Dec 11th, 11:40 AM - 12:40 PM

Influence of hydraulics on the dowsntream migratory route of Atlantic salmon (Salmo salar)

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Influence of hydraulics on the downstream migration route of Atlantic Salmon

Ana T. Silva

NINA
Norwegian Institute for Nature Research

SAFEPASS

The Research Council of Norway

Safe and efficient two-way migration for salmonids and European eel past hydropower structures (2015-2019)

NINA

NTNU
100 skapende år

SINTEF

NSERC
HydroNet
CRSNG

KARLSTAD UNIVERSITY
KAU.SE EDUCATION FUTUR

eDF

Technical University of Denmark
DTU Aqua
National Institute of Aquatic Resources

uni Research

Energy Norway, 12 HP companies, Environment and energy management of Norway

SAFEPASS

Fish Passage 2018, Albury

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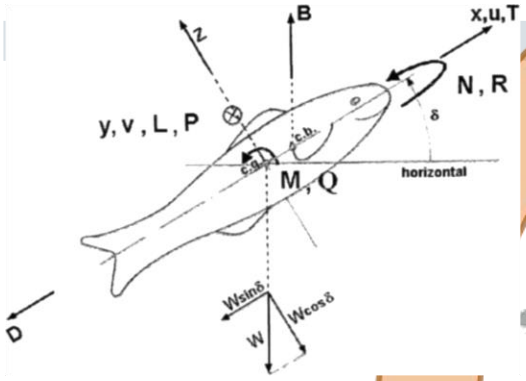
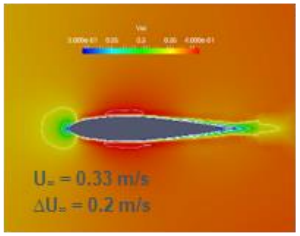
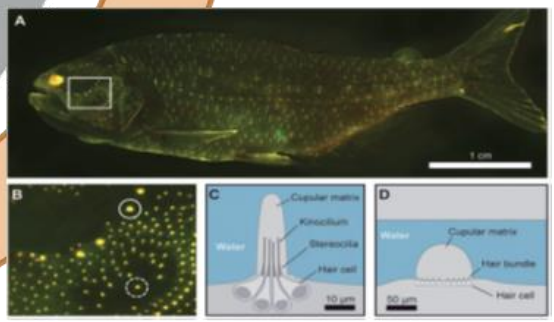

B
x,u,T
z
N, R
y, v, L, P
δ
horizontal
M, Q
D
Wsinδ
Wcosδ
W

1 Action
2 Changes environment
3 Sensory input
Effectors
Sensors
4 Action
5 Perception
6 Sensation


U∞ = 0.33 m/s
ΔU∞ = 0.2 m/s

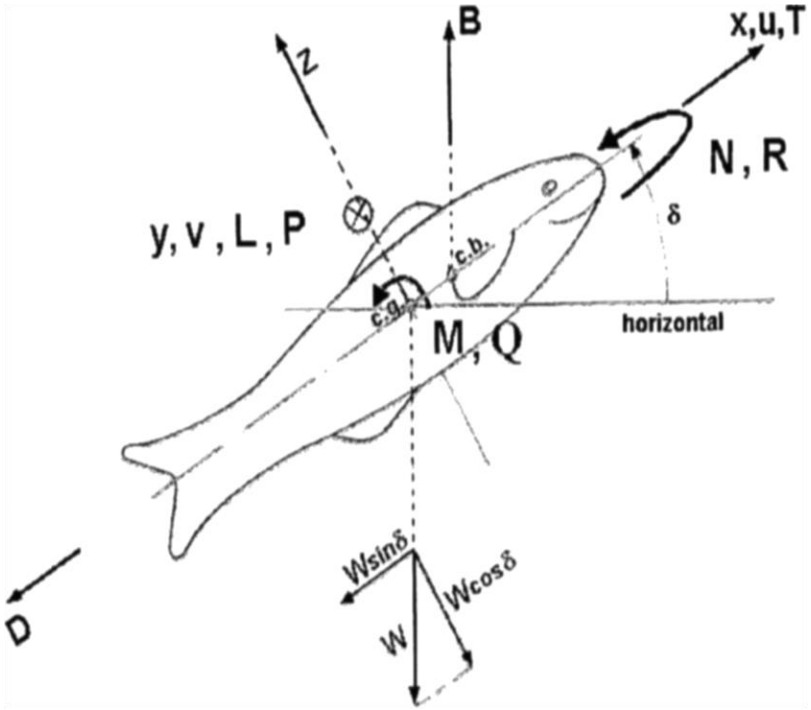
U∞ = 1 m/s
ΔU∞ = 0.7 m/s


A
B
C
D
Cupular matrix
Kinocilium
Stereocilia
Hair cell
Water
Hair bundle

Which route?

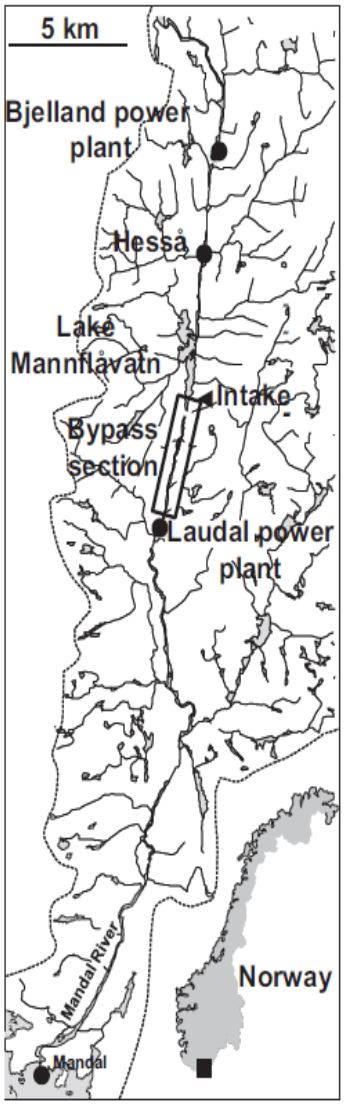
Alan Majchrowicz / Getty Images. *Time*

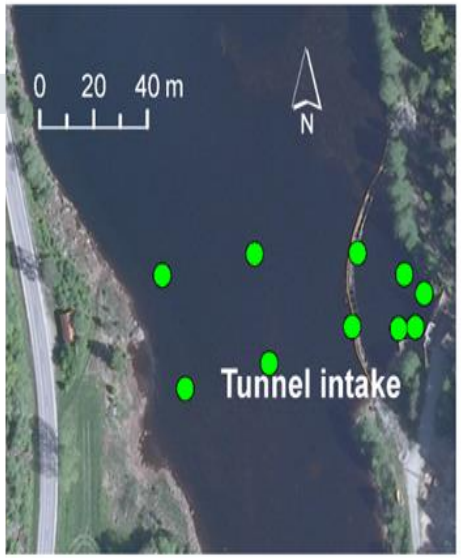
Hydraulics influence fish swimming behaviour

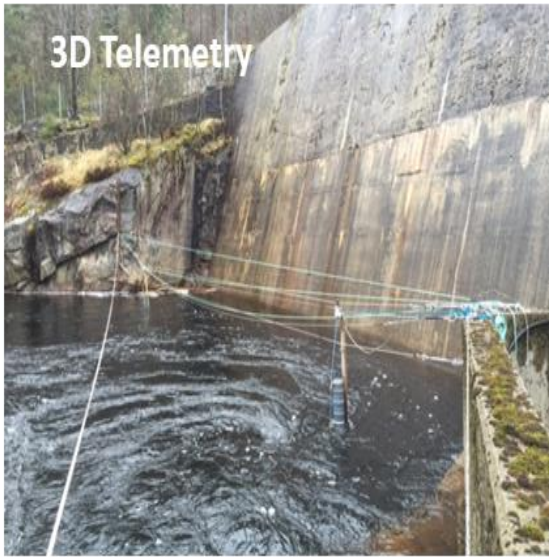


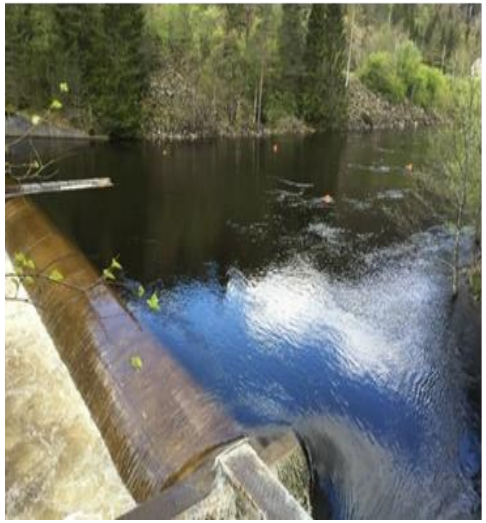
Water velocity
Acceleration
Turbulence intensity
Turbulence kinetic energy
Reynolds shear stress
Eddies size, orientation and vorticity

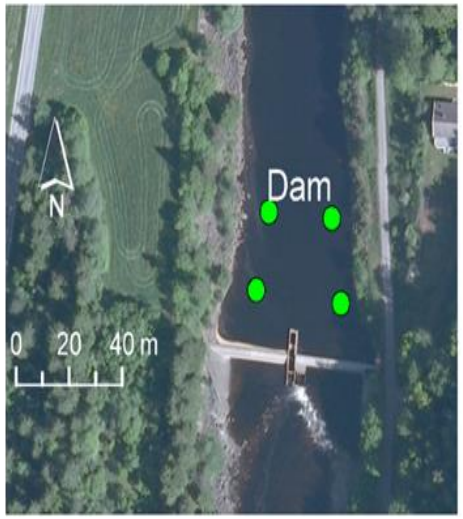
2D and 3D Telemetry

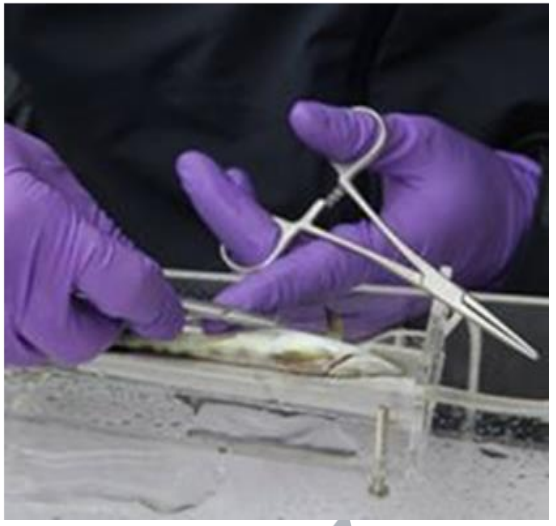




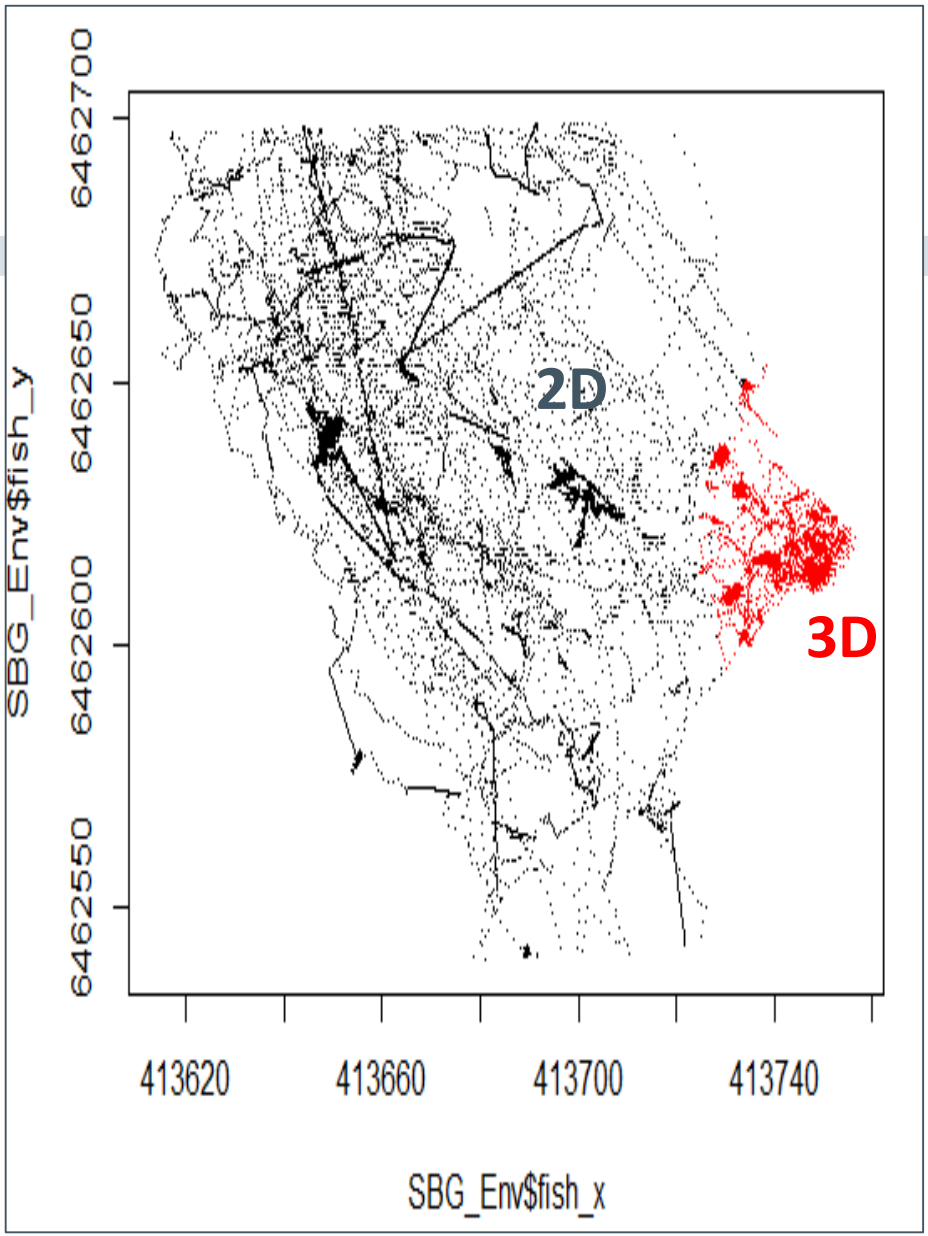


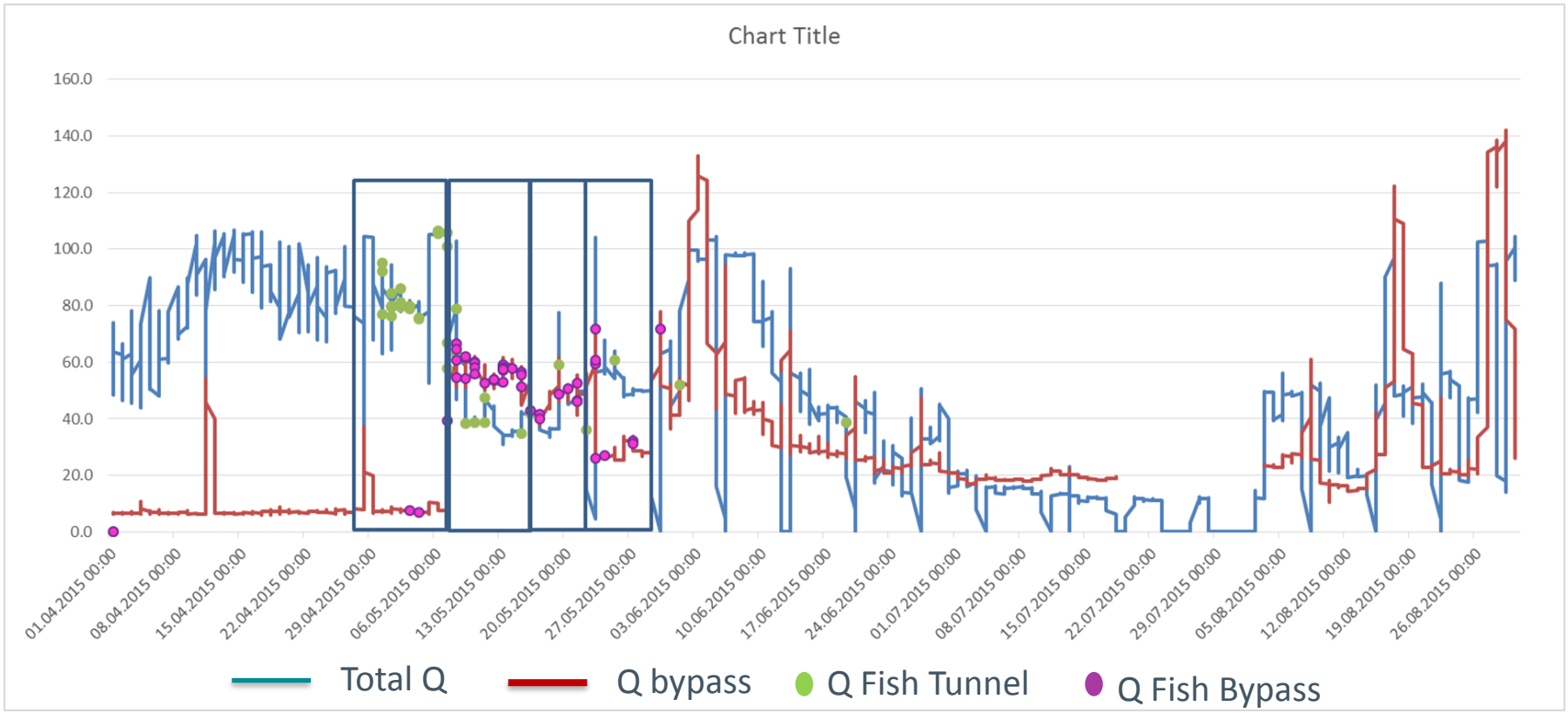






Fish swimming route





Modelling 4 conditions:

Q88 ~ 36% BP, 64% T
Q92 ~ 11% BP, 89% T
Q94 ~ 51% BP, 49% T
Q98 ~ 56% BP, 44% T

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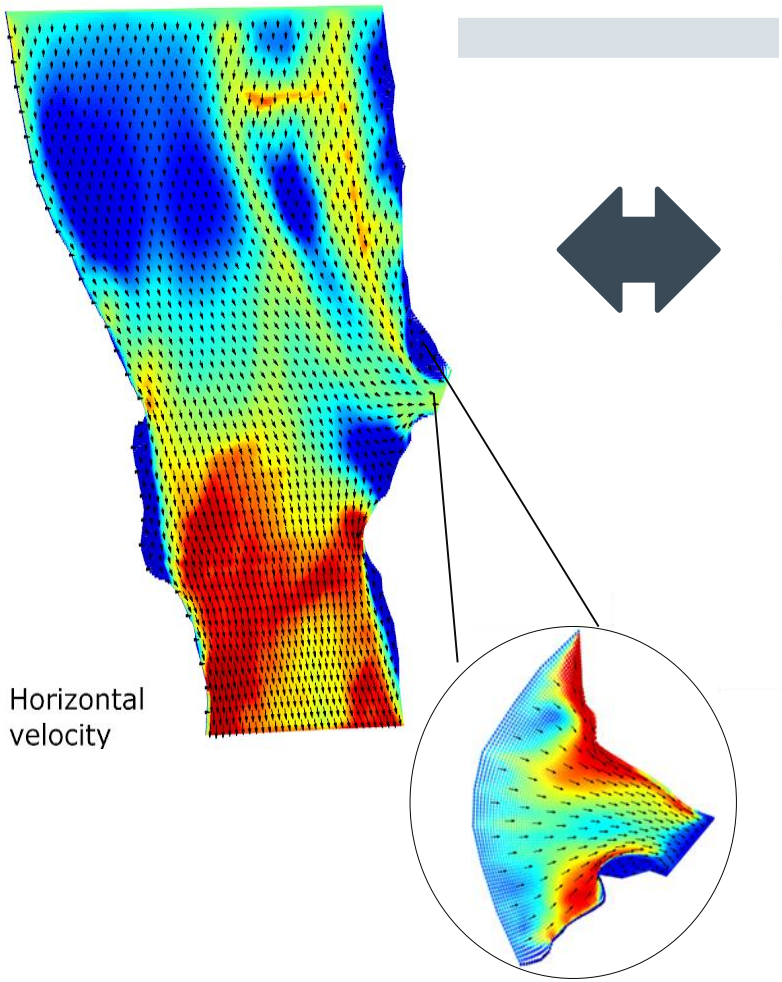
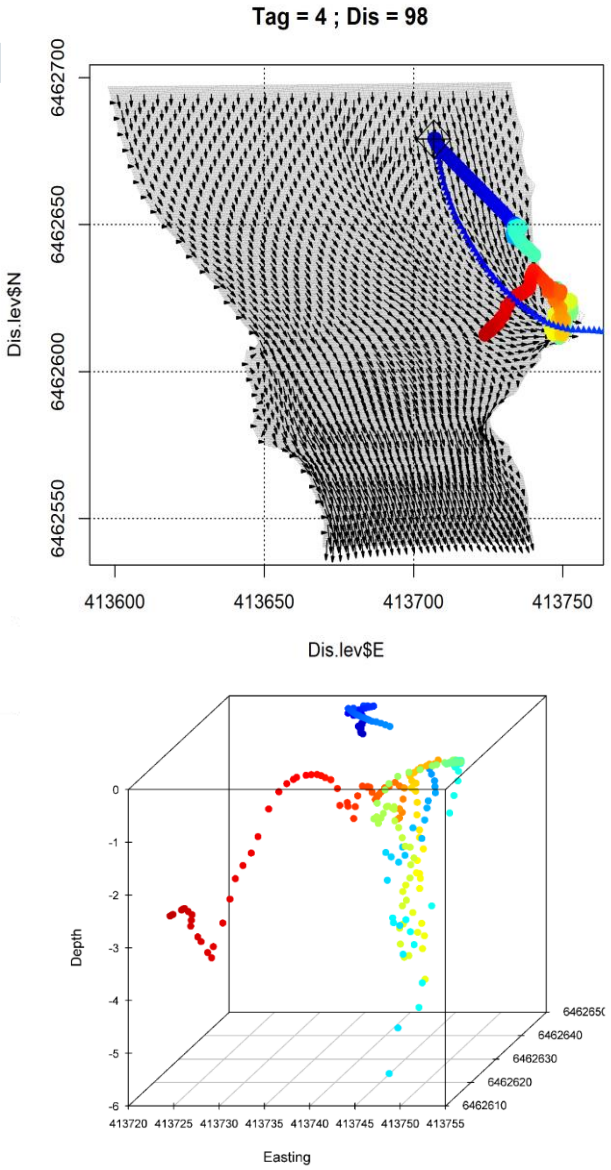
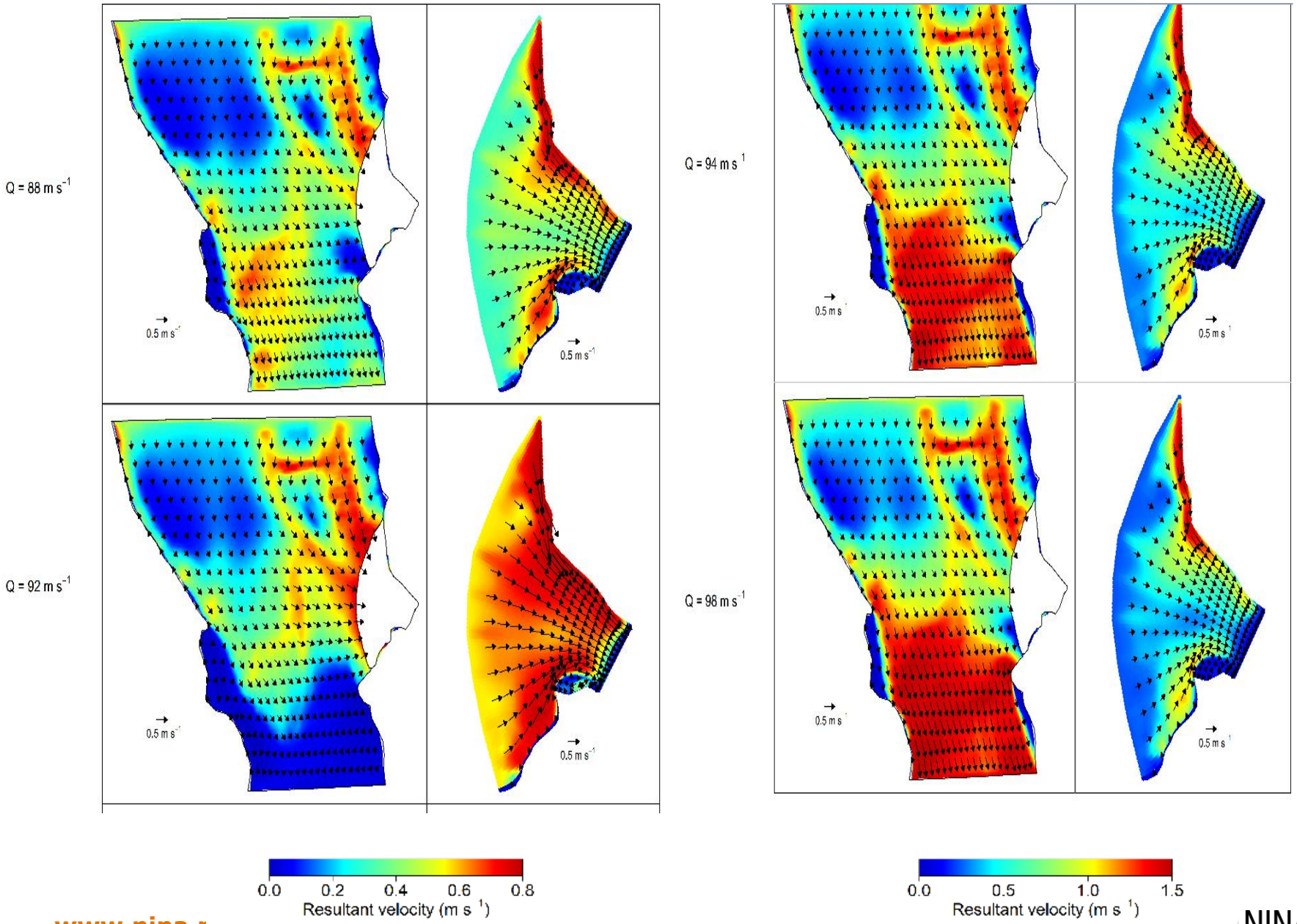
SSIM


Horizontal
velocity

YAPS


Tag = 4 ; Dis = 98
Dis.lev$N
6462700
6462650
6462600
6462550
413600
413650
413700
413750
Dis.lev$E
Depth
0
-1
-2
-3
-4
-5
-6
413720 413725 413730 413735 413740 413745 413750 413755
Easting
6462640
6462630
6462620
6462610
Northing


Q = 88 m s-1
Q = 92 m s-1
Q = 94 m s-1
Q = 98 m s-1
0.5 m s-1
0.0 0.2 0.4 0.6 0.8
Resultant velocity (m s 1)
0.0 0.5 1.0 1.5
Resultant velocity (m s 1)

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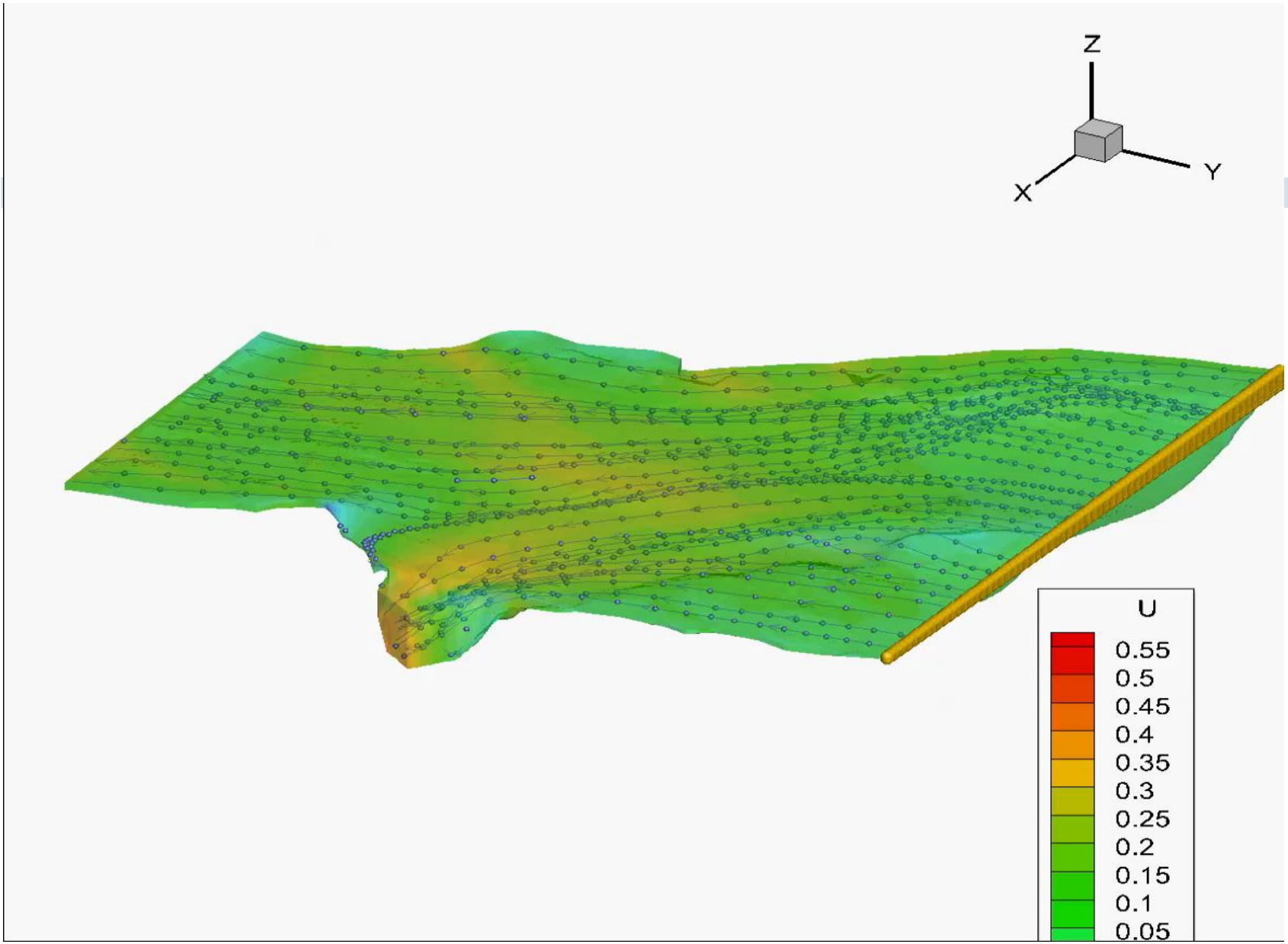
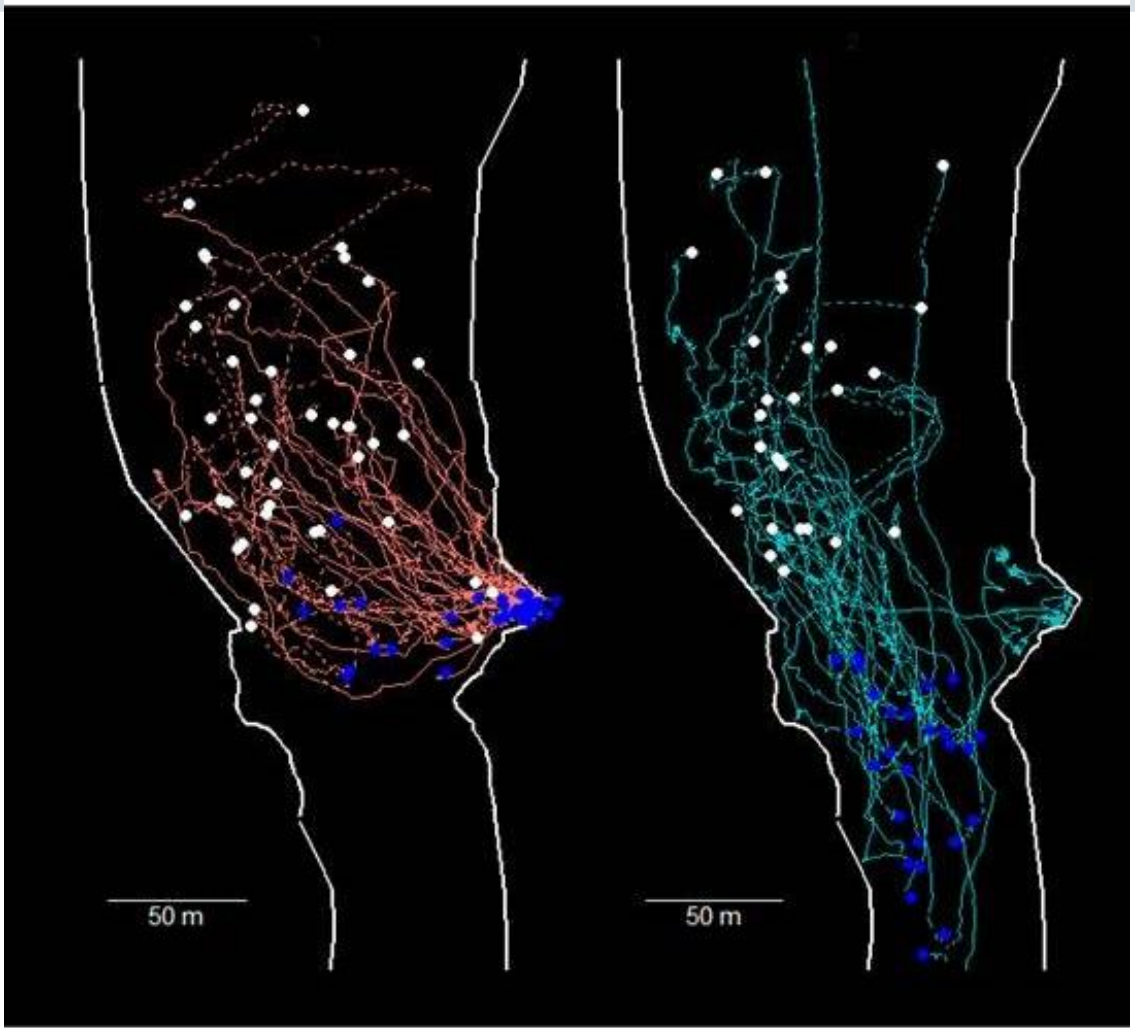
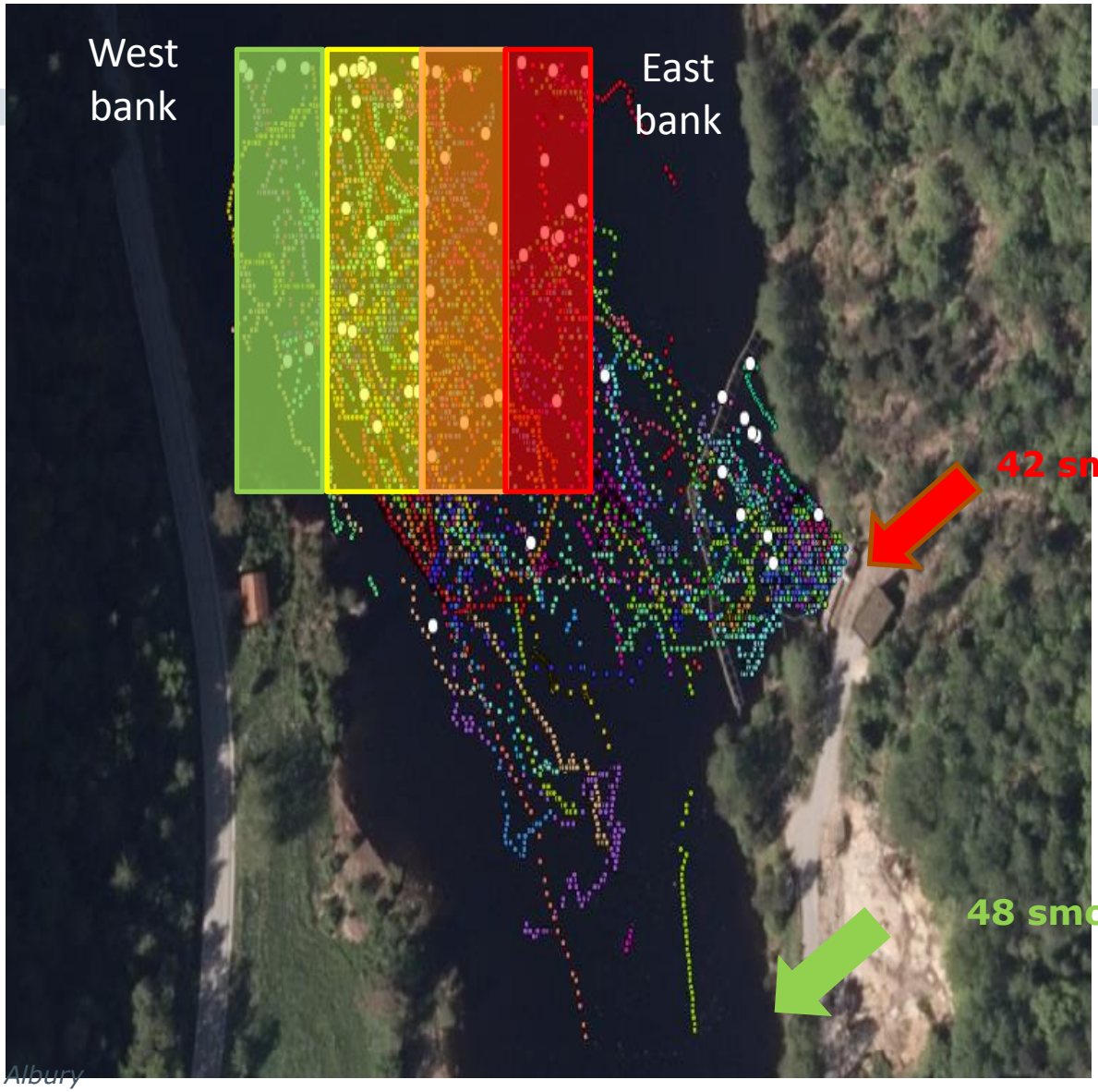

Z
X
Y
U
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05

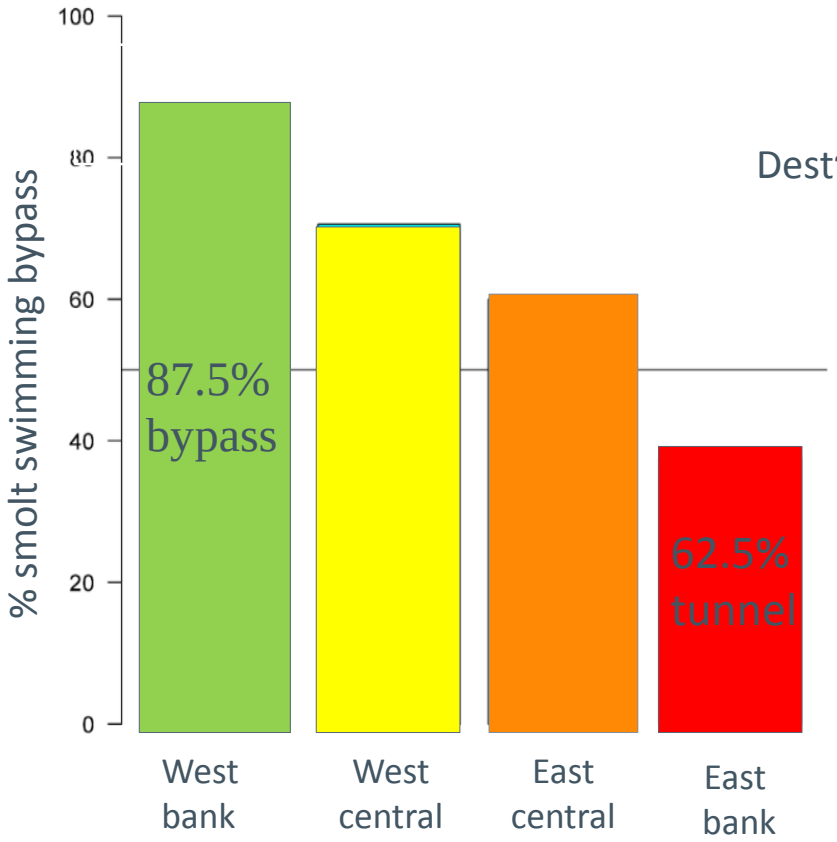
Individual-based behaviour



Destination ?



Destination (Bypass or Tunnel?)



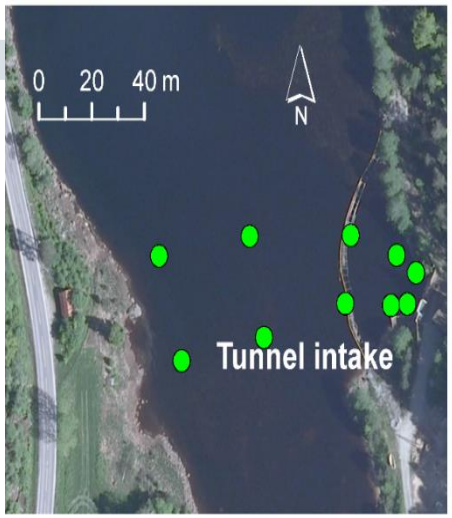
Probability of migrating into bypass

Dest~TL+W+FF+SI+IniTimeDay+Discharge*Pro.bp+InLoc

Entry location in the system (P<0.05)

Percentage of flow in the intake (P<0.001)

Passage time



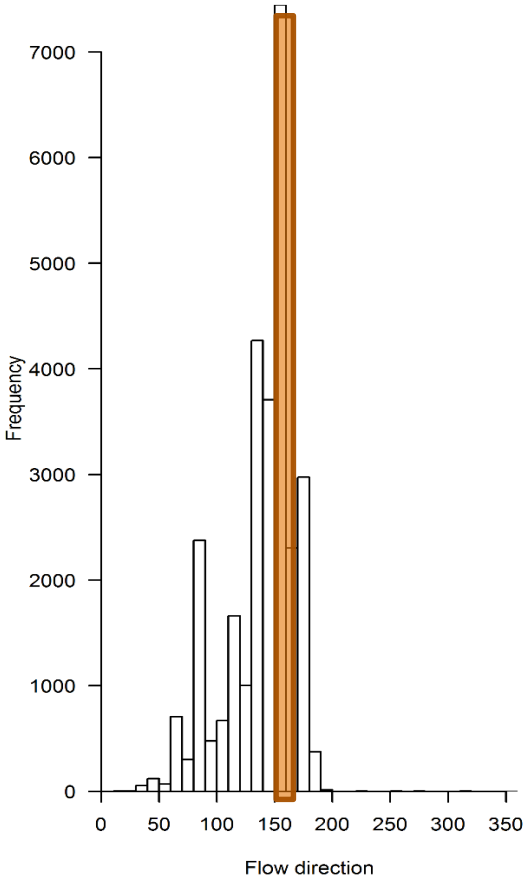
Longer passage times:

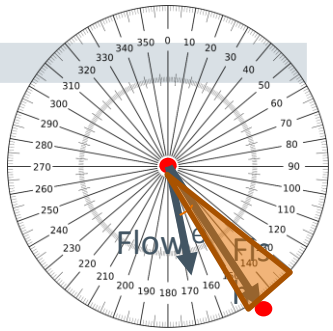
- Fish that arrived in the system during twilight (P<0.01).
- Lower ischarge (P<0.001)
- Fulton`s Conditioner Factor (P<0.01)

PT~TL+Wt+IniTimeDay+Discharge*Pro.bp+InLoc

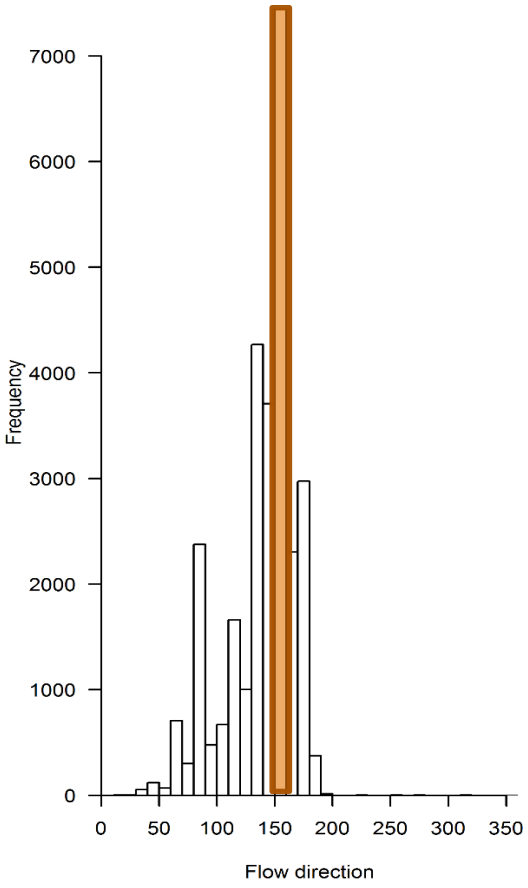
$$F = \frac{1000W}{L^x}$$

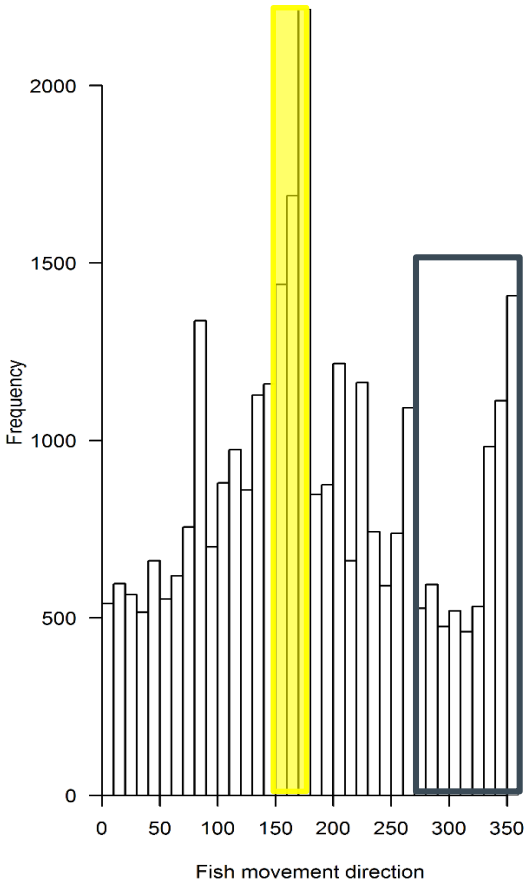
Fish orientation vs Flow orientation

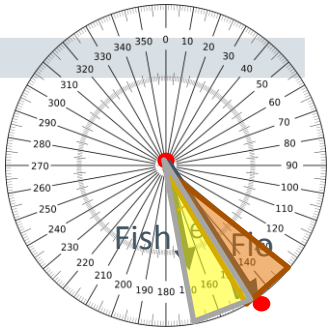




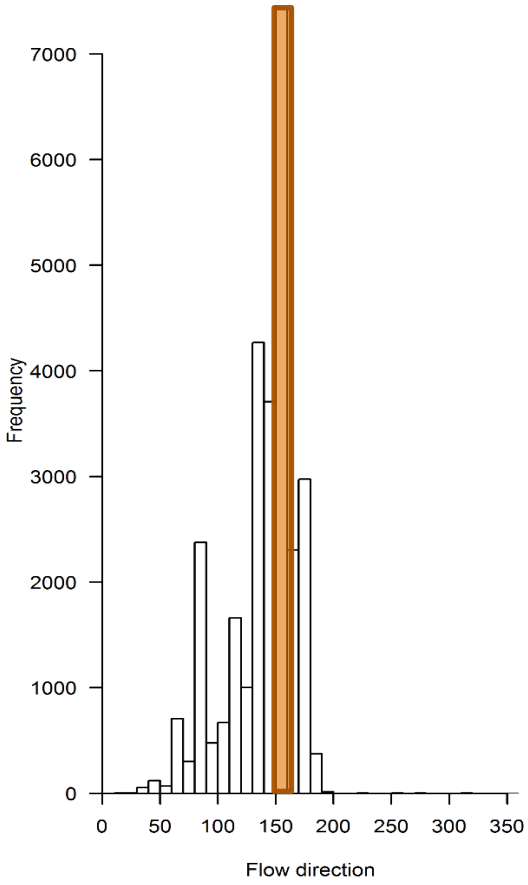
Fish orientation vs Flow orientation

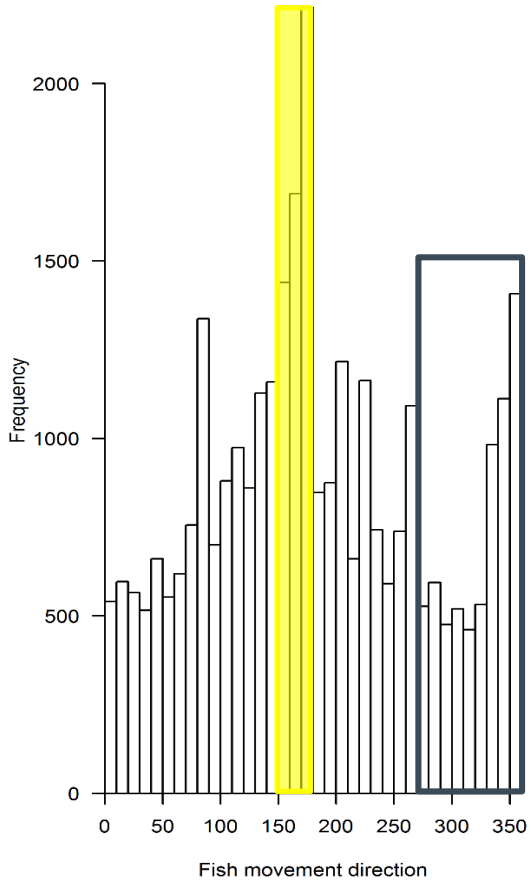


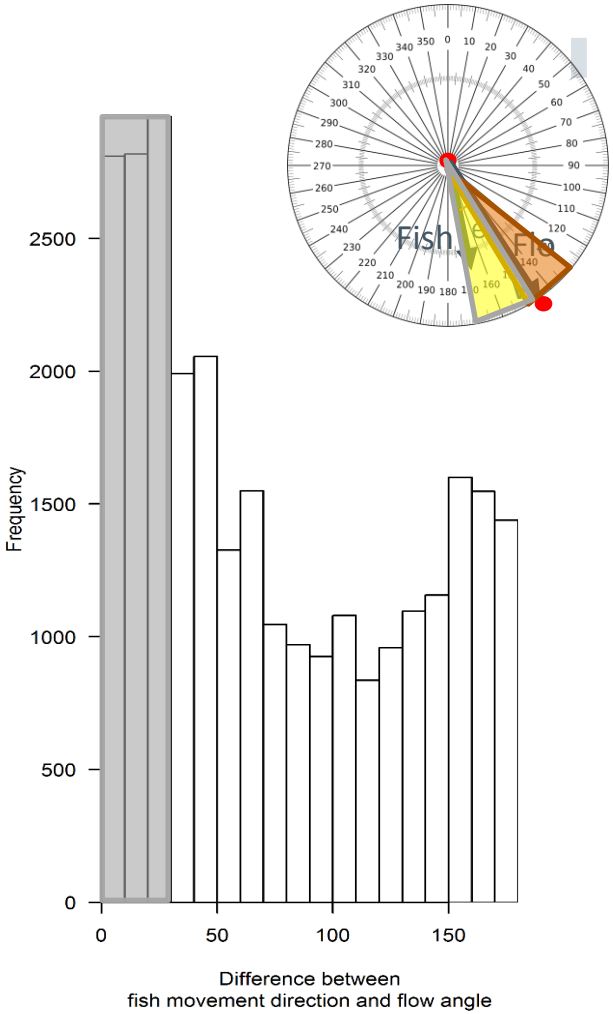




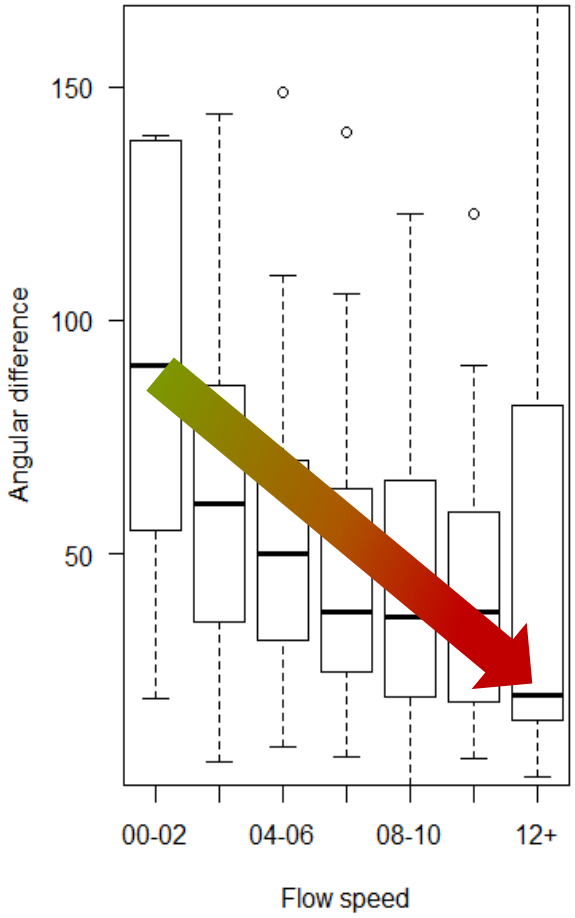
Fish orientation vs Flow orientation

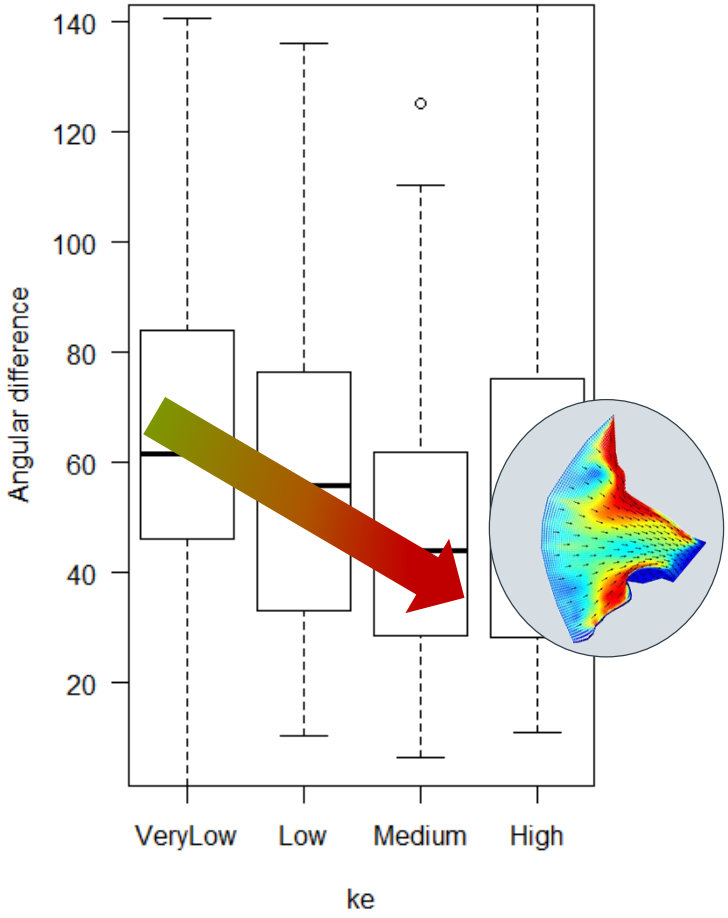






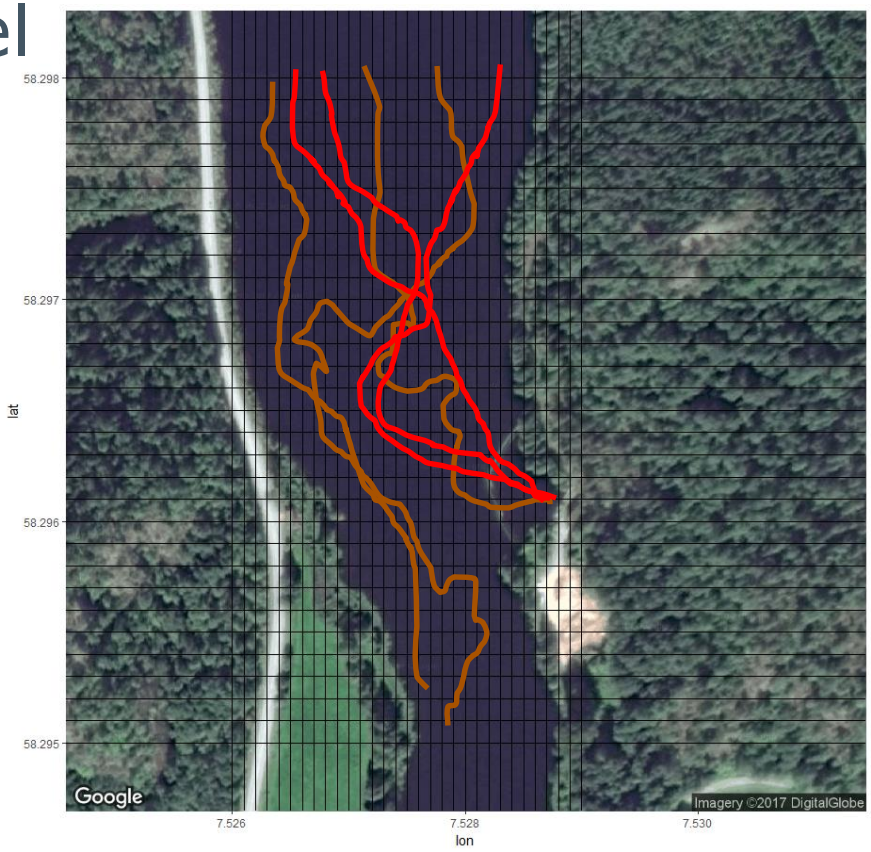
Flow velocity and TKE affect Fish orientation





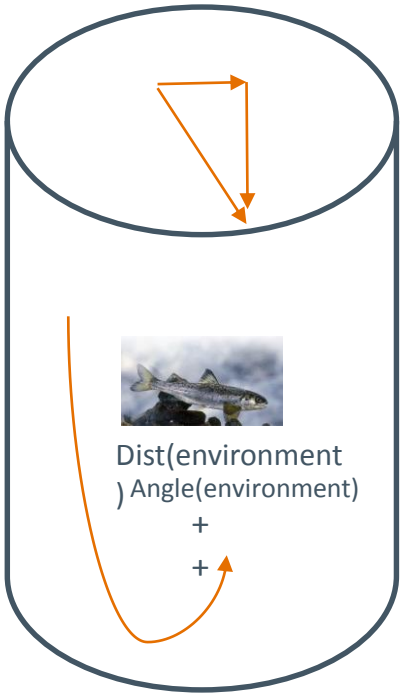
Predicting smolt movement

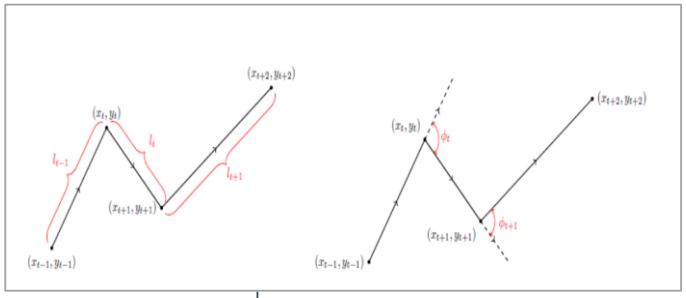
- Individual based model



Predicting smolt movement

- Assumption:
  - Fish movement/swimming behaviour is a function of multiple hydraulic parameters.





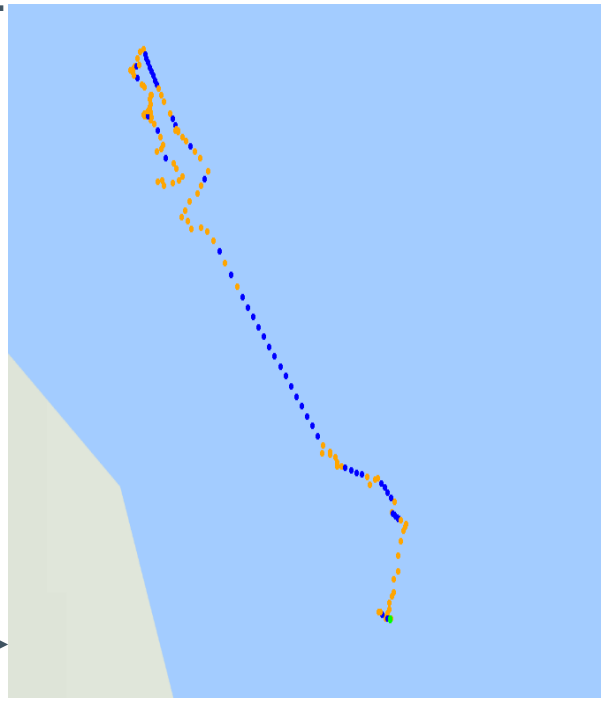


Foto: Bjørn Ove Johnsen / NINA

Thank you!