Part 3 Freshwater fishes and fish production in Wester Ross

3.1 Introduction

This part of the fisheries management plan provides an overview of what we know about freshwater fish species within the Wester Ross Fisheries Trust area [River Kanaird to River Barrisdale] including the distribution and current (2008) status of respective species. Much of the information is from WRFT surveys; some of it has been collated from earlier reports.

The following freshwater fishes have been recorded within the WRFT area:

1. *Sea lamprey*
2. *Brook (& ?River) lamprey*
3. *European Eel*
4. *Atlantic salmon*
5. *Brown trout*
6. *Arctic charr*
7. *Brook charr*
8. *Eurasian minnow*
9. *Three-spined stickleback*
10. *Pike*
11. *Flounder*

The species of fisheries importance are the *Atlantic salmon* and *Brown trout* especially sea trout. The *Arctic charr* is currently of considerable conservation interest. The *Eurasian minnow*, *Brook charr* and *Pike* are considered to be non-native to the area. All the other fishes are considered to be naturally occurring.

In recent years, the *Sea bass* (which is sometimes included in lists of freshwater fish) has also been recorded around the shores of Wester Ross. Sea bass have been taken by anglers fishing at Red Point, in Loch Gairloch and in Gruinard Bay. However, to date it has not been recorded in the freshwaters of the area.

Wild brown trout lochs in the hills above Loch Maree

3.2 Lampreys

Lampreys have a cartilaginous skeleton and no jaws and are regarded as being rather primitive fishes. Adult sea lampreys and river lampreys are anadromous and parasitise other fish; the Brook lamprey has very similar mouth parts to the River lamprey and is evidently closely related. All lampreys are listed in the EU Habitats & Species Directive 1990 as species of conservation priority. Box 3.2.1 describes the findings from initial surveys (reproduced from WRFT Review May 2005).

3.2.1 **Sea lamprey** *Petromyzon marinus*

Within the WRFT area, the Sea lamprey has been recorded only in the River Carron. Ammocoetes (juvenile lampreys) were found in organic sediment below the road bridge near Strathcarron, during survey work led by Dr Jon Watt of Ecological Research Services (ERA) for SNH in September 2004.

In August 2007, adult sea lampreys were seen in the River Carron further upstream by Bob Kindness of Seafield College*: 'I observed the pair of sea lampreys while wading just below the stepping stones downstream from the old bridge at the outfall from Loch Dughaill. They were in water about 15 inches deep and the habitat was a mix of weed and cobble-sized stones. They were moving around together in the one spot and I observed them for about 10 minutes before leaving them to it. They were totally oblivious of my presence.'*

3.2.2 **Brook (& River?) lamprey** *Lampetra planeri* or *Lampetra* spp.

Lampetra ammocoetes were found in the River Carron, River Croe and Glenmore River in 2004, and in the River Shiel in 2006. They have not all been identified to species level with certainty, though most are thought to be Brook lamprey *L. planeri* rather than River lamprey *L. fluviatalis*. Ammocoetes of these two species are difficult to distinguish. Those from the River Shiel looked intermediate in appearance; there remains some doubt as to how separate the two *Lampetra* spp. are [Maitland, *pers comm*.]. Lamprey ammocoetes were not found in the Dundonnell, Ewe, Torridon or Elchaig Rivers. Small populations may be present in some of the smaller rivers in the south of the area which have not been surveyed.

In the River Carron *Lampetra* ammocoetes were found in suitable patches of organic silty debris at the sides of the main channel up to Loch Dughaill, and in several of the inflowing streams. High densities ammocoetes were found in twiggy silt behind the boat house near the mouth of an unnamed burn at NGR 200350 847850. Lampreys were seen spawning in another minor tributary entering Loch Dughaill at in 2007 by Bob Kindness *'The brook lampreys that I watched spawning were immediately below the culvert in the small burn that flows into Loch Dughaill just east of the big parking lay-by towards the west end of the loch. When I went back the following day there were several dead lampreys on the bed of the burn.'*

In the River Croe, *Lampetra* ammocoetes were found in 2004 and again in 2007 in silt patches beneath alder trees by the outdoor centre at NGR196000 821050.

In the River Shiel *Lampetra* ammocoetes were found on 25th August 2005 in weedy silt patches beneath alder trees [NGR 195800 816000]. These appeared to be intermediate between the two 'species' (if they are indeed true species [Maitland, *pers comm*.]). One of these fish was kept alive in the WRFT office, in a bucket of water with an air stone, an old tea bag (=silt substrate!) and a black plastic bag as a cover for 8 months, after which it was returned to the river apparently none the worse for its extended sabbatical.

In the Glenmore River *Lampetra* ammocoetes were found in fine silt by the sides of the main river from just above the road bridge at Glenelg to Scalascaig. They were also found in twiggy silt at a ford over the Beolary burn at NGR 186150 918850, and in 2007 near the Cnoc Fionn Road end in the main river.

3.2.3 Lamprey conservation and management

Most rivers in the WRFT area are swiftly flowing with coarse sediment substrate providing little suitable habitat for lampreys. In the mainstem rivers Carron, Croe, Shiel and Glenmore, lamprey habitat is closely associated with riparian alder trees that provide suitable eddies and bays between tree trunks and their roots where silt gathers and ammocoetes can burrow.

There is no information to indicate whether or not any of the lamprey populations are currently threatened. *Lampetra* populations appeared to be particularly healthy with a wide range in the size of ammocoetes.

The only other rivers in the WRFT area with areas of potentially suitable lamprey habitat are the Dundonnell and the Kanaird. Electro-fishing surveys of suitable habitat in these rivers have so far failed to locate ammocoetes.

3.2.4 Recommendations for Lamprey conservation (see Part 6 'actions' plan)

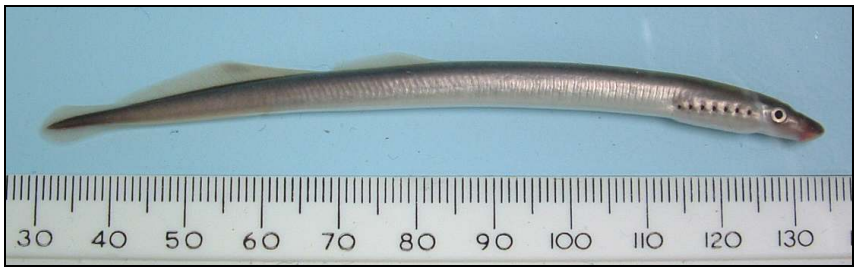
1. Further efforts are required to clarify the species identity of *Lampetra* ammocoetes in the south of the WRFT area. Samples of *Lampetra* populations should be collected for genetic analyses to find out whether one or two species are represented.

2. Spawning areas should be located in respective rivers. Further work is require to locate where lampreys spawn, building on the observations of Bob Kindness. People living in and around river catchments with lampreys should be alerted to the possibility of lampreys spawning and invited to report any observations.

3. The status of lamprey populations in respective rivers could be monitored every two years. This can be done most efficiently at the time of electro-fishing surveys for juvenile salmonids.

4. Further discussions with scientists working in other areas and with SNH would be useful to clarify the conservation importance of local populations relative to other lamprey populations in Scotland.

Lamprey ammocoete / emerger from the River Shiel. August 2005.



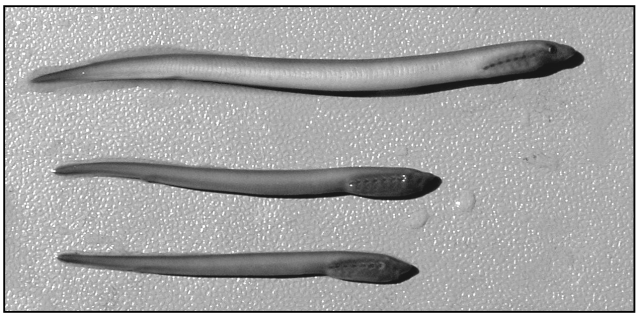
Box 3.2.1 *Lampreys in Wester Ross (from WRFT Review, May 2005)*

There are three lamprey species in the UK. Brook lamprey (*Lampetra planeri*) remain in freshwater. River lamprey (*L. fluviatalis*) and Sea lamprey (*Petromyzon marinus*) are anadromous—migrating to sea where they parasitize other fish. After hatching, juvenile lampreys, known as ammocoetes spend up to 5 years growing in their burrows in silt before developing eyes and teeth and emerging. In early September 2004, Peter Cunningham and Dr Lorna Brown joined Dr Jon Watt of Ecological Research Associates [ERA] to begin a survey of lampreys within the area as part of a contract for SNH.

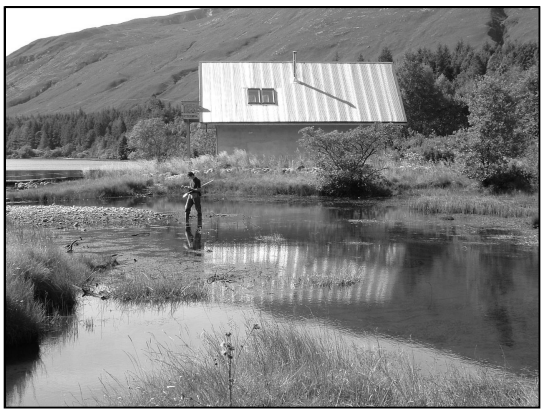
Ammocoetes of both *Lampetra* sp. and *Petromyzon marinus* were found in the R. Carron below the bridge at Strathcarron. *Lampetra* sp. were also found above Loch Dughaill, with the highest densities recorded in twigging silt in the mouth of the Achnashellach Burn near Os Lair. No lampreys were found above Glencarron falls. Lampetra *ammocoetes* were also found in the Glenmore (Glenelg) River and in the River Croe.

Petromyzon marinus are not know from any other rivers within the area. *Lampetra* have been found in the River Croe and Glenmore (Glenelg) rivers but not further north. So far as is currently known, the River Carron has the highest diversity of native freshwater fish species of any river system within Northwest Scotland.

0+ Lampetra ammocoete from the Glenmore River at Glenelg.



Ammocoetes of Lampetra sp. (top) and sea lamprey (bottom) from the River Carron near Strathcarron bridge.



Lamprey habitat in the Glenmore River (left) and by Loch Dughaill (River Carron).

3.3 European eel *Anguila anguila*

From somewhere deep in the Sargasso Sea, eel larvae drift randomly towards the rivers of Europe according to the vagaries of ocean currents. It is thought that they don't have much choice so far as to where they'll end up. Some get lucky and find themselves in a nutrient-rich lowland stream full of juicy invertebrates and other choice items of animal prey. Others, through no fault of their own, end up at the bottom of some barren loch in Wester Ross, where they remain for 10+ years with little besides chironomid midge larvae or perhaps an absent minded benthic charr for food (they have the option of heading back down to the sea from time to time which some take). All European eels are understood to belong to a single interbreeding population, in contrast to the wide biodiversity of char, trout and salmon populations.

Eels are recorded during routine WRFT electro-fishing surveys. Because of the time it takes for eels to emerge from the streambed relative to juvenile salmon or trout during electro-fishing surveys, recorded catches represent a lower proportion of the eel population at any given site than those of trout or salmon which are usually the target species.

The European eel has been found throughout the WRFT area. Eels are most abundant in the lower parts of river systems (see Figure 3.3.2). Eels are scarce in the infertile streams furthest from the sea (e.g. upper Gruinard, Little Gruinard above Loch na Sealga). Eels have been found in several streams where trout or salmon do not occur, including above a 10m waterfall in a tributary of the River Talladale.

Eels of less than 100mm in length are rarely found more than 5 km from the sea. Eels found towards the headwaters tend to be 250mm+ in length. Research elsewhere has suggested that the larger eels found in upper catchment areas may be predominately females. One of the largest eels recorded by WRFT was taken in a trap in Loch nan Dailthean in the Tournaig River system in 2000, was over 80cm in length, and weighed 4.5lb.

The Tournaig monster: an eel of 4.5lb taken in an eel trap at Tournaig in 2000

During the 1990s there were intermittent eel fisheries in the Ewe and Little Gruinard catchments. In the Little Gruinard the fishery exploited the elver run. In the River Ewe elvers were targeted using traps and dip nets, and silver eels were targeted with fyke nets. Neither enterprise proved to be particularly successful owing to the unpredictability of elver runs and the generally small size of silver eels caught rendering them of little commercial value (Butler 2002).

There is little information on numbers of elvers entering the rivers in the area since the 1990s.

Tournaig data

Descending silver eels are recorded each year at the WRFT Tournaig trap on their way to sea. Not all descending eels are recorded. Very high spate flows overtop the screens that divert fish into the trap. These often occur in the autumn. In 2005, 200 silver eels were caught descending to sea in the autumn, with the majority descending from 27th to 29th September. The trap was kept in operation almost throughout the autumn. However, water levels over topped the screen on the 13th of September and during November, so other eels may have been missed. This was the largest number of silver eels so far recorded leaving the Tournaig system. As in previous years, most eels were between 30 and 34 cm in length; the largest was 44 cm (Figure 3.3.1). In 2006 and 2007, fewer eels were caught and large spates again prevented the operation of the trap at highest flows.

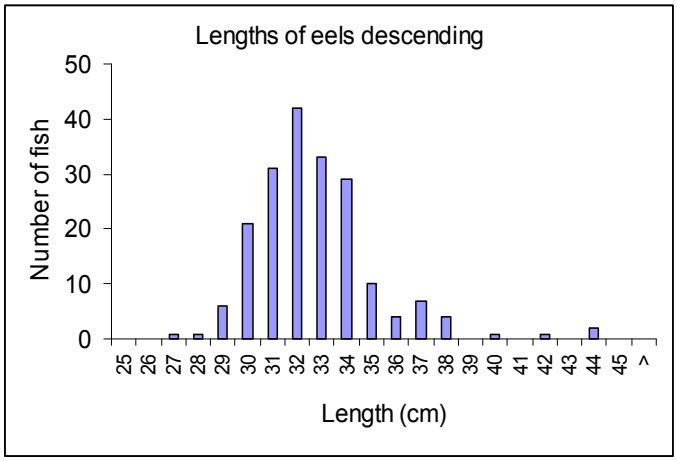
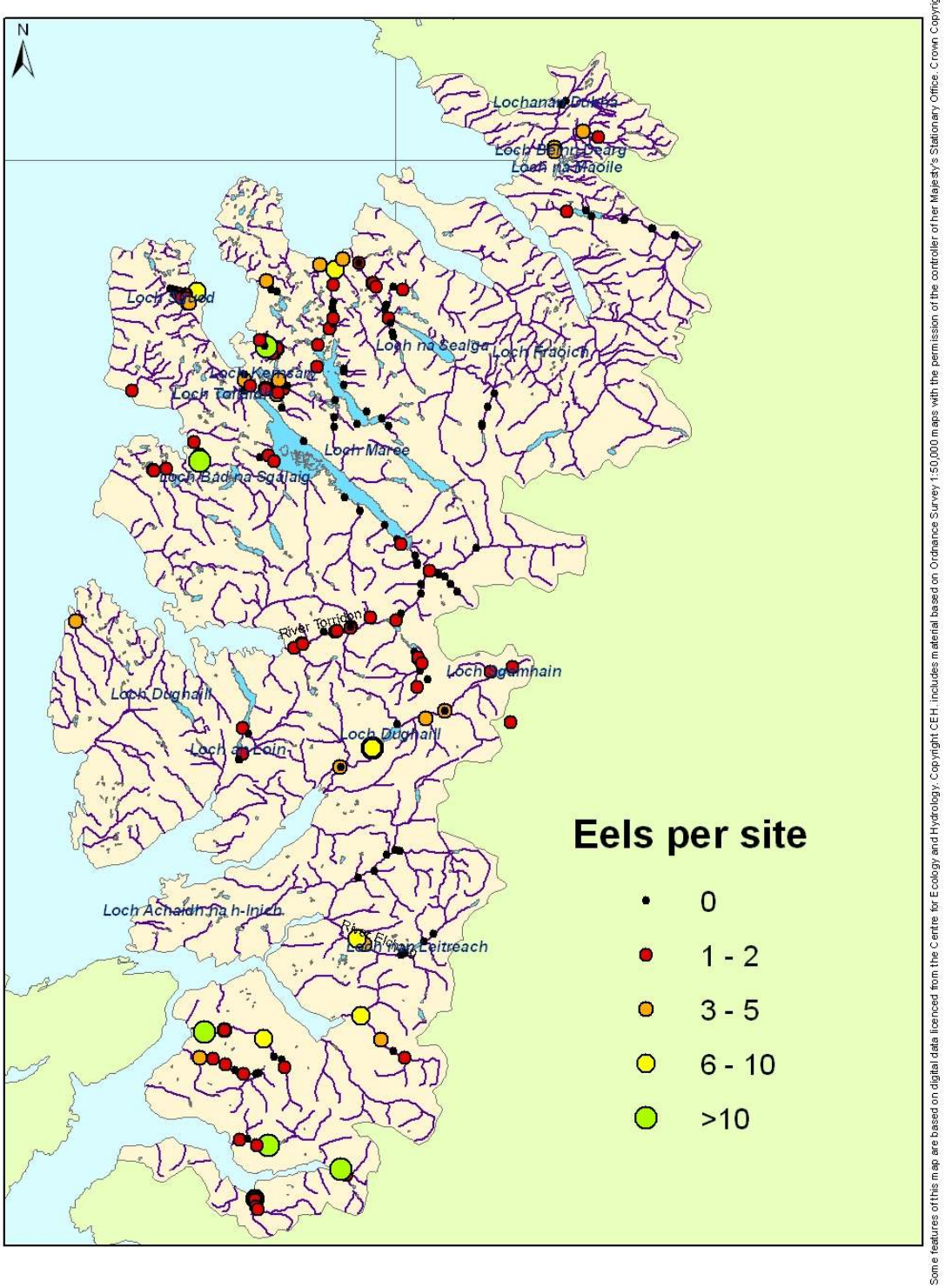


Figure 3.3.1 *Lengths of silver eels descending through the trap at Tournaig in 2005*

An elver monitoring trap could be established at Tournaig to record the timing and numbers of elevers entering the system.

Silver eels taken in the Tournaig trap on their way to sea (Ben Rushbrooke).

Figure 3.3.2 *Distribution of eels recorded at electro-fishing sites fished in 2006 and 2007. These numbers do not relate directly to CPUE, not all eels seen are caught or recorded. [Note that many eels were recorded in the Lower Ullapool River, River Broom and Dundonnell River in surveys prior to 2006.]*



3.4 Atlantic salmon *Salmo salar*

The Atlantic salmon is an iconic species for Wester Ross. Both the Gairloch Heritage Museum and the Wester Ross Coastal Trial have adopted a salmon symbol based on the design on the museum's Pictish stone [see Part 1] as their logo. Salmon were formerly netted around the coastline and continue to support valuable rod fisheries. The Little Gruinard River has been designated as a Special Area of Conservation [SAC] for Atlantic salmon under the EU Habitats and Species Directive.

3.4.1 Occurrence

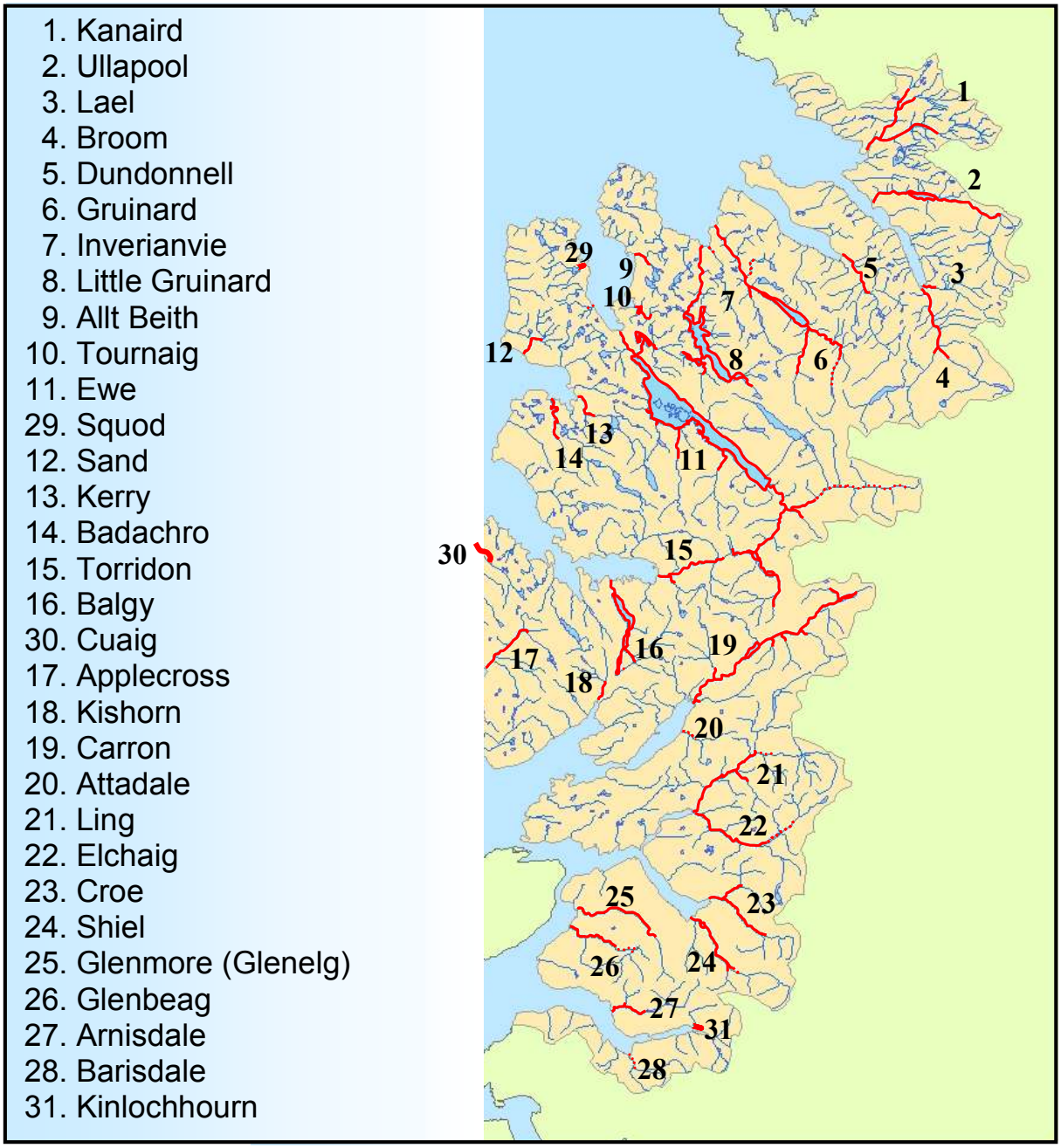
Juvenile salmon are currently known or thought to be present in over 30 river systems within the WRFT area. These range in size from the little Tournaig system near Poolewe to the River Ewe system nearby (Table 3.4.1).

Table 3.4.1 *River systems where juvenile Atlantic salmon have been recorded. 'Distribution' refers to the occurrence of juvenile salmon within the area considered to be accessible to adult fish. 'Date' refers to the time of the most recent WRFT e-fish record. 'Genetic status' refers to the likely status of the population. Please refer to main text for further details. All rivers listed excluding the Applecross, Kishhorn and Attadale were visited by the WRFT e-fishing team in 2006 or 2007.*

	River	Distribution	Date	Genetic status	Notes
1	Kanaird	widespread	2007	uncertain	Genetic status uncertain: stocking & escapees
2	Ullapool	widespread	2007	uncertain	See text for further details
3	Lael	restricted	2005	uncertain	May be part of Broom metapopulation
4	Broom	widespread	2006	uncertain	
4	Dundonnell	widespread	2007	uncertain	supplementary stocking from native fish
5	Gruinard	part-restricted	2007	part- healthy	salmon absent from headwater
6	Inverianvie	present	2007	metapop?	small system
7	Little Gruinard	widespread	2006	healthy	population healthy
8	Allt beith	present	2007	metapopulation?	salmon recolinised area above fish ladder
9	Tournaig	widespread	2007	metapopulation?	salmon spawned in 2004 after absence of 3 yrs
10	Ewe	part-restricted	2007	part-healthy	wild fish absent from Bruachaig headwaters
11	Sguod	present	2007	metapopulation?	lower densities in 2007 than 2006
12	Sand	present	2007	metapopulation?	one site fished each year
13	Kerry	widespread	2007	uncertain	
14	Badachro	widespread	2006	?healthy	
15	Torridon	widespread	2007	uncertain	
16	Balgy	widespread	2007	uncertain	FRS genetics studies on-going
17	Cuaig	present	2007	recolonised	
18	Applecross	unknown	pre 2002		stocked (Bob Kindness)
19	Kishhorn	unknown	pre 2002	uncertain	small system
20	Carron	widespread	2007	uncertain	stocking throughout system (Bob Kindness)
21	Attadale	present	?2007	metapopulation?	Bob Kindness records; small system
22	Ling	widespread	2007	healthy	part-stocked with native fish
23	Elchaig	widespread	2006	uncertain	wild salmon recolonised top of system in 2005
24	Croe	widespread	2007	healthy	
25	Shiel	widespread	2006	uncertain	
26	Glenmore	restricted	2007	uncertain	salmon absent from top in 2006
27	Glenbeag	restricted	2006	uncertain	salmon absent from top in 2007
28	Arnisdale	widespread	2007	uncertain	stocked from native rod-caught adults
29	Kinlochhourn	widespread	2007	metapop?	small system
30	Barrisdale	restricted	2006	metapop?	small system

Distribution within river systems varies. Rivers where juvenile salmon are currently present throughout the accessible area are categorised as distribution 'widespread'. Rivers categorised as 'restricted' are those where wild juvenile salmon are currently absent from areas where they were formerly present. These include the headwaters of the Gruinard River (Abhainn Loch a' Nid); the headwaters of the River Ewe (upper Bruachaig above falls at NGR 206000 862850); headwaters of the River Balgy (above Loch an Loin); and headwaters of the Glenmore and Glenbeag rivers above complex falls.

Figure 3.4.1 *Known distribution of Atlantic salmon in the WRFT area at end of 2007.*



3.4.2 The abundance of adult salmon

Rod catches provide an indication of the numbers of wild and escaped farmed fish returning to and entering local waters. In the absence of other information, rod catch data has been used to estimate 'spawning escapement' (the number of spawning adult salmon) for management purposes; please refer to river specific WRFT Fisheries Management Plans. For rivers in Wester Ross, catches may vary from year to year according to fishing effort, the skill and knowledge of anglers, and to fishing conditions especially river levels. So far as the health and status of salmon and sea trout populations is concerned, any interpretation based on catch figures needs to take all these factors into account.

History of salmon fisheries in Wester Ross

The River Ewe is the largest salmon and sea trout river system within the area. Graham-Stewart (2005) notes that angling traditions on the Ewe go back to the late 1700s; 'by the start of the 19th Century its reputation was without peer'. In 1852, Osgood Mackenzie caught 30 salmon up to 27.5lb when only 10 years of age (MacKenzie, 1995); in earlier days catches were even more prolific in the River Ewe when cruives held back the fish in pools where they could easily be netted; Calderwood (in G-S 2005) notes that three cobble-fulls of salmon were taken in a single sweep of the net in the 1830s. Cruives were removed in 1847-1848 to allow fish through; catches subsequently collapsed. MacKenzie (2000) provides details of the river, its pools and other notable catches.

Net fisheries for salmon operated at many locations along the WRFT area coastline, and took many thousands of salmon per year. G-S (2005) quotes catches of salmon and grilse taken at bag net stations at Gairloch and Torridon which averaged between 4,500 and 6,000 salmon and grilse per year during this period. Former employees tell stories of 'bottle' fish; for every 100 salmon taken, they would be awarded a bottle of whiskey. As recently as 1993, 3,119 salmon were taken in a year at Red Point netting station alone. The following year, 1673 wild salmon were taken in a season at Redpoint; an additional 405 fish were recorded as 'escaped farm salmon'. The Red Point Netting station operated until 2000 when catches were so poor that it was economically non-viable. The station operated briefly again in 2004 but has since been abandoned and the netting bothy / store room has subsequently lost its roof and is much in need of attention (as are its contents).

Other netting stations that were operated into the 1990s around the WRFT area were the Laide netting station by Gruinard Bay (maximum catch of 2,880 salmon in 1971, minimum 239 salmon in 1990) which was closed in 1992 and the Bad an Tarbert netting station at Achiltibuie which operated until 1998.

In living memory, 'lorry loads' of salmon are said to have been taken in nets at Glenelg; declared catches for some years in 1970s show in excess of 1000 salmon taken. Many of these fish may have been destined for rivers further south: the Kyle Rhea narrows nearby is an obvious bottleneck for migrating salmon returning to the rivers of Lochaber and Argyll. The only legal netting station operated in the past two years is in Loch Long (near Loch Duich). In addition to legal netting, there is a long history of illegal netting of salmon, usually of the 'one for the pot' for local people sort. Plenty of local anecdote about that after a dram or two!

There are at least 22 rivers in the Wester Ross area where anglers have targeted and taken salmon within the past 20 years. Records for highest (or estimate of highest) total catches in recent years, which are available to WRFT provide an indication of the potential productivity of respective rivers – these are shown in Table 3.4.2. Bear in mind that a larger proportion of fish returning to respective rivers may have been taken in netting stations nearby until recent decades.

Table 3.4.2 *High (?-est) rod catches of salmon taken from rivers in WRFT area (from north to south) in recent decades to provide indication of productive potential. From the mid 1980s, escaped farm salmon may have been represented in some of the high catches (e.g. Balgy, where farm salmon which escaped as smolts may have been included)although in recent years these have been recorded seperately where anglers have recognised them as such.*

River	High rod catch of salmon	Year
Kanaird	95	1986
Ullapool	(269) 122	(1927) 1985
Lael	5+	1970s
Broom	163	1974
Dundonnell	76	1987
Gruinard	450	1978
Little Gruinard	130+	late 1980s
Ewe	394	1979
Kerry	20+	?
Badachro	42	1973
Torridon	30+	?
Balgy	65	1987
Applecross	100+	?
Carron	262	2007
Ling	105	1985
Elchaig	50+	?
Croe	130	1974
Shiel	97	1987
Glenmore	63	1980
Glenbeag	14	1980
Arnisdale	65	1981
Barrisdale	5	1970 & 1980

Fresh run grilse taken at the Tournaig trap in July 2008 (Ben Rushbrooke)

Recent catches

The Scottish Government through Fisheries Research Services [FRS] compiles and publishes summarised information from catch returns usually towards the latter part of the year following the season in question. As the catch figures from several rivers may be grouped together, these summaries are inadequate to provide an indication of how individual rivers are performing within the WRFT area. Under the Freedom of Information (Scotland) Act 2002, FRS kindly provided WRFT with copies of all catch returns from rivers in the WRFT area for the 2007 season for fisheries management purposes.

Rod catches of salmon in 2007 were higher than in 2006 and other recent years for nearly all major rivers within the WRFT area. Figure 3.4.2 shows the catch of salmon (including grilse) for the River Ewe system and the Gruinard River; traditionally the two most productive salmon rivers in the WRFT area.

Figure 3.4.2 *River Ewe system and Gruinard River salmon catches (to rods)*

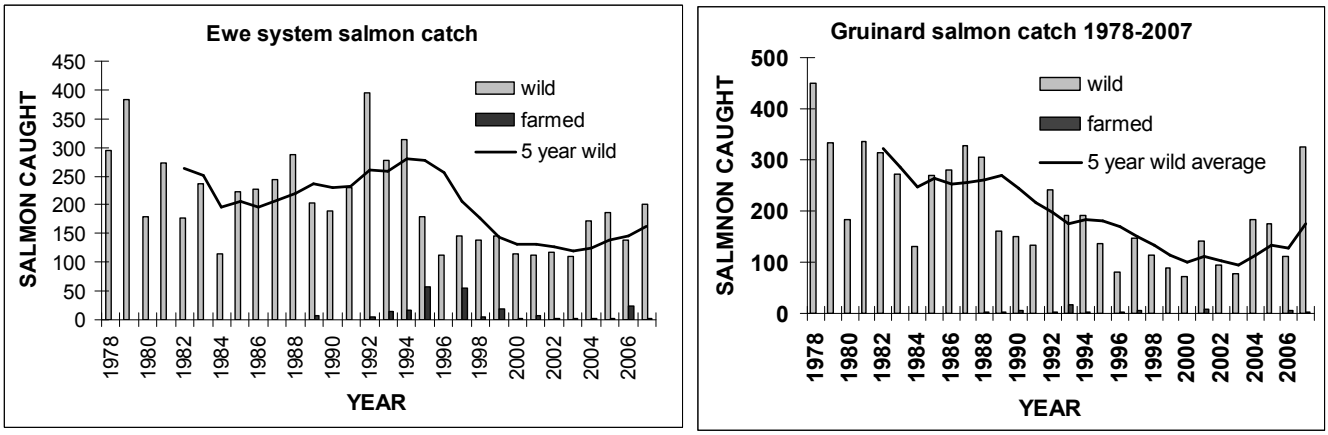
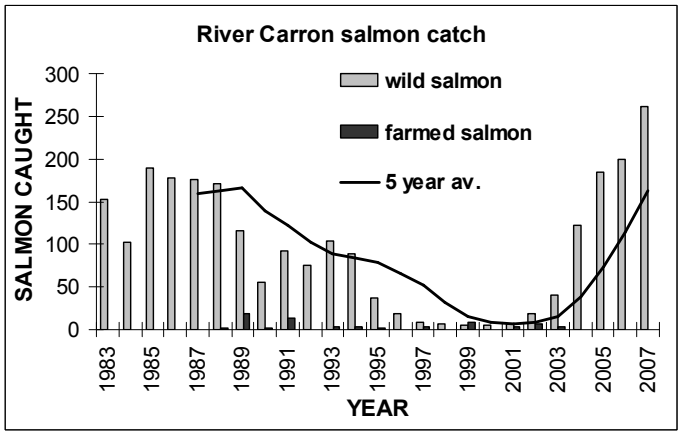


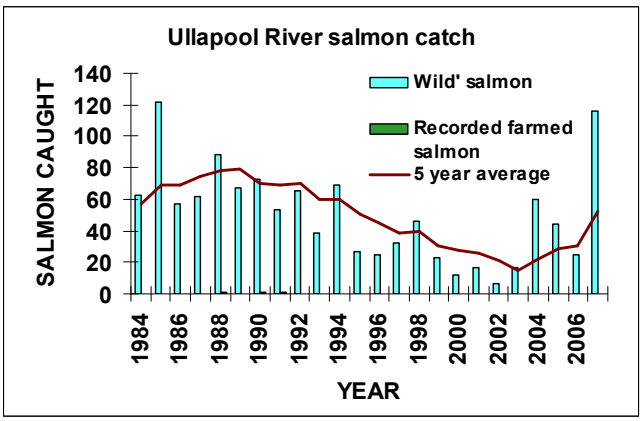
Figure 3.4.3 *River Carron system salmon (rod) catches and the record salmon estimated at 32lb taken in September 2007 (© Bob Kindness). The River Balgy also produced a record salmon of 32lb in 2007.*

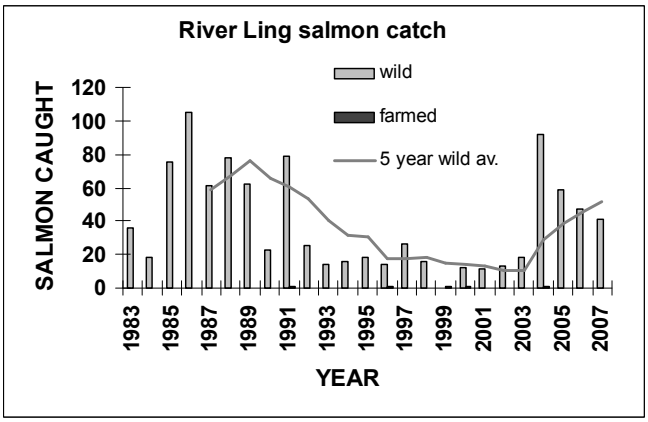


In the south of the area, the remarkable recovery of the River Carron fishery continued in 2007 with a record catch of 262 salmon (Figure 3.4.3). This included a river record 32lb salmon taken by Bob Kindness.

Two of the rivers in which salmon have to ascend sizeable falls to reach spawning areas are the River Ullapool and River Ling. Figure 3.4.4 shows that the catch of salmon in the Ullapool River was one of highest for many years; the Ling did less well. Over 100 salmon were taken in nets near the mouth of the Ling.

Figure 3.4.4 *Ullapool River and River Ling salmon rod catches*

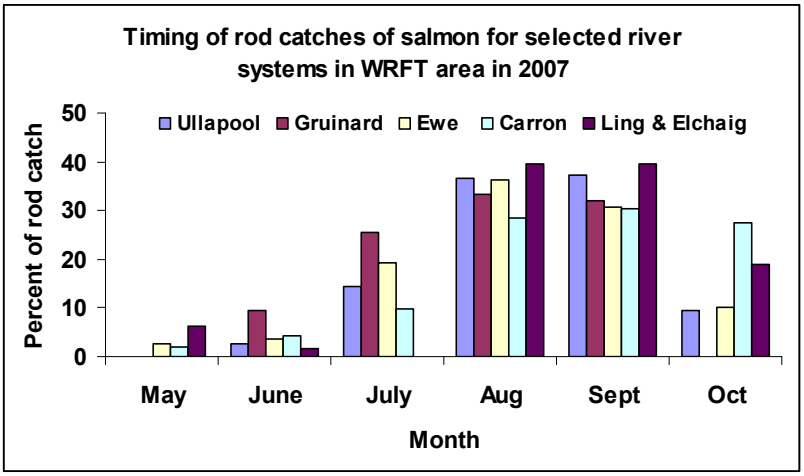




Timing of rod catches of salmon

Figure 3.4.5 shows the timing of rod catches for 6 rivers in the WRFT area in 2007. Traditionally, both the Ullapool River and River Ling were noted for a high proportion of 'spring' salmon in the rod catch (see WRFT Review May 2005). In 2007, the majority of the rod catch for these rivers was taken in August and September as elsewhere in the WRFT area. Some rivers cease fishing at the end of September or fish only for broodstock in October, other rivers fish only lightly during spring months to conserve stocks.

Figure 3.4.5 *The timing of rod catches of salmon for selective river systems within the WRFT area in 2007. Note that catches for the Ling and Elchaig have been combined.*



3.4.3 Population structuring and run-timing

Until around the end of the 1980s, adult salmon were regularly caught in the River Ewe and Loch Maree in the spring. Some were taken as early as February (Butler, 2002). Many of these Ewe **'spring salmon'** are thought to have been part of a population that spawned in the upper Bruachaig above waterfalls at NGR 206000 862850. Juvenile salmon of wild origin were last recorded in this part of the system in the 1990s. In 2001, WRFT carried out a radio-tracking study of rod caught Ewe salmon, the results of which suggested that earlier entering fish headed for the upper parts of the catchment (Cunningham *et al*, 2002).

The Ullapool River was noted as a 'spring salmon' river. Most rod caught fish were 2 sea-winter salmon taken before June. From then on, the proportion of summer grilse relative to 2SW fish taken increased; by the 1990s the majority of salmon were grilse taken during the summer months. In recent years, small numbers of 2SW fish are taken in May. The Elchaig and Ling were also noted by Mills and Graesser (1981) as rivers with spring runs.

In contrast, many of the rivers, including the two 'Gruinards' have consistently been regarded primarily as 'grilse' waters, although some of the larger multi-sea winter 'early summer fish' in the 'big' Gruinard may belong a separate population which spawns above Loch na Sealga.

The River Carron salmon population collapsed during the 1990s. Since then, a restocking programme has helped to restore a productive rod fishery. In recent years, fresh run salmon have been taken from as early as March through to the end of the season. It is not clear whether this is indicative of residual stock structuring in the system or of a single variable population that produces a diversity of fish including grilse and large multi-sea winter salmon that enter at different times of the year.

There is much still to learn about the structuring of salmon populations in Wester Ross. From initial genetic sampling and analyses (ASAP project, SAC genetic sampling, and other FRS led studies) salmon populations in the River Kerry and the lower Little Gruinard have been shown to be distinct from each other (Verspoor, presentation at RAFTS AGM March 2007). In comparison with other salmon populations in Europe, these two populations had closest affinities with other west of Scotland salmon populations.

Thompson *et al* (2006) demonstrated that even small river systems around Loch Feochan in Argyll may have several discrete populations of salmon. These rivers are similar in size and other characteristics to those in Wester Ross. It is therefore possible that rivers such as the Ullapool, Gruinard, Little Gruinard and Balgy, where large lochs are present, have (or had) separate populations above and below lochs. Waterfalls in the Kanaird (Runie), Ling and Elchaig may also delineate spawning areas for discrete salmon populations. WRFT, supported by the Scottish Government is developing a genetic sampling programme for the area.

A Ewe 'springer': Ray Dingwall with a fresh run cock salmon caught by Gavin Ramsay in the River Ewe, May 2007 (Gavin Ramsay). Note the similarity in the profile of this fish with the carving of a salmon on the Pictish stone (and Loch Maree poster)!

3.4.4 'Metapopulations' (populations that extend across more than one river system)

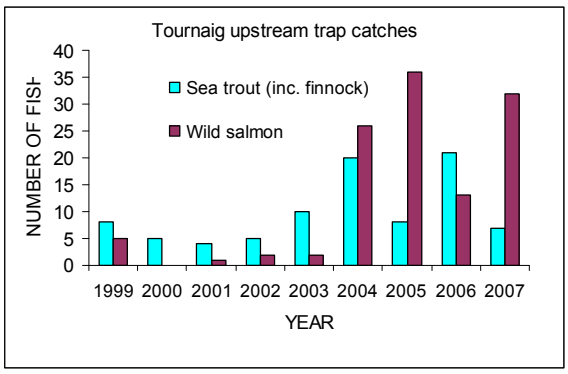
Juvenile salmon have been found periodically in several smaller river systems. The size of many of these little systems is such that even during periods of relatively favourable freshwater and marine survival it is unlikely that more than 1000 smolts could be produced and more than 50 adult fish would return. Such systems include the Inverianvie, Allt Beith, Tournaig, Sguod, Sand and Shieldaig.

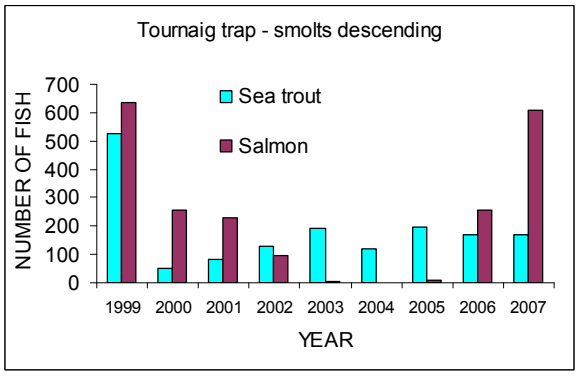
The Tournaig trap project has already demonstrated that sizable numbers of stray fish may enter a small river and spawn to the extent that the juvenile salmon population in subsequent years comprises entirely, or almost entirely of the progeny of stray fish. It is therefore clear that in the short-term at least, salmon in the Tournaig system are part of a 'metapopulation', presumably sharing a gene pool with some of the salmon in the River Ewe system (see Box 3.4.1).

Box 3.4.1 *Tournaig salmon – part of a 'metapopulation'?*

The Tournaig River is the smallest river system in Wester Ross known to have supported wild salmon. The Tournaig Trap project was set up in 1999 to monitor the salmon and sea trout populations. Fish are recorded as they descend on their way to sea, and as they return to freshwater. Each year an electro-fishing survey is carried out to assess the distribution and relative abundance of juvenile salmon and record the size of juvenile fish. The project is currently demonstrating how a small river system that has lost its salmon population can be recolonised by straying wild salmon without stocking. The project informs the Loch Ewe AMG and local management requirements.

Salmon failed to spawn in the Tournaig system in 2000, 2001 and 2002. In 2003 and 2004, no salmon smolts left the Tournaig River system. However, contrary to expectations, catches of salmon in the upstream trap in 2004 and 2005 were the highest on record. Grilse entering the system in 2004 and 2005 were all stray fish from other river systems (probably, the River Ewe). Salmon spawned within the system in 2003 for the first time since 1999, and again in 2004. In 2004, the electro-fishing survey demonstrated that juvenile salmon were widely distributed within the accessible area. In 2005, salmon fry and parr were found throughout the accessible area. Fry were smaller than in 2004, suggesting that densities were near carrying capacity in the main juvenile rearing area (Allt na Coille). 11 S1 salmon smolts descended in 2005. In 2006 over 250 salmon smolts descended; and in 2007 607 salmon smolts descended indicating that production was back up to near carrying capacity.





Note that there has been no comparable recovery in the sea trout population.

3.4.5 Stocking, escaped-farm salmon and genetic introgression.

Salmon face a remarkable diversity of pressures in freshwater and in the sea during their life cycle (see Part 4). Salmon populations which are adapted to the local conditions and local environments have higher rates of lifetime fitness than those which have been stocked from other river systems. In other words, more of them survive until they are adult fish. River systems with 'native' salmon populations that through natural selection have become adapted to local conditions usually support the most productive fisheries.

The extent to which population structuring in Wester Ross salmon populations remains adaptive is subject to conjecture. There have been repeated releases of large numbers of salmon fry of non-native origin during the past 100 years. These include the Kanaird, Ullapool (see Cunningham, 2006), Ewe and Arnisdale. The biggest stocking programme in recent years has been in the River Carron, where over 100,000 juvenile salmon have been stocked into the river annually since 2001; progeny of a captive broodstock reared by Bob Kindness of Seafield College (Kindness, 2006).

Over the past 20 years, adult farm salmon have been recorded in the catches of many rivers. In the 1990s, salmon fry containing artificial pigments from farm feeds were found in the rivers Kerry, Torridon and Carron (Webb *et al* 1993). Up to 30% of rod caught salmon taken in the River Ewe were of farmed origin in 1997 (Butler, 2002). The entire catch of salmon in the Kanaird in 1997 was ascribed as escaped farm salmon (Butler, 2000).

In 2006, escaped farm salmon were recorded in rod catches from the Dundonnell, Gruinard and River Ewe. In the River Ewe, 23 escaped farm salmon were taken, the third highest total on record. Many of the fish were taken from late September and were of very similar in size, and were males. Two mature male escaped farm salmon were taken during broodstock capture at Coulin near the head of the River Ewe system. Similar fish were taken in the FRS Shieldaig trap by Loch Torridon from late September onwards.

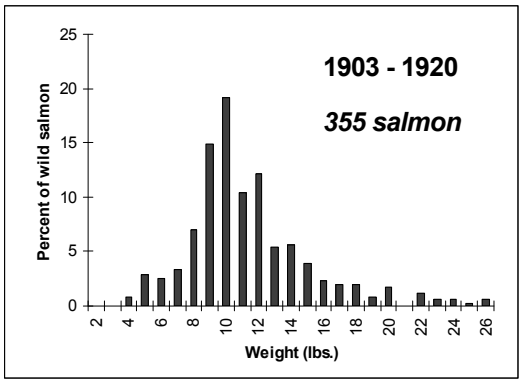
Sometimes it is stated that escaped farm salmon which enter freshwater tend to remain in the lower parts of river systems. This has not been the WRFT experience in Wester Ross. In autumn 2001, a radio-tagged female escaped farm salmon also ascended the Ewe system as far as the Coulin River where it was assumed to have spawned (Butler *et al*, 2005).

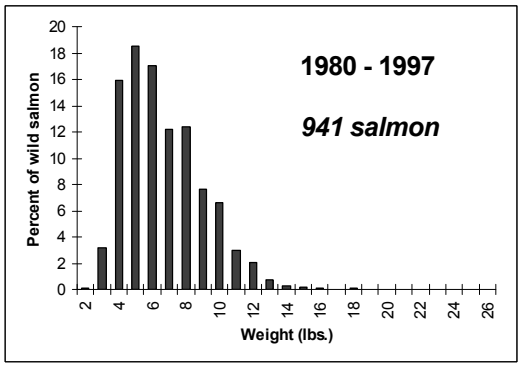
Despite widespread and repeated invasion of escaped farm salmon into some rivers in Wester Ross, there is reason to believe that even in some systems where farmed fish were frequently recorded in the past, some local genetic characteristics have been retained (e.g. the River Kerry [Verspoor, *pers comm.* 2007]). However, the occurrence of large numbers of large one-year-old salmon smolts (Middlemas and Stewart, 2008) and other evidence suggests that the native River Balgy salmon population may have been replaced by a feral salmon population descended from escaped farm fish.

David Price with an escaped male farmed salmon, taken in the headwaters of the River Ewe system in 2006.

WRFT has recorded escaped farm salmon throughout the River Ewe system.

Box 3.4.2 *Changes in Run timing in the Ullapool River*

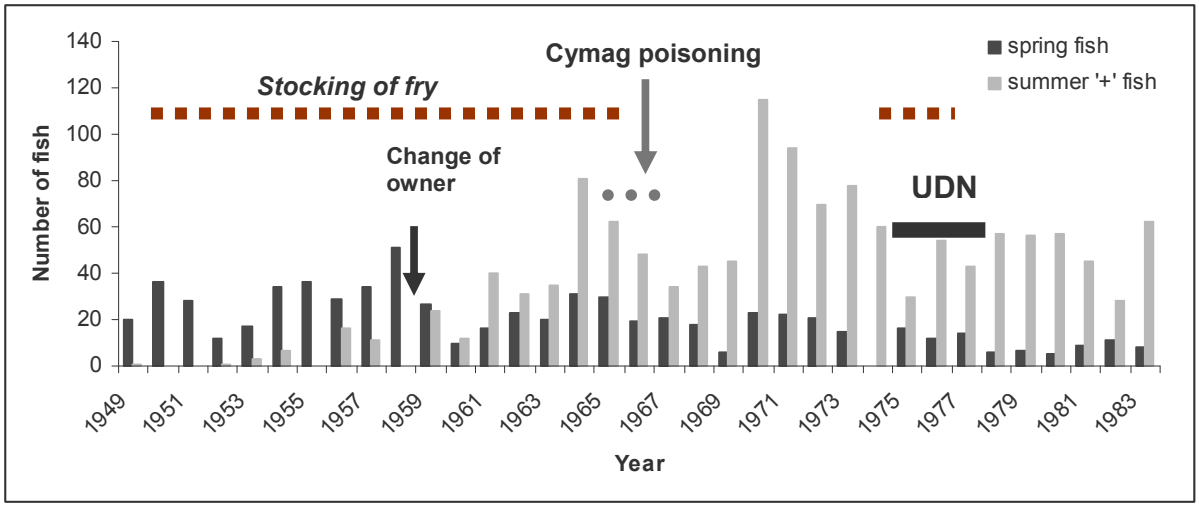




The weight distribution of salmon caught by rods in the Ullapool catchment during the period 1903 -1920, and 1980 – 1997

The Ullapool River is remarkable for having supported a fishery for 'spring' salmon for over 100 years. This unusual population may have evolved in response to the Ness Falls situated downstream from the main spawning areas. During the first half of the 20th Century rod catches of salmon from the Ullapool River comprised almost entirely of 2SW spring salmon taken before the end of June.

From the mid 1950s, catches of summer salmon and grilse increased. By the 1960s catches of 'summer fish' exceeded those of 'spring fish'. This change may be associated with stocking non-native salmon into the river from 1947.Catches fell to their lowest levels during the 1990s, but subsequently recovered. The Ullapool River retains a 'spring run'. Of 44 salmon caught in 2005, 8 were caught during spring months.



Recorded numbers of spring fish (taken before June) and summer fish (salmon and grilse) taken from the Ullapool River during the period 1949 – 198. From WRFT Ullapool River FMP (Cunningham et al 2006).

3.4.6 Juvenile fish populations

Each year WRFT survey teams try to visit as many river systems as possible. Surveys are carried out primarily to inform local management. Teams focus initially upon areas where there is greatest uncertainty about the occurrence of wild salmon or where findings are likely to be of particular value (e.g. to inform stocking requirements).

Informing local management

The Trust aims to utilise its limited resources as efficiently as possible. Before visiting a river, the team agrees a time when the local fisheries proprietor or manager can be so that surveys and other observations can be reported and discussed on the day of the field visit. When the fishery manager is able to join us in the field, our work can be particularly effective in delivering and exchanging up-to-date information. Subsequent preparation of river specific reports is prioritised according to the need for management intervention (or non-intervention!) and local interest (feedback always welcome), although we try to ensure that a report is produced every two or three years for each of the major river systems.

2006 and 2007 electro-fishing surveys

Between July and October, electro-fishing teams trained to SFCC survey protocols sampled sites in 27 systems. Most sites were in shallow riverine habitat which is more suitable for juvenile salmon than trout. Eel, flounder, minnow and stickleback were also sometimes recorded. At nearly all sites, a timed 'semi-quantitative' methodology was used to produce catch-per-unit-effort [CPUE] data. This type of data combined with fish size data, provides the most useful information required to guide local fisheries management. At a few sites, the more time-consuming SFCC 'fully-quantitative method' using stop-nets and multiple-run fishing was used to obtain more precise data describing local densities of juvenile fish at the time of fishing. Data from 'fully-quantitative' surveys can be used to investigate longer-term trends in fish densities in more detail. To date, however, it has been difficult to interpret (c. Armstrong, 2005) and has generally not been found to be more useful in terms of informing local fisheries management decisions than data from a larger number of 'timed' sites.

Juvenile salmon occurrence in 2006 and 2007 (see figures 3.4.6 and 3.4.7)

Results in 2006 and 2007 were as good as any over the past 5 years. Salmon parr (progeny of adult salmon that entered in 2003-2005) and fry (progeny of 2005 & 2006 fish) were found virtually throughout accessible parts of the Kanaird, Ullapool, Dundonnell, Little Gruinard, Tournaig, Sguod, Kerry, Badachro, Torridon, Ling, Croe and Arnisdale Rivers. Wild salmon were found to have recolonised the Sguod, Barrisdale and Cuaig river systems and parts of the Elchaig and Kanaird since surveys in 2004 or 2005. As described earlier, we are learning much about how wild salmon can recolonise a river system naturally (i.e. without any stocking) at the Tournaig Trap project where wild salmon strayed into the system and spawned in 2004 and 2005 in sufficient numbers that the juvenile salmon population was considered to be at or near 'carrying capacity' for the system in 2005, 2006 and 2007.

Figure 3.4.6 *Distribution of salmon fry at sites fished in WRFT area in 2006. The relative abundance is expressed as the number of salmon fry recorded per minute during timed electro-fishing using an electro-catch back-pack, and staff trained to SFCC protocol.*

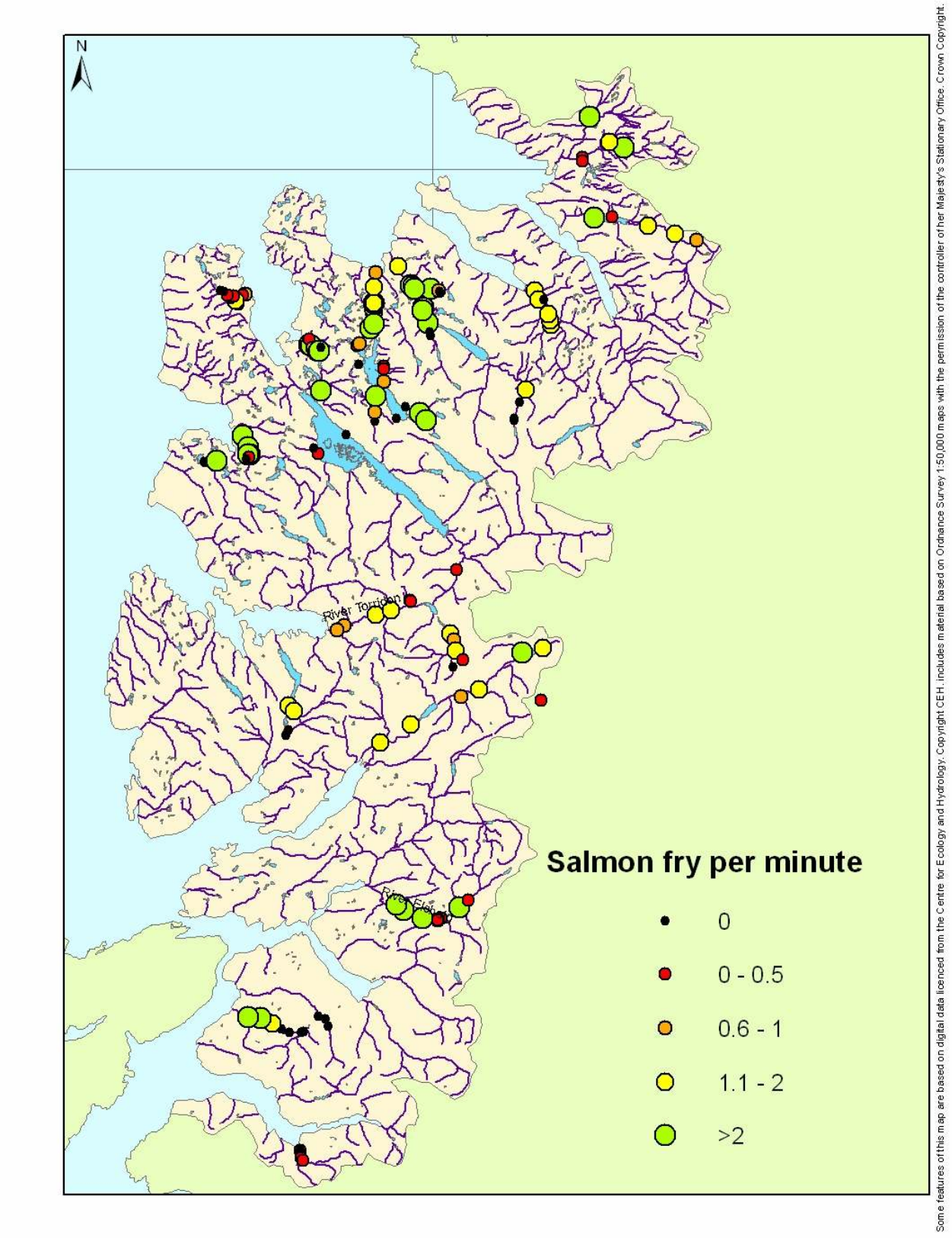
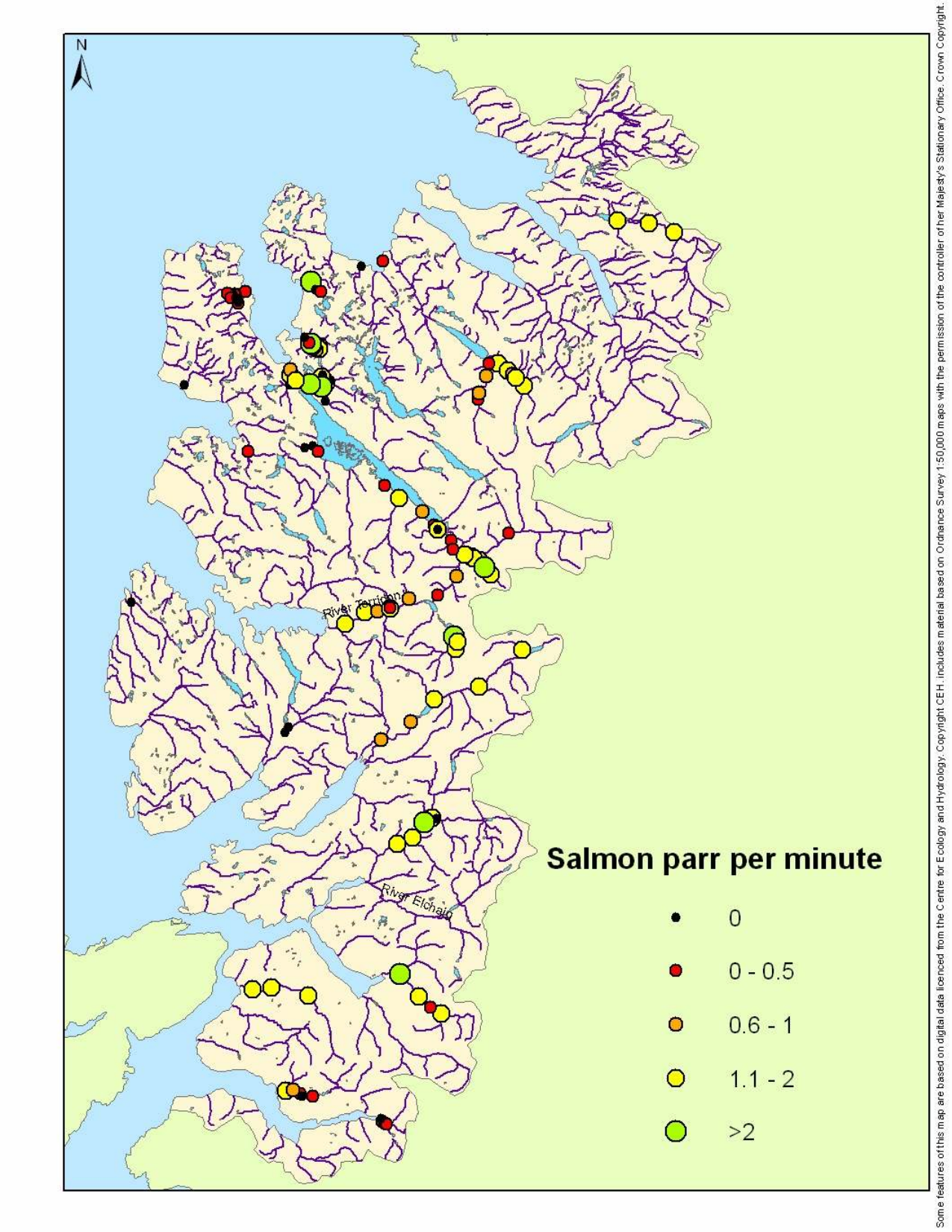


Figure 3.4.7 *Distribution of salmon parr at sites fished in 2007. See Figure 3.4.6 for further explanation.*



3.4.6 Production of salmon smolts from rivers in Wester Ross

The WRFT Tournaig project provided an opportunity to learn about smolt production from a river system. In 2007, 607 salmon smolts were recorded passing through the downstream trap on their way to sea, the highest total to date (see Box 3.4.1).

For other river systems the estimates of salmon smolt production at optimum levels are based on the product of the accessible area as measured during habitat surveys (Table 3.4.3), and estimates of potential smolt production per unit area. WRFT has little idea of the potential of lochs to produce salmon smolts: figures for Newfoundland Lakes were used for systems where there are large lochs.

Figures are presented in Table 3.4.4 for estimated maximum smolt production from 10 river systems within the WRFT area. These figures are based on information presented in respective Fisheries Management Plan's. WRFT has little information on actual smolt production for any of these systems, except the Balgy, where FRS estimated a run of 11,331 smolts in 2007 (Raffell *et al*, 2007), of which 6,428 – 9,065 were thought to be fish farm escapes, leaving up to 4,900 smolts of wild origin (c. estimate in table from River Balgy FMP, Butler, 2001).

Table 3.4.3 *Areas of water accessible to salmon and sea trout within respective river systems. Riverine area has been calcaulated from WRFT habitat surveys.*

River System	Riverine area (m^2)	Loch area (m^2)	Total accessible area (m^2)
Kanaird	201,913	112,000	313,913
Ullapool	192,157	1,250,000	1,442,157
Broom	156,360	0	156,360
Dundonnell	71,632	0	71,632
Gruinard	363,242	3,947,000	4,310,242
Ewe	647,504	30,358,000	31,005,504
Balgy	47,200	3,707,000	3,754,800
Carron	373,302	1,660,000	2,033,302
Ling	223,803	0	223,803

Table 3.4.4 *Estimated potential maximum wild salmon smolt output from some major river systems in WRFT area. Figures are from respective WRFT Fisheries Management Plans.*

System	Riverine habitat	Loch habitat	Total
Kanaird	10,298	224	10,522
Ullapool	9,671	3,125	12,796
Broom	6,914	0	6,914
Dundonnell	3,166	0	3,166
Gruinard	16,939	2,759	19,698
Ewe	28,620	21,225	49,845
Balgy	2,360	3,085	5,455
Carron	16,507	Not estimated	16,507+
Ling	9,892	0	9,892