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Imitative and exploitative foraging behaviour  
in waterfowl and waders

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A typical aspect of the ecology of both waterfowl and waders is that they aggregate in mixed-species foraging flocks that may be composed of thousands of individuals. One of the major hypotheses advanced to explain flocking includes food-detection advantages. When foraging, individuals in groups can use the information provided by other individuals, so that they can copy the foraging modes and/or locations, or even can steal the food previously procured by the other individuals. The nature of food would condition the prevailing type of interaction: when food requires short handling times and/or the defence of the site is costly, and it also presents a patchy distribution, there is a possibility for the development of imitative (copying) foraging tactics; when food requires longer handling times, there is possibility for a more exploitative foraging tactic (kleptoparasitism). In between these two situations there are other cases, such as supplanting from foraging sites. The usurpation of food, either directly (kleptoparasitism) or indirectly (supplanting, copying), may have some impact on the rate of food intake of the usurped individual. To reduce such impact, usurped individuals may adopt several behavioural tactics. The prevalence of imitative and exploitative foraging interactions varies between waterfowl and waders, probably in association with some factors of their ecology which make more or less likely the occurrence of scroungers when individuals of these groups forage in flocks.

Smews *Merqus albellus* at Lake Ijsselmeer, the  
Netherlands: the significance of social fishing  
in diving waterfowl

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Social foraging in piscivorous diving waterbirds has been described in various species. Smew are observed fishing in social groups at Lake Ijsselmeer, The Netherlands. It is found to be the most usual fishing method employed by the rather large wintering population of Smew in this relatively shallow and troubled lake.

As explanations for this spectacular foraging behaviour two theories have been proposed. Since socially fishing birds generally tend to show a strong synchronization in their diving pattern, it might be that they achieve protection against possible avian predators and/or kleptoparasites, which find it more difficult to aim their attacks when faced with either a compact group of victims or none at all. On the other hand, it has been assumed that, especially when feeding on pelagic fish species living in shoals, foraging in large groups could somehow enhance individual foraging success for each of the participating

birds. There is evidence that this could be achieved by confusing the shoals of prey fish, so that their anti-predator movements, that is very effective in attacks by individual predators, would not be performed.

In this paper we shall look into some of the factors that might make the birds decide whether to fish individually or socially, thus showing that more insight could be gained concerning the relative survival values of both fishing techniques. Additionally, some detailed observations on the social fishing technique, as used by Smews, will be interpreted.

Conditions for growth in wader chicks

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Retarded growth in small chicks occurs in cold weather, when too much time is lost for foraging because the chicks have to be brooded. Lapwing chicks are more cold sensitive, and develop homeothermia more slowly than those of Black-tailed Godwit and Redshank.

The number of dry hours/day above 15°C during daylight gives an indication of the time available for foraging. Daily weight gain is positively correlated with this parameter, in small chicks. In larger chicks, this relationship is lost.

In spring, the number of dry, warm hours increases with date. Yet, when weight gain is plotted against the date, a different pattern is found. In small chicks, the positive correlation remains as above, but in larger chicks, the relationship turns into a negative correlation.

There is no good explanation yet, only theories, all having to do with food. We need more information on feeding behaviour of the chicks, and properties of the available prey fauna. Here we have a nice field of research for the next few years.

Wigeon *Anas penelope* exploitation of  
contrasting refuge areas in Britain

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The feeding behaviour and movements of Wigeon in relation to human disturbance and food availability were assessed at three contrasting wintering grounds. Implications for refuge management are discussed.

At the Ouse Washes, a large inland site, observations and radio telemetry techniques revealed that Wigeon fed on grasses for long periods day and night. Radio tracked birds rarely left the hunting free refuge and showed a strong loyalty to certain fields. There was a general movement of birds out of the refuge at the end of the hunting season to exploit other areas of the site.

At the Exe Estuary, a small estuarine site subject to various forms of human disturbance, Wigeon fed day and night on *Zostera* beds. Feeding was restricted to bouts of 2 to 3 hrs duration during intertidal periods. The *Zostera* within the disturbance free refuge was preferentially exploited and those birds which selected to feed elsewhere on the estuary returned to the refuge to roost.

At the Ribble Marshes, a large salt marsh site, Wigeon fed predominantly on *Puccinella* during hours of darkness only; birds choosing to desert the hunting free refuge during the day seemed to roost elsewhere. Grazing pasture was assessed through fortnightly faecal counts along sampling lines transecting the refuge boundary. During early winter grazing was concentrated in the refuge area.

The exploitation of *Zostera* by wintering Wigeon *Anas penelope* in Britain

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Studies in inter-tidal areas in the Moray Firth (northern Scotland) and the Exe Estuary (south-west England), show that Wigeon at several different sites feed principally on *Zostera* from their arrival in September. Wigeon fed on *Zostera* beds by day and night, but only during specific inter-tidal periods. Direct observations (during daylight and using night-sight techniques during darkness) and radio telemetry methods showed that birds roosted during high tide and low tide periods, feeding commencing only after high tide when the *Zostera* can be exploited by birds up-ending. Foraging continued on average for two hours before the ducks left to roost in favoured areas. Wigeon optimised their exploitation of *Zostera* beds, by using different feeding techniques according to depth of water.

Diet and exploitation of marshes by nesting Avocets *Recurvirostra avosetta*

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The aim of this study is to acquire better knowledge on the importance of habitat quality on nesting success of Avocets (colony of Chanteloup, marais d'Olonne, west coast, France). For at this colony, a reserve since 1976 and now holding 350 pairs, it was seen that as the number of pairs increased, the number of fledging young declined similar to the situation at the UK Havergate and Minsmere colonies. (Since the management of Chanteloup.) Because the main characteristics of this habitat (localisation and surface of pounds, management) have been stable since 1976, we will study the role of feeding in this decrease. Here, two different parts of feeding study will be reviewed:

-the diet of birds undertaken by faecal analysis,  
-exploitation of marshes in space and time, during breeding period.

Results show changes of the diets during the breeding periods and during the growth of the chicks. Larvae of *Diptera*, *Ephydriidae* and *Chironomidae* constitutes the major components of the adult diet. The diet of chicks is more diverse and dominated by adult *Diptera* and other prey caught by sight.

Breeding and feeding sites are dependant; the density of adults feeding on a pond is correlated to the number of breeding or rearing pairs in this place. Some mudflats can be exploited in opportunistic means; these are accessible for feeding just during a few days (2-7), and sometimes exploited by important groups of adults and fledging young. After hatching, families go to feeding places where the adults defend territories mainly exploited by chicks. Adults usually feed outside territories or in places inside them but different from those exploited by chicks. Surveys of ringed Avocets during the incubating period showed for the first time the existence of another type of territories. These territories, where Avocets feed and survey their nest site, are defended by one or several pairs whose nests are closely settled.

Agrarian feeding of inland breeding Oystercatchers *Haematopus ostralegus*

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The feeding behaviour of inland breeding Oystercatchers was studied during February to August (1978-1980) in North West England. Terrestrial and 'coprophilous' invertebrates were sampled bimonthly over the whole year. Bimonthly mean bird feeding intensity (peck, ingestion, success rates/min). Prey items were related to available prey in the soil, ambient and soil temperature, time of day and daily feeding effort. Feeding behaviour was recorded during the complete breeding cycle of 130 days (subdivided into 9 stages) for 8 pairs of individually marked birds. Sexual variation in feeding effort, intensity and prey corresponded with activity-time budget differences particularly during incubation and parental-care stages.

For each stage of the breeding cycle a daily energy budget was estimated from Daily Energy Income (Ingestion rates) and Daily Energy Expenditure (Activity time budget) for each sex. This was compared with energy budgets based on multiples of standard metabolic rate from various authorities.

The conservation of estuarine waders; the use of long-term counts to determine preferred estuaries

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The Birds of Estuaries Enquiry has been counting waders in the UK since 1969. Peak winter counts of 8 species of waders made on 70 UK sites were analysed for evidence that sites were at carrying capacity.

The log peak for each species on each site was regressed on the log of the national index (as

a measure of total population size). Sites with a significant positive slope were not considered to be at capacity whilst those with a significant curvilinear regression were considered to approach capacity at high index levels. Sites with no significant regression between the peak winter count and the index were considered at capacity if they had a low coefficient of variation between counts.

As an example of the value of this approach in the conservation of wader populations, these data were used to determine the likelihood that other estuaries in south west Britain could absorb any birds that might be displaced from the Severn estuary if a barrage was constructed. It was predicted that there was surplus capacity for individuals of two nationally important species (Ringed and Grey Plovers) in south west Britain, but that few additional birds of the three internationally important species, (Dunlin, Redshank and Curlew) could be absorbed.

Behaviour and nutrient reserves of pre-breeding Knots *Calidris canutus* and Turnstones *Arenaria interpres* at Alert, Ellesmere Island, Canada

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The behaviour, weights and fat and protein reserves of Knots and Turnstones in the three weeks after their arrival have been studied at one of the most northerly wader breeding grounds of waders in the world, at Alert, on northern Ellesmere Island (82°30'N) in 1986, 1987 and 1988, and studies are continuing. Some additional information is available also from the early 1970s. Birds arrived on similar dates in late May each year, but the maximum numbers present, and their timing, differed between years. Most birds present in years of low May temperatures and late snow-melt. Artificial habitats, particularly a rubbish tip and sewage outfall at the military base at Alert, provided favoured feeding sites at these times. In late May and early June birds foraged less and roosted more during periods of severe weather (low temperatures, high windchill). By mid-June, however, when more snow-free areas were available for foraging, this behaviour had reversed and birds tended to forage more during bad weather. Both Knots and Turnstones arrived after their migration from Iceland or Norway with substantial reserves of fat and muscle protein remaining. Knots, but not always Turnstones, used some fat but little protein during the two weeks after their arrival, although there were differences between years. At the time of starting to breed in mid-June, both species had retained nutrient reserves. The inter-relationships between reserve storage and use and behaviour in relation to survival and preparations for breeding will be discussed.

Diving as a time constraint for prey size in Tufted Duck *Aythya fuligula* feeding on fresh water mussels *Dreissena polymorpha*

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*Dreissena polymorpha* is an important food source for diving ducks in Western Europe. We used an outdoor diving device in order to

manipulate diving depth (0-5.5 m) in four captive ducks. Food selection was analysed in relation to diving and rate of depletion of the food source. Intake rate per size class was measured and proved to be very different.

The ducks possessed two foraging methods depending on the size of the mussels. A switch point between both methods occurred at a fixed size class corresponding to a similar switch point in profitability of the prey.

Diving to greater depths made the birds more selective in their uptake. Time budget studies are in progress to reveal the relationship between allocation, time spent foraging and diving depth.

Feeding ecology of Avocets *Recurvirostra avosetta* in Senegal and Schleswig-Holstein

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The aim of the running study is to describe the influence of food availability on foraging behaviour and breeding success of Avocets. Investigations took place in the winter quarters in the Senegal Delta as well as in the breeding sites in Schleswig-Holstein. In both sites we measured the density of benthic invertebrates. In Senegal we recorded time budgets and intake rates. In the breeding sites we also tried to study hatching success, chick survival and movements of families in relation to food availability.

For wintering Avocets we used time budget data, intake rates and mean biomass data for invertebrates to estimate the biomass consumption in the study lagoon.

For Schleswig-Holstein breeding success data is presented for a site with a rich food supply (an intertidal saltmarsh) and two sites poor in invertebrates (a freshwater habitat and an artificial salt lake).

It is discussed in which way food may be a limiting factor for the Avocet population.

Reproductive success in the Oystercatcher *Haematopus ostralegus*: Why do so many Oystercatchers settle in poor quality territories?

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Since 1984 the reproductive success of a population of approximately 160 colour-marked Oystercatchers breeding on the saltmarsh of Schiermonnikoog has been recorded. Several social categories can be distinguished:

1. Non-breeders (young birds and a surprising number of one time breeders that have been ousted from their territory) do not defend a territory on the saltmarsh but may defend a territory on the mudflats and may be mated.
2. Residents (or 'hokkers') are breeders that defend a territory on the edge of the saltmarsh as well as a territory on the directly adjacent mudflats.
3. Leap-frogs (or 'wippers') are breeders that defend a territory on the saltmarsh further inland and may defend a territory

on the mudflats at distances of 200 m or more from the shore.

Oystercatchers provision their chicks with food until well after fledging and virtually no food is available on the saltmarsh itself. Residents fledge more chicks than leap-frogs. This difference is primarily due to starvation of large leap-frog chicks. Only leap-frog parents that expend much energy in transporting food to the chicks prove successful. Resident parents spend very little energy in transporting food since they can take their chicks with them to the adjacent mudflat territory. Hence, the energetic cost of transporting food to the chicks defines territory quality in oystercatchers.

The majority of Oystercatchers return to the same territory to breed with the same mate from one year to the next. Nevertheless, several birds breeding in a poor quality (i.e. leap-frog) territory have moved to a high quality territory when a vacancy occurred. When all the transitional probabilities describing the probability of changing from state X in year  $t$  to state Y in year  $t+1$  are combined into a demographic model it turns out that settling in a poor quality territory still leads to an expected life-time reproductive success well below that of birds settling in a high quality territory. It would be premature, though, to accept the hypothesis that individuals settling in a poor-quality territory are making the best of a bad job which is forced upon them by inferior fighting abilities for instance. Young birds take several years to acquire a territory and it may be that settling directly in a resident territory takes more years than settling in a leap-frog territory. The lugubrious story of Rambo, a 16 year old non-breeding male whose major achievement during the past 4 years has been a gradual shift of his mudflat territory more closely to the shore, indicates that our observations have to be continued for many years to come.

Wigeon *Anas penelope* distribution in the UK - the effect of disturbance

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The effect of disturbance on the distribution of British wintering waterfowl has been the object of much recent debate. This paper reviews the current distribution of Wigeon *Anas penelope* in Britain in relation to wildfowling. Changes in the distribution of this species in recent years are also reported. Based on recent research in SW Scotland and elsewhere, daily energy expenditure of Wigeon is estimated from defecation rate and digestive efficiency to be 630 KJ per bird per day. Recent distribution changes may, therefore, be due to disturbance effects caused by this species' requirement for long feeding periods. This may be the reason why Wigeon tend to be concentrated on reserves and refuges, compared to other wildfowl. The implications of disturbance for the conservation of British Wigeon stocks are discussed.



Nocturnal feeding activity of *Aythya* and its impact on stream benthos

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River "Seerhein" is a part of River Rhine connecting two basins of Lake Constance. Benthic fauna is dominated by *Dreissena polymorpha* (Mollusca), reaching a standing crop of up to 18.3 kg freshweight  $m^{-2}$  in autumn; this is among the highest values reported for Western and Central Europa. River "Seerhein" is situated near the important nature reserve "Wollmatinger Ried" where more than 20 000 individuals of wintering waterfowl have been reported from an area of 5  $km^2$ . In spite of the close vicinity to such important wintering grounds, number of waterfowl are low on River "Seerhein" during daytime due to disturbances by boating etc. After sunset and during night numbers increase and may culminate to 23 000 individuals; dominating species are Pochard *Aythya ferina* and Tufted Duck *Aythya fuligula*. The heavy predation causes a breakdown of the *Dreissena* population until spring, when only 10% or less of autumnal biomass could be found.

Diving activity of Tufted Duck was observed even at depth of 10 m and more, and *Dreissena* was effectively removed from sandy substrates down to the same depth. On gravel higher biomasses of *Dreissena* could persist until spring. The profitable nocturnal feeding activity is only possible because of the poorly structured substrate. Where gravel or otherwise structured substrates dominate, the need for visual localization of food makes nocturnal feeding ineffective.

An approach to understanding how increased mortality rates in winter might affect year-round population dynamics in waders

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Research in recent years suggests that the continued loss of winter feeding grounds will gradually increase the mortality rates of waders in winter because, as bird density increases on the diminishing feeding grounds, competition for food will increase. The problem is to find out what effect such an increase in mortality rates would have on the overall, year-round dynamics and size of wader populations. This is difficult to study in such mobile populations but one possible approach is suggested in this talk. It combines detailed studies on bird behaviour in winter with simulation modelling of species populations. The effect of increased winter mortality depends critically on the behaviour of these populations on the breeding grounds, and it is argued that more intensive studies on breeding populations would be highly desirable.

The effects of re-seeding of heathland on breeding Whimbrel *Numenius phaeopus* in Shetland

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The effects of re-seeding heathland on breeding Whimbrel were studied over a three year period, using a population of individually colour-ringed adults.

Heathland provided the main nesting habitat and re-seeds which had been prepared with prior ploughing or harrowing were avoided by nesting Whimbrel, although some pairs continued to nest in areas which had been subjected only to surface re-seeding. Avoidance of ploughed or harrowed re-seeds was associated with changes in vegetation composition and structure, and such re-seeds lacked attributes important in the selection of nest-sites by Whimbrel. Habitat change was less marked in surface re-seeds.

Ploughed or harrowed re-seeds were used extensively as feeding habitat by adults during the pre-laying period and evidence was obtained to suggest that re-seeding improved feeding conditions for adults. However, there was little evidence to indicate that the improved feeding conditions on re-seeds would provide any major benefits to breeding success.

Approximately 30% of all broods studied used re-seeds at some stage prior to fledging. Although some broods did show preference for this habitat, there was little evidence that this was associated with either decreasing the risk of predation on chicks or improving chick food supply. The survival of chicks to fledging did not vary according to the habitat-use of broods.

#### The feeding ecology of breeding Common Snipe *Gallinago gallinago*

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The paper describes part of a study of the factors affecting the population density and reproductive success of Common Snipe breeding on lowland wet grassland in southern England. Investigation of the ranging behaviour of radio-tagged breeding birds showed that they foraged for soil invertebrates in meadowland provided that the surface soil was moist and easy to probe with the bill. If the soil near the nest was dry and difficult to probe, or if it was deficient in invertebrates, incubating females moved to pools and ditch margins to feed. Studies of ranging behaviour, weight gain rates and survival of Snipe chicks showed that they moved least far from the nest, gained weight most rapidly and survived best in areas where soil invertebrate density exceeded a threshold. Chicks tended to be located at ditch margins when meadowland soil was difficult to probe. A comparison of the temporal pattern of breeding in different study areas indicated that Snipe were able to breed for longer periods and hatch more young per season where moist soil conditions conducive to feeding in meadowland persisted until late summer.

#### Breeding waders in Iceland: A review of present knowledge

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There are eleven wader species which breed regularly in Iceland, and three other that have recently been recorded breeding, probably on irregular basis or in very low numbers. Most of these species do partly or entirely breed in wet meadows. In the recent review of population size estimates in Europe, compiled by Theunis Piersma (WSG Bull. 48, Supplement), rough estimates of numbers of breeding waders in

Iceland were published. Because very little work has yet been done to estimate the breeding density of waders in Iceland and still much less has been published, these estimates are very close to being just guesswork at present. Still, based on own experience, I feel that those figures are not unrealistic. They highlight the importance of Iceland as one of the main breeding areas for many species within Europe, such as Ringed Plover, Golden Plover, Purple Sandpiper, Dunlin, Snipe, Black-tailed Godwit, Whimbrel, Redshank and Red-necked Phalarope. The few data available on wader densities in Iceland will be summarized. Threats to breeding waders in wet meadows, such as ditching, will be discussed.

#### Population dynamics of the Avocet *Recurvirostra avocetta* breeding in Britain

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1. The number of breeding Avocet pairs, eggs laid, chicks hatched and young fledged were recorded annually at Havergate Island and Minsmere, Suffolk, from recolonisation in 1947 and 1963, respectively. Data up to 1986 were used in a key factor analysis. Individual mortalities used were the inability to realise maximum egg production (k), egg loss (k), chick loss (k) and overwinter loss (k).

2. At both sites the number of pairs increased and young fledged per pair decreased following re-colonisation.

3. Chick loss at both sites was identified as the key factor explaining 86% and 83% of the variation in total loss at Havergate and Minsmere, respectively. Egg loss at both sites and chick loss at Havergate increased over the study period.

4. Egg loss was positively correlated with the number of eggs laid at both sites. Chick loss at both sites was unrelated to the number of chicks hatched.

5. The main density-dependent loss at both sites was the loss occurring from the autumn population in year  $t$  and the breeding population in year  $t+2$  since most Avocets return to their natal site in their second year. During two phases, 'increase' and 'plateau' the strength of density-dependence was determined. During the plateau phase density-dependence was almost perfectly compensatory.

6. At both sites the numbers of Black-headed Gulls *Larus ridibundus* L., which predate Avocet eggs and chicks and appropriate Avocet nests, have increased during the study periods although they have been controlled at Havergate and Minsmere since 1964 and 1966, respectively. Those at Minsmere declined after intensive control from 1977 onwards.

7. At Havergate chick loss was correlated with the number of breeding gulls up to and including 1971, beyond which Kestrel *Falco tinnunculus* L. predation also occurred, obscuring the relationship with gull density. At Minsmere neither egg nor chick losses were related to the number of breeding gulls.

8. Mortalities were compared between sites. Egg losses were higher at Minsmere than Havergate. Chick losses were higher at Havergate than Minsmere. Possible reasons for the difference, based on hypersaline conditions at Havergate, are discussed.

9. An empirical model was developed in order to determine effects of various management activities on population densities and productivity. Preliminary results are presented.

Survival of Oystercatcher *Haematopus ostralegus* during hard winter weather

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Oystercatchers have a long life span with correspondingly low annual mortality and reproductive output. The great majority of the Oystercatchers breeding in the Western Palaearctic winter in the North Sea area, with the Wadden Sea and the Irish Sea as the most important centres. Here, the birds concentrate in large flocks in sandy estuaries feeding primarily on large bivalves like cockles *Cerastoderma* and mussels *Mytilus* and to a lesser extent on marine worms *Nereis*, *Arenicola*. During most winters prevailing weather conditions guarantee free access to food. However, when temperature drops below zero the availability of food decreases and when a cold spell lasts longer food becomes virtually inaccessible. Under the latter conditions mass emigration is often observed as well as heavy mortality, many birds dying of starvation. In the normal winter quarters, periods with sub-zero temperatures lasting a few days usually occur a few times every winter, but cold spells lasting a week or longer occur infrequently. Oystercatchers can tide over periods without food by relying on their body reserves, varying from a few to maximally twelve days depending upon the amount of reserves and prevailing weather conditions.

The question now is, on what basis do Oystercatchers decide to leave an area when a cold spell has arrived? Are threshold levels in body reserves involved, and do all individuals within a population take the same decisions?

These questions will be addressed by presenting information on:

- the relationships between recoveries of ringed birds and the severity of the winter weather,
- the detailed pattern of a few documented mass emigrations,
- the role of the body reserves as a means to survive fasting periods under different temperature regimes.

The use of wrack-bed fauna by waders on Helgoland

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Beds of deposited wrack and their invertebrate fauna are usually considered to be a relatively unimportant source of food for birds. However, studies on wrackbeds at Helgoland (composed mainly of dead *laminariae*) have shown that larvae, pupae and imagoes of seaweed flies *Coelopa* spp. are the main diet of many migrant waders, gulls and passerines. The occurrence of these birds is mainly dependant on the availability of *Coelopa* larvae. Seaweed flies can only develop during a single phase of algal decay. Their density is heavily influenced by the amount of algae casted ashore. The predation on the larvae by birds seems to reduce numbers rapidly, resulting in food

shortage, inter and intraspecific aggression and finally abandonment of the stopover site.

Wrack-beds at Helgoland form a simple but highly dynamic ecosystem consisting of rather homogenous dead plants as input energy, very few primary consumers and only a dozen bird species as secondary consumers. Such a system is very appropriate for studying energy flow and regulatory processes in numbers and behaviour of stop-over migrants. Hence, an attempt was made to quantify 1) the food consumption of the main species (based on estimates of intake rates and on time-activity-budgets), 2) feeding techniques and 3) interactions (e.g. cases of competition and commensalism) in relation to food availability.

Habitat characteristics and wader breeding success: implications for conservation management

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Intensive studies of breeding success of Dunlin, Redshank and Ringed Plover, on the internationally important breeding grounds in the Outer Hebrides of Scotland, showed that they used a wide range of habitats including seashore, arable fields, pasture and marshes. Larger inter-site and inter-year differences were found in breeding performance. In most instances these differences were correlated with differences in those physical characteristics of the habitats which influenced avian predation rates. Dunlin and Redshank breeding performance appeared to be dependent on the amount of cover available. Overgrazing during a harsh winter resulted in much less available nesting cover in the following breeding season than after two benign winters and led to poorly concealed nests susceptible to predation.

Ringed Plover relied more on camouflage to protect nests from predators; nests on gravel or partly vegetated ground were better camouflaged than those on grass. Ringed Plover nesting on grass swards frequently chose to nest on old cow-pats; this probably promoted nest camouflage.

At present the agricultural economy of the islands is mainly based on low intensity traditional cattle rearing. Even quite small changes in the management practices could have marked effects on the characteristics of the habitats and affect their suitability for breeding waders.

Feeding behaviour of breeding Wigeon *Anas penelope* in relation to diet and seasonal emergence of Chironomids

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Feeding behaviour of breeding Wigeon was studied in Western Norway in 1988 and 1989. The birds use 3 different kinds of feeding modes:

- grazing terrestrial vegetation
- sub-surface feeding in water
- insect pecking from water surface and/or from aquatic vegetation.

When the birds arrive on their breeding grounds in April, they graze mostly terrestrial

vegetation on shore meadows and in shallow water. However, when chironomids emerge in large numbers from the bottom substrate in the end of April, the ducks switch to feed upon those food items. The numbers of insects consumed throughout the day is related to the swarming behaviour of the chironomids. The intake rate is highest in females.

This switch in feeding behaviour of breeding Wigeon is mainly due to the energetic demands during the reproductive stages. The chironomids are of high calorific value; they contain calcium for eggshell formation and other nutrients required for egg production.

The Wigeon must have been adapted through natural selection to breed when the availability of insects is at a maximum level. This may in turn increase the breeding success of the birds.

#### Patterns of distribution and abundance of feeding waders in Liverpool Bay, NW England

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Preliminary studies of the distribution and abundance of feeding waders in Liverpool Bay (the Dee, Mersey, Alt and Ribble estuaries) were undertaken during the winter of 1986/87 in relation to numerous development proposals in the area. These studies were extremely mobile within the study area, moving extensively between adjacent estuaries even within the same day. In 1988/89, studies were intensified, both geographically and temporally. Twenty, broadly simultaneous, low-tide counts were undertaken of approximately 80 sections (encompassing the entire area) of Liverpool Bay by teams of volunteer ornithologists. The results of these surveys are presented, important areas are highlighted and for part of the area, the Dee estuary, the distribution of waders is related to sediment and invertebrate data collected during the survey period.

#### Consequences of habitat loss to marine waders in NW Europe

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A review will be presented of existing data on habitat loss. Knowledge about the feeding ecology of the major wading species has been considerably increased over the last two decades. The different studies gave us more insight into the factors or mechanisms that may affect the number of birds in a specific area. This allows a more conceptual thinking about the possible impact of a proposed project (as e.g. in the Morecambe Bay and Wash feasibility studies), but is still relatively far from clear quantitative predictions. Few field tests are available. Well-known are the studies of the Seal Sands embankment (NE England). Population sizes in this area were relatively small, however. Current studies are dealing with the consequences of some embankments in the German and Danish Wadden Sea and of the large hydraulic engineering projects in the Oosterschelde (Dutch Delta area), all major Wadden areas. The recently suggested relationship between the increase of the salt marsh plant *Spartina* and the decline of Dunlin in Great Britain is of interest also. The importance of long-term background data will be illustrated by a case study, concerning the

enclosure of the Grevelingen estuary (Dutch Delta area). Preliminary results of the Oosterschelde study emphasize the importance of food stock, access time and harsh winter weather. Lack of coherent data sets are a serious handicap in the evaluation of possible long-term effects on a population level (cf. annual recruitment and survival). Finally, the present situation in NW Europe will be considered, in particular the possibility to compensate elsewhere for a loss of feeding areas, and the significance of human activities in those.

#### Prey density or sediment type; which factors determine the distribution of waders on tidal flats?

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In spring and autumn many wader species gather in large flocks on intertidal flats where they forage. The distribution of the different species from the foreshore to the low water line often seems disorganized and chaotic. The classical assumption that length of bill and legs of the species determine their position in relation to one another is not confirmed. In order to analyse if there is any pattern in the distribution of waders their positions were mapped in eight transects and analysed in relation to biotic and abiotic factors. Some results from this analysis will be presented, and the influence of prey densities and sediment types on the distribution will be discussed.

#### Distribution and diet of the Common Eider *Somateria mollissima* in the Danish Wadden Sea in relation to mussel fishery

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In 1984 a strong increase (from 2 000 to 15 000 tons) in the fishing for Blue Mussels *Mytilus edulis* took place in the Danish Wadden Sea. In the following year a further increase took place. This development worried us and was the background of the study.

Monthly aerial counts (from 1979) showed that there was a general decrease in the number of Eiders in the winter months due to intensified mussel fishery and that the distribution of the eiders has changed markedly.

Diets and weights of Eiders have been examined in relation to depletion of the mussel stock. For adults the number of mussels in the diet has decreased from 32.5% to 9.3% whereas the Razor Mussel had increased from 0.7% to 40.9%. Regarding the size of the three main prey items, Blue Mussel, Edible Cockle and Shore Crab there was a change in prey size in Blue Mussel and Edible Cockle whereas there seemed to have been no change in the prey size of Shore Crab. In Blue Mussel the mean prey size decreased from 42.0 mm in 1986/87 to 19.3 mm in 1987/88. In winter the weight of the eiders decreased by 10%.

From the decreasing number, change in geographical distribution, diet composition and size of food items plus decrease in weight we conclude that the fishing for Blue Mussels in the Danish part of the Wadden Sea has an impact on the Eider number and distribution and on the condition of the birds.



The significance of water as a key trigger enabling Wigeon *Anas penelope* to feed on grass leaves of *Agrostis stolonifera* in a wet meadow system in Lake Lauwersmeer, The Netherlands

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Wigeon show a strong preference for partly inundated areas where they feed on grass leaves. This well known phenomenon has been suggested to be related to an increased safety condition on fields covered by water. We analysed the detailed distribution of grazing Wigeon in relation to the presence of water on the vegetation. The degree of inundation highly influenced the birds' choice of foraging locality, readily changing with changing water conditions.

Several alternative explanations concerning food availability have been tested, both in the field and with the aid of captive Wigeon. The physiological need for the uptake of water is stressed as the prime factor and the experiments point towards the importance of quality of the grass leaves as secondary factors governing the choice of a feeding area by the ducks.

Feeding ecology of migrant shorebirds on Hanzhou Bay, China

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The study was conducted on both northern and southern Hangzhou Bay, China (30° 8' N, 121° 4' E and 30° 3' N, 121° 2' E) where there is an extremely important staging area for a wide variety of migratory shorebirds. During two springs and two autumns (April 1986 and 1987, and September 1986 and 1987) 1 080 birds of 42 species in total were sampled and their stomachs were analysed. The food of shorebirds contains (in order of frequency) small *Lamellibranchia*, *Gastropoda*, weed seeds, *Crustacea*, grasses, insects and so on. Although type, frequency and proportions of the food of the same species in spring and autumn are almost the same, the efficiency of foraging is much higher in autumn than in spring. Shorebirds using the area increase their body weight by 2-3% per day in spring and 4-7% per day in autumn. *Calidris alpina* even doubled their body weight during the first two weeks upon arrival to the area in autumn. The biomass of several main prey items on intertidal mudflat is not showing much difference between spring and autumn, the bird density is, however, higher in autumn than in spring. The biomass of the middle tidal zone is highest, the high tidal zone is next, and the low tidal zone is lowest which coincides with results of previous studies.

Food and habitat use of Great Snipe *Gallinago media* during the breeding season

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(1) Great Snipe is considered as an endangered species. Its food and habitat use during breeding was studied in a sub alpine/low alpine

habitat in Central Norway.

(2) Earthworm setae were the dominating remnants both in fecal and stomach samples. Estimation suggested that by weight earthworms constituted more than 95% of Great Snipe food. The remaining consisted mainly of diptera larvae.

(3) Of the different vegetation units, feeding birds selected low herb willow shrub by a factor of 2.3, and eutrophic fen by a factor of 1.5, although the latter was the most used vegetation unit due to its area dominance. Birds did not select eutrophic dwarf birch/juniper heath, (selection factor 0.5), due to its large area it was the third most used vegetation unit.

(4) In Eutrophic fen, feeding birds were found at sites with lower soil penetrability (i.e. drier), higher earthworm abundance and better cover than random localities. In low herb willow shrub, birds were found at sites with less cover and lower earthworm densities than random sites. Sites in heath selected by birds differed from random sites only by having less shrub cover.

(5) Although soil penetrability, cover and earthworm density was very different in the different vegetation units, the sites selected by Great Snipes were almost similar in these parameters. Great Snipes select for an optimal combination of soil penetrability and earthworm density, and for a medium scrub cover.

(6) Great Snipe is considered as a food and habitat specialist, demanding rich soil types with abundant food. This may explain its scattered distribution in Scandinavia, and makes it vulnerable towards habitat alterations.

The effect of habitat destruction on the abundance of breeding waders

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The study was carried out on meadow swamp covering 2 km<sup>2</sup> by the Kuanas water reservoir (Lithuania). The census plot itself was 80 ha. The censuses of breeding waders were taken from 1973.

79.5±8.87 (+SD) pairs of four species were censused in 1973-78. A few pairs of Dunlin, Curlew and Ruff, included in the Red Data Book of Lithuania, were found nesting there too.

In autumn, 1978 55% of the whole area, including 48 ha of the census plot, was ploughed. In spring 1979 wetland drainage was stopped and the greater part of the ploughed area was flattened. From 1979 to 1981 the changes of herbaceous plant species composition and expansion of willows and alders became visible. The rare species of waders disappeared and the total number of pairs decreased to 40.7±2.89. 1982-1984 was a period of intensive rehabilitation of herbaceous plant communities. The total number of waders increased (55.0±8.19 pairs). In 1985-1987 the average number of breeding pairs was only 38.0±8.54 because of the shrub invasion. The abundance of Common Snipe was affected least of all as their most important nesting sites were untouched. The encroaching of willows and alders had greater influence on the decreasing of number of Lapwing than ploughing. The ploughing of the area affected the Redshank and Black-tailed Godwit most of all, besides their rehabilitation was limited by the shrub invasion.



Disturbance effects of recreational activities on wildfowl

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Several studies have shown that human recreational activities, and especially shooting, can cause disturbance with a consequent unproportional concentration of staging and wintering wildfowl. It is of critical importance to conservation of waterfowl habitats to know whether disturbance induces loss of feeding and roosting habitats, and consequently leads to quicker emigration, or there are behavioural and ecological means by which the birds can compensate from lost feeding time and space, e.g., by alternative foraging patterns or habituation.

Case stories which have analysed disturbance effects by use of natural experiments with disturbed/undisturbed study plots and analysis of behavioural and ecological responses to human activities are reviewed and discussed. Future disturbance studies should incorporate analysis of food supplies and exploitation rates by the birds.

Feeding patterns of avian predators in response to tidal and seasonal changes in the behaviour of their mudprawn prey

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The thalassinid mudprawn *Upogebia africana* inhabits U-shaped burrows in the intertidal mudbanks of southern African estuaries. The numbers that left their burrows and became available to surface feeding birds were assessed at the Swartkops estuary, Port Elizabeth, South Africa. Only the largest mudprawns came to the surface and most left their burrows at the beginning of low tide. Many more were found on the surface in the austral summer than in the austral winter. The mudprawns carried large parasite loads, which may have been responsible for this unusual behaviour.

Short-billed birds (e.g. Grey Plovers *Pluvialis squatarola* and Kelp Gulls *Larus dominicanus*) took mudprawns of a similar size to those on the surface and fed most when these were most numerous. In winter they took fewer mudprawns and fed for longer, suggesting that food was scarcest then. At low tide mudprawns in their burrows moved up to the air/water interface and came within reach of long-billed birds, such as Whimbrels *Numenius phaeopus*, which showed no consistent seasonal changes in diet. Very long-billed birds (e.g. Curlews *Numenius arquata*) were able to reach the mudprawns when they were not near the surface of their burrows.

Nocturnality in waterbirds, with special reference to a tropical environment

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We present a short review of nocturnality and its significance in waterbirds (Ardeidae, Anatidae, Charadriiformes), including seabirds (Petrels). Then we present results concerning waders and other waterbirds feeding in a lagoon

of northern Venezuela. During day-time and night-time, we measured the abundance of each species and environmental factors (time, wind velocity, cloudiness, tide level, presence of moonlight and bioluminescence). Night-time observations were done through a night vision module (light intensifier). Some birds like the "egrets", the Whimbrel *Numenius phaeopus* and the Grey Plover *Pluvialis squatarola* fed principally during daylight, but most other species, including a majority of waders, fed more regularly and in higher numbers at night. Yellowlegs *Tringa* spp. and Willets *Catoptrophorus semipalmatus*, foraged with comparable frequency during the day and the night. Tide level was the factor which best explained both the variations of nocturnal and diurnal abundance of birds. Species generally classified as visual foragers (e.g. *Himantopus mexicanus* and plovers) during daylight also foraged frequently, or only, by sight at night. The Yellowlegs switched from a daylight visual feeding method to a tactile one (sidesweeping) during darkness. Short-billed Dowitchers *Limnodromus griseus* were tactile feeders (probers) both by day and by night. Some waders seemed to feed at night on prey different from those they fed upon during daylight. Some wader species continue to occupy their feeding territory during night-time.

Effects of tidal changes and habitat loss on the foraging behaviour of waders in the Oosterschelde, The Netherlands

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Coastal engineering works reduced the intertidal area of the Oosterschelde from 16 000 to 10 500 hectares. In the remaining estuary the tidal amplitude is reduced and during some time in the course of the construction of the dams the tidal amplitude was manipulated severely by means of a storm-surge barrier in the mouth of the estuary.

In this paper we describe the effects of these temporal severe changes in tidal regime and the permanent reduced tidal amplitude and habitat loss on foraging behaviour and numbers of waders, particularly Oystercatchers.

During the closure of the Tholense Gat in October 1984 the storm surge barrier was closed for three tidal cycles and only the upper parts of the intertidal area were exposed. Although the flats were exposed continuously, birds still showed a tidal pattern in foraging. The intake rate of Oystercatchers were very low as only Cockles *Cerastoderma edule* of less than 10 mm were available. When the birds could return to the musselbeds after they had been covered for six consecutive low water periods, the intake rate of Oystercatchers was not higher than before suggesting they are foraging at a maximum rate.

After the completion of the works the number of Oystercatchers in our study area increased as did the densities at low water. This increase is, however, not reflected in more social interactions between the individuals. The increase in density is also not evenly spread over the entire mudflat. The data clearly indicate that the increase is proportionally much higher in the marginal than in the optimal feeding areas. As the food supply did not change and birds seem to feed at their maximal

rate we hypothesize that the carrying capacity of the area, certainly for Oystercatchers, is reached and that any further disturbance (severe cold spell or human disturbance) could affect the population severely.

Feeding ecology of wintering Eiders *Somateria mollissima* and Common Scoters *Melanitta nigra* at the coast of the Baltic Sea of Schleswig-Holstein, BRD

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Eider and Common Scoter are the most abundant waterfowl species wintering in the Baltic Sea of Schleswig-Holstein. Their numbers have been estimated by regular aerial counts to be approximately 100 000 and 30 000 birds, respectively.

In the winters of 1987/88 145 Eiders and 175 Common Scoters, which had drowned in fishing nets of known position, were measured, weighed, and their age and sex was determined (by dissection). The contents of each oesophagus was analysed with regard to numerical presence and biomass (wet weight) of the food items. Frequently consumed species were the bivalves *Arctica islandica*, *Mya arenaria*, *Cerastoderma edule*, *Mytilus edulis*, *Astarte borealis*, *Mya truncata*, *Macoma baltica* and *Abra alba*, which were all measured in length and weight.

Preliminary results show that the composition of the species preyed upon depends mainly on the availability of specific food resources on different feeding grounds. On the contrary to this opportunistic behaviour Eiders and Common Scoters show an evident selection according to the size of prey.

Their choice of diet is discussed to be a result of intra- and interspecific competition as well as a foraging strategy regarding the energy content of the mussels very effectively.

Teal *Anas crecca* as a specialist on seeds in the early stage of vegetation succession: large scale implications of foraging conditions on concentration patterns of migratory ducks

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In the Netherlands during the past twenty years three periods of peak seed production important as food for Teal were noticed. In the mid 1970s the embanked mudflats of the former Lauwerzee provided enormous amounts of seeds of the plant species *Salicornia* and *Spergularia*. Around 1970 and again in 1988 foraging conditions were extremely good in Oostvaardersplassen - a fresh water marsh in the polder Southern Flevoland. In different cases 65 000-125 000 Teal were present compared to several thousands in other years.

Seed production and consumption was measured in the field revealing different depletion levels according to seed type, substrate and water depth. Trials with captive Teal were carried out to measure intake rate and preference in relation to seed profitability.

Feeding habits and exploitation of feeding areas by resting and wintering geese in southernmost Sweden

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Feeding habits and exploitation of feeding areas in agricultural districts of south Sweden by Greylag Geese were studied in late summer and autumn 1985-87, whereas resting and wintering Bean Geese, White-fronted Geese and Canada Geese were studied during 1977/78 - 1986/87.

Geese in south Sweden almost entirely exploited agricultural land. Greylag used grassland in summer changing in turn to peas when ripening and later after the harvest to wheat stubbles.

In the autumn Bean Geese and Canada Geese mainly fed on root crops, changing to autumn sown cereals with freeze up or when fields were ploughed, changing to grassland in spring. White-fronted Geese accompanying Bean Geese had the same field choice as this species but preferred autumn sown cereals and grassland when in larger homogenous flocks.

Exploitation rates for fields with different food types were calculated. Moreover, activity patterns were studied.

Feeding behaviours of an Indian Egret *Bulbulcus ibis*

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The shrinkage and pollution of water bodies and wetlands around Calcutta has resulted in the change of behaviour of feeding in the Common Indian Egret. There has been an extension of feeding hours from the early morning and evening to the middle of days with bright sunshine. The usual feeding sites provide inadequate supply of small fishes including shell-fishes to these birds. Consequently, there are lesser cases with termination of hunger. Among options these birds follow the soil movements made by the farmers in their fields. This provides small insects, mites, myriapods and earthworms to the birds and accepts these hurriedly. The presence of solitary birds in unusual puddles and fields during the day time clearly indicates a substantial drop in the catches of preys from the water bodies.

Feeding ecology of waterfowl in wetlands of Kashmir Himalaya

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In the western Himalaya a large number of diversified types of freshwater wetlands, spread all along the floodplains of River Jhelum and Sind at the base of Kashmir Himalaya (34°5' - 34°10'N 74°6' - 74°9'E and 1 580-1 600 m altitude), provide overwintering resorts to about 0.2 million migratory waterfowl (ducks, geese and rails migrating from their breeding grounds in the Palaearctic region, extending from north Europe to central Asia) and breeding grounds to a wide variety of other birds in summer. Information concerning food consumed by birds in sub-temperate wetlands of Kashmir is scarce. The present study aims at the elucidation of feeding ecology of nine species of wild ducks and geese and fourteen more

abundant species of summer breeding birds inhabiting the wetlands either temporarily or permanently. The data, collected 1975-1978, showed that plant foods (mostly seeds of macrophytes) comprised 90.5 - 99.1% of the diet of ducks while geese exhibited complete herbivory. *Polygonum* sp., *Cyperus serotinus*, *Scirpus lacustris*, *Carex* spp., *Sagittaria sagitifolia*, *Najas gramineae*, *Potamogeton crispus*, *Potamogeton lucens*, *Nymphoides peltata*, *Nymphaea* sp. and *Trapa natans*, besides *Oryza sativa* were estimated to be the potential duck food plants. Paddy grains, *Trapa natans* and vegetative parts of *Phragmites australis* were selectively preferred by Greylag Goose only. Besides macrophytes, high proportion of algae played an important role in the food intake of Coot and Wigeon. The summer breeding birds, both residents and summer migrants (migrating from the plains of India to the high altitude valley of Kashmir), were classified as carnivores, omnivores, insectivores and piscivores. The differences in the diet of watering live-stock are attributable mainly to the availability and abundance of food items, changing nutritional requirements and adaptive feeding behaviour of the birds. It is in view of the feeding ecology of waterfowl vis-a-vis the wetland ecosystems, the conservation of the wildlife resource is discussed in detail.

#### Status of waterfowl in Kashmir, India

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In the high altitude valley of Kashmir the natural freshwater biotopes, viz., the lakes and wetlands, featuring open water for some part and a rich source of potential food, provide overwintering resorts to about 0.2 million waterfowl, migrating from their breeding grounds in Palaearctic region extending from north Europe to central Asia, and breeding and nesting grounds to a host of other birds in summer. The small game birds (wild ducks, geese and rails) come to wetland reserves early in September and stay till the end of April depending upon the climatic conditions and the species behaviour. Hokarsar, Haigam, Mirgund, Shalabogh, and Kranchu, besides the littorals of Wullar and Anchar lakes, are among the important game reserves. The season from 15 September to 7 April, barring from the Wildlife Week from 1 to 7 October, is open for shooting and every year 4 322-8 013 wild ducks and geese are killed, out of which 50% account for Teal and Mallard together. These are under-estimates because more birds are killed illegally. Among the common waterfowl that inhabit the wetlands are Mallard *Anas platyrhynchos*, Common Teal *A. crecca*, Blue-winged Teal *A. discors*, Pintail *A. acuta*, Gadwall *A. strepera*, Wigeon *A. penelope*, Shoveler *A. clypeata*, Brahmany Duck *Casarca ferruginea*; Pochard *Aythya ferina*, rails, Coot *Fulica atra* and Greylag Goose *Anser anser*. Common Snipe *Gallinago gallinago* is also found in these wetlands most abundantly on Malgam.

The waterfowl concentrations in some protected wetlands such as Haigam and Hokarsar (27 000 in mid-December at Haigam and 124 000-142 000 in mid-November at Hokarsar) have developed due to the deterioration in the formerly important migration areas such as Mirgund, Kranchu, Malangpora, Narkora, Nowgam, Malgamm and Shalabogh and the littorals of Lake Wullar and Anchar (Pandit & Fotedar 1982; Pandit 1988). The carrying capacity of these socio-economically important wetlands for wildlife

resources has lately been greatly reduced, mainly as a result of accelerating human impacts that make the future bleak for waterfowl, which no longer breed in the wetlands of Kashmir now as they did before 1921 (Bates & Lowther 1952).

Waterfowl populations in the region are now subject to a number of threats either directly or through the deterioration of their habitats due to various ecological stresses, consisting in I) the receding of waterlevel and complete drying of temporary wet lands such as Nowgam, Mirgund, Malangpora and Shalabogh mainly through drainage, and subsequent reclamation of land for agricultural purposes; II) land clearing and land levelling for road building and housing developments; III) heavy siltation due to cannalizing of flood waters and also dumping of refuse and domestic garbage etc. Pollution represents a major threat to birds through contamination of the foodchain and the destruction of aquatic habitats; IV) change in vegetation cover as a result of heavy cattle grazing, harvesting of macrophytes and autumnal burning of residual vegetation; V) poaching and over-hunting of gamebirds, always harassing the bird populations to a great extent; and VI) the vagaries of weather, resulting either in recurring floods or drought exposing the fish and birds to vulnerable predation. Severe cold in winter and freezing of waterbodies causes mortality of many birds mainly due to nonavailability of food supplies.

Keeping in view the overall ecology of wetland reserves, a number of adaptive measures, under the Wildlife Restoration Programme, are suggested.

#### Effects of food abundance and population density on duck reproduction

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Studies on three duck species, Long-tailed Duck, Eider and Mallard have shown different types of density-dependent processes affecting duck reproduction. Small ducklings, catching their own food, are restricted to special types of food compared to more experienced and morphologically developed older birds. However, small and swift ducklings are able to use smaller and more abundant food items than grown and bulkier adults. The consequence is that egg-laying females and small ducklings, represent two separate energy demanding reproductive phases, may rely on different food bases occurring independent of each other.

On the Swedish west coast, where laying Eider hens depend on blue mussels in shallow water, mussel reduction through packing of ice in cold winters has severely affected reproduction. In a dense Mallard population egg size was reduced, indicating reduced quality and exhausted abundance of subaquatic hen food in foraging territories or heavy exploitation of available resources, which are not renewed during a laying season. In a diverse Mallard duckling foraging habitat, however, the abundance of emerged insects is renewed during an extended season. When nest predation is low in lemming years, large numbers of Long-tailed Duck ducklings reduce the available food stock of crustaceans resulting in increased duckling mortality. The declining duckling food source is available only during a short season and is not renewed.

Effects of grouping on foraging patch exploitation and dynamics in dabbling ducks

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Group foraging is common in many species of birds including waterfowl. The advantages of grouping have frequently been considered in studies of foraging ecology and behaviour but, excluding some wader species, possible costs associated with sociality have not received so much attention. This paper examines the effects of sociality on foraging patch exploitation and dynamics in dabbling ducks *Anas spp.*

As exemplified by the Teal *A. crecca*, feeding depth (i.e. the depth at which prey is captured from the water column) increases with the time spent foraging at an open water patch. This is reflected in the gradual switch in the use of foraging methods. In consequence, as foraging methods differ with respect to the time available for effective food straining, feeding rate of teals at the patch decreases. The greater the Teal group size, the more rapid the increase in feeding depth. Through these effects, grouping should shorten profitable patch residence time. This was, in fact, reflected in the dynamics of Teal groups at the patch.

The implications of the decrease in patch quality as described above for interspecific foraging interactions among dabbling ducks will be discussed.

Ecosystem research project planned on the North-eastern Wadden Sea

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An ecosystem research project on a large scale is planned in the North-eastern Wadden Sea. The project will deal with applied as well as with basic research. It is divided into two sections and will last 5 years.

The first project started this summer and will cover the whole Schleswig-Holstein Wadden Sea area. Concerning birds the main aims are monitoring of migratory species, monitoring of breeding birds and assessing the influence of disturbances on birds.

The second part will start in the beginning of 1990. It is restricted to the well defined German/Danish Wadden Sea area north of the Hindenburg-dam (the NE of Sylt) and south of the Romodam. The ornithological part will mainly cover the energy-requirements, the food-consumption and the position of the birds in the food web.

Both parts will be carried out by the WWF Wadden Sea Project in close cooperation with the Game Biology Station, Kalo, Denmark, the "Inselstation der Vogelwarte Helgoland" and the "Institut für Haustierkunde" of the Kiel University.



Food habits of some species of shorebirds of India

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The Great Vedaranyam swamp (10° 18' N; 79° 51' E) located on the bay of the Bengal Coast of Tamil Nadu, India, is one of the important wintering grounds for many species of migratory shorebirds (Charadrii) in India. The food habits of four common species of shorebirds such as Little Stint *Calidris minuta*, Curlew Sandpiper *Calidris testacea*, Marsh Sandpiper *Tringa stagnatilis* and Lesser Sandplover *Charadrius mongolus* were studied.

In total, 111 birds belonging to the four species mentioned were killed and analysed for their stomach contents. The most preferred food of *Calidris minuta* and *Charadrius mongolus* was *Chironomus* larvae whereas for *Calidris testacea* it was the polychaete *Ceratonereis costae* and for *Tringa stagnatilis* it was the amphipod *Grandierella sp.* Apart from the most preferred food items, the other prandial items collected from the stomach of all four species were aepsudes, artemia, bivalves, gastropods, pupae and larvae of ephydrid fly, ostracods, copepods, foraminiferans etc. Besides, algal matter, seeds, feathers, pebbles and sand were observed in their stomachs. It has been found that all four species studied were opportunists in their food preferences. Variations in the preference of feed items could be seen.

Among the four species the lowest diversity of food items was found in *Calidris testacea* and the highest in *Charadrius mongolus*. Niche breadth was narrowest in *Calidris testacea* and broadest in *Tringa stagnatilis*. The niche overlap was highest between *Calidris testacea* and *Charadrius mongolus* and lowest between *Charadrius mongolus* and *Tringa stagnatilis*.

Studies on the effects of disturbance in the Dutch Wadden Sea and Delta

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The Dutch Wadden Sea and Delta area are wetlands of very large importance to waders and other shorebird species. At the same time the areas are used for a variety of human activities, some of these disturbing large quantities of birds, either on the feeding grounds or on the high tide roosts. Studies on the effects of disturbance have focussed on recreation (including tidal flat walking as a sport, non-commercial lugworm digging, yachting, small aircrafts), military activities and fisheries. The results of these studies have generally been expressed as distances at which birds fly up or stop feeding. Such observations, however, give little insight into what has really happened to the birds which have been disturbed. Observations of birds displaying site fidelity to a specific feeding area show that they may stop feeding for some time to wait until the source of disturbance has gone. Cage experiments with Oystercatchers show that compensation for lost feeding time, at least to some extent, may be possible. For

birds not obviously displaying site fidelity it is much more difficult to evaluate the effects of disturbance. There are some indications that military shooting activities may lead to a lower diversity in the area where sound pressure is heaviest. This implies that in other areas bird densities will have to go up. Much work will have to be done to determine the effects of higher bird densities on food intake.

The fodder ration of the Black-tailed Godwit *Limosa limosa* in the Volyn Region, The Ukraine SSR

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The study of the fodder ration of the Black-tailed Godwit was carried out by means of an analysis of the capacity of 52 bird stomachs in the nesting period during 1954-62. Two stomachs were empty and were excluded of the analysis.

In the fodder ration of the Black-tailed Godwit the most frequent prey revealed was Chrysomelidae found in 31 stomachs (62%) in a quantity of 200 specimens. In between these 26 specimens of *Donacia sp.* were found in 5 stomachs (10%).

In 23 stomachs (46%) 156 specimens of *Tipula poludesa* (Diptera) were revealed and in 14 stomachs (28%) were 296 specimens.

Study of the feeding of the Lapwing *Vanellus vanellus* in a nesting period in the Western Ukraine

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A study of the feeding of the Lapwing during nesting time was carried out on the territory of the West Ukrainian Wooded in the Volyn region during 1953-62.

A total of 72 Lapwing stomachs were analysed. Eight of them were empty and omitted from the analysis.

In the fodder ration *Selatosomus aeneus* made up 62.2% found in 40 stomachs in a quantity of 394 specimens. In 39 stomachs (60.9%) there were *Tipulidae* in a quantity of 143 specimens. In 29 stomachs (45.4%) there was *Tobanidae* in a quantity of 114 specimens, and in 19 stomachs (29.6%) there was *Lepidoptera* in a quantity of 57 specimens.

The modern situation and the foods of Green Sandpiper *Tringa ochropus* and Wood Sandpiper *Tringa glareola* in Western Ukraine

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A study of the nesting of both kinds of Sandpipers in the Western Ukraine was carried out 1953-88. The diets during nesting were studied by means of investigation of stomachs from 1954 to 1962.

Green Sandpiper: During the last 35 years the number of pairs decreased from 320-350 to 140-170. In the regions of Lviv and Volyn it arrived in the second half of March - first half of April. The first layings appeared in

the beginning of May and chickens at the end of May - the beginning of June. The autumn migration started at the end of July and in August. The first case of wintering we know of on the river of Vereshchytsya (Lviv region) was registered on 23.01.1989.

Wood Sandpiper: During the last 35 years it has disappeared during the nesting period. From 1953 till 1962 approximately 100-120 pairs nested on the marshes of the Volyn Wooded district and of the Rivno region. After the intensive hydro-landreclamation in 1960-1970 only few pairs remained on the marshes of the Rivno region.

The nesting phenology and the migration of the Wood Sandpiper and the Green Sandpiper are alike. In 1970-1980 and in some years on significant flocks of vagrant Wood Sandpiper were seen at the end of May-June. There are non-breeding birds gathering in flocks of 12-40 specimens.

In 1981 and 1982 up to 1 000-1 400 of the vagrant Wood Sandpiper were seen in the Western Ukraine.

Wintering feeding ecology of Long-tailed Ducks *Clangula hyemalis* in the Gulf of Gdansk, Southern Baltic

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The feeding ecology of Long-tailed Ducks was studied in the Gulf of Gdansk during winter seasons, November-April, 1972-75, 134 food samples and 1986-88, 143 samples. Oesophageal and gizzard contents of the birds entangled and drowned in fishing nets were examined / volumetric percentages, frequency of occurrence. The number of food taxa consumed was at least 20. Long-tailed Ducks mainly fed on bivalves from which *Mya arenaria* and *Macoma baltica* were the most important, then *Cardium glaucum*, and the least important was *Mytilus edulis*. Fish, mostly *Ammodytidae* and fish eggs, were present in approximately every third sample. Crustaceans, polychaetes and gastropods constituted the remaining significant prey taxa. Plant food was incidental.

Differences in diet between age-sex groups of Long-tailed Ducks as well as monthly changes in prey importance was found. Possible factors responsible for it are as follows: temporal changes in age-sex ration of the wintering population of ducks; seasonal changes in prey availability; differences in foraging experience between young and adult birds; differences in body size and proportions influencing diving capabilities of males and females, and young and adults. Long-tailed Ducks showed clear dietary preferences, eating much of *Mya* and *Cardium*, the least numerous bivalves in the zoobenthos of the Gulf of Gdansk, and ignoring the very common blue mussel. Mean shell length of each of 4 bivalves consumed was very similar, approximately 10 mm, regardless of their different average size found in the zoobenthos.

Long-tailed Ducks function as first- to fourth-order carnivores in the food web, depending on which prey they eat. Due to their high number and long period of stay in the Gulf of Gdansk, Long-tailed Ducks consume a considerable biomass of the food. At least locally, they prey significantly on the certain age classes of the most important food taxa.

The importance of traditionally managed agricultural landscapes for waterfowl in Britain: implications for conservation

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Recent studies in Britain have demonstrated to an increasing extent the importance of traditionally managed farmland habitats for a wide variety of birds including waders and other waterfowl. Studies on the Scottish Outer Hebridean Islands, and the islands of Coll and Tiree, have shown that farming systems have evolved landscapes of international importance for breeding waterfowl.

Recent studies in widely separated areas of Scotland have investigated the processes involved in habitat selection by a variety of birds associated with such low-intensity agricultural land which include geese and other waterfowl. Of particular importance are mosaics of areas with differing management and structural characteristics. These different land-types provide a range of feeding and nesting opportunities.

Agriculture is rapidly changing in Britain: following decades of intensification with resultant habitat loss especially for waders, there are now moves to "set-aside" significant areas of farmland habitat. However, both intensification and lack of management would adversely effect the breeding waders and other waterfowl of these traditionally managed landscapes (although set-aside may bring benefits to other areas). The problems and opportunities that such changes present to conservation are reviewed.

The growth of the population of Dark-bellied Brent Geese *Branta b. bernicla* between 1955 and 1986

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The growth of the world population of Dark-bellied Brent Geese between 1955 and 1988 can be explained by an annual survival rate of 84.5% (for birds over 6 months old) and a pattern of breeding success which has been good (0.38 - 1.51 first-year birds per breeding adult the previous winter) once or twice in every 3 years. There is no evidence of density dependent factors operating in this population as yet. This result contrasts with 2 recent studies.

Unusual mass starvation of diving ducks in Switzerland in late winter 1986

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Between late February and the second half of March 1986, unusually high numbers of Pochard *Aythya ferina* and Tufted Duck *A. fuligula* died on the river Rhine, in a 40 km long section below Lake Constance. Some 1 500 dead birds

were counted, but total losses could only be estimated at >3 000 individuals. In mid-March, 3 000 Tufted Ducks and 800 Pochards were still present in the area. By comparing these counts with subsequent samples of dead birds we conclude that at least 40% of the Pochards and 20% of the Tufted Ducks died. The difference is significant. Both species depend of Zebra Mussels *Dreissena polymorpha*, whereas nearby concentrations of Goldeneyes *Bucephala clangula*, which mainly fed on Caddisfly larvae *Hydropsyche*, were not affected. In dabbling ducks and grebes no unusual mortality was observed.

Examination of the bodies showed that the birds had starved, but no signs of disease or contamination were found. We know from earlier research further upstream that mussel banks are depleted at this time of the year. The ducks apparently died from lack of food. The question arises why did they not simply leave the area as they do in other areas. February 1986 was unusually cold, with negative temperature deviation of 5.5-7°C from the long-term area. It seems that this late cold spell left the birds undecided what to do. They were probably reluctant to move southwards, since it was time to migrate towards their breeding grounds. Instead they decided to wait until it was too late.

Habitat selection and available food resources of wintering Velvet Scoter *Melanitta fusca* in Lithuanian coastal waters of the Baltic Sea

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The number of wintering Velvet Scoter in Lithuanian coastal waters of the Baltic Sea has been estimated at 14 000-16 000 birds. The single most important wintering site is in a restricted area along the 30 km seashore, holding an average 13 000 birds with the mean density of about 400 individuals per km<sup>2</sup> and the highest density up to 1 000 birds on the one km shoreline. Large seaduck aggregations are presumably caused by the convergence drift with transport of ground deposits of two opposite directions (along the coastline) and formation of the new branch littoral drift directed to the sea, exactly in this area. Dynamic mechanisms with transport of deposits localize seaduck prey. According to the data gathered in 1984-86, the region is the major spawning ground of the Baltic Herring and Baltic Sprat (10-15 larvae per m<sup>2</sup> and 30-50 larvae per m<sup>2</sup>, respectively) in the East Baltic area. The density of other prey is also great. We have detected *Nereis diversicolor* (up to 20 individuals per m<sup>2</sup>), *Macoma baltica* (25 specimens per m<sup>2</sup>), *Mya arenaria* (12 individuals per m<sup>2</sup>), *Mytilus edulis* (11 specimens per m<sup>2</sup>), *Neomysis integer* (520 per m<sup>2</sup>), *Crangon crangon* (32 per m<sup>2</sup>), the larvae of Baltic Cod (10-20 per m<sup>2</sup>) and the larvae of Plaice (20-25 per m<sup>2</sup>).

Night feeding in waterfowl

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Most animals are mainly diurnal, yet waterfowl species tend to be nocturnal: night feeding occurs frequently both in winter and summer according to schedules which vary from one situation to another. Several points must be

cleared up. On one hand, a preliminary inventory of those species which are nocturnal feeders, even occasionally, and mention be made of some of their main characteristics: systematic position, anatomy, feeding behaviour, trophic level, type of distribution when feeding. On the other hand, to isolate the environment variables when night feeding occurs: period of the year, geographical position, weather moon phase, disturbance (hunting, farming), type of habitat, availability of food resources. These two sets of data should help defining both internal and external conditions which lead to specific and/or temporary strategies when night feeding occurs. They allow an analysis of the evolutionary significance of this pattern.

Finally a few methodological points will be reviewed concerning the collection and analysis of nocturnal distribution and time-budget data.

#### Food of chicks of inland breeding waders in The Netherlands

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The food of chicks of Oystercatcher *Haematopus ostralegus*, Lapwing *Vanellus vanellus*, Godwit *Limosa limosa*, Redshank *Tringa totanus* and Ruff *Philomachus pugnax* breeding in meadows was studied by means of analysis of faeces.

Oystercatcher chicks, which are fed by their parents, eat predominantly *Tipulidae* larvae and *Lumbricidae*. Lapwing chicks mainly fed on invertebrates which live in or upon the soil, like *Lumbricidae*, *Garabidae* and *Stratiomidae* larvae. The food of Godwit chicks mainly consists of insects which live on the vegetation, e.g. *Curculionidae* and *Tenthredinoidea* larvae sawflies. The food of Redshank and Ruff chicks are more or less intermediate between Lapwing and Godwit.

For Lapwing and Godwit it was possible to analyse the relation between food and age, time and other environmental factors. Age and time seem to be important. Soil type, humidity and farming intensity are somewhat less important.

#### Breeding performance of the Great Crested Grebe *Podiceps cristatus* in three different breeding habitats on a fishfarm

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Breeding performance of Great Crested Grebes was studied from 1986 to 1988 at a fishfarm in Valkenswaard (S-Netherlands).

The fishfarm contained three different breeding habitat types which differed in vegetation structure, food supply and temporal changes of the environment. The mean number of breeding pairs and breeding success per fish-pond was influenced by fish-pond surface and average fish size.

The survival of young to independence differed significantly between habitats. Breeding pair density did not differ between the three habitat types.

#### Food stocks and food availability in relation to migratory movements of waterbirds

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Food is an important factor determining the number of birds an area can support outside the breeding season. Different examples of studies carried out recently, or still being in progress, point towards the important role that few species (both animal or plant) may have to attract waterbirds in key areas. Here they moult or fatten up on the way back or to the breeding areas. The importance of food quality and intake rate is stressed and determines largely the sequence of foods being taken. The occurrence of rich food situations under natural conditions is discussed. In single-source food situations the highest depletion levels occur among grazers and the lowest among pursuit divers. Intermediate levels occur among dabblers, rooters and stationary divers. These differences may be related to the time spent foraging per day which in turn seems a reflection of the costs for foraging.

Threshold levels dictating the lower limit to which birds can exploit the food supplies are commonly occurring. These thresholds limit the over-exploitation of the food source. They may vary between years according to the food supply and differ for birds of different social status.

#### Energetic requirements of growing wader chicks

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Chicks of Ruff *Philomachus pugnax*, Redshank *Tringa totanus*, Lapwing *Vanellus vanellus*, Black-tailed Godwit *Limosa limosa* and Curlew *Numenius arquata* differ widely in their hatching weight (about 15, 16, 18, 28 and 55 g respectively), maximum growth rate (about 5, 5, 7, 10 and 20 g/day, respectively) and asymptotic body mass (about 90, 130, 200, 275 and 900 g, respectively).

All these species breed in Dutch agricultural grasslands and their chicks have to find their own food. When ambient temperatures are low, the chicks are cooling rapidly while foraging. Therefore, the chicks are brooded frequently. The time the chicks spend being brooded is lost for feeding activities. The development of the thermoregulation of the chicks plays an important role in their time budgets in the fields.

Chicks of the five species were reared in captivity. When exposed at an ambient temperature of 10° C, chicks of these species can maintain their body temperature after 7, 7, 15, 6 and 4 days, respectively. Although the chicks of Ruff and Redshank are slightly smaller compared to Lapwing, they reach the homeothermic stage at an earlier age. Measurements on metabolic rates showed an elevation of 50% for Ruff and Redshank compared to Lapwing. Differences in body insulation were relatively small.





From these data on metabolic rates, food intake and growth rates, combined with litterature data on digestibility and costs of tissue synthesis, an energy budget can be made for growing chicks in the laboratory. These budgets can give us an idea of the number of insects that need to be caught dialy by the chicks, when growing in the field.

#### Kleptoparasitism amongst waders

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Reviewing the literature ten years ago, Brockman and Barnard (1979) found records of seven species of waders which had been the victims of food robbery by other birds, and only one record of waders being the kleptoparasite. This list (Table 1) can now be extended by a further seven species of victims and twelve kleptoparasites, as indicated below.

Table 1. Haematopodidae, Charadriidae and Scolopacidae in which kleptoparasitism observed (based on personal observations unless otherwise stated)

Kleptoparasite	Victim (source or place observed)
A) Wader as both victim and pirate	
Oystercatcher	Oystercatcher (Goss-Custard and Durell 1987)
Oystercatcher	Curlew (A = Ens et al. 1990 in press)
Curlew	Curlew (A)
Whimbrel	Grey Plover (South Africa, A.P. Martin pers. comm.)
Lapwing	Turnstone (B = grass field in Kent)
Grey Plover	Turnstone (B)
Grey Plover	Dunlin (Warnock 1989)
Willet	Marbled Godwit (sandy beach in California)
Redshank	Dunlin (B)
Turnstone	Turnstone (Metcalf 1984)
Turnstone	Redshank (B)
Turnstone	Ringed Plover (B)
Turnstone	Dunlin (B)
Ringed Plover	Sanderling (C = sandy beach in Outer Hebrides)
Ringed Plover	Ringed Plover (C)
Sanderling	Ringed Plover (C)
Dunlin	Ringed Plover (B)
Dunlin	Dunlin* (Payne & Howe 1976)
Purple Sandpiper	Ringed Plover (C)
B) Wader as victim only	
Herring Gull	Curlew (A)
Common Gull	Curlew (A)
Black-headed Gull	Curlew (A)
Black-headed Gull	Avocet (Loire Atlantique, S. Bouche pers. comm.)
Black-headed Gull	Grey Plover (B)
Black-headed Gull	Redshank (B)
Black-headed Gull	Turnstone (B)
Black-headed Gull	Snipe (B)
Black-headed Gull	Dunlin (B)
Black-headed Gull	Ringed Plover (B)

\* Overlooked by Brockman & Barnard

No cases have been observed of waders kleptoparasiting species in families other than

those listed above. Kleptoparasitism by waders seems to be opportunistic, occurring most often at times when birds are crowded together - for example by the rising tide. Nonetheless, some Oystercatchers, Turnstones and Sanderlings obtain a substantial part of their food by robbing other waders at certain times of the year.

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#### Conservation biology of Kentish Plover *Charadrius alexandrinus* in Hungary

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A study of the status and breeding biology of Kentish Plover was started in 1988, and here some results of the first year are presented. Kentish Plover breeds both on alkaline grasslands and on bottom of lakes in Hungary. The vegetation is very scarce in both types of habitats. The hatching success was 45.3%, the most important predators were mammals. There is no significant morphological difference between the sexes. The parental behaviour of sexes seems to be different during both incubation and the attendance of young. The possible causes of endangered situation of Kentish Plover is discussed.

#### The spring migration of the Little Stint through a coastal wetland in Israel

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In 1989 the spring migration of waders and other waterfowl has been studied in an artificial fishpond complex, on the Mediterranean coast of Israel, between Haifa and Tel Aviv. In this paper the timing and turnover of migrating Little Stints is described.

Between 17 March and 3 June, all the waders were counted approximately twice a week. A total of 194 Little Stints were marked individually. Every counting day, and, as far as possible, between counting days observations were made to determine the number of individuals still present in the study area.

Immigration and emigration were calculated based on the method described by Kersten and Smit, 1984.

On 17 March a population of 265 Little Stints was already present in the study area. This population probably consisted of birds which have wintered here. The departure rate of this population is very low with some birds still present at the end of May. In the second half of March there is a small influx of birds which leave the study area in the beginning of April (average duration of their stay 9.7 days). In April total numbers are increasing rapidly with a peak number of 800 birds in the beginning of May. On 3 June almost every Little Stint has left. During this period there are three influxes of birds even in May, when total numbers are decreasing. From the end of April the emigration rate is increasing gradually with a peak around 20 May. After this date emigration rate drops steeply. Average duration of its stay of immigrants declines from the beginning of April towards the end of May (from 24.3 to 10.1 days).

The total number of birds which used the study area was about 1 600, twice as high as the maximum number counted on one day.



#### POSTERS

##### Supplanting from foraging sites among Coots *Fulica atra*

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When individuals forage in groups there is an opportunity for some of them to pay attention to the activities of the others, so that they can acquire information about the foraging success of some members of the group, and consequently about the best feeding sites. When foraging during the non-breeding season, the less efficient members in groups of Coots "parasitized" the discoveries of the more efficient members. This was facilitated because, after each foraging dive, coots usually bring the food plants to the water surface to eat them there, what can be used by other individuals as a cue about the quality of a foraging site. Once a Coot was spotted feeding in a good site by another individual, the last one approached the forager by adopting a "shield-showing" posture, and then performing a "charging-attack", which was effective in supplanting the forager from the feeding site. Supplanted birds foraged less efficiently immediately after having been supplanted. Apparently, supplanters did not forage with increased efficiency by supplanting conspecifics. As the more efficient birds should be more frequently supplanted, this would create a situation in which the ration supplanter/supplanted at each wetland should be frequency-dependent.

##### Towards an Estuarine Nature Conservation Strategy for Britain: The Nature Conservancy Council's Estuarine Review

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Estuaries and their fauna and flora are a scarce natural resource. Britain has many estuaries around its coast, and many are nationally and internationally important for their migrant and wintering waders and wildfowl populations. Man has long used estuaries for many purposes, and whilst many of them do not damage, or can benefit, estuarine wildlife, some for example waterbased recreation, and barrages schemes are increasing in scale or frequency and are causing considerable concern. Despite their wildlife importance and the international agreements such as the "Ramsar Convention" and the EC Directive on Wild Birds, loss and damage to important estuaries still occurs. To help seek ways of effectively conserving Britain's remaining estuarine resource, the Nature Conservancy Council - the UK government's statutory advisors on nature conservation - have begun an Estuaries Review. The first phase of this review will produce a report that will summarise the nature conservation importance of all 150 estuarine sites in Britain and how each of man's activities affects it. This report will form the basis for developing an overall strategy for estuarine conservation in Britain. The work of the Estuaries Review and some of its findings will be presented.

##### Winter distribution of Nearctic shorebirds on the coast of South America

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The major "wintering" areas used by Nearctic shorebirds on the coast of South America were identified by a series of aerial surveys carried out in January/February between 1982 to 1986. Over 2.9 million shorebirds were counted during the surveys which covered some 28 000 km of the coastline of the continent, including all areas thought to contain significant habitat for shorebirds. Important wintering areas were found on the north coast of South America, especially in the Guianas on the southern Atlantic coastline, especially in southern Brazil and on the coastlines of Patagonia and Tierra del Fuego, and along the beaches of the Pacific coast.

The surveys demonstrated that major proportions of a species were usually concentrated into a limited number of sites. This finding, with similar results from other internationally coordinated survey schemes in Canada and the U.S.A. on migration areas, has led directly to a conservation initiative to set up a Western Hemisphere Shorebird Reserve Network, which would protect all the key areas throughout the migration ranges of the birds. Maintaining the integrity of the entire network of critically important sites will be essential if conservation is to be successful.

Moulting Shelducks *Tadorna tadorna* along the German Coast

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The German Wadden Sea is the principal moulting area of the north-west European Shelduck population. Numbers and distribution of moulting Shelducks were mapped by aerial surveys during high and low tide in 1988. Highest numbers were reached in early August when 180 000 Shelducks occurred on the mudflats north and south of the river Elbe. The turnover rate seems to be small, but in total about 200 000 Shelducks moult in that area. The biggest concentrations stay around Trischen (100 000) and Scharhorn (40 000), whereas in the Knechtsand area, which held the highest number in the fifties and sixties, only small numbers (10 000) were found.

There is a marked difference in the tidal rhythm of moulting and non-moulting birds. Before and after moult the Shelducks stay closer to the shore, feeding on low tide on *Hydrobia* and algae on the mudflats and resting on or close to the saltmarsh. Flightless birds stay far away from the shore, resting at low tide in the gullies and feeding on rising and ebbing tide on bivalves (*Macoma* and small *Cerastoderma*). On high tide they rest again in large flocks on the water.

Weights and duration of stays of Ruffs *Philomachus pugnax* during spring migration: some data from Italy

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Ruffs forming roosts in northern Italy between late February and late March show a wide range of weights, some of them being very low as a direct consequence of non-stop flights from the wintering grounds.

Dye-marking allowed to assess that some birds return to our study-roost for 20 days or more, and this fact can explain the records of higher weight values inside our sample. Dye-marked birds were sighted also in regular feeding areas located at some distance from the roost (av. distance: 26 km).

No correlation between weights and data was observed among ringed birds. This fact might suggest the existence of a gradual turn-over of migrants, with new birds balancing the leaving ones. Biometrics didn't reveal the passage of different populations during the whole month.

Shell dropping by Herring Gull *Larus argentatus*

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Herring Gulls are known as feeding opportunists using different techniques in order to obtain certain food items: shell-dropping is a rare one. During a field trip to the Wadden Sea island of Baltrum we observed Herring Gulls foraging on mussels *Mytilus edulis* by dropping them from an appointed height. Mainly adult gulls searched for those bivalves that washed ashore and ignored those growing on a nearby stonedike. Subadults and juveniles used the

mussels attached to the dike by swallowing them completely. Thus a definite prey choice for one foraging patch over another occurred in the adult gulls although both prey patches were available to them simultaneously. The adults dropped the mussels onto a stony ground from a lower height than onto a sandy ground. By optimizing the dropping behaviour they required less attempts to be successful than younger birds. Especially large and barnacle-free shells were dropped. Experiments with caged birds supported our observations concerning size-selection in free-living gulls.

Purple Sandpiper *Calidris maritima* wintering north of the Arctic Circle

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Seven samples of Purple Sandpipers were cannon-netted in north Norway during early November 1988. There were differences in age and sex structure between localities. The overall bias towards males was believed to be due to the females being elsewhere rather than there being greater mortality among females. Adult birds were heavier than first-year birds.

The information on mass and the fact that many birds were still moulting (especially males) suggests that Purple Sandpipers wintering in north Norway are not physiologically stressed. The population is thought to be wholly or mainly composed of birds which breed in the U.S.S.R.

Breeding and habitat selection patterns by Painted Storks *Mycteria leucocephala* in Delhi Zoological Park Heronies

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Painted Storks, one of the most common stork species of Indian sub-continent, have been regularly breeding in the natural heronies of Delhi Zoological Park since 1960. Surveys around Delhi suggest that these are perhaps the only major breeding grounds for Painted Storks in this area. Several species of cormorants and herons (occasionally White Ibis also) breed here as well.

This field study spans the period between storks' arrival in August 1988 to their departure around June 1989. Populations were classified into 3 age groups: juveniles (<2 mo), sub-adults (2-5 mo) and adults. Individuals in each category were counted monthly. Total populations reached an apex during November-December after which they gradually declined. However, proportions of specific age groups always varied, in a way suggestive of two distinct breeding cycles.

The number of successful nests were considered with respect to height, tree species, number of surrounding nests and general direction. A significant proportion of nests were found on *Prosopis* trees neat water, 2-10 m from ground level.

This study and subsequent ones on Delhi Zoo Painted Storks will form a base for research on natal site fidelity, habitat selection and community ecology - hitherto scantily understood aspects in Indian birds. For the immediate future some field studies are being planned to study breeding success, mortality factors, time budgets or parental birds in storks as well as resource partitioning in the overall heronies.