Virkninger av fleksibel kraftverksdrift og effektkjøring

Miljøvirkninger av effektkjøring: Kunnskapsstatus og råd til forvaltning og industri

NINA Temahefte 62

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CEDREN
Centre for Environmental Design of Renewable Energy
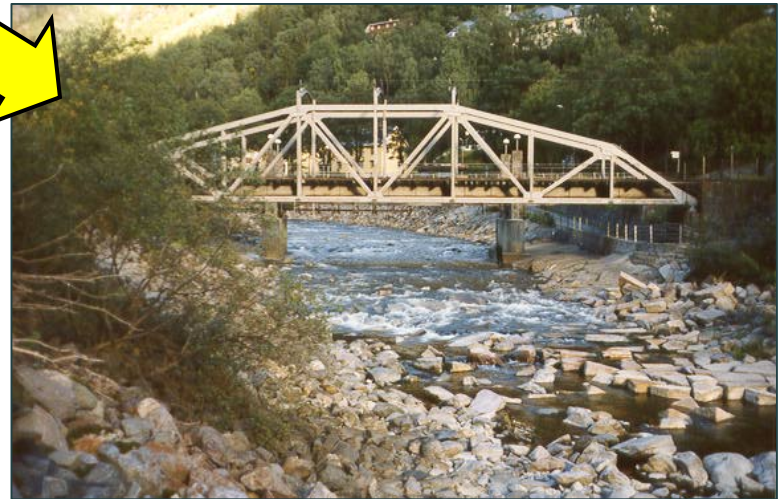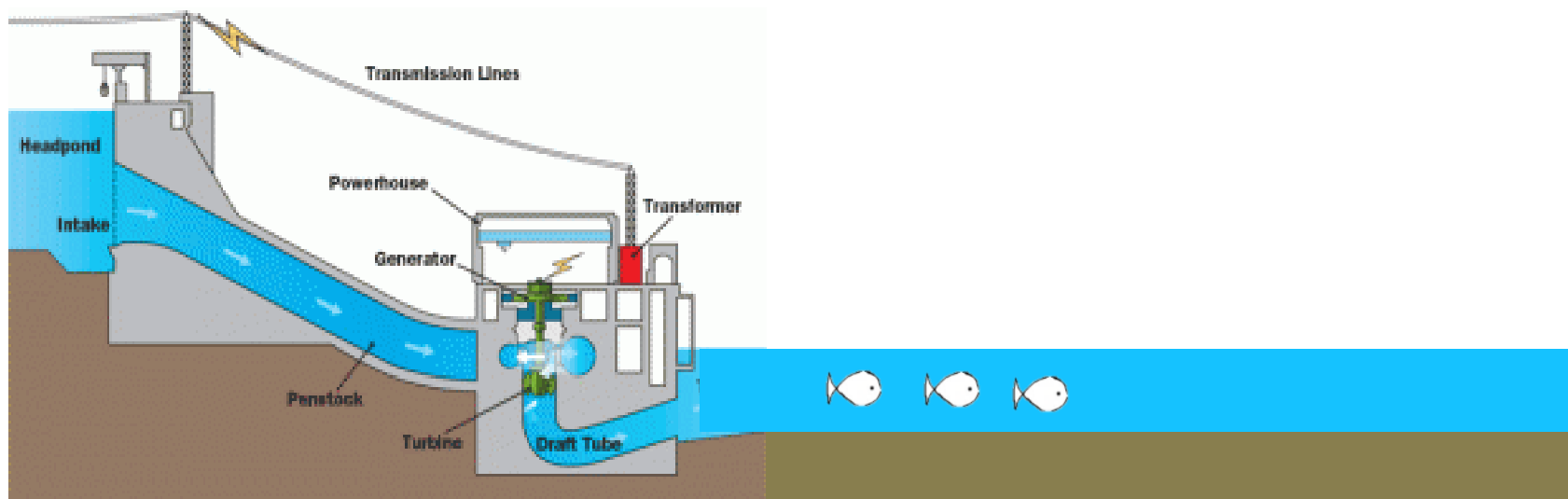
1. Hydropeaking ???

Rapid changes in power **production** by hydro-electric facilities as a consequence of varying electricity generation and **demand** on the electricity market.

1. Hydropeaking ???

→ Rapid **fluctuations** of flow and water level

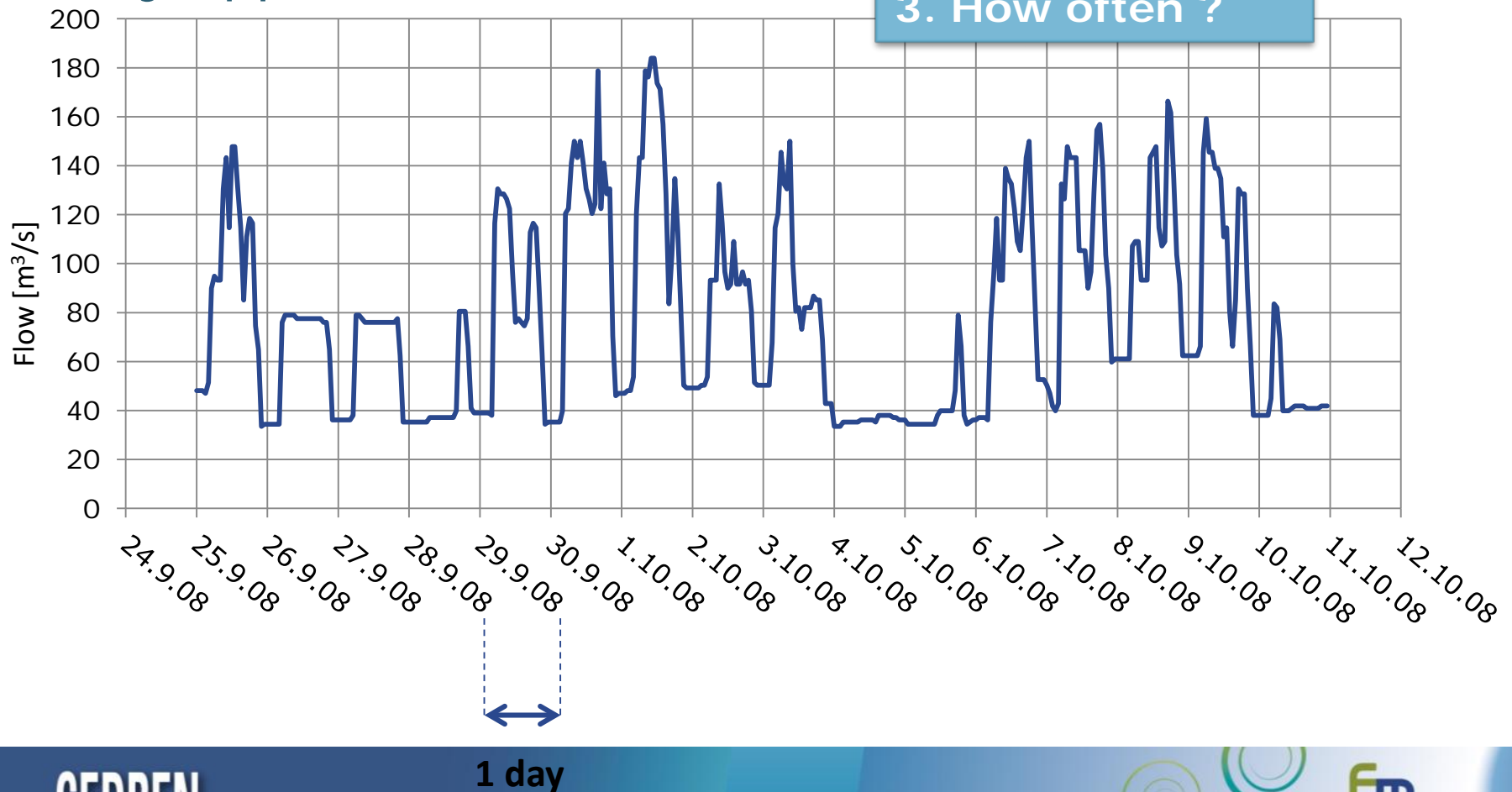→ Impact on **ecosystems** of water bodies downstream of the power plant outlet.

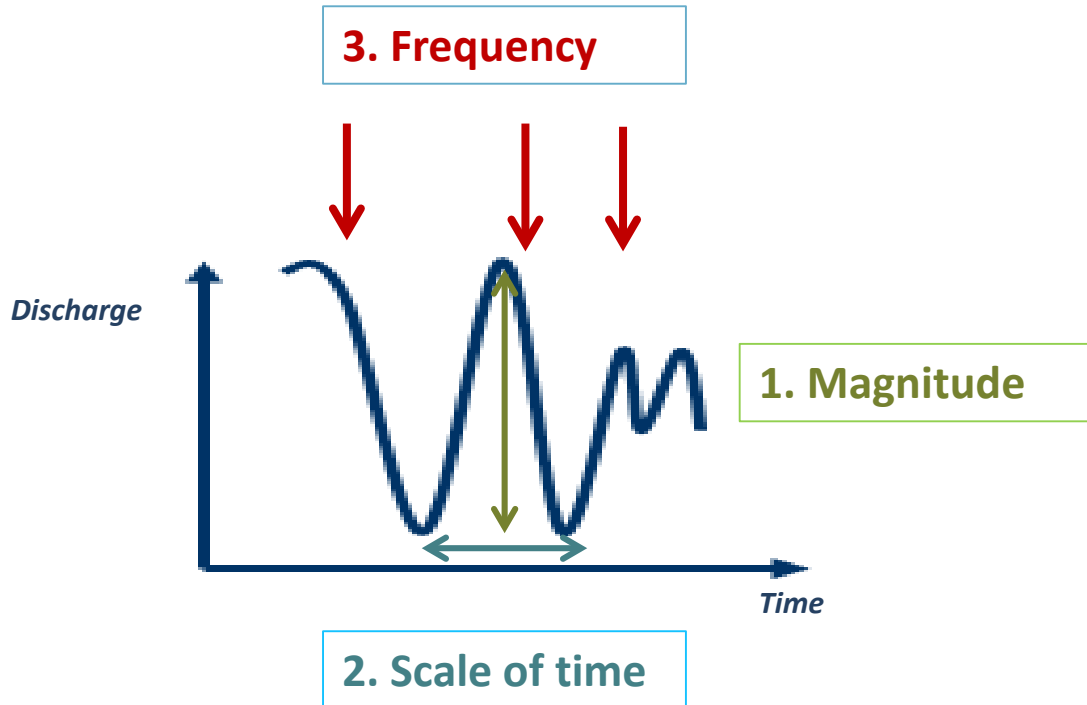**Power plant** **Downstream river**

1. Hydropeaking ???

- May appear as follows:

1. How big?
2. When?
3. How often ?

1 day

2. COSH-Tool

Characterisation of Stream Hydropeaking - Tool

**Automated analysis** of time series of flow and stage

3. Frequency

Discharge

1. Magnitude

2. Scale of time

Time

Parameter	Symbol	Unit
Magnitude		
Flow	Q	m³/s
Stage	H	cm
Flow maximum/minimum of a rapid increase	$Q_{max,inc}$, $Q_{min,inc}$	m³/s
Flow maximum/minimum of a rapid decrease	$Q_{max,dec}$, $Q_{min,dec}$	m³/s
Stage maximum/minimum of a rapid increase	$H_{min,inc}$, $H_{max,inc}$	m
Stage maximum/minimum of a rapid decrease	$H_{max,dec}$, $H_{min,dec}$	m
Flow ratio of a rapid increase/decrease	$(Q_{max}/Q_{min})^{inc}$, $(Q_{max}/Q_{min})^{dec}$	-
Scale of time		
Mean rate of flow increase/decrease	$R_{Qm,inc}$, $R_{Qm,dec}$	m³/(s*h)
Mean rate of stage increase/decrease	$R_{Hm,inc}$, $R_{Hm,dec}$	cm/h
Maximal rate of flow increase/decrease	$R_{Qmax,inc}$, $R_{Qmax,dec}$	m³/(s*h)
Maximal rate of stage increase/decrease	$R_{Hmax,inc}$, $R_{Hmax,dec}$	cm/h
Time of the start/end of a rapid increase	$t_{s,inc}$, $t_{e,inc}$	hh:mm
Time of the start/end of a rapid decrease	$t_{s,dec}$, $t_{e,dec}$	hh:mm
Duration between a rapid increase and decrease	T_{high}	h
Duration between a rapid decrease and increase	T_{low}	h
Frequency		
Count of rapid increases/decreases per year	$N_{a,inc}$, $N_{a,dec}$	1/a
Portion of days with certain number of rapid increases/decreases per day	$D_{n,inc}$, $D_{n,dec}$	-
Portion of rapid increases/decreases during daylight/twilight/darkness	N_{dl} , N_{tl} , N_{nl}	-

2. COSH-Tool
Characterisation of Stream Hydropeaking - Tool

- **Separation into increases and decreases**

  Different impacts
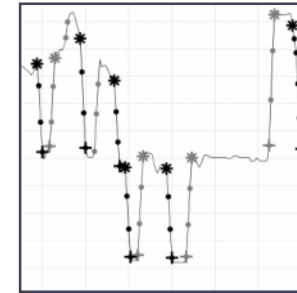
- **Light conditions**

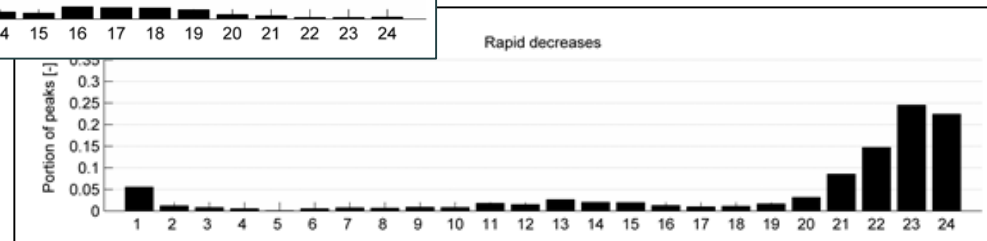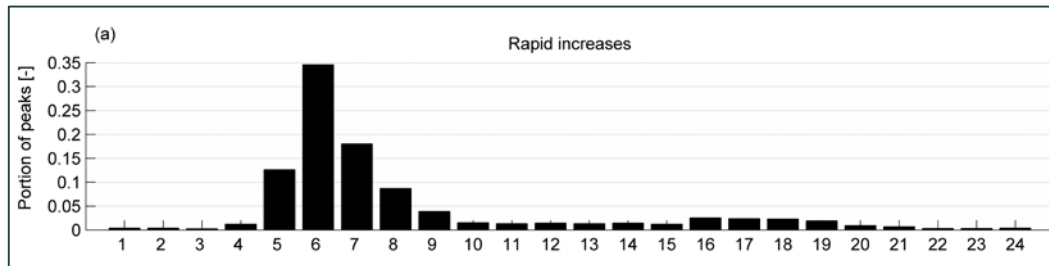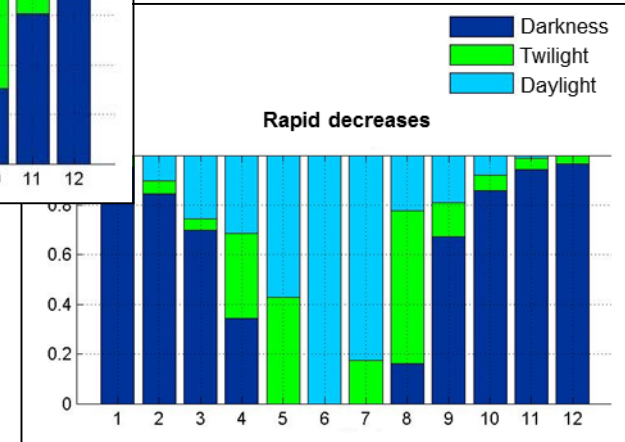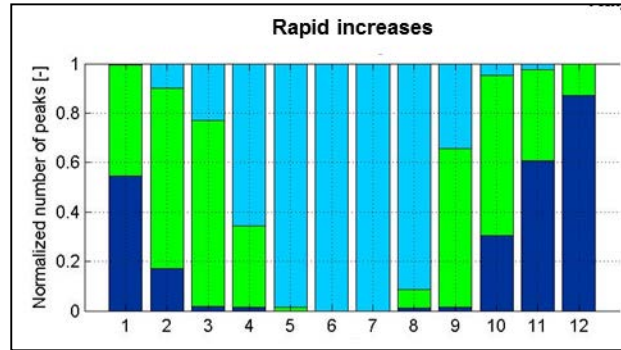 Seasonal shift in habitat use, diel activity and behaviour of fish

- **Seasonnal analysis**

2. COSH-Tool

- Light conditions

- Hour of the day

Hydropeaking – rapid flow change in downstream river

Bunnforhold

- Armering av bunnen?
- Utvasking av finstoff?
- Økt transport av sedimenter?
- → Avhenger av variasjonene i vannføring
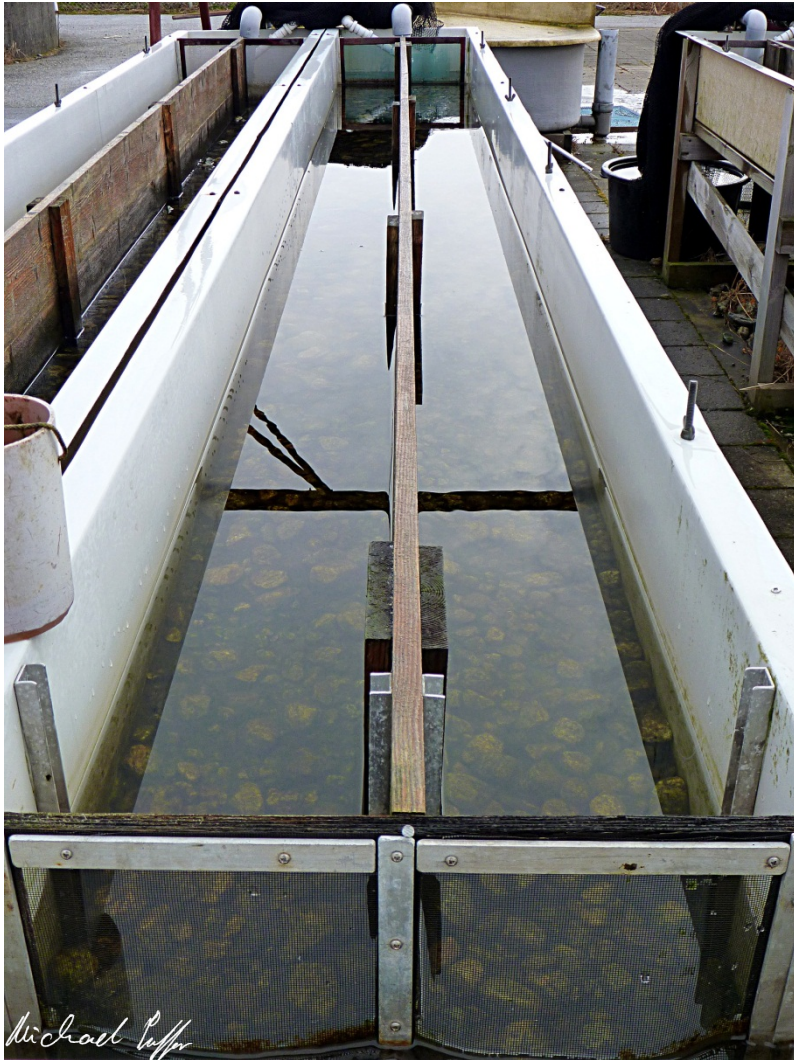
Isforhold

- Mindre overflate-is
- Økt sarrproduksjon

Strandingsfare
- fiskens bruk av utsatte områder

Fish: Experimental setup in Ims

Growth of fish in peaking environment - experimental setup in Paltamo (Finland)

Results - hydropeaking

- Flow fluctuations had no effect on body fat in fish
- Survivors of stranding in winter had significant less body mass – no effect in summer

- Significant effects on body weight and fat in winter:
  - control fish 2.56 g (= 10.3%) heavier
  - control fish have 0.25 g (= 16.6%) more body fat

- Relatively small effects on fish when stranding is avoided in strong fish populations

Elvemusling

- Forsøk med effektkjøring ga ingen dødelighet av individer

- Forsøk har vist at muslinger som blir tørrlagt har større vandringsuro enn de som ikke blir tørrlagt

- Muslinger på dypt vann utsatt for effektkjøring (ikke tørrlagt), viste større vandringsuro enn muslinger ikke eksponert for effektkjøring

- Studier fra utlandet viser at bestander av muslinger eksponert for kraftig effektkjøring reduseres kraftig
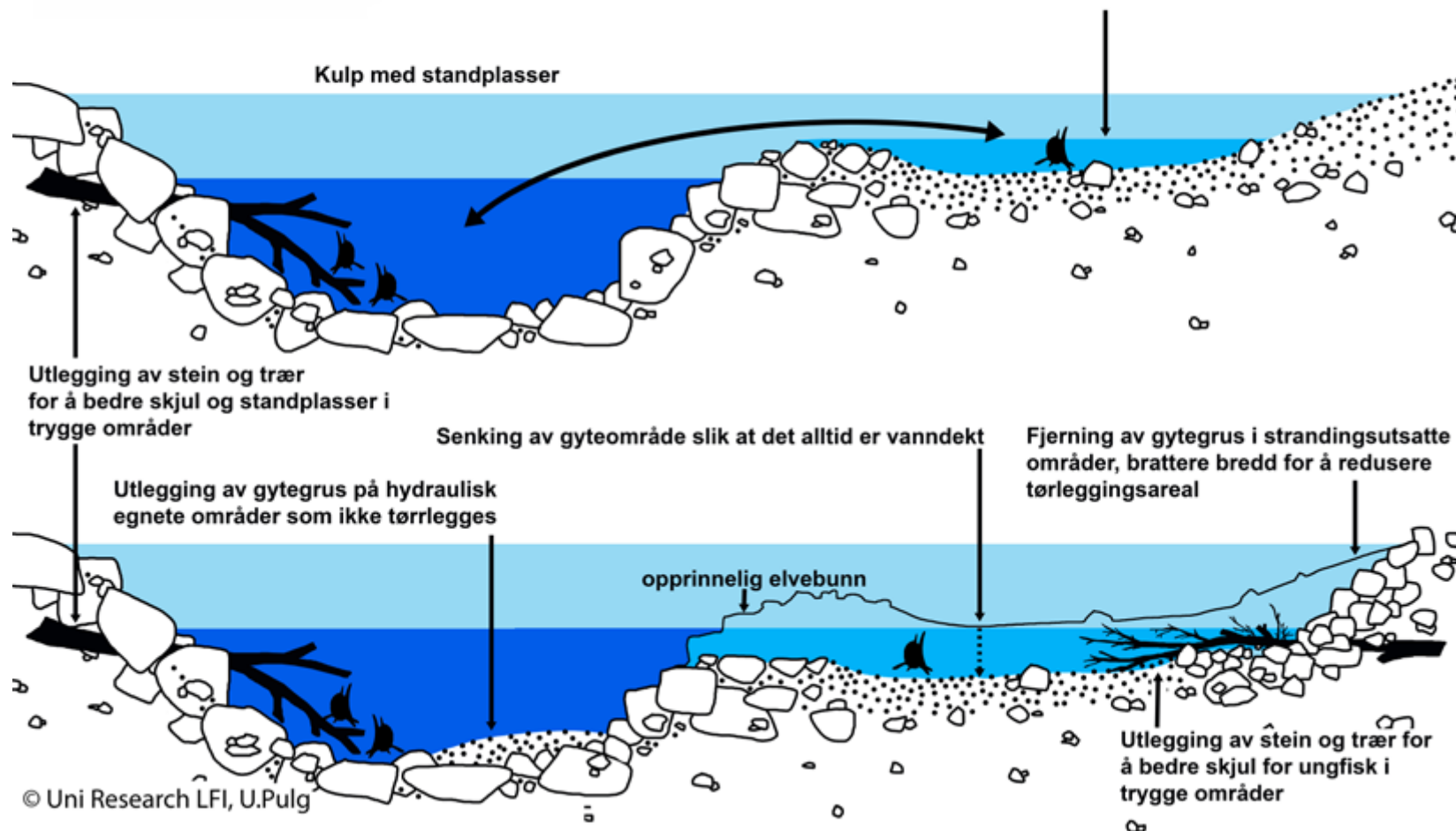
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Assessment and characterization Effect factors:

Effect factors	Indicator
• Rate of change	• Water level change ratio
• Dewatered area	• Change in water-covered area
• Magnitude of flow changes	• Flow ratio
• Frequency	• Annual frequency
• Distribution	
• Timing	• Flow reductions in critical periods

Valued into different classes according to given criteria:
• Small
• Moderate
• Large
• Very large effect

Combine effect and score for total effect score

Assessment and characterization Vulnerability factors:

Vulnerability factors	Indicator
• Effective population size	• Number of females last 5 years
• Degree of limitations in recruitment	• Amount and distribution of spawning grounds
• Low flow periods as bottlenecks	• Change in lowest annual weekly flow in winter and summer combined
• Habitat degradation	• Change in magnitude and frequency of flood events
• Reduced water temperature	• Reduction in summer water temperature
• Other factors	
• Percentage of impacted river length compared to total length	• Proportion of river reach with peaking operations compared to total length [%]

Valued into different classes according to given criteria:

• Low

• Moderate

• High vulnerability

Combine vulnerability for total score

Combinations of hydropeaking effects and vulnerability for total impact assessment

		Hydropeaking effects			
		Very large 21-32	Large 15-20	Moderate 10-14	Small 4-9
Vulnerability	High 16-21	🟥	🟥	🟧	🟨
	Moderate 10-15	🟥	🟧	🟨	🟩
	Low 4-9	🟧	🟨	🟩	🟩