

Stock assessment and exploitation of Atlantic salmon *Salmo salar* L. in the river Drammenselv

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In 1985 the total salmon run and the exploitation rate in the river Drammenselv were estimated by combining catch statistics, counts of ascending salmon in a salmon ladder at Hellefoss, and a tagging-recapture experiment of the spawning stock below the ladder. The total run was estimated to 3028 individuals. The exploitation rate above the ladder was 0.04, which is a minimum estimate. Below the ladder the estimated exploitation rate was 0.33. The relatively low exploitation of the salmon stock in the river Drammenselv is probably one of the main factors responsible for the rapid increase in this salmon population.

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INTRODUCTION

Good management of salmon stocks requires knowledge of the size of the mature population and the exploitation rate both in the sea and the rivers.

In Norway there are very few data on the run of multisea winter salmon stocks. Hansen (1986, 1987 (in press.)) presents data on sea exploitation rates from smolt tagging experiments in the river Imsa. This stock, however, consists primarily of grilse and no data on the exploitation rates in the river is available. Jensen (1979, 1981) and Rosseland (1979) presented rough exploitation estimates from the rivers Eira and Lærdalselv, respectively. River exploitation rates varied between 0.40 and 0.83.

The river Drammenselv salmon stock consists of grilse, 2, 3 and 4 sea winter fish (Hansen unpubl. data). Most of the grilse are males, and most of the 2-sea winter fish are females. Among the sea run fish the male/female ratio was not significantly different from 1.

In recent years facilities to control upstream migration and very good routines for registrations in the fishery have been developed in the river Drammenselv. The present paper presents estimates of the total run of Atlantic salmon and the exploitation upon this stock in the river during 1985.

MATERIAL AND METHODS

The river Drammenselv drains large areas of south east Norway (drainage area = 17140 km²). In lower parts of the river the average annual water

discharge is about 225 m³ s⁻¹, and the river width is about 200 m.

At the end of the last century the river Drammenselv gave an annual yield of 20–25 tons of salmon. Due to pollution from pulp mills and several regulations of the river the size of the salmon stock decreased considerably during the present century (Fig. 1). In recent years, however, the water quality has again improved. This, combined with an enhancement programme has again increased the stock. The salmon in the river is only exploited by rod fishing. At present the catch statistics from the river are excellent.

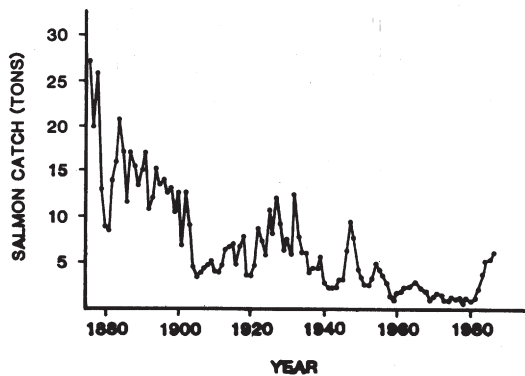


Fig. 1. Reported catch of Atlantic salmon in the river Drammenselv from 1876 to 1986.

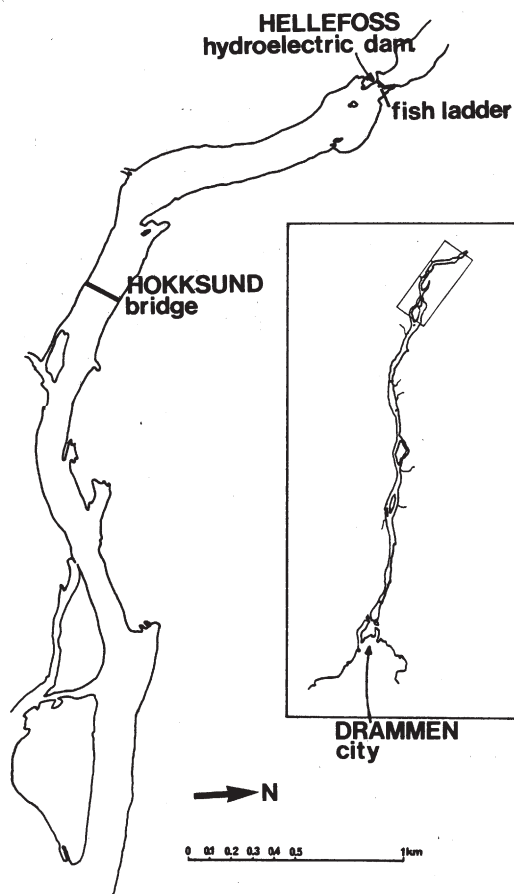


Fig. 2. Map of the lower part of the river Drammenselv, with the especially investigated section shown in an enlarged scale.

A salmon ladder is in function about 19 km above the river mouth (Fig. 2). In the upper end of the ladder a trap catches all ascending salmon. After control they are released above the trap. Below the ladder spawning is limited to an area reaching from the hydroelectric dam at Hellefoss and about 3 km downstream.

In 1985 the total salmon run was estimated by using catch statistics, trap counts and by a mark-recapture experiment. About two weeks before spawning 274 prespawners were caught by drift nets, individually tagged, kept under observation for 3–6 days and then released. There was no mortality during this period. A week later, the area was fished using the same procedure.

Estimates of the population size below the ladder was calculated according to the formula (e.g. Ricker 1975)

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)}$$

$$\text{where } SE(\hat{N}) = \hat{N} \sqrt{\frac{(\hat{N}-M)(\hat{N}-C)}{MC(\hat{N}-1)}}$$

- \hat{N} = estimate of total number of salmon in the population
- M = total number of tagged fish in the population
- C = number of fish in the sample
- R = number of tagged fish recaptured in the sample
- SE = standard error

RESULTS

In 1985 a total of 1040 salmon were reported caught in the river, of which 1006 fish were reported from below the salmon ladder. This is a minimum figure because a few fish caught are probably not reported.

In the trap a total of 941 salmon were registered.

Of the 86 females and 188 males tagged below the fish ladder (Fig. 3), 14 and 64 fish were recaptured. This gives population estimates of 563 females and 518 males respectively (Table 1).

The total run of Atlantic salmon in river Drammenselv in 1985 was estimated to 3028 individuals (Table 2) of which 1040 were caught. The total estimated exploitation rate within the river is therefore $1040/3028 = 0.34$.

Exploitation rate was very low above the salmon ladder (0.04), compared with the area below the ladder (0.33) (Table 3).

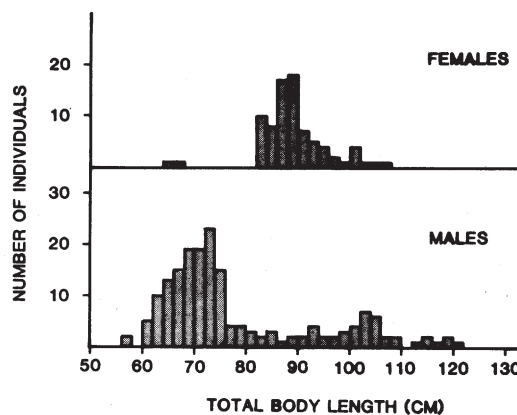


Fig. 3. Length distribution of 86 females and 188 males of Atlantic salmon tagged and released below Hellefoss, the river Drammenselv autumn 1985.

Table 1. Estimated population size of female and male Atlantic salmon below the salmon ladder at Hellefoss, the river Drammenselv 1985. Explanation of the symbols, see material and methods.

| Sex | M | C | R | \hat{N} | SE (\hat{N}) |
|---------|-----|-----|----|-----------|------------------|
| Females | 86 | 96 | 14 | 563 | 123 |
| Males | 188 | 177 | 64 | 518 | 42 |

Table 2. Estimated number of Atlantic salmon entering the river Drammenselv 1985.

| | |
|---|------|
| Fishery below the ladder: | 1006 |
| Trap counts: | 941 |
| Estimated population size below the ladder: | 1081 |
| Estimated total run: | 3028 |

Table 3. Estimated exploitation rates above and below the salmon ladder at Hellefoss, the river Drammenselv 1985, based on the total run in the different areas.

| | Total run | No. caught | Exploitation rate |
|-----------------|-----------|------------|-------------------|
| Above Hellefoss | 941 | 34 | 0.04 |
| Below Hellefoss | 3028 | 1006 | 0.33 |

DISCUSSION

Experiments carried out in the river Imsa have demonstrated that the total exploitation rate for salmon in the sea may exceed 0.90 (Hansen 1986, 1987 (in press)). High total exploitation rates (0.78–0.97) have been estimated from the river Eira and the river Lærdalselv (Jensen 1979, 1981, Rosseland 1979). Preliminary results from smolt taggings in the river Drammenselv indicate a much lower exploitation rate in the sea (Hansen unpubl. data). The river Drammenselv salmon return along the southern coast of Norway. In this area acid water has wiped out most salmon populations (Jensen & Snekvik 1972), which has led to a serious decline in the salmon fisheries in these areas.

Even though most fish spawn within the sampling area below Hellefoss (Fagerlid Olsen pers. comm.) we can not exclude that a few fish spawn a further downstream. Furthermore the collection of catch statistics in the system is very good. Still a few

fish may have gone unreported. Thus, the estimated total run is a minimum estimate.

The accuracy of the exploitation rate is dependent on both the catch statistics and the tagging-recapture experiments. The sources of error in tagging-recapture experiments are discussed in detail by Ricker (1975).

Due to the relatively large standard error of the population estimates and the possibility that not the total spawning area below the ladder has been sampled, the catch statistics is probably more accurate than the estimates of the spawning population below the ladder. If so, the exploitation rate of salmon in this area is most probably a maximum estimate.

The estimated exploitation rate above the ladder is probably a minimum estimate as some fish caught may not have been reported. The very low exploitation rate above the ladder might be caused by several factors. In 1985 salmon entered the ladder from 4 July onwards, and at the end of the angling season about 800 fish had passed. The fishing season above the ladder is therefore shorter than below the ladder. The angling effort in this area is also very low compared to the situation below the ladder. In addition the angling conditions are much less favourable.

The total exploitation of Atlantic salmon in the river Drammenselv (0.34) is relatively low compared with data from the river Eira and the river Lærdalselv (Jensen 1979, 1981, Rosseland 1979). The methods used in these studies were based on visual countings of spawning redds in the river Eira and of spawners in the river Lærdalselv. These data were combined with reported catches. In the river Eira the exploitation rate varied between 0.40 and 0.83 and in the river Lærdalselv between 0.43 and 0.68.

The low exploitation rate of the river Drammenselv salmon stock is probably one of the key factors for a rapid restoration of the salmon population in this river (cf. Fig. 1).

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