SKYE & WESTER ROSS FISHERIES TRUST

REVIEW September 2020

 Registered Charity Number SCO39771

SKYE & WESTER ROSS FISHERIES TRUST

A Charity Registered in Scotland No. SCO39771 and A Company Registered in Scotland No. SC344382

REVIEW

compiled by Peter Cunningham

September 2020

Cover photos (all photos in this report © SWRFT unless stated otherwise):

Please note that all the photographs of fish from our surveys in this report are of anaesthetized fish which were kept out of water for typically less than 30 seconds before being transferred into a recovery bucket to wake up prior to release.

From top right *(clockwise):*

(1) *Wester Ross Wild Trout Workshop participants netting sea trout in the Flowerdale Burn estuary by Gairloch Harbour on 1st May 2019. The TV cameras were recording for 'Sean's Scotland'. Over 500 parasitic sea lice were counted on one of the sea trout from the sample.*

(2) *Despite very high numbers of sea lice recorded on sea trout earlier in the year, this large mature female sea trout was taken in the sweep net at Flowerdale in September 2019. Note the louse damaged but healed dorsal fin. In some situations, sea trout are able to recover from heavy infestations of sea lice by moving into freshwater where the sea lice detach.*

(3) *Skye fisheries biologist and Glasgow University PhD student Isabel Moore (front left) and other members of the Skye sweep netting team by Loch Slapin in June 2019. To be able to carry out its field work programme, SWRFT depends upon support from many volunteers. Thank you to all!*

(4) *Gone fishing! Peter Davison and Peter Cunningham on Isle Maree at lunchtime on the 6th of September 2019. Many brown trout of up to 34cm were caught. A larger sea trout was hooked, jumped by the boat and got away. The photograph was taken by Keith Dunbar who later described the day as one of the best of the year. Elsewhere in Loch Maree, brown trout of up to 3lb were caught in 2019; the largest sea trout was only 2.5lb.*

(5) *A sea trout spawning burn by Loch Coulin in the headwaters of the River Ewe, October 2019. The burns around Loch Coulin provide good spawning habitat for Loch Maree sea trout and good nursery habitat for young trout; they are carefully managed by Coulin Estate.*

The SWRFT has the right to use information it has collected and analysed in order to meet its aims and objectives. Since the SWRFT is funded in part by income from the public sector, this information may be passed on to other public or charitable bodies involved in fisheries management. It is not the SWRFT's right or intention to use this information for commercial gain.

Learning about wild fishes.
Little Loch Broom, August 2019 (photo by Donald Rice)

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(at 30th March 2020)

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Supporters

The Skye and Wester Ross Fisheries Trust has been generously supported by:

and by generous donations from members and other individuals and in-kind support from estates, boat operators, and many local volunteers from Achiltibuie to Barrisdale on the mainland and Glendale to Sleat on the Isle of Skye.

Chair's Introduction

This review of the Trust's activities during 2019 and early 2020 describes the most comprehensive and broad ranging body of fishery monitoring activity ever undertaken by the organisation. Extending across the entire Wester Ross and Skye area and with the assistance of our partners at Glasgow University, University of the Highlands & Islands and many kind volunteers this has provided a detailed indication of the state of our fishery populations, together with valuable indications of the factors limiting their productivity. At a time of growing concern at both local and national level over the sustainability of fish populations and the political debate surrounding it, the value of authoritative, local scientific data to inform the public, river managers, government agencies and decision makers has probably never been greater.

In common with all Trusts an important part of our charitable function relates to the education of the public and during 2019 we were successful in our application to the Robertson Trust and Nineveh Trust to undertake a pilot programme aimed at providing teaching input to all schools in the Skye and Wester Ross area. Aligned with the national curriculum this will cover biodiversity within river systems, the role of fishery management in species conservation, the impact of invasive species and a continuation of the successful "salmon in the classroom" initiative.

We also report on a successful application to the William Grant Foundation to undertake a pilot study of herring and bait fish productivity in Wester Ross coastal areas with our partners at Edinburgh Napier University. This is a logical extension of our activity in freshwater and estuarine habitats to the adjacent marine environment particularly in respect of concerns over smolt survival and the productivity of sea trout populations in coastal water.

Particularly at the conclusion of such a productive and interesting period, at the time of reporting, regrettably, it is simply not possible to ignore the profound and far -reaching impact of Covid-19 on the activities of the Trust. In mid-February 2020 Trustees approved a business plan and budget aimed at further growth of its activities, not least with the employment of a second post-doctoral Fisheries Biologist covering Skye and the Small Isles.

Unfortunately, over the following 6 weeks, as a result of Covid-19, 96% of total budgeted fisheries income had been withdrawn which together with Government lockdown and social distancing measures meant the abandonment of all planned activity for 2020. This has had the gravest impact on the financial sustainability of the organisation. It has required the expenditure of significant capital reserves, together with a number of unprecedented actions and far -reaching restructuring to create a low-cost model which may be capable of ensuring its future survival. No doubt, we face a predicament shared by very many small organisations across the UK.

Given the restoration of funding and in the absence of further lockdown, albeit in a different model, Trustees remain hopeful that it will be possible to re-build activity in 2020 and 2021.

Ian Lindsay, September 2020

Part 1 **Introduction**

This review presents a summary of the work of the Skye and Wester Ross Fisheries Trust over the 15 months up to March 2020, and some related contextual information. For many rivers, rod catches of salmon and of sea trout were amongst the lowest on record (Part 2.1). Juvenile salmon were surveyed at sites on the mainland and on the Isle of Skye; fry numbers were very low in some rivers (Part 2.2). High numbers of parasitic sea lice were recorded on sea trout sampled at coastal sites around the SWRFT area, but not everywhere (Part 3). Much of our work continued to focus on learning how emissions of larval sea lice from marine salmon farms affected wild fish. Several new salmon farms with 2000+ tonne biomass consents were granted planning permissions (Part 3.3). From July 2019, applicants for new salmon farms were required to present a sea lice dispersal model with their planning application. These models demonstrate the potential for further increases in concentrations of infective stage sea lice several tens of kilometres away from fish farms of projected origin, according to coastal currents and wind direction.

In contrast to sea trout, wild salmon post-smolts which become infested with sea lice remain at sea. Those which migrate through areas with high cumulative concentrations of infective stage lice may have been more vulnerable than has so far been established through sampling. Hence much concern and many hours of largely unpaid work by the Wester Ross Area Salmon Fishery Board in response to planning consultations, informed by the results of some of the Trust's work (Part 4); and research by scientists at the Scottish Government's Marine Scotland Science (Part 5). In 2020, the Trust was to participate in a collaborative West Coast salmon tracking project led by the Atlantic Salmon Trust to learn more about migration pathways of wild post-smolt salmon.

Some long awaited results of genetic studies of wild trout around the Loch Maree area were reported (Part 6). Anadromous trout populations appeared to be resilient in some areas, able to keep going despite being subject to high levels of sea louse infestation. Parasitic sea lice detach from their host after a few days in freshwater; some sea trout which were able to move to estuary pools recovered. An abundance of readily available food may have also helped. Spring spawning herring were again recorded to the west of Gairloch (Part 7.1).

The Trust also supported student projects to learn more about seabed habitats of importance to wild fish populations (Part 7.2) and has continued to raise awareness and actively support the control of non-native invasive species (Part 8). The Trust's Biologist has also worked with other organisations including the Portree Angling Association and the Wester Ross Biosphere with a focus on issues of shared interest and concern (Part 9).

Further details can be found within the following pages. Our wild salmon and wild trout populations are special things that have survived and adapted to changing environments over millennia. The Wester Ross Fisheries Trust (which joined with the Skye Fisheries Trust to form SWRFT in 2017) was established in response to the threats they face, in recognition of their value to humankind and as a critical part of the biosphere's complex web of life. The challenge of looking after wild salmon is now as great as it has ever been. When all the anxiety and disruption associated with the Coronavirus has settled back down, one hope's that our self-sustaining wild salmon populations are given the level of protection required not just to prevent further extirpation of local populations but to revive prolific runs of these remarkable fish for those who come after.

Thank you for your interest and support.

Peter Cunningham, (revised) September 2020

Part 2 **Salmon and sea trout stocks**

2.1 Rod catches

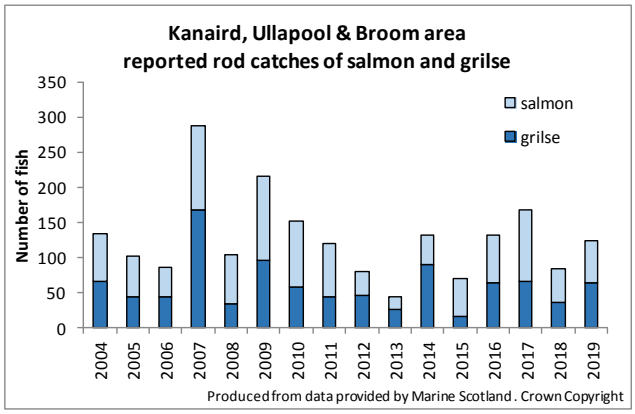
Following a legal challenge to the Scottish Government citing the new General Data Protection Regulations [GDPR], rod catch figures can no longer be published by the Scottish Government at the fishery district level. Instead catches have been grouped together into a series of reporting areas of which there are now six which cover the SWRFT area. At the time of writing it is still not clear whether SWRFT can continue to request catch data and publish graphs for any of the individual river systems as in previous SWRFT reviews; so for the purposes of this review the graphs below follow the new Scottish Government guidance and published rod catch figures[1].

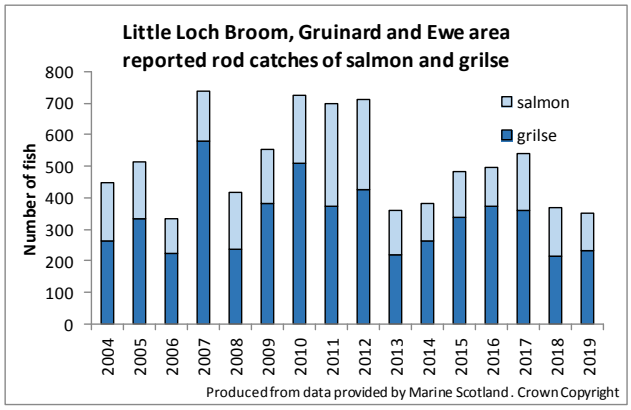
Salmon and grilse – mainland rivers

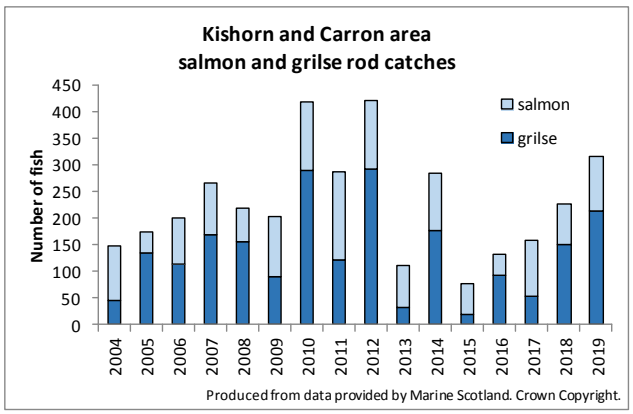
Published catches of salmon and grilse reported for five out of the six reporting areas show lower catch of salmon and grilse in 2018 than in 2017. For the Badachro – Applecross area, and the Loch Long to Arnisdale area, the combined catch in 2018 was the lowest since 2004. The only area to surpass the 2017 total in 2018 was the River Carron - Kishorn area.

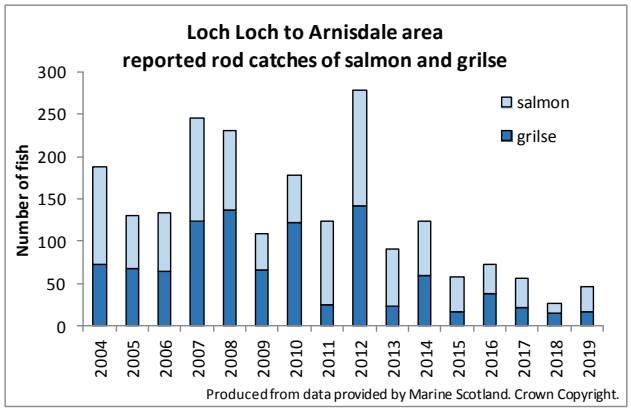
Totals for salmon and grilse for some of the 'core' salmon rivers (Little Loch Broom to Ewe) in 2019 were similar to those in 2018. In contrast, the River Carron – Kishorn reporting area again recorded higher rod catches than in the previous year. However, reported catches for the Loch Long – Arnisdale area were again very low.

Figure 2.1 Rod catches of salmon and grilse for mainland parts of the SWRFT area.









[1] Scottish Government rod catches of salmon and sea trout https://data.marine.gov.scot/dataset/salmon-and-sea-trout-fishery-statistics-2018-season-reported-catch-and-effort-method

(left) Escaped farm salmon, River Ewe, 2nd July 2019. This fish has characteristic features of a freshly escaped farm salmon including a stunted dorsal fin, tatty tail and different spot pattern from a native wild River Ewe salmon.

(right) Probable escaped farm salmon (about 7lb) Dundonnell River, August 2019. This fish was thought by the angler to be a sea trout so released. It does indeed have many trout like features and would have been the biggest sea trout taken in the area for several years. However, its spot pattern and general appearance were subsequently judged to be more akin to some of the spotty escaped farm salmon that have been seen in the SWRFT area in recent years.

Salmon - Skye

The total reported catch of rod caught salmon and grilse for the Skye and Small Isles area for 2019 of just above 100 fish was the lowest on record since 2004.

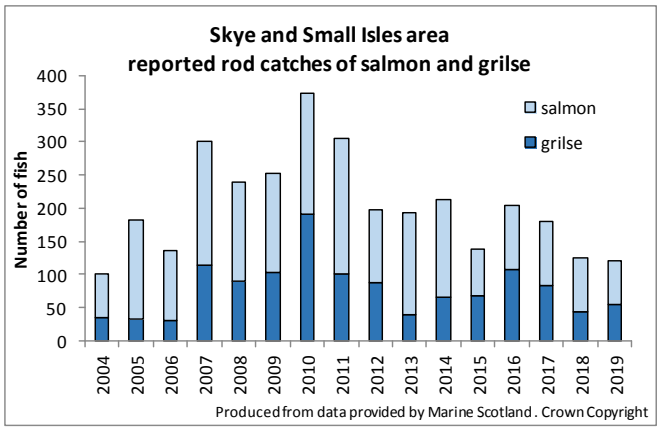


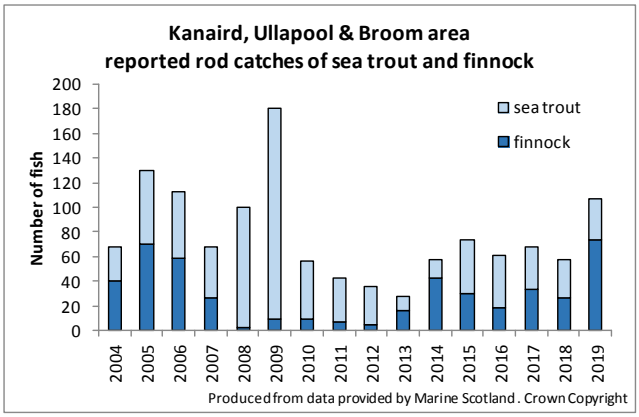
Figure 2.2 Rod catches of salmon and grilse for the Skye and Small Isles reporting area.

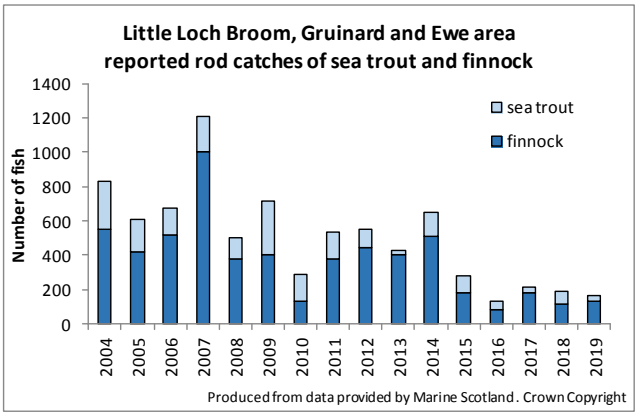
This new reporting area is very large, and includes both major salmon rivers (Snizort, Varagill, Kilmartin and Sligachan) and several smaller streams where salmon or grilse have previously been regularly caught (e.g. Hinnesdal, Drynoch, Ose, Brittle, Hamara, Broadford). Little can be said about the performance of individual rivers around the island from these figures, other than that perhaps none of them have been doing well.

Sea trout – mainland waters

Reported catches of sea trout and finnock were mixed. For the Kanaird to Broom area, the combined total for 2019 was higher than for many years. However, for the Little Loch Broom to Loch Ewe area, combined totals were close to the lowest on record with less than 150 fish reported in both 2018 and 2019. Formerly the River Ewe system alone produced 2000 sea trout in a year, many of which were caught from boats fishing in Loch Maree.

Figure 2.3 Rod catches of sea trout and finnock for north SWRFT mainland reporting areas.





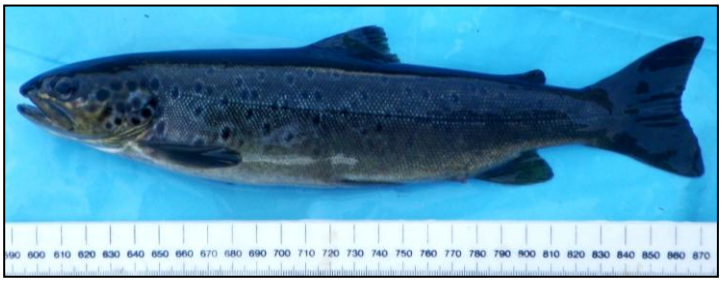
Wild trout are still present in all waters. However in river systems with large lochs, it is thought that because those that remain in freshwater throughout their lives have been more successful than those which migrate to sea, the genetic composition of some trout populations may have changed in favour of resident brown trout rather than anadromous sea trout, with fewer sea trout smolts migrating to sea (see also Part 6).

There were signs of some recovery around the Two Brooms area in 2019; several sea trout of over 4lb were taken in rivers around the Two Brooms area (Loch Broom and Little Loch Broom).

(left) SWRFT Trustee Alasdair Macdonald with a sea trout of 4lb 10oz taken on 7th July 2019, his largest sea trout to date. Congratulations Alasdair!

(right) Keith Dunbar & Peter Davison fishing Loch Maree on 6th September 2019. Several finnock and brown trout of up to just below 1lb were caught; a sea trout of around1.5lb was hooked and lost after jumping out of the water beside the boat. Photograph by occasional ghillie, Peter Cunningham. Elsewhere on the loch, brown trout of up to 3lb were caught from boats in 2019.

Over the past 20 years, many adult male resident brown trout have been taken in and around Loch Maree by both rod and line and in fyke net samples. Until recently most adult female trout were assumed to be sea trout. The capture of a maturing female brown trout by Grudie on 19th October 2018 was notable; the trout population in this part of the loch may now be sustained by female resident brown trout rather than by female sea trout.



Maturing female resident brown trout (270mm, 237g) from Loch Maree taken on 19th October 2018 from Loch Maree.

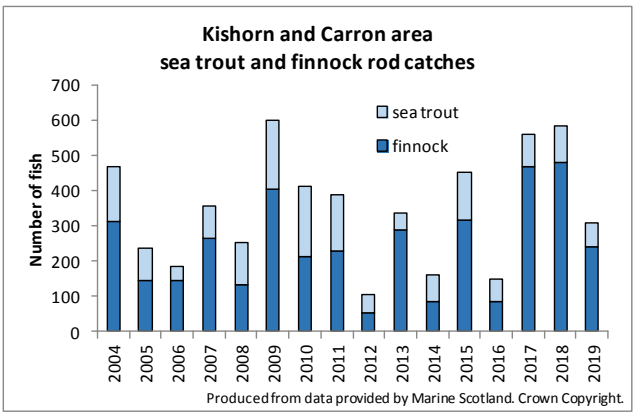
Many of the sea trout taken in Loch Maree in recent years have been at the south end of the loch, suggesting that headwater streams above Kinlochewe including those in the Coulin area now provide the main spawning areas for the trout populations which produce most of the sea trout. For those still interested in restoring the once prolific Loch Maree sea trout fishery, the challenge may be to tip the genetic balance back in favour of an anadromous life-history for trout populations in other areas including the Talladale – Loch Maree Hotel area.

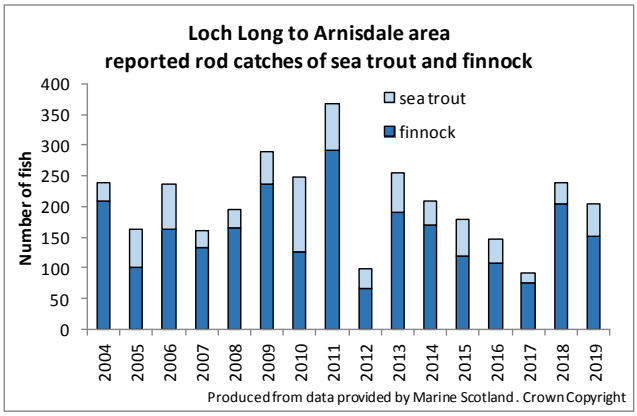
(below) Sea trout, 15.5lb from Loch Maree, taken by M. M. Johnson, 18th August 1934, Ghillie John Mackenzie. This fish must have been quite close to the rod caught record for a Scottish sea trout when caught. Subsequently a fish of 19.5lb caught in Loch Maree in September 1951 by David McNaught became the British record for a rod caught sea trout (it has since been surpassed by sea trout taken elsewhere).

Photo by Robin Ade who found this fish in the Kircudbright Museum in 2019. If anyone else has stories of other notable Loch Maree sea trout please get in touch! (Robin painted the Loch Maree wildlife poster which can be found at https://www.wrft.org.uk/files/wildlife.pdf copies of which are still available from SWRFT).

Further south, rod catches of finnock in the Loch Carron and Loch Long to Arnisdale area were higher in 2018 than for many years. However, numbers of sea trout remained much lower, suggesting low rates of survival from finnock to sea trout (see Part 3 and Part 5 for related discussion).

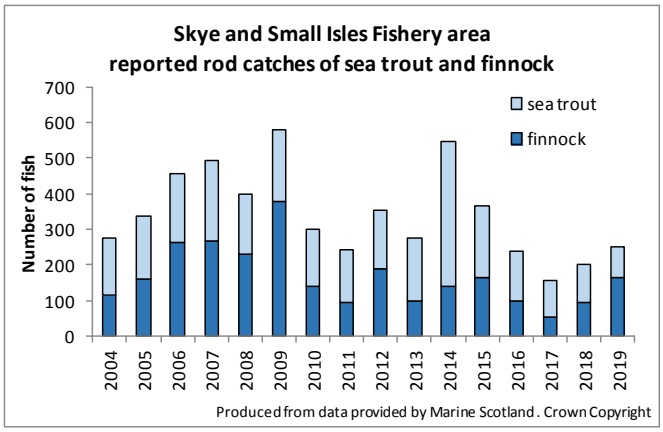
Figure 2.4 Rod catches of sea trout for southern mainland part of the SWRFT area.





Sea trout - Isle of Skye & Small Isles

There is uncertainty about levels of catch reporting for rod caught sea trout and finnock in the Isle of Skye and Small Isles area, perhaps even more than for salmon and grilse. Assuming that reporting has been consistent in recent years, published figures (Figure 2.5) indicate that catches of sea trout were the lowest on record in successive years up to 2019.



(right) Figure 2.5 Rod catches of sea trout for the Isle of Skye and Small Isles reporting area.

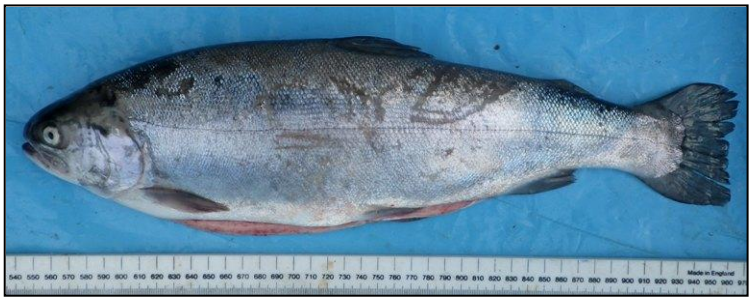
In addition to all the rivers listed under 'salmon catches', there are many smaller sea trout rivers on Skye and several sea trout waters on the Isle of Rum, some of which were described in the SWRFT Review February 2018[2]. Furthermore, angling for sea trout in the sea has been practiced around some parts of the Isle of Skye and parts of the mainland, rod catches from which do not appear in official statistics.

Anecdotal information suggests that in some areas, the number of sea trout caught by shore anglers in the sea may be greater than the number taken and reported by anglers fishing rivers and lochs. It would be useful to learn more about how much fishing takes place in coastal areas around the SWRFT area and to improve the reporting of rod catches from all waters. Enthusiastic shore anglers may also be able to help to improve and look after some of the smaller coastal burns which produce sea trout, in much the same way as around Orkney.

Escaped farm rainbow trout

On 7th September 2019, an estimated 1300 rainbow trout mostly of between 500g and 900g in weight escaped from a fish farm in Loch Poolteil in Northwest Skye. Subsequently, over 100 rainbow trout were caught by anglers fishing the nearby Hamara River, with other rainbow trout taken from the Drynoch, Brittle, Snizort, Varagill and several other rivers around Skye; and from the River Inver, Little Gruinard River and River Kerry on the mainland.

A 'fresh run' rainbow trout was caught early in 2020 from the River Snizort, demonstrating that some fish had survived over the winter.



(right) Escaped farm rainbow trout, taken by an angler fishing the Little Gruinard River, September 2019.

As all the fish that escaped were said to be triploid (3 sets of chromosomes instead of two) and therefore infertile, there is no risk of spawning in the wild. To assess the possibility of adverse impact to native trout and salmon populations, some of the rivers where larger numbers of rainbow trout were caught may be surveyed in 2020.

[2] SWRFT Review February 2018; see page 41.
http://www.wrft.org.uk/files/SWRFT%20Review%20February%202018%20Final%20for%20web%20V2.pdf

2.2 Juvenile fish surveys

supported by the Scottish Government, WRASFB & local businesses

Electro-fishing surveys, using specially designed equipment, provide the means of monitoring the distribution and relative abundance of juvenile fish within the river systems of the area. Using this method, juvenile salmon have been recorded within 38 river or stream systems on the mainland from the River Kanaird to the Barrisdale River (inclusive) and another 18 stream systems on the Isle of Skye so far this century.

In 2018, the collaborative National Electro-fishing Programme of Scotland [NEPS] was launched by the Scottish Government' Marine Scotland Science [MSS] to provide data from which trends in the abundance of juvenile salmon at the regional level can be assessed. NEPS electro-fishing survey sites were randomly selected by MSS and widely spread across Scotland. More background information can be found here: https://www2.gov.scot/Topics/marine/Salmon-Trout-Coarse/Freshwater/Monitoring/ElectrofishingProgramme

In both 2018 and 2019, 30 quantitative NEPS electro-fishing sites were surveyed within the SWRFT area. In both years, approximately two thirds of sites were on the mainland and one third on the Isle of Skye. Some sites required expeditions to remote areas; other sites were more easily accessible from nearby roads. Most sites were surveyed between July and September. Field work for this programme was carried out to standard protocols, led by fisheries trusts. Although the focus was on wild salmon; trout, eels and other fish were also recorded. Data compilation and analyses, and preparation of the national reports were carried out by colleagues at MSS. Genetic samples were also taken from some sites to learn more about salmon population structuring.

To complement the NEPS survey and to maintain our own information base for local salmon conservation and fisheries management purposes, additional 'semi-quantitative' sites were surveyed in some rivers with the support of river proprietors and the Wester Ross Area Salmon Fishery Board. Additional surveys were carried out to fulfil monitoring contracts for the salmon farming industry, hydropower companies, or for demonstration purposes.

Surveys of mainland sites were led by Peter Cunningham assisted by Colin Simpson (both SFCC qualified) and David Holland, with help from many other volunteers and estate staff. Surveys on the Isle of Skye were carried out by the University of Highlands and Islands' Rivers and Lochs Institute led by Prof Eric Verspoor; and by a team from Glasgow University.

The purpose of the following section is to provide a summary of results in 2019, focussing on salmon. A brief summary of the results of surveys in 2018 can be found in the SWRFT Newsletter February 2019[3].

(right) Colin Simpson and son Finn with Coulin Estate keeper Neil Morrison by the Coulin River, July 2019.

[3] SWRFT Newsletter February 2019
http://www.wrft.org.uk/files/SWRFT%20Newsletter%20February%202019%20v%2011%20Feb%202019.pdf

Results

The recorded distribution and relative abundance of salmon fry and parr at sites surveyed within the SWRFT area in 2019 are shown in Figure 2.6 and Figure 2.7 respectively. For NEPS sites on the mainland, only the fish that were caught in the first run are included. For NEPS sites on Skye, results are shown as present or not recorded.

Juvenile salmon were found at all NEPS sites in rivers surveyed on the mainland in 2019. However, the average density of salmon fry (young of the year) was lower in 2019 than in 2018 (Table 2.1). In contrast, the average density of salmon parr (age 1+ years) was higher in 2019 than in 2018.

(right) Table 2.1 Summary of NEPS e-fishing results for mainland sites surveyed in 2018 and 2019.

	2018	2019
Number of sites surveyed on the mainland	**21**	**21**
Salmon fry (0+ young of the year)		
Number of sites with salmon fry	**19**	**17**
Average number of fry per minute fished (CPUE)	**1.35**	**0.77**
Average salmon fry density (fish per 100m^2)	**17**	**9**
Salmon parr (age 1++ years)		
Number of sites with salmon parr	**21**	**19**
Average number of parr per minute fished (CPUE)	**0.69**	**1.08**
Average salmon parr density (fish per 100m^2)	**8**	**12**

Similar results were found at several other non-NEPS sites, including in the little Tournaig system by Loch Ewe where the salmon population has been monitored since 1999.

Reduced salmon egg deposition in the autumn of 2018 as well as extreme weather events during the winter and spring of 2019 may have contributed to lower salmon fry densities in 2019. Some rivers experienced severe streambed-damaging spate events. Water temperatures were unusually high in February 2019 possibly leading to premature hatching. Unusually low flows in May 2019 may have dried out nursery areas when newly emerged salmon fry were vulnerable. Unusually high temperatures in June 2019 following the drought may have been too much for salmon fry in some areas.

River by river summaries

The following section provides a river by river summary focussing on juvenile salmon occurrence in 2019, from north to south. Table 2.2 defines the CPUE grades and minimum density estimate grades used for describing the broad variation in juvenile fish abundance recorded within the SWRFT area[4].

*(right) Table 2.2 Definitions of **Catch per Unit Effort [CPUE]** & **estimated density** grades as used in the following text.*

CPUE	Minimum density estimate	Grade
0	0	Absent
0.1 – 0.5 fish per minute	1 – 5 fish per 100m^2	Very low
0.6 – 1.0 fish per minute	6 – 10 fish per 100m^2	Low
1.1 – 2.0 fish per minute	11 – 20 fish per 100m^2	Moderate
> 2 fish per minute	> 20 fish per 100m^2	High

[4] There was a consistent relationship between CPUE and minimum density estimates for mainland NEPS sites surveyed by the SWRFT electro-fishing team in 2018 and 2019. Linear trendlines for juvenile salmon give: minimum fish density [number of fish per 100m^2] = CPUE [number of fish per minute] x 11.7 for fry; and = CPUE x 11.35 for parr.

Figure 2.6 Recorded distribution and relative abundance of salmon fry at sites surveyed within the SWRFT area in 2019. For NEPS sites on the mainland, only the fish in the first run are included.

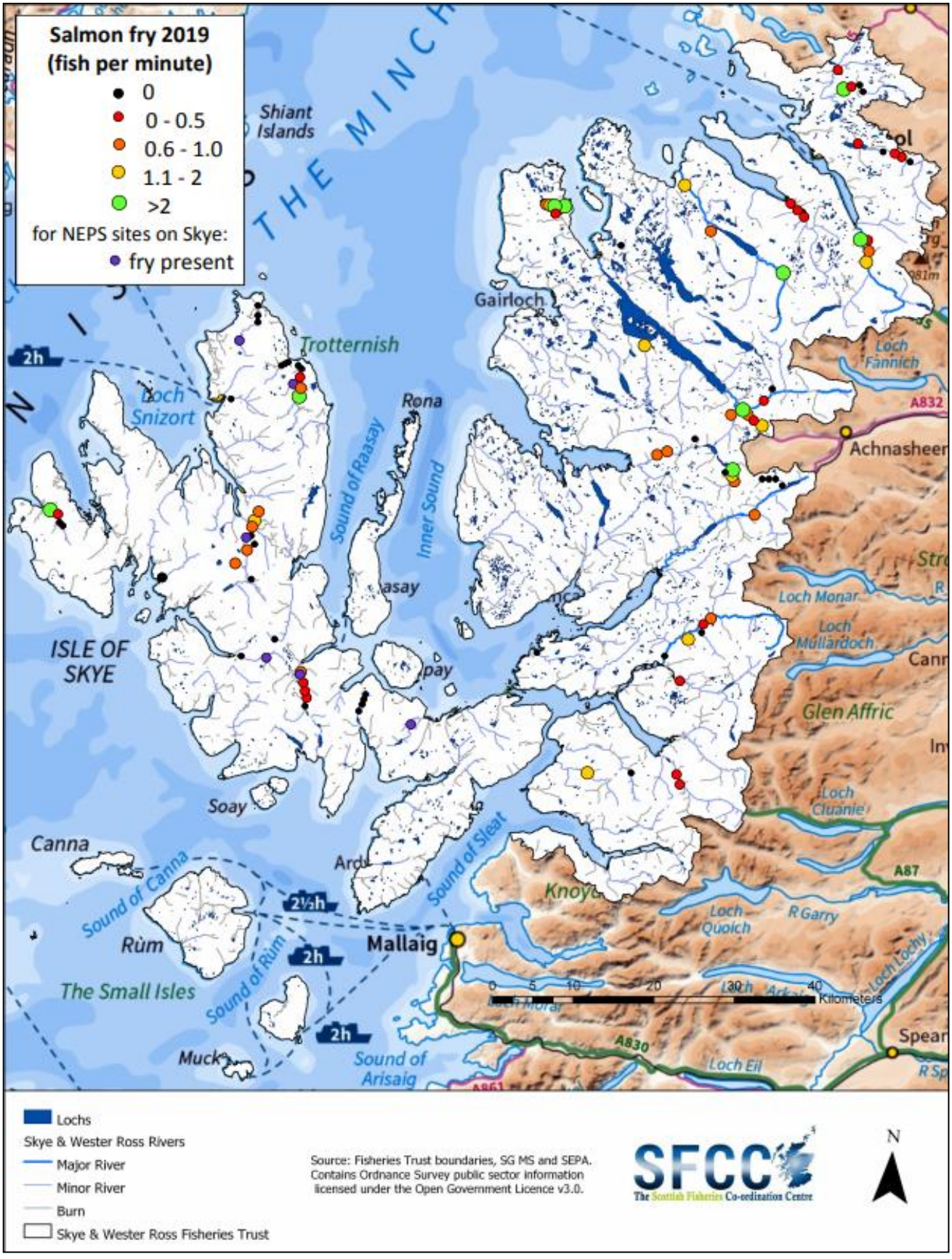
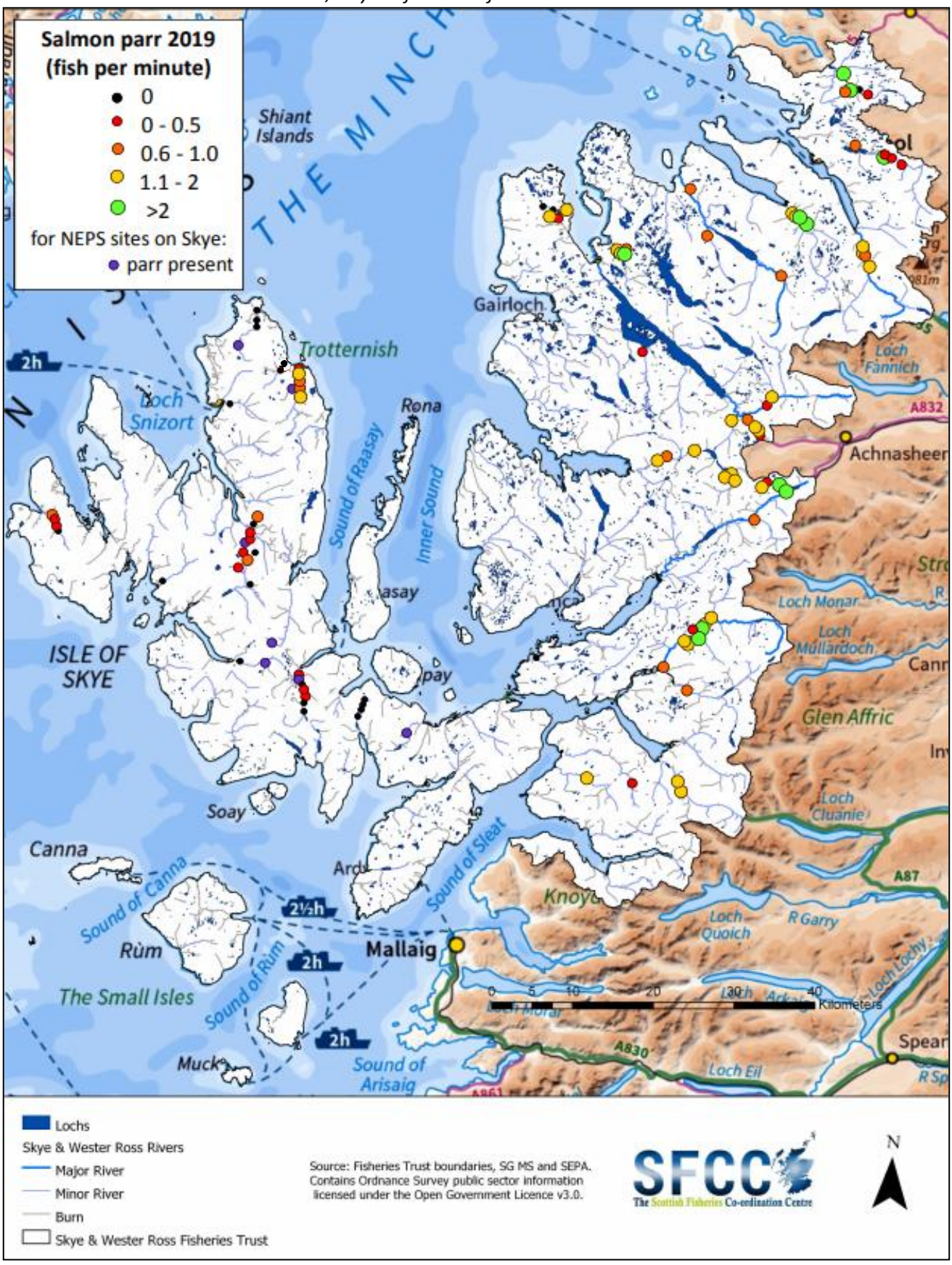


Figure 2.7 Recorded distribution and relative abundance of salmon parr at sites surveyed within the SWRFT area in 2019. For NEPS sites on the mainland, only the fish in the first run are included.



River Kanaird (Canaird)

Four sites were surveyed on 30th July 2019 in the upper Kanaird as part of a contract to monitor juvenile salmon populations in the river following the development of the Langwell Hydropower Project. The powerhouse for this scheme is located 3km upstream from a complex waterfall over which adult salmon were only occasionally able to ascend even prior to development of the scheme. One of the objectives of the survey has been to find out whether there is any evidence of salmon spawning above the falls following the development of the new power scheme.

At the two sites above the falls, no salmon fry were found and the only parr were aged at 2 years old. In contrast, at a site ~80m downstream from the falls, salmon parr CPUE was high; and at a site between the fields below Langwell, salmon fry CPUE was high as in previous years. The 3km section of river above the falls provides good habitat for juvenile salmon. The riparian corridor has improved with maturing alder trees thanks to a riparian woodland scheme developed by former proprietor Tony Fenwick. To enable adult salmon to recolonise the upper part of the accessible area, it would be a relatively straightforward job to ease passage over the already much modified Langwell falls. Such action is currently prohibited by SEPA.

Further downstream sedimentation of the man-made river channel has resulted in the river level and water table rising, leading to water logging of surrounding agricultural land. If the embankments on either side of this channel are breached, much valuable topsoil will be eroded away without any benefit for wild salmon populations. Sediment (gravel and pebbles) could be periodically removed from the side of the river channel here for purposes of both protecting freshwater habitat in downstream areas and protecting surrounding farmland. Furthermore, the sediment could be used for a range of local road and estate maintenance purposes rather than bringing in crushed quarry rock sourced from further away.

Salmon parr (of above average size) were also recorded at high CPUE at a NEPS site in the River Runie, the other main tributary of the River Kanaird on 30th July 2019. Both the water chemistry (conductivity 110 µS) and healthy riparian corridor (plenty of leaf litter) along this section of the Runie contribute to good growing conditions for juvenile salmon.

Box 2.1 'Bootlace' eels ascending the Langwell Falls, 30 July 2019

On 30th July 2019, eels outnumbered other fish at the uppermost e-fishing site in the River Kanaird by Glen Cottage, a few hundred metres downstream from the new HP scheme powerhouse. Eels were of lengths 165mm – 280mm. Further downstream, many eels (~50) were observed attempting to ascend the Langwell falls. These fish were mostly 120mm – 200mm in length; they had left the main flow by the side of the upper part of the falls and were attempting to move upstream over spray-dampened rocks.

Why do eels move upstream in the summer? The water temperature was recorded at 18C nearby. There would have been much greater competition from juvenile salmon for food (mostly insect larvae) below than above the falls. Are eels able to locate and exploit habitats where densities of other fish are very low and there is more food?



Ullapool River

In both 2018 and 2019, a series of NEPS sites were surveyed in the Rhidorroch River above Loch Achall. In 2018, salmon fry were recorded at moderate to high CPUE and parr at low CPUE in the Rhidorroch River. However, in 2019 (19th July & 29th July) salmon fry were absent or present at only very low CPUE at all three sites surveyed. Salmon parr (small) were recorded at low CPUE except at an additional site in the Allt Coire Cronaidh tributary.

The Rhidorroch River is very unstable. It suffers not just from redd washout (when salmon eggs are washed away during winter spates) but also from excessive bedload sediment transportation during increasingly frequent major spate events. Following intensive rainfall events, much sediment is transported from Glen Douchary in the upper catchment to the Rhidorroch River valley, causing scouring and mobilisation of other sediment on its way down. For juvenile salmon which normally seek cover in the stream bed, the Rhidorroch River provides an uncertain place to live: conditions can be favourable in some years, impossible in others. Insect larvae are also washed away in big spates so there is less food for juvenile salmon.

The Rhidorroch River problem, assessed prior to preparation of the Ullapool River Fisheries Management Plan 2005-2010, may have become worse in recent years. As extreme weather events associated with global warming are predicted to become more frequent, the SWRFT Biologist recommends that estate management groups and the Scottish Government, through its agencies SEPA and SNH, consider taking actions to develop ecological solutions which reduce rates of rainwater runoff, erosion, and sediment transportation from upland catchment areas.

(left) An electro-fishing site in the Rhidorroch River downstream from East Rhidorroch, July 2019. This section of river is very unstable with frequent realignment associated with sediment movement. Densities of juvenile salmon were very low here.

River Broom

Five sites were surveyed along the River Broom and tributaries on the 21st of August 2019. Water levels were on the high side making fishing less effective than usual. However, at sites by Inverbroom and Achindrean salmon fry were recorded at high and moderate CPUE respectively, and parr at low CPUE. These results underestimate juvenile salmon abundance in the main river due to the difficult fishing conditions. Salmon fry and parr were also present at three other sites including two sites in tributaries.

(right) three year classes of juvenile salmon and two mayfly nymphs from the River Broom at Achindrean bridge on 21st August 2019.

The River Broom and tributaries were much modified when Sir John Fowler reclaimed large parts of the valley for agriculture early in the 20th Century. That both the river and fields remain productive after over 100 years is a credit to his vision. Hydropower schemes developed in the 1950s in the upper catchment have not been as detrimental to salmon in the main river as might have been anticipated, as compensation flows are released. The new Loch a' Bhraoin Hydropower scheme is anticipated to further stabilise flows in downstream areas, providing some protection from peak spate events.

Dundonnell River

Five main river sites were fished in the Dundonnell River in 2019 (28th August & 27th September) including two NEPS sites. Salmon parr were recorded at moderate or high CPUE at all sites. However salmon fry were absent or recorded at only very low levels giving cause of concern. Our initial interpretation is that the low salmon fry numbers related to adverse weather and river conditions, and to redd washout earlier in the year (c. Rhidorroch River). Recent spates had caused bank erosion and much streambed sediment movement in the Dundonnell River.

(left) Discussing how best to stabilse the Dundonnell River: Alasdair Matheson and David Wilby of SEPA with Alasdair Macdonald and Prof Eric McVicar, 19th August 2019.

Gruinard River

Three NEPS sites were surveyed in 2019; one in the Abhainn Loch an Nid above Loch na Sealga (6th August); one in the Ghuibsachain burn (9th September), and one in the main Gruinard River by the islands above the Iron House Flats (6th August). Salmon fry were recorded at high CPUE at the top site above Loch na Sealga, moderate CPUE at the main river site; and low CPUE in the Ghuibsachain burn (underestimate due to high water at time of survey). Salmon fry were very small at the main river site. Parr were recorded at moderate CPUE at all sites. As described in the SWRFT Review February 2018, most juvenile salmon grow more slowly in the Gruinard River than in rivers where there is more riparian vegetation to provide food.

Tournaig (supported by MOWI)

Six sites have been fished in the spawning burn above Loch nan Dailthean in late July or early August every year since 2003. In 2018, salmon fry were recorded at an average of 3.0 fry per minute (High CPUE) for the six sites; parr were recorded at 0.81 fry per minute (Low CPUE). In 2019 salmon fry were recorded at only 4 of 6 sites, at an average CPUE of 1.07; however salmon parr were recorded at all six sites at an average CPUE of 1.40, the highest average parr CPUE on record. Will the relatively high parr CPUE in 2019 lead to more salmon smolts migrating to sea than usual in 2020 (see also section 2.3)?

Sguod (supported by MOWI)

This is another smaller loch-river system by Loch Ewe which has been surveyed each year since 2011 with some interesting results. On the 14th August 2019 salmon fry were recorded at medium to high CPUE at sites in the River Sguod and lower part of the north burn. Parr were recorded at low CPUE. Some of the salmon fry may drop down into Loch Sguod where they grow on. Formerly Loch Sguod had a reputation as a sea trout fishery, so trout fry numbers are of as much interest as salmon. Trout fry were recorded at 5.2 per minute at the top site; the highest of any site surveyed by SWRFT in 2019.

(left) A slippery handful! Sometimes eels are caught which are longer than the measuring board. By Loch Sguod, 14th August 2019.

River Ewe – Loch Maree system

In 2018, salmon fry were recorded at high CPUE and parr at moderate CPUE at sites in the Kernsary subsystem. The absence of juvenile salmon at a randomly chosen NEPS site surveyed in the nearby Inveran River in 2018 is a reflection of the unsuitable habitat for juvenile salmon at this particular location (weedy, silty, slow flowing). Also in 2018, salmon fry were found at high CPUE at sites in the Slattadale River (by Loch Maree) and at moderate – low CPUE at other sites, including at a sites in the Bruachaig River near the Heights of Kinlochewe where salmon parr were also recorded.

In November 2018, adult salmon were seen spawning in the Bruachaig River above the new hydropower scheme and fish pass at the falls (see SWRFT Newsletter February 2019). So we were optimistic of finding salmon fry in 2019. However at a NEPS site surveyed nearby on 15th July 2019, only one salmon fry and 9 parr were recorded in 16 minutes of electro-fishing. In contrast, further downstream by Incheril salmon fry were recorded at 3.84 fish per minute and parr at moderate CPUE. On 10th July, salmon parr were more numerous than salmon fry at all four sites surveyed in the Docherty Burn; combined fry and parr numbers were lower in the Docherty burn than when last surveyed in 2017. Four sites were surveyed in the Coulin River on the 7th August, including a site above the Stone Bridge; fry were recorded at up to high CPUE, and parr at moderate CPUE.

(right) Measuring an electro-fishing site in the headwaters of the Coulin River, August 2019.

A NEPS site was surveyed in the Talladale River just below the road bridge in both 2018 and 2019. In both years parr were more numerous at this site than salmon fry. Some of the parr may move into this site from spawning areas elsewhere; some may enter from Loch Maree. The overall picture for the River Ewe system is that juvenile salmon production remains adequate in most places. The upper Bruachaig River provides the largest opportunity for increasing production of juvenile salmon. Production could possibly also be increased in the Coulin River by enhancing riparian vegetation and nutrition.

Torridon River

Three sites were surveyed on this river over two visits in 2019. Salmon fry were recorded at low CPUE and parr at low to moderate CPUE. On the first occasion (18th July) the river was higher than ideal for electro-fishing so figures may underestimate numbers of fish present. On 20th September, parr were recorded at moderate CPUE at a NEPS site near the council lay-bye.

(left) Chris Beresford, Peter Davison and Tom Brown by the Torridon River on 20th September; (right) three year classes of juvenile salmon recorded from a nearby electro-fishing site. We also watched airborne spiders on gossamer lines drifting by.

River Carron

In 2019, five sites were surveyed in the Allt Coire Crubaidh in the headwaters of the River Carron. No salmon fry were recorded at any of these sites. On the 5th of August salmon parr were found at up to moderate CPUE at the two sites above the new hypdropower intake. On the 13th of August, salmon parr were found at high CPUE at sites above and below the new Allt Coire Crubaidh powerhouse. This part of the catchment has been regularly stocked with juvenile salmon; it is possible that all the juvenile salmon recorded were of stocked origin, including the parr above the fish pass by the intake.

In addition, a NEPS site was surveyed in the River Carron in the Achnashellach forest on 5th August. Here, salmon fry were recorded at low CPUE and parr at very low CPUE; the fry (at least) were thought to be of wild origin. Prior to any stocking of salmon in 2020, an electro-fishing survey of sites above Loch Dughaill in 2020 would help to clarify the status of wild salmon in this part of the River Carron.

(right) The new HP intake weir and fish pass on the Allt Coire Crubaidh, and (far right) two salmon parr from an electro-fishing site further upstream on 5th August 2019.

River Ling

The Ling is one of the larger salmon rivers in the south of the SWRFT mainland area. In 2019 two survey expeditions were carried both later in the year than usual, following completion of NEPS sites all of which were on other rivers. On the 1st October sites were surveyed in the upper Ling above the confluence of the Coire-domhain burn. Salmon parr were recorded at moderate to high CPUE at all sites including the top site just below the confluence with the Blackwater. However salmon fry were absent or recorded at only low or very low CPUE; and the fry: parr ratio was nearer 1:2 than the other way around.

In previous recent years salmon fry of native origin were stocked into the middle part of the river, but not further upstream. As there had been no stocking of salmon fry in 2019, there was interest in finding out about juvenile salmon populations in the middle section. An opportunity arose to revisit the river on 13th December and four sites were surveyed. Despite low water temperatures (~4C) salmon fry were recorded at three sites above the lower falls, and parr at all sites including a site by the road bridge near the tidal limit. All the juvenile salmon were thin at the two main river sites above the lower falls. In contrast, much larger, better fed parr were recorded at the site in the lower river. Our survey supported the contention that juvenile salmon production in the upper River Ling is limited primarily by a lack of available food. See also Box 2.2.

(left) The River Ling from the slopes of Creag a' Ghallain, 1st October 2019. Sheep cattle and deer crop riparian vegetation. There is a new woodland enclosure in centre right of picture. Photo by David Holland. See Box 2.2 for related observations.

Box 2.2 Of thin parr & fat parr: observations from the River Ling, 13th December 2019.

The River Ling is one of the larger rivers within the southern part of the SWRFT mainland area, and flows into Loch Long near Dornie. Adult salmon are able to access the main river for approximately 10km upstream from the sea; to reach the main spawning and nursery areas they have to ascend one or more waterfalls. The river has a reputation for early running ('spring') salmon, an adaptation believed to be associated with the waterfalls. The main river has much cobbly run, riffle and glide type habitat with channel widths of 20m+ along larger sections all the way to the top of the accessible area. In terms of physical attributes, there are extensive areas of excellent nursery habitat for juvenile salmon. However, in terms of its biological productivity, conditions are not so good. The photos below were all taken during an electro-fishing expedition to the river on the 13th December 2019. The juvenile salmon in the photographs on the right are all shown approximately to scale.

Site A: Section of main river above the Goblet Pool (below left); stream width about 20m. Streambed of 'clean' cobbles and pebbles. 6 salmon fry (50mm – 62mm) and 4 parr (79mm – 102 mm) were caught here, all thin (below right).

Site B: small burn by track (below left). Salmon fry and parr were recorded at higher CPUE here than at site A. 13 fry (50mm-61mm) and 10 parr (75mm-98mm) were caught here (below right). As narrow streams have a higher bank length to wetted area ratio than wide rivers, there is more food of terrestrial origin per unit wetted area than for wide river habitat.

Site C: Side of main river by road bridge close to tidal limit (not shown) downstream from Nonach farm. Here the river receives additional nutrition from anthropogenic sources. The stream bed here was of green stones (moss and algae) with a corridor of riparian alder trees on either side. All the salmon caught here were chunky parr of lengths 90mm to 128mm (below right).

Some questions:

- Is there adequate nutrition at site A for the thin parr to become smolts of adequate size and condition to survive at sea? Or were some parr starving?
- To what extent were surplus salmon eggs important as food for pre-smolt salmon parr in the River Ling (and other oligotrophic rivers)?
- Were some of the big parr at site C fish which have descended from the upper river? Given results of Armstrong et al 2018[5], their prospects at sea are likely to be much better than for the smaller thin parr at site A in the upper river.
- If the parr at site C smoltify in the lower river and survive at sea, will they home back to where they became smolts or will they continue upstream, over the waterfalls to spawning areas in the upper river?

[5] Armstrong J, McKelvey S, Smith G, Rycroft P, Fryer R. Effects of individual variation in ength, condition and run-time on return rates of wild-reared Atlantic salmon Salmo salar smolts. J Fish Biol. 2018;92(3):569–78
See also: https://www.gwct.org.uk/fishing/research/salmon/survival-in-the-sea-bigger-is-better/

River Croe (surveyed by SEPA)

The SEPA e-fishing team surveyed four sites on 17th and 18th September 2019. Salmon fry and parr were found at all sites. At the top two sites, minimum densities for salmon fry of over 20 fish per 100m^2 were recorded; and fry outnumbered parr. At the two lower sites salmon parr were recorded at high density and fry at moderate density. Genetic samples were taken. Thank you to Anthony Watkins and the SEPA fish survey team for sharing their results.

River Shiel (Kintail)

Two NEPS sites were fished on the Shiel in both 2018 and 2019. One site was surveyed in both years. On the 20th August 2018, salmon fry were recorded at high CPUE and parr at low CPUE at both sites surveyed. In contrast, on 27th August 2019, salmon parr were recorded at moderate CPUE but salmon fry at only very low CPUE at both sites (including the repeat site).

(right) Colin Simpson and David Holland by an electrofishing site by the River Shiel on 27th August 2019. Many parr were recorded, but very few salmon fry.

Glenmore River

On the 20th of August 2018 two NEPS sites were surveyed. At the more bouldery site near Moyle parr were present at moderate CPUE but fry at very low CPUE; at the lower site near Beolary, salmon fry were recorded at high CPUE and parr at very low CPUE. On the 26th of August 2019 a NEPS site was surveyed above the waterfalls above Bealachasan. Salmon parr were found above the Bealachasan falls for only the second time! However no salmon fry were recorded. Juvenile trout were also recorded.

Glen Beag River

On the 21st of August 2018 three sites were surveyed including two near the top of the accessible area by Srath a Chomair. Both fry and parr were recorded at up to moderate CPUE here (though lower at a nearby NEPS site). At the third site below the brochs, salmon fry were recorded at high CPUE (3.5 fish per minute) and parr at moderate CPUE. On the 26th of August 2019 both salmon fry and parr were recorded at moderate CPUE at a site just downstream from Balvraid.

Isle of Skye

In 2019, juvenile fish surveys were carried out on the Isle of Skye on behalf of SWRFT by teams from the UHI Rivers and Lochs Institute [R&LI] and Glasgow University [GU]. The R&LI team surveyed NEPS sites; the GU team surveyed sites as part of a wild fish monitoring programme funded by salmon farm companies operating nearby.

Kilmaluag River

In 2019, the GU team surveyed three sites in the lowest 2km of this river. No juvenile salmon were recorded at any of these sites; just trout and eels. In contrast, on the 19th September, the R&LI team recorded both salmon fry (55mm-73mm) and parr at moderate CPUE at a NEPS site ~6km upstream from the sea. The status of juvenile salmon in this river requires further investigation; this river may have enough suitable habitat to retain its own unique salmon population.

(right) Sea trout smolt and salmon smolt from a fyke net set close to the top of the estuary, Kilmaluag River, May 2019 (Isabel Moore)

Brogaig

No juvenile salmon were recorded at any of the three sites surveyed by the GU team in 2019. Juvenile salmon were recorded at only one site in this river in 2012. Satellite photos and local knowledge suggests that water from this river sometimes filters through the cobble beach. Salmon and sea trout may therefore have difficulty entering from the sea except at very high spate flows. During periods of low flows in the spring time smolts may be obstructed from reaching the sea. Obstacles above the main road may also hinder access for salmon. Local action to clear the mouth of the river of obstructing stones following storms might help anadromous fish populations.

Kilmartin

Juvenile salmon were recorded at all of the five sites surveyed by the GU team within the lowest 5km of the river. Figures for CPUE were high at one of the upper sites. In addition both salmon fry and parr were recorded at a NEPS site in the tributary, the Maligar Burn by the R&LI team. Results suggest that this river retains its own discrete wild salmon population and as such represents one of the more important 'core' rivers for the conservation of wild Atlantic salmon on the Isle of Skye.

Varagill

Only one NEPS site was surveyed in this river at a site located high up the river. Only one juvenile salmon was caught, plus 14 trout and an eel. This site may be located upstream from the main juvenile salmon nursery habitat in the river. In recent years the Varigill River has been stocked with juvenile salmon.

Sligachan

The GU team surveyed five sites in the river of which juvenile salmon were recorded at all four in the lower 4km of the river. Numbers were generally low except at one site where fry were recorded at moderate CPUE. The R&LI team also surveyed a NEPS site in the lower part of the river and recorded low densities of both salmon fry and parr. Much of the Sligachan catchment is sparsely vegetated; the Sligachan is very much a spate river rising and falling in response to rainfall on the Black Cuillin mountains. However the underlying geology is base-rich and the water is very clear and there are some large holding pools. The river could be more productive than in living memory if riparian vegetation could be protected from grazing pressure (some enclosures with alder and willow trees) and other measures were taken to restore and enhance catchment fertility and the amount of food for juvenile fish.

Broadford River

One NEPS site was surveyed on 19th September by the R&LI team; modest numbers of both salmon fry (54mm-70mm) and parr (77mm-105mm) were recorded. Nine eels, three minnows, one trout and one stickleback were also recorded. The Broadford River has limestone and much woodland within its catchment and is potentially of relatively high productivity.

Conon

This is a relative short river. Waterfalls that obstruct passage for migratory fish are located a short distance upstream from where the river enters the sea at Uig in the north of Skye. Three sites were surveyed by the GU team; trout were recorded at all sites and 11 eels and a flounder at the lowest site below the falls. Juvenile salmon have not been recorded in this river by the fisheries trust.

Snizort

The River Snizort is the largest and most productive salmon river on the Isle of Skye. Juvenile salmon were recorded by the GU team at seven out of eight sites surveyed including in a tributary burn approximately 11km upstream from the sea. Assorted juvenile salmon were also recorded by the R&LI team in challenging fishing conditions (high water) on 17th September at a NEPS site. In some previous years parts of the River Snizort were stocked with juvenile salmon. All fish recorded in 2019 were understood to be wild fish. Further surveys of juvenile salmon in headwater streams are required to fully assess the status of wild salmon in this important salmon river.

Hamara (Glendale) River

This is a short but sometimes very productive river in the NW of Skye. The river runs through the crofting township of Glendale and many crofts drain into it. The GU team surveyed five sites in 2019, and recorded juvenile salmon at three with high densities at a lower site, along with trout at all sites.

Ose

Only one NEPS site, close to the mouth of the river was surveyed in 2019 by the R&LI team. No juvenile salmon were recorded; however conditions were not good for electro-fishing, the river was in spate and the water coloured. The River Ose has the potential to be one of the more productive salmon rivers on the west side of Skye; the status of wild salmon in the Ose requires further survey.

Drynoch

Two NEPS sites were surveyed by the GU team. Low numbers of juvenile salmon and large numbers of eels were recorded. The Drynoch River enters the sea at the head of a west-facing sea loch and may be favourably located for attracting elvers from the sea as they seek freshwater.

Strath Mor

In 2019, four sites were surveyed by the GU team. Juvenile trout were recorded at all sites, but no juvenile salmon. Juvenile salmon had previously been recorded at low CPUE at two of four sites surveyed in 2018. The Strath Mor River flows through a heavily grazed valley and there are very few riparian trees. There is much potential for restoring riparian habitat and fertility for the benefit of both wild fish and other wildlife living in the catchment.

Box 2.3 Salmon spawning delayed in 2019 by low water

November 2019 was one of the driest on record in parts of NW Scotland. At Torridon, Colin Blyth recorded only 27.7mm of rainfall for the month, compared to 129.1mm for November 2018, 256.1mm for November 2017 and 110.1mm for November 2016.

While parts of England experienced unprecedented flooding, Wester Ross experienced a period of drought at the time when salmon are normally spawning. In some places adult salmon were crowded into deeper pools unable to access some of the places where they normally spawn.

The picture *(left)* is a screenshot from a video recorded on 26th November 2019 in the headwaters of the River Ewe. The river was at a low level and fish were crowded together.

At least thirteen adult salmon can be seen. They include two or three females, two of which had attempted to cut a redd in the streambed which is far from ideal for spawning with only small amounts of pebble-sized stones. The other salmon are males, some of which were estimated to be around 90cm long. In the top right of the picture one of the larger males is lunging with its mouth open at one of the smaller grilse.

At the beginning of December 2019, weather patterns changed, and water levels in many of the headwater streams began to rise. Subsequently the winter of 2019-2020 was one of the wettest on record. The 2020 juvenile fish survey may clarify whether the November drought and subsequent high flows affected recruitment of salmon fry.

Thank you to Colin Blyth for rainfall data and to licensed drone pilot Tom Forrest *(right).*

2.3 Tournaig trap project

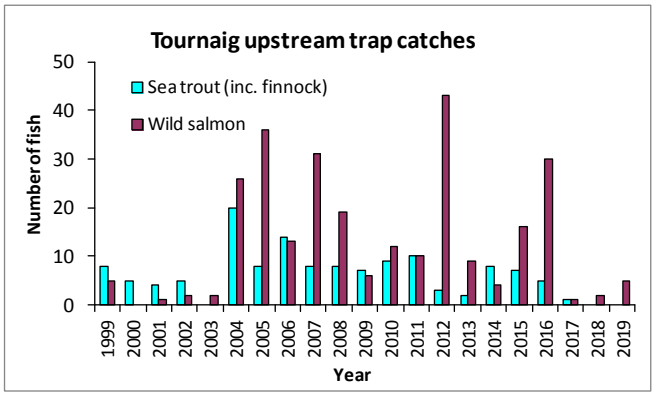
Supported by MOWI and NTS Inverewe estate.

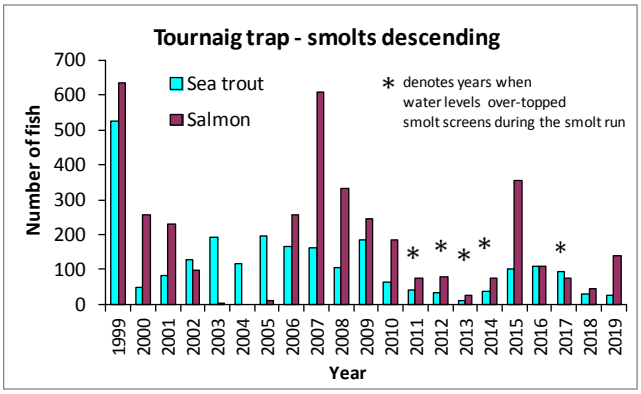
The little Tournaig river system which drains into Loch Ewe is one of the smallest within the SWRFT area to support a wild salmon population. In 1999, an upstream – downstream trap was installed within an old fish ladder near the mouth of the river. Since then it has been operated from the spring to the autumn each year, providing records of salmon and sea trout smolts migrating out to sea and of adult fish entering the system.

As this river system has not been stocked in recent years, the monitoring of salmon and trout populations at Tournaig provides useful information about the performance of wild fish, contributing to a clearer understanding of some of the factors that are of concern to fisheries managers.

Upstream and downstream trap catches at Tournaig to 2019 are shown in Figure 2.3 below.

Figure 2.3 Trap catches at Tournaig, 1999 to 2019. (left) Upstream trap; (right) downstream trap.





Lower numbers of both salmon (and grilse) and sea trout were recorded in 2017, 2018 and 2019 than in the three preceding years. Salmon and sea trout are known to be able to bypass the trap during high spate flows, so not all the adult fish which entered the Tournaig system are thought to have been caught. However through much of 2018 and 2019 the upstream trap was operational and trapping 'effort' was similar to that of previous years.

Very low water during late spring in both 2018 and 2019 may have delayed or prevented some of the smolts from emigrating. At very low flows, water levels are inadequate even for smolts to migrate downstream at Tournaig without running aground. Otters are known to move up and down the Tournaig river regularly throughout the year; they and other predators may take a higher proportion of emigrating smolts during periods of very low flows.

(right) Tournaig grilse, 25th June 2019; condition factor 1.2 (fat!). Note predator damage: that of a seal? Common seals patrol the river mouth. Photo by Ben Rushbrooke.

Tournaig juvenile fish survey

In addition to the fish traps, an annual electro-fishing survey has been carried out in early August primarily to find out about the distribution of juvenile salmon in the principle spawning burn, the Allt na Coille, above Loch nan Dailthean. Each year, six sites are surveyed in the last week of July or first week of August.

Table 2.1 presents a summary of the results since the Tournaig system was recolonised by wild salmon in 2003.

Year	Adult salmon recorded in upstream trap	Number of sites where salmon fry recorded	Salmon fry average number per minute	Number of sites where salmon parr recorded	Salmon parr average number per minute	Salmon smolts recorded in down-stream trap
2003	2	0	0.00	0	0.00	0
2004	26	4	1.81	0	0.00	0
2005	36	6	1.09	6	0.55	11
2006	13	5	1.99	6	0.87	257
2007	31	6	1.07	6	1.17	607
2008	19	4	0.67	6	0.74	332
2009	6	5	1.05	5	0.41	246
2010	12	5	0.88	6	0.55	183
2011	10	2	0.06	5	0.24	77*
2012	43	2	0.14	4	0.08	78*
2013	9	5	2.61	3	0.32	25*
2014	4	2	0.81	6	0.81	77
2015	16	2	0.66	5	0.44	354
2016	30	5	1.73	2	0.22	110
2017	1#	6	3.55	6	0.63	76
2018	2	6	3.00	6	0.81	44
2019	5	4	1.07	6	1.40	138

*some smolts missed when water level higher than screen

#hole in upstream trap found in 2018 & high water assume other salmon missed

(right) Table 2.1. A summary of trap and juvenile survey data for salmon collected at Tournaig. Year-class colouring assumes that a majority of smolts are 2 years old.

In 2018, for a second year in succession, salmon fry were found at all sites, strongly suggesting that some adult fish had entered the Tournaig river from the sea and bypassed the upstream trap in 2017.

Salmon fry were present at only four of the six sites in 2019; concurring with a low run of adult salmon entering the system the previous year. However salmon parr were recorded at all six sites and at a higher average catch per unit effort than in any previous year.

If water levels are favourable in spring 2020, the salmon smolt run may be one of the largest on record.

In 2016, higher trout fry numbers were recorded in the Allt na Coille than in any previous year; this correlated with a run of four large maturing female sea trout entering the system in 2015. Scale reading has shown that many of the sea trout smolts which leave the Tournaig system are three or four years old. If like (sea trout) produces like (sea trout smolts), then it is possible that the run of sea trout smolts in spring of 2020 will also be one of the largest for several years.

Thank you very much to Ben Rushbrooke (Tournaig Garden Cottage Nursery) who looks after traps, data compilation and scale reading. Thank you to MOWI, NTS Inverewe and Tournaig Estate for continued support.

Colin Simpson recording electro-fishing data at the top site in the Allt na Coille, Tournaig, on 31st July 2019. Photo by Ben Rushbrooke.

Part 3 **Sea trout, sea lice and salmon**

Supported by the Scottish Government via Fisheries Management Scotland, the Wester Ross Area Salmon Fishery Board [WRASFB], salmon farming companies and many volunteers . . .

3.1 Sea trout sampling

Infestations of the parasitic sea louse *Lepeophtheirus salmonis* remain a principle concern for both wild sea trout and salmon. There are now a series of studies correlating high levels of sea lice on sea trout with proximity to salmon farms in Norway, Ireland and Scotland[6]. Sea trout carrying high numbers of lice experience higher levels of mortality. High levels of sea lice on sea trout can also indicate that emigrating post-smolt salmon in nearby waters are subject to higher levels of infestation[7].

In 2019 sea trout were sampled from coastal waters around the SWRFT area to learn more about lice levels, as in previous years. Sea trout were sampled at four sites on the mainland (Kanaird estuary, Little Loch Broom; Boor Bay, Loch Ewe; and Flowerdale, Loch Gairloch); and four sites around the Isle of Skye (Loch Poolteil, Loch Snizort, Sligachan estuary and Loch Slapin). A 50m long beach seine net ('sweep net') was used at all mainland sites and three out of the four sites on Skye to catch sea trout; at one site on Skye (River Sligachan estuary) a fyke net provided samples of fish. All fish were released after processing and recovering from anesthetic.

Table 3.1 presents a summary of data for sites sampled in both 2018 and 2019. The results of sampling in 2018 were presented in the SWRFT Newsletter February 2019. The following section provides a summary of results of sea trout monitoring in 2019.

The sweep netting team by the Kanaird River estuary, 16th July 2019. Thankyou to everyone!

[6] Moore, et al, 2018 The influence of aquaculture unit proximity on the pattern of *Lepeophtheirus salmonis* infection of anadromous *Salmo trutta* populations on the Isle of Skye, Scotland. J. Fish Biol, V 92, I 6, June 2018, Pages 1849-1865 https://onlinelibrary.wiley.com/doi/abs/10.1111/jfb.13625

[7] Vollset et al, 2017 Salmon lice infestations on sea trout predicts infestations on migrating salmon post-smolts ICES Journal of Marine Science, Volume 74, Issue 9, November/December 2017, Pages 2354–2363, https://doi.org/10.1093/icesjms/fsx090

Table 3.1 Summary of sea trout sampling data collected in 2018 and 2019. Samples where the average number of lice per gram of sea trout was greater than 0.2 are shaded in yellow; those where the average is greater than 0.3 are shaded in pink. See 'notes' at bottom of table for further explanation.

Location	Method	Date	Number of sea trout in sample		Average length	Condition factor	*Lepeophtheirus salmonis* all stages			Fish with >0.3 lice / per gram		Lice per gram average
			Total	Infected	(mm)		Prevalence	Abundance	Intensity	number	%	
Kanaird estuary	sweep	12-Jun-18	17	15	214	1.03	88	23	26	4	24	0.35
Kanaird estuary	sweep	13-Jul-18	30	30	249	1.06	100	50	50	9	30	0.29
Kanaird estuary	sweep	18-Jun-19	9	0	159	0.91	0	0	0	0	0	0.00
Kanaird estuary	sweep	16-Jul-19	2	1	240	1.16	50	1	1	0	0	0.00
Little Loch Broom	sweep	12-Aug-19	19	19	213	1.04	100	10	10	1	5	0.11
Boor Bay, Loch Ewe	sweep	15-Jun-18	2	2	289	1.16	100	18	18	0	0	0.06
Boor Bay, Loch Ewe	sweep	27-Jun-18	3	3	278	1.28	100	17	17	0.13	0.17	1.00
Boor Bay, Loch Ewe	sweep	15-Jun-19	15	8	187	0.97	53	3	6	0	0	0.04
Boor Bay, Loch Ewe	sweep	02-Jul-19	10	10	203	1.15	100	27	27	3	30	0.31
Flowerdale, L. Gairloch	sweep	18-Apr-18	18	18	246	0.9	44	4	9	0	0	0.02
Flowerdale, L. Gairloch	sweep	28-Jun-18	2	2	280	1.17	100	9	2	0	0	0.04
Flowerdale, L. Gairloch	sweep	19-Apr-19	30	30	330	0.88	100	109	109	11	37	0.35
Flowerdale, L. Gairloch	sweep	07-Jun-19	8	6	217	0.99	75	13	17	1	13	0.35
Flowerdale, L. Gairloch	sweep	19-Jun-19	26	25	274	1.08	96	62	65	13	50	0.45
Flowerdale, L. Gairloch	sweep	16-Sep-19	16	9	363	1.09	56	3	5	0	0	0.01
Applecross estuary	sweep	18-Jul-18	17	16	228	1.12	94	7	7	0	0	0.05
Glenelg estuary	sweep	18-Jun-18	7	5	153	1.04	71	5	7	2	29	0.14
Loch Poolteil	sweep	01-Jun-18	30	4	148	1.09	13	0	1	0	0	0.00
Loch Poolteil	sweep	29-Aug-18	2	1	210	0.89	50	1	1	0	0	0.01
Loch Poolteil	sweep	03-May-19	34	26	220	0.95	76	27	35	9	26	0.26
Loch Poolteil	sweep	15-Aug-19	14	14	231	1.1	100	6	6	0	0	0.04
Snizort estuary	sweep	31-May-18	6	4	200	1.04	67	7	11	1	17	0.10
Snizort estuary	sweep	08-May-19	19	2	151	1	11	0	2	0	0	0.01
Snizort estuary	sweep	14-Aug-19	11	8	223	1.1	73	4	6	0	0	0.03
Sligachan estuary	fyke	28-May-18	13	0	128	1.03	0	0	0	0	0	0.00
Sligachan estuary	fyke	22-May-19	12	12	276	0.84	100	89	89			0.34
Loch Slapin	sweep	29-May-18	11	5	198	1.28	45	6	13	0	0	0.02
Loch Slapin	sweep	24-Aug-18	3	3	255	1.03	100	2	2	0	0	0.01
Loch Slapin	sweep	06-May-19	25	24	333	0.9	96	30	31	4	16	0.25
Loch Slapin	sweep	13-Aug-19	16	16	146	1.02	100	9	9	0	0	0.04

Notes: 'Condition factor' K= (weight of fish in grams x 10^5)/(length of fish in mm)^3 ; 'Prevalence' is the % of sea trout in the sample carrying sea lice; 'Abundance' is the average number of lice per sea trout in the sample; and 'Intensity' is the average number of lice on the sea trout that carry sea lice. Sea trout carrying > 0.3 lice per g weight are in Taranger et al 2015's[8] '100% mortality or return prematurely to freshwater' category (please refer to this paper for other categories). 'Dorsal fin damage' is a score for observed damage to a fish's dorsal fin associated with sea lice infestation, where '1' is up to 33% of the dorsal fin is damaged, '2' means between 33% and 66% of the fin is damaged, and '3' means over 66% of the dorsal fin is damaged. Sea lice come off a sea trout over a period of days following return to freshwater; dorsal fin damage can be indicative of previous infestation by high numbers of lice when the lice are no longer present on the fish.

[8] Taranger *et al.*, 2014 Risk assessment of the environmental impact of Norwegian Atlantic salmon farming https://www.researchgate.net/publication/266672998_Risk_assessment_of_the_environmental_impact_of_Norwegian_Atlantic_salmon_farming

Kanaird estuary

Sea trout were sampled on 18th June and 16th July 2019. On both occasions sample sizes were small. On 18th June, nine trout were caught none of which carried lice; on 16th July, despite much effort over three sweeps, just two trout were caught. Our conclusion was that there were fewer early-returned sea trout in the estuary on both occasions compared to 2018 and some other earlier years when sea lice levels on sea trout were high.

Dundonnell, Little Loch Broom

A fyke net was set at the mouth of the Dundonnell River in June 2019 as in previous years. The net fished over 18 tides from 10th June to 28th June. Only three trout were caught. Only one of the trout carried sea lice, a fish of 350mm (518g) with 60 copepodid & chalimus stage lice and 7 preadults and adults. The other two fish were small smolts of ~140mm neither of which had evidence of having been to sea.

On 12th August the sweep netting team caught 19 sea trout in Little Loch Broom near the mouth of the Dundonnell River. These fish were from 146mm to 280mm in length and carried a maximum of only 21 lice. However some of them had dorsal fin damage indicative of possibly higher sea lice levels earlier in the summer. Thank you to Alastair MacDonald, Dundonnell Estate and many volunteers for much help.

(above right) Processing fish by the mouth of the Dundonnell River, 12th August 2019 (photo by Donald Rice).

Boor Bay, Loch Ewe

Sea trout were sampled on two occasions at Boor Bay using a seine net set from a small boat and pulled up onto the shore. On 15th June, fifteen mostly small post-smolt sea trout were taken (lengths 145mm to 265mm); most of these fish were still thin and sea lice levels were low. On 2nd of July, 10 trout were taken; these fish were slightly larger (175mm – 245mm) and quite fat with condition factors of up to 1.24 indicating good feeding nearby. However lice levels were high; four of the trout carried more than 0.3 lice per gram.

The high numbers of lice on sea trout at Boor Bay correlated with high numbers of lice on sea trout sampled in Loch Gairloch in June 2019. The nearby Isle Ewe salmon farm was harvested out in February 2019 and restocked in March, and was therefore at an early stage of the production cycle so an unlikely source of the majority of the sea lice observed on the sea trout sampled at Boor in July (see Part 3.2).

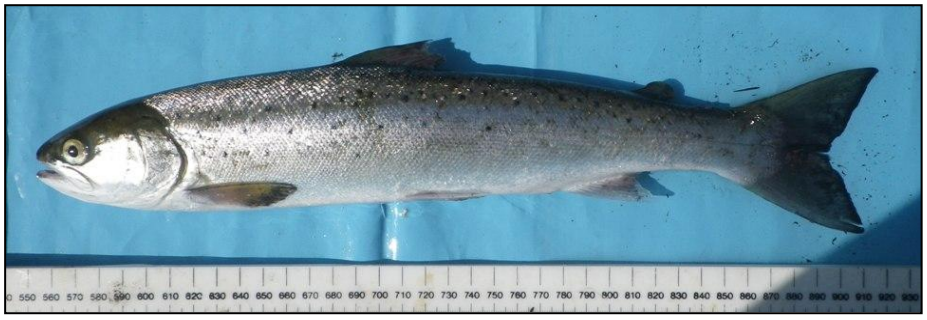
(*left) Sweep netting team at Boor Bay, Loch Ewe on the evening of 15th June. Thank you to all the helpers especially boatman Cameron Thomas!*

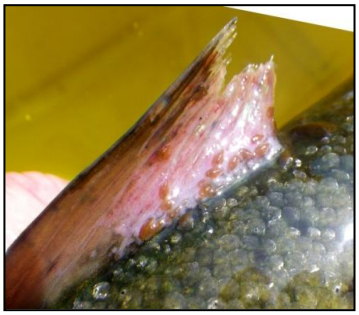
Flowerdale, Loch Gairloch

The sweep netting site below the SWRFT office by the harbour at Gairloch has become one of the most successful for obtaining samples of sea trout, and one of the most interesting (see SWRFT Review February 2018 for some background information[9]). Many trout were caught in samples taken in 2019. On 19th April, a random sample of 30 fish was taken for processing from a catch of 37 sea trout. These fish were overwintered finnock and older trout, of between 225mm and 450mm in length. Many of the fish were heavily lice-infested with up to 1.35 lice per gram and damaged dorsal fins.

(right) The sweep netting team at Flowerdale on 19th April 2019

(left) Thin, overwintered sea trout sampled at Flowerdale, 19th April 2019. (right) Sea lice damaged dorsal fin.

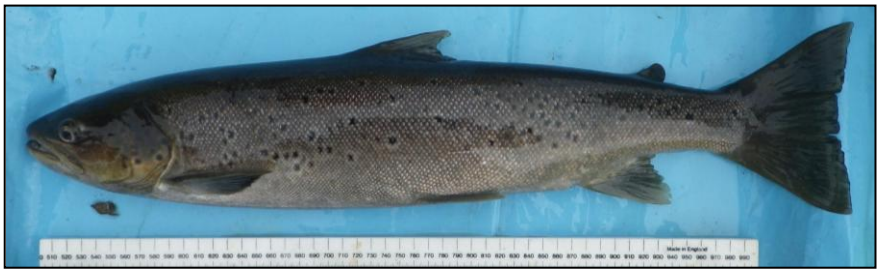




On 1st May, a sea trout carrying over 500 lice was sampled during the field excursion following the Wild Trout Workshop (see Part 6). On 7th June, a small post-smolt sea trout of 132mm (24g) carried 56 lice, an infestation level of 2.33 lice per gram. On 15th June, 13 out of the 26 trout (170mm to 445mm in length) in the sample carried more than 0.3 lice per gram. See Part 3.2 for related discussion.

Following the high levels of lice recorded on sea trout at Flowerdale from April to June 2019, an attempt was made to obtain a sample of sea trout in the autumn to learn more about the adult population prior to spawning. On 16th September, sixteen sea trout were caught, many of which were maturing female fish of up to 560mm. Lice levels were low; most of these fish had damaged but healing dorsal fins indicative of sea lice damage earlier in the year.

(right) Female sea trout of 560mm, 1700g, Flowerdale estuary, 16th September 2019. This fish carried no sea lice, but had a damaged dorsal fin indicative of lice infestation earlier in the year.



[9] SWRFT Review February 2018
http://www.wrft.org.uk/files/SWRFT%20Review%20February%202018%20Final%20for%20web%20V2.pdf

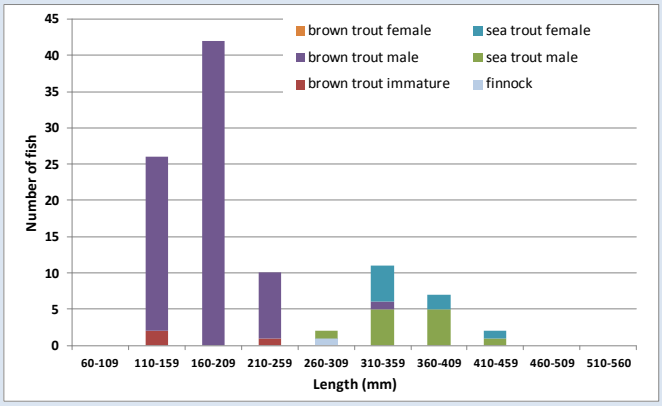
Box 3.1 Composition of the spawning run: Sand River sea trout, October 2019

In the autumn of 2015 a fyke net was set in the Torridon River to learn more about the sea trout population following records of high numbers of sea lice on sea trout sampled around Loch Torridon and Loch Gairloch in the spring and summer of 2015. The fyke net caught many trout and demonstrated that despite high numbers of sea lice being recorded in nearby waters earlier in the year, the adult trout population in the Torridon River, particularly of female fish, was still dominated by sea trout some of which had spawned previously[10].

In October 2019, following another year with high numbers of sea lice reported on salmon farms in Loch Torridon and recorded on wild sea trout at Flowerdale Loch Gairloch, a fyke net was set in the Sand River (by Loch Gairloch) to find out more about a nearby adult trout population at spawning time.

(right) Chris Beresford & Cory Jones helping to process the catch on 25th October 2019.

The trap was operated over just 3 nights from 22nd to 25th October. There were 104 fish captures (Figure 3.1). Some of the trout were caught more than once. Mature male trout were most numerous and were a mix of resident brown trout, the smallest of which was only 128mm long and the largest 335mm, and male sea trout (295mm to 410mm). All the mature female trout were sea trout (320mm to 435mm). The study indicated that the Sand River trout population, like that of the Torridon River sampled in 2015, is sustained by anadromous (sea-going) female trout; and that despite high numbers of sea lice recorded on sea trout at Flowerdale nearby earlier in the year, many sea trout had survived to reach maturity.



(left) Figure 3.1. Size distribution of trout captures in the Sand River fyke net 22nd – 25th October 2019.

(below l & r) Mature male trout from the Sand River fyke; all are resident brown trout except top right (a sea trout).

[10] WRFT River Torridon Sea Trout Report, 2015
https://www.wrft.org.uk/files/Torridon%20sea%20trout%20report%20Jan%202016.pdf

Sea trout sampling around the Isle of Skye

In 2019, sea trout were sampled at four locations around the Isle of Skye using a 50m seine ('sweep') net or a fyke net set in an estuary. The following summary has been prepared from reports by Isabel Moore. Please also refer to Table 3.1.

Loch Poolteil (supported by Kames Fish Farming)

Sea trout were sampled near the mouth of the Hamara River on 3rd of May and again on 15th August 2019. On 3rd May, 133 fish were caught including both sea trout and salmon smolts. A random sample of 40 of these fish was retained for processing, of which 75% carried sea lice. The largest sea trout retained was a fish of 510mm. The lousiest fish was a sea trout of 335mm which carried 108 mostly small attached lice. The smaller post-smolt sea trout carried only small early stage sea lice; in contrast the older sea trout which had presumably been at sea for longer carried a mix including both juvenile attached and pre-adult and adult stage lice.

In addition to sea trout, six salmon smolts were recorded some of which also carried sea lice. This may be the first record of sea lice on salmon post-smolts in a sweep netting sample from the SWRFT area.

(left) Processing sea trout at Loch Poolteil on 3rd May 2019; (below) a sea trout of 510 mm from the sample.

On 15th August, fourteen sea trout (189mm – 269mm), several flounder, a pipe fish and a sea bass were caught. All the sea trout carried sea lice, however, the mean number of lice recorded was only 6 (maximum 12).

Lice infestations levels on some of the sea trout recorded in the May sample, following a period of drought with little freshwater entering the sea loch, were high enough to compromise the health of fish.

However, by August lice levels were much lower. Following rainfall, infested sea trout would have been able to move into the Hamara River and "delouse" themselves before returning to the marine environment to feed.

(right) Sea bass caught during seine netting

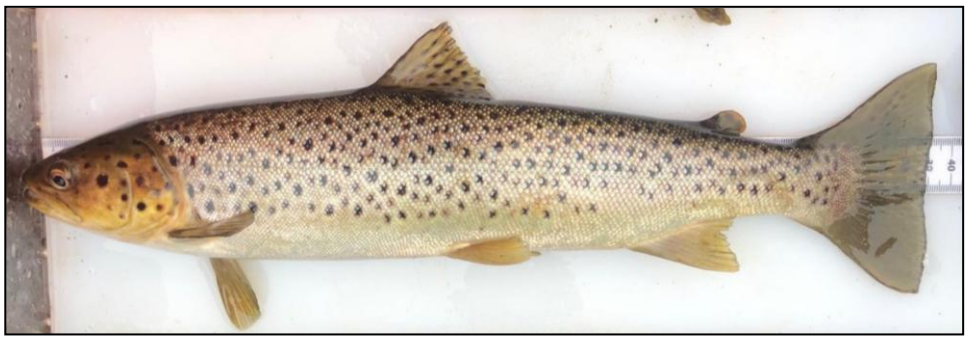
Loch Snizort (supported by Greig Seafood and MOWI)

Sea trout were sampled using a seine net on the 8th May (13 trout) and 14th August (11 trout). On both occasions most of the trout carried very low numbers of sea lice. The lousiest trout was a well fed fish of 222mm (condition factor 1.35) which carried 20 lice and was otherwise in good condition.

Loch Snizort continues to be a difficult site to efficiently and successfully catch a sample of sea trout big enough to yield statistically robust results. However, because this site is in such close proximity to a large aquaculture facility and has previously reported high lice loads, particularly in 2016, it is important to continue searching for an effective catch method that will provide useful data on wild salmonids and parasite loads in this area.

(right) a 'slob' (estuarine) trout of 389mm from the Snizort River, taken by the Skye sweep netting team on 14th August 2019.

(photo by Isabel Moore).



Loch Sligachan (supported by MOWI)

Fyke nets were set in the estuary at the head of Loch Sligachan on May 20th and were left in the water until the 22nd May, and checked at low tide. A total of 13 salmonids were caught during this period, five sea trout on the 21st of May, and seven sea trout and one salmon smolt (of 150mm) on the 22nd of May.

The sea trout were mix of post-smolts and older fish (139mm - 490mm). Sea lice burdens were high especially on the larger fish of >250mm, with an overall average of 89 lice per fish. The lousiest fish, a sea trout of 351mm, carried 428 lice (405 copepod & chalimus lice; 23 pre-adult & adult lice), the highest level of sea louse infestation recorded on a sea trout at any Skye site in the past five years. Lice levels were higher in 2019 than in 2018.

A second sampling period later in the year was not possible due to weather conditions. So it is unknown if lice levels declined over the course of the summer as observed in other sea lochs around Skye (i.e. Loch Slapin and Loch Pooltiel). More intensive monitoring should be carried out in Loch Sligachan in 2020 to gather more data on the typical lice loadings on wild salmonids in this sea loch.

A thin sea trout with extensive dorsal fin damage caused by high levels of sea lice, from a Loch Sligachan fyke net, May 2019 (photo by Isabel Moore).

Loch Slapin (supported by the Scottish Government and MOWI)

On May 6th 2019, twenty five sea trout were caught using a seine net in Loch Slapin. These fish were from 130mm to 530mm in length, with an average condition factor of around 0.9. Only three of the fish were considered to be smolts or post-smolts, the others were 250mm or greater in length and were classified as finnock or mature sea trout. Lice numbers varied from zero (on a small smolt of 130mm) to 191 per fish, with a mean of 30 lice per fish. One of the trout carried an ovigerous *Caligus elongatus* louse in addition 104 other lice (assumed to be *Lepeophtheirus salmonis*, the salmon louse).

On 13th August 2019, sixteen sea trout were caught, ranging in length from 179mm to 392mm. With a mean condition factor of just over 1.0, these fish were slightly fatter than those taken in May. Lice numbers were lower than in the May sample, and ranged from 2 to 36 lice per fish. The most heavily infested trout had extensive dorsal fin damage.

(right) The Loch Slapin sweep netting team on 6th May 2019. Skye biologist, Isabel Moore is holding one of the sea trout taken in the sample that day!

For help with sampling sea trout around the Isle of Skye in 2019, thank you to local staff at Mowi Scotland and Greig Seafood, the John Muir Trust and Ally MacAskill, local anglers including Portree Angling Association members, and the University of Glasgow in their assistance with sweep netting in 2019.

Conclusions of monitoring sea lice on sea trout in 2019

Samples of heavily lice-infested sea trout were taken between April and the end of June from sites around the Isle of Skye and by the mainland at Flowerdale, Loch Gairloch and Boor Bay, Loch Ewe. Some of the fish carried higher numbers of lice than recorded in previous years.

However, there was little evidence that sea trout had experienced similar high levels of lice infestation in the Loch Broom – Little Loch Broom area and in Loch Snizort.

The severity of the 2019 sea louse epizootic can be partly explained by a period of drought between April and June, when many rivers became too low to enable lice infested sea trout to return to freshwater to delouse. Subsequent rainfall enabled sea trout to move into freshwater. Sea lice levels on fish sampled in August and September were much lower than earlier in the year.

These results are perhaps of greatest concern with regard to wild salmon post-smolts migrating through coastal waters around the Isle of Skye and between Skye and the mainland in May and June 2019, as they indicate that concentrations of infective stage sea lice were once again likely to have been high across extensive sea areas. In contrast to sea trout, infested post-smolt salmon do not return prematurely to freshwater to delouse; they swim on.

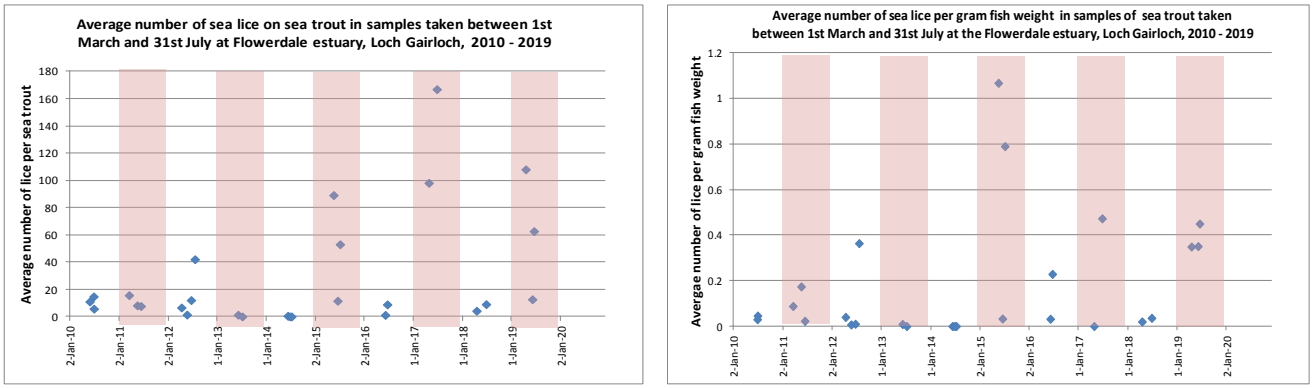
3.2 Sea lice, salmon farming and wild fish populations

Sea lice continued to cause problems for both farmed fish and wild fish in 2019. Following the summer of 2019, Mowi (formerly Marine Harvest) reported the death of 700,000 salmon on its farms partly as a result of elevated sea lice populations associated with 'unusually warm' sea temperatures.

How were the Flowerdale sea trout infested with sea lice?

Some of the highest numbers of sea lice recorded on wild fish were on samples taken at Flowerdale, Loch Gairloch. Since 2015, a pattern of infestation has emerged at Flowerdale. Heavily infested sea trout were recorded during the first half of the year in odd years (2015, 2017 and 2019) but not in intervening even years (Figure 3.2).

Figure 3.2. Sea lice abundance on sea trout samples between March and July (inclusive) at Flowerdale, Loch Gairloch from 2010 to 2019, shown as (left) average numbers of lice per fish; and (right) average numbers of lice per gram fish weight. Pink shading denotes years when the nearest salmon farms in Loch Torridon (26km away) were in the second year of the 2 year production cycle.



The Scottish Government's Marine Scotland Science [MSS] has closely monitored sea lice and sea trout by Shieldaig, Loch Torridon since 1998. MSS data sets demonstrate two-year cycles in the occurrence of planktonic sea lice larvae in coastal waters, in the number of sea trout carrying sea lice in the Shieldaig River in May and June, and in the return rates of sea trout to the fish trap[11].

The MSS data, and since 2015, the results from sea trout sampling at Flowerdale, correlate with the two year farm salmon production cycle in Loch Torridon. Farm salmon production in Loch Torridon increased in 2014 when the Sgeir Dughall salmon farm (consented biomass of over 2000 tonnes) commenced operation. The Sgeir Dughall farm became the nearest salmon farm to Loch Gairloch.

There are two possible ways that sea trout in Loch Gairloch could have come into contact with sea lice from Loch Torridon. Firstly, some of the sea trout may have become infested with sea lice in Loch Torridon and then swum around the coast to Loch Gairloch. Recent MSS tracking work has again shown that some sea trout from Loch Torridon can move around the coast to areas at least 40km away by sea (see Part 5). However in the same study many other sea trout remained close to their rivers of origin. The recapture of several sea trout at Flowerdale over periods of up to two years also suggests that some trout do not venture far from their river of origin.

Alternatively, infective stage sea lice may have dispersed away from salmon farms in Loch Torridon and become concentrated in Loch Gairloch. Sea lice dispersal models were produced by several companies in 2019 which

show how coastal currents and wind directions can cause infective stage sea lice to be distributed to sea areas more than 40 km away from the fish farms harbouring the parent lice. Mowi's sea lice dispersal model for the planned new Scalpay salmon farm near Broadford on Skye projected that some of the infective stage lice from the new farm could be dispersed via coastal currents to areas as far away as the Summer Isles (Figure 3.3). This model projected that the highest concentrations would be in the Inner Sound near Applecross, some 12km from the location of the planned new farm.

Figure 3.3. Projected sea lice dispersal from the planned new Mowi Scalpay salmon farm. From report presented in support of the planning application.

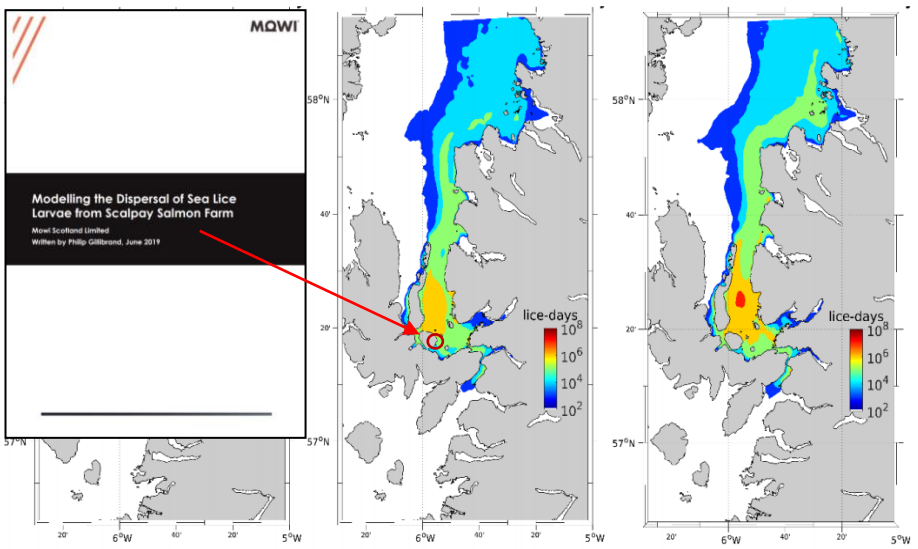


Figure 2. Predicted mean infection pressure (lice-days) for April – June from Simulation 1 (Scalpay only) with average adult female lice count of 0.2 (left), 0.5 (middle) and 1.0 (right). Note that the colour scale is logarithmic, indicating orders of magnitude of infection pressure.

It therefore seems likely that the sea lice travelled further than most of the Flowerdale sea trout, and that many of the lice recorded on these fish encountered their hosts close to where they were sampled in Loch Gairloch. It is also possible that many of the sea lice infesting sea trout at Boor Bay, Loch Ewe in 2017 and 2019 were also of Loch Torridon origin, an interpretation consistent with the Mowi's Scalpay sea lice dispersal model. In the spring of 2019, the Isle Ewe salmon farm, operating at a much smaller biomass than salmon farms in Loch Torridon, was in the first year of the production cycle so an unlikely source of large numbers of infective stage lice.

Implications of sea lice infestation and dispersal modeling for migrating wild salmon post-smolts

The results of SWRFT monitoring together with sea lice dispersal modeling provide further evidence that wild fish can be adversely affected by salmon farming operations several tens of kilometres away from the fish farms themselves. With regard to the SWRFT area, this is perhaps of greatest concern for the wild salmon populations in the rivers of the Loch Alsh – Loch Hourn area (rivers Ling, Elchaig, Croe, Shiel, Glenmore, Glenbeag and Arnisdale) where rod catches fell to just a few fish in 2018 and 2019. Salmon smolts from these rivers are most likely to pass through the Inner Sound between the isles of Skye and Raasay and the Scottish mainland, passing within about 15km of sampling sites where heavily lice infested sea trout were recorded in 2019.

Figure 3.4 shows the locations of existing and planned open cage salmon farms around the SWRFT area (see also Part 3.3). Note how many farms are located close to the Inner Sound, a projected salmon smolt migration route between the Isle of Skye and the mainland for the rivers of the Loch Alsh – Loch Hourn area and the River Carron. Many of these farms have consented biomass of over 2000 tonnes. With on-farm sea lice control still uncertain and unreliable on existing farms by the industry's own admission, it is far from clear how any increase in the number of open cage farms of this size is possible without high risk of further adverse consequences for wild fish.

[11] MSS Shieldaig Project: https://www2.gov.scot/Topics/marine/Salmon-Trout-Coarse/Freshwater/Research/Aqint/Shieldaig

Figure 3.4. The Skye and Wester Ross Fisheries Trust area showing the locations of existing, planned and permitted new salmon farms within the area (as at December 2019).

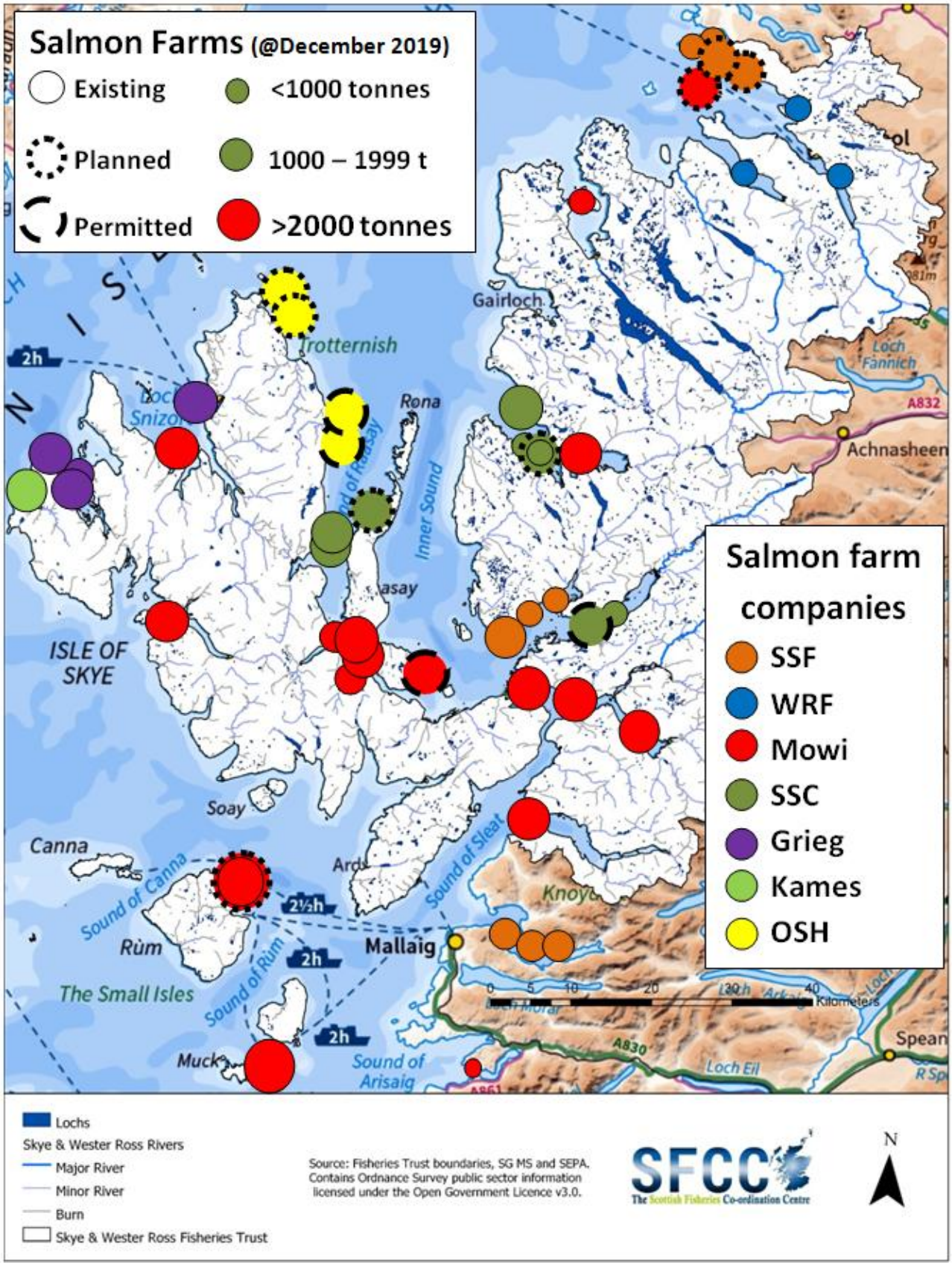


Figure 3.5 *(right)* presents a series of graphs which show sea lice indices* for farm salmon production areas (January 2013 to March 2020).

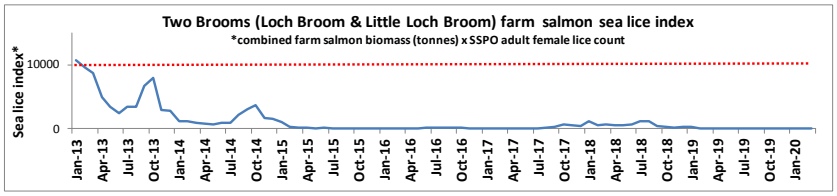
The graphs, shown approximately to scale, are based on biomass figures published on [Scotland's Aquaculture] website by the Scottish Government, and reported adult female lice counts published in SSPO sea lice reports.

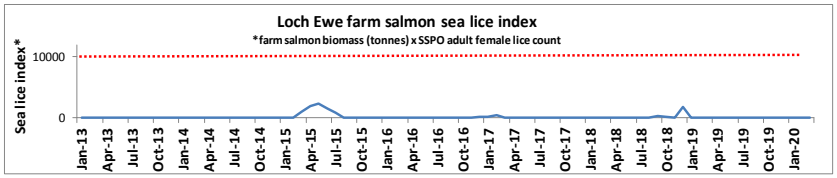
The graphs suggest that overall there were fewer sea lice on salmon farms in 2019 than in some previous years.

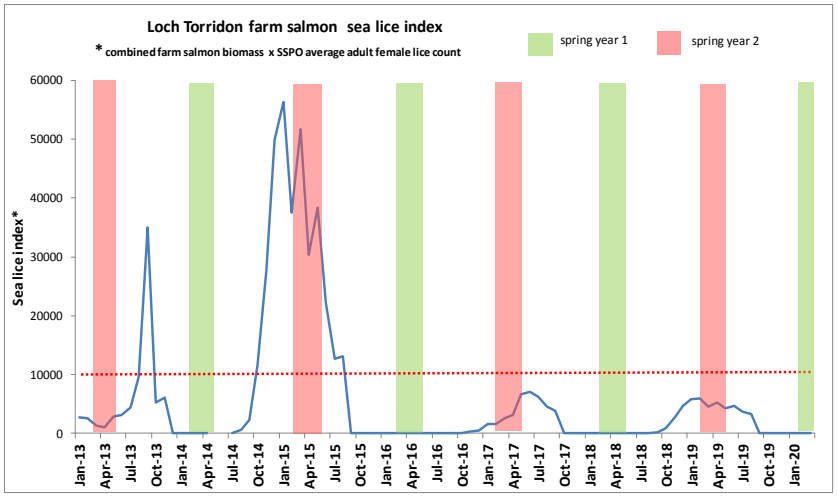
Sea lice numbers in the Loch Broom were lower in spring 2019 than in spring 2018. In contrast sea lice numbers were higher in spring 2019 than in spring 2018 in the Loch Torridon, East of Skye and Loch Carron – Kishorn areas.

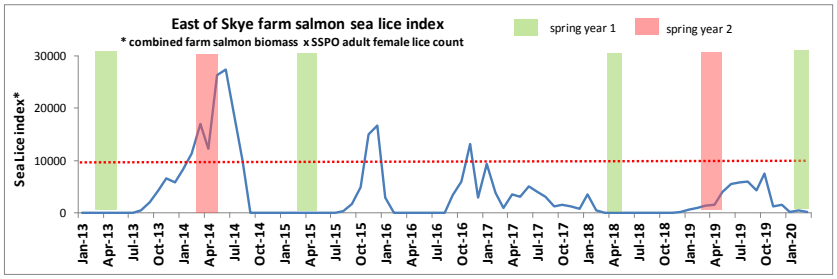
Note that patterns of farm salmon production changed. Until 2018, the Loch Torridon production cycle was out of sync with production cycles of farms in the neighbouring Loch Carron and East of Skye production areas. By 2019 all three of these production areas were almost in sync.

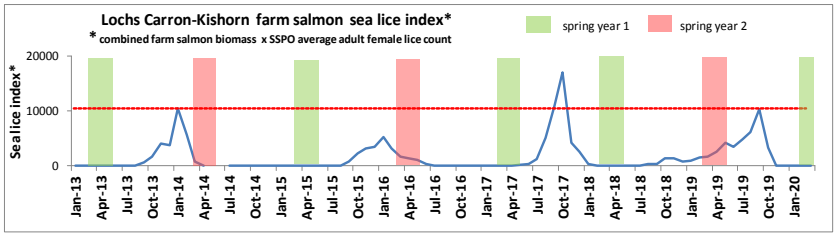
However, from 2018 farms in the Loch Long – Croe area were out of sync with production areas to the north; and given the prevailing south to north current, were potentially a source of larval sea lice affecting farms in the other production areas (e.g. in spring 2020).











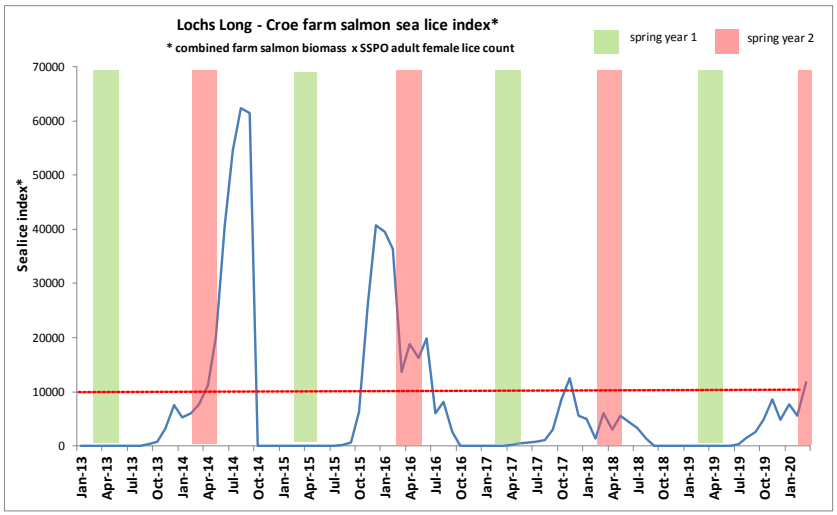
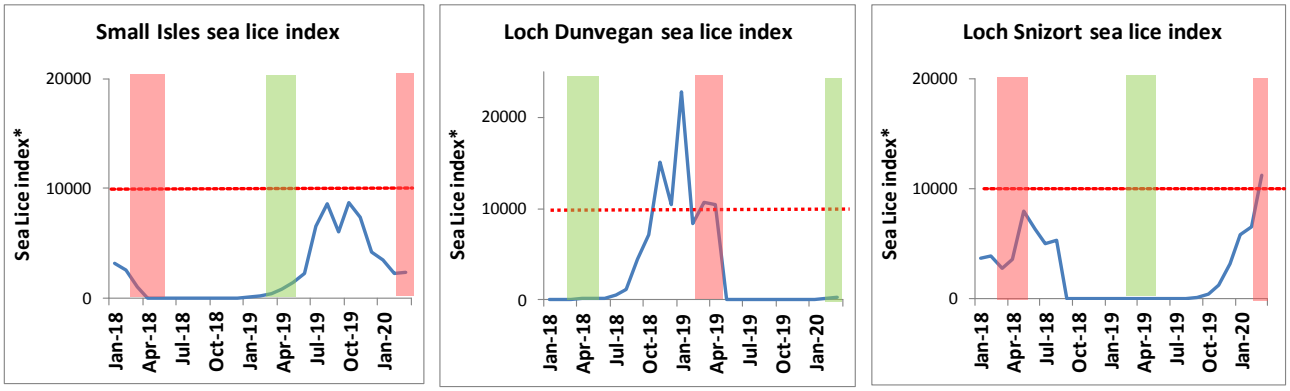


Figure 3.5. Sea lice indices for the east of the SWRFT area. See text above and Figure 3.6 for further explanation.

Figure 3.6 presents a similar series of graphs for farm salmon production areas in the north of Skye and the Small Isles. Note that because the Loch Poolteil fish farm in NW Skye produces rainbow trout, figures for sea louse counts were not included in the SSPO sea lice reports, so are not included here.

Figure 3.6. Sea lice indices for salmon farm production areas in the north and west of Skye.



*sea lice index is the reported monthly biomass multiplied by the reported monthly average adult female sea lice count per fish for all of the farms in the area added together. Note that earlier in the production cycle when on-farm biomass is usually composed of a larger number of smaller fish, sea lice index is likely to under-represent the overall number of adult female sea lice on a salmon farm; and that later in the production cycle when the reported biomass is composed of a smaller number of larger fish approaching harvest weights, sea lice index may over-represent the overall number of adult female lice. This problem could be resolved if data for on-farm fish numbers was published. To date monthly figures for the numbers of fish held at individual salmon farms have not been published to enable more accurate estimates of actual sea louse populations.

These graphs (Figures 3.5 and 3.6) are useful for consideration of the most likely sources of the sea lice infesting the sea trout sampled by SWRFT in 2019 and previous years. Observed sea lice levels on sea trout sampled around Skye and the mainland in 2019 were consistent with projected sea lice levels on nearby farms. Sea trout sampled at Flowerdale and Sligachan were closest to farm salmon production areas reporting high numbers of lice. Sea trout sampled in Loch Poolteil in May 2019, just around the corner from the very licey Loch Dunvegan salmon farming area, had higher numbers of sea lice than in previous years. In contrast, sea trout sampled in Loch Snizort carried few lice; concurring with reports from nearby salmon farms of low numbers of lice. The new Isle of Rum salmon farm is now the closest one to the Loch Slapin sea trout sampling site and may have been a source for some of the lice recorded on sea trout sampled there in 2019.

Lice levels in the Loch Snizort area were very high in spring 2020, of concern to salmon smolts migrating to sea from the River Snizort which supports the biggest wild salmon fishery on the Isle of Skye.

An extended period of dry weather with little rainfall is not unusual in the spring time and early summer when wild sea trout and salmon smolts are migrating through coastal waters; it is the norm and cannot be regarded as the primary reason for the very high numbers of sea lice recorded on some sea trout.

Given that rod catches of wild salmon have continued to fall particularly in the Loch Alsh – Loch Hourn area, one can only conclude that more needs to be done to further reduce the threat to wild fish from emissions of sea lice from salmon farms in the area, or else some wild salmon populations may fail altogether.

3.3 Expansion of the salmon farming industry

Despite on-going problems with controlling sea lice to the detriment of both wild fish and farmed salmon production, the salmon farming industry continued to seek to increase production within the SWRFT area during 2018 and 2019.

Four large new open-cage salmon farms were granted conditional planning permissions by The Highland Council, despite rigorous objections from local district fishery boards based on both Trust data and the Scottish Government's own published research, on account of the additional threat they would pose to wild fish populations (see Part 4). The new farms which may go into production later in 2020 or early 2021, are listed in Table 3.2.

Table 3.2. New salmon farms in the SWRFT area which were granted planning permission in 2019.

Location	Sea area	Company	Circular Cages	Biomass (tonnes)
West Strome	Loch Carron	SSC	16x100m	2000
Scalpay	near Broadford	MOWI	12x120m	2500
Scorrybreck	near Staffin	OSH	12x120m	2500
Invertote	near Staffin	OSH	12x120m	2500

In addition to these farms, applications were submitted to the Highland Council for new 2000+ tonne salmon farms by Horse Island (near Ullapool), North Aird (Loch Torridon), Raasay, Flodigarry (near Staffin) and Balmaqueen (near Staffin); and for expansions at new Isle of Rum farm (from 12 to 18 cages).

All new farms were required to submit an Environment Management Plan [EMP] to the Highland Council prior to the commencement of developments. The EMPs aim to ensure that wild fish populations in areas that could be affected by the new farm are monitored and that if sea lice levels exceed agreed thresholds, that actions will be taken to improve the situation through management intervention. However, so far, what those 'thresholds' would be has not been agreed. There is still uncertainty about the number of sea trout required to provide an adequate sample (if they can be caught) and the number of lice that would be required to be able to demonstrate that a 'threshold' had been crossed. Furthermore, given that in some areas there are many farms in close proximity from which larval sea lice will mix, it is not clear which farm(s) would be required to take action. Given recent WRASFB experiences with attempts to defend wild fish from salmon farm developments in Loch Torridon, one can imagine a series of increasingly expensive challenges if actions that might affect the profitability of a fish farm were to be proposed.

Rod catches and electro-fishing results (see Part 2.2) highlight the fragility of wild salmon populations in many of the rivers in the SWRFT area especially those around the Isle of Skye and southern part of the mainland area. The salmon farming industry has still to demonstrate that it can reliably control sea lice on its existing farms. So any further expansion can only be a major cause of concern for wild salmon and sea trout, including post-smolt salmon from far away rivers which migrate through coastal seas adjacent to the SWRFT area. If any of the new salmon farms start production before existing farms have been able to consistently achieve much better control of sea lice on their farms, the threat to wild salmon will increase.

As stated in previous reports, when the number of farmed salmon in close proximity (e.g. along a salmon smolt migration route) is in the order of a million fish or more, simply keeping on-farm lice levels to the SSPO's 'Code of Good Practice' standards of 0.5 adult female lice per fish (January to June) is unlikely to be adequate to safeguard wild fish populations.

3.4 Safeguarding wild salmon populations

There have been calls from some to 'stock' rivers to maintain juvenile salmon numbers. However, salmon geneticists (e.g. Verspoor, Fergusson, McGinnity, Coulson, . . .) have warned that in the long term, inappropriate stocking can do more harm than good to a wild salmon population. Hatchery-reared stocked fish compete with remaining wild fish. Regular stocking can reduce the ability of a wild salmon population to adapt to ever changing environmental pressures through natural selection.

The River Carron in Wester Ross is often cited as an example of the recovery of a salmon fishery based on stocking. The Carron fishery certainly experienced a remarkable recovery having collapsed to a far greater extent than any other wild salmon river of comparable size in the SWRFT area by the turn of the Century[12]. In the 1990s, the River Carron was subject to a double whammy from salmon farming. In addition to problems associated with sea lice infestations in coastal waters, from the early 1980s until around 2008, a freshwater open-cage salmon smolt rearing unit operated in Loch Sgamhain at the top of the river. It is possible that genetic introgression associated with escaped farm salmon contributed to the collapse of the wild salmon population in the River Carron in the 1990s. Escaped juvenile farm salmon can out-compete wild juvenile salmon in freshwater; however their whole life-cycle fitness is much less than wild native populations.

Following the start of a large scale stocking programme in the River Carron there was a remarkable recovery in the salmon fishery. The role of stocking to maintaining the current River Carron salmon population is uncertain. Note that from monitoring the Tournaig system (and other studies) we know that wild salmon sometimes stray into rivers away from those in which they were bred and can establish a large juvenile population and smolt run.

One of the legacies of the smolt farm was elevated phosphorus concentrations, initially just at the top of the river but over time all the way down (Figure 3.5). Phosphorus is the nutrient which limits biological production in much of Wester Ross. There is currently much interest in nutrient addition as a method of supporting failing salmon populations in nutrient deficient rivers. Inadvertently, biological productivity in the River Carron may have been raised to levels far above those of pre-salmon farming days; hence greater than anticipated wild and stocked salmon smolt production.

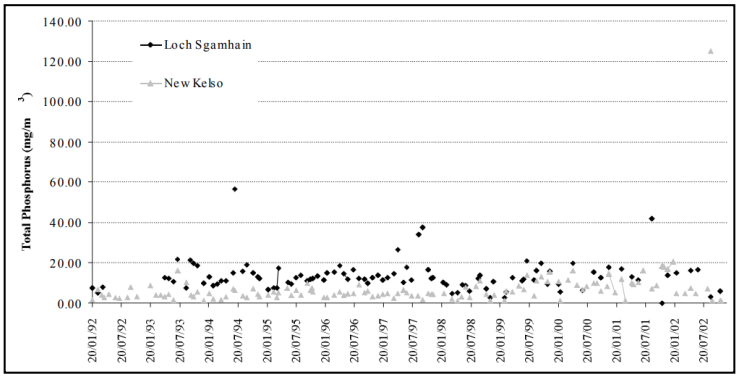


Figure 3.5. Total phosphorus concentrations in the River Carron as measured at the two SEPA monitoring stations.

The genetic integrity of some of the salmon populations in the south of the SWRFT area and Isle of Skye may already be compromised as a result of very few returning adult fish. However some rivers (for example the River Ling) may still retain unique adaptations which enable fish to complete their challenging life-cycle; such salmon populations should be of highest priority for protection. Perhaps a way forward, at least until sea lice in open cage salmon farms are regulated for the purpose of protecting wild fish, is to establish, as a matter of some urgency, wild salmon genebanks of the sort adopted in the Hardangerfjord in Norway to conserve threatened native populations, from which future stock restoration programmes based on careful science can be developed?

**Please also see a separate statement from Bob Kindness who has managed the remarkable recovery of the River Carron fishery in Appendix 1.*

[12] See WRFT River Carron Fisheries Management Plan 2004-2008
http://www.wrft.org.uk/files/Carron%20FMP%202004%20(distrib).pdf

Part 4 **Wester Ross Area Salmon Fishery Board report**

supported by Fisheries Management Scotland and Fish Legal

by Peter Jarosz (Clerk to WRASFB)

The Wester Ross Area Salmon Fishery Board [WRASFB] has continued to work in close co-operation with Skye & Wester Ross Fisheries Trust [SWRFT] over the past two years in two distinct areas of work:

- **Monitoring of fisheries.** Data collected in 2018 and in 2019 by SWRFT (e.g. from sweep netting and electro-fishing surveys) has added to the data bank that the WRASFB requires in performing its remit as the statutory consultee for wild fish. A summary of these surveys can be seen elsewhere within this document.
- **Responding to planning applications**. SWRFT has provided background information for responses to planning applications for fish farm sites both within and outwith the Board's area.

As far as aquaculture planning applications are concerned, the past twenty-four months has witnessed efforts by the Scottish Salmon Company [SSC], utilizing the legal processes available to them (and engaging lawyers) in connection with two planning applications.

In the first of these, SSC applied under S42 of Town and Country Planning (Scotland) Act 1997 to have the ten-year term at their farm in Loch Torridon (Sgeir Dughall) removed and for the operations to be replaced with a permanent planning consent. This resulted in the Reporter on appeal granting the new planning permission with the condition that there needs to be an agreed Environmental Management Plan [EMP] in place prior to any commencement under this new (S42) planning consent. The Board has been informed in email correspondence with Mark Harvey, Highland Council Planning Department [HCPD], that as yet (August 2020) there has been no agreement between the HCPD and SSC on an EMP for this conditional consent under S42.

In 2019, SSC applied for planning permission to operate a new fish farm at their existing North Aird site, i.e. as a larger consolidated site, with an EMP. WRASFB objected to the application in a detailed response. SSC offered to cease operations at its nearby site at Kenmore. However, the planning application was refused by the HCPD and was then appealed to the Scottish Government's DPEA by SSC, which as part of its appeal offered to submit to a condition that it cease operations at Kenmore if the new site at Aird were consented. The WRASFB submitted a detailed response to this planning appeal arguing against it. The decision of the Reporter is awaited.

This year, Mowi (formerly Marine Harvest) submitted to HCPD a S42 planning application to remove the ten year condition that applies to the current planning consent at their Camas an Leim site in Upper Loch Torridon, and to replace that condition with an EMP. The ten year period is due to expire in March 2021. The WRASFB has also objected to this application in a detailed response. The planning decision is awaited.

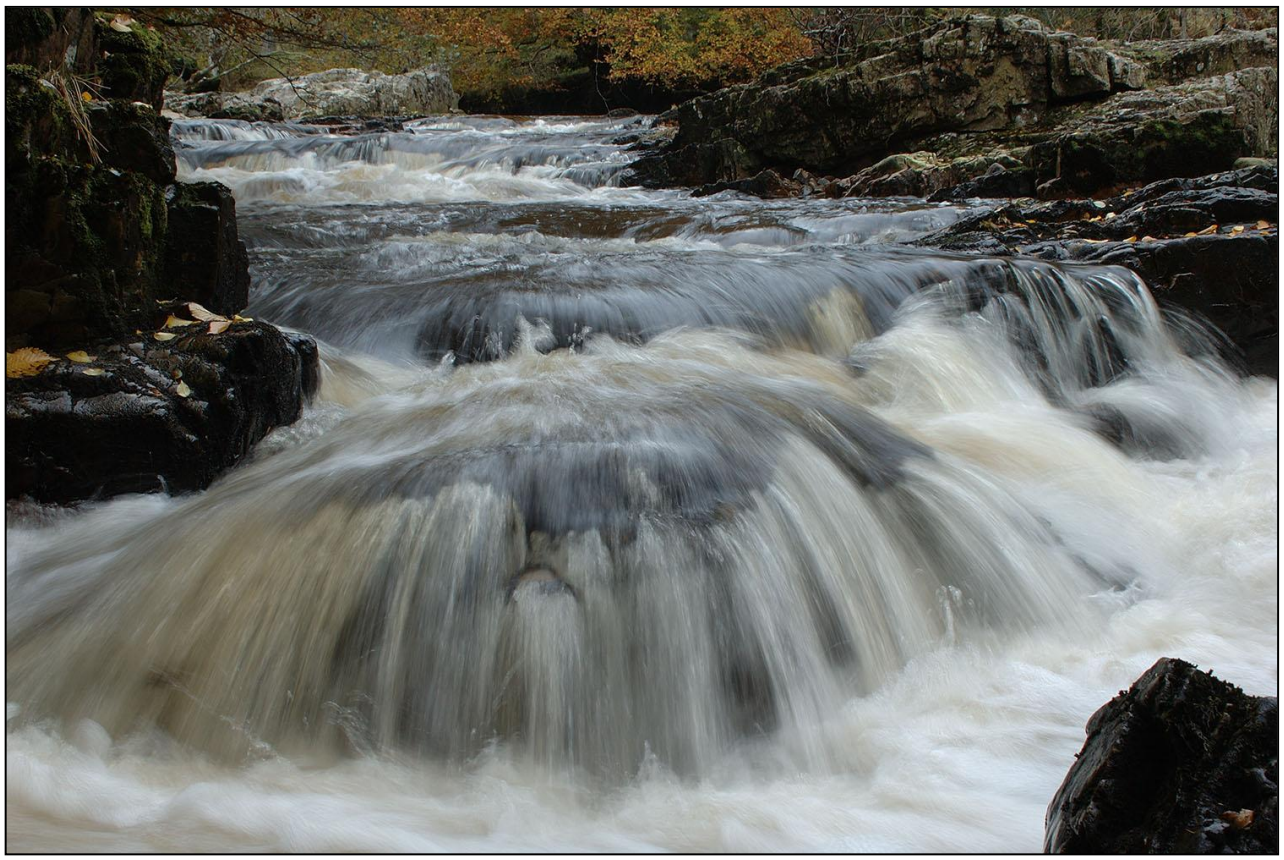
Alongside these three on-going planning cases (all of which concern sites in the Loch Torridon area), WRASFB has responded, with the help of data/information from the SWRFT, to a number of aquaculture planning applications that are outwith the WRASFB area but of a close enough proximity to impact upon the rivers within the Board's area either directly or to the fish migrating from the Board's rivers. These applications included in the early part of 2018, Marine Harvest's Scalpay fish farm site at Broadford on Skye (consented in September 2019) as well as in late 2018, Marine Harvest's scoping application for a significant biomass increase at their fish farm in Loch Hourn to which WRASFB objected with a structured response.

The WRASFB also objected to Organic Sea Harvest's 2019 planning application for their Flodigarry (Isle of Skye) site which was refused in January 2020. Following another unsatisfactory benthic impact survey in early 2019 at Mowi's Isle of Ewe fish farm, about which WRASFB corresponded with SEPA urging for a biomass reduction to be imposed, SEPA did impose a biomass reduction and Mowi then appealed that decision to DPEA. WRASFB submitted a response to DPEA that was based solely on legal arguments for the reduction of biomass to be endorsed. DPEA in fact reversed SEPA's biomass reduction decision.

On less political issues, WRASFB has helped to support the educational projects run by the SWRFT as part of the Board's public awareness remit.

Both WRASFB and SWRFT supported the start of 2018 fishing season with the first cast on the Ullapool River being performed by pupils from the Ullapool Primary School's Gaelic class accompanied by Duncan Macleod on the pipes. Both the teachers and the pupils wanted to have a cast with the event being enjoyed by a good sized gathering. In 2019 the ceremony took place at Loch nan Dailthean, Tournaig just at the seaward exit of the Tournaig burn with the first cast performed by the SWRFT ex-chairman (Prof Andrew Barclay). A pipe band from Gairloch High School led the procession from the estate house to the loch-side and accompanied the first cast. In recognition of the pipe band's sterling performance the WRASFB gave a donation of £100 to the school's pipe band funds.

Further information about WRASFB, including copies of responses to planning applications, can be found on the Board's website at http://wrasfb.dsfb.org.uk/ .



Cascade, Dundonnell River (photo by Virginia Jarosz).

Conservation Measures to Protect Wild Salmon in the Isle of Skye & Wester Ross in 2020

The Scottish Government's proposed categories for rivers in the SWRFT area for the 2020 fishing season are shown below. The assessment is based on reported rod catches from which estimates of the probability that there were adequate numbers of adult female fish to achieve egg deposition targets over the past 5 years were calculated.

River	2017	2018	2019	Proposed Category for 2020
Mainland				
Kanaird	3	3	2	**2**
Ullapool	2	2	3	**3**
Broom	3	3	2	**2**
Dundonnell	2	3	3	**3**
Gruinard	2	3	2	**1**
Little Gruinard	2	3	3	**3**
Ewe	2	3	1	**1**
Kerry	1	3	1	**2**
Badachro	1	3	1	**2**
Torridon	3	3	3	**3**
Balgy	2	3	2	**2**
Applecross	3	3	3	**3**
Carron	3	3	2	**2**
Ling & Elchaig	2	3	2	**3**
Croe & Shiel	3	3	3	**3**
Glenmore	3	3	3	**3**
Glenbeag	3	3	3	**3**
Arnisdale	2	3	3	**3**
Isle of Skye				
Kilmaluag & Brogaig	3	3	3	**3**
Stenscholl (Kilmartin)	3	3	3	**3**
Lealt	3	3	3	**3**
Varagill	2	3	2	**2**
Sligachan	3	3	3	**3**
Broadford	3	3	3	**3**
Hinnesdal	1	3	2	**3**
Haultin & Romesdal	1	3	2	**3**
Snizort & Ose	3	3	2	**2**
Drynoch & Eynort	3	3	3	**3**
Fhionnairigh, Scavaig & Strath Mor	3	3	3	**3**

Source: https://www2.gov.scot/Resource/0054/00548161.pdf

The egg deposition targets do not include consideration of the importance of surplus eggs as food for pre-smolt salmon parr to ensure that emigrating salmon smolts, especially those from rivers which rely more heavily on marine nutrient additions, are adequately nourished to go to sea. The SWRFT mainland biologist therefore recommends that all wild salmon are returned until such time as there is a clear and strong recovery of wild salmon populations throughout the area.

Frank Buckley carefully returning a rod caught salmon to Loch Maree.

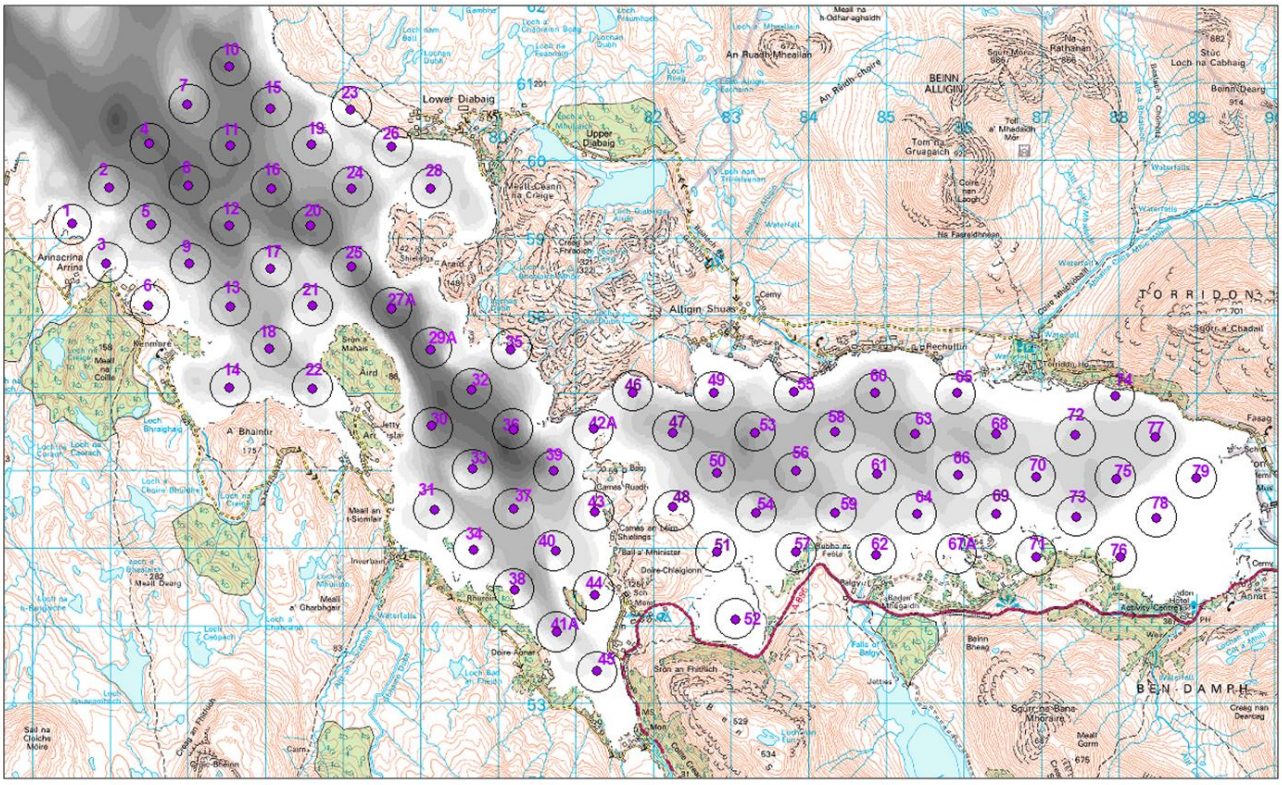
Category	Probability of Meeting CL	Advice
1	At least 80%	Exploitation is sustainable therefore no additional management action is currently required. This recognises the effectiveness of existing non-statutory local management interventions.
2	60-80%	Management action is necessary to reduce exploitation: catch and release should be promoted strongly in the first instance. The need for mandatory catch and release will be reviewed annually.
3	Less than 60%	Exploitation is unsustainable therefore management actions required to reduce exploitation for 1 year i.e. mandatory catch and release (all methods).

Part 5 **Acoustic tracking of salmon and sea trout in Torridon**

by Jason Godfrey, David Morris and Jim Raffell

During 2018 and 2019 Marine Scotland Science have been tracking salmon and sea trout smolts in the Loch Torridon system. Fish were fitted with acoustic transmitters and tracked in a grid-based array of 80 acoustic receivers that spanned Upper Loch Torridon, Loch Shieldaig and most of Outer Loch Torridon (Figure 5.1). The spacing of the receivers (approximately 800m apart) was such that the movements of individual fish could be tracked around the study area.

Figure 5.1. Location of acoustic receivers in Loch Torridon for recording the movements of tagged juvenile sea trout and salmon smolts.



Over the two years, smolts were tagged in each of the three main rivers emptying into the system: the Torridon (35 salmon, 53 sea trout), the Balgy (85 salmon, 50 sea trout), and the Shieldaig (274 sea trout). At this latter river Marine Scotland has been operating a trap for the past 20 years to examine return rates of sea trout. The acoustic transmitters used to tag the fish were either ID tags (which report only their identity) or data tags (which additionally report temperature and depth). In addition, sea trout were PIT-tagged so that they could be recognised if subsequently caught at the Shieldaig trap after the acoustic tag battery had failed.

During the course of the study, over 2.5 million pings from fish tags have been detected in the array, meaning that there are a lot of data to process, and most of this work still lies ahead. Even so several key findings are emerging.

Firstly, salmon from both the Torridon and the Balgy showed marked variation in time taken to leave the array, indicating potential differences in individual exposure to hazards encountered in the inshore environment. None of the salmon remained at the river mouth, but were instead actively swimming around Upper Loch Torridon and Loch Shieldaig. In general, once a salmon reached Outer Loch Torridon its egress from the array was then swift and direct. This implies that finding the way out of a complex loch may be no simple task for some salmon smolts.

A second finding is that sea trout also exhibited a range of movement patterns, from fish that remained in the area surrounding their river mouth, to fish that moved to a non-natal river mouth, to fish which moved regularly between basins, and finally to fish which performed wide-ranging movements, leaving and returning to the array several times over the course of the summer. For example, one fish from the Shieldaig river spent several days in the sea pool of the Applecross River (where a lone receiver had been stationed) before returning to Torridon.

Thirdly, predation was identified as a source of mortality for sea trout, with mammalian predators being principally indicated. Predation events could be identified through pronounced changes of tag behaviour and speed of movement in the array and, for data tags, increases in reported temperature and associated changes in depth patterns. Additionally, some 25 % of fish were never heard in the array at all.

Fourth, we detected non-lethal tag ejection events. This was determined by a tag being recorded as stationary on the sea bed, while the fish it had been inserted into was subsequently recaptured in the Shieldaig fish trap, recognised by its secondary tag. That tags can be ejected while the fish survives shows that the non-detection of an acoustic tag cannot always be regarded as a proxy for mortality.

Finally, sea trout depth-use varied between day and night (deeper in the day). This behaviour could be due to a change in food availability or a response to a change in predation risk. Possibly allied to this behaviour, there was a notable reduction in detections of sea trout at night.

In 2020 MSS will again be tagging fish in the three rivers and deploying an array of acoustic receivers. This year however, the array's design will be modified in an attempt to discover the fate of the fish that are never detected at sea, and to shed further light on the night-time 'disappearance' of sea trout. We also aim to collect further information on the 'escape times' of salmon, and to perform an analysis of genetic material from the fish.

(right) Loch Shieldaig, from the mouth of the River Shieldaig. Photo from MSS website.

Marine Scotland Science would like to thank the riparian owners of the Torridon, Balgy and Shieldaig rivers for their continuing support, and the creel fishers of the Loch Torridon system for their patience in maintaining the integrity of the array, despite its inconvenience to them[13].

Thank you to Marine Scotland Science for contributing this article.

[13] Further information about other research and monitoring carried out in Loch Torridon by Marine Scotland Science can be found on the MSS Shieldaig web page at: https://www2.gov.scot/Topics/marine/Salmon-Trout-Coarse/Freshwater/Research/Aqint/Shieldaig

Part 6 **Loch Maree Wild Trout Project**

6.1 Wester Ross Wild Trout Workshop

30th April 2019, Kinlochewe Village Hall

Supported by The Wild Trout Trust, Middlesex University, Wester Ross Area Salmon Fishery Board, UHI Rivers and Lochs Institute and the Scottish Government Marine Scotland Science.

This workshop focused on the genetic diversity of wild trout within the Loch Maree catchment area. The main purpose of the workshop was to provide an opportunity for Dr Steve Kett of Middlesex University and his research team (Vu Dang, Dr Toby Landeryou and Dr Martijn Timmermans) to report their findings following over 12 years of sampling within the Gairloch, Loch Ewe and Loch Maree areas.

Dr Steve Kett introduced the project**.** Launched at the Loch Maree Hotel ('anglers Mecca of yesteryear') in 2007, **the objectives of the Loch Maree Wild Trout Project** included unraveling the genetic diversity of wild brown trout (including sea trout) within the Loch Maree catchment area for the purposes of informing conservation and fisheries management. Samples of both brown trout (non-seagoing) and anadromous trout (sea trout) were collected from isolated hill lochs high in the hills, spawning streams accessible to sea trout around Loch Maree and other lochs, river estuaries and nearby coastal area. Funding for analyses included biomedical research grants (; with regard to parasite research, trout can be useful proxies for people) and other providers not normally associated with trout research. Some of the material collected also provided novel opportunities for student teaching.

Vu Dang's project **'A first look at the population structure of Loch Maree wild trout'** was based on 192 samples of trout taken from 35 sites within the Loch Gairloch to Loch Maree catchment area. The results suggested that the trout population decline associated with the collapse of the sea trout fishery may have caused a genetic bottleneck. Samples of sea trout from Gairloch and the NW Loch Maree area showed the greatest similarities and overall diversity; suggesting large overlapping coastal ranges of different populations. These results implied that sea trout from different spawning populations mix together as they move around the coast in their search for food before returning to spawning streams. Genetic divergence of resident trout populations correlated with geo-hydrological distance ('distance as the fish swims'). For example samples of trout from headwater streams above Kinlochewe were least similar to those taken close to Poolewe. However, there was also evidence of some introgression between populations, suggesting some straying and interbreeding of trout at spawning time. Trout from streams and lochs above impassable barriers had the least genetic diversity. Vu suggested that all the trout were descended from an ancestral sea trout population rather than from trout that had remained in freshwater during the Ice Age. Protection of trout populations in headwaters within the area accessible to sea trout would have conservation benefits all the way downstream. Vu's presentation can be found here: http://www.wrft.org.uk/files/Loch%20Maree%20wild%20trout%20population%20structure%20first%20look%20by%20Vu%20Dang%2030%20April%202019.pdf

Wester Ross sea trout: female (l) and male (r), illustrated by Paul Vecsei www.flickr.com/photos/fishasart/

Dr Toby Landeryou focused on parasites of trout. His talk, **'Immunogentic adaptation of UK brown trout populations to parasite infection'**, was based on samples from 14 hill lochs in the Gairloch area. The Brown trout is an intermediate host for many parasites. Heavy parasite infestation of wild trout can limit fish size and age. A total of 2143 parasites were dissected from 210 trout. Three types of parasite were found. Cestodes (tapeworms) were present only in three lochs including Lochan na Breac in the northwest of the study area. Nematodes (roundworms) were recorded only in samples from two hill lochs in the middle of the study area. However, trematodes (eye flukes) were found in trout sampled in 13 of the lochs. Eye flukes cause cataracts; heavily infected trout have compromised eye sight.

(right) Toby Landeryou and Vu Dang sampling trout in Wester Ross in 2016.

From genetic analyses, eye flukes were identified as belonging to the *Diplostomum baeri* species complex. Gairloch trout had greater *D. baeri* genetic diversity than those sampled on the European mainland and in Iceland. As the life cycle of Diplostomum includes birds such as divers and gulls; bird migration provides an explanation of observed diversity. Three species of cestode (tapeworms) were identified, including *Diphyllobothrium* spp. We were reminded that wild fish should be thoroughly cooked; one of the *Diphyllobothrium* species recorded can infect humans. The next part of the study focused on finding out whether any of the hill loch trout populations had developed genetic immunity to parasites? Analysis of a genetic complex linked to parasite infestation [Satr-DAB] demonstrated clear inter and intra-population diversity. There was greater diversity in lochs where cestode infestation occurred, implying selective potential, and the potential importance of adaptation to local environmental pressures within trout populations. Such information is of relevance to possible stocking programmes; trout from populations which have not encountered the parasites before may do less well than those from populations which have evolved in an environment where parasites are present.

Prof Eric Verspoor's (UHI Rivers and Lochs Institute) talk **'The diversity of lacustrine brown trout in Scotland'** included a summary of the widely reported Loch Laidon trout diversity study as well as previously unpublished findings from Loch Maree. Genetic analyses of samples collected from Loch Laidon in the Central Highlands had revealed the presence of four different forms of trout, each belonging to a discreet population. Each form of trout was found to occupy a different habitat with different ecology within the loch. One of the forms had an unusually large eye relative to other trout in the loch. It was found in the deepest water, occupying habitat usually associated in other Highland lochs with benthic arctic charr. This was the first time a profoundal benthic form of trout had been reported from a lake in Europe; highlighting how little is known about population diversity of wild trout. Genetic analyses of samples of trout taken from different depths in Loch Maree suggested that there were also four different populations within Loch Maree, or perhaps as many as 10 trout populations! Further work is required to learn more about the differences in the morphology and ecology of trout in Loch Maree.

Wild trout diversity in Wester Ross: mature males, illustrated by Paul Vecsei www.flickr.com/photos/fishasart/

Peter Cunningham's talk **'Wester Ross: a stronghold for the future of wild brown trout?'** with illustrations by Paul Vecsei ['Fish as Art'], highlighted the remarkable diversity of wild trout and their habitats in Wester Ross. The appearance of trout caught in the Fionn Loch suggested complex population structuring. Within the Loch Maree catchment were ferox trout which grow to over 4kg, sea trout (formerly to over 8kg) and various isolated hill loch and hill stream trout growing to no more than 100g. Sea trout had been sampled in estuaries, off sandy beaches, over seagrass beds and were known to utilise other habitats. Some of the main findings of SWRFT sea trout sampling work, referred to earlier in this review, were reported. Peter's presentation can be found here: http://www.wrft.org.uk/files/Wester%20Wild%20Trout%20Workshop%20presentation%20by%20Peter%20Cunningham%2030%20April%202019.pdf

Dr David Morris (Marine Scotland Science) provided a summary of some of the **research at the nearby MSS Shieldaig Field Station by Loch Torridon and an introduction to the Loch Torridon sea trout and salmon tracking project**. Initial results from the tracked fish were shown by way of an animation. Tagged sea trout smolts displayed many different behaviors moving to and from and within large parts of upper Loch Torridon. Please see Part 5 for further information about the Loch Torridon tracking project.

Dr Martijn Timmermans (Middlesex University) described how **the sea louse (*Lepeophtheirus salmonis*) can be used for teaching students about natural selection.** Parasitic sea lice have been a major health concern for farmed salmon for many years. To control on-farm sea louse infestation, several pesticide treatments including bathing salmon in organophosphate solution had been used. However sea lice had developed resistance to some of the pesticides, making treatments less effective. Kaur et al. 2015 had investigated the mechanism behind resistance in salmon lice against the organophosphate pesticide 'Azamethiphos' and identified the associated genetic mutation. It was now possible to screen sea lice to find out whether or not they carried this genetic mutation for organophosphate resistance. Fjortoft et al. 2017 demonstrated widespread distribution of organophosphate resistant lice around Norway. A small number of sea lice were collected from wild sea trout and salmon around Wester Ross for teaching purposes. Lice from the sea trout were also found to have the genetic marker for organophosphate resistance. However those taken from wild salmon did not have the associated genetic mutation.

Gareth Pedley (The Wild Trout Trust) described some **examples of habitat problems and solutions along some of the wild trout streams** elsewhere in Scotland and NW England. The Wild Trout Trust provides targeted advice for wild trout conservation and management, and supports habitat restoration projects in partnership with many other groups or organisations. Common problems include: siltation of spawning gravels associated with soil and river bank erosion sometimes linked to grazing pressures from livestock; stream widening, and a lack of riparian vegetation. Leafy riverbanks especially those with some tree cover are best for protecting river channel morphology and for providing food for the insects upon which trout feed. A range of examples of interventions to restore or improve trout habitat were shown some. Similar interventions may benefit wild trout [and juvenile salmon production] along many of the streams within the Wester Ross area.

Thank you very much to Dr Steve Kett, colleagues Dr Martijn Timmerman, Vu Dang and Dr Toby Landeryou and Middlesex University for much work over many years, and to Prof Eric Verspoor, Dr Dave Morris and Gareth Pedley and their employers for supporting this workshop. Thank you to Paul Vecsei for permission to reproduce his illustrations of wild trout sampled by Wester Ross Fisheries Trust in previous years. Thank you to everyone for coming along and helping especially Dr Pat Brunton, Nick Benge, Chris Beresford, Prof Eric McVicar, Alasdair Macdonald, and the Scottish Television film crew with Sean Batty for recording field sampling on 1st May 2019.

6.2 Wild trout studies, summer 2019

Dr Steve Kett returned to Wester Ross in July 2019 with colleagues Dr Andy Vicks and Marta Matuszewska to collect additional genetic material and to sample bacteria and viruses from wild trout. Wild trout and other vertebrates can harbour some of the same microorganisms as people, and one of the aims of the sampling programme was to screen wild trout for those which are of particular interest to medical research.

Some of our most serious pandemics are caused by pathogens switching and establishing in a new host species and so understanding the epidemiological factors for switching success is essential for curbing pathogen spread. The capacity for some pathogens to jump into new host-species populations leading to the emergence of pathogenic clones is a major threat to public health and food security[14].

To obtain samples of wild trout many volunteers were recruited. On the 12th of July an angling expedition was organised to sample the trout of the Golden Lochs in the hills above Kinlochewe. The sampling team included many members of Dr John Ogle's party staying at Kinlochewe Lodge and Peter Cunningham's fishing pal from school days, Dr Malcolm Stewart.

Many wild trout, mostly of between 20cm and 25cm in length, were caught from several different lochs. The trout were carefully processed by the support team, which included energetic and highly efficient microbiology student, Sofie Bannister.

(right) A typical wild brown trout from one of the hill lochs.

The clouds came down; by mid-afternoon, the expedition became a navigation challenge. Descent from the hill lochs back down to the valley of the Kinlochewe River was made by way of a goats' path, and wading through 2m tall bracken.

Thank you to all the adventurous volunteers for your enthusiastic and support!

(left) The processing team with one of the hill loch trout. (right) Watching through the mist as trout are returned to one of the hill lochs.

[14] See https://www.infectiousdisease.cam.ac.uk/directory/marta-matuszewska

6.3 A revived Loch Maree fisheries restoration programme?

Until the 1980s, Loch Maree had a reputation for world class angling for sea trout. The fishery provided seasonal employment for ghillies and other staff at several hotels and supported other local businesses. Some of the sea trout grew large; they were not fast growing fish, but survivors which returned from the sea to spawn many times. Until the mid-1980s, a few sea trout of over 10lb were still recorded: a principle reason why anglers kept returning. Alas, thirty years on, the Loch Maree sea trout fishery has become something of a fading memory.

The collapse of sea trout stocks in Wester Ross and elsewhere in the west of Scotland, Ireland and Norway led to much research and discussion. From the early 1990s, attention focussed on sea lice epizootics associated with the emerging salmon farming industry; anglers witnessed many heavily lice infested sea trout in river estuaries. There was less attention on an increase in trawling within inshore waters around Scotland following the removal of the three mile limit by the Inshore Fisheries (Scotland) Act in 1984. Fisheries for cod, haddock, plaice, turbot and other white fish around Wester Ross enjoyed a few years of bonanza in the late 1980s, before they too collapsed with the loss of many jobs in fishing and fish processing. Numbers of grey seals increased in coastal waters from the 1980s.

For sure, there is agreement that the main factors leading to the collapse of the Loch Maree sea trout fishery were in the sea. Since designation of the Wester Ross Marine Protected Area in 2014, fishing by dredgers in Loch Ewe has ceased and marine life appears to be recovering. In 2019, Mowi reached an agreement with the Wester Ross Area Salmon Fishery Board to end farm salmon production within Loch Ewe at the end of 2020, citing plans for the development of the new much larger Scalpay salmon farm (near Broadford) as an alternative location. So there is renewed interest in reviving the Loch Maree fishery.

For reasons described earlier in this report, improvements in sea louse control in other salmon farming areas may be prerequisite to enable a full recovery of the Loch Maree sea trout stock. This includes Loch Torridon area and the east of Skye including NE Skye where Organic Sea Harvest plan to start production at two large new sites with another application pending. Sea lice dispersal models show how elevated concentrations of larval stage lice may drift from salmon farms as far away as Scalpay towards Loch Ewe.

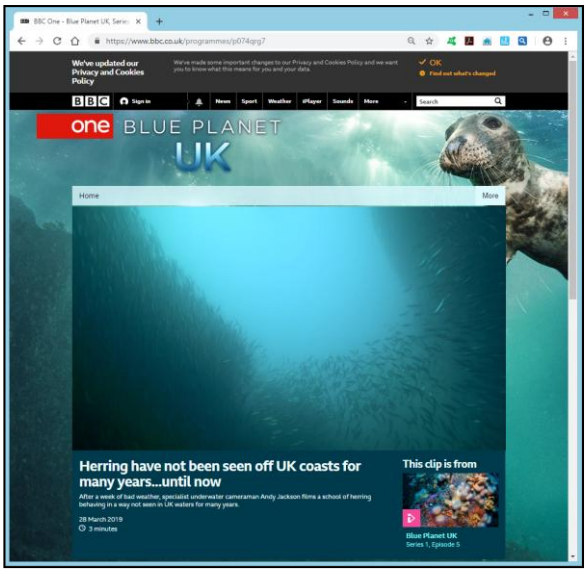
Fishery proprietors are currently considering options for future monitoring and other activities to support the revival of the River Ewe and Loch Maree sea trout fishery.

A breezy day by Grudie, Loch Maree, 28th August 2020 (photo by Peter Cunningham).

Part 7 **Some other marine activities**

7.1 Spring spawning herring recorded to the west of Loch Gairloch

Following the rediscovery by scallop divers of a large area of seabed covered by herring eggs near Gairloch in March 2018[15], underwater cameraman, Andy Jackson of Subsea TV, expressed much interest in attempting to film herring at spawning time. In March 2019, after much effort and with support from many other people, especially Bill Whyte, John Mackenzie (K-2), George Brown (Inverness Dive Club) and local fishermen, Andy was successful in recording the shoals of herring just prior to spawning, herring spawning activity, and herring eggs on the seabed just before they hatched[16].



(above) Eyed herring eggs on maerl gravel to the west of Red Point farm, March 2019. Screenshot from video recorded by Andy Jackson. (right) Herring shoal recoded to the west of South Erradale on 6th March, 2019. Recorded by Andy Jackson.

The eggs were distributed as a layer several eggs deep extending over hundreds of square meters, centered about 1km to the west of Red Point farm just outside Loch Gairloch from around 8th to 10th March. They had been laid over highly porous maerl gravel in water of about 16m to 25m deep. Andy was also able to record in close up using a macro lens herring eggs hatching in a specially set up maerl aquarium in the SWRFT office.

Andy's video were shown on BBC1 Blue Planet UK in April 2019 https://www.bbc.co.uk/programmes/p074qrg7 and subsequently a short film about the spawning herring, narrated by Chris Packham, was broadcast on BBC Springwatch in May 2019.

Following the success of the project, SWRFT was contacted by The William Grant Foundation, and an offer of grant funding was accepted to carry out further work to learn more about why the herring returned to spawn where they were recorded. Attention is focusing on developing a clearer understanding of the importance of maerl gravel as a spawning habitat. Collaboration between the Trust and Professor Karen Diele from Edinburgh Napier University has been set up. At the time of writing everything is on hold due to the Coronavirus pandemic; as soon as we receive the all clear, further investigations will commence.

Tragically, Andy died in September 2019. An appreciation can be found on page 62 of this review.

[15] See http://www.wrft.org.uk/news/newsitem.cfm?id=214

[16] Seehttp://www.wrft.org.uk/files/Wester%20Ross%20spring%20spawning%20herring%20recoded%20on%20video%20to%20the%20west%20of%20Red%20Point%20near%20Gairloch%20v2.pdf

7.2 MASTS student projects

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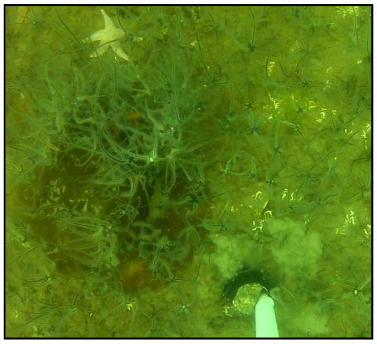
The shallow seas around the SWRFT area remain potentially some of the most productive and biodiverse in Europe, thanks to varied topography, exposure to waves, and the mixing of cool nutrient rich waters associated with the Gulf Stream. Two of the most important seabed habitats for biodiversity and the secondary production they support are seagrass and maerl.

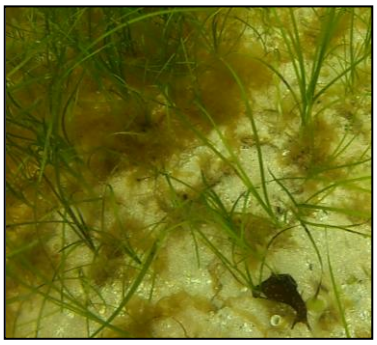
The seagrass, *Zostera marina,* was more widespread in north European coasts before damage by disease in the 1930s. Seagrass has recently been found in several sea lochs of the area. Maerl beds are formed by the accumulation of slow growing, twiggy coralline algae. Maerl is one of the priority marine habitats for which the Wester Ross Marine Protected area was designated. Both habitats are vulnerable to dredging and nutrient enrichment. So we were delighted to welcome two enthusiastic and highly able post-graduate students from Edinburgh University to Wester Ross in May 2019 to learn more about the health of these habitats.

Josie Williams focused on maerl beds in Loch Ewe and the Summer Isles, using drop-down camera and baited underwater camera trap. From video footage, she was able to map out and assess the condition of a large area of maerl to the west of the Inverewe peninsula and another area in the Summer Isles, both within the Wester Ross Marine Protected Area. Much of the maerl was covered in a layer of filamentous algae thought to be associated with nutrient enrichment. Few fish were seen by the baited camera, possibly partly due to the time of year.



(right) an aggregation of thousands of brittlestars over degraded maerl habitat to the west of Inverewe (screenshot from dropdown video).

Calum MacDonald used a combination of snorkeling and drop-down video camera to assess the health of seagrass beds in Gruinard Bay, Loch Ewe and the Sound of Longa. Like the maerl, much of the sea grass was covered in filamentous algae raising concerns about its health. Calum returned to Wester Ross in September to find that some of the seagrass beds in Loch Ewe were in better condition than earlier in the year; much of the filamentous algae had gone. Calum has since set up an organisation (Seagrass Restoration Scotland).



(right) seagrass and brown filamentous algae near Mellon Charles. Several sea hares can be seen in videos from this site (screenshot from GoPro video).

Both Josie and Calum completed detailed dissertations which include a wealth of analyses and information about respective habitats; they will be very useful documents for future reference. Both students were awarded Master of Science degrees: well done, congratulations and good luck with future work!

Thank you especially to Kevin Frediani at NTS Inverewe for accommodation; to Dr Pat Brunton, Peter Jarosz, Fiona MacKenzie, Jamie Elder, Sara Nason (Sea Change Wester Ross), Tim Allen (Glassbottom boat) and Philip Grant for much support including boat time. Thank you to Owen McGrath and SNH for setting up these projects and to Dr Sebastian Hennige, University of Edinburgh for supervision.

Part 8 **Invasive species control**

8.1 Scottish Invasive Species Initiative [SISI]

by Dr Lorna Brown education@swrft.org.uk

The Scottish Invasive Species Initiative (SISI) is a 4-year partnership project in Northern Scotland, which aims to control invasive non-native species that impact freshwater fisheries. It is led by SNH and funded by the Heritage Lottery Fund and SNH, with in-kind support from project partners and volunteers. In the SWRFT area, the project covers mainland Wester Ross and is now being co-ordinated by Lorna Brown.

SISI plant control focuses on five species (Giant Hogweed; Japanese Knotweed; Himalayan Balsam; American Skunk cabbage; White Butterbur). Left unmanaged, these plants rapidly engulf riverbanks, outcompeting native species. This growth impacts invertebrate communities within rivers, but the main concern is the winter die-back which leaves bare banks extremely vulnerable to erosion. Recently volunteers have started to tackle Himalayan balsam in Laide. To be effective we work at a catchment scale so that nothing is left to re-infest the river downstream. In Laide this translated as working out which gardens and crofts feed seeds into the Sand burn. The local enthusiasm has been fantastic, and we hope that over the next 2 years we can get the invasion under control to such an extent that any new growth will more easily be managed by local landowners. Through SISI, small patches of regrowth remaining from our previous Japanese knotweed programme on the River Broom will be also be treated in 2020 and 2021.

Another SISI aim is to establish a network of monitoring rafts throughout the north of Scotland to determine American mink distribution. From a fisheries perspective, mink can have a significant impact on juvenile salmonid populations. As “surplus killers” they also decimate populations of ground nesting birds and water voles. We are indebted to our small team of dedicated volunteers who have monitored, trapped, and dispatched mink since the project began in 2018 and we are delighted to be welcoming new volunteers in 2020, helping to widen our monitoring area. Anyone wishing to be involved should contact Lorna.

A vital part of SISI is increasing public awareness of invasive plants and animals. Events delivered to date have included displays at shows, public talks, and school activities. Specific biosecurity awareness talks have been provided for anglers, swimmers, and kayakers. The pupils of Poolewe and Kinlochewe Primary School created excellent posters which were displayed at these biosecurity events, while Badcaul primary pupils gave a great biosecurity “Check, clean, dry” demonstration at the First Cast event at Dundonnell Estate. In the coming year we will be involved in a primary school film production project with Media Education. Gairloch High School pupils will also be helping SISI as part of their John Muir award.

SISI funding may be extended for an extra year, running to October 2022. The intention of the project is that after it finishes, the community control of ‘invasives’ we have developed will continue, providing a local, sustainable long-term solution. For more information see: https://www.invasivespecies.scot.

8.2 Kerrysdale *R. ponticum* control 2020

by Chantal Awbi and Eamonn Flood

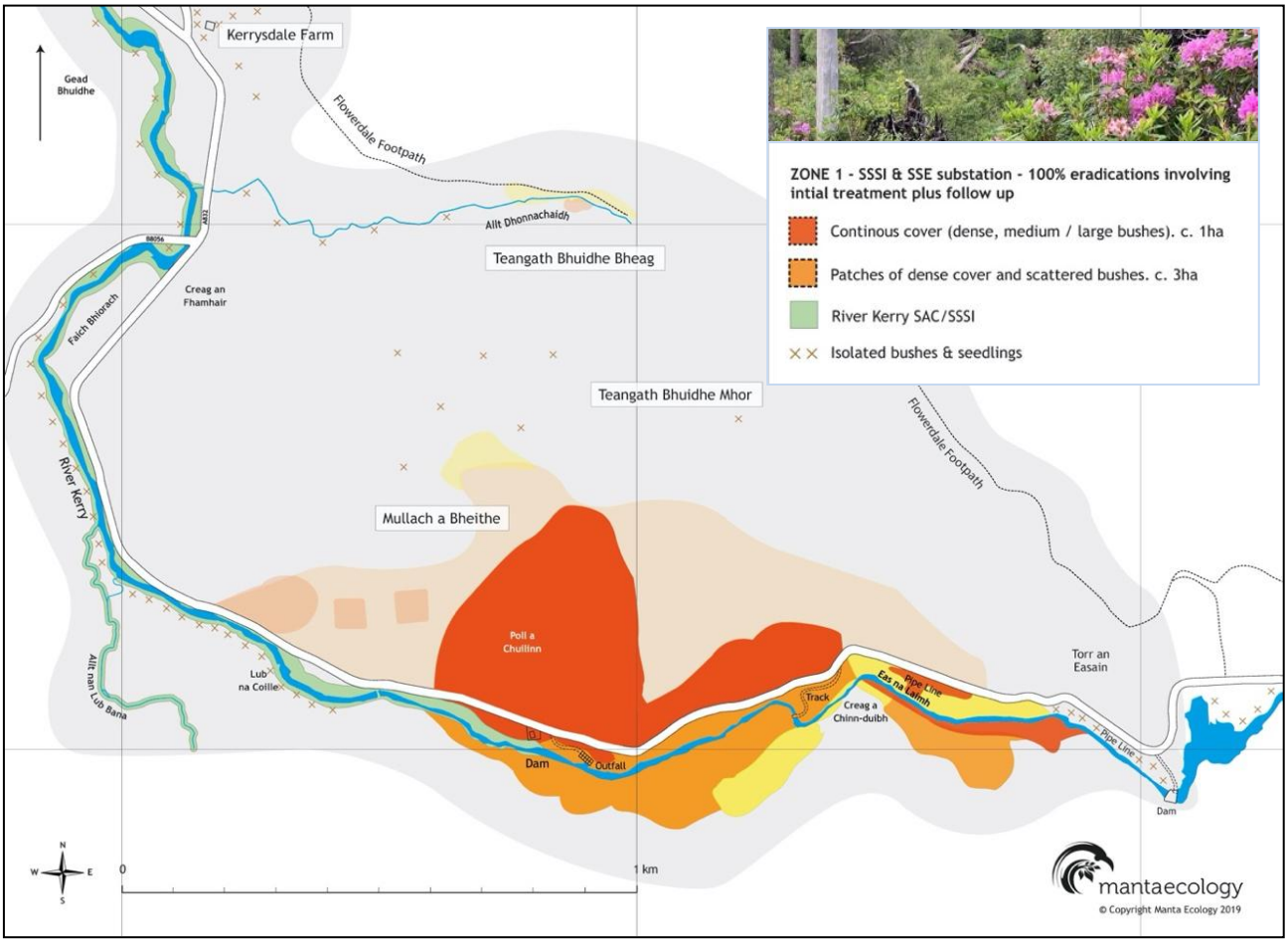
In 2019, SWRFT was fortunate in attracting funding from the Highland Council through the Scottish Landfill Communities Fund and also from SSE to eradicate the source of a major infestation and seed source of *Rhododendron ponticum* in Kerrysdale, Wester Ross. The acidic and damp soils of the region have provided ideal conditions for infestation spreading into native woodland.

The work programme is being managed by Manta Ecology. Given the sensitive nature of the site, our control programme approach has been to:

- Primarily grub up or stem treat the rhododendron plants.
- Where access is difficult, or plants are hard to treat, chainsaw the rhododendron plants around the young trees and shrubs followed by stump treatment.
- As a last resort, spot-spray isolated rhododendron bushes only where absolutely necessary avoiding any other species. No spot spraying has taken place within 10m of any watercourse.

As per the 3-year plan, it has been agreed that the core area, home to the main seed source, the SSSI site and the SSEN grounds are tackled in year 1 (Figure 8.1).

Figure 8.1 Kerrysdale Rhododendron ponticum infestation site.



The work commenced in February 2020 in woodland to the west of the SSE power station. Previous cutting has left a dense cover of buried stumps with several new stems. Stumps were unearthed where possible and stem injected; if that has not been possible each large stem was treated. A follow-up sweep of the woodland will be conducted later in the year.

R. ponticum growing in Kerrysdale by the roadside (left); under the powerlines (middle); and as dense layering in woodland (right).



Work was then continued in patchy woodland along the north shore of the river, through dense patches of rhododendron plants mixed in with willow scrub. The rhododendron infestation here was found to be similar to that in the main woods. The plants had been cut and had regrown with multiple stems requiring each stem to be treated and stumps exposed where possible for injection.

Work then continued through the SSSI along the bank and in heath and birch scrub westwards along the river and then carried out on the south bank of the river opposite the power station. The riverbank was lined with rhododendron requiring stem injection while scattered bushes were found on the hillside above the river. Further work took place in grounds around the power station in May.

(right) tackling rhododendron bushes in patchy woodland.

Work on the core area was started in June and competed in August 2020. This large patch extends up into the hillside from the north side of the road. It was imperative that the core infestation was approached with caution as there is significant regen / new growth of native tree species amongst the *R. ponticum*. Great care was taking to ensure impact was kept to a minimum. A team of four skilled and licensed operatives were briefed in detail on this and have successfully completed the task. There has been very little impact on other vegetation. Next we will be working, with great caution, along the River Kerry to eradicate *R. ponticum* within the SSSI area.

Thank you to all project funders and to Gairloch Estate and Scottish Natural Heritage for permissions to carry out this control programme and for continuing support, and to John McNally and team.

(left) dead and dying rhododendron bushes following targeted stem injection treatment.


Part 9 **Working with others**

9.1 Portree Angling Association

Portree AA leases fishing rights on many of the rivers on the Isle of Skye, and there is much interest amongst members in protecting and restoring wild fish populations and improving the quality of fishing. Members of the Portree Angling Association [Portree AA] have contributed many days of enthusiastic voluntary effort in support of the Trust's sea trout monitoring activities around the Isle of Skye.

PAA's most popular fishery is the Storr Lochs trout fishery. In May 2019, Peter Cunningham met Ian Stewart and long-time club member Duncan Currie by the club hut to review options for future management. Having fished the Storr Lochs on less than a handful of previous occasions, and increasingly aware of previous visits by eminent fisheries biologists including Dr Neil Campbell and Dr Andrew Walker and the wealth of knowledge and experience within the club membership, Peter initially felt somewhat daunted about being asked to provide further advice!

(right) Ian Stewart and Duncan Currie overlooking Loch Leathan on 31st May 2019. There was no shortage of freshwater that day!

The catchment area of the Storr Lochs contains limestone and some of the best fishing of the year is during the mayfly *Emphemera danica* hatch in May and June. During the first half of the 20th century the lochs regularly yielded over 1000 brown trout averaging around 9oz (250g) to anglers each year. Then, in the early 1950s, the lower and larger loch, Loch Leathan, was dammed for a hydropower project.

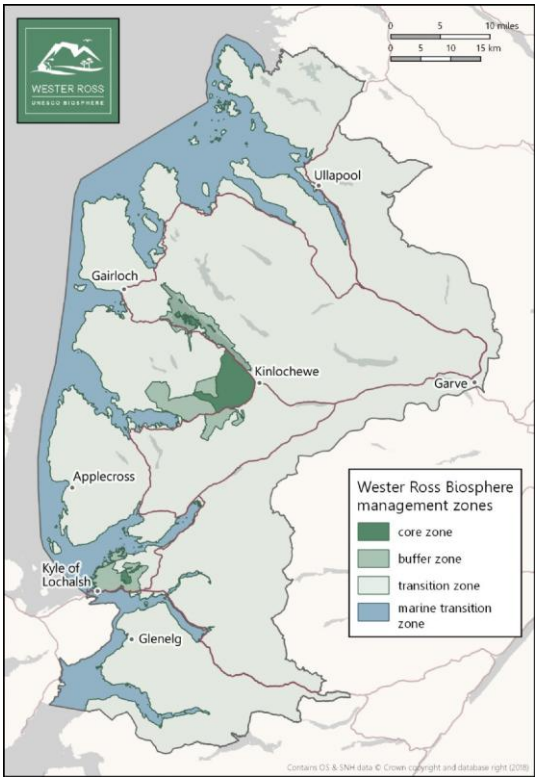
Initially the average size of trout increased to over 1lb (450g) but gradually the quality of angling on Loch Leathan declined. In recent years winter drawdown by the hydropower company has exposed extensive areas of peatland that were flooded when the dam was built. The number of fish taken by anglers fishing Loch Leathan had declined greatly and to maintain angling interest club members decided the only thing to do was to stock with triploid rainbow trout.

(right) Large areas of flooded peatland are exposed and eroded during winter drawdown. Photos by Ian Stewart.

At a follow up meeting of club members on 21st February 2020 various issues were considered, including exploring ways to either stabilise or remove some of the extensive areas of eroding peat in the drawdown zone (c. SNH Peatland Action initiative). Several ideas emerged which may help to sustain and improve angling interest in future years; including things which the Trust may be able to help with. The upper loch, Loch Fada sustains a prolific wild brown trout fishery and there was agreement that this should be carefully looked after. Options for the lower loch include habitat enhancement, and further stocking of rainbows, asking anglers to kill all that are caught on the basis that the amount of natural food is currently unlikely to be adequate to support both rainbow trout and wild brown trout. It may be possible to enhance natural food production in Loch Leathan. Thank you to many club members for sharing stories.

9.2 Wester Ross Biosphere

The UNESCO Wester Ross Biosphere [WRB] is 'a place where people live and actively work alongside their surroundings to promote a legacy, rich in both natural and cultural heritage'[17]. The biosphere was expanded in 2016 following a nomination process supported by government, stakeholders and local communities. The new biosphere, one of over 650 in 120 countries worldwide, covers approximately 5,200 square kilometres of Wester Ross and Lochalsh (Figure 9.2).



(right) Figure 9.2 Map of the Wester Ross Biosphere.

The WRB boundary overlaps with the mainland part of the Skye and Wester Ross Fisheries Trust area. As both organisations have a remit for supporting biodiversity, conservation and the natural productivity of the area, there is much shared interest. The biosphere is divided into management zones according to their nature conservation value. Core areas include Beinn Eighe National Nature Reserve, the Loch Maree islands and the Coille Mor oak woodland near Balmacara. Loch Maree is part of a 'buffer zone' where activities compatible with nature conservation objectives are encouraged.

Although it has no power and is a non-lobbying organisation, WRB Ltd aims to promote sustainable development in collaboration with local communities, businesses and other organisations working within the area. Several 'themed' working groups have been set up, including a 'natural heritage' group to take forward actions of shared interest. Other participants of the natural heritage group include countryside rangers, local wildlife recorders, estate managers, foresters, Woodland Trust staff, crofters, fishermen and a range of other individuals with an interest in the ecology of the area. WRB Ltd has also received support from the National Trust for Scotland, Highland Council and Scottish Natural Heritage (soon to be Nature Scot). Plans include promoting woodland conservation and restoration (including riparian woodlands); and a collaborative wildlife week, when life gets back to normal after the Coronavirus pandemic.

Following a series of large damaging wildfires affecting several parts of the Wester Ross Biosphere in 2018 and 2019, a workshop took place at Kinlochewe Village Hall on the 6th March 2020, following a series of related activities led by countryside rangers Jenny Grant (Highlife Highlands) and Gavin Skipper (NTS Balmacara). The aim of the workshop, organised jointly with the Highland Environment Forum [HEF], was to improve awareness of the threat of wildfire, especially ahead of the traditional muirburn season. Some of the most destructive wildfires have been caused by uncontrolled muirburn. Over 50 people attended including senior members of the Scottish Fire and Rescue Service who highlighted the severity of recent wildfires in Scotland and other parts of the world, and the need for improved planning.

Thank you to all who supported the workshop, especially Caroline Vawdrey of HEF, Graham Philips and family, SNH staff and volunteers at Beinn Eighe NNR and the Scottish Fire and Rescue Service.

[17] See WRB Strategic Plan: https://www.wrb.scot/10-year-plan

Part 10 **Summary**

This review describes activities carried out by Skye and Wester Ross Fisheries Trust during the period from January 2019 to March 2020, and presents a summary of results and related information.

- In March 2019, underwater cameraman Andy Jackson, with support from SWRFT and local volunteers, recorded unique footage of herring spawning on the seabed to the west of Gairloch. His videos were subsequently broadcast on BBC1 Blue Planet UK and BBC Springwatch.
- Sea trout monitoring began in April 2019 with a sample of lice-infested sea trout in the Flowerdale estuary, Loch Gairloch. Samples of lice-infested sea trout were also recorded from three sites around the Isle of Skye and in Loch Ewe before the end of June. However samples from the Snizort estuary, the Kanaird estuary and Little Loch Broom and other samples later in the year carried fewer sea lice.
- Thirty National Electrofishing Programme of Scotland [NEPS] sites were surveyed across the SWRFT area between July and September 2019. Additional electro-fishing sites were surveyed on the mainland and on the Isle of Skye to provide information for conservation and fisheries management, and to fulfil contracts for salmon farming and hydropower companies.
- Numbers for salmon fry were lower at many sites in 2019 than in 2018; low enough to be of concern for the conservation of salmon populations in some rivers. Numbers for salmon parr were generally higher. Survival rates salmon smolts in 2020 may need to be high to sustain some salmon populations.
- Rod catches of salmon in 2018 and 2019 were close to the lowest on record for many of the rivers in the southern part of the SWRFT mainland area and for the Skye and Small Isle reporting area. Salmon catches were higher for some of the rivers in the WRASFB area.
- On-farm sea louse production in 2019 was lower in some parts of the SWRFT area than in some previous years. However, salmon farms experienced problems with sea louse management despite use of new technologies and previous assurances. Sea lice dispersal models submitted in support of new salmon farm planning applications demonstrated connectivity between production areas, highlighting the need for improved on-farm management of sea lice throughout the area.
- Four large (2000+ tonne) new salmon farms along the east of Skye were given planning permission by the Highland Council despite objections from local fishery boards based on evidence of already excessive cumulative sea louse infestation pressures associated with existing salmon farms for wild salmon populations which migrate through the Inner Sound. Many other new farms are planned.
- Prospects are therefore bleak for wild salmon populations in the southern mainland part of the SWRFT area. The status of many salmon populations on the Isle of Skye also remains fragile. The use of genebanks may now need to be considered to safeguard some of the probably more highly adapted salmon populations such as that of the River Ling.
- In contrast, several trout populations demonstrated resilience to sea lice infestation. The results of genetic studies by Dr Steve Kett and colleagues from Middlesex University were reported at a wild trout workshop at Kinlochewe in April 2019. These findings can help to guide restoration of the Loch Maree sea trout fishery.
- The Trust was also able to carry out a range of other activities including non-native invasive species control, student projects, trout fishery assessment, workshops and presentations for and in collaboration with other organisations, with support from many dedicated volunteers.
- Thank you to all.

SNH Beinn Eighe NNR volunteers and David Holland by an electrofishing site, River Ling, 1st October 2019

Part 11 **Financial Statement**

The End of Year accounts for 2019-20 that have been submitted to Companies House and OSCR are available in full on the SWRFT website.

Statement from the Chair - Activities & Achievements 2019/2020

Strategic Overview; In addition to the delivery of an expanded freshwater and estuarine monitoring programme across Skye and Wester Ross, during 2019/20 the Trust has been successful in achieving funding to undertake innovative research into herring and bait fish productivity in the coastal waters of Wester Ross. The fieldwork associated with this project should have been delivered in March 2020 in partnership with academic partners at Edinburgh Napier University but due to Covid-19 had to be postponed and the period of herring spawning was missed.

Applications for grants to deliver a comprehensive school education programme in 2020/21 across all primary and secondary schools in Skye and Wester Ross were submitted to different funding organisations. The Robertson Trust awarded £7,000 on 27th March 2020 but on condition that match funding was achieved and the Education Officer had been recruited by the Trust. Decisions on other grant funding are awaited.

The Trust has benefited from additional donations at the end of the financial year to strengthen the administration and fundraising/development capacity during 2020/21.

Broadly speaking, by late February 2020 the Trust had enjoyed a successful year providing sufficient additional donations, contract income and reserves to underwrite a planned expansion of its activities in 2020/21. This would involve a significant expansion of our research and monitoring activities through the employment of a second Fisheries Biologist.

Sadly, over a three-week period during March 2020, the Covid-19 Crisis and resulting lockdown regulations caused the cancellation of 96% of budgeted fisheries income for 2020/21, principally in the form of Government / monitoring contracts, Fishery Board donations and the enforced cancellation of other fieldwork.

Putting the fishes back again.
Duirinish, August 2019.

Appendix 1 **The River Carron salmon fishery: the role of stocking**

***article by Bob Kindness**, River Carron Fishery Manager*

The salmon stock in the River Carron suffered a dramatic collapse during the 1990's with the annual rod catch dropping to single figures. The suddenness and severity of the collapse suggested that the most likely reason was a series of 5 consecutive winters each of which had at least one major spate big enough to disrupt the gravel, causing wash out of most, if not all, of the eggs from natural spawning. With such a series of winters, very little would have been left either in the river or at sea since the smolt run was lost (if nothing goes out then nothing comes back).

The river had no shortage of excellent fry and parr habitat but almost no young fish to occupy it, so a stocking programme was established in an attempt to re-establish the salmon population. A captive broodstock was produced from eggs taken from the few wild Carron salmon that could still be caught and the first significant stocking of 150,000 fed-fry went in throughout the river in 2001. The first real increase in rod catches was in 2004 and corresponded exactly to this first stocking. Apart from the stocking, no other material change took place that would have accounted for the sudden and huge increase in rod catches. It is clear that the stocking restored the salmon stock in the Carron and with the occurrence of damaging spates almost every winter, stocking has continued every year primarily to mitigate against egg loss. Fry have been produced from a combination of captive and wild broodstock and catches have held up well over the last 16 seasons with over 400 being recorded in each of two of them. The current 10-year average rod catch is 246, a figure considerably higher than any recorded in the past.

Because stocking has continued beyond the initial recovery of the river, the question that now needs to be answered is what contribution stocked fish make to current catches? When stocked fish return to the river as adults, they are indistinguishable from fish produced in the wild both in appearance and in the quality of their eggs and offspring if used as broodstock. This has been demonstrated from tagging work on the Carron. Therefore, to answer the question in a way acceptable to the scientific community, it is necessary to genotype the broodstock used in the hatchery and then compare this with the DNA of migrating smolts and rod-caught adults. To achieve this, in excess of 6,000 fin clips have been collected dating back to 2011. Funding is currently being sought to carry out this task, the results of which will be of great importance to all salmon rivers especially those where the salmon stocks are struggling.

Bob Kindness with a magnificent fresh run spring salmon from the River Carron, April 2018.

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…and all the other anglers, mink project volunteers, keepers and ghillies, fish farmers, school teachers, schoolchildren and parents, and everybody else who has helped us with our work to support wild fisheries in the Wester Ross area.*To comply with advice regarding the General Data Protection Regulations we have abbreviated the names of some of those listed above.

The planned **work programme for 2020 – 2021** was to include helping to look after fish traps, excursions to sample trout lochs and streams, electro-fishing surveys of many of the rivers on the mainland and on the Isle of Skye, sweep netting for sea trout, river surveys, an anglers information project and much else which may be of interest. At the time of writing (23rd September 2020), plans are subject to uncertainty primarily as a consequence of the Covid-19 pandemic. Please contact either of the biologists or the administrator (contact details at front of report) for further details of how to continue to support our work in the future.

Andy Jackson

Andy Jackson died suddenly near his home in September 2019. Andy was an outstanding underwater cameraman who did much to support our work and that of several other groups in the Wester Ross area.

Andy not only gave freely of his time and expertise to help to raise awareness of underwater wildlife in the area, he did more than anyone else to raise the profile of marine habitats, including maerl beds, flameshell beds, kelp forests, and associated wildlife including spawning herring, contributing videos from the Wester Ross area to BBC Springwatch, BBC Winterwatch, BBC Blue Planet UK, BBC One Show, and many other local and national projects.

Andy first worked with the Trust in the autumn of 2014 when he came to Wester Ross to film Arctic charr. We were unsuccessful in finding char; instead Andy was able to record salmon in spawning areas, obtaining sequences of rarely seen behaviour, some of which appeared in the BBC Highlands TV series. A very big male salmon filmed in the Kinlochewe River featured in many of our subsequent presentations and reports.

In February 2019 Andy came to Gairloch to attempt to film spawning herring. That was a challenge requiring skill, patience, determination, and one that many local people including fishermen from all sectors supported. His subsequent videos made national headlines and prompted a review of the need to protect the places where herring spawn.

The Lochcarron Marine Protected Area is another area where Andy's videos helped to provide the evidence from which the need for greater protection of seabed features could be seen by everyone including those with the responsibility for safeguarding our marine environment.

The archive of material that Andy leaves behind is a wonderful legacy for everyone in the Wester Ross area concerned about looking after the sea and our underwater wildlife; and for all who work towards greater understanding and protection of fish and other marine wildlife. A small part of his archive can be seen here https://vimeo.com/subseatv .

It was a great privilege to have spent time assisting Andy.

'. . . when he resurfaced he took his mouth piece out: a big smile. Video of herring swimming around and above him had been captured. The shoal was so dense that the amount of light reaching the seabed was barely enough for the camera . . .'

West of Carr Point. Tuesday, 5th March 2019.