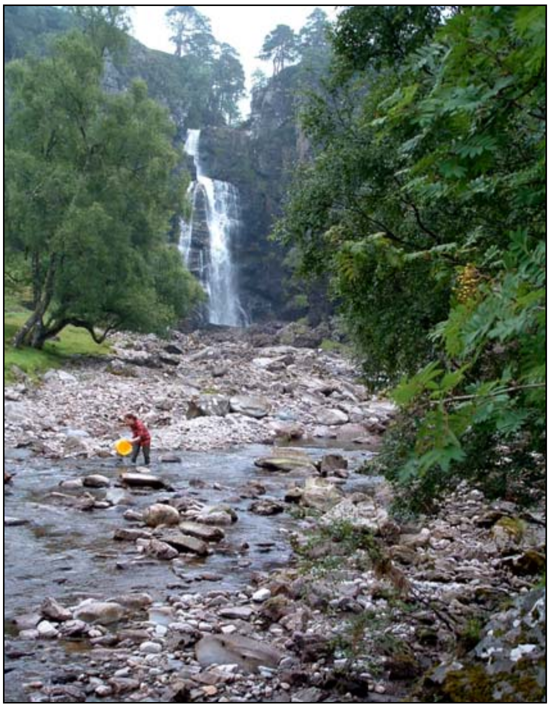
WESTER ROSS FISHERIES TRUST

ULLAPOOL RIVER

FISHERIES MANAGEMENT PLAN 2006-2010



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WESTER ROSS FISHERIES TRUST

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ULLAPOOL RIVER FISHERY MANAGEMENT PLAN 2006–2010

by
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Ullapool River

Fisheries Management Plan 2006–2010

Contents

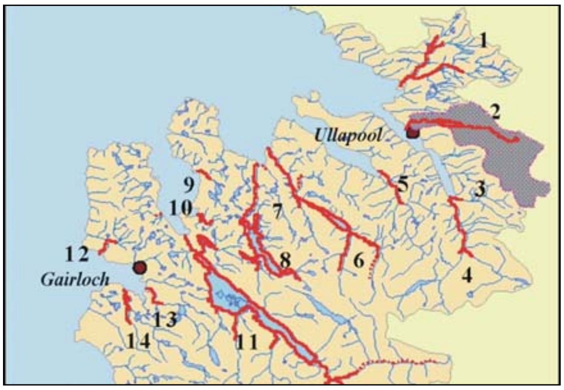
1. Introduction: The Ullapool River Fisheries Management Plan 2006–2010 presents work carried out by WRFT in 1997–2006 to assess salmon and trout stocks and identify factors determining their characteristics abundance, and suggests actions to restore and develop the natural potential of the river system for wild fishes. Recommendations are primarily aimed at protecting the salmon population and maximising the freshwater production of juvenile salmon, since this is largely within the control of riparian owners.

2. Ullapool River catchment: The Ullapool River has a catchment area of 168km^2 and drains glaciated, hilly terrain, with peaks of up to 928m (Seana Bhraigh). The River Douchary gathers headwaters streams and plunges over a series of waterfalls, to become the Rhidorroch River, which flows for a further 8km to Loch Achall. From Loch Achall (125 ha area), the Ullapool River flows through glacial moraines before dropping through a rocky gorge. From the Ness Falls (Eas Dubh), located 1 km below the loch, the river flows swiftly through a wooded valley for a further 3km to the tidal limit.

Most of Ullapool catchment area lies to the east of the Moine Thrust Zone. The rocks underlying the catchment comprise a complex assortment of hard, generally base poor metamorphic rocks, predominately granulite, schists and gneisses of the Moine Series.

Heather moor is the dominant vegetation, with mosaics of upland grasslands, meadows and bare rock above about 500m. The catchment is noted for extensive areas of native woodlands, dominated by Scots Pine. In March 2005 the Rhidorroch Woods were designated as a Special Area of Conservation (SAC) for Caledonian forest and Northern Atlantic wet heaths with *Erica tetralix* (Cross-leaved heath). There are also areas of alder woodland on the floodplain between East Rhidorroch and Loch Achall.

Location of the Ullapool River (no. 2) catchment area with other nearby salmon river systems.



3. Important species and habitats: At least 14 habitats and species listed under the EU Habitats Directive occur within the Ullapool catchment, including the Atlantic salmon (*Salmo salar*). Five of these, Freshwater pearl mussel, Otter, Red-throated diver, Black-throated diver and alder woodland, would also benefit directly from action to conserve the catchment's fish stocks and riverine habitats.

4. Salmon fishery: The Ullapool River is remarkable for having supported a fishery for 'spring' salmon for over 100 years. This unusual population may have evolved in response to the Ness Falls situated downstream from the main spawning areas. During the first half of the 20th Century rod catches of salmon from the Ullapool River comprised almost entirely of 2SW spring salmon taken before the end of June. From the mid 1950s, catches of summer salmon and grilse increased. By the 1960s catches of 'summer fish' exceeded those of 'spring fish'. This change may be associated with stocking non-native salmon into the river from 1947. Catches fell to their lowest levels during the 1990s, but subsequently recovered. The Ullapool River retains a 'spring run'. Of 44 salmon caught in 2005, 8 were caught during spring months.

5. Trout fishery: Loch Achall supports a wild brown trout population which consistently yielded 500 -1000 trout, of average weight 5 to 6 oz (145-175g), per year to anglers. There is no evidence that the average weight of trout in Loch Achall changed as a result of the stocking of trout fry, freshwater shrimp, or in response to heavy fishing pressure. Small numbers of sea trout were taken below the Ness Falls, but seldom were sea trout caught in Loch Achall above the Falls.

6. Production of juvenile salmon and trout: Electro-fishing surveys were carried out in 1997, 1999, 2002, 2004 and 2005 to investigate the occurrence of juvenile trout and salmon within the Ullapool River system. Juvenile salmon and trout were recorded throughout the accessible area. However, their occurrence and overall densities varied between years. Salmon parr densities were consistently low at sites fished in the lower part of the Rhidorroch River. The possibility that larger salmon parr in the Rhidorroch River inhabited pools and deeper glides was investigated by snorkel survey in 2004 and 2005. Although visibility was good, few parr were observed and they were outnumbered by trout. Further investigations are required to assess the extent to which juvenile salmon utilise Loch Achall.

7. Freshwater habitat: In total, the accessible area for salmon comprises about 1,250,000m^2 of loch habitat (87% of total) and 192,157m^2 of riverine habitat (13%). Of the riverine habitat, 60% is within the Rhidorroch River, 35% in the Ullapool River below the loch, and only 5% in other minor tributaries flowing into Loch Achall or the Rhidorroch River. The most important minor tributaries in terms of accessible area are the Allt Coire Cronaidh, the Allt Dail a' Bhraid and the Allt Beallach na h-Imrich. Access for salmon above the Ness Falls (Eas Dubh) is dependent upon spate flows and probably also water temperature. Above Loch Achall, there are no major obstructions within the accessible section of the Rhidorroch River below the impassable falls at the top.

The Rhidorroch River provides the largest area of salmon spawning habitat but is unstable throughout its length with highly mobile substrate, braided channels (below East Rhidorroch), erosion and bank collapse, associated with frequent scouring events due to 'bed-load transportation' of sediment from Glen Douchary and remobilisation of alluvial sediment. Habitat for juvenile salmon is less than ideal: habitat instability is likely to be a major factor limiting both recruitment of fry and the growth and survival of salmon parr.

8. Fisheries Management Recommendations

- *Protect wild salmon*

Over the next 5 years, a policy of catch and release of all salmon before the end of June will help to safeguard the unique 'spring salmon' of the Ullapool River. If snorkel surveys / direct observations indicate strong runs of late running salmon and grilse, then fresh run fish taken below the Ness Falls could be kept for the table later in the season.

- *Habitat restoration*

Production of juvenile salmon could be increased through stabilisation of riparian areas to reduce the sediment supply into the Rhidorroch River. A considered appraisal of the potential benefits (an increase in production of salmon and other wildlife associated with rivers) vs. disadvantages (short to medium-term reduction in deer production) of establishing riparian woodland enclosures in Glen Douchary would be helpful; this is out with the scope of this report.

- *Stocking*

Only during years when egg deposition is inadequate ***and*** severe spates 'wash-out' eggs of wild fish from redds within the Rhidorroch River is stocking recommended. The aim should be to supplement natural production to minimise interference and competition with the progeny of any wild fish that have spawned. Try to find out where wild fish spawn by walking spawning streams from late October through November. Do spring salmon spawn earlier in the Rhidorroch River than later running grilse?

- *Record keeping*

The Rhidorroch Estate Game books are a remarkable record. These have enabled much to be learned about the fisheries and their management over the past century. They demonstrate the value and importance of good record keeping. Where details of stocking, water levels, severe weather, wildlife sightings and other events are also recorded, much can be learned. We are able to know that the Ullapool River supports a special salmon population largely thanks to good record keeping.

9. Recommendations for further study

- *Investigate the utilisation of loch habitat by juvenile salmon*

Are juvenile salmon present within Loch Achall? If so which parts of the loch do they utilise? Loch Achall is large enough to contribute significantly to smolt production. Further research is required to learn about the occurrence of juvenile salmon in lochs.

- *Investigate levels of predation of juvenile salmon by trout*

Do brown trout in Loch Achall target smolts in the loch, perhaps as they leave the 'Loch Pool'? Samples of trout should be taken (rod and line) during March and April to investigate the extent to which numbers of smolts may be reduced by brown trout within Loch Achall.

- *Nutrient restoration*

Ecosystem fertility relates to vegetation and to grazing pressure and 'harvesting' of livestock and deer over many years. Is there a need to restore fertility in the Ullapool catchments?

1. Introduction

1.1 Preface

The wild fisheries of Wester Ross and surrounding seas are an invaluable renewable resource. Wild 'salmonids' (salmon, trout and charr) are amongst the most successful opportunists: able to colonise, recolonise and to proliferate as the environment changes. Rod fisheries can represent an important source of tourism revenue for the local economy, while both salmon and trout are often 'keystone' species in the ecology of freshwater habitats. In addition, the Atlantic salmon 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. Faced with a array of pressures from human activities that impact upon aquatic environments, the potential economic and ecological value of wild salmon populations can probably only be reached and sustained through well informed fisheries management.

The most important fishery in the Ullapool River system is the fishery for wild salmon. Unlike other river systems in Wester Ross, many of the salmon that have returned to the Ullapool River over the past 100 years have entered freshwater during the spring months (March to May) rather later in the year (June onwards). Although genetic studies have yet to establish how 'different' Ullapool salmon are from those of other Wester Ross rivers, this tendency to 'return early' to the river may be an adaptation that has evolved over many salmon generations to provide returning salmon with the best chance of surviving within the Ullapool River system.

Wild salmon returning to the Ullapool River have probably supported local fisheries for as long as people have inhabited the area. There are also brown trout in Loch Achall; a few sea trout are caught in the lower river each year, and a few eels can be found upstream at least as far as the Rhidorroch River. This Fisheries Management Plan focuses upon the remarkable wild salmon of the Ullapool River: how to safeguard the salmon population and the fishery that it supports for the future.

The end and the start of the journey.

1.2 Aims of the Fishery Management Plan

The Wester Ross Fisheries Trust (WRFT) is a charity formed by river owners, angling clubs and salmon farmers in 1996. Its aim is to 'conserve, restore and develop sustainable wild salmon, sea trout and brown trout fisheries in 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 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.

This report presents the conclusions of the WRFT's work on the Ullapool River 1997-2005. This work has included juvenile surveys, habitat surveys and an adult stock assessment from catch records. One of the core areas for salmon production in the Ullapool River is in the Rhidorroch River above Loch Achall. Much of the habitat in this part of the river is unstable, with river channel movement, bank erosion and bank collapse, and frequent transportation and redeposition of sediment (cobbles, pebbles).

In 2005, WRFT was awarded a further grant by SNH to focus investigations on this part of the river system, to try to identify any factors that might be contributing to river condition and to consider options for habitat improvement.

The estimated costs of this work are shown in Table 1.1.

Table 1.1 Estimated costs of work contributing to production of the Ullapool River Fishery Management Plan

Work	Cost
Juvenile surveys, 1997-2005	£4000
Habitat surveys,1998-2005	£3000
Redd Washout Project, 2000-2001	£400
Catch Record Analyses	£1000
Plan Preparation and Production	£5,000 (including in-kind contributions)
Total	*£13,400*

Based on these findings a Fishery Management Plan has been developed. The actions suggested are primarily aimed at securing or raising the natural production of juvenile salmon from the freshwater habitat. If successful other species listed by the Habitats and Species Directive will also benefit. Since the freshwater environment is largely controlled by the land owners concerned, the plan has been produced primarily for them. If required, the WRFT can assist with the implementation of the Plan and review its progress, developing new targets and recommendations if needed.

To obtain the best quality of information, much of the work contained in the Plan has been carried out with the guidance of the Scottish Executive agencies, including the Fisheries Research Services (FRS), Scottish Natural Heritage (SNH), and the Scottish Environment Protection Agency (SEPA). The WRFT also acknowledges financial assistance provided by CED-RACE for purchase new electro-fishing equipment and from Scottish Natural Heritage and the Highland Council's Landfill Tax Credit Scheme for habitat surveys and the production of this report.

1.3 Scottish Fisheries Coordination Centre

The WRFT is one of 15 similar fisheries research and management organisations established throughout Scotland. To ensure that highest quality of fisheries data collected, and the comparability of that data, a Scottish Fisheries Coordination Centre (SFCC) was set up in 1997. The SFCC has developed standard procedures for the surveying of juvenile salmon and trout and their freshwater habitat, and is developing a computer based Geographic Information System to map this and other fisheries information. Habitat surveys and electro-fishing surveys for this plan were carried out according to SFCC's protocols, and detailed field survey records are kept on file in the WRFT office.

Salmon parr, from electro-fishing site UPL6 at the top of the Ullapool River; late summer, 2004

Part 2: Salmon and trout ecology

2.1 Introduction

Fisheries are usually based on catches of *adult* salmon and trout. However, adult fish represent only one stage of each species' life cycle. The effective management of fisheries requires an understanding of the entire life cycle of the fish concerned. This section summarises the ecology of west coast salmon and trout, and the factors affecting their abundance.

2.2 Atlantic salmon ecology

2.2.1 Life cycle

The life cycle of the Atlantic salmon is now well understood, and is summarised in Figure 2.1. The key stages are as follows:

Redd and eggs: A 6 lb hen salmon will lay approximately 4,800 eggs in several nests or 'redds', usually in November. Salmon spawn in runs and glides with a gravel or cobble bed. Up to 95% of eggs can hatch successfully.

Alevins: Surviving eggs hatch into alevins in early spring and they remain in the redd until their yolk sacks have been absorbed.

Salmon eggs and alevins

Fry: Once the surviving alevins have begun feeding they are known as fry. These fish disperse from the spawning area and set up feeding territories. Salmon fry favour shallow, faster flowing areas of the river, and competition for space in a well-stocked river will be fierce, resulting in high mortality during their first summer.

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. Much of this food may fall into the water from bankside vegetation. Salmon parr will also inhabit lochs.

Smolts: Having reached approximately 12 cm in length the parr will begin to smolt, turning silver and migrating downstream to the sea during April and May. The further north the river, the shorter the growing season, and therefore the longer parr take to reach smolt size. In Wester Ross most juvenile salmon require three years to smolt, with a minority smolting after two or four years. Salmon smolts leave their estuaries quickly, with most heading into the open sea within two or three days.

Post-smolts and adults at sea: Smolts migrate northwards feeding near the surface on crustaceans and juvenile sandeels, capelin and herring. During this stage they are known as post-smolts. Little is known of the specific feeding grounds of west coast salmon, but most British salmon feed off the Faroe Islands. Salmon which mature in their first year at sea are known as grilse, and these probably migrate no further before turning back to the Scottish coast. Fish which mature in their second or third year (Multi Sea Winter 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 electromagnetic field to navigate. On reaching the coast 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

Spawning adults and precocious parr: As autumn approaches the 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 are simultaneously fertilised by the cock salmon, and often mature 'precocious' parr as well. The hen 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. A few survive to return and spawn a year later.

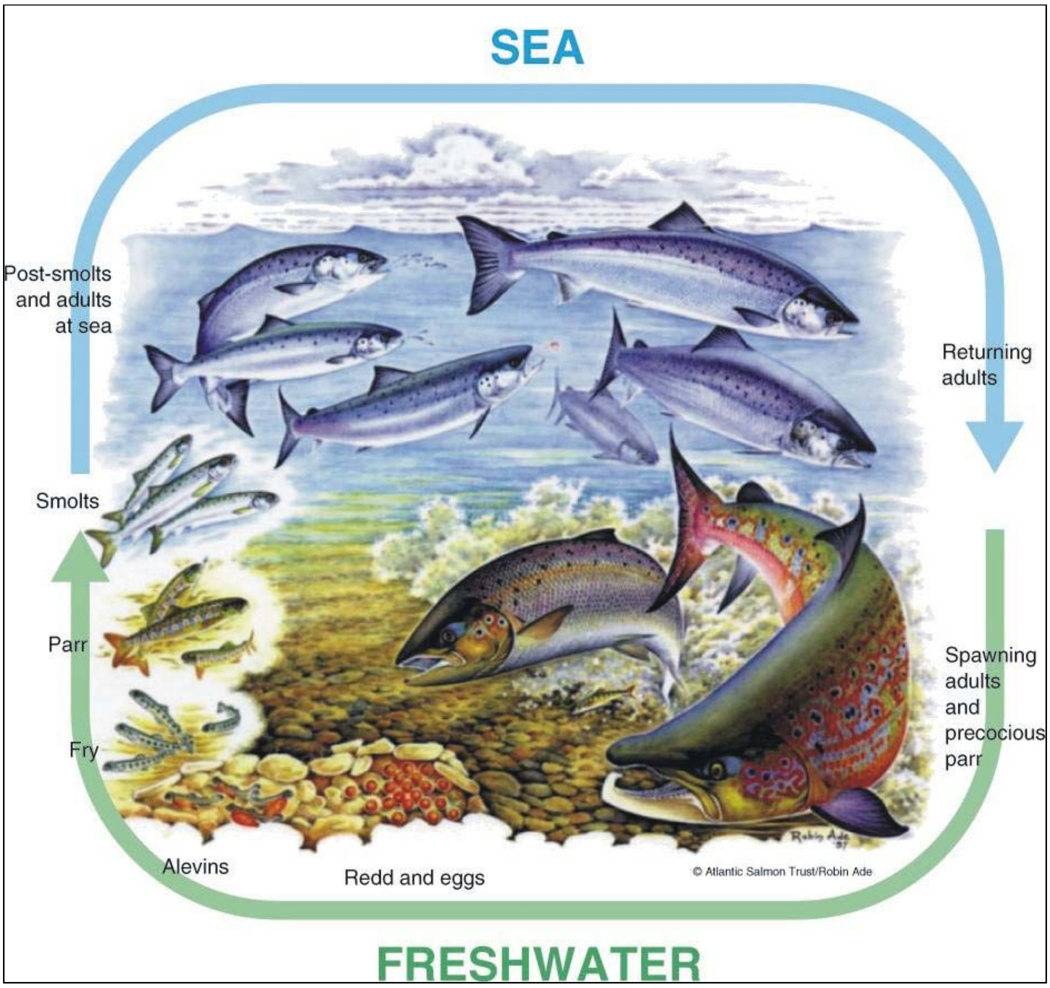


Figure 2.1 Life cycle of the Atlantic salmon

2.2.2 Freshwater problems

Factors limiting the abundance of salmon in the freshwater phase of their life cycle are:

Redd washout: During severe winter spates in which the river bed moves, redds can be washed away. Newly-hatched alevins are most vulnerable.

Food availability: This affected growth rates and survival of fry and parr. Weaker fish are excluded from the best feeding areas by stronger fish. Starving fish are less able to resist spate flows and may be 'washed' downstream and become more vulnerable to predation.

Acidification: Acidification caused by atmospheric pollution can kill salmon eggs and alevins, and if particularly severe will also kill fry. Parr are more resistant to acid events. Coniferous forestry can exacerbate acidity.

Pollution: Contamination of rivers by industrial and agricultural waste (e.g. sheep dip) can kill fish of all sizes.

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.

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 probably does not affect wild fish, although they can carry the virus. Of greater concern is the parasite *Gyrodactylus salaris* which has spread to many parts of Europe 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: Fry, parr and smolts are eaten by a wide range of piscivorous birds in freshwater. The most prevalent predators are mergansers, goosanders and cormorants. Feral mink can also be serious predators of juvenile salmon, but only rarely occur in Wester Ross. Humans and otters are the main predators of adult salmon in freshwater.

2.2.3 Marine problems

Feeding: In the 1960s and 1970s marine survival was as high as 30% for some east coast rivers. In recent years it has reduced to less than 5% in some years. 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. As a consequence, more smolts die, and the surviving post-smolts and adults grow to smaller sizes than in the past. Furthermore, because Multi Sea Winter salmon remain longer in the sea, they are even less likely to survive than grilse and have become more scarce than grilse.

Commercial netting: High seas netting has been vastly reduced in recent years owing to buy-outs by the North Atlantic Salmon Fund (NASF), and quota management by the North Atlantic Salmon Conservation Organisation (NASCO). Drift nets off the west coast of Ireland and Northumberland are of concern to Scottish east coast rivers, but do not directly affect west coast salmon. The greatest netting threats to Scottish west coast salmon were coastal bag and sweep nets, but with the recent local declines in stocks coastal netting stations have become unviable and none are likely to be operated in 2004.

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. However, the extent of seal predation has never been quantified. St Andrew's University Gatty Marine Laboratory are developing seal scaring devises which may be of use in estuarine situations for protecting wild salmon and sea trout.

Sea lice infestations: Sea lice epizootics are believed to be primarily a problem for wild sea trout which tend to remain in coastal areas. However, recent studies of salmon post-smolts in Norway have shown that fish leaving fjords with salmon farms have been infected with lethal levels of sea lice, most likely produced by salmon farms in the area.

Escaped farm salmon: This problem may occur in either fresh or saltwater, since juvenile salmon are produced in hatcheries and cages in freshwater, and in cages at sea. Escaped salmon will breed with wild salmon, and if this occurs consistently over a number of years, Canadian and Irish research has shown that the wild stock will suffer a cumulative loss of genetic fitness. The level of genetic dilution will be minimal if the wild population is healthy, but the effect is disastrous if the wild stock is depleted. A hybrid population will be more vulnerable to marine mortality and any sudden changes in the freshwater environment, leading to possible extinction.

Scottish Executive rod catch records for the north-west statistical region indicate that since 1952 catches have varied widely between years, but have generally increased gradually. However, in the mid-1990s stocks fell suddenly to record low levels. It is likely that this regional problem has been caused by the combined effects of many of the factors listed above.

2.3 Sea trout and brown trout ecology

2.3.1 Life cycle

The ecology of sea trout and brown trout is less well understood than that of the salmon. The brown trout is very adaptable, and can take many forms. Of principle interest to west coast fisheries is the sea trout, and its relationship with brown trout.

As for salmon, the juvenile stages of the trout's life cycle are confined to freshwater. 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.

On reaching smolt size young trout can either become sea trout or remain in freshwater as brown trout. In general, most females become sea trout, and most males remain as brown trout (Figure 2.3). 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 their river in late summer, although it is not understood why, since the majority are immature. Other finnock 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. Female sea trout then pair with male brown trout in October and November and spawn. Sea trout kelts return to the sea, and may run 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.

Finnock and detached sea lice taken at Poolewe

Research on brown trout has shown that there may be several races of trout in a river or loch system, of which sea trout may be only one. 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 to become successful predators of other fish, and Arctic charr in particular.

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.

Acidification: Trout are less sensitive to acidity than salmon.

Nutrient enrichment: Sea trout are thought to have evolved as a result of lack of food, causing females to migrate downstream to the sea, and 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, the fish will lose the physical 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.

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:

Sea lice infestations: Catch statistics show that sea trout stocks in the North West have been declining slowly since 1952, but the decline accelerated during the late 1980s and early 1990s correlated with the rapid growth of the salmon farming industry. It is highly likely that sea lice emanating from salmon farms were the major cause of the collapse, as lethal levels of sea lice were found on sea trout post-smolts in salmon farming areas, but not in areas without salmon farming. Until 2003, WRFT lice monitoring also showed that in fallow years lice infestations on sea trout fell, and then increased in years when production restarted in the sea loch.

However, since 2003 with use of the new in-feed medicine SLICE, on-farm lice management has significantly improved, and there are signs from many sea lochs including Loch Broom of improved health and survival of sea trout.

Coastal feeding: The long-term decline of sea trout prior to salmon farming clearly suggests that another factor has 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 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 live in 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, out-competing the salmon. In the context of the Ullapool River, this is further considered in parts 4 and 6.

Part 3: The Ullapool River

3.1 Location, inshore fisheries, salmon netting and salmon aquaculture

3.1.1 Loch Broom

The Ullapool River enters the sea by Ullapool at the narrows of Loch Broom, initially a long narrow sea loch 15 km in length and 1-1.5 km wide, that opens out into the Minch, 3 km northwest of Ullapool.

3.1.2 Inshore Fisheries

Loch Broom is a spawning area for sprats and herring. Herring and sprats are important prey items for sea trout. In 1788, the town of Ullapool was developed by the British Fisheries Society to provide a base from which to exploit herring. By the middle of the 19th Century, the inshore fishery had virtually been abandoned. Although there were periods of recovery after then, the herring fishery was temporarily closed to allow stocks to recover in the late 1970s following a period of sustained over-fishing.

Stocks of haddock and cod have declined greatly within the area within living memory. The local spawning status of these and other white fishes requires ongoing investigation. Mackerel move into inshore waters to feed on sprats, sandeels and juvenile herring in summer. During the 1980s and early 1990s large quantities of mackerel were landed or processed on east European 'klondyker' factory ships anchored in Loch Broom.

In 2005, large trawlers and long-liners from France and Spain landed deep water species caught at the edge of the continental shelf at Ullapool.

Prawns (*Nephrops norvegicus*) are taken both by creel fishermen and by trawlers from inshore waters around Wester Ross. Lobsters have declined within the inner loch over many years. Brown crabs and lobsters are still taken by creel fishermen further out. Scallops are taken by dredgers and by SCUBA divers. Mussels, Horse mussels and winkles are collected by hand at low tide primarily for local consumption. Cockle beds at the head of Loch Broom were also formerly harvested.

- *During the 1970s, trawl surveys were carried out by the Scottish Marine Laboratory (now Fisheries Research Services, FRS) to investigate the local abundance of juvenile herring and sprats. Annual surveys of juvenile fishes are important to establish population trends in coastal areas.*

- *The potential for restoration of productive inshore fish and shellfish fisheries may be considerable. Effective integrated coastal zone management measures (possibly including Marine Conservation Zones) are needed to restore yields of many species within Loch Broom and surrounding inshore waters. The restoration of healthy coastal fisheries will also ensure an abundance of many of the varied prey items upon which salmon and sea trout feed.*

3.1.3 Nearby salmon rivers

Neighbouring rivers also support rod fisheries for salmon. The estuary of the Kanaird River is 5km to the north of the Ullapool River. The Ullapool River enters the sea 10 km from the estuary of the River Broom which enters the sea at the head of the inner loch. The Lael River joins the Broom in the inter-tidal area. The Lael may still support a few salmon - WRFT recorded one parr during electro-fishing surveys in 1999. To the west, the next river (as the ‘sea trout swims’) is the Dundonnell at the head of Little Loch Broom (35 km by sea); then two larger systems, the Gruinard and Little Gruinard (27 km and 28 km by sea respectively). The extent to which each of these rivers had/has retained a genetically distinctive salmon population(s) is currently being investigated.

Rod catches of salmon and sea trout in all five rivers fell during the late 1980s and/or early 1990s but recovered in 2004 and 2005. Salmon populations in the Gruinard and Little Gruinard Rivers remain relatively healthy. WRFT Fishery Management Plans for the rivers Kanaird, Dundonnell, Gruinard and Broom provide further details.

- *The genetic variability of wild salmon and trout populations in the west of Scotland is currently being investigated by FRS. These studies aim to identify integral 'populations' and their origins. The occurrence of non-native genes (e.g. from stocked fish or escaped farm salmon) within wild populations may also be recorded.*

3.1.4 Salmon netting around Ullapool

Sweep nets were operated at the mouth of the Ullapool River until the 1970s. Early in the 19th century there was also a net and cobble fishery nearby (Graham-Stewart, 2005). Bag nets on the Coigach coast (<20km to northwest) were operated up until the late 1980s by which time catches were too small for netting to be economically viable *(ibid).* There are netting rights for salmon in upper Loch Broom at Leckmelm (Leckmelm Estate), Lochbroom Glebe (Church of Scotland General Trustees) and Inverlael (Inverlael Estate) which may have also taken fish destined for the Ullapool river. Net and cobble fisheries have not been operated in the area since 1987.

Illegal netting remains a potentially serious threat to the recovery of salmon and sea trout fisheries in the west of Scotland. With the recent revival of salmon populations around Wester Ross, interest in netting (legal and illegal) is likely to regenerate.

- *Local support for salmon conservation and restoration programmes may depend upon whether or not local communities are able to share the economic benefits of healthy salmonid fisheries.*

3.1.5 Intensive aquaculture

The closest active marine salmon-farming site is situated within Loch Broom south of Corry Point, approximately 4 km from the river mouth. The site is owned by Wester Ross Salmon Ltd., and has operated since the early 1980s. The biomass consent for this site is currently set at 1050 tonnes. The site is currently operated as a single year class site. Wester Ross Salmon also have sites in Loch Kanaird, 6 km from the river mouth.

Other 'active' salmon farms within the Loch Broom - Little Loch Broom area are Scottish Sea Farms by the Summer Isles and Ardessie Salmon Ltd. in Little Loch Broom. Marine Harvest Scotland has a 1400 tonne biomass salmon farm at the mouth of Little Loch Broom near Stattic Point. Plans to develop a 1900 tonne biomass salmon farm (subsequently cod and haddock) at Annat Bay were rejected by the local council. However, at the time of writing the outcome of an appeal is awaited.

- *In line with the Tripartite Working Group concordat chaired by the Scottish Executive (2000), discussions have taken place between river owners, fish farms and WRFT to set up an Area Management Agreement (AMA) within an area encompassing the 'Two Brooms' (Loch Broom and Little Loch Broom). The proposed AMA has the overall aim of improving the health of both farmed and wild fish stocks.*

- *In 2004 and 2005, local anglers were trained by WRFT to assist with the monitoring of sea lice on wild sea trout entering the tidal pools of the Ullapool River. There were no reports of fish with heavy lice infestations.*

3.1.6 Estuary

The Ullapool River flows for only about 1km from the upper tidal limit to its lower tidal limit point of entry into the sea. Common fish-eating birds include gulls, divers, Cormorant, Shag, Red-breasted Merganser and Heron. Common and Grey seals inhabit inshore waters and otters live around the coasts and along the rivers. Although salmon and sea trout can form part of the diet of these animals in local situations, other predators and pests of salmon are also taken (e.g. eels, sea lampreys, pollack, etc.).

Levels of predation may increase and be a problem when stocks are already depleted for other reasons, or where the health of salmon and sea trout smolts is compromised (e.g. sea lice infestations).

- *Long-term monitoring of predator occurrence (vs. time) at the mouth of the Ullapool River may help to establish any changes that may impact upon levels of predation of juvenile and adult salmon and trout.*

Sweep netting catch in Loch Broom c 1960s. (Ullapool Museum)

3.2 Characteristics of the Ullapool River Catchment

3.2.1 The catchment

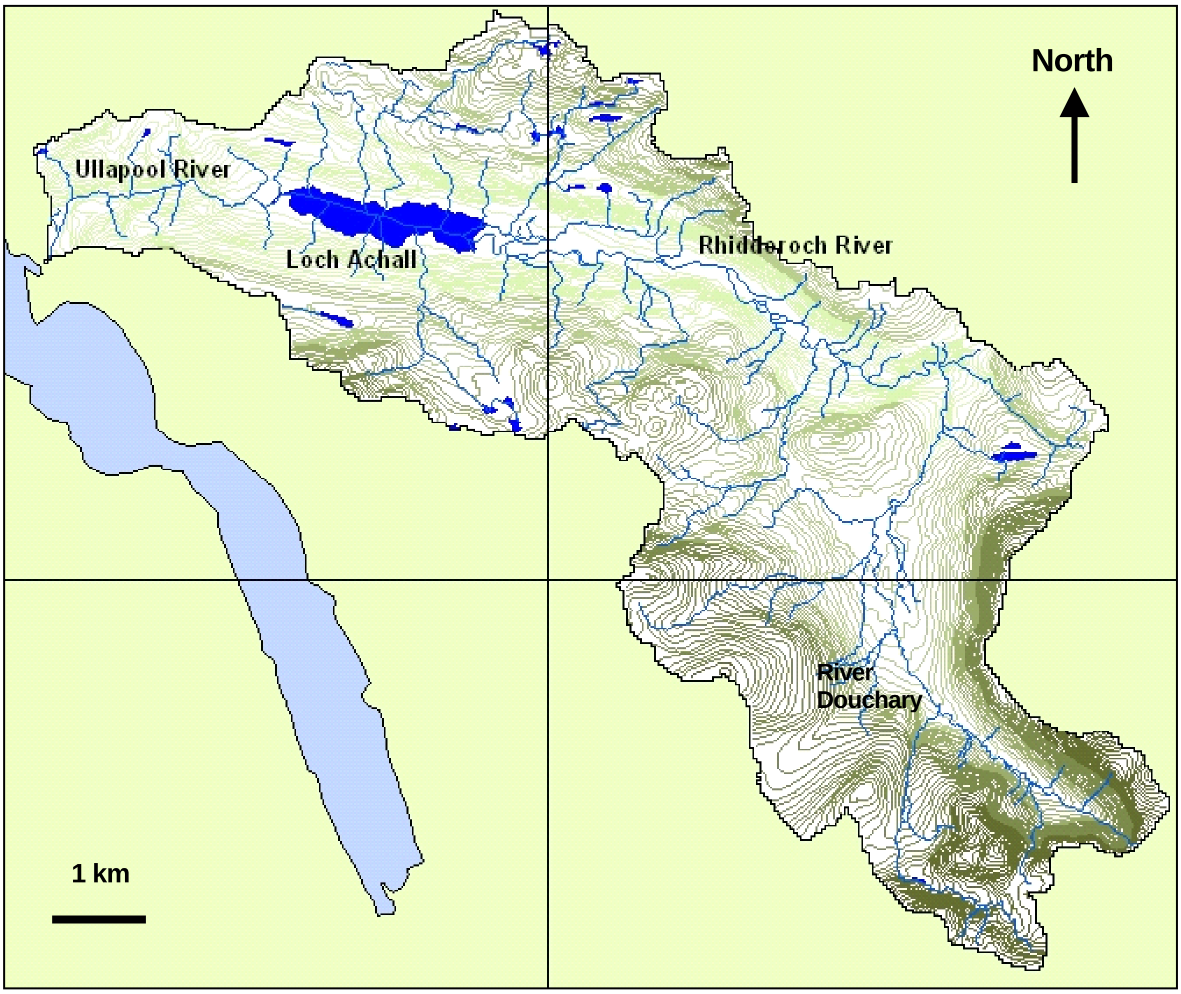


Figure 3.1: Catchment area of the Ullapool River

The Ullapool River has a catchment area of 168km^2 (Figure 3.1) and drains hilly terrain, with peaks of up to 928m (Seana Bhraigh).

The River Douchary gathers headwaters and flows northwest then north from headwater streams towards the head of Glen Achall. After plunging over a series of waterfalls, the river becomes the Rhidorroch River and flows west - northwest through a deep, shady wooded gorge. The Rhidorroch River is about 8km long and is accessible to salmon. Initially, a fast flowing stream with bouldery bed, the river becomes wider and loses energy as the gradient becomes more level. Below East Rhidorroch the river channel becomes braided as sediment transported from higher parts of the catchment settles out. Below Cadubh the river develops a series of 'active' meanders and flows through alder woodland before entering Loch Achall.

Loch Achall is a little over 3 km long, about 125ha in area (depending upon water level) and relatively shallow (mostly less than 10m deep, maximum depth ~22m).

From Loch Achall, the Ullapool River flows through glacial moraines before dropping through a rocky gorge. From the Ness Falls (Eas Dubh), located 1 km below the loch, the river flows swiftly through a wooded valley for a further 3km to the tidal limit. Details of fish habitat are presented in Part 5.

3.2.2 Geology

Most of Ullapool catchment area lies to the east of the Moine thrust zone. The rocks underlying the catchment comprise a complex assortment of hard, generally base poor metamorphic rocks, predominately granulite, schists and gneisses of the Moine Series.

The landscape reflects a glacial origin. Within the catchment are fine examples of glacial features including the U-shaped valley of Glen Achall, steep crags and moraines. Soils are generally nutrient poor. Thick peat deposits extend over large parts of the upper catchment area (especially over ground between 250–550m altitude). The fluvio-glacial alluvium of the Glen Achall floodplain provides the only relatively fertile agricultural land within the catchment area.

Frequent movements of rocks and cobbles in stream channels particularly within Glen Douchary and Glen Achall cause stream-bank and stream-bed destabilisation. This has consequences for the stability of spawning and nursery habitat for salmon and in some years may cause damage to salmon redds and emerging fry (see Part 5).

3.2.3 Climate and rainfall

Wester Ross has a moist maritime climate. Weather patterns are dominated by a westerly, Atlantic air-stream. Meteorological records from Kinlochewe (SNH Beinn Eighe Field Station) show 1973–2000 averages of monthly maximum and minimum temperatures of 12.2^{o}C and 4.9^{o}C respectively and average annual rainfall of 2278mm.

View to south east over Glen Douchary from shoulder of Meall na Moch-eirigh. This part of the Ullapool River catchment area is grazed by red deer is inaccessible to salmon.

3.2.4 Vegetation and hydrology .

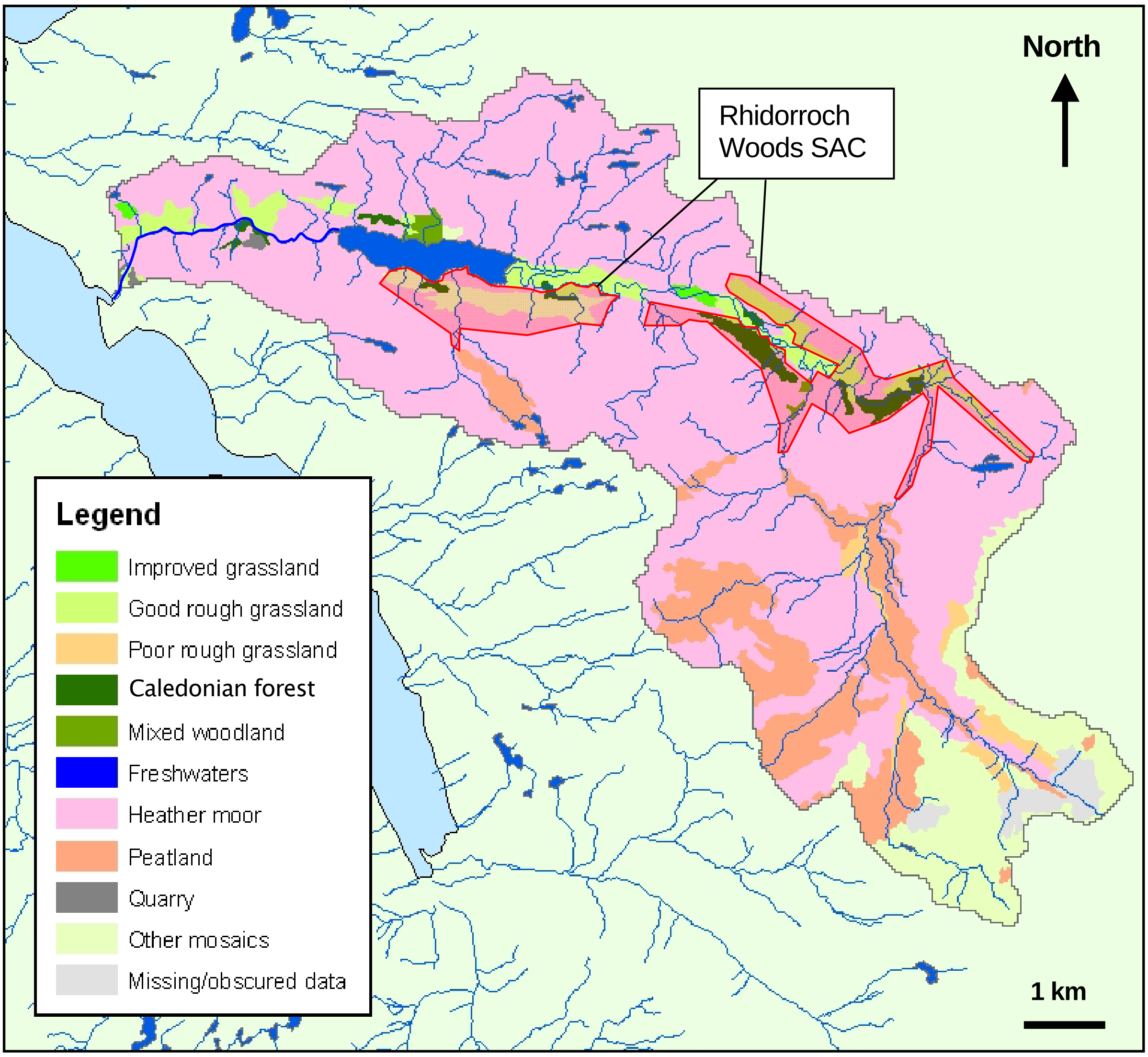


Figure 3.2: Vegetation map of the Ullapool River catchment area, also showing the Rhidorroch Woods Special Area of Conservation. Data supplied under licence from the Centre of Ecology and Hydrology

The predominant vegetation type within the catchment area is heather moor (mainly 250m - 500m altitude), followed by 'peatland', and 'other mosaics': mainly of grasses, sedges, mosses and lichens on ground above 500m.

The catchment is noted for extensive areas of native woodlands, dominated by Scots Pine. In March 2005 the Rhidorroch Woods were designated as a Special Area of Conservation (SAC) for Caledonian forest and Northern Atlantic wet heaths with *Erica tetralix* (Cross-leaved heath). There are also areas of alder woodland on the floodplain between east Rhidorroch and Loch Achall. Alder trees live in symbiosis with nitrogen fixing bacteria, *Frankia alni,* and thereby enhance the fertility of associated soils and water courses.

Rhododendron ponticum is spreading around Rhidorroch House. *Rhododendrons* can create dense shade and toxins (phenols) from their leaves and roots build up within the soil, preventing growth of other plants for 10 years or more following removal of the living plant. Efforts are underway to limit their spread.

3.2.6 Hydrology

The Ullapool River is a west-coast spate stream, which rises and falls rapidly in response to rainfall. To date there are no long-term hydrographic records for the river. Peak flows are usually recorded during the autumn and early winter, and lowest flows in the spring and summer. Flow patterns in the main river below Loch Achall are probably similar to those of the

River Broom. In the Broom example (Figure 3.3), there were spates in excess of 5 m^3/s in June and July, but none in May and August. Note that spates lasted for only a few days, with discharge returning to levels below $5m^3/sec$ within a few days (unless rainfall is sustained).

The river levels at which salmon enter the river is not known. However, their timing of entry is likely to relate to the timing of spate flows and vary from year to year accordingly. Perhaps more importantly for salmon in the Ullapool River, water levels and water temperature are likely to determine when, and if, salmon are able to ascend the Ness Falls to reach spawning areas above.

One of several falls on the River Douchary above the area accessible to salmon. Isolated trout populations living between falls may be of interest to geneticists.

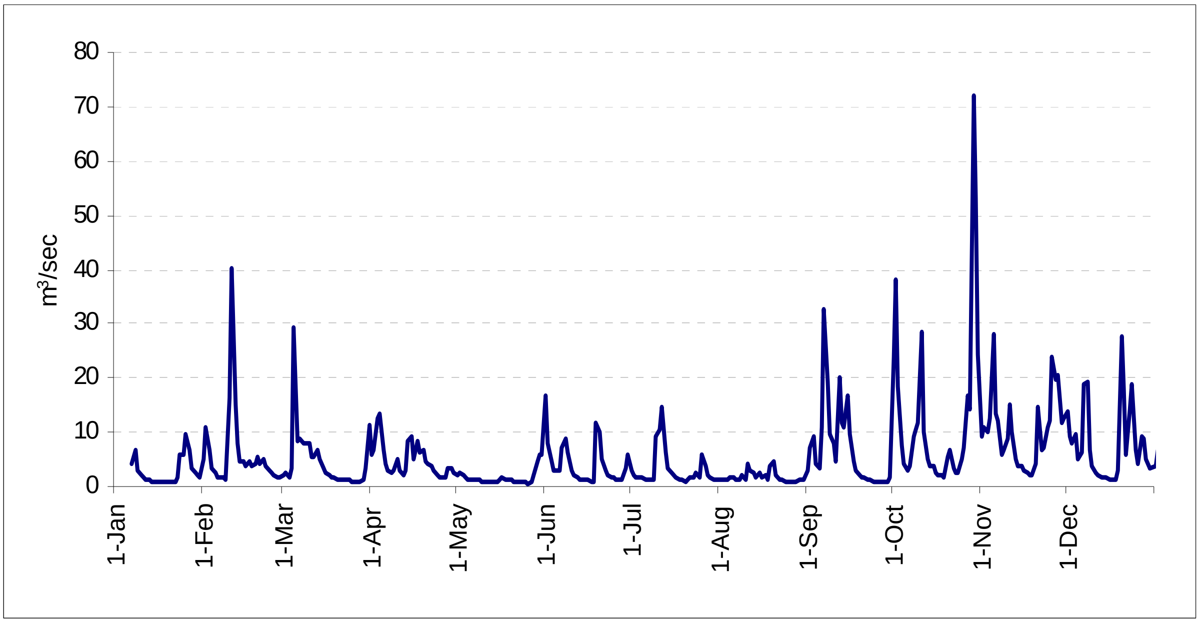


Figure 3.3 Discharge of the neighbouring River Broom, a similar sized west coast spate stream, at SEPA Croftown Gauging station by Inverbroom in 2001. Note how flows may change rapidly over few days, and how summer levels tend to be much lower than autumn and winter flows.

3.3 Water Quality

3.3.1 Freshwater Fish Directive

In 1976 the European Economic Community (now the European Union [EU]) introduced the Freshwater Fish Directive, which aimed to establish 'quality requirements for waters capable of supporting freshwater fish'. Rivers were divided into salmonid or cyprinid water, and water quality standards were set for each using certain criteria (e.g. pH, temperature, pollutants). In Scotland, The Scottish Environment Protection Agency (SEPA) are responsible for monitoring water quality and for assessing whether rivers and lochs are attaining the standards set, and if not, they must identify and rectify the pollution problem.

The Ullapool River was designated as a salmonid water under the Directive in 1977. A water sampling station is located in the lower part of the Ullapool River near Morefield. Water samples are taken at monthly intervals and analysed by the SEPA.

3.3.2 Scottish River Classification Scheme

In 1996 SEPA established a further water quality assessment, the Scottish River Classification Scheme. This takes into account invertebrate and water chemistry information to classify rivers from A to D, with rivers graded C and D requiring government action to improve water quality. The Ullapool was classified grade A, indicating that the catchment has no major pollution problems.

3.3.3 Nutrient status

The Ullapool River is oligotrohpic with low levels of dissolved nutrients throughout the year. Above East Rhidorroch, there is no human habitation and no upstream anthropogenic nutrient input. Nutrient availability is further discussed in Part 6.

3.3.4 Water Framework Directive (WFD)

In April 2006, the Controlled Activities Regulations (CAR) come into force. These are intended to give greater protection to river systems and coastal waters. SEPA has been given the task of monitoring and regulating activities which affect the ‘ecological health’ of rivers; arrangements and practicalities are currently being finalised.

From 2006 routine monitoring by the (SEPA) is likely to include distributions and densities of both aquatic plants and aquatic animals in river systems and coastal waters.

3.4 Important species and habitats in the Ullapool catchment

3.4.1 Habitats Directive species

In 1992 the European Union set out to satisfy the requirements of the Biodiversity Convention signed at the Rio Earth Summit by introducing the Habitats directive. The prime purpose of the Directive was to establish Special Areas of Conservation (SACs) and Special Protected Areas (SPAs) for rare and endangered habitats or species. SNH are charged with establishing SACs and SPAs in Scotland, but also to promote the sensitive management of all listed species and habitats outside these conservation areas.

At least 14 listed habitats and species occur within the Ullapool catchment, including the Atlantic salmon (Table 3.1). Five of these, Freshwater pearl mussel, alder woodland, otters, Red-throated divers and Black-throated divers would also benefit directly from action to conserve the catchment's fish stocks and riverine habitats. Conversely, salmon and trout populations will benefit from many of the actions to conserve other listed habitats and species, especially those that help to maintain the natural fertility and productivity of the catchment area.

Annex 1	**Annex 2**
Caledonian forest	Atlantic salmon
Blanket bogs	Freshwater pearl mussel
Northern Atlantic wet heaths with *Erica tetralix*	Otter
Alder woodland on floodplain	Red-throated diver
	Black-throated diver
	Golden Eagle
	Merlin
	Peregrine
	Dotterel
	Golden Plover

Table 3.1: Species listed under the EU habitats Directive which occur within the Ullapool River Catchment area

3.4.2 Local Biodiversity Action Plan

The Wester Ross Local Biodiversity Action Plan (WR LBAP) was published in March 2004. The plan aimed to raise local awareness and interest in biodiversity and to promote the sustainable management of biodiversity in Wester Ross. The plan was put together by a working group of local people representing a wide range of interests and organisations.

The plan listed a number of habitats and species of national and local priority in addition to those of 'European' concern listed earlier. These include 'lochs and rivers', 'wet alder woodland'; Sand martin, Barn owl, Woodcock, Greenshank, Azure hawker, Brown trout and Water vole. The NW Highlands may be one of the last strongholds for water voles in the UK; elsewhere the spread of non-native mink has led to the loss of water voles from much of their former habitat.

3.4.3 Native fish species

During the course of juvenile surveys carried out by the WRFT four indigenous fish species were identified within the River Ullapool catchment. Atlantic salmon (*Salmo salar*), Brown Trout (*Salmo trutta*), European eel (*Anguilla anguilla*), and Flounder (*Platichthys flesus*).

Salmon and sea trout (sea-going populations of brown trout) occur within the Ullapool River and accessible sections of tributary streams (see Part 6). Resident populations of Brown trout exist throughout the catchment, including the hill lochs. Further details of salmon and trout populations are given in Part 4 and Part 5.

<u>European Eel (*Anguilla anguilla*)</u>

There is growing concern that eel numbers are declining in some parts of their range. In many respects, the life cycle of the eel is the opposite of that of the salmon. Eels spawn in the Sargasso Sea and *enter* freshwater aged 2 as elvers where they may grow for ten or twenty years before returning to the sea as mature adults. Although eels eat trout eggs, fry and parr, trout, large salmon parr and sea trout eat small eels!

European eels were recorded at sites as far upstream as the Rhidorroch River though were more common in the lower reaches below the Ness falls during surveys.

Elvers ascend rivers in the spring. The survey suggests that many of them remain within the lower part of the Ullapool River during their first spring - summer.

<u>Brown trout (*Salmo trutta*)</u>

Loch Achall is the largest loch within the Ullapool River catchment and supports a large population of brown trout (see Part 5).

<u>(Arctic charr, *Salvelinus alpinus*)</u>

Scottish populations of land-locked charr originate from sea going charr populations at the end of the last period of glaciation. Although charr are present within many of the lochs to the north and south of the Ullapool River catchment, they have not been reported from any of the apparently suitable lochs in the Ullapool River catchment.

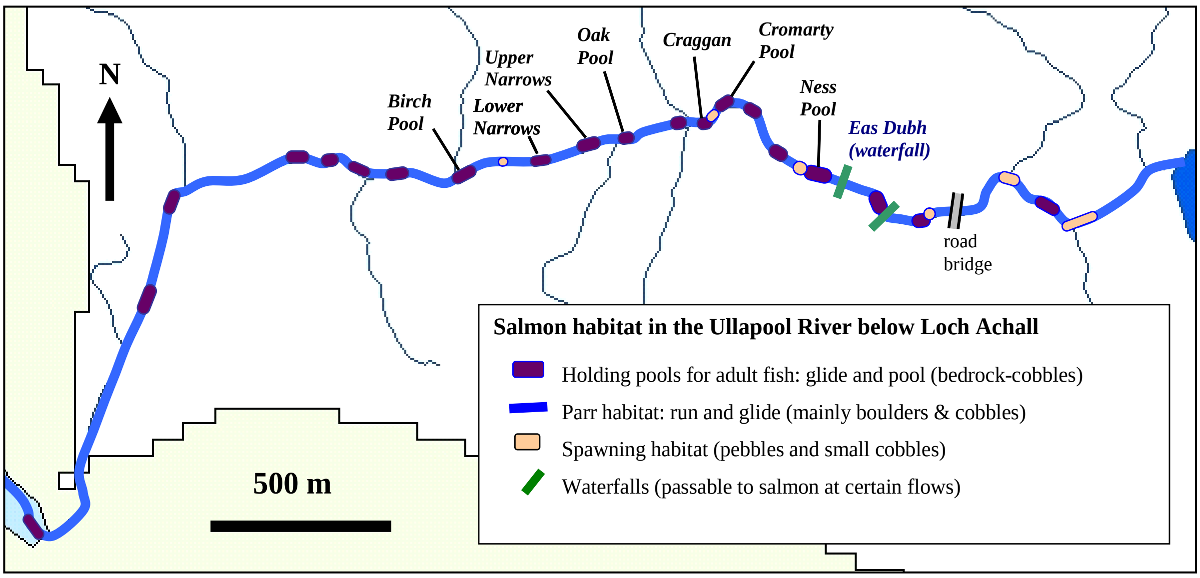


Figure 3.4: The Ullapool River, showing locations of holding pools and water falls.

3.4.4 Other species

Water & / or fish-eating Birds

Dippers are resident along the Ullapool River, and Herons are frequently seen. Common sandpiper, Grey wagtails, and sometimes Osprey are summer visitors; Black-throated diver and red-throated diver visit lochs within the catchment area; White-tailed eagle are occasional visitors. Numbers of Snipe and Woodcock increase in the autumn.

These birds feed on invertebrates; aquatic insects are likely to be a major item in their diet.

- *Records of birds such as Dipper within the Ullapool River catchment(including the Rhidorroc River) at different times of year provide an indication of aquatic insect abundance*

Aquatic invertebrates

Aquatic invertebrates are a major part of the diet of juvenile salmonids. Growth rates and production of juvenile salmon relates to the abundance of larvae of mayflies, stoneflies, caddis flies and other insects.

Most of the stream systems within Wester Ross are naturally oligotrophic (nutrient deficient). Production of plants and animal, including insect larvae, tends to be limited by the availability of phosphorus (see Part 6)

- *From 2006, WRFT will gather and collate information about the occurrence of aquatic invertebrates within Wester Ross river catchments. This data may be presented within a second generation of 5-year Fisheries Management Plans for Wester Ross river systems.*

Black throated diver (Laurie Campbell)

Stonefly (2 tails) and Mayfly (3 tails) larvae

3.5 Human activities within the Ullapool River catchment area

3.5.1. Human population

The only permanently lived in house in the catchment area above the A835 road bridge is Rhidorroch House. There are holiday houses at Glastullich, Cadubh and East Rhidorroch

3.5.2 Land ownership

Land ownership within the catchment is divided between the following estates: Rhidorroch (East and West), Corriemulzie, Alladale, Foich and Leckmelm Hill Ground. All waters accessible to salmon (Ullapool River, Loch Achall, Rhidorroch River) are within Rhidorroch Estates; inaccessible headwater areas in Glen Douchary are divided between the four other estates.

3.5.3 Land use and management

The catchment area provides grazing for wild red deer and livestock (sheep and cattle).

<u>Sporting estates</u>

Red deer are found both on the open hill and on good ground in Glen Achall particularly in winter. Roe deer occur primarily along the riparian corridor and other wooded areas. Sika deer also occur within the catchment area. Deer stalking takes place between August and February inclusive. Red deer are given supplementary feed during winter months on some estates.

<u>Agriculture</u>

Sheep and cattle are grazed around Loch Achall and within Glen Achall where the best grazing (including improved enclosed areas) is located. Headwater areas are currently grazed by red deer; sheep were taken off many years ago.

<u>Muir-burn</u>

Small areas of heather moor are occasionally burnt under careful management - usually in early April with the aim of promoting new growth of vegetation for grazing animals. From the fisheries perspective, wind-blow insects from moorland areas can form a substantial part of the trout & juvenile salmon diet at certain times of year. Insect diversity and abundance relates to soil fertility and vegetation; frequent muir burn can contribute to long term net loss of nutrients and reduced production from land and adjacent waters.

<u>Protected areas</u>

Rhidorroch Woods SAC was formally designated in March 2005 to conserve areas of Caledonian forest, predominately of Scots pine (see Figure 3.2), including riparian woodlands at the head of Glen Achall.

<u>Forestry and Woodland Grant Schemes</u>

Native woodlands are managed for wildlife and amenity. Five Woodland Grant Scheme (WGS) enclosures were established to foster regeneration of mixed woodlands on the south side of Loch Achall and Glen Achall. Young trees were establishing well and there had been reports of Blackcock seen within the catchment area in 2004 having been absent for many years previously.

Mixed woodland at the head of the Rhidorroch River, part of the Rhidorroch Woods SAC.

3.6 Fishing rights and access

Fishing rights on the Ullapool River, Loch Achall and hill lochs to the north belong to Rhidorroch Estate. Fishing is made available to the public through holiday lets and through day tickets available from Lochbroom Hardware Shop in Ullapool.

In recent years, Ullapool Angling Club, WRFT and Rhidorroch Estate have together organised young angler's trout fishing competitions at Loch Achall. These have been greatly enjoyed by all (apart from a few midges) and have led to the capture of some fine trout!

Brown trout from Loch Achall taken during Ullapool Angling Club's annual children's fishing competition.

Part 4: Salmon (and trout) Fisheries

4.1 Introduction

The Ullapool River is remarkable for having supported a fishery for ‘spring’ salmon for over 100 years. ‘Spring salmon’, or ‘springers’ as anglers often refer to them, are fish which enter freshwater during the winter or spring months, usually five or more months before they spawn. In Scotland, springers are normally associated with the much larger east coast river systems. The Ullapool River is one of few systems in the west of Scotland where the majority of the rod catch was taken before the end of May.

Anglers have high regard for springers for good reasons. Springers enter freshwater at an early stage of maturity when they are in their prime. Salmon tend to ‘home’ back to their natal areas to spawn. Radio-tracking studies of spring salmon in the Dee, N. Esk, Tay and Spey have shown that they tend to home to spawning streams furthest from the sea, at altitudes of 200m, 300m or even 400+m. The Ullapool River system is accessible to adult salmon up to an altitude of only 140m. In other river systems in Wester Ross and neighbouring areas, most salmon enter freshwater from the sea between June and September. Why were salmon in the Ullapool River different?

There are also wild brown trout within the streams and lochs of the Ullapool River catchment; sea trout are taken below the Ness Falls (they have rarely been taken in Loch Achall). Eels are also present. In the past, considerable effort has also gone into the management of ‘trout lochs’. However, in terms of biodiversity conservation, eco-system function and value to the local economy, the wild salmon of the Ullapool River are of particular importance.

This part of the report focuses upon the history of the salmon fishery over the past 100 years and what it tells us about the nature and performance of the Ullapool River’s salmon population.

4.2 Sources of information

Most of the information presented and discussed in this part of the report is based on entries in the Cromartie and Rhidorroch Estate game books. Together, these books are an invaluable record of the productivity of the rivers, lochs and hill ground of the estate over the past 110 years, and provide insight into changes in the performance and productivity of fisheries. Without this record, we would have much less knowledge of just how dominant ‘spring salmon’ were in former years. Thanks to Ewen and Jennie Scobie for maintaining detailed entries over many years, and for providing access to this wonderful archive.

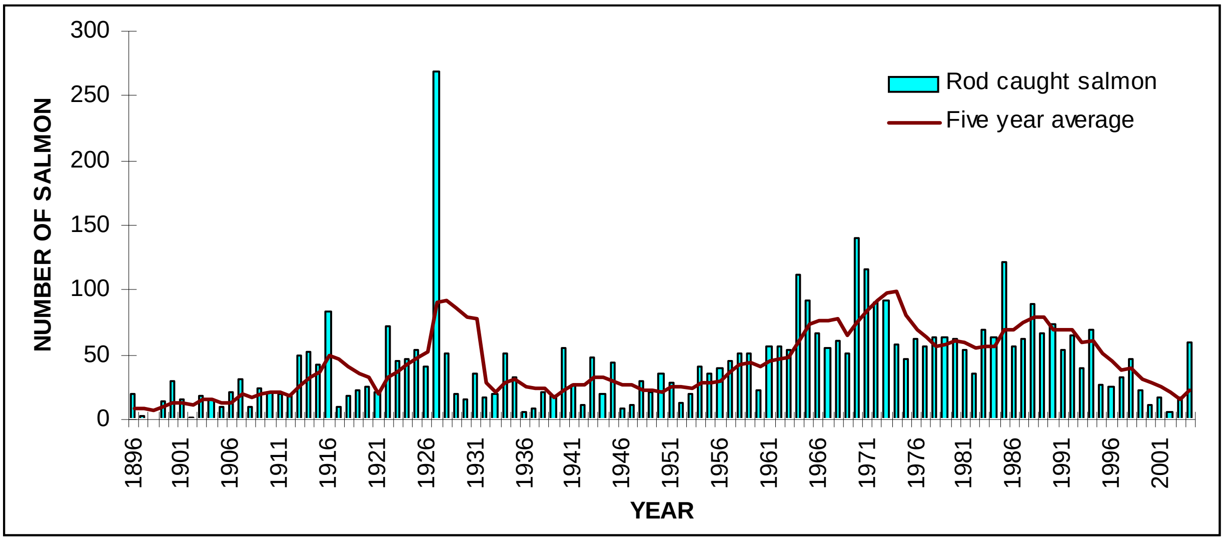


Figure 4.1: Recorded rod catch of salmon in the Ullapool River, 1896 – 2004, based on records in the Cromartie Estate and Rhidorroch Estate Game books

4.3 Salmon catches

The most remarkable rod catch of salmon was in 1927 (Figure 4.1) when over 100 salmon had been taken by the end of April and 230 had been caught by the end of May. The total recorded catch of 269 salmon that year far exceeds the catch in any other year before or since. It is not easy to explain why 1927 should have been so productive without information about numbers of fish taken by nets operating in nearby waters.

In more recent years, catches of salmon declined from a five year average of between 60 and 80 fish per year during the 1970s and 80s to less than 20 per year at the turn of the millennia. Subsequently, in 2004 and 2005, the rod catch has recovered substantially (Figure 4.2).

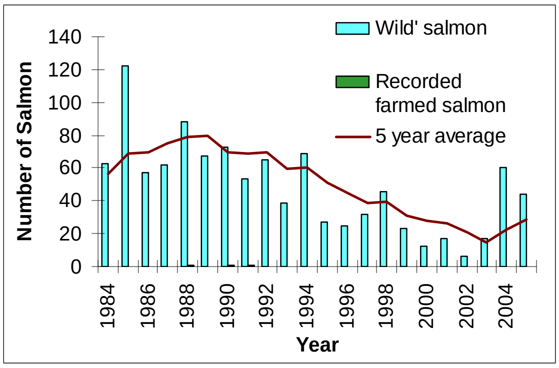


Figure 4.2: Total annual rod catch of adult wild and escaped salmon from the Ullapool system, 1983-2005 (including the five year average).

4.4 Run timing of salmon

Records of catches for three periods were compiled to find out about changes in the timing of catches (Figure 4.3). During the periods 1903-1920 and 1937-1954, over 75 percent of the rod catch was taken before the end of June. Some of the fish taken later in the year may have also been fish that had entered early in the season.

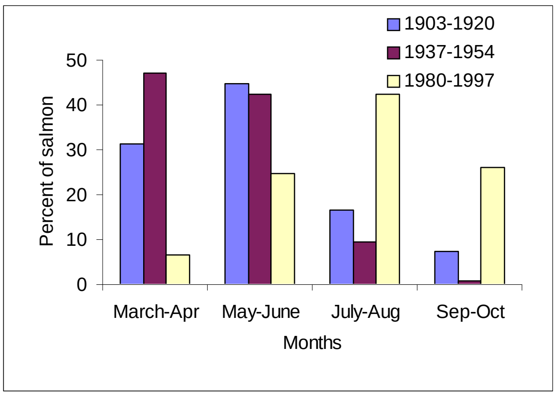


Figure 4.3: Percentage of rod catch of salmon from the Ullapool River taken at different times for three periods during the 20th century

However, during the period 1980–1997, over 70 percent of salmon were taken between July and the end of the season in October (Figure 4.3)

4.5 Size of salmon

The average size of salmon taken by rods from the Ullapool River declined during the 20th century (Figure 4.4). The largest rod caught fish was a 33lb, a 3SW hen fish of smolt age 2, taken on 20 June 1928 (an even larger fish of 42lb was found dead at the Ness Falls in June 1945). Between 1903 and 1920, >70% of fish were between 9 and 13lb in weight with >15% of 15lb or more; large fish were not uncommon: 15 fish of between 20lb and 25.5lb were caught between 1909 and 1919.

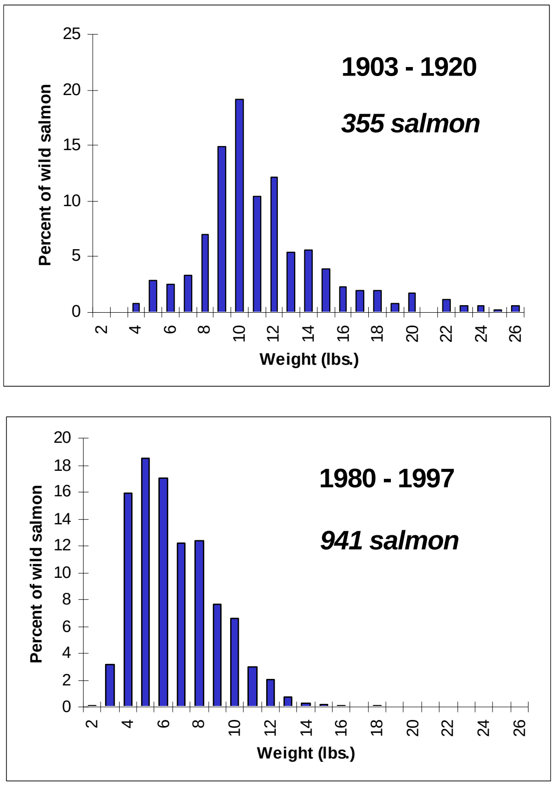
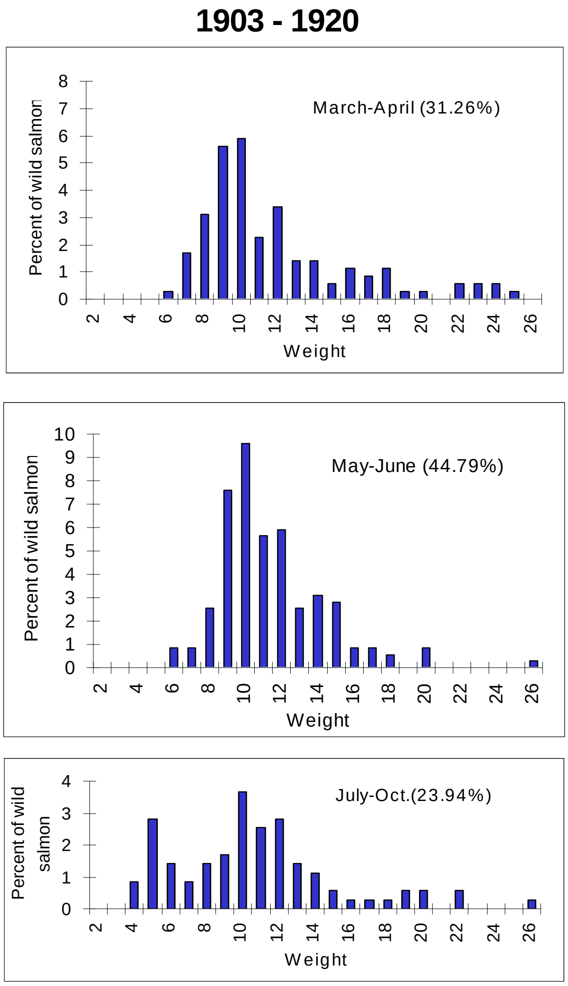


Figure 4.4: The weight distribution of salmon caught by rods in the Ullapool catchment during the period 1903–1920, and 1980–1997

However, during the period 1980–1997, over 90% of the catch was of fish of smaller than 10lb, with a median size of only 5lb. No fish of over 20lb were recorded.



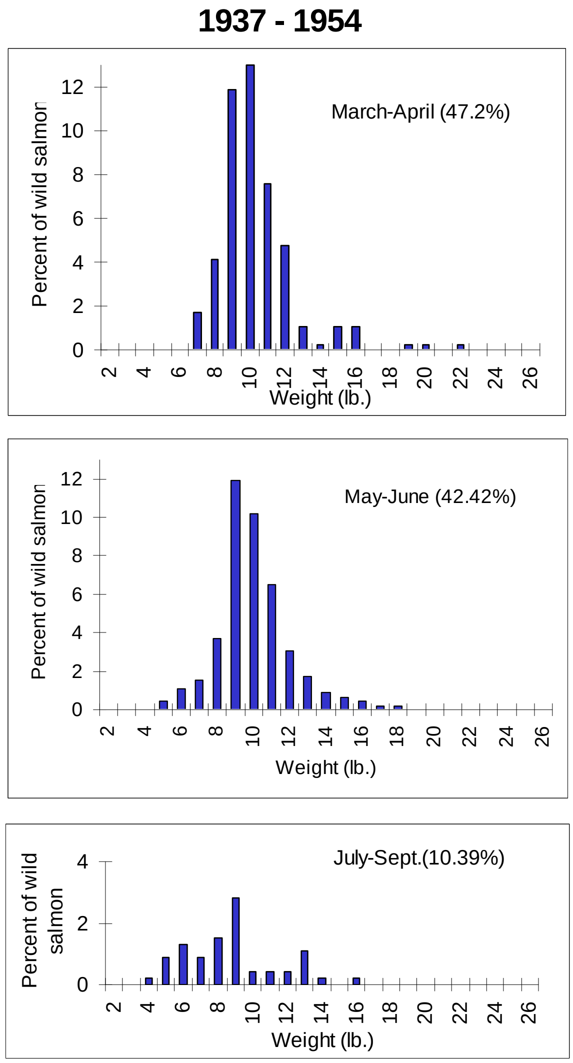


Figure 4.5: Size – frequency distribution of salmon caught in the Ullapool River according to month. Left: 1903-1920 (355 salmon); right 1937 – 1954 (462 salmon).

Further investigations suggest that at least for the first 50 years of the 20th century, there was little change in the composition of salmon caught in the river (Figure 4.5). Catches were dominated by salmon of around 10lb in weight, most of which were taken during the early part of the year.

Age of salmon

Scale samples of 50 salmon caught between 4 April 1925 and 25th June 1926 were read by Herbert Nall, Fisheries Research Officer for the Salmon Fishery Board of Scotland. Most of these fish were caught in April or May; 27 of them had spent 3 years in freshwater before heading to sea as smolts; 23 had spent 2 years in freshwater. All had spent 2 winters at sea before their initial return to freshwater; 4 (8%) had returned to the river for a second time as follows:

15.5lb fish (3.2sm+) caught on 3rd June 1925
19.5 lb fish (2.2sm1+) caught on 16th March 1926 (having spent 2 winters at sea after first return)
13 lb fish (3.2sm+) caught on 23 June 1926
11.5 lb fish (2.2sm+) caught on 25 June 1926

The largest fish of this group was a 21.5 lb maiden fish on 3rd June 1926 of (3.2), the smallest a 5.5 lb maiden fish (also a 3.2) on 16th April 1926. The data set also suggests that the average size of the spring fish in 1925 was 1–2 lb heavier than in 1926; though the sample is too small to say very much more.

These records strongly suggest that the Ullapool salmon population during the first half of the 20th century was dominated by early running 2SW salmon with only small numbers of grilse entering the river later in the year. However, during the second half of the 20th century the salmon fishery appears to have changed with increasing numbers of grilse taken in catches.

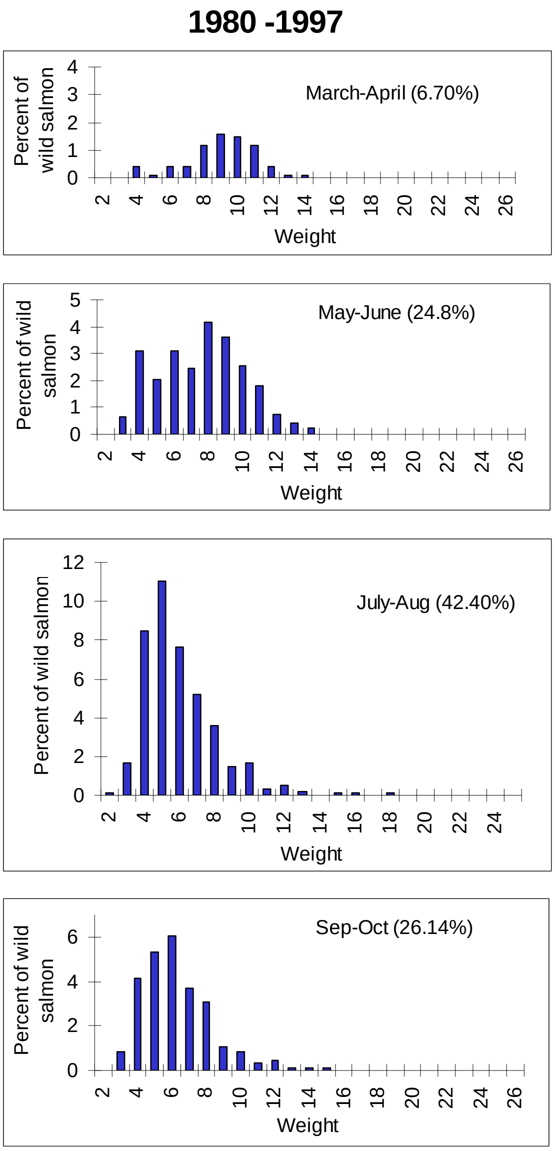


Figure 4.6: Size – frequency distribution of 941 salmon caught in the Ullapool River between 1980 and 1997 according to month.

4.6 Reasons for changes in salmon runs

Why was the Ullapool River primarily a Spring salmon river until the 1950s?

Studies of ‘spring’ salmon in east coast rivers (e.g. Dee, North Esk) have shown that they differ from later running fish in a number of ways:

- spring salmon tend to spawn earlier in the autumn. Spring salmon in the upper Dee spawn in late October, ~6 weeks earlier than salmon spawning in the lower part of the Dee system.
- their eggs are often larger relative to their overall length and bodyweight (Youngson 1995)

Both these characteristics appear to be adaptations to the colder water that eggs incubating in river gravels at higher altitudes are subject to. Salmon egg development relates closely with water temperature; the times of ‘hatch’ and ‘swim up’ can be roughly predicted according to the number of ‘degree-days’ (temperature ^{o}C x number of days) since fertilization. In other words if the water temperature doubles, the rate of development of eggs will also double. So, for example, at 6^{o}C eggs will hatch in roughly half the time it takes them to hatch at 3^{o}C.

If fry emerge from their redd too early in the year (having used up their yolk) they may starve because of a lack of food or a lack of daylight to locate it. If they emerge too late in the year, they may miss an opportunity to grow quickly and be subsequently out-competed by other fry (see Box 4.1). In summary, spring salmon which return to the cool, oligotrophic, headwaters of long, east coast river systems appear to be adapted physiologically and behaviorally to give their progeny the best chance of survival.

However, in contrast to east coast river systems, the Ullapool River is a short river: the furthest spawning areas are only 16km from the sea, at an altitude of <150m. Why then should it have produced a dominant spring run?

Is it possible that winter water temperatures in the upper Rhidorroch River are similar to those of streams at higher altitudes in the East of Scotland? Water plunges into the Rhidorroch River over a series of falls, dropping rapidly from altitudes of over 200m; and the first 2–3km of the river comprise a deep shady gorge with little direct sunlight, particularly during the early months of the year when salmon eggs are incubating.

- Water temperatures in the upper Rhidorroch River could be recorded using an automatic data recorder for comparison with other spawning streams.

Water temperature may be part of the explanation for Ullapool ‘springers’. However, could later running salmon not just as easily be ready to spawn in late October? Why enter the river so early?

There are a few other rivers within the WRFT area where there are records or anecdotes of consistent spring salmon runs. These include the Bruachiag (Ewe), upper Carron, and Ling. In each of these systems, as in the Ullapool River, the spring run appears to be associated with a waterfall that is passable to salmon only during spate flows.

Studies of the leaping ability of salmon show that swim speed (and hence ability to jump) relates to body size and water temperature. Larger fish can swim faster than smaller fish and can therefore surmount a higher obstacle. For example according to Beach 1984 (in SOAFD, 1995), at 15^{o}C, a 75cm salmon (e.g. spring salmon) can manage a top swim speed of 5.6m/s but a 60cm fish (e.g. grilse) can manage only 4.8m/s. Jumping vertically from the water at top swim speed, the 75cm salmon would reach a height of about 1.57m, but the 60cm grilse only about 1.15m.

Swim speed and jumping ability may also relate to the condition of the fish. Salmon cease feeding prior to river entry. As the spawning period approaches, physiological changes take place that are likely to gradually reduce their maximum swim speed and ability to jump: reproductive organs develop; energy reserves are metabolized. In female salmon, up to 25% of body mass may be of eggs prior to spawning. It is hard to imagine how such a fish could clear as high an obstacle as a fresh run 'springer'.

In the Ullapool River, the Ness Falls' clearly presents a formidable obstruction to salmon attempting to reach higher parts of the system. Female salmon that have to be ready to spawn by late October and yet be in prime condition to get over the falls may have to clear the falls early in the year before low summer flows set in. By late summer they may be too near spawning condition. Hence, the arrival of salmon below the Ness falls in April or May awaiting the first 'warm' spates of the year.

This explanation could also apply to the 'springers' of the Bruachaig and Ling. Further studies of the leaping ability of salmon as they approach maturation are required.

Why did the spring salmon fishery decline and the grilse fishery increase during the latter part of the 20th century?

Catch records suggests that the salmon fishery began to change during the 1950s with increasing numbers of grilse and summer 'salmon' in rod catches (Figure 4.7).

From 1947, salmon fry from Ardgay hatchery possibly of non-native River Shin origin were stocked regularly into the Rhidorroch River (Table 4.1).

Table 4.1: Salmon stocking records for the Rhidorroch River 1947-1975

Year	Number of salmon fry stocked	Source
1947	5,000	Ardgay
1948	10,000	Ardgay
1953	2,000	Ardgay
1955	5,000	Ardgay
1956	5000	Ardgay
1959	15,000	Ardgay
1960	15,000	Ardgay
1961	15,000	?
1962	0	
1963	?	?
1964	'normal stocking'	?
1965	'usual stocking'	?
1966–74	?	?
1975	20,000	?
1976	20,000	?

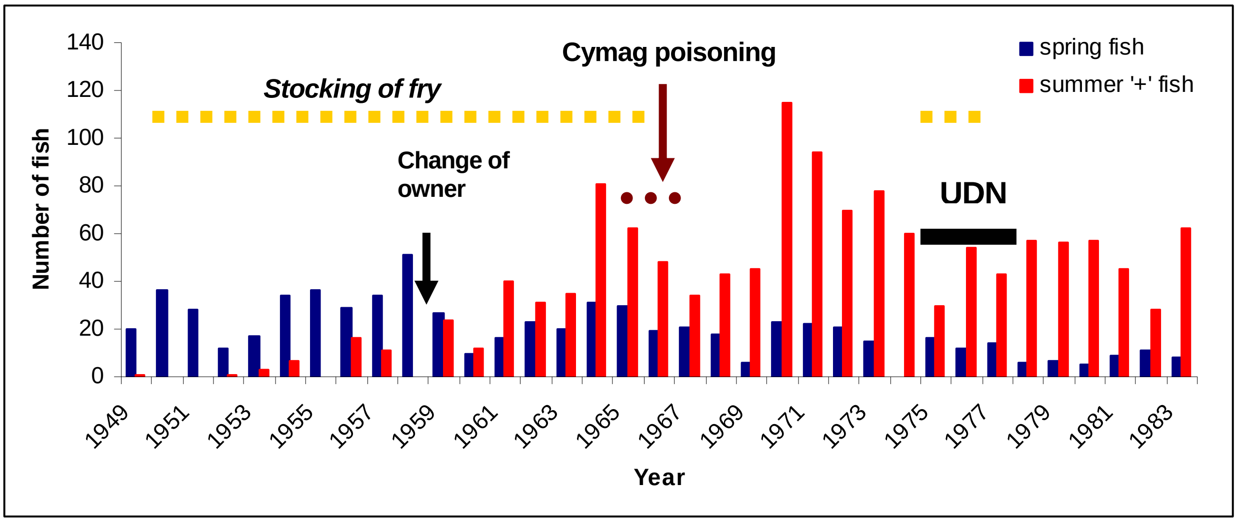


Figure 4.7: Recorded numbers of spring fish (taken before June) and summer fish (salmon and grilse) taken from the Ullapool River during the period 1949 - 1984

Ownership of the river changed on 28 November 1958 and possibly patterns of fishing with increasing fishing effort during the summer months thereafter. This complicates matters. Some of the fish subsequently taken during the summer and autumn may have been spring fish that had already spent a few months in the river. However, during the period 1980–1997, most of the fish taken were much smaller than the 'springers' of earlier years (see Figs 4.4, 5.5 & 4.6). On balance, evidence suggests that the composition of the salmon population changed.

If fish stocked were descended from a population of later-running salmon with a higher grilse 'rate', then it is possible that changes in catches from the end of the 1950s reflect their survival and subsequent dominance within the river. In 1962 there was a 'tremendous run of grilse' and the river was full of 'grilse in August'. Although most of the salmon caught were taken below the Ness falls, some ascended the falls. In 1963 there was a 'great run of grilse and spawning [presumably in the Rhidorroch river] in November appeared adequate'

However, numbers of spring fish taken from rivers elsewhere in Scotland also declined during the same period. This appears to have been primarily related to changes in their survival at sea and after return to freshwater relative to later running fish. The disease Ulcerative Dermal Necrosis (UDN) in the mid 1970s disproportionately affected stocks of spring salmon in many river systems, and runs of spring salmon in the Tweed never recovered; their 'place' subsequently taken by later running fish (e.g. Youngson, 1994).

The most likely explanation for the Ullapool River is that a combination of stocking, UDN, changes in marine survival and perhaps other factors were responsible for the decline in catches of spring salmon up to the early 1980s.

Why did the rod catch of salmon collapse during the 1990s?

From the late 1980s, the total catch of salmon declined with the lowest recorded catches in 2000 and 2002. During this period, catches of salmon and sea trout in other nearby rivers also collapsed. Early-returned post-smolt sea trout infested with sea lice were recorded in the Broom and Kanaird estuaries nearby. It is likely that sea lice also infected salmon smolts emigrating from the Ullapool River. Subsequent research demonstrated that sea lice epizootics were associated with salmon farming.

Genetic introgression caused by escaped fish farm salmon spawning with wild salmon has been proposed as an explanation for changes in fish runs in other rives (e.g. Butler, River Ewe FMP, 2002). However, in contrast to salmon catches in the Ewe and Kanaird, less than 10 escaped farm salmon were recorded in the Ullapool River during this period. It seems unlikely that escaped farm salmon ascended the Ness Falls and spawned in higher reaches in sufficient numbers to substantially contribute to the juvenile salmon population (see Figure 4.2).

Table 4.2: Numbers of salmon stocked into the Ullapool River system during the period 1987–2005.

Year	Number of salmon fry stocked	Origin
1987	10,000	Ullapool
1988	0	
1989	9,000	Ullapool
1990	11,000	Ullapool
1991 - 1992	0	
1993	18,000	Non-native
1994	17,000	Non-native
1995	18,000	Non-native
1996	18,000	Non-native
1997	18,000	Non native
1998	9,000	Ullapool
1999	19,000	Ullapool
2000	21,000	Ullapool
2001	20,000	Ullapool
2002	20,000	Ullapool
2003	19,000	Ullapool
2004	25,000	Ullapool
2005	no stocking	

In an attempt to sustain the salmon fishery, annual stocking of fry resumed (Table 4.2). During the years 1993–1997, non-native fish were stocked at densities which may have been high enough to form a substantial part of the juvenile salmon population. The very poor catches of salmon in 1999–2002 may have been partly related to the poorer survival of these non-native fish at sea. Subsequent research in Ireland (e.g. McGinnity *et al,* 2003) demonstrated that even stocked progeny of salmon native to neighbouring rivers can have poor whole-life cycle fitness relative to native fish during the first generation.

In the 1990s, the Rhidorroch estate set up its own hatchery to recycle eggs from native Ullapool salmon. Catches of salmon in 2004 and 2005 were higher than for many years (Figure 4.2). It is possible that the estate's stocking programme ultimately contributed to this recovery.

Following a much improved rod catch in 2004, the decision was made not to stock in 2005 to avoid competition between wild and stocked fish. An electro-fishing survey in August 2005 found salmon fry of wild origin throughout the accessible area, indicating successful spawning of wild fish in 2004.

4.7 Trout fisheries

Sea trout

The Ullapool River and Loch Achall have never been noted as sea trout waters. Recorded sea trout catches from the middle beat of the Ullapool River and above exceeded 20 only during the years 1963–1965 (Figure 4.8). The lower part of the river including the sea pool was fished by Ullapool Angling Club and records appear to be incomplete for their catches (Table 4.3).

Table 4.3: Numbers of Sea trout caught by Ullapool Angling Club in the lower part of the Ullapool River for years where records exist.

Year	Recorded Sea trout catch
1961	43
1962	50
1963	70
1964	60
1965	48
1981	54
1982	81

The highest recorded totals are of 89 sea trout (mostly finnock) in 1964 of which the UAC recorded 60; and a UAC catch of 81 in 1982 – averaging 10 oz. In 1981, the UAC took 54 sea trout for 76lb (av. weight 1lb 7oz). Records for the lower river appear to be incomplete; these figures possibly provide only an indication of historic catches.

Non-native sea trout fry were stocked into the Rhidorroch River periodically from the 1950s. In 1975, 5,000 sea trout fry were stocked into the Rhidorroch River. It is possible that some of the fish taken in 1981 and possibly 1982 from the Ullapool River were from this stocking. However, sea trout are known to wander: some of the fish taken from the lower pools of the river may have originated from other streams entering the Loch Broom area.

Over the years, sea trout have been recorded intermittently in catches from Loch Achall as follows; 3 in 1959, 3 in 1964, and 6 in 1971. It appears that sea trout are only able to ascend the Ness Falls during exceptional conditions. Loch Achall and the river above seem unable to sustain a sea trout population.

Brown trout

Catches of small brown trout from Loch Achall, though not analysed as part of this study, have clearly been considerable with consistent catches of 1,000 or more per year during periods in the past (e.g. 1961–1965). Trout of over 1lb are occasionally taken In 2005 a brown trout of about 5lb was taken from below the loch; this fish was aged by scale reading at over 10 years old. However, despite attempts to improve the 'quality' of trout, through stocking fry (from 1947) and even introducing 'freshwater shrimp' to improve feeding (in 1948), the average size of trout caught remained remarkably consistent throughout the 20th century at just under 3 to the lb.

Much of the habitat around Loch Achall and in the Rhidorroch River as far upstream as Cadubh is more suitable for trout than salmon, with streamy glides, slow weedy back waters and burns.

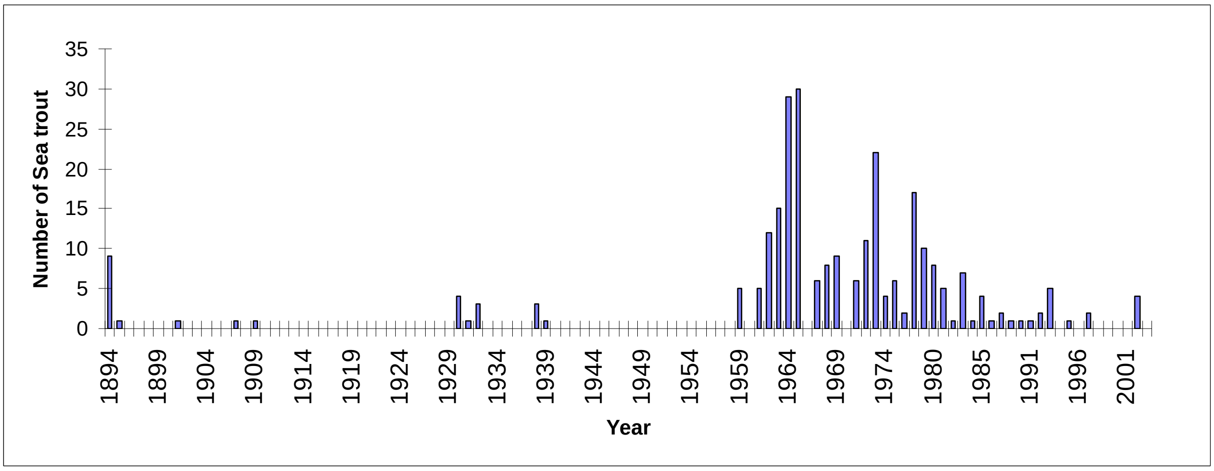


Figure 4.8: Recorded rod catches of sea trout in the middle Ullapool River and above, 1896 – 2004, based on records in the Cromartie Estate and Rhidorroch Estate Game books

There are many small hill lochs within the Ullapool River catchment area, some of which have been managed as trout fisheries at certain periods in the past 100 years. Brown trout (including Loch Leven trout) and rainbow trout have been stocked and in some waters have grown well. However further consideration of hill loch fisheries is out with the scope of the current study.

4.8 Interaction between trout and salmon populations

Juvenile salmon share their habitat with trout. During the summer, juvenile salmon tend to be found at highest densities in faster water over cobble substrate where there is good cover. However, to some degree they compete with juvenile trout for food and space; and as Dougie Williams demonstrated clearly in August 2005, trout eat juvenile salmon.

The extent to which the trout population in Loch Achall and the Rhidorroch River influences the productivity of the salmon fishery is difficult to assess. Following periods when the largest numbers of trout have been taken from Loch Achall, there has been little indication of increasing catches of salmon or grilse during subsequent years. However, interaction between trout and juvenile salmon, both within the river and loch would be worth further investigation (see Part 5 for further discussion).

Dougie Williams with 2 Brown trout electro-fished from Rhidorroch River at East Rhidorroch in August, 2005. Each trout contained a salmon parr of 8cm.

4.9 Summary

1. During the first half of the 20^{th} Century rod catches of salmon from the Ullapool River comprised almost entirely of 2SW spring fish taken before the end of June.

2. The evolution of 'spring' salmon runs in the Ullapool River may be associated with the Ness Falls and with cold winter water temperatures in spawning areas at the head of the Rhidorroch River.

3. From the mid 1950s, catches of summer salmon and grilse increased. By the 1960s catches of 'summer fish' exceeded those of 'spring fish'.

4. From 1947, salmon fry of non-native origin were stocked into the river at regular intervals. Subsequent changes in the composition of the salmon catches correlate with this stocking programme.

5. During the 1990s, catches declined to their lowest levels on record. This appears to be associated with a reduction in marine survival of both wild and stocked fish.

6. In 2004 and 2005, the salmon catch recovered substantially. This correlated with an increase in catches of salmon for other nearby rivers and with the stocking of salmon fry of native origin from 1998.

7. Small numbers of sea trout were taken below the Ness Falls, but seldom were sea trout caught in Loch Achall above the Falls.

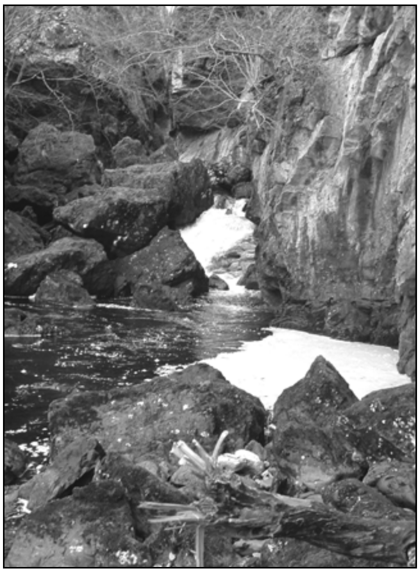
8. Loch Achall supports a wild brown trout population which consistently yielded 500–1000 trout per year to anglers, of average weight 5 to 6 oz (145–175g) during periods in the 20^{th} century.

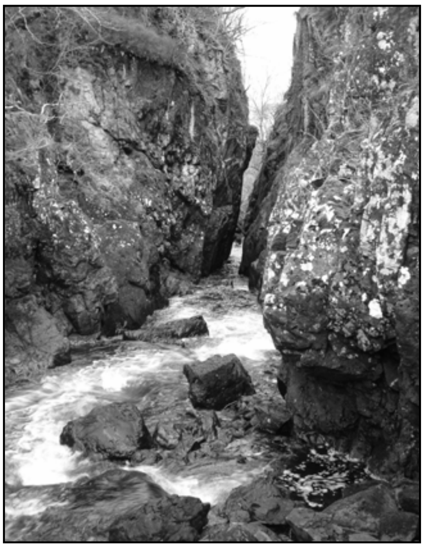
9. There is no evidence that the average weight of trout in Loch Achall changed as a result of the stocking of trout fry, freshwater shrimp, or in response to heavy fishing pressure.

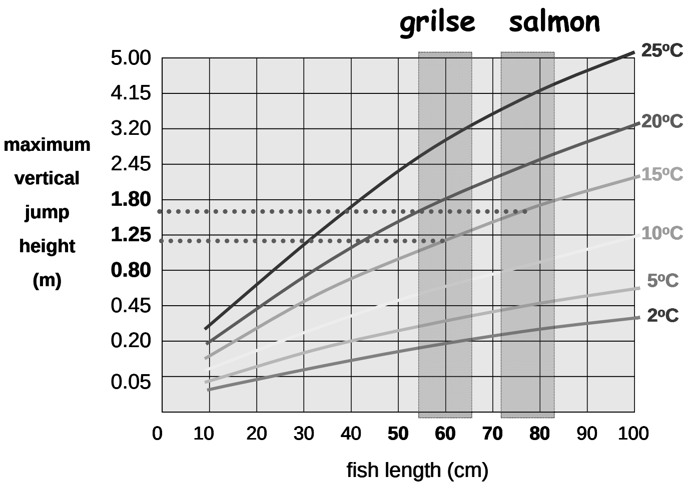
10. Further investigations are required to learn more about relationships between trout and juvenile salmon within the upper Ullapool River system.

Box 4.1 **Spring salmon and waterfalls**

Until the 1950s, The Ullapool River appears to have had a distinctive population of early running 2SW salmon with few later running (1SW) grilse. Over many generations, the salmon population of the Ullapool River may have evolved to produce a high proportion of 2SW salmon that entered the river early in the year, in response to the need to be able to surmount the falls to reach the main spawning habitat within the river system. Together, the Ness Falls (*below left*) and the narrow gorge immediately above the falls through which the flow is accelerated after heavy rain (*below right*) may have acted as the selective pressure determining whether or not salmon were able to reach upstream spawning areas. Sea trout, although regularly taken below the falls, were very rarely recorded above the falls.







Maximum vertical jumping height for trout and salmon based on values for maximum swim speeds presented in Beech, 1984.

Note how a typical salmon would be able to jump higher than a grilse at any given water temperature (dotted lines contrast a 60 cm grilse with a 75cm salmon). Also note that smaller fish (e.g. a sea trout of 40cm) would have difficulty surmounting waterfalls that salmon and grilse would be able to ascend.

Genetic studies need to be undertaken to clarify *how* different Ullapool River salmon are now from salmon returning to neighbouring rivers. The salmon population of the Little Gruinard SAC is dominated by grilse (90% of catches in 1995–2000), as is the Gruinard River nearby. Neither of these systems have major obstructions such as the Ness falls. The only other comparable system within the WRFT area with a consistent run of spring salmon is the River Ling near Dornie (although records for the Ling are not as detailed as those for the Ullapool River). The River Ling also has challenging water falls over which salmon must ascend to reach spawning areas. The River Bruachaig (River Ewe system) also has several formidable waterfalls and also supported a salmon population which may have been characterised by early running fish. Wild salmon have not been recorded above the Bruachaig falls since 1999.

Box 4.2 **Population structuring: spring salmon versus summer grilse**

Until the 1950s, The Ullapool River appears to have had a distinctive population of early running 2SW salmon with few later running (1SW) grilse. Subsequently, numbers of spring salmon recorded in catches declined and numbers of smaller, summer grilse, more typical of Wester Ross river systems, increased. Records indicate that this change may have been partly as a result of stocking. Some of these later fish have shown that they are more than capable of surmounting the falls (Eas Dubh) and reaching headwater streams to spawn. Can the spring salmon 'population' of the Ullapool River be restored?

Over the past 20 years, geneticists have greatly extended our knowledge of salmon populations and how fish in different parts of their range are related to each other. Some studies have found genetic variation that appears to be associated with phenotypic characteristics and / or environmental variables. These studies support the hypothesis that different salmon populations have become adapted to their local environments. For example, genetic protein variation at one of the loci [*MEP-2**] has been shown in a series of studies to be correlated with latitude, January and July temperature and local river gradient, and with phenotypic traits such as mean size at age, specific growth rate and sea age, and also with growth variation within families. Another study found associations of *MEP-2** genotype with survival and growth in the early life-history stages among planted-out fish as well as an association with smolt age and male parr maturation. Please refer to the review paper by Verspoor, *et al.,* 2005 for more detailed discussion and the full list of studies cited.

The model presented here considers how competition between first-feeding fry may influence population structuring.

Consider a spawning stream (e.g. upper Rhidorroch River) where 20,000 fry are needed to 'saturate' the available habitat.

Scenario A: In year 1, only 10,000 fry emerge from spawning areas and of these 50% are progeny of summer grilse and 50% progeny of 2SW spring salmon. The burn is cold, oligotrophic and food is limited. Although progeny of grilse are initially a little smaller and swim up later than those of 2SW spring salmon, growth is not limited by competition between fry and rates of fry survival for both groups are relatively high. Subsequently, smolt runs comprise 50% progeny of grilse and 50% progeny of 2SW Spring salmon.

Rates of smolt to spawning adult female survival remain low. However, the survival of summer grilse (that spend 1 winter at sea) is higher than that of spring salmon (2 winters at sea). In subsequent years, egg deposition remains below 'saturation' levels. Because of the higher rates of survival and higher egg deposition of grilse, the proportion of grilse in subsequent years increases relative to 2SW spring salmon.

Scenario B: In year 1, 50,000 fry emerge from spawning areas and of these 50% are progeny of summer grilse and 50% progeny of 2SW spring salmon. The burn is cold and oligotrophic: food is limited. Progeny of 2SW spring salmon emerge from the gravel earlier than those of grilse. They are already larger and occupy available habitat. Food becomes even more limited as there are many mouths cropping drifting items. Progeny of 2SW out-compete those of grilse and through 'self thinning' dominate. Subsequently, smolt runs comprise 95% progeny of 2SW Spring salmon and only 5% progeny of grilse.

Although rates of survival of spring salmon progeny remain lower than those of grilse, numbers of adult female 2SW spring salmon in excess of those required to saturate available habitat with fry return in subsequent years. In other words, the egg deposition by 2SW female fish remains higher than required; and because their progeny are better adapted to the environmental conditions of the spawning burn, the progeny of any female summer grilse which return to spawn perform poorly. In subsequent years, the population becomes increasingly dominated by 2SW spring salmon.

The aim of this model is to demonstrate why **spawning targets** (or conservation limits) for adult fish may need to be set at levels high enough to ensure that there is a high degree of competition for food and habitat as fry emerge from gravels if populations dominated by 2SW spring salmon (such as that of the Ullapool River) are to be retained. For the Ullapool River, with a relatively small area of spawning and nursery habitat, it is possible that selection can work quite rapidly (within a few generations) to favour 'spring salmon' if sufficient numbers of female spring salmon spawn. But conversely, if densities of spawning fish remain lower than those required to ensure high levels of competition between fry, the population will tend to become increasingly dominated by fish capable of producing the most eggs that are viable the fastest (i.e. late-running, later-spawning, grilse).

Reference: Verspoor, E. *et al* (2005): Population structure in the Atlantic salmon: insights from 40 years of research into genetic protein variation. *Journal of Fish Biology* (2005) **67** (Supplement A), 3–54

Part 5: Juvenile salmon and trout

5.1 Introduction

The productivity of a salmon fishery depends upon both marine survival and freshwater production of salmon smolts. Many of the pressures that determine marine survival are out with the influence of fisheries managers. However, the production of wild salmon smolts within any river system depends upon four major factors:

- 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
- interactions with other species (e.g. competition, predation)

Catch data for the Ullapool River (Part 4) suggests that numbers of adult salmon returning have varied considerably over the past 100 years. This part of the report presents the results of surveys to assess the status of both juvenile salmon and trout populations and to learn more about the 'production capacity' of different parts of the accessible area.

Surveys were carried out to assess both the distribution and densities of juvenile salmon and trout within the accessible part of the catchment area.

5.2 Methods

Surveys were carried out following Scottish Fisheries Co-ordination Centre (SFCC) protocols. Until 2002 'Intelisys' back-pack electro-fishing equipment was used. In 2004 the equipment was upgraded to bring the Trust in line with the SFCC, and 'Electracatch' equipment was purchased.

Surveys adopted both quantitative and semi-quantitative (timed) electro-fishing techniques. In quantitative electro-fishing, a section of river is closed off with nets and fish within that section are systematically removed. Having measured the area of water fished, an estimate of the density of fish can be made. By fishing through the closed-off section two or more times, estimates of fish densities can be made on the basis of a depletion curve. Estimates of fish densities are then standardised to the numbers of fish per 100m^2 to allow comparisons between sites and rivers.

Timed fishing involves fishing for a recorded time through a section of habitat and gives an index of abundance of juvenile "fish caught per minute". Because it is a relatively fast technique, many sites can be surveyed in a day. Timed fishing can provide a good 'index' of juvenile fish distribution and abundance throughout the river in one season.

Quantitative electro-fishing is a more accurate technique for comparison of densities between rivers and between years but is more time consuming than 'timed' fishing.

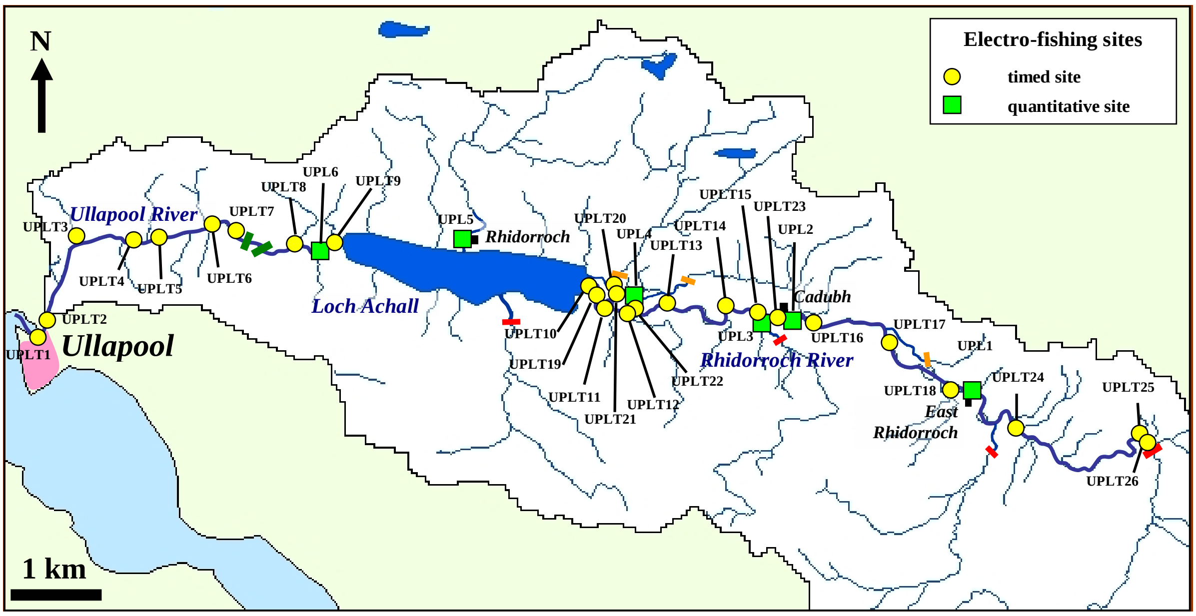


Figure 5.1: Locations of electro-fishing sites in the Ullapool River catchment area

5.3 Locations

In 1997, six quantitative electro-fishing sites were selected, one on the Ullapool River, two on the main Rhidorroch River and three on side burns (Figure 5.1). These sites were resurveyed 1999 and 2002. From 2004 site UPL2 on the main river by Cadubh Cottage was removed from the quantitative survey because the site was no longer suitable for quantitative fishing as a result of changes in habitat (downstream movement of a gravel bar).

In 1999 the first extensive timed fishing survey took place. Eighteen sites were selected from the lower end of the river up to the sheep fanks at East Rhidorroch. These were revisited in 2002 and two new sites were added above East Rhidorroch. In 2004, six new electro-fishing sites were selected to examine potential areas for management initiatives. Until 2005, parts of the Rhidorroch River were stocked annually with salmon fry, so distributions and densities of fish in these areas are for combined stocked plus wild fish.

Catches of adult salmon over the 2004 season were much higher than for many years previously (see Part 4). No stocking took place in 2005 for the first time in many years. To assess the distribution of salmon fry of wild origin in the upper catchment in 2005, six sites were surveyed.

5.4 Results

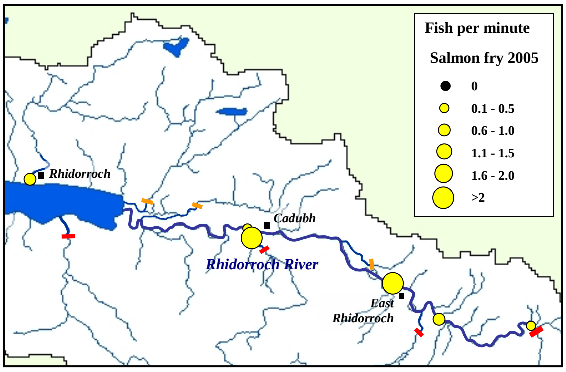
Results of quantitative surveys are presented in Appendix 6.1 at the back of this part.

5.4.1 Fish distribution and relative abundance

Salmon

The extensive timed surveys in 1999 showed that salmon fry were present at all main river sites within the accessible part of the catchment area at least as far upstream as East Rhidorroch (Figure 5.2). Salmon fry were absent from two sites on smaller burns entering Loch Achall, including a site by Rhidorroch House. The highest 'densities' of fry were found in parts of the lower Rhidorroch river and at the outflow of Loch Achall, probably reflecting the suitability of habitat in these areas for spawning and fry (see Part 6).

In 2002, salmon fry were again found at sites in the Ullapool River between the estuary and Loch Achall, and throughout the Rhidorroch River. However, 'densities' were lower than in 1999 even though the survey was earlier in the year. The rod catch of salmon in 2001 was one of the lowest on record with less than 50% of the catch in 1998, and the results of the electro-fishing survey may have been partly a reflection of low densities of spawning fish in 2001. In 2004 and 2005 (Figure 5.4), salmon fry were recorded at sites below the 'Smokey Falls' at the top of the Rhidorroch River. In 2005 this confirmed that wild salmon had reached the top of the accessible section in 2004 and spawned because no fry had been stocked out that year.



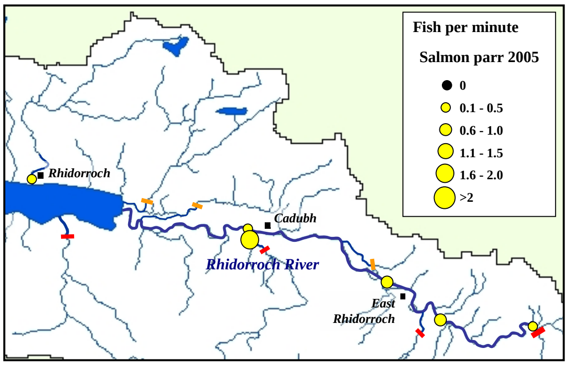


Figure 5.4: Juvenile salmon recorded during the 'high water' survey on 17 August 2005

Although salmon fry have been found throughout the accessible part of system, they have been absent from some sites in some years suggesting a patchy distribution of spawning. For example, at three sites on the lower Ullapool River salmon fry were recorded in 1999 but not in 2002. One site (UPLT20) first surveyed in 2004 had no salmon fry. This site is in a small burn and is slow flowing and weedy so more suitable for trout than salmon.

Salmon parr were also found throughout the system (Figure 5.3). However, salmon parr densities were low in the lower part of the Rhidorroch River in all years. This appears to reflect a lack of cover for salmon parr (see Part 6). Only two of the timed sites (UPLT9 and UPLT16) had no parr in both 1999 and 2002. As for fry, salmon parr were not found in all sites in all years.

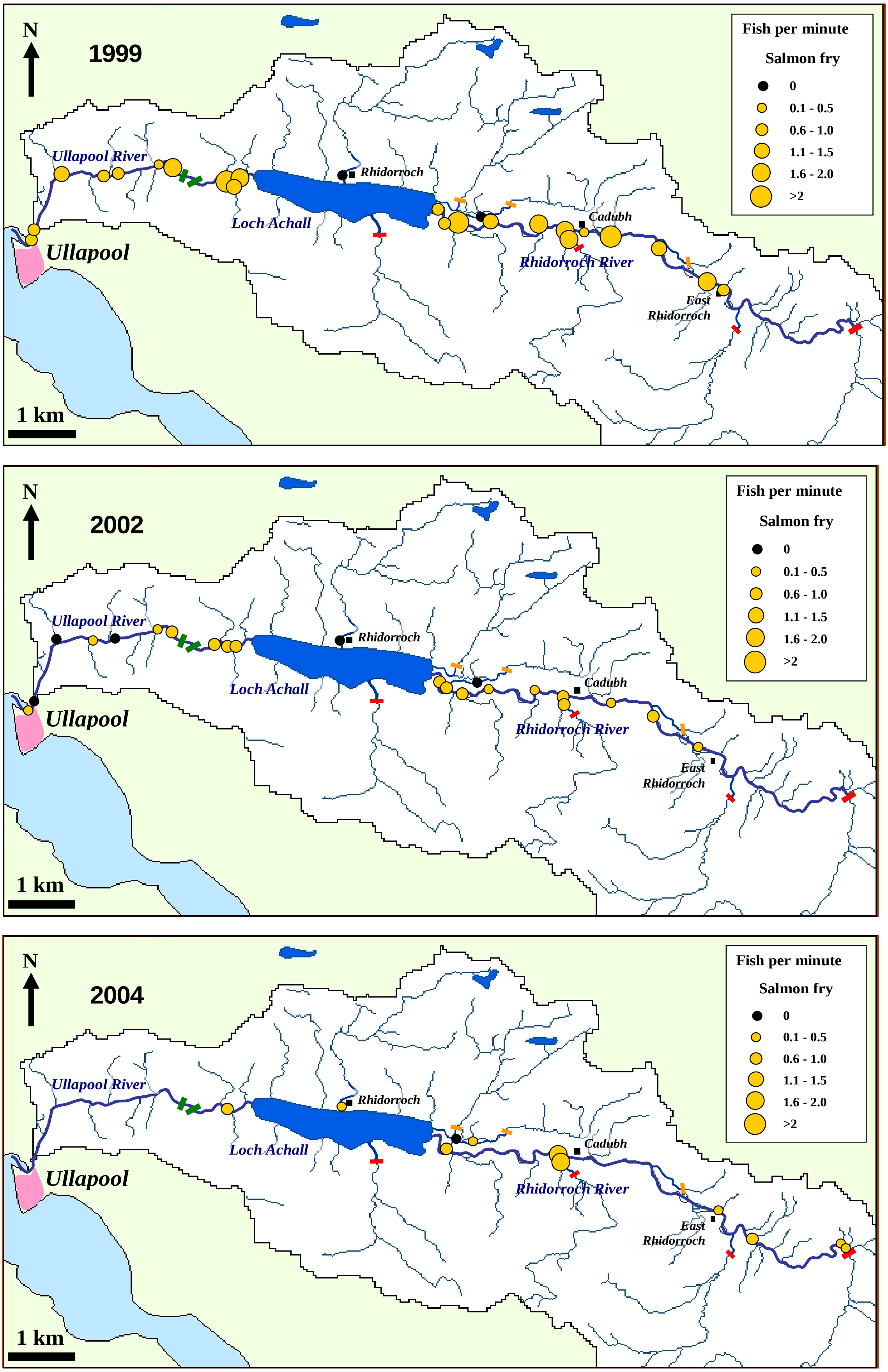


Figure 5.2: Distribution and relative abundance of salmon fry in the Ullapool River at sites surveyed in 1999, 2002 and 2004.

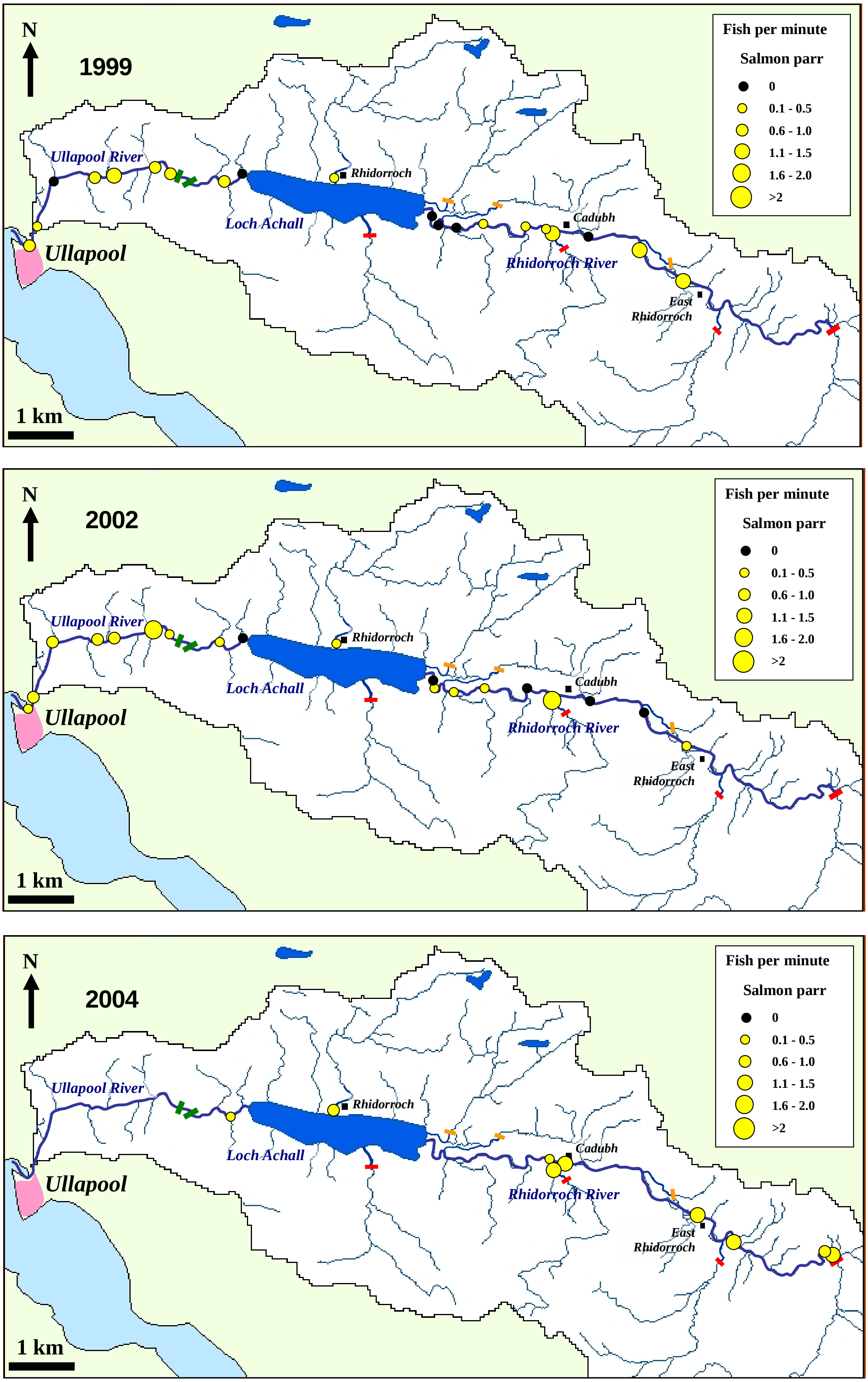


Figure 5.3: Distribution and relative abundance of salmon parr within the Ullapool River catchment at sites surveyed in 1999, 2002 and 2004.

Trout

The timed and quantitative surveys have found trout in a patchy distribution throughout the system. Trout have never been recorded at three sites (ULPT4, ULPT13 and ULPT23). Juvenile trout were most abundant at sites near Loch Achall. Most electrofishing sites were over habitat more suitable for juvenile salmon than trout (shallow riffle – run type habitat). Trout tend to be more abundant in slower flowing water. Trout fry are often most abundant in small streams. Larger trout tend to occupy deeper water (as observed during snorkel surveys in 2004) and were not recorded during the electro-fishing survey 2005.

Trout fry (top) and salmon fry.

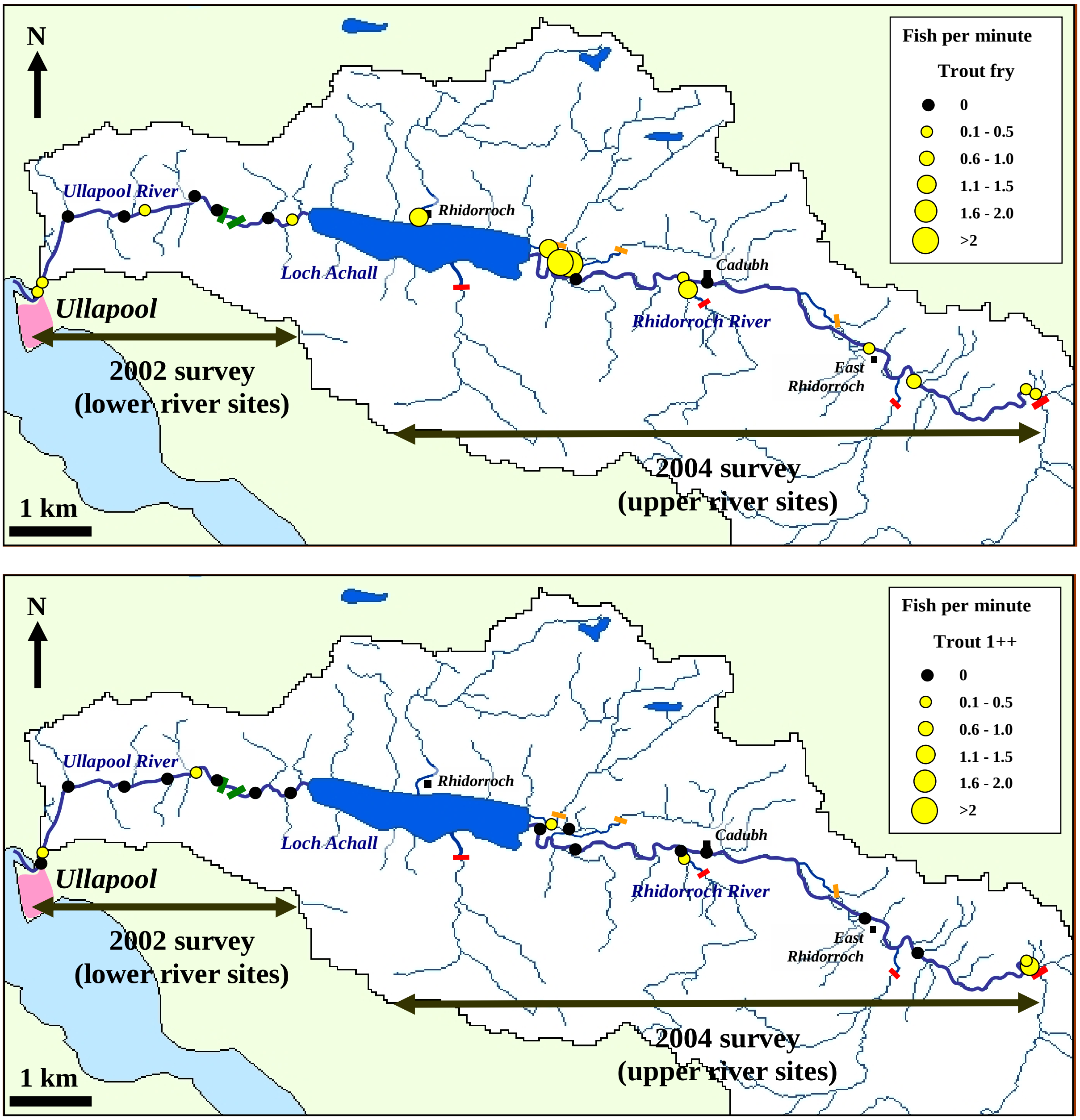


Figure 5.5: Distribution and relative abundance of juvenile trout in the Ullapool River.

5.4.2 Overall densities between years

For a long-term comparison between the four survey years, average densities were calculated from data for the 5 quantitative sites (Figure 5.6).

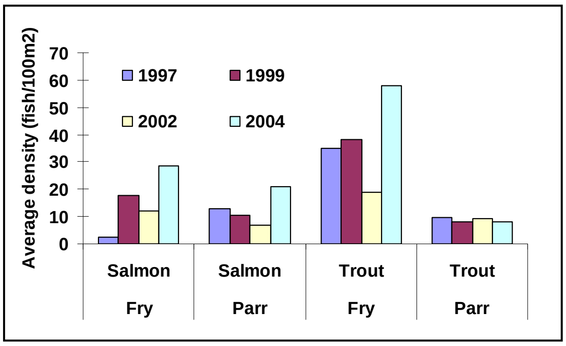


Figure 5.6: Densities of juvenile trout and salmon at 5 quantitative electro-fishing sites in the Ullapool River. Stocked fish may have been present at some sites in all years. See Appendix 5.1 for data.

Salmon

The average density of both salmon fry and salmon parr for the 5 sites was higher in 2004 than in any previous year. Unfortunately it is not possible to easily interpret whether this was primarily as a result of higher recruitment of juvenile fish, stocking, or environmental – climatic factors.

Trout

The average density of trout fry was also higher in 2004 than in any previous surveys. Assuming that there is little variation in the spawning stock of brown trout from year to year, this suggests that 2004 was simply a good year for recruitment with high rates of survival of both salmon and trout progeny. Water levels remained relatively high through much of the summer in 2004.

5.4.3 Sizes of salmon fry and parr

By late summer, both salmon fry and parr were slightly larger in the Ullapool River than in the Rhidorroch River (Figure 5.7). This may reflects differences in emergence times and growth rates. There were fewer parr of pre-smolt sizes (90mm+) in the Rhidorroch River than in the Ullapool River.

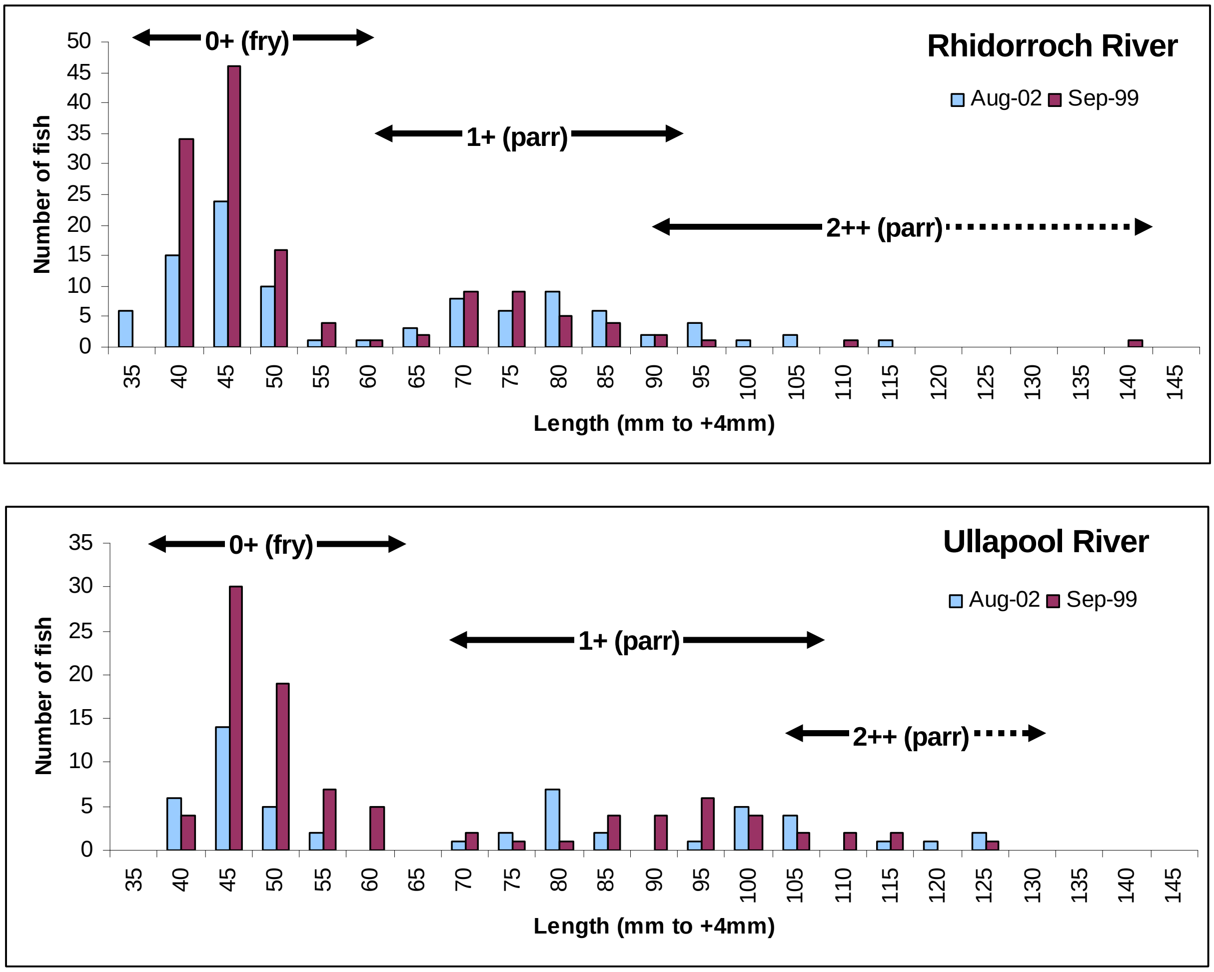


Figure 5.7: Lengths of juvenile salmon (in 5mm length classes) recorded during the 1999 and 2002 electro-fishing surveys.

This may relate to food availability and water temperature. One might expect the ratio of 3 year old smolts to 2 year old smolts to be higher from the upper part of the catchment. However, rates of over winter survival may be poor in the Rhidorroch River (as suggested by Figure 5.7).

5.5 Snorkel surveys

In the summer of 2004 and 2005, deeper sections of the Lower Rhidorroch River were investigated by snorkelling to find out whether larger salmon parr inhabited the pools or glides, rather than the shallow sites electro-fished.

On both occasions, water clarity was ideal for fish observation with underwater visibility of over 10m. A few larger salmon parr were seen, sometimes moving in shoals together with trout of similar size. However, overall, they were greatly outnumbered by trout – many of which were large enough to eat juvenile salmon.

However, it remains a possibility that some of the salmon parr from the Rhidorroch River migrate (or are washed) downstream into Loch Achall, where they remain until they smolt.

Trout (top) and salmon parr (bottom)

5.6 Summary

1. Electro-fishing surveys were carried out in 1997, 1999, 2002, 2004 and 2005 to investigate the occurrence of juvenile trout and salmon within the Ullapool River system.

2. Juvenile salmon and trout were recorded throughout the accessible area. However, their occurrence and overall densities varied between years.

3. Only in 2005 was it possible to assess the distribution of salmon fry of wild origin in the upper part of the Rhidorroch River. Salmon fry were found at all of the sites fished. In earlier years, the river was stocked with salmon fry.

4. Salmon parr densities were consistently low at sites fished in the lower part of the Rhidorroch River.

5. Salmon parr caught in the Rhidorroch River were smaller than those from the Ullapool River.

6. The possibility that larger salmon parr in the Rhidorroch River inhabited pools and deeper glides was investigated by snorkel survey in 2004 and 2005. Although visibility was very good, few parr were observed and they were outnumbered by trout.

7. Further investigations are required to assess the extent to which juvenile salmon utilise Loch Achall.

8. The genetic status of the Ullapool salmon populations also requires further investigation. To what extent is the population vulnerable to change following years with limited recruitment and stocking?

Appendix 5.1: Quantitative electro-fishing data for the Ullapool River

UPL1: Rhidorroch River, NH 237937. East Rhidorroch from footbridge downstream

				Zippin estimate (fish/100m2)				
Date	Area (m2)	Conductivity (mS/cm)	Runs	Salmon fry	Salmon parr	Trout fry	Trout parr	Other species caught/notes
04/08/1997	165.5	40	3	1.2	18.6	0	0.6	
02/09/1999	97.2	56	1*	20.8	11.1	6.7	0	
12/08/2002	208.8	53	1*	3.1	8.4	0	3.62	
09/08/2004	194.7	60	1*	11.4	19.9	9	0	

UPL2:Rhidorroch River, NH215946. Riffle infront of cottage

				Zippin estimate (fish/100m2)				
Date	Area (m2)	Conductivity (mS/cm)	Runs	Salmon fry	Salmon parr	Trout fry	Trout parr	Other species caught/notes
30/07/1997	407	62	3	0	1.6	1.2	2.3	3 eels
02/09/1999	121	58	1*	9.5	0	7.6	4.6	
12/08/2002	167.1	50	1*	10.2	0	6.1	4	

UPL3: Loch Thormaid burn, NH211945. 30m upstream from confluence.

				Zippin estimate (fish/100m2)				
Date	Area (m2)	Conductivity (mS/cm)	Runs	Salmon fry	Salmon parr	Trout fry	Trout parr	Other species caught/notes
04/08/1997	103.9	60	3	3	19.2	11.3	10.9	2 eels
02/09/1999	101.9	77	1*	42.3	21.9	73.6	7.9	
12/08/2002	104.9	59	1*	41.1	21.3	34.6	9.1	
09/08/2004	53.9	83	1*	86.6	47.3	90.8	7.6	
17/08/2005	128	31	2	88.94	15.98	123.33	6.51	

UPL4: Namless side burn, NH197948. From confluence with smaller burn downstream.

				Zippin estimate (fish/100m2)				
Date	Area (m2)	Conductivity (mS/cm)	Runs	Salmon fry	Salmon parr	Trout fry	Trout parr	Other species caught/notes
30/07/1997	106.8	83	3	0	2.8	72.1	23.1	2 eels
02/09/1999	82.7	71	1*	0	3.7	40.7	17.8	
06/08/2002	95	62	1*	0	3.8	16.4	18.8	
09/08/2004	59.3	78	1*	5.8	4.7	86.6	21.5	

UPL5:Lochanan an Uillt Mhoire at Rhidorroch House, NH176954. From watergate upstream to fallen tree.

				Zippin estimate (fish/100m2)				
Date	Area (m2)	Conductivity (mS/cm)	Runs	Salmon fry	Salmon parr	Trout fry	Trout parr	Other species caught/notes
27/07/1997	186.9	70	3	3.2	23.3	79.7	14	3 eels
02/09/1999	69.4	60	1*	0	14.6	64.4	14.6	
06/08/2000	83.3		1*	0	0	43.1	9.1	
10/08/2004	44.9	74	1*	17.2	27.7	98.4	11.8	

UPL6: Ullapool River, NH158953. 100m downstream of old bridge

				Zippin estimate (fish/100m2)				
Date	Area (m2)	Conductivity (mS/cm)	Runs	Salmon fry	Salmon parr	Trout fry	Trout parr	Other species caught/notes
04/08/1997	160	44	3	4.4	0.0	12.3	0	2 eels
02/09/1999	170.6	47	1^	44.4	0	5.9	0	
01/08/2002	129.7	35	1^	16.4	0	0	5.8	
10/08/2004	196	44	1^	22.3	5.4	5.4	0	

* For 1 run fishing at sites with >50 mS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:
Fry density = 2.28 (fry run 1) + 1.99 (n=20, r^2=0.86, $p<0.001$)
Parr density = 1.43 (parr run 1) + 2.25 (n=29, r^2=0.92, $p<0.001$)

^ For 1 run fishing at sites with <50 mS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:
Fry density = 2.37 (fry run 1) + 1.73 (n=30, r^2=0.82, $p<0.001$)
Parr density = 1.39 (parr run 1) + 4.71 (n=29, r^2=0.49, $p<0.001$)

Part 6: Habitat and fish production

6.1 Introduction

This part of the report assesses the characteristics of the Ullapool River system in terms of current and potential freshwater production of juvenile salmon. In doing so, factors that may limit production are identified. For salmon, the productive capacity of a river system is determined by the area of water accessible to adult fish and by the suitability of the habitats therein. Habitats which are good for fish production also tend to support a rich diversity of other wildlife, including aquatic plants, insect larvae (mayflies, stoneflies, caddisflies, dragon-flies, water beetles, etc.), birds (dipper, sand martin, heron, divers, osprey), and mammals (otter, badger, water vole...).

6.2 An overview of habitat

Stream habitat (see also Part 3.2) varies naturally according to gradient and rates of sediment discharge. Above Loch Achall the river channel is particularly active. Spate flows erode glacial deposits in Glen Douchary and bedrock (gorge section above East Rhidorroch). The major areas of sediment deposition are between East Rhidorroch and Loch Achall where the gradient falls. After heavy rainfall Loch Achall may rise by 1.5m. The loch acts as a 'sediment trap' and consequently the out-flowing Ullapool River carries a much smaller sediment load and is more stable than the Rhidorroch River.

6.3 Productive area

A primary aim of the habitat survey in 1998 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 obstacles into account (Figure 6.1), the accessible riverine and loch areas were calculated (Table 6.1).

Table 6.1: Area accessible to Atlantic salmon within the Ullapool River system.

Freshwater	Area	
	(m^2)	%
Ullapool River	66,720	4.63
Rhidorroch River	114,860	7.96
Minor tributaries	10,577	0.73
Loch Achall	1,250,000	86.68
Totals	**1,442,158**	

In total, the accessible area comprises about 1,250,000m^2 of loch habitat (87% of total) and 192,157m^2 of riverine habitat (13%). Of the riverine habitat, 60% is within the Rhidorroch River, 35% in the Ullapool River below the loch, and only 5% in other minor tributaries flowing into Loch Achall or the Rhidorroch River. The most important minor tributaries in terms of accessible area are the Allt Coire Cronaidh, the Allt Dail a' Bhraid and the Allt Beallach na h-Imrich.

Access for salmon above the Ness Falls (Eas Dubh) is dependent upon spate flows and probably also water temperature. Above Loch Achall, there are no major obstructions for fish within the accessible section of the Rhidorroch River below the impassable falls at the top.

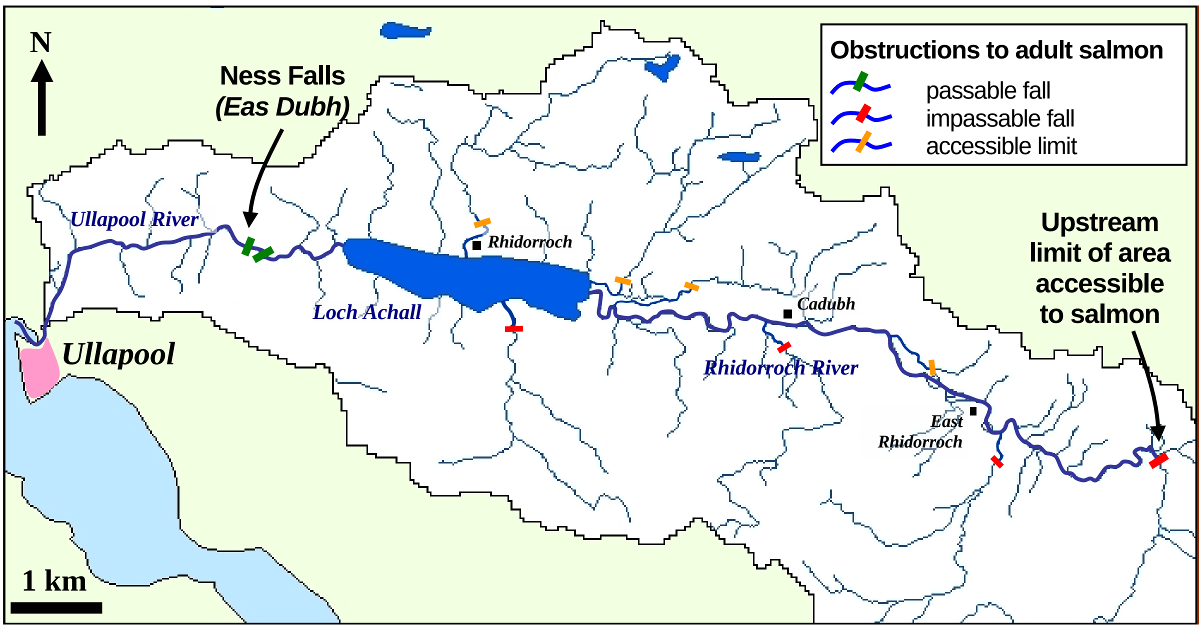


Figure 6.1: Parts of the Ullapool River that are accessible to adult Atlantic salmon.

6.4 Salmon and trout habitat

6.4.1 Spawning and fry habitat

The most extensive spawning areas for trout and salmon are within the Rhidorroch River (Table 6.2). However, in terms of providing an environment where fish can easily bury large quantities of eggs and where a high proportion of those eggs are likely to survive, the suitability of spawning areas varies.

Most of the spawning habitat within the Rhidorroch River is unstable and subject to frequent movement and redeposition of sediment. In contrast, some of the spawning areas in the Ullapool River, particularly those at the outflow of Loch Achall are very stable but may silt up without actions of spawning fish.

Table 6.2: Spawning habitat within the Ullapool River System recorded during the 1998 habitat survey.

Stream	Area of suitable spawning habitat (m^2)				% unstable
	Salmon	S & T	Trout	Total	
Ullapool R. (below N. falls)	349	9	7	365	0
Ullapool R. (above N. falls)	1,454	319	5	1,420	0
Rhidorroch River	6,980	3,570	704	11,254	88
Allt a' Ghuibhais	53	77	3	133	43
Allt Mor	0	0	0	0	0
Allt Bealach na Imrich	24	35	5	64	0
Allt Coire Cronaidh	0	0	0	0	0
Allt Dail a' Bhraid	20	15	1	36	0
Allt Bad a' Mhanaich	0	6	0	6	0
Allt an Luchda	0	0	0	0	0
Other	**0**	**1**	**13**	**14**	**0**

note: salmon or trout sometimes are able to spawn successfully in areas which would generally be regarded as 'unsuitable' habitat (e.g. Allt Mor!).

6.4.2 Salmon parr habitat

Trout and salmon parr have slightly different habitat preferences. During the spring and summer, salmon parr tend to occupy faster flowing sections of the larger rivers or tributaries (riffles & runs) with cobble or boulder cover where they feed and grow. Trout tend to dominate in slower glides, pools, tributaries that are too shallow for adult salmon, and loch margins.

Unstable habitat in the Rhidorroch River

Within the Ullapool River system, the largest areas of 'salmon parr' habitat (Table 6.3) are within the Rhidorroch River. Much of the Ullapool River is suitable salmon parr habitat (possibly a higher percentage than indicated in the Table 6.3). Because of its greater stability, it is generally of higher quality than that within the Rhidorroch River.

Loch Achall and the streamy pools of the lower part of the Rhidorroch River provide the largest areas of 'trout parr' habitat.

Table 6.3: Distribution of salmon parr habitat within riverine parts of the Ullapool River system.

Stream	Total area (m^2)	% of total	Parr habitat (m^2)	% of total
Rhidorroch River	114,860	59.8	64,776	66.98
Ullapool River	66,720	34.7	26,366	27.26
Allt Dail a' Bhraid	2,297	1.2	695	0.72
Allt Coire Cronaidh	1,725	0.9	1,238	1.28
Allt Beallachna h-Imrich	1,690	0.9	966	1.00
Allt a' Ghuibhais	1,150	0.6	905	0.94
Allt Mor	880	0.5	591	0.61
Allt an Luchda	525	0.3	183	0.19
Other minor streams	2,310	1.2	993	1.03
Total	**192,157**	**100.0**	**96,712**	**100.00**

6.4.3 Habitat shared by juvenile salmon and trout

Juvenile salmon and trout interact. They are commonly found in close proximity especially within the smaller streams (e.g. UPL3). During the winter months when water temperature reduces the speed at which fish are able to swim, juveniles of both species tend to move into slower flowing water (lochs or pools in river).

Loch Achall, representing 86% of the accessible area within the Ullapool River System, is predominately 'trout' habitat. The extent to which it is utilised by juvenile salmon has not been investigated. Elsewhere in Scotland, some lochs may play a significant role in production of juvenile salmon (e.g. Loch Langavat on the Grimersta River system in Lewis). Further investigations are required to understand the importance of Loch Achall for production of juvenile salmon within the Ullapool River system.

Loch Achall is primarily trout habitat

6.5 Potential salmon smolt production

Having established the size of the productive area for juvenile salmon within the Ullapool river system, it is possible to produce a range of estimates for the production of salmon smolts. Table 6.5 provides a range of potential smolt production estimates for both riverine habitat and for Loch Achall. 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 animals.

Estimates are based on a range of published and unpublished figures, including recorded salmon parr densities for similar habitat elsewhere in Wester Ross.

Table 6.5: Potential salmon smolt output from the Ullapool river system.

A. Riverine habitat

Stream	Parr habitat (m^2)	Potential salmon smolt production per year at				
		0.03	0.05	0.06	0.08	0.1
		smolts per m^2 parr habitat per year				
Rhidorroch River	64776	1943	3239	3887	5182	6478
Ullapool River	26366	791	1318	1582	2109	2637
Allt Dail a' Bhraid	695	21	35	42	56	70
Allt Coire Cronaidh	1238	37	62	74	99	124
Allt Beallachna h-Imrich	966	29	48	58	77	97
Allt a' Ghuibhais	905	27	45	54	72	91
Allt Mor	591	18	30	35	47	59
Allt an Luchda	183	5	9	11	15	18
Other minor streams	993	30	50	60	79	99
Total	**96712**	**2901**	**4836**	**5803**	**7737**	**9671**

B. Loch habitat

Loch	area (m^2)	Potential salmon smolt production per year at					
		0.0005	0.0007	0.001	0.0015	0.002	0.0025
		smolts per m^2 loch area per year					
Loch Achall	1250000	625	875	1250	1875	2500	3125

Note: These figures encompass a range of estimates for Canadian lakes. Figures for salmon smolt production from Scottish lochs are not yet known.

Based on these figures, estimated potential smolt production in the Ullapool River system may vary between a maximum of about 12,000 salmon smolts per year and a minimum of only about 3,500 assuming recruitment is not a limiting factor (see next section).

However, 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 lower Rhidorroch River and Loch Achall may be taken by trout. The level of predation of pre-smolt (parr and fry) salmon by trout is unknown.

6.6 Factors limiting production of juvenile salmon

The actual level of production of salmon smolts from the Ullapool River system depends upon a wide range of factors relating to adult salmon numbers, habitat quality and environmental conditions. Smolt production may vary widely from year to year according to variation in weather and river conditions. For convenience, factors influencing smolt production can be subdivided into 1, those that affect recruitment of salmon fry; and 2, those that affect growth and survival of salmon parr. This section considers how these may influence smolt production.

Recruitment of salmon fry

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

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 eaten by 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 found that 66% of redds in the Rhidorroch River were 'washed out'. 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 is the up-welling of groundwater low in dissolved oxygen through redds (Malcolm et al., 2003).

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 that the system is able to support. Under these conditions, losses prior to 'swim up' may have little impact on overall smolt production.

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 Ullapool River, there may have been years during the 1990s when production of swim-up fry has been inadequate for cumulative reasons relating to both a lack of spawning fish, and the survival of eggs and alevins prior to swim up. However, the extent to which the supplementary stocking programme compensated for losses of wild fry is difficult to assess.

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. One 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 – so long as they are not filled in or scoured out or filled in.

Box 6.1: Inorganic sediment definitions as used in the text (measurements are for the <u>longest</u> axis of the particle)

Silt	fine, sticky, mostly inorganic material
Sand	particles </= 2mm
Gravel	particles >2-16mm
Pebble	particles >16-64mm
Cobble	particles >64-256mm
Boulder	particles >256mm
Bedrock	continuous rock surface

Example: a substrate composed of a mix of stones of between 3 and 15 cm in length could be described as mix of pebbles and cobbles

Some rivers in Wester Ross (for example the Gruinard below Loch na Sealga and Little Gruinard below Fionn Loch) have an abundance of high quality 'multi-story' void-space for salmon parr. Perhaps not surprisingly, these rivers are consistently found, during e-fishing surveys, to have the highest parr densities.

Food availability is also likely to limit juvenile production. With hard metamorphic bedrock composed of minerals with low solubility, high grazing pressure and no current upstream human habitation, the Rhidorroch River is likely to be 'ultra-oligtorohpic', 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).

In the Ullapool River system, densities of salmon parr have varied between the years surveyed (1999, 2002 & 2004). Average densities were higher in 2004 than in previous years, but even during that year, parr densities for sites in the lower Rhidorroch River which forms a large part of the accessible area were low.

Quantitative electro-fishing site UPL3, in the Allt Coire Cronaidh tributary near Cadubh. Densities of juvenile salmon and trout are consistently much higher here than in the mainstem Rhidorroch River nearby.

6.7 The Rhidorroch River

6.7.1 Overview

Because the Rhidorroch River has the largest portion of potentially productive salmon habitat within the Ullapool River system, additional investigations were undertaken to identify the causes of habitat problems and find out whether there were any opportunities for improving conditions for production of juvenile salmon.

The Rhidorroch River is naturally unstable throughout its length, with highly mobile substrate, braided channels (below East Rhidorroch), bank erosion and collapse, and frequent scouring events associated with 'bed-load transportation' of sediment. Habitat for juvenile salmon is less than ideal: instability is likely to be a major factor limiting both recruitment of fry and the growth and survival of salmon parr.

Salmon have access within the river as far as the 'Smokey Falls'. The condition of the habitat below these falls is governed by what happens in the upper catchment (Figure 6.2). The erosion of sediment in the upper catchment and deposition of alluvium in the floodplain below East Rhidorroch is a natural feature of the river. However, *rates* of erosion and the *frequency* of damaging stream scouring events are also partly determined by land management practices.

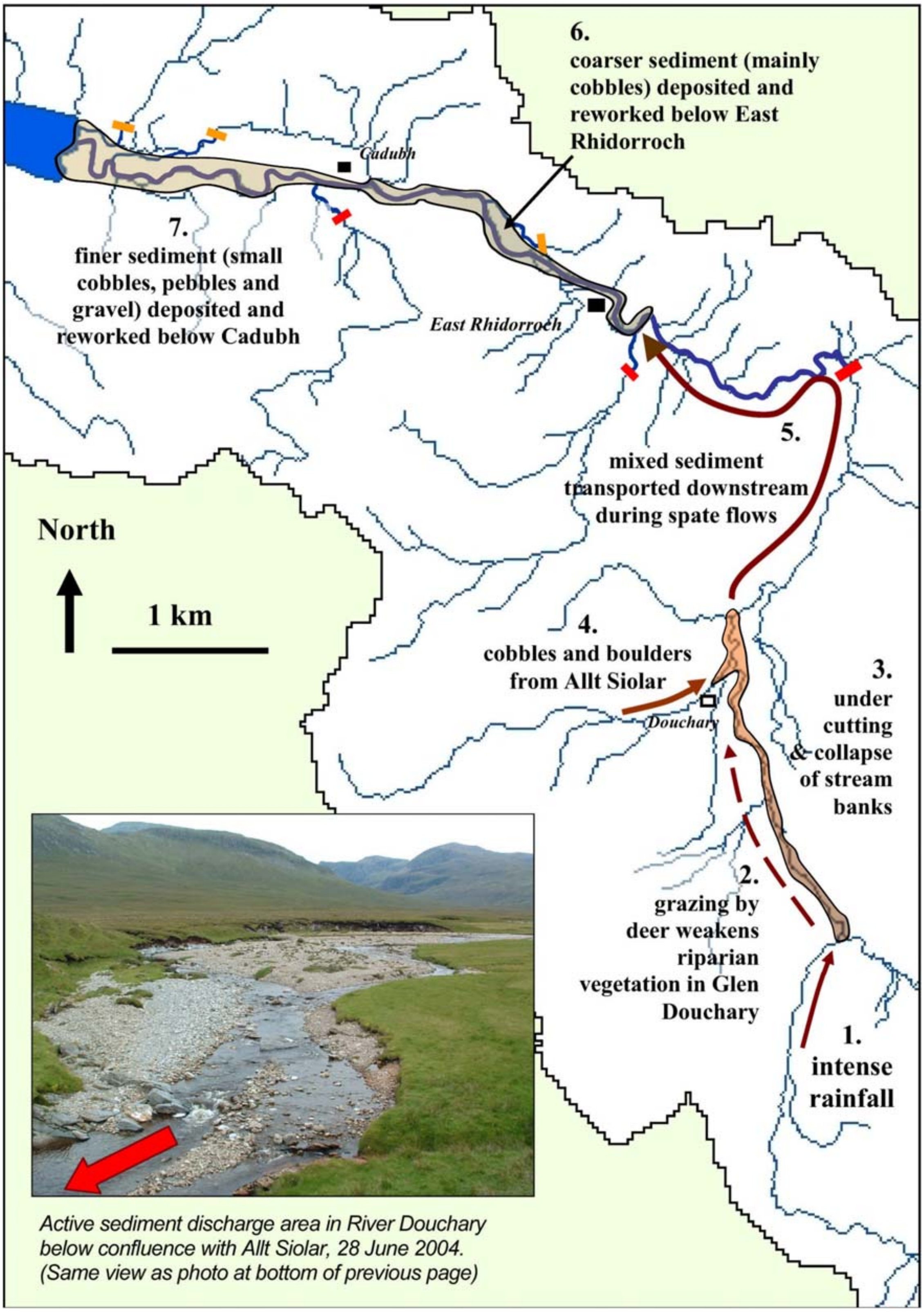
6.7.2 Erosion in Glen Douchary

Studies elsewhere have shown that grazing pressures affect stream stability by weakening deep rooted vegetation that would otherwise help to bind river banks. A survey of grazing pressure for the North Ross Deer Management Group by the Macaulay Land Use Research Institute (MLURI) in 2001–2002 identified areas of moderate and moderate-heavy grazing around Douchary in the upper catchment.

In December 2005, a very active sediment deposition/reworking area was located around Douchary. A high proportion of the coarser material (cobbles) appeared to originate from the Allt Siolar. Below this point, the gradient of the river becomes steeper. Most of the sediment that enters the river in Glen Douchary during spate flows is likely to be accelerated downstream trundling over the series of waterfalls and into the accessible part the Rhidorroch River. Much of this material is likely to remain in motion at least as far as East Rhidorroch before settling out. On its way down it destabilises the streambed, scours algae from substrate, and may 'wash out' eggs, invertebrates and even small fish.

Active erosion (above) and bank collapse (below) downstream of confluence with Allt na Creige Duibhe.

(above and below) Active sediment deposition and remobilisation area downstream from mouth of Allt Siolar. See Figure 6.2 for explanation.



Active sediment discharge area in River Douchary below confluence with Allt Siolar, 28 June 2004. (Same view as photo at bottom of previous page)

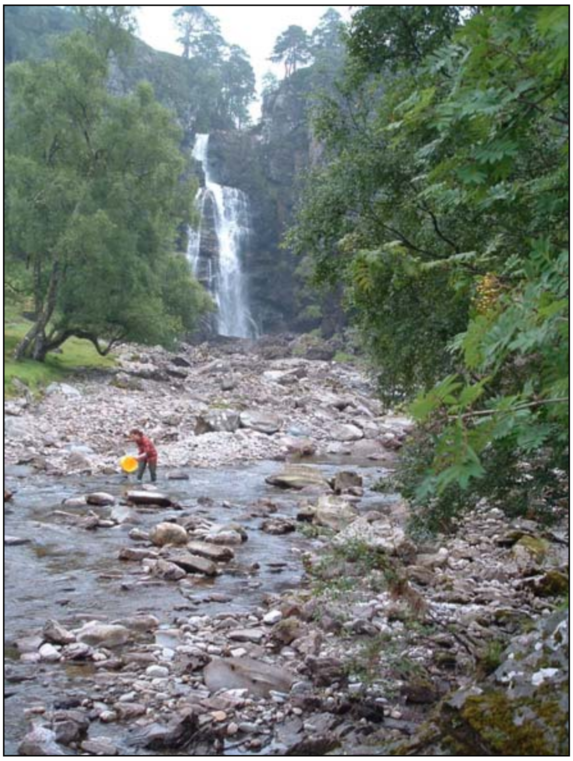
Figure 6.2: The quality of juvenile salmon habitat within the Rhidorroch River is governed by erosion and sediment discharge from Glen Douchary. If rates of erosion and sediment discharge go up, stream stability and fish habitat quality goes down.

6.7.3 Sediment deposition in Glen Achall

The main areas of sediment deposition in Glen Achall area are from East Rhidorroch downstream. Much of the coarser material (cobbles) settles out across an extensive (5+ ha) depositional area 1km downstream from East Rhidorroch. The rate at which sediment is 'dumped' in this area roughly determines the rate at which the river is pushed against the left bank, undercutting alder trees, parkland and fences. Over recent years knock-on erosion has been rapid. Alluvial sediment remobilised from here is transported downstream towards Cadubh.

Below Cadubh, there are a series of extensive deposition areas where finer material (smaller cobbles) settle out. These bars are also very active; as they develop, the river further erodes and undercuts the bank on the opposite side of the river. Over recent years rates of erosion have been rapid and there has been little growth of vegetation that might help to bind material.

The river continues through alder woodlands as it approaches Loch Achall. Finer sediment settles out here (mainly pebbles). Deposition areas here are also highly unstable. As they move, the river further undercuts riparian trees.



(above) The riverbed below the falls at the top of the Rhidorroch River is a jumble of freshly reworked boulders and other sediment, resting on freshly scoured bedrock. Not an easy place for small fish to live.

During spate flows, river banks above (top) and below East Rhidorroch are scoured by sediment from Glen Douchary.

(below) Much of the sediment settles out 1-2 km further downstream, shown at high water (14 Nov 05) and low water (20 Aug 02).

6.7.4 Impacts upon juvenile fish production of sediment movement and scouring

The degree to which high levels of sediment supply and stream instability impacts adversely on juvenile salmon production within the Rhidorroch River is not easily quantified. In 2004, densities were quite good in some part of the river (e.g. by East Rhidorroch, UPL1). Densities of juvenile salmon and trout at site UPL3 have been much higher than in adjacent parts of the main river in each of the years surveyed. This may be an indication of contrasting differences in habitat quality & food availability between the two waters.

Many of the 'gravel bars' in the Rhidorroch River may appear to be ideal spawning habitat for both trout and salmon. However, most of the spawning 'fords' are wide and shallow. During wet winters, excessive sediment movement may expose redds. Fish that are able to bury their eggs most deeply are likely to be most successful.

Mortality of juvenile salmon can be very high if the streambed in which they have sought shelter becomes mobile. For example, on 13 September 2005 the juvenile salmon population in the lower Talladale River (by Loch Maree) was decimated when the streambed (large boulders and cobbles) began to move. Local residents observed crows and other birds picking dead fish off the river bank. An electro-fishing survey a few days later confirmed that densities of juvenile salmon were very low (<1 fish per 100m^2).

6.7.5 Impacts upon fish food production

Over the past 40 years, there has been much concern about eutrophication (nutrient enrichment) of waters draining agricultural areas in the east and south of the UK as a result of land management. Little attention has been paid to long-term **oligotrophication** (nutrient impoverishment) of waters, where land management practices cut-off 'trophic' pathways and hinder nutrient recycling. In some areas more nutrient is removed through human activity (e.g. phosphorus in bones of deer and sheep carcasses) than recycled into the land. Further reduction of catchment fertility occurs where growth of plants such as clover, vetches and alder trees is limited by grazing pressure.

Unstable substrates tend to support fewer invertebrates than stable substrates. Primary production is restricted if algal growth is limited by low concentrations of dissolved nutrients and frequent movement of stones. 'Green' areas of streambed tend to support more insect larvae and more fish than 'bare' areas.

Leaf litter from riparian vegetation (including nitrogen rich alder trees) provides additional food for some insect larvae. However, frequent scouring also washes out organic material that can be utilised by secondary producers including various mayfly, stonefly and caddis fly larvae, further limiting production of food for fish.

The Rhidorroch River below Cadubh. Bars of small cobbles and pebbles are highly mobile. Salmon redds in this area are vulnerable to redd washout.

(above) Alder trees & woody debris provide cover for juvenile salmon, habitat for insect larvae, and help to stabilise the river channel. Regeneration (below) is limited by grazing pressure.

6.7.6 Synopsis

The Rhidorroch River is as it is for a range of reasons some of which are natural, some of which relate to land management practices over many years, and some of which may relate to changes in global climate with more intensive rainfall events and spate run-off that accelerate rates of erosion and sediment deposition. Although much of the Rhidorroch River is far from ideal as juvenile salmon habitat, each year it produces a run of wild salmon smolts.

Further work could be done to investigate and describe patterns and processes of erosion, sediment transportation and deposition along the Rhidorroch River. This might contribute to a more detailed understanding of how different parts of the river channel have developed and how the channel may change in the future, affecting both the quality of nearby grazing areas and fish production. However, this is beyond the scope of this report.

Part 7: Management options

7.1 Introduction

7.1.1 Development of management recommendations

Fisheries management is not simply about managing populations of fish. Around the world, there are too many examples of fisheries that are failing because attempts at intervention by 'experts' have been unsuccessful in generating understanding and support at the local level. Successful fisheries management requires effective, on-going, two-way communication with all people who are involved with the fishery, and mutual understanding and agreement. This is rarely easy to achieve!

Although 'catch and release' angling is becoming more popular, the most basic long-term aim of *fisheries* management (in contrast to *fish* or *wildlife* conservation) is usually to secure and sustain a harvestable surplus of wild fish. The recommendations for actions that are presented here aim to sustain or increase the productivity and/or value of the wild fisheries of the Ullapool River system.

Proposed actions are largely based on the information presented in earlier parts of this report. Much has been learnt about the river system and its fisheries. However, there are still important areas of uncertainty (e.g. Loch Achall; genetic status of fish populations). Some recommendations therefore remain tentative. Factors relating to ongoing changes in the status of wild fish populations, other wildlife, changes in the river, and changing priorities and opportunities for land management (e.g. grant availability, market values for stalking, livestock, etc.) may affect the relevance of some of the proposed actions. Already some of the information presented in earlier parts of this report is a little dated: recommendations should be considered and reconsidered in light of the latest available information.

As elsewhere in this report, suggested action points are bulleted.

7.1.2 Priority fisheries

The most important fishery in the Ullapool River system is the rod fishery for salmon. Brown trout and European eel are also present throughout the accessible area. The wild trout population, upon which the trout fishery in Loch Achall is based, is healthy and presents no cause for concern. However, there is international concern for conservation of the European eel. The eel population within the Ullapool River system is not known to have supported a local fishery although the population of eels in Loch Achall may be quite large.

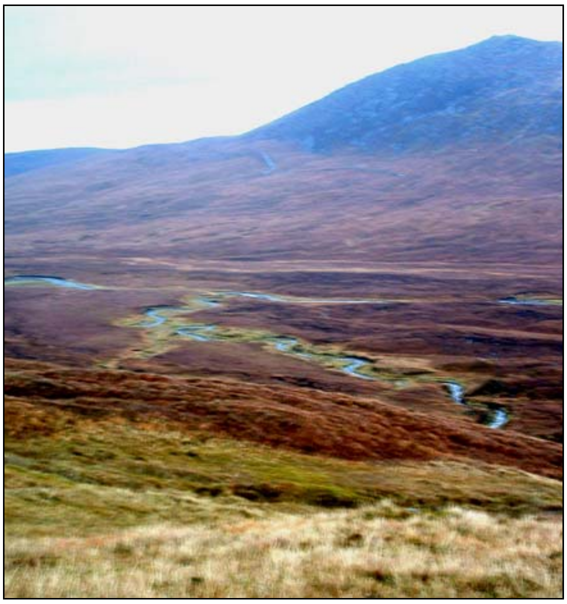
- *Eels now need to be protected. Fishing for elvers or adult eels should not be permitted.*

- *Further studies to learn more about eels in west coast river systems are required.*

One of the main objectives of the Fisheries Management Plan is therefore to identify ways of maximising the production of wild juvenile salmon from the Ullapool 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. The 'freshwater' part of the fishes' life cycle is within the riparian owners' control, whereas marine factors largely are not. This approach is also justified by the fact that the numbers of returning adult salmon depends partly upon the number of smolts produced by the river system, which in turn is determined by the numbers of juvenile fish that the river can support.

7.1.3 Catchment-based management

Production of juvenile salmon from the Ullapool River system varies according to how the catchment area is managed. Where appropriate, management recommendations address issues at the river catchment level.



A catchment based approach which takes account of management practices in Glen Douchary is required to achieve optimum conditions for wild fisheries production.

7.2 <u>Objective 1</u> *Protect Wild Salmon*

7.2.1 Responsible angling practices

To achieve a harvestable surplus with a wild fish population, the conservation of genetic diversity within the fish population and protection of the natural 'environment' (in its broadest sense) to which the fish population is adapted are of importance. Fish populations that are poorly adapted to the environments and life-challenges that they encounter are less productive than those with appropriate genetic characteristics.

Catch records presented in Part 4 of this report indicate that the Ullapool River's salmon fishery was characterised by an unusually high proportion of 2 sea-winter (2SW) salmon that were caught before the end of May. It is likely that the 'spring-running' characteristic of the Ullapool River salmon population is adaptive and has a genetic basis (see Part 8). Studies elsewhere have shown that early-running salmon can be subject to disproportionately higher levels of capture than later running salmon; 40% or more of early running salmon can be taken by anglers. This is partly because anglers have longer to fish for them, and perhaps also because spring salmon may more readily take an angler's fly that some of the salmon that enter later in the year.

- *Spring salmon need to be given the highest level of protection. Catch and release of 'spring running' fish, which has been practiced by anglers fishing the river for many years, is one way to ensure that losses are minimised. Guidelines for 'Catch and Release' are available from the Atlantic Salmon Trust and WRFT.*

Following preparation of an earlier draft of this report, two salmon were caught and released in the Ullapool River below the Ness Falls in April 2006. On 11th May 2006, the WRFT biologist snorkelled the pool, and counted three adult salmon, including one with a mark to its lower jaw (possibly one of the released fish). To progress upstream, these fish will need to be able to surmount a major obstacle.

- *If numbers of spring fish are thought to be very low (<10 fish), it may be prudent to delay the start of the fishing season to give maximum protection to what are potentially the most valuable 'broodfish' for the long-term wellbeing of the fishery.*

Without a fish counter it is difficult to establish whether or not 'surplus' salmon are available for capture. Snorkel surveys at other times of year (or observation from above) can help to establish salmon numbers in the Ness Pool. Production of salmon smolts from the system is likely to increase as numbers of spawning salmon increase perhaps up to ~40 spawning 2SW females (deposition of ~240,000 eggs)[1] especially if surplus eggs that are washed out of spawning gravels in the Rhidorroch River provide an important over-winter food resource for juvenile salmonids[2].

Visual surveys of pools can help to provide an indication of numbers of adult salmon.

Box 7.1 Catch and Release

The following tips and reminders are based on a recent article in the Atlantic Salmon Trust Summer Journal 2006 by John Webb (AST Biologist):

- *Flies with small single hooks with crimped barbs are less likely to damage fish than large treble hooks. Prohibit the use of tailers, gaffs and knotted nets. Only lightweight knotless mesh nets should be used. Ensure that all anglers have the right equipment including forceps to unhook fish.*
- *When showing rods the pools for the first time, it is useful to advise anglers where to land, unhook and release their fish safely at different water heights.*
- *Unless access or personal safety is an issue, then fish should be kept in the water at all times. Sea-liced & other fresh run fish are particularly susceptible to scale loss. It is therefore important to ensure that anglers and ghillies wear waders.*
- *Provide copies of C&R advice in fishing huts and accommodation.*

7.2.2 Maintain support for salmon conservation within the local community

Providing access to fishing through the local angling club and day tickets is one way to maintain support for protecting wild salmon within the river. The current access arrangements seem to work well. However:

- *It is important that all anglers are aware of concerns for wild salmon in the Ullapool River and understand the management requirements for safeguarding the salmon population. WRFT would be delighted to design and provide interpretative information leaflets or information panels about the Ullapool River's salmon population for angling guests.*

If numbers of wild fish increase within the area, incentives for illegal fishing may reach the point when poaching becomes a problem. Salmon gill nets are available through the internet for as little as £40. The Scottish Fishery Protection Agency (SFPA) can help to police inshore waters.

- *The appointment of a local 'Fish Conservation Officer' to work within the local community and raise awareness of the need to protect wild fishes may help to discourage illegal activity. This is something that could be discussed with the new Wester Ross Area Salmon Fishery Board (WRASFB), SFPA, and Scottish Natural Heritage (SNH).*

7.2.3 Monitor sea lice levels on wild sea trout in May–June

It is several years since sea lice epizootics have been reported from Loch Broom. Although salmon smolts do not return to freshwater if they become infected with sea lice, sea trout smolts do and may provide an indication of infection pressures in inshore waters during the period when salmon smolts head to sea.

- *Foster communication and cooperation between wild fisheries interests and salmon farming interests. WRFT supports the Tripartite Working Group (TWG) and the formation of Area Management Agreements (AMAs) to improve the health of both wild and farmed fish. WRFT also supports the appointment of a Fish Health Regulator, as proposed in the forthcoming Aquaculture Bill (2006), to ensure that sea lice are adequately monitored and controlled on farmed fish.*

- *The level of surveillance for sea lice on wild sea trout within the tidal pools of the Ullapool River and other nearby river estuaries should be adequate to ensure that lice epizootics (the occurrence of more that 30 lice on consecutive sea trout), should they occur at any time of year, are recorded and reported in a timely manner to all interested parties, including WRFT, local fish farm companies and Fisheries Research Services. The Ullapool Angling Club may be able to help to ensure that sea lice surveillance is adequate.*

7.2.4 Monitor predators

It may also be useful to monitor numbers of seals and fish-eating birds in the river estuary, especially during the period when smolts are descending. Smolts tend to head out to sea at night so late evening or early morning observations are most likely to relate to any possible predation of smolts. Note that other fish species (e.g. flounder, sandeels) are usually targeted by fish eating predators in estuaries. However, particularly during periods of low flow in April, May and early June, smolts may be particularly vulnerable.

- *If there are concerns that predators are targeting salmon smolts (or adult fish) to the extent that the salmon population and fishery may be adversely affected, in the first instance observations of predators (including, date, time place, species, number of predators, and behaviour) should be recorded and reported to WRFT, WRASFB and SNH. Any justification for subsequent action will depend upon the quality of evidence presented. Please contact WRFT or WRASFB for further information and to arrange training.*

7.3 <u>Objective 2</u> *Where possible, take action to improve habitat for salmon*

7.3.1 Introduction

The Rhidorroch River provides the largest area of accessible habitat for production of juvenile salmon within the Ullapool River system. As discussed earlier, the Rhidorroch River is naturally unstable. Although wild salmon are adapted to life within unstable river environments, eggs, fry and parr are vulnerable if the streambed in which they shelter is filled in with fine sediment or scoured-out during spate flows.

Densities of juvenile salmon, particularly of larger parr, were found to be low within the Rhidorroch River (see Part 5). Production of wild salmon smolts from this part of the river (which is described in Part 6) is probably compromised by excessive instability caused by river bank erosion and bedload sediment transportation from Glen Douchary. The frequency of spate events; the rate of stream bank erosion, sediment deposition and remobilisation, and the frequency of scouring, are determined by:

1. the frequency of intensive rainfall
2. the strength and stability of stream banks and the river bed.

Changes in rainfall patterns associated with global climatic change may be leading to an increase in the frequency and intensity of rainfall, with more rapid run-off and more powerful and erosive spate events.

Little can be done to influence rates of water run off. However, the amount of sediment that is transported downstream with each spate is partly determined by how easily material can be eroded into the river, mobilised and remobilised. Where riparian vegetation is stronger and binds riverbanks together, the rate and frequency at which sediment enters the river and is transported downstream during spate events is lower.

It is not possible to easily quantify the benefits to levels of production of juvenile fish as a result of any management action aimed at stabilising rapidly eroding stream banks. This is because sediment transportation is unpredictable and varies from year to year according to the magnitude of spate events. However, densities of juvenile salmon over stable substrates are usually much higher than over very unstable substrate [3].

- *A comparison of densities and relative growth of salmon fry and salmon parr in areas where in-stream habitat is stable substrate with areas where in-stream habitat is unstable may help to further clarify the extent to which stream stability influences levels of salmon smolt production.*

7.3.2 Upper Catchment

Assuming that frequent scour, erosion and remobilisation of in-stream sediment is detrimental to salmon smolt production, any actions that help to strengthen stream banks and help to stabilise sediment bars in the upper catchment will help to limit any damage that can be caused to juvenile salmon habitat within the accessible part of the Rhidorroch River. There are a number of very active erosion 'scars' along the River Douchary and in-flowing tributaries where rates of erosion and rates of sediment transportation could be reduced if riparian vegetation could be strengthened. The roots of native trees & bushes such as alder and willows would help to bind stream banks together if they were able to grow (see Box 7.2)

Eroding stream banks on the Allt na Creige Duibhe in Glen Douchary

<u>Options:</u>

1. Do nothing. Deer stalking is of primary economic importance to local estates and any action that would reduce the deer grazing area is unlikely to be regarded as being acceptable by the landowner.

2. Reduce deer numbers to levels at which trees and shrubs are able to regenerate naturally. This is the option for long-term recovery of a more productive ecosystem (i.e. restoration of more nutritious vegetation including nutrient mobilising plants; restoration of soil fertility including a more

active soil biota; restoration of higher levels of plant and animal growth and production).

3. Establish woodland enclosures to limit rates of erosion within the upper catchment area. These could be targeted to help stabilise the areas that are most unstable. In addition to helping to stabilise stream banks, leaves from trees can provide food for aquatic insect larvae and woody debris provides additional cover for fish.

Recommendations:

- *The productivity and health of the salmon population within the Ullapool River system is likely to increase if deeper rooted trees and bushes could be established in currently unstable riparian areas along the River Douchary within Glen Douchary (above the accessible area). Options for creating riparian woodland enclosures within the glen should be explored further with all stake-holders, including landowners and SNH.*

- *A cost-benefit analysis might be the most sensible first step. This could include an investigation of the availability of grants for riparian enclosures. All stakeholder groups, including estates, government agencies and management organisations should be con-sulted to ensure that values used in any analyses are realistic and agreeable to all parties. Following the establishment of strongly rooted trees and bushes, limited grazing within riparian enclosures may be possible.*

[A tentative cost-benefit analysis which attempted to contrast possible increases in the value of salmon fishing in the Ullapool River with possible decreases in the value of deer stalking in Glen Douchary following the establishment of riparian woodland enclosures in Glen Douchary, based around figures provided by the Deer Commission Scotland and WRFT juvenile fish survey data and presented in an earlier draft, has been removed following comments from SNH. At the time of writing, the Scottish Forestry Grant Scheme (SFGS) and support for woodland restoration is currently under review].

7.3.3 Rhidorroch River

The main sources of sediment that destabilise the Rhidorroch River are in Glen Douchary (see above). However, to reduce the rate of remobilisation of sediment in Glen Achall and thereby improve habitat for juvenile salmon and other fish, riparian vegetation with stronger roots could be established along denuded sections of the Rhidorroch River corridor below East Rhidorroch. In this part of the catchment the erosive power of spate flows is such that fully established deep-rooted trees will be required to make any significant difference in terms of resisting stream bank erosion. Especially in the short-term, fences and riparian bushes would be vulnerable to bank collapse. Much of the lower Rhidorroch River is primarily 'trout' habitat.

<u>Options</u>:

1. Do nothing. The Rhidorroch River floodplain is the most important grazing area for cattle, sheep and deer on Rhidorroch Estate. The management priority is to maximise the value of riparian areas and the floodplain for grazing livestock. Any actions that lead to a reduction in the grazing area or obstruct animals moving within or across the valley would not be acceptable.

2. Reduce grazing levels to allow for natural regeneration of alder trees along riparian areas. This could be achieved either through a reduction of grazing animals (including deer) within the area, or through the creation of enclosures along parts of the river corridor. For the latter, the main difficulty would be the provision of suitable water gates to prevent deer or livestock from entering enclosures. Technical problems can be addressed if there is justification for floodplain woodland restoration on this scale.

Recommendation:

- *If a catchment-based management approach is adopted, actions to stabilise riparian areas in the upper catchment (Glen Douchary) should be regarded as being of higher priority than actions within Glen Achall. Even without actions to reduce rates of erosion in Glen Douchary, actions to reduce rates of erosion of riparian areas in Glen Achall may be beneficial to the salmon fishery. However, it is less likely that these could be justified on the basis of possible advantages to the salmon population alone.*

Undercut stream bank turfs on the move in Glen Douchary.

Box 7.2 Alder trees and juvenile salmon production

Alder trees (or bushes) are particularly valuable as riparian trees, where the aim is to enhance production of juvenile salmon or trout.

Firstly, the roots of alder trees can help to bind riverbanks together and limit rates of erosion and stream bed destabilisation. For the Rhidorroch River, this could be particularly important, for areas both above and below the accessible area. Secondly, the roots of established alder trees provide cover for both small fish and invertebrates. Thirdly, alder trees are a source of leaves and woody debris providing additional food for insect larvae, and indirectly, for fish.

Fourthly, alder trees live in symbiosis with the nitrogen fixing bacteria, *Frankia alni.* Where instream productivity is limited by nutrient availability, additional nutrient that leaches out of soils can increase levels of primary production. Soils beneath alder trees tend to be more fertile. Where alder trees are present, productivity is usually determined by the availability of phosphorus.

The only potential disadvantage of riparian trees is that they can shade out in-stream vegetation. River water temperatures may be cooler during summer months where there is dense canopy cover reducing the amount of sunlight that falls on the water. Ideally, alder trees are coppiced to maintain vigorous growth of leaves (and roots) with minimal shading.

Alder trees, Abhainn Gleann na Muice (Gruinard River system, 150m above sea level).
Left: living tree roots extending 20m from the trunk prevent bank erosion and collapse.
Right: nearby, a tree has recently died: roots are rotting and the bank is eroding causing stream widening with resulting loss of cover for adult and juvenile fish.

7.3.4 Tributary streams

There are a number of opportunities for the development of natural riparian habitat along minor tributaries flowing into Loch Achall and the Rhidorroch River, to enhance the production of both juvenile trout and salmon. These are best considered *in situ.*

This back channel on the Rhidorroch River floodplain could provide salmon parr habitat if a permanent flow could be maintained!

7.3.5 *Rhododendron* control

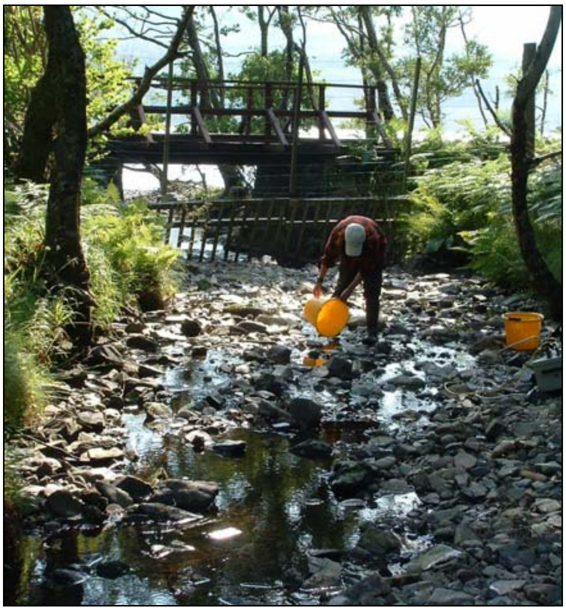
The removal of *R. ponticum* will have little immediate or obvious direct benefit to wild fisheries. However, if action is not taken, native vegetation around Loch Achall may be gradually overwhelmed. This will adversely affect biodiversity and also the potential to restore and enhance the natural productivity of the area including wild fisheries. If the abundance of native invertebrates declines, the availability of terrestrial food for juvenile fish will also decline.

Removal of *R. ponticum* can be a sensitive matter. To date, there are no laws requiring landowners to control it (as for ragwort). There are many other attractive rhododendron species which are non-invasive and can be grown in gardens without the same levels of threat to native wildlife and ecosystems. Advice about alternative species and support for rhododendron control programmes is available from SNH and SEERAD.

Along the north side of Loch Dughaill (River Carron system), the spread of rhododendrons has reached the stage where eradication is practically impossible, and control hugely expensive.

Recommendation:

- *A programme to control and ultimately eradicate Rhododendron ponticum from the Ullapool River catchment sooner rather than later would be of benefit to wild fisheries. Grants to replace R. ponticum with native trees and shrubs, e.g. Holly, Juniper, Blaeberry may be available from SNH or the Scottish Forestry Grant Scheme.*



Salmon spawning burn by Rhidorroch House. Recent (July 2006) gill net studies of Loch Maree found salmon parr in shallow margins of the loch. Small burns around lochs may be of particular importance as fry habitat for salmon, with juveniles migrating to loch habitat to spend their 1st winter (post-hatch) and 2nd summer.

7.4 <u>Objective 3</u> *Supplementary stocking ('re-cycling' eggs of native fish)*

7.4.1 Why stock?

Through natural selection, wild salmon become adapted to the environments in which they live. The most productive wild salmon populations are therefore those that have reproduced within an environmentally stable system over many generations.

There has been a long history of stocking both the Rhidorroch River and the hill lochs of Rhidorroch Estate with salmon and trout fry. We now have a much better understanding of why the stocking of non-native salmon can be detrimental. Studies elsewhere have shown that stocked of non-native origin perform poorly relative to fish of native origin. Changes in runs of salmon in the Ullapool River during the 2nd half of the 20th Century may relate to the stocking of non-native salmon fry from 1947. However, in more recent years, stocking by 'recycling eggs' of native Ullapool River fish may have accelerated the recovery of the population (see Part 4). 'Recycling eggs' means taking wild broodfish from the river, stripping eggs and incubating eggs in a hatchery, then stocking progeny back into their native river.

The risk of adversely affecting the genetic 'integrity' of the juvenile salmon population through stocking with fish of native origin needs to be balanced against the risk of there being inadequate numbers of juvenile salmon to maintain production of an adequate number of suitable smolts. By using native stock, any risk to the genetic integrity of the population can greatly reduced. The question is then whether it is more sensible to leave all returning adult fish to spawn naturally in the wild or whether there is any advantage in intervention.

In situations where the combined risk to subsequent recruitment of A: predation to a wild adult female salmon within the river system before she has completed spawning and of the loss of her eggs and alevins through redd washout, is considered to be significantly higher than the combined risk to subsequent recruitment of B: loss of the same fish, removed from the river and retained in captivity, and the loss of her eggs and alevins within a hatchery and following release back into the wild, ***recycling of eggs may help to safeguard a salmon population and fishery***.

In the wild, especially when numbers of spawning fish are low, predation by otters may account for 20%+ of adult salmon (Cunningham et al., 2002) and redd washout may lead to the loss of 50% or more of eggs and alevins prior to swim up (Butler, 2000). Experiences of estate hatchery programmes in Wester Ross are mixed[4]. Rates of mortality of retained rod-caught adult salmon before spawning are often low where the fishery manager has experience: probably less than one in four salmon die prior to being stripped. Egg and alevin survival in established hatcheries is usually high (90%+ survival to swim up). This is something that the fishery manager has to decide for himself.

With regard to the Ullapool River, several additional points should be made. In years when there have been adequate (surplus) numbers of wild salmon spawning, stocking of fry is likely to have made little difference to smolt output. This is for the following reasons.

1. Electro-fishing surveys (Part 5) suggest that the production of smolts from the Rhidorroch River has been limited not simply by a lack of fry, but by a lack of larger juvenile fish. The main factor limiting salmon smolt production in most years is possibly poor over-winter survival relating to habitat quality (discussed above), food availability and perhaps predation of juvenile salmon by trout (see Part 8).

2. Eggs and alevins that are washed out of redds may be a vital source of food for salmon fry and parr in the Rhidorroch River during the winter. They are not necessarily wasted.

3. Although survival to the 'fry stage' may be higher in hatcheries than in the wild where 'washout' occurs, in some situations stocked fish may suffer higher mortality after being stocked out into an unfamiliar environment than their wild counterparts.

4. The genetic health (and productivity) of the salmon population relates to the overall size and of the gene pool and how well adapted (in a genetic sense) the population is to its 'environment'. If stocked fish do out-compete the progeny of fish that have spawned naturally, there is a risk that subsequent smolt runs will be dominated by progeny of the fish used as broodstock rather than by progeny of any fish that spawned naturally in the wild.

Nevertheless, there are reasons why in some situations, stocking by ‘recycling eggs’ may be beneficial. When recycled eggs and fry of native origin were stocked into areas where wild salmon fry were not present (e.g. upper Gruinard, Bruachaig – both areas where wild salmon had not spawned), they grew well, potentially adding considerably to the overall production of smolts from respective systems. If stocked fish are also progeny of wild salmon that have returned to the river, any subsequent diminution of the gene pool may be no more than that which would occur in any case during periods when the numbers of wild spawning salmon are very low and / or many redds are washed out.

Over the past 20 years numbers of spawning adult fish have been low in some of the other small rivers within the WRFT area, and it is possible that in some years, smolt runs from these rivers were dominated by progeny of only one or two female salmon. Fin clip samples of many salmon populations in Wester Ross have been collected for DNA analyses by Fisheries Research Services (FRS); useful results are still awaited. Are salmon in the Ullapool River part of a discrete population or part of a ‘meta-population’ with frequent gene flow between nearby rivers?

During the period 1990 to 2000, wild juvenile salmon were absent from parts of many river systems within the WRFT area including parts of the Kanaird, Lael, Gruinard, Tournaig, Ewe (including the Bruachaig), Balgy, Elchaig and Glenmore Rivers. Some populations appear to have retracted or even been lost as a result of ‘downward spiralling’: a reduction in rates of marine survival meant that fewer adult salmon returned to spawn, fewer eggs were deposited, fewer smolts were produced, and subsequently even fewer adult fish returned to spawn. Parts of river systems from which salmon populations were lost include sections above difficult waterfalls where there may have been additional mortality of returning adult fish and areas where habitat instability would have led to relatively high losses of eggs and alevins compared to more stable spawning habitat in ‘core’ parts of river systems. Much potentially valuable genetic material has probably been lost (as with Herring, Cod and other economically valuable fish species?). In some situations, appropriate, timely management intervention could probably have made a difference.

If salmon populations (and the fisheries they support) in more ‘’marginal areas’’ are to remain viable during periods when rates of marine survival are low there may be an over-riding need to ensure that adequate numbers of suitable smolts are produced to prevent ‘downward spiralling’. These smolts need to be of native or near-native origin if they are to make a contribution to the long-term survival and success of a salmon population. For small west-coast river systems, an ‘adequate’ number of smolts may mean a number close to the smolt production capacity of the river system. Note that the ‘smolt production capacity’ of the system relates primarily to the ***area and quality*** of accessible habitat, as discussed in Part 6.

- *In the context of the Ullapool River, there is therefore justification for considering stocking through recycling of eggs of native fish to support the salmon population during years when numbers of wild adult salmon are known to be low (less than ~50 salmon above the Ness Falls) or severe spates ‘wash out’ eggs of wild fish from redds within the Rhidorroch River. The risk of adverse genetic consequences can be minimised by following best practices outlined in Fisheries Research Services ‘Salmon and Sea Trout to Stock or Not?’ (copies available from WRFT) and seeking river specific guidance from FRS and the WRFT biologist.*

Rarely will it be clear whether or not there has been adequate recruitment until electro-fishing surveys have been carried out during the summer following the spawning season. Nevertheless, the risk of harm to the salmon population by stocking up to 15,000 salmon fry (mixed families of native origin) into the Rhidorroch River when there are already sufficient numbers of fry in the river is likely to be less than the risk of harm to the salmon population by not stocking when natural recruitment has been inadequate. Salmon fry should come from two or three female salmon each crossed with as many different suitable male salmon as possible. A 2SW female salmon of 4kg will produce about 6000 eggs.

All said (!), rod catches of salmon in 2004 and 2005 suggest that numbers of salmon returning to the river have recovered substantially since the turn of the century. In 2005, salmon fry of wild origin were found in the upper Rhidorroch River in 2005, and at high densities near East Rhidorroch. These are the best fish to have in the river. Therefore:

- ***For the time being (based on 2004–2005 catches) there is probably no need to stock.***

If, in the future, falling rod catches or other observations indicate that numbers of wild salmon returning to the Ullapool River have again fallen to critically low levels, resumption of a stocking programme may help to safeguard a salmon population and a fishery.

7.4.2 When to stock

When the number of returning adult salmon is likely to be insufficient to ensure adequate recruitment, recycling of eggs should be considered as a means of safeguarding production of juvenile salmon. In the context of the Ullapool River above the falls, a minimum 'spawning target for salmon' may be as low as 20 female salmon (and a further 20 male salmon to fertilise them) depending upon the likelihood that eggs from natural spawnings will survive to hatch. Because egg survival is likely to vary from year to year according to winter river conditions, it is difficult to be more precise about the numbers of salmon required. It also depends whether the spawning salmon distribute themselves evenly within the system (there is some evidence that, given suitable water levels, they are quite good at doing this!). Low water conditions may lead to crowding. As discussed earlier, the 'wash-out' of eggs and alevins may not be entirely detrimental if older juvenile salmon are able to gain nourishment by eating them.

7.4.3 Selecting broodstock.

Fish taken from above the Ness Falls (i.e. fish which have demonstrated that they are capable of surmounting the falls) are likely to be best suited in the long-term for the health of the salmon population. Only during exceptional years when, due to drought, salmon are unable to ascend the falls, should fish from below the falls be taken. In such years, stocking may be of particular importance. It is tempting to suggest that only 2SW spring salmon caught in the autumn at the mouth of the Rhidorroch River should be used as female broodstock. However, changes in stock composition from the 1950s to a higher proportion of summer grilse may in part be in response to natural changes in the environment and salmon population (see Box 4.2). Male broodfish could include a few precociously mature male salmon parr taken from the Rhidorroch River if suitable adult male salmon are unavailable.

7.4.4 How many to stock and where?

The aim should be to supplement natural production and as far as possible to minimise competition with the progeny of any wild fish that have spawned. Try to find out where wild fish spawn by walking spawning streams from late October through November. Do 2SW salmon spawn earlier in the Rhidorroch River than later running female grilse?

Ewen Scobie with a magnificent MSW cock salmon at Rhidorroch.

Given the area of parr habitat and potential smolt production in the Rhidorroch River (maximum about 6,500 smolts), the stocking of ~15,000 fry of native origin into suitable salmon habitat (substrate of large pebbles and small cobbles) at low densities is likely to be most efficient in terms of minimising subsequent mortality. The best places to stock may vary from year to year. It may be helpful to discuss where to stock with the WRFT biologist so that what is known about spawning distribution of wild fish and subsequent 'redd washout' prior to stocking can be fully considered.

7.4.5 Monitoring success of stocked and wild fish

Another reason why efforts should be made to stock away from areas where wild fish may have spawned is to enable subsequent monitoring of the progeny of both wild fish and stocked fish. It is not usually possible to assess the success of natural spawning until an electro-fishing survey is undertaken. If sites to be electro-fished have earlier been stocked, the usefulness of the electro-fishing survey may be greatly reduced. Recently emerged fry can sometimes be seen around redds in low water on sunny days as early in the year as May.

In the context of the Rhidorroch River, if the top 1000m of the accessible area was left unstocked, it would allow for annual monitoring of the wild salmon population. This area is likely to include some of the spawning area of 2SW spring salmon (although there is little reason to suppose that any fish that reach Loch Achall are unable to reach the top of the accessible area to spawn). Some of the parr from downstream areas are likely to migrate upstream during their second spring and summer and thereby 'fill in' any suitable vacant habitat.

7.5 Objective 4 *Monitoring and record keeping*

The status of fish populations may change from one year to the next. The need for intervention and likely value of any intervention may also change. These can be reassessed following monitoring.

- *WRFT should continue to provide information describing the occurrence, distribution, relative abundance and growth of juvenile salmon and other fish on an annual basis via electro-fishing surveys to inform management.*

- *Surveys of spawning fish in late autumn or of redds in early winter (John Webb pers. com.) may help to clarify the abundance of spawning fish, their distribution and the success of spawning. Any need for supplementary stocking may also be clarified.*

The Cromarty Estate and Rhidorroch Estate's game books have enabled much to be learned about the fisheries and their management over the past century. They demonstrate the value and importance of good record keeping. We are able to know that the Ullapool River has supported a special salmon population largely thanks to good record keeping.

- *Rhidorroch Estate should continue to record details of all fish caught within the system. Where details of stocking, water levels, severe weather, wildlife sightings and other events are also recorded, much can be learned.*

7.6 Summary of fisheries management recommendations

Table 7.1 Presents a summary of the recommendations of the WRFT biologist as of 10th July 2006. Note that some recommendations may change following the next survey!

Table 7.1 Summary of main fisheries management recommendations for the Ullapool River.

Objective	Action
1. Protect wild salmon, *especially early returning fish. Carefully handle and release all salmon caught before the end of June. If there are few early fish, consider delaying the start of the angling season to give them the best chance of survival until spawning.*	Rhidorroch Estate, anglers, WRFT
2. Where possible establish stronger-rooted riparian vegetation *to help stabilise stream banks and reduce rates of sediment movement within the Rhidorroch River. Consider options to establish riparian woodland enclosures in Glen Douchary and Glen Achall.*	Estates, SNH, SNW, Deer Commission Scotland
3. Don't stock for the time being. *If there is concern that numbers of returning adult salmon have again fallen to very low levels, consider recycling eggs of native salmon. Seek further guidance from WRFT or FRS.*	Rhidorroch Estate
4. Monitoring and Record keeping*. WRFT can provide information on an annual basis to inform management. Continue to maintain detailed records of fish catches.*	WRFT, Rhidorroch Estate

Abbreviations:
FRS: Fisheries Research Services
SFGS: Scottish Forestry Grant Scheme
SNH: Scottish Natural Heritage
SNW: Scottish Native Woods
WRASFB: Wester Ross Area Salmon Fishery Board
WRFT: Wester Ross Fisheries Trust

References and notes

[1.] Armstrong, J.D. (1994) Habitat requirements of Atlantic salmon. In ‘Salmon in the Dee Catchment: The Scientific Basis for Management’ Atlantic Salmon Trust ‘Blue Book’ Moulin, Pitlochry. There is a graph showing how smolt production varies according to egg deposition in the Girnock Burn.

[2.] Youngson, A.F. and Hay, D.W. (1996) The Lives of Salmon. Swan Hill. There is a section describing the occurrence of marine lipids in juvenile salmon: they were found to have been derived from ingested salmon eggs. Earlier studies by Henry Egglishaw at the Freshwater Fisheries Laboratory looked at the number of eggs eaten by juvenile trout and salmon in the Sheligan Burn.

[3.] WRFT electro-fishing data. The highest densities of juvenile salmon were recorded at stable sites in the Gruinard and Little Gruinard Rivers. Juvenile salmon were particularly hard to find in the River Talladale (by Loch Maree) and Abhainn Gleann na Muice following a streambed scouring spate in September 2005. The upper Rhidorroch River has much in common with the Talladale River.

[4.] WRFT information. In a worst case scenario, several adult salmon were lost in a holding tank prior to being stripped when the water supply failed. This appears to have been an atypical event: elsewhere salmon have been transported from the river to holding tanks and survived several weeks until the spawning season. Rhidorroch Estate has already much experience of operating a small hatchery programme to recycle eggs for the river and is therefore as able to weigh up the risks of mishap as any outside party. Peer review of hatchery programmes might be helpful in minimising the risk of any losses.

Part 8: Recommendations for further research

8.1 Introduction

Recommendations for the management of fisheries in the Ullapool River system are presented in Part 7 of this report. These focus on measures to protect wild salmon, actions to improve instream habitat and riparian habitat for juvenile salmon and on when and when not to 'recycle' salmon eggs to safeguard the salmon population. However, there are several areas where further research could be particularly helpful to inform management decisions in the future.

Many of the topics presented here are flagged up for collaborative study with a research institution. Some of the questions presented here are the same questions that need to be answered to inform fisheries management in other areas.

8.2 <u>Research Topic 1</u>

To what extend do juvenile salmon utilise Loch Achall?

Little is known about the occurrence of juvenile salmon in loch habitat, as elsewhere in Scotland.

Even if present at relatively low densities (~10 salmon parr per ha), Loch Achall is large enough to contribute significantly to the production of salmon smolts from the Ullapool River system. Based on research elsewhere, the loch may contribute up to 25% of the salmon smolts produced in the river system (see Table 6.5). Larger salmon parr were scarce within the Rhidorroch River. The loch may provide important habitat for salmon parr during their final year in freshwater before smolting.

PS: Larger salmon parr were found in shallow parts of Loch Maree during gill netting studies in July 2006.

Loch Achall has supported a fishery which has sustained catches of as many as 1000 trout per year of average weight 100-150g (1/4-1/3lb). Larger trout exist: in 2005, a brown trout of 5lb was taken from the mouth of the loch. Sea trout were rarely recorded from the loch; in most years they appear to be unable to ascend the Ness Falls. Trout are known to take juvenile salmon (see Part 4.8). In contrast to other comparable lochs on salmon rivers in Wester Ross (e.g. lochs Dughaill, Damph, Maree, Fionn, na Sealga) Arctic charr are not known to inhabit the loch. Minnows have not been recorded (they are known to be present in lochs Dughaill, Damph, Maree, but not Fionn or na Sealga). Black-throated diver has attempted to breed in the loch and small fishes are likely to be of importance to them.

- *A fish inventory survey using multiple mesh size gillnets, following standard European protocol would provide some basic data regarding the relative occurrence of different fish species including juvenile salmon at different depths within the loch. Such a study could be developed in collaboration with FRS and SNH.*

Are juvenile salmon present in the shallow areas of Loch Achall?

8.3 <u>Research Topic 2</u>

To what extent is the production of juvenile salmon restricted as a result of interaction with brown trout?

Trout and juvenile salmon are known to compete for habitat and for food during both summer and winter months. Small trout eat juvenile salmon (see Part 4). In most river systems in Wester Ross the accessible area for salmon and sea trout are the same: so many of the juvenile trout which grow in areas where juvenile salmon are found are likely to be progeny of sea trout. In these situations, juvenile trout and salmon are both of comparably high value to a fishery. However, the Ullapool River system is unusual in that very few sea trout ascend the Ness Falls. The population of small trout in the Rhidorroch River is therefore likely to comprise almost entirely of brown trout progeny.

From fisheries management perspective, juvenile salmon in the Ullapool River are worth more than small brown trout. If the juvenile salmon population were to fall because of a lack of spawning adult salmon within the system, the trout population may increase as trout crop drifting food items that would otherwise have been taken by salmon in the faster flowing water (riffles and runs) between the pools. If the population of trout were to increase (e.g. in the lower part of the Rhidorroch River), then levels of predation of salmon by trout may also increase, further limiting production of juvenile salmon.

- *The lower Rhidorroch River is ideal for snorkel survey of juvenile salmon and trout during low flows in the summer. An annual snorkel survey may provide a measure of the relative abundance of trout and salmon in a part of the system where the frequency of interaction (competition and predation) between the two species may be particularly high.*

- *Following Dougie William's discovery, the stomach contents of trout caught at other times of year (particularly late winter and spring) should be investigated to learn more about predation of salmon by trout.*

8.4 <u>Research Topic 3</u>

To what extent does the Ullapool River support a unique salmon population?

Preparation of this Fisheries Management Plan has highlighted the unusual characteristics of the Ullapool River's salmon population. The predominance of early running fish until the 1950s set it apart from nearly all other salmon populations within northwest Scotland. In contrast, the salmon population of the Little Gruinard River (a SAC for Atlantic salmon) is dominated by grilse (90% of catches in 1995–2000), as is the Gruinard River nearby. Neither of these systems have major obstructions such as the Ness Falls. The only other comparable system within the WRFT area with a consistent run of spring salmon is the River Ling near Dornie (although records for the Ling are not as detailed as those for the Ullapool River).

One concern that emerged was that the 'early running' characteristic, which presumably had a genetic basis, may have been lost as a result of the stocking of non-native fish or poor marine survival of 2SW fish.

- *Genetic studies need to be undertaken to clarify how different Ullapool River salmon are from salmon returning to neighbouring rivers.*

8.5 <u>Research Topic 4</u>
A culturally oligotrophied river system?

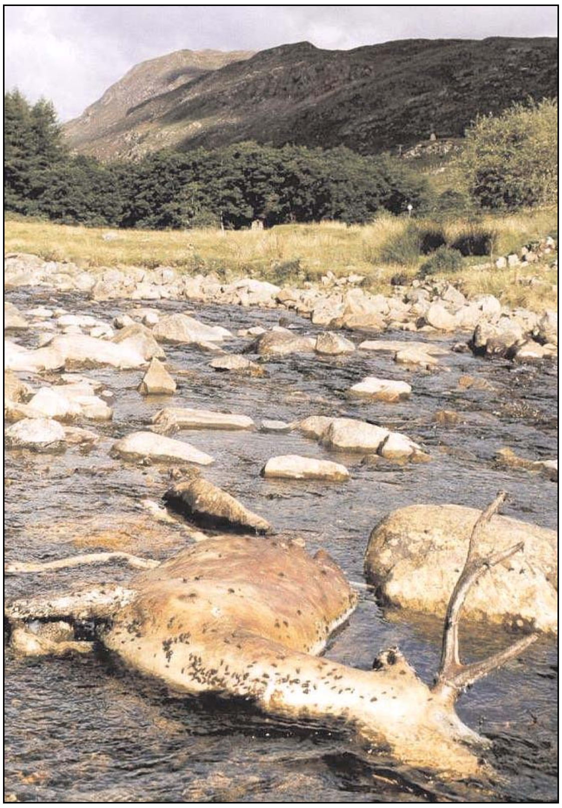
8.4.1 Introduction

Most of Wester Ross - both terrestrial and aquatic habitats - is oligotrophic. Growth of plants and production of animals which graze upon them is limited by the availability of nitrogen and phosphorus. Catchment fertility relates to climate, vegetation cover (especially of 'nitrogen fixing' plants such as *legumes* and alder), soil erosion and land use. Where bedrock is of low solubility or is overlain by infertile glacial drift or peat, the natural availability of phosphorus (though still inadequately understood in Scotland) is probably largely dependent upon the gradual accumulation and recycling of phosphates within the biota.

Human impacts over the past 1,000+ years, including deforestation, extermination of top predators such as wolves and bears, and elevated levels of grazing by large herbivores (sheep, deer and cattle) have led to a loss of fertility (net export of nutrient) from the Ullapool River catchment area. Adult salmon and sea trout can also transfer nutrients of marine origin into catchment areas; their carcasses and surplus eggs provide additional food for juvenile fish during winter months and insect larvae in the spring (Nislow *et al*. 2005). More recently, studies by FRS in the River Conon catchment nearby have shown how salmon carcasses contribute to production of stream invertebrates.

- *In collaboration with WRFT, FRS and SEPA, research is required to investigate whether there is a need to restore levels of fertility in oligotrophied stream systems such as the Rhidorroch River.*

- *The diversity and relative abundance of small animals (e.g. insect larvae) should be recorded during electro-fishing surveys. How does the abundance of insect larvae compare with the abundance of juvenile salmon and trout within the river system?*



Every deer or livestock carcass that is lost from the catchment represents an export of nutrient. Although nitrogen can be replenished via nitrogen fixing bacteria associated with plants such as clover, vetches, and alder trees, phosphates can not so easily be replenished if minerals in underlying rocks are of low solubility, or bedrock is blanketed with infertile glacial deposits and peat. Formerly, wolves and bears would have helped to recycle phosphorus concentrated in the carcasses (especially bones) of large herbivores, promoting nutrient retention within the ecosystem.

Distracted by the many eutrophied stream systems in areas of higher population density or agricultural impact elsewhere in Scotland, government agencies have yet to develop an adequate understanding of the potential for restoration and development of natural ecosystem fertility across large areas of upland Scotland such as the Ullapool River catchment.

Wester Ross has some of the most exciting and prolific wild game fishing in Scotland. Although many of the numerous brown trout lochs can still provide outstanding sport, stocks of salmon and sea trout have declined in many river systems over the past 10–15 years.

Healthy salmon and sea trout populations are not simply of importance to fisheries. These fishes were probably of 'keystone' importance to the development of diverse and productive freshwater ecosystems. The breeding success of birds such as Black-throated diver, Osprey and White-tailed eagle may have been related to the abundance of fish. The distribution of otters and freshwater-pearl mussels may also be partly related to the abundance of trout and salmon.

Wester Ross Fisheries Trust was established in 1996 in response to the need for solutions to fisheries problems and to improve the management of wild fisheries. The Trust employs a full-time biologist and several part-time assistants. This report provides an outline of the following:

- **Catches of salmon and trout in the UllapoolRiver**
- **Results of juvenile salmon and trout surveys within the catchment**
- **An assessment of the freshwater habitat accessible to salmon and sea trout**
- **Management recommendations and options to restore the natural fisheries productivity of the Ullapool River system**

Wester Ross Fisheries Trust is a registered charity dedicated to the conservation, restoration and development of healthy and sustainable fisheries in Wester Ross.

New members are always welcome!

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