

Implementation of the Swiss regulatory context from an operator perspective



Foto: Dr. Markus Zeh

IEA Hydropower

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1. Introduction – Situation in Switzerland

Energy Situation in Switzerland

- About 55% Hydro Power Plants
- About 40% Nuclear Power Plants
- About 5% others

Goals of Energy Strategy

- Reduction of Nuclear Power Plants
- No Thermal Power Plants
- Slight increase of Hydropower
- Increase in Photovoltaik and Wind
- Decrease of Energy Consumption

Challenges of Swiss Energy Strategy

- Slight Increase of Hydropower
 - with higher standards of residual flows...
- Increase in Photovoltaik and Wind
 - Landscape issues...
- Decrease of Energy Consumption
 - Capitalism...
- Net Stability:
 - Short Term Fluctuations
 - Hydropower / Pumpstorage
 - Seasonal Storage
 - from Summer into Winter (new reservoirs)...



Main Impacts of Hydropower on Aquatic Organisms

- Residual Flow
- Hydropeaking
- Fish Migration
- Graveltransport / Flood-Dynamics
- Morphological Impacts
- Ponding

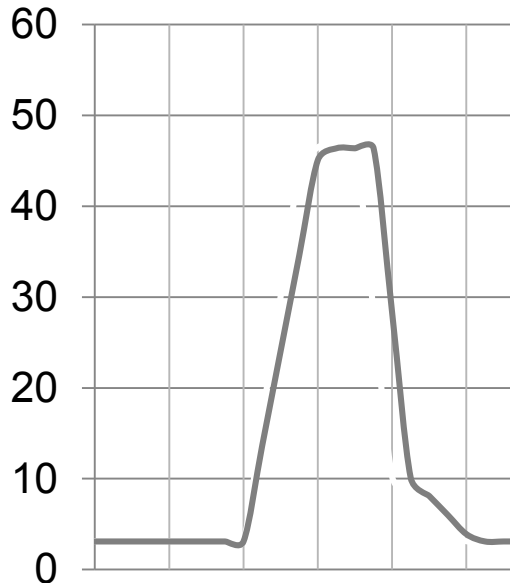
2.1 Swiss Law – Residual Flow

- Usually, a concession lasts 60 to 80 years
- Hydropowerplants pay "Wasserzinsen" \approx 1.2 Cent / KWh
- Definition of Residual Flow depends on:
 - Natural Minimum Flow Q_{347}
 - Occurrence of Fish
 - Occurrence of protected species / habitats
 - Ecological Potencial
 - Fish Migration
 - Landscape Issues
 - Seasonal Aspects
 - Morphological Measures
 - Aspects for Hydropower Production



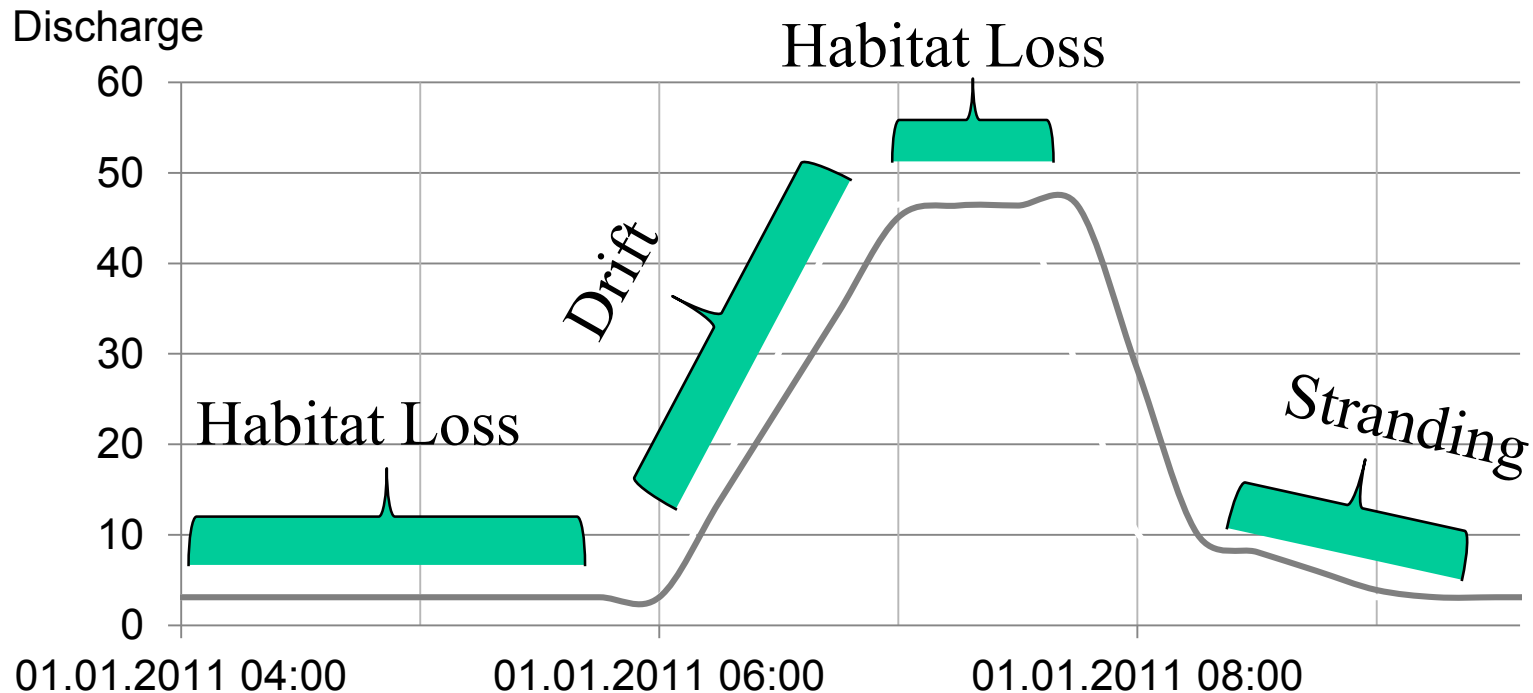
Since 2011 Further Requirements of the Swiss Law

- Until 2030: Mitigation of
 - Hydropeaking
 - Gravel Transport (Power Plants & Canton)
 - Fish Migration (Power Plants & Canton)
- *Payed by Energy Consumers (0.1 Rp/KWh (Powerplants pay «Wasserzinsen» = 1.2 Rp/KWh)*



Hydropeaking

- «Mitigation of Hydropeaking: no significant Impacts on aquatic Flora and Fauna»
 - «under Restriction of Commensurability» (Disproportional Costs)
 - With Constructional Measures Operational Measures only when Owner of the Powerplant agrees



Vollzugshilfe II „Hydropeaking Measures“ (2017)

→ Selection of the Adequate Measure(s)

All Indicators can be modelled and are sensitive to hydropeaking

Core Indicators

F2 Stranding of Fish

F3 Spawning of Fish

Q1 Watertemperature

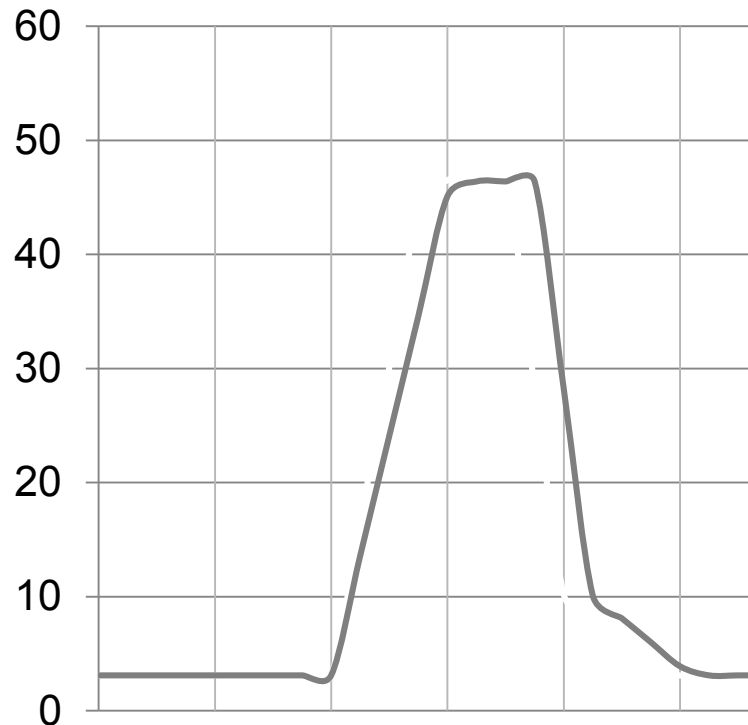
F6 Habitat of Fish

B5 Habitat Macrozoobenthos

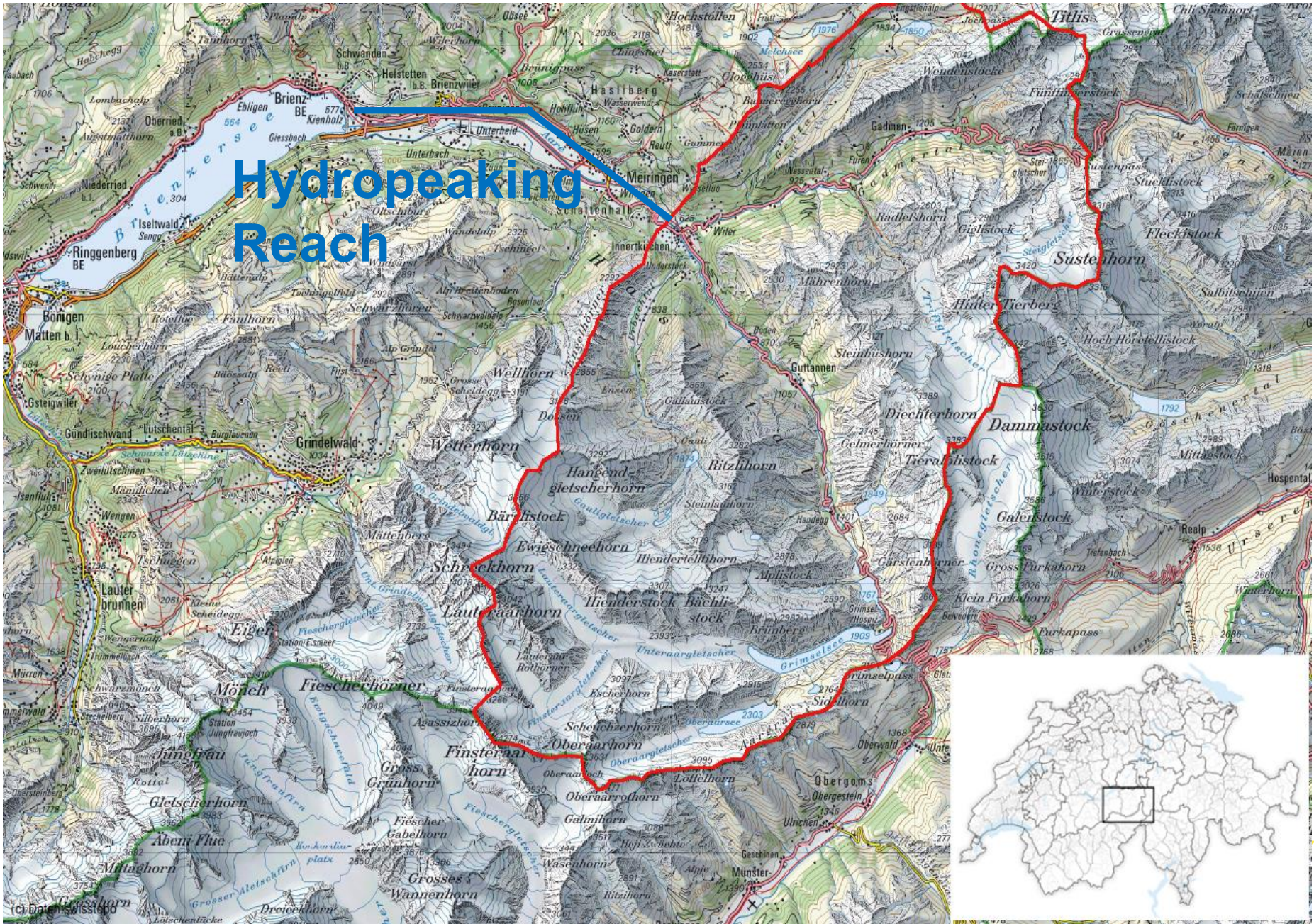
Further Indicators

D1 Drifting of Macrozoobenthos

H1 Clogging



3. Introduction Case Study Hasliaare

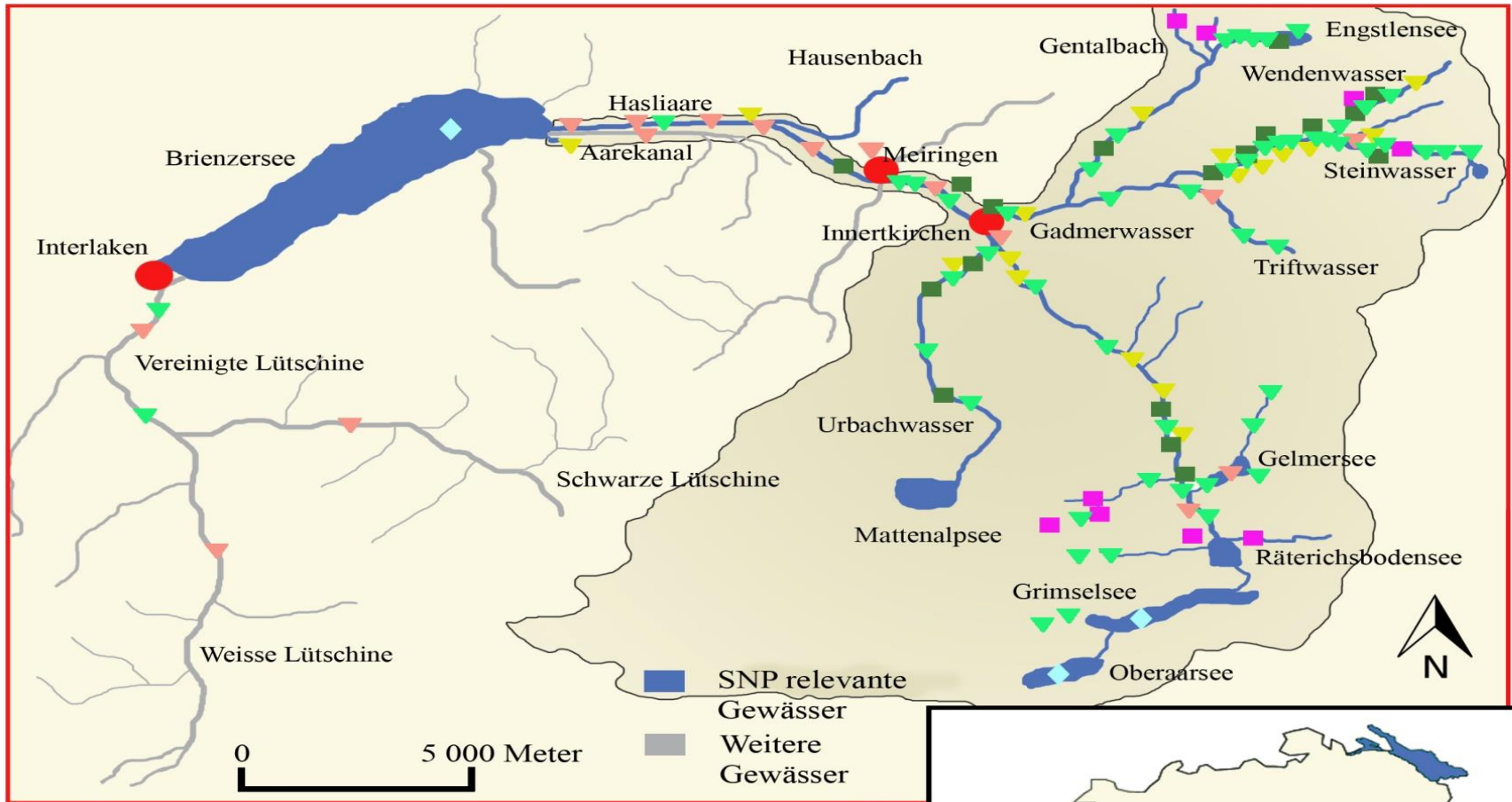


Site Characteristics

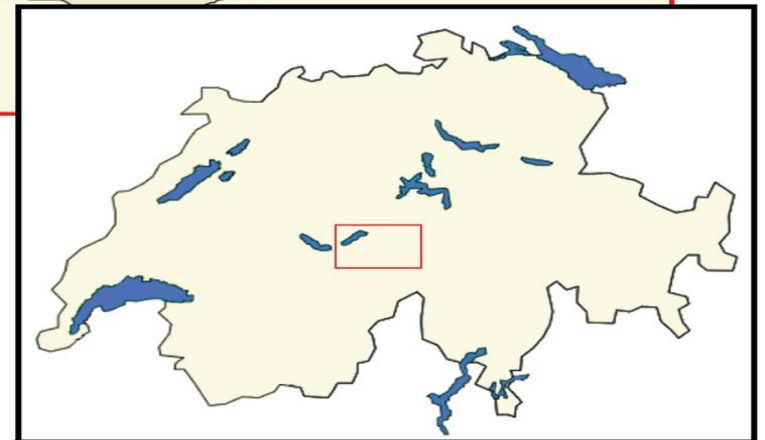
- Area 450 km² with Aare- (Grimselgebiet) and Gadmental (Sustengebiet)
- 21% Glaciers, Precipitation per year \pm 2000mm
- Glacial Discharge Regime
- MQ at Innertkirchen 35 m³/s
- Energy Production KWO 2500 GWh/a (inkl. 800 GWh/a Pump-Storage)



Ecological Investigations

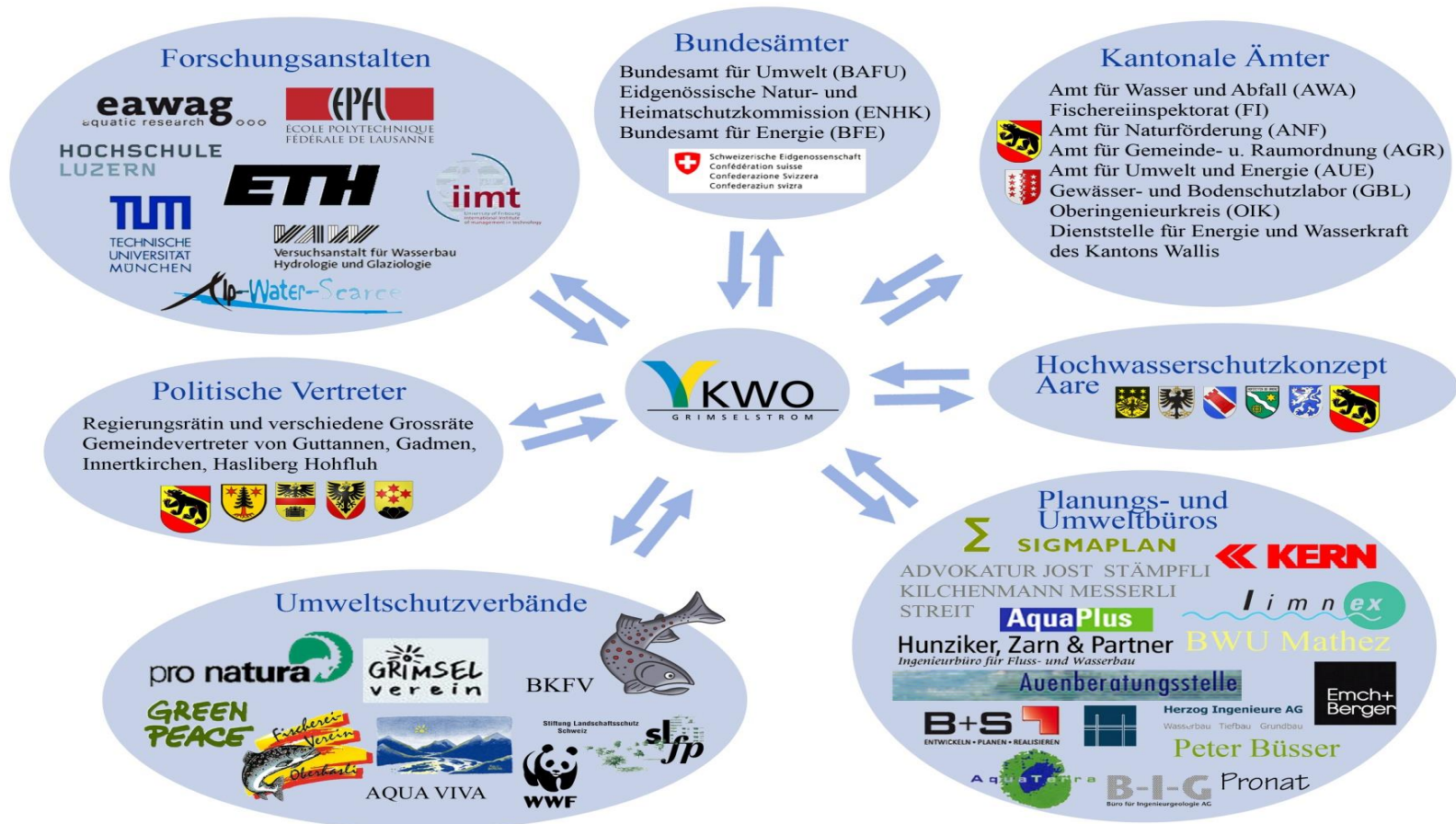


- Hydrologische Untersuchungen
- Hydraulische und landschaftliche Untersuchungen
- ▼ Fischökologische Untersuchungen
- ▼ Wirbellose und Wasserpflanzen
- ▼ Aue und Vernetzung
- ◆ Untersuchungen zur Trübung



Participation Process defining

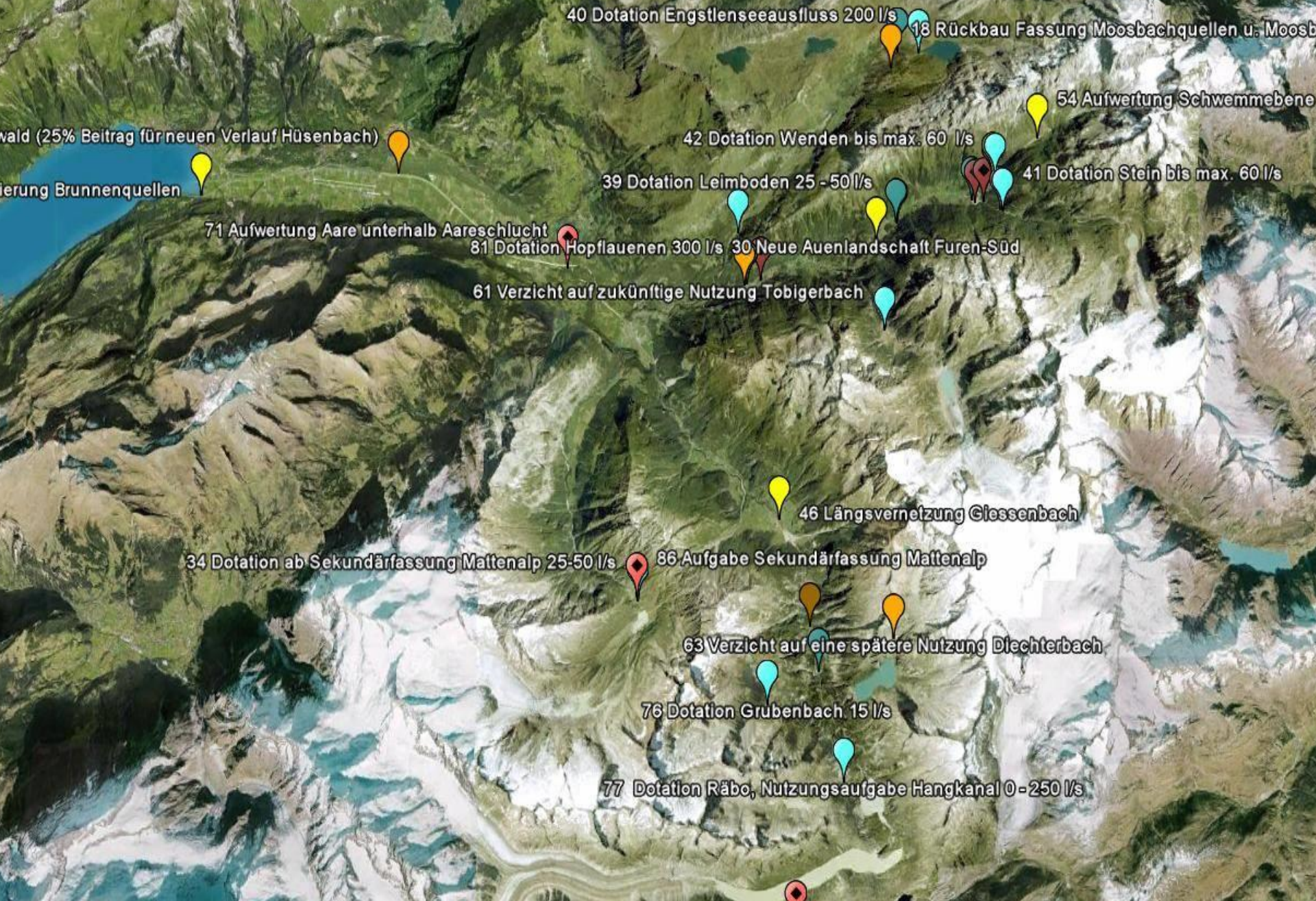
- Residual Flow
- Ecological Measures
- Power Plant Extensions (+10% without taking more water)



→ More than 150 persons have been involved



Overview Ecological Measures



Mitigation of Hydropeaking

- $MQ = 35 \text{ m}^3/\text{s}$ $Q_{\text{Summer}} = 100 \text{ m}^3/\text{s}$ $Q_{\text{Winter}} = 2 \text{ m}^3/\text{s}$
- $Q_{\text{Sunk}} = 3 \text{ m}^3/\text{s}$ $Q_{\text{Schwall}} = 95 \text{ m}^3/\text{s}$

Groyens
Innertkirchen

Width 25 m



Gravel Bar
Meiringen

Width 25 m

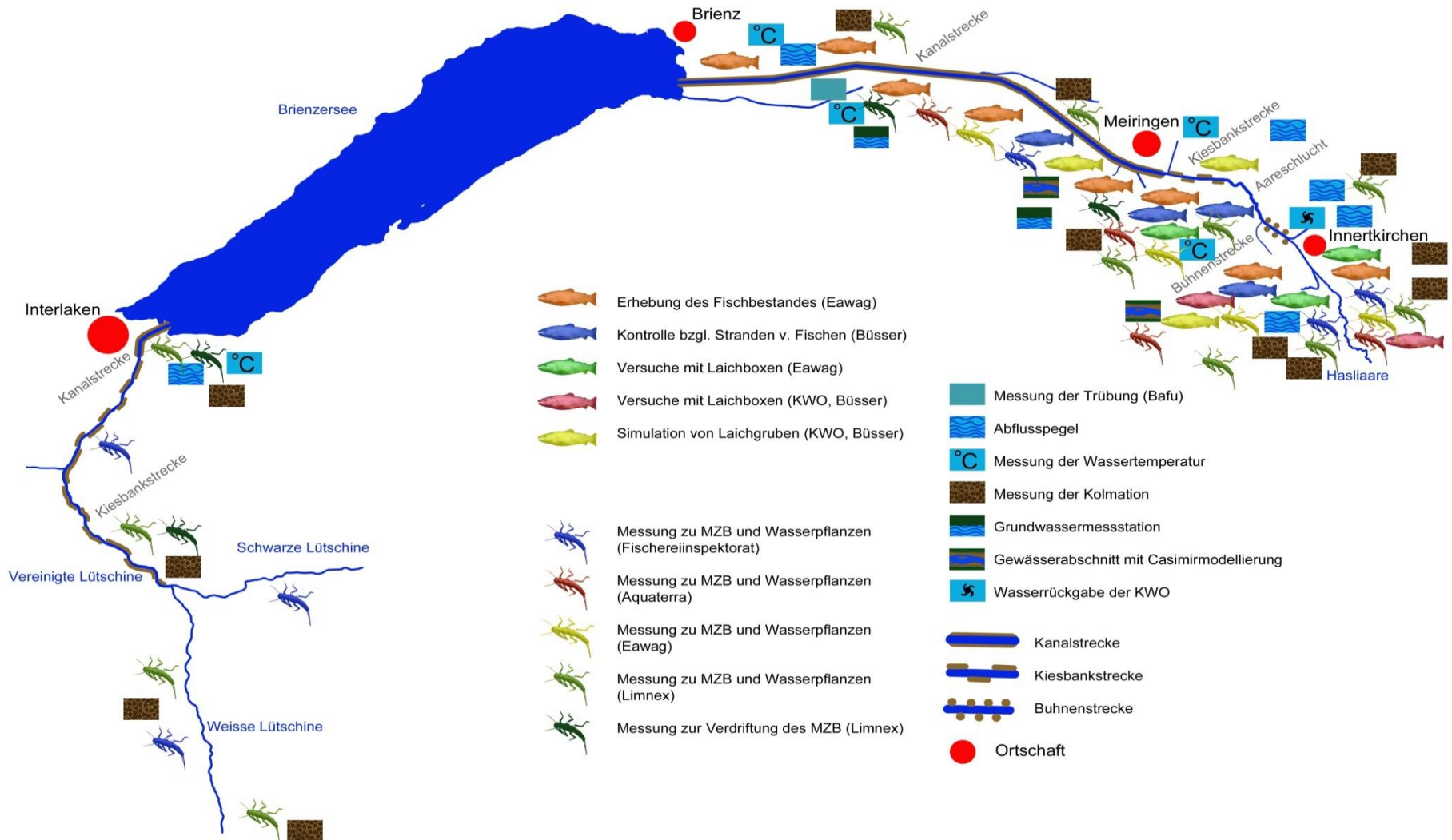


Channel
Meiringen-Brienz

Width 18 m



Aquatic Investigations with respect to Hydropeaking



Offices

- BAFU, AWA

KWO

- Production

KWO

- Engineering

Experts Ecology

- Limnex, Eawag, Büsser

Cantonal Group

- FI, GBL, OIK, ANF, AGR, AWA

Fachstelle
Ökologie KWO

Experts Hydraulics

- Schneider & Jorde

Experts Hydrology

- EPFL

NGOs

- Pro Natura, BKfV, Gemeinde IK

Ecological Evaluation of different Mitigation Measures

- $V = 50'000 \text{ m}^3$
- $V = 60'000 \text{ m}^3$
- $V = 80'000 \text{ m}^3$
- $V = 100'000 \text{ m}^3$

→ *Decreasing Ramping Rates / Increasing Reaction Time*

- *Tunnel to Lake of Brienz (20 km) → too expensive*

We have been "too early" and had to apply Vollzugshilfe I (developped for evaluation of actual state)



Evaluation from Experts (Experience, Literature, Conclusions by Analogy) ...



...with some Uncertainty



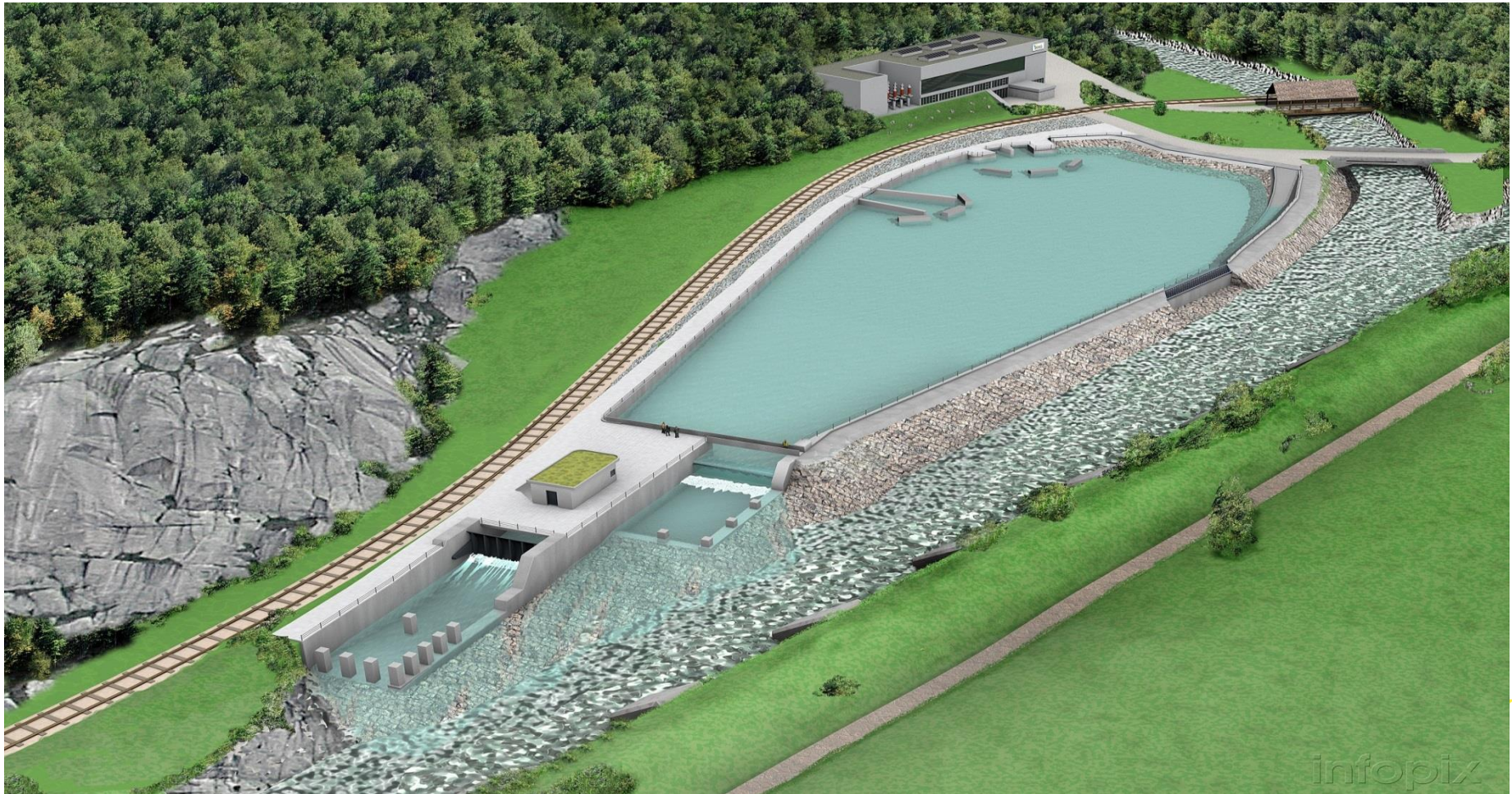
Gesamtbewertung



	I	50	60	80	100	Remarks
Clogging	Green	Green	Green	Green	Green	Weak
Wassertemperatur	Green	Green	Green	Green	Green	Weak Impact
Base Flow	Green	Green	Green	Green	Green	Higher than natural Q_{347}
Biomasse MZB	Yellow	Green	Green	Blue	Blue	Zust. III: Reduction of Drifting
MSK MZB	Green	Green	Green	Green	Green	
Zonation MZB	Blue	Blue	Blue	Blue	Blue	Zust. III: Reduction of Drifting
EPT MZB	Green	Green	Green	Green	Green	
MSK Fische	Yellow	Yellow	Yellow	Yellow	Yellow	Natural Flow Regime is lacking of Habitats for juvenile Fish due to Channelisation
Stranding of Fish	Yellow	Green	Green	Blue	Blue	Reduction of Downramping Rate
Spawning of Fish	Green	Green	Green	Green	Green	Spawning Areas stable at maximum Flow and never dry
Juvenile Fish	Red	Red	Red	Red	Red	Compare MSK Fische
Productivity of Fish	Orange	Yellow	Yellow	Yellow	Yellow	Compare MSK Fische

Selection of Scenario V = 80'000 m³

- Volume of Retetion Basin = 20'000 m³
- Volume of Gallery (from Powerplant INN1 to Retention Basin) = 60'000 m³



Evaluation of all Experts



- To improve Situation for juvenile Fish (Indicator F4) the Morphology has to be ameliorated (independently from Hydropeaking the main Problem)

Instream Measures

Group of Boulders

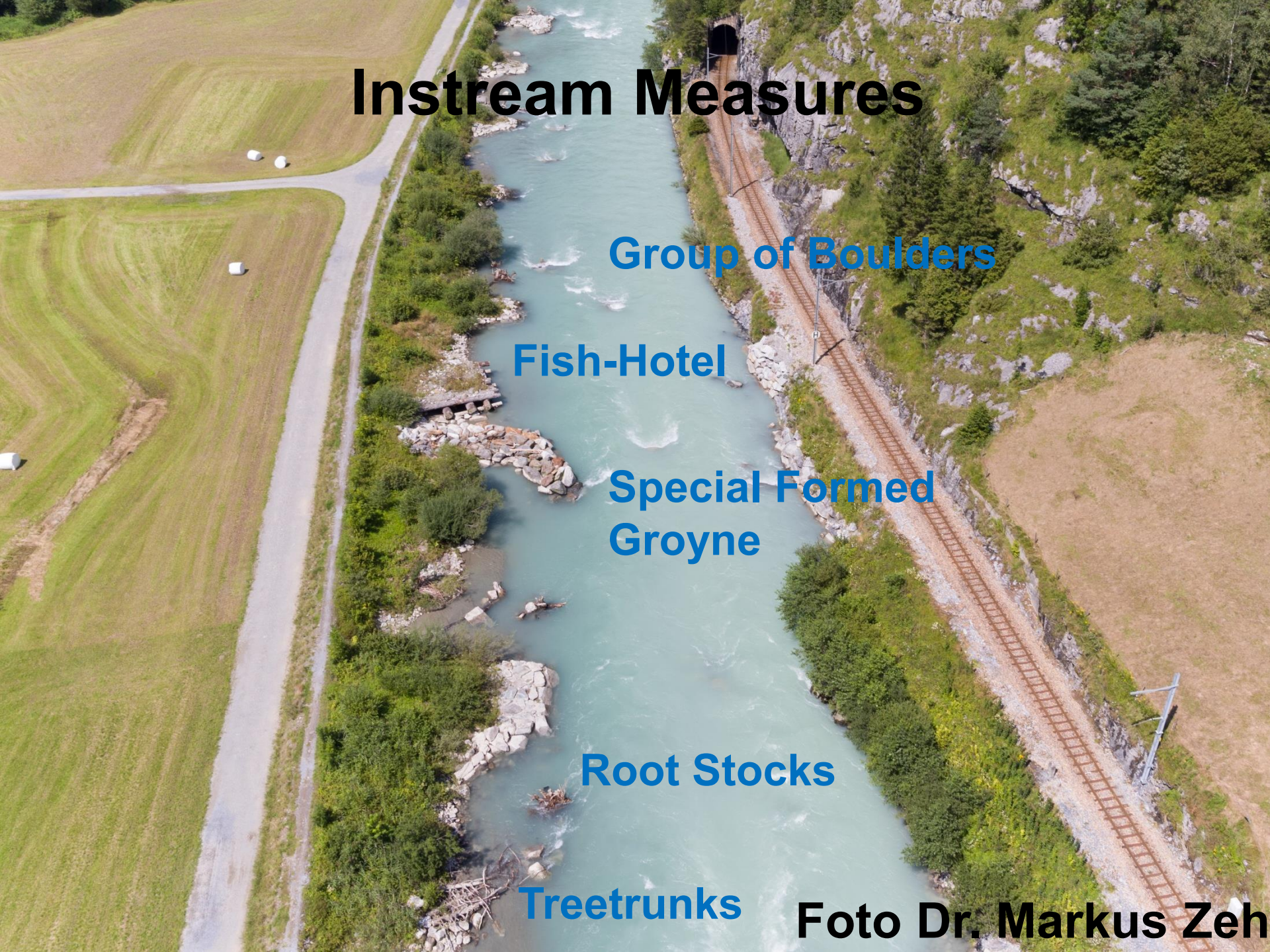
Fish-Hotel

Special Formed
Groyne

Root Stocks

Tree trunks

Foto Dr. Markus Zeh



First Results



E-Fishing: Nov 2015 and Mar 2017
Significant Increase of Juvenile Fishes
Indicator F4 from red → yellow/green

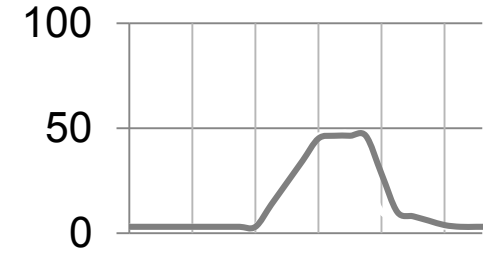
Fish Migration – Fish-Lift Gadmerwasser



4. Most Important Knowledge-Gaps

Hydropeaking

- Effects of Mitigation Measures
- Critical Values for Minimising Stranding of Fish
- 2017-2018 Experiments with wild fishes in the Hasliaare
- General Process-Understanding



Fishmigration

- Downstream Migration



Residual Flow

- Critical Waterdepth for Big Salmonids
- Other Parameters influencing the Movement of Big Salmonids
- "Hope" in Horizon 2020 (KWO as a Case Study)

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Thank You for your Attention!



**Foto Dr. D. Tonolla & Dr. M. Döring,
eQcharta / ZhAW**