

## Research article

# The importance of birds in the diet of otter *Lutra lutra* on Shapwick Heath

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This study investigates the importance of avian species in the diet of Shapwick Heath's otter population. The frequency occurrence of prey items was recorded from spraints collected between July 2006 and January 2007. Bird feathers extracted from otter spraints were investigated under a microscope. Where possible, feathers were identified to species level. The presence of fish scales in spraints was recorded, but not quantified. Bird feathers were recorded in 41% of all spraints, compared with 4.6% on Slapton Ley in 1981 and 4.7% on the Somerset Levels in 1975. The highest proportion of bird feathers was recorded in July 2006, at 61%. Ralliformes were more frequently recorded than any other family of birds. Coot *Fulica atra* L. were more frequently recorded than any other species; 15 spraints were found to contain coot feathers. Mallard *Anas platyrhynchos* feathers were recorded in six spraints. Cormorant *Phalacrocorax carbo* feathers were found in three spraints and Water rail *Rallus aquaticus* feathers were found in two spraints. Pintail *Anas acuta*, teal *Anas creca*, moorhen *Gallinula chloropus* and little grebe *Tachybaptus ruficollis* feathers were found in one spraint each. Two spraints contained feathers from both mallard and coot, respectively. The high proportion of birds in the otter's diet, in comparison with past studies suggests that otters are substituting birds for part of their traditional diet of fish. It is recommended that studies into the nature of the fish stock and the development of the aquatic ecosystem on Shapwick Heath be undertaken.

**Key words:** *Lutra lutra*, Shapwick Heath, diet, ralliformes, spraint, feather.

## Introduction

### Feeding strategy

Previous studies<sup>1,2</sup> have suggested that otters predate on small, immobile fish species with a high calorific value and a low handling time in preference to large or highly agile prey. While cubs are learning to become proficient hunters, it has been suggested by Kruuk<sup>2</sup> that cubs favour prey that is readily available, with the emphasis on ease of capture, rather than the calorific value or shortest handling time. Perhaps the most important factor affecting rates of predation is availability of food. Otters are commonly thought of as a species that predate solely on fish, but their diet includes a wide range of species. The otter is therefore a generalist carnivore that is able to capture prey as chance allows, rather than being a specialist piscivore as was commonly perceived. Chanin<sup>3</sup> describes the differences in otter diet on Slapton Ley in Devon, 86 miles from the study site, being attributed to seasonal changes in the activity of the prey. The increased

predation on birds, in the case of Slapton Ley in the spring, may be due to vulnerable fledglings and adult birds sitting on eggs, which are easier to catch than the fish.

The feeding habits of the Eurasian otter *Lutra lutra* L. have been extensively researched.<sup>1–8</sup> These studies have often overlooked or ignored the importance of individual bird species as a component in the otter's diet. Chown<sup>9</sup> suggested that the population of certain bird species, i.e. coot *Fulica atra* L. and dabchick *Tachybaptus ruficollis* Pallas, on Shapwick Heath National Nature Reserve (NNR) have not reached the numbers that ecologists would normally have expected in an area that is of national importance for wildfowl and wading birds. Chown<sup>9</sup> implies that the poor reproductive success of bird species, in particular some Ralliformes, may be the result of learned behaviour, i.e. predation on birds, by the otter population.

The purpose of this study is to investigate the claim that the otters on Shapwick Heath predate on the resident wildfowl population to a higher degree than previously reported.

It is intended to establish if certain species of birds are favoured for predation by otters and if any seasonal variation in the predation rates can be established.

## Methods

For the purpose of this study, diet was assessed using the contents of otter faeces. The use of spraint analysis to determine otter diet is considered a viable method and has been used frequently before.<sup>2, 7, 8, 10–12</sup> The methods for spraint identification have normally been used to identify the species of fish in otters' diet; the identification of bird feathers has previously only been undertaken to family level. Identification of bird remains has in the past been carried out on the stomach content of stoats<sup>13</sup> and this has been adapted and expanded on to enable identification of birds to species level from otter spraints.

### The study site

Shapwick Heath was created from flooded peat workings that have become a habitat well suited to wetland birds. Shapwick Heath is designated a Site of Special Scientific Interest (SSSI) and a Special Protection Area (SPA). It is part of the Somerset Levels Wetlands Ramsar Site and a National Nature Reserve. The site is owned and managed by Natural England. Shapwick Heath has 394 acres in area, consisting of a mixture of eutrophic open water habitat, reedbed, fenland and meadows.

### Spraint collection

Otter spraints were collected on Shapwick Heath National Nature Reserve between July 2006 and January 2007. Spraints were collected from various sites along the main path that runs from east to west of Shapwick Heath National Nature Reserve OS ST 449, 397 and OS ST 423, 411. The path allows year round access to the sprainting sites. Spraints were identified by their distinctive appearance, often containing visible feather and fish scales.

In addition to visual signs, spraints were identifiable by their characteristic smell.<sup>14</sup> Spraints were only collected from areas showing evidence of use by otters, such as runs in the vegetation on the drain banks, which displayed otter footprints. Before collection began, all spraints were removed from the site so that a clear time-scale could be given as to when the faeces were produced.

Gloves were worn at all times when handling spraints to prevent infection. Spraints were stored individually in freezer bags that were labelled with: a record of the location of where the spraint was found, the date and comments on the condition of the spraint, i.e. its freshness. While collecting the spraints, the presence of wildfowl species on the reserve and those flying over it were recorded.

### Spraint contents identification

After air-drying the spraints, they were placed in a solution of water and detergent (5:1) for a minimum of 2 h. Tweezers were used to help break up the spraints and feathers were removed from the detergent solution and washed in fresh detergent and water solution. The feathers were rinsed in water and then alcohol, before being left overnight to dry out; dry feathers being easier to prepare than wet ones.

Preparation of the feathers under the microscope was adopted from Day.<sup>13</sup> A single barb was cut from the rachis using a scalpel, mounted on a slide and held with a drop of alcohol. To prevent the barbules from closing together and remain fanned out; a cover slip was aligned with the barbule from the proximal end to the distal end. Identification from a single barbule was not always possible. If this occurred, a second barb was removed and the process repeated, until identification could be made.

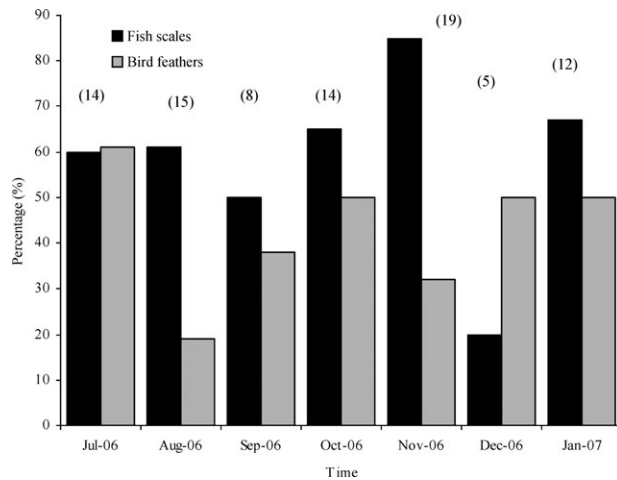
The barbules were examined using a binocular Nikon Labphoto 2 light microscope, and findings were cross-referenced with information from Day<sup>13</sup> and from the Bird Remains Identification System (BRIS).<sup>15</sup>

## Results

A total of 87 spraints were analysed from Shapwick Heath from July 2006 through January 2007. They were collected and analysed using procedures outlined in the Methods. As the number of spraints found present per month varied, so the number analysed varied. The majority were collected from the bridge at British Ordnance survey grid reference ST 449, 397.

Due to the structure of the bridge, the spraints remained out of the water all year round and the bridge structure prevented them from being washed away by rain. The bridge at OS ST 423, 411 at Ashcott Corner was less useful as the water level inundated the ledges under the bridge, making it impassable for otters at times of peak flow. During low flows, waterfowl often rested on the ledge under the bridge and contaminated the otter spraints by defecating on them. For these reasons, the bridge at Ashcott Corner was often unsuitable for collecting spraints. A spatial analysis of the site was attempted. However, due to the nature of the collection site, an unbiased result for a spatial analysis of the site was not possible. The majority of the spraints were collected under bridges. This is likely to represent the amount of time that a spraint survives, rather than demonstrate a difference in the levels of predation in different areas of the reserve.

Figure 1 shows the monthly trend in prey items found in otter spraints. The remains of fish have been found more frequently than any other prey remains. In July 2006, the percentage of fish remains as same as bird feathers found in the otter spraints, being 60% and 61%, respectively. In August, the amount of spraints containing fish remains was consistent with July, amounting to 61%, but bird remains



**Figure 1.** The percentage change of spraints content through time using data from 87 spraints, which were collected from July 2006 to January 2007 on Shapwick Heath. The number of spraints collected each month is shown in brackets. Percentage distribution is used to allow for the variation in the number of spraints collected throughout the study period.

were found in only 19% of the spraints. The percentage of spraints with fish remains fell during August and September from 60% to 50% and the number of spraints containing bird feathers increased to 38%. The spraints collected in October were recorded as having the third largest percentage of fish remains in them, being 65% and the percentage of spraints that had feathers in them rose to 50%. November saw the percentage of spraints with fish rising again to 85%. The amount of bird feather remains in November declined, with only 32% of the spraints collected and analysed containing bird feathers. December saw the lowest recorded percentage of fish during the monitoring period, only 20% of the analysed spraints had evidence of fish scales, the remains of birds feathers was recorded as 50%. From the spraints collected in January 2007, there was evidence of fish scales in 67% of the sampled spraints, and 50% of the spraints had bird remains.

Table 1 shows observed behavioural responses of wildfowl species in relation to otters. Black-headed gulls were observed displaying mobbing behaviour in the presence of otters. They were sighted hovering over a bed of *Phragmites*, following the progress of an otter that emerged from the reedbed. The mobbing behaviour continued after the otter had entered the water. Moorhens were observed in the backwater of the nature reserve in smaller areas of water that was well vegetated. Moorhens were also observed foraging on dry land on the reserve. Coots were observed foraging in large groups, often in 20 or more, in areas of open water in the Roughet and West Meare Heath. They were observed resting on the water edge in West Meare Heath. Cormorants were observed at the end of the day resting on protrusions from the water

such as dead trees at the Roughet. Juvenile birds were often seen closer to the water than adult birds. Mute swans and herons were often observed within a few metres of an otter in the water at West Meare Heath.

## Discussion

The importance of fish in otter diets has been widely published, recorded with fish the highest-ranking component in the otters' diet.<sup>1, 5, 6</sup> On Shapwick there appears a markedly smaller reliance on fish as a food as compared with similar studies.<sup>1, 5</sup>

The majority of studies on otter diet have investigated the type of fish that have been taken by otters. This study looked at the frequency occurrence of fish remains found in otter spraint. It did not attempt to quantify which species were predated upon. The results showed that 67% fish remains in otter diet on Shapwick Heath shows a similarity with the European otter populations, in that they are less reliant on fish than on the diet shown in studies of the British otter population.<sup>3, 6</sup>

If the assumption that otters feed on the prey items as the chance arises is correct<sup>2</sup> then there may be a number of reasons for a smaller reliance on fish by the Shapwick Heath otter population may be a number of reasons; there may be a less well-formed aquatic ecosystem as a result of low pH, which is due to the high peat content of the soil. Acid water results in fewer invertebrates and generally has sparser and less complex aquatic vegetation than water with a higher pH.<sup>16</sup> There has been a reported decline in the freshwater fish population forcing the otter to eat other prey items.

The decline of an important prey item such as eel<sup>17</sup> may have had a knock-on effect of forcing the otter to change its foraging behaviour, so that time is not wasted searching for a prey item that is no longer present in large numbers. Therefore, it is feasible that otter population on Shapwick Heath has adapted its behaviour, so that hunting birds have become a larger part of foraging practice.

The findings on Shapwick Heath follows a pattern that is similar to those described by other European studies,<sup>3</sup> though in Europe it is often crayfish rather than birds that are taken in larger numbers. The percentage of fish in Shapwick Heath otters' diet is lower than that may have been expected, when compared with other studies, such as McMahon and McCafferty.<sup>8</sup> These authors found that fish scales were present in up to 90% of the otter spraints. On Shapwick Heath 67% of the spraints showed evidence of fish scales. There were temporal variations in the percentage of fish scales found in the otter spraints. In October 2006, scales were found in 80% of the spraints but this fell in December to 20%. The results imply that the otter population relies on fish for about 60% of their diet. The rest of the energy needs are made up by substituting birds for fish, and to some extent other prey items. December had a very low percentage of fish remains found in the sample. This month also had the

**Table 1.** Bird behavioural activity observed during the survey

Species	Date	Activity	Relation to otter activity
Black-headed gull	12 August 2006	Mobbing an otter when in reeds <i>Phragmites australis</i> and when in water at West Meare Heath	Number of birds aggressive to otter
Coot	All year	Intraspecific competition whilst on open water. Sheltering in exposed areas of the Meare Heath	Foraging in open water. Intra- and interspecific aggression. Ground nesting bird
Moorhen	All year	Foraging amongst vegetation on the land	Foraging behaviour on land and nesting on the ground
Cormorant	All year	Distance from water when drying wings	Often the juvenile birds were observed perching near to water
Mute swan	All year	Foraging	Unconcerned by presence of otters
Grey heron	All year	Foraging	Unconcerned by presence of otters

All behavioural aspects are intended to show the relationship between otter and wildfowl on Shapwick Heath.

lowest total spraint collections, just six spraints, which may have skewed the accuracy of the results for December. The proportion of birds predated upon by otters is much larger than in other similar studies. Chanin<sup>3</sup> and Mason and Macdonald<sup>6</sup> recorded the highest previous percentage of 10.3% from Blakeney, but the Shapwick Heath otter population in 2006 appears to be predated up to four times that amount. Webb<sup>4</sup> investigated otters' diet on the Somerset Levels and recorded similar levels to Chanin,<sup>3</sup> which were 4.7% and 4.6%, respectively. When compared with Webb<sup>4</sup> and Chanin<sup>3</sup> the results of this study suggest that Shapwick Heath otters could be eating 10 times the amount of birds that have been previously reported.

This study supports the theory that otters are predated certain wildfowl species at a higher proportion than has been expected. The peak period of predation on birds was July when 60% of the spraints had bird feathers in them, and coincides with the breeding season of many wildfowl species, when fledglings and adult birds are considered to be more vulnerable.<sup>18</sup> August was the month with the lowest recorded percentage of bird feathers, being 20%. The reason for this low level is unknown.

Chown<sup>9</sup> speculated that the coot population might be lower than expected in the reserve as a result of predation pressure from otters. There were 16 cases of analysed spraint samples containing coot feathers. This was the most frequently recorded wildfowl species in the study. Coots are ground-nesting birds, which construct their nests on the edge of the water, often in the reeds.<sup>19</sup> During the period of the study, coots were often seen resting on the edge between the phragmites beds on open water (*personal observation*). This behaviour makes coots and their fledgling vulnerable to otters and mink predation.<sup>20</sup>

Coots feed on open water, and while feeding they are very vocal and spend a lot of time displaying aggressive behaviour.<sup>19</sup> Aggressive interaction with conspecifics is an energy-reducing activity; it reduces time vigilance in quarry

species, which increases the risk of predation. Chanin<sup>3</sup> suggested the reason for higher indices of predation, when comparing ducks to Ralliformes, is because ducks roost on open water. This is suggesting that otters do the majority of their foraging nocturnally, catching ducks in the open while they are unaware. Ducks were as common as coot on all areas of Shapwick Heath, and Ralliformes were as numerous as ducks on Slapton Ley.<sup>3</sup> Therefore, a difference in population density cannot explain the different ratio in predation on the two sites.

Ferraras and Macdonald<sup>18</sup> investigated the rates of predation on waterfowl by mink. The study found that mink predate on coot to a far greater frequency than on moorhen. The reason for this has been suggested to be the difference in roosting behaviour between the two bird species. Coots roost on the extremity of the water margins, whereas moorhen roost in deeper, thicker part of vegetation. Moorhen often build their nest on the top of logs, which lifts them out of the water.<sup>20</sup> If this adaptation helps reduce predation from mink<sup>18, 20</sup> which is much more agile and capable of climbing, it would seem likely that by lifting their nest out of the water, moorhens also reduce the risk of predation by otters.

Cormorant feathers were found in three spraints twice in July and once in August. The presence of cormorant feathers in the spraints for that part of the year suggests that otters were predated on inexperienced juveniles. Young birds are much more likely to be predated on as they lack awareness that is gained through experience. Cormorants are a very common sight on Shapwick Heath and they were observed every month during the study. Cormorants have wettable plumage that requires drying out after diving into water and it is also theorized that cormorants sunbathe to allow large meals to digest.<sup>21</sup> It was observed that the cormorants often stood on objects that protruded from the water. Juvenile cormorants were seen perched on objects that were only just protruding from the water (*personal observation*). This social exclusion may increase predation risk in juvenile cormorants.

Some birds associate otters as a threat to themselves and their nests. Black-headed gull were seen displaying mobbing behaviour towards an otter on 12 August 2006. While collecting spraints, three black-headed gulls were observed flying up and down a bed of *phragmites*. An otter emerged from the reedbed and entered the water, the gulls continued to mob the otter. Clode *et al.*<sup>22</sup> investigated the mobbing behaviour of black-headed gull and terns (*Sterna* spp.). Their findings suggest that birds offer differing responses to predators. Adult birds hover over animals that are potential threat to them, which is classed as a fleeing response. Birds that feel their eggs and young are threatened often offer an aggressive response to the predator. They will attempt to drive the predator away from the young, by repeatedly diving towards the predator. This aggressive response to potential predators carries the risks of death or injury to the mobbing adult birds, so much so that the black-headed gulls chose the fleeing type of mobbing. Mobbing behaviour is learned through experience<sup>22</sup> possibly implying that otters have attempted to predate upon black-headed gulls and that otters are now perceived as a threat by black-headed gulls on Shapwick Heath. Though there was no evidence in the spraints of gulls being taken by otters, the adaptation of anti-predator by black-headed gulls suggests that they are predated on.

Otters are not perceived as threats by all birds. Grey herons and mute swans took no notice of otters in water near to them, which may be due to the bird's larger size. Grey herons have been reported as prey items of otter in Spain<sup>23, 24</sup> and suggested that the otters are killing the heron as an act of super-predation rather than killing the herons to consume them.

Therefore, it may be concluded from this study that the otters on Shapwick Heath demonstrate a larger proportion of birds in otters' diet than that from previous studies. Whether this is due to the particularly high local availability of birds as a food source at Shapwick Heath and whether this level of predation impacts significantly on the overall bird population levels would require further research.

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