7th Symposium on Limnology and Aquatic Birds

The Aquatic Birds Working Group of the International Society of Limnology (SIL)








Held at Kristianstad Biosphere Reserve, Naturum 15th-17th August 2012

In association with Kristianstad University

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Photographs on title page by Sven-Erik MAGNUSSON

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Preliminary symposium program:

Time	15 August	16 August	17 August	18 August	19 August
9:00 – 9:20	Registration	Dessborn	Skoruppa et al.	Field trip 1	Field trip 2
9:20 – 9:40	Naturum presentation		Suhonen & Nummi		
9:40 – 10:00	Kerekes	Mineev & Mineev	Elmberg		
10:00 – 10:20		Sammalkorpi et al.	Symposium summary		
10:20 – 11:00	Coffee break				
11:00 – 11:20	Brochet	Nummi et al. (habitat use)	Workshop		
11:20 – 11:40		Horváth et al.			
11:40 – 12:00	Nakamura et al.	Nilsson			
12:00 – 12:20	Kameda et al.	Takekawa et al.			
12:20 – 13:40	Lunch				
13:40 – 14:00	Englund	Clausen	Boat trip on Vattenriket	Field trip 1	Field trip 2
14:00 – 14:20					
14:20 – 14:40	Kloskowski & Trembaczowski	Cronert			
14:40 – 15:00	Coffe Break				
15:00 – 15:40	Sjöberg	Eriksson			
15:40 – 16:00	Walk through Biosphere reserve	Milberg et al.			
16:00 – 17:00	Poster session at Kristianstad University				
19:00		Conference dinner			

Presentations:

Plenary Presentations:

Authors	**Country**	**Title**
Arzel C.	Finland	*Feeding behaviour and habitat selection in ducks*
Brochét A.-L.	France	*Waterbirds as vectors of seeds and invertebrates*
Clausen P.	Denmark	*Interplays between eutrophication, vegetation, invertebrates, fish and waterbirds - lessons learnt from manipulated brackish lagoons and freshwater lakes in Denmark*
Englund G.	Sweden	*Interactions between fish and and breeding waterbirds*
Kerekes, J.	Canada	The background of the formation of the Aquatic Birds Working Group of the Societas Internationalis Limnologiae (SIL)

Oral presentations:

Authors	**Country**	**Title**
Cronert	Sweden	Birds and limnology – challenges concerning the wetlands in Kristianstads Vattenrike Biospere Reserve
Eriksson	Sweden	Fish communities and water chemistry in freshwater lakes used by Black-throated Loon (*Gavia arctica*) and Red-throated Loon (*Gavia stellata*) for foraging.
Horváth et al.	Hungary	European soda pans as important stopover sites for migratory waterbirds – the keystone role of fairy shrimps (Brachiopoda: Anostraca) and microcrustacean zooplankton
Kameda et al.	Japan	Ecosystem function, ecosystem services, and conflicts with people by nutrient transportation mediated by the Great Cormorant in freshwater areas
Kloskowski & Trembaczowski	Poland	Trophic ecology and nutrient allocation to reproduction in red-necked grebes breeding on fishless and fish-stocked ponds: insights from stable-isotope and conventional dietary analyses
Milberg et al.	Sweden	Inter- and intra-annual variation in the number of autumn feeding ducks in Lake Tåkern, southern Sweden

Mineev & Mineev	Russia	Waterfowl distribution between pond types in the Malozemelskaya tundra (Nenet autonomous district, Russia)
Nakamura et al.	Japan	Rapid and Delayed effects of Nitrogen and Phosphorus from Waterfowl Migration in a bird sanctuary pond
Nilsson	Sweden	South Swedish lakes as staging areas for different waterbird species during the early part of autumn migration
Nummi et al.	Finland	Determinants of habitat use of duck broods in a boreal landscape
Sammalkorpi	Finland	Interactions between lake productivity, fish, and aquatic birds in Finland
Sjöberg	Sweden	Bird-fish associations at a river and its estuary in northern Sweden
Skoruppa et al.	USA	Body Condition Indices of Redheads (*Aythya americana)* and Salinity Regimes of Wintering Areas along the Gulf of Mexico, USA
Suhonen & Nummi	Finland	Whole-community facilitation by the beaver: ecosystem engineer increases waterbird diversity through habitat modification
Takekawa et al.	USA	Macroinvertebrate colonization and avian community response following restoration of salt ponds in northern San Francisco Bay, California, USA

Poster presentations:

Authors	Country	Title
Amano et al.	Japan	Dispersal of bloom-forming cyanobacteria by waterbirds: Retention time of *Microcystis aeruginosa* in the digestive tract of ducks and its growth ability afterwards
Bagheri & Hedayati	Iran	Study of effect of some physicochemical factors (temperature & salinity) on ability of cyst hatching of *Artemia urmiana*
Batanero et al.	Spain	Testing the effects of guanotrophication by flamingos on the microbial community
Bhattarai	Bhutan	Conservation of Limnological attributes for critical survival of endangered wetland species of birds in Bhutan Himalayas – a case of Black necked crane (*Grus nigricolis*)
Etezadifar et al.	Iran	Effects of Invasive Black Rat (*Rattus rattus*) on the Breeding Success of Waterbirds in Hara Biosphere Reserve, Persian Gulf
Gunnarsson et al.	Sweden	Within-season trends in natal orgin, body size, and influenza a virus subtypes in migrating mallards
Kovács et al.	Hungary	Waterbird assemblage response to human disturbance in a freshwater shallow lake environment (Lake Balaton, Hungary)
Nummi et al.	Finland	Fish-duck interactions in boreal lakes: Observations and an experimental test
Prusty	India	Breeding colonies of water birds in the catchment of Keoladeo National Park, India: Multidimensional conflicts for water
Urfi	India	Ecology and conservation of aquatic birds in India: An overview
Quadros et al.	India	Importance of conserving wetlands as a habitat for birds as observed at Uran a coastal town in Maharashtra, India
Smith et al.	Australia	The effect of salinity on the distribution of waterbirds in wetlands of an Australian coastal floodplain: implications for wetland restoration and management
Wood et al.	UK	Using an individual-based model to manage a swan grazing conflict

PLENARY TALKS

Foraging behaviour of ducks and habitat selection

Céline ARZEL

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Most dabbling ducks (Tribe Anatini) which are breeding in Fenno-scandia are migrating from southern European or Northern African wintering locations. Dabbling ducks usually forage in shallow wetlands. They face different habitat and food type across their annual cycle. Dabbling ducks are globally generalists which allow them to adjust to these changes in habitat and food resource along their flyway.

Foraging activity of dabbling ducks have been extensively studied on the wintering ground. Less is known concerning the staging / breeding ground despite the fact that conditions encountered at that period of the year are likely to affect the breeding output of birds. Diurnal foraging activity seems to increase drastically in spring, when nocturnal foraging remains relatively stable. Ducks are thus supposed to meet the increase in energy requirements due to migration and preparation to subsequent reproduction by increasing the time allocated to foraging on a daily basis. In particular female Anatinae generally obtain protein and calcium for egg production from exogenous sources through intensive foraging during the laying stage. Females are thus generally foraging more intensively than males, when the latter generally increase the time allocated to vigilance, probably as a strategy to maintain their pair bound and increase survival chance of the pair.

Similarly food diet studies are mainly available during the hunting period, i.e. autumn to early spring. Nevertheless a switch in diet seems to occur in spring. Our knowledge on duck diet is limited. There is a general bias in the studies depending on the part of the digestive tract that has been analysed: oesophagus versus gizzard for example, data from the latter are generally biased toward foods with slower rates of digestion (invertebrates versus seeds). Nevertheless macroinvertebrates are considered to account for a high proportion of the diet in summer, when seeds and plant material make up most of the diet the rest of the year. Insects, particularly larvae and nymphs of aquatic species in the orders Diptera, Coleoptera, Odonata, and Trichoptera, are the principal animal foods consumed by nesting females. The diet of ducklings is globally unknown even if their behaviour tends to prove that they rely mainly on emerging and terrestrial invertebrates during their first stage to globally switch to food items located deeper in the water column as they grow.

Reproduction in birds is generally timed so that the breeding cycle is generally thought to coincide with maximum availability of food for nesting adults or developing young. Food availability to birds can vary widely within and between years, however, with major implications to reproductive success. Recruitment among waterfowl is supposed to be particularly sensitive to the quantity and quality of food resources available. Nevertheless results of study are contradictory concerning the

food availability at the time of ducklings hatching. Peak of invertebrates seem to occur in the richest wetlands but not in the oligotrophic ones. Nevertheless emerging and terrestrial insects seem to be the major diet of ducklings during their first week of life.

Within the dabbling duck group there is some markedly different behaviour between species. Coevolved patterns of habitat use and morphology set general limits on the potential food resources available to each waterfowl species. Therefore differences in foraging strategies likely allow birds to coexist at place where the food resource could be a limiting factor.

Waterbirds as vectors of seeds and invertebrates

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The role of waterbirds in aquatic organism dispersal between wetlands has long been recognized. These birds are indeed abundant, widely distributed across wetlands and highly mobile at local and continental scales. We studied the consequences of duck movements for seed and invertebrate dispersal at the scale of a wintering quarter (the Camargue) and of a continent (Europe), and we quantified these dispersal events. For seed transport by teal (*Anas crecca*), for example, we experimentally showed that an average of 27% of ingested seeds are later collected while still being viable in the faeces. In the field, we observed 9 and 6% of teal to carry at least one viable propagule internally or externally, respectively. Although the likelihood for one bird to disperse one propagule at a given point in time is low, such probabilities potentially get important when considering the hundreds of thousands of ducks which move daily between wetlands. This therefore suggests that ducks do play an important role in the dispersal of many aquatic organisms. In the current context of habitat fragmentation, climate change and invasive introduced species, taking dispersal into account becomes an issue of great importance for management and habitat conservation.

Interplays between eutrophication, vegetation, invertebrates, fish and waterbirds – lessons learned from manipulated brackish lagoons and freshwater lakes in Denmark.

Preben CLAUSEN

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Danish inland freshwater and coastal brackish wetland habitats have since the 1970s been subject to elevated eutrophication resulting from their positioning in a densely and increasingly populated landscape with likewise increasingly intensified agriculture as the single most important land-use activity. This unfortunate combination has led to elevated phosphorus and nitrogen outlets in most Danish wetlands from the tiniest streams, through major river catchments and associated lakes, out to coastal inlets, estuaries, bays, and even more open sea areas. Problems with unicellular and macro-algae blooms, oxygen depletion, and their associated losses of rooted populations of submerged aquatic vegetation (SAV) and bottom-dwelling invertebrates, have been a widespread phenomenon throughout the country. Although some species of herbivorous birds have been able to switch to macro-algae as alternative food sources, and some carnivorous species may have been benefitted by increasing populations of filter-feeding organisms in areas where eutrophication levels where beneficial rather than detrimental to benthic organisms, more avian species have lost favored feeding habitats through this human influence. In this talk I will take the audience through a presentation of the development in Ringkøbing Fjord, a coastal lagoon under severe human influence, where a unique series of data back to the beginning of the 19th century gives strong evidence of cascadal effects of eutrophication hammering through several trophic levels – a development that unfortunately seems to have been mirrored in several other previously important staging areas for waterbirds in Denmark. In the second part I will look into restoration efforts through national actions plans on the aquatic environment – both through reductions of P- and N-outputs to the wetlands, and through wetlands restoration and manipulation. Here the focal study site will be Maribosøerne, a lake-system that have been changed into the single-most important freshwater body for breeding and staging waterbirds through dedicated restoration activity over the past 15 years, but we will also look into some other examples of successful restoration efforts.

What are the effects of fish on duck populations – really?

Göran ENGLUND

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There are ample correlative and experimental evidence that fish can have negative effects on abundance and reproductive success of ducks. In this talk I will discuss the generality of this pattern. How does interaction strength vary between different species of ducks? Does it depend on fish species composition? To what extent are negative effects of fish modified by environmental factors?

I will also discuss the possible effects of fish on the spatial distribution of ducks. How can we extrapolate the results from studies in individual lakes to whole landscapes. How much of variation in local abundance and breeding success of ducks can be attributed to effects of fish and how much is caused by variation in other environmental factors? The answer to the latter question obviously depends on the distribution of fish in the landscape and the degree of habitat overlap between the two groups. My discussion will be based on a review of the literature and our data from Northern Sweden.

The Aquatic Birds Working Group of Societas Internationalis Limnologiae (SIL) is twenty years old.

Joseph KEREKES

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During the SIL Congress in Munich, Germany in 1989, a small group of participants get together and realized that waterbirds can be treated in a limnological context. This led to an *ad hoc* Symposium, "Aquatic Birds in the Trophic Web of Lakes"(Sackville, New Brunswick, Canada, 1991). The proceedings of this symposium were published. The outstanding success of this symposium led to the formation of the Aquatic Birds Working Group during the XXV SIL Congress in Barcelona, Spain, in 1992.

The main objective of the Aquatic Birds Working Group is to integrate waterbirds into hydrobiology and treat waterbird studies in a limnological context. To achieve this goal, the Working Group organizes conferences, since 1994, to facilitate communications among limnologists interested in aquatic birds and ornithologists interested in the aquatic habitat. These conferences (proceedings published) are held at least once every three years between SIL Congresses During the SIL Congresses sessions and/or workshops devoted to waterbirds are held.

ORAL PRESENTATIONS

European soda pans as important stopover sites for migratory waterbirds – the keystone role of fairy shrimps (Brachiopoda: Anostraca) and microcrustacean zooplankton

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The Carpathian Basin, with its diverse aquatic habitats, has a major role in the migration routes of many waterbirds, meaning important stopover sites for several species. It has been well-known for a long time that astatic soda pans on the lowlands attract many species in high numbers during migration, which is presumably attributable to the high invertebrate food biomass of these habitats. During the early spring migration, anostracans are the main constituents of the macroinvertebrate fauna of the pans. Apart from them, only mezozooplankton is available in significant numbers. Therefore, we tested the connection between the abundance of fairy shrimps and their waterbird predators on these pans on large scale, together with the possible effects of other invertebrate prey types to assess their role in shaping waterbird communities. 83 natural and semi-natural astatic soda pans in the Carpathian Basin were chosen for this study, which more or less mean all the relatively undisturbed representatives of this habit type in Europe. Of them, 46 are located in Hungary, 29 in Austria (Seewinkel) and 8 in Serbia (Vojvodina), The pans were all visited between 4th March and 9th April 2010. We aimed to identify the main factors in the distribution and densities of waterbirds that are known to be at least occasional consumers of anostracans. We analysed the effect of the abiotic characteristics of the pans (e.g. area, water depth, catchment, ratio of open water), together with the invertebrate food sources present in the water (anostracans, microcrustaceans, chironomids, heteropterans). Only six environmental variables proved to be significant in the constructed RDA model. Variance partitioning of the data revealed that aquatic invertebrate food (*Arctodiaptomus*, *Daphnia***,** Anostraca) has a much higher importance than other variables (water depth, open water ratio, ratio of natural habitats in the catchment area). Avocets (*Recurvirostra avosetta*) and northern shovelers (*Anas clypeata*) differed from all the other species as they showed high association with Anostraca and *Arctodiaptomus* densities. Among them, avocets were more dependent on *Arctodiaptomus* density and biomass, while in the case of shovelers, the biomass of the two invertebrate groups had more similar effect,

and anostracan prey density was much more important than *Arctodiaptomus* density. Due to the significance of fairy shrimps and microcrustaceans in the trophic web of soda pans, especially of the most frequent *Branchinecta orientalis* and *Arctodiaptomus* species, owing to their role in structuring waterbird assemblages on the pans during the spring migration, they can be regarded as keystone elements of this habitat.

Ecosystem function, ecosystem services, and conflicts with people by nutrient transportation mediated by the Great Cormorant in freshwater areas

Kayoko O. KAMEDA, Hiroaki FUJII, Atsushi MAKINO, Satoru HOBARA, Keisuke KOBA, Takashi OSONO, Satomi FUJIWARA, and Atsushi TAKAYANAGI

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Aquatic birds are “mobile links” (Lundberg and Moberg 2003) that connect aquatic habitats with terrestrial ones by transporting nutrients in their excreta. For example, nutrient subsidies by seabirds often contribute to the sustainability of terrestrial communities and ecosystems of nutrient-poor oceanic islands.

However, the surplus nutrients transported by aquatic birds sometimes have negative influences on nutrient dynamics and vegetation in the nutrient-rich areas, such as forests. Moreover, nutrient runoff from the colonies of the aquatic birds causes eutrophication of water bodies next to the colonies. These problems usually occur in freshwater areas, because many people live near freshwater areas and use various resources from them. Human disturbances are also severe in freshwater areas. In addition to indirect effects on aquatic birds, such as the degradation of habitats, direct effects, such as capture or removal, affect the population and distribution of aquatic birds in freshwater areas. On the other hand, aquatic birds sometimes establish a symbiotic relationship with people through the nutrient transportation in some areas. In the past, local people collected guano of aquatic birds for a fertilizer, and maintained the colonies for sustainable use of guano. In contrast to the occasional and short-term relationships between seabirds and people in oceanic areas, aquatic birds and people have had continuous and long-term relationships in freshwater or coastal areas. This made it possible for people to enjoy ecosystem services from the aquatic birds for a long time.

The Great Cormorant, *Phalacrocorax carbo hanedae*, is the only cormorant species that mainly inhabits inland areas of Japan. They transport nutrients from foraging areas to the forests they colonized. They damage the forest vegetation and change the nutrient dynamics of the forests, and sometimes cause eutrophication of ponds next to the colonized forests. People feel that these effects are not favorable and try to remove the cormorants from the colonized forests. On the other hand, there were several colonies existing for more than one hundred years without removal of the cormorants. Such colonies were located in shrine or temple forests, homestead woodlands, or Satoyama forests (the forests used for collecting daily resources) with high anthropogenic disturbances. In these forests, local people often collected guano from the forest floor and maintained the forest to persuade the cormorants to stay.

In this study, I clarify previous studies about the ecosystem functions and ecosystem services of the great cormorant as a nutrient transporter in freshwater ecosystems. I also describe present problems caused by nutrient supply by the cormorants and try to investigate the factors determining the positive (ecosystem services) or negative (conflicts with people) effects of the nutrient transportation mediated by the cormorants.

The studies were conducted on Chikubu Island and Isaki Peninsula in Lake Biwa, Shiga Prefecture, and Unoyama in Mihama Town, Aichi Prefecture, both of which are located in the central part of Honshu Island in Japan. In Lake Biwa, rapid increase of the cormorants from the 1980's caused damage to the forest vegetation and freshwater fisheries. In Mihama Town, the Unoyama colony had been maintained for more than one hundred years by local residents, in order to collect guano as a fertilizer. After the end of guano collecting, the trees were damaged and the cormorants disappeared from the study area in 1970. Then, the succession of the forests advanced and the cormorants re-colonized the forest in 1990.

Our previous research showed that the cormorants supply large amount of nitrogen and phosphorous to the forests. The soluble character of nitrogen and the accumulative character of phosphorous changed the nutrient balance of the colonial forests. Nitrogen supply by the cormorants also affected the nitrogen decomposition process in a forest for a long time. On the other hand, the cormorants decreased canopy coverage in the short-term by collecting foliage for nest materials. Therefore, the damage to the trees tended to be affected by the breeding activities in a short time, whereas nutrient supply affected long-term changes of nutrient dynamics in a forest floor.

The ecosystem service by the nutrient transportation mediated by the cormorants was the guano supply to the local residents in the Unoyama colony. The people maintained the colony by removing surplus nutrients and planting pine trees. On Chikubu Island, I did not find records of guano collecting in the cormorant's colonies, although local residents also used and maintained the forest. Chikubu Island is recognized as a historical, religious, and sightseeing place. Thus, the scenic value would be more important than Unoyama. A more detailed study would be needed, but at least the different value of each forest might explain the differences of the relationships between the cormorants and people.

Trophic ecology and nutrient allocation to reproduction in red-necked grebes breeding on fishless and fish-stocked ponds: insights from stable-isotope and conventional dietary analyses

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The trophic rank and reproductive success of waterbirds may strongly depend on the presence and size-structure of fish. In central and eastern Europe red-necked grebes *(Podiceps grisegena)* breed primarily on fish ponds, where fish are exploited by birds but may also suppress grebes' alternative food resources. We assessed the sources of nutrients allocated to clutch formation and potential differences in trophic position and feeding ecology during the period prior to egg laying between grebes nesting on fishless ponds and ponds densely stocked with common carp *(Cyprinus carpio)*. We combined stable isotope analyses of tissues of grebes and their potential prey with conventional methods of diet estimation. Strong enrichment of ^{13}C and ^{34}S in the feathers and pectoral muscles of birds arriving at the ponds in spring indicated that the grebes had wintered in marine habitats. The comparatively lower $\square^{13}C$ and $\square^{34}S$ values of egg components and tissues of freshly-hatched chicks were similar to those of grebe prey on the breeding grounds, indicating that nutrients for egg formation were acquired locally. Observations of foraging grebes indicated the prevalence of fish in the diet of birds on ponds containing carp, while grebes on fishless ponds fed mainly on adult amphibians. Analyses of grebe alimentary tracts revealed the dietary importance of aquatic insects during the pre-laying period on both types of ponds, especially adult *Donacia* beetles, apparently picked from emergent vegetation. Due to the opportunistic feeding habits of grebes, which use diverse food sources from different trophic levels, including prey items of both terrestrial and aquatic origin obtained by diving or taken above the water surface, dietary information from stable isotope values was limited. Fish importance for grebes' pre-laying nutrition was substantiated by the higher trophic position of adult grebes nesting on fish-dominated ponds compared to ponds without fish, in terms of ^{15}N enrichment in albumen, yolk and natal down of hatchlings. Combining different approaches provided information on the trophic role and foraging patterns of grebes that would not have been apparent if only a single method was used to infer feeding ecology.

Inter- and intra-annual variation in the number of autumn feeding ducks in Lake Tåkern, southern Sweden.

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ABSTRACT: We analysed data from a 23-year period of standardised counts of waterfowl at eutrophic Lake Tåkern, southern Sweden. The biomass of submerged macrophytes was a major force affecting the assemblage of birds using this lake for feeding in the autumn, with high biomass leading to peak numbers for most bird species, except piscivors. Counts, conducted in August, September and October, showed that submerged macrophyte abundance also explained the shift in composition during the autumn. The results are discussed in relation to the availability of stop-over sites during migration.

Waterfowl distribution between pond types in the Malozemelskaya tundra (Nenets autonomous district, Russia)

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Investigations were carried out (1973-2005) in the Malozemelskaya tundra of Nenets autonomous district of Arkhangelskaya region. In different orographic areas of tundra ponds were calculated and their characteristics were described according to scheme: area, configuration, depth, acidity of water, overgrowing of coastline and area of water by vegetation (bushes, sedges and aquatic vegetation). When we registered birds we ascertained character of their staying on the ponds. It is discovered within the bounds of homogeneous flat territory there are series of thermokarst formation of different ages. In hilly and hilly-ridge landscape are predominating lakes of glacial and glacial-accumulative origin. Salted Kolokolkova bay, fresh Korovinskaya bay and rivers with sizeable length within area of the Malozemelskaya tundra were examined. From these heterogeneous habitats on the investigated territory waterfowl (registered 41 species, 25 from them breeds) prefer different types of lakes (71,6 % of registrations). On these ponds Long-tailed Duck, Common Scooter, Black-throated Diver and Tufted Duck predominate; subdominants are Greater Scaup, Bean Goose and Wigeon. The most populated by species are thermokarst lakes (23 species). There were registered on glacial lakes - 17, on glacial-accumulative – 14, oxbow lakes - 20 and on lagoon lakes - 16 waterfowl species. On the salt Kolokolkova bay (20 species registered) and its coast dominants are: Bean Goose, Barnacle Goose and Greater White-fronted Goose, Red-breasted Merganser and Common Scooter; subdominants are: King Eider and Greater Scaup. On the fresh Korovinskaya bay (19 species registered) in summer period predominates Greater Scaup, Bewickii Swan and Long-tailed Duck, and subdominants are King Eider and Goldeneye. General number of waterfowl inhabiting watercourses is counts 23 species. The greater diversity of waterfowl species is registered on rivers Neruta (22) and Velt (21) and in Pechora River Delta (17 species) also. Species composition dominants of river habitats in summer period are richer than on lakes. Dominants on the river watercourse are Black-throated and Red-throated Divers, Bean Goose, Wigeon, Greater Scaup, Long-tailed Duck and Goldeneye, subdominants are Greater White-fronted Goose, European Teal and Common Scooter.

Rapid and Delayed effects of Nitrogen and Phosphorus from Waterfowl Migration in a bird sanctuary pond

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Anseriformes (geese, swans, and wild ducks) are typical migrating waterfowl that visit Japan every winter. Most Anseriformes are herbivorous and tend to feed in paddy fields in Japan. Thus, it had been considered that they play a role in the eutrophication at their roosting places. Indeed, many studies reported nitrogen (N) and phosphorous (P) concentrations in roosting pond were increasing during winter season. Especially, previous studies showed that total phosphorous concentration in the pond remains at high level several months after geese had daparted from pond. These results indicate that the effect of Anseriformes on water quality is occurred immediately in their duration of stay in pond. Whereas, the effect of Anseriformes on water quality is occurred at a slow rate after they have flown away. In this study, we study rapid and delayed effects from Anseriformes on each of N and P roosting pond water. In addition, we conducted year-round research to examine stability of delayed effect.

The study was carried out in Tsubasa pond in Yonago Waterbird Sanctuary that is home to many Anseriformes, and

it is the largest place for wintering tundra swans (*Cygnus columbianus*) in western Japan. The Sanctuary locates in Tottori Prefecture, Japan (35°26” N, 133°172” E), and it was constructed after partial reclamation on Lake Nakaumi in 1994. The number of waterfowl was counted to identify their species. The observations were performed two to four times in a month from March 1999 to September 2000. The total waterfowl weight (TWW) in each observation was calculated from the number of birds and the average weight of each species. Previous studies have shown that avian excretion amount is proportional to the body weight, therefore, the excretion was evaluated from TWW values. Water samples were collected from the surface of the pond. In this study, total nitrogen (TN) and total phosphorus (TP), which seasonal changes showed positive correlation with seasonal change of TWW, was defined as rapid effect from Anseriformes.

Correlation coefficient between the seasonal changes of TN or TP and seasonal change of TWW was calculated, and the following results were obtained. The seasonal change of TN showed the same tendency with TWW, thus they exhibited a significant positive correlation in our observation ($r=0.74$ $p=0.0003$). The seasonal change of TP increased gradually during wintering season of Anseriformes, however the peak of TP was detected just after migratory Anseriformes flew away. The delayed increase of TP concentration continued until late May that corresponds to two months after Anseriformes flew away. Furthermore, TP did not show a significant positive correlation with TWW ($r=0.44$ $p=0.06$), suggesting that TP is affected with delayed increase from Anseriformes than rapid one. Detail analysis showed that TN, exhibited significant positive correlations with TWW from just to two months after Anseriformes flew away. By contrast, no significant positive correlations between TP and TWW was observed at just after Anseriformes flew away and the TP showed significant positive correlations with TWW from one to three months Anseriformes flew away. Consequently, these observations suggest that TN is affected with both rapid and delayed increases from Anseriformes, but TP is only effect of delayed increase from Anseriformes. These might be caused by following reasons. First, Anseriformes is mainly excreted as unine (uric acid) that is easy to dissolve in the pond water. Second, P mainly excreted as feces needs a decomposition process time to dissolve in the pond water. Decomposition activity of feces was inhibited during wintering season of Anseriformes. Then, feces are decomposed with the rise of water temperature and regenerated into the water just after Anseriformes flew away (in early spring). Although we are trying to survey about the decomposition mechanism for Anseriformes excretion in the pond, our investigations can demonstrate that there are different effects of Anseriformes migration on increases of N and P in a roosting pond.

South Swedish lakes as staging areas for different waterbird species during the early part of autumn migration.

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Many lakes in south Sweden are important as staging areas for a number of waterbird species both during autumn and spring migration, some lakes in the southern part of the country are also used for wintering during mild winters. The staging waterbird populations of some of these lakes has been annually monitored since 1973 (some even longer), when an annual September count of waterbirds was started in Sweden as a part of the waterbird monitoring program to cover those populations that leave the country during the winter and are not covered by the International Midwinter Counts in Sweden.

Annual national indices based on the September counts have shown marked fluctuations between years but some species have shown significant trends since the start of the September counts, including decreasing trends for *Anas crecca, A platyrhynchos, Bucephala clangula, Cygnus olor, Fulica atra* and *Podiceps cristatus*, whereas *Anas penelope* showed a significantly increasing trend. Another species showing a marked increase was *Anas strepera* although the counts during the first years were too low to allow the calculation of annual indices. Other species such as *Aythya fuligula* and *Mergus merganser* showed marked annual fluctuations without a trend. In *Fulica atra* there was a marked initial decline related to a crash in the population during a hard winter followed by some recovery and then fluctuations around a lower level.

The fluctuations and trends in the waterbird counts for some long time-series from some lakes are analyzed against the background of the national pattern as elucidated by the September indices. The counts from individual lakes showed a marked variation between different years both for the total waterbird counts and for individual species. To a large extent the variation in waterbird counts for individual lakes could be related to different states of the lakes, with high waterbird counts of several species during years with clear water and a rich submerged vegetation in contrast to years with turbid water and reduced submerse vegetation.

In several cases the counts of individual species on some lakes showed a marked variation between different years without any relations to the state of the lake as discussed above. This pattern was typical for *Aythya ferina*, which could be found in large flocks on some lakes for one or a few years, being nearly absent in some years.

Determinants of habitat use of duck broods in a boreal landscape

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We studied the habitat use of broods of four common boreal duck species. We focused on habitat structure (lake size and vegetation luxuriance) as well as on food (two size classes of emerging insects and aquatic invertebrates). Both habitat structure and food resources affected the habitat use of duck broods, but their importance varied between species. For ducklings of the Common Goldeneye (*Bucephala glangula*), a diving duck, food – aquatic invertebrates and large emerging insects – were the most important factors affecting habitat use. In contrast, the habitat use of the Eurasian Wigeon (*Anas penelope*) was merely influenced by habitat structure. For the Common Teal (*A. crecca*) and the Mallard (*A. platyrhynchos*), both food and habitat structure were important. The most important factor for the Teal was emerging dipterans accompanied by habitat structure; in Mallard, the habitat structure and large emerging insects were equally important. The varying requirements of various duck species should be taken into account in wetland management.

Interactions between lake productivity, fish, and aquatic birds in Finland

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We estimated the biomass of breeding water birds (Gavidaea, Podicipedidae and Anatidae) and average species specific individual biomass in 85 lakes of different trophic and conservation status. The lakes were from <1 to >1 000 ha in area, had from 6 to 500 µg L^{-1} in total phosphorus (TP) concentration, and their fish populations ranged from non-existent to a high density of cyprinids (CPUE of Nordic multimesh gillnets > 5 kg/net, fish biomass removed > 200 kg ha^{-1}). The waterfowl biomass varied from < 0.2 kg ha^{-1} to > 10 kg ha^{-1}. The frequency of waterfowl breeding decreased by surface area of forest lakes, but many small eutrophic lakes had high waterfowl densities. When the fish community was not dominated by benthivorous cyprinids, especially Roach *Rutilus rutilus*, Bream *Abramis brama* or Crucian carp *Carassius carassius*, and in fishless habitats, the waterfowl biomass was related to TP of water. The highest biomasses were found in former wastewater ponds. In small oligotrophic or mesotrophic forest lakes the presence of Perch *Perca fluviatilis* had a modest impact on the breeding density of waterfowl and the especially density of Goldeneye *Bucephala clangula*. This species could have almost equally high densities or biomasses both in the oligotrophic and hypertrophic edge of the phosphorus gradient of the lakes. The highest biomasses of diving ducks were found in eutrophic ponds in which also Tufted duck *Aythya fuligula* and Slavonian grece *Podiceps auritus* were present. The biomass of piscivorous birds also varied only moderately in the TP range. However, in oligotrophic lakes the species was the Black throated loon *Gavia arctica* while in eutrophic lakes it was mainly the Great crested grebe *Podiceps cristatus*. In dabbling ducks Mallard *Anas platyrhynchos* and Teal *A. crecca* were the generalists and the biomass of dabbling ducks increased with higher TP and higher number of species.

The differences in density of breeding waterfowl between lakes of similar trophic category were related to fish. A higher density of cyprinids probably increased resource competition and decreased the amount of submerged vegetation. Thus, management of eutrophic lakes by fish removal to control fish density would be beneficial especially for non-piscivorous aquatic birds. Food web management does not exclude the piscivorous birds from lakes since recruitment of the target species is effective in eutrophic lakes, and even the moderate biomass of fish in oligotrophic lakes sustains the low biomass of piscivorous birds.

Bird-fish associations at a river and its estuary in northern Sweden

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The study reviews of how fish-eating birds relate to their prey items in the lower section and estuary of a mid-sized river in northern Sweden. Depending on the size of the bird species, time of arrival and brood rearing season, they use fish of specific size and ages and which are either migrating upstream for spawning, or migrating downstream to the sea. The early- arriving goosander (*Mergus merganser*) for example can utilize the river lamprey (*Lampetra fluviatilis*) as food as soon as the rapids in the river are free of ice. This fish is abundant in the rapids and of suitable size as prey item for the goosander, which allows the goosander to start breeding early. When the ducklings are hatched, they have access to a variety of prey items of suitable size, for example sculpins (*Cottus gobio*) which are commonly distributed in running waters, or they can select upstream migrating three-spined sticklebacks (*Gasterosteus aculeatus*), or downstream migrating whitefish (*Coregonus lavaretus*) and grayling (*Thymallus thymallus*) of the year class 0+. The smaller red-breasted merganser (*Mergus serrator*) arrives later during the spring, at a time when the three-spined stickleback comes in large numbers to shallow bays in the estuary of the river, and when the peak in upstream migration occurs. The red-breasted merganser, which more commonly breeds along the coast, hatches their broods when the resources of suitably-sized food items is increasing in the sea, but decreasing in the river. In attrition, birds breeding along the coast utilize the food resources in the river, for example terns (*Sterna hirundo and S. paradisaea*), but also different species of gulls. Particularly during the spawning period of the river lamprey in the beginning of June, there is a constant flow of gulls coming from the coastal area to catch lamprey, which are especially accessible to gulls after spawning, when the lampreys die and drift down the river. The mergansers preference among available prey species, as well as the capacity of the predator to catch a given prey item varies with the behaviour of the prey species when they meet a predator, is discussed in relation to salmon (*Salmo salar*) and brown trout (*S.trutta*) parr.

Body Condition Indices of Redheads (*Aythya americana)* and Salinity Regimes of Wintering Areas along the Gulf of Mexico, USA

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Redheads (*Aythya americana*) concentrate annually in traditional wintering areas along the Texas and Louisiana coasts of the Gulf of Mexico: Chandeleur Sound (Louisiana), Redfish Bay (Texas), upper Laguna Madre/Baffin Bay complex (Texas), and lower Laguna Madre (Texas). Chandeleur Sound salinities typically range from 20-30 ppt, and the salinity of Redfish Bay normally approximates 32 ppt. Hypersalinity often prevails in the Laguna Madre; during this study, salinities in the upper Laguna Madre/Baffin Bay complex were 45-59 ppt, and in the lower Laguna Madre, which receives fresh water from agricultural drainages, salinities tended to be more moderate (about 34-36 ppt). Redheads from all of these traditional wintering areas subsist entirely on marine foods, which consistently are rhizomes of shoalgrass (*Halodule wrightii)* and associated small marine mollusks. Redheads in the Chandeleur Sound of Louisiana very seldom used fresh water, whereas redheads in Redfish Bay and the upper Laguna Madre/Baffin Bay fly regularly to coastal ponds to drink water to offset ingestion of salt in their foods. Redheads from the lower Laguna Madre of Texas have access to freshwater inflow from drainage outlets and can also fly to coastal freshwater ponds.

We collected a total of 399 redheads from these four areas during the winters of 1988-1990. Ingesta-free body mass, whole skin mass (along with associated fat deposits), and flight and leg muscle masses were used as indices of body condition and compared among the four different wintering areas. Body mass and whole skin mass were significantly greater in birds from Louisiana and Redfish Bay; where offshore salinities were lowest. Flight muscle mass was significantly greatest in birds from the upper Laguna Madre/Baffin Bay and Redfish Bay locations, from where birds had to fly to inland coastal ponds to obtain drinking water. Leg muscles weighed the most in birds wintering in Louisiana, where shoalgrass occurred in patches intermixed with other seagrass species, rather than in extensive, monospecific beds of shoalgrass, as in Texas. The only site for which birds showed no significant over-winter increases in any of the four condition indices which we measured was the upper Laguna Madre/Baffin Bay complex, where salinity was highest during the study. These patterns of variation in condition indices of redheads reflect the effects of prevailing salinity regimes and the birds' need to access fresh water to meet the demands of osmoregulation. These factors must be considered in understanding the basic ecology and bioenergetics of birds of inland salt lakes and wetlands and marine and estuarine environments.

Whole-community facilitation by the beaver: ecosystem engineer increases waterbird diversity through habitat modification

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Wetlands are rich in biodiversity, but globally threatened. Recently, beavers have returned to many Holarctic areas after a long regional extinction and are now restoring wetlands. The beaver is peculiar in that it has a substantial impact on the communities of other species. We studied the facilitative effect of the North American beaver *Castor canadensis* on a waterbird community of seven species of waders and ducks in boreal ponds. The study took place in southern Finland in 1988–2009. Ducks and waders were surveyed four times during each breeding season. In the course of the study, natural experiments were created as beavers caused disturbance by flooding 14 forest ponds. For each flooded pond, one non-flooded pond was selected as a control. All seven species of the study increased in numbers during the first two years of beaver flooding. Changes were negligible in the control ponds. The number of waterbird species per pond per year was higher during beaver inundation than before beaver activity, as was the waterbird abundance per survey. The teal *Anas crecca* and green sandpiper *Tringa ochropus* showed numerically the most positive response to flooding. The mallard *A. platyrhynchos* and wigeon *A. penelope* were new species entering the duck guild in the beaver-affected wetland patches. The beaver acted as a whole-community facilitator for waterbirds by modifying the habitat to a more productive and structurally favorable state. In the restoration of degraded wetlands, the promotion of beavers could be a worthwhile tool.

Macroinvertebrate colonization and avian community response following restoration of salt ponds in northern San Francisco Bay, California, USA

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The Napa-Sonoma Marshes Wildlife Area is located in the northern reach of San Francisco Bay, California, USA and comprises more than 6,000 ha of former salt evaporation ponds that have been restored and breached to tidal action. In November 2008, we initiated a study to examine macroinvertebrate colonization and waterbird response to breaching of Ponds 9 and 10 along the Napa River. Because the ponds were formerly used to make salt, the bottoms of the ponds were covered with a salt crust, thus no benthic macroinvertebrates were initially present. However, we found that benthic macroinvertebrates were colonizing the site within seven months following restoration of tidal flows (May 2009). The earliest colonizers were Cumacea, Amphipoda, Polychaeta, Oligochaeta and Diptera larvae that collectively comprised 72% of all individuals. By the spring of 2010, macroinvertebrates in the restoration site were more abundant than in the reference sites in the adjacent river. Cumacea, a detritivore, was detected at a mean peak density of 23,631/m^2 in the restored site in July 2010, and in the same month densities in the reference sites were much lower with <1,500/m^2. The higher Cumacea abundance in the restoration site may be related to high organic matter deposition following restoration as the older terrestrial plants were inundated and decomposed. We then used historical surveys of reference sites and the project area to examine avifaunal changes. No ducks and a monthly mean of <250 shorebirds were counted during the winter in the units prior to restoration from 2006-2008, and all observations were of non-foraging birds. Following restoration breaching, we observed an immediate numerical response by >1,000 waterbirds, and within three years, the mean monthly number of birds observed during the winter increased to >2,000 waterbirds. On high tides, dabbling and diving ducks increased as did small and large shorebirds to a lesser extent, and on low tides, small shorebirds and diving ducks greatly increased. Our study indicated that both macroinvertebrates and waterbirds responded quickly to salt pond restoration, and macroinvertebrate densities in these newly formed habitats exceeded those in reference areas.

POSTER PRESENTATIONS

Dispersal of bloom-forming cyanobacteria by waterbirds: Retention time of Microcystis aeruginosa in the digestive tract of ducks and its growth ability afterwards

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Dispersal of the water-bloom-forming cyanobacteria *Microcystis aeruginosa* is an important issue for ecology, and also for human and animal health because of its severe toxicity. Passive dispersal of such cyanobacteria and algae occurs by water currents, wind, and animals (birds, mammals, and insects). Especially waterbirds have long been considered a major disperser of aquatic organisms, transporting them in their guts (endozoochory or internal dispersal) or attached to their bodies (ectozoochory or external dispersal). As an example of external dispersal, *M. aeruginosa* was cultured from the feet and feathers of ducks (Schlichting 1960). In some early studies, a few viable cells of algae and cyanobacteria were shown to be present as well in the lower digestive tract or caecum of waterbirds (Proctor 1959, Schlichting 1960). Nonetheless, most evidence for such dispersal by waterbirds is anecdotal, and detailed quantitative investigations are very scarce.

We conducted feeding experiments using mallard ducks to provide the first detailed information on the internal dispersal of *M. aeruginosa* by waterbirds. All ducks excreted cells of *M. aeruginosa* after having been force-fed them. The cells seemed intact and displayed auto-fluorescence when observed through a fluorescence microscope. The quantity of *Microcystis* cells in the feces peaked on average 2 hours after feeding, and they were detected until 24 hours after feeding. 16S rDNA of *M. aeruginosa* was detected in duck feces until 8 days after feeding. Cultures from single *Microcystis* cells isolated from feces were established; 1.59% of the cells excreted 2 hours after feeding increased in number. Up until 4 hours after feeding, cultures started from 20-30 cells could succeed. Cultures of diluted feces all failed; furthermore, the longer the retention time in the gut, the lower the survival rate over 10 days.

These results suggest that *M. aeruginosa* can survive passage through the intestinal tract of mallard ducks and maintain a proliferative capacity when retained for up to 4 hours, at least, in the gut. Because mallards fly at a speed of 78 km/h (Clausen et al. 2002), our study suggests that mallards can contribute to the passive dispersal of *M. aeruginosa* within a radius of at least 300 km in one step. Our study is the first report demonstrating a capacity for the internal dispersal (endozoochory) of *M. aeruginosa* by waterbirds.

This study was supported by the Environment Research and Technology Development Fund (D-0905) of the Ministry of the Environment, Japan.

Study of effect of some physicochemical factors (temperature & salinity) on ability of cyst hatching of *Artemia urmiana*

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Artemia is one of the most important live foods for aquatic creatures and is essential for larva stage of many species of fish. One of the usual ways of using Artemia is hatching of cyst and if this hatching occurred with high percentage, production of Artemia and then Aquatic creature will be increase and eventually human protein requirement will be provided. In this examination , we study the effect of three level of temperature (25,30,35 ◦c) and three level of salinity (25,30,35 ppt) with together in three time (24, 26,28 h) after hydration on percentage of cyst hatching of *Artemia urmiana* for determining optimum of salinity and temperature on ability of hatching cyst of *Artemia urmiana* . Totality we had 9 factors with 27 repetition (3 repetition for every factors). The results indicates that effect of salinity in this experiment has not any significant variance in all of the factors. ($p > 0.05$)But temperature is more effective on hatching and has significant variance in factors . ($p<0.05$)The high percentage of hatching observed in temperature of 30 ◦c and salinity of 35 ppt, but in statistics result, temperature of 30◦c in all salinity has high percentage of hatching.The low percentage of hatching observed in temperature of 25◦c and salinity of 25ppt but in statistics result temperature of 25◦c in all salinity has low percentage of hatching. So, temperature appeared to be more effective for hatching than salinity and percentage of hatching has shown to be increased by time, and high percentage of hatching appeared 28 hours after hydration in 30 C and 35 ppt.

Testing the effects of guanotrophication by flamingos on the microbial community

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Policies of wetland conservation have promoted increases in densities of some waterbird species. These increases have been linked to macronutrient loadings and, consequently, chlorophyll *a* blooms due to bird faeces. This process is termed guanotrophication and has been poorly studied at the microbial level. We performed two experiments to assess the direct effects of guano addition on the microbial community of a saline wetland. Bioassays were performed using water from Fuente de Piedra lagoon in southern Spain. Fuente de Piedra is an athalassohaline lagoon which houses one of most important colonies of breeding greater flamingos (*Phoenicopterus ruber*) in the Western Mediterranean. This lagoon presents strong changes as a fuction of the annual hydrological budget, with salinities that oscillate from less than 20 to more than 200 g l^{-1}. Hydrological cycles consist of a filling phase during autumn and winter and an evaporation phase during late spring and summer. Nutrient concentrations in the water follow this pattern, with concentrations, increasing by up to 3 times more during the evaporation phase. The density of flamingos increases from spring to the autumn ranging from 12 to more than 50,000 individuals. The experiments were performed in these two well-contrasted scenarios: first (A) during the filling phase with low flamingo density and second (B) during the evaporation phase and a high flamingo density. Each experiment consists of three treatments using water from the lagoon and sterilized samples of flamingo faeces: Control (no faeces addition), Medium (faeces addition simulating natural loadings) and High (faeces addition simulating x 5 and x 3 times the natural loadings). From each experiment we took samples for prokaryotic abundance and production and virus abundance every 12h during 5 days. Prokaryotic activity increased in response to fecal addition only in the experiment with water from the filling phase and low flamingo density. The stimulus in prokaryotic activity increased as the guano addition was higher. In contrast, the activity of prokaryotes did not show any difference among treatments in the experiment performed during the high flamingo density and evaporation phase. Phosphorous was the only nutrient which showed a significant decrease the period of incubation in all treatments in both experiments. This result was attributed to the high N: P ratio present in the lagoon in both hydrological phases, underlining an extreme P-limitation of the microbial community.

Conservation of Limnological attributes for critical survival of endangered wetland species of birds in Bhutan Himalayas – a case of Black necked crane (*Grus nigricolis*)

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Bhutan, a small kingdom in the Himalayas is known today by a unique philosophy of Gross National Happiness (GNH). One of the pillars of the GNH is the environment conservation which is greatly accomplished by its large areas of protected natural reserves and overall constitutional commitment of maintaining 60% of forest cover at all times. With over 30% of the revenue dependent on the hydropower, the conservation of watersheds, wetlands and river ecosystems within the natural reserves and in the inhabited areas of the country is of paramount importance for this fragile and rugged mountainous country.

Of several small wetlands at varied altitudes of the country, the Phobjikha valley at an elevation of 2600m have extensive marsh, with many small watercourses and an abundant growth of grasses and herbaceous plants. The shallow freshwater marsh in the valley's bottom is surrounded by heavily grazed bamboo scrub and cultivated land adjacent hillsides. The meandering river that feeds the wetlands at the vicinity of its course is rich in flora and fauna including several poorly documented species of phyto- and zooplankton that are found in the small pools and stagnant water bodies. This panoramic valley hosts, as a wintering habitat, an endangered species of black-necked crane (*Grus nigricollis*), and a large celebrity bird in Bhutan. It is found in greater numbers in Tibet, China and several Indian Himalayan regions, east and west of Bhutan. About 500 species of this large bird visits few valleys in Bhutan including Phobjikha where the number is slowly but steadily increasing from around 100 in early nineties to above 300 today. This success story is greatly owing to very effective conservation policy of the Kingdom of Bhutan. A very popular tourist site, Bhutan has identified this valley for eco-tourism for its high-end tourists with a crane festival among other activities. In recent times, their bird is reported from several new locations in the country. This sporadic movements is still not clearly understood.

In this paper an attempt is made to highlight the success of Bhutan's effort in protecting this and other similar wetlands, for not just hosting this and other wetland birds including critically endangered White-bellied Heron (*Ardea insignis*) and water fowls, but also ensure the supply of much needed freshwater and in doing so protect the wetland as well as semi-aquatic flora and fauna. Along with the Black necked crane, the list of other birds that are observed in this wetland are enlisted. The diversity of the plankton that helps to enrich the wetlands will also be presented along with physico-chemical parameters that contribute to plankton productivity. Finally an attempt is made to correlate the choice and preference of these and perhaps some other birds for overwintering and seemingly thriving in the rich habitat.

However on the face of developing and changing Bhutan, the social and cultural influence of the community living in the valley as well as increasing number of tourists shall be reported to forecast the future of these birds in the valley and other parts of Bhutan.

Effects of Invasive Black Rat (*Rattus rattus*) on the Breeding Success of Waterbirds in Hara Biosphere Reserve, Persian Gulf

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The effects of invasive species and habitat destruction are among the most serious threats to global biodiversity. Black Rat (*Rattus rattus*) is among the most widespread and damaging invasive mammalian species in the world, known to cause significant ecological damage to animal species. We studied the effects of invasive Black Rat on the breeding success of two main colonial breeding waterbirds (Western Reef Heron *Egretta gularis* and Great Egret *Egretta alba*) in Hara Biosphere Reserve Persian Gulf during 2008-2009 breeding seasons. Breeding success was estimated before and after Black Rat eradication. We also compared breeding success between habitats in which Black rats were eradicated with those habitats that Black Rats were present. Findings showed effects of Black Rats on the breeding success of Western Reef Heron and Great Egret suggesting significant increase after rat eradication at the sample islands. Measures are presented for management of rat in order to prevention of further effects on colonial breeding waterbirds in the area.

Within-season trends in natal orgin, body size, and influenza A virus subtypes in migrating mallards

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In the northern hemisphere, the Mallard *Anas platyrhynchos* is probably the most important reservoir for the influenza A virus. Notably high prevalence rates have been found in Mallards before and during the autumn migration, which is rather prolonged in the species. It has been suggested repeatedly that the influenza A virus is brought from the breeding grounds in the north on an annual basis and later transmitted to conspecifics during subsequent staging during autumn migration. Accordingly, a better knowledge of the natal origin of autumn staging ducks is crucial to understand the spatial and temporal dynamics of the influenza A virus. Located in southeast Sweden about halfway downstream the Northwest European flyway is Ottenby, an important staging site used by a vast number of waterfowl each autumn. From 1962 to 2009, Mallards were trapped at Ottenby to be measured (wing, tarsus, bill-head; 2004-2009), and sampled for influenza A virus infection (2004 and 2005). In addition, a piece of an unmoulted tail feather was collected from 252 juveniles Mallards (2004 and 2005) for isotope analysis (deuterium). Samples positive for the influenza A virus were subtyped to explore possible links to the natal areas. The latter were determined by a novel approach combining ringing recovery data (from 924 Mallards ringed in Ottenby from 1962 to 2009) and isotopic (deuterium) measurements of feathers grown on breeding grounds. The results show that the main breeding areas of the Mallards passing Ottenby in autumn are in Estonia, southern and central Finland, and northwestern Russia. However, there was a significant temporal trend within the season, with less distant Mallards caught in early autumn (August to September) and more distant ducks caught in mid-October to early December. Mallards in early autumn were bigger (males: tarsus, bill-head, wing; females: tarsus) than those caught in late autumn, possibly reflecting different subpopulations. In total, 16 subtypes of the influenza A virus were found in 2004 (most common were H1N1 [33%] and H1N2 [10%]) and 22 in 2005 (most common were H4N6 [20%], H1N1 [13%], and H3N8 [10%]). Interestingly, there was a

temporal pattern of subtype diversity, reflected by the fact that most subtypes were unique for early and late autumn periods; only two subtypes were found in both early and late autumn periods in 2004 (H1N1 and H4N6) and 2005 (H3N8 and H5N3), respectively. Acknowledging that these different patterns were based in part upon different samples, a likely interpretation worth further testing is that the early arriving birds, which were bigger and with more proximate origins, have different influenza A subtypes than the more distantly originating and smaller late autumn birds. If true, this provides novel insight into the origins and transmission of the influenza A virus among migratory hosts previously unavailable through traditional approaches.

Waterbird assemblage response to human disturbance in a freshwater shallow lake environment (Lake Balaton, Hungary)

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Lake Balaton is the largest freshwater shallow lake in Central Europe with a surface covering approximately 600 km^2. Its formerly continuous, now largely fragmented wetland habitats (fishponds, marshes) were once parts of Lake Balaton. Their present area coverage is less than 3% of the lake. The whole area is one of the most important waterbird breeding and wintering sites in the Carpathian Basin. The southern shore is for the most part an artificial shore area frequented by tourists mostly during the summer period. For this reason the coverage of semi-natural habitats is small. Most of the shoreline consists of man-made embankments. Areas with littoral vegetation and larger, continuous reedbeds can be found in a few shore sections only.

Systematic long term monitoring has been carried out since 2003 to follow the waterbird population trends and changes in community structure.

Due to the human disturbance, including tourism, and the lack of semi-natural habitats, Lake Balaton is less significant as nesting area in the breeding season. It is therefore a seasonally-restricted Ramsar site only. Based on the results of our waterbird surveys, Lake Balaton proved to be a very important site for feeding and resting during the autumn and spring migration and wintering period when tens of thousands of birds use this area. The dominant species are the Mallard (*Anas platyrhynchos*), the Black-headed Gull (*Larus ridibundus*), the Coot (*Fulica atra*), the Goldeneye (*Bucephala clangula*), the Pochard (*Aythya ferina*), the Yellow-legged Gull (*Larus michahellis*) and the Great Cormorant (*Phalacrocorax carbo*).

The small wetland sites surrounding Lake Balaton, like fishponds and marshes covering 20−400 ha each, can also be considered as important habitats during the migration and wintering period but their main functional importance is even more significant as nesting area, even though they are not unaffected by human impacts, either. The land use in these areas represents, however, a different kind of human disturbance. The wetland sites are surrounded by human infrastructure (roads and settlements) and they are also affected by intensive fishing and shooting. Nevertheless, their conservation importance is well reflected by higher waterbird species richness and density compared than observed on the Lake Balaton itself. The phenomenon is true for both the nesting and migration period. Waterbird species breeding here include several strictly protected ones such as the Ferruginous Duck (*Aythya nyroca*), the Pygmy Cormorant (*Phalacrocorax pygmeus*), the Great White Egret (*Egretta alba*), the Little Egret (*Egretta garzetta*) and the Night Heron (*Nycticorax nycticorax*). The area consisted of these fragmented wetlands fulfils all nine of the Ramsar criteria.

Fish-duck interactions in boreal lakes: Observations and an experimental test

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We studied the hypothesis that fishes play an important role in lake use of ducks in boreal lakes. We assumed that fishes may have both competitive and predatory impacts on ducks. The study was based on observations of densities of different duck and fish species in 28 boreal lakes in Southern Finland, as well on an introduction experiment with three lakes. We focused on the three most common duck species (Mallard *Anas platyrhynchos*, Teal *A. crecca* and Goldeneye *Bucephala clangula*) and on the three most common fish species (Perch *Perca fluviatilis*, Roach *Rutilus rutilus* and Pike *Esox lucius*) in the region. In the observational part, we considered both competitive and predatory interactions between ducks and fish, the Perch and Roach being potential competitors and the Pike a potential predator of ducks. Considering the fish species together, we found a negative association between Teal brood density and total fish density, the other duck species having no association with total fish density. When the three fish species were considered separately, a negative association, indicating food competition, was found most consistently between Goldeneye pairs and broods and Perch, whereas the role of Roach as a food competitor seemed to be of minor importance. We did not find any clear signs of predatory effects of Pike on ducks. Our results indicate that food competition is a more important factor than pike predation in affecting duck lake use in boreal environments.

In the experimental part, the effect of Perch on invertebrates and Goldeney was studied in more detail. Our aim was to test the hypothesis that the Perch play a controlling role in small, oligotrophic, and poorly vegetated boreal lakes, affecting both invertebrate numbers and community structure. In addition, we predicted that Perch impact lake usage by Goldeneye. In the three fish-free lakes, we found that upon successful Perch introductions, the number and biomass of invertebrates, the proportion of large dytiscids, and lake usage by Goldeneye broods significantly decreased. We conclude that Perch plays a key role as a predator of invertebrates in boreal lakes with few aquatic macrophytes. It is evident that Perch can strongly affect their prey populations and communities, and this predation may have an indirect effect on species, e.g. Goldeneye, that consume the same prey.

Breeding colonies of water birds in the catchment of Keoladeo National Park, India: Multidimensional conflicts for water

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With increasing demand for resources including space and water due to ever-increasing human population, the human-environment relation around protected areas have been strained by the day. This is becoming worse with increasing climatic uncertainties and frequency of natural disasters. Nevertheless, examples of some of the protected areas and/or wildlife sanctuaries reveal the role of human being in maintaining the ecological integrity of the area. One of the prominent examples is that of Keoladeo National Park (KNP), in the state of Rajasthan, India, a Ramsar site, witness to human beings' changing attitude towards wildlife. It also experiences water conflicts, where several contrasting issues have arisen viz., i) what should be given priority in our water management issues: biodiversity needs or agricultural requirements? ii) Does wildlife have a say in our water management policies? iii) Is the shift in breeding colonies (of several species aquatic birds to other wetlands or newly made water structures) is an indication of the socio-political pluralism? The present abstract is based on the author's experience of working in the area for the past decade and partly the outcome of a recent survey made to evaluate the changes during the previous decade in the catchment of Keoladeo National Park.

The unique habitats of KNP have been in existence for more than 275 years. Located amidst a vast agricultural landscape, the wetland ecosystem in KNP supports thousands of migratory avian visitors and is also an abode to hundreds of native species. Till date, over 375 species of birds have been reported from this national park. Scientific investigations to understand its ecological functioning and threats to the ecosystem started in early 1980s by Bombay Natural History Society, Mumbai, India. Several parallel studies (by Iowa State University) were also undertaken to understand the vegetation dynamics of the park. Additionally, scientific investigations in the form of several postgraduate, pre-doctoral and doctoral research works by researchers from across the globe have also been undertaken. Some of the recent scientific investigations in KNP include *inter alia* ecological monitoring of KNP during 2002-2006 by the author and his team, and a study on ecology of Indian rock python by Sálim Ali Centre for Ornithology and Natural History, India. The studies clearly indicated drastic changes in the ecology of KNP driven by both natural and anthropogenic factors.

The present talk will include the questions presented in the previous paragraphs and issues related to climate induced changes in and around the KNP at large. Old and long-term data around the KNP can identify the current management problems and perturbations at this Ramsar site. In particular, shifts in water management practices are changing the biodiversity and ecological functioning in KNP. The park experiences extremes of climatic conditions and often has been a victim of erratic and low rainfall. Currently the investigation is in progress to assess the present state of

environment, and to make a historical analysis of the scenario with respect to last four decades, i.e. ever since KNP was enlisted as a Word Heritage Site for its unique wetland ecosystem and large flocks of avian visitors.

Vast agricultural fields of Bharatpur and Karauli district serve as the catchment and flood plains for two non-perennial rivers, i.e. Banganga and Gambhir and also serve as the catchment for Ajan dam, which supplies water to the KNP wetland ecosystem for its very sustenance. Water changes in recent years due to drought, upstream water diversion, and possibly climate change have greatly reduced the water available to the Park during the last two decades. The frequent occurrence of droughts, owing to the increasing demand of water, in the region in the recent past has adversely affected the agro productivity of the region and consequently led the use of chemical fertilizers and pesticides in enhancing the agro-productivity and containing the pest outbreak, respectively. There have been several attempts by Park management to bring in water to KNP for its sustenance, which has yielded little result as the water release to the wetland system depends more on the socio-political factors than the actual ecological requirement of the KNP wetland. Due to uncertainty in water availability and resultant migration of winter avian visitors to other wetlands and/or suitable sites: satellite wetlands around the park spread across seven districts in Rajasthan namely Alwar, Jaipur, Dausa, Bharatpur, Sawai Madhopur, Karauli and Dholpur. There has been a gradual shift in the breeding colonies of water birds from KNP to other wetlands in its catchment. Around 27 wetlands have been identified as ***High Value Biodiversity Areas*** by the Rajasthan Forest Department, which also act as safe abode for migratory birds especially when KNP doesn't get enough water from Ajan dam. These wetlands are either a product of gradual water diversion and damming of water in the upstream areas on KNP, or existing natural wetlands. Most of these wetlands are being used for irrigation, and others are situated amidst farm lands. They are directly exposed to the runoff from the agricultural fields and get exposed to different agrochemicals, thereby influencing the breeding success of several aquatic bird species. However, due to untiring efforts by the forest department, a pipeline could be laid to make water available from Chambal River to KNP. Since January 2012, Chambal water has started reaching KNP, which again is raising several questions on ecological sustainability of this unique ecosystem. As the piped water is likely to be devoid of macrophytes, and nutrients of catchment area (required for ecological functioning of KNP), its long-term impact on the bio-geochemical cycling in KNP needs to be tested in the years to come. This in turn is a depiction of multidimensional impact of socio-political claims in natural ecosystems (Biodiversity Vs Agriculture).

Ecology and conservation of aquatic birds in India: An overview

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In India freshwater ecosystems, though diverse, are crucially dependent upon the seasonal precipitation brought in by the monsoon, believed to be under threat due to global climate change. Given the rich diversity of aquatic birds in this region, many of which are endangered, the aquatic ecosystems are therefore of immense ecological and conservation interest. Though systematic studies on limnology and aquatic birds are few in number, this paper/presentation reviews the broad contours of Indian studies on the ecology of aquatic birds in context of their habitat and the relationships therein. The diversity of water dependent birds, the degrees of their dependence and their taxonomic groupings are first enumerated, followed by issues of foraging ecology and diet, covering fish eating birds, grazing herbivorous species etc. In context of ecosystem level interactions the few estimates that have been undertaken on harvesting, enrichment due to droppings and other impacts are examined. This paper also touches upon some flagship projects which have attempted to investigate hydrobiological relationships and birds in a tropical context as well as the relationships between monsoon and bird reproduction. Finally, conservations issues, particularly the need to examine the impact of invasive species of fish in Indian wetlands is included, with directions for future work.

Importance of conserving wetlands as a habitat for birds as observed at Uran a coastal town in Maharashtra, India

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Wetlands provide home for a huge diversity of wildlife such as birds, mammals, fish, frogs, insects and plants (Buckton, 2007). Water birds have gained interest as indicators of wetland quality and as parameters of restoration success and regional biodiversity (Kumar and Gupta, 2009). India is blessed with numerous rivers and streams. By virtue of its geography, varied terrain and climate, it supports a rich diversity of inland and coastal wetland habitats.

The present study was conducted along the wetlands of Uran situated in the Raigad district of Maharashtra (Lat.18° 52' 48" N and Long.72° 56' 24" E) (Fig.1). According to Pawar and Kulkarni, (2007), entire coastal belt of Uran is under a rapid process of urbanization due to the number of industries located along the coastal line of Uran. Further, 2587 hectares of land comes under Navi Mumbai Special Economic Zone (NMSEZ) and Jawaharlal Nehru Port Trust - Special Economic Zone (JNPT-SEZ) project. This area includes large patch of Uran wetlands which had very rich biodiversity and popularly known for its amazing bird diversity. Present study was carried out to determine the impact of the SEZ project on bird diversity along the Uran wetlands. During the study 20 hectares area was observed (Fig. 2) for bird diversity as sub sample out of 204 hectares of wetland from July to December 2009. The sample area was selected as per the reclamation activity and the presence of water, vegetation, saltpans and fishing activity along the wetland. To estimate the density and diversity of birds Line Transect method was used described by Javed and Kaul (2002). The transect length was 500 m and the width was 100 m. Multiple visits were made every month to record the birds. The floral species and other fauna was also documented along the four transects.

The wetland had fresh water at the pond in Transect four while the remaining entire wetland was saline in natureA total of 21 floral species were recorded, out of which nine are mangroves including two front mangroves, seven back mangroves and four species of mangrove associates. Eight terrestrial plant species including the *Gloriosa superba*, which is a threatened plant species according to IUCN criteria, were observed. Benthic fauna included two species of crustacean fish, 10 fin fishes, six gastropods and polychaetes. Along the wetland region 21 reptile species were also recorded. In addition there were frequent sightings of Indian Mongoose and the

Indian Jackal. Presence of all these organisms indicates the healthy habitat of Uran wetlands that supported a very rich biodiversity of avian fauna.

The total 96 of birds species were recorded, which included 57 of water and water dependent bird species and 39 of terrestrial birds species both were recorded within the transect and in flight. During investigation it was observed that among the four transects, the diversity of bird's was maximum in transects three and four while the density was maximum in transects two followed by transect three. This was mainly due to the fact that the birds had some refuge in terms of water food and shelter before the reclamation in the second and third transect. The transect one had poor density and diversity of birds and can be attributed to degradation of natural habitat at the beginning of the study in the month of May. This affected the availability of food in wetlands and that caused drastic reduction in number of waders.

Over all 17 species of birds were observed common to all the four transects, of which eight were terrestrial birds, seven water and two water dependant birds. The Marsh sand piper was the most dominant bird with high density and observed in all the transects. This was followed by Little Cormorant > Jungle Crow > Indian Pond Heron > Ashy Prinia. However, density wise black winged stilt was the most dominant one followed by Ruff Sand piper > Black tailed godwit > Marsh sand piper > Eurasian Spoon Bill > Little Cormorant > Garganey > Jungle Crow > Indian Pond heron and Ashy Prinia. From this observation it was clearly evident that the birds with high population density completely avoided the first transect corroborating the earlier inference.

Reclamation started along the second and third transect from mid of the November which caused disturbance and destruction to a large extent to the natural wetland ecosystem. This encroachment affected the density and diversity of birds. Due to less water availability most of the migratory birds were concentrated at one corner of the wetland, where water was available to support large number of birds

Till end of the December almost all area along with the second and third transect was reclaimed, only area along the fourth transect was in condition to support the habitat. Because of the availability of water as well as food large numbers of birds were concentrated to the fourth transect. However, due to the reduction in space the density and diversity showed a reduction as is observed from the monthly variations in Density and diversity of birds from the study area.

The study throws light on the fact that though development is necessary it should not be done at the cost of habitats that support variety of fauna including birds.

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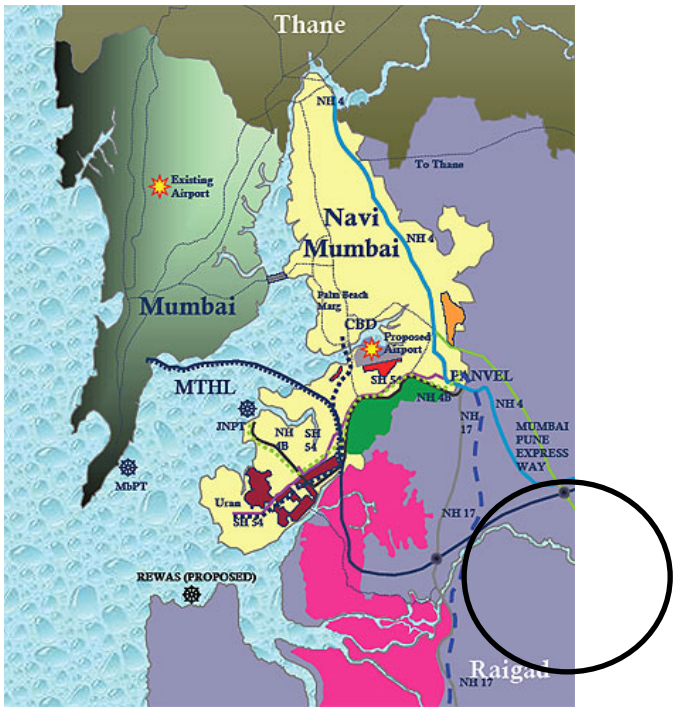

Fig. 1- Location of Uran Mudflats in Raigad district, Maharashtra.

Fig. 2- The location of the four transects along Uran wetlands.

The effect of salinity on the distribution of waterbirds in wetlands of an Australian coastal floodplain: implications for wetland restoration and management

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Salinity is an important factor determining the distribution and abundance of waterbirds in wetlands. This is particularly important in managed landscapes such as the Clarence River floodplain on the east coast of Australia that support wetlands of varying salinities. Many wetlands there are managed by hydrological control structures such as drains and floodgates. Restoration of natural wetlands in this agricultural landscape by modifying these structures has been ongoing since 1997 and includes strategic manipulation of water quality and quantity. The effects of introducing water of higher salinity into wetlands are of great concern to landholders and natural resource managers. More accurate knowledge of the salinity associations of locally-occurring waterbird species can assist wetland managers achieve improved outcomes for biodiversity conservation.

Repeated observations of 13 wetlands on the Clarence River floodplain and the waterbirds present were undertaken from 2005 to 2007. Of the 53 waterbird species recorded, 13 were observed mostly in water of low salinity (<5 ppt total dissolved salts), with five of these species mostly limited to freshwater (<3 ppt), while 25 species occurred across all salinities (up to ~ 28 ppt). The Comb-crested Jacana *Irediparra gallinacea,* Pink-eared Duck *Malacorhynchus membranaceus* and Plumed Whistling Duck *Dendrocygna eytoni* were observed only in freshwater. Fifteen species were not categorised due to too few observations.

Changing the salinity regime in many wetlands might not affect species presence but could affect the relative abundance of each species, therefore affecting the species composition of the waterbird community in a particular wetland. Apart from species limited to freshwater only, other species such as the Eurasian Coot *Fulica atra*, White-necked Heron *Ardea pacifica*, Australasian Grebe *Tachybaptus novaehollandiae,* Australian Wood Duck *Chenonetta jubata* and Hardhead *Aythya australis*, although occurring widely in salinities up to 10 ppt, were more abundant in fresh wetlands.

The introduction of more saline water could have an impact upon the preferred habitat of threatened species, such as the Comb-crested Jacana and other species that prefer freshwater, locally at least. Other threatened species, such as the Black-necked Stork *Ephippiorhynchus asiaticus* and Brolga *Grus rubicunda*, which occur in both fresh and saline habitats, are less likely to be adversely affected, and may even benefit.

Introducing extra water of higher salinity need not necessarily make the entire wetland more saline. Water can act as a wedge and retainer of fresher water in zones of wetlands more distal from drains and floodgates. Where water does not mix well, for example, due to substrate or vegetative barriers, zones could appear to function as separate waterbird habitats within the one wetland. Therefore, with careful control of flows through floodgates, the introduction of some higher salinity water might act as a hydrological wedge and maintain areas of fresher water in the upper reaches of a wetland. Furthermore, the introduction of additional water into drained wetlands could positively affect waterbirds by dramatically increasing their foraging habitat. However, managers would need to proceed cautiously with such a practice with careful consideration for the flow dynamics, water quality, bathymetry and waterbird ecology specific to each wetland.

Using an individual-based model to manage a swan grazing conflict

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Waterfowl can reduce the abundance of aquatic plants by up to 100 %, which in turn can have wider negative effects on the structure and functioning of aquatic ecosystems. Where waterfowl grazing causes ecological or socioeconomic damage this can be termed a 'grazing conflict'. Managers may try to alleviate the effects of a grazing conflict, for example through scaring, culling or habitat management. However, management can be both expensive and controversial. Therefore ecological models, which allow management options to be evaluated prior to field trials, are a key tool in waterfowl management. Individual-based models (IBMs), which use the simple behavioural rule that foragers should attempt to maximise their perceived fitness, have been used to successfully manage populations of geese and coastal wading birds.

In shallow rivers, flocks of mute swans (*Cygnus olor*) reduce the abundance of the dominant plant water crowfoot (*Ranunculus spp*.). Water crowfoot supports abundant invertebrates and salmonid fishes, and regulates the hydrology and biogeochemical cycles of the ecosystem. There are concerns that swan grazing is damaging both the ecological and sport fishery value of the shallow river ecosystem.

Using data from two years of field work and literature, we constructed and tested an IBM of non-breeding swans foraging on the River Frome and its adjacent pasture in Dorset, England. The model ran for a yearly cycle and predicted the number of swan days, macrophyte biomass depletion, swan feeding time, and the relative use of each patch. The model considered seasonal changes in plant quantity, plant energy content and foraging costs associated with aquatic and terrestrial vegetation. We used our IBM to assess the potential of a suite of habitat management strategies, alone and in combination, to alleviate the swan grazing conflict. We examined the effects of changes in riparian shading, water velocity, and riparian access, on the grazing conflict. The model was subjected to a sensitivity analysis to identify how changes in parameter values affected our results. Our study demonstrates the value of ecological modelling as a tool in the management of waterfowl grazing conflicts. As populations of herbivorous waterfowl, and number of grazing conflicts, are rising in many regions across the world, we argue that such models will be increasingly important.

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