Differential Exploitation of Atlantic Salmon Populations by a Rod Fishery on the River Spey, Scotland

Fisheries Research Services

Spey Fishery Board

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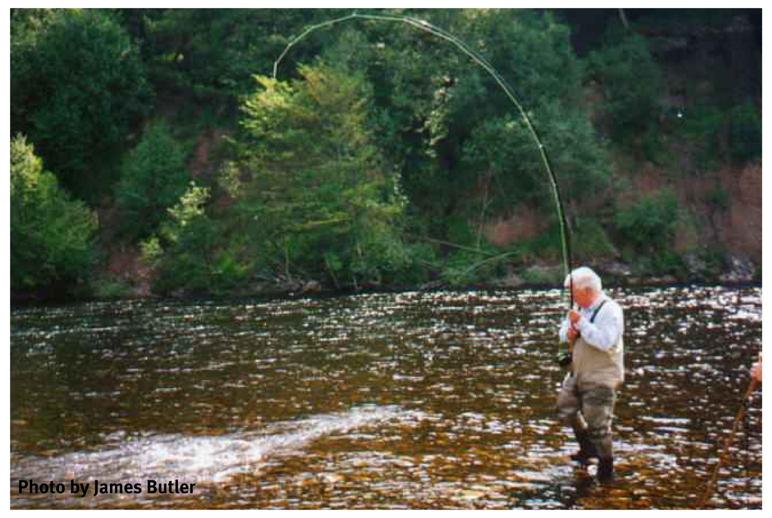
Introduction

Due to heritable population differences in run-timing, Atlantic salmon (*Salmo salar*) enter Scottish rivers throughout the year. Maintenance of this diversity is vital for the continued commercial and recreational value of the associated rod fisheries, which extend on most rivers from February to September. However, as the data we present demonstrate, management of the rod fishery on the River Spey, Scotland, is complicated by differential exploitation of the Atlantic salmon from the various run-timing groups.



Method & Results

During the 2000 to 2002 fishing seasons on the River Spey, Scotland, 862 rod-caught Atlantic salmon were Floy-tagged by trained ghillies (guides) and released. Of these three were later found in a diseased state and were excluded from the study. The numbers tagged and released in each month are shown in Figure 1. Thirty-nine salmon were re-caught by anglers before October. The proportion of fish tagged in each month that were subsequently re-caught is shown in Figure 2. Fish of different sea-age classes are not distinguished.

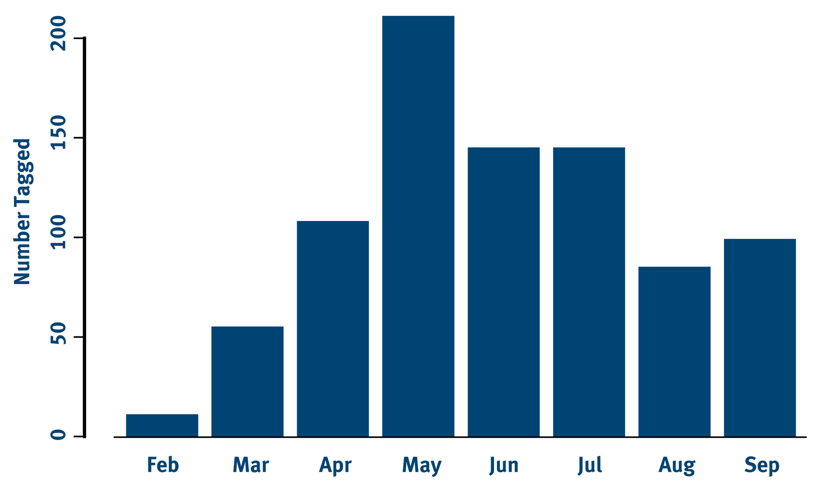


Figure 1.
The number of salmon tagged in each month.

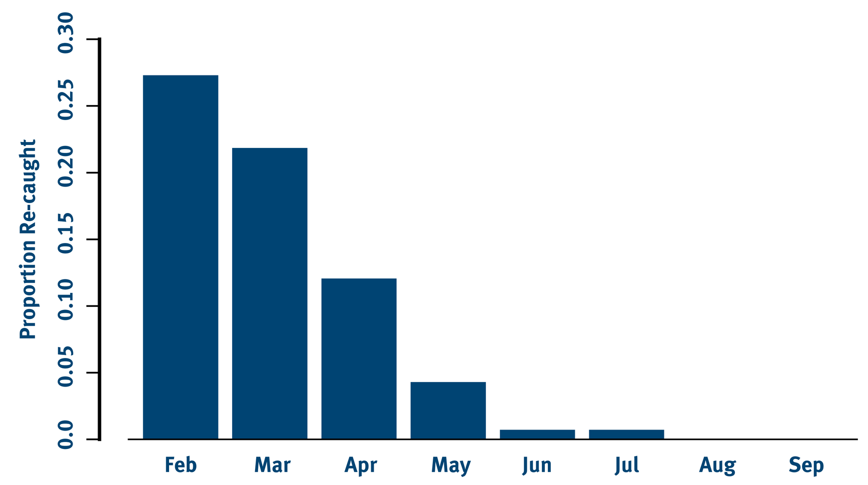


Figure 2.
The proportion of salmon tagged in each month and subsequently re-caught before October.

The probability of recapture by Julian Day was estimated by a logistic model with recapture coded as a binary variable. Since an additive logistic model did not significantly improve the fit and since year was not a significant explanatory variable, the following logistic regression model was fitted:

$$P(\text{Recapture}) = \frac{\exp(1.33 - 0.0335\,\textit{JulianDay})}{1 + \exp(1.33 - 0.0335\,\textit{JulianDay})}$$

The adequacy of the model was established by simulating data. The logistic regression complete with confidence intervals is shown in Figure 3.

The probability of recapture from date of tagging, by days, was estimated for fish tagged in March, April or May by a Cox proportional hazards model. Too few fish from the remaining months were re-caught for inclusion in the model. Since the fish became re-exploitable in September, captures after the 31st of August were excluded. Salmon tagged in March had a significantly different baseline hazard to those tagged in April and May ($p < 0.005$). The two separate models are plotted in Figure 4. Julian Day of tagging was a significant negative coefficient of proportionality for the salmon in the April-May model ($p < 0.05$) but not the March model ($p > 0.5$).

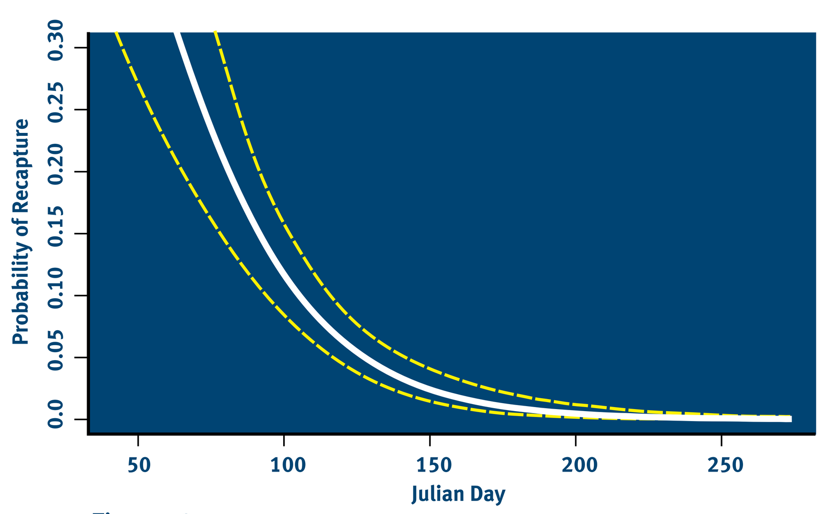


Figure 3.
The probability of recapture before October by Julian Day tagged as estimated by logistic regression. The dashed lines are pointwise 95% confidence intervals.

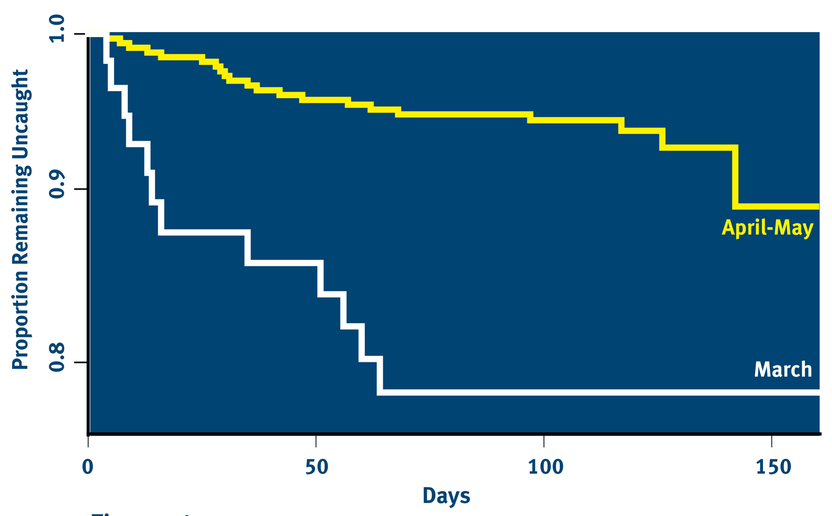


Figure 4.
The proportion of tagged salmon remaining uncaught by days from tagging.

Discussion

The results have to be interpreted carefully because the recapture probabilities estimate re-exploitation level - which may not be the same as exploitation level. A discrepancy could arise in four ways. Firstly, **(1)** if individual salmon differ in their catchability then tagged salmon will tend to be the most catchable fish and re-exploitation will exceed exploitation. Alternatively, **(2)** if capture decreases the probability of capture at a later date, through for example a higher mortality rate, then exploitation will exceed re-exploitation. This will also be the case **(3)** if fish lose their tags or recaptures are unreported. Finally, **(4)** if the probability of capture declines from date of river entry then exploitation will once again exceed re-exploitation.

To the best of our knowledge, the only study to consider inter-individual variation in catchability found that salmon which entered the Welsh Dee in the same month did not experience any difference in exploitation level associated with sea-age (Davidson *et al.*, 1996). Since the other three mechanisms, which are all probably operative, cause exploitation to exceed re-exploitation, the recapture probabilities presented in this study are likely to be conservative estimates of the levels of exploitation.

In Scotland, early-running (or so-called ‘spring’) salmon belong to genetically distinct populations which typically spawn in the upper parts of catchments (Laughton & Smith, 1992; Stewart *et al.*, 2002). Spring salmon are large, multi-sea winter fish that are sought after by anglers. As this study demonstrates, they are also highly exploitable – a property that further increases their value to the rod fishery.

However, due at least partly to changes in the marine environment, early-running salmon are declining in abundance (Youngson *et al.*, 2002). Unless fisheries managers protect these populations, the genetic diversity underlying run-timing may be compromised. This could leave the ‘stock complex’ unable to rapidly respond to future environmental change and therefore vulnerable to collapse (Hilborn *et al.*, 2003). Fisheries managers must consider differential exploitation of the various run-timing groups when implementing conservation measures.

Acknowledgements

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Photo by Ian Neale

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