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Draft EC Guidance Document on Hydropower Development & Nature 2000 -  
Consultation Meeting 8 July 2015, Brussels

# MEASURES TO MITIGATE IMPACTS OF HYDROPOWER USE ON AQUATIC ENVIRONMENT

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# HYDROPOWER PLANT TYPE SPECIFIC IMPACTS

Hydropower use is causing plant type specific hydrological and morphological alterations leading to ecological impacts potentially jeopardising achievement of EU environmental objectives

- Nature 2000 (FFH & Birds Directive)
- Water Framework Directive (WFD) objective
  - good ecological status/ potential
  - no deterioration

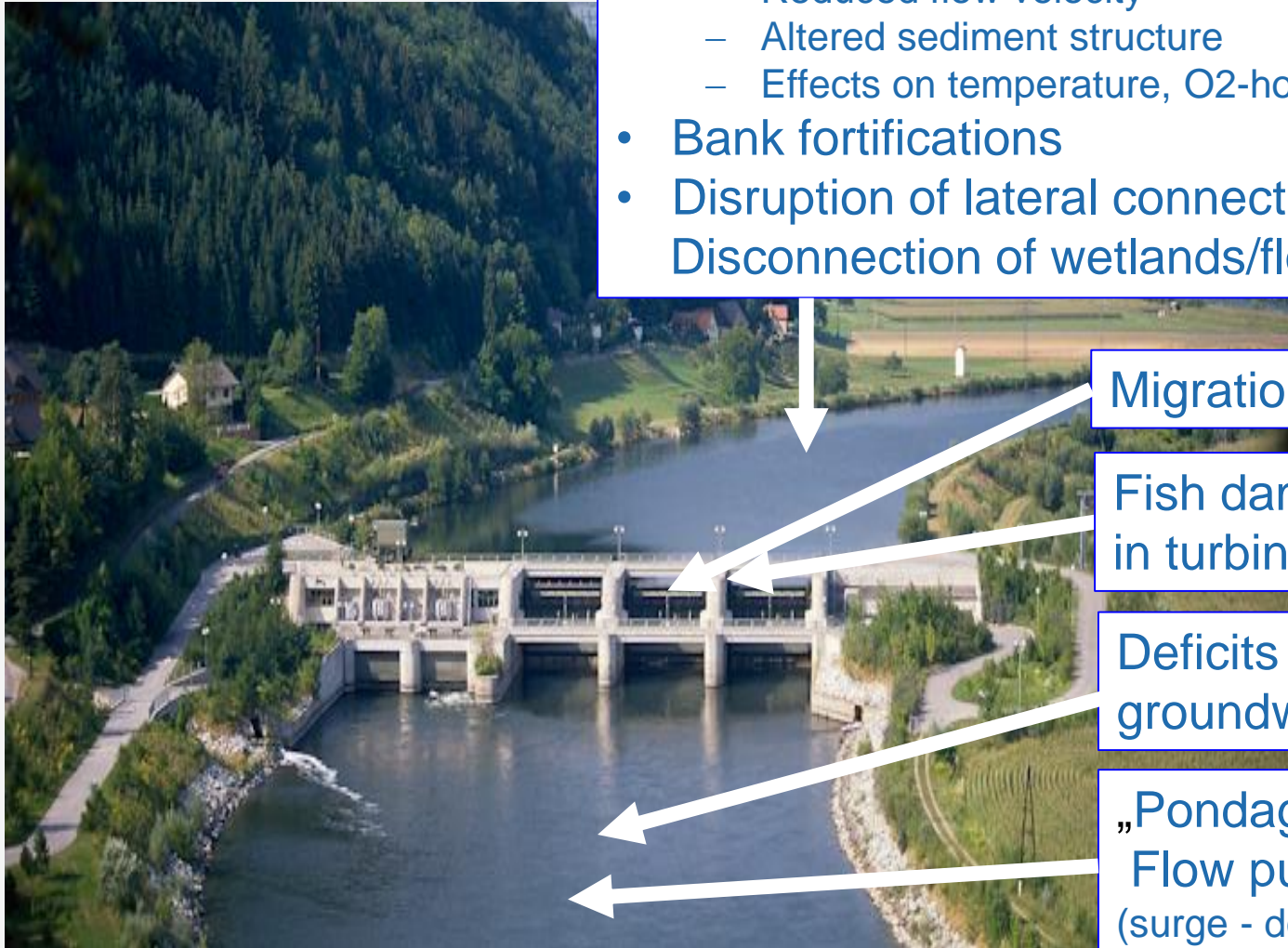
Need of restoration/ mitigation measures



# MAIN HYMO IMPACTS

## HP type „In-stream plant“

- Ponding effect - change of river character
  - Reduced flow velocity
  - Altered sediment structure
  - Effects on temperature, O<sub>2</sub>-household
- Bank fortifications
- Disruption of lateral connectivity,  
Disconnection of wetlands/floodplains



Migration barrier

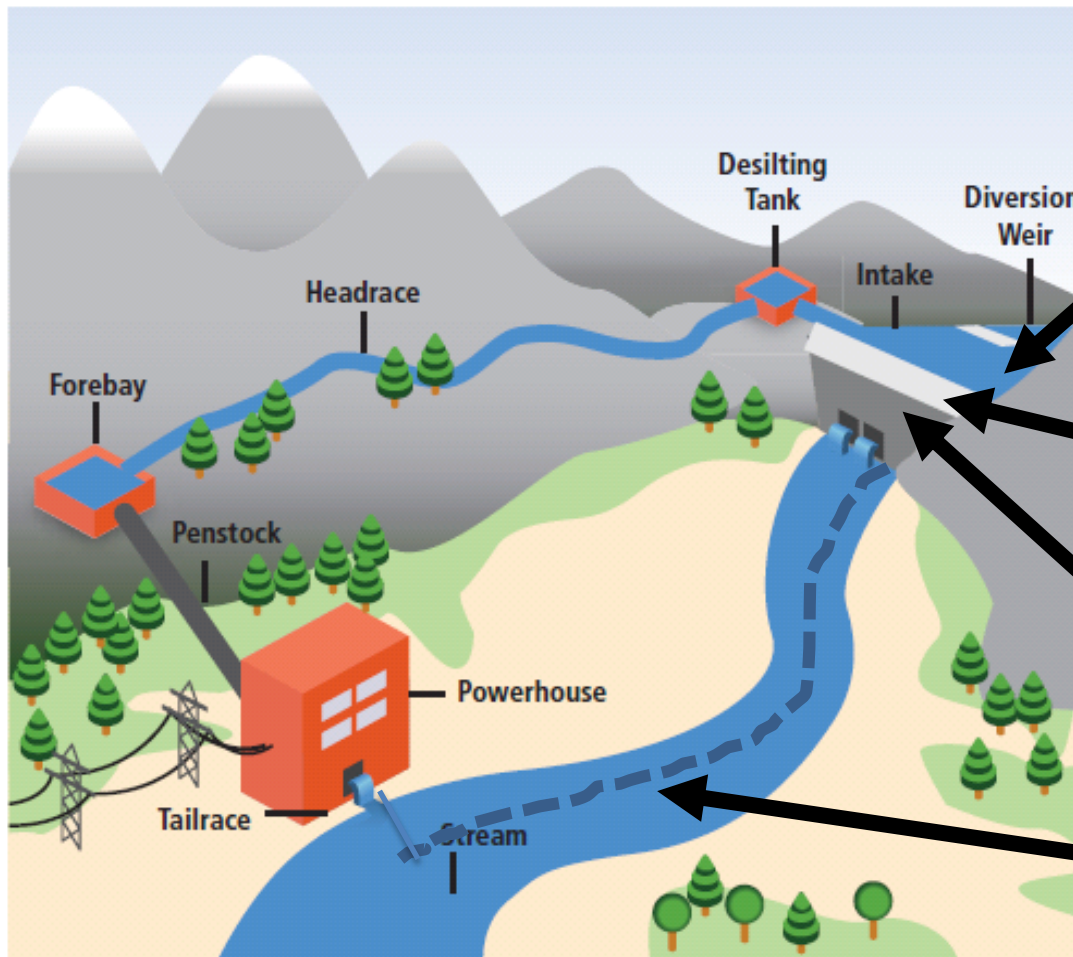
Fish damage  
in turbines and screens

Deficits in sediment and  
groundwater connectivity

„Pondage operation“:  
Flow pulses  
(surge - downsurge effects)

# MAIN HYMO IMPACTS

## HP Type „diversion plant“



Ponding effect ...

- Change of river character
  - Reduced flow velocity
  - Altered sediment structure

Fortified banks

Migration barrier

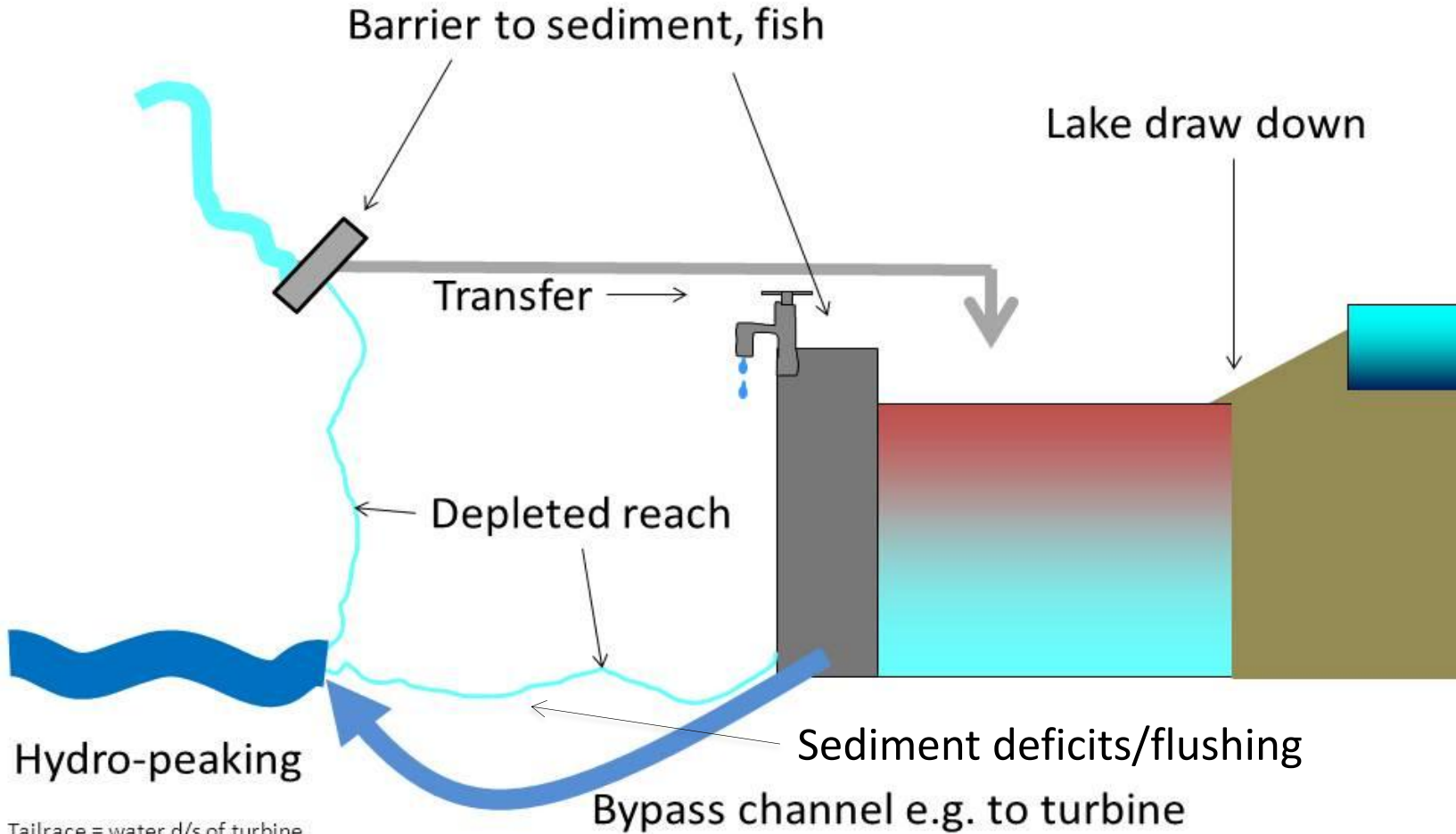
Fish damage at screens

Depleted reach  
(reduced flow quantity and dynamics)

Figure 5.5 | Run-of-river hydropower plant.

# MAIN HYMO IMPACTS

## HP type „storage plant“ (& Pumped storage plant)



Tailrace = water d/s of turbine

# TOOL: LIST OF APPROPRIATE MITIGATION MEASURES

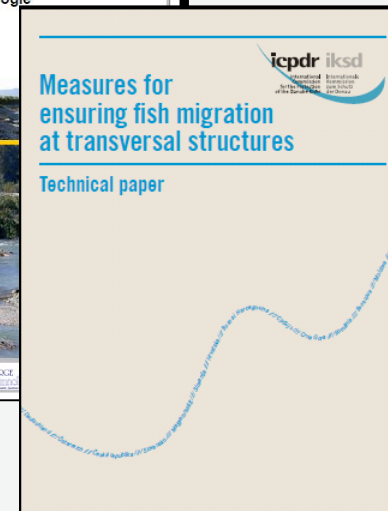
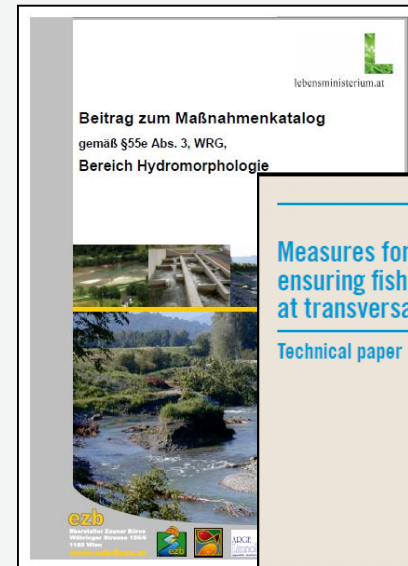
**National level**

**River basin level**

**EU level**

i.e.

WFD CIS ECOSTAT WG – Intercalibration of good ecological potential:  
„Mitigation measure library“ (MML)





# SYSTEMATIC APPROACH FOR DERIVING MITIGATION MEASURES

- Water uses (hydropower, water supply, ...)
- Pressure
- Hydrological alteration
- Ecological impact
- Detailed mitigation measure



# GEP Intercalibration MML

## Flow mitigation measures

Hydromorphological alteration	Ecological impact	Mitigation measure type	Detailed mitigation measure
<p><b>3. Artificially extreme low flows or extended low flows.</b> Reduction in widths, depths, velocities. River continuity for fish spawning reduced or interrupted. Increased likelihood of temperature &amp; oxygen level extremes</p>	<p>Reduced abundance of plant &amp; animal species. Alterations to composition of plant &amp; animal species</p>	<p>3. Mitigation low flow</p>	<p>Provide <u>additional flow</u> to river</p> <p>River morphology changes to make best use of available flow</p>
<p><b>4. Loss of, or reduction in, flows sufficient to trigger &amp; sustain fish migrations</b></p>	<p>Migratory fish absent or abundance reduced</p>	<p>4. Mitigation fish flow</p>	<p><u>Mitigation flows</u> for fish migration</p>
<p><b>5. Loss, reduction or absence of variable flows sufficient to flush out</b> encroaching vegetation; mobilise and refresh bed sediment. Changes to structure &amp; composition of bed (eg armouring; build up of fine sediment)</p>	<p>Reduced abundance of fish &amp; invertebrate species. Alterations in invertebrate composition (favouring disturbance-intolerant species)</p>	<p>5. Mitigation variable flow</p>	<p>Passive <u>flow variability</u> (e.g. using natural variability via V-notch weir)</p> <p>Actively delivered <u>flow variability</u> e.g. timed release from dam</p>



# MITIGATION MEASURES

## Additional information

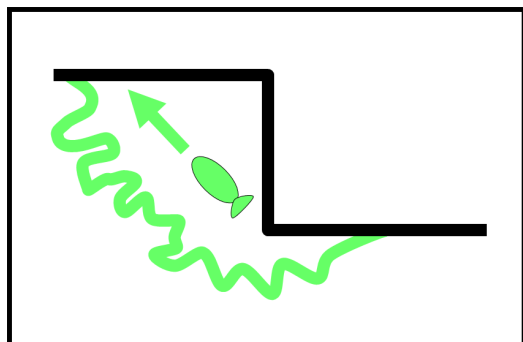
- Typical minimum scale of impact for which mitigation would be considered
- Type of measures
- Measure hierarchy
- Ecological effectiveness
- Practical effectiveness (self-sustaining /regular maintenance)
- Relative magnitude of effect on use





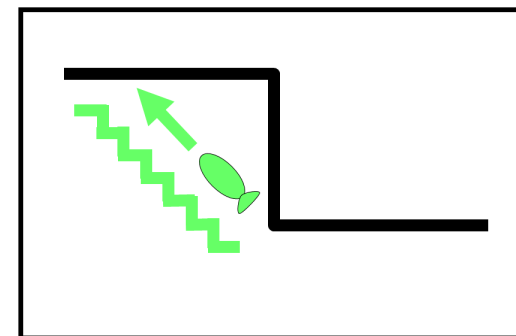
- Mitigation of impaired **river continuity** for fish migration – **upstream**
- of impaired **river continuity** for fish migration - **downstream**
- of extreme or extended **low flows** d/s of dam and of tailrace
- of inadequate **flows for fish migration** in rivers (diadroms)
- for variable i.e. **dynamic flows** in d/s rivers to maintain ecological diversity
- of **flow pulses** downstream of tailrace relating to **hydropeaking**
- for interrupted **sediment movement**
- for artificially extreme **changes in lake level** - reservoirs from dammed rivers and lakes
- for reduced river flow - **ponding upstream of run-of-river hydropower**
- of **temperature** downstream of reservoirs or river intake structures

# IMPAIRED UPSTREAM FISH MIGRATION MITIGATING MEASURES



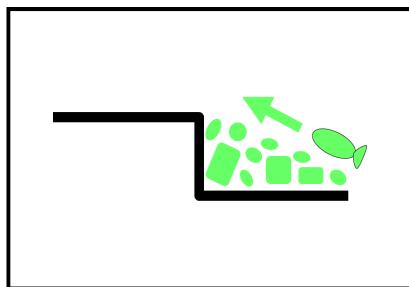
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Constructing  
by-pass channel



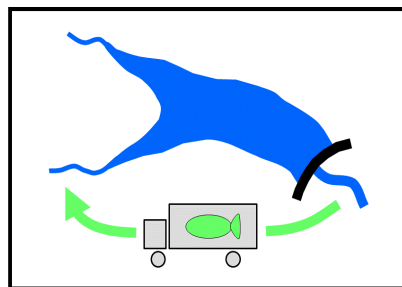
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Constructing  
fish pass (upstream)  
e.g. vertical slot, lift, etc.



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Constructing  
ramp

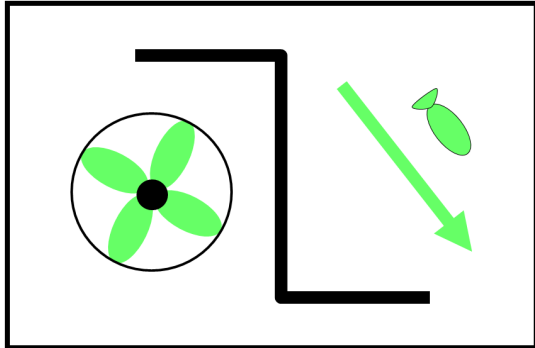


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Catch, transport &  
release

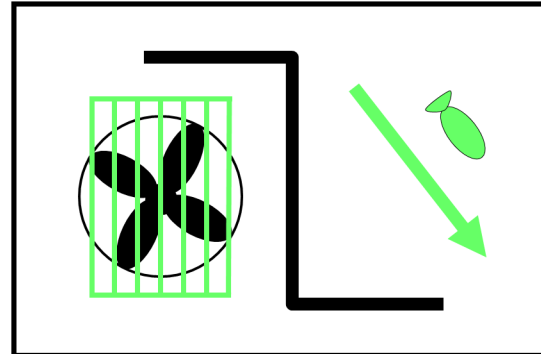


# IMPAIRED DOWNSTREAM FISH MIGRATION MITIGATION MEASURES



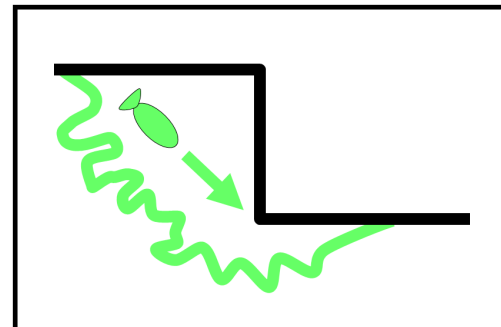
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Installing  
fish-friendly  
turbines



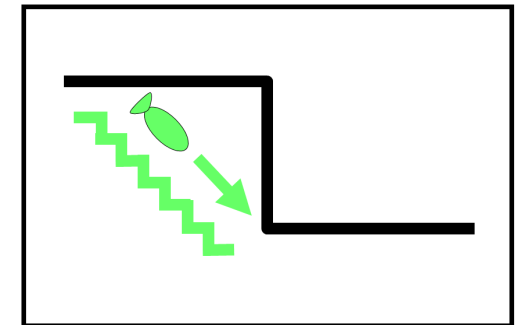
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Installing  
fish screens



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Constructing  
bypass channel



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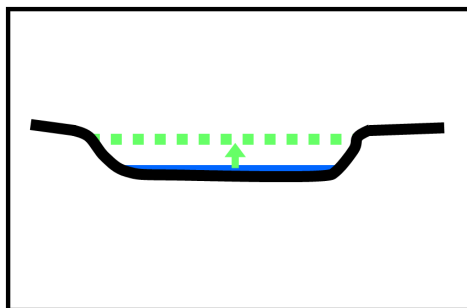
Constructing  
fish pass  
(downstream)  
(e.g. notch in small  
intake structure, lift,  
ladder, ramp, etc.)

# EXTREME/EXTENDED LOW FLOWS MITIGATION MEASURES



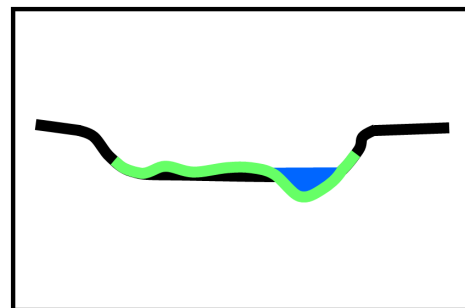
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- artificially extreme low flows or extended low flows.
- Reduction in widths, depths, velocities.
- River continuity for fish spawning reduced or interrupted.
- Increased likelihood of temperature & oxygen level extremes



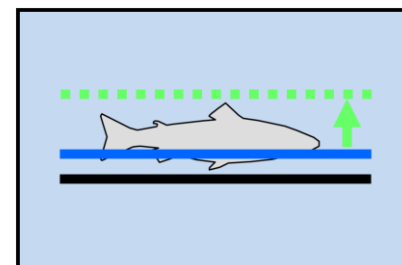
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Providing additional flow



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Optimising river morphology for available flow

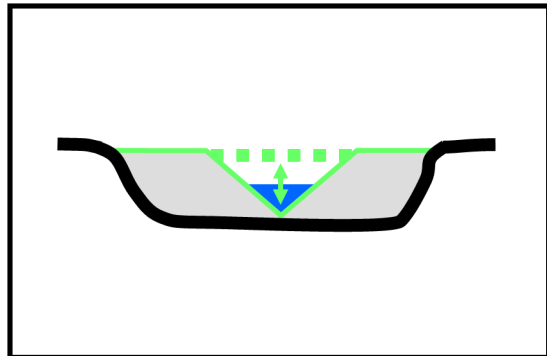


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4. Mitigation fish flow

**Providing additional flow to trigger fish migration (diadroms)**

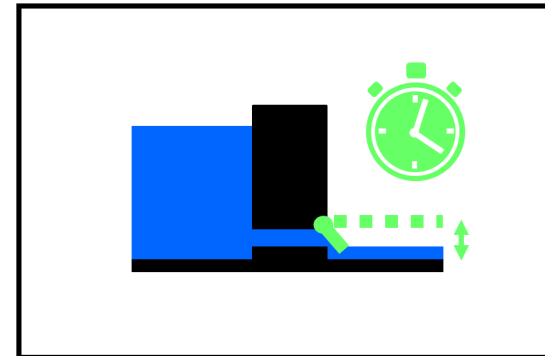
# MITIGATION FOR VARIABLE FLOWS



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Establishing  
variable discharge  
(passive)

e.g. using natural  
variability via V-notch weir



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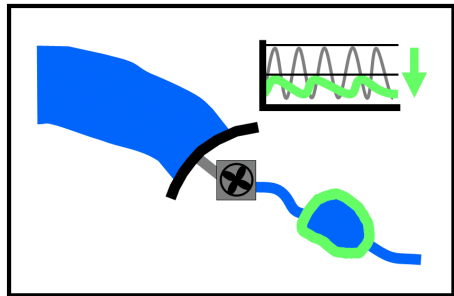
Establishing  
variable discharge  
(active)

e.g. timed release  
from dam

CIS Guidance No 32 Ecological Flow - Flow components: (magnitude, frequency, duration, timing and rate of change)

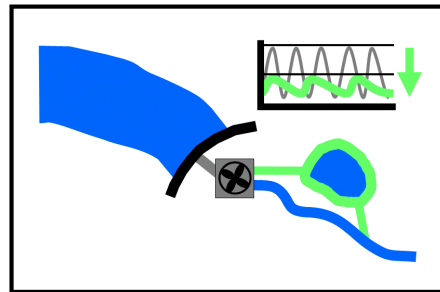
[https://circabc.europa.eu/sd/a/4063d635-957b-4b6f-bfd4-b51b0acb2570/Guidance%20No%2031%20-%20Ecological%20flows%20\(final%20version\).pdf](https://circabc.europa.eu/sd/a/4063d635-957b-4b6f-bfd4-b51b0acb2570/Guidance%20No%2031%20-%20Ecological%20flows%20(final%20version).pdf)

# HYDROPEAKING (flow pulses) MITIGATION MEASURES



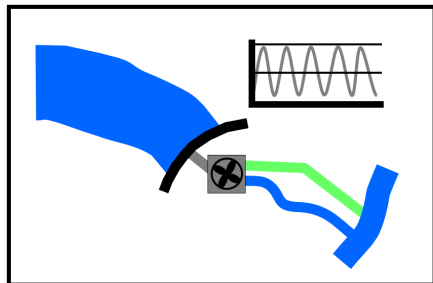
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Constructing  
instream balancing  
reservoir(s)



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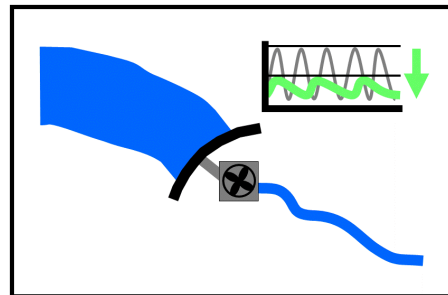
Constructing  
external balancing  
reservoir



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Relocating  
tail race

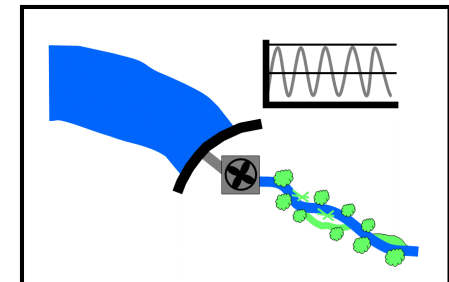
to sea, a lake or to a  
larger river or into a  
new bypass channel



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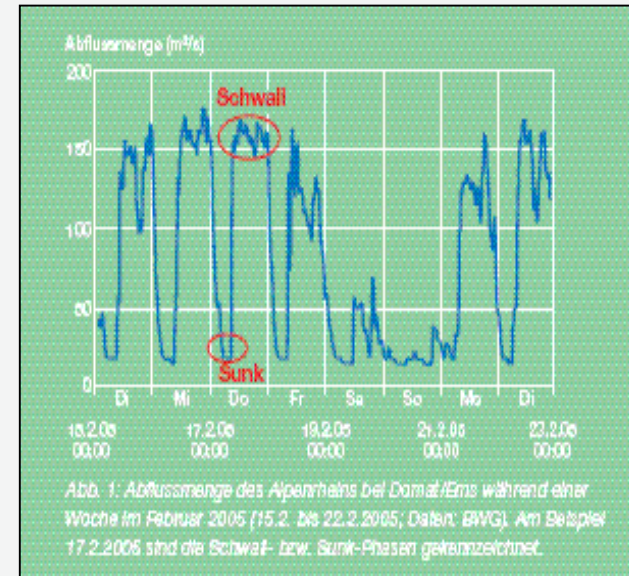
Reducing  
hydropeaking rate

by changing operation mode  
i.e. reducing velocity of  
downramping phase

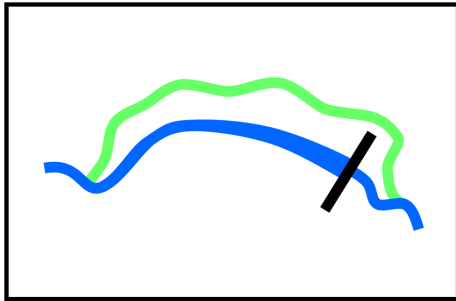


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Improving river  
morphology



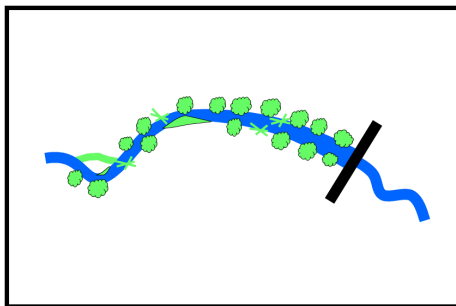
# PONDING EFFECTS MITIGATION MEASURES



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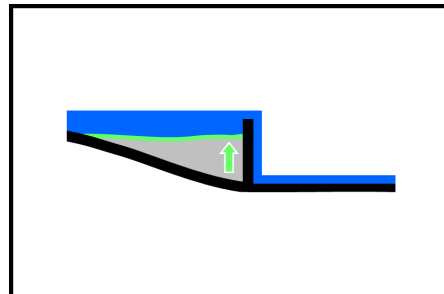
Synergy with  
ensuring river  
continuity

Constructing  
by-pass channel  
to provide additional  
flowing habitats



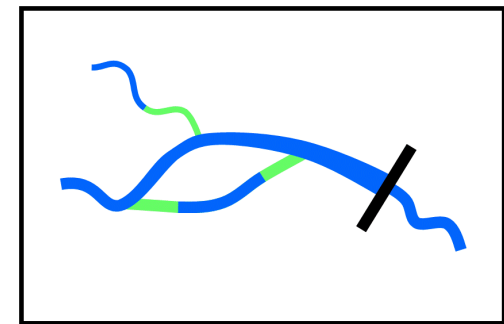
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Improving  
in-channel habitats



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Reducing storage  
level  
e.g. by raising bed or  
lowering dam to increase  
flowing water habitat



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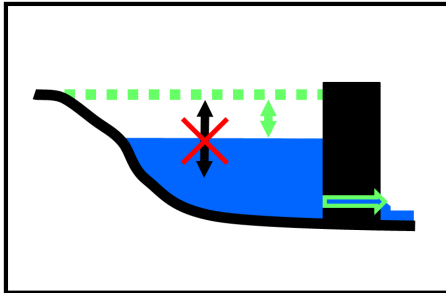
Reconnecting  
tributaries /  
floodplain features  
ensuring lateral  
connectivity



# EXTREME CHANGES IN LAKE LEVEL MITIGATION MEASURES

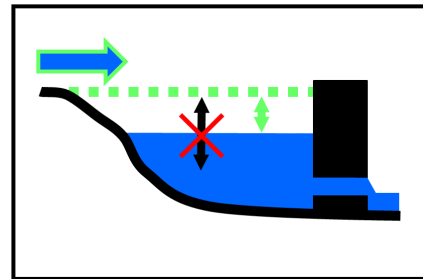


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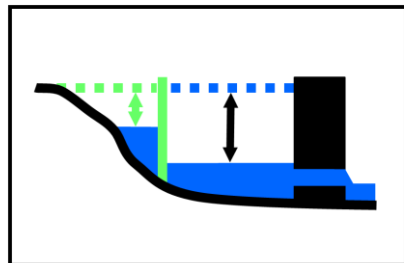
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Limiting level  
variation – reduced  
abstraction



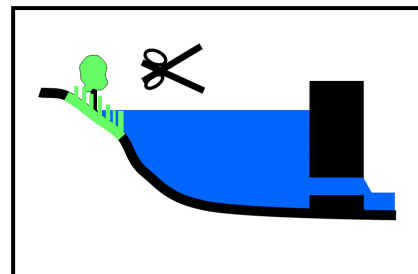
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Limiting level  
variation –  
increased inflows



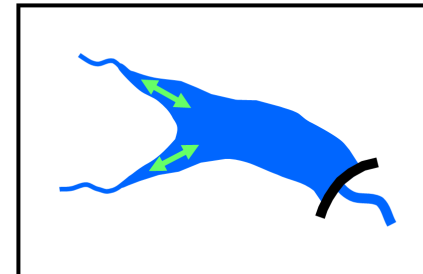
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Limiting level  
variation in part(s)  
of the reservoir



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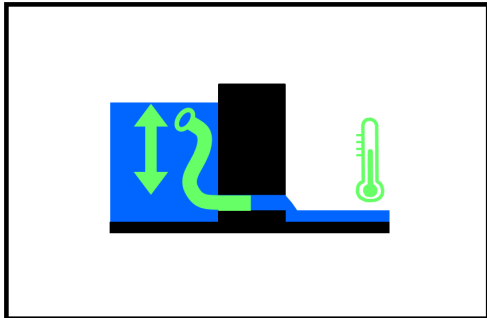
Manage  
shore / shallow  
habitats



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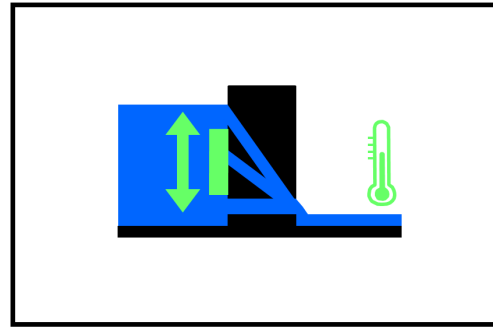
Maintain  
connectivity to  
tributaries

# TEMPERATURE ALTERATION MITIGATION MEASURES



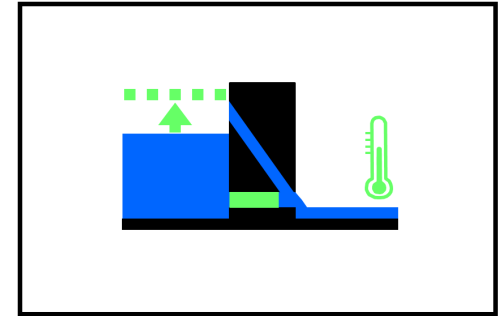
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Installing flexible  
intake



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Multiple intakes at  
different heights in  
reservoir dam



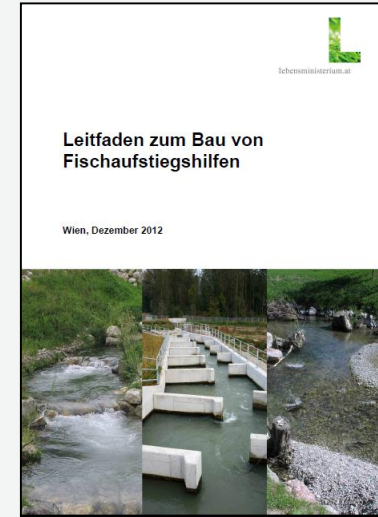
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Managing  
reservoir level

# GENERAL OBLIGATIONS FOR HYDROPOWER PLANTS

Legally fixed in Austria ...  
to ensure achievement/maintenance  
of good ecological status

- river continuity for fish migration (all typespecific dominant and subdominant species fish species, 1+ generation)  
... also in impounded sections/chains of Hpp
- providing ecological flow in case of diversion plants



Other mitigation measures often have to be decided case by case –  
(HP alterations mostly lead to HMWB designation)

For new hp development non deterioration principle has to be  
respected also (exemption acc. Art.4.7 WFD possible) –  
Strategic planning!

# Thank you for your attention



Foto: ©Helena Mühlmann

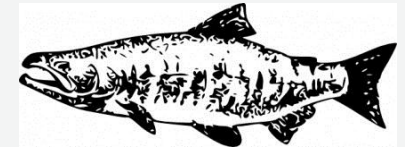
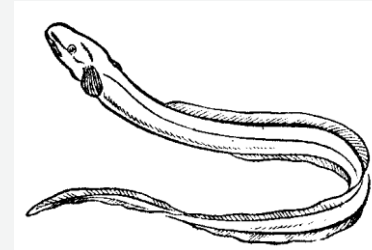


# MIGRATING FISH SPECIES

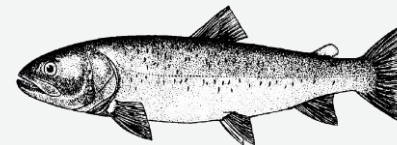
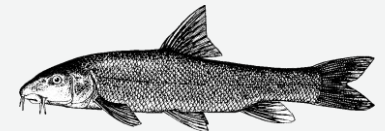
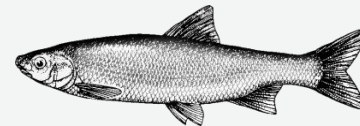
## All species of fish need to migrate

... performing habitat shifts (at least in certain life stages) as a consequence of changing habitat requirements and to optimise resource use and productivity (Schmutz et.al. 1997, ...)

- Long distance migrators > 300 km



- Medium distance migrators 30 -300 km



- Short distance migrators < 30 km

