

Part 7 Habitat and juvenile salmon production

7.1 Introduction

This part of the report assesses the characteristics of the Little Guinard River system in terms of current and potential freshwater production of juvenile salmon. In doing so, factors that may limit production are identified. Habitats which are good for fish production also tend to support a rich diversity of other wildlife, including aquatic plants, insect larvae (mayflies, stoneflies, caddis flies, dragonflies, water beetles, etc.), Freshwater Pearl Mussel, birds (Dipper, Sand Martin, Heron, divers, Osprey), and mammals (Otter, Badger, Water Vole. . .).

The production of wild salmon smolts within any river system depends upon four major factors:

- The area of suitable habitat that is accessible to adult salmon
- Recruitment of salmon fry (number and survival of salmon eggs and alevins to swim up)
- Habitat quality and environmental conditions (particularly in relation to water temperature and food availability)
- Interactions with other species (e.g. competition, predation)

Prime juvenile salmon habitat: looking down to the Pulpit Pool and the Lower (1st) flats of the Little Guinard River, with quantitative electro-fishing site in the foreground. September 2004.



7.2 An overview of habitat

7.2.1 Introduction

Juvenile salmon are designed for life in swiftly flowing well-oxygenated rivers, with a steady food supply and places between stones in the streambed where they can hide from predators and take shelter during the winter (see Part 2). In most of these respects, the Little Gruinard River possesses some of the finest juvenile salmon habitat in Scotland; indeed it is hard to imagine a river with habitat of higher physical quality for salmon. The riverbed is unusually stable throughout its length and has a substrate which varies according to gradient from boulders and cobbles to pebbles, with several slower weedy pools where adult salmon are able to find refuge. Most of the river's discharge comes all the way from the Fionn Loch, and the river carries very little silt. Even after heavy rainfall and large spates, the streambed remains stable and unsilted, with virtually no bank erosion.

7.2.2 Salmon spawning habitat

Within the main river, the most extensive areas of spawning habitat are located at the Lower Flats and Upper Flats (these are indicated on Figure 4.5). In both places the actions of generations of spawning female salmon have created some of the best examples of 'ancestral spawning redds' in Wester Ross: ridges of pebbles and small cobbles where eggs have been buried. There are also prime spawning areas by the Major's Pool; and above the Fionn Loch, in the Beannach system above the Beannach Loch and other streams entering the Fionn Loch and the Dubh Loch where salmon fry were found.



'Ancestral redds' by the lower (1st) Flats of the Little Gruinard. The river bed in the centre of the picture has been formed by the actions of female salmon over many fish-generations (see p72).

Spawning activity takes place in November and provides one of the best opportunities of the year for fish watching as male salmon fight for supremacy and female salmon work the gravels. What other wildlife is attracted to the spawning channel?

Above the Fionn Loch, each spawning stream has its own character. Many of the small streams which enter the loch are subject to more rapid rise and fall in water levels than the main river. Some tributary streams are as stable as the main river, particularly the Garbh Allt and the Beannach river between Lochan Beannach Beag and the Fionn Loch and above Lochan Beannach Mor. There are extensive areas of spawning habitat for salmon and trout, particularly in the streams above the Beannach lochs and in the Allt a' Chadain at head of the Dubh Loch.

7.2.3 Salmon parr habitat

Much of the bed of the main river below the Fionn Loch has been derived from glacial deposits left behind as the ice melted towards the end of the last period of glaciations 10,000+ years ago. Little new material has been deposited during the time that has elapsed since then; finer material has been winnowed away; some of the stones have been chemically weathered creating an unusually rough, irregular texture. Much of the course is over a substrate of cobbles or boulders, and is now full of void spaces in which small fish can hide. There are extensive areas of fast flowing run - riffle type habitat: these areas are ideal for salmon parr.

As good as it gets for a salmon parr? The bed of the Little Guinard River just above the mouth of the Allt Riabhach: an exceptionally stable streambed with plenty of places for small fish to hide between cobble and boulder-sized stones. Note how the stones are of irregular shape – rather than rounded: finer material has been winnowed away, and many of the stones exhibit chemical erosion rather than abrasion from movement of stones along the streambed. However, wide shallow sections such as this may obstruct adult salmon at low flows: smaller grilse may be less vulnerable (to being taken by an otter) than larger salmon.



LITTLE GRUINARD FISHERIES MANAGEMENT PLAN 2011+

7.2.4 Holding pools for adult fish

Figure 4.9 (page 54) shows the location of some of the main pools. Many of the fishing pools in the Little Gruinard where salmon lie are small, some are only a metre deep next to a boulder. The main areas of slow – flowing deeper water are around the First, Second and Third Flats where salmon may gather prior to spawning. Above the Little Gruinard River, salmon gather in the Fionn Loch, particularly in bays adjacent to the mouths of the spawning burns.

7.2.5 The Fionn Loch and Dubh Loch

The Fionn Loch and Dubh Loch have not been surveyed in detail. In comparison to other large lochs in Wester Ross (Loch Maree and Loch na Sealga), the Fionn Loch has relatively extensive areas of shallow water less than 10m deep. Most of the loch is less than 30m deep (maximum depth between 40 and 50m). The loch provides good habitat for a large brown trout population. Arctic charr are also present, but little is known about them. Because of their size and the shoreline length relative to the riverine habitat within the Little Gruinard catchment area, the two lochs may also be of considerable significance for the production of juvenile salmon, even if they occur at very low densities relative to trout and charr. Juvenile salmon occupy shallow wave-washed stony areas in some lochs.

Beannach Bay, Fionn Loch at the mouth of the Beannach River. Quantitative electro-fishing site LGD9 is located between the stop nets in the foreground of the picture in front of the island. In August 2009, an Arctic charr fry and a Minnow were caught here in addition to juvenile salmon.



7.3 Productive area

A primary aim of the habitat survey in 2001-2002 was to identify the productive freshwater area accessible to salmon. This involved surveying rivers and tributary burns to assess how far migratory fish would be able to ascend and the mapping of obstacles such as falls. Electro-fishing for juvenile salmon could sometimes help to establish whether small burns were accessible or not. Taking the locations of barriers into account (Figure 7.1), the accessible riverine and loch areas were calculated (Tables 7.1 and 7.2).

Table 7.1 Area of riverine habitat accessible to Atlantic salmon within the Little Guinard River system.

Stream Section	Length (m)	Total area (m ²)	Parr Habitat (m ²)	Spawning Habitat (m ²)
Little Guinard River mainstem	6420	71940	42783	660
Tributaries below the Fionn Loch	1000	1985	1460	4
Streams in the Beannach sub-system	3750	10555	6089	637
Other tributary streams above the Fionn Loch	6360	7912	6036	1062
Totals (m²)	17530	92392	56368	2363

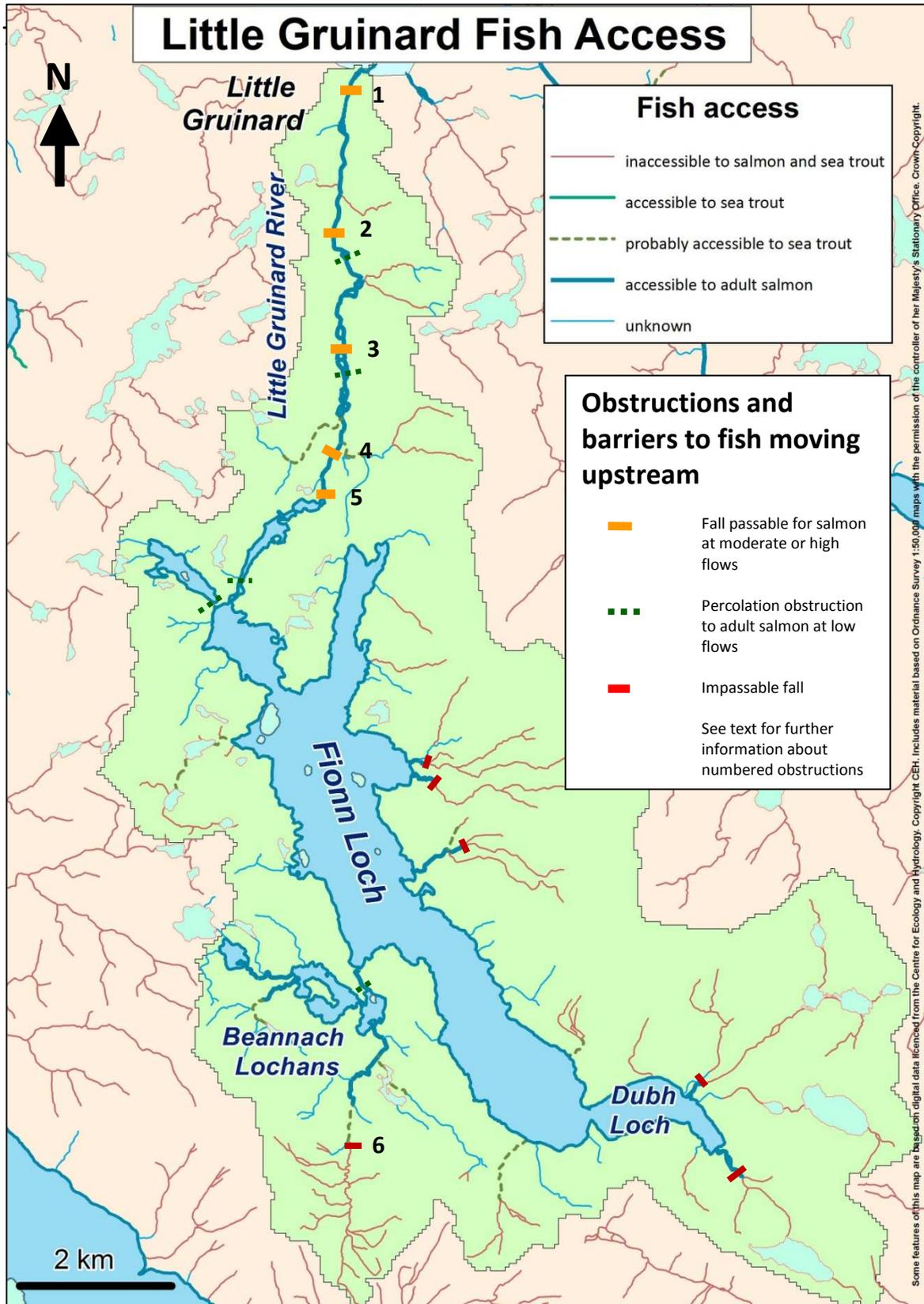
Loch habitat	Area (ha)
Fionn Loch & Dubh loch	1000
Beannach lochans	44
Loch na Moine Buige	24
Totals (ha) or (x 10,000m²)	1068

Table 7.2 Area of loch habitat accessible to Atlantic salmon in the Little Guinard River system.

Of the total 'wetted' freshwater area accessible to salmon, there are about 10,680,000m² of loch habitat (99% of total) and 92,392m² of riverine habitat (1%). Of the riverine habitat, 77% is within the mainstem Little Guinard River, 11% is in the Beannach streams above the Fionn Loch, and the remainder (12%) is in other minor tributaries flowing into the Fionn Loch. 'Parr habitat', defined as areas of riffle, run and shallow glide, accounted for over half of the riverine area accessible to salmon.

These figures are used in Part 7.4 to estimate the productive potential of the river system in terms of salmon smolts.

Figure 7.1 Area accessible to salmon and sea trout within the Little Gruinard River system; based on the findings of the 2002 habitat survey. Some of the smaller burns which are too small for salmon may be accessible to trout and sea trout moving upstream from other parts of the system.



Having established the size of the productive area for juvenile salmon within the Little Gruinard River system, it is possible to produce a range of estimates for the production of salmon smolts. Table 7.5 provides a range of potential smolt production estimates for both riverine habitat and for loch habitat. These estimates are intended to illustrate the *possible* range of smolt production from the system, according to variation in habitat suitability and quality, food availability, over-winter survival, interaction with trout or other animals²⁸.

Estimates are based on a range of published and unpublished figures, including salmon parr densities recorded for similar riverine habitat elsewhere in Wester Ross. There are no reliable estimates for salmon smolt production from Scottish lochs; loch estimates are based on figures for Canadian lakes.

Table 7.5 Estimates of potential salmon smolt output from the Little Gruinard system.

A. Riverine habitat (streams and mainstem river)

(i) estimates based on the total riverine area within the Little Gruinard catchment area identified in the habitat survey in 2002

Riverine Section	Total area (m ²)	0.05 smolts (m ² /yr)	0.1 smolts (m ² /yr)
Little Gruinard River mainstem	71940	3597	7194
Tributaries below the Fionn Loch	1985	99.25	198.5
Streams in the Beannach sub-system	10555	527.75	1055.5
Other tributary streams above the Fionn Loch	7912	395.6	791.2
Totals	92392	4619.6	9239.2

(ii) estimates based on the area of 'parr habitat' identified in the habitat survey in 2002

Riverine Section habitat	Parr Habitat (m ²)	0.05 smolts (m ² /yr)	0.1 smolts (m ² /yr)
Little Gruinard River mainstem	42783	2139.15	4278.3
Tributaries below the Fionn Loch	1460	73	146
Streams in the Beannach sub-system	6089	304.45	608.9
Other tributary streams above the Fionn Loch	6036	301.8	603.6
Totals	56368	2818.4	5636.8

²⁸ Juvenile salmon utilise and prefer different types of habitat as they grow. Figure 6.6 (page 72) shows how different numbers of juvenile salmon were found in different types of habitat in 2004 within the system. The Wester Ross Fisheries Trust is currently involved with a Carrying Capacity Project to improve our knowledge of the number of juvenile salmon and other fish that different types of stream habitat can support, and for the purposes of fisheries management for rivers like the Little Gruinard, the role of differing factors in determining levels of productivity. We anticipate being able to provide clearer guidance for ways of raising the natural productivity of juvenile salmon habitat in future years.

LITTLE GRUINARD FISHERIES MANAGEMENT PLAN 2011+

B. loch habitat

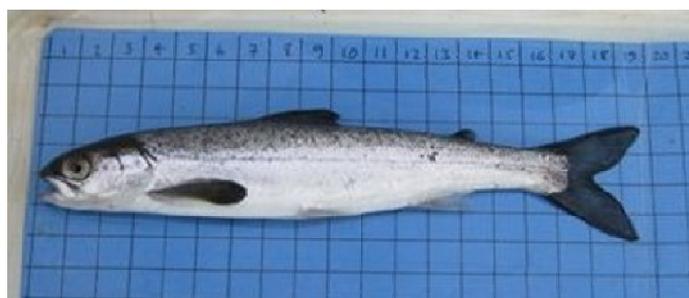
Loch habitat	Area (ha)	5 smolts (ha/yr)	2 smolts (ha/yr)
Fionn Loch & Dubh loch	1000	5000	2000
Beannach lochans	44	220	88
Loch na Moine Buige	24	120	48
Totals	1068	5340	2136

note: These figures encompass a range of estimates for Canadian lakes. There are no reliable figures for salmon smolt production from Scottish lochs (see Part 8).

C. total estimates

Estimated salmon smolt production	Maximum	Minimum
Little Gruinard River mainstem	7194	2139
Tributaries below the Fionn Loch	199	73
Streams in the Beannach sub-system	1056	304
Other tributary streams above the Fionn Loch	791	302
Fionn Loch & Dubh loch	5000	2000
Beannach lochans	220	88
Loch na Moine Buige	120	48
Totals	14579	4954

An unusually large salmon smolt from the Sguod River. Juvenile salmon which spend a year in loch habitat may grow larger than those which remain in riverine areas (photo by Mark Williams).



Based on these figures, estimated potential salmon smolt production in the Little Gruinard River system vary between a maximum of about 14,580 smolts per year and a minimum of only about 4,900 assuming recruitment is not a limiting factor (see next section). Note that even at low production rates, approximately 50% of salmon smolts may be produced from the Fionn Loch and stream systems which flow into the Fionn Loch. Until we know more about loch production, these estimates remain uncertain.

These figures do not take account of possible predation of smolts as they migrate to sea. In particular, salmon smolts migrating into and through the Fionn Loch and Boat Pool may be taken by trout. In dry years, smolts descending from the Beannach sub-system and through the Fionn Loch

may be delayed by low flows in April and May. The level of predation of pre-smolt (parr and fry) salmon by trout is also unknown.

7.5 Factors limiting production of juvenile salmon in the Little Gruinard

7.5.1 Introduction

Factors affecting the life cycle-success of salmon are summarised in Part 2 of this report. The actual level of production of salmon smolts from the Little Gruinard system depends upon a wide range of factors relating to adult salmon numbers, habitat quality and environmental conditions. Salmon smolt production will vary widely from year to year according to weather and river conditions. For convenience, factors influencing smolt production can be divided into: 1, those that affect recruitment of salmon fry; 2, those that affect growth and survival of salmon parr and migrating smolts; 3, those that affect survival and spawning success of adult fish. This section briefly reconsiders how these may influence smolt production in the Little Gruinard.

7.5.2 Recruitment of salmon fry

Recruitment of salmon fry depends upon the numbers and distribution of spawning salmon (particularly adult females which determine where eggs are buried) within the system, how successfully they spawn, and the survival of eggs and alevins within the substrate.

Studies from other rivers where salmon have been counted as they enter fresh water have shown that typically between 5% and 15% of fish are caught by anglers²⁹. A higher proportion of earlier entering fish are taken³⁰. In the context of the Little Gruinard fishing effort varies from year to year; if catches reflect numbers of fish within the range above, numbers of adult salmon entering the system are likely to be in the range of 500 – 1,500 fish per year.

Adult female salmon are usually good at selecting the best places to spawn. However, in some streams, the 'best places' may be far from ideal with little habitat in which eggs can be easily buried. Eggs that are not buried may be eaten by trout or hungry salmon parr, so are not necessarily wasted. Salmon eggs and alevins require a stable environment, and a steady supply of cool, clean, well-oxygenated water.

During the winter, eggs are vulnerable to 'redd washout' if the substrate in which they are buried moves. The WRFT Redd Washout study during the winter of 1998-1999 investigated whether salmon and trout eggs would be vulnerable to redd washout in river systems throughout the WRFT area. Nine artificial redds were created in the Little Gruinard system in which bone beads were planted to resemble the fish eggs. Four redds were created in the main river; five were in tributaries around the Fionn Loch. For salmon, bone beads were larger and buried more deeply than for trout (Butler, 1999).

²⁹ For example, Milner's study of River Dee, Kindness, Carron – references to follow.

³⁰ For example, the River Spey <http://www.scotland.gov.uk/Uploads/Documents/FW18RodCap.pdf>

LITTLE GRUINARD FISHERIES MANAGEMENT PLAN 2011+

Of these, only two salmon (22%) and three trout redds (33%) were mobilised, all from tributary streams around the Fionn Loch; sites in the main river remained stable. This compared to an average of 57% and 68% washout for Wester Ross rivers as a whole, demonstrating that spawning areas within the Little Gruinard river are amongst the most stable of any salmon river in Wester Ross.

If there are hard frosts, eggs may be frozen when water levels are unusually low. Another factor which has recently been shown to be capable of killing eggs and alevins is the up-welling of groundwater low in dissolved oxygen through redds (Youngson, *et al*, 2005).

When stocks of salmon are healthy, there are usually large surpluses of salmon eggs relative to what is 'needed' to attain maximum levels of recruitment. Given a surplus of spawning fish and extensive areas of suitable spawning habitat, many more fry 'swim-up' from redds than the system is able to support. Under these conditions, losses prior to 'swim up' may have little impact on overall smolt production: washed-out eggs can also provide a food source for parr improving over-winter survival.

However, when numbers of adult fish reaching spawning streams are low, numbers of 'swim up fry' may ultimately limit smolt production. Furthermore, to maintain stock structuring and a healthy population of 'spring salmon', competition between swim up fry may be of importance (see Box 4.1).

For the Little Gruinard River, there is no indication that smolt production has been limited due to inadequate recruitment of salmon fry in the past 10 years at least. To the contrary, densities and CPUE for salmon fry were consistently found to be high during e-fish surveys (see Part 6). This may be partly due to the 'Catch and Release Policy' helping to ensure that there were adequate numbers of salmon spawning throughout the system even when numbers returning from the sea were low.

7.5.3 Growth and survival of juvenile salmon

Salmon fry and parr require cover and food. Juvenile salmon are territorial and defend feeding areas from visible intruders. Fry find cover between the stones where the substrate is composed primarily of small cobbles or pebbles.

As they grow larger juvenile salmon require larger substrate in which they can hide from each other. A primary defence from predators is to hide *within* the substrate. Voids between cobbles and boulders are ideal places in which juvenile salmon can find sanctuary. These 'refuges' are also important at times of high water and fast flows and in the winter – so long as they are not scoured out or filled in. In these respects, the Little Gruinard River provides ideal habitat for juvenile salmon.

With very low levels of dissolved phosphate and nitrogen and consequently low levels of in-stream biological production and terrestrial inputs, food availability for juvenile salmon may be limited for many months of the year (especially between August and March). Indeed, surplus salmon eggs at spawning time may be an important food source that enables weaker fry and parr to maintain energy reserves and body condition during winter months (and not be swept away during spate flows). Within the main river, the fastest growing salmon fry and parr were found by the Stepping Stones,

just below the Fionn Loch outflow, where densities were lowest and food available to each fish probably greatest, with insect larvae from the loch adding to food produced in the river.

The lack of riparian tree cover is not thought to be of serious concern with regard to physical habitat. The main river channel is unusually stable throughout its length and there is not a shortage of cover for fish, except perhaps in the lower reaches of the Allt a' Chladhain. However, the lack of leaf litter and woody debris entering the river reduces the amount of habitat and food for certain invertebrates, notable caddisfly (sedge fly) larvae, and in turn, food availability for juvenile salmon and trout.

7.5.4 Access and survival of adult salmon

As salmon rivers go, the Little Gruinard is a small river. Although there are no major waterfalls, a series of smaller falls, cascades and wide shallow sections obstruct upstream movement of adult salmon at low flows. Adult salmon are known to return from the sea to the Little Gruinard River between June and September, with a few fresh run fish taken as early as April or in October in some years. Most fresh-run salmon are taken during the summer months, when river levels tend to be at their lowest.

The first major obstacle ('1' on Figure 7.1) above the tide is a complex cascade between large 'hippo' sized boulders located only 1km upstream from the top of the tide.



Over the years several larger salmon have been recovered dead below the fall. Salmon which are held up by falls, or attempt to pass them at low flows may be more vulnerable to capture by otters.

Small grilse may be better able than larger Multi Sea Winter [MSW] salmon at moving upstream over this and other obstacles in the River at low flows.

The Hippo Pool and cascade: top left, 1st June 2004; bottom, 12th May 2010. Many trees were felled in a storm 2005; woody debris has been left in situ to provide habitat for wildlife.

LITTLE GRUINARD FISHERIES MANAGEMENT PLAN 2011+

There are a series of small falls and obstacles in the Gorge, including the cascade near the top (*below left, '2' on Figure 7.1*). 500m upstream from this obstacle, the First Flats provide one of the longest holding pools in the river (*right*). This pool is only a few hundred metres below the spawning area shown on page 79.



Further upstream, slower long, weedy pools are also located at the Second and Third Flats, latterly just below the second most extensive area of spawning habitat in the main river. Above the Third Flats, salmon ascend a series of cascades to reach Eileach Mhic'ille Riabhaich and the Fionn Loch.



Cascade section 250m upstream from the mouth of the Allt Riabhach, '4' on Figure 7.1.

Cascade section at the top of the Little Gruinard river just below Pait Fhearchair, '5' on Figure 7.1.



Above the Fionn Loch, the habitat survey identified one man-made obstruction: a dry stone dyke crossing the burn flowing out of Loch na Moine Buige. This obstruction has been removed, adult salmon are now able to swim through a hole in the wall and juvenile salmon have been found above the wall.



The burn between Loch na Moine Buige and the Fionn loch flows through a dry stone wall (left). Following the creation of a hole through the wall large enough for adult salmon to swim through, juvenile salmon were found above the wall at the outflow of the upper loch.

The Beannach lochs (shown on cover picture and page 32) provide sanctuary for salmon which spawn in the small burns that flow into it. The upstream limit for adult salmon in these burns may



vary from year to year according to water levels during the spawning season. In 2004, juvenile salmon were found to within 500m of the falls by the footbridge on the Carnmore path (*left*), but not in the section of river above these falls ('6' on Figure 7.1).

Through natural selection, the combination of obstacles and shallow streams may be a principal reason why Little Gruinard salmon tend to be characterised by small grilse rather than larger fish.

Juvenile trout but no juvenile salmon were found in the Carnmore jetty burn in 2006 (*below*). This burn may be too small for even small Little Gruinard grilse to enter; it is possible that only trout can safely enter the burn at normal flows during the spawning season.



7.6 Summary

1. The Little Gruinard River has extensive areas of prime quality habitat for production of juvenile salmon.
2. The most extensive areas of salmon spawning habitat in the main river are by the First Flats and Third Flats. These represent some of the finest examples of 'ancestral redds' in Wester Ross.
3. A series of small falls and obstructions restrict movement of salmon within the river system at low flows. Holding pools where adult fish can retreat to safety are located adjacent to the main spawning areas.
4. Above the Fionn Loch, salmon spawn in several streams around the Fionn Loch, most notably in the Beannach sub-system. Habitat is generally also good in these streams with stable substrate in all streams except the Allt a' Chladain at the head of the Dubh Loch. Brown trout also spawn in these streams and in many smaller burns which flow into the Fionn Loch.
5. From the WRFT Habitat Survey in 2000 – 2001, the area of riverine habitat accessible to adult salmon within the system is estimated at 92,392m³, of which 71,940m³ is in the mainstem Little Gruinard River and the remainder in streams above the Fionn Loch. The productive area of loch habitat accessible to adult salmon within the system was estimated at 1068ha.
6. Estimates of potential smolt output based on per unit habitat area production range from 5,000 to 14,500 salmon smolts per year, with approximately 50% of total from the Fionn Loch and streams which enter it.
7. Actual smolt output is likely to vary from year to year according to water levels and growing conditions. Longer term changes in smolt production may be associated with changes in catchment fertility and food availability.
8. Juvenile salmon grow fastest towards the top of the river, and at the outflow of the Fionn Loch. Food availability together with habitat are considered to be the main factors limiting production of juvenile salmon.
9. No major physical habitat problems associated with human impacts that affect production of adult salmon within the Little Gruinard catchment were identified. The lack of riparian tree cover was not considered to be detrimental to stream stability or available fish cover.
10. However, the restoration of tree cover and increased input of leafy and woody debris into the river could enhance the food supply for aquatic invertebrates and indirectly lead to increased production of juvenile salmon.
11. Natural selection may have favoured small grilse-sized salmon rather than larger MSW salmon in much of the system due to shallow water depth.

Part 8 Management recommendations

8.1 Introduction

The foregoing sections of this report provide a description of the Little Gruinard river system and what is known about its fish populations and fisheries.

In 2009, a fisheries management plan for the WRFT area outlining actions needed to support and strengthen wild fish populations in the area³¹. The recommendations presented here add to those in the [WRFT Fisheries Management Plan 2009+](#).

The most basic management aim for the Little Gruinard River is to secure healthy wild fish populations, particularly salmon, within the catchment area. The recommendations for actions that are presented here are aimed at achieving this and sustaining and increasing the productivity of the wild fisheries of the Little Gruinard River system.

These fall into three categories:

1. Management recommendations for salmon
2. Management recommendations for trout
3. Recommendation for investigations aimed at informing management.

These recommendations are not set in stone and can be challenged and revised at any time if there is good reason to do so. A few changes have been made following comments received during the period of formal consultation. Please contact the WRFT Biologist at info@wrft.org.uk if you have further comments.

³¹ <http://www.wrft.org.uk/downloads/files.cfm?id=17>

8.2 Recommendations for Salmon

The Little Gruinard River is of international importance for the conservation of Atlantic salmon (*Salmo salar*). The most important management aim is therefore to secure 'favourable' status for the Special Area of Conservation (SAC) for Atlantic Salmon under the European legislation, and is therefore an obligation for the Scottish Government.

The greatest threats to the future of Little Gruinard salmon are within the marine environment. At sea, salmon are at risk from fishing, both legal (e.g. capture as bycatch) and illegal (e.g. poacher's gill net). In coastal waters, the health of emigrating salmon smolts may be compromised by parasitic infection by the sea lice *Lepeophtheirus salmonis*³².

The 'freshwater' part of the fishes' life cycle is within the riparian owners' control, whereas marine factors largely are not. One of the main objectives of the Fisheries Management Plan is therefore to identify ways of maximizing the natural production of wild juvenile salmon from the Little Gruinard River. This is firstly in order to safeguard the salmon population, especially during periods when rates of marine survival (smolt to adult salmon) are low.

This approach is also justified by the fact that the numbers of returning adult salmon depend upon the numbers of smolts produced by the river system, which in turn is determined by the numbers of juvenile fish that the river can support and their rates of growth.

No major problems have been identified within the Little Gruinard system for juvenile salmon. Juvenile salmon were found consistently throughout the catchment area, and usually at CPUE levels indicative of a healthy population.

There is no reason to believe that the genetic integrity of native Little Gruinard salmon has been compromised by genetic transgression. Escaped farm salmon were regularly recorded during the 1990s; and less frequently since the turn of the century.

Recommendations for wild salmon are as follows:

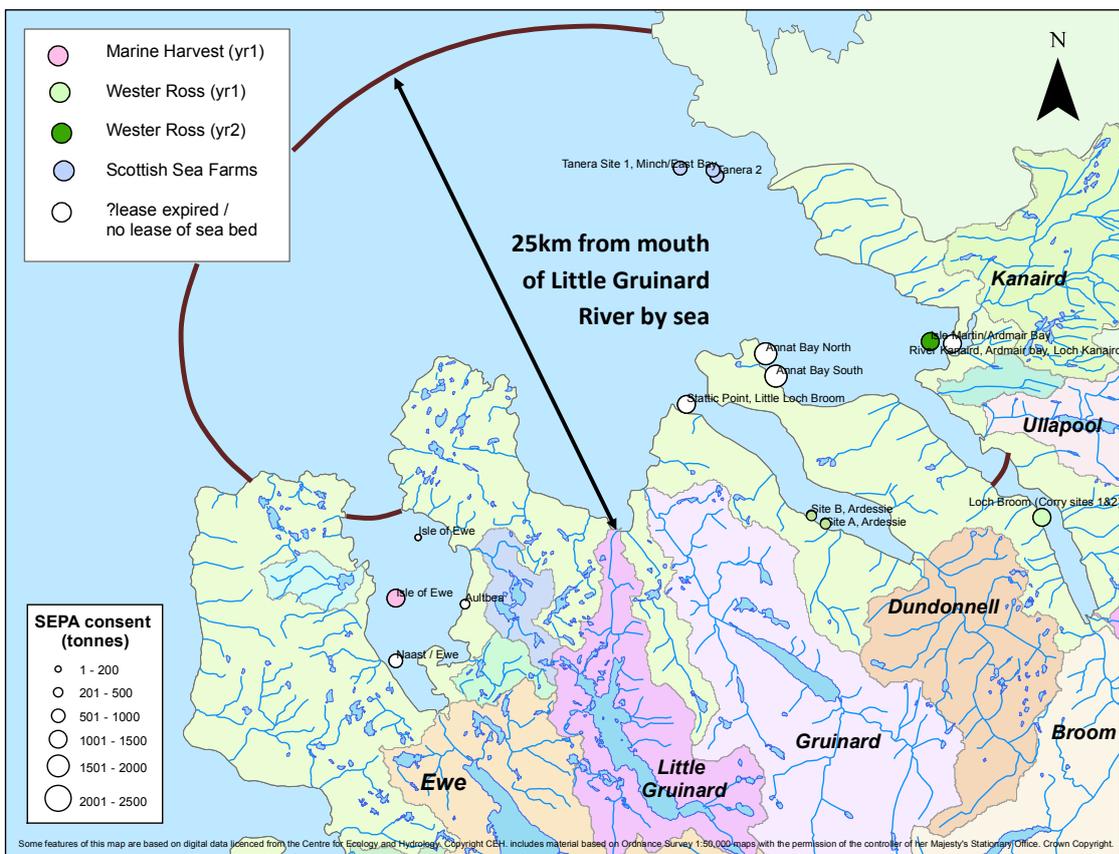
A1. & A2 Maintain levels of support for measures to protect wild salmon within the marine environment. Over the past 20 years much has been achieved with buy-outs of drift nets around the United Kingdom, and international agreements. Organisations addressing problems within the marine environment should be supported [e.g. [NASCO](#), [NASF](#), [Atlantic Salmon Trust](#)]. Unless there is a substantial recovery in marine survival of wild salmon, local netting stations should remain closed.
ACTION: WRASFB, Scottish Government, local estates, local community groups.

A3. Protect wild salmon from the risk of sea lice epizootics associated with salmon farming. Studies in Norway have demonstrated that the survival of Atlantic salmon post-smolts can be compromised by as few as 11 sea lice (Holst, *et al* 2003). Sea lice epizootics affecting wild sea trout and salmon within

³² For review please see: <http://www.scotland.gov.uk/Uploads/Documents/IR1206.pdf>

the Loch Broom – Gruinard Bay were documented as recently as 2008 (and in 2010?). Until the salmon farming industry can demonstrate that it is able to operate within local waters without adversely affecting the health of wild salmon and sea trout, any applications to expand farm salmon production within the area around the mouth of the Little Gruinard River should be assessed against salmon and trout conservation objectives and if in doubt a precautionary approach should be taken.
ACTION: WRASFB, SG and agencies; Crown Estate; Scottish Salmon Producer’s Organisation.

Figure 8.1 Locations of salmon farms in the coastal area around the Little Gruinard SAC for Atlantic salmon. Within 25km of the river mouth there were 7 active fish salmon farm sites in 2010. Because of the importance of the area for wild salmon and sea trout, applications to expand salmon farm production within 25km of the river mouth should be assessed against salmon and trout conservation objectives and if in doubt a precautionary approach should be taken.



A4. Maintain the ‘Catch and Release’ policy for rod caught salmon. ‘Catch and Release’ demonstrates a commitment by Letterewe Estate and anglers to the conservation of the wild salmon population. The ‘catch and release radio-tracking study’ by Walker 1991, demonstrated that a high proportion of fish survive to spawn. Kindness (2007) recommends the use of a keep net to hold a rod caught fish in quiet water, providing the fish with time for recovery prior to release back into the river; this may be useful if water is swiftly flowing nearby and the fish could get swept away.
ACTION: Letterewe Estate and anglers

A5. Maintain detailed records of rod caught salmon. The current recording system provides good information with details of both the length and weight of rod caught fish, water height and barometric pressure. Any other objective information (e.g. numbers of sea lice rather than ‘many’ or

LITTLE GRUINARD FISHERIES MANAGEMENT PLAN 2011+

'few') would add to the value of this as a catch record, and where possible a photograph and scale sample of the fish (so long as the welfare of the fish was not compromised).

ACTION: Letterewe Estate & WRFT

A6. Do not stock salmon into the river. Juvenile salmon populations were found to be healthy throughout the area, including areas where spawning gravels were less stable and redd washout could be a problem. There is no basis for initiating a stocking programme for the Little Gruinard River.

A7. There are no major problems with the physical stream habitat quality within the main river. For discussion: riparian habitats along two smaller streams flowing into the Fionn Loch – Dubh Loch could be improved through fenced enclosure of a 5-10m wide riparian margin and planting of alder, aspen and willow. If carefully designed these could provide useful habitat for other wildlife and shelter (wind breaks) for deer without loss of extensive grazing areas. These are small scale projects and would have relatively minor benefits for salmon and trout populations.

- Allt Feith a' Chaisgean (Sandy Bay Burn)

The lowest 200m of this burn above the loch is unstable with undercutting and collapse of stream banks.



- Allt a' Chladhain (at the head of the Dubh Loch).

This is an important salmon spawning stream at the head of the Dubh Loch. The lower part of this stream is one of the most mobile within the Little Gruinard system. Restoration of stronger rooted riparian vegetation could ultimately strengthen stream banks and help to stabilize the burn. Riparian alder or willow trees would require enclosing the lower part of the burn within deer fences. Note that the surrounding grassland on the alluvial fan is also an important grazing area for red deer and water voles. Management objectives for mammal populations would need careful consideration.

ACTION: Letterewe Estate



A8. & A9. Salmon smolts are vulnerable to predation. Mink should be trapped. Smolts are a natural part of the diet of trout, eels, marine fish, fish-eating birds (heron, red-breasted merganser, goosander, gulls, cormorant) and various mammals. Native wild salmon smolts have evolved to migrate through areas with predators in ways which maximize their chances of survival. In some years, particularly years when water levels are low during the smolt migration period, smolts may be particularly vulnerable to capture by fish-eating birds. The occurrence and distribution of fish eating animals should be monitored if there are concerns for fisheries. ACTION: Letterewe Estate, SNH, WRFT

A10. Returning adult salmon can also be vulnerable to predation, particularly by seals if they are held up at the mouth of the river by low water. For smaller, less healthy salmon populations, the loss of any salmon may be detrimental to the wellbeing of the salmon population. Any policy to manage seals should be based on knowledge of local seal populations: the occurrence of seals should therefore be monitored. ACTION: NW Seal Management Group, Letterewe Estate.



Ala MacKenzie of Gairloch Angling Club, with a small Fionn Loch grilse taken on a trout fly in Sandy Bay in August 2006. The fish was released after the photo was taken.

LITTLE GRUINARD FISHERIES MANAGEMENT PLAN 2011+

A11. Wild salmon are part of a larger marine and freshwater ecosystem. The transfer of marine nutrient from the Arctic Ocean to headwater streams above the Fionn Loch represents a valuable ecosystem service. Salmon are of importance as food for many other species particularly during and immediately after the spawning season. Opportunities for restoring and enhancing the natural productivity and value of the Little Gruinard catchment and nearby coastal waters for fisheries and wildlife should be explored further. ACTION: Letterewe Estate, WRFT, WRASFB, SNH, local community groups.

There is a limit to the number of juvenile fish a stream can support. A collaborative management trial is underway to understand how habitat and fertility affect the carrying capacity of streams for juvenile salmon. On 21st August 2009, these fish (right) were caught over three electro-fishings of the section of cobbly run – riffle habitat between the nets in the picture below. The stream had been stocked to over-capacity with salmon fry earlier in the year.



8.3 Recommendations for trout

The Brown trout populations of the Little Gruinard river system represent a major component of the fish fauna particularly in lochs and are of conservation importance in their own right. Sea trout are known to run up the main river as far as the Fionn Loch. Although the Little Gruinard is not noted as a sea trout system, the Fionn Loch wild brown trout fishery is one of the most productive in the northwest of Scotland. So far as there are records, the numbers of brown trout which can be caught during a day's fishing and their size appears to have changed little over the past 100 years or more, except perhaps that fewer of the larger trout have been reported in recorded catches in recent years. There is little cause for concern for the future of the trout population.

Recommendations for wild trout are as follows:

A11. Support measures to protect and restore populations of herring, sandeels and other food fish and the habitats which support them within the inshore environment. This will be of benefit to sea

trout populations of the area. The big Gruinard River has a larger sea trout population than the Little Gruinard River and it is possible that some of the sea trout taken at the river mouth originate from other rivers. ACTION: SNH, WRASFB, Marine Scotland, local estates, local community groups.

A3. Sea lice epizootics associated with salmon farming damaged local sea trout populations during the 1990s and in some years of the 21st century. Until the salmon farming industry can demonstrate that it is able to operate within local waters without adversely affecting the health of wild salmon and sea trout, any applications to expand farm salmon production within the area around the mouth of the Little Gruinard River should be opposed. ACTION: WRASFB, SG and agencies; Crown Estate; Scottish Salmon Producer's Organisation.

A4. Maintain a catch and release policy for sea trout. The policy could be reviewed if there is a substantial recovery in the abundance of larger, older sea trout. ACTION: Letterewe Estate

A5. Maintain catch records for sea trout from the river as for salmon. ACTION: Letterewe Estate

A6. Do not stock Brown trout or Sea trout into the river system. ACTION: Letterewe Estate

A12. Develop a more formal catch recording system for the Fionn Loch. This will provide useful information on the productivity of the loch. The WRFT Angler's log book scheme in 2003-2004 yielded useful data from which some of the information in this report is based.

ACTION: Letterewe Estate, Tournai Estate, WRFT

A13. The 'fly only' rule for brown trout fishing helps to safeguard salmon in the Fionn Loch. Larger brown trout in the population may be under-represented in catches. Is it possible and sensible to relax the 'fly only rule' on a trial basis for a few weeks in the spring in 2011 [e.g. month of May] to allow for a short '*ferox*' fishing season prior to the arrival of fresh run adult salmon in the loch?

ACTION: Letterewe Estate, Tournai Estate, WRFT

A14. Fishermen should be given guidance regarding the locations of important breeding birds in and around the Fionn Loch in order that disturbance can be minimized. All anglers who are unfamiliar with the loch should be accompanied by an experienced ghillie.

8.4 Recommendations for management related investigations

A15. **Juvenile salmon populations** By visiting sites within the accessible part of the Little Gruinard catchment area every two years, WRFT maintains a record of the distribution and relative abundance of juvenile salmon populations within the Little Gruinard catchment. Is this adequate to inform management and maintain knowledge of SAC salmon population status? ACTION: Letterewe Estate, SNH, WRFT

A16. **Salmon production from lochs** Are salmon smolts produced in the Fionn Loch? Anecdotes suggest that larger salmon smolts tend to migrate downstream later in the season than smaller salmon smolts. There are various possibilities: salmon parr may utilize shallow wave washed areas of

LITTLE GRUINARD FISHERIES MANAGEMENT PLAN 2011+

the Fionn Loch and Dubh Loch from late autumn, or perhaps some live within the loch for a larger part of their freshwater life? The need to know should be discussed. ACTION: Letterewe Estate, WRFT, SNH

A17. **Brown trout genetics** Studies have shown that some Scottish lochs have more than one sympatric trout population. *Ferox* trout in Loch Laggan and Loch Awe maintain a separate population by spawning in the loch outflow (Duguid, 2006). Are all the trout within the accessible part of the Little Gruinard system including the lochs part of a single population? Or, as suggested by old crofters tales, is there more than one type of trout? ACTION: WRFT, Letterewe Estate, RAFTS Genetics

A18. **Freshwater pearl mussels** Freshwater pearl mussels are potentially an important part of the Little Gruinard ecosystem in terms of instream biomass and their influence on water quality and instream production. Elsewhere in Europe FPM populations have been devastated and there is much concern for the survival of the species. A few old Freshwater pearl mussels have been found within the Little Gruinard River in recent years. The river was fished for pearl mussels within living memory. There are large areas of stable, potentially ideal habitat for freshwater pearl mussels. What is the current size distribution and size of the FPM population? Are FPMs still reproductively viable? Is the population self-sustaining? What actions can be taken to restore FMP populations? ACTION: WRFT, Letterewe Estate, SNH

A19. **Arctic charr** Little is known about charr populations within the Fionn Loch and Beannach Loch system. What role do they play in the Fionn Loch ecosystem? How fast and how big do they grow? Where and when do they spawn? Are they of any potential fisheries value? Are they of conservation importance? All these questions could be answered as part of a student project. ACTION: Letterewe Estate, Tournaig Estate, WRFT, University

A20. **Ecosystem fertility** The Fionn Loch Islands, isolated boulders and ledges inaccessible to grazing animals suggest that but for grazing by cattle, sheep and deer over many hundreds of year's, much more of the catchment area of the Little Gruinard river would have been wooded. Formerly there were more people living in and around the Fionn Loch. Many animals, both livestock and deer carcasses have been exported from the system over the years. To what extent have levels of catchment fertility changed within the catchment area? Is the river currently 'starving' compared to the past? ACTION: WRFT, Letterewe Estate, University

A21. **Biosecurity** The Eurasian Minnow was first recorded in the catchment in 2010. Nothing can be done to prevent its spread throughout the system. What measures should be taken to minimize the risk of other non-native fish species being introduced into the system? Should actions be taken to prevent *Rhododendron ponticum* from establishing a stronger base in the woodlands near Inverianvie from where seeds could spread to the Little Gruinard? The Wester Ross and Lochalsh Biosecurity Plan can be found at <http://www.wrft.org.uk/downloads/files.cfm?id=22> .

ACTION: WRFT, Letterewe Estate, WRFT, SNH.

Table 8.1 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 substantial 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 perceived to be a major threat to salmon population, agree a plan to control problem species.	Letterewe Estate	WRFT, WRASFB, IFM, SNH, Marine Scotland (stomach analyses)	Ongoing	Medium unless bird numbers high in spring.

LITTLE GRUINARD FISHERIES MANAGEMENT PLAN 2011+

Table 8.1 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,	Ongoing	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	Ongoing	High

Table 8.1 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 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

References

Bacon, P.J. and A.F. Youngson (2007) The application of electro-fishing to produce census estimates of juvenile salmonid populations within defined areas: taking stock of the options. Scottish Fisheries Research Report, No 67. Scottish Government

Butler, J. (2001) The Gruinard River Fisheries Management Plan, WRFT

Cunningham, P.D. (2009) WRFT Fisheries Management Plan 2009+ WRFT. On line at <http://www.wrft.org.uk/downloads/files.cfm?id=17>

Cunningham, P.D. (2010) Wester Ross and Lochalsh Biosecurity Plan. WRFT. On line at <http://www.wrft.org.uk/downloads/files.cfm?id=22>

Duguid, R. A, A. Ferguson and P. Prodöhl (2006) Reproductive isolation and genetic differentiation of *ferox* trout from sympatric brown trout in Loch Awe and Loch Laggan, Scotland [Journal of Fish Biology Volume 69 Issue sa](#), Pages 89 – 114

Fergusson, A., I.A. Flemming, K. Hindar, Ø. Skaala, P. McGinnity, T. Cross and P. Prodöhl (2007) Farm escapes. In Verspoor, E., L. Stradmeyer and J.L. Nielsen [eds.] *The Atlantic Salmon: Genetics, Conservation and Management*. Blackwell Publishing, 2007.

Graham-Stewart, A. (2005) *The Salmon Rivers of the North Highlands and the Outer Hebrides*. Robert Hale Ltd, London.

Holst, J.C., P. Jakobsen, F. Nilsen, M. Holm, L. Asplin, and J. Aure (2003) Mortality of Seaward migrating Post-smolts of Atlantic Salmon Due to Salmon Lice Infection in Norwegian Salmon Stocks. In Mills, D. [ed.] *Salmon at the Edge*. Blackwell Publishing, 2003

Jackson, D.B. (2005) Environmental correlates of lake occupancy and chick survival of Black-throated Divers *Gavia arctica* in Scotland, *Bird Study* 52, 225-236.

Kindness, Robert (2007) Catch and Release on the River Carron. In WRFT Review, May 2007 http://www.wrft.org.uk/files/WRFT_Review_May_2007.pdf

MacKenzie, Osgood (1921) *One Hundred Years in the Highland*. This book describes the area including the Fionn Loch, its people, wildlife and fisheries. Reprinted in 1995; available from local bookshops.

MacLaren, M and Currie, B. (1972) *The Fishing waters of Scotland*. John Murray.

Mc Vean, D. N. & Lockie, J. D. (1969) *Ecology and Land Use in Upland Scotland*. Edinburgh University Press.

[Mónica V., Garduño-Paz](#) and [Colin E. Adams](#) (2010) Discrete prey availability promotes foraging segregation and early divergence in Arctic charr, *Salvelinus alpinus* *Hydrobiologia*, Volume 650, Number 1 / August, 2010

Peach, B.N., Horne, J., Gunn, W., Clough, C.T., Hinxman, L.T. (1913) The Geology of the Fannich Mountains and the country around Upper Loch Maree and Strath Broom. Memoirs of the Geological Survey , Scotland.

Sawyer, R.W. (1944) Nature of the acid in soft water in relation to the growth of brown trout. *Nature* 153, 55-56 (8 January 1944 doi:10.1038/153055b0 Letter)

Sigourney, D.B., G.E. Horton, T.L. Dubreuil, A.M. Varaday & B. H. Letcher (2005) Electroshocking and PIT Tagging of Juvenile Atlantic salmon: Are There Interactive Effects on Growth and Survival. *North American Journal of Fisheries Management* 2005; 25: 1016-1021

Walker, A. and Walker, A. (1991) The Little Grunard salmon Catch and Release Experiment . Fisheries Research Services Report No 2/91

Walker, A. (1990-1996) Unpublished letters and reports to Paul van Vlissingen, with results of fish surveys.

Youngson, A. F., I.A. Malcolm, J.L. Thorley, P.J. Bacon and C. Soulsby (2005) Long-residence groundwater effects on incubating salmonid eggs: low hyporheic oxygen impairs embryo development and causes mortality. *Canadian Journal of Fisheries and Aquatic Sciences*, 61, 2278-2287.

Ziuganov V., Zotin A., Nezlin L., & Tretiakov V. (1994) "The fresh water pearl mussels and their relationships with salmonid fish." VNIRO Publishing House, Moscow

Acknowledgements

Thank you to Graeme Wilson, Barbara MacDonald and Derek Darville of Letterewe Estate; Hamish Lawrie, Ala MacKenzie, Alan Jackson, Colin Gunn, Prof Peter Maguire for help with access and information, data compilation or photographs. Electro-fishing surveys were carried out with help from Dr Lorna Brown, Norman Thomas, David and Jenny Mullaney, Ala and Dee MacKenzie, Roger McLachlan, Garry Bulmer and Ken Williamson with support from Letterewe Estate and keepers Mark Melville and Graeme Wilson. The 2004 electro-fishing survey was carried out under contract from SNH, and data was analysed by Dr Jason Godfrey and Hilary Anderson of SFCC at the FRS (now Marine Scotland Science) Freshwater Laboratory near Pitlochry. Dr James Butler and Dr Andy Walker surveyed the river in earlier years and provided information. The Little Gruinard habitat Survey was carried out by Karen Starr assisted by Matthew Dawson.

Thank you to Mary Gibson of SNH, Graeme Wilson, Hamish Lawrie, Dr Andy Walker, Prof Peter Maguire and an anonymous reviewer(s) for comments on earlier drafts of this report. Please contact WRFT at info@wrft.org.uk if you would like to comment further.