NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

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Council

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Can the impact of seals on salmon and salmon fisheries be reduced?

NGO Statement

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Can the impact of seals on salmon and salmon fisheries be reduced?

by W M Shearer

Introduction

In his first report on Scottish east coast salmon fisheries to the new Fishery Board for Scotland, Archibald Young, Inspector of Salmon Fisheries, quoted a letter from Messrs Joseph Johnston and Sons Limited of Montrose, dated 18 April 1883 "*Sirs, We beg to bring under your notice the heavy destruction of salmon on the sea coast and tideways by seals*".

Some 75 years later, the Salmon Net Fishing Association of Scotland recognised the probable danger to salmon stocks and fisheries from the rapid increase (about 7% per annum) in grey seal numbers around the Scottish coast, and warned government of the likely repercussions in a Memorandum dated 16 January 1958. This Memorandum included a daily log which recorded seal numbers and their behaviour between March and September 1957 at both the Hallowstell and Sandstell fisheries on the lower River Tweed. Since then, similar data sets have been made available, on a regular basis, to government, and members of the Association have also permitted the government's own scientists to inspect their catches to determine the proportion mutilated by seals. To date, the government's response has been limited and when prodded has called for yet more research. Although that may have been a valid defence prior to 1998 such a stance can no longer be sustained because the North Atlantic Salmon Conservation Organization (NASCO) and its Parties have agreed to adopt the Precautionary Principle when information is uncertain, unreliable or inadequate, and the absence of sufficient scientific information should not be used as a reason for postponing or failing to take conservation and management measures. Therefore, government must accept that there is a problem and support whatever action may be necessary to immediately protect salmonids and salmonid fisheries even if that means new legislation to aid the management of local seal populations and support for limited seal culls.

Government sponsored action

The more important government action can conveniently be summarised under three headings, legislation, culls and research.

Legislation

For a limited number of years in the late 1950s and early 1960s the protection for grey seals during their breeding season (1 September to 31 December) under the Grey Seal Protection Act, 1932, was waived to allow fishermen and other interested parties to kill seals during the breeding season.

This dispensation was continued with the passing of the Conservation of Seals Act 1970 which empowers the Secretary of State to grant licences to kill or take seals (grey and common) for a number of purposes, one of which is the prevention of damage to fisheries during their respective breeding seasons. However, this Act prohibited the use of any

poisonous substance and any firearm other than a rifle using ammunition which has a muzzle energy of not less than 600 foot pounds and a bullet weighing not less than 45 grains to kill seals. As a result of this legislation netsmen could no longer continue to use strychnine which they had used sparingly, effectively and with great caution to control those seals (rogue) which entered fixed engines (mainly bag nets) to mutilate, consume or remove the catch. A suitably endorsed firearm certificate is also now required. Following the tightening of the gun laws in Scotland in the 1990s this latter requirement has been difficult to obtain in a number of police regions; something unlikely to have been considered when the 1970 Act was drafted.

In 1998, the Conservation of Seals (Common Seals) (Shetland Islands Area) Order 1991 was revoked. This Order had prohibited the wilful killing, injuring or taking of common seals in the Shetland Islands Area within the seaward limits of the territorial waters adjacent thereto.

Culls

In 1959, a Consultative Committee on Grey Seals and Fisheries was set up to advise on what research was necessary to investigate the impact of grey seal populations on fisheries. The Committee's report was published in 1963 and recommended, among other things, that the grey seal populations breeding in Orkney and the Farne Islands should be reduced by a quarter by culling pups. These culls were intended primarily to reduce damage to salmon fisheries.

At the Farne Islands pups were killed in 1963, 1964 and 1965. However, the number of pups born each year continued to increase until 1972 when the increase was halted by a series of adult culls (Anon 1984). Seal culls on the Farne Islands have continued under licences obtained by the National Trust, the owners, to protect both the pupping habitat and that preferred by many of the seabirds which nest on these islands, and to prevent the pups suffering from eye infections.

An annual cull began in Orkney in 1962, but pup production continued to increase. In the later years up to 1977 the licences were granted to exploit the resource rather than protect the fisheries.

In 1976, the Department of Agriculture and Fisheries for Scotland (DAFS) and the Nature Conservancy Council jointly approached the National Environmental Research Council (NERC) for advice on the best method of reducing the grey seal population in the Outer Hebrides and Orkney to the level in the mid-1960s of some 35,000 animals. The aim was not only to protect fisheries but also to safeguard the conservation of the species, since more than 50% of the world's population breeds in British waters. The NERC advised that this could be achieved by killing 900 cows, their pups and an additional 4,000 moulted pups annually over a six-year period. This scheme was implemented in the Outer Hebrides in 1977, but only 386 cows were killed. In 1978, the cull was due to take place in Orkney but it was disrupted by demonstrations and had to be abandoned in the interests of public safety. In order to take the heat out of the situation the Secretary of State announced that the Management Plan would be halted temporarily because of the widespread public concern.

At that time the estimated grey seal population around the Orkneys and the Scottish coast amounted to 12,000 and 50,000 animals respectively. The 1999 population estimate for the Orkneys alone is 50,000 animals.

Although a number of culls have since taken place they have been organised locally and undertaken by professional marksmen, frequently estate employees and/or fishery board staff, without any government involvement. At least one of these culls involved the slaughter of almost 1,000 animals.

Salmon netsmen have also continued to kill seals during the course of their normal fishing activities and for some years a number of District Boards jointly employed a seal hunter and operated a bounty scheme.

Research

From 1959 until the loss of the bulk of coastal net fisheries, DAFS carried out a long-term study of the interactions between grey seal and salmon fisheries (Rae 1960, 1962; Shearer 1962). Rae and Shearer (1965) used the data from 1958 to 1963 to estimate the total loss to the Scottish salmon fishery caused by seals. Parrish and Shearer (1977) used the longer time series available to them to look for trends in the level of damage to both nets and catch. They found a marked decrease in the level of damage to nets during the 1960s and attributed this to the replacement of natural fibre nets with those made from synthetic twines but they failed to find any obvious trend with time in the level of seal damage or in the number of seals seen around netting stations, although the UK seal population had increased significantly during the time period covered by their data. More recently, data collected at net fisheries located on the coast near Montrose and in the River North Esk in 1970-1997 show a four-fold increase in the percentage of seal-damaged salmon in the catch taken before 1 June each year. Although the proportion of seal-damaged salmon occurring in catches taken at most stations after 31 May was generally less, the underlying trend was still upwards, (pers. comm.). A recent paper has suggested that some of the damage attributed to seals was caused by odontocete cetaceans including bottlenose dolphins and harbour porpoises (Thompson and Mackay 1999). Although this observation is interesting there can be little doubt that on the basis of numbers alone, seals still pose the main threat to salmon in the coastal waters around Scotland.

In an attempt to provide answers to the many questions raised following the publication of the Parrish and Shearer paper in 1977, in which they had also calculated that the quantities of fish consumed by seals in 1976 could have represented a loss of £15-20 million to the relevant commercial fisheries, and at the same time pacify some of the concerns voiced immediately prior to the abandonment of the cull on the Orkneys, DAFS commissioned the NERC's Sea Mammal Research Unit (SMRU) to undertake a three-year research programme beginning in 1980. The research programme consisted of four projects of which the more important studies were the interactions between grey seals and salmon fisheries and the variations in grey seal diet throughout the year. The Report "Interactions between Grey Seals and UK Fisheries" was published in 1984. Although it was generally accepted and then ignored by government, many of the results were hotly disputed by the Associations representing the various groups of fishermen. Perhaps the most contentious result was the diet of grey seals which made sand eels the most important fish species (60% by weight). Next in order of importance were ling/tusk (12%) followed by trisopteris, (Norway pout),

whiting, flatfish, haddock/saithe/pollack and cod (7%, 6%, 5% and 3% respectively). This information had been obtained from an analysis of faecal remains (Anon 1984).

Part of the salmon fishermen's strength of argument has always been based on long observation and experience, and the results from the other major study of the diet of grey seals in Scottish waters. The Marine Laboratory at Aberdeen, over a 20-year period, examined the contents of a large number (368) of seal stomachs (Rae 1960, 1968, 1973). The relative importance of the more important prey items based on the percentage of stomachs in which they were found were salmonids (28.1), cod (21.9), haddock/saithe/pollack (14.6), sand eels (12.5) and whiting (9.9). Any similarity between Rae's results and those summarised in the SMRU report was minimal. In particular, Rae frequently found salmonid remains whereas the SMRU study found none, and sand eels occurred much less frequently in his samples. Nevertheless, SMRU (1984) admitted that, even if salmon was 1-2% of the average diet, consumption by seals would be of similar magnitude to the commercial salmon catch (some 1,000 tonnes). Some 15 years later the commercial salmon catch has dropped to less than 60 tonnes whereas the amount consumed by seals has increased beyond 1,000 tonnes.

In an attempt to resolve the differences highlighted in the two major studies of the diet of seals in Scottish waters and provide answers to some of the many questions raised by fishermen and others concerning the reasons for the lack of salmonids in the dietary studies undertaken by SMRU, DAFS let a number of research contracts to Aberdeen University in the late 1980s.

These studies (Boyle et al. 1990; Pierce et al. 1990, 1991 and 1994; Carter and Pierce 1997) and others (Tollit and Thompson 1996; Brown and Pierce 1997) have provided limited evidence of salmon consumption by seals.

The absence of salmonid remains in seal faeces could be explained by the complete digestion of the bones and other hard parts or because they were not eaten. Many fishermen's observations would support the latter hypothesis as would the frequent finding of salmon at various stages of skinning sometimes together with only the head and backbones of the prey species in nets. Although captive grey seals have been shown to eat salmon heads, the recovery rate of ingested salmon otoliths in their faeces may be as low as 2% and salmonid bones are almost totally digested (Boyle et al. 1990). Thus the examination in faeces for hard parts is unlikely to yield reliable estimates of the contribution made by salmonids to the diet. Similarly, the flesh may be digested too quickly to provide reliable evidence of the diet of seals from an examination of stomach contents.

Although a new antisera method has been developed for detecting salmon remains in stomach contents and faeces it has not been widely applied because of doubts about its sensitivity (Boyle et al. 1990; Pierce et al. 1990). Molecular methods now allow individual seals to be identified from DNA in their faeces (Reed et al. 1997) and this approach may ultimately solve the present problem of detecting salmonid remains.

In the 1980s, honours students from Aberdeen University observed seal behaviour (mainly common) in the Dee and Don estuaries and from their observations they attempted to quantify the level of predation on salmonids, (Houseman 1992; McKibben 1993 and Sinclair 1993).

Most kills occurred during the autumn and winter with little difference between day and night. In 1993-1994 and 1995-1996 the number of salmonids estimated to have been predated on by seals in the Dee estuary (Aberdeenshire) was 864 and 531 respectively. The highest monthly loss occurred in December 1993, when an estimated 275 salmonids were taken in the Dee (Pierce et al. 1994, 1997; Carter and Pierce 1997). These estimates are probably minimal values and they also fail to take into account any juvenile salmonids that may have been consumed underwater. As a comparison, the number of salmon reported caught by all methods in the Dee Salmon Fishery District in February to April 1993, 1994, 1995 and 1996 was 1,681, 1,014, 774 and 704 respectively (Anon 1994, 1995, 1996 and 1997a).

These estimated losses may have been sufficiently large to have had a major negative impact on the salmon population, particularly during the winter when the component of the stock generally agreed to be under most pressure in its fight for survival is returning from the sea in greatest numbers.

An additional loss is the fish, including salmon, which seals mutilate and which die before spawning.

Perhaps the most important conclusion from those and similar earlier dietary studies is that seals are opportunistic predators which take whatever prey are locally abundant. Common seals in the Moray Firth may switch their diet from one year to the next. When sprats and herring are abundant, they are eaten in preference to other species. When these prey species are in short supply, then cod, sand eels and other species are eaten (Hawkins 1996; Tollit and Thompson 1996). However, at particular seasons salmonids are probably the largest biomass of fish now available to seals in estuaries and in adjacent inshore waters.

Additional information

Returns of Atlantic salmon to North American rivers have declined two-fold or more during the past 20 years (Marshall et al. 1999) but after reviewing legal and illegal fisheries, marine environmental conditions, disease, parasites and predation Dempson et al. (1998) found no evidence to clearly link any of these factors to the salmon decline. Major salmon predators in the Northwest Atlantic rarely eat salmon (few salmon were found in about 10,000 stomachs examined) but even if salmon are only a minute fraction of their diet these predators could consume a high percentage of marine-phase salmon. For example, if the predator with the largest consumption, the harp seal, harvested 100% of a post-smolt cohort, the worst scenario, these post-smolts would have contributed a mere 0.09% to their diet. Given the rising populations of seals and some seabirds it is thus plausible that seal and seabird predation could have caused the decline in salmon returns, but present data are insufficient to determine whether this, in fact, has occurred (Cairns and Reddin in press).

The Salmon Strategy Task Force concluded that if salmon was only 1% of the minimum daily food requirement of Scotland's 96,800 grey seals in 1995, they would have eaten about 400,000 fish or about 2.5 times the total catch of wild salmon and grilse taken that year by all homewater fisheries. In addition, about 70,000 fish may have been consumed that year by Scotland's 26,400 common seals (Anon 1997).

In 1998, for the very first time, the ICES Working Group on North Atlantic Salmon had the confidence to state in its report "two decades of increasing seal populations, a decadal decline in many North American salmon stocks and a lower probability of observing salmon in harp seal stomachs even under extremely high predation rates suggest that the potentially significant impact by seals should not be discounted" (Anon 1998). Although the Working Group was referring to North America the decline in salmon stocks and the massive increase in seal numbers are common to both sides of the Atlantic.

The following year the Working Group reviewed a model which estimated number of smolts leaving North American rivers, daily numbers alive as post-smolts, salmon biomass and vulnerability windows (size and age at which salmon are susceptible to predation by estimated seal populations and potential seabird predators). Although the estimated salmon harvest based on calculated consumption rates and estimated seal populations were subject to numerous sources of error, the analysis suggested that predators could conceivably account for a substantial fraction, and possibly the majority, of salmon mortality at sea. Analyses also suggested that extremely large samples would be required to detect and accurately characterise salmon predation (Anon 1999).

Damage and losses to demersal fisheries

A very similar situation to that described for salmon fisheries exists in the Scottish inshore small-boat set gill net and line fisheries for cod and other demersal species. In most areas around the Scottish coast fishermen are now regularly reporting high incidences of seal damage to their gear and catches. In some localities its magnitude has been such as to force them to abandon or heavily curtail their fishing activities.

In addition, there are losses in potential catch to these fisheries resulting from seal predation on free-swimming fish either in the near vicinity of, or remote from, fishing gears. Whilst the actual loss of potential catch as a result of predation by grey seals cannot reliably be determined, since the overlap in the size distribution of the fish killed by the seals and those exploited by the fisheries is large, the potential loss in both fishery catch and revenue must be significant.

Yet another harmful effect of seals on fish stocks and the commercial value of catches is their contribution to the incidence of the larval stages of the parasitic nematode, *Porrocaecum decipiens* Krabbe, in the flesh of cod and other marine fish. The degree of infestation in grey seals is invariably greater than that in common seals and only the very young pups appear to be free from infestation. This form of parasitism is accumulative and if seals are permitted to increase or even remain at their present level, the infestation of cod will certainly increase.

Protection of gear and catch

In addition to employing various methods including shooting, poisoning, trapping and tangle netting to kill seals raiding their nets and/or interfering in the operation of their fishery prior to the Conservation of Seals Act 1970 coming into force, many salmon fishermen have altered the design of their nets and more recently some have attached seal scarers in an attempt to discourage seals damaging or removing their catch.

Although the ease with which seals hole net traps (mainly bag nets) was a major concern in the days of cotton netting, the introduction of synthetic twine in net manufacture in the 1960s significantly reduced the level of net damage, particularly if a heavier gauge of twine was used when weight was no longer a consideration. However, the level of damage to catch continued even in those nets which had not been holed and where the door into the inner chamber (fish court) had been modified to prevent the majority of seals gaining access (Shearer 1962).

In an attempt to reduce, and hopefully eliminate, this problem without decreasing the fishing efficiency of the net, a standard bag net was set to fish at a fishery on the west coast and it was monitored for approximately six weeks using underwater CCTV cameras. The pictures beamed back to a portacabin on the shore showed that because of the very acute angle between each scale and the side of the net directly opposite, the design of a standard bag net fish court prevented salmon turning freely when they swam into either of these corners. As a consequence seals, usually working singly, had little difficulty cornering salmon in these tight corners by swimming round the outside of the net until the fish were exhausted. It was then a fairly simple task to grasp the fish, remove the skin and suck the soft parts through the mesh, invariably without breaking a single half leg.

The method which seals have adopted to rob sea cages at salmon farms is somewhat similar. They trap fish in a pocket of netting, usually at a bottom corner, and then extract the soft parts through the meshes of the net in a similar manner to that seen to occur at bag net fisheries.

This loss was partially eliminated fairly simply, by stretching a curtain of netting the depth of the fish court between each scale and the opposite side wall of the net to prevent fish entering and being trapped in the corners. The net curtains had to be positioned no more than half way along each scale to prevent them guiding fish towards the door and freedom. Although salmon caught in modified bag nets continue to be destroyed, netsmen have reported that the occurrence has been much reduced.

Netsmen operating net and coble fisheries also changed from natural to synthetic fibre to manufacture their nets about the same time but the success rate against seal attack and loss of catch when fished in tidal estuaries frequented by seals, e.g. River Tweed, was markedly less even when a heavier gauge of synthetic twine was used to knit the bag or cod-end.

Scaring seals by sound

Lack of progress in finding solutions to the problems of seal damage seem to result from the difficulty and diversity of the problems. Although some techniques may afford protection at bag net fisheries they will not at sweep net. The use of sound to scare seals seemed to present few obvious difficulties since the hearing ranges of salmonid fish and seals barely overlap; salmon are sensitive only to lower frequencies, while the hearing of seals and odontocete cetaceans extends to very high frequencies.

In the mid-1970s a joint team of DAFS and SMRU staff investigated the use of sound as a seal deterrent. The response to a range of recorded sounds, including calls of Killer whales, which are one of the few predators of seals, and electronically generated sounds was tested at the mouth of the River Tweed at a site where the reactions of seals at three sweep net fisheries could be observed from a single stance.

In the absence of clear positive results from either the experimental or the field trials it was concluded that acoustic methods of scaring seals are ineffective (Anderson and Hawkins 1978). Because the sound they used covered the entire hearing range of seals, they concluded that it was most unlikely that there are sounds which they had not used which may be disturbing to seals. In addition, there was some evidence that the captive seal used in the initial experiment showed habituation to an initially alarming sound.

Because of the reported limited success at salmon farms and the increasing proportion of a much reduced catch being mutilated by seals, custom-built seal scarers were deployed in the 1990s at two bag net stations operating along widely separated and physically different stretches of the Scottish coast with very marked differences in the level of success.

At one station, a high level of success was obtained when only one net in the fleet was protected by a seal scarer but when they were attached to the total fleet the overall damage to catch returned to about its original level. The netsmen concluded that when the total fleet is supposedly protected hunger forces seals to raid nets, and having successfully completed the exercise on a number of occasions they quickly learn that scarers do not harm them and the deterrent effect which initially scarers may have had quickly disappears (Bruce 1994).

The netsman's experience at the remaining netting station was somewhat different. In 1992, he purchased a single scarer which was moved around his fleet of nets at weekly intervals depending on where seals had been seen. During that season only one attack on fish in a net to which a scarer had been attached was recorded. The following year he purchased an additional two scarers and all three were moved around the fleet of nets in a similar manner to that adopted in 1992. Only two instances of seal damage to fish in nets fitted with scarers were recorded that season. Unfortunately, any changes in the level of damage to catch at the unprotected nets was not recorded (Paterson 1994).

In order to improve the design of these devices limited tests have been carried out near Oban on the Flude seal scarer which consists of a series of disks with holes in them, mounted in a cylinder. When a pump is attached the disks contrarotate, producing very intense underwater sound – rather like an air-raid siren.

The initial trials evoked a strong reaction from seals in the water. They dived with violent splashes immediately following the switching on of the device. This behaviour is totally alien. Normally, diving is a more gradual submergence, the head simply disappearing beneath the surface. Some animals also moved behind peninsulas and reefs when the seal scarer was activated. Seals clearly detected and responded to the sounds with what appeared to be a fright reaction. The device worked, and it seemed to scare seals quite effectively but the need for power to drive the 2.2 kVA high pressure pump would limit its use (Hawkins pers. comm.).

Although scarers attached to nets may limit the damage to catch they will not decrease the consumption of fish in the open sea.

Non-lethal methods of population control

The published paper (Brown et al. 1997) indicates that grey seals can be sterilised for at least five years with a one-shot contraceptive vaccine but it would be necessary to sterilise very large numbers annually to limit the growth of the UK seal population as a whole even if those sterilisations were targeted in the most effective manner possible. Limiting the population to the same level by culling would require a similar number of animals to be targeted as with sterilisation. In either case it is difficult to predict future population growth patterns, even with the help of simulation models, and accurate estimates of current population size.

Other factors, including disease and the lack of food, may change population size. The change in the ratio of adult males to fertile females may put excessive pressure on these females to mate and as a result reduce their survival prospects. A really large-scale sterilisation regime might lead to a change in the distribution of breeding seals with further unpredictable consequences on their survival, and sterilising a given number of females will have less effect if it is carried out at a location where pup survival is low in any case (Hiby 1994).

Main conclusions

Most fair-minded people will agree that the number of seals (grey and common) at most breeding sites around the Scottish coast has, and will continue to, increase for the foreseeable future and that the lack of food is unlikely to limit the present rate of expansion. Not only has the number of seals increased but also the number of breeding colonies and 'haul out' sites, particularly along sections of the coast adjacent to salmon rivers once occupied by active net fisheries. Grey and, more frequently, common seals have extended their range into estuaries and rivers and have been observed many miles above the head of tide. The frequency with which common seals are seen in fresh water may peak during the smolt migration season.

On the other hand, reported salmon catches across the North Atlantic in 1960-1997 have declined from a peak of 12,670 tonnes in 1973 to 2,218 tonnes in 1999 (Anon 2000). Although there has also been a significant decline in net fishing effort, the spawning stock has not responded and in most rivers around Scotland the fraction of the multi-sea-winter component which presently returns to fresh water over the winter and spring may be incapable of producing sufficient eggs to seed the preferred habitat at the optimum density.

Although large samples have been amassed, seal diet studies remain inadequate to reliably assess the contribution of salmon to the diet of seals. This value is a precursor to determining the proportion of salmon biomass that they harvest, a measure which would resolve many of today's uncertainties.

This situation, however, is unlikely to change because salmon are relatively rare and becoming rarer in the ocean and predators can harvest substantial fractions of salmon biomass even if salmon constitute minute fractions of predator diet. The proportion of harvested salmon biomass is also essential to determine the probable effect on a prey population (salmon) of removing substantial numbers of predators (grey seals).

Nevertheless, Amiro (1998) has shown that increasing harp seal populations in the Northwest Atlantic are statistically related to the decline in Atlantic salmon and Cairns and Reddin (in

press) have concluded that despite the limitations there is sufficient bulk of evidence to demonstrate that seals and sea birds are significant potential predators on North American Atlantic salmon during their marine phase.

Even if it was logistically possible to mount a seal cull on the major breeding sites, to successfully remove the number of animals estimated to be necessary to maintain the grey seal population at its present level and not even attempt to reduce it, the effect on both the number of salmon returning annually to homewaters and salmon fisheries is likely to be insignificant (Shearer 1992).

The only time when the UK grey seal population congregates in large numbers is towards the end of the year during the breeding season but since their preferred sites are frequently islands, access can be extremely difficult. Although a massive sterilisation programme might be feasible if the vast majority of the breeding population was located at a small number of readily accessible sites, the Scottish grey seal population does not necessarily meet that requirement.

The information contained in the letter from Messrs Joseph Johnston and Sons Limited in 1883 to the Inspector of Salmon Fisheries is highly significant since it suggests that even at low population levels (the total population in 1883 was unlikely to exceed 2,000 animals) seals will continue to predate on salmon in coastal waters.

Furthermore, attitudes have changed over the last 50 years and whereas it was possible in the 1950s to seriously consider the use of aircraft based at Leuchars to control seals on the Tay estuary sandbanks, a similar approach to the RAF would certainly not be entertained today.

The relationship between marine predators and their prey is complex with many potential cause-and-effect chains. Predator increases do not necessarily lead to lower prey populations (Gulland 1987; Smith 1995).

A major cull of grey and, to a lesser extent, common seals at their respective breeding sites is, logistically, not possible at the present time. There may also be strong biological reasons why such an exercise may fail to produce the desired effect – a marked increase in the number of salmon returning to spawn and a decrease in the impact on fisheries.

Management strategies

Seal culls

As a general rule, seals which enter rivers, estuaries, frequent bays and 'haul out' sites adjacent to salmonid rivers, including those which damage nets and catch, should be culled until such time as those locations can be satisfactorily protected by some other means, e.g. seal scarers. However, even if exclusion zones can be successfully created there will always be a need to kill some seals. These fall into three groups and include those seals which:

a) enter rivers and estuaries and frequent bays and 'haul out' sites adjacent to salmon rivers where the use of scarers to create exclusion zones would be impractical;
b) continue to frequent locations where scarers have been deployed; and
c) damage, enter or raid nets whether or not a scarer has been deployed.

The fraction of the seal population frequenting these locations probably includes the major proportion of the animals which target salmon and salmon caught in nets, and therefore may be inflicting the greatest impact on salmon biomass and fisheries. These culls should be co-ordinated and managed by District Salmon Fishery Boards and, where appropriate, Fishery Trusts. Where there are no District Salmon Fishery Boards, the fishery owners should take on the management role. Culling should only be undertaken by skilled marksmen who have been trained in the use of rifles, e.g. stalkers. Such culls, properly planned and managed, have been proven to be both feasible and effective.

Culling seals on breeding sites such as the Isle of May is excluded because of the scale of the operation and also because tracking studies have shown that their feeding migrations may involve substantial journeys in the open sea where it is unlikely that many salmon are targeted and any niche freed would soon be filled by seals from elsewhere – possibly the Orkneys. However, there may be good reason to prevent new breeding colonies becoming established adjacent to salmon rivers.

No new government legislation would be necessary. Nevertheless, government should examine the present legislation, which permits seals to be killed exclusively by a high-powered rifle, and also the application for permission to shoot seals to protect fisheries, to determine whether any changes are necessary, based on the experience of having operated this system for 30 years. It would be surprising if improvements were not possible, particularly in relation to the need for the appropriate endorsement on the fire-arm certificate.

Seal scarers

Investigations should commence immediately to test whether the seal scarers presently on the market could be strategically deployed in the field to prevent seals entering rivers and to create exclusion zones around the mouths of rivers where immigrating adults and emigrating smolts and kelts are probably most vulnerable to attack. Initially it may be necessary to remove any resident seals which have learnt to enjoy the lush pickings to be had.

In addition to encouraging fishermen to continue to modify their nets to prevent the loss of catch, technical help should be provided to test, in a series of controlled experiments, whether the seal scarers presently on the market will decrease seal damage to an acceptable level irrespective of where the net is located. In common with the previous investigation it may be necessary to shoot some seals. Seal scarers should also be tested on the gear (set gill nets and lines) presently used by inshore fishermen to catch demersal species, e.g. cod and haddock, relatively close to the coast.

However, shooting seals to protect fish and fisheries may always be necessary, particularly if scarers are ineffective at individual sites.

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