



**CENTRE FOR EVIDENCE-BASED CONSERVATION**

**SYSTEMATIC REVIEW No. 13**

***WHAT ARE THE EFFECTS OF SALMONID STOCKING IN LAKES  
ON NATIVE FISH POPULATIONS AND OTHER FAUNA AND  
FLORA?***

***PART A: EFFECTS ON NATIVE BIOTA***

**REVIEW REPORT**

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**COVER SHEET**

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## SYSTEMATIC REVIEW SUMMARY

### Background

In Europe and North America, lakes are often stocked with salmonid species, primarily to provide game fisheries, but concerns have long been raised about the ecological consequences of this practice. The addition of a species high in the food chain can impact other organisms, some of which may be of conservation value. Interbreeding between stocked and native fish may affect population viability and fish taxa can be potentially lost through hybridization, competition or inadvertently introduced diseases. The impacts of salmonid stocking in rivers are widely reported in contrast to their impacts in lakes. The impact of salmonid stocking on the abundance and species richness of non-stocked native fish species in lakes is a primary focus of the review together with changes in the abundance or species richness of other fauna and flora including amphibians, invertebrates, aquatic plants and plankton.

### Objectives

What are the effects of salmonid stocking in lakes on native fish populations?

What are the effects of salmonid stocking in lakes on flora and fauna other than fish?

### Search strategy

Electronic databases and web sites were searched using key words. Bibliographies were also searched and personal contacts were made with researchers to retrieve relevant material.

### Selection criteria

Studies were included in the review where the following criteria were met:

1. *Subject*: lakes
2. *Intervention*: stocking with brown trout *Salmo trutta*, rainbow trout *Oncorhynchus mykiss*, Atlantic salmon *Salmo salar* (landlocked forms), arctic charr *Salvelinus alpinus*, brook trout *Salvelinus fontinalis* and charr X salmon hybrids, or other salmonids when present in combination with the above.
3. *Outcomes*: primary outcomes were changes in abundance or species richness of non-stocked fish species. Secondary outcomes were changes in abundance or richness of other species, and changes in size of individual fish.
4. *Type of study*: any field (*in situ*) study

### Data collection and analysis

Study inclusion assessments were performed and the observed agreement between independent reviewers was “substantial” indicating that the relevance assessment was repeatable. Relevant studies were categorized according to the subject, study type and outcome using an *a priori* data extraction protocol. In the case of amphibians, sufficient data were captured to derive effect sizes which were combined using random effects meta-analysis.

## **Main results**

Despite the apparently large literature base available on this topic, insufficient information is available regarding the impact of salmonid stocking in lakes on non-stocked fish species for management to be based on empirical evidence.

Of 316 studies identified with relevant titles and abstracts, six present sufficient standardized empirical measures for synthesis of data on the effects of salmonid stocking in lakes on flora and fauna other than fish. Available evidence indicates that Urodela (newts and salamanders) are less likely to be found in water bodies stocked with salmonids than water bodies that do not contain salmonids. There is no significant difference in anuran (frog and toad) occupancy between stocked and unstocked water bodies. However, considerable variation in responses remains unexplained for both newts and frogs. *Rana cascadae* (Cascades frog) and *Rana muscosa* (Mountain yellow-legged frog) are both significantly less likely to be present in water bodies stocked with salmonids than water bodies which do not, whilst the converse is true for *Bufo boreas* (Western toad).

Results for other biota, including fish, are not presented in sufficient numbers or in consistent formats across studies, making it impossible to draw robust conclusions regarding any other impact of stocked salmonids on lake ecosystems from the data currently available.

## **Conclusions**

There is very little evidence available on impacts of stocked salmonids on lake ecosystems. Monitoring the impacts of stocking programmes, both before and after stocking events, is necessary in order to develop an evidence base.

Lakes into which salmonids have been introduced are less likely to contain newts or salamanders than those which contain no salmonids. A precautionary approach to stocking with salmonids is necessary if potentially deleterious impacts to anuran populations are to be avoided.

The impact of stocking on frogs and toads is variable, but overall, available evidence suggests that stocked lakes are as likely to contain them as unstocked lakes. In general, they therefore appear less vulnerable to stocking than newts and salamanders. However, *Rana cascadae* (Cascades frog) and *Rana muscosa* (Mountain yellowlegged frog) are both significantly less likely to be present in water bodies stocked with salmonids than water bodies which do not. The latter species is of conservation concern and a precautionary approach to stocking with salmonids is necessary if potentially deleterious impacts to *R. cascadae* and *R. muscosa* populations are to be avoided.