Life history of the American eel–"Mythbusters" Style

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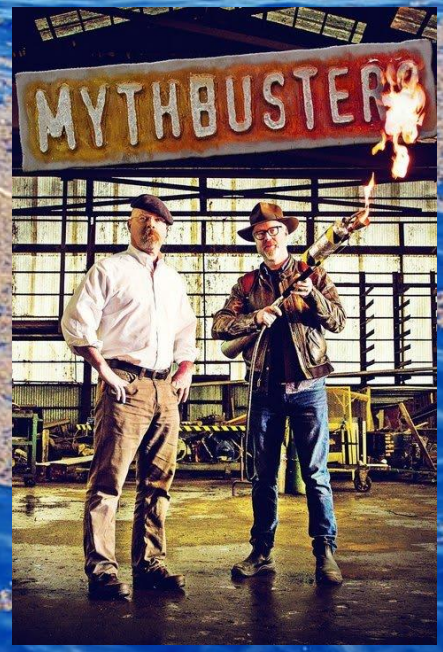
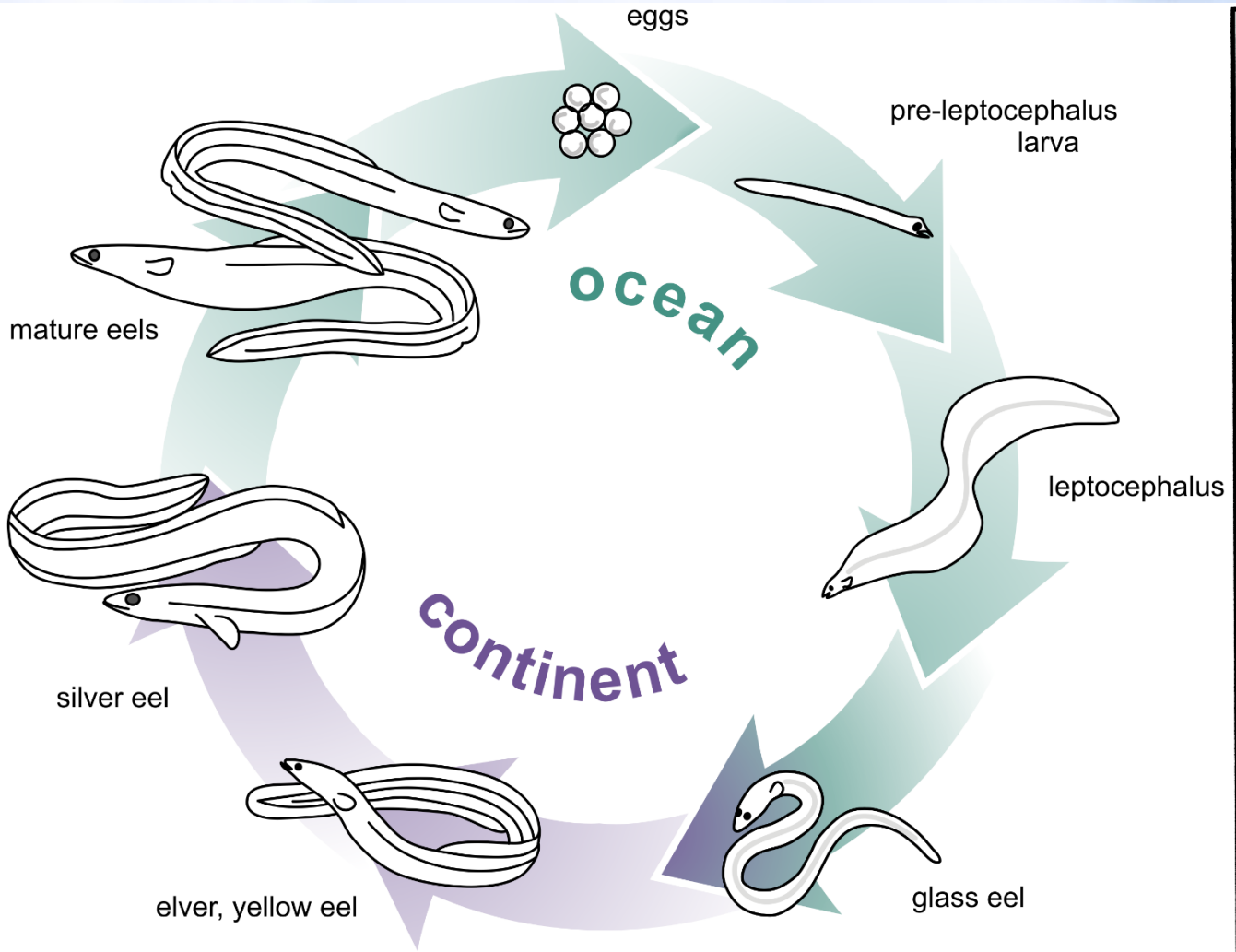
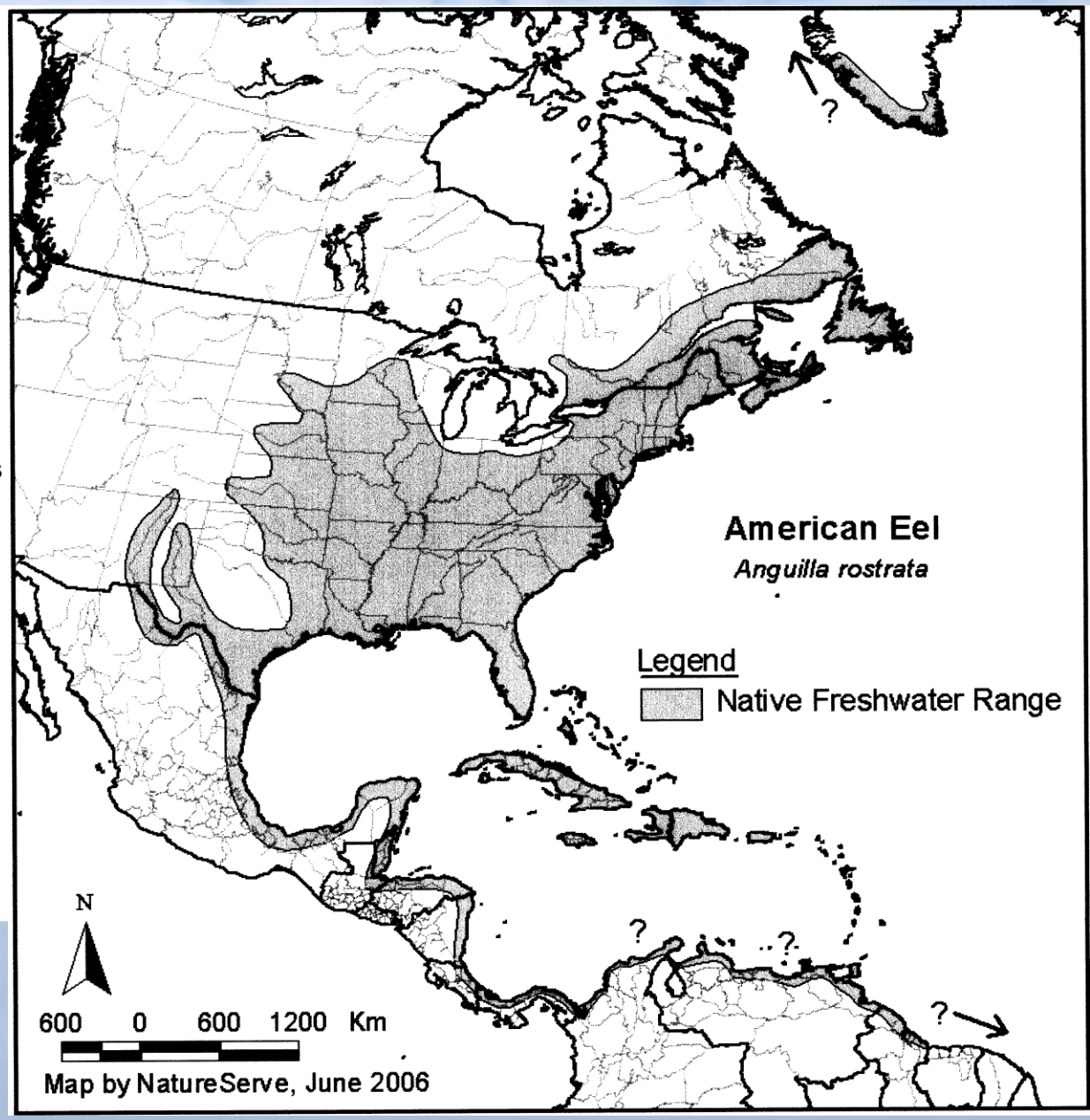


American Eel Symposium: Future Directions for Science, Law and Policy
Portland, Maine, 23-25 October 2015


eggs
pre-leptocephalus larva
leptocephalus
glass eel
elver, yellow eel
silver eel
mature eels
ocean
continent


American Eel
Anguilla rostrata
Legend
Native Freshwater Range
N
600 0 600 1200 Km
Map by NatureServe, June 2006

How do we know American eels spawn in the Sargasso Sea?

Spawning eels have never been seen there.

But leptocephalus distribution has been described.

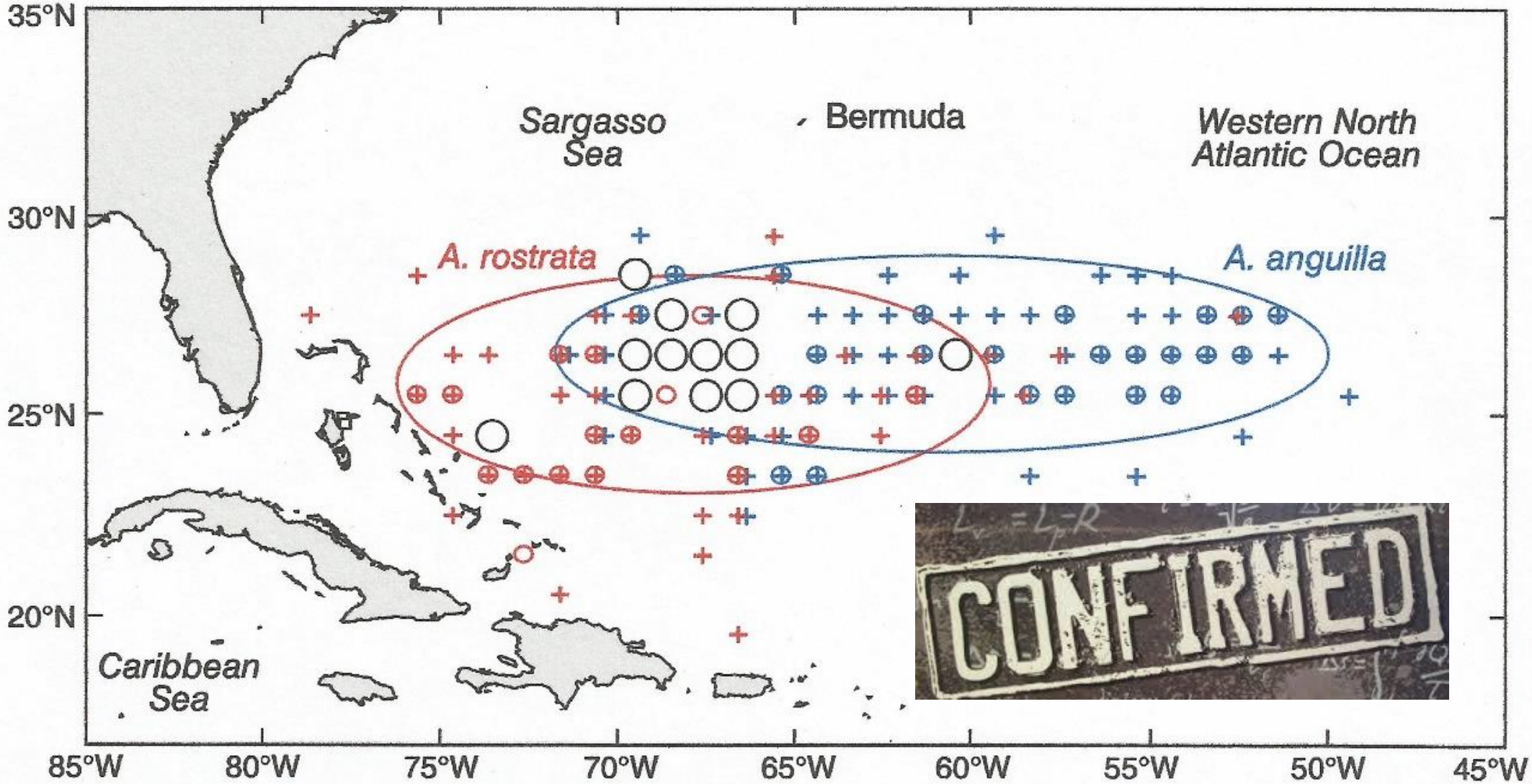
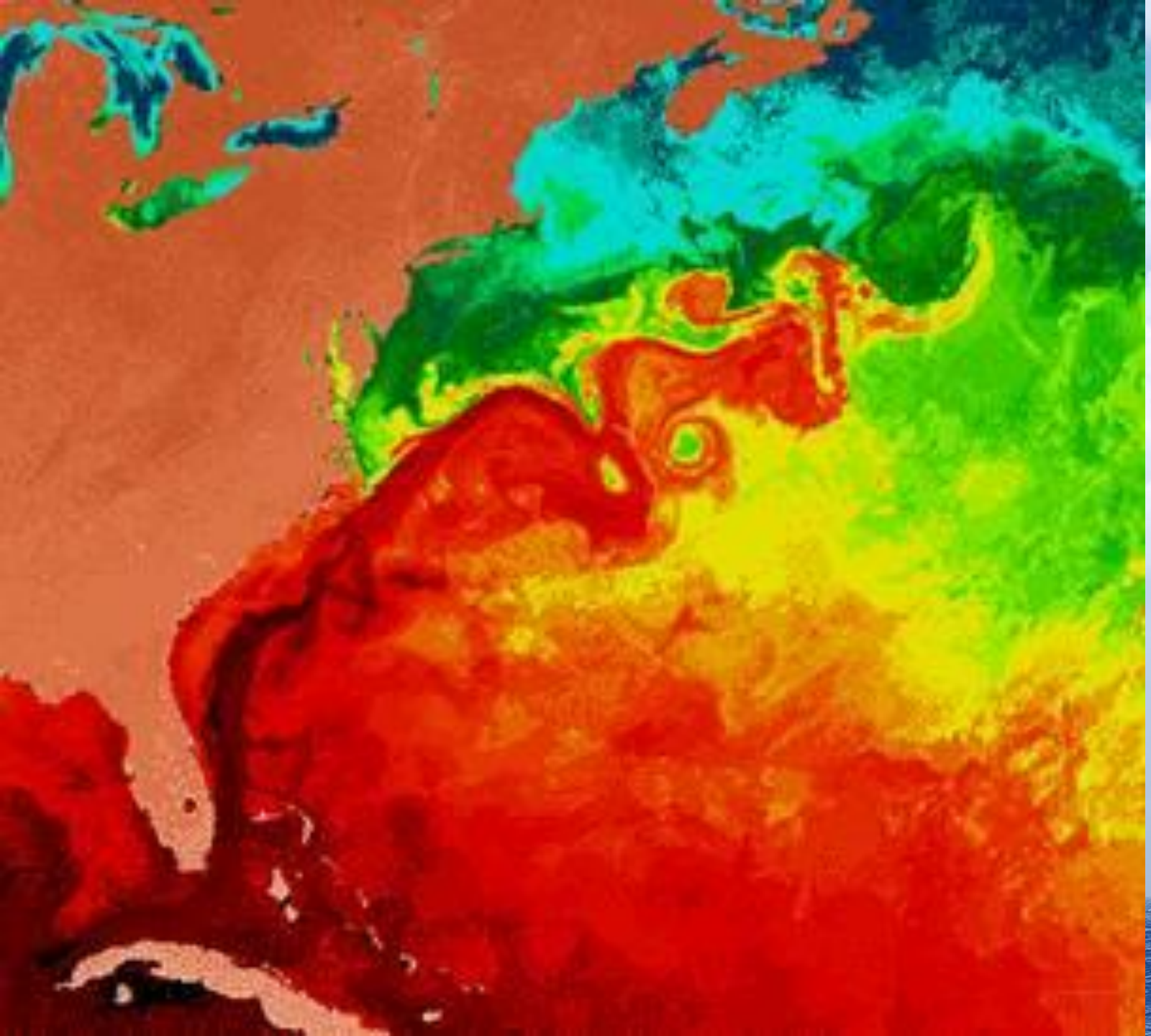


Fig. 15. Locations where small larvae 3.0–5.9 mm (small circles) and 6.0–10.9 mm (crosses) of *Anguilla rostrata* (red symbols) and *Anguilla anguilla* (blue symbols) were collected, pooled into 1° areas. Large circles show areas where <6 mm-long larvae of both species were collected. Ovals show estimates of the primary spawning regions of the two species.

Miller et al. 2015



How do leptos detrain from the currents and cross the shelf?

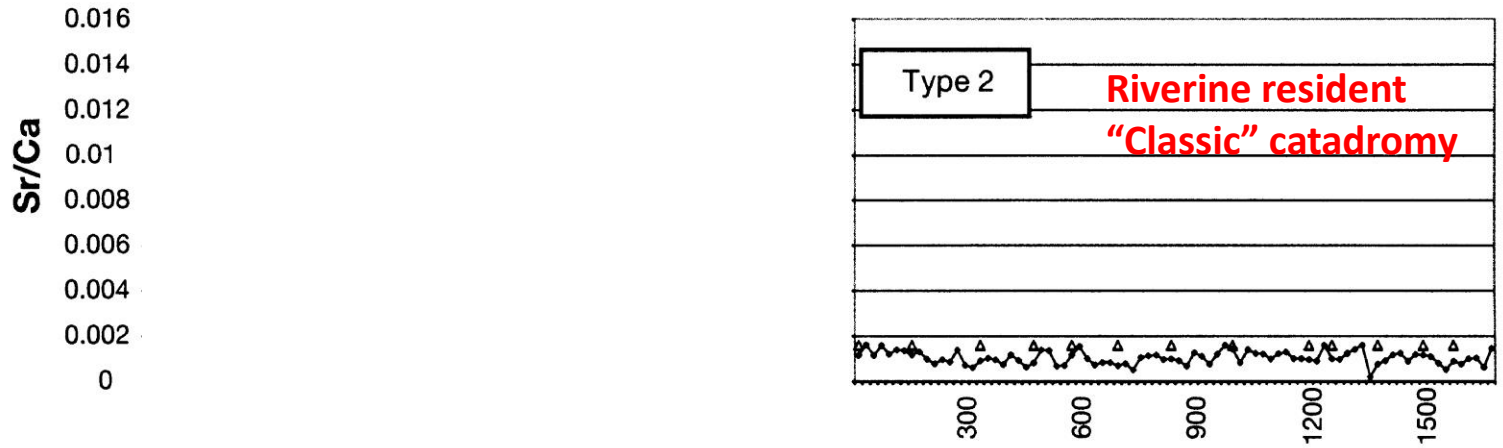
Unknown, maybe oriented swimming.

Anguilla the quintessential catadromous fishes?

Strontium:Calcium ratio much greater in sea water than fresh water.

Sr:Ca measured across the ear stones, otolith, from core to periphery is a means to trace the salinity history of an adult eel .

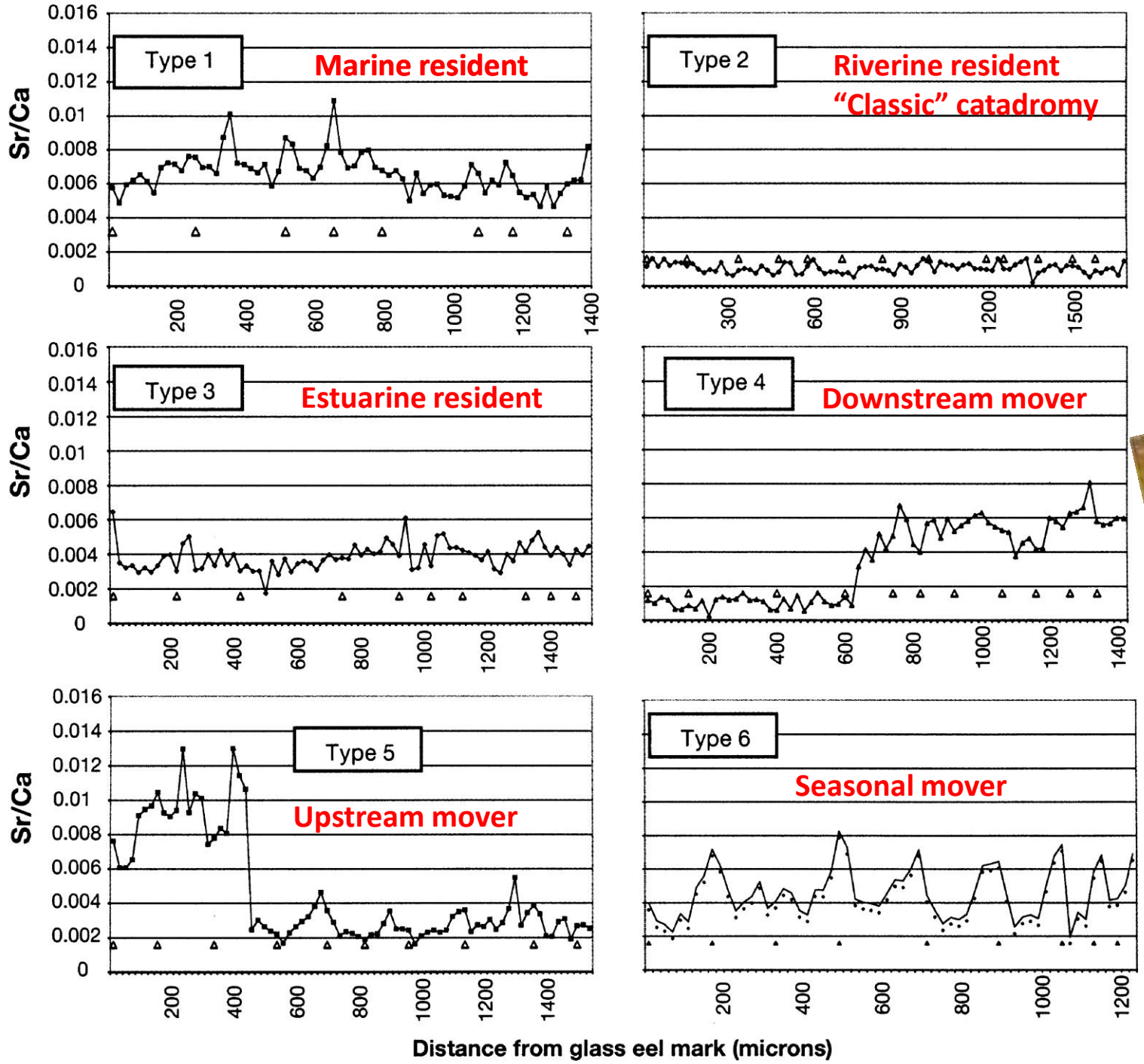
Overwhelming evidence for many life history patterns in continental waters for temperate eel species.



Distance from glass eel mark in otolith, µ

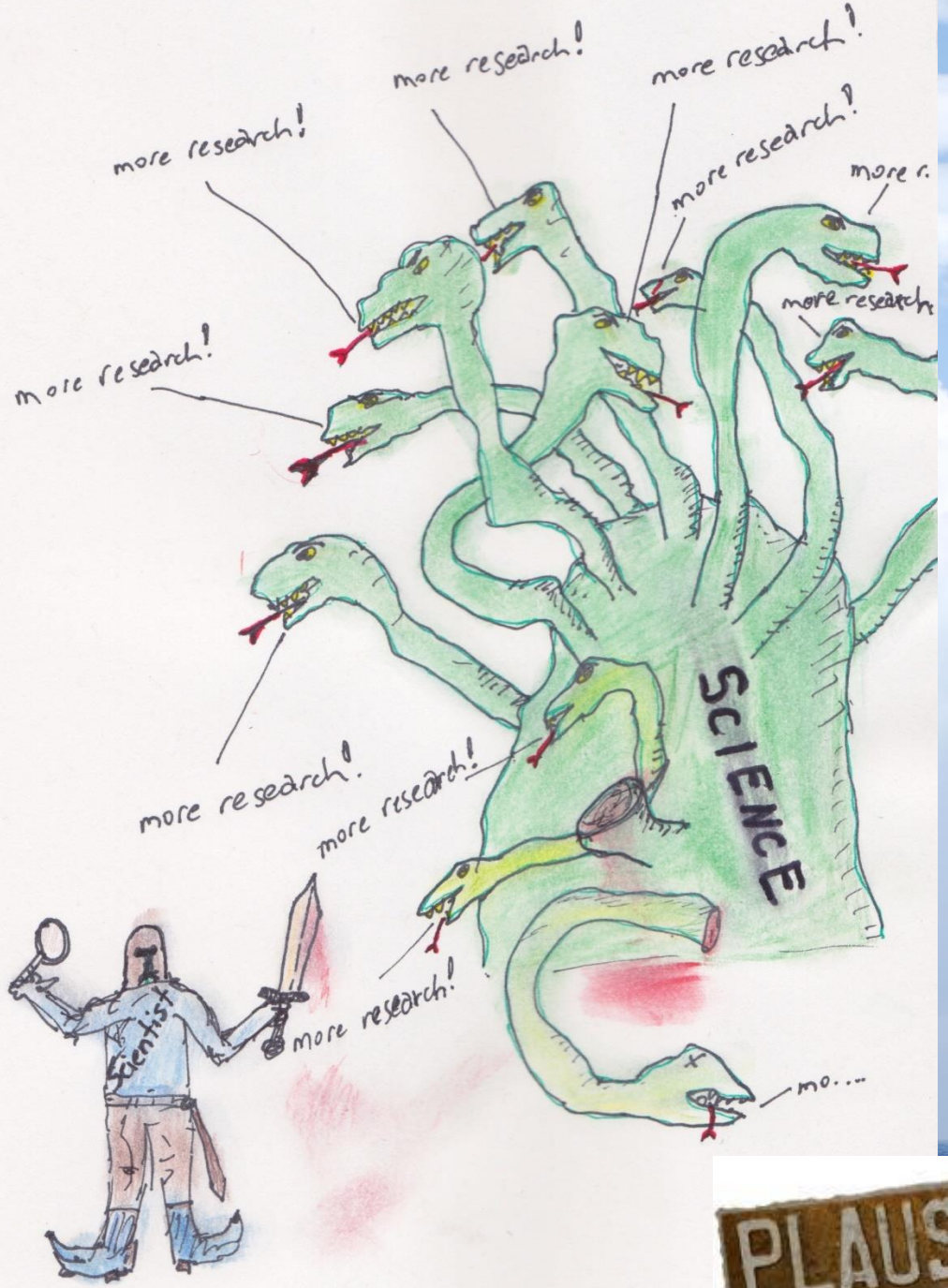
From Daverat and Tomás (2006)

Otolith of a13-year old European eel, after leptocephalus-glass eel metamorphosis. Triangles mark annuli.



Obligatory catadromy is…

Catadromy is facultative.



Scientists always call for more research. So here are some unknowns.

What is the extent of marine habitat use?

What determines settlement of glass eels? Later movements?

- Physiological status, competition, food supply, genetic predisposition?

Why does catadromy persist in temperate-zone eels (Cairns et al. 2009)?

- Use of diverse habitats reduces fitness variation in the population.
- Fitness in some individuals might be greater in fresh than saline waters.

Panmixia, the great debate for eels.

Panmixia is the state in which a species exists as a single, randomly mixed population, where an individual is equally likely to mate with any member of the opposite sex.

Does panmixia mean each eel is genetically identical?

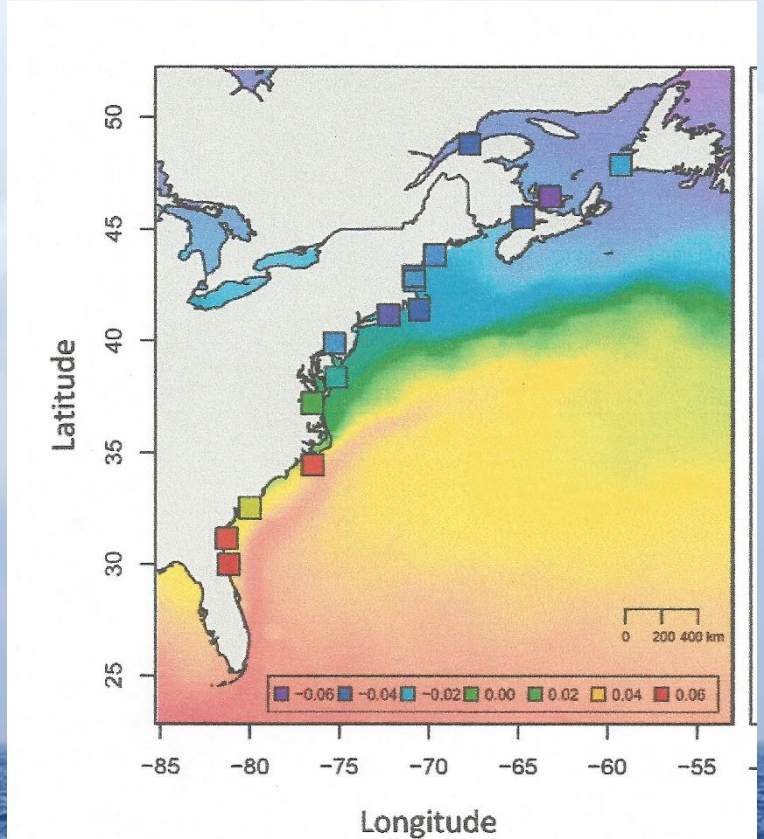
No, it means that each individual in a generation begins with a random assortment of genes from a pool common to the entire population breeding that year.

Panmixia gives species with a complex life cycle, huge geographic range, and unpredictable larval dispersal the opportunity to thrive under a myriad of environmental conditions. For eels, panmixia is reinforced by many age classes spawning together.

Variability of traits under varying environmental conditions may arise phenotypically or genotypically.

Is there a genetic component to variability of traits under panmixia in eels? Three elegant Canadian experiments!

Gagnaire et al. (2012)



Variability of traits under varying environmental conditions may arise phenotypically or genotypically.

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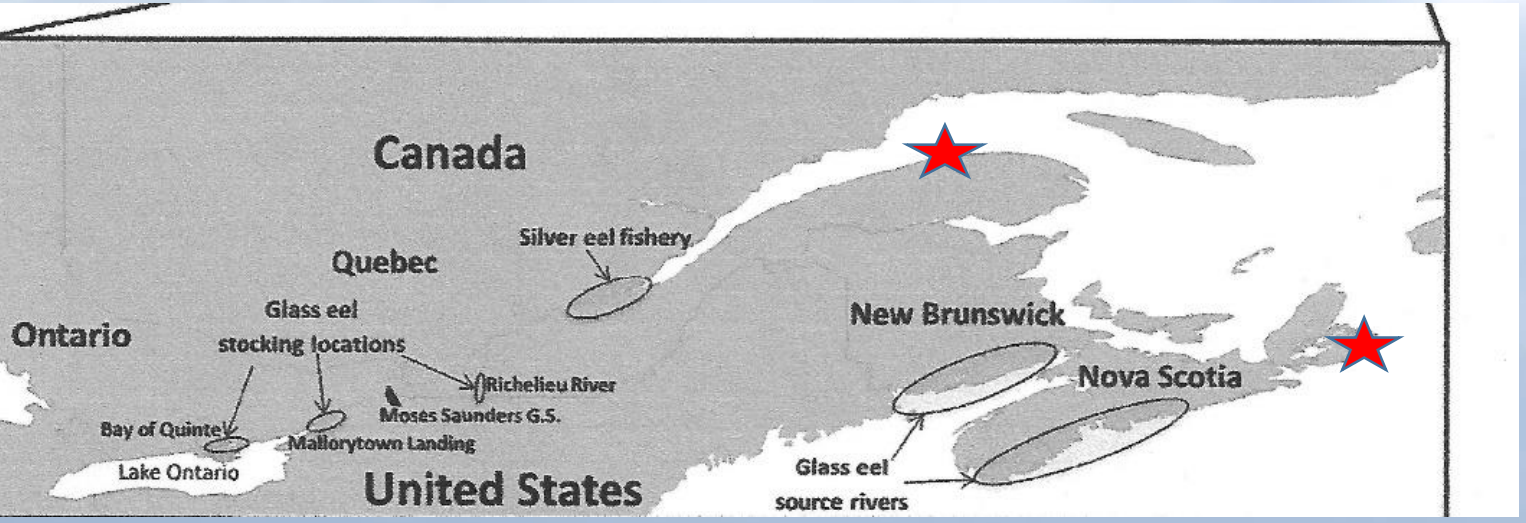
Côté et al. (2014)



<u>Functional groups of genes:</u>

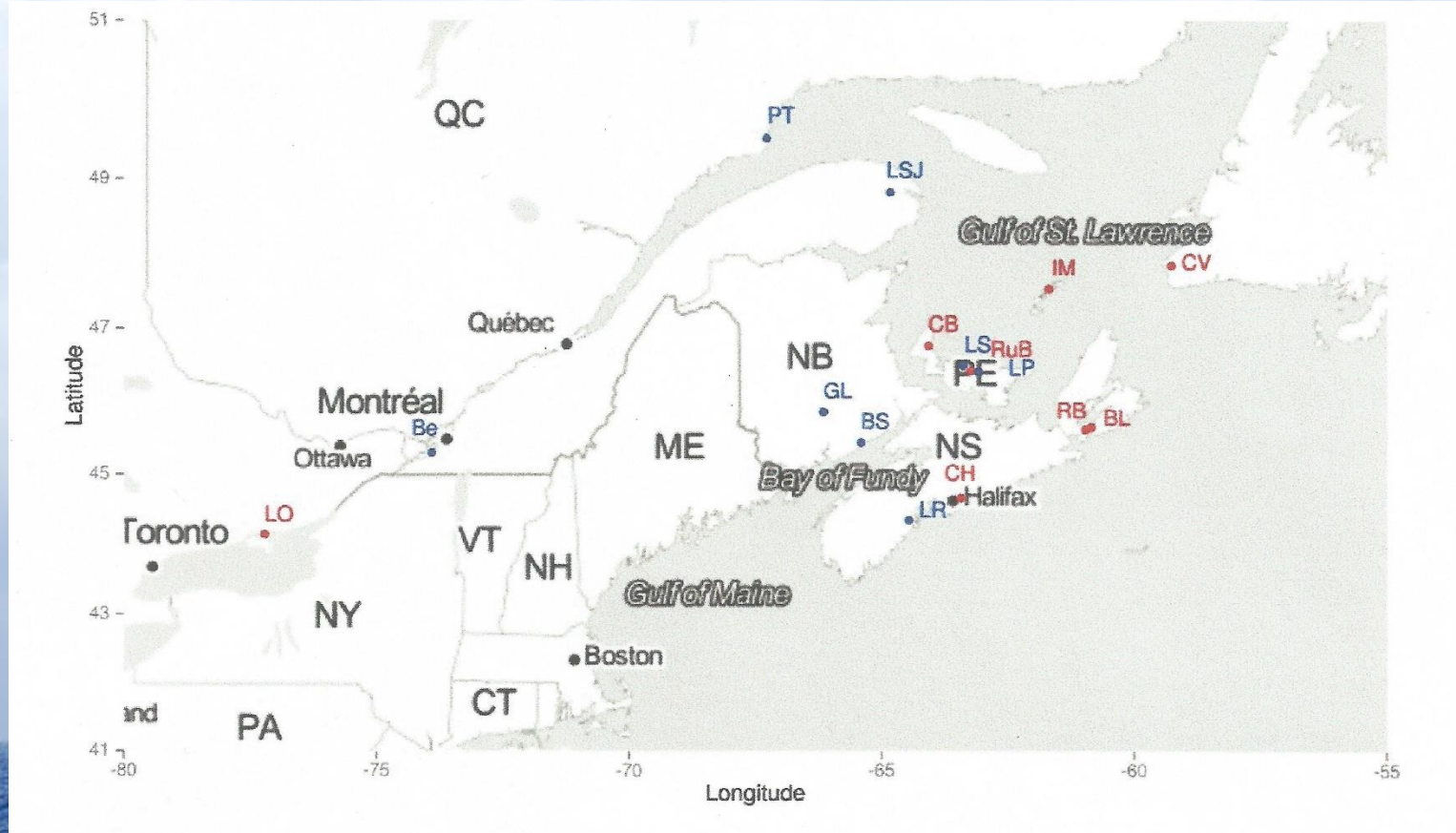
Cell protection and immunity
Detoxification
Energy metabolism and respiration
Growth and development
Transporters and carrier proteins
Signal transduction
Structural complex
Transcription/translation

Variability of traits under varying environmental conditions may arise phenotypically or genotypically.

Is there a genetic component to variability of traits under panmixia in eels? Three elegant Canadian experiments!

Pavey et al. (2015)

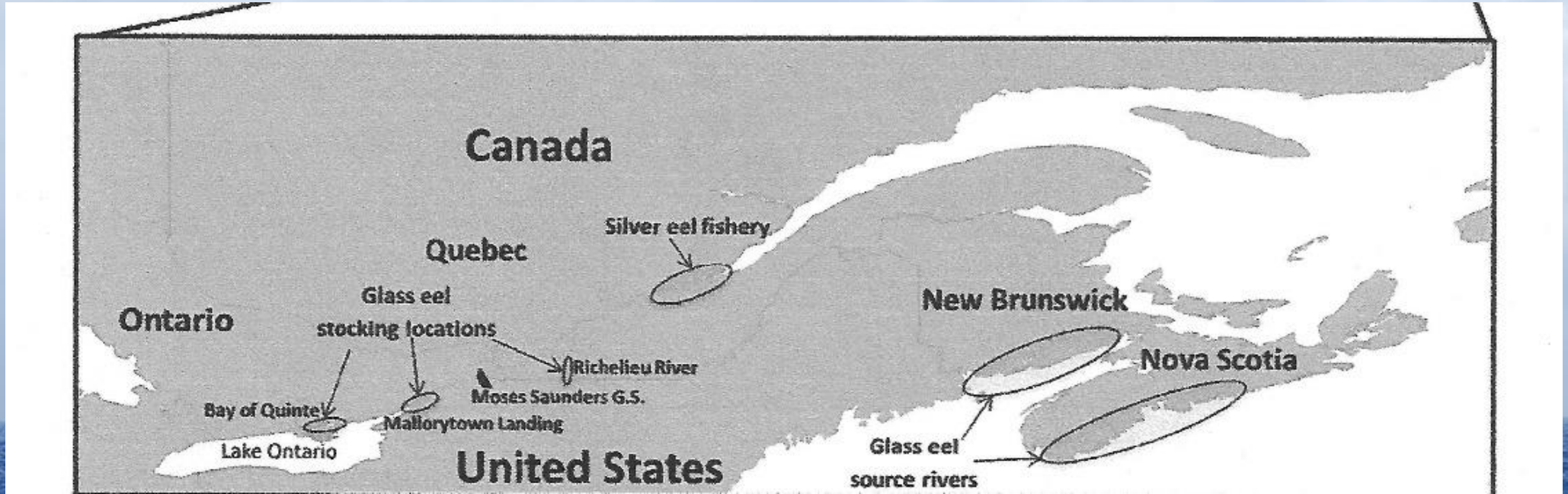
Fresh water = **red**
Brackish water = **blue**



Because of panmixia, one might postulate that human influences are insignificant. Three points.

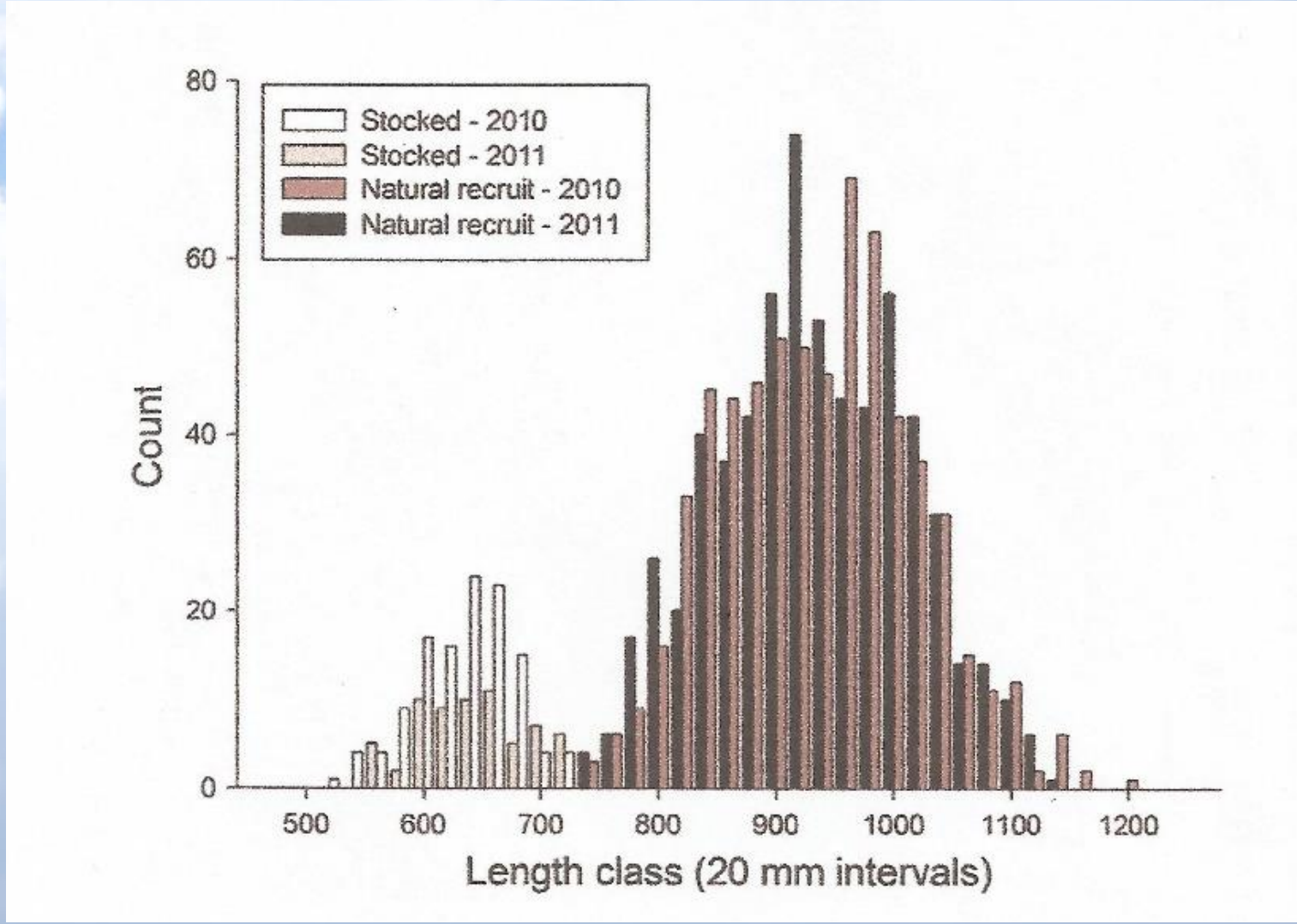
Translocation of glass eels could enhance stocks in depleted areas thus restoring silver eel production.

Canadian experiments:
Pratt and Threader (2011), Verrault et al. (2009, 2010), Stacey et al. (2015)



191 silver eels from glass eel stocking and 1277 natural silver eels, all female, were caught in a commercial fishery (Stacey et al. 2015).

	Mean length, mm
Stocked eels	651 ± 48
Natural eels	940 ± 83



“These results provide a warning about the use of conservation stocking as a panacea for declining recruitment in North Atlantic eels… [and] …do not support the contention that eels will take on the life-history traits of naturally recruiting eels to the same water body. [We] question whether the translocation of eels from different geographic locations…is an effective conservation measure for American eels.”

Stacey et al. (2015)

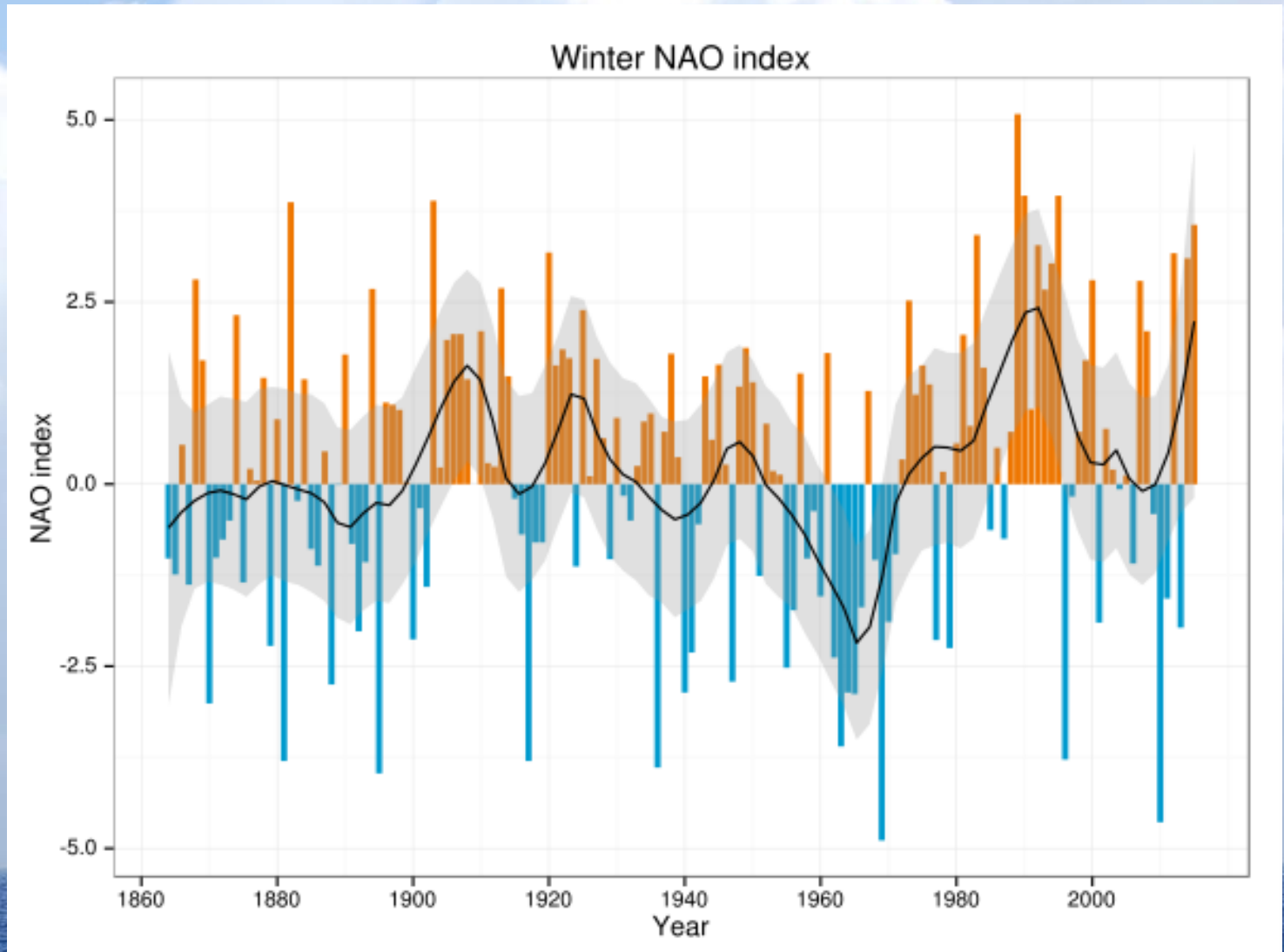
Sex in *Anguilla* is environmentally, not genetically, determined. Mechanism not understood.

Already seen that stocking glass eels into the St. Lawrence system produces males in a previously female-dominated region.

Sex ratios of several eel species in some rivers or lakes changed from female dominated to male dominated after stocking or as a result of commercial fishing.

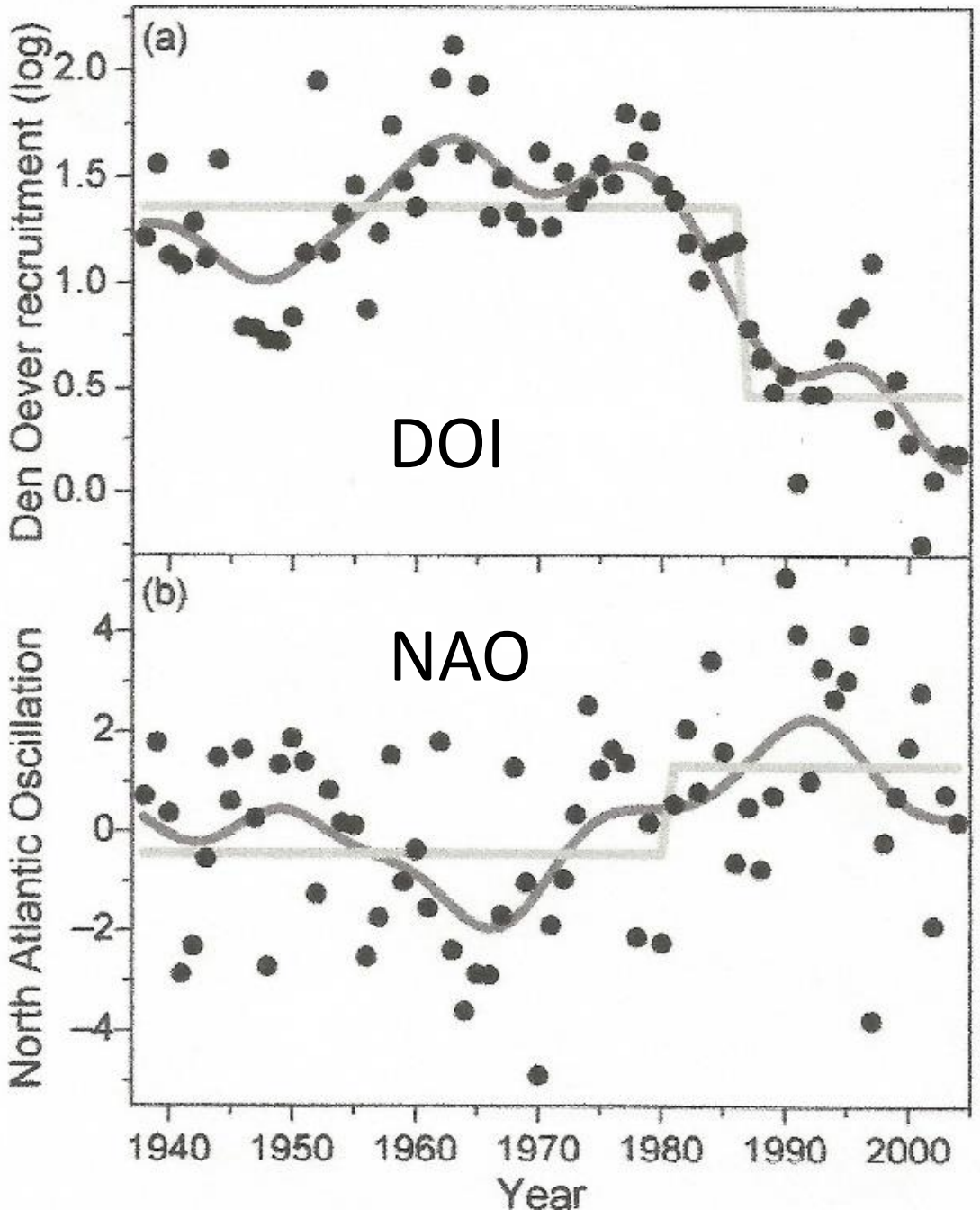
Could oceanic changes in the North Atlantic alter recruitment patterns and abundance?

The North Atlantic Oscillation is a proxy for many oceanic changes. NAO is wintertime sea level atmospheric pressure difference between Icelandic low and Azores high pressure systems, standardized to an index.



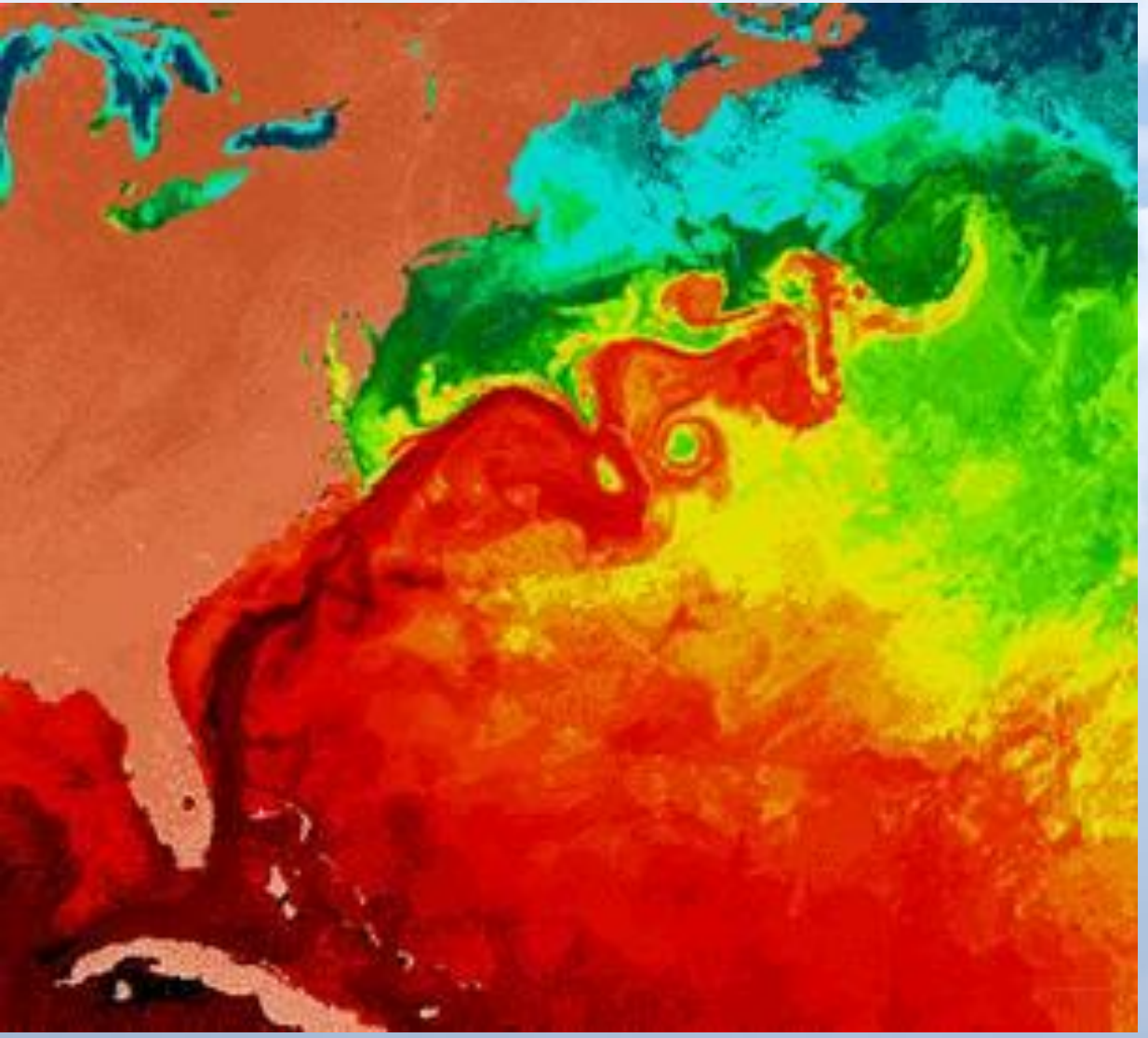
The NAO is correlated with a long-term glass eel recruitment series, DOI, in the Netherlands (and elsewhere).

Correlation about -0.4 at 1-2-yr lag, reflecting a year or two as drifting leptocephali.



The NAO affects wind and precipitation on land and sea, alters weather patterns in Europe and North America, sea surface temperature distribution, surface current patterns, mixing depth, location of the Gulf Stream, strength of gyres, location of frontal zones in the Sargasso Sea, primary production, and more.

Two examples of long-term changes in the Sargasso that could have had serious consequences for Atlantic eels (Friedland et al. 2007).



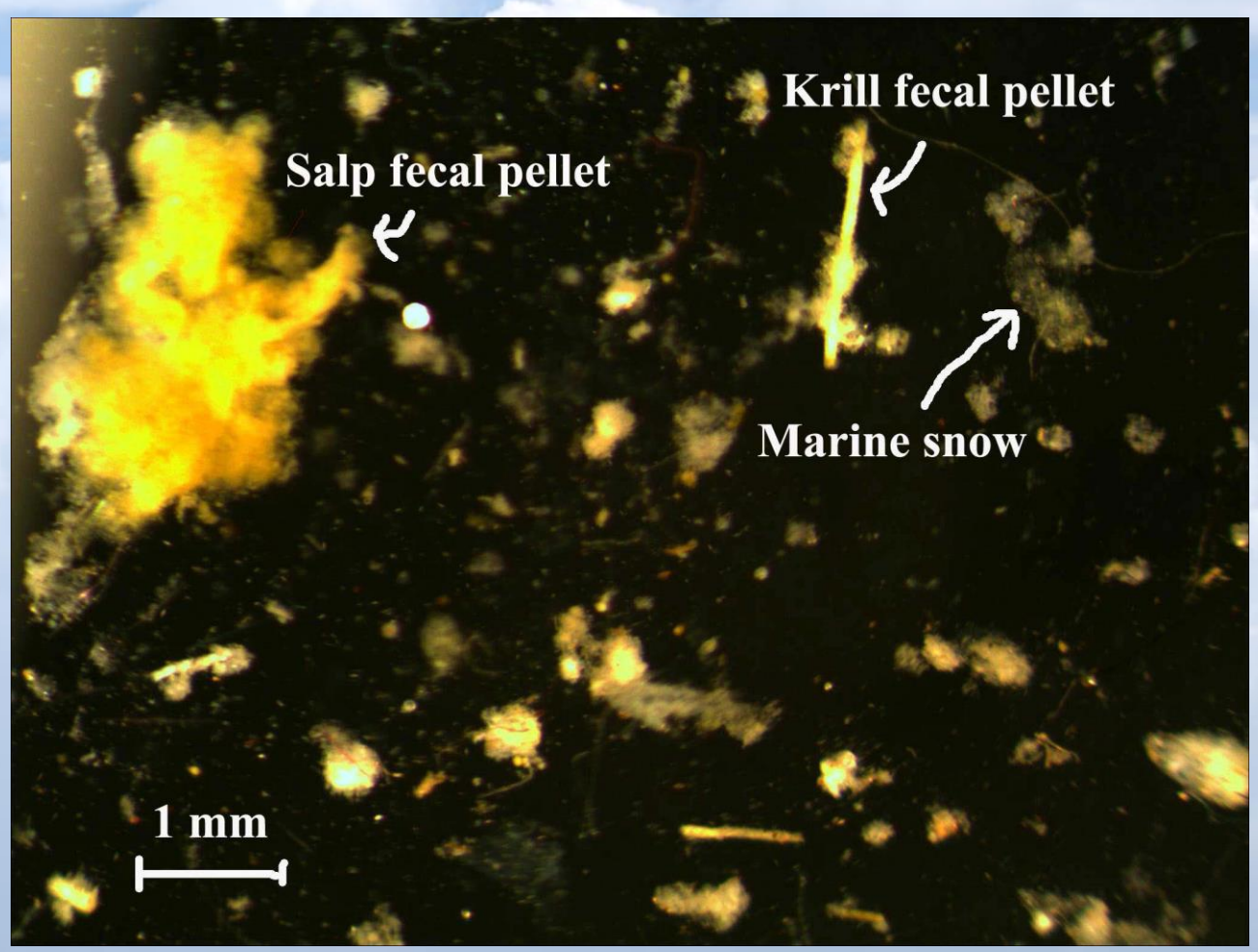
Weakened Ekman transport in recent decades weakened convergence zone.

Eels spawn in convergence (frontal) zone. Did it become harder to find mates? Leptocephali rely on currents to exit the Sargasso. Did drift toward the Antilles Current and Gulf Stream weaken?

Weakened Ekman transport in recent decades made mixing depth shallower.

That may have reduced nutrient supply to surface waters and reduced primary productivity. That reduced production of particulate organic matter, “marine snow”.

Did leptocephali encounter reduced food supply?



Could oceanic changes in the North Atlantic alter recruitment patterns and abundance?

Very likely but direct links not yet demonstrated.

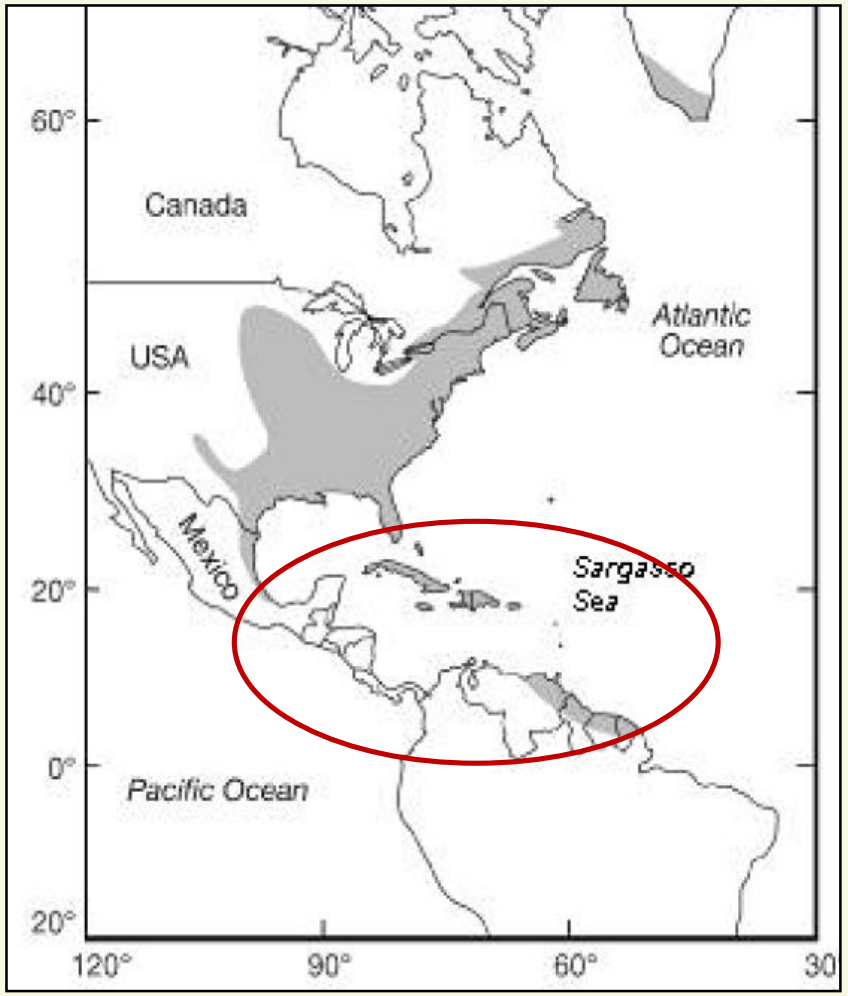

GRAHAM CHAPMAN · JOHN CLEESE · TERRY GILLIAM · ERIC IDLE · TERRY JONES · MICHAEL PALIN
MONTY PYTHON'S
AND NOW FOR SOMETHING COMPLETELY DIFFERENT
DVD
THE BEST OF MONTY PYTHON'S FLYING CIRCUS
12

DISTRIBUTION OF THE AMERICAN EEL IN THE WIDER CARIBBEAN: CURRENT STATE OF KNOWLEDGE

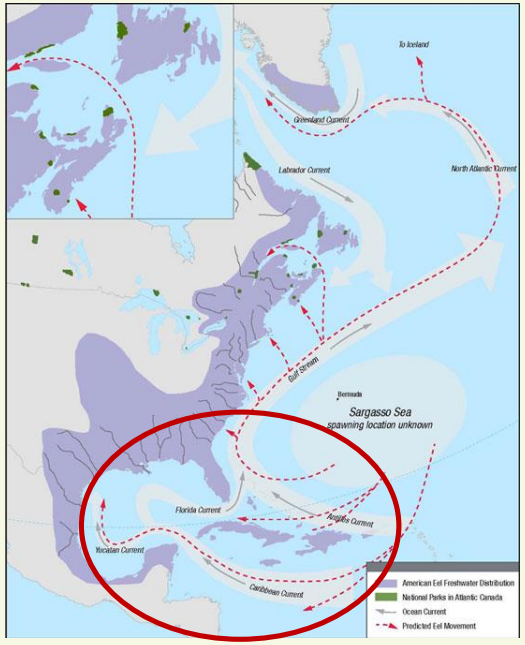
October 2015

Jim McCleave & José Benchetrit

American eel distribution extends to the **tropics**

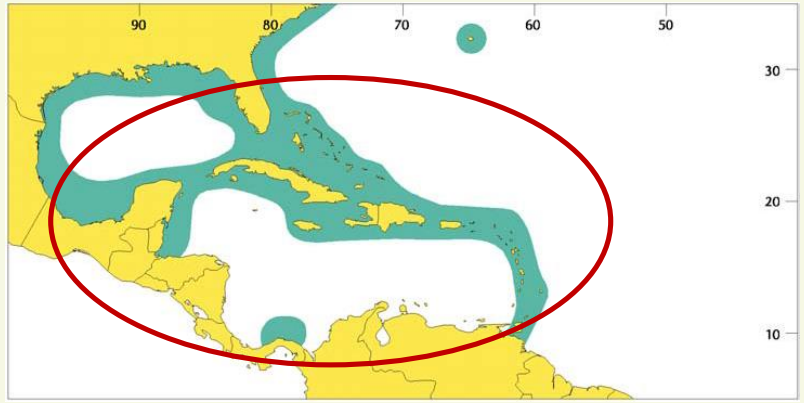


COSEWIC Status Report 2012



Source: Parks Canada Agency

All three of these are incorrect to the south.



Source: Smith 1989

What do we know about American eels in the Caribbean?

Very little information is available on the American eel in the tropical part of its range.

?

?

?

Benchetrit J, McCleave J (2015). Current and Historical Distribution of the American eel, *Anguilla rostrata,* in the Countries and Territories of the Wider Caribbean. *ICES Journal of Marine Science.*

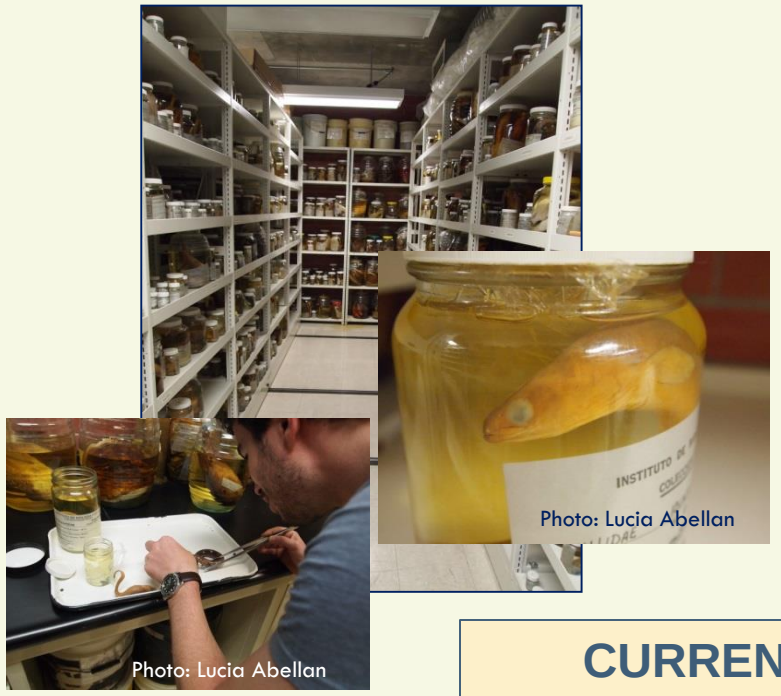
STUDY OBJECTIVES:

- Document the **CURRENT** and **HISTORICAL** distribution of the American eel in the tropical part of its range.
- Preliminarily examine potential threats to American eels in the tropics.

DESKTOP STUDY - METHODOLOGY

Specimen Records from Museum/University Collections

Information/Records from primary and secondary literature



CURRENT→ 2000 and later

HISTORIC → before 2000

METHODOLOGY (continued)

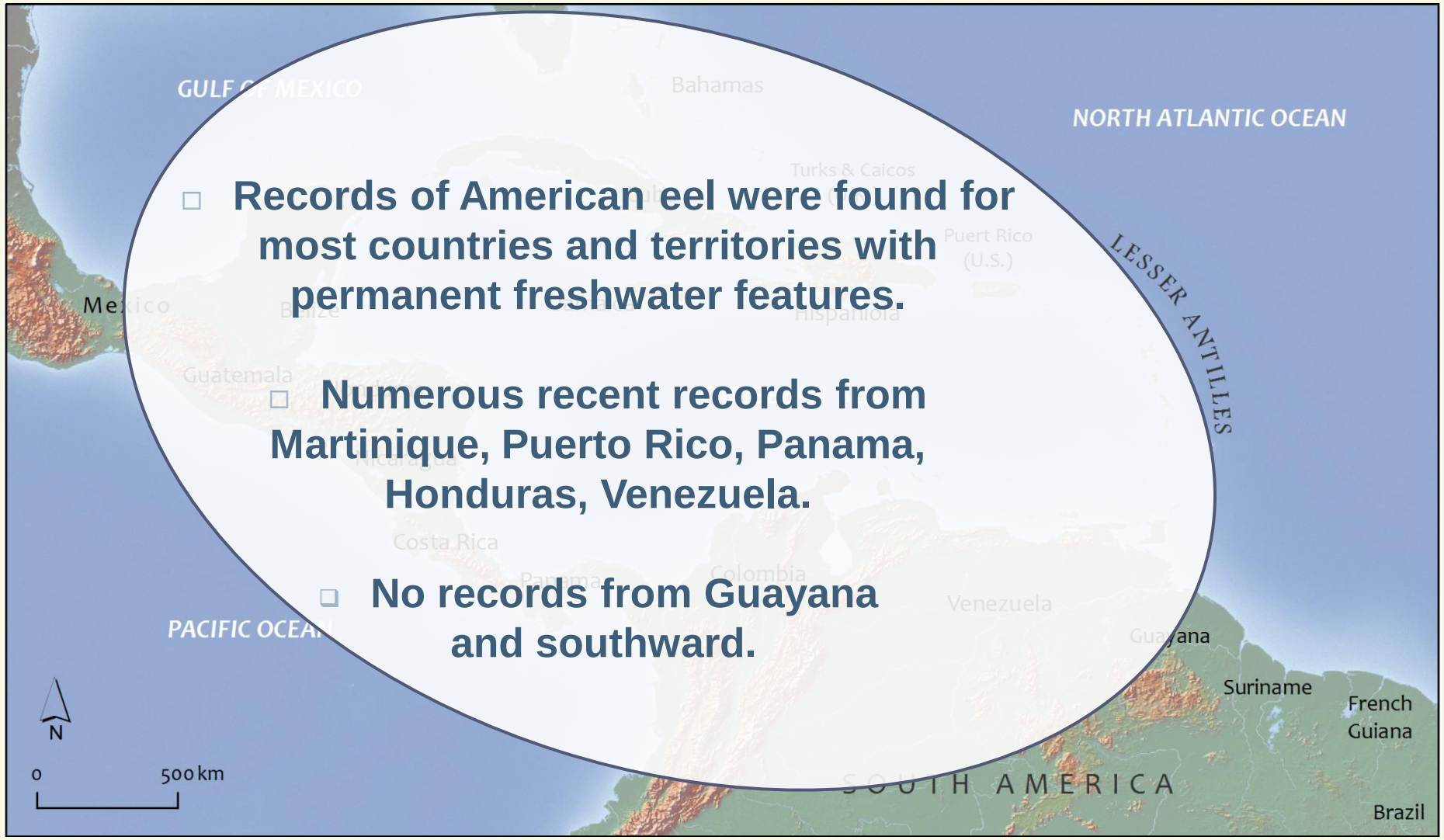
CONTACT:

- Collection curators
- Local scientists
- Fisheries personnel
- Local government officials

- Obtain additional data from specimens records
- Obtain additional information from publication authors
- Develop database

WIDER CARIBBEAN REGION

GENERAL RESULTS



- Records of American eel were found for most countries and territories with permanent freshwater features.
- Numerous recent records from Martinique, Puerto Rico, Panama, Honduras, Venezuela.
- No records from Guayana and southward.

Threats: Habitat Loss/Degradation

Negative effects of hydroelectric and other dams and water abstraction on the Islands of **Guadeloupe** (Fièvet *et al*. 2001) and **Puerto Rico** (Cooney and Kwak 2013).

Threats to local fish communities from proposed dams in Western **Panama** (McLarney *et al.* 2010 a & b).

Negative impact of pollution on American eels in rivers of **Trinidad** (Kenny 1995; Phillip 1998).

BUT…little understanding of threats to eels in region.

Threats: Under-regulated & Unreported Commercial Fishing in the Caribbean

Commercial Fishery for glass eels currently active in the **Dominican Republic**. **CODOPESCA** is the **government agency** that **manages** fishery with some **science activity** and **research** being carried out there.

EVIDENCE of commercial harvest also found in:

- Mexico
- Cuba
- Haiti

CONCLUSIONS

- **American eels occur broadly** in the watersheds of the **Caribbean basin** at **PRESENT** and **HISTORICALLY.**
- **Eastern Venezuela** and **Trinidad and Tobago** appear to represent the true **southern limit** of the distribution.
- Pressure from fisheries has emerged in several locations in the **Caribbean.**
- **Habitat loss and degradation** represent important **threats** to America eels in the **Caribbean region.**

Because of panmixia:

Effective international efforts to manage the species MUST address the current lack of knowledge in the Caribbean and engage with partners in the region.


WWW.LONDONSTIMES.COM
Jim, I'M AFRAID YOU'RE MENTALLY EEL!!!
Sigmund
(c) 2001: RICK LONDON / JOEL COUGHLIN