

The Effect of Water Removal
on the Catch of Salmon in the
River Úlfarsá, Iceland

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The river Úlfarsá is a small river emptying into the Faxa Bay, South-western Iceland. It is about 18 kilometers long with Lake Hafravatn on the river system. The length of the river above the lake is about 8 kilometers and the part below is 10,4 kilometers long. The Lake Hafravatn is 0,9 square kilometers and is 68 meters above sea level. The river flow varies from 165 liters per second to 12000 liters per second, the flow most often being 800 to 1000 liters per second.

In the Úlfarsá and Lake Hafravatn there are all five species of fish which occur naturally in fresh waters in Iceland. These are the Atlantic salmon (Salmo salar), brown trout (Salmo trutta) both sea-run and stationary, arctic char (Salvelinus alpinus), European eel (Anguilla vulgaris), and the three-spined stickleback (Gasterosteus aculeatus). The Atlantic salmon is of the greatest commercial value of these species. It migrates upstream during the months of June, July and August. It ascends as far as to a waterfall about 800 meters above Lake Hafravatn. Spawning takes place in October and November through almost the entire length of the migrateable part of the river. Fishing in the Úlfarsá is done exclusively by anglers. The fishing effort is restricted to two rods daily during the fishing season, which extends from the beginning of June to the end of August each year.

In 1953 a dam was built across the Úlfarsá about four kilometers above its estuary. From the reservoir thus formed, 220 to 230 liters per second of water is drawn from the river and piped to a fertilizer factory which is located on the coast of Faxa Bay a few kilometers below the dam, this water being a total loss to the river.

The removal of 220-230 liters per second continuously from the lower Úlfarsá was expected to have some effect on the stock of salmon in the river and on the salmon fishing. A study was made of possible effects on catch of salmon, spawning, living conditions for young salmon, upstream migration of mature salmon, and changes in fishing places.

Angling records for the Úlfarsá since 1940 are at hand. They show that the catch is about one third larger during the years 1940-1953 (275 salmon) than during the years 1954-1963 (176 salmon). Lindroth (1950) found that "the trend of the catches in most" rivers for each year "is very similar". This statement relates to rivers in Northern Sweden. The trend of catches in many Icelandic rivers has been studied by the present author, and these studies show the same trend. When the trend of catches in the Úlfarsá is compared to that of the nearby river Laxá in Kjós the average catch of the Úlfarsá during the years 1954-1963 should have been 457 salmon instead of 176. According to this the effect of the removal of water from the Úlfarsá has resulted in a loss of 281 salmon on the average each year during the mentioned period, or 61,5 per cent.

The effect of abstraction of water from the Úlfarsá on spawning seems to be slight. There are ample spawning grounds distributed throughout the length of the river. Surveys on salmon spawning during six different seasons show that about 40 per cent of the spawning takes place in the river below the dam.

The removal of water from the lower part of Úlfarsá impairs the living conditions in the river below the dam with respect to food supply and shelter, when the water drops below a certain level. This can be expected to happen when the water flow above the dam is less than 1000 liters per second. With diminished flow these effects should increase. Estimates based on figures by Aass (1961) show that at 750 liters per second the drying of the river bed would be about 8 per cent. At 500 liters per second about 17 per cent of the river bed will be left dry and at 400 liters per second 22 per cent.

Water gauging in the Úlfarsá has taken place since 1956 at a location about half a kilometer above the dam. It shows that the flow of water in the river varies mostly between 700 and 2000 liters per second. Usually the water level is at its lowest in March or April and in August or September. When the water flow during the months of June, July and August, at the time when the food production should be at its highest, was studied, the following results were had: In 1957 and 1959 the water flow was close to or more than 1000 liters per second all through this period. The amount of flow was the same in June and July of 1960 and 1962, but dropped down to between 500 and 600 liters per second in August of those years. In 1956 the flow was above 1000 liters per second during the first half of this period, but diminished gradually to 500 liters per second towards the end of August. In 1961 the water flow was about 800 liters per second all through these three months, leaving about 5 per cent of the river bed below the dam dry. The water flow was much less in 1958 and 1963 all through those months, being about 500 liters per second, leaving about 17 per cent of the river bed dry.

During the years 1956-1963 the flow has gone down 15 times below 500 liters per second. In 1958 the water flow went below 500 liters per second three times for 10 to 15 days each time and the same happened twice in 1956 for 10 and 14 days respectively. In other cases the flow of less than 500 liters per second has lasted from one to four days.

An accurate estimate of the effect of a lowered water level in the Úlfarsá below the dam on the stock of salmon in the river cannot be made from the available information. It seems obvious, however, that the impaired living conditions in the Úlfarsá, caused by removal of water from the river, does not explain all of the estimated 61,5 per cent loss of the salmon stock in the river. There must be other causes influencing the mortality of the young salmon in the river. Likely additional explanations may be found in the following :

1. Young salmon get into the water pipes leading to the fertilizer factory, and are thus lost to the perpetuation of the salmon stock in the river.
2. The sudden drying up of the river bed below the dam in the winter time, during snowstorms and freezing weather, due to loss of water to the fertilizer factory is likely to cause high mortality in the young salmon below the dam.

The effect of loss of water from the lower Úlfarsá on upstream migration of mature salmon was studied. The weekly catches of salmon in the Úlfarsá was compared to those of the nearby river Elliðaár during the years 1949 to 1963. The study shows that the salmon catches in both rivers were similar, both before the dam was built in the Úlfarsá and after.

A study was made of possible changes in the fishing places, as affected by the abstraction of water from the Úlfarsá. Considerable changes have taken place after the building of the dam, since more salmon are now caught in the lower reaches of the river than before. This change means an eventual shift in the income of fishing-right owners in favour of the ones on the lower parts of the river.

Other possible causes leading to reduced catches of salmon in the Úlfarsá after 1953 have been taken into consideration. One case is known of temporary drying up of the river bed from the cascades just above the dam downwards. This was caused by a very unusual interplay of heavy wind and freezing weather. Drainage of land and pollution from human habitats were looked into. The former item seemed to be of little consequence in reducing catches of salmon after 1953, whereas the other item might cause some damage to young salmon when the water level of the river is low.