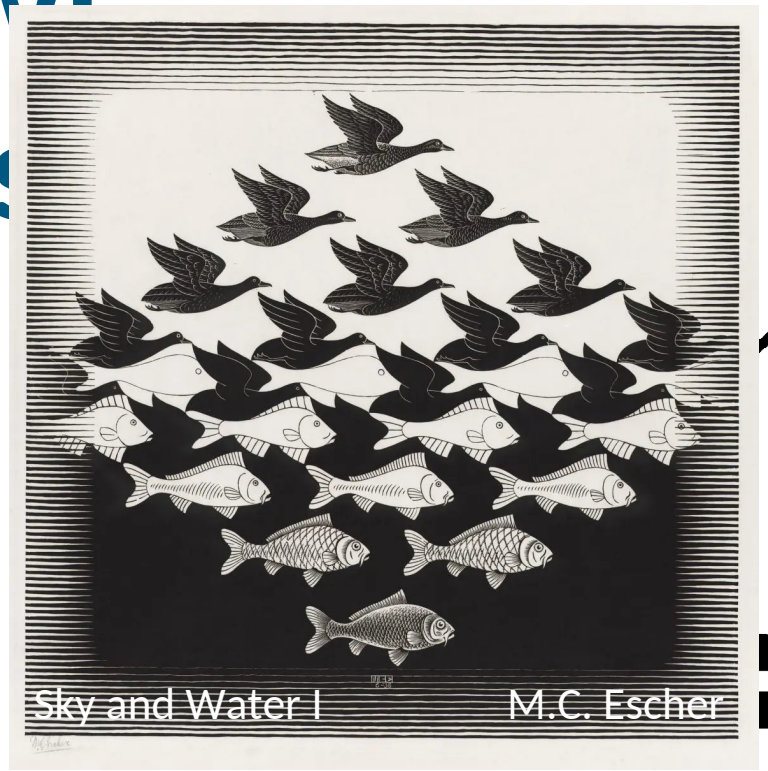
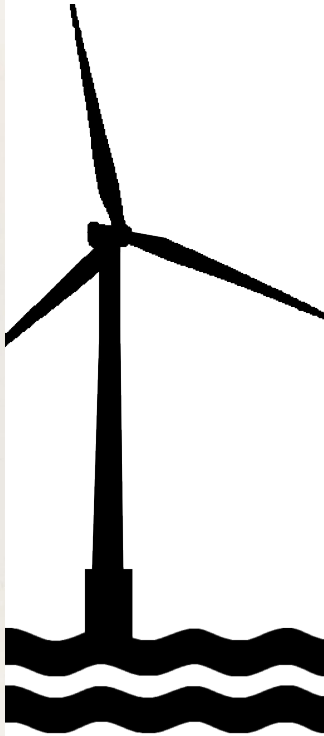
Flyway Models and Metrics in the Assessment of OW/E Impacts on Migratory Fis

Michael O'Brien, Matthew Breece, Aaron Carlisle, Dewayne Fox, Bradley Wetherbee, David Secor





ACT Network Annual Meeting

March 3 2026



ROSA Responsible Offshore Science Alliance

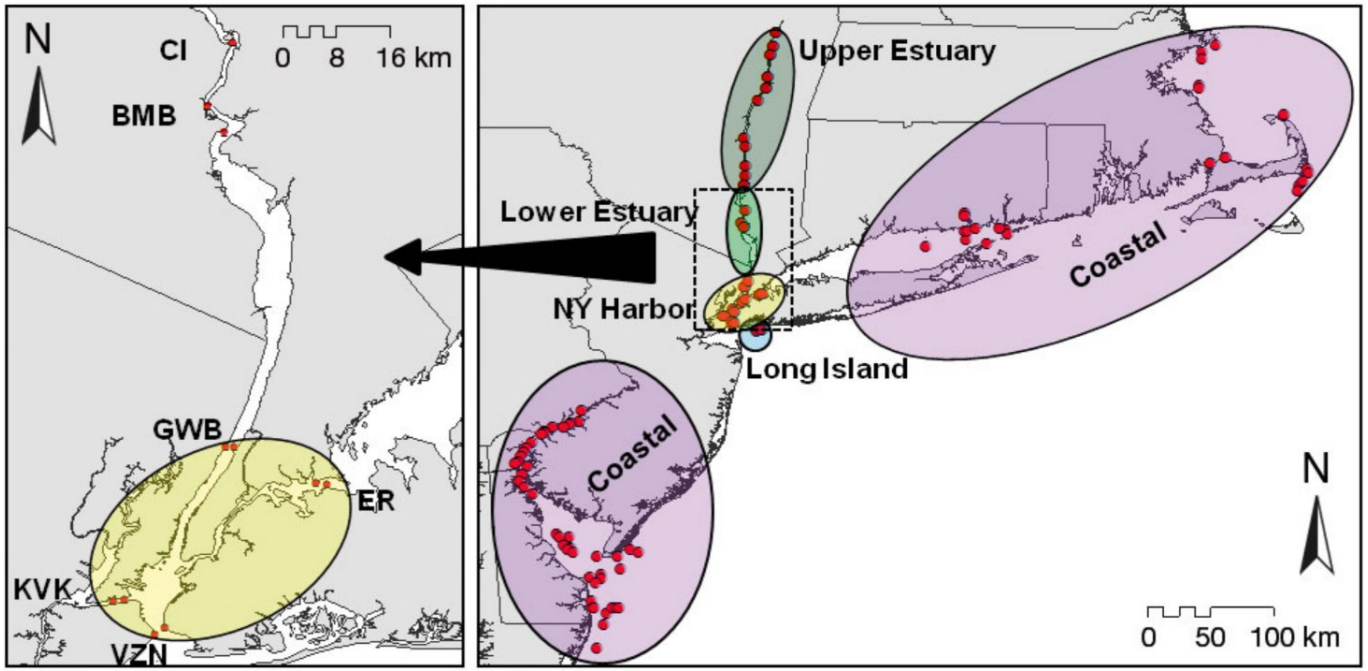
University of Maryland Center for Environmental Science

TailWinds

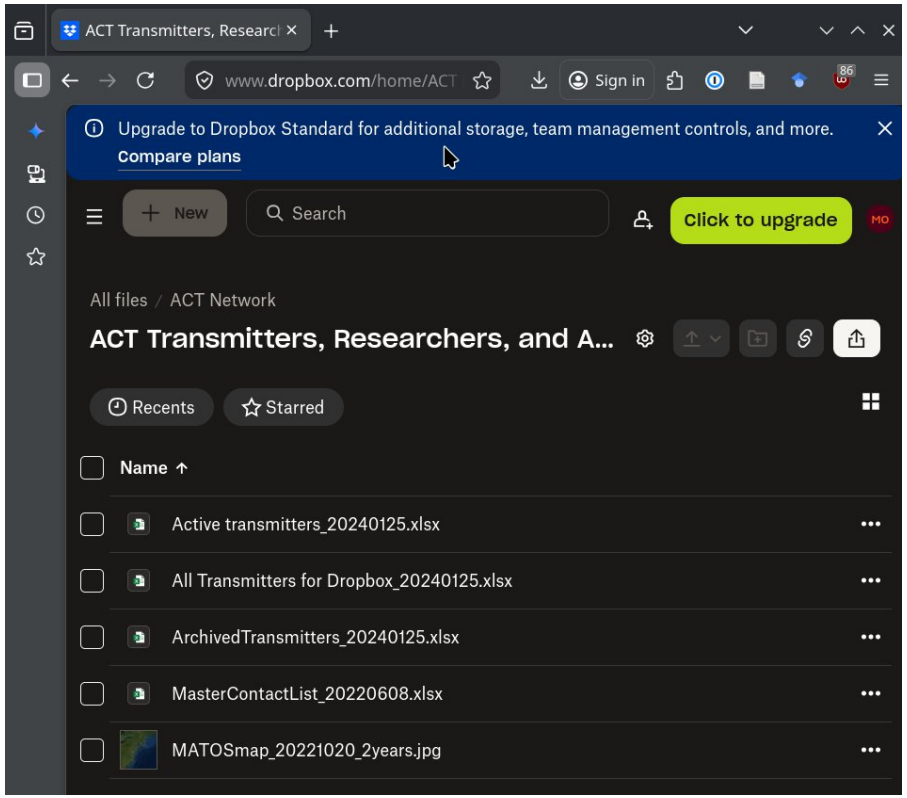
ACT Network, October 2009 - December 2011



ACT Network, October 2009 - December 2011

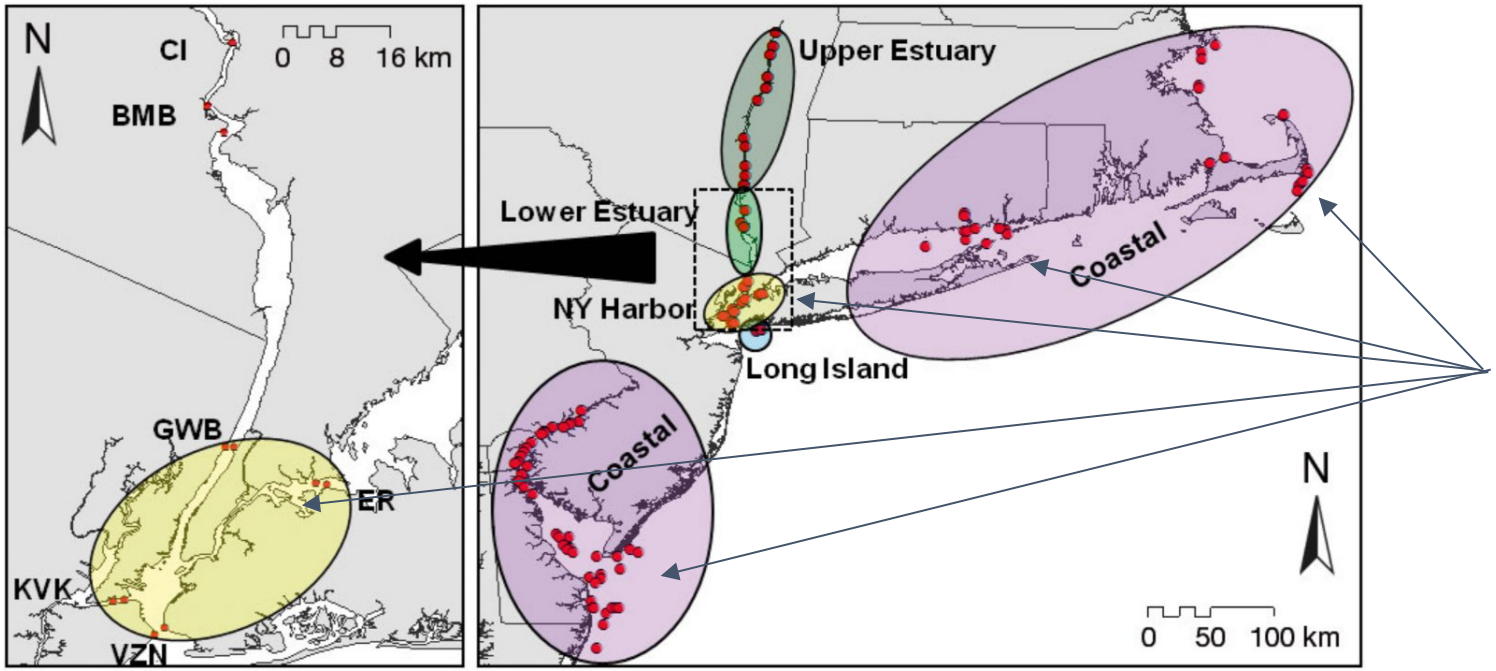


Gahagan, Fox, and Secor 2015



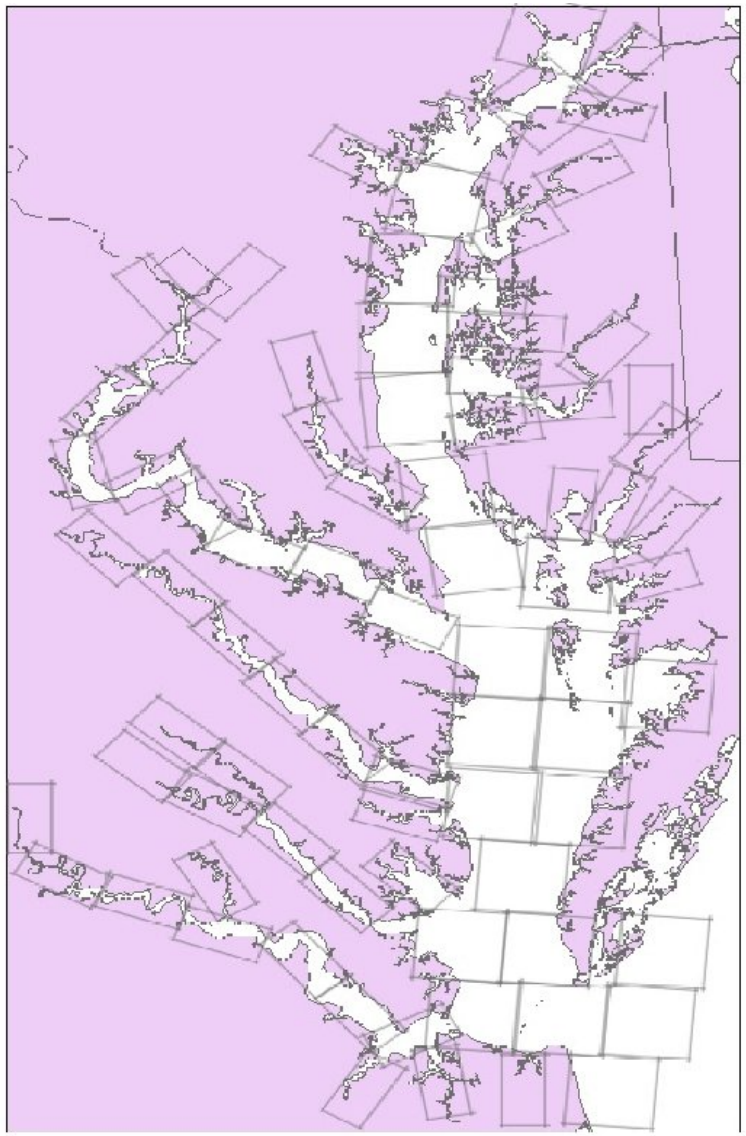
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ACT Network, October 2009 - December 2011



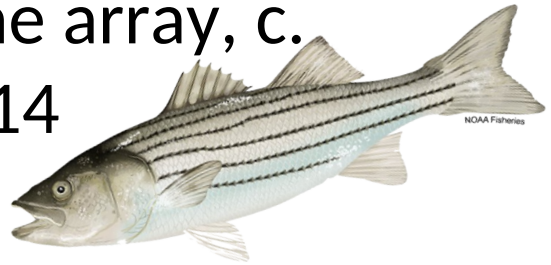
Bespoke, project-driven arrays

Gahagan, Fox, and Secor 2015

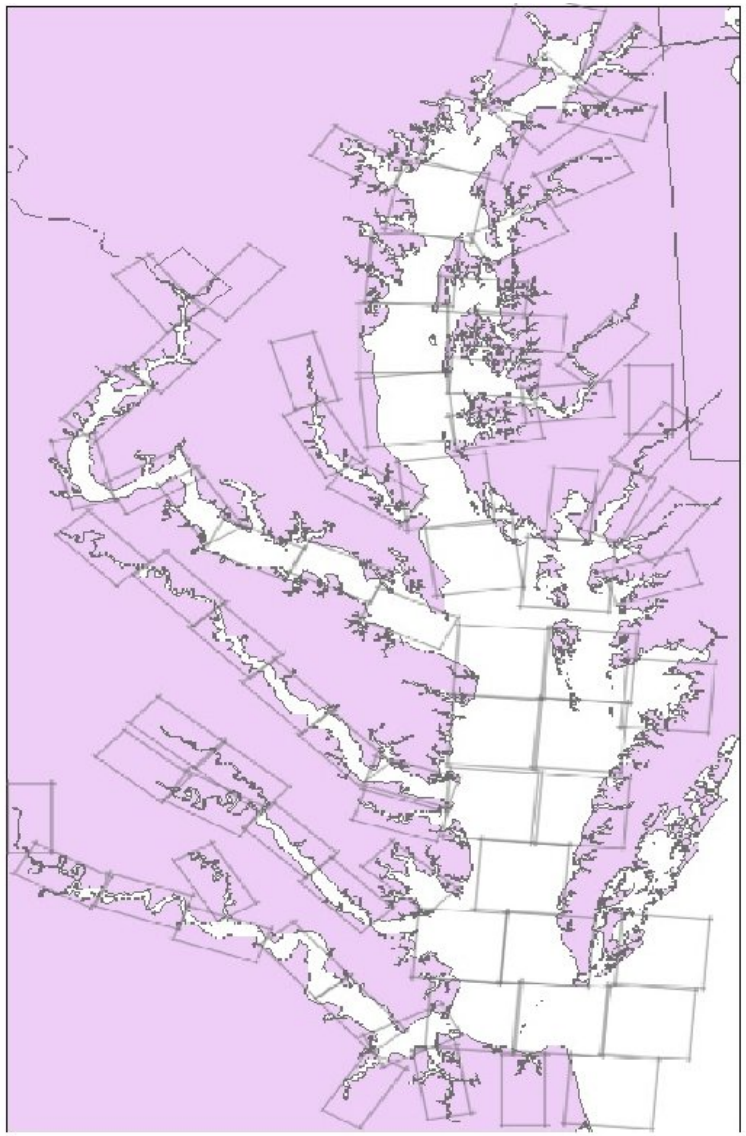


Backbone arrays??

Sketch Chesapeake Backbone array, c. April 2014



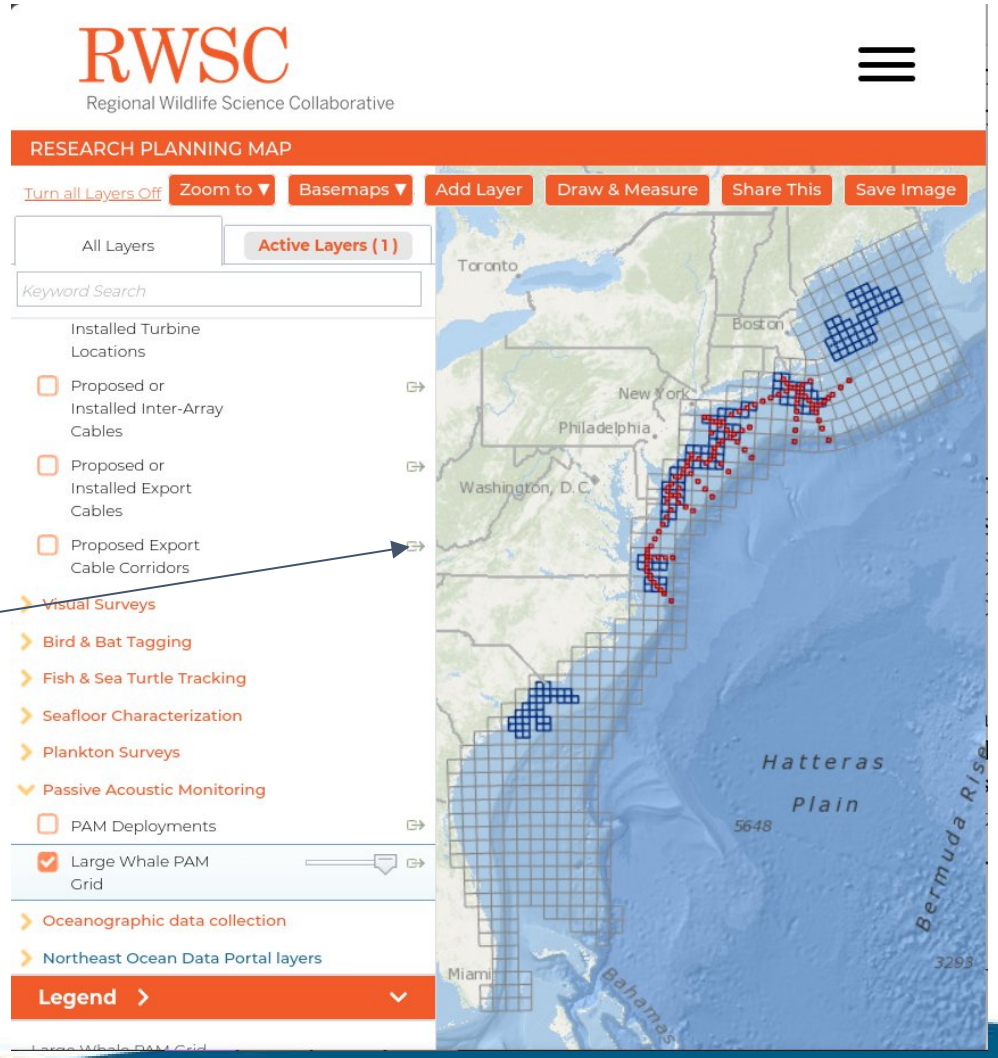
Backbone arrays??



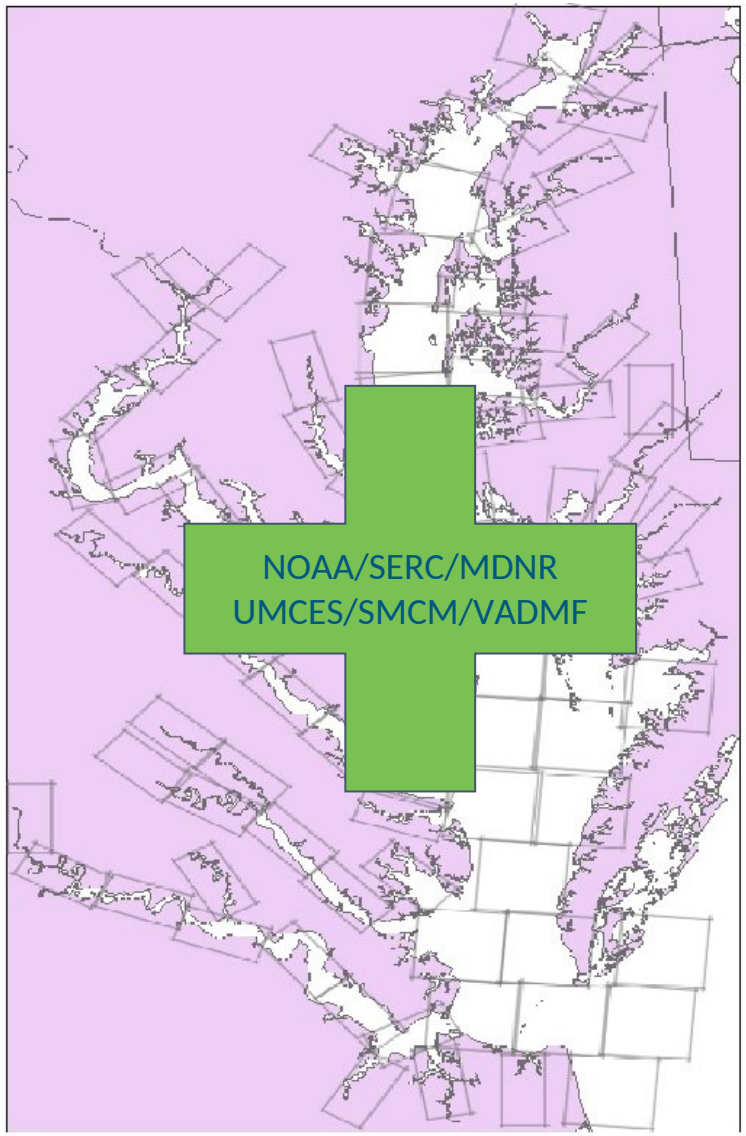
Sketch Chesapeake Backbone array, c. April 2014



PAM backbone array, c. 2021
Van Parijs

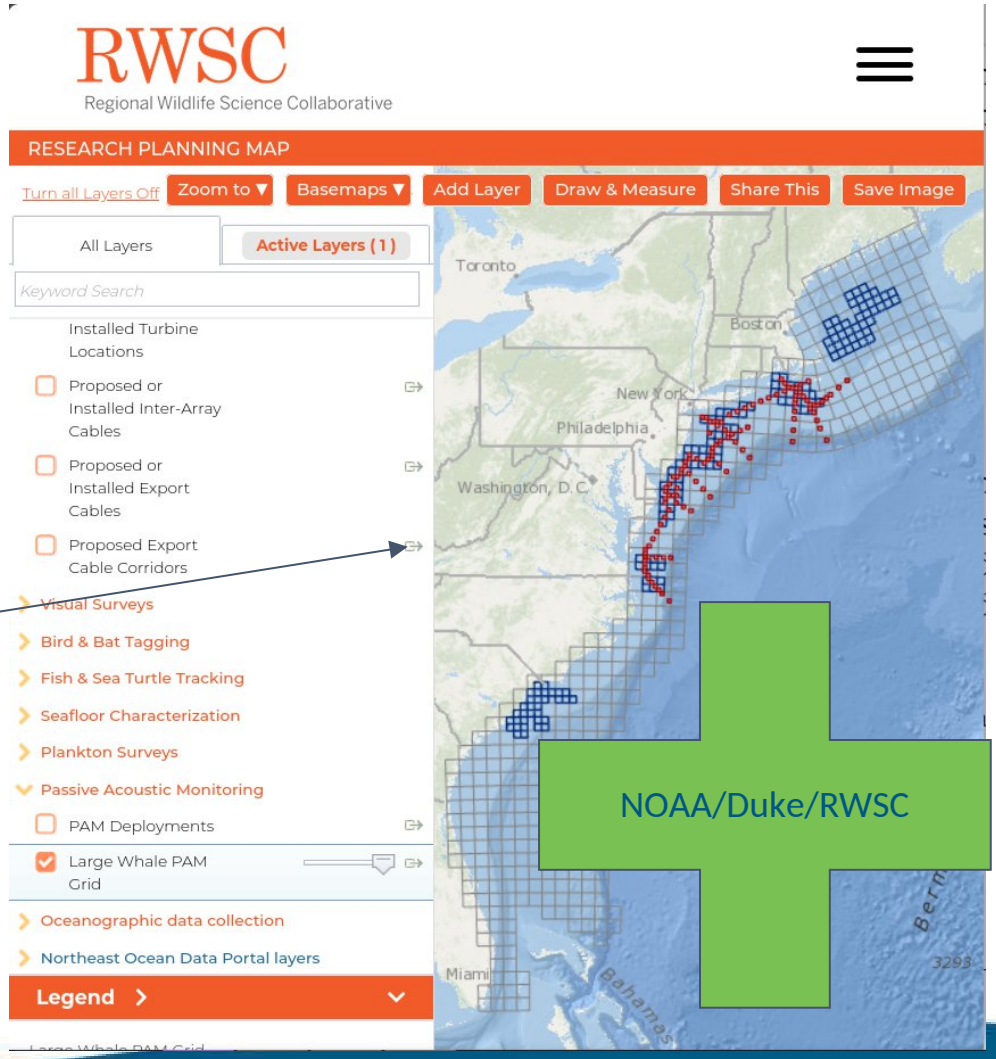


Backbone arrays!!



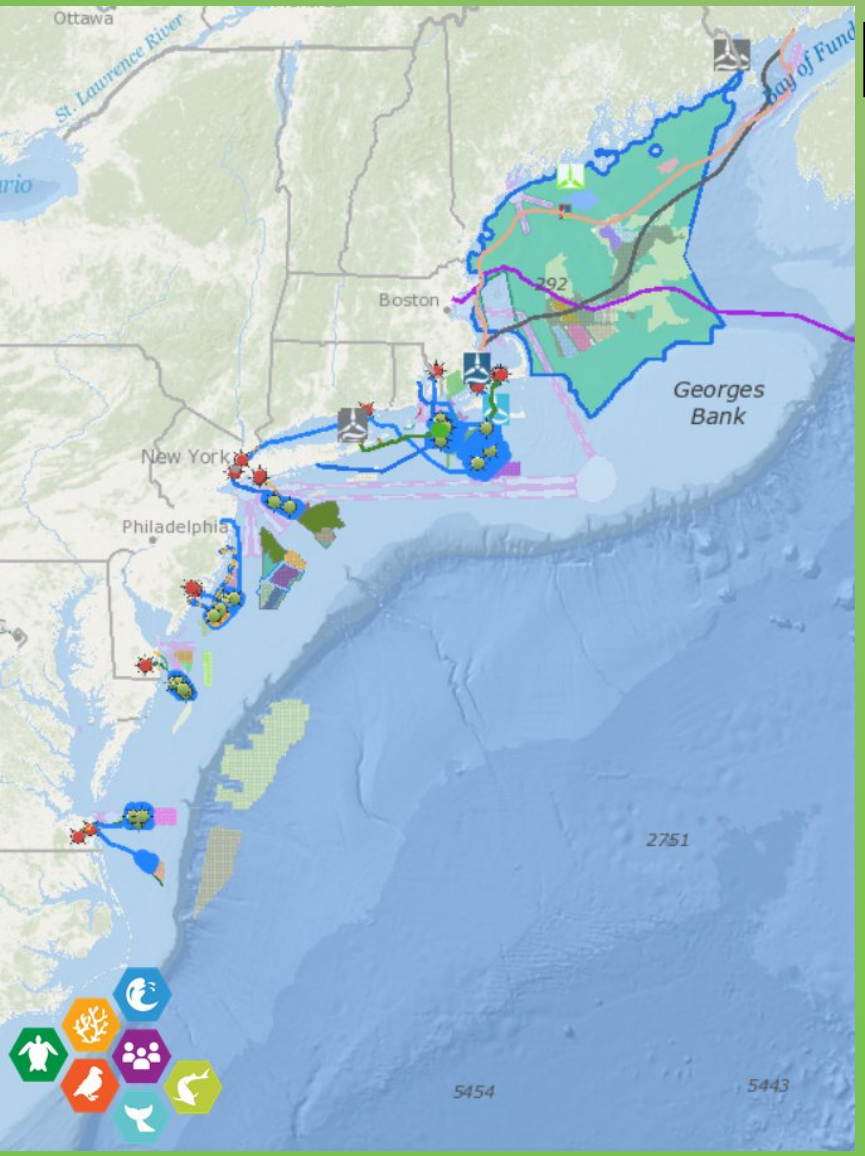
Chesapeake
Backbone array
May 2021

PAM backbone array,
c. 2024
Van Parijs, Brill, et al.



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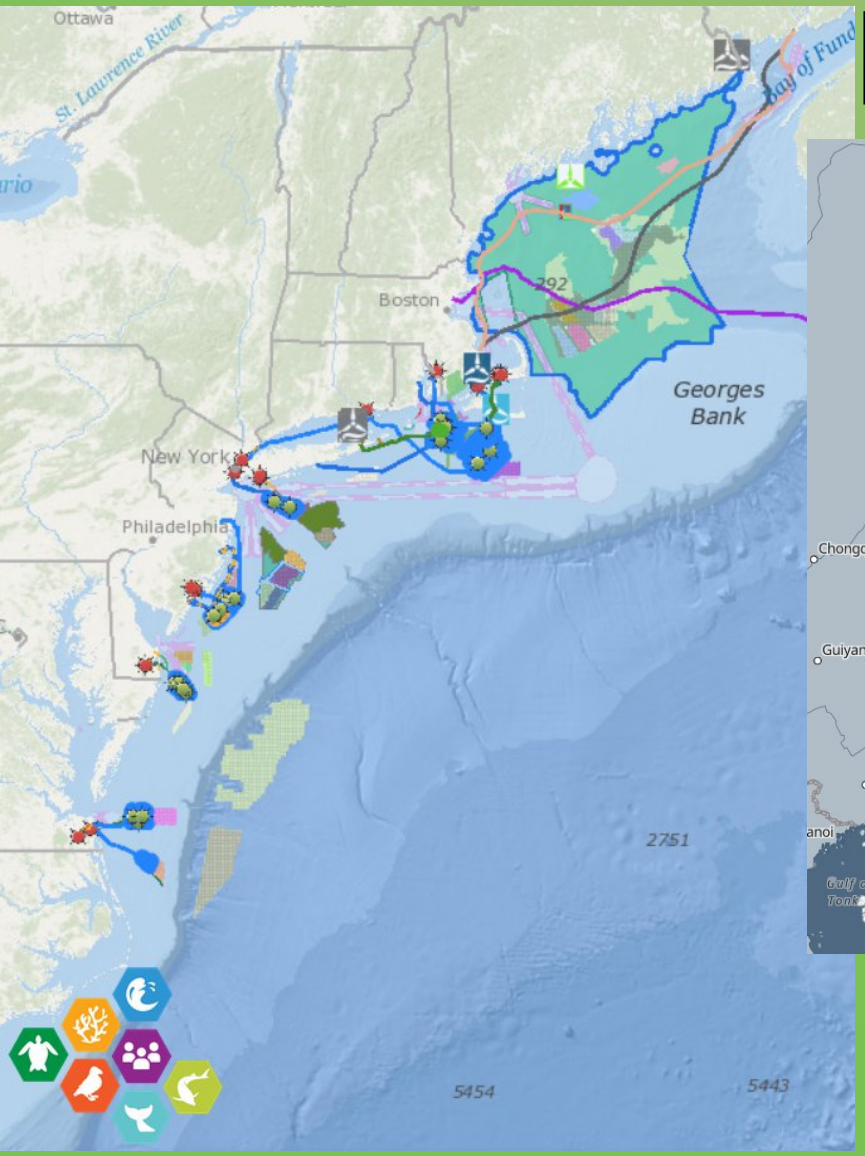


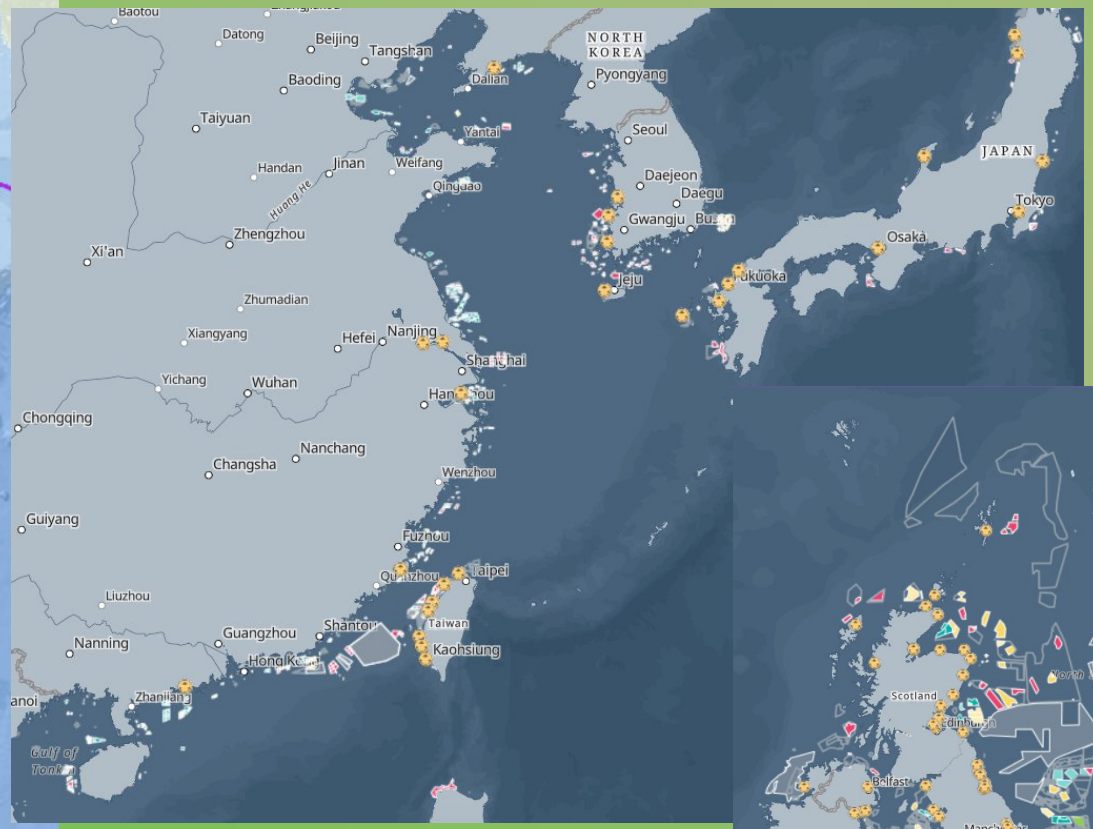
Backbone arrays?!

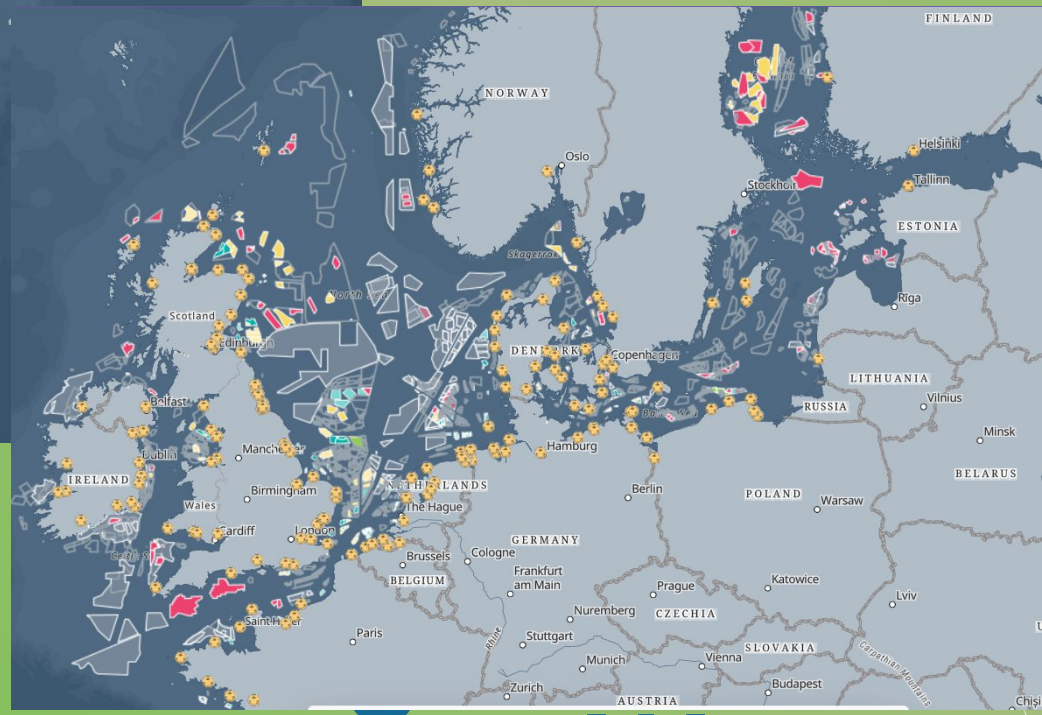
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Backbone arrays!!







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Why do we need backbone arrays?

- ~~They're neat~~
- ~~Acoustic telemetry is fun~~
- ~~I want to see how far my fish can go~~
- ~~I want to publish a paper with as may coauthors as humanly possible~~

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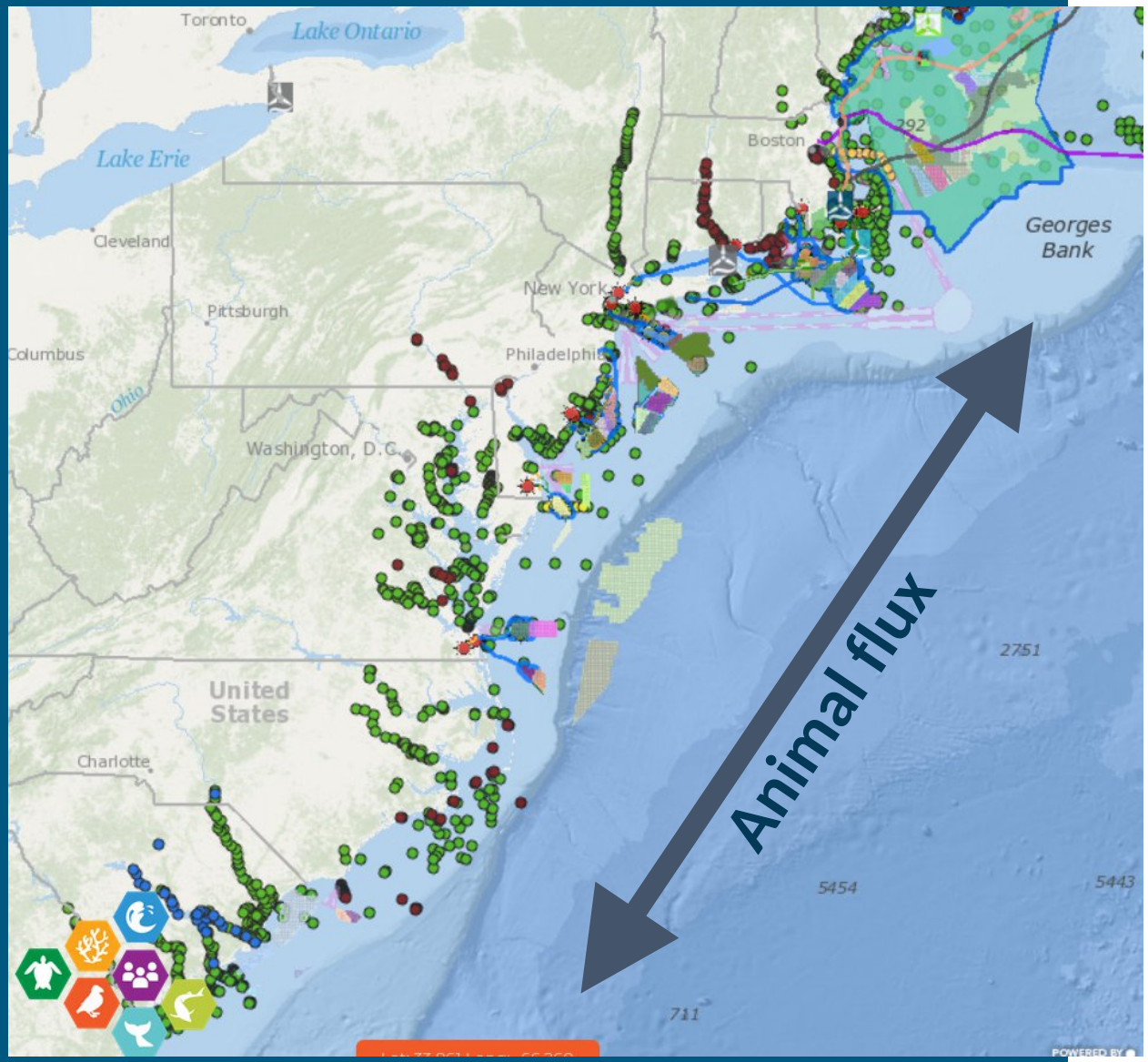


~~Why do we need backbone arrays?~~

What can we do with backbone arrays?

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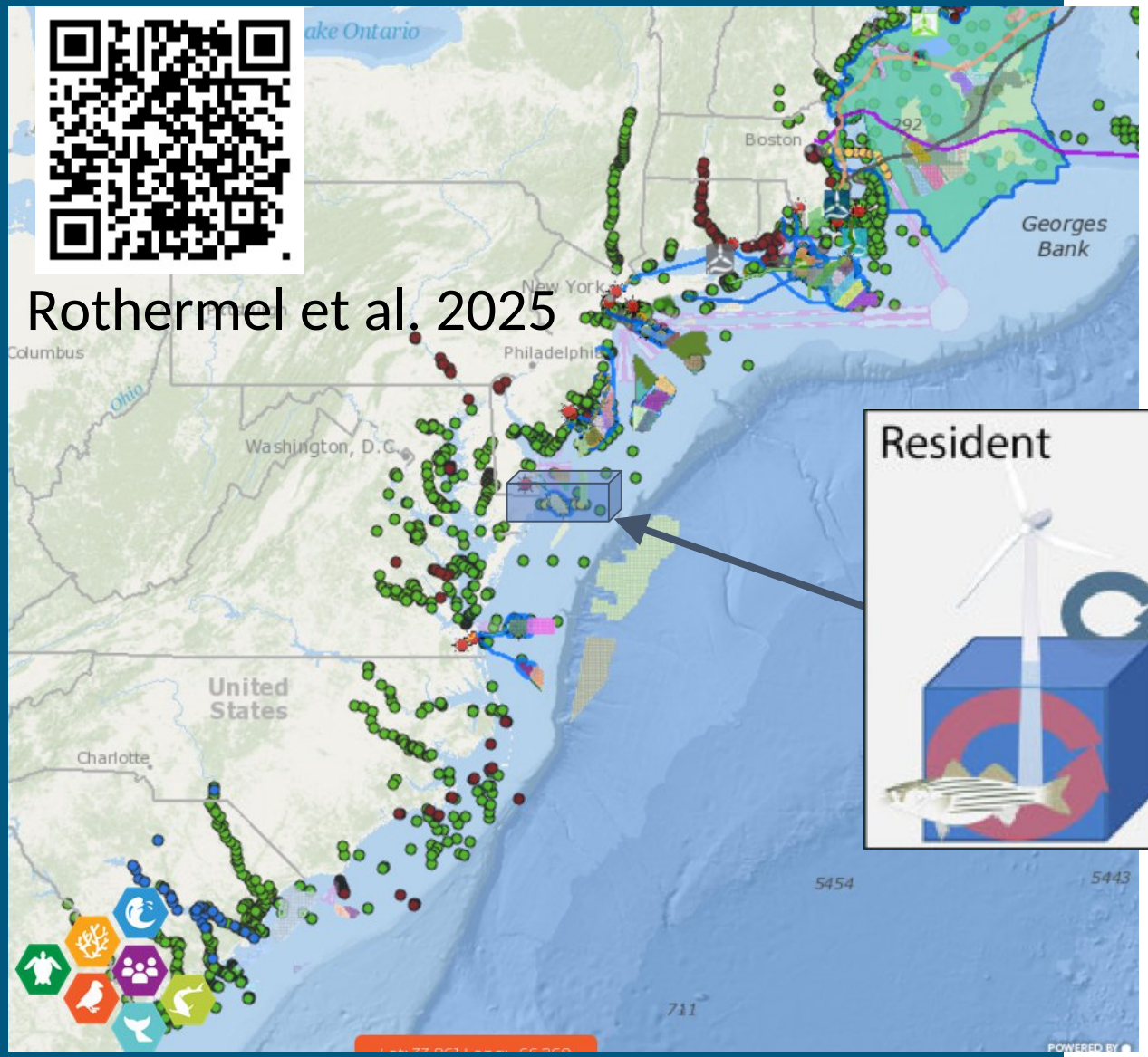


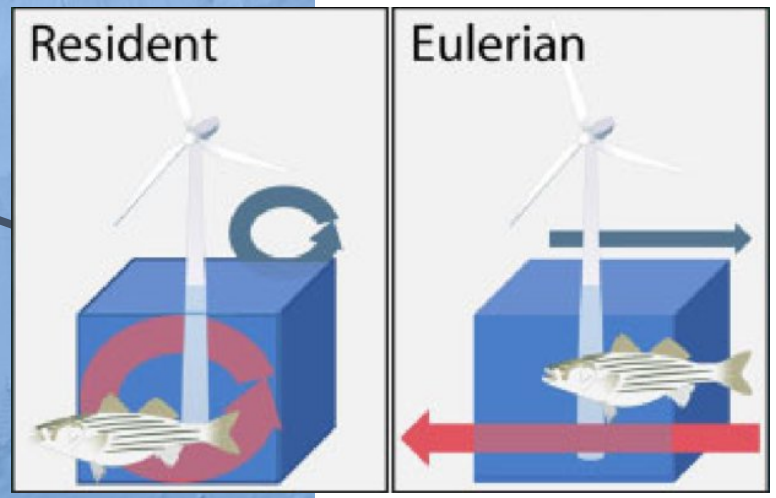
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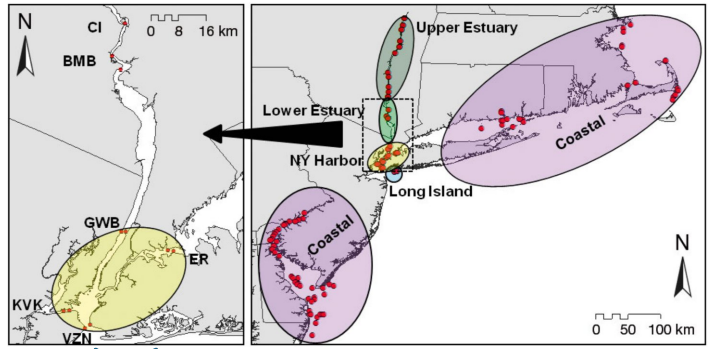
Eulerian approach

Rothermel et al. 2025







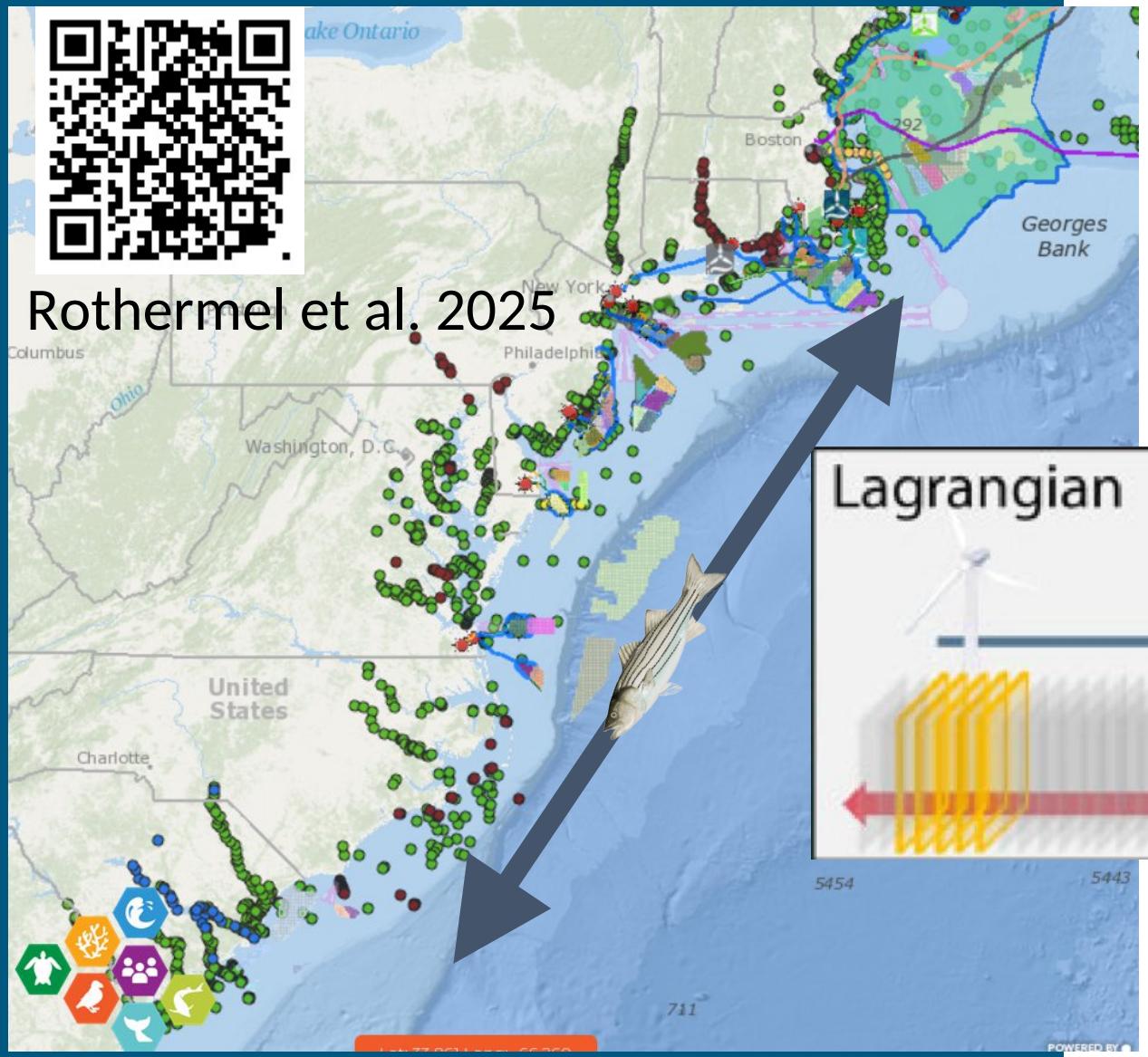


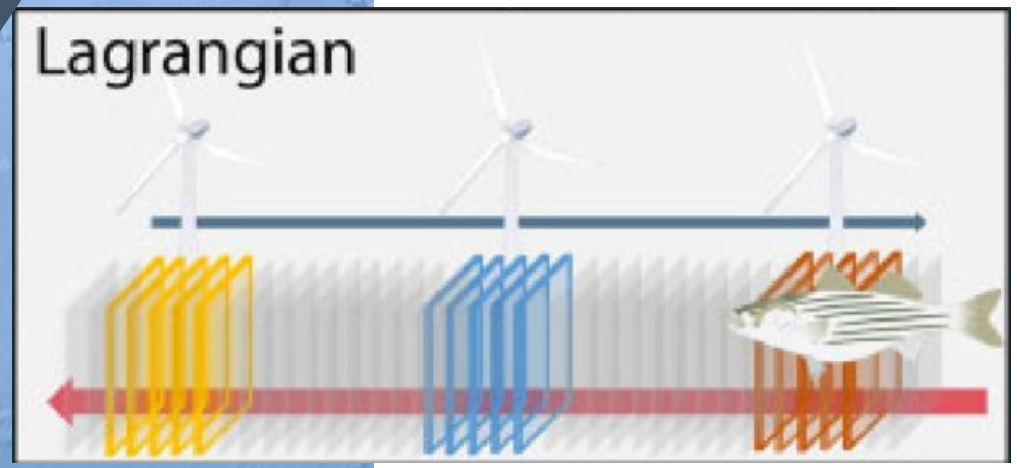
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Lagrangian approach

Rothermel et al. 2025







(aspirational)

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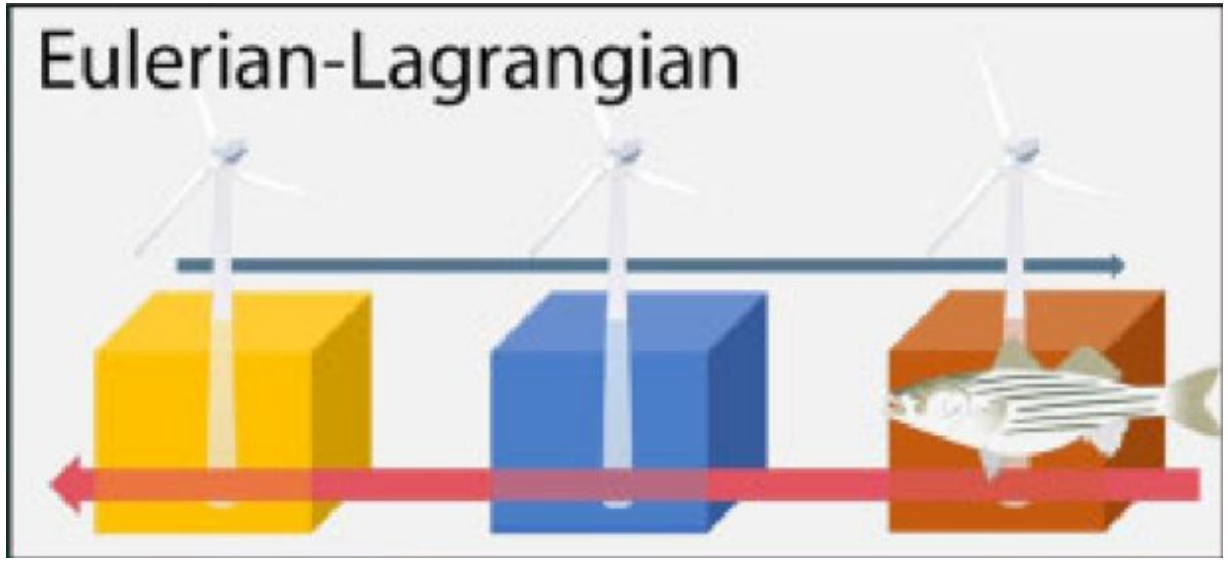
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Secor et al. 2025

Hybrid Eulerian-Lagrangian

What OWF backbone arrays allow



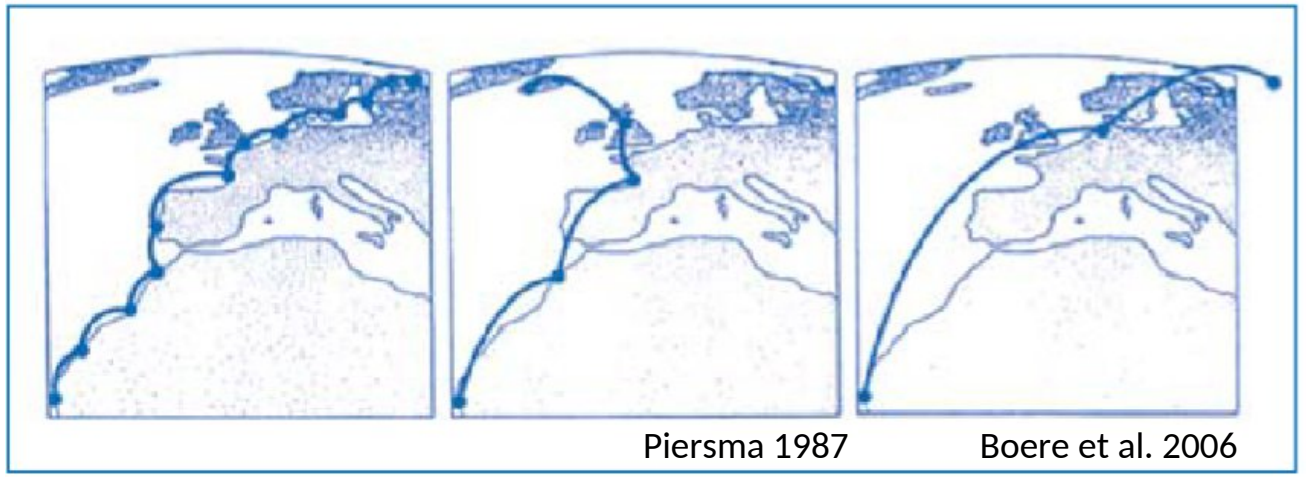
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Flyways

- “Annual migration **circuit** that **connects** a **network** of avian stopover and destination **habitats**” (Boere and Stroud 2006)

Hybrid Eulerian-Lagrangian



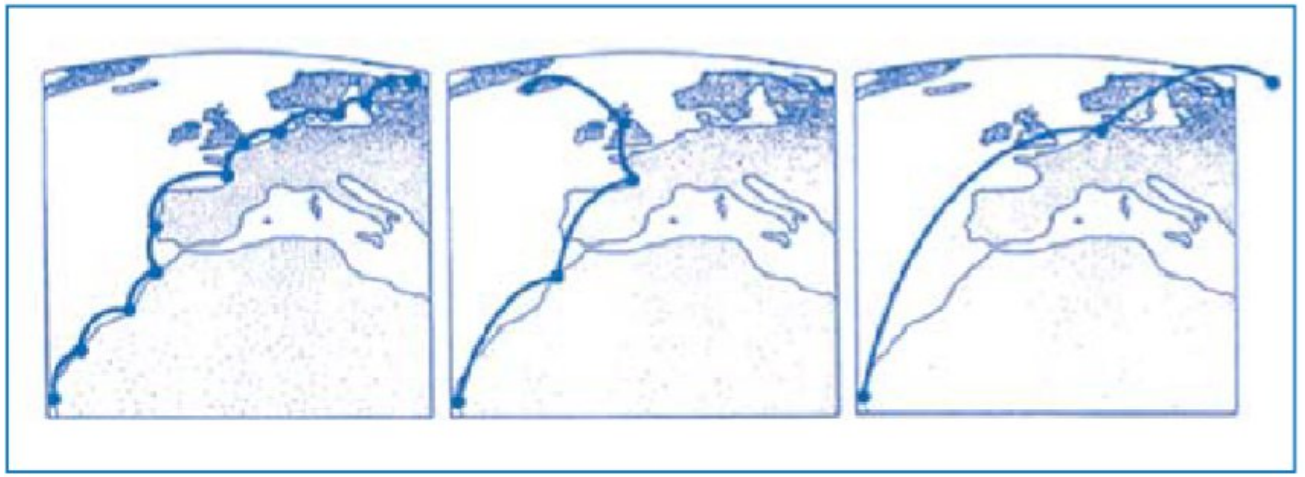
Piersma 1987 Boere et al. 2006

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Flyways

- “Annual migration circuit that connects a network of avian stopover and destination habitats” (Boere and Stroud 2006)
- **But does it *need* to be a bird?**



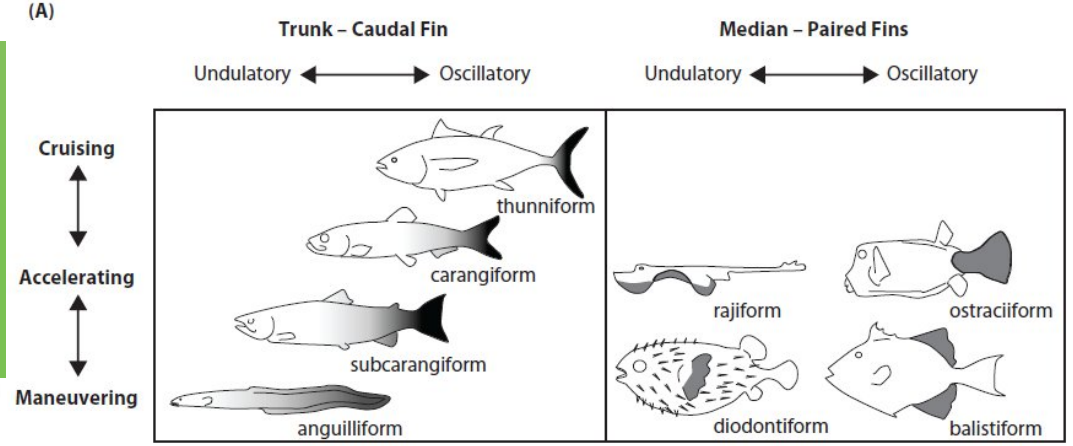
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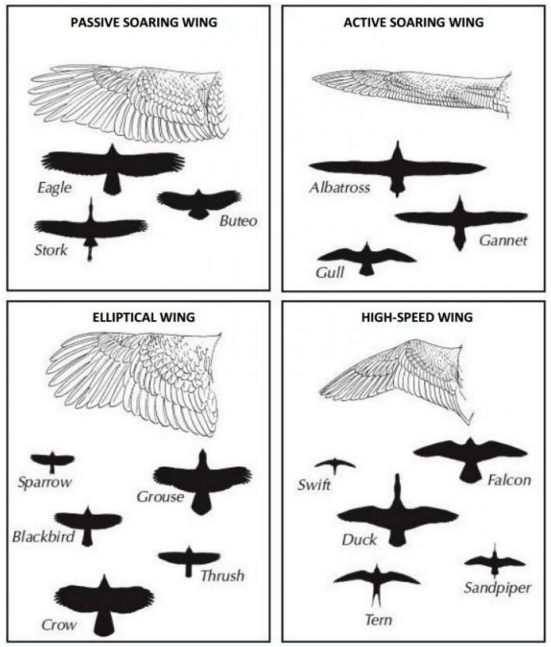
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Flyways

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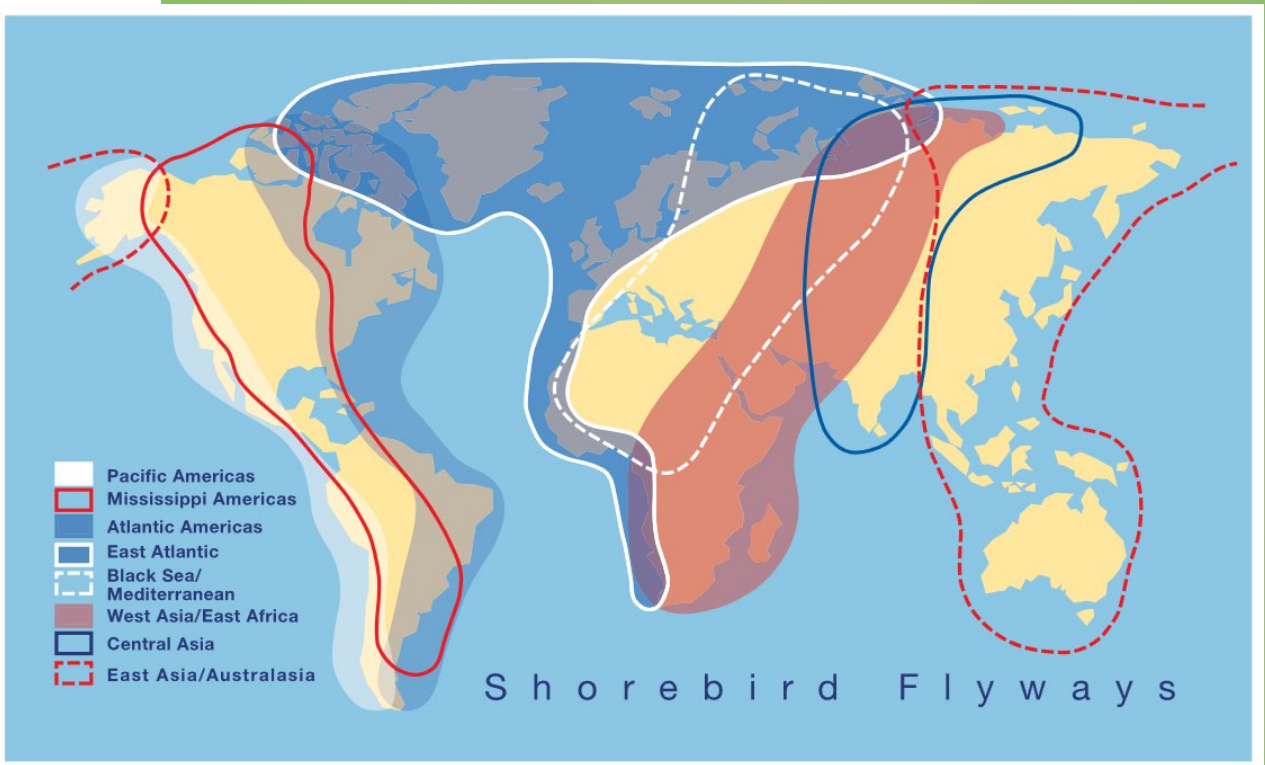
Migratory birds and fish – two types of animals, moving through a fluid, responding to the seasons, looking for a place to eat/rest.

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Flyways

- “A flyway is in fact the totality of the ecological systems that are necessary to enable a migratory waterbird to survive and fulfil its annual cycle. ” (Boere and Stroud 2006)
- **But does it *need* to be phenomenological?**

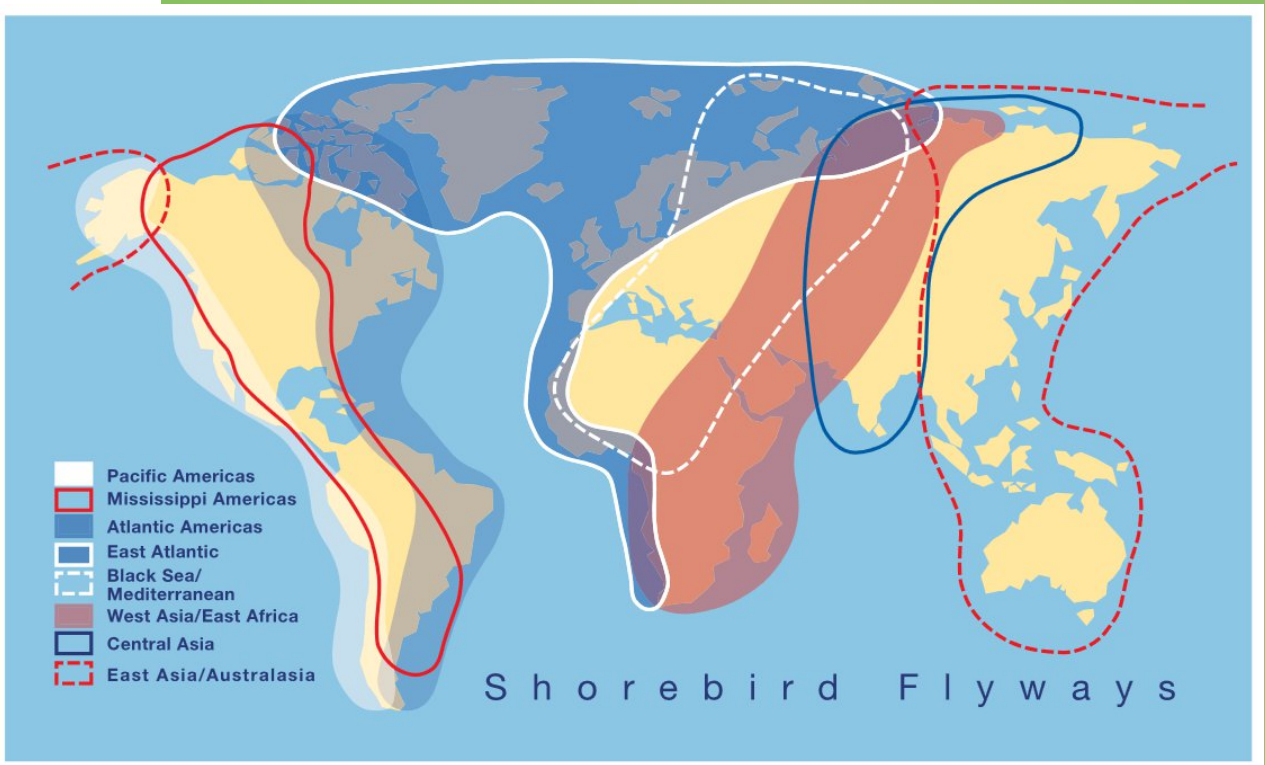


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Flyways

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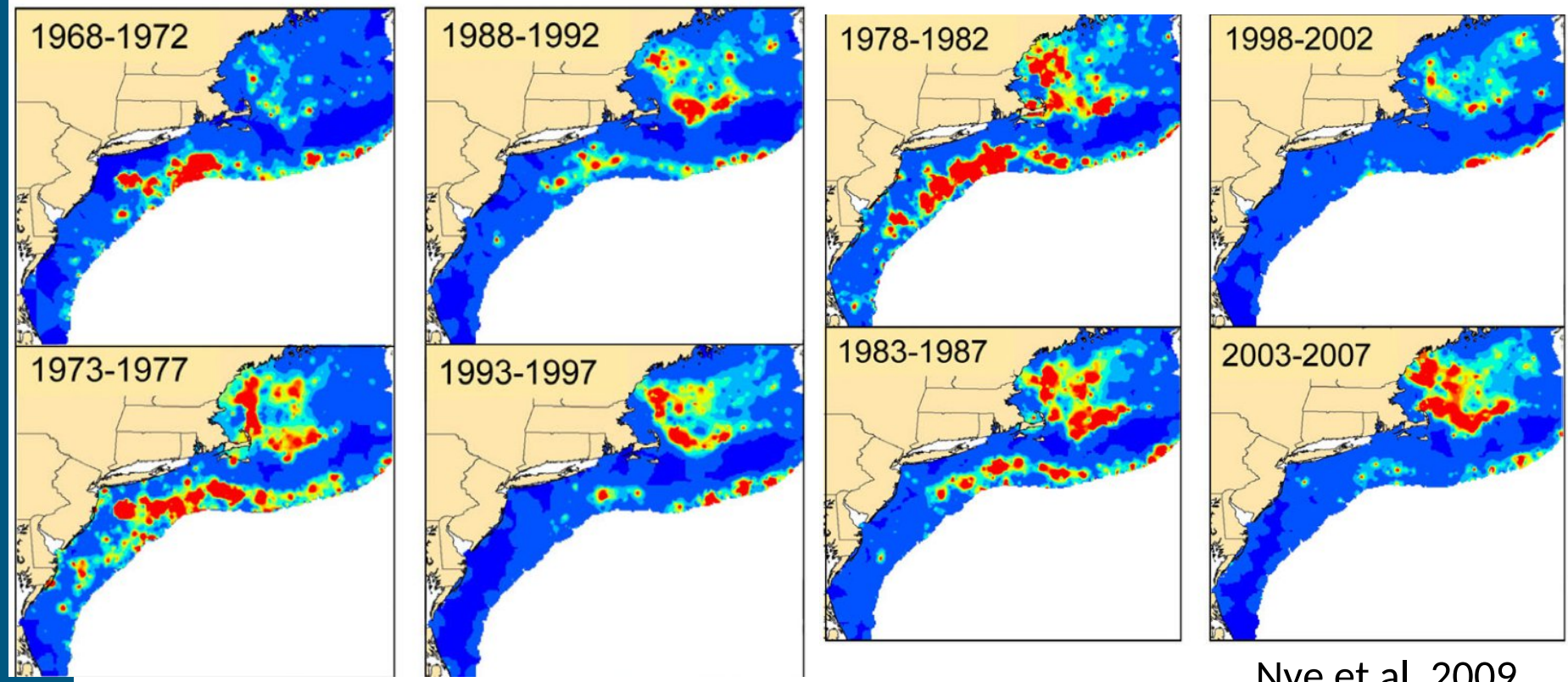
That one is a little tougher…

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Phenomenological view of fish movement

Snapshots - Group distribution through time



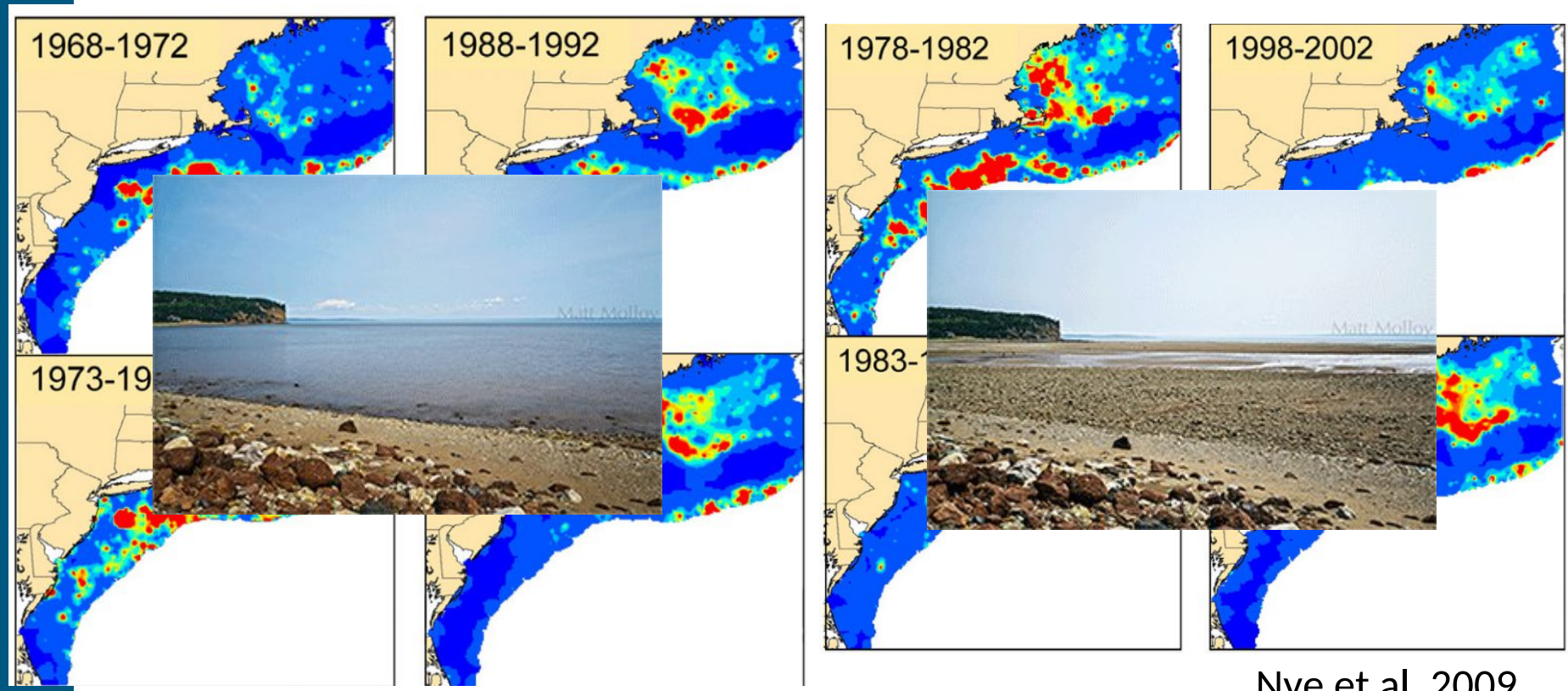
Nye et al. 2009

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Phenomenological view of fish movement

Snapshots - Group distribution through time



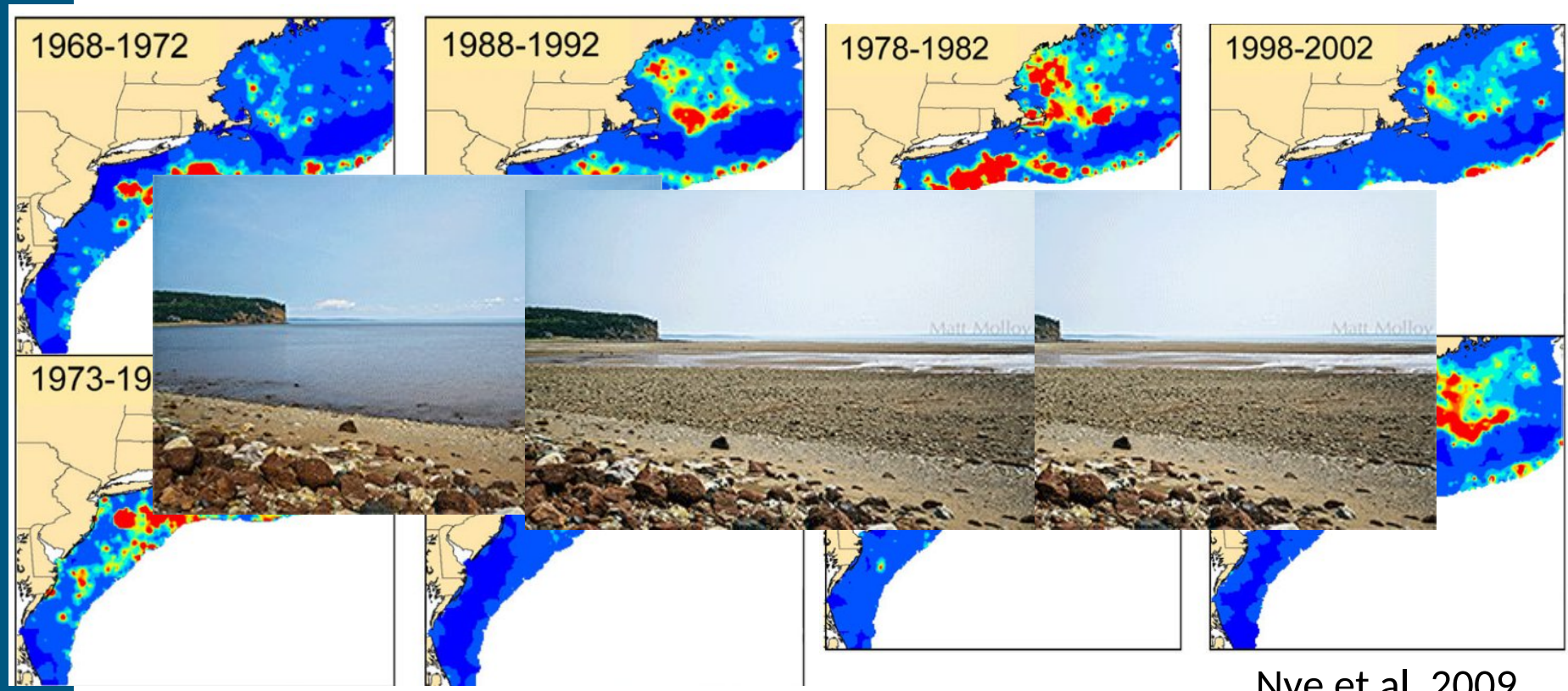
Nye et al. 2009

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Phenomenological view of fish movement

Snapshots - Group distribution through time



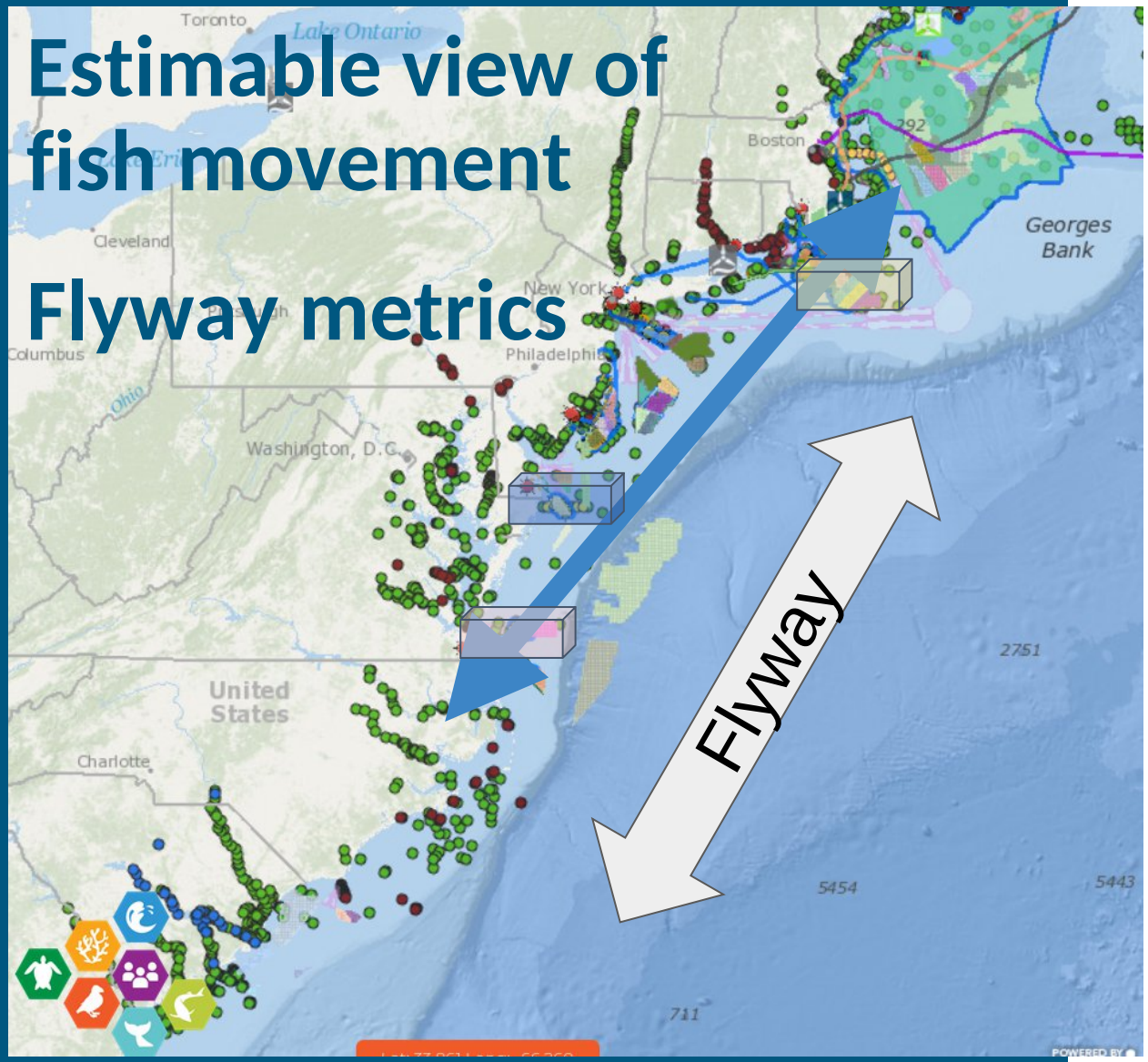
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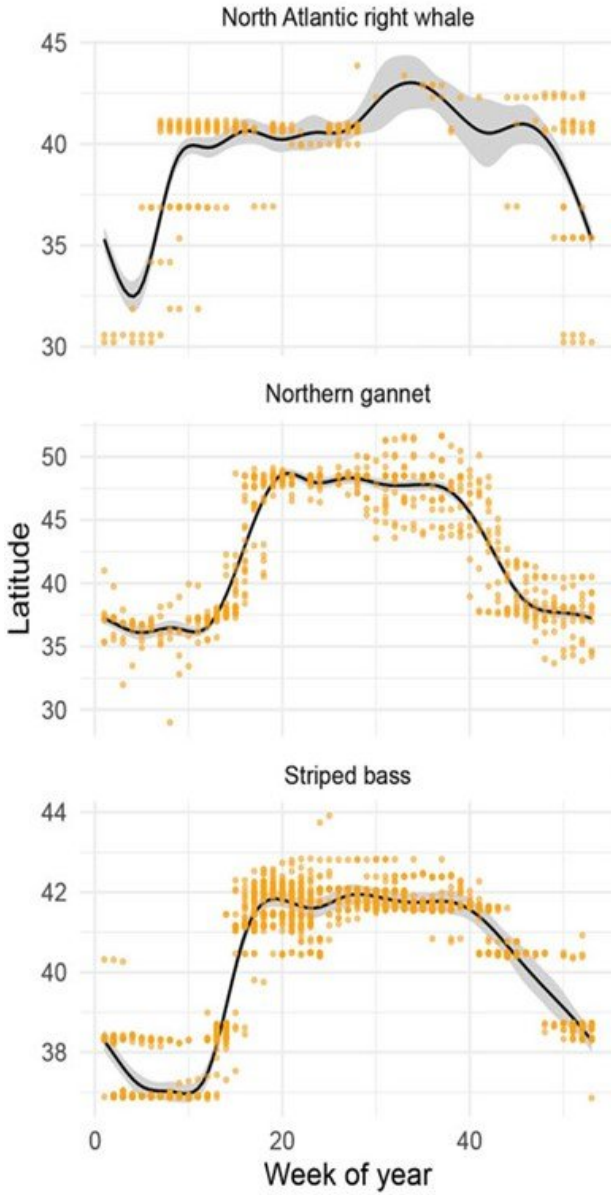
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Estimable view of fish movement

Flyway metrics



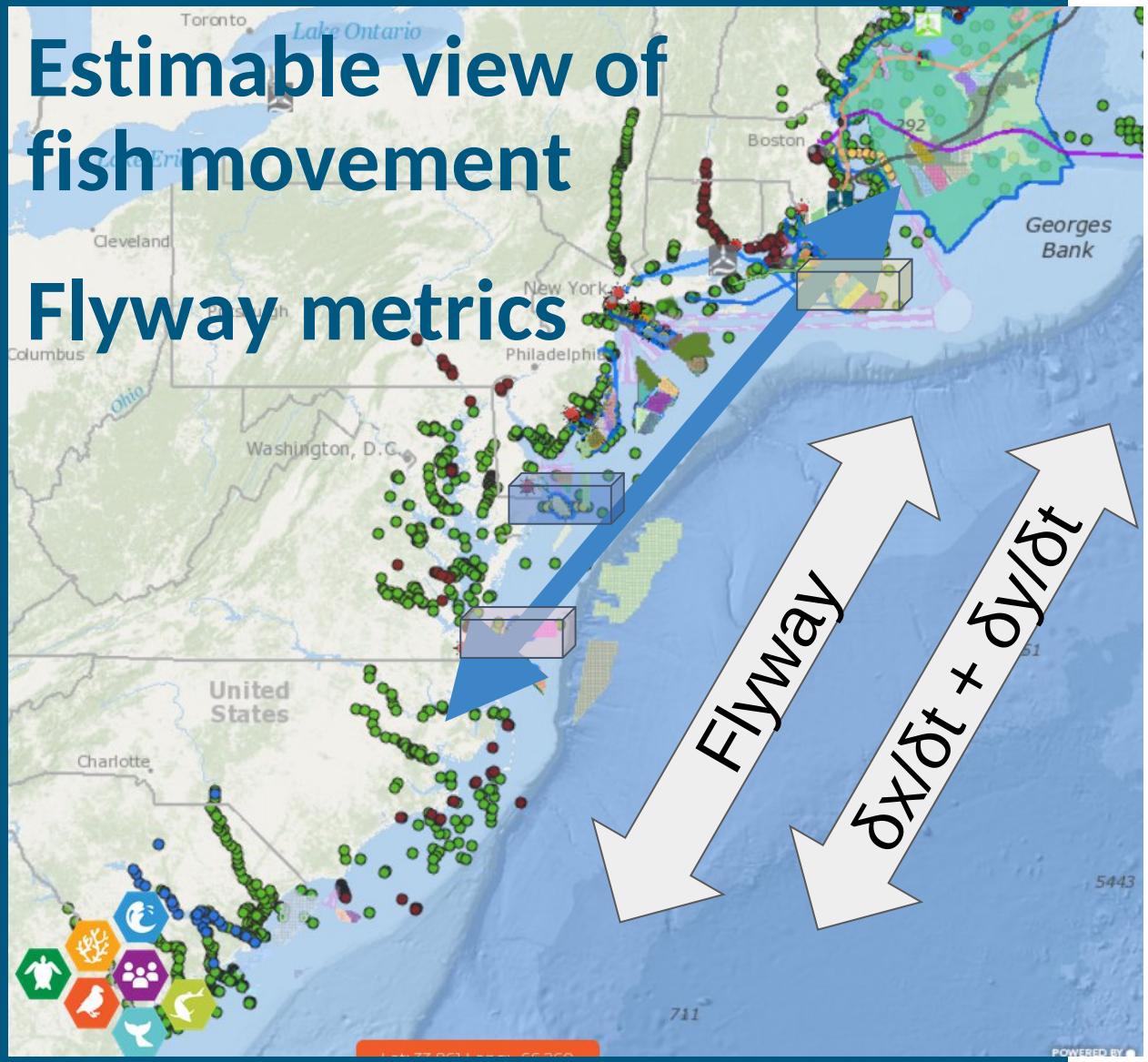


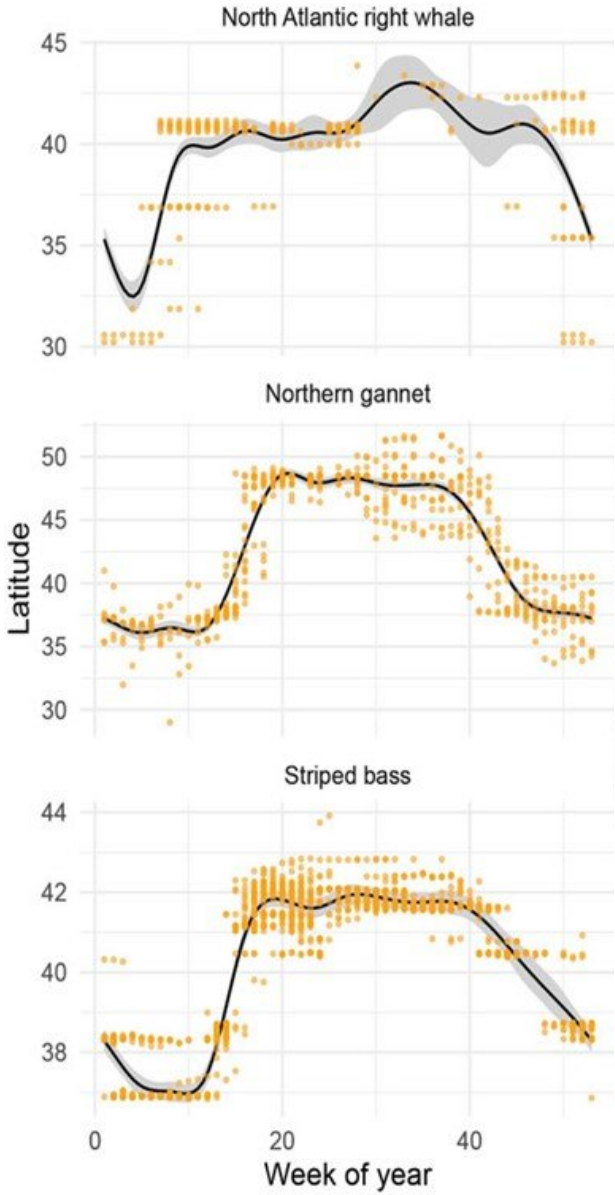
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Estimable view of fish movement

Flyway metrics



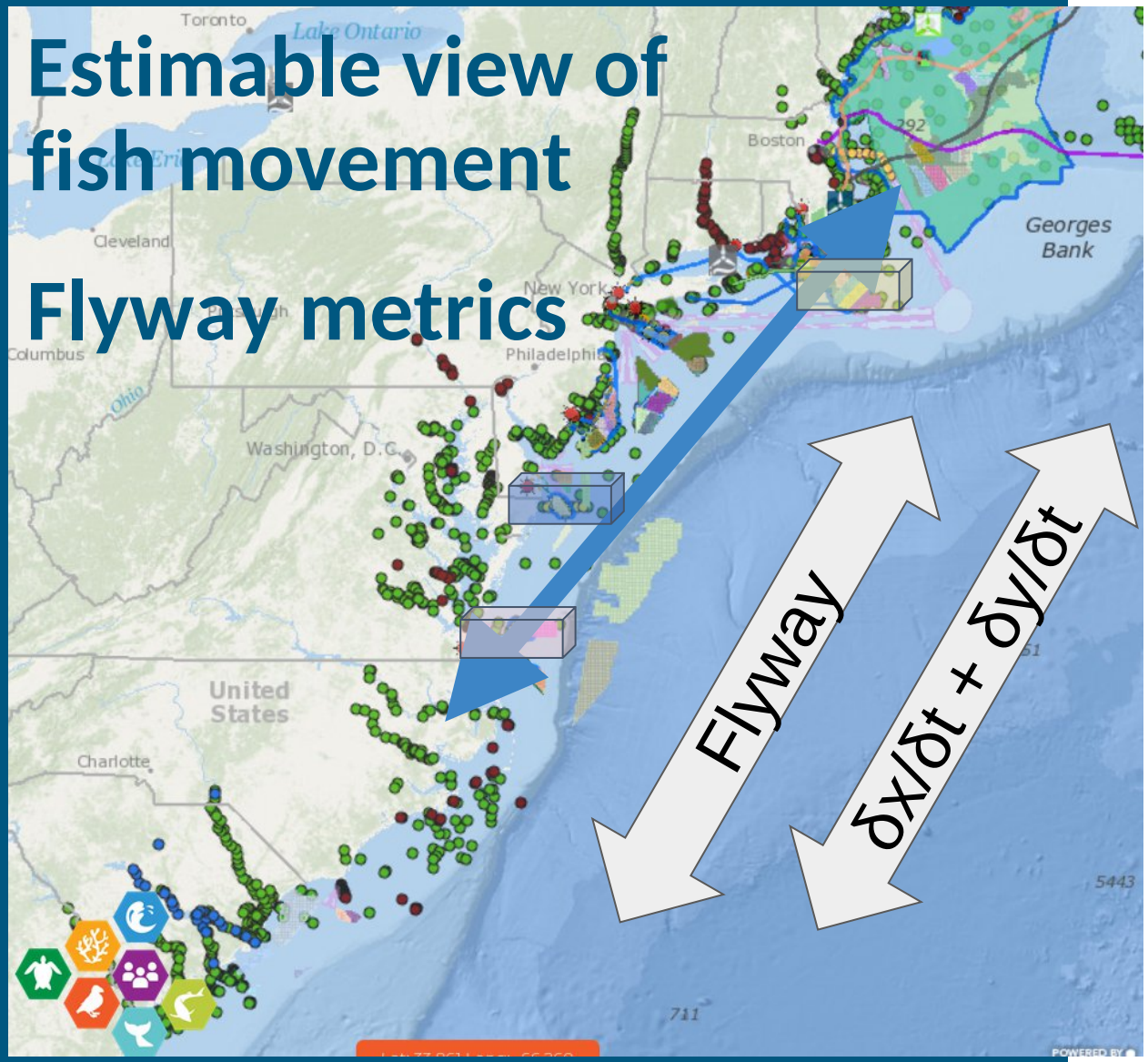


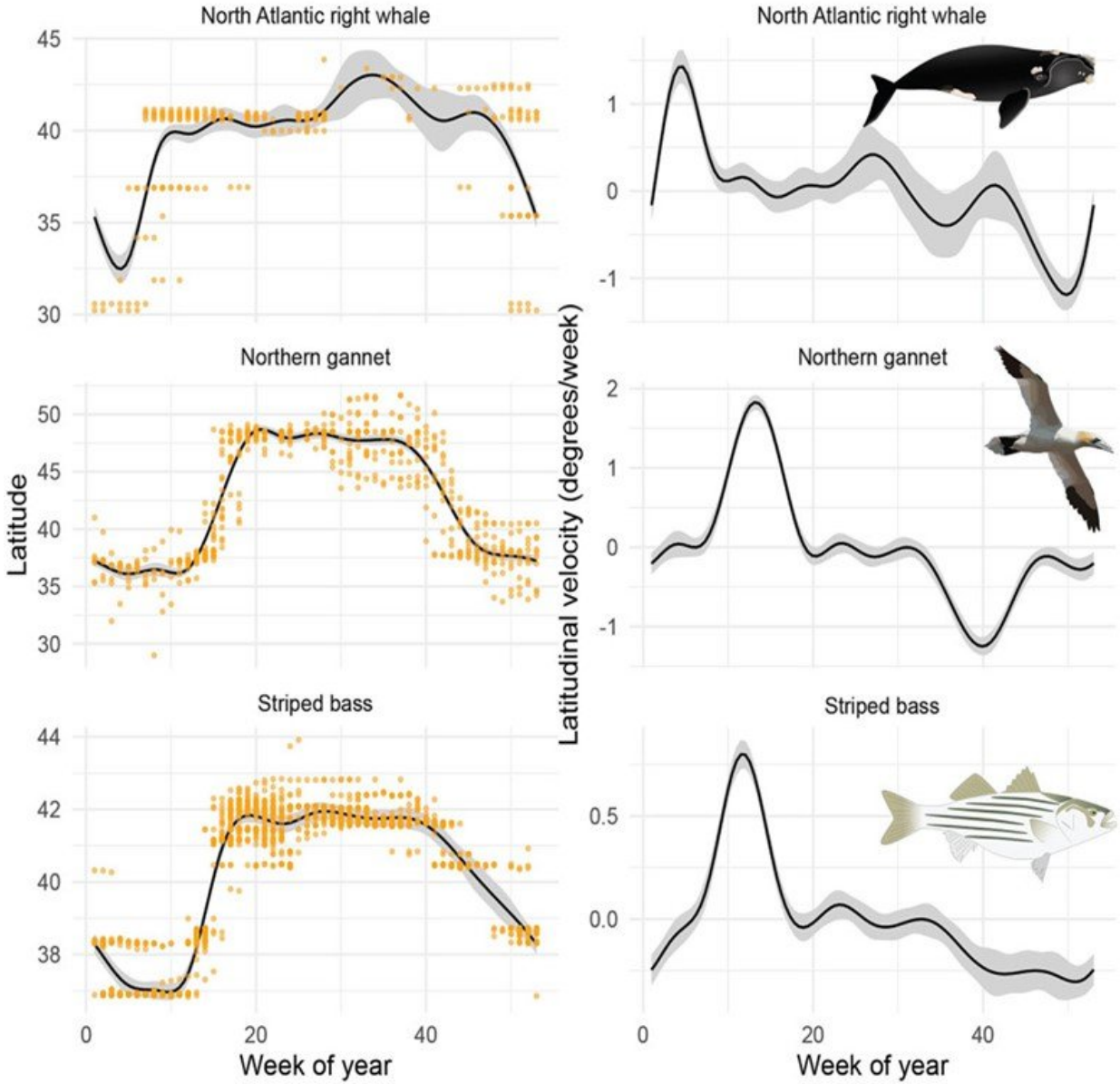
$\delta y/\delta t$ = Migration velocity

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Estimable view of fish movement

Flyway metrics

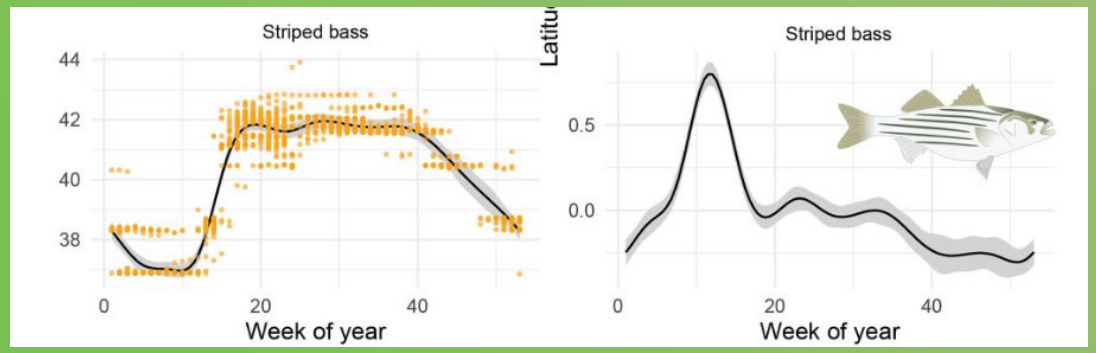


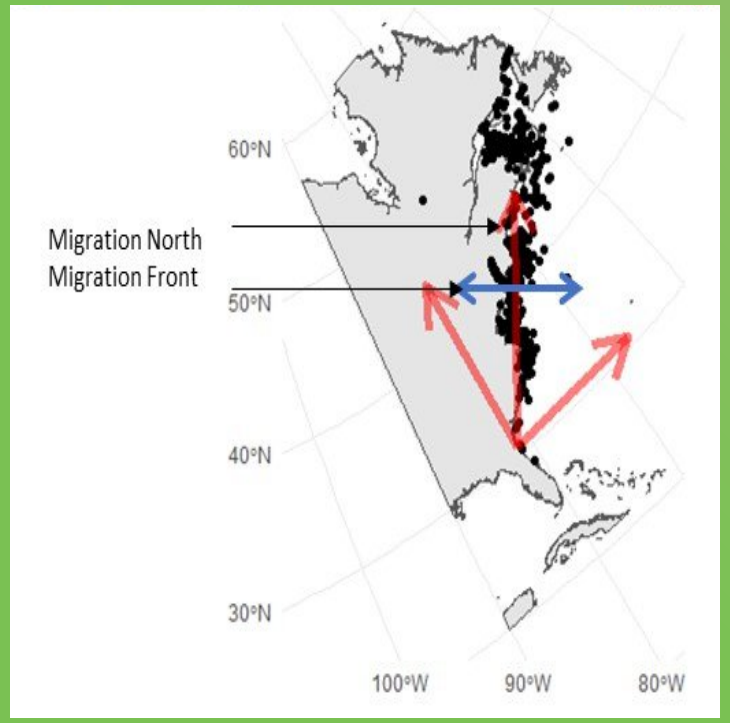


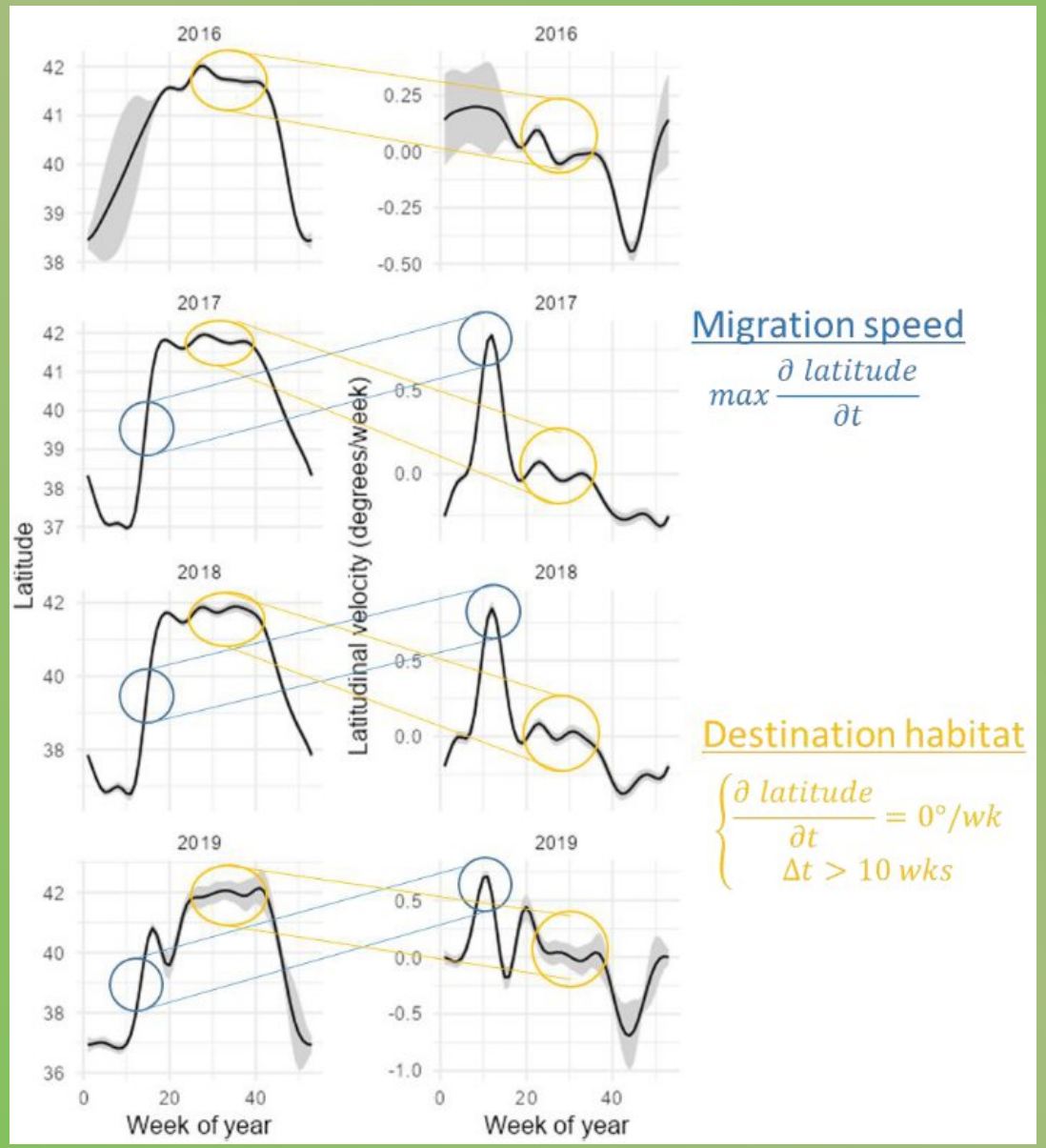
$\delta y/\delta t$ = Migration velocity

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Flyway metrics







Migration speed

$$max \frac{\partial\ latitude}{\partial t}$$

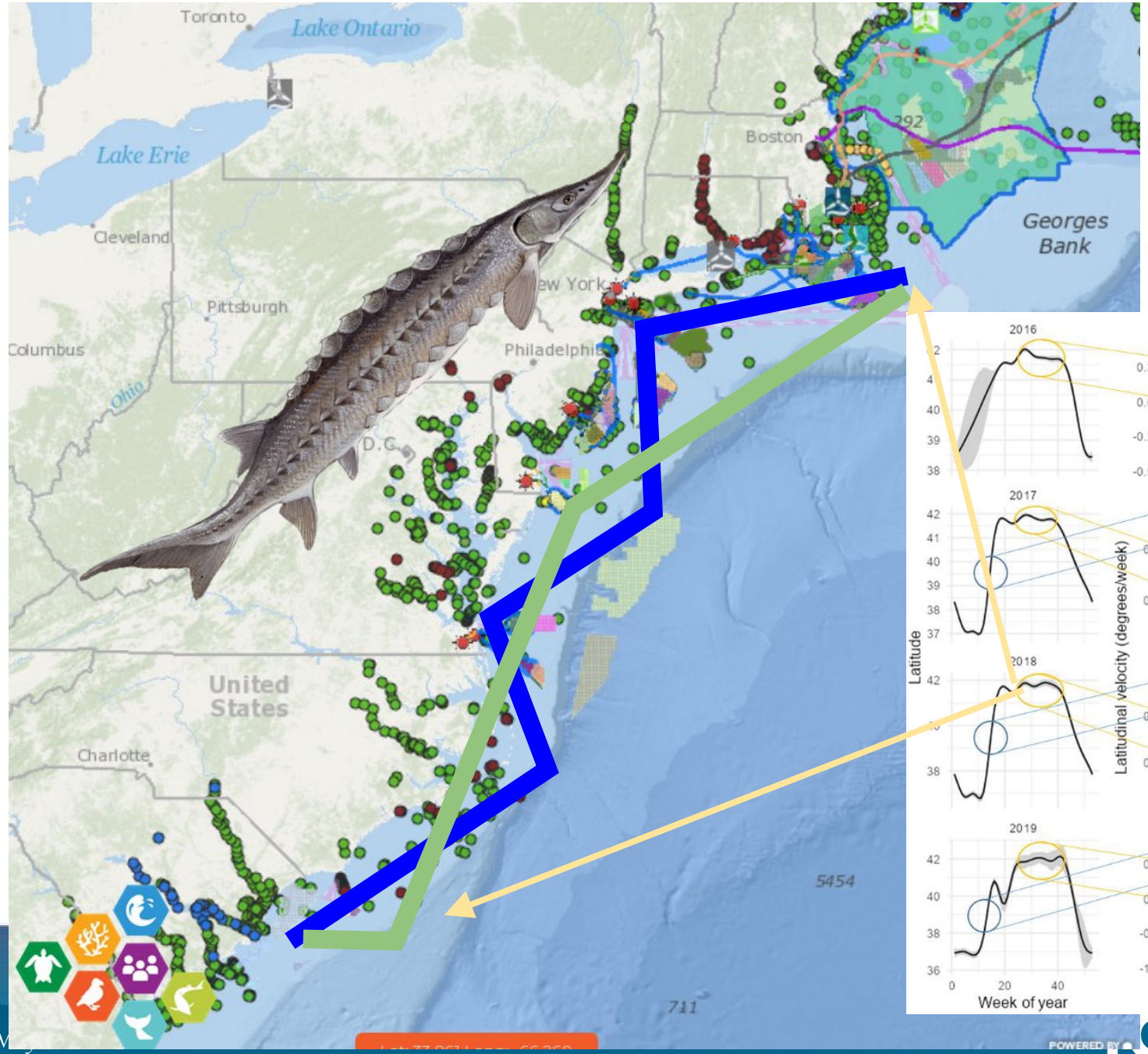
Destination habitat

$$\begin{cases} \frac{\partial\ latitude}{\partial t} = 0°/wk \\ \Delta t > 10\ wks \end{cases}$$

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Flyway metric
Flyway extent
Seasonal species distribution
Destination habitats
Hotspots, stopovers
Migration front
Migration synchrony
Migration speed
Stopover and destination habitat thresholds



Migration speed

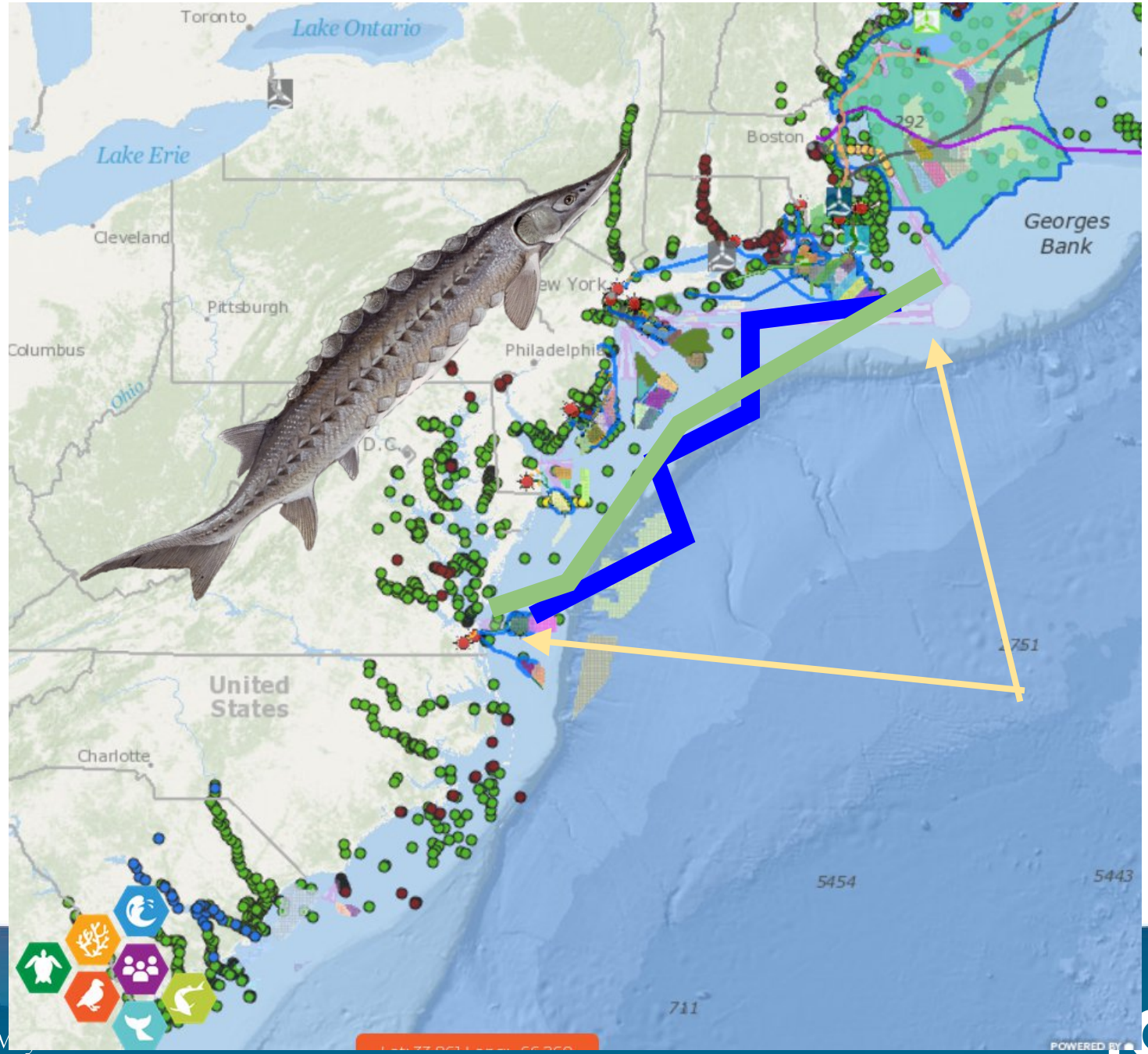
$$max \frac{\partial\ latitude}{\partial t}$$

Destination habitat

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Flyway metric
Flyway extent
Seasonal species distribution
Destination habitats
Hotspots, stopovers
Migration front
Migration synchrony
Migration speed
Stopover and destination habitat thresholds



- Flyway metrics are estimable
- Change in the flyway is estimable
- Migration impacts are estimable

- Flyways bridge gaps in acoustic arrays
- OWF backbones can make this possible

OWF backbones =/= Offshore wind



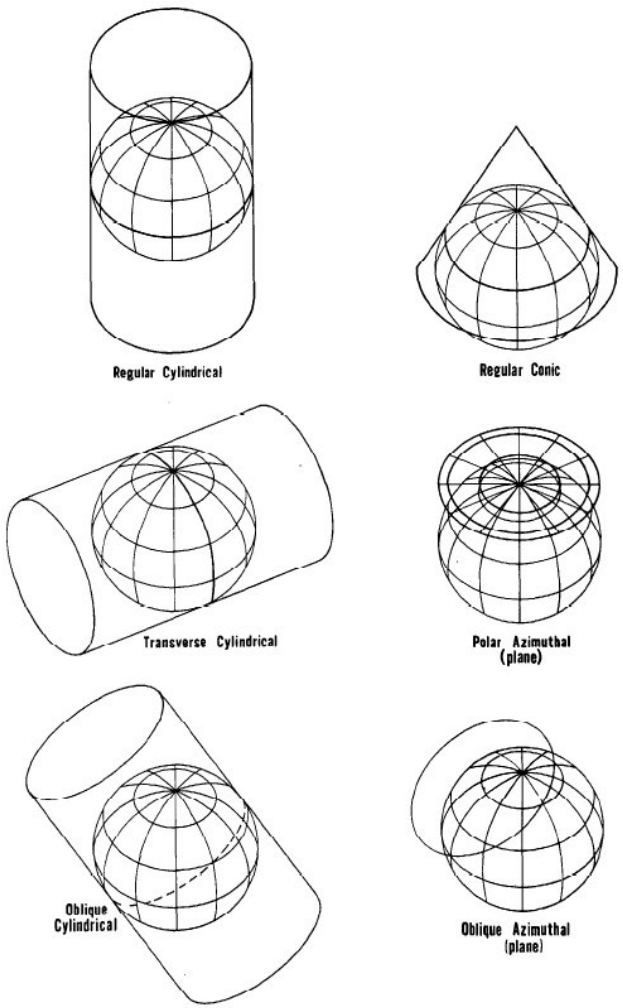


OWF backbones == YOU!

Input, permissions, etc. incoming!

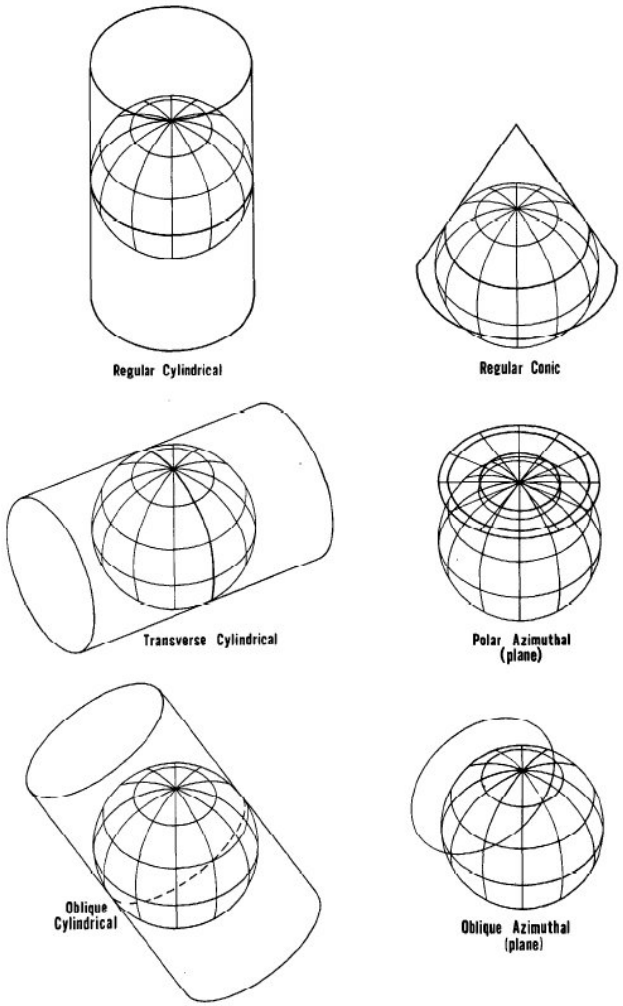
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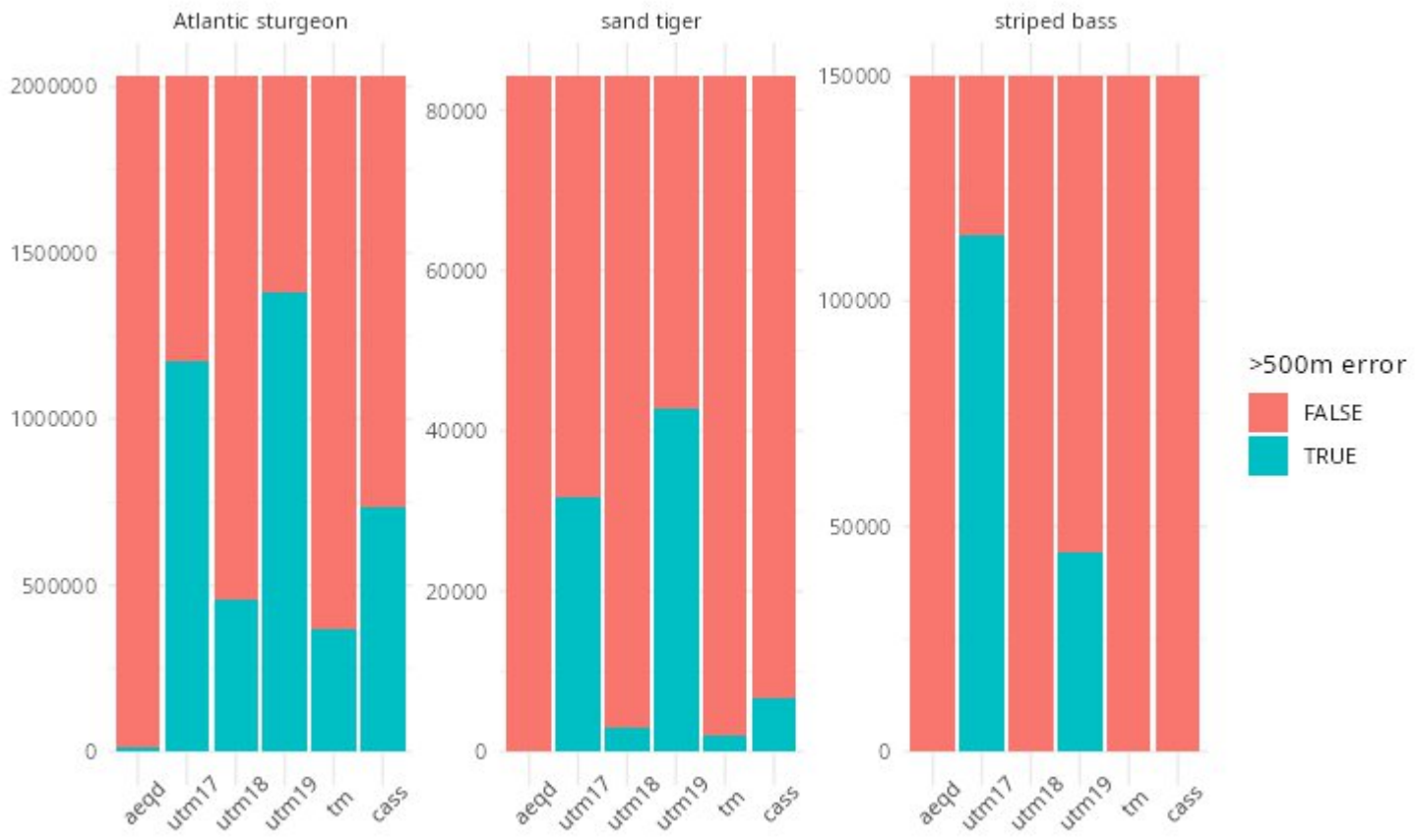
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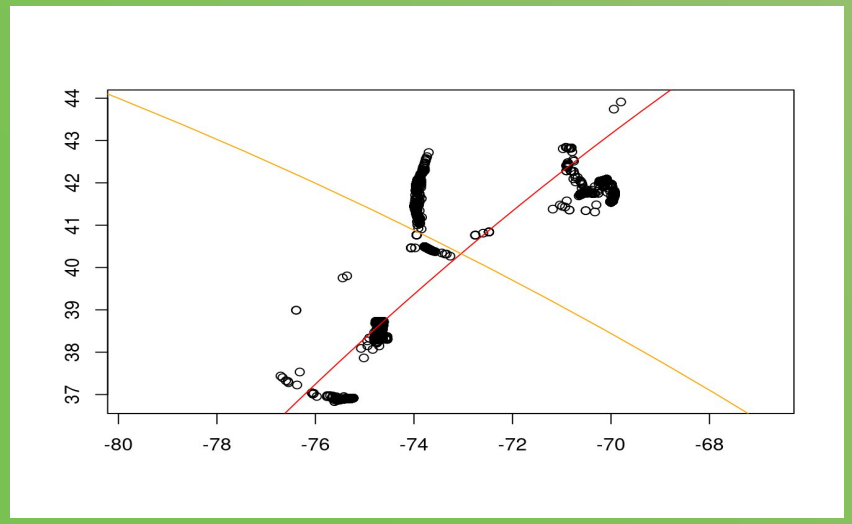


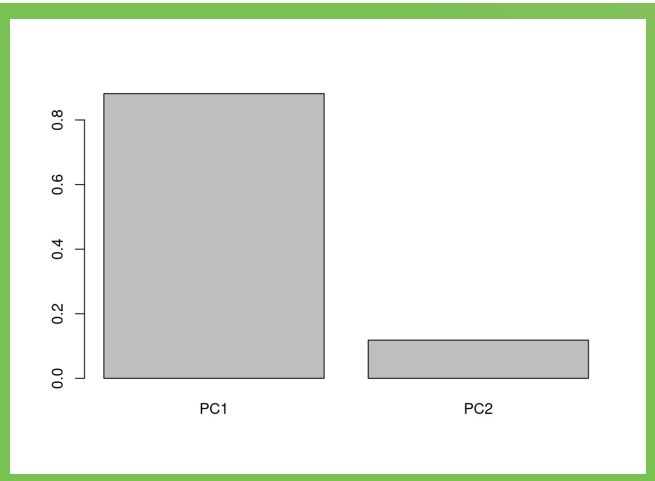


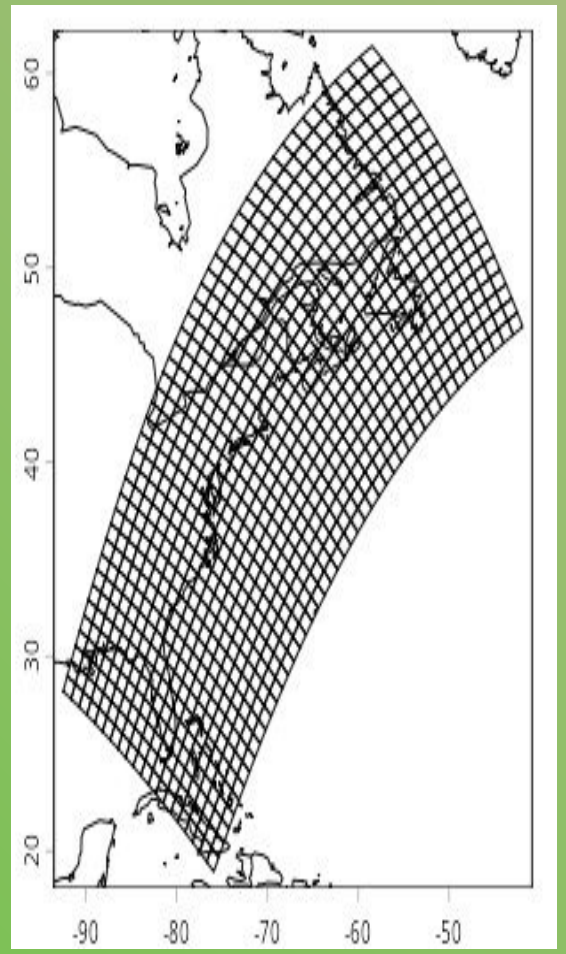
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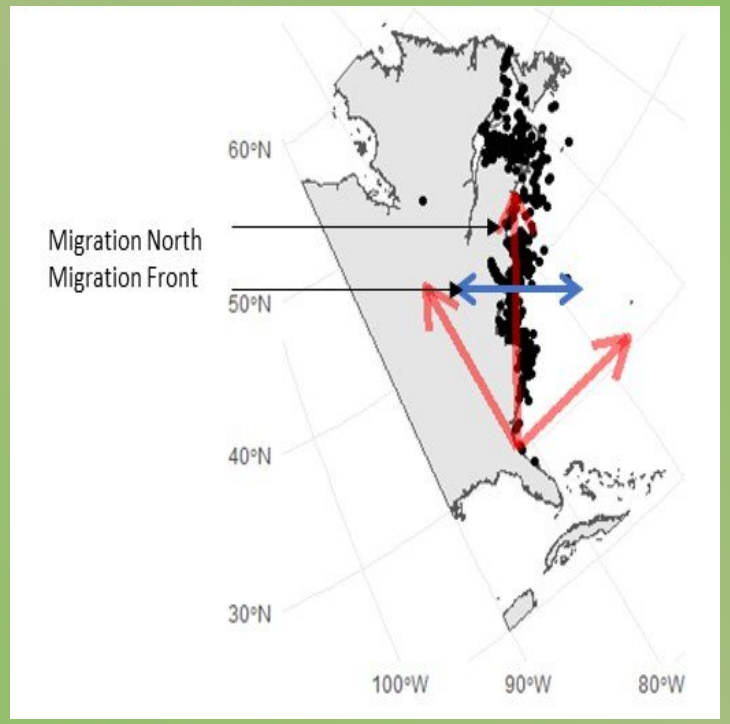
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Just getting started!









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