

Oceanic scale spawning migration pattern of the American eel

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Ocean Tracking Network

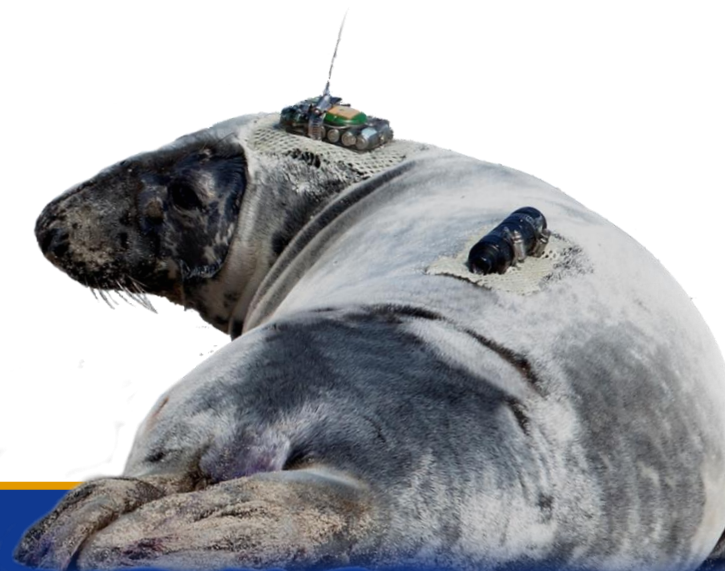
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2- Dalhousie University, Dept of Oceanography, Halifax, NS, Canada

3- Fisheries and Oceans Canada, Maurice-Lamontagne Institute, Mont-Joli, QC, Canada



The OTN: Marine technology in service to biological observation of the ocean



The Technology of Electronic Tracking

Data
loggers



Satellite
tags



Acoustic tags



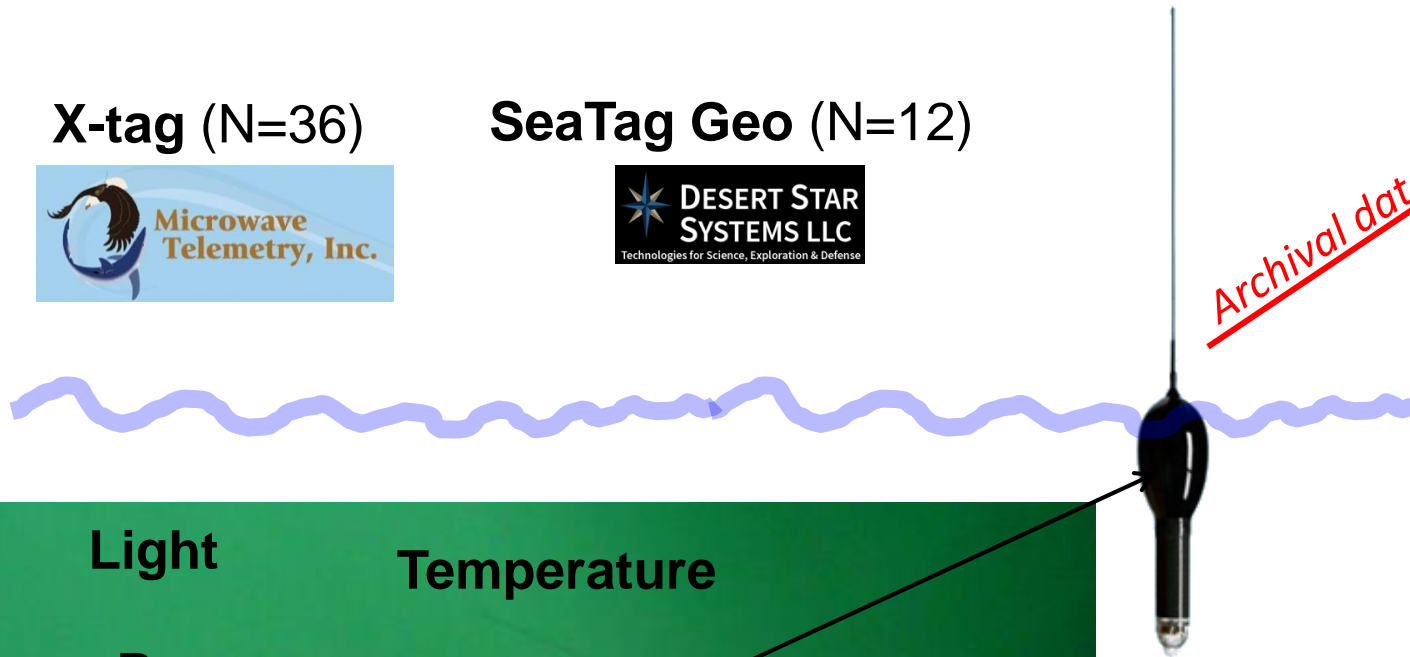
Tracking silver eels at sea

Using pop-up satellite archival tags (PSAT) coupled with Argos satellites

X-tag (N=36)



SeaTag Geo (N=12)



Archival data



Light

Temperature

Pressure
(depth)

Geomagnetic field
intensity

Inferring location from PSAT data

> Daily recorded values matched with modeled values

X-tag



SeaTag Geo



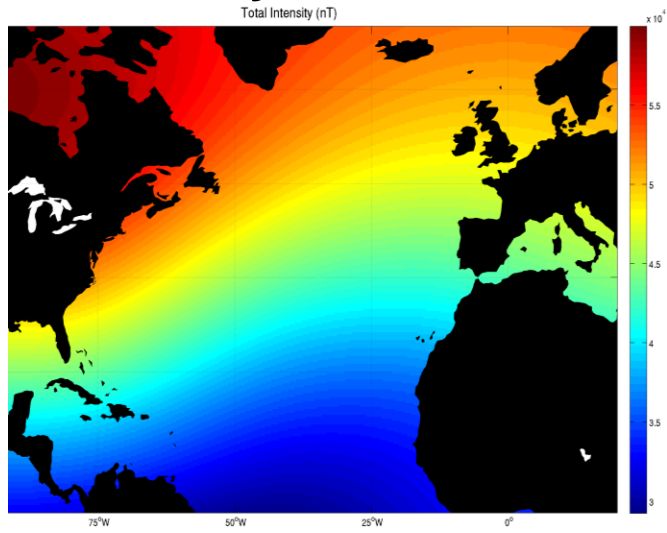
Depth



DVM: sunrise and sunset

(Westerberg et al, 2014; Chow et al, 2015)

Geomagnetic field intensity



International Geomagnetic Reference Field



OTN Theme I.1
Physical oceanography

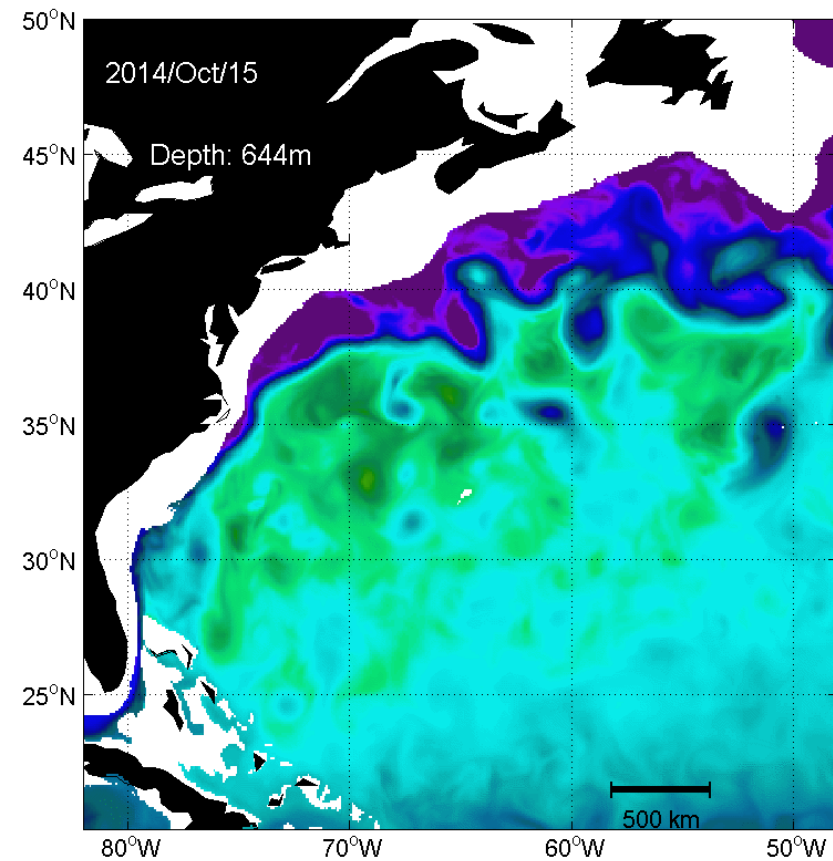
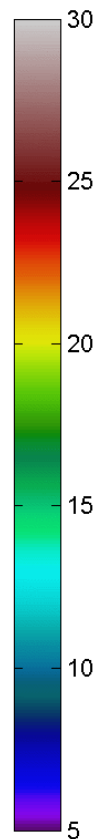
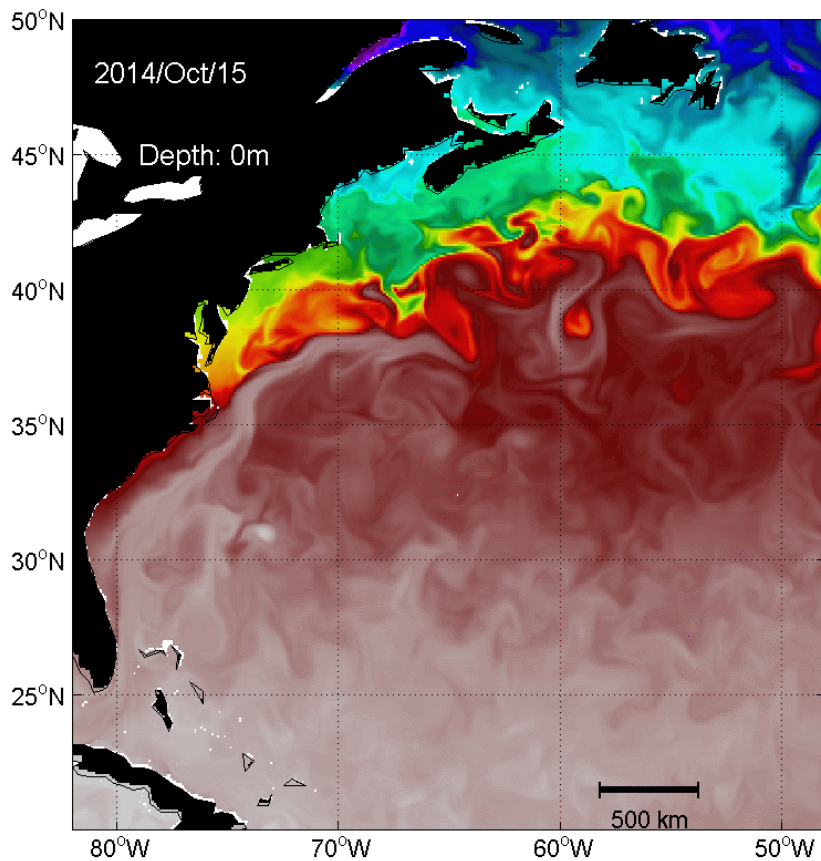
Inferring location from PSAT data

Temperature field from NEMO

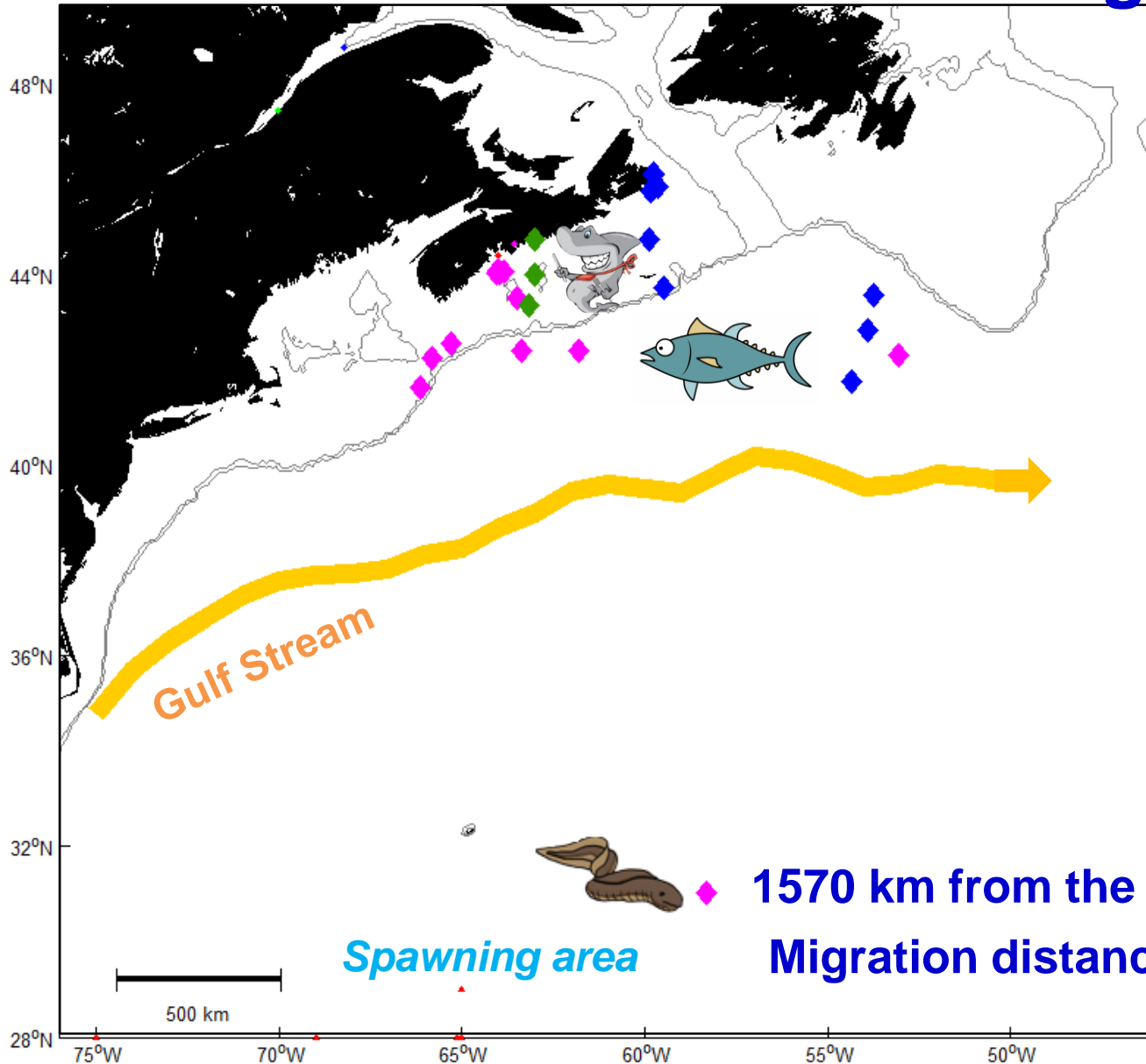
(Nucleus for European Modelling of the Ocean)

Surface

~ 650 m



First direct evidence of migration to the Sargasso Sea !



20 eels
8 beyond the
continental shelf

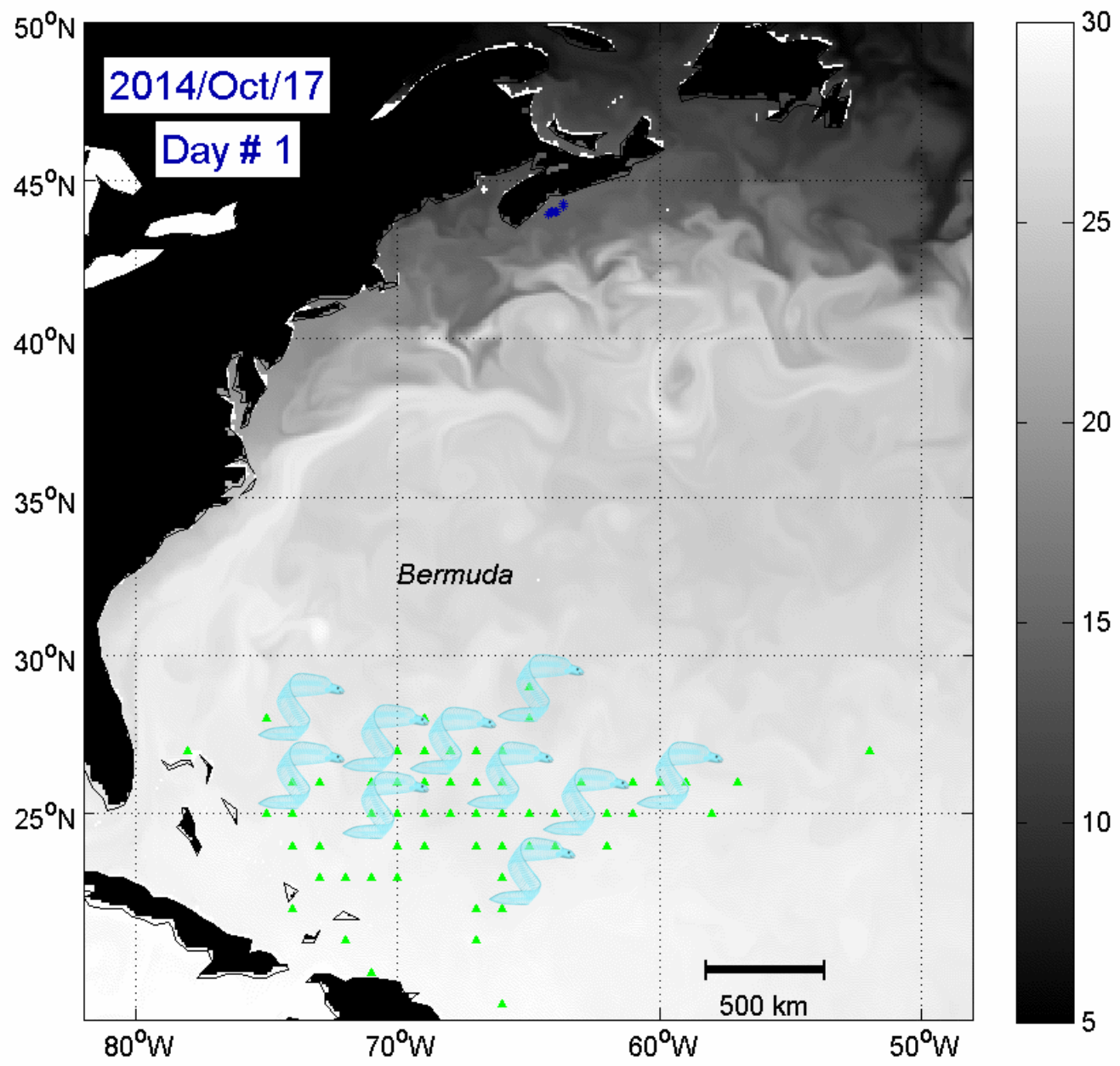
428 days of activity

2 predated

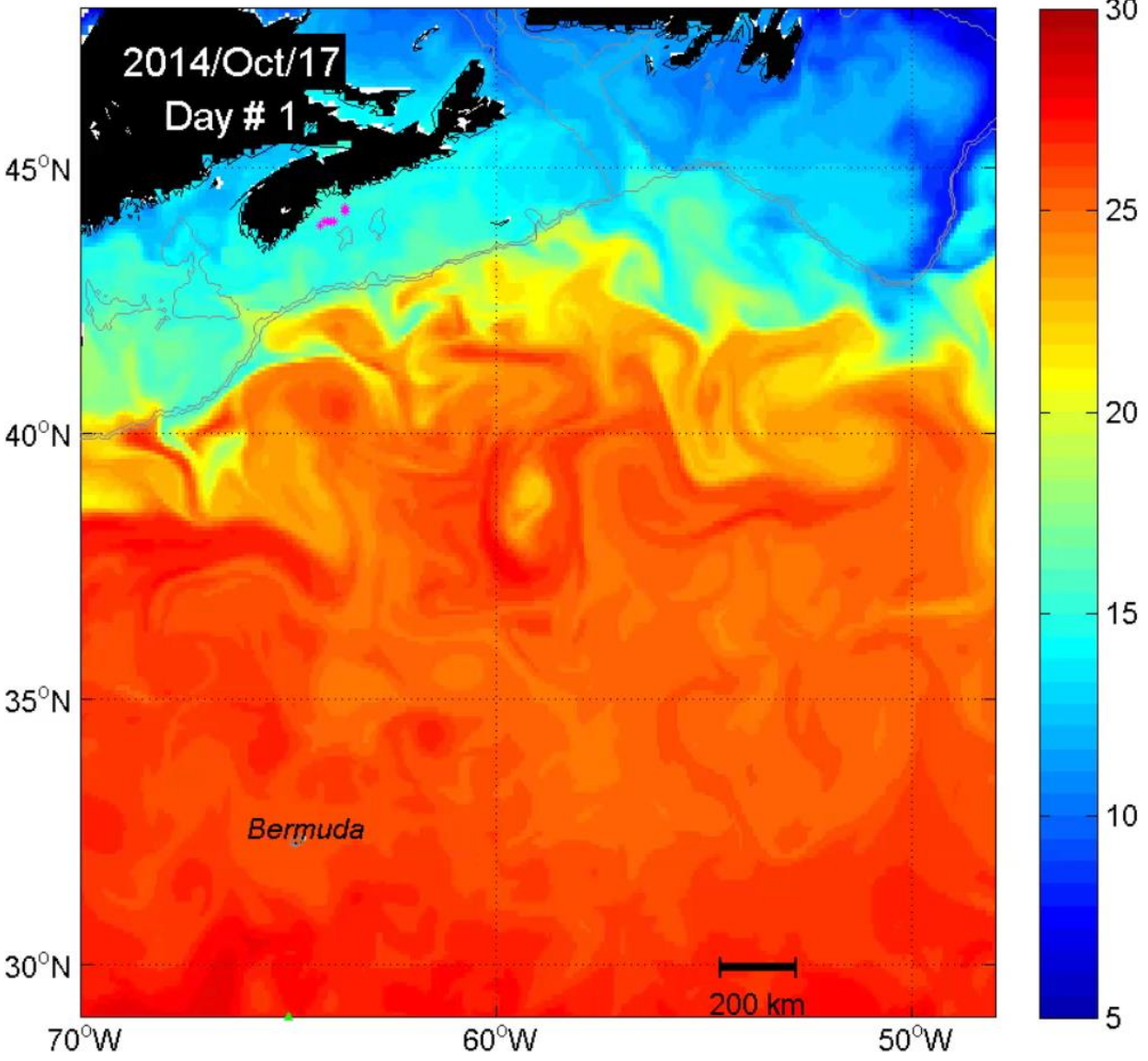
◆ 1570 km from the release site!

Migration distance ~ 2400 km

Late 2014...



Migration in two phases



≠ years, ≠ locations,
≠ eel origins
BUT
similar paths and
vertical behaviors

Continental shelf:
Shallow waters,
Erratic dives

Open Ocean (S>35):
Deeper waters
DVM
Constant heading

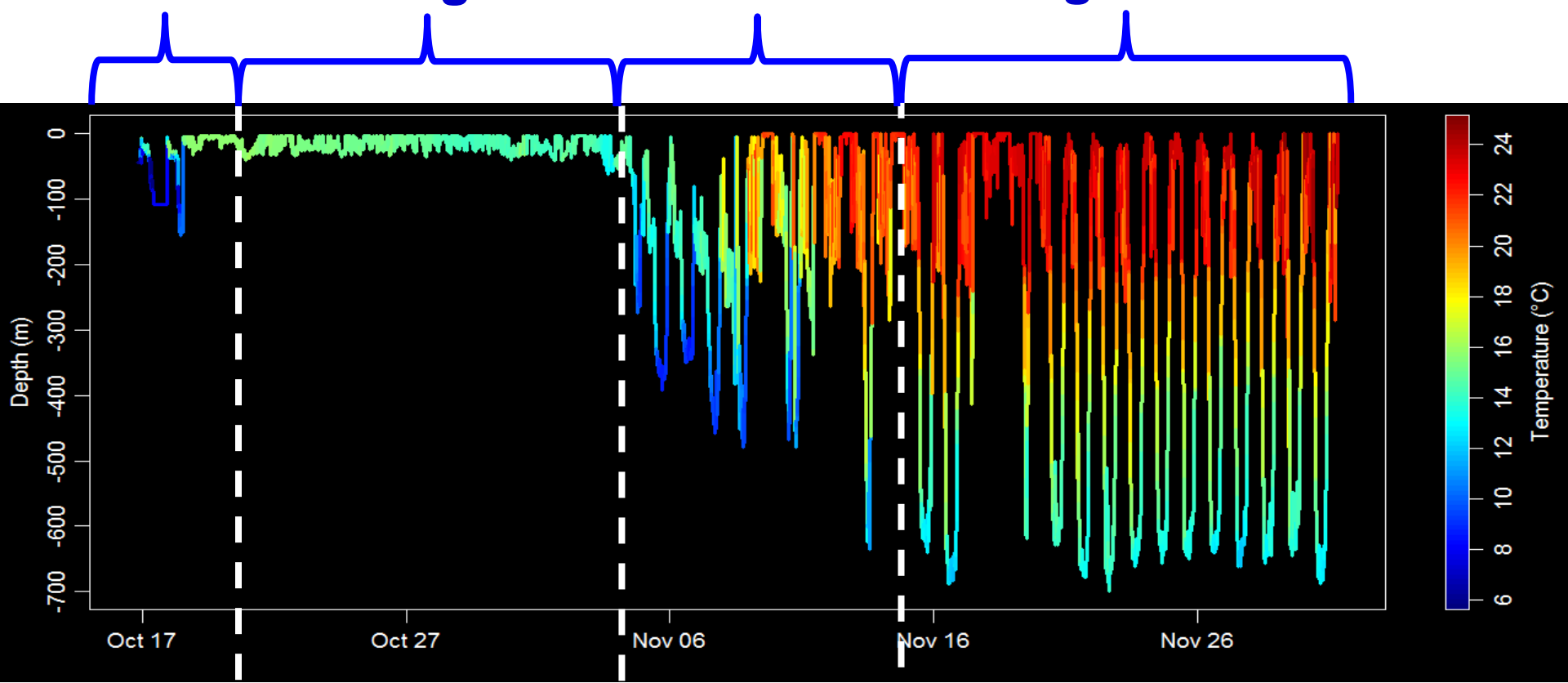
Diel vertical migrations: variable

Scotian Shelf

Edge

Gulf Stream

Sargasso Sea



Using a biophysical particle-tracking model

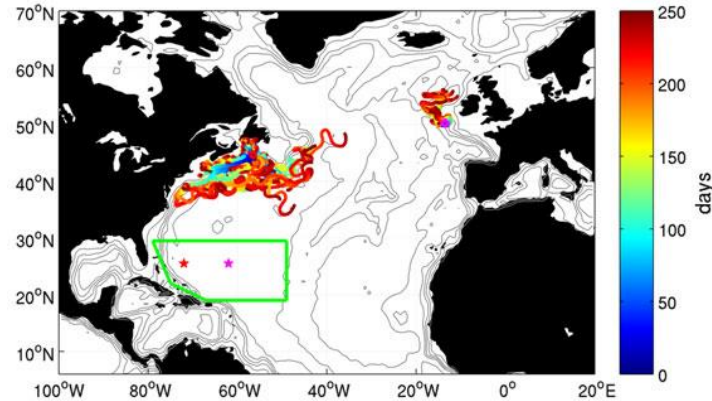
Objectives: testing two orientation behaviours (true navigation, compass orientation toward south) and various swimming speeds to determine which ones match the observed paths.

Simulations using a biophysical tracking model and NEMO suggest that the Sargasso Sea spawning area can be reached in time by constantly swimming and following a readjusted heading (true navigation) or a constant heading (compass orientation) even at the lowest swimming speed tested (0.2 m s^{-1}) for most virtual eels. True navigation might not be necessary to reach the spawning area.

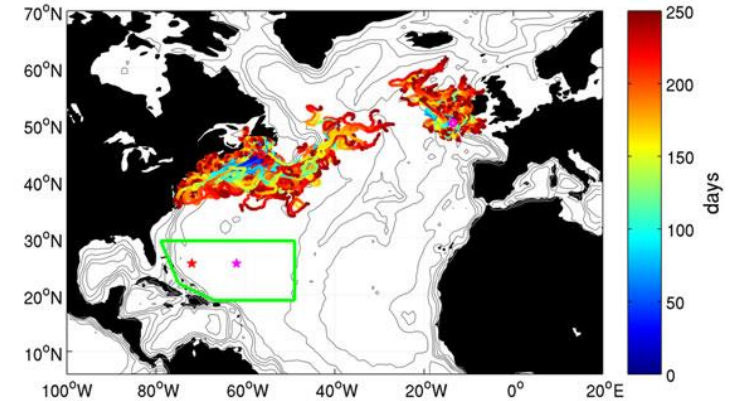
Béguer-Pon, M., Shan, S., Thompson, K.R., Castonguay, M., Sheng, J., and Dodson, J.J. 2016. Exploring the role of the physical marine environment in silver eel migrations using a biophysical particle tracking model. ICES J. Mar. Sci. 73: 57-74.

Examples of particle tracking experiments

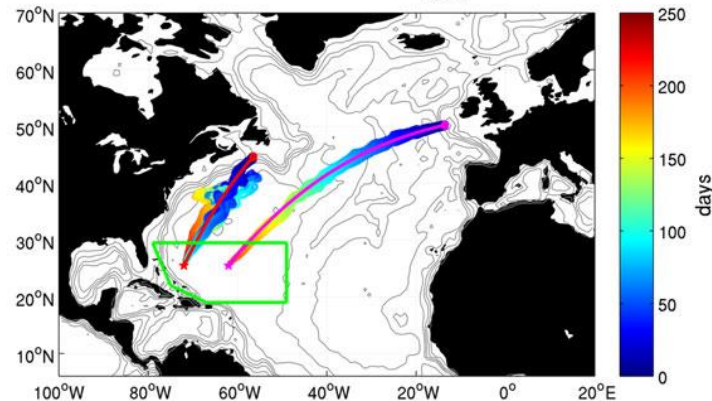
(a) Passive drift ($\text{Exp}_{\text{Drift}}$)



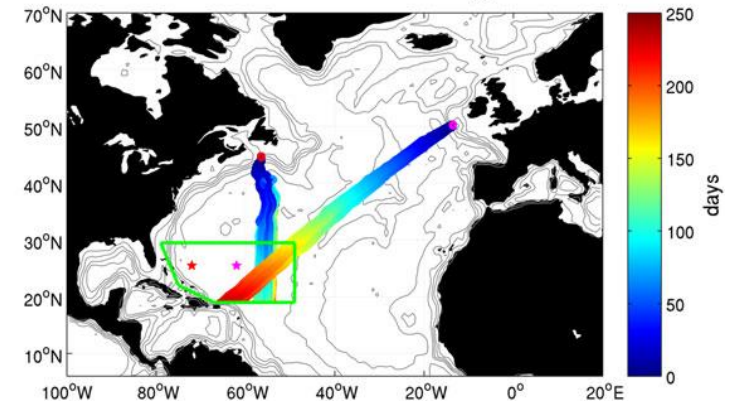
(b) Random direction (Exp_{Rand})



(c) True navigation (Exp_{Navi})



(d) Compass orientation (Exp_{Ori})



Oceanic biology of eel larvae in the Sargasso Sea

- I participated in 5 oceanographic cruises in the Sargasso Sea on oceanic biology of eel larvae: Feb 83, Apr 83, Aug 84, Oct 84, Mar 85 in Jim McCleave's lab at U. Maine
 - **Our group discovered that American & European eels spawn south of thermal fronts (associated with the subtropical convergence) that extend W→E for 100s km in Spring in the Sargasso**
- I participated in 2 more cruises in Mar 07 (Denemark) and Mar 11 (Germany)

Summary

Tracking silver eels at sea is challenging BUT POSSIBLE



First direct evidence of eels migrating to the Sargasso Sea

Migration in two phases suggested, with \neq orientation mechanisms

Béguer-Pon, M., Castonguay, M., Shan, S., Benchetrit, J., and Dodson, J.J. 2015. Direct observations of American eels migrating across the continental shelf to the Sargasso Sea. Nature Communications DOI: [10.1038/ncomms9705](https://doi.org/10.1038/ncomms9705).



The future

- Optimizing and integrating new ocean observation with existing infrastructure
- New tag sensors to answer new tag questions
- Fusing with other technology to provide new insights (genomics, physiology, epidemiology)

The southern Sargasso Sea

