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S31-3 The effect of irrigated agriculture on bird populations on the Mahi Right Bank Canal System, India

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Abstract Most bird explosions in cultivated areas are correlated with dry-land agro-ecosystems. Agriculture under irrigation, however, is expanding rapidly around the world, and, as in the case of dry-land agriculture, irrigated areas have also spawned explosions in bird populations. I discuss interactions between irrigation development and birds in India using the Mahi Right Bank Canal System as a case study. After a rapid initial expansion, water logging and soil salinization resulted in loss of cultivable areas that became marshlands dominated by wetland vegetation, providing excellent habitat for many wetland birds. As these wetlands developed next to agricultural fields, crops became a potential target for bird damage. At the same time, a marked increase in food availability resulted from spilled rice and wheat grains, particularly after the introduction of machine harvesting. The sarus crane, a globally threatened species, expanded and increased in irrigated areas, causing some agricultural damage. Bird population increases in the study area bore striking similarities to those in dry-land agro-ecosystems, driven by the same key factors. Habitat became available because irrigation created artificial wetlands, and extra food, at least for granivorous birds, was provided by crops and quantities of spilled grain.

Key words Agricultural expansion, Irrigation, Wetland birds, Land degradation, Habitat change, Colonization, Crop impact, Opportunistic food

1 Introduction

Most bird explosions in cultivated areas are correlated with dry-land agro-ecosystems. Agriculture under irrigation, however, is expanding rapidly around the world, and, as in the case of dry-land agriculture, irrigated areas have also spawned explosions in bird populations. In principle, the same factors driving bird population growth in dry-land agro-ecosystems also operate in irrigated areas, i.e. increased food supply from standing crops, wasted grain and the creation of favorable habitat. Therefore, analysis of such factors may become extremely important when searching for general processes underlying population explosions in agro-ecosystems.

In this paper, I analyze bird-land management interactions in irrigated areas in India where marked increases in bird numbers have occurred, in some cases associated with crop damage. The analysis will focus on the following aspects: habitat change, effects of wasted grain, raw growth in bird populations, and crop damage problems.

2 Habitat changes

2.1 Irrigation in India

Agriculture is the mainstay of the Indian economy; almost three quarters of the country's working population is engaged in agriculture and about half of the gross national product is generated by agricultural production. Agricultural development depends on water, but a large part of the subcontinent is arid, and rainfall often cannot ensure even a single crop. Irrigation, therefore, is indispensable to the welfare of Indian agriculture. Its use can be traced back to prehistoric times, but it gained momentum after Independence (1950). The gross area under irrigation in 1950–1951 was already 22.6 million ha. Multipurpose irrigation projects have since been launched, such as the Bhakra Nangal in Punjab, Damodar Valley in Bihar, Hirakund in Orissa and Mahi Right Bank in Gujarat, the study area of this paper.

The adoption of irrigation techniques increased areas under crop production, but unforeseen problems arose. End users, for example, often got too much water, either because they had no choice or deliberately took it as they wished and often more than was needed. The cropping pattern employed, often very different from the designed pattern due to diverse circumstances, also contributed to low irrigation efficiency.

2.2 The Mahi Right Bank Canal System, Gujarat

The Mahi Right Bank Canal System was begun in 1955 to increase crop production, both in variety and by two annual harvests. Canal irrigation is available to most of the region through the Mahi Right Bank Canal (MRBC) which links fifteen man-made reservoirs. The reservoirs are filled periodically for agricultural use, and so are essentially perennial wetland. Extensive waterlogging, however, soon followed, resulting in soil salinization. Other factors such

as poor natural drainage and lack of incentives for community use of water have added to the problem. In a total area of 212 694 ha, as much as 138 676 ha is now affected by salinity. The lost agricultural area became marshlands dominated by wetland vegetation, particularly *Typha angustata*, *Ipomoea aquatica*, and *Phragmites* sp., providing excellent habitat for many wetland-dwelling birds. As these wetlands are adjacent to agricultural fields, crops there have become potential targets for bird damage.

When irrigation was introduced, the major crops in Gujarat were paddy rice and wheat; others in more arid areas included sugar cane and tobacco. Market forces then complicated matters, applying pressure to replace the food crops of rice and wheat with the cash crops of tobacco, cotton and sugar cane. As a result, a drastic change in land use and cropping pattern happened, causing a negative impact on the overall bird community as well as those farmers who continued growing cereal crops and suffered from bird concentrations on them. Furthermore, increasing use of harvesters scattered and shattered larger proportions of grain in the field, increasing the food available for granivorous birds and mammals.

3 Waste grain availability

3.1 Food supply: crop production and grain spillage in wetlands

Increases in food availability in irrigated land are due mostly to spilled rice and wheat grain, as shown from measurements made late mid harvest in the study area in 1997. Twelve fields were sampled soon after the harvest by 1 m × 1 m quadrats fixed randomly in 5 m × 5 m quadrats in the center of each field. All loose grains and small pieces of seed heads (ears) with less that 10 grains were collected from the small quadrat, and whole seed heads or parts with more than 10 grains were collected from the larger quadrat. Grain samples were oven dried for 48 hours at 48°C and weighed. Sampling was repeated weekly on four successive weeks to evaluate the depletion rate of spilled grain.

An estimate of total field grain available was calculated for each plot using the formula of Frederick et al. (1984):

$$\text{Total kg/ha} = (25\,K + E)/\,2.5$$

where K (g/m^2) = weight of loose grain + grain from small seed heads of less than ten grain, and E ($g/25\ m^2$) = weight of grain from seed heads with more than ten grains. Bird species seen feeding on scattered grains in harvested field during the study were also recorded and are listed below. The results of grain depletion estimations are as follows.

Paddy rice: The quantity of rice grain scattered on the ground from harvesting was estimated for twelve fields on the day of harvesting. Mean grain loss due to scattering was 107 ± 11 kg/ha. There was wide variation in the amount of grain scattered, ranging from 49 kg/ha to 197 kg/ha. Nearly 60% of the grain was depleted within one week of harvesting. Of the remainder, 38% was taken over the next three weeks. The reduction rate of both loose grain and seed heads was similar throughout the study period.

Wheat: The quantity of scattered wheat grain left on the ground after harvesting was estimated from eleven fields. Mean grain loss due to scattering was 183 ± 17 kg/ha. The quantity of grain scattered was much higher than for ears. There was wide variation in total grain scattered, ranging from 97 kg/ha to 264 kg/ha. Nearly 40 % of the grain was depleted within the first week of harvesting. Of what was left, 54 % was taken within the next three-weeks. The reduction rate of loose grain and ears was similar throughout the study period.

4 Bird population increases

More than 200 species of birds have been recorded in Gujarat. Because of the aridity of the region, these birds need man-made wetlands directly or indirectly for survival. In the last two years, the bird population has increased significantly, particularly in passerines, although reliable numeric data are not available. A total of 67 species of birds have been recorded on the wetlands, and at least 39 are confirmed to eat rice and 15 species wheat from the stubble. Relative abundance below is denoted by the acronym RA.

Ruff (*Phylomachus pugnax*) (RA 52%) were the first to concentrate in large numbers in harvested paddy fields, followed by the eastern skylark (*Alauda gulgula*) (RA 14%); and large flocks of black-tailed godwit (*Limosa limosa*) have since been recorded feeding on rice. Other important species frequently present on the fields in large flocks include the short-toed lark (*Calendrella cinerea*), blackthroated weaver (*Ploceus benghalensis*), and three cranes: sarus (*Grus antigone antigone*), demoiselle (*Anthropoides virgo*) and common (*Grus grus*).

The Indian sarus crane is a true wetland species. Because of its restricted distribution and small population size it has been included in the list of globally threatened cranes (Meine and Archibald, 1996). Its decline is related to the loss of natural wetlands and marshlands, many of which have been degraded or drained. Recently, sarus cranes have expanded into paddy wetlands, which has led to conflict with farmers (O'Connor and Shrub, 1986; Conver and Decker, 1991). In Gujarat, fields are inundated during most of the cropping season (July–October) and thus form temporary wetlands with very high productive potential, menaced by the cranes. My observations indicate a marked increase in sarus cranes in the Mahi Right Bank Canal System area. The population there increased from 252 individuals (density of 0.13 pairs/km^2) in 1989 to 414 birds (density of 0.36 pairs/km^2) in 2000 (Mukherjee et al., 2002).

Due to the availability of inundated paddy fields, breeding performance has also increased. A total of 70 sarus crane nests were monitored over the period 1996–1998. The study revealed that 68 nests were in the agricultural marshland and only two in the non-agricultural area. Of the 68 nests in agricultural land, 31 were built in paddy fields and the rest in inundated fallow wasteland lost due to water

logging (Mukherjee, 2000).

Sarus cranes are highly conspicuous, and therefore readily perceived by farmers as a threat to crops. In recent years, reports of damage by cranes have increased world wide (Sugden et al., 1988; McIvor and Conver, 1994; Pivovarov, 1995; Swanberg and Lundin, 1995; Vaverins, 1995; Katondo, 1996; Mukherjee, 2000). However, very few detailed assessments of crop loss are available (McIvor and Conver, 1994; Parasharya et al., 1998).

5 Crop damage problems

Reliable estimates of damage and damage potential are important for understanding the impact of birds on crop yield and subsequent economic loss to farmers. To assess grain loss in rice and wheat, the study area was visited weekly to identify crane damage throughout crop development, from June to November. Precise measurements were made in 10 fields (0.09–0.35 ha), including those of damage caused by trampling and uprooting at harvest time.

Crane damage was easy to differentiate from damage caused by other birds, being characterized by the type of seed head damage, and presence of large pale gray feathers and toe prints on the ground. Sarus cranes also use paddy plants for constructing nests and other platforms for raising chicks, especially if both chicks survive. They either uproot the whole plant or cut the tillers just after transplanting. As a result, the whole area around nests is cleared of plants.

Paddy rice loss from the standing crop was always negligible, but loss due to trampling was high, ranging from 0.02% to 4.39 %. Trampled areas where all seed heads were damaged ranged from 10.1 to 210 m^2, mainly around nests. I estimated the overall yield loss in five fields as being between 5% and 14%.

Wheat damage was assessed just before harvesting in one field at Sojitra. Plant loss ranged from 1.5% to 15.2%, and yield loss from 14 kg to 120 kg/ha.

6 Discussion

Bird population increases in Indian wetlands bear striking similarities to those in dry agro-ecosystems in terms of driving processes. Habitat is made favorable because irrigation creates artificial wetlands. Favorable habitat is increased by mismanaged areas that are abandoned to production. Extra food, at least for granivorous birds, is provided by significant amounts of spilled grain which become even more copious when modern machinery is used. Damage caused by birds, particularly by sarus cranes, results from direct grain consumption, trampling, and plant uprooting.

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References

Conver MR, Decker DJ, 1991. Wildlife damage to crops: Perceptions of agricultural and wildlife professionals in 1957 and 1987. Wildl. Soc.Bull. 19: 46–52.

Frederik RB, Klaas EE, Baldassarre GA, Reinecke KJ, 1984. A method for sampling waste corns. J. Wildl. Managem. 48 : 298–303.

Katondo J, 1996. An overview of the status and distribution of the Grey-crowned cranes in Tanzania. In: Beilfuss RD, Tarboton WR, Gichuki NN ed. Proceedings of the 1993African Cranes and Wetlands Training Workshop. USA: International Crane Foundation, 205–208.

McIvor DE, Conver MR, 1994. Impact of greater sandhill crane foraging on corn and barley crop. Agric. Ecosyst. Environ. 49: 233–237.

Meine CD, Archibald GW, 1996. The Cranes: Status Survey and Conservation Action Plan. Gland, Switzerland: IUCN.

Mukherjee A, 2000. Ecology of the Indian Sarus Crane *Grus antigone antigone* Linnaeus in Central Gujarat. Ph. D. Thesis. Rajkot, Gujarat: Saurashtra University.

Mukherjee A, Borad CK, Parasharya BM, 2002. Comparative account of breeding pair density of the Indian Sarus Crane in Kheda district, Gujarat. Zoos Print. 17: 839–843.

O'Connor R, Shrubb M, 1986. Farming and Birds. Cambridge: Cambridge University Press.

Parasharya BM, Sukhadia AG, Yadav DN, 1998. Protecting groundnut crop from demoiselle cranes with reflective tapes. In: Dhindsa MS, Rao PS, Parasharya BM ed. Birds in Agricultural Ecosystems. Hyderabad: Society for Applied Ornithology, 56–63.

Pivovarov AT, 1995. Cranes in the Tselinograd region of Russia. In: Prange H ed. Crane Research and Protection in Europe. Halle-Wittenberg, Germany: European Crane Working Group and Martin Luther-Universität, 528–529.

Sugden LG, Clark RG, Woodsworth EJ, 1988. Use of cereal fields by foraging sandhill cranes in Saskatchewan. J. Appl. Ecol. 25: 111–125.

Swanberg PO, Lundin G, 1995. Strategies for the preservation of common cranes (*Grus grus*) in Sweden. In: Prange H ed. Crane Research and Protection in Europe. Halle-Wittenberg, Germany: European Crane Working Group and Martin Luther-Universität, 520–523.

Vaverins G, 1995. Crane research in Teici nature reserve, Latvia, and current problems of crane protection in this area. In: Prange H ed. Crane Research and Protection in Europe. Halle-Wittenberg, Germany: European Crane Working Group and Martin Luther-Universität, 525.