



Towards environmental requirements related to hydropeaking in Europe (WFD) & an overview for Norway

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INTER-COMPARISON OF GOOD ECOLOGICAL POTENTIAL/HMWB IMPACTED BY WATER STORAGE - TOWARDS AN HARMONIZED UNDERSTANDING AND COMPARABLE PRACTISE

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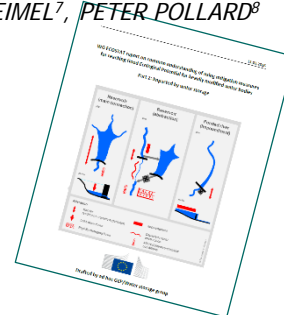
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⁷ Ministry with the long name, Austria,

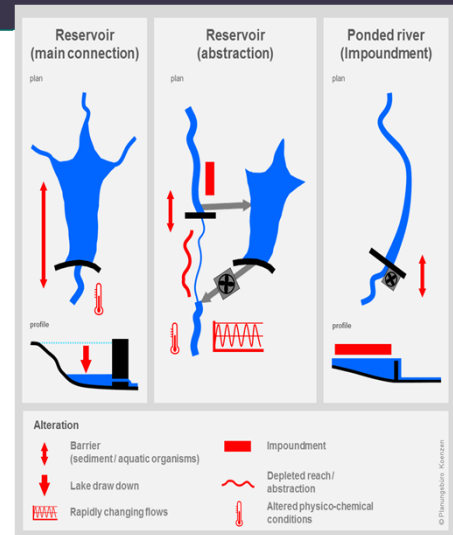
⁸ Scottish Environment Protection Agency, Scotland.



Common implementation - mitigating impacts from water storage - WFD

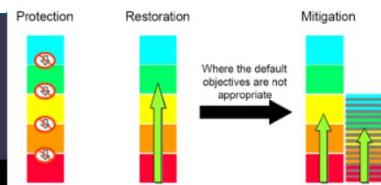
EU-report (CIS - WFD) on Good ecological potential and mitigation measures in water bodies impacted by water storage

- Common terminology
- Key impacts to be mitigated
- Minimum requirements
- Emerging good practise



CIS - ECOSTAT approach to assessing comparability (2013-2016)

Hydro-morphological alterations	Pollution pressures
Mitigation measures expected in HMWBs for GEP	Existing intercalibrated methods - where not significantly affected by the hydro-morphological alterations



Comparison of biology/hymo standards ruled out so far...



Availability and relevance of impacts/measures – water storage

	1. Upstream continuity fish	2. Downstream continuity fish	3. Low flow	4. Fish flow	5. Variable flow	10. Physico-chemical alteration	6. Rapidly changing flows	7. Sediment alteration	8. Lake level alteration	9. Poned rivers (impoundments)
Austria – AT	Yes	Yes	Yes	Not relevant	Yes	Yes	Yes	Yes	Yes	Yes
Belgium – BE	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bulgaria – BG	Yes	Not relevant	Yes	Yes	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
Croatia – HR	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cyprus – CY	Not relevant	Not relevant	Yes	Not relevant	Not relevant	Not relevant	Not relevant	No measure in library but impact identified	Not relevant	Not relevant
Czech Republic – CZ	Yes	-----	-----	-----	-----	-----	-----	Yes	-----	-----
Denmark – DK	Yes	Yes	Yes*	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
Estonia – EE	Yes	Yes	Yes	Yes	No measure in library but impact identified	No measure in library but impact identified	Yes	No measure in library but impact identified	Yes	No measure in library but impact identified
Finland – FI	Yes	Yes	Yes	Yes	Yes	No measure in library but impact identified	Yes	No measure in library but impact identified	Yes	Yes

Response: water managers in 23 WFD countries, (3 not possible, 4 no reply)

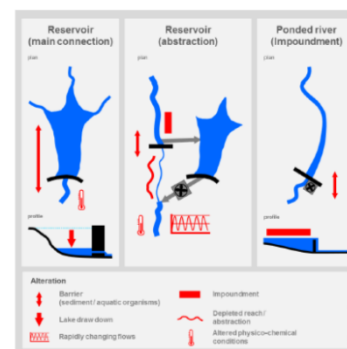


Key measures to mitigate impacts from water storage in Europe

- Key mitigation measures and options
 - Interrupted continuity for fish
 - Flow alteration (**incl hydropeaking**)
 - Sediment alteration
 - Poned rivers (impoundments)
 - Lake level alteration
 - Physico-chemical alteration (e.g. temperature)**
- Sustainable vs non-sustainable mitigation solutions
- Scale of impacts typically mitigated
- Significant adverse effect on water use and wider environment
- Reasons for “outruling” measures
- Minimum requirements for GEP and objective setting

2016-10-06
WG ECOSTAT report on common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies

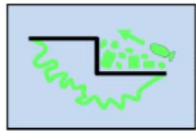
Part 1: Impacted by water storage



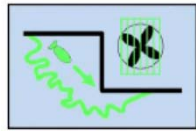
Drafted by ad hoc GEP/Water storage group
for CIS WG ECOSTAT

Mitigation measure options and/or combination needs

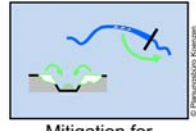
Continuity mitigation measures



1. Upstream continuity fish

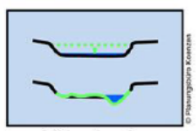


2. Downstream continuity fish

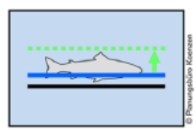


Mitigation for sediment alteration

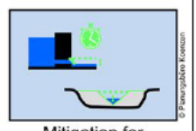
Flow mitigation measures



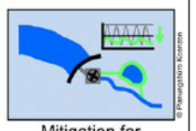
Mitigation for low flow



Mitigation for fish flow



Mitigation for variable flow

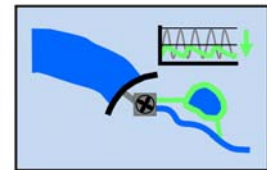


Mitigation for rapidly changing flows

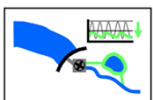


Measure options – hydropeaking mitigation

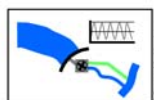
Hydromorphological alteration	Main ecological impact*	Mitigation measures options
<u>Rapidly changing flows</u> (including hydro peaking)	Reduction in animal & plant species abundance due to stranding & wash out	<ol style="list-style-type: none"> Balancing reservoir(s) (internal) Relocate tailrace Reduce rate Modify river morphology Balancing reservoir(s) (external) (Fish stocking - some countries)



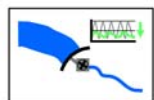
Mitigation for rapidly changing flows



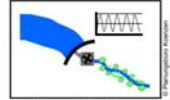
Constructing external balancing reservoir



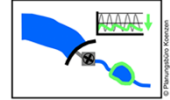
Relocating tail race



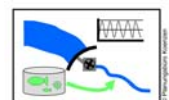
Reducing hydropeaking rate



Improving river morphology



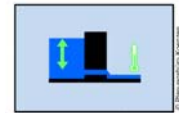
Constructing balancing reservoir(s)



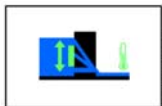
Compensating with fish stocking

Measure measures – physio chemical alteration

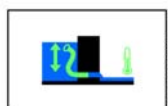
Typical hydromorphological impacts	Alteration of physico-chemical conditions downstream of water storage Transaction of water and/or deep water intake E.g. altered water temperature or quality and ice conditions in alpine rivers
Typical ecological impacts	Altered composition or growth of biological quality elements Reduced survival/growth rate of fish in particular
Success criteria - mitigation	Mimicking more natural physico-chemical conditions Increased growth and survival of fish and macroinvertebrates More natural composition of biological quality elements



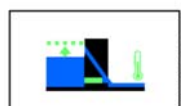
Mitigation for physico-chemical alteration



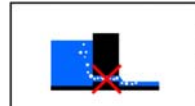
Multiple intakes at different heights in reservoir dam



Installing flexible intake



Managing reservoir level



Mitigating oversaturation



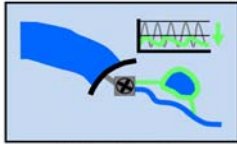
Degree of similarity between countries on impacts and mitigation measures

The key findings related to the similarity between countries on impacts and measures were that:

- The most frequently identified impacts due to water storage were mitigation of
 - fish migration,
 - a viable minimum environmental flow
 - insufficient flow variability.
- The highest level of heterogeneity for measures aimed at mitigating
 - physico-chemical alteration
 - rapidly changing flows (hydropeaking)
 - sediment alteration and ponded rivers.

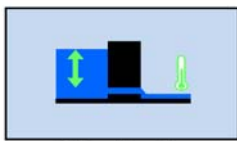
Mitigation measure	Impact identified	Use of measure	Impacts and mitigation	
			Type of highest ranked measure	No of countries identifying the need for this mitigation
Upstream continuity for fish				21
Downstream continuity for fish			Bypass channel	20
Low flow			Provide additional flow	18
Fish flow			Flow for up and downstream migration	14
Variable flow			Actively delivered flow	18
Physico-chemical alteration			Multiple reservoir intakes	13
Rapidly changing flows			Reduce rate of flow change	15
Sediment alteration			Introduce mobilising flows	15
Lake level alteration			Reduce abstraction during sensitive period	16
Ponded rivers (impoundments)			Lateral reconnection	13

Emerging good practise (WFD)



Mitigation for rapidly changing flows

- Installing external balancing reservoirs
- Reducing the rate of which the discharge ramps down
- Relocation of tailrace
- Improving in-channel structures



Mitigation for physico-chemical alteration

In general less experience in implementing these measures;

- Flexible or multiple intakes
- Managing lake level (reservoir) in sensitive periods



Key recommendations (WFD)

- **Recommendation 3:**
 - *Further clarification on the reasons for heterogeneity across countries on measures used for mitigating especially:*
 - *physico-chemical alterations,*
 - *rapidly changing flows (hydropeaking),*
 - *sediment alterations and impacts from ponded rivers (impoundments).*
- **Recommendation 5:**
 - *Countries are strongly recommended to take account of the emerging good practice identified in this report (on e.g. hydropeaking).*



Key recommendations (WFD)

- **Recommendation 6:**
 - *An optimal combination of good practice measures might even lead to GES*
 - *avoiding designating water bodies as HMWBs,*
 - *as they can be considered as restoration measures.*
- **Recommendation 13:**
 - *HMWB case study exercise on national methods*
 - *incorporating into a good practice guide.*
 - *Supplement CIS Guidance no. 4 on HMWB,*
 - *needed to ensure common environmental requirements in HMWBs.*
- **GEP report to be published as an JRC report in 2016**
 - *Under consultation CIS - WG ECOSTAT*



Hydropeaking - Norway

Relevant R&D and Management practise



Management of hydropеaking in Norway

- Rapid flow change, stranding of fish and hydropеaking a major issue
 - >50 % of the storage capacity in Europe
 - Tailrace from HP to fish rivers are widespread
 - Accidental drop out of HP
- No systematic assessment nor classification yet
 - Peaking seems so far less extensive than in the alps



Raske vannstandsendringer i elver - Virkninger på fisk, bunndyr og begrøning



Sluttrapport fra forskningsprosjektet "Konsekvenser av effektivisering på økosystemer i rennende vann"

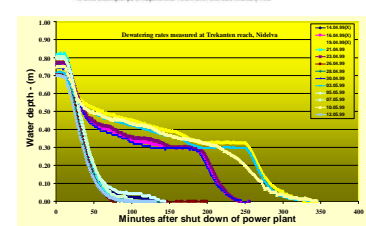
A. Harby, K. Alfreidsson, J.V. Arnekleiv, L.E.W. Fjodmark, J.H. Halleraker, S. Johansen, S.J. Saltveit
 Februar 2004



Management of hydropеaking in Norway

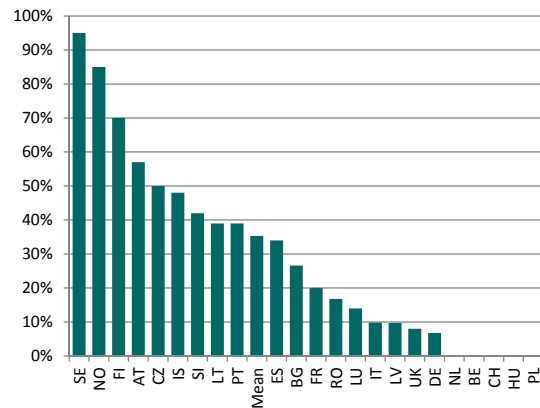
Dominating measures

- New hydropower schemes
 - Gentle ramping (restriction on operation)
 - By-pass valves (technical solution)
- Older hydropower
 - Gentle ramping on a volunteer basis
 - By-pass valves installed in some
 - Focus on mitigation when revising terms
- Balancing reservoirs not in focus

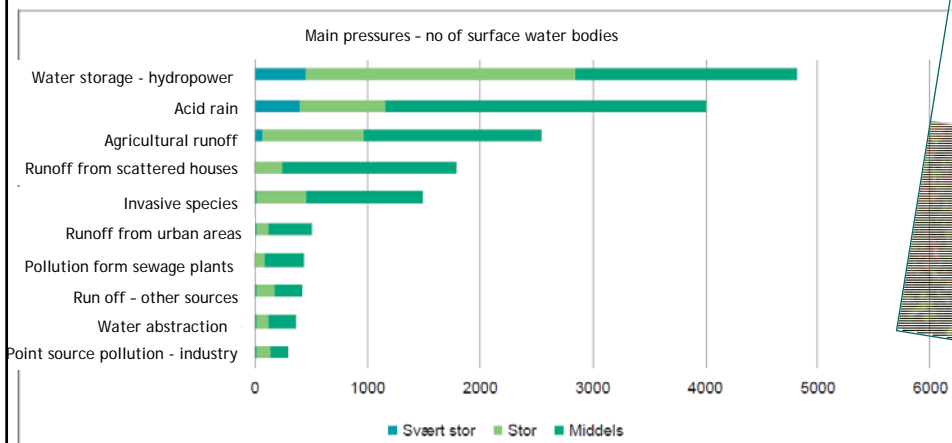


HMWB and hydropower

- The Nordic + alpine countries have much in common
- Highest share of designation for HMWB due to storage for hydropower



Significant pressures – Norway (2016)



RBMPs and objectives in regulated rivers

- Priorisation exercise
 - Strategic masterplan covering ca 80 % of Norwegian hydropower
 - Mitigation measures vs restoration potential (environmental values)
- Regulated rivers and Norwegian RBMPs (WFD) until 2021
 - Significant water issue in all 11 river basins
 - > 2500 HMWBs - impacted by HP
 - Minimum flow requirements in by-passed river stretches (significant effect on use)
 - Revision of terms needed in old schemes

Disse er topp prioritert

Riverting	Utslippskategori	Utslippskategori
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10
11	11	11
12	12	12
13	13	13
14	14	14
15	15	15
16	16	16
17	17	17
18	18	18
19	19	19
20	20	20
21	21	21
22	22	22
23	23	23
24	24	24
25	25	25
26	26	26
27	27	27
28	28	28
29	29	29
30	30	30

Process to improve the regulated water environment

- Melding on energy and biodiversity in parliament 2016
 - Increase revision of terms
 - Strengthen the legal possibilities in management
 - Mitigation measure without effect on use → pressure pay principle
- Regulated rivers and Norwegian RBMPs (WFD) 2021-20133
 - RBMPs adopted by Ministry July 2016
 - 387 water bodies specified in decision
 - Flow measure in more than 50 rivers 2021-2033 (revision required)
 - Physical measures <2021

Water bodies (mainly rivers) to be improved by mitigating impacts from hydropower			
River basin	Flow measures	Other measures	Total
Glomma/Västerhavet	35	33	68
Vest-Viken	35	56	91
Agder	17	8	25
Rogaland	2	1	3
Hordaland	10	13	23
Sogn/Fjordane	13	48	61
Møre/Romsdal	12	10	22
Trøndelag	8	10	18
Nordland/JM	16	23	39
Troms	8	21	29
Finnmark/norsk-finsk	4	4	8
Norway	160	227	387

Management of hydropeaking

Mitigation efforts and experience:

- Main focus on gentle ramping in salmon rivers
 - HP tailrace with outlet in rivers
 - Environmental challenges mainly in rivers not reservoirs or coastal water
- Normally requirements in modern licenses
 - Gentle down-ramping
 - By-pass valves (also in small scale hydro)
- Hardly no experiences with balancing reservoirs
- Further mitigation highlighted topic in revision of terms in the years to come
- In process of implementing R&D results from CEDREN/ENVIPEAK in 2016
 - Probably more focus on mitigating hydropeaking in the next RBMP cycle



We welcome swiss water managers to get on board on the CIS activities on Hymo intercomparison



River Rinna