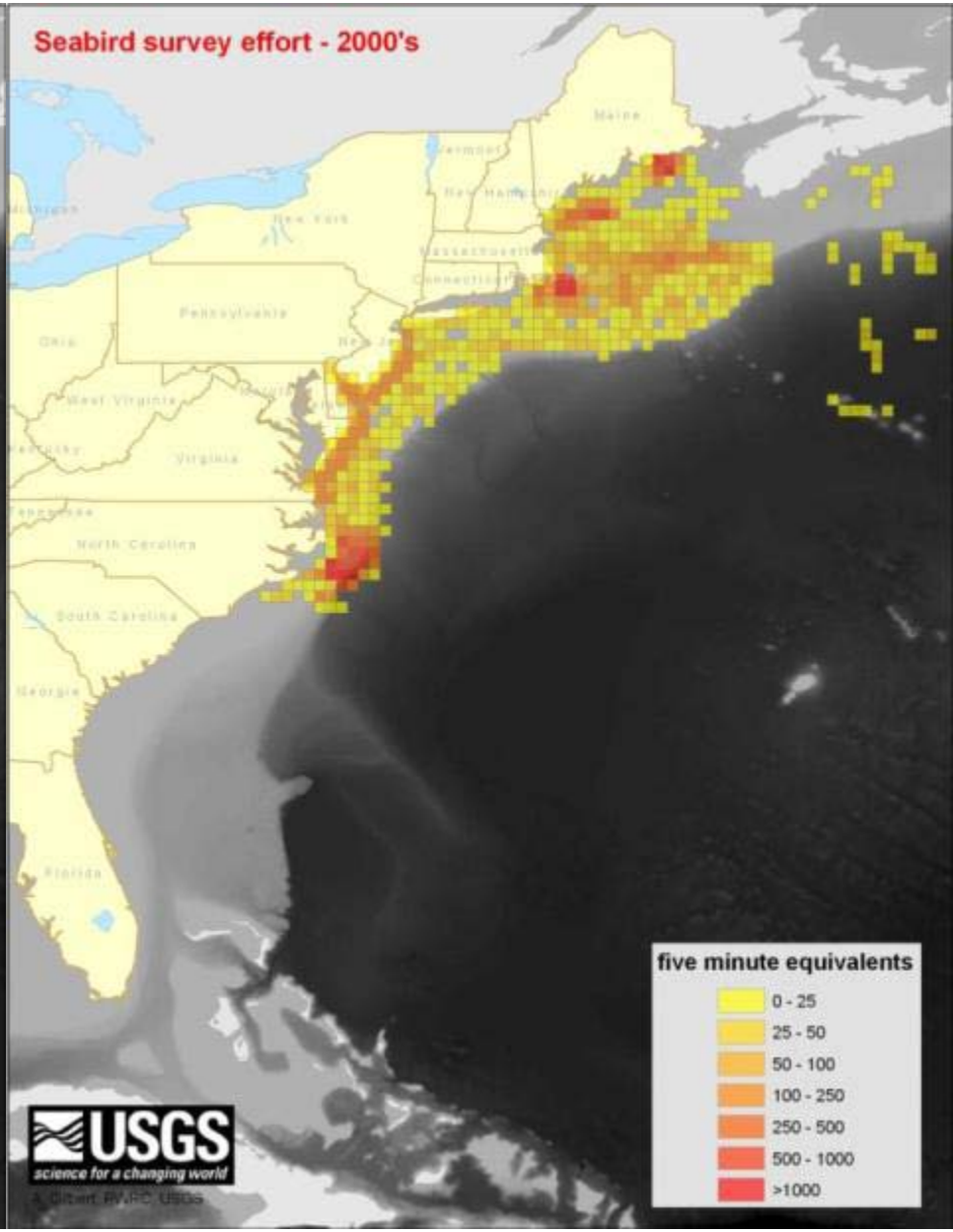
North Carolina
South Carolina
Georgia
Florida
five minute equivalents
0 - 25
25 - 50
50 - 100
100 - 250
250 - 500
500 - 1000
>1000
USGS
science for a changing world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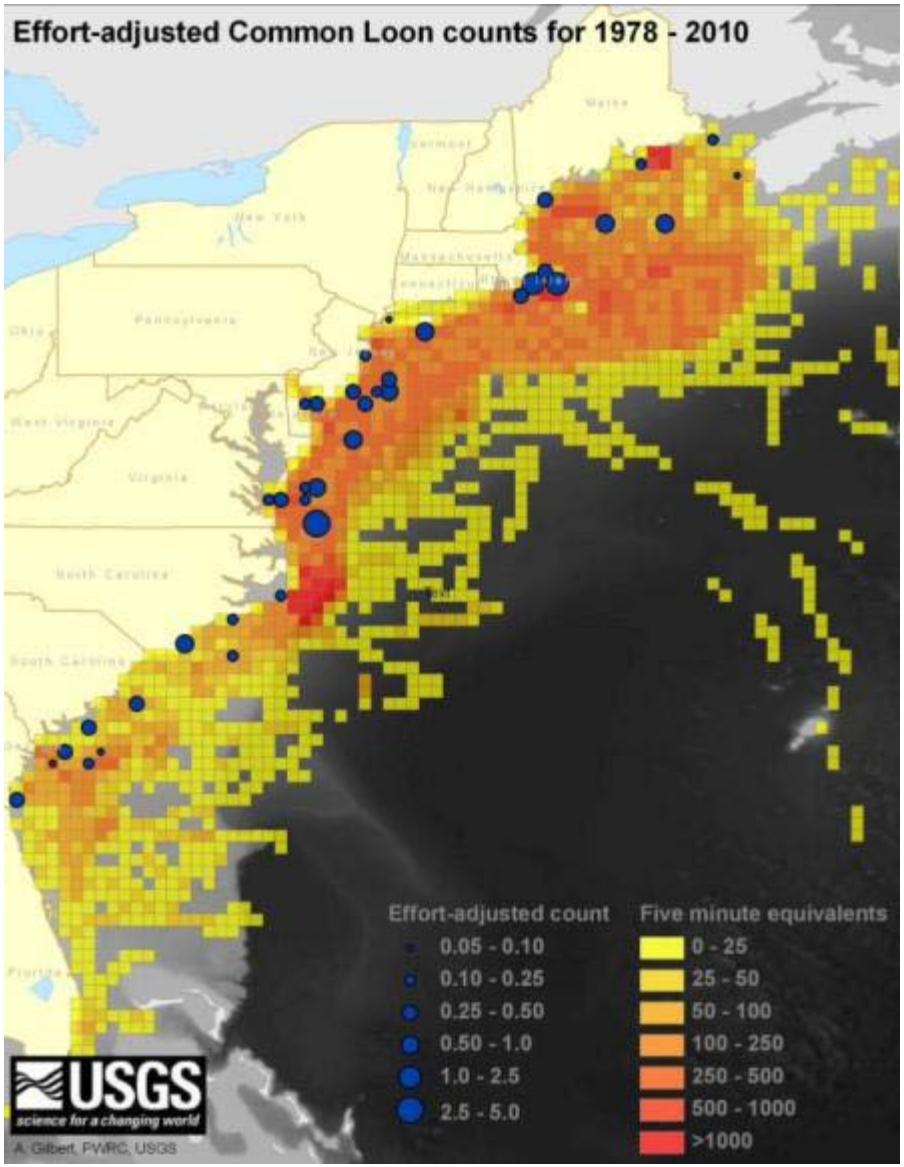
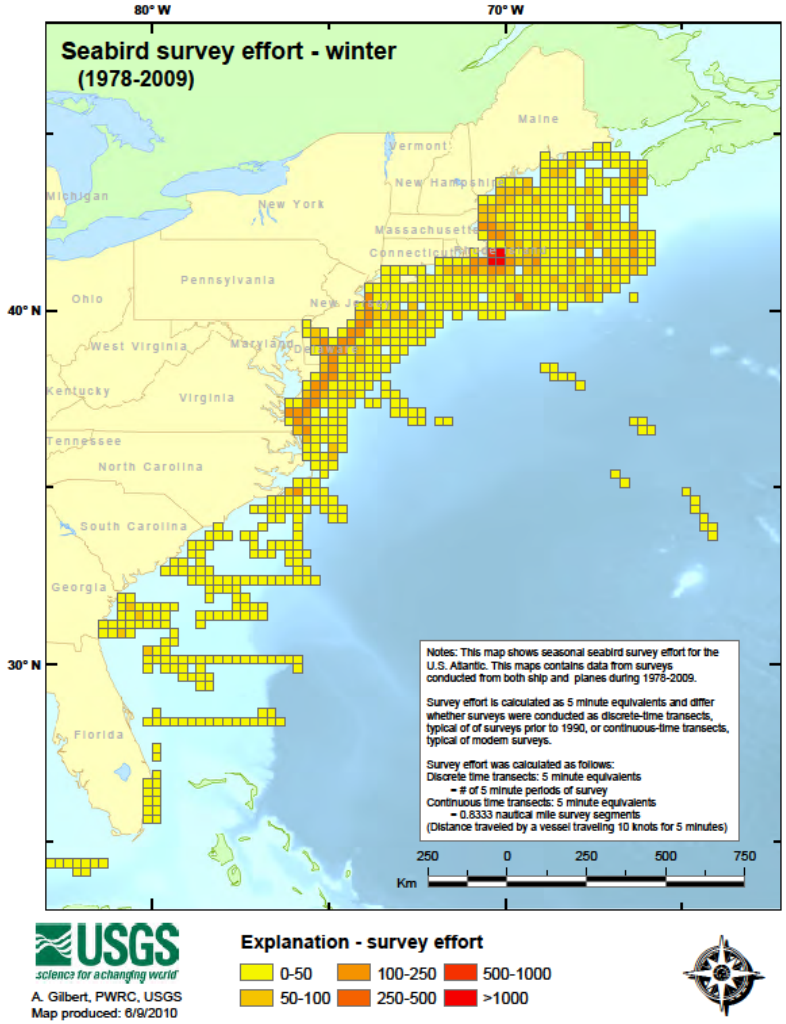
Maine
Vermont
New Hampshire
New York
Massachusetts
Connecticut
Pennsylvania
Ohio
New Jersey
West Virginia
Virginia
Kentucky
Tennessee
North Carolina
South Carolina
Georgia
Florida
five minute equivalents
0 - 25
25 - 50
50 - 100
100 - 250
250 - 500
500 - 1000
>1000
USGS
science for a changing world

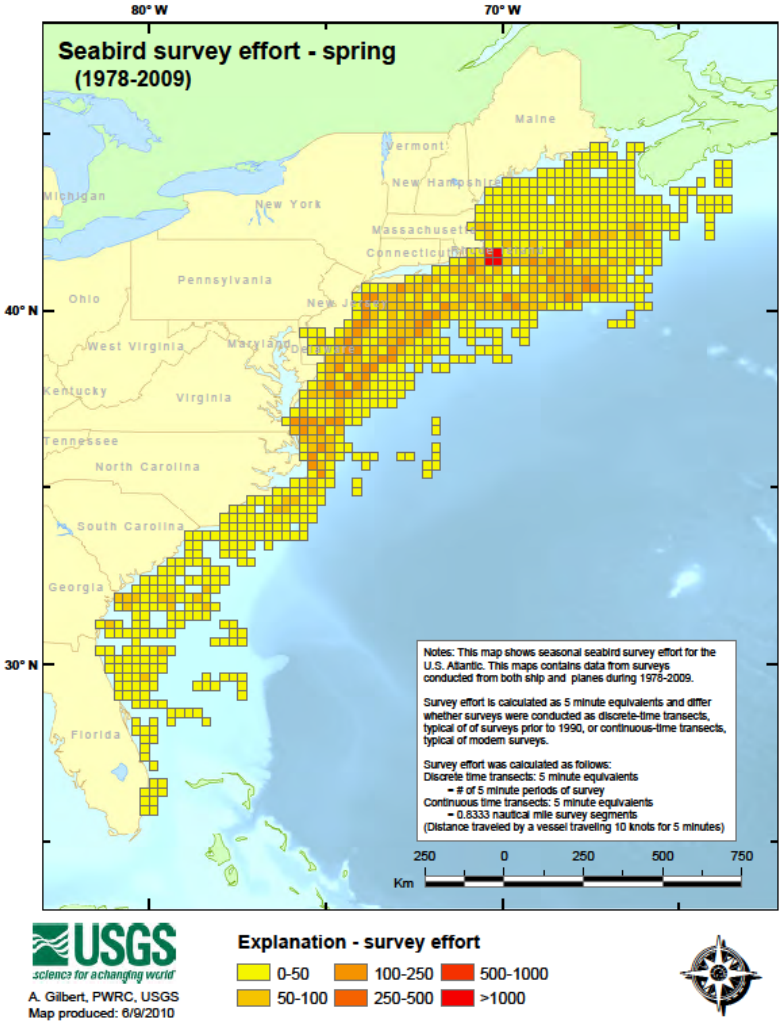
Example Effort – Corrected Species Data: Common Loon

- Common loon count per unit effort (five min. equivalent).
- Combining datasets increases our spatial and temporal knowledge of species distribution.
- Including survey effort information yields a less biased and more informative view of distribution.
- Not modeling however, and can't predict where we have no data.

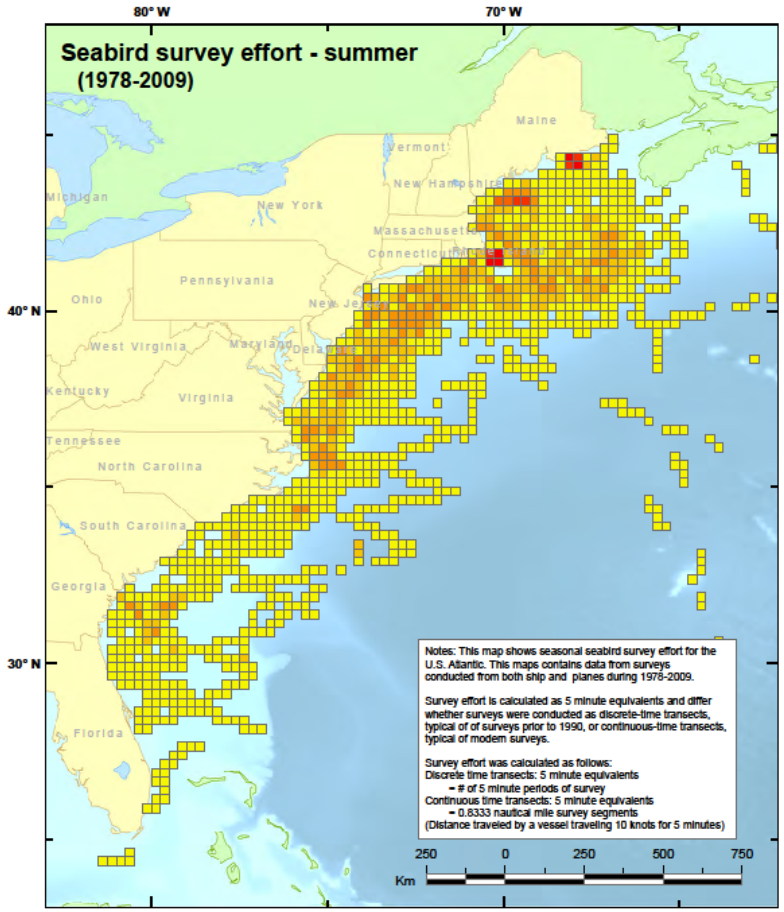


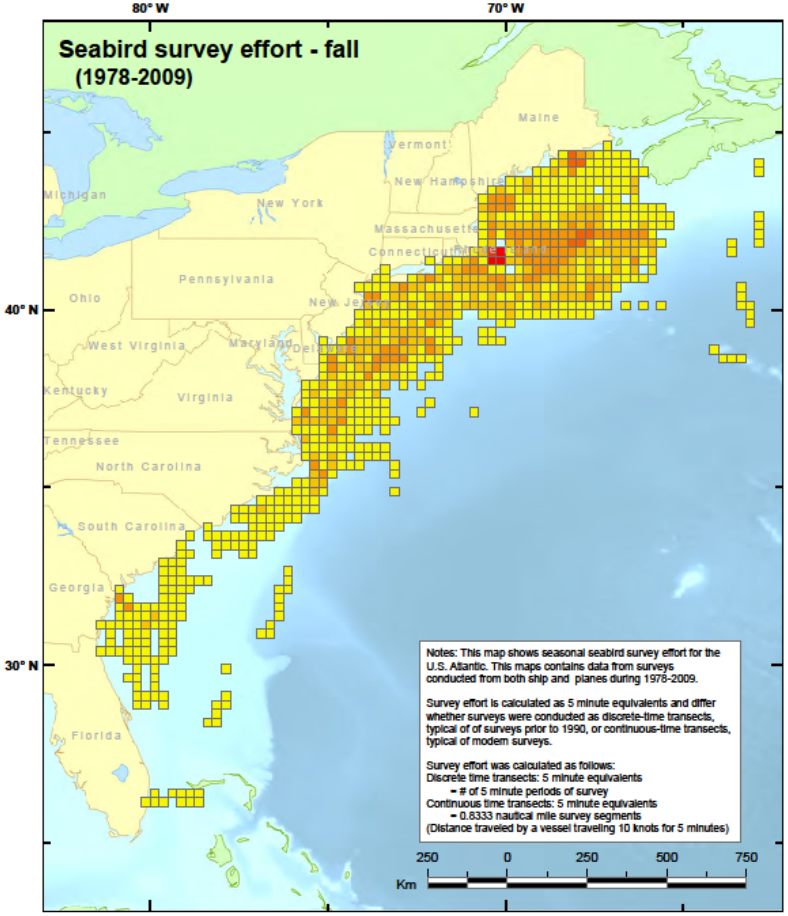
Seasonal Survey Effort

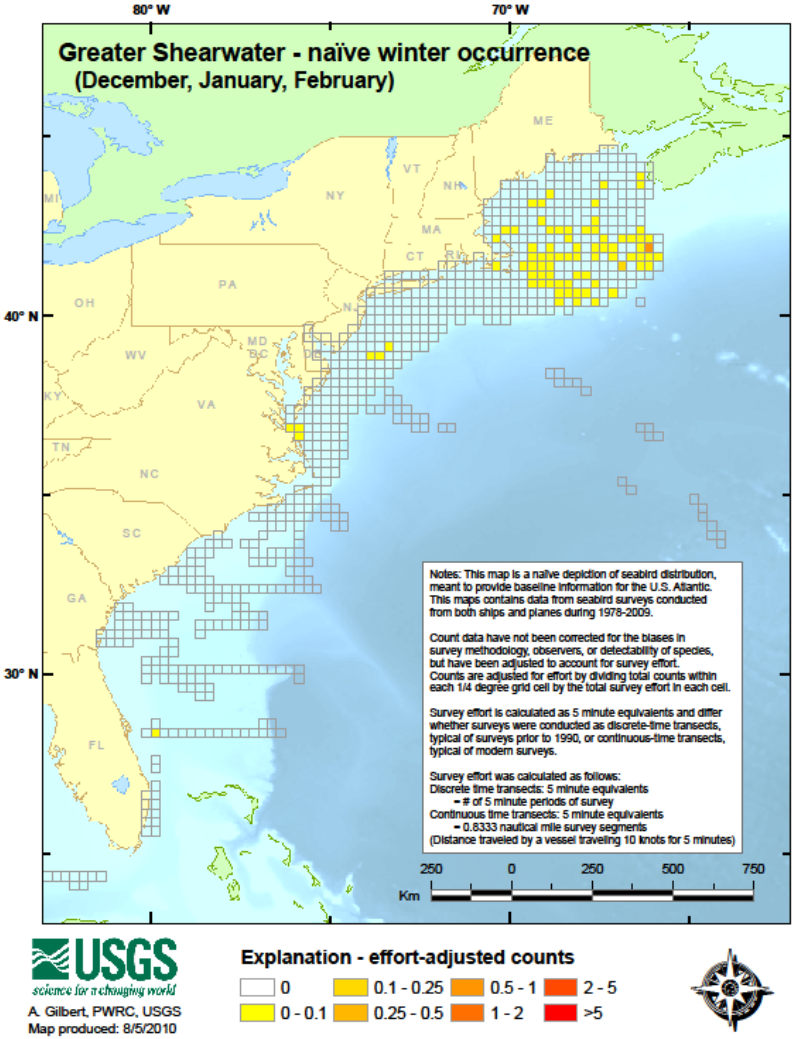




Seasonal Survey Effort (cont.)







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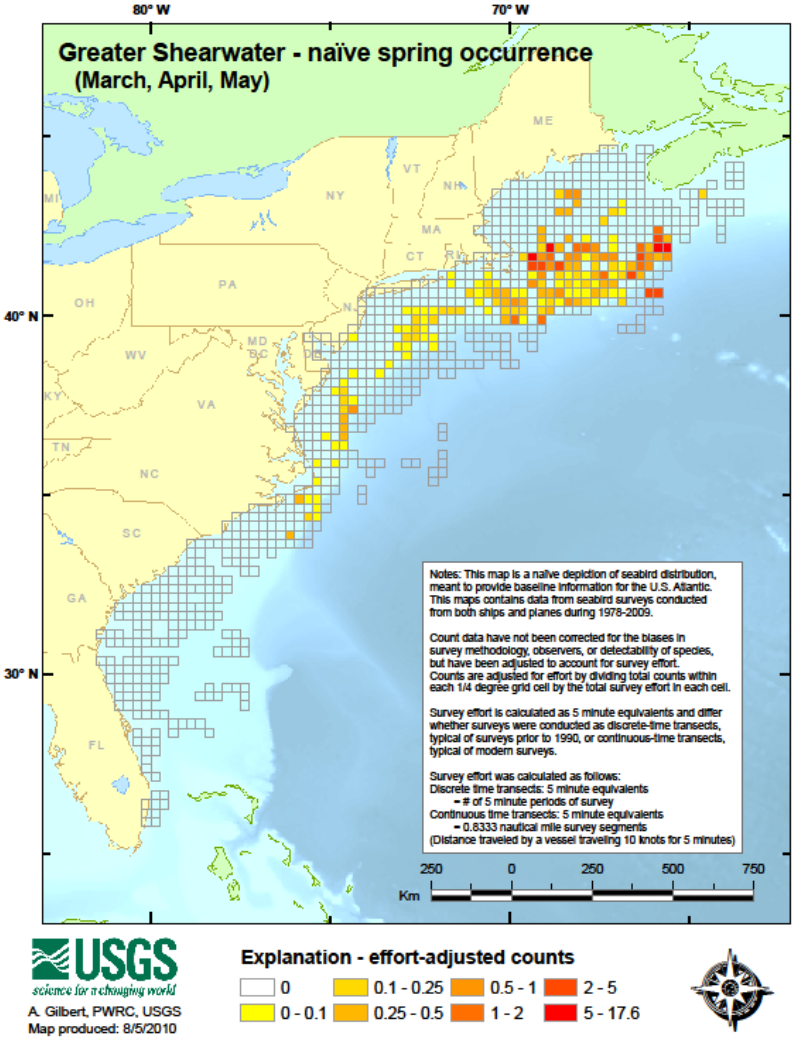
Map produced: 8/5/2010

Explanation - effort-adjusted counts

0	0.1 - 0.25	0.5 - 1	2 - 5
0 - 0.1	0.25 - 0.5	1 - 2	>5



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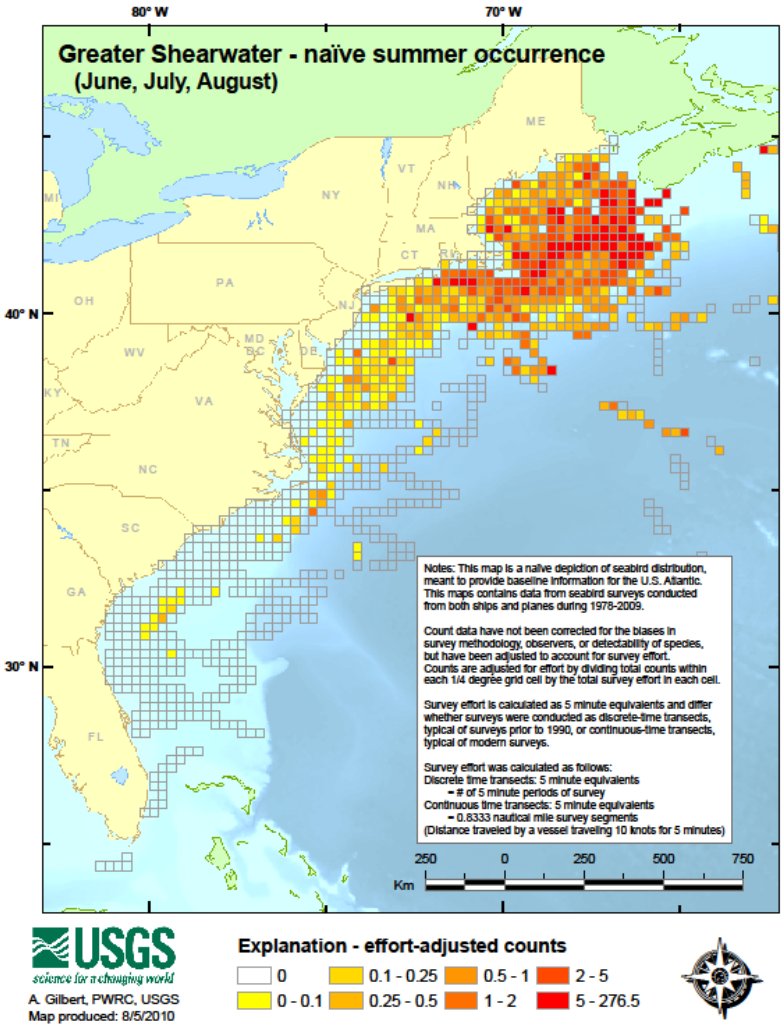
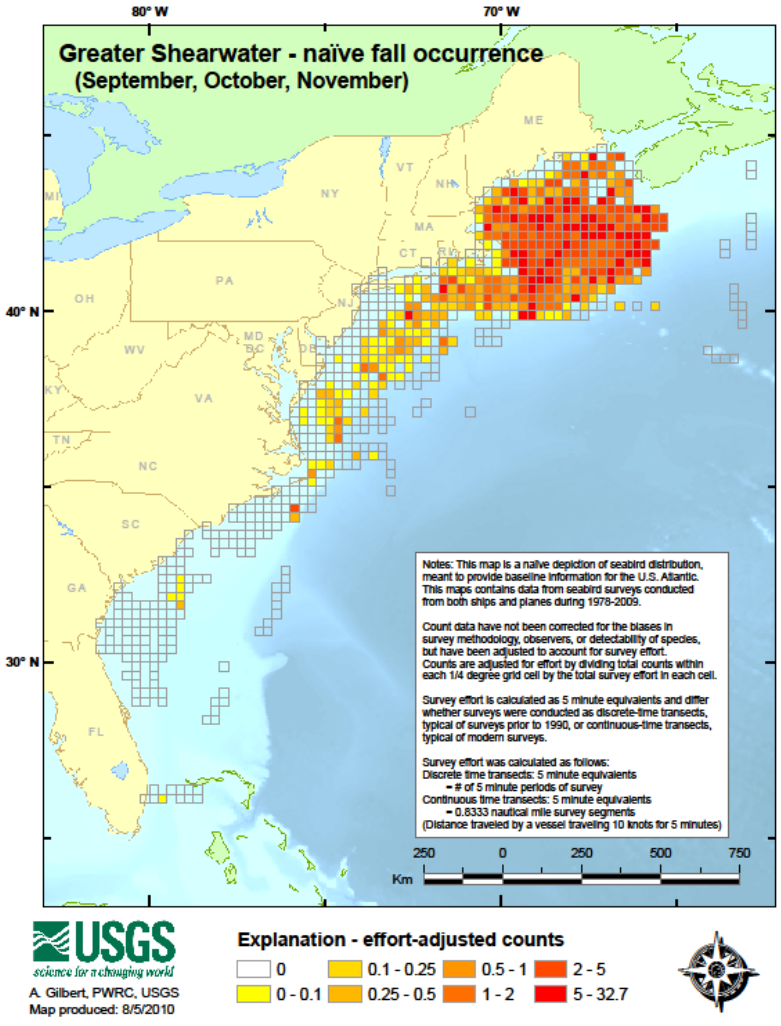
Explanation - effort-adjusted counts

0	0.1 - 0.25	0.5 - 1	2 - 5
0 - 0.1	0.25 - 0.5	1 - 2	5 - 17.6


Greater Shearwater - naïve summer occurrence
(June, July, August)
80° W
70° W
40° N
30° N
ME
VT
NH
NY
MA
CT
RI
PA
NJ
OH
MD
DE
WV
VA
KY
TN
NC
SC
GA
FL
Notes: This map is a naïve depiction of seabird distribution, meant to provide baseline information for the U.S. Atlantic. This maps contains data from seabird surveys conducted from both ships and planes during 1978-2009.
Count data have not been corrected for the biases in survey methodology, observers, or detectability of species, but have been adjusted to account for survey effort. Counts are adjusted for effort by dividing total counts within each 1/4 degree grid cell by the total survey effort in each cell.
Survey effort is calculated as 5 minute equivalents and differ whether surveys were conducted as discrete-time transects, typical of surveys prior to 1990, or continuous-time transects, typical of modern surveys.
Survey effort was calculated as follows:
Discrete time transects: 5 minute equivalents
= # of 5 minute periods of survey
Continuous time transects: 5 minute equivalents
= 0.8333 nautical mile survey segments
(Distance traveled by a vessel traveling 10 knots for 5 minutes)
250 0 250 500 750
Km
USGS
science for a changing world
A. Gilbert, PWRC, USGS
Map produced: 8/5/2010
Explanation - effort-adjusted counts
0
0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
5 - 276.5


Greater Shearwater - naïve fall occurrence
(September, October, November)
80° W
70° W
40° N
30° N
ME
VT
NH
NY
MA
CT
RI
PA
NJ
OH
MD
DE
WV
VA
KY
TN
NC
SC
GA
FL
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(Distance traveled by a vessel traveling 10 knots for 5 minutes)
250 0 250 500 750
Km
USGS
science for a changing world
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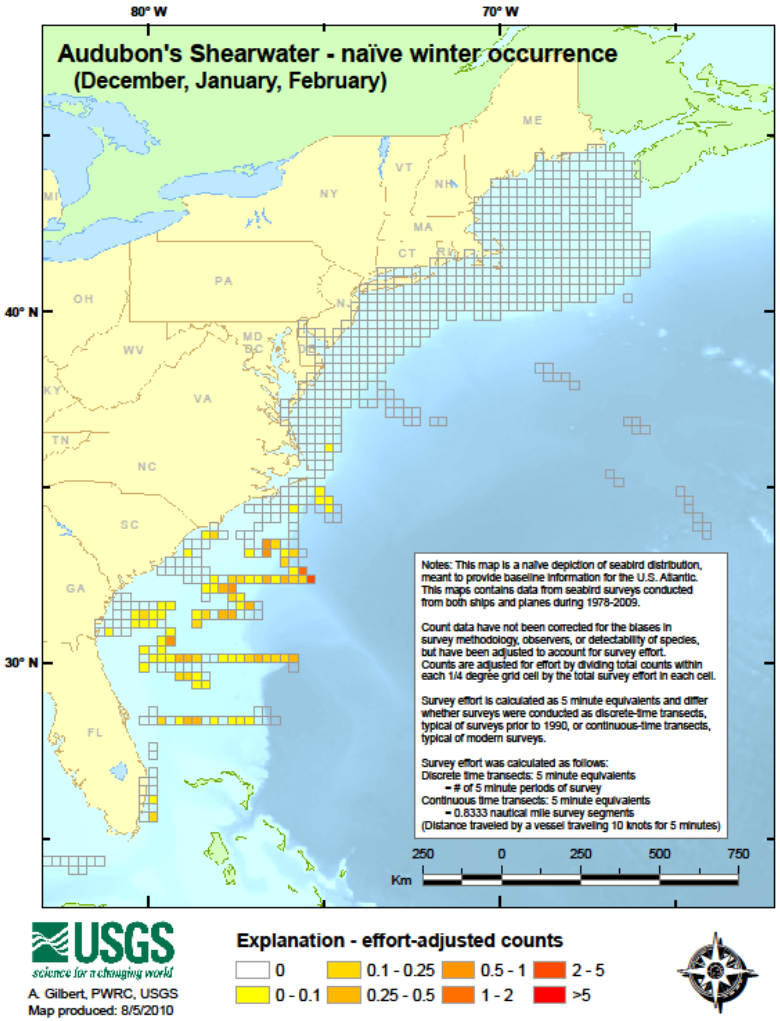
Map produced: 8/5/2010
Explanation - effort-adjusted counts
0
0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
5 - 32.7


Audubon's Shearwater - naïve winter occurrence
(December, January, February)
80° W
70° W
40° N
30° N
ME
VT
NH
NY
MI
MA
CT
RI
PA
OH
NJ
MD
DE
WV
VA
KY
TN
NC
SC
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250 0 250 500 750
Km
USGS
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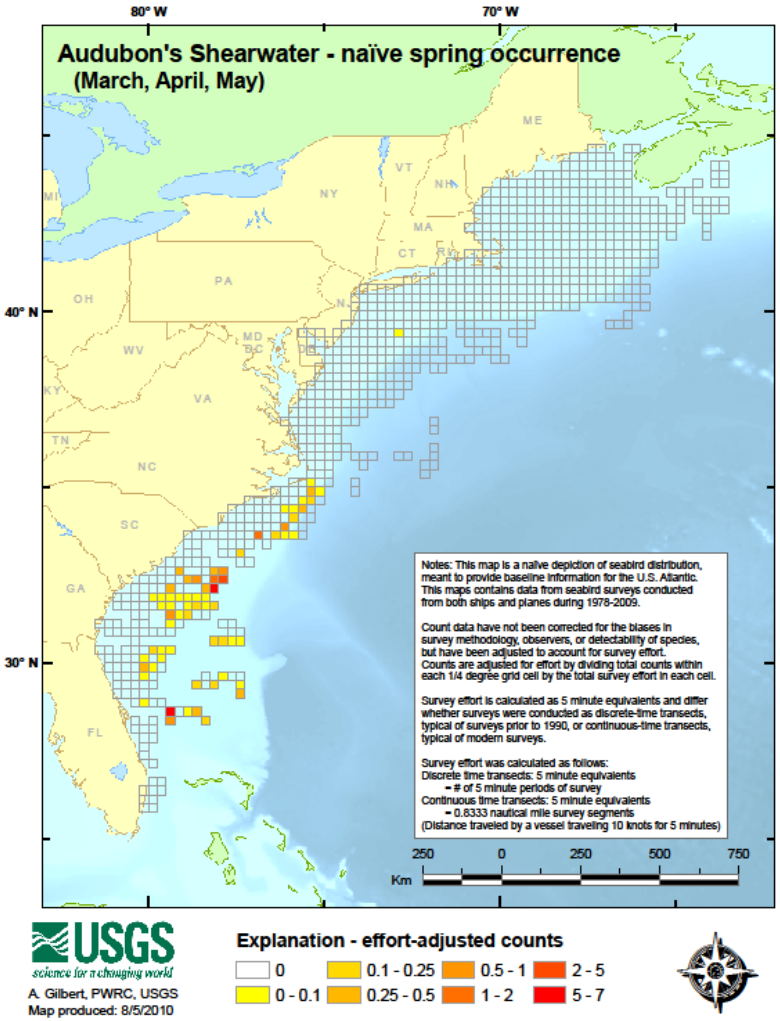
Map produced: 8/5/2010
Explanation - effort-adjusted counts
0
0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
>5


Audubon's Shearwater - naïve spring occurrence
(March, April, May)
80° W
70° W
40° N
30° N
ME
VT
NH
NY
MI
MA
CT
RI
PA
OH
NJ
MD
DE
WV
VA
KY
TN
NC
SC
GA
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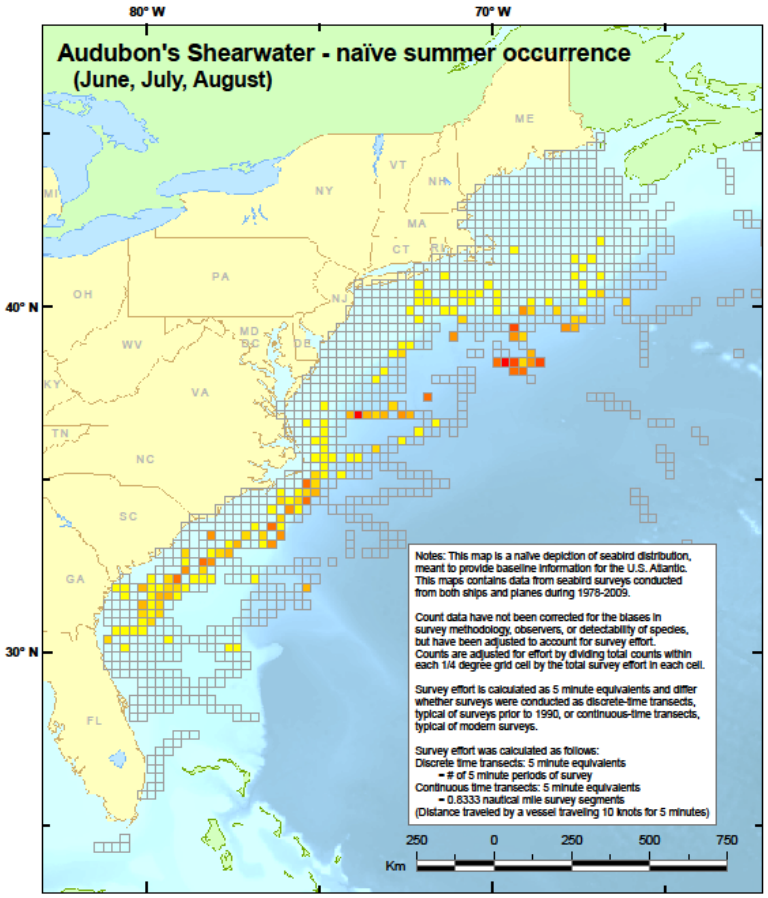
(Distance traveled by a vessel traveling 10 knots for 5 minutes)
250 0 250 500 750
Km
USGS
science for a changing world
A. Gilbert, PWRC, USGS
Map produced: 8/5/2010
Explanation - effort-adjusted counts
0
0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
5 - 7


Audubon's Shearwater - naïve summer occurrence
(June, July, August)
80° W
70° W
40° N
30° N
ME
VT
NH
NY
MA
CT
RI
PA
NJ
OH
MD
DE
WV
VA
KY
TN
NC
SC
GA
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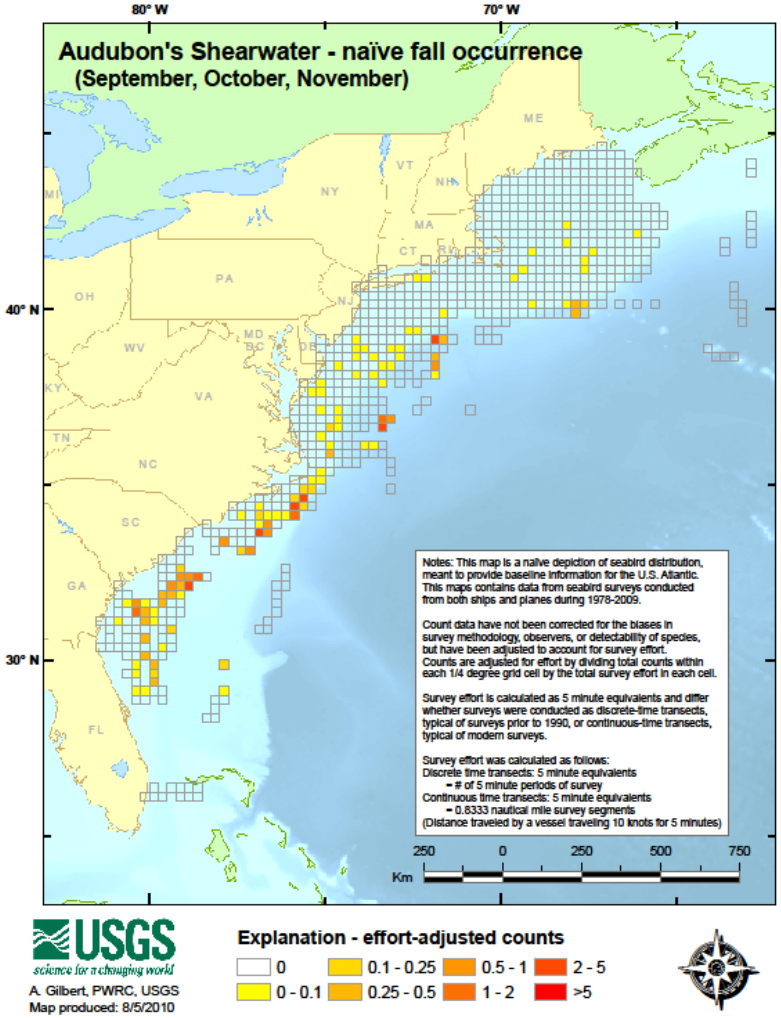
250 0 250 500 750
Km
USGS
science for a changing world
A. Gilbert, PWRC, USGS
Map produced: 8/5/2010
Explanation - effort-adjusted counts
0
0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
5 - 8.1


Audubon's Shearwater - naïve fall occurrence
(September, October, November)
80° W
70° W
40° N
30° N
ME
VT
NH
NY
MA
CT
RI
PA
NJ
OH
MD
DE
WV
VA
KY
TN
NC
SC
GA
FL
MI
Notes: This map is a naïve depiction of seabird distribution, meant to provide baseline information for the U.S. Atlantic. This maps contains data from seabird surveys conducted from both ships and planes during 1978-2009.
Count data have not been corrected for the biases in survey methodology, observers, or detectability of species, but have been adjusted to account for survey effort. Counts are adjusted for effort by dividing total counts within each 1/4 degree grid cell by the total survey effort in each cell.
Survey effort is calculated as 5 minute equivalents and differ whether surveys were conducted as discrete-time transects, typical of surveys prior to 1990, or continuous-time transects, typical of modern surveys.
Survey effort was calculated as follows:
Discrete time transects: 5 minute equivalents
= # of 5 minute periods of survey
Continuous time transects: 5 minute equivalents
= 0.8333 nautical mile survey segments
(Distance traveled by a vessel traveling 10 knots for 5 minutes)
250 0 250 500 750
Km
USGS
science for a changing world
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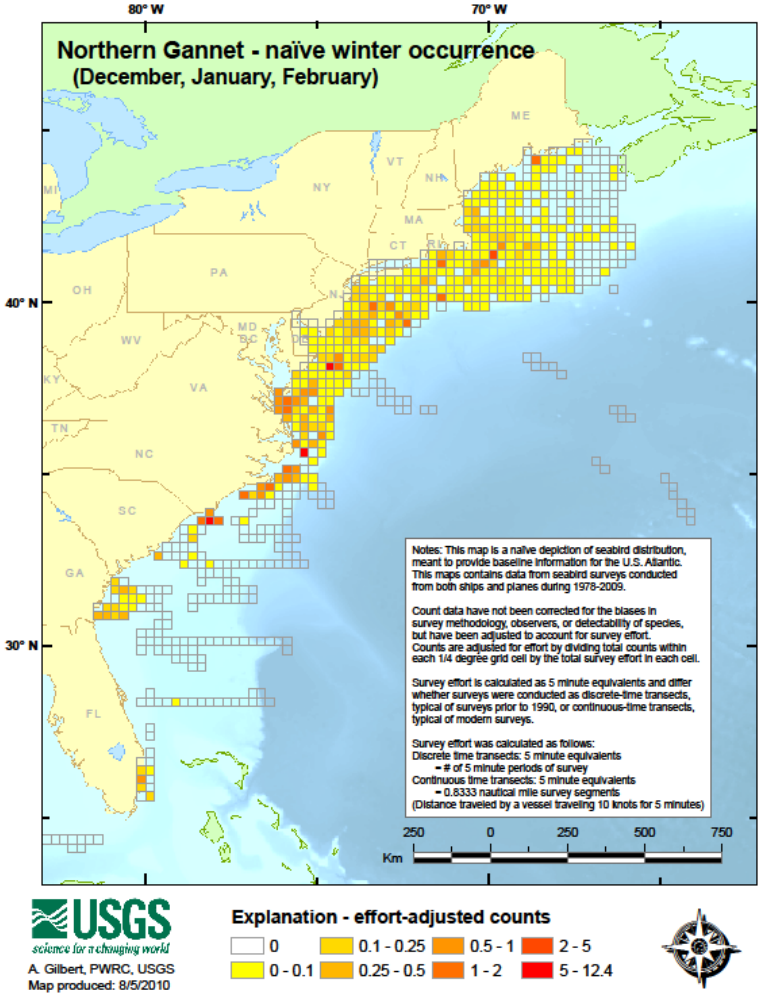
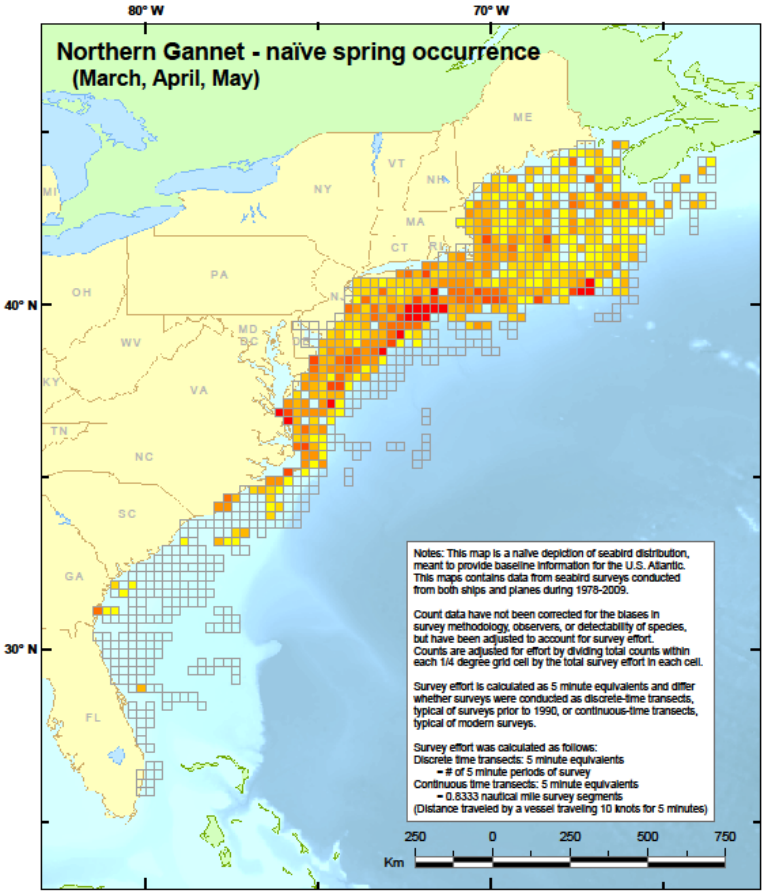
Map produced: 8/5/2010
Explanation - effort-adjusted counts
0
0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
>5



USGS
science for a changing world
A. Gilbert, PWRC, USGS
Map produced: 8/5/2010

Explanation - effort-adjusted counts

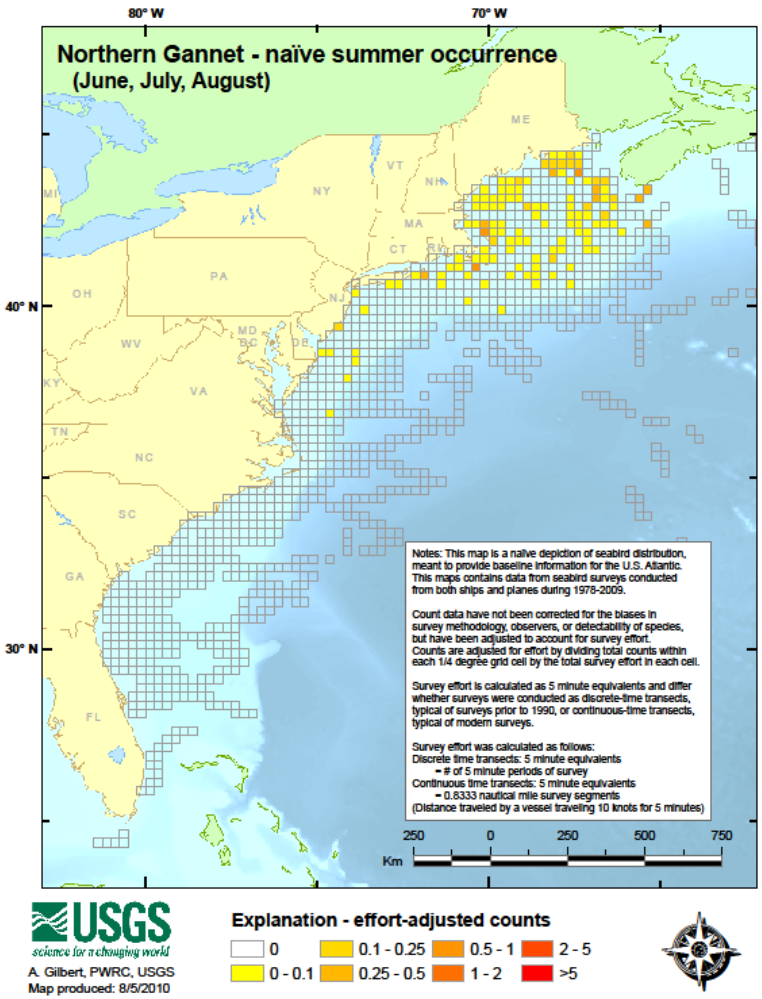
0	0.1 - 0.25	0.5 - 1	2 - 5
0 - 0.1	0.25 - 0.5	1 - 2	5 - 12.4



USGS
science for a changing world
A. Gilbert, PWRC, USGS
Map produced: 8/5/2010

Explanation - effort-adjusted counts

0	0.1 - 0.25	0.5 - 1	2 - 5
0 - 0.1	0.25 - 0.5	1 - 2	5 - 207.5


Northern Gannet - naïve summer occurrence
(June, July, August)
80° W
70° W
40° N
30° N
ME
VT
NH
NY
MI
MA
CT
RI
PA
OH
NJ
MD
DE
WV
VA
KY
TN
NC
SC
GA
FL
Notes: This map is a naïve depiction of seabird distribution, meant to provide baseline information for the U.S. Atlantic. This maps contains data from seabird surveys conducted from both ships and planes during 1978-2009.
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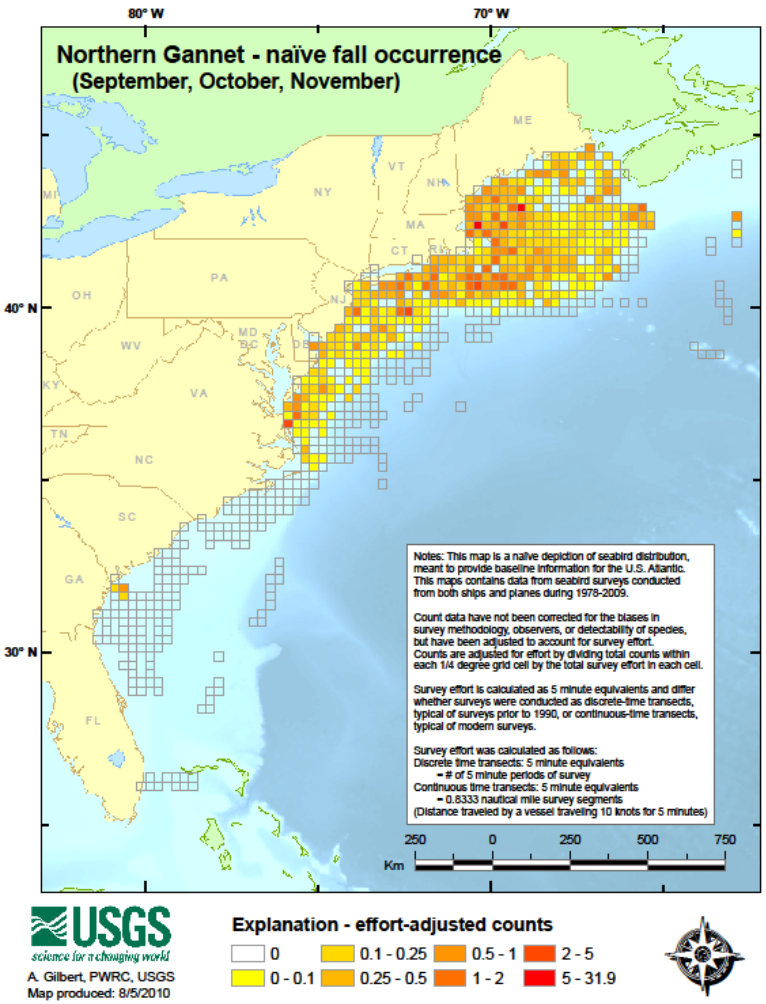
= # of 5 minute periods of survey
Continuous time transects: 5 minute equivalents
= 0.8333 nautical mile survey segments
(Distance traveled by a vessel traveling 10 knots for 5 minutes)
250 0 250 500 750
Km
USGS
science for a changing world
A. Gilbert, PWRC, USGS
Map produced: 8/5/2010
Explanation - effort-adjusted counts
0
0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
>5


Northern Gannet - naïve fall occurrence
(September, October, November)
80° W
70° W
40° N
30° N
ME
VT
NH
NY
MI
MA
CT
RI
PA
OH
NJ
MD
DE
WV
VA
KY
TN
NC
SC
GA
FL
Notes: This map is a naïve depiction of seabird distribution, meant to provide baseline information for the U.S. Atlantic. This maps contains data from seabird surveys conducted from both ships and planes during 1978-2009.
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(Distance traveled by a vessel traveling 10 knots for 5 minutes)
250 0 250 500 750
Km
USGS
science for a changing world
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Map produced: 8/5/2010
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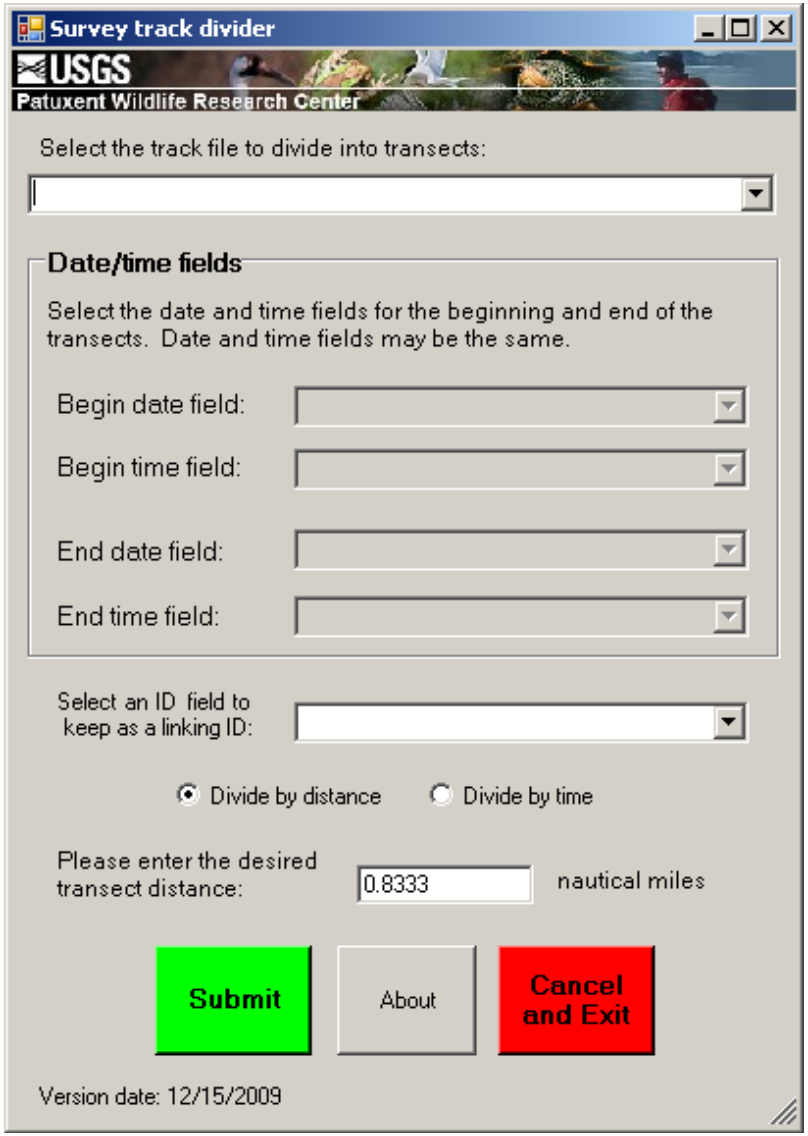
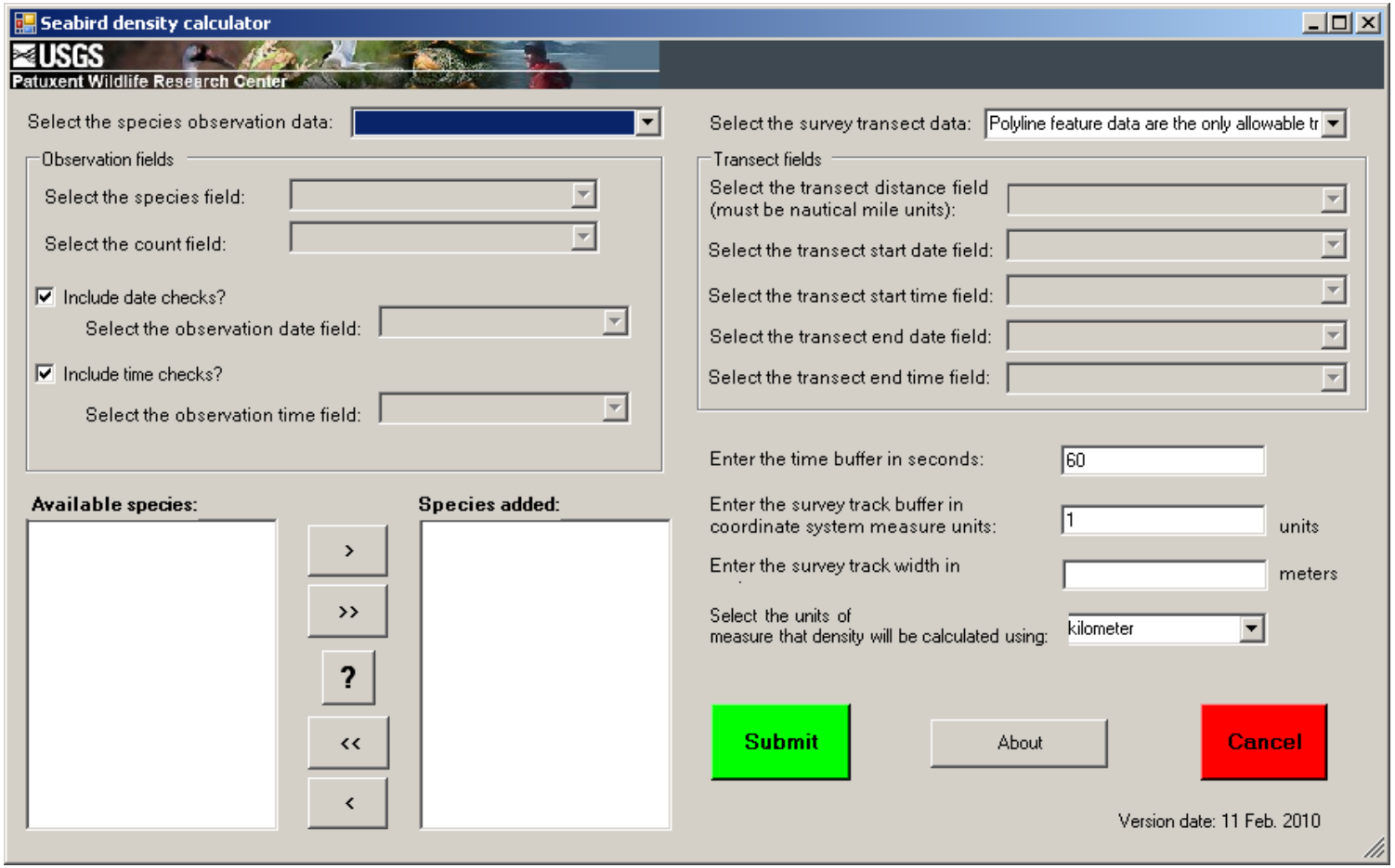
0
0 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 5
5 - 31.9

Seabird Survey Tools

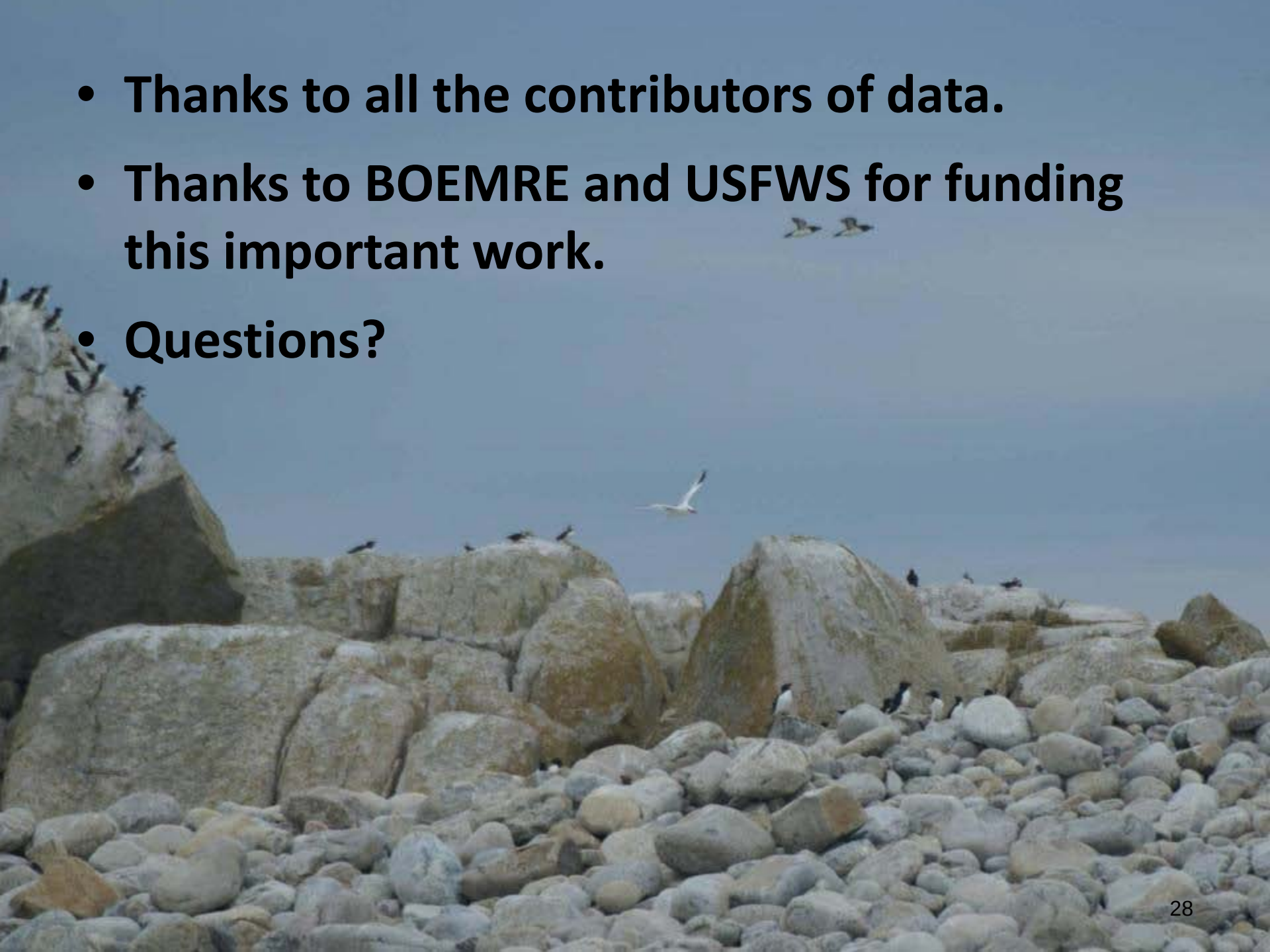
- Tools developed to work with existing seabird datasets
- Survey track divider – divides tracks by distance or time
- Seabird density estimator – calculates densities for chosen species based on discrete transects and species counts



Seabird Density Calculator



Future Plans for Database

- Transfer data to USFWS servers for public accessibility
- Create metadata files to allow filtering of sensitive data
- Create web accessible front end
- Develop tools for exploring data
- Work with other regions to incorporate additional datasets
  - SEANET data to be incorporated next
  - Create connection to OBIS for data sharing availability among other online data access sites

- Thanks to all the contributors of data.
- Thanks to BOEMRE and USFWS for funding this important work.
- Questions?