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# A Comparison of Waterbird Utilization of Two Northwest Arkansas Reservoirs

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## Abstract

Waterbird use of two moderately-sized reservoirs in northwest Arkansas was studied in the autumns of 1993 and 1995. In addition to waterbird counts; surface area, water temperature, conductivity, pH, turbidity, dissolved oxygen, macrophyte presences, number of total macroinvertebrates and degree of human activity were evaluated. Lake Fayetteville supported a greater overall waterbird species richness and species abundance than Lake Wedington. The observed number of ducks per hectare showed a significant difference between the lakes in both 1993 and 1995. Surface feeding birds were significantly more abundant at Lake Fayetteville in both 1993 and 1995, whereas diving birds, which feed on fish and invertebrates, showed no significant difference between the two lakes. Water temperature, pH, turbidity, and dissolved oxygen were not significantly different, but conductivity was consistently higher in Lake Fayetteville. However, total biomass for standing crop of macrophytes was higher for Lake Wedington. The number of macroinvertebrates at various depths was slightly higher for Lake Wedington, and human activity due to boating and fishing was not significantly different between the two lakes. Many characteristics may influence waterbird abundance of these lakes, but siltation of Lake Fayetteville is occurring at a faster rate than Lake Wedington. This has resulted in extensive shallow areas which probably enhances availability of food for surface feeding birds at Lake Fayetteville.

## Introduction

Some waterbirds, especially waterfowl, have been declining throughout North America. Six major duck species have declined since the U.S. Fish and Wildlife Service started keeping records in 1955 (Low, 1987). However, recent surveys of waterfowl populations have shown an increase in most waterfowl numbers (Young, 1995). This increase is probably due to protection of wetlands plus relatively high amounts of rainfall in key waterfowl breeding areas of Canada and the northern United States. Clearing of wetlands once used by migrating and overwintering waterfowl throughout the United States has concentrated waterfowl in fewer wetlands, thus increasing the potential for predation and disease. Many reservoirs have been constructed throughout the United States, and some of these attract diverse species of waterbirds with high abundance while others do not (Kadlek, 1962). Research is needed to determine habitat features important to waterbirds so that construction and management of reservoirs can be improved for waterbirds use.

Many physical, chemical, and biological properties have been investigated in relation to waterfowl and waterbird utilization of rivers, creeks, lakes, and ponds. Most studies investigate spring breeding periods where no single characteristic seemed to be associated with high or low use. Water quality properties do not seem to have a direct affect on waterbird use, but they do structure the aquatic community in which waterbirds feed (Begon et al., 1990). Waterbirds are diverse in habitat selection (White and James, 1978). This selection is probably due to diverse means of foraging behavior, such as wading, dabbling, and diving (Bent, 1866-1954; Ehrlich et al., 1988). Lake morphology is an important characteristic in habitat selection by breeding waterfowl, especially lake size (Mulhern et al., 1985; Godin and Joyner, 1981). Larger wetlands can support a greater number of breeding pairs of waterfowl (MacArthur and Wilson, 1967; Godin and Joyner, 1981; Lillie and Evrard, 1994) and higher species composition (Connor and McCoy, 1979; Suter, 1994 ). Research by several workers (Mack and Flake, 1980; Hoyer and Canfield, 1990; Suter, 1994) suggest that lake characteristics have limited influence on overwintering waterfowl numbers. Suter (1994) states food availability is probably the main factor affecting lake selection by overwintering waterfowl, but the effects of differing levels of macrophytes and invertebrates on waterfowl are not clear. Mack and Flake (1980) showed that invertebrate numbers and taxa were correlated with waterfowl use, whereas macrophytes abundance had no influence. Other studies suggested that invertebrates and macrophytes have no affect on overwintering waterfowl numbers (Murkin and Kadlec, 1986; Hoyer and Canfield, 1990).

We had two main objectives. The first was to determine waterbird species composition and relative abundance in two northwestern Arkansas reservoirs. The second was to evaluate the relationship between site characteristics, water quality, macrophyte abundance, macroinvertebrate abundance, human activities, and waterbird use of the two lakes. The term waterbird includes all birds observed using the two reservoirs during the survey periods and includes the following avian orders: Anseriformes, Charadriiformes, Ciconiiformes, Coraciiformes, Gaviiformes, Gruiformes, Pelecaniformes, and Podicipediformes.

***Study Site.***--Research was conducted at two reservoirs in northwestern Arkansas, Lake Fayetteville (T. 17N, R. 30W, Sec. 24) and Lake Wedington (T. 16N, R. 32W, Sec 3). Lake Fayetteville, constructed in 1949-1950, is located north of Fayetteville, Arkansas. At the time of impoundment, the lake had a surface area of 69 ha, a maximum depth of 12.19 m, and a shoreline length of 8,420 m (Hulsey, 1956; Browne, 1967), but since that time siltation has reduced the maximum depth to 10.5 m (Jackson, 1977). Lake Wedington, located 25.8 km west of Fayetteville, Arkansas, was constructed in 1937 by the U.S. Forest Service. The lake has a surface area of 33 ha, a maximum depth of 12 m, a mean depth of 4.48 m and a shoreline length of 6,115 m (Allman, 1952; Owen, 1952).

## Materials And Methods

Both lakes were censused once a week on the same day until all waterbirds were counted from the second week September to the third week of November in 1993 and 1995 using 7 X 35 binoculars and a 20X power telescope. Three vantage points were selected in which all possible shoreline and open water could be carefully scanned. Birds were counted and identified to species (Robbins et al., 1983).

Site characteristics, including lake surface area, lake shoreline length, and lake depth, were obtained from previous studies (Allman, 1952; Hulsey, 1952; Owen, 1952; Browne, 1967; Jackson, 1977). Water quality properties measured in 1995 included surface water temperature, pH, turbidity, conductivity, and dissolved oxygen. These variables were measured on a weekly basis on the day that censusing occurred. Water temperature was measured using a mercury thermometer, and pH was measured using pH indicator paper. Dissolved oxygen, conductivity, and turbidity were measured using portable water analysis instruments. Dissolved oxygen was measured using YSI Model 57 Oxygen meter. Conductivity was measured using YSI Model 33 S-C-T meter, and turbidity was measured using Model 16800 turbidimeter. Macrophyte and macroinvertebrate abundances were obtained from previous studies (Sullivan and Brown 1994; Aguila, 1993). Macrophyte abundance was measured for both lakes in the autumn of 1993, where macrophyte mean biomass was calculated in order to obtain estimates of total biomass for standing crop for each lake (Sullivan and Brown, 1994). Macroinvertebrates were sampled in autumn 1993 at three different water depths for both lakes using dredges, corers, and pond nets (Aguila, 1993). One single transect, extending from littoral zone to pelagic zone, was established in each lake which varied in length depending on the morphometric characteristics of the lake, in order to obtain the three selected depths. Three sampling stations were placed in the transect as follows: shallow (3-4 m), intermediate (6-7 m), and deep (9-10 m) in which two bottom samples were taken at each station. Human activity was monitored on a weekly basis in 1993 (Erwin, 1993) and 1995. In the autumn of 1993, Erwin obtained information on human activities, such as fishing, camping, picnicking, and hiking on both lakes. Interviews with lake managers and rangers, direct observations, and weekly records of fishing permits were evaluated twice a week. During weekly waterbird censuses in 1995, the number of boats in each lake were counted.

Data compilation consisted of species lists and relative abundance. Wilcoxon matched pairs signed rank test was used in data analysis because the data were not normally distributed.

## Results

Lake Fayetteville had a consistently higher species richness and number of waterbirds than Lake Wedington over the 10 week sampling interval for both years (Table 1). Lake Fayetteville had a total of 21 species in 1993 and 26 species in 1995 compared to only 12 species observed on Lake Wedington for each of the years (Table 2). Overall observed number of birds per hectare was significantly higher ($P < 0.05$) for Lake Fayetteville than Lake Wedington for both years. The second week of September to the third week of October showed relatively low species richness and abundance (Table 1). Pied-billed Grebes, Great Blue Herons, and Belted Kingfishers were the most frequently observed species during the entire study. Increased numbers of waterbirds during the second week of September 1995 at Lake Fayetteville was due to migration of Blue-winged Teal and Wood Ducks (Table 1). Peak migration of waterbirds, especially waterfowl, occurred during the last four weeks of sampling from the last week of October through November (Table 1) during which Canada Goose, American Coot, Mallard, Northern Shoveler, and Gadwall species exhibited

Table 1. Species richness and number of waterbirds observed during the 10 week sampling period on Lake Fayetteville and Lake Wedington in 1993 and 1995.

| | | Lake Fayetteville | | | | Lake Wedington | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number of Species | | Birds/Hectare | | Number of Species | | Birds/Hectare | |
| Week | Month | 1993 | 1995 | 1993 | 1995 | 1993 | 1995 | 1993 | 1995 |
| 1 | September | 6 | 4 | 0.38 | 0.30 | 4 | 2 | 0.12 | 0.06 |
| 2 | September | 5 | 8 | 0.20 | 1.45 | 0 | 3 | 0 | 0.24 |
| 3 | September | 6 | 4 | 0.38 | 0.42 | 2 | 1 | 0.18 | 0.06 |
| 4 | October | 5 | 4 | 0.33 | 0.36 | 2 | 1 | 0.09 | 0.15 |
| 5 | October | 8 | 8 | 0.45 | 0.45 | 4 | 1 | 0.24 | 0.09 |
| 6 | October | 8 | 9 | 0.55 | 1.32 | 2 | 1 | 0.09 | 0.24 |
| 7 | October | 6 | 17 | 0.19 | 9.73 | 4 | 8 | 0.42 | 5.18 |
| 8 | November | 13 | 16 | 3.67 | 8.95 | 4 | 3 | 2.09 | 0.24 |
| 9 | November | 14 | 10 | 1.19 | 8.34 | 3 | 4 | 0.30 | 0.27 |
| 10 | November | 12 | 9 | 1.64 | 8.22 | 3 | 2 | 0.39 | 0.27 |
| | **Average** | **8.3** | **8.9** | **0.90** | **3.95** | **2.8** | **2.6** | **0.39** | **0.68** |

peak numbers, especially at Lake Fayetteville (Table 2).

Species were grouped into four guilds based on foraging habits and food selection (Table 3). Guilds include surface plant feeders (Canada Goose, Mallard, Gadwall, American Widgeon, Northern Shoveler, Blue-winged Teal, Green-winged Teal, Wood Duck, and American Coot), surface fish feeders (White Pelican, Great Blue Heron, Green Heron, Little Blue Heron, Ringbilled Gull, Caspian Tern, and Belted Kingfisher), diving invertebrate feeders (Redhead, Canvasback, Ring-necked Duck, Lesser Scaup, Bufflehead, and Ruddy Duck), and diving fish feeders (Common Loon, Horned Grebe, Pied-billed Grebe, Double-crested Cormorant, Hooded Merganser, and Red-breasted Merganser). Numbers of surface feeding birds were significantly greater at Lake Fayetteville than Lake Wedington in both 1993 and 1995, whereas the number of diving feeding birds showed no difference between the two lakes in both 1993 and 1995 (Table 3).

Water temperature, pH, turbidity, and dissolved oxygen were not significantly different between the lakes, but conductivity was consistently higher ($P < 0.01$) for Lake Fayetteville (Table 4). Macrophyte abundance was consistently higher in Lake Wedington compared to Lake Fayetteville for both mean biomass (143.6 $g/m^2$ and 110.6 $g/m^2$ respectively) and estimated total biomass for standing crop (3430.9 kg and 2285.8 kg respectively). Total numbers of macroinvertebrates were similar for Lake Fayetteville and Lake Wedington (1647 and 1670 respectively). Human activity was not significantly different between the lakes in either 1993 or 1995 (Table 4) and dropped rapidly as the weather cooled. Over the course of the study, in 1993, Lake Fayetteville had a 94% decreased in overall human activity (fishing, camping, picnicking, and hiking) compared to 92% on Lake Wedington. However, considering only fishing activity a 90% decreased occurred on both lakes. In 1995, both Lake Fayetteville and Lake Wedington exhibited a 100% decrease in boat use over the censusing period in which the last three weeks no activity was reported on the lakes.

## Discussion

Species richness and number of waterbirds per hectare were significantly higher for Lake Fayetteville than Lake Wedington over the 10 week sampling interval in 1993 and in 1995 (Table 1). Connor and McCoy (1979) and Suter (1994) reported that larger lake surface areas attract more

Table 2. Number of weeks each species was observed in a 10 week period from September to November, the high count, and high count date of waterbirds observed at Lake Fayetteville and Lake Wedington in 1993 and 1995.

| Species | Lake Fayetteville | | | | Lake Wedington | | | |
|---|---|---|---|---|---|---|---|---|
| | Weeks Seen | | High Count (Date) | | Weeks Seen | | High Count (Date) | |
| | 1993 | 1995 | 1993 | 1995 | 1993 | 1995 | 1993 | 1995 |
| Common Loon | 0 | 1 | 0 | 1 (08 Nov) | 1 | 0 | 1 (12 Sept) | 0 |
| Horned Grebe | 4 | 1 | 6 (11 Nov) | 3 (08 Nov) | | | | |
| Pied-billed Grebe | 8 | 9 | 16 (10 Oct) | 25 (02 Nov) | 7 | 9 | 10 (31 Oct) | 20 (02 Nov) |
| American White Pelican | 0 | 1 | 0 | 1 (18 Oct) | | | | |
| Double-crested Cormorant | 4 | 4 | 1 (12 Oct) | 3 (25 Oct) | 1 | 1 | 1 (03 Nov) | 1 (02 Nov) |
| Canada Goose | 0 | 6 | 0 | 154 (21 Nov) | | | | |
| Mallard | 6 | 7 | 19 (31 Oct) | 95 (21 Nov) | 0 | 1 | 0 | 3 (02 Nov) |
| Gadwall | 4 | 5 | 100 (31 Oct) | 193 (08 Nov) | 1 | 1 | 58 (27 Oct) | 50 (02 Nov) |
| AmericanWidgeon | 1 | 1 | 2 (31 Oct) | 2 (08 Nov) | | | | |
| Northern Shoveler | 3 | 4 | 17 (31 Oct) | 80 (02 Nov) | 0 | 1 | 0 | 11 (02 Nov) |
| Blue-winged Teal | 1 | 2 | 14 (14 Sept) | 15 (26 Sept) | | | | |
| Green-winged Teal | 2 | 1 | 3 (03 Nov) | 10 (02 Nov) | 0 | 1 | 0 | 46 (02 Nov) |
| Wood Duck | 6 | 7 | 20 (22 Oct) | 17 (25 Oct) | | | | |
| Redhead | 0 | 1 | 0 | 16 (02 Nov) | | | | |
| Canvasback | 0 | 1 | 0 | 1 (08 Nov) | | | | |
| Ring-necked Duck | 0 | 1 | 0 | 45 (02 Nov) | 1 | 1 | 6 (27 Oct) | 33 (02 Nov) |
| Lesser Scaup | 2 | 2 | 60 (31 Oct) | 8 (08 Nov) | 1 | 0 | 3 (27 Oct) | 0 |
| Bufflehead | 4 | 4 | 16 (11 Nov) | 27 (21 Nov) | | | | |
| Hooded Merganser | 1 | 1 | 3 (31 Nov) | 10 (02 Nov) | 0 | 1 | 0 | 7 (02 Nov) |
| Red-breasted Merganser | 2 | 1 | 1 (07 Nov) | 2 (25 Oct) | | | | |
| Ruddy Duck | 3 | 4 | 29 (14 Nov) | 31 (02 Nov) | 2 | 1 | 5 (17 Nov) | 4 (08 Nov) |
| Great Blue Heron | 1O | 10 | 3 (31 Oct) | 3 (17 Sept) | 2 | 2 | 2 (31 Oct) | 1 (26 Sept) |
| Green Heron | 2 | 1 | 2 (12 Sept) | 1 (26 Sept) | 1 | 1 | 1 (14 Sept) | 1 (17 Sept) |
| Little Blue Heron | 2 | 0 | 2 (28 Sept) | 0 | | | | |
| American Coot | 6 | 5 | 12 (31 Oct) | 351 (15 Nov) | 2 | 0 | 3 (10 Oct) | 0 |
| Ring-billedGull | 3 | 0 | 2 (03 Nov) | 0 | | | | |
| Caspian Tern | 0 | 1 | 0 | 2 (17 Sept) | | | | |
| Belted Kingfisher | 10 | 8 | 3 (19 Sept) | 3 (18 Oct) | 8 | 5 | 3 (11 Nov) | 1 (08 Nov) |
| Spotted Sandpiper | | | | | 1 | 0 | 1 (14 Sept) | 0 |

Table 3. Mean number of waterbirds per hectare observed in the four guilds during the 10 week sampling period in 1993 and 1995.

| | 1993 | | 1995 | |
|---|---|---|---|---|
| Guild[a] | Lk. Fayetteville | Lk. Wedington | Lk. Fayetteville | Lk. Wedington |
| **Surface Plant Feeders** | 0.451** | 0.191 | 3.340** | 0.333 |
| **Surface Fish Feeders** | 0.072* | 0.045 | 0.072* | 0.024 |
| **Diving Invertebrate Feeders** | 0.265 | 0.048 | 0.317 | 0.112 |
| **Diving Fish Feeders** | 0.110 | 0.109 | 0.220 | 0.203 |

[a] See text for species included in each guild.
* Indicates a significant difference between reservoirs, $P < 0.05$.
** Indicates a significant difference between reservoirs, $P < 0.01$.

Table 4. Mean values for water chemistry parameters and index of human activity for Lake Fayetteville and Lake Wedington.

| | Lake Fayetteville | Lake Wedington |
|---|---|---|
| **Water Chemistry** | | |
| Turbidity (NTU) | 15.5 | 10.0 |
| Dissolved Oxygen (p.p.m.) | 11.1 | 10.4 |
| Conductivity (μmhos/cm) | 148.0** | 102.0 |
| pH | 6.6 | 6.6 |
| Temperature (°C) | 12.4 | 12.8 |
| **Human Activity** | | |
| 1993 (persons/day) | | |
| Overall[a] | 33.6 | 34.7 |
| Fishing | 14.9 | 12.9 |
| 1995 (boats/day) | 2.0 | 1.2 |

[a] Includes fishing, camping, picnicking, and hiking.
** Indicates a significant difference between reservoirs, $P < 0.01$.

birds. Therefore, surface area of the two lakes was used to standardize the number of birds per hectare since Lake Fayetteville has twice the surface area as Lake Wedington. Nevertheless Lake Fayetteville had significantly more waterbirds per hectare, specifically surface plant and surface fish feeders, than Lake Wedington (Table 3). Number of diving invertebrate and diving fish feeders were not significantly different between the two lakes.

Lake surface area probably accounts for much of the difference in waterbird numbers between the lakes, but why is Lake Fayetteville dominated by surface feeders? Siltation of Lake Fayetteville has resulted in extensive shallow areas, which probably makes food readily available for surface feeding birds. Water quality measurements between the lakes were similar, only conductivity was significantly different (Table 4). This difference in conductivity is only slight and probably does not directly affect bird utilization, however, it indicates higher siltation rates for Lake Fayetteville. Food availability appears to be similar between the two lakes, especially macroinvertebrates (Aguila, 1993). *Chaoborus* and the family Tubificidae dominated the total taxa of Lake Fayetteville and Lake Wedington (89% and 82% respectively). Comparable macroinvertebrate numbers may explain why both lakes had similar numbers of diving foraging birds. Macrophyte biomass was higher for Lake Wedington than Lake Fayetteville in the autumn of 1993 (Sullivan and Brown, 1994). In 1992, however, most of the macrophytes were eliminated by herbicides in Lake Fayetteville (Sullivan and Brown, 1994). Based on casual observation, we suspect in 1995 that macrophytes may be just as or even more abundant in Lake Fayetteville than Lake Wedington. The mean number of surface plant feeders increased approximately eight fold from 0.451 birds per hectare in 1993 to 3.340 birds per hectare in 1995 for Lake Fayetteville (Table 3). This increase was probably due to regrowth of aquatic macrophytes. *Potamogeton* (pondweed), *Zannichellia* (horned pondweed), Polygonum (smartweed), *Ceratophyllum* (coontail), and *Lemna* (duckweed) are excellent food sources for waterfowl (Darling and Cottam, 1936). Estimates of total biomass of these preferred food sources was similar between the two lakes (Sullivan and Brown, 1994). However, duckweed was more abundant in Lake

Fayetteville for both 1993 and 1995, which could influence the number of surface foragers on Lake Fayetteville. Although Lake Fayetteville was twice the size as Lake Wedington, human activity did not appear to affect abundance of waterbird assemblages. When peak waterbird migration occurred, most human activity ceased.

## Conclusions

Several characteristics were evaluated in order to explain relative abundance of waterbirds between the two lakes. Water quality, number of macroinvertebrates, and human activity monitored on and around the two lakes had the least influence on explaining the difference in waterbird abundance between the lakes. Lake surface and water depth seem to be major factors affecting waterbird utilization. Lake surface area probably explains some of the variation between the two lakes. In addition, eutrophication of Lake Fayetteville has resulted in extensive shallow areas which enhances food accessability for surface feeders. Increase of shallow water and the probable regrowth of macrophytes since herbicide use in 1992 on Lake Fayetteville may help explain why surface feeders are becoming more abundant on Lake Fayetteville.

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