Jun 21st, 3:10 PM - 3:30 PM

Evaluation of the effectiveness of upstream fish passage facilities in the Rhine River assessed by a PIT-tagging study

Armin Peter
Peter FishConsulting

Lukas Bammatter
Lucerne University of Applied Science and Arts, Engineering & Architecture

Rolf Mettler
Federal Office for the Environment FOEN

Nils Schölzel
Peter FishConsulting

Evaluation of the effectiveness of upstream fish passage facilities in the Rhine River assessed by a PIT-tagging study



Armin Peter[1], Lukas Bammatter[2], Rolf Mettler[3], Nils Schölzel[1]

[1]Peter FishConsulting, Hagmattstr. 7, 4600 Olten/Switzerland

www.fishconsulting.ch, e-mail: apeter@fishconsulting.ch

[2]Lucerne University of Applied Science and Arts, Engineering & Architecture, Horw

[3]Federal Office for the Environment FOEN, Bern/Switzerland

International Conference on Engineering and Ecohydrology for Fish Passage
Oregon State University, Corvallis OR – June 21, 2017

PETER
FISHCONSULTING

Hydropower and fish in Switzerland

- hydropower plays an important role in energy production in Switzerland (about 55-60 %)
- Swiss rivers are highly affected by fragmentation
- 35 % the hydropower plants are equipped with fish ladders (almost all of the big ones)
- increasing trend in constructing big nature-like fishways
- new important topic:
  downstream migration at hydropower p

PETER
FISHCONSULTING

Swiss water protection Law

(latest revision 2012)

- obligation to restore rivers

- restore connectivity for fishes till 2030

- Cantons have to plan and enact re-establishment of fish migration
- all hydropower plants have to be remediated until 2030
- operators are fully compensated (fund, financed by electricity consumers)
- the monitoring costs are also compensated

PETER
FISHCONSULTING

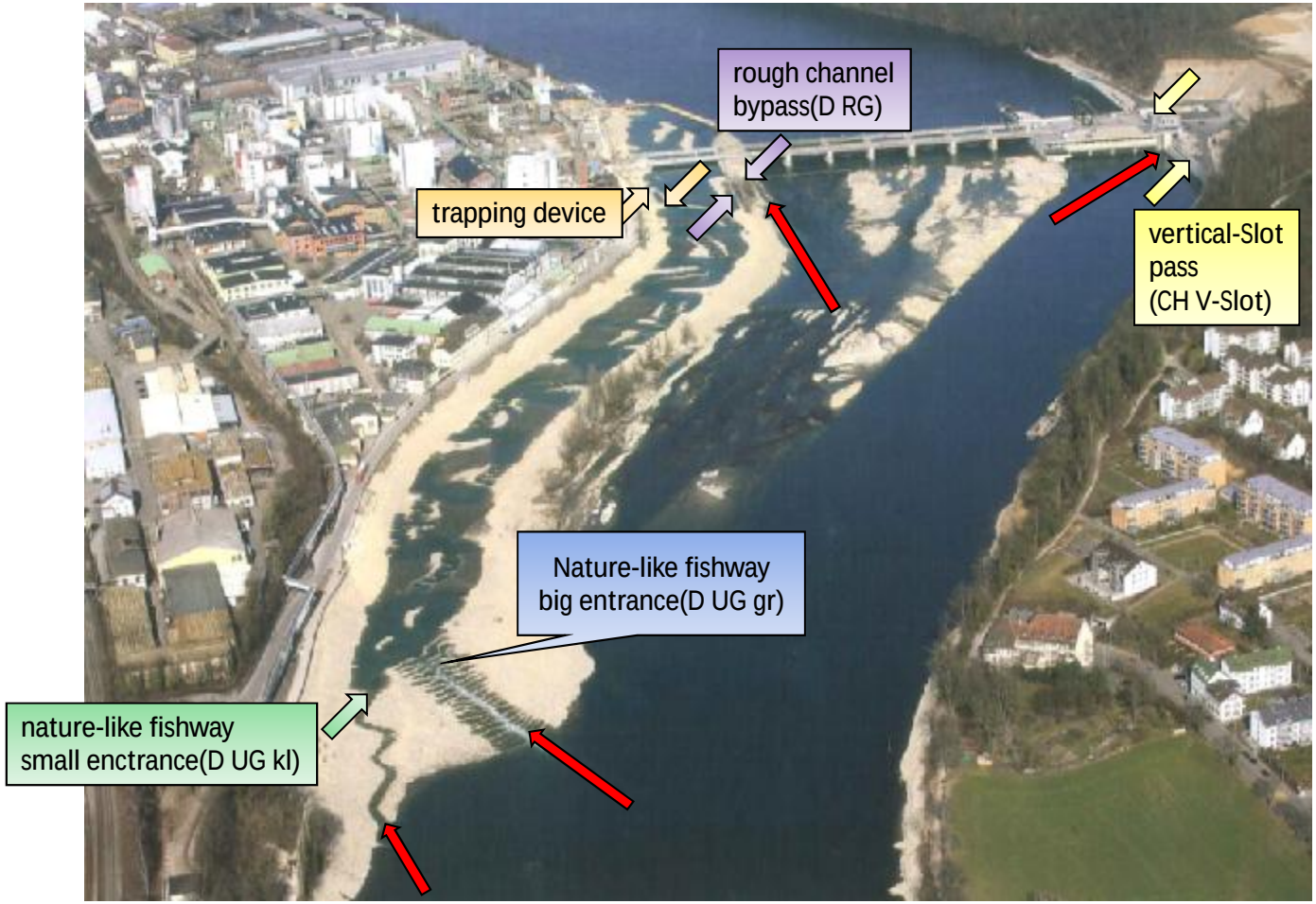
Hydropower plant Rheinfelden – aim of the preliminary study

- To gain experience in conducting a main PIT-tag study and tagging of different fish species
- **Evaluation** of the use of different entrance location of fish ladders
- of the passage efficiency
- Measuring of the time needed for the passage
- Checking for additional problems

April – December 2016

Hydropower plant Rheinfelden (discharge capacity: 1500m^3/s, installed capacity 100 MW

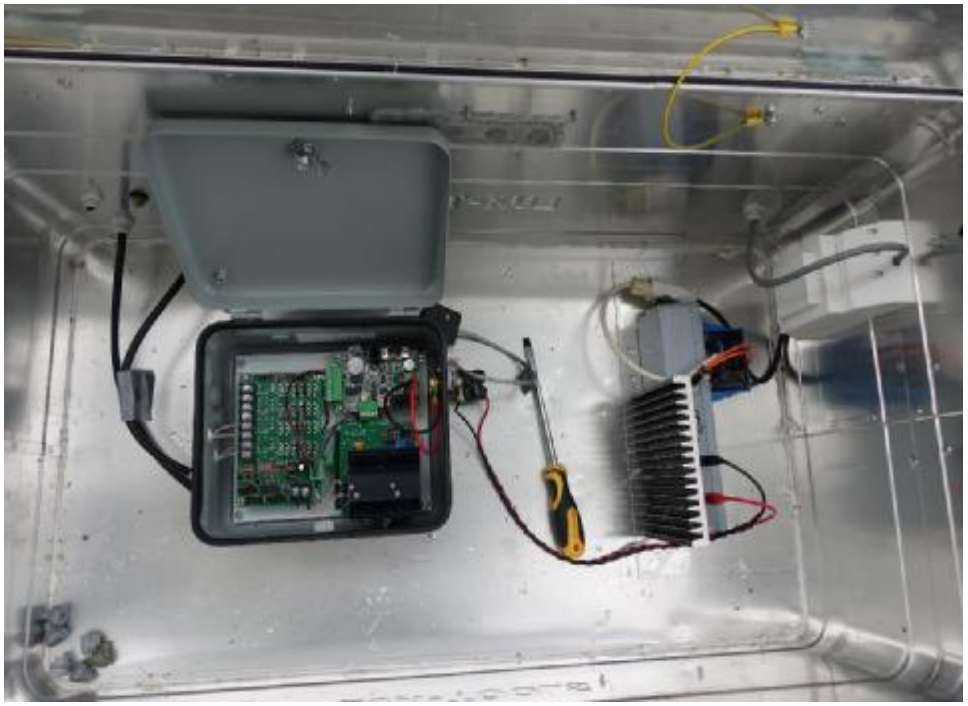
Overview: entrance locations and sites of antennas at hydropower plant Rheinfelden



PETER
FISHCONSULTING

PETER
FISHCONSULTING

PETER
FISHCONSULTING



Hydropower plant Augst
8.5 km downstream of Rheinfelden

PETER
FISHCONSULTING

PETER
FISHCONSULTING

Methods

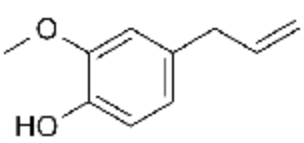
- Half-Duplex (HDX) Technology, 134.2 kHz
- 12 mm and 23 mm tags
- Single/Multi-antenna Reader
- Antenna: self-made constructions
  (different characteristics depending on the site)

Noise problems:
power line noise

PETER
FISHCONSULTING

Biological methods

Tagging



- fishes TL 90-160 mm tagged with 12 mm tags
- > 160 mm tagged with 23 mm tags
- Anesthesia: with clove oil, stage 4-5 (Summerfelt et al. 1990)
- Incision with scalpel, ventral into the body cavity

species	number	Site				
		Rhf D	Rhf CH	Augst	Rhf Ow	Wyhlen
eel	5	0	0	5	0	0
chub	332	231	6	12	82	1
trout	11	5	1	5	0	0
barbel	1019	356	262	401	0	0
bream	9	7	0	1	0	1
perch	101	98	0	3	0	0
Prussian carp	1	1	0	0	0	0
bullhead	1	1	0	0	0	0
gudgeon	10	10	0	0	0	0
dace	46	45	0	1	0	0
pike	1	0	1	0	0	0
carp	3	2	1	0	0	0
bleak	267	226	2	39	0	0
nase	26	23	1	2	0	0
rainbow trout	3	1	0	2	0	0
roach	140	60	0	79	1	0
tench	5	4	0	1	0	0
spirlin	58	53	5	0	0	0
catfish	4	4	0	0	0	0
total	**2042**	**1127**	**279**	**551**	**83**	**2**

PETER FISHCONSULTING

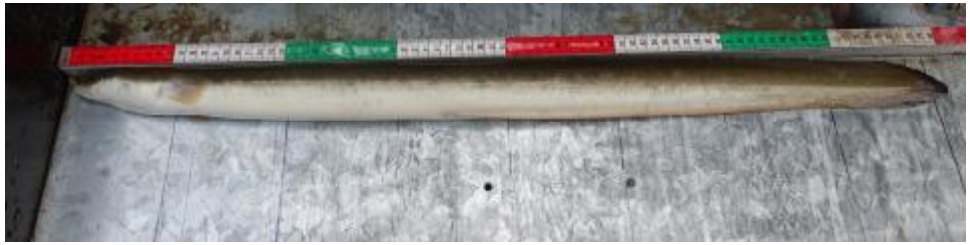
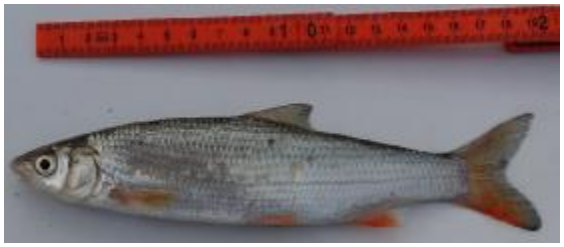
Tagged fish
total 2‘042
19 species

fishes were released 500 m downstream of the nature-like fishway

PETER FISHCONSULTING

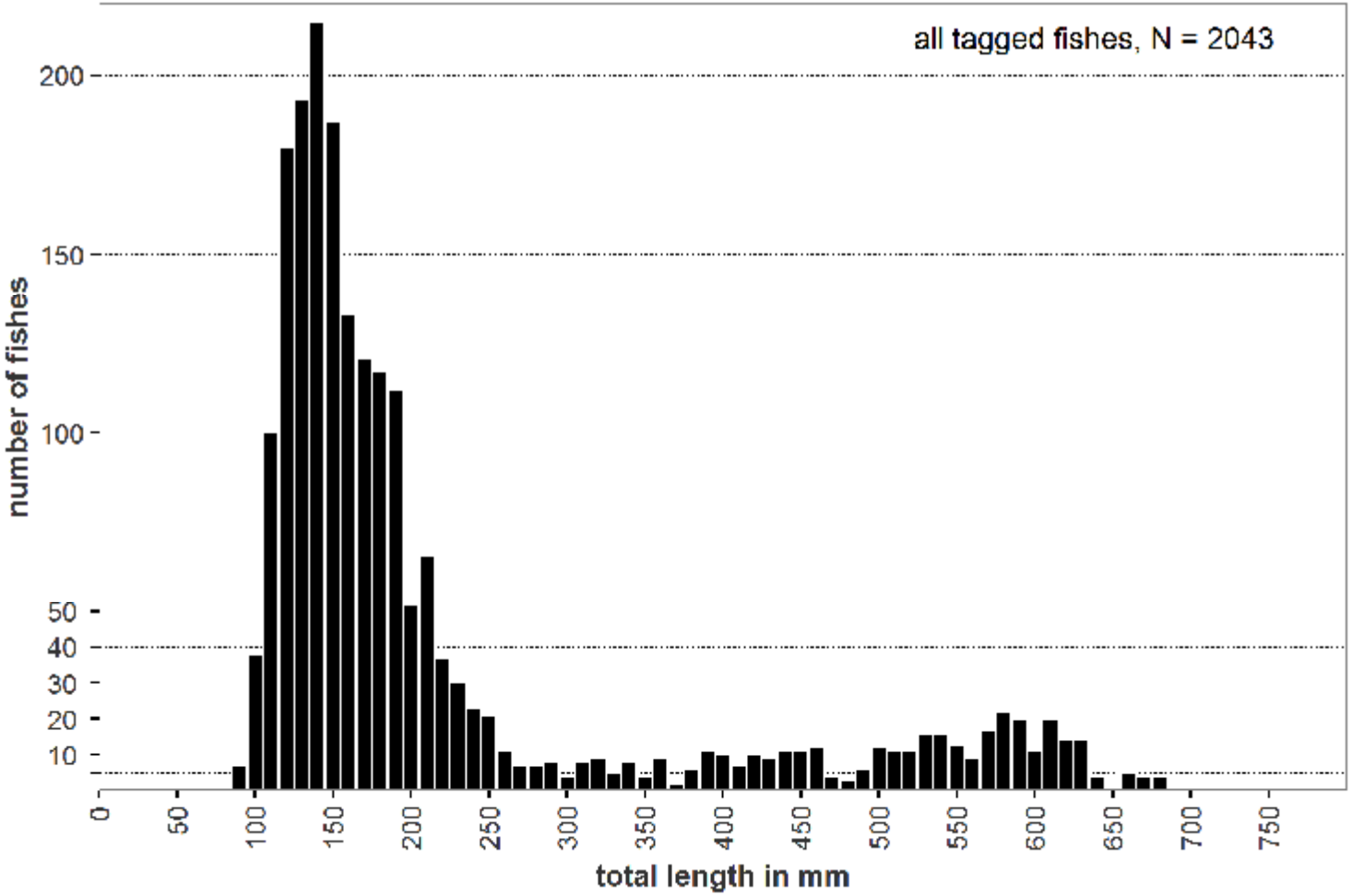
Tagging effort

- Very high
- Collecting the fish – transportation – tagging – releasing
- Problems with the lack of target species for the main study: eel, bream, trout, nase, spirlin (compulsary species)

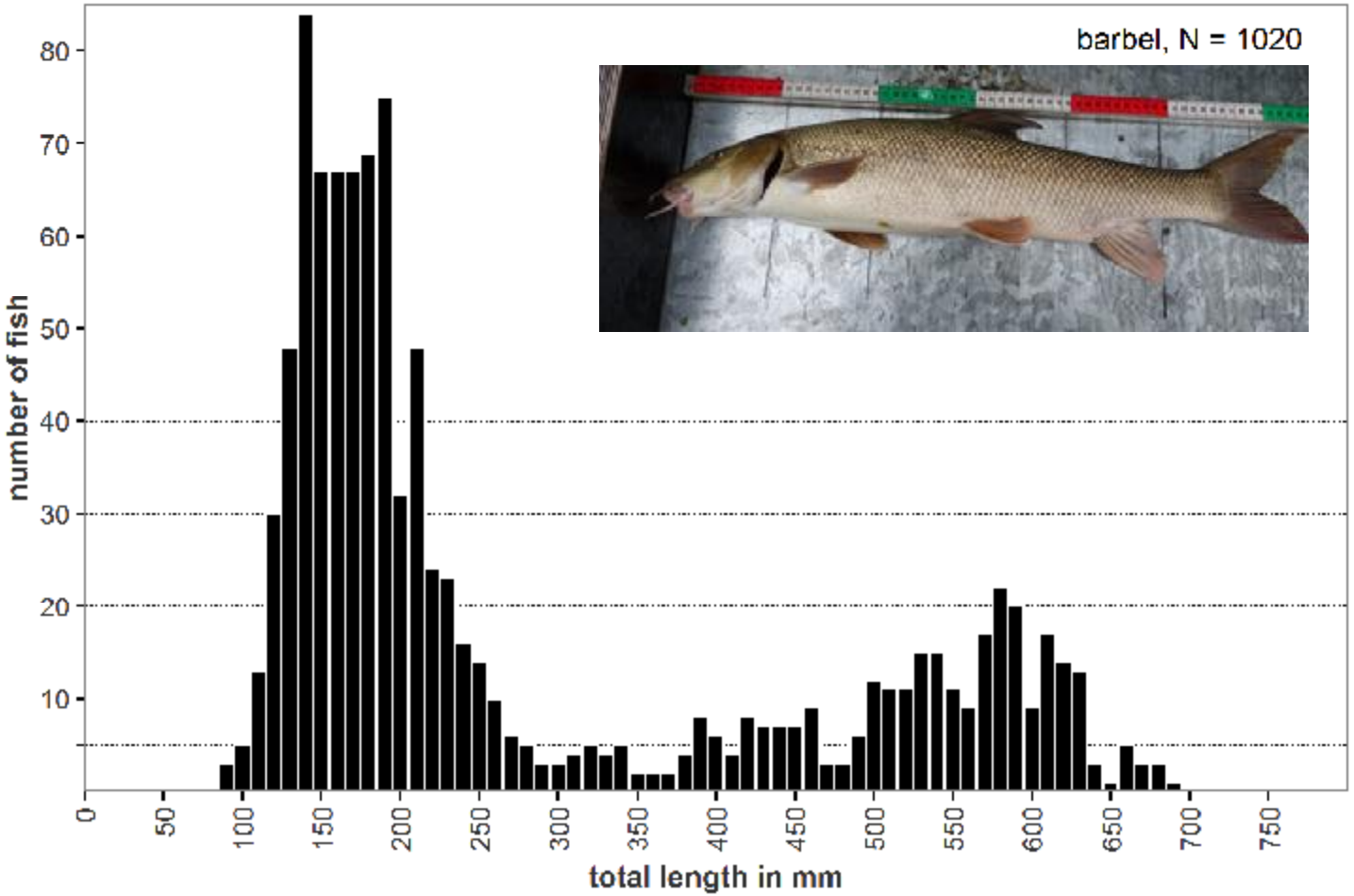




PETER
FISHCONSULTING

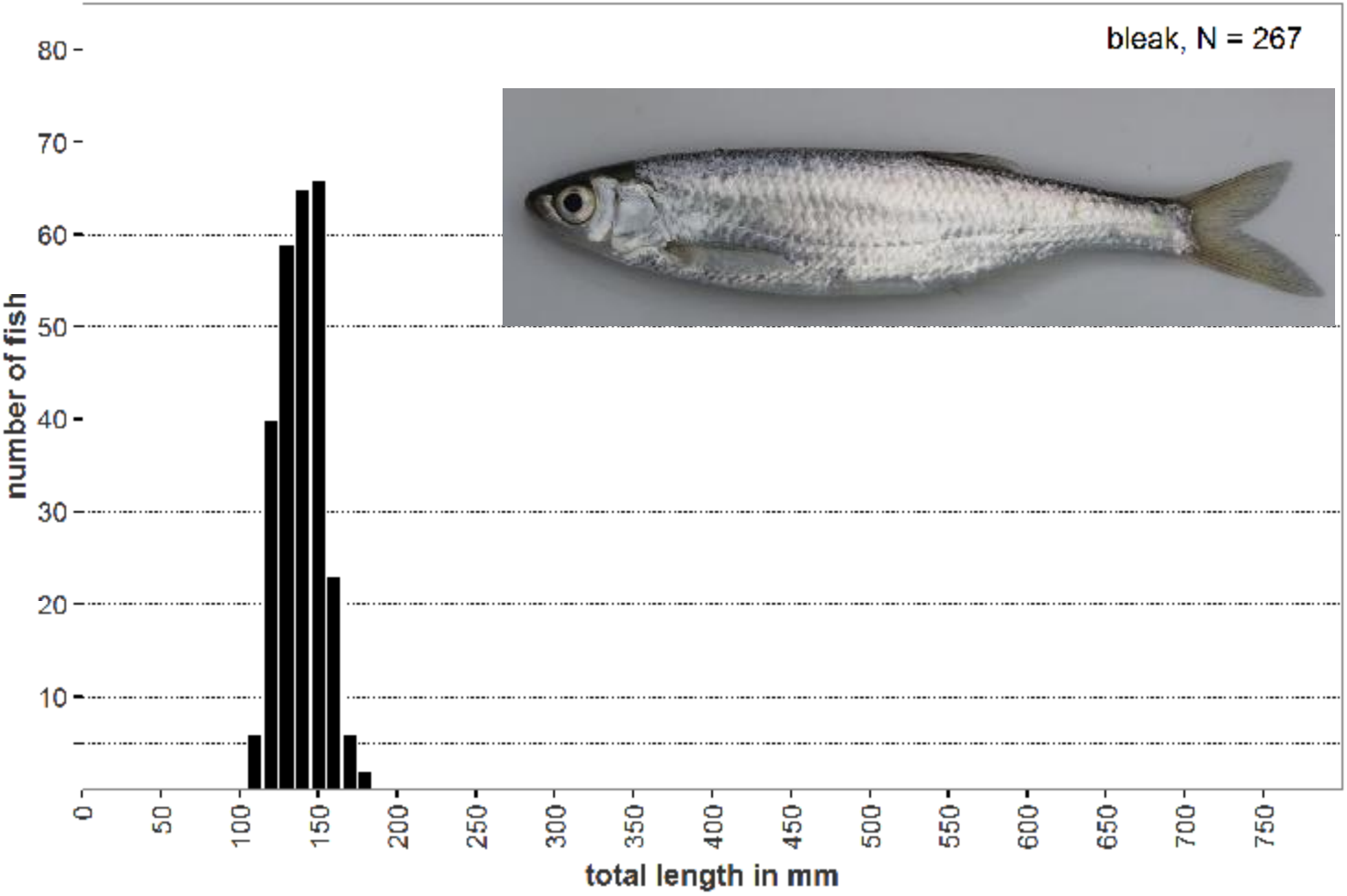
PETER
FISHCONSULTING



PETER
FISHCONSULTING

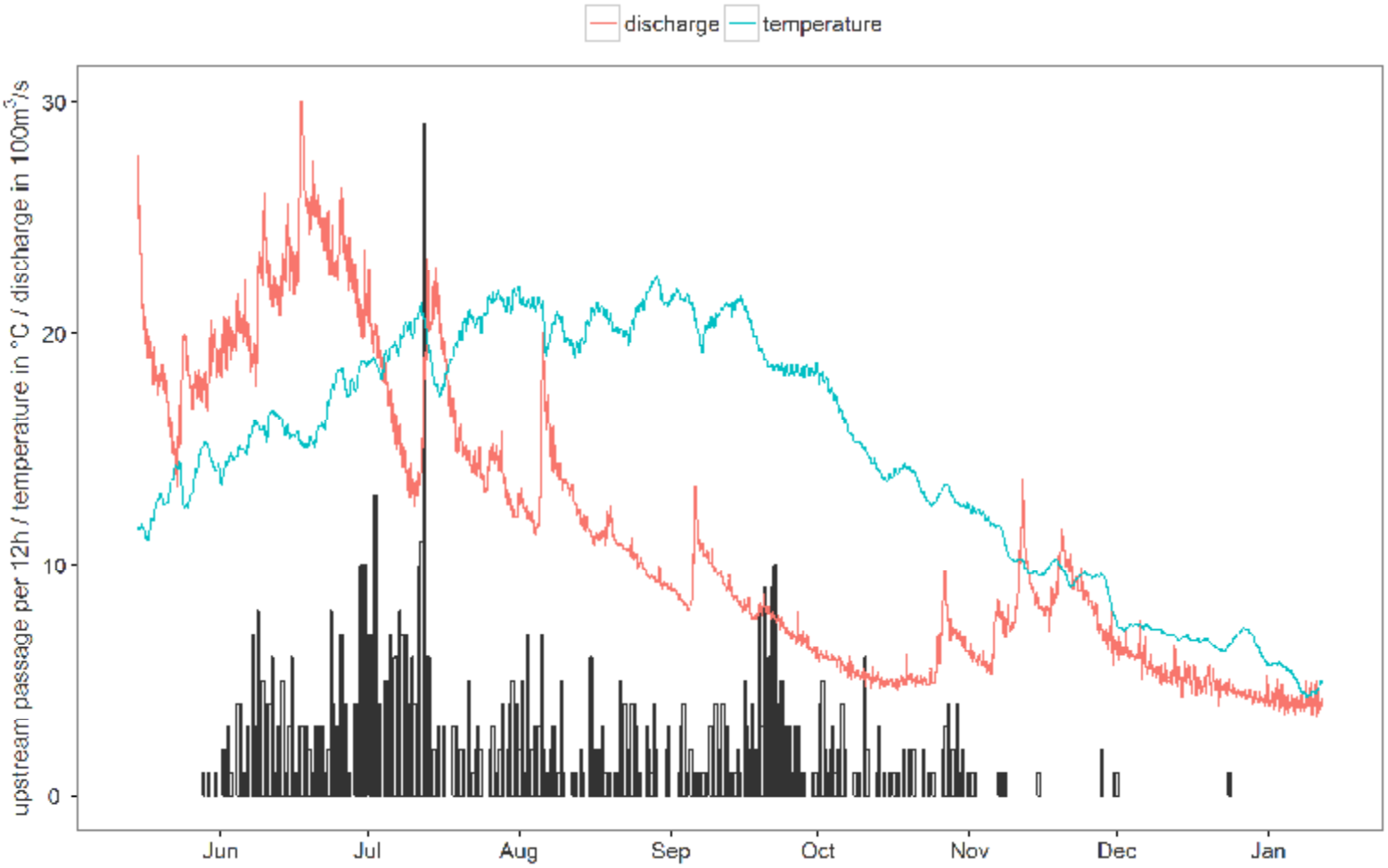


PETER
FISHCONSULTING



Ascent of fishes – overview

PETER FISHCONSULTING

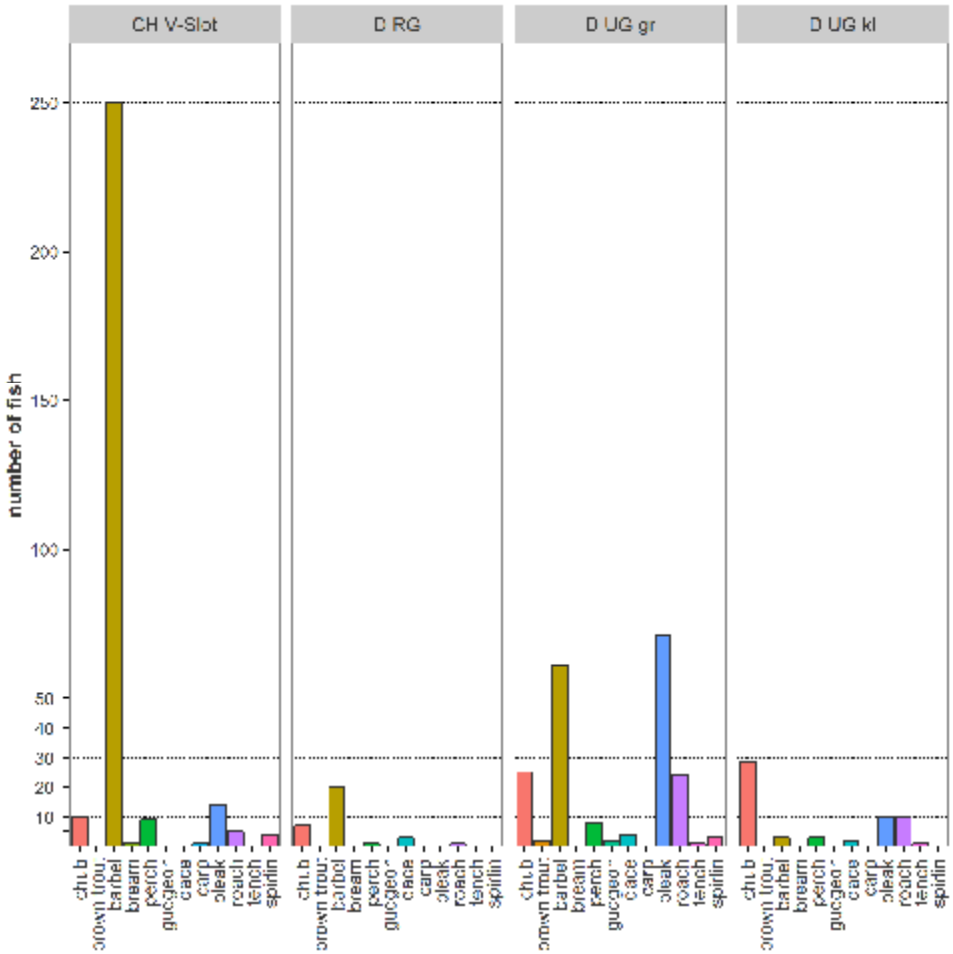


Detected and sucessful upstream migration

species	N tagged	N detected	detection in %	N sucessfull passage	successful passage in %
chub	332	124	37.3	71	21.4
barbel	1019	371	36.5	333	32.7
perch	101	29	28.4	21	20.8
dace	46	11	23.9	9	19.6
bleak	267	106	39.7	95	35.6
roach	140	47	33.6	40	28.5
spirlin	58	10	17.2	7	12.1
all species	2042	641	31.4	584	25.8

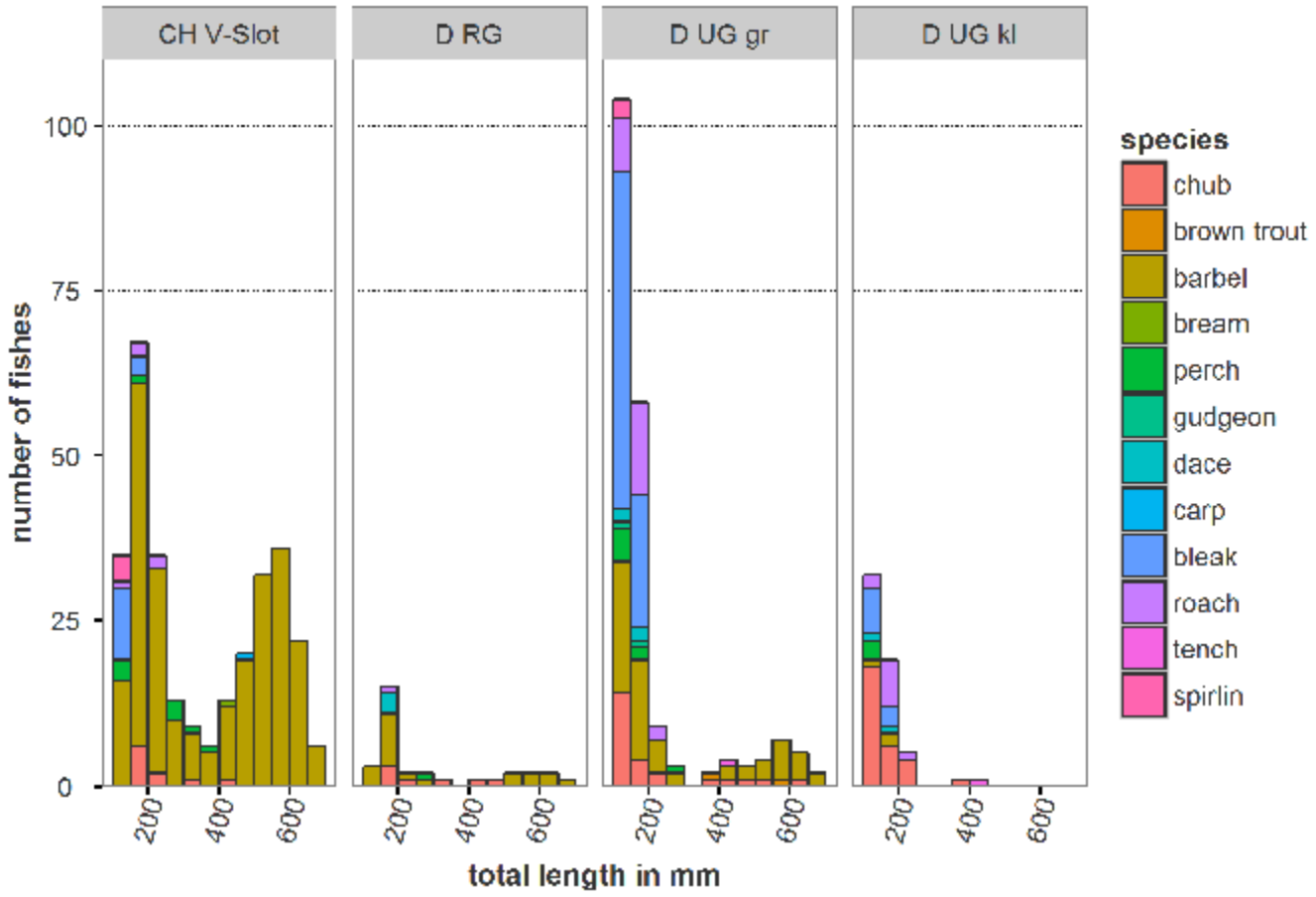
Which enctrance location do the fish use ?

PETER FISHCONSULTING



Length frequency histogram

PETER
FISHCONSULTING



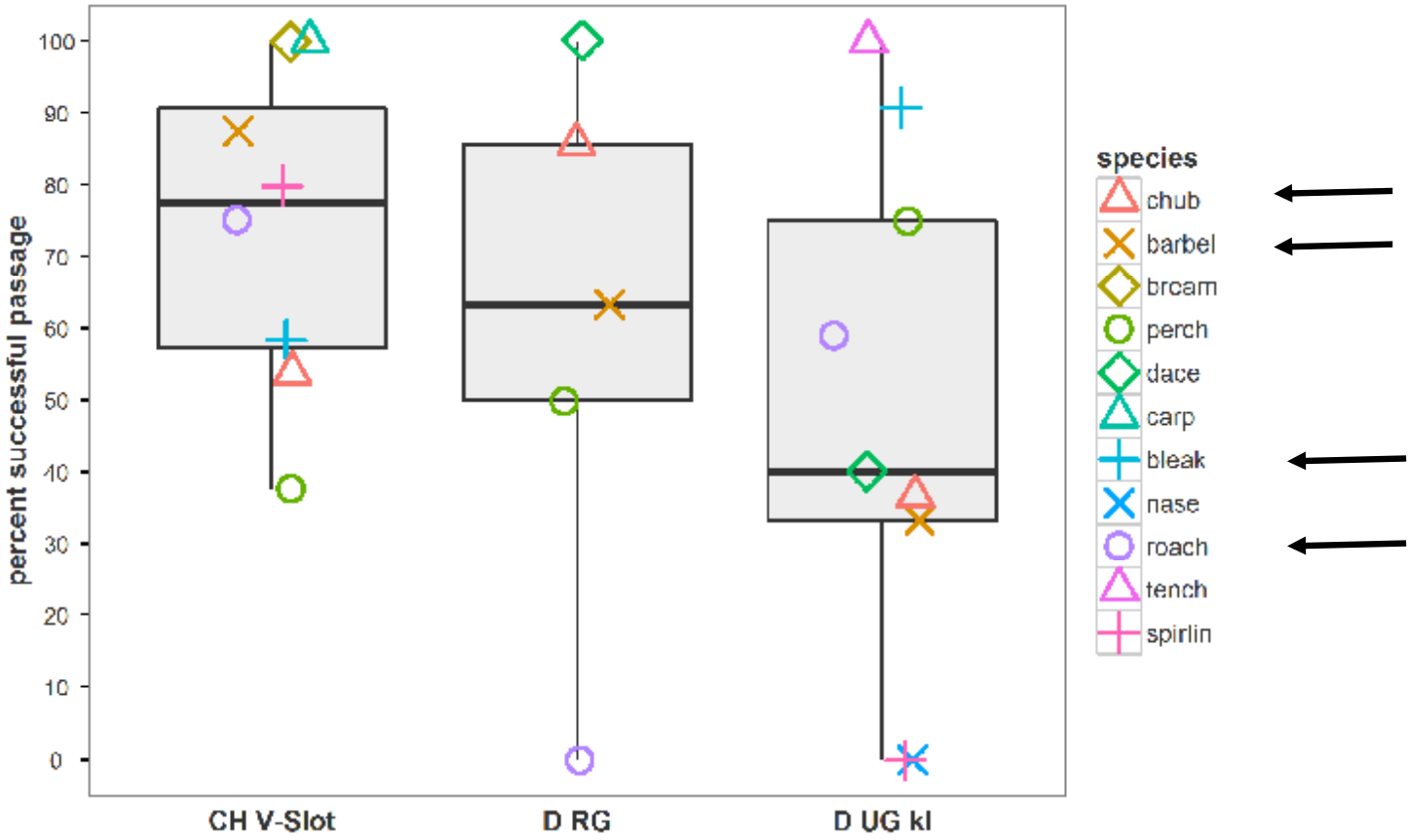
Time of ascent in minutes / days

PETER FISHCONSULTING

species	length	fish ladder	mean	minimum	median	maximum	N
chub	>160mm	CH V-Slot	276	69	145	753	13
barbel	>160mm	CH V-Slot	135	18	53	1.8	241
bleak	≤160mm	CH V-Slot	599	46	521	1.7	17
chub	>160mm	D RG	450	35	128	2.0	9
barbel	>160mm	D RG	3791	15	26	88	35
chub	>160mm	D UG kl	34476	0.9	6.1	114	9
bleak	≤160mm	D UG kl	937	172	446.5	2.6	10

Passage efficiency of different species at three different entrances

PETER FISHCONSULTING



PETER
FISHCONSULTING

Return of fishes – function of the trapping device

Vertical-Slot pass CH

- 41.2 % of the ascended barbel migrate downstream probability of capture p = 58.8 %
- p all species = 64 %

Nature-like fishway D

- p all species = 15 %
- chub = 18.4 %
- barbel = 5.2 %

PETER
FISHCONSULTING

Injuries of fishes

0 no injuries

1 light injuries: body areas with missing scales, light injuries of fins etc., little abrasions

2 clear injuries: clear loss of scales, clear injuries of fins, clear abrasions

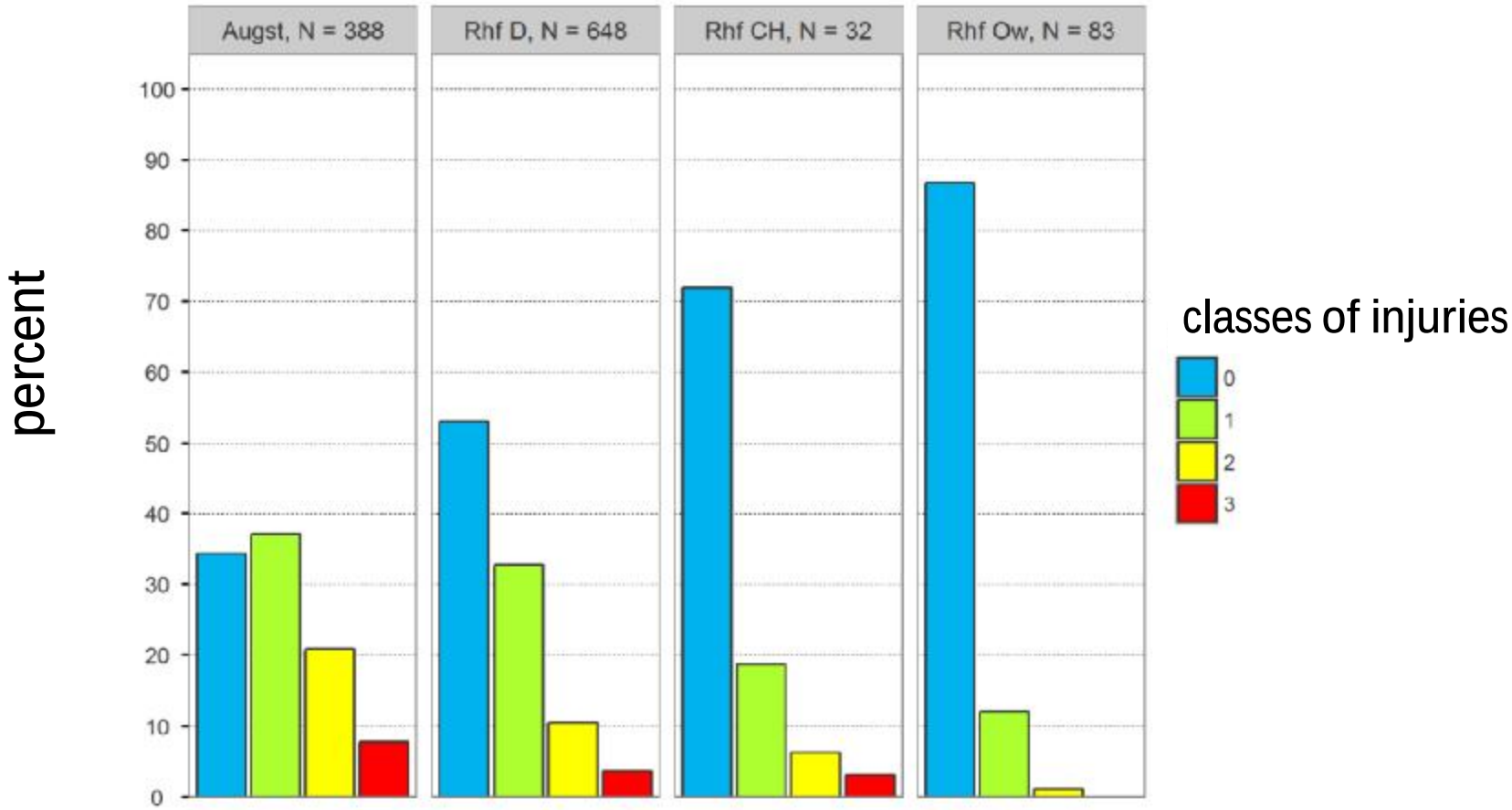
3 severe injuries: marked abrasions, sign of strong pressure on fish body, massive injuries of fins, open wounds, hematoma



PETER
FISHCONSULTING

PETER
FISHCONSULTING

Injuries of fishes



PETER
FISHCONSULTING

Conclusion and recommendation1of 3

Operation of the equipment

- additional antennas should be installed

  use marker tags
- data management

  time-consuming - statistical methods and biological interpretation

Fish tagging

- without problems – however big tagging effort

  many interesting species were underrepresented
- should be adapted to the migration peaks
- adapt the target species to the existing species pool
- **reduce transportation of fishes**

Conclusion and recommendation 2 of 3

Time needed for ascending: short, especially for barbels
but longer in the nature-like fishway: barbel and roach

Passage efficiency

- very good for the vertical-slot pass
  (barbel, roach and spirlin) and
  good for the rough channel bypass (dace and chub)
- nature-like bypass: very good for bleak and good for perch

PETER
FISHCONSULTING

Conclusion and recommendation 3 of 3

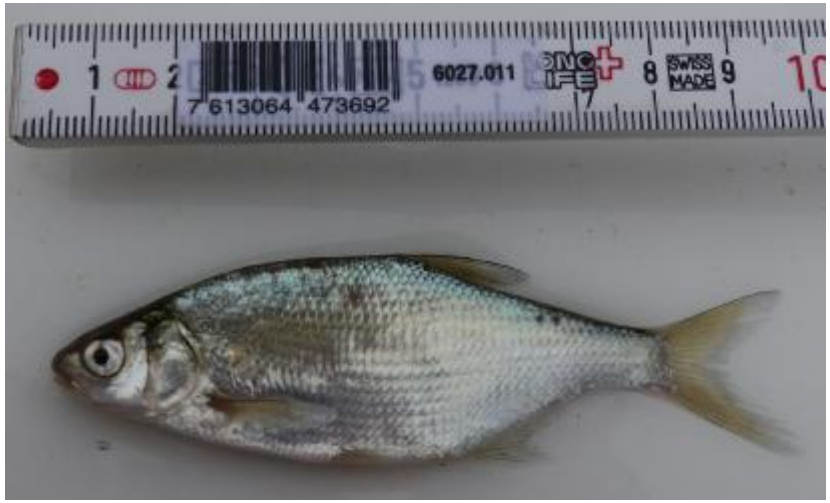
Trapping device has to be improved

- fishes should not be able to escape from the trapping device
  (use proper equipment at the entrance)

- use it only for a short time
  (disruption of the ascent)

Reduce the injuries of fishes

- trapping devices are a problem:
  only 35 % of fishes had no injuries (hydropower plant Augst)
  installed trapping device: possibilities for improvement



Thank you

barbel 571 mm, tagged on 28.6.2016 in Augst ID 0164993600