I BEEP, THEREFORE I AM?

An overview of the use of telemetry methods in studies of fish downstream migration

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Norwegian Institute for Nature Research (NINA)

- Norway's leading institution for applied ecological research
- Independent, non-governmental

Main office in Trondheim




- Research scientist **NINA in Trondheim**, full-time position
- Adjunct professor **University of Tromsø,** 20% position

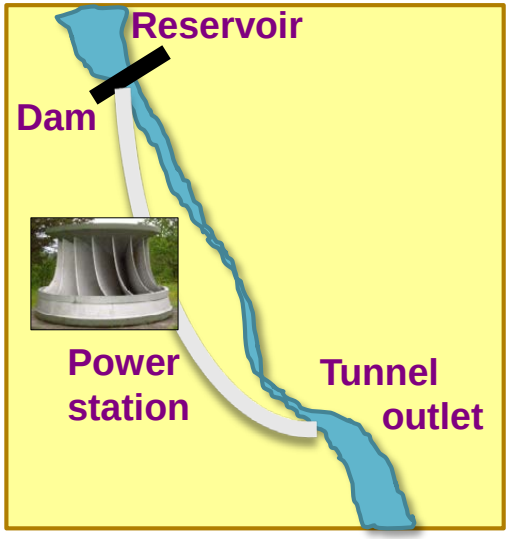
Worked with fish migrations and telemetry in rivers and at sea since 1995



Many fishes are dependent on safe downstream migration to complete their life cycle



Downstream migrants can be injured, killed and delayed in reservoirs and at power stations



All fish photo:
Frode Kroglund

Data on movements of individual fish can be used to document:

- Mortality rates
- Sites and causes of mortality
- Migration routes
- Timing of migration
- Migration speeds and delays

FISH TELEMETRY / USE OF ELECTRONIC TAGS
can be used to follow movements of individual fish over time

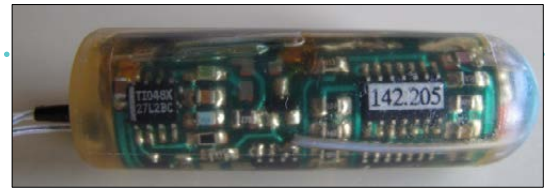
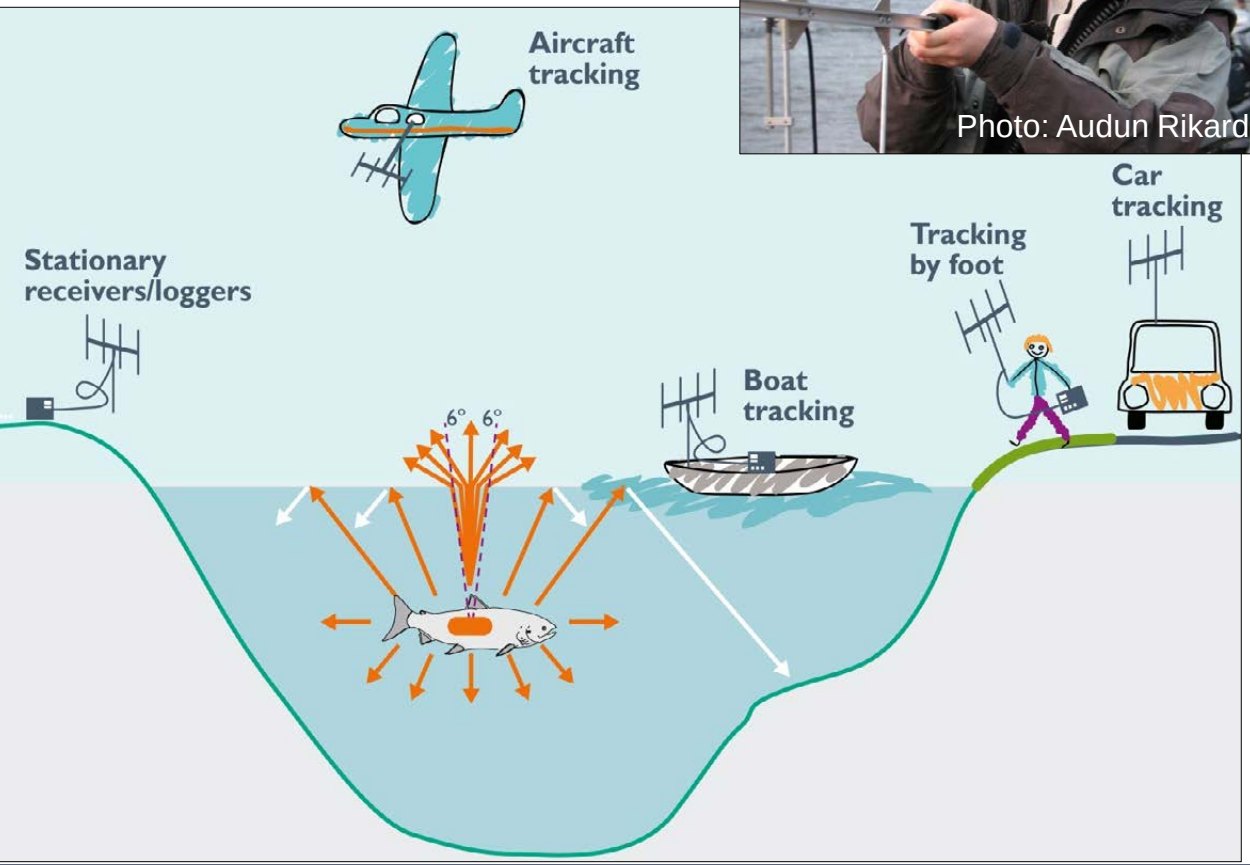



Photo: Audun Rikardsen

- **Radio and acoustic transmitters**
- PIT tags
- Data storage /archival tags
- Pop-up satellite tags

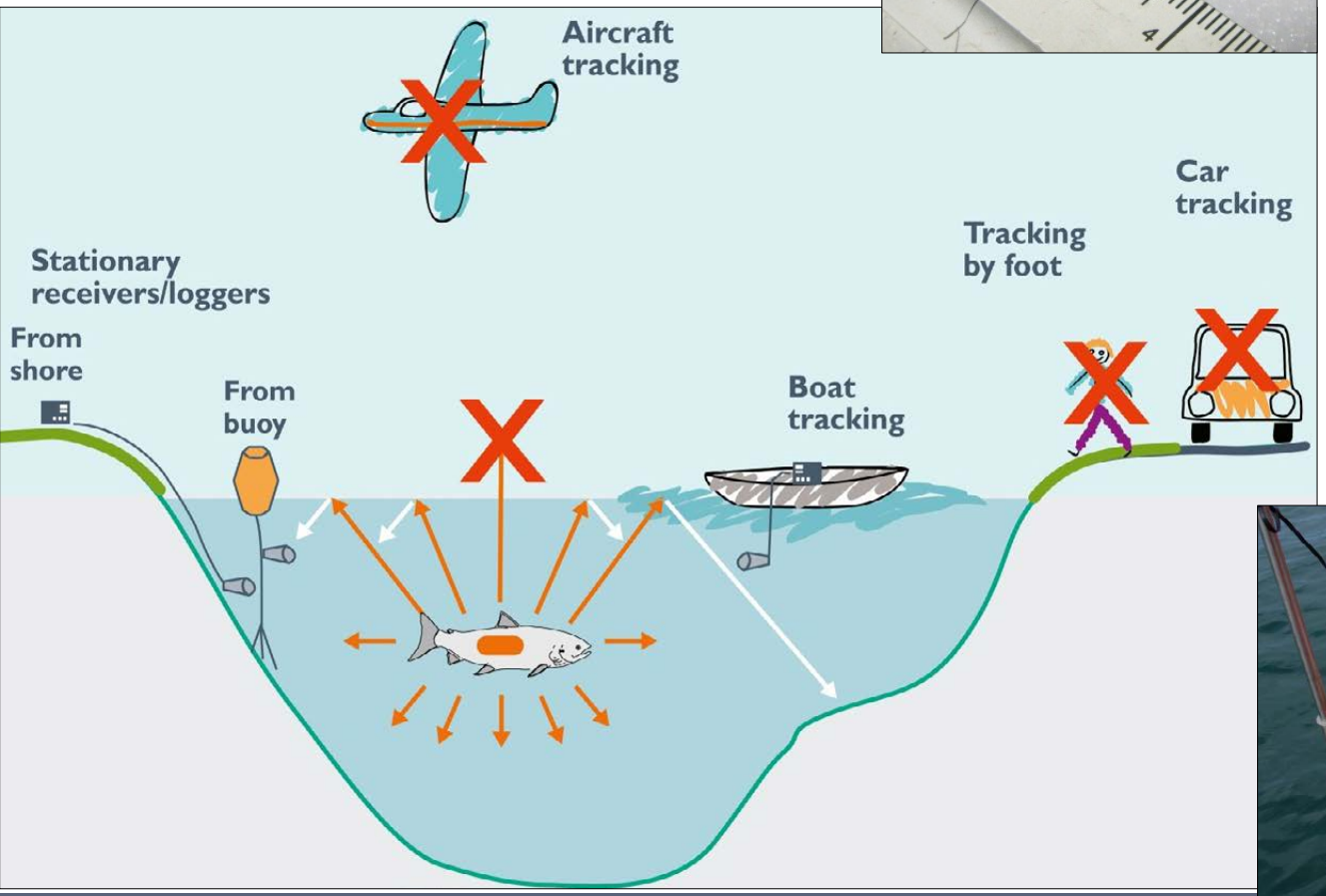
RADIO TRANSMITTERS



- Transmitter with antenna
- Signals propagate through water and air, receiving antenna usually in air
- Works **only** in freshwater
- For use in rivers, streams and shallow lakes

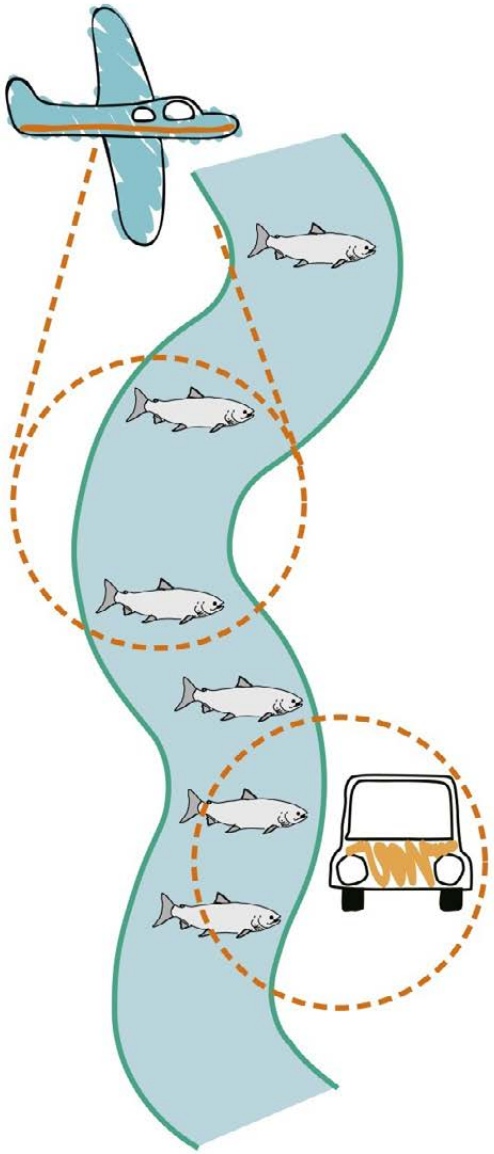
ACOUSTIC TRANSMITTERS

- Transmitter without antenna
- Signals propagate throgh water, not air, receiving antenna in water
- Works at sea, in estuaries, lakes and rivers



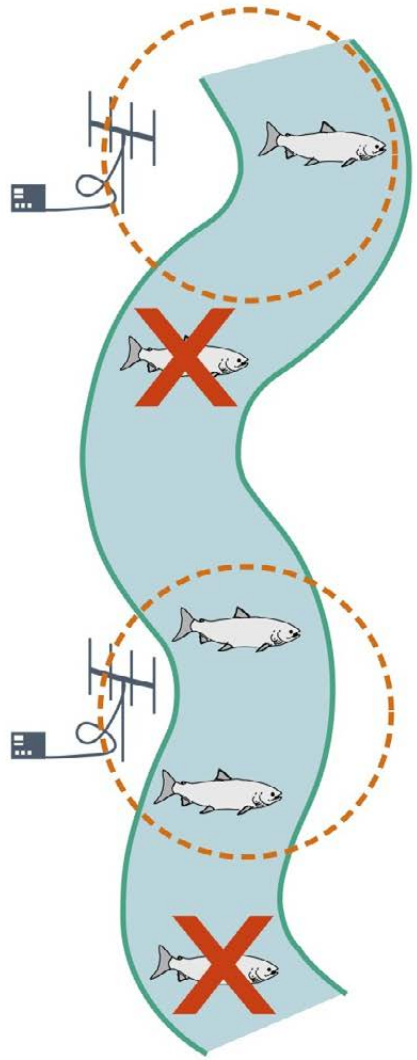
Manual mobile tracing

Can position all fish in study area during tracking survey



Stationary receivers/ loggers

Store time and id only for fish within range



SIGNAL RANGE ~ 20 m to 2-3 km

- Smaller transmitters = shorter range

For RADIO

- Deep water reduces range

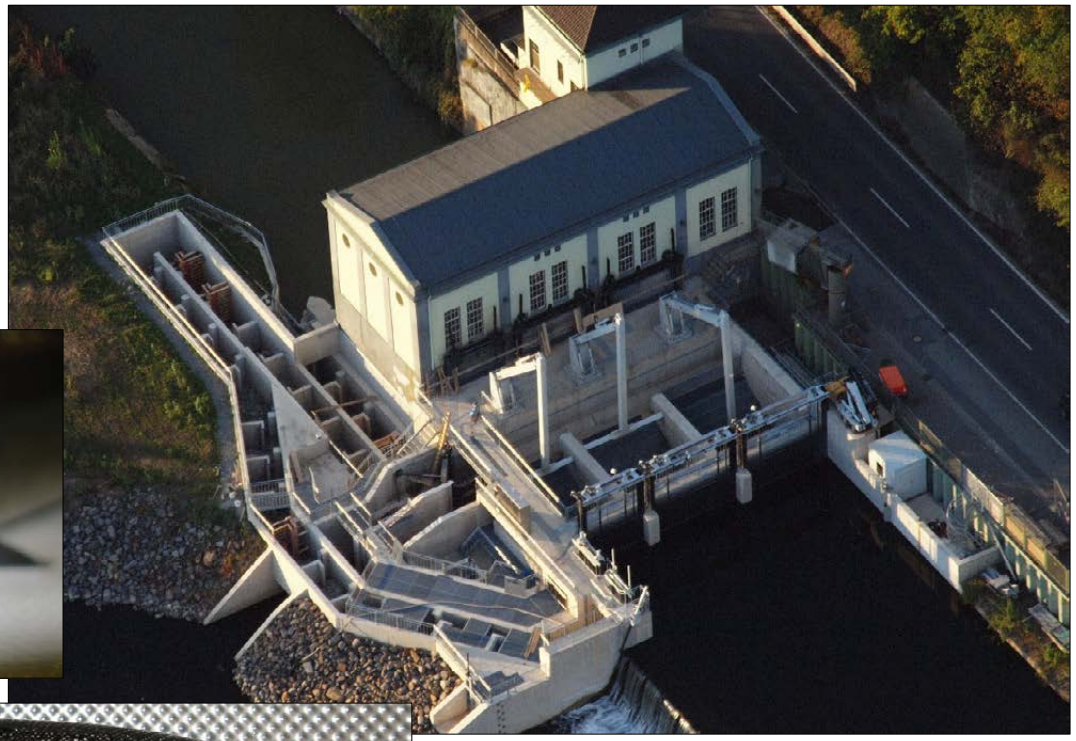
For ACOUSTIC

- Gas bubbles reduce range (turbulence, wind)
- Longer range in freshwater than sea
- Complicated, must be tested in each case

Studies at Unkelmühle power station in the River Sieg, Germany

- Results are published in report, which can be found here: http://hdl.handle.net/11250/2412774

- Downstream migration and mortality of European eel and Atlantic salmon smolt



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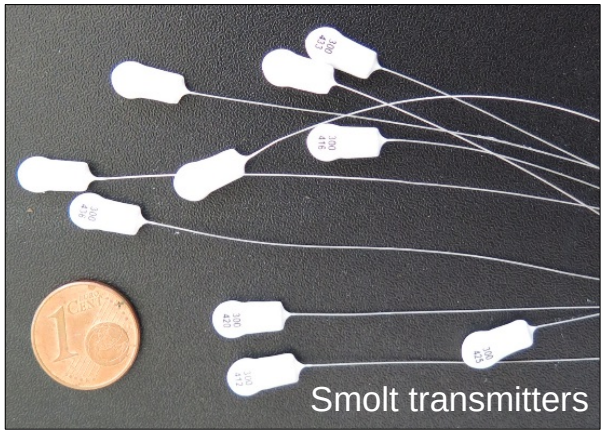
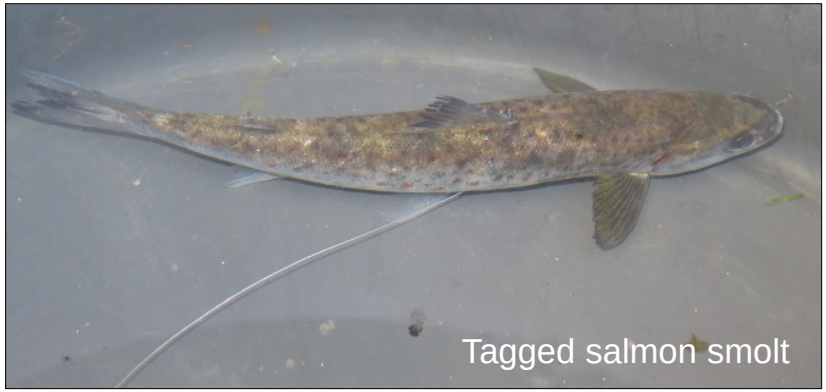
Radio transmitters were surgically implanted in the fish

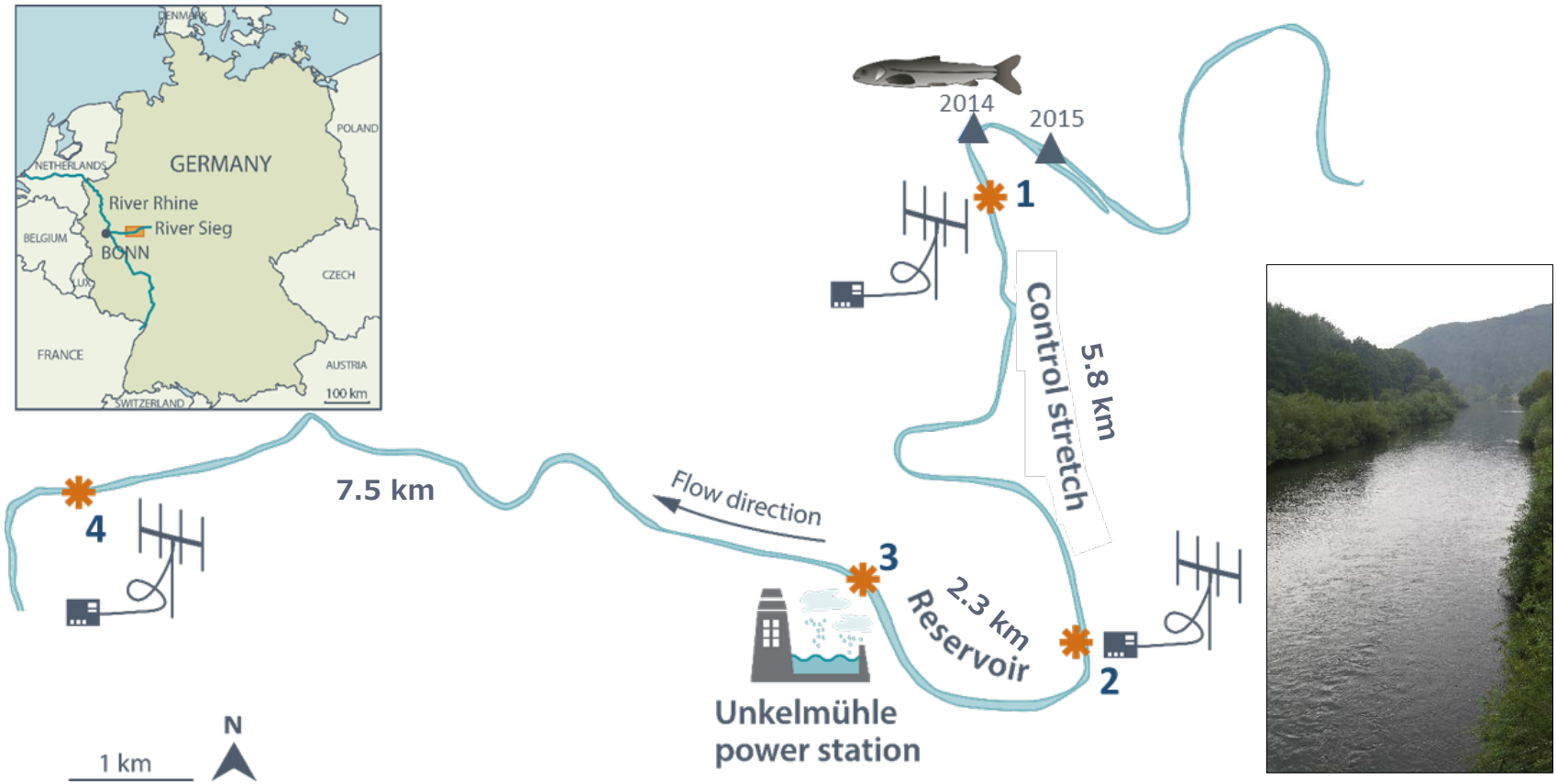

Smolt transmitters


Eel transmitters


Anaesthetisation


Tagged salmon smolt

Needed to follow individuals at least 16 km and in detail past power station



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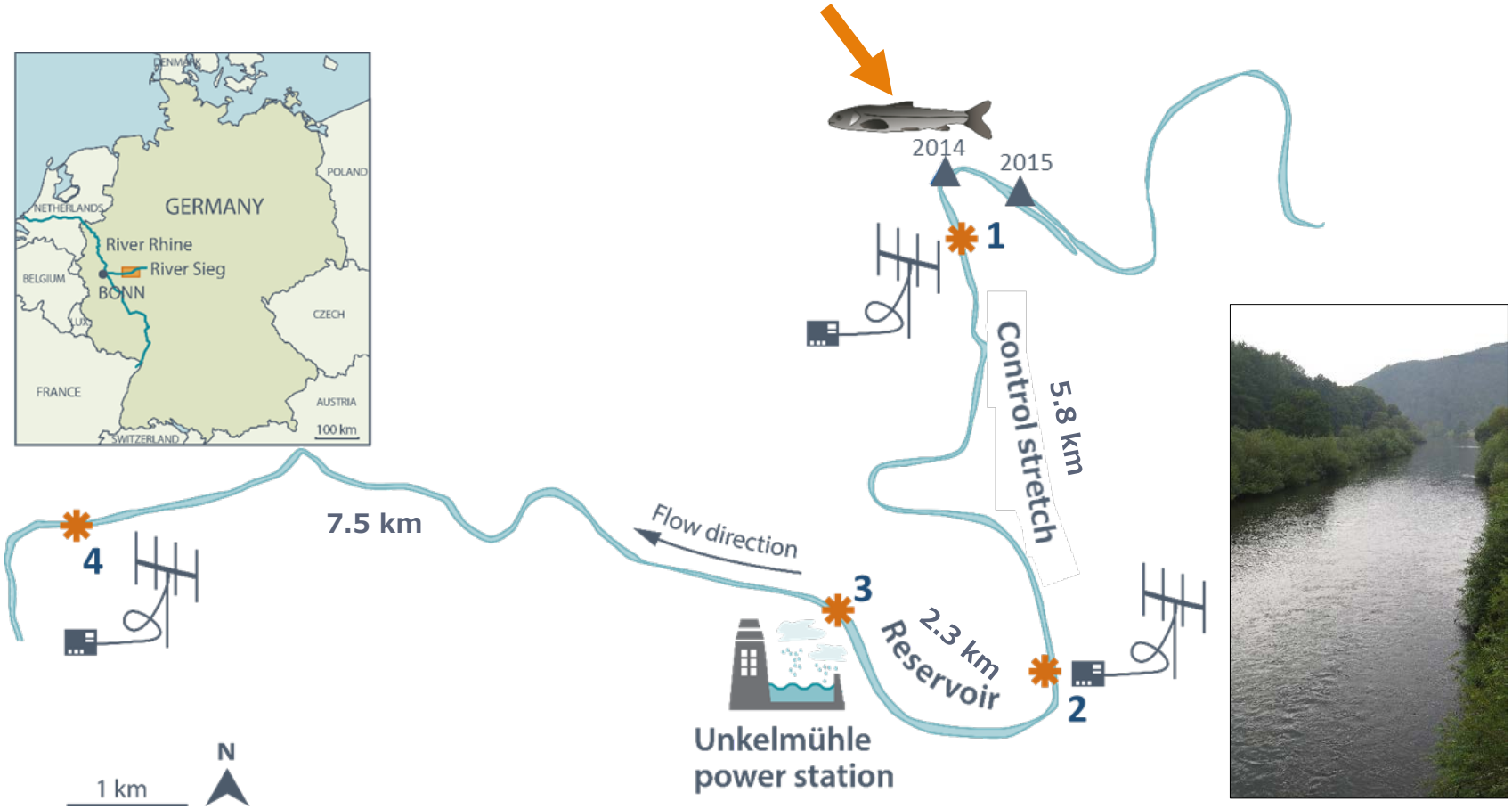

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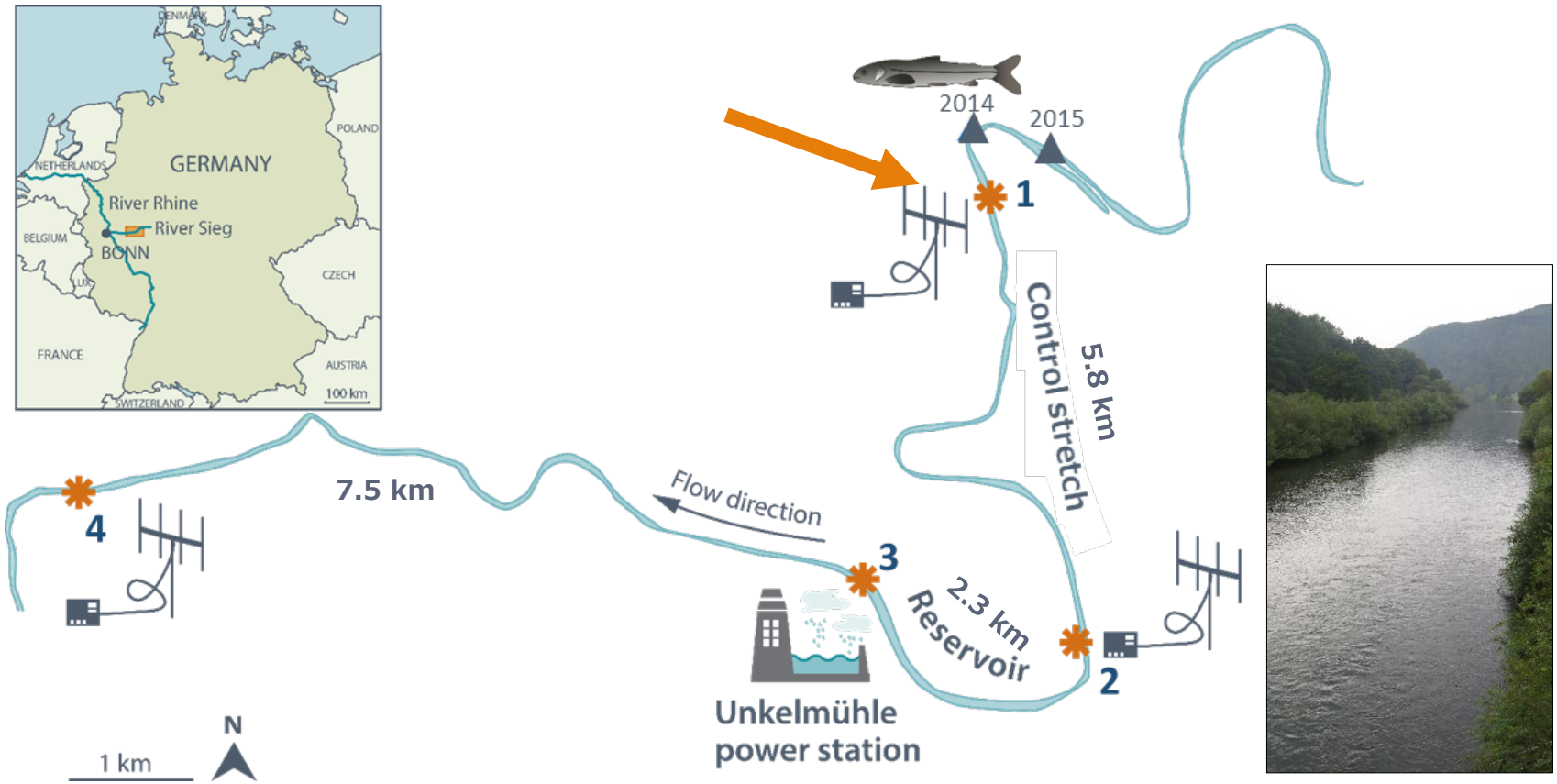

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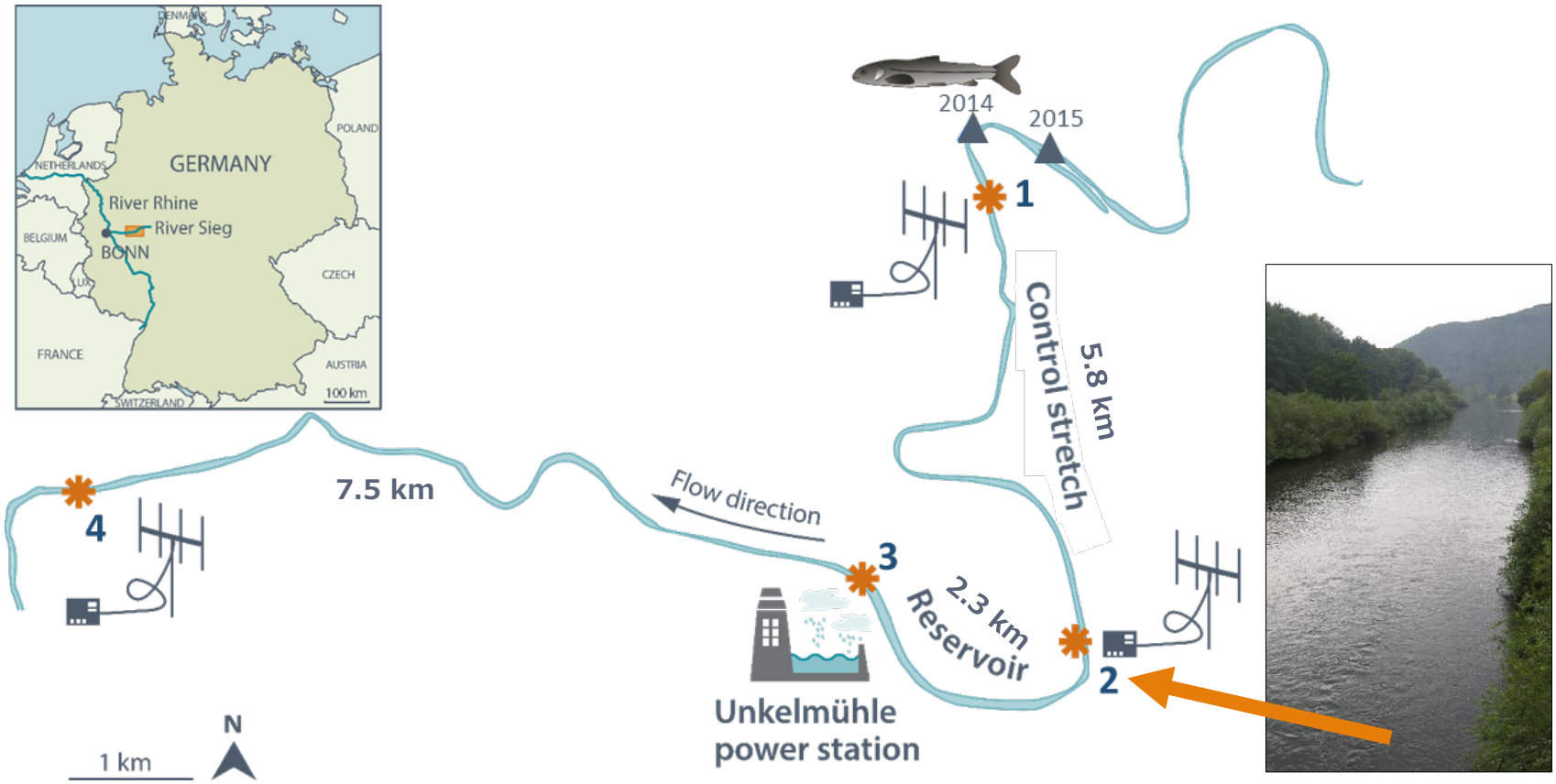

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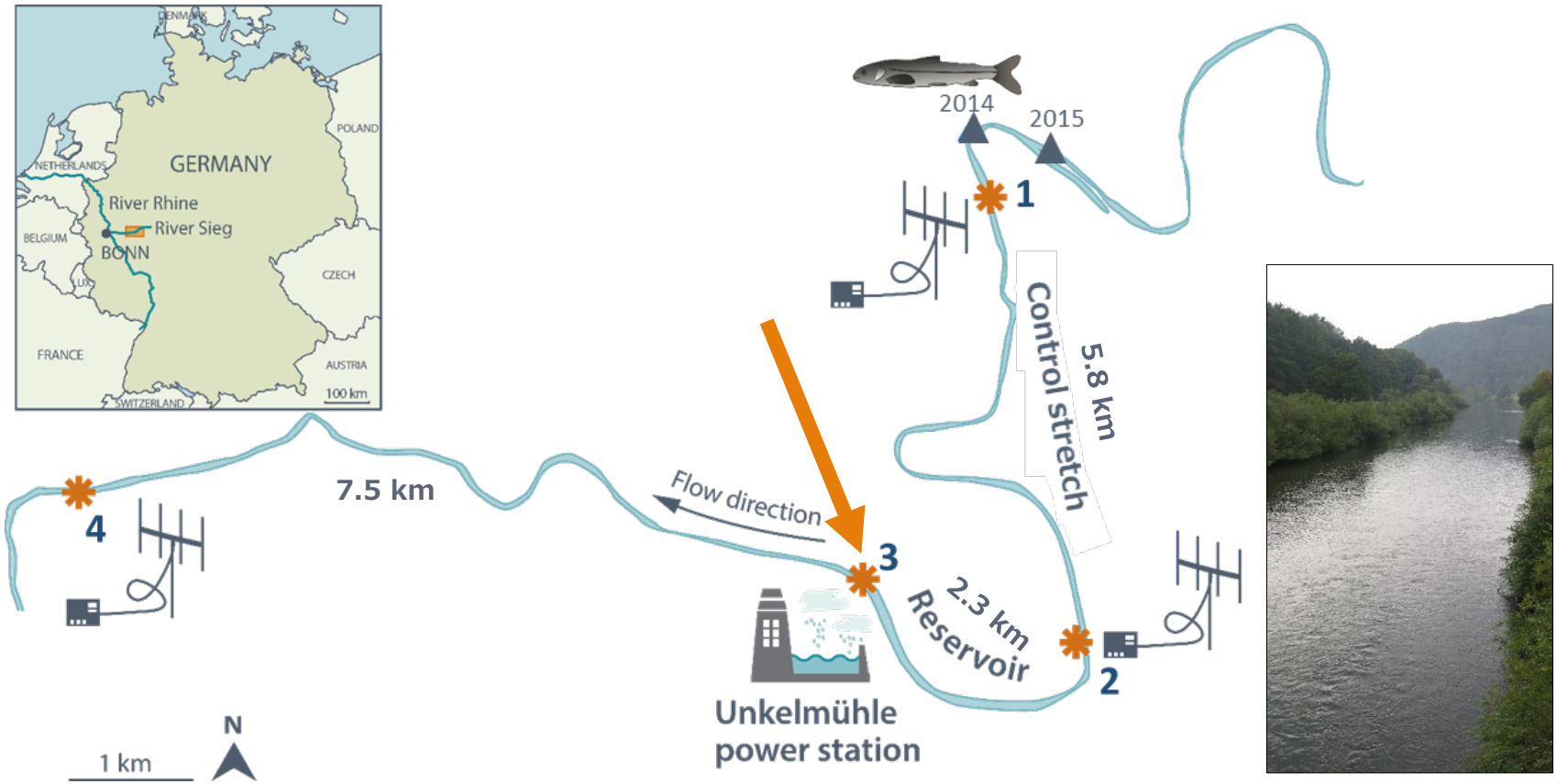

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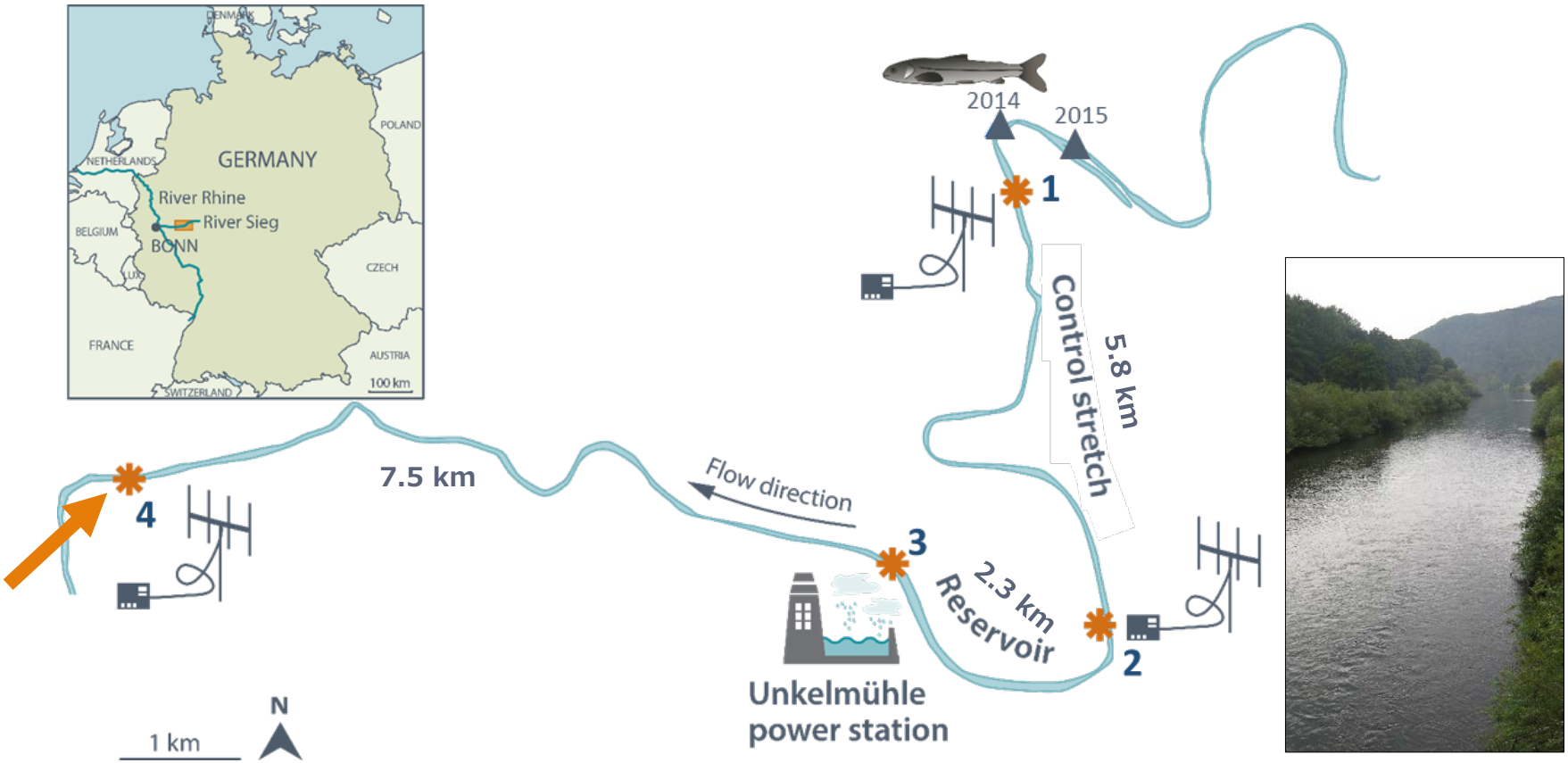
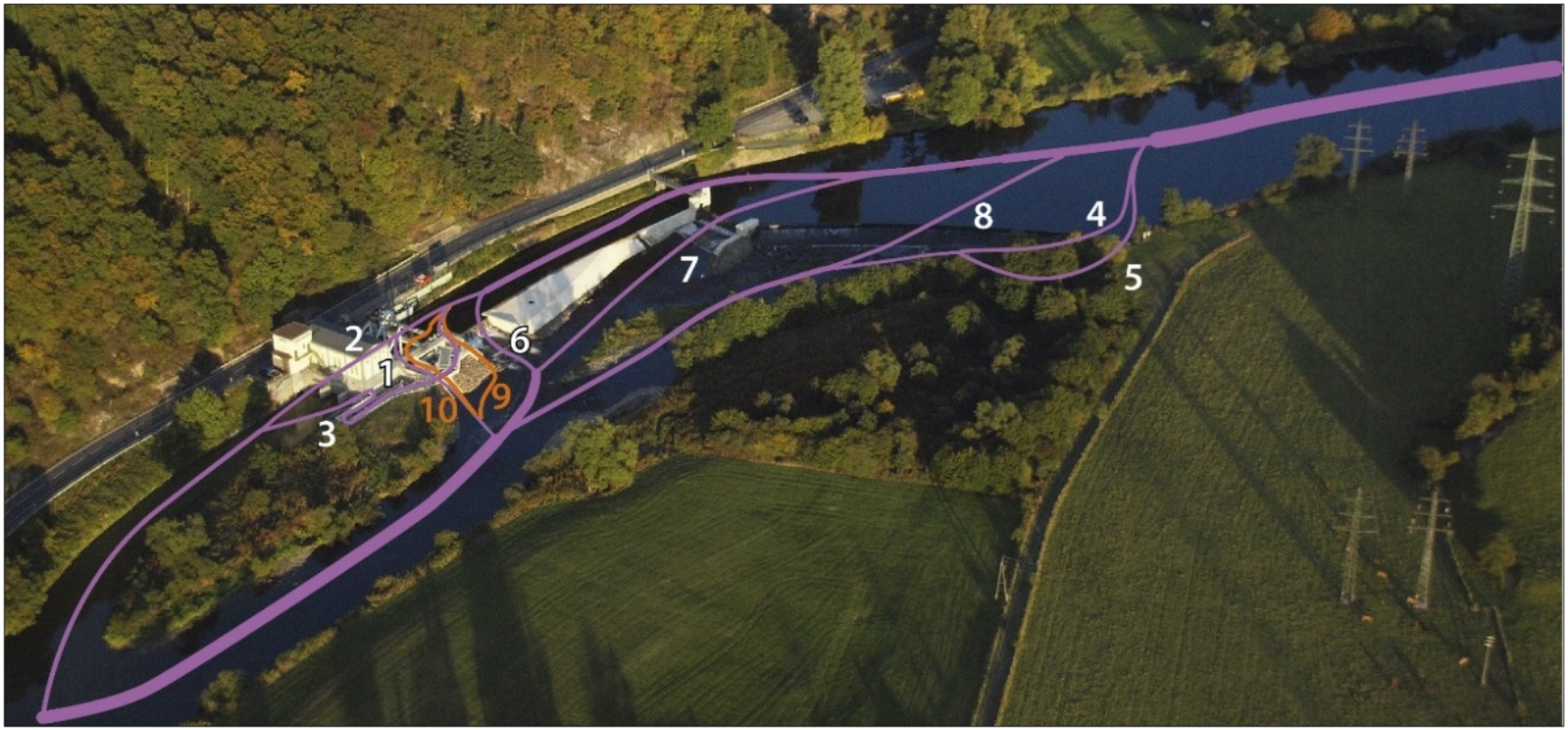


Ten possible routes for downstream migrants past the power station



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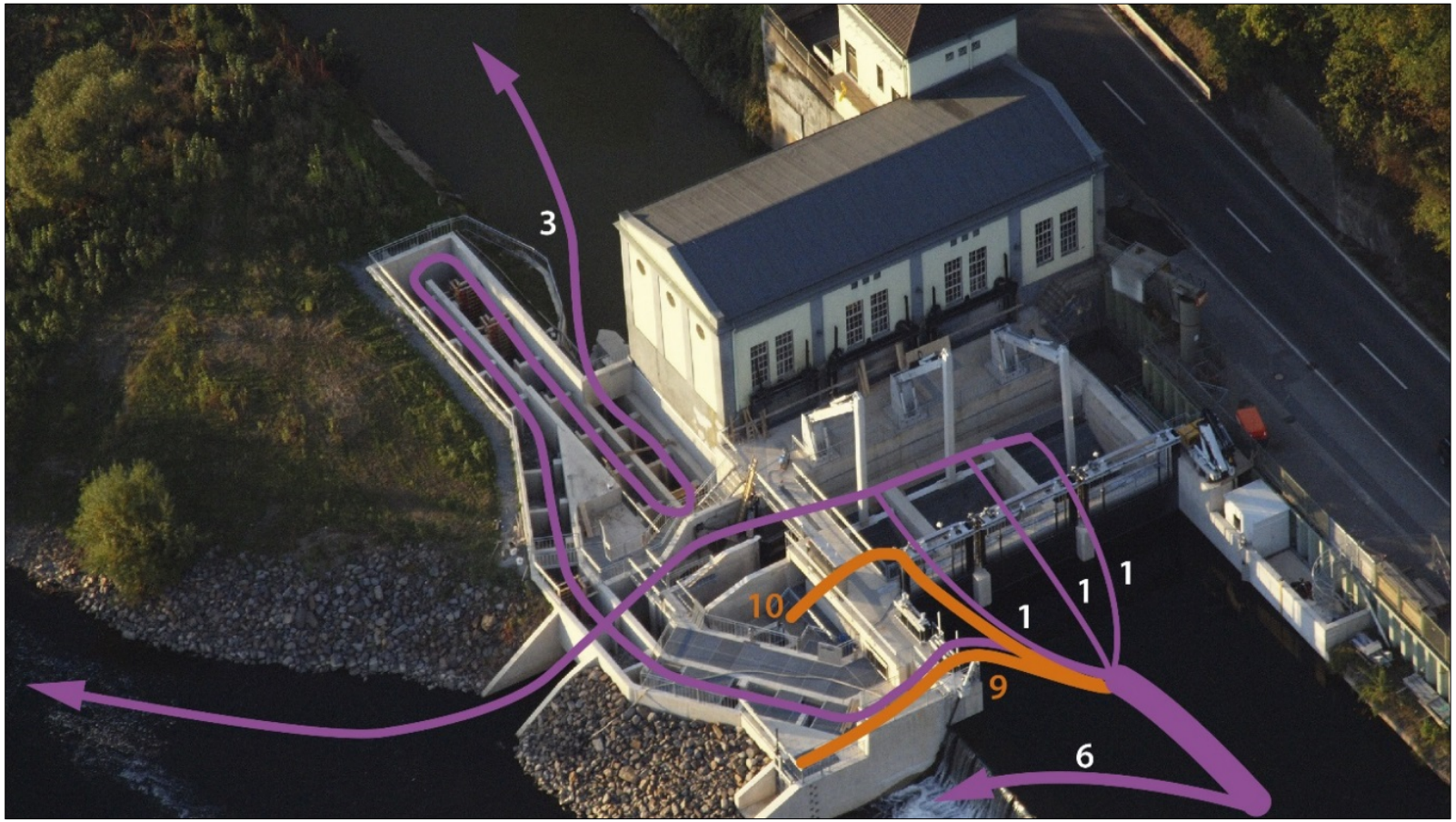

Used 17 antennas with different ranges to cover all the migration routes

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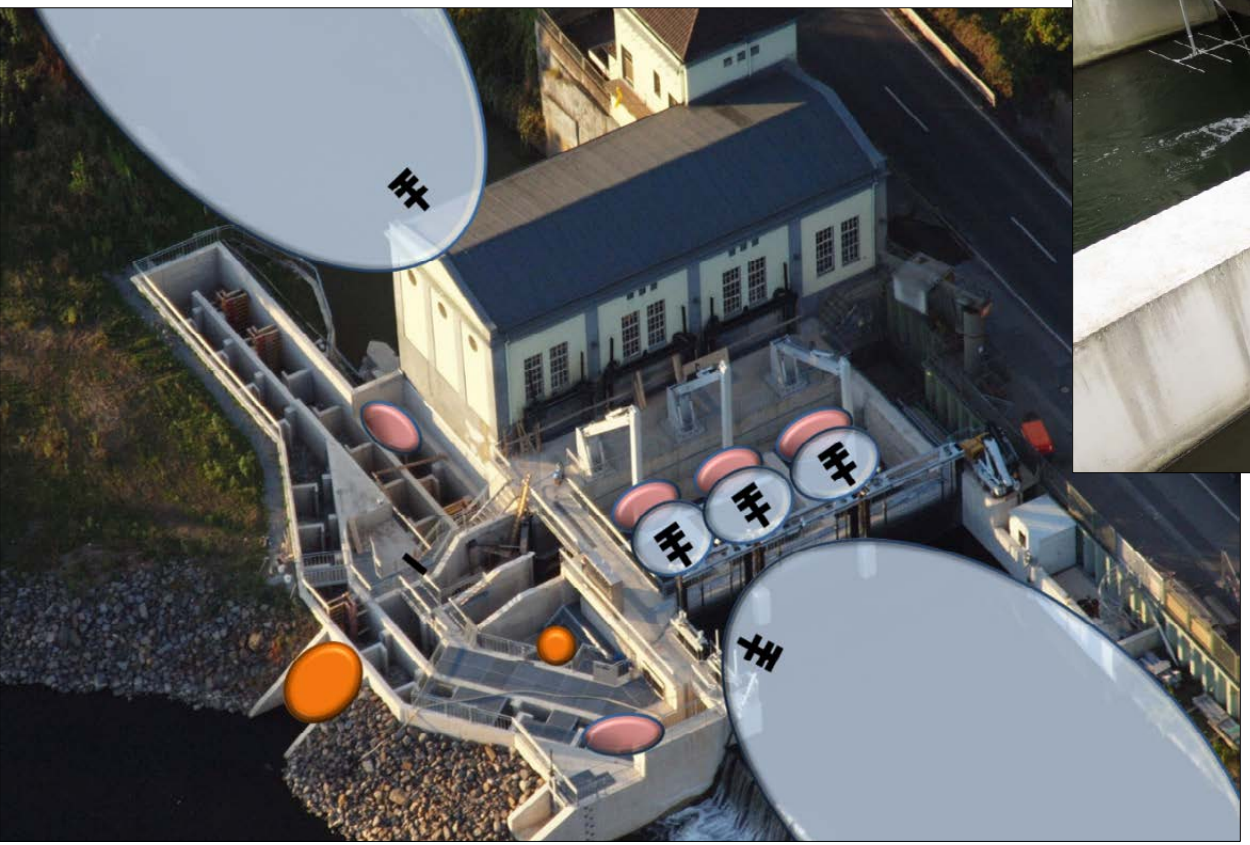


Yagi antennas in air

Underwater antennas

Radio technology was chosen because range of acoustic receivers cannot easily be adjusted and fine-tuned – which we needed at the power station

The antennas were connected to SRX 600 receivers:

- Receive and store radio signals from tags
- Can adjust range separately for up to 8 antennas connected to each receiver
- Can identify 500 codes on one frequency

I beep, therefore I am?

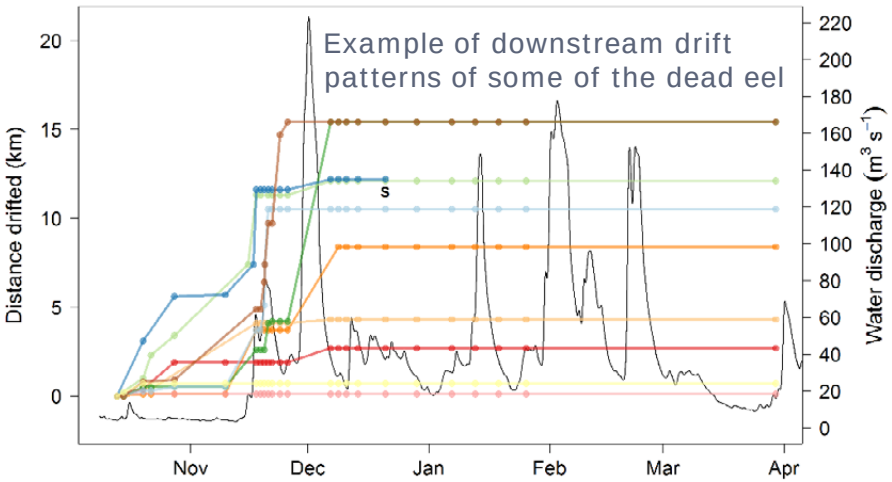
How easy is it to recognise a live fish from a dead fish?

- We radio tagged and released dead salmon and eel and recorded their movements

I beep, therefore I am?

Dead salmon drifted up to 2,4 km and eel 30 km downstream

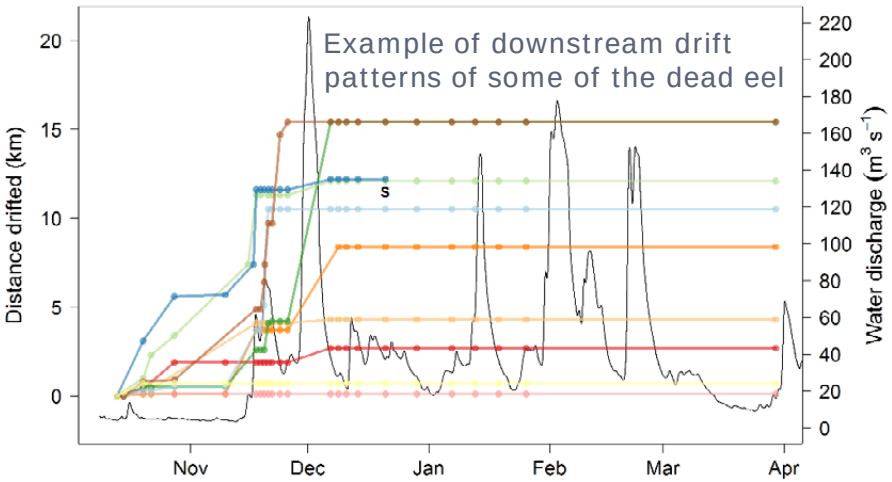
Dead fish were also moved upstream by scavengers and brought out of the river



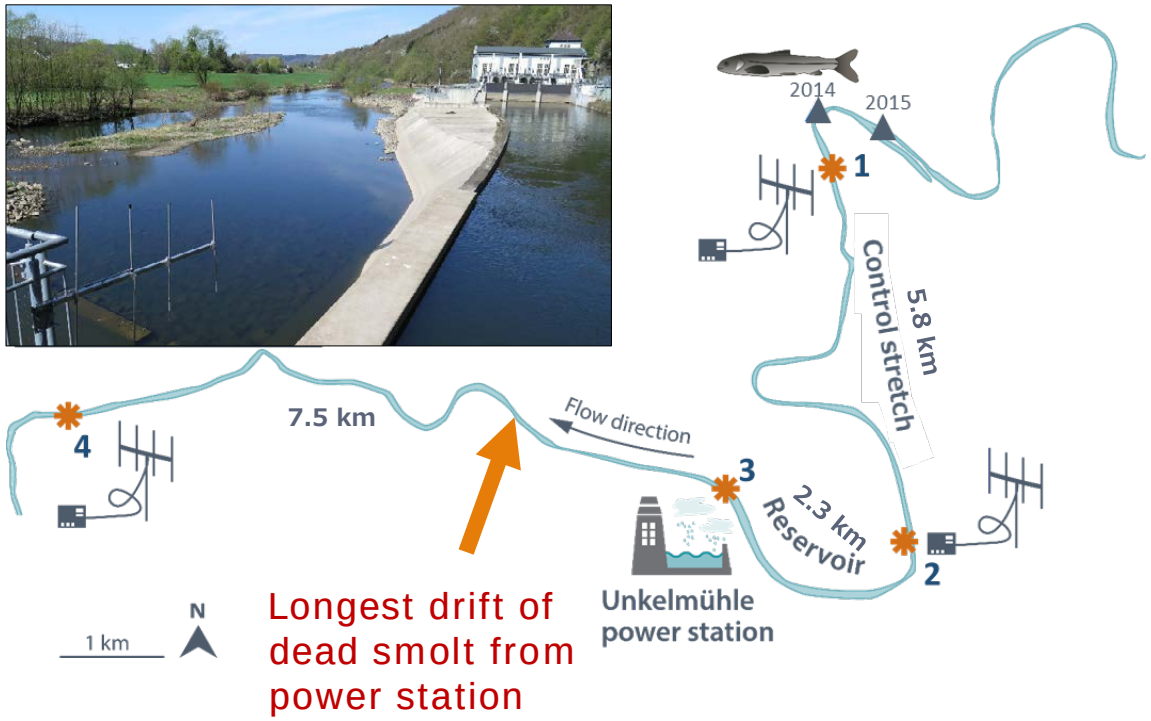
I beep, therefore I am?

A fish dying at a power station may not become stationary, but can continue to move downstream or upstream or disappear from the river

Complicates data analysis ….

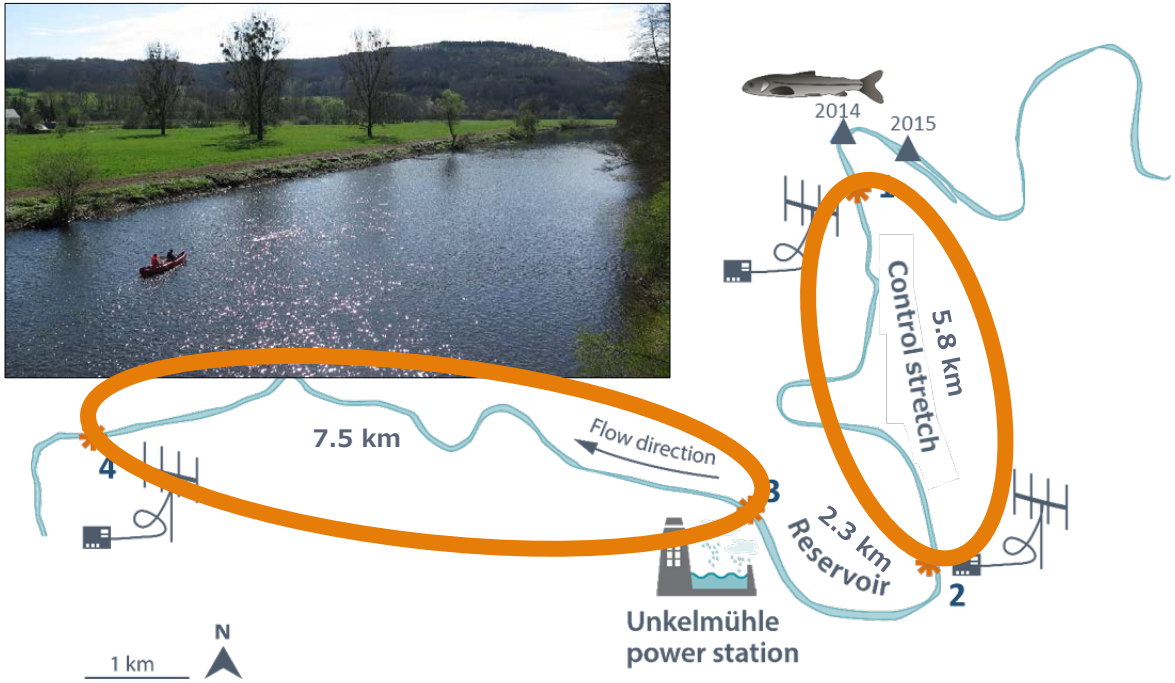


Release of dead fish can be used as control groups to evaluate mortality at power stations



Individuals that migrate further than dead fish drifted can be considered as survivors

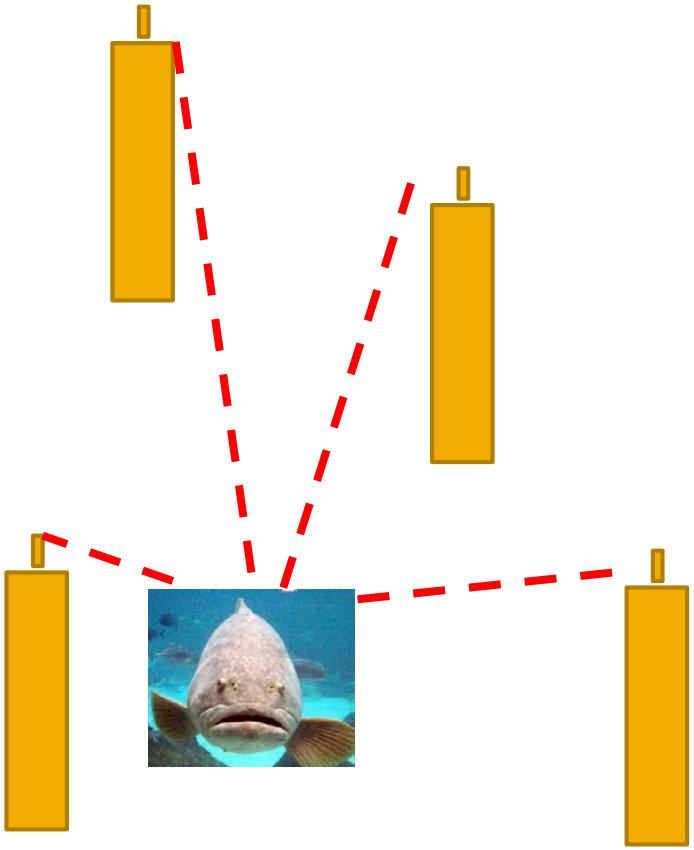
Approach to analyse smolt loss caused by the reservoir and power station



- We used loss per km in a control stretch as baseline to calculate *extra* loss in reservoir and at power station
- A stretch below can be included in calculation of extra loss due to power station –> includes injured fish dying below the power station

Fish movements can also be monitored continuously in 2 or 3 dimensions

- In restricted areas for instance in reservoirs and above dams



- Based on deployment of a number of acoustic receivers in the area

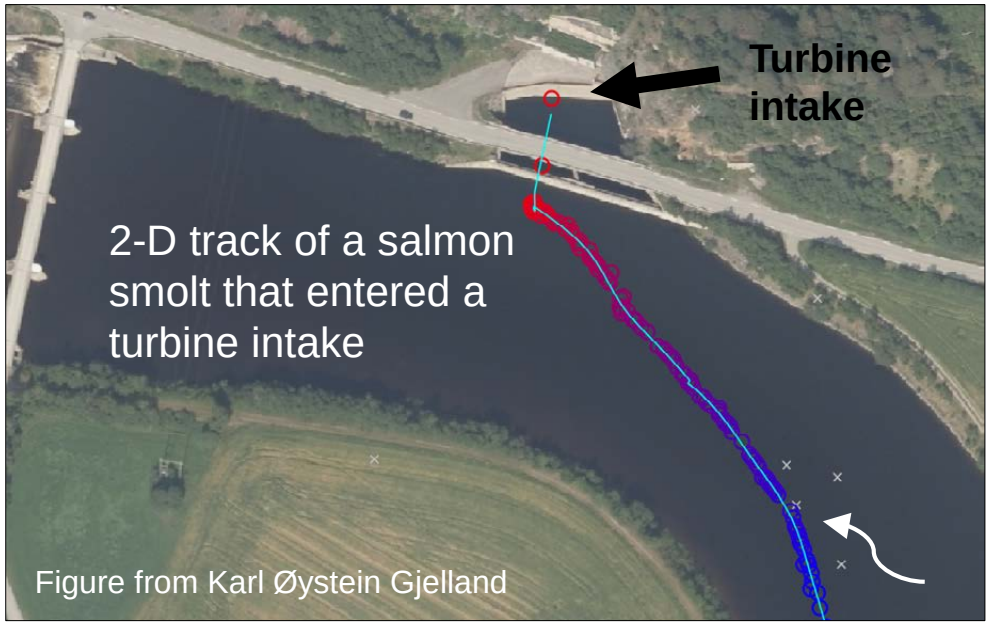


Figure from Karl Øystein Gjelland

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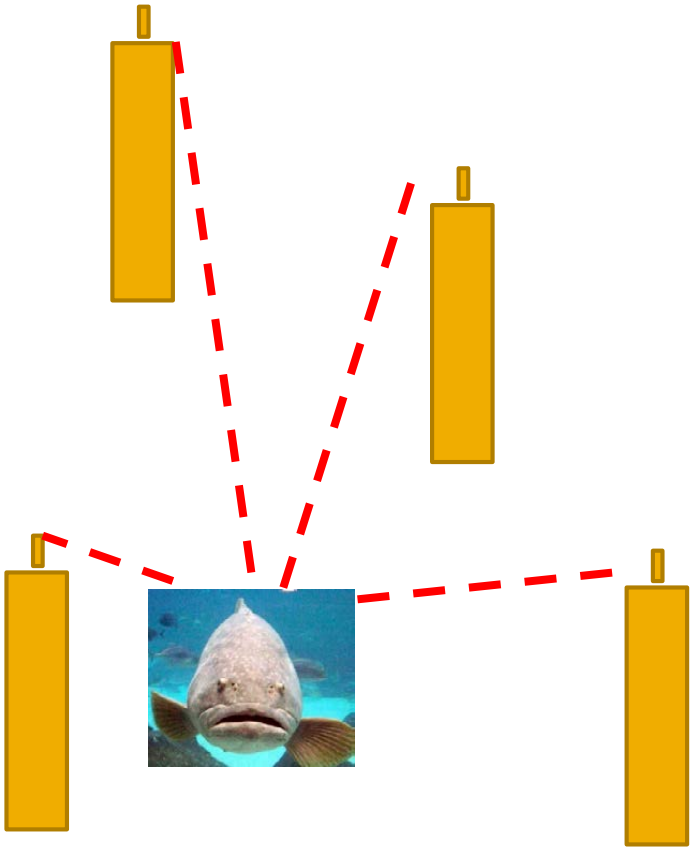

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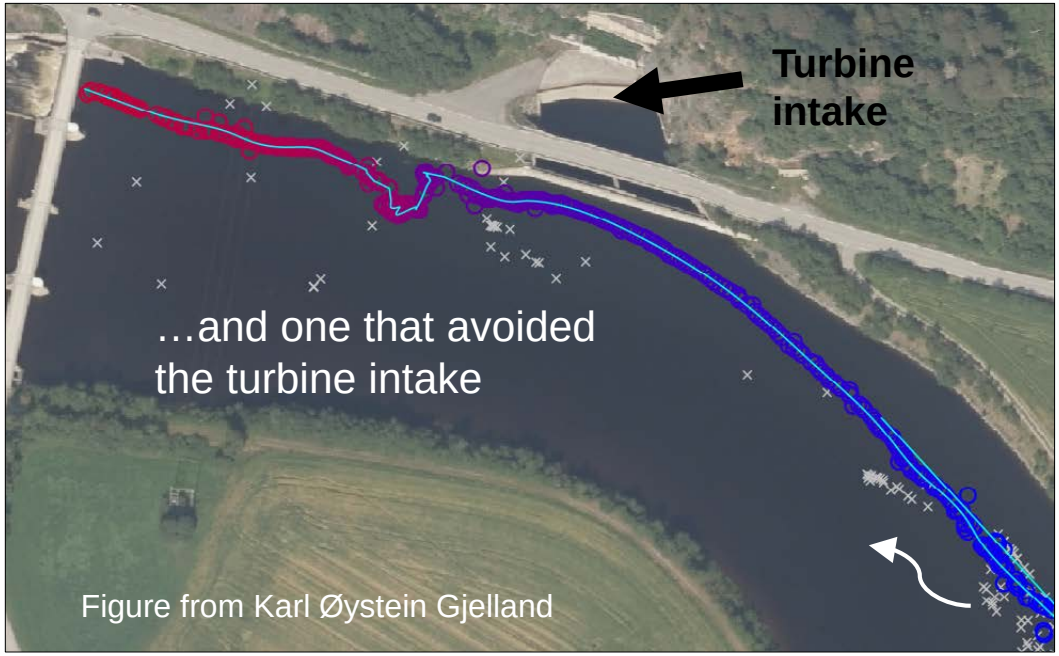


Figure from Karl Øystein Gjelland

Fish movements can also be monitored continuously in 2 or 3 dimensions

= receivers in lake

= male pike

= female pike

From PhD Henrik Baktoft

Conclusion

- Radio and acoustic telemetry are highly suitable tools to study behaviour, migration speeds and losses of downstream migrating fish
  - on natural river stretches
  - past reservoirs
  - due to power stations

- Delayed effecs of impacts in freshwater on the marine migration of diadromous species can be studied by use of acoustic telemetry

Conclusion

Challenging to choose the right methods and equipment:

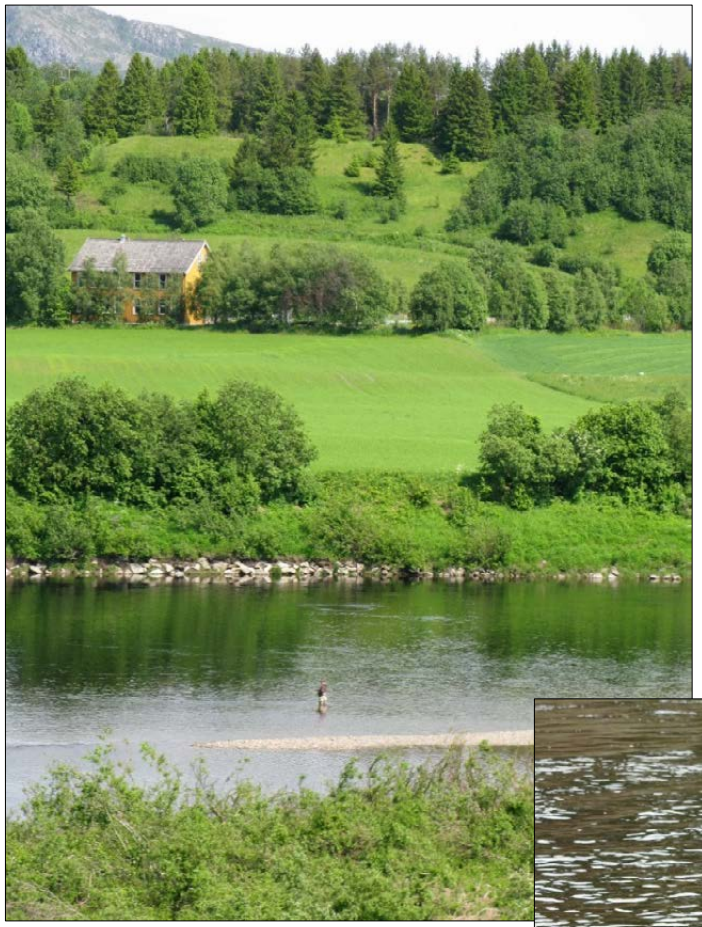
- Capture and handling of fish?
- Sample sizes?
- Internal or external tagging methods?
- Radio, acoustic or transponders?
- Automatic listening stations, manual tracking or both?
- How detailed recording of behaviour?
- Which antennas/receivers to use?
- Coded or pulsed tags?
- Pulse frequency vs. lifetime of transmitters?
- Tags with additional sensors, like depth, temperature, muscle activity?
- How to analyse the data?

Conclusion

- Not necessary to inventing the wheel again
- Concentrate first on the questions, not the methods
- Employ and collaborate with people that have experience with using the methods

Often suitable methods to involve local people in the field work

- A common understanding of methods and results often reduces conflicts



Thank you

for listening!