

THE SMELT *OSMERUS EPERLANUS* IN SCOTLAND

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Introduction

The smelt *Osmerus eperlanus* (Linnaeus 1758) (Plate 3A, p. 65), or sparring as it is called in Scotland (and in northern England), is a small to medium-sized fish whose adult size varies greatly according to habitat. The normal range in length is 10 to 20 cm but the fish can sometimes reach 30 cm. In general, fish from non-migratory freshwater populations are much smaller than those which have lived in the sea. The smelt occurs from southern Norway around the western coast of Europe (including the Baltic Sea) to north-west Spain. It lives in coastal waters and estuaries and migrates into large clean rivers to spawn in the spring. The species is tolerant of wide salinity changes and there are several non-migratory purely freshwater populations in large freshwater lakes in Finland, Sweden and Norway. The sole British freshwater population of smelt, in Rostherne Mere in Cheshire, became extinct in the 1920s (Ellison & Chubb 1968), probably due to eutrophication.

Elsewhere in Great Britain, the smelt was once a common estuarine species and occurred in most larger rivers from the Clyde and Tay southwards. It supported small commercial fisheries in the estuaries of most of these rivers. Over the last century, the species has gone into decline and has disappeared from many rivers. In spite of its return to a few rivers (e.g. the Forth and the Thames) it has been regarded as significantly threatened for over two decades (Maitland 1971, 1979) but little conservation action has been taken to date.

General status in Scotland

Smelt populations have been recorded from at least 15 rivers in Scotland (Fig. 1 and Table 1) but over the last century the species has suffered a severe decline and has disappeared from all of its former sites except the Rivers Cree, Forth and Tay. These populations must now be regarded as having high conservation importance (Maitland 1985).

There are probably several different reasons for this decline. In some rivers (e.g. the Clyde and the Stinchar), pollution in the lower reaches has prevented successful spawning migration and reproduction. In other rivers, high weirs and barriers (e.g. the Tongland Power Station on the River Dee) have completely cut off access to spawning grounds. In some estuaries and rivers

(e.g. the Solway Firth), overfishing is believed to have been responsible for eliminating local stocks (e.g. in the Rivers Esk, Annan, Nith and Urr).

A fishery for smelt used to take place at Erskine on the Clyde Estuary (Henderson & Hamilton 1986) but the species was last reported there in 1845. Although a single specimen was recorded by the Clyde River Purification Board in one of the Glasgow docks in the 1980s (A. Henderson, personal communication), none has been found since then.

Table 1. Rivers in Scotland known to have or have had populations of smelt. (Note: under Reference, pc = personal communication).

River	Reference	Present status	Reason if extinct
Almond	Sinclair (1779) Wood (1791)	Extinct	Pollution
Annan	Maxwell (1922) Gladstone (1912) Service (1902) Henderson (pc 1994) Pascoe (pc 1994)	Extinct	Overfishing
Blaonoch	Gordon (1921)	Extinct	Overfishing
Clyde	Scott & Brown (1901) Clyde RPB (pc 1994)	Extinct	Pollution
Cree	Gladstone (1912) Service (1902) Maxwell (1897) Maxwell (1922)	Extant	-
Dee	Parker (pc 1993)	Extinct	Barrier
Esk	Service (1902)	Extinct	Overfishing
Fleet	Parker (pc 1993)	Extinct	Overfishing
Forth	Parnell (1838)	Extant	-
Girvan	Smith (pc 1994)	Extinct	Pollution
Lochar	Henderson (pc 1994)	Extinct	Pollution
Nith	Maxwell (1922) Gladstone (1912) Service (1902) Hamilton (pc 1994) Henderson (pc 1994) Truckell (pc 1994) Robson (pc 1994)	Extinct	Overfishing
Stinchar	Smith (pc 1965) Gibson (1984)	Extinct	Pollution
Tay	Parnell (1838)	Extant	-
Urr	Service (1902)	Extinct	Overfishing



FIG. 1. Southern Scotland, showing the locations of past and present populations of smelt (also see Table 1).

Smelt in the River Cree

The population of smelt currently found in the River Cree and its estuary (Plate 3B and 3C, p. 65) is the sole survivor of several populations which formerly occurred along the south and west coasts of Scotland. Although the population is still thriving, and is the only one in Scotland to have been studied in some detail (Hutchinson 1983; Hutchinson & Mills 1987), it faces an uncertain future with a number of serious threats to its existence.

Catches in the local fishery for smelt have declined considerably in recent years (Table 2) although netting still continues. The present status of the Cree population may in part be due to overfishing in the past but may also be related to habitat changes in the spawning area caused by local pollution from sewage discharges and acidification from the upper parts of the catchment.

Although no estimates of the size of the Cree population have been attempted, some data are available which indicate the minimum numbers in the adult stock. Catches of up to six tonnes have been made by the fishery in the recent past (Table 2). The average weight of fish collected in the present study from 1991 to 1994 was 116.35 g (= 8,595 fish per tonne) and so the minimum size of the population in the River Cree in some years at least (e.g. 1984) must have been well in excess of 50,000.

Smelt in the River Forth

The River Forth at one time supported an enormous population which was the basis of an important fishery, both for local needs (McLusky 1978) and as a luxury item for the Edinburgh market (Parnell 1838). The spawning run was spectacular and Parnell (1938) records that at spawning time in the river about 3 km below Stirling Bridge "every stone, plank and post appears to be covered with their yellowish coloured ova".

Howard et al. (1987), reviewing the fisheries of the Firth of Forth, noted that: "Data on the catches from this fishery are available from 1891 to 1974 . . . This fishery yielded an average of 15 tonnes of fish each year up to the mid 1910s, from then until the mid 1940s the annual catch was around 7.5 tonnes. Following a short period of higher catches in the late 1940s the catches declined to zero by the mid 1950s, during the 1960s there was a slight recovery in the fishery but it again declined to zero in the mid 1970s. Although the catches of sparring in the area have never been high, this species, particularly in the late 19th century, was highly prized and commanded a high price".

The species then disappeared from the Forth (Maitland et al. 1980; Maitland & Lyle 1990) until a single specimen was recorded in 1989 (Forth River Purification Board 1989). Three further specimens were taken in 1990. The smelt is now common again in the Forth estuary and is taken regularly in monitoring trawls and in boom netting for sprats *Sprattus sprattus*, and is entrained in considerable numbers on screens at Longannet Power Station. Here, entrainment rates of up to 3,312 smelt per day were estimated during 1994, so the population must now be sufficiently large to be able to stand such mortality.

Smelt in the River Tay

Smelt are known to have occurred in the Tay Estuary for many years (Parnell 1838) and have been the basis of an erratic fishery there. This diminished in size until the 1970s when only two boats were fishing part time, but catches have increased in recent years and smelt are regularly sold by fishmongers in

Table 2. Past commercial catches of smelt from the River Cree. The estimated numbers of fish in each catch are based on the mean weight of spawning fish (166.35 g) in recent years (1991 to 1994).

Year	Catch (kg)	Estimated numbers
1980	1,931	16,596
1981	4,135	35,539
1982	641	5,510
1983	5,040	43,318
1984	6,361	54,671
1985	4,928	42,355
1986	953	8,191
1987	nil	0

Perth and in the villages around the estuary. In the early 1990s the annual catch obtained by one boat was about 10 to 15 tonnes (C. Johnston, personal communication).

Although few statistics are available from the Tay, the catch in 1991, when fish were obtained for the present study, was at least 15 tonnes. This, with an average weight that year of 47.5 g (much smaller than the Cree smelt), represents some 315,889 adult fish.

Adult size and reproduction

Some aspects of the biology of smelt in the River Cree have been studied previously by Hutchinson (1983) and Hutchinson & Mills (1987). During the present study (1991 to 1994), 294 adult smelt were collected from the spawning grounds in the River Cree, 52 fish were obtained from the Tay estuary fishery in 1991 and 48 fish were obtained from the Forth Estuary (Longannet Power Station) in 1994. All fish were taken at or just prior to spawning. In addition, 342 smelt were examined from those entrained at Longannet Power Station throughout 1994.

The frequency distributions for body length of adult smelt taken around spawning time show clear differences in the lengths of fish from the three locations (Table 3). Cree smelt typically range from 175 to 250 mm, Tay smelt are from 150 to 200 mm and Forth smelt range from 125 to 175 mm in length. However, there is evidence that the length of adult smelt in the Forth is increasing since they reappeared in 1989 and occasional specimens more than 200 mm long are now taken there.

The mean lengths and weights of adult females are consistently greater than those of males at all three sites (Table 4). Hutchinson (1983) found the same

Table 3. Length classes (mm) and numbers of spawning smelt collected from the River Cree and pre-spawning smelt from the estuaries of the Tay and Forth.

Length class (mm)	Forth	Tay	Cree				
	31 Jan 1994	17 Mar 1991	15 Mar 1991	29 Feb 1992	5 Mar 1992	22 Feb 1993	12 Mar 1994
75-99	1	-	-	-	-	-	-
100-124	2	-	-	-	-	-	-
125-149	30	2	-	-	-	-	-
150-174	7	22	-	-	-	-	2
175-199	7	22	7	24	25	6	16
200-224	1	5	21	35	31	35	6
225-249	1	2	37	1	4	15	17
250-274	-	-	4	-	3	1	23

Table 4. Mean body lengths (mm) and weights (g) of adult male and female smelt collected on given dates at spawning times in the River Cree and pre-spawning times in the Tay and Forth estuaries. N is the number of fish and SD is the standard deviation.

River	Date	N	Length	SD	Weight	SD
MALES						
Cree	15 Mar 91	43	224.2	17.6	107.0	24.4
	5 Mar 92	32	204.8	19.7	82.4	26.0
	22 Feb 93	30	234.3	9.3	121.4	14.7
	12 Mar 94	20	235.7	25.6	118.2	37.6
Tay	17 Mar 91	19	176.3	15.3	45.4	12.6
Forth	31 Jan 94	27	143.3	19.7	31.9	14.3
FEMALES						
Cree	15 Mar 91	26	231.9	17.6	112.7	27.5
	5 Mar 92	31	206.7	14.9	88.1	22.8
	22 Feb 93	29	250.4	12.7	158.4	24.4
	12 Mar 94	33	256.1	29.9	147.5	47.6
Tay	17 Mar 91	33	178.5	20.0	49.5	17.6
Forth	31 Jan 94	21	158.4	33.0	50.1	32.7

with the adult Cree fish in the early 1980s but noted that for fish aged 1+ years the reverse was the case.

Coastal and estuarine smelt are generally regarded as migrating up rivers into fresh water to spawn during spring. This is certainly the case in the River Cree and was also the case in the River Forth in earlier times when the population there was large. However, since its recovery in recent years the present spawning grounds in the Forth have not been located, despite searches there from 1991 to 1994. Similarly, it has not yet proved possible to identify the spawning grounds of smelt in the River Tay. It is suspected that, in both these rivers, the smelt spawn, unseen, in relatively inaccessible freshwater parts of the upper estuaries.

Of the existing Scottish stocks, therefore, the Cree population is the most vulnerable at spawning time when it is more exposed and is readily accessible to netting. Moreover, the Cree stock has few age-classes: Hutchinson & Mills (1987) found that the age structure in spawning fish was 61.3% aged 1+ years, 37.6% were 2+ years and only 1.1% were 3+ years old. Moreover, fish in the last age-class were present in only half of the samples taken during the 1980 and 1981 spawning runs.

However, smelt are highly fecund and 16 fish examined by Hutchinson & Mills (1987) had a mean fecundity of 56,603 eggs per female. In the present study, the fecundity of 32 female smelt from the Tay Estuary was estimated at 30,360 eggs per female.

Threats to existing populations

It is clear that the status of smelt in Scotland has declined markedly over the last century and the current number of populations (three) is too low to be confident of the future survival of this species here (Maitland & Lyle 1991).

The main threats to the smelt, which account for its demise in previous locations and endanger present stocks, are overfishing and pollution, obstruction of spawning migrations by dams and weirs, and physical destruction of spawning and nursery areas by engineering works. Abiotic conditions are known to be of importance during the period of spawning and larval development (Borchardt 1988).

Most of the historical data on smelt in Scotland is from the Solway area, where the extinction of stocks, with the exception of the Cree, was almost certainly due to overfishing, although pollution and river barriers were also likely contributory factors.

A century ago Maxwell (1897) wrote of his concern: "There is no close time provided for these fish by law; hence in some rivers - the Annan and the Nith, for example - where they have been netted to the verge of extinction, and the industry, once profitable, no longer pays. All fishermen to whom I have spoken on the subject agree that a close time is desirable; but so long as

it is not made binding upon all alike, none is willing to hold his hand while others may be fishing at other parts of the same stream".

Twenty-five years later, Maxwell (1922) stated: "we reported strongly in favour of a statutory close-time for the protection of this valuable food fish during the spawning season. This recommendation was subsequently approved and reiterated in the Report of the Royal Commission in Salmon Fisheries, 1902, and it is much to be regretted that legislative effect has not yet been given to these recommendations. Every witness before my committee spoke of the urgent need for such a close-time. Sparling-fishing, once a remunerative industry in the Annan, had been brought to an end through indiscriminate netting during the spawning season".

Since then, with the exception of the Cree stock, smelt have disappeared from the Solway. In general, over the last century threats additional to overfishing have increased. Changes in land-use practice in agriculture and forestry have led to the enrichment of rivers and estuaries and to altered hydrology. Pollution from domestic and industrial sources and from the atmosphere has also contributed to habitat damage.

Social relevance of smelt in Scotland

There is no doubt that the smelt fishery of the Solway was an important one until the last few decades and, as with the vendace *Coregonus albula* at Lochmaben (Maitland 1966), many rituals and local traditions were linked to it. The Minnigaff Kirk Session Minutes for the 1730s record that one man was charged with sleeping with one of the female servants at Machermore. The man's defence was that it was traditional that the men coming for the "spirling harvest" should sleep with the female farm servants "time immemorial, past memory of man".

The Penninghame Parish records for 1731 note that the Kirk Session had been informed that "some people in Newton Stewart and Barbuchanie had gone out to the spirling fishing on the Sabbath night, which practice they judge sinful and offensive". Two of the men were found guilty and "They were call'd in and rebuked accordingly". In addition "this to be intimate from the pulpit and also that warning be given against the like as to any sort of fishing or any worldly business".

Plate 3 *on facing page*. A, (Top): An adult smelt *Osmerus eperlanus* from the River Cree in southwest Scotland (see Fig. 1). The 50 pence coin shown above the fish is 3 cm in diameter. B, (Centre): The upper spawning grounds of smelt in the River Cree just below Newton Stewart. Note: this photograph was taken at an extreme high tide; at other times the river here is mainly fast-flowing riffle. C, (Bottom): Eggs of smelt on a moss-covered stone. These eggs (translucent when alive) have died (and become white) because of a drop in water level.



Future conservation of smelt in Scotland

A Species Action Plan for the smelt has been prepared and it is hoped that this will be the basis of a future conservation strategy for this species in Scotland. Sufficient data are already available for specific conservation proposals to be acted upon with the objective of restoring the former status of this valuable fish.

One aspect of the proposals is that there should be proactive conservation management of the population in the River Cree (Lyle et al. 1995). This will involve habitat restoration and management of the spawning grounds, making sure that spawning smelt have access to these grounds, ensuring that future commercial fishing is sustainable, and implementing an adequate scheme to monitor the status of the population.

Other measures proposed relate to the recovery of stocks in rivers where the smelt previously occurred through a suitable translocation programme. Research carried out during the present study has shown that large numbers of smelt eggs can be obtained readily during the spawning run and that these can be transferred and hatched elsewhere. Assuming that the factors responsible for the extinction of the species have been, or could be, eliminated, then a careful programme of translocation (Maitland & Lyle 1992) should be attempted. Obvious rivers to which stock from the River Cree could be transferred are the Annan, Nith and Urr.

Given the success of such conservation measures, new smelt fisheries may eventually be created for the sensible sustainable use of this once valuable resource. The opportunity exists to create a programme of action where conservation enhancement of smelt and legislative controls on its exploitation can proceed in a structured and sustainable way for the benefit of all. The collapse of the smelt populations in the Forth and in the Solway, preceded as they were by the warnings of Maxwell in 1897 and 1922, should not be forgotten.

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