WATERFOWL OF THE

REGIONAL COPPER-NICKEL STUDY AREA

MEQB Regional Copper-Nickel Study

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INTRODUCTION TO THE REGIONAL COPPER-NICKEL STUDY

The Regional Copper-Nickel Environmental Impact Study is a comprehensive examination of the potential cumulative environmental, social, and economic impacts of copper-nickel mineral development in northeastern Minnesota. This study is being conducted for the Minnesota Legislature and state Executive Branch agencies, under the direction of the Minnesota Environmental Quality Board (MEQB) and with the funding, review, and concurrence of the Legislative Commission on Minnesota Resources.

A region along the surface contact of the Duluth Complex in St. Louis and Lake counties in northeastern Minnesota contains a major domestic resource of copper-nickel sulfide mineralization. This region has been explored by several mineral resource development companies for more than twenty years, and recently two firms, AMAX and International Nickel Company, have considered commercial operations. These exploration and mine planning activities indicate the potential establishment of a new mining and processing industry in Minnesota. In addition, these activities indicate the need for a comprehensive environmental, social, and economic analysis by the state in order to consider the cumulative regional implications of this new industry and to provide adequate information for future state policy review and development. In January, 1976, the MEQB organized and initiated the Regional Copper-Nickel Study.

The major objectives of the Regional Copper-Nickel Study are: 1) to characterize the region in its pre-copper-nickel development state; 2) to identify and describe the probable technologies which may be used to exploit the mineral resource and to convert it into salable commodities; 3) to identify and assess the impacts of primary copper-nickel development and secondary regional growth; 4) to conceptualize alternative degrees of regional copper-nickel development; and 5) to assess the cumulative environmental, social, and economic impacts of such hypothetical developments. The Regional Study is a scientific information gathering and analysis effort and will not present subjective social judgements on whether, where, when, or how copper-nickel development should or should not proceed. In addition, the Study will not make or propose state policy pertaining to copper-nickel development.

The Minnesota Environmental Quality Board is a state agency responsible for the implementation of the Minnesota Environmental Policy Act and promotes cooperation between state agencies on environmental matters. The Regional Copper-Nickel Study is an ad hoc effort of the MEQB and future regulatory and site specific environmental impact studies will most likely be the responsibility of the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency.

INTRODUCTION

The drainage of wetlands has been viewed as a necessary step in civilization's expansion. Conversion of "unproductive" wetlands to agricultural and industrial use has seriously reduced the total habitat available for waterfowl. It is estimated that in the United States alone "at least 45 million acres of the original 127 million acres of natural wetlands have been drained or otherwise destroyed" (Shaw and Fredine 1971).

An inventory on an estimated 90 percent of the wetlands used by waterfowl has been published for the United States by the U.S. Fish and Wildlife Service (Shaw and Fredine 1971). Ranked fourth out of the 48 states in availability of wetlands, nearly 7 percent (5 million acres) of Minnesota's 74.4 million acres were classified as potential waterfowl habitat (Table 1). Less than 9 percent (440,000 acres) of the habitat occurs within the Study Area. Although eighty thousand acres of Minnesota's wetlands were designated as being of "primary importance" to waterfowl, watersheds in the area of the mineral resources contained no "primary" wetlands Minnesota's prime waterfowl habitat is concentrated in the western prairie.

The report that follows is a brief characterization of the waterfowl habitat within the Study Area. It is based upon results from three aerial surveys conducted to assess the relative importance of different watersheds to migrating waterfowl.

THE IMPORTANCE OF FOREST HABITAT TO WATERFOWL

As the drainage of prairie wetlands continues to reduce the available habitat for waterfowl, waterfowl production in forest ecosystems, such as

northeastern Minnesota, may be of increasing importance. Because of their low productivity, however, few research efforts have been directed towards documenting the utilization of these habitats. Results of an earlier study by Marshall (1959) on a forested lake in northcentral Minnesota illustrated that the annual production of even the most abundant species in the area, the mallard (Anas platyrhynchos), was relatively low. Nevertheless, Marshall states that "when one visualizes the large number of lakes of this type in the forested regions of Minnesota, it becomes apparent that there is a considerable production of waterfowl." Although the annual production is low, it is relatively constant, and Mathison (1966) proposes that the future of waterfowl may well depend upon peripheral breeding zones such as the forest ecosystem.

Future studies may also document the importance of forest habitats during periods of drought. With the use of such sophisticated techniques as radiotelemetry (Gilmer 1971, Ball 1973, and Kirby 1976), it may become possible to document a shift of breeding ducks from the drought-stricken prairie to protected forest lakes. A shift of prairie-nesting waterfowl to Arctic regions, during similar climatic conditions, has been demonstrated by Hanson and McKnight (1964). Data collected from aerial surveys illustrated an inverse relationship between the breeding population of dabbling ducks in the Canadian prairie provinces and the breeding population in the northern regions of Alaska.

OBJECTIVES

Because the waterfowl of forested regions have received low priority by the U.S. Fish and Wildlife Service (USFWS), federal census programs

currently do not exist for northeastern Minnesota. As a result, the terrestrial program of the Regional Copper-Nickel Study conducted three aerial waterfowl surveys over the Study Area in April and May, 1977. These surveys were concentrated in the area of the mineral deposits and did not include the complete Study Area. The purpose of the surveys was to: 1) enumerate migrating waterfowl in the area; 2) identify lakes, rivers, and creeks that receive the predominant use; and 3) determine the relative importance of the major watersheds to migrating waterfowl. Waterfowl observations from the ground were also collected during the 1976 and 1977 field seasons and were used to determine the relative abundance of different species. The final analysis will permit an evaluation of the potential impacts to waterfowl that could result from copper-nickel development.

METHODS

Route Establishment

The route flown for the aerial waterfowl survey was designed to cover the major lakes and rivers, along with several of the larger creeks, that originate on or traverse the Study Area (Figure 1). In all, 58 lakes and ponds, 8 creeks, and 6 rivers were censused in 7 different watersheds. A total of 96.2 miles of rivers and creeks and 12564.3 acres of lakes and ponds were censused. This is judged to be approximately 20 percent of the surface area of all lakes in the Study Area, 20 percent of all river mileage, and less than 5 percent of the total length of various creek systems.

Flight Techniques

Sampling techniques of the present survey were similar to those employed in census studies on the Chippewa National Forest in northcentral Minnesota (Kirby 1976). Techniques incorporated into the sample design by the Regional Copper-Nickel Study were as follows:

1) the same aircraft (Cessna 180), pilot, and observers were used to conduct all three surveys in order to reduce bias (Caughley 1974);

2) the route was flown at 100 to 200 feet above the forest canopy at an average air speed of 85 mph;

3) all census flights began 30 to 60 minutes after sunrise, the entire route being covered in 2.5 to 3 hours. During the breeding season the most accurate waterfowl estimates are obtained in the morning (Smith 1956) and there is no evidence to suggest that this pattern would be any different during migration. Early morning periods also provided better light conditions for observation (less surface glare) and more stable flight conditions than periods later in the day;

4) all waterfowl observations were recorded, regardless of their proximity to shorelines. The exception was Birch Lake, where all ducks were counted within one quarter mile of shore. However, due to the low density of ducks on this lake, enough time was spent observing the center portion of the lake to give us confidence that few, if any, large groups of ducks were missed; and

5) all flights, especially over lakes, were made along a course that allowed the best possible use of available light and reduced surface glare. If large duck concentrations could not be counted accurately on the first pass, a second pass was made and the maximum number from either count was recorded.

Mr. Don Glazer, a warden-pilot for the Minnesota Department of Natural Resources (MDNR), flew each census flight. Mr. Glazer is an experienced pilot and has flown several low altitude wildlife surveys. Two observers, Dick Huempfner and Lee Pfannmuller, were used on each flight. Although both biologists were experienced in waterfowl identification from the ground, neither had previous experience at waterfowl identification from an aircraft. Because this "art" requires a great deal of prior experience,

the aerial census over the Study Area was strictly an enumeration of the individual waterfowl observed, regardless of species. However, great blue herons (Ardea herodias), gulls, Canadian geese (Branta canadensis), and loons (Gavia immer) were readily identifiable and were recorded by species. During each flight one observer sat in the seat next to the pilot to assist with navigation, to record data, and to observe. The second observer sat in the rear seat and was free to move from one side of the plane to the other to maximize observation time. Together the three census flights covered 250 air miles and required 18 hours of observation time.

Census Schedule

A preliminary noncensus flight was made on April 6, 1977, to familiarize the pilot and observers with the route. At the time, some lakes were still partially or entirely covered by ice, although most fast flowing rivers were open. On April 22, approximately 7 to 12 days after ice-out on most lakes, the first census flight was conducted. The second and third flights were conducted on April 27 and May 6.

Dabbler species of ducks usually return to breeding areas one to two weeks before divers (Dzubin 1967) with the interval for optimum census for all breeding ducks ranging from April 24 to June 6. The two-week interval during which this census was conducted was probably adequate to enumerate the relative numbers of both waterfowl groups during migration. This can be illustrated by the similarity of the first two counts where a total of 801 and 810 ducks, respectively, were tallied. The third census on May 6, however, totaled only 442 ducks. Nesting, which reduces visibility, may have begun early and could be partially responsible for the reduction. However, the most likely cause was an extensive movement of migrants to breeding zones further north.

Limitations of Aerial Census Techniques

All waterfowl census techniques are beset with complications. A comprehensive paper by Dzubin (1967) states that "spring and summer duck population estimates, whether based on direct air or ground counts, remain relatively inexact." Some of the problems affecting census techniques include weather, breeding phenology, vegetative growth, the daily activity of waterfowl, and the field experience of personnel.

Although all these factors enter into the final interpretation, the most important problem is the difference between the number of ducks reported on a ground census and the number reported on an aerial census of the same area. The ground census has generally tallied a much larger number of individuals. Because of the discrepancy, air:ground comparison studies were initiated to assess the accuracy of the aerial census technique. The studies have developed an index, the air:ground ratio, which corrects for the visibility bias encountered when censusing an area from the air. Martinson and Kaczynski (1967), in summarizing USFWS data, concluded that within the Tristate Area (North Dakota, South Dakota, and Minnesota) less than one-fourth of all ducks present on the ground are recorded from the air. During a four-year period from 1963 to 1966 the air:ground ratio for their area averaged .227. This ratio included data from all species of ducks; air:ground ratios computed for individual species often differ significantly from one another. In addition, the census data from Minnesota was from the prairie region of the state where waterfowl densities are considerably higher than in northeastern Minnesota. On the other hand, a five-year study in Wisconsin (March et al. 1973), where a large portion of the area censused was in forested regions, resulted in an air:ground ratio that was similar in magnitude (.199).

As the above discussion points out, the three aerial census flights over the Study Area provide data that yield a relative, rather than an absolute, measure of duck abundance. Studies have demonstrated that approximately twenty percent of the population that is tallied during a ground census will be tallied when the same area is censused from the air.

RESULTS

Migrating Duck Concentrations on Lakes

Total Number Observed and Density Estimates--Results of the aerial census are presented in Table 2. The observations have been tabulated by watersheds in the mineral resource zone and have been converted to density estimates. More than seventy percent of the observations summarized in Table 2 were reported from lakes. Four of the lakes (Stone, Long, Seven Beaver, and Birch) contributed over forty percent (879/2053) of all observations.

Stone Lake, located in the St. Louis River watershed, is the most heavily used lake in the Study Area. Approximately 260 acres in size, it represented only 2 percent of the total surface area of all lakes censused. Nevertheless, 18.6 percent (280/1507) of all lake observations were reported from Stone Lake. It is a shallow lake, the majority less than 2 m deep, and the shoreline is surrounded by emergent vegetation. Together these two factors suggest that adequate food resources were available for migrating waterfowl. A similar lake in the St. Louis River watershed (Long Lake) recorded 17.9 percent of all lake observations. Its relative density, however was much lower because of its large size (442 acres)(Table 1). Although it is also a shallow lake (mean depth of .5 m), little emergent vegetation was present during the census period.

Birch Lake, the largest lake that was censused, accounted for the third largest number of observations. Yet, because of its large size the total density of ducks ranged from 15 to 64 times lower than on Stone or Long Lake. With a mean depth of 4 m, rocky shorelines, and very limited emergent vegetation, this lake was not nearly as attractive to migrating waterfowl.

Seven Beaver Lake accounted for the fourth largest number of observations. Like Stone Lake and Long Lake, it is shallow and located in the St. Louis River watershed. Because it is considerably larger than either lake, the total density of ducks was relatively low.

Seven additional lakes also sustained relatively significant use by migrating waterfowl (Table 3). Together these 11 lakes (19 percent of the 58 lakes censused) contributed 81 percent (1221/1507) of all lake observations.

Importance Value--A common method for comparing the availability and proportional utilization of a resource, such as food or habitat, is to divide the frequency of use by the frequency of occurrence, both being expressed as percentages. Often termed an "Importance Value" (IV), components of the resource (e.g. different foods or different habitats) can subsequently be ranked on the basis of their importance. A value of 1.0 indicates that utilization of a resource is in proportion to its availability. Values greater than 1.0 suggest preferential use, while values less than 1.0 suggest avoidance. This method was applied to the lakes and rivers that were censused within the Study Area. The results for rivers are presented in Table 4 and will be discussed in the following section; the results for lakes are presented in Table 3 and are discussed below.

Lakes ranked by their importance value are compared on the basis of their relative density per acre. Therefore, lakes with the highest number of observations may not have the highest importance values. The lake with the highest ranking in the Study Area was an unnamed lake (T59N, R11W, Sec. 22), located in the St. Louis River watershed. Two other lakes in the same vicinity, another unnamed lake (T59N, R11W, Sec. 15) and Bonga Lake (T59N, R11W, Sec. 14), were also ranked high. These lakes are all located in a sparsely-forested bog containing slow-growing, generally stunted tamarack (Larix larciana) and black spruce (Picea mariana). Like other lakes in the general area these are bog lakes with sedge shorelines. Two studies (Stoudt 1938, Marshall 1959) have indicated that lakes of this type may be important to duck broods, especially broods of ring-necked ducks (Aythya collaris).

Migrating Duck Concentrations Along Rivers and Creeks

Portions of 6 different rivers were flown during the census for a total of 75.7 miles. From the total of 2053 duck observations made on the three survey flights, 25.1 percent (515) occurred on rivers.

Although ranked second in importance, the St. Louis River provided the longest river system of favorable habitat within the Study Area (Table 4). Over half of all river observations were recorded along this river. The largest concentrations were recorded in the two mile portion just south of the Norway Point Picnic Area. Unlike the rocky shoreline immediately to the east, the shoreline at this point is covered with sedge and grass. Additional concentrations of ducks were observed along a four-mile segment of the river extending southwest of Seven Beaver Lake. In this area the

river also flows through grass, sedge, and shrub communities, thus providing favorable waterfowl habitat. Near its confluence with Seven Beaver Lake, the meandering shoreline of the North River also contained relatively high concentrations of migrating ducks. Ranked third in total observations, the North River was ranked first in relative duck density per mile (Table 4).

The segment of river that extends from the Birch Lake Dam to White Iron Lake produced the major portion of observations (79.3 percent) along the South Kawishiwi River. Although ducks were scattered throughout this segment, the major concentrations were recorded within 100 m downstream from the dam and were predominantly goldeneye (Bucephala clangula). Portions of this river remain open during the entire winter. A wintering population of common goldeneye have been observed in this area for a number of years (Fred Thunhorst, area manager, MDNR, personal communication). Frequent observations made by the terrestrial biology team during the winter of 1976-1977 recorded a maximum of 35 birds on January 17, 1977, from the bridge on Highway #1 adjacent to the dam. The Ely Christmas bird count recorded 58 goldeneye in the same location (Eckert 1977).

Portions of the remaining three rivers were seldom used by migrating waterfowl (Table 4). Although both the Dunka and Partridge rivers are meandering with sedge-grass shorelines, both had very low duck densities (Table 2). The Stony River, with predominantly steep banks and rocky shorelines, had intermediate duck densities.

Segments of eight different creeks were also censused, totaling 20.5 miles (Table 1). Very few individuals were observed along four of the creeks while none were observed along the remaining four. In general, the duck

density observed along creeks was only 20 to 30 percent of the density observed along rivers.

Watershed Comparisons

Data from all the areas censused are summarized on a watershed basis. Because densities for lakes and ponds (ducks/acre) are not directly comparable to densities along rivers and creeks (ducks/mile), these two categories of data are separate. Summary statistics are presented in Tables 5 and 6.

Migrating duck observations on lakes and ponds within the St. Louis River and Stony River watersheds (ranked number 1 and 2, respectively) accounted for 79.9 percent (1204/1507) of all observations, while covering only 34.5 percent of the total area censused (Table 5). Apparently, requirements of migrating (and presumably breeding) ducks are met by lakes and ponds in these two watersheds to a much greater degree than is true for the remainder of the Study Area.

The St. Louis River watershed was also ranked number 1 in importance, based on observations along rivers and creeks (Table 6). Alone it contributed over 65 percent (356/546) of all observations. The high ranking of the St. Louis River watershed resulted from the high relative densities observed along both the St. Louis and North rivers. Ranked number 2 in importance, the Kawishiwi River watershed reported its highest relative densities along the short segment of the South Kawishiwi River north of Birch Lake Dam.

Miscellaneous Observations

The prime objective of the aerial census was to enumerate migrating duck concentrations. However, when other species, such as geese and loons, were observed they were also recorded. These observations are summarized in Table 7.

A total of 21 observations of the Canadian goose were recorded, 16 of these on April 22. Aerial recognition and visibility of these birds was excellent and resulted in a complete enumeration of the species during the aerial survey. All 16 observations on April 22 were in the St. Louis River watershed, with the largest concentration (10) on the St. Louis River.

A total of 21 observations of the common loon were also made. Eight of the observations were from the St. Louis River watershed, 8 from the Kawishiwi River watershed, and 4 from the Stony River watershed. Generally, loons were readily identified from the air. However, there may have been a number of instances when loons were recorded as ducks, especially on lakes and rivers where birds were numerous. Because only 20 to 25 percent of large ducks, such as mallards, are recorded from the air (March et al. 1973), it seems likely that as many as 75 percent of the loons actually present were not counted.

The data also include observations of great blue herons and gulls. Gulls were only tallied on the last flight, May 6. The gulls observed were judged to be primarily herring gulls (Larus argentatus) although a small number of ring-billed gulls (Larus delawarensis) may have been present and counted. Herring gulls are known to breed in the area, whereas ring-billed gulls do not (Green and Janssen 1975).

GROUND OBSERVATIONS

During Migration

Ground observations of ducks from the 1976 and 1977 field seasons are presented in Table 8. Approximately half of these observations were obtained by the fisheries staff while conducting stream, river, and lake surveys. The remainder were obtained as incidental observations by members of the terrestrial biology team.

Table 8 summarizes the observations for each month of the field season (April-November). The relative abundance of individual species observed during the months of April and May may be interpreted as the "probable" distribution of ducks during the migration period. The first seven species listed in Table 8 contribute 93.1 percent of all duck observations. Mallards are the most common ducks present, with nearly equal numbers of common goldeneyes and common mergansers. Ring-necked ducks are moderately numerous, followed by relatively low numbers of wood ducks (Aix sponsa), blue-winged teal (Anas discors), and black ducks (Anas rubripes). A total of eleven species were observed during migration.

During the Breeding Season

The "probable" species distribution during the breeding season (June-August) appears similar to the distribution observed during migration (Table 8). The major difference is the lower percentages of common mergansers and common goldeneyes and the higher percentages of blue-winged teal. The number of mergansers and goldeneyes seen during migration tends to be high because peak movements through the state occur in late March and early April for

both species (Green and Janssen 1975). The large numbers observed in mid-April probably represent a flush of migrants through the region, with reduced numbers remaining to breed. Blue-winged teal, on the other hand, are late migrants—they are not observed in northern Minnesota until at least the second week in April (Green and Janssen 1975).

The relative abundance of waterfowl species observed in the Study Area is similar to that observed during the breeding season in other forested regions of Minnesota (Stoudt 1938, Marshall 1959, Mathison 1966). Mathison, for example, found that over 90 percent of the breeding population on the Chippewa National Forest was comprised of six major species: mallard, blue-winged teal, common goldeneye, American widegon (Anas americana), ring-necked duck, and wood duck.

ESTIMATED BREEDING POPULATION

Data from a five-year breeding duck census conducted in the northern forests of Wisconsin (March et al. 1973) provided the best comparative estimate of breeding duck densities for the Study Area. The northern forests included in the Wisconsin study were divided into a "Low Density" region and a "northwest" region. Maple and hemlock dominate the vegetation of this forest; however, it also includes some pines and lowland conifers (Curtis 1959).

All of the predominant duck species found in the Study Area were included in the study by March, with the exception of goldeneyes, a rare breeder in Wisconsin. The estimated number of breeding ducks per square mile was calculated by first correcting for the air:ground ratio of each species and then dividing the estimated number of breeding ducks in the "Low Density"

region by the size of the study zone, 25,700 mi^2. The results for the five years between 1965 and 1970 were as follows:

1965	2.39 ducks/mi^2
1966	3.09 ducks/mi^2
1967	no data
1968	1.85 ducks/mi^2
1969	2.12 ducks/mi^2
1970	3.93 ducks/mi^2

Spring breeding population estimates for the study zone were calculated using the low estimate (1968), the high (1970), and the average (2.68 ducks/mi^2) (Table 9). The data suggest that approximately 5360 ducks were present on the 2000 mi^2 Study Area. Because the 1967 estimate for the statewide breeding population in Minnesota was 695,000 (USFWS 1977), it appears that 0.8 percent of the total state breeding population of ducks breed within the entire 2000 mi^2 Study Area.

The relative importance of Minnesota's breeding population can be derived from estimates of the entire North American breeding population. The USFWS (1977) estimates that there were approximately 39.6 million ducks during the 1976 breeding season and 38 million during the 1977 breeding season. For the same two years, a total of 676,000 and 695,000 breeding ducks, respectively, were estimated to be present in Minnesota (census conducted by R.L. Jessen and J. Parker, MDNR, USFWS, 1977). Therefore, the state contributes approximately two percent of the continental waterfowl population.

CONCLUSION

Although the state is relatively well-endowed with wetlands, the forests of northeastern Minnesota contain only a small quantity of prime waterfowl habitat. The mineral resource zone within the Study Area includes approximately 100,000 acres of wetlands, all classified as being of "lesser

importance" to waterfowl. Because waterfowl census data were not available for this area, the Regional Copper-Nickel Study conducted three aerial surveys in the Spring of 1977 for the purpose of assessing the relative importance of different watersheds to migrating waterfowl.

The most heavily used watersheds during waterfowl migration were the St. Louis, Stony, and Kawishiwi rivers. Within these areas the highest duck concentrations on lakes were observed on Stone, Long, Seven Beaver, and Birch lakes. The highest river concentrations were observed along the St. Louis, North, and South Kawishiwi rivers. It is assumed that these areas are also equally important to breeding populations.

Spring migrants, and presumably breeders, are dominated by mallards, common goldeneyes, common mergansers, ring-necked ducks, blue-winged teal, and black ducks. There were also scattered observations of green-winged teal (Anas orecca), hooded mergansers (Lophodytes cucullatus), and buffle head (Bucephala albeola). Miscallaneous observations were reported for Canadian geese, loons, great blue herons, and herring gulls.

The results from a five-year breeding duck survey in Wisconsin were used to project the estimated breeding duck population within the Study Area. Using an average density of 2.68 ducks/mi^2, the projected population for the entire Study Area (2130 mi^2) is approximately 5360 ducks. This figure represents less than one percent of Minnesota's breeding population of waterfowl in 1977. The largest contribution to the state's population is from the western prairie region where the density of ducks may be as high as 40 to 100 ducks/mi^2 (Moyle 1964). Although the relative contribution of forest regions, such as the Study Area, may be small, as wetland habitat continues to disappear, forest ecosystems may be of increasing importance.

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Table 1. Distribution of wetlands and their relative values to waterfowl in the Study Area and the state.[a] (Values in thousands, rounded to nearest ten thousand)

TYPE OF WETLAND	MINNESOTA ACRES	MINNESOTA %	STUDY AREA ACRES	STUDY AREA %[d]	STUDY AREA %[e]
"Primary" Importance[b]	2050	41	80	18	1.6
"Lesser" Importance[c]	2990	59	360	82	7.1
TOTAL	5040		440		8.7

[a]Data obtained from Shaw and Fredine, 1971; Table 6 and Plate 21 (see Figure 1).

[b]"Primary" includes "High" class ("Habitat of highest waterfowl use in present condition...") and "Moderate" Class ("Habitat of significant waterfowl use in present condition...") (op. cit, p 16,17).

[c]"Lesser" includes "Low" Class ("Habitat receiving relatively low waterfowl use under natural conditions...") and "Negligible" Class (none classified for Minn.)(op. cit, p16,17).

[d]Percent of wetlands in county or study areas classified as "primary" or "lesser."

[e]Percent of total Minnesota wetlands in study areas classified as "primary" or "lesser."

Table 2. The 1977 spring migration aerial duck census by watershed.
(Values are uncorrected for visibility bias.)

CENSUS AREA	SYMBOL FOR UNIT OF MEASURE[a]		DATE OF CENSUS FLIGHT			ALL PERIODS	
			April 22	April 27	May 6	Total No. Ducks	Percent
Crocket Lake	A	=	4-.16-.10			4	
Unnamed Lake	A	=	2-.35-.22			2	
White Iron Lake	A	=	22-.11-.07	7-.03-.02	3-.01-.01	32	
S. Kawishiwi River	B	=	30-4.41-2.75	7-1.03-.64	32-4.70-2.94	69	
Unnamed Lake	A	=					
Unnamed Lake	A	=					
Shamrock Lake	A	=					
Starting Lake	A	=	8-.94-2.35			8	
Climber Lake	A	=					
Baird Lake	A	=					
Leatherleaf Lake	A	=	2-.23-.59			2	
August Creek	B	=	2-.39-.24		6-1.18-.73	8	
Labrador Pond	A	=					
Norway Lake	A	=		1-.07-.18	2-.14-.35	3	
Gesend Pond	A	=	9-.63-1.58	3-.21-.53		12	
Unnamed Lake	A	=		3-.86-2.14		3	
August Lake	A	=	2-.01-.02			2	

Table 2 (contd.)

CENSUS AREA	SYMBOL FOR UNIT OF MEASURE[a]		DATE OF CENSUS FLIGHT April 22	April 27	May 6	ALL PERIODS Total No. Ducks	Percent
S. Kawishiwi River	B	=	8-1.07-.67	2-.27-.17	8-1.07-.67	18	
Birch Lake	A	=	91-.01-.03	59-.01-.02	21-.003-.008	171	
Kangas Lake	A	=			2-.08-.20	2	
Kangas Creek	B	=					
Little Lake	A	=	5-.07-.17		1-.01-.03	6	
Total ducks observed			185	82	75	342	16.6
Percent per watershed							
Per census period			23.1%	10.1%	16.9%	C=.03 D=.03	
UNNAMED CREEK WATERSHED							
Unnamed Creek (actual creek name)	B						
Total ducks observed						0 D=.00	0.0
KEELEY CREEK WATERSHED							
Heart Lake	A	=		2-.06-.15	3-.09-.22	5	
Total ducks observed				2	3	5	0.2
Percent per watershed						C=.05	
Per census period				0.2%	0.7%		

Table 2 (contd.)

CENSUS AREA	SYMBOL FOR UNIT OF MEASURE[a]		DATE OF CENSUS FLIGHT April 22	April 27	May 6	ALL PERIODS Total No. Ducks	Percent
DUNKA RIVER WATERSHED							
Unnamed Lake	A	=	2-.24-.59			2	
Unnamed Lake	A	=					
Snort Lake	A	=		2-.14-.35		2	
Dunka River	B	=	1-.12-.08	15-1.85-1.15		16	
Unnamed Lake	A	=					
Total ducks observed			3	17		20	1.0
Percent per watershed						C=.03 D=1.98	
Per census period			0.4%	2.1%			
STONY RIVER WATERSHED							
Sand Lake	A	=	9-.02-.04	20-.04-.1	13-.03-.06	42	
Bonga Lake	A	=		30-.24-.60	49-.39-.10	79	
Unnamed Lake	A	=	38-4.47-11.18	2-.24-.59		40	
Fools Lake	A	=		7-.22-.56	2-.06-.16	9	
Jackpot Lake	A	=	3-.26-.65	2-.18-.43		5	
Jackpot Creek	B	=	9-1.76-1.10	1-.10-.12	1-.10-.12	11	
Fran Lake	A	=		1-.06-.15	4-.24-.59	5	
Chow Lake	A	=	6-.15-.38	2-.05-.13		8	
Unnamed Lake	A		2-.71-1.8			2	

Table 2 (contd.)

CENSUS AREA	SYMBOL FOR UNIT OF MEASURE[a]		DATE OF CENSUS FLIGHT April 22	April 27	May 6	ALL PERIODS Total No. Ducks	Percent
Unnamed Creek	B	=					
Stony River	B	=	12-1.54-.96	4-.51-.32	18-2.31-1.44	34	
Unnamed Lake	A	=					
Slate Lake	A	=	32-.13-.34	14-.06-.15	3-.01-.03	49	
Unnamed Creek	B	=					
Swallow Lake	A	=	9-.06-.16	5-.03-.09	3-.02-.05	17	
Two Deer Lake	A	=	2-.05-.12	2-.05-.12	5-.12-.29	9	
Alsike Lake	A	=			2-.10-.25	2	
Unnamed Lake	A	=					
Unnamed Lake	A	=					
Highlife Lake	A	=		2-.12-.29	1-.06-.15	3	
Dunnigan Lake	A	=	1-.01-.03	2-.02-.06		3	
Harris Lake	A	=	14-.13-.32	4-.04-.09		18	
Nira Creek	B	=	2-.38-.24		7-1.35-.84	9	
Total ducks observed			139	98	108	345	16.8
Percent per watershed						C=.07	
Per census period			17.4%	12.1%	24.4%	D=.57	

Table 2 (contd.)

CENSUS AREA	SYMBOL FOR UNIT OF MEASURE[a]		DATE OF CENSUS FLIGHT April 22	April 27	May 6	ALL PERIODS Total No. Ducks	Percent
ST. LOUIS RIVER WATERSHED							
Bird Lake	A	=	2-.10-.25	3-.15-.38		5	
Lillian Lake	A	=		4-.47-1.18	1-.12-.29	5	
Hush Lake	A	=		2-.10-.25		2	
St. Louis River	B	=	135-5.04-3.15	92-3.43-2.14	64-2.39-1.49	291	
Unnamed Lake	A	=		6-.13-.33	13-.29-.71	19	
Long Lake	A	=	132-.30-.75	78-.18-.44	60-.14-.34	270	
Seven Beaver Lake	A	=	39-.03-.07	104-.07-.19	15-.01-.03	158	
Round Lake	A	=	9-.02-.06	4-.01-.03		13	
Mud Lake	A	=	2-.04-.10	2-.04-.10	4-.08-.20	8	
Stone Lake	A	=	72-.27-.68	169-.64-1.60	39-.15-.37	280	
Swamp Lake	A	=	1-.01-.03	15-.20-.50	3-.04-.10	19	
North River	B	=	15-3.06-1.92	43-8.78-5.51	7-1.43-.90	65	
Lake Culkin	A	=	6-.10-.24	5-.08-.20	8-.13-.32	19	
Continental Lake	A	=		13-.51-1.27		13	
Lobo Lake	A	=	2-.01-.03	8-.06-.14		10	
Unnamed Lake	A	=	2-.57-1.43	14-4.00-10.00	29-8.28-20.7	45	
Unnamed Lake	A	=		7-7.0-17.5		7	
Unnamed Lake	A	=	38-3.33-8.26	2-.18-.43		40	

Table 2 (contd.)

CENSUS AREA	SYMBOL FOR UNIT OF MEASURE[a]		DATE OF CENSUS FLIGHT April 22	April 27	May 6	ALL PERIODS Total No. Ducks	Percent
Total ducks observed			455	571	243	1269	61.8
Percent per watershed						C=.10	
Per census period			56/8%	70.5%	55.0%	D=3.74	
PARTRIDGE RIVER WATERSHED							
Stubble Creek	B	=	3-1.15-.71	9-.65-.41		3	
Partridge River	B	=	3-.22-.16	9-.65-.41	10-.72-.45	22	
Big Lake	A	=	13-.02-.04	31-.04-.10	3-.004-.01	47	
Total ducks observed			19	40	13	72	3.5
Percent per watershed							
Per census period			2.4%	4.9%	2.9%	C=.02	
			100.1%	99.9%	99.9%	D=.51	
Total ducks observed by census period			801	810	442	2053	99.9
Percent ducks observed by census period			39.1	39.4	21.5		

Table 2 (contd.)

[a]Key to symbols used for UNIT OF MEASURE.

KEY TO HOW DENSITY ESTIMATES ARE PRESENTED IN TABLE

Data From Each Flight

A = No. of ducks observed - ducks per acre - ducks per hectare

B = No. of ducks observed - ducks per mile - ducks per kilometer

Data, All Flights Averaged

C = Avg. no. of ducks observed per acre (for 3 census periods combined) for entire watershed

$$= \frac{\text{Total ducks obs. on lakes-ponds}}{\text{Total acres censused}} \div 3$$

D = Avg. no. of ducks observed per mile of creek-river (for 3 census periods combined) for entire watershed

$$= \frac{\text{Total ducks obs. on rivers-creeks}}{\text{Total miles censused}} \div 3$$

Blanks = Zero ducks observed

Table 3. Importance Values (I.V.)[a] and rank of eleven lakes containing the largest concentrations of spring migrating ducks.

LAKE NAMES	NO. DUCKS OBSERVED	% DUCKS OBSERVED	÷	% CENSUS AREA[b]	= I.V.	RANK
Stone	280	22.9		2.5	9.16	3
Long	270	22.1		4.2	5.26	5
Birch	171	14.0		63.8	0.22	10
Sand	42	3.4		4.9	0.69	8
Bonga	79	6.5		1.2	5.42	4
Unnamed Lake (T59,R11,Sec.11)	40	3.3		0.1	33.0	2
Slate	49	4.0		2.3	1.74	6
Seven Beaver	158	12.9		13.3	0.97	7
Unnamed Lake (T59,R11,Sec.22)	45	3.7		0.03	123.33	1
Unnamed Lake (T59,R11,Sec.15)	40	3.3		0.1	33.0	2
Big	47	3.8		7.5	0.51	9
TOTAL	1221	99.9		99.9		

[a]Percentages of ducks observed and water area censused were calculated from total observations and total acreage censused on these eleven lakes only (total observation on all lakes, n = 1507).

[b]See Table 1.

Table 4. Importance Values (I.V.)[a] and rank of six rivers used by spring migrating ducks.

RIVER NAMES	NO. DUCKS OBSERVED	% DUCKS OBSERVED	÷	% CENSUS AREA	=	I.V.	RANK
South Kawishiwi	87	16.9		18.9		0.89	3
Dunka	16	3.1		10.7		0.29	5
Stony	34	6.6		10.3		0.64	4
St. Louis	291	56.5		35.4		1.60	2
North	65	12.6		6.5		1.94	1
Partridge	22	4.3		18.2		0.24	6
TOTAL	515	100.0		100.0			

[a]Percentages of ducks observed and distance (miles-km) of river censused were calculated from observation census distances on these six rivers only.

Table 5. Importance Values (I.V.)[a] and rank of nine watersheds based on concentrations of spring migrating ducks using lakes and ponds.

WATERSHED	NO.DUCKS OBSERVED	% DUCKS OBSERVED	÷	% CENSUS AREA	= I.V.	RANK
Kawishiwi	247	16.4		58.7	.28	6
Unnamed Creek		NO LAKE AREA CENSUSED				
Keeley Creek	5	0.3		0.3	1.00	3
Dunka River	4	0.3		0.4	0.75	4
Stony River	291	19.3		11.2	1.72	2
St. Louis	913	60.6		23.3	2.60	1
Partridge River	47	3.1		6.2	0.50	5
TOTAL	1507	100.1		100.1		

[a]Percentages of ducks observed and water area censused were calculated from total observations and total acreage censused on all lakes and ponds on each watershed.

Table 6. Importance Values (I.V.)[a] and rank of watersheds based on concentrations of spring migrating ducks using rivers and creeks.

WATERSHED	NO. DUCKS OBSERVED	% DUCKS OBSERVED	÷	% CENSUS AREA	=	I.V.	RANK
Kawishiwi	95	17.4		21.0		0.83	2
Unnamed Creek	0.0	0.0		1.1		0.00	6
Keeley Creek		NO RIVERS - CREEKS CENSUSED					
Dunka River	16	2.9		8.4		0.34	4
Stony River	54	9.9		19.4		0.51	3
St. Louis	356	65.2		32.9		1.98	1
Partridge River	25	4.6		17.0		0.27	5
TOTAL	546	100.0		99.8			

[a]Percentages of ducks observed and miles (km) of stream-creek censused were calculated from total observations and total distance censused for each watershed.

Table 7. Numbers and locations of geese, loons, great blue herons, and gulls observed during 1977 aerial duck census. (Values are uncorrected for visibility bias.)

CENSUS AREA	DATE OF CENSUS FLIGHT[a]									
	April 22			April 27			May 6			
	GBH	GE	LO	GBH	GE	LO	GBH	GE	LO	GU
Crocket Lake										
Unnamed Lake										
White Iron Lake										2
S. Kawishiwi River										
Unnamed Lake										
Unnamed Lake										
Shamrock Lake						1			2	
Starting Lake										
Climber Lake										
Baird Lake										
Leatherleaf Lake										
August Lake										6
Labrador Pond										
Norway Lake										
Gesend Pond										
Unnamed Lake										
August Lake										
S. Kawishiwi River						1			2	5
Birch Lake	1					2	3	2		7
Kangas Lake										
Kangas Creek										
Little Lake										8
TOTALS	1					4	3	2	4	28

UNNAMED CREEK WATERSHED

Unnamed Creek (Actual creek name)	

Table 7 (contd.)

CENSUS AREA	DATE OF CENSUS FLIGHT[a]									
	April 22			April 27			May 6			
	GBH	GE	LO	GBH	GE	LO	GBH	GE	LO	GU
KEELEY CREEK WATERSHED										
Heart Lake										
DUNKA RIVER WATERSHED										
Unnamed Lake										
Unnamed Lake										
Snort Lake										
Dunka River										
Unnamed Lake										
TOTALS										
STONY RIVER WATERSHED										
Sand Lake										
Bonga Lake					2					
Unnamed Lake									2	
Fools Lake										
Jackpot Lake										
Jackpot Creek										
Fran Lake										
Chow Lake										
Unnamed Lake										
Unnamed Creek										
Stony River										1
Unnamed Lake										
Slate Lake										
Unnamed Creek										
Swallow Lake										3
Two Deer Lake			2							

Table 7 (contd.)

CENSUS AREA	DATE OF CENSUS FLIGHT[a]									
	April 22			April 27			May 6			
	GBH	GE	LO	GBH	GE	LO	GBH	GE	LO	GU
Alsike Lake										
Unnamed Lake										
Unnamed Lake										
Highlife Lake										
Dunnigan Lake										
Harris Lake										
Nira Creek										2
TOTALS			2		2				2	6
ST. LOUIS WATERSHED										
Bird Lake										
Lillian Lake										
Hush Lake									2	
St. Louis River	1	10		1			1			
Unnamed Lake										
Long Lake		2				4				
Seven Beaver Lake	1	2								8
Round Lake	2									1
Mud Lake										
Stone Lake										3
Swamp Lake										1
North River										
Lake Culkin	1									
Continental Lake										
Lobo Lake	1	2						1		
Unnamed Lake										
Unnamed Lake										
Unnamed Lake									2	
TOTALS	6	16		1		4	1	1	4	13

Table 7 (contd.)

CENSUS AREA	DATE OF CENSUS FLIGHT [a]									
	April 22			April 27			May 6			
	GBH	GE	LO	GBH	GE	LO	GBH	GE	LO	GU
PARTRIDGE RIVER WATERSHED										
Stubble Creek										
Partridge River										1
Big Lake			1							3
TOTALS			1							4
Total Observations by Census Period	7	16	3	1	2	8	4	3	10	51

[a] GBH = Great Blue Heron (Ardea herodias)
GE = Canadian Geese (Branta canadensis)
LO = Loons (Gavia immer)
GU = Gulls (mostly herring gull [Larus argentatus], observations recorded only on May 6)
Blanks = Zero observations

Table 8. Species, number, and frequency of ducks observed on the natural resource studies subregion during 1976-1977 (April to November).

SPECIES	YEAR	APRIL 1-10	APRIL 11-20	APRIL 21-30	MAY A	MAY B	MAY C	NO.	%
*Mallard	1976				7	3		10	24.4
	1977		23	4	11	34	2	74	37.9
*Goldeneye, common	1976				2			2	4.9
	1977		23		2			25	12.8
*Merganser, common	1976				4	2		6	14.6
	1977		21			4		25	12.8
*Ring-Necked Duck	1976				2	3		5	12.2
	1977		2	9		4		15	7.7
*Blue-Winged Teal	1976				4	1	4	9	22.0
	1977					15		15	7.7
*Black Duck	1976				7		2	9	22.0
	1977				3	7	1	11	5.6
*Wood Duck	1976							--	
	1977		8		4	2	3	17	8.7
Lesser Scaup	1976							--	
	1977				6			6	3.1
Green-Winged Teal	1976							--	
	1977					2		2	1.0
Hooded Merganser	1976							--	
	1977		2					2	1.0
Bufflehead	1976							--	
	1977					3		3	1.5
TOTALS	1976							41	100.1
	1977							195	99.7

Table 8 (contd.)

SPECIES	YEAR	JUNE A	JUNE B	JUNE C	JULY A	JULY B	JULY C	AUG. A	AUG. B	AUG. C	SEPT. A	SEPT. B	SEPT. C
*Mallard	1976	3									24		20
	1977	(1)		1	6	(1)							
*Goldeneye, common	1976				(2)			(2)					
	1977												
*Merganser, common	1976		(1)		(1)								(1)
	1977		1	2									
*Ring-Necked Duck	1976			(1)									
	1977												
*Blue-Winged Teal	1976					(1)					2		3
	1977	6		1									
*Black Duck	1976	1											4
	1977												2
*Wood Duck	1976	(1)											4
	1977	4											
Lesser Scaup	1976												
	1977												
Green-Winged Teal	1976												
	1977												
Hooded Merganser	1976												
	1977												
Bufflehead	1976												
	1977												

Table 8 (contd.)

SPECIES	YEAR	OCT. A	OCT. B	OCT. C	NOV. A	NOV. B	NOV. C	No.	$\%A_1$	No.	$\%B_1$
*Mallard	1976					4		51	62.2	61	49.6
	1977							9	36.0	83	37.7
*Goldeneye, common	1976							4	4.9	6	4.9
	1977							--	----	25	11.4
*Merganser, common	1976					2		5	6.1	11	8.9
	1977							3	12.0	28	12.7
*Ring-Necked Duck	1976							1	1.2	6	4.9
	1977							--	----	15	6.8
*Blue-Winged Teal	1976					2		8	9.8	17	13.8
	1977							7	28.0	22	10.0
*Black Duck	1976							5	6.1	14	11.4
	1977							2	8.0	13	5.9
*Wood Duck	1976							5	6.1	5	4.1
	1977							4	16.0	21	9.5
Lesser Scaup	1976	3						3	3.6	3	2.4
	1977							--	----	6	2.7
Green-Winged Teal	1976							--		--	----
	1977							--	----	2	0.9
Hooded Merganser	1976							--		--	----
	1977							--	----	2	0.9
Bufflehead	1976							--		--	----
	1977							--	----	3	1.4
TOTALS	1976							82		123	
	1977							25		220	

KEY TO SYMBOLS:

*Known to breed in St. Louis or Lake counties, or both (Green & Janssen 1975).

A_1 = Percent of observations (June-November incl.), broods recorded as one observation (adult female).

B_1 = Percent of observations (April-November incl.), brood records counted as in A_1.

Numbers in circles are brood observations (e.g. (1) = 1 brood recorded).

Table 9. 1977 estimated duck breeding population in Study Area.

POPULATION ESTIMATE[a]	STUDY AREA
High	8370
Low	3940
Average	5708

[a]Values calculated from March, 1973, Table 4.
See text, page __.