Waterbirds around the world

A global overview of the conservation, management and research of the world's waterbird flyways

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Cover photography: Whooper Swans *Cygnus cygnus* arriving at Martin Mere, England. Photo: Paul Marshall. (www.paulmarshallphotography.com)

Managing shorebird flyways: shrimp aquaculture, shorebird populations and flyway integrity

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ABSTRACT

Requirements for the conservation of shorebird habitat are changing as human use of coastal wetlands has shifted from traditional, low-level, resource-conservative patterns to intense "frontier-style" occupation and conversion. Within coastal wetlands, salt flats are being targeted for development because they are considered barren wastelands, are "non-mangrove", and are not protected by national legislation in most countries. In the Neotropics, the role of these wetlands as stopover sites for migratory shorebirds remains ignored or unknown by resource managers in most countries. We believe that increasing awareness is required to promote coordination efforts at regional and flyway level, to conserve these shorebird habitats and the potentially threatened migratory processes of these birds.

INTRODUCTION

At a meeting of the International Wader Study Group (IWSG) in 2003, it was concluded that most species of shorebirds (waders) with known population trends were in decline all around the world, making this issue a matter of international conservation concern. Forty-eight percent of populations with known trends were found to be declining, in contrast to 16% which were increasing. The reasons for these declines were stated to be diverse and poorly understood (IWSG 2003). The IWSG was reluctant to state explicitly that there was a relationship between the decreasing shorebird populations and the considerable loss of coastal wetlands that had occurred as a result of recent human activities such as transformation of coastal wetlands for industrial aquaculture. Although the loss of mangroves and its resulting environmental effects have been well publicized and this awareness has triggered massive and effective conservation campaigns and conservation legislation, the loss of mangrove-associated salt flats remains unrecognized as a threat to coastal ecological processes including the long-distance migrations of shorebirds. Salt flats are extremely important components of stopover habitats for shorebirds in the Neotropics as elsewhere in the world. In this paper, we suggest that the declines of populations of shorebirds in the Western Hemisphere must be assessed in the context of the widespread loss of a naturally limited habitat (upper inter-tidal salt flats) and the exponential rate at which the remaining salt flats are being converted by a rapidly growing shrimp-farming industry on both the Pacific and Atlantic coasts of South America, as well as on the Pacific coast of Mexico and Central America. Salt flats are now, *de facto*, open-access areas into which anyone can encroach, or worse, are seen by governments as wastelands that should be reclaimed for the development of highly profitable activities.

Forty-nine species of shorebirds regularly breed in North America and undergo extraordinary migrations to wintering grounds as far south as the tip of South America (Tierra del Fuego). These birds migrate through some 13 countries in South America and seven in Central America. Many of these shorebird populations are showing significant decreases (Brown *et al.* 2001). Comprehensive management to ensure the survival of these species is made difficult by the fact that events occurring at migration stopover habitats are often unknown to resource managers and management agencies in the breeding grounds of the birds.

Coastal wetlands: a resource of unknown extent

The extent of coastal wetlands in the Neotropics is poorly known. In general, it is estimated that coastal wetlands comprise less than 3% of the land surface of the Western Hemisphere (Bildstein *et al.* 1991). Large-scale development of coastal wetlands in the region is limited by physiographic and hydrological features to relatively few locations where tides and local hydrology act synergistically. Information on the extent of wetlands at a global scale has been found to be inadequate, but even the most basic information is not readily available for much of the Neotropics (Finlayson & Davidson 1999). Of even greater concern is that there is little agreement on what constitutes a wetland, and there are numerous gaps and inaccuracies in the information that is available. The resulting fundamental discrepancies in estimates of wetland cover and wetland type make the few existing estimates of dubious usefulness (Finlayson & Davidson 1999). Thus, too little information is available to make even an approximation of the current extent of coastal wetlands in the Neotropics, or to calculate the loss of habitat for migratory shorebirds on a regional basis.

Although salt flats are important elements of stopover habitats and constitute a significant feature of coastal seascapes in the Neotropics, they remain unrecognized as wetlands because they are frequently confused with dry, barren, non-tidal lands. The banded or zonal arrangement of associations inland from the sea or tidal channels is well recognized and described, but the hypersaline upper portions where high salinity is inimical to mangrove trees are mistakenly considered to be "bare" when, in fact, they maintain inconspicuous but important associations of epipelic (mud-living), tapetic (felt-forming) microorganisms. Although lacking above-ground vascular vegetation, the algal mats and bacterial films that grow on upper inter-tidal substrates are extraordinarily productive, and build up a complex and very rich trophic structure. Features such as salinas, albinas, coastal sabkhas or apicum-like structures are, in fact, productive marine depositional environments characterized by distinctive sedi-

ments (evaporitic mudflat facies, algal mats and mud-halite crusts) that reveal marine influence and origin (Gallaway & Hobday 1996). The sediment bacteria, including autotrophic cyanobacteria and chemo-autotrophs, are food sources for a diverse and rich invertebrate fauna, and this crustacean/molluscan-dominated assemblage in turn provides an abundant and reliable food source for shorebirds of the suborder Charadrii that use these "bare" flats as staging areas during their long-distance migrations. Plovers, sandpipers and some migratory waterfowl are the major and most conspicuous users of these habitats as food sources. Hypersaline flats are a dominant feature of low-gradient coastal landscapes where climatic and oceanographic conditions give rise to extreme aridity and prolonged droughts. Examples of coastlines dominated by salt flats are those of north-eastern Brazil on the Atlantic coast, and those of northern Peru (Tumbes), most of the Ecuadorian coast, Panama, the Gulf of Fonseca and western Mexico on the Pacific coast. These habitats, which are of high value for shorebirds, are not generally recognized as wetlands by resource managers; they have remained unreported in the few available wetland inventories, and remain unprotected by national legislation in most countries in the region.

Industrial shrimp farming in the Western Hemisphere

Aquaculture is not a novel development in the Neotropics (the Incas practiced mariculture 500 years ago). However, shrimp farming on an industrial scale is a new development. This began in Ecuador in 1969 and has grown at a phenomenal rate of 10-30% per year in the last two decades, spreading rapidly to Peru, Panama, Mexico, Colombia and Central American countries during the 1980s. Industrial shrimp farming as practiced in the Western Hemisphere differs from that in Asia by being an export-oriented and industrial-scale activity since its establishment. This is significant because the impacts of industrialized activities, in terms of demand for conversion of natural wetlands and degradation of the surrounding areas, are greater than those of subsistence-level aquaculture. Industrial-scale aquaculture is characterized by extremely detrimental impacts in terms of demands for space, intensity of development and the magnitude of the transformation of the coastal landscape.

On a global scale, shrimp farming has transformed itself from a traditional, small-scale endeavor into a US$ 6 billion business with severe environmental repercussions for resources associated with coastal ecosystems. In 1995, aquaculture accounted for 30% of the total world shrimp production. If current trends continue, it will supply 50% of global demand by 2005 (the total world production of marine-farmed shrimps in 2001 was 1 270 875 MT). Much of the expansion required to meet the projected demand is expected to take place within Neotropical coastal wetlands, particularly in the remaining shorebird habitats in Central America, Mexico and Brazil. Brazil is projected to produce 160 000 MT by 2005: a 400% increase from the 2001 production level of 40 000 MT (Rocha 2004).

METHODOLOGY

This paper was developed in an effort to evaluate a probable cause for the observed declines in shorebird populations in the Western Hemisphere despite increasing conservation efforts and increasing regulatory structures on the breeding grounds. We use the term "shorebird" to refer to birds of the Suborder Charadrii. The words "shrimp" and "prawn" are often used interchangeably in the literature. Here the term "shrimp" is used to refer to

Table 1. Shrimp production in converted coastal wetlands (mangrove and salt-flat habitats) in Latin America in recent years.

Country	Marine farmed shrimp production (MT)	Coastal wetlands converted (ha)	Shrimp production ÷ coastal wetland area (MT/ha)
Ecuador (1996)[5]	120 000	130 000	0.92
Ecuador (1998)[1]	130 000	200 000	0.65
Ecuador (2001)[2]	60 000	200 000	0.30
Mexico (1998)[1]	16 000	20 000	0.80
Colombia (1998)[1]	10 000	2 800	3.57
Panama (1998)[1]	7 500	5 500	1.36
Peru (1996)[5]	5 000	3 000	1.66
Peru (1998)[1]	6 000	3 200	1.88
Nicaragua (1996)[5]	3 000	4 000	0.75
Nicaragua (1997)[6]	4 000	5 000	0.80
Brazil (1998)[1]	4 000	4 000	1.00
Brazil (2002)[2, 4]	50 000-60 000	11 016	4.54-5.44
Honduras (1996)[3]	10 000	12 000	0.83
Honduras (1998)[6]	12 000	14 000	0.86

Sources: [1] Hinrischsen (1998); [2] FAO (2002); [3] Rosenberry (1996); [4] Rocha (2004); [5] World Bank *et al.* (2002); [6] Rodríguez & Windevoxhel (1998).

Peneaid or tropical marine shrimps. In the US market, "shrimp" is the usual name for marine shrimps, but the term "prawn" often refers to freshwater shrimps or to large saltwater shrimps.

Shrimp farms are preferably established on upper inter-tidal flats. Recent awareness of the need to conserve mangroves has driven most new pond construction into salt flats. Because of the lack of information on wetland transformation in the hemisphere, the rate at which coastal wetlands are being transformed was estimated indirectly from production and yield figures from various sources. For Latin America and the Caribbean, we used FAO shrimp aquaculture statistics for the period 1984-1995 (FAO 1997). For Brazil, we used a data set derived from various sources spanning the time period 1997-2003 (Hinrichsen 1998, World Bank *et al*. 2002, Rocha 2004, WRM 2004, FAO 2005). Because the reported yields per hectare for individual farms are highly variable, depending on farm management procedures, local conditions and the emergence of disease, we have chosen to use aggregate (country-level) production statistics to assess the space requirements of the industry. Estimates of the potential space requirements for pond complexes and the resulting annual loss of wetlands were based on three levels of aggregate yield: low yield (<1 MT/ha), medium yield (1-3 MT/ha) and high yield (>3 MT/ha). Yields lower than 0.5 MT/ha are considered to be below the profit threshold and were disregarded. Low yields reflect poor farm performance, unsuitability of environmental conditions or emergence of disease, whereas high yields reflect higher farm performance and adequate environmental subsidies but require larger investments and involve greater risks (Quarto 2004, WRM 2004).

RESULTS

Shrimp production in Latin America was reported to be 146 000 MT in 1995, and the industry has shown a steady linear increase in production of approximately 10 000 MT per year since 1984 (FAO 2005). Production yields range from 0.65 to 4.50 MT/ha (Table 1). Based on reported production and production trend figures, the rate of conversion of salt-flat habitat is currently estimated to be in the range of about 4 000 ha/year (medium yield) to 10 000 ha/year (low yield). Medium yields are most likely to be the result of frequent disease outbreaks in all production areas, the large number of idle ponds (>20%) due to disease and environmental problems (such as El Niño events and other flood causes), and the need to clean and disinfect ponds regularly. Projections for the expansion of the industry in Brazil suggest that the rate of occupation of coastal wetlands (16 000 ha/year) will exceed by a factor of four the present estimate of the annual conversion rate based on recent production levels. This is because of the unrestricted growth of the industry in Brazil, driven by the current potential for expansion (availability of undeveloped salt flats) and government policies that support the occupation of up to 80% of tidal lands (Federal-level CONAMA Resolution No. 312/2002 and state-level subsidies).

The rate of occupation of coastal wetlands (mangrove/salt flat system) in Brazil is in an exponential growth phase ($Y = b_0 e^{.212}$; $r^2 = 0.984$). Making projections in aquaculture is particularly speculative because of the large number of factors that influence production and demand. However, applying the exponential model described above projects a requirement of salt flats ranging from 37 000 to 55 000 ha by the year 2010. The actual rate of occupation may be much greater than this because of land speculation and the tendency to seize the most accessible sites as rapidly as possible.

Brazil's plans for the development of aquaculture are extremely optimistic. Of Brazil's 16 coastal states, nine north-northeastern states have moderate salt flat/apicum development. The area of salt flats in north-eastern Brazil with potential for transformation into shrimp ponds has been estimated by the industry to be 350 000 ha, but the basis for this estimate is unknown. Government agencies have not carried out an inventory of coastal resources to assess the potential for sustainable expansion or for potential resource allocation. Although Brazil has a National Coastal Zone Management Plan (PNGC), this has yet to be implemented. New areas are being explored and opened up for production along the northern coastline of Brazil, where local governments consider that they have been left out of the "Blue Revolution" in aquaculture that has taken place elsewhere. The coast of north-central Brazil, between Belém (Pará State) and São Luiz (Maranhão State), stands out as one of the most spectacular areas in the Western Hemisphere, in terms of its importance for migratory shorebirds. This coastal segment contains the "Reentrâncias Maranhenses", a geomorphologically diverse landscape that comprises 2 680 911 ha, of which 1 775 036 ha have been designated as a Western Hemisphere Shorebird Reserve Network (WHSRN) site and a Ramsar site.

DISCUSSION

Currently one of the greatest obstacles to the protection of shorebird habitat in the Western Hemisphere is the lack of explicit national legislation throughout the hemisphere to protect salt flats, even if these are ecologically a part of mangrove ecosystems and functional elements of coastal wetlands (Box 1). Regrettably, the returns brought by the "Pink Gold" economic growth in many of the hemisphere's developing nations have been invested in further exploitation of the remaining natural resources, rather than in increasing efforts to develop means to manage the residual coastal systems on a sustainable basis to ensure delivery of ecological services and food security for coastal populations.

The Neotropical Realm of Central America, the Caribbean and South America was, until recently, one of the least disturbed and most biologically rich of the Earth's biogeographical regions. Coastal wetlands, in particular, remained relatively undisturbed. The emergence of industrial-scale shrimp farming has now changed this because of its aggressive expansion and the fact that shrimp aquaculture in the region is embedded in a governance context which is extremely frail and generally incapable of developing strong policies to protect valuable resources. Regional and international funding and development agencies (the World Bank, the Interamerican Development Bank and the U.S. Agency for International Development in Central America) have fueled the growth of aquaculture despite its negative environmental and social impacts. This points towards the need for changes in the operational policies for development lending. Throughout the Neotropics, government and state-level policies support perverse subsidies and prescribed plans of actions that promote escalating coastal degradation in support of industrial-scale aquaculture and coastal development.

The impacts of shrimp monoculture on coastal wetlands are unambiguous. The occupation of coastal habitats takes place on a landscape scale, and involves extreme hydrological and topographical transformation. For instance, Ecuador lost half of its

Box 1. Summary of findings and conclusions.

1) Aquaculture is a significant threat to shorebird populations on both the Atlantic and Pacific flyways in the Western Hemisphere. High rates of habitat conversion are taking place despite total ignorance of the extent of the remaining habitat.

2) Salt flats must be considered as an intrinsic part of coastal wetland ecosystems. They are ecologically important habitats that support migratory shorebirds as well as coastal processes which provide key services including maintenance of local fisheries that contribute to food security. Resource managers must consider coastal wetlands as a functional whole that includes all inter-tidal habitats such as mangroves, salt flats and mudflats.

3) Shorebird conservation is given little priority in most Western Hemisphere countries. High-value habitats such as salt flats are not considered to be wetlands and remain unreported in wetland inventories and unprotected by legislation in most countries. Salt flats are, *de facto*, open-access areas into which anyone can encroach, or worse, are seen by governments as wastelands that should be reclaimed for development of highly profitable activities.

4) Although the exact extent of the resource is unknown, it is being allocated without consideration of quantity, quality or ecological function. The role of these wetlands as stopover sites for migratory birds remains ignored or unknown by resource managers in the region.

5) Shorebird population levels should be seen as indicators of coastal wetland health. Decreasing populations are the result of transformation and degradation of habitats.

6) The greatest obstacle to the protection of shorebird habitat is the lack of national legislation throughout the Neotropical region to protect salt flats, even when these are a functional part of mangrove ecosystems.

7) Industrial aquaculture should be relocated away from ecologically important wetlands such as mangroves and salt flats.

8) Development organizations, such as the World Bank and the Interamerican Development Bank, must be alerted to the impacts of their lending policies on salt-flat conversion and migratory shorebirds. Shorebirds have the potential to be used as indicators of the functional integrity of coastal wetlands that is required to meet the "Millennium Development" (MD) goals and targets agreed by most countries in the region.

9) Unless extraordinary measures are taken, unrestricted free trade agreements within the region, operating without strict environmental safeguards, could fuel further degradation and destruction of stopover habitats for shorebirds.

10) Shorebird conservation must be seen as an essential component of coastal resource and biodiversity conservation to support integrated coastal zone management and sustainable fisheries.

mangrove forests in the last two decades (Lacerda *et al*. 2002) and 77% of its salt flats (c. 4 000 ha/year of c. 66 000 ha) in the last fifteen years (Southgate 1992). In Honduras, a significant increase in shrimp farming is destroying important coastal wetlands and polluting coastal waters. Even a Ramsar site (No. 1000) in Honduras has been invaded by shrimp farms (Lal 2002). The government continues to encourage further development, although it is estimated that over 280 km^2 of shrimp farms have been developed in a region which USAID has estimated could support a maximum of only 200 km^2 (NAWCC 1993). Whereas in most of the Western Hemisphere the growth of industrial aquaculture faces a number of constraints such as diminishing space (most salt flats being already occupied), frequent and severe outbreaks of disease and increasing local community awareness and resistance to further development, in north-eastern Brazil, investors have found favorable conditions that include resource availability (large areas for development) and government policies that subsidize occupation and transformation of salt flats.

The increasing proliferation of shrimp aquaculture is evident in satellite images of the coast of northern Peru, Ecuador, Central America (Gulf of Fonseca) and the northern and north-eastern coastal states of Brazil. International agreements such as the Ramsar Convention have proven unable to limit the large-scale conversion of salt flats despite resolutions expressing concern for such conversion (Ramsar Resolution VII. 21) and the pledge of Contracting Parties to conserve the ecological character of designated wetlands.

CONCLUSION

Although the loss of mangrove ecosystems and resultant environmental effects have been well publicized, the potential impact of the loss and degradation of bare salt flats in the upper inter-tidal zone on shorebirds has been largely disregarded, even though this may threaten flyway phenomena at hemispheric level. The loss of these salt flats now constitutes the greatest threat to the conservation of entire populations of shorebirds in the region because of its scale and the high rates of conversion. Shorebirds have the potential to be used as indicators of the functional integrity of coastal wetlands within the region, and shorebird conservation must be seen as an integral part of coastal resource and biodiversity conservation to support sustainable fisheries.

Unless extraordinary measures are taken, unrestricted free trade agreements within the region, without strict environmental safeguards, could encourage further conversion and loss of stopover habitats for shorebirds on a regional scale. The loss or alteration of even small areas may be critical because of the degree to which migratory shorebirds concentrate at particular sites. Regrettably, shorebird conservation now has little priority for most countries in the Western Hemisphere. However, coastal wetlands, including mangroves and salt flats, are important productive units that support local fisheries, and are also a source of food for large segments of coastal communities. Furthermore, it is a requirement of the "Millennium Development" goals and targets agreed by most countries in the region that the ecological integrity of these coastal wetlands be safeguarded by 2015.

Shorebirds, because of their "flagship" status, could be used as indicators of the ecological integrity of these coastal systems, as well as a tool to promote shrimp production under more envi-

ronmentally and socially acceptable conditions, if it were made possible to differentiate these products in the market (shrimps that were not grown in converted inter-tidal zones). Ironically, farmed shrimp is now sold in the USA as "turtle safe" because it is not trawled and does not endanger sea turtles, but consumers are unaware of how environmentally unfriendly these farmed shrimp are, particularly for shorebirds. We trust that increasing awareness will promote efforts at both regional and flyway level to conserve these important shorebird habitats and thereby help to safeguard migratory shorebird populations throughout the hemisphere.

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