Jun 24th, 5:15 PM - 5:40 PM

Session E9: Function Control of Fish Migration Facilities at the Hydro Power Plant Kostheim at River Main

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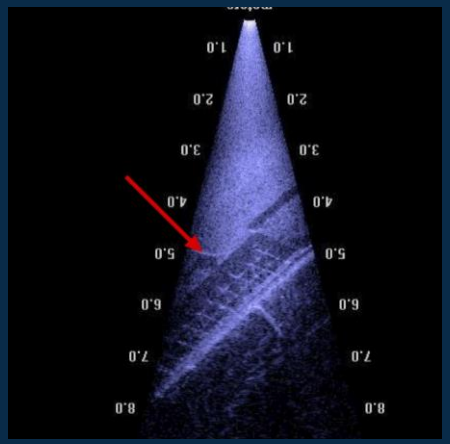
BFS
Bürogemeinschaft
für Fisch- & Gewässerökologische Studien
Frankfurt – Marburg

Fische – Makrozoobenthos – Makrophyten – Gewässerökologie - FFH - EG - WRRL

Beratung – Konzeption – Planung

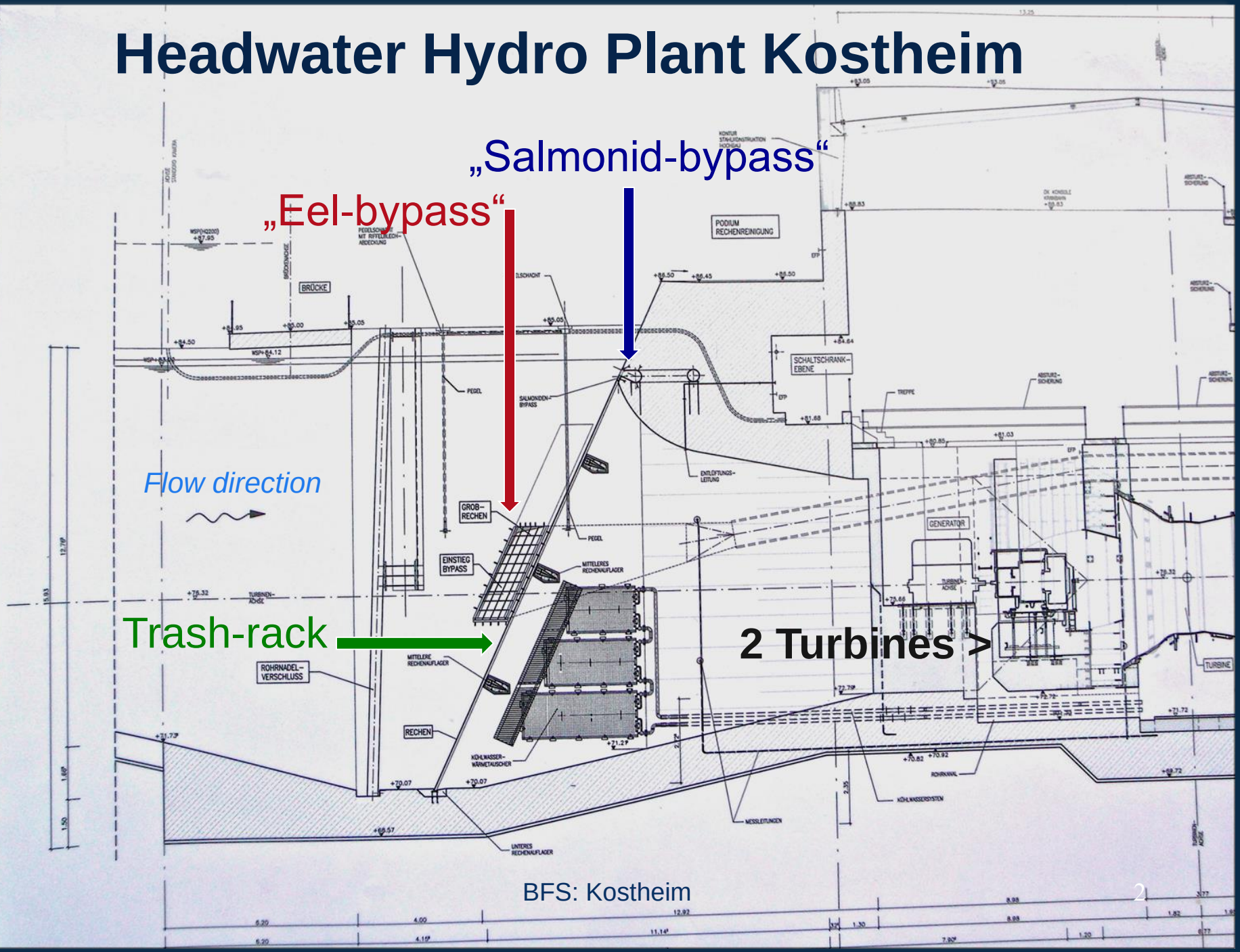
Function control of fish migration facilities at the Hydro Power Plant Kostheim at river Main

Dr. Jörg Schneider, BFS Frankfurt am Main Germany



Fish Passage 2015, June 20-24, Groningen, NL

Headwater Hydro Plant Kostheim



BFS: Kostheim

Hydro Plant & migration facilities

Production capacity: 4,9 MW
2 Kaplan turbines, 2 x 80 m^3/s
3 blades, 85 rotations/min

VAKI fish counter

Nature-like fish pass, flow 1,2 m^3/s

Exit „eel-bypass“

Entrance nature-like fish pass
40 m below turbines

Trash-rack
Bar spacing 20 mm
V = 0,5 m/s
Slope 25°

Questions

on downstream migration

- Relative use of different corridors (eel-bypass, salmonid-bypass, nature-like fish pass, turbine passage, failed passage = trash container)
- Quantitative use of corridors by released fish (marked)
- Mortality at trash-rack *and* turbine passage (combined)

on mortality at turbine passage

- Mortality of released fish (inserted *behind* the trash rack). These fish were forced to pass the turbines (no contact with bars of trash-rack)

Downstream migration

Reference mortality „catch & handling“:

300 smolts released in stow net

1st trial: salmon smolts in April 2011

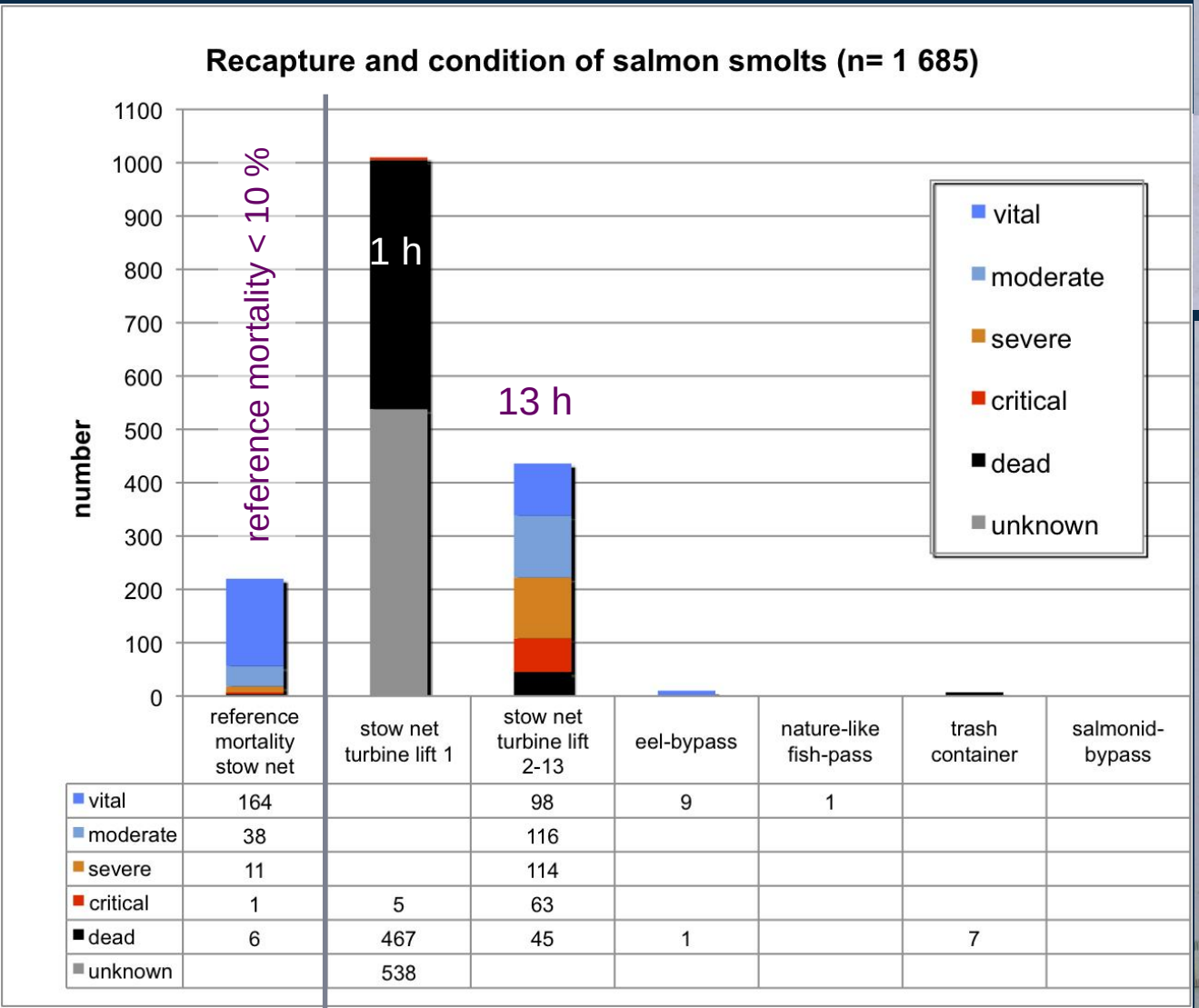
Selection of migration corridor & mortality at turbine passage:

2.500 marked smolts released 30 m upstream of the trash-rack

Downstream migration 1st trial: salmon smolts in April 2011

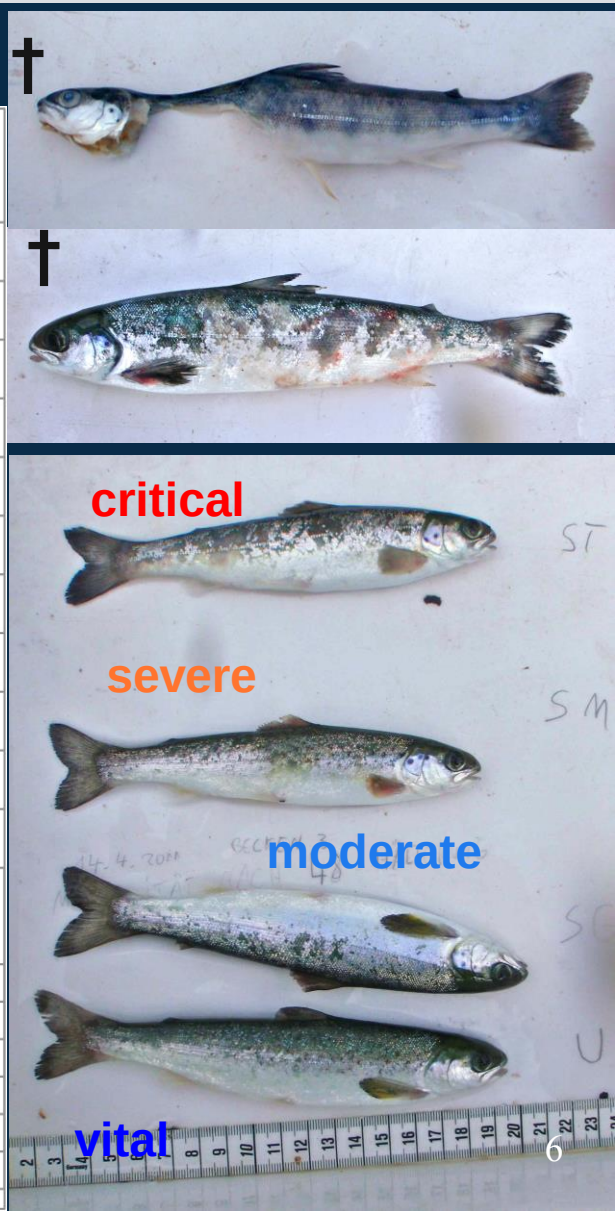
Non-letal injuries and mortality after 48 h observation

Recovery rates: reference 73,7 % - trial: 58,6 %



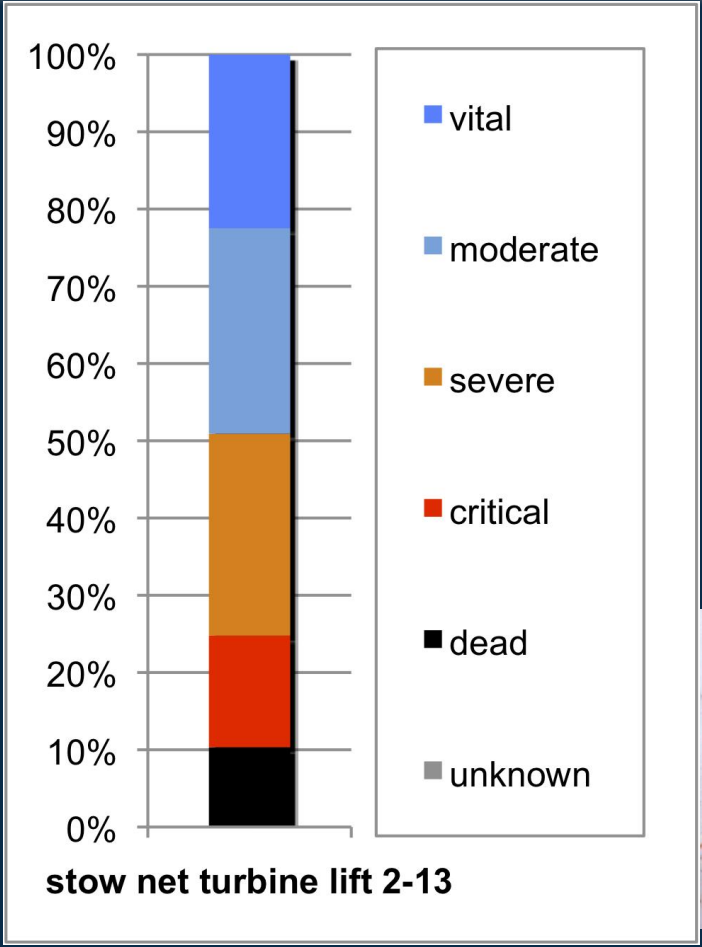
	reference mortality stow net	stow net turbine lift 1	stow net turbine lift 2-13	eel-bypass	nature-like fish-pass	trash container	salmonid-bypass
vital	164		98	9	1		
moderate	38		116				
severe	11		114				
critical	1	5	63				
dead	6	467	45	1		7	
unknown		538					

Classifying the extent of injury

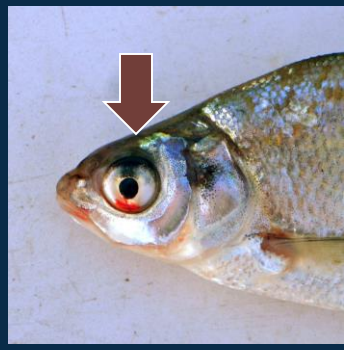


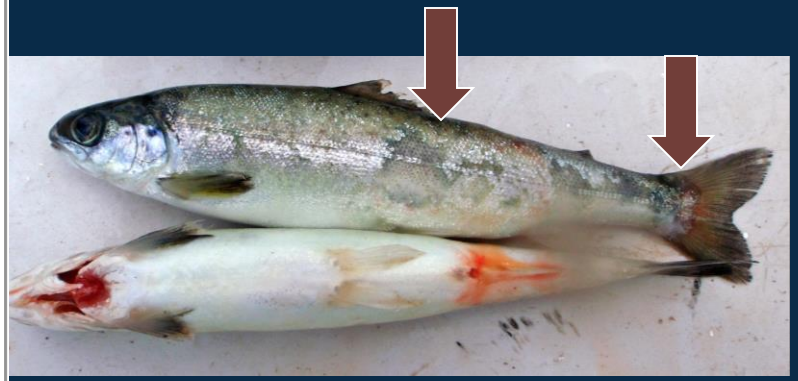
Downstream migration 1st trial: salmon smolts in April 2011

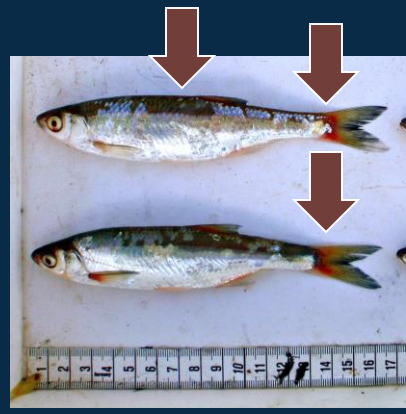
After 48 h in holding tanks 50% of the smolts were dead or not capable of surviving, due to scale loss, haematoma at the basis of caudal fins and internal bleeding.



1. **The direct and indirect mortality of smolts (also bleak, roach) at hydro-plant Kostheim amounts to 50%**
2. **Most individuals displayed injuries characteristic for contact with trash rack**

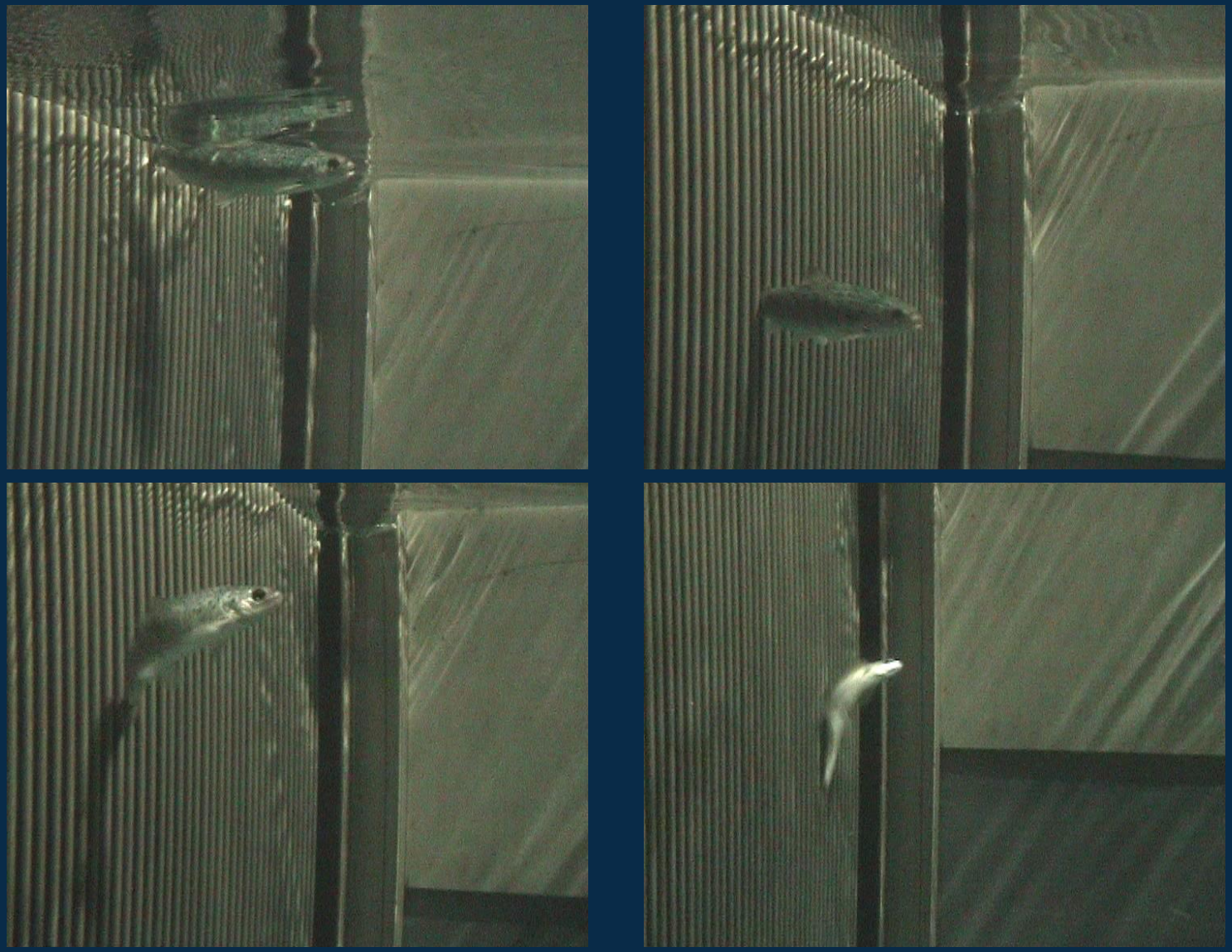






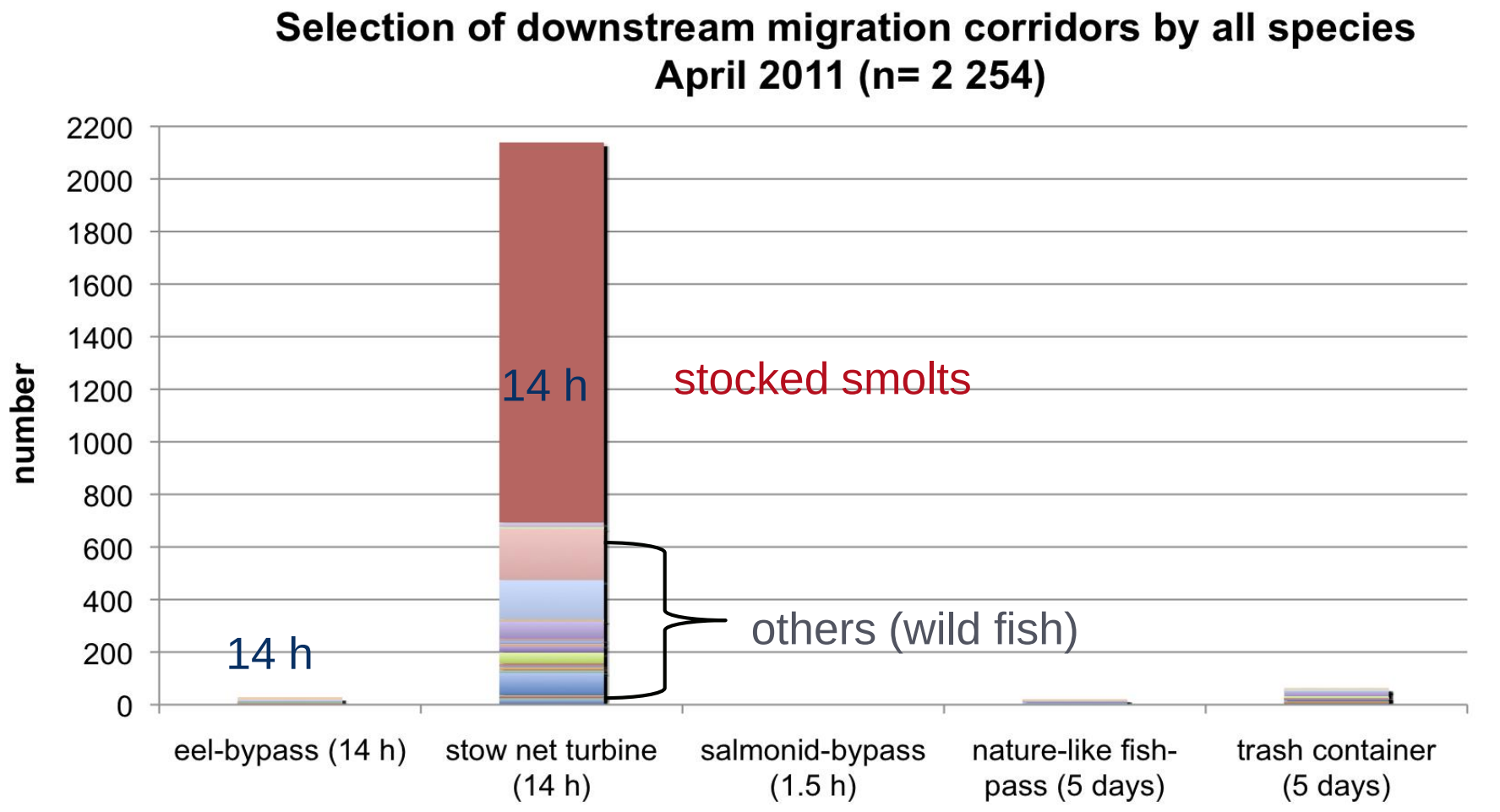
Behaviour of salmon smolts encountering a vertical rack equiped with 10 mm bar space, velocity 0,5 m/s

Lab study by DIRK HÜBNER (BFS-Marburg)



Selection of downstream migration corridors

- 95% of individuals migrating downstream passed the trash rack (all species)
- Downstream migration facilities and the nature-like fishpass were not frequented

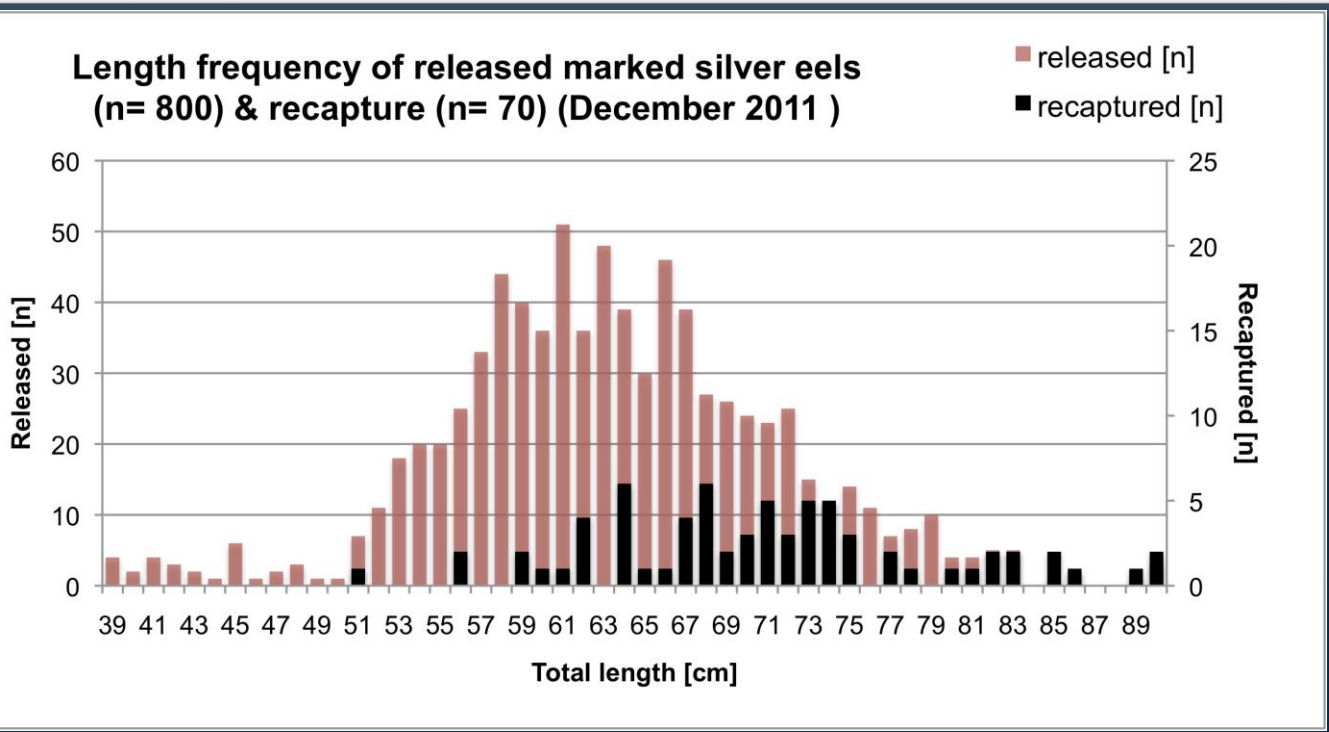


2nd trial: downstream migration of silver eels

Autumn eel migration started 5th December (monitoring trash container)

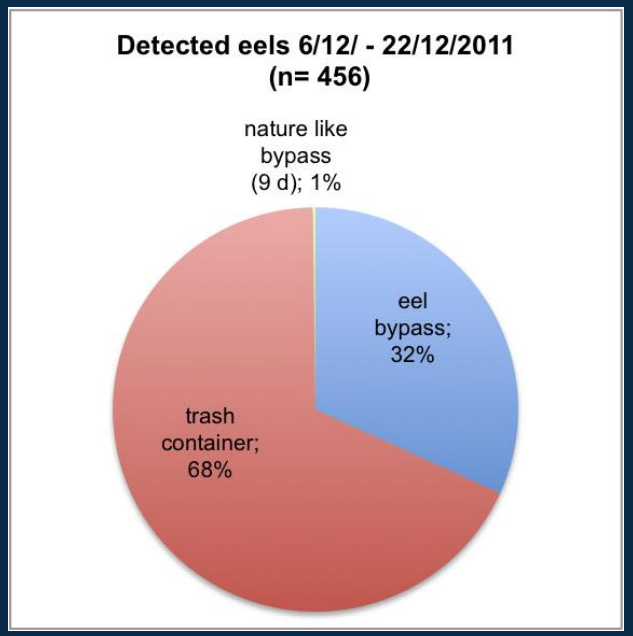
17th December: **800 marked eels** from river Main were released 30 m in front of the trash-rack – **70 eels were recaptured** (7 days monitoring)

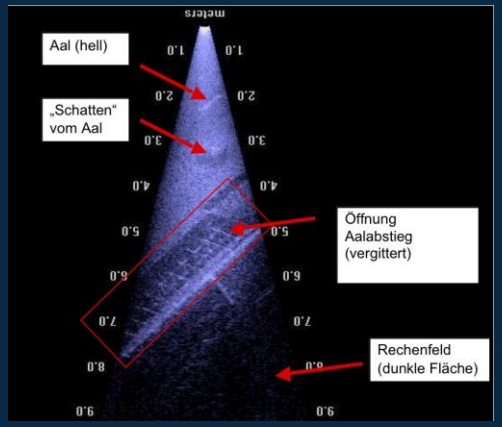
Eels ≤ 60 - 65 cm (ca. 50%) were able to pass the trash rack and could not be recorded as the stow net underneath turbine could not be set up due to strong winds => only large eels could be detected (trash container & eel-bypass)



Small stow net at the exit of the eel-bypass

2nd trial: downstream migration of silver eels

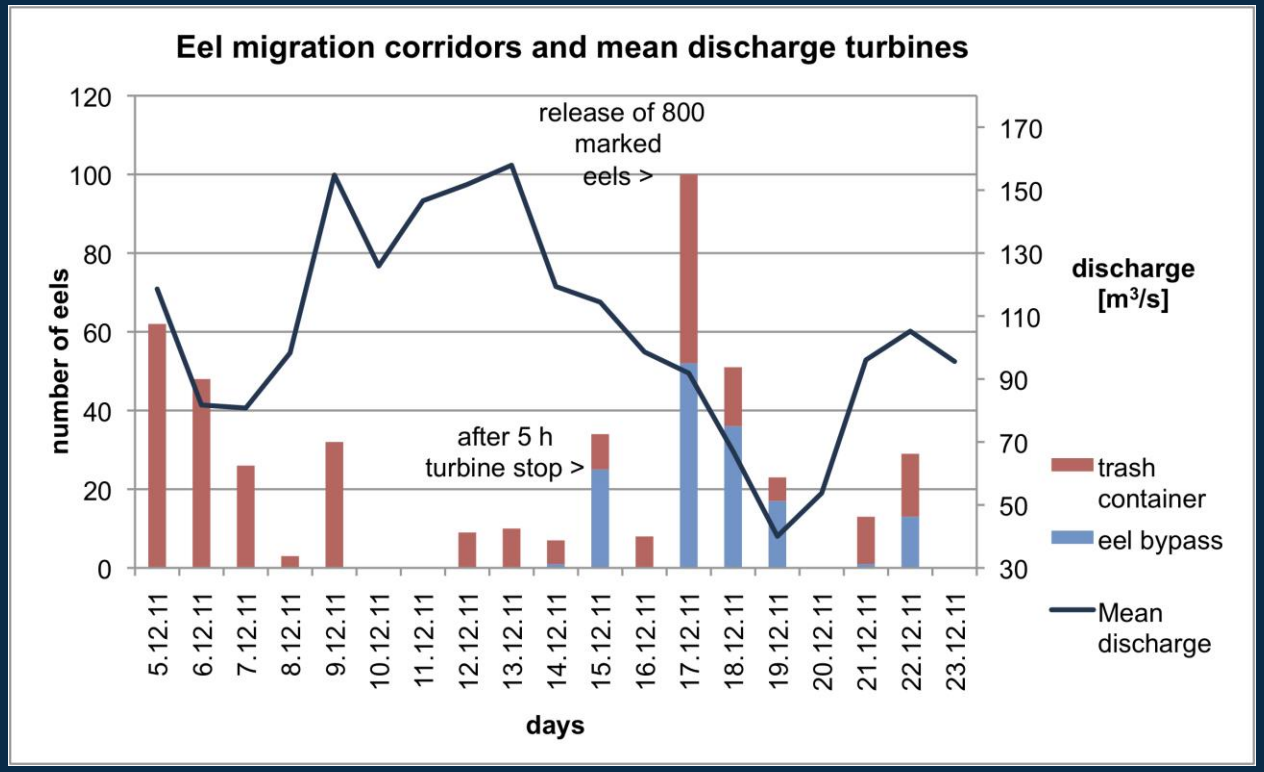




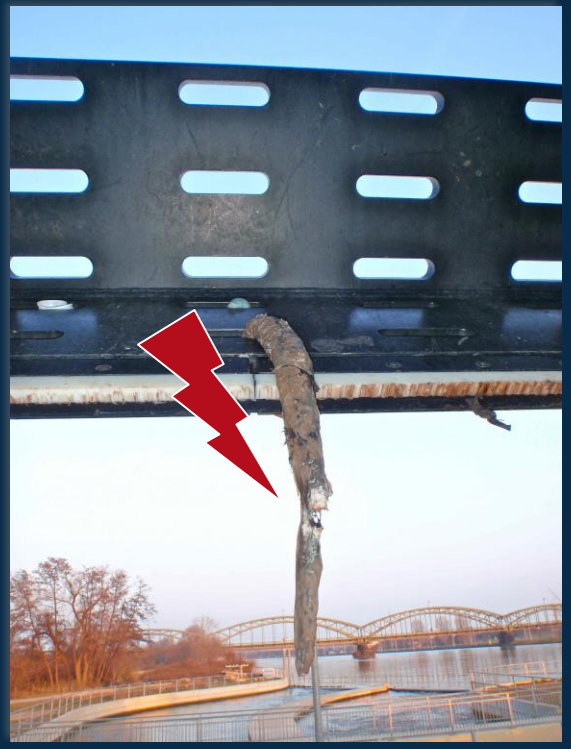
Main conclusion:

Under normal operating conditions the eel-bypass is hardly detectable - due to the improper entrance position on the side of the partition wall, and in the middle of the water column respectively.

This interpretation is supported by DIDSON-sonar observations



Eels in the trash container

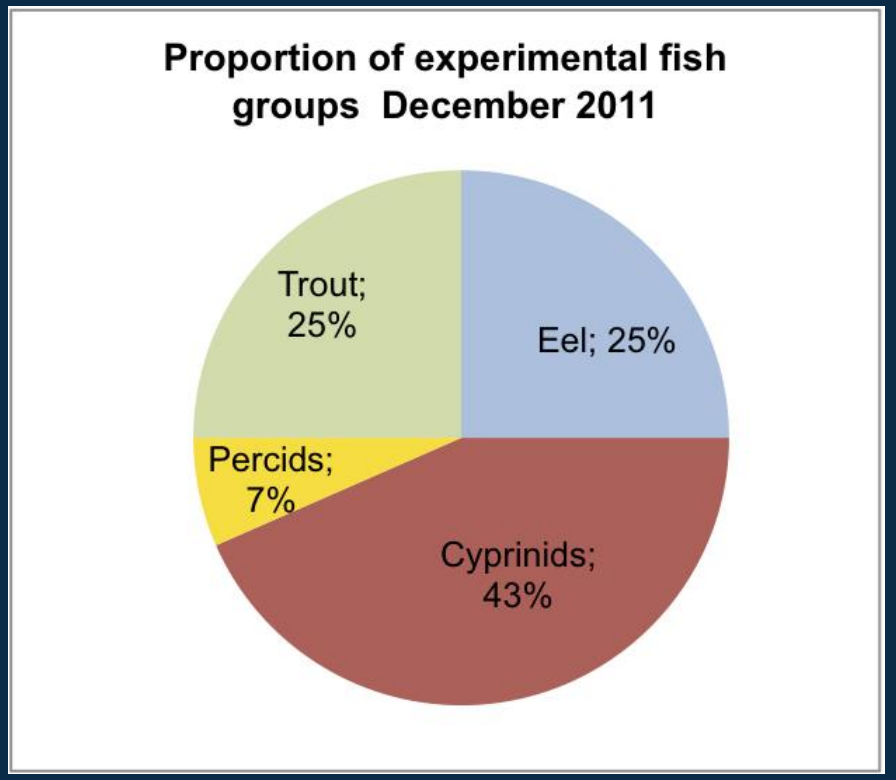


Typical injuries due to clutching the bars during rack cleaning operation ...

3rd trial: mortality and „fish-friendly turbine“

1.200 marked fish (and 102 dummies, size 16 cm) were released behind the trash-rack. Fish were *forced to pass the turbines* - no contact with bars of trash-rack

< Biodegradable dummies



3rd trial: mortality and „fish-friendly turbine“

Typical injuries ...

3rd trial: mortality and „fish-friendly turbine“

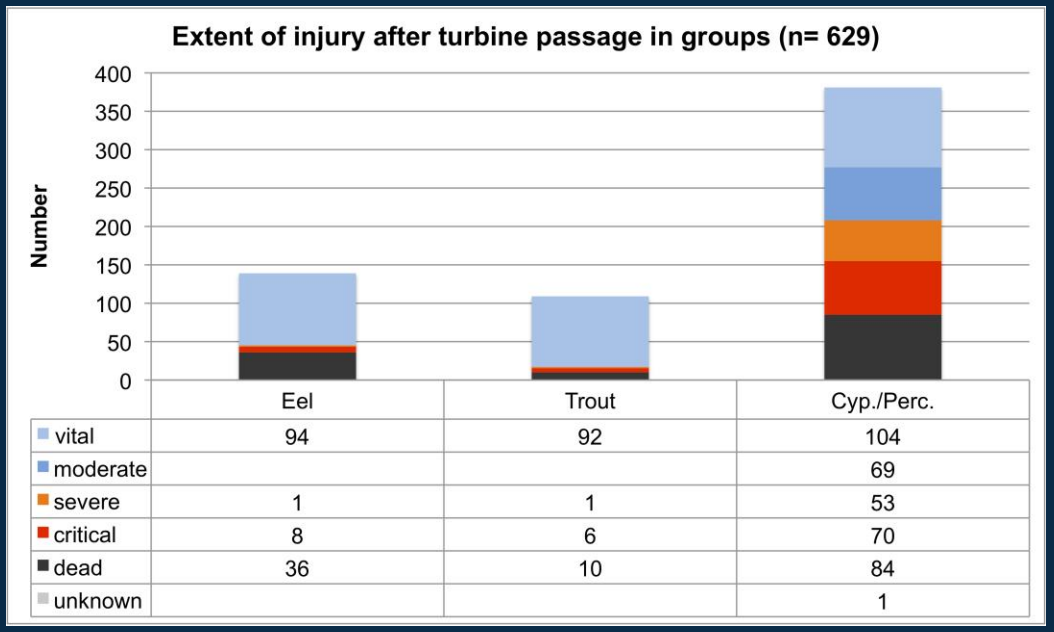
Results

30% of eels,

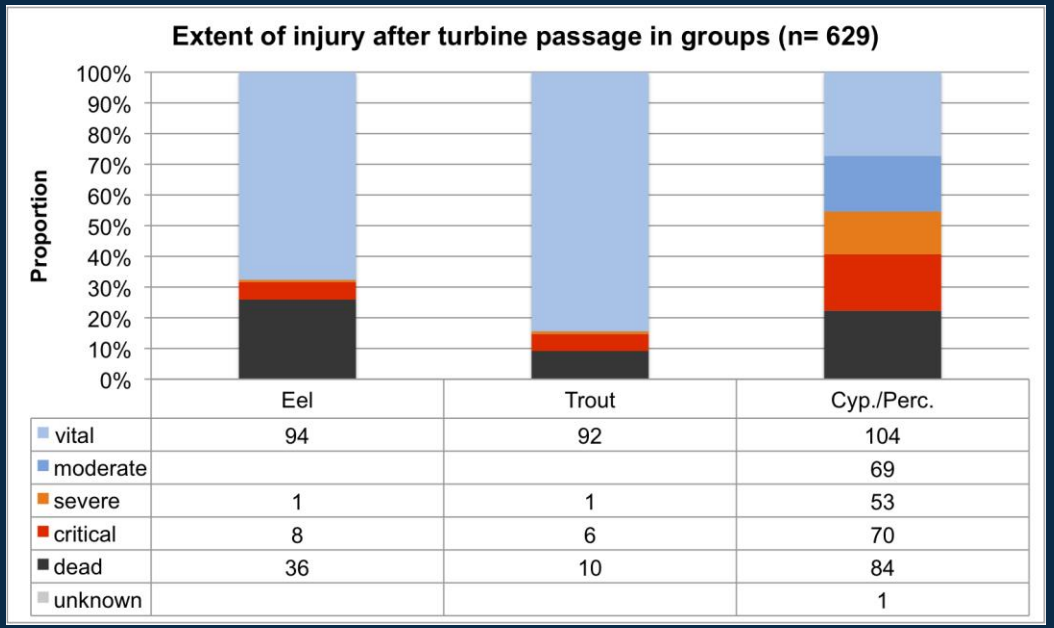
15% of trouts and

55% of cyprinids/percids

were killed instantly or estimated to be non-viable (= severe and critical injured)



	Eel	Trout	Cyp./Perc.
vital	94	92	104
moderate			69
severe	1	1	53
critical	8	6	70
dead	36	10	84
unknown			1



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vital	94	92	104
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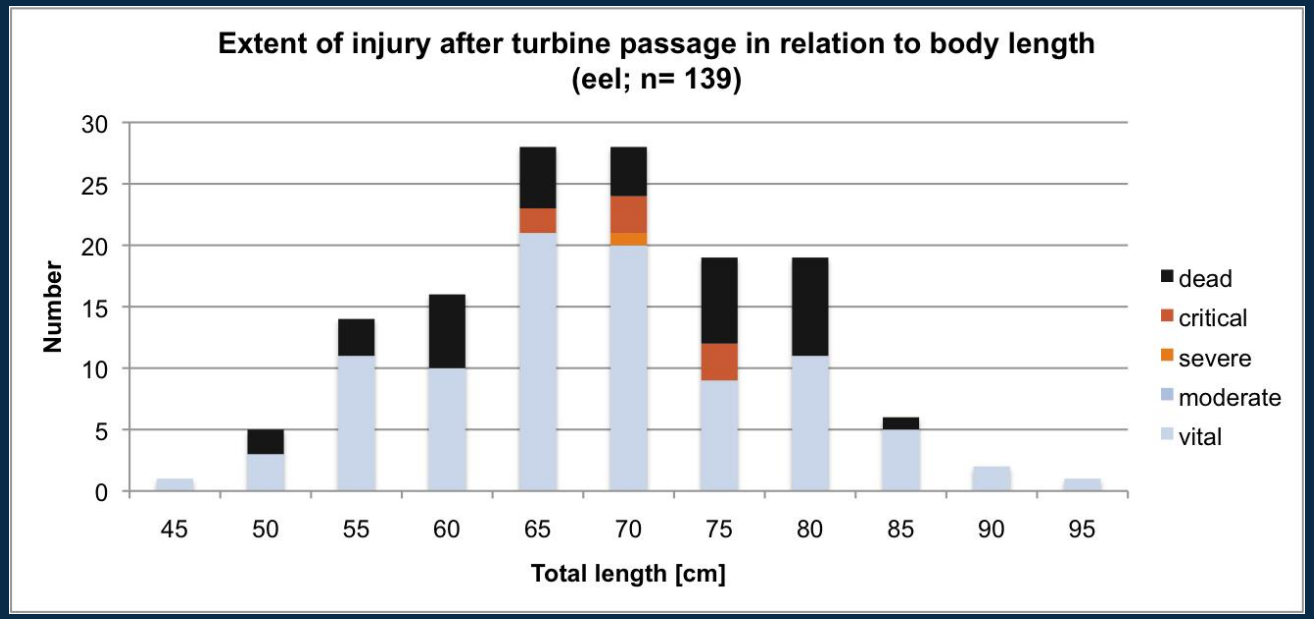
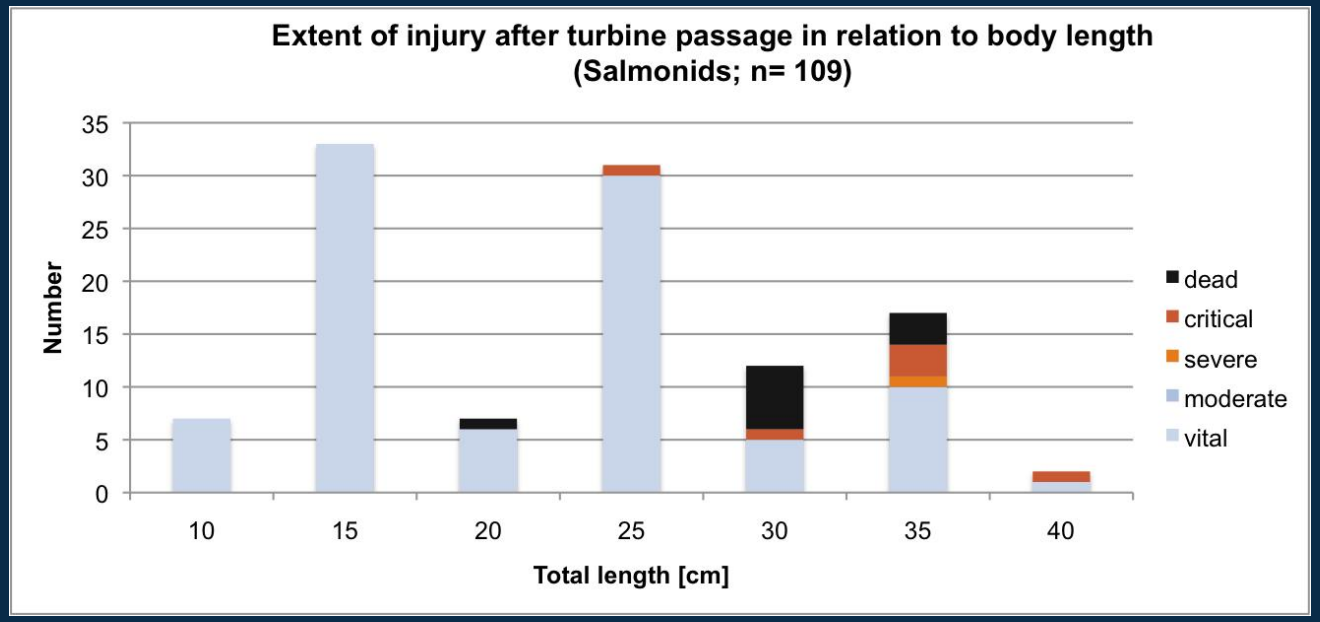
3rd trial: mortality and „fish-friendly turbine“

Results

Large eels and salmonids demonstrated higher mortality rates than smaller individuals.

This indicates that collision is a major factor.



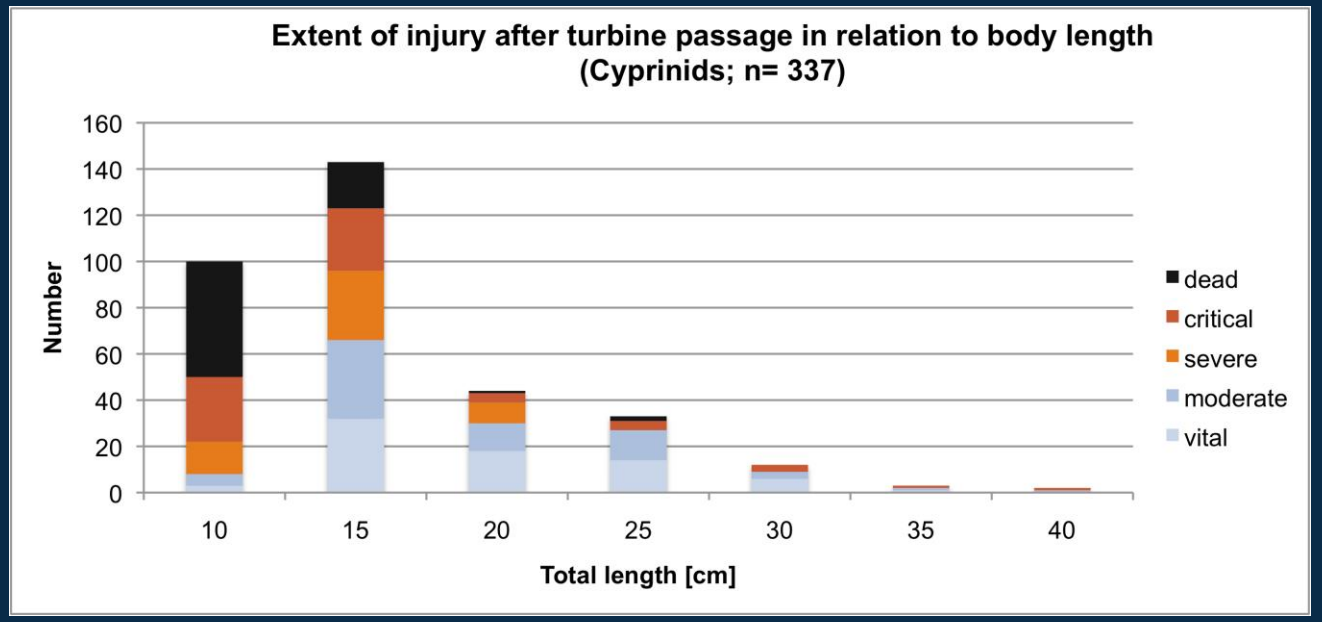


Results

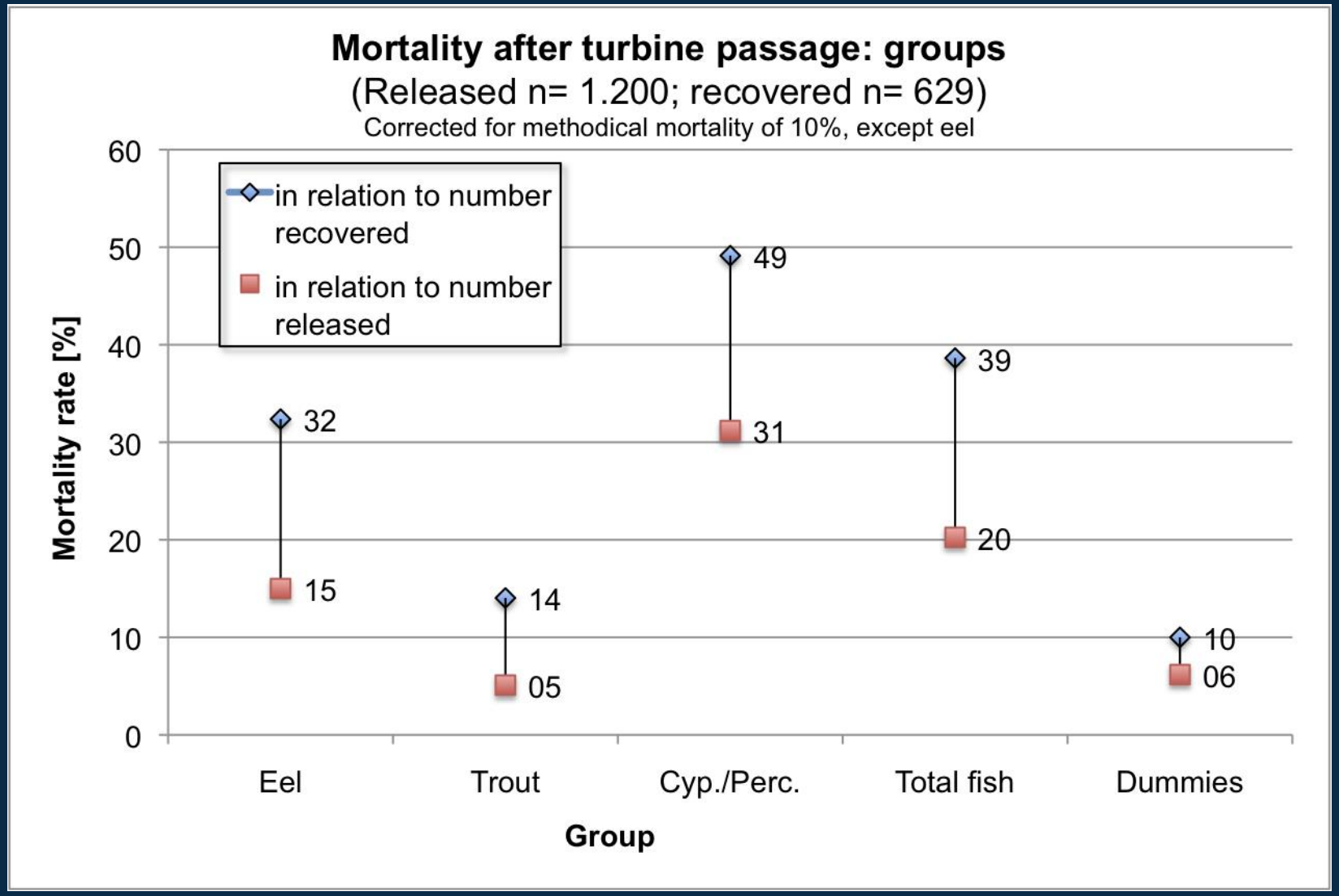
Small cyprinids and percids demonstrated higher mortality rates than medium size individuals (cavitation?). The few large perch were comparable with large salmonids (mortality rate 40-50%)

Dummy mortality: only 11%

3rd trial: mortality and „fish-friendly turbine“



3rd trial: mortality and fish-friendly turbine



Mortality varies according to reference figure

Conclusions:

• The effectiveness of the downstream migration facilities proved to be low, leading to high mortalities at the trash-rack and during turbine passage.

• The trash-rack with a bar spacing of 20 mm showed little repellent effect and was passed by most fish up to a size of 20-25 cm, causing scale loss and haematoma.

• Eels > 60-65 cm were unable to pass the trash-rack and the majority was killed by the trash-rack cleaning device.

• Large eels & salmonids as well as small cyprinids & percids experienced high mortalities at the turbine passage (near 50%); average mortality is 20-30 %.

• The turbine is not fish-friendly, and new bypass systems need to be developed.

• We need more research – field work and lab work.

Thanks for your attention –
and sorry for the ugly pictures!