Non-breeding Abundance of Great Lakes Waterbirds: Integrating Aerial Survey Data Across Multiple Protocols

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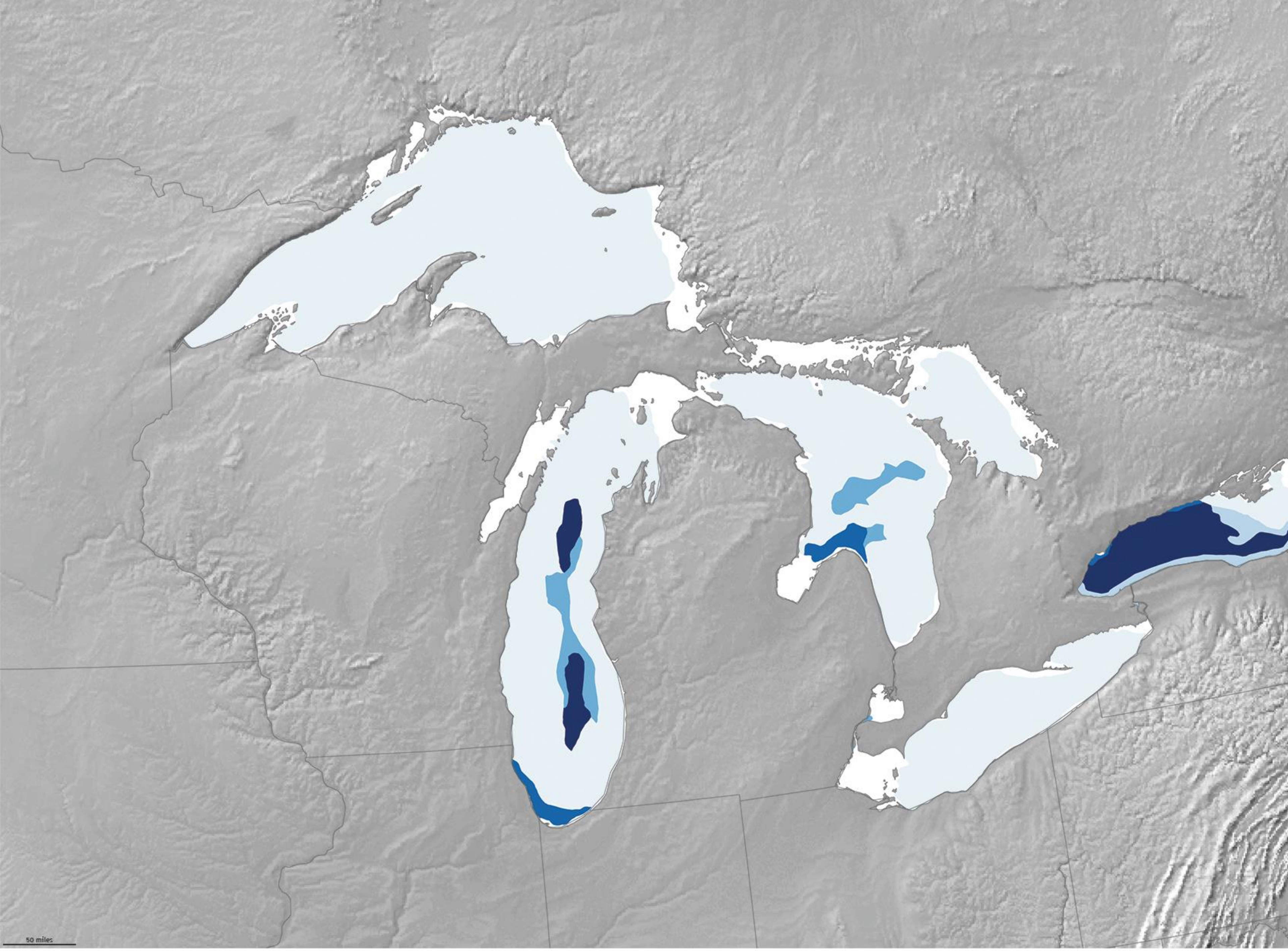
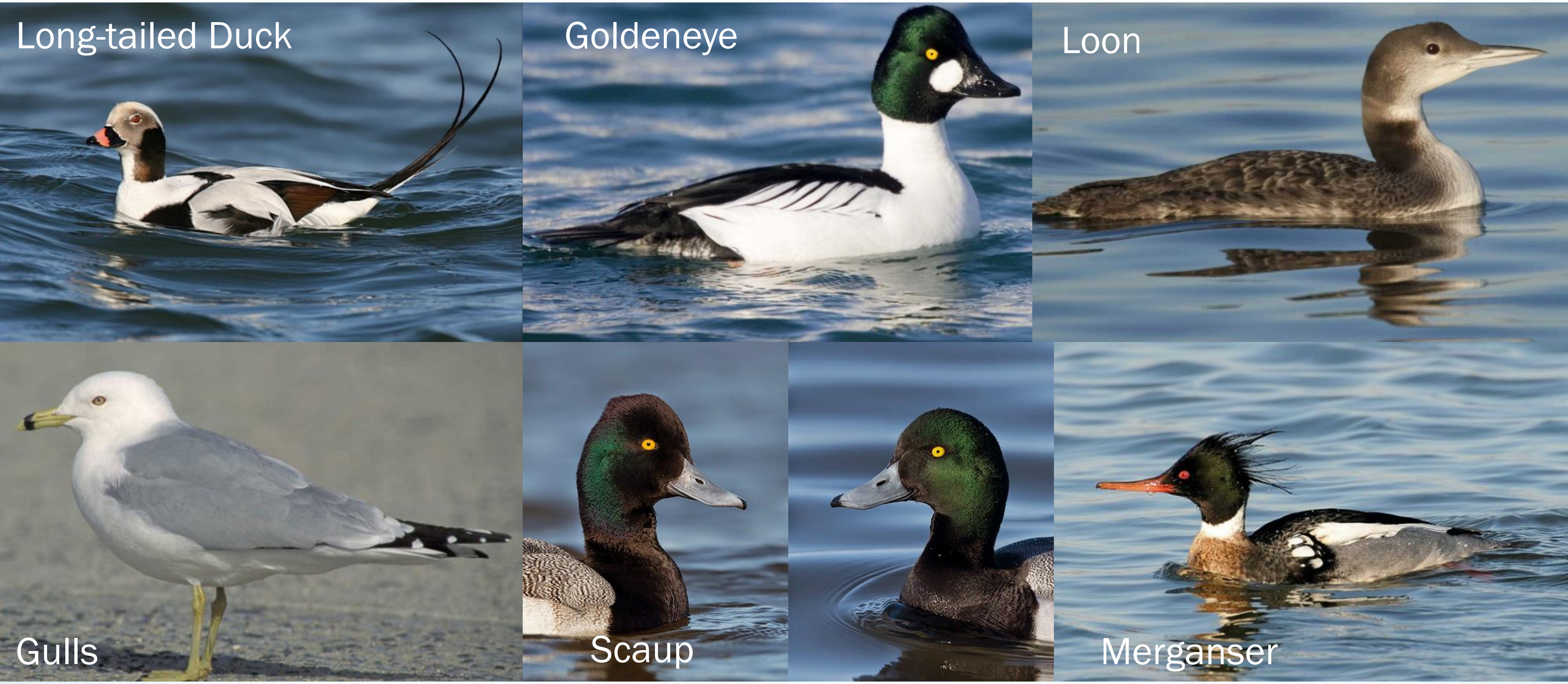


Ice concentration (%)

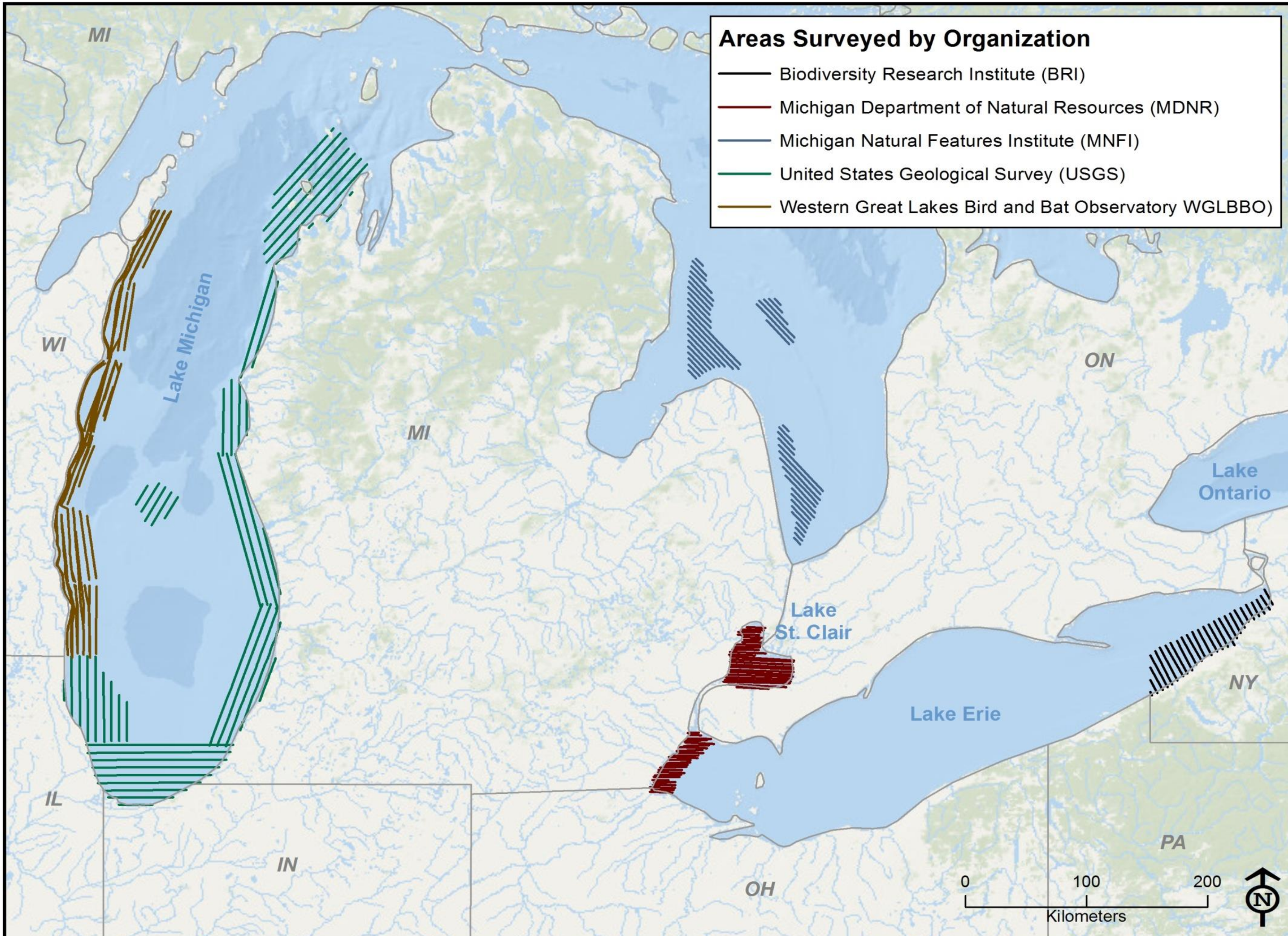
Objectives

- To describe spatial patterns of abundance in six Great Lakes waterbird species/species groups
- To integrate data from 5 different aerial surveyors over two years of data collection
- To incorporate habitat and environmental covariates to explain variation in abundance

Taxonomic Groups



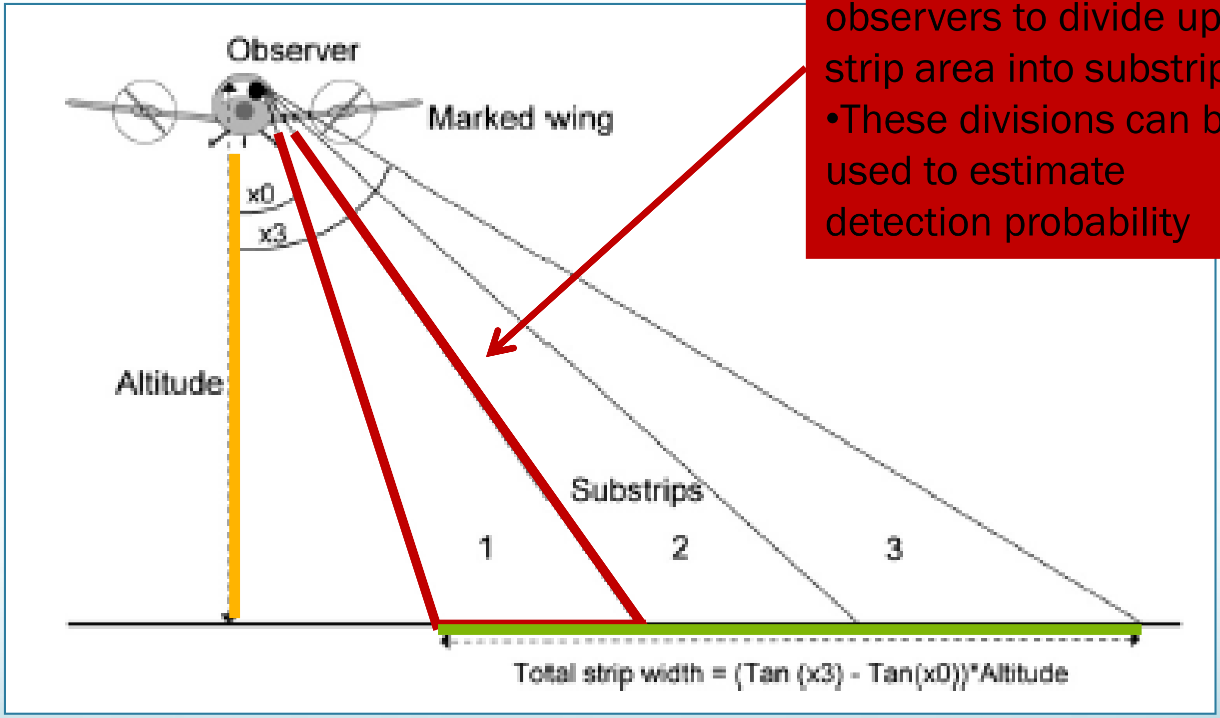
- Why?
  - Helps with observations that aren't identified to species
  - Helps reduce the number of zeroes



Areas Surveyed by Organization
Biodiversity Research Institute (BRI)
Michigan Department of Natural Resources (MDNR)
Michigan Natural Features Institute (MNFI)
United States Geological Survey (USGS)
Western Great Lakes Bird and Bat Observatory WGLBBO)
MI
WI
Lake Michigan
MI
ON
Lake Ontario
Lake St. Clair
NY
Lake Erie
IL
IN
OH
PA
0
100
200
Kilometers
N

Aerial Survey Techniques

Flight Height



Substrips:
- Marks on the wing allow observers to divide up the strip area into substrips
- These divisions can be used to estimate detection probability

Strip Width:
- Total area surveyed

from Certain and Bretagnolle (2008)

Variation in Survey Methods Across Protocols

	U.S. Geological Survey (USGS)	Western Great Lakes Bird and Bat Observatory (WGLBBO)	Michigan Natural Features Inventory (MNFI)	Michigan Division of Natural Resources (MDNR)	Biodiversity Research Institute (BRI)
Geographic area	Lake Michigan	Western shoreline of Lake Michigan	Portions of Northern Lake	Lake St. Clair and western Lake Erie	New York's portion of Lake Erie
Years surveyed	2013-2014	2013-2014	2012-2014	2012-2014	2013-2014
Transect spacing	4.8 km	3.2 km	5 km	3.2 km	5 km
Plane type	Partenavia P.68		Partenavia P68C	amphibious Cessna	amphibious Cessna
Altitude of flights	61-76 m (200-250 ft)	100 m	91 m (300 ft)	91 m (300 ft)	61 m (200 ft)
Flight speed	200 km/hr	148 km/hr	130-200 km/hr	145 km/hr	145-169 km/hr
Strip width (when no distance provided)	200 m		412 m		200 m
Distance bands	2	3	4 or 5	5	3
Species recorded	Waterbirds and waterfowl	Waterbirds and waterfowl	Waterbirds and waterfowl	Waterbirds and waterfowl	Waterbirds and waterfowl

Challenges

- To estimate abundance, we need to incorporate variation in detection
- Each surveyor implemented a different sampling protocol that could change between years
- Counts of birds were highly variable and included a large number of zeroes

Multi-Protocol Distance Sampling

- Combined distance detection protocols for each species along shared parameters of interest
- Three components:
  - Detection function based on distance
    - Half-normal or hazard function
  - Model for observed groups
    - Zero-inflated overdispersed Poisson
  - Group size regression
    - Allows group size to vary with distance to observer (i.e., detection probability)

Modeling Numbers of Groups

- Zero-inflation model
  - Estimates the probability that a species could be found at the site
- Overdispersed Poisson model
  - Given that the animal can be found at the site, this estimates the number of groups there

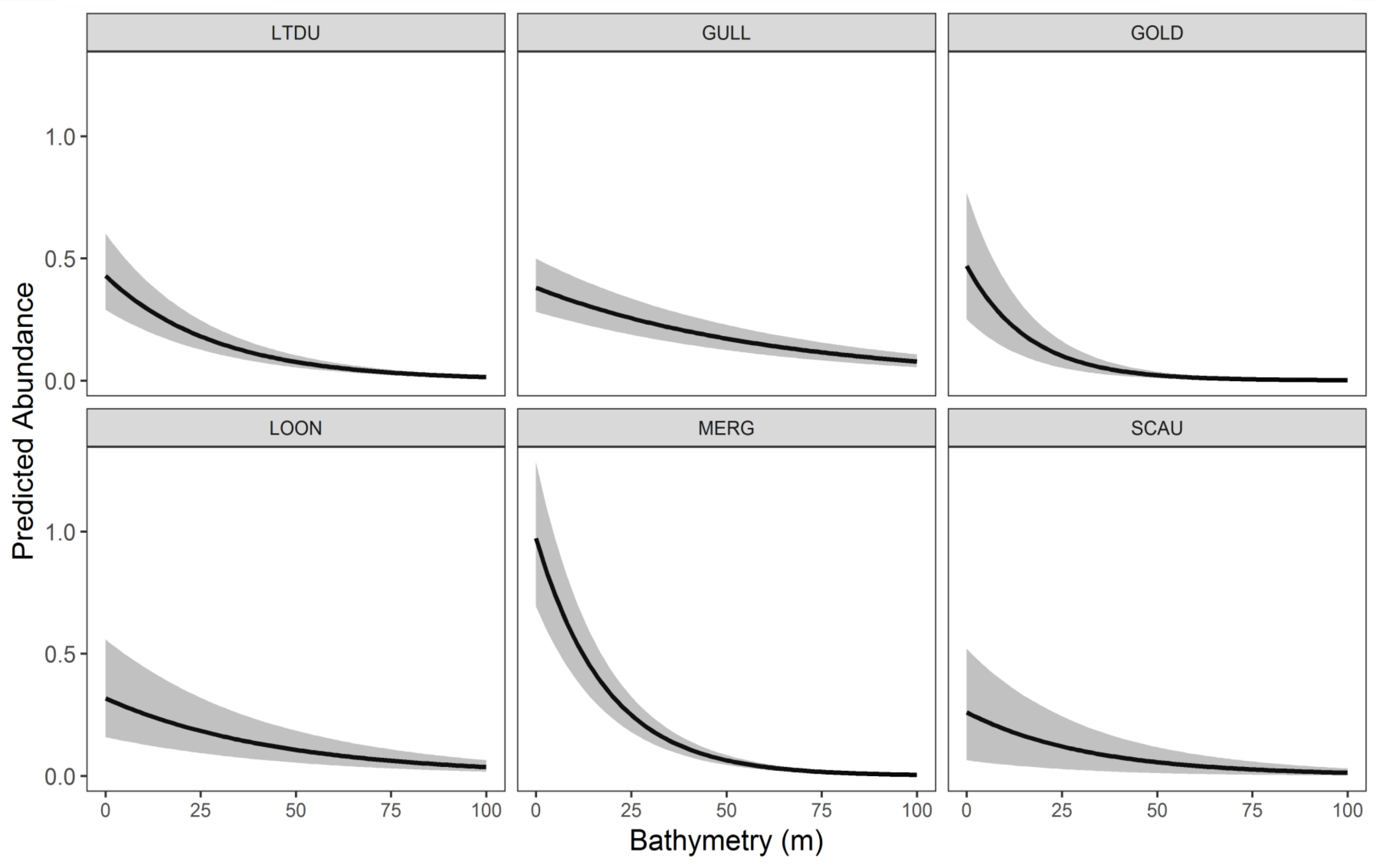
Environmental Covariates

- Zero-inflation covariates
  - Longitude
  - Time of year (fall, winter, spring)
  - Ice coverage (solid ice or not)
- Abundance covariates
  - Bathymetry (m)
  - Lake bottom substrate (6 categories)
  - Ice coverage (% coverage)
  - Area offset

Model Implementation

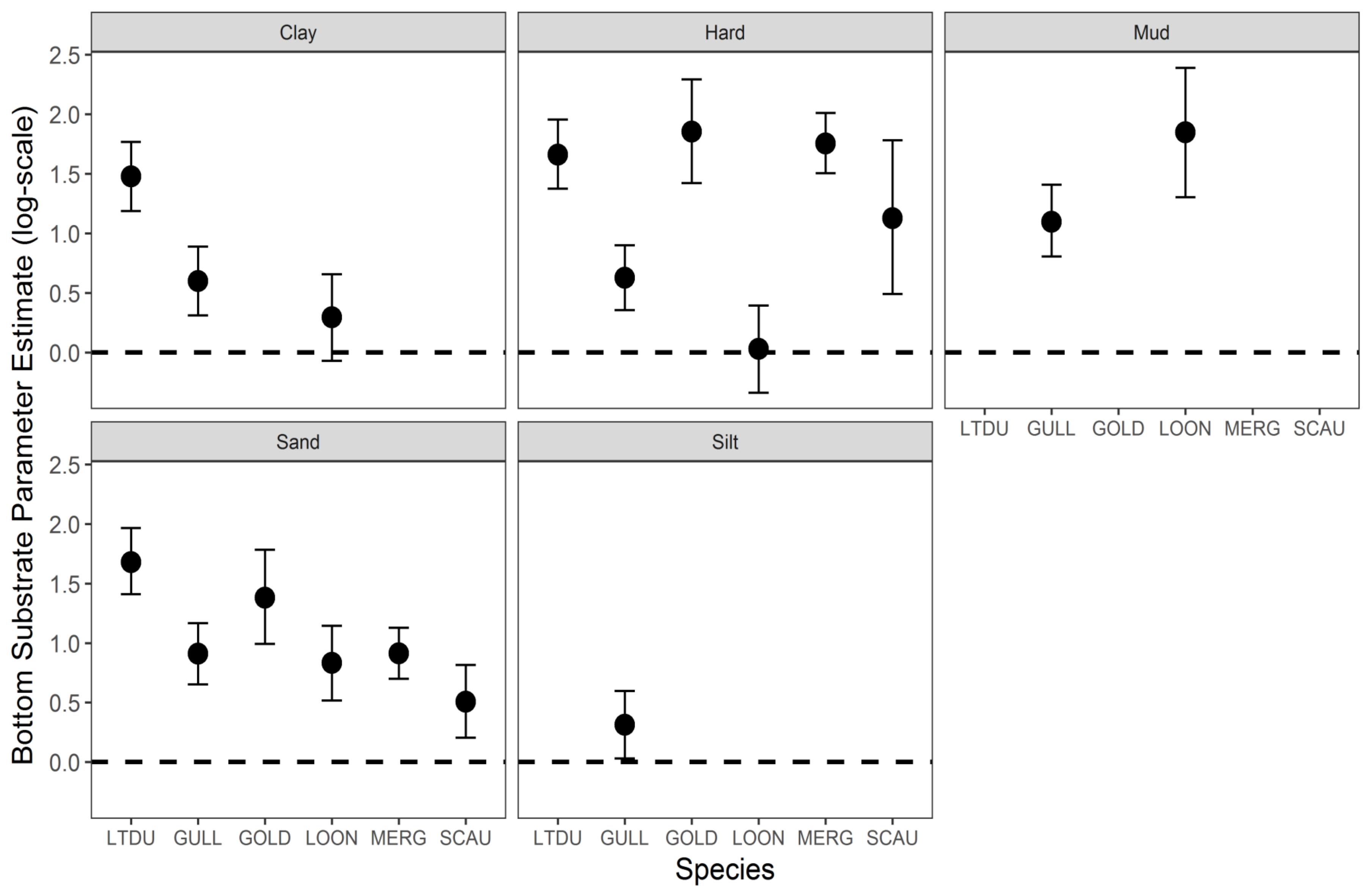
- A Bayesian framework using JAGS 4.0
- Convergence assessed visually and the Gelman-Rubin statistic
- A posterior predictive check using a Bayesian *p*-value was used to quantify goodness of fit

Bathymetry

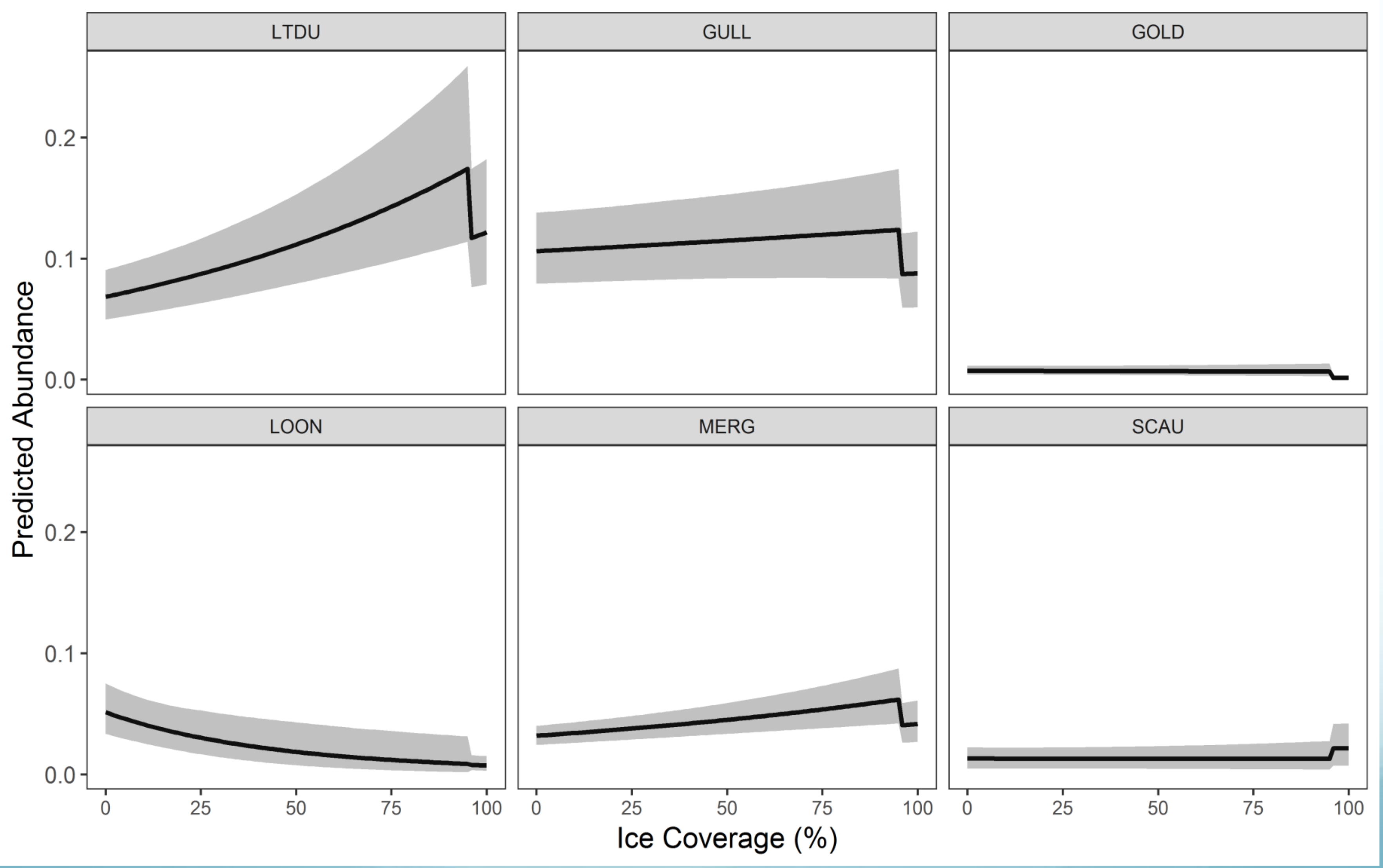


LTDU
GULL
GOLD
LOON
MERG
SCAU
Predicted Abundance
0.0
0.5
1.0
0
25
50
75
100
Bathymetry (m)

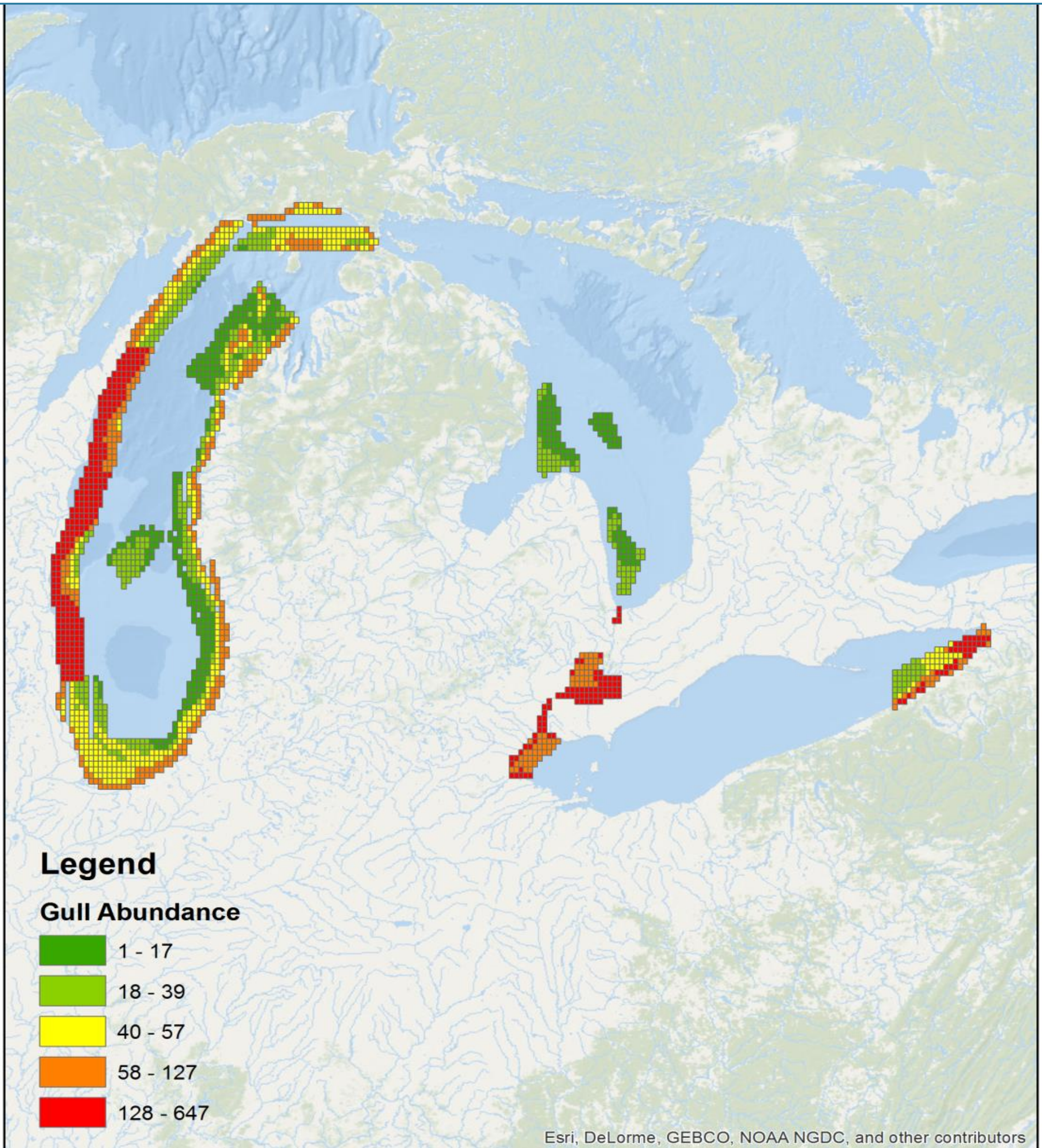
Lake Substrate



Ice Cover


LTDU
GULL
GOLD
LOON
MERG
SCAU
Predicted Abundance
0.0
0.1
0.2
0
25
50
75
100
Ice Coverage (%)

Abundance Estimates



Summary

- The multi-protocol distance model allowed us to describe patterns of abundance at the scale of four Great Lakes
- All species had higher abundance in shallower waters
  - But the rate of change differed considerably among species
- Most species were less likely to be present at high ice locations
  - Scaup were the opposite and Long-tailed Ducks decreased but were still higher than zero ice
  - These results suggest error in our ice coverage estimates or attraction to icy edges for these species (or both)

Future Directions

- More aerial surveys to fill in gaps in inference
  - Groups are highly clustered, can make it difficult to predict to unsurveyed areas
  - Particularly a focus on areas of high regulatory or conservation interest
  - High annual variance due to ice coverage, so repeating surveys for multiple years will be key
- To make useful predictions, we would need estimates of ice coverage across the lakes
  - Current forecasting occurs up to 5 days out
    - Great Lakes Coastal Forecasting System
  - Longer time scale forecasting is an area of active research

Thanks!