National Salmonid Index Catchment
Erriff

Annual Report 2022

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Table of Contents

1 Scope

This document reports on research activities undertaken in the National Salmonid Index Catchment (NSIC) River Erriff during 2022. The document recounts the data recorded in the NSIC for this year, and sets it in the context of the long-term annual data time series collected as part of the core NSIC Erriff research programme. Summaries of specific research activities conducted in the relevant reporting year are also provided. More detailed and comprehensive information on methods used and outputs from specific areas of interest can be found in associated literature as this is made available. The research undertaken aims to address knowledge gaps on migratory salmonids to better inform fisheries management in Ireland as well as to inform national and international scientific advice provision and the reporting obligations of IFI.

2 Introduction

Inland Fisheries Ireland (IFI) is the statutory competent state agency responsible for the conservation, protection and management of wild salmonids in Ireland. As part of its obligations, it conducts extensive research on salmonids to inform the better management of these conservationally-important species. The River Erriff system has been designated as the National Salmonid Index Catchment (NSIC). A dedicated research station with fish counting and trapping facilities is located at Aasleagh Falls by the mouth of this prestigious Atlantic salmon and sea trout fishery which flows into Killary Harbour fjord on the Atlantic coast in the west of Ireland. The research facility is managed by IFI and supports a wide range of scientific research and monitoring activities principally on the resident salmonid populations and their migratory component as undertaken by the state agency and its national and international partners.

This work aims to contribute to developments in the scientific understanding of the biology, marine and freshwater ecology, life histories and population dynamics of Atlantic salmon and sea trout, and the effects of environmental and anthropogenic factors on their continued sustainability. In this regard, as an “index catchment” for salmonids, the Erriff acts as a representative model system to inform the better conservation and management of salmon and sea trout stocks throughout Ireland and further afield, meeting national and international obligations through the focused research activities described herein that are undertaken there.

Such obligations notably include providing scientific information on Atlantic salmon stock status for national assessments (for the Technical Expert Group on Salmon, North-South Standing Scientific Committee for Inland Fisheries, IFI, Department of Environment, Climate and Communications and Habitats Directive reporting) and international assessments (for the International Council for the Exploration of the Sea, the EU and North Atlantic Salmon Conservation Organisation). As such, the research activities aim to support EC Habitats Directive conservation objectives which are “to restore the favourable conservation condition of Atlantic Salmon” in Irish SACs.

3 Site description

3.1 Study area

The NSIC Erriff is located in Co. Mayo in the west of Ireland. It comprises the Erriff Catchment and Killary Harbour fjord area with research activities further extending out into the adjacent marine zone. The catchment comprises the Erriff River, a number of its tributaries such as the Black, Owenmore and Derrycraff rivers and main two lakes, Loughs Tawnyard and Glenawough, encompassing a total catchment area of 167.8 km^2. The river discharges into the Atlantic Ocean *via* Killary Harbour at Aasleagh Falls located at the innermost point of the fjord. The Harbour is 14 km long extending from townland of Aasleagh to the outer end of Inishbearna Island and has a maximum depth of 45 m. A commercial enterprise, Rosroe Salmon Farm, operates at two sites in Killary and surrounding waters, namely west of the pier in the village of Rosroe and on the eastern shore of Inishdeighil island outside the mouth of the Harbour. Extensive cultivated mussel farms also extend the length of the Killary along its south shore (Figure 1). The majority of the Erriff catchment is within the Mweelrea/Sheeffry/Erriff Complex Special Area of Conservation (SAC). Killary Habour is also bordered by the Twelve Bens Garraun Complex and Maumturk Mountains SACs on its southern side.

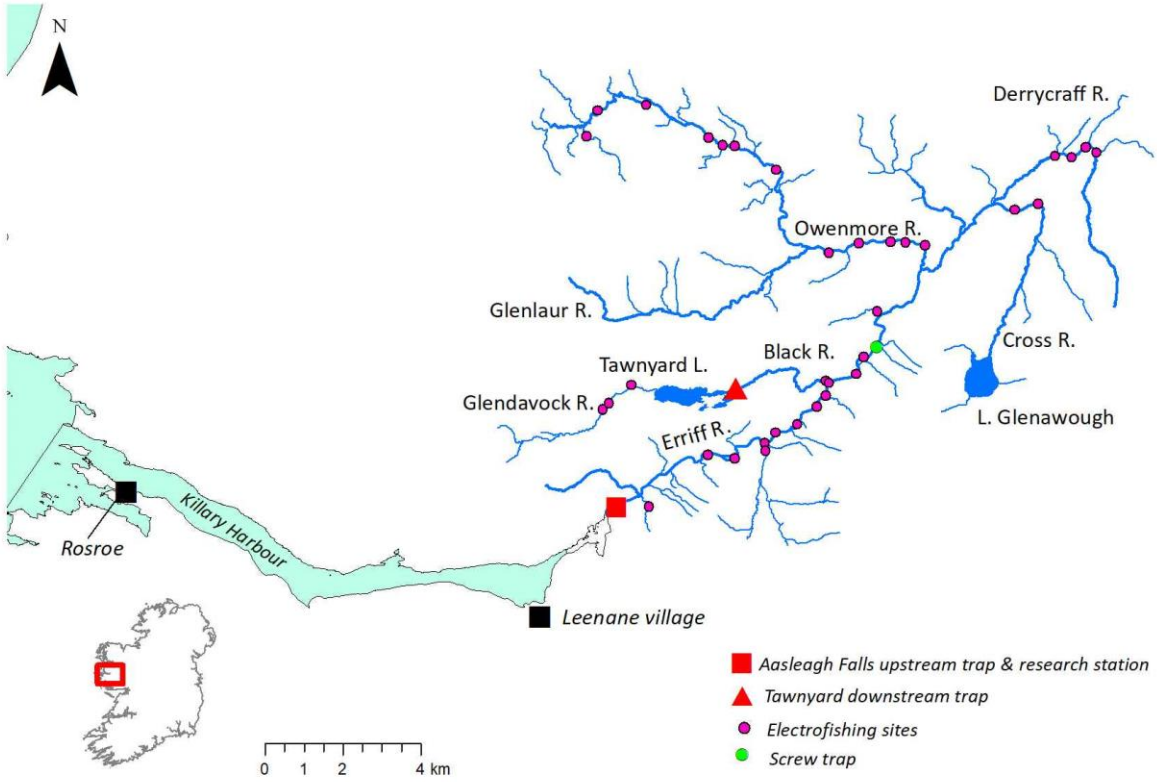

Figure 1 National Salmonid Index Catchment (Erriff Catchment and Killary Harbour) showing fixed trapping infrastructure and principal tributaries and lakes.

3.2 Resident and migratory fish species

Erriff fish stocks principally comprise Atlantic salmon, sea trout and brown trout. Eels, minnow and stickleback are also present. The salmon conservation limit for this river system is 1385. The salmon stock is predominately made up of one-sea-winter grilse. Annual sea trout returns are principally comprised of finnock (i.e. return in the same year as smolt migration), more notably so since the wider collapse of sea trout stocks in the west of Ireland in the early 1990s which has been associated with commercial salmon farming. The Tawnyard sub-catchment is the most productive area of the catchment in terms of sea trout. Brown trout are present throughout the catchment, notably more abundant in the smaller order streams and lakes. No specific stock information is available for eels.

Salmon ranching for scientific purposes (i.e. studies on the effects of sea lice on marine survival) has been undertaken in the Erriff since 2003 with smolts released annually until 2019 when this work ceased. However, ranching solely for angling purposes commenced in 2021. Ranching strays from the nearby Bundorragha River are intercepted annually at the lowermost reaches in the Erriff in the upstream fish trap and by anglers at Aasleagh Falls and typically removed from further upriver migration. Farmed salmon and Pacific pink salmon have on occasion been intercepted attempting to enter the river and removed in the same manner.

3.3 Fisheries

Game angling is an important activity in the Erriff main channel and at Aasleagh Falls with salmon the principal species targeted. A catch and release policy has been implemented in recent years with all wild salmon caught released and a ranched salmon is given to the angler in lieu. Trout angling also takes place on Lough Tawnyard. A tightly regulated and licensed commercial draft-net fishery operates in Killary Harbour each summer. Both angling and commercial fishing activity is managed locally by IFI and subject to catch quotas which are informed by annual scientific stock assessments undertaken by the Technical Expert Group on Salmon and published in national regulations.

3.4 Research infrastructure

The following research infrastructure[1] is present and utilised in the NSIC Erriff:

- A fixed upstream hydraulically-operated trap at Aasleagh Falls at the mouth of the river to monitor runs and trap fish for sampling that are returning from the sea. This has a fixed VAKI fish counter and PIT tag antenna installed at its entrance (Figure 2).

[1] See https://www.fisheriesireland.ie/NSIC/research-and-monitoring-infrastructure.html

- An on-site research laboratory adjacent to the Aasleagh fish trap. This includes a wet lab for sampling and dissecting fish, computer hardware, a digital fish scale reader, electronic weighing scales, two chest freezers, a small chemical store and a series of tanks for temporarily holding live fish.
- A fixed downstream Wolf-type trap at Tawnyard (on the Black River directly downstream of Tawnyard Lough) constructed in 1984, to monitor, trap and sample out-migrating smolts and kelts (Figure 3).
- A catchment-wide water temperature logger network (35 stream locations), a full-water column thermistor array and dissolved oxygen loggers in Lough Tawnyard and a weather station located at Aasleagh Falls associated with climate change studies.
- A telemetry network in the Tawnyard sub-catchment, Erriff main channel and Killary Harbour area (periodically deployed in association with acoustic and radio tagging studies)
- Fish sampling equipment such as two mobile rotary screw traps (Figure 4), gill-nets, fyke-nets and electrofishing backpacks (deployed for specific studies as required).
- Plankton sampling equipment (a sea lice sampling rig).
- Three mobile PIT tag circular antenna periodically deployed between the Erriff and Corrib systems.
- Four aquaculture tanks adjacent to the Aasleagh laboratory for holding ranched smolts.
- A dedicated Research Officer periodically supported by local IFI WRBD staff and a seasonal Fisheries Assistant.
- A temporary research room located at Aasleagh Lodge.

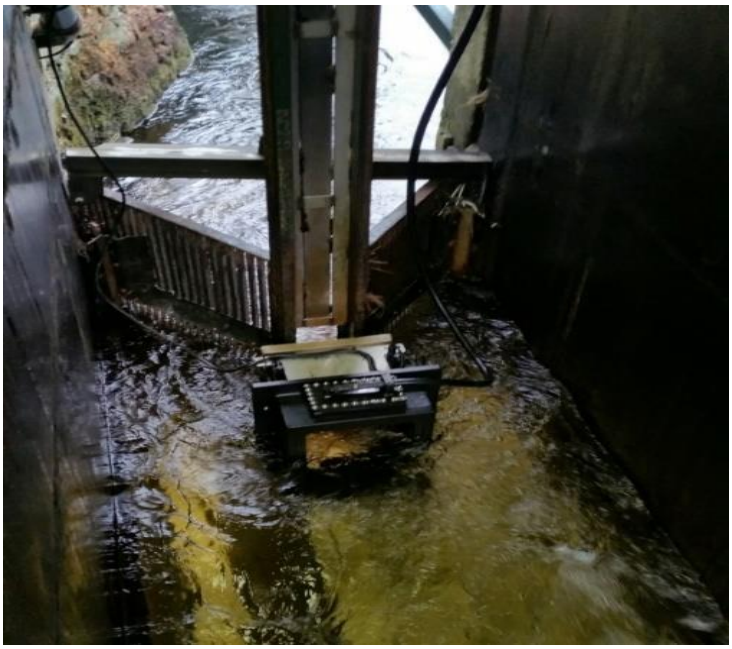

Figure 2 Erriff upstream trap with VAKI Riverwatcher counter and Biomark antenna (dark rectangular unit).

Figure 3 Wolf-trap located along the outflow from Tawnyard Lough captures downstream migrating smolts and kelts.

Figure 4 Rotary screw trap for capturing smolts in operation on the main river channel at Erriff Bridge.

4 Research objectives and activities

4.1 Background

The principle guiding objective informing the research undertaken in the NSIC Erriff is:

> *to assess current status and address key knowledge gaps to better understand the biology, ecology and stock dynamics of migratory salmonids and the associated influences of environmental and anthropogenic pressures and threats to their continued sustainability to better inform their wider protection, fisheries management and conservation in Ireland and further afield*.

Dedicated research on migratory salmonids (i.e. Atlantic salmon and sea trout) has been undertaken in the NSIC Erriff since the early 1980s. This has principally focused on monitoring the annual stock status of returning adults and out-migrating smolts and kelts, as well as quantifying the impacts of sea-lice associated with salmon aquaculture on wild stocks. Since 2007, catchment-wide juvenile fry production has been assessed annually. This annual programme of work has enabled the collation of valuable long-term time series which are used to monitor stock trends; identify, quantify and better understand threats and pressures; comply with Ireland's reporting obligations; and provide necessary data to develop and populate national and international stock assessment models which are used to inform fisheries management. The latter includes the provision of data to establish conservation limits and set catch quotas to protect against the over-exploitation of salmon stocks and better ensure their long-term sustainability.

In addition, the unique setting of both downstream and upstream traps facilitate annual sub-sampling of wild juvenile and adult salmon and sea trout populations to record pertinent biological information such as length and weight and to retrieve scale samples for further analyses (Figure 5). Such information can provide insight into freshwater and marine growth rates, which can ultimately affect marine survival and fecundity.

Figure 5 Recording length of a sea trout kelt, undertaking it's second emigration from Tawnyard Lough to the marine environment. The NSIC Erriff infrastructure and biological sampling programme offers unprecedented insights into the ecology of wild anadromous trout.

Reporting obligations for IFI include:

- Provision of adult returns, biological data and catch information to the Technical Expert Group on Salmon for the annual national stock assessment. Biological information is used to determine necessary inputs to the stock assessment model.
- Provision of catch and biological information on salmon to the European Union Multi-Annual Programme (EU DCMAP) pending its commencement.
- Article 17 reporting of stock status under EC Habitats Directive.
- Provision of fisheries and biological data on salmon to the International Council for the Exploration of the Sea (ICES) and the North Atlantic Salmon Conservation Organisation (NASCO). Biological information is primarily used to determine necessary inputs to the ICES stock assessment model.
- Provision of sea trout smolt and kelt output and adult returns to determine marine survival and other biological data.

More recent research (since the mid-2010s) has focused on quantifying the survival of migratory stocks during their freshwater and the marine life stages and identifying the key contributory pressures (such as impacts from salmon aquaculture) and migration bottlenecks (such as predation hot-spots and migration barriers) that may unduly supress stocks. This is principally conducted through tagging / telemetry studies.

The NSIC Erriff has also provided a valuable dedicated resource to undertake disease surveillance (notably of red vent syndrome, red skin disease, sea lice and other parasites), and invasive species surveillance (for farmed escapees and Pacific Pink salmon) annually throughout the seasons. Furthermore, the NSIC Erriff has recently been developed as key index site in Ireland for an IFI project to monitor and assess the impacts of climate change on fish and their surrounding environment through the establishment of a catchment-wide environmental sensor network. Research in the NSIC Erriff is often undertaken in collaboration with international partners which contribute to the research objectives.

4.2 Current research activities

This section describes the research activities occurring currently at the NSIC Erriff. Research activities currently undertaken are:

- Tagging of Atlantic salmon and sea trout annually with acoustic, radio, DST, satellite and PIT tags (Figure 6) to monitor marine survival, elucidate life history characteristics and establish migration patterns of these conservationally-important fish species. A maximum of 1,200 salmon and 1,200 sea trout smolts are each tagged and subsequently released annually (pre-dominantly *via* PIT tagging).
- Capturing and monitoring returning Atlantic salmon and sea trout annually at the fixed trapping infrastructure at Aasleagh Falls for enumeration, biological sampling and disease surveillance purposes. This trap also enables the removal of non-native Pacific pink salmon and fish farms escapes which are periodically encountered attempting to migrate into the system. Surveillance for disease (red skin disease (RSD), red vent syndrome (RVS), sea lice loads) and invasive species (Pacific pink salmon and escaped farmed salmon) are conducted here. Sea lice infestation rates are documented for a subsample of the adult sea trout run by visually counting and recording numbers of both chalimus juvenile and pre-adult/adult lice present (Appendix 1). In 2022, a revised classification system was developed in association with the Environment Agency UK, Marine Scotland and Natural Resources Wales to align reporting between Ireland and Britain in regard to assessing the prevalence and severity of red skin disease (RSD) in salmon (RSD Severity Field Guide, 2022, Appendix 2). In addition, in the same regard, the classification system used by the Environment Agency UK and Marine Scotland was adopted to assess the severity of RVS in salmon (RVS Severity Field Guide, 2011, Appendix 3).
- Capturing and monitoring out-migrating Atlantic salmon and sea trout annually at the fixed trapping infrastructure at Tawnyard and in the temporary deployed screw traps for enumeration and sampling purposes.

- Electrofishing activities to capture juvenile salmonids (fry and parr) in order to provide annual stock information and translocation studies to boost natural productivity. This annual monitoring of juvenile stock status takes place at 36 discrete locations in the catchment.
- Installation and ongoing maintenance of a stream and river water temperature monitoring network, a fully-automated on-site weather station and limnological monitoring system on Lough Tawnyard (temperature, dissolved oxygen, shoreline meteorological station) (Figure 7).

Figure 6 Pit tag and DST tag inserted into sea trout smolt captured at Tawnyard downstream trap.

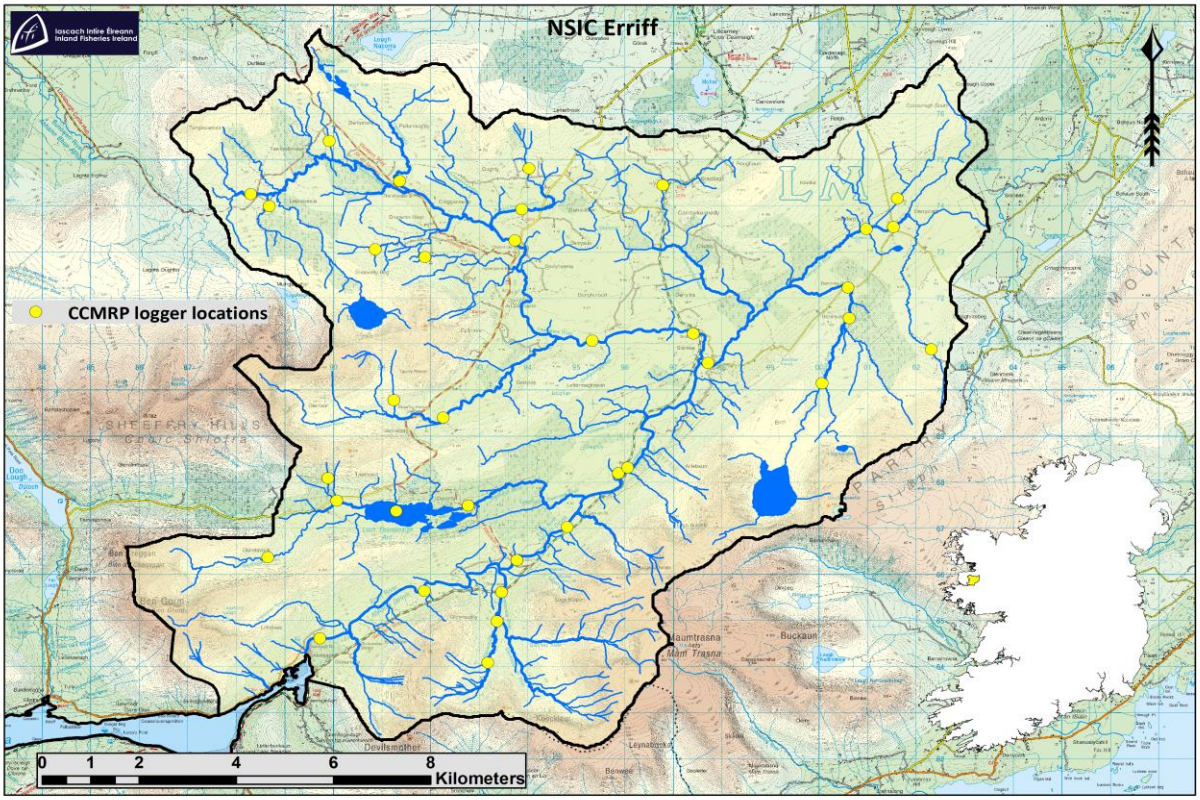

Figure 7 Catchment-wide water temperature monitoring network in NSIC Erriff for Climate Change Mitigation Research Programme (location of stream and lake water temperature loggers).

5 Results

5.1 Adult returns

In 2022, provisionally, adult wild salmon and sea trout returns were 1,368 and 1,958, respectively. 333 ranched salmon also returned to the Erriff (Table 1). Returns of salmon in 2022 were marginally up on 2021 but below that recorded in the period 2018-2020. Returns of sea trout were similar to both 2020 and 2021 but lower than 2019 (Figure 8). Returns of salmon in the peak months of 2022 are well below the preceding mean returns (Figure 9 and Table 2).

5.2 Out-migrating smolts and kelts

In 2022, 1312 wild salmon and 1294 sea trout smolts and 268 sea trout kelts and one salmon kelt were recorded at the Tawnyard trap (Table 1 and Figure 10). Since 2020, the run of sea trout smolts has decreased and the periodic relatively large runs recorded prior to 2009 have not been observed since that time. An upward trend is evident in salmon smolt runs since the time series low of 2013 with 2022 numbers an increase over the 2021 run. Sea trout kelt runs have progressively improved since 2020 but remain relatively lower than that observed in earlier periods of the time series.

5.3 Salmonid biological data

Analysis of length-frequency distribution of salmon smolts sampled in 2022 (n=1195) revealed a mean length of 12.3 cm. Partitioning sampled salmon smolts between the Tawnyard trap and the Erriff main channel screw trap revealed that smolts emigrating from the lake were on average 1.62 cm (~14%) larger compared to smolts captured in the main river channel trap (Figure 11). Average length of seaward migrating sea trout smolts sampled from the Tawnyard trap in 2022 (n=497) was 19.91 cm. Only 13 sea trout were sampled from the main Erriff channel screw trap, with considerably fewer numbers of trout smolts caught in this location compared to salmon smolts.

Sea trout kelts sampled during the river descent through the Tawnyard trap in 2022 (n=36) had an average length of 27.6 cm, ranging from a minimum of 23.8 to a maximum of 39.8 cm (Figure 12). The length-frequency distribution was not unimodal, highlighting the contribution of various different sea trout age classes to the overall kelt run. This was further confirmed by the detection of twenty of these kelts as PIT tagged fish, with 85% (n=17) tagged as smolts during 2021. The remaining 3 PIT tagged kelts had been tagged 2-years prior, during the 2020 smolt run. Based on the overall length-frequency distribution of sampled kelts (<20% of the fish had a length greater than 30 cm) as well as the detection of a high proportion of fish PIT

tagged in 2021 as emigrating smolts, it is estimated that most of the descending trout classified as 'kelts' initially returned to the Erriff system as 'finnock' in 2021 (first-time migrants spending only 1-3 months at sea). The exact contribution of these smaller migratory adult fish, as well as the cohort of smolts in an overlapping size class (23-25 cm), to the overall population ecology of the Tawnyard sub-population warrants further investigation. Future analyses using scale samples and multiple years of PIT tagging mark-recapture growth and survival data are intended to elucidate the migratory demographics of sea trout in this system.

Forty-six wild salmon were sampled for lengths and weights during the adult return run in 2022, with an overall mean length of 62.9 cm and mean weight of 2.97 kg (compared to mean values of 58.9 cm and 2.21 kg calculated for sampled adult salmon (n=88) during 2021) (Table 3). The mean condition index [$log_{10}(Weight(kg)/Length(m)^3$] of sampled adult returns in 2022 was 1.02, which showed a slight improvement over the value of 1.01 estimated for sampled adults during 2021. However whilst predominantly a grilse river, sampled adult returning fish included fish visually classified as multi-sea winter salmon (and potentially previously-spawned grilse) and the exact proportions of each cohort making up the total adult run may change from year-to-year. Therefore, assessment of size data from sampled adult returns can offer insight into the characteristics of one-sea winter and multi-sea winter stock components. Based on visual inspection of the length-frequency histogram for all adult fish sampled during 2021 and 2022 (n=134) and subsequent statistical testing for the number of population modes present (e.g. Silverman, 1981), two estimated size modes occur: one centred around 56.8 cm (i.e. median size for one-sea winter fish) and one centred around 74.3 cm (i.e. median size for multi-sea winter fish). An estimated anti-mode implied that a preliminary size cut-off of ~68.7 cm could effectively partition adult fish between multi-sea winter and one-sea winter cohorts for the River Erriff (Figure 13). An assessment of recorded adult lengths as a function of day of year on which return to freshwater occurred, indicates that 78% of fish above this 68.7 cm threshold returned earlier during the run (prior to July 1st), consistent with premature upriver migration strategies associated with larger, multi-sea winter "spring" salmon. However, interpretation of collected scale samples is needed to fully corroborate these length-based categorisations. As changes in body size and proportions of multi- and one-sea-winter fish impact overall spawning fecundity estimates, and different sea-age classes may be subject to different environmental pressures, this is an active area of research currently underway in the Erriff system which may help to inform effective conservation management in other Irish salmon rivers over the coming years.

154 adult sea trout migrating upstream through the Aasleagh trap underwent biological sampling during the main river ascent period in 2022 (May through September). The average

length of sea trout returning to the Erriff river in 2022 was 29.07 cm, with a mean weight of 0.31 kg (compared to 29.86 cm and 0.34 kg in 2021 (n=104)) (Table 3). Similar to the wild Atlantic salmon run, mean length of returning sea trout decreased over the course of the summer, with larger fish (>35 cm) returning earlier during the run (May through July) (Figure 14).

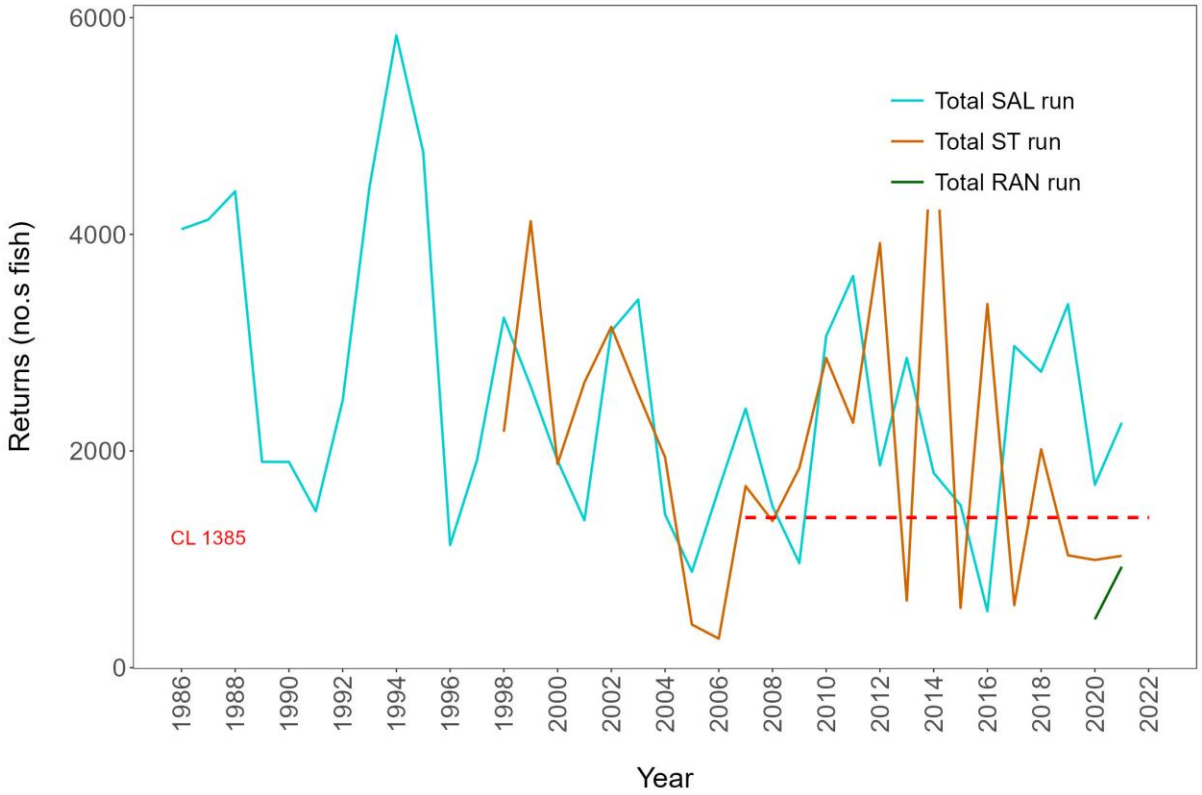

Figure 8 Adult returns of wild salmon, sea trout and ranched salmon to River Erriff since 1986 (conservation limit for wild salmon of 1385 indicated).

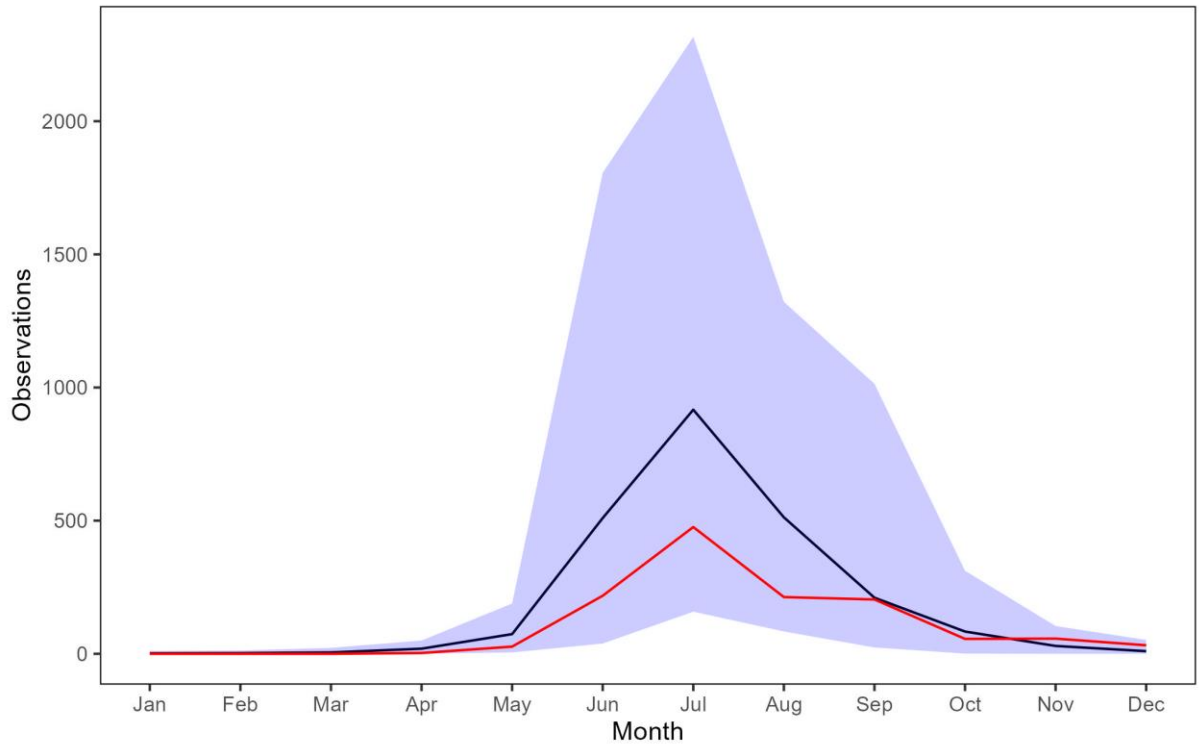

Figure 9 Wild salmon returns based on counter by month (black line is mean returns per month preceding most recent year and blue shading is associated 95% confidence intervals; red line is most recent year).

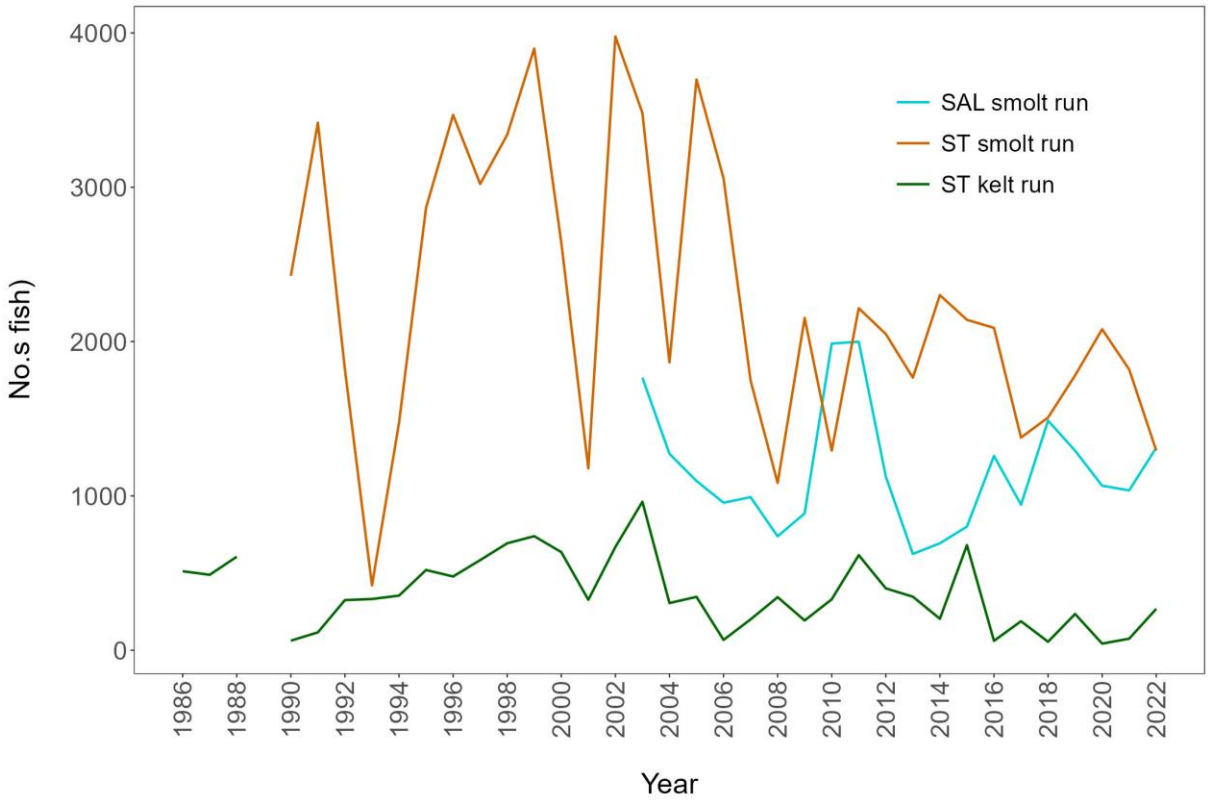

Figure 10 Runs of outward migrating salmon and sea trout smolts and sea trout kelts at Tawnyard trap since 1986.

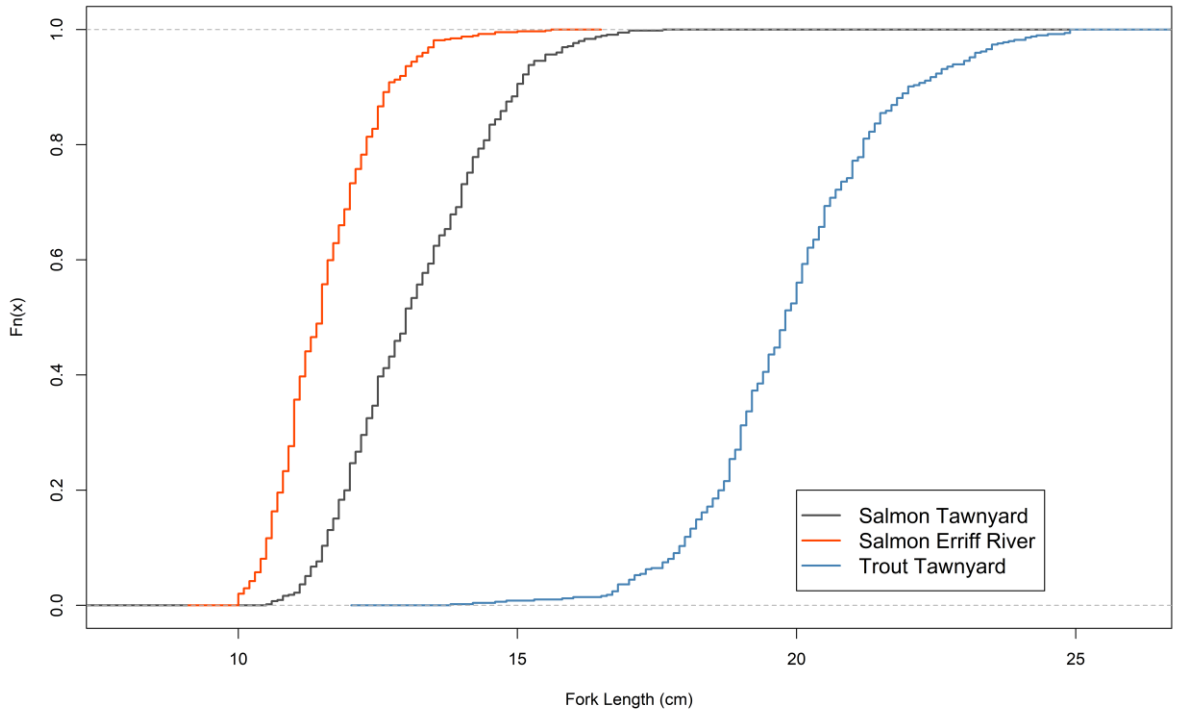

Figure 11 Empirical cumulative distribution function of fork length (cm) of Atlantic salmon and sea trout smolts sampled during 2022 smolt run.

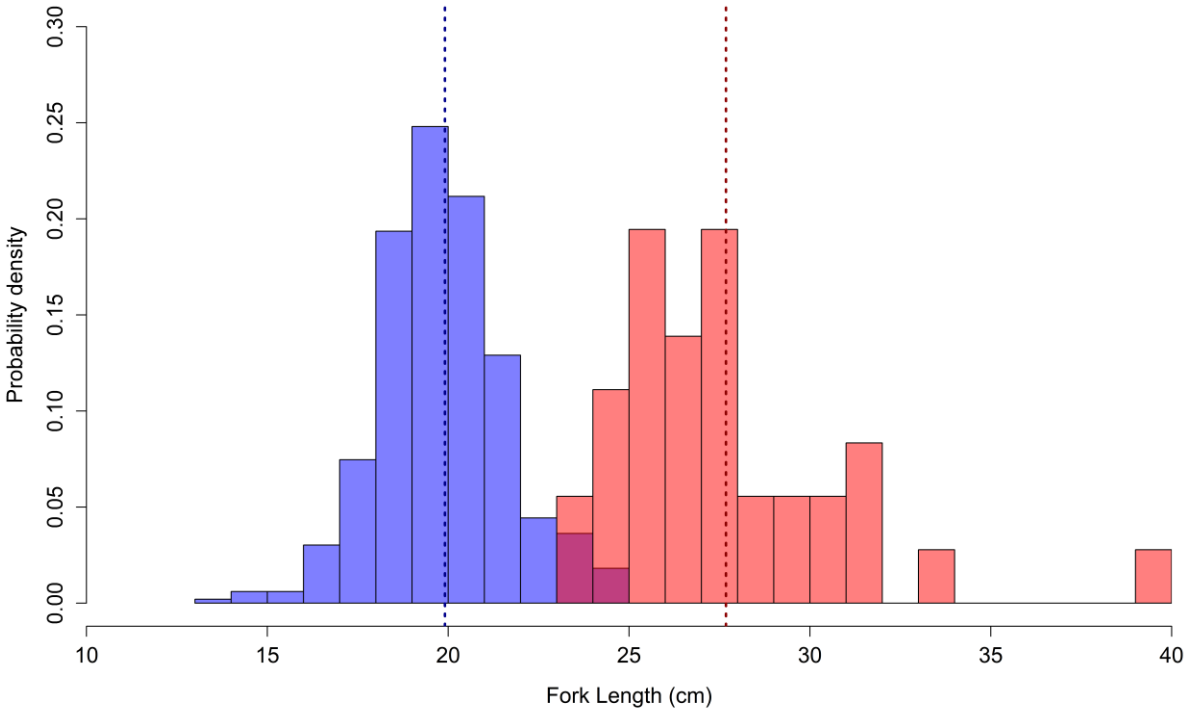

Figure 12 Probability histogram of fork length (cm) for sea trout smolts (blue) and sea trout kelts (red) sampled in the Tawnyard trap during 2022. Vertical dashed lines denote the mean length for smolts and kelts. (Note a small amount of overlap between fish recorded as smolts (visual categorisation) and kelts (recapture of a pit-tagged smolt) (23 – 25 cm length category). This could imply that a number of smolts tagged previously return to freshwater without significant marine growth (I.e. maturation) and thus may not contribute significantly to the overall spawning escapement.)

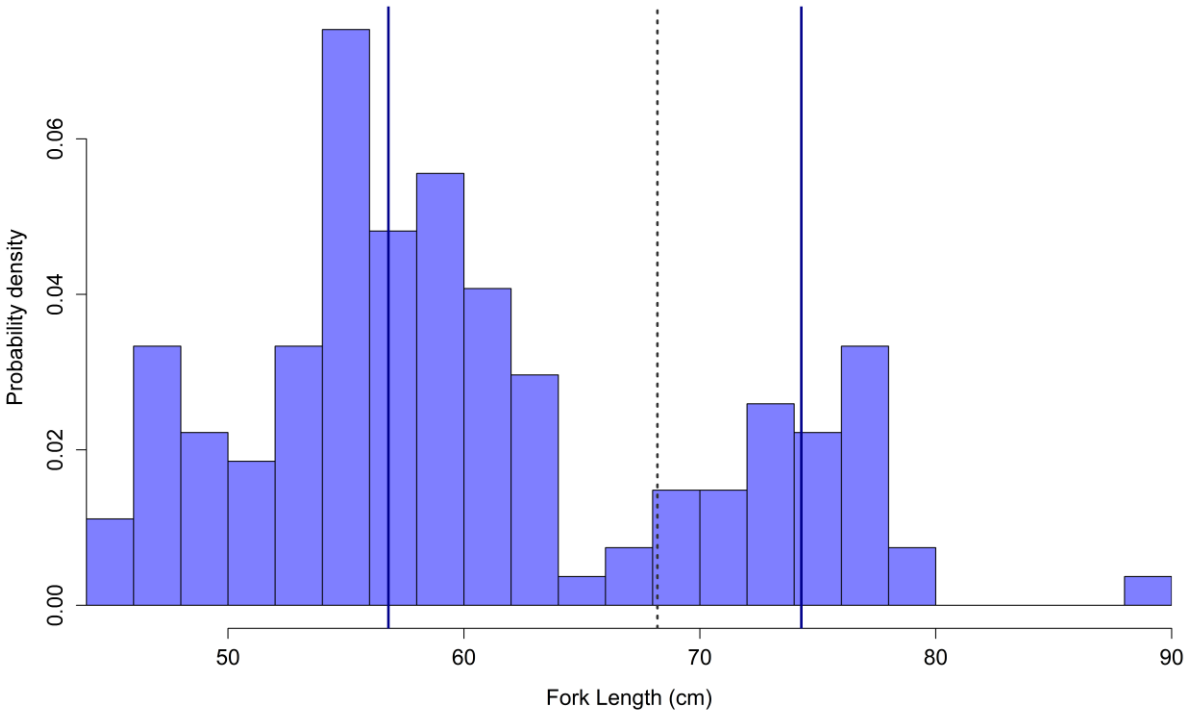

Figure 13 Length-frequency of fork length (cm) for returning wild adult salmon sampled during 2021 and 2022 (n=134). Solid vertical lines indicate estimated size modes for mean grilse (56.8 cm) and multi-sea winter (74.3 cm) lengths. Dashed vertical line denotes anti-node (68.7 cm).

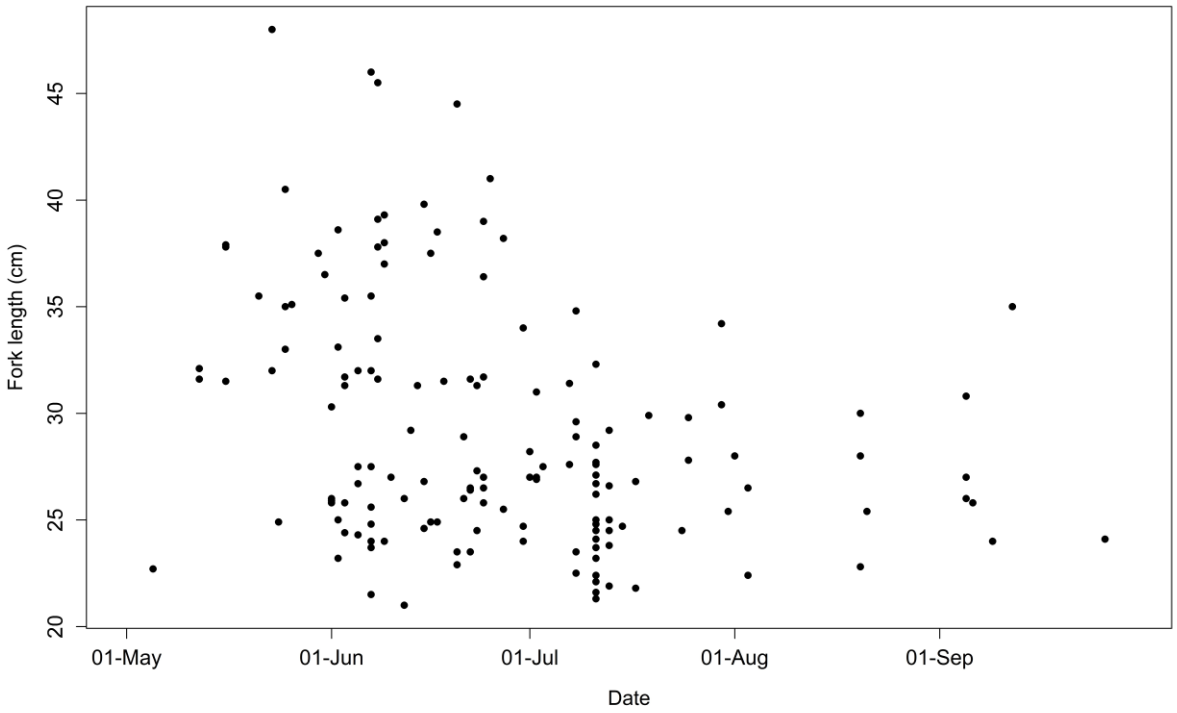

Figure 14 Measured lengths of adult sea trout sampled in the NSIC Erriff upstream trap over the course of the 2022 summer run.

5.4 Predation marks and net marks on wild adult returns

Monitoring of predation mark and net marks on wild salmonid returns is undertaken by examining adult salmon and sea trout intercepted for routine sampling in the Aasleagh upstream trap as they entered the river on their upstream migration. The prevalence of both are generally under 2.5% since 2020 except for salmon in 2022 where 10.6% had predation marks and 27.7 had net marks. It should be noted that the sample size of 47 was relatively low in this case (Table 4).

5.5 Catches

In 2022, the total rod catch of adult salmon was 202 fish with 156 of these wild (four wild salmon were harvested and 152 were released). The total number of ranched fish caught was 46. The vast majority of rod catch was at Beat 9 (Table 5). The total commercial harvest in the mixed-stock fishery in Killary in 2022 was 208 salmon of which Erriff fish comprised 171 and wild Erriff salmon 85 fish (Table 6).

5.6 Juvenile salmon abundance

Mean salmon fry abundance in the River Erriff catchment from catchment-wide electrofishing surveys has remained well above the minimum fry threshold of 17 since the time series low in 2017 (Figure 15 and Table 7). In 2022, mean fry abundance was 38.17 fry. Site-specific results of the CWEF survey in 2022 are presented in Figure 16 and Table 8.

Figure 15 Results of mean salmon fry abundance in the River Erriff catchment from catchment-wide electrofishing surveys since 2007.

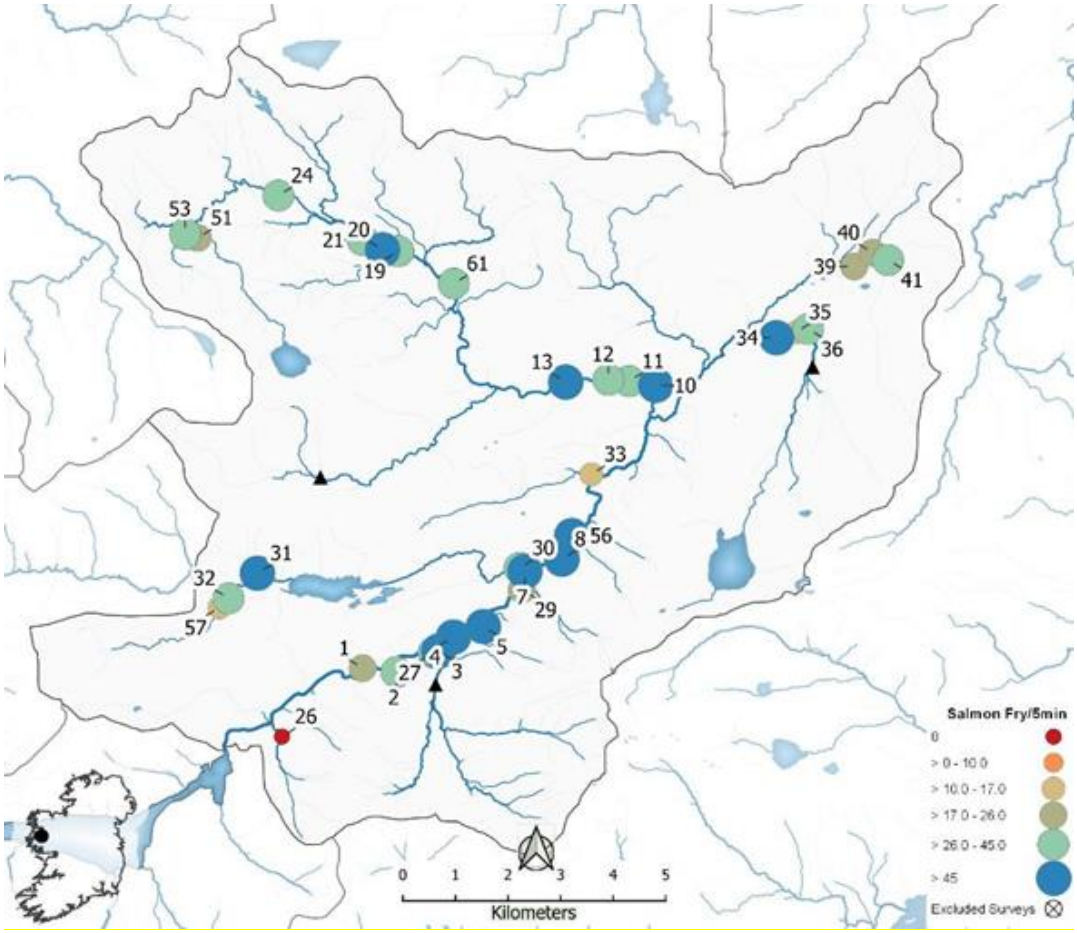

Figure 16 Site-specific results of mean salmon fry abundance in the River Erriff catchment from catchment-wide electrofishing surveys in 2022.

5.7 Telemetry and tagging studies

A range of telemetry and tagging studies have been undertaken in the NSIC Erriff in recent years to assess survival and monitor migration of both salmon and sea trout through the freshwater, estuary and marine environment and better understand the factors that influence these. The numbers of smolts tagged by method and location are presented in Table 9 to Table 11).

5.7.1 PIT tagging

In 2022, a total of 1,195 salmon and 510 sea trout smolts, respectively, were PIT tagged. This comprised 551 and 644 salmon smolts at Tawnyard trap and at the screw trap in the main channel, respectively, and 497 and 13 sea trout smolts at Tawnyard trap and at the screw trap in the main channel, respectively.

From the cohort tagged in 2021, a total of 19 PIT tagged adult salmon returned to the Erriff representing a provisional marine survival of 1.5%. Any multi-sea-winter fish which will return in 2023 will have to be considered when finalising this estimate. No two-sea-winter salmon returned in 2022 from the cohort tagged in 2020. For salmon PIT tagged in 2017, 2018, 2019 and 2020 marine survival was 2%, 3.8%, 3.2% and 1.5%, respectively (Figure 17 and Table 12).

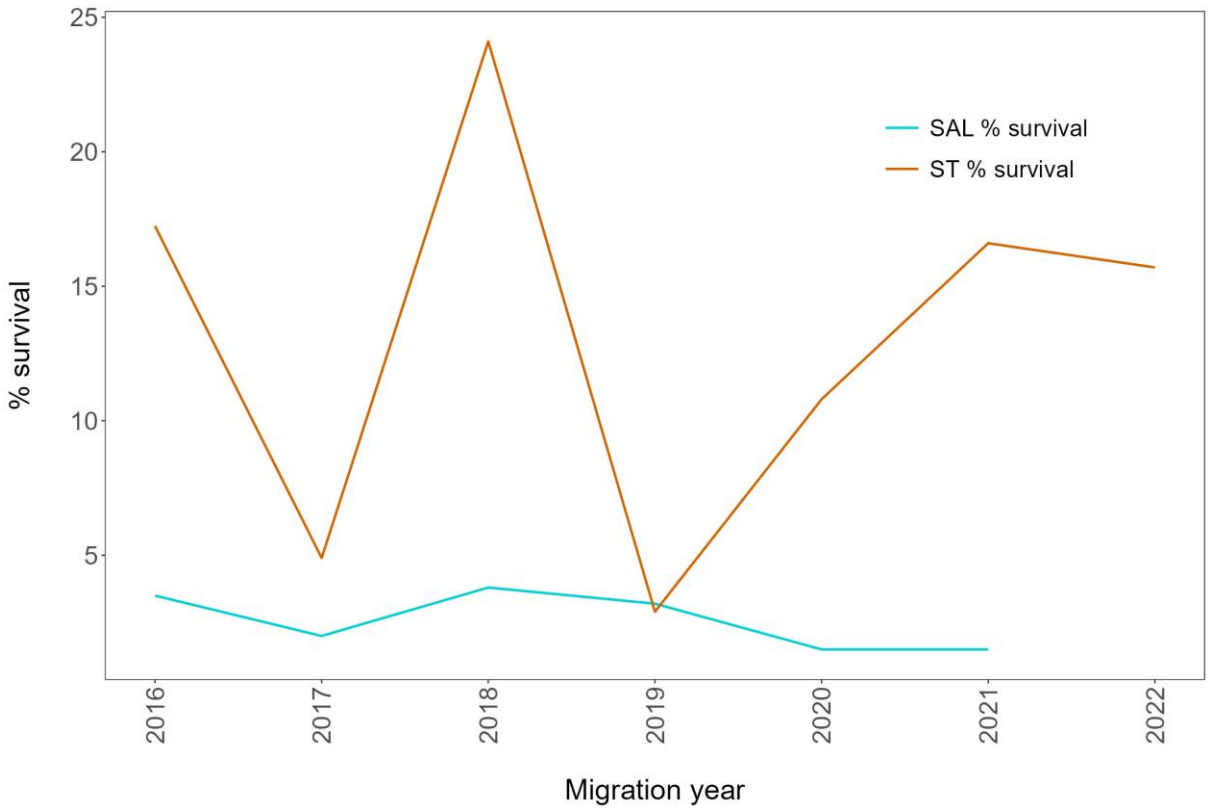

Figure 17 Return of PIT tagged salmon and sea trout smolts which returned as adults.

From the cohort tagged in 2021, a total of 67 PIT tagged adult sea trout returned to the Erriff representing a provisional marine survival of 16.6%. Of these 85.4% were zero-sea-winter finnock and 14.6% were one-sea-winter maidens. Repeat spawners represented 18.8% of tagged fish (i.e. returned in both 2021 and 2022). Any multi-sea-winter fish and repeat spawners which will return in future years will have to be considered when finalising these results. The provisional return for sea trout PIT tagged in 2022 (i.e. zero-sea-winter finnock) was 15.7%. Again, there is the potential for further returns of this tagged cohort in future years. For sea trout PIT tagged in 2017, 2018, 2019 and 2020 return rates were 4.9%, 24.1%, 2.9% and 10.8%, respectively (Figure 17 and Table 13). A more comprehensive picture of salmon marine survival trends will become available when a more long-term time series of results from the Erriff are available.

5.7.2 Acoustic tagging

Prior to tagging, 20 acoustic receivers were deployed in the River Erriff, Killary Harbour and Ballinakill Bay to detect tagged sea trout smolts (Figure 18). A total of 20 sea trout smolts were tagged. Tagging started on 20th April and was completed on 9th May 2022. The mean length and weight were 20.cm and 81.7g respectively. Sea trout survival rates are calculated by determining the number of tagged fish that successfully returned to the River Erriff following their marine migration. Survival rates are a minimum estimate as it possible for them to stay at sea for extended periods during which time the tag's battery expires (battery life 337 days).

One sea trout smolt successfully returned to River Erriff which is a survival rate of 5%. All smolts survived to Killary Harbour, 35% were lost on their migration through Killary Harbour to sea. The largest losses occurred at sea with 55% being lost. One fish (5%) was lost in Killary Harbour following its seaward migration. Two fish (10%) returned prematurely and were detected in the Bundorragha River. Three fish (15%) were detected on the receivers south of Killary Harbour in Ballinakill Bay.

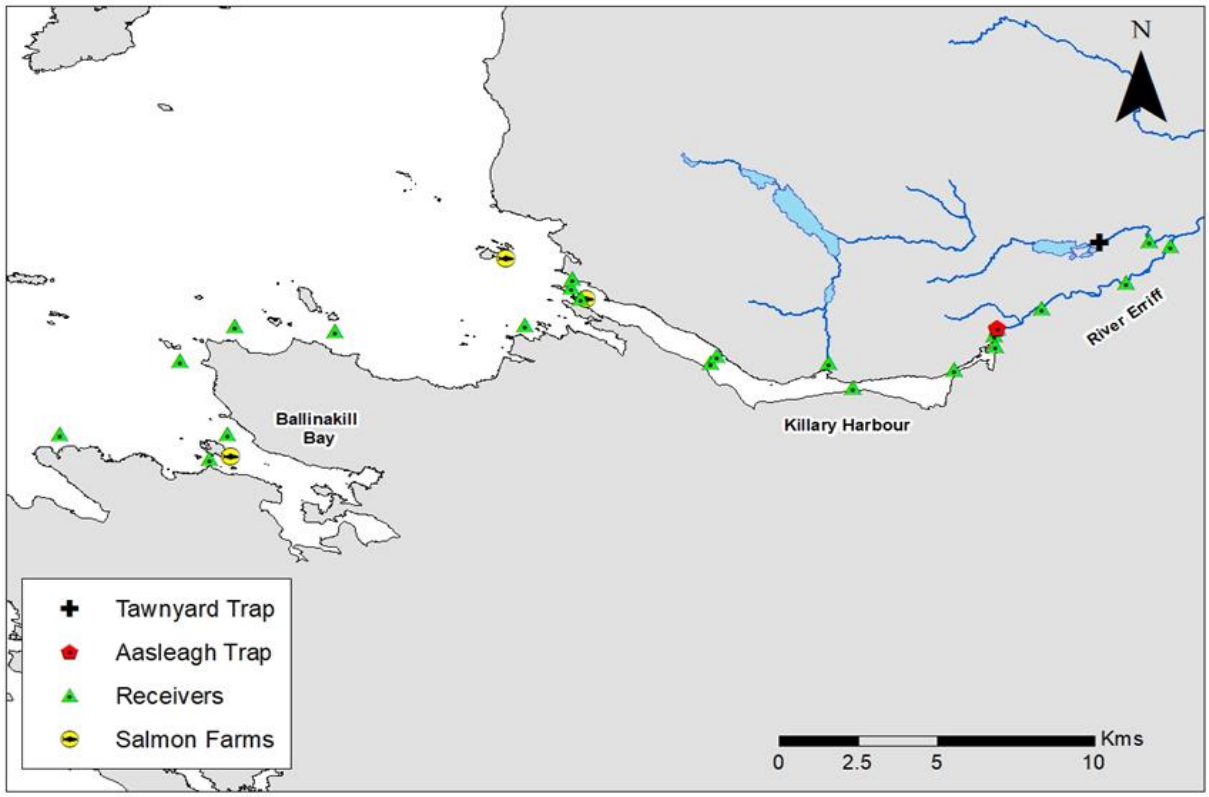

Figure 18 Location of acoustic receivers in Ballinakill Bay, Killary Harbour and the Erriff catchment.

5.7.3 Sea trout temperature project

The Sea Trout Temperature (ST Temp) project aims to record the range of temperatures that migrating sea trout smolts experience over their outgoing riverine and sea migration. This study will contribute to improved understanding of temperature factors which are likely to influence their marine survival. Increasing temperatures have been highlighted as potentially a key factor in the decline of migratory salmonid populations both at local and oceanic scale. Climate change has been flagged as a major threat to the long-term survival of this species.

Tagging started on the River Erriff on April 6th and was completed April 20th using the Tawnyard Wolf trap (Figure 3). Sixty smolts were successfully tagged, 30 tagged with NanoT tags (records temperature at 5 min. intervals for 151 days) and 30 with MicroTD tags (records temperature and depth at 5 min. intervals for 151 days). Tagged fish ranged in size from 16.8 - 24.9 cm fork length and ranged in weighted from 46.0 - 135.0 g. In addition, the fish were tagged with a PIT tag to identify them on their return for tag extraction. No tags were recovered in 2022.

5.7.4 SmolTrack III (Eval-Smolt)

Eval-smolts investigated wild salmon smolt survival by assessing two tagged groups (treatment and control). Both groups were intercepted in freshwater and tagged with acoustic

transmitters and PIT tags during their outward migration. The control group will be released in freshwater at Tawnyard Trap after a transport of equal distance/duration as the treatment group. The treatment group was transported downstream and released to avoid existing identified smolt-loss bottlenecks in previous SmolTrack work packages. Survival will be measured during migration via the acoustic transmitters.

One hundred forty-nine salmon smolts were successfully tagged at Tawnyard trap between 6th - 20th April. Seventy-four were transported/trucked around the predation bottleneck, of these 50 were implanted with 7mm tags and 24 with 6mm tags. Here after called the Trucked-7 and Trucked-6 groups respectively. Seventy-five received an equal transportation journey and were released at the trap site, of these 50 were implanted with 7mm tags and 25 with 6mm tags. Here after called the Trap-7 and Trap-6 groups respectively.

Survival differed between tagging groups. Survival through the river was 56% and 40% for the trap-6 and trap-7 groups respectively (Figure 19). Survival through the river was 58% and 70% for the trucked-6 and trucked-7 groups, respectively (Figure 19). Survival through Killary Harbour is calculated from the number of fish entering and exiting the harbour. Survival was high through Killary Harbour for all groups with 79%, 80%, 71% and 86% for the trap-6, trap-7, trucked-6 and trucked-7 groups, respectively (Figure 19). Overall survival is calculated from the number of smolts released and the number that exit Killary Harbour. Overall survival was 44%, 32%, 42% and 60% for the trap-6, trap-7, trucked-6 and trucked-7 groups, respectively (Figure 19).

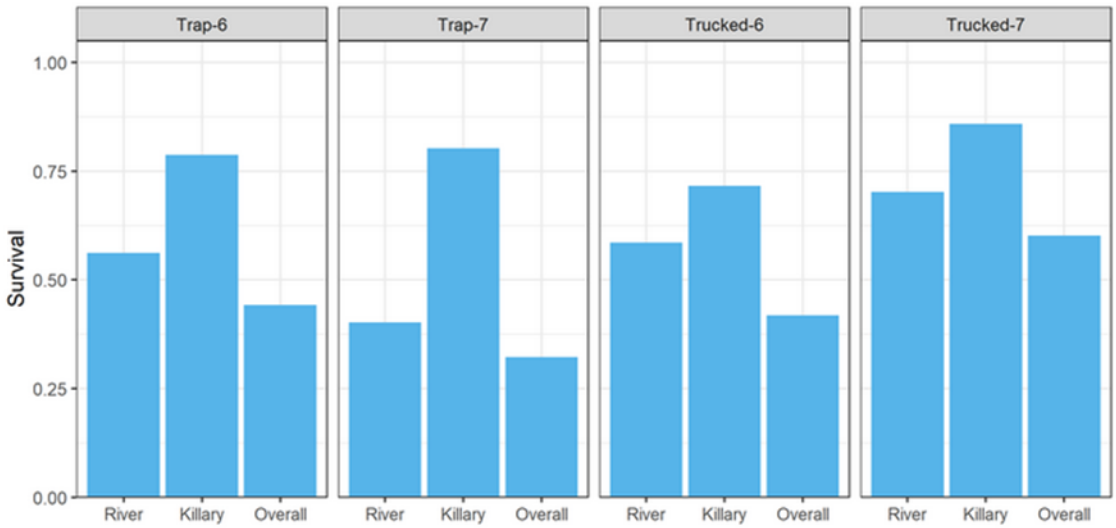

Figure 19 Migration fate for the acoustic tagged smolts in the study groups. Killary survival was calculated based on the number of smolts that successfully entered the Killary Harbour. Overall survival represents the proportion of smolts that reached the sea based on the number of released.

5.7.5 SmolTrack IV (Ocean-Temp)

Ocean-Temp aims to record the range of temperatures that migrating salmon from smolt stage to adult river return experience over their full oceanic migration. Outgoing smolts were tagged with miniature Data Storage Tags (DST). This newly developed tag was implanted in suitably sized smolts on the River Erriff to capture freshwater, transitional waters, and marine temperature data during their migration. The tags record temperature every 30 minutes for the first year then hourly until mid-September 2023. In addition, the fish were tagged with a PIT tag to identify them on their return for tag extraction.

One hundred wild salmon smolts were tagged at the rotary screw trap at Erriff Bridge between 7-28th April. Surviving fish are expected to return in 2023. In 2021, 100 smolts were tagged in the same manner. No fish from this tagging returned in 2022.

5.8 Invasive species

No Pacific pink salmon were recorded in Ireland in 2022. No farmed salmon were intercepted in the Aasleagh upstream trap in 2022.

5.9 Disease

5.9.1 Sea lice

Monitoring of sea lice loads on wild sea trout returns is undertaken as part of the routine sampling of sea trout intercepted in the Aasleagh upstream trap as they enter the river on their upstream migration (Appendix 1). Of the sampled upriver migrating sea trout returning from the marine environment in 2022, 125 underwent full sea lice counts. 68.8% of fish showed some presence of sea lice (similar to the value of 67.6% in 2021 sampled fish (n=99)). Sea lice load was calculated for each sampled fish as number of lice per gram of body mass (n g^{-1}) and an assessment of the severity of individual lice infestation rates performed using the established salmon lice risk index (so-called 'traffic-light system' as used in Norway (Taranger *et al*. 2015)). 4% of sampled adults were in the high-risk category (100% probability of lice-related mortality), 5.6% in the medium-risk category (50% probability of lice-related mortality) and 16% in the low-risk category (20% probability of lice-related mortality). These categories were then used to assess lice-related increased mortality risk at the whole-population level (Taranger *et al*. 2015; Gargan *et al*. 2016). Results show that 25.6% of fish had lice infestation rates > 0.1 n g^{-1}, denoting that lice levels impacting the 2022 Erriff sea trout cohort had an intermediate probability of increasing population-level mortality risk. This figure compares almost identically to the 2021 Erriff sea trout cohort, with 25.2% of fish having lice infestation rates > 0.1 n g^{-1} and therefore also an intermediate risk of population-level mortality.

Over 60% of the historical surveys carried out in Killary harbour and in the estuarine zone of the primary river inflows to Killary, including the Erriff, indicated high mortality risk levels during the 1990s, 2000s and 2010s (Gargan *et al*. 2016). Given that the sea lice sampling reported here is carried out on individual fish that have spent variable amounts of time back in freshwater (and thus would be anticipated to have lost a proportion of their lice load), the intermediate-risk reported here should be considered an absolute minimum, and lice-induced mortality risk is likely higher in the adjacent coastal habitat utilised by Erriff sea trout, and by extension, outmigrating salmon smolts.

5.9.2 Red skin disease

Anecdotal observations suggest that mild RSD-like signs have been observed in Irish salmon for many decades. However, there has been no specific focus in this regard until 2019 when more obviously diseased fish were encountered in some Irish rivers. Routine surveillance for RSD in the NSIC Erriff commenced in 2020 when ranched salmon were examined to assess prevalence and severity of this emerging phenomenon. Since 2021, surveillance for RSD has been undertaken by examining wild adult salmon intercepted for routine sampling in the Aasleagh upstream trap as they entered the river on their upstream migration. Assessment of severity of disease is classified according to the scheme used in the RSD Severity Field Guide, 2022 (Figure 20; Appendix 2). In 2022, 16 of the 47 wild Erriff adult salmon examined had signs of RSD, 69% of which were classed as mild and 31% as moderate in severity (Figure 21). This represents a prevalence rate of 34% in the total numbers of wild salmon examined (a notable increase on the low prevalence of 4.5% recorded in 2021) and of a similar magnitude to the prevalence of 22.4% observed, albeit in ranched salmon, in 2020 (Table 14). In 2022, 14 of the 16 wild salmon with signs of RSD (87%) were multi-sea-winter fish with all such cases of RSD detected recorded between the 17 May and 16 June 2022. Previous to this, the majority of cases were observed in one-sea-winter fish. RSD has been variably observed in Erriff adult salmon returns from May until September which coincides with the routine biological sampling period (Figure 22).

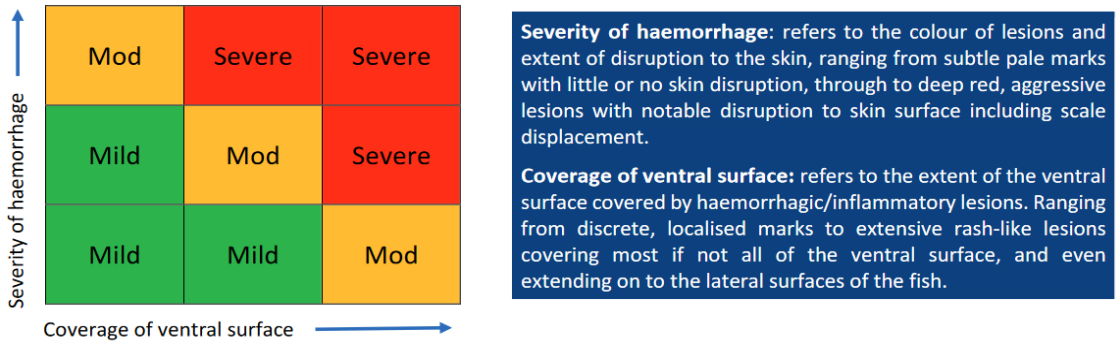

Figure 20 Classification scheme for reporting of red skin disease (extracted from RSD Severity Field Guide 2022).

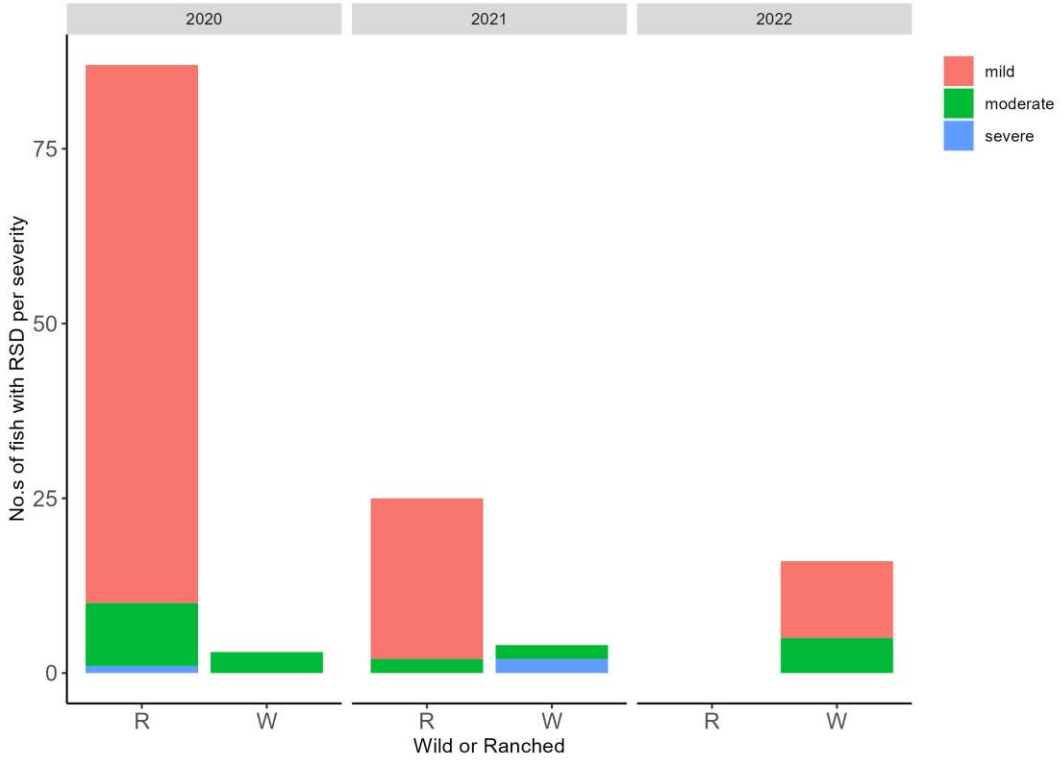

Figure 21 Severity of occurrence of RSD in Erriff adult wild (W) and ranched (R) salmon returns intercepted in the Aasleagh upstream trap since 2020 (ranched salmon were not examined for RSD in 2022).

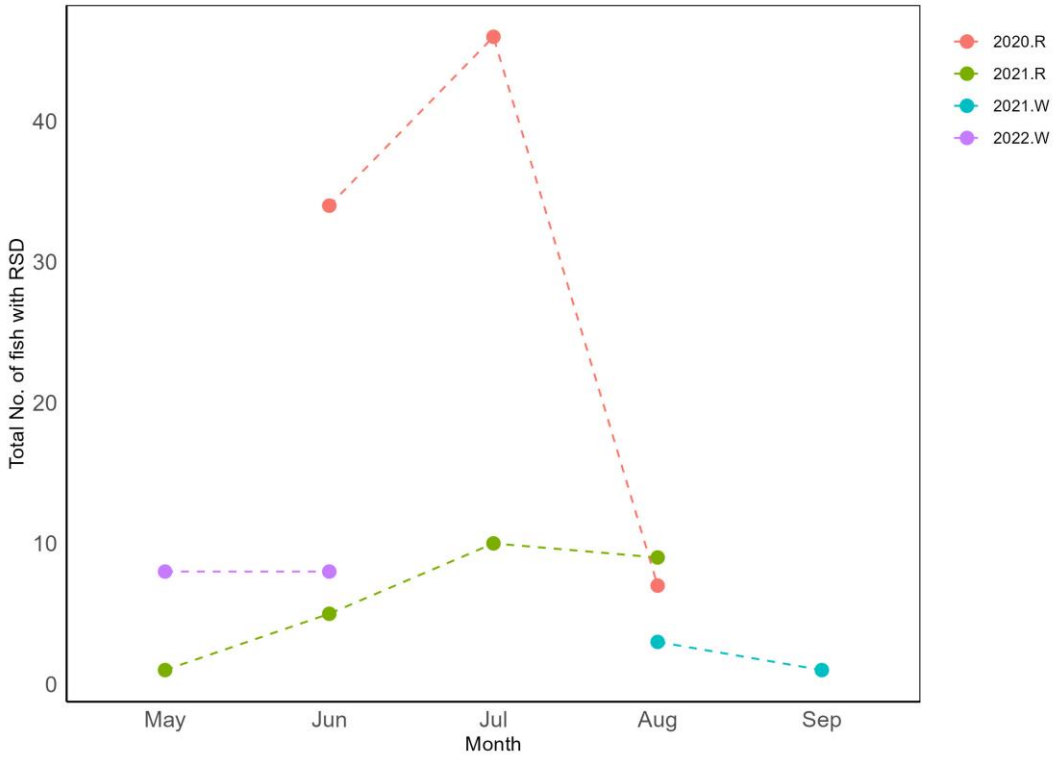

Figure 22 Monthly frequency of occurrence of RSD in Erriff adult wild (W) and ranched (R) salmon returns intercepted in the Aasleagh upstream trap since 2020.

It should be noted that although the majority of recorded cases of RSD in Ireland are observed in one-sea-winter grilse, this is not the case elsewhere in Europe (notably Scandinavia) where RSD is principally observed in multi-sea-winter salmon stocks. This may be a consequence of the Irish stock being pre-dominantly one-sea-winter.

5.9.3 Red vent syndrome

Routine surveillance for RVS in the NSIC Erriff commenced in 2020 when ranched salmon were examined to assess prevalence and severity of this disease. A standardised classification method to record RVS has been introduced to align with the mild-moderate-severe severity scale used in Britain by the Environment Agency and Marine Scotland.(RVS Severity Field Guide, 2011; Appendix 3). Since 2021, surveillance for RVS has been undertaken by examining wild adult salmon intercepted for routine sampling in the Aasleagh upstream trap as they entered the river on their upstream migration. In 2022, 6 of the 47 wild Erriff adult salmon examined had signs of RVS, of which 67% were classed as mild and 33% as moderate in severity (Table 15). This represents a prevalence rate of 12.8% in the total numbers of wild salmon examined which is lower than 2021 (19.3%).

5.10 Climate and Environmental Monitoring Programme

River water temperatures on the main channel of the Erriff river as recorded by the Office of Public Works' hydrometric station located just below Aasleagh Falls during 2022 varied largely across seasons ranging from a low of 1.2 °C during December to a high of 21.0 °C during July (Figure 23). In general, water temperatures remained below 10 °C until late March rising to peak summer monthly mean temperatures of 17.7 °C (July) and 17.5 °C (August). Temperatures dropped below 10 °C in November. River water levels (proxy for river flows) on the main Erriff channel also showed a seasonal cycle, although less defined compared to temperature (Figure 23). February was a particularly wet month with levels across the month remaining elevated above 1 m (1 m is the long-term median water level recorded at Aasleagh 2007-present). March through September exhibited typical spate-type river levels with water levels often low apart from sporadic, transient floods (e.g. May, June). High water levels predominated during October and November with variable conditions during December.

River temperatures on the River Erriff main channel during 2022 were largely within the bounds of climatological norms compared with the period 2007-2021 (Figure 24). However January and February exhibited warmer conditions compared to longer-term averages for this time of year, as did much of the period from July through October. River water levels varied compared to long-term averages over the course of the year with notably low water conditions during January followed by relatively normal conditions through spring and early summer. Water

levels tended to be below climatological norms from July through October. A brief but notable period of very low water in December, comparable to summer baseflows, corresponded with a significant drop in water temperature also.

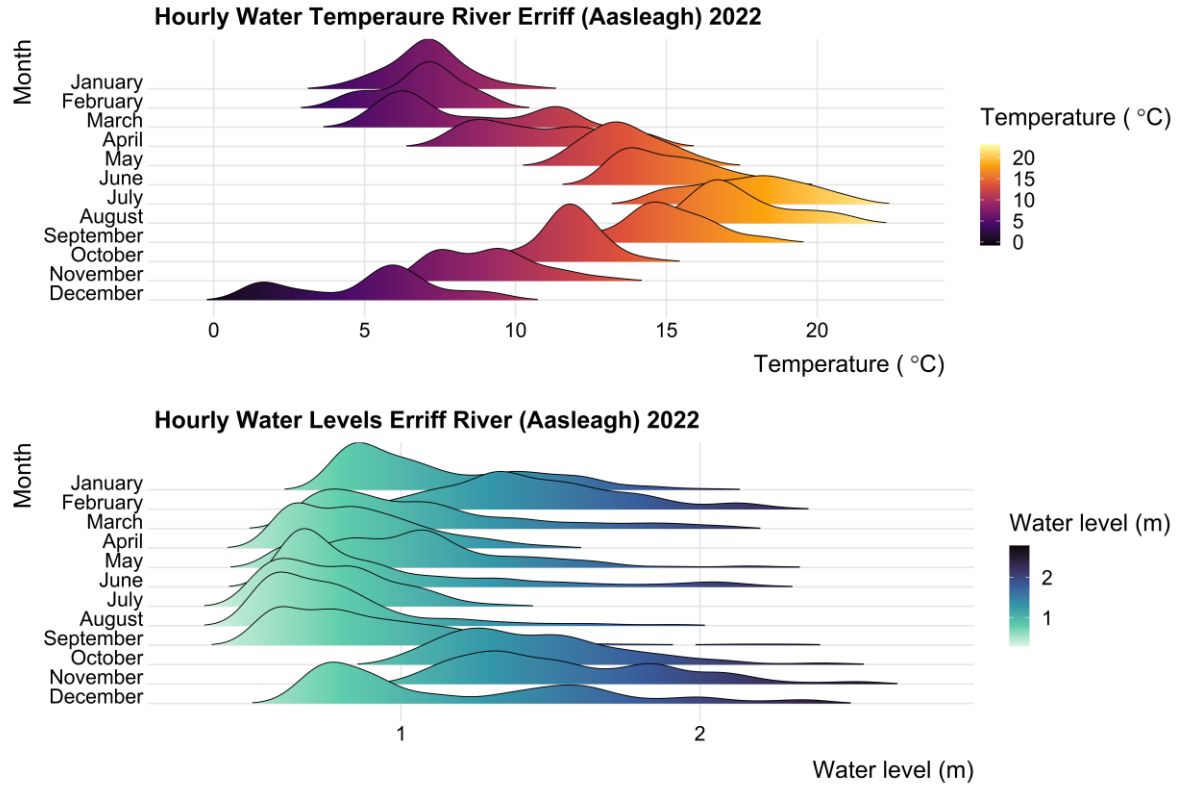

Figure 23 Distribution of river water temperatures (top panel) and river water levels (bottom panel) by month on the River Erriff main channel during 2022 (using data recorded by the hydrometric gauging station below Aasleagh Falls maintained by the Office of Public Works).

Monitoring of climatic and limnological variables continued in 2022, primarily through the IFI Climate Change Mitigation Research Programme (CCMRP). Thirty-five water temperature loggers and a fully-automated meteorological station installed during summer 2019 continue to record the thermal dynamics of fishery habitat throughout the Erriff river system every 30-minutes. Analysis of the temperature data recorded during the first 3-years of logger deployments is currently underway, which will allow detailed assessment of the thermal response of salmonid habitat to climatic conditions.

Additionally, during 2022 the limnological appraisal of Tawnyard Lough, potentially crucial to Erriff trout population demographics, was expanded significantly. This included the installation of dissolved oxygen loggers throughout the water column in conjunction with a thermistor array originally installed in 2019. A meteorological station, measuring wind speed and direction and solar radiation was also installed at the lake shore, in order to capture local meteorological conditions that drive in-lake physical changes. Results from this analysis will allow unprecedented insight into the potential linkages between climate conditions and the physical

and biogeochemical lake habitat utilised by lacustrine brown trout and anadromous sea trout populations during various life-stages.

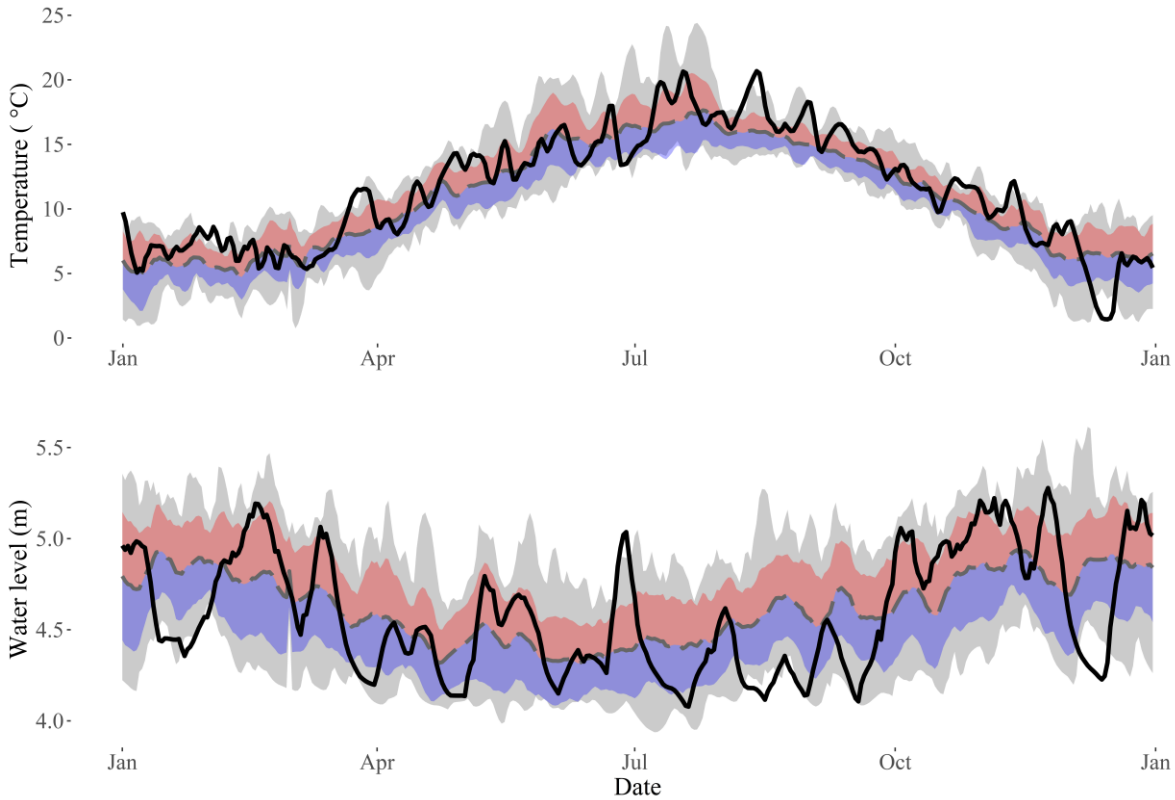

Figure 24 Comparison of river water temperatures (top) and water levels (bottom) on the River Erriff main channel in 2022 (thick solid black line) with conditions during the period 2007-2021. Dashed grey line is climatological mean, red and blue shaded areas denote standard deviation around the climatological mean and grey shaded areas indicate historical maxima and minima. Temperatures were filtered using a 3-day moving average and water levels using a 7-day moving average to improve plot interpretation. (Data was obtained from the hydrometric gauging station below Aasleagh Falls maintained by the Office of Public Works)

6 References

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7 Appendices

7.1 Appendix 1 Sea lice screening of adult sea trout returns

Monitoring of sea lice loads on wild sea trout returns is undertaken as part of the routine sampling of sea trout intercepted in the Aasleagh upstream trap as they enter the river on their upstream migration. The fish are anaesthetised and held partially submerged in water during lice counts to reduce stress. Numbers of sea lice observed are recorded as juvenile chalimus or pre-adult / adult life stages (Figure 25 and Figure 26).

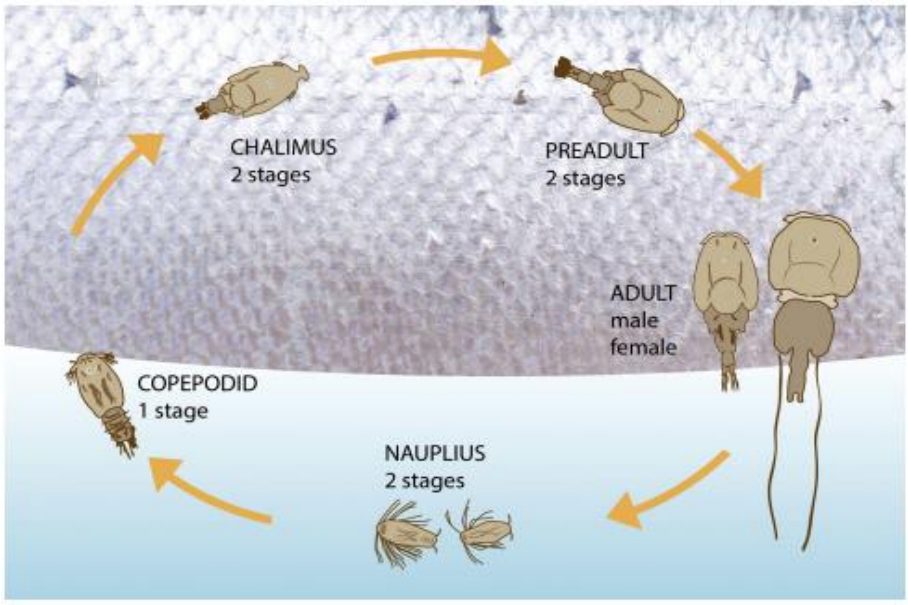


Figure 25 Life cycle of *Lepeophtheirus salmonis* showing the attached chalimus, pre-adult and adult stages which are routinely screened for as part of the NSIC annual sea trout biological sampling programme (figure from Thorstad *et al*. (2015)).

Figure 26 Counting sea lice on returning wild sea trout in the NSIC Erriff.

7.2 Appendix 2 RSD severity field guide

Environment Agency | Cyfoeth Naturiol Cymru Natural Resources Wales | marinescotland science | Iascach Intíre Éireann Inland Fisheries Ireland

Red Skin Disease in wild Atlantic salmon – a severity field guide

Red Skin Disease (RSD) is a term given to an emerging disease of wild Atlantic salmon characterised by haemorrhaging along the underside of the body, and occasionally the lower flanks. Milder symptoms of ventral haemorrhaging have been recorded in some populations of salmon for decades, but the severity and prevalence appear to have increased markedly in the last few years.

The most consistent characteristic of the condition appears to be distinct and pronounced ventral haemorrhaging in fresh run Atlantic salmon. This haemorrhaging is described as petechial or pinpoint, expressed as rounded reddened spots on the skin.

The cause and impact of RSD are currently unknown and detailed histopathological descriptions are still being established. Until then, the following field guide has been produced to standardise clinical reporting of RSD-like lesions to support ongoing monitoring of this condition across salmon rivers. It also serves to distinguish this emerging condition from other, frequently observed skin lesions in migratory salmonids.

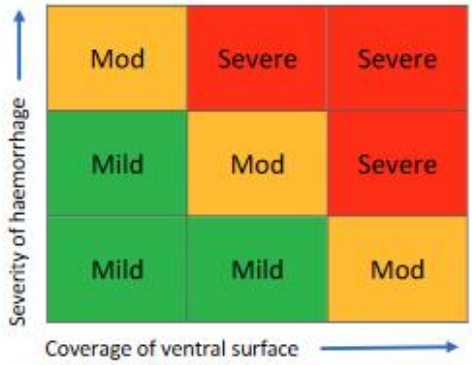
This index is not intended as a definitive diagnostic guide, but simply to standardise reporting of RSD. This document may evolve as our understanding of RSD develops and will be updated accordingly alongside a more detailed case description.

The images in this guide show the ventral surface of salmon exhibiting varying severities of ventral haemorrhaging associated with RSD, along with descriptions to assist the assessment of individual fish.

To distinguish RSD-like lesions from other skin conditions, there is a page at the end of this guide showing a range of images of wild Atlantic salmon with common symptoms and infections - none of which are considered to be consistent with RSD. Whilst secondary infections may be a typical progression of RSD-like lesions, these growths often mask underlying characteristics and hinder a reliable assessment of this condition.

Severity and characteristics of RSD

Based on observations from rivers across the UK and Ireland, it appears that RSD-like lesions can vary widely both in the extent and severity of ventral reddening. As such, the categorisation of mild, moderate, and severe lesions is based on the coverage of ventral regions of affected fish and the severity of haemorrhage/inflammation. The contribution of these two factors to the assignment of RSD severity is demonstrated in the diagram below.



Severity of haemorrhage: refers to the colour of lesions and extent of disruption to the skin, ranging from subtle pale marks with little or no skin disruption, through to deep red, aggressive lesions with notable disruption to skin surface including scale displacement.

Coverage of ventral surface: refers to the extent of the ventral surface covered by haemorrhagic/inflammatory lesions. Ranging from discrete, localised marks to extensive rash-like lesions covering most if not all of the ventral surface, and even extending on to the lateral surfaces of the fish.

Version 1. February 2022

Normal ventral surface

Clean, white ventral surface with no evidence of haemorrhaging or significant skin lesions. N.B. Some minor blemishes or imperfections in wild migratory fish are common and normal and may arise from multiple causes.

Mild RSD-like lesions

Ventral haemorrhage typically focal or diffuse, with minimal disruption to the skin. Lesions are relatively pale, discrete and typically cover less than 50% of the ventral surface.

Moderate RSD-like lesions

Coverage and severity of lesions variable with patches of more significant reddening including raised or more disrupted regions of the skin. Coverage may be extensive and variable, with either mild severity of lesions covering a large proportion of the fish, or focal regions consisting of more pronounced red marks.

Severe RSD-like lesions

Pronounced and extensive petechial or rash-like haemorrhage covering large proportions of the ventral surface, occasionally extending onto the flanks of the fish. Evidence of skin disruption including raised areas of scale displacement with marked petechiae, extending into larger patches, usually raised and deep red in colour.

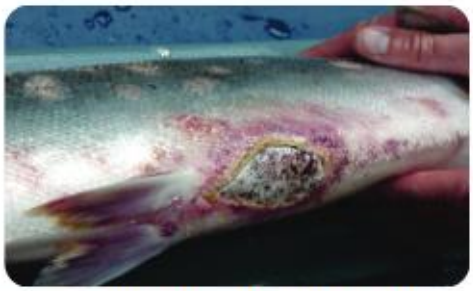
Version 1. February 2022

Symptoms associated with other skin conditions of wild salmon

Red Vent Syndrome, involving localised swelling and reddening of the vent.

Lice damage, with typical fine, petechia often localised posterior to the fin bases.

Abrasion, with associated scale displacement.



Severe bacterial infection with ulceration and inflammation.

Saprolegnia infection with typical rounded, cotton wool-like growths.

Mixed secondary infections involving bacteria and Saprolegnia.

Contact details

England: To report fish mortalities or fish in distress please contact the **Environment Agency** incident hotline on 0800 80 70 60. For further information on RSD please contact our National Fisheries Laboratory on 02084 745244 or email fish.health@environment-agency.gov.uk

Wales: contact the **Natural Resources Wales** hotline on 0300 065 3000, or visit the website: Natural Resources Wales / Report an incident. For further information, contact fisheries.wales@cyfoethnaturiolcymru.gov.uk

Ireland: contact **Inland Fisheries Ireland**. Tel: 0818 34 74 24, or email salmonhealth@fisheriesireland.ie

Scotland: contact the Fish Health Inspectorate at **Marine Scotland**. Telephone 0131 244 3498, or email ms.fishhealth@gov.scot

For further information on this document, please contact fish.health@environment-agency.gov.uk

Version 1. February 2022

7.3 Appendix 3 RVS severity field guide

marinescotland science | The Scottish Government | Environment Agency

Red Vent Syndrome in wild Atlantic salmon – A severity field guide

Background

Wild Atlantic salmon returning with inflamed, swollen and bleeding vents have been seen in rivers throughout the UK since 2006. This condition has been called Red Vent Syndrome (RVS). This index has been developed to standardise the recording of RVS within Britain, allowing consistent reporting and monitoring. It replaces all earlier field guides. The following images show the normal vents of salmon and vents with varying degrees of RVS. Descriptions are provided to help clarify the different stages of RVS. Please use this guide when recording RVS and report these cases to the contact details below.

Contact us: For more information about RVS or to report affected fish please contact

- In England and Wales contact the Fisheries Technical Services at the **Environment Agency**. Telephone 02084 745244, or email fish.health@environment-agency.gov.uk
- In Scotland contact the Fish Health Inspectorate at **Marine Scotland**. Telephone 01224 876544 and ask for the Duty inspector, or alternatively email MS.fishhealth@scotland.gsi.gov.uk

Vent condition

The vents of salmon can differ in appearance for natural reasons. For example, just prior to spawning the vent may become pinker and protrude slightly, but should appear clean. Some salmon may also have abrasions in the vent area or some sea lice damage as seen in the right hand image below (circled). This should not be recorded as RVS, which involves more pronounced reddening and swelling. The severity of RVS varies. Some evidence suggests that the condition of the vent can improve the longer the salmon are in fresh water. Consequently, please include date of capture, the river and location when reporting RVS cases.

Normal

Normal: Small, pink coloured vent with no evidence of swelling, lesions or haemorrhaging.

Mild RVS

Mild: Slight or no swelling. Reddening around the vent and/or a few red spots (petechial haemorrhage). No evidence of skin erosion, dead skin (necrosis) or scale loss.

Moderate RVS

Moderate: Pronounced reddening around the vent with marked swelling. Some bleeding (haemorrhage), skin erosion and scale loss may be evident.

Severe RVS

Severe: Severe swelling and/or open lesions with bleeding and/or prolapsed tissue from the vent. Eroded or dead skin (necrosis) evident around the vent. Secondary infections may also be present.

7.4 Appendix 3 Data tables

Not published

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