welcome back to the ‘new’ Wester Ross Fisheries Trust

The ‘old’ Wester Ross Fisheries Trust was set up in 1996 in response to the decline in wild salmon and collapse of sea trout fisheries including that of Loch Maree, formerly one of the most productive sea trout fisheries in North West Europe.

With support and encouragement from a dedicated membership, anglers, wildlife enthusiasts, scientists and volunteers of all ages and abilities, the Trust has been able to carry out much work to learn more about the pressures facing wild fish populations and what can be done to address them. The Trust works in partnership with the Wester Ross Area Salmon Fishery Board and many others.

We depend upon many volunteers and other helpers to carry out fish surveys . . .

Wester Ross remains an international stronghold for **wild Atlantic salmon** and **wild Brown trout** and for other freshwater wildlife including Freshwater pearl mussel, Otter and Black throated diver.

Wild brown trout

Black-throated diver

The Little Gruinard River was designated by the European Union as a Special Area of Conservation [SAC] for the Atlantic salmon (*Salmo salar*) in 2005. It is not the largest nor the most productive wild salmon river within Wester Ross but it does contain some of the most remarkable habitat for juvenile salmon production.

Juvenile salmon survey team

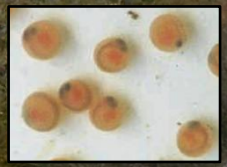
Mayfly

After entering the river from the sea and swimming upstream against strong currents through a series of rocky cascades, wild salmon must negotiate challenging waterfalls around huge boulders to continue their remarkable journey home.

photo by Ben Rushbrooke

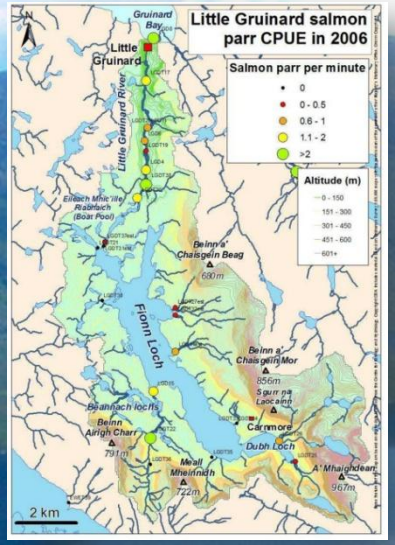
from Bing Maps

photo by Andy Jackson



Salmon eggs

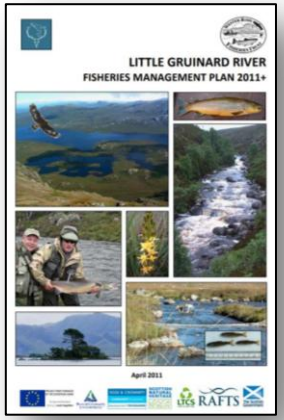
Wild salmon spawn where the streambed is composed of pebbles and small cobbles. In some parts of the Little Gruinard River adult female salmon have been the main movers of the stones for hundreds, perhaps for thousands of years. Ancestral salmon redds (old nests) can even be seen in satellite photographs.



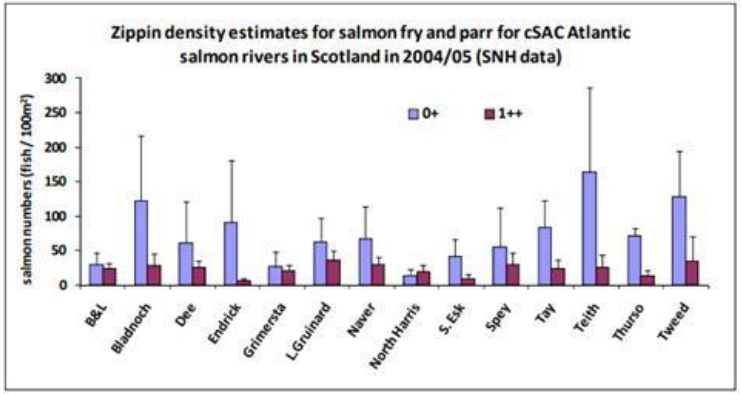
Some adult salmon go no further than the main river where there are deep pools and abundant areas of spawning and nursery habitat areas.

Other fish continue upstream as far as the Fionn Loch and beyond. Some headwater spawning streams within the SAC have not been surveyed for many years.

The end and the start of the journey



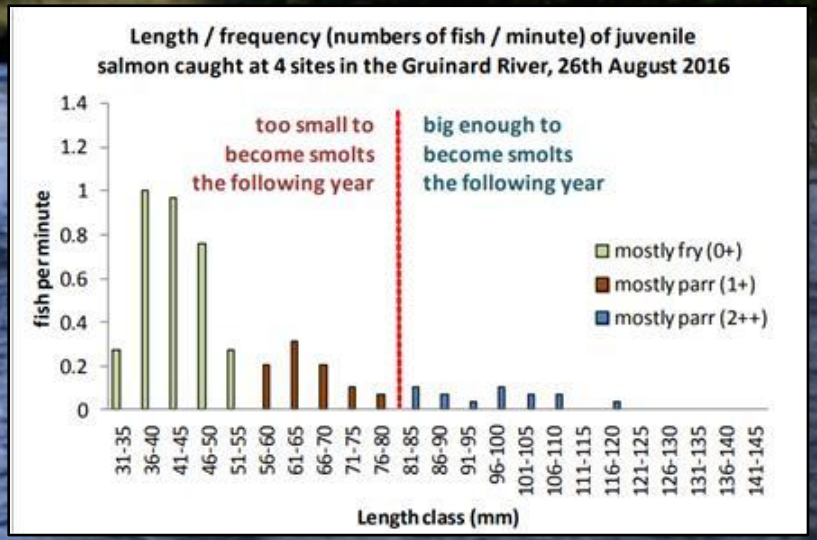
The WRFT electro-fishing team recorded some of the highest densities of salmon parr (age 1++) for any SAC salmon river in Scotland. However, for their age they included some of the smallest and slowest growing.



Four year classes of juvenile salmon from a Little Gruinard headwater

The neighbouring big Gruinard River is the most productive wild salmon river within the Wester Ross area. However, WRFT surveys recorded mostly small salmon fry, with few salmon parr large enough to go to sea the following year.

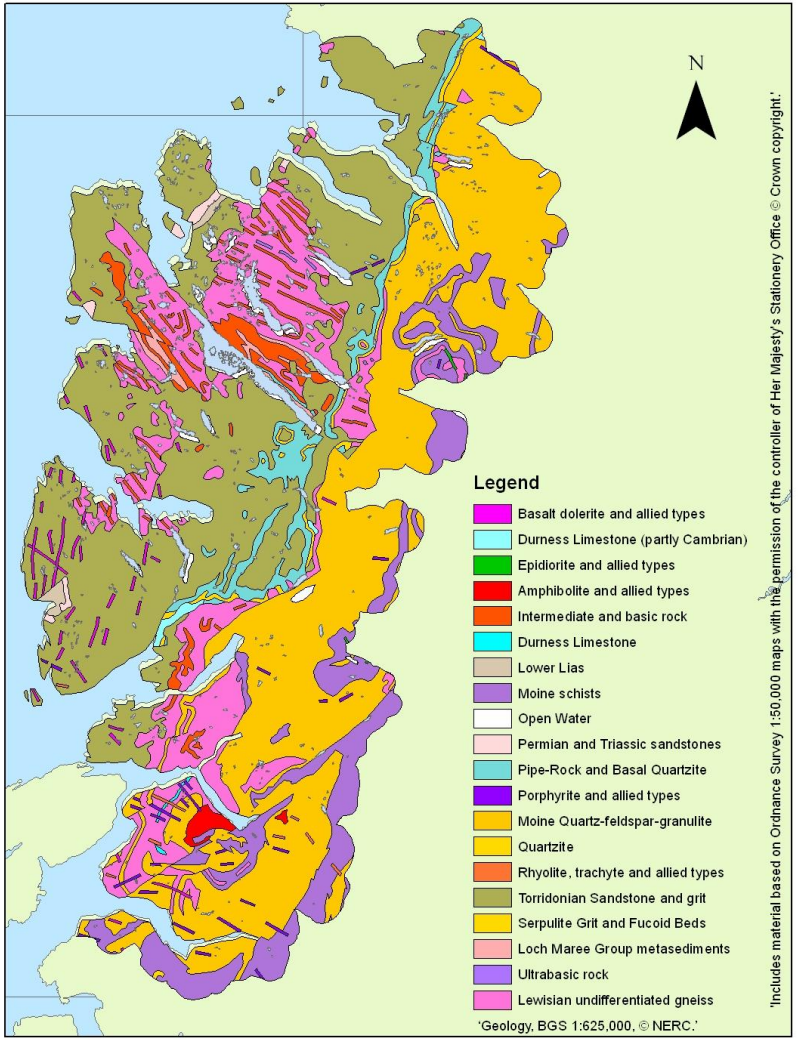
Small Gruinard salmon fry



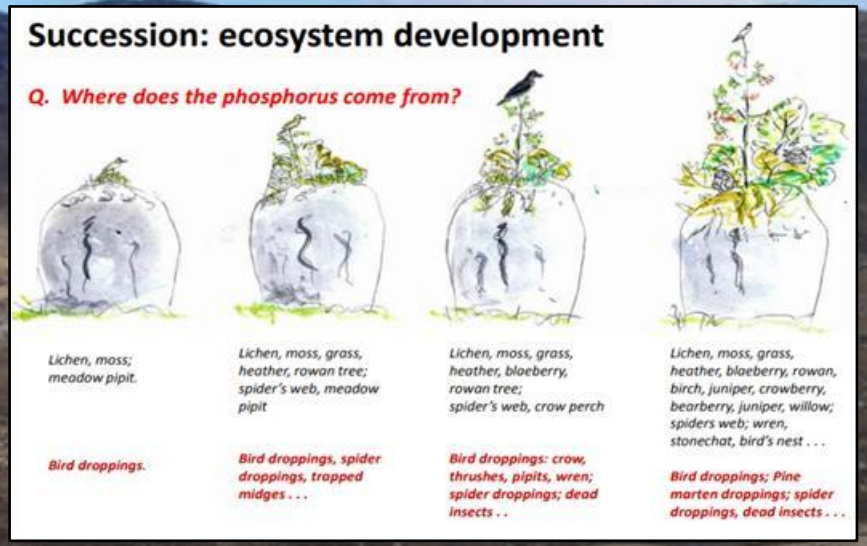
The bedrock beneath many river catchment areas in Wester Ross yields very little nutrient.

Life on land and in freshwater depends upon the provision and circulation of life-limiting nutrients, especially phosphorus, through the ecosystem.

Gneiss and sandstone boulders

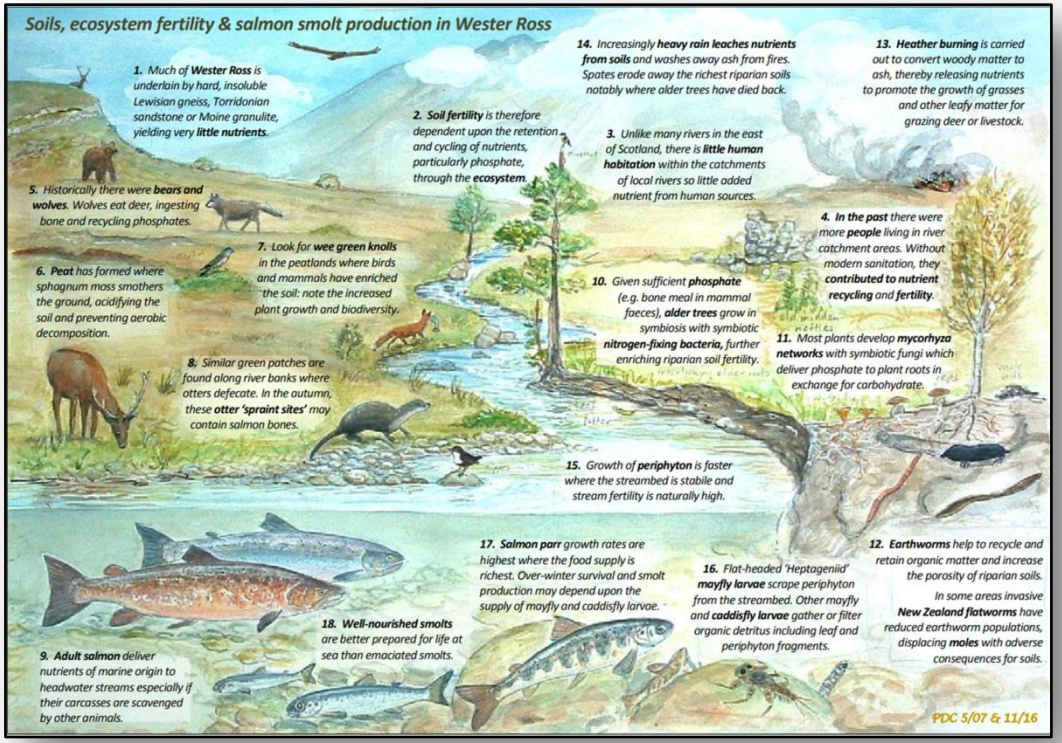


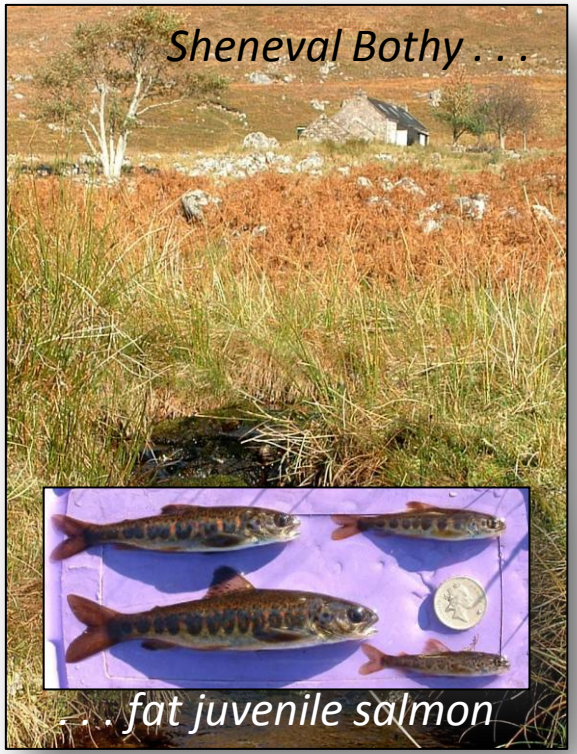
Wildlife production across large areas of Wester Ross is limited by a lack of food. This issue has been the subject of two WRFT workshops, Ecosystem Fertility and Salmon Smolt Production in Wester Ross (2007) and Refertilising Wester Ross (2016).



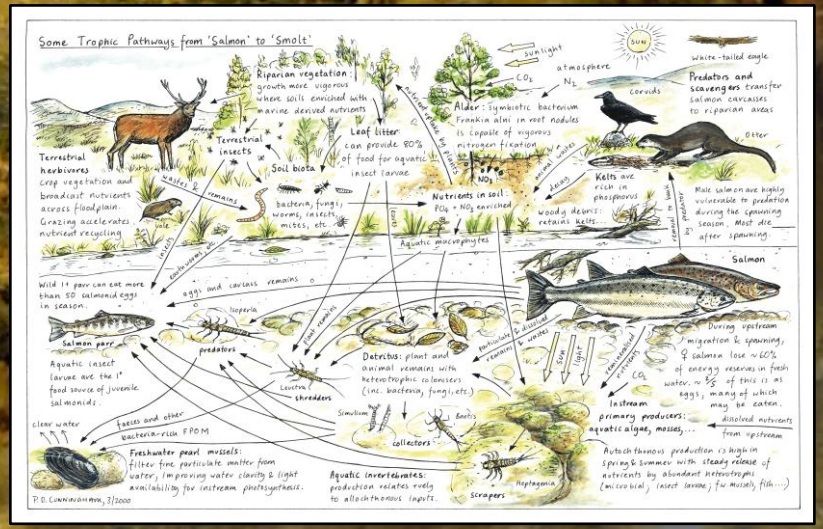
A forest on a boulder?

Historically there were more people living away from the coast and even wolves and bears in the more distant past. They all contributed to the fertility of the ecosystem, enriching nursery streams for production of juvenile salmon . . .





With fewer adult salmon returning to the rivers of Wester Ross in recent decades, there is less transfer of marine nutrients into river catchment areas. There is much interest in collaborative research to learn more about ways to restore nutrition to benefit many species including declining freshwater mussel populations.



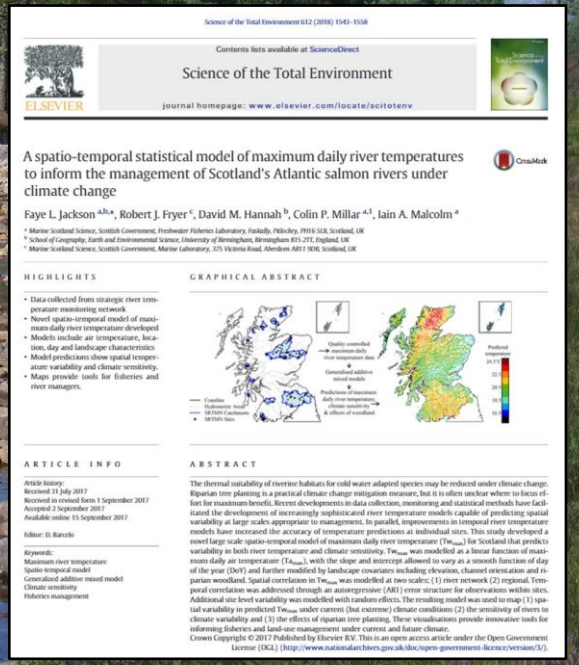
Trophic pathways from salmon to smolt

Salmon jaw (left by an otter) on a mid-stream island . . .

We are also learning how high water temperatures can restrict the growth of juvenile salmon in some areas during summer months.

During periods of low flow in June and July, water temperatures can rise to critical levels (above 24C) where juvenile salmon become stressed and stop feeding.

Too warm ?



Science of the Total Environment 612 (2018) 1543–1558

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

A spatio-temporal statistical model of maximum daily river temperatures to inform the management of Scotland's Atlantic salmon rivers under climate change

Faye L. Jackson [a,b,*], Robert J. Fryer [c], David M. Hannah [b], Colin P. Millar [a,1], Iain A. Malcolm [a]

[a] Marine Scotland Science, Scottish Government, Freshwater Fisheries Laboratory, Faskally, Pitlochry, PH16 5LB, Scotland, UK
[b] School of Geography, Earth and Environmental Science, University of Birmingham, Birmingham B15 2TT, England, UK
[c] Marine Scotland Science, Scottish Government, Marine Laboratory, 375 Victoria Road, Aberdeen AB11 9DB, Scotland, UK

HIGHLIGHTS

- Data collected from strategic river temperature monitoring network
- Novel spatio-temporal model of maximum daily river temperature developed
- Models include air temperature, location, day and landscape characteristics
- Model predictions show spatial temperature variability and climate sensitivity.
- Maps provide tools for fisheries and river managers.

GRAPHICAL ABSTRACT

ARTICLE INFO

Article history:
Received 31 July 2017
Received in revised form 1 September 2017
Accepted 2 September 2017
Available online 15 September 2017

Editor: D. Barcelo

Keywords:
Maximum river temperature
Spatio-temporal model
Generalized additive mixed model
Climate sensitivity
Fisheries management

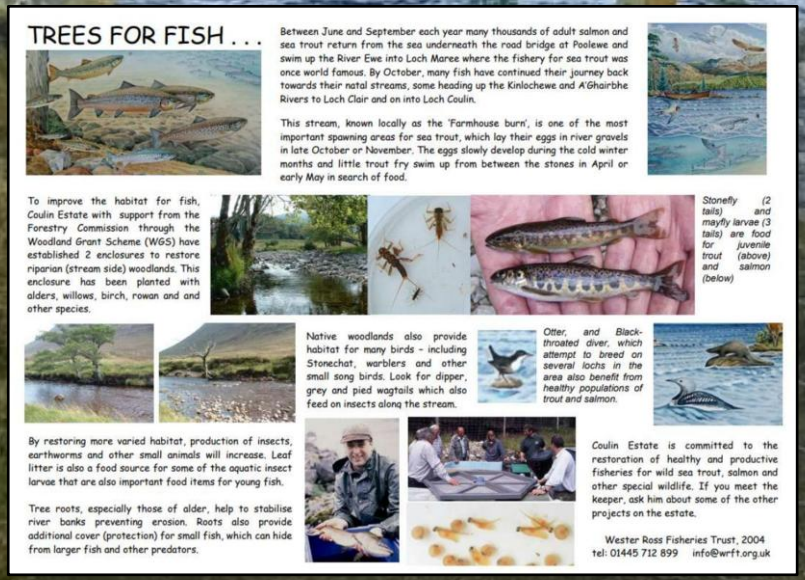
ABSTRACT

The thermal suitability of riverine habitats for cold water adapted species may be reduced under climate change. Riparian tree planting is a practical climate change mitigation measure, but it is often unclear where to focus effort for maximum benefit. Recent developments in data collection, monitoring and statistical methods have facilitated the development of increasingly sophisticated river temperature models capable of predicting spatial variability at large scales appropriate to management. In parallel, improvements in temporal river temperature models have increased the accuracy of temperature predictions at individual sites. This study developed a novel large scale spatio-temporal model of maximum daily river temperature (Tw_{max}) for Scotland that predicts variability in both river temperature and climate sensitivity. Tw_{max} was modelled as a linear function of maximum daily air temperature (Ta_{max}), with the slope and intercept allowed to vary as a smooth function of day of the year (DoY) and further modified by landscape covariates including elevation, channel orientation and riparian woodland. Spatial correlation in Tw_{max} was modelled at two scales; (1) river network (2) regional. Temporal correlation was addressed through an autoregressive (AR1) error structure for observations within sites. Additional site level variability was modelled with random effects. The resulting model was used to map (1) spatial variability in predicted Tw_{max} under current (hot extreme) climate conditions (2) the sensitivity of rivers to climate variability and (3) the effects of riparian tree planting. These visualisations provide innovative tools for informing fisheries and land-use management under current and future climate.

Torridon River on a bright sunny day in early August

Colleagues elsewhere in Scotland have also recognised the threat to wild salmon from climate change.

They have responded with ambitious riparian woodland restoration programmes to **provide shade** and to **improve habitat** and **nutrition** for juvenile salmon.



TREES FOR FISH . . .

Between June and September each year many thousands of adult salmon and sea trout return from the sea underneath the road bridge at Poolewe and swim up the River Ewe into Loch Maree where the fishery for sea trout was once world famous. By October, many fish have continued their journey back towards their natal streams, some heading up the Kinlochewe and A'Ghairbhe Rivers to Loch Clair and on into Loch Coulin.

This stream, known locally as the 'Farmhouse burn', is one of the most important spawning areas for sea trout, which lay their eggs in river gravels in late October or November. The eggs slowly develop during the cold winter months and little trout fry swim up from between the stones in April or early May in search of food.

To improve the habitat for fish, Coulin Estate with support from the Forestry Commission through the Woodland Grant Scheme (WGS) have established 2 enclosures to restore riparian (stream side) woodlands. This enclosure has been planted with alders, willows, birch, rowan and and other species.

Stonefly (2 tails) and mayfly larvae (3 tails) are food for juvenile trout (above) and salmon (below)

Native woodlands also provide habitat for many birds - including Stonechat, warblers and other small song birds. Look for dipper, grey and pied wagtails which also feed on insects along the stream.

Otter, and Black-throated diver, which attempt to breed on several lochs in the area also benefit from healthy populations of trout and salmon.

By restoring more varied habitat, production of insects, earthworms and other small animals will increase. Leaf litter is also a food source for some of the aquatic insect larvae that are also important food items for young fish.

Tree roots, especially those of alder, help to stabilise river banks preventing erosion. Roots also provide additional cover (protection) for small fish, which can hide from larger fish and other predators.

Coulin Estate is committed to the restoration of healthy and productive fisheries for wild sea trout, salmon and other special wildlife. If you meet the keeper, ask him about some of the other projects on the estate.

Wester Ross Fisheries Trust, 2004
tel: 01445 712 899 info@wrft.org.uk

Fallen leaves

Main picture: riparian woodland enclosure (River Dee Trust)

Salmon are not just found in the big rivers that support important fisheries, there are also many smaller rivers with wild salmon and sea trout.

Some of these could also be improved to benefit fish and other wildlife and for the enjoyment of people living nearby. Could you help?

active landslip, Applecross River

main picture and far left:
Allt Beith (Aultbea River)

Wester Ross is also a **stronghold for wild brown trout** (*Salmo trutta*).

There are thought to be over 300 lochs or lochans within the Wester Ross area which support wild brown trout. All are amazing places to visit on a warm summer day when there is just enough breeze or sunshine to keep the midges away.

Sampling expeditions

On an expedition into the hills you may find colourful dragonflies, damselflies, sedge flies and water beetles, and hear or see red deer, greenshank, red-throated diver or a golden eagle.

Take care not to disturb protected wildlife; please move on if you think special birds may be nesting nearby!

Emerald damselfly

Golden-ringed dragonfly

Student projects

Populations of the rarely seen Arctic charr (*Salvelinus alpinus*) have inhabited some lochs since the end of the last period of extensive glaciation around 10,000 years ago. The distribution of this mysterious fish has not been surveyed in recent years. How many charr populations survive in Wester Ross?

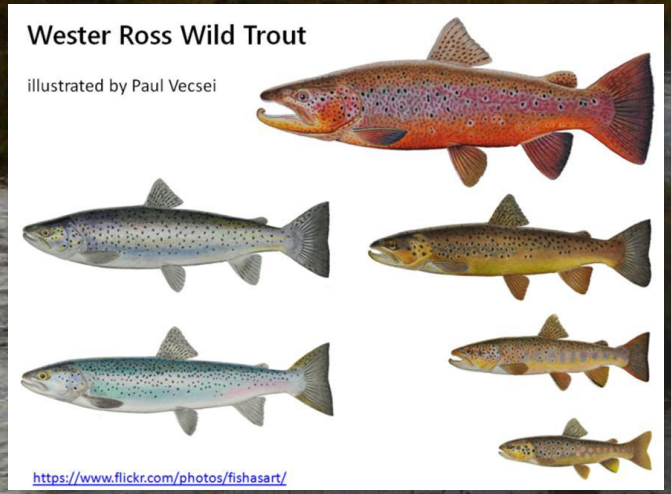
Two kinds of charr from Loch Maree

Wild brown trout from above impassable falls

Some lochs and streams have unique wild trout populations that have been isolated above impassable waterfalls for thousands of years.

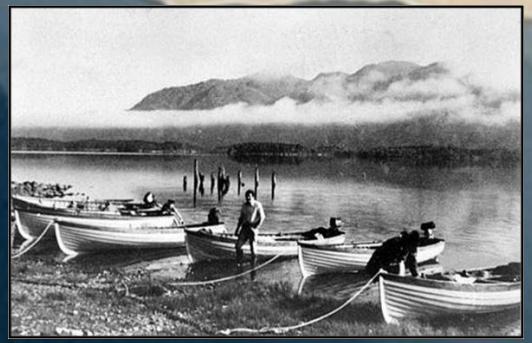
Other waters are linked to the sea by rivers and support sea trout populations.

At the **Wester Ross Wild Trout workshop** in 2019, we learned much more about trout diversity in Wester Ross following collaborative research over many years including much work led by Dr Steve Kett from Middlesex University.



Middlesex University London | marine scotland The Scottish Government | Wild Trout Trust | Wester Ross Area Salmon Fishery Board | University of the Highlands and Islands Inverness College

Loch Maree was the most famous and most productive sea trout fishery in the Wester Ross area. For most of the 20th Century, anglers from far away returned to the Loch Maree Hotel from where up to 12 boats each with a ghillie (fishing guide) set out each day from May until October in their quest for fabled sea trout.

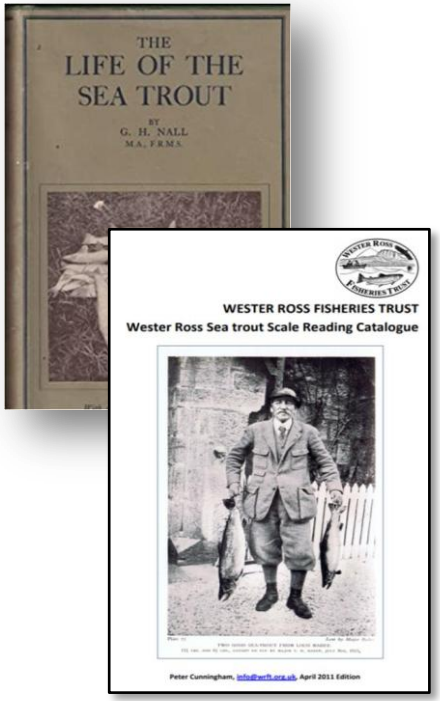


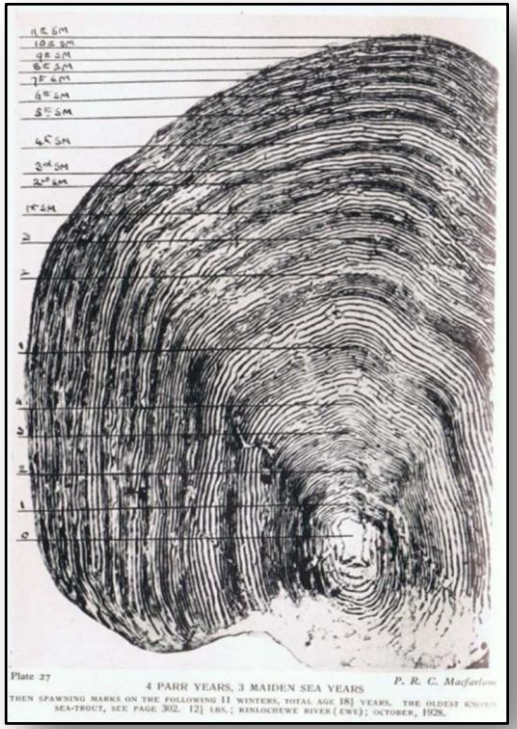
In 1955 a British record rod caught sea trout of almost 20lb (9kg) was caught near Ash Island in Loch Maree. Many other sea trout of over 10lb were caught in Loch Maree during the 20th century; but so far, none since.

Former British record sea trout

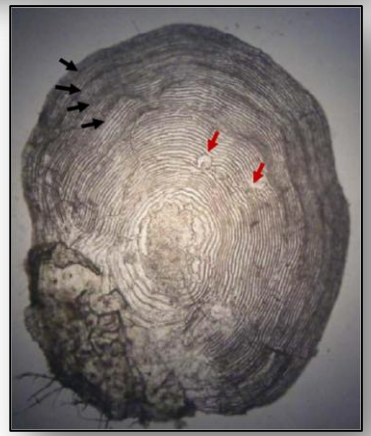
The big sea trout grew slowly returning to the sea to feed many times before attaining their remarkable size.

A sea trout caught in the Kinlochewe River in 1928 aged by Herbert Nall (1930) at 18 years old may still be the oldest wild sea trout known in Europe.





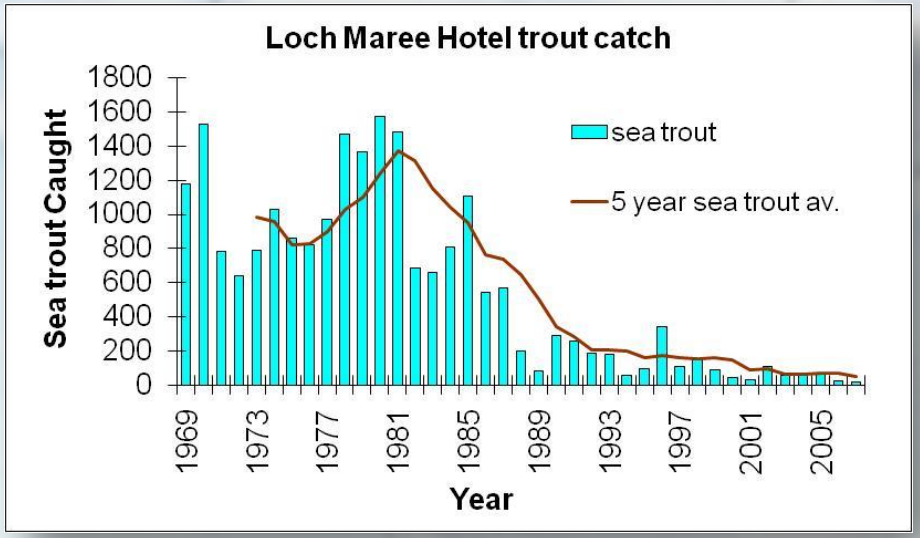
The biggest sea trout sampled by WRFT to date was this fish of 59cm in length, Gairloch, 2010



At the end of the 1980s and during the early 1990s the Loch Maree sea trout fishery collapsed. The big fish disappeared.

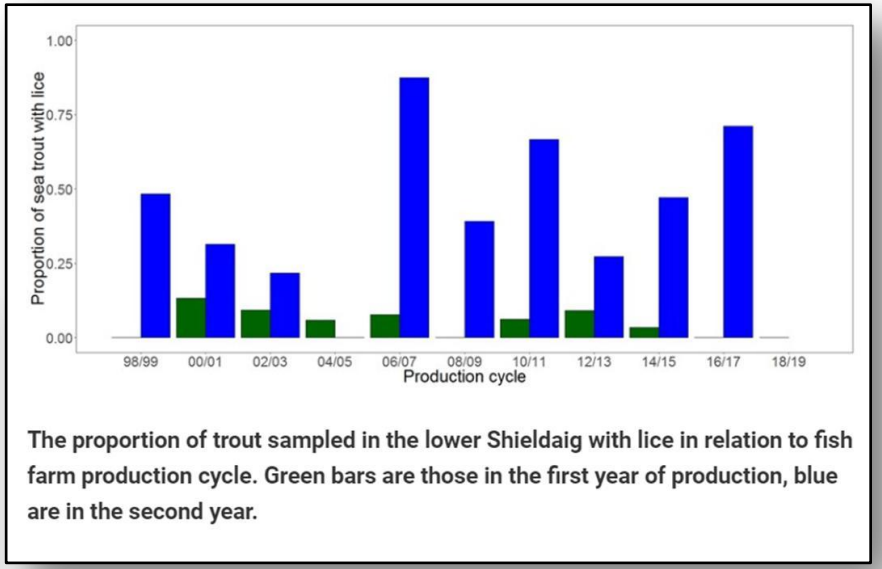
Anglers reported finding high numbers of parasitic sea lice on ‘early returned’ sea trout in the River Ewe.

Then during the 1990s, anglers stopped coming and the fishery went into decline with the loss of many jobs and much unhappiness.



WRFT biologists together with colleagues elsewhere including Marine Scotland Science in nearby Loch Torridon have collected much data demonstrating links between sea lice infestation of sea trout, reduced growth and survival of sea trout, and proximity to open cage marine salmon farms.

Sea lice on sea trout caught by WRFT in Loch Gairloch

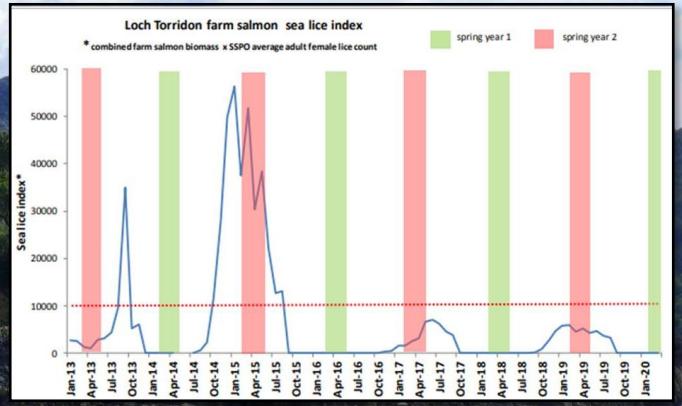


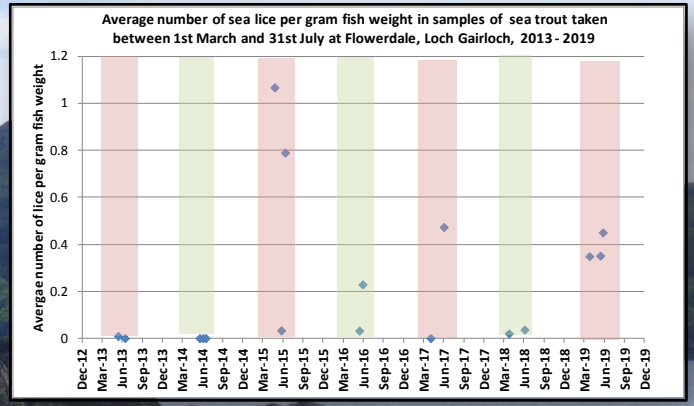
The proportion of trout sampled in the lower Shieldaig with lice in relation to fish farm production cycle. Green bars are those in the first year of production, blue are in the second year.

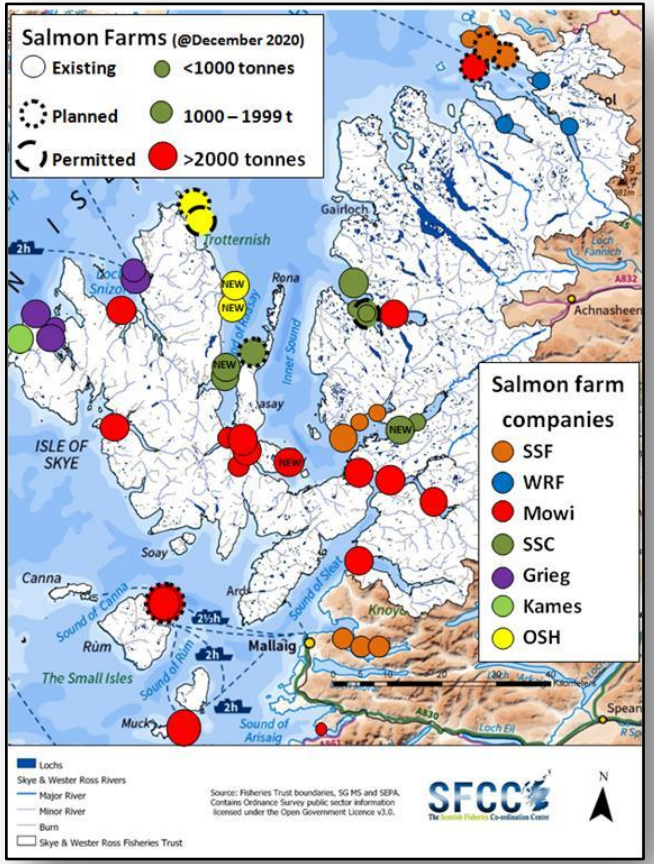
Please see: https://www.gov.scot/publications/aquaculture-interactions-shieldaig-field-station/pages/lice-burdens-in-the-lower-reaches-of-the-river-shieldaig/ .

The sea lice problem typically manifests itself where nearby salmon farms are in the second year of the two year farm salmon production cycle.

Larval salmon lice are dispersed away from salmon farms and may remain infective for up to 15 days after being shed by the adult female lice on host fish.

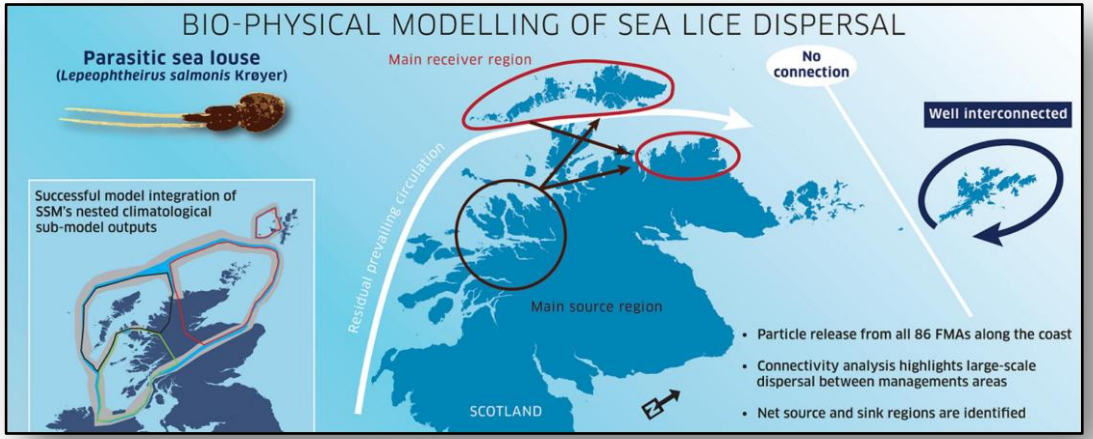






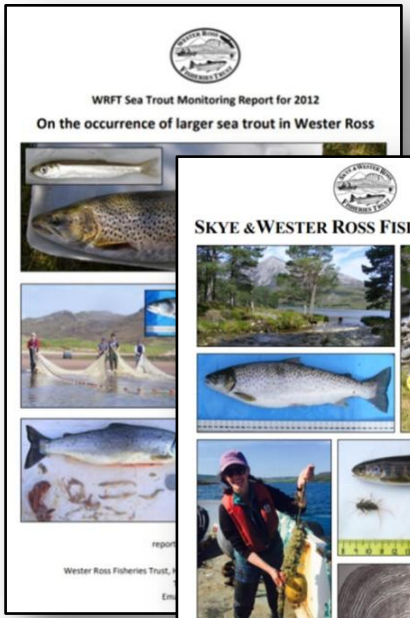
For this reason, there is much concern about increasing farm salmon production in areas where existing farms have failed to control sea lice to safeguard wild fish.

Cumulative larval sea lice production on salmon farms around the Isle of Skye and Lochalsh poses a growing threat to wild fish in Wester Ross and as far away as west Sutherland.



There is already more than enough scientific evidence demonstrating the threat to wild salmon and sea trout for precautionary action to be taken.

How much worse does the situation for our sea trout and wild salmon populations have to get before adequate regulation for sea lice on salmon farms?



The best salmon farmers are wild fish enthusiasts too! We have always strived to maintain friendly relations with local salmon farm staff.

The old Wester Ross Fisheries Trust received much support for sea trout monitoring and other work from several salmon farming companies.

And there have been some big improvements in on-farm sea lice management, demonstrating that where there is the will, there is a way.

In recent years, Wester Ross Fisheries, a locally owned, locally managed company with marine salmon farms in Loch Kanaird, Loch Broom and Little Loch Broom has achieved and sustained very low on-farm salmon lice levels.

Since 2015, elevated on-farm sea lice levels have been prevented using only locally sourced cleaner fish (wrasse) and skilled hands-on husbandry.

Ballan wrasse

We know that wild sea trout can recover where on-farm sea lice are properly controlled . . .

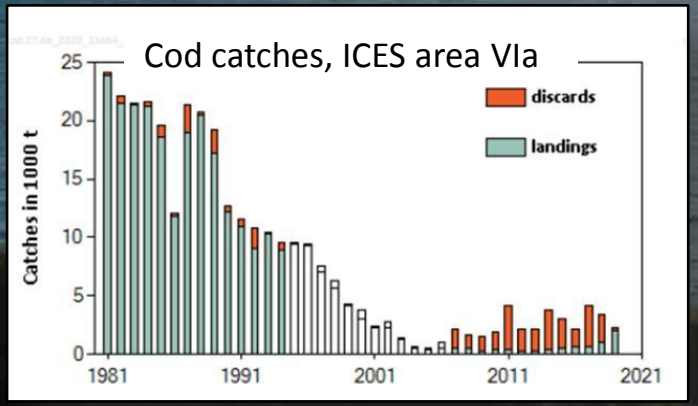
Sea trout of about 450mm dropped by an osprey near the mouth of the River Kanaird, April 2017. Apart from claw marks, the fish was in good condition (photo by Ailsa Hayes)

So why can't **all** fish farm companies control their on-farm sea lice down to near zero so that wild fish populations are able to recover?

We don't think it is OK for some big multi-national companies to continue to damage wild fish populations. They need to take more ownership and responsibility for the damage they cause and to be held to account by those who regulate their activities.

For wild salmon and sea trout, problems in the sea are not just about sea lice.

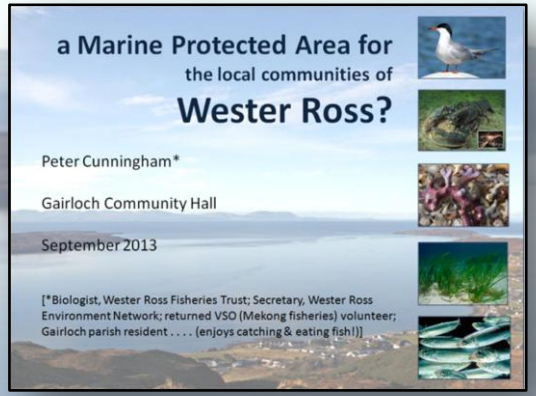
Many fisheries for other marine fin-fish species declined or collapsed in the 1990s and early 2000s following the removal of the three mile coastal limit by the Inshore Fisheries Act in 1984.



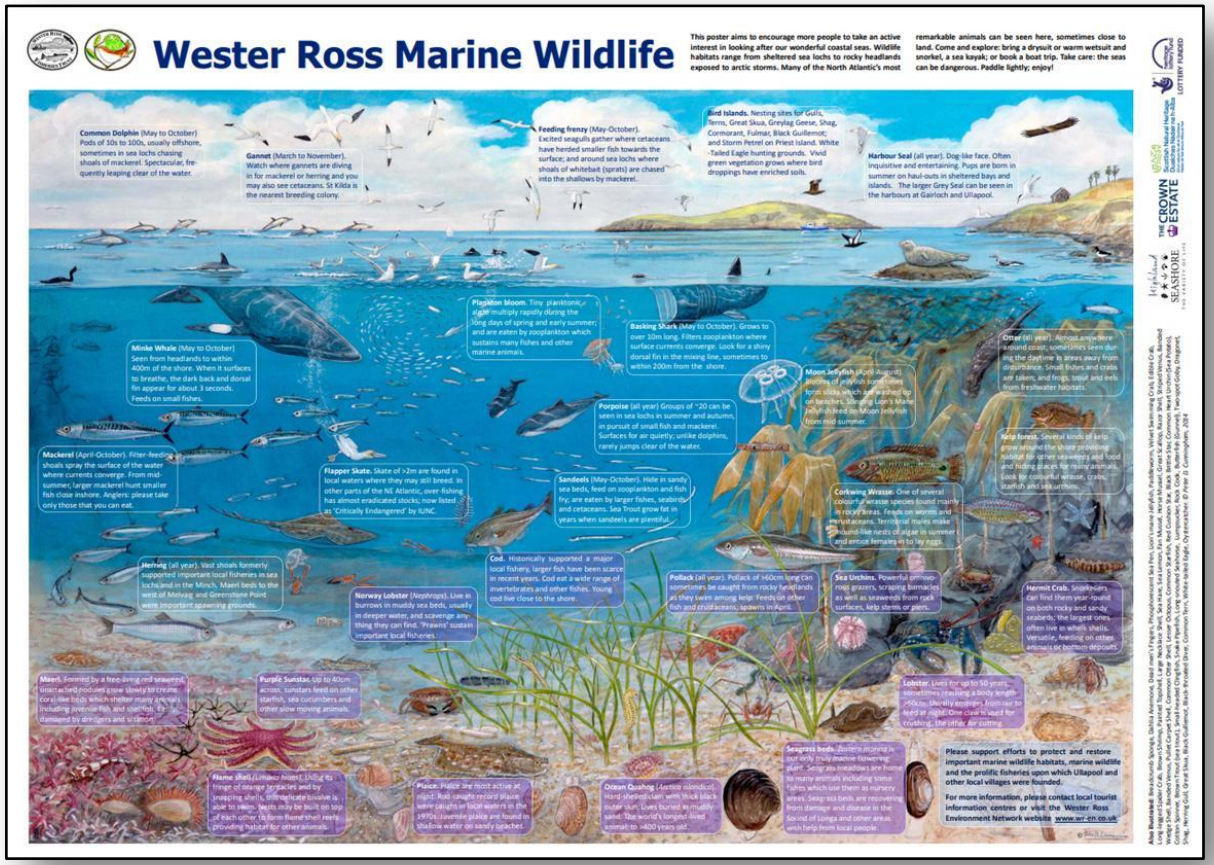
Derelict seafood factory, Gairloch 2003

The old WRFT recognised the need to take an ecosystem approach and to protect and restore coastal habitats of importance to marine fisheries and other wildlife.

In 2012, a local community bid was submitted to the Scottish Government in support of a Marine Protected Area in local waters; subsequently the ‘Wester Ross Marine Protected Area’ was designated.



A Wester Ross marine wildlife poster was published by The Highland Seashore Project to highlight some of the habitats and spectacular wildlife in coastal waters.



Several other local marine community groups are now actively looking after coastal habitats with support from Nature Scot.

Sea trout habitat

In 2019, the Trust supported filming of herring spawning on the seabed to the west of Loch Gairloch by the late Andy Jackson. This generated much interest in reviving wild herring populations for the benefit of local people and other fishes.

Herring eggs on maerl gravel (by Andy Jackson)

So to the future?

Our focus remains on continuing to work with those who are also dedicated to looking after wild salmon and wild sea trout.

We rely on support from the Wester Ross Area Salmon Fishery Board, some funding from the Scottish Government, project grants, and donations from generous supporters who share our passion for the revival of important wild fish populations.

main photo by Andy Vicks

We'll continue to invest in education and raising awareness: our work is primarily for future generations, for those who follow.

With the continued support, financially and in kind, of those who share our dedication towards the revival of wild fish populations, much more will be achieved.

Gairloch sweep netting teams

And perhaps some of us will be lucky enough to see or perhaps even to catch a big sea trout in Loch Maree?

photos by Peter Cunningham and Robin Ade

If you would like to support our work, please contact info@wrft.org.uk. Thank you.