

**RORUM**

# Assessment of Salmon Lice infestation on Wild Salmonids in four fjords in Westfjords.

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## Abstract

The purpose of the project is to assess infestation of salmon lice on wild salmonids in the sea of Patreksfjord, Talknafjord, Dyrafjord and Isafjardardjup (Kaldalon). Salmonids were caught in July through beginning of October 2015. Total number of fishes caught was 249 fishes. Arctic char was the most abundant species in Dýrafjörður and Kaldalón whereas Sea trout was the most abundant species in Patreksfjord and Talknafjordur. Three Atlantic salmon were caught in separate fjords. Highest infection rate was found in August and there were only found female lice with egg strings on Sea trout in Patreksfjord and Talknafjord.

## Útdráttur

Markmið verkefnisins var að kanna smit laxalúsar á villtum laxfiskum í sjó í Patreksfirði, Tálknafirði, Dýrafirði og Ísafjarðardjúpi (Kaldalón). Veiðar á villtum laxfiskum fóru fram í júlí fram í byrjun október árið 2015. Alls veiddust 249 fiskar en mest var um bleikju í Dýrafirði og Kaldalóni en urriða í Patreksfirði og Tálknafirði. Í allt veiddust þrjár laxar, allir í sitthvorum firðinum. Mesta smit var í ágúst og eingöngu fundust lýs með eggjastrengi í Patreksfirði og Tálknafirði á urriða.

## 1. Introduction

The fish farming companies: Arctic Sea Farm hf., Fjarðalax hf. and Háafell ehf. requested that Rorum ehf. would process data gathered in four fjords in Westfjords in a project focused on monitoring salmon lice (*Lepeophtheirus salmonis*) on wild salmonids. All companies aim to get certificated by the Aquaculture Stewardship Council (ASC) Salmon Standard. (Salmon Aquaculture Dialogue, 2012). The primary aim of principle 3 in the ASC Salmon Standard is to ensure that salmon farms do not harm the health of wild populations. Impacts associated with disease, parasites, escapes and siting are addressed. This rapport will be focused on parasites, namely the salmon louse.

The project started out as a masters' project and the goal was to find what species of anadromous fish could be found in ocean in the fjords and measure prevalence and abundance of salmon lice on them. The project was meant as an extension of another masters' project from 2014 conducted in Arnarfjörður (Karbowski 2015). After data collection the masters' student changed interests and did not finish the masters' thesis. The environmental research and consulting company RORUM ehf. was brought in to finish the final rapport.

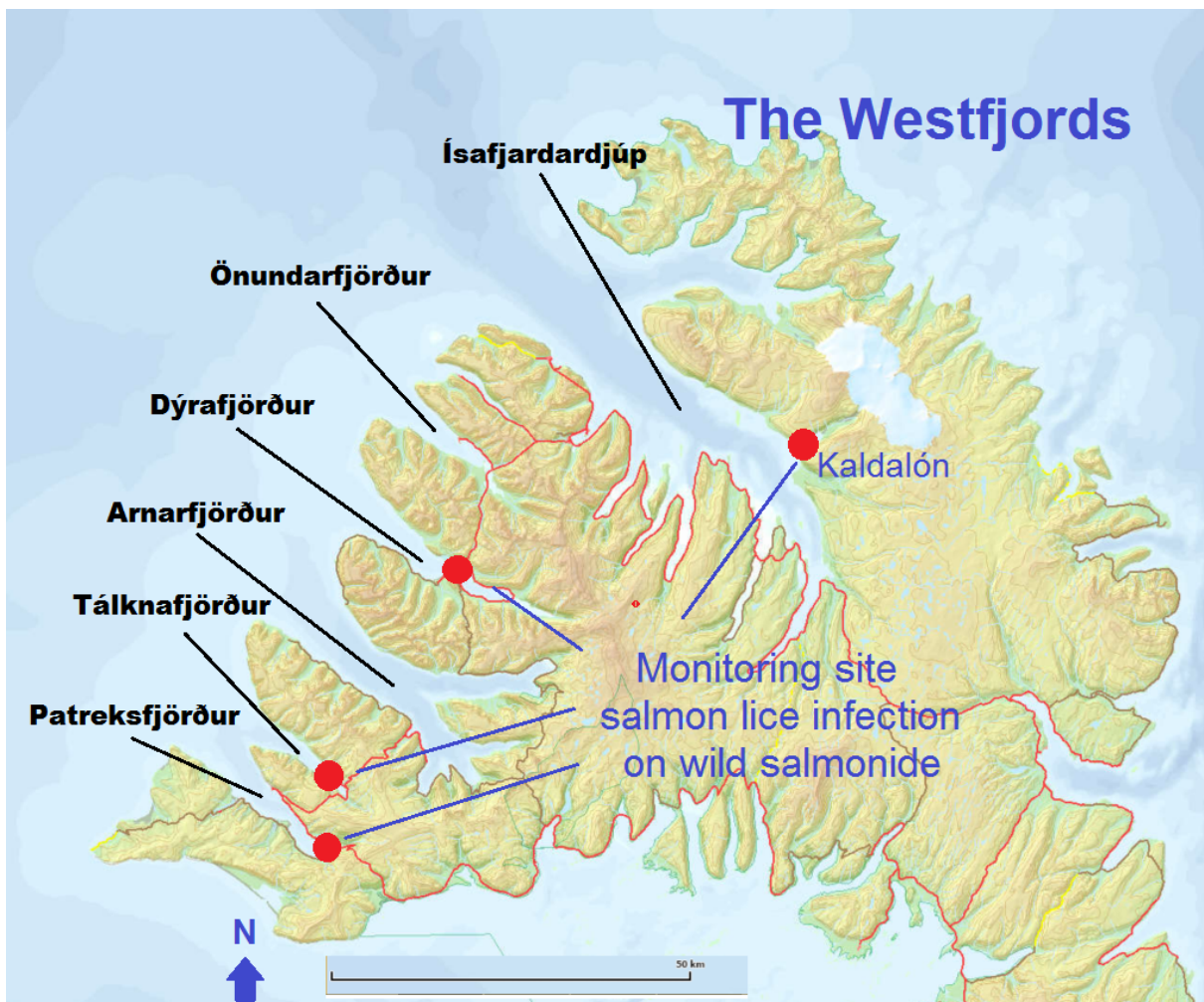


Figure 1. Map of Westfjords, marked in are fjords from Patreksfjordur to Isafjarðardjup. Sampling stations are marked with red.

## 2. Fish farms

Salmonid farming areas are in all the fjords. Fjardalax hf. has a license to produce a total of 3.000 t of Salmon annually in Patreksfjord and Talknafjord together and plan to increase production to 10.700 t annually. Arctic Sea Farm hf. plans to produce 6.800 t annually in the two fjords which comes to a total production of 17.500 t salmon annually in the fjords. Biomass will never proceed 20.000 t combined (Teiknistofan Eik 2016).

Arctic Sea Farm hf. has been farming Rainbow trout in Dýrafjörður since 2009 and has a license to produce 200 t of salmon in Dýrafjörður and Ísafjarðardjúp each. The company will begin farming salmon in 2016 and has plans to farm about 12,000 t of Rainbow trout and Salmon at several sites in Ísafjarðardjúp (Teiknistofan Eik 2016).

Háafell ehf. plans to produce 6,800 t Salmon at various sites in Ísafjarðardjúp (Seydisfjord, Kofradypí, Skotufjord, Baejarhlid, Kaldalon, Mjoifjord, Biskupavik and Hamar). The company farmed Cod (*Gadus morhua*) until 2015 when it began to farm Rainbow trout in Álftafjörður (Háafell ehf. 2016).

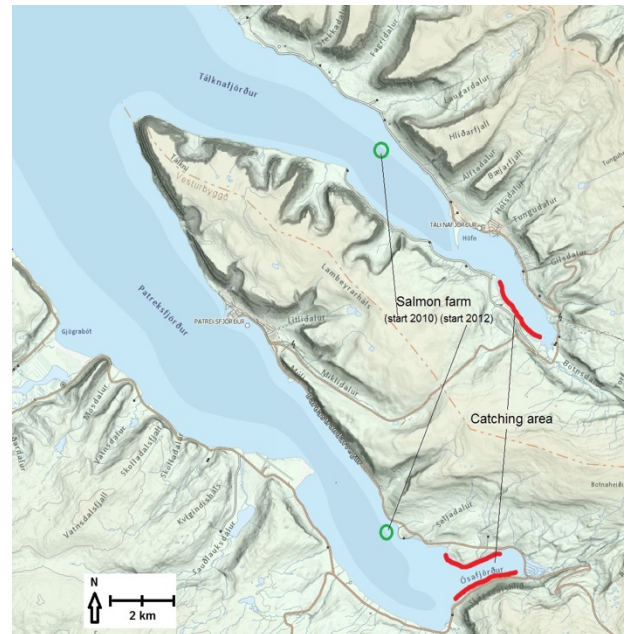


Figure 2. Farming and fishing areas in Patreksfjord and Talknafjord. Farming areas are green and fishing areas red.

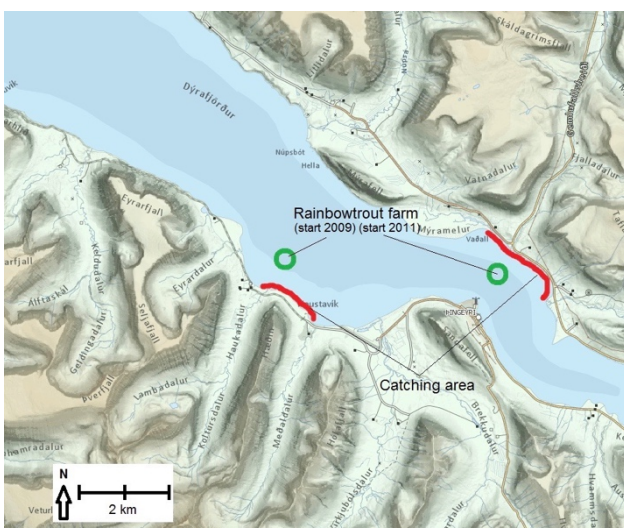


Figure 3. Farming and fishing areas in Dýrafjörður, farming areas are green and fishing areas red.

## 3. Methods

Sampling (fishing) areas were chosen due to their proximity to already developed salmonid aquaculture in the fjords. That is, according to the ASC Salmon Standard, major waterways within 50 km of the farming area. Fishing areas in Patreksfjordur and Talknafjordur were within 10 km of the farming sites, in Dýrafjordur within 2 km and within 20 km in Isafjardardjup (Figure 2, 3 and 4).

Gill-nets with two different mesh sizes were used for catching salmonids, one of them being 21 mm and the other 26 mm. The nets were 25 m long and 2 m deep with weights at the bottom and floats at



Figure 4. Farming and fishing areas in Ísafjarðardjúp in 2015. Farming area is green and fishing area is red.

(2004) Practical identification of pelagic sea lice larvae. Adult females found with eggs were recorded and all lice were placed in glass vials containing 70% isopropanol. Fish lice were also counted and noted.

Fishing days were one to three days on each occasion, with 5 to 20 nets and total sampling time being 31-185 hours. In 2014 a similar project was carried out in Arnarfjrdur where Sea trout was caught in gillnets in July and August. Fishing days in Arnarfjordur ranged from 1 to 4 days, with 5 to 20 nets and 35-70 hours of sampling (Karbowski, unpublished data).

Total catch numbers were calculated from all nets over all times and are pictured in graphs below regardless of mesh size.

Stock size was estimated from numbers of fish caught every hour by dividing catch with total net hours in sea at each location.

Length distribution is pictured below in a graph where each location is represented with size ranging from 17-50 cm. Fish length was rounded up to centimeters and average size calculated for each species and each location.

Calculations were made for abundance of lice on fish for all locations in all periods. That is how many lice are found at each location in each period. Prevalence of lice was calculated as a ratio of infected fish out of all fish caught. Infection intensity was calculated as median of lice per gram of fish weight on infected fish.

## 4. Results

### 4.1. Salmonid catch

Apart from three Salmons (*Salmo salar*) caught in Isafjardardjup, Dyrafjordur and Talknafjordur in august, and three Rainbow trouts (*Oncorhynchus mykiss*) caught in Dyrafjordur also in august, the

the top and anchored at each end. The nets were put out at low tide one at a time perpendicular to the shoreline with a distance of 50-100 m between them and removed at high tide. Nets were checked on an hourly basis to prevent loss of sea lice from the fishes. Fishes discovered in the nets were removed immediately to prevent lice escaping and handling time was cut as short as possible for the same reason. All individuals were killed quickly, placed in plastic bags and labeled with site name, date and net number and then kept in a cooler.

Every fish was classified to species and sex and length and weight measured. All lice found were analyzed under a stereoscope and classified to species and stage in life cycle using Schrams'

salmonid species caught were Arctic char (*Salvelinus alpinus*) and Sea trout (*Salmo trutta*). Arctic char made up approx. 2/3 of the total catch and Sea trout approx. 1/3, or 162 and 81 individuals out of 249 respectively. Over 60% of all Arctic char were caught in Isafjardardjup and 90% of Sea trout were caught in Talknafjordur and Patreksfjordur (figure 5).

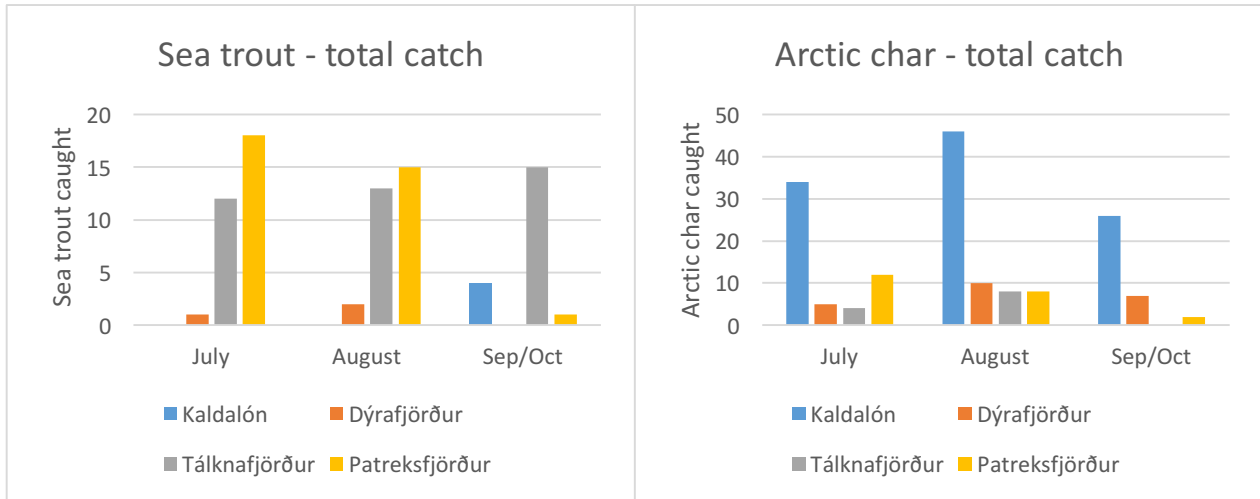


Figure 5. Total catch of Arctic char and Sea trout in all fjords from July to October 2015.

Almost half of the total catch were caught in Kaldalon or 45% and only 12% in Dyrafjord. Catch in Talknafjordur and Patreksfjordur were more even with 21% and 22% of the total catch respectively.

Table 1. Total days, nets and hours spent fishing in each location. Results from fishing in Arnarfjordur in 2014 are also show.

Fjord	Month	# days	# nets	Total hours
Arnarfjord	July	4	20	70,0
Arnarfjord	July	3	15	52,5
Arnarfjord	July	1	5	50,0
Arnarfjord	August	2	10	35,0
Arnarfjord	August	4	20	70,0
Arnarfjord	August	1	5	50,0
Isafjardardjup	July	2	5	31,0
Isafjardardjup	August	2	13	53,0
Isafjardardjup	September	2	13	49,0
Dyrafjord	July	2	15	95,5
Dyrafjord	July	1	9	67,5
Dyrafjord	August	2	20	185,0
Dyrafjord	September	1	8	24,0
Talknafjord	July	3	12	58,0
Talknafjord	August	3	17	80,0
Talknafjord	October	2	13	71,0
Patreksfjord	July	2	16	86,0
Patreksfjord	August	2	24	85,0
Patreksfjord	Sept/Oct	2	14	59,5



Wild salmonids were only caught in August and July in Arnarfjordur in 2014. For comparison and estimation of stock size between fjords we only use catch from these months in 2014 and 2015. Most were caught in Isafjarðardjup or 0.95 Arctic char per hour and no trout. In Arnarfjordur, 0.49 Sea trouts were caught per hour and one char. Both species were caught in Patreksfjordur and Talknafjord, 0.12 and 0.09 Arctic char per hour and 0.19 and 0.18 Sea trout respectively. Fewest salmonids were caught in Dýrafjordur or 0.04 Arctic char and 0.01 Sea trout per hour (figure 6).

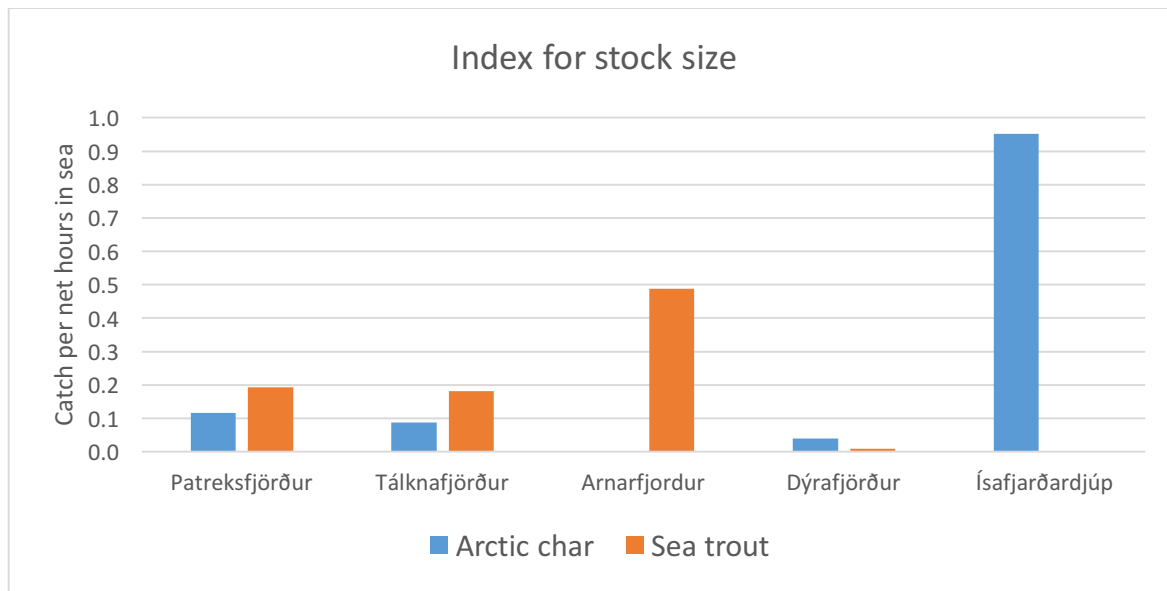


Figure 6. Salmonids caught per hour in all fjords in July and August 2015, catch from Arnarfjordur in August and July 2014 are included for comparison.

Average size of Arctic char was 27 cm over all areas and 68% were between 20-30 cm. Over 60% of Arctic char caught in Kaldalon was between 20-30 cm, smallest 17 cm and largest 43 cm. In Dýrafjordur 66% of Arctic char were between 20-25 cm or 14 out of 21 char, smallest being 19 cm and largest 35 cm. In Patreksfjordur 50% of char were between 25-30 cm, smallest being 19 cm and largest 37 cm. Arctic char between 20-30 cm made up 67% of char caught in Talknafjordur, smallest being 22 cm and largest 50 cm. Only 12 chars were caught in Talknafjordur with three or 25% over 40 cm (figure 7).

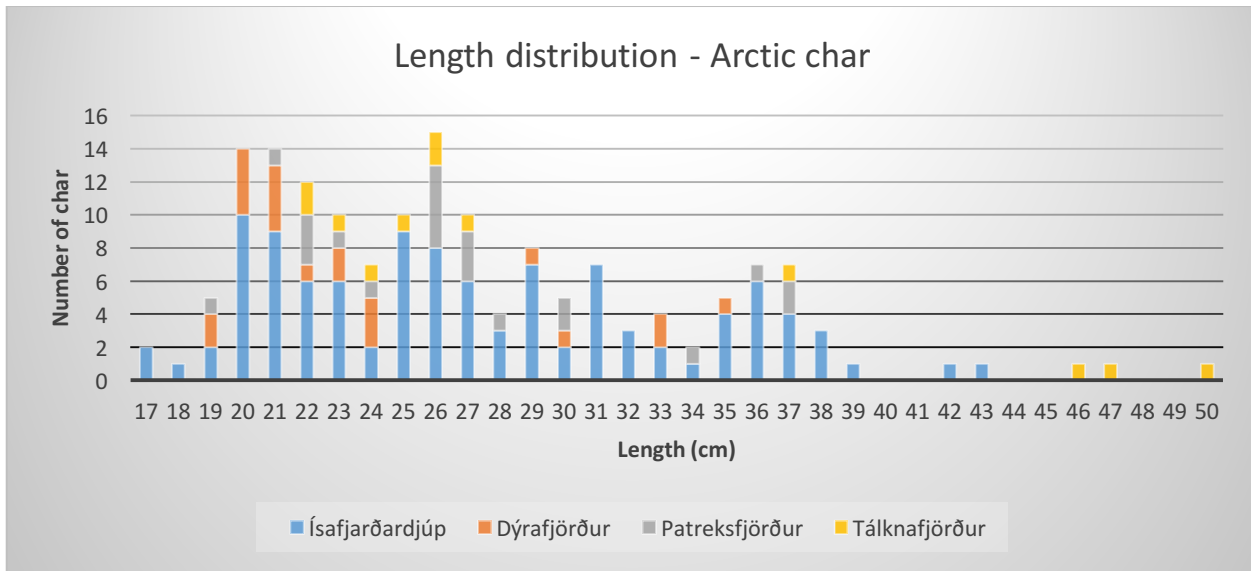


Figure 7. Length distribution of wild Arctic char caught in August till beginning of October 2015 in Kaldalon, Dýrafjörður, Patreksfjörður and Tálknafjörður.

Average size of Sea trout from all areas was 30 cm and 63% were between 20-30 cm (both sizes included), largest being 55 cm and smallest 18 cm. Length distribution in Isafjarðardjúp ranged between 24-36 cm with only four trouts caught. Only three trouts were caught in Dýrafjörður, sizes 20 and 26 cm. In Patreksfjörður, where most of the Sea trouts were caught, their size ranged from 22-55 cm with 76% between 25-40 cm. In Tálknafjörður size of Sea trout ranged from 18-36 cm with 79% between 20-30 cm (figure 8).

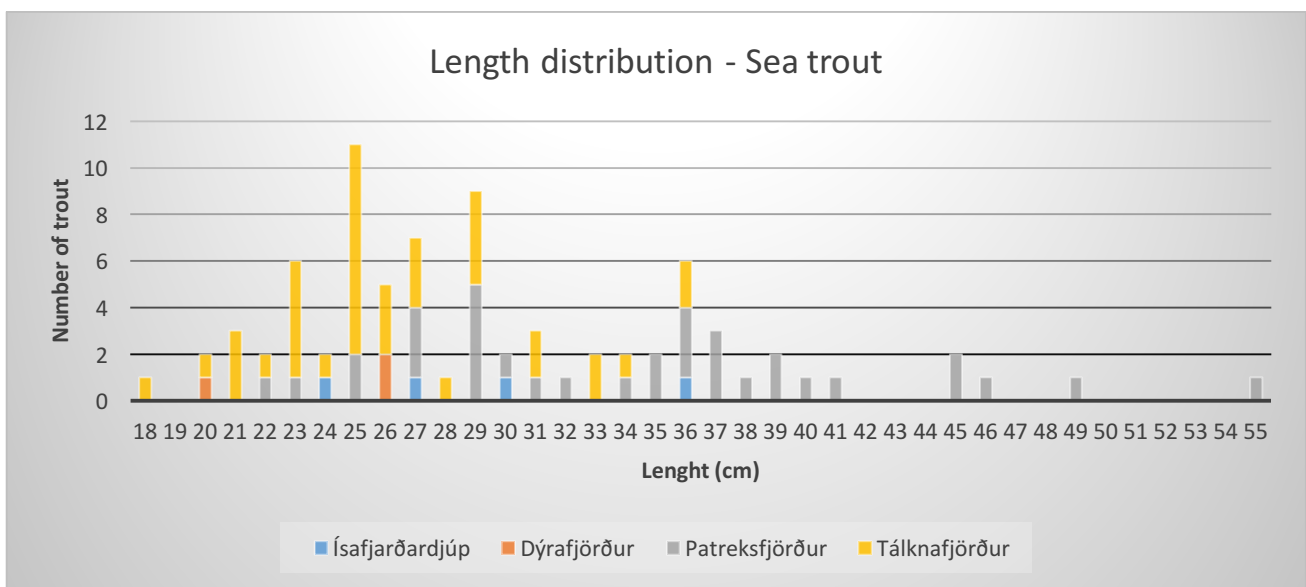


Figure 8. Length distribution of Arctic char caught August till beginning of October 2015 in Kaldalon, Dýrafjörður, Patreksfjörður and Tálknafjörður.

4.2. Infestation on wild salmonids

Salmon lice were only found in July in Patreksfjordur, both on Arctic char and Sea trout. No infection was found on Arctic char after August. Density (mean number of salmon lice on fish) was highest on Sea trout over all. Highest density on Arctic char was in August and in September / October on Sea trout (figure 8).

Two salmon lice were found on the four Sea trouts caught in Kaldalon and Dyrafjordur giving the density of 0.5 lice per trout. Density of salmon lice on Sea trout in Patreksfjordur and Talknafjordur in August to October was about 2.5-2.7 lice per trout (figure 8). Salmon lice were found on three trouts caught in Patreksfjordur in July. Only one Sea trout was caught in Patreksfjordur in October with four salmon lice.

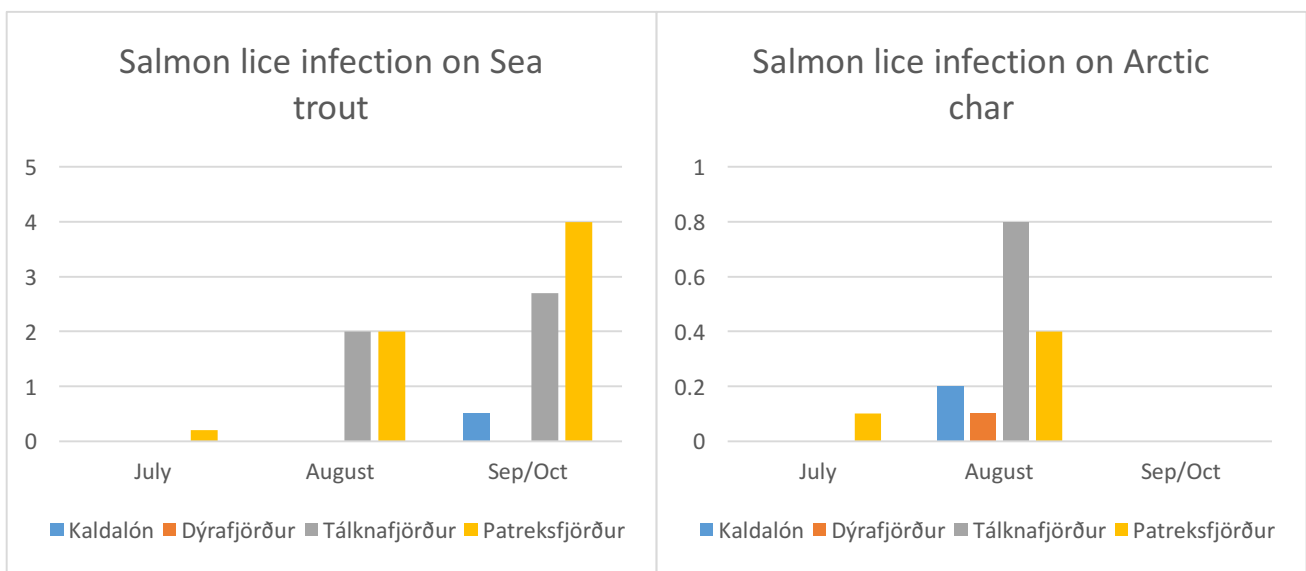


Figure 8. Abundance of lice per fish in all locations over all periods.

Prevalence (ratio of infected fish) in Isafjardardjup was 0.13 in August on Arctic char and 0.10 in Dyrafjordur. Prevalence in Patreksfjordur was 0.08 in July and 0.25 in August on Arctic char and 0.25 in Talknafjordur. Prevalence on Sea trout ranged from 0.13 to 1.00 in Patreksfjordur from July to Sept / Oct and from 0.71 to 0.94 in Talknafjordur in August and Sept / Oct respectively.

Table 2. Prevalence of infected fish in all fjords over all periods.

Prevalence of infected fish						
Fjord	Arctic char			Sea trout		
	July	August	Sept/Oct	July	August	Sept/Oct
Isafjardardjup	0,00	0,13	0,00	0,00	0,00	0,08
Dyrafjord	0,00	0,10	0,00	0,00	0,00	0,00
Patreksfjord	0,08	0,25	0,00	0,13	0,53	1,00
Talknafjord	0,00	0,25	0,00	0,00	0,71	0,94

For comparison the average prevalence of Sea trout caught in Arnarfjord was on average for July 0.801 and 0,941 in August.

All three Salmons caught had lice while none of the Rainbow trouts caught had lice infection.

Out of 144 salmon lice found on salmonids caught, 16 were found with eggs and all of them on Sea trout from Patreksfjordur or Talknafjordur.

Weight of Arctic char caught ranged from 45 g to 1,564 g with the average weight being 253 g. Of the 162 chars caught, 14 had salmon lice infection. Infection intensity (median of lice/g fish weight) ranged from 0.004 to 0.08 for infected char with the highest intensity in Isafjardardjup and lowest in August in Dyrafjordur and Patreksfjordur (table 3).

*Table 3. Infection intensity (median of lice per gram fish weight).*

Infection intensity (median)			
Period	Location	Sea trout	Arctic char
July	Patreksfjord	0,002	0,005
August	Patreksfjord	0,003	0,004
August	Talknafjord	0,012	0,009
August	Dyrafjord		0,004
August	Isafjardardjup		0,008
Sept / Oct	Patreksfjord	0,017	
Sept / Oct	Talknafjord	0,008	
Sept / Oct	Isafjardardjup	0,006	

Weight of Sea trout caught ranged from 66 g to 1.949 g with the average weight being 329 g. Of the 81 trouts caught, 38 had salmon lice infection. Infection intensity (median of lice/g fish weight) ranged from 0,002 to 0,017 with the highest intensity in Sept / Oct in Patreksfjordur and thereafter Talknafjordur with 0,012 and lowest in Patreksfjordur in July.

## 5. Discussion

Arctic char and Sea trout seem to be the dominant anadromous salmonid species in the fjords. Great difference is in abundance of the two species in the fjords. Arctic char is dominant in Kaldalon and Dyrafjord while Sea trout is dominant in Patreksfjordur and Talknafjordur. Results from a similar project from 2014 show that Sea trout also seems to be the dominant species of anadromous salmonids in the Arnarfjordur, it was also interesting that no Arctic char was caught in the 2014 project (Karbowski 2015).

Data from the five fjords (Arnarfjordur included) show that salmonids seem to become more abundant in sea the further north catching occurs. Index for stock size show the largest stock of salmonids are in Isafjardardjup where 0.95 Arctic char were caught on average every hour and Arnarfjordur with 0.49 Sea trout caught every hour, with these species being almost the only species

of salmonid caught in the fjords. These fjords are the largest fjords and have their own fjord system within them. Dýrafjordur showed the lowest stock size with under 0.1 salmonid caught every hour of catching.

It does not seem that Salmon is an abundant species in the fjords, as only three were caught during all catching periods, one in each fjord except from Patreksfjordur.

Highest prevalence on both species was recorded in Talknafjordur. Although prevalence was recorded higher in Patreksfjordur on Sea trout in Sept / Oct, only one trout was caught in the period. Prevalence of infected fish was only higher than 25% of the catch in Talknafjordur in Sept / Oct where 71% and 94% of the Sea trouts caught had salmon lice infection.

The Scientific council for Salmon Management assesses effect on salmonids on the median value for lice/g fish. With median value under 0.05 the assessment the infection has no effect on the population, 0.05-0.15 moderate effect and great effect if values go over 0.3 lice/g fish weight (Anon 2011). The Institute of Marine Research in Norway operates under the risk assessment that fish begin to show physiologic effect at 0.1 louse / g fish, percentage of the population infected with that intensity is then used to assess the effect it has on the population; under 10% has little effect, 10-30% has a moderate effect and over 30% great effect (Taranger et al 2011).

Infection intensity (median of infected fish) was highest on Sea trout in Patreksfjordur in Sept / Oct with the intensity of 0.017 lice / g fish weight and on Arctic char in Talknafjordur in August with the intensity of 0.009 lice / g fish weight. One Sea trout caught in Talknafjordur in Sept / Oct had the infection intensity of 0.1 louse / g fish weight witch was under 10% of the total catch in the period.

Prevalence of infection and infection intensity are low with values well below threshold values for negative impact of lice in all fjords.

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