



Rijkswaterstaat  
*Ministry of Infrastructure and the  
Environment*

# Monitoring on the Rhine with the NEDAP trail system, fish tagging

André Breukelaar (RWS  
WNZ)



# Goal

To gain insight in the downstream migration of salmon smolts in the River Rhine:

- relative importance of the different migration routes
- mortality of smolts in the different river stretches
- escapement of salmon smolts to sea



## Haringvliet dam near the North Sea



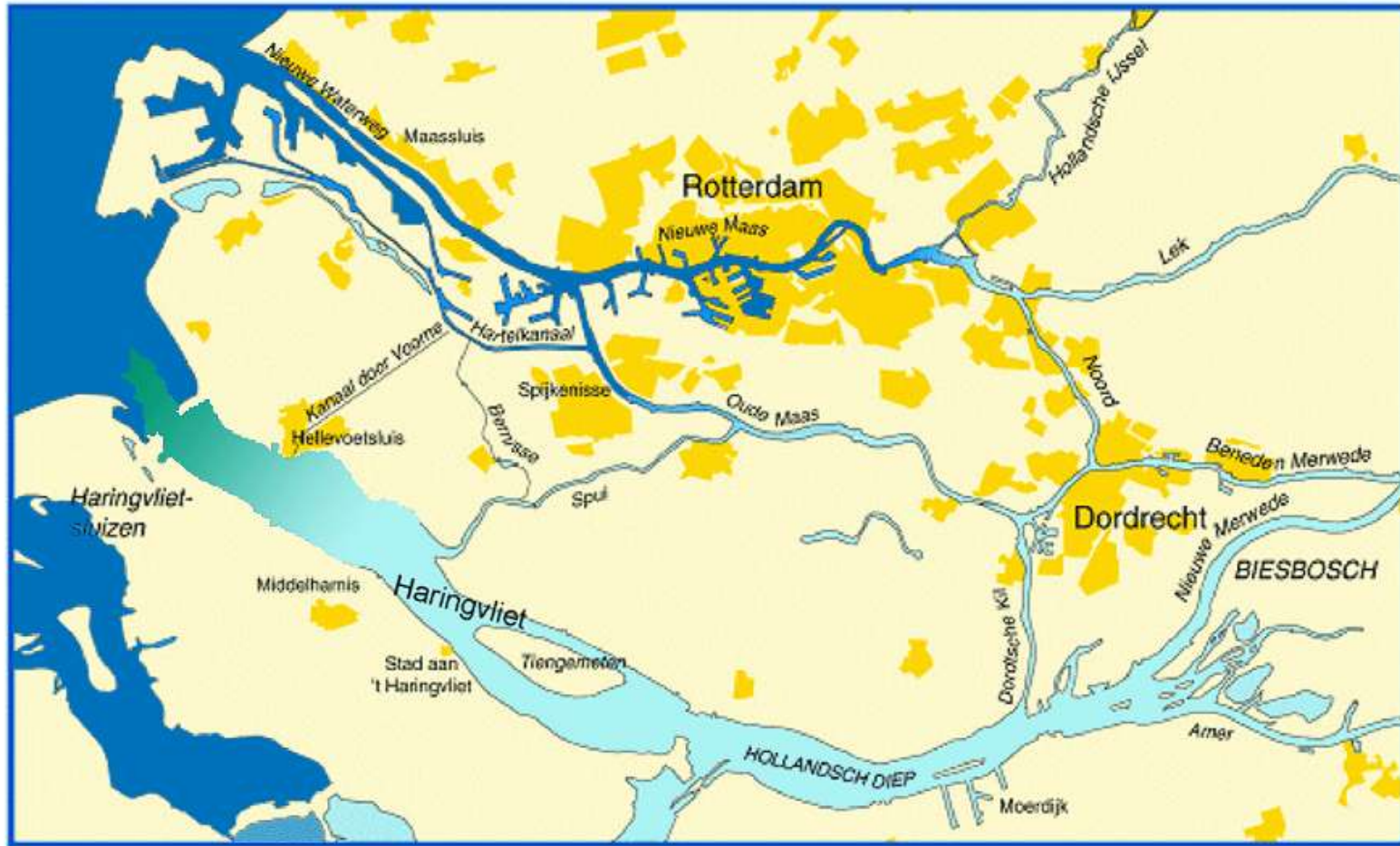


# Sluices of Haringvliet dam





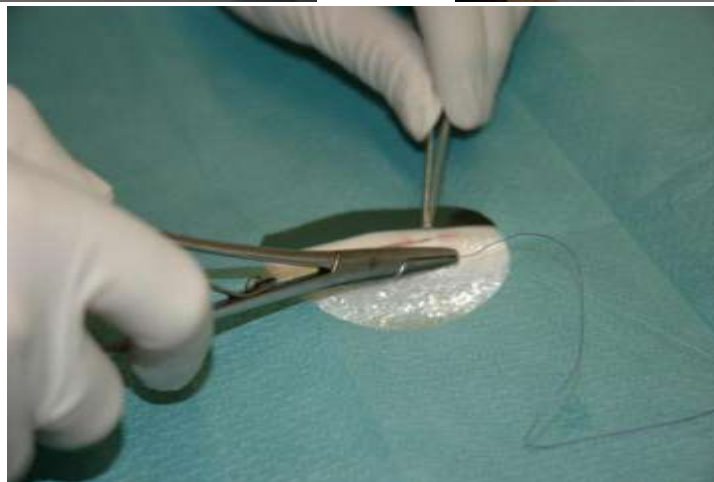
# Delta area of river Rhine and Meuse







# Implantation of a transponder



# Transponders





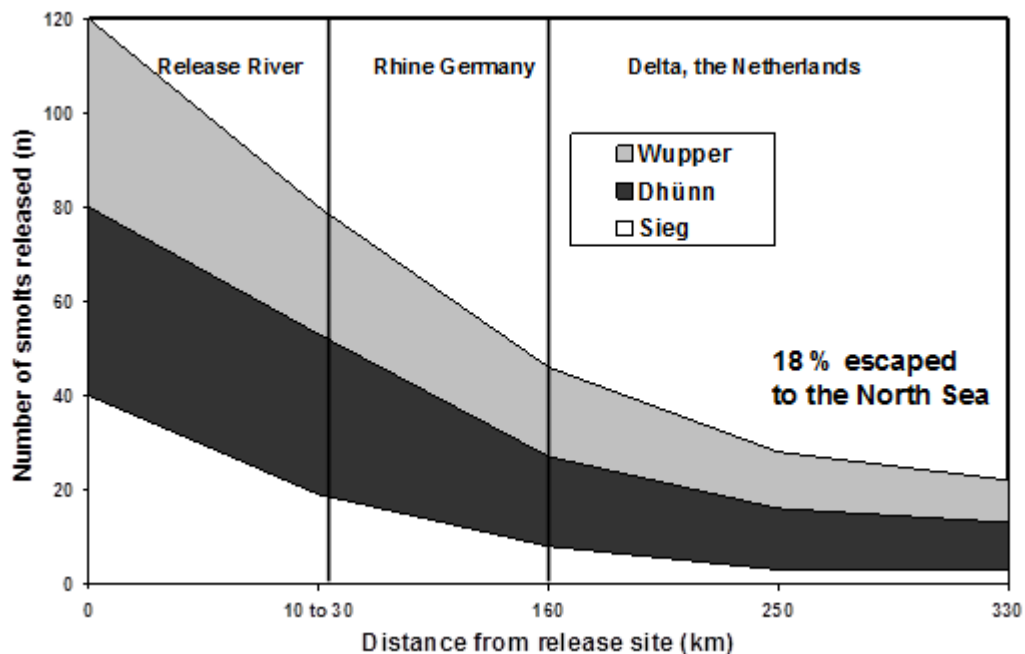
## Detection stations in river Rhine and Meuse







# Tagged Atlantic salmon smolts released to the tributaries Wupper, Dhünn and Sieg





## Aim of the study

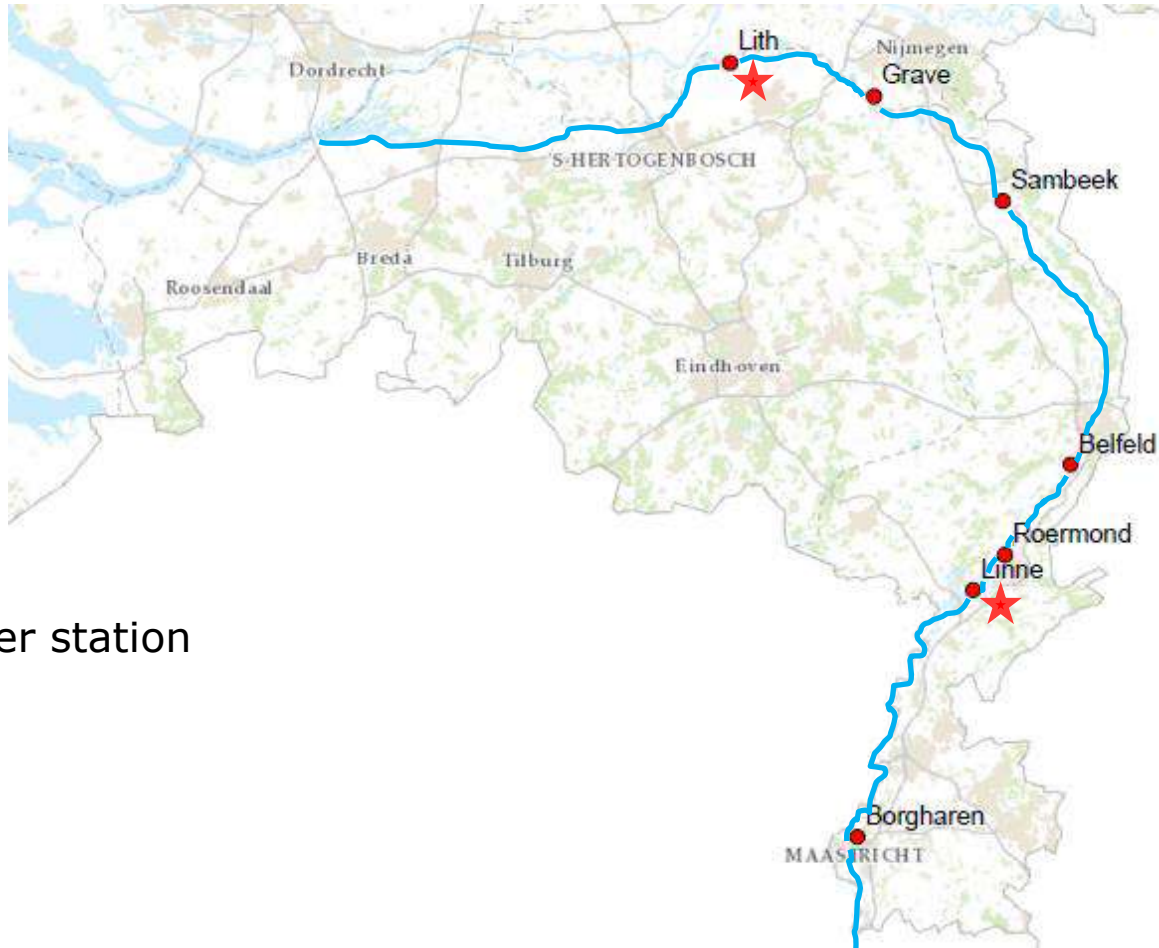
- To gain insight in the migration of Salmon smolts in the river Meuse, to determine choice of route and migration speed of individual fishes in relation to river discharge and other factors;
- To obtain a reliable estimation of the average mortality of Salmon smolts during downstream migration in the Dutch part of the river Meuse
- To quantify direct and indirect mortality of smolts passing hydropower stations and weirs.

This knowledge helps to formulate suitable measures to facilitate fish migration at barriers like hydropower stations and weirs, to protect fish in general and to support decision making in the process of licencing hydropower stations.



# Weirs and hydropower stations in the river Meuse

North Sea



- ★ = hydropower station
- = weir



## Hydropower station Linne, weir and fishway





## Weir at Linne







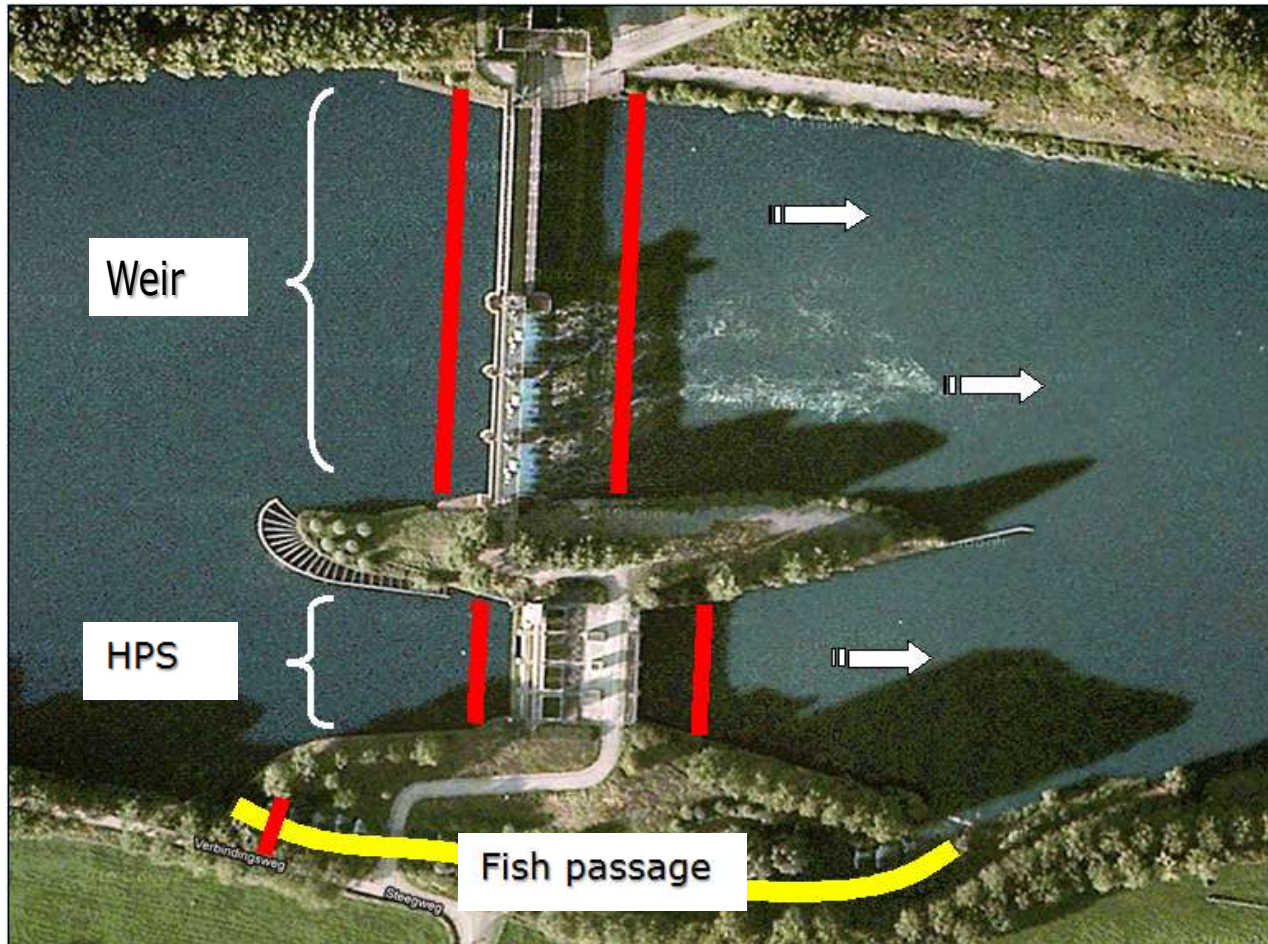
# Fishway Linne







## Detection stations at Linne





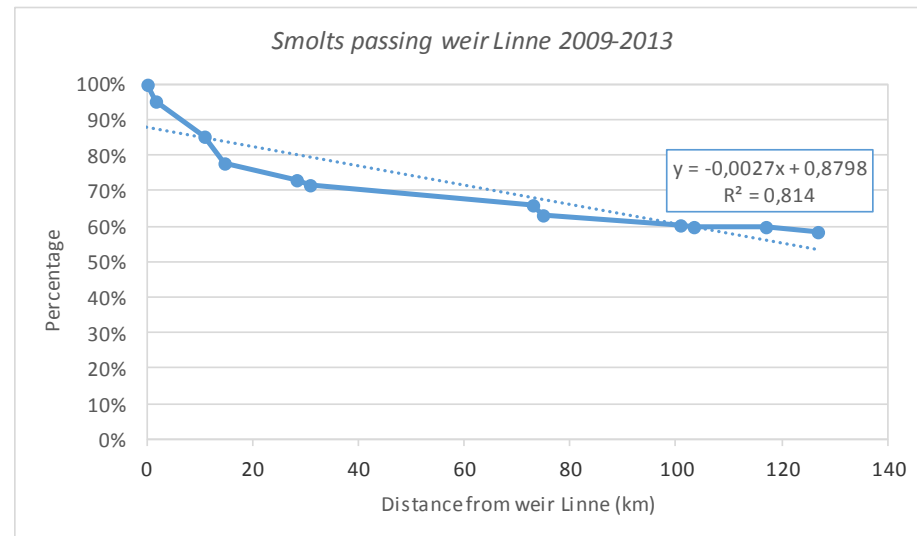
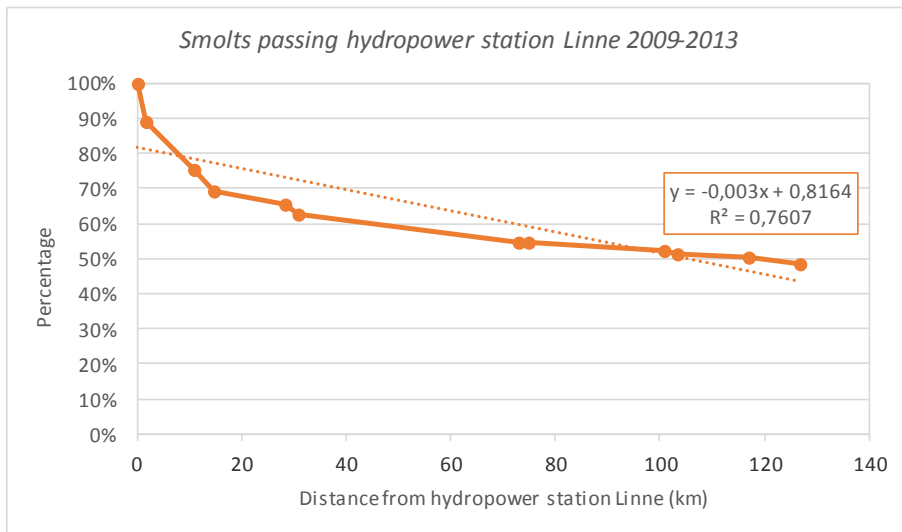
## Results migration of smolts 2009-2013

- In total 897 smolts were released at two different locations in the river Meuse (near Belgian border and 56 km downstream)
- At location Linne, 192 smolts passed through the hydropower station and 144 smolts passed over the weir in downstream direction.
- In the downstream river stretch from Linne to Lith (126 km), 52% of the smolts that passed through the hydropower station Linne were lost, compared to 42% of the smolts that passed over the weir



# Migration of smolts 2009-2013

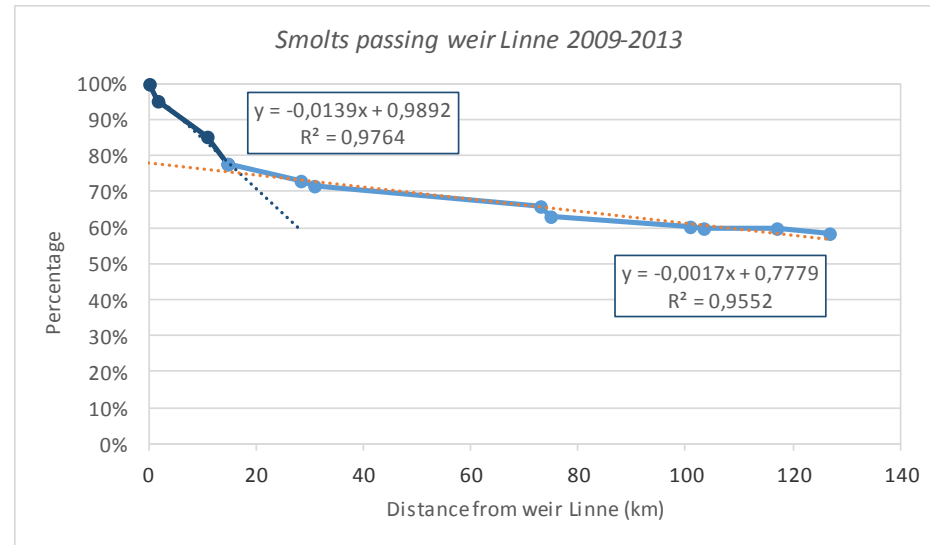
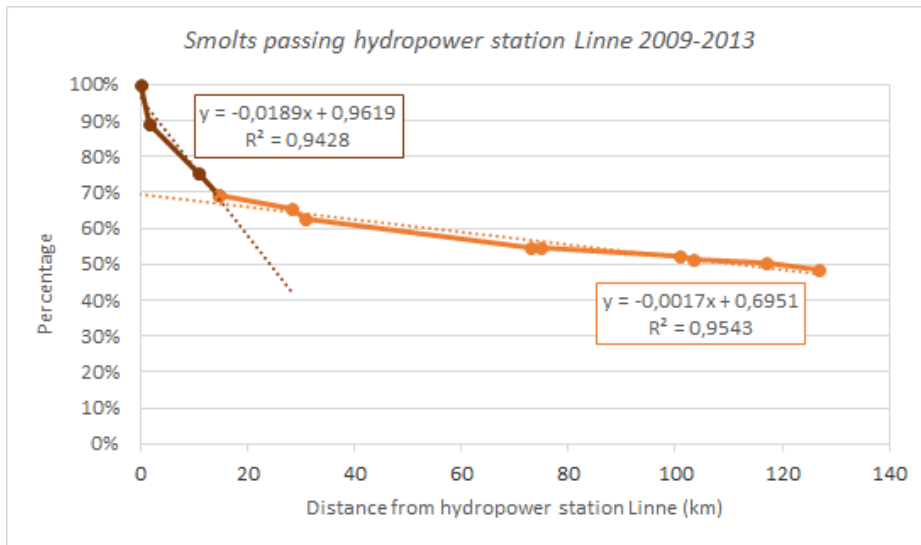
Linear regression shows no significant difference in mortality rate of smolts passing through the hydropower station and smolts passing over the weir.





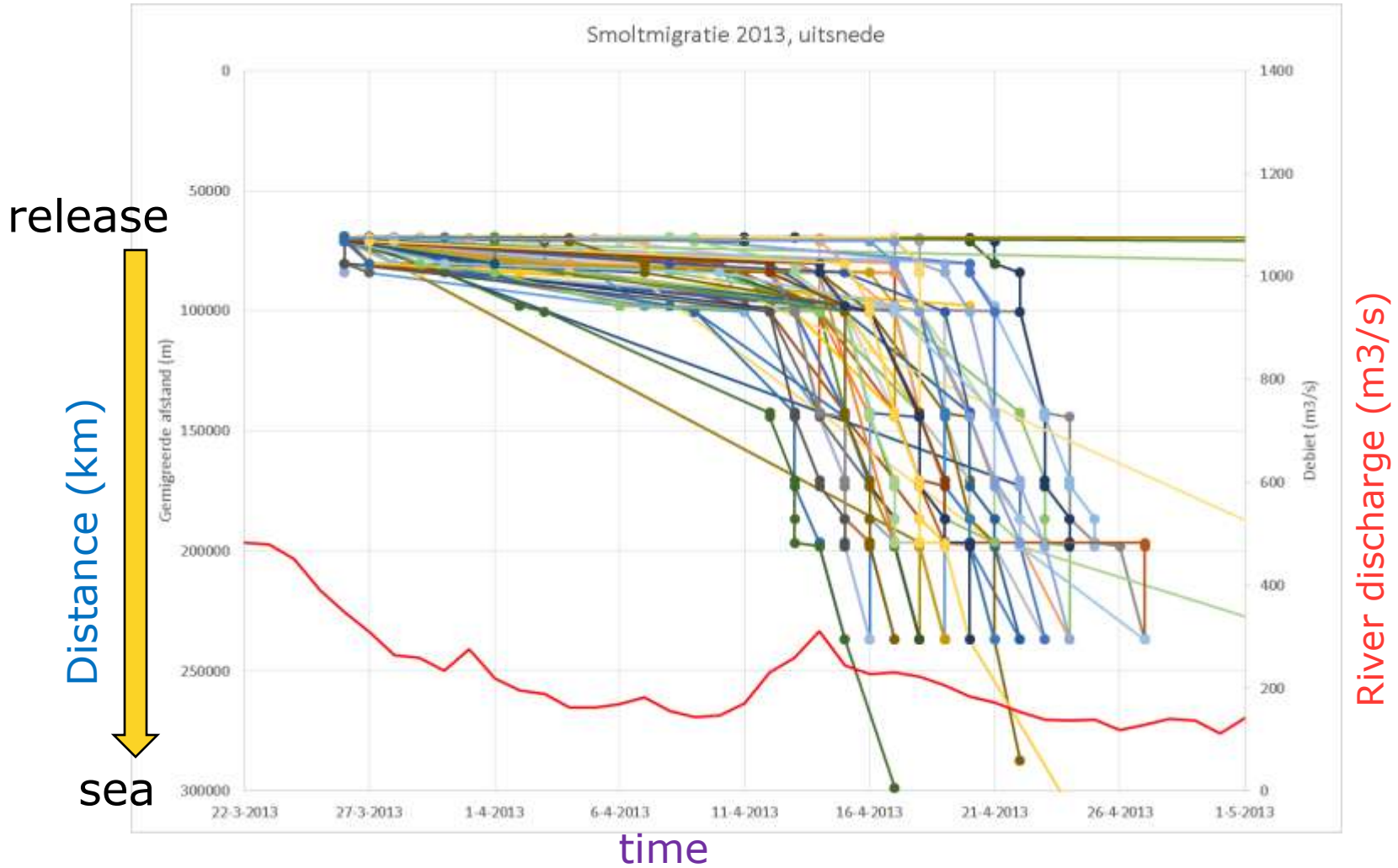
# Migration of smolts 2009-2013

Segmented linear regression shows significant difference in mortality rates over the first stretch after passing hydropower station and weir, compared to the latter part of the route to sea.





# Smolt migration in 2013





## Effects of cormorants?







## Conclusions

- In all relevant years, mortality of smolts is higher when passing through the hydropower station compared to passing over the weir:  
  
2009: 48% hydropower smolts, 25% weir smolts (+23%)  
2010: 37% hydropower smolts, 31% weir smolts (+8%)  
2013: 65% hydropower smolts, 54% weir smolts (+11%)
- The mortality rate of smolts is increased in the first 15 km downstream the hydropower station and weir. More downstream mortality rate is lower.
- An increase of river discharge seems to stimulate the migration.



Thanks for your attention!

