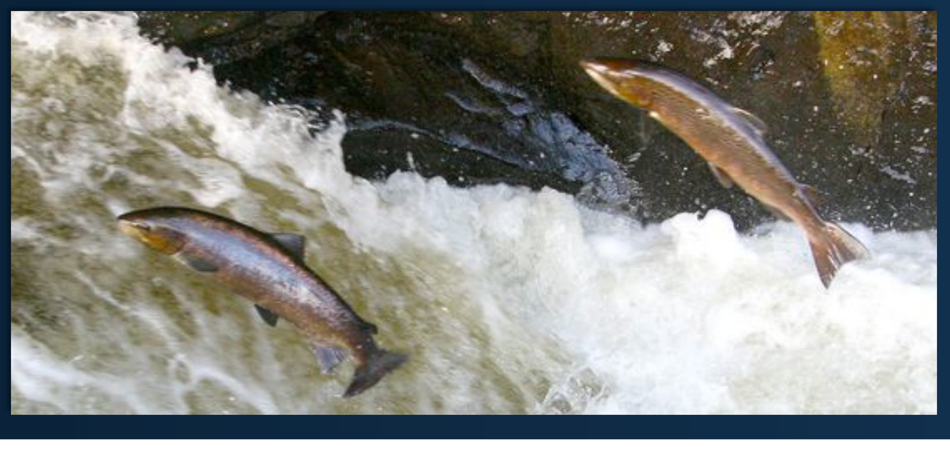
Assessing potential impacts of hydropower regulation on salmonid habitats using connectivity metrics



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Background

- ✧ Global increase in hydropower development.
- ✧ Fragmentation of riverine ecosystems resulting from this impacts the viability of fish populations, e.g. [1].
- ✧ Connectivity metrics and graph-theoretic approaches prove to be efficient to map impacts and guide river restoration efforts, e.g. [2,3,4].
- ✧ We focus on Atlantic Salmon (*Salmo salar*) in Scottish rivers, as impact of hydropower constructions (HCs) depends not only on the HC's design but also on spatial scale, spatio-temporal dynamics in hydrological connectivity and habitat requirements and salmon life stage (Fig. 1).

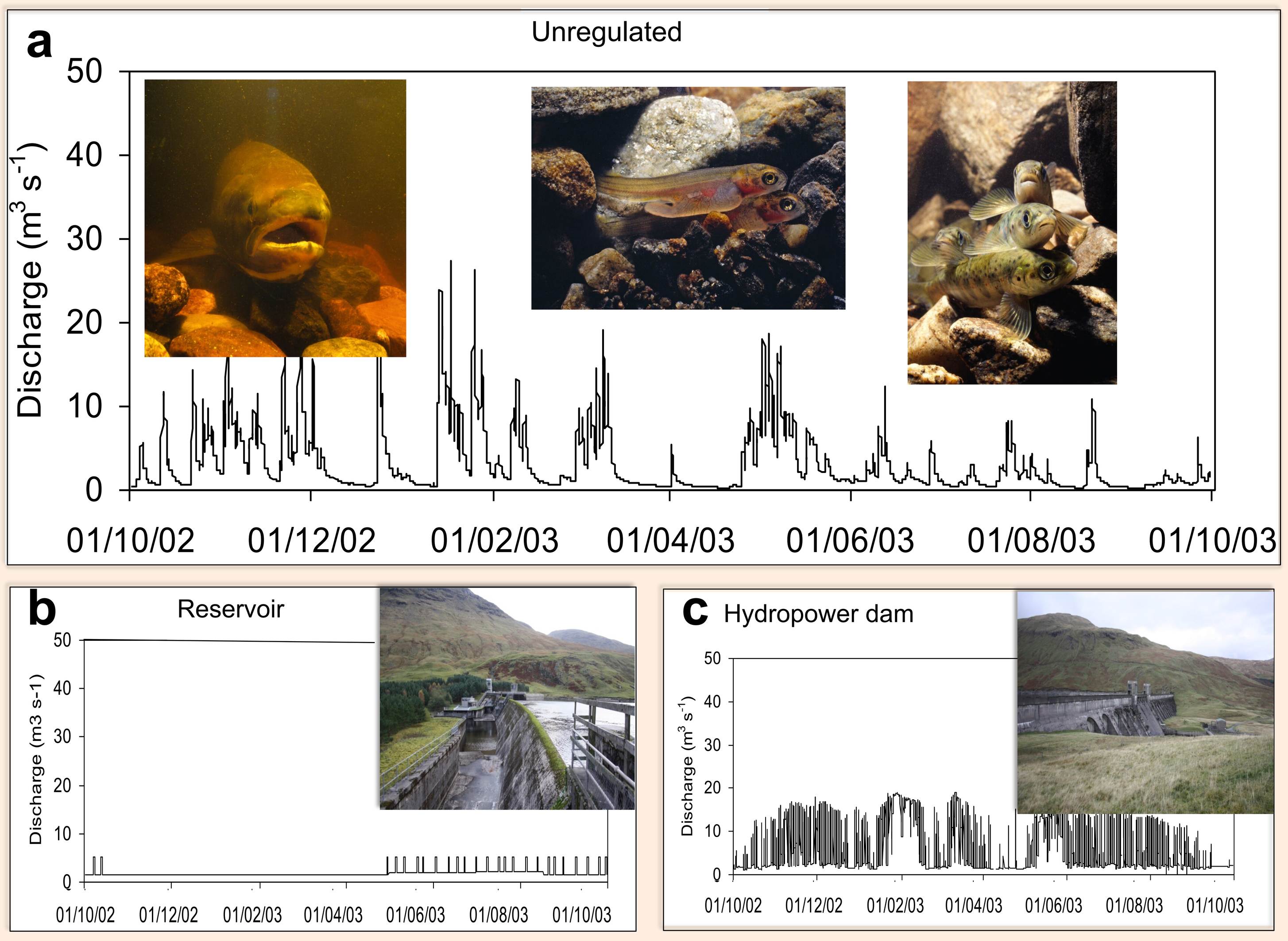

Fig. 1: a) Flow requirements of Atlantic salmon are different for different life stages. This strongly links to dynamics in spatio-temporal connectivity; which can be altered in different ways depending on the design of hydropower constructions (b, c). Hydrographs adapted from [5].

Research questions

- ✧ How is connectivity affected by HCs?
- ✧ How do HCs influence sustainability of salmonid habitat?
- ✧ Do we have tools for site selection to optimise hydropower generation and habitat maintenance?

Methods

- ✧ GIS approach to obtain a first order approximation of suitable habitat in small catchment in the Cairngorms, Scotland (Fig. 2 and 3).
- ✧ Perform computer simulations to study the effect of obstructions on connectivity using the HCIU connectivity metric [6] (Fig. 3).
- ✧ Three impact scenarios versus a natural situation and apply a weighting factor for spawning habitat (Fig.4).

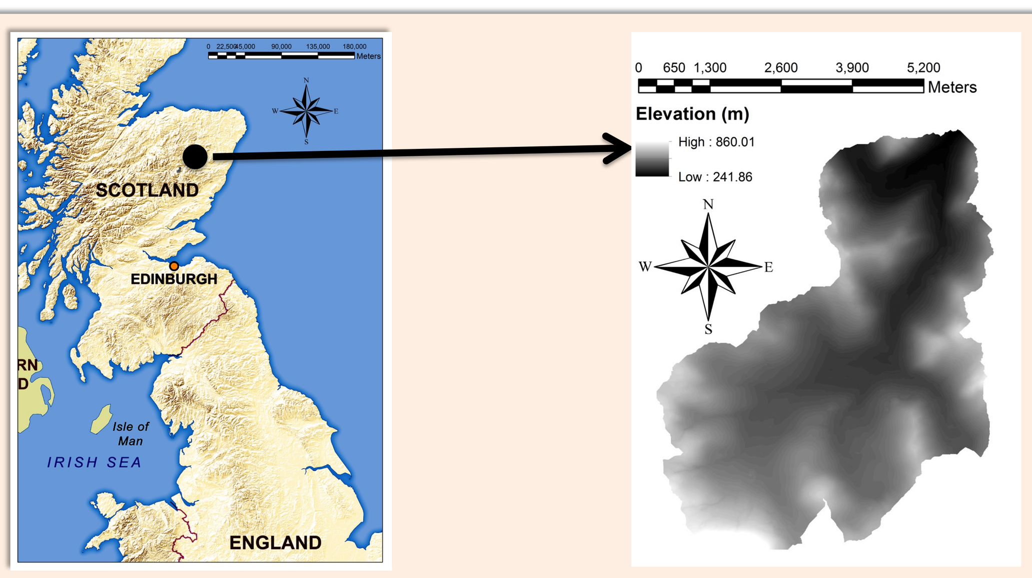

Fig. 2:Location of the Girnock Burn catchment (30km^2), in the Cairngorms.

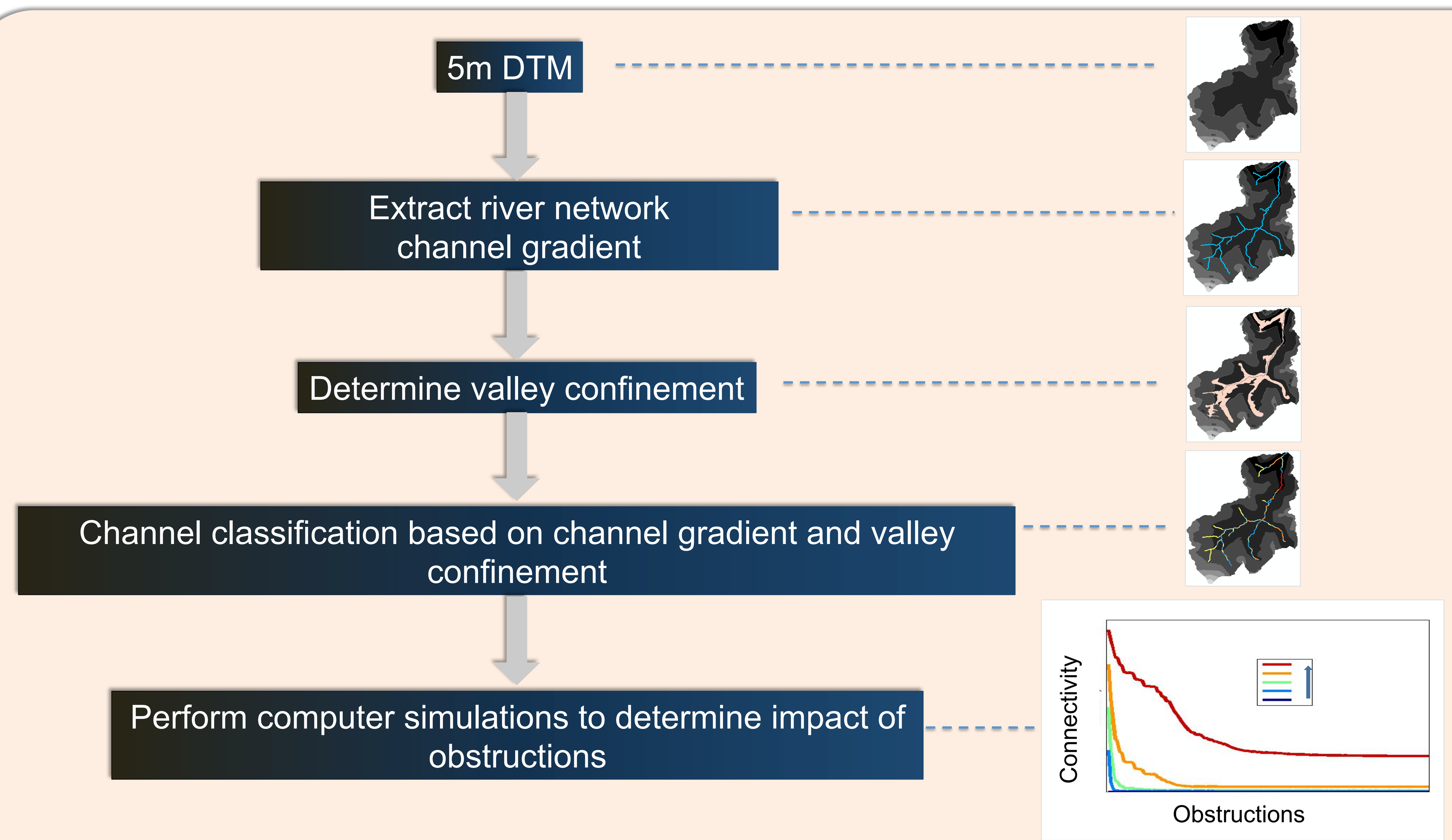

Fig. 3: Workflow. The lines in the bottom panel represent different passability values for obstructions.

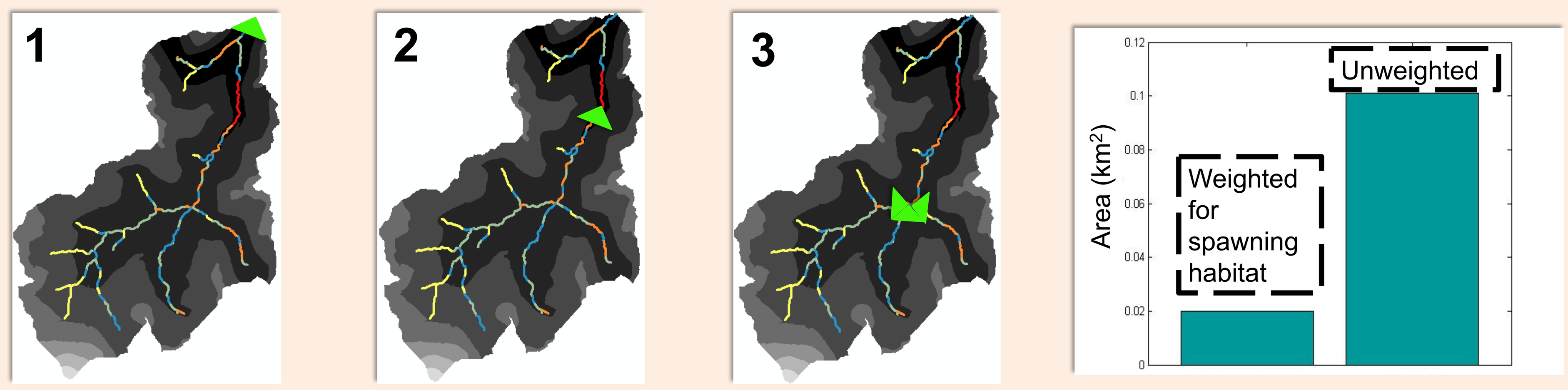

Fig. 4: We consider three scenarios: 1) one hydropower construction at the outlet; 2) one hydropower construction on the main stem; 3) three hydropower constructions on tributaries. We apply a weighting factor for spawning habitat, which reduces the total amount of available habitat.

Preliminary results

- ✧ Impact on connectivity depends on location (Fig. 5a).
- ✧ multiple smaller HCs may potentially have a lower impact than a single larger HC (Fig. 5a).
- ✧ There is a clear relationship between habitat and connectivity (Fig 5b).
- ✧ Losing less but more suitable habitat potentially has a disproportionally large impact (Fig. 5b).

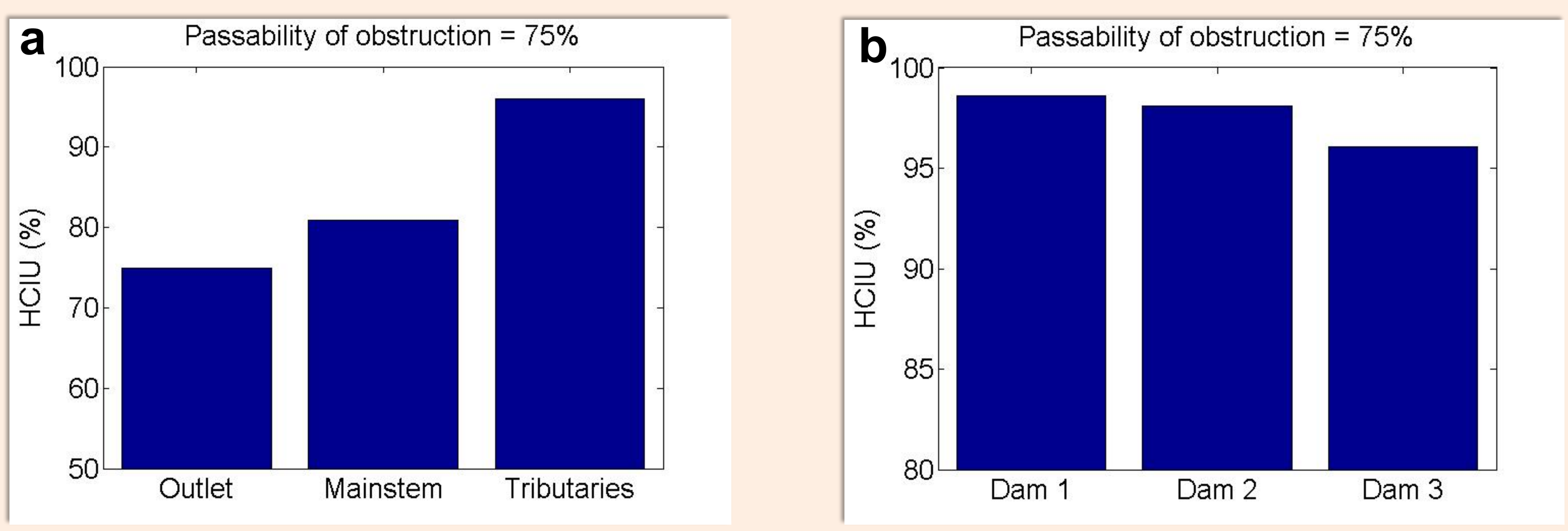

Fig. 5: a) largest impact in scenario (1) and lowest impact in scenario (2). b) adding dams in sequence shows that there is a relationship between habitat and connectivity, the largest impact is seen in the smallest tributaries that harbours the largest amount of habitat.

Further work

- ✧ Include hydrological/hydraulic/biological data in connectivity metrics.
- ✧ Adjust the weighting based on spatial patterns of habitat distribution to investigate if in-stream spatial distribution of habitat types may have different relationships with connectivity [7].
- ✧ Trends may be different at larger scales [8]. We will apply and ground-truth approach in larger catchments, allowing us to cover scales from 30-3200km^2.
- ✧ Investigate the impact of hydrological change on habitat suitability using hydrological models [9] and hydraulic habitat modelling.

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