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SALMON RIVERS OVER THE KOLA PENINSULA. ANALYSIS OF STATUS AND POSSIBLE MEASURES TO MANAGE THE POPULATION STRUCTURE OF ATLANTIC SALMON IN THE KOLA RIVER.

by

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INTRODUCTION

The Kola river is one of most productive salmon rivers over the Kola Peninsula. Before 1959 (the year when the fishery at the counting fence was initiated) wild salmon spawned on the grounds along the entire river extent. In addition, from 1934 onward from 110 000 to 370 000 juvenile Atlantic salmon at different age were annually released into the river. These juveniles were produced by the Taibola hatchery, located about 70 km upstream the river mouth.

Beginning from 1959 to reduce elligal fishing and to improve the system to safeguard the spawning grounds, a counting fence has been annualy installed 25 km upstream the river mouth. During the whole period of operation of the counting fence all spawners are retained at it and only those salmon can migrate up-river who have passed the site during the spring flood before the fence is set. Therefore, from 1959 to stock the vacant nursery grounds in the river stretch upstream the counting fence around 120 000 2+ salmon at length 10-13 cm are released into the river. Of all released juveniles smolts account for only about 20%, therefore, most juveniles reside in the river for one more year. In the downstream of the river the production is still natural.

As evidenced by tagging (adipose fin clipping) the return rate of reared salmon in 60-70s was about 1%. In recent years it has grown to 2% on the average, for instance, in 1990-1992 the percentage of hatchery-reared salmon in catch was 13.3%, 13.9% and 4%, respectively.

Earlier it has already been indicated many times (Belousov, 1978, Bakshtansky et al., 1980; Salmov, 1981; Vshivtsev, 1990) that enhancement activities are producing an adverse impact on the status of Atlantic salmon population in the Kola river (decline of the number of age classes of spawners, reduction of their mean age, growth of the proportion of males in the spawning stock, participation in spawning of fish with retarded growth etc.). However, authors of these papers did not go further than giving the evidence. Along with this, a downward trend observed in recent years in the stocks of Atlatic salmon globally and notable impact of cultured salmon on genofonds of wild stocks urge to undetake a more thorough analysis of changes that occurred in the Kola river salmon population and to consider measures to manage its structure.

MATERIAL AND METHODS

The paper addresses materials on the biology of adult salmon collected at the counting fence during 1989-1992 as well as historic data for a series of years. Sampling and processing of materials were done in accord with established methods.

RESULTS AND DISCUSSION

Analysis of materials for recent years has shown that a trend towards changes of principal Atlantic salmon population parameters in the Kola river observed since 70s still persists (Belousov, 1978; Bakshtansky et al., 1980; Salmov, 1981; Vshivtsev, 1990).

In particular, in 1989-1992 the number of age classes of wild spawners varied from 12 to 16, while among spawners of hatchery origin it was below 11 (Table 1,2). Besides, compared to the period of 1945-50 5SW salmon completely fell out of production (Table 3). The number of 4SW and 3SW salmon declined much and the proportion of main age classes changed.

According to Azbelev (1960) the number of grilse (1SW) in the spawning stock was between 19.3% and 39.9% in 1945-1950. In 1982-1992 this percentage grew markedly (40.7-72.6%) even against 1969-1973 (52.4% on the average) (Bakshtansky et al., 1980). In 1977-1982 hatchery-reared grilse accounted for 78.6% on the average, while wild grilse - 45.7% (Vshivtsev, 1990). This could likely be a reason why the proportion of grilse among wild salmon averaged 62.4% during 1989-1992 (Table 1), thus exceeding relevant estimates for the same period for hatchery-reared adults (Table 2).

This, in our view, quite convincingly shows the extent of the impact of enhancement activities on natural production and in fact makes the term "wild salmon" conventional for the Kola river population, since there is no doubt, that the level of panmixia between wild and reared salmon in previous generations was quite high.

The Atlantic salmon is known to exhibit very strong genetic and ecologic heterogeneity and to have a complex population structure. High heterogeneity enables salmon populations to survive from degeneration and eventually ensures their vitality. Therefore, it is quite natural that in salmon culture one should seek preservation and production of all of the diversity, to this end matings of adults from different size-age groups are recommended (Krueger et al., 1981) as well as production of as many as possible individual local and temporal groups of salmon (subpopulations)(Altukhov, 1974; 1983).

However, a complex hereditary structure of salmon populations is quite often disturbed either deliberately or accidentally at hatcheries. Breeding and biological characteristics of broodfish are neglected. Eggs are collected from random fish.
Their age, size, fecundity and appearence are not made account of. For instance, at the Taibola hatchery in 1990 eggs and milk were collected from only 6 age groups of broodfish, while the spawning stock contained 16 age groups (their number reached 18 in the 50s according to Azbelev (1960)). For broodstock 1 SW males and 2SW females were sampled. This is likely to be the reason why the Kola river salmon population shows a persistent downward trend in the number of age groups of adult fish.

We could hardly be categoric to state that changes in the proportion of major age group in the population have been caused by only enhancement activities. Sea fishery and poaching are to a certain extent responsible (Bakshtansky et al., 1980). Nevertheless, Zelinsky and Safonov (1986) believe, that hatchery breeding, and in particular, sampling of practically 1SW males only for breeding purposes and, furthermore, sampling among them of individuals with not the best size and weight characteristics produce significant effect. In the light of this, it is therefore likely that a persistent trend towards lower mean length and weight shown by salmon of the Kola river population (Figs.1,2) and first reported in the 70s (Salmov, 1981) is associated with inadequate establishing the broodstock.

In an earlier review of the status of salmon in the Kola river it has already been mentioned, that spawners both wild and of hatchery origin show a shift in the timing of their spawning run (Vshivtsev, 1990). And this trend is still valid now (Figs.3,4), which is indicative of almost total distruction of a subpopulation structure of the Kola salmon. To a certain degree evolutionally developed biological forms are maintained by natural spawning in the downstream river stretch and at the expense of fish who have passed upstream before installation of the counting fence. However, serious concerns are expressed that this equilibrium could be any time destroyed. This is, in particular, indicated by clear difference in the timing of run of adults from different age groups produced through natural spawning nowadays and 30-40 years back (Figs.5-9).

Thus, it is quite clear that it was, in the first instance, enhancement activities in which due account of the structure of salmon population in the Kola river was not made, that caused significant destructive changes. It was not only a change of some parameters (ratio between age groups, reduction of weight, younger age of spawners etc.) at the first population level, but also similar changes at the second (subpopulation) level. Besides, it should be noted, that cessation of fishing in the river under continuing sea fishing and pressure from poaching would not improve the situation. Therefore, to rebuild and maintain the original salmon population structure in the Kola river directed breeding works are needed, which would make account of biological structure of the population at all levels, because according to Dirin (1985) aquaculture which is based on programmes ignoring population genetics, does not enhance a population and rehabilitate its structure, but rather aggravates negative trends (lesser eggs weight, fecundity, age and weight of spawners).

Successful experience of rebuilding Atlantic salmon populations in the Narova river and some rivers of Great Britain, USA, France and other countries (Lidell, 1973; Royce, 1973; Fay, 1978; Brunet, 1980; Kazakov, Iljenkova, 1983) proves that properly designed and managed fish culture can give positive results. Research in this field has shown that selection works permit to have results within fairly short time (Gjedrem, 1976), for instance, when fish are released as 2-year-olds a population of salmon develops within 6-7 years (Yandovskaya, Persov, 1978), in other words, within a return time of one generation, which is not, according to fish culture temporal dimensions, so long process.

The analysis of data available shows, that in respect of the Kola river salmon population first priority should be given to rebuilding its original age structure at both populational and subpopulational level. In our view, selection works conducted on a regular basis would also help to eliminate discrepancies associated with declining mean age, mean weight of adult salmon by age, changes in male/female ratio and to restore spawning run structure and timing typical of this population. To this end it is quite likely that there may be a need to use donor materials from other rivers to rehabilitate certain valuable attributes lost by the population as a result of enhancement activities, irrational sea fishing and poaching.

What are prerequisites and feasibility of selection works with the Kola river salmon? According to Kazakov (1980), who analyzed data on the river phase of salmon life cycle, its length is not a hereditary attribute and it is in the first instance related to geographical latitude of a river and its specific features (hydrology, food availability etc.). Nevertheless, it appears that this process may be governed to some extent. For instance, through grading the juveniles into size groups, breeding them separately until smolt stage and prolonging a release of one generation by at least 2 years.

This measure is well justified, because the growth rate of juvenile Atlantic salmon is proved to be hereditary (Gunnes, Gjedrem, 1978; Gjerde, Gjedrem, 1983; Refstie, Steine, 1978) as well as the timing of smoltification (Thorpe, Morgane, 1978; Thorpe et al., 1983). And it is known that the timing of smoltifictation is related to the growth rate of juveniles, and each particular river has smolts of specific size.

As indicated by data given by Azbelev (1960) on the proportion of different age groups in the Kola river salmon population and current data, it is in the first instance necessary by using the afore mentioned measures to change the proportion of juveniles at age performing a seaward migration, since it is likely that due to residence of reared juveniles in the river for one more year, the number of smolts at age 2+ declined significantly while the proportion of smolts at age 4+ increased. This might, probably, be due to sampling for broodstock of predominantly bigger females, i.e. fish from older age groups. While there it is suggested (Zelinsky, Safronov, 1986), that a prevalence of such fish in the breeding process leads to extension of a generation cycle.

Some researchers (Saunders, 1967; Gardner, 1976; Dirin, 1976, 1978, 1985, 1987; Khristoforov, Murza, 1985 and others) believe, that there exists a certain relationship between the length of sea and river phases. It was found that the timing of spawning run by parents and their progeny coincides (Saunders, 1967), and genetic mechanisms are proved to be behind the production of precocious males (Saunders, Bailey, 1980). D.K.Dirin derived a positive correlation between smolt age and growth rate in adult fish. Besides, it was proved that the length of sea phase is a hereditary attribute (Gjerde, 1984) and the size of eggs, fecundity are related to the length of sea phase (Galkina, 1970; Kazakov, Melnikova, 1980).

All this confirms the feasibility of having a positive outcome from selection works with the Kola river salmon.

To avoid further decline of the number of age groups, a complete destruction of subpopulation structure and a shift in run timing of individual biological forms it is logically important while sampling fish for broodstock to adhere to a certain scheme based on the population age structure observed before 60s (Table 3). A specific number of males and females at age sampled for broodstock should, probably, be related to their proportion in each single age group, although Zelinsky (1981), for instance, believes that an optimal ratio of grilse and males of older age as in feeding grounds is 1:1. A more detailed scheme of sampling broodfish appears to be in good conformity with the opinion by Dirin (1985) to calculate means individually by elementary age groups for males and females taking account of their biological differentiation.

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Table 1

Proportion of adult salmon of hatchery origin by age in Kola river in 1989-1992, %

River age	Sea age			
	1SW	2SW	3SW	4SW
2+	28.2	17.1	10.3	0.1
3+	24.5	7.5	9.1	0.1
4+	1.4	1.2	0.5	-
Total	54.1	25.8	19.9	0.2

Table 2

Proportion of wild adult salmon by age in Kola in 1989-1992, %

River age	Sea age			
	1SW	2SW	3SW	4SW
2+	7.6	2.0	2.5	-
3+	44.6	15.3	7.0	0.7
4+	9.2	6.6	2.9	0.1
5+	0.9	0.3	0.1	-
6+	0.1	0.1	-	-
Total	62.4	24.3	12.5	0.8

Table 3

Proportion of wild adult salmon by age in Kola river 1945-1950, % (Azbelev, 1960)

River age	Sea age				
	1SW	2SW	3SW	4SW	5SW
2+	5.2	5.7	3.8	0.5	-
3+	18.8	26.0	18.9	1.3	0.1
4+	3.0	9.1	5.7	0.4	0.1
5+	0.2	0.7	0.4	0.1	-
Total	27.2	41.5	28.8	2.3	0.2

Fig.1. Trend-analysis average length of atlantic salmon in Kola'R. in 1980-1992

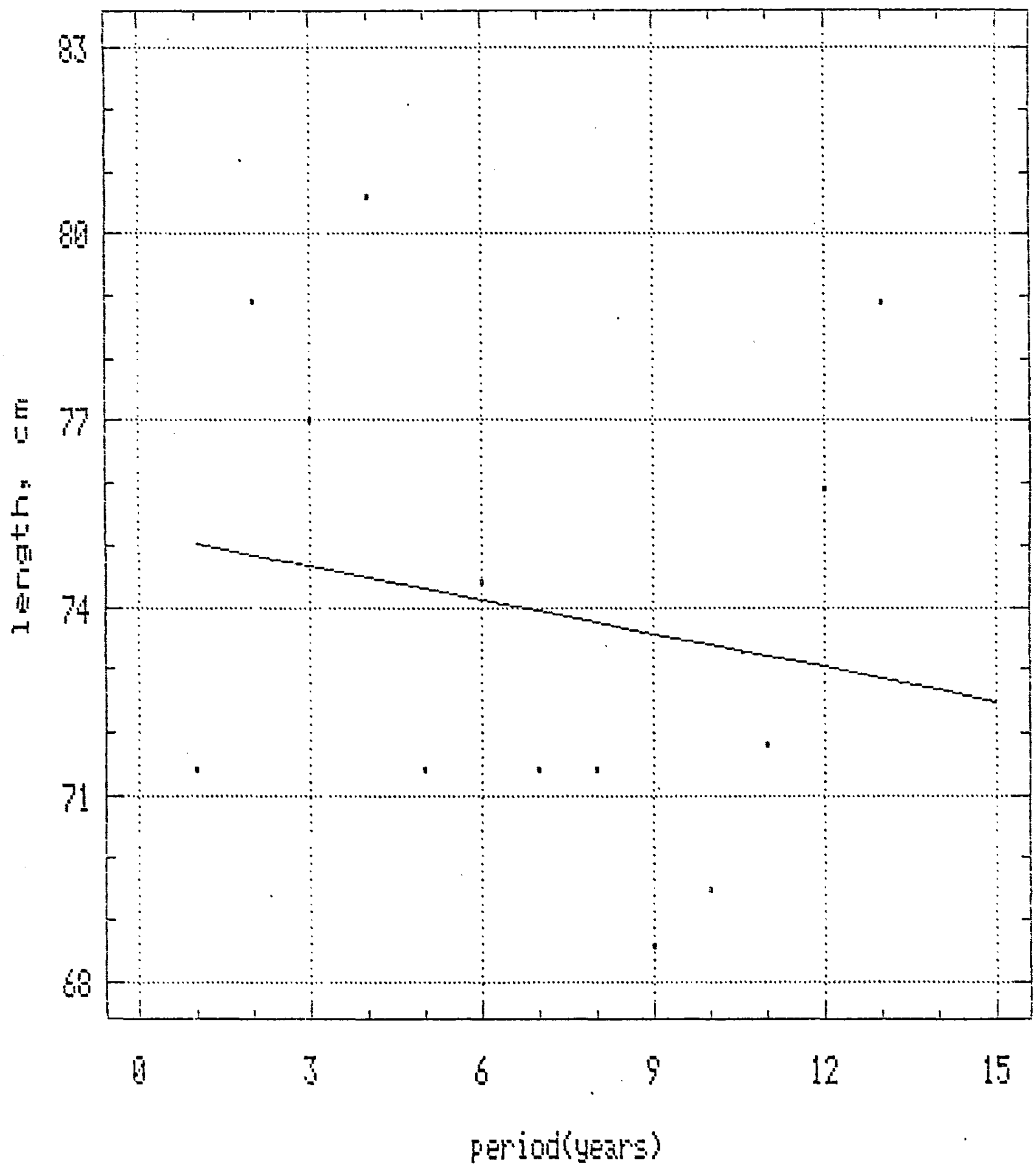


Fig.2. Trend-analysis average weight of atlantic salmon in Kola'R. in 1980-1992

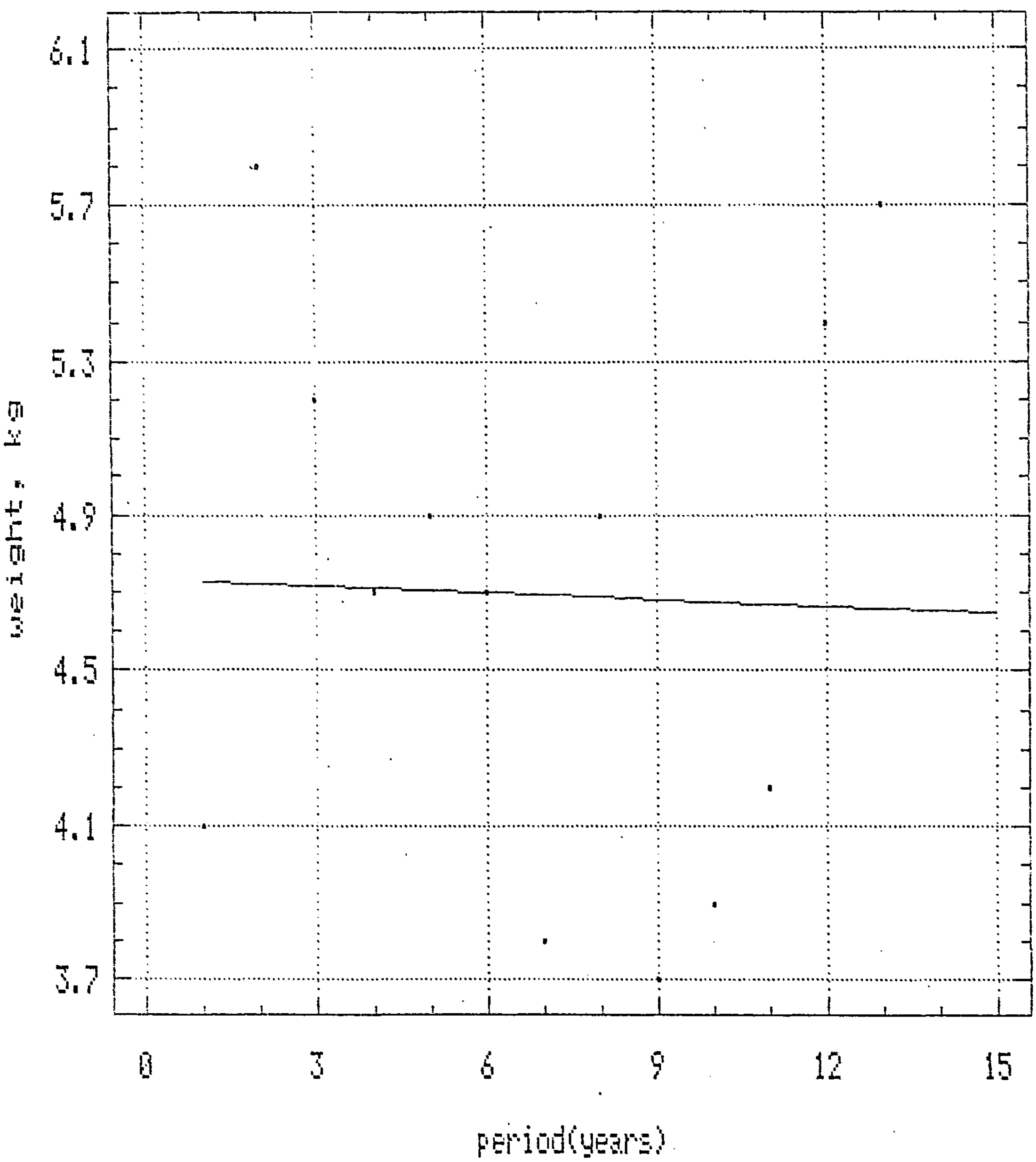


Fig.3. Dynamics of run of wild and reared salmon into the Kola'R in 1990-92

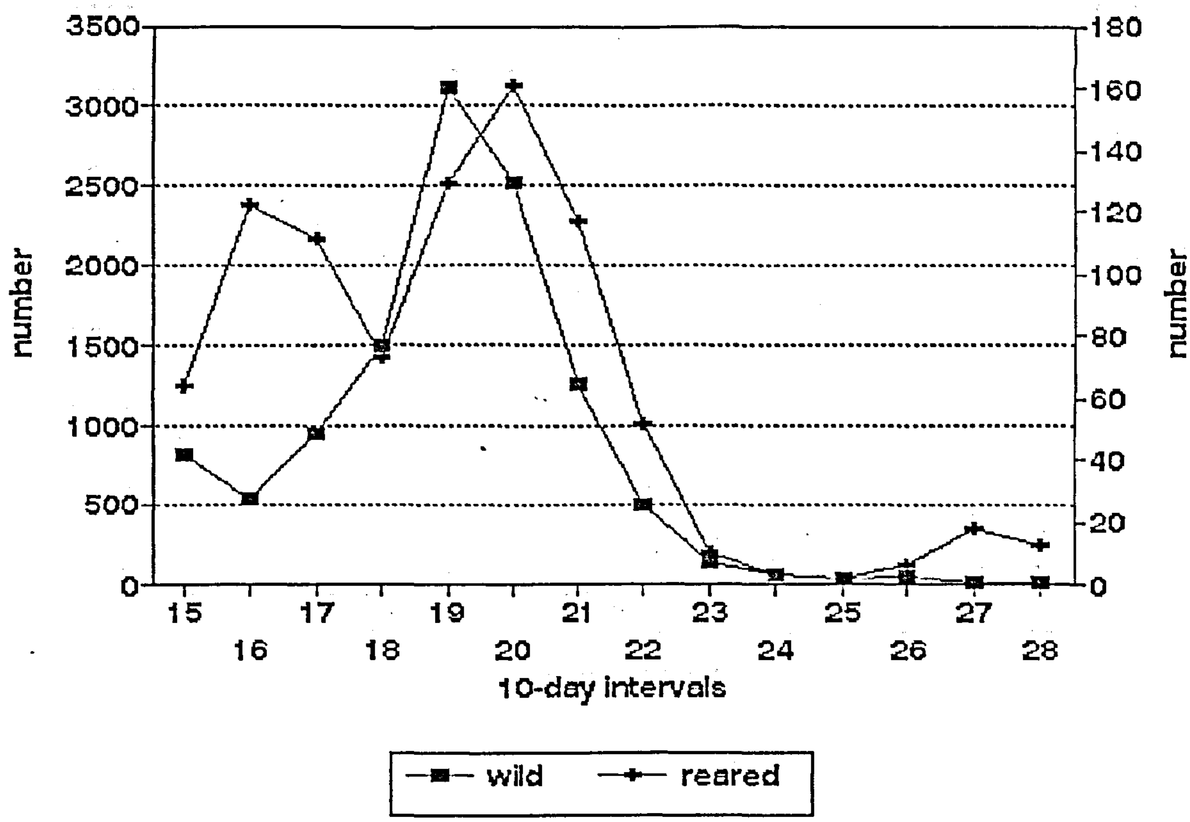


Fig.4. Variation of mean age of spawners in the Kola'R. in 1992

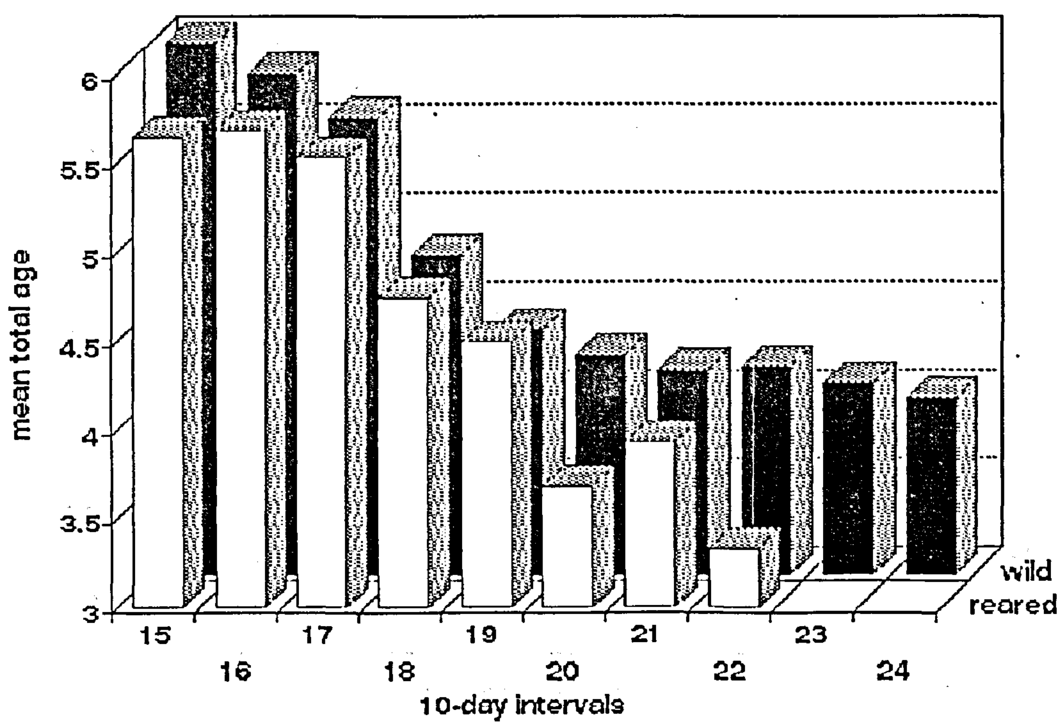


Fig.5. Dynamics of grilse run into the Kola'R. in 1945-50 and in 1989-1992

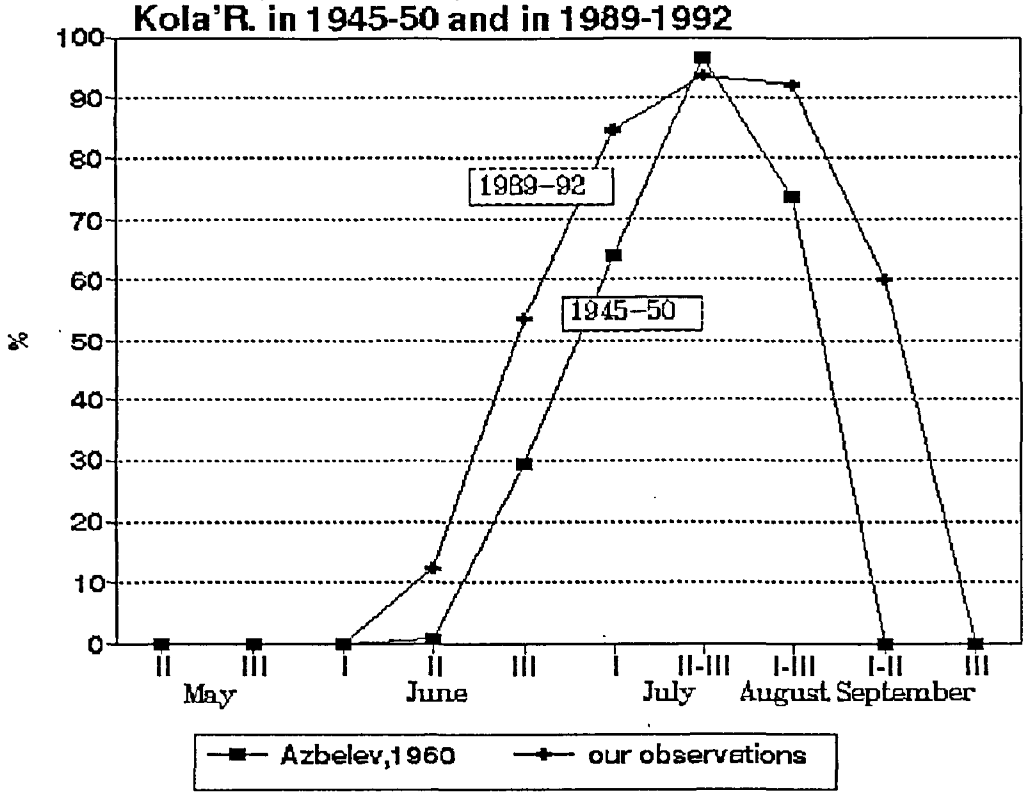


Fig.6. Dynamics of 2SW salmon run into the Kola'R. in 1945-50 and in 1989-92

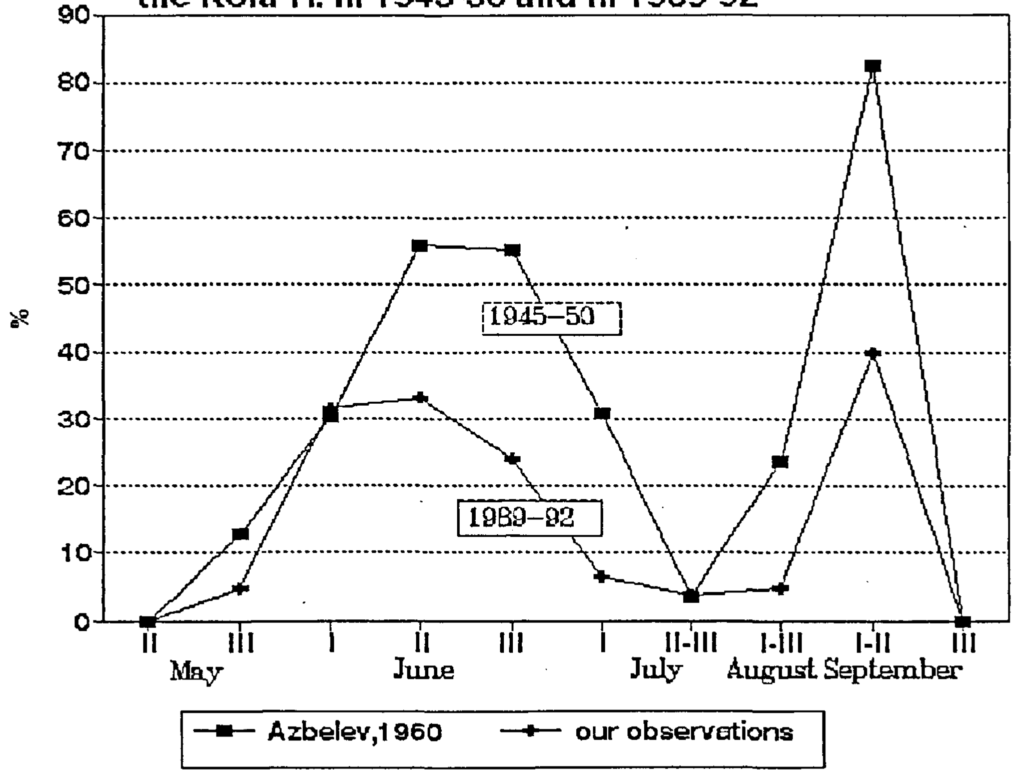


Fig.7. Dynamics of 3SW salmon run into the Kola'R. in 1945-50 and in 1989-92

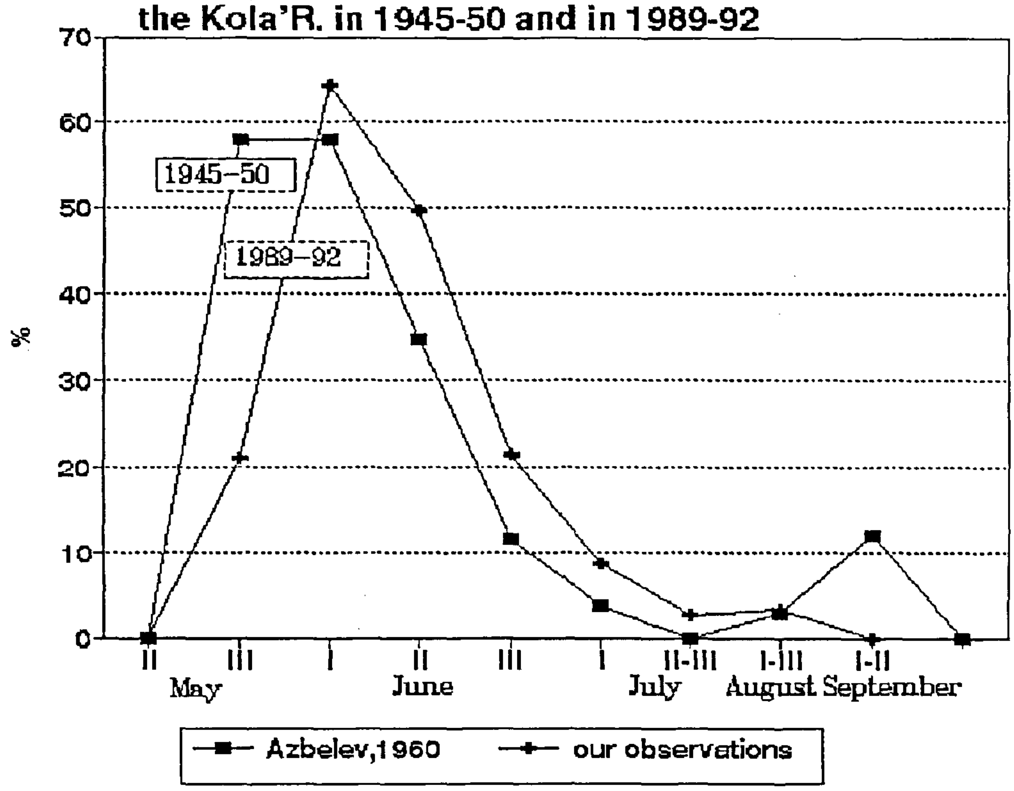
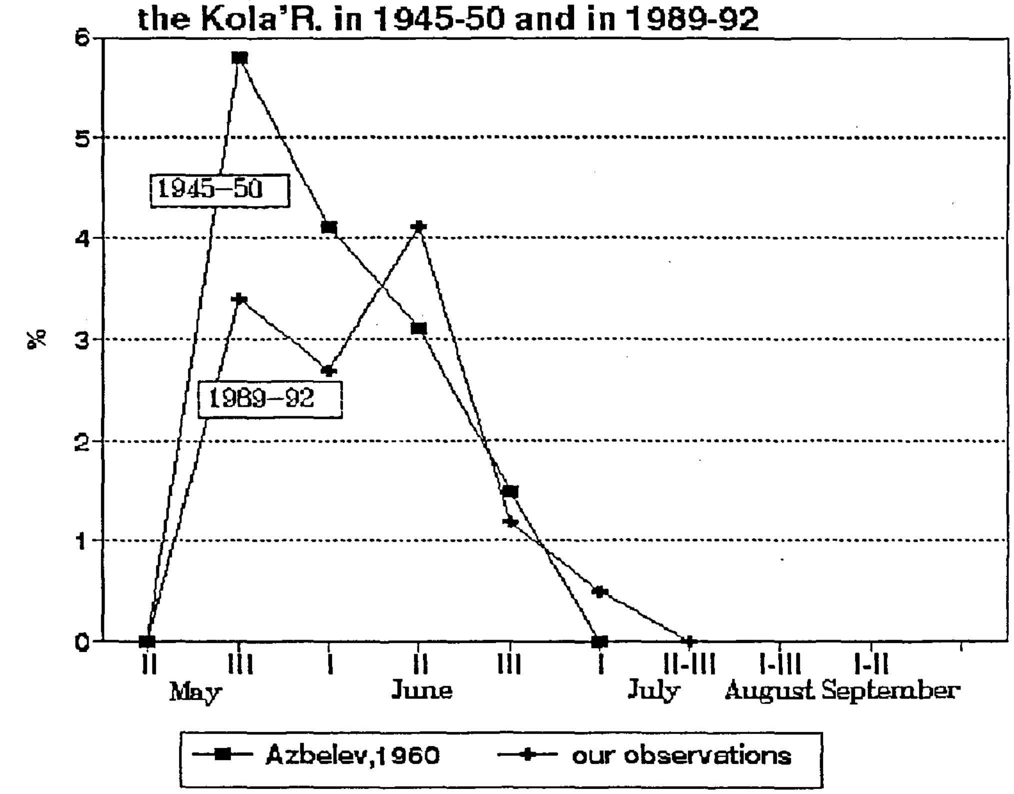


Fig.8. Dynamics of 4SW salmon run into the Kola'R. in 1945-50 and in 1989-92



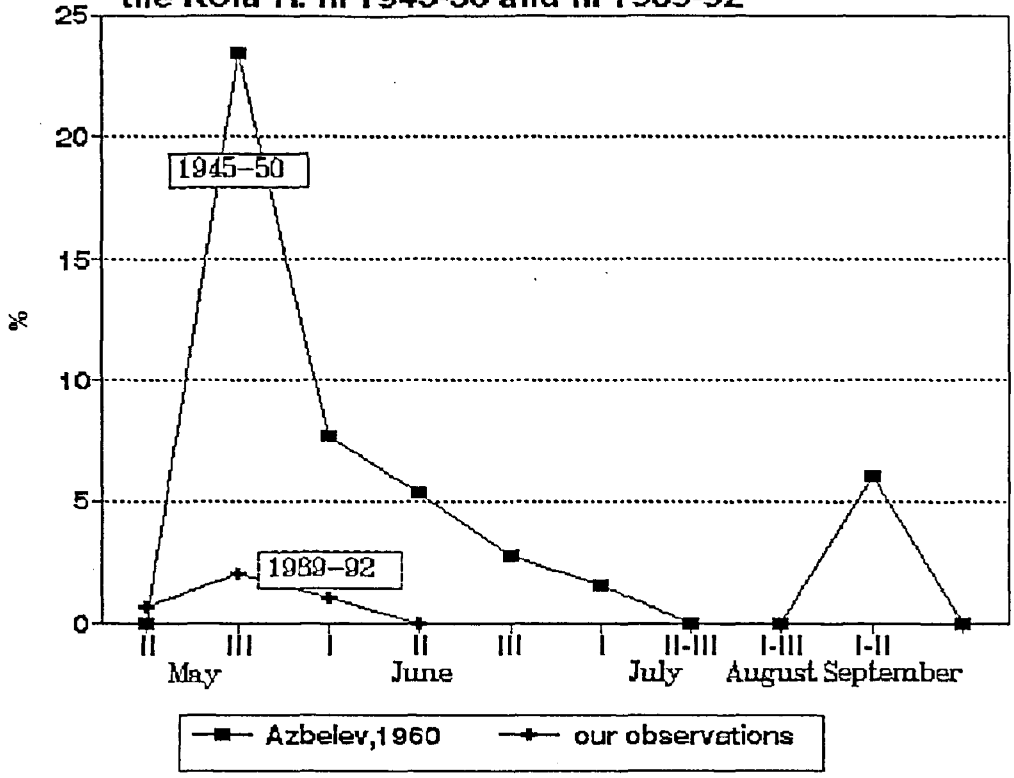


Fig.9. Dynamics of PS salmon run into the Kola'R. in 1945-50 and in 1989-92