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A Preliminary Study of Fish Refuges as a Means of Mitigating Perceived Cormorant Damage to a Put and Take Fishery

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EXECUTIVE SUMMARY

A pilot study took place in the Lee Valley Country Park during February and March 1997 to investigate the potential for fish refuges to mitigate against Cormorant damage at fisheries.

1. The provision of fish refuges did not appear to influence Cormorant behaviour. This may have been the result of very few Cormorants at the site, the early departure of Cormorants and the possible low quality of the site as a foraging area for Cormorants.

2. Thirty foraging bouts were observed, 33.3% of which were successful. Within these foraging bouts 216 dives were observed with 6.5% being successful.

3. The average size of fish taken was 8.5±2.1 cm, with a range of 2-30 cm (n=12).

4. The methodology was successful and should be used in further studies of fish refuges. It is recommended that such studies continue.

1. INTRODUCTION

1.1 The Piscivore Issue

Cormorants *Phalacrocorax carbo* are perceived to be a major problem at fish farms, stocked ponds and other still waters, in terms of the economic damage which they may inflict on fisheries (e.g. Davies & Feltham, 1995; Russell *et al.*, 1996). In the United Kingdom Cormorants are considered to cause the largest problem at stocked still-water fisheries (Feare, 1988) where reductions in fish stocks or angling catches are regularly assumed to be the result of Cormorant predation. The angling community is increasingly concerned about predation rates, with the more militant components calling for a large scale Cormorant cull.

Such culls would currently be illegal in the UK, legalisation would require alteration of the Wildlife and Countryside Act and possibly the EEC Directive on the Conservation of Wild Birds. Ethical concerns have been raised by Animal Welfare organisations. Conservationists are concerned about the effects of a cull on the viability of Cormorant populations.

For these reasons there is much interest in the possibility of controlling damage to fisheries without resorting to killing Cormorants. This report describes a pilot study which investigated the ability of fish refuges to reduce Cormorant damage at a put and take fishery in the Lea Valley, Hertfordshire, in early 1997.

1.2 Rationale for Using Refuges as a Mitigation Measure

Numerous studies indicate that Cormorants are generalist feeders which exploit fish stocks in proportion to their local abundance and profitability (e.g. Warke & Day, 1995). This suggests that reducing total fish availability, or the relative availability of key species, could result in a shift in foraging location or Cormorant diet. Such changes in Cormorant behaviour have been demonstrated in response to natural fluctuations in fish stocks at large lakes. In Northern Ireland Cormorants changed their foraging locality in response to reduced fish stocks (Keller, 1995). In The Netherlands a large scale change in the fish community resulted in many Cormorants leaving the foraging site and the remaining ones changing their diet (Dirksen *et al.*, 1995).

There is no data available to indicate whether Cormorants would respond in the same manner following changes in the fish community of small lakes. Cormorants foraging in small pits may benefit from specialised knowledge about fishing sites and fish behaviour at that site (Voslamber *et al.*, 1995). Changes in the fish community of a site would reduce the value of prior knowledge. Thus alterations in the availability of fish at small sites may result in higher magnitude changes in Cormorant behaviour than have been documented for large lakes.

Fish refuges are potentially an inexpensive method for altering the availability of fish to Cormorants. They could be used to reduce the total number of fish available to Cormorants or to shift their foraging activities away from commercially important species. A potential draw back is that they may reduce the availability of fish to anglers.

1.3 Objectives

The study aimed to investigate the effects of refuges on:

- The number of Cormorants visiting the pits.
- Cormorant foraging behaviour.
- Catch rates of anglers.

Additional data on the effects of disturbance on Cormorant activity were also collected.

2. METHODS

2.1 Study Site

The study site was located in the Lee Valley Country Park, between Wormley and Turnford at TL3704. Observations were made at two small pits, both less than 5 hectares in area, which formed part of a larger complex of pits. Both pits were located between the railway line and the River Lea Navigation Canal and formed part of an actively managed put and take fishery. Cormorants are consistently present within the Lee Valley during the winter period. Foraging birds regularly visited the two study pits and anglers had raised concerns about the effects of Cormorant predation. This had led to the instillation of an inflatable scaring device on one of the pits.

2.2 Study Design

The study was based on a paired experimental design divided into four stages, with each stage lasting for two weeks (see Table 2.2). During each stage monitoring was undertaken on one full week day each week, the day was divided into eight one hour sampling periods. Monitoring was alternated between pits every hour. Dawn and dusk were included in the sampling periods as Cormorant foraging activity is often concentrated at these times.

One pit (Pit B) contained an inflatable scaring device. Due to the concern of fishery managers it was not possible to disable the device during the study period. As a compromise the device's activation frequency was reduced to the minimum level throughout the study period.

DATES	STAGE	PIT A	PIT B
4 Feb - 17 Feb	One	-	-
18 Feb - 3 March	Two	✓	-
4 March - 15 March	Three	-	✓
16 March - 29 March	Four	-	-

Table 2.2 Study Design: sampling dates in relation to placing of tyre refuge

2.3 Refuge Design

The refuge consisted of 15 car tyres arranged into three columns, of five tyres each, and lashed together in a triangular arrangement. The refuge was approximately 1m. high and 2m. long. Rope strands over the column entrances prevented Cormorants from gaining access to the refuge, gaps were wide enough to permit access to fish. Weights were used to anchor the refuge at the bottom of the pit. As the pits were shallow, varying between 2m. and 3m., the refuge design enabled it to accommodate both bottom and mid-water feeding fish. The same refuge was used in both pits.

2.4 Bird Observations

2.4.1 Counts

At 15 minute intervals the number of Cormorants (and wildfowl, herons and Kingfishers) at the site were recorded in the following categories:

- Flying overhead.
- Feeding.
- Loafing (on land and on water).
- Preening (on land and water).

To allow the number of Cormorants in the wider locality to be estimated, the total number of Cormorants flying over the pits in each 15 minute period was recorded. Cormorant arrivals and departures were logged along with those of other species.

2.4.2 Focal Sampling

Detailed data on the foraging behaviour of Cormorants were collected between the quarter hourly counts described above. Individual Cormorants were observed for a maximum of ten minutes and the following data were recorded:

- Amount of time on the water.
- Number of dives.
- Duration of each dive.
- Success of each dive.
- Prey size.
- Prey type.

The success of a dive was judged by whether a prey item was brought to the surface and prey size was judged in comparison to bill length.

2.4.3 Disturbance

Any events which had the potential to disturb Cormorants were recorded (e.g. pedestrians, the inflatable scarer). Cormorant behaviour before, during and after these events were documented.

2.4.4 Human Fishing Activity

During each monitoring period the number of fishing rods was recorded. The CSL 'Cormorant Fisheries Questionnaire' was distributed to all fishermen observed at the site. Information was sought on catching rates, the number of damaged fish caught and anglers' estimations of the numbers of Cormorants present and the number of fish which they took.

3. RESULTS

3.1 Cormorant Numbers

The number of Cormorants at the two study ponds was generally low, the maximum number present during the four stages of the experiment is shown in Figure 1. Counting the number of birds flying over the study area showed that larger numbers were present within the wider area. Cormorant numbers declined significantly from the end of February and no Cormorants were present at the site by the end of March (Figure 2).

3.2 Foraging Activity

The number of observed foraging bouts and their success rates between the four experimental stages are shown in Figure 3 and Table 3.2. Similar data for dive length are presented in Figure 4.

Activity	No. Observed	No. Successful	% Successful
Foraging Bouts	30	10	33.3
Dives	216	14	6.5

Table 3.2 Foraging Activity: Summary of foraging data

3.3 Size of Fish Taken

The size of all fish caught by Cormorants was estimated in the field by reference to bill length. Actual length was then estimated using 6.5 cm as the standard bill length (the figure for *P. carbo carbo* given by Cramp & Simmons, 1977). Using this method the average size of fish taken was 8.5±2.1 cm, with a range of 2-30 cm (n=12).

3.4 Disturbance

Before landing on the pits Cormorants tended to circle the area, suggesting that they were wary of human presence. This behaviour was more noticeable on Pit B, the smaller and more enclosed of the two pits. Occasionally whilst walking around Pit B observers flushed Cormorants from the water. Members of the public walking past the pits were observed to disturb the Cormorants on two occasions. On the first occasion the two Cormorants present flew away; on the second occasion a fishing Cormorant adopted an alert position, with an outstretched neck, for one minute before continuing to fish. Other human activities, including dog walking and low flying helicopters, did not have any noticeable effect on the behaviour of Cormorants at the site.

The presence of the inflatable scarer on Pit B presented an opportunity to assess the effectiveness of this device as a mitigation measure. When it was activated only Cormorants within a narrow radius, 10-15 metres, were affected. Foraging birds within this distance left the pond, birds at other distances continued to fish. On one occasion a Cormorant was flying low over the pit when the scarer sounded, the Cormorant increased its speed and veered away from the pond. The device had been installed since early winter and may have been more effective at the start of this period, or when activated at more regular frequencies.

3.5 Questionnaire Survey

No results are available as no completed questionnaires have been returned from the very few fishermen observed at the site.

4. DISCUSSION

Observational studies of Cormorant foraging behaviour are sometimes criticised as underwater predation rates cannot be recorded. Underwater predation rates are often considered to form a significant proportion of total predation, especially for small size classes of fish. In this study most dives were of a short duration, suggesting that Cormorants rarely had the opportunity to find, catch and swallow fish whilst underwater. Moreover, Cormorants brought fish as small as 2 cm long to the surface before swallowing. It is thus unlikely that Cormorant predation rates were significantly underestimated in this study.

Visual inspection of the data reveals that the refuge had no discernable effect on Cormorant foraging activity. The number of Cormorants present at the site was much lower than in previous years and Cormorants departed from the site much earlier than usual (Rutherford, pers. comm.). As a result much less data were collected than anticipated. This may be a significant factor in the experiment's inability to detect an effect of the refuge on Cormorant behaviour. However, the pilot study successfully demonstrated the suitability of the study design.

Data from four still water sites in the NW and Midlands have shown that the proportion of successful foraging bouts can vary between 12-80%, and dive success varies between 2-15% (Pilcher, pers. comm.). The data from this study fall within the lower end of these ranges. Average dive time (22 sec.) was higher in this study than that recorded elsewhere in the Lea Valley (Pilcher, pers. comm.). These data suggest that the ponds were below average quality in terms of Cormorant foraging habitat. This may also partly explain the lack of any detectable effect of the fish refuge on Cormorant behaviour.

This study's lack of evidence for an effect of refuges on Cormorant behaviour does not lead to the conclusion that refuges cannot mitigate against Cormorant damage at fisheries. The general study design was validated and research on the effectiveness of refuges should continue. Suggestions for the direction such research should take are outlined below.

5. RECOMMENDATIONS FOR FURTHER WORK

Future studies should ensure that they are completed when Cormorant numbers at the site are high. They should thus start at the beginning of winter, e.g. December, and be completed by mid February. The low percentage of successful dives found in this, and other studies, suggests that a large number of dives need to be recorded to ensure that any effects of refuges can be demonstrated statistically. To increase sample size the total length of the observation period should be increased in future studies.

Effects on Cormorant behaviour will be magnified if refuges are designed to accommodate the most abundant size and species of fish. For bottom dwelling fish a design based on a series of open ended pipes may be more appropriate. Wire cages are a potential alternative design for mid-water fish. The size and number of refuges should be related to the size of the pond.

The survey design would yield very useful data on the effect of refuges on Cormorant fishing behaviour, but would be less able to directly measure the impact on fish stocks. The observational methodology described above could be incorporated into a 'randomized block' experiment to directly measure the effect of refuges on fish stocks. A minimum of three pits would be needed: one of which would be netted, one provided with a refuge and one left to act as a control. Following drainage each pit should be stocked with a similar and precisely known fish community. Cormorant fishing behaviour should then be monitored. After monitoring, draining the pits would allow predation rates to be calculated with and without refuges and compared to the rate of fish loss when avian predation was prevented.

6. CONCLUSIONS

Theory, combined with data from previous studies, suggests that refuges could mitigate against Cormorant damage to put and take fisheries. No evidence was found during this study to support this hypothesis. This may have been caused by unusually low Cormorant numbers, early departure of Cormorants from the site and below average Cormorant foraging habitat at the site. Further studies to investigate the potential for refuges are needed and recommendations are made for their design.

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