AN INTERMEDIATE EGRET flies over rice fields.

Balanced on a Wing

Although seemingly at odds, rice production and biodiversity conservation can exist together—the trick is to find the right balance

STORY AND PHOTOS BY GREG FANSLOW

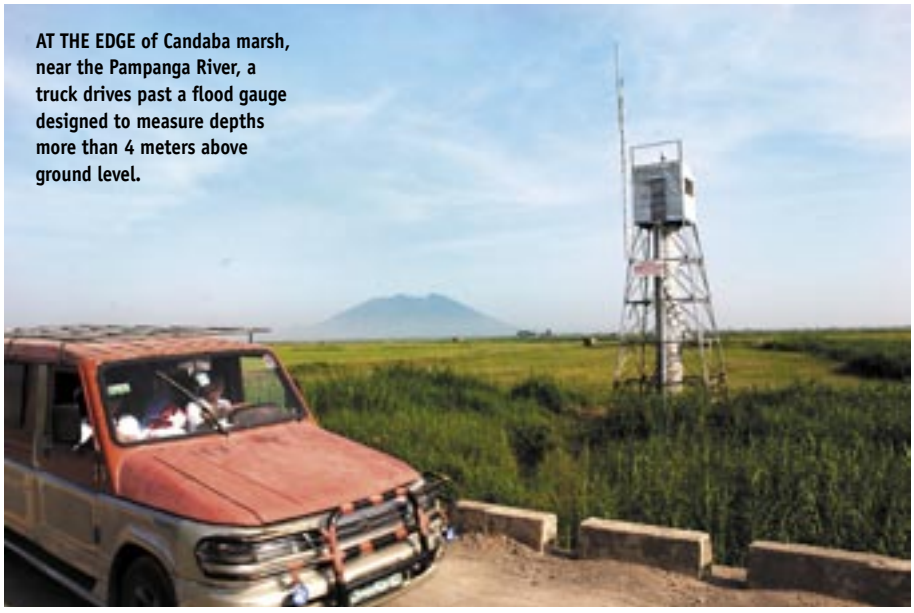
You might see something strange if you go bird watching near the small town of Candaba in the middle of the Philippine island of Luzon—next to rice fields and a dusty road, with no water in sight, are houses perched on stilts with boats stored underneath. This area is a cultivated floodplain and it's the quintessential place between land and water—an area defined by its potential both in terms of agricultural productivity and as a habitat for a profusion of wildlife.

Almost every wet season, about a third of Candaba's 18,000 hectares of farmland are flooded up to several meters by the Pampanga River. This is in some ways a vestige of floodplain landscapes that used to be much more widespread in Asia. However, as demand for rice has increased, many areas like this—with soils that are potentially good for agriculture, but usually too wet—have gradually been appropriated for rice production.

It is a scene repeated again and again in the planet's rice-producing areas. From an agronomist's perspective, wetland conversion exemplifies the application of human ingenuity to optimize nature's fickle resources for enhanced food production. And, satellite imagery shows us that, over the past 30 years, human ingenuity has been hard at work converting Candaba marsh into a homogeneous landscape of agricultural terrain (see maps on page 14).

Bringing floodplain wetlands into agricultural production generally requires flood control and drainage to manage water levels. These hydrologic modifications, along with plowing, land leveling, and bunding, radically alter the ecology of the system and tend to eliminate nonproductive native vegetation. From a wildlife conservation perspective, converting wetlands to agricultural fields too often represents habitat simplification to favor the needs of just one species—the crop—and creates nonoptimal circumstances for other species and ecosystem functions.

While at first the arguments over high levels of food production versus



AT THE EDGE of Candaba marsh, near the Pampanga River, a truck drives past a flood gauge designed to measure depths more than 4 meters above ground level.

maintaining biodiversity may seem hopelessly at odds, International Rice Research Institute (IRRI) ecologist K.L. Heong maintains that these debates are mainly a problem of semantics and the scale at which we think about agricultural systems.

"If we say that our goal is to optimize natural resources to maximize only grain production or only the number of bird species, for example," says Dr. Heong, "we perceive the world quite differently than if we say we want to optimize the totality of services that humanity derives from an ecosystem over many generations. Once the discussion expands to include a larger basket of environmental services over long time scales, there is usually much less misunderstanding."

Understanding the "totality" of almost anything is a daunting undertaking, particularly the totality of a landscape, but Dr. Heong points out the value of indicator organisms for this kind of task—particularly the kind with feathers.

According to Dr. Heong, there are two compelling things about birds that make them useful for understanding how human activities influence ecosystems. First, birds are widely cherished and, compared with less cherished groups of organisms (such as insects), many people have some knowledge about how the abundance and species composition of birds have changed with time. Second, birds are a very diverse group, with many species that specialize on particular resources within the overall environment. This specialization means that changes in abundance of a particular species can give us clues to specific things that have changed in the overall environment.

Tim Fisher, a prominent Philippines-based naturalist and co-author of the authoritative *Guide to Birds of the Philippines*, has observed declining numbers of bird species in Candaba and other parts of the Philippines for nearly 30 years. Fisher points out that the major threat to bird abundance seems to be the loss of native vegetation that accompanies the development of homogeneous agricultural areas.

While there can be large numbers of birds in rice fields, there generally aren't nearly as many species as exist in undisturbed wetlands. According to Fisher, "The very abundant species we see tend to be the ones that are lucky enough to have an ecological niche that overlaps with some aspect of the rice system. Such species might do extraordinarily well because the system has essentially been optimized for them as well."

However, Fisher warns that "while rice fields provide excellent feeding habitat for many of the seasonal migrants to the region, there are very limited breeding opportunities for resident species on field margins and almost no birds actually breed in rice fields."

As well as being affected by the amount of land that is brought into cultivation, local bird species are also affected by the amount of time during the year that the land is cultivated. "Early in the conversion process," says Fisher, "there is usually just one crop per year with a long fallow period when native vegetation can recover and birds may be able to breed in overgrown areas. However, as water control becomes more effective and cropping cycles are added, the periods when native vegetation can recover are drastically reduced." (See *The calculus of conservation*, page 36, for more on the response of birds to specific environmental changes.)

The streaked reed-warbler (*Acrocephalus sorghophilus*) is a rare species seen as quite sensitive to wetland conversion. Breeding in China and wintering in reed-beds in the Philippines, this small bird is now rarely observed in Candaba marsh and is generally regarded as in decline.

On the other hand, changing conditions can favor species that were previously alien to the landscape. The Eurasian tree sparrow (*Passer montanus*), for example, is a ubiquitous rice pest that can eat large amounts of grain, and which now thrives in extraordinarily high numbers in rice-growing areas throughout the Philippines.

Despite these examples, much can be done. Take Candaba, for instance. Candaba City Mayor Jerry Pelayo has established a 72-hectare bird sanctuary adjacent to Candaba marsh. The sanctuary attracts some 500 local and foreign visitors each year, boosting the local economy through increased employment and tourism. Although an isolated sanctuary is unlikely to significantly help species that require very large areas, a number of species do appear to have benefited from the mayor's efforts. Perhaps the most notable is the Philippine swamphen

IN THE HEART of Candaba marsh, about 8 meters above the fields they work in, farm workers camp on one of the major levees that holds back seasonal floods.

(*Porphyrio pulverulentus*). Common in the past, the swamphen became rare as wetlands were lost, but now breeds successfully and is a familiar site in the Candaba sanctuary.

In addition to preserving biodiversity for bird lovers, there are myriad other human benefits from wetlands. According to the secretariat of the Ramsar Convention on Wetlands, other services provided by healthy wetlands include protecting downstream areas by storing floodwaters during the wet season, recharging aquifers, and releasing the stored water during the dry season. Wetlands also act as biological filters by retaining and processing nutrients and pollutants. Wetlands are also critical habitat for many fisheries. For a complete list of environmental services, see Barbier et al 1997 (www.ramsar.org/lib/lib_valuation_e.htm).

According to Thomas Brooks, senior director of the Center for Applied Biodiversity Science at Conservation International in Washington, D.C., in the U.S., it works both ways—while humans receive benefits from wetlands, the wetlands must be managed appropriately by humans.

A PURPLE HERON prowls the bund of a rice field in a once-marshy area.

"While we must restore wetland habitat to effectively conserve bird biodiversity," explains Dr. Brooks, "this alone won't be effective unless the rice systems in the same landscape are managed in a manner that maintains appropriate flow of water into the areas within the system that are important to wildlife."

Can high food production coexist along with biodiversity? "Why not?" asks Ruaraidh Sackville Hamilton, leader of the T.T. Chang Genetic Resources Center at IRRI. "Although agricultural intensification during the 20th century was based on reducing biodiversity, it is not at all clear that increasing biodiversity per se would reduce productivity. In theory, judicious selection of the appropriate components of a biodiverse system can increase productivity by enhancing beneficial processes like the activity of natural enemies of diseases and pests, and increase the stability of production by buffering the impacts of climatic uncertainty."

"It's a false dichotomy," says Thomas Brooks. "The most authoritative study on this (Balmford et al 2002, *Science* Vol. 297, p 950–953) shows that, if the value of all environmental services is considered, conservation areas are generally worth 100 times the opportunity costs of establishing them."

Further highlighting the potential for a win-win solution, Sackville Hamilton turns the issue on its head and adds that "when you look at very extensive wetlands, they are actually rather homogeneous at the landscape level and it's quite possible that when agriculture is introduced to the landscape in patches, it can actually increase the overall biodiversity of the system."

The real issue, it seems, is to carefully find the right balance.

Greg Fanslow is an environmental consultant at IRRI.

The calculus of conservation

by Jonas Rune

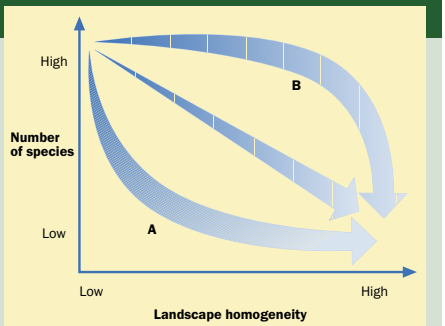
The figure to the right shows a theoretical model of species richness (for birds, for example) as a function of landscape homogeneity (the variation of types of habitat in the landscape). The more intense the farming, usually the more homogeneous the landscape and the fewer native species can be expected. This does not necessarily mean that the *number* of birds will be lower, as we may see a rise in the abundance of invasive species (species that expand rapidly when they are introduced from another region or when environmental conditions change).

The shape of the curve depends on what species and habitats make up the ecosystem. The more specific environmental demands a species has, the sooner it will disappear when its environment changes.

Case A presents an example where most native species disappear quite early in the land conversion process. An example of this would be converting forest to rice fields, where most of the forest species are lost very quickly because their niches don't overlap with the rice system. In case B, species richness is sustained much longer. An example here could be rice farming in an existing wetland, where more species may be able to use the new habitat and patches of natural habitat still remain.

The relationship between wetlands and birds is shaped by many factors, so it is difficult to determine the exact shape of the curve, but this conceptual model provides an idea of how much effort is needed to restore biodiversity. Case A, for example, would require the system to be restored to close to its original condition—a very large effort. In case B, however, even small measures can have significant positive effects.

An understanding of how species react to land use gives us a clearer idea about which areas are likely to experience the maximum benefit from our restorative efforts.



Potential relationships between degree of landscape homogeneity (variation of types of habitat in the landscape) and the number of species able to use an area.

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