A scientific consensus on salmon stocking

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On 27-28 November in Glasgow UK, the Atlantic Salmon Trust supported a conference on Atlantic salmon (*Salmo salar*) stocking sponsored by IBIS, a European funded collaboration between the Loughs Agency, University of Glasgow and Queen's University Belfast (IBIS 2013). As an output from that conference, the organisers have published a document, 'To stock or not to stock', which summarises the advice on stocking from various salmon management organisations. In support of that document, this paper summarises what the authors believe accurately reflects the current scientific consensus on salmon stocking.

We have written this paper for fisheries policy makers and managers who may not be familiar with the relevant scientific terminology, concepts and evidence. It presents our consensus view of the current scientific understanding of stocking in a series of brief statements, using non-technical language as far as possible (see *Definitions*).

The following statements are informed not only by research on Atlantic salmon, but also by research on other ecologically similar salmonids. The statements are sufficiently general to often apply to the stocking of these species as well. We recognise that uncertainty remains around specific scientific questions related to stocking. The complexity of salmonid ecology and life histories, the diversity of habitats and stocking programmes, and the difficulty in studying long-lived organisms that spend the majority of their lives at sea all contribute to this uncertainty. We do not believe, however, that current areas of uncertainty preclude stating the following evidence-based principles.

- Removing adult salmon from the natural environment, breeding them in captivity, and stocking their hatchery-reared offspring into the natural environment can, but does not always, increase the number of adults they contribute to the next generation. The net demographic outcome of stocking depends on the balance between the higher survival rates experienced by fish in captivity, and the subsequently lower survival rates of stocked fish relative to wild fish of the same age.
- Hatchery fish that survive to reproduce as adults in the natural environment, whether through mating with other hatchery fish or wild fish, typically produce fewer adults in subsequent generations than do wild fish, and this difference is more pronounced where permanent hatchery lines or non-native fish are used for stocking.
- Stocking may thus increase the number of adults in a population temporarily, but is likely to reduce the longer-term productivity of the population.
- Stocking poses a risk to wild salmon populations through a variety of ecological and evolutionary mechanisms, such as increased competition for food and interbreeding between hatchery and wild fish.
- The risk to wild populations is scale-dependent. The more hatchery fish that are stocked and the higher the ratio of hatchery to wild fish in the natural environment, the greater the risk to the wild population.
- The impact of stocking on the genetic make-up of a salmon population depends in part on the type of broodstock used. Some impacts can be minimised by using wild native broodstock (i.e. same population) bred and reared using best practice. However, even in this case genetic changes can occur due to the absence of sexual selection (i.e. crosses are artificially produced that would not happen in the wild), and relaxed and domestication selection in the hatchery environment.

- Following the cessation of stocking, the integrity of a wild population is likely to recover over time. However, in some cases stocking may lead to permanent changes in the genetic composition of a population, which may affect population productivity.
- Where the integrity of wild salmon is a management priority, stocking hatchery fish into wild populations is unlikely to contribute to management objectives.
- Where a population is at imminent risk of extinction, and all appropriate and possible fishery management and habitat restoration interventions have been realised, time-limited stocking may be appropriate to rescue the population. That is, when local extinction is imminent, the benefit of a short-term increase in adult abundance may outweigh the risk of long-term damage.
- Where the integrity of wild salmon is *not* a management priority, stocking may support fisheries by producing adults for capture or harvest. In such instances, however, some stocked fish will inevitably stray to neighbouring populations, which may have different management objectives. It is important to appreciate and assess this risk.
- The costs, benefits and impacts of a stocking programme on wild populations can only be assessed with well-planned monitoring programmes. Such monitoring is an important part of all stocking activities.
- Science alone does not determine the role of stocking in salmon management. Social, political and economic factors all influence fisheries management decisions.

Definitions

- **wild** refers to fish whose entire life, from the fertilisation of eggs to death, occurs in the natural environment in the absence of direct human intervention. Intervention in this context includes the direct and indirect effects of stocking, e.g. when hatchery fish survive to reproduce in the natural environment, their offspring are not wild. This definition does not strictly depend on habitat quality or stocking history. Wild salmon can be present in severely degraded 'non-wild' rivers and in rivers currently or historically subjected to stocking.
- **hatchery** refers to fish that have spent some portion of their life (from fertilisation) in captivity, without regard to the duration of time spent in, or the naturalness of, that captive environment.
- **stocking** refers to the act of placing hatchery eggs or fish in the natural environment.
- **population** refers to a group of interbreeding salmon which is to some degree genetically distinct from other such groups. For example, a river's salmon stock might contain multiple populations that spawn at different times or locations within the same catchment.
- **productivity** refers to a population's capacity to grow in size.
- **integrity** refers to the degree to which a wild salmon population interacts naturally with the environment and other species sharing aquatic ecosystems.