# How can seabird diets be used to inform fisheries management?

**Lauren Scopel**, A. Diamond, S. Kress, A. Hards, and P. Shannon

University of New Brunswick and National Audubon Society Seabird Restoration Program

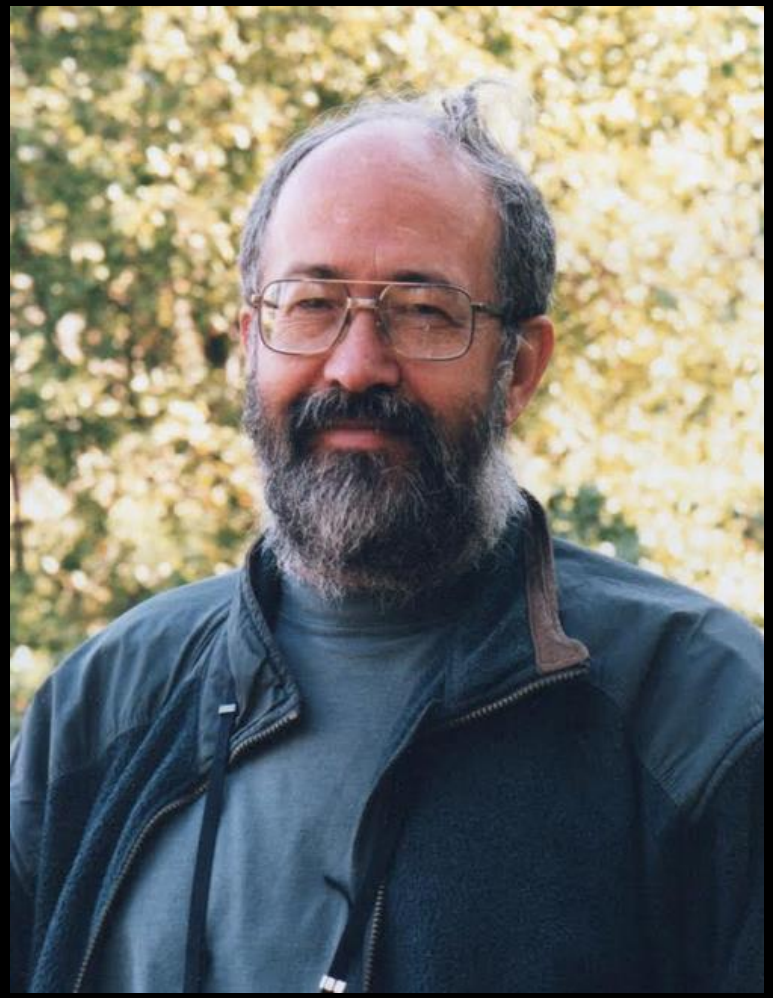
March 7, 2018

NRC Research Press

ARTICLE

# Seabird diets as bioindicators of Atlantic herring recruitment and stock size: a new tool for ecosystem-based fisheries management

Lauren C. Scopel, Antony W. Diamond, Stephen W. Kress, Adrian R. Hards, and Paula Shannon



Tony Diamond

Tony Diamond

Project Puffin

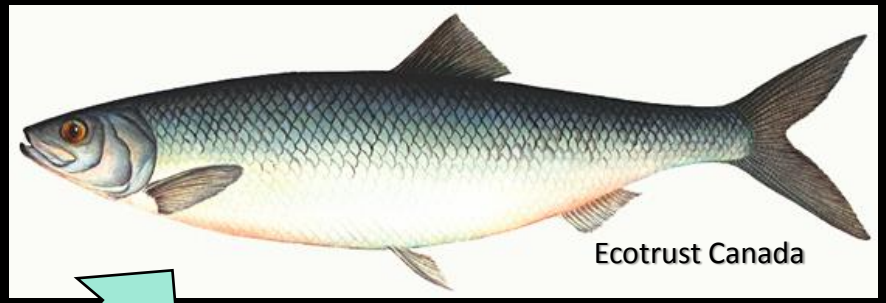
Steve Kress


Bay of Fundy
Gulf of Maine
Image Landsat

# Species-specific fisheries management

# Species-specific fisheries management

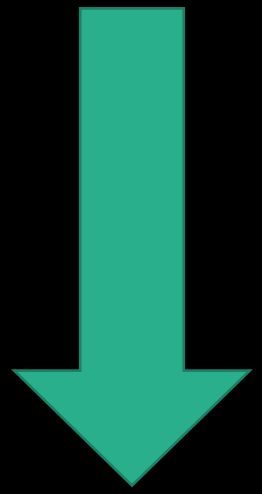
PEW Charitable Trusts



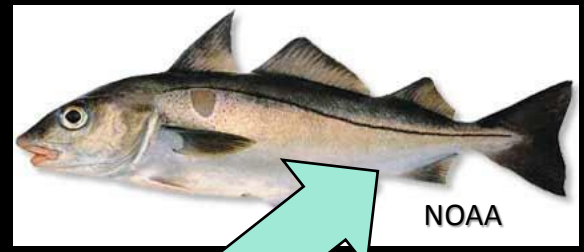
Ecotrust Canada

Tony Diamond

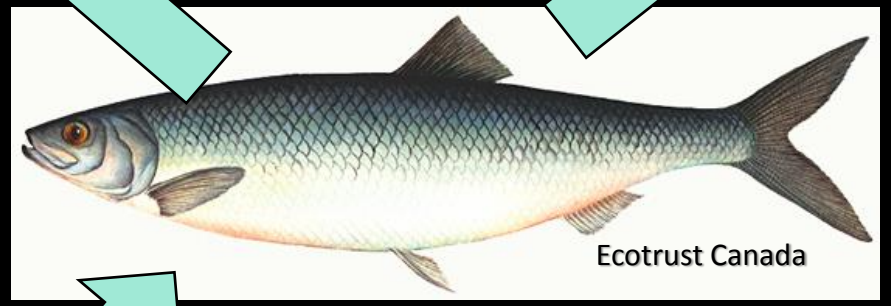
Species-specific fisheries management



Ecosystem-based fisheries management


PEW Charitable Trusts



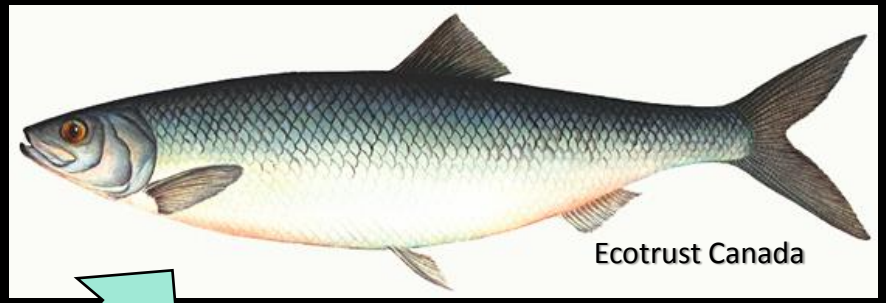

Alison Cornford Matheson




ALAR

# Ecosystem-based fisheries management

PEW Charitable Trusts



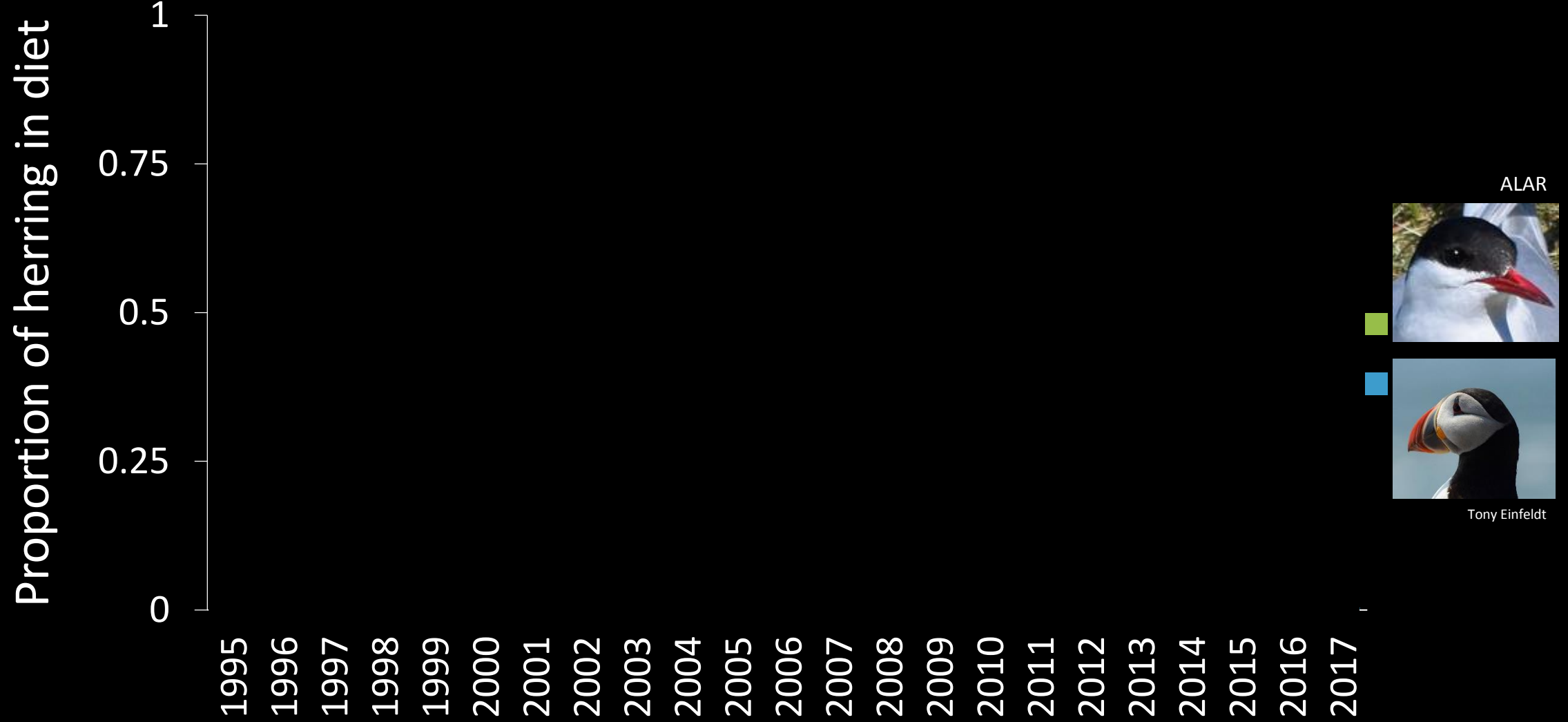


Alison Cornford Matheson

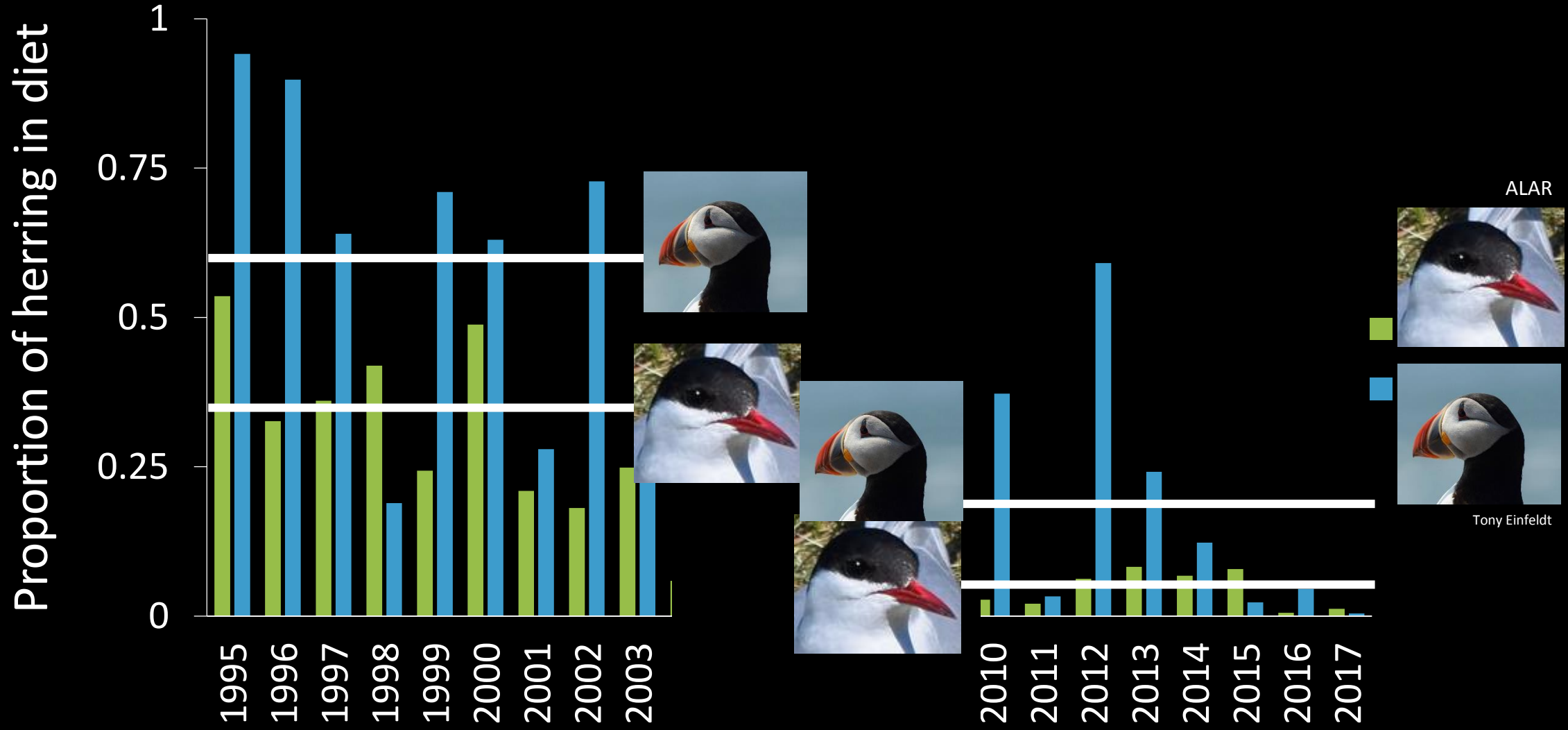
ALAR

# Ecosystem-based fisheries management

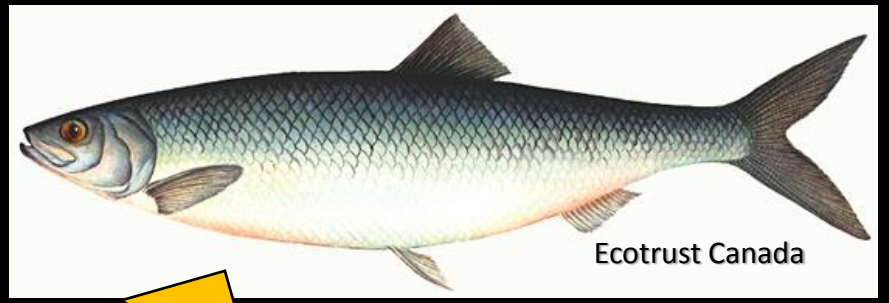
# Herring most abundant in 1990s, least in 2010s



# Herring most abundant in 1990s, least in 2010s



PEW Charitable Trusts

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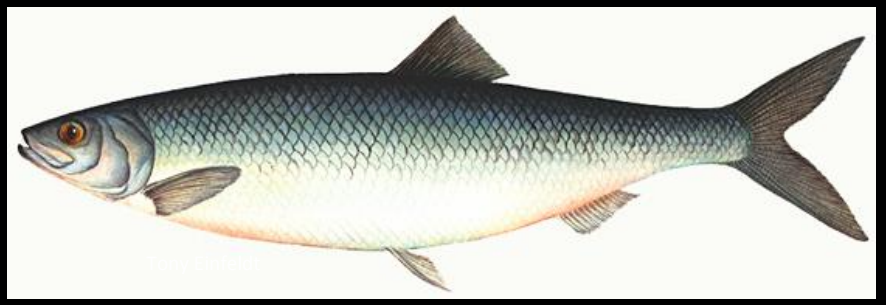
ALAR

# Ecosystem-based fisheries management

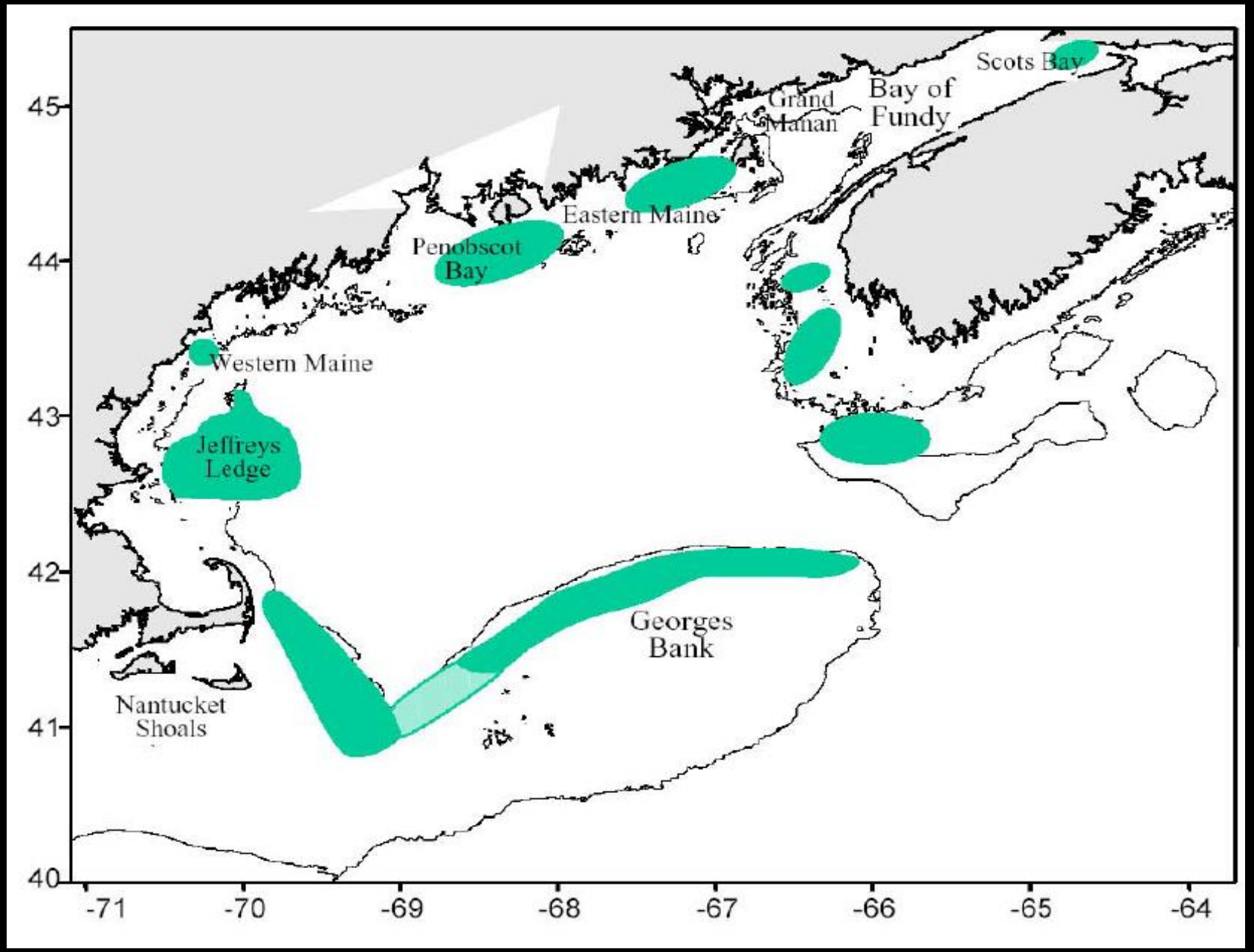
Landings

Juveniles (modeled)

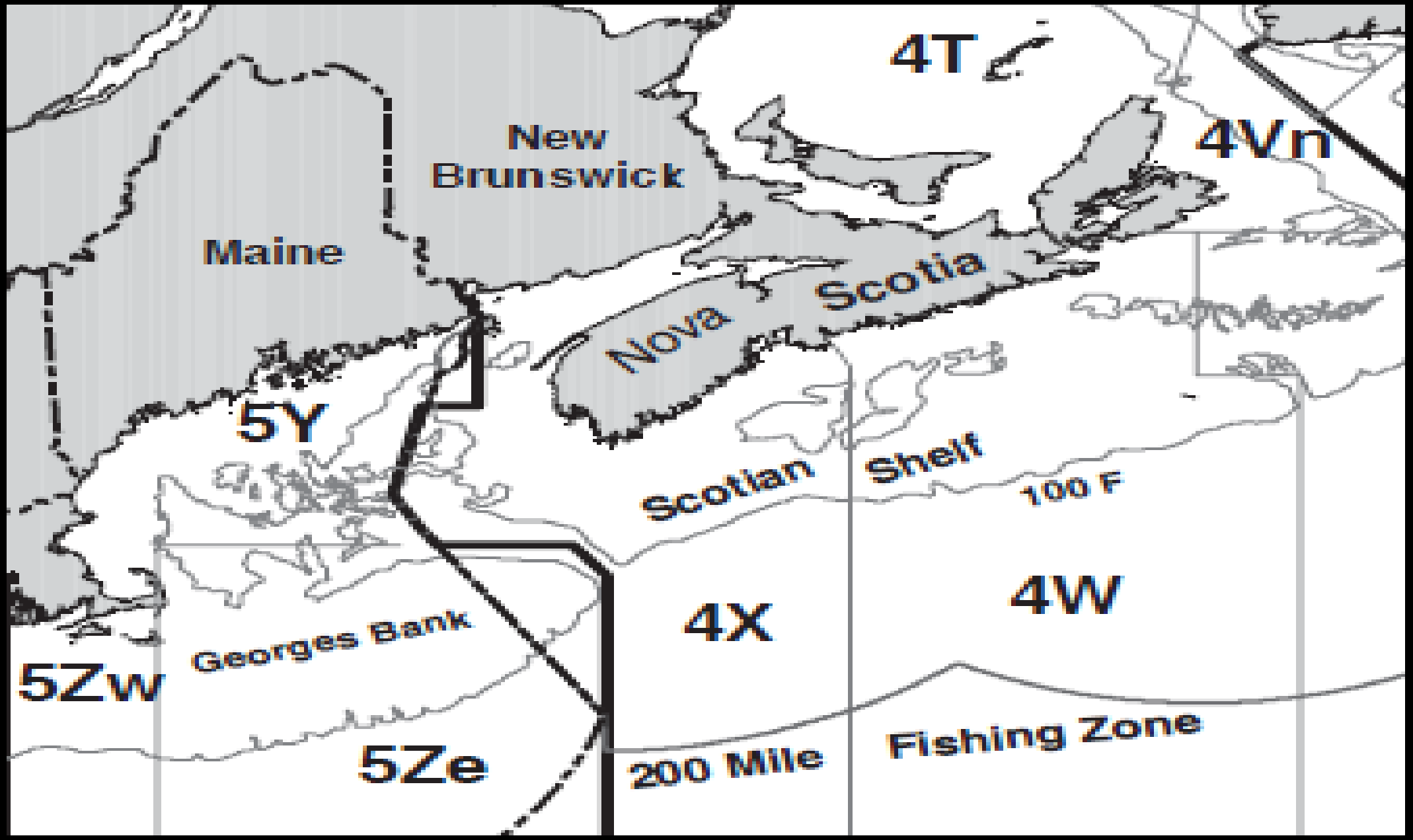


Acoustic Surveys

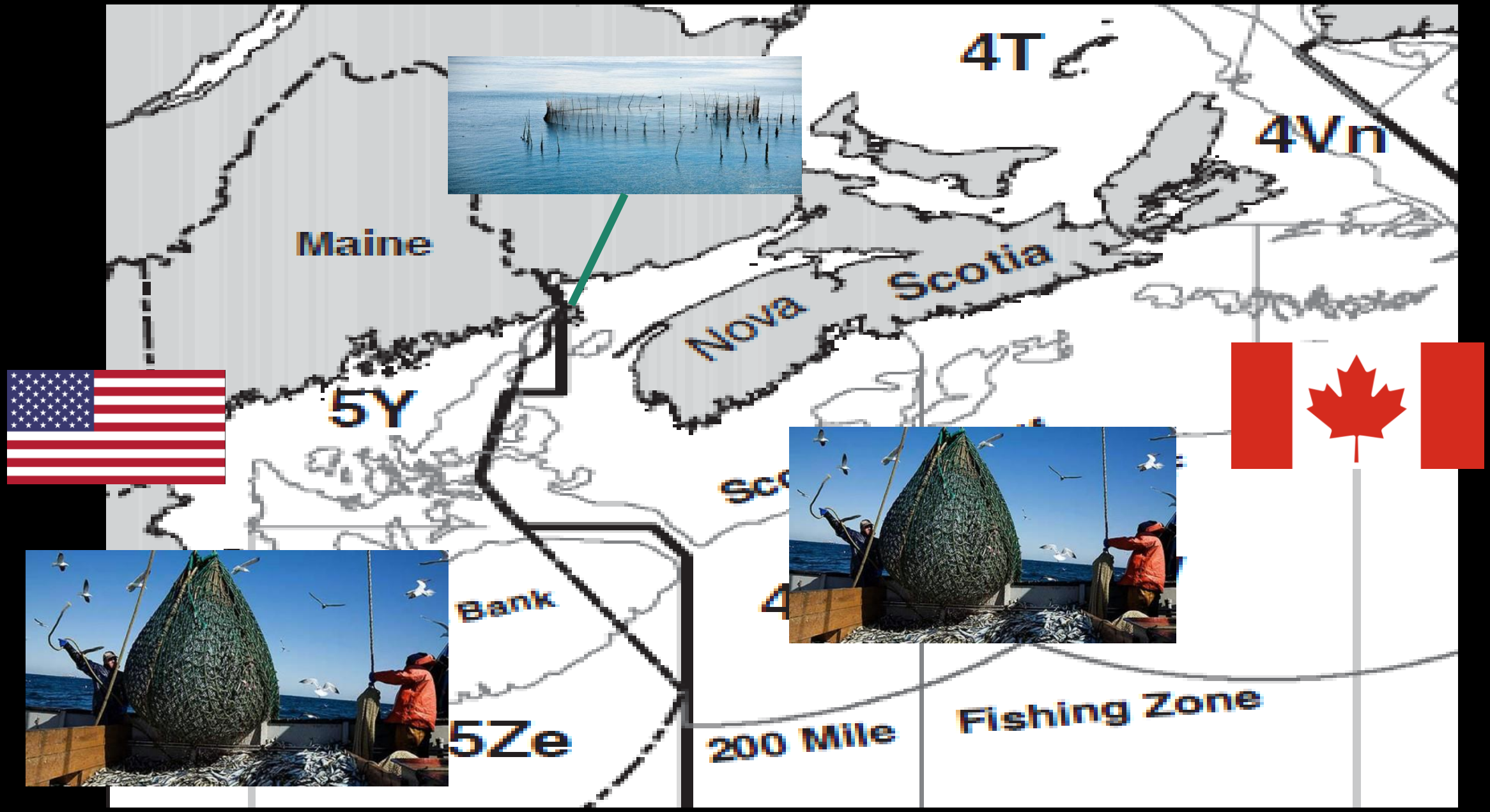
# How correlated are fishery and seabird herring data?



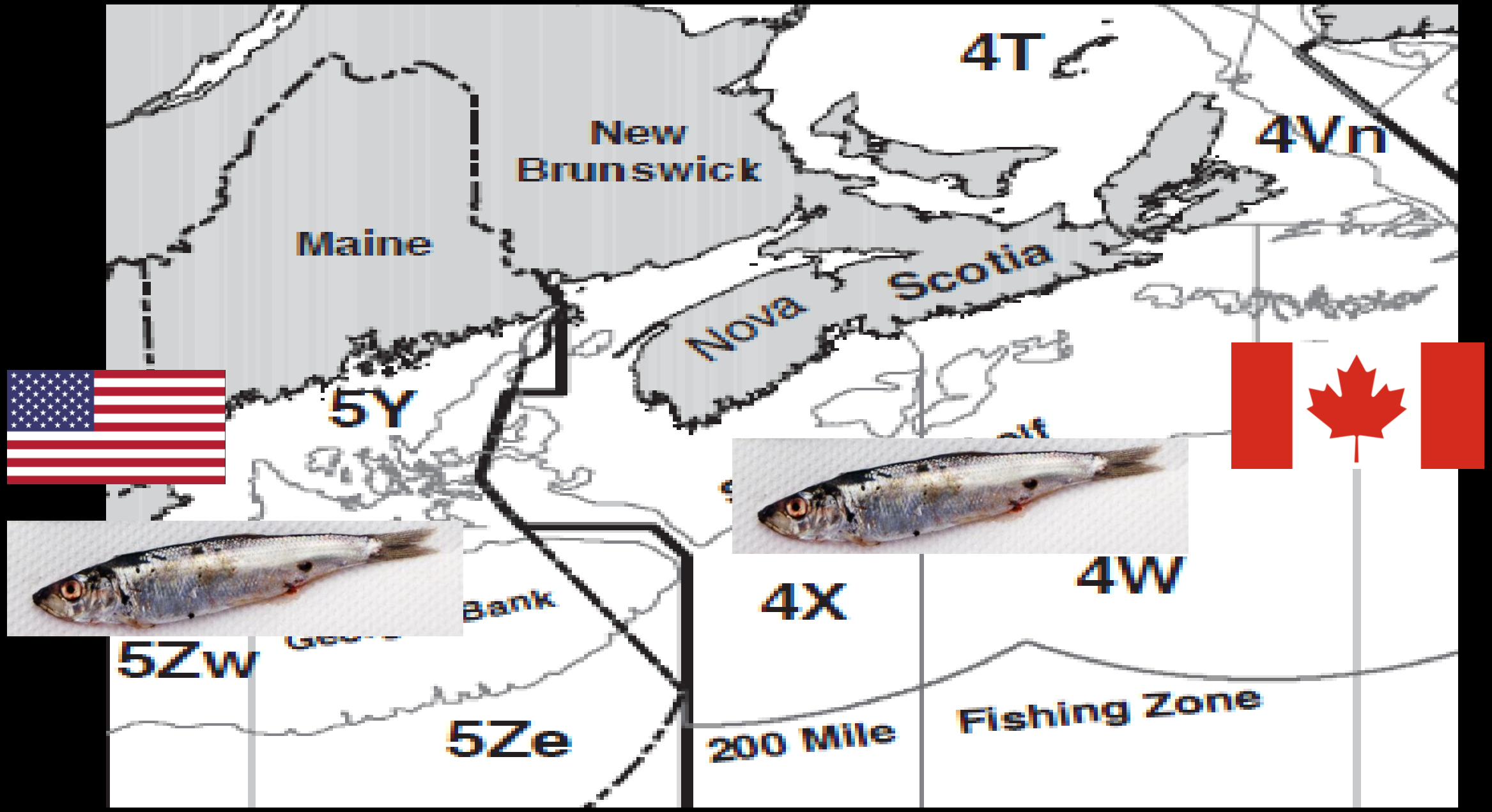

Overholtz et al. 2004


4T
4Vn
New Brunswick
Maine
Nova Scotia
5Y
Scotian Shelf
100 F
4W
4X
Georges Bank
5Zw
5Ze
200 Mile
Fishing Zone

NEFSC 2012




NEFSC 2012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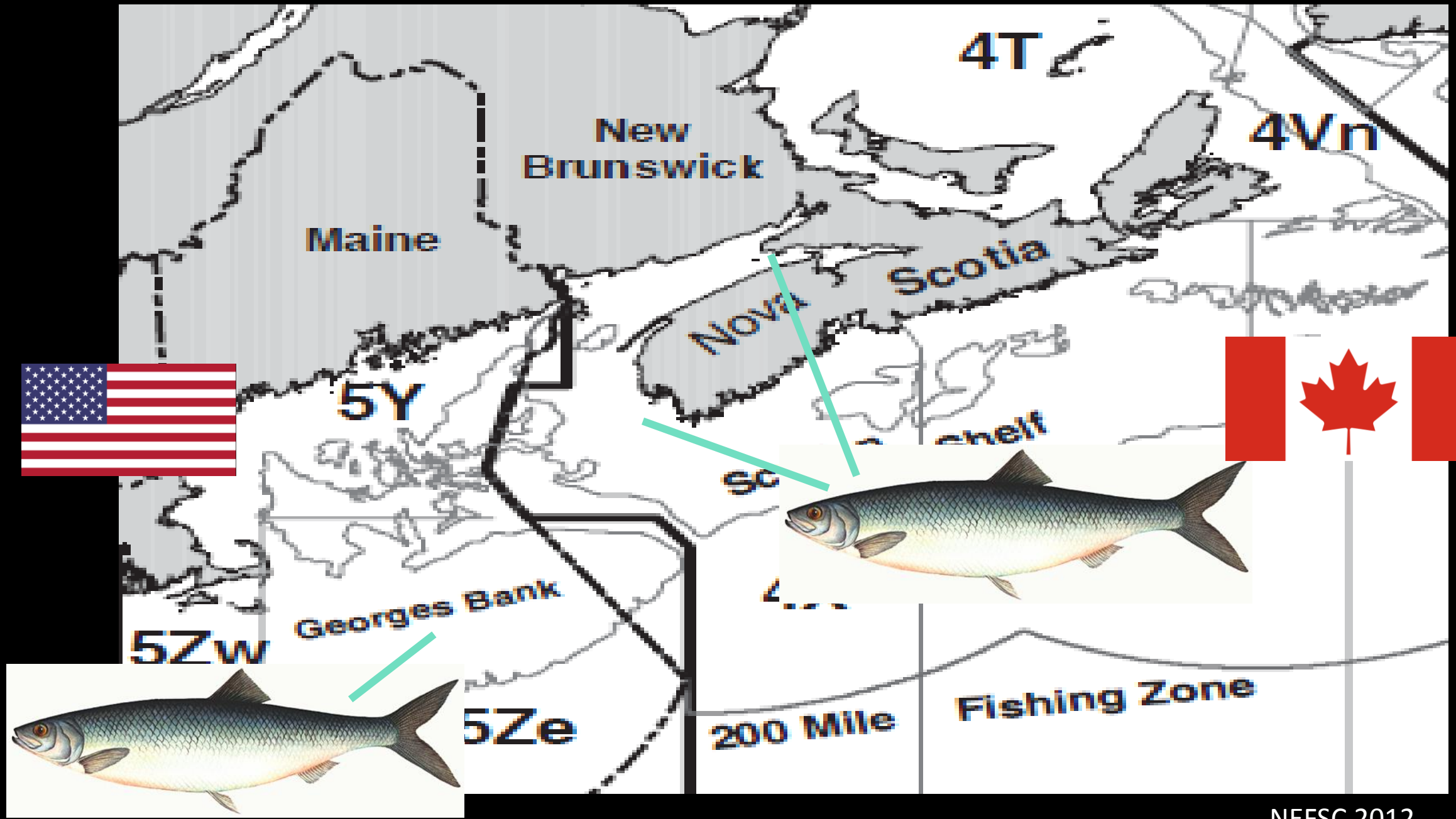
New Brunswick
4Vn
Maine
Nova Scotia
5Y
4X
4W
5Zw
5Ze
200 Mile
Fishing Zone

NEFSC 2012


4T
New Brunswick
4Vn
Maine
Nova Scotia
5Y
Georges Bank
5Zw
5Ze
200 Mile
Fishing Zone

NEFSC 2012


Patrick Coin


Matt Klostermann


ALAR


Alcides Morales


Maki Briggs

ALAR

## Arctic Tern

## Common Tern

ALAR

## Atlantic Puffin

Tony Einfeldt

## Razorbill

ALAR



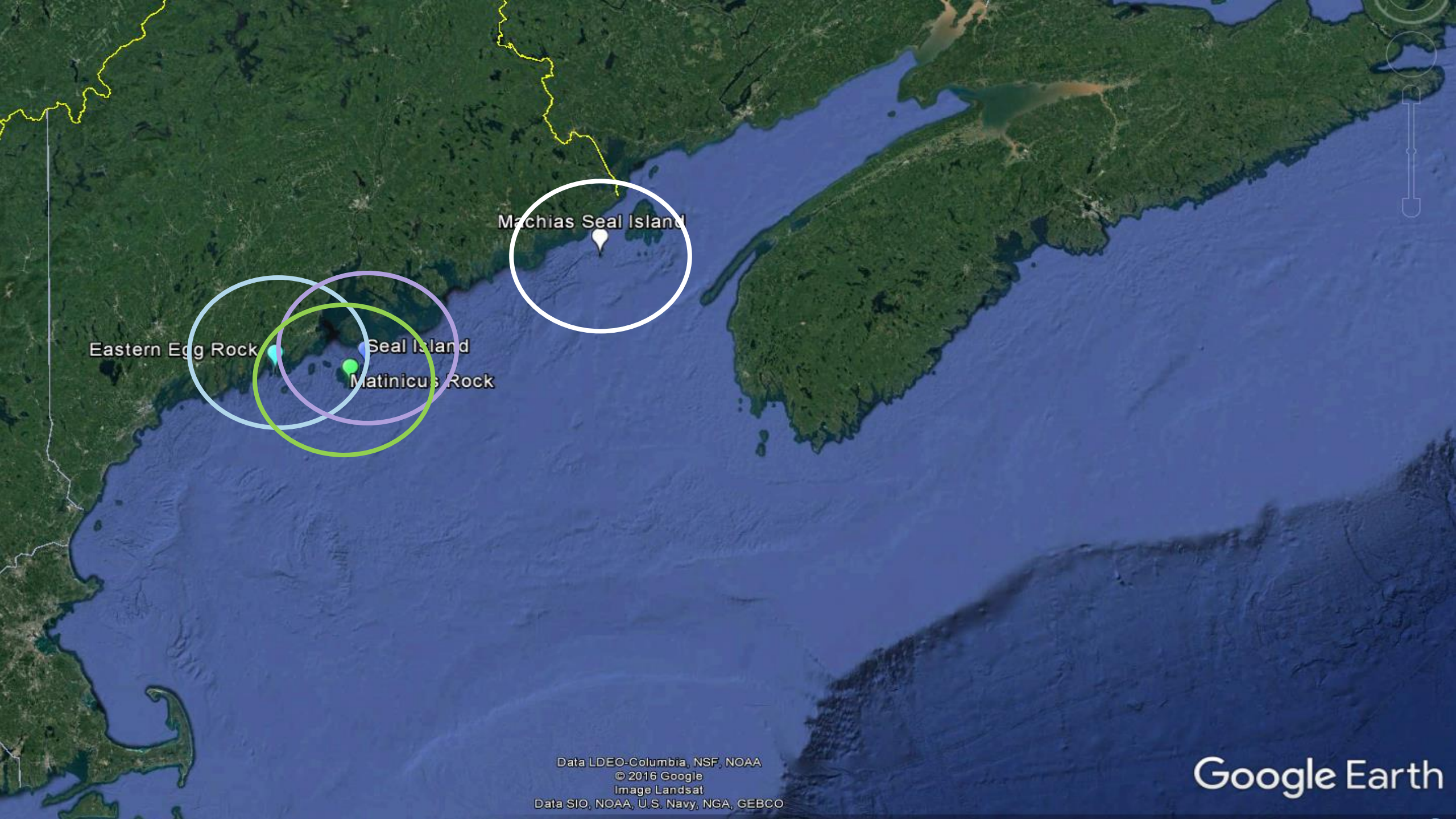

Adam Chrząstowski

Adrian Hards




Adam Chrząstowski

Adrian Hards


Machias Seal Island
Eastern Egg Rock
Seal Island
Matinicus Rock
Data LDEO-Columbia, NSF, NOAA
© 2016 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth

Matt Klostermann

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$$\text{Weight} = a * \text{Length}^{b}$$

$$\frac{\text{Herring mass}}{\text{Total mass}} = \text{Proportion}$$

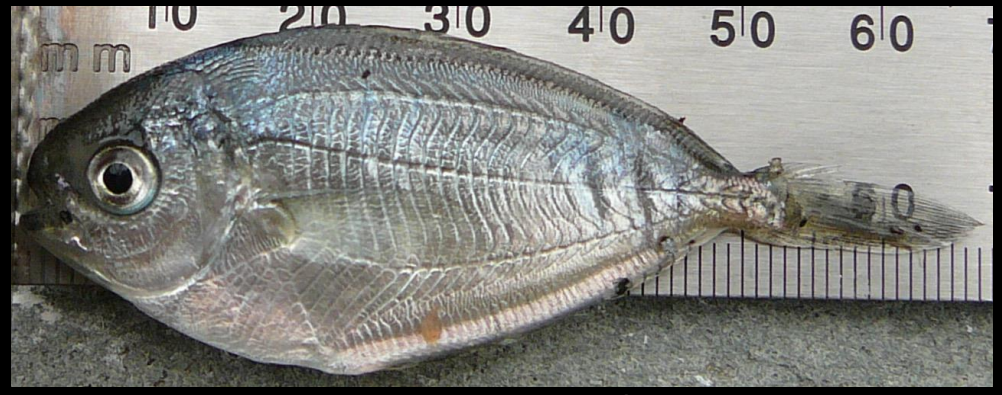
$$\frac{\text{Herring mass}}{\#\ \text{feedings or hours}} = \text{Rate}$$

# Common Prey Types

SRP and ALAR

Atlantic Herring

White Hake



Butterfish

Sand lance

Euphausiids and Amphipods

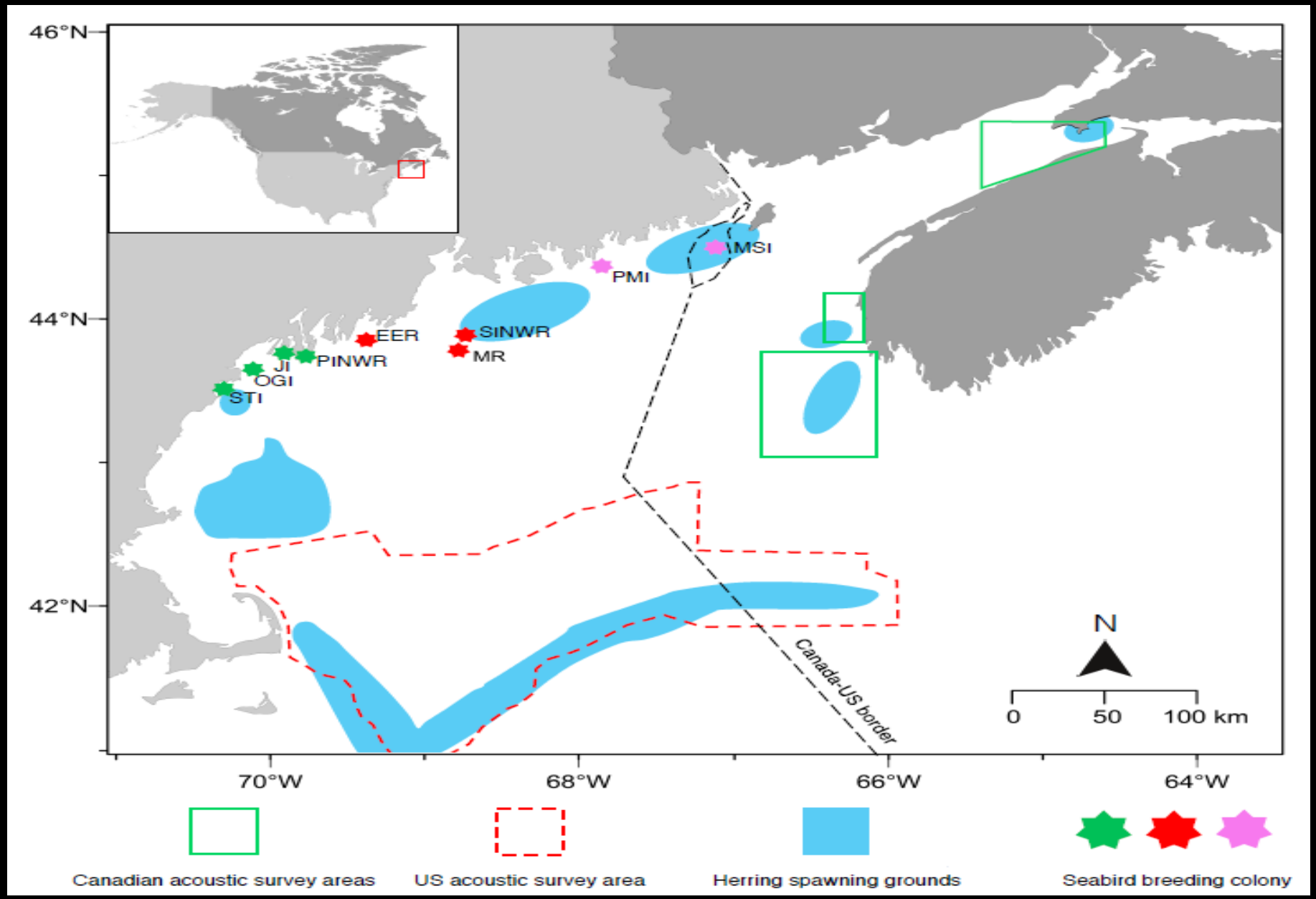
# New Prey Types

Haddock

Redfish

Claude Nozeres

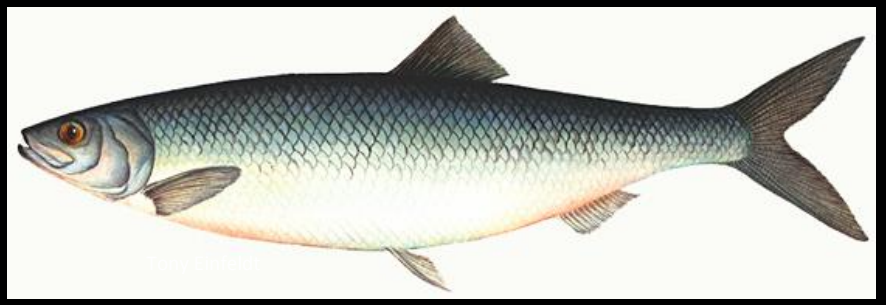
Mackerel




Scopel et al. 2018

Landings

Juveniles (modeled)



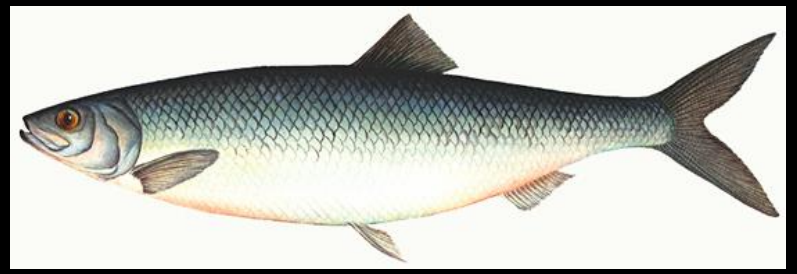
Acoustic Surveys

# How correlated are fishery and seabird herring data?

Lagged -3 to +5

Landings

Juveniles (modeled)



Acoustic Surveys

Arctic Tern

Atlantic Puffin

Razorbill

Proportion

Rate

Proportion

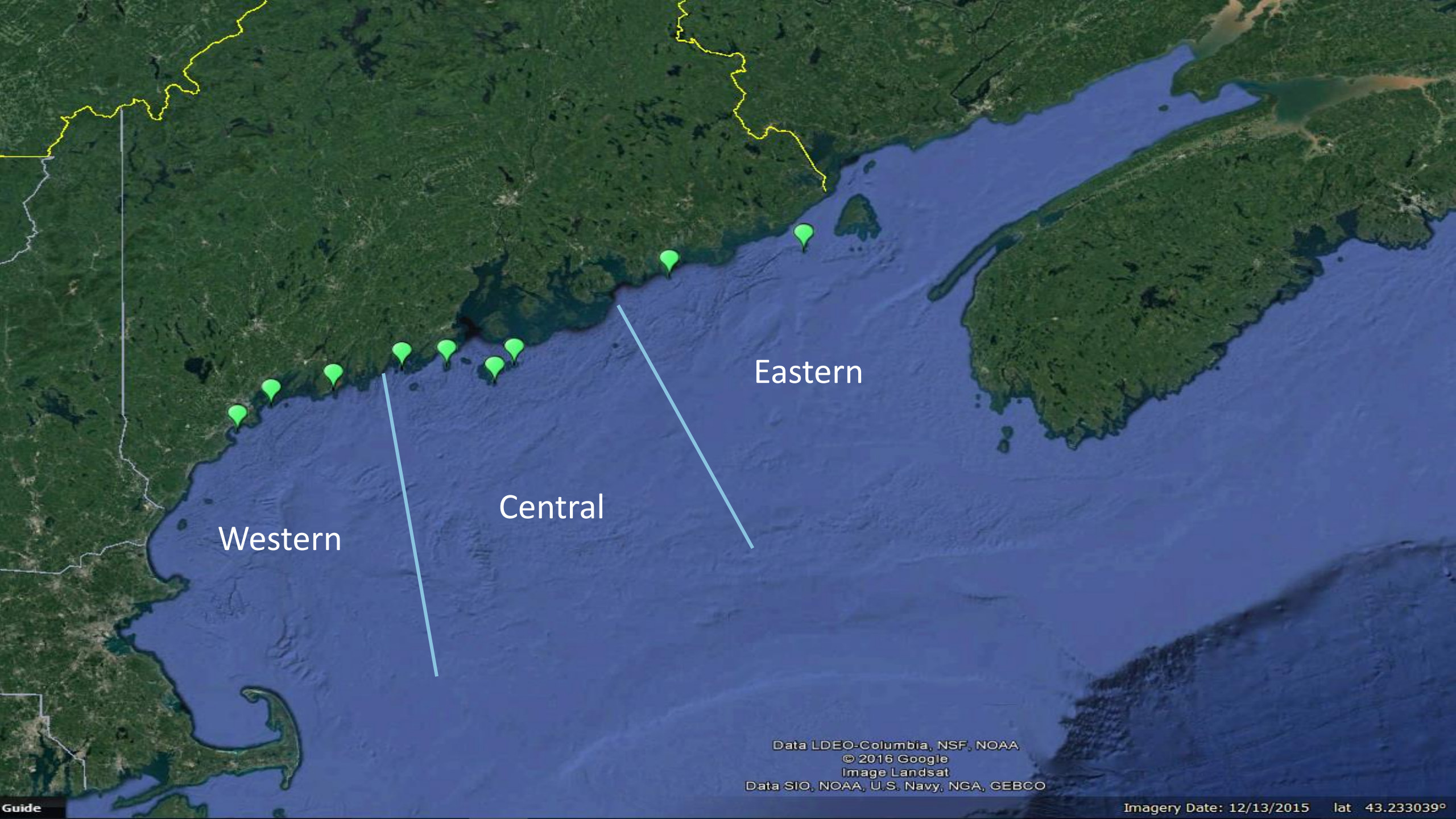
Rate

Proportion

Rate

Lagged -3 to +5

Common Tern


Eastern
Central
Western
Data LDEO-Columbia, NSF, NOAA
© 2016 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Guide
Imagery Date: 12/13/2015 lat 43.233039°

Year

95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16

Eastern
- MSI-ARTE
- MSI-COTE
- MSI-ATPU
- MSI-RAZO
- PMI-ARTE
- PMI-COTE

Central
- MR-ARTE
- MR-COTE
- MR-ATPU
- MR-RAZO
- SI-ARTE
- SI-COTE
- SI-ATPU
- EER-COTE
- EER-ATPU

Western
- PI-COTE
- JI-COTE
- OGI-COTE
- STI-COTE

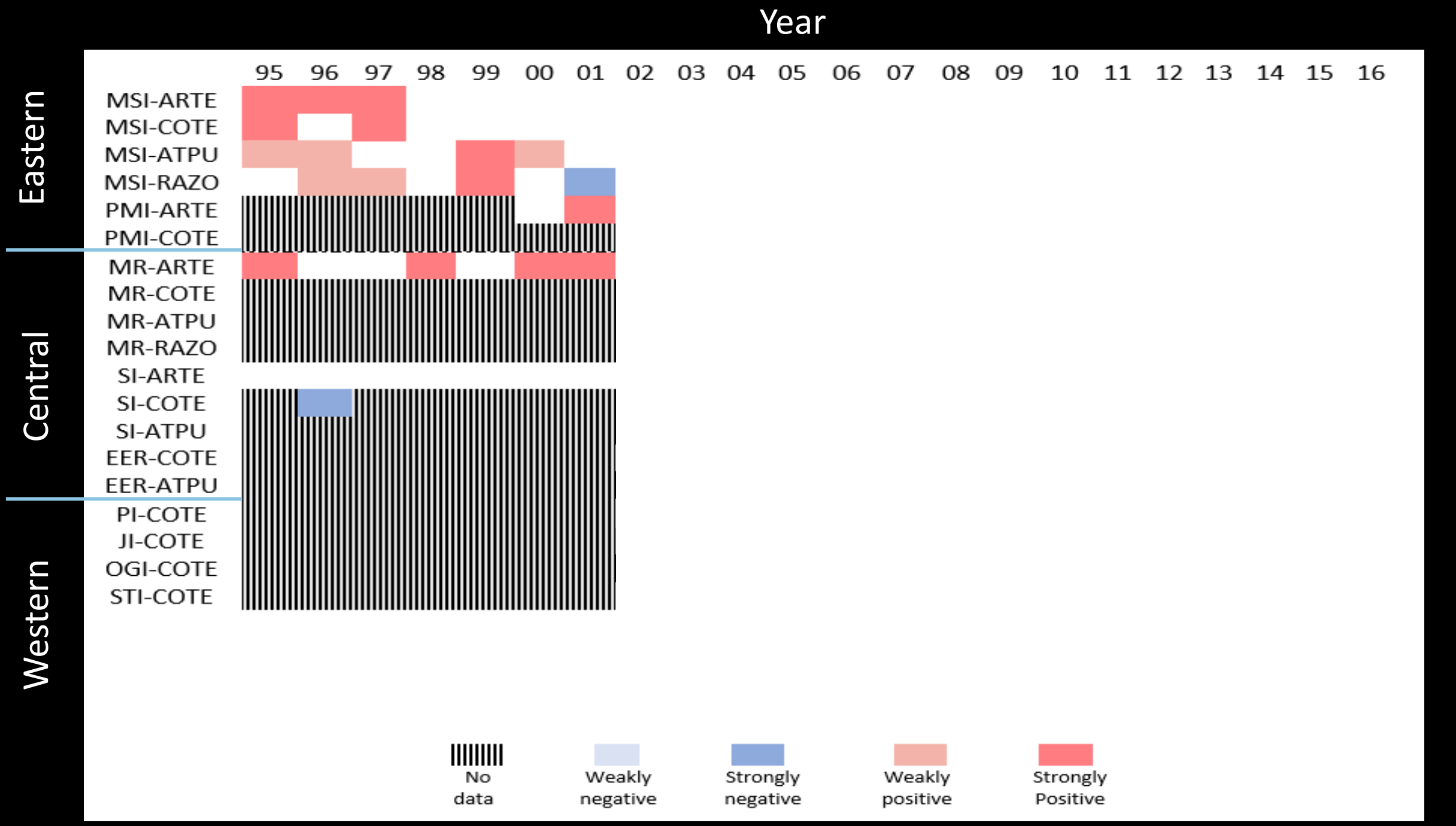
Arctic Tern - ARTE

Common Tern - COTE

Atlantic Puffin - ATPU

Razorbill - RAZO

No data | Weakly negative | Strongly negative | Weakly positive | Strongly Positive


Year
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JI-COTE
OGI-COTE
STI-COTE
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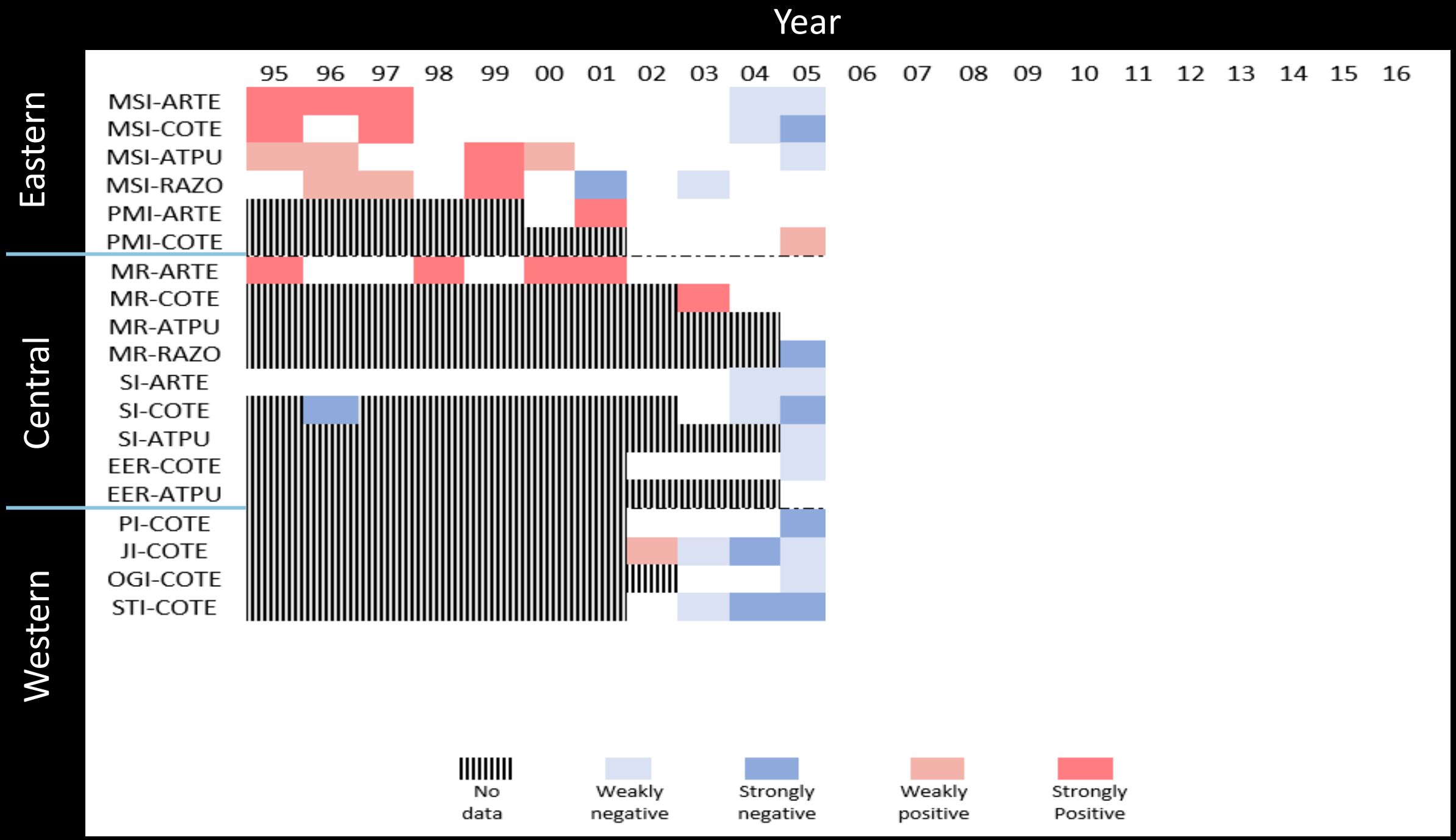
Strongly negative
Weakly positive
Strongly Positive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No data
Weakly negative
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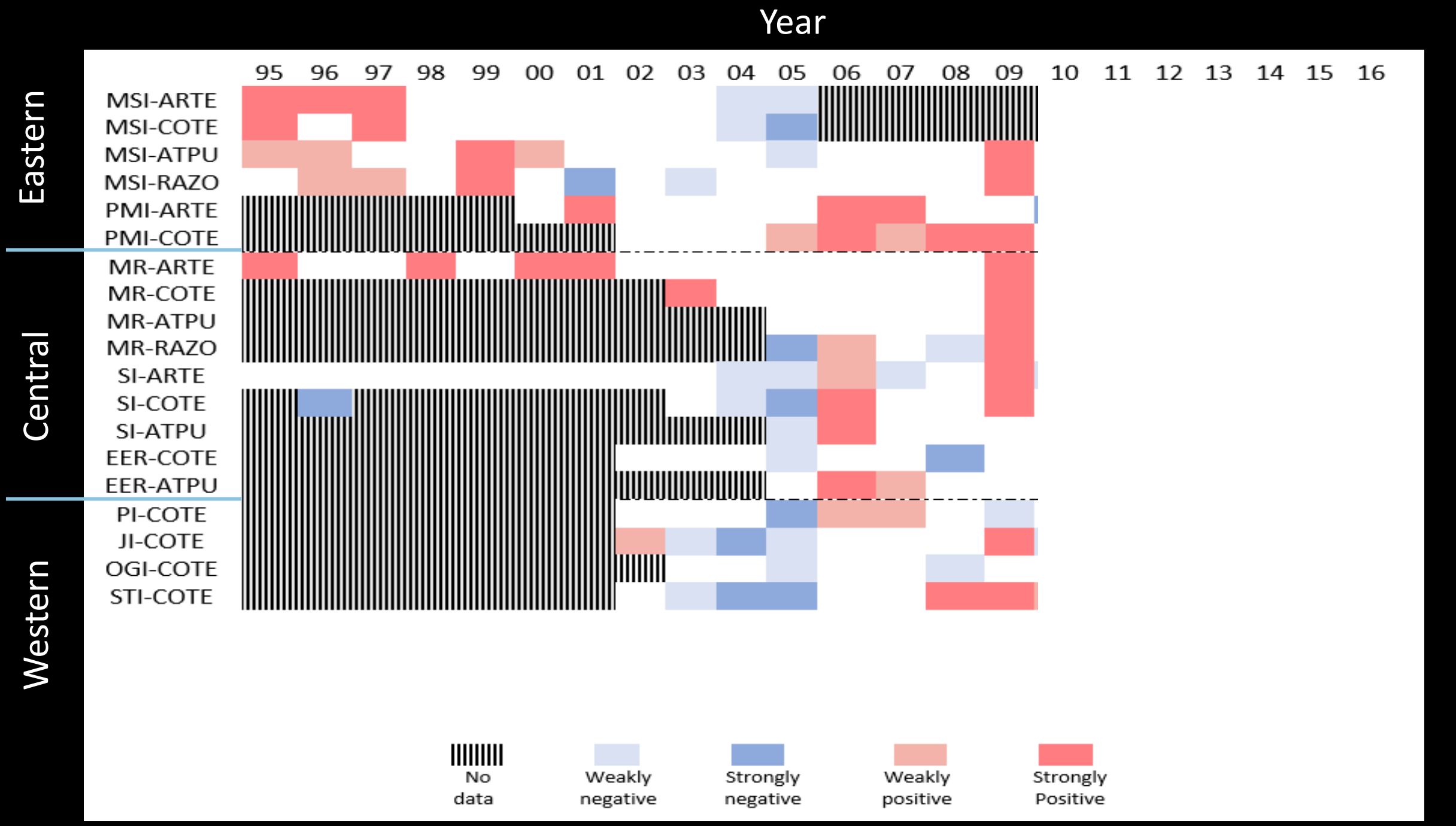
Year
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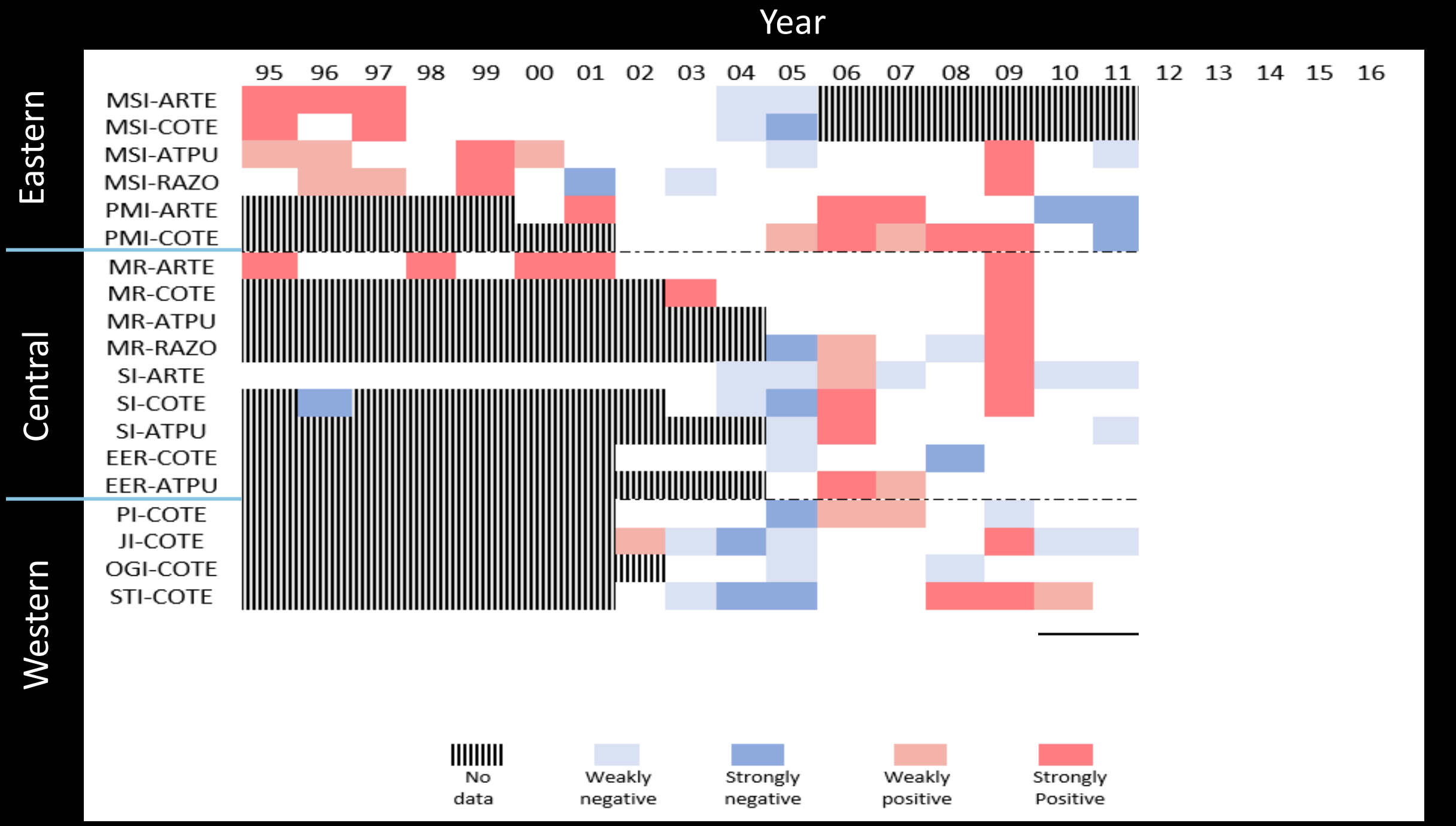
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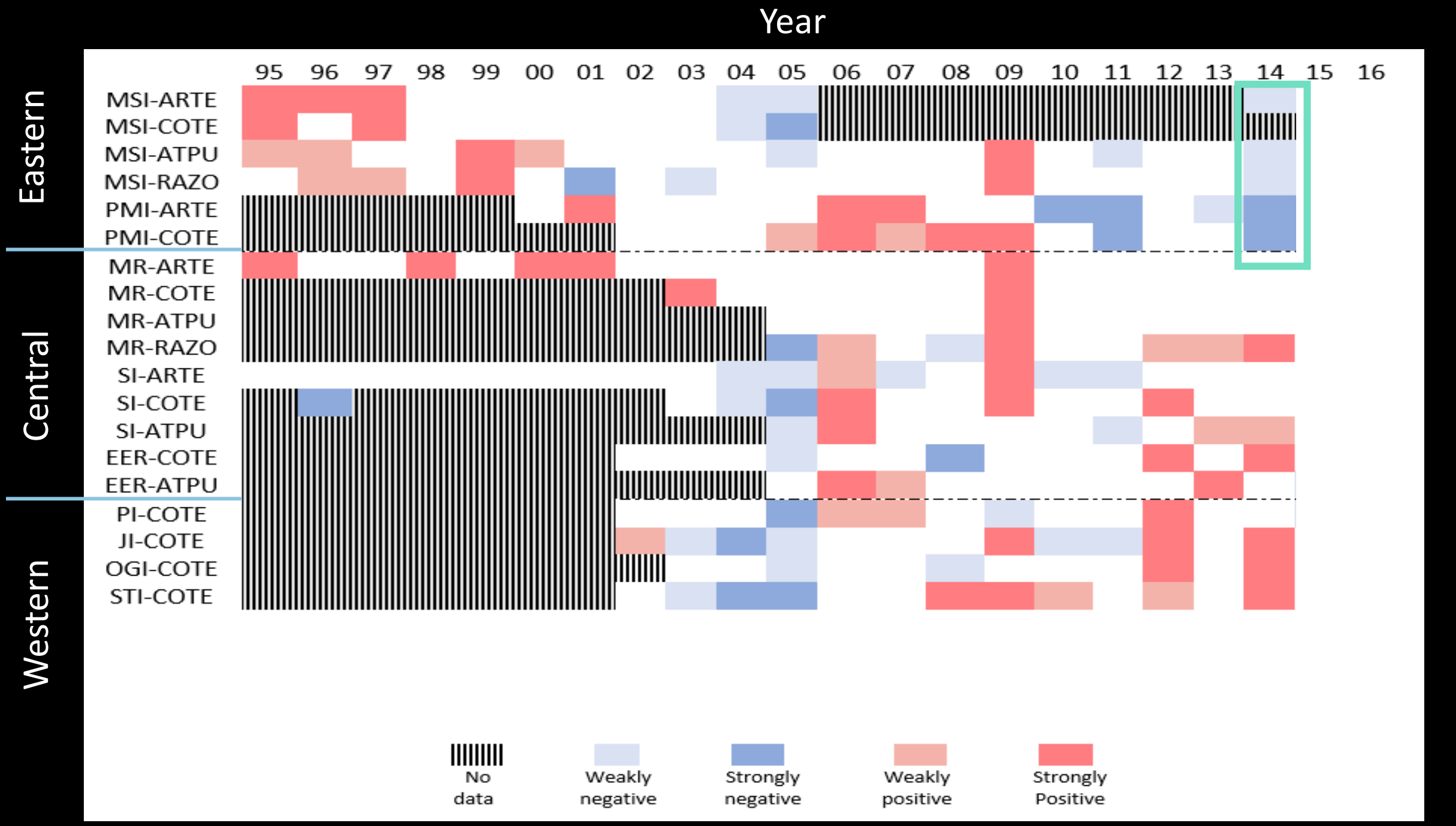
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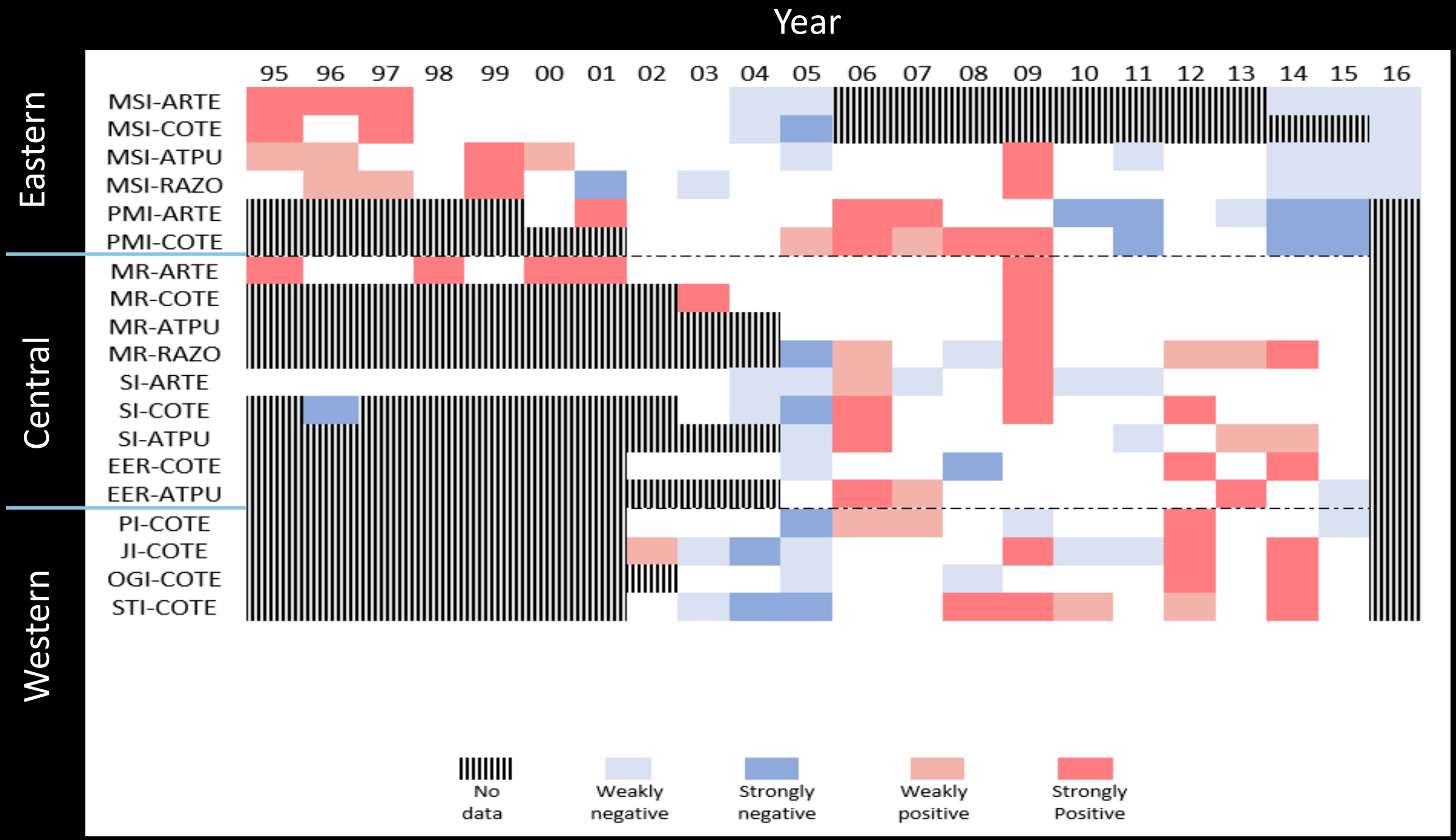
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STI-COTE
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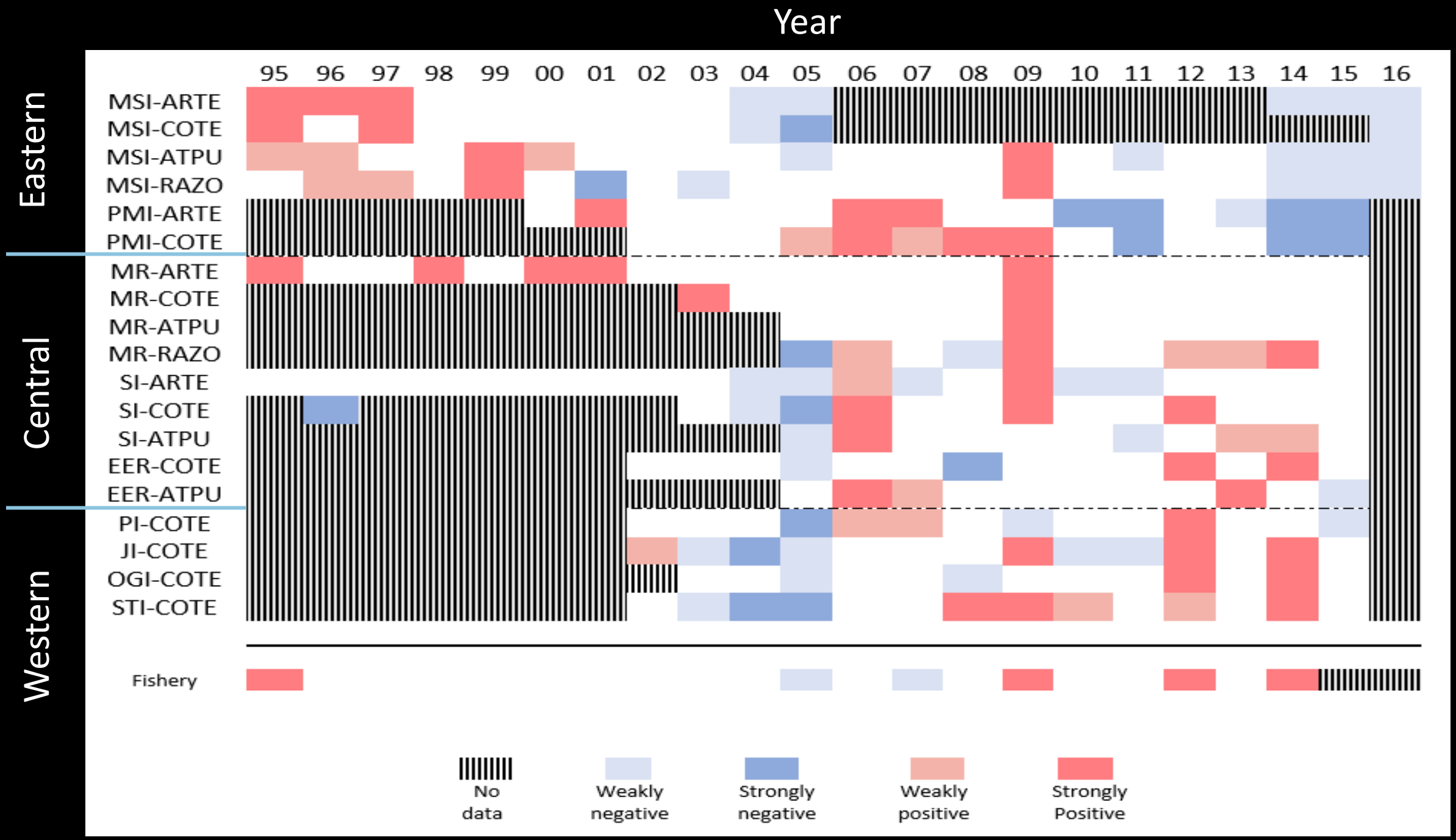
Strongly Positive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Fishery
No data
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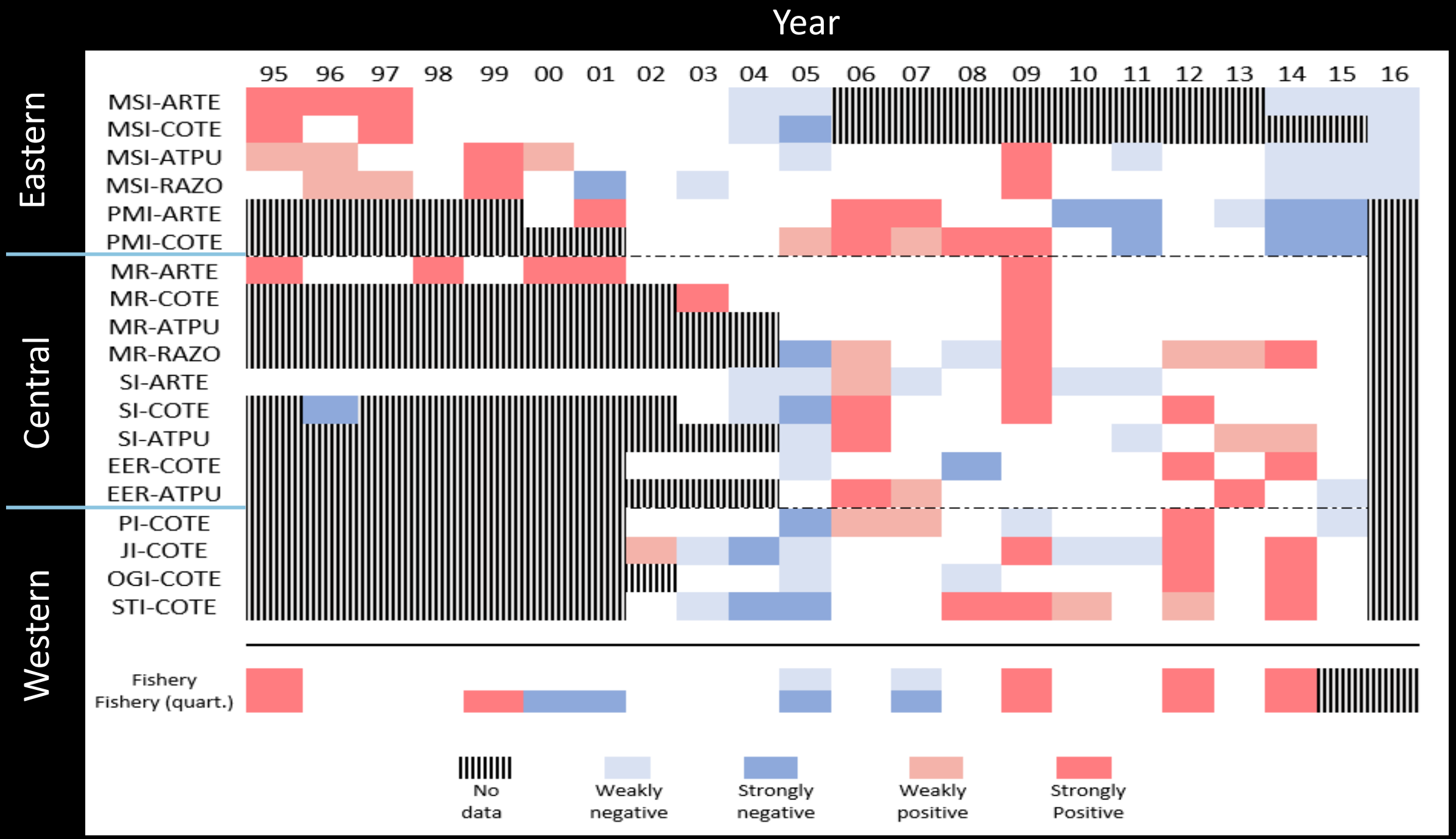
Year
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Eastern
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PMI-ARTE
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SI-ARTE
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Fishery (quart.)
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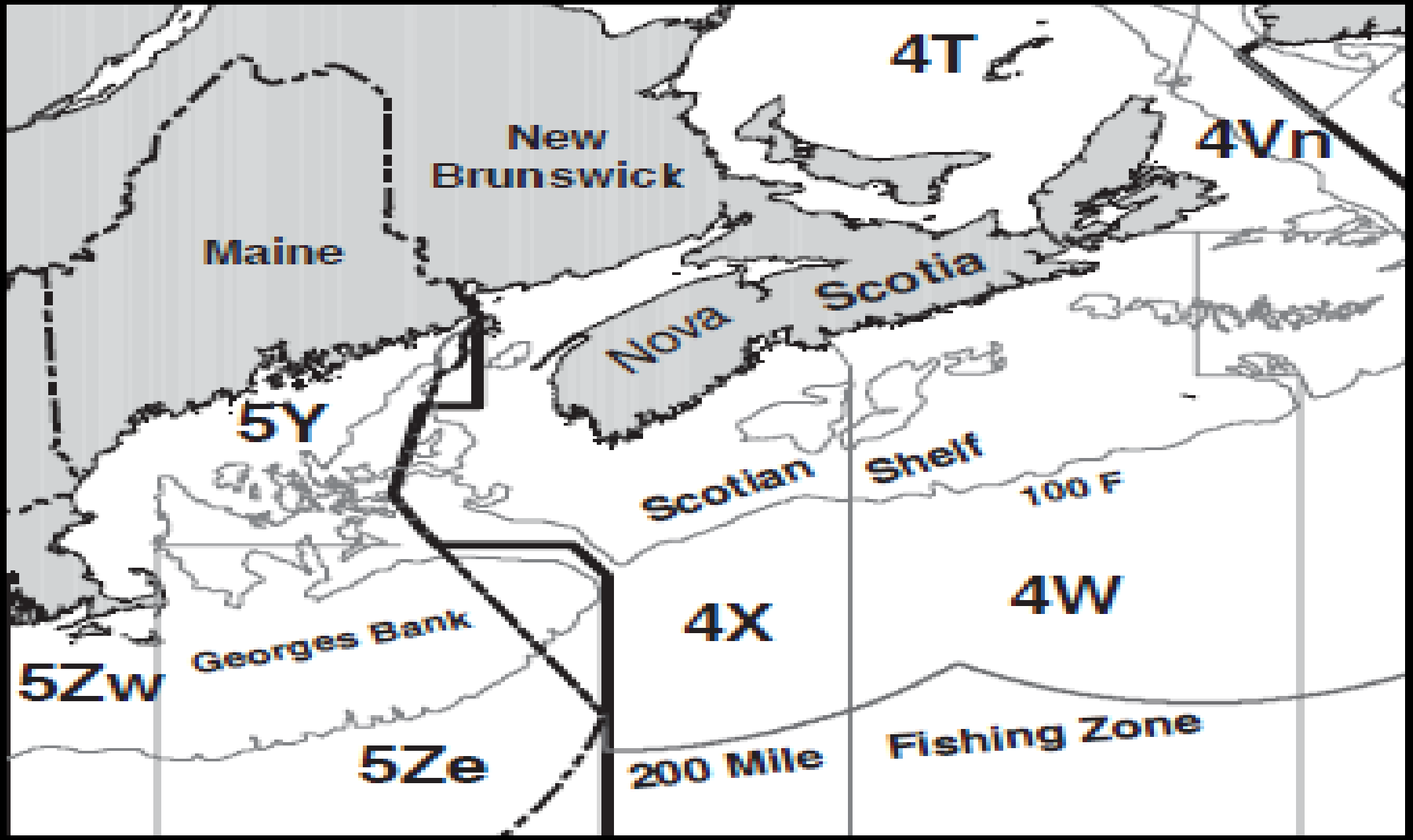
4T
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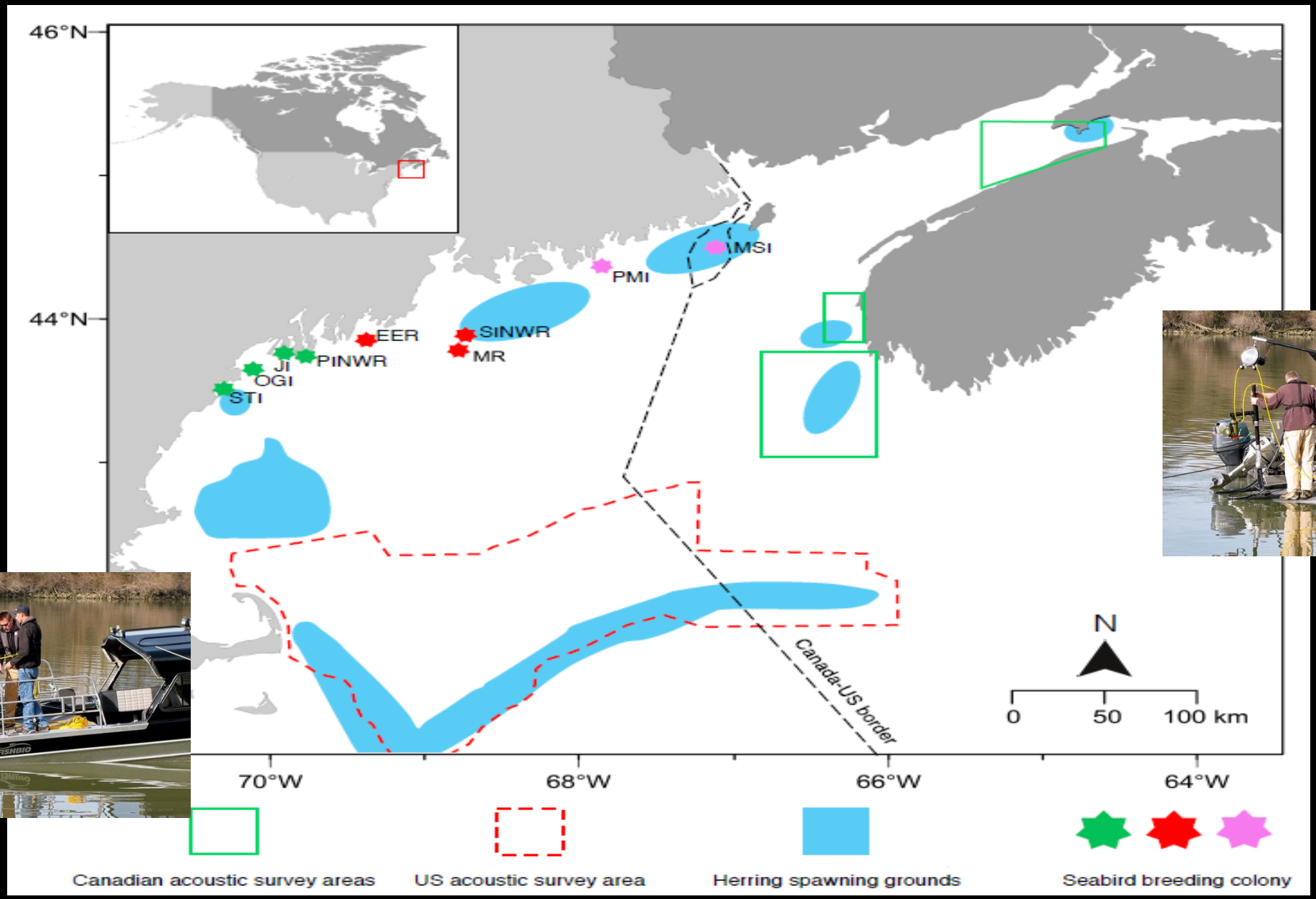
4X
Georges Bank
5Zw
5Ze
200 Mile
Fishing Zone

NEFSC 2012




Fishbio.org



Fishbio.org

Scopel et al. 2018

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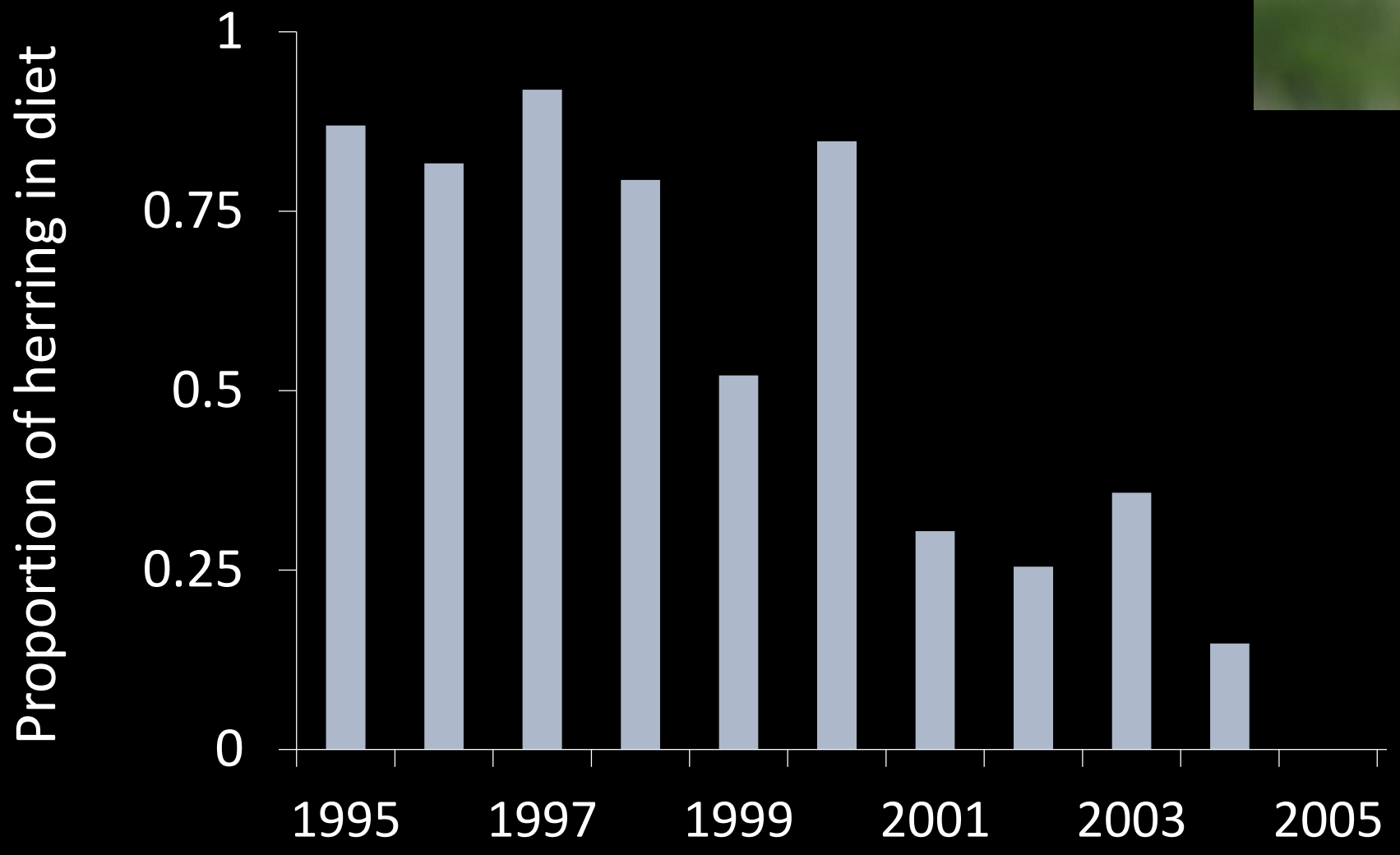
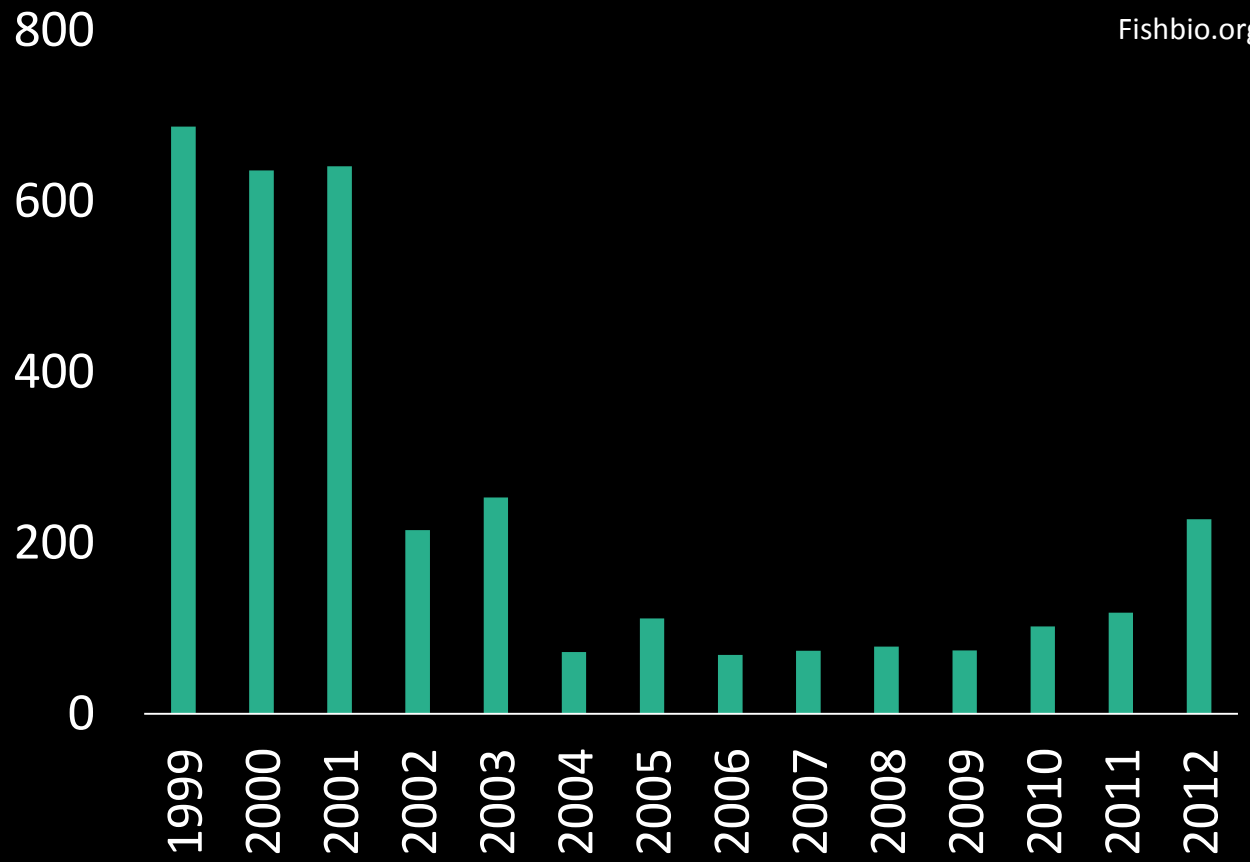
Biomass at Georges Bank (000 mt)

800
600
400
200
0

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012


Proportion of herring in diet
1
0.75
0.5
0.25
0
1995
1997
1999
2001
2003
2005

Fishbio.org


800
600
400
200
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2000
2001
2002
2003
2004
2005
2006
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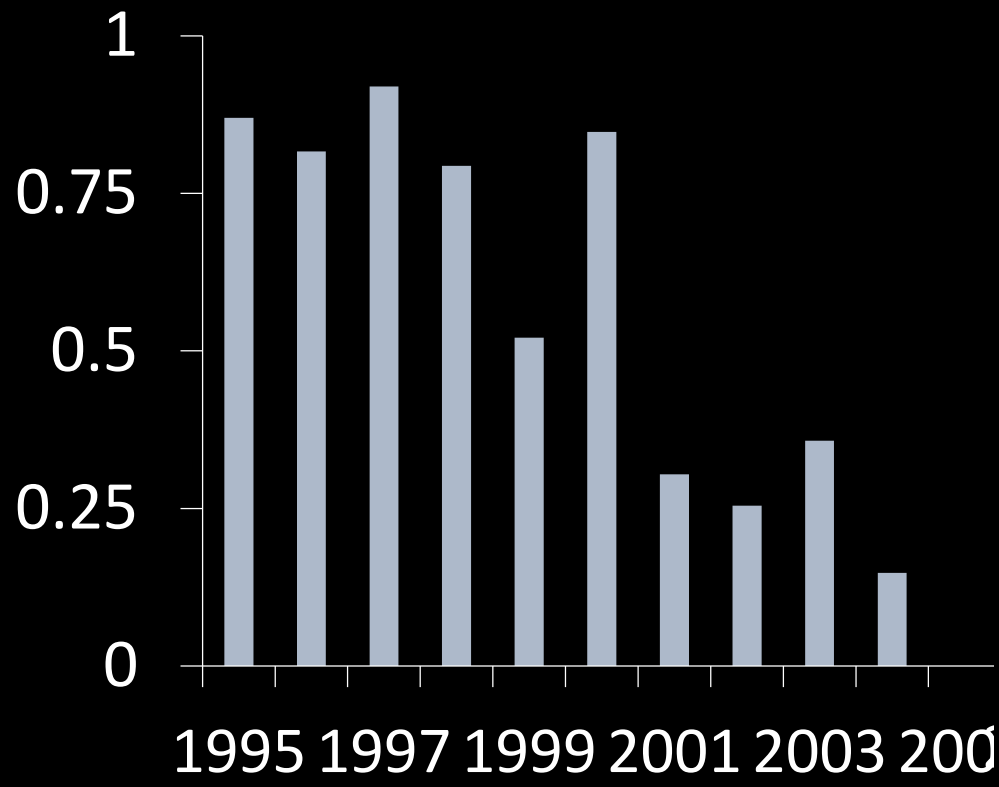
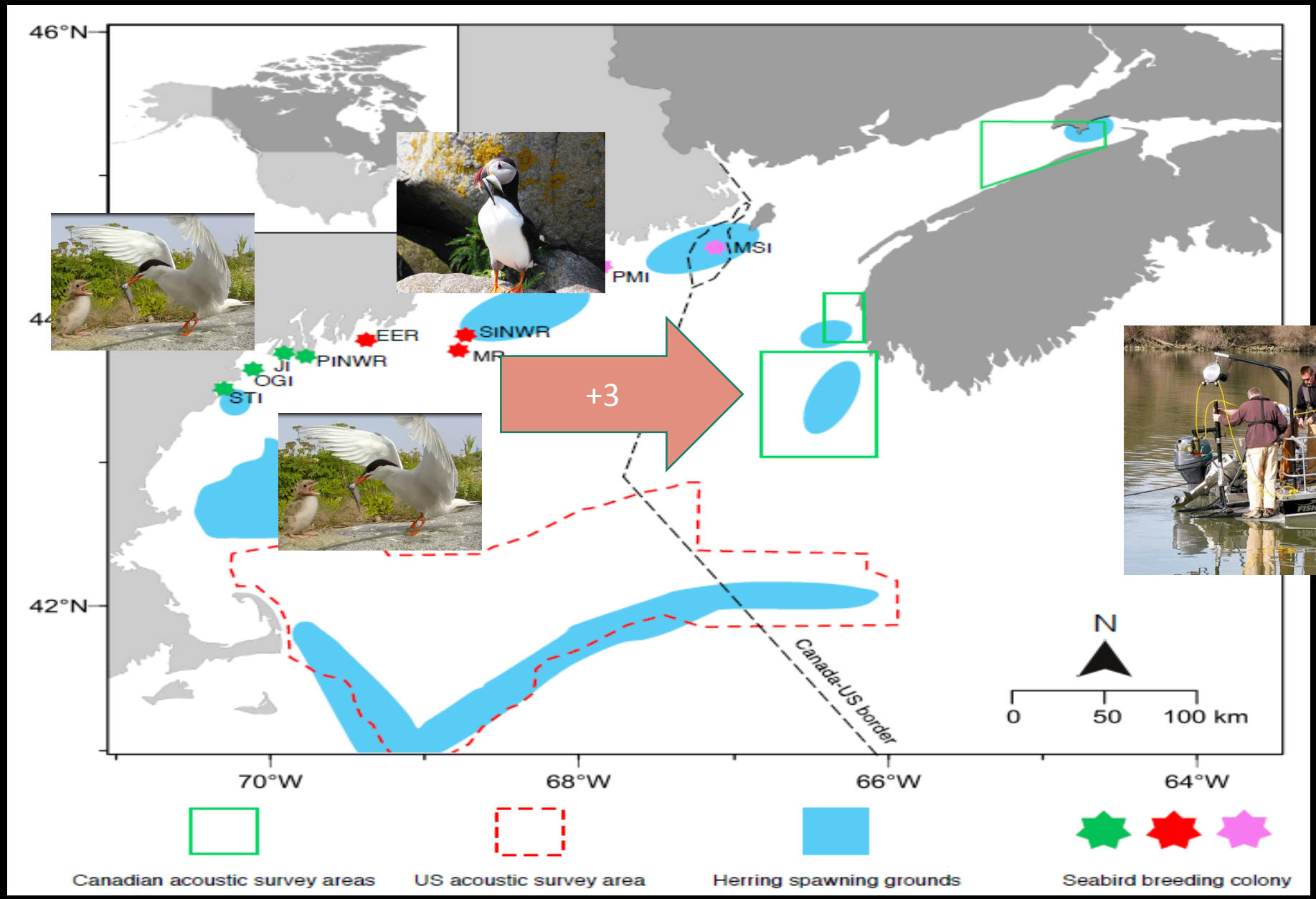
2008
2009
2010
2011
2012


1
0.75
0.5
0.25
0
1995
1997
1999
2001
2003
200

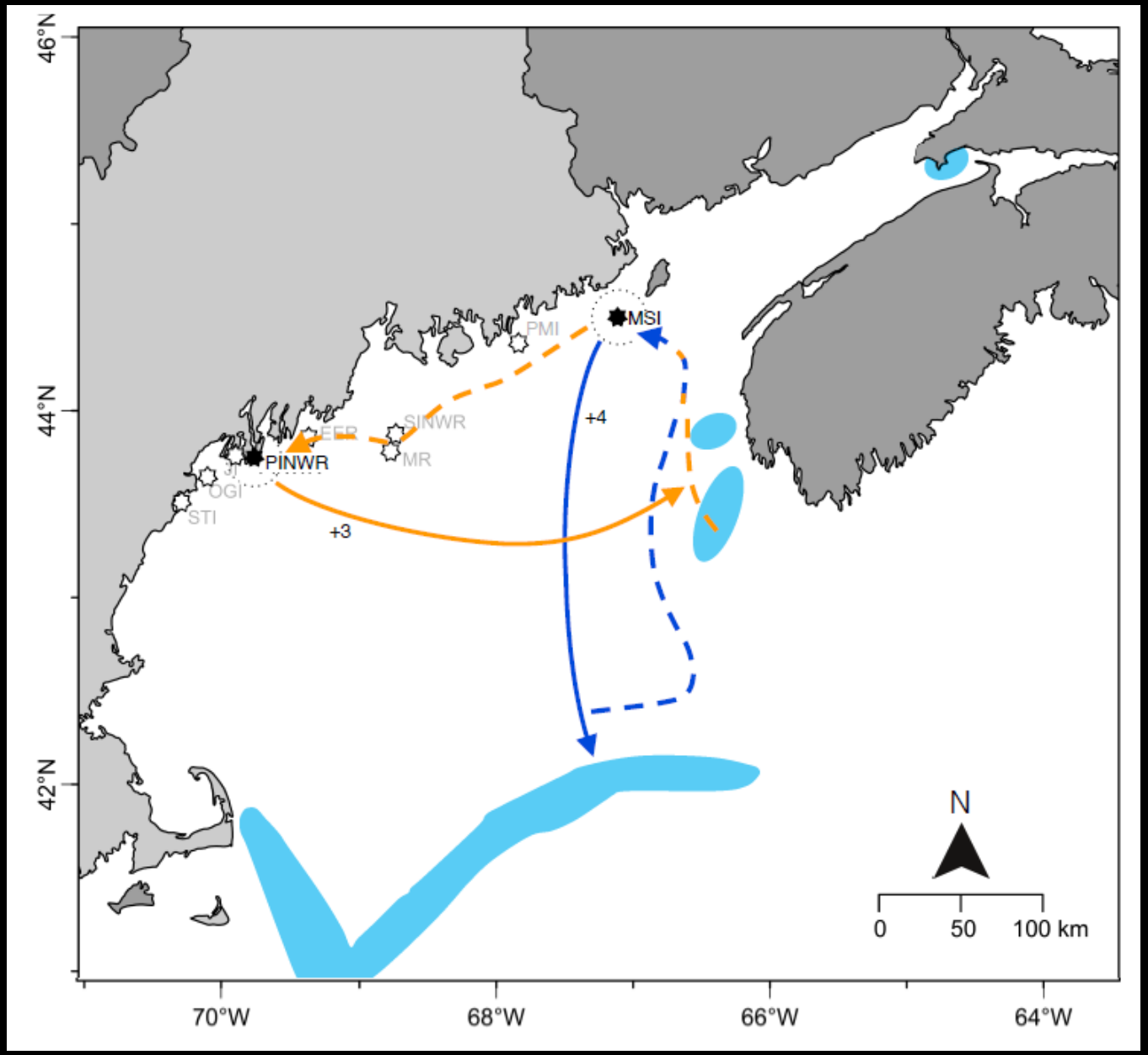
Fishbio.org



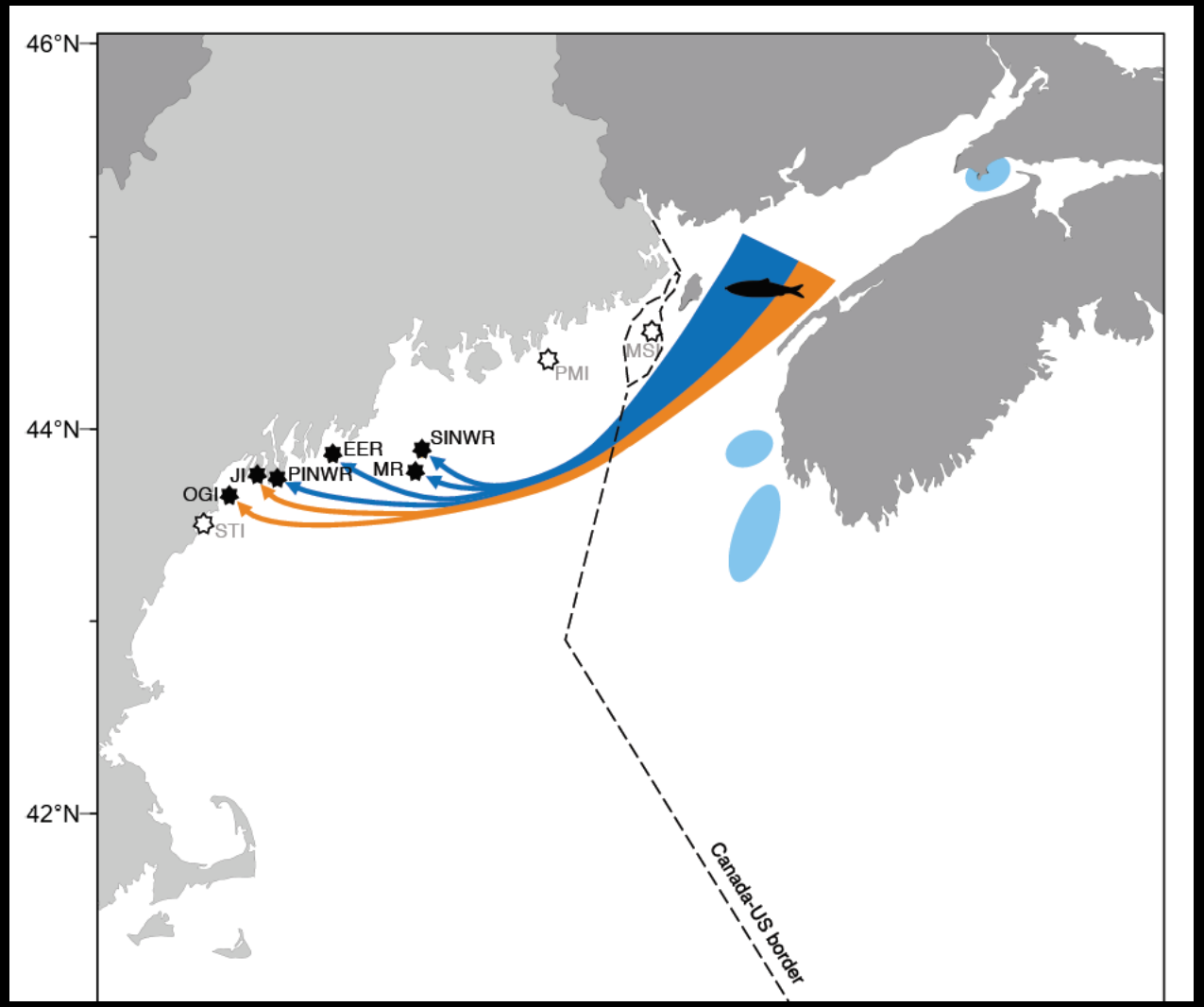

Scopel et al. 2018



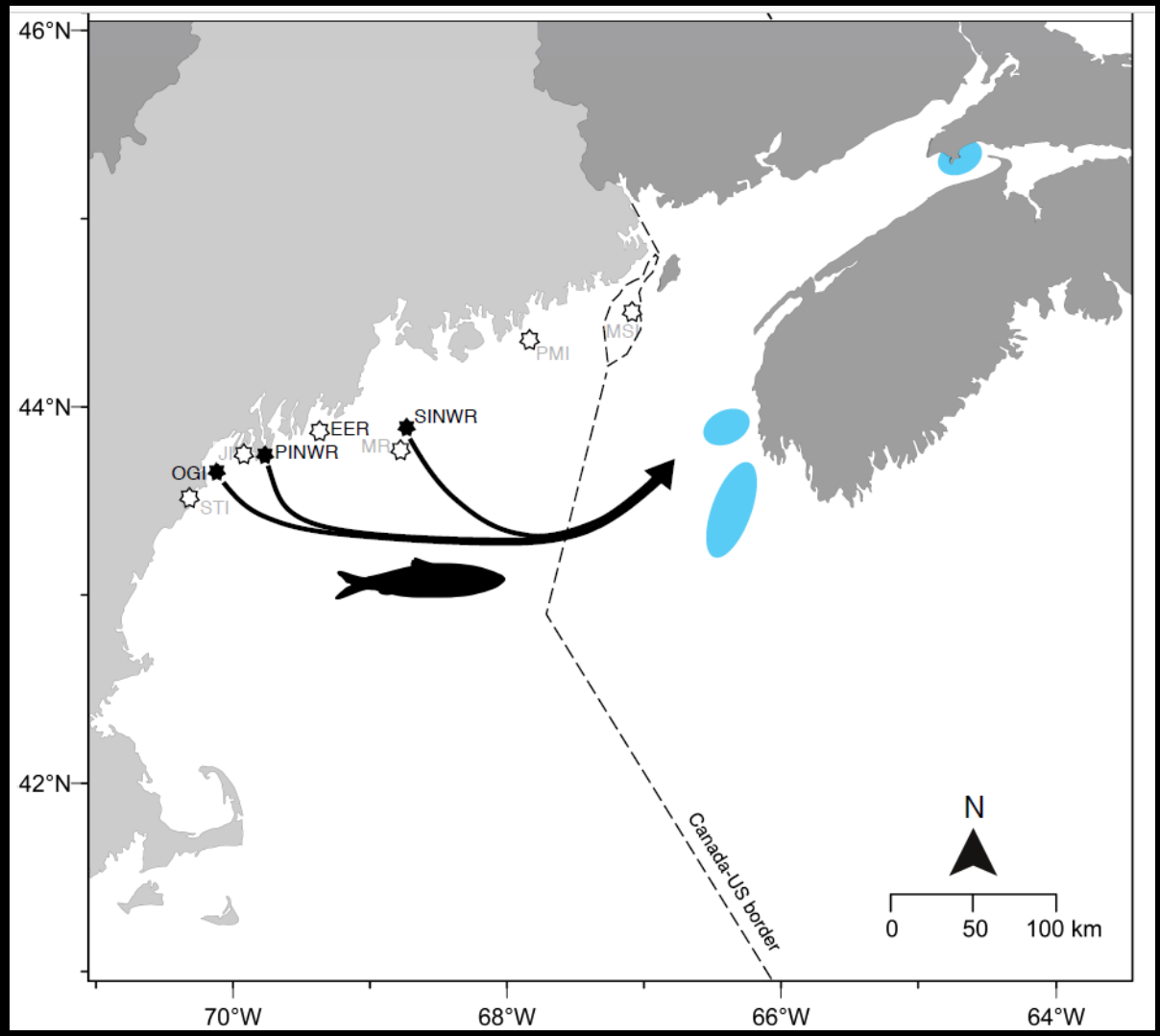

Scopel et al. 2018



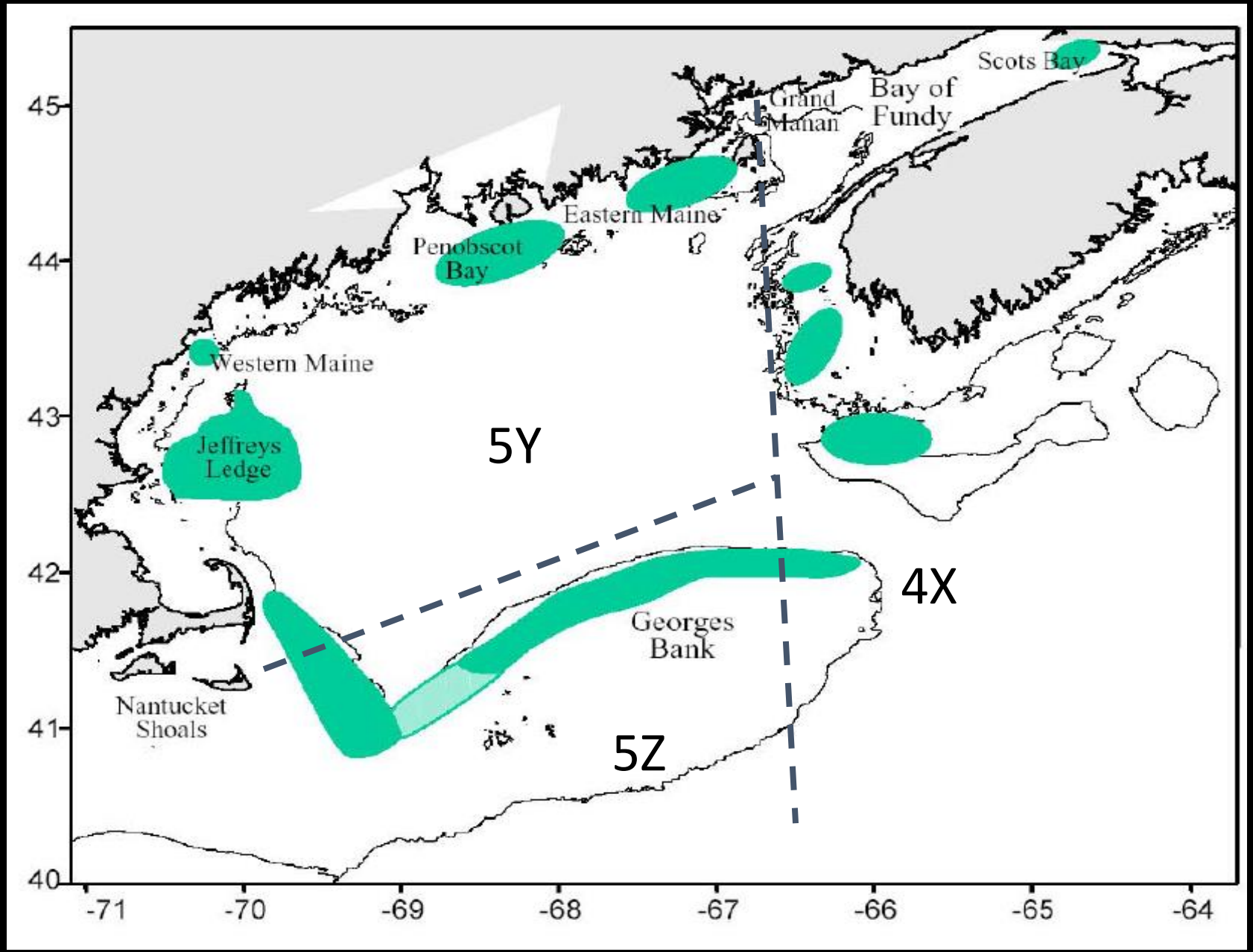

Scopel et al. 2018




Weight-at-age 1 and juvenile abundance indices



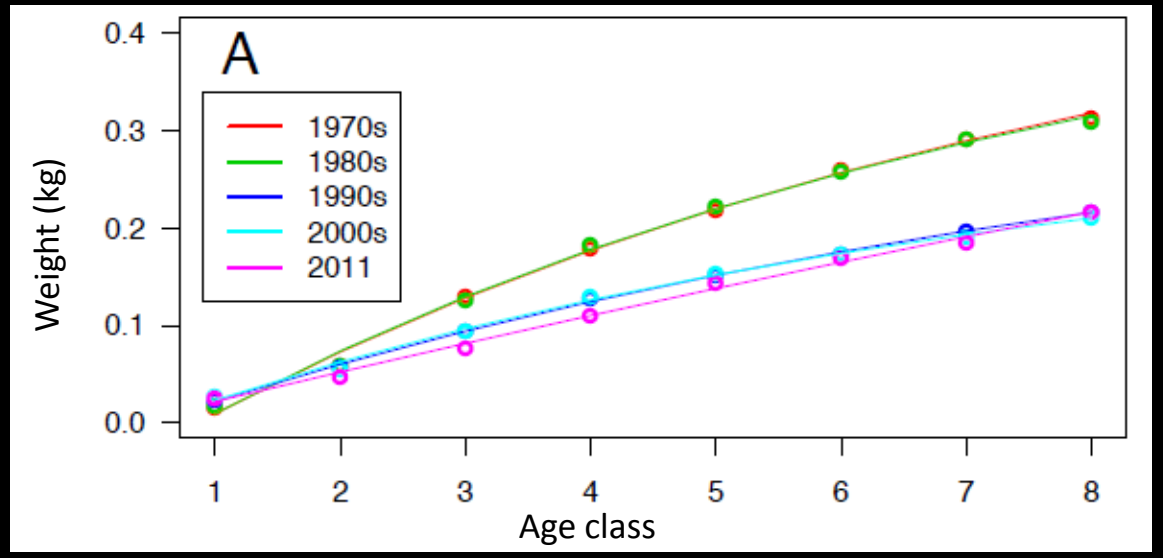

Acoustic survey (adults)



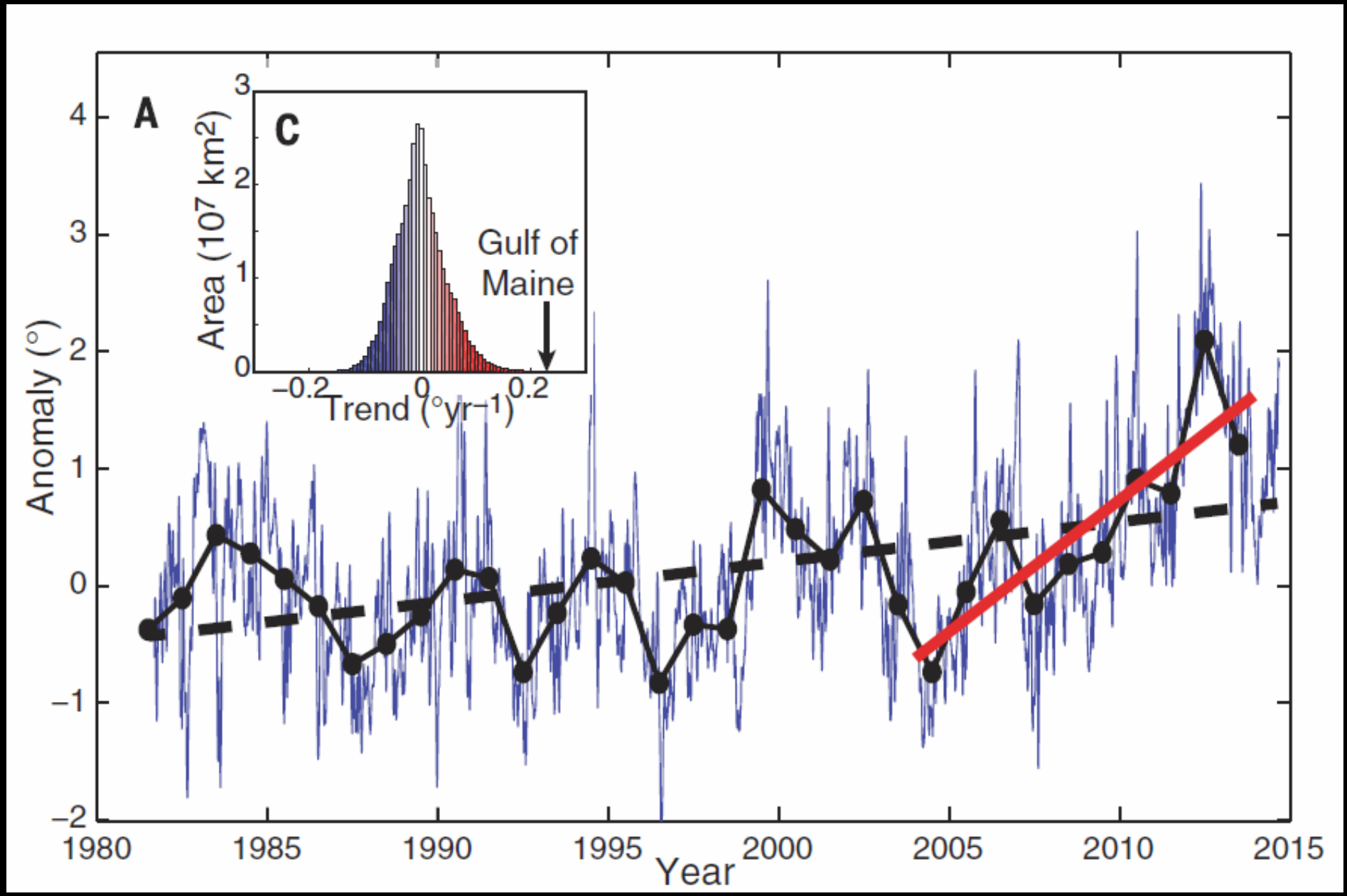

Overholtz et al. 2004

# Weights-at-age in decline, especially between age 2-3

Canada

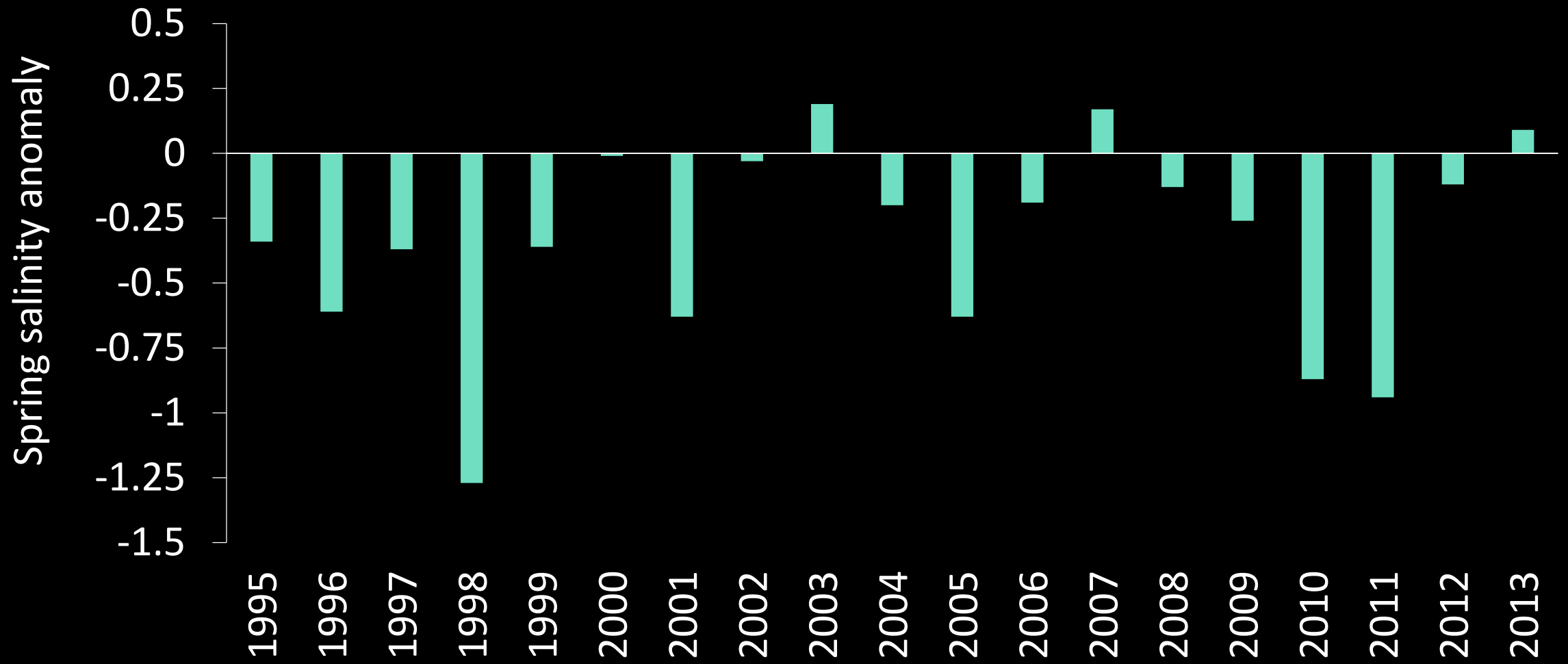



USA




Pershing et al. 2015

# Years of low salinity often were poor for seabirds



Nick Hawkins

# Conclusions

Seabird data do show relationships with fishery data

- Regional trends in a west-east pattern
- Strong relationships with “unusual” datasets

Unexpected movements of juvenile herring

- Georges Bank herring around Grand Manan
- Bay of Fundy herring in western Maine

Declining weights-at-age are a cause for concern

# Acknowledgements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NEFSC

NOAA

Andy Patterson

Michelle Staudinger

Shannon Scott Tibbetts

Linda Welch

Sara Williams

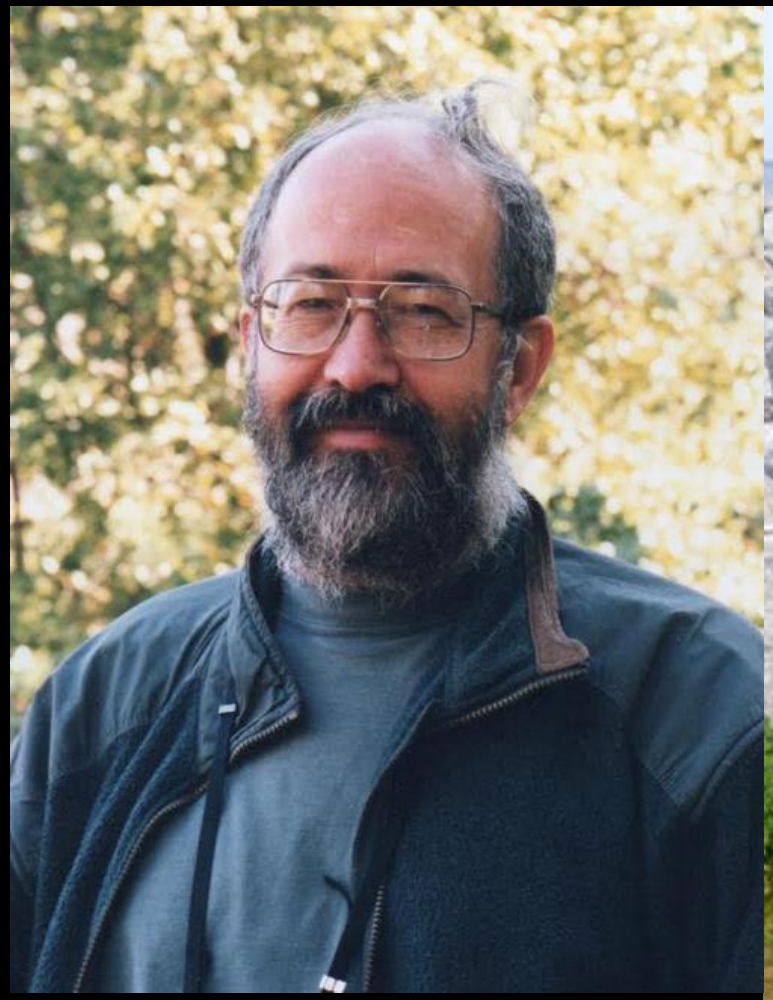
…and you!

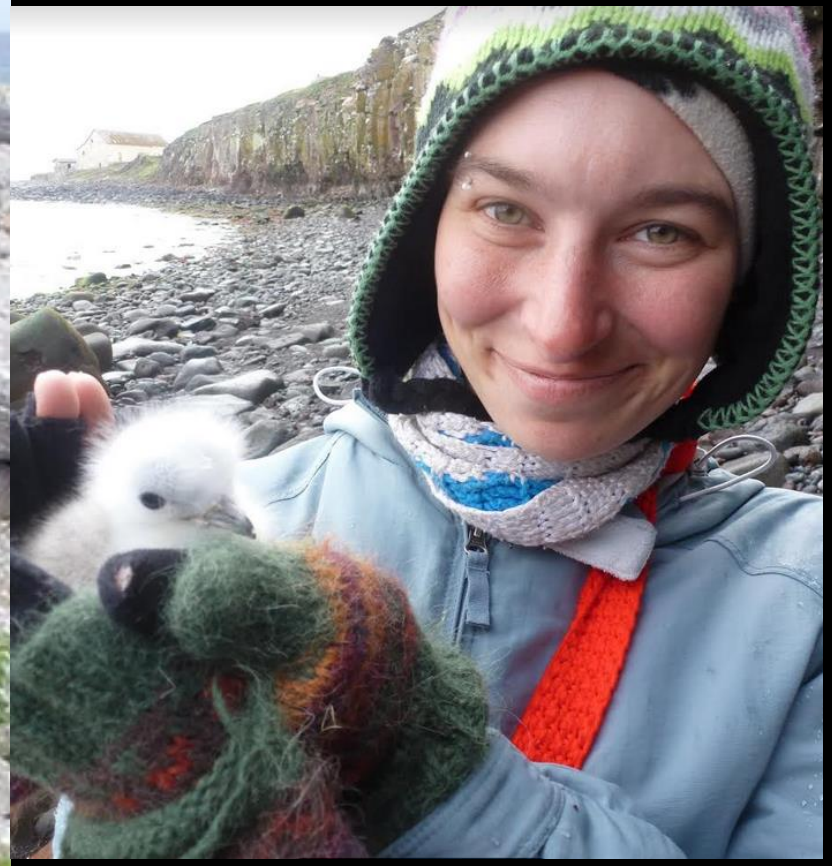













Tony Diamond

diamond@unb.ca

Steve Kress

skress@audubon.org

Lauren Scopel

l.scopel@unb.ca


Tony Diamond

diamond@unb.ca

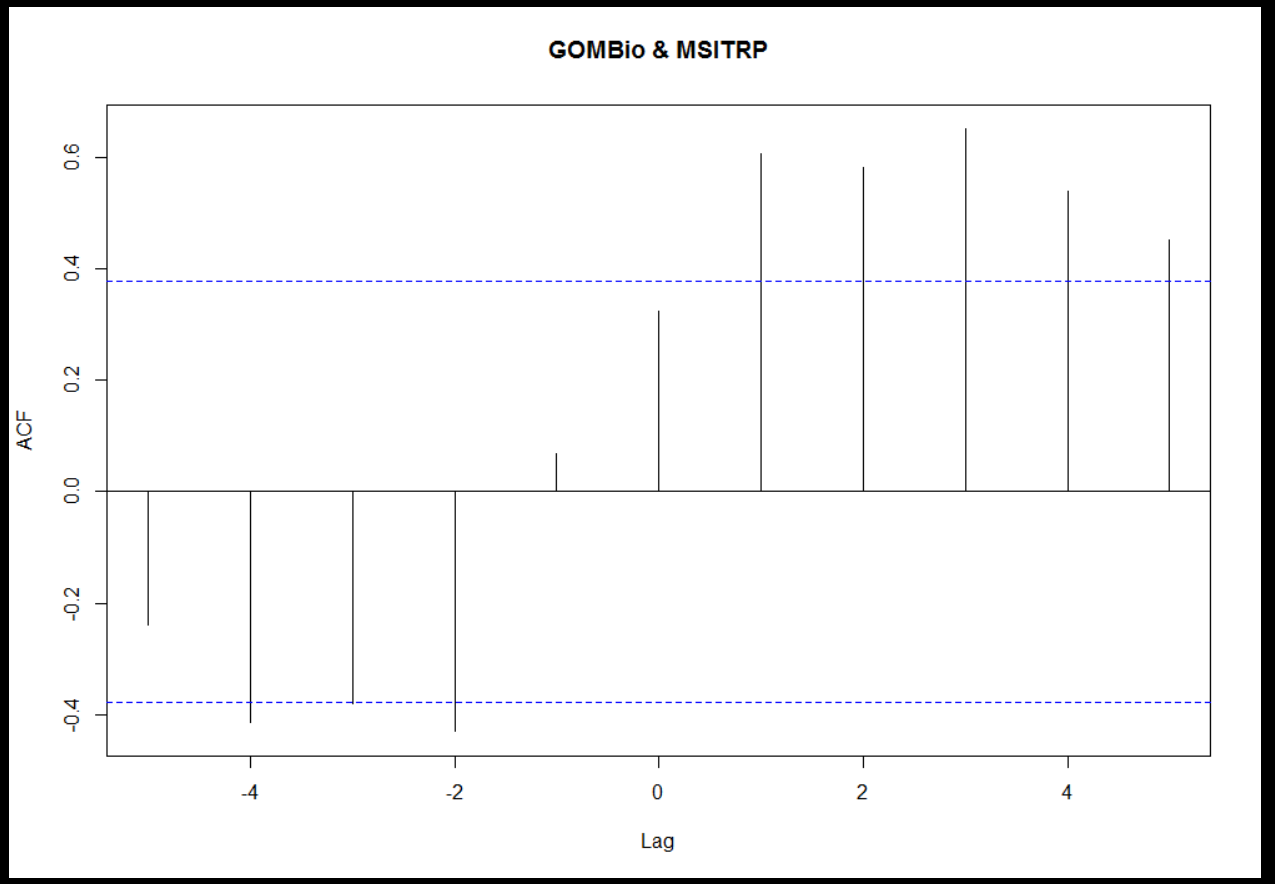
Steve Kress

skress@audubon.org

Lauren Scopel

l.scopel@unb.ca

# Examined temporal autocorrelation between seabird-fish data pairs




Fit univariate regression models based on observed time lags


Data LDEO-Columbia, NSF, NOAA
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Imagery Date: 12/13/2015 lat 43.233039°

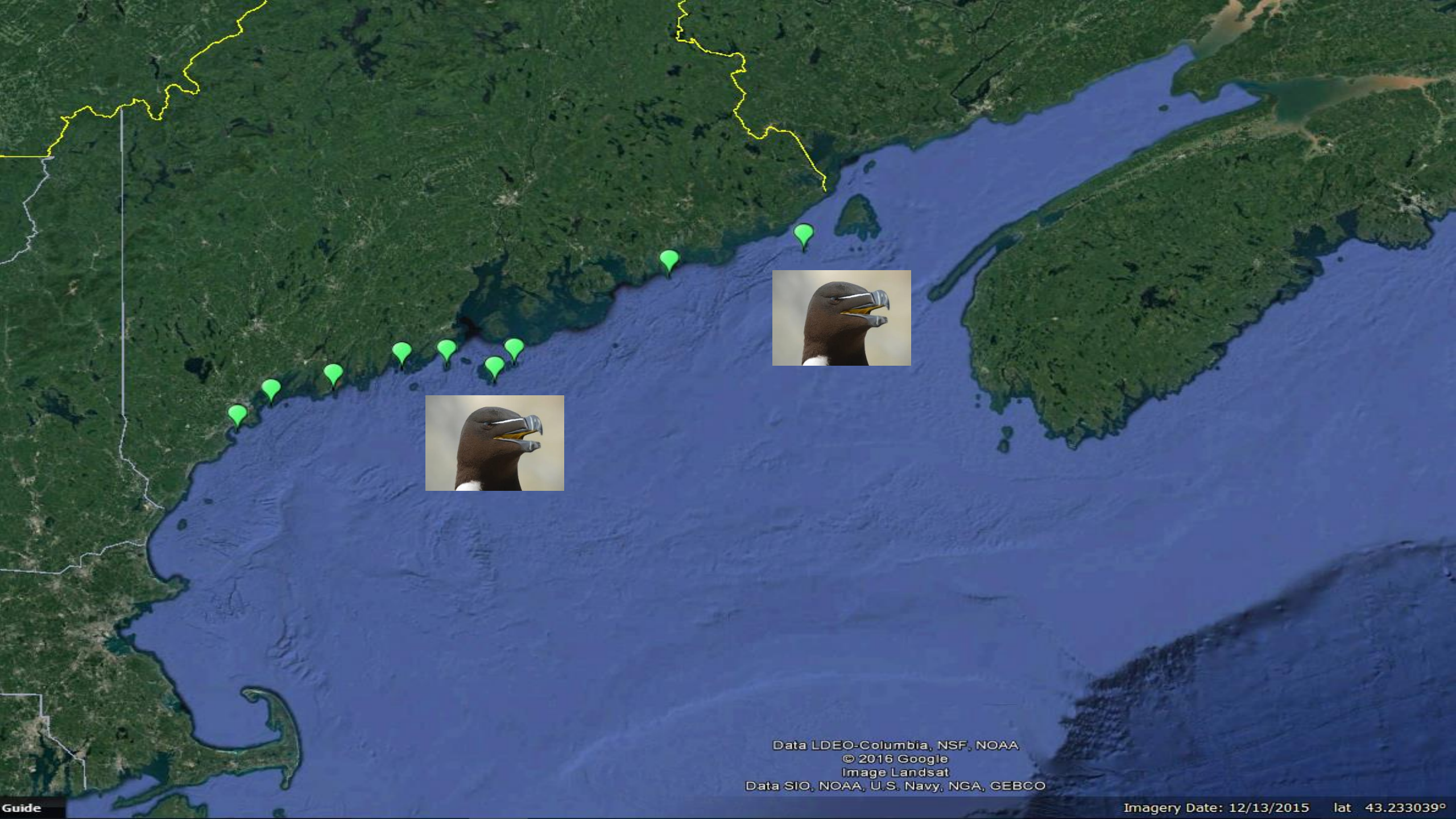







Guide

Imagery Date: 12/13/2015 lat 43.233039°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Imagery Date: 12/13/2015 lat 43.233039°