



– om vann fra fjell til fjord



Flow targets for key env issues/objectives in regulated rivers and HMWB



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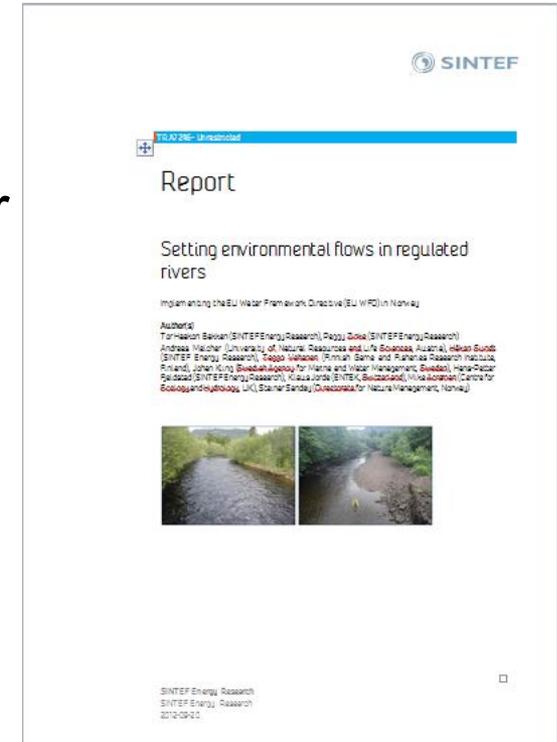
..and thanks to lots of Researchers for illustrations....

Flow target workshop, SINTEF, 23.-24. April 2012

Focus – Flow targets

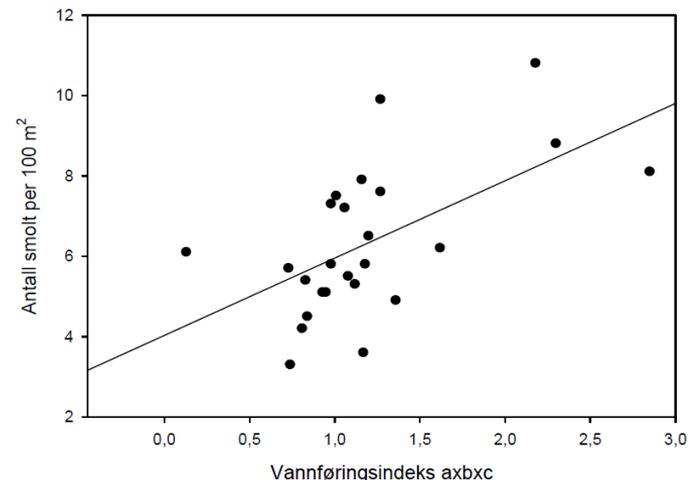


- Finding the right balance
 - EUs blueprint for water – defining standards
 - Baselines
- «Everyone» talks about it – practise?
- «Enough» water in rivers is effective for
 - Fundamental for (key) aquatic organism
 - Riverine organisms
 - Key processes
 - Landscape, recreation etc
- Basis requirement for other mitigation measures
- Flow target requirement, assessments
 - Significant adverse on hydropower
 - Environmental objectives





- Crucial to define ambition level for
 - Environmental standards
 - Key issues and objectives
- Establish dose-response relationship
 - Hydrology and ecological/environmental response
 - Morphological alteration
 - E.g. migration barriers
 - Physio-chemical change
 - Temperature
 - Acidification

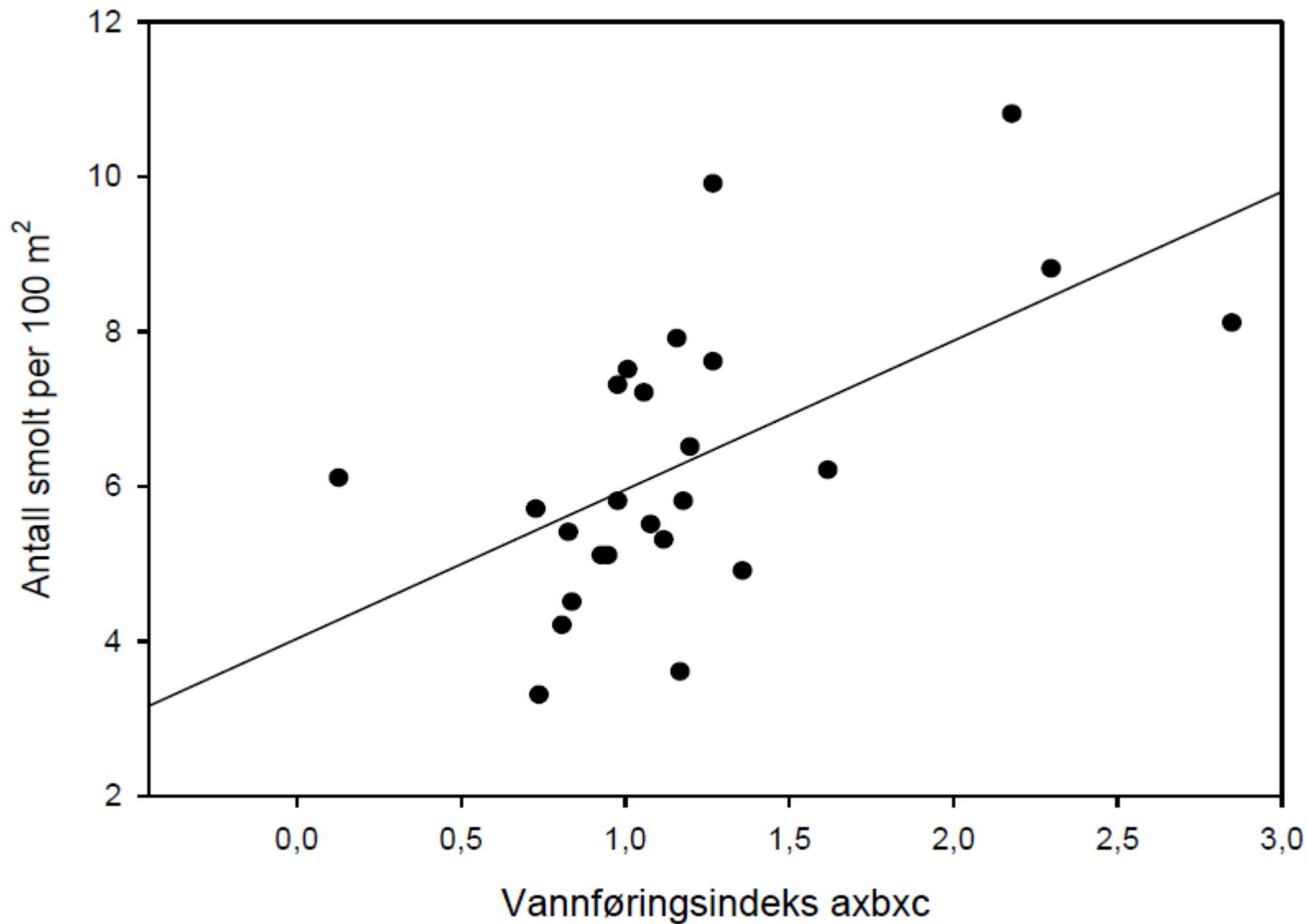




- Hydrological indexes
 - “Hydrological impact on evolution”
- Wetted area
 - Landscape consideration, recreation – human preferences.
- Historical knowledge
- Expert judgment
- R&D results
 - E.g 13 cm/h
- Habitat modeling and GES/GEP?



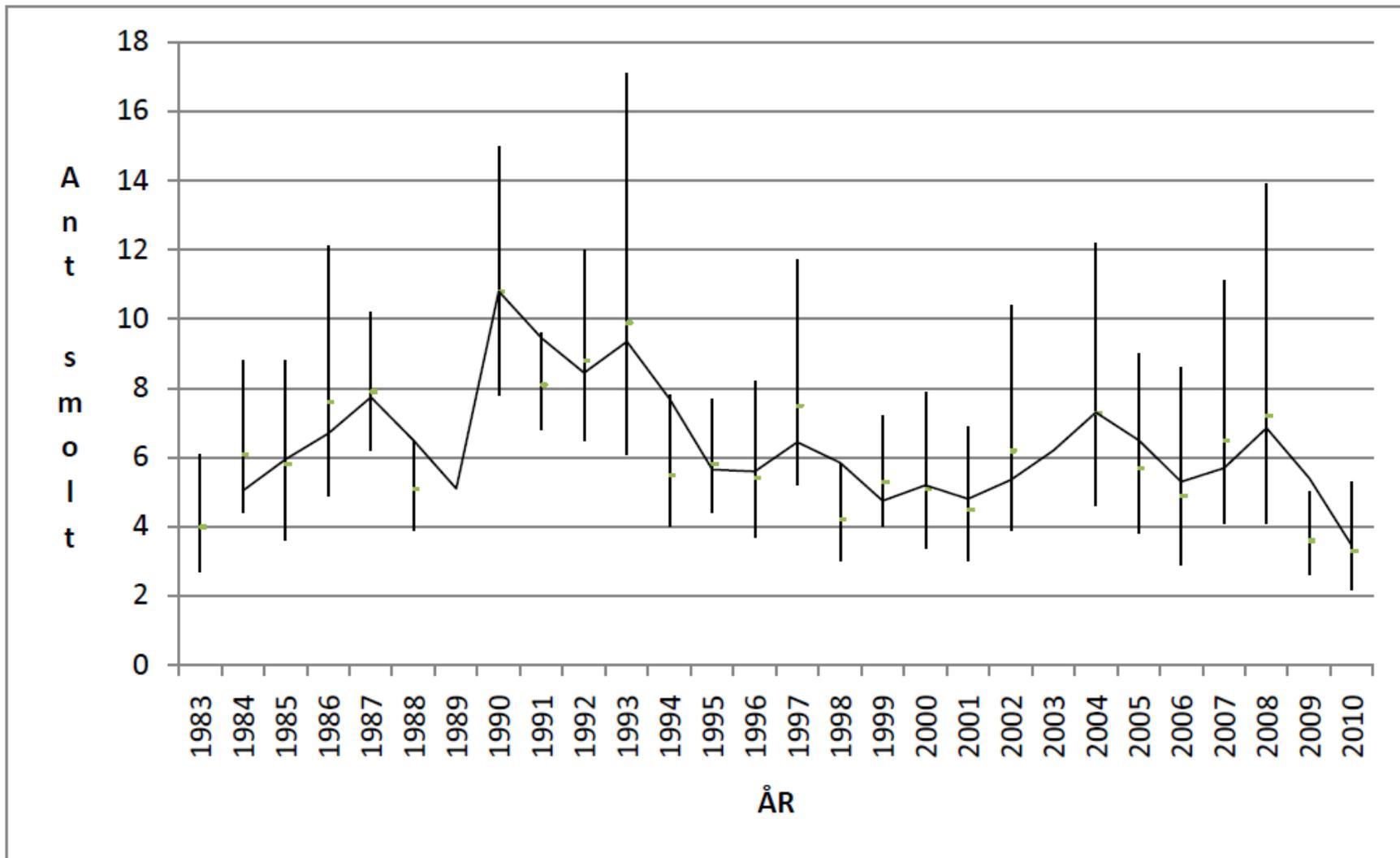
Orkla – smoltproduction vs winter_Q



Smolt production in Orkla



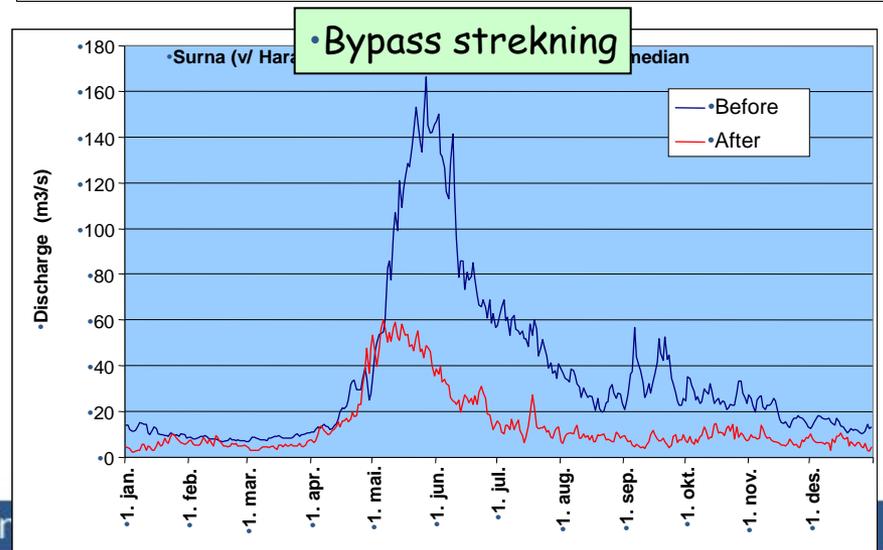
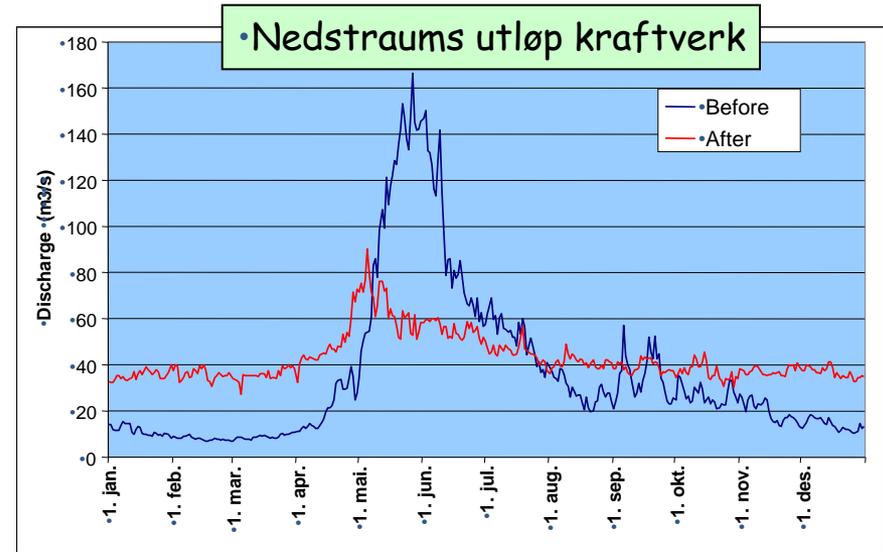
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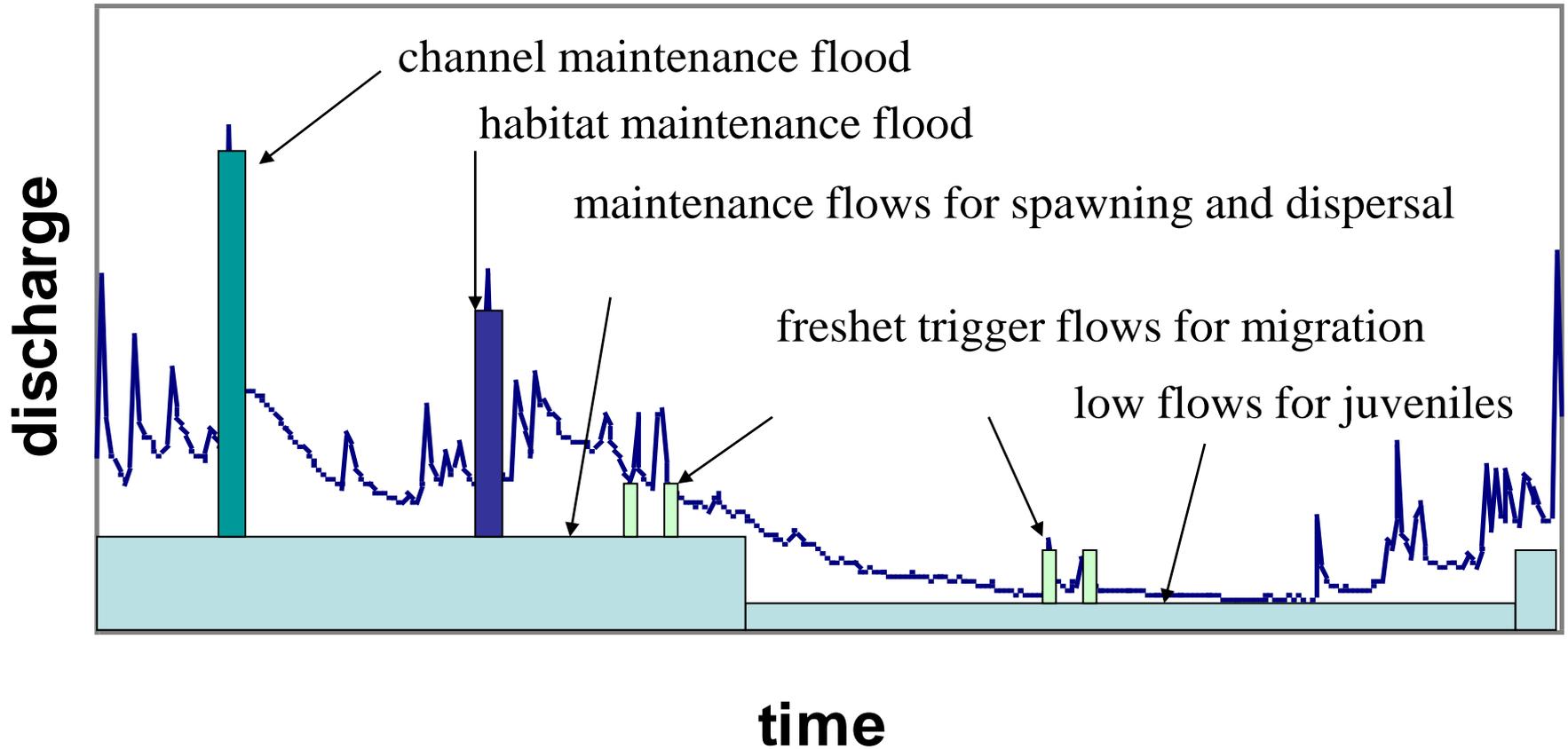
Find acceptance level....



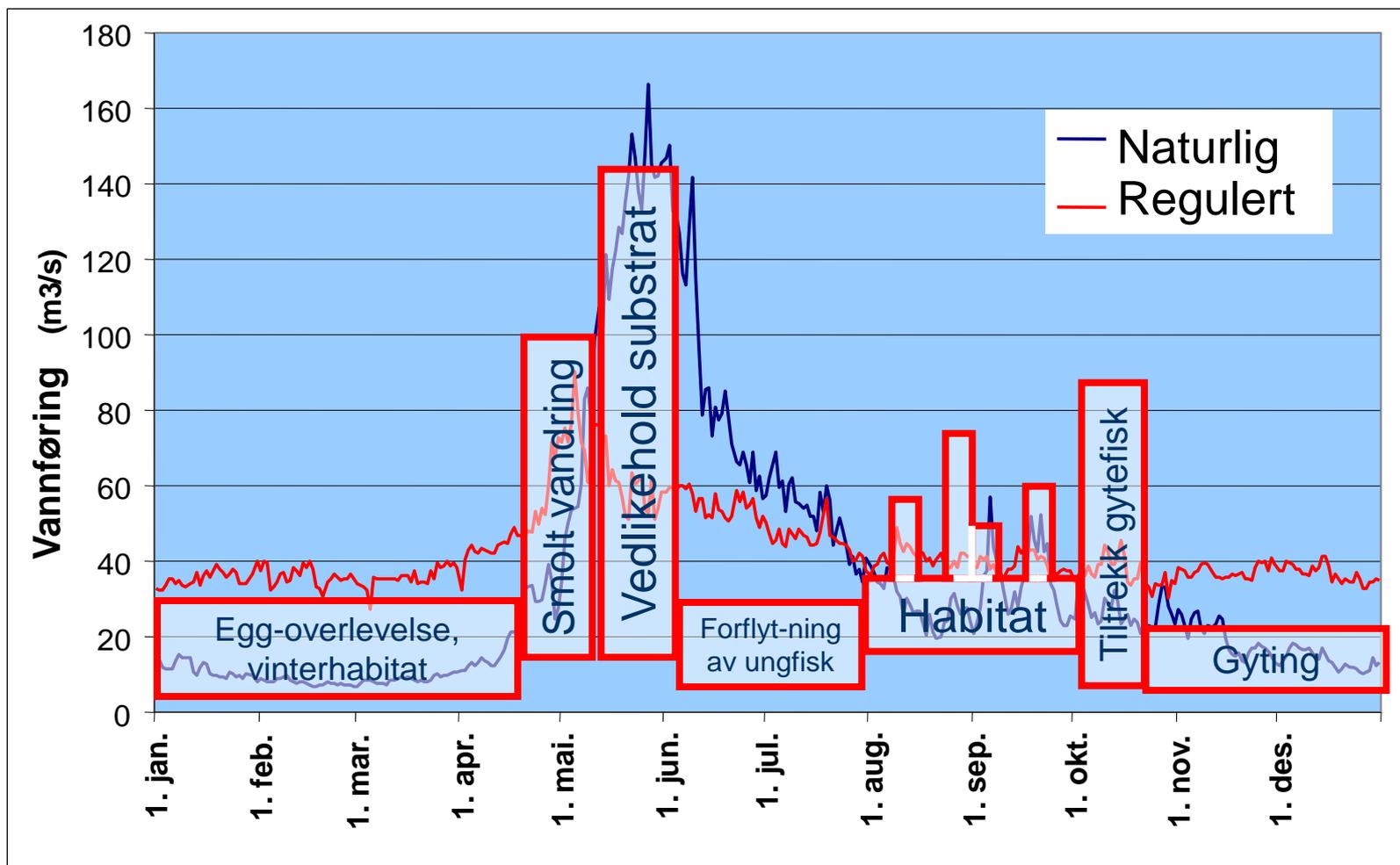
- Downstream HPP
- By-pass sections
- Importance of unregulated instream flow
 - Temperature
 - Water quality
 - Q



WFD recommendations

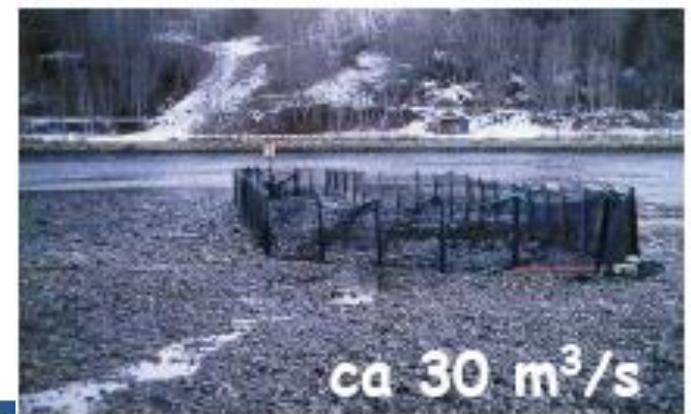
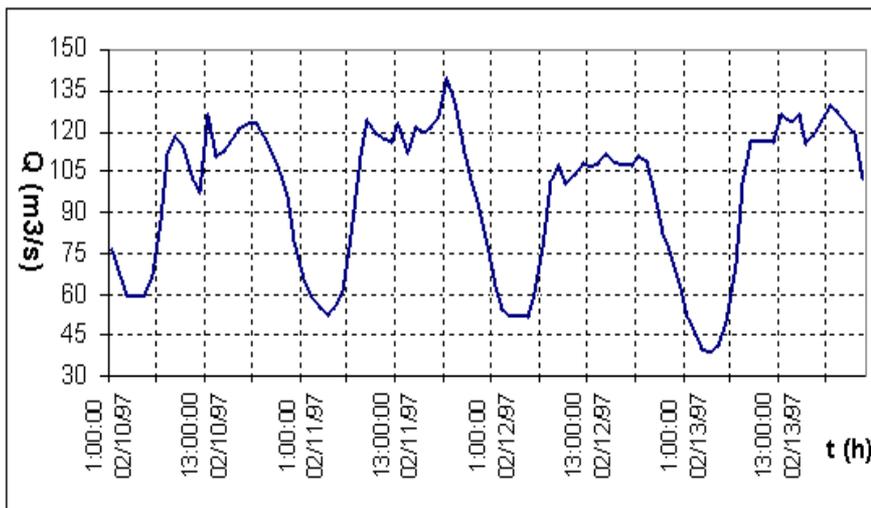


Blocks vs reponse

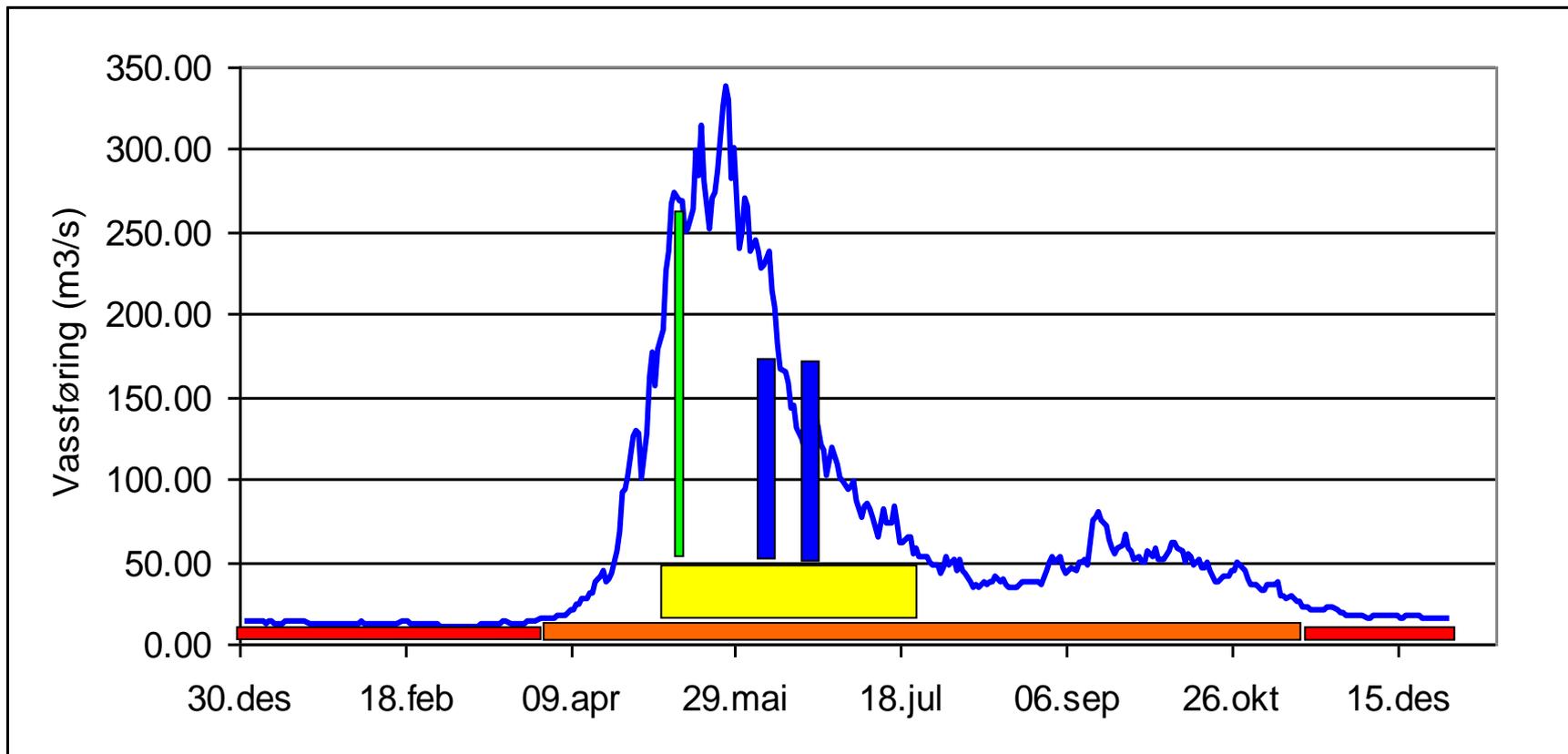


Gentle ramping

- < 10-15 cm/hour
- Better summer than winter
- Better night than daytime
- Speed and frequency of importance for impact
- Dewatering time also important
- Minimum flow requirement crucial!



Bottlenecks?



■ • Lavvassføring vinter

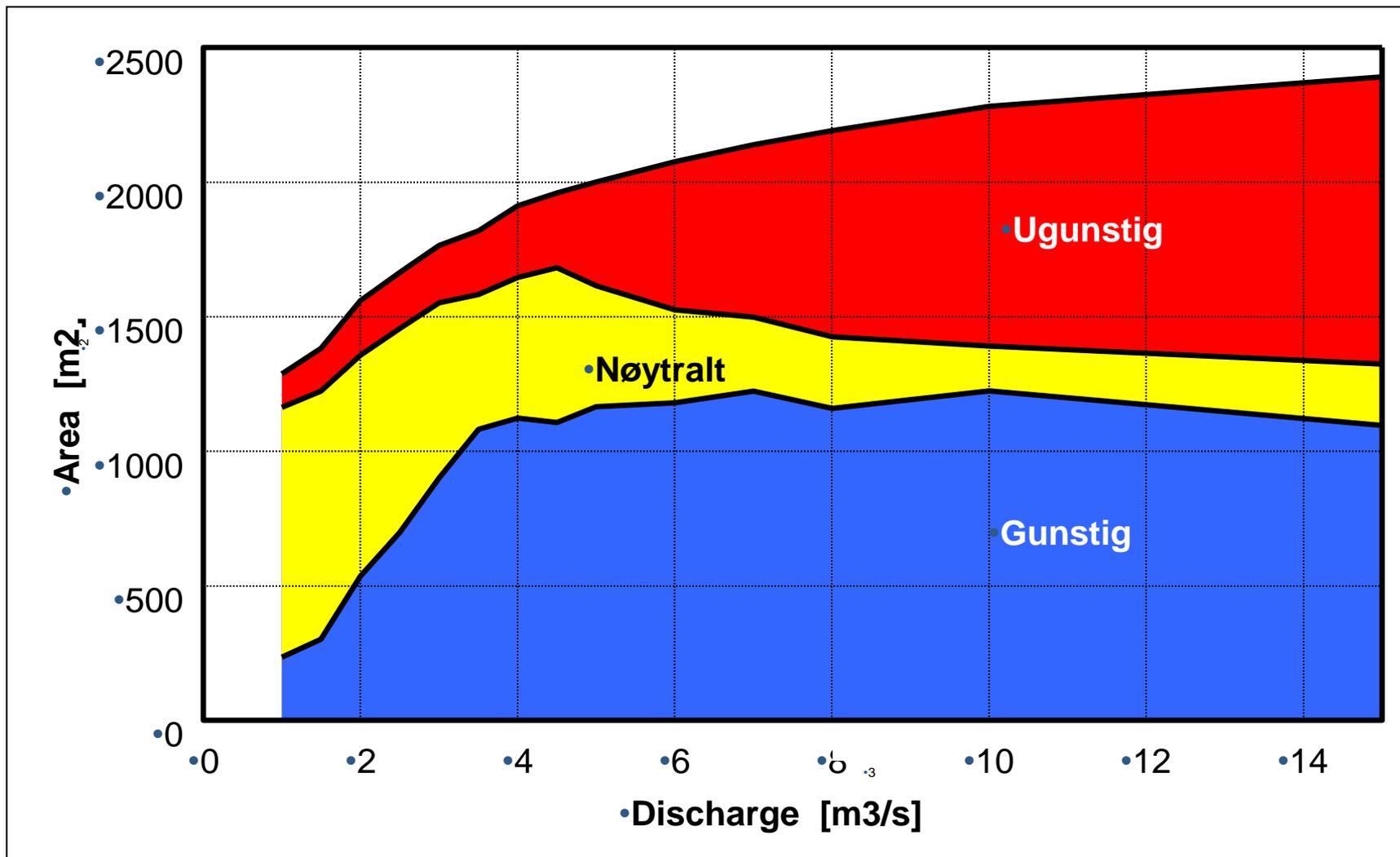
■ • Høgvassføring for kanalvedlikehold

■ • Lavvassføring vår-sommar

■ • Høgvassføring for oppvandring

■ • Sommarvassføring for rekreasjon

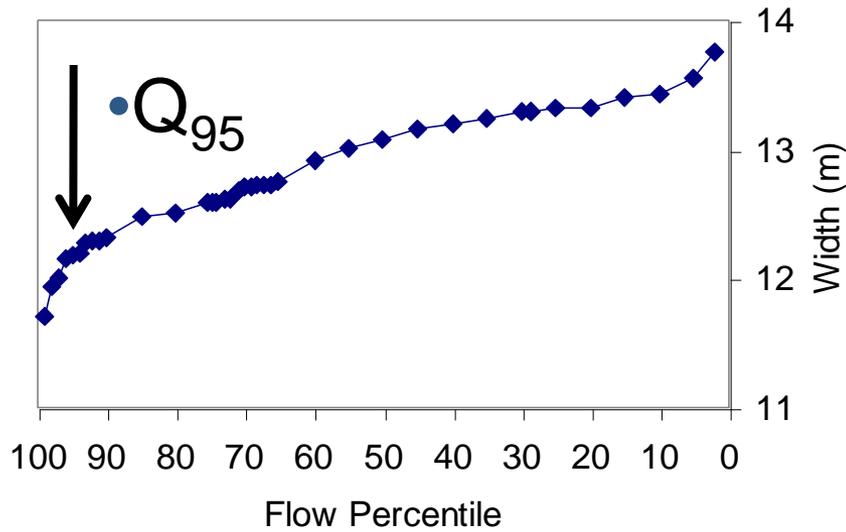
Result and relevance of habitat modelling?



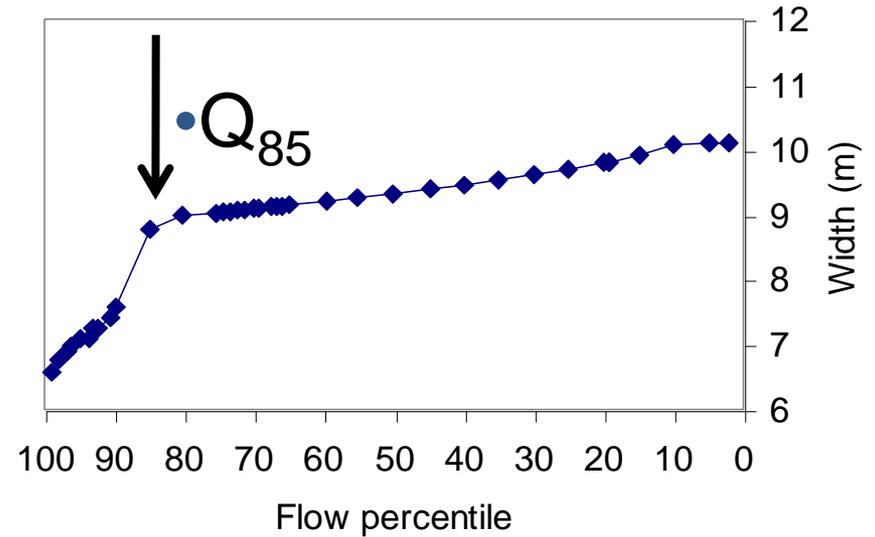
Hydraulic geometry relations



Site 53



Site 212



Classification of water covered area - draft



Økologisk tilstand	Svært god	God	Moderat	Dårlig	Svært dårlig
$Q_{\min\text{reg}} / Q_{\min\text{nat}}$ Vinter	>0,80	0,80->0,60	0,60 ->0,40	0,40->0,25	$\leq 0,25$
$Q_{\min\text{reg}} / Q_{\min\text{nat}}$ Sommer	>0,70	0,70 ->0,50	0,50 ->0,30	0,30 ->0,20	0

- **Tabell 7** Klassifisering basert på støtteparameteren minimum 7-døgns middel i vannføring om vinteren og sommeren i regulert elv ($Q_{\min\text{reg}}$) i forhold til naturlig vannføring ($Q_{\min\text{nat}}$): $Q_{\min\text{reg}} / Q_{\min\text{nat}}$

Endangered species



Fossegrimemose (*Herbertus stramineus*)

i Åskåra, Bremanger



Vasshalemose (*Isoetes holtii*)



Rådgivende Biologer AS

How much water is needed to achieve...?



- Ecological or environmental objectives must be defined!
- Mitigation measures method
- Then dose-response relations
 - R&D
 - Expert judgment
 - Adaptive management
- Building block
 - Ecological bottlenecks
 - Protect other env objectives



Water Framework Directive maximum abstractions

Type or sub type	Season	flow > Qn ₆₀	Flow > Qn ₇₀	flow > Qn ₉₅	flow < Qn ₉₅
Lowland meandering	Apr – Oct	30	25	20	15
	Nov – Mar	35	30	25	20
Middle reaches	Apr – Oct	25	20	15	10
	Nov – Mar	30	25	20	15
Headwaters	Apr – Oct	20	15	10	7.5
	Nov – Mar	25	20	15	10
Salmonid spawning & nursery areas (not Chalk rivers)	Jun – Sep	25	20	15	10
	Oct – May	20	15	flow > Q ₈₀ 10	flow < Q ₈₀ 7.5

Summaries E-flow target and WFD



- No – it is not the easiest task
- Case by case acceptable?
- Some flow targets possible to establish
 - Linked to key processes and indicators (water covered area)
 - Most relevant quality elements (e.g. fish)
 - Landscape, recreation, other env objectives
- Building block method an appropriate framework
- Multicriteria analysis and participation process

Fig. 6 Consequence matrix after Mankin regression (2005), adapted to E-values.

E-value	Small	Medium	Large
Little negative	Low	Medium	High
Medium negative	Low	Medium	High
Strong negative	Low	Medium	High

According to Fig. (4), for residual flows of about 3 Q₁₀₀, there is hardly any impact on the flow appearance of a waterfall, because E is 0. However, even lower flows of Q₁ are usually sufficient to limit the extent of water diversion on flow appearance significantly, see steps 6 to 9 below.

Step 6: Determination of the value of the waterfall
The consequence of the extent E on the appearance of a waterfall depends on its value. The classification system of Deibel (2006) and Planch (1997) can be taken into account to evaluate the waterfall value. Further evaluation criteria are location, accessibility, connection to the surrounding landscape, economic flow value.

Step 7: Selected flow to keep a sufficient appearance, E
Q₁ is recommended to be selected so that for a given waterfall value the water diversion has little or medium negative consequences on its visual appearance according to the consequence matrix in Fig. 6. For instance, the extent E may be chosen up to about 0.6 if the waterfall has a large value. Depending on the value of the waterfall and the selected extent E, one subsequently chooses the value Q₁ (from the selected E-C-diagram (see Fig. 5) or Fig. (4)) and one determines Q₂.

Step 8: Evaluation of the consequence for the selected Q₁
For the selected Q₁, the consequence is evaluated (see Fig. 6, combining the extent E from Fig. (3) and the waterfall's value). The lower the value, the higher the extent E may be selected in step 7 to limit the negative consequences of water extraction from the waterfall.

Step 9: Review of the selected residual flow Q₁
Reviewing the discharge-related pictures and comparing these with the chosen Q₁ helps to check if the selection is also adequate from a knowledge point of view. There may be a need to evaluate more pictures to increase the number of data. Plotting A₁ (Q₁) against Q₂ (Q₁₀₀) may help to recognize critical discharges.

Fig. 7 Picture series of the waterfall at 100 Q₁ (A₁), 50 Q₁ (B₁) and 20 Q₁ (C₁) according to the methodology, and 10 Q₁ (D₁) as an alternative.



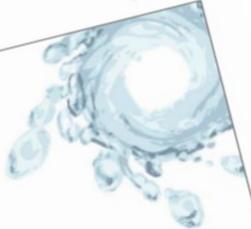
SOUTH EAST EUROPE

HydroPower

COMPARATIVE ANALYSIS OF METHODOLOGIES FOR THE IMPLEMENTATION OF ENVIRONMENTAL FLOWS (EF), ACCORDING TO THE WFD

WORK PACKAGE 4 – Preserving Water Bodies Ecosystems

Final Version
Date 07/31/2011



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T0.0226 - Unrestricted

Report

Setting environmental flows in regulated rivers

Implementing the EU Water Framework Directive (EU WFD) in Norway

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SINTEF Energy Research
2010-09-02

Fig. 6
Flow regime diagram showing the relationship between discharge (Q) and time (t) for different flow regimes.

Flow Regime	High	Medium	Low
High	High	Medium	Low
Medium	High	Medium	Low
Low	High	Medium	Low

Step 1: Review flow in Step 1 within a given river.
Q1 is considered to be the selected value for a given river. The value of Q1 is determined by the river's natural flow regime. The value of Q1 is determined by the river's natural flow regime. The value of Q1 is determined by the river's natural flow regime.

Step 2: Review of the consequences for the selected Q1.
The selected Q1 is reviewed for the consequences for the river's natural flow regime. The value of Q1 is determined by the river's natural flow regime. The value of Q1 is determined by the river's natural flow regime.

Step 3: Review of the consequences for the selected Q1.
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Step 4: Review of the consequences for the selected Q1.
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Fig. 7
Photographs of a river showing the effects of a dam on the river's natural flow regime. The left photo shows a river with a dam, and the right photo shows a river with a dam.

Challenging to settle flow targets on top of Europe...

