Project 4.5: Oceanic migration of the threatened American eel to spawning grounds in the Sargasso Sea

PI: Julian Dodson and Martin Castonguay
R.A.: Mélanie Béguer-Pon
Master student: José Benchetrit
Collaborators: Shiliang Shan, Kyoko Ohashi, Jinyu Sheng, Keith Thompson
Guy Verreault, David Stanley

OCEAN TRACKING NETWORK

ONTARIO POWER GENERATION | Fisheries and Ocean Canada | Forêts, Faune et Parcs AECOM Québec | UNIVERSITÉ LAVAL | DALHOUSIE UNIVERSITY Inspiring Minds | SSHRC CRSH | NSERC CRSNG

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The American eel: a threatened enigmatic species

Panmictic population

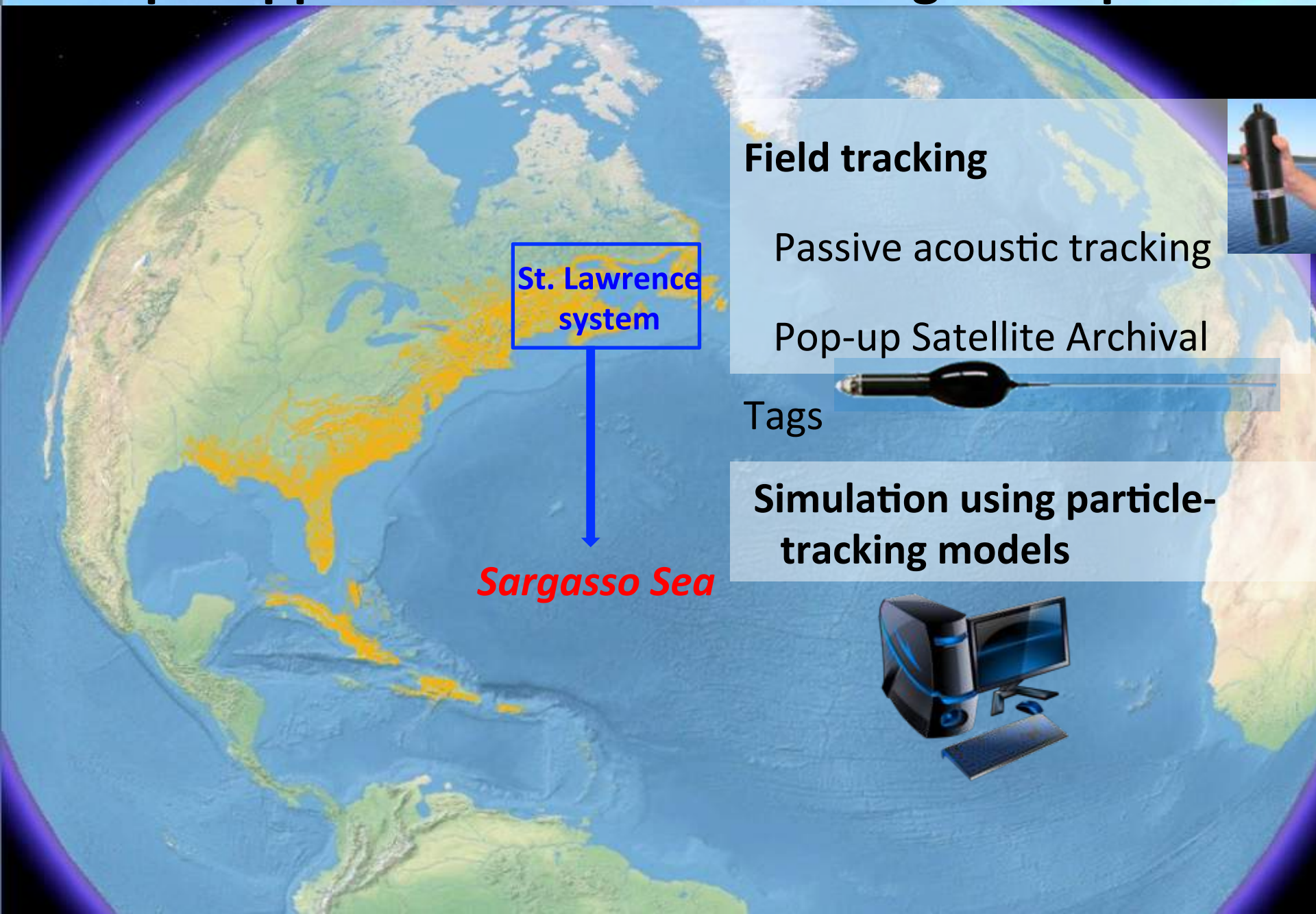
Endangered (IUCN red list)
Threatened in Canada (COSEWIC, 2012)

Complex life cycle

Spawning migration largely unknown

Escapement rate
Exact location
Migration routes
Environmental conditions/cues
Vertical behaviour
Swimming speed

Multiple approaches to reveal the migration pattern



Field tracking

Passive acoustic tracking

Pop-up Satellite Archival Tags

Simulation using particle-tracking models

Many partners and collaborators

- **Ministère des Forêts, de la Faune et des Parcs** (Quebec)

(D. Hatin, G. Verreault, M. Legault, Y. Mailhot)

- **AECOM** (V. Tremblay)
- **Ontario Power Generation** (D. Stanley)
- **Fishermen**: H. Hawkins, D. Larade, G. MacKay and C. McNeil,

G-H Lizotte

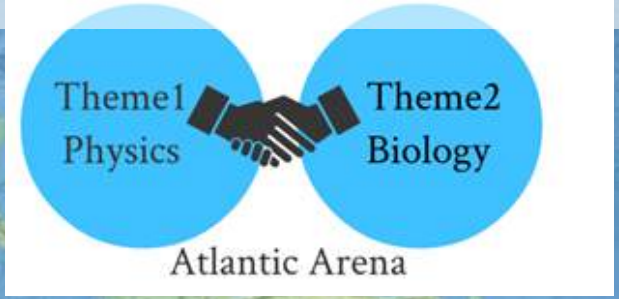
- Lucia Abellan

Field tracking

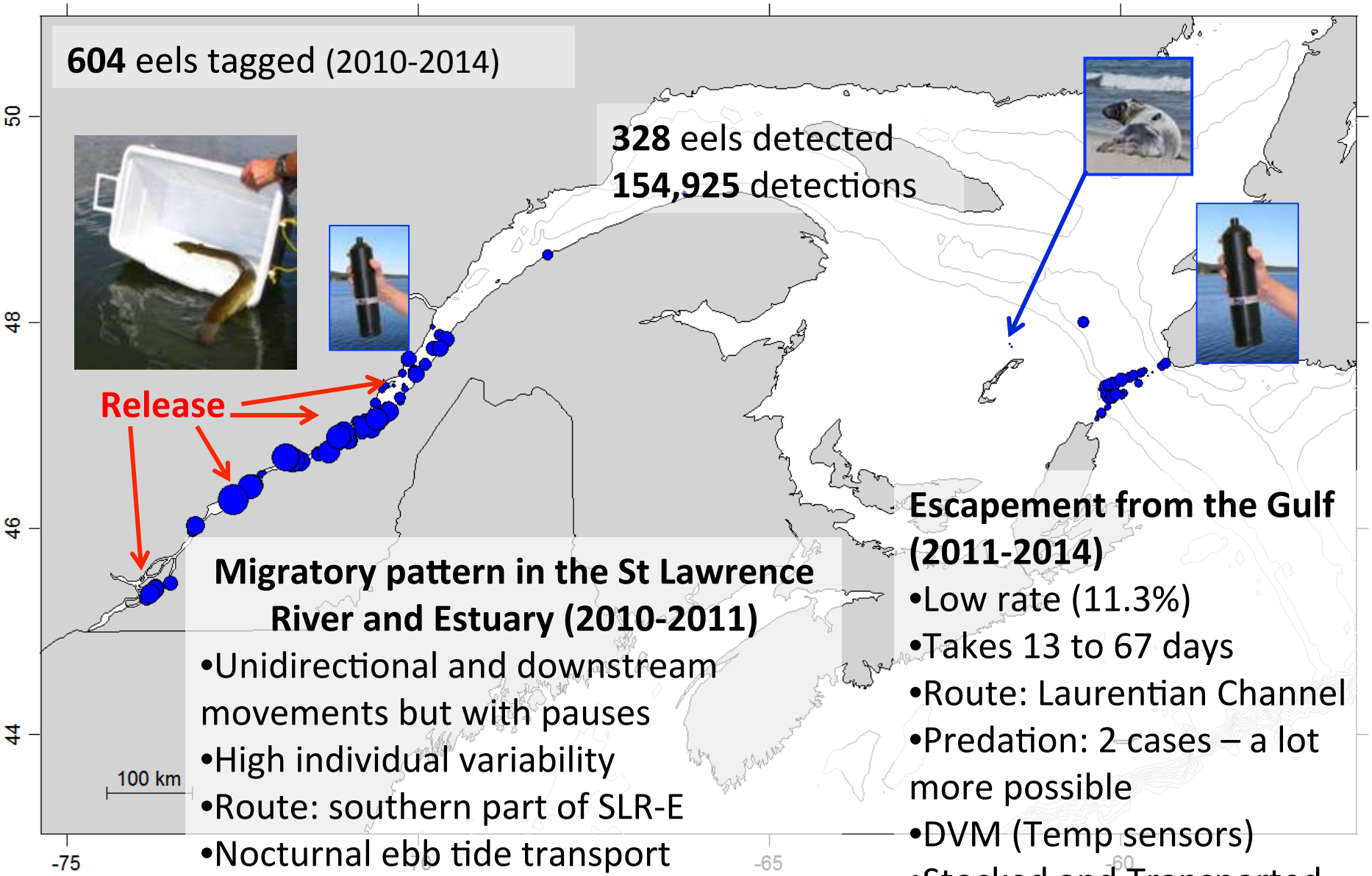
- **Dept of Oceanography, Dalhousie University**

K. Ohashi, S. Shan, K. Thompson and J. Sheng

Modelling



Acoustic tracking in the St. Lawrence system



Migratory pattern in the St Lawrence River and Estuary (2010-2011)

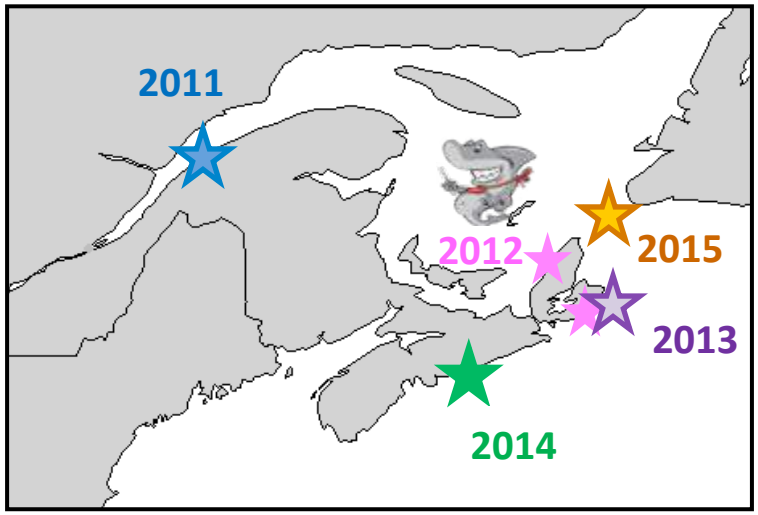
- Unidirectional and downstream movements but with pauses
- High individual variability
- Route: southern part of SLR-E
- Nocturnal ebb tide transport

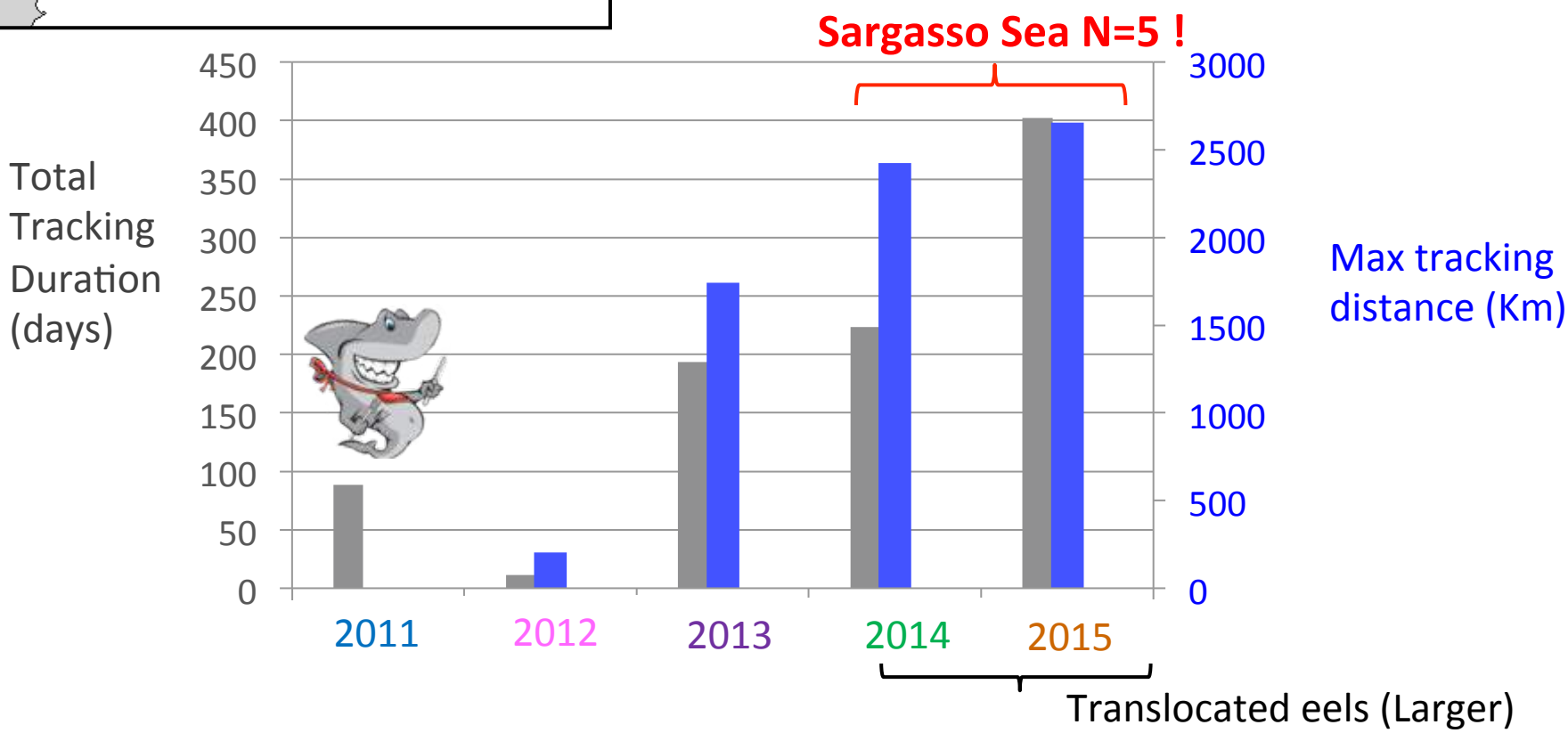
Escapement from the Gulf (2011-2014)

- Low rate (11.3%)
- Takes 13 to 67 days
- Route: Laurentian Channel
- Predation: 2 cases – a lot more possible
- DVM (Temp sensors)
- Stocked and Transported eels can find their way out

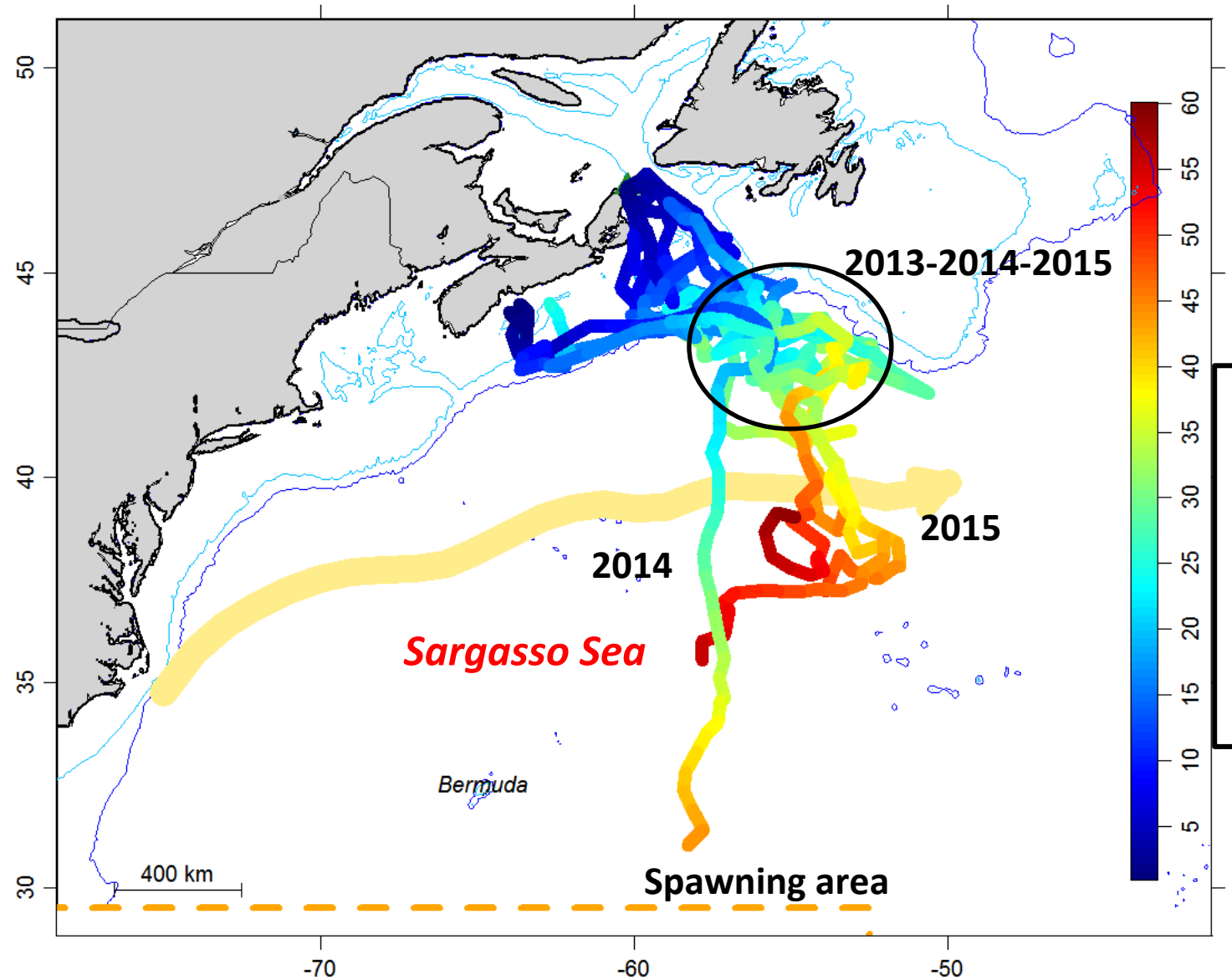
Béguer-Pon et al, 2014. CJFAS; Béguer-Pon et al, In prep

Tracking using PSAT: increasing success over the years





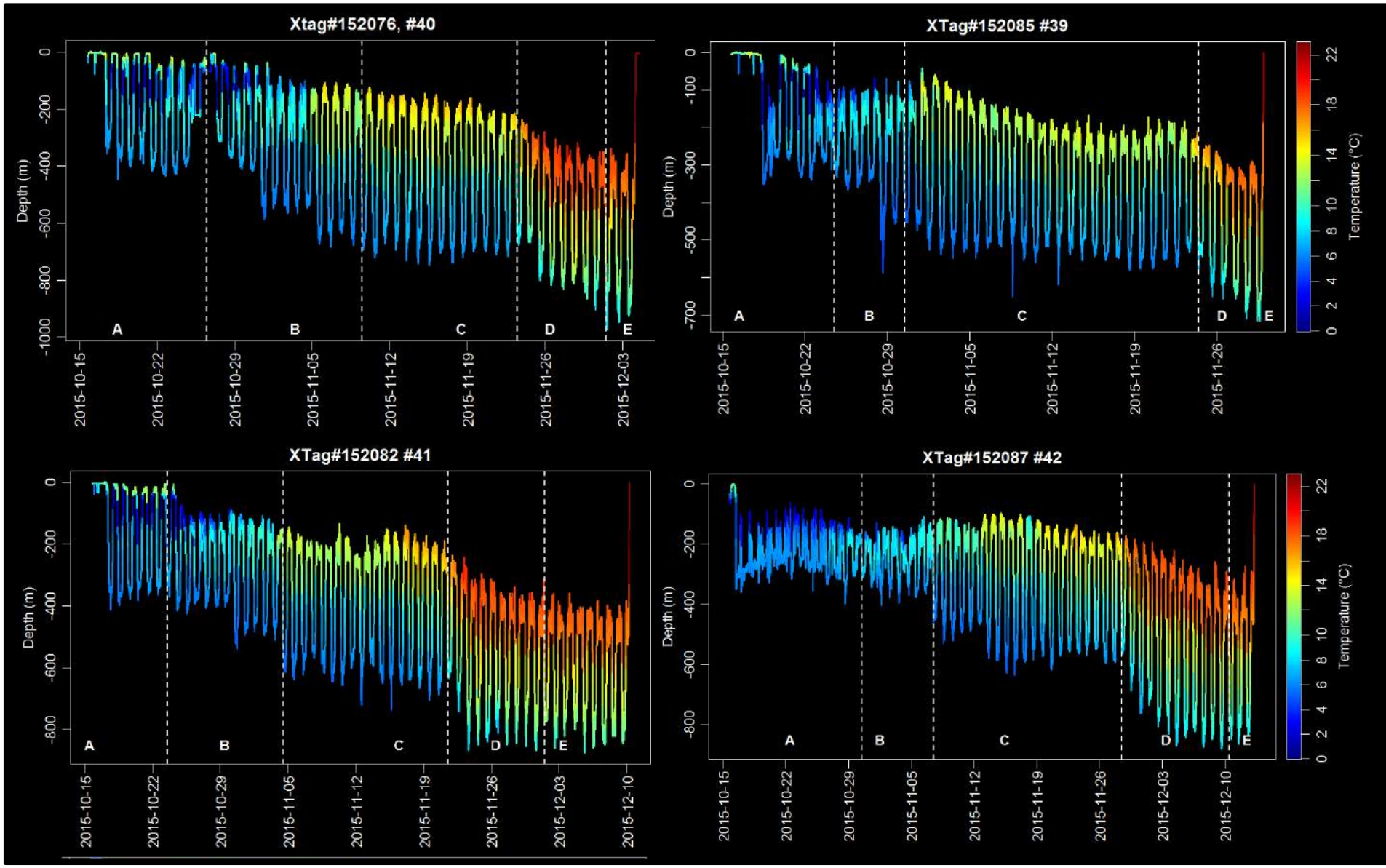
First direct evidence of eels migrating to the Sargasso Sea



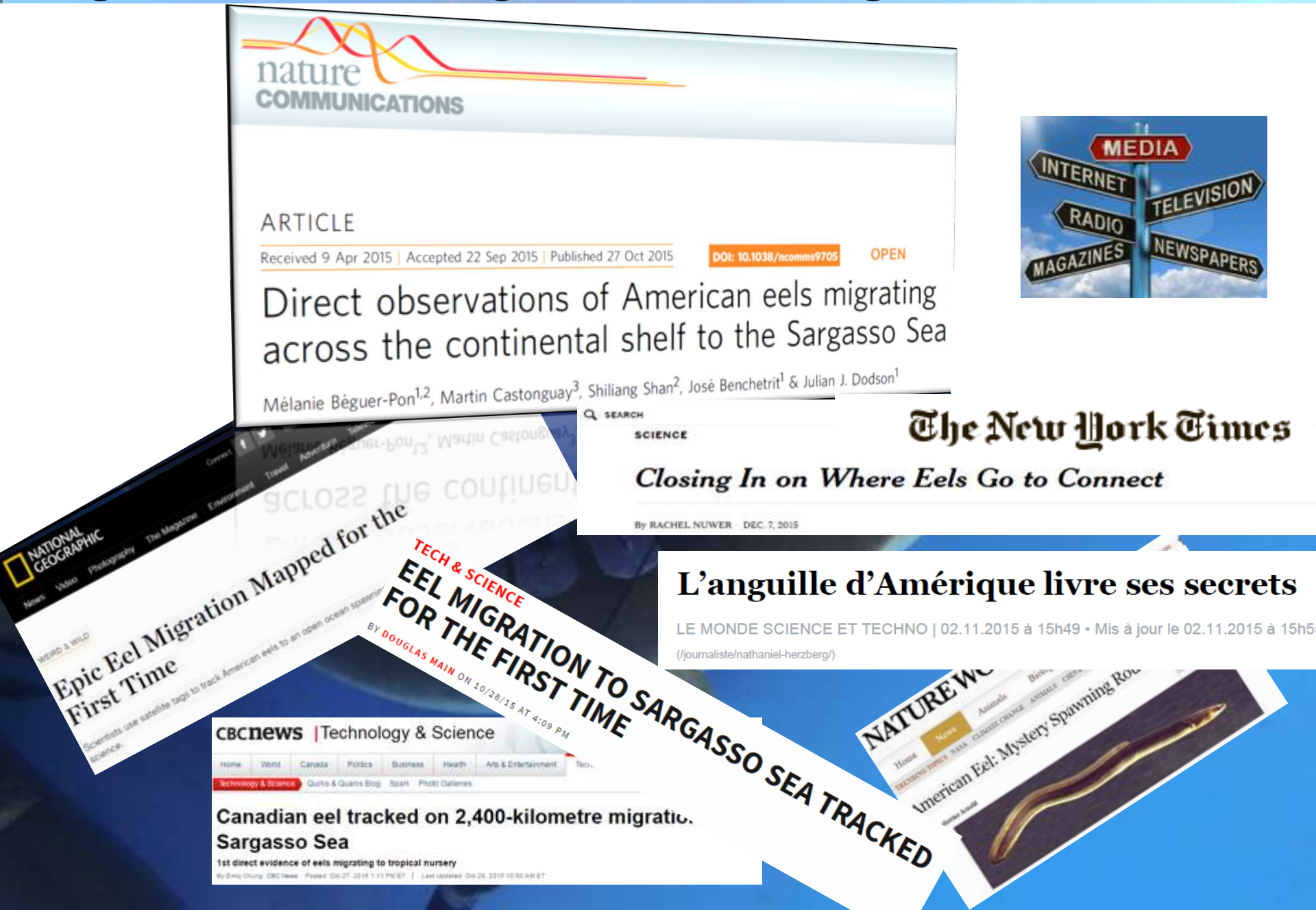
- Particular areas
- Similar trajectories
- Little effect of currents
- True navigation?

Béguer-Pon et al, 2015. Nature Communications

Vertical behaviour documented



Large Media coverage of our findings

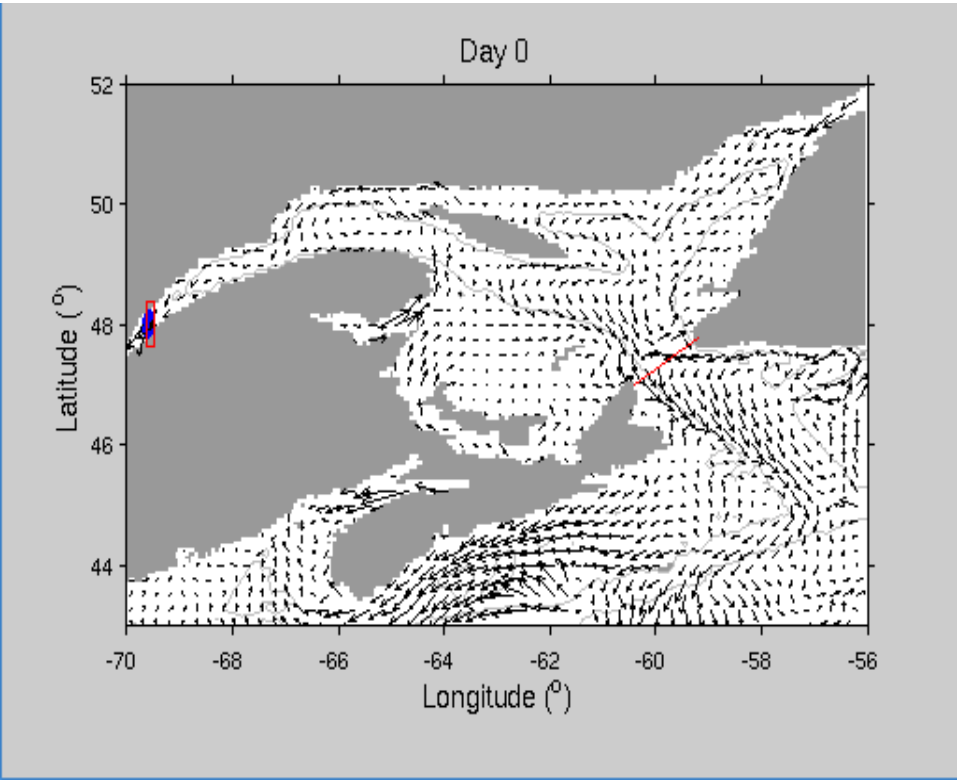


Simulating the migration

⇨2 individual-based models coupled with ocean circulation model

<u>In the St. Lawrence Estuary and Gulf (Dalcoast)</u>

Which behaviours allowed v-eels to reproduce the migration pattern observed by telemetry experiments?



→Active swimming and complex orientation strategies must be employed

→Selective tidal stream transport sufficient in SLE (but active)

→Orientation based on salinity gradient or depth not sufficient

→Tool for evaluating the potential effect of climate change on the duration of migration

Béguer-Pon et al, 2016. MEPS

Simulating the migration

In the North Atlantic Ocean (NEMO)

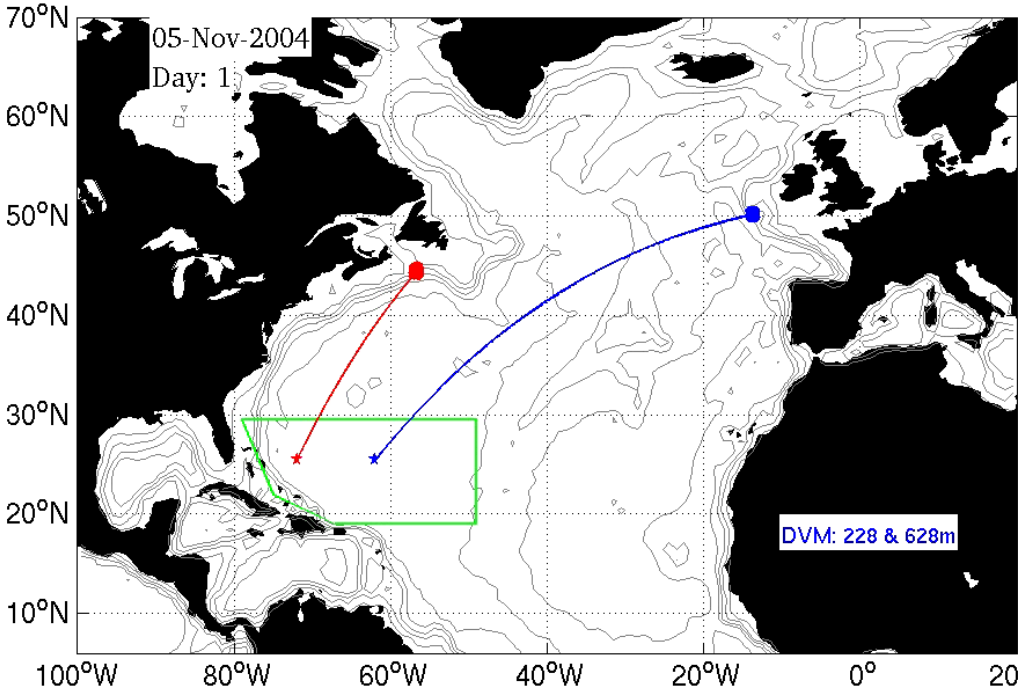
Exploring the role of the physical marine environment in silver eel migrations (European and American eel)

2 swimming-directed behaviours simulated

→Minimum swimming speeds assessed

→Effects of ocean currents for swimming speed <0.8 m/s

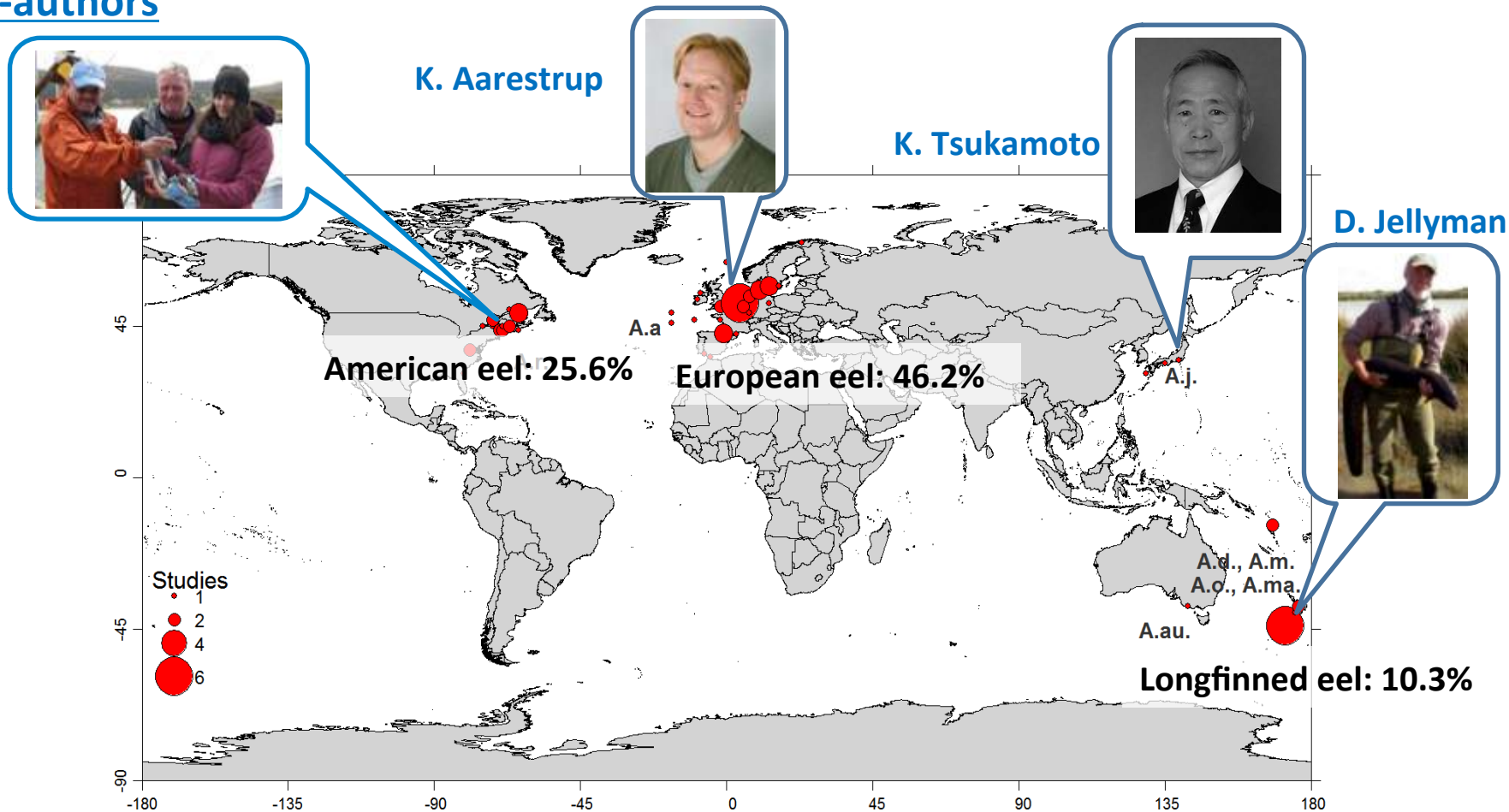
→Energy would not be a limiting factor; affected by range of DVM



Béguer-Pon et al, 2016. ICES Journal of Marine Science

Tracking eels: a review of telemetry studies

6 co-authors



- 81 References
- Acoustic (51%), Radio (28%), Satelite (16%)
- Freshwaters/Brackish/Marine Waters
- Direct Management component: 43%

- Small eels (males) neglected
- Little use of tags equipped with sensors
- Satellite tracking challenging

Béguer-Pon et al, In prep.

Project 4.5. List of publications

- *Béguer-Pon, M., J. Benchetrit, M. Castonguay, K. Aarestrup, S.E. Campana, M.J.W. Stokesbury & J.J. Dodson. 2012. Shark predation on migrating adult American eels (Anguilla rostrata) in the Gulf of St. Lawrence.* ***PloS ONE*** *7: e46830.*
- *Engler-Palma C., VanderZwaag D.L., Apostle R., Castonguay M., Dodson J.J., Feltes E., Norchi C., White R. (2013). Sustaining American Eels: A Slippery Species for Science and Governance.* ***Journal of International Wildlife Law & Policy****. 16:2-3, 128-169*
- *Béguer-Pon, M., M. Castonguay, J. Benchetrit, D. Hatin, M. Legault, G. Verreault, Y. Mailhot, V. Tremblay & J.J. Dodson. 2015. Large-scale, seasonal habitat use and movements of yellow American eels in the St. Lawrence River revealed by acoustic telemetry.* ***Ecology of Freshwater Fish*** *24: 99–111.*
- *Béguer-Pon, M., M. Castonguay, J. Benchetrit, D. Hatin, G. Verreault, Y. Mailhot, V. Tremblay, D. Lefaivre, M. Legault, D. Stanley & J.J. Dodson. 2014. Large-scale migration patterns of silver American eels from the St. Lawrence River to the Gulf using acoustic telemetry.* ***Canadian Journal of Fisheries and Aquatic Sciences*** *71: 1579-1592.*
- *Béguer-Pon, M., M. Castonguay, S. Shan, J. Benchetrit & J.J. Dodson. 2015. Direct observations of American eels migrating accross the continental shelf to the Sargasso Sea.* ***Nature Communications*** *DOI 10.1038/ncomms9705.*
- *Béguer-Pon, M., K. Ohashi, J. Sheng, M. Castonguay & J.D. Dodson. 2016. Modeling the migration of the American eel in the Gulf of St. Lawrence.* ***Marine Ecology Progress Series*** *doi: 10.3354/meps11706.*
- *Béguer-Pon, M., S. Shan, K. Thompson, M. Castonguay, J. Sheng & J.J. Dodson. 2016. Exploring the role of the physical marine environment on silver eel migration using biophysical particle-tracking model.* ***ICES Journal of Marine Science*** *73: 57-74.*
- *Benchetrit, J., M. Béguer-Pon, P. Sirois, M. Castonguay, J. Fitzsimons & J.J. Dodson. 2015. Using otolith microchemistry to reconstruct habitat use of American eels Anguilla rostrata in the St. Lawrence River–Lake Ontario system****. Ecology of Freshwater Fish****: DOI 10.1111/eff.12246.*
- *Chang, Y.-L., Y. Miyazawa & M. Béguer-Pon. 2016. Simulating the Oceanic Migration of Silver Japanese Eels.* ***PLoS ONE*** *11: e0150187.*
- *Chang, Y.-L., J. Sheng, K. Ohashi, M. Béguer-Pon & Y. Miyazawa. 2015. Impacts of Interannual Ocean Circulation Variability on Japanese Eel Larval Migration in the Western North Pacific Ocean.* ***PLoS ONE*** *10: e0144423.*

In preparation

- *Béguer-Pon, M., Dodson, J., Castonguay, M., Jellyman, D., Aarestrup, K., Tsukamoto, K. (In prep) Tracking eels: a review of telemetry studies.*
- *Béguer-Pon, M., Stanley, D., Threader, R., Verreault, G., Castonguay, M., Dodson, J. (In prep) Leaving the St. Lawrence system : can stocked or transported silver eels make it?*

Ongoing collaboration with Ifremer

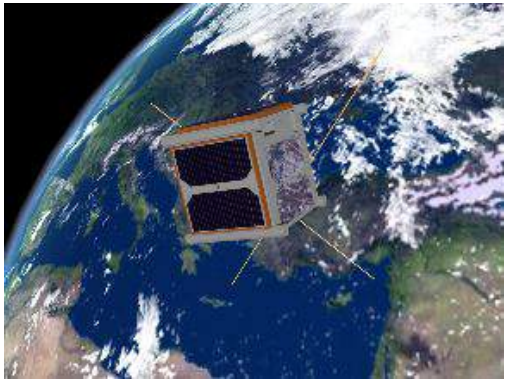
Tag-it-Yourself (TiY) project

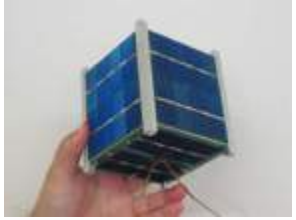
Sylvain Bonhommeau

Objective:

Collecting more accurate and diverse information from electronic tags

⇨Development of a new generation of affordable electronic tags which will transfer data through a **nano-satellite**





Meeting scheduled Mid-July (Sète & Montpellier, France)

In collaboration with:
- the Institut d'Electronique du Sud (IES, Montpellier)
- Laboratoire d'Informatique, Robotique et Micro-électronique de Montpellier (LIRMM)

Thank you for your attention