Jon Olaf Olaussen

On the Economics of an Atlantic Salmon Recreational Fishery

Thesis for the degree philosophiae doctor

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Norwegian University of Science and Technology
Faculty of Social Sciences and Technology Management
Department of Economics

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Contents

Chapter 1

Introduction

1. Introduction

This thesis includes four essays on the management of wild Atlantic salmon (*Salmo salar*). The main focus is on the management of the recreational fishery; thus, the focus is on salmon in the rivers, where anglers buy fishing permits from landowners in order to fish for salmon. However, because there are many important events influencing salmon in the marine environment, marine fishing of salmon and aquaculture are also included exogenously in the models. The issues considered range from pure bioeconomic modelling of management regimes, bioeconomic modelling of invasive species interacting with native species, game theory aspects regarding side payments from riparian to marine right holders, and more specific analyses of components in the demand function for angling experiences. The first three chapters contain theoretical bioeconomic modelling illustrated by numerical simulations. The final chapter is mainly empirical reporting results from a contingent valuation survey that was a part of the project.

2. Summary of the essays

Chapter 1: The Bioeconomics of a Wild Atlantic Salmon (salmo salar) Recreational Fishery

In this chapter, the baseline biomass model of a wild salmon (*Salmo salar*) river recreational fishery is formulated. The aim of this essay is to analyse how biological and economic factors affect harvest rates, stock growth, the economic benefits, and the distribution of economic benefits among anglers and landowners in a representative Norwegian Salmon river. In line with today's stylized management practice in Norway, it is assumed that the suppliers of fishing permits do not take into account the fact that this year's fishing effort influences next year's stock size. Hence, they act as myopic agents. We study both price-taking and monopolistic supply and these myopic schemes are contrasted with the social planner solution. Gear regulations in the recreational fishery, but also in the commercial fishery, are analysed under the three management scenarios. Both the steady states and the dynamic paths are examined. It turns out that it is generally unclear how the various harvesting schemes distribute total surplus between anglers and landowners. This hinges critically on the uncertain stock and effort effects under the different management scenarios. One novel result is that imposing gear restrictions in the recreational fishery may have the exact opposite stock effects of imposing restrictions on the marine harvest.

It has traditionally been argued that the recreational fishery is of minor importance to the wild Atlantic salmon stock abundance because the escapement needed to ensure recruitment is quite low. Thus, NASCO (2001) regards low marine survival as the crucial factor determining the decreasing wild stock. This chapter offers an alternative explanation as we show that, even with a constant marine survival, large stock fluctuations may be due to type of river management. The analysis also provides some policy implications as we demonstrate that an increased marine harvesting activity may in fact be stock conserving under myopic management. Moreover, measures taken to reduce the marine harvesting activity may produce unclear stock effects as well as large stock fluctuations. The crucial factor here is how strong the demand quality effect is. We show that this hinges critically on type of management scheme in the river, and in the myopic case we find that a reduced marine harvest rate may go hand in hand with a reduced stock. Imposing gear restrictions in the river generally increases the stock and decreases total surplus, but may also lead to reduced stock fluctuations over time.

Chapter 2: Playing Chicken with Salmon

In this chapter, we analyse the case where wild Atlantic salmon stock is harvested by both recreational anglers and commercial fishermen. Many studies have argued that the share of the total harvest caught in the recreational sector should typically increase because the value of the fish in this sector is greater than that in commercial fisheries (for example, see Cook and McGaw 1996, Laukkanen 2001, and Olaussen and Skonhoft 2005). This is also the case for Atlantic salmon, where the return from sport fishing in rivers is several times higher than marine 'for meat only' harvests. However, when at least one party has property rights, agents left to their own devices should be able to allocate resources according to the well-known 'Coase Theorem'. Hence, this situation calls for a side payment regime where river owners pay marine fishermen not to fish, and where both parties gain. It is argued that the reason why such side payment regimes are rarely seen, despite the obvious mutual gain, is due to the potential free-riding incentives among river owners. Although it is shown that the decision each river owner faces can be described as a game of chicken, taking the stochastic ecology into account may reveal a different pay-off structure.

The game played between the river owners is a side payment game (acquisition of marine fishing rights). We use equilibrium levels in mixed strategies as indicators of the likelihood that each manager cooperates (acquisition of marine fishing rights) or defects (no acquisition). The influence of stochastic survival of recruits on the mixed strategy equilibrium levels is analysed under two different price setting regimes in the rivers: rigid and flexible fishing permit prices. Rigid permit prices are in accordance with present price setting in most salmon rivers because the permit prices are announced in the winter, long before the stock is observed (in summer) and the fishing season opens. Since this rigid price setting lacks motivation in any formal requirements, but rather seems to reflect some traditional practice, we want to analyse an alternative price setting regime that takes the stochastic ecology of salmon into account. Flexible permit prices mean that the permit price is set at the beginning of the fishing season, after the stock size can be determined. We demonstrate that when ecology is stochastic, rigid and flexible prices may shift the equilibrium mixed strategy levels in opposite directions. The reason why rigidities may strengthen the incentives of river owners to free ride is as follows. With rigid prices and stochastic survival, the owners earn less when survival is high, and may even face potential losses when survival is low.

Chapter 3: On the Economics of Biological Invasion: An Application to Recreational Fishing

In this chapter, we analyze the influence escaped farmed species may have on the natural habitants. More specifically, we study the effects that escaped farmed salmon (*EFS*) may have on wild Atlantic salmon. The invaders can be viewed as biological pollution, and in that sense, the paper is essentially an extension of McConnell and Strand (1989). They analysed the social returns to commercial fisheries when water quality influenced both demand and supply of commercial fish products under both open access and when fish stocks were efficiently allocated. The invasion case considered here requires additional demand and supply effects to be considered.

The paper demonstrates four general mechanisms that may affect economically valuable species when exposed to biological invasion. We distinguish between an *ecological level effect* and an *ecological growth effect*. The *ecological level effect* is due to the fact that *EFS* adds to the wild stock and hence increases the upstream migration in the rivers. The *ecological growth effect* reflects the fact that the growth of the wild population is affected by e.g. crossbreeding with the escaped farmed salmon. In addition we present an *economic quantity effect* working through demand. This is the economic analogue to the ecological level effect as the yearly inflow of *EFS* ceteris paribus increases the catches in the rivers. Finally we suggest that there is an *economic quality effect* that reflects the possibility that invasions affect the harvesting agents directly through demand-side forces. For example, this may occur because the state of the original species or the ecosystem is altered. We depart from the existing literature by revealing ecological and economic forces that explain why different agents may lack incentives to control invasions.

Our results indicate that, even if the growth rate of the wild species is reduced, the total stock may increase when there is an ecological invasion. Hence, measures to reduce an invasion may very well reduce the overall river surplus because less biomass will be available to catch. One interesting result is that, if there is no *economic quality effect*, the harvesting effort will be higher due to the *economic quantity effect* and, hence, the stock will be less than before the invasion. In this case, the river profit and the angler surplus will always be higher *ex post* the invasion, and both will increase with invasion of the farmed species. Thus, one consequence that follows directly from the analyses is that reporting the share of invasive species in an ecosystem may reduce the demand for harvesting the wild species. This will in turn increase the wild stock and depending on the composition of the catch, the share of resident species in the ecosystem may increase.

The mechanisms discussed in the essay may also be transferable to other situations where escaped farmed animals mix with their wild congeners, or where an ecosystem faces a yearly influx of invasive species for any reason. For example, there is an apparent analogue to agricultural invaders that is grown commercially but escapes to interbreed with wild plants. We demonstrate that the overall surplus may rise following an invasion. Of course, this may have important implications for incentives to reduce the accidental releases of farmed species. As shown, participants in the harvest may want invasions to persist. Perhaps more importantly, these economic forces, or lack of incentives, may explain why policymakers must intervene if they want to reduce invasions.

Chapter 4: Bandwagon or snob anglers: Evidence from a recreational fishery.

This chapter analyses the effect of congestion on the demand for wild Atlantic salmon recreational fishing in Norway. Both social interaction and crowding are usually reported to be important determinants of recreational outdoor activities. As they are both determined by the total number of simultaneous participants in the recreational activity, the effect of increasing the number of participants are generally ambiguous. An analogue to Leibenstein´s (1950) bandwagon and snob effect in demand is presented, and these theoretical models are extended to allow for different congestion effects at different congestion levels. Empirical evidence from a CV study on Norwegian recreational Atlantic salmon fishing demonstrate that the crowding effect dominates the social interaction effect for all levels of congestion. Moreover, we show that the marginal crowding effect is diminishing in the congestion level, as opposed to Schuhmann and Schwabe (2004) that finds an increasing marginal effect of congestion on recreational angling demand. On the other hand, the diminishing marginal utility from congestion with respect to beach use in McConnel (1977) is supported by our result for angling. In line with the literature on heterogeneous preferences for congestion (see e.g. McConnell 1988 and Schumann and Schwabe (2004)), we try to identify different user (angler) groups. However, we find no socioeconomic or other differences between the “snob” and “bandwagon” anglers in the sample.

From a management point of view, crowding in popular recreational activities may reduce the overall welfare, and therefore needs to be addressed. Evidence of the impacts of congestion is important to resource managers because congestion can be an effective way of rationing the usage. To understand the relationship between congestion and sociability is of equal importance, and the relationship may obviously differ for different recreational activities.

From a river manager point of view, this may obviously be important information when deciding how to manage the fishery.

3. Discussion

Modelling is about making simplifying assumptions without losing the essence of the real-life situation that we want to say something about. What to include and what to leave out is not an exact science. In a good model, the general driving forces revealed will survive when the model is extended to include more components from real life. To what extent the papers presented in the following chapters fulfil these requirements is up to future research to reveal. However, I feel the most important aspects omitted deserve some thoughts and remarks.

As already mentioned, more complete models would require the marine harvest decision (especially in chapter 2) and the aquaculture production decision (in chapter 4) to be endogenously modelled. However, given the focus on river management and incentives facing river managers, the decision to limit the models with respect to these aspects seems natural. Another increasing and important aspect omitted is the possibility of catch-and-release fishing. There are two main reasons for this. First, catch-and-release fishing is analysed thoroughly in a bioeconomic model by Anderson (1993). Second, so far, catch-and-release fishing of Norwegian Atlantic salmon is very rare.

Although many management regimes are considered in chapters 2, 3 and 4, these must be considered as stylized extremes. As mentioned in the chapters, most real-life situations are somewhere between these extremes. For example, a type of monopolistic competition may very well occur since there are always at least some differences between different pools in a river. However, as some rivers are more likely to be characterized as price-taking than monopolistic rivers, and vice versa, analysing the extremes provides information that may be more-or-less in accordance with the actual situation in various rivers.

Also, the demand side is obviously simplified in the thesis, as explained in chapter 2. In the baseline model presented there, only stock size and aggregate demand affect the willingness to pay (wtp) for fishing permits. Other things that may influence demand such as accommodation, situation, nice surroundings, average size of the fish (which varies between rivers), stability of water flow during season, sociability, number of permits sold per day and so forth, are neglected in the bioeconomic models presented. However, the demand side is extended in one aspect in chapter 4 where the pureness of the salmon, in terms of the percentage of escaped farmed salmon in the river, is taken into account. Moreover, chapter 5 focuses more explicitly on the demand side and the relationship between sociability and congestion in recreational fishing.

Finally, the instantaneous Schaefer-type harvest function applied in the thesis needs to be mentioned. As the recreational fishery normally lasts for three months during the summer, the instantaneous harvest function may seem inappropriate. However, it turns out that it is more suitable than one would imagine. The reason is as follows: salmon reach their specific home river continuously during the whole fishing season. Some start their upstream migration at the beginning of June, some in July and others in late August. Some salmon even arrive before June and some after the fishing season closes at the end of August. It turns out that the good time to catch a salmon is when they arrive and during their upstream migration; these are the so-called newly arrived fish. When salmon are no longer newly arrived, they are much harder to catch (Fiske and Aas 2001). Hence, fish that arrived in June and were not caught in June are much less likely to be caught in July or August. This means that the instantaneous harvest function seems to be a reasonably appropriate representation of the actual harvest process in the rivers, after all.

References:

Anderson, L.G. (1993): Toward a Complete Economic Theory of the Utilization and Management of Recreational Fisheries. *Journal of Environmental Economics and Management* **24**, 272-295.

Cook, B. A., and R.L. McGaw (1996): Sport and Commercial Fishing Allocations for the Atlantic Salmon Fisheries of the Miramichi River. *Canadian J. of Agricultural Economics* **44**, 165-171.

Fiske, P., and Ø. Aas, ed. (2001): *Laksefiskeboka. Om Sammenhenger mellom Beskatning, Fiske og Verdiskaping ved Elvefiske etter Laks, Sjøaure og Sjørøye,* NINA Temahefte 20, 1-100.

Laukkanen, M. (2001): A Bioeconomic Analysis of the Northern Baltic Salmon Fishery: Coexistence versus Exclusion of Competing Sequential Fisheries. *Environmental and Resource Economics* **18**: 293-315.

Leibenstein, H. (1950): Bandwagon, Snob, and Veblen Effects in the Theory of Consumers` demand. *The Quarterly Journal of Economics* ***64*** (2): 183-207

McConnell, K. E. (1977): Congestion and Willingness to Pay: A Study of Beach Use. *Land Economics* ***53***: 185-195.

McConnell, K.E., and I. Strand (1989): Benefits from commercial fisheries when demand and supply depend on water quality. *Journal of Environmental Economics and Management* **17**, 284-292.

NASCO (2001): Report on the Activities of the North Atlantic Salmon Conservation Organization 2000-2001. Retrieved from http://www.nasco.int/ on 10 December 2003.

Schuhmann, P.W and K.A. Schwabe (2004): An Analysis of Congestion Measures and Heterogeneous Angler Preferences in a Random Utility Model of Recreational Fishing. *Environmental and Resource Economics* ***27(4)***: 429-450.

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