Urban glass eels in a man-made fragmented catchment: migration from large ship locks in the North Sea Canal to Amsterdam and surrounding polders

A.B. Griffioen, O.A. van Keeken, T. Wilkes, P. Deitelzweig, X. de Boer, B. van Houten, A.D. Buijse and H.V. Winter

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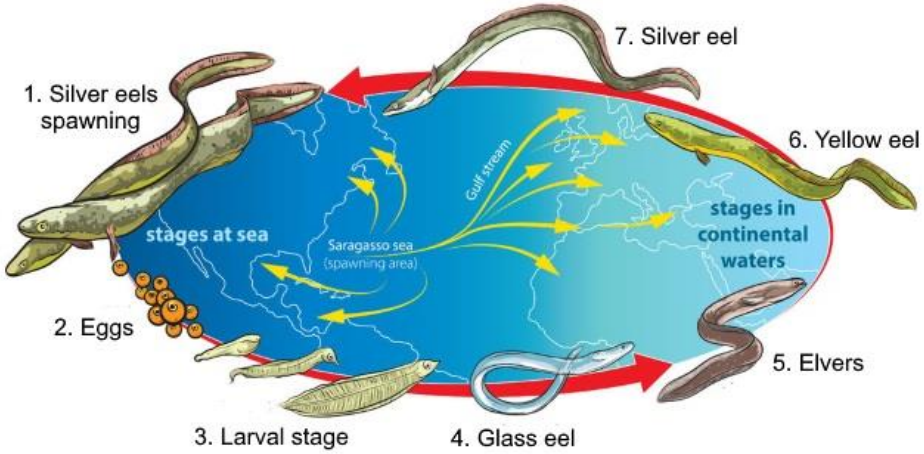
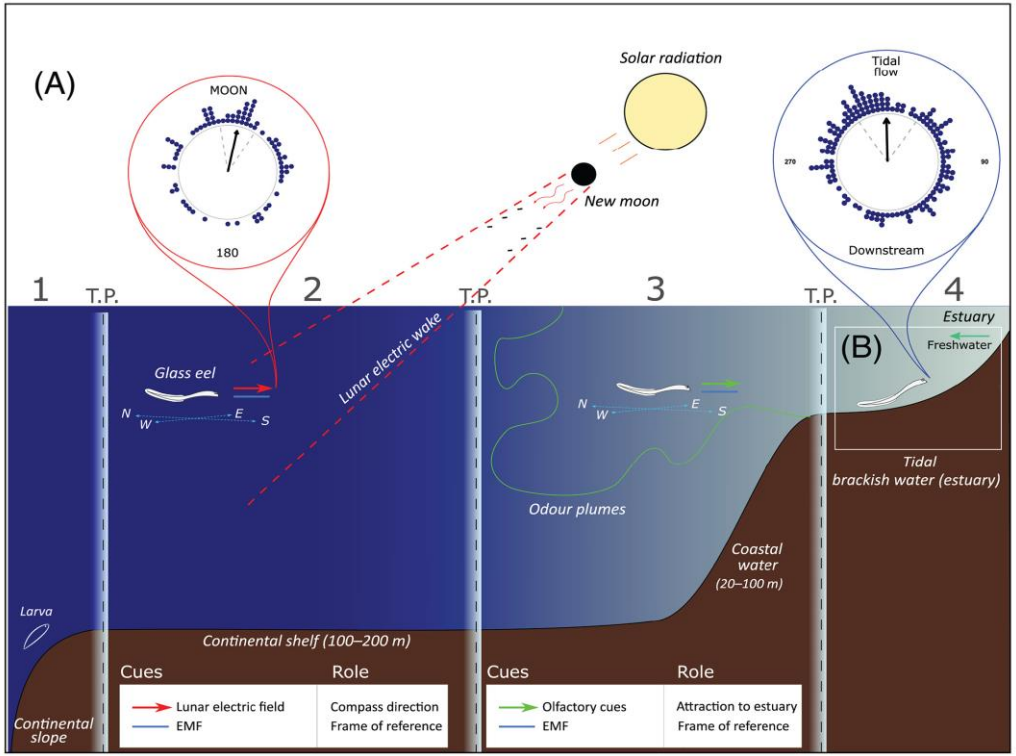
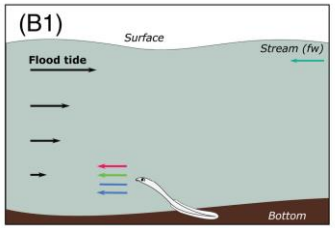
The European eel

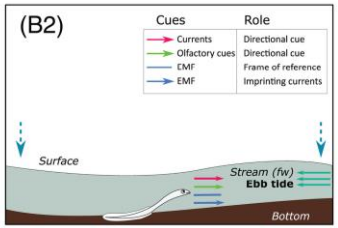


British Sea Fishing.com

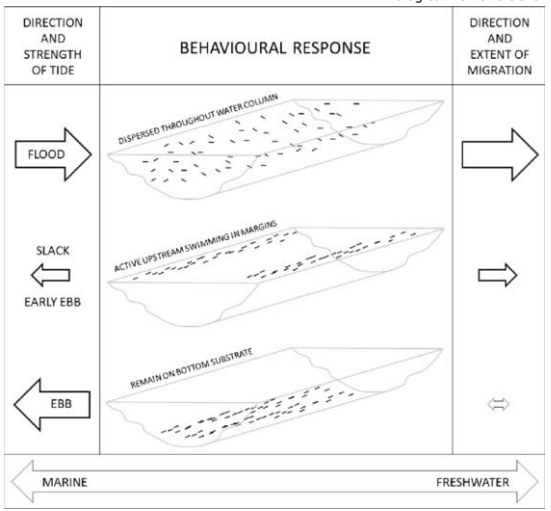
Strategies to navigate and transport







Cresci et al. 2020
A comprehensive hypothesis on the migration of European glass eels (*Anguilla anguilla*)
Biological Reviews 95:5



Harrison et al. 2014
A review of glass eel behaviour
Rev. Fish Biology and Fisheries

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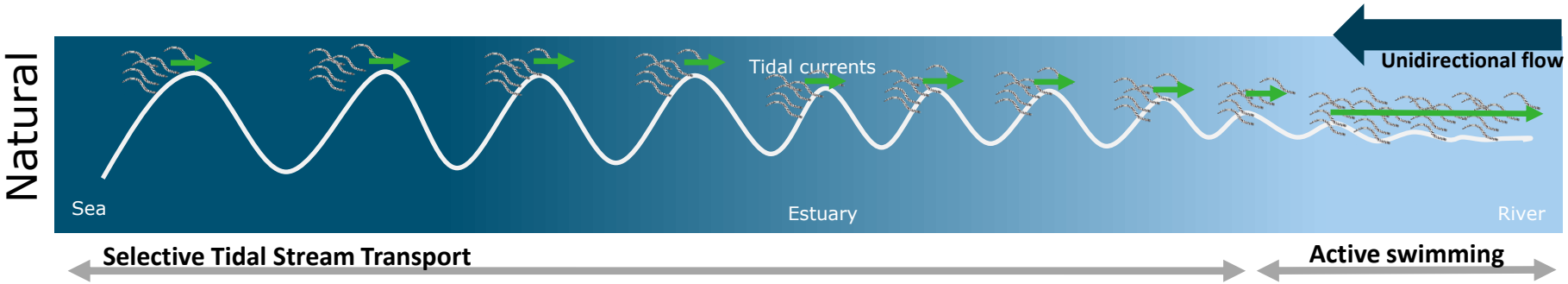
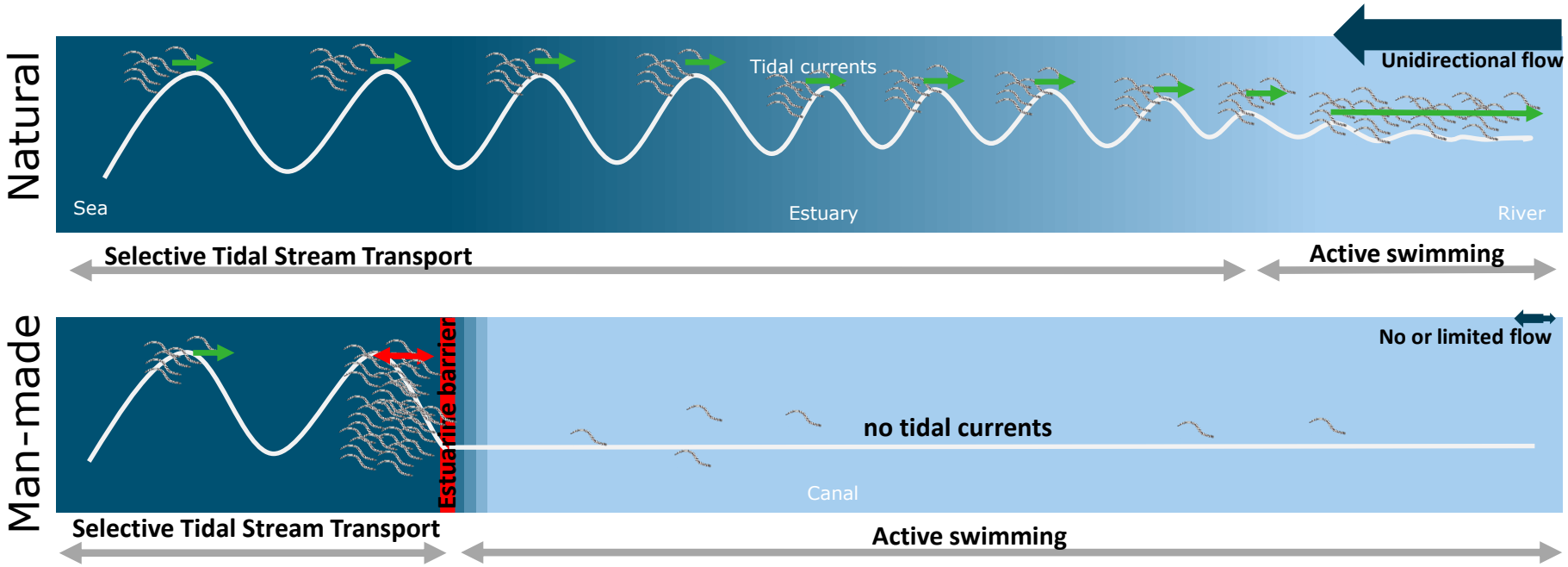
Selective Tidal Stream Transport



Selective Tidal Stream Transport



Conflicting associated cues
Abrupt salinity differences, no gradual salinity transition
Conflicting water currents (e.g. during discharge): Selective Tidal Stream Transport not applicable
Higher predation risk?
Delay?

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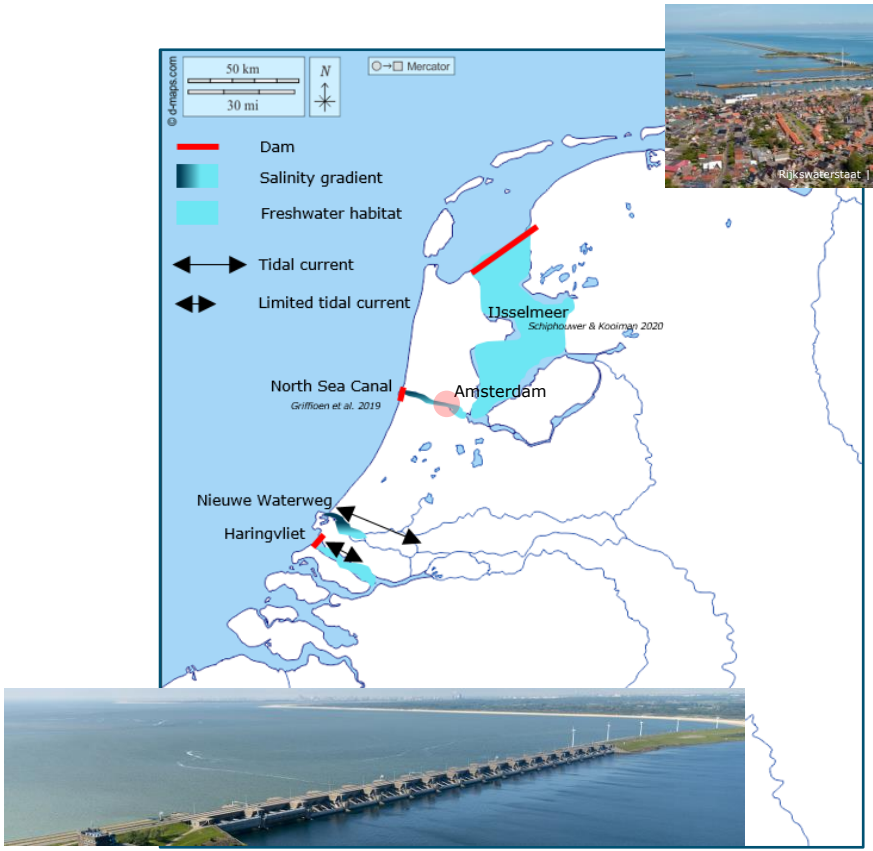
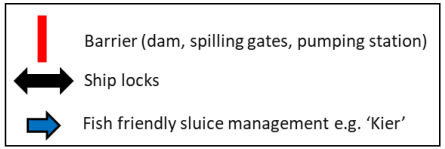
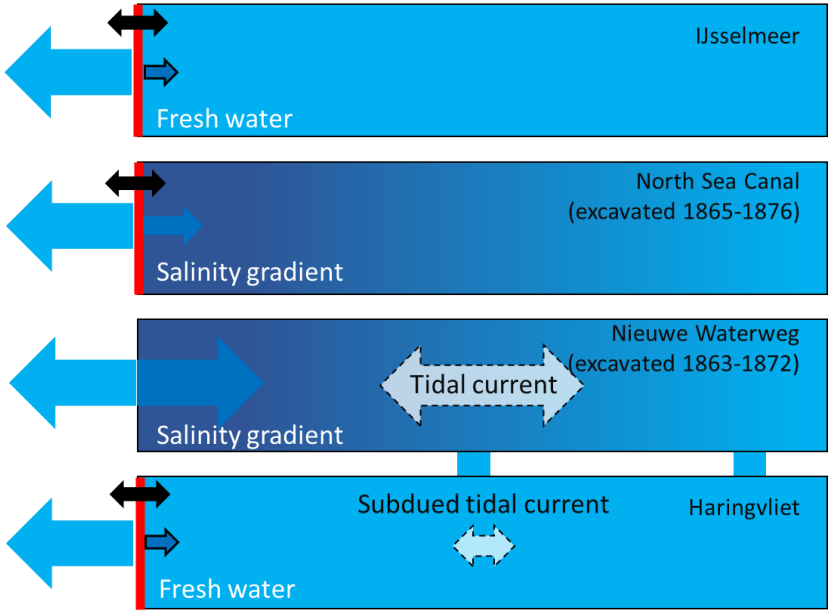
Barriers along the Dutch coast







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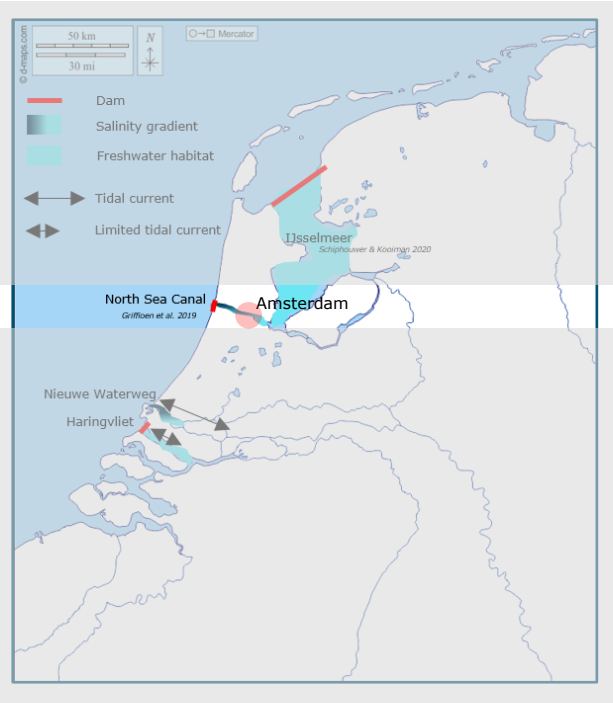
North Sea Canal

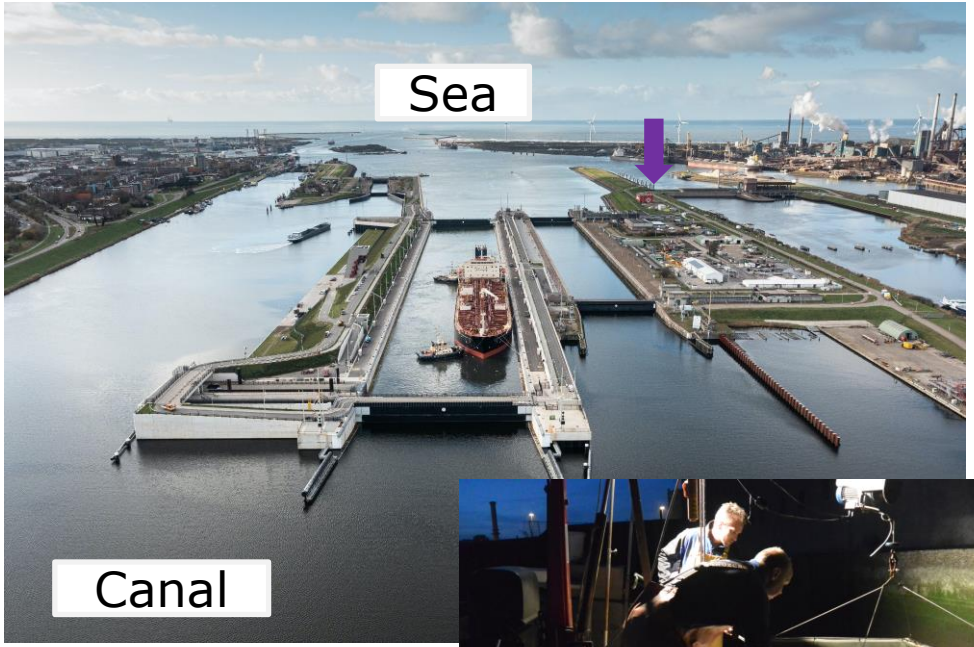
Study Aim

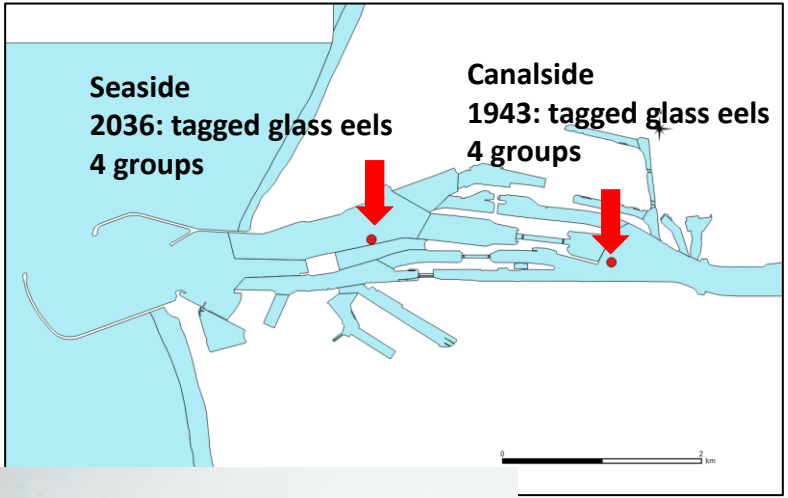
Understand glass eel adaptability in relation to water flows with conflicting associated cues and to prioritize management measures on catchment level.

- **Passage efficiency** and **delay** from sea to canal and from canal to polder areas.
- **Distribution** alongside the canal system including altered distribution of initial selected barriers
- **Abundance** of glass eel in the canal an at inland locations (in relation to discharge)



Catch, mark and release





Group 1: 26 March
Group 2: 29 March
Group 3: 8 April
Group 4: 16 April

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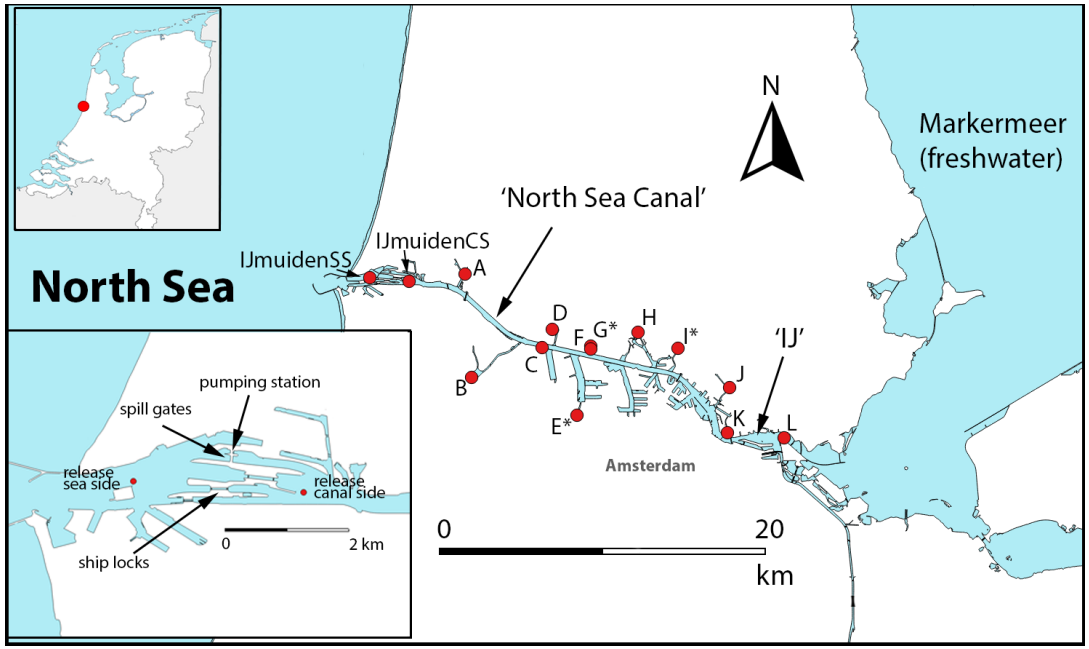
North Sea Canal – Recapture network



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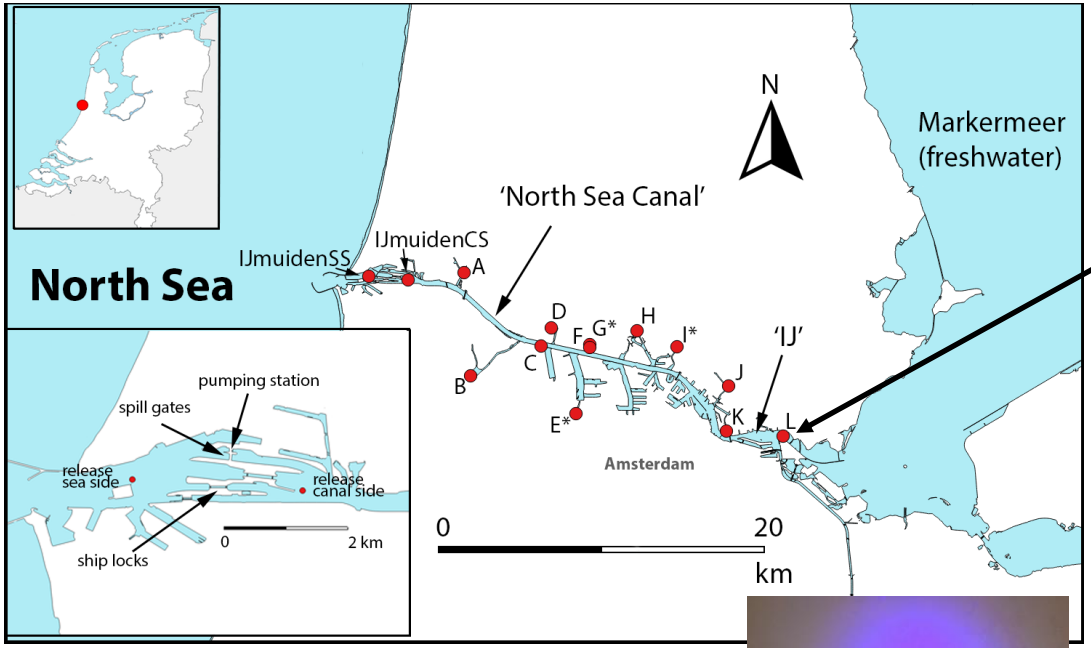
North Sea Canal



Local mark recapture program 0f 53-504 tagged glass eels per site.
Total 2.663 / 11 groups

Single orange tagged glass eel recaptured at loc. L

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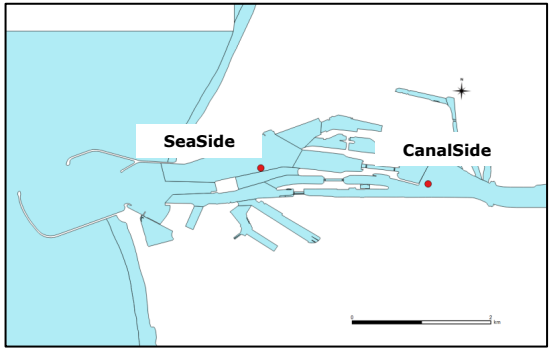
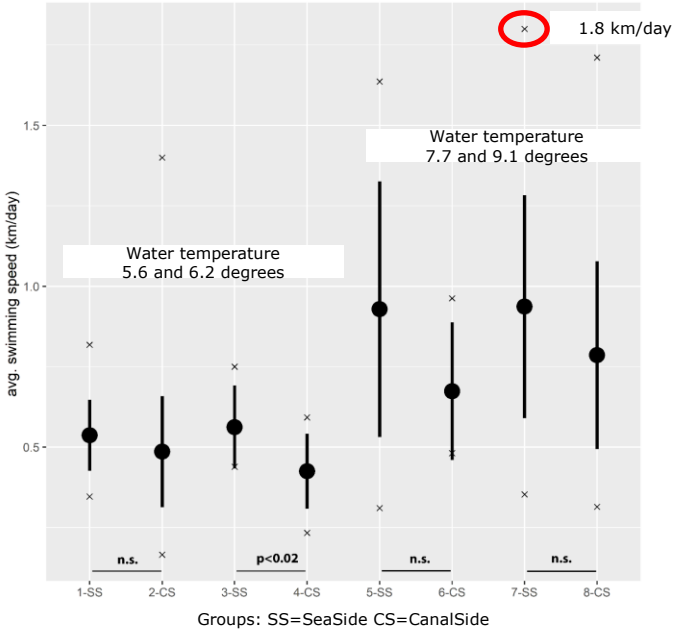
Results

- 3979 glass eels released 274 were recaptured
  SS: 5.2-8.5% vs. CS 4.7-8.5% p=0.63. No difference SS and CS
  ~100% passage efficiency.

- Avg. swimming speed
  highest: 1.8 km day^{-1}
  SS: 0.8 km day^{-1}
  CS: 0.6 km day^{-1}
  SeaSide glass eels slightly faster





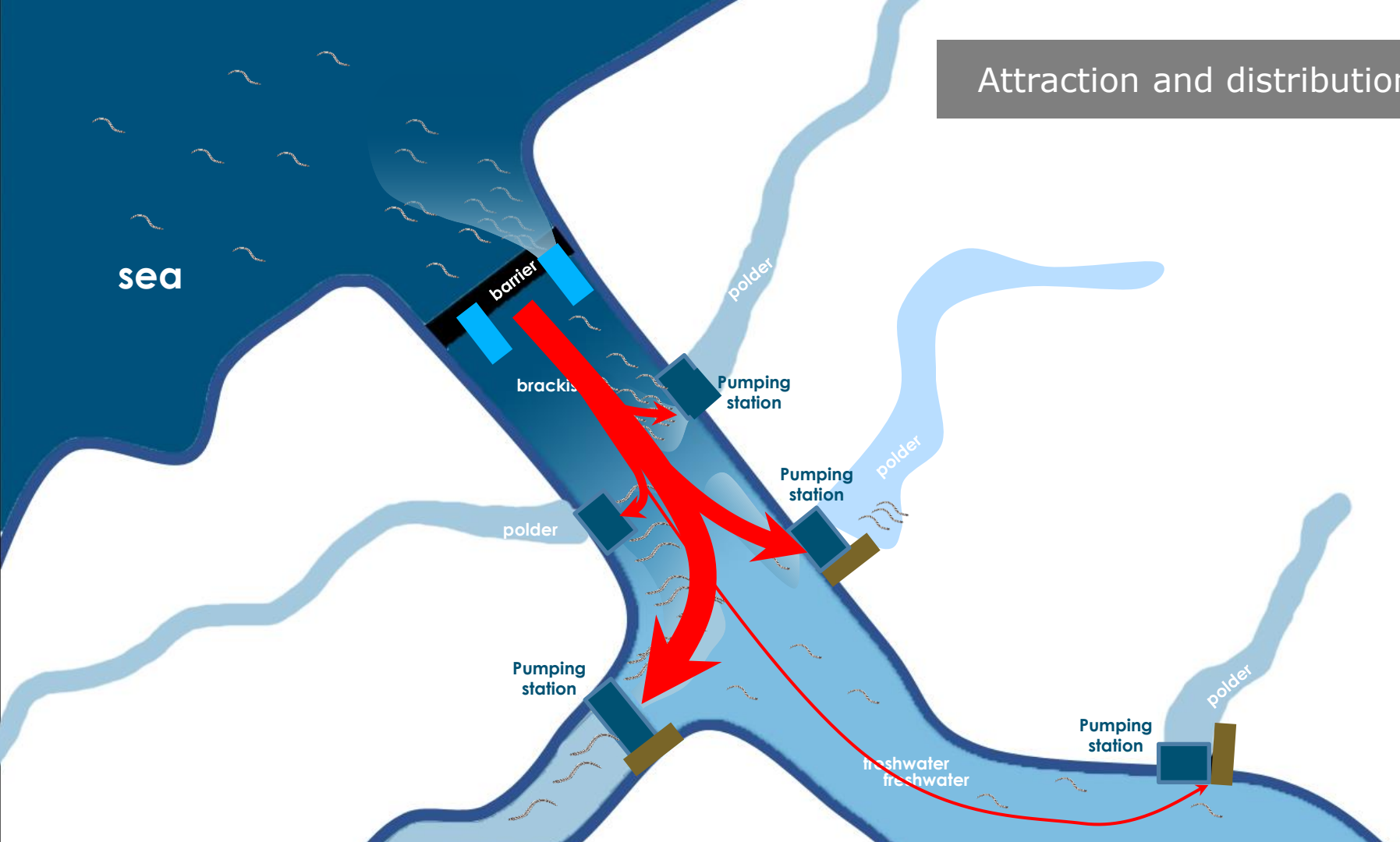
Abundance

- 706.076 glass eels **C**aught and checked for VIE tags
- **R**ecaptured: 274 glass eels
- **M**ark 3979
- Pop **N**: 10.3 ± 0.6 million glass eels in the Canal

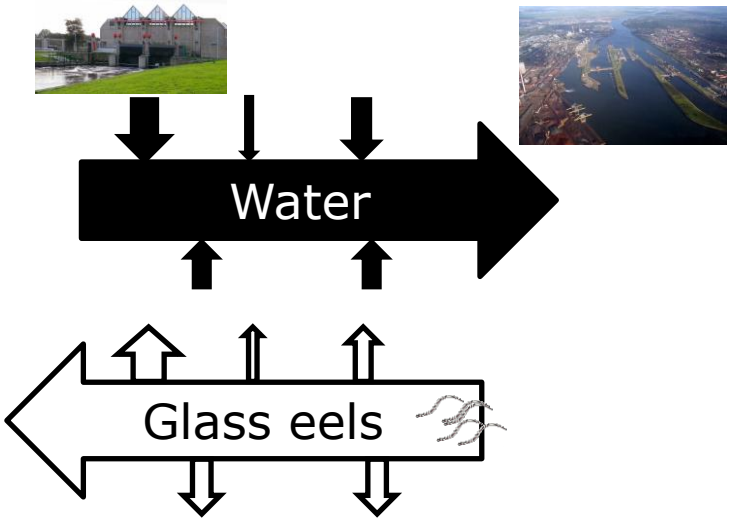
How are the distributed over the locations?

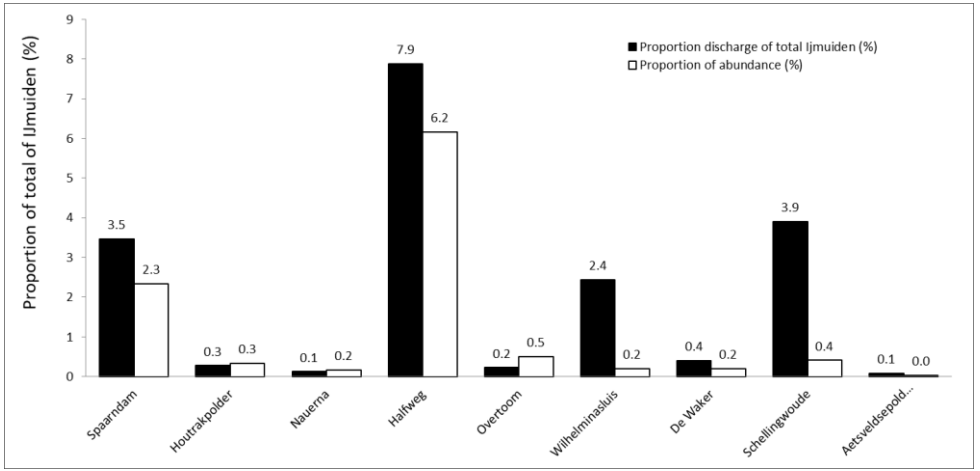

Attraction flows
sea
barrier
brackish
polder
Pumping station
polder
Pumping station
polder
Pumping station
Pumping station
polder
freshwater

Attraction and distribution

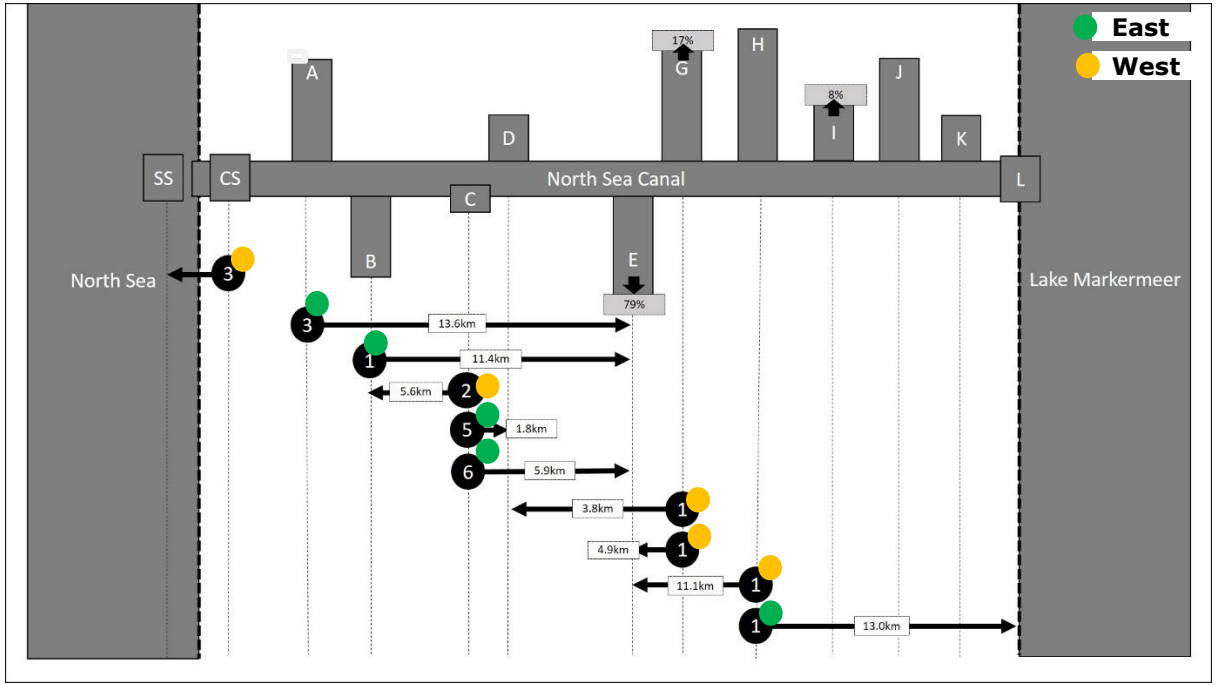


Distribution of glass eels and discharge





Altered distribution of initial selected barriers

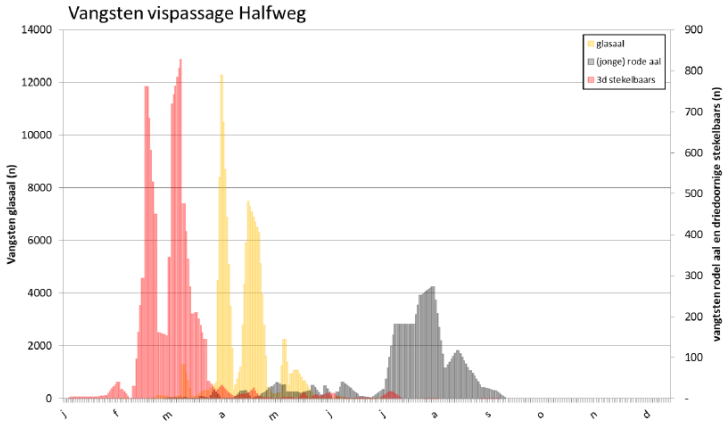


21 tagged glass eels found elsewhere.

Est. ≥1.4% showed altered distribution.

Discussion & Conclusion

- 10.3 ± 0.6 million glass eels distributed along canal. Relation with discharge: more discharge more attraction. → guide them to 'safe areas' fish friendly pumps?
- Passage efficiency ~100% due to 24/7 sluice operation. What if no sluices are present or only used during daylight?
- Avg. swim speed of 0.6-0.8 km day^{-1}: no difference between groups but slight confusion (?) CS-group due to ...?
- Glass eels (≥1.4%) showed altered distribution of initial selected barriers in all directions. Good news for location with no passage opportunities?
- Settlement in canal and migration of elvers



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