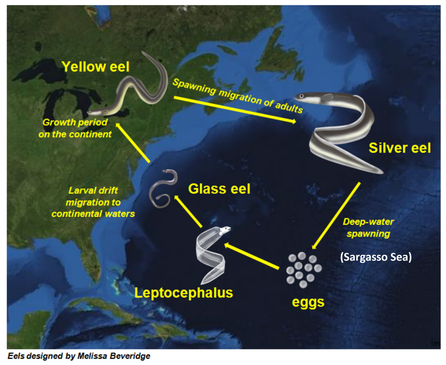
The Challenge of tracking Eels during their marine migration



Life Cycle of American Eel

OTN Project I.2.2

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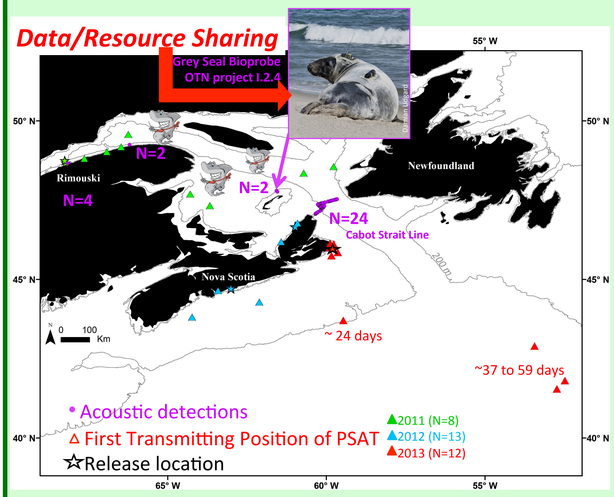
Facts

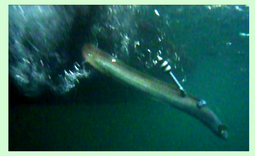
Eels (anguillid species) are in a precarious situation worldwide (American eel is a THREATENED species in Canada - COSEWIC, 2012)
They are socio-economically important (freshwater fisheries)
The marine migration of adult eels (from continental waters to the Sargasso Sea) remains a complete mystery, even after over a century of research

Tracking movements of eels in the field

Using Passive Acoustic Tracking and Pop-up Satellite Archival Tags (PSAT)



X-tag (Microwave Telemetry, N=23)



SeaTag Geo (Desert Star Company, N=10)

- Low acoustic detection rate at the exit of the Gulf (24/328)
- All PSAT popped up prematurely
- High predation rate by homeothermic fishes in the Gulf
- 30 % of the PSAT disappeared (10/33)
- Eels avoid the euphotic zone during daytime preventing tags from recording any light data (so no light–based geolocation method to infer their trajectories)

Insights into eels migratory behaviour obtained from our field efforts:
In the Gulf: duration of migration ~14 to 67 days, eels remain in the deep Laurentian Channel and do marked diel vertical migration. Also no apparent use of tidal transport at Cabot Strait.
In the Open Ocean: they do not seem to follow the coasts but go directly south

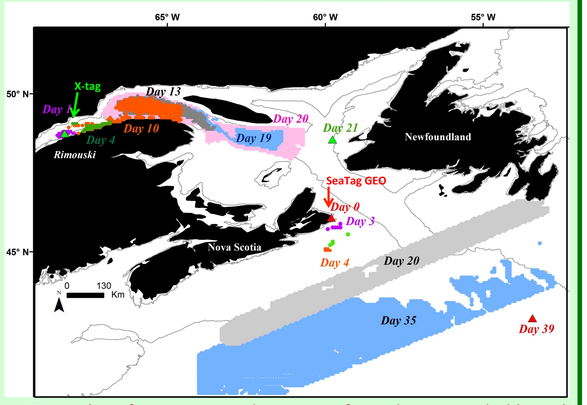
Geolocation using environmental data and hypotheses

Environmental data recorded by PSAT:
- Temperature
- Pressure (X-tag only)
- Geomagnetic field total intensity (SeaTag GEO only)

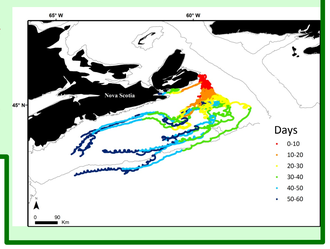
These values are matched with:
-Hourly outputs of the physical model Dalcoast in the Gulf (K. Oshahi) (temp & depth)
-Daily Assimilated values from HYCOM (temp & depth)
-Modeled value of Geomagnetic field from IRGF

Additional constraints: maximum distance based on maximum daily migration speed

Issues with the SeaTags GEO:
- Low transmission rate of sensor data (~30%)
- Geomagnetic field values not well-calibrated and sometimes unrealistic



Examples of reconstructed positions from data recorded by eels equipped with PSAT (X-tag in the Gulf; SeaTag GEO off NS)



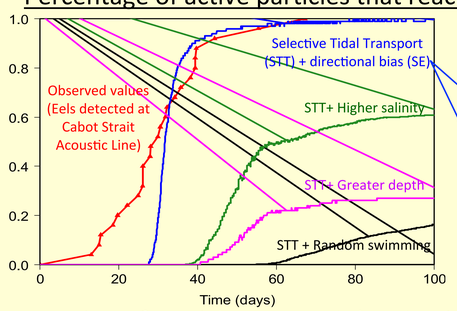
Simulated trajectories of randomly selected passive particles released off Cape Breton in October

Collaborative work and data sharing with OTN Theme I.1
Physical model outputs
Programming skills

Simulating the migration using 2 coupled biophysical particle-tracking models

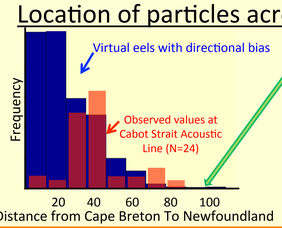
Gulf: the physical model **Dalcoast** is used

Percentage of active particles that reached the Cabot Strait



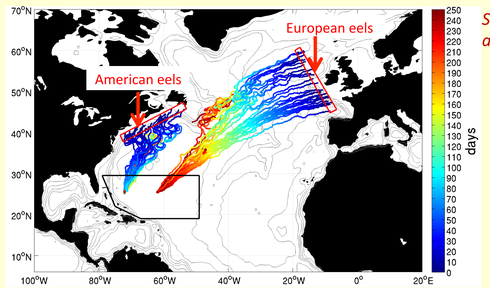
Simulated behaviour that best matches with the observed duration of migration in the Gulf

Location of particles across Cabot Strait



The absence of acoustic detection at the Northeastern part of the Cabot Strait may reflect an absence of migrating eels

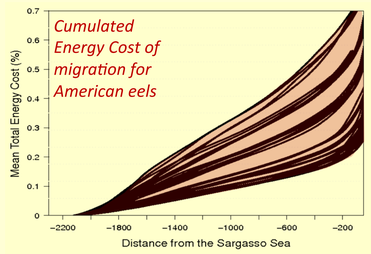
Open Ocean: the physical model **NEMO** is used



Simulated trajectories of eels swimming at a speed of 0.5 BL.s^{-1} and with a true navigation behaviour ability (moderate)

In the case of a strong navigation ability, the first smallest eels released off North America would arrive 32 days later on average than the first largest eels.

Energy would not be a limiting factor



Both models suggest that a strong orientation ability is necessary for eels to reach their goal within the observed timing window (particularly for European eels in the Open Ocean). Environmental cues (salinity, bathymetry, currents) would not be sufficient cues for orientation in the Gulf of St. Lawrence.

What's next?

Field tagging next fall (Nova Scotia)
Modelling eel migration off Cape Breton

Implications for natural resource management and policy

Refining the location of the spawning site will help in creating and defining a **High-sea Marine protected area** on the Sargasso Sea

Establishing the environmental conditions eels experienced during their maturation/migration will provide **essential information for aquaculture**

Knowning the routes eels take and which cues they use will allow us to simulate migratory routes under various climate change scenarios

The migration model can be used as a tool for assessing various management issues (e.g. stocking program)

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