Chapter 25
Management of the cormorant, *Phalacrocorax carbo*, and endangered whitefish, *Coregonus lavaretus*, populations of Haweswater, UK

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Abstract

Within the UK, the whitefish, *Coregonus lavaretus* (L.), is protected under nature conservation legislation. The status of one population in Haweswater, a reservoir in the English Lake District, has declined since the 1960s due to increased variations in lake level during the spawning period. A substantial reduction in leakage from the water distribution system has reduced overall demand for water, and this development, aided by recent rainfall patterns, has resulted in a series of years with good spawning conditions. Nevertheless, recruitment has continued to be poor and studies have indicated that foraging by a local cormorant, *Phalacrocorax carbo* L., colony, which has grown rapidly from its establishment in 1992, is likely to be responsible. In this paper management measures undertaken on the cormorant colony in 1999 and 2000, together with those proposed for the future, are described. The context of this conflict of fish and bird conservation issues is also explored with respect to future potential developments within the wider English Lake District.

Keywords: breeding colony, conservation, *Coregonus lavaretus*, Haweswater, impact, *Phalacrocorax carbo.*

25.1 Introduction

The whitefish, *Coregonus lavaretus* (L.), occurs in just seven UK lakes and is accordingly considered to be of national conservation importance with protection under Schedule 5 of the Wildlife and Countryside Act, 1981. All of the English populations of this coregonid occur in the north-west of the country within the English Lake District. The present study is concerned with the population of Haweswater and the potential impact upon it by a recently established breeding colony of cormorants, *Phalacrocorax carbo* L. Although increased use of freshwater habitats by this piscivorous bird has been

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widespread in the UK in recent years, with attendant concerns over impacts on many fish populations (see Russell *et al.* 1996), the establishment of inland breeding colonies has been limited to just seven sites (Newson 2000).

During the 1990s, the whitefish population of Haweswater was extensively studied (Beaumont *et al.* 1995; Winfield *et al.* 1996; Winfield, Fletcher & Cubby 1998; Winfield *et al.* 2002) and monitored (Winfield *et al.* 2001) to provide a sound scientific basis for its conservation management. Corresponding, but less extensive, investigations (Winfield, Winfield & Fletcher 1998; Newson 2000; Winfield *et al.* 2002) have also been undertaken on the cormorant population of this lake in the late 1990s. The Haweswater lake fish and cormorant system is thus one of the best-studied examples of its kind in the UK, and so has the potential to make a significant contribution to the development of a national policy towards resolving this controversial issue. Note that at Haweswater, the conflict is simply between fish and bird conservation as there are no significant commercial or recreational fisheries interests on the lake.

Here, the ecology, status and management of the whitefish population are described, followed by an account of the development, ecology and impact of the cormorant population and its management in 1999 and 2000. Finally, this conflict of fish and bird conservation issues is considered in a wider context, including future potential developments within the English Lake District.

25.2 Study site

Situated in the north-west of England (National Grid Reference NY 480 140), Haweswater lies at an altitude of 240 m, with a surface area of 391 ha and a maximum depth of 57 m. The present surface area and maximum depth were increased by 252 ha and 29 m, respectively, over those of the original lake by the construction of a dam in 1939, which facilitates the lake's current operation as a potable water reservoir by United Utilities and which incidentally created the lake's only island, Wood Howe (National Grid Reference NY 477 119). In addition to whitefish, the fish community of this oligotrophic lake comprises Arctic charr, *Salvelinus alpinus* (L.), brown trout, *Salmo trutta* L., eel, *Anguilla anguilla* (L.), perch, *Perca fluviatilis* L., minnow, *Phoxinus phoxinus* (L.), and three-spined stickleback, *Gasterosteus aculeatus* L. (Winfield *et al.* 1996). The only fishery activity is very limited recreational angling for trout.

25.3 Ecology, status and management of the whitefish population

In the early 1990s, a gill-netting survey of all whitefish populations in England and Wales revealed the Haweswater population to be relatively slow growing and have restricted length and age frequency distributions, indicating extremely inconsistent recruitment in the late 1980s and early 1990s (Winfield *et al.* 1996). Subsequent comparisons of whitefish entrapped in the water abstraction system between 1992 and 1994 with specimens of the same origin between 1965 and 1967 reported by Bagenal (1970) showed that there had been a decline in age class equitability and individual growth (Winfield *et al.* 1998a). In the 1970s, Broughton (1972) found entrapped whitefish from a 1972 sample to include a wide range of individual lengths, including young individuals, but a depressed growth pattern similar to that recorded in the 1990s. Specimens entrapped in 1983 and examined but not aged by Maitland (1985) included only large individuals. Furthermore, the numbers of whitefish entrapped from 1973 to 2000 (Fig. 25.1(a)) showed a marked decrease in the early 1980s between the sampling periods of Broughton (1972) and Maitland (1985).

Since 1992, the whitefish population of Haweswater has been monitored by quantitative echo sounding. Following isolated surveys in May 1992 and May 1996, the fish community has been monitored in May, July and September each year between 1997 and 2000 by echo sounding using a Simrad EY200P echo sounder with a 200 kHz single-beam transducer and data analysis using HADAS (for full details see Winfield *et al.* 1998a). While the numbers of recorded small (40–100 mm in length, Fig. 25.1(b)) and medium (100–250 mm in length, Fig. 25.1(c)) sized fish are probably a combination of whitefish, Arctic charr, brown trout and perch, the numbers of large (greater than 250 mm in length, Fig. 25.1(d)) fish are probably mainly adult whitefish. Variation within the abundance of such large fish from 1992 to 2000 was significant (ANOVA, $F_{5,54} = 6.882$, $P < 0.001$), with post-hoc comparisons by the Tukey HSD test revealing that the 1992 abundance was significantly higher ($P < 0.05$) than in all subsequent years. The abundances of small- and medium-sized fish will be returned to below.

All of the above population data are consistent with an interpretation of the whitefish population having a good status in the mid-1960s, with a decrease in growth rate by the early 1970s, followed by a decrease in the consistency of recruitment by the 1980s. These reductions in growth and recruitment have been shown to be attributable to increases in water level variability of this reservoir between the 1960s and 1990s (Winfield *et al.* 1998a). Whitefish recruitment is primarily influenced by water level variations during the first 90 days of the year, during which spawning occurs largely within days 20 to 40, followed by incubation to beyond day 90. Water levels during days 1 to 90 of the year are shown in Figure 25.2 for three example years from the 1960s and 1980s, and for 1998, 1999 and 2000, which are the most recent years with available data. Between 1965 and 1967 (Fig. 25.2(a)) water levels were generally very high and stable, while 20 years later, from 1985 to 1987 (Fig. 25.2(b)), falls in water level in excess of 4 m were not unusual. During the mid to late 1990s, significant reductions in leakage from the water distribution network by the owners of Haweswater (United Utilities, formerly North West Water Limited), leading to a reduction of overall demand from the reservoir, contributed to a water level regime more sympathetic to the requirements of whitefish spawning. Thus, between 1998 and 2000 (Fig. 25.2(c)) variations in water level during the early part of the year were markedly reduced.

In addition to the more sympathetic water level management described above, management measures instigated in recent years for the benefit of the whitefish population included the development of a mobile artificial spawning substrata system and an attempt to establish refuge populations in two smaller lakes within the Haweswater catchment. Both of these actions are described in more detail by Winfield *et al.* (2002).

Despite the above management actions and conducive spawning conditions in the mid to late 1990s, the decline of adult whitefish which began in the early 1980s (Fig. 25.1(a)) has not been reversed or even stopped (Fig. 25.1(d)). By contrast, the abundance of small

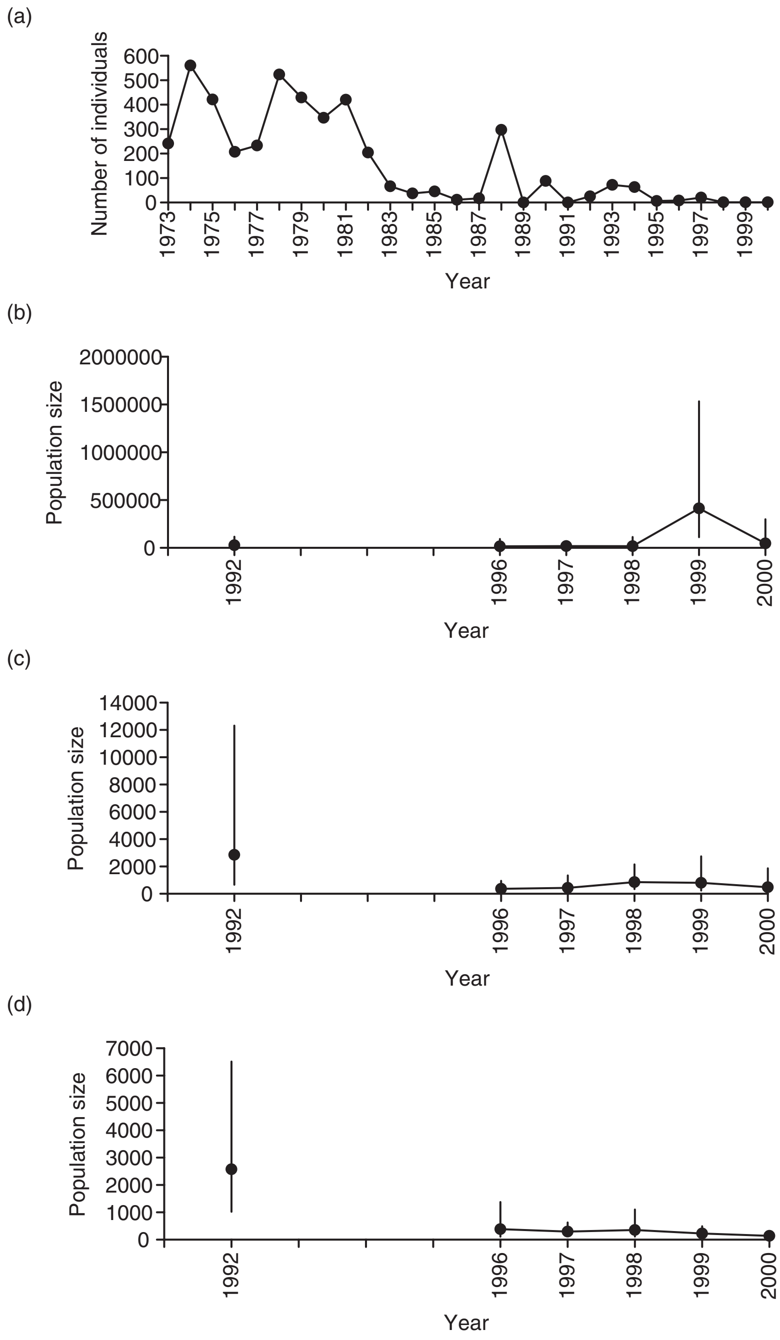

Figure 25.1 (a) Numbers of whitefish entrapped from 1973 to 2000, and estimated population sizes (geometric means with 95% confidence limits) of (b) small (40 to 100 mm in length), (c) medium (100 to 250 mm in length), and (d) large (greater than 250 mm in length) fish in May 1992 and 1996 to 2000. Small and medium fish are probably a combination of whitefish, Arctic charr, brown trout and perch, while large fish are probably mainly adult whitefish

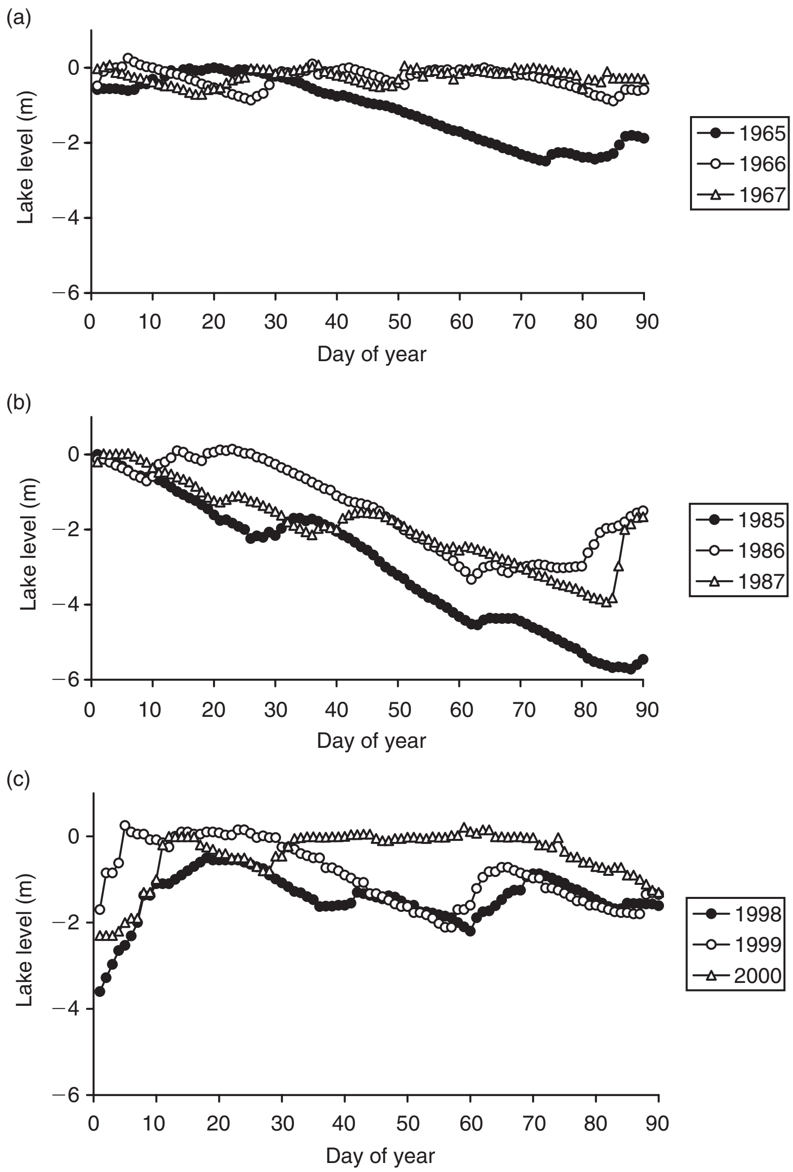

Figure 25.2 (a) Lake levels during the first 90 days of the year from (a) 1965 to 1967, (b) 1985 to 1987, and (c) 1998 to 2000. Whitefish spawning occurs largely within days 20 to 40, followed by incubation to beyond day 90

fish in Haweswater (Fig. 25.1(b)), which may include young whitefish among several other species, has shown some positive signs in the 1990s with significant variation (ANOVA, $F_{5,54} = 3.358$, $P < 0.01$) and post-hoc comparisons by the Tukey HSD test revealing that the 1999 abundance was significantly higher than equivalent figures from 1996, 1997 and 1998. Variations in the abundance of medium fish, however, have shown no significant variation (ANOVA, $F_{5,54} = 2.264$, $0.05 < P < 0.10$). Thus, although there have been indications of successful whitefish recruitment from the egg to juvenile stages in the 1990s, particularly by the 1995 year class (Winfield *et al.* 2002), few individuals have survived to adulthood and the status of the whitefish population remains extremely poor. A potential cause for this whitefish recruitment failure in the late 1990s was the foraging activities of local cormorants.

25.4 Development, ecology and impact of the cormorant population

Although great increases in the numbers of overwintering cormorants have been seen in recent years on many lakes and reservoirs in the UK, such a trend has not occurred on Haweswater (Fig. 25.3(a)). By contrast, between the early 1970s and the late 1990s, overwintering numbers have tended to decrease at this site. It should be noted that before the whitefish decline of the early 1980s, the numbers of overwintering cormorants ranged up to 25 individuals, but since the mid 1980s they have not exceeded 13 individuals.

However, the number of cormorants frequenting Haweswater during the spring and summer months has increased greatly in recent years due to the development of a breeding colony on the island of Wood Howe. Following the first record of breeding by one pair in 1992, the colony rapidly increased, such that by 1998 there were 48 breeding pairs including both *P. c. carbo* and *P. c. sinensis* (Fig. 25.3(b)). A comparative study of cormorant breeding performance at a range of inland and coastal colonies in 1997 and 1998 by Newson (2000) showed that the Haweswater colony had the highest mean clutch size in both years (ranked first among eight sites), with mean brood size also relatively high in 1997 (ranked second among 10 sites) but lower in 1998 (ranked equal sixth among 10 sites).

Given the above increase in the numbers of cormorants at Haweswater and their potential for impacting on the whitefish population, a project was undertaken to determine the numbers and local feeding behaviour of cormorants from November 1996 to December 1997 (Winfield *et al.* 1998b; Winfield *et al.* 2002). During the breeding season (Fig. 25.3c), cormorant numbers increased markedly in April and peaked in July at 84 individuals, including young. Numbers subsequently decreased in the late summer as young and adults dispersed from the lake. Using data on the fish standing stock from the May 1997 echo-sounding survey, the above cormorant counts, and an assumed daily consumption rate of 0.6 kg cormorant d^{-1}, the total annual consumption by cormorants was expressed as a percentage of the fish community standing stock and ranged from 943 to 3867% for minimum and maximum daily cormorant counts, respectively (Winfield *et al.* 2002). Clearly, such a local predation rate cannot be sustained by the Haweswater ecosystem, but the solution to this apparent paradox is that although cormorants do feed at Haweswater, where whitefish have been observed to be eaten and identified in regurgitated pellets (Winfield *et al.* 1998b), they also make extensive movements off the lake to feed elsewhere (Winfield *et al.* in press). Nevertheless, even the limited amount of feeding observed at Haweswater itself in 1997 may account for 44% of the adult whitefish standing stock of that year. Adopting the precautionary principle (see below), management of the cormorant population is warranted.

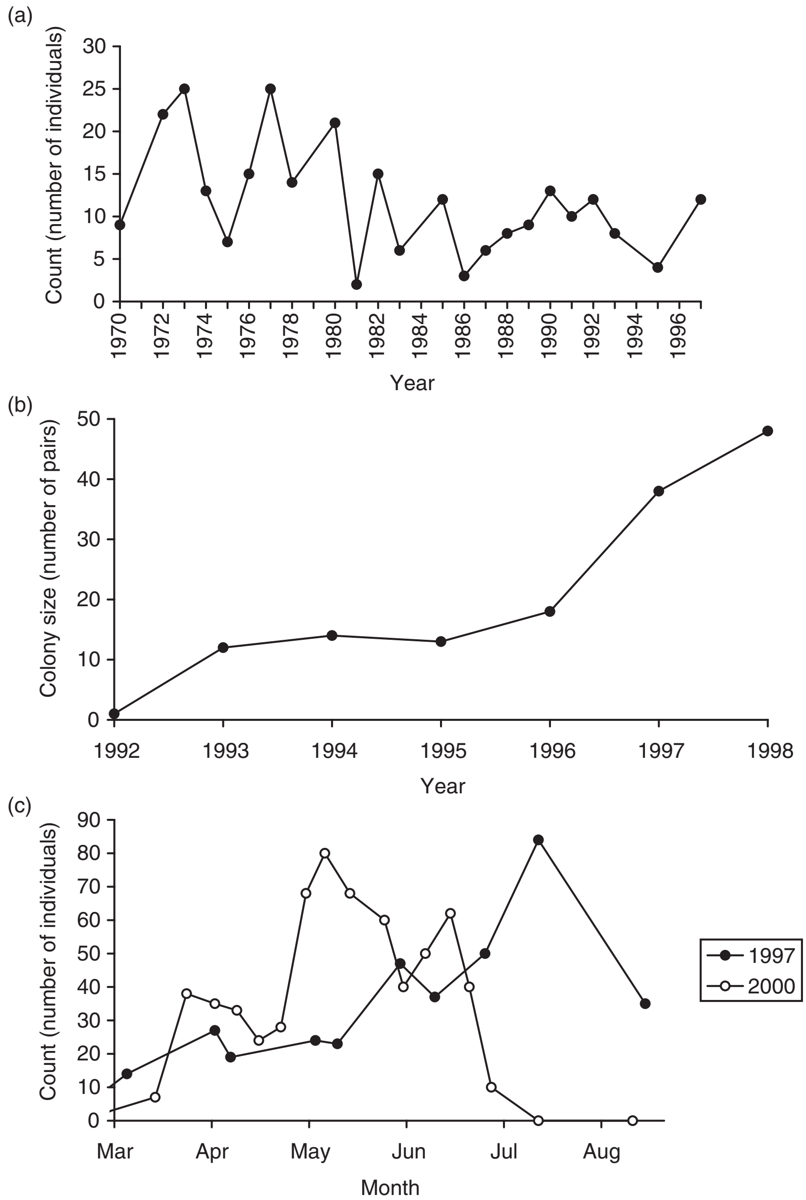

Figure 25.3 (a) Numbers of overwintering cormorants present in January from 1970 to 1997 (data supplied by Kathleen Atkinson, The Wildfowl & Wetlands Trust and the first author), and (b) development of the breeding colony from the first record of breeding (1992) to the last year before scaring (1998) (data supplied by the Royal Society for the Protection of Birds and The Wildfowl & Wetlands Trust), and (c) the numbers of cormorants present at the breeding colony from March to August in 1997 (when no scaring was undertaken, data from Winfield *et al.* (1998b)) and in 2000 (during scaring, data supplied by Tony Benson)

25.5 Management of the cormorant population

Following a meeting in 1998, attended by stakeholders including English Nature, the Environment Agency, the Lake District National Park Authority and the Royal Society for the Protection of Birds, steps were taken by United Utilities to discourage cormorants from nesting in 1999. This was attempted by initially deploying a variety of scaring activities and devices (human visits to the island, ballons, reflective plates, a stuffed eagle owl, *Bubo bubo* L., and a loud radio) on the nesting island from April to July, although the nearby presence of England's only nesting pair of golden eagles, *Aquila chrysaetos* L., precluded the use of gas cannons. All scaring activities and devices were approved by English Nature. The only effective scaring technique was found to be frequent disturbance by human visits to the island, which were made during 24 person-days from 19 April to 17 August 1999. In this way, nesting was successfully prevented, although considerable numbers of adult cormorants still used the lake for roosting, loafing and some feeding. A second meeting of stakeholders in late 1999 recommended the repetition of these scaring measures in the 2000 breeding season, during which island visits totalling 19 person-days were made between 3 March and 23 August 2000, together with limited roost management to cut down some trees used for roosting and nesting. Nesting was again successfully prevented, although considerable numbers of adult cormorants continued to frequent the island from April to early July: the numbers counted on the island in 2000 exceeded those seen in 1997 when no scaring was undertaken (Fig. 25.3(c)). Foraging pressure on the whitefish population is thus unlikely to have been reduced markedly by scaring alone.

Stakeholders agreed a continuation of the above scaring measures for the cormorant breeding season of 2001, although local access restrictions due to foot-and-mouth disease subsequently prevented any cormorant management during the spring and or summer. Irrespective of this practical problem, given that the extensive scaring measures employed in 1999 and 2000 only prevented nesting and did not reduced the numbers of adult cormorants at the lake, a cull of adult birds is recommended as the only means of further reducing the impact of foraging on the whitefish population. This contentious issue is returned to below.

25.6 Discussion

The management of any vertebrate predator has a great potential to become a controversial issue, and in this context cormorants foraging on inland waters have proved to be no exception. Moreover, the science of impacts on freshwater fish populations by this species, although being far from fully understood, is highly variable as evident from recent UK case studies (Feltham *et al.* 1999). This site-specificity makes it extremely dangerous to transfer scientific conclusions from one lake or river to another, meaning in effect that interactions at the majority of inland sites will never be understood on a robust scientific basis.

Such scientific uncertainty besets the management of a range of other environmental problems and prompted the agreement of *Principle 15* in the 1992 *Rio Declaration On*

Environment and Development which states 'In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.' This approach is particularly appropriate for the situation at Haweswater where scientific evidence strongly suggests, but does not prove beyond any doubt, that a population of a native rare fish is threatened with extinction by the foraging activities of an alien species which has established a breeding population at the site only within the past 10 years, and even then only on an artificial island. In this situation, the precautionary principle should be adopted to the benefit of the whitefish over the cormorant.

Taking management action against the cormorant colony at Haweswater can only be robustly defended if other adverse environmental factors that impact on the whitefish population have themselves been addressed to the fullest feasible extent. This is the case at Haweswater, where water level fluctuations are now more sympathetic to whitefish spawning requirements and a mobile artificial spawning substrata system has been developed for possible use in extreme conditions. There are no eutrophication, acidification or species introductions problems at this lake, leaving the cormorant issue as the only area where further practicable management action can be taken. Nevertheless, the scaring activities and roost management conducted in 1999 and 2000 have only prevented breeding and have not significantly reduced the numbers of adult birds frequenting the lake in the spring and summer months. Among the range of options suggested for the control of cormorants in a guidance leaflet issued by the Ministry of Agriculture, Fisheries and Food (Ministry of Agriculture, Fisheries and Food 2000), considerations or trials at Haweswater showed that noise generating scarers, stocking control, 'buffer' species and fish refuges are inappropriate, visual scarers are ineffective, and roost management and human disturbance had only limited success. This leaves culling of the adult birds by shooting as the only realistic management option that may reduce the predation impact on the whitefish to levels that may allow the population to recover.

The cormorant is a relatively long-lived bird which, given the high natal fidelity found by Newson (2000), means that adults originating from the Haweswater colony during the 1990s are likely to keep returning for some considerable time to come. This further reinforces the conclusion that stopping current and future breeding is not in itself sufficient to safeguard the conservation of the whitefish. Moreover, on a national perspective, cormorant population modelling by Newson (2000) indicated that there will be considerable inland population development of this species in the near future. For the English Lake District, where adult cormorants in breeding plumage are already frequently seen at a number of the major lakes (IJW, personal observation), this is likely to mean the establishment of additional colonies. An examination of maps indicates that a further nine lakes within the area offer potential island nest sites. Even the establishment of cormorant colonies on only some of these additional nine lakes would lead to increased predation pressure on other whitefish populations, together with those of Arctic charr and the UK's rarest freshwater fish, the vendace, *Coregonus albula* (L.). Returning to the specific case of Haweswater, unless appropriate management measures are taken very soon there is a serious risk of the local extinction of the endangered whitefish.

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