# Fish-Eating Birds

## Assessing Their Impact on Freshwater Fisheries

Institute of Terrestrial Ecology

NRA

*National Rivers Authority*

R&D Report 15

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# GLOSSARY OF ACRONYMS

BTO British Trust for Ornithology

MAFF Ministry of Agriculture, Fisheries & Food

RSPB Royal Society for the Protection of Birds

SOAFD Scottish Office, Agriculture & Fisheries Department

WOAD Welsh Office, Agriculture Department

WWT Wildfowl & Wetlands Trust

# SUMMARY

In Britain and elsewhere, fish-eating birds, particularly cormorants and sawbill ducks (goosanders and red-breasted mergansers), are widely believed to affect fisheries, reducing the abundance of fish or changing their behaviour so as to reduce harvest or angling catches. These birds are protected by law, but with provision for the issue of licences (by SOAFD - Scottish Office, Agriculture & Fisheries Department - in Scotland, MAFF - Ministry of Agriculture, Fisheries and Food - in England and WOAD - Welsh Office, Agricultural Department - in Wales) to kill them to "prevent serious damage to.... fisheries". There is considerable debate as to whether these birds damage fisheries, and whether licensed killing effectively prevents "serious damage".

The National Rivers Authority (NRA) has a statutory duty to maintain, improve and develop fisheries, and also to further conservation, on the waterways of England and Wales. Whilst the NRA is aware of the concerns of fisheries interests, full consideration of all the available evidence is needed when the NRA is asked to comment upon applications for licensed killing. The NRA therefore commissioned the present work to review the existing information on the status of these birds, their impacts on fisheries and the effectiveness of management procedures to control bird predation on fish populations. The present study also discusses criteria for serious damage to fisheries, evaluates the current NRA position statement and suggests future action with regard to policy and research.

Cormorants have increased dramatically in Europe and to some extent in England and Wales. Their increasing use of inland freshwaters has coincided with increased fish farming and intensive fish stocking for angling. Newly established breeding populations have increased, particularly in southeast England. There are good reasons to anticipate cormorant numbers eventually stabilising, but the process will be protracted as long as their food supply continues to be artificially increased. Sawbill duck numbers have also increased in parallel with an expansion of their breeding range. However, this expansion has now slowed and numbers have fluctuated, perhaps even declined, within the existing range.

Studies of diet suggest that all three species are unlikely to be damaging fisheries over much of their range. Experimental fish community studies show that predation can affect fish populations, but to date there are no experimental studies that have shown bird predation to damage fisheries seriously other than at small enclosed systems such as fish farms. Most evidence of damage is anecdotal or circumstantial. Models of bird/fish interaction have so far been unsatisfactory and their predictions remain untested. The lack of hard evidence for bird damage to fisheries is not necessarily because there is no bird effect, but could be because the appropriate experiments have not yet been done. No study has shown that killing birds effectively prevents damage to fisheries and moreover, work currently underway in Britain is unlikely to do so.

The review concludes with recommendations that:

- the current NRA position, of not supporting licensed killing until serious damage has been established and killing proven to be the most effective management procedure for preventing it, remains unchanged until new information accrues;
- the NRA initiates, or promotes in a supporting role, research to address the problem using an experimental approach;
- experimental research should investigate whether bird predation has a measurable impact on fisheries, and if so, what mechanisms are the most cost-effective in reducing this impact; and
- fisheries interests, the licensing authorities, nature conservation organisations and the NRA have a common interest in promoting the appropriate research and should consider joint funding.

# KEYWORDS

Cormorant, sawbill duck, fish-eating birds, fisheries, impact.

# 1. INTRODUCTION

In Britain, many birds eat fish in freshwaters and some can be a nuisance, but only three species, cormorant, red-breasted merganser and goosander, are commonly perceived to present serious problems for freshwater fisheries. Complaints are mainly that:

- cormorants eat large fish so that there are fewer to be harvested or angled;
- all three bird species eat so many juvenile fish that there are subsequently fewer large fish to be harvested or angled; and
- there are indirect behavioural effects, so that for example, persistent predation by birds in one habitat or area displaces fish to another where, though free from predation, they are less able to feed and grow, or are less easily harvested or angled.

This report reviews existing information on the three bird species, discusses fish population dynamics within the context of predation and reviews existing evidence for bird impacts on fisheries. It then describes current legislation, discussing potential criteria for "serious damage" to a fishery, and suggests ways forward for NRA policy and research. The full review and supporting bibliography can be found in R&D Project Record 461/8/N&Y, available from NRA Regional Offices.

# 2. SPECIES REVIEW

## 2.1 Cormorant

### 2.1.1 Species and subspecies

Two subspecies of cormorant occur in Europe. *Phalacrocorax carbo carbo* breeds in the north and west, including Britain, and is mainly resident. The other race, *P.c. sinensis*, breeds elsewhere and is migratory, most moving south and east for the winter. Some *sinensis* winter in southeast England and a very few breed there. The *sinensis* subspecies is specially protected by its designation as an Annex I species of the European Community Birds Directive (see Section 4.1) so its occasional, but increasing presence in Britain as both a wintering and breeding bird has implications for the management of *carbo* populations here.

### 2.1.2 Diet

Cormorants feed almost entirely on fish. A review of 34 European studies records at least 77 prey species but only about a third of these feature regularly, mainly associated with habitat. In the sea, cormorants mainly feed on bottom-dwelling fishes, wrasse and gadoids over rocky and weed-covered substrates, flatfish over soft substrates and eel and eelpout in a variety of areas. On occasions, small, shoaling, midwater fishes such as clupeids, capelin and even sandeels, are also taken. In estuaries, flounder, trout, eel and saithe are the most frequent prey, and sandsmelt, mullet and sea bass are important in southern Europe. On rivers, trout, salmon and grayling are the main prey in fast-flowing sections, cyprinids (roach and bream) in slower, deeper parts and flounder in the lowest reaches. At freshwater lakes, the commonest recorded prey are roach, perch and eel. Other cyprinid prey in 'rich' freshwaters include bream, rudd and tench, and other percids, ruffe and zander. In more 'acid' and/or species-poor waters, cormorants feed mainly on brown trout or perch. They also frequently take brown and rainbow trout from stocked stillwaters, carp from fish farm ponds and escaped stock from around fish cages. The sizes of fish taken range between 30 and 650 mm, the majority 100-300 mm. Diet is to some extent predictable as there is circumstantial evidence that it varies according to the availability of the principal prey fish.

### 2.1.3 Foraging behaviour

Cormorants mainly feed independently of one another, diving deep if necessary to catch their prey on the

bottom, although in places they also feed socially on midwater shoaling fish. They can commute up to 70 km from roosting sites and 35 km from the breeding colony. There is indirect evidence that they preferentially select for prey species and size, and for foraging habitat. Such behaviour has important implications for predicting the use of sites by cormorants, and for any attempts at managing cormorant populations.

#### 2.1.4 The amount of fish consumed by cormorants

Twelve studies have estimated daily food intake variously as 6-32% of the bird's body weight of fish per day. The most realistic figure probably lies within the range estimated from energetics calculations (17-26%), equivalent to between 340 g and 520 g fish per day.

#### 2.1.5 European population trends: changes in numbers and distribution

Breeding populations are assessed by counts of nests in colonies, and winter populations by counts at roosting or foraging sites. The accuracy of these counts has only occasionally been quantified. The population of *sinensis* has increased at about 21% per annum over the last 50 years, to its 1992 level of about 105 000 pairs. The breeding range has expanded south and east, and wintering numbers (and range) have increased in parallel. *Carbo* populations have increased moderately at about 3-6% per annum, to the 1992 level of about 40 700 pairs, of which about 7000 pairs were in Britain and 4700 in Ireland. In Britain numbers have increased most in the southeast and could have declined in parts of Scotland. Formerly some wintered in France and Iberia, but now most apparently winter locally, the numbers at freshwater sites increasing in association with increases in stocked fisheries. The British wintering population has increased by about 4% per annum, with the most recent estimate (1990) at 16 800 birds.

#### 2.1.6 Factors influencing population change

The dramatic increase in the *sinensis* cormorant population has been attributed to a reduction in killing by man, a reduction in the detrimental influence of environmental pollutants, and an increase in food supply, but the evidence is insufficient to distinguish between these factors. In Britain, the increase in the *carbo* population could be associated with all three factors, and the local decreases in parts of Scotland with killing, mainly at fish farms. There is now circumstantial evidence from Europe of limits on numbers in summer and winter populations. Left alone, the cormorant population in Britain will stabilise, its size proportional to the amount of available food, but it is expected that this process will be prolonged if cormorant food supply continues to be increased artificially.

### 2.2 Goosander

#### 2.2.1 Distribution, habitat, breeding and movements

'Sawbills', goosander *Mergus merganser* and red-breasted merganser *M. serrator*, are specialised ducks of the boreal and low arctic zone shallow waters, that feed mainly on fish by pursuit diving. Both species feed on small fishes but goosanders have stouter beaks and are larger than red-breasted mergansers, which forage in more open, sometimes deeper waters, and more often take crustacea.

The goosander is a predominantly freshwater duck producing young on rivers and sometimes on lakes. Northern breeding birds may move south for the winter, though most of those in the southern and western part of the range are resident, moving relatively short distances to winter on the lower reaches of rivers, estuaries and freshwater lakes. In a few places they aggregate in very large numbers in shallow brackish waters and large lakes.

Outside the breeding season, goosanders gather to roost communally on standing waters, most birds leaving just before sunrise and returning in late afternoon. By spring, mature goosanders have paired and move to the upper, faster flowing parts of rivers to breed. Birds at the southern end of the range start to lay in March, but those in the far north not until May. They lay clutches of 7-14 eggs in cavities in trees, cliffs or among boulders and, led by the female, the young leave the nest within two days of hatching to feed themselves. In Britain, on three rivers in Scotland and one in Wales, annual average breeding production has varied from 0.0 to 3.6 ducklings fledged per spring adult female, average brood size from 6.1 to 7.4 ducklings per brood, and brood density from 0.0 to 0.4 broods per km of river.

Males migrate north in April (in the south), May and early June, to moult in July and August on estuaries, firths and shallow fjords, the majority in North Norway and a few in Scotland, alongside females. By late October, fledged juveniles have dispersed and moulted adults return to their wintering areas.

### 2.2.2 Diet

In 26 studies, diet has been estimated from the contents of the foregut, but the accuracy of this information has not been quantified. In spring, goosanders can feed on frogs or carrion fish. In summer, small ducklings feed on large insects, and at times adults have been known to take freshwater crayfish. However, for the most part year-round, the diet comprises small fish, 50-110 mm long on rivers and slightly larger on lakes. There is bias in the literature towards the diet of birds in places where it was thought they were eating commercial or sporting fishes, but in most places at most times of year the evidence suggests that goosanders do not eat commercially valuable fish.

On rivers in North America the main elements of diet are suckers, sculpins, salmonids, shiners and eels, with the inclusion of fallfish and alewife in autumn. Ducklings feed mainly on shiner, with some small salmonids and cottids. The diet on lakes includes a similar array of fish types but also includes 'chub', smelt, yellow perch and killifish in the north. In the warmer waters of the southern lakes and reservoirs, the winter diet is mainly gizzard shad, carp, perch, freshwater drum and white crappie. The birds sometimes feed on fish of commercial interest: in winter, on Washington lakes stocked with hatchery rainbow trout and on Michigan rivers on trout (including stocked brook trout); and in summer and autumn, on a few rivers in New Brunswick and Nova Scotia, where they take juvenile Atlantic salmon.

In the Palaearctic the diet is similar: on rivers it includes salmonids, eel, lamprey, bullhead, grayling and perch; ducklings consuming minnows, salmonids and stoneloach. On lakes outside the breeding season, the diet is mainly cyprinid and percid fish and sticklebacks. In winter and spring, in shallow coastal waters, they take eel, eelpout, stickleback, gobies, sandsmelt, butterfish, cottids and roach.

Goosanders feed on fish of commercial interest on only a few rivers, so far only established for Scandinavia and northern Scotland, where they take arctic char, trout and salmon in spring and summer. There has been no detailed study of diet in England or Wales. In general terms, the diet appears to consist of the most easily caught small fish, of those most abundant in the various habitats used by the birds. Thus the only areas where goosanders are likely to consume large numbers of fish of economic interest, are in places where the fish community is dominated by such fish, such as salmonid dominated northern fast-water rivers, or artificially stocked salmonid fisheries.

### 2.2.3 Foraging behaviour

Goosanders locate fish from the surface or by diving and, when no fish are visible, often probe the river or lake bed with their bills, sometimes turning over smaller stones. Mostly they feed independently of one another, even when in groups. Only in places where they are feeding on huge shoals of midwater fish do they congregate in large flocks to feed socially. Studies of foraging birds have shown that fish are most vulnerable to goosander predation if they are easily seen, relatively slow swimming and living in places with few hiding places. This is sufficient to explain selection for fish species and size in the diet. Naive hatchery fish seem to be particularly vulnerable.

### 2.2.4 The amount of fish consumed by goosanders

Six studies have variously estimated food intake at 18-50% of body weight per day for full grown birds, and 80% for 10 day old ducklings, falling to 30-40% just prior to fledging. These figures give a daily ration of between 240 and 520 g of fish.

### 2.2.5 Population trends in Europe and Great Britain

Goosanders are not easy to count, but the spread in breeding distribution has been well documented, particularly in Britain where first breeding was in about 1871. Southern Scotland and northern England were colonised from 1950 to 1980, and Wales, from 1970 to 1990. Further major expansion in the British breeding range seems unlikely. The current breeding population of western Europe could be 30 000-40 000 pairs. Britain's population has been estimated at about 2700 pairs, with the greatest concentration on rivers in southern Scotland and northern England. A survey in 1987 recorded average densities of 0.18 pairs per km on rivers in Scotland, 0.21 in England and 0.08 in Wales. Winter populations have been most recently estimated at about 100 000-150 000 birds in western Europe with about 5500 in Britain. Counts at specific sites within the last decade have shown constant numbers in winter on three Scottish rivers but a major decline at the single largest winter concentration, the Beauly Firth. There has been a decline in breeding numbers on two of three regularly counted rivers in Scotland.

## 2.3 Red-Breasted Merganser

### 2.3.1 Distribution, habitat, breeding and movements

The red-breasted merganser is a predominantly marine species living in shallow coastal waters. Most of the British population breeds in sheltered sealochs and estuaries, and a small but perhaps increasing proportion breeds on the slower-flowing, wider, lower reaches of rivers and on freshwater lakes, which is the commoner breeding habitat elsewhere in the range. Almost all red-breasted mergansers spend the winter on the coast, entering freshwaters in late April and May, producing eggs in May and June and young in July and August. Egg-laying is probably slightly later at higher latitudes. Seven to 12 eggs are laid in a scrape on the ground amongst vegetation, and the young leave the nest within a day or so of hatching to feed themselves. One female can guide many ducklings which sometimes congregate into a single large group particularly on shallow lakes and estuaries. This habit of creching is far more common in red-breasted mergansers than in goosander broods. Average production in individual years has varied from 0.7 to 2.5 ducklings per spring female (0.7 to 1.8 on a river in Northeast Scotland). In this latter study, low duckling production was associated with high river flows at the time of hatching and in the subsequent ten days.

Adult red-breasted mergansers moult their wing feathers in August and September, at this time congregating in open areas of shallow water; in Britain, on the coast around Scotland, Northumberland and North Wales. After moult the birds become well dispersed around the coast with large aggregations at fewer sites.

### 2.3.2 Diet

Thirteen dietary studies have shown that mergansers eat small fishes (20-100 mm), mainly sticklebacks, shiners, minnows and gobies, but also large insects and shrimps. Only on some rivers in Scotland have they been shown to eat fish of commercial importance. There they sometimes ate juvenile salmon, but only in any quantity during April. Moreover, the fish consumed were very small (30-130 mm), mainly parr (mean length 70 mm), but including some small smolts (mean length 115 mm) from the beginning of the smolt migration. Other studies have deduced diet from a combination of visual observations and an association with certain habitats. From this it is inferred that the diet consisted of sandeels, young clupeids, shrimp, flatfish and sticklebacks on the coasts of Scotland in autumn and winter; predominantly insects and sticklebacks in spring and summer in the north of the breeding range but including some other species such as eels, minnow or perch fry in the south.

### 2.3.3 Foraging behaviour

Red-breasted mergansers feed in similar ways to goosanders except for a tendency to use their wings underwater and for more diving and less surface scanning than goosanders when searching for prey. Both these features could be associated with red-breasted mergansers' greater use of deeper, slower moving waters, that often have soft or sandy substrates and can be more turbid. Similar to goosanders, they sometimes congregate to forage socially and can show diurnal patterns correlated with the activity rhythms of their major prey.

### 2.3.4 The amount of fish eaten by red-breasted mergansers

Two studies have estimated the food intake of red-breasted mergansers, one from captive birds and another on a theoretical energetic demand basis. The values, 29% and 23% of body weight per day are similar to those for goosanders, and represent a daily intake of between 210 and 320 g.

### 2.3.5 Population trends in Europe and Great Britain

Counts of red-breasted mergansers at specific sites can fluctuate erratically from year to year and movements are poorly documented, so the wintering population of northwest Europe is only roughly estimated at about 40 000 and the total breeding numbers are unknown. As with goosander, the best documented population change is in Britain where numbers have increased alongside an expansion in breeding range.

Red-breasted mergansers have long bred in Scotland but the population increased dramatically from about 1885 to 1920, spreading into northern England in 1950 and North Wales in 1953. Although the breeding population of Britain continues to be concentrated in western Scotland, there are well established populations in the Lake District, Anglesey and North Wales. Recently, there has been further colonisation in the Peak District and southwards in Wales, but further dramatic changes seem unlikely.

There has been no direct attempt to census the whole breeding population of Britain and Ireland.

The abundance indices accompanying the most recent distribution map in *The New Atlas of Breeding Birds*[1], give the most recent estimate of about 2150 pairs in Britain and 700 in Ireland, but it is not known what proportion breeds in freshwaters. An index of wintering numbers increased from 1962/3 to 1979/80, but not since, paralleling the expansion and increase in the breeding population. The most recent estimate of the winter population is 6000-10 000 birds.

[1] Gibbons, D.J., Reid, J.B. & Chapman, R.A. 1993. The New Atlas of Breeding Birds in Britain and Ireland: 1988-91. Academic Press.

# 3. THE IMPACT OF BIRDS ON FISHERIES

## 3.1 Fish Population Dynamics

A recent comprehensive review of temperate stream and lake fish community studies concluded that there was good experimental evidence for the influence of both predators and prey on fish populations, as well as for the direct effects of environmental factors. The implications are that neither an effect of bird predation on fish populations, nor the lack of one, can be assumed.

This means that any postulated impact of fish-eating birds needs to be demonstrated unequivocally, but this is not easy to do. Most freshwaters in Britain are in flux; changing in association with a fluctuating climate, natural ecological succession or anthropogenic influences, such as nutrient and sediment inputs, water acidification, weed control, fish stocking, and fish introductions. Reduced fish catches cannot be attributed with certainty to increased bird predation when they are so often accompanied by other changes. Consequently, properly controlled experiments are the only way to demonstrate cause and effect.

## 3.2 Experimentation

The hypothesis of a specific impact can be generated by theoretical argument, by using anecdotes or by quantitative prediction. The experimental manipulation of bird predation and the measurement of the outcome can be easy at small enclosed systems, but impractical on larger water bodies or river systems. Most importantly, with larger, open systems it is difficult to match the experimental site to a suitable 'control' site - an identical set-up but with no experimental manipulation of bird predation. The best of field experiments should therefore include repetition, reversing the procedures between experimental and 'control' sites.

Field experiments are expensive and difficult to carry out, so assessments of impact have mainly relied on a mixture of anecdotal and circumstantial evidence. It is easy to argue both for and against fish-eating bird effects, but by assessing diet and bird abundance, substantial impact can often be ruled out, leaving only a few situations where impact might be sufficient to lead to fishery losses, and where experimentation need be applied to resolve it.

## 3.3 The Impact of Cormorants on Fish Populations

Cormorants are large, are seen to catch large fish, and congregate in numbers, so that at least in some places they could be consuming large quantities of fish potentially to the detriment of harvest or angling catches. Moreover, the cormorant population has been increasing for the last 25 years so any decline in fish catch during that period can be shown to have been accompanied by an increase in cormorants. Such superficial evidence is sufficient to raise the hypothesis of an impact, but closer scrutiny is required.

### 3.3.1 Cormorants at fish farms

Cormorants feed on the large concentrations of wild and escaped fish in the waters immediately adjacent to cage farms, but also attack stock through the net meshes. The amount of stock lost is small and can be further reduced by using properly positioned, underwater anti-predator netting. There is little evidence that cormorants are a problem at tank or pond farms in Britain, but in other parts of the world ponds are larger and losses could be substantial. There is also anecdotal evidence that flocks of cormorants landing on ponds or beside cages stress fish so much that it reduces their feeding and may increase susceptibility to disease.

The concentration of fish at farms is so attractive that the shooting of birds will be ineffective until the majority of the local cormorant population has been killed; a mammoth and impractical task. Excluding cormorants from anywhere other than small ponds seems to be difficult. Protective ropes and scaring are only partially successful, human presence being one of the few persistent deterrents. Cage enclosures within ponds may protect small fish from cormorants until they grow too big to be eaten. Changing the stocking regime and providing alternative (low commercial value) foods has been successful.

### 3.3.2 Cormorants at stocked stillwaters

In Britain, the number of stocked stillwaters of various sizes has increased dramatically over the last 20 years to satisfy the demand for recreational angling. Cormorants can congregate at such sites in winter, increasing from October to February, and there is some evidence that they feed on 'takeable' stocked fish, so competing directly with anglers. However, it has not been shown that reducing cormorant predation results in greater catches for anglers.

At one trout fishery enhanced by stocking, cormorant numbers increased and angling catches declined, but shooting large numbers of cormorants failed to increase catches and moreover, stock assessment showed fish were very abundant. Other contemporary events at this particular site included the removal of pike, a decline in perch, a high nutrient input, changes in aquatic plant cover, and a series of algal blooms; so in the absence of experiment, it was impossible to say what had reduced angling catches.

If cormorants are indeed reducing catches, the problem is difficult to solve. On large water bodies, total exclosure is impossible, and deterrents and shooting are ineffective. A potential remedy might be to reduce the stocking density of the angled species and increase alternative cormorant forage by stocking 'buffer' populations of low value fish. Another approach is to stock at times of year when cormorants are leaving the area. This may not be an option at some sites in the future if inland breeding cormorants continue to increase as predicted.

### 3.3.3 Cormorants on large lakes

Outside Britain, large lakes often support commercial freshwater trawl or seine fisheries as well as recreational angling, and cormorants can number hundreds or thousands at some of these sites. The evidence of impact on fish populations is anecdotal or at best circumstantial, usually a decline in fish catches as cormorant numbers increase. In three of four studies, cormorants did not eat the commercial species in question. In another study, commercial fish catches increased along with cormorant numbers, the former being associated with the effects of nutrient enrichment of the water.

Six studies have estimated impact by multiplying the number of birds by their estimated fish intake. The fish consumed by cormorants were calculated at about 2-17% of the standing crop of fish in lakes, and as 2-10% of the human harvest. None of these studies gave confidence limits to their estimates of bird numbers, diet, or fish abundance; neither did they consider fish population dynamics, so it is difficult to judge the veracity of such calculations.

### 3.3.4 Cormorants on rivers

On rivers, cormorants are commonly thought to affect fisheries by their consumption of large numbers of salmonid fish. Six studies of diet from British rivers have shown that salmonids are rare in the diet of cormorants feeding in estuaries, and only occasionally important further upstream. Most of the trout consumed are small, and salmon smolts were only important in one sample from a northern river.

Three studies have investigated smolt predation by large numbers of cormorants. In one of these, the consumption was insignificant (0.2% of released smolts) and in another, although 6-13% of smolts were estimated to have been taken, there was little impact on the fishery because the adult return rate was so low compared with wild fish. In the third study, the estimated losses of 13-28% of released hatchery smolts and 51-66% of smolt from an intensively stocked area, were unfortunately based on diet estimated from only four stomachs in each instance. There is no documented case of cormorants congregating to feed on untagged wild smolts.

On large rivers in Switzerland, where grayling are stocked for angling, there is conflicting circumstantial evidence of an effect of cormorant predation, yields declining in one area but increasing in another alongside increases in cormorants. There have also been claims that cormorants on the River Ribble in northwest England have harassed fish so much as to make them less 'catchable', driving them into the sidestreams where the fish cannot feed so well. The situation is under investigation but for the present, the evidence remains anecdotal.

## 3.4 The Impact of Sawbill Ducks on Fish Populations

### 3.4.1 Sawbill duck predation at fish farms and on stillwaters

A review of diet and seven case studies suggests predation by goosanders and red-breasted mergansers is not a serious problem at fish farms or on stillwaters.

### 3.4.2 Sawbill duck predation on rivers

Dietary studies of goosander and red-breasted merganser have shown that they consume small fish, which at most times of year and in most places are of no commercial interest. Only on a few rivers in eastern Canada, Scandinavia and northern Scotland does the diet suggest that there could be an effect of sawbill predation on salmonid fisheries. At least six experiments have been attempted in eastern Canada. The three that have been published have failed to show any effect of duck predation on salmon stocks mainly because of poor experimental design or procedure. The best conducted experiment suggested that if a duck effect existed, it was small compared with other factors affecting salmon abundance. In Britain, no controlled duck removal experiments have been done.

Calculations of the effects of duck predation have produced estimates of up to 35% loss in salmon returns, but recent work has shown the assumptions used in these mathematical models were invalid. Sawbill abundance and diet varies from river to river and could be influenced by stock enhancement and some fish-tagging procedures. Most of the juvenile salmonids eaten by sawbills are parr from the main stem of the river, and the smolts consumed are smaller than average and come from the early part of the smolt run. Modelling the effect of the removal of such fish requires a knowledge of salmon population dynamics that at present is incomplete. Even if a mathematical model is produced that adequately takes account of fish population dynamics, it would still require validation by artificially reducing sawbill predation and confirming the predicted outcome in terms of fish catches.

# 4. THE LEGAL PROTECTION OF CORMORANTS AND SAWBILL DUCKS

## 4.1 Legal Protection and Licensed Killing in Great Britain and Europe

### 4.1.1 Great Britain

Cormorants, goosanders and red-breasted mergansers are fully protected in Britain under the **Wildlife and Countryside Act 1981**, which implements the **European Community Directive on the Conservation of Wild Birds (EEC/79/409).** The 1981 Act makes provision for the killing of birds by licensed shooting (Section 16(1)(k)) "for the purposes of preventing serious damage to... fisheries". A further clause (Section 4(3)(c)), provides a mitigating defence for the unlicensed shooting of birds, provided it is for "preventing serious damage to... fisheries".

Each licence issued represents a **Derogation** under **Article 9** of the EEC Directive which allows deviation from the Directive where "serious damage" to fisheries occurs and where no other satisfactory solution can be found:

*Article 9, EEC/79/409*

*"member states may derogate from the provisions of Article 5, 6, 7 and 8, where there is no other satisfactory solution for the following reasons:*

*(a) - in the interest of public health and safety;*

*- in the interest of air safety;*

*- to prevent serious damage to crops, livestock, forests, fisheries and water;*

*- for the protection of flora and fauna".*

There is thus ample provision in both British and European law to allow measures to be taken where cormorants, goosanders or red-breasted mergansers are doing "serious damage" to the welfare or livelihood of people, or to conservation interests.

The licensing authorities which deal with licence applications for the purposes of preventing serious damage to fisheries are the Scottish Office Agriculture and Fisheries Department in Scotland, the Ministry of Agriculture, Fisheries & Food in England and the Welsh Office Agriculture Department in Wales. Licences for the protection of flora and fauna, and those for the purposes of scientific research, are processed by Scottish Natural Heritage in Scotland, English Nature in England and the Countryside Council for Wales in Wales.

In theory, no licences need be currently issued in Britain to prevent "serious damage" to fisheries because there is no hard evidence for such damage. Furthermore, there is no hard evidence that shooting is effective in preventing damage, other than in small enclosed systems such as fish farms. Indeed, at such places managers can shoot birds to protect their livestock or fishery, relying for their defence, if prosecuted, on the mitigation clause (Section 4(3)(c)).

In practice, fishery managers do not wish to take risks and prefer the security of a licence. Some licences have been issued in England for the killing of cormorants where there is circumstantial evidence of serious damage to stocked fish and where other means of solving the problem have been tried, and have failed. In Scotland, licences have been more readily issued to kill cormorants, goosanders and red-breasted mergansers, with conditions limiting the number of birds to be shot, specifying the time of year and requesting that carcasses be returned to examine their stomach contents. Licences have been issued on the basis of the circumstantial evidence that these birds are abundant, and that they can eat stocked fish and wild salmon and trout. Every attempt is made to issue licences for specific places where such evidence appears to be greatest; the presumption being that the consumption of large numbers of stocked fish, or juvenile salmonids results in serious damage to a fishery. However, a causal link between consumption and serious damage has certainly not been scientifically established and so the licensing authorities remain vulnerable to criticism. In recent years scientific licences have been issued in Scotland to kill cormorants and sawbills to investigate diet, but no licences have been issued anywhere in Britain specifically to protect flora and fauna for conservation purposes.

### 4.1.2 Europe

Elsewhere in Europe, cormorants and sawbills are similarly protected except by derogation (Article 9, EEC/79/409), or where they are deemed quarry species for hunting. Wherever and whenever the birds are protected, there is usually provision for killing or compensation in circumstances where there is fisheries damage, but no countries have specified criteria for such damage. Cormorants are widely perceived as damaging

to fisheries, whereas sawbill ducks are only considered to have a potentially damaging effect in Norway, where some licences are issued annually for fisheries protection.

An analysis of questionnaire returns from ten European countries showed cormorants were consistently perceived as damaging at fish farms and sometimes at other fisheries, but only by fish-farmers, fishermen or sport-fishermen. In most countries, serious damage was thought to occur only at fish ponds. Two countries, Germany and the Netherlands, provide financial compensation for damage. Scaring and killing was allowed in some circumstances in all countries, but in none could shooting be reported as effective in preventing damage. Only a few countries had addressed the issue with research or management plans.

In Sweden, shooting of cormorants is permitted year round within 200 m of static fishing nets, but following complaints from fishermen, a management plan is being devised. Denmark is the only country so far that has actually produced a management plan and this gives emphasis to preventing damage by scaring. Commercial fishermen are allowed to kill cormorants at any time within 100 m of their fishing gear and the state is funding research to devise effective covers to protect pound nets. In Poland, shooting is allowed at fish farms and to deter new breeding colonies from becoming established nearby. A previous attempt in 1987 and 1988, to cull the population in fish farming areas by killing at breeding colonies, failed because surviving birds moved and bred well elsewhere. In Germany, fish farmers can kill up to eight birds per farm from July to December and compensation can be paid to lake fisheries. In the Netherlands, the emphasis is on scaring and compensation has been paid to eel fisheries. In France, cormorants can now be killed at all fish farms, but in Italy no licences are issued and illegal killing is commonplace. Illegal killing of cormorants was said to occur in almost all European countries, including those such as Sweden where there is ample provision for legal killing.

In some countries, cormorants and sawbills are hunted as quarry species, within specified seasons. Cormorants are shot for sport in Iceland and Sweden, goosanders in France, Denmark, Norway and Estonia, and red-breasted mergansers in France, Iceland, Denmark, Norway and Estonia. In Iceland, the eggs of goosander and red-breasted merganser can be taken provided four are left in the nest, and the eggs and young of cormorants can be taken for food, though adults cannot be shot at breeding cliffs.

# 5. SERIOUS DAMAGE TO FISHERIES

## 5.1 What Constitutes "Serious Damage to Fisheries"?

The term 'fisheries' includes not only the occupation or industry of catching fish but also the place associated with it. In freshwaters, fisheries can vary from a syndicate-run whole watershed river system, to a club-run angling stretch; from a commercial fish farm pond, or a small put-and-take sport fishery, to lake-based angling or netting operations. This diversity of operations has, in common, the use of fishery as an applied term to describe the exploitation of a fish population. The fish may be caught for recreation, harvested for food, or both.

One of the objectives of the present review was to address both the economic and ecological impacts of piscivorous (fish-eating) birds on freshwater fisheries. The detrimental economic impacts of birds on freshwater fisheries can be measured as economic loss to a fishery. In contrast, detrimental ecological impact cannot be measured except against some benchmark that involves subjective value judgement. Ecological damage has been defined as a "negative influence on the (fish) population resulting in long term decline". This definition is questionable because ecological systems are in flux; they can be complex or relatively simple, oscillating or relatively stable. An increase in piscivores at the expense of their prey is part of a natural process, and cannot be said to be damaging in purely ecological terms. However, it could be said to be damaging if one aspect of an ecological system is valued above others.

Therefore, for the purposes of the present discussion, the term "detrimental ecological impact" is used within a conservation context and refers to the loss of something considered desirable in conservation terms, such as the 'naturalness' of a fish community, fish community diversity *per se*, fish productivity, or perhaps a rare or endangered native fish species. A pre-requisite to measuring any "detrimental ecological impact" would therefore be some statement of what is considered desirable for the site of a particular fishery. The relevant measurements, for example of fish community, fish production or the abundance of a particular species, can then be defined and the appropriate data collected. The issue is at present academic, for there is no known study that has shown cormorants or sawbill ducks to be responsible for impoverishing an unstocked river or lake fish community, or endangering the future of a scarce native species.

### 5.1.1 Criteria for "serious damage to fisheries"

The Wildlife & Countryside Act 1981 allows that licences be issued "for the purposes of preventing serious damage to... fisheries", but does not give criteria for "serious damage", or qualify it with description or with examples.

It can be reasonably argued that damage refers to some sort of loss. In simplest terms, this might be the economic loss of a reduced fish harvest, or a reduction in angling catch leading to a reduction in ticket sales and economic loss to a fishery. Other types of loss may not be easily defined in economic terms if they involve, for example, a reduction in club members using a fishery, or lower catches per angler, but with no change in membership fee. Nevertheless, in every case loss should be measurable, though not necessarily in direct financial terms.

The point at which damage becomes "serious" is more difficult to assess because it is subjective and will vary according to site and circumstance. Each fishery operation has its own economic circumstances such that a loss of, for example 10% of fish stock, may result in only slightly lower catches at one site, but the collapse of a marginally viable fishery at another, perhaps involving closure of a business and the loss of jobs. At both sites the loss of fish is the same, but the subsequent economic damage is clearly more serious in the latter case. Measuring loss is therefore an essential starting point for assessing damage, but the seriousness of damage can only be judged using the appropriate context. Case law may eventually set guidelines for "serious damage" in financial terms where commercial fishery operations are concerned.

Irrespective of where precisely the line is drawn, damage cannot be considered "serious" if it cannot be measured. Thus the criteria for "serious damage" must involve measured losses. Fish stocks can be measured by direct sampling, fish harvest and angling catches; ticket sales or club membership can be measured directly. Provided this is done properly, "damage" to a specific fishery can be quantified in terms of measured losses, and its "seriousness" judged against the economic circumstances of that particular time and place.

To justify a licence to kill birds, however, not only has "serious damage" to be established on the basis of measured losses, but also these losses have to be shown to be the result of bird predation.

### 5.1.2 What evidence is required to establish that bird predation is responsible for losses?

As discussed in Section 3.2, the only way to unequivocally demonstrate an impact of bird predation on fisheries is by experiment. At present, licences are issued on the basis of anecdotal and circumstantial evidence which is an inherently unsound procedure. Anecdotal information is subjective, while circumstantial evidence is often misleading, and almost always ambiguous or inconclusive. Nevertheless, it is impractical for every fishery with a perceived bird problem to undertake an experiment. The most efficient way to proceed would therefore be to conduct experiments at a variety of sites, thought to have bird problems. The results should establish the circumstances in which bird predation could result in "serious damage", and thereafter individual cases could be assessed by analogy.

### 5.1.3 Does licensed killing prevent "serious damage"?

Given that there may well be circumstances where "serious damage" by birds occurs, there still remains the issue of whether licensed killing can effectively prevent such damage. Again, the issue is best tackled by direct experimentation. It has been argued that experiments investigating bird predation on fisheries are impractical and that it is difficult to get a clear answer. This is an invalid argument. Put simply, if birds are killed but a subsequent increase in fish abundance, fish catches or fishery harvest cannot be detected, then killing birds cannot be said to prevent "serious damage". In such circumstances, killing cannot be considered to be cost-effective; it is a waste of effort and resources and alternative practical remedies should be sought.

# 6. THE WAY FORWARD

## 6.1 Suggestions for Future NRA Policy and Research

In formulating future policy and identifying research requirements, the NRA should carefully consider the following:

(i) there is ample evidence that in many countries there is a belief that fish-eating birds, particularly cormorants, adversely affect fishery harvest;

(ii) there is no hard experimental evidence that fish-eating birds seriously damage fisheries, nor that licensed killing effectively prevents damage;

(iii) the lack of such evidence does not necessarily mean that fish-eating birds do not have an effect, merely that to date the appropriate experiments have not been carried out;

(iv) this situation reflects the expense and difficulty of such research work, as well as the poor design and procedure of some previous attempts; and

(v) the failure to carry out appropriate experiments has obliged the use of circumstantial evidence and anecdote in debate and in decision-making. This in turn has lead to haggling and the polarisation of views, the issue itself remaining unresolved. This is both unsatisfactory and expensive.

### 6.1.1 Policy with respect to applications for licensed killing

The existing NRA position statement on cormorants and sawbills, formulated in 1992 (Appendix) shows that the Authority is fully aware of the concerns of fishing interests, but that in line with Section 16(1)(k) of the Wildlife & Countryside Act 1981, it cannot support shooting birds as a control measure unless serious damage to specific fisheries is proven and other deterrent methods have failed. In fulfilment of its statutory duties, the NRA has addressed the issue by implementing the current review. This extensive literature review has found no hard evidence that the killing of fish-eating birds prevents "serious damage" to fisheries.

**Consequently it is recommended that there is no change in the current NRA position until such evidence accrues.**

Support for the shooting of birds as a control measure could only be sanctioned if:

- serious damage to the fishery was established by measured economic losses;
- these losses could be attributed (directly or indirectly) to birds alone;
- other remedial measures had been tried and had failed; and
- it had been established that shooting would be effective in preventing the damage.

The most compelling evidence would derive from experimental work at that site or under similar circumstances elsewhere.

### 6.1.2 Recommendations for future research

Without new information, there can be no justification for changing the current NRA position with respect to shooting fish-eating birds. It is therefore recommended that future research proceeds in one of three ways outlined below. All three options have advantages and disadvantages.

***Option 1*** - To initiate no new NRA research but merely examine, through liaison with the licensing authority, each claim of bird damage as it arose, in the absence of any data collection.

The advantage of this approach is that no specific NRA research or monitoring is required. Those with a fishery interest would have to pay for any research required to demonstrate "serious damage" to apply for a licence, or to defend killing if the use of the mitigation clause led to prosecution. The onus would clearly be with the licensing authority to initiate research to defend a policy of issuing licences.

The disadvantage of this approach is that it does not immediately address the concerns of anglers and fisheries managers, many of whom wholeheartedly believe that fish-eating bird predation is damaging fisheries. Consequently, the NRA could be accused of not fulfilling its statutory duty of maintaining, improving and developing fisheries. It could be reasonably argued that the duty of improving and developing fisheries need not be fulfilled if it required the killing of protected birds, as this would be at odds with the Authority's statutory duty to further conservation. Certainly, under this option, pressure from fishing interests will continue and the situation may remain unresolved, thereby prolonging conflict and resulting in illegal practices.

***Option 2*** - To limit NRA research to monitoring and the investigation of specific cases as they arise.

This approach would be more expensive, with the need to provide resources for monitoring fish and bird populations, and collating data for investigative casework. The option would fulfil the NRA statutory duties towards both fisheries and conservation and, in examining each case as it arose, would also address the concerns of the fishing interests lobby.

The main disadvantage of this option is that it could only truly resolve those cases where the circumstantial evidence ruled out "serious damage" by fish-eating birds; on the basis, for example, of no substantiation of losses, or where the consumption of fish by birds could not possibly account for measured losses. Many cases would remain unresolved, leading to protracted and wasteful debate. This option could only be used as an interim measure because some cases would arise again and again until the results of experimental work provided resolution.

***Option 3*** - To initiate (or promote in a supporting role) research to address the problem using an experimental approach, in anticipation of increasing claims of bird damage.

The main advantage of this approach is in the chance of objectively resolving some long-standing problems once and for all. Depending on the study site, the results could eventually provide hard ('cause and effect') evidence to enable rational decisions regarding fisheries management and wildlife conservation at many sites under NRA jurisdiction. The option would properly address the concerns of fishing interests and would also fulfil the statutory duties of the NRA towards fisheries and conservation in a proper and positive manner.

The disadvantages of this approach are that it would be expensive (though the cost could be shared - see Section 6.1.5) and would require long term commitment to specified management at one or more experimental sites. Only one specific fishery problem could be addressed at one time and place, and as with all such field experiments, the outcome might not be conclusive. In the meantime, the fishery interests will be impatient and individual cases will, in the short-term, have to be handled using only circumstantial evidence, with its inherent problems.

**It is recommended that the NRA adopts Option 3.**

### 6.1.3 The experimental research required

Two questions require answers:

(a) what mechanisms are the most cost-effective in reducing bird predation at a fishery?, and

(b) does bird predation have a measurable impact on fish stocks?

From the present review of the literature, it seems that in most instances, sawbills in England and Wales will prove to have little impact on fisheries. The most pressing demand is therefore for studies on cormorants, which could well cause losses, particularly of stocked fish on small put-and-take fisheries, on larger stillwater sites and possibly on rivers. The best approach might be case-led, with the important proviso that intensive work should only proceed where the financial resources are sufficient and the habitat is workable, so that the fish population can be monitored accurately. To this end, several cases may need to be investigated until a suitable candidate for intensive study arises. The ultimate objective should be the results from field experiments, but good experiments can only be designed if there is adequate background information. The process leading up to an experiment would therefore involve collecting the same sort of information that is required to investigate any claim of bird impacts.

The investigation should first look at both fish catches and fish abundance to see if they have declined. If neither have been measured, any claim of bird impact is easily dismissed as unfounded. Fishery interests should be encouraged to collect 'fish catch' and 'fishing effort' data themselves, and fish population abundance (which need not be correlated with catches at all) needs to be monitored professionally for all important fisheries where it is thought problems might arise. If fish abundance cannot be measured, bird impact problems can never be resolved beyond reasonable doubt.

If fish populations have declined as claimed, bird diet and abundance require estimation, and the potential fish consumption calculated. Provided these figures are of a magnitude consistent with the possibility of a detrimental impact on the fishery, an experiment may be feasible. However, the best method for manipulating bird predation would need to be resolved before an experiment commenced, and consideration should be given to scaring as well as shooting. A control site, similar to the experimental site but where bird predation is not manipulated, is also necessary. Control and experimental sites need to be reversed as a second part to the study; bird predation being reduced at the control

site, to compare with no manipulation on the original 'experimental' site during this second phase. The study sites and sufficient finances need to be dedicated for the full term of the experiment. Previous 'experiments' investigating bird predation have failed because of a changed protocol as the experiment proceeded.

**To answer questions (a) and (b) above, it is recommended that controlled experiments should address:**

(a)• **the effect of scaring techniques in reducing the number of cormorants using a site;**

- **the effect of shooting in enhancing 'non-destructive' scaring techniques; and**
- **the effect of changing stocking regime (varying stocking density or adding 'low value' buffer fish) on the numbers of cormorants using a site.**

(b)• **the effect of reducing cormorant predation on fish abundance and harvest at a small 'put-and-take' fishery;**

- **the effect of reducing cormorant predation on catches of coarse fish on rivers; and**
- **the effect of reducing cormorant predation on smolt output and adult harvest, on a salmonid river where there is no artificial stocking.**

#### 6.1.4 Other research and monitoring

In anticipation of bird predation problems, some financial support might be directed towards peripheral research as well as the national and local monitoring of fish and bird populations, their abundance, reproductive success, mortality and movements.

#### Cormorants

(i) Cormorant subspecies

It would be useful to know the origin of the cormorants using fisheries, particularly whether the birds are coming from continental Europe, and whether this represents a potential change in the behaviour of birds here. This can be investigated by funding the colour marking of cormorants, through the British Trust for Ornithology (BTO), the Wildfowl and Wetlands Trust (WWT) and through the efforts of individual cormorant enthusiasts. The issue of cormorant subspecies would best be tackled using molecular genetic techniques by funding the work at an appropriate Institute or University. Large numbers of tissue samples (from carcasses used to estimate diet in Scotland) have already been preserved in anticipation of such studies.

(ii) Choice of foraging sites by cormorants

More needs to be known of the ways in which cormorants choose feeding sites. Work should concentrate on the relationship between fish availability, cormorant foraging success and their movements between sites, using colour marked birds and radio telemetry. The work needs to be funded at an appropriate Institute or University.

(iii) Prey selection by cormorants

Within a fish population individuals vary in their size, age, condition and parasite burden, and cormorants may select fish of a particular sort. A comparison of the fish taken by cormorants and anglers, with random samples from the fish population, will give estimates of selection, and the level of direct competition between birds and fishermen.

(iv) Cormorant diving patterns in relation to foraging

Cormorant foraging success is related to their diving behaviour, which should be studied using telemetric techniques already used on shags *Phalacrocorax aristotelis*. Comparative work, funded at the appropriate Institute or University may be the most cost-effective way forward.

(v) Cormorant numbers

The cormorant population needs to be monitored using census of breeding colonies and of wintering populations, paying attention to the accuracy of methods. This work should be done by the funding of existing national census organisations, the Seabird Monitoring Group, the BTO and the WWT.

(vi) Breeding success

Cormorant reproductive success and mortality need to be studied to investigate the factors influencing population changes. This work requires nationwide sampling to monitor breeding success, and an analysis of ringed bird recoveries. Some data could be collected by

amateur cormorant enthusiasts but this needs to be carefully coordinated by the national organisations such as the BTO and WWT.

**Sawbill ducks**

**(vii) Sawbill numbers**

Sawbill populations need to be monitored in winter, spring and summer, to detect trends in their numbers, distribution, breeding density and reproductive success. The work requires widespread sample monitoring and particularly for breeding birds this may prove practical only on a localised basis or as an intermittent widespread exercise. Funding of winter monitoring should be done through the existing National Wildfowl Counts and Birds of Estuaries Counts, organised by the WWT and the BTO. The same organisations should be approached to discuss the logistics of nationwide monitoring of breeding numbers, distribution and breeding success.

**(viii) Sawbill impact**

More information is required to predict sawbill abundance at particular sites and the effects of scaring or killing. Sawbill movements need to be studied in relation to fish availability, foraging success, bird density and scaring at specific sites. It is difficult to catch and colour-mark sawbills, and very difficult to estimate foraging success, so research here might not be easy. Some preliminary work might be funded at an Institute or University.

**(ix) Cormorant and sawbill diet on rivers**

There is only sparse information on the diet of sawbills and cormorants on rivers in England and Wales. Extrapolation from dietary studies elsewhere is possible but it would be best to directly estimate the diet of birds at those sites where damage is claimed. If it were necessary to kill birds for analysing stomach samples, scientific licences would be required from English Nature or the Countryside Council for Wales. The laboratory analysis of stomach contents could be commissioned from an Institute or University.

**Bird numbers visiting fisheries**

**(x) Monitoring numbers at fisheries**

Sawbill and cormorant numbers need to be monitored locally wherever a fishery perceives a threat. The national organisations, Institutes and Universities can carry out this work but consideration should be given to counts coordinated and carried out cooperatively by local fishery and bird interests, guided by a professional ornithologist. Such a procedure has been adopted successfully on the River Tweed. The Tweed area also has a useful catchment discussion group - the Tweed Forum.

**It is recommended that the NRA considers supporting these studies on a case-by-case basis.**

### 6.1.5 Who should pay for the research?

Sections 6.1.2-6.1.4 identify research to be done, but it is beyond the remit of research contractors to recommend how it might be funded. Fisheries interests claim they have a problem and it could be argued that they should pay for research to demonstrate that the problem truly exists. The authorities that issue licences need to defend their actions and should therefore pay for research to show that the issue of licences does indeed prevent serious damage to fisheries. The NRA has statutory duties towards maintaining, improving and developing fisheries as well as to further conservation. This remit demands detailed knowledge of fish-eating bird/fisheries interactions, to make decisions in specific instances where differing statutory duties might demand conflicting management options. English Nature and the Countryside Council for Wales require knowledge to fulfil their statutory duty to advise on the issue of licences. Voluntary nature conservation organisations also require knowledge to argue their own case.

All the parties mentioned above require some research in this area. It is clear that they all have a vested interest in pursuing research that might resolve issues, rather than prolonging the debate over the true effects of fish-eating birds on fisheries.

**It is recommended that all parties consider the long term view that money spent on well conceived and properly conducted research will ultimately be recuperated in better informed, more efficient resource management.**

# APPENDIX: THE 1992 NRA POSITION STATEMENT ON CORMORANTS AND SAWBILL DUCKS

*Taken from Paper FRCN(92)16 Rev. 1, agreed by NRA Fisheries, Recreation, Conservation and Navigation managers.*

- The NRA recognises that in some locations there is considerable concern by anglers that cormorants or sawbill ducks may be adversely affecting fish stocks, either strictly through predation, or indirectly by affecting fish behaviour. The NRA understands the anglers' concerns.

- The NRA has a duty to both maintain, improve and develop fisheries and to further conservation.

- The NRA has no legal powers to issue licences to control cormorant or sawbill-related predation. Any enquiries on this issue will be forwarded to MAFF or WOAD as appropriate.

- Unless serious damage to specific fisheries is proved and every effort to deter cormorants or sawbills has failed, the NRA cannot support shooting as a control measure.

- The NRA will continue to liaise closely with MAFF, English Nature, WOAD and the Countryside Council for Wales with regard to assessing the impact of cormorant and sawbill predation, providing relevant information as appropriate.

- The NRA is actively addressing the issue through its research and development programme. This research will take time to reach considered conclusions.

- In the meantime, the NRA will continue to monitor the situation.

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