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Waterfowl Brood Use of Wetlands in Relation to Habitat Parameters in the Kvichak Area

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INTRODUCTION

Waterfowl populations across North America are currently at historically low levels due to increasing losses of breeding, wintering and migration habitat (N. Am. waterfowl Manage. Plan 1986). These declines are primarily a result of the continued conversion of wetland habitat to agricultural use in the mid-continent prairie-parkland breeding areas (Tiner 1984, Sanderson 1980). In addition, cyclic drought conditions during most of the 1980's in portions of the prairie potholes have caused decreases in pond numbers, poor habitat conditions, and reduced waterfowl production (USFWS 1985). The production potential of high latitude areas is therefore increasingly important, as these areas now contain substantial portions of breeding populations of species of significant management interest (e.g. northern pintails) (Derksen and Eldridge 1980,Smith 1970, Hansen and McKnight 1964).

Alaska contains millions of acres of wetland habitat representing a significant nesting area for many species of waterfowl (Bellrose 1980). While much of this habitat is managed by the U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game, important breeding areas exist on Bureau of Land Management (BLM) lands. While some of these lands may be more important waterfowl breeding habitat than others, the Kvichak block within the Anchorage District contains substantial wetland habitat, and is therefore being considered for its waterfowl production potential. Aerial breeding pair surveys in 1992 revealed breeding waterfowl densities of 35.9 ducks per square mile of habitat in stratum 8 (Bristol Bay) (Connant and Groves 1992). While these densities are low relative to other BLM lands in Alaska, it is crucial to understand habitat features important to breeding, nesting and brooding waterfowl using the Kvichak block so the area can be assessed for its waterfowl production potential and comparisons can be made with more productive areas.

RELATED STUDIES

Past research has assessed waterfowl use patterns and hydrochemical characteristics of interior Alaska wetlands. Murphy et al. (1984) showed phosphate and nitrate concentrations in the water column to be correlated with duck use. High concentrations of these nutrients were linked to both high duck density and species richness. Hydrological connection to flowing water was also associated with higher densities of ducks when compared to isolated waterbodies, because of higher nutrient levels associated with the inflow of water (Murphy et al. 1984, Kessel et al. 1980, Heglund 1988). Breeding densities of waterbirds (ducks, geese, swans, loons, grebes) were found to be positively correlated to total phosphorous concentrations by Nilsson and Nilsson (1978) as well.

Inorganic nutrients, particularly phosphorous and nitrogen, are considered limiting factors in the productivity of wetlands (Richardson et al. 1978). Growth of aquatic plants is often limited by nitrogen and phosphorous availability, therefore the rates at which these nutrients are supplied, cycled and removed from the wetland environment are critical to plant growth (Kadlec 1979). Ducks in turn may use nitrogen and phosphorous rich lakes in a response to higher primary productivity levels. On interior Alaska wetlands Heglund (1988) reported a positive correlation between waterbird density (ducks, geese, swans, loons, and grebes) and total phosphorous and nitrogen concentration, cation salinity (calcium, sodium, and potasium concentration) and shoreline length. Large, productive, slightly brackish lakes supported the highest densities of waterbirds.

Habitat requirements for duck broods depend both on the amount of surface water available and wetland fertility. Patterson (1976) found the highest density of duck broods on fertile, hard water ponds with abundant submerged macrophytes because these ponds provided both escape cover and food. Courcelles and Bedard (1979) found that broods, as well as adult birds selected habitats of open cattail (<u>Typha</u> <u>augustifolia</u>) with open areas dominated by submerged hydrophytes (<u>Lemna</u>, <u>Myriophylum</u>, <u>Ceratophylum</u> and <u>Utricularia</u> species). Submerged aquatic plants and their associated invertebrates are important factors in waterfowl use of ponds. Duck use of wetlands is positively correlated with invertebrate numbers (Joyner 1980), although invertebrate numbers depend largely on the species and abundance of submerged aquatic plants (Krull 1970). Aquatic vegetation alone can be an important waterfowl food, however even those plants of low food value are indirectly important to waterfowl production as they provide habitat for macroinvertebrates which are an important source of animal protein for ducks (Krull 1970, Serie and Swanson 1976). Dabbling ducks concentrate their foraging in areas with the highest abundance and biomass of invertebrates and often seek out areas inhabited by prey items of high nutritive quality (Kaminski and Prince 1981). High invertebrate populations often coincide with peak hatching of waterfowl (Bergman et al. 1977) and constitute a major portion of the diet for many species of ducklings (Sudgen 1973).

Brood use of saline lakes is determined principally by salt concentrations, the availability of freshwater, and aquatic foods (Swanson et al. 1984). Ducklings cannot tolerate high levels of sodium chloride. Also, high levels of sodium chloride cause changes in the species structure of invertebrates and plants attractive to ducks, thus affecting their use of saline wetlands (Swanson et al. 1984).

A similar study looking at waterfowl brood use of wetlands in relation to habitat types was conducted in the Iditarod George block of BLM lands in the Lower Innoko-Yukon River area in 1990 and 1991. Physical, chemical and biological variables were compared with duck brood use on 104 separate wetlands in 4 different habitat strata (Seppi in press). Results of that study suggest a positive correlation between shoreline length, potasium, total nitrogen, color and pH for dabbling ducks, and shoreline length, aquatic invertebrates, chlorophyll a and specific conductivity for diving ducks.

It is clear that physical and chemical characteristics of wetlands influence plant and invertebrate communities which are important to waterfowl. These characteristics are therefore critical in evaluating wetlands as potential habitat for waterfowl. Before management to increase waterfowl production is undertaken, it is essential that the relationship between habitat factors and brood production be understood. Limited data exist that relate characteristics of Alaskan boreal forest wetlands to their use by waterfowl broods (Murphy et al. 1984, Heglund 1988). The Lower Innoko/Iditarod George study is the only data that exist for BLM lands in Alaska. The purpose of this project is therefore to examine the correlation between habitat parameters of wetlands and waterfowl brood use on BLM lands in the Kvichak area. These results will in turn be compared to other waterfowl use of habitat studies on public lands under BLM management in an effort to recognize those lands most important to waterfowl production.

OBJECTIVES

The objectives of this project are to measure the limnological characteristics of wetland habitats found in the Kvichak area and relate these characteristics to their use by duck broods. Specific objectives include:

1. Identify and describe types of wetlands used by waterfowl broods.

2. Describe the morphometric characteristics of wetland habitats and examine the correlation between those characteristics and duck brood use of wetlands.

3. Describe the water chemistry of wetland habitats and examine the correlation between these chemical factors and duck brood use of wetlands.

4. Describe the aquatic and surrounding terrestrial vegetation of wetlands and examine the correlation of those plants with duck brood use of wetlands.

STUDY AREA

The study area is located at the base of the Alaska Peninsula near King Salmon, Alaska. These lands (Kvichak block) are public lands under BLM management, and lie approximately 340 kilometers southwest of Anchorage. The area, (59° 00'N, 156° 30'W) covers approximately 5625 square kilometers and extends east to the western shore of Lake Illiamna, west to the Nushagak River, north to 59^{o} 45'N latitude, and south to the village of King Salmon. Within this area, approximately 4940 square kilometers of BLM administered lands are interspersed with private and state owned lands (BLM 1987). The major drainage rivers for the area are the Kvichak, Alagnak, and Nushagak Rivers.

The area lies on a glacial outwash of shallow sandy/gravelly soils with discontinuous and isolated masses of permafrost (Selkregg 1976). Its vegetation is a transition between the forest/tundra plant communities found farther north and the treeless grass/sedge/dwarf shrub/lichen tundra typical of the Alaska Peninsula. Most of the area is rolling dwarf shrub tundra with numerous small pothole lakes to the north and larger, more productive wetlands to the south. A band of spruce forest (Picea sp.) extends in a narrow strip across the center of the area, approximately along the path of the Alagnak and Kvichak Rivers. Wetlands in the northern portion tend to be small, deep, clear, and virtually void of sediment and aquatic plant life. These wetlands have a deep emerald green color that is apparent from the air and when using a Secchi disk to measure transparency. They have deep, bowl shaped basins with rock or gravel bottoms that drop off quickly in depth with no shallow areas along the shoreline. Maximum depth in these lakes sometimes exceeds 15 meters. These wetlands have closed hydrological regimes with snowmelt, rain and ground water as their only source of water replenishment. Such wetlands obtain their nutrient flux mainly from rain and ground water, depending on the substrate (Gosselink and Turner 1978), thus have a low nutrient flux and may be less desirable to waterfowl (Murphy et al. 1984). Wetlands in the southern portion are larger in surface area, shallower, more turbid, and have more aquatic plant life than those in the north. Although these wetlands also have closed hydrological regimes, they are relatively more productive because of their shallow depth (1 meter maximum) which provides favorable conditions for aquatic plant growth. The higher surface areas, shallow depths, and the subsequent higher productivity (Seppi in press), as well as more abundant aquatic plant growth, may make these wetlands more desirable to breeding waterfowl.

METHODS

Selection of Wetlands

Wetlands were selected with the aid of 1:121120 black and white aerial photographs and 1:63360 topographic maps of the study area. To select individual wetlands, each 1 square mile section marked on the topographical maps were assigned a number. Within these sections, each wetland was also assigned a consecutive number. A single section within the study area was then selected with the use of a random numbers table. A second random number was taken from the table to pick a wetland from that section. If sections without wetlands were chosen, they were rejected and a new section chosen. This was done repeatedly until 200 individual wetlands had been selected.

All wetlands were accessed by aircraft. Those wetlands at least 2500 feet in length in at least one direction were accessed by float plane. Smaller pothole wetlands were accessed by helicopter. A total of 100 different waterbodies were sampled in the first field season; 60 accessed by helicopter and 40 by floatplane. No wetlands were repeatedly surveyed.

Brood Surveys

Use of individual wetlands by waterfowl broods was estimated by aerial and ground surveys. All wetlands accessed by helicopter were surveyed for broods from the air as they were first approached. The entire shoreline of the wetland was flown at low altitude (<100 feet) and broods recorded as they flushed. Larger wetlands accessed by floatplane were surveyed from the ground. Field crews of two persons walked, or when possible canoed in opposite directions along the shoreline of each waterbody. In both aerial and ground surveys species, age class (Gollup and Marshall 1954) and number of all waterfowl broods observed were recorded.

Brood surveys and collection of habitat parameters were conducted simultaneously at each wetland. The survey started on 25 June and continued until 17 July. Surveys were conducted once for each waterbody. Brood surveys should be started when an abundance of dabbling duck broods of class IB (approximate age) are seen (J. Sedinger, pers. comm.). When the majority of broods seen are of this age class, most of the dabbling duck broods are assumed to have hatched. More broods were seen later in the field season, especially diving and sea ducks. It is therefore possible that those species may have been under sampled.

Limnology

Limnological characteristics were sampled starting 25 June and continued until 17 July. Water samples for chemical analysis were collected in appropriate containers at the surface of each waterbody. Physical characteristics (transparency, surface temperature, average depth) and those chemical characteristics which could be measured on site (specific conductivity, total alkalinity, color, pH) were also measured at each waterbody. Shoreline length and surface area will be estimated by planimetry of aerial photographs. Shoreline development, which reflects the degree of shoreline irregularity, will be calculated from these measurements. Hydrological regime will also be determined from these photographs. I determined chlorophyll a concentrations from field samples myself using laboratory facilities at the University of Alaska Fairbanks. Water samples were sent to the University of Missouri at Columbia to be analyzed for total phosphorous, total nitrogen, and the major cation and anions (Calcium, magnesium, sodium, potasium, chloride, and sulfate). The results of these analysis have not yet been obtained.

Water transparency was measured using a Secchi disk attached to a graduated cord and recorded to the nearest 1/4 meter. Specific conductivity (recorded in micro semens) and pH were measured with a Corning Check-Mate 90 hand held meter with detachable conductivity and pH sensors. Water temperature was measured at the surface using a digital thermometer built into each of the detachable sensors. Filtered water samples were visually compared with a Hach color disk to determine color and recorded in platinum cobalt units. Bicarbonate alkalinity was determined colorimetrically using a Hach digital titrator and recorded in mg/l. Chlorophyll a samples were collected using a hand operated vacuum pump to filter up to 1 liter of water through a .45-.50 micron glass filter. The glass filters where then wrapped in paper filters and placed in airtight darkened containers with desiccant. Chlorophyll a concentrations were later measured flourometrically (Knowlton 1984) using an acetone extraction method (Satory and Grobbelaar 1984) and recorded in mg/l.

Water samples for total nitrogen and total phosphorous were collected in 500ml bottles and subsamples of 10ml each were pipetted into clean acid washed test tubes at the end of each day. Total nitrogen samples were preserved with one drop of concentrated sulfuric acid, and concentrations were later determined by cadmium reduction followed by a colorimetric measure of nitrite (USEPA 1975). Total phosphorous samples were preserved by refrigeration as soon as possible and concentrations were determined by a colorimetric measurement using a molybdateantimony reaction which measures orthophosphate after a persulfate digestion (USEPA 1975). A single filtered water sample of 50ml was taken for calcium, magnesium, sodium, and potasium and also preserved with one drop of concentrated sulfuric acid. Calcium concentrations were later determined by titration with EDTA while magnesium, potasium, and sodium concentrations were determined by atomic absorption spectrophotometry (USEPA 1975). A single water sample of 125ml was taken for sulfate and chloride and also preserved by refrigeration as soon as possible. Sulfate concentrations were determined by spectrophotometry of turbidity caused by a barium sulfate reaction, and chloride concentration by titration with mercuric nitrate (USEPA 1975).

Vegetation Sampling

Dominant terrestrial vegetation types will be described using black and white aerial photographs and descriptions from field notes.

Aquatic vegetation types were sampled using a modified belt transect described by Jensen and Van der Maarl (1971). On each wetland 2 transect lines were established in east-west and north-south directions perpendicular to the shoreline. In a strip 1 meter wide along the transect line (Bergman et al. 1977) plant species were recorded at 10 meter intervals. All plant species were identified using Welsh (1974) and Hulten (1968). Depth measures were also taken along the aquatic vegetation transect lines. Depth was determined using a weighted measuring line. Soundings were taken at 10 meter intervals and depth measurements will be averaged across each transect.

Statistical Analysis

Simple linear regression (Neter et al. 1985) was used in a preliminary analysis to evaluate the relationship between brood density for all dabbling and diving ducks combined and transparency, temperature, specific conductivity, pH, color, chlorophyll *a*, and bicarbonate alkalinity. Brood densities were regressed against each variable individually. Stepwise regression (Neter et al.

1985) and principle components analysis (Johnson and Wichern 1988) were used to select those wetland characteristics that were responsible for the largest portion of variability in duck brood density. All statistical tests were performed using BMDP (BMDP 1987).

Results

Habitat variables and brood comparisons

A total of 19 duck broods were recorded on the Kvichak study area in the 1992 field season, 17 of which were dabbling species (Table 3).

Specific conductivity ($P<0.05$, Fig. 1) and pH ($P<0.05$, Fig. 1) were significantly related to duck brood densities. There was no significant relationship between transparency ($P=0.112$), temperature ($P=0.576$), total alkalinity ($P=0.634$), color ($P=0.621$) or chlorophyll a and brood density. Stepwise regression suggests specific conductivity, pH and color as the three variables most responsible for the variation in duck brood density. The first 2 factors of principle component analysis accounted for 4.16% of the total variance when calculated with transparency, temperature, pH, specific conductivity, total alkalinity, color and chlorophyll a.

Vegetation

Wetlands in the Kvichak area are somewhat unique in that many of them are completely void of aquatic vegetation, particularly the clear, deep pothole wetlands in the northern portion of the study area. In general, aquatic plants were most abundant in the large shallow wetlands in the middle and southern portions of the area. Twenty nine different aquatic and upland plant species where recorded along vegetation transects in all wetlands (Table 2). Dwarf-shrub tundra interspersed with patches of open boreal forest is the dominant vegetation cover of the landscape surrounding surveyed wetlands. Carex *sp.*, Potomogeton praelongus, P. natans were common. Table 2 shows a list of plant species found on the study area.

Discussion

Preliminary analysis of 7 variables suggests a positive correlation with pH, specific conductivity and brood densities. These variables achieved their highest values in large, shallow wetlands with abundant aquatic vegetation along shoreline margins and submerged in open areas. Most of these wetlands were much more turbid than the smaller, deeper potholes in the north and were surrounded by a rolling tundra landscape of dwarf shrubs, lichen and moss. Brood densities reached a peak on these wetlands in early

July. No broods were seen on small, deep, clear wetlands where aquatic vegetation was absent and pH and specific conductivity measures were very low. These low productivity conditions are apparently not as desirable to duck broods (Murphy et al. 1984) although a more thorough assessment will be made when chemical variables are analyzed and a second field season is completed.

The Kvichak area is in general less important to waterfowl production than other BLM lands (e.g. Lower Innoko/Iditarod George area) in Alaska. Most wetlands are isolated hydrologically and water levels remain relatively static throughout the season. This isolated hydrological regime tends to create wetlands of a more ombrotrophic or oligotrophic nature, and does not allow the influx of nutrients which are associated with duck brood use (Murphy et al. 1984, Kessel et al. 1980, Heglund 1988). This hypothesis was supported in the Kvichak area as only 19 broods were recorded from 100 surveyed wetlands. Although brood use is relatively low, it is probable that these wetlands are an important staging area for waterfowl migrating in spring and fall because of its location along migration pathways to and from the Yukon-Kuskokwim Delta. It may also be important to breeding tundra swans that were recorded on wetlands throughout the study area but were not included in the analysis.

Problems and Recommendations

The use of aircraft provided quick and easy access and allowed field crews to sample a large number of wetlands. I am confident that broods surveys done on smaller wetlands with a helicopter provided a good estimate of brood density. However a problem arose with brood surveys on the larger wetlands that were accessed by float plane. No brood surveys were done from the float plane because of its high flight speed and difficulty of observing broods from the cockpit while in the air. Surveys on these wetlands were therefore done on the ground, usually from the collapsible canoe as field crews paddled around the entire shoreline. This was difficult in some cases as many wetlands were very large, and high winds created wave conditions that could be unsafe for canoeing. In these cases some portions of the shoreline were walked or canoed where possible or the entire wetland was scanned with binoculars to count broods. Since duck broods typically take to the margins of shoreline vegetation for escape cover, an accurate estimate of brood numbers requires field crews to travel the entire shoreline to force the broods from cover The brood densities of wetlands whose perimeters were not completely covered and only scanned with binoculars where therefore underestimated. The problem was compounded when the initial approach and landing of the float plane caused broods to take cover, before any brood survey could be attempted. This problem could best be eliminated by taking time to walk the entire shoreline of each wetland to drive the broods from cover or by using a helicopter to do aerial surveys on the very largest wetlands. Alternatively, broods surveys on large wetlands could be done when the helicopter is available, and the float plane used at a later time to collect the limnological parameters.

Field crews in the 1992 season were diligent and ambitious in collecting water chemistry data, however several members could not identify waterfowl or their broods. I many instances birds were observed and descriptions recorded, but in most cases the notes were not detailed or accurate enough to identify the species. The best solution to this problem is to recruit field personnel that are experienced in waterfowl identification. In addition, I will take more time to train individuals who are lacking in these skills or need to review the species of waterfowl typically found on the study area.

The majority of the broods seen in 1992 where dabbling species (Table 3), however many adult diving and sea ducks were observed without broods. This may indicate that these species were breeding in the area but had not yet produced a brood (ie hens were still incubating eggs). If this is the case, a later brood survey would account for these species. The brood survey was conducted until July 17 when the budget had been depleted. Class IIC dabbling duck broods were seen on the study area in late July, however diving duck broods may have been underestimated as the brood survey did not continue into August. This problem could be solved by either lengthening the field season (unlikely with budget constraints) or starting 7 to 10 days later. By extending the brood survey into the first week of August, a more accurate account of diving and sea duck broods can be obtained.

No aquatic invertebrate samples were taken in the Kvichak study area. I had decided against them after I experienced first hand the enormous amount of tedious work involved in sorting and identifying samples collected from the Innoko project. Preliminary analysis suggested that aquatic invertebrates were not significantly correlated to brood densities. However, further analysis of the data from that project suggests a relationship between aquatic invertebrates and diving duck species (Seppi, in press). I therefore think it would be beneficial to collect a limited number of benthic and water column aquatic invertebrates samples from the Kvichak area. I plan to collect samples from both the large shallow turbid wetlands and the deep, clear pothole wetlands in 1993.

The same 100 wetlands will be surveyed in 1993 to account for seasonal variations. As many additional wetlands as possible will be surveyed in the 1993 field season to increase the size of the data base.

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Figure 1. Simple linear regression of two variables showing a significant relationship between pH, specific conductivity and total ducklings for all species.

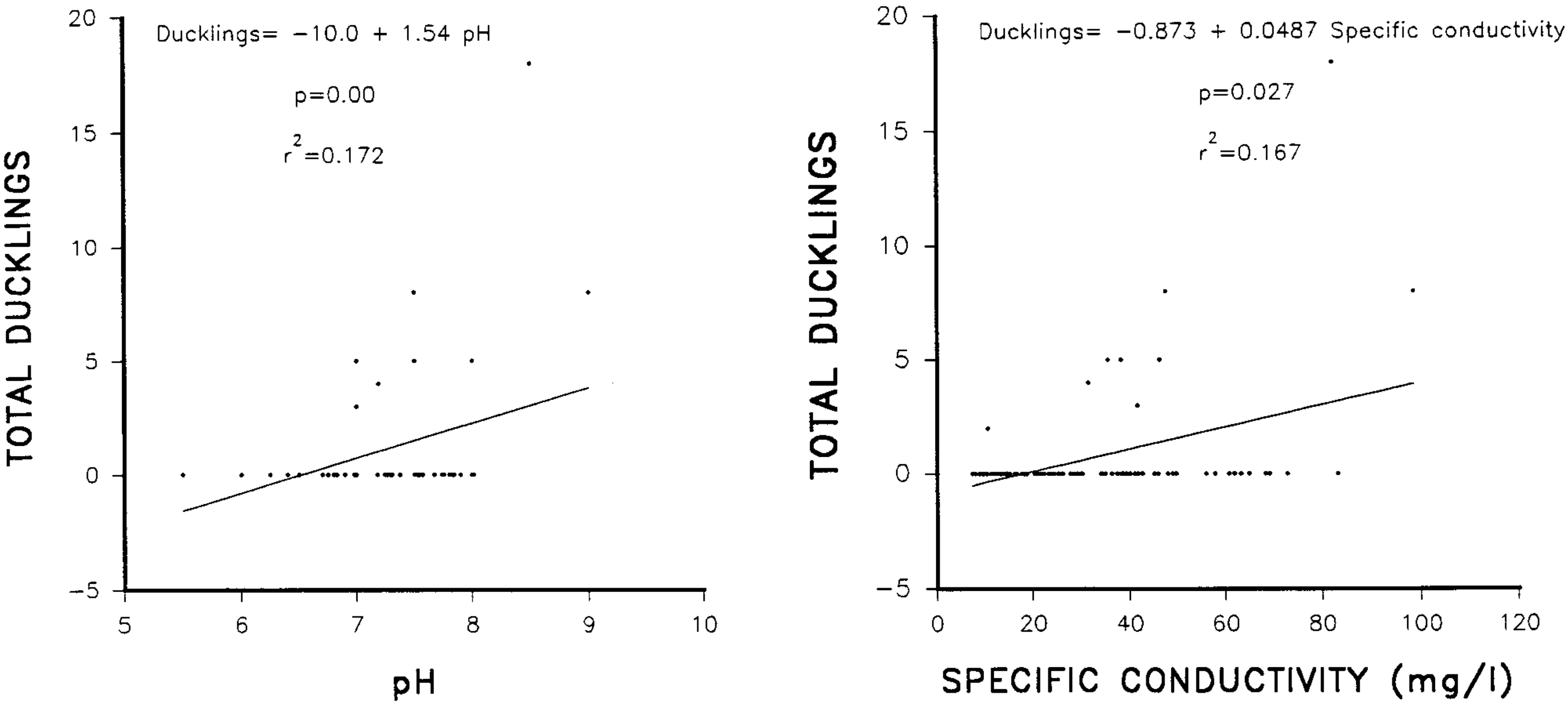

Table 1. Descriptive statistics of 7 variables measured in the Kvichak River area in 1992.

	N	MEAN	MEDIAN	S.D.	MIN	MAX
TRANSPARENCY (m)	22	1.32	0.750	1.65	0.25	7.0
TEMPERATURE (^{o}C)	96	15.78	15.64	2.57	9.10	25.16
pH	84	6.95	7.0	0.67	5.50	9.0
SPECIFIC CONDUCTIVITY (μS)	100	29.83	24.70	19.28	7.36	98.63
TOTAL ALKALINITY (mg/l)	98	9.59	8.05	8.28	0.50	46.50
COLOR (platinum cobalt units)	100	39.89	30.0	40.49	0.0	200.0
CHLOROPHYLL a (mg/l)	100	3.55	2.21	3.59	0.26	16.45

Table 2. List of aquatic and upland plant species recorded from wetlands surveyed in the Kvichak study area in 1992.

UPLAND/SHORELINE

Bluejoint Grass (*Calamagrostis canadensis*)
Sedge (*Carex rostrata, C. aquatilus, C. sp.*)
Horsetail (*Equisetum fluviatile, E.pratense*)
Cotton Grass (*Eriophorum augustifolium*)
Labrador Tea (*Ledum palustre*)
Cassandra (*Chamaedaphne calyculata*)
Dwarf Birch (*Betula nana*)
Shrub Birch (*Betula glandulosa*)
Willow (*Salix spp.*)
Marsh Fivefinger (*Potentilla palustris*)
Lingonberry (*vaccinium vitis-idaea*)
Sweet Gale (*Myrica gale*)
Alder (*Alnus crispa*)
Black Spruce (*Picea marianna*)
White Spruce (*Picea glauca*)
Moss (*Sphagnum sp.*)

EMERGENTS

Mares Tail (*Hippuris vulgaris*)
Spike Rush (*Eleocharis acicularis*)
Water Hemlock (*Cicuta mackenzieana*)
Buckbean (*Menyanthes trifoliata*)

SUBMERGENTS

Pondweed (*Potomogeton praelongus, P. natans*)
Water Milfoil (*Myriophyllum spicatum*)
Bureed (*Sparganium augustifolium*)
Water Sheild (*Brasenia schreberi*)
Pond Lilly (*Nuphar polysepalum*)

Table 3. Species and number of duck broods recorded from wetlands surveyed in the Kvichak study area in 1992.

Species	Number of Broods	Number of Ducklings
American Wigeon	10	30
Mallard	2	5
Northern Pintail	2	5
Green Winged Teal	3	13
Black Scoter	2	5
Total	19	58