Eawag:
Das Wasserforschungsinstitut
des ETH-Bereichs

eawag
aquatic research

Ökologische Auswirkungen der Kleinwasserkraft

Katharina Lange, Abteilung Oberflächengewässer

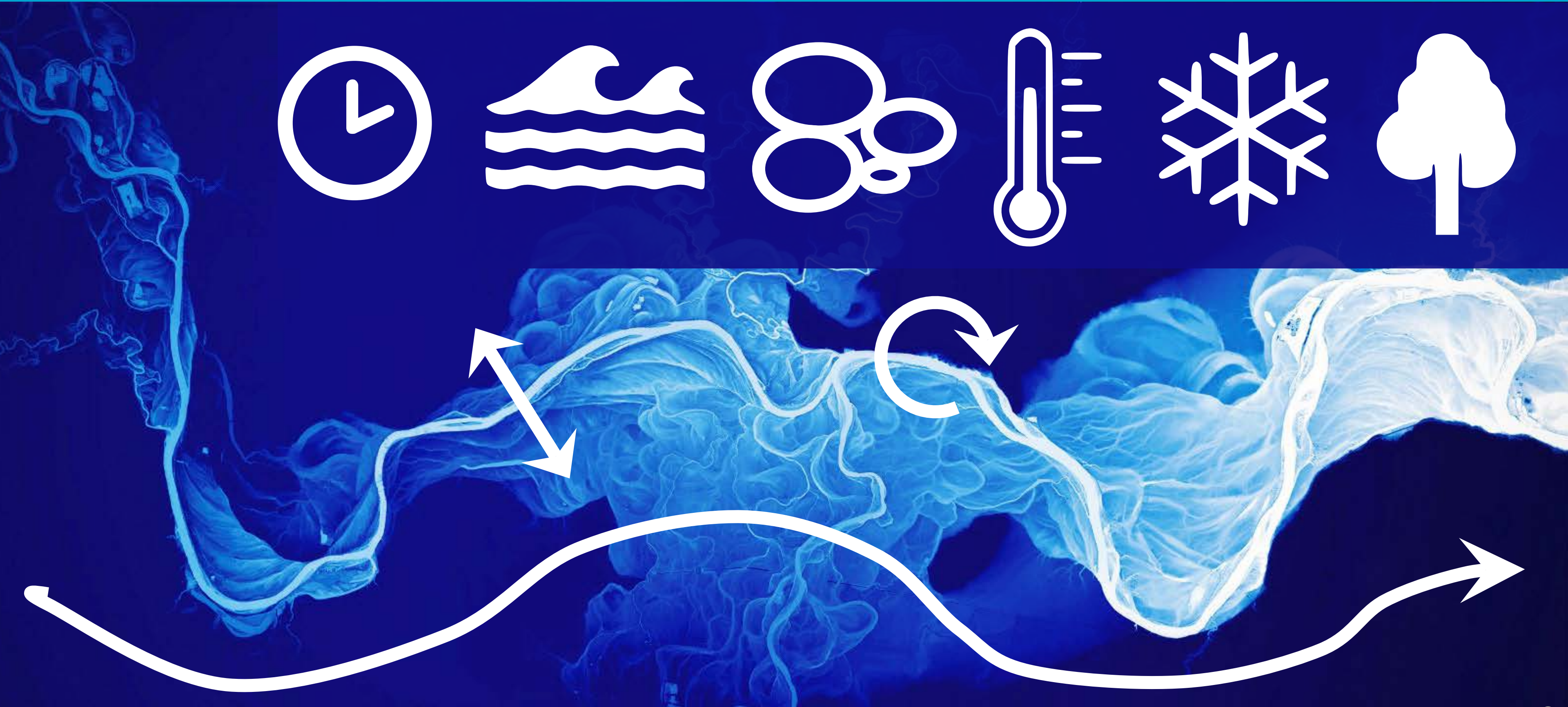
Eawag-Infotag, 3. September 2019
Gewässer in Zeiten der Energiewende

Vernetzung in Fliessgewässern

Willamette River: Daniel Coe; Oregon Dept. of Geology and Mineral Industry; Icons by Adioma

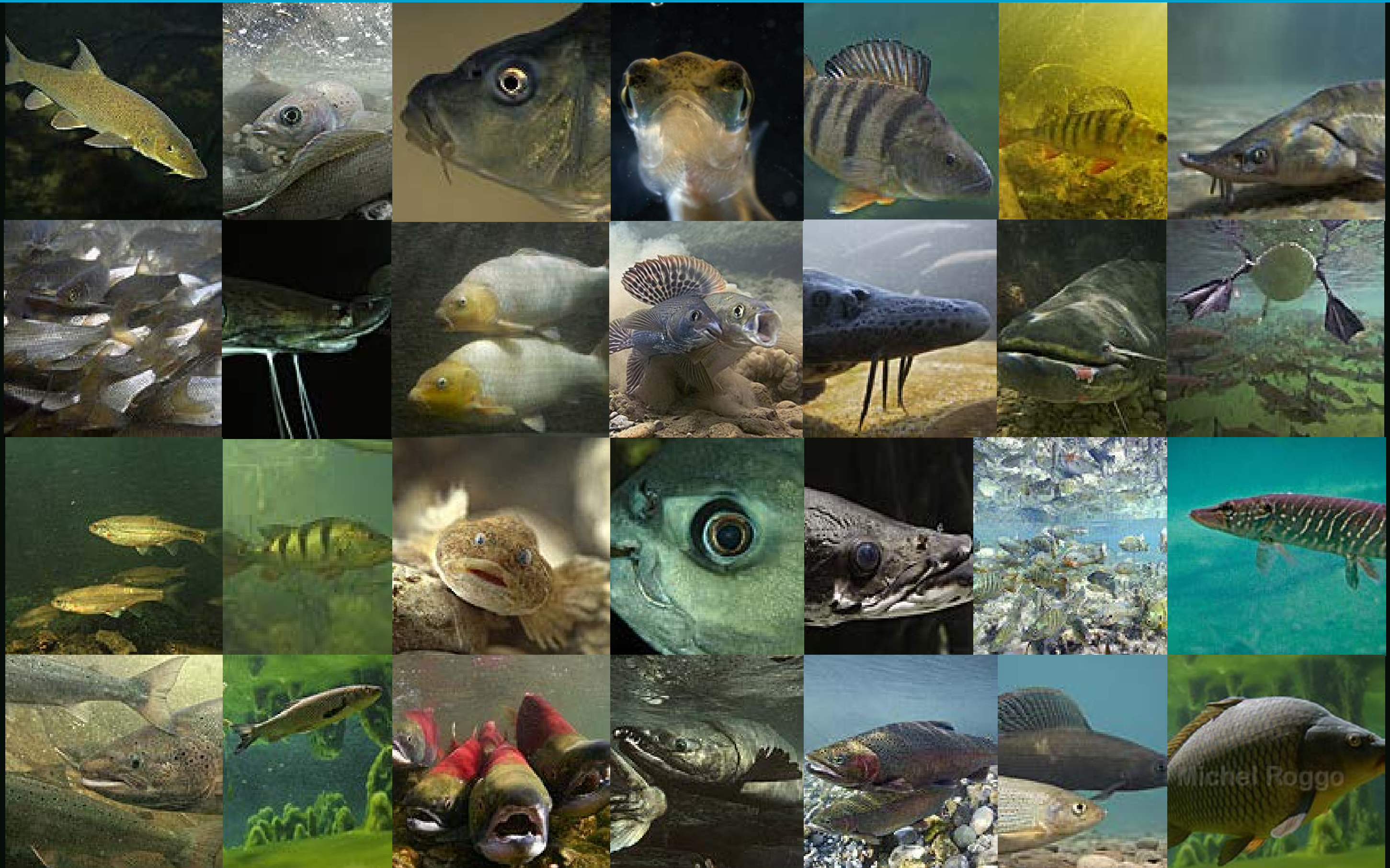
Vernetzung in Fliessgewässern

eawag aquatic research



Willamette River: Daniel Coe; Oregon Dept. of Geology and Mineral Industry; Icons by Adioma

Süsswasser Biodiversität



www.roggo.ch

Süsswasser Biodiversität

eawag
aquatic research

0.01% des Wassers

6% der globalen Biodiversität

und 40% aller Fischarten.

(Dudgeon *et al.* 2006. Biol Rev)

Icons by
Adioma

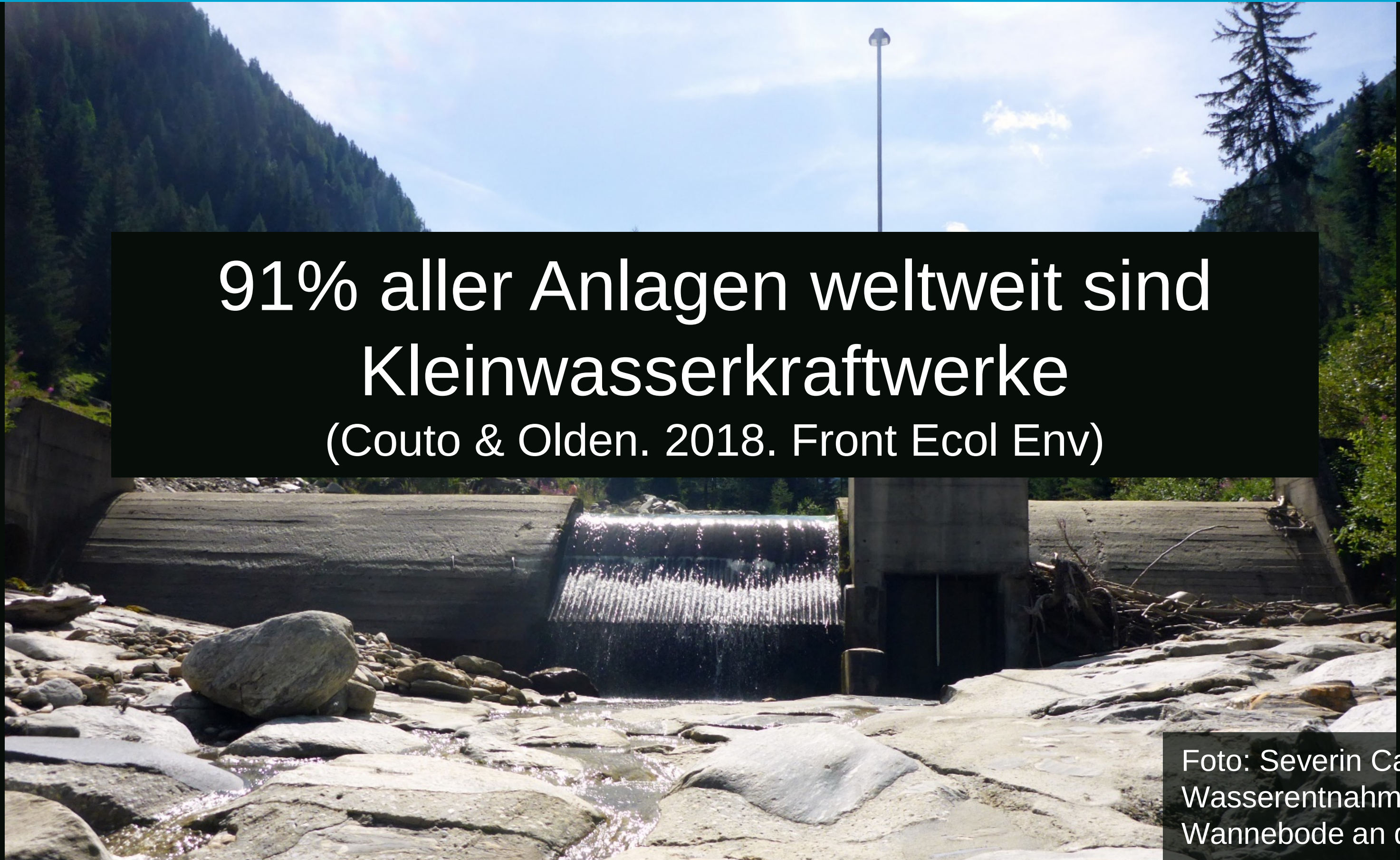
www.roggo.ch

Das Kleinwasserkraftwerk

eawag
aquatic research

Foto: Severin Caluori
Wasserentnahme Kraftwerk
Wannebode an der Blinne (VS)

Das Kleinwasserkraftwerk



91% aller Anlagen weltweit sind Kleinwasserkraftwerke

(Couto & Olden. 2018. Front Ecol Env)

Foto: Severin Caluori
Wasserentnahme Kraftwerk
Wannebode an der Blinne (VS)

Literaturstudien

eawag
aquatic research

Lange *et al.* 2018. Basin-scale effects of small hydropower on biodiversity dynamics. Front Ecol Env

Check for updates

Basin-scale effects of small hydropower on biodiversity dynamics

Katharina Lange[1,2*], Philipp Meier[1], Clemens Trautwein[1], Martin Schmid[1], Christopher T Robinson[3,4], Christine Weber[1], and Jakob Brodersen[2,5]

Construction of small hydropower plants (<10 megawatts) is booming worldwide, exacerbating ongoing habitat fragmentation and degradation, and further fueling biodiversity loss. A systematic approach for selecting hydropower sites within river networks may help to minimize the detrimental effects of small hydropower on biodiversity. In addition, a better understanding of reach- and basin-scale impacts is key for designing planning tools. We synthesize the available information about (1) reach-scale and (2) basin-scale impacts of small hydropower plants on biodiversity and ecosystem function, and (3) interactions with other anthropogenic stressors. We then discuss state-of-the-art, spatially explicit planning tools and suggest how improved knowledge of the ecological and evolutionary impacts of hydropower can be incorporated into project development. Such tools can be used to balance the benefits of hydropower production with the maintenance of ecosystem services and biodiversity conservation. Adequate planning tools that consider basin-scale effects and interactions with other stressors, such as climate change, can maximize long-term conservation.

Front Ecol Environ 2018; doi:10.1002/fee.1823

Freshwater biodiversity is declining at unprecedented rates, with habitat fragmentation and degradation among the key drivers (Dudgeon *et al.* 2006). Biodiversity, and genetic diversity in particular, may be one of our greatest assets to combat the impacts of climate change and ensure long-term ecosystem stability and provisioning of ecosystem services. The global boom in hydropower development – fueled in large part by changes in public perception following the disaster at the Fukushima Daiichi nuclear power plant in Japan in 2011 and the need to reduce atmospheric greenhouse-gas emissions – exacerbates

In a nutshell:

- Small hydropower planning often neglects large-scale ecological and evolutionary processes, as well as the cumulative effects of multiple hydropower plants
- Fragmentation by small hydropower impedes organism dispersal and migration, which can lead to reduced genetic diversity, diminishing the potential to adapt to changing environmental conditions and increasing local extinction risk
- Interactions between small hydropower and other anthropogenic stressors, such as climate change, need to be considered when assessing environmental impacts
- Spatially explicit planning tools that consider multiple objectives can substantially contribute to balancing economic needs with long-term biodiversity conservation

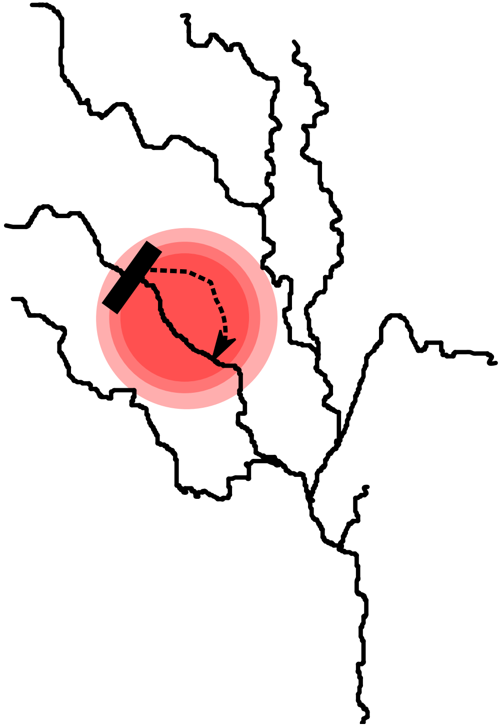
this pressure on freshwater biodiversity. The trend toward greater reliance on hydropower is projected to continue until at least 2050, with small- to medium-sized hydropower plants accounting for more than 75% of the 3700 hydropower plants planned or under construction worldwide as of 2014 (Zarfl *et al.* 2015). Small hydropower plants (installed capacity <10 megawatts [MW]; Table 1) are often constructed in high-gradient alpine streams (Zarfl *et al.* 2015), ecosystems that typically support a unique fauna and flora adapted to fast-flowing, dynamic habitats.

The increase in small hydropower plants, as opposed to large hydropower schemes, is mainly a consequence of the hydropower potential of larger rivers already being exploited in most developed countries (eg in Austria; Wagner *et al.* 2015). Many governments are subsidizing the construction of small hydropower plants because these are perceived to have fewer adverse ecological impacts than large hydropower schemes (Kibler and Tullos 2013). Impacts of large hydropower plants on flow, sediment, and temperature regimes, affecting habitat properties and organisms, have been reasonably well studied (Ellis and Jones 2013); in contrast, local- and basin-scale impacts of small hydropower plants have only rarely been examined (Jager *et al.* 2015). This gap is surprising

Literaturstudien

Offene Forschungsfragen

- Reichweite der Auswirkungen (Längs- und Quervernetzung)

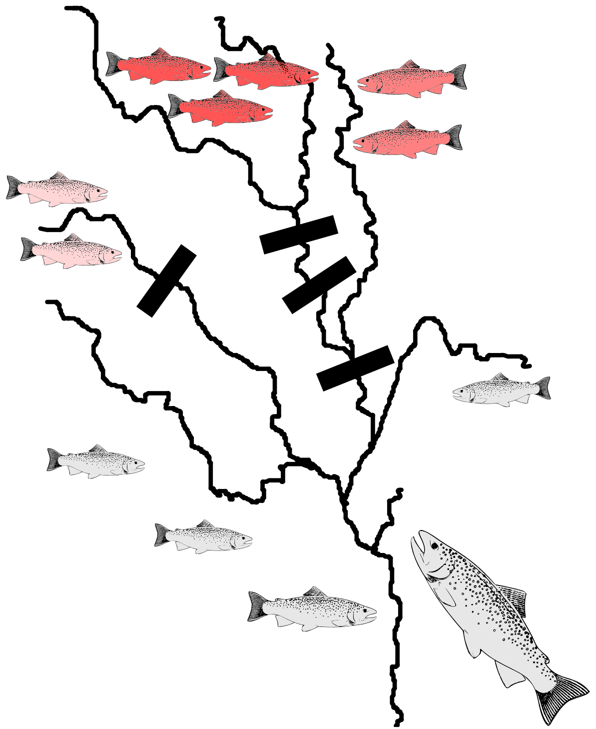


Lange *et al.* 2018. Basin-scale effects of small hydropower on biodiversity dynamics. Front Ecol Env

Literaturstudien

Offene Forschungsfragen

- Reichweite der Auswirkungen
  (Längs- und Quervernetzung)
- Interaktion von mehreren Kraftwerken
  (kumulative Effekte)
- Beeinflussung öko-evolutionärer Prozesse
  (z.B. intraspezifische Diversität)

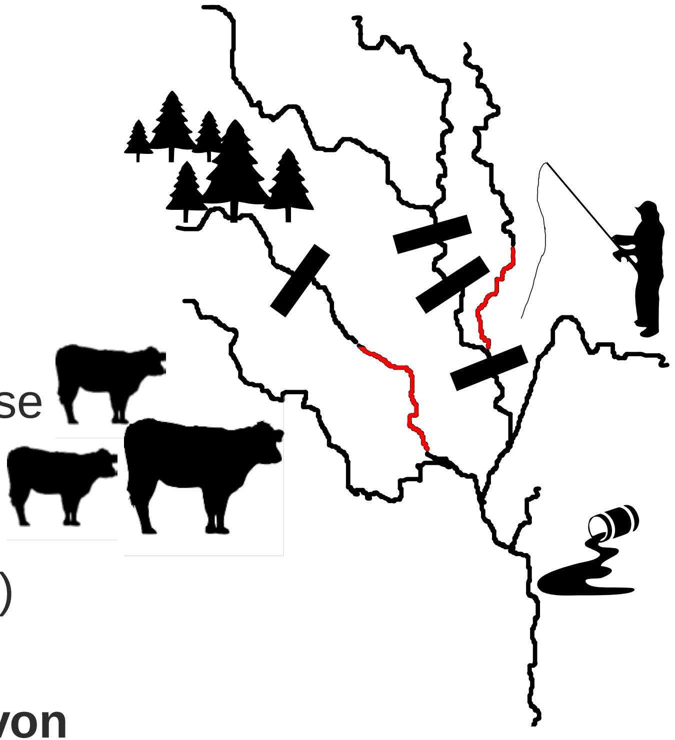


Lange *et al.* 2018. Basin-scale effects of small hydropower on biodiversity dynamics. Front Ecol Env

Literaturstudien

Offene Forschungsfragen

- Reichweite der Auswirkungen (Längs- und Quervernetzung)
- Interaktion von mehreren Kraftwerken (kumulative Effekte)
- Beeinflussung öko-evolutionärer Prozesse (z.B. intraspezifische Diversität)
- Zusammenwirken mit anderen Beeinträchtigungen (multiple Stressoren)



Lange *et al.* 2018. Basin-scale effects of small hydropower on biodiversity dynamics. Front Ecol Env

Planungsrelevant z.B. für die Selektion von Standorten für neue Kleinwasserkraftnutzung

Literaturstudien

eawag
aquatic research

REVIEWS REVIEWS REVIEWS

Basin-scale effects of small hydropower on biodiversity dynamics

rently about five times as high as that for biodiversity, as indicated by Google AdWords and Keywords Everywhere. However, when searches for climate change rise, so do searches for biodiversity. This was not the case for control terms, such as "cupcakes" or "HIV/AIDS" (WebFigure 6).

vation. *Front Ecol Environ* 16: 509–14.

Small hydropower goes unchecked

As compared to the contentious construc-

ernment is providing investment grants and feed-in tariffs over a duration of 15 years, and in China provinces offer feed-in tariffs while the government strongly supports the financing of SHPs by local investors (WSHPDR 2016).

Current policies fail to ensure that

Systematische Recherche & quantitative Auswertung

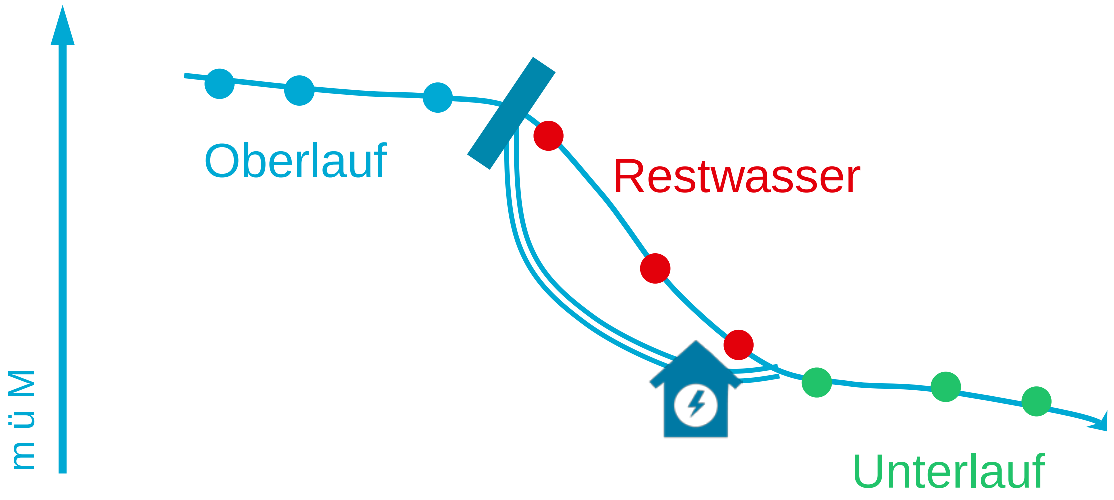
21 Artikel

73 Kleinwasserkraftanlagen

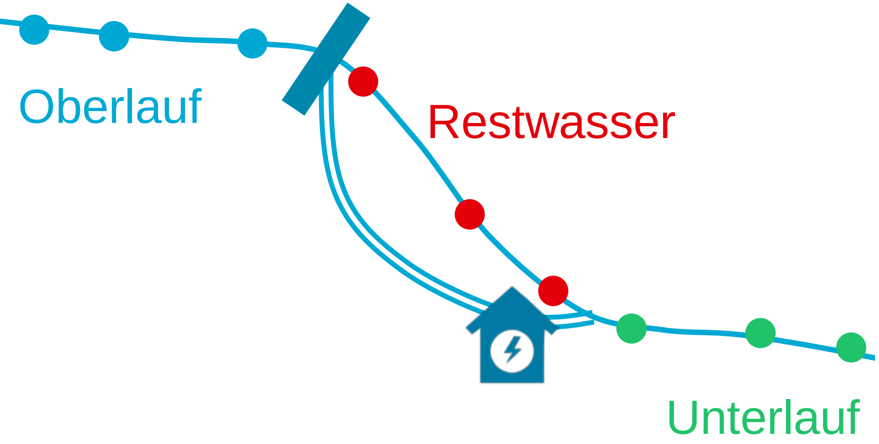
- Habitatbeschaffenheit
- Invertebraten
- Fische

Lange et al 2019. Small hydropower goes unchecked. Front Evol Env

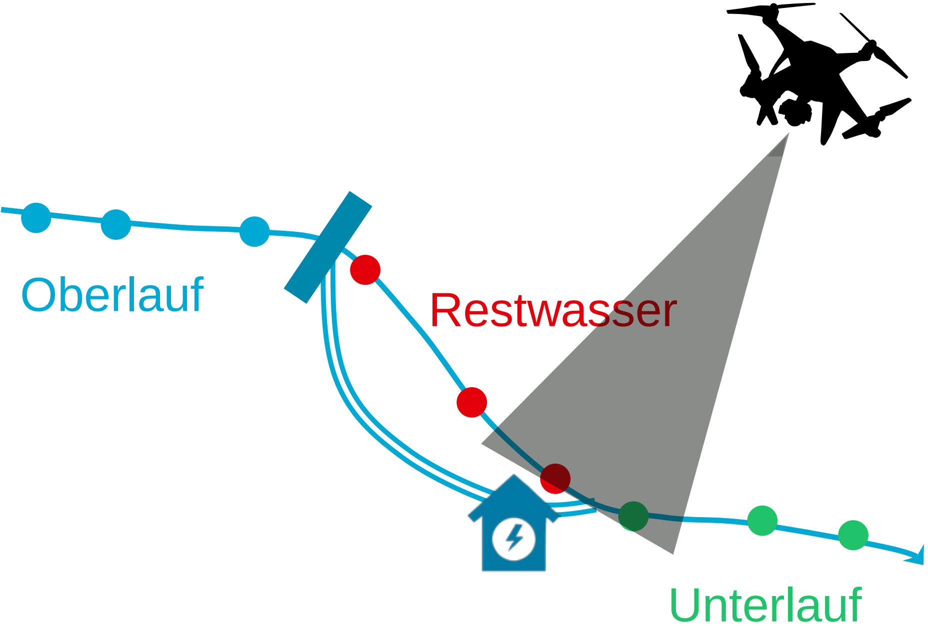
Feldstudie

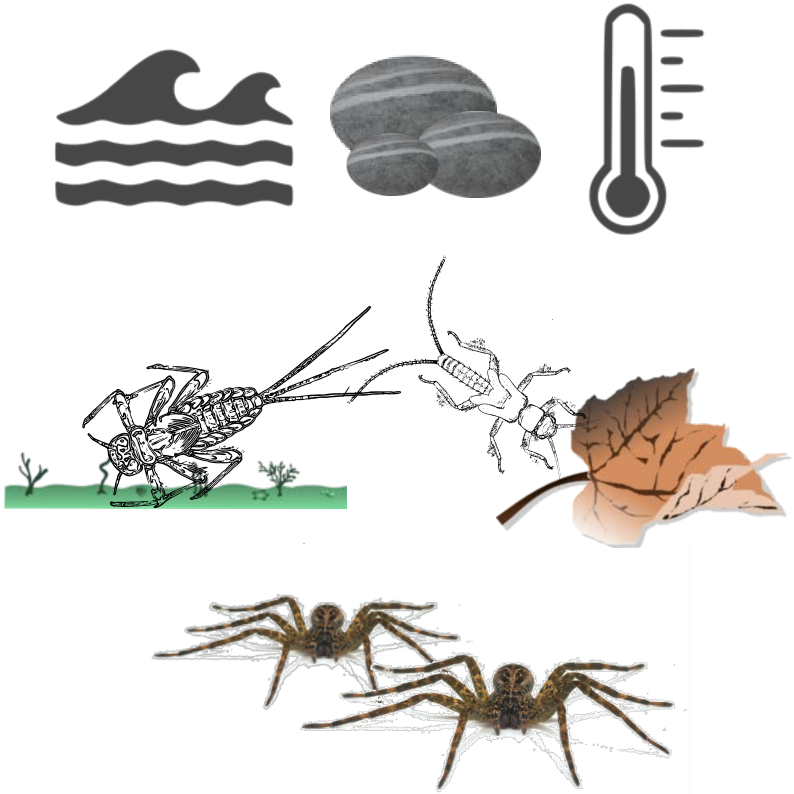


Feldstudie



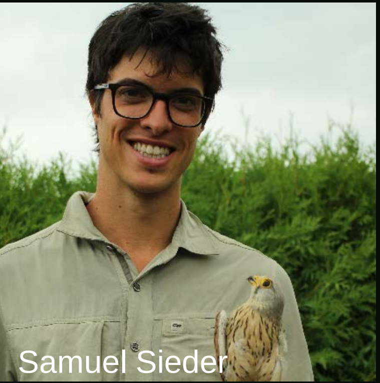
Feldstudie





Team

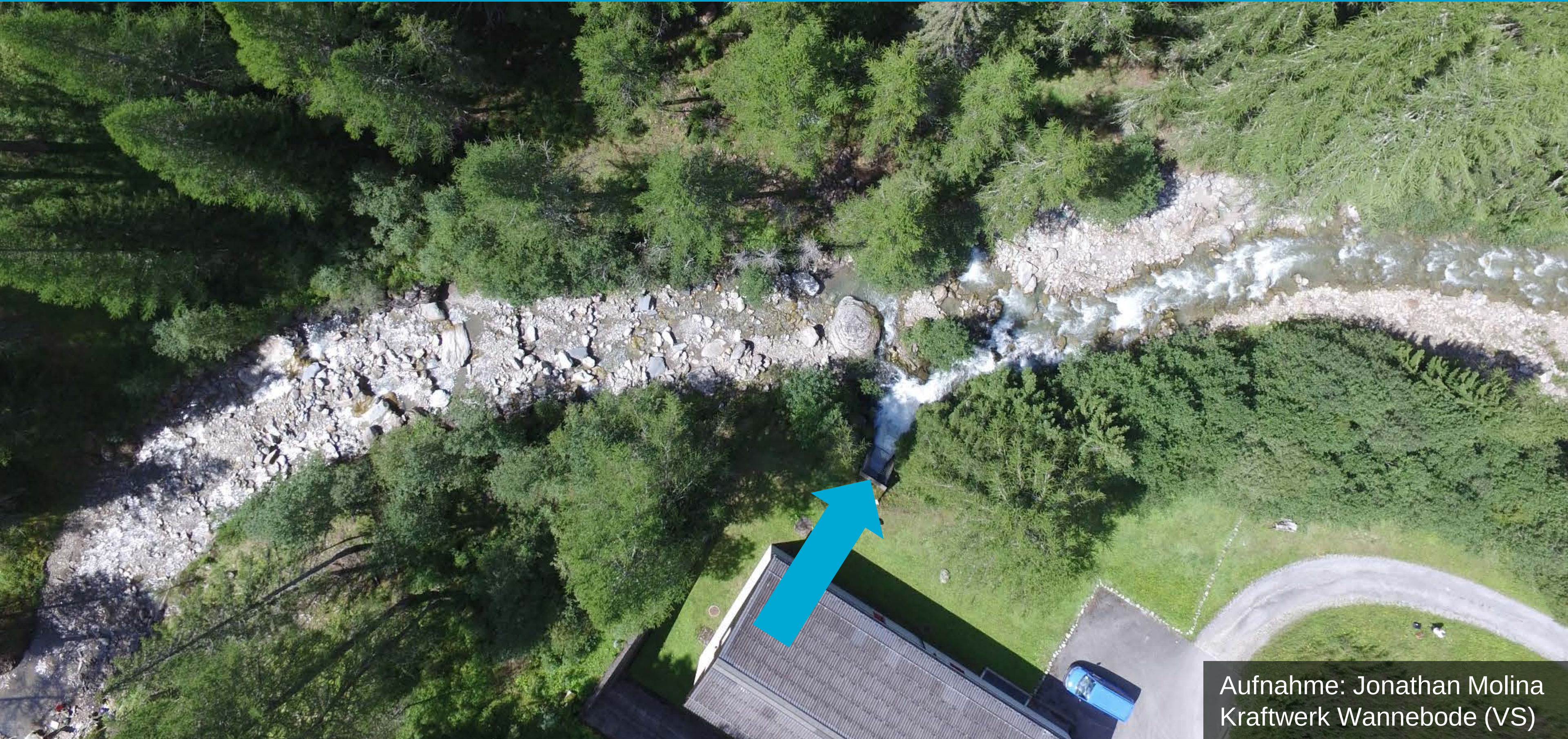
eawag
aquatic research



Wasserentnahme

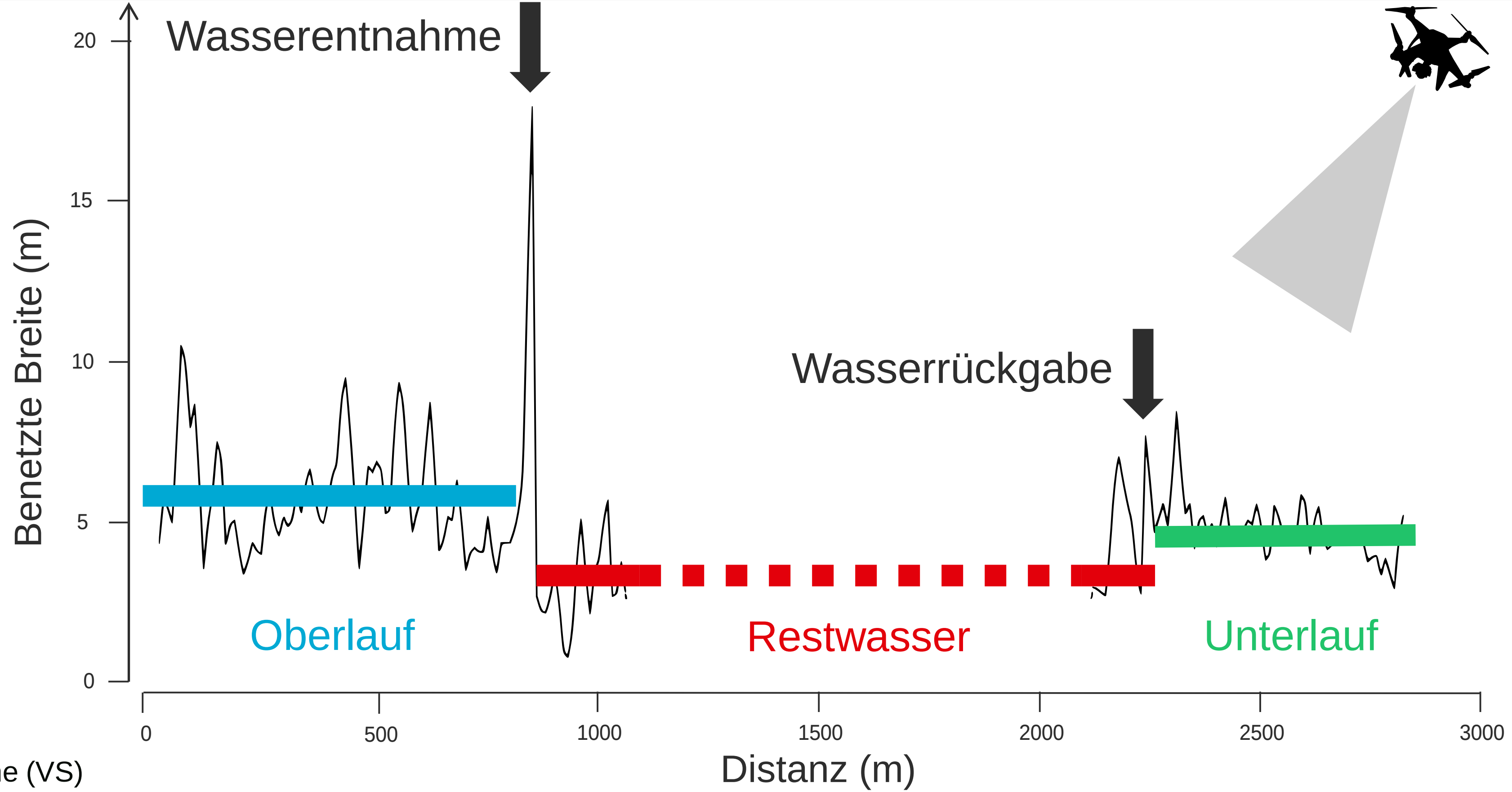
Aufnahme: Jonathan Molina
Kraftwerk Wannebode (VS)

Wasserrückgabe



Aufnahme: Jonathan Molina
Kraftwerk Wannebode (VS)

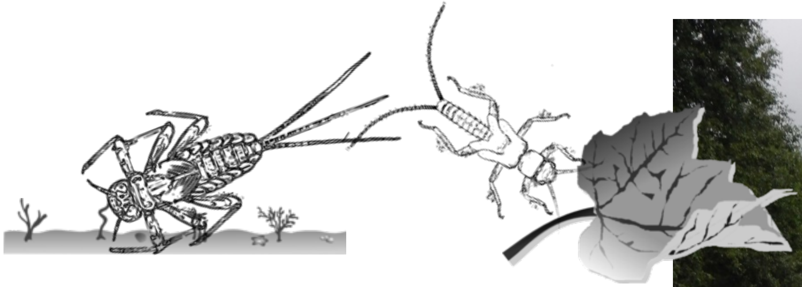
Drohnendaten: benetzte Breite

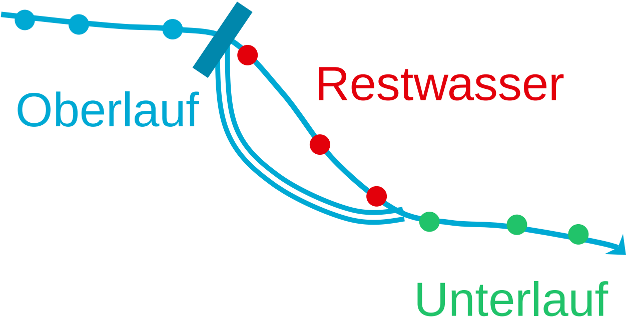


Fluss: Blinne (VS)

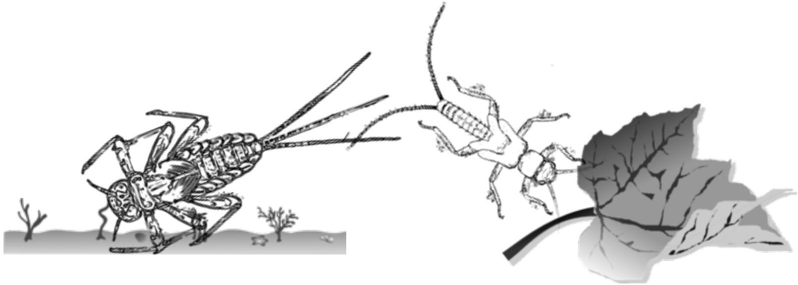
Feldstudie

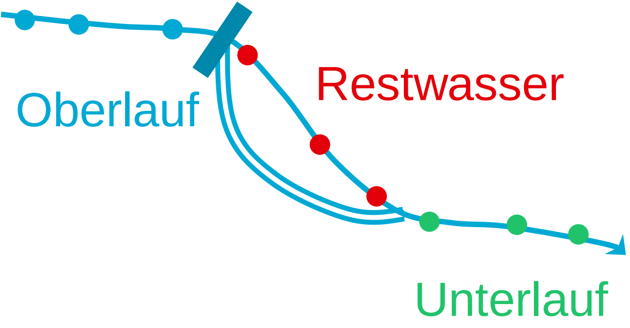
eawag aquatic research



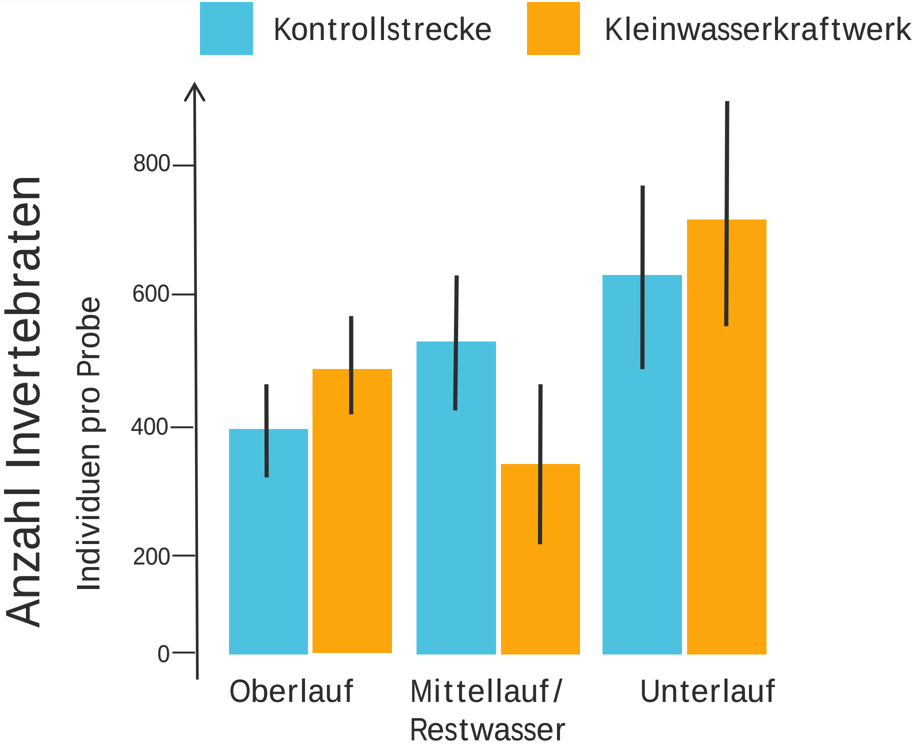


Feldstudie





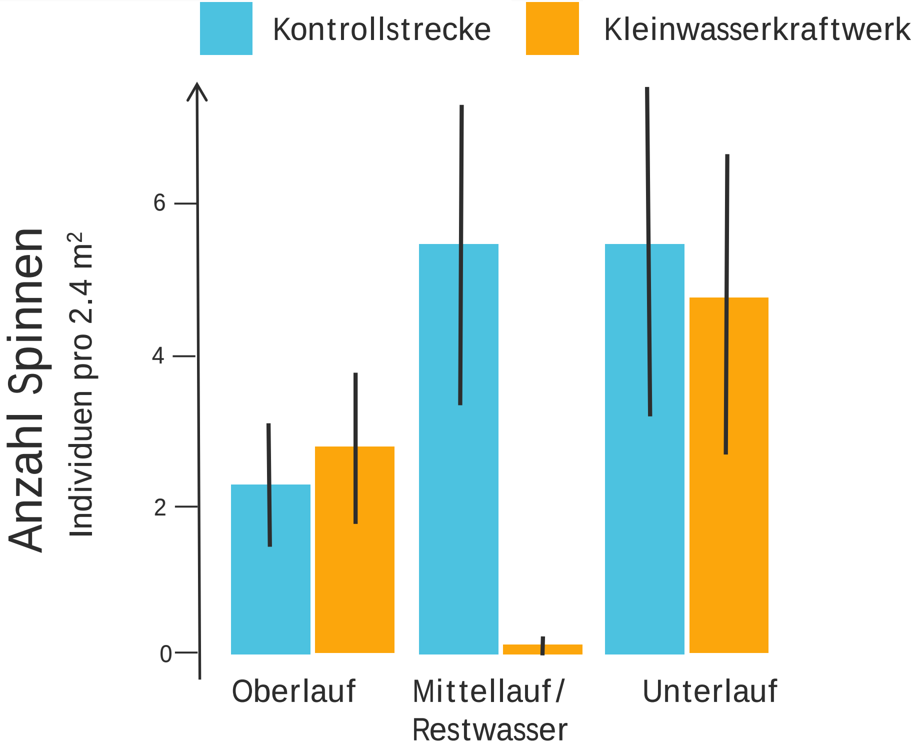
Oberlauf
Restwasser
Unterlauf

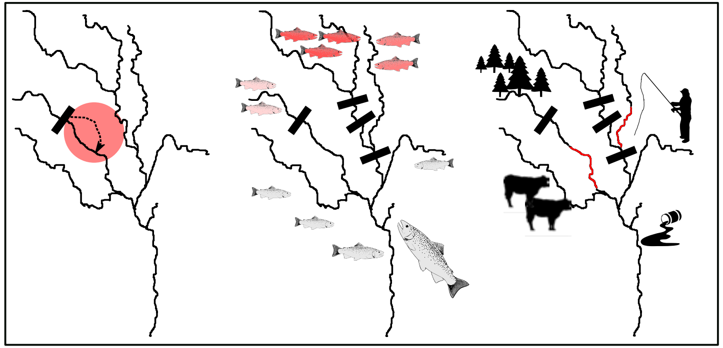


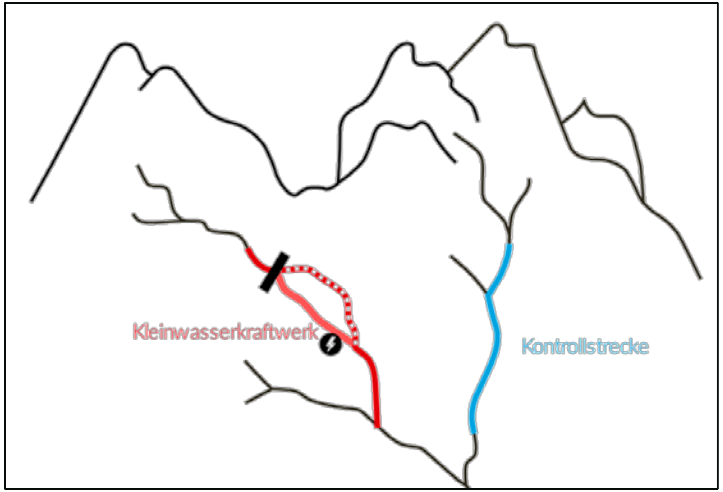
Kontrollstrecke
Kleinwasserkraftwerk
Anzahl Invertebraten
Individuen pro Probe
800
600
400
200
0
Oberlauf
Mittellauf / Restwasser
Unterlauf


Pardosa waglerii
© Alexander Mett Photography


Piratula knorrii
© Guido Gabriel


Kontrollstrecke
Kleinwasserkraftwerk
Anzahl Spinnen
Individuen pro 2.4 m²
0
2
4
6
Oberlauf
Mittellauf / Restwasser
Unterlauf





Literaturstudien

Einzugsgebietsweite Perspektive ist wichtig

Kumulative Effekte von mehreren Kraftwerken

Multiple Stressoren – z.B. Zusammenspiel mit Klimawandel

Feldstudie

Vergleich mit naturnahen Systemen ist wichtig

Beeinträchtigung von Habitatverfügbarkeit und Ökosystemfunktionen, z.B. Reduktion der Anzahl Invertebraten in Restwasserstrecken um ca. 50%

Beeinträchtigung der Quervernetzung (Wasser ↔ Land), z.B. Reduktion der Anzahl Uferspinnen in Restwasserstrecken um ca. 95%