WRFT

Wester Ross Fisheries Trust

RIVER EWE
FISHERY MANAGEMENT PLAN
2002–2006

The Highland Council
Comhairle na Gaidhealtachd

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WESTER ROSS FISHERIES TRUST

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RIVER EWE
FISHERY MANAGEMENT PLAN
2002–2006

by
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Summary

- **Introduction:** The River Ewe Fishery Management Plan 2002–2006 presents WRFT work carried out in 1997–2001 to assess salmon and sea trout stocks, to identify factors limiting their abundance, and to suggest action to fulfill their natural potential. Recommendations are aimed at maximising the freshwater production of juvenile fish, since this is largely within the control of riparian owners.

- **Ewe catchment:** The catchment has an area of 441.1 km^2, and drains mountainous peaks up to 1,010 m altitude in the Beinn Eighe-Torridon massif. Geology consists of acidic Lewisian gneisses and Torridonian sandstones and grits. Human population density is 0.8/km^2. The freshwater area is dominated by lochs (98%), of which Loch Maree constitutes the largest area (92%). Water quality is excellent, and regular monitoring by the Scottish Environment Protection Agency has found no evidence of pollution. Annual rainfall averages 1,734 mm, and average maximum temperature is 12.1°C. The catchment is largely covered by heather moor (68%). The primary land use is rough livestock grazing, followed by forestry and Woodland Grant Schemes, hydro-electricity and freshwater salmon aquaculture. Much of the catchment is protected within the Beinn Eighe National Nature Reserve, seven Sites of Special Scientific Interest, the Loch Maree Ramsar site, the Loch Maree Complex candidate Special Area of Conservation, and the Wester Ross Lochs Special Protected Area.

- **Important species:** Atlantic salmon, brown trout, European eels, Arctic charr, Eurasian minnows and three-spined sticklebacks occur in the catchment. A self-sustaining population of non-native American brook charr, introduced in the 1890s, exists in Lochan Uaine on Coulin Estate. Seven species and habitats, including salmon, are listed by the EU Habitats and Birds Directive as threatened. Of these, otters, black-throated divers, freshwater pearl mussels, white-tailed eagles and alder woodland would benefit from efforts to conserve the catchment's fish and riverine habitat.

- **Ownership and fishing rights:** The catchment is divided between six estates: Inveran, Gairloch, Letterewe, Grudie, Kinlochewe and Coulin. The Forestry Commission owns Slattadale Forest and one of the Loch Maree Islands. Scottish Natural Heritage runs the Beinn Eighe National Nature Reserve, and the National Trust for Scotland owns an area of the Kernsary sub-catchment. Salmon rod fishing rights are owned by all six estates. The Kinlochewe, Gairloch and Poolewe Angling Clubs have access to salmon and trout fishing. The National Trust for Scotland provides tickets for fishing on Lochs Kernsary and Ghiuragarstidh. Salmon netting rights in Loch Ewe are owned by Inveran Estate and Mrs Dorothy Balean, but have been inactive since the 1970s.

- **Salmon stock status:** The rod fishery in the Ewe system was the largest in Wester Ross, with a 5-year average of 200–300 wild salmon in 1978–1996, and employing 11 people. Wild salmon stocks have declined since 1996, with the lowest catch of 112 recorded in 2001. The declining abundance reflects a fall in marine survival of smolts to less than 3% in the mid-1990s. Up to 2,600 fish ran the river prior to 1995, but since 1996 only 700–900 have done so. At least 1,098 adults are required to reach the spawning target necessary to produce a maximum of 49,800 smolts. Rod catches indicate that this was probably achieved in 1978–1995, but in 1996–2001 runs have reached only 60–78% of the target. This is confirmed by juvenile surveys in 1997, 1999 and 2001, and by comparisons with the neighbouring Little Gruinard River, which is relatively healthy. Escaped farm salmon have occurred in rod catches for 86% of years since the establishment of salmon farming in 1986, contributing up to 35% of the total catch. Escaped smolts from freshwater cages have been mistaken for wild fish, and therefore their prevalence is probably underestimated. Given the depleted state of the wild salmon stock, there is considerable risk of genetic dilution. As a consequence the population's conservation status is 'Endangered' and 'Vulnerable' due to failed spawning target attainment.

- **Salmon stock components:** Currently 47% of wild salmon are grilse (1 Sea Winter), and 53% are 2 or 3 Sea Winter salmon, a relatively high proportion for Wester Ross rivers. Most smolts are 2 years old, and a minority are 3 or 4 years old. The age structure has altered since 1990–1991, when the population was dominated by 3-year-old smolts and grilse. Run-timing and radio-

tracking revealed stock discrimination. Spring salmon and early summer salmon and grilse originate from the Loch Clair–Coulin headwaters and the Kinlochewe River, while late summer fish originate from the lower catchment. Escaped farm salmon spawned widely throughout the system in 2001. The change in age structure is possibly due to hybridisation with farm salmon since 1986.

- **Salmon enhancement:** Salmon enhancement has occurred since the 1970s and 1980s. Most has involved the recycling of indigenous fish, but foreign stock has been introduced from the River North Esk. This stocking is unlikely to have boosted stocks, since the population was at or near carrying capacity at this time. In May 2000 the WRFT captured smolts from Abhainn Bruachaig to be ongrown as captive broodstock at the Marine Laboratory's Fish Cultivation Unit, Aultbea. These will be used to seed depopulated areas of the Bruachaig.

- **Sea trout stock status:** The Ewe sea trout rod fishery was the largest in Wester Ross, and centred on Loch Maree. Rod catches have declined from a 5-year average of 2,500 in 1982 to 800 in 2000. Stocks were characterised by long-lived, multi-spawning fish, but since 1987 the population has become dominated by small, immature fish, resulting in at least a 50% fall in egg deposition and stock collapse. The occurrence of prematurely-returning fish since the establishment of farms in Loch Ewe in 1987, plus the correlation between high sea lice infestations on sea trout and farm production cycles, indicate that elevated lice infection emanating from farm salmon are the primary cause of the collapse. Marine survival of sea trout smolts (1–6%) is similar to western Ireland, where stocks have also collapsed in the 1990s. Differences in marine growth rates between Ewe, Gruinard and Dundonnell sea trout indicate prey availability in Loch Ewe is poorer than in Gruinard Bay and Little Loch Broom, perhaps because trawling is permitted in Loch Ewe.

- **Brown trout stock status:** Since the collapse in sea trout, catches of brown trout in the accessible area have increased. Studies in Loch Maree confirm that brown trout dominate the spawning population, and although sex ratios remain unchanged, egg production by female brown trout now matches that of sea trout. This change may be due to reduced competition in freshwater, resulting in less impetus to migrate to sea, or may be related to stock enhancement. Nonetheless, juvenile surveys confirm that the trout population is probably below its carrying capacity.

- **Sea trout enhancement:** Trout enhancement has occurred since the 1970s. Most has involved the stocking of sea trout progeny from captive Ewe broodstock held in Loch Clair and at the Seafield Centre, Kishorn. Some fish of River Tyne origin have also been introduced. Since the sea trout collapse this enhancement has probably boosted juvenile production. The Kinlochewe and Gairloch Angling Clubs stock non-native brown trout into some hill lochs.

- **Other species:** Fisheries for silver eels and elvers have been established. Surveys suggest that the eel population is depleted, and no surplus exists for exploitation. Therefore the eel fishery should be closed until further notice. Arctic charr are occasionally caught, but no formal fishery occurs. Minnows and three-spined sticklebacks are widespread in several watercourses plus Lochs Maree, Tollaidh and Kernsary, but do not support a fishery. Both species represent ideal prey for black-throated divers. American brook charr in Lochan Uaine occur downstream from the loch in habitat inaccessible to salmon and sea trout, but are unlikely to persist outside this area.

- **Freshwater limitations:** The freshwater environment of the Ewe is relatively pristine and has not been radically modified by man. Seven occasionally passable waterfalls, nine road culverts and some natural debris obstacles may limit access to significant areas upstream. Spawning habitat is abundant but 68% is unstable and prone to redd washout. Potentially lethal spates occurred during the wet winters of 1989–90, 1996–97 and 1999–2000. Natural winter acidification capable of killing salmon eggs was detected in the Talladale and Grudie Rivers, and Allt na Doire-Daraich, affecting 9% of the accessible riverine area. Overhanging trees and other riparian vegetation is very scarce, covering only 13% of total bank length, constraining juvenile productivity of riverine habitat. Predation by mergansers, goosanders, cormorants and seals may be impacting upon the depleted salmon and trout populations. Otter predation on adult salmon can only be compensated for by restoring fish populations, and eels in particular. Mink and pike should not be introduced into the catchment.

- **Marine limitations:** The major factor limiting stocks is declining marine survival of smolts, resulting in poor returns of adults. For salmon, the long-term decline is due to sub-optimal climatic conditions in the North Atlantic, exacerbated since 1986 by the effects of hybridisation with farm salmon and sea lice infestations in Loch Ewe. The sudden collapse of sea trout in 1987 is directly related to elevated sea lice infestations emanating from salmon farms. Marine growth rates suggest that poor feeding in Loch Ewe is also a localized factor.

- **Fishery Management Plan:** Eleven recommendations are made to conserve the remaining wild stocks. Primarily this involves establishing captive broodstocks for salmon and sea trout, with an annual restocking target of 400,000 salmon fry and 800,000 sea trout fry. Exploitation of adult salmon and trout should be reduced by introducing catch and release of all fish, including brown trout, and maintaining the closure of local netting stations. The impacts of local salmon farms must be eliminated by improving management, such as zero ovigerous sea lice targets for farm salmon and preventing further escapes from marine and freshwater cages. The removal of partial obstacles and the restoration of riparian and in-stream habitat would increase the production of juvenile fish and simultaneously benefit the other EU Habitats and Birds Directive species occurring in the catchment. ❑

Summary of the 11 recommendations forming the River Ewe Fishery Management Plan, 2002–2006, in descending order of priority and including estimated costs

Recommendation		Action	Cost
1	**Salmon restoration programme**		
	• Catch and release programme	Ewe DSFB	None
	• Maintain netting closures	Inveran Estate, Mrs D Balean, Gairloch Estate, Eilean Darach Estate	None
	• Stock enhancement	Ewe DSFB, WRFT, FRS Fish Cultivation Unit	Unknown
2	**Sea trout restoration**		
	• Catch and release programme	Ewe DSFB	None
	• Maintain netting closures	Inveran Estate, Mrs D Balean, Gairloch Estate, Eilean Darach Estate	None
	• Stock enhancement	Ewe DSFB, WRFT, Coulin Estate, FRS Fish Cultivation Unit, Seafield Centre	£8,000 p.a.
3	**Improve management of salmon farms**		
	• Minimise escapes	Marine Harvest, Wester Ross Salmon	Unknown
	• Control ovigerous sea lice	Marine Harvest	Unknown
	• Minimise disease risks	Wester Ross Salmon, Ewe DSFB, Kinlochewe Angling Club, Gairloch Angling Club, WRFT	Unknown
4	**Improve fish access**		
	• Road culverts	Highland Council	£7,000
	• Estate culverts	Letterewe Estate, Coulin Estate	£2,000
	• Ghiuragarstidh salmon ladder	Letterewe Estate, National Trust for Scotland	£1,500
	• Debris obstacles	Ewe DSFB	Unknown
5	**Restore degraded habitat**		
	• Fencing	Letterewe, Kinlochewe, Coulin Estates, SNH	£192,000
	• Conifer removal	Forestry Commission, Coulin Estate	Unknown
	• Restore Allt na Doire-Daraich	Kinlochewe Estate	£1,000
6	**Assess and control predation**	Ewe DSFB, SNH, WRFT, RSPB	Unknown
7	**Re-evaluate Shieldaig/Slattadale hydro scheme**	Highland Light & Power, Ewe DSFB	Unknown
8	**Avoid the introduction of pike and mink**	Ewe DSFB, SNH, WRFT	Unknown
9	**Close eel fisheries**	Ewe DSFB	None
10	**Extend Inshore Fishing Order to Loch Ewe**	Ewe DSFB, Scottish Ministers	None
11	**No river works in October–June**	All estates	None

Part 1
Introduction

1.1 Aims of the Fishery Management Plan, 2002–2006

Atlantic salmon and trout populations in Wester Ross are an invaluable renewable resource. Rod fisheries based on these fish represent an important source of tourism revenue for the local economy, while both salmon and trout are key species in the area's ecology. In addition, the Atlantic salmon is listed in Annex II of the European Union Habitats and Birds Directive, and has therefore been identified as a threatened species requiring conservation action. The potential economic and ecological value of salmon and trout populations can only be reached, and then maintained, through careful and sustainable fisheries management.

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 salmon, sea trout and brown trout fisheries in Wester Ross*'. The WRFT's scope also covers other freshwater fish species. This remit was to be achieved with 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 Fishery Management Plan for each river system in the WRFT area aimed at achieving the fishery's potential**

The Fishery Management Plan presents the conclusions of the WRFT's work in the River Ewe catchment in 1997–2001. Much of the research builds upon extensive studies and recommendations made by Dr Andy Walker of the Fisheries Research Services (FRS) Freshwater Laboratory in 1980–1996[1]. In addition, the Plan collates further relevant information collected by various other bodies. The estimated costs of the WRFT's work are shown in Table 1.1.

The Fishery Management Plan has been formulated for a 5 year period. The suggested actions are aimed at maintaining the natural freshwater production of salmon, trout, and other fish species. If successful, other species listed by the Habitats and Birds Directive will also benefit. Since the freshwater environment is largely within the control of the land owners and other authorities concerned, the plan is designed specifically for them. If required, the WRFT intends to assist in the implementation of the Plan and to review its progress in 2007, when new targets and recommendations will be put forward.

To obtain the best quality of information, the work contained in the Plan has been carried out with the guidance of the Scottish Executive agencies, including FRS, Scottish Natural Heritage (SNH) and the Scottish Environment Protection Agency (SEPA). The WRFT acknowledges financial assistance provided by SNH and the Highland Council's Landfill Tax Credit Scheme for the production of this Plan.

This Fishery Management Plan has also been designed to meet the requirements of the North Atlantic Salmon Conservation Organisation (NASCO), to which the UK government is a Contracting Party. In 2001 the NASCO Council agreed a Plan of Action for member governments, calling for the development of comprehensive salmon habitat protection and restoration plans. Primarily the objective is to maintain or increase (where possible) the current productive capacity of salmon habitat.

Table 1.1 Estimated costs of producing the River Ewe Fishery Management Plan

Juvenile survey, 1997, 1999, 2001	£22,000
Catchment habitat survey, 1998–2000	£12,000
Acidification survey, 1997–1998	£1,200
Redd Washout Project, 1998–1999	£1,000
Sea lice surveys, 1997–2001	£13,000
Salmon Radio-tracking Project, 2001	£15,000
Catch record analysis, 1997–2001	£3,000
Plan preparation and production	£5,000
Total	***£72,200***

1.2 The Scottish Fisheries Coordination Centre

The WRFT is one of 15 similar fisheries research and management organisations established throughout Scotland. To ensure the highest quality of fisheries data collected, and the comparability of that data, a Scottish Fisheries Coordination Centre (SFCC) was established in 1997 at the FRS Freshwater Laboratory, Pitlochry. The SFCC has developed standard procedures for the surveying of juvenile salmon and trout and their freshwater habitat, and a computer-based Geographical Information System to map this and other fisheries information. All of the information presented in this Plan was collected according to the SFCC's standardised methods, and utilised the Geographical Information System. ❑

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.

- **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.

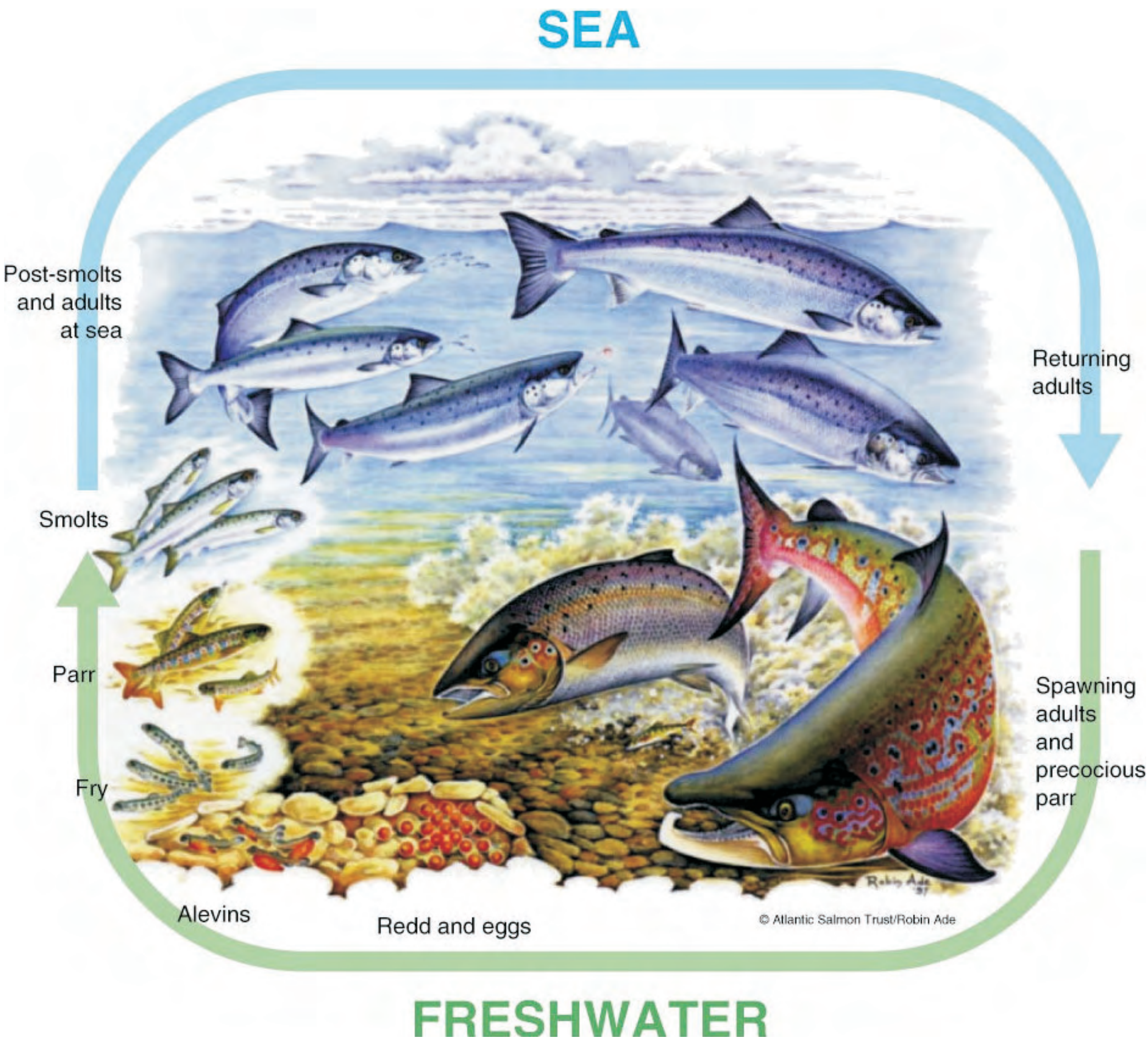
- **Smolts**: Having reached approximately 12 cm in length the parr will begin to smolt, turning silver and migrating downstream to the sea during April and May. The further north the river, the shorter the growing season, and therefore the longer parr take to reach smolt size. In Wester Ross most juvenile 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.

- **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 The 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.

- **Acidification**: Acidification caused by atmospheric pollution can kill salmon eggs, 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.

- **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 so far do not occur in Wester Ross. Humans and otters are the main predators of adult salmon in freshwater.

2.2.3 Marine problems

- **Feeding**: Fish traps run by the WRFT at Tournaig (Loch Ewe), and the FRS Shieldaig Sea Trout Project (Loch Torridon) indicate that as few as 3% of west coast salmon smolts survive to return to their natal rivers. In the 1960s and 1970s marine survival was as high as 30%. The main cause of this decline has 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 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 threat to Scottish west coast salmon are coastal bag and sweep nets, but with the recent local declines in stocks most netting stations have become unviable.

- **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.

- **Seal predation**: The Scottish grey seal population is estimated to be growing by 8% per annum, and there are fears that predation on returning adult salmon may be increasing. However, the extent of seal predation has never been quantified.

- **Sea lice infestations**: Recent studies of salmon post-smolts in Norway have shown that fish leaving fjords with salmon farms have been infested with lethal levels of sea lice, most likely produced by the farms.

- **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.

The grey seal population is growing at 8% per annum *(Inverness News)*

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 (Figure 2.2). However, in the mid-1990s stocks fell suddenly to record low levels, and this has coincided with the rapid expansion of the salmon farming industry on the west coast. However, it is likely that this regional collapse has been caused by the combined effects of many of the factors listed above, rather than the expansion of the salmon farming industry alone.

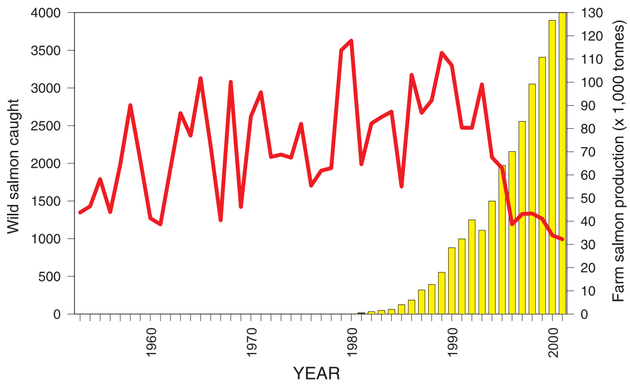


Figure 2.2 Total rod catches of wild salmon for the Scottish Executive's north-west region, compared to Scottish salmon farm production, 1952–2001

The WRFT Tournaig trap (top) and FRS Shieldaig Sea Trout Project trap (bottom) *(J Butler)*

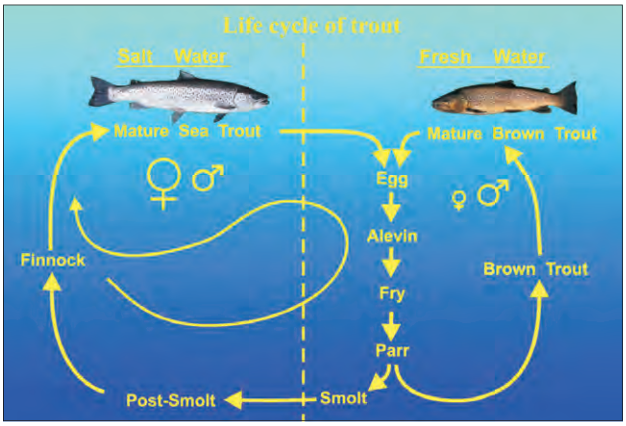


Figure 2.3 The life cycle of Scottish west coast sea trout (© *FRS Freshwater Laboratory)*

2.3 Sea trout and brown trout ecology

2.3.1 Life cycle

Unlike the Atlantic salmon, the ecology of sea trout and brown trout is not well understood. This is primarily because 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 (Figure 2.3). 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.

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.

Sea trout (top) may remain in freshwater as brown trout (bottom) if their food supply improves *(J Butler)*

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 with the rapid growth of the salmon farming industry (Figure 2.4). It is highly likely that sea lice emanating from salmon farms have been the major cause of the recent collapse, as lethal levels of sea lice have been found on sea trout post-smolts in salmon farming areas, but not in areas without salmon farming. WRFT lice monitoring also shows that in fallow years lice infestations on sea trout fall, and then increase in years when production restarts in the sea loch.

Unlike salmon, sea trout react to heavy lice burdens by returning prematurely to freshwater, where the lice die. While in freshwater the sea trout stop feeding, and therefore lose growth and condition. Skin damage from the sea lice also causes secondary infection, and combined with the stress of transfer from sea to freshwater, many die. The result is that lice-infested sea trout grow more slowly in the marine phase of their life cycle, and their life expectancy also falls. Consequently the average size of sea trout declines, as shown by the Scottish Executive statistics. Between 1952 and 1988 the

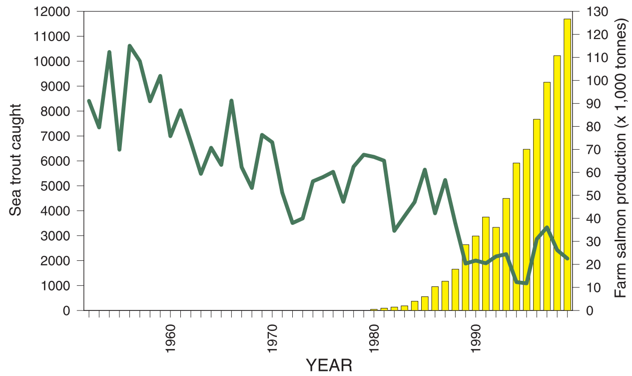


Figure 2.4 Total rod catches of sea trout for the Scottish Executive's north-west region, compared to west coast salmon farm production, 1952–2001

average weight remained between 1½ lb and 2 lb, but in 1989 declined rapidly, coinciding with the growth of the salmon farming industry. The FRS Shieldaig Sea Trout Project shows that currently less than 1% of sea trout smolts survive to maturity, whereas in the past up to 15% did. In contrast, sea trout in the Solway region, outside the salmon farming zone, have maintained their average weight (Figure 2.5).

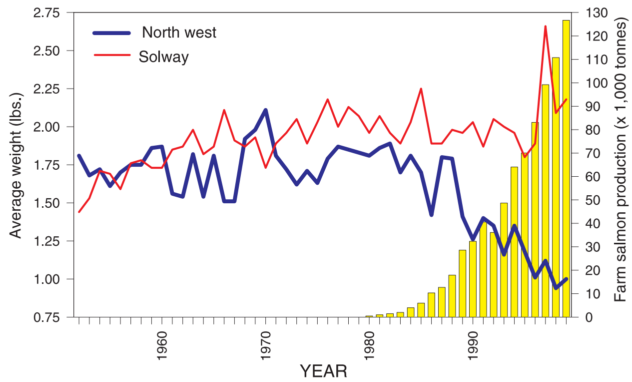


Figure 2.5 Average weight of rod caught sea trout for the north-west and Solway regions, compared to Scottish salmon farm production, 1952–2001

Sea lice damage to the dorsal fin of a sea trout post-smolt *(S Northcott)*

- **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 (see Figure 2.5). 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 collapsed in the 1970s, and were severely over-fished in the post-war years. The abandonment of the three-mile limit may also have allowed over-fishing of other coastal white fish by industrial vessels, exacerbating the problem.

Sea trout feed on juvenile sea fish in west coast sea lochs
(J Butler)

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 will aggressively colonise the more open areas, out-competing the salmon. ❑

Part 3
The River Ewe Catchment

3.1 Location

3.1.1 Loch Ewe

The River Ewe catchment drains into Loch Ewe, a sea loch 12 km long and up to 5 km wide. Three other small catchments drain into Loch Ewe: Allt Beithe, Tournaig and Loch Sguod (Figure 3.1). The River Ewe flows through a very short 300 m estuary into the sea at the village of Poolewe.

3.1.2 Salmon aquaculture

There are two active marine salmon farming sites in Loch Ewe, one at Boor, 4 km from the river mouth, and another at Aultbea, 7 km from the river. Both sites were established in 1987, and are now owned by Marine Harvest (Scotland). In December 1999 Marine Harvest applied to SEPA to increase the discharge consent at Boor from 919 tonnes to 1,000 tonnes, while maintaining the consent for 950 tonnes at Aultbea. SEPA responded by reducing the Boor site's discharge consent to 750 tonnes from April 2002, and reducing the Aultbea consent to 500 tonnes. Marine Harvest are currently appealing to the Scottish Ministers against this decision and are applying to the Crown Estate to relocate the Boor site to Isle of Ewe, 8 km from the river mouth.

The Aultbea salmon farm site in Loch Ewe *(J Butler)*

Production at both sites is synchronised, with S1 smolts stocked in Spring 2000 after a 4-week fallow. This production cycle will be completed in Spring 2002. Based on tidal flows, the Scottish Executive has identified management areas within which farms should operate single-year-class production to minimise the risk of cross-infection of disease.[2] Loch Ewe has been defined as one management area. By synchronising production, the sites are currently adhering to the Scottish Executive's recommendations.

The FRS Marine Laboratory's Fish Cultivation Unit also owns a pump-ashore tank facility at Mellon Charles, and a small lease for four research cages on the eastern shore of Isle of Ewe, with a consented maximum biomass of 30 tonnes. This cage site is not currently active.

3.1.3 Salmon netting stations

There are two salmon netting rights within Loch Ewe, owned by Inveran Estate and Mrs Dorothy Balean. Neither have been active since 1973. Two stations have also existed in the past in neighbouring sea lochs. The Redpoint netting station, in Loch Torridon, was closed in 1999. The rights are leased by Gairloch Estate to Mr W Mackintosh, Gairloch (Figure 3.1). Laide netting station, in Gruinard Bay, was closed in 1992 by the owners, Eilean Darach Estate.

Salmon netting stations in Loch Ewe were last operated in the 1970s *(J Butler)*

3.1.4 Inshore fisheries

Creeling for shellfish is common within Loch Ewe. A Several Order was granted to Mrs Jane Grant, Isle of Ewe, for cultivating scallops in 1999. Loch Ewe is a major spawning and nursery ground for herring, sprats, whiting, saithe, cod and plaice. However, unlike the

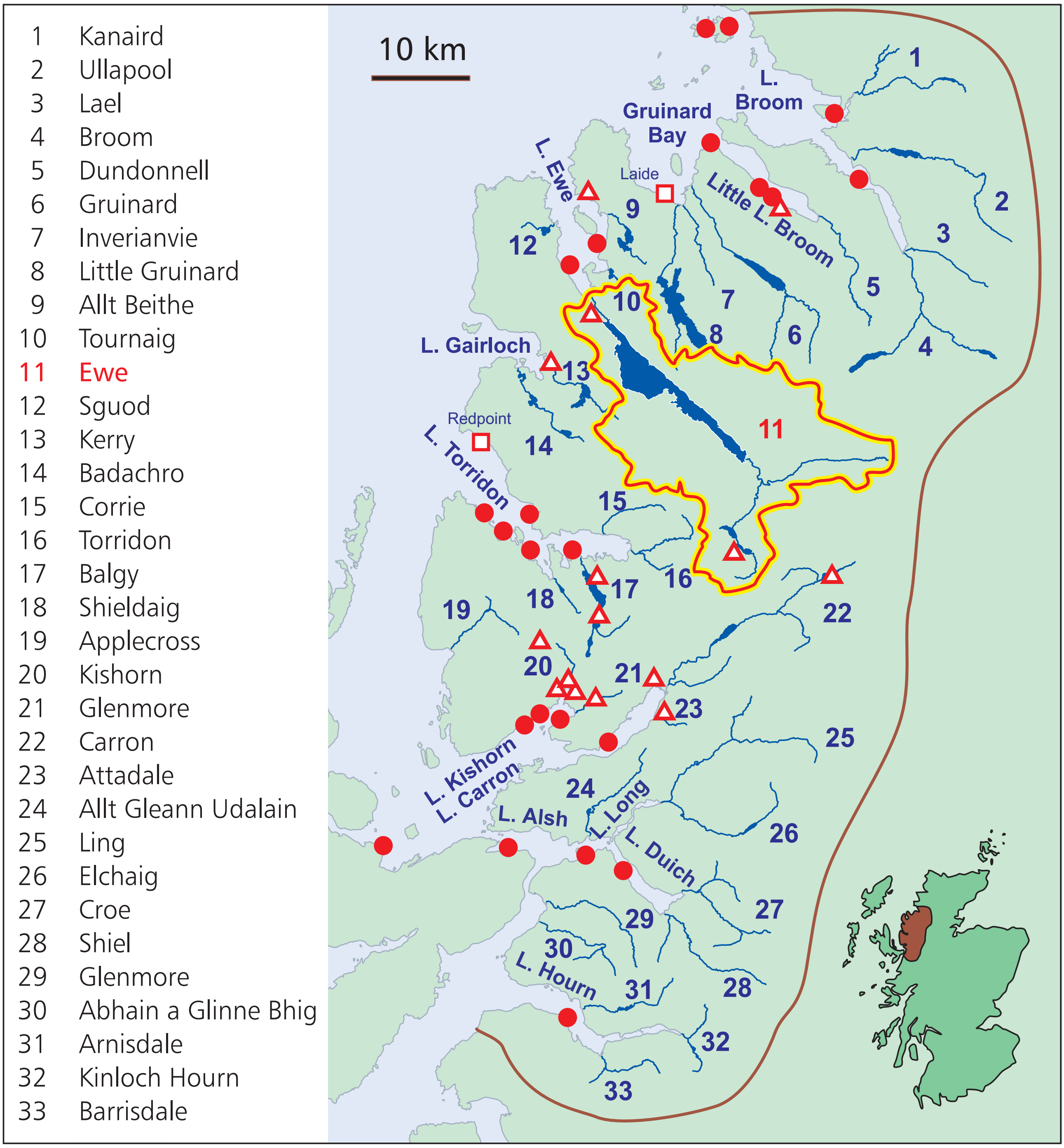


Figure 3.1 The River Ewe catchment relative to the WRFT area, and marine (●) and freshwater (△) salmon farm sites, and salmon netting stations (□)

neighbouring sea lochs of Gruinard Bay and Loch Gairloch, Loch Ewe is not closed to mobile trawling by the Inshore Fishing Order (1989).

3.1.5 Military sites

The Ministry of Defence owns a naval refuelling depot near Aultbea. Shipping traffic is often evident, particularly during NATO exercises carried out annually in June and November.

3.2 Characteristics of the catchment

3.2.1 Catchment

The Ewe catchment is the largest in Wester Ross, with an area of 441.1 km² (Figure 3.2). The catchment drains mountainous terrain, with peaks of up to 1,010 m in the Beinn Eighe–Torridon ridge. The river system is dominated by Loch Maree, a narrow and deep glacial ribbon lake 20 km in length and up to 3.5 km wide, with

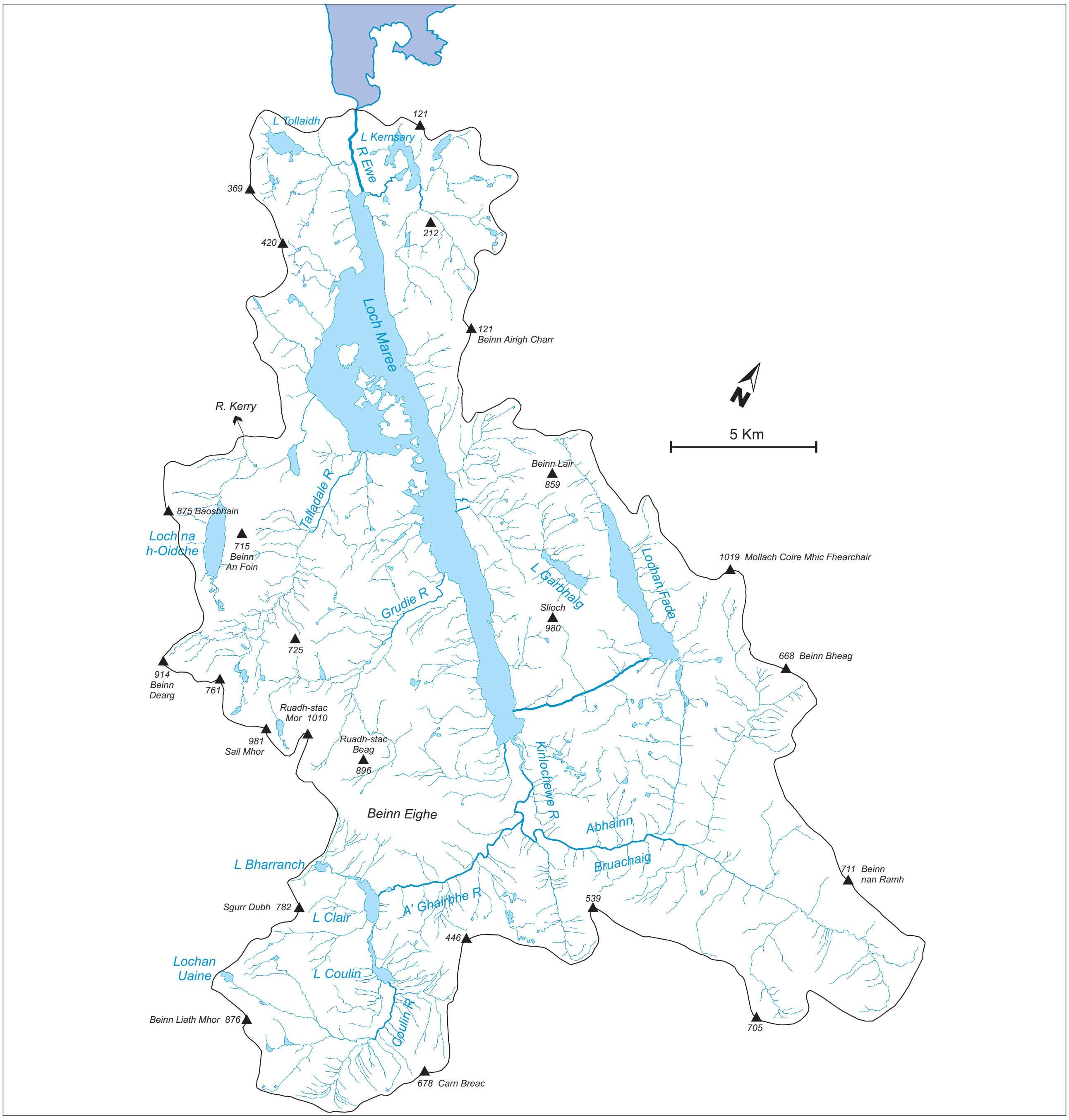


Figure 3.2 The River Ewe catchment, showing primary watercourses and peaks *(Crown Copyright)*

Loch Maree and Loch Ewe from Beinn Eighe *(SNH)*

Loch Coulin, Loch Clair and the A'Ghairbhe River *(SNH)*

Loch Maree and the Torridon headwaters *(SNH)*

Beinn Eighe from Loch Coulin *(J Butler)*

a maximum depth of 110 m. The primary headwaters are the A'Gairbhe River and Abhainn Bruachaig, both of which drain into Loch Maree via the Kinlochewe River. Several smaller sub-catchments feed into Loch Maree, of which the Rivers Talladale, Grudie and Loch Kernsary systems are the most significant. The River Ewe itself is only 2.5 km long, descending 10 m from Loch Maree to the estuary. The catchment is unusual in having a bifurcation downstream from Loch na h-Oidhche, which takes 55% of normal flow into the River Kerry system, leaving 45% to continue into Loch Garbhaig (Figure 3.2). This is reputed to have been man-made in the 1890s in an attempt to increase flows over Victoria Falls, located on the Garbhaig River.

3.2.2 Climate and rainfall

Wester Ross has a moist maritime climate. Weather patterns are dominated by a westerly, Atlantic air stream. Meteorological records from the National Trust for Scotland's Inverewe Garden, Poolewe, show a 20-year average annual maximum temperature of 12.1°C, and average rainfall of 1,734 mm (max 2,315; min 1,430 mm). The mountainous headwaters are prone to more localised, heavy rainfall. Between November 1999 and March 2000, 1,746 mm of rain was recorded by Letterewe Estate at Kinlochewe. By contrast, for the same period in 2000–2001 only 688 mm was recorded.

3.2.3 Human population

Human settlement in the catchment is greater than for most other Wester Ross river systems, owing to the presence of Poolewe and Kinlochewe villages. In 1991 the National Census estimated that their populations were 218 and 107, respectively. These numbers may have increased in the last decade. In addition there are scattered households along the A832 and A896 roads. Hence the total human population in 2001 is estimated to be 350, giving a density of 0.8/km^2.

3.2.4 Ownership and management

Land ownership in the catchment is divided between six estates: Inveran, Gairloch, Letterewe, Grudie, Kinlochewe and Coulin Estates. The Forestry Commission owns the 478 ha Slattadale Forest on the western shore of Loch Maree, including the northernmost Loch Maree islands. Beinn Eighe National Nature Reserve (NNR) was established in 1951, and is administered by SNH. A small section of the Kernsary sub-catchment is owned by the National Trust for Scotland (Figure 3.3).

The River Ewe lies within the Ewe Statistical Fishery District, which includes the neighbouring catchments of Loch Sguod, Tournaig and Allt Beithe, and also the salmon netting interests. Currently a statutory Ewe District Salmon Fishery Board (DSFB) manages salmon and sea trout fishery interests within the river system and Loch Ewe.

3.3 Geology

The geology underlying the lower catchment consists of acidic and nutrient-poor Lewisian gneisses, Torridonian sandstones and grits. The U-shaped river valleys are typical of glacial geology, and fertile ground is limited to fluvio-glacial alluvium on the floodplain beside the Coulin River, Kinlochewe River, parts of Abhainn Bruachaig, Docherty Burn and Loch Kernsary.

3.4 Vegetation

The predominant vegetation type is heather moor (67.5%), followed by other mosaics on the mountain peaks (Table 3.1). Areas of grassland suitable for livestock grazing are limited (5.3%), and confined to the Kinlochewe River valley floor, parts of Abhainn

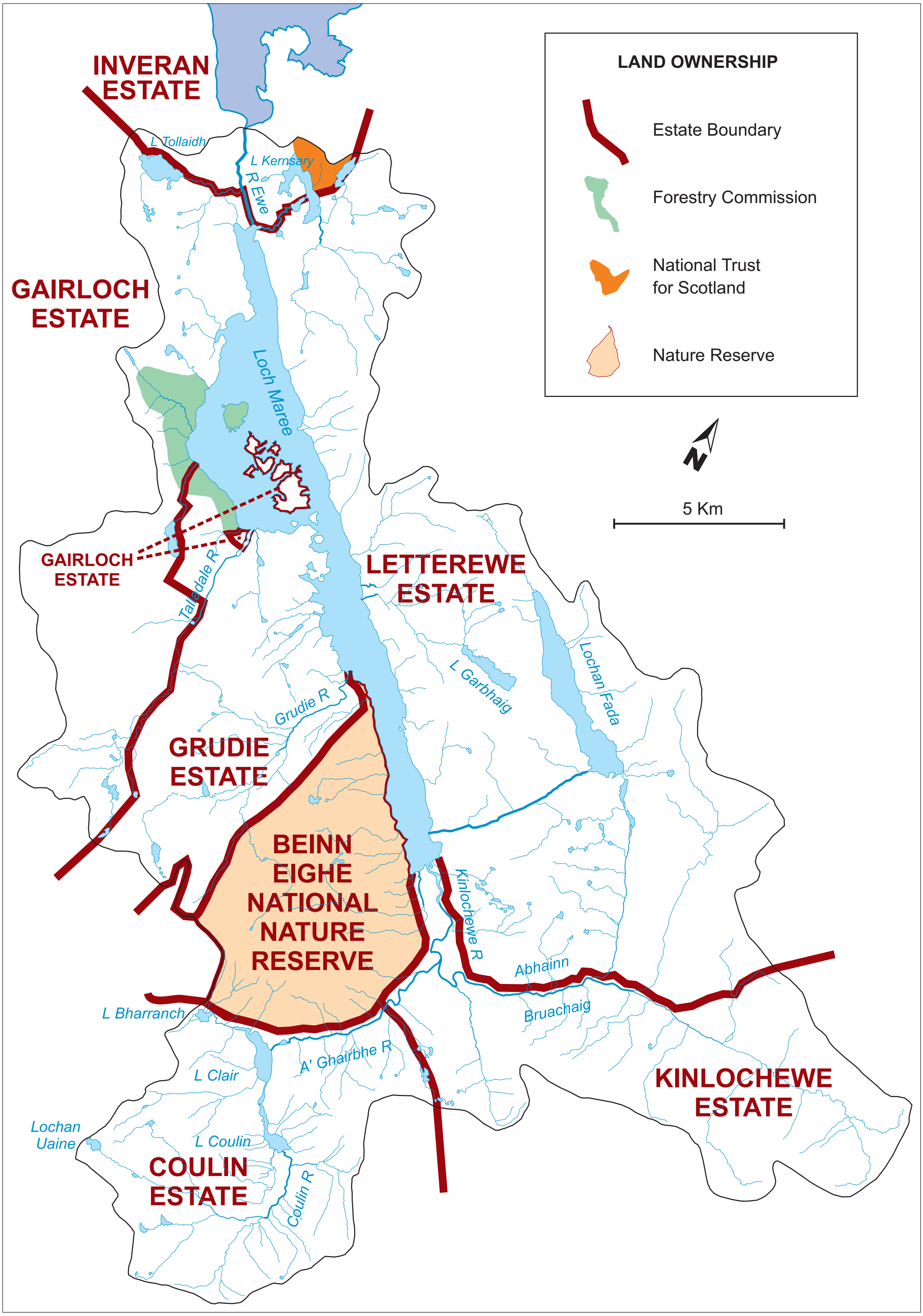


Figure 3.3 Land ownership in the River Ewe catchment *(Crown Copyright)*

Bruachaig, Docherty Burn, Talladale, the River Ewe and Loch Kernsary (Figure 3.4). The Slattadale Forest and other conifer plantations on Coulin Estate, Letterewe Estate and within Beinn Eighe NNR cover a minimal area (3.9%). This area is likely to be reduced in the future through felling (see 3.5.2). Native broadleaf and Scots pine woodland is also limited (1.3%), and concentrated along the upper reaches of the River Ewe, the northern shore of Loch Maree and its islands, the slopes of Beinn Eighe and also around Loch Clair.

Table 3.1 Areas and proportions of different vegetation types in the River Ewe catchment.

Vegetation type	Proportion (%)
Heather moor	67.5
Other mosaics	20.5
Rough grassland	5.3
Conifers	3.9
Peatland	1.4
Native woodland	1.3
Urban	0.1

3.5 Land use

3.5.1 Agriculture

The predominant land use in the catchment is livestock farming. Sheep and cattle grazing is concentrated on the improved and rough grassland and heather moor along the Kinlochewe River valley floor, plus the Abhainn Bruachaig and Docherty Burn valleys in the upper catchment (Figure 3.4). In the lower catchment, livestock are grazed at the Talladale and Garbhaig Rivers, from Loch Tollaidh downstream, along the north bank of the River Ewe, and at the head of Loch Kernsary.

3.5.2 Forestry and Woodland Grant Schemes

Forestry represents the second most important land use, of which the Forestry Commission's Slattadale Forest constitutes the largest area (478 ha). The forest was established in the 1920s, and a Forest Design Plan has been formulated for the period 2001–2031. This focuses on the clearance of lodgepole pine, followed by a 30% increase in the area of Scots pine, and a 256% increase in native broadleaved woodland. The forest was established long before the Forestry Commission's Forest & Water Guidelines (1993), and consequently much of the length of the Slattadale Burn is overshadowed by conifers (see Part 6). A joint application is being made by the Forestry Commission, SNH and the WRFT to the Heritage Lottery Fund to finance the removal of all conifers along the watercourse, and to replace them with native woodland.

Most exotic conifers in Slattadale Forest are being removed *(J Butler)*

The remaining significant areas of forestry are owned by Coulin Estate and SNH on the south and north banks of the A'Ghairbhe River. Both of these areas are currently being felled utilising Woodland Grant Schemes, leaving areas for the regeneration of Scots pine and native woodland. There are no plans to replant with exotic conifers.

A further nine Woodland Grant Schemes have been established in the catchment. Of most relevance to watercourses is the scheme at Inveran Estate, which encloses part of the Inveran River, and three plots in the headwaters of the Coulin River on Coulin Estate, which enclose significant areas of Allt Doire Beithe. Of further importance is a 3,328 ha scheme being developed by Gairloch Estate which covers the shores of Loch Maree from Slattadale to Loch Tollaidh. Large areas of the foreshore, and several minor watercourses will be enclosed for native woodland planting and regeneration (Figure 3.4).

3.5.3 Hydro-electricity

There is one hydro-electricity scheme within the catchment, at Loch Garbhaig. This 900 kW project was established in 1993 by the Garbhaig Hydro Power Company Ltd, a sister company of Highland Light & Power Ltd. A 2 m weir has been built at the outflow of Loch Garbhaig. A 1.4 km buried pipeline runs from the

The intake weir for the Loch Garbhaig hydro scheme *(J Butler)* weir to a generating shed 1 km upstream from Loch Maree. Water is passed back into the Garbhaig River above Victoria Falls, and therefore there is little impact on flows below this point (Figure 3.4).

Highland Light & Power is currently proposing to install a second, 1.45 MW scheme at this site, as part of a wider Shieldaig/Slattadale project. A weir would be built at the bifurcation downstream from Loch na h-Oidhche, diverting all but compensation flow into a pipeline running parallel to the Garbhaig River. The pipeline would run into a generating shed 500 m upstream from Loch Maree. Water would be discharged into the Garbhaig River, increasing flows from this point downstream by 40%.

A second hydro-electric installation is located in the headwaters of Abhainn Bruachaig (Figure 3.4). During the 1950s an off-take weir was built on Allt a Claiginn under the Hydro-Electric Development Act (1945). Water is diverted via an aqueduct into Loch Fannich to contribute to Scottish & Southern Energy plc's Conon hydro-electric scheme. A maximum of 3 million gallons/day are diverted, but only during spates. Occasionally spate water is redirected into Abhainn Bruachaig when Loch Fannich is spilling, or when the aqueduct requires maintenance. The operation of the installation has remained unchanged since its inception.

The intake of the Allt a Claiginn–Loch Fannich aqueduct *(K Starr)*

Wester Ross Salmon Ltd smolt cages in Loch Tollaidh *(J Butler)*

3.5.4 Freshwater aquaculture

There is one commercial salmon farming operation in the catchment, located in Loch Tollaidh and owned by Wester Ross Salmon Ltd. Salmon smolt cages were established in the loch in 1986, with a discharge consent for a maximum biomass of 4.5 tonnes (Figure 3.4). A second commercial salmon cage site was started by Coulin Estate in Loch Clair in 1986. However, the operation closed in 1992 following an outbreak of disease, possibly Infectious Pancreatic Necrosis (IPN).

In 1996 Dr Andy Walker of FRS began an experimental sea trout broodstock scheme, utilising one small cage in Loch Clair. Coulin Estate now manages the site in partnership with FRS, and has a discharge consent for 1.5 tonnes maximum biomass. This has been augmented by a small hatchery on Coulin Estate, which is nearing completion (see Part 5).

3.5.5 Protected areas

In addition to the Beinn Eighe NNR, the Ewe catchment contains seven Sites of Special Scientific Interest (SSSIs): the two Coulin Pinewoods, Torridon Forest, Loch Maree and the Loch Maree Islands, the Talladale Gorge, and the Ardlair–Letterewe area (Figure 3.5). All of these are component parts of the Loch Maree Complex candidate Special Area of Conservation (cSAC). Loch Maree is also designated under the Convention of Wetlands of International Importance (1971) as a 'Ramsar' site, and is a cSAC for oligotrophic standing water. The entire catchment lies within the Wester Ross National Scenic Area.

In 2000 an additional SSSI was established to cover Loch Kernsary. This loch forms part of the Wester Ross Lochs Special Protection Area (SPA), which aims to protect the local population of black-throated divers. It is estimated that 5% of the British breeding population utilise the SPA for nesting and rearing chicks in the spring and summer. To avoid disturbance of nesting birds, SNH recommends that angling should be minimised during the spring. In addition, the introduction of alien species such as pike (*Esox lucius)* must be avoided in order to maintain the balance of the native fish community, on which the divers depend for food.

3.6 Water quality

3.6.1 Freshwater Fish Directive

In 1976 the European Economic Community (now European Union) 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 waters, and water

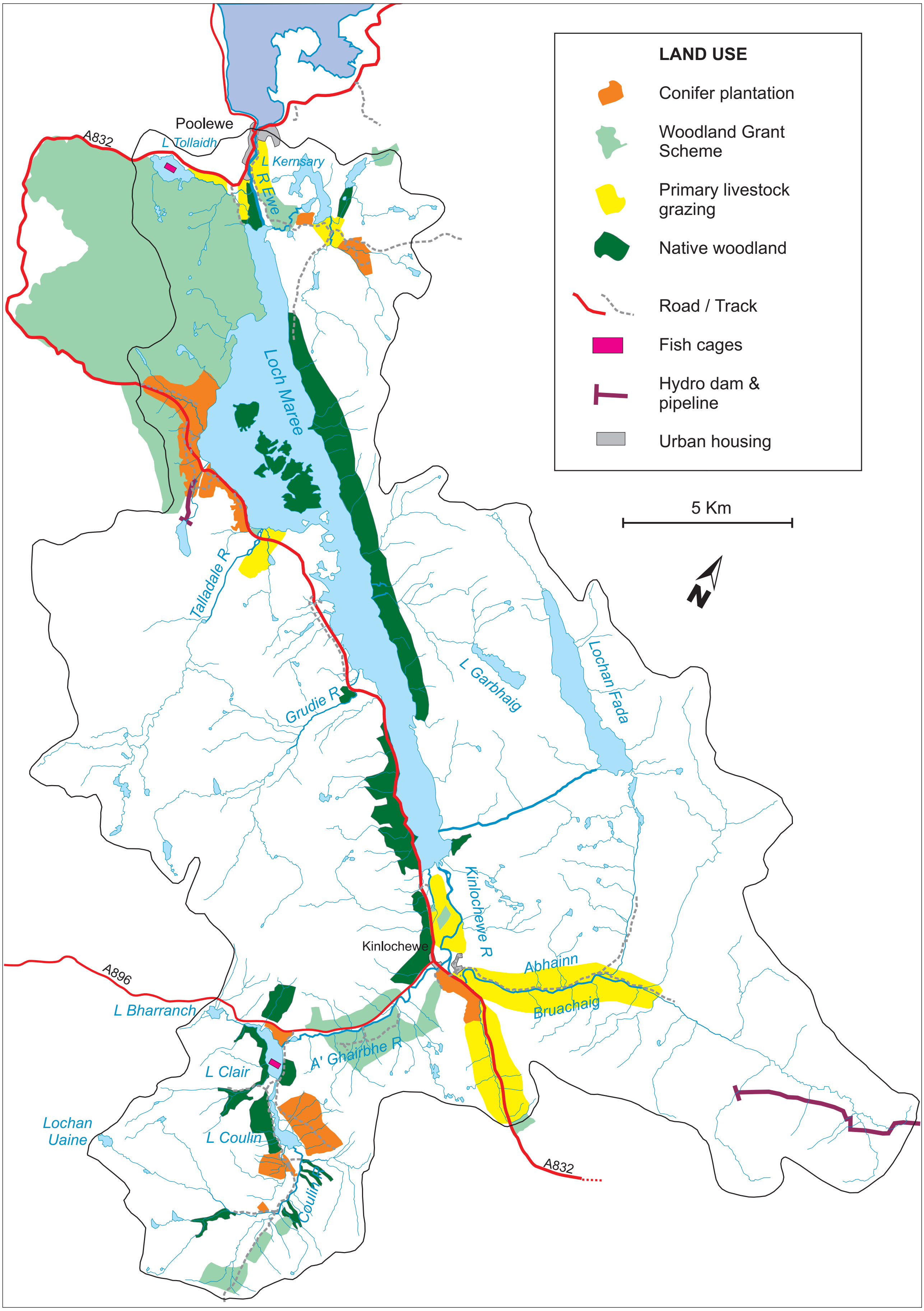


Figure 3.4 Land use in the River Ewe catchment *(Crown Copyright)*

quality standards were set for each using certain criteria (e.g. pH, temperature, pollutants). In Scotland, SEPA is responsible for monitoring water quality and assessing whether rivers are attaining the standards set.

The River Ewe was designated as a salmonid water under the Directive in 1977. A water sample is taken every month by SEPA at the Poolewe road bridge (grid ref. NG 858806), which is at the river mouth and therefore provides an indication of the entire catchment's water quality. SEPA results for 1996–1999 indicate that water quality is excellent, reaching all of the Directive's standards. A summary of water chemistry recorded by SEPA is given in Table 3.2.

Table 3.2 Average values of water chemistry parameters recorded by SEPA during monthly sampling of the River Ewe, July 1996 to October 1999

	pH	total P (mg/l)	cond. (mS/cm)	Ca (meql)
average	6.5	4.5	61	1.2
maximum	7.2	14.6	na	na
minimum	6.0	0.8	na	na

3.6.2 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 Ewe was sampled in 1995 and 2000, and in both years was classified grade A, indicating that the catchment has no pollution problems and is in a pristine state. Further information on water chemistry is given in Part 6.6.

3.6.3 Potential pollution points

SEPA also conducts detailed monitoring of the two major potential sources of pollution in the catchment: the Wester Ross Salmon Ltd smolt cages in Loch Tollaidh, and the outflow of the Kinlochewe public septic tank.

Loch Tollaidh is classified as an oligotrophic (i.e. nutrient poor) loch, and SEPA's Policy No. 16 (Total Phosphorus Water Quality Standards for Scottish Freshwater Lochs, 1997) states that as such, total phosphorus levels should not exceed 8 g/l in order that the trophic status of the loch is not altered. Monthly water samples have been taken from the outflow of the loch (grid ref. NG 848787) since November 1988. A total of 116 samples were taken, with an average total phosphorus level of 9.8 g/l, marginally exceeding SEPA's threshold. The resulting enrichment may have contributed to two toxic blue-green algal blooms that occurred in Loch Tollaidh in August 1999 and May 2000. Although a risk to animals drinking the water, the bloom had no apparent effect on farmed or wild fish in the loch. In terms of eutrophication of the catchment downstream, SEPA considers that the effect of the cages is negligible.

A blue-green algal bloom in Loch Tollaidh, August 1999 *(J Butler)*

The Kinlochewe village public septic tank is run by Scottish Water. The tank has a 30,000 gallon capacity and is emptied biannually. Scottish Water has a discharge consent from SEPA to release waste water from the tank into the Kinlochewe River to a maximum Biological Oxygen Demand and Suspended Solids level of 100 mg/l. A second tank of 3,000 gallons services the neighbouring township of Incheril, and discharges into Abhainn Bruachaig. A third, smaller tank is located at the SNH Field Station, Anancaun, and drains into the Kinlochewe River.

To assess the impact of these discharges, SEPA takes water and invertebrate samples from the Kinlochewe River downstream of these points (grid ref. NG 027627). Under the Scottish River Classification Scheme the water quality registered Grade A in 1995 and 2000. However, there was an incident in July 2000 when the Kinlochewe septic tank overflowed due to delayed emptying of the tank. Raw sewage entered the river, but immediate investigation by the WRFT showed no sign of fish kills downstream. SEPA has concluded that the dilution rate of any such event is so high that biological problems are unlikely to occur.

3.7 Important species and habitats in the Ewe catchment

3.7.1 Fish species

During the course of WRFT work in the catchment (see Appendix I), past surveys by FRS and other bodies, and anecdotal information provided by the estates, six indigenous fish species have been identified in the Ewe catchment: Atlantic salmon (*Salmo salar*), brown trout

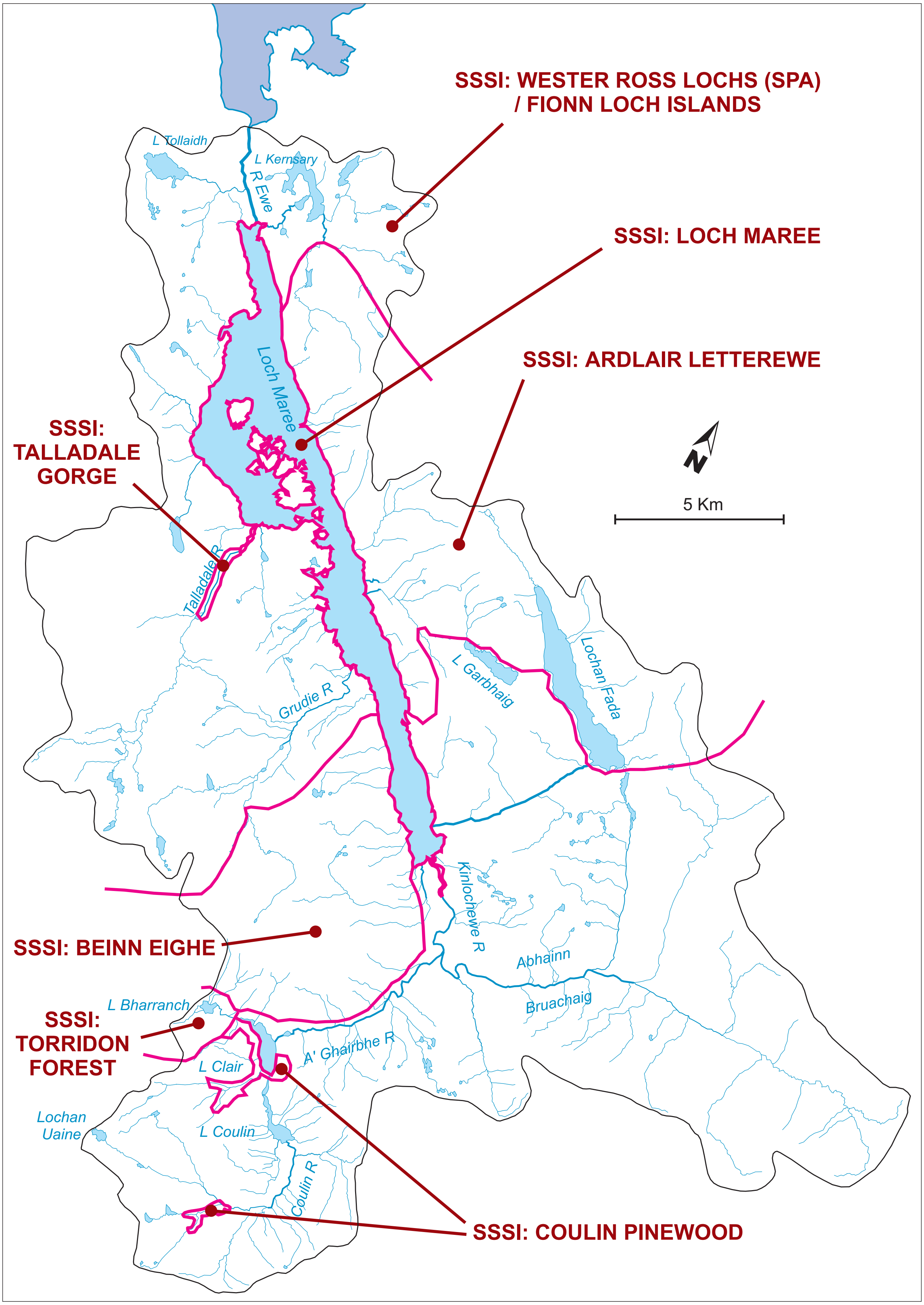


Figure 3.5 Location of Sites of Special Scientific Interest (SSSIs) and Special Protected Areas (SPAs) within the River Ewe catchment *(Crown Copyright)*

(Salmo trutta), European eel *(Anguilla anguilla),* Arctic charr *(Salvelinus alpinus),* Eurasian minnows *(Phoxinus phoxinus)* and three-spined sticklebacks *(Gasterosteus aculeatus).* A self-sustaining population of non-native American brook charr *(Salvelinus fontinalis)* exists in Lochan Uaine (Coulin), having been introduced in the 1890s (see Part 9). One rainbow trout *(Oncorhyncus mykiss)* weighing 2 lb was caught in the River Ewe on 4 September 1993, and was assumed to be a sea-run farm escapee. Rainbow trout have never been stocked into the catchment.

Pike occur in the neighbouring Kerry and Conon catchments, but so far have not been introduced to the Ewe system.

3.7.2 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 and Birds Directive. The prime purpose of the Directive was to establish Special Areas of Conservation (SACs) and Special Protected Areas (SPAs) for rare or endangered habitats and species, and these were listed in Annex I and Annex II, respectively. SNH is charged with establishing SACs and SPAs in Scotland, but also promotes the sensitive management of all listed species and habitats outside these conservation areas.

Of species and habitats directly relevant to the management of fisheries, seven occur within the Ewe catchment, including the Atlantic salmon (Table 3.3). All of these would benefit directly from action to conserve the catchment's fish stocks and freshwater environment. The black-throated diver, in particular, is reliant on small fish and invertebrates for successful breeding. It is a keystone species within the catchment, as reflected by the establishment of the Wester Ross Lochs SPA and the Loch Maree SSSI.

Table 3.3 Annex I habitats and Annex II species designated by the 1992 EU Habitats and Birds Directive that occur in the River Ewe catchment

Annex I	Annex II
• Alder woodland on flood plains • Atlantic oakwood	• Atlantic salmon • Freshwater pearl mussel • Eurasian otter • Black-throated diver • White-tailed eagle

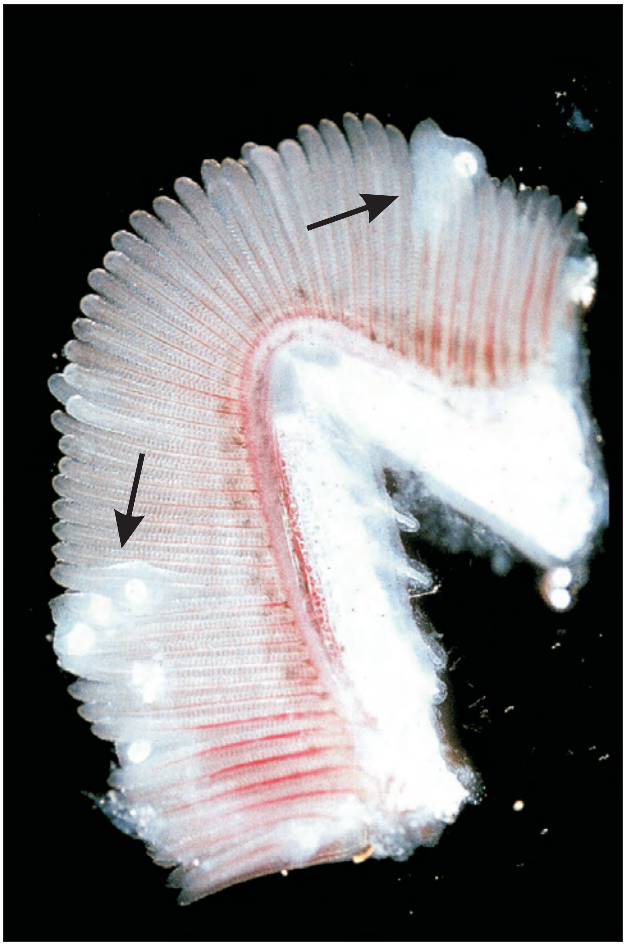
Otters (top), white-tailed eagles (middle) and black-throated divers (bottom) are Habitats and Birds Directive species in the catchment that would benefit from fish conservation *(J Watt, D Vuijk, D DesJardin)*

3.7.3 Freshwater pearl mussels

Although once widespread across Europe, most populations of freshwater pearl mussels have become extinct owing to pearl fishing, industrial pollution and enrichment from agricultural run-off, and consequently they are listed in Annex II of the Habitats and Birds Directive. The north-west of Scotland is one of the few remaining strongholds of the species, and within the Ewe catchment populations occur in the Tollie Burn and possibly the Talladale River and neighbouring Allt a Choire Sliabh.

Young salmon and trout are intermediate hosts for juvenile mussels. In mid-summer each female mussel releases microscopic larvae, called 'glochidia', which drift downstream. Some are inhaled by salmon and trout fry, and the larvae attach themselves to the gill filaments. The glochidia live on the gills as parasites for 6 to 12 months. As the fry disperse the glochidia drop off into the bed and recolonise the river; they take 12 years to mature,

Freshwater pearl mussels depend on salmon and trout in the Ewe catchment *(S Scott)*



Glochidia attached to the gill filaments of a salmon fry *(M Young)*

and may live for more than 100 years. Because of the mussel's dependence on salmon and trout, there is concern that the decline of west coast stocks will further threaten its existence. Consequently the sound management and conservation of wild salmonid stocks is of prime importance for the future existence of mussels.

3.8 Fishing rights in the Ewe catchment

Salmon rod-fishing rights within the catchment are divided between the six estates (Table 3.4). The main fishery on Loch Maree is the Loch Maree Hotel, leased from Gairloch Estate. The Poolewe Angling Club has access to salmon fishing on the River Ewe via Inveran Estate.

There is considerable organised access to trout fishing. The Gairloch Angling Club leases fishing on Loch Tollaidh from Gairloch Estate, for which they sell day tickets at an outlet in Gairloch. Mr Harry Davies also leases a boat on Loch Tollaidh. The Kinlochewe Angling Club leases trout fishing on Lochan Dubh a Phluic (Talladale) from Grudie Estate, and on Loch Bharranch and Lochan Feith Leothaid from Coulin Estate. Day tickets are sold in Kinlochewe for fishing on these lochs. In addition, the National Trust for Scotland sells day tickets at Inverewe Gardens for trout fishing on Loch Kernsary and Loch Ghiuragarstidh. ❑

Table 3.4 Salmon fishing rights within the Ewe catchment

Landowner	Water body
Inveran Estate	River Ewe, Loch Maree
Gairloch Estate (Loch Maree Hotel)	Loch Maree
Letterewe Estate	Loch Maree
Grudie Estate	Loch Maree
Kinlochewe Estate	Loch Maree, Kinlochewe River, Abhainn Bruachaig, A'Ghairbhe River
Coulin Estate	Loch Clair, Loch Coulin, Loch Bharranch

Part 4
Salmon Fisheries and Stocks

4.1 Economic value of the rod fishery

The rod fishery for salmon within the Ewe catchment is the largest in Wester Ross, in terms of numbers of fish caught and economic value. Fishing is carried out by all six estates that own rights, and most is let to tenants on a weekly basis. The size of the fishery is augmented by the relatively long season, with takeable salmon present for 6 months of the year, between March and October (see 4.5.2). Eleven ghillies, keepers or boat men are employed throughout the catchment, with varying levels of seasonal involvement in the fishery and its management. In 1995 rod fishermen visiting Ross-shire were estimated to spend £106/day each,[3] and in the Western Isles angling contributes 12% of all tourism revenue.[4] The value of the Ewe salmon fishery to the Wester Ross economy is unknown, but judging from these studies it is likely to be significant.

The Ewe salmon rod fishery is the largest in Wester Ross *(J Butler)*

The total annual catch has varied since 1978, probably due to variable summer flows and the resulting fluctuations in angling conditions.[5] However, Coulin Estate records also indicate that on that estate fishing effort has varied between years, influencing catches. In spite of this, the 5-year average remained between 200 and 300 wild salmon in the 1980s (Figure 4.1). Catches increased markedly in 1992–1994, with a record total of 313 in 1994. This is reputed to have resulted from intense fishing on Kinlochewe Estate prior to its sale. Since 1994 fishing effort has stabilised, but catches have declined and the 5-year average has fallen to 130. The lowest recorded catch of 112 was made in 2001. This pattern reflects the regional trend (see Part 2), suggesting that the decline is a reflection of stock abundance and is not due to reductions in fishing effort.

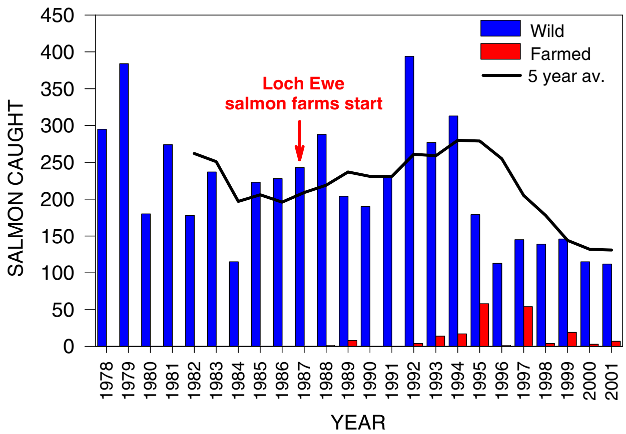


Figure 4.1 Total annual rod catch of adult wild and escaped farm salmon from the Ewe system, 1978–2001

4.2 Rod catches of wild salmon

Catch records for the Ewe Statistical Fishery District were provided by the Scottish Executive, and game books for the individual estates were also kindly made available. Most records have been kept in great detail, providing useful historical information on adult salmon stocks and enhancement exercises. However, for some years there were discrepancies between estate catches and those submitted to the Scottish Executive. In these cases the estate records were assumed to be the more accurate figures.

4.3 Escaped farm salmon

Escaped farm salmon have occurred in the catch for 12 (86%) of the 14 years since the establishment of salmon farms in Loch Ewe in 1987 (Figure 4.1). A maximum of 58 were caught in 1995, contributing 35% of the total rod catch of 173 fish. In 1997–2001 farm salmon contributed on average 12% of the total rod catch.

However, escapees are probably underestimated in catches, since scale samples show that some fish recorded as 'wild' by fishermen had in fact escaped as smolts from freshwater farms. Of 24 'wild' fish radio-tagged by the WRFT in 2001, two grilse subsequently proved to be farmed smolts (see Appendix II),[6] which may have originated from the escape that occurred in Loch Tollaidh in 2000 (see Table 4.1). Since smolt cages have been present in the Ewe catchment since 1986, it is possible that many similar escapees have gone undetected.

Farmed salmon occur regularly in Ewe system catches *(J Butler)*

Escapes have been reported both from marine cages in Loch Ewe, and also from the freshwater cages in Loch Tollaidh and Loch Clair (Table 4.1). Of particular concern were 400,000 parr and smolts released into Loch Clair by Coulin Estate in 1992 following the closure of the enterprise. It is possible that some of these fish contributed to the 1994 record catch, but no scales were collected to investigate this. In 1999 an estimated 10,000 smolts were maliciously released from the Loch Tollaidh cages. Funded by Wester Ross Salmon Ltd, the WRFT set a fyke net at the loch's outflow to trap the descending smolts in April–August 2000. Only 260 were intercepted, but hundreds were taken by Gairloch Angling Club and ticket fishermen. However, many fish probably dropped into the River Ewe during the 1999–2000 winter, and then to sea. Previous escapes of unknown quantity have also occurred in Loch Tollaidh, as demonstrated by the capture of farmed smolts during a netting survey undertaken by the Royal Society for the Protection of Birds (RSPB) in 1993.[7]

Table 4.1 Reported escapes of farmed salmon in the Ewe catchment and Loch Ewe

Date	Location	Number	Type
June 1989	Loch Ewe	35,000	growers
Summer 1990	Loch Clair	15,000	smolts
Summer 1992	Loch Clair	400,000	parr & smolts
February 1993	Loch Ewe	67,000	growers
June 1999	Loch Ewe	20,000	growers
Summer 1999	Loch Tollaidh	10,000	smolts

In the past farmed smolts (lower fish) have escaped from cages in the Ewe system *(J Butler)*

Fyke net at the outflow of Loch Tollaidh intercepting escapee smolts *(J Butler)*

4.4 Fishing regulations and catch and release

The Ewe DSFB's rod fishing season runs from 11 February to 15 October. There is an agreement that spinning is allowed until 30 June. In an effort to conserve spring salmon stocks, the Ewe DSFB applied to the Secretary of State for Scotland in 1997 for a by-law banning the use of shrimp and prawn. The application was granted and came into force on 1 April 1998 as 'The River Ewe Salmon Fishery District (Baits and Lures) Regulations 1998'.

The Ewe DSFB has no formal regulations on catch and release, leaving the matter to the discretion of fishermen. Prior to 1988 all wild salmon caught were killed. Since then the numbers released have gradually increased, to a maximum of 29% in 2001 (Figure 4.2). Most fish released have been those caught late in the season, other than in 2001 when fresh salmon were released as part of the WRFT's Radio-tracking Project. Only Coulin Estate has a formal policy of catch and release for all wild salmon, introduced in 2000.

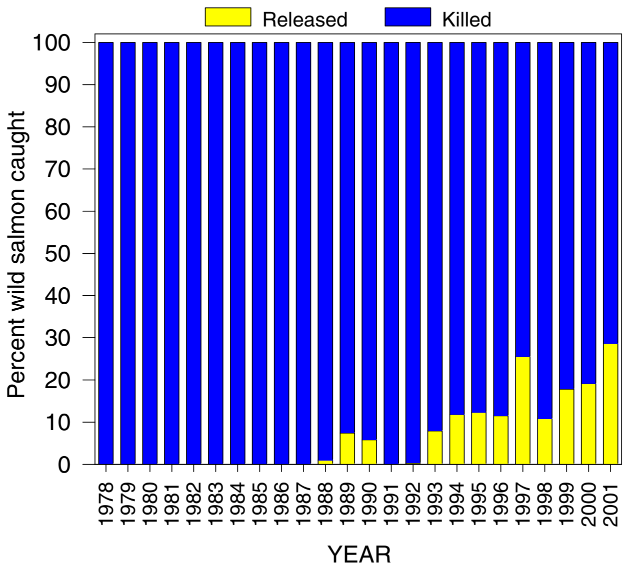


Figure 4.2 Proportion of wild salmon caught annually in the Ewe catchment released, 1978–2001

4.5 Salmon ages, run-timing and stock components

4.5.1 Marine ages

Scale samples taken from wild adult salmon caught on all estates in 1997–2001 indicate that 47% are grilse (1 Sea Winter fish; Table 4.2). The majority (53%) are Multi Sea Winter salmon, which have spent two (47%) or three years (6%) at sea. By contrast a sample taken by FRS in 1990–1991 showed a higher proportion of grilse (65%), and a minority of Multi Sea Winter salmon (35%), which constitutes a significant change.

Table 4.2 Relative marine ages of wild Ewe system salmon, derived from scale samples taken by the WRFT in 1997–2001 (96 fish), and FRS in 1990–1991 (136 fish)[8] (see Appendix III for data)

	1 Sea Winter	2 Sea Winter	3 Sea Winter
1997–2001	47%	47%	6%
1990–1991	65%	34%	1%

The contribution of Multi Sea Winter salmon to the adult population is significantly higher than in other local rivers. In the Gruinard, Little Gruinard, Dundonnell, Kanaird, Balgy and Ling 9–30% are Multi Sea Winter salmon, while 70–91% are grilse (Table 4.3).

Table 4.3 Comparison of wild salmon marine ages between the Ewe system and the Rivers Gruinard,[9] Little Gruinard,[1] Dundonnell,[10] Kanaird,[11] Balgy,[12] and Ling,[13] derived from scale samples. (Multi Sea Winter salmon are 2 and 3 Sea Winter fish combined)

	1 Sea Winter	Multi Sea Winter
Ewe, 1997–2001	47%	53%
Gruinard, 1995–2001	80%	20%
Little Gruinard, 1990–1995	91%	9%
Dundonnell, 1997–2000	70%	30%
Kanaird, 1991–1999	71%	29%
Balgy, 1993–1999	87%	13%
Ling, 1999–2000	80%	20%

Multi Sea Winter salmon form an unusually high proportion of adult fish in the Ewe *(K Starr)*

A comparison between the weights of salmon caught in 1971–1980 and in 1993–2000 also shows the increase in Multi Sea Winter salmon detected by the scale samples (Figure 4.3). Salmon in the 12–22 lb range have become more common, while grilse have become less common. Although a fish of 28 lb was caught in 1971–1980, there were few other fish larger than 18 lb. However, fish of up to 25 lb have occurred regularly in recent years. It is also notable that in the 1990s most grilse weighed 5–6 lb, while in the 1970s the most common size was 6–7 lb. Overall, the average weight of fish caught in the 1990s was 8½ lb, with the smallest 3 lb and the largest 25 lb.

4.5.2 Run-timing and stock components

Rod catches recorded by Inveran Estate on the River Ewe give a useful indication of the seasonal running time of adult salmon, since this fishery is located immediately upstream from the estuary and catches mostly fresh-run fish. Using scale samples and weight distributions it has been possible to age the different stock components. Figure 4.4 illustrates the monthly catches of wild salmon

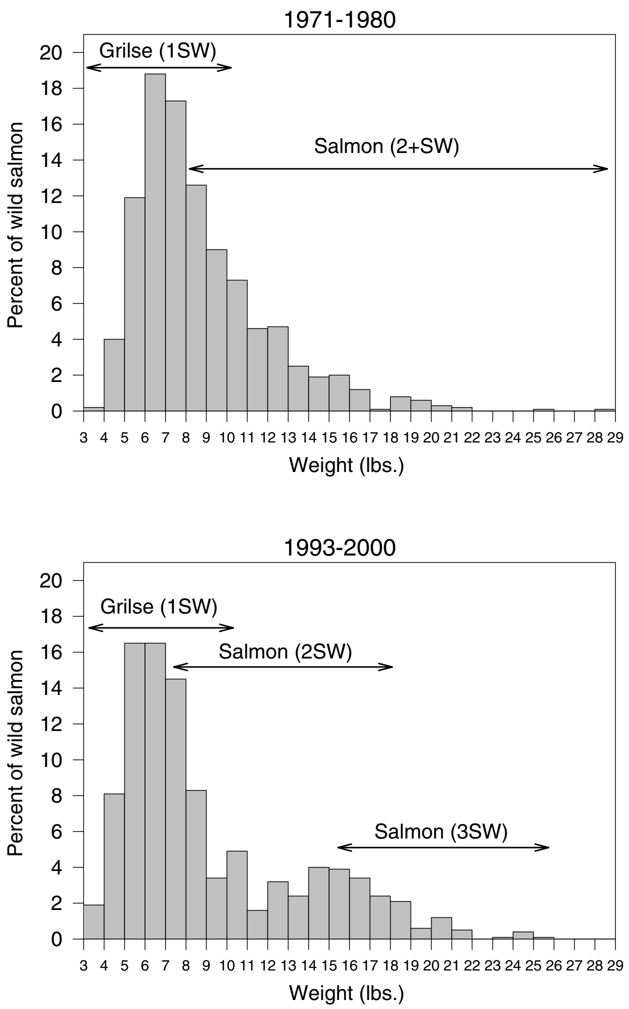


Figure 4.3 Weight distribution of 1,024 wild salmon caught in the River Ewe by Inveran Estate in 1971–1980 (top), compared to 943 caught in 1993–2000 (bottom)

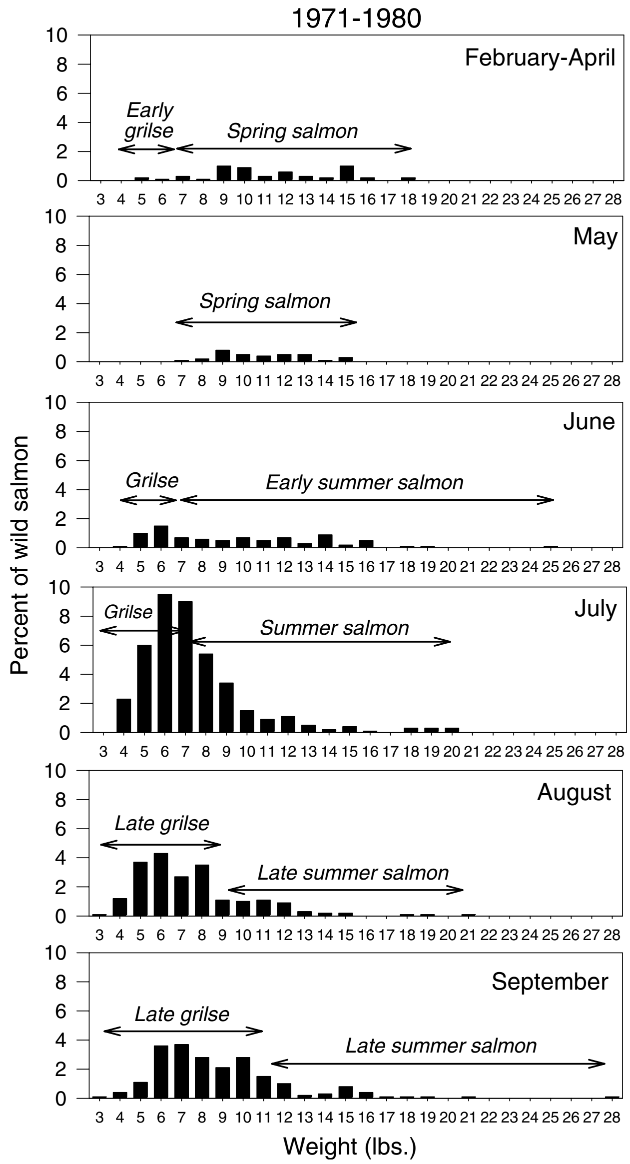


Figure 4.4 Relative monthly catches of wild salmon on the River Ewe in 1971–1980 (above: 1,024 fish) versus 1993–2000 (above right: 943 fish)

in 1971–1980 and 1993–2000. The broad pattern for both periods is:

February–May: A few Multi Sea Winter spring salmon, ranging 7–19 lb, and some early grilse.

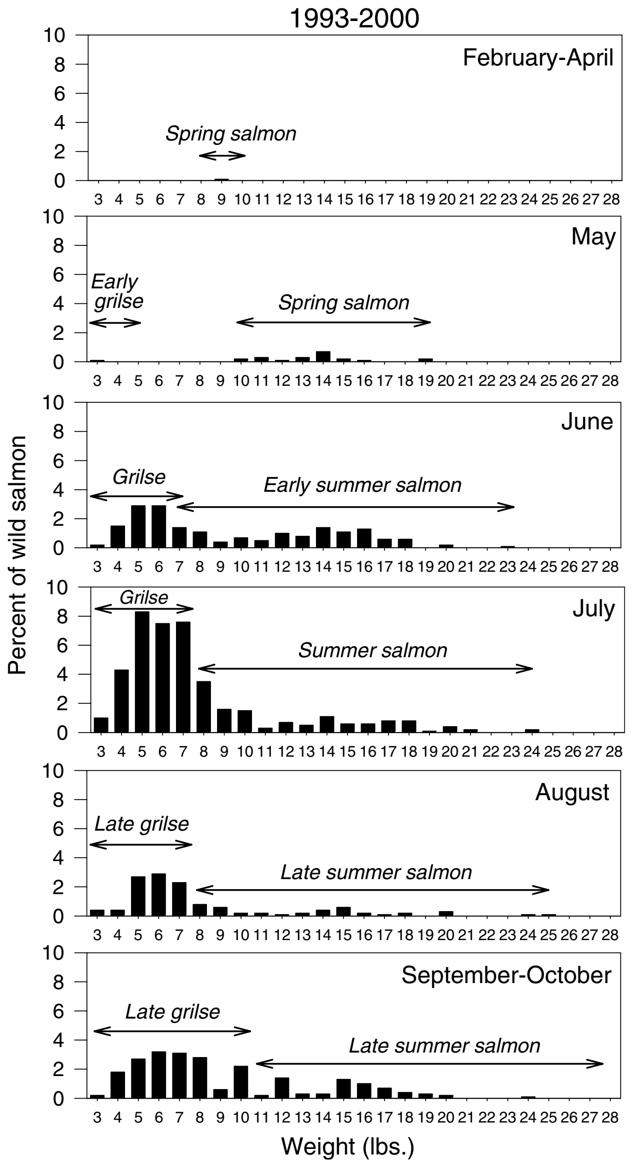
June: Increasing numbers of fish, dominated by early grilse of 3–7 lb, and a strong component of early summer Multi Sea Winter salmon, weighing 7–25 lb.

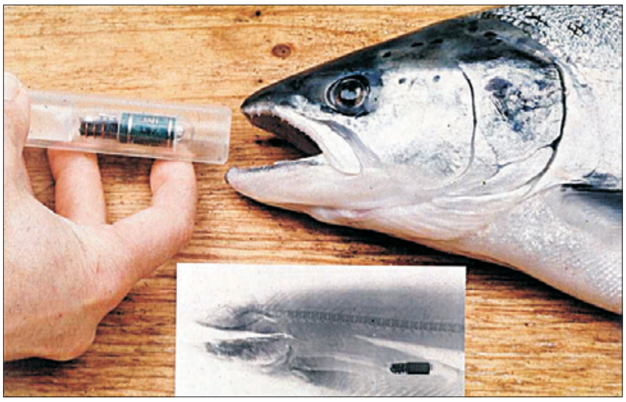
July: The majority (41– 42%) of fish enter, dominated by grilse of 3–7 lb. Summer salmon are present, but not as common as in June.

August: A similar pattern as for July, but fewer fish. Some late grilse are evident, weighing up to 8 lb.

September–October: Marginally more fish enter than in August, including late grilse of up to 10 lb and late-running Multi Sea Winter salmon.

There are some noticeable differences between the two periods, however. First, early grilse and spring salmon have become relatively scarce during the 1990s. In 1971–1980, 9% of the annual catch was taken in February–May, whereas this had declined to 2% in 1993–2000. This parallels the decline of early-running salmon in all Scottish rivers. Second, runs during June have increased, from 8% of the catch to 19%. The increase in Multi Sea Winter salmon that has occurred during the 1990s (see Figure 4.3) is manifested most clearly during June and July.





Radio transmitters were inserted into the salmon's stomach (top), the salmon was released (middle) and then followed with receivers (bottom) *(FRS/K Starr)*

4.5.3 Ewe Radio-tracking Project, 2001

In 2001 a radio-tracking study was carried out to assess the origin of different stock components in the catchment. In collaboration with FRS, and funded by the Highland Council, Ross & Cromarty Enterprise, SNH and the Ewe DSFB, radio-transmitters were inserted into rod-caught salmon. Fish were released and, using receivers, tracked to their approximate spawning locations.[6]

In total, 25 fish were donated by anglers (see Appendix II for details). Judging by the presence of sea lice or their silvered appearance, 17 were captured within a week of entry into the river, and could therefore be defined within the stock components identified in Figure 4.4.

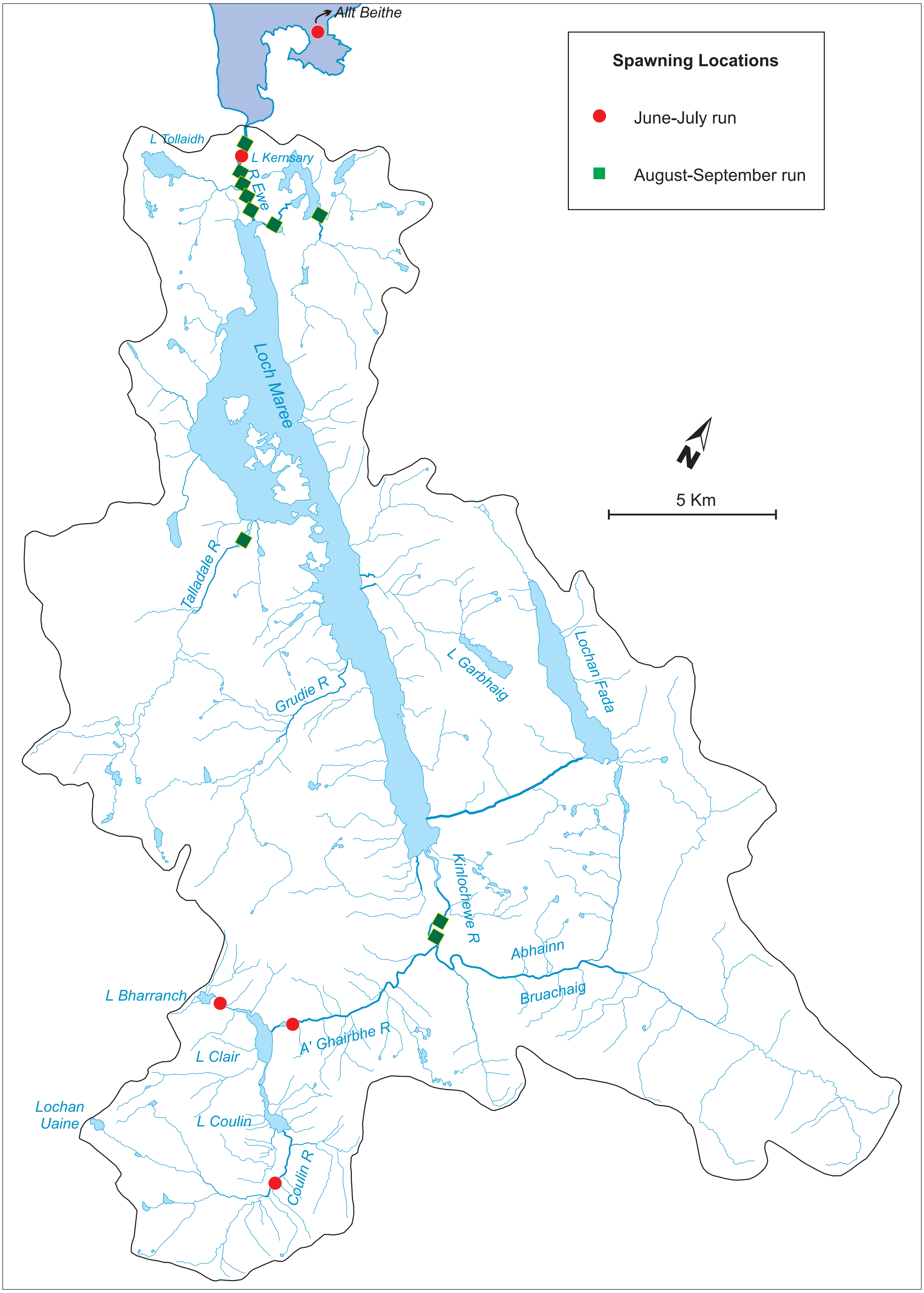


Figure 4.5 Approximate spawning locations of 14 fresh-run grilse and salmon (12 wild and two escapees) relative to their stock component, determined by radio-tracking in 2001 *(Crown Copyright)*

Three left the system having stayed in the River Ewe for up to three months. One of these was located in November in Allt Beithe, 8 km to the east, where it is assumed to have spawned. This left a sample of 14 fish, which were divided into the June–July run (early summer and summer fish), and the August–September run (late summer fish). Figure 4.5 illustrates the approximate spawning locations of the fish relative to their stock component.

The results suggest that most early-summer and summer fish originate from the upper reaches of the river system, and the Loch Clair–Coulin sub-catchment in particular. One tagged fish captured in early June may have entered the river in late May as a spring salmon. This fish spawned in the Loch Bharranch–Clair Burn. By contrast, one captured in late July remained in the River Ewe.

Most late summer fish spawned in the lower catchment, with five remaining in the River Ewe, and two in the Loch Kernsary system. One spawned in the Talladale River, a tributary of Loch Maree, and two spawned in the Kinlochewe River, immediately upstream from Loch Maree.

Although the Ewe system is small relative to the large east coast rivers, the results nonetheless suggest that there are sub-populations of salmon within the catchment. This parallels the results of a previous radio-tracking study carried out on another Wester Ross river, the Little Gruinard.[14] The predominant runs of June and July fish, many of which are Multi Sea Winter salmon (see Figure 4.4) originate largely from the area upstream of Loch Maree. The runs of late summer grilse and salmon in August and September originate from the Loch Maree tributaries, and the River Ewe itself. However, there is overlap, with some July fish spawning in the Ewe, and some late fish spawning in the Kinlochewe River.

Interestingly, two tagged salmon were fish that had escaped from a farm as smolts, yet they conformed to the general pattern demonstrated by the wild fish. If these fish had escaped from Loch Tollaidh in 1999 (see Table 4.1), it is surprising that they did not return to the loch. Including a third farmed fish which was tagged, escapees were located at the extremities of the catchment at spawning time, namely the Coulin River, Abhainn Bruachaig, and the Loch Kernsary system (see Appendix II). Therefore genetic introgression by escapees may be widespread throughout the catchment, potentially affecting all of the stock components within it.

4.5.4 Smolt ages

The scale samples taken by the WRFT from wild salmon and grilse throughout the system in 1997–2000 indicate that 59% had spent 2 years in the river prior to smolting,

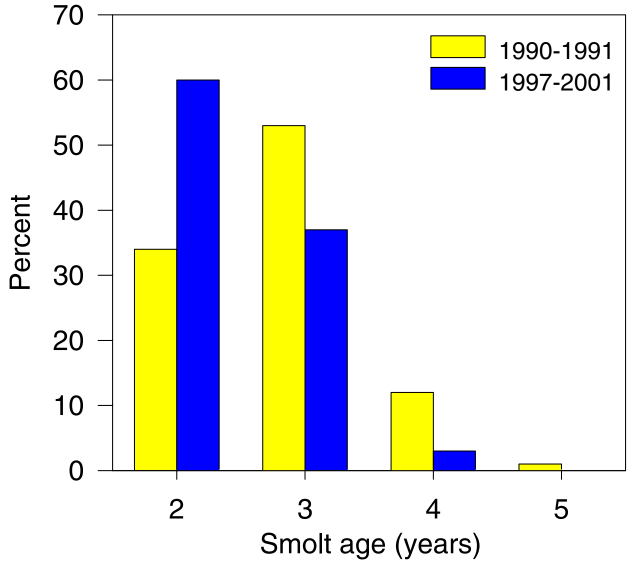


Figure 4.6 Relative smolt ages of wild Ewe system salmon, derived from scale samples taken by the WRFT in 1997–2001 (96 fish), and FRS in 1990–1991 (137 fish)[8] (see Appendix III for data)

while 35% had spent 3 years, and 6% had spent 4 years (Figure 4.6). By contrast, samples taken by FRS in 1990–1991 were characterised by older smolts, with 3-year olds being most common (73%), 2-year olds less common (46%), and the presence of relatively more 4- and 5-year old fish.

Thus it appears that both the marine and freshwater age structure of the Ewe salmon population has altered since 1991. Today the stock is dominated by younger smolts and relatively more Multi Sea Winter salmon, whereas in the early 1990s smolts were older, and grilse were more common (see Table 4.2). It is not clear why the balance has altered in recent years. One possibility is that densities of juvenile salmon have fallen, reducing competition and allowing fish to grow to smolt size more quickly. Another is that the incidence of escaped farm salmon since 1986 has resulted in inter-breeding with wild Ewe salmon, yielding rapidly-growing hybrids, and hence younger smolts and more Multi Sea Winter salmon.

4.6 Salmon stock enhancement

There is a history of salmon stock enhancement in the Ewe catchment, including the capture and stripping of wild fish caught in the river system, and the introduction of fish from foreign salmon stocks. The capture and hatching of eggs from fish caught within the system is referred to here as 'recycling', since these eggs would have been laid in the river naturally. The introduction of fish from outside the river system is termed 'stocking', since this may have augmented existing indigenous juvenile stocks.

Salmon enhancement has largely involved recycling of fish *(J Butler)*

Wild Ewe smolts are being held for captive broodstock by the FRS Fish Cultivation Unit *(J Butler)*

There were two periods of stocking with non-native fish, first into the Ewe in 1975–1980, and then into the Kinlochewe River from 1982–1986 (Table 4.5). Although the source of the Ewe fish is unknown, the Kinlochewe stocks were of River North Esk origin, and apparently introduced to augment spring salmon. Recycling occurred in 1988–1991, when Wester Ross Salmon Ltd captured and stripped fish from the lower Abhainn Bruachaig in lieu of establishing smolt cages in Loch Tollaidh (see Part 3). More recently small numbers of fry have been recycled by the Seafield Centre, Kishorn (1997) and the FRS Fish Cultivation Unit, Aultbea (2000). The 30,000 fry of unknown origin stocked in 2001 were also provided by the Fish Cultivation Unit. Thus, in recent years, most fish have been recycled, and comparatively few have been stocked, resulting in minimal enhancement of the population. However, there may have been some genetic dilution of the native Ewe salmon stock owing to the introduction of foreign fish.

In order to produce large numbers of additional native fish for the restoration of Abhainn Bruachaig, the WRFT collected 70 salmon smolts from the lower Bruachaig and Docherty Burn in May 2000, using electro-fishing equipment. These were transferred to tanks at the FRS Fish Cultivation Unit and are being grown on to produce a captive broodstock. The first eggs from these fish will be produced in autumn 2002.

Table 4.5 Recorded instances and locations of salmon enhancement in the Ewe system, differentiated as 'recycled' and 'stocked'

	'Recycled'		'Stocked'		
Year	**Number**	**Location**	**Origin**	**Number**	**Location**
1975–1980	—		unknown	4,000 fry p.a.	Ewe
1982–1986	—		North Esk	unknown	Kinlochewe
1988	15,000 parr	Bruachaig		—	
1990	12,000 parr	Bruachaig		—	
1991	80,000 fry	Bruachaig		—	
1991	9,000 parr	Bruachaig		—	
1997	6,000 fry	Loch Clair		—	
2000	7,000 fry	Ewe		—	
2000	3,000 fry	Tollie Burn		—	
2001	—		unknown	30,000	Tollie Burn

4.7 Conclusions

- **The Ewe system has the largest salmon rod fishery in Wester Ross, with a 5-year average of 200–300 fish in 1978–1996. However, catches have declined since 1996, with the lowest recorded catch of 112 made in 2001.**

- **Escapes of farmed salmon have occurred regularly since the establishment of marine salmon farms in Loch Ewe in 1987, and freshwater cages in Loch Tollaidh and Loch Clair in 1986. A maximum of 58 were caught in 1995, and escapees represented 12% of all rod-caught fish in 1997–2001. Numbers have probably been underestimated owing to the escape of some fish as smolts. Radio-tracking indicates that escapees probably spawned widely in the catchment in 2001, potentially affecting sub-populations in these areas. Therefore the risk of genetic introgression has been sustained and widespread since 1986.**

- **Only Coulin Estate has a policy of catch and release for all wild rod-caught salmon. Until 1988 all wild salmon caught in the catchment were killed, but since then the proportion released has increased to a maximum of 29% in 2001.**

- **Currently an unusually high proportion of adult fish are Multi Sea Winter salmon (53%), and a minority are grilse (47%). In 1997–2001 the majority of smolts were 2-year olds. The age structure of the population has altered within the last decade, and may be caused by hybridisation with escaped farm fish, and declining abundance and therefore competition amongst juvenile salmon.**

- **Run-timing has also altered in the 1990s in comparison to the 1970s, with fewer spring salmon, and more early grilse and summer salmon in June. Radio-tracking indicates that early summer and summer fish largely originate from the Loch Clair–Coulin headwaters, while late summer fish originate from the Kinlochewe River, Loch Maree tributaries, Kernsary and River Ewe.**

- **Radio-tracking also demonstrates that some rod-caught fish reside in the Ewe for up to three months before departing to other rivers. One fish spawned in Allt Beithe. Therefore rod exploitation in the Ewe may be affecting stocks in other local rivers.**

- **Salmon enhancement has occurred in the catchment. Most has involved the recycling of indigenous fish, but foreign stocks have also been introduced from the River North Esk. The numbers introduced are unlikely to have significantly augmented the population, but may have contributed to the genetic dilution of Ewe salmon.** ❑

Part 5
Trout Fisheries and Stocks

5.1 Sea trout rod fishery

Historically the rod fishery for sea trout has been centred on the River Ewe and Lochs Maree, Coulin and Clair. Loch Maree in particular was once famous as the premier sea trout loch in Scotland, and the Loch Maree Hotel was the primary centre for visiting anglers. During the 1970s and 1980s the hotel employed nine ghillies through the fishing season (June–October) but, following recent declines in catches, only one part-time ghillie has been employed.

Scottish Executive rod-catch statistics for the Ewe Statistical Fishery District show a marked decline since 1981 (Figure 5.1). The 5-year average has fallen from a peak of 2,500 in 1982 to 800 in 2000. The maximum of 2,994 sea trout was recorded in 1980, and the minimum was 116 in 1999. The poorest sequence of catches has occurred since 1987, coinciding with the establishment of marine salmon farms in Loch Ewe. Unfortunately, anecdotes from estate records suggest that prior to the decline in catches only 'takeable' sea trout were recorded, and smaller fish were ignored. Since the late 1980s smaller fish have been recorded as they now comprise the bulk of the catch (see 5.4). Hence catches in the 1980s were probably underestimates, while those in the 1990s are more representative. Another probable source of variation is river flows, which are known to affect fishing conditions and thus catches.[5]

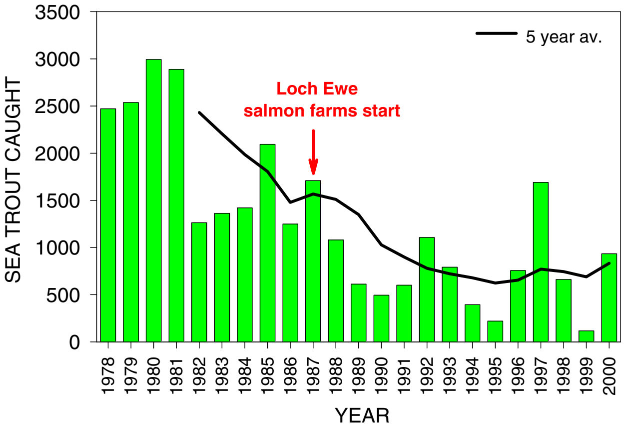
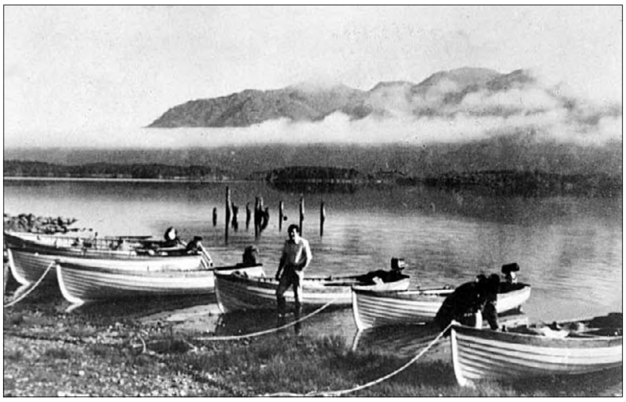


Figure 5.1 Total declared annual rod catch of sea trout for the Ewe Statistical Fishery District, 1978–2000

To minimise these problems it is useful to examine records for one fishery only. The Loch Maree Hotel provides the best opportunity for this since nine boats were operated daily on Loch Maree, providing consistent fishing effort. However, following the decline in catches in the late 1980s fishing effort has undoubtedly lessened and become more variable.

The Loch Maree Hotel was a premier sea trout fishery in the 1900s (top) and 1970s (middle), employing nine ghillies in 1986 (bottom) *(Gairloch Heritage Museum)*



Fishing effort was consistent on Loch Maree until the decline in catches *(Gairloch Heritage Museum)*

These records show that catches fluctuated in the 1970s, with between 600 and 1,500 sea trout caught annually (Figure 5.2). A period of poor catches in 1971–1976 is reputed to have been caused by an outbreak of Ulceral Dermal Necrosis (UDN), which killed large numbers of fish in Loch Maree. However, catches recovered in 1978–1981 before falling again in 1982–1984, perhaps as a knock-on effect from poor spawning during the UDN outbreak. Since the establishment of the Loch Ewe salmon farms in 1987, catches have collapsed, with no more than 340 fish caught in any one year. Overall the 5 year average has declined from between 800 and 1,400 fish in 1974–1987 to 81 in 2001.

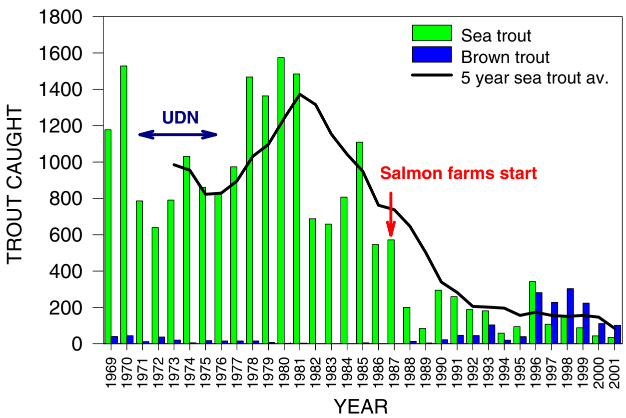


Figure 5.2 Total annual rod catch of sea trout and brown trout from the Loch Maree Hotel, 1969–2001

5.2 Brown trout rod fishery

Traditionally brown trout have not featured regularly in the Loch Maree rod catch. However, since the collapse in sea trout catches, the number of brown trout caught has increased (Figure 5.2). Brown trout have constituted a growing proportion of all trout caught, with a maximum of 74% in 2001 (Figure 5.3). A similar pattern is evident for catches in Lochs Clair and Coulin.

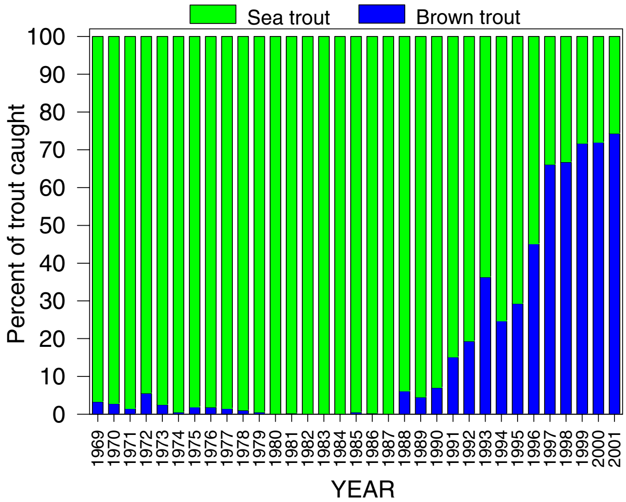


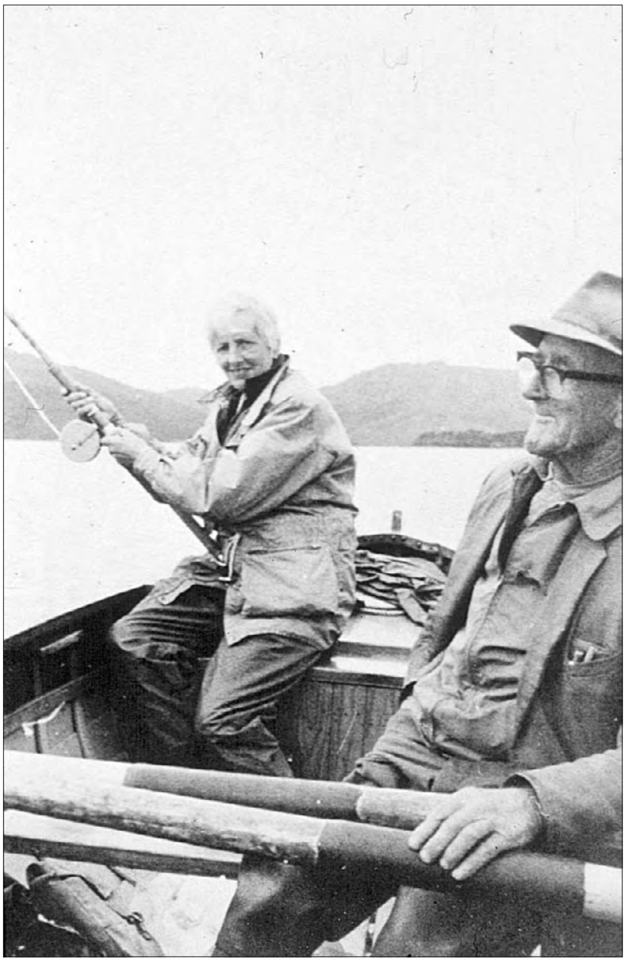
Figure 5.3 Proportion of the total Loch Maree Hotel rod catch consisting of sea trout and brown trout, 1969–2001

The brown trout fisheries run by the Gairloch Angling Club (Loch Tollaidh), National Trust for Scotland (Lochs Kernsary and Ghiuragarstidh) and the Kinlochewe Angling Club (Lochs Dubh a Phluic, Bharranch and Feith Leothaid) are managed through the sale of day tickets to visiting anglers. Because returns are rarely made, it is impossible to assess catches or the characteristics of the trout stocks, although some data exist for Loch Tollaidh (see 5.8.3). Similarly, almost no information is available for the other hill lochs in the catchment.

With the decline of sea trout (above), brown trout (below) have become more abundant in catches *(J Butler)*

5.3 Catch methods

On the River Ewe there has been a long tradition of fly-fishing for sea trout at night. However, on Loch Maree fishing from boats is allowed only during daylight. As for salmon, trolling with spinners is permitted until 30 June, after which fly-fishing is the norm. Historically the technique of dapping has been popular on Lochs Maree, Clair and Coulin.



Dapping from boats is the favoured fishing method on Loch Maree *(Gairloch Heritage Museum)*

The Ewe DSFB has a general agreement between all estates that sea trout should be returned by anglers, and this is largely upheld. However, most brown trout caught within the main sea trout fisheries are killed. There are no regulations governing the return of brown trout on the lochs managed by angling clubs or by the National Trust for Scotland.

5.4 Sea trout growth and reproduction

5.4.1 Freshwater growth

In 1997–2001 the WRFT collected 262 scale samples from sea trout caught throughout the river system by anglers, during the course of broodstock collection, sea lice surveys and other research work. With the assistance of Dr Andy Walker and Alistair Thorne of FRS the age and life history of each fish was derived from growth patterns on the scales. The results indicated that the majority of fish (71%) remained in freshwater for 3 years before smolting (Table 5.1), while a minority smolted after 2 years (15%) and 4 years (14%).

Table 5.1 Details of the smolt and sea ages of 262 Ewe system sea trout, determined from scale samples taken in 1997–2001. (See Appendix IV for data)

	Years					
	0	1	2	3	4	5
Smolt age	0	0	15%	71%	14%	<1%
Sea age	44%	36%	16%	3%	<1%	0

Comparison with scales taken by FRS in 1991 suggests that sea trout began to smolt at a younger age during the 1990s (Figure 5.4). Two-year old smolts are more common today (15% versus 3%), as are 3-year olds (71% versus 55%), and smolts older than this are less common than in 1990–1991. This pattern mirrors that for salmon (see Part 4), and may be linked to lower densities of juvenile trout, resulting in less competition for food, and faster growth rates.

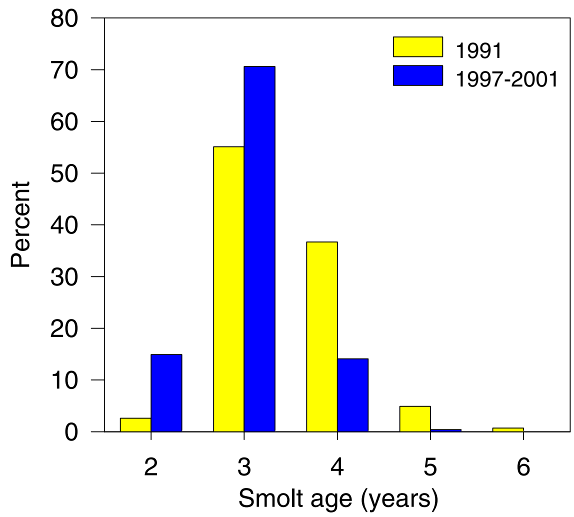


Figure 5.4 Relative occurrence of smolt ages derived from 267 sea trout sampled by FRS in 1991,[8] compared with 262 sampled by WRFT in 1997–2001

5.4.2 Current marine growth

In 1997–2001 most sampled fish (44%) had spent only a few months at sea ('post-smolts'), while fish with one sea year ('finnock') were less common (36%). Larger, older sea-age sea trout were scarce, and no fish of more than 4 sea years was recorded (Table 5.1). In terms of weight, all post-smolts and finnock weighed less than 1 lb. Therefore of all fish sampled, the majority (80%) were of this size. All older sea trout sampled (i.e. 2–4 sea years) weighed 1–2 lb.

Smolt ages of both sea trout (top) and salmon (bottom) have decreased during the 1990s *(J Butler)*

By calculating the average length of sea trout at each sea age it was possible to estimate marine growth rates. Relative to fish from the Dundonnell and Gruinard Rivers, Ewe sea trout grow slowly (Figure 5.5). After 3 years at sea, a Ewe sea trout will have reached 37 cm (1¼ lb), while fish of the same age from the Dundonnell and Gruinard will have reached 45–50 cm (2½–3 lb), at least twice the weight. This difference may be related to food supply. As sea trout grow larger, their marine diet consists largely of juvenile sea fish such as herring and sprats.[15] Little is known about the current abundance and distribution of such fish stocks in west coast sea lochs, but Gruinard Bay and Little Loch Broom are closed to mobile fishing gear in October–March under the Inshore Fishing Order (1989), to protect stocks of juvenile herring.[9,10] No such ban exists in Loch Ewe, and this may have had some influence on the availability of small fish for Ewe sea trout.

Juvenile sea fish may be less abundant in Loch Ewe than in neighbouring sea lochs *(J Butler)*

5.4.3 Historical marine growth

The Ewe is fortunate in having had extensive studies carried out on the river system by Dr Andy Walker of FRS in the 1980s and early 1990s, both prior to and immediately after the collapse of the rod fishery. This work provides a useful basis for comparison with the state of sea trout stocks in the late 1990s. By comparing growth rates determined from scales taken in 1926 (by G H Nall), 1980, 1989 and 1992, an interesting pattern emerges (Figure 5.6). In 1926 and 1980 growth rates were relatively fast, and large, multi-spawning fish of up to 11 sea years were present. However, coinciding with the collapse of the rod fishery, there was a decline in growth rates. Furthermore, in 1989 no fish older than 8 sea years was found, and in 1992 none older than 6 years was sampled.

Scales taken by WRFT show that this trend has continued, with the maximum age falling to 4 sea years in 1997–1999, and to 3 sea years in 2000–2001 (Figure 5.6). Growth rates have declined to the extent that a sea trout of 3 sea years typically measured 37 cm (1¼ lb) in 2001, but in 1989 a fish of the same age would have weighed 43 cm (2¼ lb). This represents a 44% reduction in marine growth rates in 12 years.

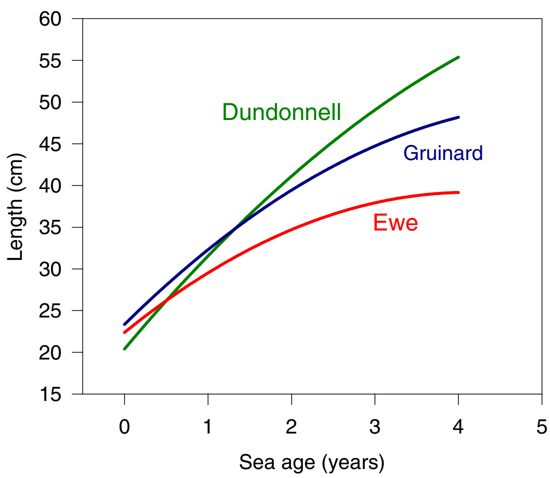


Figure 5.5 Relative rates of marine growth for Ewe sea trout in 1997–2001 (262 fish) versus Gruinard and Dundonnell River sea trout

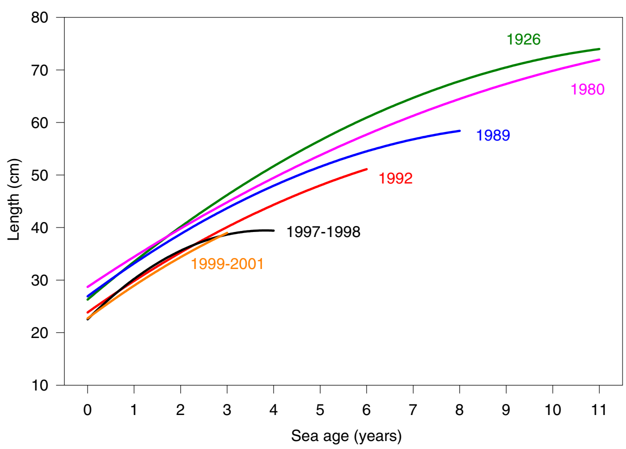


Figure 5.6 Relative rates of marine growth for Ewe sea trout in 1926, 1980, 1989 and 1992 *(from Walker, 1993)*[5], compared with 1997–1998 and 1999–2001

A similar pattern is shown by the weights of rod-caught sea trout from the River Ewe in 1971–1980 and 1992–2001 (Figure 5.7). Prior to the collapse of the rod fishery, post-smolts and finnock weighing under 1 lb contributed 60% of fish, while mature, multi-spawning fish formed the remaining 40% of the population. In addition, large and long-lived sea trout of up to 11 lb were present. In contrast, post-smolts and finnock contributed 81% of the stock in 1992–2001, and larger fish were scarce, representing only 19% of the catch. No sea trout of more than 4 lb was caught during this period.

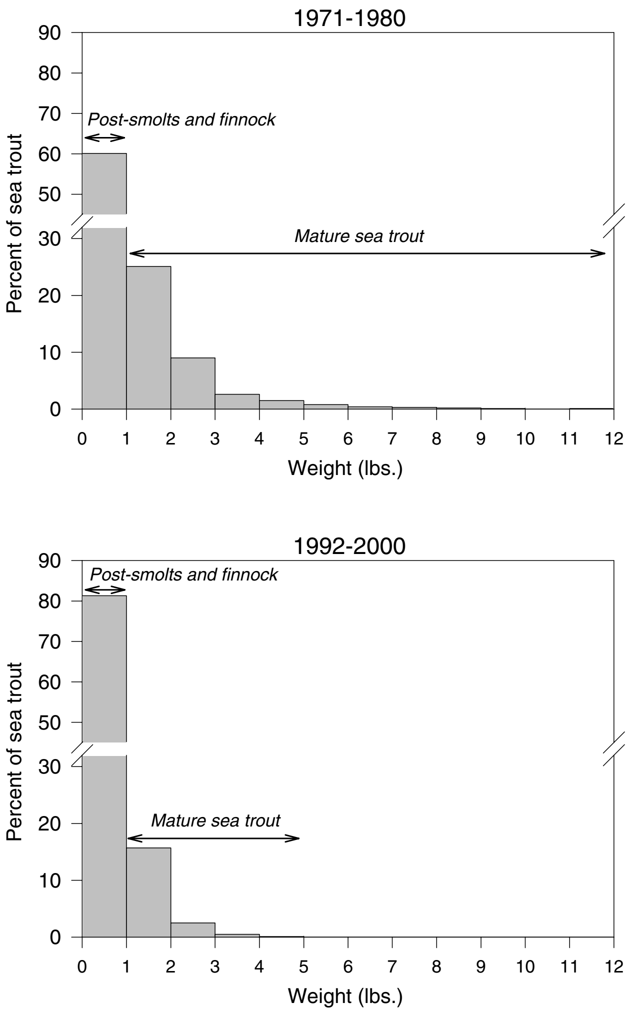
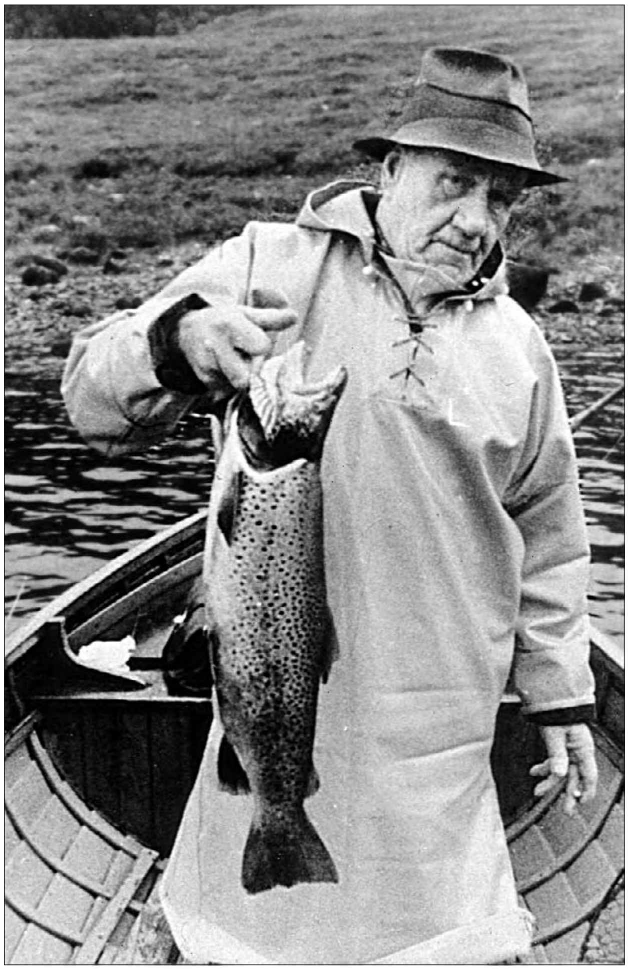


Figure 5.7 Weight distribution of 3,305 sea trout caught by Inveran Estate on the River Ewe in 1971–1980 (top) relative to 7,094 caught in 1992–2001 (bottom)

5.4.4 Sea trout egg production

On the Scottish west coast 53–59% of sea trout are females, while less than 30% of brown trout are females.[1,5] Therefore female sea trout are the primary source of trout eggs within populations that have access to the sea. As a consequence of the simultaneous fall in numbers and size of mature sea trout in the Ewe system since the late 1980s, it has been estimated that trout egg deposition has dropped by at least 50%.[5] The ensuing reduction in the recruitment of juvenile trout may well explain the



Large, long-lived sea trout were common prior to the late 1980s *(Gairloch Heritage Museum)*

marked shift towards younger sea trout smolts that has occurred in the 1990s (see Figure 5.4).

Utilising 'spawning marks' found on sea trout scales, it has been possible to compare the reproductive characteristics of fish sampled in 1980, 1991 and 1997–2001. In 1980, 40% of fish had spawned once, and a total of 60% had spawned at least twice (Table 5.2). In 1991, 80% had spawned once and relatively few had spawned twice or more. In 1997–2001 the pattern was similar, but no fish was found to have spawned more than twice. Thus a further characteristic of the sea trout collapse is a progressive lack of multi-spawning sea trout during the 1990s, resulting in lower egg production.

Table 5.2 The relative numbers of spawning marks on mature Ewe system sea trout sampled in 1980 (588 fish)[16] and 1991 (269 fish)[8] and in 1997–2001 by the WRFT (22 fish)

	Spawning marks					
	1	2	3	4	5	>6
1980	40%	24%	19%	9%	5%	12%
1991	80%	15%	3%	0	<1%	0
1997–2001	73%	27%	0	0	0	0

Spawning marks also suggest that sea trout are maturing at a younger age. In 1980 most fish matured and spawned for the first time after 1 or 2 sea years, and only 4% matured within their first sea year (Figure 5.8). However, in 1997–2001 fewer fish matured after 1 or 2 sea years, and 24% spawned within their first sea year, indicating a more rapid rate of maturation since the stock collapse.

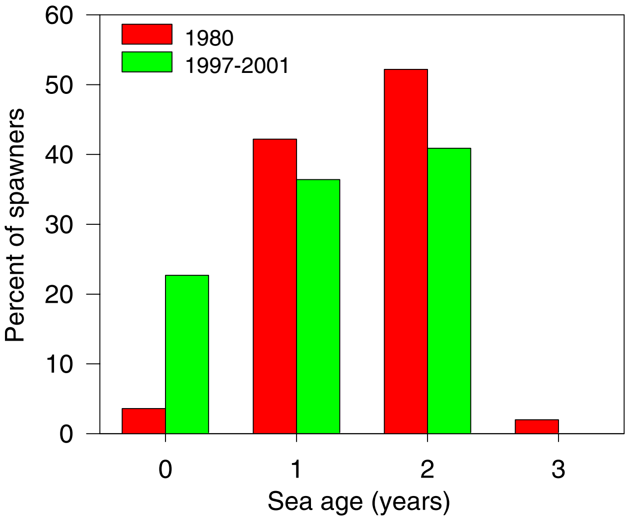


Figure 5.8 The relative sea age at maturity of sea trout sampled in 1980 by Dr Andy Walker (588 fish)[19] and by the WRFT in 1997–2001 (22 fish)

5.5 Sea trout run-timing

Catches from the River Ewe were used to describe the run-timing of sea trout, since this fishery is located immediately upstream from the estuary (Figure 5.9). The pattern for the period 1971–1980 can be summarised thus:

May: A few large, multi-spawning fish (2–4 lb) enter.

June: More mature fish enter weighing 1–8 lb, with the majority in the 1–5 lb range. These fish comprise 5% of the run.

July: The peak month for sea trout entry, comprising 53% of the run. Fish are dominated by post-smolts and finnock weighing less than 1 lb. Mature sea trout of 1–11 lb are also present.

August: Runs decline, comprising 37% of the catch. While post-smolts and finnock are as common as in July, older sea trout are less evident.

September: Most fish have progressed further up the river system. Some post-smolts and finnock and late-running older sea trout are evident, comprising 5% of the run.

In 1992–2000 this pattern appears to have altered, however:

May: Early-returning post-smolts and finnock are evident, comprising 4% of the run.

June: The majority of fish enter, comprising 61% of the run. This is dominated by post-smolts and finnock.

July: Post-smolts and finnock are still prevalent, but there are fewer mature sea trout than in June.

August and September: Runs dwindle, comprising 5% of the total catch.

During 1992–2000 there has been a clear shift towards sea trout entering the river earlier than in 1971–1980. This is characterised by the arrival in May and June of post-smolts and finnock, which in the 1970s were not evident until July. Results from the Tournaig Trap show that most sea trout smolts emigrate into Loch Ewe in May.[17] Therefore many of the post-smolts returning in 1992–2000 had been at sea for less than four weeks, whereas in 1971–1980 they had remained at sea for longer. Hence earlier run-timing is a further symptom of the stock collapse.

5.6 Sea lice

5.6.1 Monitoring lice infestation

In 1997 the WRFT began monitoring sea lice on sea trout caught at the mouth of the River Ewe every June. This site was also sampled by previous surveys in June 1991 and 1992,[18] and in June 1994,[19] providing some information for comparison. Fish were caught using gill nets or on rod and line, and then measured, aged from scale samples and had their lice counted (see Appendix V for detailed data).

The results showed that in 1997–2000 lice abundance (i.e. average lice per fish) varied alternately from year to year (Figure 5.10), and this was related to the stage of production on the salmon farms in Loch Ewe. In the first spring of the production cycle (after a fallow period) lice numbers were low. In the second and final spring of production, when lice numbers had accumulated on the farms, lice infestations were high, and up to 30% of fish had more than the potentially lethal threshold of 30 lice. The feeding activity of lice frequently caused skin damage to the dorsal fin.

Similar variation was found by the surveys in 1991 (lice abundance 15.4), 1992 (93.9) and 1994 (5.5). However, only in 1994 were details given of the stage of production on the local farms, and this was a fallow year (Figure 5.10).

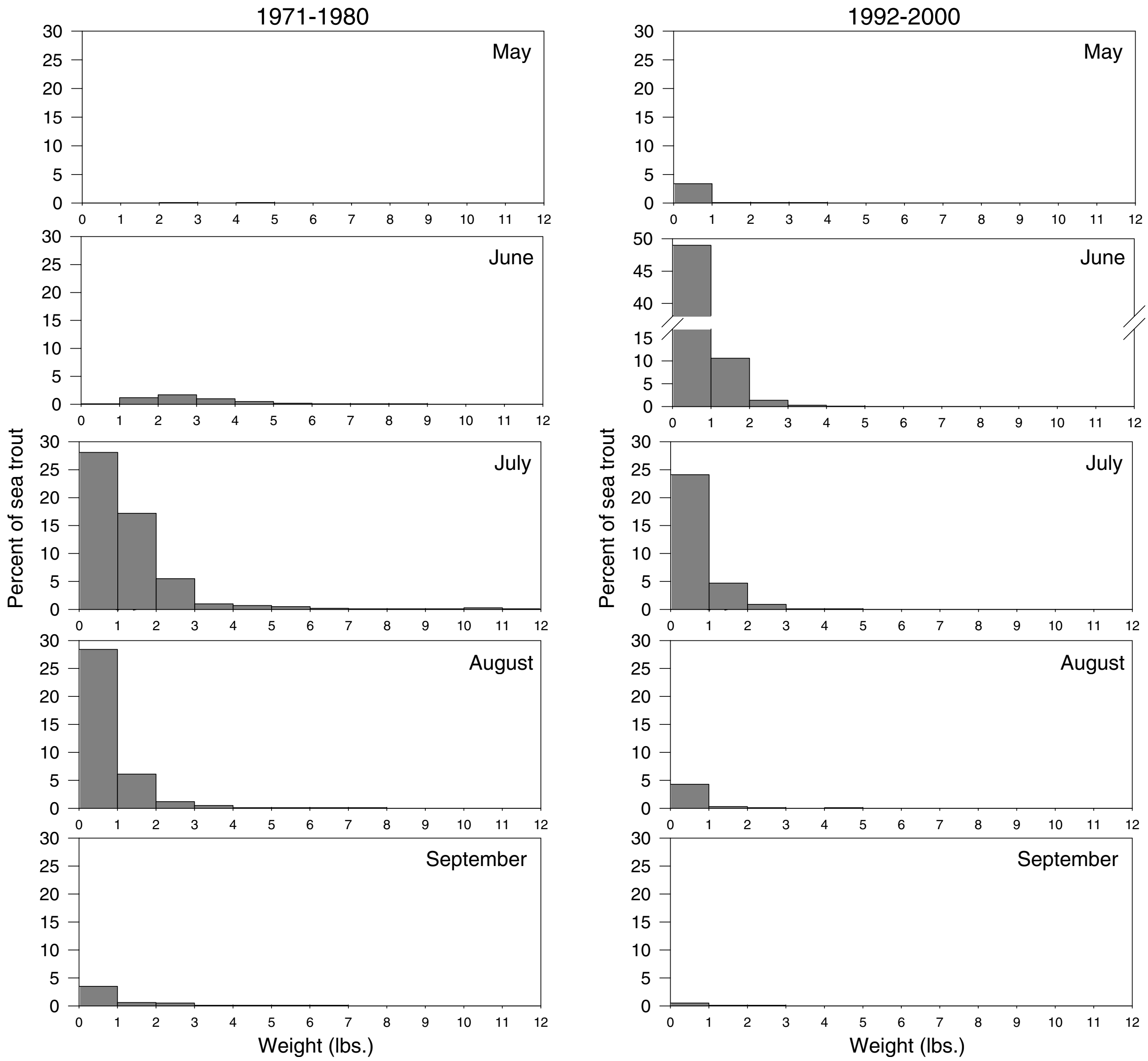


Figure 5.9 (above and above right) Run-timing of sea trout, determined from the monthly rod catch on the River Ewe by Inveran Estate in 1971–1980 (above: 3,305 fish) and 1992–2000 (above right: 7,094 fish)

Gill-netting for sea trout at the mouth of the River Ewe *(A Walker)*

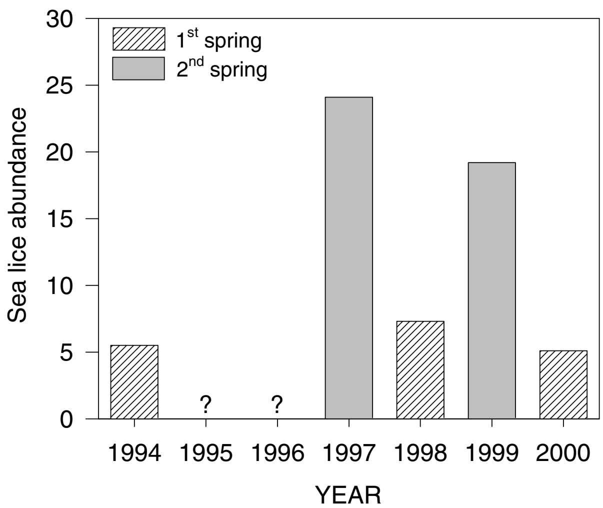
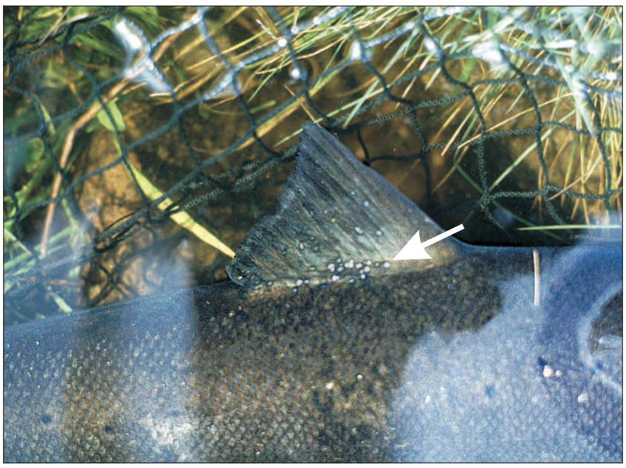


Figure 5.10 Abundance of sea lice found on sea trout sampled at the mouth of the River Ewe in June 1994 *(from Mackenzie et al.)*[21] and June 1997–2000 relative to the stage of the production cycle on salmon farms in Loch Ewe

These results, combined with patterns of lice infestation in other west coast locations, suggest that salmon farms are the primary source of lethal sea lice infestations on wild fish.[20] This is to be expected, since farmed salmon currently outnumber wild salmon and sea trout by a ratio of 242:1, and as a consequence produce 78–97% of sea lice larvae in coastal waters during the spring period. To prevent serious infection of wild fish, it is estimated that at current farm production levels numbers of ovigerous lice must be reduced to 0.005 per farm salmon (i.e. 1 per 200).[21]

Lice infestations on sea trout are correlated with the stage of production on local salmon farms *(J Butler)*

There is also some evidence that wild Ewe salmon have been infected by abnormally high lice infestations. In 2001 one radio-tagged grilse carried more than 200 lice, most of which were juvenile (chalimus) stages which are indicative of recent settlement. Two others had scars on their dorsal fins consistent with heavy infection by chalimus (see Appendix II). However, it was impossible to assess whether these fish had been infected as emigrating smolts, or when returning as adults. Regardless, such acute infestations are unusual and have not been recorded by previous studies of lice on wild salmon in Scotland.



Scars from juvenile lice infestation have been found on wild Ewe salmon *(J Butler)*

5.6.2 Early-returning sea trout

Research in Ireland and Norway shows that sea trout that have become heavily infested with lice suffer physiological stress and return to freshwater, where the lice die. Recent work at the FRS Shieldaig Sea Trout Project in Loch Torridon indicates that infective stages of lice congregate at river mouths during the spring, and emigrating sea trout become rapidly infested as they leave the river.[22] As a consequence, both post-smolts and older sea trout return prematurely to freshwater, altering their normal run-timing. Fish returning to freshwater do not feed, and they stop growing. Both in sea and freshwater many die owing to the effects of the lice infestations, or are so weakened that they suffer abnormally high rates of predation.

To assess whether there has been any early-returning behaviour on the River Ewe, the catch records of Inveran Estate were examined for the date that the first post-smolts or finnock were caught by anglers fishing for salmon in April–June. The results of the analysis show that in 1974–1986 the first fish entered the river in late June to mid July (Figure 5.11). After the establishment of marine salmon farms in Loch Ewe in 1987, entry times advanced into May and June. Many of the earliest fish caught in 1987–2001 were noted to have heavy lice infestations and physical damage.

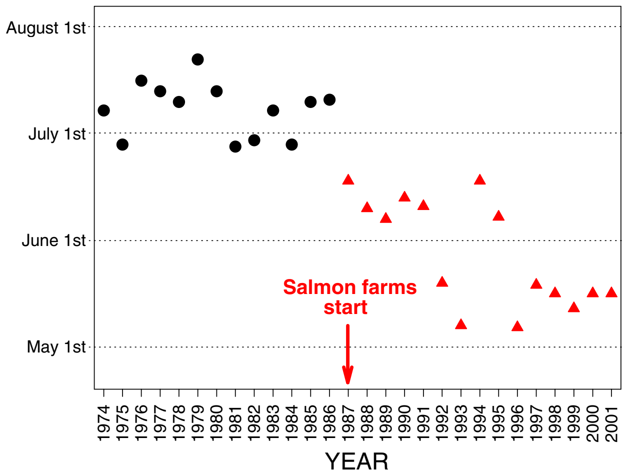


Figure 5.11 Date of the first post-smolts or finnock caught on the River Ewe by Inveran Estate before (●) and after (▲) the establishment of salmon farms in Loch Ewe

This comparison shows that early-returning behaviour has occurred annually since 1987. The pattern is also reflected in the marked alteration in the run-timing of sea trout towards May and June in 1992–2000 (see Figure 5.9). The decline in catches (see 5.1), and concurrent decreases in marine growth rates, marine survival and egg production (see 5.4) have also occurred over the same period. That this coincides with the start of salmon farms in Loch Ewe strongly suggests that the cause has been elevated lice infestations induced by large numbers of farm salmon in the sea loch.

However, it is notable that early-returning sea trout were caught not only in the second spring of production on the farms, when lice levels were high, but also during the first spring when infestations were low (see Figure 5.10). This may be because some fish leave Loch Ewe and become infected in neighbouring lochs, where salmon farms are at a different stage of production, and then return to the Ewe. Acoustic tracking of Ewe sea trout post-smolts by FRS in May 1994 revealed that most fish remain near the mouth of the river at this time, but a minority travel quickly towards the mouth of Loch Ewe.[23] Other tagging studies of west coast sea trout show that some migrate considerable distances from their natal rivers.[21]

5.7 Marine survival of sea trout

The establishment of the Tournaig Trap in 1999 has provided an opportunity to monitor the marine survival rates of sea trout entering Loch Ewe.[17] Of the 1999 smolt run, only 1.3% returned. Of the 2000 smolt run, 5.9% have returned, although this is a preliminary estimate. These return rates are within the range of 1.3–11.0% found since 1996 at the FRS Shieldaig Sea Trout Project, Loch Torridon,[17] where sea trout stocks have also collapsed.[22] Notably, the marine survival of Tournaig smolts in 2000 was almost six times higher than in 1999. This may be related to the fact that lice infestations in Loch Ewe were low in 2000, but high in 1999 (see Figure 5.10).

The only other data with which these survival rates can be compared is from the Burrishoole system in Western Ireland, where sea trout have a life cycle similar to that of Scottish west coast fish. Sea trout stocks also collapsed there in the late 1980s because of sea lice infestations related to marine salmon farming. Prior to the collapse in 1987, marine survival ranged from 19–66%, but fell to 2–12% after 1988.[24] Therefore the estimates recorded at Tournaig are likely to be representative of sea trout marine survival in areas with elevated sea lice levels such as Loch Ewe.

5.8 Brown trout growth and reproduction

5.8.1 Changes in the relationship between brown trout and sea trout

Catch records from the Loch Maree Hotel indicate that since the sea trout collapse resident brown trout have become more common, contributing 74% of the catch in 2001 (Figure 5.3). Similar trends are evident in catches for other parts of the river system, and also in other sea trout rivers such as the Gruinard.[9] To investigate the issue further, the Loch Maree Hotel records for the period 1997–2001 were analysed in greater detail.

Of 689 trout caught, 72% were recorded as brown trout and 28% as sea trout (Figure 5.12). Small brown trout of less than 1 lb in weight predominated, but fish of up to 5 lb were caught. Amongst sea trout, fish of less than 1 lb predominated, and none over 4 lb was caught. However, ghillies and anglers have expressed some confusion about the identity of trout caught owing to the variation in colouration found. Many fish are dull silver, and are assumed to be sea trout.

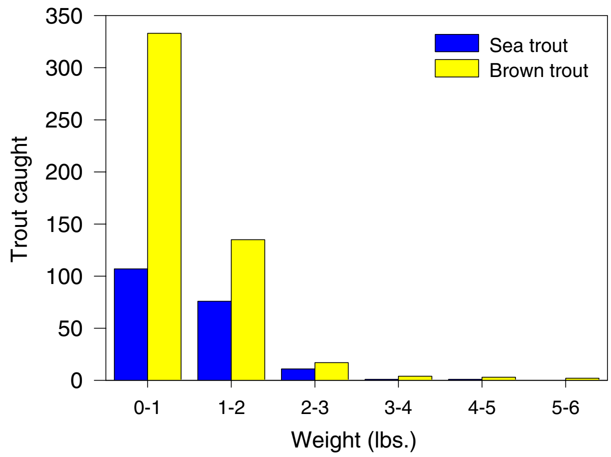


Figure 5.12 Relative numbers and weights of brown trout (493) and sea trout (196) caught by the Loch Maree Hotel, 1997–2001

Some brown trout have a silvered appearance and are mistaken for sea trout *(J Butler)*

To verify these catch records, and to clarify the identification of trout, a study was undertaken in the Loch na Fideil Burn, a tributary of Loch Maree. During October–December 1997, a fyke net was set in the burn mouth to trap trout ascending to spawn. The net was emptied daily, and fish were measured, had scales taken, defined as brown or sea trout according to appearance, sexed according to the presence of milt or eggs, and released. The true identity of each trout was later determined from growth patterns on scales.

Fyke net set in the Loch na Fideil Burn, Loch Maree, to trap spawning trout *(J Butler)*

In total, 60 trout were trapped (Figure 5.13). Scale readings confirmed that 53 (88%) were brown trout and only 7 (12%) were sea trout. Based on their appearance, numbers of sea trout were over-estimated by 36%. This has ramifications for the interpretation of catch records, suggesting that the decline in sea trout could be more severe than that indicated by catches, and that the increase in brown trout may be more marked.

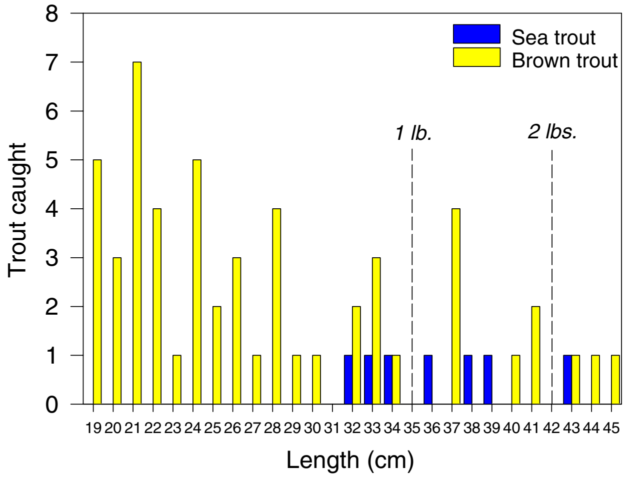


Figure 5.13 Numbers and sizes of trout verified as brown trout (53 fish) and sea trout (7 fish) from scale readings, trapped in the Loch na Fideil Burn, 28 October to 8 December 1997

This study also served to verify the catch records in terms of the size distribution of trout. As in Figure 5.12, brown trout of less than 1 lb predominated, while fish of 1–2 lb and over 2 lb were progressively more rare. This confirms that the Loch Maree hotel catch records probably are an accurate reflection of the relative numbers and sizes of trout present in Loch Maree, although the abundance of sea trout is overestimated.

The Loch na Fideil Burn results also provided an opportunity to assess whether the sex ratio of the trout population has altered with the increase in brown trout. In 1990–1995 Dr Andy Walker assessed the sex ratio of brown trout in the Ewe system, and concluded that 86% were males and 14% were females.[1] For west coast sea trout, 41–47% were male and 53–59% were female.[5] In the Loch na Fideil Burn, very similar results were found, suggesting that sex ratios have not changed during the 1990s (Table 5.3).

Table 5.3 Sex ratios of mature trout trapped in the Loch na Fideil Burn (48 brown trout, 7 sea trout) in 1997, relative to Ewe system brown trout *(from Walker 1996)*[1] and west coast sea trout *(from Walker 1993)*[1] in 1990–1995

	Brown trout		Sea trout	
	male	female	male	female
1997	87%	13%	43%	57%
1990–1995	86%	14%	41–47%	53–59%

However, in terms of egg production, female brown trout may now be equally important as female sea trout. In the Loch na Fideil Burn, equal numbers of female brown trout and sea trout were found (four of each). Furthermore, the brown and sea trout were of similar size and therefore likely to produce similar numbers of eggs. Consequently the combination of declining sea trout and increasing brown trout numbers has altered the structure of the population from one driven by sea trout eggs to one equally dependent on brown trout eggs.

5.8.2 Ferox trout

Sea trout are only one of several forms of brown trout occurring within the Ewe system. Of those remaining in freshwater for their whole lives, ferox trout are the least understood. They are typically long-lived fish that attain a size threshold that enables them to catch smaller fish. Ferox are usually associated with Arctic charr which, unlike young trout and salmon, are shoaling fish and easier to catch. Of the river system accessible to salmon and sea trout, ferox have been recorded in Lochs Coulin, Clair, Bharranch, Maree and Kernsary. Of the inaccessible lochs, they are known to occur in Lochan Fada, and perhaps Loch Tollaidh. It is notable that Arctic charr are found in all these lochs (see Part 9).

Scales taken from brown trout sampled throughout the accessible area of the river system show that they grow at a slightly slower rate than sea trout (Figure 5.14). However, having reached 30–35 cm (6–7 years) they become ferox, and their growth rates increase rapidly. From 7 years onwards, the rate of freshwater growth is greater for ferox than for sea trout growing in saltwater.

Very few ferox are caught within the trout fisheries of the Ewe system, and consequently little data has been collected. The WRFT has taken detailed samples from only one ferox trout, which measured 51.5 cm (3¼ lb) and was caught in Loch Maree on 28 September 2001. The fish was male and aged 8 years. Its stomach contained one 11 cm charr, and another unidentifiable fish of 8 cm.

If ferox are to be better understood and conserved, more information is needed. For example, it is not clear whether ferox are a genetically distinct race, or simply longer-lived individuals amongst the resident trout population. Nor is it known where they spawn within the Ewe system. Furthermore, the implications for ferox of the current flux in the relationship between sea trout and brown trout are impossible to assess.

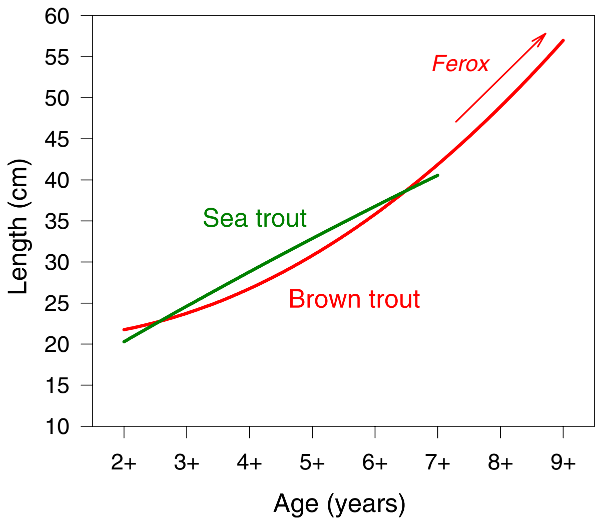


Figure 5.14 Comparative growth rates of brown trout (119 fish) and sea trout (171 fish, freshwater and sea ages combined) derived from scales of fish sampled in the accessible area of the Ewe system, 1997–2001 (see Appendix VI for data)

Little is known about ferox trout in the Ewe system *(A Walker)*

5.8.3 Loch Tollaidh trout

There is little information available on the trout stocks within the areas of the catchment inaccessible to sea trout. The one exception is Loch Tollaidh. It is unusual in having had salmon smolt cages operating in it since 1986, which may have altered the trout ecology owing to the enriching effect of the cages (see Part 3). In a similar situation in Loch Damph, in the River Balgy system, brown trout growth rates have accelerated.[12]

During 2000 a small sample of scales was taken from trout in the course of recapturing escapee salmon smolts (see Part 4). Comparisons with the growth of Loch Maree brown trout showed that Loch Tollaidh trout have a more rapid growth rate during their first years, but by the age of 4 and 5 they reach only a marginally larger size than Loch Maree fish (Figure 5.15). Unfortunately no fish older than this was captured, preventing a comparison of the growth rates of ferox in each loch. Therefore these preliminary results suggest that the impact of the smolt cages is marginal, despite the relatively high levels of phosphorus recorded by SEPA (see Part 3). A similar conclusion was reached by the RSPB survey of the loch in 1993.[7]

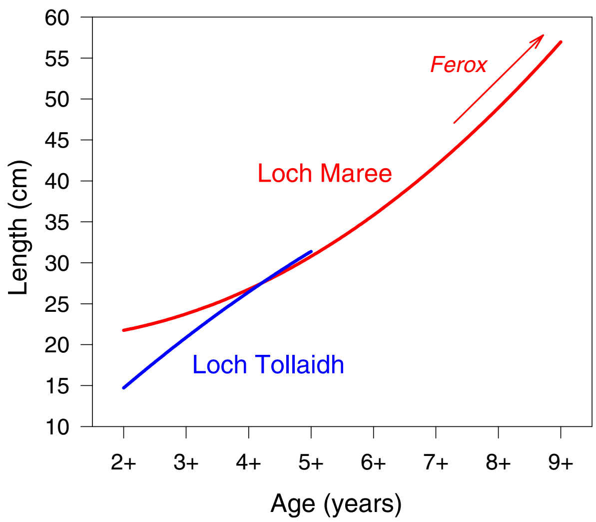


Figure 5.15 Growth rates of brown trout from Loch Maree in 1997–2001 (119 fish) compared with those taken from Loch Tollaidh in 2000 (12 fish) (see Appendix VI for data)

5.9 Trout stock enhancement

5.9.1 Sea trout

There is a history of sea trout stock enhancement in the Ewe system, and efforts have intensified in the 1990s since the collapse in catches. As for salmon, this has included both ‘recycling’, where fish that would otherwise have spawned are stripped, and ‘stocking’, where extra fish are introduced from captive broodstock. Details are shown in Table 5.4.

Table 5.4 Recorded instances and locations of sea trout enhancement in the Ewe system, differentiated as 'recycled' and 'stocked'

	'Recycled'		'Stocked'		
Year	**Number**	**Location**	**Origin**	**Number**	**Location**
1970s	—		unknown	50,000 fry p.a	Coulin/Clair
1990	10,000 fry	Loch Maree	Tyne–Oscaig	100,000	unknown
1991	10,000 fry	Loch Maree	Tyne–Oscaig	66,000	unknown
1992	10,000 fry	Loch Maree		—	
1993	—		Tyne–Oscaig	117,000	unknown
1997	10,000 fry	Loch Maree		—	
1998	—		Coulin	200,000 fry	Coulin/Clair
1999	8,000 fry	Slattadale	Coulin	14,000 smolts	throughout
1999	—		Coulin	35,000 fry	Loch Maree
2000	8,000 fry	Loch Maree	Coulin	40,000 fry	Ewe
2001	700 parr	Loch Maree	Coulin	7,000 parr	Coulin/Clair
2001	—		Coulin	420,000 parr	throughout

Recycling was carried out at a small hatchery built at the Loch Maree Hotel in 1989. Records exist of approximately 10,000 eggs stripped from sea trout caught in nearby spawning burns in 1989–1991, which were planted as fry the following year. This exercise was repeated in 1997 and 1999, with fish planted into the Slattadale Burn, Loch Maree. In 1999 27 sea trout were caught in Loch Maree and moved alive to the FRS Fish Cultivation Unit, Aultbea. Of these, 21 survived to be stripped, producing 8,000 fry which were stocked in 2000, plus 700 parr in 2001.

Stocking has been more prevalent. Non-native sea trout were introduced by Coulin Estate during the 1970s, with up to 50,000 fry planted out per annum. In 1990, 1991 and 1993 large numbers of fish of Tyne–Oscaig origin were obtained from Culnacraig hatchery, Achiltibuie, and planted into unknown locations.

In addition, an FRS project aimed at establishing a captive broodstock of Ewe system sea trout in Loch Clair was started in 1994.[1] Eggs were obtained from sea trout captured on Coulin Estate and transferred to the Seafield Centre's facilities in Kishorn for ongrowing. Approximately 1,000 yearlings were then moved to a net cage in Loch Clair in 1996, and these have subsequently been thinned to 200 adult fish, which have been stripped annually since 1997 and back-crossed with wild male sea trout netted from the Loch Bharranch–Clair Burn. Of the eggs produced, 25,000 are stocked annually into the Shieldaig system as part of the Shieldaig Sea Trout Project, while the remainder are returned to the Ewe system. Consequently extra fry were introduced in 1998 (200,000) and 2001 (7,000). The former were hatched by the Seafield centre, while the latter were reared in the new Coulin Estate hatchery, established in 2000.

The Loch Maree Hotel has retained rod-caught sea trout (above) for recycling of eggs in its hatchery (below) *(J Butler)*

Captive broodstocks of Ewe sea trout have been established at Coulin Estate (above) and the Seafield Centre (below) *(J Butler)*

From the original collection of Coulin eggs, the Seafield Centre has also established a captive broodstock that is held in earth ponds at Glen Mhor, Kishorn. In 2000 Inveran Estate purchased 40,000 fry produced by these fish, which were stocked into the River Ewe. In July 1999 Marine Harvest (Scotland) purchased 14,000 smolts for donation to the Ewe DSFB, followed by 35,000 fry stocked in November 1999, and 420,000 parr in April 2001.

Added to the captive broodstocks established in Loch Clair and at the Seafield Centre, 120 sea trout parr are being retained by the FRS Fish Cultivation Unit for on-growing. These fish originate from fish caught by the Loch Maree Hotel in 1999, and will provide an additional source of extra eggs should problems occur at Loch Clair and Glen Mhor. This was exemplified in winter 2000–2001 when many of the Clair fish escaped because of ice damage to the cage.

Hence approximately 56,000 eggs have been recycled in 1990–2001, compared with 1 million fish stocked during the same period, 30% of which were of non-native origin. Unfortunately it is impossible to judge the success of these enhancement efforts. This may be significant in the future, since there is evidence to show that reared sea trout progeny often remain in freshwater as brown trout instead of migrating to sea. It is unlikely that the numbers introduced in the early 1990s contributed greatly to the increase in brown trout catches through the decade. However, the significant numbers stocked in 1998–2001 may make a greater contribution in coming years when they grow to catchable sizes.

Marine Harvest stocking sea trout smolts into Loch Maree, 1999 *(J Butler)*

5.9.2 Brown trout

There are sketchy records of brown trout being stocked into two inaccessible lochs. Gairloch Angling Club have introduced fish of unknown origin into Loch Garbhaig (Slattadale). The Kinlochewe Angling Club have stocked non-native fish into Loch Dubh a Phluic (Talladale) every second year for the past 15 years. These normally number 500 to 800, and are obtained from Inverness Fish Farms, Alvie. To prevent these fish entering Loch Maree the Kinlochewe Angling Club have placed grills in the outflow burn.

Grills prevent the escape of stocked brown trout from Loch Dubh a Phluic into Loch Maree *(C Macdonald)*

5.10 Conclusions

- **The Ewe system was once a premier sea trout rod fishery on the west coast, with a 5-year average catch of 2,500 in 1982. However, catches collapsed after 1987, falling to an average of 800 in 2000. Catches from the Loch Maree Hotel reflect this pattern. In addition, brown trout have formed a growing proportion of the rod catch since 1997, contributing 74% of all trout caught in 2001.**

- **Prior to 1987, the sea trout stock was abundant and consisted of relatively fast-growing, long-lived fish. Since 1987 numbers have declined, and marine growth rates and the longevity of fish have progressively fallen. The sea trout stock is now dominated by small, immature fish, indicating increased marine mortality.**

- **The primary cause of the collapse is probably elevated sea lice infections resulting from the establishment of marine salmon farms in Loch Ewe in 1987. This is supported by the occurrence of early-returning, lice-infested sea trout since 1987, and the correlation between abnormally high sea lice infestations on sea trout at the mouth of the River Ewe and the production cycle on the salmon farms. However, some sea trout may become infected by lice from farms outside Loch Ewe. Therefore lice control on farms in Loch Ewe and other neighbouring sea lochs needs to be radically improved.**

- **Low marine survival rates of sea trout smolts recorded at the Tournaig Trap are consistent with those found at Shieldaig, Loch Torridon, and Burrishoole, Western Ireland, where stocks have also collapsed. Annual fluctuations in marine survival in Loch Ewe correspond with farm production cycles, and therefore lice levels.**

- **Marine growth rates of Ewe system sea trout in 1997–2001 are considerably less than for fish from the Gruinard and Dundonnell Rivers for the same period. This may be linked to the limited availability of juvenile herring and sprats in Loch Ewe, where there is no winter ban on trawling with mobile gear. Such a ban should be sought by the Ewe DSFB.**

- **Collapses in the abundance and size of mature sea trout have resulted in at least a 50% decline in the deposition of trout eggs. No sampled fish spawned more than twice in 1997–2001. This may have led to lower densities of juvenile trout, and the growing predominance of younger smolts during the 1990s.**

- **Studies on Loch Maree confirm that brown trout now dominate the spawning population. It is not clear why more trout are remaining in freshwater rather than migrating to sea. Despite this trend, the sex ratio of both brown and sea trout remains unchanged. However, egg deposition by female brown trout may now match that of female sea trout because they are of equal number and size.**

- **Sea trout stock enhancement has resulted in the recycling of approximately 56,000 eggs in 1990–2001, and the stocking of 1 million fry, parr and smolts over the same period. Seventy percent of these have been derived from captive broodstock of Coulin origin, while 30% were of non-native origin. It is likely that many of these reared fish will have remained in freshwater as brown trout.**

- **The management of brown trout fisheries is disjointed and requires better coordination with the sea trout and salmon fisheries. This is imperative for the transfer of fish into the catchment during stock enhancement exercises, and the resulting risk of disease transmission.** ❑

Part 6
The Freshwater Habitat

6.1 Introduction

The main objective of the Fishery Management Plan is to maximise the natural output of juvenile salmon and trout from the river. This part of the fishes' life cycle is within the riparian owners' control, whereas marine factors are not. This approach is also justified by the fact that the number of returning adults will largely depend on the number of smolts produced by the river, which in turn is governed by the number of parr that the river can support. This section assesses the characteristics of the Ewe system in terms of current and potential freshwater production. In doing so factors that may limit juvenile production are identified.

Falls and old salmon ladder (arrowed) on Allt Loch Ghiuragarstidh, Kernsary *(J Butler)*

6.2 Obstacles and accessible area

A primary aim of the habitat survey undertaken in 1998–2000 was to identify the area of water accessible to salmon and sea trout. This involved the mapping of obstacles such as natural falls and man-made obstructions. Electro-fishing carried out above these obstacles determined whether or not juvenile salmon were present. If not, it was assumed that the obstacle was probably impassable to both salmon and trout migrating upstream. Local anecdotes also provided information on the historical range of salmon and sea trout.

6.2.1 Occasionally-passable falls

The upper limits of most tributaries are formed by natural waterfalls (Figure 6.1). However, there are seven sets of falls that require high flows for fish to leap them, and therefore are only occasionally passable. In dry years these falls may limit access for spawning adults to areas upstream:

A. Allt Loch Ghiuragarstidh (NG 893798): A salmon ladder has been built around these falls, reputedly in the late 19th century by Osgood Mackenzie, but it is now in disrepair. Trout have been observed successfully leaping the falls in recent years, and juvenile salmon have also been found upstream (see Appendix I). Fish that can ascend the falls or ladder have access to a considerable area upstream, including Loch Ghiuragarstidh.

Falls on the Tollie Burn are passable *(C Macdonald)*

B. Tollie Burn (NG 863790): Anecdotes indicate that both salmon and sea trout have ascended these falls in the past.

C. Slattadale Burn (NG 883727): Anecdotes suggest that sea trout can ascend these falls.

D. Allt an Fearna (NH 014593): This fall restricts fish from accessing a small area upstream.

E. Alltan na Caise (NH 011589): As for Allt an Fearna, only a limited area is affected by this fall.

F. Abhainn Bruachaig, Lower Falls (NH 059628): Traditionally salmon have ascended these falls, and in 1999 juvenile salmon were found upstream (see Appendix I). In the past the gorge below the falls has been blocked by boulders swept downstream, obstructing the approach of salmon. A croy was built above the falls in the 1920s to modify flow through the gorge, and this remains intact.

Efforts have been made to ease the Lower Falls on Abhainn Bruachaig (top) by building a croy upstream (bottom) *(J Butler)*

G. Abhainn Bruachaig, Upper Falls (NH 077642): These falls at the Heights of Kinlochewe require a vertical leap, and anecdotes indicate that fish used to access the area upstream as far as Abhainn Gleann Tanagaidh. However, no juvenile salmon were found here in 1997 (see Appendix I).

6.2.2 Man-made obstacles

There are several man-made obstacles in the river system, and all are caused by road crossings that have not been constructed with upstream fish passage in mind. In 1992 the A832 was upgraded along the western shore of Loch Maree, and several culverts and bridge crossings were put in place, creating barriers. In 1993 the Ewe DSFB requested the Highland Council to carry out remedial works on crossings over three major burns to ease fish passage: Allt a Choire Sliabh, Alltan Odhar and Allt na Doire-Daraich.

Allt a Choire Sliabh (NG 915704) *(J Butler)*

Alltan Odhar (NG 974679) *(J Butler)*

Allt na Doire-Daraich (NH 018633) *(J Butler)*

However, during the 1998–2000 habitat survey a further nine impassable culverts were identified which if eased would restore access to spawning and juvenile habitat. Four were created in 1993 during the upgrading of the A832, three are located on the A896, and two have been built on estate roads.

1. **Allt Folais** (NG 950716): An Irish culvert bridge has been built by Letterewe Estate, obstructing access to excellent spawning and juvenile habitat upstream. Although possibly passable in high flows, no juvenile salmon have been found above it (see Appendix I).

The Irish bridge on Allt Folais obstructs passage to a large area upstream *(J Butler)*

2. **Allt Ghiubhais Beag** (NG 946693): Although a small burn, there is useful juvenile habitat upstream from the culvert under the A832.

3. **Allt Ghiubhais Mor** (NG 950690): A concrete apron has been built at the outflow of the culvert under the A832, which is decaying.

The concrete apron on Allt Ghiubhais Mor *(J Butler)*

4. **Alltan Ruadh** (NG 993658): A concrete sill at the mouth of the culvert under the A832 may be impassable.

5. **Allt an Achaidh** (NH 011640): A series of concrete steps leading to the culvert under the A832 may be impassable.

Concrete steps on Allt an Achaidh should be eased *(C Macdonald)*

6. **Allt a Chuirn** (NH 024609): A low timber weir has been constructed across the burn to hold back paving under the A896. Although passable to adult fish, it may restrict upstream movement of juveniles.

The timber weir on Allt a Chuirn restricts upstream movement of juveniles *(T Coulson)*

7. **Nameless Burn** (NH 023604): An impassable culvert exists under the A896.

8. **Am Fionn Alltan** (NG 977578): This is a major spawning burn flowing into Loch Bharranch, and three culvert pipes under the A896 obstruct both adult and juvenile fish moving upstream.

Culvert pipes on Am Fionn Alltan *(K Starr)*

9. Nameless Burn on Allt Doire Beithe (NH 023530): This culvert pipe under a track on Coulin Estate is entirely impassable, and impedes access to a small area of spawning habitat upstream.

Culvert pipe on a tributary of Allt Doire Beithe, Coulin Estate *(K Starr)*

6.2.3 Debris obstacles

During the course of the habitat survey, several obstacles were found that had been formed by fallen woody debris. Sometimes these were mixed with man-made items such as watergates. Although unlikely to be permanent, such blockages may well temporarily obstruct both adult and juvenile fish passage, and should be removed. In the past, ghillies have tackled such problems, but with the decline in fishing-related employment the task has been neglected in recent years. However, some debris is useful as instream cover for juvenile fish, and only the major obstacles should be cleared.

Fallen trees can create temporary obstacles and should be cleared *(K Starr)*

6.2.4 Accessible area

The naturally accessible area of the catchment was calculated (Table 6.1) assuming that the obstacles described above have been passable in the past. The majority (98%) is loch habitat, most of which is dominated by Loch Maree (91%). Riverine habitat is relatively scarce (2%), and the Kinlochewe River and its tributaries contribute the largest proportion (1.5%), followed by the other rivers and burns flowing into Loch Maree (0.4%) and the Ewe itself (0.1%).

Table 6.1 River and loch area naturally accessible to salmon and sea trout in the Ewe catchment

	Water Body	Accessible (m^2)	Proportion
River:	River Ewe and tributaries	39,504	0.1%
	Loch Maree tributaries	18,483	0.4%
	Kinlochewe River and tributaries	489,517	1.5%
	Total river:	***647,504***	***2.0%***
Loch:	Loch Ghiuragarstidh	150,000	0.5%
	Loch Kernsary	837,000	2.7%
	Loch Maree	28,200,000	91.0%
	Loch Clair	632,000	2.0%
	Loch Bharranch	151,000	0.5%
	Loch Coulin	388,000	1.3%
	Total loch	***30,358,000***	***98.0%***
TOTAL AREA:		***31,005,504***	

Loch Maree (above) constitutes 91% of the accessible area, while the Kinlochewe River system (below) contributes most of the riverine area *(SNH/J Butler)*

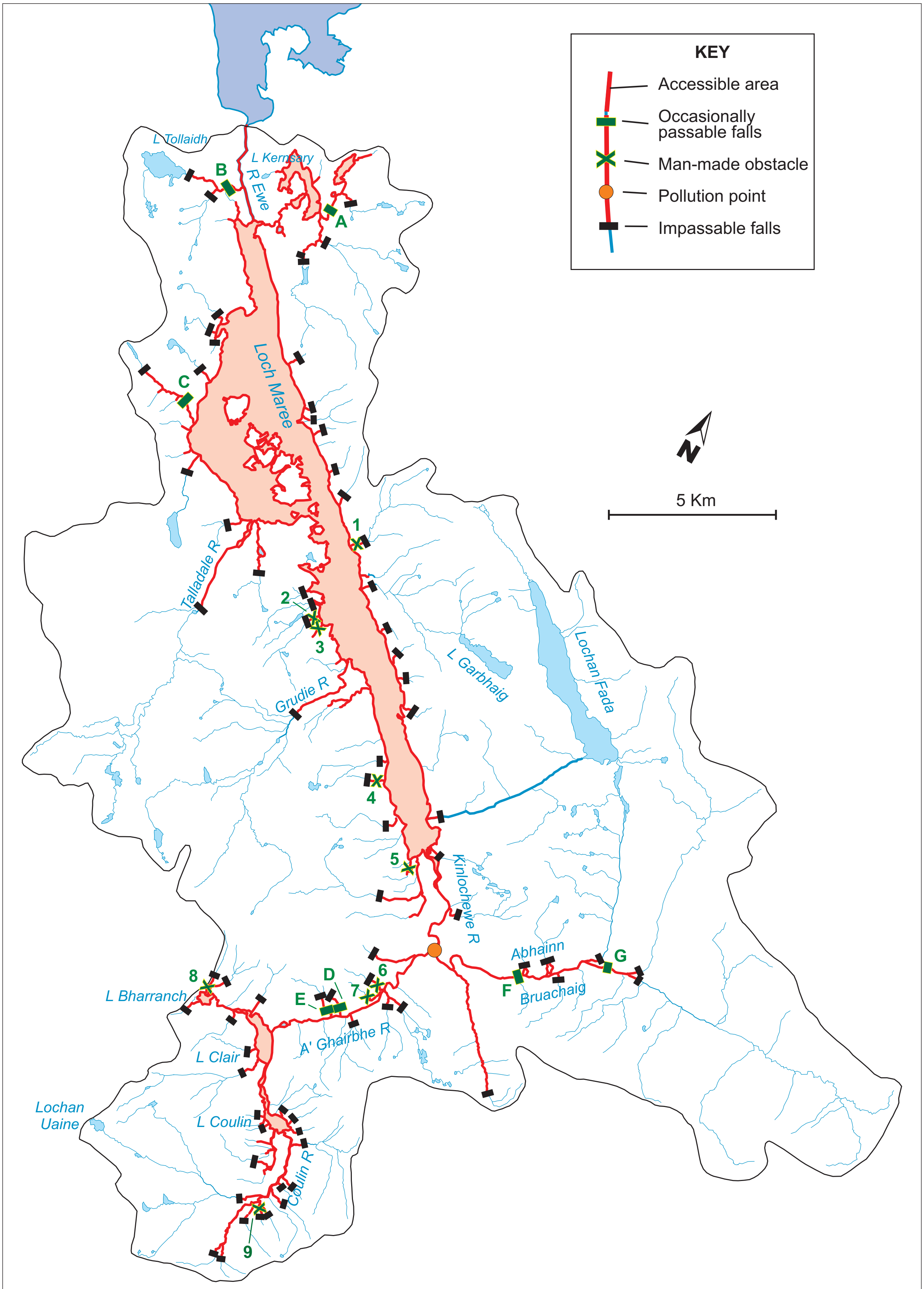


Figure 6.1 The area of the Ewe catchment accessible to salmon and sea trout, also showing the potential pollution point at the Kinlochewe public septic tank. Letters and numbers are referred to in the text *(Crown Copyright)*

6.3 Channel modifications

6.3.1 Historical modifications

Mackenzie[25] gives an interesting history of the River Ewe. During the 18th and 19th centuries a system of stone dykes or 'cruives' existed from Loch Maree downstream. Traps were inserted in gaps in the cruives to catch salmon for commercial sale. In 1852 the cruives were removed to lower the level of Loch Maree and reclaim flooded land at Kinlochewe. The remains of these cruives form the basis of the many artificial pools that exist in the river today. Similar remains are evident in the Cruive Pool of the A'Ghairbhe River at the outflow of Loch Clair.

Modifications in the River Ewe are based on old cruives
(J Butler)

Extensive bank armouring on the Kinlochewe River (above), and limited work on the Kernsary River (below)
(T Coulson/J Butler)

6.3.2 Bank armouring

Because of flooding problems the Kinlochewe and lower A'Ghairbhe Rivers were armoured extensively by Kinlochewe Estate during the 1980s and early 1990s. Large sections of bank were stabilised using boulders. More limited bank protection has been carried out by Letterewe Estate on the Kernsary River, and by Coulin Estate on Allt Doire Beithe.

6.3.3 Artificial pools

Recent attempts have been made to create artificial pools on the A'Gairbhe River to provide additional fishing. During the 1980s Kinlochewe Estate built a series of pools on the lower A'Ghairbhe using a technique involving a heavy gauge chain stretched across the river, to which concrete slabs were attached. Large boulders were then placed along the upstream edge of the chain, forming a weir. However, with the disintegration of the slabs many of these structures have fallen into disrepair. In 1998 Coulin Estate also formed a series of pools in the upper A'Ghairbhe River using placed boulders, rather than chain weirs.

Weir formation on the A'Ghairbhe River using chain (above, arrowed), and boulders (below) *(T Coulson/K Starr)*

6.3.4 Channel excavation

Flooding of grazing land on river deltas is a common problem. In these situations river channels have been excavated and straightened. The two areas most affected are the Kinlochewe and Coulin River deltas. In the Kinlochewe River delta the mainstem was regularly excavated in the 1980s and 1990s by Kinlochewe Estate. On the same floodplain, Allt na Doire-Daraich has been canalised and repeatedly excavated at Taagan Farm, leaving an artificial channel. Similarly, the Coulin River has been straightened over its final 1 km above Loch Coulin, and the neighbouring Allt na Feithe Buidhe has had similar modifications upstream from Coulin Farm.

Straightened channels of Allt na Doire-Daraich (above) and the Coulin River (below) *(J Butler)*

6.3.5 Spawning channels

During the 1990s, Coulin Estate experimented with the formation of 'spawning channels', where additional spawning habitat is created by modifying small burns and ditches. One trial involved the diversion of water from Allt na Feithe Buidhe down an old flood channel. However, this has not been a success, and has resulted in further flooding and the extraction of water from an already valuable burn. More practical steps have since been taken to straighten and clear small burns flowing into Loch Coulin.

Failed water diversion from Allt na Feithe Buidhe (above), and successful spawning channel creation (below) on Coulin Estate *(J Butler)*

6.4 Juvenile salmon and trout habitat

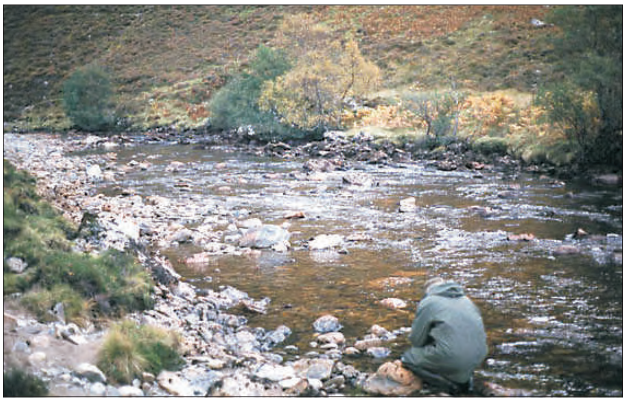
Because 98% of the accessible area consists of lochs, still water is very abundant. This form of habitat is best suited to juvenile and adult trout. In addition, there are many smaller burns that flow directly into the lochs, providing ideal and readily available spawning and nursery areas for trout.

Juvenile salmon prefer riverine habitat, especially streamy riffles, runs and glides over boulders. Such water is abundant and widespread in the catchment, covering 80% of the accessible riverine areas. The remaining 20% consists of pools and deep glides, which are suitable refuges for adult salmon, trout, and over-wintering salmon parr.

6.5 Spawning habitat and redd washout

6.5.1 Spawning habitat

The principal salmon and trout spawning areas within the accessible area of the catchment are shown in Figure 6.2. Spawning is widely distributed, but certain areas



Loch habitat suitable for trout is abundant (above), while salmon parr habitat is widespread in the riverine areas (below) *(SNH/J Butler)*

Table 6.2 Distribution of spawning habitat in the accessible riverine area of the Ewe catchment. Also given is the proportion of spawning area in each section considered to be unstable

Section	Subsection	Spawning area (m^2)	Proportion unstable
River Ewe	mainstem	382	0%
	Tollie Burn	39	8%
Kernsary		889	29%
Loch Maree	Slattadale	391	92%
	Garbhaig	211	100%
	Talladale	166	97%
	Grudie	188	100%
	Doire-Daraich	2,815	60%
	Other burns	1,383	72%
Kinlochewe	mainstem	441	97%
	Bruachaig	924	61%
	Docherty Burn	3,938	97%
	A'Ghairbhe	649	63%
Loch Clair–Coulin		419	76%
TOTAL AREA:		***12,835***	***68%***

contribute relatively large proportions of that available. Of greatest importance are the Docherty Burn and Allt na Doire-Daraich, which constitute 31% and 22% of the total spawning area, respectively (Table 6.2). The concentration of habitat in these burns is emphasised by their small size relative to the total riverine area. Also of significance is Abhainn Bruachaig (7%) and the Kernsary River system (6%). Considering their major contribution to the riverine area, spawning is relatively limited in the Rivers Ewe, Kinlochewe, A'Ghairbhe, Talladale and Grudie.

Overall, 68% of the spawning habitat was judged to be unstable and prone to bed movement during spates (Table 6.2). Areas worst affected were those located in rivers or burns flowing off steeper terrain. Those situated downstream from lochs tended to be more stable owing to the buffering effect of still water during spates (Figure 6.2). Thus spawning areas in the River Ewe, Tollie Burn and Kernsary are stable, while the Coulin River, Docherty Burn, Abhainn Bruachaig, and Rivers Grudie and Talladale are highly unstable (Table 6.2, Figure 6.2). Of most concern is the instability of the Docherty Burn, Allt na Doire-Daraich and Abhainn Bruachaig, since they together contain 60% of the total available habitat.

The Docherty Burn (above) and Allt na Doire-Daraich (below) contain a high proportion of the available spawning habitat, but are unstable *(J Butler)*

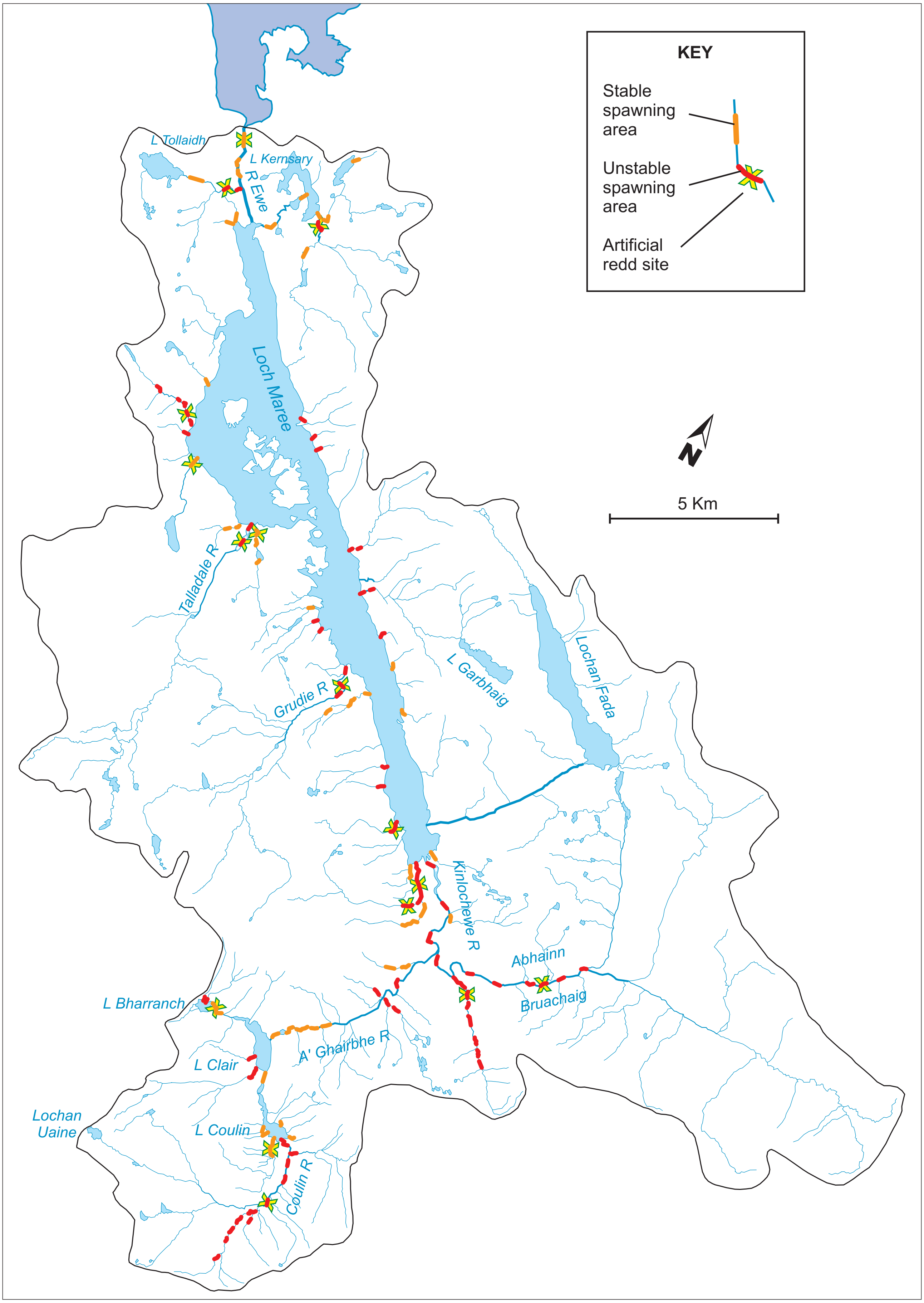


Figure 6.2 Locations of the principal salmon and trout spawning habitat in the accessible area of the Ewe catchment. The locations of artificial redd sites are also shown *(Crown Copyright)*

6.5.2 Redd washout

Weather patterns are changing on the west coast of Scotland, and compared with the 1970s winters are becoming wetter, with more frequent and intense spates. Long-term data from the SEPA flow-gauging station on the River Ewe confirms that the trend is also occurring in Wester Ross, and the 1999–2000 winter was the wettest on record. By comparison, however, the 2000–2001 winter was one of the driest (Figure 6.3).

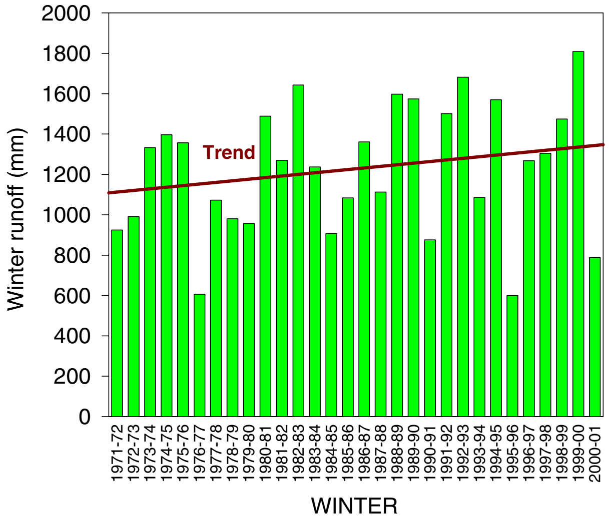
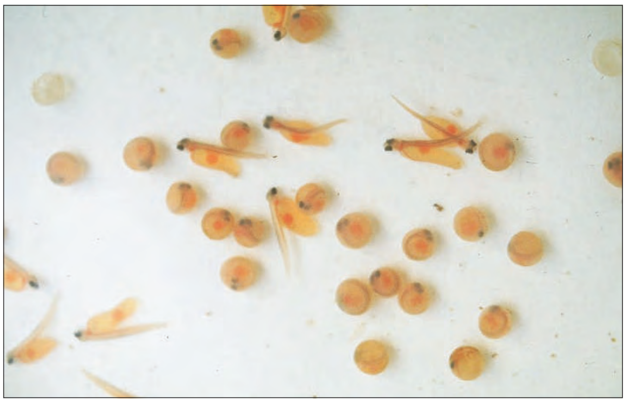


Figure 6.3 Total winter runoff (November–March inclusive) in the River Ewe catchment, 1971–1972 to 2000–2001 *(data kindly provided by SEPA)*

As a result of the greater frequency and size of spates, redd washout has become a problem in unstable rivers and burns.[26] Detailed studies in collaboration with FRS and SEPA on the River Broom in Wester Ross suggest that the greatest damage occurs in March, when eggs are hatching. Any spate larger than 80 cumecs in this month is likely to cause river bed movement capable of killing emerging alevins, and limiting the number of smolts eventually produced by that year class.



Hatching eggs are most vulnerable to redd washout *(J Butler)*

Tollie Burn in low summer flows (top) and a typical large winter spate (middle). Such spates have resulted in considerable physical damage, for example on Abhainn Bruachaig (bottom) *(J Butler)*

To analyse whether such spates have also occurred in the Ewe catchment, SEPA flow data from the River Carron (Wester Ross) was used. The SEPA flow-gauging station on the River Ewe is located downstream from Loch Maree, which buffers rapid rises and falls in water levels. However, because the Carron borders the headwaters of the Ewe, the SEPA station there probably gives a better description of rainfall and spate patterns in the upper Ewe catchment. The results show that in the past decade there have been potentially lethal March spates in the winters of 1989–90, 1996–97, 1998–99, and 1999–2000 (Figure 6.4).

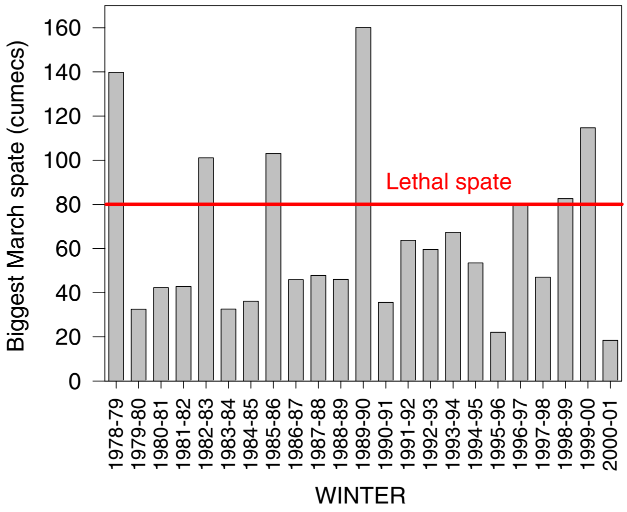


Figure 6.4 Largest March spates recorded on the River Carron during the winters 1978–1979 to 2000–2001, relative to the potentially lethal level of 80 cumecs determined on the River Broom *(data kindly provided by SEPA)*

In the winter of 1998–1999 the WRFT carried out experiments to examine which spawning areas in the Ewe catchment were at greatest risk of redd washout. Artificial redds were created in November using bone beads to represent salmon and sea trout eggs (see Appendix VII). At each site a salmon redd was formed, with beads buried at 30 cm depth, and a sea trout redd with beads buried at a shallower depth of 15 cm. The redds were checked in April, when natural eggs would have hatched.

Sea trout eggs (left) and bone beads (right) used to imitate them *(J Butler)*

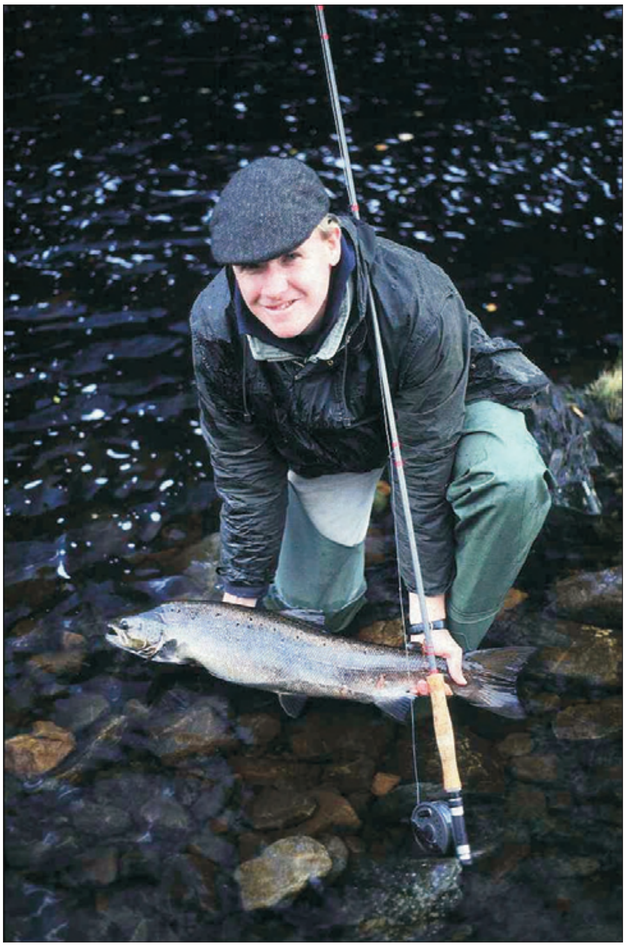
Sixteen sites were established to represent typical spawning areas (Figure 6.2). Overall, 75% of the salmon redds, and 81% of the sea trout redds were washed out (Table 6.3). These results are similar to the total proportion of spawning area judged to be unstable (68%), suggesting that they are representative. Furthermore, the 1998–1999 winter had a potentially lethal spate in March 1999 (see Figure 6.4), indicating that the experiments reflect a worse-case scenario which may also have occurred in March 1990, 1997 and 2000.

The instability of the Ewe catchment's spawning habitat may partly explain the unusually high proportion of Multi Sea Winter salmon in the population (see Part 4). It is probable that larger female salmon are capable of digging redds deeper than 30 cm, and so their eggs are more likely to survive destructive spates than those of

Table 6.3 Results of the winter 1998–1999 redd washout experiments within the accessible area of the Ewe catchment

Site		Grid ref.	Salmon	Sea trout
1	Kernsary River	NG 893793	Washed out	Washed out
2	River Ewe	NG 859804	Intact	Intact
3	Tollie Burn	NG 859804	Washed out	Washed out
4	Slattadale Burn	NG 886724	Washed out	Washed out
5	Garbhaig River	NG 895714	Washed out	Washed out
6	Talladale River	NG 919702	Washed out	Washed out
7	Loch na Fideil Burn	NG 922704	Intact	Intact
8	Grudie River	NG 966677	Washed out	Washed out
9	Glas Leitir Burn	NH 002651	Washed out	Washed out
10	Allt na Doire-Daraich	NH 016637	Washed out	Washed out
11	Allt na Doire-Daraich	NH 017631	Washed out	Washed out
12	Docherty Burn	NH 044617	Washed out	Washed out
13	Abhainn Bruachaig	NH 064633	Washed out	Washed out
14	Coulin River	NH 024532	Washed out	Washed out
15	Allt na Feithe Buidhe	NH 017546	Intact	Washed out
16	Loch Bharranch–Clair Burn	NG 983576	Intact	Intact

smaller grilse. This possibility is supported by the fact that the increasing proportion of Multi Sea Winter salmon during the 1990s has coincided with a period of wetter winters (see Figure 6.3).



The prevalence of Multi Sea Winter salmon in the Ewe may be related to unstable spawning habitat *(J Butler)*

As also found in other rivers, the results indicate that sea trout are more prone to washout than salmon, because they dig shallower redds owing to their smaller size. This problem may have been acute in recent years owing to the decreasing size of mature sea trout following the collapse in stocks in the late 1980s (see Part 5). Hence redd washout may be exacerbating the decline in sea trout.

The small size of mature Ewe sea trout renders them more vulnerable to redd washout *(J Butler)*

Given the unstable nature of most spawning habitat in the catchment, efforts should be made to avoid exacerbating the problem where possible. Thus Highland Light & Power's proposal to increase flows by 40% in the Garbhaig River as part of the Shieldaig/Slattadale hydro-electricity project is inappropriate. The Garbhaig River is a significant spawning tributary for Loch Maree, but is entirely unstable (Table 6.2) and prone to redd washout (Table 6.3). Extra flows are likely to further limit its productivity for salmon and sea trout.

6.5.3 Siltation

Despite the unstable nature of the river and the evidence of erosion and bank collapse in some areas of the catchment, siltation problems were not identified by the habitat survey. Although forestry harvesting has been underway recently along the Slattadale Burn and the A'Ghairbhe River (see Part 3), silting resulting from timber extraction has not occurred.

6.6 Pollution and acidification

6.6.1 Pollution

As shown by SEPA's EU Freshwater Fish Directive sampling, water quality in the Ewe catchment is excellent, despite a relatively high human population density and sewage discharge (see Part 3). Furthermore, targeted sampling of the three potential point sources of pollution at the Kinlochewe, Incheril and Anancaun public septic tanks (see Figure 6.1) has shown no evidence of degraded water quality. Nonetheless, Scottish Water should be pressured to empty these tanks regularly to avoid further sewage overflows into the Kinlochewe River, as occurred in July 2000.

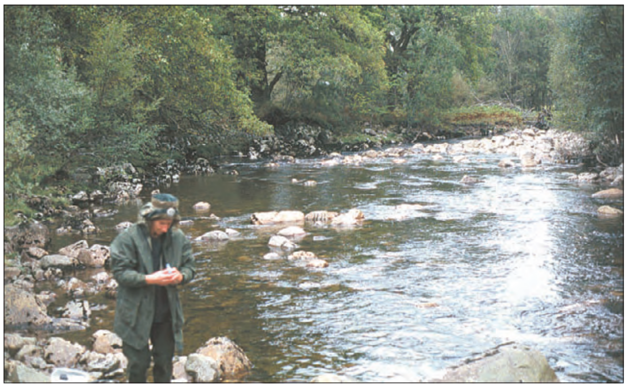
Sheep are grazed extensively by Kinlochewe Estate along the Docherty Burn and Abhainn Bruachaig, and also on grazing bordering the Tollie Burn and River Ewe, but none of these are dipped within the catchment. Therefore this form of pollution does not currently pose a risk.

The Kinlochewe village septic tank outlet: further overflows into the Kinlochewe River must be prevented by Scottish Water *(K Starr)*

6.6.2 Acidification

The majority of the Ewe catchment's geology is mildly acidic. Although water flowing off such rock is also naturally acidic, it does not harm fish because of the buffering effect of dissolved organic matter carried in the water. However, the amount of organic matter naturally decreases in winter months, and becomes even more diluted during spates. Consequently, if a burn has a naturally high acidity (i.e. a low pH), it may pose a threat to fish during winter spates. Eggs are most prone to mortality from acidity, and salmon are more vulnerable than trout.

Burns that are potentially sensitive to winter acidification are those that drain high ground with little vegetation and a naturally acidic geology. Those downstream from large lochs tend to be protected from high acidity because still water acts as a natural 'sink' for acid events. Thus, although SEPA monitoring of the River Ewe has not found any acid problems, their results may have been affected by the presence of Loch Maree upstream. To investigate this issue further, water samples were taken from headwater tributaries flowing directly off mountainous terrain during the winter of 1997–1998. Samples were taken during high flows from nine rivers and burns (Table 6.4) and analysed by FRS.



The Grudie River (above) and Talladale River (below) are prone to natural winter acidification *(J Butler)*

Only three tributaries experienced pH levels of below 6.0 during winter spates: Allt na Doire-Daraich, and the Rivers Grudie and Talladale. FRS consider that in each case TOC was inadequate to buffer the acidity (2.2, 2.1 and 2.7 mg/l, respectively). Hence it is likely that these burns are prone to natural acid events which may affect the survival of salmon eggs. Of most concern is Allt na Doire-Daraich, which contains 22% of the catchment's spawning habitat. However, in terms of the total accessible area affected, these tributaries combined together represent an insignificant amount (0.2%). In terms of the accessible riverine area, which is where salmon production is concentrated, 9% may be affected.

Table 6.4 Levels of pH and Total Organic Carbon (TOC) recorded from water samples taken during high flows from the nine tributaries of the Ewe catchment, winter 1997–1998

	Tributary	Grid ref	Date	pH	TOC (mg/l)
1	Abhainn Bruachaig	NH 073641	9.2.98	6.1	4.4
2	Docherty Burn	NH 060599	9.2.98	7.1	2.7
3	Allt na Doire-Daraich	NH 018633	9.2.98	5.3	2.2
4	Allt Cul Leathard	NH 024549	9.2.98	6.0	4.0
5	Glas Leitir Burn	NH 002651	13.3.98	6.2	1.5
6	Grudie River	NG 966678	9.2.98	5.7	2.1
7	Talladale River	NG 919703	9.2.98	5.6	2.7
8	Slattadale Burn	NG 888723	13.3.98	6.4	4.6
9	Kernsary River	NG 891784	11.2.98	6.3	4.3

6.7 Bankside vegetation

Bankside vegetation has several important functions in the freshwater production of juvenile salmon and trout. Deciduous leaf litter fertilises the stream, providing vital organic input which in turn enhances aquatic insect life, and thus food for young fish. Terrestrial insects falling on to the water from bankside vegetation also provide an additional food source for fish. Tree roots and limbs provide shade and cover for parr, and also reinforce banks and limit erosion and collapse.

The 1998–2000 habitat survey found that overhanging trees or shrubs were very scarce in the accessible area of the catchment, covering only 13% of the total bank length. When examined in detail the watercourses with least cover were the River Ewe, Kernsary River, Garbhaig River, Allt na Doire-Daraich, Kinlochewe River, A'Ghairbhe River and Abhainn Bruachaig (Table 6.5). Given the importance of these sections to the total accessible riverine area, the lack of vegetation is of concern. Also of concern are the significant contributions of coniferous trees to the banks of the Slattadale Burn, and Allt na Feithe Buidhe (Loch Coulin), causing

Most Loch Maree burns have good bankside vegetation (top), but the Kernsary River (middle) and Abhainn Bruachaig (bottom) have poor cover *(J Butler)*

excessive shading. The scarcity of bankside vegetation is mostly caused by the cumulative impact of livestock and deer. None of the affected watercourses is effectively fenced, and sheep and deer have grazed along their banks for many years. The only Woodland Grant Schemes that are likely to benefit significant watercourses are those established by Inveran Estate on the Inveran River, and three established by Coulin Estate along Allt Doire Beithe (see Part 3).

Table 6.5 The proportion of the lengths of river banks covered by overhanging vegetation in the accessible area of the Ewe catchment

Watercourse	% overhanging vegetation
River Ewe	1
Tollie Burn	71
Kernsary River	6
Slattadale Burn	41
Garbhaig River	5
Talladale River	67
Grudie River	29
Allt na Doire-Daraich	8
Other Loch Maree burns	34
Kinlochewe River	9
Docherty Burn	10
Abhainn Bruachaig	10
A'Ghairbhe River	7
Loch Clair–Coulin burns	11

6.8 Freshwater predation

6.8.1 Fish-eating birds

Several species of fish-eating birds occur within the Ewe system, including mergansers, cormorants, herons and the protected black-throated diver. White-tailed eagles may also scavenge carcasses of adult salmon and sea trout, but are unlikely to impact upon juveniles. Of these species, only mergansers, goosanders and cormorants can be legally controlled, and the Ewe DSFB has made unsuccessful attempts to apply for licences in the past. Given the depleted status of both salmon and sea trout stocks, some culling may be justified. If numbers of juvenile salmon and trout are limited, control of mergansers, goosanders and cormorants may also benefit the endangered black-throated diver by reducing competition for prey.

6.8.2 Otters

Otters are known to prey upon both adult and juvenile salmonids. The WRFT Radio-tracking Project in 2001 gave some indication of the rates of predation by otters on adult salmon. Of 12 radio-tagged salmon present in the Kinlochewe, A'Ghairbhe and Bruachaig Rivers, six (50%) were probably taken by otters at spawning time. In common with other rivers, the majority (five) of these fish were males. However, remains of untagged carcasses

Control of predation by cormorants may be justified
(N Stewart)

suggested that some females were being taken either before or during spawning, indicating that otter predation may be reducing the breeding success of the salmon population in this area of the catchment.[6,27]

Otters are protected under the Wildlife and Countryside Act (1981) and therefore their impact upon stocks of Ewe salmon and trout cannot be easily controlled. Otters are also a qualifying feature of the Loch Maree Complex cSAC, and are therefore of particular conservation value within the catchment. One solution to this problem is to protect and restore the salmon population to compensate for losses to otters. Another may be to boost stocks of alternative prey species, such as eels (see Part 9).

6.8.3 Mink and pike

Historically mink have not existed in the catchment. However, one was recently trapped in Kishorn, suggesting that the species may be extending its range from southern Scotland. Mink are efficient predators of fish, and as non-native predators they can destabilise freshwater ecosystems. Consequently their numbers must be controlled if they become established in the Ewe system.

There is evidence that mink are colonising Wester Ross
(SNH/Laurie Campbell)

Similarly, pike are naturalised in the neighbouring catchments of the Rivers Kerry and Conon. Their introduction to the Ewe system must be avoided, since their impact as predators will also modify the ecology of the river system. This is particularly pertinent to the conservation of black-throated divers which tend not to breed on waters with pike, as the size of potential fish prey becomes too large owing to the effects of pike predation.

Otter predation of adult salmon could limit stocks in the Ewe
(J Butler)

Colonisation of the Ewe catchment by pike must be avoided
(B Laughton)

Although the Kerry system is linked to the Ewe catchment via a bifurcation downstream from Loch na h'Oidche (see Part 3), pike are unlikely to gain access through it. This is because there are impassable falls between the bifurcation and Loch Bad an Sgalaig in the Kerry system, the furthest upstream point where pike occur in that river. Therefore although Highland Light & Power's proposed Shieldaig/Slattadale hydro-electricity scheme may divert greater flows from Loch na h-Oidche into the Ewe catchment (see Part 3), the risk of pike invasion remains negligible. Nonetheless, future hydro-electric proposals should avoid the transferral of water from the Kerry or Conon river systems into the Ewe.

6.8.4 Seals

Both common seals and grey seals are present in Loch Ewe, but some have been known to ascend the Ewe and reside in Loch Maree, hauling out on the Loch Maree Islands. Most recently two common seals were present in Loch Maree during the summer of 1997. It must be assumed that they were feeding while in the loch, presumably on trout, salmon, eels or charr. Given their potentially large intake of fish, and the current depleted state of salmon and sea trout stocks, such incursions should be discouraged.

6.9 Conclusions

- **The freshwater habitat of the Ewe catchment is relatively pristine, and alteration by man has been minimal. The area accessible to salmon and sea trout is largely constrained by natural waterfalls, but there are seven occasionally-passable falls that may limit access to substantial areas upstream during low flows. The easing of nine road culverts, restoration of one salmon ladder and removal of debris obstacles would improve access to significant areas of spawning and juvenile habitat.**

- **98% of the accessible area consists of loch habitat, of which Loch Maree constitutes 91%. The abundance of still water and small tributary burns favours trout production. Within the riverine area, habitat suitable for salmon parr is also abundant.**

- **Spawning habitat is well distributed, but 68% is unstable and prone to redd washout. 60% of the spawning area is located in the Docherty Burn, Allt na Doire-Daraich and Abhainn Bruachaig. Potentially lethal March spates have occurred in the 1989–90, 1996–97, 1998–99 and 1999–2000 winters, and salmon and sea trout smolt production was probably reduced in these years. Larger Multi Sea Winter salmon may be less vulnerable to this problem, perhaps partly explaining their relative increase within the population during the 1990s.**

- **The proposed Shieldaig/Slattadale hydro-electricity scheme should be re-assessed to avoid the increase of flows in the Garbhaig River. Such an increase would render this important tributary more susceptible to redd washout.**

- **Water quality is excellent, with no evidence of sewage, forestry or agricultural pollution. However, overflows from the Kinlochewe public septic tank should be avoided by regular emptying by Scottish Water. There was evidence of winter acidification capable of killing salmon eggs in the Talladale and Grudie Rivers, and Allt na Doire-Daraich, potentially affecting 9% of the total accessible riverine area.**

- **Bankside vegetation is limited throughout the catchment, covering 13% of total bank length. Worst affected watercourses were the Ewe, Kernsary, Garbhaig, Kinlochewe, A'Ghairbhe and Bruachaig Rivers, and Allt na Doire-Daraich. Sections of the Slattadale Burn and Allt na Feithe Buidhe are impacted by shading from forestry plantations. If rectified, improved riparian habitat could increase the natural productivity of these riverine areas for juvenile salmonids.**

- **Control of predation by mergansers, cormorants and seals is justified by the depleted status of salmon and sea trout stocks in the catchment. Predation of adult salmon by otters may be further limiting stocks, but can only be compensated for by restoring fish populations. Colonisation by mink and pike must be avoided. Hydro-electricity schemes transferring water from the Kerry or Conon systems into the Ewe catchment may introduce pike and should be prevented.** ❑

Part 7
Freshwater Production of Juvenile Salmon

7.1 Methods

To assess the status of the Ewe system's juvenile salmon stock, an electro-fishing survey was carried out in late summer and autumn 1997, 1999 and 2001. Two forms of survey were used: quantitative and semi-quantitative (timed). Quantitative electro-fishing involves closing off a section of typical juvenile habitat with nets and removing the fish within that section. Having measured the area of water, an estimate of the density of fish is made. Semi-quantitative surveys involve timed fishing at a large number of sites. The results give an index of the distribution and abundance of fish over a wider area.

The FRS survey in 1992 established 19 quantitative sites, of which 17 were within the accessible riverine area of the catchment.[8] Also in 1992 FRS surveyed three sites within the accessible area as part of a water chemistry study of the British Isles.[28] This total of 20 quantitative FRS sites was used as the basis of WRFT surveys in 1997, 1999 and 2001. To increase the coverage of the WRFT survey a further 8 sites were added. In addition, the WRFT surveyed 85 semi-quantitative sites in 1999, two of which were used to assess whether falls were passable (see Appendix I).

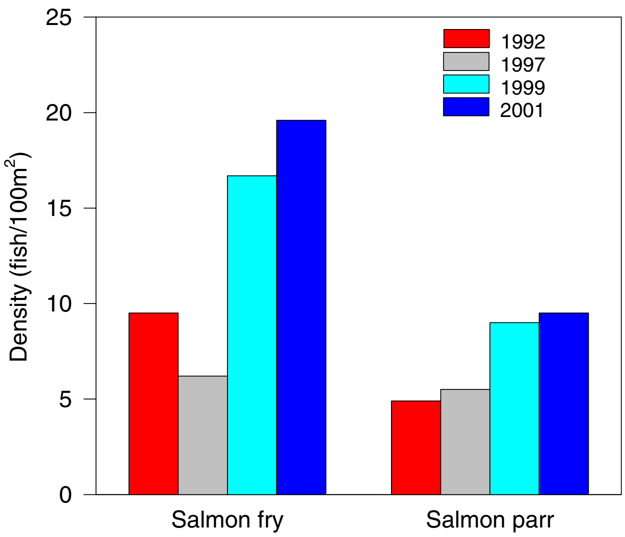


Figure 7.1 Average densities of salmon fry and parr found at 20 quantitative electro-fishing sites in 1992, 1997, 1999 and 2001 (see Appendix I for data)

7.2 Densities of juvenile salmon

The results of the 20 quantitative sites surveyed in 1992 by FRS are shown in comparison to the WRFT results for those same sites in 1997, 1999 and 2001 (Figure 7.1). On average the density of fry was low in 1992 and 1997, but has improved in 1999 and 2001. Meanwhile parr densities have remained low in all years, with slight improvements in 1999 and 2001.

These results may reflect the abundance of spawning adults in years immediately prior to the surveys. However, such assessments may be confused by variations in winter mortality of eggs, since 68% of the available spawning is unstable and prone to redd washout, and 9% of the accessible area is sensitive to winter acidity (see Part 6). For example, low parr densities in 1992 may have been partly caused by the large spates of winter 1989–1990. Similarly, poor densities of fry in 1997 may have been due to a large spate in March 1997, and the dry winter of 2000–2001 could have contributed to improved fry densities in 2001.

The apparently poor state of the juvenile population is confirmed when the full WRFT results are compared with the healthiest local river, the neighbouring Little Gruinard (Table 7.1). Even in 2001, the best of the three surveyed years, Ewe densities were less than half that found on the Little Gruinard. This anomaly cannot be explained by geographical differences, since both rivers have similar geology, spawning availability and parr habitat. Although the Little Gruinard has been managed as a catch and release fishery since 1992,[14] it has not been stocked, in contrast to the Ewe (see Part 4). Therefore the variations shown in Figure 7.1 are relatively minor fluctuations around a low level of abundance, rather than signs of significant improvement.

Table 7.1 Average densities (fish/100 m^2) of juvenile salmon fry and parr found at 28 quantitative electro-fishing sites in the Ewe system in 1997, 1999 and 2001. For comparison the average densities are given for 8 sites on the Little Gruinard River in 1997, and 10 sites in 1999 and 2001 (see Appendix I for data)

	Ewe			Little Gruinard		
	1997	1999	2001*	1997	1999	2001
Fry	12	18	22	36	45	50
Parr	8	8	10	19	23	22

*2001 data exclude Tollie Burn, which was stocked (see Part 4)

7.3 Distribution of juvenile salmon

7.3.1 Salmon fry in 1999

The timed survey in 1999 gave the most comprehensive indication of juvenile salmon distribution in the catchment. In particular, concentrations of salmon fry identified areas where successful spawning had occurred the previous autumn. As suggested by the salmon fry densities in 1999, their distribution was moderate, occurring at 75% of the sites (Figure 7.2). The abundance of fry was good in the River Ewe, Kernsary River, lower Abhainn Bruachaig and Docherty Burn, and the Loch Clair–Coulin system.

Salmon fry were moderately distributed in the Ewe catchment in 1999 *(J Butler)*

Numbers and distribution were poor in many of the smaller Loch Maree tributaries. Although not fully investigated, distribution within the Loch Ghiuragarstidh sub-catchment may also be limited. Of particular concern was the paucity of fry in the Tollie Burn, the Talladale and Grudie Rivers, Allt na Doire-Daraich, the upper Docherty Burn and the Upper Bruachaig, since these watercourses contribute significant areas of spawning and riverine salmon parr habitat. These results are consistent with the conclusions of Part 6, however, which demonstrated that these tributaries were prone to redd washout, and a potentially lethal spate did occur in March 1999. Furthermore, the Grudie, Talladale and Allt na Doire-Daraich may also have suffered from acid episodes.

7.3.2 The Bruachaig problem

Juvenile salmon were most consistently absent from Abhainn Bruachaig above the Lower Falls (NH 059628), which are occasionally passable (see Part 6). This was most evident in 1999, when timed sites showed the pattern clearly (see Figure 7.2). Similarly, no juveniles were found above the falls in 1997 at three quantitative sites, nor in 2001. However, the timed survey in 1999 did find two 1-year-old parr near the confluence of Abhainn Gleann na Muice, indicating that fish had negotiated the falls and spawned in autumn 1997 (see Appendix I).

The scarcity of juvenile salmon above the Lower Falls suggests either that adults have had difficulty in ascending this partial obstacle in recent years, or that there have been too few to adequately saturate the area upstream. Prior to the fish that spawned in autumn 1997, the previous rod-caught fish above the falls was in October 1996 (5 lb), and then in October 1993 (8 lb) and July 1993 (10½ lb). Historically, Kinlochewe Estate regularly caught fish above the falls from June onwards, suggesting that the Upper Bruachaig stock were early summer salmon and grilse. The results of the WRFT's Radio-tracking Project endorse this conclusion (see Part 4), as does the weight distribution of fish caught in the Upper and Lower Bruachaig during the 1990s (Figure 7.3).

There are four possible explanations for the decline of the population above the Lower Falls. First, the operation of Scottish & Southern Energy's Allt a Claiginn aqueduct

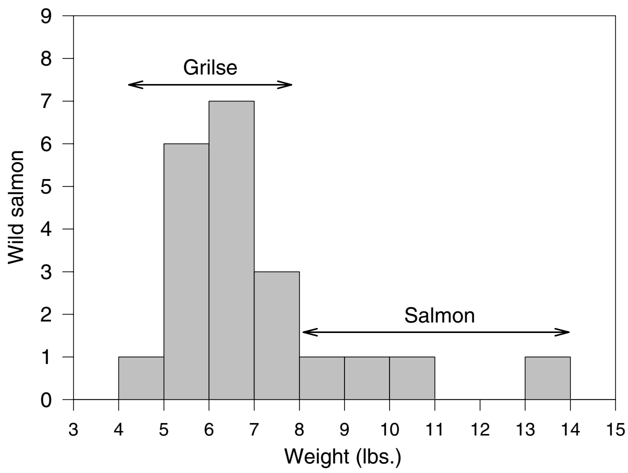


Figure 7.3 Weight distribution of 21 wild salmon caught in the Upper and Lower Abhainn Bruachaig by Kinlochewe Estate, 1993–1999

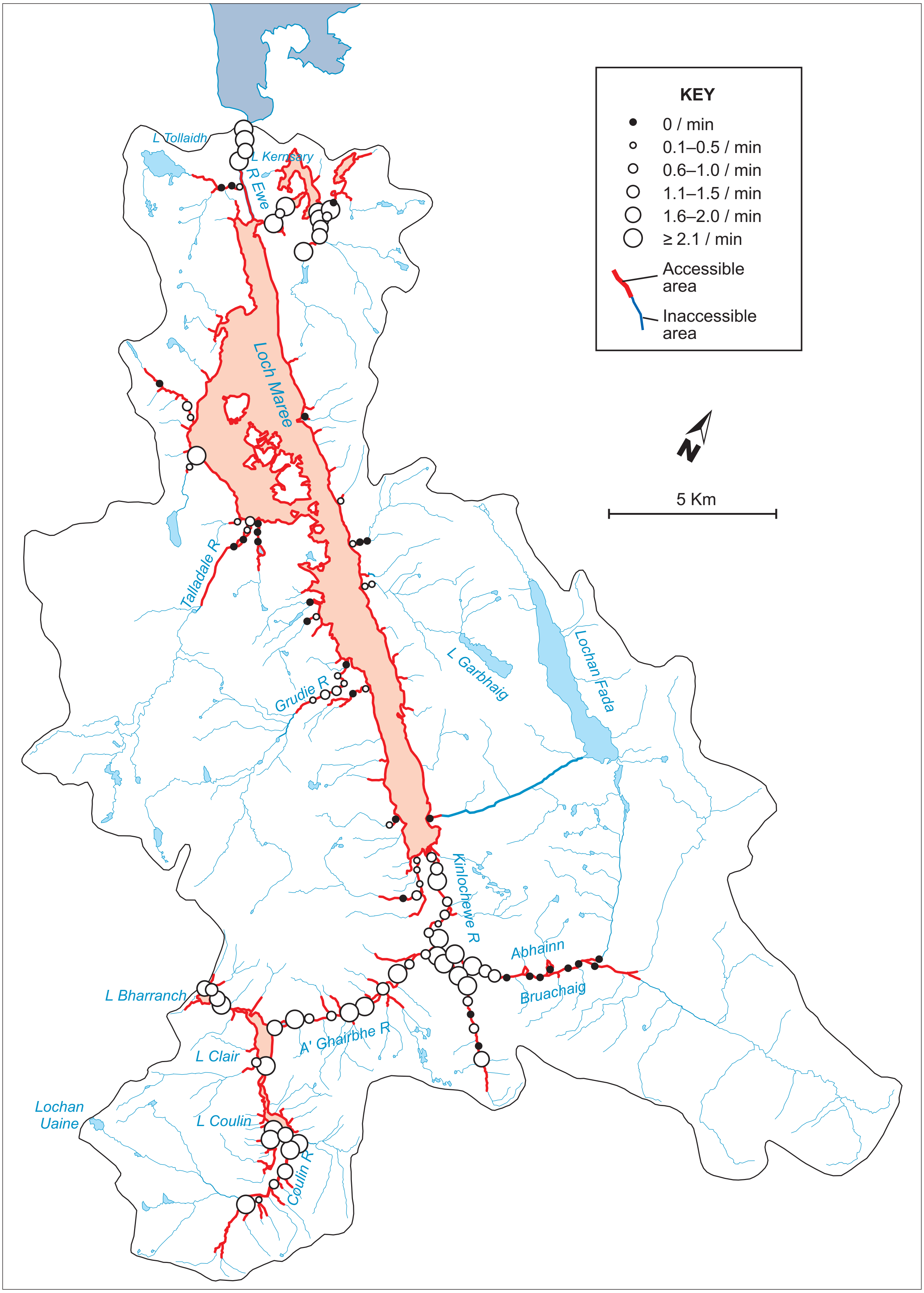


Figure 7.2 Distribution and abundance of salmon fry in the accessible area of the Ewe catchment in 1999, estimated from 111 quantitative and semi-quantitative electro-fishing sites *(Crown Copyright)*

may be diverting too much water from the Bruachaig catchment, limiting the ability of fish to leap the falls (see Part 3). However, Scottish & Southern Energy claims that it has not altered the timing or frequency of water diversions to Loch Fannich since the scheme was established in the 1950s. Second, about 35 salmon were taken by rod and line in 1992 prior to the sale of Kinlochewe Estate from the pool below the Lower Falls. These fish may have represented a substantial proportion of the Upper Bruachaig population. Third, the gorge below the falls may have become blocked with boulders, obstructing the approach of running fish. Finally, all of these factors may be to blame, combined with declining runs of salmon in the 1990s and a series of wet winters, resulting in redd washout. Regardless, the problem requires further investigation and clarification.

Many factors may explain the decline of salmon in the Upper Bruachaig (top), including the operation of the Allt a Claiginn aqueduct (bottom) *(J Butler/K Starr)*

7.4 Age structure of juvenile salmon

By reading scales taken from juvenile salmon caught during the surveys, it was possible to examine the age structure of the population (Figure 7.4). The patterns found verified the results of the quantitative electro-fishing, with the increasing densities of fry (see Table 7.1) reflected in increasing prevalence of fry relative to parr. In 1997, 1999 and 2001, parr of 1+, 2+ and 3+ years old were present, suggesting successful spawning in

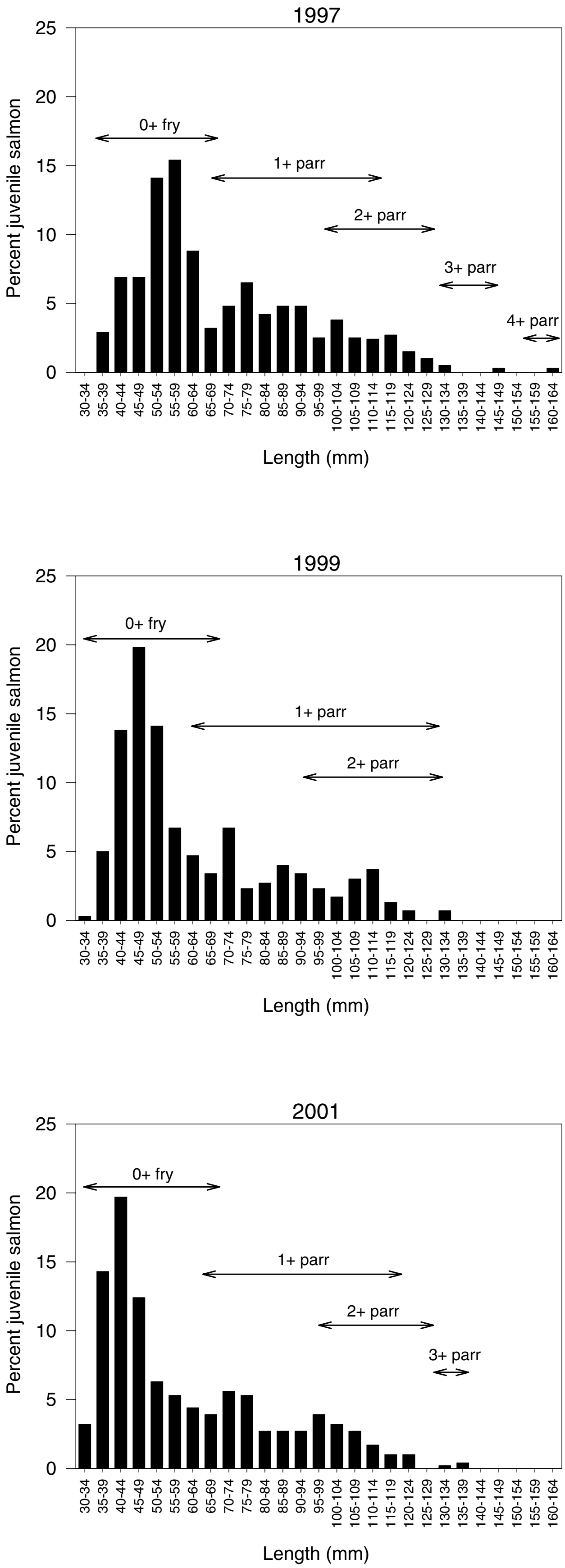


Figure 7.4 Age structure of juvenile salmon in the Ewe catchment at 28 quantitative electro-fishing sites in 1997 (525 fish), 1999 (299 fish) and 2001 (422 fish)

successive years prior to the surveys. The age structure also confirms that most fish leave the river as smolts after 2 or 3 years, since very few parr older than this were found. This corresponds with the analysis of adult salmon scales, which showed that currently 59% smolt after two years, and 35% after three years (see Part 4).

There was also marked overlap in the lengths of parr of different ages. This is primarily because parr found in tributaries at lower altitudes grew quicker for every year in freshwater, while those at higher altitudes grew more slowly. A further cause of overlapping year classes was low densities of fish in some tributaries, which resulted in quicker growth rates than in better populated areas.

7.5 Spawning targets

7.5.1 Calculation of Ewe spawning targets

Long-term research into the Atlantic salmon has led to the development of new management techniques, including the setting of spawning targets. Every river has a natural carrying capacity for juveniles, based on the accessible area available to spawning adults. By calculating the minimum number of salmon eggs required to saturate the accessible area with parr, and therefore maximise the output of smolts, it is possible to assess from runs of adult fish whether the river is reaching its natural potential. Spawning targets are now being recommended by NASCO as a simple method for managing salmon stocks on a river-by-river basis, and are currently used in England and Wales, Canada and the USA.

The calculation of spawning targets begins by estimating the minimum number of eggs ('egg target') required to produce the carrying capacity of fry, parr and smolts in the accessible river habitat (see Appendix VIII). For the Ewe at least 2,800,685 (i.e. 2.8 million) eggs are needed to saturate the accessible area of 31,005,504 m^2 (Table 7.2). Using typical egg-smolt mortality rates it can then be estimated that, if the egg target has been reached, the river system should produce a maximum of approximately 49,800 salmon smolts.

Overall, 58% of these would be produced by the riverine areas, of which the Kinlochewe River and its tributaries contribute the most (43%) (Table 7.2). Despite the fact that lochs constitute 98% of the accessible area, they contribute only 42% of smolts. This is because still water is not the preferred habitat of salmon fry and parr, although exploratory electro-fishing by FRS in Loch Maree[8] and catch records confirm that juvenile salmon do exist in the lochs.

The egg target can then be translated into the number of female salmon needed to lay the required quantity of eggs. The average weight of Ewe salmon is currently 8½ lb. On average female salmon in Wester Ross produce 600 eggs per lb; therefore each Ewe hen produces approximately 5,100 eggs. Thus a run of at least 549 hens is required to reach the egg target of 2.8 million, plus a further 549 males to fertilise them, giving a minimum spawning target of approximately 1,098 adult salmon.

This minimum level is termed the Minimum Biological Acceptable Limit (MBAL), and is effectively the carrying capacity of the river. To allow for losses of adults from disease and predation, or egg loss due to redd washout,

Table 7.2 Calculation of the minimum target of salmon eggs required to maximise the smolt output from the accessible area of the Ewe catchment. All lochs are considered oligotrophic and therefore 'Grade 2' (see Appendix VIII)

	Water body	Area (m^2)	Min. egg target*	Max. smolts
Rivers	River Ewe and tributaries	39,504	102,710	1,746
	Loch Maree tributaries	118,483	308,056	5,237
	Kinlochewe River and tributaries	489,517	1,272,744	21,637
	TOTAL RIVERS	*647,504*	*1,683,510*	*28,620*
Lochs	Loch Ghiuragarstidh	150,000	5,520	105
	Loch Kernsary	837,000	30,802	585
	Loch Maree	28,200,000	1,037,760	19,717
	Loch Clair	632,000	23,258	442
	Loch Bharranch	151,000	5,557	105
	Loch Coulin	388,000	14,278	271
	TOTAL LOCHS	*30,358,000*	*1,117,175*	*21,225*
	OVERALL TOTALS	***31,005,504***	***2,800,685***	***49,845***

* 2.6/m^2; for Grade 2 loch = 368/ha

an over estimate is made of the number of adults required to create a safety margin (see Appendix VIII). FRS employs a margin of 15% to give a Management Level (ML). For the Ewe the ML is therefore 1,263, and given the problems with redd washout (see Part 6) it would be judicious to use this target in the future.

Without a fish counter, it is impossible to measure the annual run of salmon into the Ewe. However, extensive research on another west coast river, the Awe (Argyll) using a fish counter has shown that on average 15% of salmon are caught on rod and line.[29] Using this figure the annual Ewe rod catch of wild salmon was translated into an estimate of the total run for 1978–2001. Having deducted fish caught and killed, the annual wild escapement (i.e. fish that survived to spawn) was calculated and compared with the MBAL and ML spawning targets (Figure 7.5).

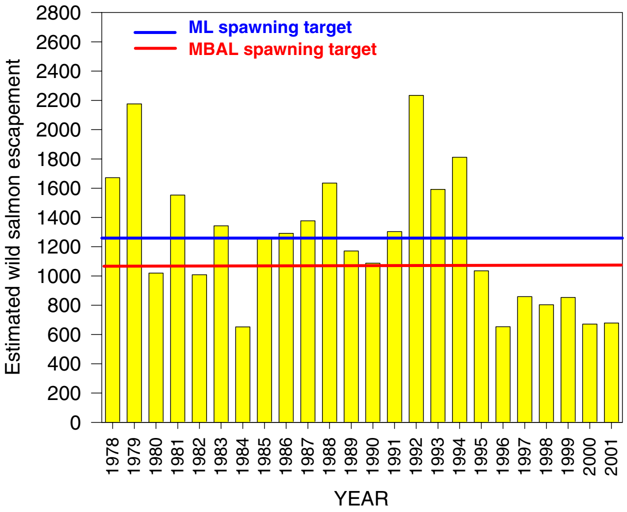


Figure 7.5 Estimated annual escapement of Ewe wild salmon, 1978–2001, relative to the Minimum Biological Acceptable Limit (MBAL) and Management Level (ML) spawning targets

This method indicated that the MBAL target was exceeded or nearly attained annually in 1978–1995. The only exception was 1984, which was a drought year and hence catches may not have reflected adult runs. Since 1996 escapement has consistently fallen below the MBAL by 60–78%. The ML target was achieved in 12 of the 18 years prior to 1996, suggesting that runs during this period were healthy and maintained the catchment near its carrying capacity for juvenile salmon. However, since 1996 the population has fallen below carrying capacity, resulting in runs of smolts fewer than the maximum of 49,800.

7.5.2 Spawning targets and juvenile surveys

The validity of this assessment can be cross-checked using the results of juvenile surveys. The FRS survey in 1992 found poor densities of salmon fry, suggesting that runs of adults had fallen below the MBAL spawning target in 1991 (see Figure 7.1). However, according to rod catches the spawning target was met in 1991 (Figure 7.5). This suggests that some other factor reduced juvenile survival from the 1991 spawning season. It is possible that the wet winter of 1991–1992 was to blame, although no potentially lethal spate was recorded in March 1992 (see Part 6). Alternatively, the relatively limited number of sites surveyed by FRS may not have adequately reflected the abundance of fry throughout the catchment.[8]

The more extensive WRFT surveys in 1997, 1999 and 2001 do corroborate the spawning target estimations. The poor fry densities in 1997 (see Table 7.1) were preceded by an adult run that achieved only 60% of the MBAL spawning target. Similarly, relatively low densities in 1999 and 2001 reflected poor runs in 1998 and 2000 (Figure 7.5). The surveys also identify those areas where inadequate spawning has consistently occurred: the Upper Bruachaig (see 7.3.2), Allt na Doire-Daraich, Rivers Grudie and Talladale, and the Tollie Burn.

The link between inadequate numbers of spawning adults and juvenile abundance in the Ewe is further validated when comparisons are made with the Little Gruinard, which had more than twice the density of fry and parr in 1997, 1999 and 2001 (see Table 7.1). Over this period the rate of fish caught on rod and line (wild salmon per hour) was compared between the two rivers (Figure 7.6). In 1999–2001 the rate of capture on the Little Gruinard exceeded that on the Ewe, suggesting that smolt runs and adult returns have indeed been depleted in recent years.

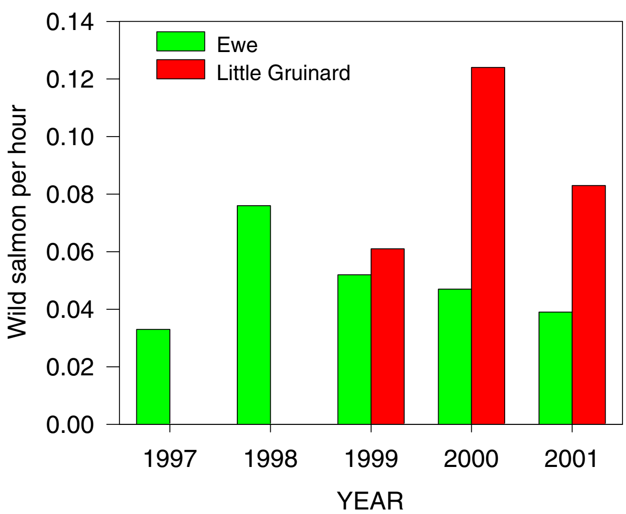


Figure 7.6 Relative rod catch rates of adult salmon on the Rivers Ewe and Little Gruinard, 1997–2001

Ewe salmon stocks are depleted relative to those in the Little Gruinard River *(J Butler)*

Marine survival of Ewe salmon smolts has fallen to less than 3% since 1995 *(J Butler)*

7.5.3 Marine survival

The shortfall of returning adults since 1996 suggests that the marine survival of Ewe smolts has declined during the 1990s. Based on the estimated numbers of returning adults, and assuming that maximum smolt output was achieved in most years prior to 1996, marine survival rates can be calculated. During 1978–1995, returns of adults reached about 2,600, which equates to marine survival rates of 6% (Table 7.3). Therefore, for adult returns to have fallen to 700–900 adults since 1996, resulting in failure to achieve the MBAL spawning target, marine survival must have decreased to less than 3% in 1994–1995. This compares poorly with estimations on the East coast of Scotland, where the River North Esk average marine survival for the 1990s was 6–11%.[30]

Table 7.3 Estimates of the Ewe wild salmon runs and rod catches (at 15% exploitation rate) at decreasing levels of marine survival, given the maximum estimated smolt run of 49,845 smolts. The Minimum Biological Acceptable Limit spawning target of 1,098 is achieved at survival rates of 3% and above

Marine survival (%)	Returning adults	Rod catch
20	9,969	1,495
15	7,477	1,122
10	4,985	748
5	2,492	374
4	1,994	299
3	1,495	224
2	997	150
1	499	75

The Ewe estimates are supported by the results of the Tournaig Trap, where marine survival of salmon smolts leaving Loch Ewe is estimated to have fallen to less than 3% during the mid-1990s, and to less than 1% in 1998–2000.[17] In Loch Torridon, the FRS Shieldaig Sea Trout Project has found similarly poor rates of survival over the same period. Results from both traps indicate that having fallen below their spawning targets, salmon smolt output is consistently depressed, and marine survival must improve radically to prevent the populations from approaching extinction.[17] While relatively large numbers of salmon still enter the Ewe system, further decreases in marine survival could seriously threaten the stock.

7.6 Conservation status

Many classifications exist for the assessment of animal populations. These have recently been standardised for Atlantic salmon by the World Wide Fund for Nature,[31] based upon several criteria (see Appendix IX). The Ewe salmon stock presently has more than 500 returning adults, and can therefore be considered ‘Healthy’. However, only 60–61% of the MBAL spawning target was reached in 2000 and 2001, which classifies the population as ‘Vulnerable’. Most importantly, 12% of rod-caught salmon in the last five years have been escapees (see Part 4), indicating that at least 10% of spawners were farmed fish during this period. Therefore the wild population is ‘Endangered’ from the perspective of genetic introgression.

The classification procedure also requires the identification of human-derived problems which, if reversed, would improve the conservation status of the salmon stock concerned. In the case of the Ewe, the most likely man-made cause of the population’s decline is salmon farming. Large scale escapes have occurred in Loch Ewe, Loch Tollaidh and Loch Clair in 1989–1999, resulting in hybridisation of wild Ewe salmon (see Part 4). The deleterious effects of such genetic pollution are known to manifest themselves after two or more generations, which might explain the onset of the decline in 1996, 10 years after the establishment of farms in the catchment and sea loch. The impacts of escapes are probably exacerbated by sea lice infestations of emigrating smolts, emanating from the marine farms in Loch Ewe. The effect of this parasite on the Ewe sea trout

Wild Ewe salmon are classified as 'Endangered' owing to influxes of farm salmon *(K Starr)*

stock since 1987 is evident, and abnormally high lice levels have also been found on Ewe salmon (see Part 5).

7.7 Conservation measures

7.7.1 Reducing exploitation

Because the salmon stock has probably not reached carrying capacity since 1996, the numbers of smolts produced by the river are being limited directly by the numbers of spawning adults. Therefore every extra adult fish that is allowed to spawn will produce additional smolts. In order to boost smolt output, conservation measures should be introduced within the rod fishery. The most obvious approach is to encourage the release of all wild rod-caught fish, and all hen fish in particular. Currently no more than 29% of fish have been released by anglers (see Part 4). The Ewe Radio-tracking Project demonstrated that all tagged fish that could be accounted for survived to spawning time.[6] Furthermore, a catch and release policy on the River Ewe would benefit neighbouring rivers, where stocks are also likely to be depleted, since the radio-tracking demonstrated that some foreign fish enter the Ewe and are caught.

Netting rights owned in Loch Ewe by Inveran Estate and Mrs Dorothy Balean have not been operated since 1973 (see Part 3). Nonetheless, to ensure the conservation of all adult salmon entering the Ewe, these rights should not be activated until further notice. Similarly, nets operated at Redpoint (Loch Torridon) and Laide (Gruinard Bay) are also likely to have captured some Ewe salmon.[9] Therefore their closures should be maintained by the owners, Gairloch Estate and Eilean Darach Estate.

7.7.2 Stock enhancement

Most stock enhancement carried out since 1975 has involved the recycling of eggs, and therefore will have produced very few extra smolts (see Part 4). The only gains will have occurred when eggs were saved from redd washout or acid episodes during wet winters. The

All wild Ewe salmon should be released by rod fishermen *(J Butler)*

introduction of non-native juveniles from outside the catchment occurred in 1975–1986, when spawning targets were probably being met (see Figure 7.5), and most areas of the river system were at their carrying capacity for juveniles. Therefore these extra fish are also unlikely to have contributed to the smolt run, other than if stocked into tributaries where mortalities had occurred during wet winters.

The only exception is the stocking of 30,000 fish into the Tollie Burn in 2001. Surveys in 1997 and 1999 showed that no wild salmon had accessed this area, and therefore available habitat was vacant. A survey of the Tollie Burn in 2001 subsequent to the stocking showed that densities were very high (see Appendix I), indicating that extra smolts probably will be produced from this burn. If adults return to spawn in the tributary, this exercise will have seeded the area, albeit with non-native fish. With similar gaps in the Upper Bruachaig, Allt na Doire-Daraich, the Rivers Grudie and Talladale and the Loch Ghiuragarstidh sub-catchment, seeding should also be considered for these areas. Native Ewe stock is most likely to produce best results, particularly if the stock discrimination shown by the Radio-tracking Project is taken into account when selecting broodstock for each area. This approach has already begun with collection of Bruachaig smolts in 2000 to form a captive broodstock for the seeding of the upper river above the lower falls (see Part 4).

The problems of redd washout and acidification suggest that stocks from the worst affected burns (Abhainn Bruachaig, Docherty Burn, Allt na Doire-Daraich, Rivers Grudie and Talladale) could also benefit from continual recycling of eggs. Given predictions of wetter winters, salmon production in these tributaries may become more frequently impaired, and any eggs saved from winter mortality are likely to boost smolt output.

7.6 Conclusions

- **Surveys in 1997, 1999 and 2001 indicate that the stock of juvenile salmon is depleted. This is verified when comparisons are made with the neighbouring Little Gruinard River. Successful spawning has not occurred in the Upper Bruachaig since 1997, but there may be several reasons for this, which require further investigation. Other tributaries with evidence of poor salmon production are the upper Docherty Burn, Allt na Doire-Daraich, Rivers Grudie and Talladale and the Tollie Burn. Therefore smolt runs are likely to have been sub-optimal in 1998–2002.**

- **Maximum potential smolt output is estimated to be approximately 49,800, requiring an egg target of at least 2.8 million. This translates to a MBAL spawning target of 1,098 adult salmon, and a ML of 1,263.**

- **Estimates of adult runs support the conclusions drawn from the juvenile surveys. The salmon population has fallen below its carrying capacity since 1996, with adult runs failing to achieve the MBAL by 60–78%. Spawning targets were probably exceeded in 1978–1995. Estimates of runs show that up to 2,600 fish entered the river prior to 1995, but since 1996 only 700–900 have done so. This equates to a reduction in smolt marine survival to less than 3% during the same period, and is supported by results from the Tournaig Trap. These survival rates are considerably lower than those for the River North Esk during the 1990s.**

- **The conservation status of the wild salmon population is 'Endangered', because 12% of spawners are escaped farm fish. Failures to reach spawning targets since 1996 also classify the population as 'Vulnerable'. The man-made causes of the problem are likely to be genetic introgression by farm salmon and sea lice infestations in Loch Ewe, and should be addressed urgently. Meanwhile, conservation measures within the rod fisheries are imperative, including a policy of total catch and release for wild fish.**

- **Stock enhancement carried out in 1975–2001 is unlikely to have produced additional smolts, other than by compensating for mortalities caused by wet winters. Seeding of depopulated parts of the system is warranted, and recycling of eggs in tributaries affected by redd washout and acidification is also justified. Enhancement programmes should take into account the stock discrimination revealed by radio-tracking.** ❑

Part 8
Freshwater Production of Juvenile Trout

8.1 Densities of juvenile trout

The electro-fishing surveys carried out in 1992, 1997, 1999 and 2001 were also used to assess the juvenile trout population. The results of the 20 quantitative sites surveyed in 1992 by FRS are shown in comparison to the WRFT results for those same sites in 1997, 1999 and 2001 (Figure 8.1). On average, fry densities were similar in 1992, 1997 and 1999, but improved markedly in 2001. Meanwhile parr densities were highest in 1992, and have decreased marginally since.

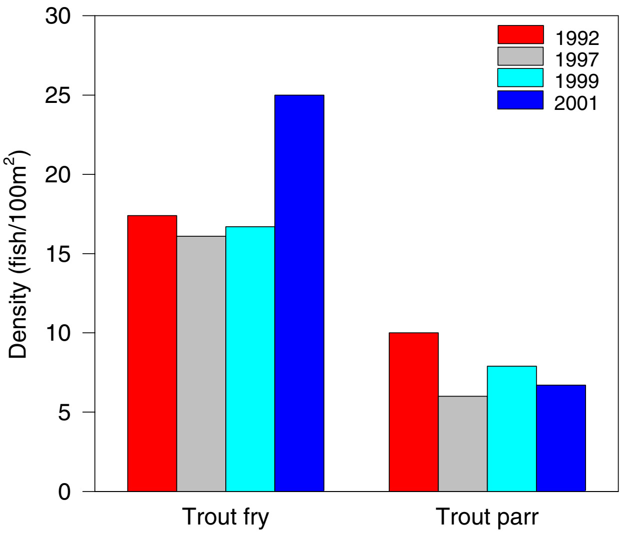


Figure 8.1 Average densities of trout fry and parr found at 20 quantitative electro-fishing sites in 1992, 1997, 1999 and 2001 (see Appendix I for data)

These results are difficult to interpret. First, many of the sites may have been affected by stock enhancement (see Part 5). Second, the influence of redd washout is likely to have been more acute for trout than for salmon (see Part 6). Third, the surveys represent the abundance of juveniles only in riverine areas, yet the majority of trout exist in lochs, which are the species' favoured habitat. For example, exploratory electro-fishing by FRS has found trout fry present along the Loch Maree shoreline.[8] Finally, the contribution of eggs from resident female brown trout has probably increased during the 1990s (see Part 5), masking declines in egg deposition from the dwindling sea trout population.

The health of the juvenile trout population can best be assessed when results are compared with the average density found in 1999 in other unstocked Wester Ross rivers. The densities of fry in the Ewe were marginally higher in 1997 and 1999, and far higher in 2001 (Table 8.1). Similarly, Ewe parr densities were considerably higher than the regional average in all years.

As for the Ewe, sea trout stocks in all of these rivers have collapsed since the late 1980s. Therefore the lower average densities are probably a true reflection of the resulting depressed juvenile trout production, while the elevated densities in the Ewe may be due to stocking and increasing numbers of female brown trout.

Table 8.1 Average densities (fish/100 m^2) of juvenile trout fry and parr found at 28 quantitative electro-fishing sites in the Ewe system in 1997, 1999 and 2001, compared with average densities for 13 other unstocked Wester Ross rivers surveyed in 1999 (see Appendix I for data)

	Ewe			Wester Ross average*
	1997	1999	2001	1999
Fry	19	18	38	16
Parr	6	8	6	4

* Kanaird, Ullapool, Lael, Broom, Dundonnell, Gruinard, Inverianvie, Little Gruinard, Allt Beithe, Tournaig, Loch Sguod, Kerry and Balgy

8.2 Distribution of juvenile trout

The timed survey in 1999 gave an indication of trout fry distribution in the catchment. Distribution was moderate, with fish found at 67% of sites (Figure 8.2). Areas of high abundance were patchy, and appeared to be limited to smaller burns running into Loch Maree, Allt na Doire-Daraich, upper Docherty Burn, Allt na Feithe Buidhe and Loch Bharranch. Fry numbers were poor in the River Ewe, Kernsary system, Slattadale Burn, the Rivers Talladale, Grudie, Kinlochewe, A'Ghairbhe and Coulin, and Abhainn Bruachaig. Because juvenile trout prefer smaller burns, their absence from some these larger rivers might have been expected. Their paucity in the Kernsary system and Slattadale Burn, where suitable habitat is abundant, is more probably due to a lack of successful spawning by adult trout.

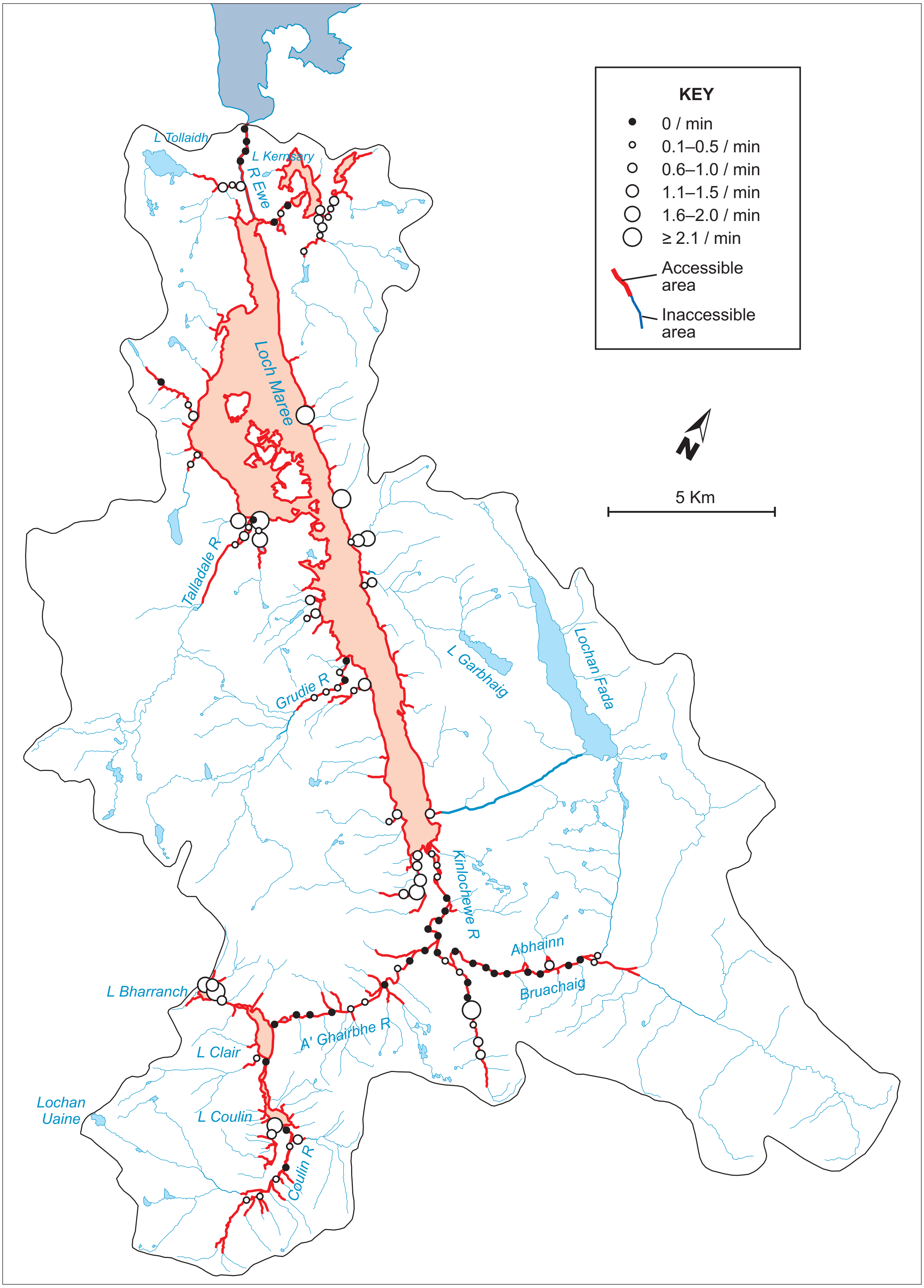


Figure 8.2 Distribution and abundance of trout fry in the accessible area of the Ewe catchment in 1999, estimated from 111 quantitative and semi-quantitative electro-fishing sites *(Crown Copyright)*

Trout fry are abundant in smaller burns flowing into Loch Maree *(J Butler)*

8.3 Age structure of juvenile trout

Representatives of each year class were found in 1997, 1999 and 2001, indicating consistent juvenile production (Figure 8.3). However, in all three years fry were considerably more prevalent than parr, suggesting that many either die off before becoming parr, or else emigrate from the spawning burns to inhabit lochs. As with the salmon, there was considerable overlap in the sizes of different age classes of trout each year, owing to the variable influences on growth rates of altitude and competition from other fish. The results also confirm the analysis of sea trout scales (see Part 5), showing that most parr leave the burns after 2, 3 or 4 years, either as sea trout smolts or as larger brown trout moving into deeper water.

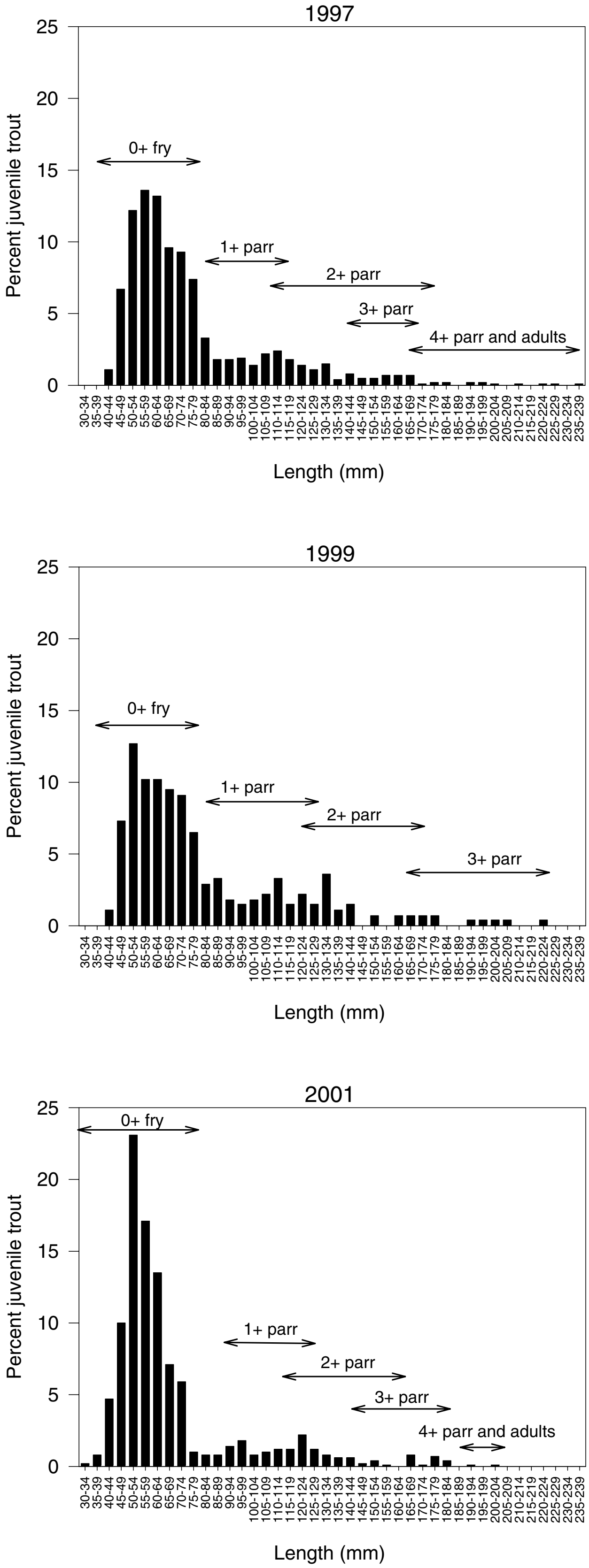


Figure 8.3 Age structure of juvenile trout in the Ewe catchment at 28 quantitative electro-fishing sites in 1997 (723 fish), 1999 (275 fish) and 2001 (510 fish)

8.4 Competition between trout and salmon

The juvenile surveys suggest that fish populations in the Rivers Grudie and Talladale have switched from being trout-dominated to salmon-dominated during the 1990s (Figure 8.4). Because juvenile trout are more aggressive than juvenile salmon, this pattern indicates that in some riverine areas of the catchment the decline in sea trout has resulted in an expanded range of juvenile salmon. As a result, the output of salmon smolts may have increased from these areas. If egg production from female brown trout continues to grow, it is possible that these tributaries will revert to being dominated by trout. In the meantime, in order to avoid displacing juvenile salmon, stock enhancement of trout should concentrate on lochs rather than larger rivers.

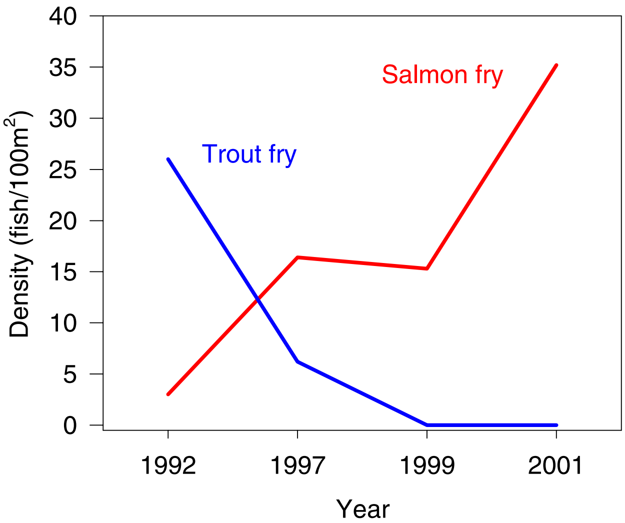


Figure 8.4 Relative densities of trout and salmon fry found at a quantitative electro-fishing site in the River Grudie in 1992, 1997, 1999 and 2001 (see Appendix I for data)

8.5 Spawning targets for sea trout

Insufficient research has been carried out on west coast sea trout to provide the data required for setting sea trout spawning targets. Although the Tournaig Trap and the Shieldaig Sea Trout Project may provide information in the long term, insufficient data has been generated to date.

Although the relatively high densities of juvenile trout suggest that the Ewe trout stock is in a moderately healthy state, many are likely to have been produced by brown trout and from stock enhancement. When stocks are healthy, most eggs in the accessible area of a river will be produced by sea trout (see Part 5). Given the collapse in the numbers and size of mature sea trout, and therefore egg deposition, it should therefore be assumed that the Ewe trout population is below its carrying capacity.

8.6 Conservation measures

8.6.1 Reducing exploitation

Since most sea trout are female, it is imperative that exploitation is minimised to boost numbers of trout eggs laid. To achieve this, the current policy of catch and release for all sea trout should be maintained by all estates. As for salmon, netting rights in Loch Ewe should not be activated until further notice.

In addition, catch and release should be enforced for all brown trout within the accessible area of the system. Although the majority are males, egg production by females may now equal that of sea trout (see Part 5). Should the numbers of brown trout continue to increase in response to the collapse of sea trout, female brown trout may drive the revival of the population.

All brown trout should be released by rod fishermen
(M Melville)

8.6.2 Stock enhancement

Most enhancement carried out since the 1970s has involved stocking with either non-native fish or juveniles taken from captive broodstock (see Part 5). These introductions will have boosted the juvenile trout population, particularly in the 1990s when sea trout stocks had collapsed, and following redd washout in wet winters. Although sea trout progeny, many fish may have remained in freshwater as brown trout. This is not a disadvantage, however, since the ability to migrate to sea probably remains imprinted within the population as a whole, and the tendency to emigrate may recur when marine conditions improve.

Stocking of Loch Garbhaig by the Gairloch Angling Club and Loch Dubh a Phluic by the Kinlochewe Angling Club should be monitored more closely. Movement of fish into the catchment represents a considerable risk, since it provides a route for the introduction of disease and parasites that could threaten the health of all fish stocks in the catchment. Closer coordination is required between the angling clubs and the Ewe DSFB to avoid such a mishap occurring in any stock enhancement exercises.

8.7 Conclusions

- **Juvenile trout densities are higher than the average for Wester Ross rivers. However, the surveys may not reflect the status of sea trout stocks owing to enhancement exercises in the late 1990s and the increasing contribution of eggs from female brown trout. Also, most trout production probably takes place in loch habitat, which was not surveyed.**

- **Distribution of trout fry in 1999 was patchy, with highest concentrations found in smaller tributary burns of Lochs Maree, Coulin and Bharranch. There is evidence that larger tributaries such as the Rivers Grudie and Talladale have been colonised by salmon following the collapse of sea trout stocks during the 1990s.**

- **Given the sea trout collapse, and the absence of juvenile trout from some smaller tributaries such as the Slattadale Burn and Kernsary system, it is assumed that the trout population is below its carrying capacity. Conservation measures are therefore required, including catch and release for all sea trout and brown trout, and the continued closure of netting stations in Loch Ewe.**

- **Stock enhancement is also justified, not least to compensate for winter mortality caused by redd washout. Juvenile trout should be largely introduced into lochs within the accessible area to avoid competitive displacement of salmon. Although many stocked juveniles may remain in freshwater as brown trout, they are still likely to enhance the sea trout population in the long term. Stocking of hill lochs by angling clubs needs to be coordinated to avoid the introduction of disease and parasites.** ❑

Part 9
Other Fish Species

9.1 Introduction

Five other fish species are known to exist in the Ewe catchment: European eels, Arctic charr, Eurasian minnows, three-spined sticklebacks and American brook charr. Although not of the same economic importance as salmon and trout, all of these species form a significant part of the freshwater ecosystem and should not be ignored. Any measures taken to conserve the freshwater habitat of salmon and trout will also benefit these species.

9.2 European eels

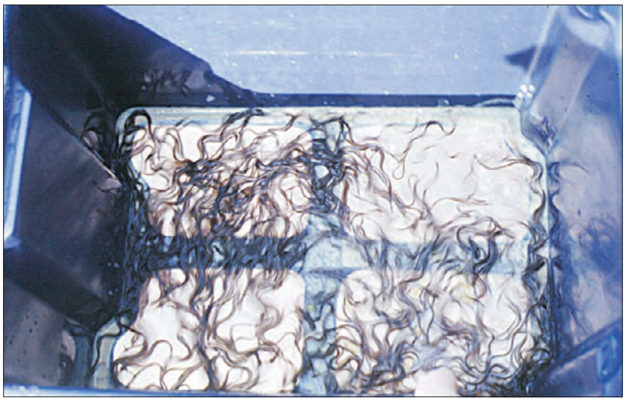
9.2.1 Life cycle

Eels are probably the third most numerous fish in the Ewe catchment after salmon and trout. Their life cycle begins in the Sargasso Sea, in the Western Atlantic, where adult eels spawn at great depth. Hatched eel larvae ('leptocephali') are carried on eastward currents for 4,000 km back to the European shelf, a journey that takes three years. By the time they reach coastal waters and run into rivers, they measure 60 mm in length and are known as 'elvers'. Once in a river, males remain in the lower catchment while females migrate to the headwaters.

Eels take up to 12 years to mature in freshwater, and during this phase are known as 'yellow' eels. When less than 300 mm in length they are primarily insectivorous, but when they are larger their diet switches to small fish. Once mature, the adult eels turn silver and stop feeding, returning to sea in August–October. These 'silver eels' then complete the life cycle by migrating to the Sargasso Sea, where they breed and die.

9.2.2 Eel fisheries

Eel fisheries have occurred in the Ewe catchment during the 1990s. These have focused on exploiting the spring elver run in the River Ewe using traps and dip nets, and fishing for silver eels in Loch Maree with fyke nets. Neither has proved particularly successful owing to the unpredictability of elver runs, and the small size of silver eels caught, rendering them of little commercial value.



Elver runs have been unpredictable in the Ewe (top), and silver eels are of little commercial value (bottom) *(J Butler)*

9.2.3 Distribution and status of eels

The wide coverage of the 1999 electro-fishing survey gave an opportunity to assess the distribution of eels within the area of the catchment accessible to salmon and sea trout (see Appendix I). Eels were relatively scarce, occurring at only 29% of sites, and where they did occur they were never numerous (Figure 9.1). It was notable that they occurred more frequently at sites nearer to the sea. From the head of Loch Maree downstream, eels occurred at 52% of sites; from the Kinlochewe River upstream they were found at only 9% of sites.

Eels caught ranged in size from elvers 80 mm long to yellow eels of 480 mm (Figure 9.2). Three silver eels were captured of 320–440 mm in length, suggesting that most yellow eels mature at this size and then migrate to sea. It should be noted, however, that these results reflect the

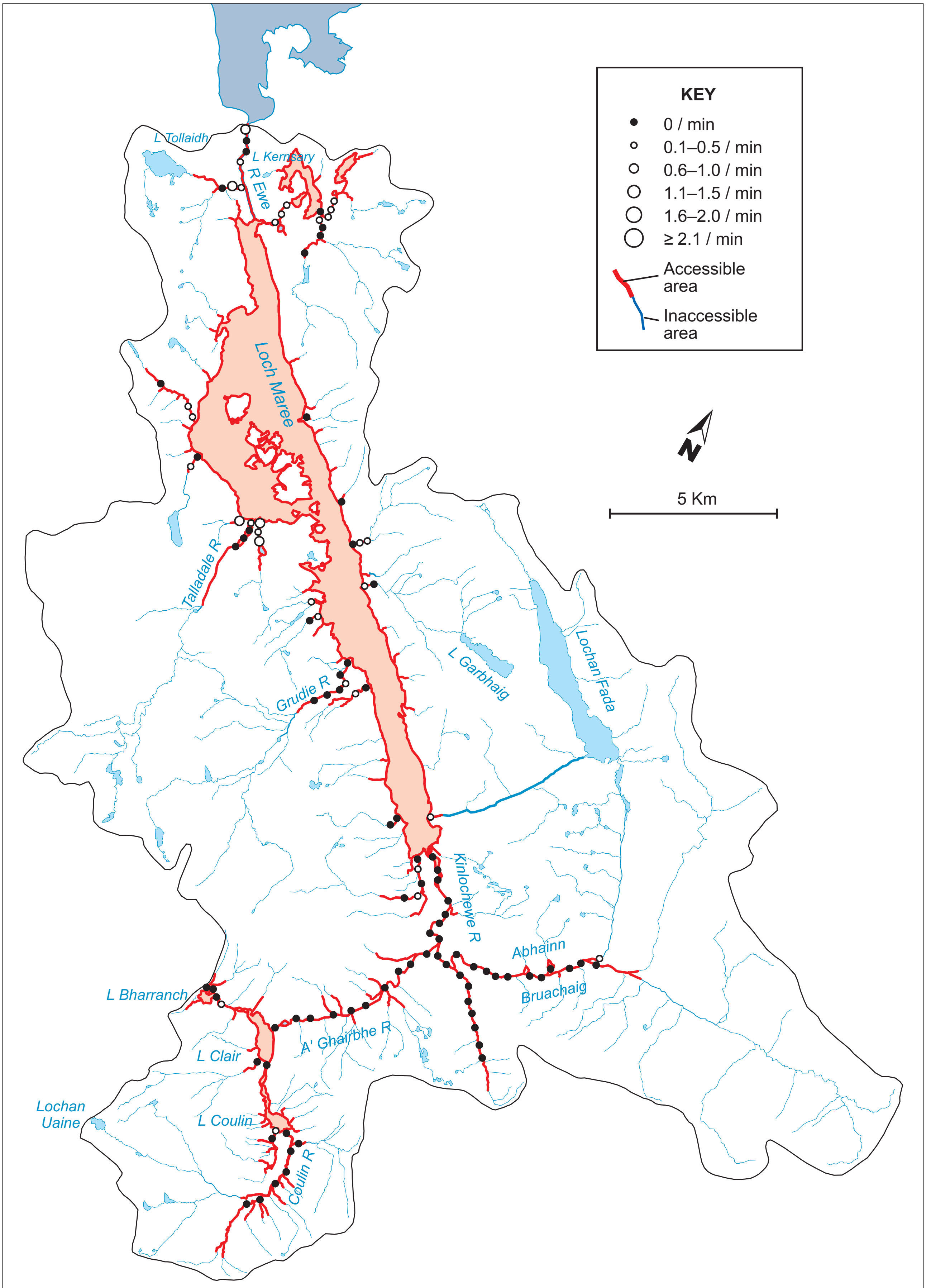


Figure 9.1 Distribution and abundance of eels in the accessible area of the Ewe catchment in 1999, estimated from 111 quantitative and semi-quantitative electro-fishing sites *(Crown Copyright)*

eel population only in riverine areas and not those in lochs. Glasgow University's survey of Arctic charr in Lochs Maree, Clair and Coulin in September–October 1997 experienced severe eel damage to nets at depths of up to 90 m.[32] Larger specimens existing in the catchment are most likely to live in the seclusion of these lochs.

The size distribution of eels (Figure 9.2) indicated that most were at least 2 years old, with the 1 year old age class slightly weaker, and the elver year class weakest of all. Such an age distribution is indicative of a declining population, with fewer elvers entering the river in 1999 than in 1998 or 1997. The poor distribution of eels in the upper catchment is also symptomatic of a depleted stock (see Figure 9.1). This pattern is consistent with declining elver runs across Europe in the 1990s, where many eel fisheries are being closed as a consequence. This policy should also be adopted in the Ewe catchment. A further advantage of conserving eels would be to provide some alternative prey for otters, reducing their impact upon adult salmon (see Part 6).

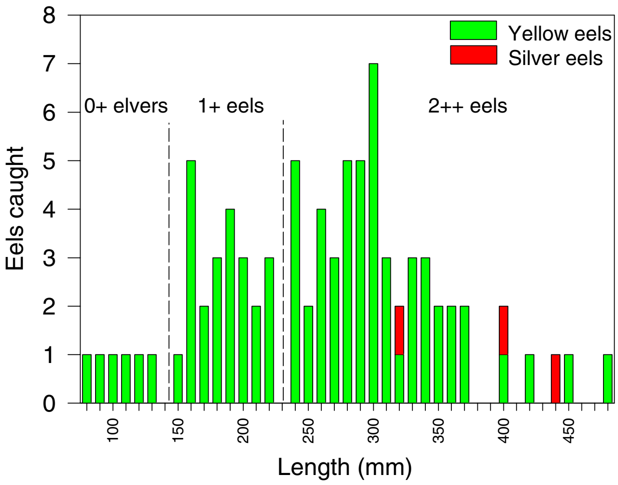


Figure 9.2 Size and age distribution of 80 eels caught at 111 quantitative and semi-quantitative electro-fishing sites within the accessible area of the Ewe catchment in 1999

The largest eels are likely to live in the seclusion of lochs *(J Butler)*

Eels should be conserved to provide alternative prey for otters *(J Watt)*

9.3 Arctic charr

9.3.1 Distribution

Arctic charr do not support a rod fishery, although they are occasionally caught by anglers fishing for trout. Consequently little is known about their distribution within the Ewe catchment, but it has been possible to map their presence based on scientific studies, rod catches and anecdotes (Figure 9.3). A black-throated diver survey carried out by the RSPB confirmed anglers' reports that charr occur in Loch Tollaidh.[7] The survey by Glasgow University in 1997 confirmed their occurrence in Lochs Maree, Clair, Coulin and Lochan Uaine.[32] While operating a fyke net in the Loch Bharranch–Clair Burn, FRS captured mature charr migrating upstream to spawn,[1] and therefore they are assumed to occur in Loch Bharranch. Estate records show that they also occur in Lochs Kernsary, Garbhaig (Letterewe) and Lochan Fada. While it is possible that populations also exist in some of the smaller hill lochs, there are no records to confirm this.

9.3.2 Charr genetics

Because charr exist largely in lochs, populations have become separated geographically over long periods of time, and therefore may have evolved into genetically-distinct stocks. The primary aim of the Glasgow University study was to establish whether this was the case throughout the British Isles. Body measurements taken from charr caught in Lochs Maree, Clair, Coulin and Lochan Uaine have been analysed, and preliminary results show that the four populations have distinctive head shapes. This suggests that these stocks do differ in evolutionary terms. Furthermore, genetic screening of tissue samples taken from Loch Maree charr show that there are two distinct populations existing in that loch alone.[32] The isolated situations of Lochs Tollaidh, Kernsary, Garbhaig and Fada would suggest that there may be at least a further four genetically-distinct charr populations in the catchment.

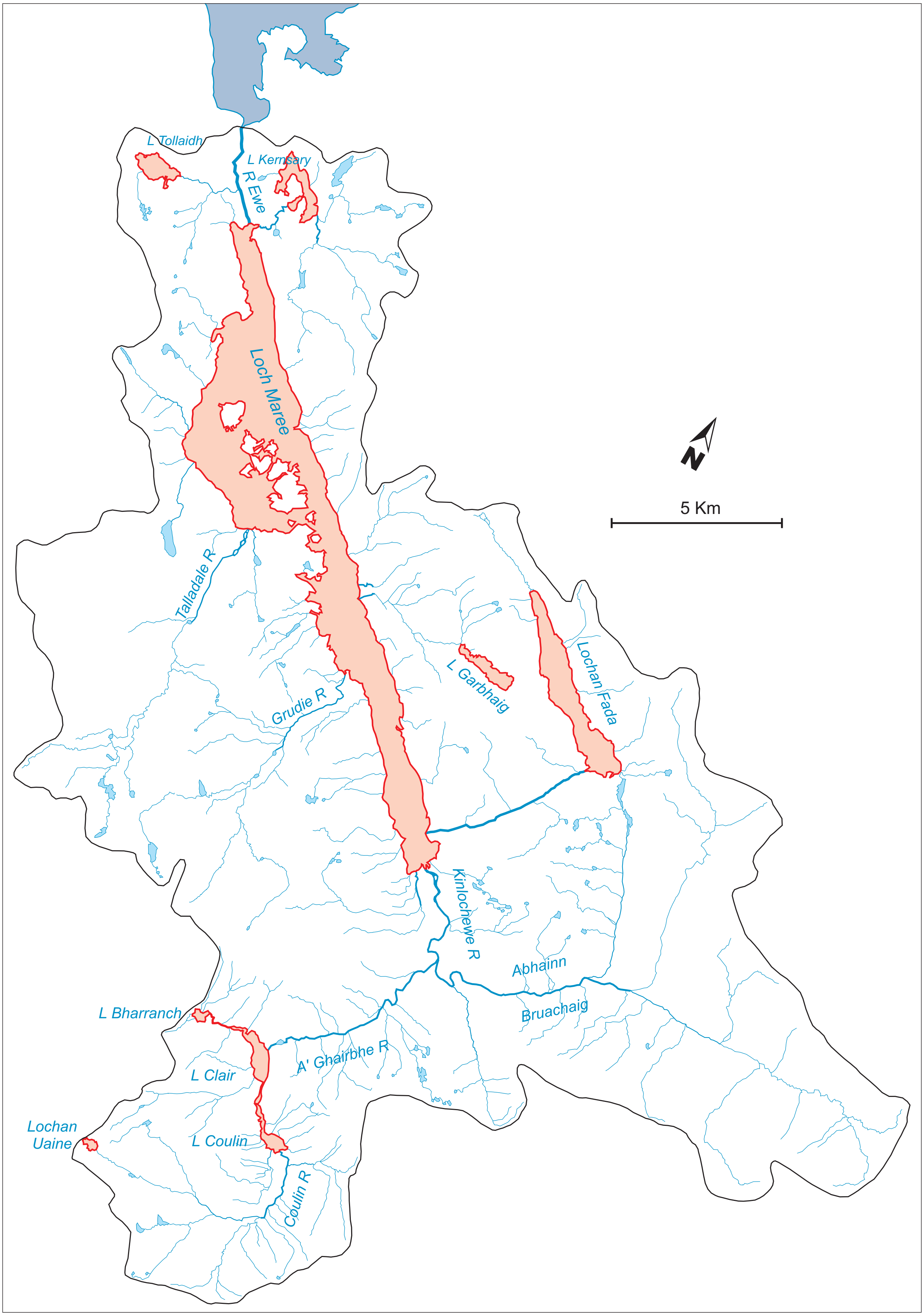


Figure 9.3 Known distribution of Arctic charr within the Ewe catchment *(Crown Copyright)*

Female (above) and male (below) Arctic charr from Loch Maree *(G Alexander)*

While most charr in the British Isles spawn on shingle banks within lakes during either the autumn or spring, a few populations are known to spawn in running water in autumn. There are two regular instances of such behaviour in the Ewe system, both within the Clair–Coulin sub-catchment. The first definite spawning location is the narrows flowing between Lochs Coulin and Loch Clair, in the vicinity of the collapsed wooden foot bridge.[1] The second probable site is the Loch Bharranch–Clair Burn. Spawning fish have often been trapped here by FRS while netting for sea trout broodstock in October–December.[1] Also, on 22 October 1999 an adult male charr was caught in the burn during a WRFT electro-fishing survey. The fish measured 205 mm and from scale readings was estimated to be 5 years old. However, no juvenile charr were found at this site in the summers of 1997, 1999 or 2001, suggesting that the fry emigrate out of running water soon after hatching in the spring. A similar scenario is evident in the other known instance of stream-spawning charr in Wester Ross, in Allt Doire an Fhuarain within the River Gruinard catchment.[9]

9.3.3 Effects of freshwater aquaculture

The establishment of freshwater cages in lochs containing Arctic charr can result in increased growth rates and abundance of the species. In the River Balgy system, for example, larger than average charr appeared in Loch Damph after the start of salmon smolt farming.[12] This was probably caused by improved feeding opportunities as a result of waste food under the cages, and boosts in plankton production induced by increased nutrient levels. It is not known what knock-on impacts such improved growth rates have on populations of ferox trout, which prey upon charr (see Part 5).

Similar effects were recorded in Loch Clair following the introduction of smolt cages in 1986. In 1990 a 3¼ lb charr was caught in Loch Clair on rod and line, and several others of 1 lb or more were recorded. Since the removal of the cages in 1992, such large fish have not been seen, and the Glasgow University survey in 1997 found the more usual small fish.[32]

Male Arctic charr (top) caught in the Loch Bharranch–Clair Burn (bottom) *(J Butler)*

In Loch Tollaidh, however, there is no evidence of any major modification of the charr population since the inception of the Wester Ross Salmon Ltd smolt cages in 1986. Charr caught by the RSPB's 1993 survey of black-throated diver lochs were not unusually large (195 mm),[7] and the Gairloch Angling Club have not recorded any exceptional fish. This conclusion is supported by the analysis of trout growth rates in Loch Tollaidh, which were not noticeably faster than Loch Maree trout (see Part 5). Although the average total phosphorus levels recorded in Loch Tollaidh by SEPA have marginally exceeded their threshold (see Part 3), it appears that nutrient enrichment is not sufficiently acute to disrupt the ecology of the charr and trout populations.

9.4 Eurasian minnows

Minnows are native to Scotland, but were probably introduced to the Ewe catchment when released by trout fishermen using them as bait. It is not known when this occurred. Minnows were found in Loch Tollaidh in 1993 by the RSPB survey,[7] although they were not recorded by the FRS electro-fishing survey elsewhere in the catchment in 1992.[8] WRFT studies in 1997–2001 gave a wider coverage of the catchment, yielding more detailed information on minnow distribution. Minnows were found spawning at the outflow of Loch Tollaidh in May–June 2000 when escapee salmon smolts were being recaptured. They were also found during WRFT electro-fishing surveys in three watercourses flowing into Loch Maree (Table 9.1). Their presence in the Inveran River also indicates that they may occur in Loch Kernsary, although none was found in the Kernsary River itself. None was found upstream of the Kinlochewe River, suggesting that they do not occur in Lochs Clair, Bharranch or Coulin.

Table 9.1 Watercourses where minnows and three-spined sticklebacks were found during WRFT electro-fishing surveys in 1997, 1999 and 2001 (see Appendix I for data)

Minnows	Sticklebacks
Inveran River	River Ewe
Garbhaig River	Inveran River
Kinlochewe River	Allt Loch Ghiuragarstidh
	Allt a Choire Sliabh
	Loch na Fideil Burn
	Allt Ghiubhais Beag

The minnows captured in riverine habitat ranged in size from 40–79 mm, with an average size of 60 mm (Figure 9.4). These results are similar to those found by the RSPB in Loch Tollaidh, where the range was 50–95 mm.[7] It is known that black-throated divers favour fish of this size, and therefore minnows, and probably also trout fry and parr, salmon fry and parr, and sticklebacks are the mainstay of their diet in Lochs Tollaidh, Kernsary and Maree.

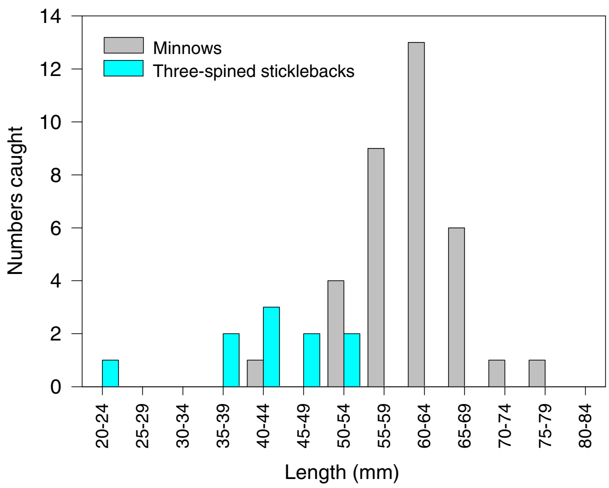


Figure 9.4 Numbers and size distribution of minnows (35 fish) and three-spined sticklebacks (10 fish) caught at electro-fishing sites in the Ewe catchment, 1999 and 2001

9.5 Three-spined sticklebacks

This species can live in both salt and fresh water, and is common along the Scottish West coast. Their distribution within the Ewe catchment was more widespread than for minnows (Table 9.1), with sticklebacks occurring in six watercourses. Four of these are tributaries of Loch Maree, while one is a tributary of Loch Kernsary, indicating that sticklebacks occur in both of these lochs. As for minnows, none was found in the Loch Clair–Coulin sub-catchment. Despite their wider distribution, sticklebacks were not as abundant as minnows. They were also smaller, ranging between 20 mm and 54 mm (Figure 9.4).

9.6 American brook charr

The American brook charr is closely related to the Arctic charr, and was first introduced to the British Isles from eastern Northern America in 1868. The species is firmly established at only a few sites in Britain, and one of these is Lochan Uaine, a hill loch draining into the Coulin River (see Figure 9.3). Fish were apparently introduced here in the 1890s. It is suspected that brook charr are out-competed by brown trout, and consequently most self-sustaining populations occur where trout are absent. This is certainly the case in Lochan Uaine, where they share the loch with Arctic charr.[1]

The brook charr spawn successfully in the outflow from Lochan Uaine, but never reach sizes larger than 8 oz. Some charr descend the burn and were found by the 1992 FRS electro-fishing survey in the area inaccessible to sea trout and brown trout.[8] However, they have not successfully colonised the Coulin River below this point, probably owing to the presence of brown trout.[1] Glasgow University's charr survey took samples of brook charr from Lochan Uaine for genetic analysis, but results are not yet available.[32] Potentially the population is of great interest because it is a relict wild North American strain, and no further introductions have been made to the loch since the 1890s.[1] Although an alien species to the Ewe catchment, the inability of brook charr to successfully compete with trout ensures that it is unlikely ever to become established elsewhere in the system, and therefore does not represent a threat to the native fish community.

American brook charr from Lochan Uaine, Coulin *(C Kirkpatrick)*

9.7 Conclusions

- **The limited distribution of eels, and the weak year class of elvers in 1999 indicate that the eel population is depleted. This parallels assessments of eel stocks throughout Europe. Therefore fisheries for elvers and silver eels should be closed until further notice. Conservation of eels may also provide alternative prey for otters, reducing predation pressure on adult salmon.**

- **There are at least four distinct populations of Arctic charr in the Ewe system, including two rare forms of stream-spawning fish in the Loch Clair–Coulin sub-catchment. Final results of Glasgow University's genetic survey carried out in 1997 will improve knowledge of the conservation importance of these populations. There is evidence of freshwater aquaculture modifying charr growth rates in Loch Clair in 1986–1992, but less so in Loch Tollaidh. The knock-on impact of such ecological disruption is not known, particularly for ferox trout. Nonetheless there should be a presumption against large-scale cage production of fish in those lochs containing charr.**

- **Minnows occur in Lochs Tollaidh and Maree, and perhaps Loch Kernsary. Three-spined sticklebacks occur in Lochs Maree and Kernsary. Size distributions of fish sampled suggest that they offer ideal prey for black-throated divers in these lochs. Conservation of the freshwater environment for salmon and trout will benefit these species, and in turn black-throated divers.**

- **The isolated population of introduced American brook charr in Lochan Uaine and its outflowing burn do not present a threat to the native fish communities of the Ewe system, since they are outcompeted by brown trout.** ❑

Part 10
The Fishery Management Plan, 2002–2006

Introduction

So far this report has described the Ewe catchment and its accessible area, and assessed the stocks of salmon and sea trout and the factors limiting their abundance. The following section puts forward recommendations to rectify those problems that are within the control of the river owners. If successful the measures taken will improve the economic value of the fisheries, while also contributing towards SNH's obligations to conserve the Atlantic salmon and the other species and habitats listed in the EU Habitats and Birds Directive which occur in the riverine area of the catchment. Together these proposals form the River Ewe Fishery Management Plan, designed to be carried out over the next five years. The WRFT will assist in the implementation of the plan, monitor its

Table 10.1 Summary of the 11 recommendations forming the River Ewe Fishery Management Plan, 2002–2006, in descending order of priority and including estimated costs

Recommendation		Action	Cost
1	**Salmon restoration programme**		
	• Catch and release programme	Ewe DSFB	None
	• Maintain netting closures	Inveran Estate, Mrs D Balean, Gairloch Estate, Eilean Darach Estate	None
	• Stock enhancement	Ewe DSFB, WRFT, FRS Fish Cultivation Unit	Unknown
2	**Sea trout restoration**		
	• Catch and release programme	Ewe DSFB	None
	• Maintain netting closures	Inveran Estate, Mrs D Balean, Gairloch Estate, Eilean Darach Estate	None
	• Stock enhancement	Ewe DSFB, WRFT, Coulin Estate, FRS Fish Cultivation Unit, Seafield Centre	£8,000 p.a.
3	**Improve management of salmon farms**		
	• Minimise escapes	Marine Harvest, Wester Ross Salmon	Unknown
	• Control ovigerous sea lice	Marine Harvest	Unknown
	• Minimise disease risks	Wester Ross Salmon, Ewe DSFB, Kinlochewe Angling Club, Gairloch Angling Club, WRFT	Unknown
4	**Improve fish access**		
	• Road culverts	Highland Council	£7,000
	• Estate culverts	Letterewe Estate, Coulin Estate	£2,000
	• Ghiuragarstidh salmon ladder	Letterewe Estate, National Trust for Scotland	£1,500
	• Debris obstacles	Ewe DSFB	Unknown
5	**Restore degraded habitat**		
	• Fencing	Letterewe, Kinlochewe, Coulin Estates, SNH	£192,000
	• Conifer removal	Forestry Commission, Coulin Estate	Unknown
	• Restore Allt na Doire-Daraich	Kinlochewe Estate	£1,000
6	**Assess and control predation**	Ewe DSFB, SNH, WRFT, RSPB	Unknown
7	**Re-evaluate Shieldaig/Slattadale hydro scheme**	Highland Light & Power, Ewe DSFB	Unknown
8	**Avoid the introduction of pike and mink**	Ewe DSFB, SNH, WRFT	Unknown
9	**Close eel fisheries**	Ewe DSFB	None
10	**Extend Inshore Fishing Order to Loch Ewe**	Ewe DSFB, Scottish Ministers	None
11	**No river works in October–June**	All estates	None

progress by continuing to survey fish stocks, and then evaluate its progress in 2006. The 11 recommendations are summarised in Table 10.1 in descending order of priority.

Recommendation 1

Salmon restoration programme

1.1 Catch and release

Since 1996 the salmon stock has attained only 60–78% of the MBAL spawning target. As a consequence, carrying capacity is probably not being reached, and smolt runs have fallen below their optimum. In this situation, every extra adult fish allowed to spawn will produce additional fry, parr and therefore smolts. To achieve this, exploitation of adults must be reduced.

The freshwater rod fishery represents the only existing exploitation of stocks within the Ewe catchment and Loch Ewe. To date the highest proportion of fish released by anglers is 29%, in 2001. This rate should be radically improved via the introduction of a catch and release policy by all estates. Currently only Coulin Estate has such a measure in place. This policy should not extend to escaped farm salmon, which should always be killed.

A catch and release policy is particularly important for Inveran Estate on the River Ewe, since the 2001 Radio-tracking Project demonstrated that fish are caught en route to neighbouring river systems, most of which also have depleted salmon stocks.

1.2 Net fisheries

Although inactive since the 1970s, netting rights owned by Inveran Estate and Mrs Dorothy Balean should remain closed until further notice. Netting stations at Redpoint (Gairloch Estate) and Laide (Eilean Darach Estate) have also recently been closed. Since these were interceptory fisheries, capturing salmon from many rivers including the Ewe, they should also remain closed until west coast stocks recover.

1.3 Stock enhancement

The salmon population is currently 60–78% below its carrying capacity, which is equivalent to a shortfall of 0.6–1.1 million eggs. While a catch and release policy will contribute a proportion of the shortfall, extra eggs will be required to restore the population. Indeed, if marine survival continues to decline, stock enhancement will be necessary simply to maintain a core stock in the river, albeit below carrying capacity. With this objective in mind, the following enhancement plan is proposed, with a target of approximately 400,000 eggs per annum to be planted into areas of the system where salmon production is limited (Figure 10.1). The plan combines both stocking using captive broodstock and recycling of eggs:

- **Captive Ewe broodstock**: To produce the volume of extra eggs a captive broodstock of 200–400 female salmon is required. This process is already under way, with 70 Bruachaig smolts captured in May 2000 being grown on at the FRS Fish Cultivation Unit, Aultbea. These fish were collected to provide juveniles for the seeding of the upper Bruachaig, with the first eggs to be stripped in autumn 2002, and stocked in 2003. Similar exercises should be undertaken to provide captive broodstock from the other parts of the catchment to be enhanced (see Figure 10.1).

- **Annual recycling of eggs**: Given the ongoing problems of redd washout in Abhainn Bruachaig, Docherty Burn, Allt na Doire-Daraich and the Rivers Coulin, Grudie and Talladale, plus acidification in Allt na Doire-Daraich and the Grudie and Talladale, recycling could reduce levels of mortality in wetter winters. Wild adult salmon captured on rod and line should be retained alive and stripped. Alternatively, nets could be used to capture fish near their spawning locations in the autumn. For example, fyke nets set by the FRS Freshwater Laboratory in the Loch Bharranch–Clair Burn have caught salmon in the past.[1] The new Coulin Estate hatchery would provide facilities for the hatching of such eggs.

Fyke nets have been used by FRS to capture broodstock in the Loch Bharranch–Clair Burn *(A Walker)*

- **Costs**: The major cost will be the annual collection of broodstock, either as smolts or as adults, and the planting of juveniles. Currently the Fish Cultivation Unit does not charge for the growing on of smolts. Coulin Estate may charge a fee to the Ewe DSFB for the hatching of recycled eggs.

- **Stocks to be used**: Wild Ewe salmon should be used at all times. Prior to the stripping of any adults captured for recycling, scale samples should be taken and checked to determine whether the fish is a farmed escapee or not, since in outward appearance some may appear wild. Any enhancement programme should take into account the stock discrimination demonstrated by the radio-tracking. Thus for the watercourses from Loch Maree downstream, late summer stock should be used.

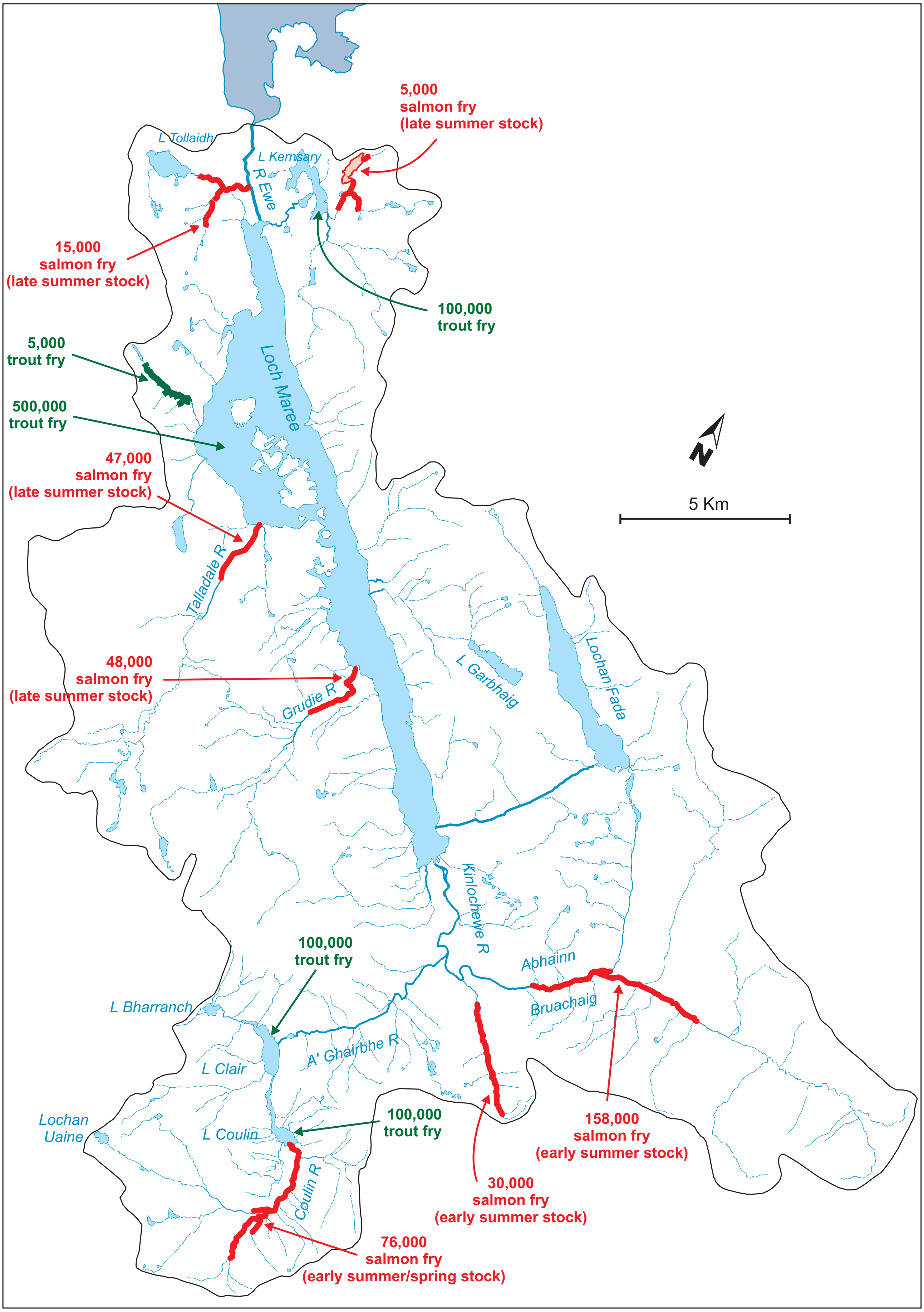


Figure 10.1 Areas within the Ewe catchment where enhancement of juvenile salmon and trout should be targeted. Also indicated are the sub-stocks of Ewe salmon from which broodstock should be obtained *(Crown Copyright)*

For the Bruachaig and Docherty Burn early summer stock would be appropriate, and for the Coulin River early summer and spring stock is most apt (Figure 10.1).

- **Areas and quantities for restocking**: The areas to be targeted for enhancement are those where salmon production is limited. In the case of the upper Bruachaig, Tollie Burn and Loch Ghiuragarstidh, stocking is intended to seed potentially productive habitat above occasionally passable falls. For the Bruachaig, seeding should be combined with the resolution of the access problem over the Lower Falls. For Loch Ghiuragarstidh, enhancement should be linked to the restoration of the Allt Loch Ghiuragarstidh salmon ladder.

Areas to be enhanced in the Grudie River (top), Docherty Burn (middle) and Allt Doire Beithe (bottom) have abundant salmon parr habitat *(J Butler)*

The quantity of juveniles to be stocked is based on results of long-term stocking by the neighbouring Conon DSFB, which shows that best results are achieved with unfed or fed fry planted out in the spring at an average density of 2/m^2. The numbers shown in Figure 10.1 are derived from this density and the estimated areas of the watercourses identified by the 1998–2000 habitat survey. Parr habitat in all of these areas is abundant, and therefore subsequent production of smolts is likely to be near optimal. Eggs should not be planted out in these areas as an alternative to fry, since they are prone to redd washout and acidification.

- **Monitoring**: The WRFT will continue to monitor juvenile stocks and evaluate the success of the programme. Catch records will provide the best indication of improved adult returns in future years, and therefore record keeping by all estates should be maintained, following the standard format (see Appendix X). Catch effort recording should be continued by Inveran Estate for the River Ewe, and all estates should collect scales from rod-caught salmon where possible. The WRFT will continue operating the Tournaig Trap to assess the marine survival of salmon smolts leaving Loch Ewe.

Recommendation 2

Sea trout restoration programme

2.1 Catch and release

With the collapse of sea trout stocks since 1987, trout egg deposition in the accessible area of the river system has probably fallen by at least 50%. This has been exacerbated by decreased marine growth rates of sea trout, and a decline in the numbers of multi-spawning, mature fish. Although egg deposition by female brown trout has increased, the trout stock is still likely to be below carrying capacity. Therefore every extra adult trout allowed to spawn will produce additional fry, parr and potentially sea trout smolts. To achieve this, exploitation of adults must be reduced.

As for salmon, the freshwater rod fishery represents the only existing exploitation of stocks within the Ewe catchment and Loch Ewe. Although most sea trout are released by anglers, this policy should be extended to cover all trout. Catch and release of all brown trout within the accessible area should now also be enforced.

2.2 Net fisheries

Netting rights in Loch Ewe and at Redpoint and Laide should also remain closed until sea trout stocks have recovered throughout Wester Ross.

2.3 Stock enhancement

Although the trout population within the accessible area is probably below carrying capacity, it is difficult to judge to what extent. Therefore only broad estimations can be made of the quantities of juveniles required to augment stocks. A target of approximately 800,000 eggs per annum has been made, which can be sourced from existing captive broodstock and the recycling of eggs:

- **Captive Ewe broodstock**: The Ewe sea trout broodstock held in Loch Clair, and also at the FRS Fish Cultivation Unit and Seafield Centre, provide an opportunity to supply extra juveniles rapidly. All of these fish are of sea trout origin and therefore should retain the tendency to migrate to sea. Although many of the juveniles stocked may mature in freshwater as brown trout, the ability to smolt should remain and could be expressed in future generations.

- **Annual recycling of eggs**: Considering that trout are more prone to redd washout than salmon, any recycling should reduce levels of mortality in wetter winters. Sea trout and brown trout captured on rod and line have successfully been retained alive by the Loch Maree Hotel using keep boxes, and this system could be extended to other estates. As shown at the Loch na Fideil Burn and the Loch Bharranch–Clair Burn, fyke nets can also be used successfully during the autumn. The Freshwater Laboratory has also used electro-fishing equipment to capture spawning adults in small burns.[1] Eggs stripped from adults caught in this way could be incubated in the hatcheries at the Loch Maree Hotel or at Coulin Estate.

Keep boxes could be used to hold rod-caught trout for stripping *(J Butler)*

- **Costs**: The major cost will be the annual purchase of fry from the Seafield Centre. Assuming that 400,000 are purchased per annum, at a cost of 2p per fry, this equates to £8,000. The remaining fry could be supplied by the broodstocks held at Loch Clair and the Fish Cultivation Unit, at no cost. The recyling of eggs will incur some costs in the collection of broodstock, and the planting of juveniles. Coulin Estate may charge a fee to the Ewe DSFB for the hatching of recycled eggs.

- **Stocks to be used**: Trout from the accessible area of the Ewe should be used at all times. Although there is no information on stock discrimination within the trout population, efforts should be made to return recycled fish to the areas where their parents were captured. Foreign trout used by the Gairloch and Kinlochewe Angling Clubs to stock Lochs Garbhaig and Dubh a Phluic should be prevented from entering the accessible area of the Ewe catchment to maintain the genetic integrity of the sea trout stock. In the case of Loch Dubh a Phluic, this is achieved with the insertion of a grid at the outflow burn. Trout from Loch Garbhaig are unlikely to successfully descend into Loch Maree due to the presence of precipitous falls and a hydro pipeline.

- **Areas and quantities for restocking**: The areas recommended for enhancement are largely lochs, since this is the favoured habitat for juvenile trout (Figure 10.1). Burns and rivers should generally not be stocked; this will avoid competitive displacement of juvenile salmon, and hence maximise the output of salmon smolts from riverine habitat. The one exception is the Slattadale Burn, which traditionally has been a sea trout spawning burn, although juvenile salmon are occasionally found in the lower reaches (see Appendix I). In order to seed this area, it is recommended that trout fry are stocked above the occasionally-passable falls. With the rehabilitation of the river corridor in Slattadale Forest (see Recommendation 5), this area will soon provide excellent habitat for juvenile trout.

  Fry, or alternatively parr should be stocked into lochs. Furthermore, eggs could feasibly be planted along gravel shorelines. However, eggs should not be planted into the Slattadale Burn, since sea trout redds are likely to be prone to washout in this watercourse.

- **Monitoring**: The WRFT will continue to monitor juvenile stocks and evaluate the success of the programme. Catch records will provide the best indication of improved adult returns in future years, and therefore records kept by all estates should be maintained following the standard format, including the recording of brown trout (see Appendix X). Catch effort recording should be continued by Inveran Estate for the River Ewe, and by the Loch Maree Hotel. All estates and angling clubs should continue to collect scales from rod-caught fish, particularly from ferox and hill loch

Brown trout should be recorded by all estates *(J Butler)* trout, for which very little information exists. The WRFT will continue operating the Tournaig Trap to assess the marine survival of sea trout smolts in Loch Ewe.

Recommendation 3
Improve management of salmon farms

The impact of both marine and freshwater salmon farms is probably the greatest man-made factor in the decline of wild salmon and sea trout stocks within the Ewe catchment. Escapes since 1986 have diluted the genetic integrity of the wild salmon population, and elevated sea lice infestations have reduced the marine survival of sea trout and salmon.

In June 1999 the Scottish Executive established the Tripartite Working Group (TWG), which brought together salmon farming and wild fishery interests to improve the management of both farmed and wild fish. The TWG recommended that local Area Management Agreements (AMAs) should be established between salmon farms and river owners to rectify the problems of lice control and escapes.[33] Considering the importance of the Ewe salmon stock in a west coast context, the Association of West Coast Fisheries Trusts recommended in 2001 that salmon farm sites in Loch Ewe should be relocated out of the loch.[34] In doing so, no marine farms would be sited in the contiguous coastline of Lochs Gairloch, Ewe and Gruinard Bay, forming a 'Conservation Zone' where risks of sea lice infestations and escapes would be minimised.[35]

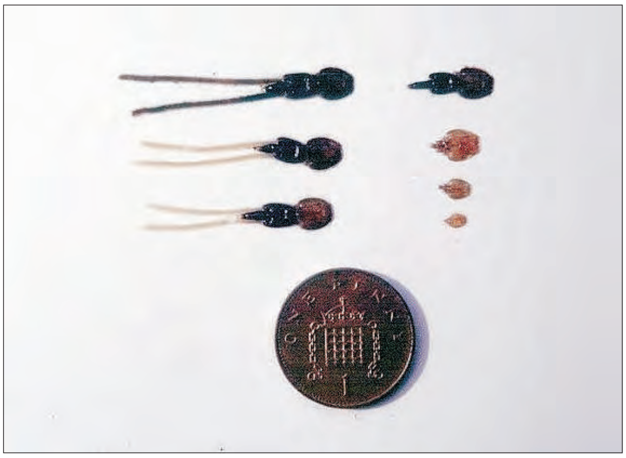
Should salmon farms remain in Loch Ewe, their management must be improved. Measures must aim to:

- **Minimise escapes**: Marine Harvest cages in Loch Ewe should be of the highest structural standard to avoid escapes from storm damage. Wester Ross Salmon smolt cages in Loch Tollaidh are most at risk from human error. Any escapes must be reported immediately to the Ewe DSFB and WRFT in order that recapture exercises can take place.
- **Improve lice control**: Ovigerous lice levels on farm salmon in Loch Ewe must be reduced to zero during March–June each year to protect runs of wild salmon and sea trout smolts leaving Loch Ewe. Ideally, this target should be attained throughout the year.

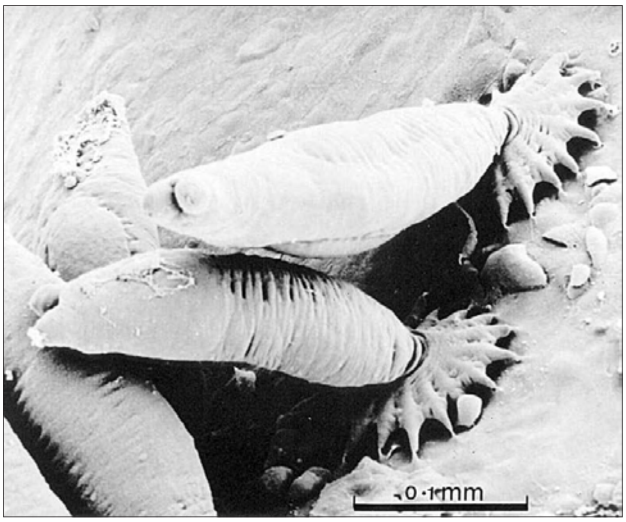
Escapes of farm salmon smolts from Loch Tollaidh must be avoided *(J Butler)*

In order to minimise the risk of introducing disease and parasites to the freshwater catchment of the Ewe, the following measures must be considered for the Wester Ross Salmon smolt cages in Loch Tollaidh, and for stock enhancement programmes undertaken by the Ewe DSFB and the Gairloch and Kinlochewe Angling Clubs:

1. Live fish can only be imported from outside the catchment if certified disease-free.
2. Eggs imported into the catchment should be disinfected and come from certified disease-free broodstock.
3. The introduction of *Gyrodactylus salaris* by anglers who have recently visited Scandinavia or continental Europe should be prevented by disinfecting, freezing or drying fishing tackle and clothing.



Ovigerous lice (left) on farm salmon must be reduced to zero in March–June *(J Butler)*



Precautions against the introduction of *Gyrodactylus salaris* should be taken by the Ewe DSFB *(T Mo)*

Recommendation 4

Improve fish access

Nine road culverts were identified that restrict adult and juvenile access to significant areas of juvenile and spawning habitat. In addition, renovation of the salmon ladder on Allt Loch Ghiuragarstidh would improve access to the Loch Ghiuragarstidh sub-catchment upstream. Temporary debris obstacles should also be located and removed. Although the locations and nature of these obstructions are given in Part 6, the following additional details are noteworthy:

- **Obstacles on A832 and A896**: Seven of the obstacles are culverts and weirs inserted during the upgrading of these roads. Under the 1986 Salmon Act it is an offence to obstruct the upstream passage of salmon, and therefore the Highland Council is legally responsible for the mitigation of these structures. Feasible modifications are described in the Scottish Executive's 2001 consultation document 'River Crossings and Migratory Fish: Design Guidance'. The costs of such works can only be estimated, and are assumed to be £1,000 per culvert.

- **Estate culverts**: The remaining two obstacles are culverts on Allt Folais (Letterewe Estate) and a tributary of Allt Doire Beithe (Coulin Estate). The responsibility for removing these should rest with each estate. In the case of Allt Folais, the Irish bridge could be rectified by removing the centre of the structure to allow fish passage. The gap would be bridged with a grill. Costs are assumed to be £1,000 for each obstruction.

The Irish bridge on Allt Folais, Letterewe Estate, could be easily rectified, as in this example *(D Macdonald)*

- **Restore Allt Loch Ghiuragarstidh salmon ladder**: The ladder requires rebuilding, and the inlet channels have fallen into disrepair. The work should be undertaken by the Ewe DSFB. However, the burn forms the boundary between Letterewe Estate and the National Trust for Scotland's property, and permission would have to be sought from the landowners. Estimated cost for renovation is £1,500.

The inlet channels of the Allt Loch Ghiuragarstidh salmon ladder (arrowed) require renovation *(J Butler)*

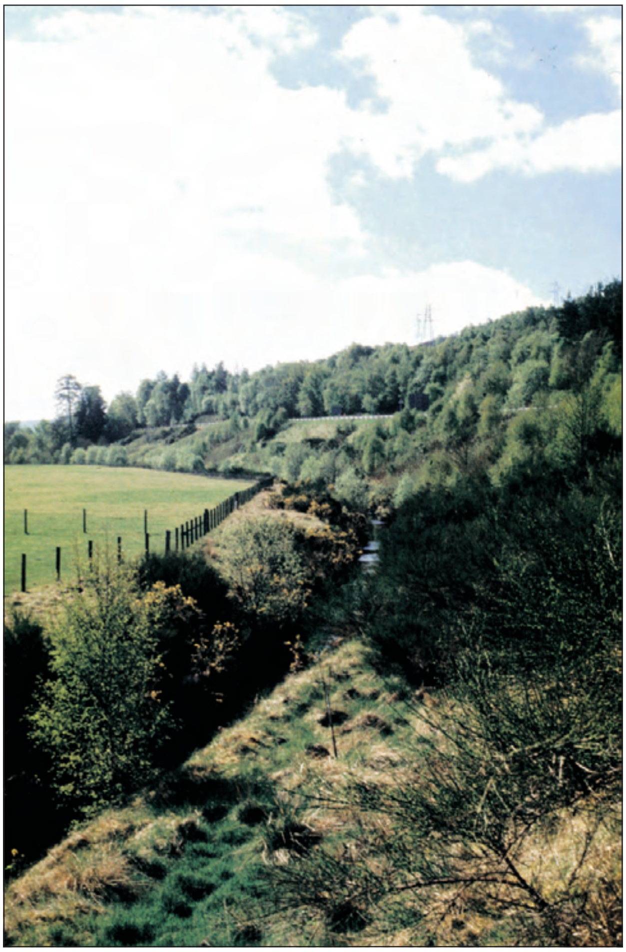
- **Debris obstacles**: In the past ghillies have walked burns to remove temporary debris obstacles, but this practice has declined in recent years. Such surveillance should be encouraged, and the removal of severe blockages undertaken by estate staff. Costs of such work would be minimal.

Recommendation 5

Restore degraded habitat

The freshwater production of juvenile salmon and trout in the Ewe system can be boosted by the proposed restoration programmes. Productivity would be further improved if the accessible area could support more juvenile fish. The 1998–2000 habitat survey identified degraded tributaries which, if restored, could produce significantly more juveniles. The following recommended restoration works combine the fencing of important tributaries to prevent livestock grazing, with the removal of conifers which have caused excessive shading, and the mitigation of canalisation. These improvements would also benefit alder woodland, one of the Habitats and Birds Directive features present within the catchment, and therefore would be supported by SNH. Funding may also be available from Woodland Grant Schemes or the Rural Stewardship Scheme.

Alder woodland is listed in the EU Habitats and Birds Directive, and could be protected within the Ewe catchment *(J Butler)*



Fencing off livestock allows riparian vegetation to regenerate *(J Butler)*

- **Kernsary River fencing**: Only 6% of the bank length within the accessible area of this tributary is covered with overhanging vegetation. The mainstem should be fenced to limit grazing by cattle, ponies and deer (Figure 10.2). The area to be fenced lies within Letterewe Estate.
  Length of fencing: 4 km. Cost @ £8/m: £32,000

The Kernsary River should be fenced off *(J Butler)*

- **Allt na Doire-Daraich fencing**: The lower reaches of this burn flow through rough pasture, and only 8% of the bank length has overhanging vegetation. The degradation has been exacerbated by repeated excavation and canalisation. It is recommended that the straightened section from the Woodland Grant Scheme at Anancaun to Loch Maree should be fenced (Figure 10.2). The burn lies within Kinlochewe Estate.
  Length of fencing: 2 km. Cost @ £8/m: £16,000

- **Abhainn Bruachaig fencing**: Sheep are grazed along the banks of the upper Bruachaig, and consequently riparian vegetation is limited, covering 10% of the bank length. This should be fenced as far as Abhainn Gleann Tanagaidh, including the lower reaches of Abhainn Gleann na Muice (Figure 10.2). The section in question lies within Kinlochewe Estate.
  Length of fencing: 8 km. Cost @ £8/m: £64,000

- **Docherty Burn fencing**: This tributary is heavily grazed by sheep from the A832 bridge upstream. As a result only 10% of the bank length has overhanging vegetation, and should be fenced off (Figure 10.2). The burn lies within Kinlochewe Estate.
  Length of fencing: 6 km. Cost @ £8/m: £48,000

- **Allt na Feithe Buidhe fencing**: The area from Loch Coulin upstream to the conifer plantation, and from the plantation upstream has little bankside vegetation and should be fenced (Figure 10.2). The burn lies within Coulin Estate.
  Length of fencing: 3 km. Cost @ £8/m: £24,000

Allt na Feithe Buidhe has little bankside vegetation *(J Butler)*

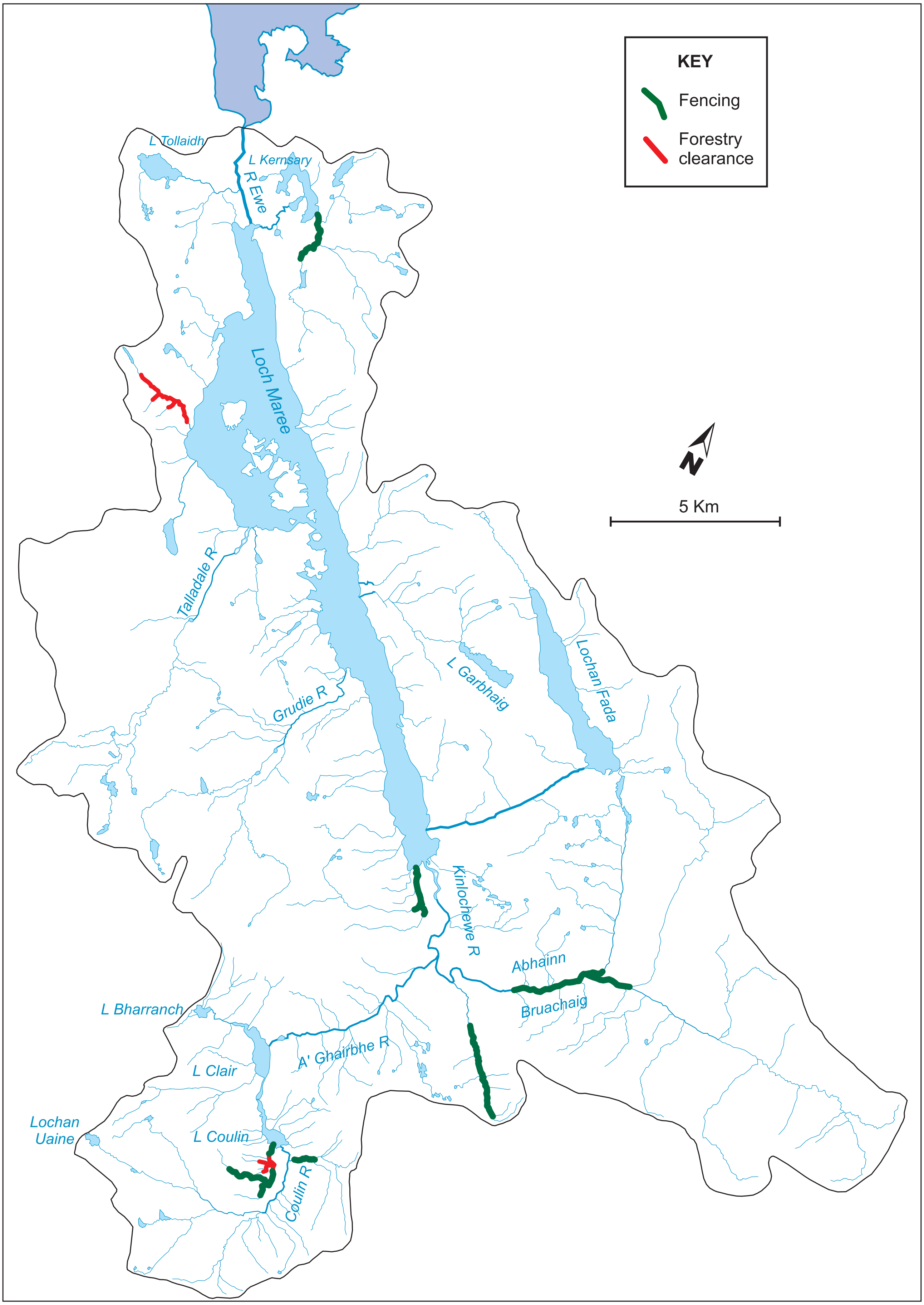


Figure 10.2 Areas of the Ewe catchment where livestock should be fenced off to allow regeneration of riparian vegetation and where conifer plantations should be cleared *(Crown Copyright)*

- **Allt Cul Leathard fencing**: Much of the Coulin River system is lacking bankside vegetation, but owing to the river's torrential nature any fencing would be difficult to maintain. However, Allt Cul Leathard could be fenced from the confluence with the Coulin River upstream to the impassable falls (Figure 10.2). The burn lies within Coulin Estate.
  Length of fencing: 1 km. Cost @ £8/m: £8,000

- **Slattadale Burn Restoration:** This important spawning burn is heavily overshadowed by exotic conifers in places (Figure 10.2). The removal of these trees has been highlighted in the Forestry Commission's Forest Design Plan 2001–2031. WRFT is also submitting a bid to the Heritage Lottery Fund for funding to enhance biodiversity within an extended riparian corridor, with the planting of native broadleaves. The proposal, developed in collaboration with SNH, Forest Enterprise, Ewe DSFB and Highland Council, includes plans to develop a network of footpaths and information boards about the important wildlife (including fish) that would benefit.

- **Forestry clearance, Allt Feithe Buidhe**: As for Slattadale Forest, the forestry plantation on Allt Feithe Buidhe was planted too close to the banks, causing excessive shading. Coulin Estate began clearing this area in 2001 (Figure 10.2).

The removal of conifers along the Slattadale Burn is under way *(J Butler)*

Parr habitat in Allt na Doire-Daraich (top) should be created by inserting boulders and deflectors, as in the Sawmill Burn, River Broom (bottom) *(J Butler)*

- **Improve instream habitat in Allt na Doire-Daraich**: As a result of repeated excavation and canalisation, Allt na Doire-Daraich holds much spawning gravel, but very little habitat suitable for parr. This can be rectified by inserting boulder deflectors and low weirs to create areas of pools and riffles. This has been achieved in a similar situation on the Sawmill Burn, River Broom, and could be replicated for Allt na Doire-Daraich. Combined with fencing, such work would restore both instream and bankside habitat in this important tributary of Loch Maree. To ensure the success of the restoration works, no further excavation should be undertaken in the burn. Allt na Doire-Daraich lies within Kinlochewe Estate.
  Cost: £1,000

Recommendation 6
Assess and control predation by fish-eating birds and seals

While stocks of salmon and trout are depleted within the accessible area of the catchment, predation by mergansers, goosanders and cormorants may be depressing any recovery. Although infrequent, incursions by grey and common seals into Loch Maree could be having a similar impact. Currently there is little information on which to base any control measures for these predators, and this should be rectified by the Ewe DSFB, SNH, WRFT and RSPB.

Recommendation 7
Re-evaluate Shieldaig/Slattadale hydro-electricity scheme

Highland Light & Power's proposed Shieldaig/Slattadale hydro-electricity scheme will increase flows by 40% in the Garbhaig River. This should be re-evaluated to prevent further redd washout in this important spawning tributary of Loch Maree.

Recommendation 8
Avoid the introduction of pike and mink

The potential risk of pike introduction is great, since they occur in the neighbouring catchments of the Rivers Conon and Kerry. Every effort should be made by the Ewe DSFB, WRFT and SNH to avoid the accidental or intentional colonisation of this predator into the Ewe system, since the ecological implications are severe for both the depleted stocks of salmon and trout, and also for black-throated divers. Future hydro-electricity schemes which propose to transfer water from either the Kerry or Conon into the Ewe system should be prevented. Similarly, should mink become established within the Ewe catchment, control measures may have to be introduced by SNH to minimise their impact upon the freshwater ecology.

Recommendation 9
Close eel fisheries

Eel stocks within the Ewe catchment are probably depleted, and therefore cannot sustain an elver or silver eel fishery. Until there is evidence of a recovery, all eel fisheries should be closed. This policy could also provide otters with an increased source of alternative prey, relieving predation pressure on adult salmon.

Recommendation 10
Extend Inshore Fishing Order to Loch Ewe

Marine growth rates of Ewe sea trout in the 1990s have been 50% lower than those for Dundonnell and Gruinard River fish, and this may be related to the availability of juvenile sea fish. Both Little Loch Broom and Gruinard Bay are closed to mobile trawling in October–March to protect herring and sprat stocks under the Inshore Fishing Order (1989), and this may partly account for the differences in growth rates. The Ewe DSFB should apply to the Scottish Ministers to extend the winter closure to Loch Ewe with a view to assisting the recovery of Ewe sea trout stocks. A similar ban was successfully extended to Loch Torridon in 2000, instigated by local shellfish fishermen.

Recommendation 11
No river works in October–June

Owing to flooding problems, the lower reaches of the Kinlochewe and Coulin Rivers have been excavated and straightened in the past. In future no works should be carried out during the October–June period, when redds or hatching alevins are vulnerable to destruction. The same guidance should apply to the timing of any other river works, such as the construction of artificial pools. ❑

Instream excavation should not be undertaken during October–June *(J Butler)*

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Appendix I

Electro-fishing results

1 FRS and WRFT quantitative electro-fishing sites and results in 1992, 1997, 1999 and 2001

EWE1: Talladale River, NG 919703. Stretch from road bridge d/s.								
				Zippin estimate (fish/100m^2)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
24.7.92	90.9	23	3	0	1.0	4.0	4.0	FRS survey
11.9.97	74.5	25	3	0	0	4.0	0	9 eels
23.9.99	74.5	29	1^	8.1	8.5	8.1	0	8 mins fished
23.8.01	89.6	22	1^	33.5	6.3	0	0	3 eels. 11 mins fished
EWE2: Allt Ghiubhais Beag, NG 947693. Stretch from Loch Maree u/s.								
				Zippin estimate (fish/100m^2)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
24.7.92	152.3	41	3	0	2.0	3.0	7.0	FRS survey
10.9.97	140.0	39	3	0	0.7	17.8	3.6	3 eels, 2 sticklebacks
7.10.99	87.4	41	1^	0	6.3	20.7	6.3	1 eel. 9 mins fished
14.8.01	84.6	40	1^	0	0	18.5	0	1 eel. 13 1/2 mins fished
EWE3: Allt Ghiubhais Mor, NG 949689. Section from road u/s.								
				Zippin estimate (fish/100m^2)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
24.7.92	119.7	45	3	0	0	13.0	4.0	FRS survey
11.9.97	88.2	47	3	0	0	14.7	4.5	2 eels
7.10.99	59.1	40	1^	0	0	5.7	7.1	4 1/2 mins fished
14.8.01	72.7	36	1^	0	0	5	10.4	6 mins fished
EWE4: Allt Ghiubhais Mor, NG 951691. Section from road d/s.								
				Zippin estimate (fish/100m^2)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
24.7.92	154.4	99	3	0	4.0	23.0	28.0	FRS survey
10.9.97	110.9	39	3	0	4.5	32.7	11.8	4 eels
7.10.99	118.6	40	1^	3.7	7.1	27.7	8.2	1 eel. 13 1/4 mins fished
14.8.01	91.1	36	1^	0	0	22.5	12.3	2 eels. 12 1/2 mins fished
EWE5: Loch na Fideil Burn, NG 923704. Section from road u/s.								
				Zippin estimate (fish/100m^2)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
25.7.92	83.6	57	3	1.0	24.0	0	0	FRS survey
10.9.97	75.2	39	3	0	0	8.2	22.5	3 eels, 4 sticklebacks
6.10.99	94.6	49	1^	0	0	9.2	10.6	3 eels. 8 1/2 mins fished
14.8.01	78.0	46	1^	0	0	0	11.8	
EWE6: Abhainn na Furnais, NG 957704. Section from Loch Maree u/s.								
				Zippin estimate (fish/100m^2)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
25.7.92	124.6	55	3	0.0	12.0	6.0	7.0	FRS survey
22.9.97	96.3	44	3	0.0	3.1	12.5	3.1	3 eels
8.10.99	85.9	49	1^	12.8	0	7.3	6.3	1 eel. 8 1/2 mins fished
23.8.01	80.1	58	1*	4.8	0	58.9	0	8 eels. 10 mins fished
* For 1 run fishing at sites with >50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.28 (fry run 1) + 1.99			(n=20, r2=0.86, p<0.001)					
Parr density = 1.43 (parr run 1) + 2.25			(n=29, r2=0.92, p<0.001)					
^ For 1 run fishing at sites with $\leq$50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.37 (fry run 1) + 1.73			(n=30, r2=0.82, p<0.001)					
Parr density = 1.39 (parr run 1) + 4.71			(n=29, r2=0.49, p<0.001)					

1 FRS and WRFT quantitative electro-fishing sites and results in 1992, 1997, 1999 and 2001 *(continued)*

EWE7: Alltan Odhar, NG 973678. Stretch from road u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
25.7.92	56.4	43	3	0	4.0	20.0	7.0	FRS survey
11.9.97	81.8	47	3	0	0	3.8	18.6	2 eels
7.10.99	109.8	41	1^	0	6.0	8.2	22.4	2 eels. 9 1/2 mins fished
23.8.01	84.2	46	1^	0	0	13.0	19.6	2 eels. 7 1/2 mins fished
EWE8: Docherty Burn, NH 049611. Stretch under road at dump.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
26.7.92	92.8	77	3	0	14.0	11.0	7.0	FRS survey
23.9.97	84.8	65	3	7.7	17.4	4.8	1.2	1 eel
12.10.99	78.2	34	1^	13.9	13.6	7.8	6.5	6 mins fished
24.8.01	127.6	86	1*	73.5	11.2	25.2	7.9	14 mins fished
EWE9: Allt Ghiubhais, NH 065633. Section from track d/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
26.7.92	79.6	40	3	0	0	18.0	11.0	FRS survey
23.9.97	195.6	46	3	0	0	22.5	11.9	
21.10.99	108.4	30	1^	0	0	25.8	27.8	
30.8.01	142.8	34	1^	0	0	26.6	8.6	14 3/4 mins fished
EWE11: Slattadale Burn, NG 888723. Section from footpath ford u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
27.7.92	92.0	77	3	0	0	46.0	32.0	FRS survey
4.9.97	77.5	52	3	0	0	40.4	0	3 eels
23.9.99	81.1	86	1*	18.9	0	27.3	9.3	
15.8.01	97.0	87	1*	6.7	3.7	159.5	8.1	
EWE12: Inveran River, NG 880788. Section from bridge d/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
28.7.92	91.7	68	3	9.0	13.0	10.0	1.0	FRS survey
29.8.97	85.7	70	3	7.0	4.7	21.2	0	
19.9.99	83.2	60	1*	15.7	5.7	7.5	0	
25.8.01	98.0	65	1*	18.3	9.5	20.6	5.2	
EWE13: Tollie Burn, NG 862788. Section from bridge u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
28.7.92	99.8	64	3	0	0	1.0	12.0	FRS survey
29.8.97	129.0	88	3	0	0	4.7	13.2	4 eels
19.9.99	103.4	58	1*	0	0	17.4	6.4	8 mins fished
25.8.01	84.1	73	1*	64.4	51.6	4.7	14	
* For 1 run fishing at sites with >50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.28 (fry run 1) + 1.99			(n=20, r2=0.86, p<0.001)					
Parr density = 1.43 (parr run 1) + 2.25			(n=29, r2=0.92, p<0.001)					
^ For 1 run fishing at sites with <u><</u>50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.37 (fry run 1) + 1.73			(n=30, r2=0.82, p<0.001)					
Parr density = 1.39 (parr run 1) + 4.71			(n=29, r2=0.49, p<0.001)					

1 FRS and WRFT quantitative electro-fishing sites and results in 1992, 1997, 1999 and 2001 *(continued)*

EWE14: Grudie River, NG 966678. Backchannel of island u/s from road.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
27.7.92	155.4	25	3	3.0	1.0	26.0	2.0	FRS survey
11.9.97	133.4	28	3	16.4	6.8	6.2	0.8	2 eels
6.10.99	52.6	25	1^	15.3	10.0	0	0	1 eel. 6 mins fished
23.8.01	63.8	22	1^	35.2	11.3	0	0	1 eel. 14 1/4 mins fished
EWE15: Allt na Doire-Daraich, NH 015638. Stretch from bridge on track u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
27.7.92	92.0	27	3	0	1.0	23.0	3.0	FRS survey
23.9.97	99.6	25	3	1.0	7.0	32.8	4.1	3 eels
7.10.99	103.7	27	1^	4.0	6.0	15.4	0	1 eel. 7 mins fished
24.8.01	114.7	22	1^	3.8	7.1	38.9	0	1 eel. 12 1/2 mins fished
EWE16: Glas Leitir Burn, NH 002651. Section from footbridge u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
28.7.92	91.1	33	3	0	1.0	26.0	26.0	FRS survey
11.9.97	107.1	33	3	2.8	6.9	6.1	6.6	2 eels
7.10.99	85.8	31	1^	0	20.9	12.8	6.3	6 1/2 mins fished
23.8.01	117.6	26	1^	3.7	4.1	84.3	0	1 silver eel. 16 mins fished
EWE18: Allt Doire Beithe, NH 023530. Section at first bend u/s from junction.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
27.7.92	86.5	31	3	1.0	5.0	9.0	6.0	FRS survey
16.9.97	102.1	32	3	6.4	14.9	6.4	1.0	
22.10.99	86.8	36	1^	7.2	22.3	7.2	11.1	6 1/4 mins fished
24.8.01	102.0	33	1^	76.1	32.0	22.6	7.4	12 1/2 mins fished
EWE19: Allt na Feithe Buidhe, NH 017547. Section 150 m d/s from bridge.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
28.7.92	97.0	36	3	107.0	7.0	85.0	1.0	FRS survey
16.9.97	78.4	35	3	7.7	8.3	47.1	1.3	1 eel
21.10.99	151.5	44	1^	87.8	15.7	47.1	9.3	
24.8.01	96.5	52	1*	56.3	31.9	42.1	8.2	12 mins fished
EWE20: Allt Cul Leathard (Torran Cuilin), NH 024549. Section from water guage u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
7.92	?	?	3	47.0	7.0	15.0	1.0	FRS survey
16.9.97	136.6	35	3	41.0	16.6	1.5	0.7	
22.10.99	82.1	44	1^	105.6	38.6	19.0	6.4	11 mins fished
24.8.01	88.0	39	1^	42.1	17.3	40.8	0	14 1/2 mins fished
* For 1 run fishing at sites with >50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.28 (fry run 1) + 1.99			(n=20, r2=0.86, p<0.001)					
Parr density = 1.43 (parr run 1) + 2.25			(n=29, r2=0.92, p<0.001)					
^ For 1 run fishing at sites with $\leq$50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.37 (fry run 1) + 1.73			(n=30, r2=0.82, p<0.001)					
Parr density = 1.39 (parr run 1) + 4.71			(n=29, r2=0.49, p<0.001)					

1 FRS and WRFT quantitative electro-fishing sites and results in 1992, 1997, 1999 and 2001 *(continued)*

EWE21: Allt na Doire-Daraich, NH 018633. Section from concrete sill d/s to water guage.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
7.92	?	?	3	12.0	20.0	0	2.0	FRS survey
23.9.97	132.8	26	3	7.5	12.1	24.9	7.5	3 eels
7.10.99	86.1	27	1^	12.8	6.3	37.5	7.9	1 eel. 7 1/4 mins fished
24.8.01	108.6	22	1^	8.3	8.5	36.6	7.3	15 3/4 mins fished
EWE22: Docherty Burn, NH 060599. Stretch from water guage d/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
7.92	?	?	3	11.0	6.0	8.0	14.0	FRS survey
24.9.97	91.8	85	3	26.1	7.8	9.9	6.7	
13.10.99	147.3	34	1^	29.1	12.3	14.6	6.6	11 mins fished
24.8.01	144.2	86	1*	28.9	37.9	14.6	13.2	14 3/4 mins fished
EWE23: Kernsary River, NG 891784. Section 200 m d/s from bridge.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
2.9.97	114.5	150	3	145.2	25.7	39.8	0	11 eels
18.9.99	56.6	50	1*	78.6	14.9	26.2	0	3 eels. 9 mins fished
25.8.01	57.8	81	1*	116	25	29.6	0	3 eels. 9 1/2 mins fished
EWE24: Allt Loch Ghiuragarstidh, NG 892796. Section from footbridge d/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
2.9.97	87.6	81	3	31.6	64.7	15.3	2.5	5 eels
19.9.99	73.5	53	1*	26.8	11.6	14.4	0	1 eel. 9 mins fished
25.8.01	88.3	65	1*	38.1	33.0	20.0	3.9	
EWE25: Abhainn Gleann na Muice, NH 074643. Section from bridge d/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
23.9.97	111.4	66	3	0	0	0	16.6	1 eel
21.10.99	97.7	45	1^	0	0	4.1	23.2	
30.8.01	128.8	39	1^	0	0	7.3	10.1	10 mins fished
EWE26: Abhainn Chrombuill, NH 083643. Section of boulder riffle.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
23.9.97	88.7	166	3	0	0	0	3.5	
* For 1 run fishing at sites with >50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.28 (fry run 1) + 1.99			(n=20, r2=0.86, p<0.001)					
Parr density = 1.43 (parr run 1) + 2.25			(n=29, r2=0.92, p<0.001)					
^ For 1 run fishing at sites with ≤50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.37 (fry run 1) + 1.73			(n=30, r2=0.82, p<0.001)					
Parr density = 1.39 (parr run 1) + 4.71			(n=29, r2=0.49, p<0.001)					

1 FRS and WRFT quantitative electro-fishing sites and results in 1992, 1997, 1999 and 2001 *(continued)*

EWE27: Loch Bharranch-Clair Burn, NG 983576. Section 100 m d/s from loch.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
16.9.97	137.4	26	3	29.0	2.2	11.6	2.9	
22.10.99	102.5	32	1^	57.2	11.5	15.6	6.1	
24.8.01	104.9	24	1^	31.1	8.7	10.8	6.0	2 eels. 12 1/2 mins fished
EWE28: Allt Folais, NG 950715. Stretch from Irish bridge d/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
22.9.97	174.2	78	3	0.6	1.3	36.9	8.5	4 eels
8.10.99	108.9	60	1*	8.3	3.6	12.5	10.1	11 mins fished
29.8.01	123.7	98	1*	0	8.0	35.2	5.7	1 eel. 13 mins fished
EWE29: Allt Folais, NG 951716. Section from Irish bridge u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught/notes
22.9.97	163.2	78	3	0	0	28.0	1.2	3 eels
8.10.99	104.2	60	1*	0	0	23.9	6.4	1 eel. 9 mins fished
29.8.01	160.9	98	1*	0	0	40.2	4.9	11 mins fished
EWE30: Allt a Choire Sliabh, NG 916704. Section from loch u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
29.9.97	119.0	100	3	0	0	57.9	3.4	26 eels, 2 sticklebacks
23.9.99	71.0	79	1*	8.4	0	66.2	10.3	8 eels. 10 1/2 mins fished
14.8.01	76.8	66	1*	10.9	0	242.3	13.4	
EWE31: Garbhaig River, NG 894713. Section from bridge u/s.								
				Zippin estimate (fish/100m²)				
		Conductivity		Salmon	Salmon	Trout	Trout	Other
Date	Area (m2)	(µS/cm)	Runs	fry	parr	fry	parr	species caught
29.9.97	111.2	80	3	0	11.7	13.3	2.7	1 eel, 1 minnow
23.9.99	80.5	27	1^	7.6	13.3	4.7	0	1 eel. 12 mins fished
29.8.01	85.5	36	1^	7.3	11.2	43.3	0	9 mins fished
* For 1 run fishing at sites with >50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.28 (fry run 1) + 1.99			(n=20, r2=0.86, p<0.001)					
Parr density = 1.43 (parr run 1) + 2.25			(n=29, r2=0.92, p<0.001)					
^ For 1 run fishing at sites with ≤50 µS/cm conductivity, Zippin densities extrapolated from all 3 run WRFT sites in 1997:								
Fry density = 2.37 (fry run 1) + 1.73			(n=30, r2=0.82, p<0.001)					
Parr density = 1.39 (parr run 1) + 4.71			(n=29, r2=0.49, p<0.001)					

2 WRFT semi-quantitative (timed) electro-fishing sites and results in 1999

						Fish caught				Catch per unit effort				
				Time	Cond.	Salmon		Trout		Salmon		Trout		
Date	**Code**	**Location**	**Grid reference**	(mins.)	(µS/cm)	0+	1++	0+	1++	0+	1++	0+	1++	**Notes/other species**
03/09/99	Ewe T1	R. Ewe d/s from Cruive Pool	NG 858805	5	46	11	1	0	0	2.2	0.2	0.0	0.0	5 eels, 3 sticklebacks
03/09/99	Ewe T2	R. Ewe, right bank of Flats	NG 859804	5	46	12	7	0	0	2.4	1.4	0.0	0.0	
03/09/99	Ewe T3	R. Ewe, Ken's Pool @ burn confl	NG 862802	3.5	46	6	0	0	0	1.7	0.0	0.0	0.0	
03/09/99	Ewe T4	R. Ewe, d/s of Lower Narrows	NG 862796	5	46	16	5	0	0	3.2	1.0	0.0	0.0	2 eels
19/09/99	Ewe T5	Tollie Burn @ mouth	NG 866792	5	58	1	2	3	0	0.2	0.4	0.6	0.0	1 eel
19/09/99	Ewe T6	Tollie Burn, u/s of 2nd falls	NG 865790	5	58	0	0	2	2	0.0	0.0	0.4	0.4	Above impassable falls. 3 eels
19/09/99	Ewe T7	Inveran R. 200m d/s of bridge	NG 880786	5	58	15	1	0	0	3.0	0.2	0.0	0.0	1 eel, 1 minnow
19/09/99	Ewe T8	Inveran R. 100m u/s bridge	NG 881790	5	58	19	1	0	0	3.8	0.2	0.0	0.0	1 eel, 2 minnows
19/09/99	Ewe T9	Kernsary R. @ confl Allt Loch Ghiuragarstidh	NG 891796	5	50	21	3	3	0	4.2	0.6	0.6	0.0	
19/09/99	Ewe T10	Kernsary R. 80m d/s of bridge	NG 893794	5	50	9	3	5	0	1.8	0.6	1.0	0.0	
19/09/99	Ewe T11	Kernsary R. 50m d/s confl Allt na Criche	NG 894790	5	50	8	7	2	0	1.6	1.4	0.4	0.0	
19/09/99	Ewe T14	Allt na Criche 100m u/s 1st falls	NG 896789	5	50	0	0	0	6	0.0	0.0	0.0	1.2	Above impassable falls
19/09/99	Ewe T12	Kernsary R. 100m d/s 1st falls	NG 892784	5	50	11	6	1	0	2.2	1.2	0.2	0.0	
19/09/99	Ewe T13	Allt Loch Tholidhoire	NG 895773	5	72	0	0	13	2	0.0	0.0	2.6	0.4	Above impassable falls
19/09/99	Ewe T15	Allt Loch Ghiuragarstidh 100m d/s ladder	NG 893796	5	53	13	4	1	0	2.6	0.8	0.2	0.0	1 eel
19/09/99	Ewe T16	Allt Loch Ghiuragarstidh 40m u/s ladder	NG 893797	5	53	0	2	5	0	0.0	0.4	1.0	0.0	1 eel
23/09/99	Ewe T17	Slattadale Burn u/s footbridge	NG 886724	5	86	4	1	2	4	0.8	0.2	0.4	0.8	1 eel
13/10/99	Ewe T18	Slattadale Burn	NG 876727	5	80	0	0	0	1	0.0	0.0	0.0	0.2	
23/09/99	Ewe T19	Garbhaig River d/s 1st island below bridge	NG 895714	5	27	13	4	1	0	2.6	0.8	0.2	0.0	
23/09/99	Ewe T20	Talladale River delta	NG 919706	5	29	5	0	0	0	1.0	0.0	0.0	0.0	1 eel
06/10/99	Ewe T21	Talladale River 100m u/s bridge	NG 919700	5	31	0	0	5	1	0.0	0.0	1.0	0.2	
06/10/99	Ewe T22	Talladale River @ islands	NG 918696	5	31	0	0	2	1	0.0	0.0	0.4	0.2	
06/10/99	Ewe T23	Loch na Fideil Burn 200m d/s road	NG 922705	5	47	0	0	11	0	0.0	0.0	2.2	0.0	5 eels
06/10/99	Ewe T24	Loch na Fideil Burn 400m u/s road	NG 923703	5	47	0	0	9	2	0.0	0.0	1.8	0.4	3 eels
06/10/99	Ewe T25	Grudie R. u/s from delta	NG 965684	4	25	0	1	0	1	0.0	0.3	0.0	0.3	
06/10/99	Ewe T26	Grudie R. 200m d/s bridge	NG 964678	5	25	2	0	2	1	0.4	0.0	0.4	0.2	
06/10/99	Ewe T27	Grudie R. 100m u/s pine wood	NG 968677	5	25	4	0	1	0	0.8	0.0	0.2	0.0	
06/10/99	Ewe T28	Grudie R. 200m u/s telegraph lines	NG 967675	5	25	4	2	1	3	0.8	0.4	0.2	0.6	

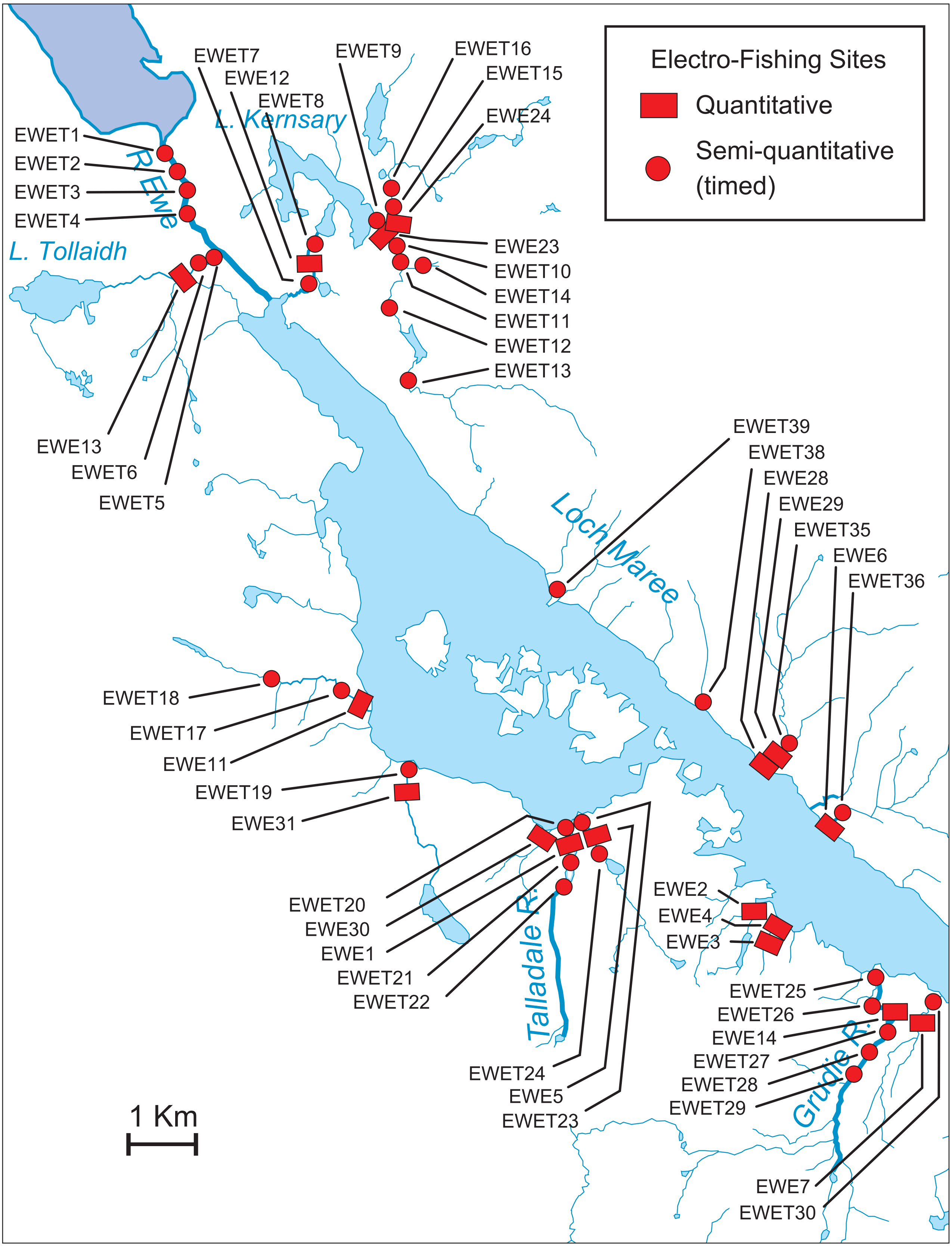
2 WRFT semi-quantitative (timed) electro-fishing sites and results in 1999 *(continued)*

						Fish caught				Catch per unit effort				
				Time	Cond.	Salmon		Trout		Salmon		Trout		
Date	Code	Location	Grid reference	(mins.)	(µS/cm)	0+	1++	0+	1++	0+	1++	0+	1++	Notes/other species
06/10/99	Ewe T29	Grudie R. @ u/s first trees	NG 964673	5	25	2	3	1	1	0.4	0.6	0.2	0.2	
07/10/99	Ewe T30	Alltan Odhar 200m d/s of road	NG 974679	5	41	2	3	7	0	0.4	0.6	1.4	0.0	
07/10/99	Ewe T31	Glas Leitir Burn 200m u/s of road	NH 002648	5	31	1	6	2	2	0.2	1.2	0.4	0.4	
07/10/99	Ewe T32	Allt na Doire-Daraich u/s water gate @ farm	NH 014640	5	27	1	1	5	0	0.2	0.2	1.0	0.0	
07/10/99	Ewe T33	Allt na Doire-Daraich d/s of WGS	NH 018635	5	27	2	4	7	0	0.4	0.8	1.4	0.0	
07/10/99	Ewe T34	Allt na Doire-Daraich 150m u/s road	NH 017630	5	27	0	3	4	0	0.0	0.6	0.8	0.0	
08/10/99	Ewe T35	Allt Folais 200 u/s from Irish bridge	NG 951716	5	60	0	0	8	7	0.0	0.0	1.6	1.4	1 eel
08/10/99	Ewe T36	Abhainn Furnais 50m u/s of bridge	NG 959706	5	49	1	0	4	4	0.2	0.0	0.8	0.8	
08/10/99	Ewe T37	Abhainn na Fhasaigh delta	NH 009654	5	34	0	4	8	0	0.0	0.8	1.6	0.0	1 eel
08/10/99	Ewe T38	Nameless Burn from mouth u/s	NG 939724	5	67	1	1	19	1	0.2	0.2	3.8	0.2	
08/10/99	Ewe T39	Witches Point Burn from mouth u/s	NG 916741	5	62	0	0	21	2	0.0	0.0	4.2	0.4	
13/10/99	Ewe T40	Docherty Burn 80m u/s of confl.	NH 040618	5	34	12	9	2	0	2.4	1.8	0.4	0.0	
13/10/99	Ewe T41	Docherty Burn 200m d/s of shop	NH 043617	5	34	16	10	0	0	3.2	2.0	0.0	0.0	
13/10/99	Ewe T42	Docherty Burn 100m u/s of bridge	NH 045616	5	34	3	5	0	3	0.6	1.0	0.0	0.6	
13/10/99	Ewe T43	Docherty Burn @ u/s end of plantation	NH 048612	5	34	0	0	12	1	0.0	0.0	2.4	0.2	
13/10/99	Ewe T44	Docherty Burn @ u/s end of braided channel	NH 056604	5	34	0	2	5	1	0.0	0.4	1.0	0.2	
13/10/99	Ewe T45	Kinlochewe R. @ end of track	NH 016645	5	42	4	1	1	0	0.8	0.2	0.2	0.0	
13/10/99	Ewe T46	Kinlochewe R. @ Taagan Pool tail	NH 020642	5	42	6	3	1	0	1.2	0.6	0.2	0.0	8 minnows
13/10/99	Ewe T47	Kinlochewe R. u/s Pat's Pool	NH 022639	5	42	17	2	1	0	3.4	0.4	0.2	0.0	
13/10/99	Ewe T48	Kinlochewe R. u/s of Anancaun Pool	NH 026636	5	42	3	0	0	0	0.6	0.0	0.0	0.0	
13/10/99	Ewe T49	Kinlochewe R. @ head of Gabions Pool	NH 028631	5	42	5	2	0	0	1.0	0.4	0.0	0.0	3 minnows
13/10/99	Ewe T50	Kinlochewe R. @ Wire Pool	NH 026628	5	42	1	1	0	0	0.2	0.2	0.0	0.0	10 minnows
13/10/99	Ewe T51	Kinlochewe R @ Manse Pool tail	NH 026625	5	42	4	3	0	0	0.8	0.6	0.0	0.0	1 minnow
13/10/99	Ewe T52	Kinlochewe R @ head of Churchyard Pool	NH 031625	5	32	15	5	0	0	3.0	1.0	0.0	0.0	
19/10/99	Ewe T53	Bruachaig u/s of Whinney Pool	NH 032621	5	32	33	5	0	0	6.6	1.0	0.0	0.0	
19/10/99	Ewe T54	Bruachaig u/s of Lodge Pool	NH 036618	5	32	15	7	1	0	3.0	1.4	0.2	0.0	
19/10/99	Ewe T55	Bruachaig u/s of Long Pool	NH 037623	5	32	17	15	0	0	3.4	3.0	0.0	0.0	
19/10/99	Ewe T56	Bruachaig u/s of Ruins Pool	NH 041623	5	32	18	15	0	0	3.6	3.0	0.0	0.0	
19/10/99	Ewe T57	Bruachaig 100m d/s of sheepfold	NH 045624	5	32	7	8	0	0	1.4	1.6	0.0	0.0	

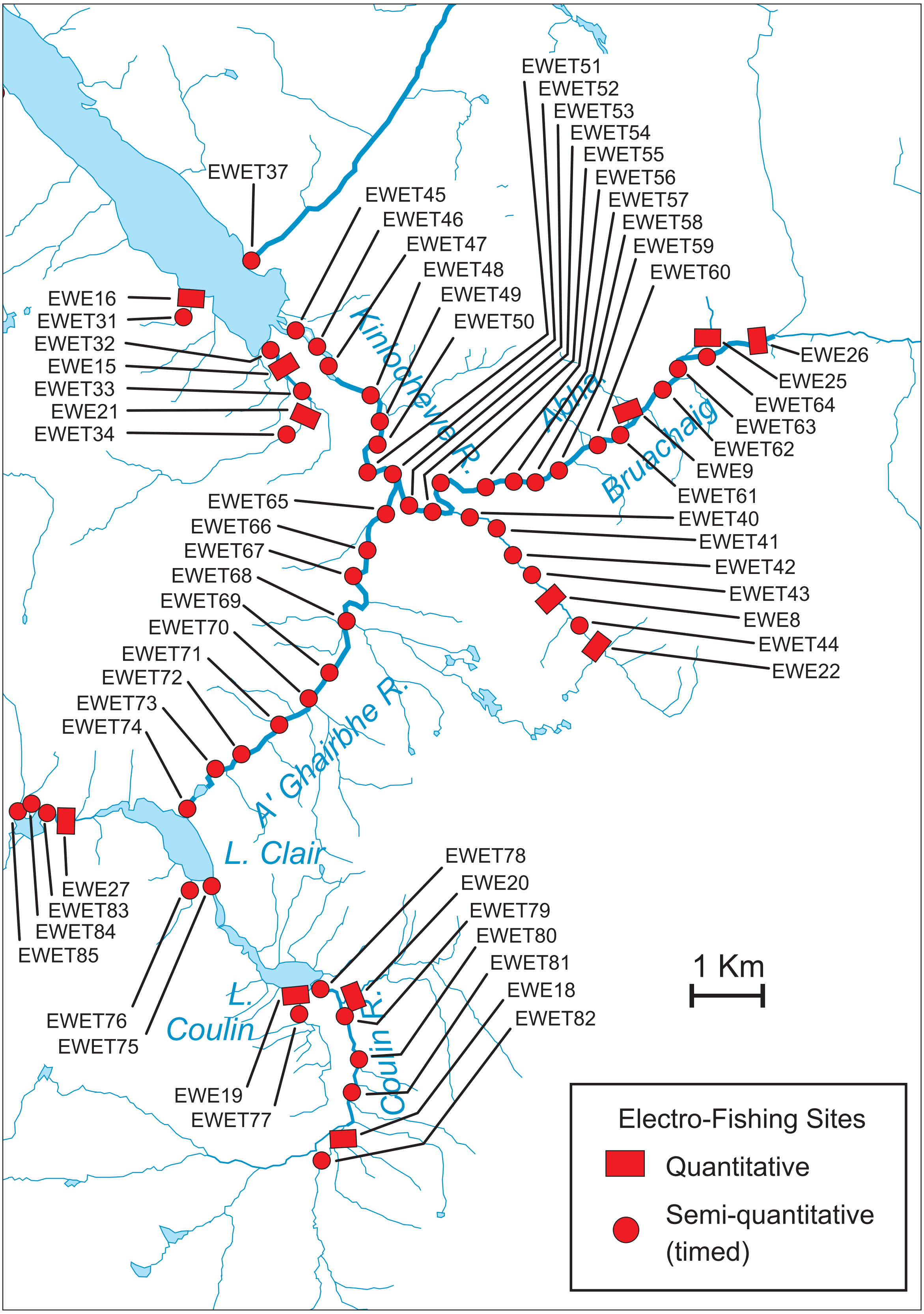
2 WRFT semi-quantitative (timed) electro-fishing sites and results in 1999 *(continued)*

						Fish caught				Catch per unit effort				
				Time	Cond.	Salmon		Trout		Salmon		Trout		
Date	Code	Location	Grid reference	(mins.)	(µS/cm)	0+	1++	0+	1++	0+	1++	0+	1++	Notes/other species
19/10/99	Ewe T58	Bruachaig immed u/s of 1st gorge	NH 050623	5	32	7	13	0	1	1.4	2.6	0.0	0.2	
19/10/99	Ewe T59	Bruachaig b/w Upper and Lower Falls Pools	NH 055625	5	32	0	9	0	8	0.0	1.8	0.0	1.6	3 stocked BT
21/10/99	Ewe T60	Bruachaig 200m u/s of Upper Falls Pool	NH 061629	5	44	0	0	0	0	0.0	0.0	0.0	0.0	
21/10/99	Ewe T61	Bruachaig 50m d/s of Allt a Ghiubhais	NH 063631	5	44	0	0	0	3	0.0	0.0	0.0	0.6	
21/10/99	Ewe T62	Bruachaig @ Wester Heights Pool tail	NH 067636	5	44	0	0	0	4	0.0	0.0	0.0	0.8	1 stocked BT
21/10/99	Ewe T63	Bruachaig d/s of Professor's Pool	NH 072638	5	44	0	1	0	1	0.0	0.2	0.0	0.2	
21/10/99	Ewe T64	Bruachaig @ Heights Cottage	NH 075642	5	44	0	1	1	1	0.0	0.2	0.2	0.2	
21/10/99	Ewe T65	A Ghairbhe R. u/s from K'ewe bridge	NH 029618	5	32	5	20	0	0	1.0	4.0	0.0	0.0	
21/10/99	Ewe T66	A'Ghairbhe R. d/s from Nurse's Pool	NH 027614	5	32	3	17	0	0	0.6	3.4	0.0	0.0	
21/10/99	Ewe T67	A'Ghairbhe R. u/s of Upper Bend Pool	NH 025609	5	32	11	11	1	0	2.2	2.2	0.2	0.0	
21/10/99	Ewe T68	A'Ghairbhe R. u/s of March Pool	NH 024604	5	32	7	12	0	1	1.4	2.4	0.0	0.2	
21/10/99	Ewe T69	A'Ghairbhe R. 100m u/s of Scots Pines	NH 021596	5	32	11	12	1	0	2.2	2.4	0.2	0.0	
21/10/99	Ewe T70	A'Ghairbhe R. u/s of forestry bridge	NH 018592	5	32	12	9	1	1	2.4	1.8	0.2	0.2	
21/10/99	Ewe T71	A'Ghairbhe R. 300m u/s of forestry bridge	NH 015589	5	32	4	21	0	1	0.8	4.2	0.0	0.2	
21/10/99	Ewe T72	A'Ghairbhe R. @ swing bridge	NH 008585	5	32	5	10	0	1	1.0	2.0	0.0	0.2	
22/10/99	Ewe T73	A'Ghairbhe R. @ forestry plantation	NH 005583	5	32	19	2	0	0	3.8	0.4	0.0	0.0	
22/10/99	Ewe T74	A'Ghairbhe R. u/s from bridge	NH 001577	5	32	9	7	0	0	1.8	1.4	0.0	0.0	
22/10/99	Ewe T75	d/s from Loch Coulin-Clair R. bridge	NH 004566	5	32	23	13	0	0	4.6	2.6	0.0	0.0	
22/10/99	Ewe T76	Hatchery Burn	NH 003566	5	21	3	8	1	0	0.6	1.6	0.2	0.0	
22/10/99	Ewe T77	Allt na Feithe Buidhe 200m u/s of bridge	NH 018546	5	44	18	1	5	1	3.6	0.2	1.0	0.2	
22/10/99	Ewe T78	Coulin R 200 m d/s of bridge	NH 022541	5	35	10	13	0	0	2.0	2.6	0.0	0.0	
22/10/99	Ewe T79	Coulin R @ first bluff	NH 024544	6	44	19	19	1	0	3.2	3.2	0.2	0.0	
22/10/99	Ewe T80	Coulin R @ Scots Pines	NH 024538	5	44	9	24	0	0	1.8	4.8	0.0	0.0	
22/10/99	Ewe T81	Coulin R 300m d/s of bridge	NH 024535	5	44	3	19	1	2	0.6	3.8	0.2	0.4	
22/10/99	Ewe T82	Allt Doire Beithe 600m u/s from confl.	NH 023527	5	36	12	8	2	1	2.4	1.6	0.4	0.2	
21/10/99	Ewe T83	Loch Bharranch-Clair Burn at outflow	NG 982576	5	30	10	2	13	0	2.0	0.4	2.6	0.0	
22/10/99	Ewe T84	Am Fionn Alltan	NG 978577	5	30	8	6	6	4	1.6	1.2	1.2	0.8	
22/10/99	Ewe T85	Am Fionn Alltan Beag	NG 977577	5	30	7	5	8	4	1.4	1.0	1.6	0.8	

3 Locations of FRS and WRFT electro-fishing sites in the western Ewe catchment *(Crown Copyright)*



4 Locations of FRS and WRFT electro-fishing sites in the eastern Ewe catchment *(Crown Copyright)*



Appendix II

Summary of Ewe Salmon Radio-tracking Project, 2001

				FISH DETAILS				LOCATIONS	
Fish	Date tagged	Location tagged	Captor	Length (cm)	Age	Sex	Sea lice *L. salmonis* notes	Spawning site	Final location
1. 'Simone'	6.6.01	Cruive Pool, A'Ghairbhe R.	Mr. Simon Stewart	77.0	3.2+	F	Quite fresh, but no lice.	Loch Bharranch-Clair Burn	Loch Clair, Jan. '02
2. 'Col. Bewsher'	17.7.01	Sea Pool, R. Ewe	Col. Bill Bewsher	62.0	3.1+	F	Fresh with sea lice.	Ault Bea River	Otter kill, mid-Nov. '01
3. 'Mrs. Strachan'	18.7.01	Macordies, R. Ewe	Mrs. Strachan	62.0	3.1+	F	Fresh with sea lice.	Loch Clair outflow	Loch Maree, Jan. '02
4. 'Browne-Swinburn'	20.7.01	Macordies, R. Ewe	Mr. Browne-Swinburne	62.5	3.1+	F	Quite fresh, no lice.	Returned to sea 20.9.01	?
5. 'Virginia'	24.7.01	Macordies, R. Ewe	Mr. Abel-Smith	61.0	1.1+ (f)	F	Quite fresh, no lice.	Coulin River	Loch Clair, Jan. '02
6. 'Steve'	27.7.01	Sea Pool, R. Ewe	Mrs. Macdonald-Buchanan	67.5	2.1+	M	Fresh with sea lice.	River Ewe?	River Ewe, Feb. '02
7. 'Anne'	3.8.01	Middle Narrows, R. Ewe	Mr. Robin Valentine	64.5	>2.1+	F	Fresh. Chalimus marks on dorsal	River Ewe?	River Ewe, Oct. '01
8. 'Lesley'	3.8.01	Macordies, R. Ewe	Mr. Les Buchan	64.0	3.1+	F	Fresh, 200+ lice with chalimus on dorsal.	River Ewe?	River Ewe, Oct. '01
9. 'Prescilla'	4.8.01	Macordies, R. Ewe	Mr. Robin Valentine	83.5	3.2+	F	Fresh, one louse	River Ewe?	River Ewe, Jan. '02
10. 'Dipsy'	6.8.01	Macordies, R. Ewe	Mr D. Wiggen	62.0	>2.1+	M	Fresh, 22 lice.	Kinlochewe River	Otter kill, mid-Nov. '01
11. 'Duncan'	28.8.01	Macordies, R. Ewe	Mr. Gordon Lawson	73.5	?.1+	M	Fresh, 3 lice. Predator damage.	River Ewe	River Ewe, Feb. '02
12. 'Martha'	30.8.01	Ken's Pool. R. Ewe	Mr. Archie Alexander	69.5	?.1+	F	Not fresh. No lice.	Talladale River	River Ewe, Jan. '02
13. 'Robin'	30.8.01	Middle Narrows. R. Ewe	Mr. Fraser Hill	72.0	2.1+	M	Not fresh. No lice. Predator damage.	Returned to sea 7.9.01	?
14. 'Belinda'	31.08.01	Macordies, R. Ewe	Mr. Archie Alexander	62.0	?.1+	F	Fresh, 16 lice. Healed lice damage.	Returned to sea 8.9.01	?
15. 'Izzy'	3.09.01	Anancaun Pool, K'ewe R.	?	55.0	2.1+	F	Fresh, no lice.	Kinlochewe River	River Ewe, Jan. '02
16. 'Guy'	4.09.01	Middle Narrows. R. Ewe	Miss Lucy Gordon	64.5	2.1+	M	Not fresh, lice damage on dorsal.	Kinlochewe River	Otter kill, late Nov. '01
17. 'Sara'	8.09.01	T Pool, R. Ewe	Sir Raymond Johnstone	70.0	2.1+	F	Quite fresh, no lice, healed lice damage.	Inveran River	River Ewe, Mar. '02
18. 'Bridgette'	8.09.01	T Pool, R. Ewe	Sir Piers Bengough	67.5	2.1+	F	Quite fresh, no lice.	River Ewe?	River Ewe, Dec. '01
19. 'Cameron'	19.09.01	Lower Narrows, R. Ewe	Lord Cameron	81.0	1.1+(f)	M	Quite fresh, no lice.	Kernsary River?	Loch Kernsary, Oct. '01
20. 'Millie'	3.10.01	Lower Taagan, K'ewe R.	Mrs. Sylvia Tellwright	63.5	2.1+	F	Moderately coloured.	A'Ghairbhe River	Loch Maree, Jan. '02
21. 'Ian'	10.10.01	Manse Pool, K'ewe R.	Mr. Ian Galloway	66.0	3.1+	M	Coloured.	A'Ghairbhe/Bruachaig	Loch Maree, Dec. '01
22. 'Alan'	13.10.01	Manse Pool, K'ewe R.	Mr. Ian Cross	68.5	1.1+(f)	M	Coloured.	Abhainn Bruachaig	Otter kill, mid-Nov. '01
23. 'Frankie'	26.10.01	Manse Pool, K'ewe R.	Mr. Frank Kalinowski	70.5	?.1+	M	Coloured.	A'Ghairbhe River	Otter kill, mid-Nov. '01
24. 'Maureen'	31.10.01	Park Pool, K'ewe R.	Mr. Frank Kalinowski	72.0	3.1+	F	Coloured.	Abhainn Bruachaig	Otter kill, mid-Nov. '01
25. 'Eoghain'	31.10.01	Park Pool, K'ewe R.	Mr. Frank Kalinowski	72.0	3.1+	M	Coloured.	Kinlochewe River	Otter kill, mid-Nov. '01

Appendix III

River Ewe adult salmon scale data, 1997–2001 (read by FRS and WRFT)

Age: The freshwater age is on the left of the point, the marine age on the right.

GRILSE (1SW)						SALMON (2SW)					
Date	Weight (lb)	Length (cm)	Sex	Age	Location	Date	Weight (lb)	Length (cm)	Sex	Age	Location
6.6.97	5 3/4	62.0	?	3.1+	River Ewe	13.5.97	12	79.0	M	3.2	River Ewe
3.7.97	7	66.0	?	3.1+	River Ewe	15.5.97	13 1/2	82.0	F	3.2	River Ewe
2.7.97	5	60.0	M	3.1+	River Ewe	5.6.97	9	72.0	F	2.2	River Ewe
21.6.97	6	63.0	M	3.1+	River Ewe	23.6.97	11	77.0	?	2.2+	River Ewe
4.7.97	4 3/4	58.0	F	3.1+	River Ewe	28.6.97	8	69.0	?	2.2	River Ewe
24.7.97	6 1/4	64.0	M	2.1+	River Ewe	17.6.98	8 1/2	75.0	F	3.2+	Loch Maree
4.7.97	7	66.0	?	2.1+	River Ewe	17.6.99	11	77.0	M	3.2	Loch Maree
14.6.97	6	63.0	M	2.1+	Loch Maree	24.5.99	11 3/4	79.0	M	2.2+	A'Ghairbhe R.
16.6.97	6 1/2	63.0	M	2.1+	River Ewe	20.5.99	10 1/2	76.0	F	2.2	Loch Maree
29.6.99	6	64.0	F	2.1+	River Ewe	25.5.99	14	83.0	M	2.2	K'ewe R.
29.6.99	5 1/2	62.0	F	2.1+	River Ewe	17.6.99	18	90.0	M	2.2+	River Ewe
24.9.99	6 1/2	65.0	M	3.1+	Loch Clair	9.6.99	12 1/2	86.0	M	2.2	River Ewe
16.8.99	5	60.0	M	2.1+	K'ewe R.	10.6.99	8 1/2	70.0	F	3.2	River Ewe
6.9.99	4	57.0	M	2.1+	Loch Clair	11.6.99	10	79.0	M	2.2	River Ewe
6.9.99	4 1/4	58.0	M	2.1+	Loch Clair	15.6.99	10	79.0	M	2.2	River Ewe
13.10.99	8	69.0	F	2.1+	K'ewe R.	16.6.99	8	69.0	F	4.2	K'ewe R.
24.7.99	3 1/2	52.0	F	2.1+	Loch Clair	20.6.99	11	77.0	M	3.2	Loch Maree
28.7.00	5 1/2	60.5	?	3.1+	River Ewe	21.6.99	16 1/2	88.0	F	2.2+	K'ewe R.
20.9.00	7 1/4	67.0	F	3.1+	River Ewe	30.6.99	7	66.0	M	4.2	K'ewe R.
9.10.00	9	72.0	F	3.1+	K'ewe R.	14.7.99	8 1/2	70.0	F	3.2	K'ewe R.
11.10.00	5	60.0	F	2.1+	K'ewe R.	6.9.99	20	95.0	M	2.2+	K'ewe R.
18.6.01	5 1/2	62.5	F	2.1+	Loch Maree	20.9.99	11 1/2	78.0	M	2.2+	Loch Clair
6.6.01	4	48.0	M	2.1+	K'ewe R.	8.10.99	11	77.0	M	3.2	K'ewe R.
19.6.01	7	65.0	M	2.1+	Loch Maree	18.5.00	11 3/4	79.0	M	2.2	Loch Maree
19.6.01	6	63.0	M	2.1+	Loch Maree	18.5.00	9 1/2	73.0	F	2.2	Loch Maree
27.8.01	6	65.0	F	2.1+	Loch Maree	18.5.00	11	77.0	F	3.2	Loch Maree
11.7.01	6 1/2	72.5	M	3.1+	K'ewe R.	31.5.00	11 1/2	74.0	F	2.2+	K'ewe R.
3.8.01	5 1/2	61.0	F	2.1+	Loch Maree	9.6.00	13	85.0	M	2.2+	K'ewe R.
17.7.01	5 3/4	62.0	F	3.1+	River Ewe	19.6.00	15 3/4	87.0	M	2.2+	K'ewe R.
18.7.01	5 3/4	62.0	F	3.1+	River Ewe	23.6.00	10	75.0	F	3.2+	Loch Maree
20.7.01	5 3/4	62.5	F	3.1+	River Ewe	23.9.00	19	92.0	F	3.2+	River Ewe
26.7.01	7 1/4	67.5	M	2.1+	River Ewe	11.10.00	19	93.0	M	2.2+	K'ewe R.
3.8.01	6 1/2	64.5	F	3.1+	River Ewe	17.5.01	11	76.0	F	2.2+	Loch Maree
3.8.01	6 1/2	64.0	F	4.1+	River Ewe	17.5.01	10	74.0	F	2.2+	Loch Maree
6.8.01	5 3/4	62.0	M	3.1+	River Ewe	18.5.01	6 3/4	70.0	F	2.2+	Loch Maree
30.8.01	9	72.0	M	2.1+	River Ewe	6.6.01	11	77.0	F	2.2+	A'Ghairbhe R.
3.9.01	4	55.0	F	2.1+	K'ewe R.	18.6.01	12 1/2	78.0	M	2.2+	Loch Maree
4.9.01	6 1/2	64.5	M	2.1+	River Ewe	18.6.01	11	76.0	M	2.2+	Loch Maree
8.9.01	8 1/2	70.0	F	2.1+	River Ewe	21.6.01	14	79.0	M	2.2+	K'ewe R.
8.9.01	7	67.5	F	2.1+	River Ewe	3.8.01	9 1/2	75.0	F	2.2+	Loch Maree
31.10.01	9	72.0	F	3.1+	K'ewe R.	4.8.01	13 3/4	83.5	F	2.2+	River Ewe
3.10.01	6 1/4	63.5	F	3.1+	K'ewe R.	31.10.01	9	72.0	M	3.2+	K'ewe R.
10.10.01	7	66.0	M	4.1+	K'ewe R.	22.11.01	Carcass of otter kill		F	2.2+	Loch Bharranch
18.11.01	Carcass of otter kill		F	3.1+	A'Ghairbhe R.	25.11.01	Carcass of otter kill		M	3.2+	K'ewe R.
30.11.01	9	72.0	M	2.1+	Loch Clair						
30.11.01	7	66.0	F	3.1+	Loch Clair						

River Ewe adult salmon scale data, 1997–2001 (read by FRS and WRFT) (continued)

Age: The freshwater age is on the left of the point, the marine age on the right.

SALMON (3SW)						FARM ESCAPES					
Date	Weight (lb.)	Length (cm)	Sex	Age	Location	Date	Weight (lb.)	Length (cm)	Sex	Age	Location
28.5.97	19 1/2	93.0	M	2.3	River Ewe	10.7.97	3 3/4	55.0	F	1.1+	River Ewe
14.6.97	18 1/2	92.0	F	3.3	Loch Maree	20.6.98	3	49.0	M	2.0+	River Ewe
23.6.97	15	85.0	?	2.3	River Ewe	21.4.98	10 1/2	76.0	F	1.1+	River Ewe
23.6.97	16	87.0	?	3.3	River Ewe	10.9.98	2	42.0	?	1.1+	River Ewe
22.5.98	19	93.0	M	2.3	River Ewe	7.9.99	7	67.0	F	1.1+	Loch Clair
24.5.99	16 1/2	88.0	F	4.3	K'ewe R.	3.9.01	5 1/4	60.5	M	1.1+	K'ewe R.
						5.10.01	4 1/2	57.0	M	1.1+	K'ewe R.
						24.7.01	5 1/2	61.0	F	1.1+	River Ewe
						13.10.01	7 1/2	68.5	M	1.1+	K'ewe R.
						19.9.01	12 3/4	81.0	M	1.1+	River Ewe

Appendix IV

River Ewe sea trout scale data (read by FRS and WRFT)

1 1997

SEA WINTERS: 0+				**1+**				**1+ (cont.)**				**2+**			
Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location
20.0	25.6.97	3.0+	River Ewe	31.0	25.6.97	3.1+	River Ewe	31.0	1.7.97	3.1+	River Ewe	31.5	23.7.97	3.2+	River Ewe
19.0	25.6.97	3.0+	River Ewe	30.0	25.6.97	3.1+	River Ewe	28.5	1.7.97	3.1+	River Ewe	37.5	21.7.97	2.2+	River Ewe
22.5	25.6.97	3.0+	River Ewe	26.0	25.6.97	2.1+	River Ewe	30.0	1.7.97	3.1+	River Ewe	36.0	23.7.97	2.1+sm+	River Ewe
20.0	25.6.98	3.0+	River Ewe	32.5	25.6.97	3.1+	River Ewe	29.0	27.6.97	3.1+	River Ewe	29.0	21.7.97	2.2+	River Ewe
21.0	25.6.97	3.0+	River Ewe	28.5	25.6.97	3.1+	River Ewe	29.0	27.6.97	3.1+	River Ewe	32.0	16.7.97	2.2+	River Ewe
17.0	25.6.97	2.0+	River Ewe	30.0	25.6.97	3.1+	River Ewe	29.5	27.6.97	3.1+	River Ewe	36.5	12.7.97	2.2+	River Ewe
20.0	25.6.97	3.0+	River Ewe	31.5	25.6.97	4.1+	River Ewe	28.5	27.6.97	3.1+	River Ewe	35.5	12.7.97	3.2+	River Ewe
21.5	25.6.97	3.0+	River Ewe	28.0	25.6.97	3.1+	River Ewe	29.5	27.6.97	3.1+	River Ewe	34.5	12.7.97	3.2+	River Ewe
21.5	25.6.97	3.0+	River Ewe	28.0	25.6.97	2.1+	River Ewe	29.5	27.6.97	3.1+	River Ewe	31.5	1.7.97	3.2+	River Ewe
18.5	25.6.97	2.0+	River Ewe	26.0	25.6.97	2.1+	River Ewe	29.0	27.6.97	3.1+	River Ewe	31.5	1.7.97	2.2+	River Ewe
19.5	25.6.97	3.0+	River Ewe	31.0	25.6.97	3.1+	River Ewe	27.5	27.6.97	3.1+	River Ewe	32.5	27.6.97	2.1+sm+	River Ewe
22.5	25.6.97	3.0+	River Ewe	31.0	25.6.97	3.1+	River Ewe	22.0	7.7.97	2.1+	Loch Maree	32.5	27.6.97	3.2+	River Ewe
24.0	25.6.97	4.0+	River Ewe	29.5	23.7.97	3.1+	River Ewe	35.0	17.6.97	3.1+	Loch Maree	35.0	27.6.97	3.2+	River Ewe
22.5	25.6.97	4.0+	River Ewe	32.0	23.7.97	3.1+	River Ewe	30.5	10.9.97	3.1+	Loch Maree	37.0	25.6.97	2.2+	River Ewe
22.0	25.6.97	3.0+	River Ewe	29.5	23.7.97	3.1+	River Ewe	30.0	27.6.97	3.1+	Loch Maree	29.5	16.7.97	2.1+sm+	River Ewe
20.5	25.6.97	3.0+	River Ewe	31.5	23.7.97	3.1+	River Ewe	34.0	31.7.97	4.1+	Loch Maree	36.0	12.11.97	3.2+	L. na Fideil Burn
19.5	25.6.97	3.0+	River Ewe	30.0	23.7.97	3.1+	River Ewe	32.0	17.11.97	3.1+	L. na Fideil Burn	29.0	5.9.97	3.2+	Loch Maree
20.0	25.6.97	3.0+	River Ewe	32.0	23.7.97	3.1+	River Ewe	33.0	12.11.97	3.1+	L. na Fideil Burn				
25.5	23.7.97	3.0+	River Ewe	31.0	21.7.97	3.1+	River Ewe	29.5	1.7.97	2.1+	River Ewe				
24.0	5.9.97	3.0+	Loch Maree	30.5	21.7.97	3.1+	River Ewe	30.0	1.7.97	3.1+	River Ewe				
29.0	9.9.97	4.0+	Loch Maree	30.0	21.7.97	2.1+	River Ewe	30.5	1.7.97	3.1+	River Ewe				
24.5	10.9.97	3.0+	Loch Maree	29.5	21.7.97	3.1+	River Ewe	29.5	12.7.97	3.1+	River Ewe				
				28.0	21.7.97	2.1+	River Ewe	29.0	16.7.97	2.1+	River Ewe	**3+**			
				28.0	21.7.97	2.1+	River Ewe	33.5	16.7.97	3.1+	River Ewe	45.0	16.6.97	4.2+sm+	Loch Maree
				30.5	21.7.97	3.1+	River Ewe	31.5	21.7.97	3.1+	River Ewe	40.0	10.8.97	3.2+sm+	Loch Maree
				29.0	21.7.97	2.1+	River Ewe	27.0	21.7.97	3.1+	River Ewe	43.0	17.11.97	3.2+sm+	L. na Fideil Burn
				25.5	25.6.97	3.1+	River Ewe	31.5	21.7.97	3.1+	River Ewe	39.0	17.11.97	4.1+2sm+	L. na Fideil Burn
				29.0	1.7.97	3.1+	River Ewe	31.0	21.7.97	3.1+	River Ewe				
				28.0	1.7.97	3.1+	River Ewe	31.0	21.7.97	3.1+	River Ewe				
				31.0	1.7.97	3.1+	River Ewe	30.5	21.7.97	3.1+	River Ewe				
				27.5	1.7.97	3.1+	River Ewe	33.5	21.7.97	3.1+	River Ewe				
				33.0	21.7.97	3.1+	River Ewe	32.0	27.6.97	3.1+	River Ewe				
								31.0	27.6.97	3.1+	River Ewe				

Age: The freshwater age is on the left of the point, the marine age on the right. The letters ‘sm’ denote a spawning mark.

River Ewe sea trout scale data (read by FRS and WRFT) (continued)

2 1998

SEA WINTERS: 0+				1+				2+				3+			
Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location
28.0	16.8.98	3.0+	Loch Maree	36.5	3.12.98	3.1+	Loch na Fideil Burn	39.0	3.12.98	3.2+	Loch na Fideil Burn	36.0	18.6.98	3.2+sm+	River Ewe
24.0	10.8.98	2.0+	Loch Maree	29.8	3.12.98	3.1+	Loch na Fideil Burn	39.0	20.8.98	3.2+	Loch Maree	39.4	3.6.98	2.2+sm+	River Ewe
24.0	12.8.98	2.0+	Loch Maree	29.6	24.6.98	3.1+	Estuary of Ewe	40.0	10.8.98	3.2+	Loch Maree				
25.0	24.6.98	3.0+	River Ewe	29.5	24.6.98	4.1+	Estuary of Ewe	37.0	24.6.98	3.2+	River Ewe				
26.0	24.6.98	3.0+	River Ewe	27.5	24.6.98	3.1+	Estuary of Ewe	31.0	17.6.98	3.2+	River Ewe	4+			
26.0	24.6.98	3.0+	River Ewe	29.5	15.6.98	3.1+	River Ewe	37.0	16.6.98	3.2+	River Ewe	Length (cm)	Date	Age	Location
24.0	24.6.98	3.0+	River Ewe	28.5	12.6.98	3.1+	River Ewe	41.5	15.6.98	3.2+	River Ewe	40.0	30.9.98	3.2+2sm+	Loch Maree
26.5	12.6.98	3.0+	River Ewe	26.5	12.6.98	3.1+	River Ewe	32.0	12.6.98	2.2+	River Ewe	37.4	3.6.98	3.2+2sm+	River Ewe
26.5	4.6.98	3.0+	River Ewe	25.5	12.6.98	2.1+	River Ewe	33.0	5.6.98	3.2+	River Ewe				
26.0	4.6.98	3.0+	River Ewe	26.5	5.6.98	2.1+	River Ewe	36.0	5.6.98	3.2+	River Ewe				
25.5	4.6.98	3.0+	River Ewe	30.5	5.6.98	3.1+	River Ewe	40.5	5.6.98	3.2+	River Ewe				
27.8	3.6.98	4.0+	River Ewe	30.0	4.6.98	3.1+	River Ewe	36.5	5.6.98	3.2+	River Ewe				
24.3	17.6.98	3.0+	Estuary of Ewe	27.0	24.6.98	4.1+	Estuary of Ewe	33.5	5.6.98	3.2+	River Ewe				
22.3	17.6.98	3.0+	Estuary of Ewe					35.5	5.6.98	3.2+	River Ewe				
21.0	17.6.98	3.0+	Estuary of Ewe					30.0	3.6.98	4.2+	River Ewe				
23.2	24.6.98	3.0+	Estuary of Ewe												
23.9	10.6.98	4.0+	Estuary of Ewe												
24.1	10.6.98	4.0+	Estuary of Ewe												
22.8	24.6.98	3.0+	Estuary of Ewe												
23.8	3.6.98	4.0+	Estuary of Ewe												
23.5	24.6.98	4.0+	Estuary of Ewe												
20.0	24.6.98	3.0+	Estuary of Ewe												
20.5	3.6.98	3.0+	Estuary of Ewe												
22.3	17.6.98	3.0+	Estuary of Ewe												
24.5	24.6.98	3.0+	Estuary of Ewe												
24.1	3.6.98	4.0+	Estuary of Ewe												
24.1	3.6.98	4.0+	Estuary of Ewe												
23.8	10.6.98	3.0+	Estuary of Ewe												
24.2	24.6.98	3.0+	Estuary of Ewe												
21.8	3.6.98	3.0+	Estuary of Ewe												
21.5	17.6.98	3.0+	Estuary of Ewe												
19.0	17.6.98	3.0+	Estuary of Ewe												
20.2	24.6.98	3.0+	Estuary of Ewe												
23.8	3.6.98	4.0+	Estuary of Ewe												
20.0	24.6.98	3.0+	Estuary of Ewe												
22.4	10.6.98	3.0+	Estuary of Ewe												
24.4	24.6.98	3.0+	Estuary of Ewe												
23.3	17.6.98	4.0+	Estuary of Ewe												

Age: The freshwater age is on the left of the point, the marine age on the right. The letters 'sm' denote a spawning mark.

River Ewe sea trout scale data (read by FRS and WRFT) (continued)

3 1999

SEA WINTERS: 0+				1+			
Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location
21.0	7.6.99	3.0+	Ewe mouth	28.0	8.6.99	3.sm+	Ewe mouth
24.0	8.6.99	3.0+	Ewe mouth	29.5	29.6.99	3.1+	Ewe mouth
23.1	8.6.99	3.0+	Ewe mouth	27.0	30.6.99	3.sm+	Ewe mouth
24.1	8.6.99	3.0+	Ewe mouth	27.5	30.6.99	3.1+	Ewe mouth
27.1	8.6.99	3.0+	Ewe mouth				
22.0	8.6.99	3.0+	Ewe mouth				
21.7	8.6.99	3.0+	Ewe mouth				
21.5	8.6.99	3.0+	Ewe mouth				
19.0	16.6.99	3.0+	Ewe mouth				
23.0	18.6.99	3.0+	Ewe mouth				
20.0	29.6.99	3.0+	Ewe mouth				
21.5	29.6.99	3.0+	Ewe mouth				
21.9	29.6.99	3.0+	Ewe mouth				
21.0	29.6.99	3.0+	Ewe mouth				
18.8	30.6.99	3.0+	Ewe mouth				
24.0	30.6.99	3.0+	Ewe mouth				
23.0	30.6.99	4.0+	Ewe mouth				

Age: The freshwater age is on the left of the point, the marine age on the right.
The letters ‘sm’ denote a spawning mark.

River Ewe sea trout scale data (read by FRS and WRFT) (continued)

4 2000

SEA WINTERS: 0+				1+				2+			
Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location
23.2	30.6.00	4.0+	Ewe mouth	31.0	10.6.00	2.1+	Loch Maree	31.4	10.6.00	3.2+	Loch Maree
25.5	30.6.00	4.0+	Ewe mouth	27.8	26.6.00	3.1+	Ewe mouth	37.0	10.6.00	3.2+	Loch Maree
21.0	29.6.00	3.0+	Ewe mouth	26.0	15.6.00	3.1+	Ewe mouth	29.4	22.6.00	4.1+sm+	Ewe mouth
28.1	29.6.00	5.0+	Ewe mouth					31.3	15.6.00	4.1+sm+	Ewe mouth
24.7	29.6.00	4.0+	Ewe mouth					33.0	15.6.00	4.1+sm+	Ewe mouth
24.7	28.6.00	4.0+	Ewe mouth								
24.8	28.6.00	4.0+	Ewe mouth								
23.3	28.6.00	3.0+	Ewe mouth								
24.9	26.6.00	4.0+	Ewe mouth								
24.2	26.6.00	4.0+	Ewe mouth								
23.7	22.6.00	4.0+	Ewe mouth								
25.7	16.6.00	4.0+	Ewe mouth								
22.7	16.6.00	4.0+	Ewe mouth								
25.2	15.6.00	4.0+	Ewe mouth								
21.3	15.6.00	4.0+	Ewe mouth								

Age: The freshwater age is on the left of the point, the marine age on the right. The letters ‘sm’ denote a spawning mark.

River Ewe sea trout scale data (read by FRS and WRFT) (continued)

5 2001

SEA WINTERS: 0+				1+				2+			
Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location	Length (cm)	Date	Age	Location
21.3	9.6.01	3.0+	Ewe mouth	29.2	14.6.01	3.1+	Ewe mouth	32.7	14.6.01	2.1+sm+	Ewe mouth
18.0	11.6.01	3.0+	Ewe mouth	31.0	14.6.01	3.1+	Ewe mouth	37.5	19.6.01	2.sm+1+	Loch Maree
21.9	11.6.01	3.0+	Ewe mouth	29.7	14.6.01	2.1+	Ewe mouth	32.5	18.6.01	3.2+	Loch Maree
21.2	14.6.01	4.0+	Ewe mouth	30.0	22.6.01	3.1+	Ewe mouth	35.0	20.8.01	3.2+	Loch Maree
22.7	16.6.01	3.0+	Ewe mouth	30.8	22.6.01	2.1+	Ewe mouth	33.8	26.6.01	2.2+	Loch Maree
20.3	21.6.01	2.0+	Ewe mouth	35.0	30.8.01	3.1+	Loch Maree				
15.6	29.6.01	3.0+	Ewe mouth	32.5	21.6.01	3.1+	Loch Maree				
23.7	29.6.01	3.0+	Ewe mouth	33.4	19.7.01	3.sm+	Loch Maree	3+			
27.3	29.6.01	4.0+	Ewe mouth	27.5	21.6.01	3.1+	Loch Maree	36.0	14.6.01	3.2+sm+	Ewe mouth
24.3	29.6.01	3.0+	Ewe mouth	32.5	13.7.01	3.sm+	Loch Maree	42.5	22.6.01	3.2+sm+	Loch Maree
18.0	29.6.01	2.0+	Ewe mouth								
22.0	28.6.01	3.0+	Ewe mouth								
18.6	28.6.01	2.0+	Ewe mouth								
19.8	28.6.01	3.0+	Ewe mouth								
19.3	28.6.01	3.0+	Ewe mouth								
21.0	28.6.01	3.0+	Ewe mouth								
20.4	28.6.01	3.0+	Ewe mouth								
22.6	28.6.01	2.0+	Ewe mouth								
22.8	28.6.01	3.0+	Ewe mouth								
21.7	28.6.01	2.0+	Ewe mouth								
22.9	28.6.01	3.0+	Ewe mouth								
24.8	28.6.01	2.0+	Ewe mouth								
19.3	27.6.01	3.0+	Ewe mouth								
23.7	30.6.01	3.0+	Ewe mouth								

Age: The freshwater age is on the left of the point, the marine age on the right. The letters 'sm' denote a spawning mark.

Appendix V

Sea lice data from Ewe sea trout

1 1997 and 1998

		SEA TROUT		SEA LICE *Lepeophtheirus salmonis*						
Date	Method	Length (cm)	Age	Ovigerous females	Other adults	Pre-adults	Chalimus	**TOTAL LICE**	Dorsal damage?	*Caligus elongatus*
1997										
25.6.97	Rod and line	21.5	3.0+	0	0	0	3	**3**	No	0
25.6.97	Rod and line	30.0	3.1+	0	0	0	28	**28**	Yes	0
25.6.97	Rod and line	32.5	3.1+	0	0	1	1	**2**	Yes	0
25.6.97	Rod and line	19.5	3.0+	0	0	0	20	**20**	Yes	0
25.6.97	Rod and line	26.0	2.1+	0	0	0	8	**8**	Yes	0
25.6.97	Rod and line	20.5	3.0+	0	0	2	13	**15**	Yes	0
27.6.97	Rod and line	35.0	3.2+	0	1	0	58	**59**	Yes	0
27.6.97	Rod and line	29.5	3.1+	0	1	16	26	**43**	Yes	0
27.6.97	Rod and line	32.0	3.1+	0	1	0	4	**5**	Yes	0
27.6.97	Rod and line	29.0	3.1+	1	2	4	51	**58**	Yes	0
1998										
3.6.98	Gill net	24.1	4.0+	0	0	6	0	**6**	?	0
3.6.98	Gill net	24.1	4.0+	0	2	2	9	**13**	?	0
3.6.98	Gill net	23.8	4.0+	0	0	0	0	**0**	?	0
3.6.98	Gill net	23.5	4.0+	0	0	6	22	**28**	?	0
3.6.98	Gill net	20.5	3.0+	0	0	22	33	**55**	?	0
3.6.98	Gill net	21.8	3.0+	0	0	0	0	**0**	?	0
10.6.98	Gill net	23.8	3.0+	0	0	1	0	**1**	?	0
10.6.98	Gill net	23.9	4.0+	0	1	14	4	**19**	?	0
10.6.98	Gill net	24.1	4.0+	0	2	2	0	**4**	?	0
10.6.98	Gill net	22.4	3.0+	0	0	0	9	**9**	?	0
17.6.98	Gill net	22.3	3.0+	0	1	1	5	**7**	?	0
17.6.98	Gill net	21.5	3.0+	0	1	0	1	**2**	?	0
17.6.98	Gill net	24.3	3.0+	0	0	0	0	**0**	?	0
17.6.98	Gill net	19.0	3.0+	0	0	0	3	**3**	?	0
17.6.98	Gill net	22.3	3.0+	0	2	1	0	**3**	?	0
17.6.98	Gill net	21.0	3.0+	0	0	0	1	**1**	?	0
17.6.98	Gill net	23.3	4.0+	0	2	0	8	**10**	?	0
24.6.98	Gill net	23.2	3.0+	0	0	0	4	**4**	?	0
24.6.98	Gill net	24.4	3.0+	0	1	0	0	**1**	?	0
24.6.98	Gill net	22.8	3.0+	0	0	0	0	**0**	?	0
24.6.98	Gill net	27.0	4.1+	1	0	0	0	**1**	?	0
24.6.98	Gill net	20.2	3.0+	1	0	0	0	**1**	?	0
24.6.98	Gill net	24.5	3.0+	3	0	0	6	**9**	?	0
24.6.98	Gill net	20.0	3.0+	0	0	0	0	**0**	?	0
24.6.98	Gill net	24.2	3.0+	3	0	2	15	**20**	?	0
24.6.98	Gill net	23.5	4.0+	0	0	0	0	**0**	?	0
24.6.98	Gill net	20.0	3.0+	0	0	0	0	**0**	?	0

2 1999 and 2000

		SEA TROUT		SEA LICE *Lepeophtheirus salmonis*						
Date	Method	Length (cm)	Age	Ovigerous females	Other adults	Pre-adults	Chalimus	**TOTAL LICE**	Dorsal damage?	*Caligus elongatus*
1999										
7.6.99	Gill net	21.0	3.0+	0	0	1	3	**4**	?	0
8.6.99	Gill net	24.0	3.0+	0	0	16	4	**20**	?	0
8.6.99	Gill net	23.1	3.0+	0	0	5	10	**15**	?	0
8.6.99	Gill net	24.1	3.0+	0	1	0	0	**1**	?	0
8.6.99	Gill net	27.1	3.0+	0	0	1	4	**5**	?	0
8.6.99	Gill net	22.0	3.0+	0	0	15	82	**97**	?	0
8.6.99	Gill net	28.0	3.sm+	0	0	2	8	**10**	?	0
8.6.99	Gill net	21.7	3.0+	0	0	1	1	**2**	?	0
8.6.99	Gill net	21.5	3.0+	0	0	3	77	**80**	?	0
16.6.99	Gill net	19.0	3.0+	0	1	29	14	**44**	?	0
18.6.99	Gill net	23.0	3.0+	0	1	1	2	**4**	?	0
29.6.99	Gill net	20.0	3.0+	0	1	2	5	**8**	?	0
29.6.99	Gill net	21.5	3.0+	1	2	8	16	**27**	?	0
29.6.99	Gill net	21.9	3.0+	1	2	4	11	**15**	?	0
29.6.99	Gill net	21.0	3.0+	1	4	7	16	**28**	?	0
29.6.99	Gill net	29.5	3.1+	1	0	2	3	**6**	?	0
30.6.99	Gill net	23.0	4.0+	1	1	2	5	**9**	?	0
30.6.99	Gill net	24.0	3.0+	1	1	1	8	**11**	?	0
30.6.99	Gill net	27.0	3.sm+	1	3	5	4	**13**	?	0
30.6.99	Gill net	18.8	3.0+	1	0	0	2	**3**	?	0
30.6.99	Gill net	27.5	3.1+	1	0	0	0	**1**	?	0
2000										
15.6.00	Gill net	33.0	4.1+sm+	0	2	6	3	**11**	?	0
15.6.00	Gill net	31.3	4.1+sm+	0	3	7	13	**23**	?	0
15.6.00	Gill net	21.3	4.0+	0	0	0	0	**0**	?	0
15.6.00	Gill net	25.2	4.0+	0	0	0	5	**5**	?	0
15.6.00	Gill net	23.7	?	0	0	0	1	**1**	?	0
16.6.00	Gill net	26.0	3.1+	0	0	0	0	**0**	?	0
16.6.00	Gill net	22.7	4.0+	0	0	3	0	**3**	?	0
16.6.00	Gill net	25.7	4.0+	0	0	0	0	**0**	?	0
22.6.00	Gill net	23.9	4.0+	0	0	4	3	**7**	?	0
22.6.00	Gill net	29.4	4.1+sm+	1	1	1	0	**3**	?	0
26.6.00	Gill net	24.2	4.0+	0	0	0	0	**0**	?	0
26.6.00	Gill net	27.8	3.1+	0	0	0	0	**0**	?	0
26.6.00	Gill net	24.1	4.0+	0	0	1	0	**1**	?	0
28.6.00	Gill net	23.3	3.0+	0	1	0	7	**8**	?	0
28.6.00	Gill net	24.8	4.0+	0	0	5	5	**10**	?	0
28.6.00	Gill net	24.7	4.0+	0	1	0	1	**2**	?	0
29.6.00	Gill net	24.7	4.0+	0	1	7	0	**8**	?	0
29.6.00	Gill net	28.1	5.0+	0	1	5	5	**11**	?	0
29.6.00	Gill net	21.0	3.0+	0	0	0	0	**0**	?	0
30.6.00	Gill net	25.5	4.0+	0	4	0	9	**13**	?	0
30.6.00	Gill net	25.2	4.0+	0	1	0	0	**1**	?	0

Appendix VI

Brown trout scale data from the accessible area of the Ewe catchment and also Loch Tollaidh (read by FRS and WRFT)

1 Freshwater age 1–4 years

AGE:	**1+**			**2+**			**3+**			**4+**			**4+** *(cont.)*	
Length (cm)	Date	Location	Length (cm)	Date	Location	Length (cm)	Date	Location	Length (cm)	Date	Location	Length (cm)	Date	Location
10.2	*3.5.01*	*Loch Tollaidh*	21.0	17.11.97	L. na Fideil Burn	28.0	17.11.97	L. na Fideil Burn	37.0	13.11.97		24.0	10.7.98	
9.5	*28.5.01*	*Loch Tollaidh*	23.0	17.11.97	L. na Fideil Burn	21.0	17.11.97	L. na Fideil Burn	40.0	12.11.97		33.7	20.6.01	
9.8	*29.5.01*	*Loch Tollaidh*	19.0	7.11.97	L. na Fideil Burn	25.0	12.11.97	L. na Fideil Burn	37.0	12.11.97		28.2	22.6.01	
			19.5	7.11.97	L. na Fideil Burn	24.0	12.11.97	L. na Fideil Burn	29.0	7.11.97		24.3	9.6.01	
			21.5	19.11.97	L. na Fideil Burn	20.0	12.11.97	L. na Fideil Burn	24.0	7.11.97		26.0	9.7.01	
			19.5	19.11.97	L. na Fideil Burn	26.0	12.11.97	L. na Fideil Burn	22.0	7.11.97		26.3	21.8.01	
			19.5	19.11.97	L. na Fideil Burn	22.0	12.11.97	L. na Fideil Burn	24.0	7.11.97				
			21.0	18.11.97	L. na Fideil Burn	20.0	7.11.97	L. na Fideil Burn	19.6	19.11.97		*25.5*	*29.7.01*	*Loch Tollaidh*
			21.0	18.11.97	L. na Fideil Burn	21.0	7.11.97	L. na Fideil Burn	28.0	18.11.97		*26.8*	*28.7.01*	*Loch Tollaidh*
			21.0	17.11.97	L. na Fideil Burn	22.0	7.11.97	L. na Fideil Burn	19.5	18.11.97		*26.0*	*27.7.01*	*Loch Tollaidh*
			21.5	10.9.97	Loch Maree	28.3	19.11.97	L. na Fideil Burn	20.0	18.11.97				
			24.0	5.9.97	Loch Maree	24.0	18.11.97	L. na Fideil Burn	37.0	18.11.97				
			24.0	3.9.97	Loch Maree	23.0	5.9.97	Loch Maree	32.0	18.11.97				
			19.5	3.9.97	Loch Maree	27.0	6.9.97	Loch Maree	37.0	18.11.97				
			15.2	28.8.97	Loch Maree	27.0	5.9.97	Loch Maree	25.0	18.11.97				
						28.0	5.9.97	Loch Maree	26.0	17.11.97				
			14.6	*3.5.01*	*Loch Tollaidh*	22.0	5.9.97	Loch Maree	27.0	17.11.97				
						22.0	16.8.97	Loch Maree	24.0	4.9.97	Loch Maree			
						19.0	7.97	Loch Maree	24.0	3.9.97	Loch Maree			
						25.5	7.97	Loch Maree	28.0	15.8.97	Loch Maree			
						33.0	17.6.97	Loch Maree	30.5	7.8.97	Loch Maree			
						35.5	19.6.97	Loch Maree	30.5	7.8.97	Loch Maree			
						20.0	31.8.97	Loch Maree	17.0	10.7.97	Loch Maree			
						24.0	16.8.98	Loch Maree	22.0	10.7.97	Loch Maree			
						34.0	6.7.98	Loch Maree	23.0	7.7.97	Loch Maree			
						17.5	6.7.98	Loch Maree	17.0	7.7.97	Loch Maree			
						25.0	8.6.98	Loch Maree	34.3	20.6.97	Loch Maree			
						19.0	*29.7.01*	*Loch Tollaidh*						
						21.6	*29.7.01*	*Loch Tollaidh*						
						22.6	*25.6.01*	*Loch Tollaidh*						
						21.5	*28.7.01*	*Loch Tollaidh*						

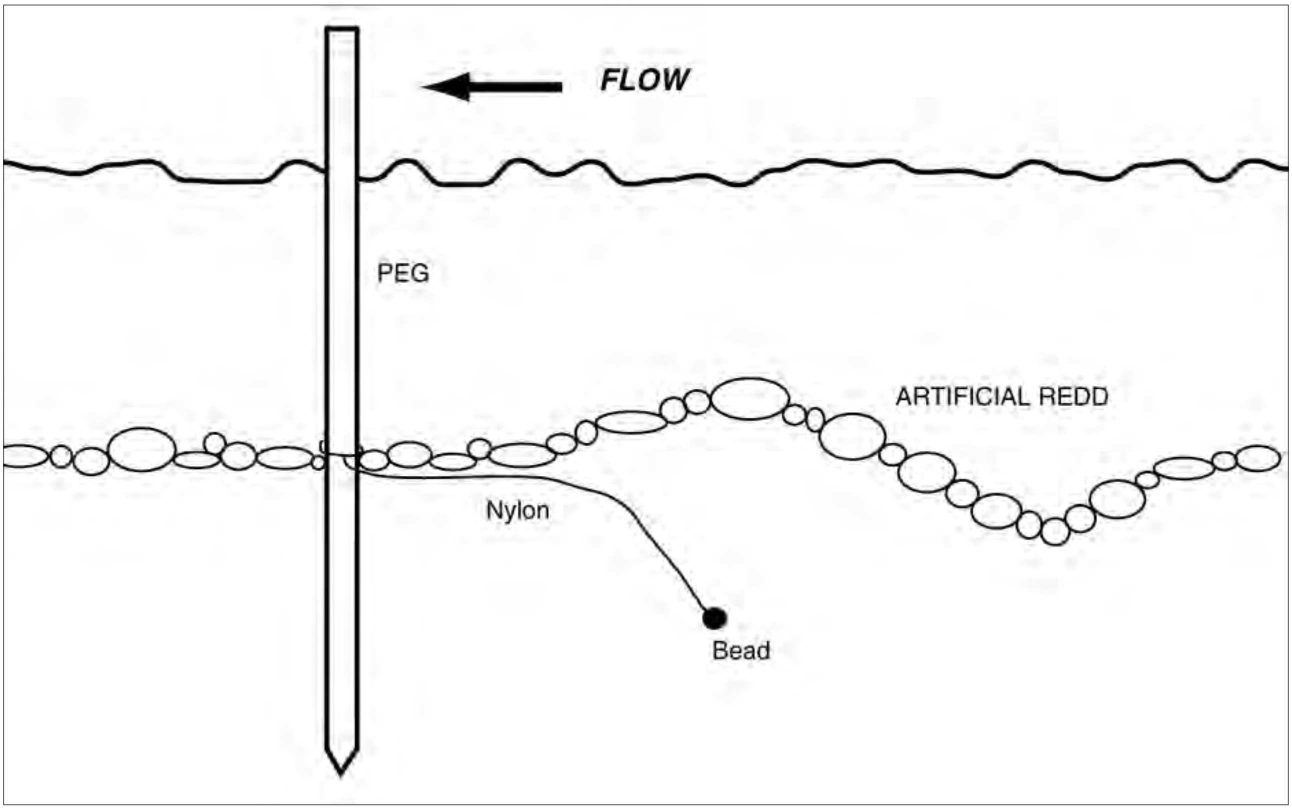
2 Freshwater age 5–9 years

AGE: 5+			6+			7+			8+		
Length (cm)	Date	Location	Length (cm)	Date	Location	Length (cm)	Date	Location	Length (cm)	Date	Location
28.5	7.11.97	L. na Fideil Burn	33.5	7.11.97	L. na Fideil Burn	45.5	6.8.97	Loch Maree	22.5	19.11.97	
45.0	8.12.97	L. na Fideil Burn	34.5	7.11.97	L. na Fideil Burn	27.0	9.00	Loch Maree	32.5	19.11.97	
26.0	19.11.97	L. na Fideil Burn	30.0	18.11.97	L. na Fideil Burn	29.6	9.00	Loch Maree	51.5	28.9.01	Loch Maree
41.0	19.11.97	L. na Fideil Burn	33.5	1.7.97	River Ewe	30.7	10.00	Loch Maree			
44.0	18.11.97	L. na Fideil Burn	36.0	1.7.97	River Ewe	42.0	21.6.01	Kinlochewe R.			
41.0	18.11.97	L. na Fideil Burn	40.5	25.6.97	River Ewe	41.5	20.6.01	A'Ghairbhe R.	**9+**		
43.0	17.11.97	L. na Fideil Burn	31.5	3.12.98	Loch Maree				57.0	8.01	Loch Maree
33.0	17.11.97	L. na Fideil Burn	40.0	3.12.98	Loch Maree						
27.5	4.9.97	Loch Maree	34.0	8.7.98	Loch Maree						
35.5	16.8.97	Loch Maree	26.5	10.00	Loch Maree						
40.0	10.7.97	Loch Maree	26.9	9.00	Loch Maree						
31.0	10.7.97	Loch Maree	34.0	20.6.01	Bruachaig						
28.0	8.7.97	Loch Maree	50.0	26.6.01	Loch Maree						
28.0	7.7.97	Loch Maree	27.5	20.8.01	Loch Maree						
31.0	16.6.97	Loch Maree	46.0	8.01	Loch Maree						
32.5	31.8.98	Loch Maree									
25.0	27.5.98	Loch Maree									
25.5	10.00	Loch Maree									
30.0	20.6.01	Kinlochewe R.									
32.0	20.6.01	A'Ghairbhe R.									
28.8	22.6.01	Loch Maree									
27.5	13.8.01	Loch Maree									
32.5	*13.6.01*	*Loch Tollaidh*									
35.0	*29.7.01*	*Loch Tollaidh*									
26.0	*29.7.01*	*Loch Tollaidh*									
32.5	*13.6.01*	*Loch Tollaidh*									

Appendix VII

Redd Washout Project, Winter 1998–1999

Creation of artificial redd site.



Method

- Two redds created at each site, at 45° upstream and to either side of the stake.
- One salmon redd (large bead buried at 30 cm), one sea trout redd (small bead buried at 15 cm).
- Site planted in November, and checked the following April. If washed out, bead found hanging on the end of the nylon, downstream from stake.

Appendix VIII

Calculation of wild salmon spawning targets

1. Data used to calculate wild salmon spawning targets

JUVENILE HABITAT	Maximum smolt output	Egg–smolt survival rate	Target egg deposition rate
[1]RIVERINE	0.05/m^2	0.017	2.6/m^2
[2]LACUSTRINE – Grade 1	20/ha	0.019	1,052/ha (0.105/m^2)
[3]LACUSTRINE – Grade 2	7/ha	0.019	368/ha (0.037/m^2)

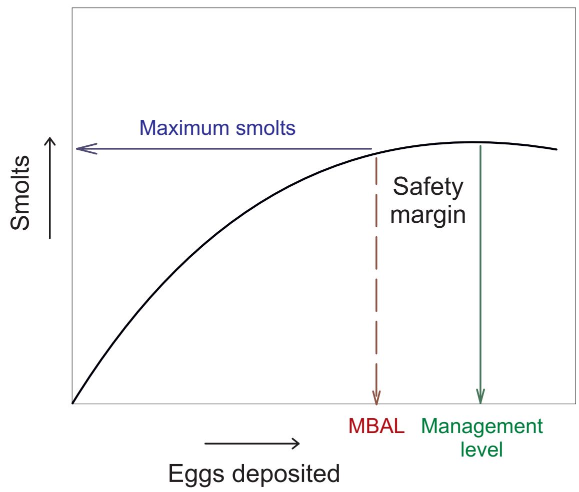
[1] **Riverine habitat** Data are used from the FRS Girnock Burn trap, River Dee. It has been calculated that the riverine area of 58,000 m^2 above the trap requires a minimum of 150,000 eggs to produce a maximum smolt output of 3,000 fish. This equates to an egg deposition rate of 2.6/m^2. However, to allow for a 'safety limit' the FRS have increased the target by 15% to 3.0/m^2.

[2] **Lacustrine habitat – Grade 1** Shallow lochs are more productive than deeper, oligotrophic ones. For the sake of definition, shallow lochs have been termed Grade 1. To estimate the potential smolt output of these lochs, data have been used from the WRFT Tournaig trap. In 1999 the system produced a run of 703 smolts, and scale samples showed that 534 (76%) had grown in Lochs Dalthean and Loch a Chuirn[17]. Both lochans are small, shallow and reedy, and have a total area of 26 ha. This equates to a smolt output of 20/ha, and using the Canadian lacustrine egg-smolt survival rate (see below) of 0.019, an egg deposition target of 1,052/ha was derived. The productivity of lochs for salmon depends on the level of competition from other species. In Tournaig only brown trout and eels are present, and since this is typical of most lochs in the WRFT area, this egg deposition target is probably transferable to other Grade 1 lochs.

[3] **Lacustrine habitat – Grade 2** There are no data available for deeper, unproductive lochs in Scotland. Instead, information for lakes in Newfoundland, Canada, were used, where the average smolt output is 7/ha. It has been calculated for these unproductive lakes that the egg-smolt survival rate is 0.019, yielding an egg deposition target of 368/ha.[36]

2. Biological and management spawning targets

Different forms of spawning target are used within the range of salmon-producing countries. The first is the Minimum Biological Acceptable Limit (MBAL). This egg deposition target is set at the minimum eggs required to produce the maximum number of smolts, and surplus return of adults. However, this target does not allow any contingency for unforeseen disasters (e.g. disease, redd washout, acidification) which might reduce the survival of eggs below that predicted. Consequently some rivers set a management level, that also produces the maximum number of smolts, but aims for a slight overproduction of eggs to compensate for any problems. Management levels also give a degree of security when the data used to calculate spawning targets may be inaccurate. These spawning targets are illustrated in the theoretical stock-recruitment graph opposite.



Appendix IX

Summary of the six conservation status categories standardised for Atlantic salmon by the World Wide Fund for Nature. (One generation is equal to 5 years.)

Category	Criteria (one of the following applies)
1 Extinct	• Known historical presence, but no evidence of reproduction for one generation.
2 Critical	• Less than 50 spawners annually. • Decline in population size by an order of magnitude within the last generation. • Average of less than 20% attainment of spawning targets in most recent years. • An average of more than 30% of spawners in last five years are farm escapees. • Non-native smolts constitute more than 30% of smolts annually.
3 Endangered	• Fewer than 50 spawners at least once in each generation. • Population reduced by 50% in most recent generation, or 75% over longer time period. • Average of 20–50% of spawning target attained in two most recent years. • An average of more than 10% of spawners in last five years are farm escapees. • Non-native smolts constitute more than 10% of smolts annually.
4 Vulnerable	• 50–100 spawners and no serious decline caused by human factors. • Average of 50–90% of spawning targets attained in two most recent years.
5 Healthy	• More than 500 spawners and no serious problems caused by human factors. • Average of 100% of spawning target attained in two most recent years.
6 Unknown	• Too little information available to enable categorisation.

Appendix X

Catch records

Please follow the following principles, as shown in the example below, for accurate catch recording:

- Record the date
- Record ***all*** fish caught, including small finnock and trout
- Record each fish individually if possible
- Record place of capture
- Record weight of fish, estimated if fish returned
- Record whether released or killed
- For salmon, record if wild or farm escapee

Note any other interesting points: sex of fish, time of day, sea lice damage, tags, put in hatchery, etc.

Sample catch records:

Date	Name	Place	FISH	Weight (lb)	Killed/Returned?	Notes (fly, pool), sea trout tag details, sea lice damage etc.
21st July 1999	Mr. Joe Bloggs	Balgy	Salmon	5 lbs.	Killed	Escaped farm fish. Grass Pool, Stoat's Tail, spate. 8 pm.
" " "	" "	"	Sea trout	8 ozs.	Returned	Finnock. Bridge Pool. Stoat's Tail. 9.30 pm. Not tagged. approx. 40 lice
25th July 1999	Mrs. Mary Bloggs	Balgy	Salmon	11 lbs.	Returned	Wild hen fish, quite stale. Thunder & Lightning, Falls Pool, dusk.
" " "	" "	"	Salmon	4 1/2 lbs.	Returned	Fresh cock fish, wild. Thunder & Lightning. Bridge Pool, 9 pm.
" " "	" "	"	Sea trout	2 lbs.	Returned	Fresh run, Bridge Pool. Zulu, 11pm. Night fishing.
" " "	" "	"	Sea trout	9 ozs.	Returned	Finnock. Bridge Pool. 11.30 pm.
" " "	" "	"	Brown trout	10 ozs.	Returned	Bridge Pool, Zulu, 12 pm. Fishing for sea trout.
1st August 1999	A.N. Other	Loch Damph	Brown trout	1 lb. 2 ozs.	Killed	Dap. 3 pm in Narrows.
" " "	" "	"	Brown trout	10 ozs.	Killed	Dap. 2.30 pm at boat house.
" " "	" "	"	Sea trout	3 lbs.	Returned	Stale hen fish. Dap in Narrows. 2.30 pm.