WILDLIFE SESSION

WATERFOWL USE OF STRIP MINE PONDS IN ALABAMA[a]

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Abstract: Waterfowl use of 23 coal strip mine ponds in Alabama was investigated from January 1976 to December 1977. Nine of the ponds were 5 years old at the time of the study, 10 were 15 years old and 4 were 25 years old. Visual observations were made on a monthly or bi-weekly basis to determine waterfowl usage. Vegetation, cover, and food production on 10 of the ponds (three 5-year-old ponds, four 15-year-old ponds, and three 25-year old ponds) were investigated to evaluate pond potential as waterfowl habitat. Older ponds were positively correlated ($P<.01$) with increased waterfowl use. Species most frequently observed were wood duck (*Aix sponsa*), ring-necked duck (*Aythya collaris*), and pied-billed grebe (*Podilymbus podiceps*). Lack of shoal waters, limited food resources, and lack of cover on younger ponds are believed to be limiting factors for waterfowl.

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Removal of coal by strip mining is becoming more common in the United States than in the past. In 1973 strip mined coal represented 60% of Alabama's total coal production (Ward and Evans 1975). Such production is likely to continue for the next decade, placing Alabama in the top 4 or 5 states in strip mining (Knight 1972). Based on coal reserves, spoil areas in Alabama could eventually amount to more than 200,000 ha in the northern part of the state.

Increased strip mining activity in Alabama coincides with a severe depletion of wetland and waterfowl habitat throughout the nation (Shaw and Fredine 1971). Only one-seventh of the original winter waterfowl habitat in the Mississippi River Valley remains (Schoenfield and Hine 1958). The destruction of the important wintering areas in hardwood bottomland in Louisiana is continuing at a rate that could eliminate such areas by the early 1990's (Douglass 1970).

Ponds and lakes are prominent artifacts of past strip mining activities. Data from some northern states indicated 10-20% of the spoil areas may contain aquatic habitat (Yeager 1940, Roseberry and Klimstra 1964). These data, extrapolated to Alabama, could mean the creation of 20,000 to 40,000 ha of aquatic habitat in strip mine areas of Alabama.

The use of strip mine ponds by waterfowl has been noted by several authors (Yeager 1940, Riley 1954, Beshears 1955, Collins 1956, Riley 1960, and Haynes and Klimstra 1975). Most referred to the presence of waterfowl on strip mine ponds and some authors indicated numbers and species of birds observed. To provide baseline data for future comparisons, we investigated in detail the use of Alabama strip mine ponds by waterfowl

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from January 1976 to December 1977.

The objectives of the study were: 1) To ascertain seasonal waterfowl occurence patterns on aquatic habitats within surface-mined lands in Alabama. 2) To determine general aquatic vegetation composition and successional trends in strip mine ponds. 3) To investigate the production of commonly used waterfowl foods on strip mine ponds.

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METHODS AND MATERIALS

Study Areas

Research and data collection took place on 4 mine complexes in the northwest quarter of Alabama: (1) Kellerman (Tuscaloosa County), (2) Peabody (Jefferson County), (3) Sunlight (Walker County), and (4) Manchester (Walker County).

Vegetation on unmined adjacent areas was primarily mixed hardwood-pine with oaks (*Quercus* spp.) and loblolly pine (*Pinus taeda*) predominating. Vegetation on the strip mined areas ranged from none on the most recently mined areas to annual weeds and grasses on the intermediate age mined areas to extensive forested growth on older areas. A detailed description of vegetation on strip mine areas of the same age classes and vicinity is given by Winterringer (1978). Twenty-three ponds were selected within these 4 complexes. The ponds were of 3 age-classes; 5, 15, or 25 years since the last mining. Nine of the ponds were of the 5-year class, 10 were of the 15-year class, and 4 were in the 25-year class. Ponds were identified by a number indicating age class and a letter designating the individual pond.

Waterfowl Observations

Observations with 10 x 50 binoculars and a 15X - 60X spotting scope were made on a monthly or bi-weekly basis on the 23 ponds except for instances when union strikes prohibited access to ponds. During each observation a careful approach to the pond margin allowed observation of the entire pond surface and shoreline for the presence of waterfowl. Distance between ponds precluded simultaneous observations so observations were made at various times of the day. Observations lasted from 1 minute on small ponds to more than 30 minutes on large, irregularly shaped ponds.

Vegetational Analysis and Physical Characteristics of Ponds

To judge the value of the strip mine ponds as waterfowl habitat and to compare the vegetational types of the different aged ponds, we used a modification of the system reported by Beard (1953). This involved the measurement of designated cover types along an established transect. Ten of the 23 ponds were selected for cover mapping and aquatic vegetation analysis: three 5-year ponds, four 15-year ponds, and three 25-year ponds.

Initially an outline map of the study pond was drawn and a number of evenly spaced transects across the pond were assigned. Using a graduated line, we then measured pond depth to the nearest 0.5 m at evenly distributed stations across the transect beginning and ending 0.5 m from the shore.

It was necessary to cover map only the shoreline, since emergent vegetation or cover on the surface of the ponds was almost nonexistent. The presence of overhead cover was measured by determining the percentage of each shoreline transect that had overhead cover. Overhead cover was designated as any type of vegetational growth at least 1 m above the water's surface and directly over the water's edge.

Light penetration was measured with a standard 20 cm Secchi disc (Welch 1948).

Hydrogen ion concentration (pH) of each pond was measured with a La-Motte pH meter, HA series. The conductivity of each pond was measured in micromhos per cm with a LaMotte Multirange conductivity meter - Model DA series. Conductivity and pH were measured on a quarterly basis in all 23 ponds except when equipment malfunctioned, ponds dried up, or when access to ponds was denied because of union strikes.

Within each of 10 randomly selected sections of pond shore, 3 measurements at systematically assigned points (30 per pond) were made of the width of the zone of potentially useful shoal water. This width was the distance from shore to a point where the depth was 50 cm, the approximate maximum depth at which dabbling duck species can feed.

Benthic organisms were sampled with an Ekman dredge that had a "bite" of 250 cm^2. Fifteen random bottom samples from each of the 10 selected ponds were taken and strained through graduated seives (10, 18, and 35 mesh). Organisms were preserved in 10% Formalin for identification and counting.

The data were interpreted statistically by analysis of variance (Steel and Torrie 1960). Data on overhead cover and shoreline vegetation were converted to Arcsin Percentage Transformation values before computations were performed.

RESULTS AND DISCUSSION

A total of 287 waterfowl representing 6 species was observed on the 23 strip mine ponds from January 1976 to December 1977 (Table 1). Most abundant species observed were wood duck, ring-necked duck, and pied-billed grebe. There was a highly significant

TABLE 1. Waterfowl counted during visits to 23 5-, 15-, and 25-year class strip mine ponds in Walker, Jefferson, and Tuscaloosa Counties, Alabama, from January 1976 through December 1977.

Numbers counted by pond age				
	Age in years			
Species	5	15	25	Total
Ring-necked duck (*Aythya collaris*)	37	0	51	88
Wood duck (*Aix sponsa*)	3	12	103	118
Lesser scaup (*Aythya affinis*)	0	4	0	4
Pied-billed grebe (*Podilymbus podiceps*)	5	47	8	60
Hooded merganser (*Lophodytes cucullatus*)	0	9	0	9
American coot (*Fulica americana*)	0	0	1	1
Unidentified waterfowl	0	5	2	7
Total Birds Counted	45(275)[a]	77(395)	165(193)	287(863)[a]
Avg. no. birds counted per observation per pond age class	0.16	0.19	0.85	

[a]Numbers in parentheses represent observations per pond group.

difference ($P<.01$) in birds observed among ponds of the 3 age classes. The difference was greatest between the 25-year class and the other age classes. The average number of birds seen per observation per pond was 0.16 for the 5-year class, 0.19 for the 15-year class, and 0.85 for the 25-year-old ponds.

In January 1977, an aerial survey of 85 strip mine ponds on and near the study area revealed only 3 ducks on 1 of the study ponds (15-H). These ducks were not positively identified but were believed to be 3 hooded mergansers (*Lophodytes cucullatus*) that were observed on this pond at other times.

Major pond uses appeared to fall into 2 categories: (1) wood ducks used the older ponds as nesting and brood rearing areas; accumulation of feathers in remote sections of the 25-year ponds also indicated they were used as molting sites; (2) diving ducks used ponds of various ages as migration resting and wintering areas.

Wood ducks were seen on 100% of the 25-year class ponds, on 20% of the 15-year class ponds, and on 11% of the 5-year class ponds. During June-August 1976, at least 2 broods of wood ducks were reared on pond 25-A. This pond was extremely acidic (pH 2.9 to 3.0) and supported no aquatic vegetation. Feeding activities of the 2 broods on pond 25-A were observed often, and it became apparent that insects were the main food consumed by the developing young. When the young were able to fly, they began to disperse, first as a group, then singly or in pairs to surrounding strip mine ponds which supported aquatic vegetation, principally southern naiad (*Najas quadalupensis*).

An absence of natural cavities and loafing sites was characteristic of the strip mine ponds studied. Recently stripped areas and ponds remote from cavity bearing trees have limited nest sites or none. Two nest boxes were mounted on pine trees on the banks of pond 25-A in February 1977. These boxes were used by wood ducks in spring 1977, but the broods were never seen. Duckling survival might also be affected by lack of adjacent nesting sites since a negative correlation was reported between duckling survival and distance of overland travel by young broods (Ball et al. 1975).

The only observed loafing site used by wood duck broods on pond 25-A was a partially sunken pine tree about 15 m from the bank. Beard (1964) stated that the number of loafing sites in a brood rearing marsh could be a limiting factor on the number of broods present and the length of time they use the area.

Beavers (*Castor canadensis*) had felled several pines which were lying partially in the water. Although these trees were never observed as utilized loafing sites, such activities by beavers on these ponds would enhance the number of loafing sites available.

The use of beaver ponds as waterfowl habitat has been well documented (Beard 1953, Speake 1956, Arner 1963, Johnson et al. 1975). Beaver were seen or their sign was found on 15 of 23 study ponds. Only 3 of 9 5-year class ponds had beaver or sign, but beaver used all except 2 of the 15- and 25-year ponds (n=14).

Use of the study ponds during the winter and migration period was primarily by ring-necked ducks. Age class of the ponds did not seem to be as important as size, seclusion, and presence of suitable food. Pond 5-F had a flock of 9 ring-necked ducks which remained through most of the 1976-77 winter. These birds may have preferred this pond because of the presence of a pond-weed (*Potamogeton pusillus*) which Martin and Uhler (1939) listed as a fair to good duck food. Pond 5-F was also relatively large (1.5 ha) and isolated.

Another flock of 51 ring-necked ducks was observed on pond 25-B in December 1976. These birds left the pond the same day they were discovered and were not observed again. This group represented the largest concentration of birds seen on any strip mine pond during the study.

Other waterfowl observations were primarily of migrating birds which used ponds for short periods. Overall, use of ponds during other than the summer nesting period was sporadic.

Vegetational Analysis and Physical Characteristics of Ponds

Most ponds in all age classes had relatively little aquatic vegetation and usually only 2 or 3 aquatic species were found. Two submerged aquatics often found in association in 3 of the 15-year or older ponds of the Manchester complex were southern naiad and chara (*Chara* spp.) (Table 2). In areas where naiad was present, it probably represented a good food resource because of its abundance and availability, (Martin and Uhler, 1939). Ponds with the extensive naiad growth were used by dispersing wood duck broods, and lesser scaup and ring-necked ducks were also observed feeding on naiad. Chara was found wherever southern naiad was present, but was also found growing with extensive stands of *Eleocharis acicularis* which covered most of the bottoms of ponds 15-G and 15-I. Neither chara nor naiad was found in 5 year-class ponds.

Wood ducks were observed feeding on *Potamogeton diversifolius* which grew on 3 of the 10 intensively studied ponds as well as 1 of the observation ponds (Table 2). *P. diversifolius* generally occurred in such limited quantities that it was probably of limited value as a duck food.

Potamogeton pusillus was found only on pond 5-H. An estimated 55-60% of the bottom area contained this plant which Martin and Uhler (1939) listed as a fair to good duck food.

Most of the other aquatic plant species indicated in Table 2 were present in very limited amounts or were not good duck foods. Species such as buttonbush (*Cephalanthus occidentalis*) and rushes (*Juncus* spp.) are considered marginal duck foods, but ducks

TABLE 2. Principal aquatic vegetation associated with 10 5-, 15-, and 25- year class strip mine ponds in Walker, Jefferson, and Tuscaloosa Counties, Alabama. 1976-77.

	Pond Designation									
Species	5D	5F	5H	15C	15F	15G	15I	25A	25B	25D
Chara spp.				X_m	X		(X)		X_m	
Potamogeton foliosus	X									
Potamogeton pusillus		*(X)*								
Potamogeton diversifolius			(X)				X_m			X
Najas guadalupensis				(X)	(X)				(X)	
Eleocharis obtusa		X	X			X	X		X	
Eleocharis acicularis						X	X			
Myriophyllum brasiliense									X	
Utricularia spp.			X							
Carex spp.				X				X	X	X
Cephalanthus occidentalis				X	X					
Typha latifolia	X	X	X			X	X			X
Scirpus cyperinus						X	X	X	X	
Juncus spp.										X

X - present but not a desirable duck food, or available in only limited amounts.
(X) - potential food source because of abundance, frequency and amounts present.
X_m - minor food source because of limited distribution and relative inaccessibility.

were not observed to use them. Their main value to waterfowl probably lies in their use as substrate by aquatic invertebrates. Various species of *Eleocharis* and *Scirpus* are noted as food sources for many insects (Frohne 1938, 1939). From the standpoint of insect abundance, ponds such as 25-A with well vegetated shorelines were more suitable as brood rearing areas than ponds with mostly rocky or barren shores.

The amount of overhead cover along the shoreline and percentage of vegetated shorelines (Table 3) were 2 of the most readily distinguishable features of ponds in the different age-classes. Among ponds of different ages, the percentage of overhead cover differed significantly ($P<0.05$) and the differences in percentage of vegetated shoreline were highly significant ($p<0.01$). These features, in addition to a very steep shoreline, limited access along the shore of the ponds and restricted visibility of ponds from the shore. This restriction of access was particularly characteristic of pond 25-A which was used by nesting wood ducks. Pond 25-A, of all ponds studied, had the highest percentage of vegetated shoreline (95%) and the second highest percentage of overhead cover (76%); this pond also had the highest recorded use by wood ducks and their broods.

The fact that wood ducks utilized and reared broods on pond 25-A, even though it was extremely acidic (pH 2.9-3.0) and contained no aquatic vegetation, demonstrates the importance of shoreline vegetation to waterfowl and indicates that even vegetatively sterile ponds are of some value.

Pond 5-F had only 30% of the shore vegetated and 0% overhead cover. The presence of the ringnecked ducks on this pond implies that shore vegetation on strip mine ponds may not be as important to diving ducks as to wood ducks.

Summer pH readings of 15 of 21 of the study ponds were 7.0 or greater (Table 3), and seasonal fluctuation of pH in most ponds was slight. The 6 most heavily used ponds (waterfowl observations ranging from 15 to 87 birds) had average pH readings ranging

TABLE 3. Chemical and physical characteristics of 10 5-, 15-, and 25-year class strip mine ponds in Walker, Jefferson, and Tuscaloosa Counties, Alabama, 1976-77.

Pond	pH	Conductivity[a]	Overhead cover[b]	Veget.[c]	Avg. Depth	Shoal Water Zone[d]	Light Penetr.	Pond Size
		(micromhos/cm)	(%)	(%)	(meters)	(cm)	(meters)	(ha)
5D	4.7	460	.1	13	2.08	102	5.00	4.6
5F	7.6	610	0	11	2.01	75	2.18	1.5
5H	7.3	275	0	30	2.92	79	3.81	0.5
15C	7.5	1400	39	52	2.74	73	2.58	0.3
15F	7.7	220	28	10	5.85	61	3.26	1.2
15G	6.8	580	10	72	1.05	95	2.12	1.0
15I	7.7	570	18	76	2.19	79	1.71	1.4
25A	3.0	1000	76	97	5.33	68	2.73	3.0
25B	8.0	1040	53	62	2.94	68	2.47	1.5
25D	7.6	60	100	77.5	1.36	120	0.48	0.2

a - Measured in micromhos/cm during July - August 1976
b - Percent of shoreline containing overhead cover.
c - Percent of shoreline interface containing some type of vegetation.
d - Indicates distance from shore to depth of 50 cm.

from 3.0 to 7.6. Four of these 6 ponds had average pH readings greater than 7.0, but the most frequently used pond (25-A) had an average pH of 3.0.

Specific conductance of pond waters varied widely, ranging from 44 to 1600 micromhos per cm. Neither pond age class nor duck observations was correlated with conductivity or pH of ponds during this study. Ponds in all age classes had both high (>1200 micromhos/cm) and low (<200 micromhos/cm) readings. The 6 most used ponds had average conductivity readings ranging from 202 to 1025 micromhos/cm.

One of the most obvious physical features of most strip mine ponds is the steeply sloping pond margin which produces a narrow band of shoal water and extensive areas of deeper water (Crawford 1942, Bell 1956). The general lack of shallow water prohibits the development of rooted vegetation and precludes extensive feeding by dabbling ducks which can feed only at depths of 45-50 cm or less. This is an important factor limiting the present and future use of strip mine ponds by dabbling ducks. Measurements of the zone of shoal water on the pond margins indicated that water 50 cm or less in depth extends outward an average of only 82 cm from the shoreline. This affords a very limited portion of total water area for establishment of vegetation useful to dabbling ducks. Development of rooted vegetation is also inhibited by lack of organic material and nitrogen in pond bottom soils (soil tests results, Auburn University 1977).

Depth of water in the strip mine ponds ranged from a few centimeters to slightly over 11 m. with an average maximum depth of 5.5 m. However, 40% of the water area was at least 2 m. deep in 7 of the 10 ponds measured.

Pond 5-F that contained *P. pusillus*, which was eaten by the overwintering ringnecked ducks, had a maximum depth of 3.5 m. This pondweed grew at all depths in the pond, but seemed to be most dense at 2.0-3.5 m. Growth of other aquatics seemed to be most dense at 1.0-2.5 m. *P. diversifolius* was found in water a few centimeters deep to 2.4 m and was most abundant in 1.5-2.0 m water. Southern naiad grew at a wide range of depths but seemed to grow best at 2.0-2.5 m. This species grew in dense mats that were often continuous from the pond bottom to the surface.

Another factor that may affect waterfowl use of strip mine ponds is size of the ponds. The 6 most used ponds averaged 1.9 ha, and all but 1 of these was 1.5 ha or larger. Eight ponds where no waterfowl were seen averaged .5 ha. Although not conclusive, this indicates that larger ponds are preferred over smaller ones. Only 8 of the 23 study ponds were 1.5 ha or larger.

Bottom Sampling

Chironomidae was the only invertebrate group found in all ponds (Table 4). Another group of midges (Chaoboridae) was found in 7 of the 10 ponds sampled. Presence of these groups was not surprising, since they are pioneer species that are often found in many polluted waters (Crawford 1942). Crawford also noted that extremely acid stripmine ponds in Missouri contained only Chironomidae, Ceratopogonids, and Odonate larvae. Of the 7 kinds of fauna found in the bottom samples, 4 (Chironomidae, Coleoptera, Gastropoda, and Odonata) are mentioned as important duck foods (Martin and Uhler 1939). A wide range in quantities of benthic organisms was noted among the ponds. Much of the variation found in the benthic fauna numbers may be due to the sampling technique which proved to be unsuitable for sampling such rocky bottoms. However, other factors may have affected sampling efforts. For instance, pond 15-C was sampled about 1 week after it was illegally dynamited, presumably to collect the fish. The large number of gastropods in the sample may reflect a large kill resulting from the shock of the explosion. Higher organisms such as Neuroptera, Odonata, and Coleoptera were associated more with the 15-and 25-year class ponds.

Benthic organisms could not be accurately quantified because of sampling problems; however, their presence made them a potential food source for ducks. The fact that most

TABLE 4. Benthic organisms[a] associated with 10 5-, 15-, and 25-year class strip mine ponds in Walker, Jefferson, and Tuscaloosa Counties, Alabama, 1976-77.

	Pond Designation									
Taxa	5D	5F	5H	15C	15F	15G	15I	25A	25B	25D
Chaoboridae	11	136	1	9	18				15	139
Ceratopogonidae							1			
Chironomidae	1	93	2	61	13	1	6	183	56	46
Neuroptera	7					5	1	30		
Odonata	1		1	1		2	1	1	5	
Gastropoda[b]			23	113	64		2		12	
Coleoptera						16	3	1		2

a - Total organisms found based on 15 samples with Ekman dredge (250 cm^2 capacity).
b - Number of Gastropods is total number of whole shells found.

of the bottom feeding area is located in water greater than 50 cm deep would make most of the benthic fauna found in these samples available only to diving ducks.

SUMMARY AND CONCLUSIONS

On the basis of 19 months of observation, waterfowl use of strip mine ponds in northwest Alabama is sporadic. Wood ducks use older aged ponds with extensive shoreline vegetation and overhead cover for nesting and brood rearing areas. The more secluded ponds may also be used as molting sites. Extremely acidic ponds can be useful to wood ducks if the shoreline vegetation provides enough food to enable the young to reach the flight stage. Diving ducks, such as ringnecked ducks, use any age ponds as resting areas during migration and may winter on ponds which have a suitable food source.

The absence of natural tree cavities and loafing sites on strip mine ponds may limit their usefulness as nesting and brood rearing areas. Establishment of nesting boxes on ponds about 20-25 years old would enhance their potential as nesting areas for wood ducks. Beavers are beneficial to the environment of the ponds in that they can provide loafing sites for ducks and habitat for invertebrates when they fell trees into the water. They also contribute organic matter to the relatively sterile ponds.

Aquatic vegetation was limited in species diversity and abundance. Usually only 2 or 3 aquatic species were found in a pond. Two species that were used by waterfowl and may offer management potential are southern naiad and *P. pusillus*. Naiad growth may be so dense that control measures may be necessary especially if the pond is to be used for other purposes. *P. diversifolius* and chara are other species which may be useful food sources if abundant. The species of aquatic vegetation that become established in a strip mine pond are probably reflective of the area where the pond is located and available seed sources. Ponds clustered in a single mining complex will tend to have the same aquatic plant species.

The most distinguishing features of different pond age-classes are the increase in shoreline vegetation and overhead cover as pond age increases. Alteration of physical features provides an opportunity to increase the potential use of ponds especially by wood ducks by grading the pond banks to create more pond shoreline and more gently sloping pond margins.

Rooted aquatic vegetation in the ponds is severely restricted by the small areas of shallow water where it can become established. The small area of water less than 50 cm deep prevents dabbling ducks from using much of the potential bottom feeding areas.

Ponds 1.5 ha or larger, are probably more useful to ducks than smaller ponds according to results of this study.

Benthic fauna, potentially useful to ducks, are present in most ponds, but because of the deep waters are available mainly to diving ducks. Higher groups of invertebrates such as Odonates and Gastropods are associated more frequently with older ponds and ponds with more aquatic vegetation.

With implementation of the Federal Surface Mining Control and Reclamation Act of 1977, the creation of new strip mine ponds is likely to be greatly reduced (Federal Register, Vol. 42, No. 239:62716). High walls and open pits left by the final cut will be eliminated and with them the areas most likely to become ponds. Under the new regulations, ponds and other permanent water bodies may be created, but they must be planned as part of the reclamation effort. This should allow for construction of ponds with more desirable physical characteristics than in the past. With advanced planning, increased shoreline length with irregular shape, gently sloping pond bottoms, and areas of shoal waters can be created. Top-soil, which must be replaced under the new regulations, will provide a much better substrate for development of rooted vegetation rather than the rocky bottom typically present. Although total water area is likely to be reduced on new strip mined areas as opposed to earlier mined areas, with proper planning the quality and potential of the new ponds for management of waterfowl should be enhanced.

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