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# Maintenance of Angling through Smolt Releases in the Rangá river in Southern Iceland

by

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## ABSTRACT

Great quantities of reared smolts of Atlantic salmon have for several decades been released into Icelandic salmon rivers in order to enhance sport fishing. Recaptures of coded wire microtags have shown that returns have been highly variable. Releases of smolts into each river, however, have usually been amounting to a few thousand smolts and rarely made strong impacts on the total run into rivers.

In the late 1980s large scale releases of smolts were started into the Rangá river in southern Iceland, which was primarily a sea-trout stream with a poor habitat for salmon. Since the start of the project yearly releases have been gradually increasing from 21.000 smolt in 1989 to 148.000 in 1992. The resulting angling catches have ranged from 450 to 1600 salmon, primarily grilse, and the river has twice been among the top 3 angling rivers in Iceland.

Profitability of the angling project, recaptures and factors affecting them are discussed i.e. quality of smolts, methods of release and influence of environmental and behavioral factors.

The project has demonstrated, that angling can be maintained artificially through smolt releases in a fairly large river and that the recaptures, as demonstrated by tags, tend to congregate close to the respective adaptation ponds used for the release.

Keywords: Angling, Atlantic salmon, enhancement, homing.

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**Introduction.**

In Iceland there are many rivers with important Atlantic salmon (*Salmo salar* L.) fishing. Most of these rivers are mainly harvested with rod. Smolts of Atlantic salmon have been released for ranching purposes since 1963 (Guðjónsson 1989). Most of these smolts have been released from ranching facilities, where all returning adults were harvested upon return for human consumption. Great quantities, however, of reared smolts of Atlantic salmon have been released into Icelandic rivers in order to enhance sport fishing. Returns have been variable but in many cases it has been difficult to see the result of these releases, which were relatively small and rarely made strong impacts on the total run into the river.

Releases of smolts into Icelandic rivers have been of two types. Firstly to enhance angling in productive salmon rivers and secondly to create salmon fishing in rivers without any significant salmon production. In the late 1980s massive releases of smolts were started into the Rangá river in southern Iceland, which was primarily a sea-trout ( *Salmo trutta* L.) stream with a poor habitat for salmon.

Homing of salmon has been recognized for centuries and is well documented phenomenon (e.g. Scheer 1939, Harden Jones 1968, Lagget 1977). It is evident that juvenile salmon learn the odor of their home stream (or ranching facility) before seaward migration (Hasler & Scholz 1983). Icelandic experiments in the 1970s showed that releasing salmon smolts into a small stream with no salmon had a great potential but the returning salmon showed a high straying rate (Isaksson et al. 1978). These experiments revealed that adaptation of the smolts in ponds on the riverbank for 2-3 weeks gave 2-4 times as good return rates as a direct plant method. More recent experiments have shown good homing of salmon smolts to salmon producing rivers and ranching sites (Ísaksson & Óskarsson 1986), but little is reported on homing within the river. Indications are, however, that hatchery smolts will home back to their release site (Wagner 1969, Cramer 1981, Einarsson *et, al.* 1987) but information has been missing on angling recaptures within a stream in relation to liberation site.

In this paper we report releases and recaptures of salmon smolts in the Rangá river, southern Iceland. We also look at homing, in particular within the river, and how release site location affects the place of angling recapture.

**The study area.**

The Rangá river is situated in southern Iceland. It has two main branches, Eystri-Rangá and Ytri-Rangá (Fig. 1). These two combined to form Hólsá. Both branches are mainly spring fed with a stable waterflow around 50 $m^3$/sec. in Ytri-Rangá and 25 $m^3$/sec. in Eystri-Rangá. The conductivity is high, 155 µS/sm at 25 °C in Ytri-Rangá and 125 µS/sm at 25 °C in Eystri-Rangá. Water temperature is rather low, rarely above 12°C in Ytri-Rangá and 10 °C in Eystri-Rangá. Ytri-Rangá was passable for salmonids to the 5m high waterfall Árbæjarfoss which is 24 km from the sea. Fishway, which was built there in 1985, gained about 29 km of new passable area.

Hólsá river and lower reaches of Ytri-Rangá are slow flowing, but about 15 km from the sea is a low passable waterfall, Ægissíðufoss. In these regions the bottom is mainly sandy or with fine gravel, with some stony areas close to the banks. Above Ægissíðufoss the slope of the river is greater and there we find some rocky areas. The main angling sites in Ytri-Rangá are from just below Ægissíðufoss to the village Hella. Good fishing sites are also below Árbæjarfoss and near the intersection with Eystri-Rangá (Fig. 1). Hróarslækur is a small (3-4 $m^3$/sec) springfed brook meeting Ytri-Rangá just below the waterfall Ægissíðufoss. Its water temperature is usually lower in summer than in the main river.

In Eystri-Rangá salmonids can migrate as far as to Tungufoss, which is a waterfall about 17 km from the sea. It is slow flowing and the bottom is mainly sand and fine gravel. Its tributary, Fiská, is a small but passable river of runoff origin which flows to the main river about 1 km below Tungufoss. Strandarsíki flows into Eystri-Rangá in its lower reaches. The main fishing sites in Eystri-Rangá are on the first 3 km below Fiská and the area from Djúpidalur to Barnaklettur (Fig. 1).

Before the initiation of massive release of Atlantic salmon smolts in the late 1980s, the Rangá river was mainly a sea-trout stream with some Atlantic salmon and Arctic charr (*Salvelinus alpinus* L.). Habitat for salmon was poor because of low water temperature and lack of suitable stony bottom for fry and parr. Rangá river has traditionally only been harvested by angling and with increasing effort since the start of the program. The effort, however, is limited to 12 rods per day for a 3.5 month period.

**Materials and methods.**

In all 80 microtagged groups of smolts have been released in various places in the rivers Ytri-Rangá, Eystri-Rangá, Hólsá and some tributaries (Fig. 1). Batches of smolts have been microtagged with a special code, identifying each release site (cf. Ísaksson & Bergman 1978). Most of the smolts were 1 year old and the average weight at tagging has ranged from 25 to 65 g. Every microtagged smolt had its adipose fin removed and adult fish from angling were screened for fin-clips and tags, which were subsequently removed. Smolts were of several ranching stock, but also originated from returning fish to the river Rangá. Most of the smolts were reared in hatcheries with an outflow into nearby river, Þjórsá.

In the 1987 and 1988 experiments smolts were held in smolt adaptation boxes in the river before release. In 1989 and subsequent years the smolts were adapted at the release site in earthen ponds prior to release (cf. Ísaksson et. al.1978). The ponds were either situated on the main river or on tributary brooks close to the intersection with the main river. These brooks were small and most of them were not passable for salmon or the salmon could only enter them close to the spawning season.

Smolts were put into release ponds in May and June, still with parr marks. While in the ponds the smolts were fed dry feed. The ponds were usually closed for some weeks. After opening of the ponds, the waterflow was increased in order to stimulate the smolts to leave. In some cases the smolts left the pond on the day of opening but in other cases it took weeks for the smolts to leave.

The angling season in the Rangá river is from June 20th to September 30th. Each fish caught was weighed, sexed and place of capture was reported. Scales were sampled from a part of the catch (105 to 407 fish each year) for age determination and in order to identify, if it originated from smolt releases (Lund et. al. 1991, Gudjónsson 1991). Scales of tagged fish released as smolt in the river were used to confirm the identification. This method, however, will tend to underestimate the proportion of ranched salmon (Gudjónsson 1991). Estimates of recaptures were based on these scale readings and tag recaptures. This was done as in some cases there were clear indications of some non-reporting of tags.

## Results.

*Releases and recaptures in river Rangá.*

Through the years some releases of salmon and trout fry have been practiced in the Rangá river. In the late seventies there were some small releases of salmon smolts with limited results. In 1987 sizeable releases of salmon smolts started with the release of 25.000 smolts and in 1988 35.000 smolts were released. These seem to have given some but little recaptures (Fig. 2 and 3.).

Since 1989 annual releases of salmon smolts have ranged from 21.270 to 148.000. Recaptures by angling have been, from 327 to 1.540 salmon, which corresponds to 0,4% to 3,2 % (average 1,5 % ) of each smolt year-class released (Table 1). The greatest part (89,9%) of the salmon have been grilse (one-sea-winter) and the rest salmon (two-sea-winter). The proportion of grilse of each year-class increased with increasing recaptures ($r = 0,81$, $p<0,05$, Fig. 4). The catch of trout and charr seems not to have declined (Fig. 3). Since 1989 there have been some dramatic increases in the salmon catches in the Rangá river and in 1990 and 1994 it was among the 3 top angling rivers in Iceland.

*Place of release and recapture of microtagged salmon.*

Of 50.745 microtagged smolts released in Rangá river, 380 adults were recaptured in the home river. These were from 51 release groups and 16 release sites. Of these 357 (93,9 %) were grilse and 23 (6,1 %) salmon. Approximately 96% (366 fish) recaptures were in the river branch of release or in the mainstream river Hólsá. Moreover most of the salmon were recaptured close to the release site or just below it. For all places of release, 37 % were recaptured at the release site or within 1,5 km below it and 57 % were recaptured within 3,5 km below the place of release (Fig. 5). Only 28 % of the salmon were recaptured above the release site and most of these (80%) within 6 km above the release site. Salmon migrating through downstream areas with good fishing sites appeared to be less vulnerable to angling than when closer to the release site.

Salmon from adaptation ponds on the main river, with the river water flowing through them, tend to be recaptured more often above the release sites than salmon released from ponds with water from tributary brooks. Tributary brook releases thus gave

19,5% recaptures above the release site, whereas main river release ponds gave 34,9% recaptures above the site ($\chi^2$ test; $\chi^2$ =4,45, p<0,05) (Fig. 6).

Sixteen (4,0 %) of total 396 recaptures were outside the river Rangá. Two were caught in the sea, one at West-Greenland and the other one in a legal set-net at the west coast of Iceland. Eleven were caught at ranching stations in southern and western Iceland. Only two were reported from other rivers in Iceland one in the southern and the other in the north-eastern part of the country (Fig 1).

**Discussion.**

Experiences in the Rangá river shows that angling of salmon can be maintained artificially by releasing smolts into a river with a poor production of salmon. The average observed recaptures by angling in the Rangá river from 1989 to 1994 releases were 1,5 %. The total return rate is thought to be considerably higher. The exploitation rate is not known, but is probably close to 50%. Estimates done for several Icelandic rivers have revealed average exploitation rate between 36 and 85 %. The angling rate decreases with increasing number of salmon in the run (Gudjónsson *et, al.* 1996). Recapture rates in the Rangá river are higher than the average recaptures of all microtagged smolts released in Icelandic rivers from 1986 to 1991, which were close to 0,8 %. These, however, are minimum estimates as corrections were not applied for nonreporting of tagged salmon (Jóhannsson *et, al.* 1994).

Rate of recapture is variable between years and many factors can be responsible. Experience from the Rangá river shows, that the quality and size of smolts is very important for survival at sea as documented by several workers (Ísaksson 1976, Staurnes *et, al.* 1993, Framer 1994, Lundquist 1994). Year-to-year fluctuation of survival in the sea is also reflecting changing conditions at sea (Scharnecchia 1984, Antonsson *et, al.* 1993, Framer 1994). Little density of smolts (<10 kg/m$^3$ ) and high enough temperature for smoltification in smolt ponds is also of importance.

At the current price level for Icelandic salmon fishing a recapture rate of 1,5 % in angling is supposed to give profit in Icelandic rivers (Einarsson 1991). Recaptures of wild smolts in Icelandic rivers tend to be considerably higher (Ísaksson *et, al.* 1978), although highly variable between rivers and areas. According to this, releases in Rangá river are profitable, but we believe that more experience with methods of rearing and release should lower costs and improve return rates and recaptures still further. At

Kollafjörður Experimental Fish Farm there are indications that salmon homing abilities and return rates have improved through a selection process, when broodfish are selected from returning salmon (Ísaksson 1994, Jónasson 1995).

In the Rangá river experiment the greatest part of returning adults were grilse and the proportion returning as grilse increased proportionally with return rates. This was found in ranching experiments at the Kollafjörður Experimental Fish Farm and is believed to be related to oceanic conditions. In years of favourable oceanic and growth conditions at sea, salmon maturity is hastened (Ísaksson 1994). Gudjonsson *et, al.* (1995) however found that the ratio of salmon increased during warmer periods and good oceanic conditions but decreased in colder periods in wild Icelandic north coast salmon stocks.

Over 96% of all recaptures of tagged salmon were in the Rangá river. Of the remaining 4% (16 salmon) only two (0,5%) were strayers to other rivers. Other salmon recaptured outside Rangá river were harvested in the sea or at ranching stations. Icelandic ranching stations often harvest their salmon in the estuary of their facilities and can therefore capture salmon bound for other rivers and areas. Similar findings have been reported for salmon in other countries (e.g. Salomon 1973). Straying of wild salmon is reported between 0 % and 20 % (Quinn 1990), but is commonly below 10 % (Stabell 1984). Straying of ranched salmon between ranching stations in Iceland was found to be between 2 % and 16 % in 1991 (Ísaksson 1994). The observed straying rates in the Rangá river are thus minor, which confirms good homing of the salmon to the river, which could be influenced by the relatively high waterflow (e.g. Hindar *et, al.*1991).

Anadromous salmonids are known to home to the very stream from where they emigrated as smolts (Hasler *et, al.* 1978) and indication are that hatchery smolts will home back to the area of the release site (Wagner 1969, Cramer 1981, Einarsson *et, al.* 1987). This was also confirmed in this study, where most adult were recaptured in its "home" river close to the release site or a few km below it. It is also of interest that even though salmon migrate through downstreams areas with favourable angling sites, they seem not to be as vulnerable to sports fishing as when closer to their release site. Smolt release ponds can thus be used as a management tool to control distribution of adult salmon in the river. The study further indicated that salmon had a greater tendency to migrate past the release site, when river water was used in the release pond than when the water was from tributary brooks. This seems to confirm that smell

of water is important in finding its destination place as cited by Sutterlin & Gray (1973).

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Table 1. Releases and recaptures by angling of Atlantic salmon released as smolt in the Rangá river, based on microtag recaptures and scale reading.

| Year of release | Number released | Number recaptured by angling 1 year at sea | 2 years at sea | Total | Percent recaptured |
|---|---|---|---|---|---|
| 1989 | 48.250 | 1.472 | 29 | 1.540 | 3,2 |
| 1990 | 21.270 | 376 | 42 | 418 | 2,0 |
| 1991 | 89.000 | 273 | 53 | 327 | 0,4 |
| 1992 | 148.000 | 876 | 142 | 1.019 | 0,7 |
| 1993 | 99.918 | 1.174 | 70 | 1.244 | 1,2 |
| 1994 | 77.500 | 1.198 | | 1.198 | 1,5* |

*Only recapture after one year at sea.

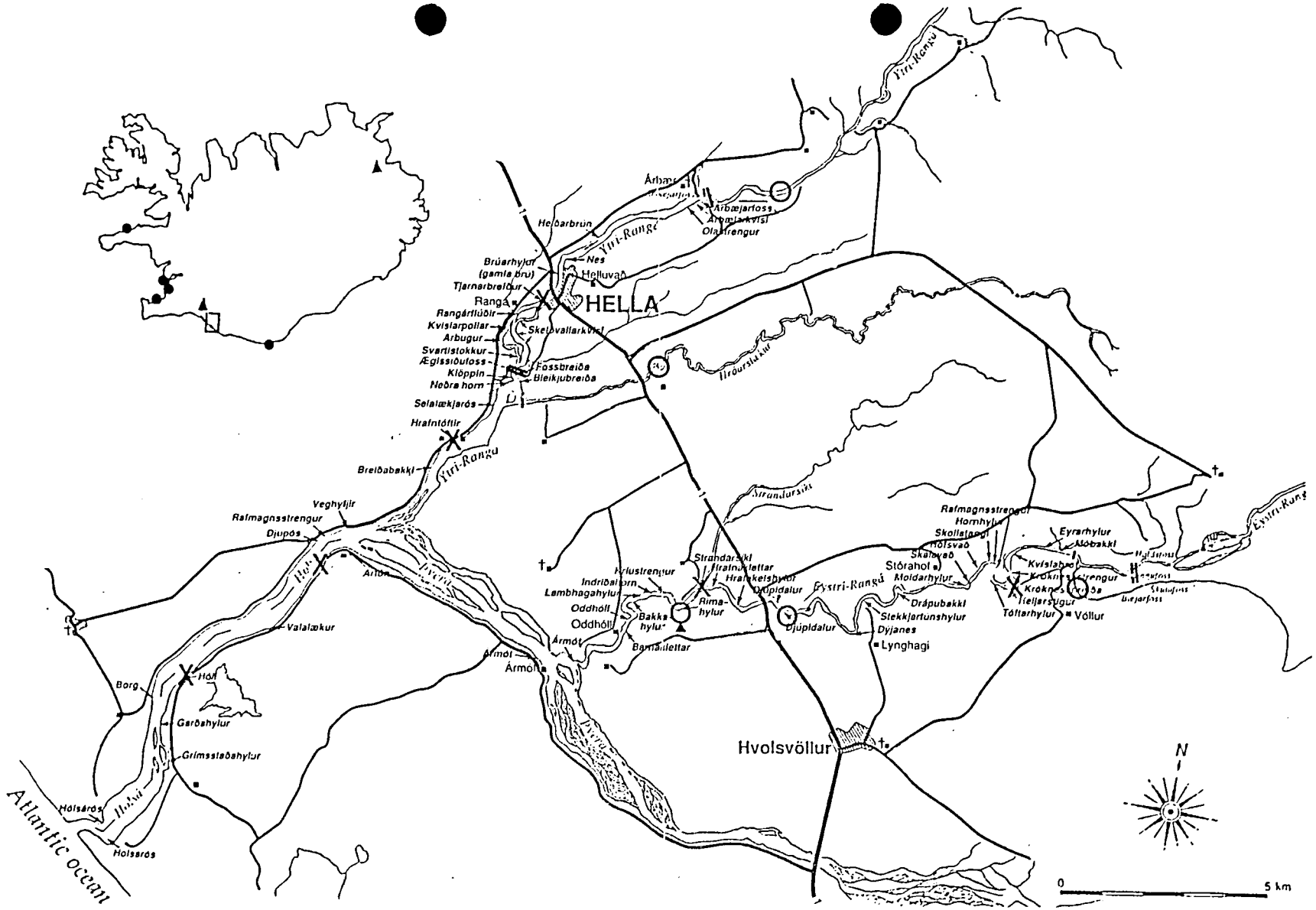


Figure 1. Location of Rangá river and its tributaries. Main releasing sites in tributaries (O) and in the main river (X). Waterfalls (II) and fishing sites (↓) are also shown. Location of recaptures outside Rangá river are marked, (•) recaptures in ranching stations and set-net, (▲) recaptures in rivers.

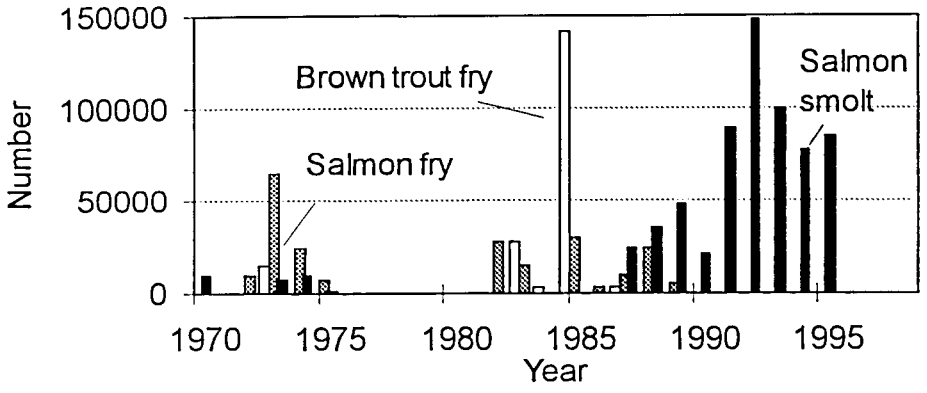


Figure 2. Number of fry and smolts of brown trout and Atlantic salmon released in Rangá river.

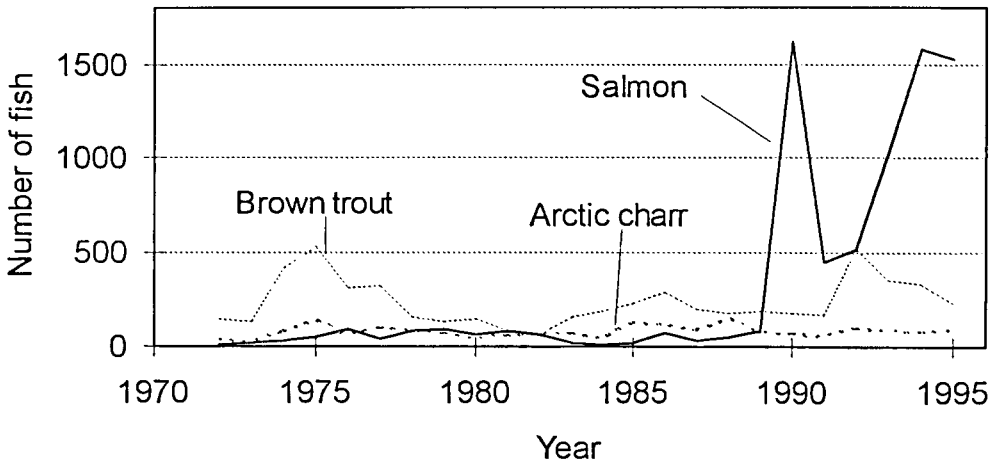


Figure 3. Total catch by angling of Atlantic salmon, brown trout and arctic charr in the Rangá river.

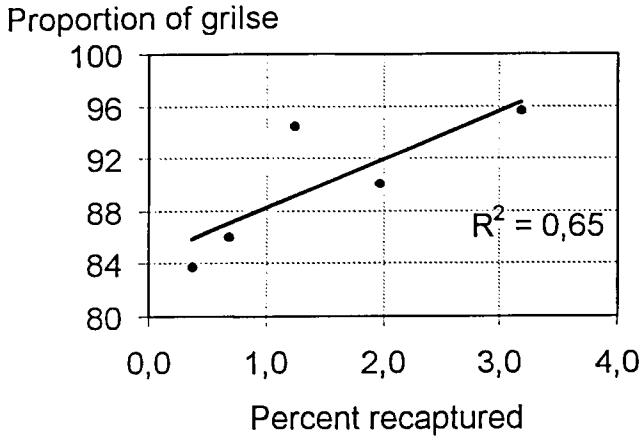


Figure 4. Correlation between percent recaptures and grilse ratio of the same cohort of released smolts in Rangá river.

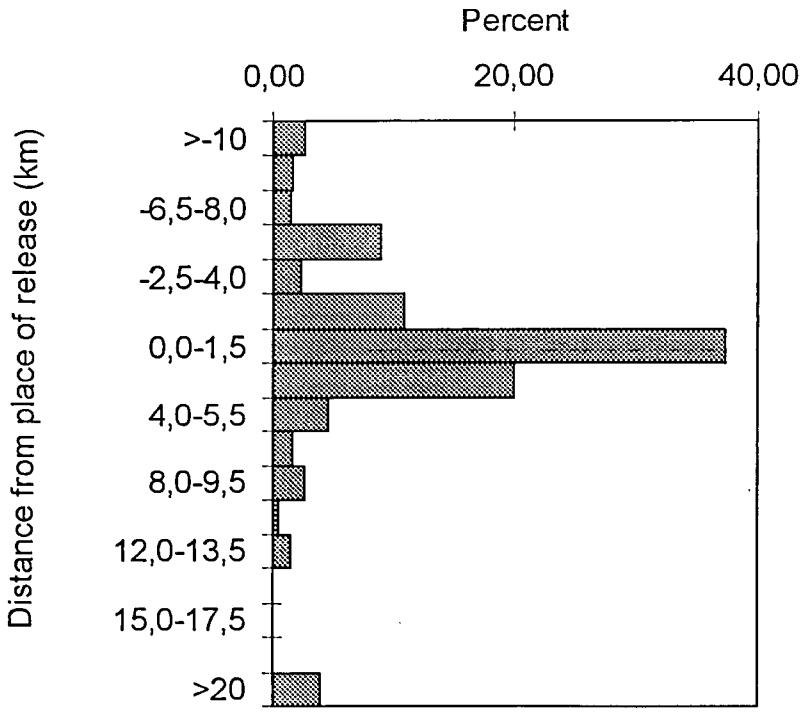


Figure 5. Distance between place of recapture in Rangá river and the release site of Atlantic salmon released as smolt in the river. Positive numbers are downstream and negative upstream recaptures. All release sites combined.

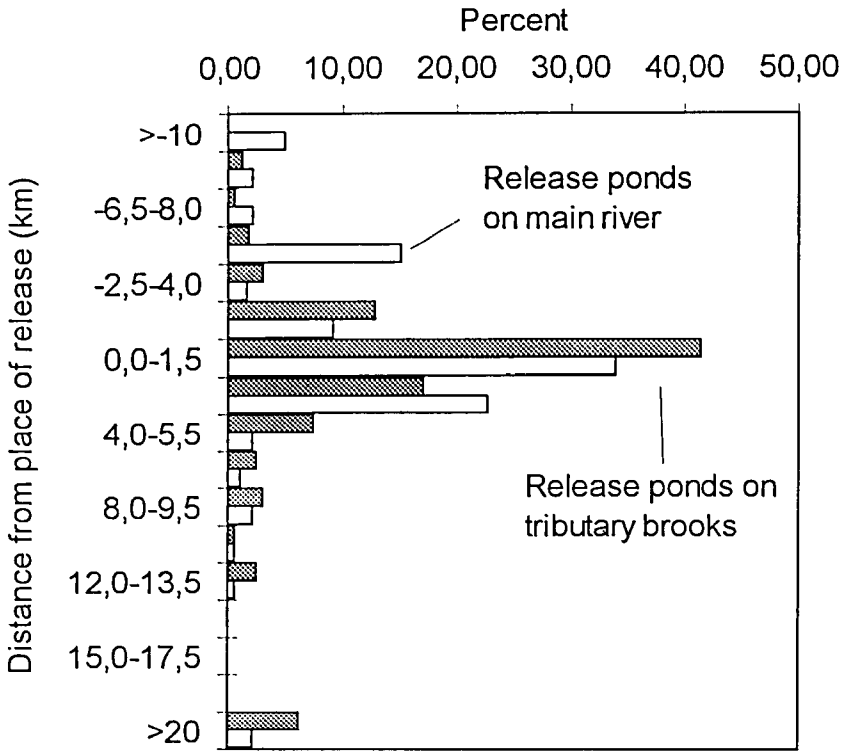


Figure 6. Distance between the place of recapture in the river and the release site of Atlantic salmon released as smolt in the Rangá river. Releases in tributaries and in the main river are separated.