

# Experience with eel protection at hydropower stations

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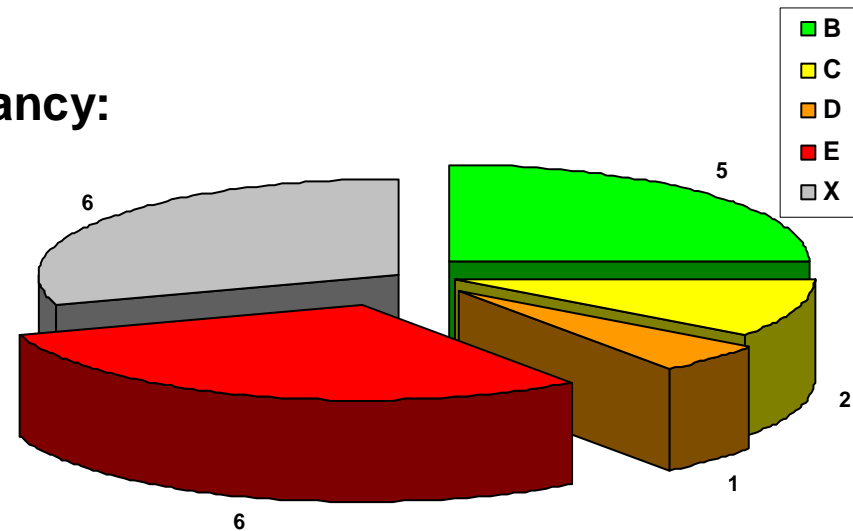


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# Hydropower in Germany

- 5600 HPS (in operation)
- 200 HPS producing 76 %, these big HPS are located in the main eel migration corridors
- 20 HPS with fish protection and/or downstream fishways

efficacy:



- number of water intakes and pumps in the estuary regions is unknown

# Damages caused by turbines



Kaplan turbine



Francis turbine



Pelton- or  
Cross-flow turbine

Rate of mortality:



~ 20 - 50 %

~ 100 %

# Trash racks



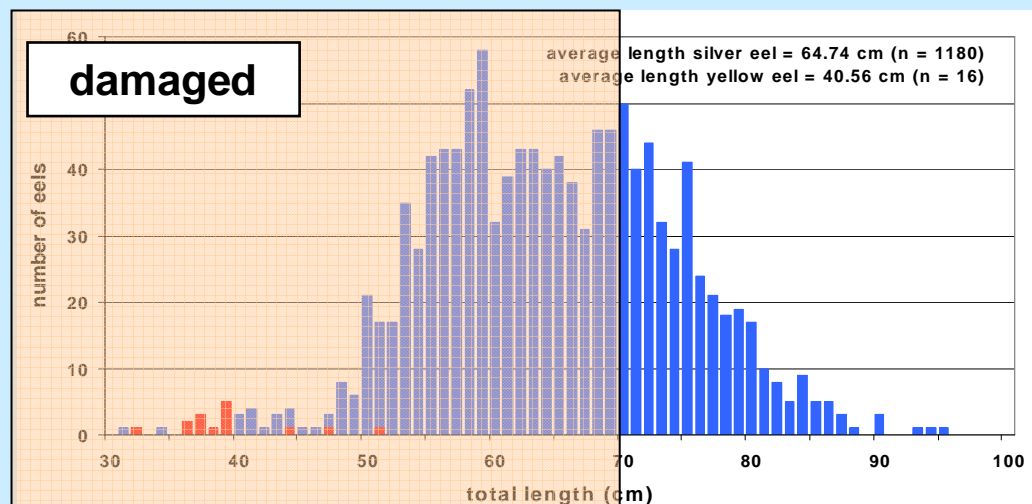
20 mm space passable  
for specimen < 70 cm

Efficacy:



eel<sub>female</sub> > 50 cm: < 15 mm space

eel<sub>male</sub> > 30 cm: < 9 mm space



## Behavioural pattern in front 20 mm trash rack



escapement just possible if  
approach velocity  $v_A \ll 0.5 \text{ m/s}$

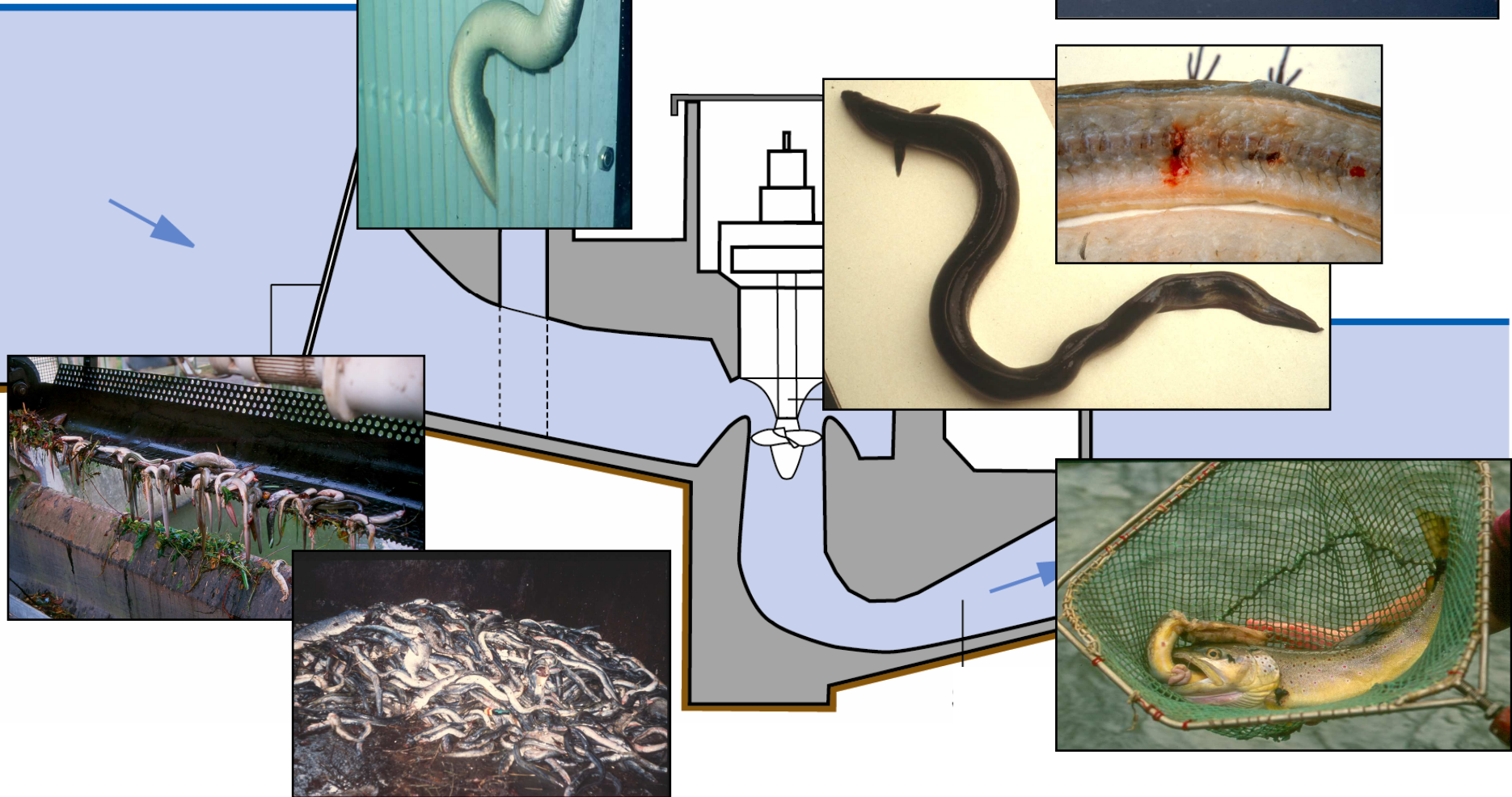
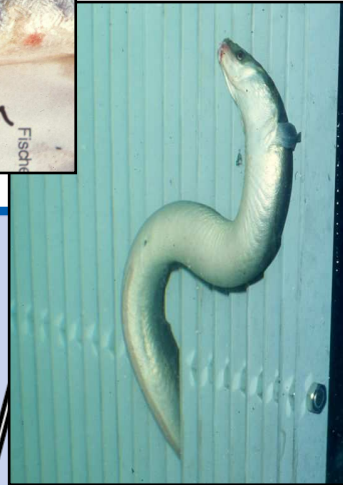
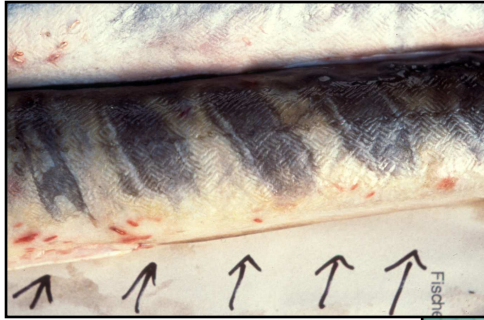


# Behavioural barriers



just effective if  
approach velocity  $v_A \ll 0.3 \text{ m/s}$

# Dangerous areas





# Prerequisites for eel protection

- 1. protection** block or hinder the entrance into dangerous areas



- 2. bypass** open alternativ migration corridors into tailwater

**traceability** without delay

**passability** safe for all sizes

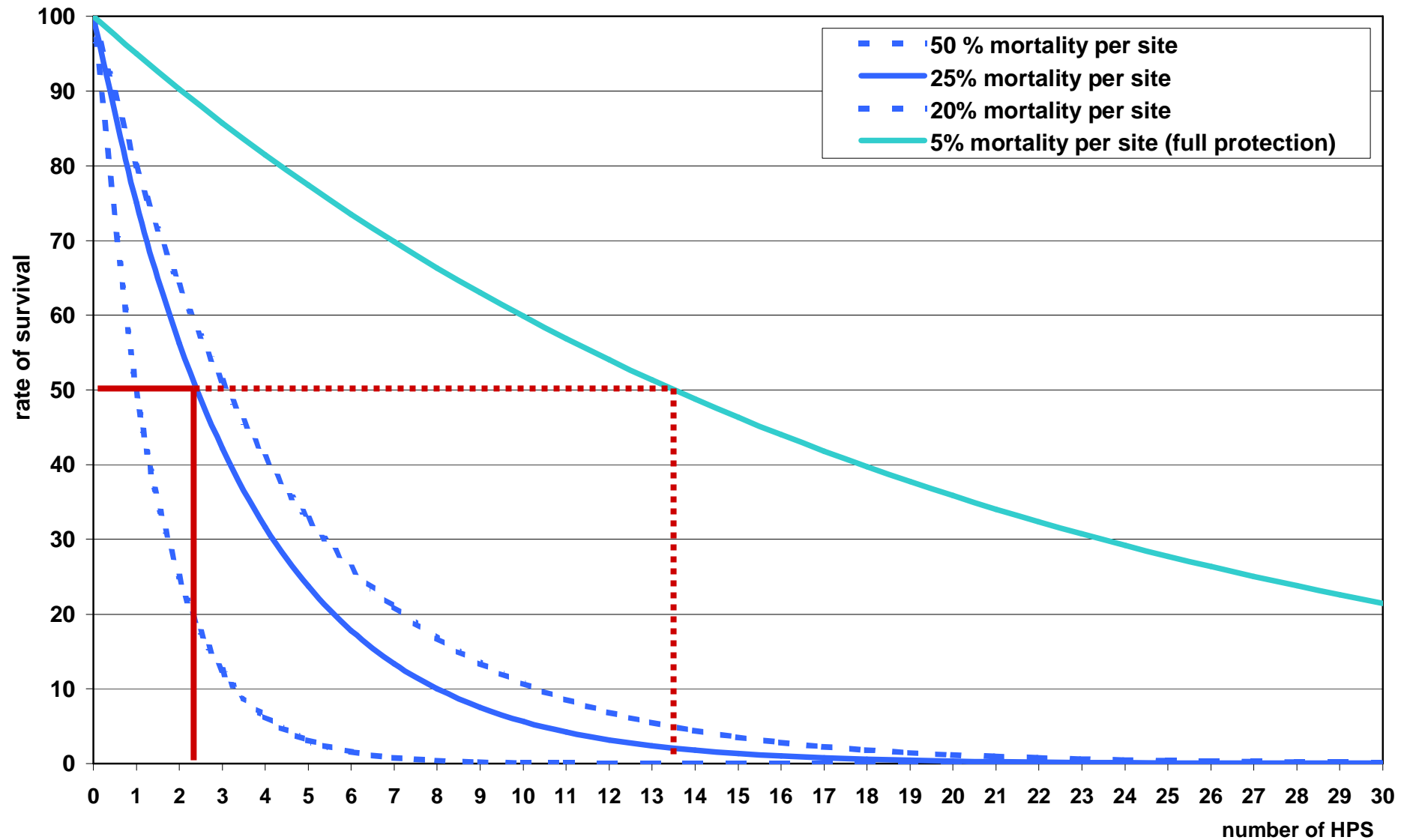




# Available technologies


<i>mechanical barriers &amp; collecting facilities</i>	
<b>conventional screens</b> <b>high costs for installation, cleaning and maintenance</b> wedge-wire screens and other stationary screens with less space	skimming walls
	louver systems
	chain barriers
<b>travelling screens</b> <b>HPS &lt; 20 m<sup>3</sup>/s</b> with and without troughs	gravel bed and cage filters
	fishpumps
<i>behavioural barriers</i>	
light	electric barriers
sound	bubble curtains
combined barriers	water jet curtains
<i>bypasses</i>	
<b>behavioural pattern</b> bottom and surface bypasses	surface bypass
fishpasses (upstream)	shiplocks
<i>alternative strategies</i>	
<b>costintensive</b> the old technology	fish-friendly turbines
<b>efficacy ~ 80 %</b> existing systems	

# Cumulative mortality



# Bilance of the impacts on silvereel in the river Meuse (Netherlands)

discharge MQ: 200 m<sup>3</sup>/s



<b>total flux of silver eel per year:</b>	<b>150 000 - 250 000</b>
<b>mortality by 2 HPS:</b>	<b>25 % per each</b>
<b>losses by professional fisheries:</b>	<b>~ 50 %</b>
<b>max. number of eels reaching the North Sea:</b>	<b>~ 30 %</b>



# Proportion of hydropower in Europe

Country	total of generated electric energy [GWh/a]	portion of hydropower [GWh/a]	proportion of hydropower [%]
Norway	112 100	111 700	99.6
Austria	48 200	34 000	70.5
Sweden	140 900	73 300	52.0
Switzerland	51 600	31 500	61.0
France	494 000	69 200	14.6
Germany	426 200	21 200	5.0
Netherlands	83 800	110	0.1

from: ASE, 1997