Experience and case of fishway design in Norway

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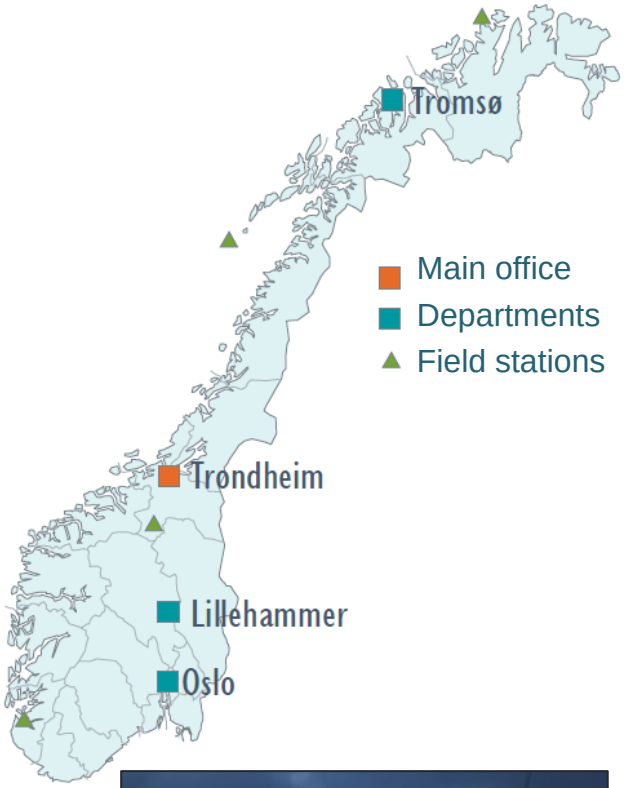
Outline

- Background NINA and hydropower in Norway
- Why are fishways important?
- How can hydropower block fish migration?
- How can we make fishways work?

Norwegian Institute for Nature Research - NINA

- Established in 1988 as private foundation
- 219 employees (2012)
- 281 Million NOK turnover (2012)

- Scientific research
- Environmental monitoring
- Consultancy
- Dialogue and dissemination

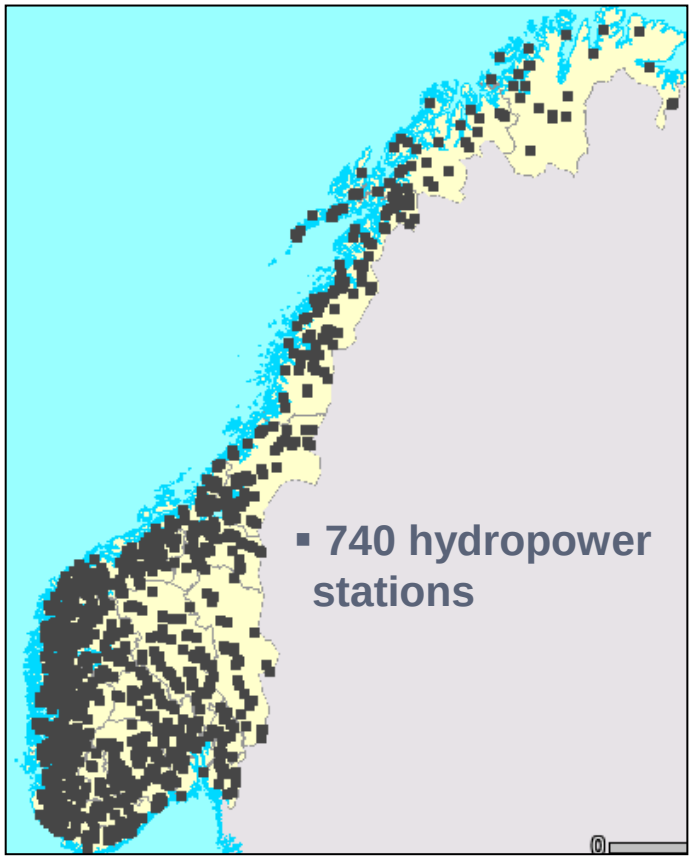


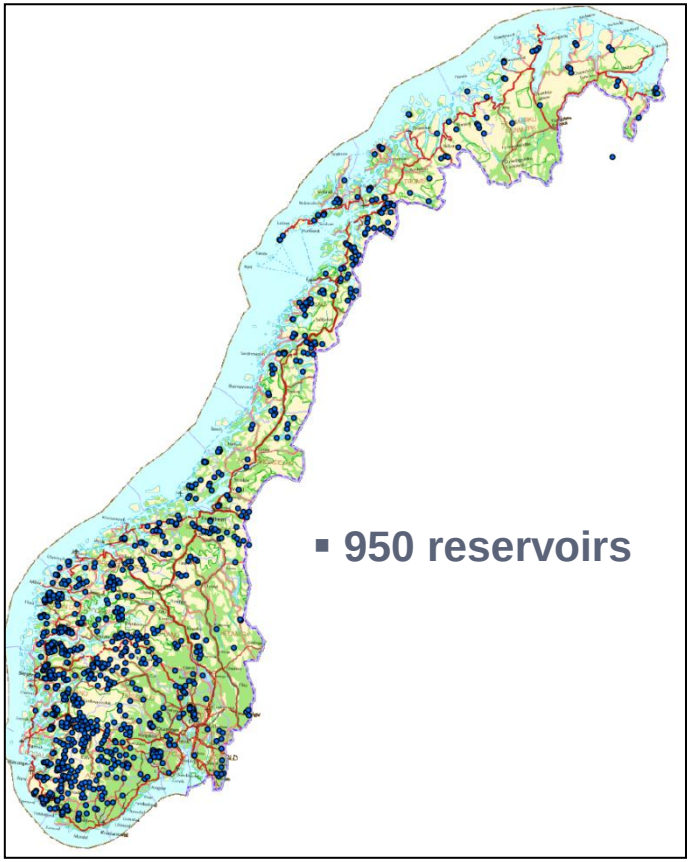
NINA has long traditions for working on biological effects of hydropower

- Research on fish and hydropower production > 60 years
- Environmental impact studies - advisor for power companies and government




Hydropower very important in Norway: 70 % of large watersheds affected





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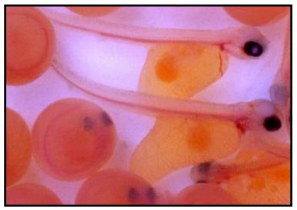
Many fish need to migrate to survive

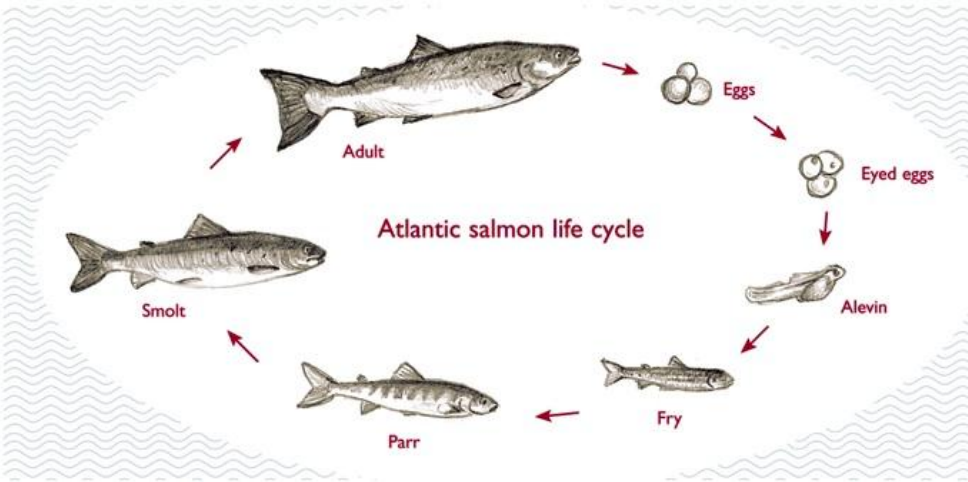
Recruitment area



Feeding area

Spawning area

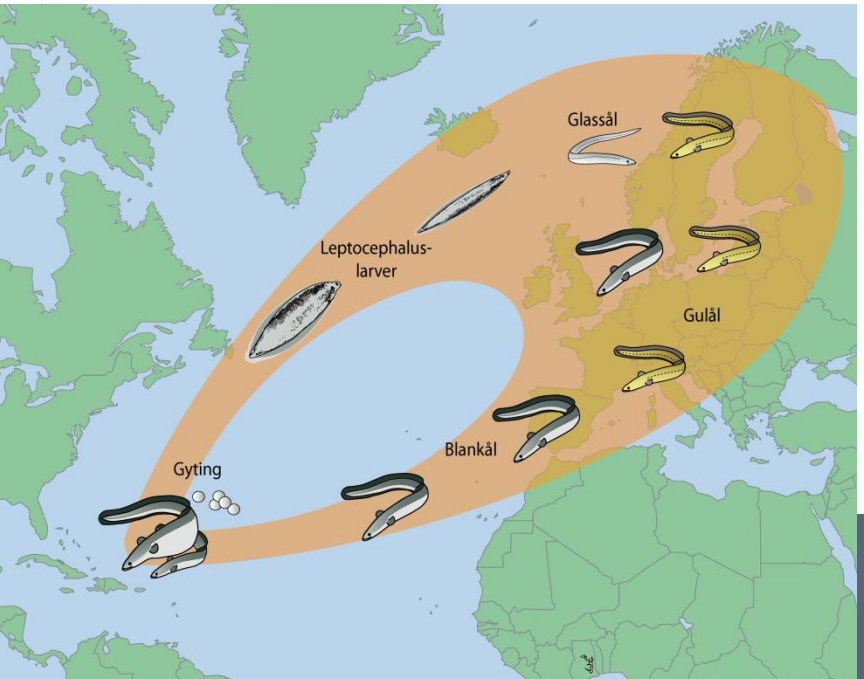
- Need access to all areas to fulfil life-cycle
- Variety of migrations
  - River < -- > Ocean
  - River < -- > Lake
  - River < -- > River
- Always migration <u>both ways</u>!



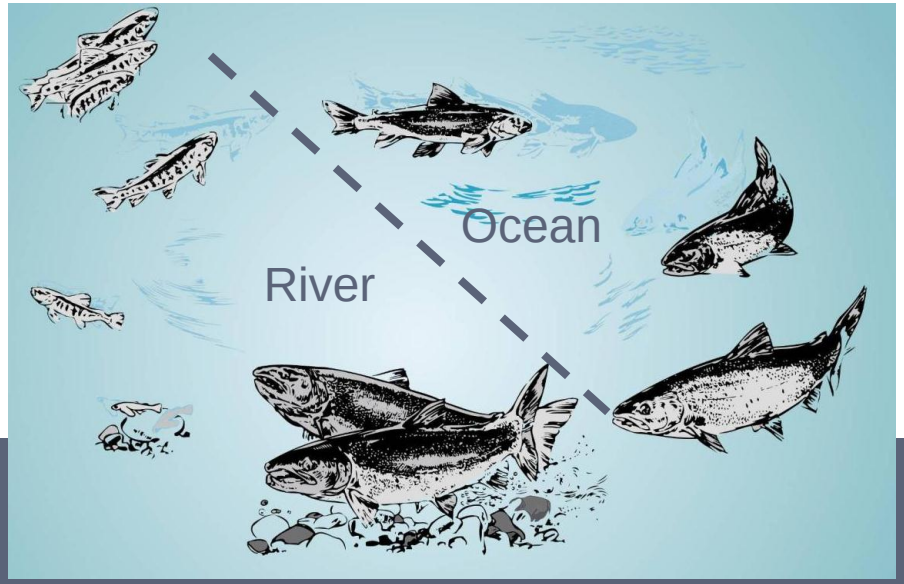
Variety of migrations

- River < -- > Ocean

Eel: Spawn in ocean, feed in river



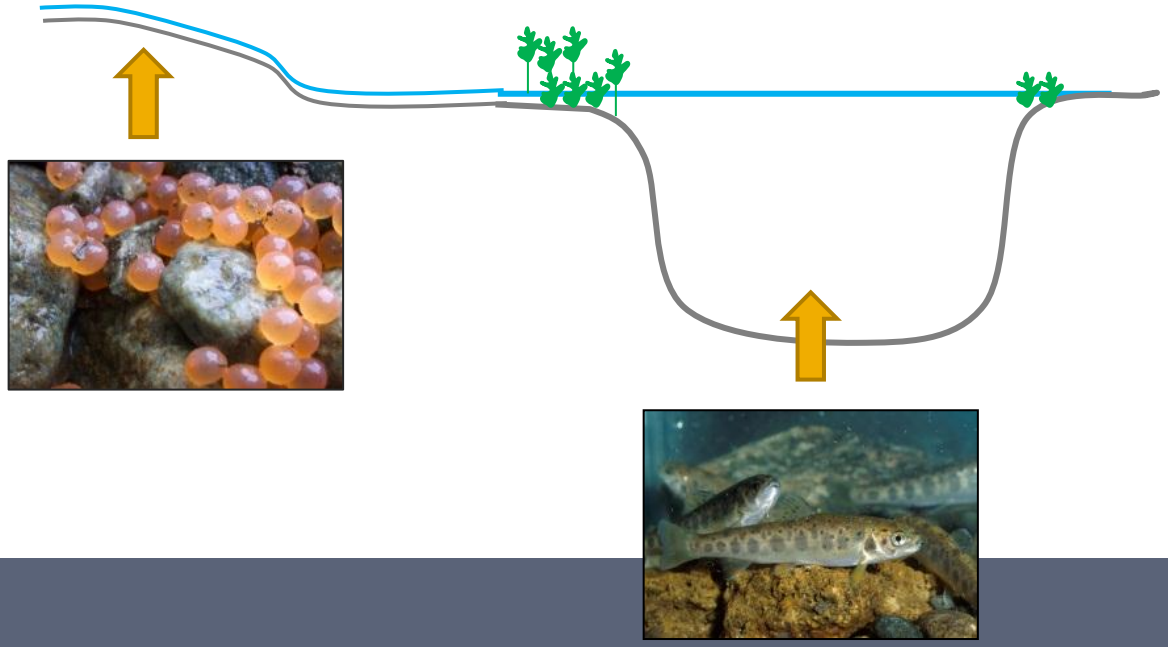
Salmon: Spawn in river, feed in ocean

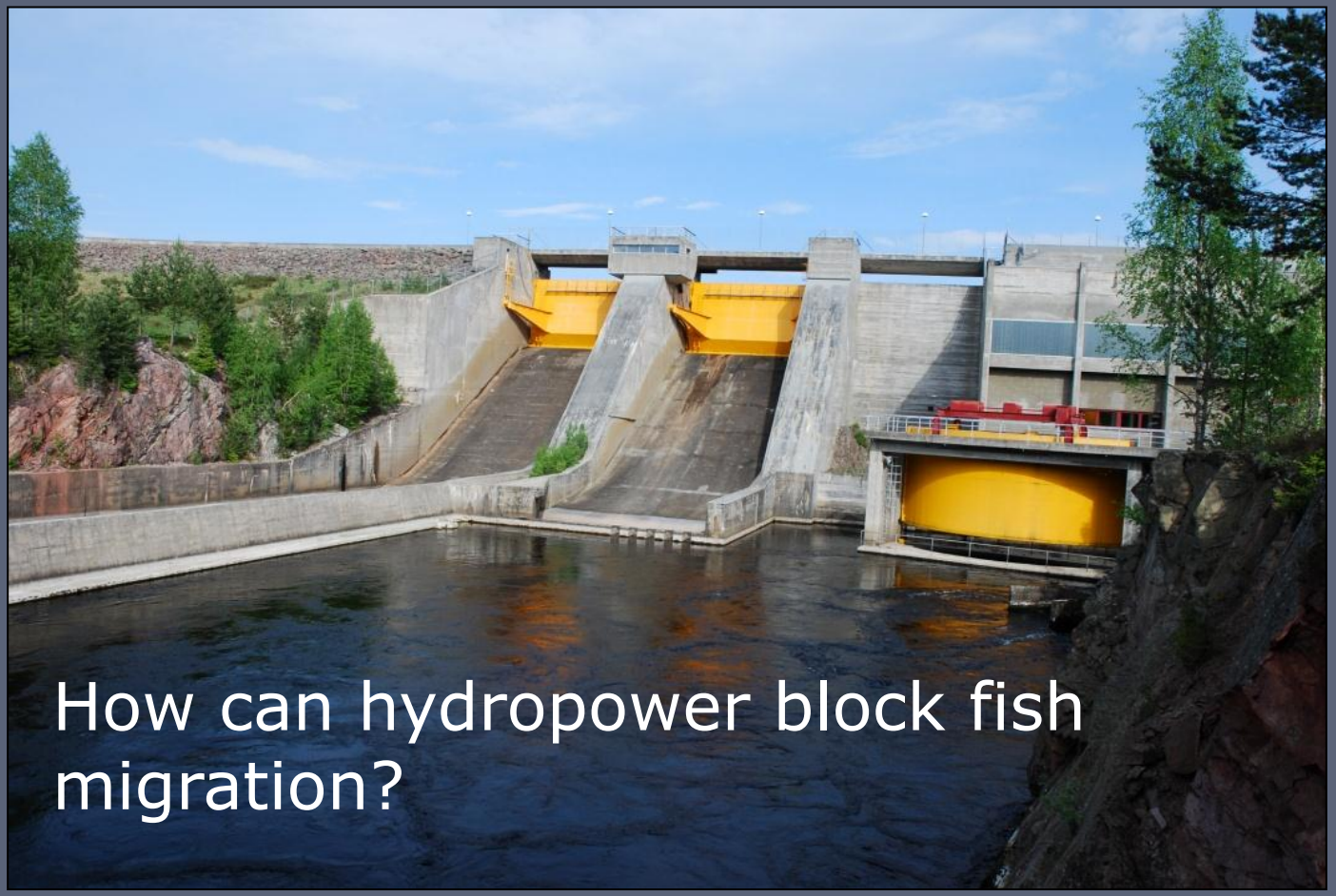


Variety of migrations

- River < -- > Lake

Trout: spawn in river, feed in lake





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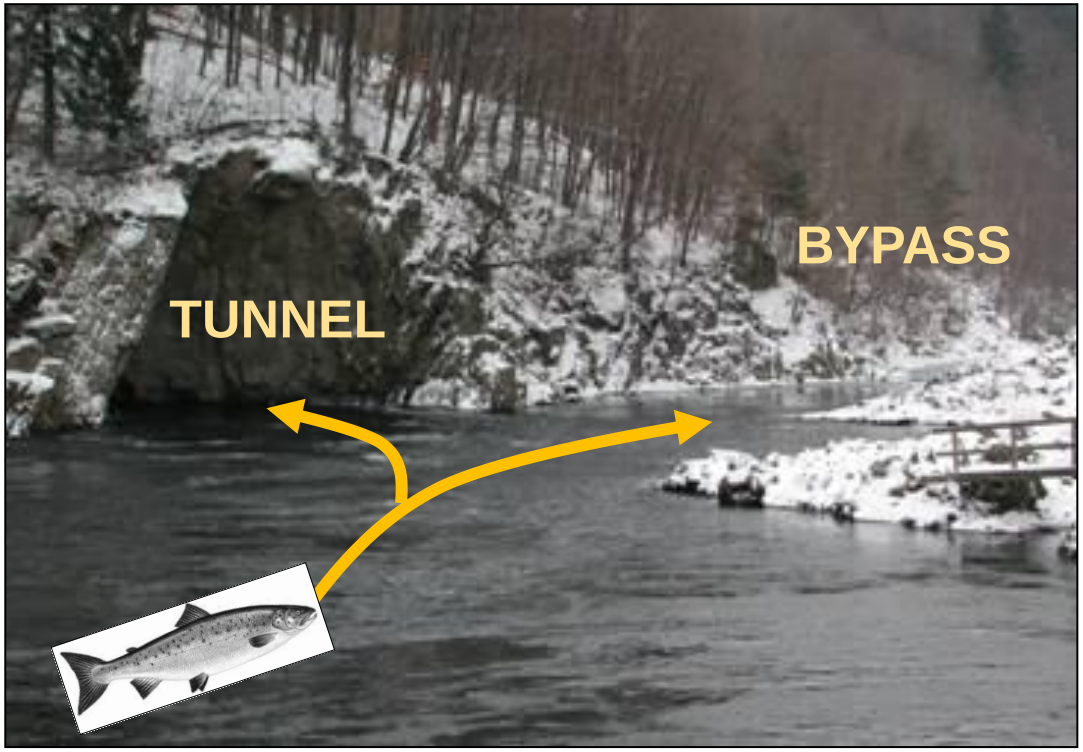
Downstream migrants in rivers: Injured, cut and killed through turbines

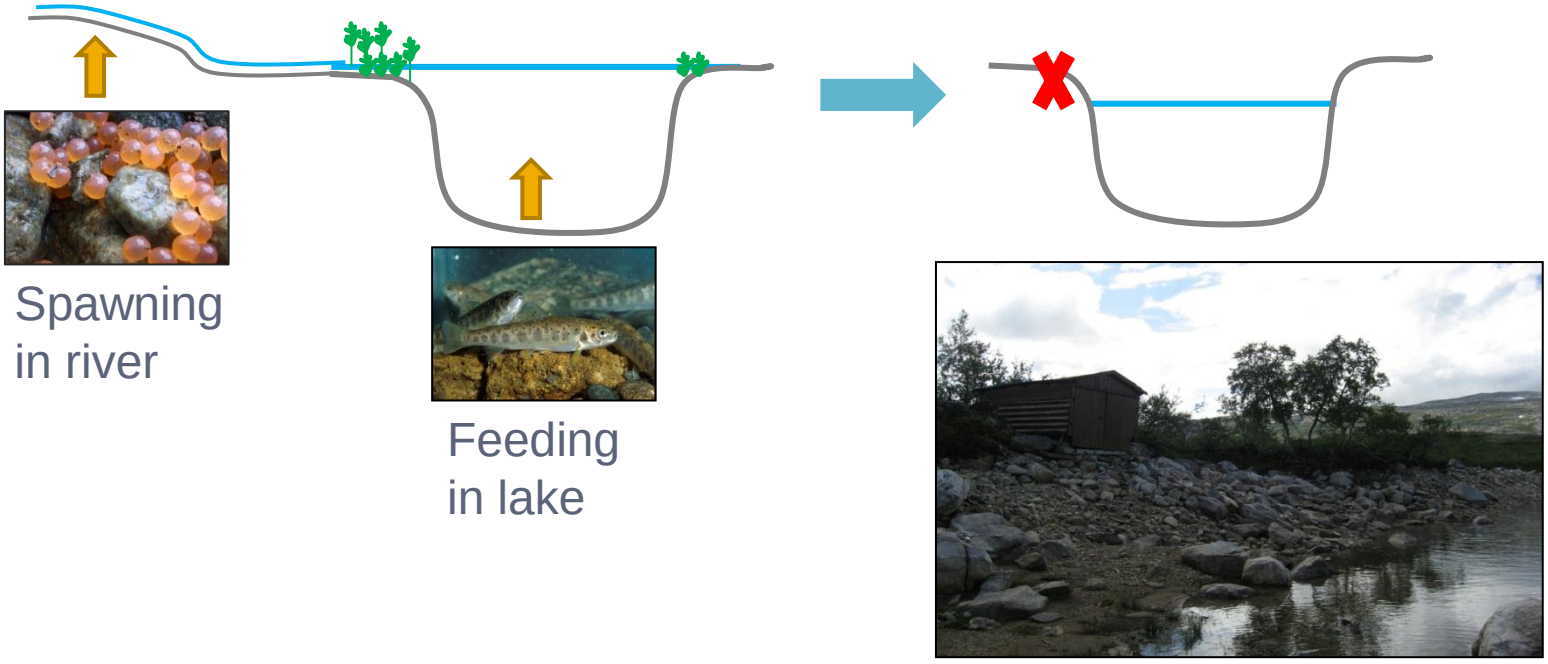
Upstream migrants in rivers: Attracted to and delayed at tunnel outlets

- Difficult to find small bypass flows



No access to spawning area for reservoir populations

- If water level is too low
  - At time of spawning: Adults cannot migrate to spawning stream
  - At time of juvenile migrations: Young fish cannot access lake



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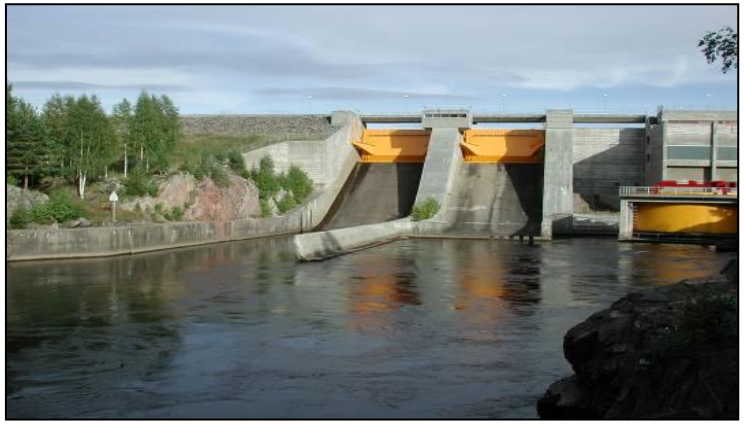
Fishways – experiences from Norway

- About 420 fishways in Norway
- All made for salmonid fishes (salmon, trout, char) – good swimmers and good jumpers, follow strong current
- Highest dam with fishway 46.5 m
- Many seem to work, but effectivness needs to be better studied

Challenge 1: Guide the fish to the fishway entrance

- Often difficult for fish to find the fishway



Challenge 1: Guide the fish to the fishway entrance

- Attraction discharge

Challenge 1: Guide the fish to the fishway entrance

Bad water discharge at fishway:

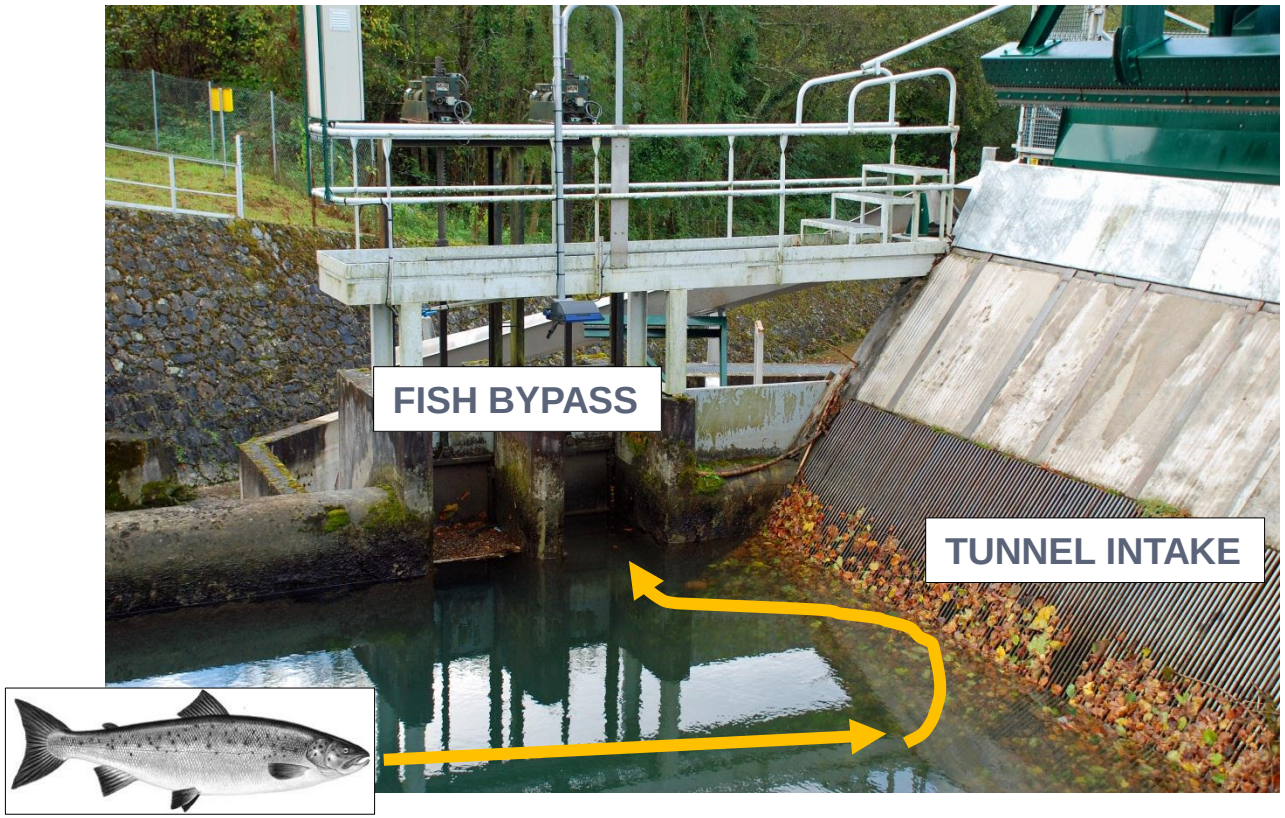
- Turbulence and waterfall in front of entrance

Optimal water discharge at fishway:

- Main current next to fishway
- Strong current from fishway

Challenge 2 :Prevent downstream fish from entering the turbine

- Screens in front of turbine intakes



Challenge 3: Different species have different needs

- Eel – very different from species
- Migrate up as small juveniles
- Bad swimmer – but good climber on land
- Cannot jump - waterfall of few cm can be barrier

Challenge 3: Different species have different needs

- Migrate down as large adult
- Long body – large risk of injury in turbines
- 4-5 times higher mortality than salmon

- Need more testing how to lead eel outside turbine
  - Type of grids in front of turbine?
  - Behavioural barriers – electric fields, light, sound?

Summary

- Migratory fish populations will die out if they don’t have access to all necessary areas
- Important to ensure two-way migrations: up AND down!
- Challenge to guide fish to the entrance – not all fishways work well
- Important to prevent fish from entering the turbine
- Different species have different needs (example: eel vs. salmon)

Thanks to helpful colleagues

- Frank Hanssen
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