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# Following the migration of glass eel and three-spined stickleback passing Europe's largest pumping station and world's largest sluice

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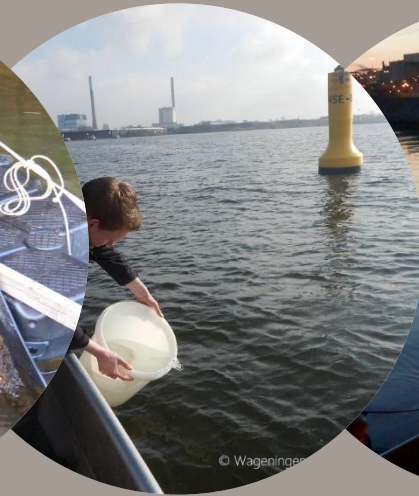
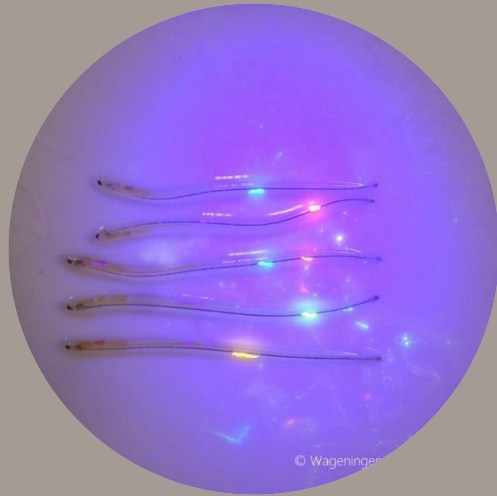
Griffioen, Ben A.B.; Winter, Erwin H.V.; van Keeken, Olvin O.A.; Deitzelzweig Senior, Patrick P.; and de Boer, Xander X.V., "Following the migration of glass eel and three-spined stickleback passing Europe's largest pumping station and world's largest sluice" (2018). *International Conference on Engineering and Ecohydrology for Fish Passage*. 22.  
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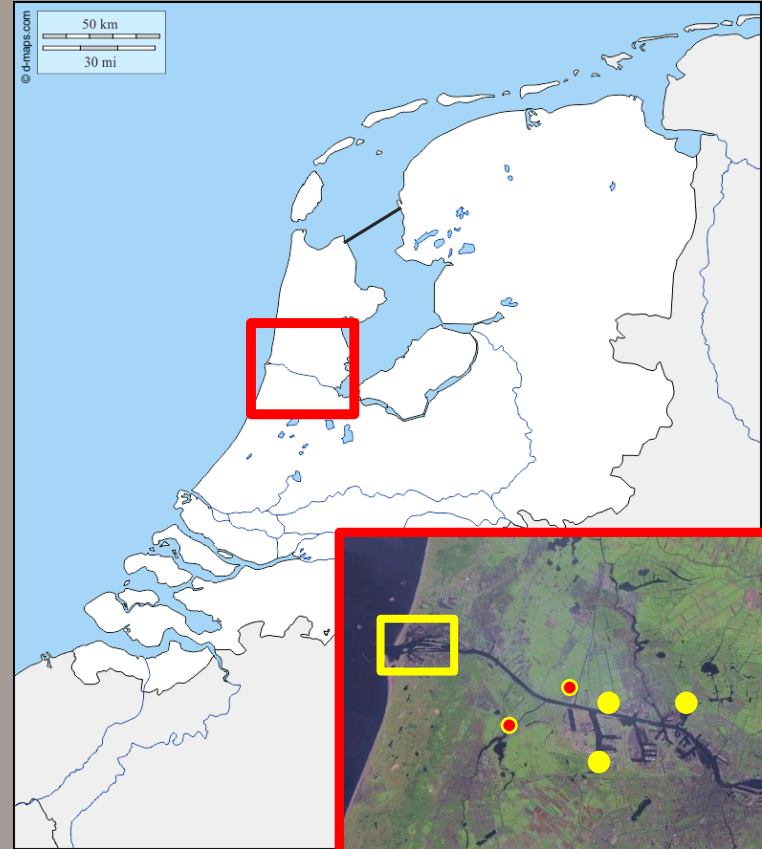
11 December 2018, Fish Passage Conference 2018, Albury

A.B. Griffioen, H.V. Winter, O.A. van Keeken, P. Deitzelweg Senior, X.V. de Boer



# North Sea Canal

- Canal: 1865 – 1876
- Brackish water / Fresh water
- Pumping station
  - 15.600m<sup>3</sup>/min
- Spill gates
- 4 sluices (500x70x18m LxWxD)
- Fish passages





North Sea  
Canal

900 meter

North Sea





**INSIDE**

N=1943

4 groups:

March 26 'yellow'

March 29 'blue - yellow'

April 4 'orange - yellow'

April 16 'blue'

VIE tag



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**OUTSIDE**

N=2036

4 groups:

March 26 'red'

March 29 'blue - red'

April 4 'orange - red'

April 16 'orange'

# Mark recapture experiments

VIE tag



**Catch**  
'salt water  
group'

release

N=1266  
6 groups:  
29 March 2018  
'salt water'  
'fresh water'

release

**Catch**  
'fresh water  
group'

**Recapture**  
Fish passage  
monitoring



**INSIDE**


N=508

2 groups:

29 March

'fresh water' (blue)

'salt water' (yellow)



Terugzetten van gemerkte  
stekelbaars bij de sluisen van  
IJmuiden

VIE tag



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**OUTSIDE**

N=509

2 groups:

29 March

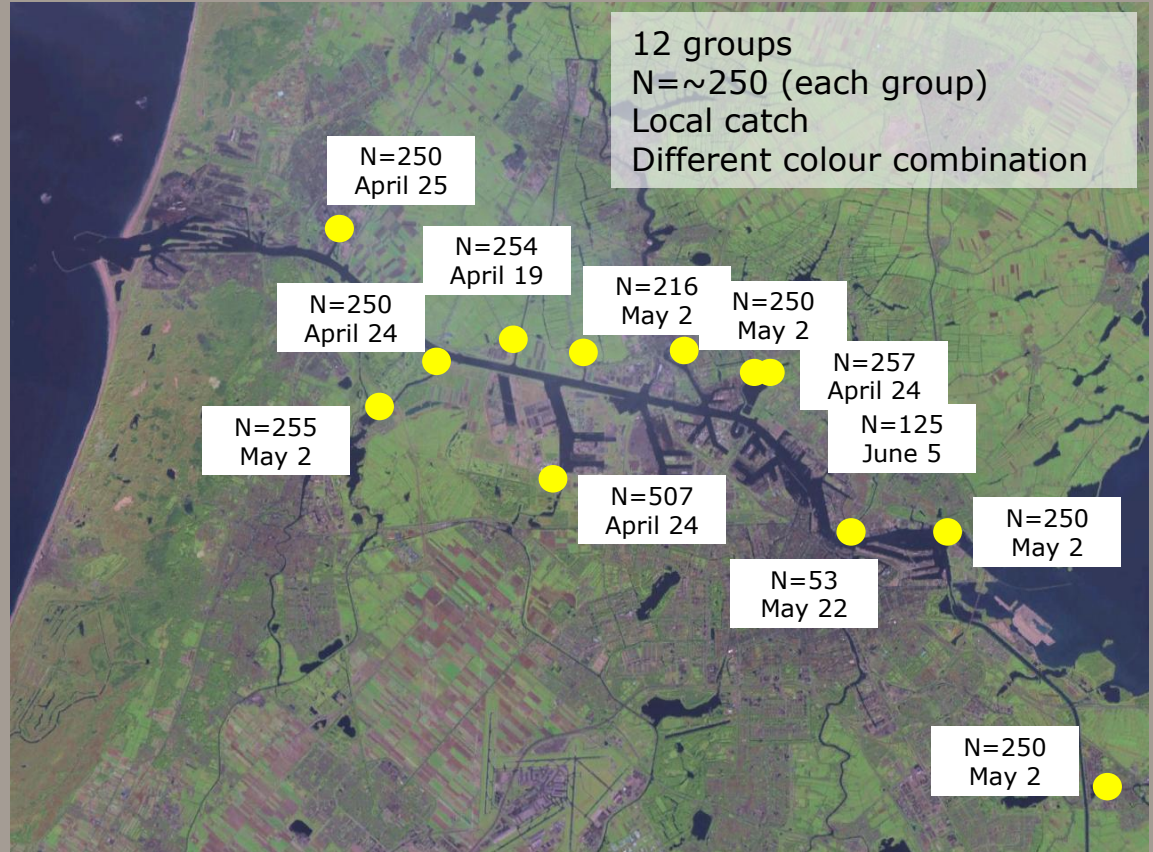
'fresh water' (orange)

'salt water' (red)





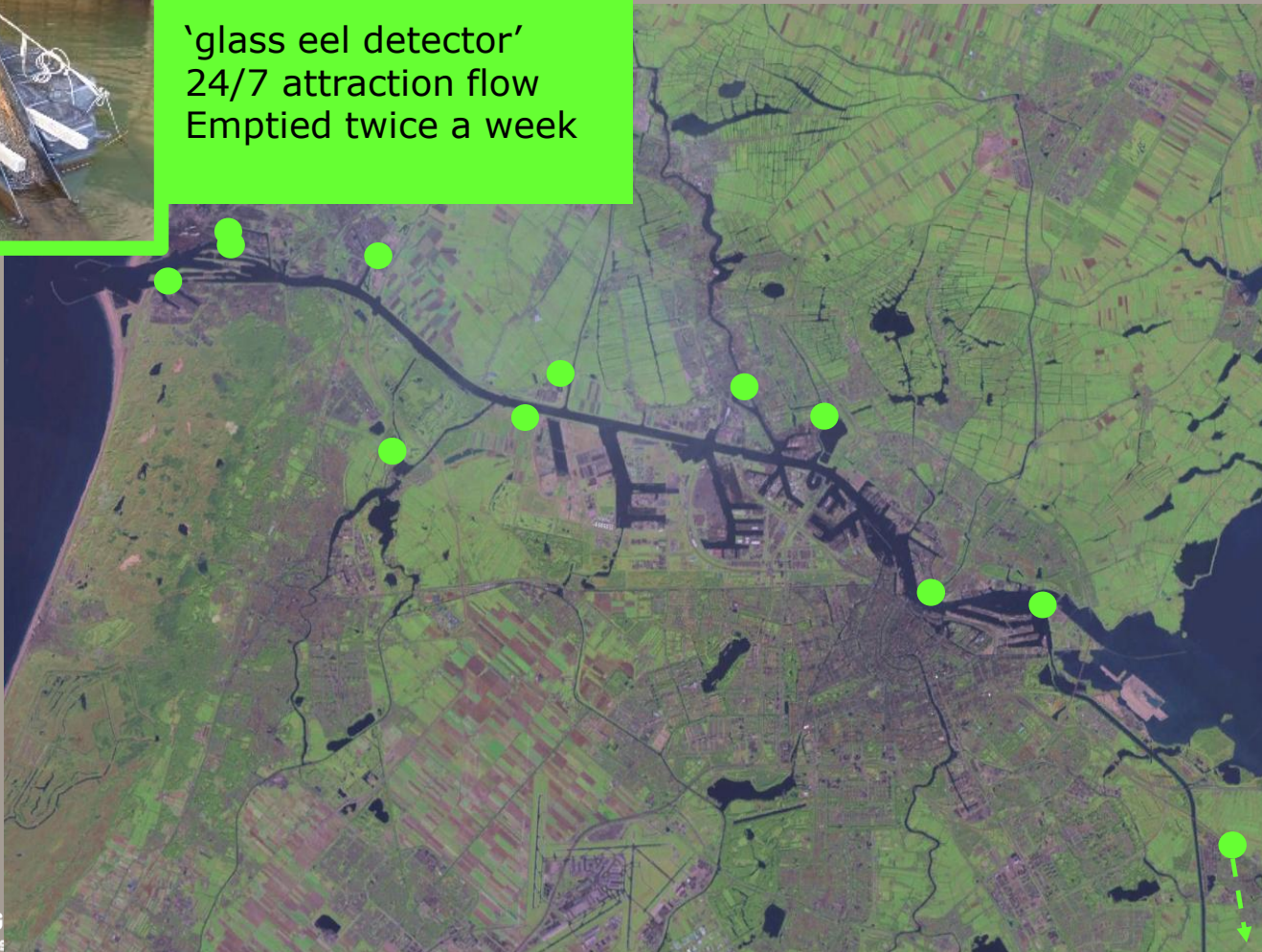
# 'local' mark recapture experiments



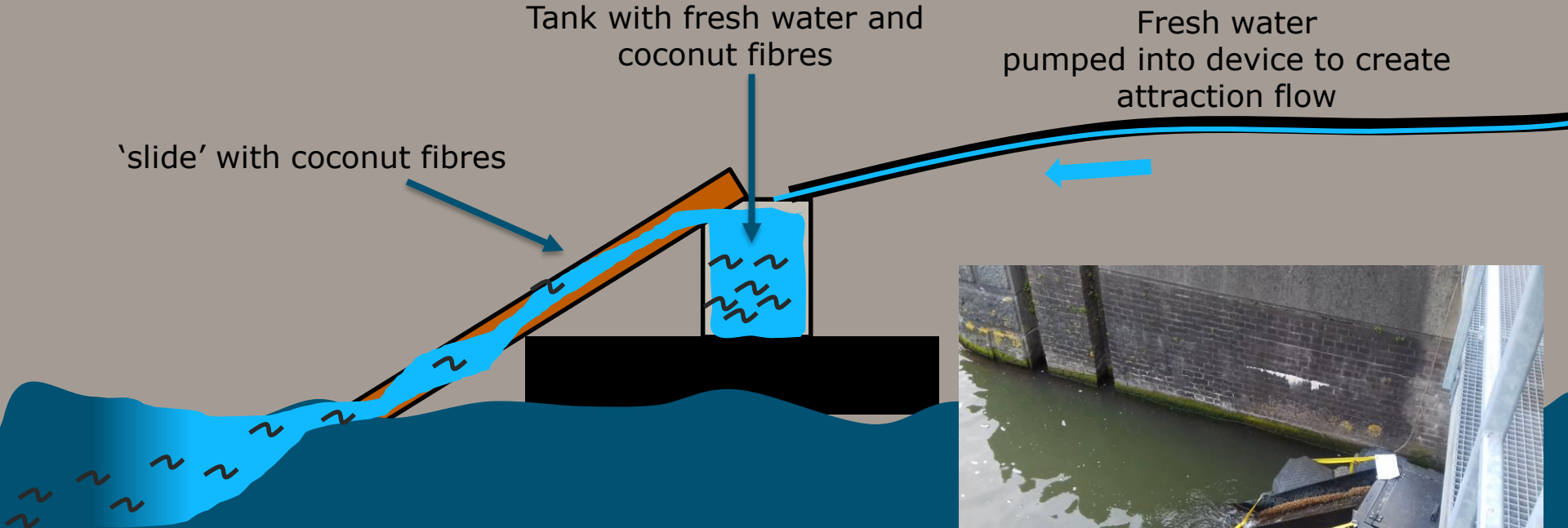
# Recapture strategy



'glass eel detector'  
24/7 attraction flow  
Emptied twice a week

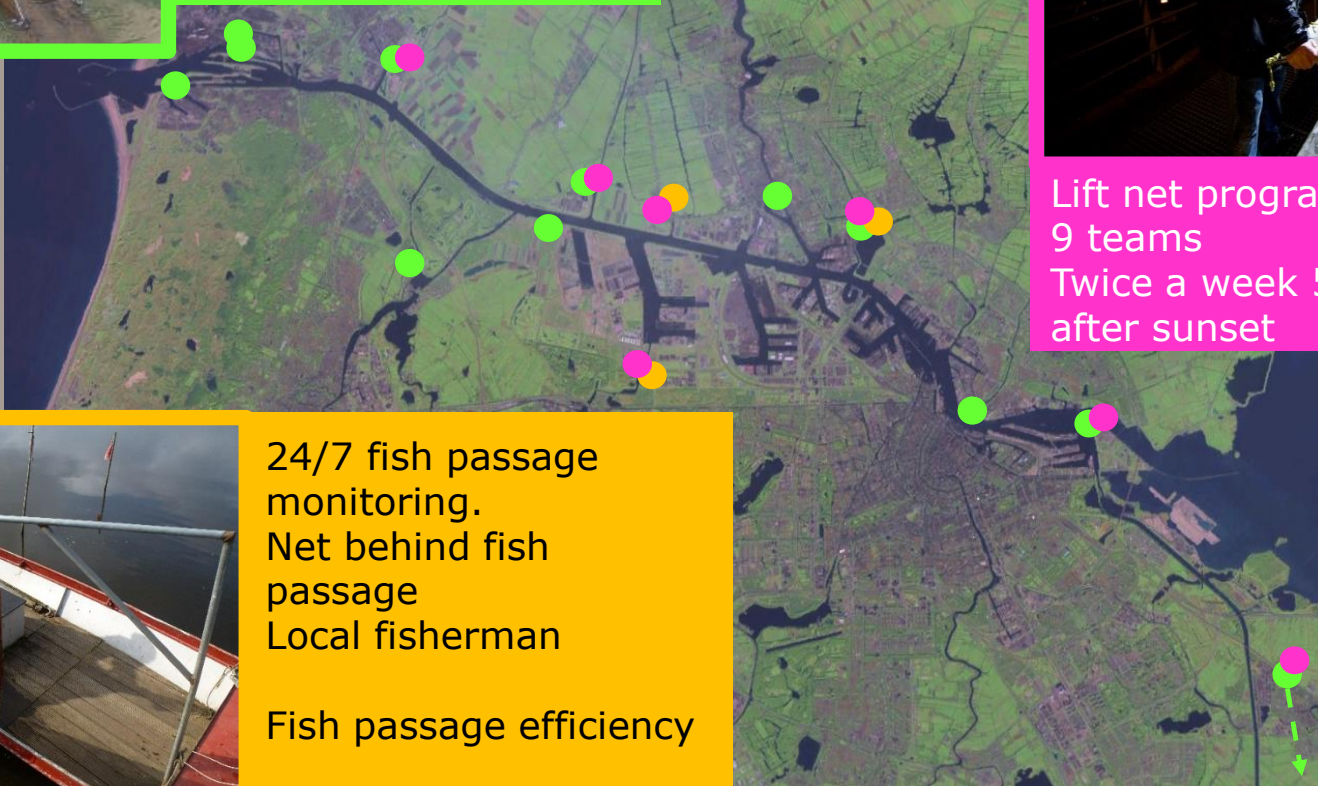


# 'Glass eel detector' - continues catching device using attraction flow





'glass eel detector'  
24/7 attraction flow  
Emptied twice a week



Lift net program (RAVON)  
9 teams  
Twice a week 5 hauls 30 min  
after sunset



24/7 fish passage  
monitoring.  
Net behind fish  
passage  
Local fisherman  
  
Fish passage efficiency

# Results

- A lot of data 😊
- 742.042 glass eels caught and checked for colour mark
- 6.348 three spined stickle back caught and checked for colour mark

M inside: n=1943  
M outside: n=2036

Recaptures n=307

0  
1

5  
15

0  
2

2  
3

0  
2

8  
12

4  
9

29km 29days = 0.01m/s

0  
0

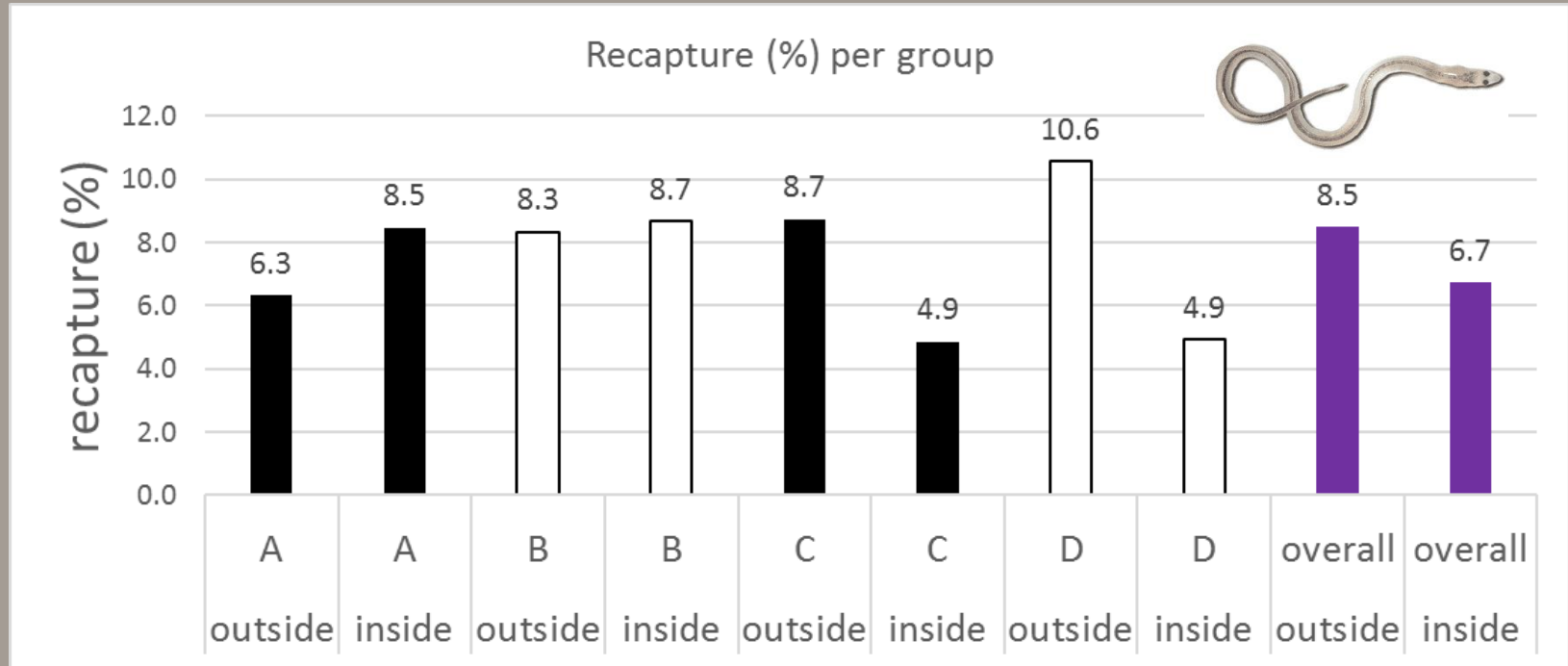
1  
5

106  
100

0  
0

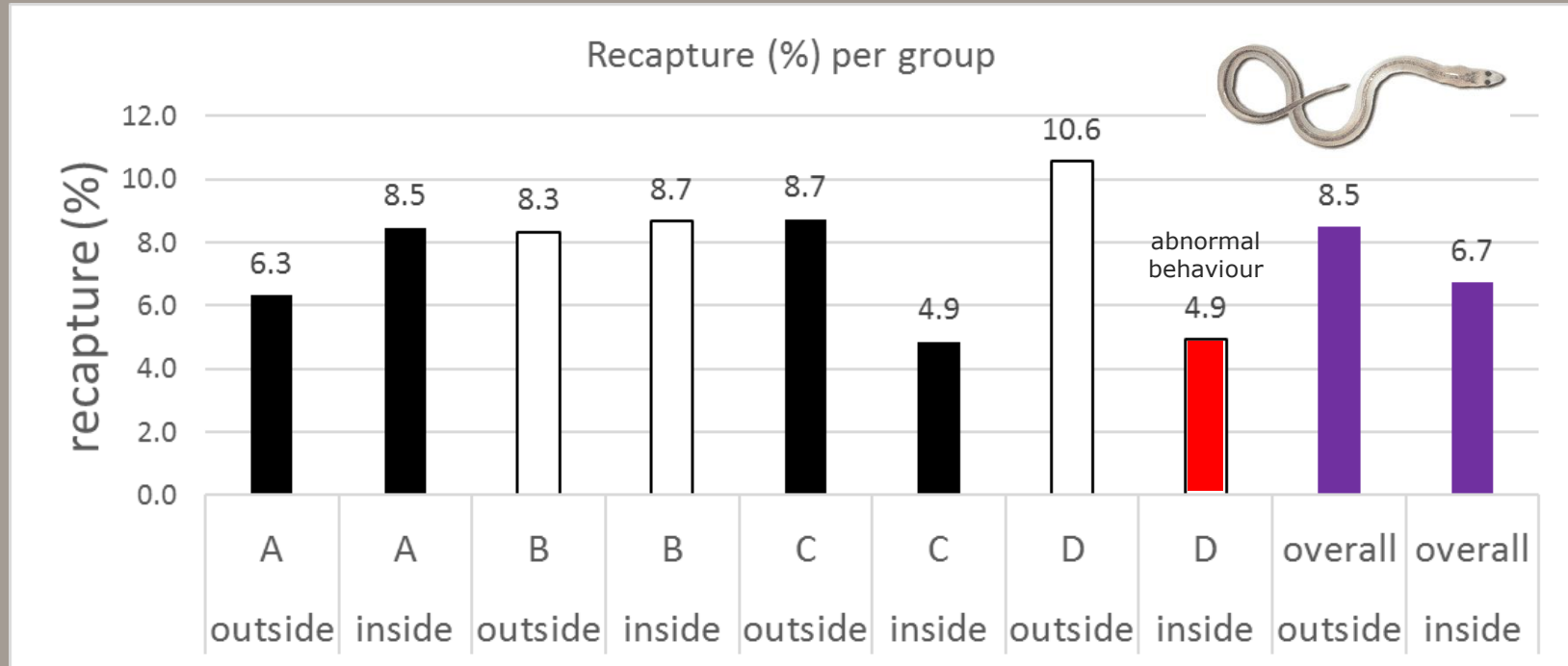


# At what level is migration hampered at the sluice complex?

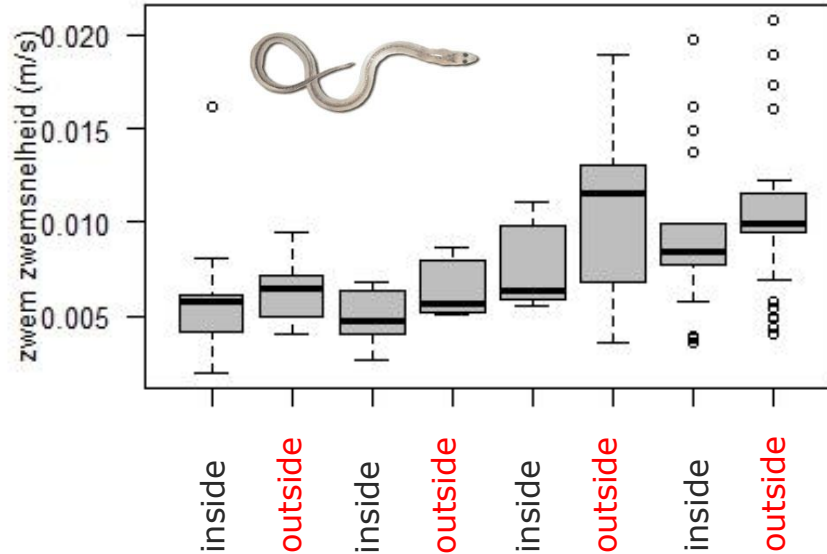




# At what level is migration hampered at the sluice complex?



# Swimming speed (m/s)

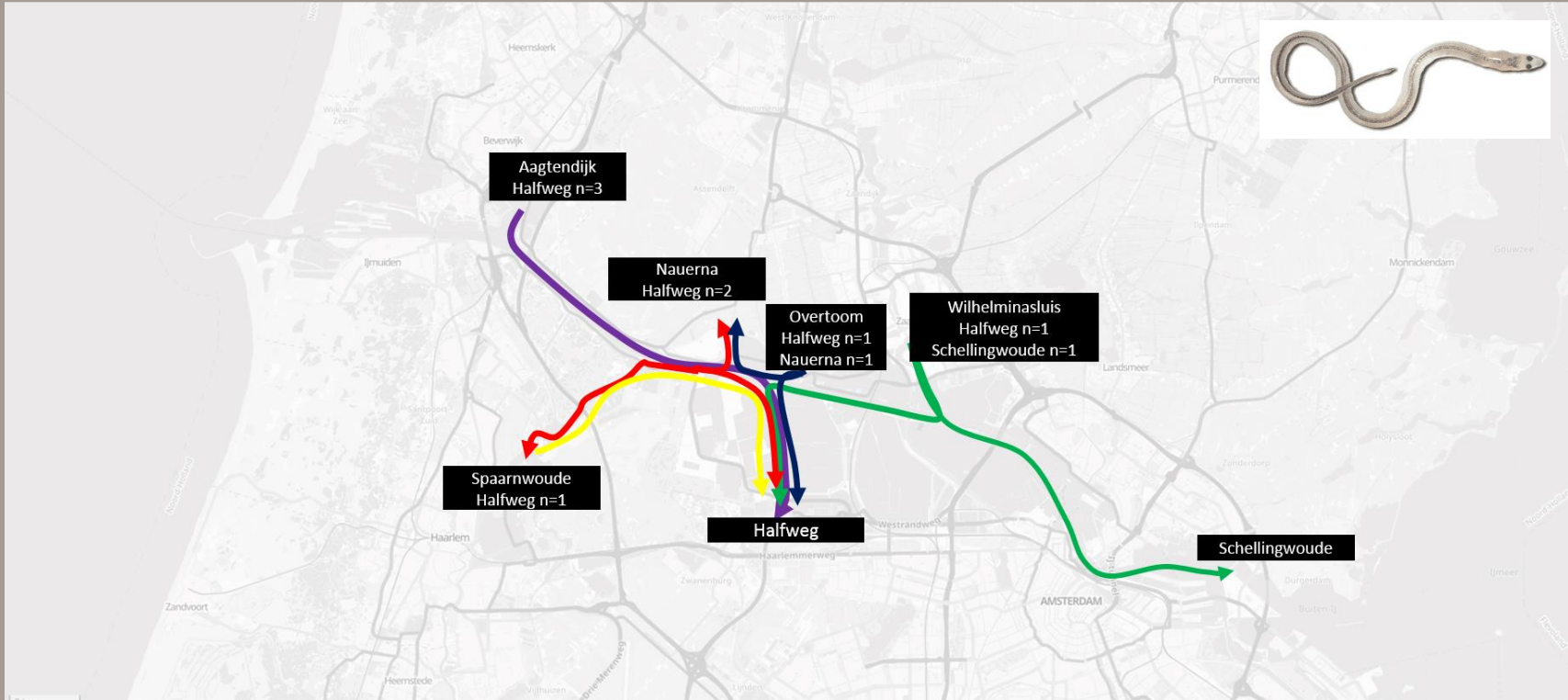


'outside group' = faster?

Three 'inside group' individuals are found 'outside' → flushed out by spill gates.

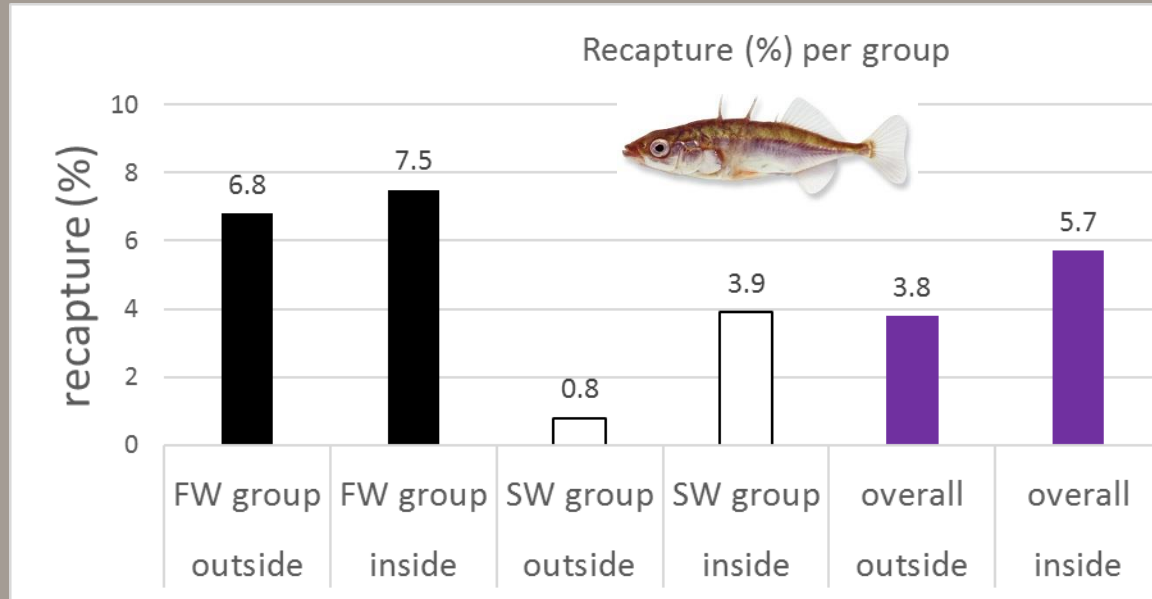
Disorientation due to salinity difference?

# Dispersal



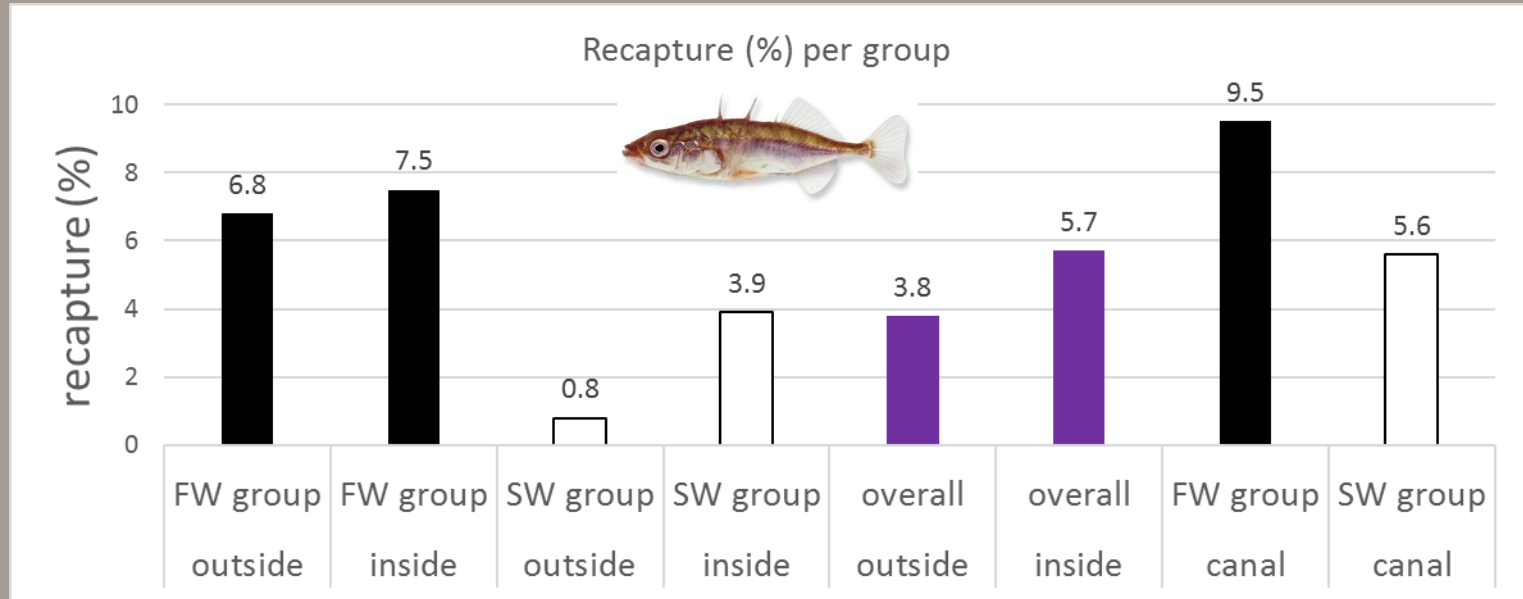
# At what level is migration hampered at the sluice complex?

(Note: recapture at one location)



# At what level is migration hampered at the sluice complex?

(Note: recapture at one location)





15.5km 2days = 0.09m/s  
Average = 0.02m/s



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# Conclusions

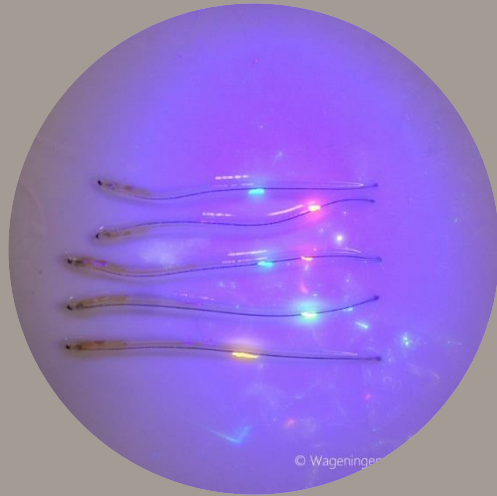
- Glass eel and stickleback are not hampered by the sluice complex to reach the North Sea Canal
- Within the canal there is re-distribution of glass eel, probably due to hampered migration to reach fresh water 'polder' areas.
- Some glass eel pass the canal towards the fresh water lake (Markermeer). Fastest observed: 29 days

■

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# Conclusions

- Glass eel and stickleback are not hampered by the sluice complex to reach the North Sea Canal
- Within the canal there is re-distribution of glass eel, probably due to hampered migration to reach fresh water 'polder' areas.
- Some glass eel pass the canal towards the fresh water lake (Markermeer). Fastest observed: 29 days
- Local mark recaptures at three fish passages showed:
  - 79% (M: 507 R:400)
  - 17% (M:216 R: 36)
  - 0% (M:250 R:0) 8% (M: 125 R:10 after minor adjustments)

# At what level is migration hampered at the sluice complex?

- Residence time at the sluice complex: 1-23 days, 5 days on average
- Compared to other barriers along the canal:
  - Longest time between release and recapture: 35-70 days
  - Average residence time: 11 days

# Research questions

- Are small diadromous fish hampered by the sluice complex?
  - Residence time?
- How do glass eel distribute along the canal?
- Do glass eel accumulate at locations along the canal?
  - Residence time?
  - Fish passage efficiency for three fish passages?
- ...