



Research article

Influence of harvest restrictions on angler release behaviour and size selection in a recreational fishery

Robert J. Lennox^{a, b, *}, Morten Falkegård^c, L. Asbjørn Vøllestad^d, Steven J. Cooke^a, Eva B. Thorstad^b^a Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6, Canada^b Norwegian Institute for Nature Research, P. O. Box 5685, Sluppen, N-7485 Trondheim, Norway^c Norwegian Institute for Nature Research, Fram Centre, P. O. Box 6606, Langnes, N-9296 Tromsø, Norway^d University of Oslo, Centre for Ecological and Evolutionary Synthesis, Department of Biosciences, P.O.Box 1066, Blindern, N-0316 Oslo, Norway

ARTICLE INFO

Article history:

Received 23 November 2015

Received in revised form

18 March 2016

Accepted 19 March 2016

Available online 4 April 2016

Keywords:

Catch-and-release

Fisheries induced evolution

Fisheries management

Co-management

Salmo salar

ABSTRACT

Fishing regulations such as harvest restrictions are implemented to limit the exploitation of many fish stocks and ensure the sustainability of fisheries. In Norway, inland recreational fisheries are co-managed by the government and by local riparian rights holders, meaning that Atlantic salmon *Salmo salar* harvest restrictions differ somewhat among rivers. Data from Norwegian rivers from 2009 to 2013 were used to test for variation in the proportion of salmon released by anglers and the relative size of salmon harvested and released by anglers in rivers that had varying harvest restrictions in terms of quotas, size restrictions, and/or female harvest restrictions. The proportion of the catch released by anglers was higher in rivers where there were harvest restrictions (proportion released = 0.09–0.24) than in rivers with no such restrictions (proportion released = 0.01). On average, salmon released in rivers with size restrictions larger (average mass difference between harvested and released salmon = –1.25 kg) than those released in rivers without harvest restrictions (difference = 0.60 kg). The proportion of the catch released was larger in rivers with seasonal quotas (0.29) than in rivers with daily (0.07) or collective (i.e. total catch for the river; 0.06) quotas. Rivers with low daily (one salmon per angler per day) or seasonal (<5 salmon per angler per year) quotas had a larger proportion of salmon released (0.23, 0.38, respectively) than rivers with moderate (0.10, 0.21) or high (0.07, 0.16) quotas. High seasonal quotas resulted in larger individuals harvested than released (difference = 1.16 kg), on average, compared to moderate (1.22 kg) and high seasonal quotas (–0.30 kg). We conclude that harvest restrictions influenced the extent to which fish were released and thus the stock composition (i.e. size distribution) escaping the recreational fishery with the potential to spawn.

© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

Natural resource based recreation and tourism provides significant economic returns through non-exploitative (see Duffus and Dearden, 1990) and consumptive activities such as hunting (Lovelock, 2007) and angling (Ditton et al., 2002; Arlinghaus and Cooke, 2009). Regulating the use of fish and wildlife resources is necessary to balance the economic returns and other socio-economic benefits with the conservation of the local ecosystems

and constituent animal populations. Managing natural resources is therefore a combination of managing the resource itself and managing human behaviour, predominantly the users of the resource, in order to ensure long-term sustainability (Clark et al., 2000; Schultz, 2011). In fisheries, regulation of human behaviour requires the implementation of restrictions on angler behaviour in order to moderate the catch and ensure sufficient escapement so that fish stocks can replace themselves and produce a harvestable surplus (Johnson and Martinez, 1995; Cooke and Cowx, 2006; Isermann and Paukert, 2010).

Recreational fisheries are increasingly experiencing over-exploitation associated with high fishing pressure in both freshwater (Post et al., 2002) and marine systems (Coleman et al., 2004). Dedicated and mobile, a group of anglers can effectively deplete

* Corresponding author. Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6, Canada.

E-mail address: robert.lennox@carleton.ca (R.J. Lennox).

fisheries resources (Hunt et al., 2011). Catch-and-release is often considered a solution for the problem of over-exploitation of fish in recreational fisheries (Wydoski, 1977; Cooke and Schramm, 2007). This assumption is based on the theory that anglers derive the majority of their satisfaction from the fish capture experience rather than from the harvest and consumption of the fish that they catch. Further, it is assumed that catch-and-release fishing is substitutable for catch-and-keep fishing, although this is not always the case (Ditton and Sutton, 2004; Anderson et al., 2007; Beardmore et al., 2011). Catch-and-release is practiced either voluntarily by anglers or to comply with regulations (i.e. regulatory catch-and-release; Arlinghaus et al., 2007). However, instead of strictly regulating fisheries using catch-and-release, fisheries managers can impose restrictions on harvest for example by implementing quotas, size restrictions, or sex restrictions that limit the proportion of a population that is available to anglers for harvest. Such restrictions provide anglers with a chance to harvest some proportion of their catch while ensuring adequate reproductive potential within the population.

Recreational fishing represents a growing driver of tourism in Scandinavia, particularly in rural regions (Stensland, 2010; Kauppila and Karjalainen, 2012). In Norway, the Atlantic salmon *Salmo salar* fishery is managed by national policies and regulations but also by local regulations developed either by landowners with exclusive rights to fishing on their property or by landowner associations, which represent the interests of a collective of fishing rights holders (Stensland, 2012). There are many restrictions on fisheries including open and closed seasons for fishing. However, there are also regulations on salmon fishing that have local variation, with different restrictions imposed on anglers fishing different rivers. These restrictions generally focus on moderating the harvest of salmon while permitting the retention of some proportion of the catch by recreational anglers. In Norway, these restrictions include quotas, size restrictions, and mandatory female release (Table 1). Regardless of the specific restriction(s) imposed by managers, the objective is consistent, aiming to balance angler satisfaction with sustainability of the fishery in the long-term (Stensland, 2010).

Adult salmon face considerable challenges throughout their migration and are increasingly threatened by habitat alteration and fishery exploitation (Parrish et al., 1998; Thorstad et al., 2008; Otero et al., 2011). Consequently, regulating Atlantic salmon fisheries is a dynamic and difficult task. Effective regulations should reflect management objectives, which are often to maintain spawning populations above conservation limits. Such objectives can be accomplished by increasing the frequency with which fish are released or decreasing the proportion of fish that are captured. Moreover, harvest restrictions might be necessary to protect certain stock components such as large fish that have high fecundity.

However, regulatory harvest restrictions can have unintended consequences, particularly when they influence the size of fish that are released such that there is directional selection. Directional selection occurs when certain phenotypes have fitness advantages over others due to intentional (e.g. preferential harvest of large individuals; Allendorf and Hard, 2009) or other (e.g. selective gear type; Kuparinen et al., 2009) mechanisms acting on fisheries. Directional selection is a precursor to fisheries-induced evolution (Kuparinen and Merilä, 2007) and it is therefore important to understand how harvest restrictions influence the size of fish that are released in salmon fisheries. Quantifying how different restrictions function for managing harvest of Atlantic salmon stocks is therefore useful to help regulations meet management objectives. To do so, we analyzed data from Norwegian catch records in Atlantic salmon fisheries with different harvest restrictions including quotas, size restrictions, mandatory female release, and combinations thereof. Specifically, we related the proportion of fish released and the relative size of Atlantic salmon released by anglers to the harvest restrictions implemented in Norwegian rivers from 2009 to 2013.

2. Methods

Salmon catch data were collected from recreational Atlantic salmon fisheries in Norway between 2009 and 2013. To ensure that we had access to comprehensive background data about the fisheries, we analyzed rivers that are assessed by the Norwegian Scientific Advisory Committee for Atlantic Salmon Management. Catch statistics for each of the rivers were provided by Statistics Norway. Detailed reporting by anglers of all individual salmon catches are mandatory in Norway, ensuring that we had accurate catch data. For each river in every year studied, we had data relating to the number of fish harvested and released by anglers as well as the total mass of the salmon harvested and released (which we could divide by the total catch to get the average mass of salmon captured by anglers in all the rivers in every year). Harvest restrictions specified by the local river authority (i.e. landowners association) and fishery management agencies were collected for each year from the local county offices. Although all Atlantic salmon fishing rivers in Norway are managed with regulations such as open and closed seasons, our analysis focused specifically on the implementation of harvest restrictions (Table 1).

Throughout, we addressed two questions about the implementation of harvest restrictions in Norwegian rivers, the first being whether there were differences in terms of the proportion of salmon released and second whether there were differences in the sizes of fish released relative to the sizes of fish harvested. The influence of harvest restrictions on the proportion of salmon released was analyzed with linear mixed effects regression in R (R

Table 1
Harvest restriction types in the Norwegian recreational Atlantic salmon fishery related to quotas and mandatory release of fish. These restrictions are used either singularly or in combination in the different rivers.

Harvest restriction	Description
None	Anglers may harvest whichever fish they choose and there are no quotas ^a .
Quota	Anglers may not exceed a personal limit for number of salmon harvested either daily, seasonally, or in combination. Alternatively, a river may have a collective quota for harvest.
Release	Special stipulations that allow the harvest of some fish but require release of others. Examples are rivers open to sea trout (<i>S. trutta</i>) fishing where salmon captured as bycatch must be released. In addition, rivers where escaped farmed salmon are common and open to harvest but in which wild salmon must be released.
Female release	Anglers may not harvest female salmon.
Size restriction	Anglers may not harvest salmon exceeding some size limit.
Other	Special stipulations such as in rivers where introduced <i>Gyrodactylus salaris</i> parasites exist and anglers are encouraged to harvest fish as part of eradication initiatives.

^a All rivers have regulations (e.g. seasonal closures, gear restrictions), but this is not covered in this study.

Download English Version:

<https://daneshyari.com/en/article/1055336>

Download Persian Version:

<https://daneshyari.com/article/1055336>

[Daneshyari.com](https://daneshyari.com)