Land Use and Community Design to Ensure Jobs and Survival of *Platalea Minor* (10/23/03)

Habitat Loss and the Botulism Die-Off

Although several direct causes for the botulism outbreak have been identified, the deaths of wintering Black-faced Spoonbills in Coastal Tainan County, Taiwan, during December of 2002 through February of 2003 may be linked directly to the stresses of overcrowding and insufficient food that result from inadequate habitat. If the situation is studied in light of conservation biology, such stochastic events leading to significant die-offs will continue to occur until adequate habitat is secured or the bird becomes extinct. This paper focuses on providing adequate winter habitat and, more precisely, providing a portion of that habitat in Coastal Tainan County, Taiwan.

Four requirements based on conservation biology must be met in order to avoid extinction: (1) habitat needs; (2) viable population size; (3) metapopulation protection; and (4) species balance and system health.

Carrying Capacity with Minimal Habitat Needs

There are multiple indicators that the habitat needs of the Black-faced Spoonbill are not being met in the 634-hectare protection area and surrounding fishponds near the Tsen Wen River. Simply, there is not enough food for the birds concentrated there. The documented foraging area includes mudflats and fishponds at least 9 -- and more likely 14 -- kilometers outside the protected area. Although documented foraging distances vary from 5.5 to 40 kilometers, this model relies on locally verified distances of 9 and 14 kilometers. This foraging area consists of between 60 and 90 gross square kilometers (fishponds and access roads) of mostly private fishponds north, south and east of the primary roosting area.

Given the relocation of 155 birds from Tsen Wen to Sitsaou in 2002, the die-off and the associated finding of underfed birds in 2003, it appears that 60-90 square kilometers of fishponds as presently managed can support no more than 400-500 Black-faced Spoonbills in a healthy condition. This is based on triangulation of scientific observations. First, when, in 2002, the population in the primary Tsen Wen Reserve reached 582 birds, there apparently was inadequate habitat for that number, leading to 155 birds moving to roost in less favorable areas around the 515-hectare Sitsaou Reserve. That left 427 birds in the main roosting area. Although not conclusive, this suggests that competition for suitable roosting and/or foraging areas may have contributed to the relocation to Sitsaou. Further, the remaining 427 birds likely indicate an upper limit to the Tsen Wen carrying capacity, the maximum population that area can support under present conditions. This would suggest that the existing foraging and area supports between four and six birds per square kilometer.

Second, the die-off of over 70 birds in the Tsen Wen area in 2002-2003, while immediately due to botulism, suggests vulnerability to disease caused by the stress of inadequate habitat and overcrowding. In other cases, vulnerability to disease has increased when carrying capacity was exceeded due to reduced fish stocks, necessitating day-and-night foraging and longer flights for food. The reports that some of the deceased Black-faced Spoonbills had little food in their stomachs further reinforces that the carrying capacity of this habitat was exceeded.

Third, an analysis of foraging patterns in the years prior to the die-off also suggests that the carrying capacity was being tested. In the years between 1992 and 1999, ten main foraging areas were studied. In the first year, when approximately 200 birds were present, only four of the ten areas (40%) were confirmed in use for foraging. By 1999, with approximately 350 birds present (an increase of 150 birds, or a 75% increase from 1992), nine of the ten (90%) of the study areas were confirmed in use for foraging. In the early years, the spoonbills seemed to be extremely selective, likely choosing the best foraging areas and abandoning others. But by 1999, with increased total numbers, competition for food seems to have required use of all nearby habitat, further evidence that the carrying capacity was near its limit.

If these events are considered in the context of recent history of the Tsen Wen Black-faced Spoonbill population, it seems the foraging area available from the central roosting area supported 150 birds in 1990, 286 birds in 1995, 390 birds in 2000, and 430 in 2001. However, the foraging habitat of 60-90 square kilometers within 9-14 kilometers distance of the roosting area likely reached its carrying capacity under present management conditions with somewhere between 400 and 500 birds. Without much more aggressive management for fish production to artificially feed the spoonbills, it appears that this area can support no more than four to six birds per square kilometer. By assuming the cost of fish-raising in the reserve and cost sharing with surrounding fish farmers, eight birds per square kilometer (500 birds per 60 square kilometers) could be supported in the Tsen Wen area. The Mai Po area, by comparison, presently supports between 7 and 11 birds per square kilometer, based on photographic interpretation.

The limiting factor in Tsen Wen presently appears to be foraging area within efficient travel distance from the roosting area. Said another way, the limiting force is roosting areas with access to suitable foraging habitat. The roosting area of several square kilometers of open water 5-20 centimeters deep, with no two shores closer than 600 meters, seems to be adequate in size for the present population. This large dimension of shallow, open water protects the roosting (and loafing) flock from disturbance from humans and domestic animals. But there is not enough food close by to support the demand. More roosting areas with access to other foraging areas are needed.

These facts and recent events suggest that the present population of spoonbills trying to winter in Coastal Tainan County needs at least one additional and comparable roosting area and associated foraging territory. A roosting area of two square kilometers surrounded by fishponds of 60-90 square kilometers for foraging could be created by converting Taiwan Salt Lands north and east of Chigu Lagoon and around Pei Men to tidal wetlands 10-20 centimeters deep and also utilizing existing private fishponds for foraging.

Viable Population Size

In order to safely extract the spoonbill from the extinction vortex, a minimum viable population must be achieved. It has been estimated that once the total world population reaches between 3,000 and 5,000 birds (others estimate more broadly that between 1,300 and 8,000 individual birds are necessary), the Black-faced Spoonbill will no longer be considered endangered, simply vulnerable. When more is known about *Platalea minor*, a population viability analysis may reveal more precise estimates, but at present theoretical projections based on Soulé and Thomas must suffice.

If recent census numbers truly indicate a population increase and the present trend continues, a sustainable population could be reached by 2025. (Recent discussion and debate among scientists much more knowledgeable than I suggest that the population may be increasing, but that most likely the worldwide awareness of the Black-faced Spoonbill has simply led to more counts.) That a sustainable population could be reached in less than a quarter-century appears to be optimistic at best and foolish at worst, given trends in wetland habitat destruction in the wintering grounds. The uncertainty of summer breeding habitat and the loss of migratory stopovers present further barriers to achieving this goal.

However, if habitat is not preserved immediately, the wild population of Black-faced Spoonbills will likely never be raised safely from the extinction vortex. It is essential, then, to designate and protect by law within the next 25 years enough habitat for a sustainable population.

Consider the habitat needs of a viable population distributed similarly as at present in its wintering habitat. In recent years, Taiwan, and especially Coastal Tainan County, has been the winter home to a low of 49 percent and a high of 67 percent of the world's known population. The highest percentages of 67 percent, 63 percent, and 61 percent occurred in 1995, 1999, and 2002, respectively. This year's count is even higher, approximately 70 percent. If these percentages persist, and a sustainable population is achieved, it is likely that between 2,000 and 3,400 spoonbills will attempt to winter in Coastal Tainan County. This population would require a minimum of roughly 250 square kilometers of foraging area appropriately distributed and managed as existing fishponds, but with more aggressive management conditions and cost sharing. This assumes the liberal estimate that every square kilometer of fishponds could support eight birds with a cost-sharing program to guarantee timely pond rotation to feed spoonbills. The conservative estimate is that each kilometer supports only four birds at present in the area around the main Tsen Wen roosting area. This would require between 500 and 850 square kilometers of habitat to support 2,000-3,400 birds. With dispersed roosting and foraging areas and more aggressive management of fishponds, it may be fair to use the liberal figure, necessitating the recreation and/or protection of 250-425 square kilometers of foraging area. For comparison, recall that from the main Tsen Wen roosting area, there are presently approximately 60 square kilometers of foraging habitat within 9 kilometers and 90 square kilometers within 14 kilometers.

Metapopulation Protection

Partially isolated subgroups of populations not only promote genetic diversity of a species but also allow recolonization of habitats after a local extinction. Although genetic diversity is not a concern in the non-breeding winter habitat, dispersed groups of spoonbills would be able to withstand events that could extinguish an entire concentrated population. There has been consistent and justified alarm about such a large portion of the Black-faced Spoonbill population being concentrated in the Tsen Wen roosting area, making it susceptible to a stochastic event that could lead to the deaths of more than half of the world's population at one time. At present there is no buffer to such disasters. The recent die-off, which killed nearly seven percent of the population, is merely the warning of worse natural or human-induced disasters to come as more birds concentrate in the one roosting area near the Tsen Wen River. The only remedy is spatial dispersal. This is dependent upon land use allocation of suitable habitat. Provision of space for metapopulations allows populations to shift locations during unfavorable environmental conditions and reinhabit after a disaster.

To lessen the likelihood of a catastrophic kill, multiple habitats for metapopulations of approximately 400- 500 individuals need to be established and protected along the Tainan County coast north and south of the Tsen Wen River. Assuming that present trends continue, between 2,000 and 3,400 Black-faced Spoonbills may attempt to winter in this area in this century. Assuming 500 birds in each roost, two thousand birds would require four metapopulation areas of protected and open-water core roosting area and foraging habitat of between 60 and 90 square kilometers; 3,400 birds would necessitate seven such areas. These four to seven reserves would greatly reduce the risk of an extinction-level catastrophe from botulism; a chemical spill from a truck or boat accident; cumulative or single-event pollution from nearby domestic, transportation, or industrial uses; natural disasters; and fluctuations of organisms upon which the spoonbill is dependent.

Species Balance and System Health

Overall ecosystem health has been addressed by many scientists studying the spoonbill. Simply stated, to maintain the spoonbill ecosystem, a healthy balance must be maintained among predators, organisms low on the food chain, and those with mutualistic relationships. In this context, the spoonbill die-off might be explained by a loss of balance of prey organisms -- too few fish and unhealthy food supply.

In the winter ecosystem of the spoonbill, fishpond management is a key variable in maintaining species balance and water quality. Careful control of pollutants from nearby industry, towns and cities, and transportation routes is key to the ecosystem health, not just for the oyster and fisheries industries. In the case of Coastal Tainan, one critical mutualistic relationship is between the spoonbills and the fish farmers. It is impossible to provide adequate foraging area for the spoonbill without the cooperation of fishermen and the management of fishponds. Similarly, the fishing industry, the ecotourism industry, local residents, and the spoonbill ecosystem are codependent upon healthy water quality. This is a complicated, symbiotic relationship, essential

for the survival of each part of this ecosystem, from fishing- and tourism-supported families to crabs, egrets, and spoonbills. The 16,000 fishing-related jobs are dependent upon maintaining mangrove nurseries, Chigu Lagoon, fishponds, and pollution-free waters. Consider, for example, the multiple functions of the fishponds. Presently, a square kilometer of fish farms supports 40 primary jobs and several hundred secondary ones while providing fresh fish to Taiwan. Additionally, each square kilometer of fishponds is the undeveloped backdrop for 40,000 tourists per year supporting up to 160 tourist-related jobs. The drawdown of fishponds also provides foraging for spoonbills.

These are precisely the same needs of the spoonbill and tourism. Tourism has increased dramatically in Coastal Tainan County in recent years, and can eventually equal the number of jobs in fishing. One study projected 24,000 jobs, assuming six million tourists per year, including both domestic tourism and international ecotourism, with an average stay of 2.5 days per visit. The National Scenic Area Study projects 70,000 jobs if an innovative Blue Way Water Tour System is implemented. (For comparison, Nan-Kuen-Shen Temple presently attracts 4.5 million visitors per year.) In gross figures, the wetland ecosystem of Coastal Tainan, if preserved, can support between 30,000 and 86,000 jobs in fishing and tourism, over half of the wintering population of the Black-faced Spoonbill worldwide, and long-term food security for Taiwan through a complex web of mutualism.

Land Use Plans to Maintain Jobs and the Ecosystem

Presently and for the long-term future, these jobs are dependent upon the preservation of existing fishponds, mangroves and riparian corridors, lagoons, sand dunes, tidal flats, the maintenance of high water quality, and the conversion of salt ponds to tidal and wetland habitat and cultural and ecological tourism sites. There are approximately 150 square kilometers of such habitat between Sitsaou Preserve and Pei Men, largely west of Highway 17. There are additional fishponds north and east of Pei Men that also connect and contribute to this wetland habitat. In total, this is adequate land to accommodate the present and anticipated jobs in fishing and tourism and to provide three core roosting areas with almost 60 square kilometers of foraging area each. (This assumes that most large-scale tourism and processing facilities are located in larger cities east of Highway 17 and in existing villages and towns of Coastal Tainan County.)

This area generally coincides with the Naning National Scenic Area proposed by Tainan County. This national scenic area is the wise strategy of Magistrate Su Huahn-Dj and his county officials. If the scenic area is protected exclusively for fish farming, fishing, recreation, tourism, ecotourism and wildlife habitat, the fish ponds are managed to support spoonbills, and Taiwan Salt lands are restored for roosting and foraging sites, the Tainan County area could provide three of the seven 60-square-kilometer roosting and foraging core areas necessary to save the Black-faced Spoonbill. This would accommodate about 1,200 of the 1,500 birds that can be expected to attempt to winter here within the next five years. Because there is overlap of foraging habitat, the food supply may limit the population to somewhat fewer birds.

Two new core areas could be established, similarly, north and south of Tainan City. If the national scenic area is expanded north, as proposed, additional core areas might be established. In total, these core areas could likely provide habitat between 2,200 and 3,400 spoonbills, their

associated ecosystems, and the before-mentioned jobs in fishing and tourism. Our model identified six sites within the study area. However, those areas outside of Coastal Tainan County have not been studied in detail, so this is a speculative preliminary conclusion.

Unfortunately, proposals continue to be advanced for industrial and other development incompatible with the plan to maintain and promote fishing and tourism. None of these proposals to date has protected the Tainan County fishing, tourism, and associated wildlife, which together create major, nationally important economies. These Tainan economies have spatial requirements that preclude other industries that occupy large land areas and diminish fishponds and water quality. Presently, fishponds, salt ponds, mangroves, wetlands, dunes, and associated landforms essential to fishing, tourism, and spoonbill habitat development over the next five years comprise about 150 square kilometers in the Tainan County portion of the Naning National Scenic Area (the area from the Sitsaou Reserve to Pei Men and west of Highway 17). The Binnan Industrial Complex would have removed 24 square kilometers of land essential for fishing, tourism, and the spoonbill. Growth associated with Binnan would likely have removed another 30-40 square kilometers of essential fishing, tourism, and wildlife habitat. This would have resulted in a combined loss of between 54 and 64 square kilometers. Such a reduction in habitat would likely have sent the spoonbill into an extinction vortex from which it could not recover. For that and other reasons, many policy makers concluded that Binnan should not be built.

Similarly, the proposed airport and free trade zone remove approximately 20 square kilometers (one measure is 22 square kilometers) of land projected to be essential in the next five years for fishing, tourism, and spoonbill habitat. Tainan County reports that the free trade zone can be enlarged to 30- 40 square kilometers if necessary. Growth induced by the airport is predicted to remove another 30-70 square kilometers. Again, this combined loss of 50-130 square kilometers produces such a deficit of essential land that the spoonbill and associated tourism would likely be extirpated. Additional habitat essential to the spoonbill would be rendered useless by airport noise, human presence, lights and raptor-like movement. Simply put, there is not enough land and water in Coastal Tainan County to support oystering, fishing, cultural tourism, the spoonbill population with associated tourism, and another large-scale industry that removes habitat and induces additional urban growth. However, based on the model exhibited here, a plan that wisely maximizes the mutualism of fishing, tourism, and wildlife habitat without another large industrial development project is feasible.

Recommended Actions Regarding Land Use, Community Development, and Habitat

The conclusions of this integrated community development and conservation biology model indicate that a number of immediate actions are critical to both jobs and the survival of the Black-faced Spoonbill. These include the following:

1. To prevent continued and more catastrophic die-offs of the Black-faced Spoonbill and the loss of related tourism, a policy of no net loss of fishponds, salt ponds, and other potential habitat

should be immediately adopted for Tainan City and County. A no-net-loss policy would not prevent development of these habitats, but would require at least one-to-one replacement.
2. To restore wading and shore bird habitats as well as nurseries for lower organisms, Taiwan Salt Lands within the Naning National Scenic Area should be designated for wildlife habitat and ecological and cultural tourism.
3. To protect metapopulations and create the habitat needed within the next decades, restore three core roosting areas, each with a minimum of two square kilometers of shallow open water surrounded by 60 square kilometers of restored foraging area and existing fishponds. One core area should remain around the existing roosting area north of the Tsen Wen River and the Sitsaou reserve and the wetlands, within nine kilometers of those sites. Open water roosting free from human disturbance should be restored in Sitsaou. The second core area should be centered in the Taiwan Salt Lands adjacent and northeast of Chigu Lagoon, with salt lands restored for roosting and foraging areas. The third core area should be centered in the Pei Men Salt Lands, creating another two square-kilometer open-water roosting area and utilizing other restored salt ponds and surrounding fishponds within nine kilometers for foraging area. Only with the creation of distinct locations can metapopulations be guaranteed and can extinction by a single, great catastrophic event be prevented.
4. To guarantee adequate food in foraging areas in private ownership, the central government should provide cost-share programs to aid fish farmers in managing ponds to maximize profits and wildlife habitat benefits.
5. To prevent pollution of the aquatic system upon which fishing industries, tourism, and wildlife depend, set-up an early warning water quality monitoring system at key locations and regularly measure contamination in sediments, oysters, fisheries, and animals low on the food chain.
6. To speed funding and draw appropriate recognition to this area of critical national importance and international concern, implement the Naning National Scenic Area immediately and use that designation to protect this national treasure and to advertise to domestic and foreign tourist markets. Concentrate public expenditures on the fishing, agriculture and tourism industries in the scenic area.
7. To increase the number and length of tourist visits in Tainan County, develop facilities that will attract both domestic and international tourists, including local, overnight accommodations, multi-day package tours, the Blue Way System, viewing areas at the multiple roosting sites, and Pei Men and Longson Village, as premier international destinations.
8. To maximize tourism in all three coastal townships, interconnect via the Blue Way Systems and cross-advertise the dozens of extraordinary, but lesser-known, attractions like local museums, temples, villages, historic and cultural sites, with major destinations like Tainan City, Salt Mountain, and Nan-Kuen-Shen Temple. Coordinate this with multi-day tours offered by local people and connect these via the unique and all-important Blue Way System.
9. To guarantee the long-term survival of the spoonbill, develop a plan to create adequate habitat for additional roosting and foraging north and south of Tainan City and in the areas of the national scenic area north of Tainan County. In these cases, Taiwan Salt Lands may provide the key core habitat.
10. To maintain fishing jobs and develop more jobs in tourism, abandon the false expectation that this area of Coastal Tainan County can accommodate additional heavy industry or large-scale development projects. Such continued proposals undermine the vibrant economy that has developed and continues to develop.

Conclusion

Tainan County is at a critical decision point, facing a choice between two starkly different futures: (1) continual viability for the fishing and tourism industries as well as the Black-faced Spoonbill, or (2) destruction of the mutualistic relationships that support fishing, tourism and wildlife. Development of any large and growth inducing industry whether it is Binnan, a Free Trade assembly plant, an airport, or some yet unnamed project would convert too much land and wetlands that are essential for the survival of fishing, tourism and the spoonbill. Tainan County and the Central Government should move forward immediately to protect this invaluable resource.

Likewise the scientific community is at a critical decision point. Although micro scale research will continue to provide new information for adaptive management, the macro scale land use allocations, filled with scientific uncertainty, will ultimately determine the fate of the Black-faced Spoonbill. The scientific community needs to recommend a land use allocation within the Naning National Scenic Area (based on the best information available at this time) to offer long-term protection for *Platalea minor*.