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Fish researches in Vatnsá and Kerlingardalsá watershed in year 2004

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Abstract

In this report we describe results from researches done on the Vatnsá and Kerlingardalsá watershed by Veiðimálastofnun in the year 2004. The aim was to evaluate the status of salmonid parr populations in rivers and streams by electro fishing and also to research the fish populations in lake Heiðarvatn, but Vatnsá is formed by the runoff from the lake. Vatnsá in Heiðardalur was originally a brown trout-fishing river, but today it is also a salmon-fishing river. The salmon originate from releases of juveniles in 7. to 9. decades of the last century. In this research 0^+ juveniles of brown trout were dominating in all research stations and the density was highest in Vatnsá. The juvenile's density was much lower in Kerlingardalsá. Salmon juveniles were found in 7 of 11 stations in Vatnsá and Kerlingardalsá and their tributaries but not in Heidarvatn or brooks draining to it. Their density was much lower than that of trout juveniles, but their proportion of total density of salmonid juveniles was highest in upper reaches of Vatnsá, or 18%. Salmon parr were also found in Kerlingardalsá. In rivers and brooks that drain to Heiðarvatn 0^+ parr were dominating. In research fishing by 12 net laying over one night in Heiðarvatn the catch was 136 brown trout and 57 charr.

Most of the trout was 20 to 30 cm but the bulk of charr were 28 to 38 cm. About 24 % of the trout was of hatchery origin. The main food of the trout was three-spine sticklebacks but wandering snail was the most important food of charr. In the end of the report we discuss the results and compare them with results of researches done in Vatnsá and Heiðarvatn in the year 1990. We also discuss future enhancement, fishing researches.

Introduction

Vatnsá was originally a trout-fishing river (Magnús Jóhannsson 1991). Sea trout (anadromous brown trout, *Salmo trutta*) was dominating like in many other rivers in South-eastern Iceland. The salmon seem to originate from releases of juveniles in 7. to 9. decades of the last century and in the years following the catch of salmon exceeded the trout catch (Magnús Jóhannsson 1991).

In 1990 a research was done by Veiðimálastofnun on the salmonid juvenile population in Vatnsá and Stakká. Wild Atlantic salmon (*Salmo salar*) parr (0^+ and 1^+) was dominating and was in high densities (Magnús Jóhannsson 1991). Brown trout parr was in lower densities but was higher in the upper reaches of Vatnsá. No trout parr was older than 1^+. Salmon smolt age seemed to be 2-3 years. In Skakká (tributary to Vatnsá) salmonid juveniles was in much lower densities than in Vatnsá. Few artic charr (*Salvelinus alpinus*) juveniles were found.

In the year 1990 research was also done by Veiðimálastofnun on Heiðarvatn. The result showed that the fish stocks in the lake consisted of resident arctic charr and brown trout in a quite quantity, most of the arctic charr was between 200 – 300 g of weight and the brow trout between 100 – 500 g. The main food items of both species were three-spine sticklebacks (*Gasterosteus aculeatus*) (Veiðimálastofnun unpublished).

In recent years the number of caught salmon has dropped but the catch of trout has been rising. The electro fishing that was done in 1990 reflects a situation when the salmon population was at maximum and therefore a same kind of survey now would be interesting as a comparison. No information exists of abundance distribution and diversity of fish stocks in Kerlingardalsá or its tributaries. The present situation is also important to know because of plans for releasing salmon-smolt in big quantities which could affect the juvenile stocks in the whole watershed

The aim of this study is to evaluate the present situation of juvenile stocks in Vatnsá and Kerlingardalsá, as in other smaller tributaries of importance and the brooks that float into Heiðarvatn. Also to research the fish populations in lake Heiðarvatn

Study area

Icelandic rivers and streams are different in type. They have been classified according to the origin of the water (Sigurjón Rist 1956). Many rivers have their origin in glaciers, they are turbid and are classified as glacial rivers. In the same manner water temperature responds quickly to variation in air temperature. Spring-fed rivers have a distinct origin often in a gushing spring (groundwater) and the flow often reach its full capacity not far from the headspring. Their flow is very stable all year round also is the water temperature. Most Icelandic rivers have a blended origin. Hydrology and fertility (nutrient content) of streams depends on the lands bedrocks and cover of vegetation it

flows through. Lakes on the catchments area stabilize the flow and increase organic production.

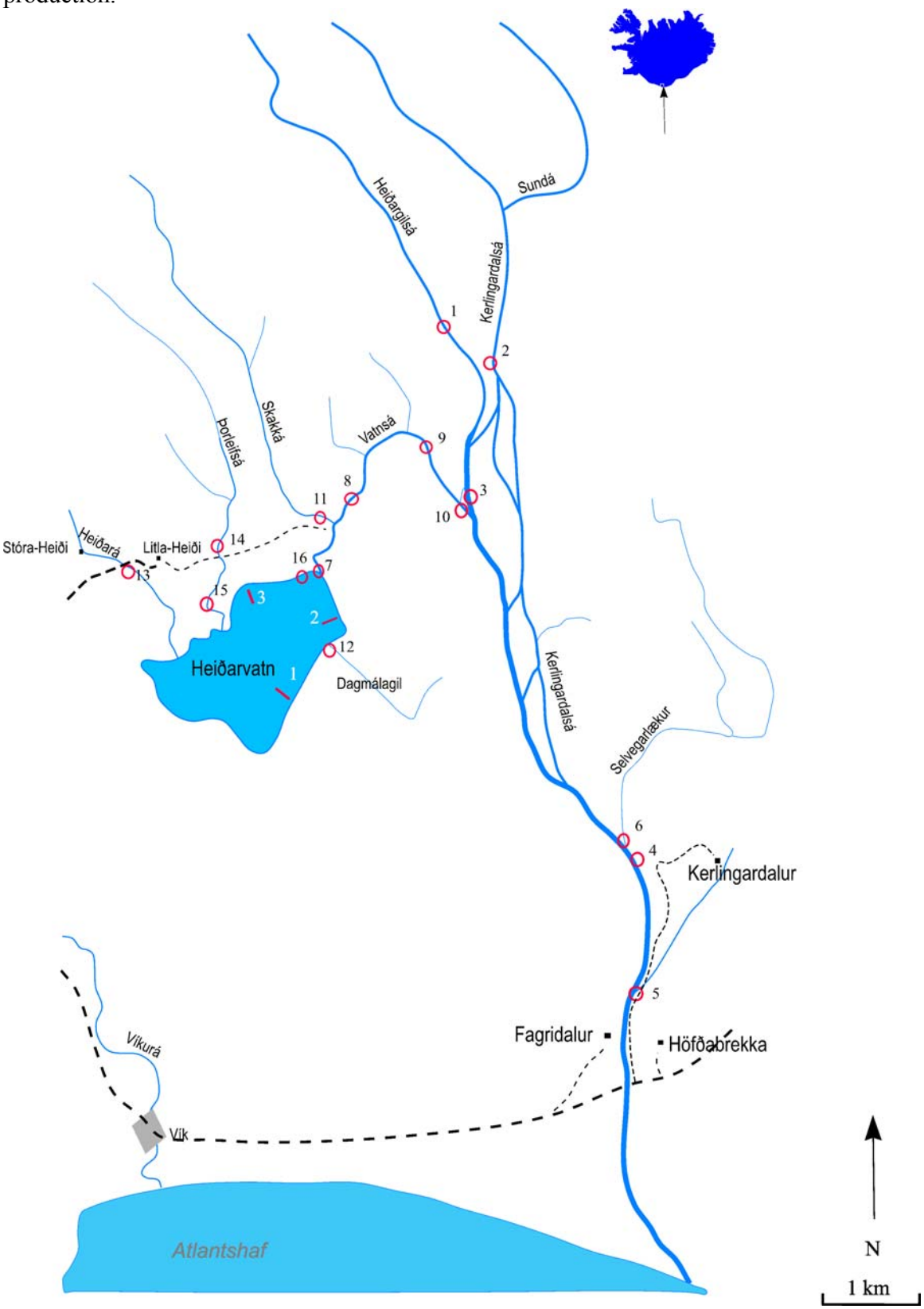

Figure 1. Vatnsá and Kerlingardalsá watershed, samplings stations in electro fishing and position of nets are shown.

The rivers and streams of the Vatnsá and Kerlingardalsá catchments area are of various types. Vatnsá is the outflow of the lake Heiðarvatn (Fig. 1), its discharge is a few m^3 large and is rather steady. The river is a mixture of a spring-fed river and a direct runoff river with a lake, that stabilizes the run-off. Vatnsá is 3 km long and flows into the glacial river Kerlingardalsá 8 km above the estuary in the Atlantic Ocean. Just below Heiðarvatn the profile of Vatnsá is not steep and therefore the bottom material is mainly fine gravel. Just above Skakká is a man maid waterfall, ca. 1 m high, made by embedded rocks in order to create fishing pool, created in the years 1996 to 1998 (Hafsteinn Jóhannsson pers. com.). About 1 km below the lake Vatnsá flow through a 1,5 km long low gorge. There we find pools and riffles. The bottom material is mostly rough gravel (particles 5-15 cm in diameter) covered with stream moss (*Fontinalis* sp.) Around 500 m below the lake a small stream falls to Vatnsá, Skakká. It is a rather cold river with origin in the mountains north of the lake. Recently a branch from Kerlingardalsá have broken its way to the lower most reaches of Vatnsá. Kerlingardalsá is a glacial river with some water of runoff and spring origin. The river comes from Mýrdlasjökull. In upstream reaches gorge rapids are dominating. The water-flow in Kerlingardalsá is characterized by heavy fluctuations, and the river bottom is very unstable. The bottom material is mostly made of rough gravel. The tributary stream Heiðargilsá, meets Kerlingardalsá above Vatnsá. The stream is of glacial origin and the riverbed is rather rough (small cobble) but unstable. The fish fauna of rivers and streams in the watershed below Heiðarvatn consists of arctic charr, brown trout (mainly anadromous), Atlantic salmon, and three-spine stickleback.

Heiðarvatn is a 190 ha (1,9 million m^2) lake in 72 m altitude above sea level. The average depth is 12,9 m and the maximum depth is 30 m. A few small runoff and spring fed streams flow into the lake (Fig. 1). However their flow can rise a lot when it is raining (Tómas Pálsson pers. com). The bottom substratum is mainly made from rather fine gravel. The lakes fish fauna consists of resident (stationary) arctic charr, and brown trout, Atlantic salmon, anadromous brown trout (sea trout) and a three-spine stickleback. Thick layers of snow can form in the region and in winters rich of snow, the ice layer on the lake doesn't brake until late in may.

Snow cover can be deep in the area and in years with heavy snow and in cold springs the ice-brake is in late may. The Vatnsá river is passable from the sea to Heiðarvatn and fish can pass streams and brooks draining to the lake. Kerlingardalsá and tributaries are also passable.

Releases of salmonid juveniles

In the middle of the seventies of the last century the first releases of salmon smolts were done in Vatnsá. Table 1 shows the amount of juvenile salmonids released in the years 1979-2004. Salmon parr were mainly released in Vatnsá and Skakká but also in Heiðarvatn. In the years before 1990 unknown quantities of trout juveniles were released.

Table 1. Releases of salmonid parr in Vatnsá and Kerlingardalsá in 1979 to autumn 2004. In addition unknown amount of trout parr were released in the years before 1990.

Year	*Place of release*	*Species*	*Under-yearlings (0^+)*	*One year (1^+)*	*Smolt*	*Origin*
1979	Vatnsá	Salmon	1800			Kollafjörður
1980	Vatnsá	Salmon	2000			Kollafjörður
1981	Vatnsá	Salmon	8000			Kollafjörður
1981	Heiðarvatn	Salmon	9500			Kollafjörður
1981	Brooks near Kerlingardalsá	Salmon	2000			Kollafjörður
1982	Vatnsá	Salmon	9000			Kollafjörður
1982	Heiðarvatn	Salmon	10000			Kollafjörður
1983	Vatnsá	Salmon	7000			Kollafjörður
1984	Vatnsá	Salmon	1000			Kollafjörður
1985	Vatnsá	Salmon	1000			Kollafjörður
1986	Vatnsá	Salmon	5200			Vatnsá
1987	Vatnsá	Salmon	1200			Vatnsá
1988	Heiðarvatn	Salmon		2550		Vatnsá
1989	Vatnsá/Heiðarvatn	Salmon	6500			Vatnsá
1990						
1991	Vatnsá	Salmon			4500	Stóra-Laxá
1992	Vatnsá	Salmon			2400	Vatnsá
1993						
1994	Vatnsá	Salmon			2500	Vatnsá
1995	Vatnsá	Salmon			3300	Vatnsá
1996						
1997	Vatnsá	Salmon	~11000			Vatnsá
1998	Vatnsá	Salmon	~15000			Vatnsá
1999	Vatnsá	Salmon	23000			Vatnsá
2000	Vatnsá	Salmon	25000			
2001	Vatnsá	Salmon	15000			Vatnsá
2002	Vatnsá	Salmon	11500			Vatnsá
2003						
2004	Vatnsá/Heiðarvatn	Trout		14500		Vatnsá
2004	Vatnsá	Salmon			9700	Vatnsá
2004	Heiðarvatn	Trout	60000			Vatnsá

In the years 1986 and 1987 some salmon parr were fed in a releasing box near Vatnsá. The aim was to rear the parr to smolt size. In the years before 1990 the salmon parr (0^+)

was 0.9-1.7 g in weight (often about 1 g). The time of release was July to August. In the year 1985 and afterwards the parr was from Kollafjörður bloodstock, eggs were hatched and reared in the hatchery at Vík. In the years between 1986-1989, and most years there after, the juveniles came from Vatnsá brood stock. In spring 2004, 5.363

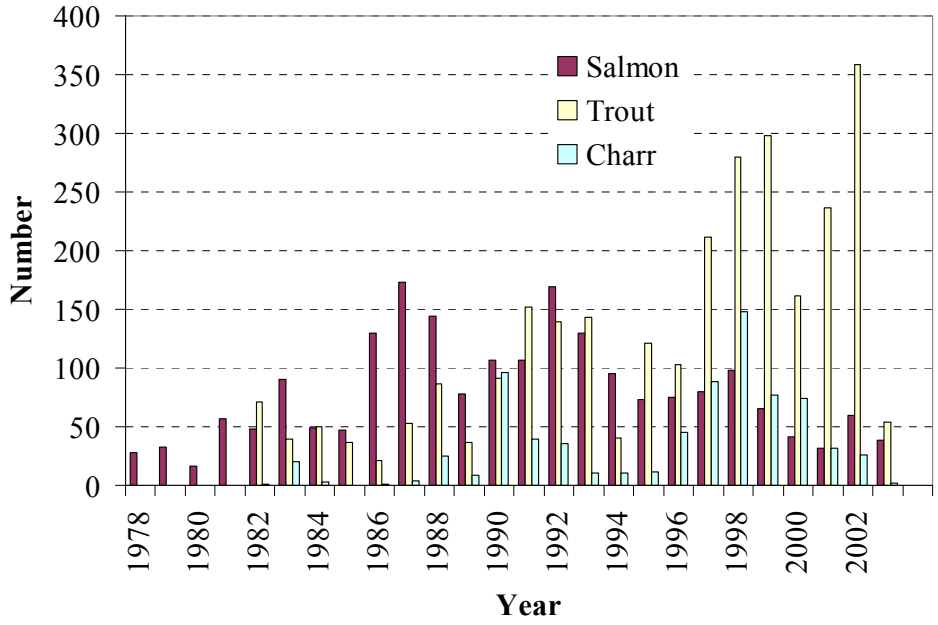

Figure 2. Angling of salmon, trout and charr in Vatnsá and Kerlingardalsá.

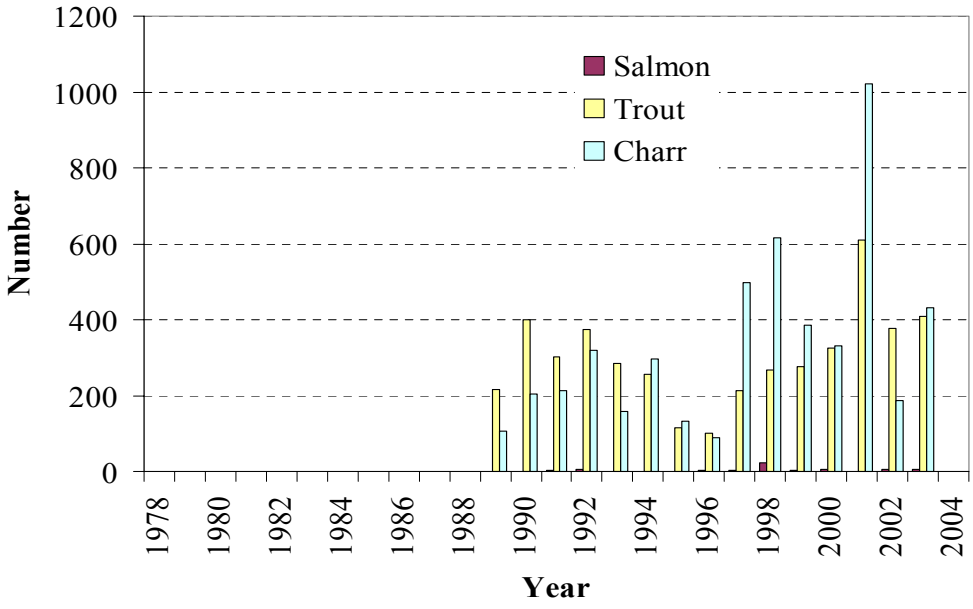

Figure 3. Angling of salmon, trout and charr in Heiðarvatn.

Catch of salmon, trout and charr

As written before Vatnsá was sea trout-fishing river before releases of salmon juveniles. However a salmon occasionally was caught but the catch of sea trout was much more than later on. In Kerlingardalsá an intense drift net fishing was operated and it is possible that over fishing have caused a decline in the population.

In recent time fishing is only done by angling in Vatnsá and Kerlingardalsá. The average catch in the years 1994-2003 was 66 salmon and the maximum catch (1987) was 173 salmon (Fig. 2, appendix I). Since 1992 the trend in catch of salmon is downward. The average catch of brown trout (1994-2003) was 187 fish. The catch of trout increased until 2002 when 359 trout were caught but in 2003 only 54 trout were landed by anglers (Fig. 2, appendix I) (Guði Guðbergsson 2004). The exploitation rate was much lower in 2003 than in the year before. The average catch of charr is 50 fish. Resident trout and charr are not reported separately, but the bulk of the trout is sea trout, but the charr is mostly resident. The migration of salmon is late in the season, often the first salmon arrive in late July. According to anglers, many salmon, and specially sea trout, migrate through Vatnsá, almost without resting in pools, but stops in Heiðarvatn and stays there until autumn, they go down to the river to spawn.

Most of the Vatnsá salmon has stayed one year at sea (grilse). The catch in the year 2003 was 38 salmon and the average weight was 2,9 kg, 31 were grilse and their weight was 2,5 kg in average and 7 were two-sea winter salmon averaging 4,6 kg in weight. The size of sea trout is varying but the average weight in recent years were from 1,1 kg to 1,5 kg. The average weight of charr was 0,5 to 0,8 kg.

In Heiðarvatn angling and gill net fishing are the harvesting methods. The average catch in the years 1994 to 2003 were 4 salmon 295 trout and 399 charr (Fig 3. appendix II). Some unreported gill net fishing is in the lake.

Methods and materials

Survey of juveniles

A survey was done by electro fishing on density, length distribution, age and distribution of different species. Density was presented as juveniles index, which is, caught fish in an area of 100 m^2. This is not the total density of parr, because only 30 to 60 % of the total population in each area is caught (Finnur Garðarsson 1983). Fishing was done on 16 stations, 4 in Vatnsá, 4 in Kerlingardalsá, one in Heiðargilsá, one in Selvegarlækur, one in Skakká, 4 in rivers that drain to Heiðarvatn and one in the lake (Fig. 1). All fish were determined to species, its length measured (fork length) and some were inspected for stomach content and scales and otoliths sampling

for later determination of age. Proportion of volume of each food item was determined by eye. The stage of fullness of the stomach was presented as 0 to 5 where 0 is no food and 5 is full. Food of parr was presented separately for Kerlingardalsá and Vatnsá but because of few stomach food samples from Selvegarlækur and Stakká they are pulled together, as from streams that drains in Heiðarvatn. On sampling stations survey was done on the stream bottom substrate and the water temperature and electric conductivity of the water were measured. Conductivity is a good indicator of the total chemical content of the water and the higher the conductivity (to a certain degree) the higher is the fertility. Electro fishing was done in 13. and 14. of September 2004.

Experimental fishing by gill nets

Experimental fishing in Heiðarvatn was performed with 11 gill nets (Fig. 1) that lay in the lake over one night. (from 13. to 14. of September). The nets were with bar mesh size 12 (2 net) – 16,5 – 18,5 – 21,5 – 24 – 30 – 35 – 43 – 50 and 60 mm. They were 25 m long and 1,5 m deep.

All fish was weighted and the fork-length measured, but in addition samples were taken for determination of age (otoliths and scales), sex, degree of maturity and parasites. Age of fish in its second year of life was presented as 1^+, and that of fish in its third year as 2^+ etc.,

Condition factor (K) were calculated as: K = weight*100 / length (cm)

The factor is an indication of the fish condition with 1,0 as a normal condition for salmonids (Bagenal and Tesch 1978).

Stage of maturity was estimated according to Dahl (1943). Fish that would not be mature in the same autumn got stage 1 and 2 and fish that would be mature in the same autumn got stage 3, 4 or 5. Mature fish got the state 6.

Fish were examined for parasites and especially for cestods (*Diphyllobothrium* spp. and *Eubothrium salvelini*) and the gill parasite *Salmincola*. Adhesion in the body cavity was also inspected, it is often caused by parasites. The intensity of infection was divided in 3 stages (1-3), were 1 is very low intensity, but stage 3 is high.

The stage of fullness of the stomach was presented as 0 to 5, where 0 is no food and 5 is full.

Proportion of volume of each food item was determined by eye. Proportional volume for group of fishes was calculated as:

$$\sum (\text{proportional volume} \times \text{stage of fullness}) / \sum (\text{stage of fullness})$$

In this way stage of fullness is important as well as proportional volume of items.

Results

Survey of juveniles

The dominating bottom substratum on sampling stations in the juveniles survey was gravel and small cobble. Heiðargilsá and Kerlingardalsá and upper reaches of Vatnsá had the coarsest substratum (Table 2). Water temperature was highest 10,5 °C in Vatnsá but lowest in Kerlingardalsá, 4,8°C. The conductivity was from 63 µS/cm to 123 µS/cm, lowest in upper reaches of Kerlingardalsá but highest in Selvegarlækur.

Table 2. Position of electro fishing stations dominating substratum, water temperature and conductivity, data were collected in 13. and 14. September 2004.

		Position				
River/stream	***St. nr.***	***N****	***W****	***Dominating substratum *****	***Water temperature °C / time.***	***Conductivity µS/cm***
Heiðargilsá	1	63.29.665	18.57.114	Small cobble	5,6 / 10:45	67
Kerlingardalsá	2	63.29.365	18.56.380	Gravel - small cobble	4,8 / 11:45	63
Kerlingardalsá	3	63.28.607	18.56.563	Gravel - small cobble	6,7 / 14:17	65
Kerlingardalsá	4	63.26.728	18.54.537	Small cobble		86
Kerlingardalsá	5	63.25.985	18.54.531	Small cobble	8,2 / 13:40	80
Selvegarlækur	6	63.26.832	18.54.759	Gravel	7,7 / 14:30	123
Vatnsá	7	63.29.251	18.58.365	Gravel		
Vatnsá	8	63.28.634	18.58.066	Small cobble	9,4 / 10:10	92
Vatnsá	9	63.28.956	18.56.982	Gravel - small cobble	10,5 / 13:05	88
Vatnsá	10	63.28.597	18.56.713	Small cobble	10,3 / 13:55	
Skakká	11	63.28.491	18.58.354	Gravel - small cobble	9,2 / 15:15	68
Dagmálagil	12	63.27.824	18.58.282	Gravel - small cobble	6,4 / 16:00	81
Heiðará	13	63.28.233	19.00.615	Gravel - small cobble	8,3 / 16:40	76
Þorleifsá	14	63.28.321	18.59.645	Gravel - small cobble	8,0 / 12:10	85
Þorleifsá	15	63.28.137	18.59.764	Gravel	7,0 / 18:45	86
Heiðarvatn	16	63.28.186	18.58.401	Gravel	9,7 / 11:15	

* Position is in degrees and minutes (3 decimals) according to WGS84.
**Class of substratum particles seize are; gravel < 7 cm, small cobble 7-20 cm and boulders > 20 cm.

Index of juveniles densities

Trout parr were dominating in all river stations. Index of trout density was highest in Vatnsá, 141,7 parr/100 m^2 at st. 8 and 135,0 at st. 9. There 0+ parr were dominating (Table 4, Fig. 4.-6.). One year old parr (1^+) were found in much lower densities. Two year old trout parr were found in Heiðargilsá and Kerlingardalsá but in low densities. In these rivers the density of salmonid juveniles was rather low (1,2 to 18,1 parr/100$m^{2)}$ especially above Vatnsá estuary. In Kerlingardalsá 0^+ trout parr were only found near Vatnsá or below Vatnsá. Salmon parr were found at 7 of 11 sampling stations in Vatnsá and Kerlingardalsá and tributaries but not in Heiðarvatn or streams draining to Heiðarvatn. They were in highest densities in upper reaches in Vatnsá, 31,3 parr/100 m^2 (st. 8), there the proportion of salmon parr were also highest, or 18,1 %. Salmon was also found in considerable densities in lower reaches in Vatnsá, 13,4

parr/100m^2 (st. 9). Most of the salmon parr were 0^+. It was of interest to find salmon parr in Kerlingardalsá just above Vatnsá (st. 3) and also near the farm Kerlingardalur (st.4) but there 1^+ parr dominated. No salmon parr were older than 1^+. Few charr parr were electro fished in the uppermost station in Kerlingardalsá (0,3 parr/100 m^2 st. 2), but none in other sampling stations below Heiðarvatn.

Table 3. Index of parr density in Vatnsá and Kerlingardalsá watershed, numbers are fished parr in 100 m², in one round in electro fishing. Line column means that no parr were found.

		Species:	***Salmon***	***Salmon***	***Charr***	***Charr***	***Trout***	***Trout***	***Trout***	***Trout***	***Stickle-back***	***Salmonids***
		Age:	***0$^+$***	***1$^+$***	***0$^+$***	***1$^+$***	***0$^+$***	***0$^+$***	***1$^+$***	***2$^+$***		***total***
		Origin:	***Wild.***	***Wild.***	***Wild.***	***Wild.***	***Wild.***	***Hatchery***	***Wild.***	***Wild.***		
River/stream	***St. nr.***	***Area m²***										
Heiðargilsá	1	170	-	-	-	-	-	-	0,6	0,6	-	1,2
Kerlingardalsá	2	296	-	-	-	0,3	-	-	0,7	0,3	-	1,4
Kerlingardalsá	3	94	-	1,1	-	-	2,1	-	-	1,1	-	4,3
Kerlingardalsá	4	78	1,3	7,7	-	-	9,0	-	-	-	-	18,1
Kerlingardalsá	5	38	-	-	-	-	5,3	-	5,3	2,6	-	13,2
Selvegarlækur	6	66	1,5	1,5	-	-	34,8	-	-	-	-	37,9
Vatnsá	7	84	-	-	-	-	4,8	-	-	-	1,2	4,8
Vatnsá	8	48	29,2	2,1	-	-	139,6	-	2,1	-	-	172,9
Vatnsá	9	60	11,7	1,7	-	-	131,7	-	3,3	-	-	148,3
Vatnsá	10	48	-	2,1	-	-	16,7	-	-	-	-	18,8
Skakká	11	140	-	1,4	-	-	25,7	-	0,7	-	-	27,9
Dagmálagil	12	24	-	-	4,2	-	120,8	4,2	4,2	-	-	133,3
Heiðará	13	90	-	-	1,1	-	24,4	-	2,2	-	-	27,8
Þorleifsá	14	92	-	-	5,4	-	28,3	-	-	-	3,3	33,7
Þorleifsá	15	66	-	-	-	-	25,8	-	-	-	-	25,8
Heiðarvatn	16	147	-	-	-	-	-	-	-	-	0,7	-

Trout parr dominated in streams and brooks that drain in Heiðarvatn (Table 4, Fig. 6) however few charr parr appeared in the upper station in Þorleifsá (5,4 parr/100 m^2 st. 14) and in Heiðará (1,1 parr/100 m^2 st. 15).

Density of trout was highest in a small brook coming from Dagmálagil (st.12, 129,2 parr/100 m^2) but in other stations the density was from 26 – 28 parr/100 m^2. Most of the trout in the streams were 0^+ and no trout parr were older than one year. In Dagmálagil one parr was identified as of hatchery origin (0^+ parr). Three spine sticklebacks were found in the upper most station in Vatnsá (1,2 fish/100 m^2 st. 7), in Þorleifsá (3,3 fish/100m^2 st. 14) and Heiðarvatn (0,7 fish/100m^2 st. 16) and was the only fish caught there.

Age and length

Length of salmon parr inn their first year of life was 3,6 – 5,7 cm and one years old 5,1 – 10,4 cm. Salmon parr of same age were longer in Vatnsá then other rivers in the area. (Table 4, Fig. 4-6). But one year old salmon parr were shortest in Kerlingardalsá

(st. 4), or 5,1 to 6,7 cm. Trout 0^+ parr were 3,0 to 6,5 cm, 1^+ 5,9 to 10,1 cm and 2^+ 10,2 to 14,9 cm. Underyearlings were smallest in Skakká and Dagmálagil.

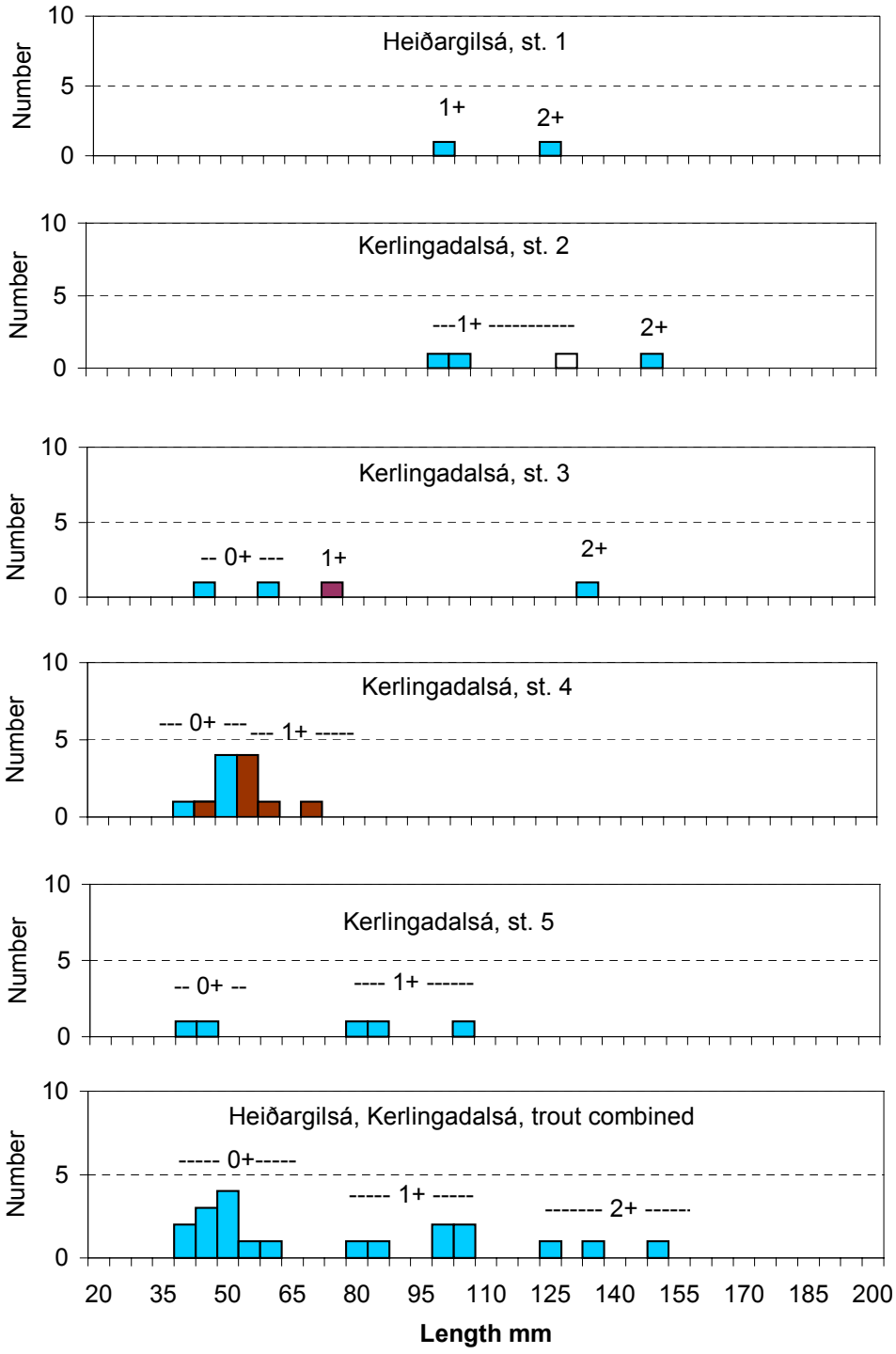

Figure 4. Length distribution and age of brown trout- (blue), salmon (brown) and charr parr (white bars) in Heiðargilsá and Kerlingardalsá.

Table 4. Average length (AL, mm), standard deviation (SD) and number of parr by art, age and origin (wild and hatchery) electro fished in Vatnsá and Kerlingardalsá watershed.

River/Stream	St. nr.	Species: Age years: Origin:	Salmon 0^+ Wild	Salmon 1^+ Wild	Charr 0^+ Wild	Charr 1^+ Wild	Trout 0^+ Wild	Trout 0^+ Hatchery	Trout 1^+ Wild	Trout 2^+ Wild	Stickle-back
Heiðargilsá	1	AL							100	125	
		SD									
		N	0	0	0	0	0	0	1	1	0
Kerlingardalsá	2	AL				127			101	149	
		SD							1		
		N	0	0	0	1	0	0	2	1	0
Kerlingardalsá	3	AL		75			50			134	
		SD					9				
		N	0	1	0	0	2	0	0	1	0
Kerlingardalsá	4	AL	44	56			47				
		SD		6			5				
		N	1	6	0	0	7	0	0	0	0
Kerlingardalsá	5	AL					41		81	102	
		SD					4		1		
		N	0	0	0	0	2	0	2	1	0
Selvegarlækur	6	AL	36	82			51				
		SD					5				
		N	1	1	0	0	23	0	0	0	0
Vatnsá	7	AL					47				59
		SD					4				
		N	0	0	0	0	4	0	0	0	1
Vatnsá	8	AL	47	104			51		79		
		SD	4				6				
		N	14	1	0	0	67	0	1	0	0
Vatnsá	9	AL	48	77			48		85		
		SD	7				5		4		
		N	7	1	0	0	79	0	2	0	0
Vatnsá	10	AL		71			45				
		SD					3				
		N	0	1	0	0	8	0	0	0	0
Skakká	11	AL		61			40		66		
		SD		8			6				
		N	0	2	0	0	36	0	1	0	0
Dagmálagil	12	AL			52		41	82	59		
		SD					8				
		N	0	0	1	0	29	1	1	0	0
Heiðará	13	AL			50		51		89		
		SD					4		18		
		N	0	0	1	0	22	0	2	0	0
Þorleifsá	14	AL			47		53				40
		SD			4		5				4
		N	0	0	5	0	26	0	0	0	3
Þorleifsá	15	AL					49				
		SD					5				
		N	0	0	0	0	17	0	0	0	0
Heiðarvatn	16	AL									62
		SD									
		N	0	0	0	0	0	0	0	0	1

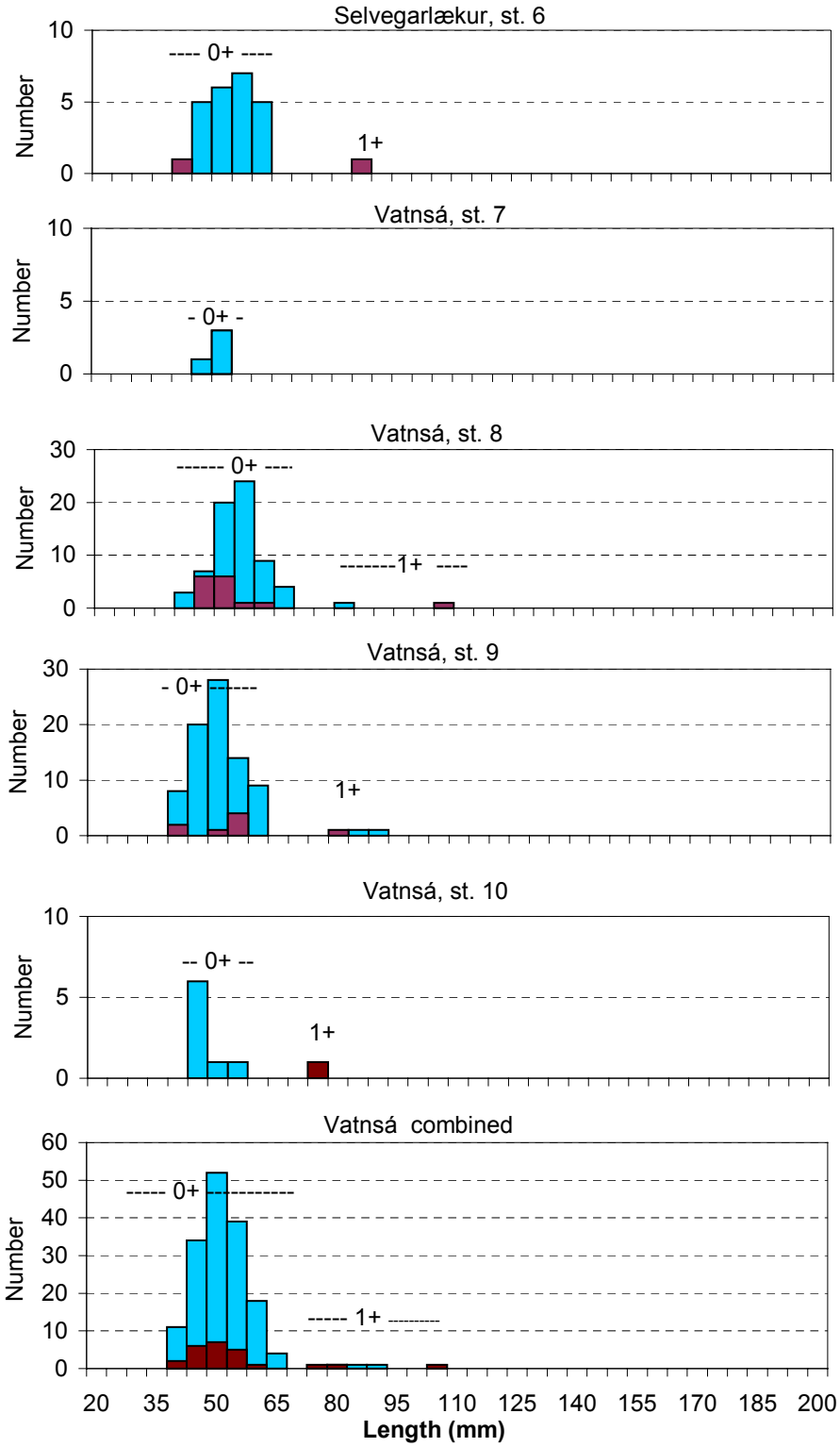

Figure 5. Length distribution and age of brown trout- (blue), salmon (brown) in Selvegarlækur and Vatnsá.

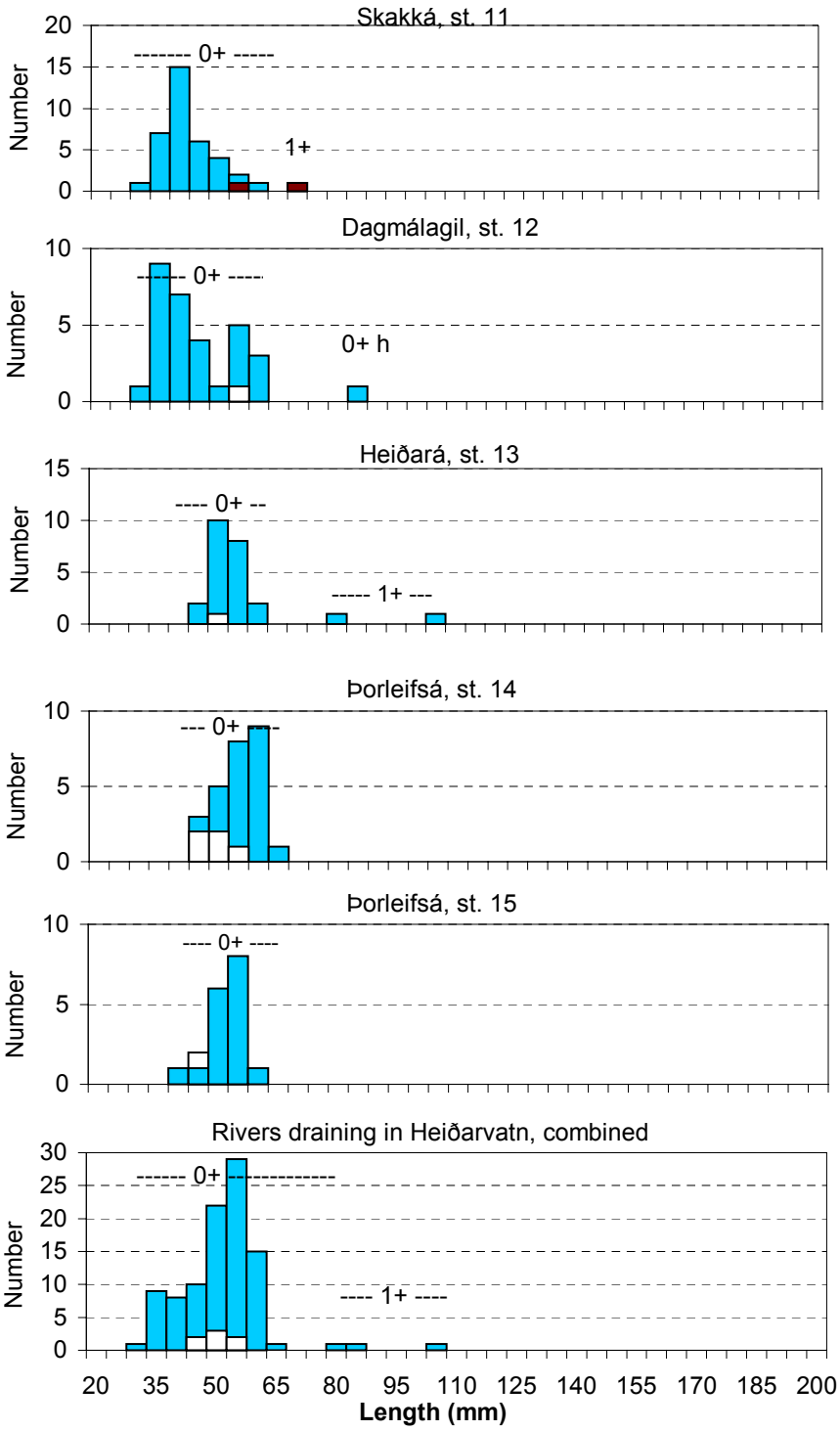

Figure 6. Length distribution and age of brown trout- (blue), salmon (brown) and charr parr (white bars) in Skakká and streams that drains to Heiðarvatn, h means hatchery origin.

Food

The food of parr is shown in Fig. 7. and 8. In Kerlingardalsá food was dominated of chironomid larvae. In salmon parr they were the only food found and in trout parr

flies also were of importance. Also in Vatnsá chironomid larvae was an important food of trout and salmon parr but simuliidae larvae was also important.

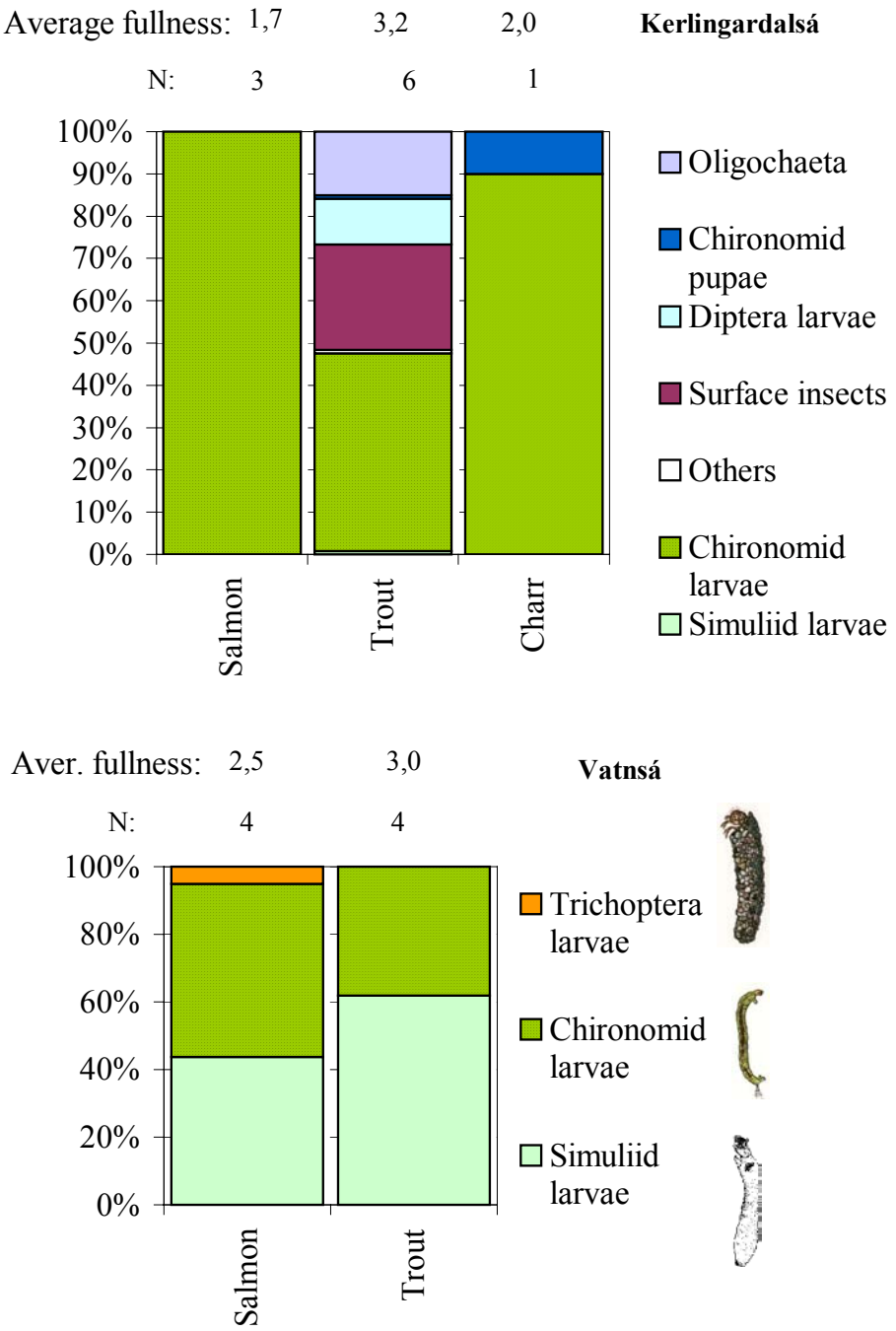

Figure 7. Proportion by volume, of food items of salmon, trout and charr parr in Kerlingardalsá and Vatnsá.

The salmon parr food in Selvegarlækur and Skakká was chiefly chironomid larvae but chironomid larvae and other diptera larvae were of equal importance in the trout stomachs.

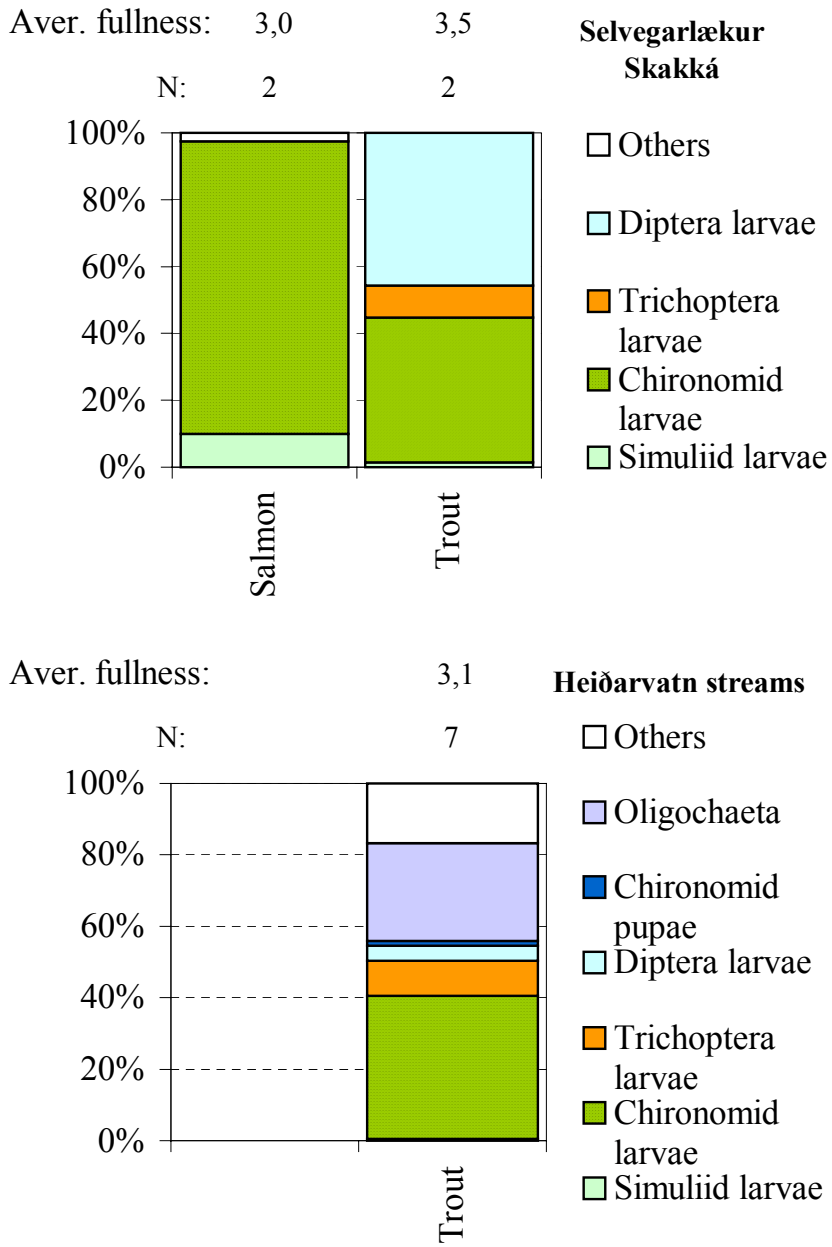

Figure 8. Proportion by volume, of food items of salmon, trout and charr parr in Selvegarlækur and Skakká and streams that drains in Heiðarvatn.

Chironomid larvae also were of most importance in the food of parr from streams that drain to Heidarvatn, but oligochaets were also of some importance.

Experimental fishing by gill nets

The total catch in the gill nets in Heiðarvatn was 136 trout and 57 charr (Table 5). Few fish came in nets with mesh size grater than 35 mm.

Table 5. Number of trout and charr fished in each gill net with different mesh size.

Mesh size (mm)	*Trout number*	*Charr number*
12,0	12	10
16,5	16	6
18,5	22	4
21,5	27	2
24,0	17	5
30,0	15	16
35,0	12	4
43,0	7	4
50,0	4	2
60,0	4	4
Total	136	57

The trout was from 8,7 to 56 cm in length, but the majority was 20 to 30 cm. The charr were from 12,3 to 40,2 cm long, but most of them were in the length interval 28 to 38 cm (Figs. 9 and 10). The age of the trout was 1 to 9 years, but in addition some of them were determined as of hatchery origin. They had the length interval 17 to 25 cm. One 42,2 cm trout had migrated once to the sea, it was 4 years old in total. The age of charr was 1 to 8 years.

Most of the charr and trout that were near sexual maturity (maturity stage 3-5) at age 5 (Table 6), but the smallest mature one was 17 cm (Figs. 13 and 14). Length of fish at same stage of maturity showed great variation as they were of several age groups (Table 6, Figs. 13 and 14).

The most important food item in the stomach of charr was wandering snail (*Radix peregra*) but *Daphnia* also had some importance. The chief diet of the trout was three spine sticklebacks (Fig. 15).

The parasite *Diphyllobothrium* was found in about half of the fish inspected. The intensity of infection was low in most of the fish, only 3 trout had infection on stage 3 (Table 7). Between 20 and 30 % of charr and trout were infected by Eubothrium, but there the intensity of infection was low and only one trout had stage 3. Salmincola was found in 1/5 of the trout but only in low intensity. Adhesions in body cavity were seen in 19 % of the charr and 37 % of the trout. However adhesions were low in intensity and in relative good accordance to the amount of parasites in the fish. Most of the trout of hatchery origin were without parasites.

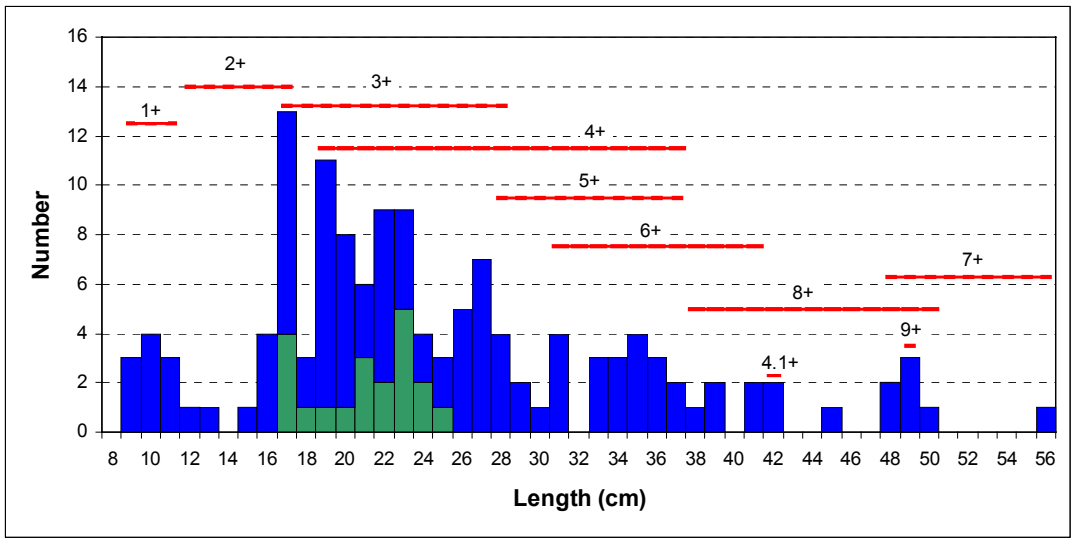

Figure 9. Length distribution of trout in Heiðarvatn. The figure shows the length interval of different age groups, and green bars are trout of hatchery origin. They were 20 of 83 inspected for age.

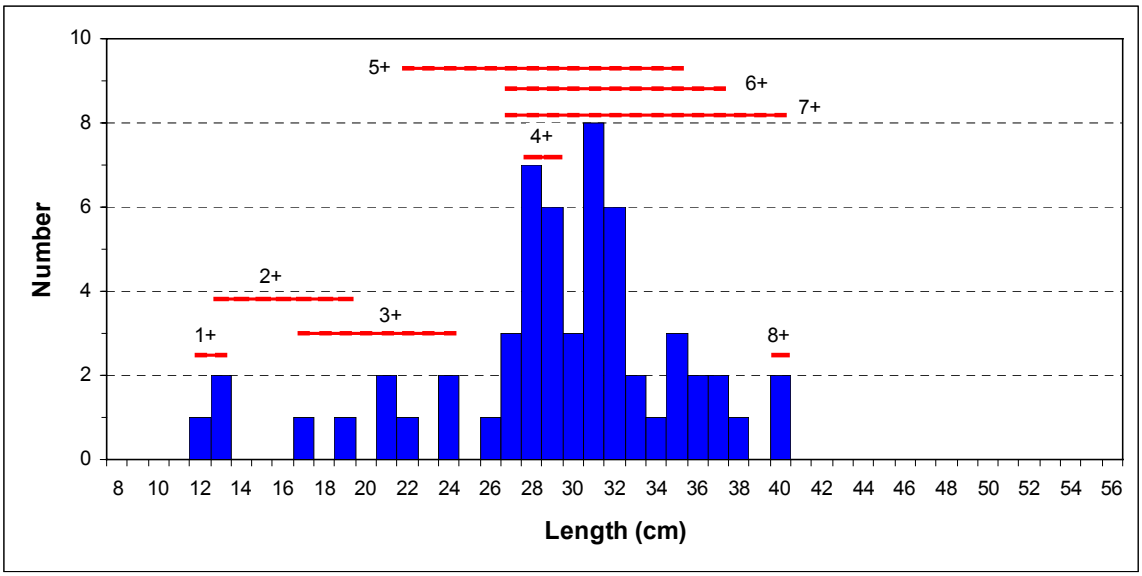

Figure 10. Length distribution of charr in Heiðarvatn. The figure shows the length interval of different age groups.

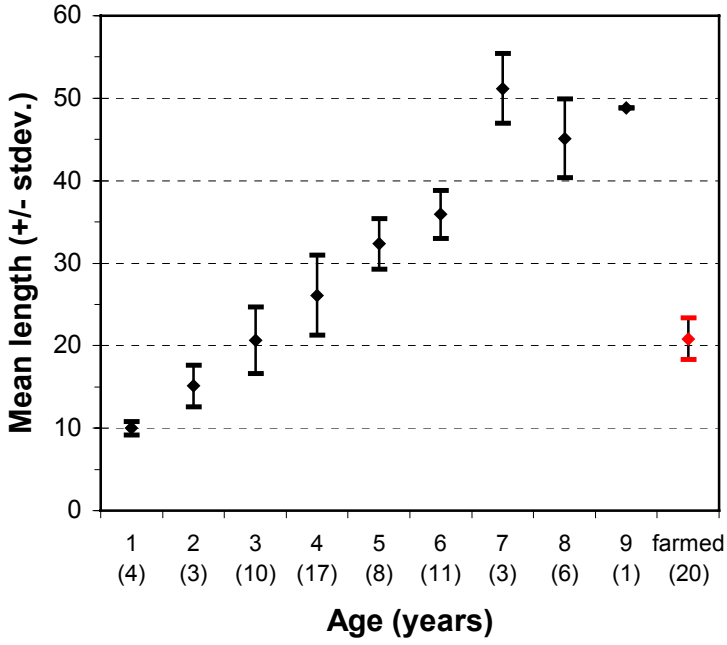

Figure. 11. The average length of trout from Heiðarvatn by age, and origin (+/- 1 standard deviation). Number in parenthesis is the number of fish behind the average.

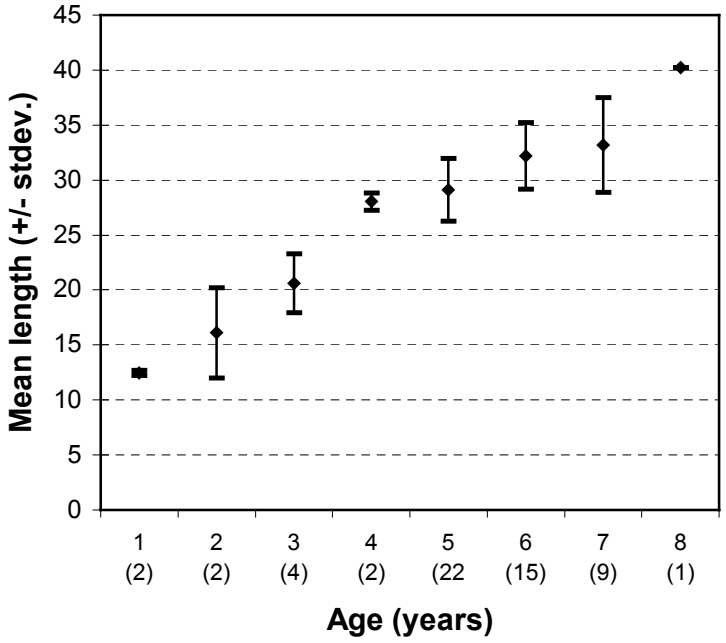

Figure. 12. The average length of charr in Heiðarvatn by age (+/- 1 standard deviation). Number in parenthesis is the number of fish behind the average.

Table 6. Number of males and females in each stage of sexual maturity (1-5), by age groups and species.

	Age	*Males*					*Females*			
Species	***(years)***	***1***	***2***	***3***	***4***	***5***	***1***	***2***	***3***	***5***
	1	1					1			
	2	2								
	3		1			2	1			
Charr	4							1		1
	5	1	3			12	1	1	1	3
	6		5		1	4		2		3
	7	1	1			5		1		1
	8					1				
	1	3					1			
	2	2								
	3	3	1	1		1	1	1		
	4	2	2			3	5	3		
Trout	5		2				1	4		1
	6	1	3			2		3		2
	7					2				1
	8		1			2	1			2
	9		1							

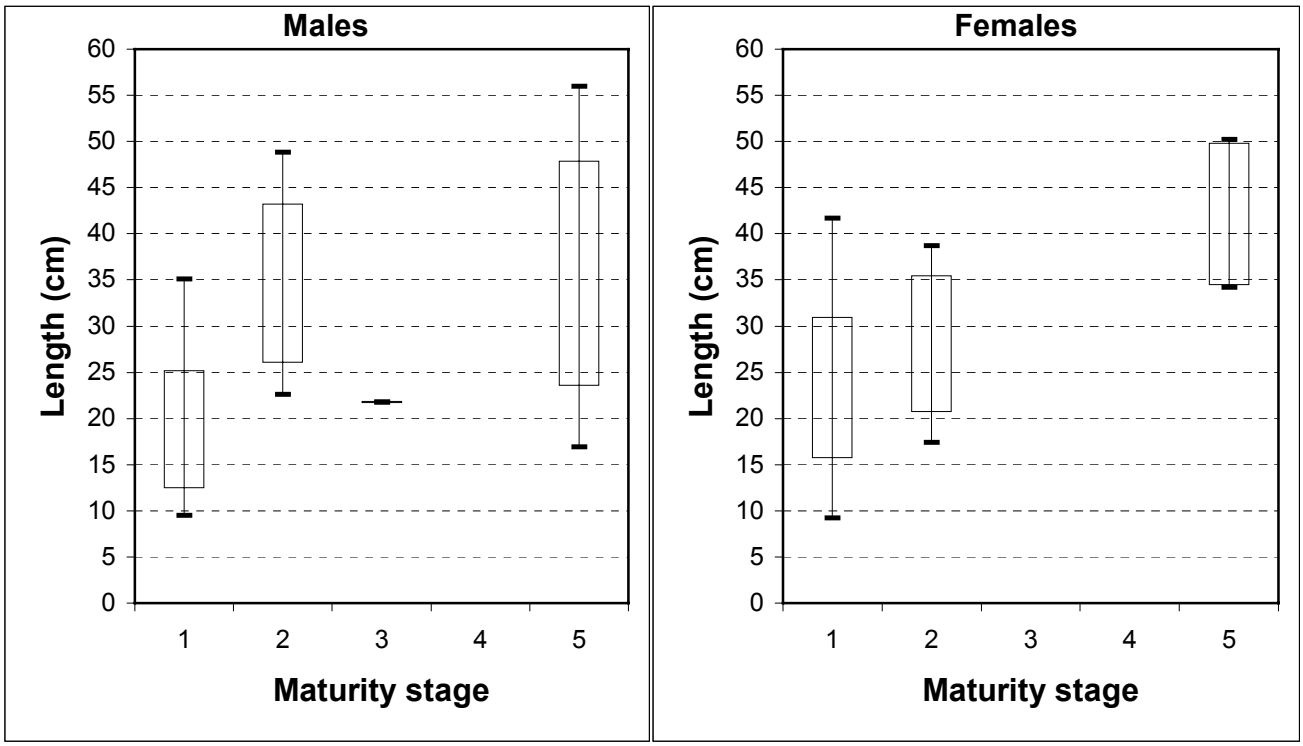

Figure 13. Trout length at different stages of maturity. Boxes shows upper and lower limits of average lengths with +/- 1 standard deviation, and vertical lines with horizontal bars on their ends show min and max length at that stage of maturity.

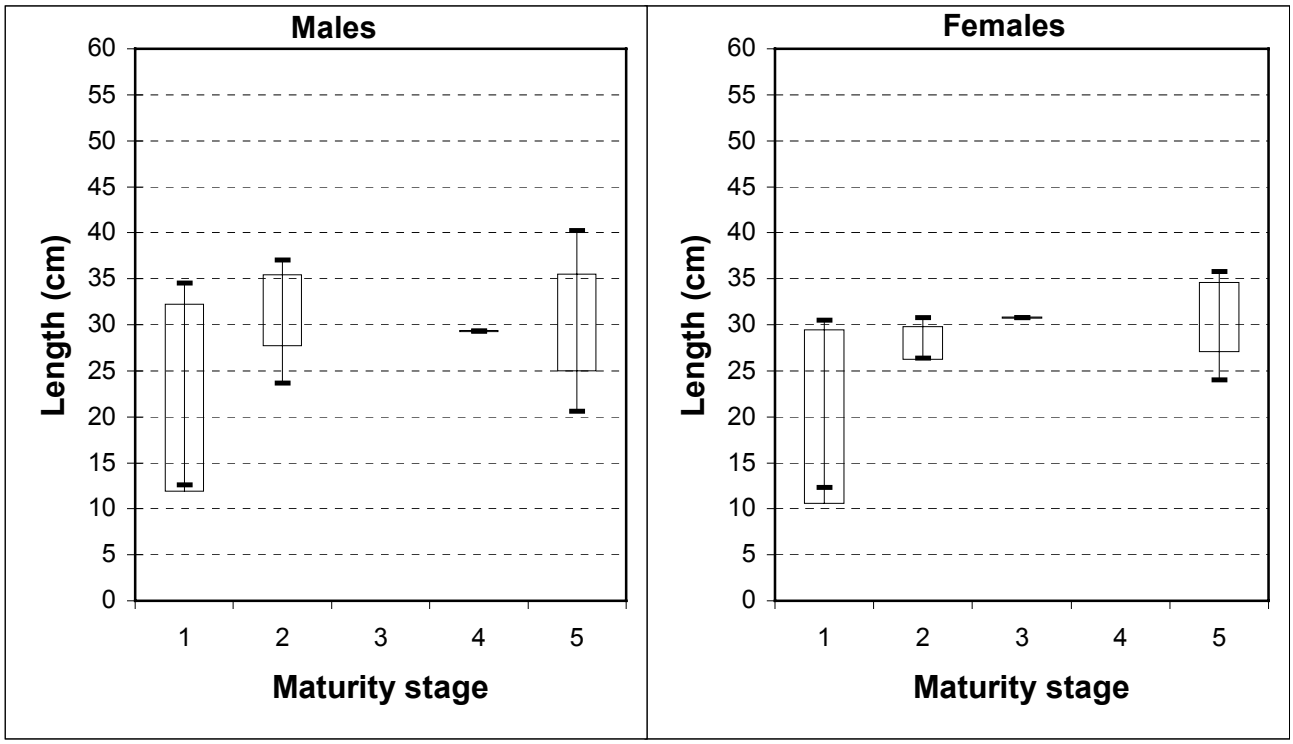

Figure 14. Charr length of different stages of maturity. Boxes shows upper and lower limits of average lengths with +/- 1 standard deviation, and vertical lines with horizontal bars on their ends show min and max length at that stage of maturity.

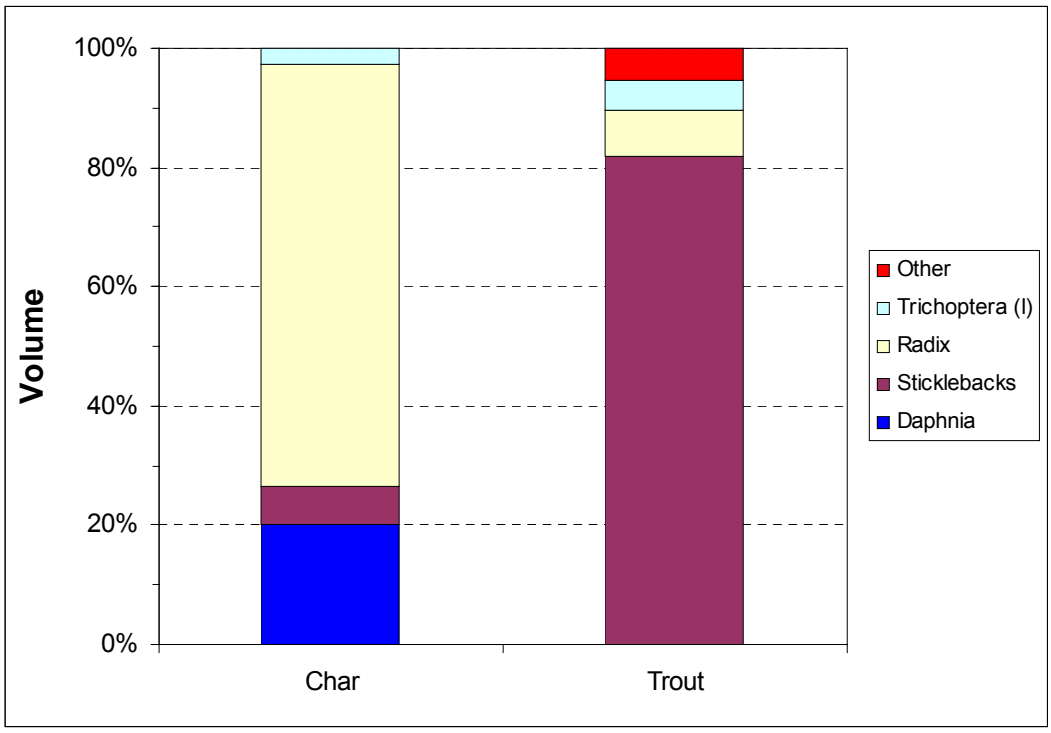

Figure 15. Food content of charr and trout Heiðarvatn, as volume percentage of each food item. Volume percentage is treated with the stomach stage of fullness. The average stage of fullness of charr was 3 and that of trout was 1,8. Of 57 charr inspected, 52 contained food in stomach (91 %), but of 91 trout 70 had food (77 %).

Table 7. Number of charr and trout of each intensity stage of infection by the parasites *Diphyllobothrium*, *Eubothrium* and *Salmincola* and adhesion in the body cavity. The intensity of infection was divided in 3 (1-3), were 1 is very low intensity, but stage 3 is high.

	Diphyllobothrium		***Eubothrium***		***Salmincola***		***Adhesions***	
	Charr	***Trout***	***Charr***	***Trout***	***Charr***	***Trout***	***Charr***	***Trout***
Not found	25	44	45	65	57	74	46	57
Infection stage 1	26	27	11	25	0	17	9	26
Infection stage 2	6	17	1	0	0	0	2	7
Infection stage 3	0	3	0	1	0	0	0	1

Discussion

Rivers and streams in Vatnsá and Kerlingardalsá watershed are of variable origin. Heiðargilsá and Kerlingardalsá are rather cold glacial rivers with some direct-run off origin, with a grate fluctuation in flow. Vatnsá is stable in flow and rather warm, because of its origin in a lake. Conductivity of the stream water was relatively high or from 63 to 123 μS/cm, lowest in upper reaches in Kerlingardalsá and highest in Selvegarlækur. Vatnsá is there in between with conductivity of 90 μS/cm. The chemical content of water depends on the amount of salts in precipitation and dissolution of chemicals from bedrock and soil. Electrical conductivity of precipitation is in the range of 10-25 μS/cm but conductivity in Icelandic rivers is in the range of 20 – 200 μS/cm but is occasionally higher. Fish life opportunity in streams and rivers is variable within rivers and between rivers and depends for example on the fertility of the water and the water temperature. The amount of food and fish production increases with fertility and water temperature. Environmental factors that have most influence on fish life opportunity in streams and rivers are the substrate of the bottom, water depth, water velocity, amount of food and turbidity. If the river channel is passable for fish migrating from the ocean and other factors not lacking, the salmon is a dominating species in fertile rivers. Trout is often found in rivers with conductivity of the range 40 - 70 μS/cm and charr in rivers with 20 to 50 μS/cm in conductivity. Turbidity of glacial rivers depends on the amount of suspended matter in the water. High electrical conductivity of the river water in the watershed is of interest. The area is near the ocean and because of that sea salts can lift the conductivity (www.orkustofnun.is/vatnam/katla/katla03). Conductivity was higher in this research than in 1990 when it was 63-68 μS/cm (Magnús Jóhannsson 1991). We do not know the reason for this difference but it is probably caused by increase in gasses from the volcano Katla (see, www.orkustofnun.is/vatnam/katla).

Juvenile survey in the rivers showed that trout parr dominated everywhere. The highest density was in Vatnsá, which confirms its importance as trout nursery area. It is not possible to see the difference between parr of resident and sea trout but it is likely

that most of the parr in Vatnsá and Kerlingardalsá are sea trout parr, parr in streams that drains in Heiðarvatn are from resident trout that grows up in the lake. The trout parr were dominated by underyearlings (0^+) and very few were older than one year. The trout probably smoltify at age 2-4 and about 20-25 cm in length (cf Magnús Jóhannsson 2004). Older parr can exist in pools were they are not vulnerable to electro fishing, it is also possible that they have migrated to lower reaches in the watershed. Kerlingardalsá is likely to host older trout parr originate in other rivers, as they were found there. It is also possible that trout parr migrate to the lake and grow up there until they migrate to the sea. However this have to be proven by further researches. Scales samples is needed from adult sea trout, of which age and life history can be determined better. It is also of interest to tag sea trout with Data storage tags (DST-tags), which can provide invaluable information about the trout migration pattern and behavior, for example time of sea entrance and where they stay in the winter. Man maid waterfall in Vatnsá, just below where Skakká meets Vatnsá, is probably not passable for parr and can therefore prevent their migration to the lake. A small fishway should be made to make them possible to migrate up.

Salmon parr were found in 7 of 11 sampling stations in rivers below Heiðarvatn. Their abundance was highest in Vatnsá (st. 9 and 8, 13, 4 and 31,3 parr/100m^2), there the proportion of salmon parr was also highest (9 and 18 %,). Underyearlings generally dominated. Salmon parr were now in considerably lower densities than in the research since 1990, in Vatnsá the density range was 186-375 parr/100 m^2 and the proportion of salmon was 75 to 86 %. Salmon also dominated downstream in Skakká (78 %) (Magnús Jóhannsson 1991). As previously stated the origin of salmon in the watershed is from releases of salmon parr that started in the 7. decade of last century. Salmon seemed soon to establish self-producing stock in a few years although parr releases were low in number, and in some years salmon dominated in Vatnsá. Probably releases of salmon parr have strengthen the population but after releases decreased in number after 1990 spawning and natural production of salmon declined. In the same period catch decreased that indicates fewer salmon migrating to Vatnsá (Fig. 2). In the same years catch of sea trout increased, this suggests that competition by salmon have caused the decline in production of sea trout. After 1999 releases of salmon parr increased again. They should have increased catch of salmon in recent years (after 3 to 4 years from release), but this was not the case. If in the future grate number of salmon parr and smolt will be released, one can expect that salmon will dominate again in Vatnsá with following decline in sea trout production.

Food for salmonid parr is likely to bee abundant in Vatnsá, as generally in lake outlet rivers. In these rivers production of invertebrates, is driven by drift of organic matter from the lakes (Gísli Már Gíslason and Arnþór Garðarsson 1988), their stable

flow is also in advantage. Drift from Heiðarvatn serves as food for simuliidae larvae in Vatnsá, an important food item for juveniles of salmon and trout, which makes their high density possible. The research in Vatnsá in autumn 1990, showed that salmonid parr fed on crustaceans drifting from the lake (Magnús Jóhannsson 1991). It was of interest because in a research in Bugða in western Iceland (Bugða is the outlet river from Meðalfellsvatn), a few salmon parr fed on drifting crustacean (Magnús Jóhannsson 1984). It is suggested that lower abundance of parr than in 1990 means lower intensity of competition for food and the parr therefore feed on food like simuliidae and chironomid larvae that have better accessibility.

Salmon parr were found in Kerlingardalsá, their growth rate appear to be low, one year old parr were only 5,6 cm (st. 4), indicating unsuitable habitat for salmon in the river. Because of its glacial origin Kerlingardalsá is high in turbidity and the flow is fluctuating, factors affecting juvenile salmonid growth and production. Although density of salmonids is low and growth is slow, the river is long and wide and the substratum coarse, thus grate areas can serve as habitat for salmonid parr. The river therefore is relatively important in producing salmonids. Further researches that include evaluation of salmonid habitat in the watershed will declare this. With habitat evaluation and juvenile survey the proportional distribution of salmonid production areas, between rivers and within rivers, will be illustrated. It requires inspection on bottom substratum, depth, river flow rate, water temperature and the fertility of the water and knowledge of required habitat for salmonids. The quality of habitat is best described by the bottom substratum and is the factor showing slowest changes (Þórólfur Antonsson et. al., 2001).

Test fishing were practiced in Heiðarvatn in July the year 1990 (Veiðimálastofnun unpub. data) by 11 nets with mesh size ranging from 21,5 to 45 mm. It gave 43 trout and 49 charr (Fig. 16. and Fig. 17). The proportion of species was 46,7 % trout and 53,3 % charr. Comparing catch from test fishing in 2004, that is to say in meshes ranging from 21,5 to 43 mm (similar meshes as used in 1990) the catch now was 78 trout and 31 charr. The proportion of the species in these meshes the autumn 2004 is therefore 71,6 % trout and 28,4 % charr.

The proportion of hatchery trout was predicted as ¼ of all trout in the lake. These trout were about 17 to 25 cm in length, which is in relatively good accordance with the size of one year old trout released to Heiðarvatn in spring 2004 (Guillaume Beucher pers. com.). Of the total catch of trout in test fishing year 2004 and excluding trout determined as of hatchery origin, about 64% of the total catch were wild trout. This indicates that the proportion of trout in 2004 is higher than it was in test fishing in year 1990. The proportion of hatchery trout of the total trout population in the lake is high, and it is not possible to say what effect it will have on wild fish stocks in the lake.

According to test fishing, charr smaller than 26 cm was in surprisingly low abundance, this was also the case in 1990. The reason is unknown.

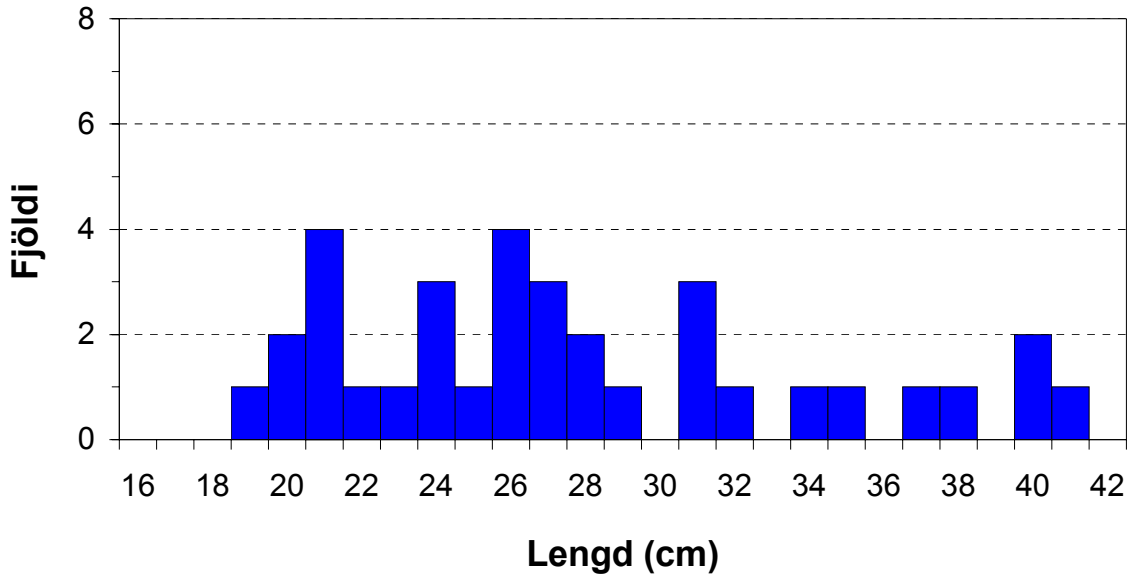

Figure 16. Length distribution of trout from test fishing with gill nets in Heiðarvatn 1990 (Veiðimálastofnun unpbl. data). N = 34.

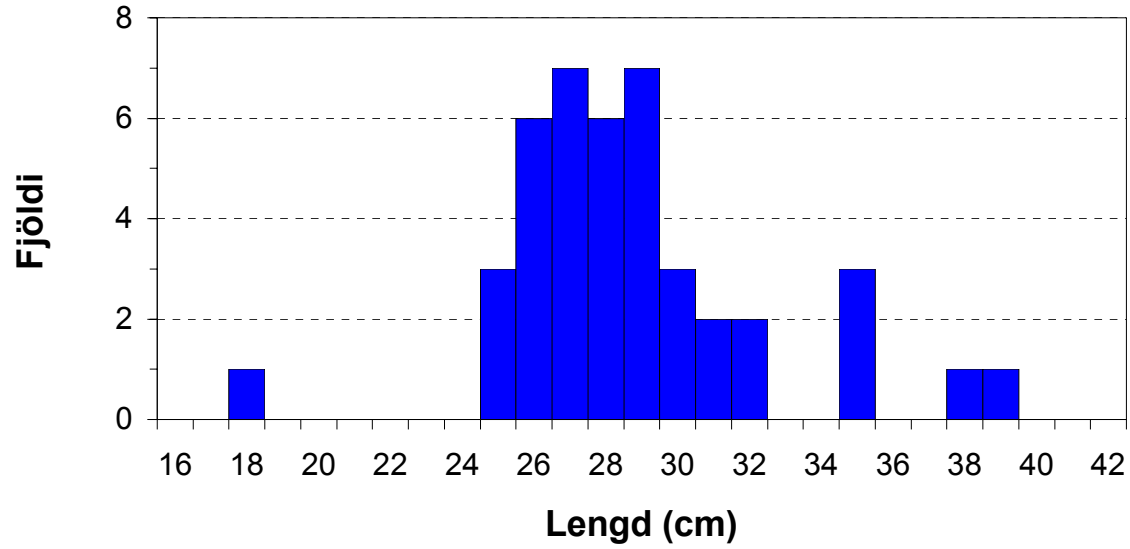

Figure 17. Length distribution of charr from test fishing with gill nets in Heiðarvatn 1990 (Veiðimálastofnun unpubl. data). N = 42.

In 1990 68 % of the charr were mature but 6 % of the trout. In the autumn 2004 about 60 % of the charr were sexual mature and about 28 % of the trout, but this can be explained by that more of bigger trout were in the catch of 2004 than in 1990. Charr in the net fishery is now about 10% but was some years a go about 90 % of the catch (Tómas Pálsson Litlu-Heiði pers. com.).

The food of charr and trout are different between autumn 2004 and summer 1990. Wandering snail was in 2004 the dominant charr food item, but in 1990 three spine sticklebacks was the dominant food item in 40 % of the charr, but in about 25 % the snail was the dominant food (Veiðimálastofnun unpubl. data). Sticklebacks now are more in abundance in the food of trout than it was in 1990. It is not known how different sampling time affects the results, but in 1990 fish was sampled in July but in September the year 2004.

Determination of spent fish (previously mature) can be difficult and it is clear that some fish in that stage is missing. However size and age at maturity is important when one is determining the status of a fish stock and therefore important to record these factors as possible. In this report spent fish are excluded, but such results should give picture of age and size at maturity when all data are inspected in perspective.

Vatnsá and Kerlingardalsá watershed is special in many ways with various types of rivers and freshwater life. This should one show regard for in enhancement programs and exploitation. It is possible to exploit the watershed, as it is, exploit the natural fish stocks now living in the area. In Vatnsá angling is the best way exploitation as is now practiced, but exploitation by rod can be increased in other parts of the watershed. Undeveloped angling possibilities are in Kerlingardalsá especially for sea trout. Angling for trout and charr can be further developed in Heiðarvatn. If the aim is to increase the number of catch-able fishes in the area, is it possible to release salmon and sea trout parr and smolt. According to Icelandic laws it is obligate to have 5 years enhancement plan. One should use brood stocks from the watershed. A grate experience is of releasing and releasing salmon smolt in Icelandic rivers but spare in Vatnsá. At least because of that it is best to proceed with caution. It is possible to release salmon underyearlings, spread them near the shore in Heiðarvatn and in Vatnsá. The result one can expect from releases of sea trout smolt is unknown, but experiments could be done. There is no need for release of smaller size trout. To follow the results of the releases, tagging of parr and smolt is necessary. Microtags (coded wire tag) are good for tagging small fish. They are tiny, made of magnetized stainless steel wire. Salmonid fishes are tagged in the snout and their adipose fin clipped for identification. To ensure that recaptured fish is reported inspection of each caught fish is required. At the same time it would be interesting to install electronic fish counter that counts fish migrating up Vatnsá. The experience of Icelandic counters from Vaki-DNG is good. To make counting possible a fence that guides all fish to the counting gate is needed. At the same time trap could be connected to the fence to catch fish migrating up. The trap could also be used to take brood stock. The trap and the counter need monitoring. The reporting of rod fishery has been good in the watershed, but it is necessary to promote recording of the net fishery in Heiðarvatn.

Proper fishery reports are very important, both for landowners to report their resources and as data for all advice in enhancement and fishery management.

With this research the status of fish population in the watershed in the year 2004 is reported. This should be followed by monitoring study of the fish stocks, a similar study as was done in 2004. This is in particular needed if the plan of smolt and parr release will be practiced, to see what effect they will have on the fish stocks in the area. It would be interesting to study the present genetic status of the salmon stocks that now live in the area, to be able to detect what effects releases have on the genetic pool of the salmon stocks. The life history of sea trout, e.g. pattern of migration is unclear in the watershed, scale sampling and Data storage tags (DST-tags) should give important information. In addition salmonid habitat survey is needed. Such a study comes in use when making register of dividends. Data logging of water temperature in Vatnsá, Heiðarvatn and Kerlingardalsá is strongly recommended, they should give useful information in evaluation of enhancement operations and also in researches of the freshwater life in the watershed.

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www.orkustofnun.is/vatnam/katla/katla03

www.orkustofnun.is/vatnam/katla/

Appendix I-II.

Appendix I. Number of salmon, trout and charr caught be angling in Vatnsá.

Year	*Salmon*	*Trout*	*Charr*
1978	28		
1979	33		
1980	16		
1981	57		
1982	48	71	1
1983	90	39	20
1984	49	50	3
1985	47	37	0
1986	130	21	1
1987	173	53	4
1988	144	87	25
1989	78	37	9
1990	107	91	96
1991	107	152	39
1992	169	139	36
1993	130	143	11
1994	95	40	11
1995	73	121	12
1996	75	103	45
1997	80	212	88
1998	98	280	148
1999	65	298	77
2000	41	162	74
2001	32	237	32
2002	60	359	26
2003	38	54	2

Appendix II. Number of salmon, trout and charr caught by angling in Heiðarvatn.

Year	*Salmon*	*Trout*	*Charr*
1989		215	106
1990		399	203
1991	2	301	213
1992	6	373	319
1993	0	284	159
1994	1	255	296
1995	1	116	131
1996	2	102	89
1997	2	212	498
1998	23	269	616
1999	3	277	385
2000	5	326	331
2001	1	609	1021
2002	6	378	188
2003	5	410	433