Stream food web responses to alpine glacier retreat

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Project outline

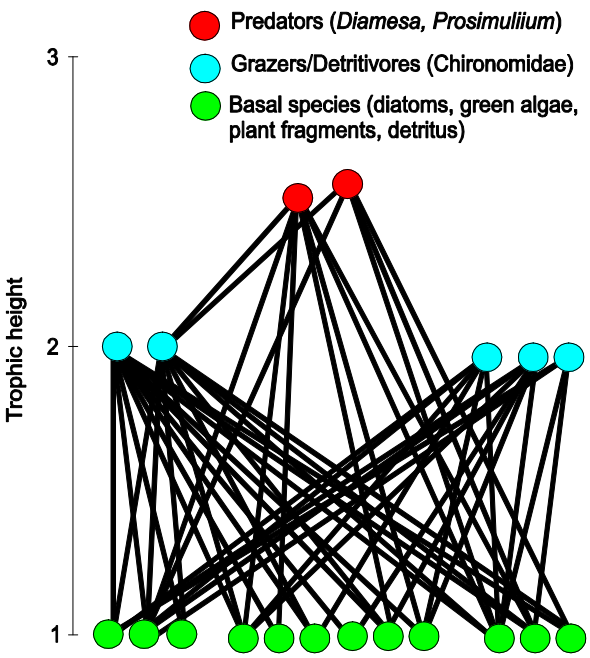
Climate change poses a considerable threat to the biodiversity of high altitude ecosystems, with alpine regions across the world already beginning to show clear responses to warming (Milner et al., 2009). Glacier mass-balance studies show consistent decreases over the last century in most regions of the world and it has been suggested that retreat may even be accelerating in many locations. Continued negative glacier mass-balance will lead to glacier- and snow-melt reductions (Barnett et al., 2005), proportionally greater groundwater contributions (Brown et al., 2006) and changes in proglacial riverscape dynamics (Malard et al., 2006). These hydrological changes will dramatically alter alpine stream communities (Brown et al., 2007a, b; Finn et al., 2010) but to date there have been no detailed assessments of responses at higher levels of organisation (i.e. whole food webs). This is a major research gap because the potential for emergent properties in complex systems means it is not necessarily possible to predict ecosystem responses, and therefore to accurately inform conservation and management strategies, by simply extrapolating from lower levels of organization (i.e. individual population responses; Woodward et al., 2010).

Alpine glacier forelands, with clear chronologies of glacier retreat, offer exciting opportunities to examine ecological network dynamics. Yet despite rapid glacier retreat being observed on all continents during recent decades (Djugerov & Meier, 2005), there are no studies of river food web responses to changes in glacial meltwater influence. Studies of aquatic community structure in glacial streams indicate that colonisation dynamics are strongly determined by cold water temperature and unstable stream channels (Milner et al., 2009). Streams with high glacial influence possess sparse populations of Diamesinae chironomids and only a few diatom species (Rott et al., 2006). In line with foraging theory, it can be expected that minimal food resources and low abundance of consumers will lead to a dominance of generalist feeding in these streams. As glacial influence diminishes (either downstream or with ice retreat), warmer water temperature and more stable stream channels are found where snow and rain-fed groundwater systems maintain base flows. In these streams, abiotic determinism should give way to more biotic interactions (Milner et al., 2001; 2008). Theoretically, these changes should include the formation of a more productive resource base, which supports increased secondary production, longer food chains and trophic network height, greater abundance of larger organisms and more specialist and nested feeding hierarchies (e.g. Woodward et al., 2010). However, testing these theories for glacier-fed rivers has not been possible to date because the only published 'food webs' are based on stable isotope analyses with no differentiation of specific consumer-resource links (e.g. Zah et al., 2001).

Of interest in this study will be how food webs are linked to glacier retreat and associated changes in water sourcing both spatially and temporally. Food webs will be analysed across a continuum of streams from those draining highly glacierized basins to those with no glacial influence. By examining streams fed by different water sources, a major output from this project will be predictions about how alpine stream food webs can be expected to change in response to future climate change.

Project Goals

This research is anticipated to allow detailed assessments of: (1) macroinvertebrate and algal community composition, (2) stream food web structure, and (3) a comparison of both taxonomic and individual-based interactions (see Woodward et al., 2010). A key focus will be to gain an understanding of how shifts in water sourcing affect biodiversity and feeding interactions. A combined approach of descriptive and experimental approaches will be utilised to gain insights into the effects of reduced glacier meltwater production on stream biodiversity and ecosystem function. The study provides an opportunity to utilise unpublished food web datasets that we have assembled from several glacier-fed rivers worldwide (e.g. Austria, France, New Zealand). **The student will have opportunities to undertake fieldwork in the European Alps, French Pyrenees or New Zealand to collect primary datasets from glacier-fed rivers**. This study design will allow comparisons of food webs in glacier-fed rivers from different river basins and potentially different mountain ranges, and analyses of seasonal food web dynamics from more intensively monitored streams.



Food web of the Odenwinkelkees Glacier river, Austria, July 2008

Benefits

The successful candidate will benefit from inter-disciplinary training in hydrology and stream ecology as part of the River Basin Processes and Management, and Ecology and Global Change research clusters in the School of Geography. Training at Leeds deals fully with the elements described in the Joint Research Centre statement on skills training for research students. PhD students take modules provided by the staff development unit (e.g. starting your PhD, small group teaching) and a faculty-training course (covering elements such as planning, critical reading and writing, oral presentations, writing research papers). Students present results and receive constructive feedback from peers in a Research Support Group, from colleagues in the River Basins research group, and at a university postgraduate research day.

The nature of the project means that **the student will be trained in project specific research methods including stream water quality analysis, algal/macroinvertebrate identification, and applied statistics** for analysing biological data, both internally and at external workshops. An additional important **part of the training will be to attend national and international conferences** (e.g. FBA, BES, SEFS) to present results and gain feedback. **The student will be encouraged to submit papers for publication** during the project.

Informal enquiries should be directed to Lee Brown l.brown@leeds.ac.uk. Further details about postgraduate research degrees at the School of Geography, University of Leeds can be found at http://www.geog.leeds.ac.uk/study/phd.html

References

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