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Sveriges rapport om statusen för Atlantlax år 2018

Bifogat är rapporten *Fisheries, status and management of Atlantic salmon stocks in Sweden: National report for 2018* om 2018 års laxsäsong på västkusten efter att den presenterats på ICES WGNAS i Norge. Den samlade ICES-Rapporten från WGNAS-mötet (ca 300 sidor) med situationen för laxen runt hela Atlanten är ännu inte klar, men borde komma de närmaste veckorna.

Som ni alla kommer ihåg var sommaren 2018 extrem och den lär få konsekvenser för framför allt smoltutvandringen 2020 och lekfiskåtervandringen 2021-2022. Frånsett det så har fisketrycket successivt minskat, framför allt på kusten (Figur 1, sidan 4 i bifogad rapport), men till del även i åarna (Figur 3 i bifogad rapport). Överlevnaden i havet är fortsatt dålig, men den minskade exploateringen gör att beståndsstatusen generellt har förbättrats något.

Överlevnaden i havet har vi tidigare följt med Carlinmärkningar av vild lax i Högvadsån och odlad lax i Lagan. Numera har märkningarna i Lagan upphört (de var ett frivilligt åtagande av Laholms laxodling) och märkningen i Högvadsån är av liten omfattning. Det bästa måttet på hur laxen överlever i havet är i alla fall att använda oss av data från Högvadsån, där vi vet hur många smolt som utvandrar och sedan kommer tillbaka som lekfisk (presenterades i fjolårets rapport, *Fisheries, status and management of Atlantic salmon stocks in Sweden: National report for 2017*). Som ni alla vet är Nydala kvarn i Högvadsån navet i vår kunskap och övervakning av laxen på västkusten.

Ett annat mått på hur laxen haft det i havet visas i figur 7 i bifogad rapport - konditionen (Fultons konditionsfaktor) på lax som fångas i sportfisket. Ju bättre förhållanden i havet desto fler och fetare laxar återvänder – och desto fler återvänder som grilse/smålax. Ni kan se en klar förbättring i kondition för grilse/smålax sedan de riktigt usla åren 2005-2009.

Dock är det många enskilda vattendrag som har problem (se sidan 15 i bifogad rapport). Problemet med blandfiske i huvudfåran av Göta älv och Lagan är fortsatt ett aber för naturlaxen i biflödena, se t ex på Säveåns svaga status. Vattenkraftutnyttjande och dåliga fiskvägar ställer till det i andra vattendrag, t ex Fylleån. Även i vattendrag som totalt sett har en bra status finns lokala problem, t ex nedströms Ätraforsdammen i Ätran där det saknas minimitappning.

Ni vet väl att vi tagit fram riktlinjer för hur många laxar som behöver stiga i varje vattendrag för att vara över säkra biologiska gränser? Det presenterades i en

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rapport 2017 (*Setting biological reference points for Atlantic salmon in Sweden*) som vi på förfrågan skickar till dem som inte fått den. Detta öppnar för den beståndsvisa förvaltning vi strävar efter. För de åar där man inte har koll på hur mycket lax som stiger, kan man istället använda elfiskeresultaten för att göra en bedömning. Det var så vi gjorde analysen ovan (den på sidan 15 i bifogad rapport). Vi har därför fått medel för att stärka elfisekprogrammet i några laxåar. Vi kommer att återkomma till länsstyrelserna under april för att samordna våra elfiskeprogram.

Gyrodactylus är ju ett problem i söder och ett ständigt hot mot de norra vattendragen. När laxbestånden åter höga tätheter så lär parasiten få stor negativ effekt, medan samtidigt ett varmare klimat är ogynnsamt för parasiten. Övervakningen fortsätter och Per-Erik Jacobsen på Sportfiskarna är ute i dagarna och tar prover. I framtiden kommer vi även utnyttja eDNA-teknik som testades framgångsrikt i höstas. Resultaten av detta presenteras i juni 2019 på NASCO's årliga laxkonferens (i Tromsö).

Vi har fortsatt arbetet med att genetiskt karakterisera laxbestånden. En del av resultaten har presenterats i ett tidigare PM. Ni finner en uppdatering på sidorna 16-17 i bifogad rapport. Vi jämför just nu våra bestånd med övriga bestånd i närliggande länder (och de odlade laxarna) och kommer förhoppningsvis 2020 att kunna säga var en främmande lax kommer ifrån med säkerhet, idag kan vi bara konstatera att den är just främmande. Alltjämt finns det åar där vi inte samlat in genetiskt material, eller där vi har färre än minimikravet 20 individer provtagna. Vi försöker komplettera detta och kanske återkommer till er för hjälp med provinsamling.

Har ni frågor eller synpunkter är ni välkomna att höra av er till oss. Ida tar successivt över arbetet från Erik som dock är kvar en bit in på 2020.

De bästa fiskevårdshälsningar

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Working Group on North Atlantic Salmon

Working paper 2019/07

FISHERIES, STATUS AND MANAGEMENT OF ATLANTIC SALMON STOCKS IN SWEDEN: NATIONAL REPORT FOR 2018

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SUMMARY

- Harvest of Atlantic salmon in 2018 was 16.5 tonnes, below the average (23.5 tonnes) for the last 24 years (since 1995). The low catch was due to restrictions on commercial fishing.
- The total harvest in numbers 2018 was 3739 salmon, whereof 2139 (57 %) wild (1SW 1043, MSW 1096).
- No catch was recorded from commercial fishing on the coast (fourth year in a row).
- Harvest of wild salmon today is only at 7 % of the historical level of 1884-1899.

- As a compensation for lost production due to hydropower production on average 128,000 reared smolts are stocked annually (1970-2018). Of the total harvested biomass was 46 % estimated to be reared salmon (ranching + enhancement stocking) in 2018.

- Recruitment of wild salmon is monitored with electrofishing. Recruitment (number of young salmon fry and parr in rivers) has increased successively since 2011.
- From electrofishing data, it was estimated that 30.4 % (7) of the stocks were in good reproductive capacity, 34.8 % (8) in risk of reduced production and 34.8 % (8 rivers) of reduced production capacity. One river did not have sufficient data for assessment.

- Stock monitoring also comprises of monitoring in the index river Ätran/Högvadsån with counting of smolts and ascending spawners since 1954. The spawning run in 2018 was above the long-term average för MSW fish, but below for 1SW.
- Only 8, out of 24, rivers have not been infected with the ectoparasite *Gyrodactylus salaris*. The effects of the parasite on salmon stocks have not been proven significant at the population level, but negative effects on individual fish are evident.

- Liming of acidified rivers (78 % of the Swedish salmon rivers require liming) is essential for salmon production and aquatic biodiversity.

- The low stock status requires further restrictions on the fishery in rivers with weak stocks, and efforts to reduce the negative impact of poor connectivity in some rivers with hydropower production. Further, no licenses for coastal salmon fishing should be issued.

Contents

1. BACKGROUND

In Sweden, there are 24 rivers, and three smaller streams, with wild salmon on the west coast. Salmon from these stocks migrate to the Atlantic Ocean. On the south and east coast of Sweden there are additional around 20 rivers with wild salmon migrating to the Baltic Sea. As the latter stocks remain in the Baltic Sea area they are called Baltic salmon and are not presented here.

The report is part of the background data required for the stock assessment conducted by the working group WGNAS (Working Group on North Atlantic Salmon) at ICES.

Due to extensive hydropower development, several Swedish salmon stocks have been lost. To compensate for the lost coastal and sea fishery reared salmon is annually released in three of the rivers with Atlantic salmon. As the largest rivers were the ones to be exploited for hydropower development, half of salmon caught on the west coast today is of hatchery origin. The releases in river Lagan are defined as ranching, while stocking in Rivers Nissan and Göta älv are defined as enhancement of existing populations.

<u>Data for the WGNAS are compiled in the Appendix.</u>

2. FISHERIES

2.1 Harvest and number of gears

Commercial fishermen report their harvest on a monthly basis. The harvest in the non-commercial fishing on the coast is not reported, while sport-fishing associations in rivers give a voluntary and generally exact reporting of catches. Especially in the larger wild salmon rivers, the catch statistics from sport fishing is accurate, however not always including information on catch and release (C&R) practise.

The total reported nominal salmon harvest, including ranched salmon, in 2018 was 16.5 tonnes, whereof 8.9 tonnes (54 %) was wild and 4.1 (25 %) tonnes ranched salmon (i.e. reared and released in River Lagan). The average total harvest during 1995-2018 has been 23.4 tonnes (±8.9 S.D.). The harvest decreased considerably 2015 due to a ban on coastal gill net fishery at depths >3m (Figure 1).

The total harvest in numbers 2018 was 3739 salmon, whereof 2139 (57%) wild (1SW 1043, MSW 1096).

Commercial catches of salmon with gill nets and traps on the coast were lacking in 2015-2018. The number of trap nets operating on the coast has decreased from circa 60 in the 1980s to 2 in 2018 (Figure 2). In 2018 all reported catch of salmon was made in rivers.

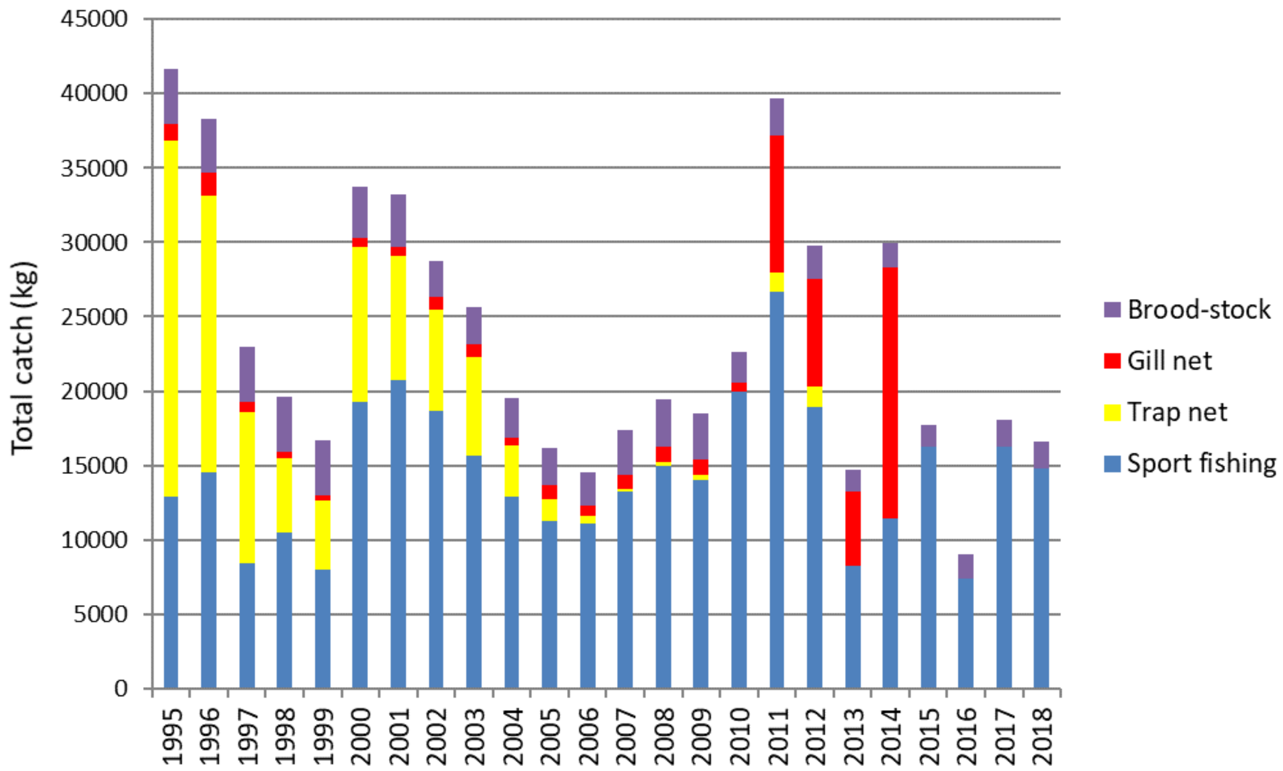

Figure 1. Total reported nominal harvest of Atlantic salmon (kg) (wild and ranched) in Sweden 1995-2018 in different kind of fisheries. Trap nets and gill nets are used only in commercial coastal fisheries. Estimated unreported catch (1.7 tonnes in 2018) is not included.

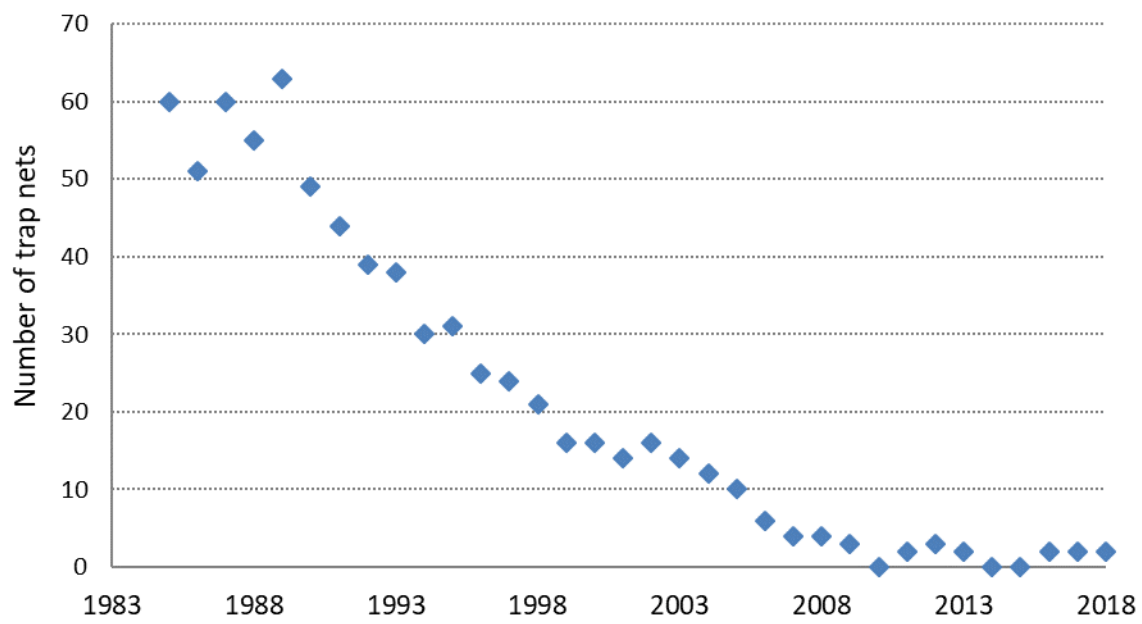

Figure 2. The number of trap nets in use at the Swedish west coast in 1985-2018

Angling in rivers has steadily increased its proportion of the total catch since the 1990's, with the exception of the early 2010's (Figure 1). The harvest in the rivers (rod and line) in 2018 was approximately 14.8 tonnes. Unfortunately, few effort data is available, e.g. number of fishing permits, number of fishermen or fishing hours. Swedish legislation does not permit mandatory reporting of catches from non-commercial fishermen. This is becoming an increasing problem, as improved fisheries statistics would improve stock assessment and national management, especially for the low status stocks.

The total unreported harvest of Atlantic salmon in Sweden, also including non-commercial fishing on the coast, in the year 2018 was guesstimated to be 1.7 tonnes or about 10 % of the national harvest. Included in this is occasional harvest of salmon with rod and line on the coast as well as harvest of salmon with gill nets by non-commercial fishermen. In River Rolfsån, fishing with gill nets is allowed due to immemorial usage. Only a few persons utilize this opportunity to fish in their part of the river. No catch data are available, so this fishery represents an unreported catch. As can be seen below (Table 5) the status of the stock in River Rolfsån is poor, and immediate management actions are required.

The sport fishing harvest of wild salmon in rivers (without stocking of reared salmon) has since the late 1980 has been 500-3000 salmon, with the lowest harvest in 1980-82 (Figure 3). The catch in 2018 was in total 2139 wild individuals (i.e. also including catch of wild salmon in rivers with stocking of reared smolt).

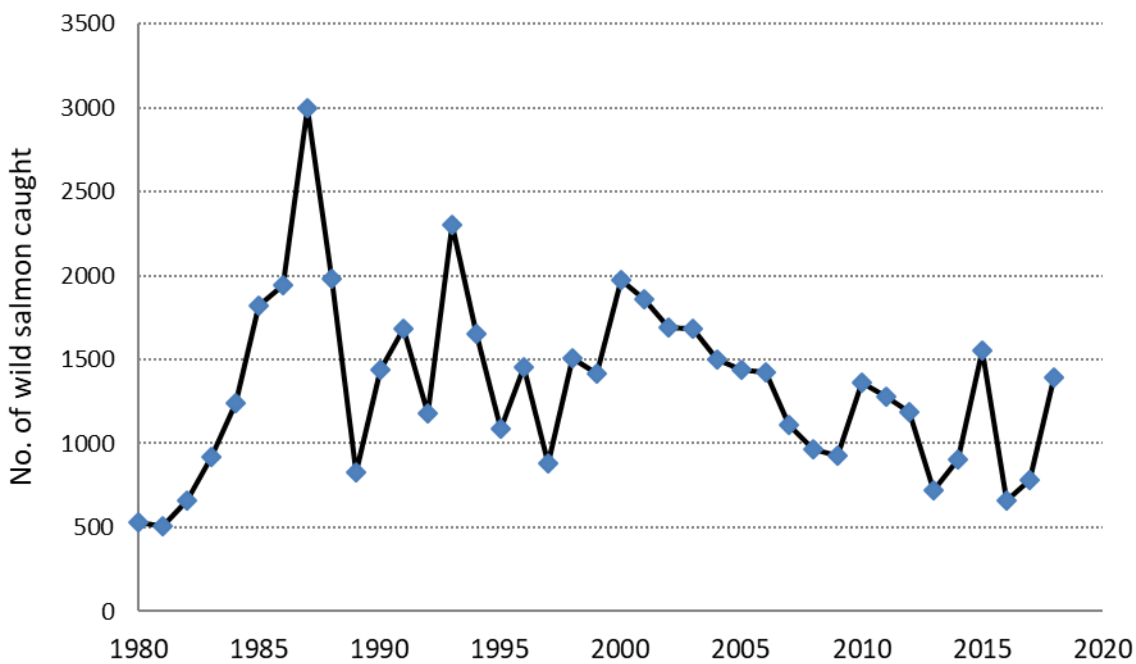

Figure 3. Reported harvest in numbers of wild Atlantic salmon in 1980-2018 in sport fishing in 15 major rivers without stocking of reared smolt.

2.2 Catch and release

Catch and release (C&R) is generally only carried out in rivers with wild salmon (with adipose fin), whereas people fishing in rivers with reared salmon generally do not release caught fish back. C&R is voluntary and there is no total statistics of the magnitude. Although a thorough statistics is lacking, the few years of data we have show that the C&R proportion has increased over time. In 2018 the C&R would have added 19 % in numbers to the total harvest (but looking only at wild salmon the figure was 27 %).

2.3 Stocking of reared salmon

As stated above releases of reared salmon smolts are performed annually in three rivers. In 2018 approximately 167,000 reared smolts were released (Table 1). Of these 75 % were 1 year old. During the period 2000-2018 the average number of released reared salmon smolt annually has been approximately 170,000 (Figure 4). The releases in Rivers Nissan and River Göta älv, are considered enhancement stockings (i.e. some of the reared fish may return and spawn), while releases of smolt in River Lagan are considered ranching (only for fishing, not stock enhancement). In River Lagan, there is no spawning areas left in the main stem, and the proportion of reared salmon that enters the tributary Smedjeån is considered low. At the WGNAS meeting in 2014 it was decided to define the catches of stocked salmon (without adipose fin) in River Lagan as ranched catch.

Table 1. Number of released reared Atlantic salmon smolts in 2018 in Sweden.

River	1 year old	2 year old	Grand total	Strain; Purpose
Lagan	69,574	24,944	94,518	Lagan; Ranching
Nissan	30,040	0	30,040	Lagan; Enhancement
Göta älv	25,050	17,040	42,090	Tributary Säveån; Enhancement
Total	124,664	41,984	166,648	

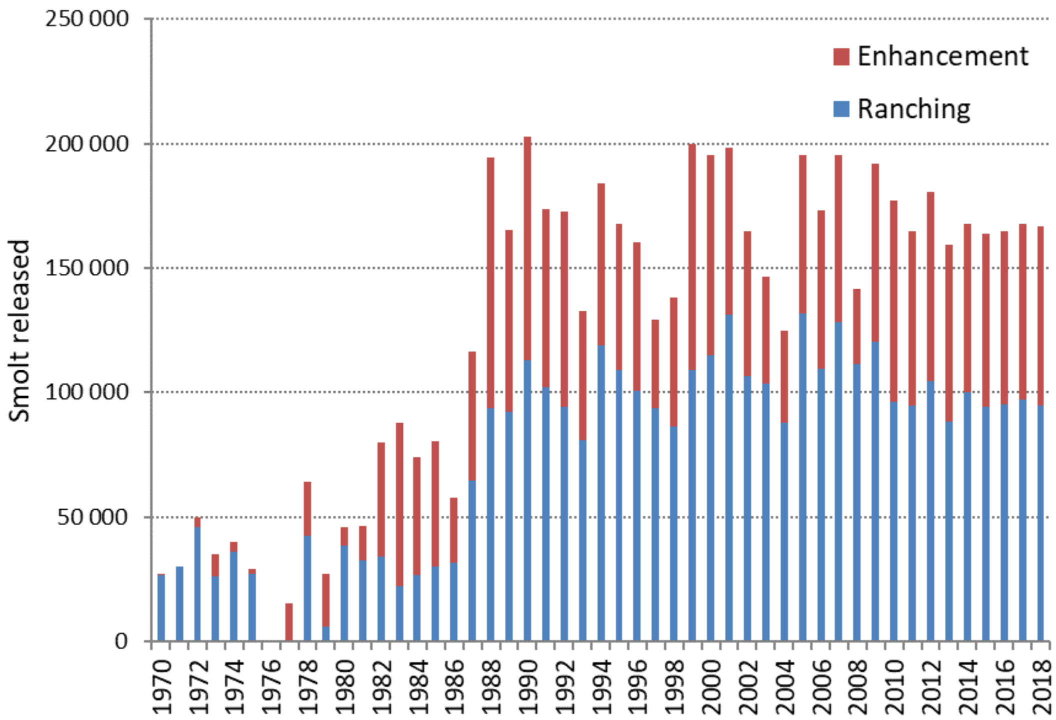

Figure 4. Number of released reared Atlantic salmon smolt (1-2 yrs old) 1970-2018 in rivers on the Swedish west coast. Ranching is practiced in River Lagan and the remaining releases are considered enhancement stocking.

2.4 Catch composition – wild or reared?

Farming of salmon (aquaculture) is not carried out in Swedish waters. Fish that originated from reared salmon smolts (i.e. without adipose fin), released as part of programmes to compensate for hydropower development (ranched and enhanced stocks), made up 46 % of the total harvest weight in the year 2018 (Table 2). The average proportion of reared salmon 2002-2018 has been circa 64 %. As more of reared smolt are released as 1 year old, the return rate from stocking is expected to drop. An evaluation of Carlin taggings from release of smolts 1992-2012 showed that 0.48 % tagged 1 year old smolt were reported and 0.84 % of 2 year old. During the same period the percentage of reported wild tagged smolt was 2 %. However, the return rate of Carlin tagged fish is lower than natural levels. The return rate could be compared with the mean survival from wild smolt to spawner in the index river - 10.5 %!

Table 2. Harvest (tonnes) of salmon separated by wild and reared origin (ranched and enhanced stocks), estimated from river catches in 2002-2018.

Year	Wild	Reared	Total	Prop. (%) reared
2002	11	17	28	61
2003	6	19	25	76
2004	7	13	19	68
2005	7	8	15	53
2006	6	8	14	57
2007	5	11	16	69
2008	4	14	28	78
2009	4	13	17	76
2010	7	15	22	70
2011	10	29	39	74
2012	10	20	30	66
2013	5	10	15	65
2014	11	19	30	65
2015	9	9	18	51
2016	4	5	9	53
2017	7	12	18	64
2018	9	8	17	46
Mean	7	14	21	64

2.5 Tags and fin-clips

In the index river (see section 4) up to 500 wild salmon smolts have been Carlin-tagged each year 1995-2017 (mean of 3000 annually 2006-2016). As from spring of 2018 pittags will be used instead. The number of Carlin-tagged reared smolt in 2018 was 0 (Table 3), and it is expected that these taggings (in River Lagan) will cease, ending a 66 year period if Carlin tagging (1951-2017).

Table 3. Tagged and fin-clipped Atlantic salmon in Sweden during 2018. All hatchery smolts are all fin-clipped.

Origin	Carlin-tag	Adipose clip	PIT tag	Total
Hatchery Adult	0	0	0	0
Hatchery Smolt	0	166,648	0	166,648
Wild Adult	0	0	0	0
Wild Smolt	0	0	218	218

2.6 Alien species

No pink salmon (*Oncorhynchus gorbuscha*) was observed in swedish west coast rivers in 2018 as it was in 2017 (Petersson et al., 2018).

A total of 385 rainbow trout (*Oncorhynchus mykiss*) passed the camera-equipped automatic Vaci-counter in Herting (River Ätran) in 2018, together with 6262 Atlantic salmon and 649 brown trout (*Salmo trutta*) (Data: Fiskevårdsteknik AB). Thus, the proportion of rainbow trout in ascending adult fish was 5.3%. However, in the reported catches in rivers, rainbow trout generally constitutes <1 % of the total catch. Rainbow trout may thus not be a problem for spawning fish, but there is always a risk of transfer of disease and parasites. As there are no pen-rearing facilities on the west coast the straying rainbows must come from inland stocking, or more probable from escapements from farms abroad.

2.7 Historical trends in harvest

Salmon fishery data from the dominating salmon fishery county of Halland is available from 1884 until today. During 1884-1899, the salmon harvest averaged 70 tonnes per year, but later decreased due to hydropower development in the salmon rivers (Figure 5). The further decline in harvest in 1965-1980 has been attributed to acidification of surface waters and increased high sea fishing. Since then freshwater survival of salmon parr has increased due to liming (Alenäs et al. 1995), but the harvest of salmon in 2018 constitutes only 13 % of the yearly catches before the 20th century. Since circa 46 % of the catch is reared salmon (Table 2) this means that the catch of wild salmon today is at only 7 % of the late 19th century levels.

Before the twentieth century, about half of the harvest was made in rivers. However, the harvest in trap nets and gill nets on the coast successively increased and from 1930 to 1980 virtually no harvest was registered in the rivers (Figure 5). Organised sport-fishing was comparatively low until the 1960s. From 1980 the harvest in rivers has increased due to increased interest in sport-fishing after large efforts to restore rivers through reducing nutrient laod, liming of acidified reaches, opening of migration routes and habitat restorations. Since 1985 the number of trap nets used on the coast has declined (Figure 2), allowing a greater proportion of the catch to be made in the rivers. In 2015-2018 all reported catch was from rivers.

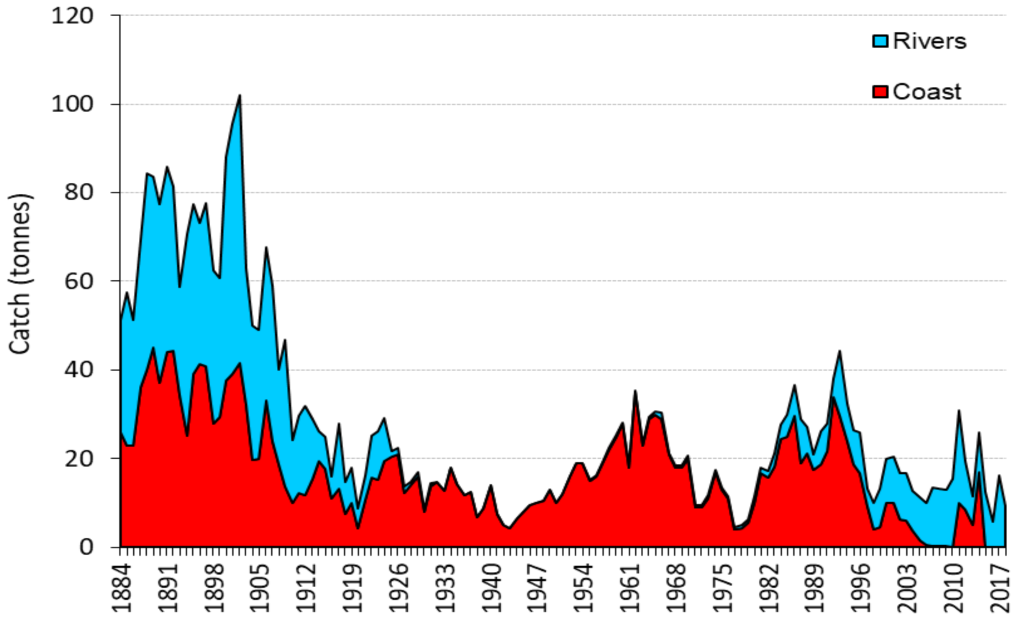

Figure 5. Total harvest (tonnes) of salmon (reared and wild) in the county of Halland 1884-2018 divided into catch in rivers and on the coast.

3. SEA AGE AND CONDITION FACTOR

3.1 Sea age

Scale reading from 1352 adult salmon caught 1997-2016 showed that most (70%) salmon left the river as smolts when they were 2 years old. This proportion has increased over time and in the most recent sample from 2016 (n=60) the proportion of salmon leaving the river as 2yr old smolts was 87 %.

The proportion of Multi Sea Winter (MSW) fish in catches has increased significantly during 1971-2017 (Figure 6), possibly indicating a successively longer time required to reach maturity at sea. In years with high productivity in the sea, more salmon may return to spawn already as 1SW. The proportion of 1SW increases with latitude in Europe, i.e. the shorter distance to the major growth area in the Norwegian Sea, the more salmon may return to spawn as 1SW. In 2018 the proportion of 1SW in the total Swedish harvest was 47 %.

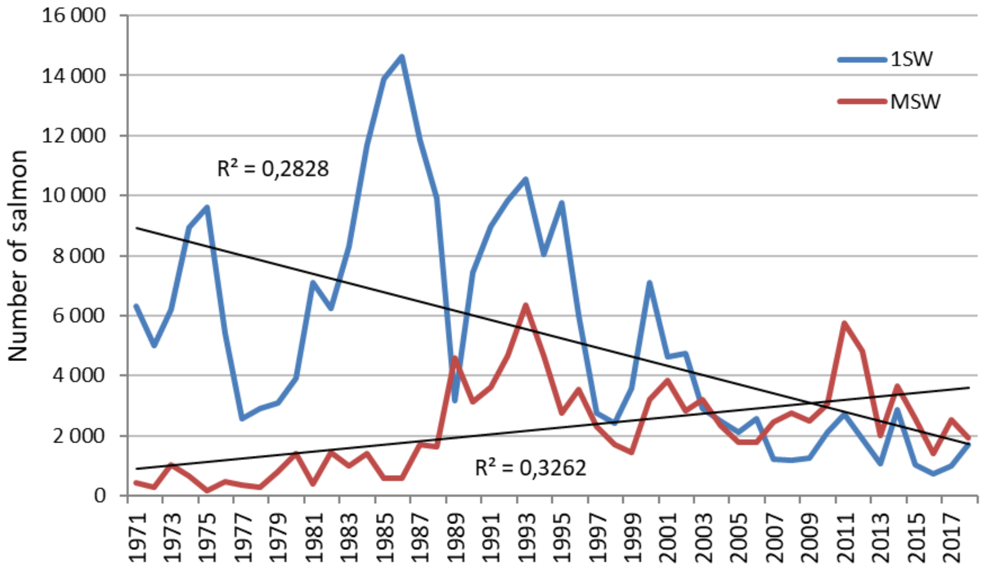

Figure 6. Number of salmon (wild & ranched) in the total Swedish harvest divided into 1SW (grilse; blue) and MSW (red) salmon during 1971-2018.

3.2 Condition of returning spawners

Using only salmon caught in sport-fishing where both length and weight had been measured, the mean Fulton condition factor was calculated for catches during March-September in 1998-2018. The number of salmon included for each year was circa 500-3000. During 2005-2006 the condition factor of returning grilse, and to a lesser extent also MSW, was noticeably low (Figure 7). Years when the catches have been lower, the condition factor has also been lower (data shown in national reports from 2014 & 2015). This indicates that years with low condition factor the number of returning salmon is lowered, i.e. the condition factor is a good proxy for sea survival. Since 2006, the condition factor of grilse has increased, while this index for MSW fish remained around one.

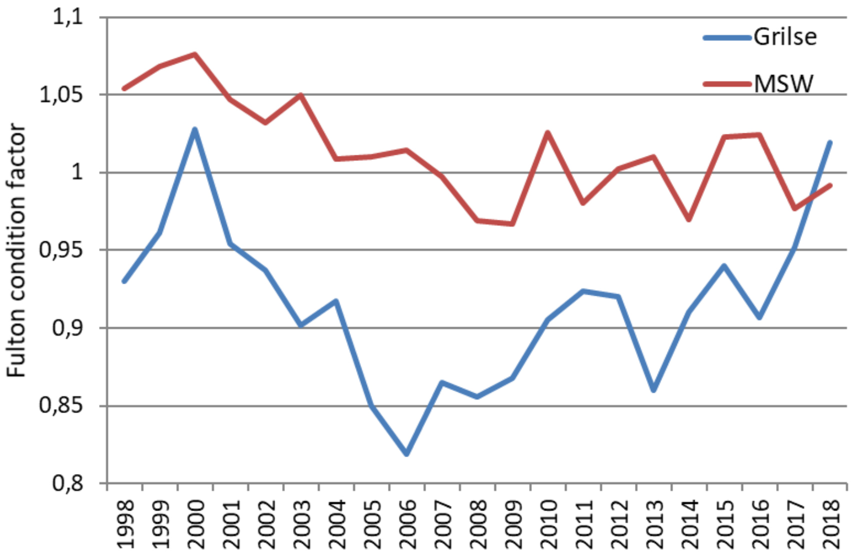

Figure 7. Mean Fulton condition factor, a proxy for sea survival, for adult Atlantic salmon caught in sport-fishing in rivers during March-September 1998-2018 (n= 30 076 individual fishes).

4. INDEX RIVER

There is one index river, River Ätran, where a smolt count is available from a partial smolt trap (Wolf type eel trap) in the major tributary Högvadsån (catchment area 476 km^2, average flow 11 m^3/s, 21.5 hectares of salmon habitat). The trap only catches a proportion (roughly 24 % depending on flow and temperature) of all descending smolts. Estimating the relation between catch efficiency and flow has proven difficult, but it is today possible to calculate the total smolt run with sufficient accuracy. The smolt production has averaged 6484 (302 smolt/ha) annually 1954-2018 (Figure 8). Smolt production in the river was low during the 1970s before liming started in 1978. The smolt run in 2018 was estimated to 3168 (147 smolt/ha), only 49 % compared to the average for 1954-2018.

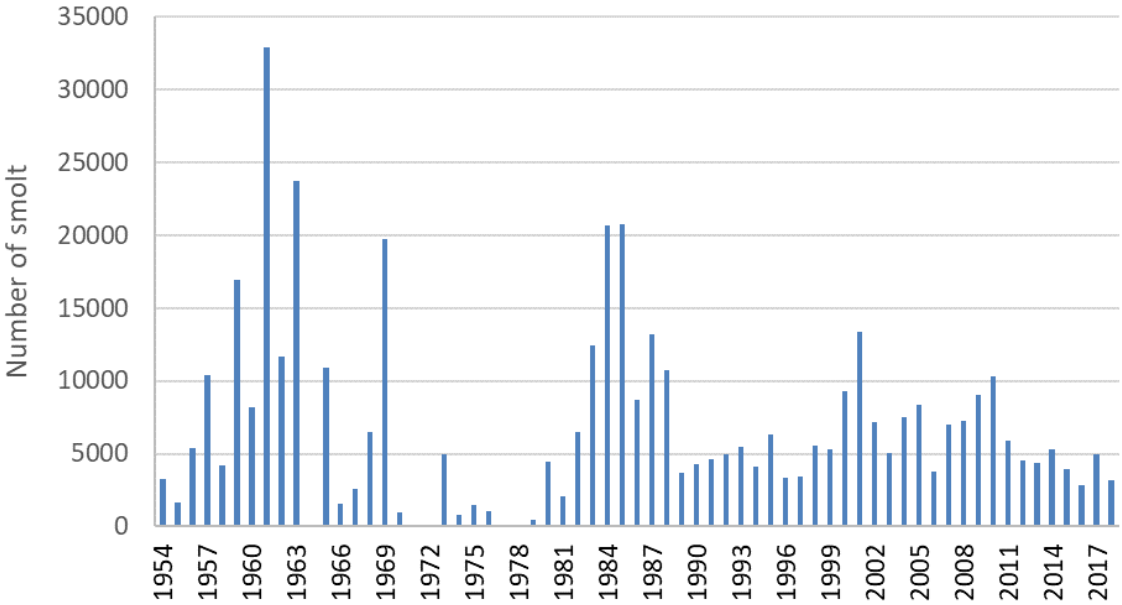

Figure 8. Estimated numbers of Atlantic salmon smolts at the trap in the tributary Högvadsån (Index River), River Ätran system 1954-2018. Numbers are adjusted for the catch efficiency of the trap. The trap was out of operation or malfunctioning in 1964, 1971, 1972, 1977 and 1978.

The number of ascending adults caught in the spawner trap in Högvadsån is also biased, as individuals may pass beside the trap at certain water levels. During 2014, the efficiency was estimated by combining ground data with a Bayesian approach and the catch efficiency was estimated to approximately 61%, depending of flow and temperature. The mean number of spawners has been 682 (32/ha) in the years 1954-2018 (Figure 9). Low returns the years 2005-2009 and 2013 corresponds well to low condition factor of returning fish in those years (compare Figure 7). The spawner run in 2018 was estimated to 897 individuals (329 1SW and 568 MSW). The MSW fish returned earlier than the 1SW fish, with a peak of returning fish in June, while the return of 1SW fish had a peak in August (Figure 10).

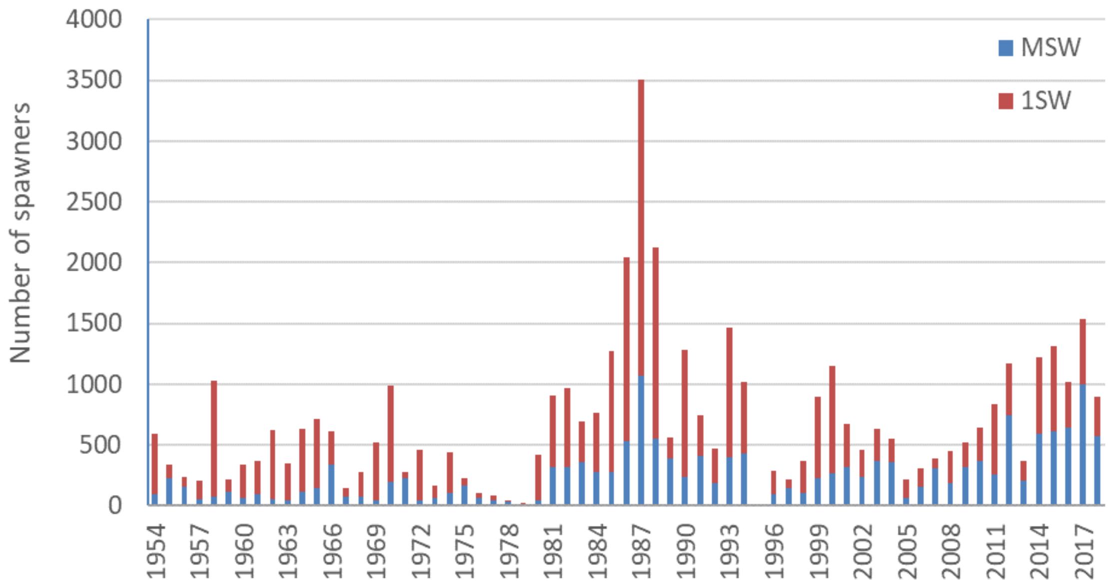

Figure 9. Ascending adult salmon (spawners) caught in the trap in the tributary Högvadsån in 1954-2018. Numbers are corrected for catch efficiency. Data is lacking for 1995. The spawning run in 1970-1979 was affected by acidification.

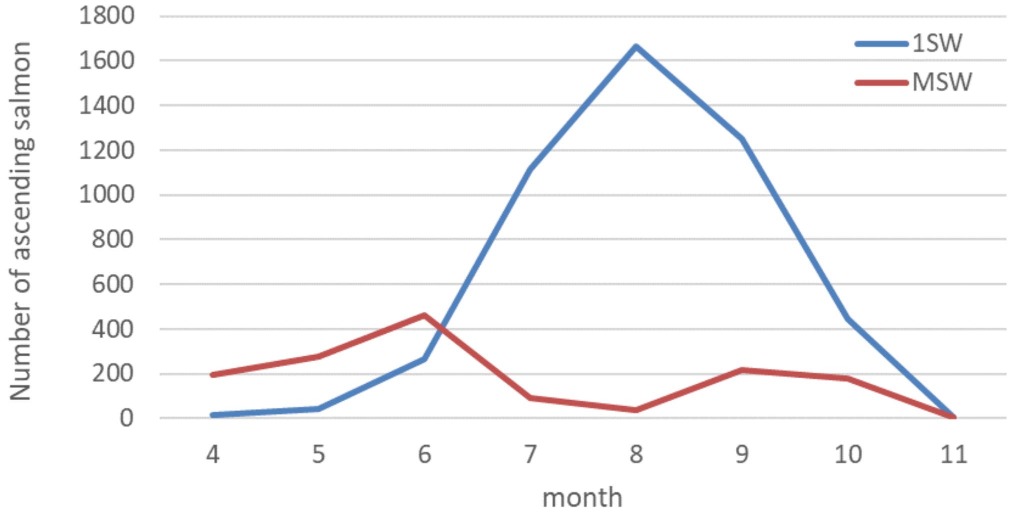

Figure 10. Ascending adult salmon (spawners) registered in the camera-equipped automatic Vaci-counter in Herting 2018, divided into 1SW and MSW fish. Data: Fiskevårdsteknik AB.

5. STATUS OF STOCKS

5.1 Estimated smolt production of Atlantic salmon

Atlantic salmon reproduces in 24 main rivers (311 hectares of nursery areas), several of them very small, on the Swedish west coast, but in River Bäveån there is presently no reproduction due to hydropower production (but new fishways are planned). A few salmon are also reproducing in small streams like Taske å, Kärraån and Anråsälven, but the production is insignificant and not included in the assessment.
The smolt production is not measured directly in all rivers, but applying the mean smolt production estimated in the index river (348 smolts per hectare) to the total amount of nursery

area, the total production is estimated to be about 100 000 salmon smolts annually. Applying the mean survival from smolt to spawner from the index river (10.5 %), this would result in ca 10,500 returning spawners each year.

5.2 Parr densities in monitored rivers

Electrofishing, by wading, is carried out to quantify the populations of parr in the spawning and nursery areas, giving a quantitative estimate of spawning success and parr population size. Annually 14-20 of the 24 salmon rivers are sampled, most at multiple sites. All data are reported to the Swedish Electrofishing RegiSter (SERS) at the Swedish University of Agricultural Sciences.

The electrofishing monitoring has shown a general decline in both fry (0+) and parr (>0+) densities (Figure 11) up until 2011, but during 2012-2018 there was an increase in fry densities. Parr densities did not show a corresponding distinct increase these years (Figure 12). During 2018, fry densities dropped slightly while parr densities increased, compared to 2017. This is mainly due to low flows during the electrofishing season (August; see section 9). During episodes of extreme low summer flow fry tends to decrease in abundance and parr to aggregate in areas with more water flow. Data from 2018 should thus be treated with care.

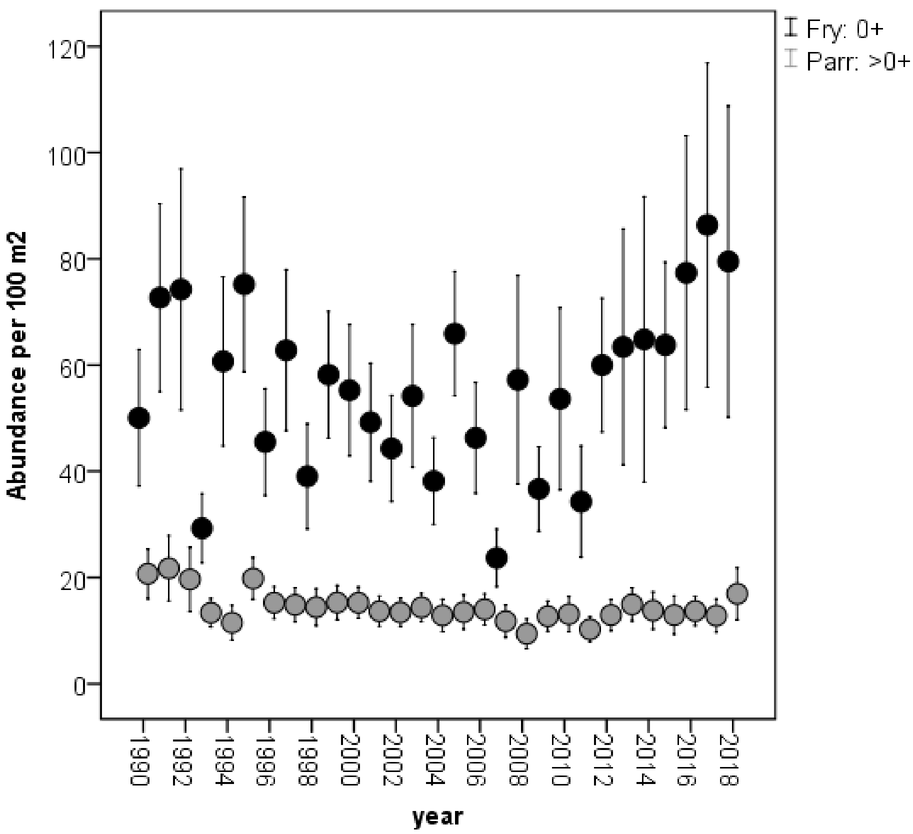

Figure 11. Mean (with 95% confidence interval) salmon fry (0+) and parr (>0+) abundance (no. per 100 m^2) of 23 salmon rivers (189 sites, 2482 fishing occasions) on the Swedish west coast in the period 1990-2018. Data from the Swedish Electrofishing RegiSter (SERS).

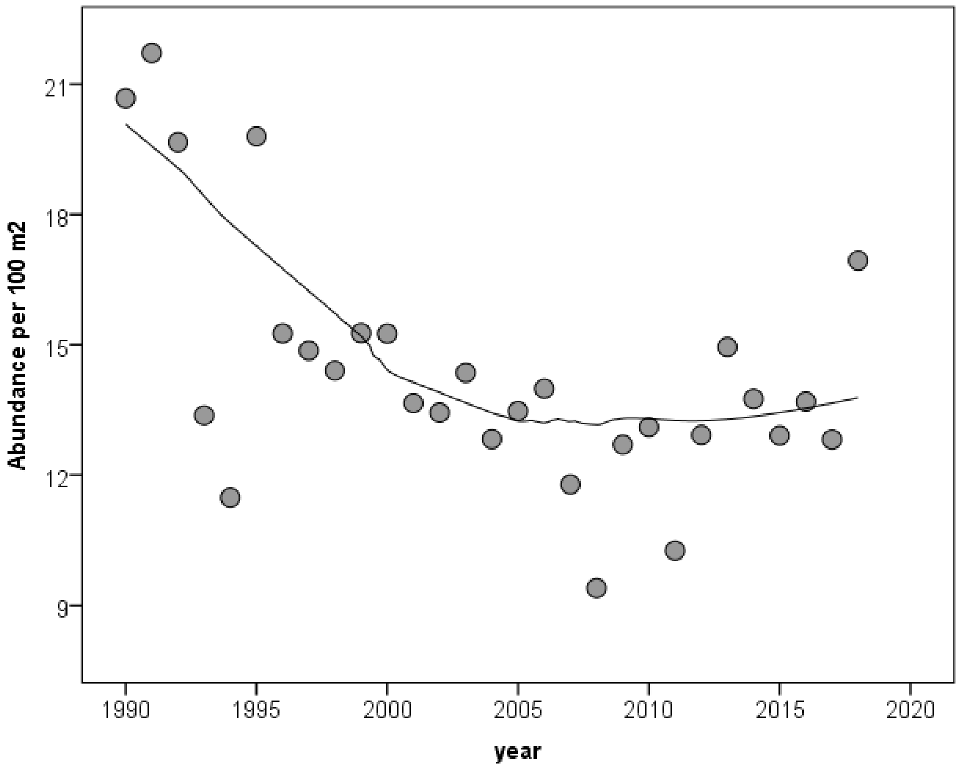

Figure 12. Mean salmon parr (>0+, pre-smolts) abundance (no. per 100 m^2) of 23 salmon rivers (189 sites, 2482 fishing occasions) on the Swedish west coast in the period 1990-2018 (same data as in Figure 12). Trend line fitted with Loess regression (80% fit).

This lowered recruitment of salmon (parr abundance) 1990-2011 was in spite of substantially reduced marine fishing, and in spite of extensive and successful liming programmes, riverbed restorations and establishment of new and improved fishways. But, without these management and restoration efforts the salmon stocks would have been considerably smaller.

5.3 Compliance with CL's

River specific CL's (Conservation limits) have been established (Tamario & Degerman 2017), where the stock status for each river is assessed using electrofishing data (abundance of parr; >0+). CL's has also been established for the required number of ascending salmon in the index river, but there are too few other rivers with automatic fish counters available to utilize this reference point at present.

Using electrofishing data, salmon habitat quality at each site is classed in nine categories (salmon habitat index; values from 0 to 8) using depth, water velocity, dominating substrate and wetted width (Degerman unpublished). Sites with a habitat quality below 5 are not included in the evaluation of status.

Where at least three sites/fishing occasions are available for a river a specific year the mean of parr >0+ (pre-smolt) density was calculated. If fewer data are available for a specific river, also data from the previous years are included until at least three observations are available. But, only rivers electrofished in 2017-2018 are initially included in the evaluation. Data from previous years may at most comprehend a period of 5 years, i.e. 2014-2018, to avoid using old data.

Stocks considered to have good reproductive capacity must have a mean abundance above 10 parr/100 m^2 (the CL suggested by Tamario & Degerman 2017), and at most 2.5% of the data (2.5%-c.i.) were allowed to be below 10. Rivers with a mean above CL, but with more than 2.5% of individual data points below CL were assigned to the group “risk of reduced productive capacity”. Rivers with a mean below CL were assigned to the group “reduced productive capacity”.

Using the period 2014-2018 data was available from 23 rivers (out of 24) with tributaries (these are not shown separately in this report). With the suggested method for setting and evaluating stock status, 7 (30.4 %) stocks were found to have good reproductive capacity, 8 (34.8 %) had risk of reduced and 8 (34.8 %) had reduced reproductive capacity (Table 5).

Table 5. Compliance of Conservation limits for individual rivers evaluated from electrofishing data (n) using salmon parr (>0+) (see Tamario & Degerman 2017).

River	Data n	Status	Mean	Lo95%	Hi95%
Stensån	26	Good	21,296	16,680	25,912
Himleån	21	Good	25,176	16,057	34,295
Örekilsälven	52	Good	20,585	14,795	26,374
Ätran	80	Good	16,748	11,842	21,653
Bratteforsån	5	Good	24,280	10,762	37,798
Genevadsån	25	Good	13,260	9,956	16,564
Göta älv tributaries	32	Good	16,850	9,945	23,755
Kungsbackaån	25	Risk	22,044	9,682	34,406
Lagan	10	Risk	13,350	8,425	18,275
Viskan	14	Risk	14,193	7,613	20,773
Rönne å	22	Risk	12,209	7,046	17,373
Strömsån	8	Risk	10,288	4,467	16,108
Löftaån	6	Risk	13,767	4,389	23,145
Arödså	5	Risk	44,780	3,725	85,835
Anråseå	10	Risk	14,660	3,075	26,245
Nissan	27	Reduced	5,485	3,448	7,522
Fylleån	26	Reduced	6,104	3,173	9,034
Säveån	34	Reduced	3,282	1,449	5,116
Suseån	10	Reduced	5,980	1,146	10,814
Enningdalsälven	30	Reduced	2,943	,922	4,965
Anråsälven	6	Reduced	,750	,045	1,455
Rolfsån	13	Reduced	4,100	-,908	9,108
Törlan	1	Reduced	3,2		

6. GENETIC BASELINE

We have quantified the degree of genetic variation within and between salmon populations in 17 main rivers and their tributaries (in total 29 "subpopulations") along Sweden's west coast using 18 microsatellite markers. Clustring of populations was done using Neighbour-joing and pair-wise genetic distances (programme PHYLIP). Geographically close rivers were more similar, but the results showed clear genetic differences where salmon from all rivers, with sufficient number of samples, were genetically separated.

Structure software shows the populations primarily can be divided into two main genetic clusters, a northern and a southern (Figure 14). The "southern cluster" consists of populations from Rönneå to Viskan, but also includes Kungsbackaån, while the "northern cluster" consists of rivers from Rolfsån to Enningdalsälven. The northern group are rivers in the Skagerrak area, and the southern group from the Kattegatt area.

The second most likely division is four clusters, which also corresponds to the phylogenetic dendrogram (Phylip, Figure 15). In this case, Göta Älv with tributaries (pink) separates from the rest of the northern cluster (yellow). Solbergsån is geographically closest to Göta älv but genetically closer to the other rivers. The southern group also split in two clusters where Lagan and Nissan forms a separate cluster as the Nissan stock has been re-established using Lagan stock. Kungsbackaån is a mixture of three different clusters (Figure 14) as the Kungsbackaån stock has been lost in the past and naturally re-established itself and could hence not be assigned to any specific cluster.

Figure 14. The genetic structure of the 29 subpopulations of Atlantic Salmon along the Swedish west coast (result from the programme STRUCTURE).

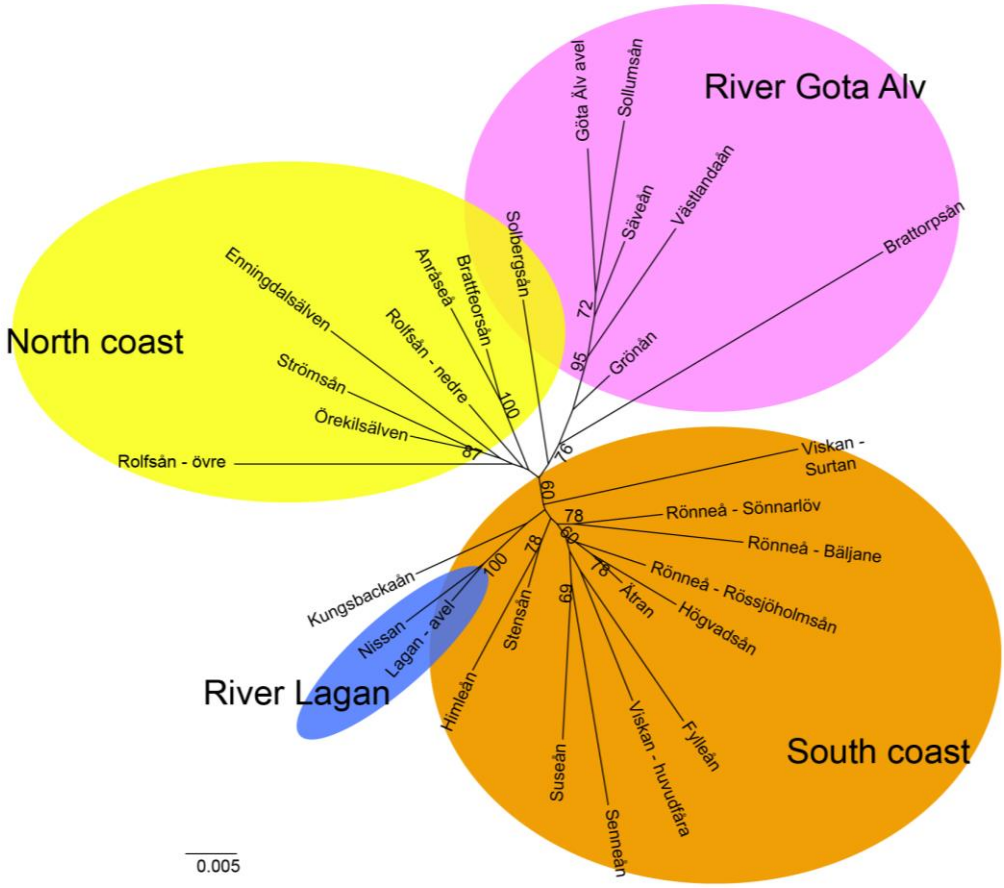

*Figure 15. Dendrogramme showing the four genetic clusters (*STRUCTURE K=4*) of Atlantic salmon along the Swedish west coast. River Lagan and R. Göta älv are the two largest rivers, and both have stocking of reared smolt to compensate for hydropower production.*

7. GYRODACTYLUS SALARIS

Due to the spread of the ectoparasite *Gyrodactylus salaris* a monitoring programme was launched 2001 (Degerman et al. 2012a). At present only 8 out of 24 rivers are uninfected. All uninfected rivers are in the northern part of the Swedish west coast, i.e. in the Skagerrak Sea close to Norway. It is suggested that northern stocks may be more sensitive to *G. salaris* as they are isolated from southern stocks (and the Baltic) by high saline ocean waters with >30 PSU, as compared to circa 20 PSU in the southern part of the Swedish west coast. The Swedish authorities consider *G. salaris* to be a great threat to remaining uninfected stocks, and also to nearby Norwegian stocks. Protective measures have been undertaken to avoid spreading the parasite, e.g. ban on stocking salmonid fish in the whole catchment of not infected rivers.

Lowered abundance of the salmon population in River Ätran coincided with the first detection of the parasite in the river system (Alenäs et al. 1998), but there has been a general decline of salmon along the Swedish west coast, also in unaffected rivers. The Gyro-monitoring programme was evaluated in 2011. The results showed that although individual parr with many parasites will have impaired growth and die; no effects can be seen at the population level according to our large scale electrofishing surveys (Degerman et al. 2012b). Comparing the parr abundance before infection with *G. salaris* with after and comparing with the abundance of reference sites in uninfected rivers showed no significant differences. The trend (Pearson r) in parr abundance over time was compared with Meta-analysis between infected rivers and reference rivers. The trend did not differ. However, it is expected that *G. salaris* may have an impact at the population level when salmon is stressed by other causes, or when the population abundance is high. Continued monitoring is therefore prioritized.

The Norwegian Veterinary Institute (Haakon Hansen & Johannes Rusch) has developed an eDNA-method that can be used to detect not only the parasite *G. salaris*, but also its two main hosts: Atlantic salmon and rainbow trout. This was tested successfully in northwestern Russia and on the Swedish west coast during autumn 2018. The results will be presented at the NASCO meeting 2019 in Tromsö, Norway.

8. DISEASE OUTBREAKS

Since 2014, an increasing number of reports from fishermen and local administrators of dying or dead salmon have come from Swedish east coast salmon rivers emptying into the Baltic Sea. The affected salmon have displayed various degrees of skin damage, from milder erythemas and bleedings to UDN-like lesions and severe ulcers and traumatic wounds, typically followed by secondary fungal infections causing death (SVA 2017). The disease prevalence has varied considerably between both rivers and years and the cause is still unknown. The Swedish west coast has been largely unaffected by disease outbreaks, but in 2018 many reports of fish with severe fungal infections came in to the National veterinary institute (SVA). The fungal infection is probably caused by Saprolegnia sp. and is likely a secondary infection following some other infection or injury, but could also be the primary infection. It should be noted that the summer of 2018 was extremely warm and with low flows (section 9), probably stressing salmon. Skin damages like the ones on the east coast has been reported on the west coast, although some mild UDN-like lesions and red vent syndrome (possibly caused by the parasite *Anisakis simplex*) has been identified. It is unknown if it is the same type of infections or cause of infections on the west coast as in the Baltic.

9. FLOWS AND TEMPERATURES

The summer of 2018 was extremely warm and with low flows. Temperature was recorded daily at the spawner trap in the index river, but also in River Säveån as this stock has decreased (see Table 5) and the cause, beside lowered sea survival, is not known. The temperature was measured with data-loggers from the 5th of July to the 14th of November 2018, and compared with the average water temperature at the site (the outlet of Lake Aspen). The average temperature was calculated for the period 1999-2018 with data from SMHI (Swedish Meteorological and Hydrological Institute). In 2018, the water temperature was on average 3 ^{o}C higher during the period, with 36 days in a row with water temperatures above 20 ^{o}C (Figure 16).

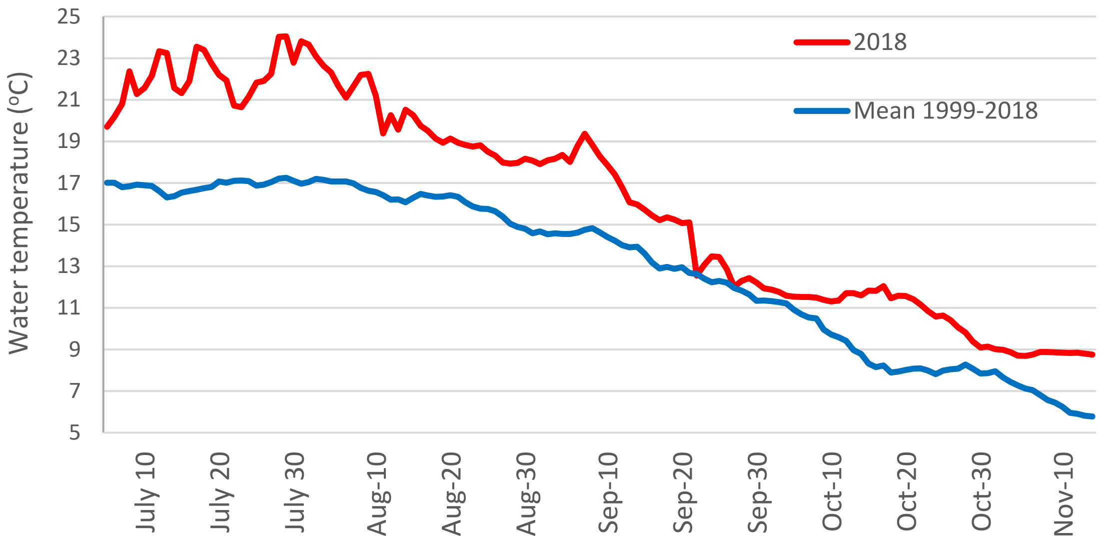

Figure 16. Water temperature at the outlet of Lake Aspen in River Säveån. Blue line=2018, red line=mean 1999-2018.

The high water temperature was accompanied by extremely low flows in all salmon rivers on the west coast. Here we exemplify this with the situation in the index River Högvadsån. Normal low flows during June to August are 4.6-6.0 m^3/s, which can be compared to 0.28-0.76 during 2018 (Figure 17). As a result, the upper parts of the river were dry at the end of July (Figure 18). Flowing water sections could be found where larger tributaries ran into the main stem. In the lower parts of the river no dry reaches occurred.

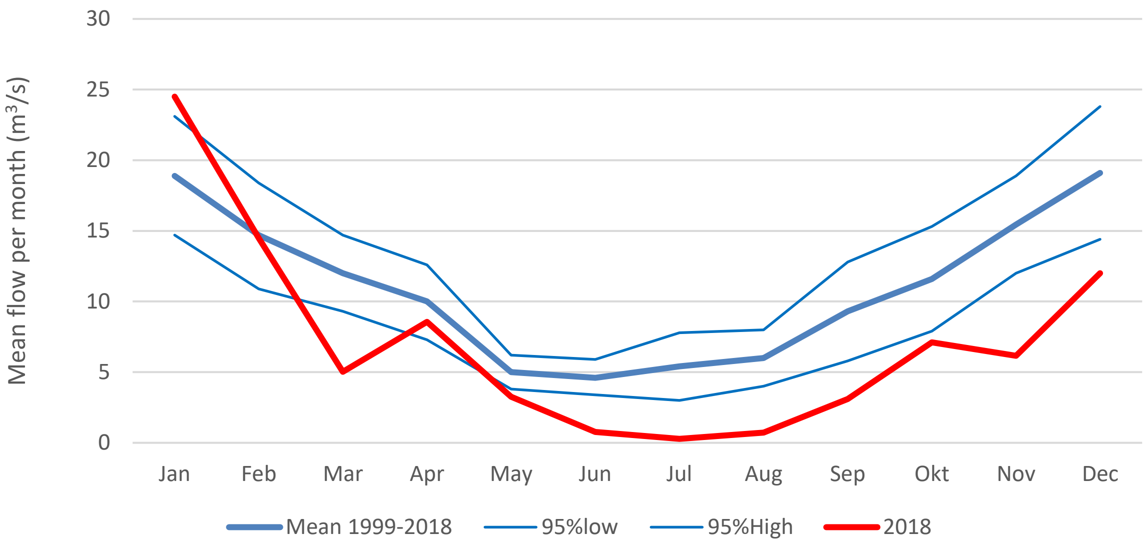

Figure 17. Mean monthly flow in the index River Högvadsån comparing 2018 with the mean of the period 1999-2018 (Data: SMHI (Swedish Meteorological and Hydrological Institute)).

Figure 18. Upper parts of the index river Högvadsån were dry at the end of July (the picture is from 31st of July just upstream the outlet of tributary Fagerredsån). Photo: Hans Schibli.

10. FISHERY MANAGEMENT

In 2013 a national implementation plan for the management 2013-2018 according to NASCO requirements was established.

10.1 Present fishing regulations

The Swedish national regulation of the Atlantic salmon fishing has been altered successively. In 2012 a ban on special type of gill nets (krokgarn) was implemented in the Idefjord area in cooperation with Norway. Certain rules apply to this area, which are not mentioned here.

From 2013 fishermen, commercial and non-commercial fishermen, may only use a maximum of six gill nets (maximum length 180 m, max. height 3 m) in shallow (<3 m) coastal waters. The allowed mesh size is 120 mm.
Gill nets are allowed from the 1st of May to the 30th of September in shallow (<3 m) coastal areas. This is to avoid catching spent or undersized sea trout early in spring and pre-spawners in autumn.

From 2014 there is a ban on gill net fishing aimed at salmon in deeper (>3 m) coastal waters to avoid mixed stock fishing. Trap nets are allowed but operating under a license system, where permits normally are not renewed.

The minimum allowed size of landed salmon (and sea trout) is 45 cm in the sea and in rivers (40 cm in the Idefjord area). Protected estuarine areas are established outside all salmon rivers and outside 118 smaller trout streams. In these areas fishing with gill nets or other passive gear is prohibited, whereas rod-and-line fishing is allowed. In some areas, where river mouths are close by one another, the protected areas have been joined forming larger units.

The salmon and trout fisheries are closed from 1st of October to 31st of March on the coast and in rivers. In southern rivers with large releases of reared salmon fishing may continue until 14th of October, and the season may open 1st of March. During March normally only sea trout (*Salmo trutta*) are caught in rivers.

Fishing for salmon or trout with trap or gill nets is not allowed in rivers and lakes, except in River Rolfsån where a few private fishing right owners are allowed to use gill nets due to immemorial usage.

From 2014 there is a bag limit on rod and line fishing of two salmonids per person and day for anglers (rod-and-line). This will have little effect on the total catch of salmon, whereas the catch of sea trout may decrease by 10 %.

Fishing rights in rivers are privately owned, but often fishing right owners have formed a fishing association (fiskevårdsområde) with joint local management for each river, or sometimes only a part of the river. Generally, local fishing rules (byelaws) are applied in rivers beside the national legislation. Often these rules may be bag limits, ban on landing female salmon from 1st of August, and a maximum number of fishing licenses sold per day. In River Örekilsälven the fishing association has determined that the open season is 1½ months shorter than allowed according to national rules.

Starting in year 2005 all reared salmon and sea trout smolts must have their adipose fin removed (fin-clipping) before release.

10.2 Restoration & liming

As from 1976 an intense liming programme is carried out to counter-act salmon mortality due to low pH and high levels of aluminium. Most (18 of 24) of the rivers or tributaries to rivers are included in the liming programme. It has been estimated that circa 50-75 % of the wild salmon smolt production would be lost without liming (Appelberg et al. 1989, Degerman & Schibli 1998).

During 2013-2018 river restoration projects were active in several rivers. A large restoration project in River Rolfsån aims at letting the Atlantic salmon again reach the upper reaches which have been inaccessible since 1909. In River Ätran one of the two lower most parallel power plants was eliminated in 2014, leaving half of the old river free for passage of fish. In River Säveån a fishway was built at Hedfors in 2015, the largest bypass fishway in Scandinavia. In some of the smaller rivers habitat restoration projects have been carried out. New efforts are planned in River Rönneå where the three lowermost dams will be removed, in River Örekilsälven where an improved fishway is planned at Torp and in River Bäveån fishways are planned restoring the salmon population.

However, the Swedish government has implemented a new water legislation for 2019 that will prioritize hydropower production in rivers over environmental consideration. All watersheds will go through a screening and measures deemed appropriate will be carried out, but only if they does not substantially affect hydropower production. Large scale hydropower production is prioritized, so measures are more likely in small rivers. The effect of this is not known, but there is a plan produced for when the environmental screening will be carried out. Looking at rivers with low reproductive status (Table 5) environmental screening is scheduled for the year 2021 in Enningdalsälven, 2022 in Bäveån and Suseån, 2023 in Rolfsån and as late as 2032 in Nissan.

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Appendix 1. Data to WGNAS

Tables 2.1.1.1. Nominal catch (tonnes) and numbers.

Harvest in numbers

Ranched = Sportfishing (reared) & brood stock catch in River Lagan

Wild=Other catch in rivers and on the coast + brood stock in R. Göta älv (enhancement)

	Total		Whereof Wild		**Ranched**		*Ranched*
Year	1SW	MSW	1SW	MSW	1SW	MSW	*prop. (%)*
1971	6330	420	6220	254	110	166	*4*
1972	5005	295	4943	201	62	94	*3*
1973	6210	1025	6124	895	86	130	*3*
1974	8935	660	8870	563	65	97	*2*
1975	9620	160	9620	160	0	0	*0*
1976	5420	480	5420	480	0	0	*0*
1977	2555	360	2453	206	102	154	*9*
1978	2917	275	2903	254	14	21	*1*
1979	3080	800	2988	661	92	139	*6*
1980	3920	1400	3842	1283	78	117	*4*
1981	7095	407	7013	284	82	123	*3*
1982	6230	1460	6177	1381	53	79	*2*
1983	8290	1005	8222	903	68	102	*2*
1984	11680	1410	11584	1266	96	144	*2*
1985	13890	590	13810	470	80	120	*1*
1986	14635	570	14415	240	220	330	*4*
1987	11860	1700	11450	1084	410	616	*8*
1988	9930	1650	9604	1160	326	490	*7*
1989	3180	4610	2803	4044	377	566	*12*
1990	7430	3135	6839	2249	591	886	*14*
1991	8990	3620	8599	3033	391	587	*8*
1992	9850	4655	9550	4205	300	450	*5*
1993	10540	6370	9468	4762	1072	1608	*16*
1994	8035	4660	7347	3628	688	1032	*14*
1995	9761	2770	8933	1528	828	1242	*17*
1996	6008	3542	5318	2507	690	1035	*18*
1997	2747	2307	2415	1809	332	498	*16*
1998	2421	1702	1953	1000	468	702	*28*
1999	3573	1460	3075	712	498	748	*25*
2000	7103	3196	5660	2546	1443	650	*20*
2001	4634	3853	3504	3026	1130	827	*23*
2002	4733	2826	3374	2075	1359	751	*28*
2003	2891	3214	1833	496	1058	2718	*62*
2004	2494	2330	1537	1528	957	802	*36*
2005	2122	1770	1503	1027	619	743	*35*
2006	2585	1772	1676	1069	909	703	*37*
2007	1228	2442	521	1001	707	1441	*59*
2008	1197	2752	615	1112	582	1640	*56*
2009	1269	2495	651	979	618	1516	*57*
2010	2109	3066	1111	1139	998	1927	*57*
2011	2726	5759	1460	3100	1266	2659	*46*
2012	1900	4826	1336	3130	564	1696	*34*
2013	1052	1996	874	1431	178	565	*24*
2014	2887	3657	2347	2797	540	860	*21*
2015	1028	2569	669	1553	359	1016	*38*
2016	742	1389	524	910	218	479	*33*
2017	1004	2674	574	1206	430	1468	*52*
2018	1712	2027	1418	1506	294	521	*22*

Harvest in tonnes (nominal)

		Whereof	
Year	**Total**	**Wild**	**Ranched**
1960	40	40	0
1961	27	27	0
1962	45	45	0
1963	23	23	0
1964	36	36	0
1965	40	40	0
1966	36	36	0
1967	25	25	0
1968	20	20	0
1969	22	22	0
1970	20	20	0
1971	18	17	1
1972	18	17	1
1973	23	22	1
1974	32	31	1
1975	26	26	0
1976	20	20	0
1977	10	9	1
1978	10	10	0
1979	12	11	1
1980	17	16	1
1981	26	25	1
1982	25	24	1
1983	28	27	1
1984	40	39	1
1985	45	44	1
1986	54	52	2
1987	47	43	4
1988	40	36	4
1989	29	25	4
1990	33	27	6
1991	38	34	4
1992	49	46	3
1993	56	44	12
1994	44	37	7
1995	37	28	9
1996	33	26	7
1997	19	15	4
1998	15	10	5
1999	16	11	5
2000	33	24	9
2001	33	25	7
2002	28	20	8
2003	25	15	10
2004	20	13	7
2005	15	9	6
2006	14	8	6
2007	16	6	10
2008	18	8	10
2009	17	7	10
2010	22	9	13
2011	39	20	19
2012	30	21	9
2013	15	10	4
2014	30	24	6
2015	16	9	7
2016	9	6	3
2017	27	17	10
2018	17	12	4

Tables 2.1.2.1. Numbers of fish caught and released in rod fisheries along with the % of the total rod catch (released + retained). Sweden.

2011	5 %
2012	6 %
2013	9 %
2014	15 %
2015	18 %
2016	17 % (in wild rivers 24 %)
2017	17 % (in wild rivers 32 %)
2018	19 % (in wild rivers 27 %)

Table 2.1.3.2. Estimates of unreported catches – Sweden.

2015	2.5 tonnes (10% of total catch)
2016	1.0 tonnes (10% of total catch)
2017	1.8 tonnes (10% of total catch)
2018	1.7 tonnes (10% of total catch)

Table 2.2.1.1. Production of farmed salmon in the North Atlantic area – Sweden

2015	No farming of salmon.
2016	No farming of salmon.
2017	No farming of salmon.
2018	No farming of salmon.

Table 2.2.2.1. Production of ranched salmon – Sweden

2015	6.614 tonnes.
2016	3.092 tonnes.
2017	9.586 tonnes
2018	4.139 tonnes

Table 2.7.1. Summary of Atlantic salmon tagged and marked – Sweden.

See table 3 above.

Origin	Carlin-tag	Adipose clip	PIT tag	Total
Hatchery Adult	0	0	0	0
Hatchery Smolt	0	166,648	0	166,648
Wild Adult	0	0	0	0
Wild Smolt	0	0	218	218

Table 3.1.3.1. Number of gear units licensed or authorized by country and gear type.

2015	2
2016	2
2017	2
2018	2

Table 3.1.6.1. Percentage (of numbers) of 1SW salmon in catches – Sweden.

2015	29 %
2016	35%
2017	27%
2018	46 %

Table 3.3.5.1. Status of spawner escapement by jurisdiction in the NEAC area in 2017 and compliance – Sweden (based on electrofishing – see section 5.3).

Using the period 2014-2018 data was available from 23 out of 24 rivers.

Status	Sum	Pct
Good reproductive status	7	30.4
Risk of reduced reproductive status	8	34.8
Reduced reproductive status	8	34.8
Total	23	100

Data for stock Annex

Number of wild salmon caught

1SW	1043
MSW	1096