Downstream spawning migration of European eel (*Anguilla anguilla* L.)

A Europe-wide telemetry meta analysis

Pieterjan Verhelst

Kim Aarestrup, Pedro R. Almeida, Tea Bašić, Jonathan Bolland, Liam Carter, Johan Coeck, José L. Costa, Justas Dainys, Jan Grimsrud Davidsen, Isabel Domingos, Malte Dorow, Eric Feunteun, Jens Frankowski, Arie Benjamin Griffioen, Rui Miguel Monteiro, Andy Moore, Damiano Oldoni, Adam T. Piper, Bernardo R. Quintella, Jake Reeds, David Righton, Damien Sonny, Thomas Trancart, Olvin Alior van Keeken, Pieter Verschelde, Hendrik Volken Winter, Jan Reubens

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Flanders State of the Art

LifeWatch BELGIUM

1 population!?

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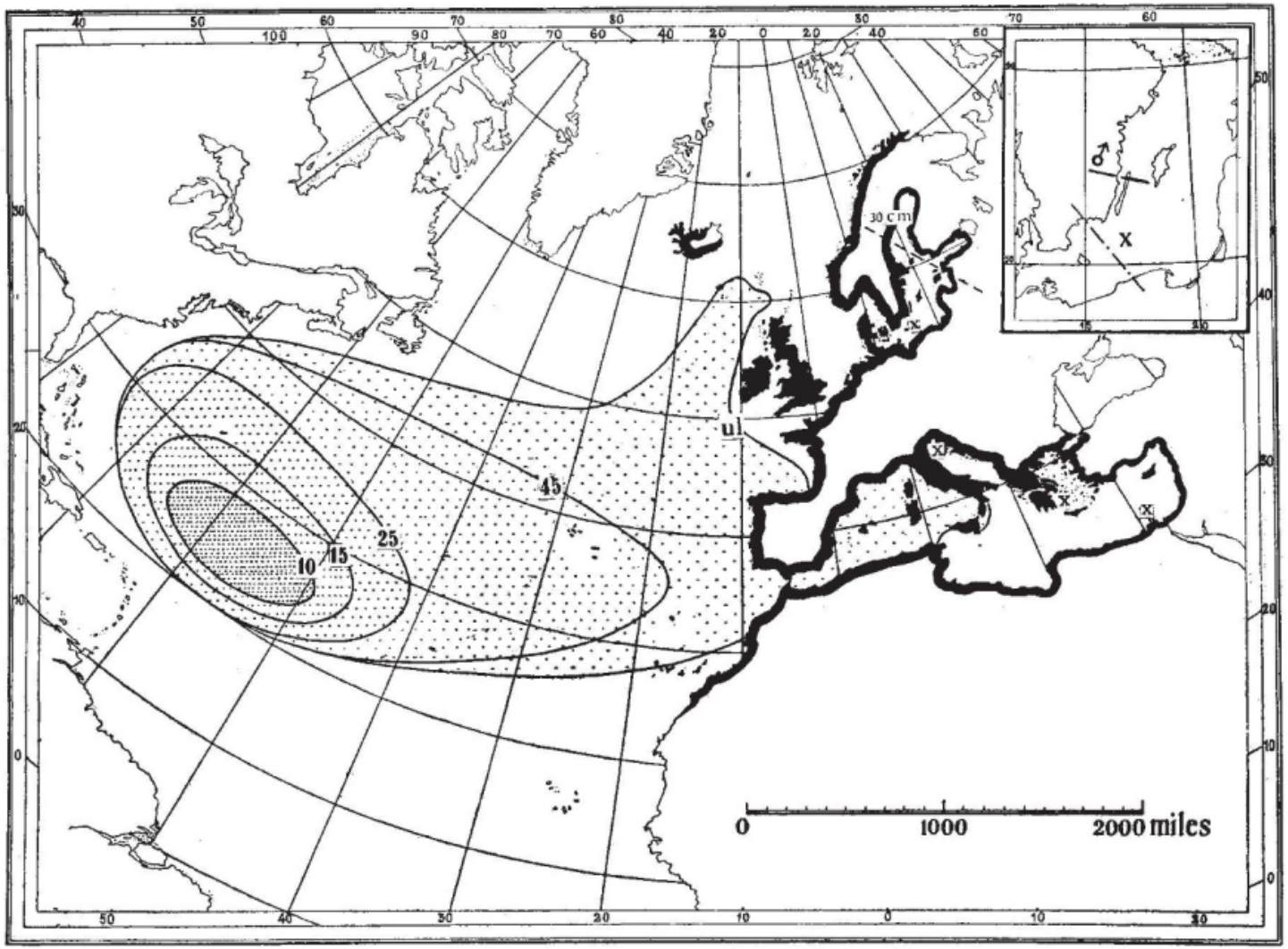

Schmidt (1923) Breeding places and migrations of the eel. Nature.

1 population!?

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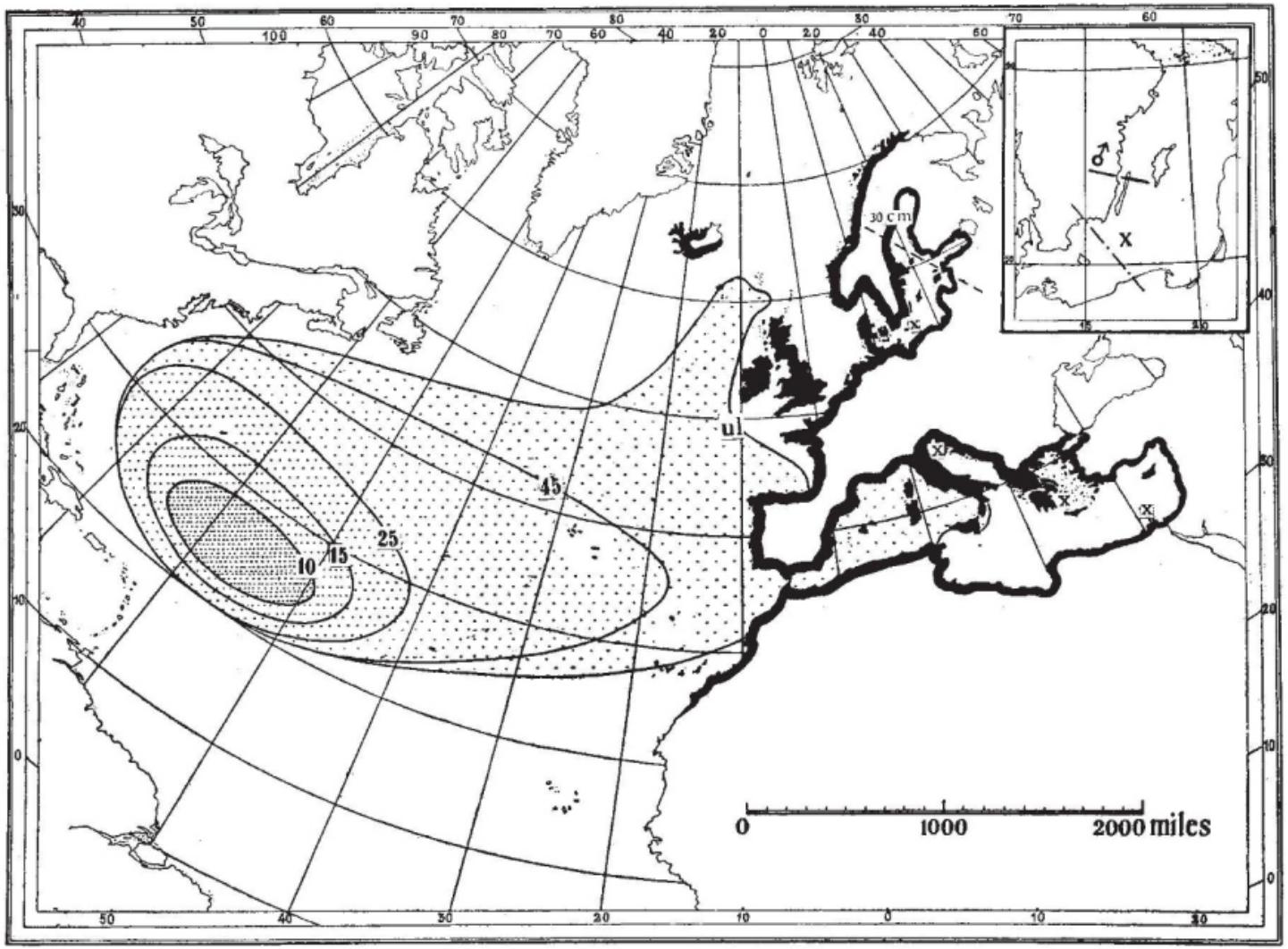

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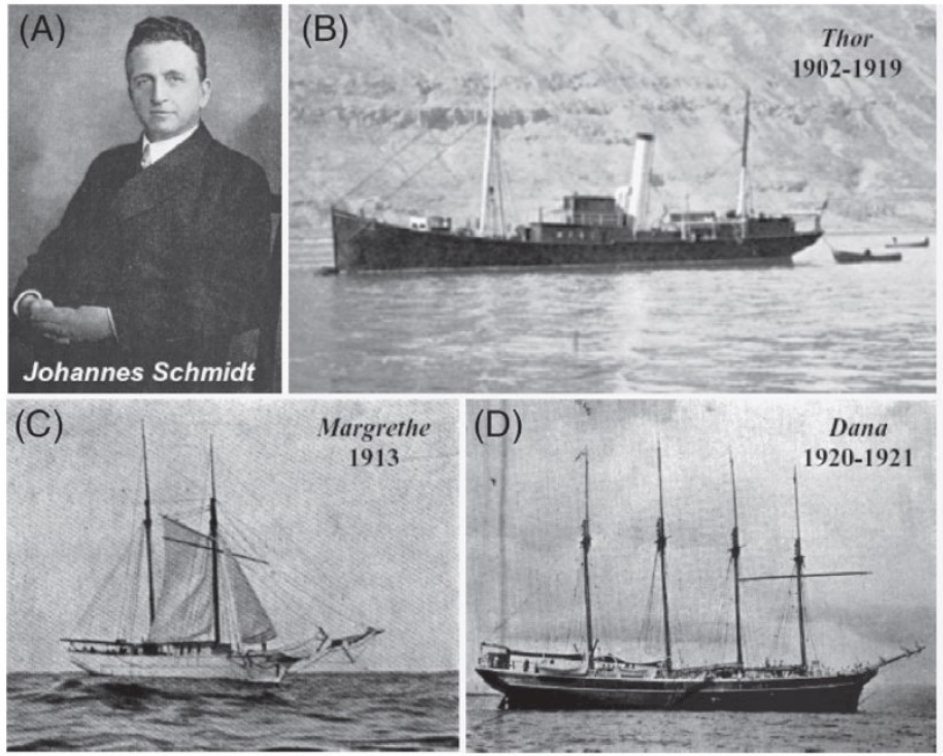
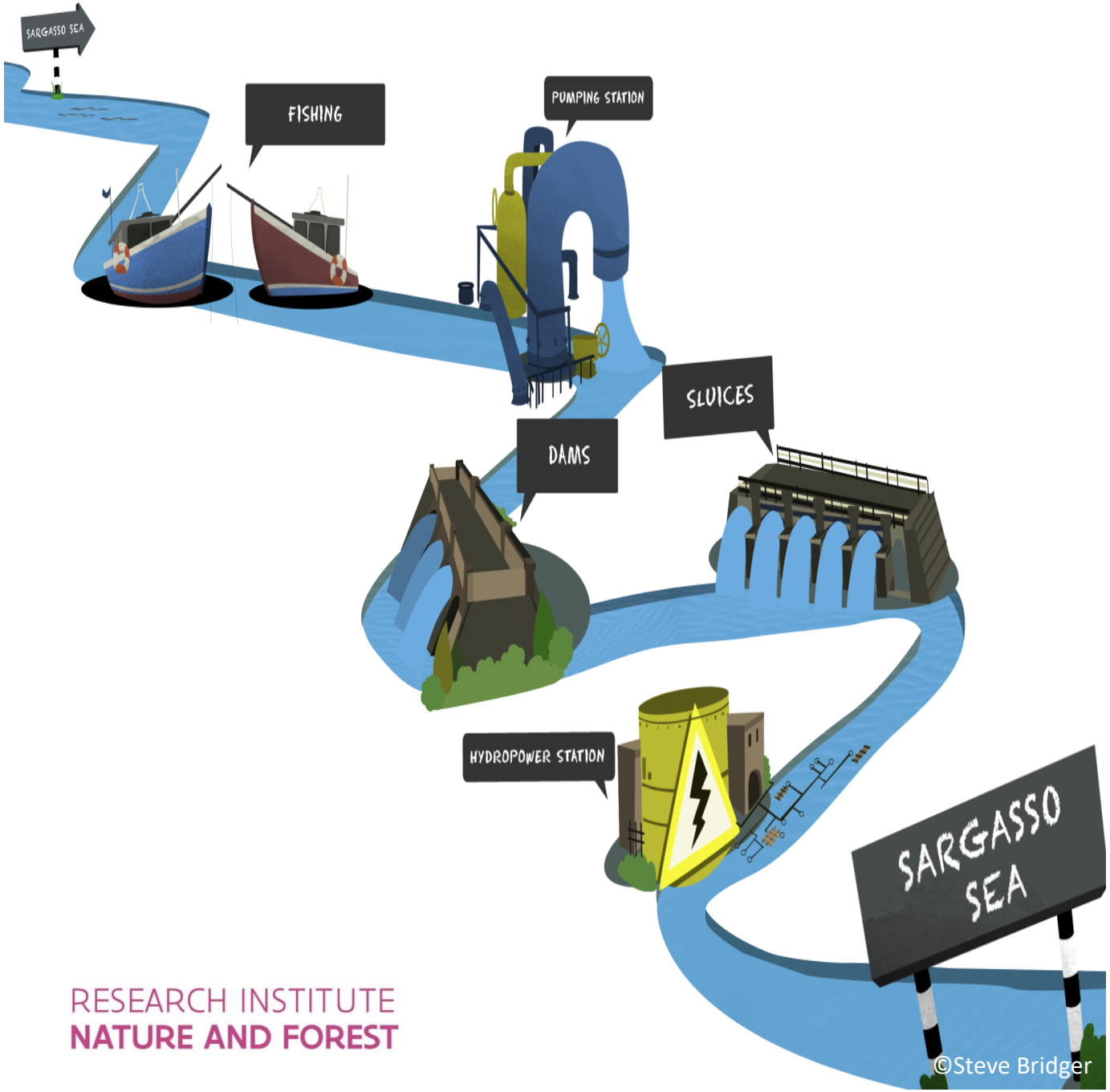


Miller et al. (2015) Biol. Rev.

February – May (Miller et al. 2015 Biol. Rev.)



More than one million barriers fragment Europe's rivers!

Belletti et al. (2020) Nature

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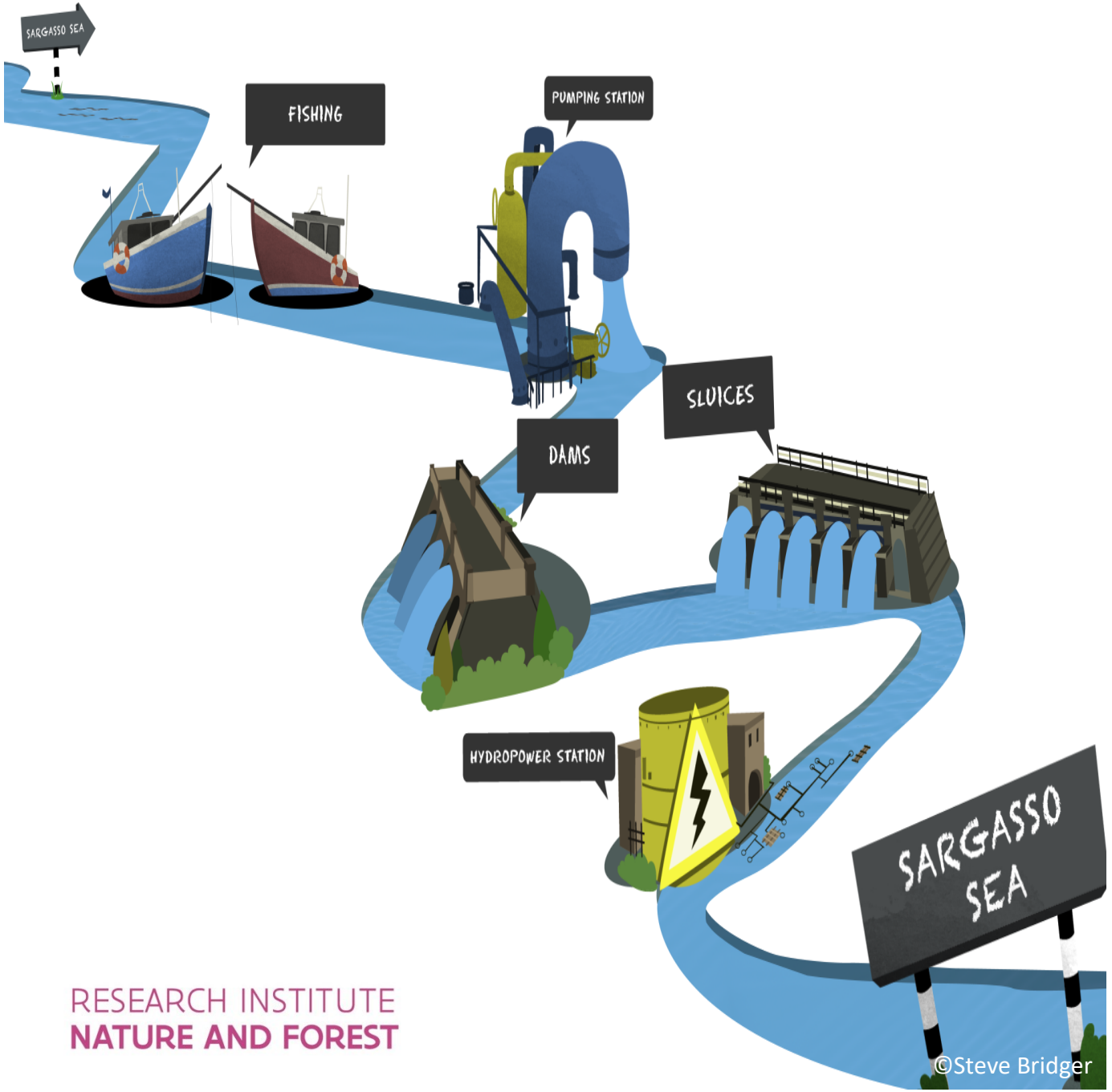
www.vlaanderen.be/inbo



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More than one million barriers fragment Europe's rivers!

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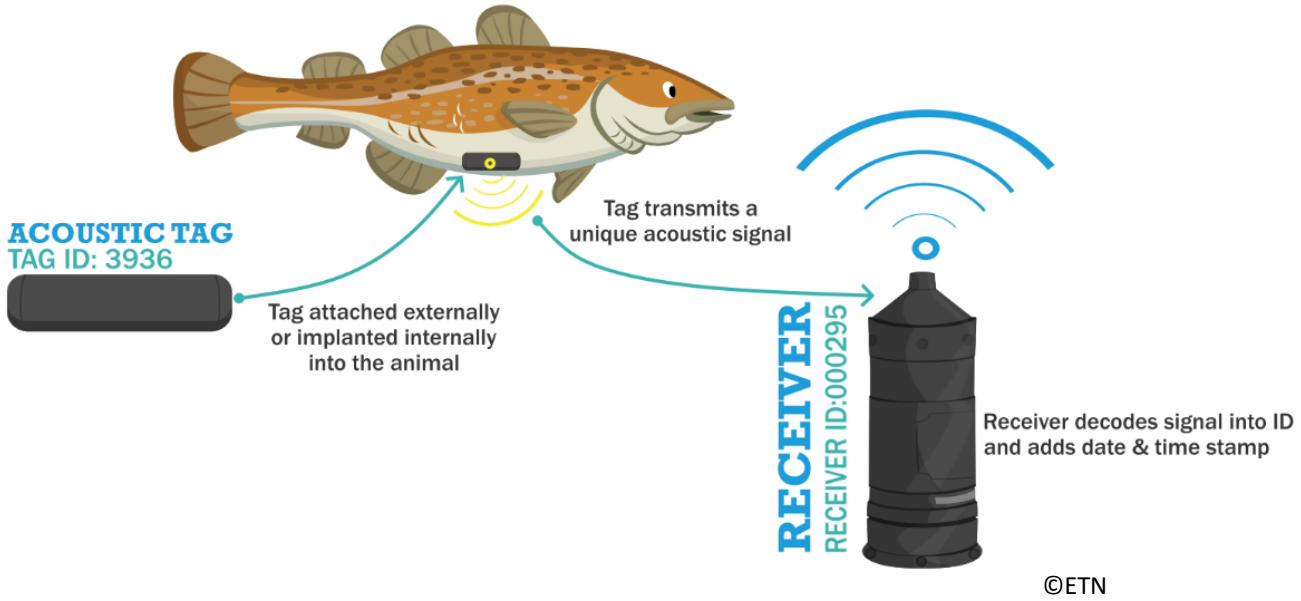
Flanders
State of the Art

Questions…

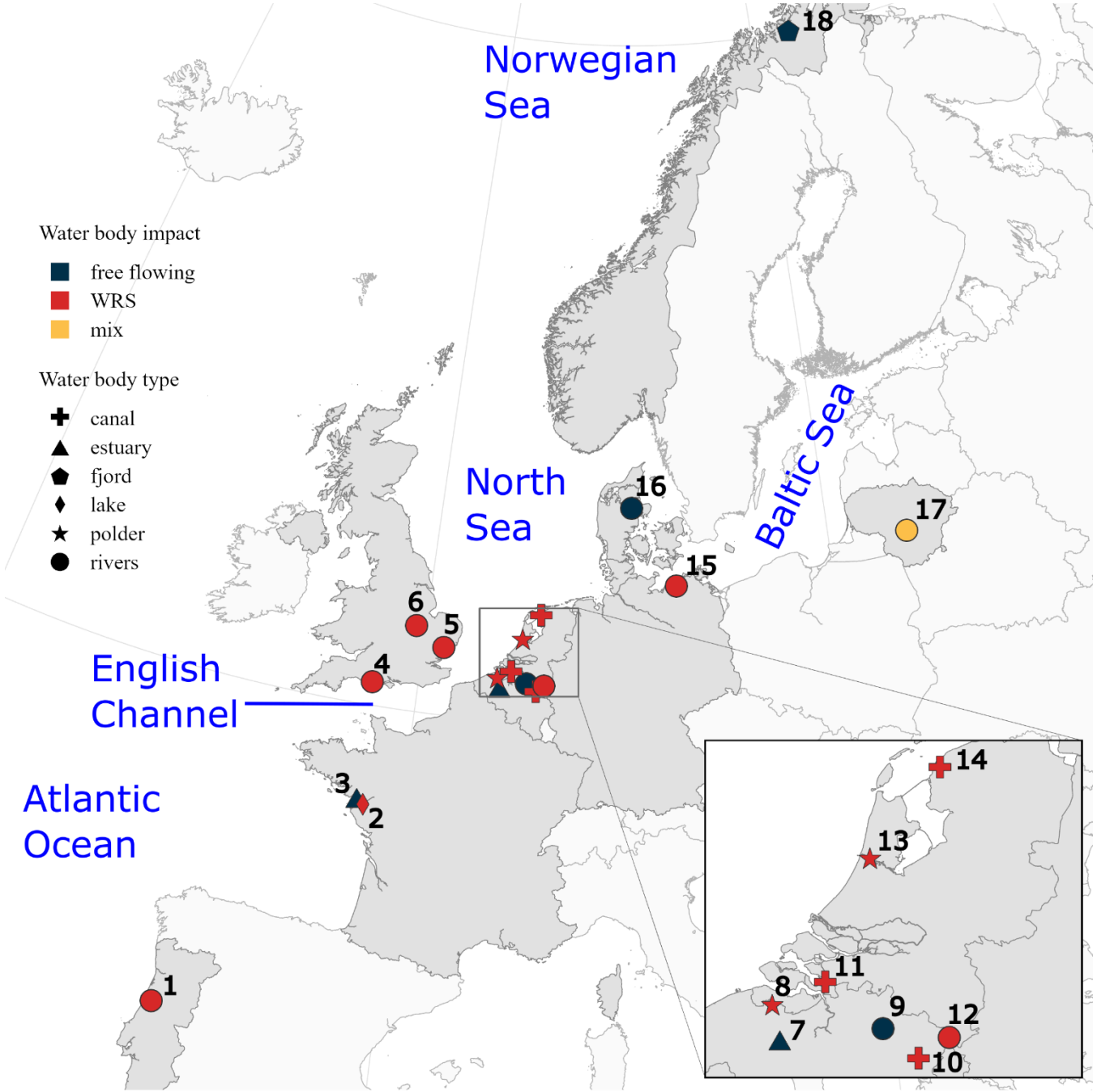
1. Escapement success to the sea?
2. Arrival time at sea (≈ migration period)?
3. Migration speed?

Acoustic telemetry



©ETN

Nedap Trail System



https://www.lifewatch.be/etn/

- 2306 tagged eels
- 2002 - 2022

Setting some definitions

Water body classification based on WRS

Class A

free flowing water bodies

Class B

regulation by weirs and sluices

Class C

hydropower plants

Class D

shipping canals with shipping locks

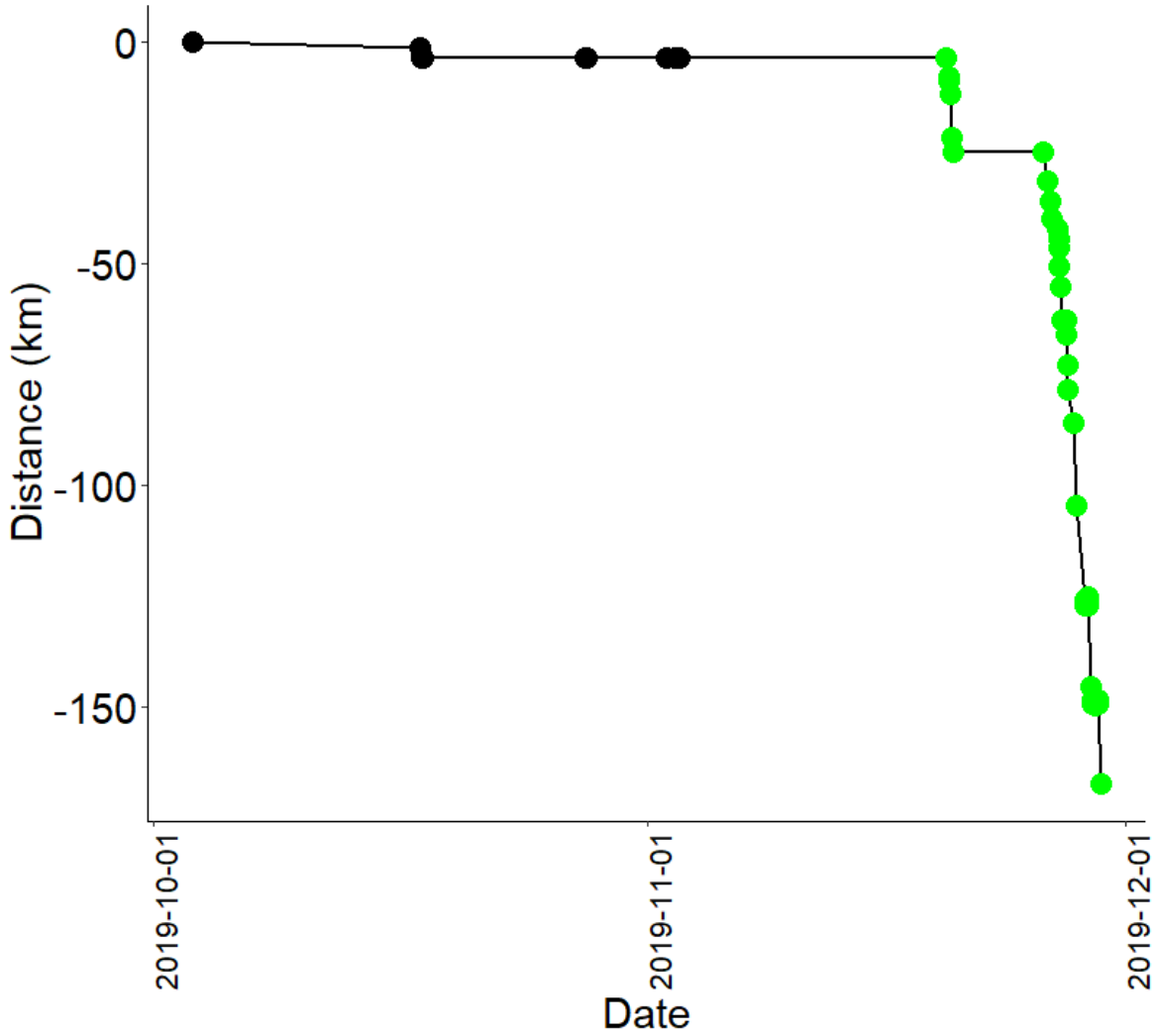
Class E

polders with pumping stations

Setting some definitions

Migration vs non-migration

- **4000 m**
- **0.01 m/s**

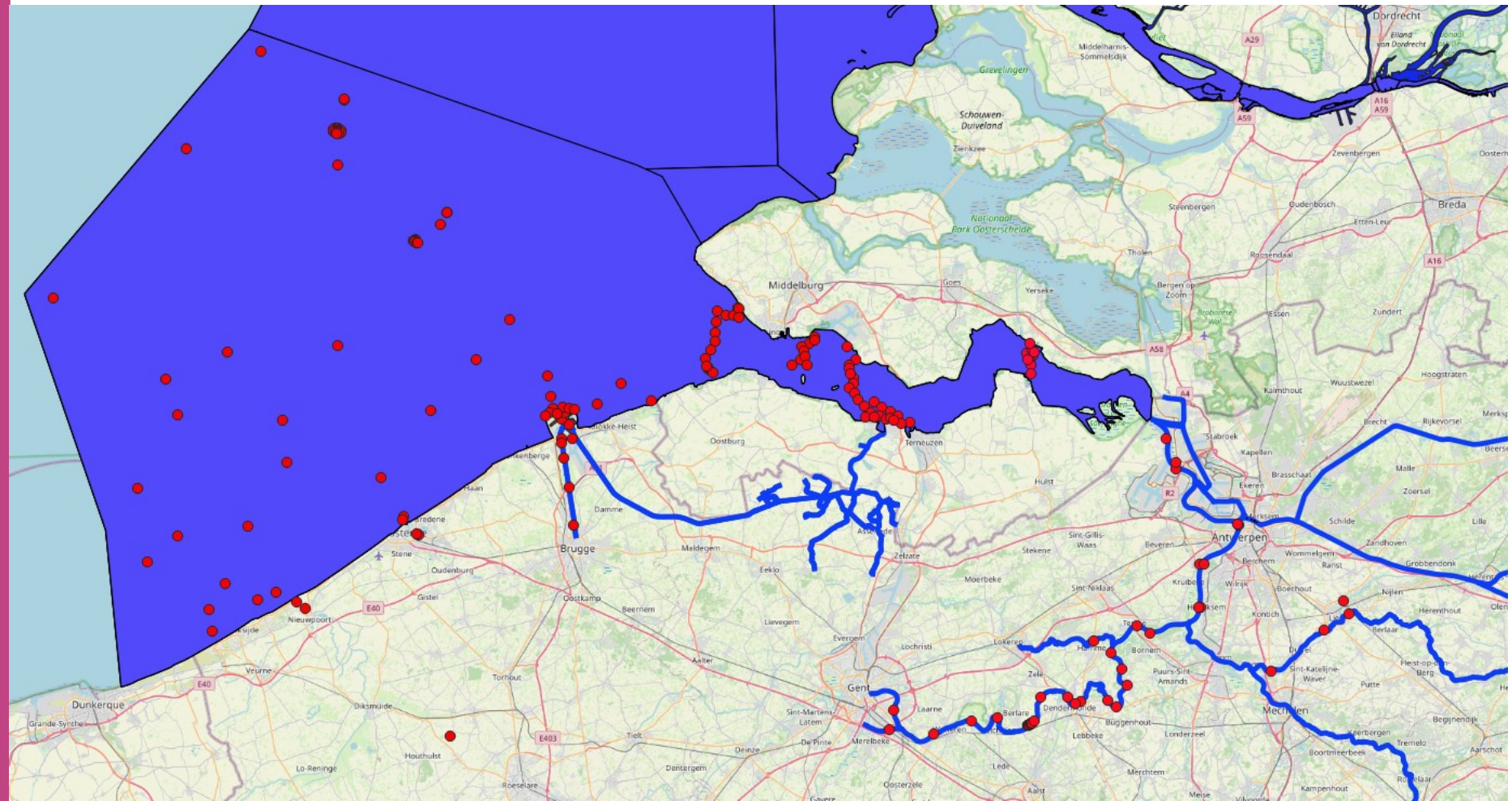


Distance calculations

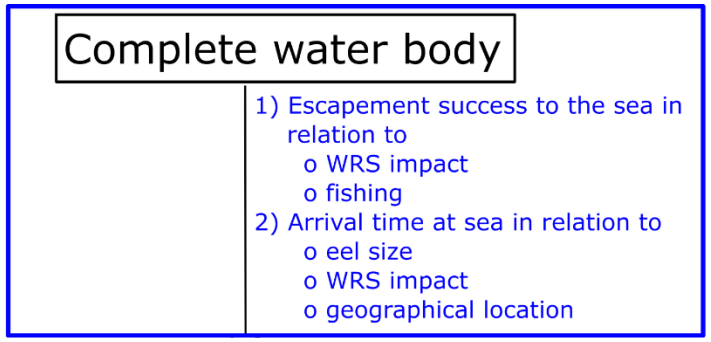
damiano.oldoni@inbo.be

Lines, polygons or combo!

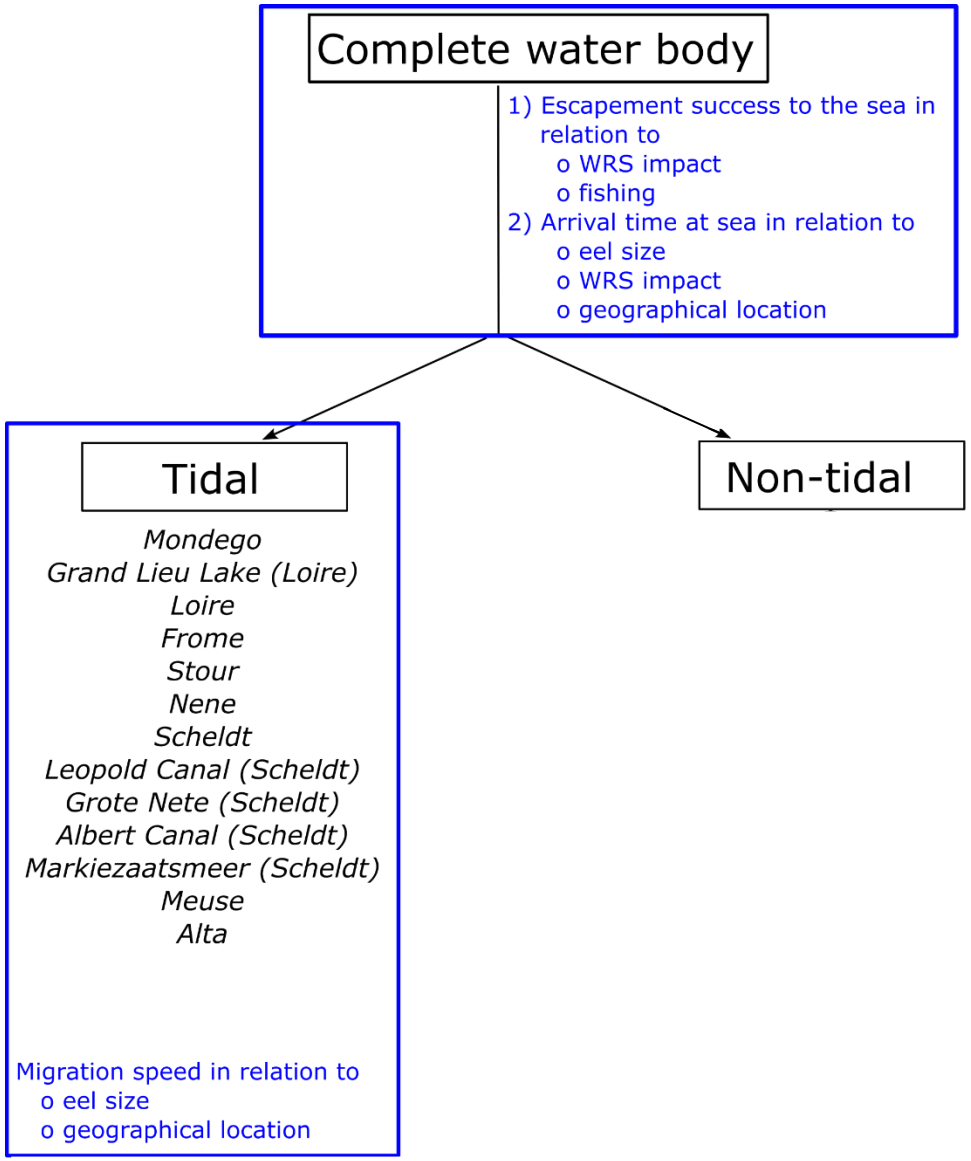
https://github.com/inbo/fish-tracking/tree/master/scripts/receiver_distance_analysis



Workflow



Workflow



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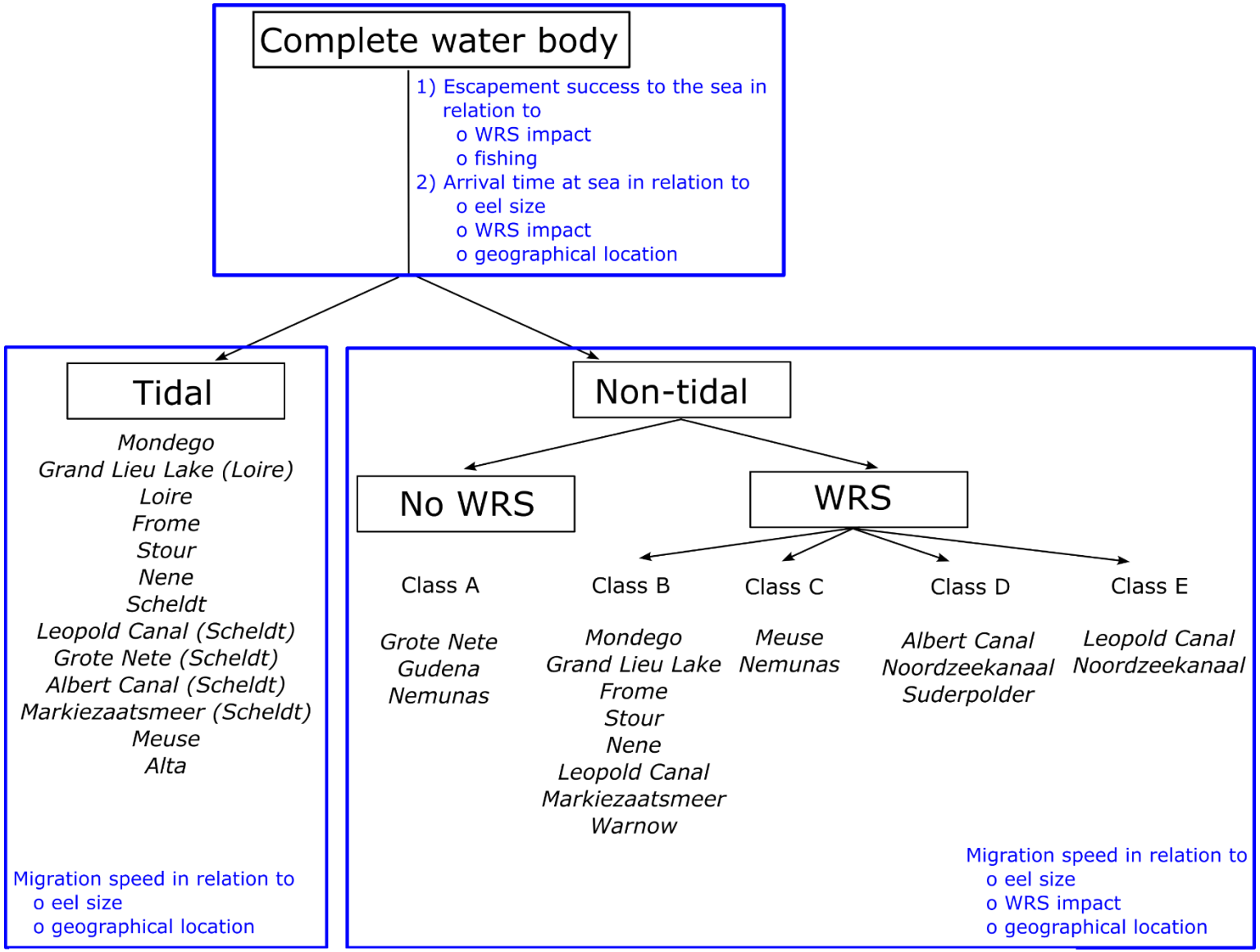

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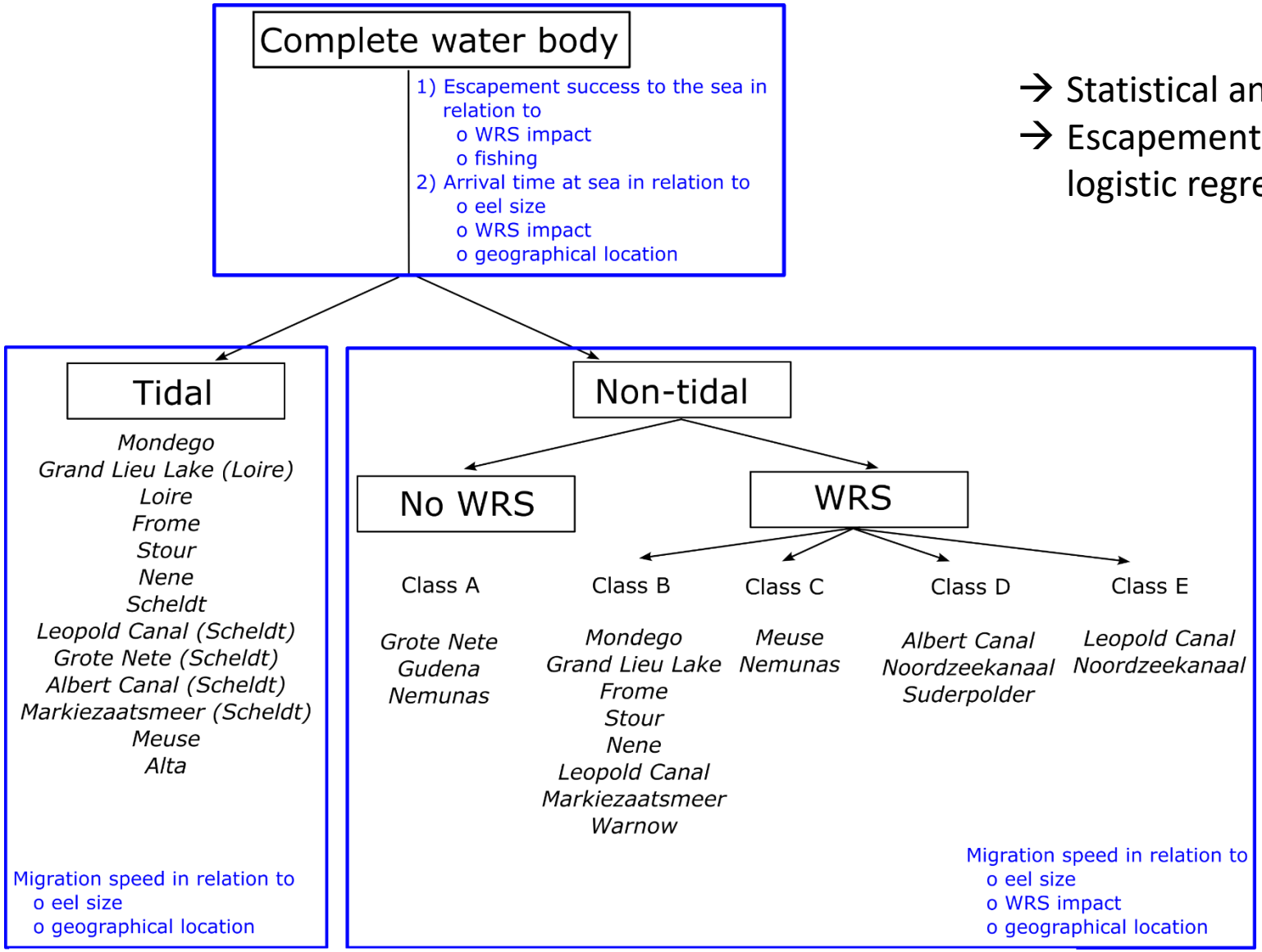
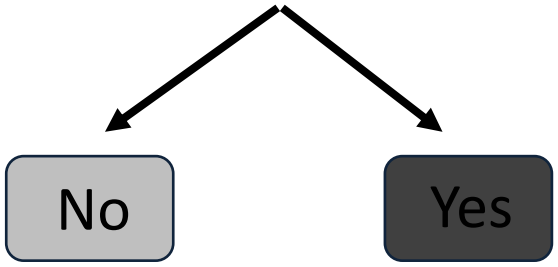


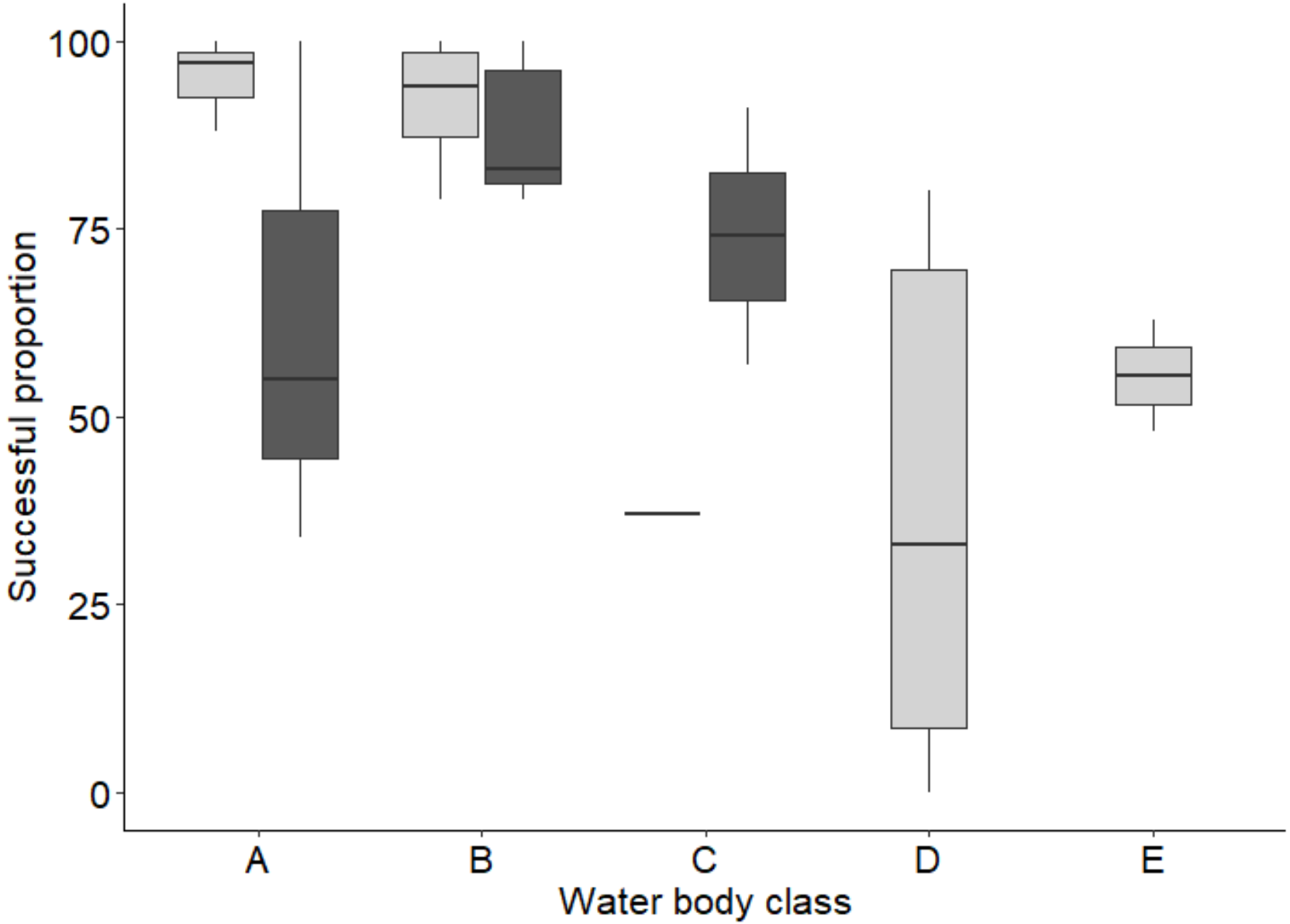
→ Statistical analyses mainly LMM

→ Escapement success to the sea: logistic regression

1. Escapement success to the sea

- WRS impact
  - A: free flow
  - B: weirs
  - C: hydro
  - D: canals
  - E: polders & pumps
- Commercial fishing





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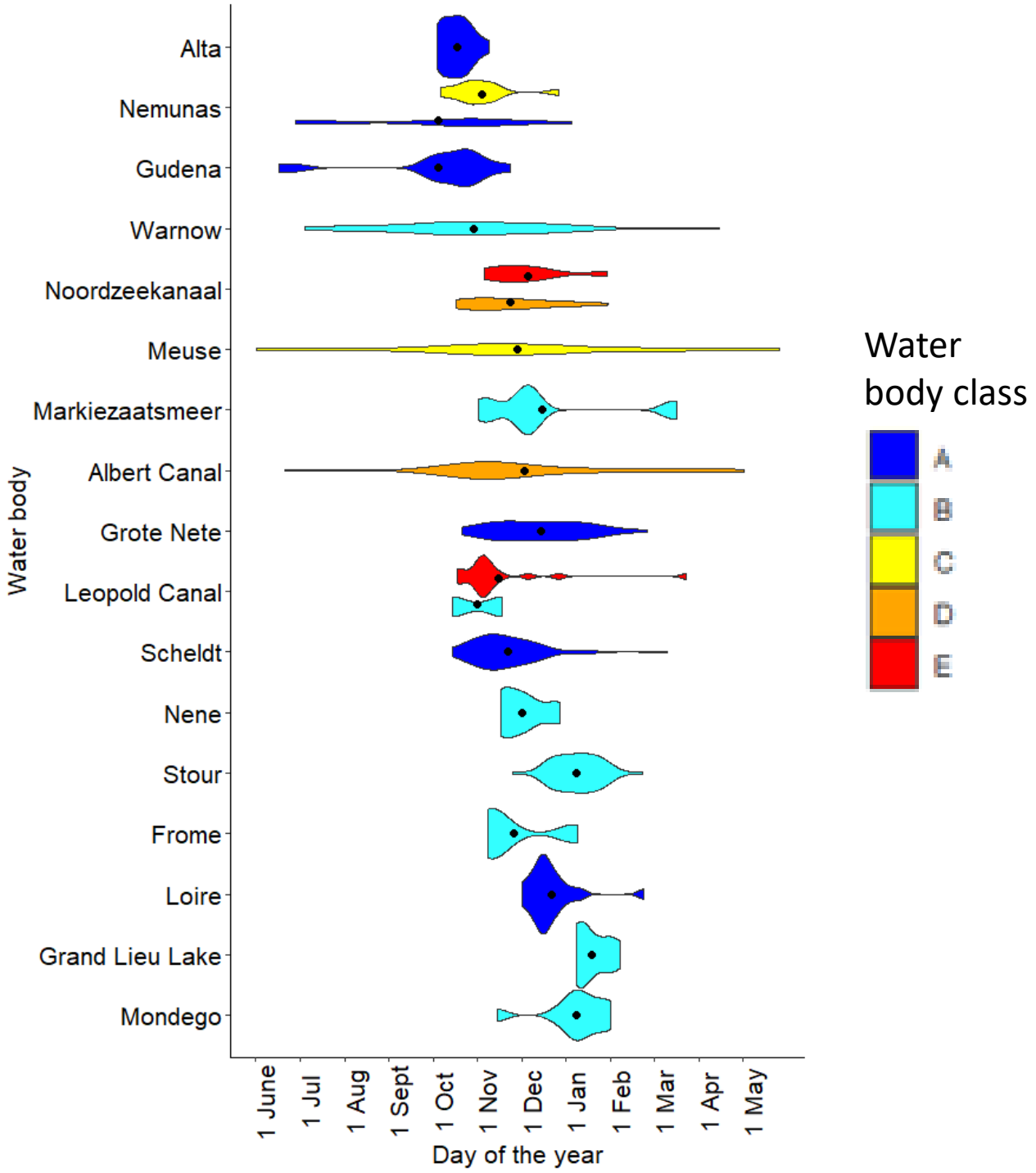
2. Arrival time at sea

- WRS impact
  - A: free flow
  - B: weirs
  - C: hydro
  - D: canals
  - E: polders & pumps
- Eel size
- Geographical location



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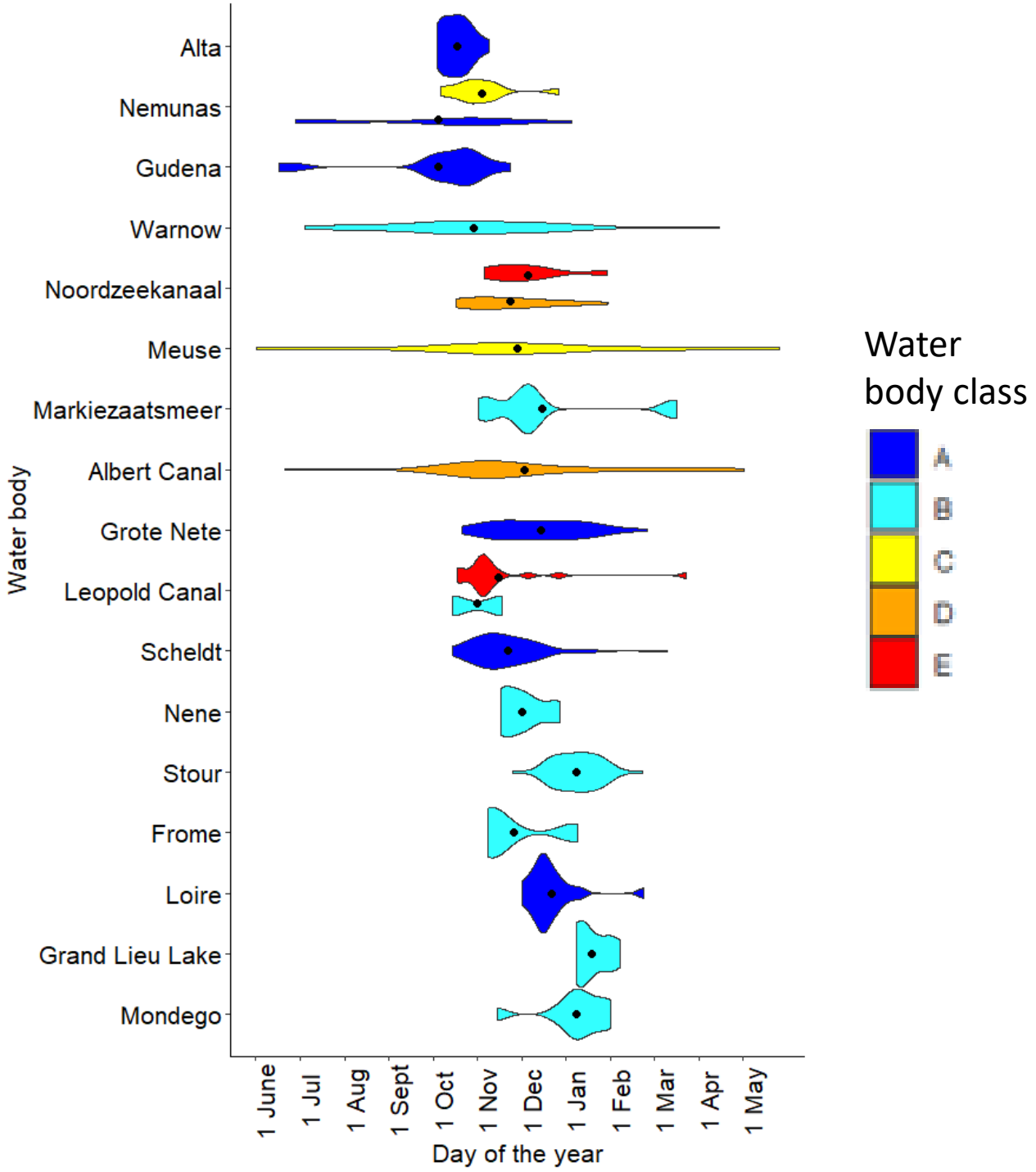

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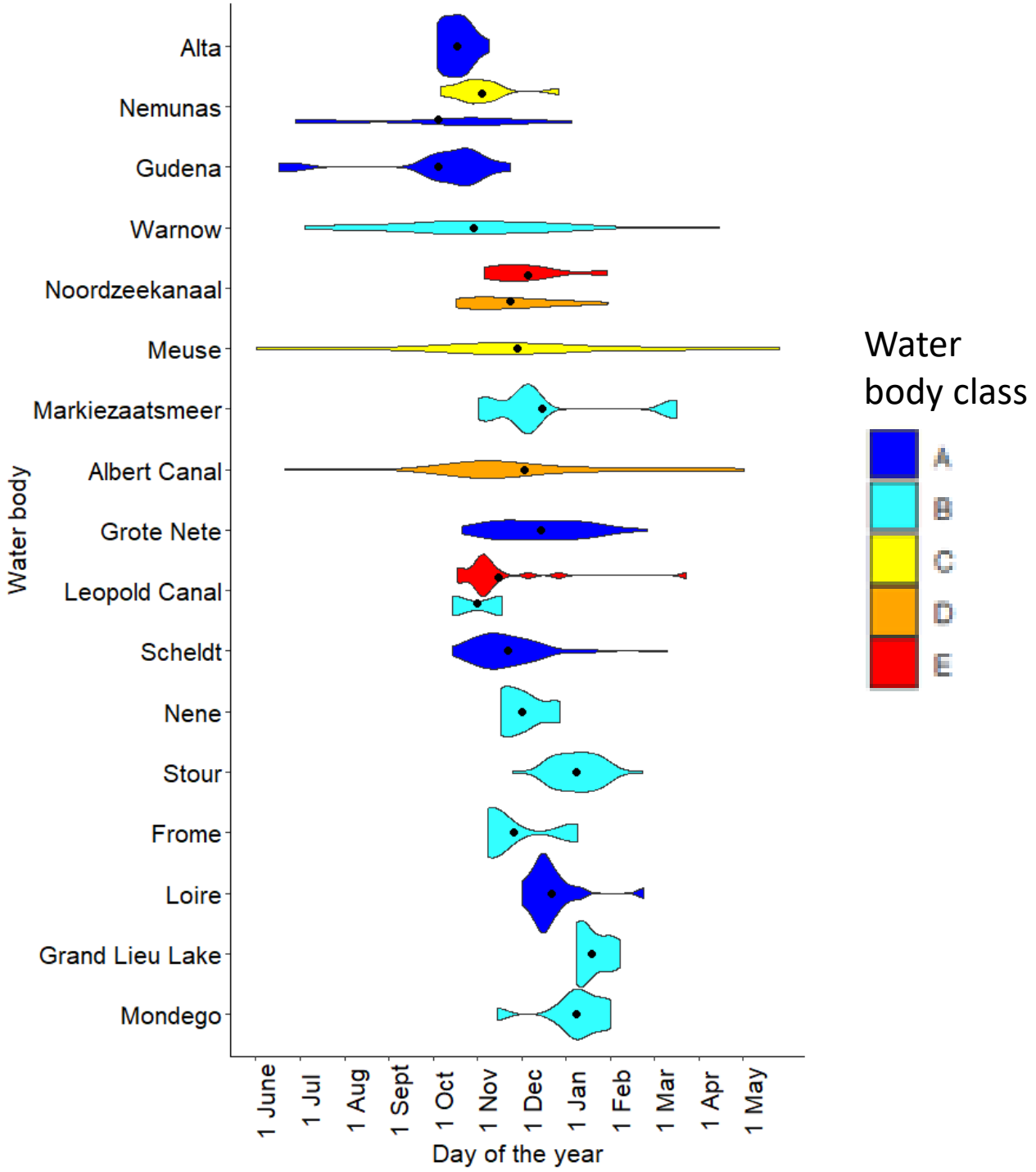
  - Larger eels migrate later
- Geographical location



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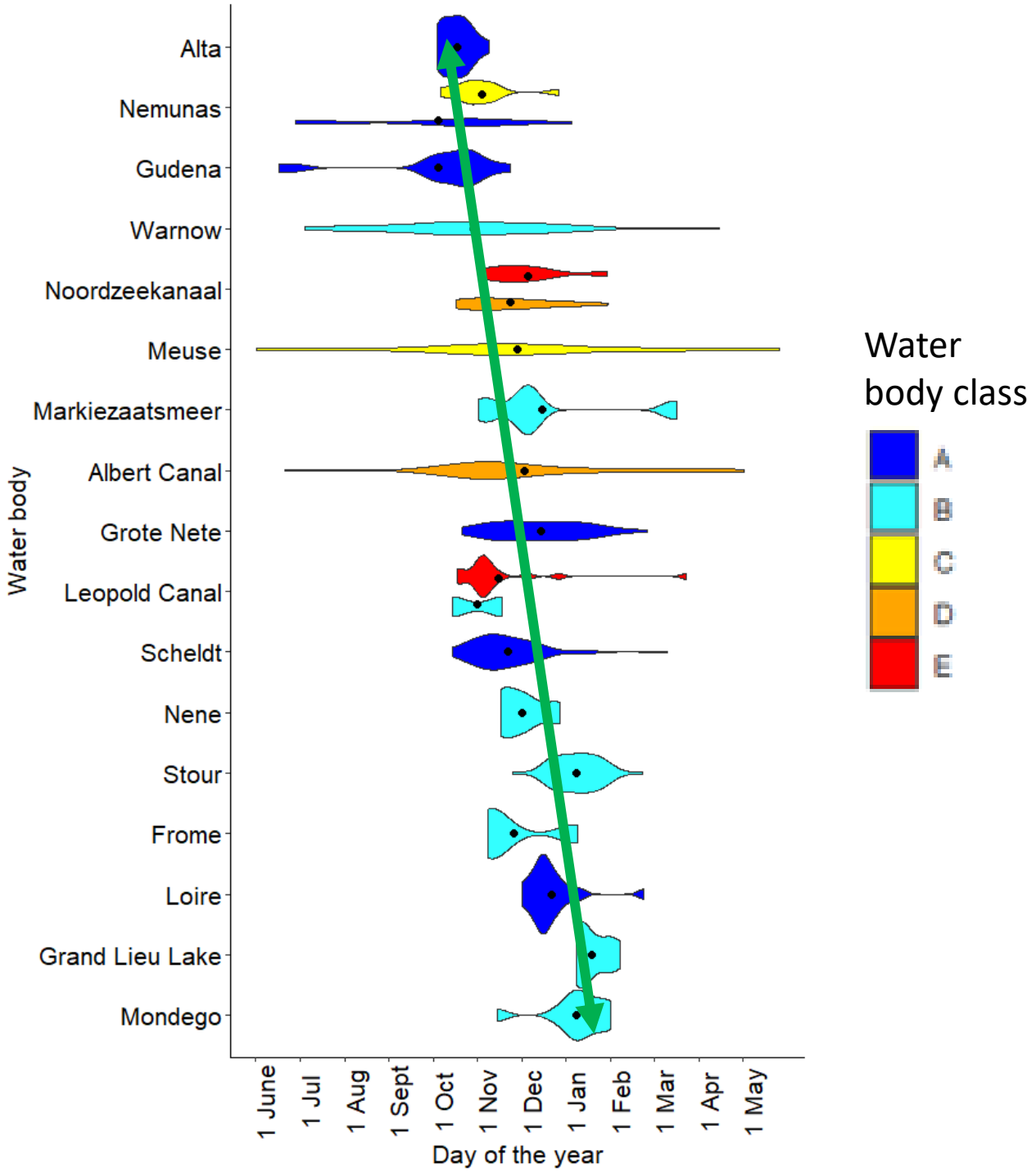
  - Larger eels migrate later
- Geographical location
  - ~ 3 months between PT & NO



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3. Migration speed

Tidal **Non - tidal**

3. Migration speed

Tidal

0.45 ± 0.93 m/s
(range: < 0.01 – 5.99 m/s)

Eel size

Geographical location

Non - tidal

3. Migration speed

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0.15 ± 0.25 m/s
(range: < 0.01 – 1.61 m/s)

Eel size

Geographical location

WRS impact

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Estuarize

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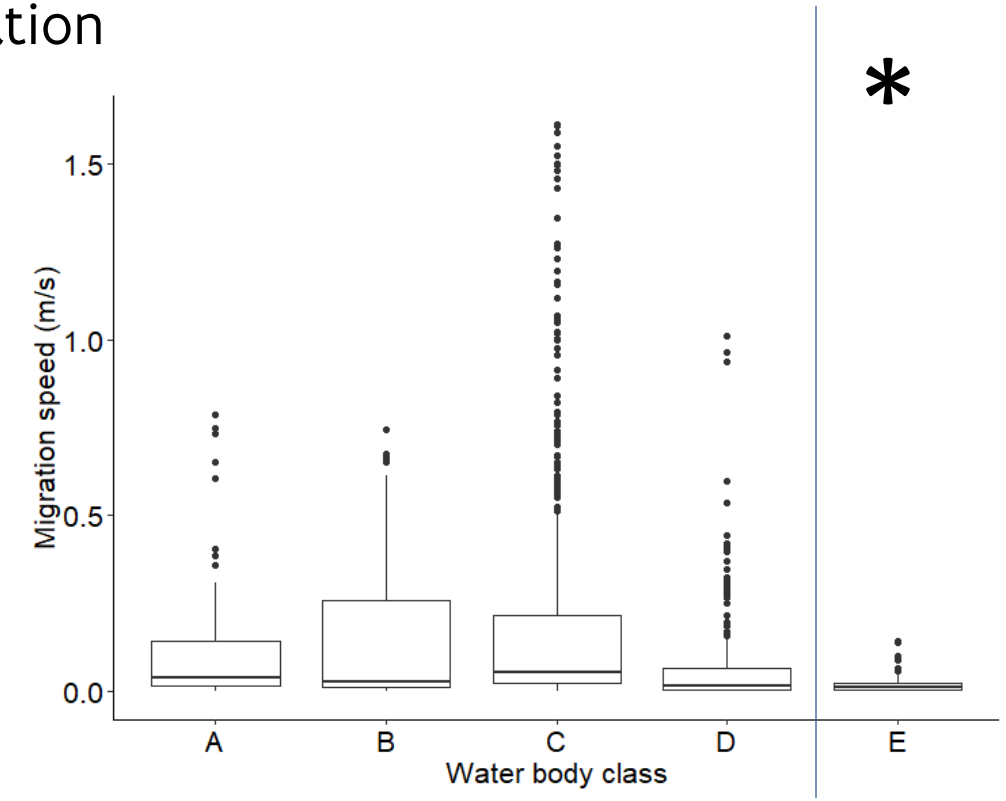
WRS impact

*



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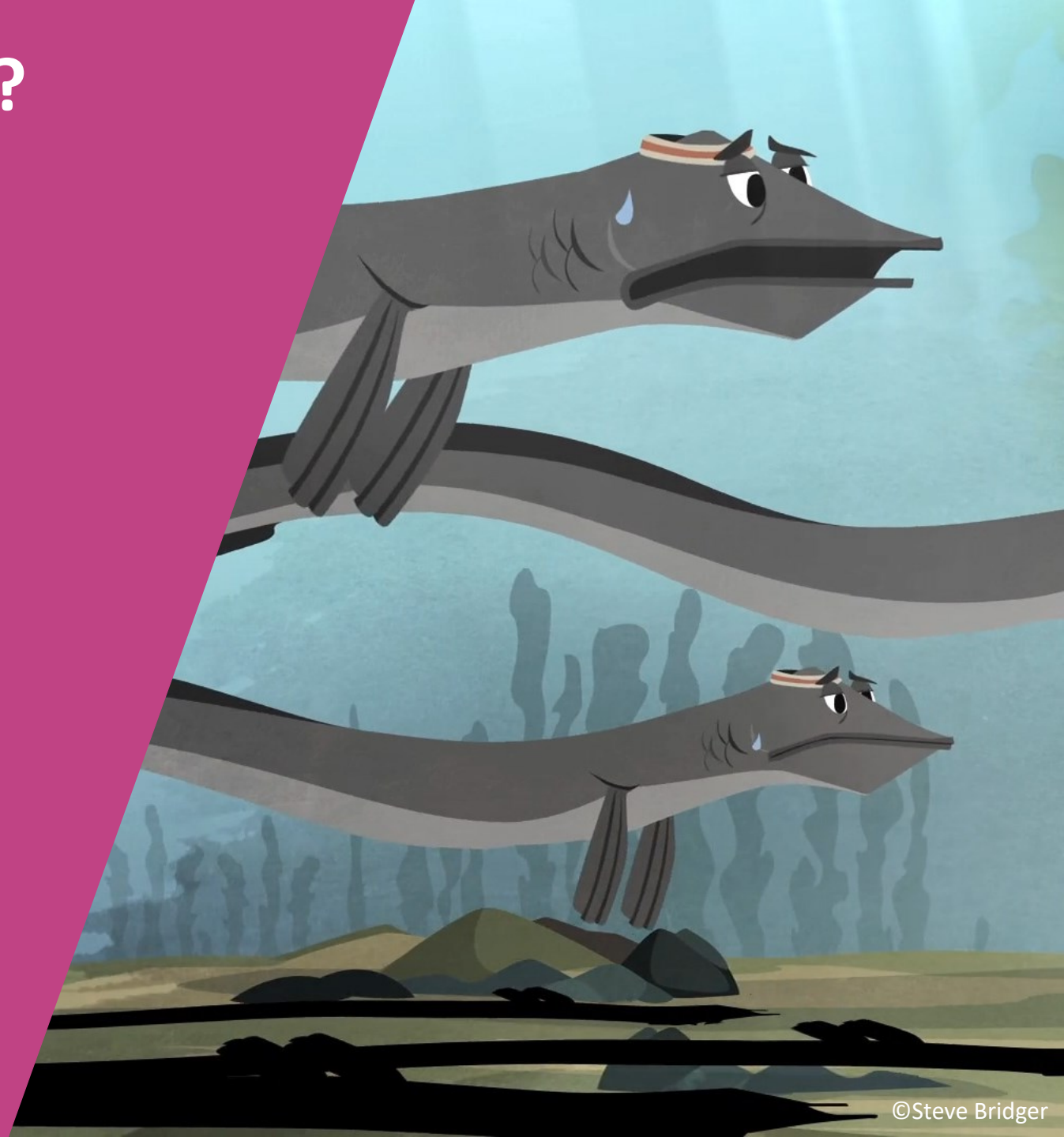
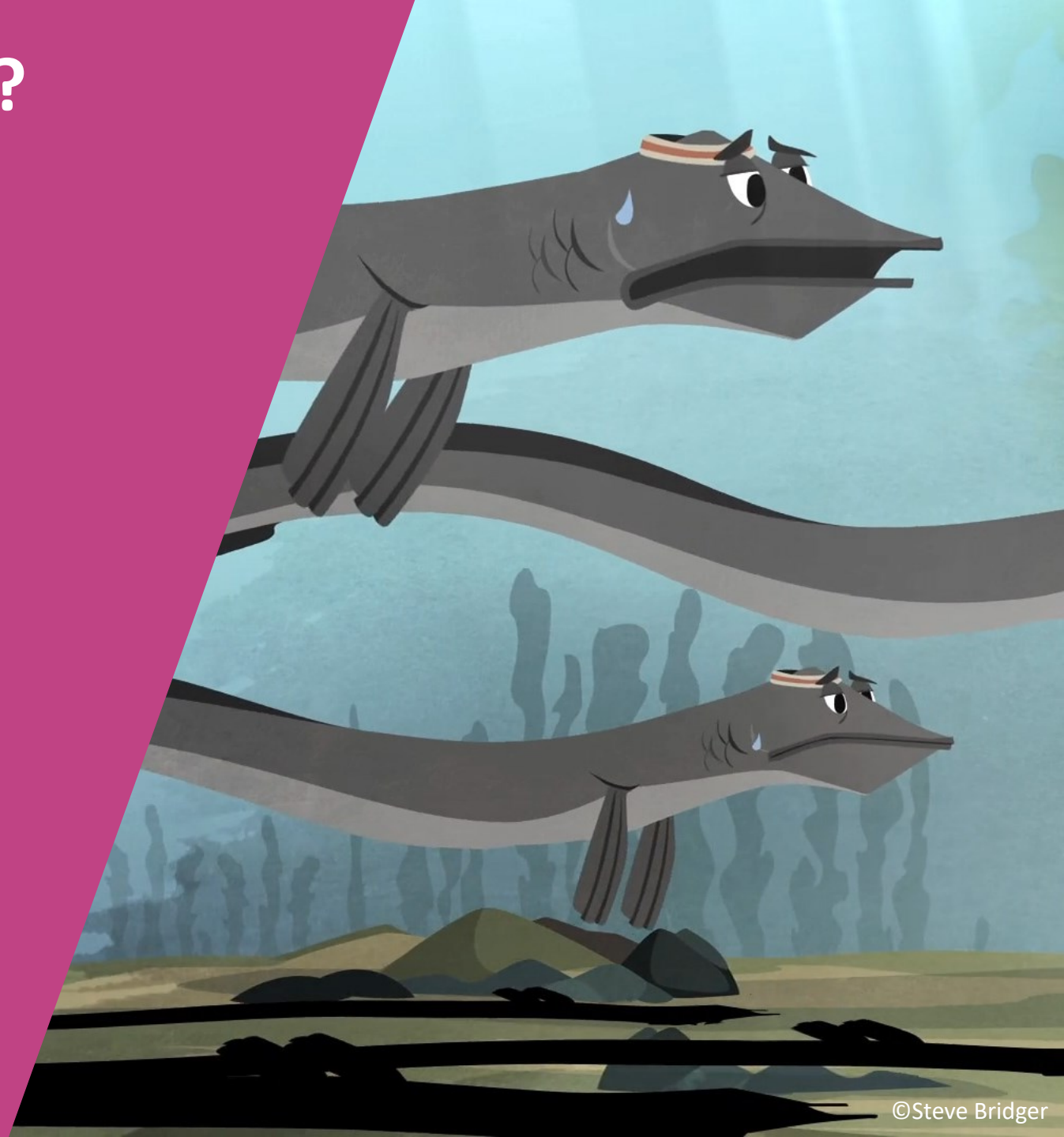
So, what does this all mean?



So, what does this all mean?

1. Escapement success
   - ❑ Free flow ≈ weirs (> 90%)
   - ❑ HP, locks, pumps < 50%
   - ❑ Fishing! Variable…



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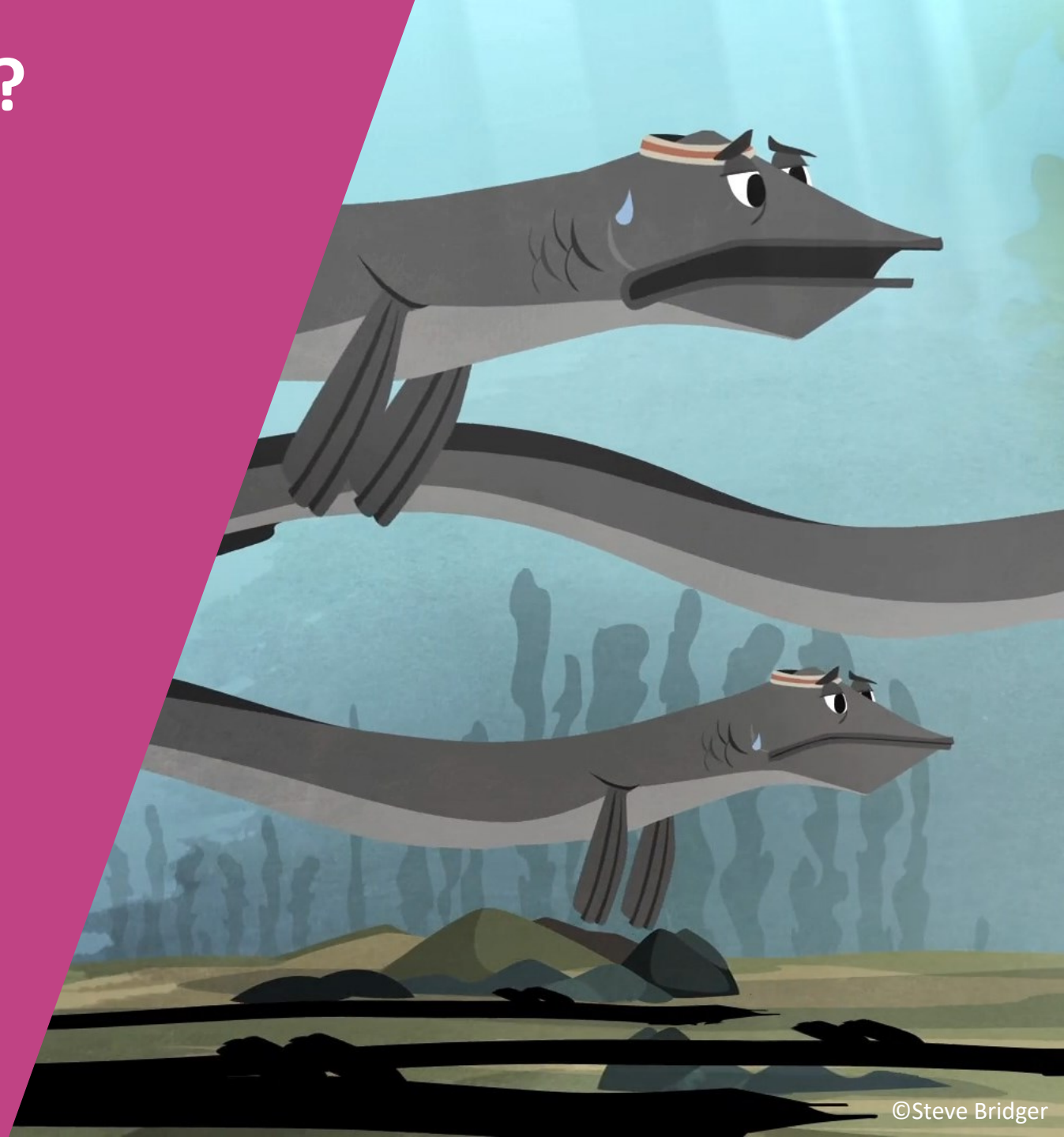
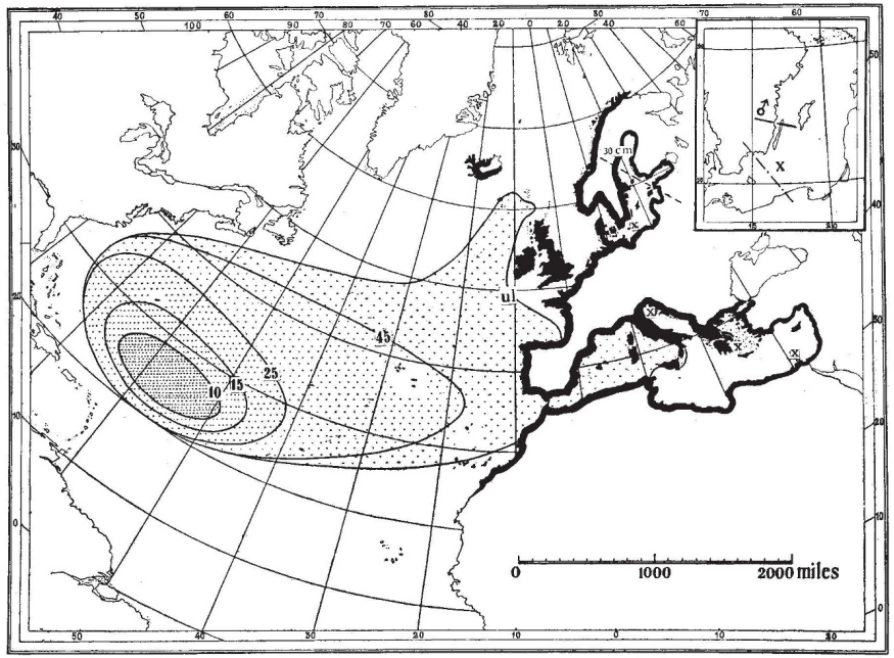


2. Arrival time at sea
   - Distance difference ≠ time difference

   → 40 – 50 km/day?

February – May (Miller et al. 2015 Biol. Rev.)



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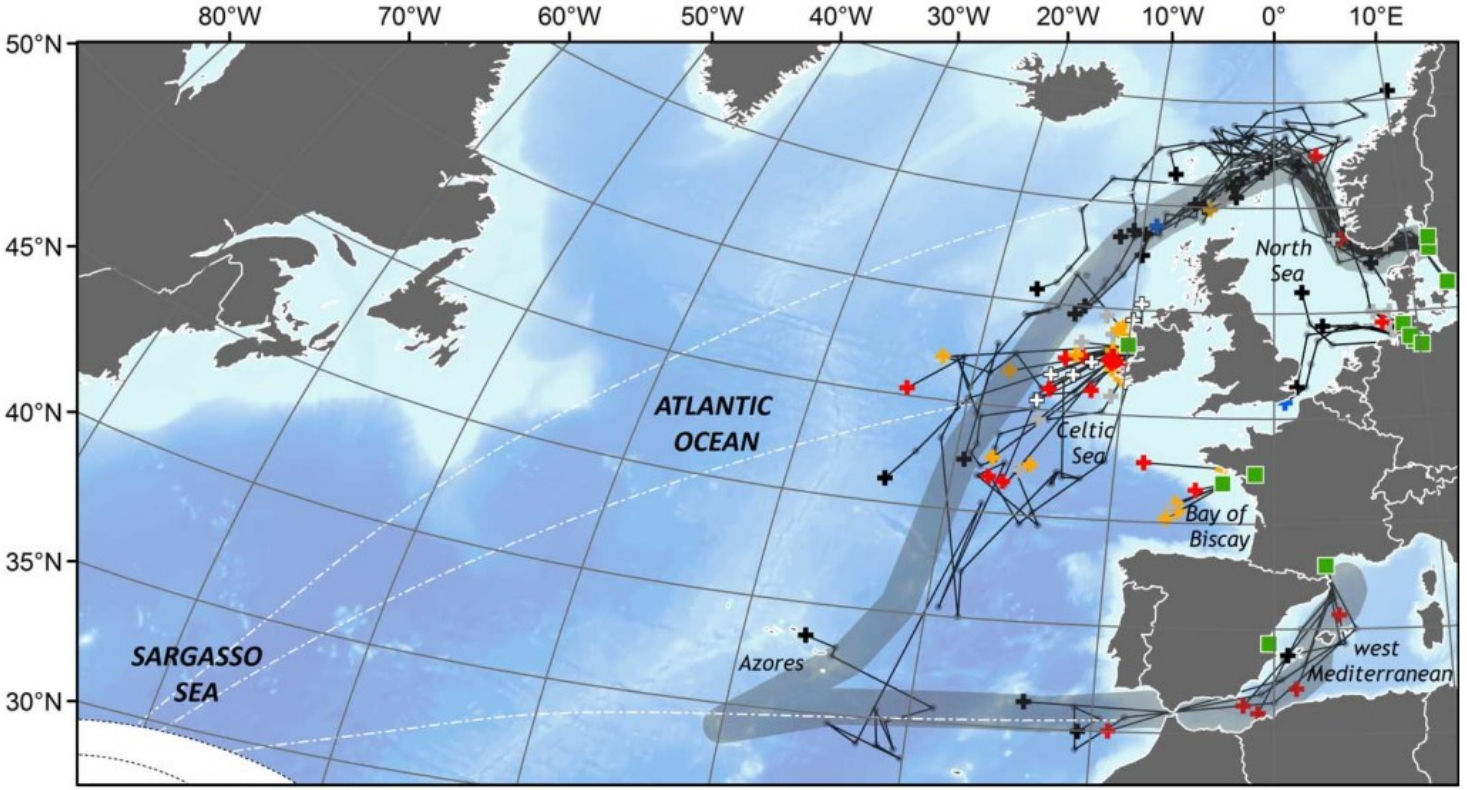

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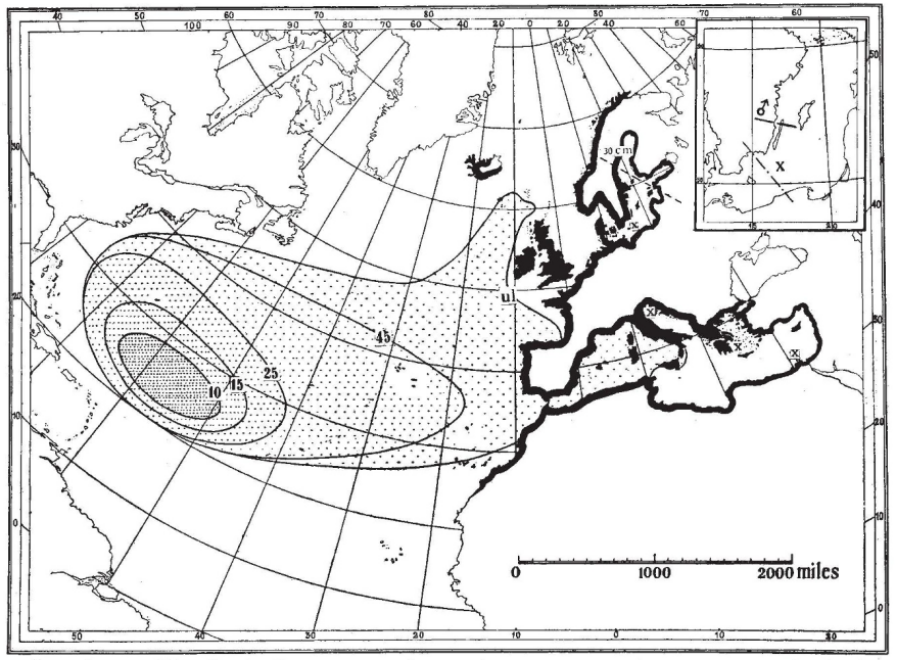

Marine speeds

Righton et al. 2016 Science Advances: **3 – 47** km/day

Verhelst et al. 2022 Scientific Reports: **7 – 45** km/day

Amilhat et al. 2016 Scientific Reports: **4 – 17** km/day

Huisman et al. 2016 MEPS: **12 – 25** km/day

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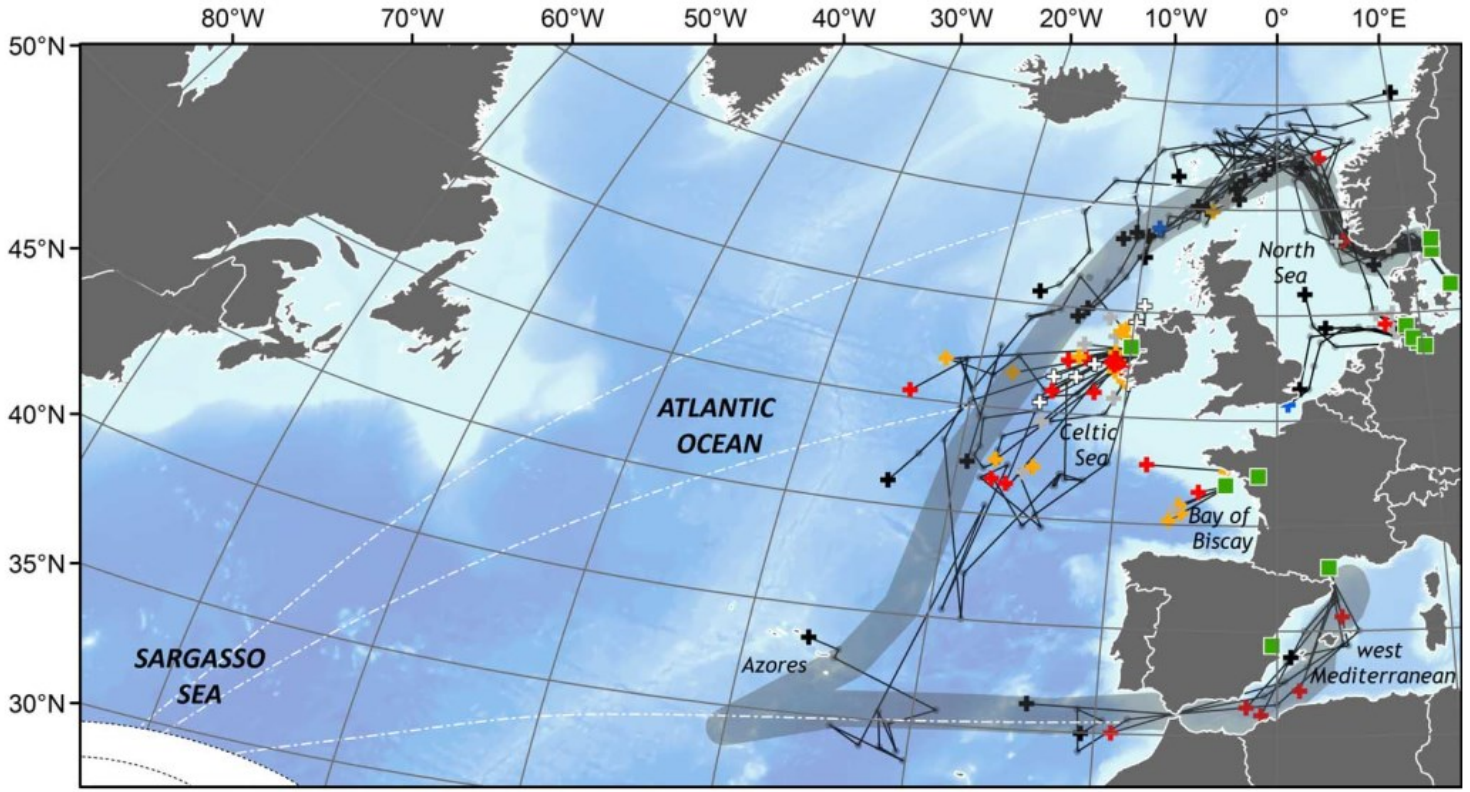
→ 40 – 50 km/day?

→ Eels arrive at the next spawning season in SG?



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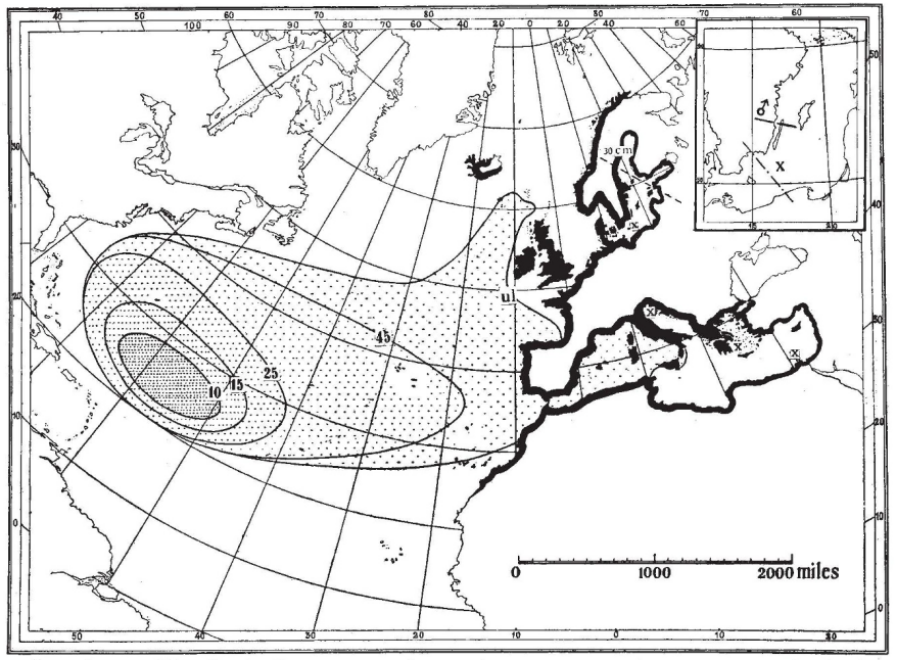

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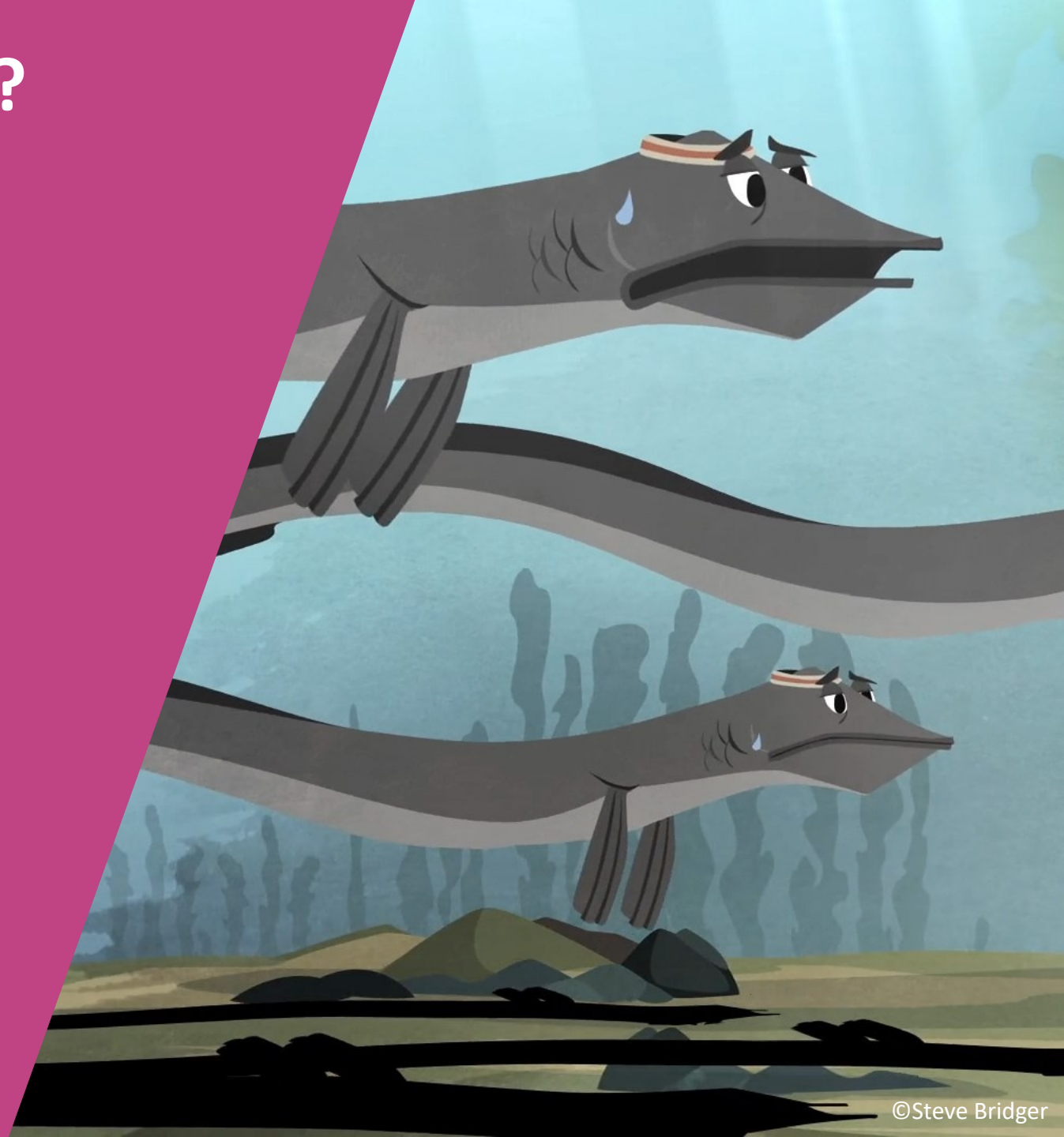
   - ❑ Standard/reference
   - ❑ More cases needed



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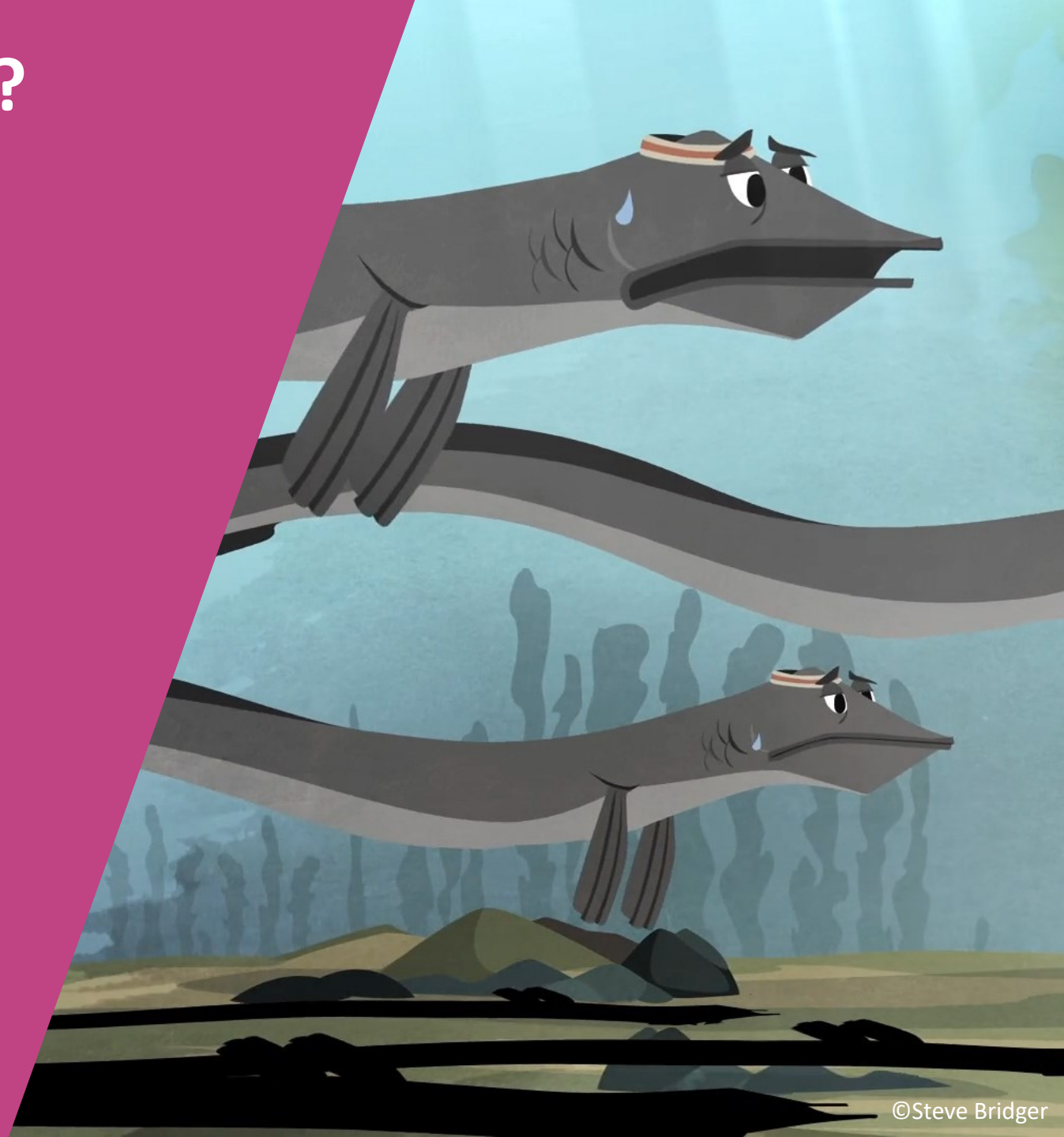
4. Gaps
   - ❑ Med?
   - ❑ Macaronesian islands?
   - ❑ Sex?



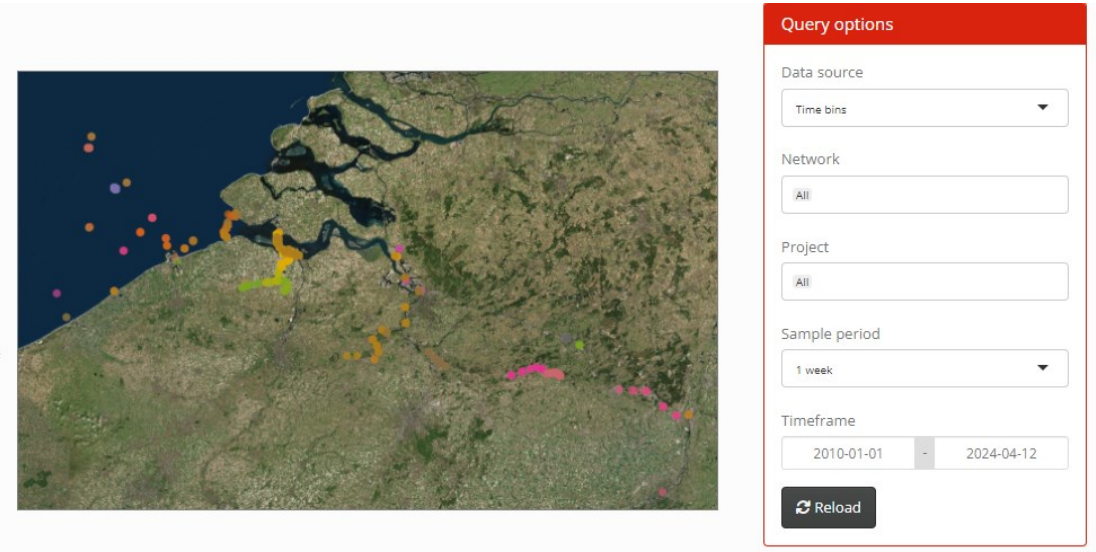
Store data in databases and help build the legacy!

https://www.lifewatch.be/etn/

- Data backup
- Reuse of data (ethics)
- Data standards
- FAIR principes
- Dataset citations!
  - Important for funding?

etn R package (GitHub)

https://rshiny.lifewatch.be/etn-data/



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Affiliations

Funding