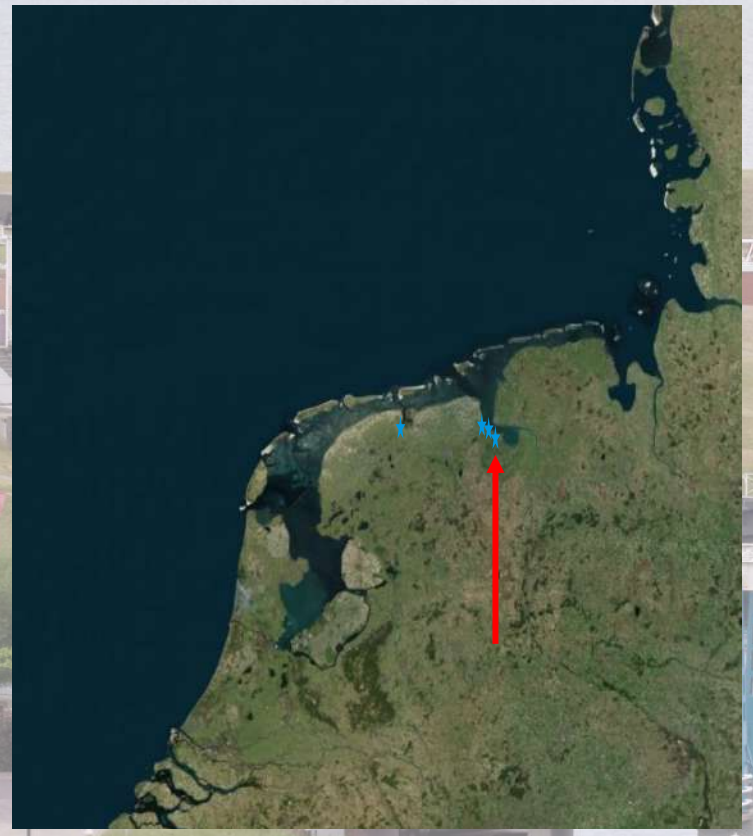
EEL MIGRATION and PUMPING STATION ROZEMA



Pumping activity

and

Activity and passage of eel

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ruim baan voor vissen

WATERSCHAP Hunze en Aa's

waddenfonds

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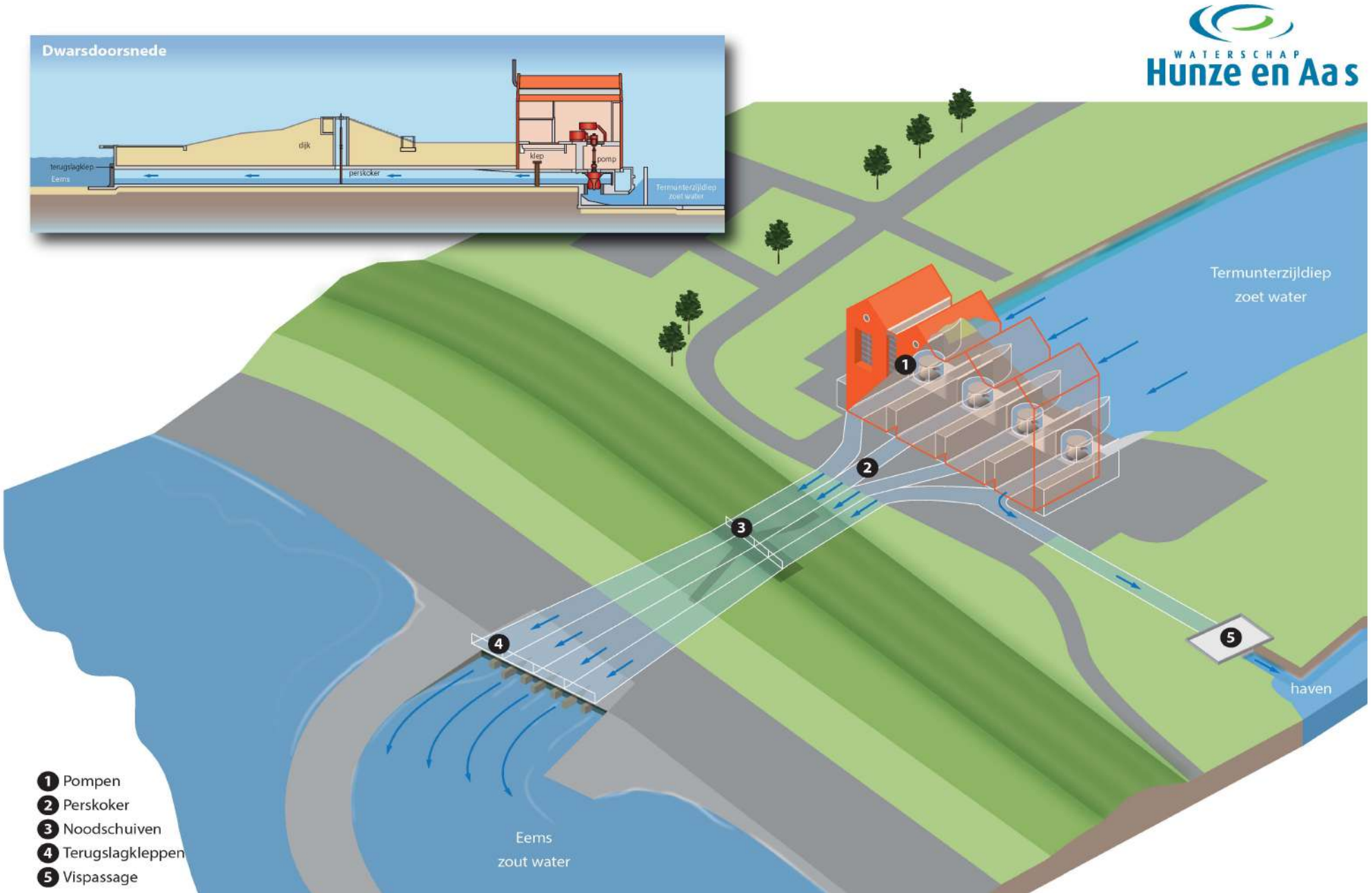
RESEARCH QUESTIONS

1. Route and mortality outwards migrating eels?
    a) Route choice?
    b) Mortality / survival?

2. If eels migrate via the pumping station:
    a) Delay?
    b) Relation between eel behavior and pumping activity?

PUMPING STATION



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Pumping station:

- 4 pumps

Pumps:

- Diameter 2.5m
- 1000 m3/min

Routes through pumps:

- Pumps (1-4) → Estuary
- Pump fish pass (5)

ROUTE CHOICE AND MORTALITY

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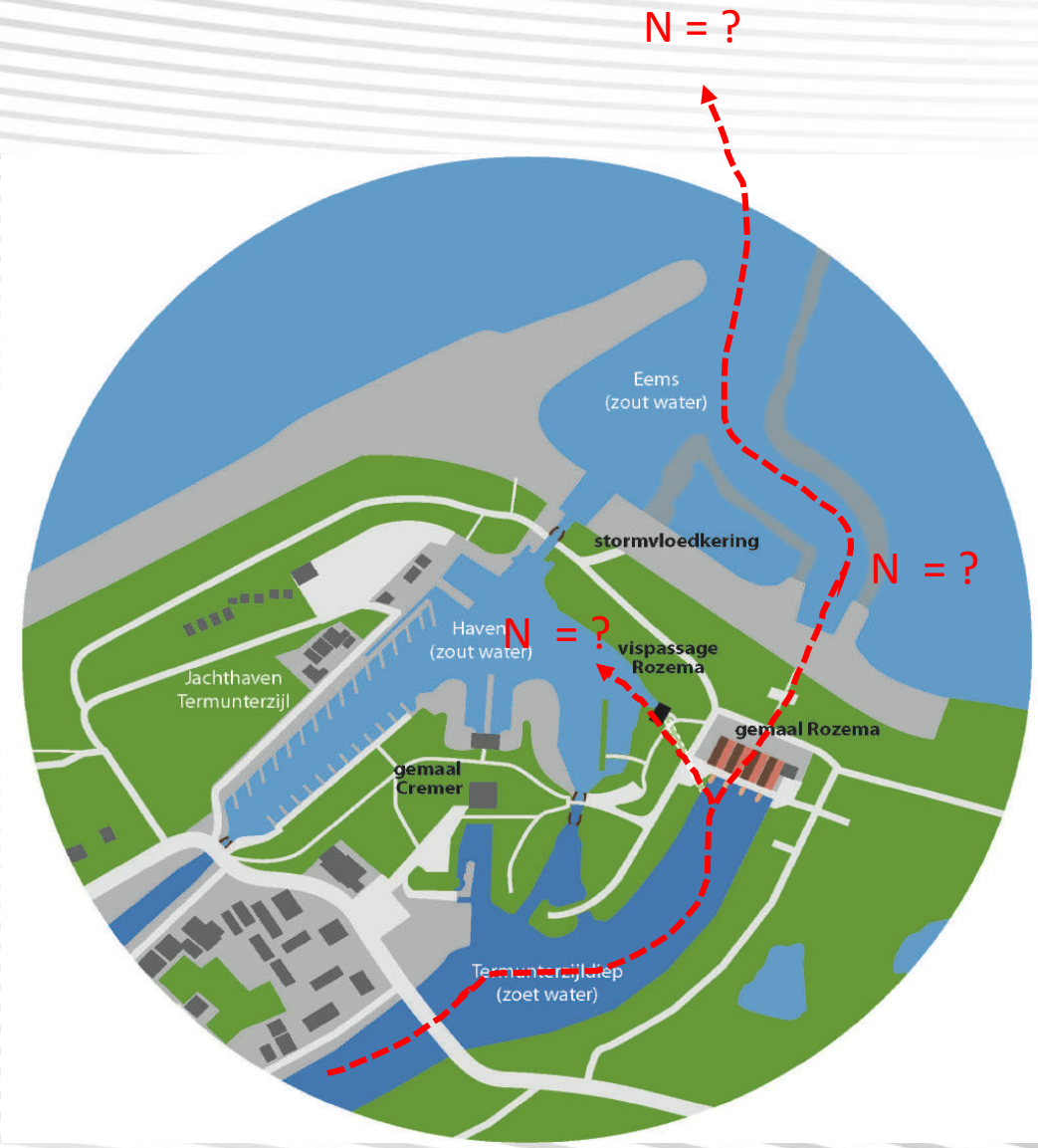
PUMPING STATION ROZEMA

Q1: ROUTE CHOICE AND MORTALITY

Q1: All eels migrate through the pumping station

Q1: No mortality



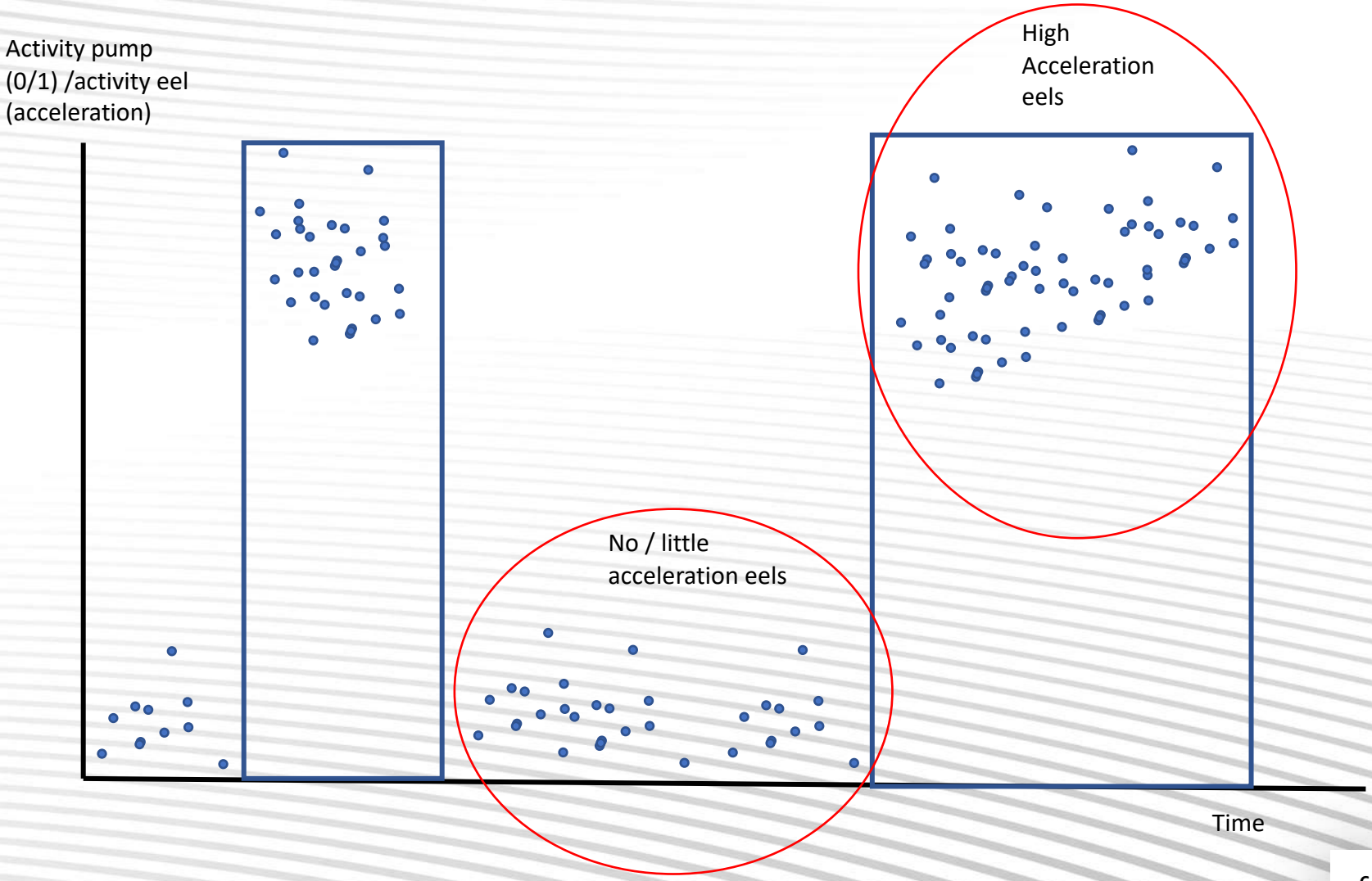
Q2: DELAY AND BEHAVIOUR

Q2: Delay = Time last detection R9 - Arrival time R5 inside number of pumping events (n=1,2=3..)

All eels utilize the first pumping event to pass!

Q2: When pumps start pumping the eels start to move

Eels do not move when the pumps are not pumping and move when the pumps are pumping



ACOUSTIC TELEMETRY

Using acoustic telemetry (69Hz), we **tagged 40 silvering eels** (average length 70.4cm, sd 13.6cm).

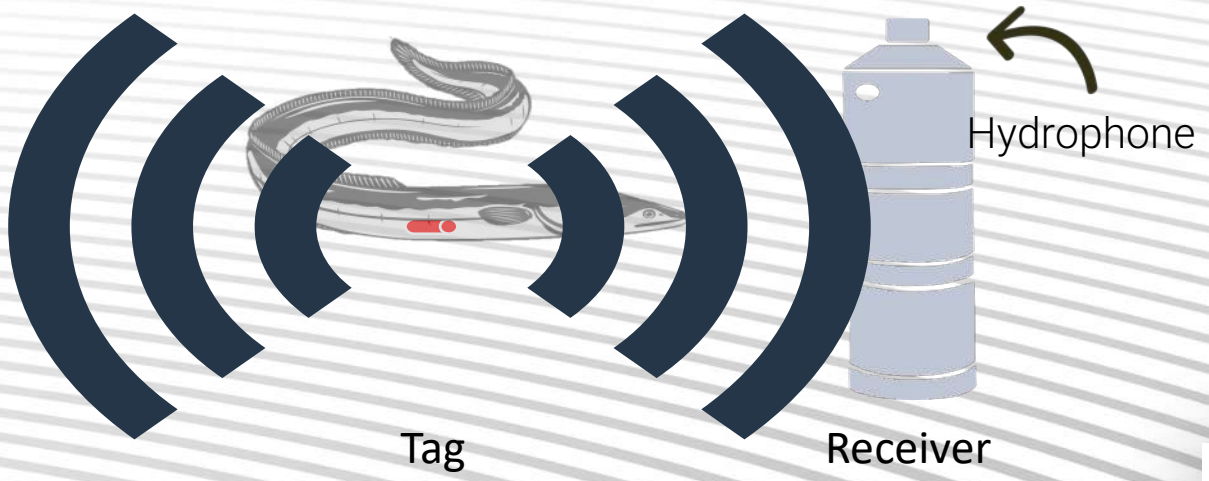
Tag = V9A, transmission interval 40-80 sec, with an accelerometer sensor measuring:

$$Vector\ Dynamic\ Body\ Acceleration = \sqrt{(x + y + z)^2}$$

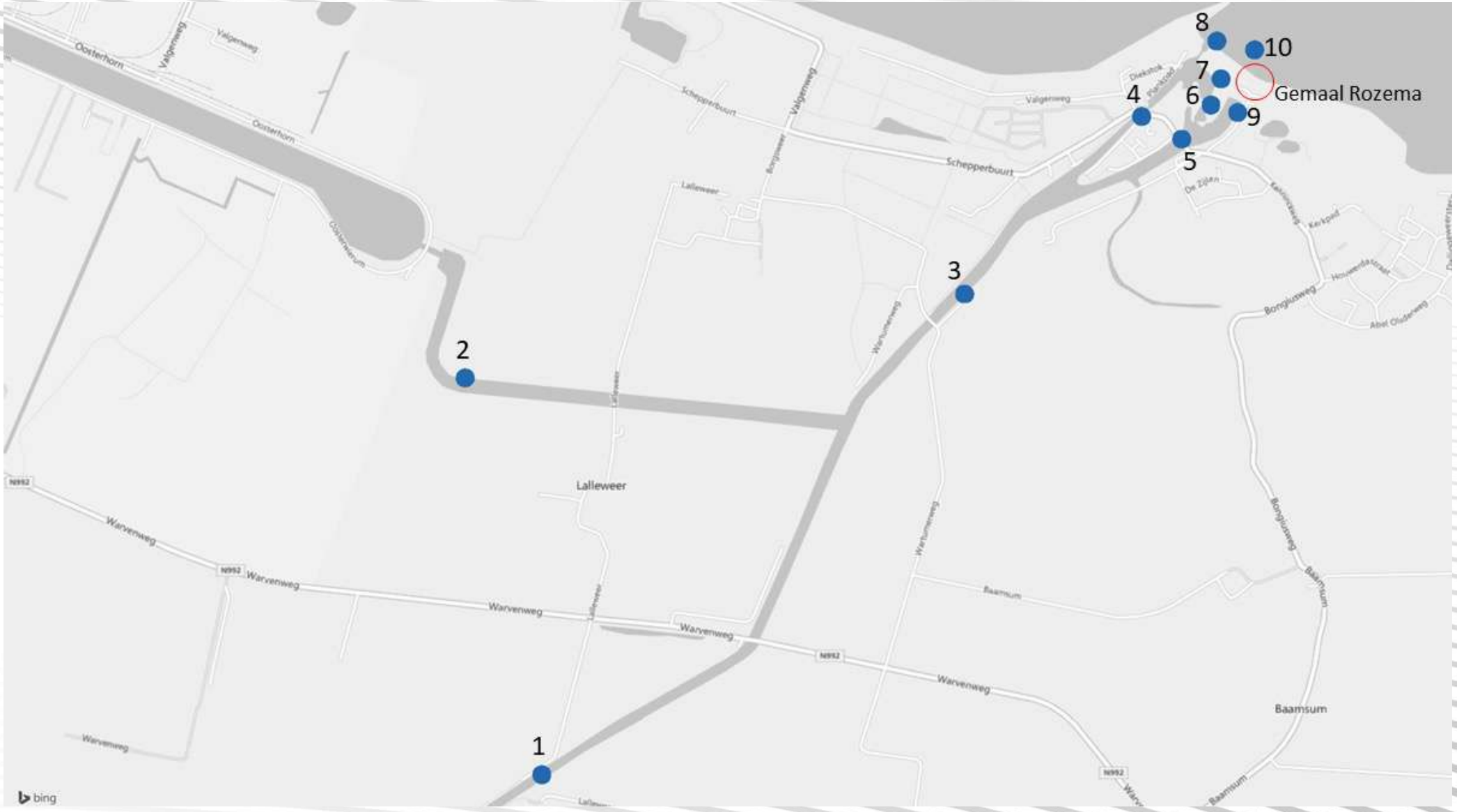
We deployed **10 acoustic receivers** on the route from release location to the estuary.

Joint German – Dutch receiver network in the estuary

Between **6-22 November 2021 and 1 March 2023** we tracked the eels on their migration out.



RECEIVER LOCATIONS



ROUTE CHOICE

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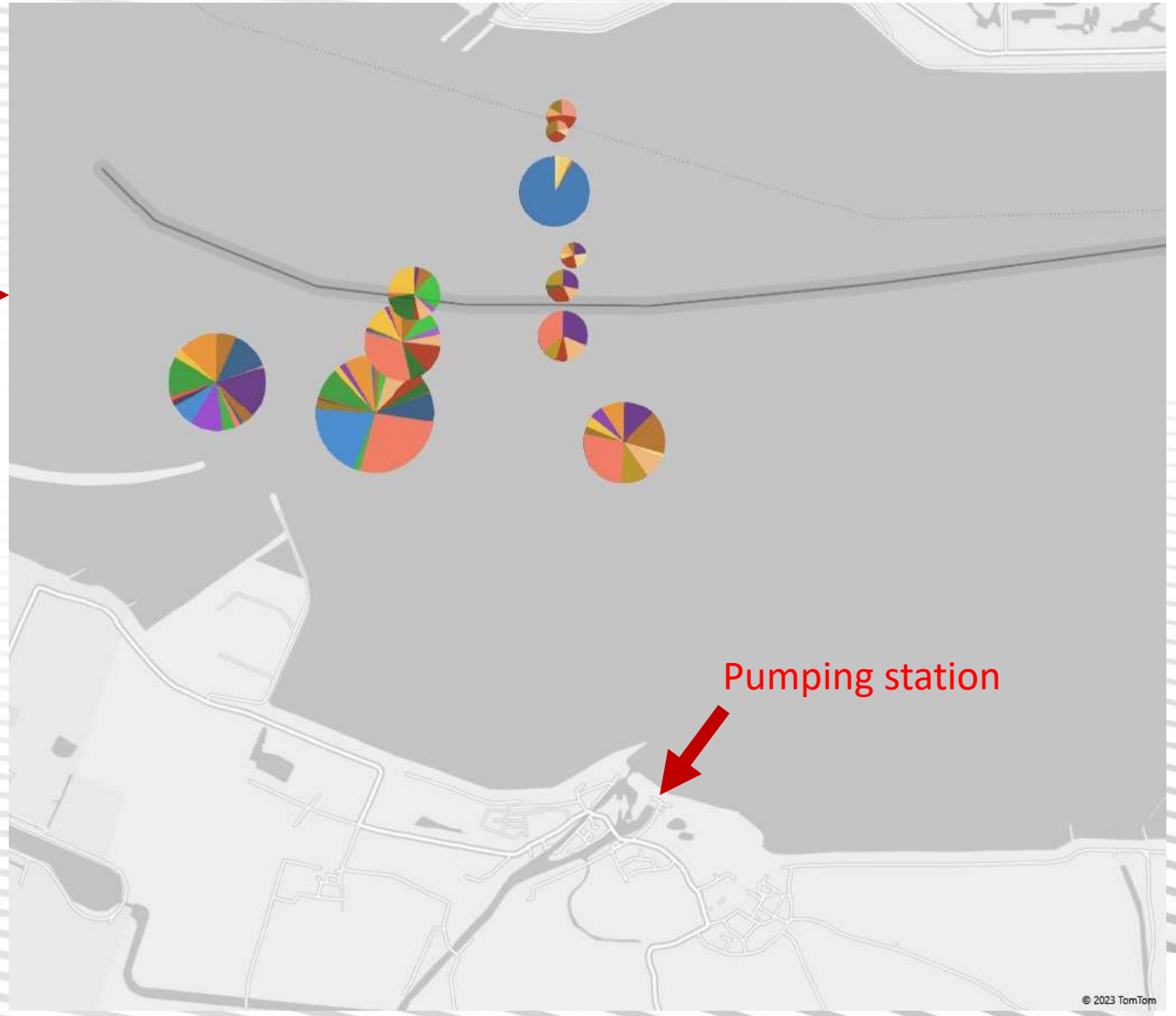
Q1: SURVIVAL/MORTALITY AND ROUTE CHOICE

30 Eels passed the pumping station:

30 survived, they were all detected on the receivers in the Ems estuary

and some even further in the Wadden Sea and Belgium

2 eels took another route!



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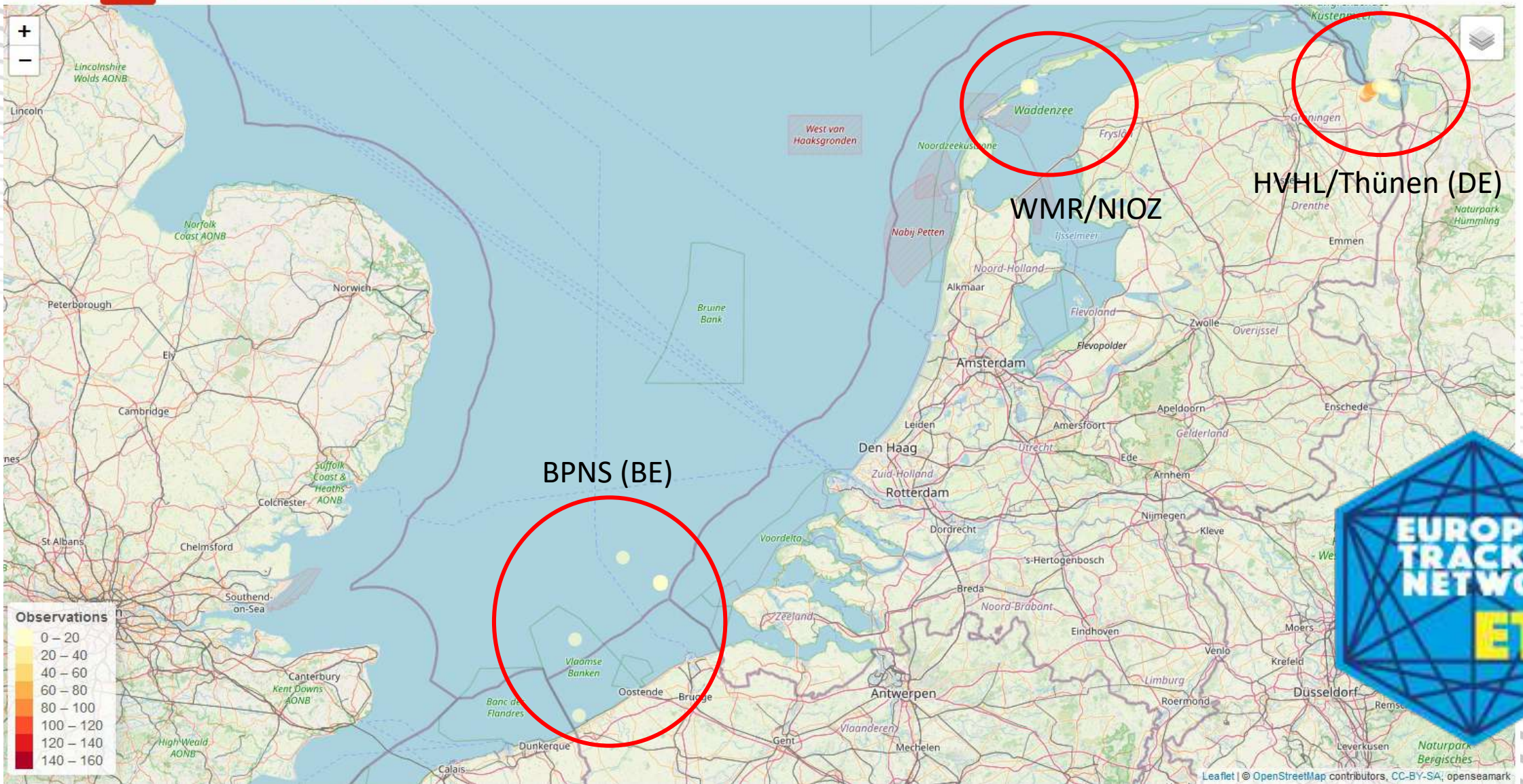
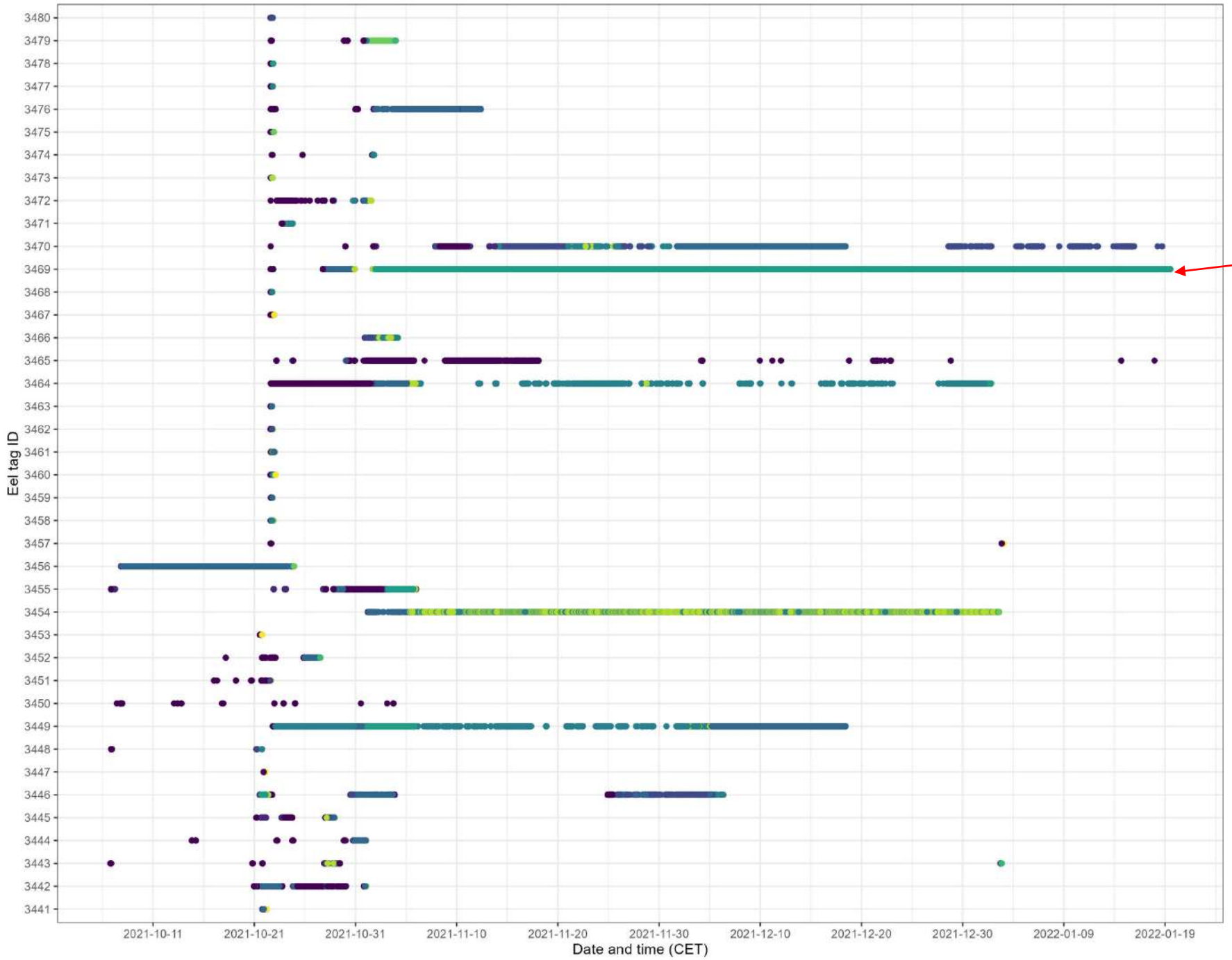
Lifewatch data explorer

Data source | Map | Data table | Time plots | Plots



EUROPEAN TRACKING NETWORK ETN

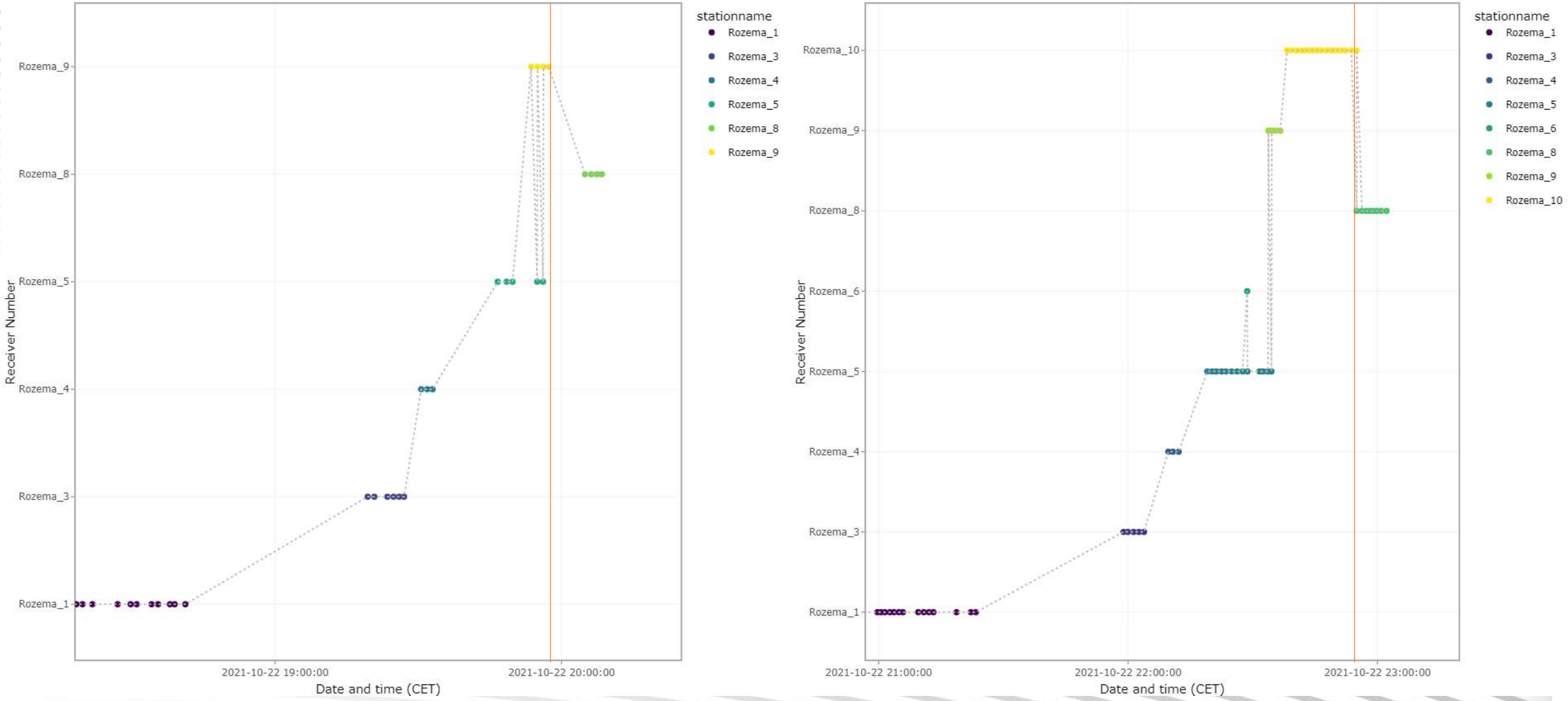


Dead?

No, acceleration data is recorded, cessation of migration/ tagging effect?

Different behaviors – the quick one's

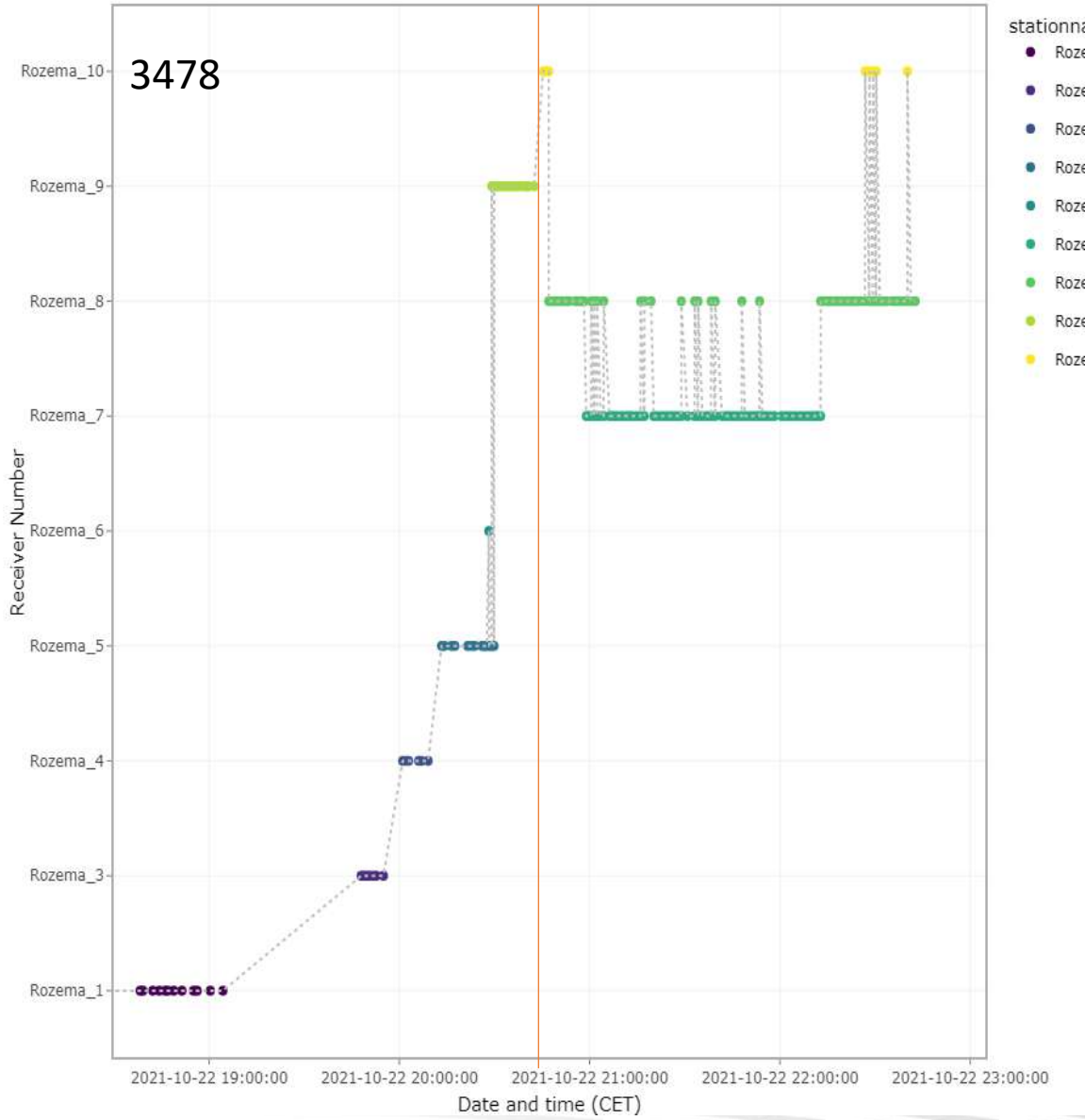
3467 Passing the Pumps



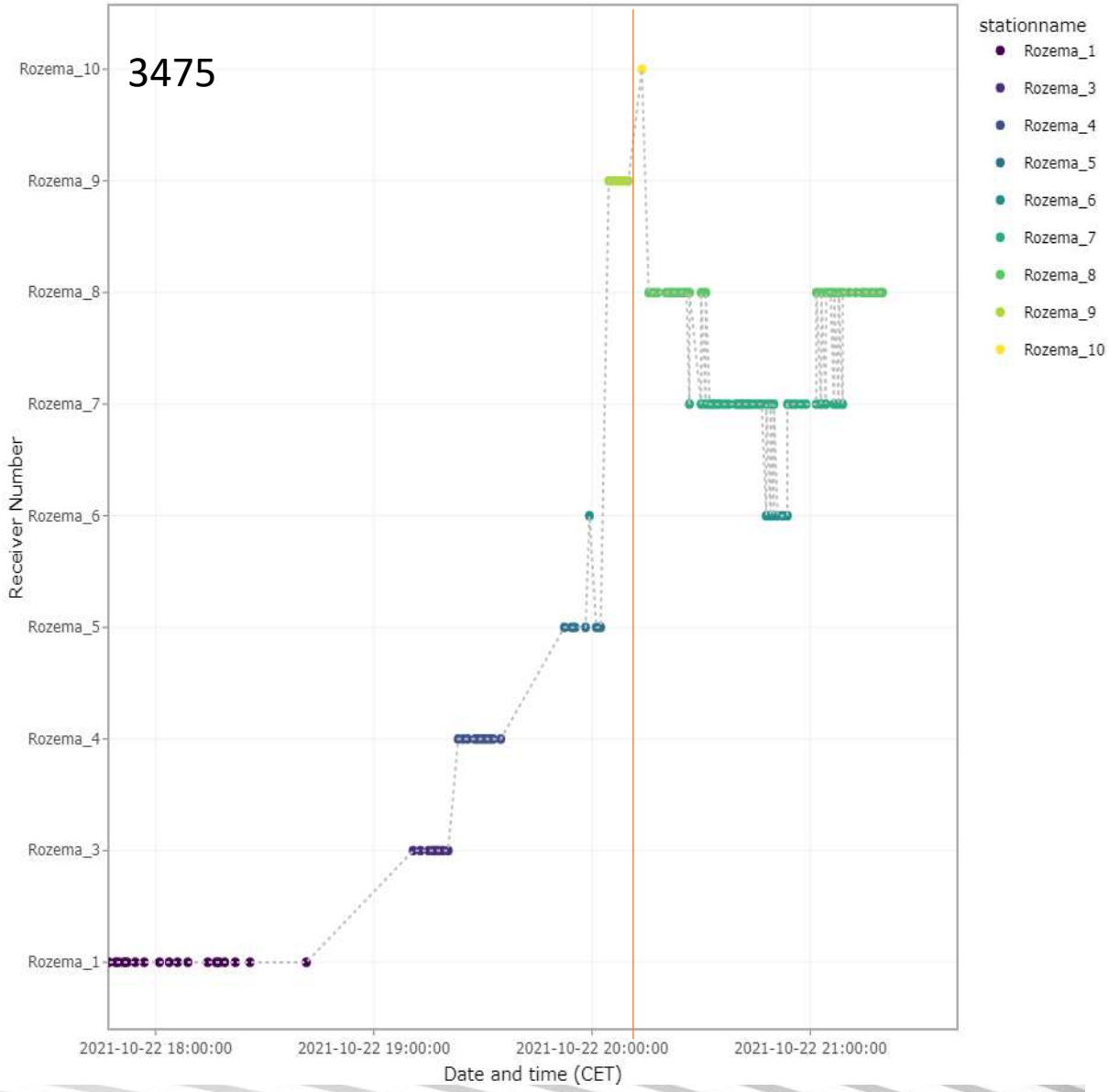
3477 Passing the Pumps

Different behaviors – the one's that come back in!

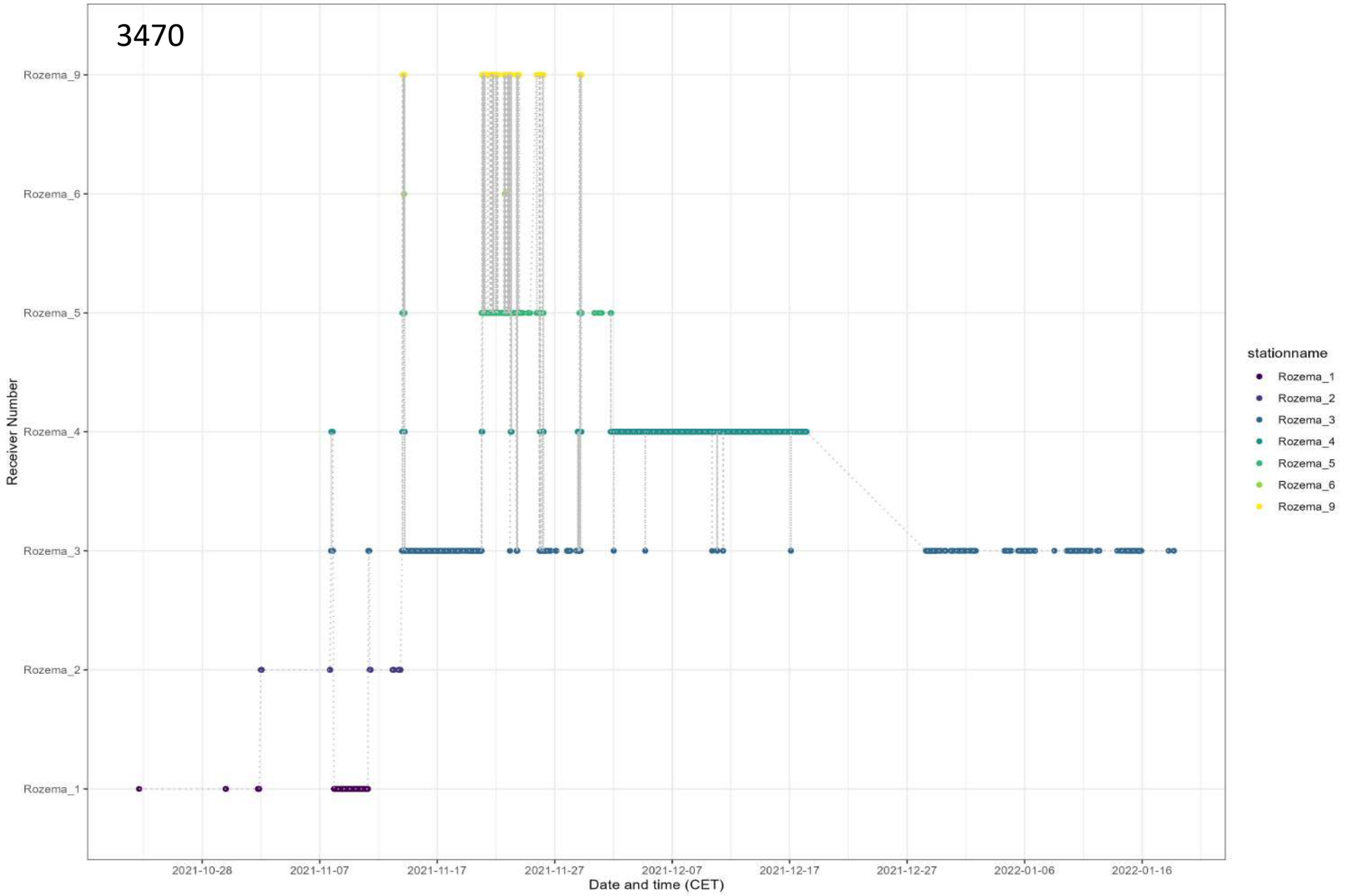
Passing the Pumps



Passing the Pumps



Different behaviors – the one's that stay?



DELAY

Delay time of eel passage through the pumping station

- 15 eels had a delay time of **less then 1 hour**
- 8 eels had a delay time of **between 1-24 hours**
- 7 eels had a delay time of **between 1.5 and 66 days**

$$Delay\ time\ = \\ last\ detection\ 9 - \ first\ detection\ 5$$

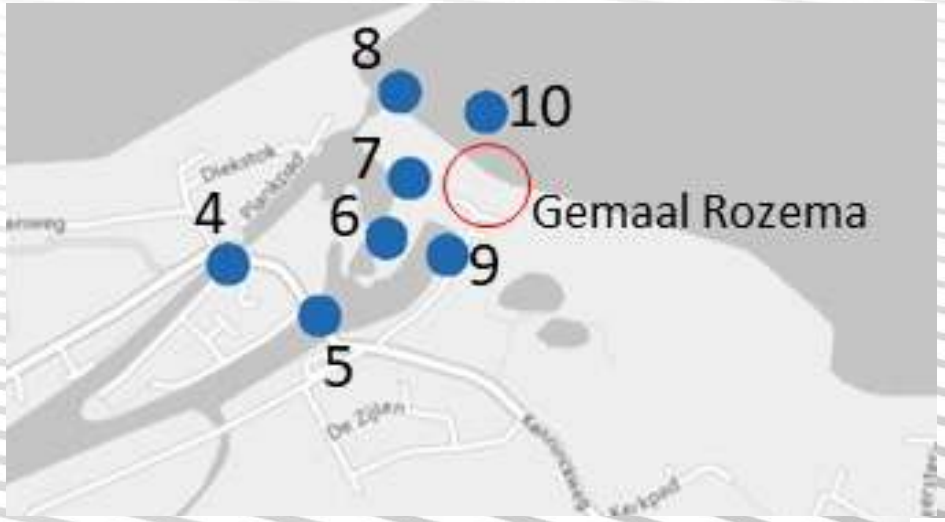
Pumping events before passage

- 13 eels passed after **6 pumping events**
- 13 eels passed after **between 17-78 events**
- 4 eels passed after **between 220-261 events**

$$Pumping\ event = \\ nr.\ pumping\ events\ between\ release\ and\ passase$$

Eels move back into the harbour

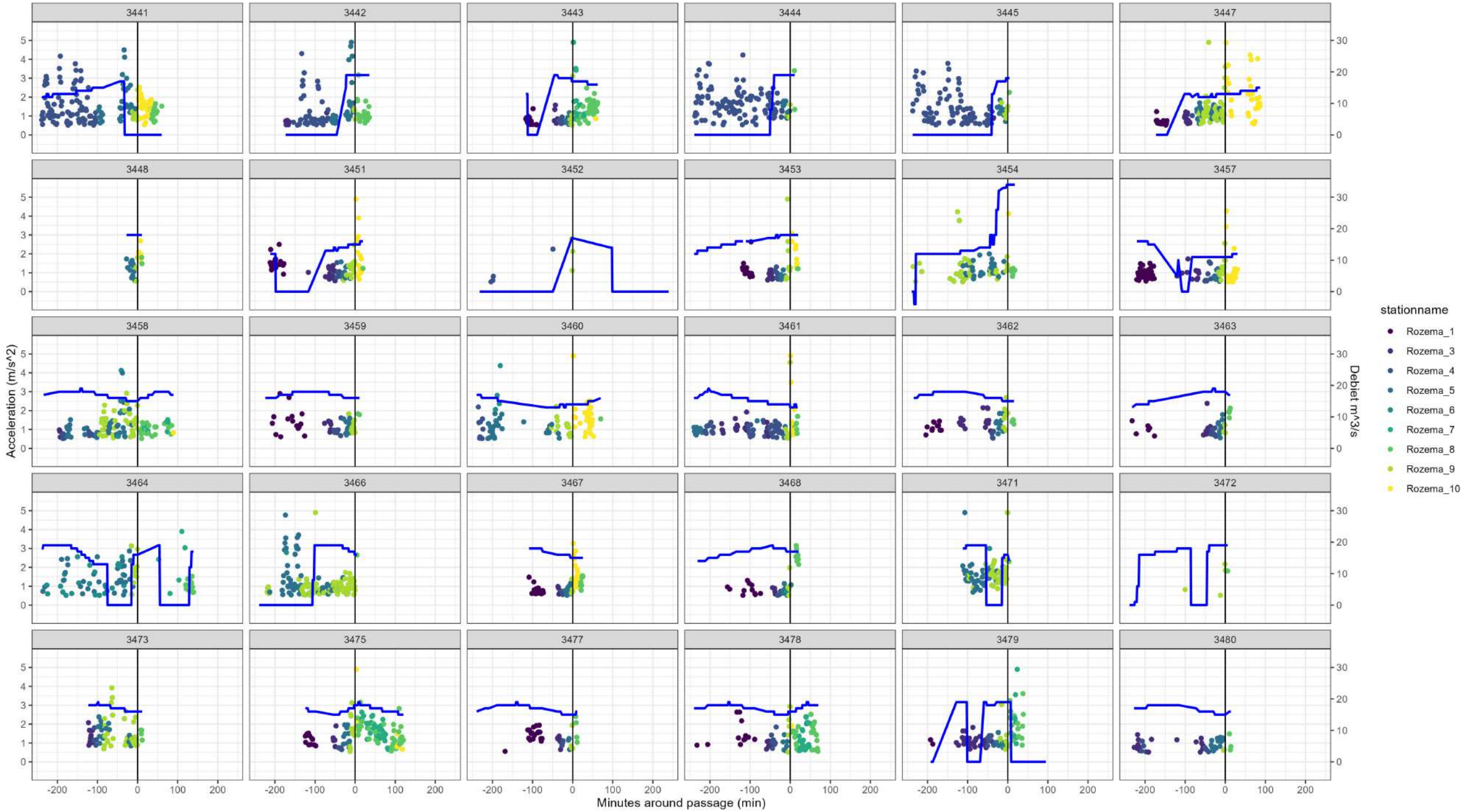
- 4/30 eels moved back into the harbour



Relation Pumping activity and eel behaviour (acceleration) ?

The effect of water flow on eel acceleration measured as the:

$$Vector\ Dynamic\ Body\ Acceleration = \sqrt{(x + y + z)^2}$$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Acceleration (m/s^2)
Debiet m^3/s
Minutes around passage (min)
stationname
Rozema_1
Rozema_3
Rozema_4
Rozema_5
Rozema_6
Rozema_7
Rozema_8
Rozema_9
Rozema_10

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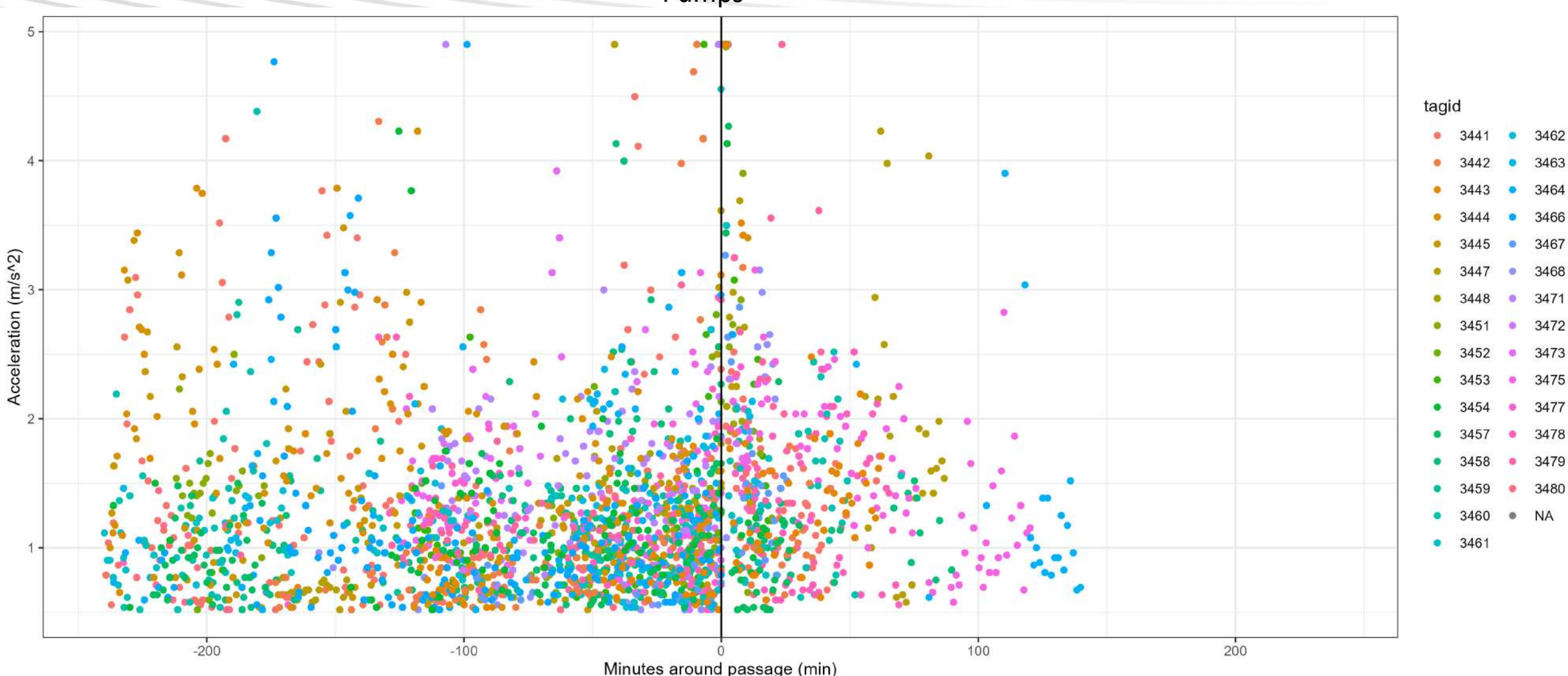
Acceleration and passage through the pumps



Summary

Q1: Route choice:	30 eels use pumping station, 1 eel used the old sluice, 1 via Delfzijl
Q1: Mortality:	100% survival pumping station
Q2: Delay:	Minimal 10.5 hours maximal 66 days
Q2: Pumping vs eel activity:	Needs further investigation (temporal!) → working on framework

Important notes:

- Mistake (almost): use of pump 1 → site specific knowledge is essential!
- 38/40 eels migrated first to the old sluice → brackish water!
- Eels that do not migrate out after tagging are not necessarily dead! Tagging effect?
- Some eels migrated back to the canal!
- Eels used near shore zone in estuary, only 7 detections!, lost receiver
- Next time use other frequency?

Paper and report end of 2023

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Inge van der Knaap, Peter Paul Schollema & Jeroen Huisman, 2023.