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THE IMPORTANCE OF WORKING WETLANDS AS AVIAN HABITAT IN LOUISIANA

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Abstract. Resident, migrant, breeding and wintering waterbirds utilize the shallow water, moist soil habitat provided by the region's 160 000 hectares of working wetlands—rice, rice-crawfish, crawfish and finfish impoundments. These include waterfowl, grebes, pelicans, cormorants, Anhingas, rails, coots, gallinules, shorebirds, gulls, and terns. One hundred species have been documented. Taxa include local, regional, continental and hemispherical populations. This habitat has replaced the 600 000 hectares of adjacent coastal wetlands lost since 1950. Numerous other bird species (180+) utilize riparian areas around these working wetland impoundments.

Impoundments (64 000 ha) used to culture crawfish, normally in some rotation with rice, provide significant small vertebrate and macroinvertebrate food resources for predaceous waterbirds. Rice is cultivated in warm months. Crawfish burrow in summer and are cultivated in the cool months in reflooded impoundments. Decomposing vegetation and seeds create the food web for crawfish. Wading bird populations have increased dramatically benefiting from a predictable food resource. Manipulation of water levels in the spring and again in the autumn provides outstanding shorebird habitat. Rails and gallinules benefit from the breeding habitat provided by rice. Waterfowl benefit from rice and weed seeds, "loafing" areas and invertebrates prior to breeding.

There are currently fewer than 2000 ha of finfish impoundments in the state. They attract many waterbirds both unwanted predators like cormorants and innocuous species like shorebirds. These impoundments tend to be located well away from the coast in river valleys.

Key Words: working wetlands, waterbirds, habitat, Louisiana.

LA IMPORTANCIA HUMEDALES DE CULTIVO COMO HÁBITATS AVIARES EN LUISIANA

Resumen. Múltiples aves acuáticas residentes, migratorias, de reproducción o invernantes, utilizan el hábitat de aguas poco profundas y suelos húmedos, proporcionado por unas 160 000 ha de humedales de cultivo en la región – embalses de arroz, cangrejos de arroz, cangrejos de río y peces. Estos incluyen anseriformes, colimbos, zampullines, pelícanos, cormoranes, anhingas, rascones, gallinas y pollas de agua, zancudas, playeras, gaviotas y gaviotines. Cien especies han sido documentadas. La taxonomía incluye poblaciones locales, regionales, continentales y hemisféricas. Este hábitat ha sustituido a las 600 000 hectáreas de humedales costeros adyacentes, perdidos desde 1950. Otras también numerosas especies de aves (>180) utilizan zonas ribereñas cercanas a estos embalses de humedales de cultivo.

Los embalses (64 000 ha) utilizados en el cultivo de cangrejos de río y que generalmente rotan con cultivos de arroz, aportan así recursos alimenticios a aves depredadoras acuáticas en la forma de pequeños vertebrados y macro invertebrados. El arroz es cultivado durante los meses cálidos. Los cangrejos de agua dulce excavan sus madrigueras en verano y son cultivados durante los meses fríos en embalses re-anegados. La descomposición vegetal y las semillas crean la red alimentaria de los cangrejos de río. Las poblaciones de aves zancudas han aumentado dramáticamente beneficiándose de un predecible recurso alimentario. La manipulación de los niveles de agua en la primavera y en el otoño, permite un excelente hábitat para las aves playeras. Los rascones y pollas de agua se benefician del hábitat de reproducción proporcionado por el arroz. Las anseriformes se benefician de las semillas del arroz y otras hierbas, de algunos invertebrados antes de su reproducción, así como de las áreas de "descanso".

Actualmente hay menos de 2000 ha de embalses de peces en el estado. Estos atraen a muchas aves acuáticas, desde indeseados depredadores como los cormoranes hasta otras especies inocuas como las aves playeras. Estos embalses tienden a estar ubicados bien lejos de la costa, en los valles fluviales.

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INTRODUCTION

Commercial production of rice dates to the early 1900s in Louisiana's prairie areas, primarily in the southwestern area of the state. Crawfish, *Procambarus* spp., were always present in these working wetlands but commercial production of crawfish from these fields dates to the 1950s. Clearing of wooded wetlands for soybean farming dates to the 1960s within the state's river basins. Declining yields and prices led farmers to convert the fields into finfish, primarily channel catfish, *Ictalurus punctatus*, ponds, especially in the central and northeastern parts of the state. In the south-central area, crawfish was the dominant species cultured in those units with rice added when tracked equipment became available for use in the soft clay substrates.

In the past, we referred to these shallow-water, moist soil agricultural systems as "agricultural wetlands" (Huner et al. 2002). More recently, the agricultural community applied the term "working wetlands" to them (Huner 2007a; Savario 2007). In any event, these systems were long known to be significant waterbird habitat with most interest generated by waterfowl hunters who gravitated to the "ricefields" to hunt ducks and geese and, to a lesser extent, coots and snipe.

As the crawfish industry developed to include a significant commercial presence in the 1970s, farmers took notice of very large concentrations of wading birds, especially egrets and ibises. They became concerned about the possible damage done to their crops and subsequently began to complain to regulatory authorities about the perceived problems. Large flocks of pelicans, cormorants, coots, gulls, and terns then began to use these habitats adding to the farmers' concern about the welfare of their crawfish crops.

Similarly, catfish farmers became alarmed by large flocks of cormorants followed by pelicans, that began to appear and feed on their fish crops in the 1980s, especially in the winter. Egrets and herons appeared to be damaging fingerlings during summer production periods.

Approximately 240 000 ha of land is used to cultivate rice in Louisiana. Crawfish is cultivated within this area either as a sole crop or a crop rotated with rice. In 2007, about 64 000 ha were in crawfish production. At one time, Louisiana had about 6000 ha of catfish and other finfish production. In 2007, market conditions reduced this area to below 2800 ha. This is a substantial landscape of moist soil and shallow water habitat.

SURVEYS OF AVIFAUNA OF LOUISIANA'S WORKING WETLANDS

We began to survey the avifauna of Louisiana's working wetlands in the mid-1990s. Our efforts were concentrated on waterbirds associated with perceived damage to crawfish crops and secondarily catfish crops in southern Louisiana (Huner 2000; Huner et al. 2002; Huner 2007a). We quickly noted the significant utilization of riparian areas and nearby wooded wetlands by other avifauna and surveyed those birds as well. Intense surveys were made for periods of at least two years and we continue to monitor birds in the following areas from the Baton Rouge area on the east, the Lake Charles area on the west, and the Eunice area on the north. This region includes the heavy clay, bottomland hardwood areas associated with the Mississippi River and the Atchafalaya River and the lighter, loessal soils associated with the prairie areas of south-central and southwestern Louisiana.

Bird lists and, in several cases, seasonal checklists have been prepared for the following areas: Gonzales-Sorrento (Huner 2007b), Catahoula-Coteau Holmes (Musumeche and Huner 2002), (Cade) Cade-St. Martinville (Huner and Musumeche 1999), Perry-Mouton Cove (Musumeche and Huner 2008), and Church Point – Eunice (Musumeche et al. 2002). We have also published an overall list of waterbirds found in the region (Huner et al. 2002) that includes 102 species. A summary of all of our various bird lists includes over 180 species other than waterbirds, per se. Therefore, our overall bird list of approximately 280 species compares favorably to the state's list of 463 species which includes pelagic seabirds and two species known to be extinct.

Conservation status of waterbirds regularly encountered in Louisiana's working wetlands is a topic of concern by several authorities (Brown et al. 2000; Kushlan et al. 2002; National Audubon Society 2007; Gulf Coast Joint Venture 2007; Louisiana Department of Wildlife and Fisheries 2007). A list of waterbirds birds found in our survey areas presented in Table 1. Those considered to be of moderate to high conservation concern are noted. A list of 53 species that may be abundant or at least regularly encountered during spring and fall migration is presented in Table 2.

HABITAT CONSIDERATIONS IN WORKING WETLANDS

A wetland by definition is an area that is periodically wet and periodically dry. In Louisiana

TABLE 1. WATERBIRDS DOCUMENTED IN LOUISIANA WORKING WETLAND SURVEYS.

Common Loon*	Pied-billed Grebe
American White Pelican	Brown Pelican*
Neotropic Cormorant	Double-crested Cormorant
Anhinga	Magnificent Frigatebird*
American Bittern	*Least Bittern*
Great Blue Heron	Great Egret
Snowy Egret	*Little Blue Heron*
Tricolored Heron	Reddish Egret*
Cattle Egret	Green Heron
Black-crowned Night-Heron	*Yellow-crowned Night-Heron*
White Ibis	Glossy Ibis
White-faced Ibis	*Roseate Spoonbill*
Wood Stork	Black-bellied Whistling-Duck
Fulvous Whistling-Duck	Greater White-fronted Goose
Snow Goose	Canada Goose
Wood Duck	Gadwall
American Wigeon	Mallard
Mottled Duck	Blue-winged Teal
Northern Shoveler	*Northern Pintail*
Green-winged Teal	*Canvasback*
Redhead	Ring-necked Duck
Greater Scaup	*Lesser Scaup*
Surf Scoter*	Bufflehead
Common Goldeneye*	*Hooded Merganser*
Red-breasted Merganser	Ruddy Duck
*Black Rail**	*King Rail*
Virginia Rail	Sora
Purple Gallinule	Common Moorhen
American Coot	*Sandhill Crane**
Black-bellied Plover	*American Golden-Plover*
*Wilson's Plover**	Semipalmated Plover
Killdeer	Black-necked Stilt
American Avocet	*Greater Yellowlegs*
Lesser Yellowlegs	*Solitary Sandpiper*
Willet	Spotted Sandpiper
Whimbrel	*Hudsonian Godwit*
*Marbled Godwit**	*Ruddy Turnstone*
*Red Knot**	*Semipalmated Sandpiper*
Western Sandpiper	*Least Sandpiper*
White-rumped Sandpiper	Baird's Sandpiper
Pectoral Sandpiper	*Dunlin*
Stilt Sandpiper	*Buff-breasted Sandpiper*
Ruff*	*Short-billed Dowitcher*
Long-billed Dowitcher	*Wilson's Snipe*
American Woodcock	*Wilson's Phalarope*
Laughing Gull	Franklin's Gull*
Bonaparte's Gull	Ring-billed Gull
Herring Gull	*Gull-billed Tern*
Caspian Tern	Royal Tern
Common Tern	*Forster's Tern*
Belted Kingfisher	

* Very rare "accidental" birds. Recorded 1-5 times.
Italicized Names – Birds listed by one or more authorities with a conservation concern of "moderate".

and adjacent states, wetlands are generally dry during the period from mid-summer into mid-fall when evaporation either exceeds precipitation or there is little precipitation. Fall rains and colder temperatures result in reduced evaporation and accumulation of surface waters. Spring rains and over bank flooding of low areas associated with spring floods of local rivers and major rivers including the Atchafalaya, Mississippi and Red rivers keep those areas flooded.

Surface water is a limiting factor in the life cycles of all waterbirds. Dry years have a negative impact on nesting birds, especially wading birds, through reduction in food for birds preparing to nest. If they do nest, the number of eggs and fledged young is reduced and

TABLE 2. WATERBIRDS FOUND TO BE COMMON OR ABUNDANT IN LOUISIANA WORKING WETLANDS.

1.	Pied-billed Grebe
2.	*American White Pelican*
3.	*Neotropic Cormorant*
4.	Double-crested Cormorant
5.	Great Blue Heron
6.	Great Egret
7.	*Snowy Egret*
8.	*Little Blue Heron*
9.	*Tricolored Heron*
10.	Cattle Egret
11.	Green Heron
12.	*Black-crowned Night-Heron*
13.	*Yellow-crowned Night-Heron*
14.	*White Ibis*
15.	White-faced Ibis
16.	*Roseate Spoonbill*
17.	*Wood Stork*
18.	Fulvous Whistling-Duck
19.	Greater White-fronted Goose
20.	Snow Goose
21.	Wood Duck
22.	Gadwall
23.	Mallard
24.	*Mottled Duck*
25.	Blue-winged Teal
26.	Northern Shoveler
27.	*Northern Pintail*
28.	Green-winged Teal
29.	Ring-necked Duck
30.	*Lesser Scaup*
31.	*Hooded Merganser*
32.	American Coot
33.	Black-bellied Plover
34.	Semipalmated Sandpiper
35.	*Killdeer*
36.	Black-necked Stilt
37.	Greater Yellowlegs
38.	Lesser Yellowlegs
39.	Willet
40.	*Whimbrel*
41.	*Ruddy Turnstone*
42.	*Semipalmated Sandpiper*
43.	*Western Sandpiper*
44.	*Least Sandpiper*
45.	Pectoral Sandpiper
46.	*Dunlin*
47.	*Stilt Sandpiper*
48.	Long-billed Dowitcher
49.	*Wilson's Snipe*
50.	Laughing Gull
51.	*Bonaparte's Gull*
52.	Ring-billed Gull
53.	Forster's Tern

Note: Species *in italics* considered by some authority to have a conservation priority of Moderate to High.
Common: Widespread and easily found in proper habitat but generally not in large numbers.
Abundant: Widespread and easily found in proper habitat in large numbers.

post fledging survival is negatively impacted. Likewise, migrants passing through the region, especially shorebirds depend on shallow water and moist soil feeding grounds to assist them in traveling to nesting or wintering grounds. Wintering birds of all taxa suffer when wetlands are dry.

The "beauty" of Louisiana's working wetlands is that shallow water and moist soil habitat is present year round. The benefits of this habitat with special reference to that involved in crawfish to wading birds have been documented by Fleury and Sherry (1995) and Fleury et al. (1999). A discussion of the various management practices that benefit the birds follows.

RICE

Rice grown in monoculture is planted in the spring (Lindscombe et al. 1999). It may be planted in water by air or a dry field may be cultivated with seed being drilled. Water must be removed from fields where rice has been applied aerially or the seedlings will die. But, the field must be flushed with water one or more times to support the growing seedlings. Likewise, drill planted rice seedlings must be flushed. As a result, a significant landscape of shallow water and moist soil habitat is available to waterbirds in the spring, especially migrant shorebirds. Once the rice has reached about 15 cm in height, a shallow flood of 2-6 cm is maintained until the rice is harvested. Once the primary harvest of rice is completed, farmers may opt to flush the field with water and apply fertilizer to generate a ratoon rice crop that will mature in the fall. In any event, ricefields provide a considerable amount of moist soil habitat with grain available for shorebirds migrating in the fall and spending the winter in the area. These systems are widely used by wintering waterfowl and farmers often maintain a shallow flood for hunting purposes.

CRAWFISH

Two species of crawfish, the red swamp crawfish, *Procambarus clarkii*, and the white river crawfish, *Procambarus zonangulus*, are cultivated in the southern USA with over 90% of the land devoted to crawfish farming being located in Louisiana (McClain et al. 2007). These crawfishes are short-lived and grow rapidly in 3-6 months to commercial size. They are adapted to the region's dry summer, wet fall-winter-spring wetland cycle. Mature crawfish burrow when wetlands dry in the summer where they lay and incubate eggs. When the wetlands accumulate water in the fall, they emerge from the burrows

and release their young. The vegetation that has grown in the wetlands generate a hay infusion effect producing a myriad of invertebrate organism, planktonic and benthic, as well as small vertebrates like minnows, fish fry, and tadpoles that serve as prey for crawfish and all manner of vertebrates including waterbirds. In addition, there is a significant amount of plant seed, corms, and tubers available to the birds, especially waterfowl and coots. Crawfish eat significant amounts of larger seeds.

Crawfish are cultivated in monoculture by stocking adults in mid-late spring at rates around 30-40 kg/ha. Crawfish begin to burrow around the margins of the ponds. The ponds are drained by mid-late summer. Forage crops such as rice, sorghums, and/or millets may be cultivated for crawfish. Volunteer vegetation, mostly wetland grasses, sedges and forbs may be grown in pond bottoms as forage in lieu of a cultivated crop. These ponds are reflooded from late summer into mid-fall. Water depths range from 25-50 cm when ponds are fully flooded. Depths are shallower in prairie areas and deeper in river basin areas. Crawfish are harvested, depending on market conditions and densities, beginning as early as mid-fall to early spring.

Depending on market conditions, crawfish densities, and other management considerations such as planting agronomic crops, ponds may be drained as early as mid-spring or mid-summer. Where crawfish crops are going to be cultivated for several consecutive years, un-harvested crawfish serve as brood stock for the next season and they are rarely restocked.

Flooding and draining of crawfish ponds extends over a long period of time creating a significant food resource for many waterbird species. During the period that the ponds are flooded, numerous waterbird species utilize the ponds.

Crawfish–Rice

Crawfish and rice are usually rotated as follows (McClain et al. 2007). Rice is planted in the spring. Once it has reached about 15 cm in height, it is permanently flooded. Crawfish are then stocked. Crawfish burrow in levees as with crawfish monoculture. Rice is harvested in mid-summer. In most cases, farmers will flush the harvested field to stimulate growth of ratoon rice. This ratoon rice crop may or may not be harvested in the fall depending on rice prices and the absolute size of the crop. This second rice crop is often not harvested providing a very significant amount of rice for crawfish and seed eating birds, especially waterfowl.

Crawfish are harvested when density and value justify the effort. If the crawfish crop is poor, farmers may opt to drain the field to plant rice again in mid-spring. However, crawfish are generally harvested into late spring-early summer. Usually the farmer will leave water on the field into early-late fall (Huner 2007). Because most rice fields are laser leveled, fields that are 25-50 ha in size will be covered with 2-6 cm of water providing shorebirds, post-breeding wading birds, and early migrant waterfowl such as Northern Pintail, Northern Shoveler, and Blue-winged Teal with ideal habitat.

In any event, fields are prepared for rice planting in early-mid-spring during the late fall-winter period. Crawfish will be stocked again after the rice seedlings are permanently flooded.

In some cases, farmers "may" grow crawfish and rice year after year. But, this is the exception, not the rule.

PROS AND CONS OF CRAWFISH MONOCULTURE AND CRAWFISH–RICE POLYCULTURE

Crawfish size is directly related to density. The standard stocking rate for adult crawfish should, theoretically, generate an over-stocked condition. However, research has shown that the survival of mature crawfish and production of young crawfish is highly variable. Where crawfish are grown in monoculture, over population may become a problem after several seasons. However, overpopulation is rarely a problem with crawfish-rice rotations. Crawfish monoculture will generally produce more kg/ha and harvests can begin earlier when crawfish prices are highest. Crawfish-rice polyculture generally generates fewer kg/ha of larger, more valuable crawfish but later in the season. Agricultural economists have also identified costs of about $310 per ha to the rice component of a crawfish-rice polyculture operation that must be accounted for in determining the profitability of the operation (Salassi et al. 2008). This becomes of considerable concern when the rice farmer is not also the crawfish farmer where leased properties are involved.

Catfish

Channel Catfish, *Ictalurus punctatus*, are cultivated in deeper systems than crawfish, roughly 1.0-1.5 m deep (Tucker et al. 2004). There are two phases to catfish production. Fingerlings are produced by stocking smaller ponds, usually under 5 ha, by stocking small fry in mid-late spring and harvesting them the following

fall and into the winter. These ponds are then drained creating shallow water and moist soil habitat.

In the second phase of catfish production, the fingerlings are stocked into larger 10-20 ha ponds where they are grown to commercial sizes around 0.75 kg. This is a continuous process where large fish are harvested several times a year and are replaced by fingerlings. Predation by cormorants, pelicans, and wading birds can be a major problem in these systems. Significant numbers of these birds are killed, normally with permits issued by state and federal authorities but there is no apparent adverse impact on their populations. While these production ponds remain flooded for 3-6 years, they must be drained for renovation. Such draining generates shallow water and moist soil habitat, often at times when it benefits shorebirds in "fall" migration.

BIRD USE OF WORKING WETLANDS

The diverse avifauna of Louisiana includes residents and fall/spring migrants as well as wintering and breeding species. Wood Storks, once resident species, appear in the late spring and remain into early fall, as post-breeding dispersants, primarily from the Mexican population but with some overlap from the Florida-Georgia population (unpublished data). Table 3 provides a seasonal abundance of major waterbird taxa associated with working wetland impoundments.

TABLE 3. SEASONAL ABUNDANCE OF MAJOR WATERBIRD TAXA IN LOUISIANA RICE AND CRAWFISH WORKING WETLANDS.

Species	SP	SU	F	W
Waterfowl	C	R	C	C
Grebes	R	U	U	R
Pelicans	-	-	-	R
Cormorants	U	C	C	U
Bitterns	R	R	R	R
Herons/Egrets	C	C	A	C
Night-Herons	U	C	C	U
White Ibises	A	C	A	A
Dark Ibises	A	C	A	A
Spoonbills	U	U	C	U
Storks	-	U	U	-
Coots	U	X	-	C
Shorebirds	C	U	A	U
Gulls	C	U	U	A
Terns	U	R	U	U

A = Abundant: widespread and easily found in proper habitat in large numbers.
C = Common: widespread and easily found in proper habitat, but generally not in large numbers.
U = Uncommon: Uncommon: widespread and present, but in low numbers at proper season.
R = Rare: found infrequently in proper season but a general pattern of occurrence is evident.

IMPACT OF BIRDS ON CRAWFISH AND FISH PRODUCTION

There have been no detailed studies of the impact of birds on crawfish production systems (Huner 2000, 2007; Huner et al. 2002; McClain et al. 2007). Crawfish are harvested with cone-shaped traps that extend above the surface of the water to facilitate harvesting them and to allow crawfish to reach the surface if dissolved oxygen levels in the water fall too low to sustain them. Virtually every waterbird associated with crawfish impoundments rest on the traps and can dislodge them causing loss of the crawfish through open-topped traps. This is a clear economic loss. Some birds also steal cut fish, used for bait during the cool season, from traps. This is also a clear economic loss. However, there are no clear data to show that carnivorous birds adversely impact crawfish production directly or indirectly by eating the crawfish or consuming the invertebrates that are important crawfish foods. In addition, herbivorous birds consume emergent vegetation, dislodge that vegetation, and consume seeds, especially lost rice grain that is important crawfish food. Dabbling ducks and coots are generally assumed to be herbivorous but, in fact, consume invertebrates, including crawfish, prior to the breeding season. Computer models show that high densities of predaceous waterbirds can adversely impact crawfish production. But, in the absence of field studies to confirm the models, the issue will be hotly debated by conservation organizations and farmers with anecdotal observations supporting both sides of the issue.

Production of large, more valuable crawfish is density dependent (McClain et al. 2007). It is basically impossible to control crawfish densities based on the stocking of brood crawfish and draining ponds in new ponds. In established ponds, it is impossible to control the numbers of un-harvested crawfish that become the brood crawfish. As a result, densities may reach the point that crawfish are "stunted". Conservationist will argue that heavy bird predation will reduce crawfish densities to the point that there will be compensatory growth. Farmers sometimes move crawfish from stunted populations to under-populated ponds with dramatic increase in growth. However, donor ponds do not show compensatory growth providing anecdotal data against the argument that predation by birds enhances production.

There is no doubt that unregulated predation by cormorants and pelicans can cause major crop losses in catfish ponds. Herons and egrets seem to have little impact in production ponds

eating only sick and injured fish, often associated with poor management leading to low oxygen putting the fish at risk. However, herons and egrets can clearly cause serious problems in catfish fingerling ponds if they are not harassed, especially when the fingerlings are being fed. Tucker et al. (2004) provide an extensive review of the behavior, seasonality, and impacts of these predaceous waterbirds on catfish production systems.

ECONOMIC CONSIDERATIONS OF WORKING WETLANDS

Economists (Westra et al. 2006, 2007) have reviewed the waterbird habitat provided by working wetlands, primarily rice, rice-crawfish, and crawfish systems. They have concluded that these systems provide a value to society at $495-$740 per ha per year for this habitat. Waterfowl hunting leases may command $2,000-5,000 per 60-80 ha unit (Nassar et al. 1991).

The economic impact of growing two crops—crawfish and rice—in the same fields was discussed above.

GENERAL COMMENTS

Dennis et al. (2008) have prepared a detailed survey entitled "Rice in the Western Hemisphere: Industry Dynamics and Opportunities for Waterbird Conservation." These authors note that "rice" constitutes a very important wetland habitat for waterbirds in the USA. They note the unique habitat role that crawfish culture plays when integrated with rice in Louisiana and the coastal region of southeastern Texas. Our various papers, reports, and checklists previously cited provide details about the particular species that benefit from this landscape of shallow water and moist soil habitat. Our surveys have been necessarily restricted to diurnal efforts. As a result, secretive marsh birds, especially rails, have been under-represented. However, Pierluissi (2006) has documented a significant nesting presence of Purple Gallinules, Common Moorhens, and King Rails in this working wetlands landscape in southwestern Louisiana. The secretive Yellow Rail is reported in good numbers in the fall when flushed by combines during the harvests of second crop rice (Cardiff 2008).

Given the importance of the working wetland landscape as waterbird habitat, the question of the area necessary to support the various waterbird species arises. Shallow water and moist soil habitats especially important for waterbird conservation during cool months. Esslinger and Wilson (2001) have concluded that approximately 36 000 ha of such wet "agricultural" habitat is required to meet the habitat goals of its waterfowl habitat model for southwestern Louisiana. There are over 64 000 ha of "crawfish" being cultivated in the landscape from the Texas border to the Atchafalaya Basin and northward to the Alexandria area. As a result, as long as the crawfish industry remains healthy, waterbirds will have sufficient cool season habitat to sustain their populations.

Continued competition from imports of inexpensive crawfish products from the Peoples' Republic of China has negatively impacted crawfish farmers for over the past decade. However, very recent spikes in energy costs have created considerable hardships for crawfish farmers who must fill ponds during the September-October period which is one of the region's driest periods. High energy costs also create problems in the usually dry April-May period because farmers must again weigh returns versus costs of pumping water to sustain water levels. In the short term, shallow, drying crawfish units are highly desirable habitat for migrating shorebirds and nesting wading birds. But, in the long term, it is desirable to sustain water levels into early summer across the landscape. Thus, we feel that it is imperative that wildlife managers evaluate the merits of providing subsidies to farmers for both flooding crawfish ponds in the fall and sustaining water levels in the spring.

Concern over the health of the southern rice industry which was in decline in the early 2000s (Huner et al. 2002; Westra et al. 2006, 2007) has given way to optimism. This change has been governed by an increased demand for rice as food and potential for use of rice in biofuels (Saichuk 2008). Increases in areas devoted to rice culture are sure to benefit waterbird populations in the region.

Working wetlands have replaced prairie habitat in southwestern Louisiana. Within this landscape, grassland birds benefit from grassy fallow fields. We have found that such areas are quickly colonized by Dickcissels and Eastern Meadowlarks (Huner and Musumeche 2008; unpublished data), both common species "in decline" (Audubon Society 2007).

In conclusion, the benefits of working wetlands, especially crawfish systems, as habitat for waterbirds are clear. Incorporating crawfish into management schemes in adjacent states in the region is warranted.

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