CENTRE FOR EVIDENCE-BASED CONSERVATION

SYSTEMATIC REVIEW No. 12

DOES THE USE OF IN-STREAM STRUCTURES AND WOODY DEBRIS INCREASE THE ABUNDANCE OF SALMONIDS?

REVIEW REPORT

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COVER SHEET

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SYSTEMATIC REVIEW SUMMARY

Background

In-stream structures (such as flow deflectors, weirs and woody debris) have been in widespread use for the last eighty years to increase the production of fish stocks, primarily salmonids, but also species of conservation concern such as European Bullhead *Cottus gobio*. A large number of studies, of variable quality, have been undertaken to assess the effectiveness of in-stream structures, often with conflicting results. It has therefore been hard to develop a consensus regarding the utility of in-stream structures despite their continued use. This systematic review formally synthesises empirical evidence regarding the effectiveness of in-stream structures in terms of impact on abundance of salmonid fish and *C. gobio* using a documented *a priori* protocol.

Objectives

To assess the impact of in-stream structures on the abundance of salmonids and *Cottus gobio.*

To assess the impact of hydrological and ecological variables on the effectiveness of in-stream structures.

Search strategy

Electronic searching of ISI Web of Knowledge, Science Direct, Directory of Open Access Journals, Copac, Scirus, Scopus, Index to Theses Online, Digital Dissertations Online, Agricola, Europa, Wildlink, JSTOR. Publication searches of Canadian Wildlife Service, Countryside Council of Wales, Department of Agriculture and Rural Development, Department of Environment, Food and Rural Affairs, English Nature, Environment Agency, Food & Agriculture Organisation of the United Nations, Fisheries Management Science Programme, Fisheries and Oceans Canada, FRS Freshwater Laboratory (formerly Freshwater Fisheries Laboratory), Joint Nature Conservancy Council, United States National Parks and Wildlife Service, Scottish Natural Heritage. Searched Fishbase.org, BiologyBrowser.org, Graylit.osti.gov, Librarian's Internet Index, Google Scholar, Scirus and Google. Hand-searches of bibliographies of accepted articles. Personal contact with researchers.

Selection criteria

Any studies examining the impact of in-stream structures on the abundance of salmonids or *Cottus gobio*. Appropriate spatial or temporal controls were a prerequisite for studies to be included in quantitative analysis.

Main results

A total of 137 studies fulfilled the inclusion criteria of which 38 provided quantitative data regarding the impact of in-stream structures on salmonids or *Cottus gobio,* suitable for meta-analysis. Fifty four independent data points

provided evidence regarding the impact of engineered in-stream devices on salmonids, with a further 30 data points regarding woody debris and nine concerning *Cottus gobio.*

Meta-analytical synthesis results in a weakly significant positive impact of engineered in-stream habitat structures on salmonid populations. No ecologically significant impact on salmonid population size or habitat preference was evident. There are no significant relationships between the effectiveness of engineered in-stream structures and hydrological or ecological variables at a population level, although there is limited evidence that in-stream structures provide preferential habitat at higher discharges.

Woody debris has a significant impact on salmonids resulting in increased population abundance. This is especially pronounced for Brook Trout *Salvelinus fontinalis.* There is a lesser, but still significant, positive impact on microhabitat preference. Woody debris provides more preferential habitat at longer timescales and higher discharges, but appears to be less effective for Coho salmon *Oncorhynchus kisutch* than other salmonid species.

Riffles increase local abundance of *Cottus gobio* but deflectors do not.

Reviewers' conclusions

Implications for conservation

Available evidence does not demonstrate an ecologically significant impact of engineered in-stream structures on populations of salmonids, although they may provide preferential habitat where discharge is high ($>6m^3s^{-1}$).

Available evidence suggests that woody debris does increase the population abundance of salmonids, especially the brook trout *Salvelinus fontinalis*. It may also provide more preferential habitat over time (>4years) where discharge is high ($>1m^3s^{-1}$) but does not appear to provide preferential habitat for *Oncorhynchus kisutch*.

Cottus gobio populations are not increased by deflectors but riffles may provide preferential habitat.

Implications for further research

Further long term work is required to corroborate the evidence presented in this systematic review. Much currently available data is of inadequate duration and assesses habitat preference rather than long-term population change. Reach and water-shed scale studies are also rare in comparison to habitat unit studies. The use of independent treatments and controls, replication, and rigorous parameters of abundance is advocated.

Numerous confounding variables operate in riverine systems and sample sizes are currently too small to assess the impact of many factors in a robust manner. Further monitoring is required to fully evaluate the potential impact of time,

discharge and species. Other hydrological and ecological factors such as stream gradient, proportion of cobbles in the substrate, degree of existing modification, water quality and canopy cover are insufficiently reported and studied, although they are known to impact fish populations.