



Effects of river regulation on Atlantic salmon populations in Scottish rivers

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Introduction

- Massive increase in number of large dams reduces percentage of rivers not impacted by river regulation to a mere 7%^{1,2}.
- Decrease in longitudinal connectivity in riverine ecosystems resulting from construction of transverse barriers identified as a major threat to biodiversity.
- Many of Scotland's rivers are regulated for hydropower (2020 Routemap³), yet also host substantial populations of Atlantic salmon.
- In addition to habitat access, flow requirements of salmon are different for different life stages, Fig 1.
- Hydropower impoundments impact the spatial and temporal connectivity along many salmon rivers in ways that are not fully understood.
- These changes may affect sustainability of habitat at local and regional scales and ultimately conservation of the species.
- Research is therefore needed to aid restoration and management of rivers impacted by previous hydropower development and guide new schemes to mitigate potentially adverse effects.

Methods

- Use connectivity metrics to study effect of transverse barriers on longitudinal connectivity (catchment scale) in the River Lyon, Fig 2.
 - ❖ GIS analysis
 - ❖ Dendritic connectivity index⁴
- Determine importance of using different weighting approaches, Fig 3.
 - ❖ Wetted area
 - ❖ Suitable habitat area
 - ❖ Juvenile production⁵
- Use 2D-hydraulic models in combination with habitat suitability curves⁶ to study effect of flow regulation on habitat suitability for juvenile salmon (reach scale), Fig 4 – 6.

Future

- Apply same approach for longitudinal connectivity to much larger Tay catchment.
 - ❖ Do we see the same/similar effect of barriers at larger scales?
 - ❖ Are areas important for the Lyon, still important for the whole Tay?
- Paper in preparation (JoH/WRR): **Using connectivity metrics to inform restoration and management of rivers impacted by hydropower regulation.**
- Oral presentation on hydraulic habitat modelling at the AGU Fall Meeting, San Francisco, December 2016

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References

1: Zarfl et al., 2015; 2: Grill et al., 2015; 3: <http://www.gov.scot/Topics/Business-Industry/Energy/RoutemapUpdate2015>; 4: Cote et al., 2009; 5: Millar et al., 2015; 6: Millidine et al., 2016.

Figures

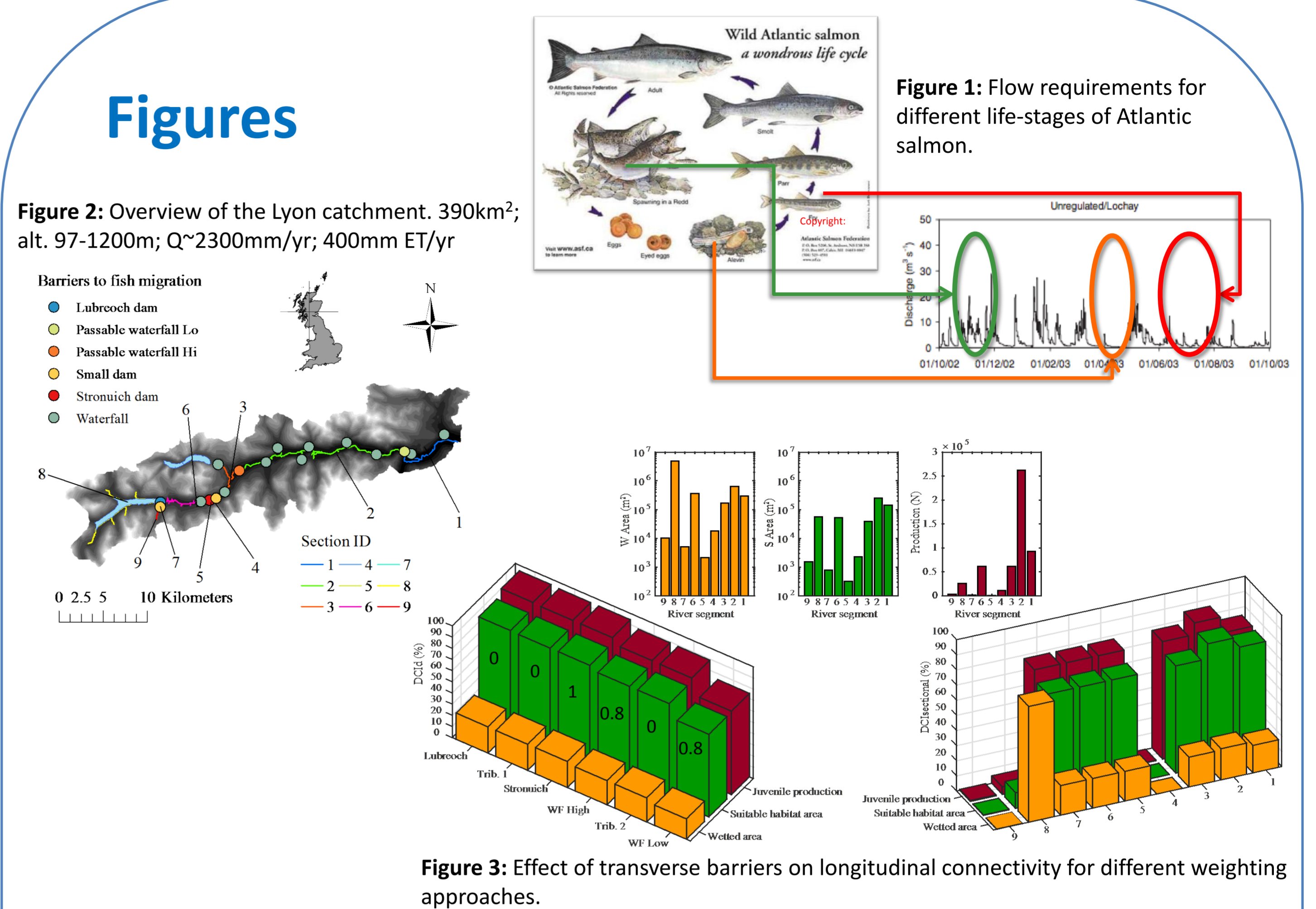


Figure 4: Output for habitat suitability under different discharges in a re-naturalised reach in the River Lyon. Quantiles refer to suitability, with Q4 being the best habitat.

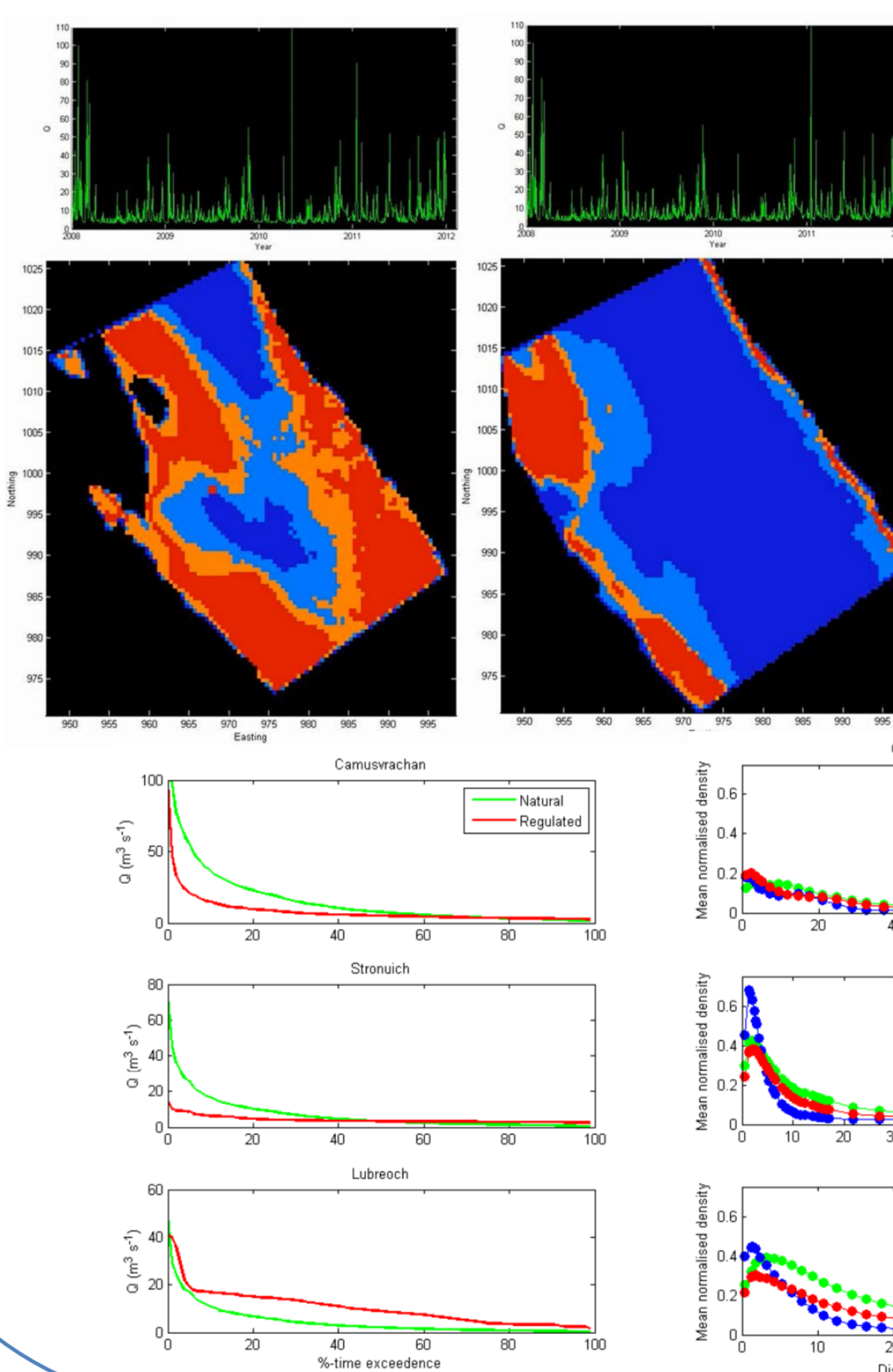
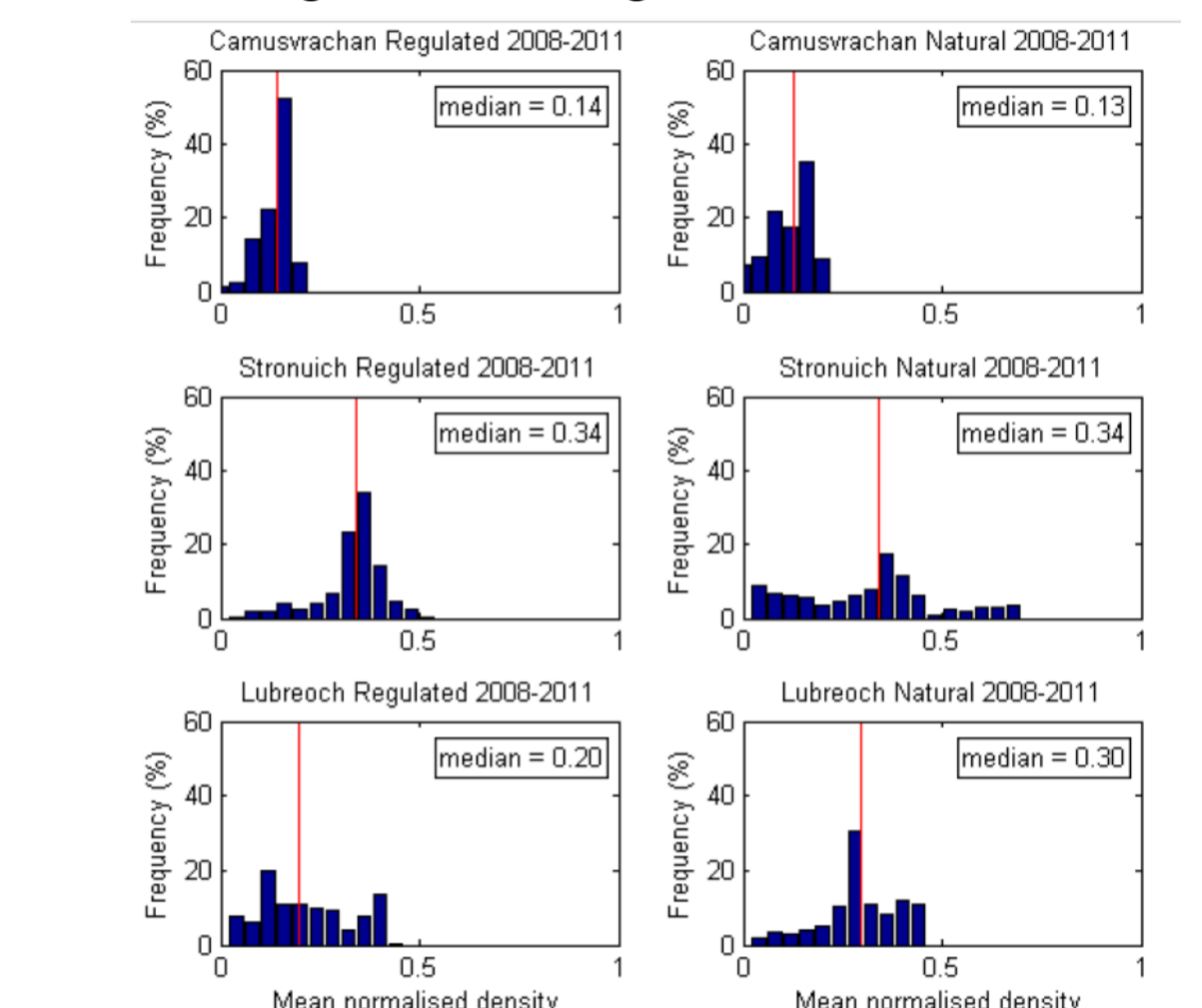


Figure 5: Frequency distributions of suitability expressed in mean normalised density over a period of 4-years for three sites at different location and under different regulated flow regimes.



Results

- Using wetted area could misinform management and planning of river restoration projects
- Inclusion of more relevant hydrogeomorphic and ecological details can improve our ability to identify those areas that are able to maintain high levels of connectivity.
- Losing less but more suitable and productive areas can have a larger impact on connectivity than losing more but less suitable and productive areas.
- This is important in terms of guiding and prioritising restoration and management targets for rivers and floodplains globally.
- Effects of regulation can vary substantially between reaches due to spatial differences in flow regime.
- Comparison to natural flow regimes suggests that flow alteration has a variable influence on habitat quality depending on the type of regulation and life stage.

KE output

- 1) Oral presentation WWC, Edinburgh 2015; 2) Poster at SEFS9, Geneva 2015;
- 3) Ooskanews panel member, RBS HQ 2015; 4) Oral presentation AGU, SF 2015;
- 5) HN panel member, World Water Day Dundee 2016; 6) Oral presentation EGU, Vienna 2016; 7) Oral presentation AGU, SF 2016