# Connectivity is a two-way street: Testing novel solutions for downstream-migrating salmonids

Larry Greenberg and Velizara Stoilova

River Ecology and Management Research Group (www.nrrv.se)

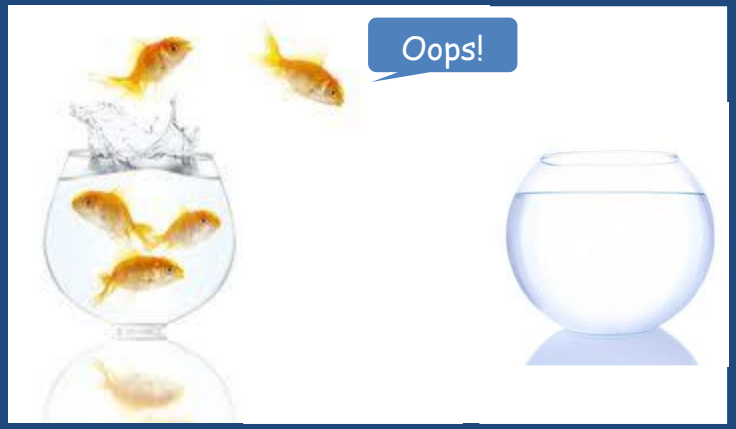
Karlstad University, Sweden

Karin Nilsson, SLU
Georgia Macaulay, SLU
Kjell Leonardsson, SLU
Patrik Andreasson, SLU and Vattenfall
David Aldvén, Kau and Vattenfall

Connectivity is about getting fish past barriers!

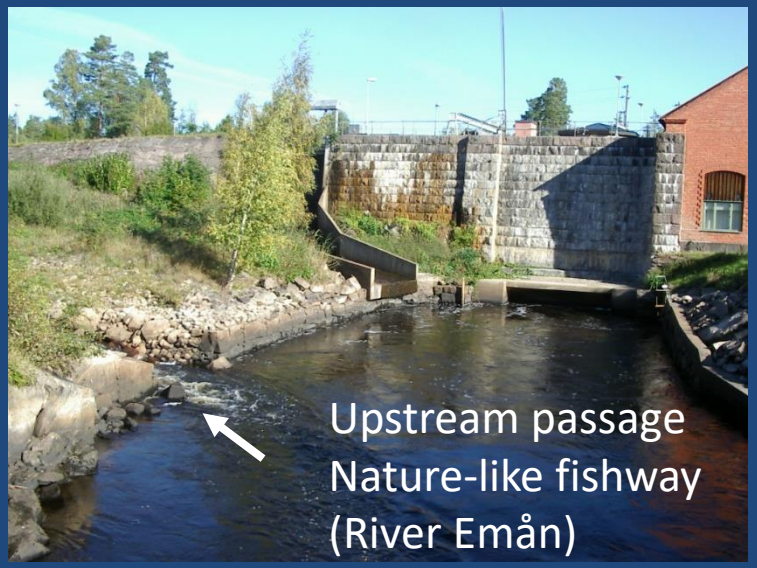
from 2 different directions….

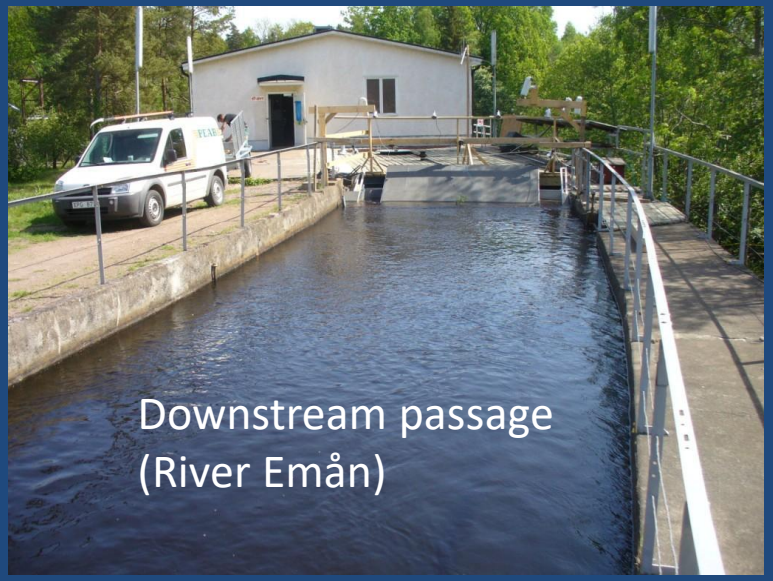
The solution must work with few losses!



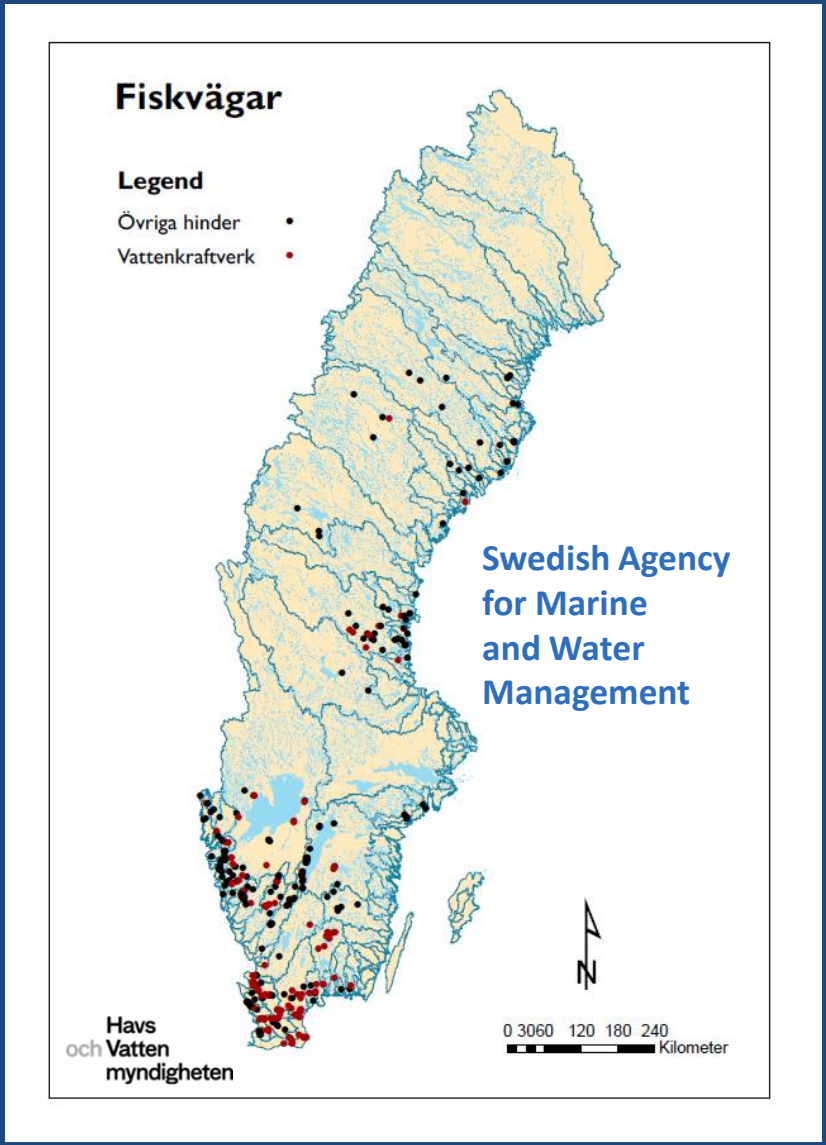

And sometimes the fish must pass more than one barrier

# Efforts in re-establishing connectivity


# *National Action Plan*




- About 2100 hydropower plants in Sweden and they provide 45% of Sweden's electricity
- Many lack remedial measures
  - 72% lack fishways

# River Klarälven/Lake Vänern system

## Atlantic salmon (*Salmo salar*)

In total, 460 km long (Norway & Sweden)
where last 250 km in Sweden

Impassable dam


Spawning/rearing habitat

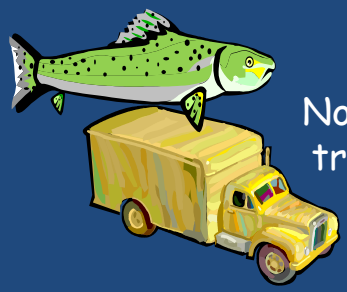
8 dams

Lake Vänern

# The Klarälven system

## Atlantic salmon


Mean annual discharge: 165 m3/s
Max discharge: 1650 m3/s



No. spawners transported

Spawning success

Production of young Höljes

Vänern
Lake mortality

Trap efficiency

Forshaga

Edsforsen

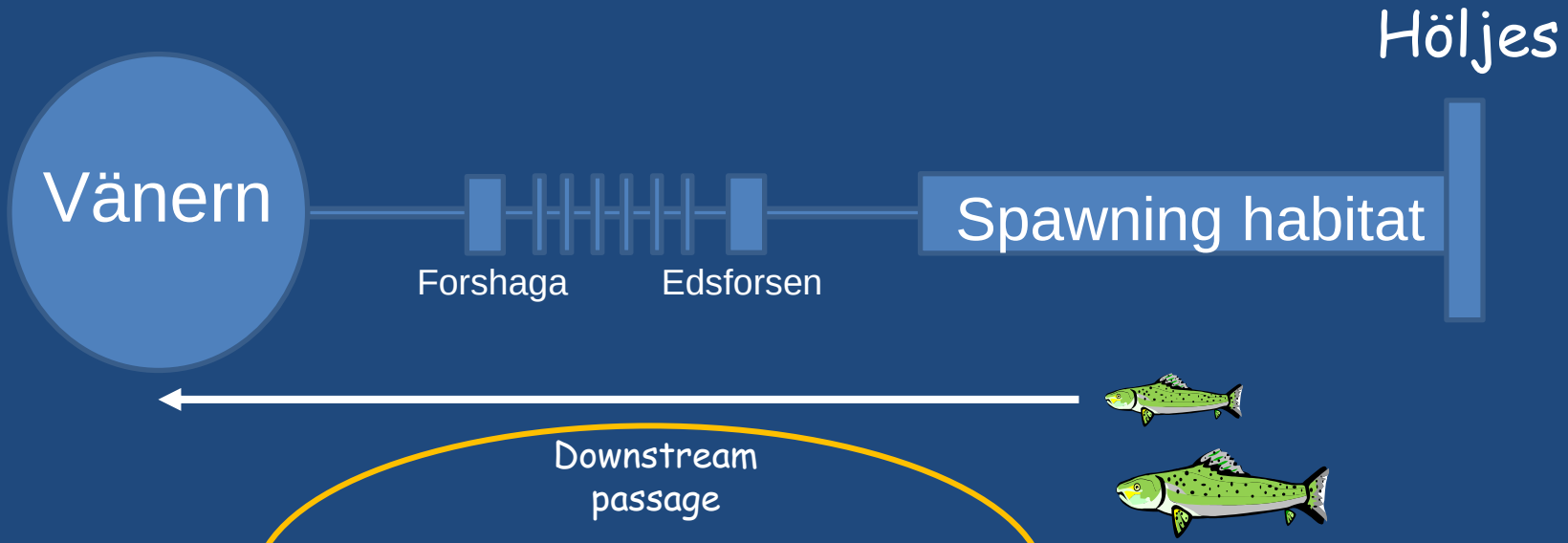
Spawning habitat

Smolt production

Downstream passage

# The Klarälven system

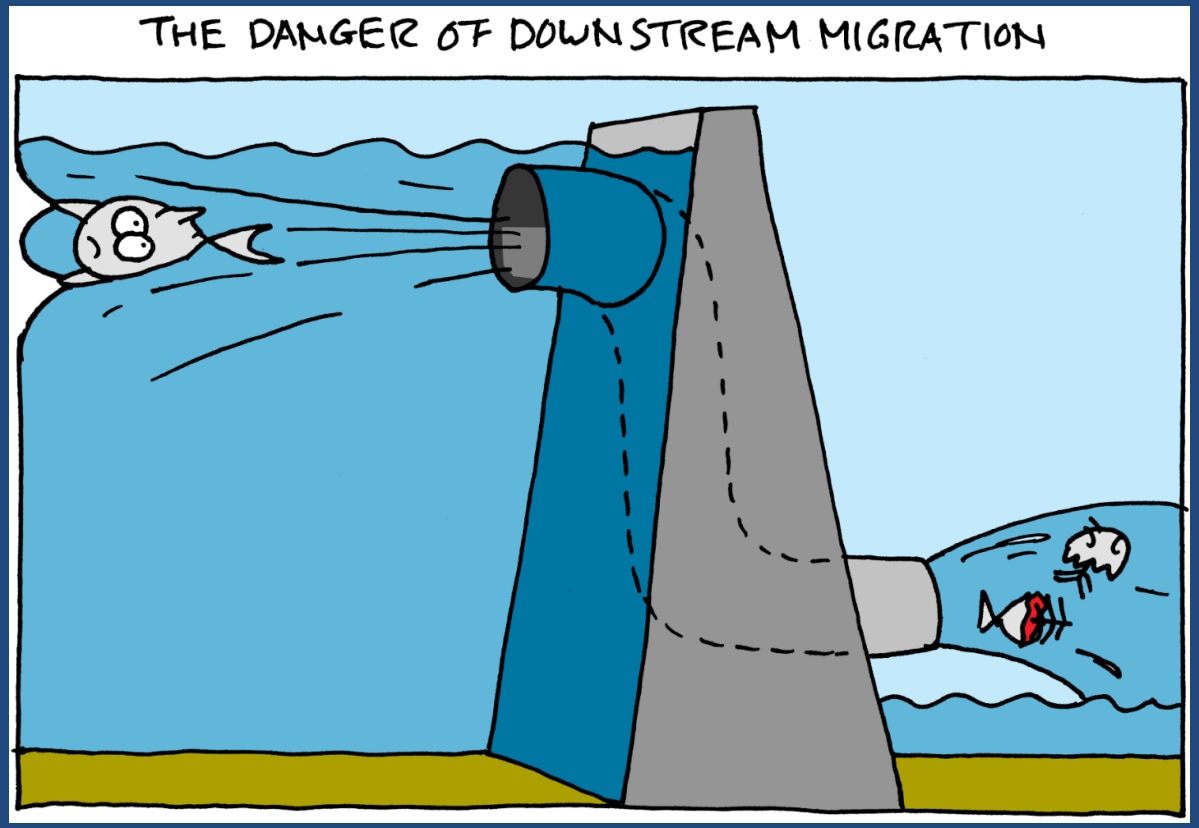
## Atlantic salmon




We focus on post-spawners (kelt)

# Downstream passage

Salmon follow the strongest flow path

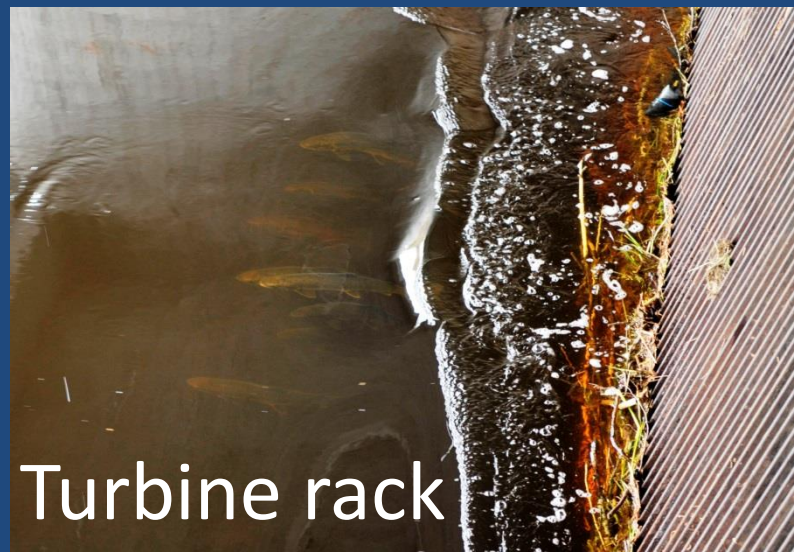


# No solutions for downstream migrants!

Spill gates

Turbine intake

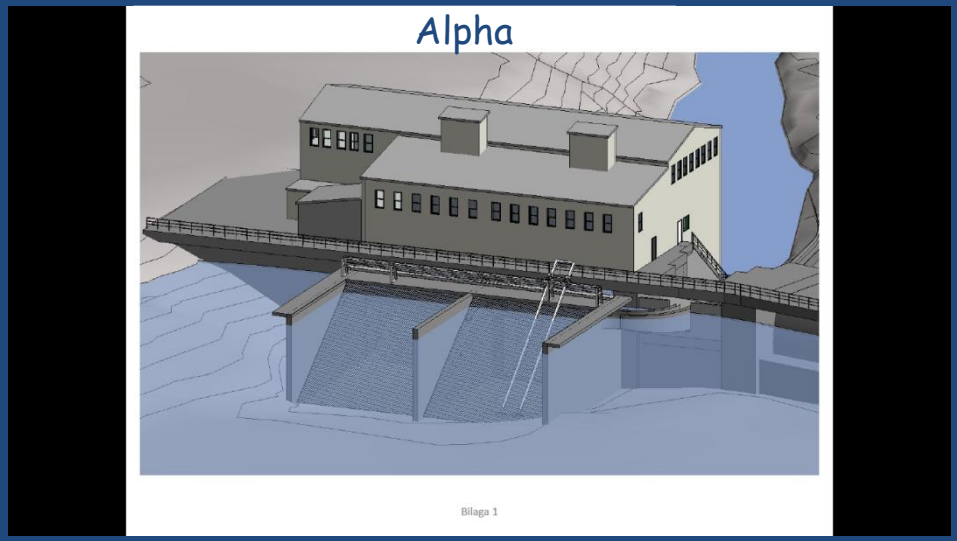

Edsforsen dam

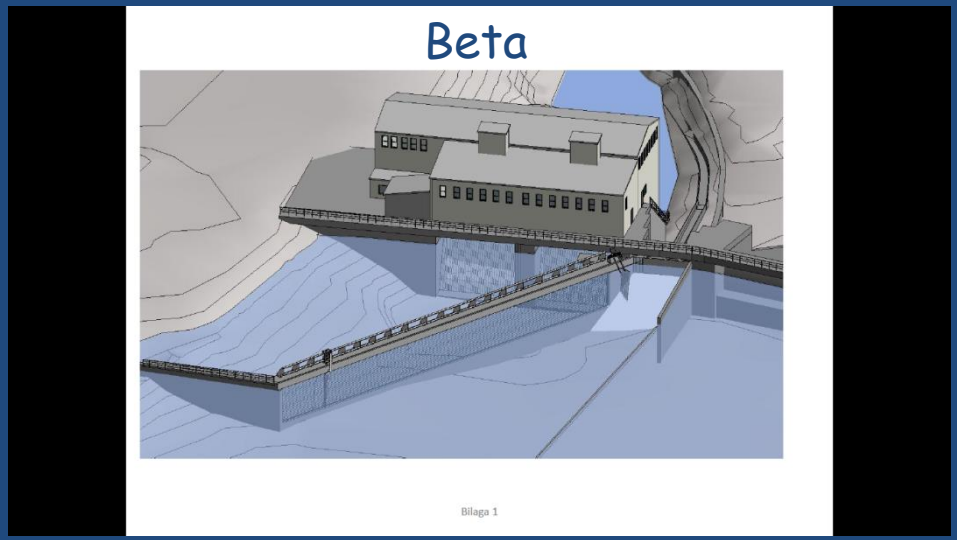



# Proposed solutions for downstream passage at Edsforsen


Costly!

Edsforsen dam



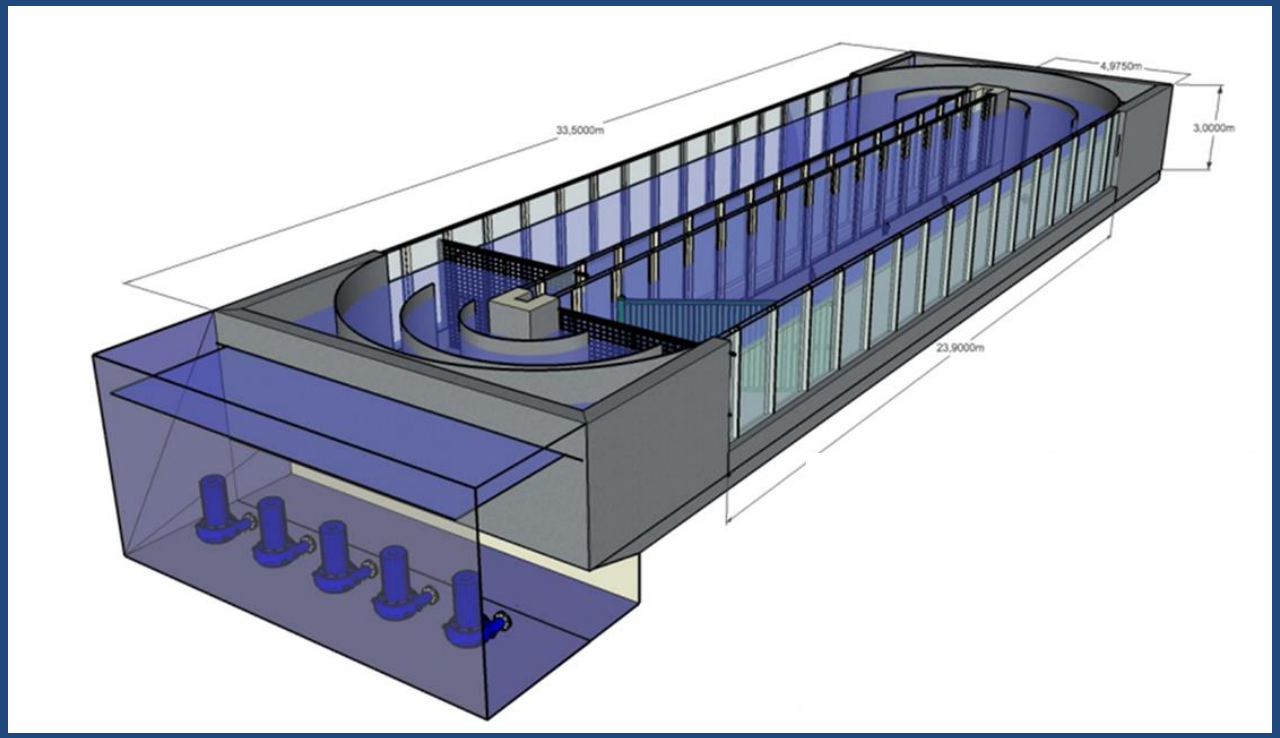
# Explore behavioral solutions

- Rely on attraction or repulsion of fish to environmental stimuli (ljud, ljus, etc)
- Fish must have sufficient time to detect, recognize and respond to the stimuli
- Generally less expensive to build and require less maintennce
- Often less effective

Focus on Veli's work using an injector pump to guide fish

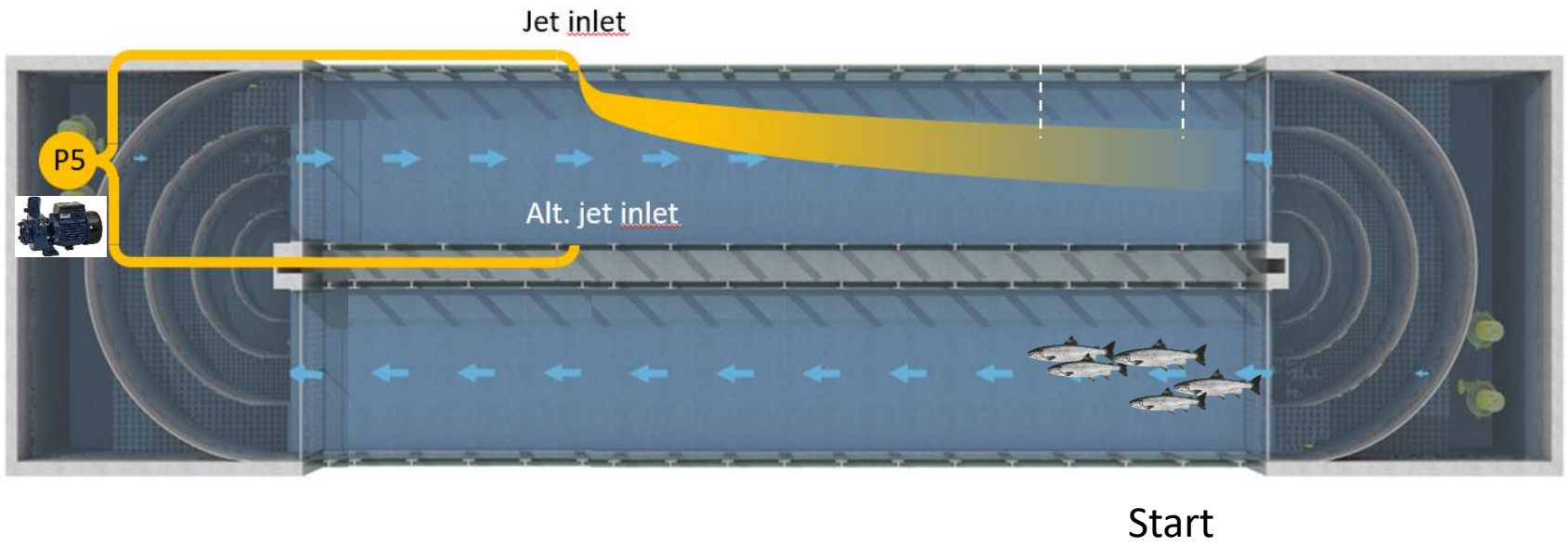
# Explore behavioral solutions

## Älvkarleby




Injector pump

# Injector flow in Älvkarleby flume



# Injector flow in Älvkarleby flume

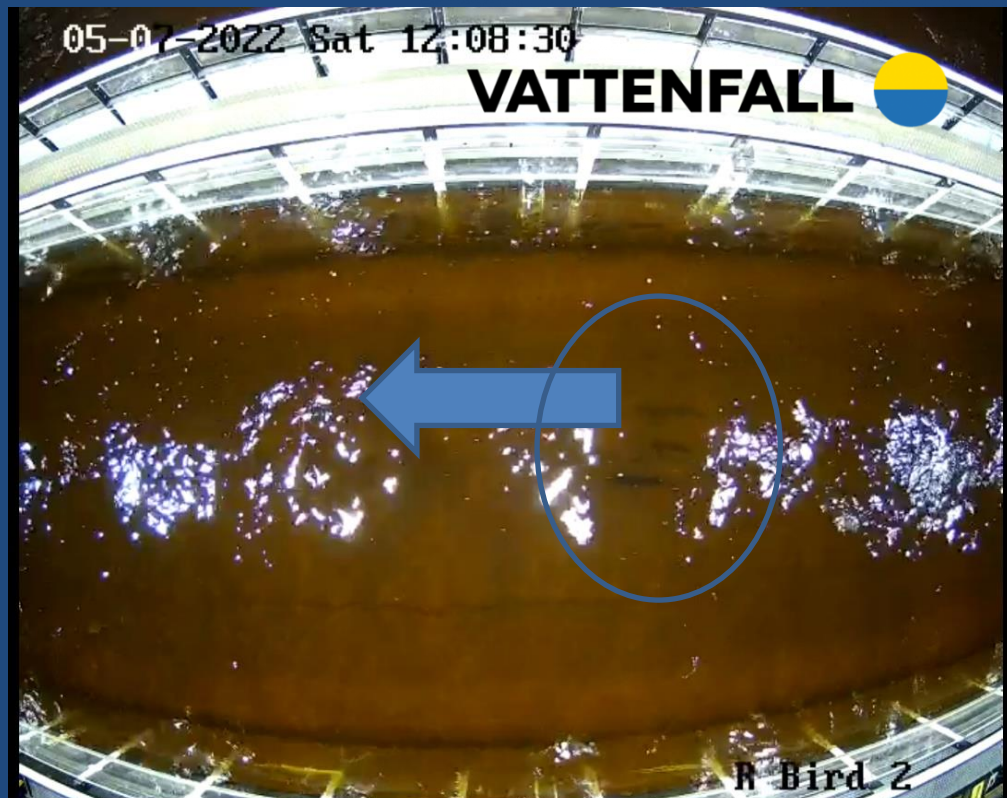
Kelts: B. trout, wild, N=60

Smolts: A. salmon, hatchery, N= 400

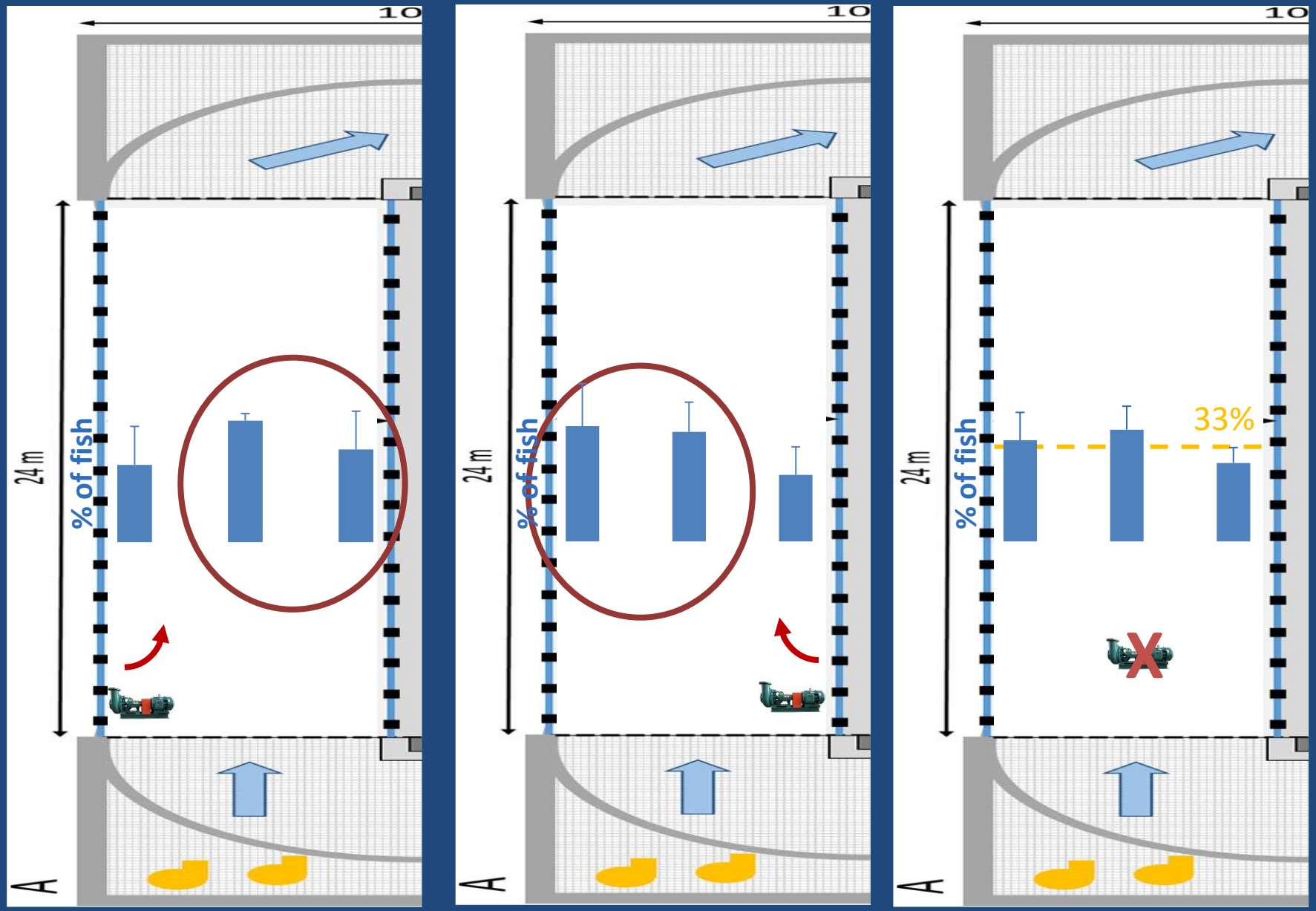
Treatments: No jet, Left jet, right jet

Two jet settings: 2m/s and 32,3 m/s (flume had 0.5 m/s)

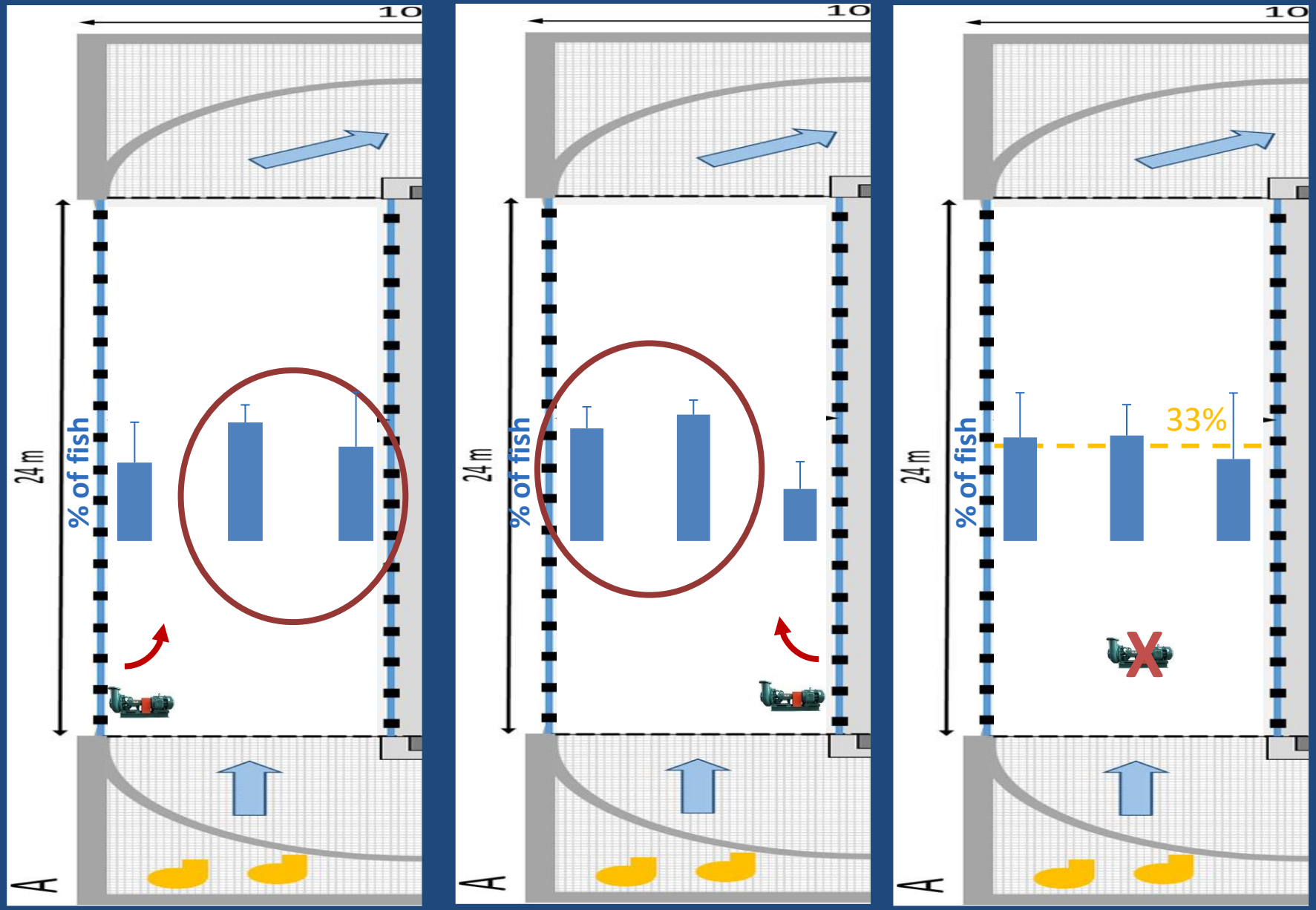
29 cameras (ARIS sonar)



# Injector pump at 2 m/s



# Injector pump at 2.3 m/s



# Injector pump at high flow

We affected swimming behavior of the fish in the flume

How does this scale up? Can we do this in a river with kelts?

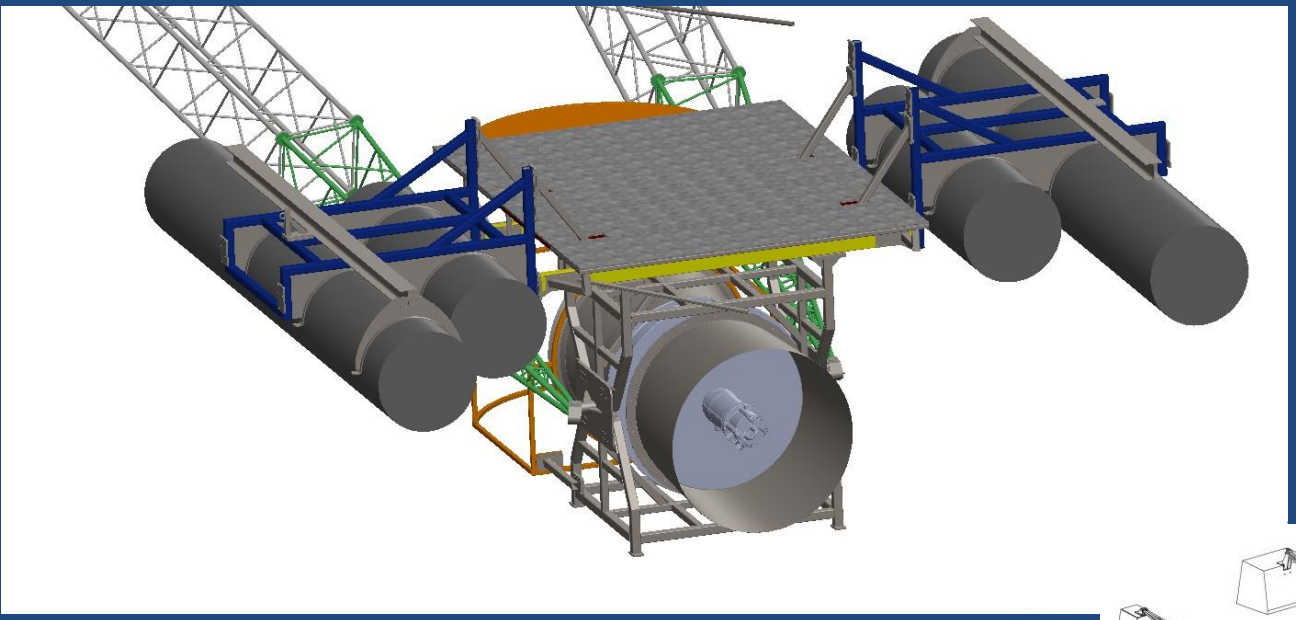
# Field test of injector pump


**Klarälven**

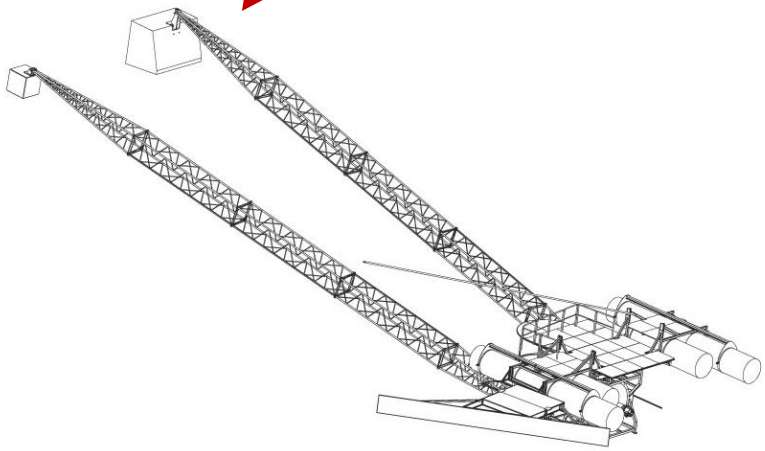
# Field test of injector pump


# Field test of injector pump

# The injector pump

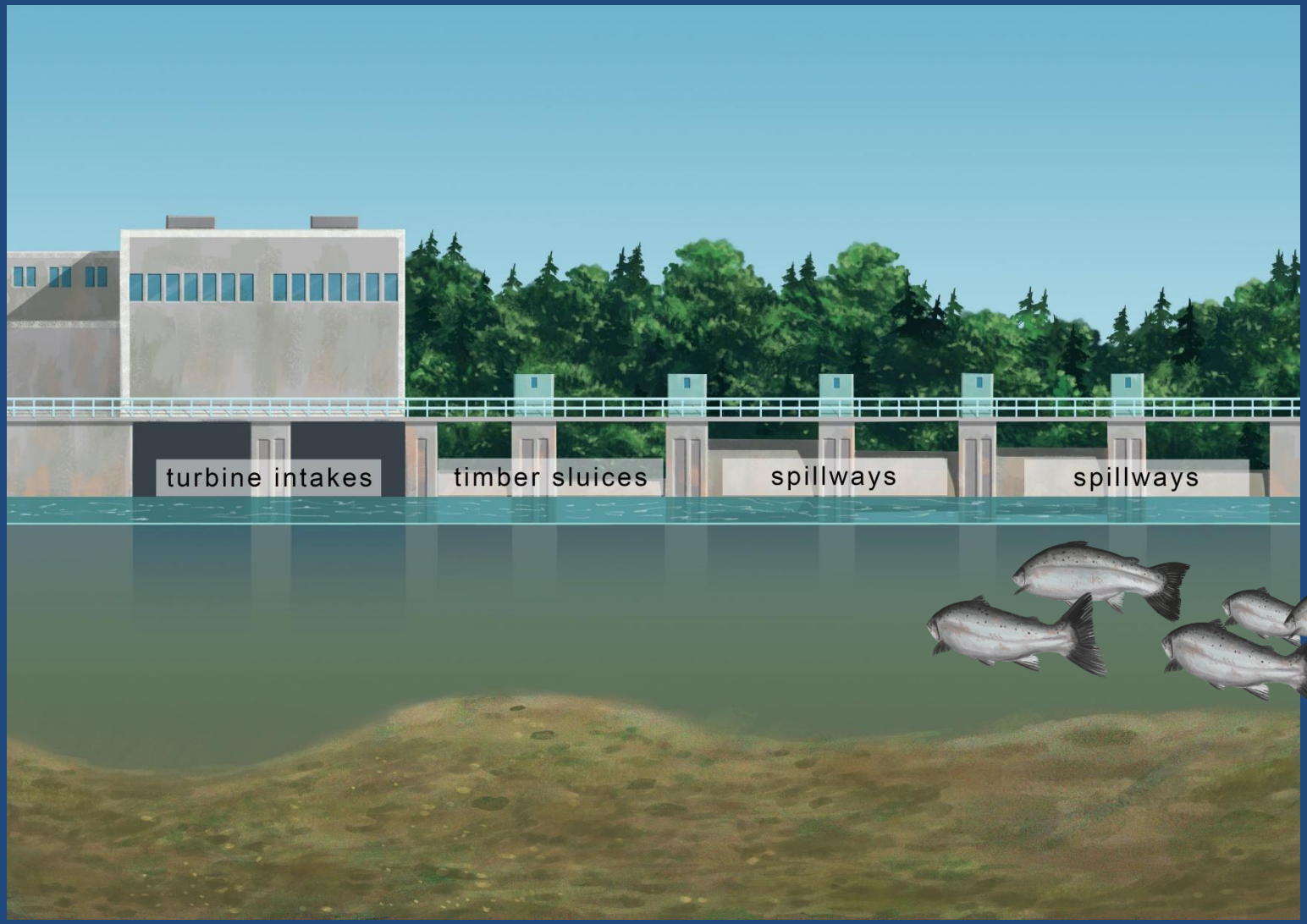


Anchor to the shore



Capacity of 9 m3/s

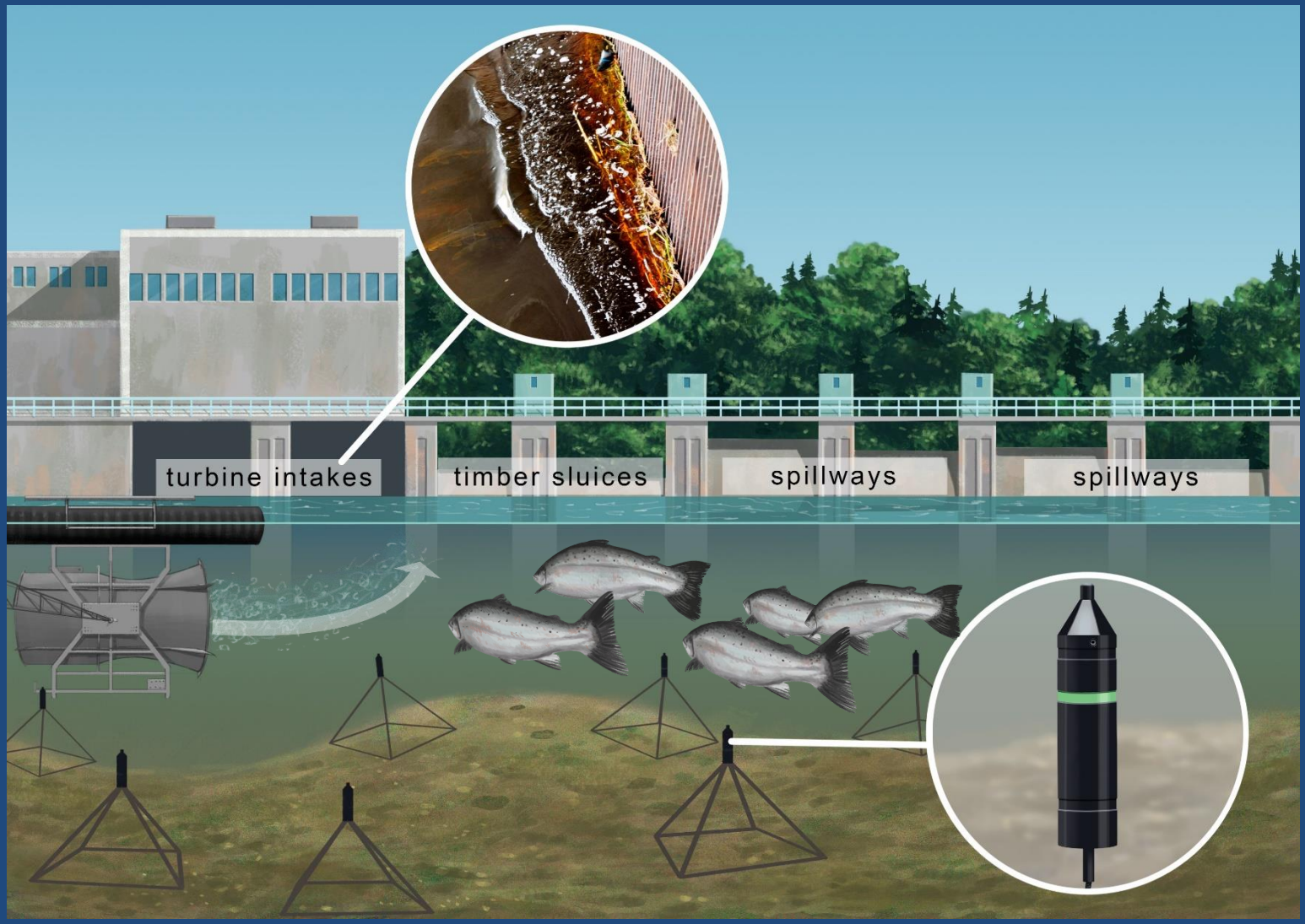
Operation: pump is on 1 h and off 1 h
for the duration of the study




Drawn by Jennifer Clausen
@JACsciart on X (Twitter)


turbine intakes
timber sluices
spillways
spillways


turbine intakes
timber sluices
spillways
spillways


turbine intakes
timber sluices
spillways
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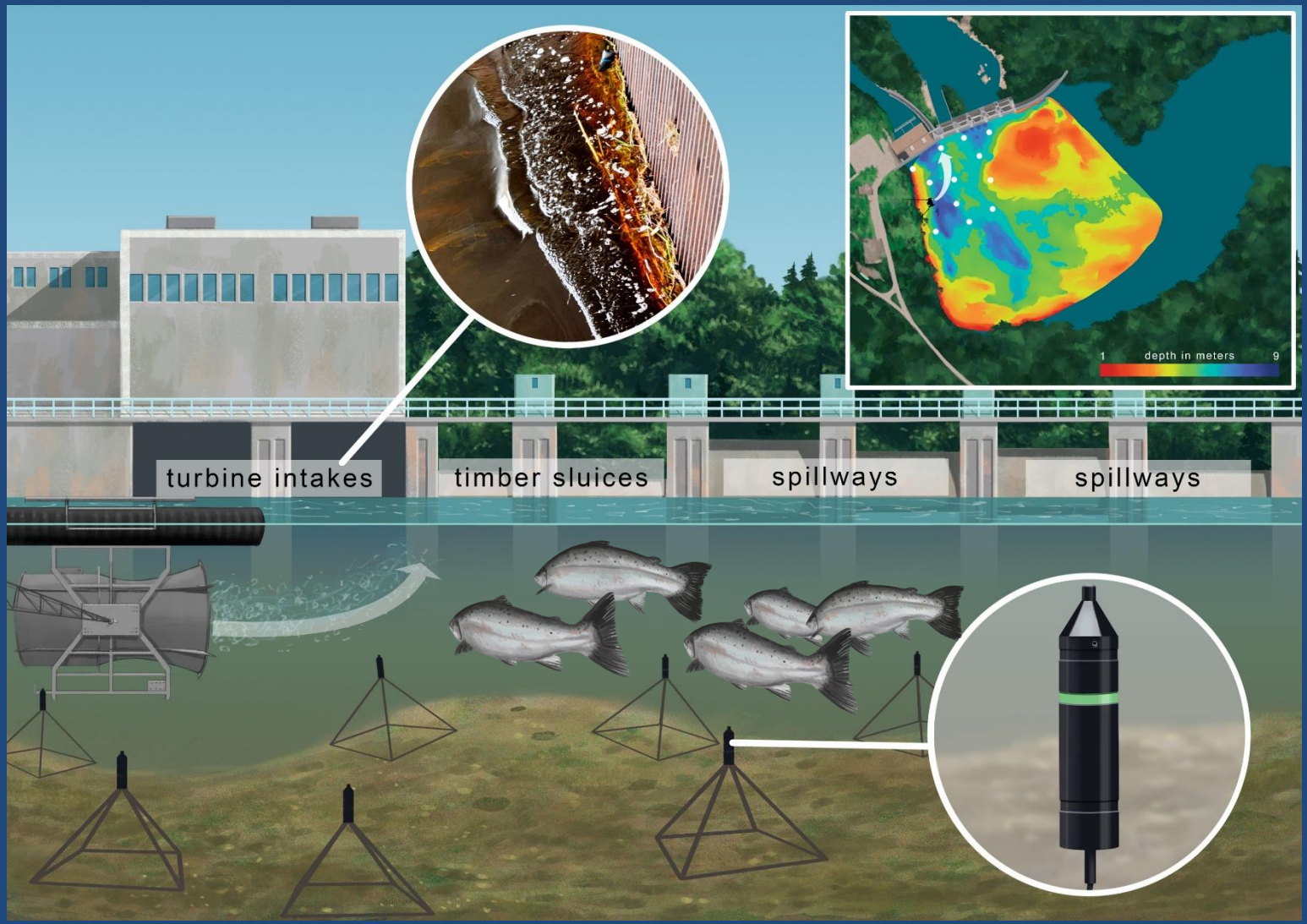
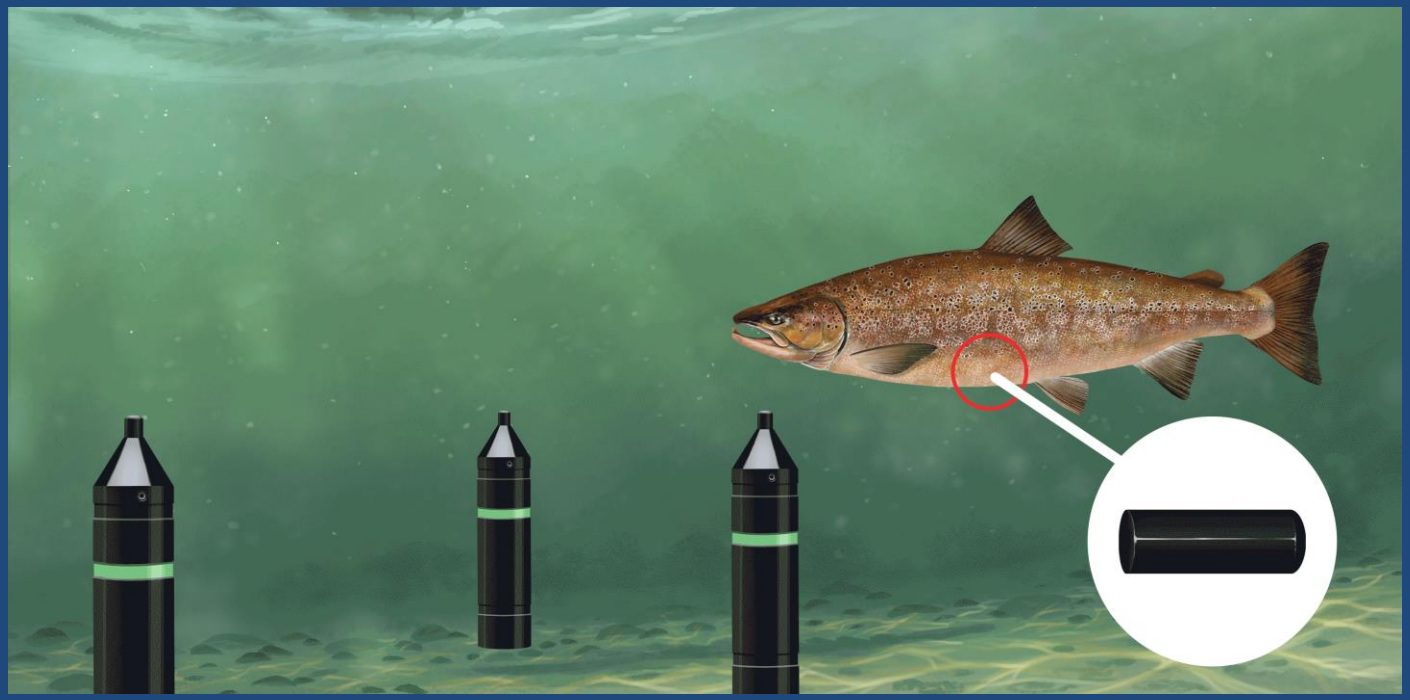
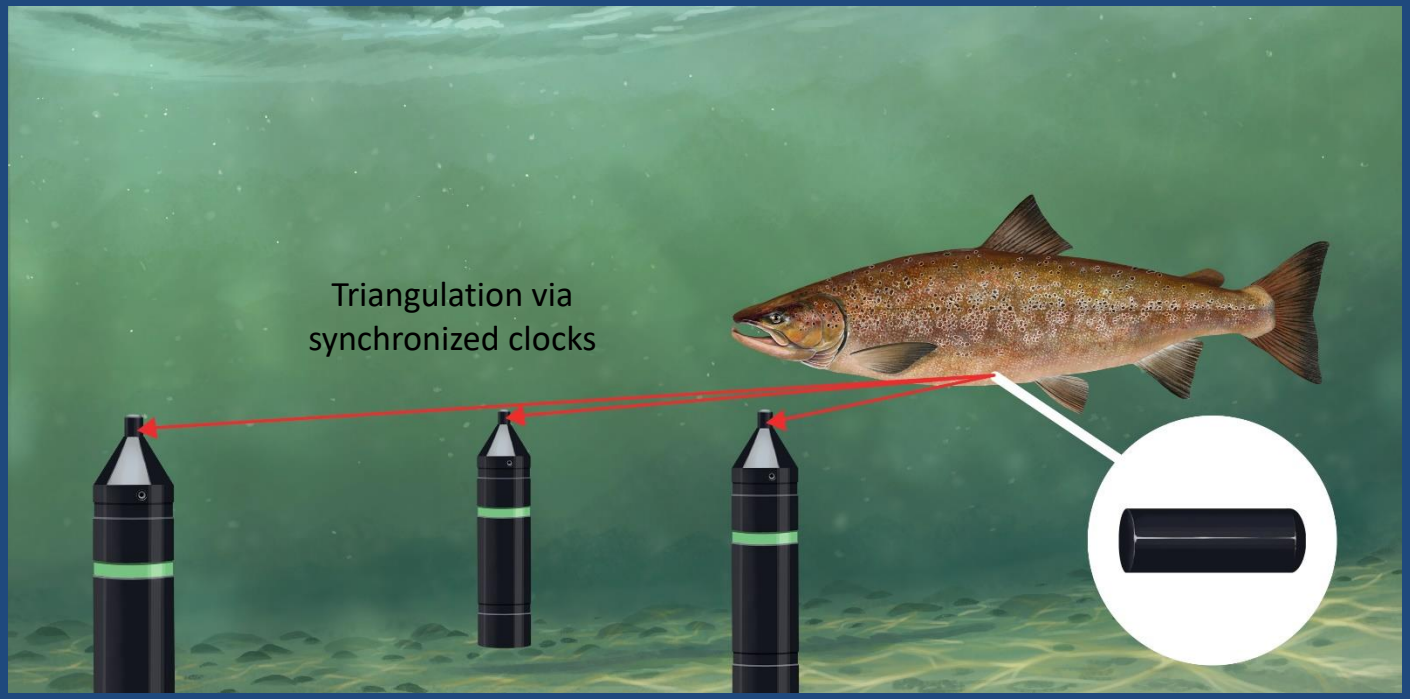
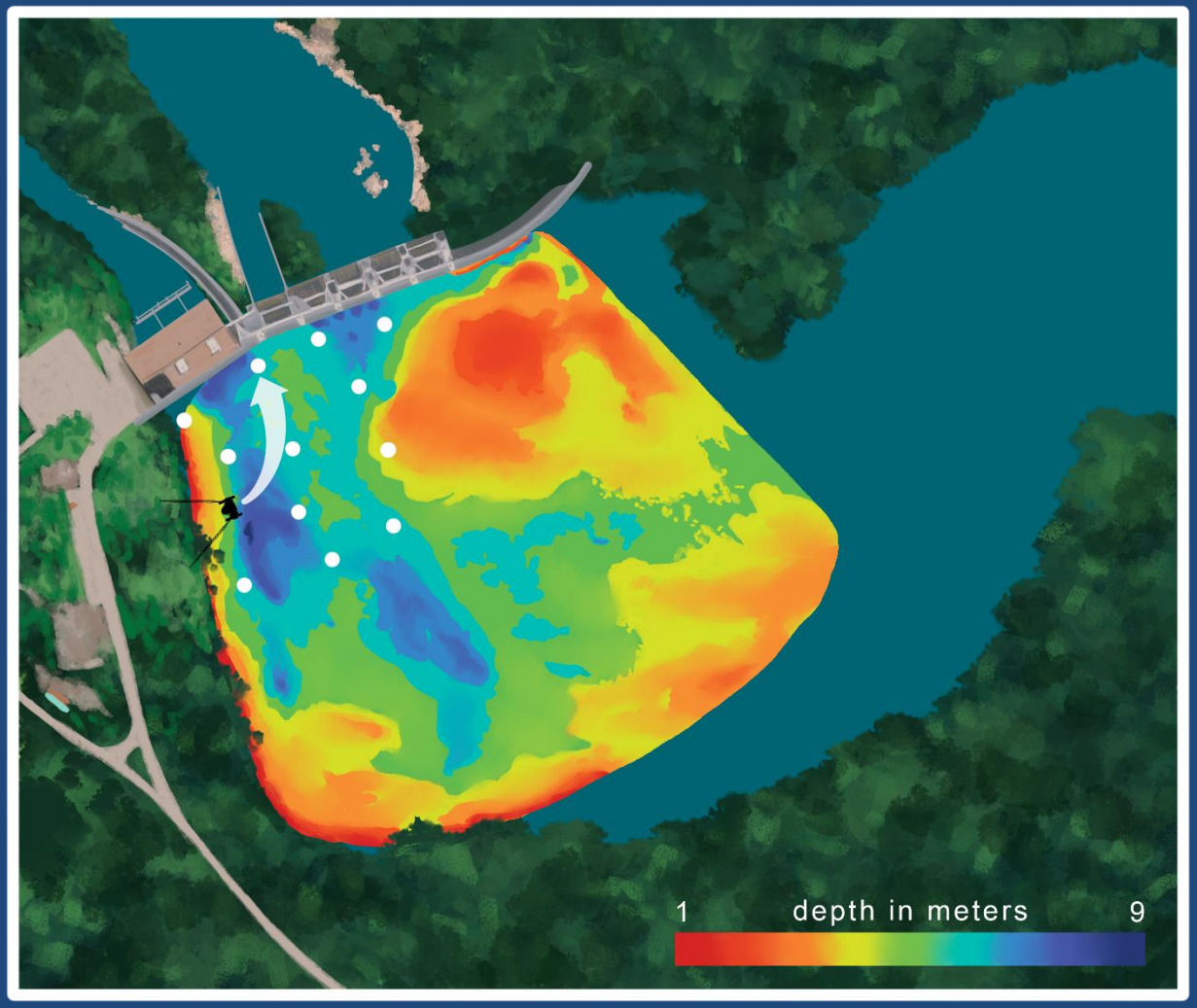

turbine intakes
timber sluices
spillways
spillways
1
depth in meters
9

# Fish Movement Tracking with Acoustic Telemetry

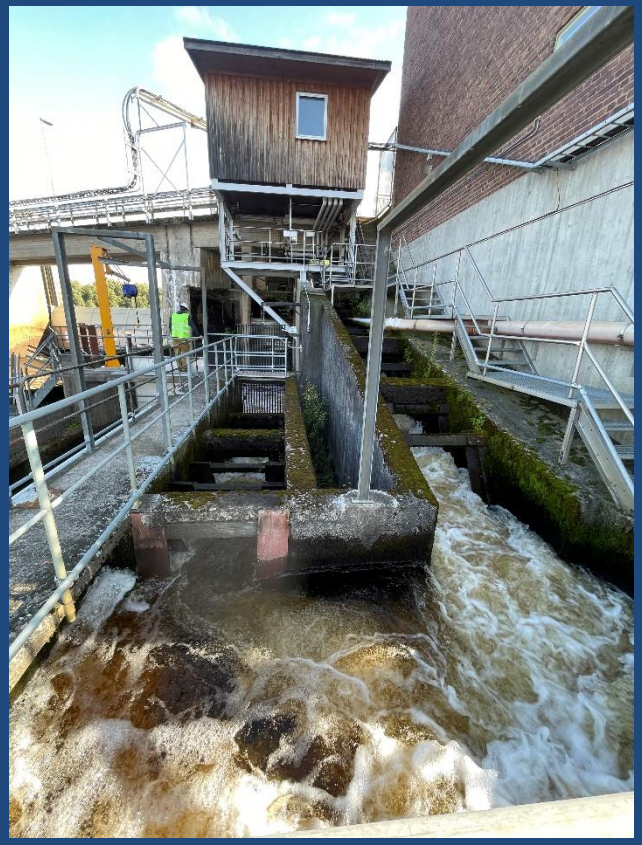


# Fish Movement Tracking with Acoustic Telemetry




1
depth in meters
9

# Where are we now?

# Where are we now?

# Where are we now?

The crew

Georgia Macaulay, Henry Hansen, Veli Stoilova, Jenny Wanke

# Where are we now?

1. We have tagged ca 90 of 160 salmon

2. Injector pump installed at Edsforsen this week

3. Salmon spawn in September-early November

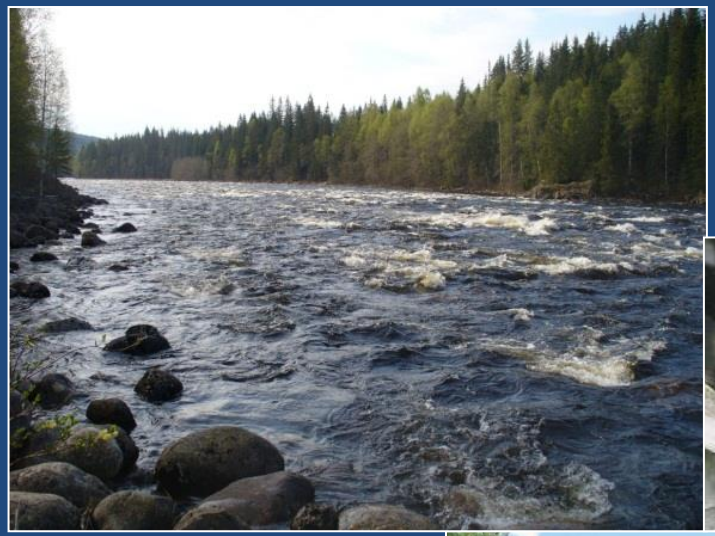
4. Salmon migration downstream in October and November


Spawning

Fish released

Fish tagged

# Thank you for listening!

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