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Fish-eating birds and their impacts upon wild fish

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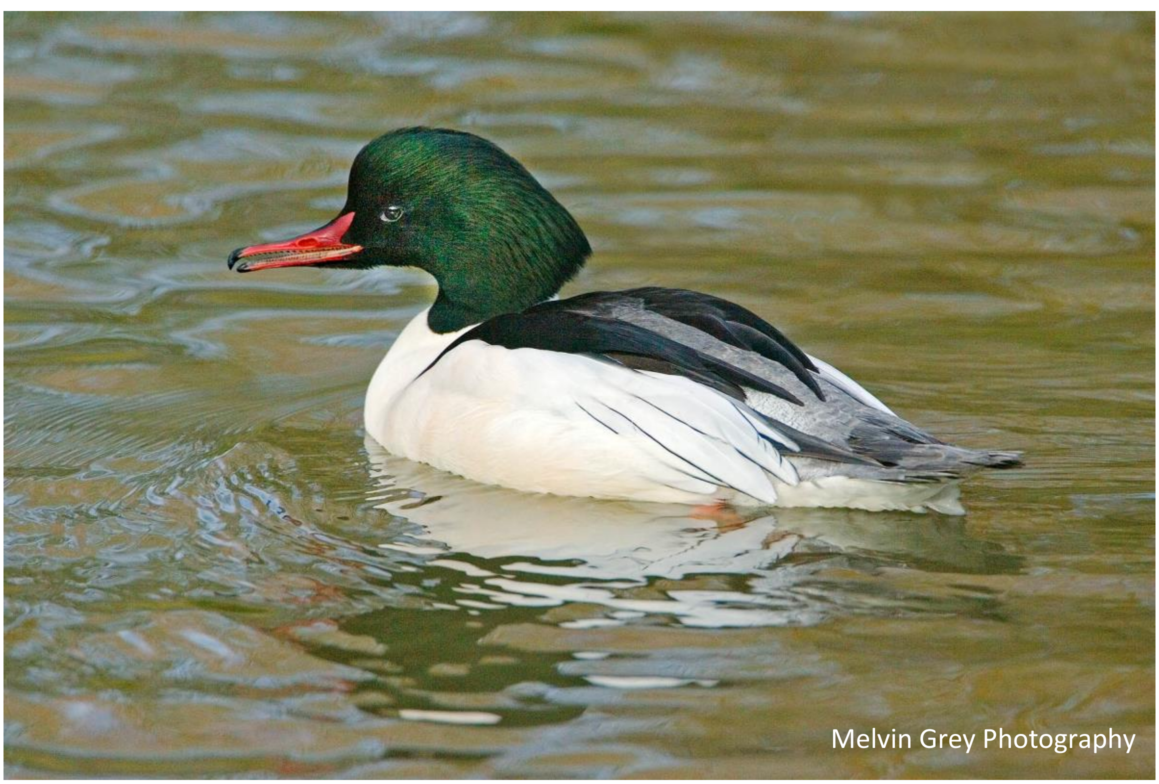


Overview

Fish populations are regulated by 'top-down' and 'bottom-up' influences. Bottom-up control stems from food availability which in turn is dependent on (for example) the availability of light and nutrients. Less food results in fewer fish or restricted growth of fish. Top-down control operates in the opposite direction: predation or competition between and within species may keep a fish population below a size that would otherwise be achieved in the absence of either or both of these two factors. 'Bottlenecks' can influence population size somewhere in between bottom-up and top-down controls. For example, limited spawning or fry habitat will constrain the number of young surviving to the next stage in the life-cycle. So, predation is a natural process regulating fish populations.

Common fish-eating (piscivorous) bird species (hereafter FEBs) foraging in UK freshwaters include: great cormorant (*Phalacrocorax carbo* & sub-species *P.c. sinensis*), the sawbill ducks (red-breasted merganser, *Mergus merganser* and goosander, *Mergus serrator*), the grebes (primarily little grebe, *Tachybaptus ruficollis*, and great crested grebe, *Podiceps cristatus*), grey heron (*Ardea cinerea*), and kingfisher (*Alcedo atthis*). Various egret species are established in the UK but are relatively low in number. Gaviiformes (the divers) are typically restricted to highland waterbodies in Scotland, as are ospreys (*Pandion haliaetus*) although there a small number of breeding pairs recorded at specific locations further south. All these birds are protected by law. FEBs are opportunistic predators that will take advantage of high prey densities, especially where those densities are artificially elevated (e.g. through stocking or on fish farms). While there have been localised reports of some species (cormorants and grey heron in particular) impacting upon the profitability of fish rearing facilities, the majority of those FEBs listed above are generally not considered as an issue to the functioning of natural wild fisheries.

However, the impact of FEBs on fish populations and specifically angler catches is perceived as significant by the recreational angling community across much of the UK and Ireland. It is widely touted that bird conservation is prioritised over that of some fish species (such as Atlantic salmon, *Salmo salar*, and brown trout, *S. trutta*) despite equality in conservation designation. With the acknowledgement that predation is a natural process which has occurred throughout the co-evolution of the species mentioned above, this document focuses on predation by FEBs (particularly from cormorant and goosander) that may cause concern for those involved in the management of biodiversity and fisheries.

Are the numbers of cormorant and goosander increasing in the UK?

The following information is derived from the British Trust for Ornithology (BTO) website.

Cormorant: While there has been a 53% range expansion since 1981-84 in Britain (and 18% in Ireland), the cormorant population has decreased in Scotland, northeast and southwest England. However, there has been a steep increase inland and in lowland areas in England, and especially in regions bordering the northern part of the Irish Sea. By 2012, cormorants were noted to have bred at 89 inland sites in England, although breeding at many of these sites was of a single nest or did not persist. Numbers from the breeding bird survey have now stabilised at a lower number than the early 2000s (Fig. 1a). The wintering population, mainly comprising the European sub-species (*P.c. sinensis*), increased markedly from the late 1980s but is now stable or in shallow decline.

Why? Various reasons are postulated: the creation of inland waters (e.g. gravel pits) heavily stocked for angling, a reduction in the pollution of inland waters, overfishing of coastal resources, and increased legal protection being some of the most cited. It is difficult to tease apart which reasons are chiefly responsible for the increase. An increase in shooting under licence since 2004 has had no detectable effect on population trend.

Goosander: Since the 19th century, the goosander breeding population has undergone rapid growth in both range and size in Britain, although in recent years (2000 – 2018), growth has tailed off (Fig. 1b). The winter trend, comprising British breeders and continental visitors, rose steeply from the late 1960s to the mid-1990s, but has since fallen back to 1980s levels.

Why? Reasons for the colonisation of the UK, and the subsequent range expansion and population increase, are unknown.

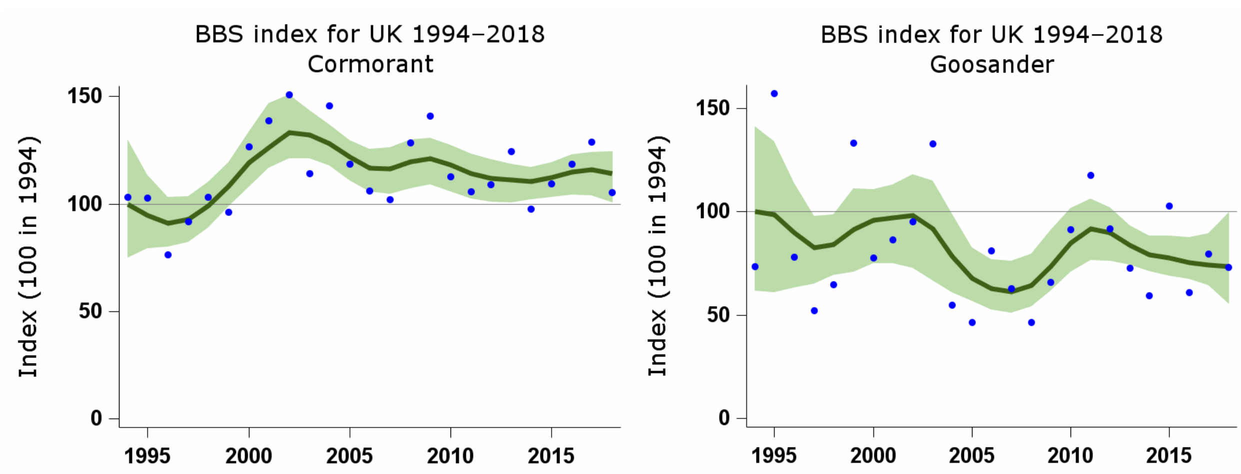
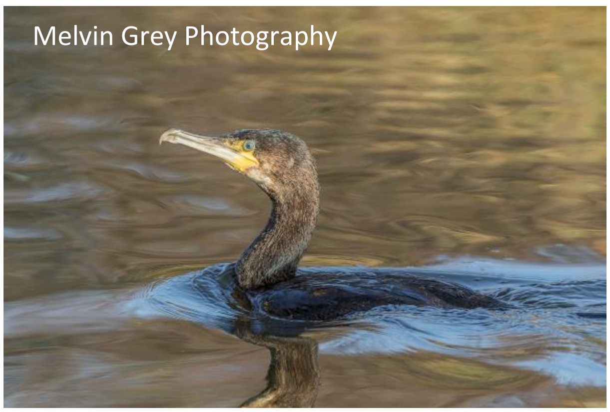


Fig 1: BTO data from breeding bird surveys for: a) cormorant; and b) goosander

How do FEBs impact on fisheries?

Birds are gape-limited predators which means that they can only swallow prey items that fit within the constraints of their beak and throat. Hence, while fish girth is actually the critical measurement, because there are reasonably robust relationships between fish length and girth, length is more commonly recorded and used in discussions below. That is not to say larger fish are unaffected by fish predation; they may be affected by indirect behavioural changes or physical injury, rather than direct consumption. Impacts to a fishery then can be ecological (affecting fish community composition and abundance), behavioural (fish behaviour and hence catch rates), or economic (loss of fishery income).

Cormorant



Cormorants have the potential to impact upon inland water fisheries, especially, as in some recorded examples, where flocks may comprise >100 birds. Adults consume around 350–585g of fish daily and can swallow fish of trout proportions up to 40cm in length. Using natural tracers and gut content analysis, studies have shown that birds shot under licence from inland sites fed almost exclusively upon freshwater fish species. The majority of evidence comes from studies of still waters although one riverine study demonstrated that of 26 recently scarred fish from the River Rye (grayling, *Thymallus thymallus*, and brown trout), 17 fitted the visual characteristics of cormorant attack, and 20-60% of fish (dependent upon study reach) exhibited some scarring.

The cormorant has been studied extensively in Europe, and some parallels can be drawn from other cormorant species (on similar fisheries) especially from the USA. However, it is difficult to make general assumptions about its overall impact on prey populations as few studies have employed the necessary controls and replication to make conclusive, unequivocal assessments. These constraints mean a high degree of uncertainty when trying to ascribe the existence and magnitude of impacts due *solely* to cormorant predation. With a lack of robust information on fish populations, numbers of feeding birds and calculations of fish consumption, it is very hard for studies to detect observable reductions in fish productivity or direct economic loss to fisheries.

''*Demonstrating the impact of cormorants in large rivers and other waterbodies is difficult, because of ecological complexities*" Carss & Marzano (2005). In some scientific studies, potential impacts have been indicated on certain species and / or life-stages, while in others, no discernible effects from FEB predation were detected; see Table 1.

Goosander

Like cormorants, goosanders are generalist, opportunistic predators that will often aggregate in large numbers to take advantage of high prey densities. Goosander predation on fish has been less studied than cormorant predation, with attendant difficulties in defining impacts on fish populations.

Goosanders are perceived more as a problem for game fisheries, especially in upland rivers and analysis of their diet has shown that juvenile salmonids (including brown trout) less than 25cm are an important component. Smolt runs for example, have been shown to be targeted by goosanders. On certain rivers, such as the Tweed in Scotland, goosander predation on the smolt run is cited as a key factor affecting the economic value of the salmon rod fishery. Smolt predation does have a greater effect than predation upon younger life stages (parr or fry) because of the reducing influence of *compensatory mortality* as fish get older.

Goosanders with a brood of ducklings will remain in the same area until the chicks have matured. On small upland streams, the impact of these family groups could conceivably be quite high on stocks of juvenile fish, especially where there is a lack of refuge habitat and variation in depth.

Table 1: **A sample of studies of cormorant predation upon fish populations**

Study	Site	Summary
Detectable impact		
Winfield et al 2002	Windermere, UK	In the most intensively studied example of a fish and cormorant system in the UK, the authors hypothesized that the growing cormorant population may have accounted for almost half the standing stock of adult whitefish that year
Vetemaa et al 2010	Estonian estuary	Despite a decline in a local net fishery, perch abundance declined over ten years leading to assumption that a concurrently increasing cormorant population might be responsible
Stewart et al 2005	Stocked freshwater loch, Scotland	Cormorants will take advantage of artificially high fish populations. Significant predation on stocked brown trout by cormorants was detected
Skov et al 2014	Danish lake	Cormorant preyed upon roach, bream and perch, but perch were most vulnerable, and predation induced an age / size truncation leaving very few larger perch in the lake
Fielder et al 2010	US lake	Double crested cormorant predation established as chief impact upon yellow perch, causing collapse of the fishery. Removal of predation

Study	Site	Summary
		pressure resulted in resurgence of perch population
Jepsen et al 2019	Danish lowland rivers	A summary paper of 24 individual studies documenting consistent cormorant predation on smolts of >20% and in worst case scenario ~88% (average 47%)
No detectable impact		
Engstrom 2001	Swedish lake	Despite the establishment of the biggest cormorant colony in Sweden and considerable fish consumption by cormorants, no discernible change in fish biomass could be detected
Boström et al 2009	Swedish estuary	An extensive fish tagging and cormorant diet analysis exercise could not prove that an adjacent cormorant colony was responsible for a declining migratory salmonid run on the River Dalälven
Carpentier et al 2009	French shallow lake	Study could not link cormorant predation to the perceived decline of a European eel fishery in the Lake Grand-Lieu fishery

Compensatory mortality, migratory fish & predators

After hatching, numbers of salmonid fry can be very high but reduce dramatically as they compete for limited resources (space and food) to support them. Therefore, predation during early life often removes fish that would not have reached adulthood; the remaining fish have higher chances of survival as competition is reduced following the reduction in number of their cohort. However, this compensatory effect declines as the maturing fish population reduces in numbers and resources become less limiting. Predation on more mature fish, such as salmon or sea trout smolts, is therefore more likely to affect the ultimate adult population size.

Controlling FEB impacts on fisheries

Some fish populations in the UK and Ireland are under significant pressure, due mostly to a variety of anthropogenic factors such as poor water quality and/or quantity, channel modification, barriers to migration or habitat degradation. These populations are not as resilient to increased predation pressure as healthy populations would be and management measures to combat predation are an appropriate option in these circumstances.

In most cases, declines in catches cannot readily be attributed to predators; other factors may be involved. However, there are a suite of measures that can be employed to minimise impacts where it is reliably believed that FEBs are adversely affecting a fishery. The Moran Committee Joint Bird Group (2001) addressed various options (Table 2) for controlling (specifically) cormorant predation.

The Angling Trust has some guidance available via their web-pages, here.

Table 2: Measures to reduce predation by FEBs

Method	Pros	Cons
Habitat management: Creating fish refuges, floating islands	- A cost effective, low maintenance method, especially in certain fishery types (e.g. small still waters) - Provides other fisheries benefits associated with increased habitat diversity & cover	- Some problems with manmade refuges in rivers; inability of fish to exploit them & problems with spate flows*
Human disturbance: Patrols & organised walks to coincide with peak feeding times for birds.	- Allows for an accurate assessment of predator numbers over time - Initially, a simple and effective method of deterring predators	- Needs to be well coordinated on rivers - Cormorants may become habituated to these kinds of activities - Implications for other wildlife - Labour intensive - Often at anti-social hours (e.g. pre-dawn)
Preventing access: i.e. Protective Netting	- Impractical on rivers and larger still waters but effective on small ponds/fish farms and used widely in Europe - Encourages FEBs to seek alternative feeding sites	- Impractical on rivers and larger still waters - Expensive and adversely affects other wildlife
Roost removal: i.e. Removal of nesting/resting sites	- Can be used to protect vulnerable areas e.g. shallow spawning zones	- Adverse environmental impacts of tree removal - Often impractical on rivers
Stock management: i.e. stocking of larger fish	- Some success at still-water trout fisheries, causing cormorants to feed on resident coarse fish populations - Better catch rates for anglers	- Increased rearing costs - Narrow application, not suitable or desirable for all water body types
Automated & Noise generating scarecrows	- Initially effective; may provide a good immediate option while other methods are considered - Effectiveness & longevity can be increased by varying their positions	- Impractical on rivers - Expensive - Cormorants/predators may become habituated to the effects of scaring - Antisocial
Shooting to scare	- Reinforces effect(s) of culling (a certain level of culling is required to maintain efficacy) - May be the only option where the public has access to a fishery	- Impermanent - Labour intensive - Antisocial
Culling	- Effective when used in conjunction with other methods (e.g. scaring) - Can be locally effective in displacing birds	- Culling on a local/small scale simply creates a vacuum soon filled by birds from adjacent areas - Shifts the problem elsewhere - Large nationwide/EU wide culling exercise politically unacceptable
Compensatory stocking		- Counter-productive, attracts more predators
*In this case, general 'softer' habitat enhancement methods may be more practical		

FEB management: final considerations

- Employing a selection of these measures can be effective. In the 1990s, around 8% of trout caught by anglers on Anglian Water fisheries showed signs of cormorant damage. By employing different stock management tactics and a combination of scaring tactics and deterrents, management reduced this to around 1% by 2001.

- DEFRA research projects found that artificial refuges in small ponds (see Fig 2) reduce the foraging efficiency of cormorants. In other words, provision of habitat makes it harder for cormorants to fish, leading to a reduction in cormorants visiting the fishery and a reduction in the amount of fish consumed by cormorants. Although this study was carried out in small still waters using artificial structures, the principles are universal. Complex habitat makes it harder for FEBs to hunt, and easier for fish to hide – see our advice section below.

- Many of the constraints described above also apply to goosanders and it should be borne in mind that goosanders are primarily river dwellers. In winter, when goosanders move onto still waters, the same tactics can be employed as for cormorants.

- Harsh winters that freeze still waters could, of course, increase the over-winter predation pressure of FEBs on flowing water systems that do not completely ice-over. Methods for increasing the proportions of river fish surviving over the winter are especially important in such cases – see advice section below.

- While no study has conclusively shown a link between culling of predatory birds and increased fish production[1], culling undoubtedly reinforces the effects of other deterrents (Table 2) but needs to be employed consistently and effectively to underpin its effectiveness.

Fig 2: Artificial refuges (top), floating islands (middle) and hedgehogs (bottom). Images courtesy of Ian Russell and www.fishkit.com

- Culling is a recognised management technique when dealing with species that are causing locally high levels of damage (e.g. deer in forestry situations). However, culling at a regional scale is unlikely to be politically acceptable and will not necessarily achieve its objectives; 6000 birds were shot in Bavaria during the winters of 1996/7 but an influx of new birds meant that the winter population was not reduced. An estimated 30,000 to 60,000 cormorants across Europe would have to be killed every year to make a difference.

- Managing wild populations always involves a certain degree of uncertainty. In the Great Lakes region (USA), wildlife managers destroyed the breeding attempts of a double-crested cormorant colony on an island. This invited predation in the newly vacated fishing grounds from birds nesting on another

[1] Partly due to the difficulty of reaching solid conclusions through fieldwork

island a considerable distance (35km) away. The net result of this *was increased predation on fish* by these cormorants to compensate for the greater distances they were travelling in order to forage.

- A European study of the non-coastal cormorant population between 2001-2009 aimed to determine the extent to which control intensity (proportion of the local population shot per winter) was associated with site-level population change. No clear differences in population (as growth rate) were evident when comparing sites which had been subject to lethal control *versus* those without. However, the few places where there was a significant influence of control *resulted in a higher cormorant population*, a seemingly counter-productive effort.

Avian predation & wild fish - WTT advice

No single method will reliably and continually protect fish against avian predation; however, a combination of approaches can reduce predation to more acceptable levels and can prevent potentially damaging declines.

Increased habitat complexity & predation: Good quality, accessible habitat is a profound, bottom-up influence that can greatly improve the structure & overall abundance of a fish population. Preserving and increasing habitat complexity will be the most common advice given by WTT Conservation Officers during Advisory Visits – see Fig 3. The response of most stream-dwelling salmonids to immediate predation threat is to seek physical cover, so it makes sense to provide some and/or maximise cover if it is lacking. Optimal foraging theory, backed by practical research, suggests that increasing the search time and reducing the capture efficiency of predators by increasing habitat complexity causes predators to “give up” on a patch sooner, leaving behind a greater number of prey.

Experimental work using replicated semi-natural streams with differing amounts of instream cover and shade demonstrated 12% better trout survival from FEB predation in the more complex and shaded streams. On the River Rye in Yorkshire, the degree of fish scarring (trout and grayling) caused by FEBs and telemetry studies of fish movement has proved revealing. More scarred fish were found in a modified reach where the channel had been dredged and the bankside vegetation structure was poor, compared to a richer and more complex natural reach. Grayling moved much greater distances in winter when cormorant predation was heavy, compared to the summer when they were absent; this points to the need for connectivity in rivers to allow fish to move away from focal points of predation. Weirs and other barriers will hinder such movement, and the impoundment of water upstream of such structures improves the chances of FEB predation by creating deeper, slower moving water.

Figure 3: Large scale brash installation responsible for dramatic increases in juvenile trout and salmon survival that is thought to be driven by reduced FEB feeding efficiency; Wye & Usk Foundation

We believe that sensitive habitat enhancement can mediate against the effects on some fish populations of top-down impacts such as predation. Angling clubs and fisheries managers can try to tip the balance in favour of the trout by following the WTT guidance:

Simple Dos and Don'ts

- **DO** consider how you can build lots of complex habitat into your river fishery (e.g. tree branches and roots trailing into the water, dense marginal vegetation, introduced brash mattresses, tree kickers, cover logs); this will provide cover for fish whilst reducing the hunting efficiency of FEBs. Predators find it very hard to follow trout into a complex web of trailing branches and tree roots; e.g. Fig 3.
- **DO** consider the use of large woody debris (LWD) to create localised areas of scour. These deeper parts of the channel will provide cover for fish from predators.
- **DO** maintain a good mix of 'shrubby' cover on river margins right through the year, particularly over shallow water in channel margins where juvenile trout often live.
- **DO** consider employing a combination of habitat enhancements and deterrents when protecting wild brown trout against FEBs. These birds are clever; so, persistence *and* variety are vital.
- **DO** consider further deterrent measures (e.g. scaring) during vulnerable periods, e.g. spawning, drought and smolt runs. In Scotland, a number of organisations increase intensity of coordinated measures during the salmon smolt run, attempting to 'shepherd' the smolts down the river and out to sea.
- **DO** build a good relationship with the conservation authority in your area. Maintain a dialogue if piscivorous bird predation is deemed to be an issue with your fishery and seek advice on control methods, including the process of licensing for lethal control. The Angling Trust has a Fishery Management Advisory service, employing field officers who can offer expert, on-the-ground advice on FEB's: www.anglingtrust.net/FMAs
- **DO** remove bottlenecks that concentrate fish in vulnerable areas. For example, weirs have been shown to delay downstream smolt migration and increase rates of bird predation. Equally, adult fish congregating below barriers during upstream spawning migrations are an easy target.

- **DON'T automatically assume that bird predation may be limiting fish production; carefully assess other potential 'bottlenecks', particularly habitat required for different life-stages**.

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