

# Using a Ballast Water Prediction Model to Inform Surveillance and response monitoring Efforts

Jennifer Sieracki, and John Bossenbroek



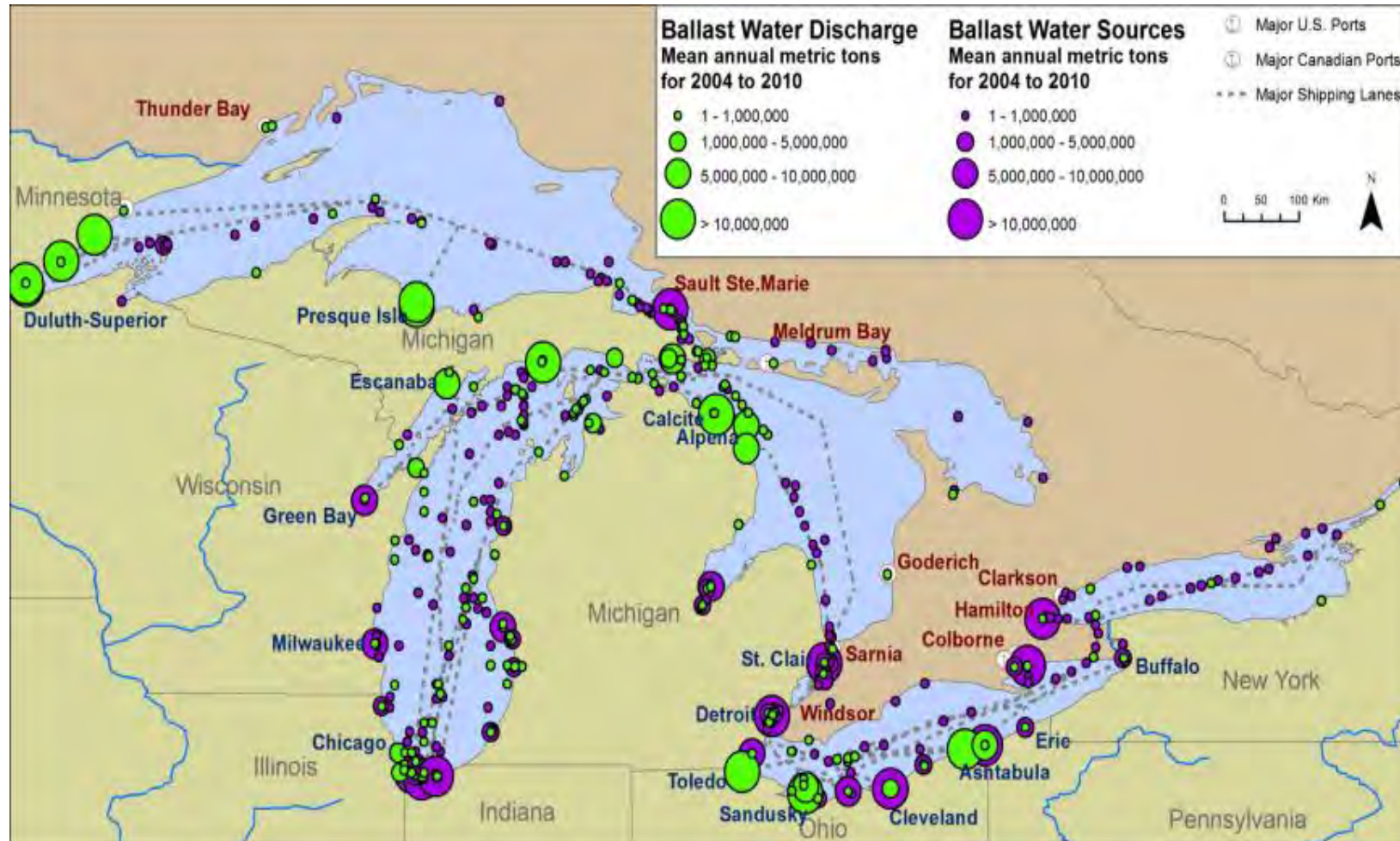
Grants:

NOAA CSCOR: #NA09NOS4780192

# Goals of Prediction Modeling

- Predict the future spread of invasive species that already occur in the Great Lakes, but are not yet widespread
  - delimit extent of newly detected invader
  - monitor for range expansion
- Predict the future spread of species that may invade the Great Lakes in the future.
- Ultimately, inform detection and surveillance programs

# Developing a ballast water mediated dispersal model



Sieracki, J. L., J. M. Bossenbroek, and M. Faisal. 2013. Modeling the secondary spread of viral hemorrhagic septicemia virus (VHSV) by commercial shipping in the Laurentian Great Lakes. *Biological Invasions*.

# Eurasian Ruffe Prediction Model

- Tested 3 models by backcasting 1986 – 2011 spread



Photo Credit: Tiit Hunt

1986-1988





1991



1992-1994



1995





1996-2001



2002



2003





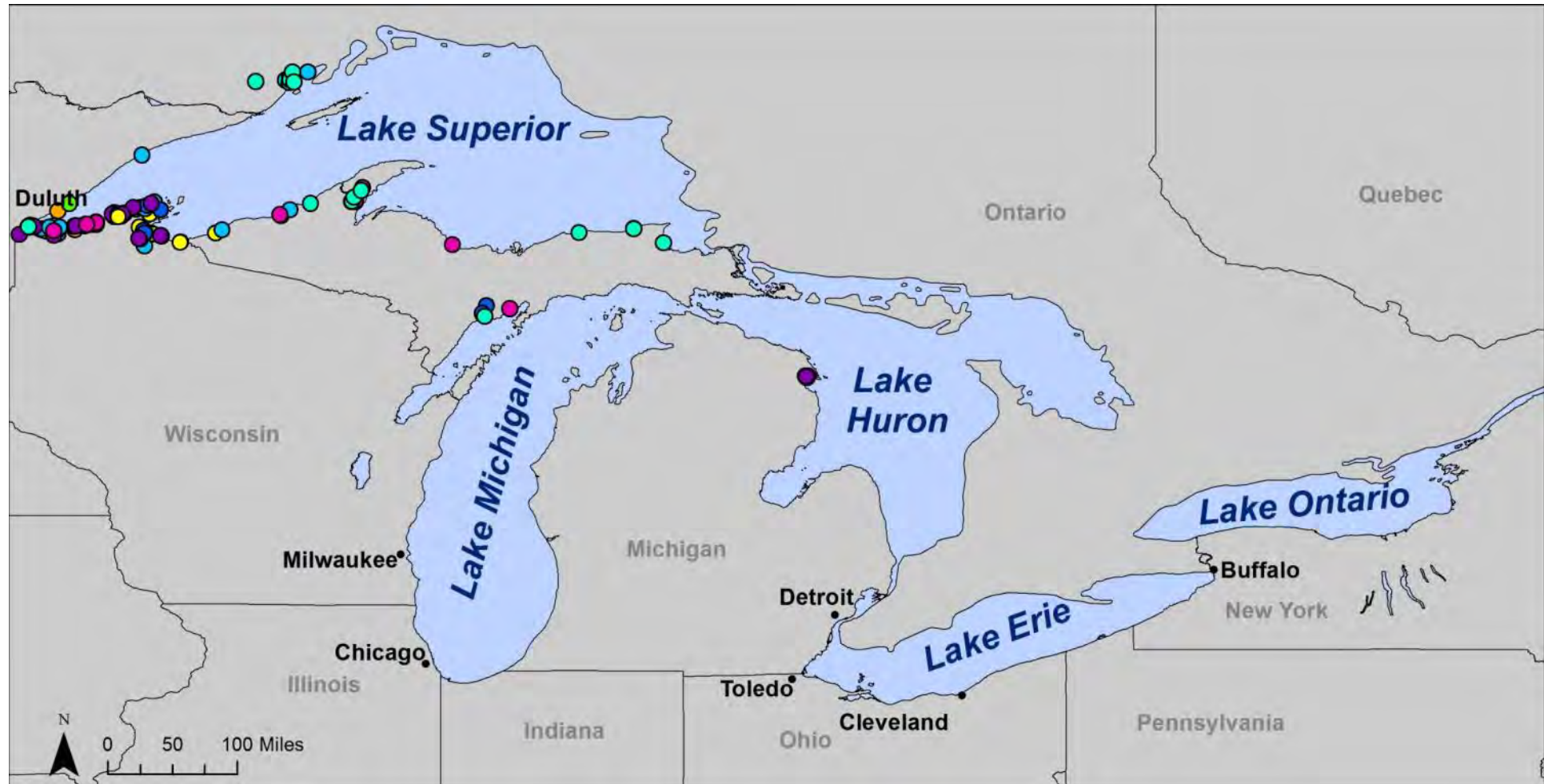
2004-2005



Good information on spread - was used to train model



2006



Good information on spread - was used to train model

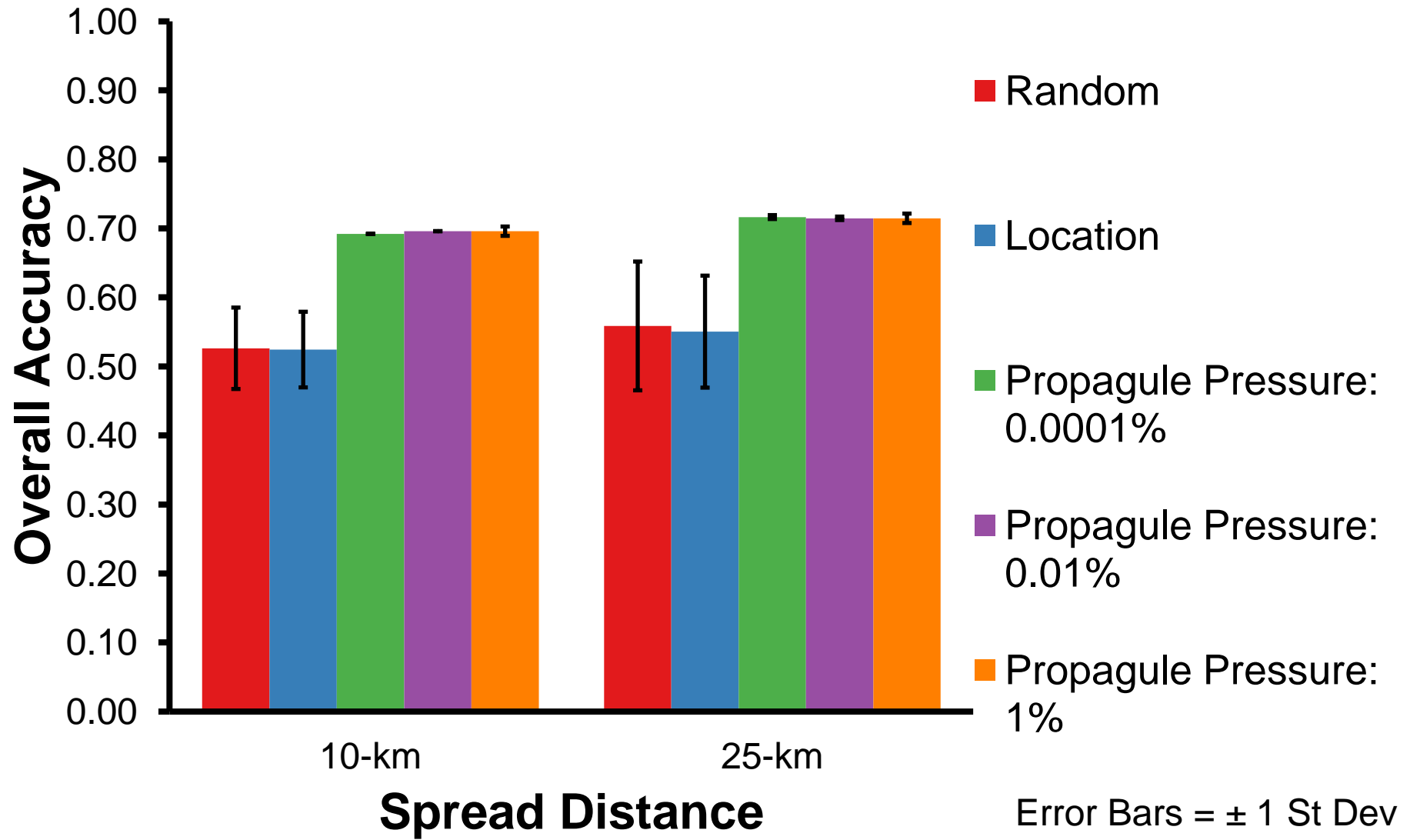
2007-2011



Good information on spread - was used to train model

# Eurasian Ruffe Prediction Model

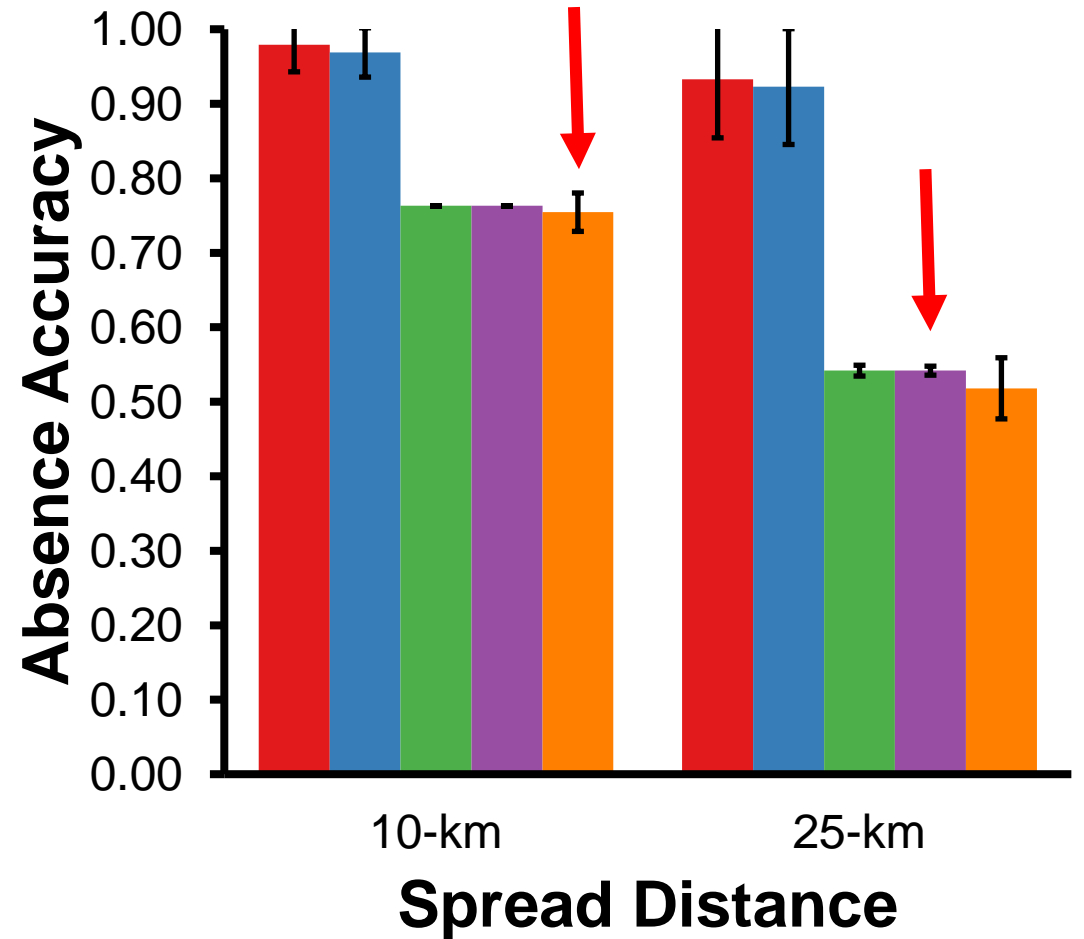
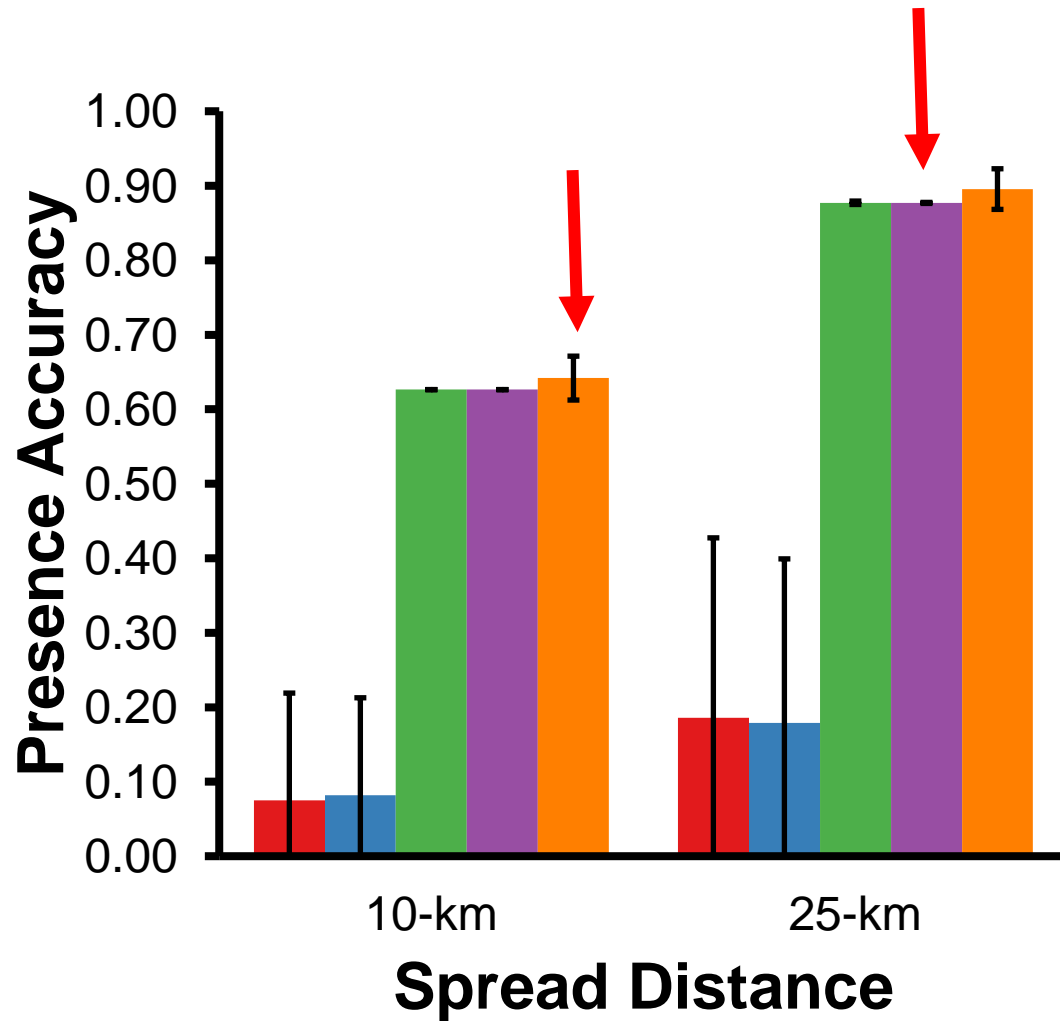
- Tested 3 models by backcasting 1986 – 2011 spread
  - Random model: Included no ballast water information
  - Location model: Tested likelihood of any ballast water discharge locations becoming invaded (random)
  - Propagule pressure model: Tested whether locations closest to invaded areas and receiving the most discharges from ruffe invaded ports were more likely to become invaded
  - Local spread distance values were included and tested for all three models



Models that included ballast discharge and trip information performed the best

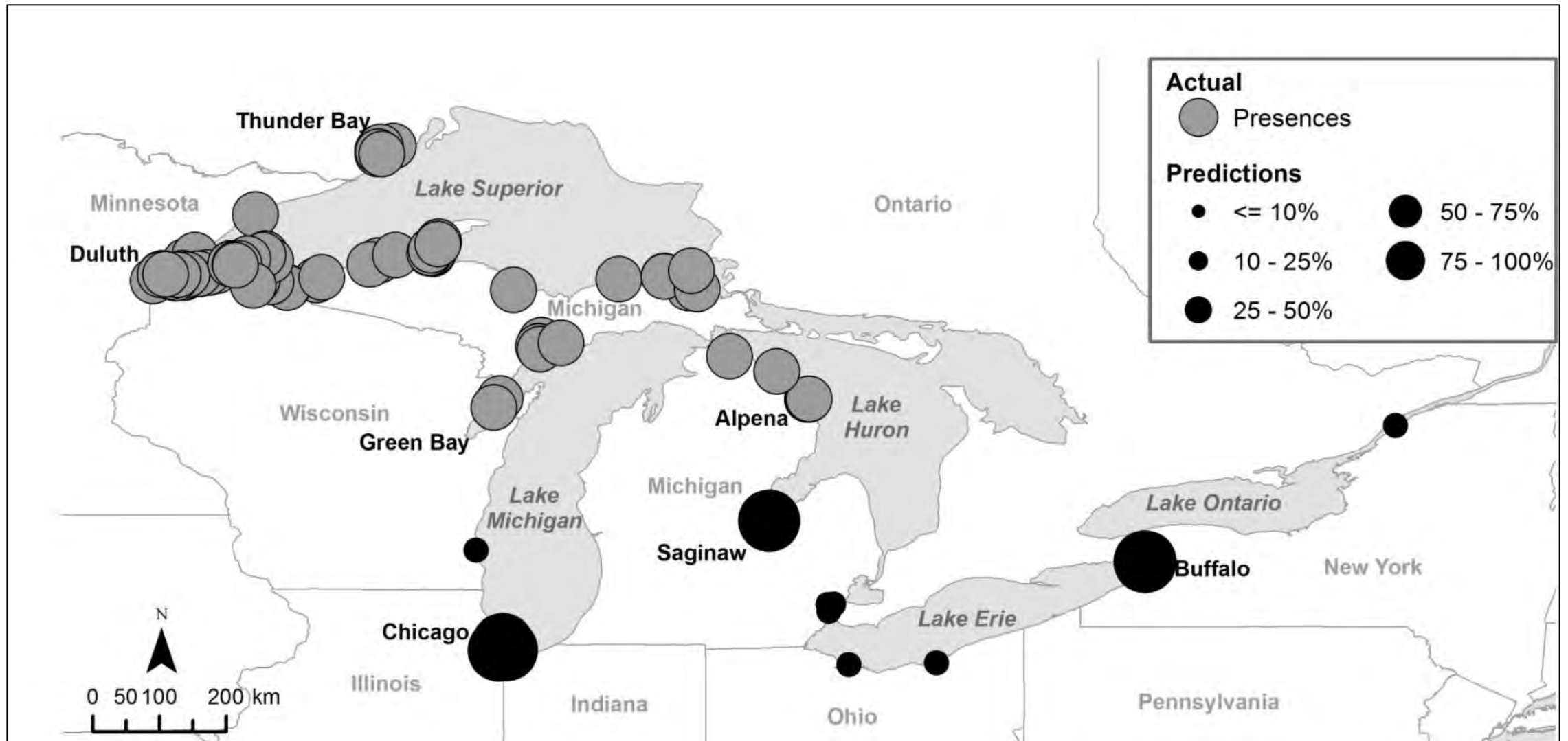


Error Bars =  $\pm 1$  St Dev

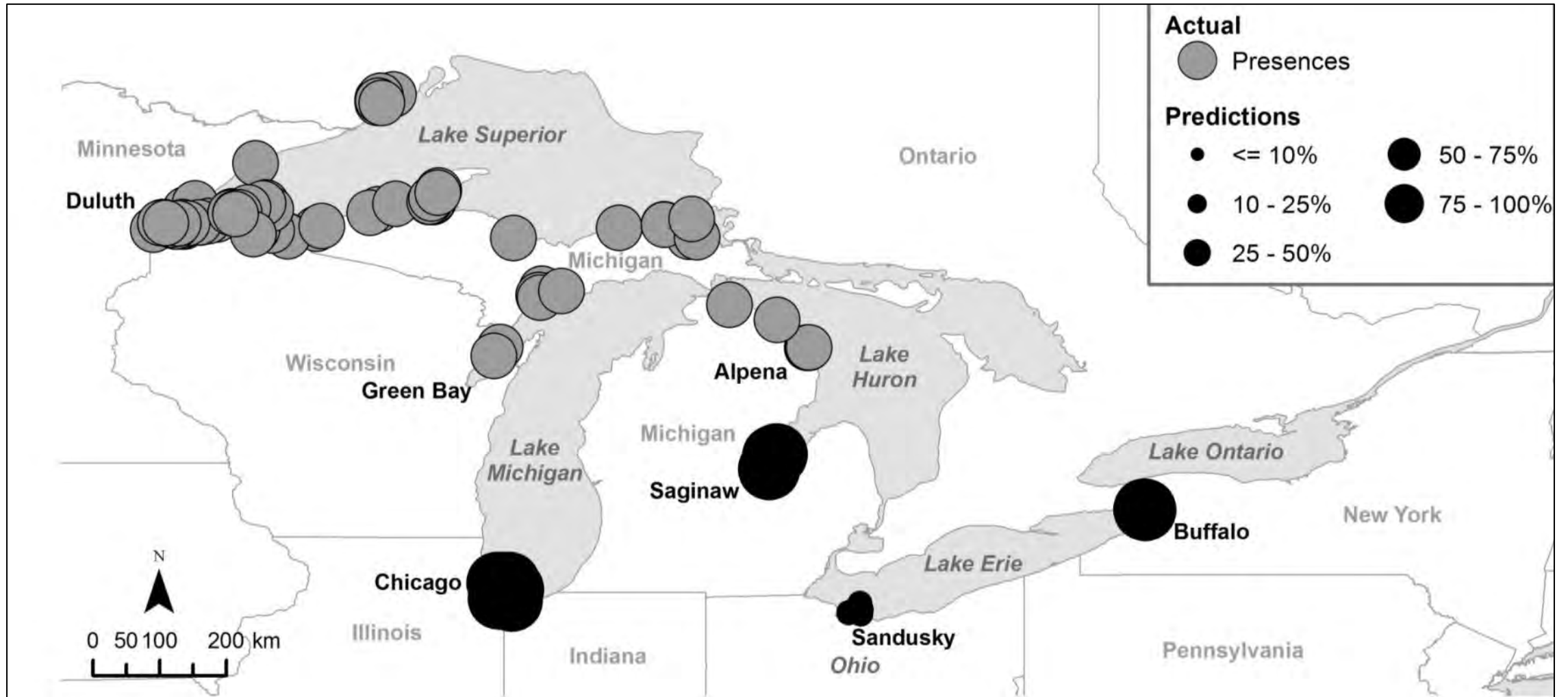


To balance differences in predicting presences and absences, prediction models were run using both local spread distances

# Ruffe Predictions: 10-km Model



# Ruffe Predictions: 25-km Model



# eDNA Surveillance

## First evidence for Eurasian ruffe spread



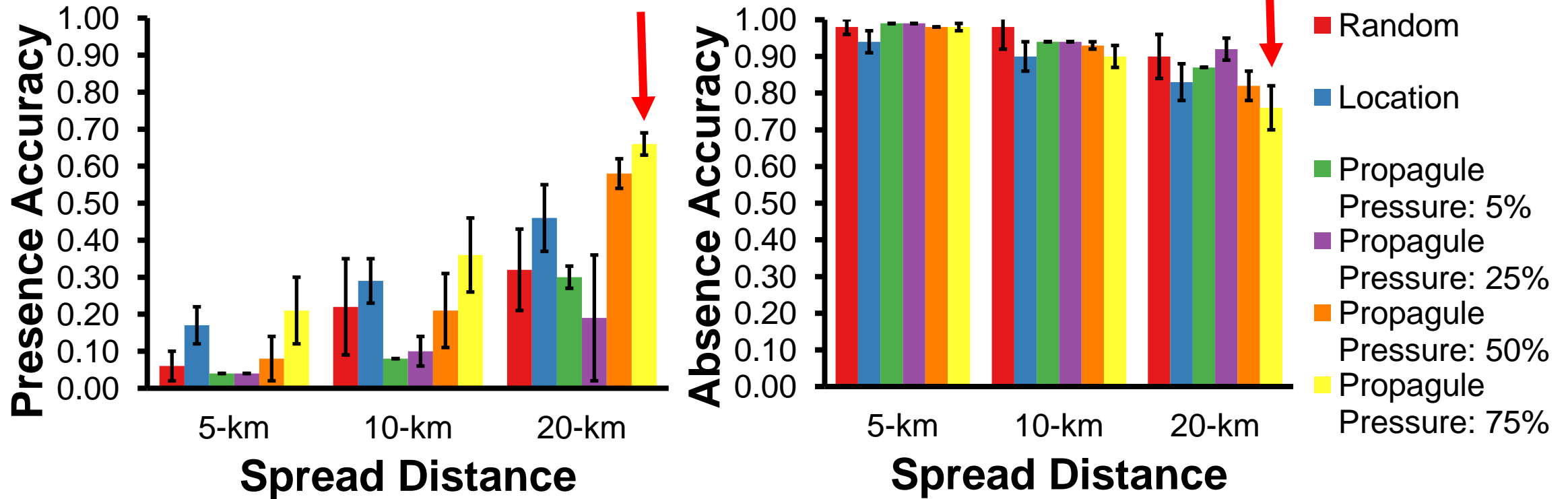


# Invertebrate spread model developed using historic zebra mussel spread data

- Zebra mussels spread in the Great Lakes was back casted
  - Same 3 models used as with ruffe
  - Random model: Included no ballast water information
  - Location model: Tested likelihood of any ballast water discharge locations becoming invaded (random)
  - Propagule pressure model: Tested whether locations closest to invaded areas and receiving the most discharges from ruffe invaded ports were more likely to become invaded

# Zebra Mussel Backcasting

Error Bars =  $\pm 1$  St Dev



The 20-km model at the 0.75 survival rate was better at predicting presences while still predicting absences  $\frac{3}{4}$  of the time

# Killer Shrimp

- Amphipod native to Ponto-Caspian region
- Widespread throughout Europe due to increased canal connectivity and ballast water movement
- Can outcompete native zooplankton
  - Aggressive predator that kills without consuming
  - Capable of eating larger prey, including larval fish
- Currently not found in the Great Lakes



Photo Credit: Simon Devin,  
Université de Metz, France

# Killer Shrimp

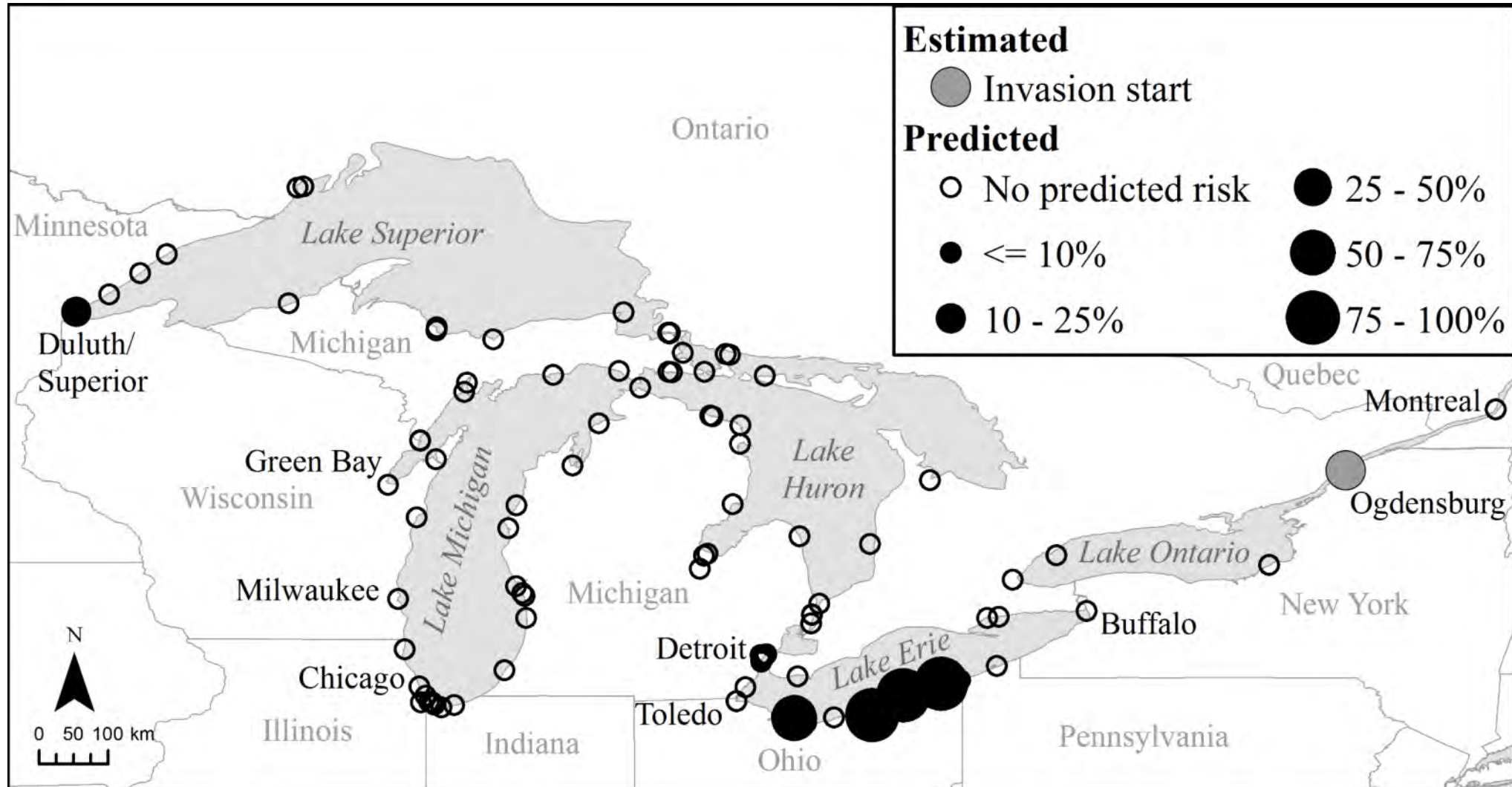
- Killer shrimp do not spend much time in the water column
  - Local spread distance = 0-km for prediction
- Based on past ballast water discharge data for the Great Lakes:

	# Ship Visits
Duluth, Minnesota	147
Toledo, Ohio	47
Superior, Wisconsin	17
Ogdensburg, New York	8
Green Bay, Wisconsin	7
Goderich, Ontario	4
Detroit, Michigan	1

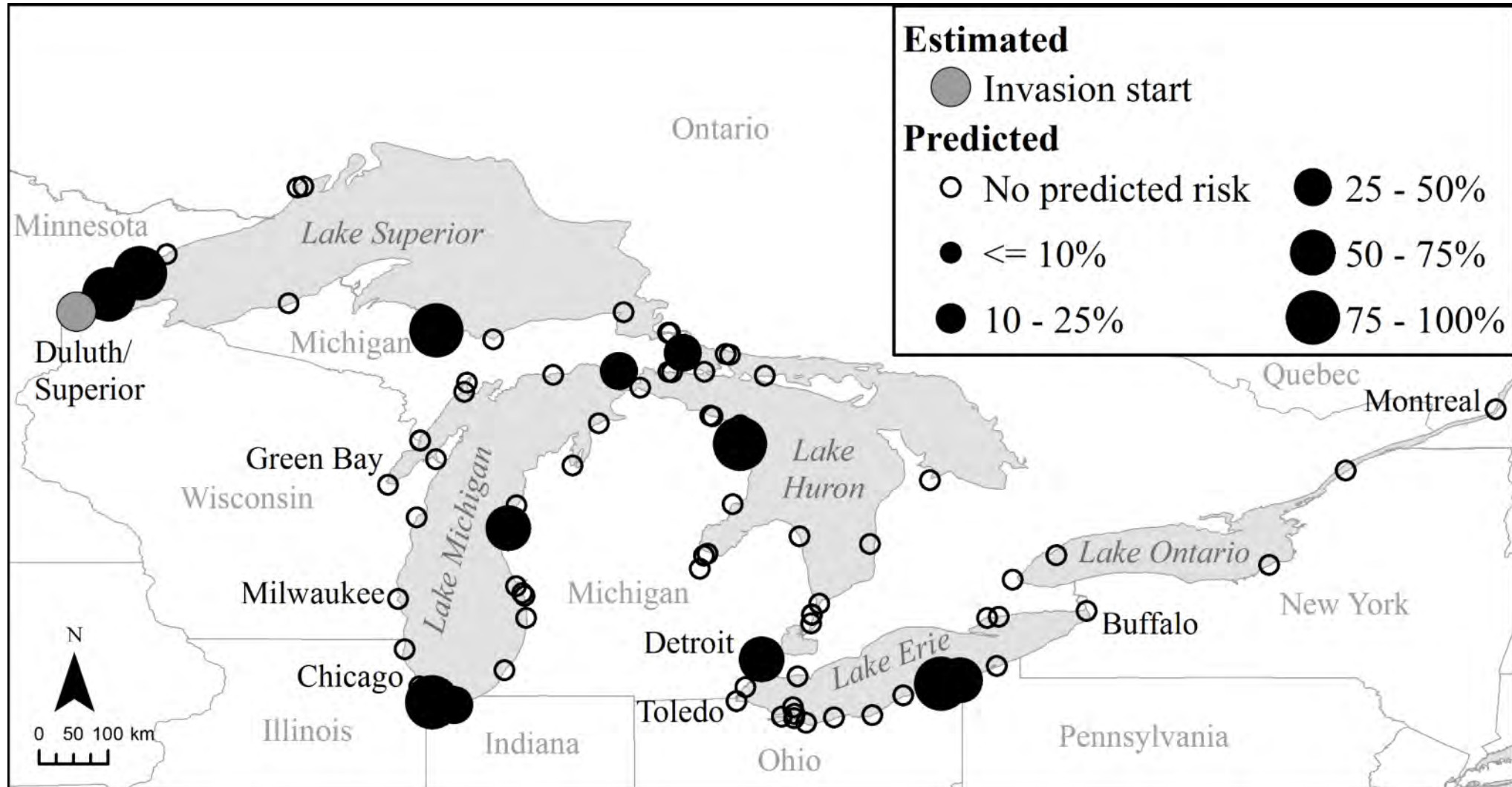
*Ballast water source, discharge, and trip data for the years 2004 to 2010 National Ballast Information Clearinghouse (NBIC; Smithsonian 156 Environmental Research Center and USCG 2009).*



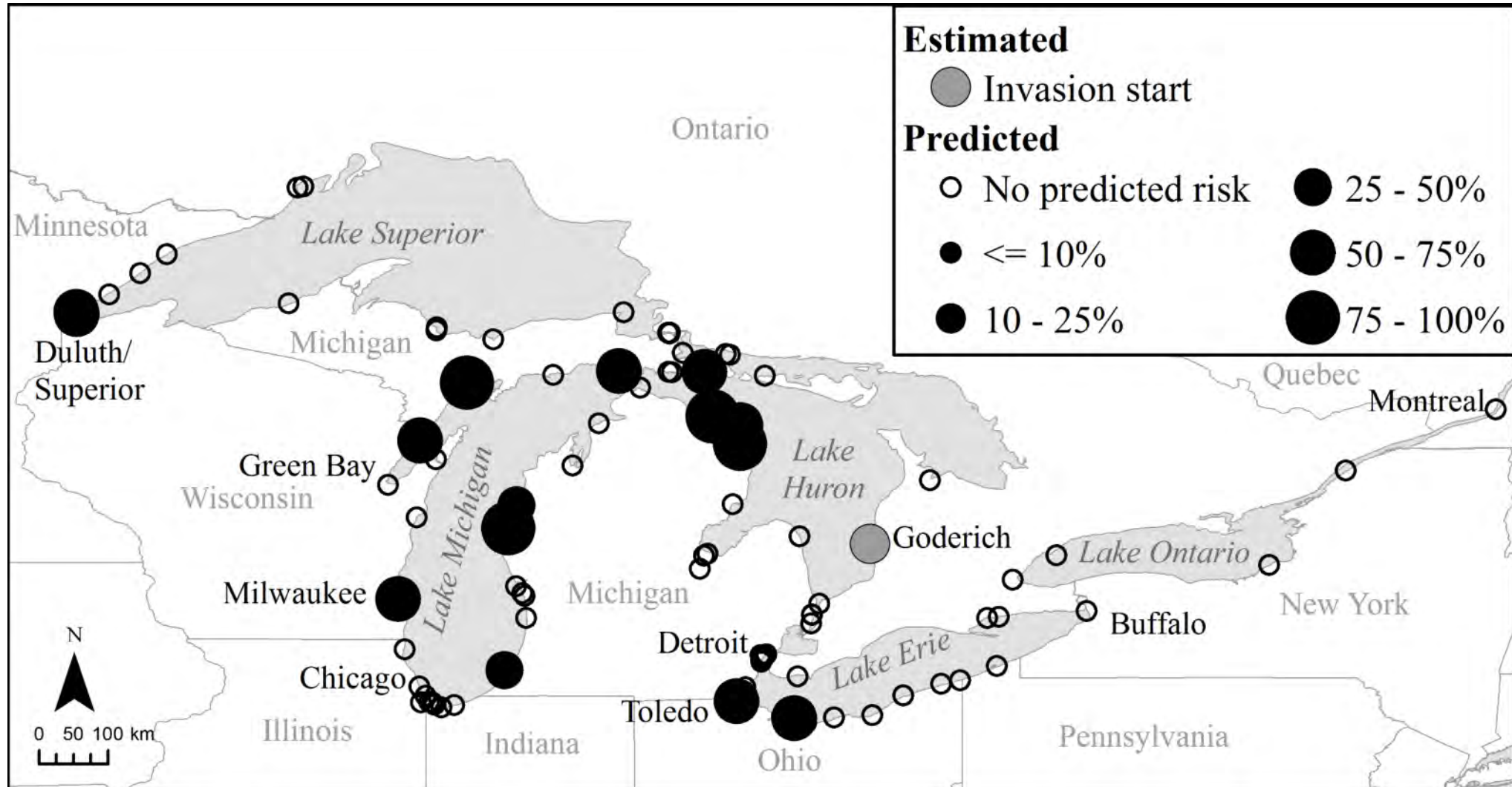
# Killer Shrimp Predictions: Ogdensburg



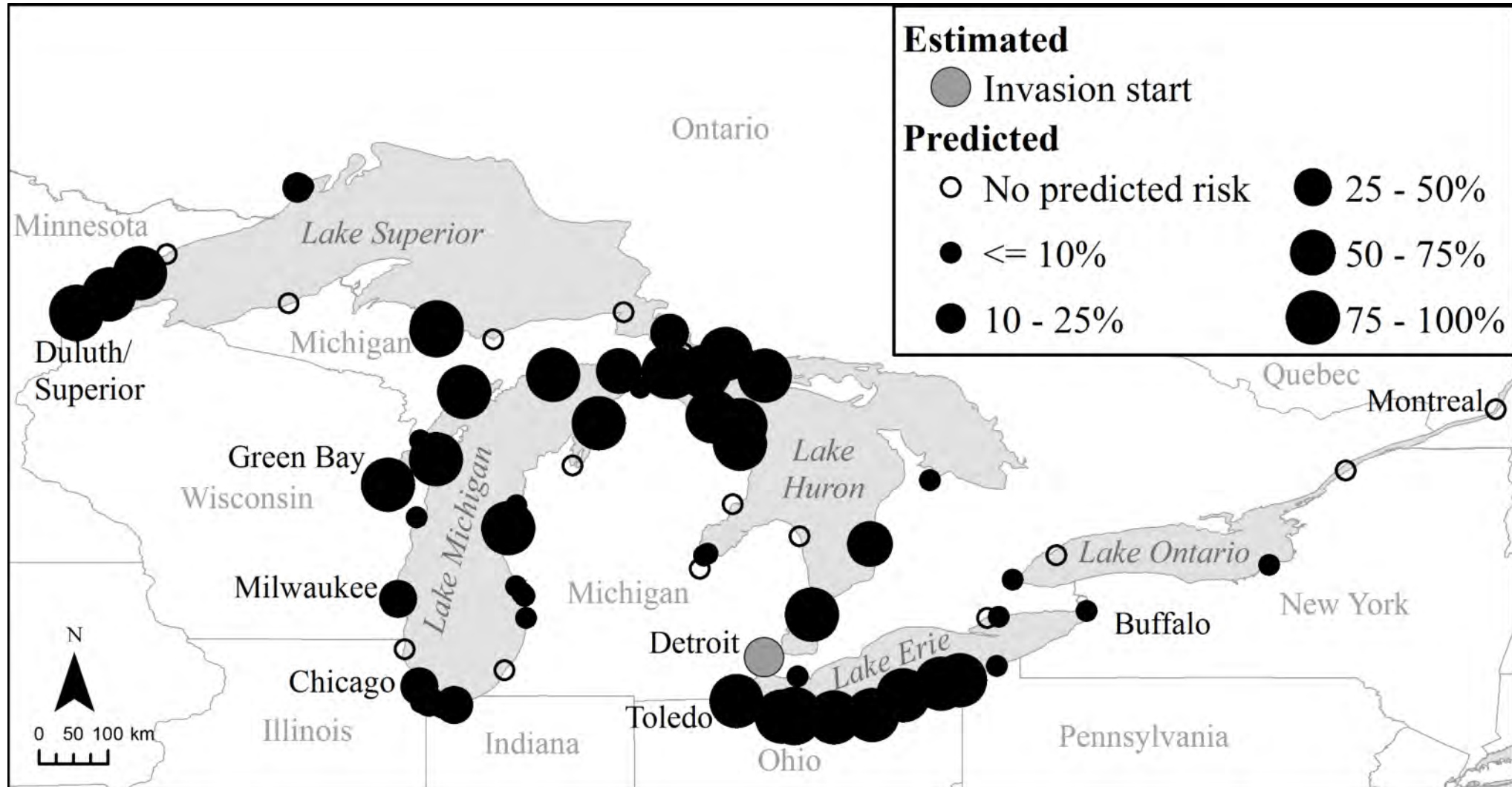
# Killer Shrimp Predictions: Duluth



# Killer Shrimp Predictions: Goderich



# Killer Shrimp Predictions: Detroit





# Killer Shrimp Predictions

- Predictions suggest that where killer shrimp is first found will determine where to start looking next
  - Model can be used to inform delimitation priorities
- Ports that are major donors of ballast water can lead to rapid spread throughout the Great Lakes
  - Toledo
  - Green Bay
  - Detroit
- Results clearly have implications for surveillance effort (sampling locations and periodicity)
- Canada – problems with an absence of comparable ballast water discharge data
- EDRR will require access to most recent ballast water discharge information

# Desk top tool development



- Adapting model run in ArcGIS by someone with basic ArcGIS skills.
- Include geodatabase with basic data required to run (i.e. ballast water source/dischARGE, GL boundary, invasion start/potential invasion points).
- Ability to input your own data
- Training workshops

Jonathan Bossenbroek, Ph.D.  
Associate Professor - Department of Environmental Sciences  
University of Toledo  
Toledo, OH 43606  
office phone: 419/530-8376  
[Jonathan.Bossenbroek@utoledo.edu](mailto:Jonathan.Bossenbroek@utoledo.edu)

Jennifer Sieracki, Data Manager  
Biological Resource Management Division  
National Park Service  
Natural Resource Stewardship and Science  
1201 Oakridge Dr, Suite 200  
Fort Collins, CO 80525

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