Climatic and Aquacultural Influences on Waterfowl Use of Catfish Ponds

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Abstract: We compared climatic and pond-management parameters with aerial census estimates of waterfowl and American coots (*Fulica americana*) on randomly selected clusters of channel catfish (*Ictalurus punctatus*) impoundments in the Delta Region of Mississippi from November 1983 to March 1984 and from October 1984 to March 1985. Mean total waterfowl and coot estimates for 1983–84 and 1984–85 were 51,853 and 81,325, respectively. Numbers of lesser scaup (*Aytha affinis*) increased four-fold the second winter. Weekly waterfowl and coot populations fluctuated with temperature, rainfall, and ice over. Waterfowl and coot numbers were positively correlated with seining, distance of ponds from disturbance, and the presence of aquatic vegetation and trash fish, and negatively correlated with hunting pressure. More coots used recently drained ponds than ponds drained 2 to 4 years prior to surveys.

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A relatively new man-made wetland habitat type has been developed in Mississippi with the commercial production of channel catfish. The total area devoted to catfish in Mississippi increased from 6,944 ha in 1977 to approximately 27,000ha in 1985 (Wellborn et al. 1985). Waterfowl use of these wetlands was first revealed by the U.S. Fish and Wildlife Service (1980–1982). Kaminski et al. (1984) suggested some general waterfowl management techniques for catfish producers. Christopher et al. (1988) compared estimates of waterfowl on catfish ponds with U.S. Fish and Wildlife Service mid-winter survey estimates. However, factors that may influence population numbers, seasonal trends of individual species, and comparisons of population estimates between years have not been addressed.

We studied relationships among waterfowl use and climatic parameters, pond characteristics, and aquacultural practices, and seasonal trends in populations of

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waterfowl species occurring on catfish ponds from fall through spring 1983–84 (first winter) and 1984–85 (second winter).

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Study Area

Most lands in the Mississippi River Alluvial Valley (Delta Region) of west-central Mississippi (Fig. 1) are used for growing cash crops or pasture. The area now includes about 21,000 ha of catfish ponds located in parts of Humphreys, Holmes, Shrakey, Sunflower, Washington, Bolivar, and Laflore counties with about 6,000 acres scattered throughout the rest of the state. Individual ponds average about 8 ha in size and the surface water area on individual farm complexes range from 20 to 850 ha ($\bar{x}$ = 80 ha). Ponds usually were categorized by farmers as brooder, fingerling, or production ponds, the latter for growth of fish for market.

Methods

Climate Variables

Temperature and precipitation data were obtained for Greenwood, Mississippi, from the National Oceanic and Atmospheric Administration (NOAA) in Ashville, North Carolina. We calculated the average minimum temperature, and totaled the precipitation (cm) for the day of aerial survey and the previous 6 days. The percentage of ice cover on fish ponds was estimated visually. Climatic variables were correlated with total and species population estimates using Spearman's rank correlation (Steel and Torrie 1980).

Pond Characteristics and Aquacultural Practices

Records of pond and farm complex characteristics and aquaculture practices were obtained from 9 fish farmers (Fig. 1). Information from farm records and from direct observations provided data on 141 and 32 individual ponds for 1983–84 and 1984–85, respectively. The farms were chosen because they had abundant waterfowl numbers throughout both winters and therefore were not chosen randomly. The farms were concentrated within Humphrey County, although two were located in central Washington County. These data included pond age (years), pond use, (production, brooder, fingerling), the number of years since last draining, presence or absence of aquatic vegetation and small fish [gizzard shad (*Dorosoma cepedianum*), green sunfish (*Lepomis cyanellus*), mosquito fish (*Gambusia affinis*)], dates and frequencies of fish feeding and harvesting, and waterfowl hunting pressure (number of hunters × days hunted). Using NASA Landsat Imagery (1:25,000) of the Mississippi Delta, we measured distances from ponds to frequently used roads, buildings, or other potential sources of disturbance.

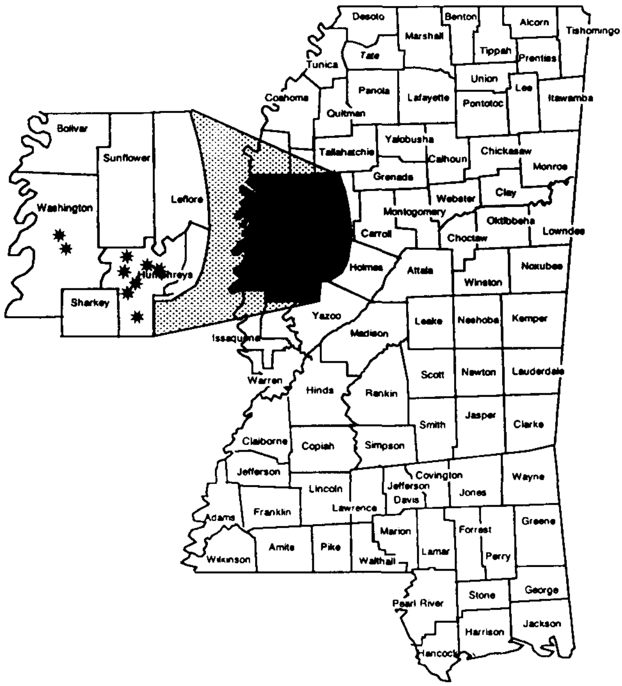

Figure 1. Seven county study area in the Delta Region of Mississippi. Location of catfish farms for which aquacultural data were obtained indicated by an asterisk.

The mean total waterfowl and species densities (birds/week/ha) were compared across multiple range test (Steel and Torrie 1980). We compared catfish pond characteristics to total waterfowl and species densities using Spearman's rank correlation and Kendall's rank correlation techniques (Siegel 1956).

Aerial Survey and Population Estimates

NASA Landsat Imagery was also used to delineate and group fish-pond complexes as clusters for single stage cluster sampling (Cochran 1977, Shaeffer et al. 1979). Catfish ponds were grouped as clusters (Christopher 1985) and were numbered (N = 261); 92 (35%) were selected randomly for weekly aerial census conducted from 5 November 1983 to 10 March 1984. During the second year, newly constructed pond clusters were added to the sampling universe (N = 310), and a new random sample of 115 (37%) was selected for biweekly censuses conducted from 27 October 1984 to 16 March 1985. Waterfowl populations for each aerial survey were estimated for the entire study area using a ratio-to-size estimate (Cochran 1977, Shaeffer et al. 1979). Confidence intervals for population estimates were calculated at the 90% level ($P < 0.10$). Results of the first winter of survey indicated very little difference between weekly surveys; therefore, biweekly surveys were initiated with no apparent or measurable bias.

Results

Climatic Relationships

Trends in the numbers of waterfowl using catfish ponds from November 1983 through January 1984 were correlated with general climatic trends (Table 1). As air temperature increased, numbers of total waterfowl, shoveler (*Anas clypeata*), ring-necked duck (*Aythya collaris*), and coot on ponds increased. Conversely, scaup numbers were highest during cold periods. In general, total waterfowl, ring-necked duck, and coot numbers declined as the percentage of ice cover increased. Shoveler numbers declined following 5–15 cm of rainfall that occurred through a week in early December 1983.

Relationships of Pond Characteristics and Aquacultural Practices

Numbers of all species, except coots, estimated during 1983–84 and ruddy ducks (*Oxyura jamaicensis*) in 1984–85 were associated positively with the number

Table 1. Spearman rank correlation coefficients (r) of climatic variables and weekly waterfowl population estimates on catfish ponds in the Delta Region of Mississippi.

Year and climatic variables	Northern shoveler	Ring-neck duck	Lesser scaup	Ruddy duck	American coot	Total
Nov 1983–Jan 1984 (N = 13)						
Temperature (°C)	0.49	0.61[a]	0.01	0.24	0.84[c]	0.78[c]
Rain (cm)	−0.53[a]	0.37	−0.26	0.58[a]	0.25	−0.01
% Ice cover	−0.31	−0.68[b]	0.06	−0.20	−0.86[c]	−0.78[c]
Feb–Mar 1984 (N = 6)						
Temperature (°C)	−0.29	−0.27	−0.87[b]	0.09	0.17	−0.32
Rain (cm)	−0.07	0.08	0.16	0.56	0.21	0.29
Oct 1984–Jan 1985 (N = 7)						
Temperature (°C)	−0.21	−0.14	−0.57	−0.85[b]	−0.07	−0.64
Rain (cm)	−0.46	−0.28	−0.53	−0.03	0.07	−0.01
Feb–Mar 1985 (N = 4)						
Temperature (°C)	0.40	0.40	0.40	−0.40	−0.40	0.20
Rain (cm)	0.00	0.00	0.80	0.80	0.00	0.60

[a] $P < 0.05$.
[b] $P < 0.01$.
[c] $P < 0.001$.

of times a pond was seined (Table 2). During 1983–84, the numbers of total waterfowl, coots, shoveler, and ring-necked ducks were correlated positively with the presence of submerged or emergent vegetation (Table 2). During a companion study of activity budgets (Christopher and Hill 1988), coots and ring-necked ducks often were observed feeding on pond vegetation.

Numbers of total ducks, ruddy ducks, and scaup were correlated during both years with the presence of small fish. Scaup and ruddy ducks were observed feeding on small fish, particularly green sunfish and gizzard shad, that appeared stressed by sudden temperature decreases that occurred both winters.

The ANOVA revealed that mean waterfowl, shoveler, scaup, ruddy, and ring-necked duck densities were similar among production, brooder, and fingerling ponds during both years ($P < 0.05$). Exceptions were that coot numbers were greater on brooder ponds in 1983–84 and on fingerling ponds in 1984–85 ($P < 0.05$).

Table 2. Simple correlation coefficients (r) of fish pond characteristics and average waterfowl density (waterfowl/week/ha) Estimated on selected catfish ponds in the Delta Region of Mississippi.

Year and pond characteristics	Northern shoveler	Ring-neck duck	Lesser scaup	Ruddy duck	American coot	Total
1983–84 (N = 142)						
Age (Years)	0.09	−0.4	−0.34	−0.04	−0.16	−0.03
Presence of vegetation	0.17[b]	0.18[b]	0.11	0.08	0.42[c]	0.21[c]
Trash fish abundance	0.13[a]	0.18[b]	0.28[c]	0.25[c]	0.01	0.21[c]
Hunting (hunters × days)	−0.13[a]	−0.28[c]	−0.21[b]	−0.11	0.18[a]	−0.13
Times seined	0.23[b]	0.21[b]	0.19[b]	0.20[b]	0.11	0.22[a]
Feed (occurrence)	−0.03	0.10	0.20[b]	0.11	−0.10[a]	−0.02
Distance to disturbance (km)	0.20[b]	0.20[a]	0.21[b]	0.15	0.02	0.21[b]
1984–85 (N = 32)						
Presence of vegetation	0.12	0.20	−0.14	0.18	0.25[a]	0.23
Trash fish abundance	0.03	−0.01	0.50[c]	0.44[b]	0.14	0.37[b]
Times seined	0.08	−0.04	0.06	0.33[a]	0.06	0.15
Feed (occurrence)	−0.15	0.45[b]	0.13	−0.14	0.16	0.02
Distance to disturbance (km)	0.10	0.12	−0.09	−0.20	−0.66[c]	−0.35[a]

[a]$P < 0.05$.
[b]$P < 0.01$.
[c]$P < 0.001$.

Numbers of scaup and ruddy ducks were greater ($P < 0.05$) on ponds drained 3 years earlier than on ponds drained < 3 years or > 3 years previously. Shoveler numbers were greater on ponds that had not been drained for 24 years before the study. Numbers of coots during both years were greater on ponds drained the previous year. Brood ponds often were drained each year which resulted in dense stands of aquatic vegetation.

Aerial Survey and Population Estimates

The average weekly total waterfowl and coot estimate during the first winter was 51,853 birds (range = 19,628 − 92,857). Weekly total population estimates were highest during November through mid-December, followed by a significant decrease in late December (Fig. 2). Shoveler population estimates averaged 17,778 birds and constituted 34% of the total waterfowl population, whereas ruddy ducks and coots averaged 12,347 (24%) and 6,324 (12%) birds of the total population estimate, respectively. Scaup estimates averaged 6,010 birds, 12% of the total, and ring-necked ducks averaged 3,265, 6% of the total.

During the second winter, the average total waterfowl and coot population estimate was 81,325 birds (range = 21,881 − 136,902). The total population estimate increased from 27 October to 11 November as fall migrants arrived (Fig. 3). The total population declined from 17 January to 9 February during a freeze-over, but increased from 9 to 16 February during a subsequent thaw.

Shoveler population estimates averaged 22,523, or 28% of the total. Ruddy duck and coot population estimates averaged 13,635 and 11,006, or 17% and 14%

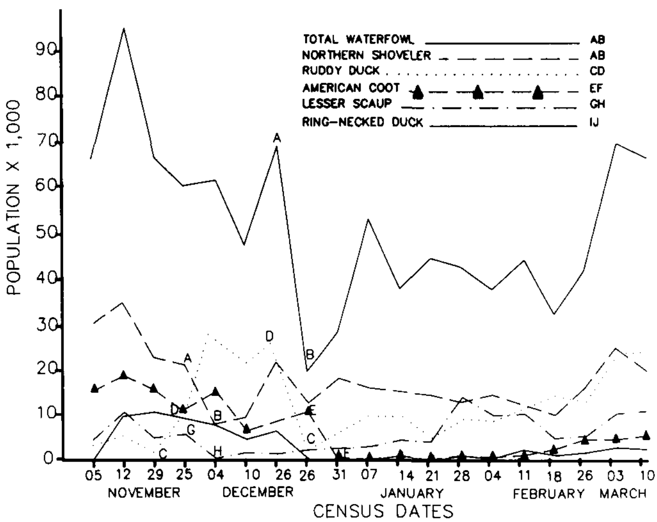

Figure 2. Population estimates of waterfowl using catfish ponds in the Mississippi, 1983–84 (consecutive estimates with different letters were significantly different at the 90% level).

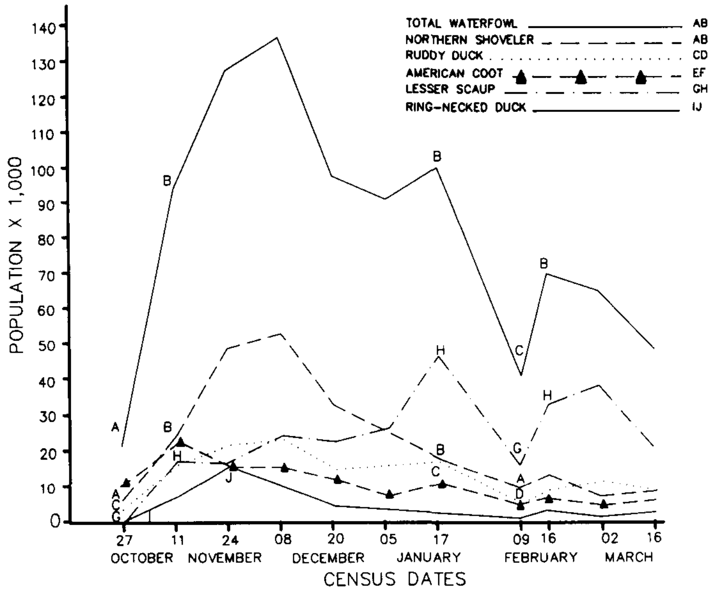

Figure 3. Population estimates of waterfowl using catfish ponds in the Mississippi, 1984–85 (consecutive estimates with different letters differ significantly at the 90% level).

of the total birds, respectively. Lesser scaup averaged 24,159 ducks, or 30% of the total population. Lesser scaup numbers declined significantly from 17 January to 9 February during the freeze-over. The average population of ring-necked ducks was 5,292 birds, or 7% of the total.

Average populations of total waterfowl, shovelers, ruddy ducks, coots, and ring-necked ducks increased slightly the second winter. However, only lesser scaup populations increased significantly from 6,010 birds in 1983–84 to 24,159 in 1984–85.

Discussion

The slight increase in waterfowl numbers between 1983–84 and 1984–85 prevailed into 1985–86 and 1986–87 (Dubovsky 1987). We suspect, as did Wells (1984), that this trend is associated with the approximately 10% to 15% annual increase of catfish pond habitat. During dry winters, about 50% of the waterfowl observed on Fish and Wildlife Service Mid-Winter Surveys in the Delta Region were using catfish ponds (B. R. Tramel and S. Woodson, pers. commun.). Wells (1984) also suggested that catfish ponds were especially important during winters with low precipitation. Thus catfish ponds constitute a wetland habitat of growing importance, and the potential for expanded and future use seems positive. Moreover, catfish ponds constitute permanent available winter habitat when less reliable wetlands are dry.

Thornburg (1973) found that hunting pressure and recreational disturbances influenced distribution patterns of diving ducks. Catfish ponds appear to provide a relatively undisturbed wintering habitat. Highest use by waterfowl occurred on farm clusters with lower hunting pressure or with centrally located ponds that were buffered from roadways and disturbances by 2 or 3 ponds (Christopher 1985).

In our study, on several occasions, waterfowl began to use a pond immediately after it had been seined to harvest catfish. Farm managers confirmed that these ponds had large numbers of small gizzard shad and green sunfish. Seining with large nets weakened or killed many of these fish, and we observed scaup and ruddy ducks eating them. Disturbance of the pond bottom through seining activities may also make invertebrates more available to waterfowl.

Slimak (1969) and Hobaugh and Teer (1981) found the relative amount of aquatic vegetation in impoundments was associated with waterfowl use. During November and early December of both years of our study, a majority of the coots and many of the ring-necked ducks were on ponds with large amounts of aquatic vegetation (e.g., *Najas guadalupensis*). Brooder ponds often were drained annually during the early spring, and fingerling ponds were drained irregularly. In addition, some production ponds were occasionally drained to reconstruct levees. Despite the use of herbicides, early successional plant communities usually developed once the ponds were re-flooded, and coots and ring-necked ducks fed heavily in them.

The distribution of feed to catfish often attracted coots or other ducks, but this food source did not appear to hold coots on a pond or farm complex for extended periods. Scaup and ring-necked ducks were rarely observed among feeding coots. Shovelers, because of their filter-feeding mode, were not believed to have consistently consumed sunken catfish feed.

Although an understanding of climatic influences may be helpful in predicting periods when the greatest numbers of waterfowl may be present, management opportunities for increasing waterfowl use of catfish ponds will be limited. Most ponds are kept filled to a depth of 1–2 m; thus, traditional waterfowl foods cannot be grown, especially since aquatic plants interfere with fish farming operations. Research is needed to identify compatible modifications of current herbicide treatments, to identify options for feeding, seining, and water manipulation, and to identify opportunities to manage pond bottoms and levees for waterfowl foods.

Waterfowl surveys of catfish ponds can provide information on local population levels and long-term waterfowl trends. Conflicts that waterfowl may pose to catfish production should be investigated. Disease and parasite vectoring, water quality, feed and fingerling depredation, and pond use by other avifauna also are topics for future research.

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