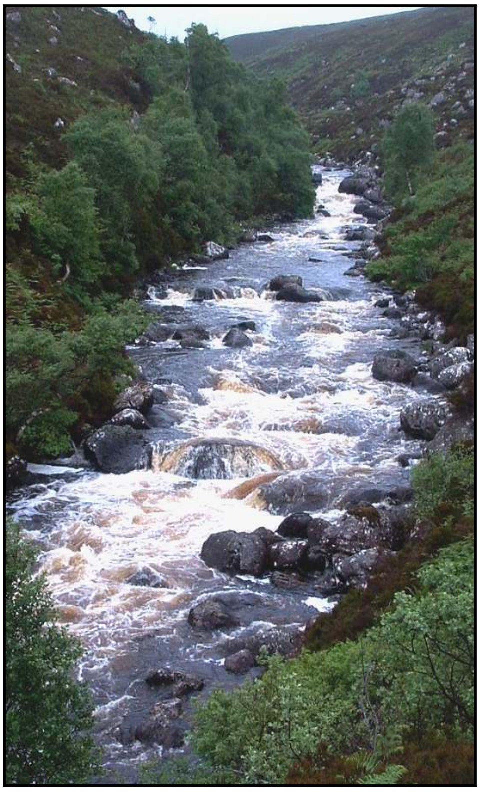
LITTLE GRUINARD RIVER

FISHERIES MANAGEMENT PLAN 2011+



April 2011

PROJECT PART-FINANCED BY THE EUROPEAN UNION
Europe and Scotland Making it work together
Ross & Cromarty Enterprise
Ross & Cromarty Community Economic Development Programme
Scottish Natural Heritage
LTCS
RAFTS
The Scottish Government

WESTER ROSS FISHERIES TRUST

Registered Charity number SCO24787

LITTLE GRUINARD RIVER FISHERIES MANAGEMENT PLAN

April 2011

by
Peter D. Cunningham

Cover photos (clockwise from top left) The Beannach lochs and the Fionn Loch from the top of Beinn Airigh Charr; 43cm trout caught by Ala MacKenzie from Sandy Bay 2004; Lower part of the Gorge, Little Gruinard River; Quantitative electrofishing site in the Little Gruinard River just above Lower flats with (inset) salmon fry from nearby; wooded islands on the Fionn Loch; Gavin Smart and Graeme Wilson with a 19.5lb salmon caught in 2009; Bog Asphodel

Part-funded by:

Contents

Summary

The Little Gruinard River is located in Wester Ross in North West Scotland and drains rainwater from a 'wilderness' area of mountainous 'deer forest' into the sea at Gruinard Bay, about 18km as the eagle flies to the west of the town of Ullapool. This document focuses upon both the remarkable wild salmon of the Little Gruinard River and the wild trout of the Fionn Loch. Information is drawn together from previous studies, including 'The Little Gruinard Atlantic salmon catch and release tracking study' (Walker and Walker, 1991), contemporary studies of brown trout, and more recent surveys of habitat and juvenile fish populations within the Little Gruinard River system carried out by the Wester Ross Fisheries Trust.

The Little Gruinard River is the only Special Area of Conservation (SAC) for Atlantic salmon (*Salmo salar*) in the west of mainland Scotland between the River Naver in Sutherland and the River Endrick which flows into Loch Lomond. The Little Gruinard is therefore of particular importance for securing the conservation of a native wild salmon population in this part of Europe for future generations.

Proposed actions in the Fisheries Management Plan are aimed at maintaining favourable status for the Atlantic salmon SAC, for conserving and learning more about wild Brown trout, Arctic charr and Freshwater pearl mussel populations, and for restoration of ecosystem fertility within the catchment area. These are outlined in Table 1.1.

WRFT Habitat surveyor, Matthew Dawson, by the Little Gruinard River in May 2001. Note the greener, 'fertilised' otter spraint site at the base of the large boulder, and browsed willow bush nearby (photo by Karen Starr)

Table 1.1 Summary of Actions

Action	Lead organisation	Others / support	Timescale	Importance
A1. Support measures to protect wild salmon at sea.	NASCO, SG, AST	all	For foreseeable future	High
A2. Maintain closure of local netting stations.	WRASFB, Local Estates	SG	For foreseeable future	High
A3. Protect wild salmon and sea trout in nearby coastal waters from sea lice epizootics: applications to expand salmon farm production near river mouth should be assessed against objectives and if in doubt a precautionary approach should be taken.	WRASFB, SG and agencies,	SSGA	Until there is clear evidence that existing salmon farming operations are not detrimental to wild fish populations.	High
A4. Maintain 'Catch and Release Policy' for salmon and sea trout.	Letterewe Estate	WRFT	Until there is a ongoing surplus of adult fish in the region.	High: demonstrates commitment to conservation.
A5. Maintain detailed records of rod caught salmon and sea trout.	Letterewe Estate	WRFT	Ongoing.	High
A6. Do not stock salmon or trout into the system.	Letterewe Estate	WRASFB	Ongoing.	High
A7. Consider opportunities for riparian habitat restoration project on two spawning burns.	Letterewe Estate	?WRFT	Not urgent.	Medium: benefits to fish uncertain and may be small.
A8. Trap Mink.	Letterewe Estate	WRFT, SNH	Ongoing	High for water voles
A9. Monitor predatory bird populations. If there is evidence of major threat to the salmon population, agree a plan to control problem species.	Letterewe Estate	WRFT, WRASFB, IFM, SNH, Marine Scotland (stomach analyses)	Ongoing	Medium unless the salmon populations are threatened for other reasons.

Table 1.1 Summary of Actions (continued)

Action	Lead organisation	Others / support	Timescale	Importance
A10. Monitor seals. If perceived to be a threat to the salmon population agree a plan to control problem species.	Letterewe Estate	WRASFB, IFM, SNH, Marine Scotland,	On going	Medium unless seal numbers are high in spring and early summer?
A11. Explore opportunities to enhance natural productivity at ecosystem level, both in freshwater and coastal marine environments.	WRFT, SNH, WRASFB, Marine Scotland, local estates, local community groups		Ongoing	High
A12. Develop catch recording system for Fionn Loch Brown trout.	Letterewe Estate, Tournaig Estate,	WRFT	2010	High
A13. Consider relaxing fly only rule for the Fionn Loch for May before salmon are in the system on a trial basis to assess ferox population.	Letterewe Estate, Tournaig Estate,	WRFT	For one year trial	Medium
A14. Provide guidance for anglers regarding breeding birds; ensure all anglers are experienced or accompanied by ghillie.	Letterewe Estate, Tournaig Estate,	WRFT, SNH	2011	High
A15. Assess the status of the juvenile salmon population every two years, through electro-fishing survey.	WRFT, Letterewe Estate	SNH	On going	High

Table 1.1 Summary of Actions (continued)

Action	Lead organisation	Others / support	Timescale	Importance
A16. Investigate the production of juvenile salmon from the Fionn Loch.	WRFT or Letterewe Estate, SNH, Marine Scotland		2011	Medium
A17. Investigate the genetic structure of the brown trout population to find out whether one or more populations.	Letterewe Estate, WRFT,		2011	Medium
A18. Investigate the freshwater pearl mussel, with view to restoring the population.	SNH or WRFT,	Letterewe Estate?	2010+	Medium
A19. Arctic charr: investigate populations to assess conservation	WRFT, SNH?	Letterewe Estate	2010+	Medium
A20. Ecosystem fertility: investigate the potential to increase levels of natural fertility, wildlife abundance and productivity within the catchment area.	WRFT, Letterewe Estate?	Letterewe Estate	On going, WRFT Carrying Capacity Project	High
A21. Biosecurity: prevent the spread of alien species into the catchment.	Letterewe Estate		On going	High

Part 1 Introduction

1.1 Background

Wild salmon and trout are at the core of our natural heritage: a vital part of who we are and where we belong. Both salmon and trout are 'keystone' species in the ecology of freshwater habitats. Can wild salmon and trout populations and the wildlife and fisheries they support be safeguarded for our future?

The end and the start of the journey (Allt Bruath an Easgain and Dubh Loch, September 2006).

The Atlantic Salmon (*Salmo salar*) is listed in Annex II of the European Union Habitats and Species Directive, and has therefore been identified as a threatened species requiring conservation action. The Little Gruinard River system is considered by SNH to support one of the 'best' wild Atlantic Salmon (*Salmo salar*) populations in Europe, for which the river system has been designated as a Special Area of Conservation (SAC) under the EU Habitats and Species Directive[1]. The Little Gruinard river system is the only Atlantic Salmon SAC in the mainland of Western Scotland north of the River Endrick, an area where many other native wild salmon populations suffered severe declines during the 1990s and early years of the 21st Century.

The Little Gruinard system is also of conservation importance for native Brown trout (*Salmo trutta*) and Arctic Charr (*Salvelinus alpinus*). In 2008, both these species were added to the UK Biodiversity Action Plan's list of priority species of conservation concern[2]. Arctic Charr are found in the Fionn Loch, and there are anecdotal records from other lochs in the Little Gruinard catchment and possible stream spawning charr population, but little information about them.

The wild fisheries of Wester Ross and surrounding seas are an invaluable renewable resource. Wild salmon and trout have supported local fisheries for as long as people have inhabited the area. The Fionn Loch has long been renowned for the quality of wild trout fishing[3]. Rod fisheries represent an

1 http://www.jncc.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0030183
2 http://www.ukbap.org.uk/NewPriorityList.aspx
3 For examples, 'One Hundred Years in the Highlands' MacKenzie, 1921

important source of tourism revenue for the local economy[4]. Faced with an array of pressures from human activities, the value of wild fish populations can now only be reached and sustained through well informed management supported by effective legislation.

1.2 Sources of information

This report presents the findings of investigations of fish and fisheries carried out within the Little Gruinard catchment by the Wester Ross Fisheries Trust (WRFT) together with summaries of earlier work. At the request of proprietor, the late Paul Van Vlissingen, fisheries scientists led by Dr Andy Walker from the Scottish Government's Freshwater Laboratory near Pitlochry (now Marine Scotland Science) undertook a number of studies of salmon and trout in the Little Gruinard River system, most notably a radio-tracking study of Atlantic salmon in the Little Gruinard in 1990. WRFT has also been given copies of papers belonging to Captain Sawyer of Inverewe who studied the trout lochs in the years between 1920 and 1940. Since 1997, the WRFT has conducted surveys of juvenile fish populations, fish habitat, an adult stock assessment from catch records, and an angler's log book scheme from which more recent information about the Brown Trout of the Fionn loch has been obtained. Other information, including detailed catch records has been provided by Graeme Wilson and Barbara Macdonald of Letterewe Estate, and Hamish Lawrie (see acknowledgements).

1.3 Aims of the Little Gruinard Fisheries Management Plan

The actions proposed in the Fisheries Management Plan are primarily aimed at ***achieving and maintaining favourable conservation status for Atlantic salmon (Salmo salar) populations in the Little Gruinard SAC*** and secondly ***securing or raising the natural production of juvenile salmon and brown trout from the freshwater habitat***. These aims are in line with the SAC Conservation Objectives, and SAC Site Condition Monitoring. The plan also aims to support other species listed by the Habitats and Species Directive including the European eel, Arctic charr, Freshwater pearl Mussel, Otter, Black-throated Diver, and White-tailed Eagle. Since the freshwater environment is largely controlled by Letterewe Estate, the plan has been produced primarily to inform and support their work.

In considering future management options, a catchment-based, ecosystem-focused approach is adopted where appropriate. Wild salmon and trout do not live in isolation. The way surrounding lands within the catchment are managed has a major influence on fish populations. A key issue for both wildlife and fisheries management of the Little Gruinard catchment is how levels of natural fertility have been influenced by human activities over many centuries. Is the Little Gruinard catchment area as fertile and biodiverse as it once was? Are the salmon and trout fisheries as productive as they were in the past? What is the natural fisheries and wildlife potential of the Little Gruinard River and lochs?

[4] http://www.scotland.gov.uk/Publications/2004/03/19079/34373

1.4 Wester Ross Fisheries Trust [WRFT], Rivers and Fisheries Trusts Scotland [RAFTS] and the Scottish Fisheries Coordination Centre [SFCC]

The **Wester Ross Fisheries Trust (WRFT**) is a charity formed by wild fisheries interests in 1996. The overall purpose of the Trust is to ***maximise and sustain the productivity of wild salmonid fisheries in the rivers and lochs of Wester Ross***.

The Trust set up a fisheries research programme, the objectives of which are to:

- Conduct exploratory work to establish baseline information on the status and potential of fish stocks in the WRFT area.

- Monitor and identify trends in stocks and possible factors affecting them.

- Produce a Fisheries Management Plan for each river system in the WRFT area aimed at achieving the fishery's potential.

The Wester Ross Fisheries Trust Fisheries Management Plan for 2009+ provides a framework for the work of the Trust and can be found at http://www.wrft.org.uk/downloads/files.cfm?id=17.

WRFT is one of 22 similar fisheries research and management organisations established throughout Scotland, represented by the umbrella organization RAFTS. Formed in 2005, **Rivers and Fisheries Trusts of Scotland (RAFTS)** is a leading independent freshwater conservation charity representing Scotland's national network of rivers and fisheries Trusts and Foundations. RAFTS is a Scottish Charity, a Company Limited by Guarantee, and as an unincorporated association manages a range of core objectives, including representing its 22 member Trusts and Foundations.

WRFT carries out much of its field work to protocols developed by the **Scottish Fisheries Coordination Centre (SFCC)**. The SFCC was set up in 1997 and has developed standard procedures for surveying juvenile salmon and trout and their freshwater habitats, and provides a facility for compiling and analysing data. Habitat surveys and electro-fishing surveys for this plan were carried out according to SFCC's standardised protocols, and field survey sheets are kept on file in the WRFT office.

Some of the work reported within this document has been carried out with the guidance of the Scottish Government agencies, including Marine Scotland's Fisheries Research Services (FRS), Scottish Natural Heritage (SNH), and the Scottish Environment Protection Agency (SEPA). WRFT acknowledges financial assistance provided by the Highland Council's Landfill Tax Credit Scheme for the production of this Plan and from Scottish Natural Heritage.

Part 2 Salmon and Trout ecology

2.1 Introduction

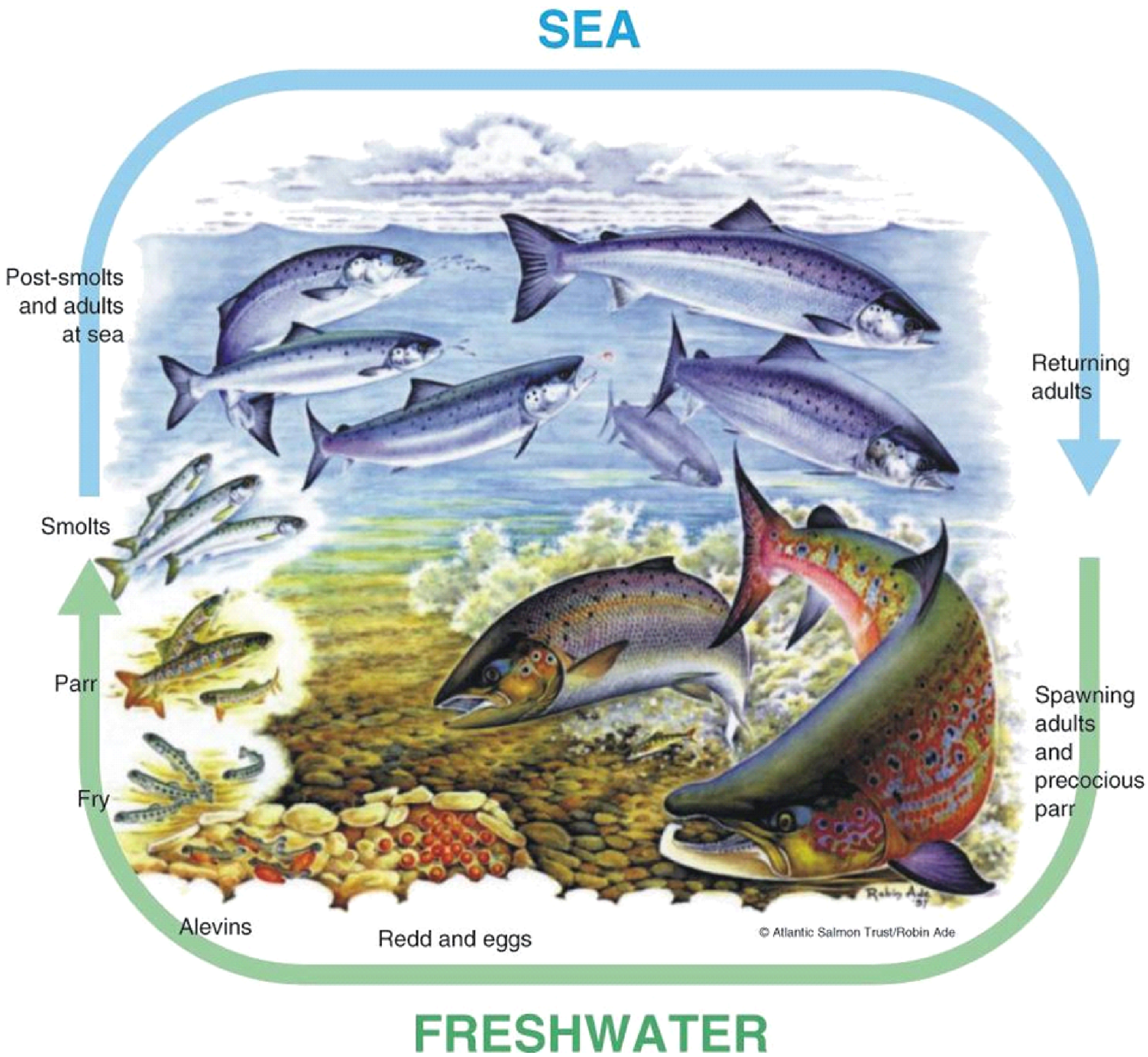
The effective management of fish populations and fisheries requires an understanding of the entire life cycle of the fish concerned. This section summarises the ecology of wild salmon and trout and the factors affecting their abundance within the context of the Little Gruinard River.

2.2 Atlantic salmon ecology

2.2.1 Life cycle

The life cycle of the Atlantic Salmon (*Salmo trutta*) is now well understood, and is summarised in Figure 2.1.

Figure 2.1 Atlantic Salmon life cycle (©Atlantic Salmon Trust)



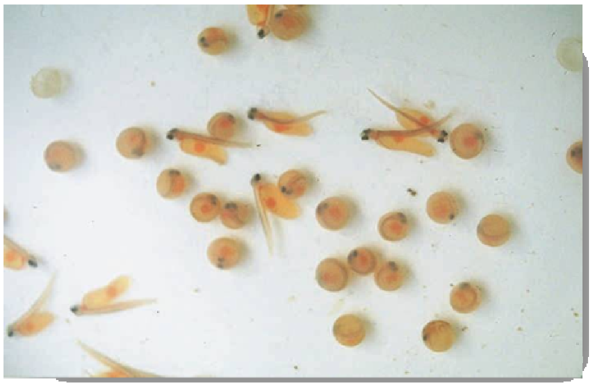
The key stages of the Atlantic salmon's life cycle are as follows:

Redd and eggs: A 2.7kg (6 lb) hen salmon will lay approximately 5,000 eggs in several nests or 'redds', usually in November. Salmon spawn in runs and glides with a gravel or cobble bed. There are some remarkable examples of 'ancestral redds' in the Little Gruinard River where fish have spawned over successive generations, creating large ridges of pebbles behind depressions excavated in the river bed by female salmon.

'Ancestral redds' in the Little Gruinard River by the top flats. Salmon fry densities are usually very high in this part of the river. With much competition for food, growth is very slow

Alevins: Up to 95% of eggs can hatch successfully, but this varies greatly according to the stability of spawning areas, water levels and temperatures during the winter, and dissolved oxygen concentrations. In some rivers redds become silted up and eggs suffocate. Surviving eggs hatch into alevins in early spring, remaining buried in the gravel until their yolk sacks have been absorbed.

Fry: Once the surviving alevins have emerged from the gravel and begun feeding, they are known as fry. This usually takes place in May. The little fish then disperse away from spawning areas as they set up feeding territories. Salmon fry favour shallow, faster flowing areas of the river, and competition for space and food in a well-stocked river will be fierce, resulting in high mortality during their first summer.



Salmon eggs and alevins (James Butler)

Parr: Once the fry have grown for a year they are known as parr. Being larger in size they require more cover to hide from predators than fry, and consequently parr favour faster flowing areas with boulders, cobbles and bankside cover. They feed on insects drifting on the current. Some of this food may fall into the water from bankside vegetation; in the Little Gruinard most of the food is in the form of aquatic insect larvae. Salmon parr also inhabit lochs; though little is known about this in the context of the Little Gruinard.

Smolts: Having reached approximately 12 cm or more in length the parr will begin to smolt, turning silver and migrating downstream to the sea during April and May. In Wester Ross most juvenile salmon require two or three years to reach the smolt stage, with a minority smolting after one or four years. This varies according to temperature, food availability and the densities of small fish. Salmon smolts leave their estuaries quickly, with most heading into the open sea within two or three days.

Post-smolts and adults at sea: Post-smolts grow quickly as they migrate northwards feeding near the surface on crustaceans and juvenile sandeels, capelin and herring. Little is known of the specific feeding grounds of west coast salmon; British salmon are known to feed over a large area of the north Atlantic. Salmon which mature in their first year at sea are known as grilse, and these probably migrate no further than the seas around the Faroe Islands before turning back to the Scottish coast. Fish which mature in their second or third year (Multi Sea Winter [MSW] salmon) migrate further north to feed off Greenland and in the Norwegian Sea.

Returning adults: As salmon mature they return southwards towards the Scottish coast, using the Earth's magnetic field to navigate. On reaching the West Coast of Scotland they locate their natal rivers by smell, and will usually run into the river during high flows after rain. Once in the river the fish darken and take shelter in deep pools or lochs. They stop feeding and rely on their fat reserves for survival and further sexual development.

Fresh run grilse taken in the WRFT Tournaig trap. Little Gruinard salmon are typically of similar size to this fish: small grilse of 55-65cm in length.

Spawning adults and precocious parr: As autumn approaches most adult salmon home in on the area or tributary of the river where they were born. The hen selects a suitable place for spawning and digs a series of redds, in which she lays her eggs. These may be fertilised by the adult cock salmon or by mature 'precocious' parr [male parr which are reproductively mature before migrating to sea] as well. The hen fish then covers the eggs with a mound of gravel.

Having spawned, salmon are known as 'kelts', and these gradually turn silver and drop back into the sea over the winter and spring. Few kelts survive to return and spawn a second time (see Part 4).

2.2.2 Freshwater problems

Factors limiting the abundance of salmon in the freshwater phase are (in life cycle order):

Redd washout: During severe winter spates in which the river bed moves, redds can be washed away. Newly-hatched alevins may be particularly vulnerable. In contrast to some other rivers in Wester Ross, the mainstem Little Gruinard and many of the headwater streams flowing into the Fionn Loch have very stable stream beds. Redd washout is considered to be a minor problem in the Little Gruinard system. The only possible problem sites are some of the spawning burns which run off the hills into the Fionn Loch or Dubh Loch (see also Part 6).

Unstable gravel bar in a spawning stream at the head of the Dubh Loch. In some years, severe winter spates in this stream may cause some redds to be washed out.

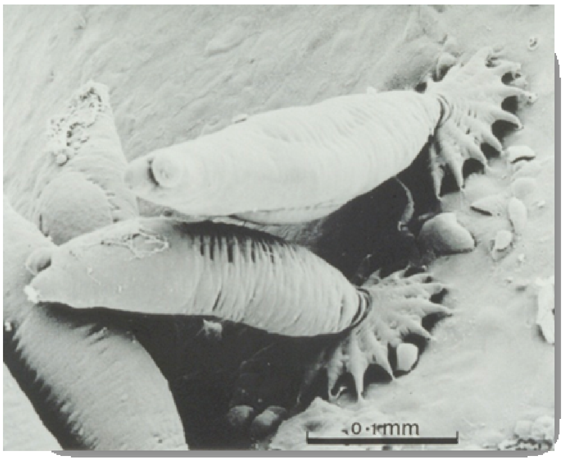
Acidification: Acidification caused by atmospheric pollution can kill salmon eggs and alevins, and, if particularly severe, will also kill fry. Coniferous forestry can exacerbate acidity. WRFT identified acid sensitive streams in other parts of Wester Ross; however acidification is not considered to be a major problem for salmon within the Little Gruinard due to buffering from surrounding geology, land and lochs.

Pollution: Contamination of rivers by industrial and agricultural waste (e.g. sheep dip) can kill fish of all sizes. With very limited human activity within the catchment, pollution is not a problem which has affected salmon in the Little Gruinard.

Siltation: The accumulation of silt in a stream can choke gravel beds, reducing the flow of oxygen to eggs and killing them. Siltation usually stems from run-off during the harvesting of forestry, or severe erosion of agricultural land. With very limited human activity within the catchment, this is not a major problem which affects salmon in the Little Gruinard.

Fertility and food availability: The river systems of NW Scotland are naturally oligotrophic (nutrient limited) as a result of their underlying geology. Production of plants, including planktonic and benthic algae at the base of the aquatic food chain, is limited primarily by the availability of the nutrient phosphorus. In turn, higher levels of biological production, including that of juvenile salmon are limited by stream and catchment fertility. In the Little Gruinard system, with few other freshwater problems, this may be a major factor limiting production of juvenile salmon. A collaborative Fisheries Trust – Marine Scotland research project is currently underway to learn more about the role of nutrients in determining the carrying capacity and production capacity of oligotrophic streams for juvenile salmon.

Disease and parasites: Although wild salmon carry many diseases their symptoms are not usually seen until the fish are stressed, for example by high water temperatures. Infectious Salmon Anaemia has become a recent problem in salmon farms, but it is not known to harm wild fish, although they can carry the virus. Of greater concern is the parasite *Gyrodactylus salaris* which has spread to many parts of Europe, notably Norway, from Sweden. Although Swedish salmon are adapted to survive the parasite, foreign salmon stocks are not, resulting in very high mortalities of fry and parr. So far *Gyrodactylus* has not reached the UK.



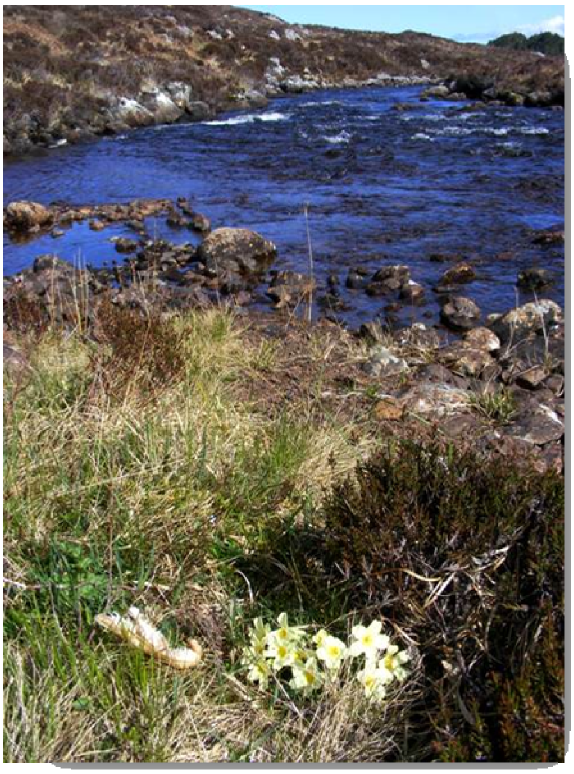
Gyrodactylus salaris (FRS Marine Laboratory)

Predation: Healthy rivers support healthy populations of fish eating birds and other animals. Fry, parr and smolts are eaten by a wide range of piscivorous birds and other fish, particularly Brown trout, in freshwater. The most prevalent predatory birds in local rivers are the Red-breasted Merganser, Goosander, Cormorant and Heron. The Fionn Loch also has Black-throated Diver in the summer.

Predation of smaller weaker fish can benefit the larger and stronger fish. In the context of the Little Gruinard, too little predation may be as much of a problem as too much except during the smolt migration: some parts of the river may be overpopulated with fry and small parr for which there is insufficient food for growth to smolt size.

Otters are the main predators of adult salmon in freshwater. Otters usually remove a salmon carcass onto the river bank, providing food for scavengers. Salmon carcasses represent a source of nutrients for riparian vegetation; and fertilise the ecosystem.

Feral North American mink are predators of juvenile salmon; in the Western Isles where there are no foxes, pine marten or badger, mink densities became very high to the detriment of breeding birds and juvenile salmon populations. Several mink were trapped by the Little Gruinard River in 2010.



Salmon jaw and primroses on a little island below the Major's Pool, May 2010.

2.2.3 Marine problems

Feeding: Fish traps and electronic counters elsewhere in Scotland indicate that in recent years, as few as 5% of salmon smolts have survived to return to their natal rivers. In the 1960s and 1970s marine survival was as high as 30% for some rivers in some years (e.g. North Esk, Marine Scotland data). The main cause of this decline is thought to have been climate change in the North Atlantic, which is restricting the availability of food for post-smolts, although the direct and indirect impacts of industrial fisheries are also poorly understood. As a consequence, more smolts die, and the surviving post-smolts and adults grow more slowly than in the past. Furthermore, because Multi Sea Winter (MSW) salmon remain longer in the sea, they are even less likely to survive and have become scarcer than grilse.

Commercial netting: High seas netting has been vastly reduced in recent years owing to buy-outs supported by the North Atlantic Salmon Fund (NASF)[5], and quota management by the North Atlantic Salmon Conservation Organisation (NASCO)[6]. The drifting gill nets off the west coast of Ireland and Northumberland that were also of concern to Scottish salmon rivers have also largely been bought out. The greatest netting threats to Scottish west coast salmon were coastal bag and sweep nets, but with the local declines in stocks, coastal netting stations became unviable. In Wester Ross, the last operating netting station at Red Point was abandoned in 2005; the nearby Laide netting station was abandoned in 1992 (see Part 3). Illegal netting is still a problem in some areas.

Industrial fisheries: Recent research has shown that salmon post-smolts feed near mackerel and herring shoals, and are accidentally taken as a by-catch by industrial trawlers. The full extent of this problem is not yet known, but research is underway in the North Atlantic to learn more about this problem.

Seal predation: In the 1990s, the Scottish Grey seal population was estimated to be growing by 8% per annum, and there were fears that predation on returning adult salmon may have been increasing. The Grey seal population is currently near an all time high. However, the extent of seal predation has never been quantified. St Andrew's University Scottish Oceans Institute[7] are developing seal scaring devises which may be of use in estuarine situations for protecting wild salmon and sea trout.

Harbour and Grey seals on a hall out on the Isle of Skye near Kyle Rhea.

[5] http://www.nasfworldwide.com/
[6] http://www.nasco.int/
[7] http://soi.st-andrews.ac.uk/

Sea lice infestations: The sea louse (*Lepeophtheirus salmonis)* is a naturally occurring parasite of salmon and sea trout. In the past 10 years, epizootics (unusually high levels of infection) have been considered to be primarily a problem for wild sea trout which tend to remain in coastal areas[8]. However, studies of salmon post-smolts in Norway have indicated that those leaving fjords with salmon farms have been infected with lethal levels of sea lice, most likely produced by salmon farms in the area (Holst *et al.,* 2003). Post-smolts with more than 11 lice were not recorded on feeding grounds; the implication being that this level of infection led to high rates of post-smolt mortality. There is also an indication that during the years 2001-2008 salmon smolts emigrating through Loch Linnhe from the River Lochy suffered higher levels of mortality as a result of sea lice infection correlating with the second year of the farm production cycle in the loch, as grilse catches were particularly low the following year (Lochaber Fisheries Trust, 2009). If salmon farm production in the Gruinard Bay – Loch Broom area was to increase without improved on-farm sea louse control, wild salmon emigrating from the Little Gruinard River could be adversely affected in addition to sea trout.

Escaped farm salmon: Salmon grown in fish farms around Wester Ross are selectively bred from non-native salmon (mostly of Norwegian origin), and typically mature when they are older and larger than native wild fish. Problems with escaped farm salmon may occur in either fresh or saltwater, since juvenile salmon are produced in hatcheries and grown on in mesh cages in freshwater and in the sea. Farm salmon which escape as fry or parr often look very similar to wild fish if they survive at sea, and may not be recognised by anglers. Escaped salmon will breed with wild salmon. If this occurs consistently over a number of years, Canadian and Irish research has shown that the wild stock can suffer a cumulative loss of genetic fitness (Ferguson, *et al* 2007). The level of genetic dilution will be minimal if the wild population is healthy, but the effect is potentially disastrous for the native population if the wild stock is already in a depleted state. A hybrid population will be more vulnerable to marine mortality and any sudden changes in the freshwater environment, leading to possible extinction.

(top) Escaped male farm salmon and (bottom) male wild salmon from broodstock tank at a nearby river in October. The escaped farm fish was removed and dispatched (photo by Ben Rushbrooke).

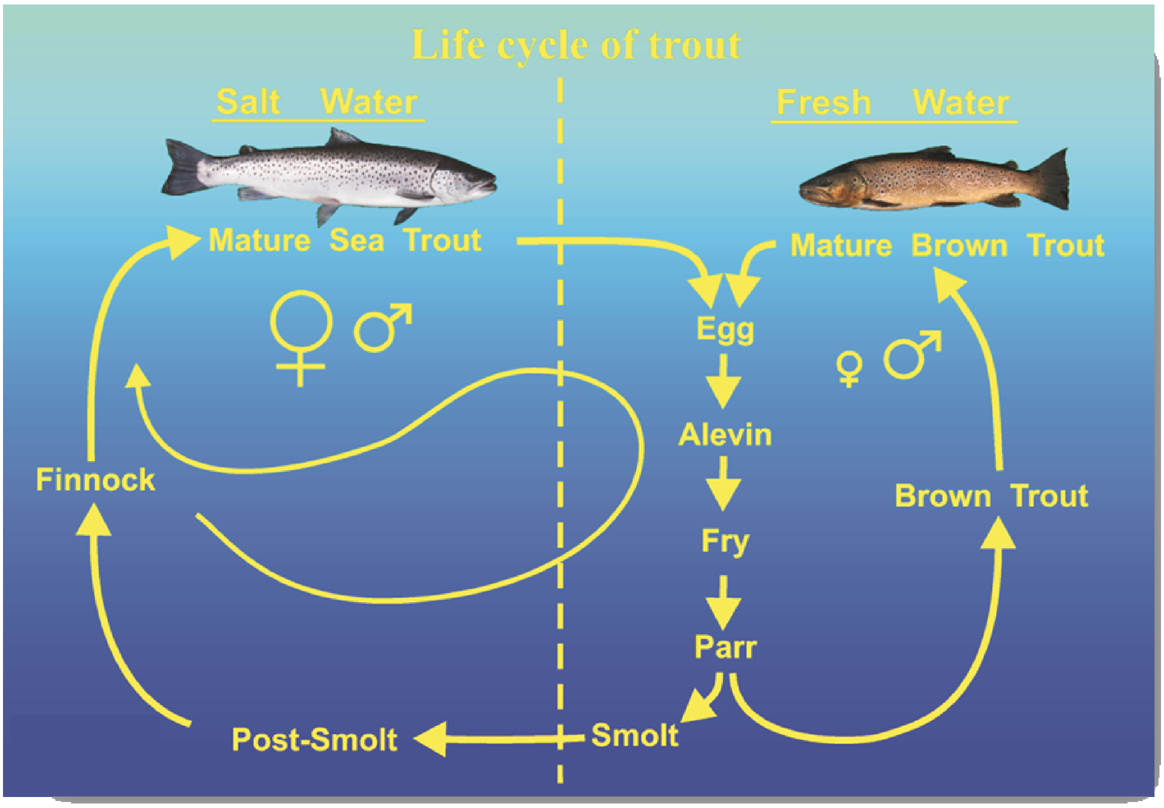
[8] See Cunningham (2009) for review of sea lice monitoring in Wester Ross. http://www.wrft.org.uk/files/WRFT%20Sea%20lice%20monitoring%20report%202007-2008%20for%20web.pdf

2.3 Sea trout and brown trout ecology

2.3.1 Life cycle

The life cycle and ecology of the Brown Trout (*Salmo trutta*) is more complex than that of the salmon. The brown trout is very adaptable, and can take many forms. Of principal interest to many west coast fisheries are populations of trout that produce sea-going 'sea trout', and how sea trout relate to 'resident' brown trout (Figure 2.2)

Figure 2.2 Brown trout (and sea trout) life cycle (copyright FRS)



As for salmon, the juvenile stages of the trout's life cycle are confined to fresh water. However, there are a few minor differences. First, trout eggs are smaller and their redds are shallower than those of salmon because adult trout are generally smaller than adult salmon. Second, trout begin spawning a few weeks earlier than salmon, typically in October.

On reaching smolt size young trout can either become sea trout or remain in freshwater as brown trout. In general, more females become sea trout; most males remain as brown trout (Figure 2.2). Sea trout smolts leave the rivers at the same time as salmon smolts, in April and May. Unlike salmon smolts, however, they remain in the sea lochs for their first summer. At this stage they are termed post-smolts, and by late summer are known as finnock. Some finnock re-enter fresh water in late summer, although it is not understood why since the majority are immature. Others remain in the sea lochs for one or two years until they mature and return to their native river to spawn.

Mature sea trout run into their native rivers in the summer and autumn. Within the Little Gruinard system, some are known to reach the Fionn Loch. Female sea trout may then pair with adult male sea trout or male brown trout in October and November and spawn. Like Atlantic salmon, sea trout kelts return to the sea after spawning, but have a much greater chance of surviving to spawn again. Historically, some fish ran their river annually to spawn up to 12 times, growing to sizes of more than 10 lb in weight. As a consequence, most of the trout eggs produced in a healthy sea trout river are laid by larger female sea trout.

There may be several forms of Brown Trout, including sea trout, in a river or loch system. Other forms of trout include 'slob' trout, which are resident in estuaries and also feed on marine organisms, but do not migrate any further than their natal river mouth. '*Ferox*' trout are long-lived brown trout which grow large enough in freshwater to become specialist piscivores [predators of other fish], and Arctic charr in particular. The Fionn Loch has a reputation for producing large *'ferox'* trout. The genetic basis to trout variation in the Little Gruinard system has not been studied.

2.3.2 Freshwater problems

Many of the problems that affect salmon in freshwater also affect trout. However, there are some minor differences:

Redd washout: Being smaller fish, trout lay their eggs in shallower redds, and therefore may be more prone to washout in some of the small burns around the Fionn loch.

Acidification: Trout are less sensitive to acidity than salmon (Grande *et al*, 1978).

Nutrient enrichment: Sea trout are thought to have evolved partly as a result of lack of food, causing females to migrate downstream to the sea in search of better feeding opportunities. Over time this behaviour has become genetically imprinted. However, if more food becomes available to trout in freshwater, either as a result of a lack of competitors or nutrient enrichment, some fish may lose the physiological trigger to migrate to sea. Consequently severe declines in trout numbers may reduce competition for food and encourage sea trout to stay in freshwater as brown trout. The enriching effect of effluent from freshwater fish cages or agricultural fertiliser can have the same result. In recent years, Loch Damph, formerly regarded as a premier sea trout loch in the River Balgy system, has produced several large trout including a fish of almost 20lb in 2009. In 2003, a 12lb 'sea trout' was shown from scale reading to have been a large trout which had not been to sea (WRFT Review, 2004); the 20lb fish was assumed likewise to have grown to large size because of increased food availability in the loch associated with salmon smolt production cages.

Competition with minnows: Juvenile trout are often found in the shallow margins of lochs where they feed on tiny invertebrates. The non-native Eurasian minnow (*Phoxinus phoxinus*) was recorded in the Little Gruinard catchment for the first time in 2009. Minnows are known to displace trout fry from shallow stillwater habitat and as a consequence may reduce levels of juvenile trout production. The overall impact of minnows on brown trout populations and sea trout production is currently being investigated by the FRS Shieldaig Sea trout Project where they are also a recent invading species.

2.3.3 Marine problems

Although sea trout are affected by the same marine problems as salmon, their coastal habits leave them more vulnerable to local influences, particularly:

Sea lice (*Lepeophtheirus salmonis*) infestations: Catch statistics suggest that sea trout stocks in the northwest were declining slowly from 1952, but the decline accelerated with the rapid growth of the salmon farming industry from the end of the 1980s. It is highly likely that sea lice emanating from salmon farms were the major cause of the collapse in the 1990s, as lethal levels of sea lice were found on sea trout post-smolts in salmon farming areas, but very rarely in areas further than 50km from salmon farms. Lice levels on sea trout trapped at the mouth of the Dundonnell River in Little Loch Broom were particularly high in the late 1990s and early 2000s (Cunningham, 2009). With use of the new in-feed medicine SLICE, on-farm lice management improved from 2001. However, samples of sea trout with an average of over 100 lice per fish were recorded in Loch Ewe and Loch Torridon in 2007 and in Loch Kanaird and Loch Carron in 2008.

Finnock and detached sea lice (taken at Poolewe)

Coastal feeding: The long-term decline of sea trout prior to salmon farming clearly suggests that other factors have been involved. Although numbers of sea trout were dropping, their average size remained consistent until 1988. One possible explanation for the long-term decline prior to the establishment of salmon farming is the decline in stocks of sea fish. Herring and sprats spawn in west coast sea lochs, and their young form an important component of the sea trout diet. Herring stocks were severely over-fished in the post-war years, and collapsed in the 1970s. The abandonment of the three-mile limit n 1985 may also have allowed over-fishing of other coastal white fish by industrial vessels, exacerbating the problem.

2.4 Competition between juvenile salmon and trout

Juvenile salmon and trout living in the same rivers tend to occupy separate types of habitat, reducing the competition for space. Salmon are better adapted to faster, shallower water, while trout favour deeper, slower-flowing water, and consequently prefer to live in lochs. While salmon favour well-lit areas, trout prefer shade and cover provided by bankside vegetation. However, if the trout's preferred habitat is over-populated they may aggressively colonise the more open areas, competing with the salmon. In the context of the Little Gruinard, this is further considered in Part 4.

Please visit the WRFT website, www.wrft.org.uk for more information about salmon and trout and related issues, and to download reports.