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Recreational Use of Six Prairie Wetlands in Eastern South Dakota

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RECREATIONAL USE OF SIX PRAIRIE WETLANDS IN EASTERN SOUTH DAKOTA

BY

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RECREATIONAL USE OF SIX PRAIRIE WETLANDS

IN EASTERN SOUTH DAKOTA

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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RECREATIONAL USE OF SIX PRAIRIE WETLANDS IN EASTERN SOUTH DAKOTA

Abstract

TIMOTHY A. THOMPSON

A recreational use survey was conducted at 6 public wetlands in eastern South Dakota from August 9, 1981 through August 8, 1982. Four hundred and fifty-eight postcard questionnaires were placed on vehicles encountered at these marshes during random time periods. Two hundred and thirty-five were voluntarily returned for a response rate of 51.3%.

Approximately 10,020 people made 4,778 trips to these wetlands and spent 63,093 man-hours. Thirty-one different activities were observed or reported. Hunting accounted for 96.0% of all fall trips and 89.1% of yearly visits. Over 89% of all visits occurred during fall and over 50% of the trips were multiple use. Duck hunting occurred during 83.8% of all fall trips; goose hunting, 49.5%; and pheasant hunting, 23.0%. Users came from 25 South Dakota counties and several other states. Seventy-two percent of all users lived within an hour drive of the marshes. The average user of the study sites made 19.4 trips for consumptive activities and 4.1 trips for nonconsumptive activities per year to South Dakota public marshes.

Marsh usage during the opening week of waterfowl season was significantly greater ($F = 3.81$, $P = 0.002$) than all other weekly totals. Opening weeks for pheasant and trapping seasons also showed

peak usage, although trapping accounted for just 2.7% of all fall trips. It appeared that high goose concentrations also contributed to greater usage by hunters. Both holidays and weekends received more use than weekdays.

Fifty-five percent of the total use was in the morning. Most duck hunters used the sunrise to 0900 period and goose hunters the 0900 to noon period. There was no significant difference ($F = 0.28$, $P = 0.885$) among time periods used by pheasant hunters.

The net present value of these wetland study sites is $653 per hectare for hunting alone when infinitely discounted into the future using the social discount rate of 7.875%. Total hunting expenditures for all study sites combined were $123,279 for the 1981 hunting season. In addition, wetlands provide other recreational benefits that can not be recorded through on-site studies.

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INTRODUCTION

Intensification of land use for agriculture, construction, and human population growth is resulting in the drainage and loss of many wetlands. Approximately half of the wetlands in the prairie pothole region were drained prior to 1950 (Harmon 1971, Horwitz 1979). The average annual drainage rate from 1964 to 1969 was 1.9% of the total wetland acreage in the tri-state area of North Dakota, South Dakota, and Minnesota (Haddock and Debates 1969). Over 95% of all natural wetlands in Iowa have been drained (Bishop 1981). The Committee on the Impacts of Emerging Agricultural Trends on Fish and Wildlife Habitat (1982) projected that all of the remaining prairie wetlands will be lost by 2055 if the present drainage rate continues.

Prairie wetlands are widely recognized for their importance to waterfowl and shorebird production (Smith et al. 1964, Hammack and Brown 1974, Flake 1978, Weber et al. 1982). Many other values of wetlands such as high plant productivity, pollution filtration, groundwater recharge, flood control, storm buffering, and sediment accretion are recognized (Niering 1977). Horwitz (1979) attributed recreation and aesthetic benefits to wetlands as well, but this has not been adequately quantified for South Dakota wetlands or for prairie wetlands in general.

As our leisure time increases, our demand for outdoor recreation also increases (Committee on Assessment of Demand for Outdoor Recreation Resources 1975). This demand will put more pressure on prairie wetlands as recreation areas. Quantitative and qualitative

usage data of prairie wetlands must be collected for management programs to be developed and for long-range acquisition and preservation policies to be formulated.

The Research Problem

As outdoor recreation increases, demand for space to provide quality outdoor experiences increases. To assess that demand, baseline data must be obtained concerning the users and uses of prairie wetlands. This study will attempt to establish baseline data for recreation in the prairie pothole region by asking: What types of recreation are occurring on selected South Dakota prairie wetlands and what are the intensities of those uses throughout the year?

Importance of the Problem

Prairie marshes and ponds are natural resources that can be both difficult and costly to reclaim after they have been drained (Wentz 1981). It is important to gather as much information as possible on wetland values in order to formulate adequate protection policies. The Comptroller General (1979) stated that without such information, the cost effectiveness of various federal wetland acquisition and protection programs cannot be adequately assessed.

Better documentation of the values of prairie wetlands would also be useful to state legislatures and other governmental bodies who in recent years have blocked or have attempted to block federal wetland acquisition and protection programs in the prairie pothole region (Flake

1979). Documentation of positive wetland values would give these people an incentive to support wetland preservation rather than drainage. Knowledge of public and private uses of wetlands is important for formulating policies.

Objectives of the Study

The following objectives have been pursued in this study:

1. To measure the amount of use on 6 public wetland areas during all seasons of the year.
2. To learn trip characteristics of visitors, such as miles traveled to the site, time spent at the area, number of people in a vehicle, activity at the wetland site, and the frequency of visits to public marshes in South Dakota per year.
3. To compare the fall season of known intensive hunting use to other nonhunting periods (winter, spring, and summer).
4. To chart periods of peak use and patterns of use by activity for the fall season.
5. To measure effects of weather on usage.

Review of Literature

Many methods have been used for sampling recreation in various parks and wildlife areas, but very little has been done to sample recreation in wetland areas specifically. There have been no reports of efforts to quantify or qualify various recreational or other uses in the prairie pothole region of the United States.

General survey methods are self-administered questionnaires, personal interviews, telephone interviews, and direct observation (Scheaffer et al. 1979). All of these have been used in sampling recreation.

Ferriss (1963) stated that there are 3 types of recreational surveys: (1) tourist studies where people are stopped along the route, (2) on-site surveys conducted at a recreation site, and (3) household recreation surveys. He believed that attitude, motivation, and decision-making factors should be more heavily explored along with the usual demographic and trip characteristics and time and cost variables.

The Environmental Research Group (1974) and Rosonke (1974) conducted personal interviews from a sample of the population of all households in a geographic region. Their studies involved discovering the attitudes and opinions along with the socio-economic characteristics of the interviewees.

Goldstein (1971) and Hammack and Brown (1974) used detailed mail questionnaires to discover the monetary values hunters placed on wetlands, particularly on the value of waterfowl hunting. Most hunters indicated that they would have to receive a large sum of money to forgo waterfowl hunting.

Jaworski and Raphael (1978) used harvest data and other government reports to estimate economic values of coastal wetlands in Michigan. Monetary values were assigned to hunting, fishing, and nonconsumptive recreation. When the public has access to a multiple use wetland, the wetland may generate several hundred dollars worth of gross annual return per acre.

Hansen (1977) used personal interviews for an on-site survey of the upper James River in South Dakota. His survey was a year-round study with 34 access points sampled at random. The year was stratified into 4 seasons and each season was sampled according to an expected use. Other factors weighted by an expected probable use were periods of the day, days of the week, and type of river access (bridge, park, etc.). He recorded volume of use, types of use and harvest (if applicable), residence, distance traveled to area, and the frequency of river use. Over 2,000 hours of sampling time were used.

Recreational surveys in Michigan have resulted in a longitudinal study of state owned wildlife areas. Gordinier (1957) used a stratified sampling of areas by conducting a car count 3 times on each sampling day. Days were selected intentionally for expected high use during the hunting season. Mail-back postcard questionnaires were placed on all vehicles encountered in these areas during the sampling periods.

Palmer (1967) expanded the car count and postcard survey to a 1 year study. He used a random stratified sampling technique for sampling days. Days were weighted based on expected use. Palmer received a return rate of 73.4% for fall users and 85.4% for spring and summer users. He used 2 follow-up letters by tracing license plate numbers to the owners to obtain this high rate. A second, more detailed mail questionnaire was sent to hunters to discover their characteristics and attitudes. Seventeen percent of the nonrespondents were interviewed by phone. The only bias detected was that urban people, married people, and blacks were less apt to respond to mail questionnaires.

About 10 years later Belyea and Lerg (1976) did a third recreational study of Michigan public wildlife areas. They stratified areas according to cover type and the potential uses. Other stratifications, weights assigned to days, and methods were similar to those used by Palmer (1967). Methods were modified by adding 1 more daily time period for the summer stratum. Recreational use was considerably higher than in 1962. Only 42% of all postcard surveys were returned. No detailed surveys or checks for bias were made.

Klonglan and Wright (1973) based their Iowa recreational study of public hunting areas on the methods of Palmer (1967). The study was conducted for 1 year. Areas used and days sampled were selected by convenience instead of randomiziation. This study provided basic man-hour data for specific areas in Iowa.

Mead (1977) used the car count method in a year long study of Ohio public wildlife areas. A detailed 8 page questionnaire left on each vehicle was also used. The response rate was very low (26%) after follow-up efforts were discontinued; the Ohio State University Behavioral Science Review Committee ruled that the follow-up method of tracing nonrespondents by their vehicle license plate number was unethical. Mead expanded the car count method to 6 time-checking periods to include more late night and early morning uses. Methods of stratification were similar to that of Palmer (1967). Mead also experimented with traffic counters. He found total monthly axle count and estimated monthly total use in man-hours to be significantly correlated ($r = 0.65$, $P < 0.05$).

All the above studies using the car count method employed the help of state conservation workers to run the samples through their respective areas. Thus, a large work force is needed for extensive coverage of many areas.

James and Ripley (1963) gave instructions for using traffic counters in recreation areas to estimate use. According to their recommendations counters should be placed across roads that serve as the only entrance and/or exit. The counters should then be read every 24 hours. Total visits will produce a linear relationship with axle counts. A sampling duration of 10 days is needed to yield error terms of less than 25% at a 67% probability level. For smaller error terms, a sharp increase in the number of sampling days is necessary.

The personal interview and car count methods were time consuming. Long mail questionnaires and those questionnaires concerning attitudes and opinions yielded low response rates. Postcard surveys which required limited personal data had a higher response rate than other types of self-administered questionnaires.

Observation has been a little used method for gathering recreational use data. Most observations have been to simply note cars in which the occupants appeared to be sight-seeing.

On-site surveys yield good data in that actual users are questioned or observed; thus there is less chance for bias.

Conceptual Framework

The conceptual model (Fig. 1) for this study theorizes that certain observable natural factors will cause peak use and possible patterns of use for wetlands. Observable factors are the season of the year, day of the week, hour of the day, daily weather conditions, and type of wetland. These factors will indicate personal free time, personal enjoyment, activity pursued, time spent at the area, and number of users. An added observation is the number of cars parked at a marsh. This number is a measurement of use. The license plate indicates the place of residency and the distance traveled.

Theoretical Framework

From the discussion of theoretical uses of wetlands, review of literature, and the conceptual model, the following set of propositions was developed:

1. The season affects the activities pursued at wetlands.
2. The day of the week has an impact on marsh usage.
3. Different activities are associated with various times of the day.
4. Daily weather conditions have an effect on the number of wetland users.
5. Certain activities on marshes have peak usage because of daily weather conditions.
6. The type and size of the wetland is associated with the activity sought.

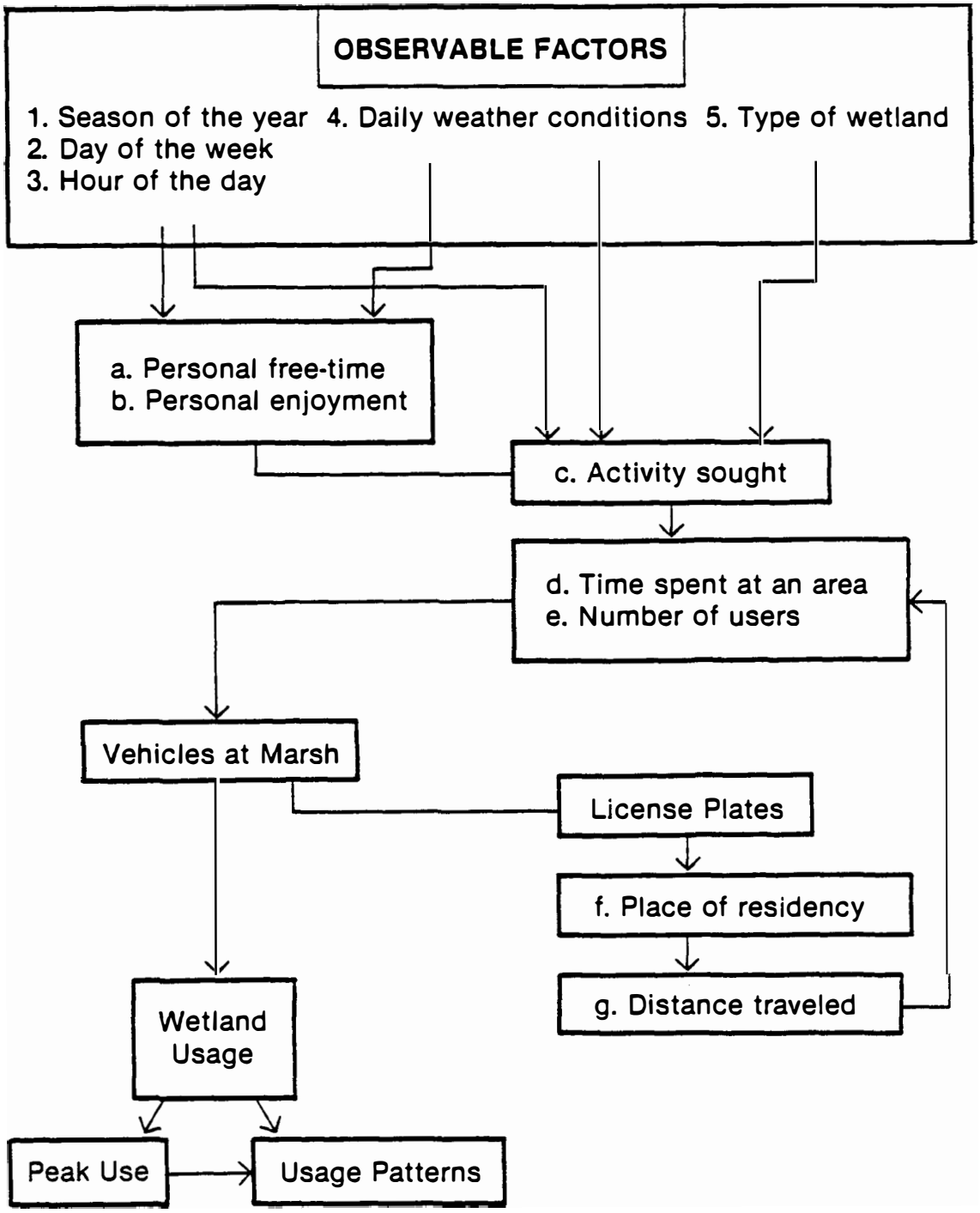


Figure 1. Conceptual model for wetland recreational use. Arrows indicate the flow of influence from a previous factor.

7. Personal free-time and enjoyment are associated with the activities sought.

Research Hypotheses

The hypotheses are:

1. The observed variation in the set of independent variables (X_1 - season of the year, X_2 - day of the week, X_3 - hour of the day, X_4 - daily weather conditions, and X_5 - type of wetland) will contribute significantly to explaining the dependent variable (Y_1 - the activity pursued at a wetland).
2. The amount of time spent and the number of users are functions of the activity at the wetland site.
3. The amount of time spent and the number of users are functions of the place of residency.

Thirty-two subhypotheses have been formulated as a breakdown of these main hythotheses (see Appendix A). These subhypotheses provided the direction of the statistical analysis.

STUDY AREAS

Six sites were selected for the study: (1) Brush Lake, Henrikson, Holm, and Larson Waterfowl Production Areas (WPAs) in western Brookings County (Fig. 2); (2) Buffalo Slough Game Production Area (GPA) in southeastern Lake County (Fig. 3); and (3) Lake Whitewood, a meandered lake in central Kingsbury County (Fig. 4). The criteria for selecting sites were that the areas must: (1) contain a Class III, IV, or V wetland (Steward and Kantrud 1971), (2) have parking access(es) for sampling ease, (3) be publicly owned land that has multiple-use potential, (4) be within an hour drive of the city of Brookings, (5) be under different types of management, (6) be different sized wetlands, and (7) be varying distances to population centers.

All of these wetland sites lie in the Coteau des Prairie Region of eastern South Dakota. They were chosen to be representative of the types of publicly owned marshes in this region. The Coteau des Prairie area contains 35 - 45% of all publicly owned wetlands in eastern South Dakota (South Dakota Sportman's Atlas: an Outdoorsman's Guide to Public Lands and Waters 1980, Dvorak no date).

Brush Lake WPA is in T110N, R52W, sections 19, 20, and 30 of Brookings County adjacent to Highway 14. In 1981-1982 Brush Lake contained 2 shallow Class V wetlands totalling a little over 81 hectares (200 acres); 1 Class IV wetland containing approximately 40 hectares (100 acres) with open water; 5 additional Class IV wetlands totalling approximately 28 hectares (70 acres) which were mostly dry and choked

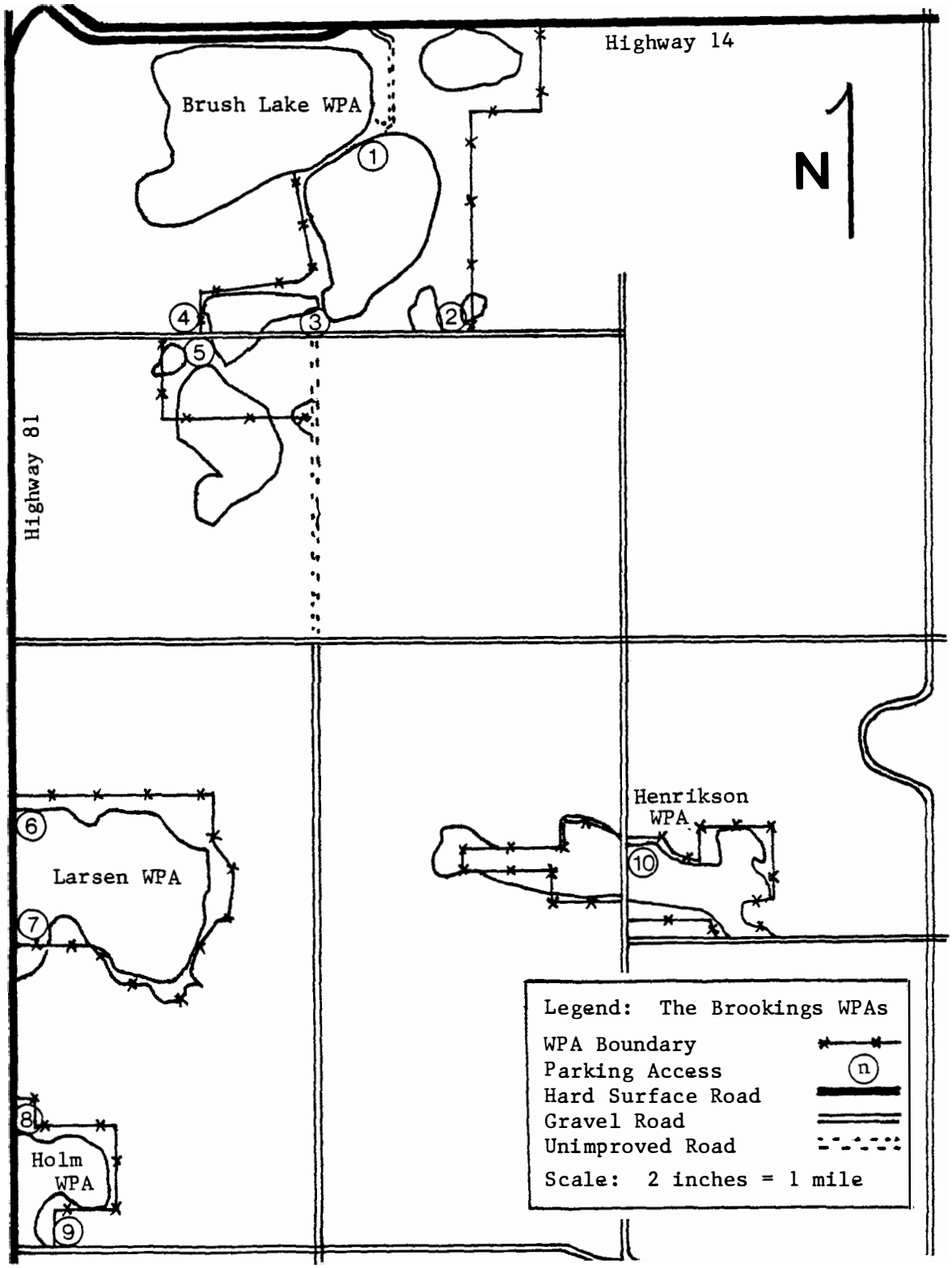


Figure 2. Location of parking accesses for the Brookings WPAs, South Dakota, sampled during a wetland recreation survey, August 9, 1981 through August 8, 1982.

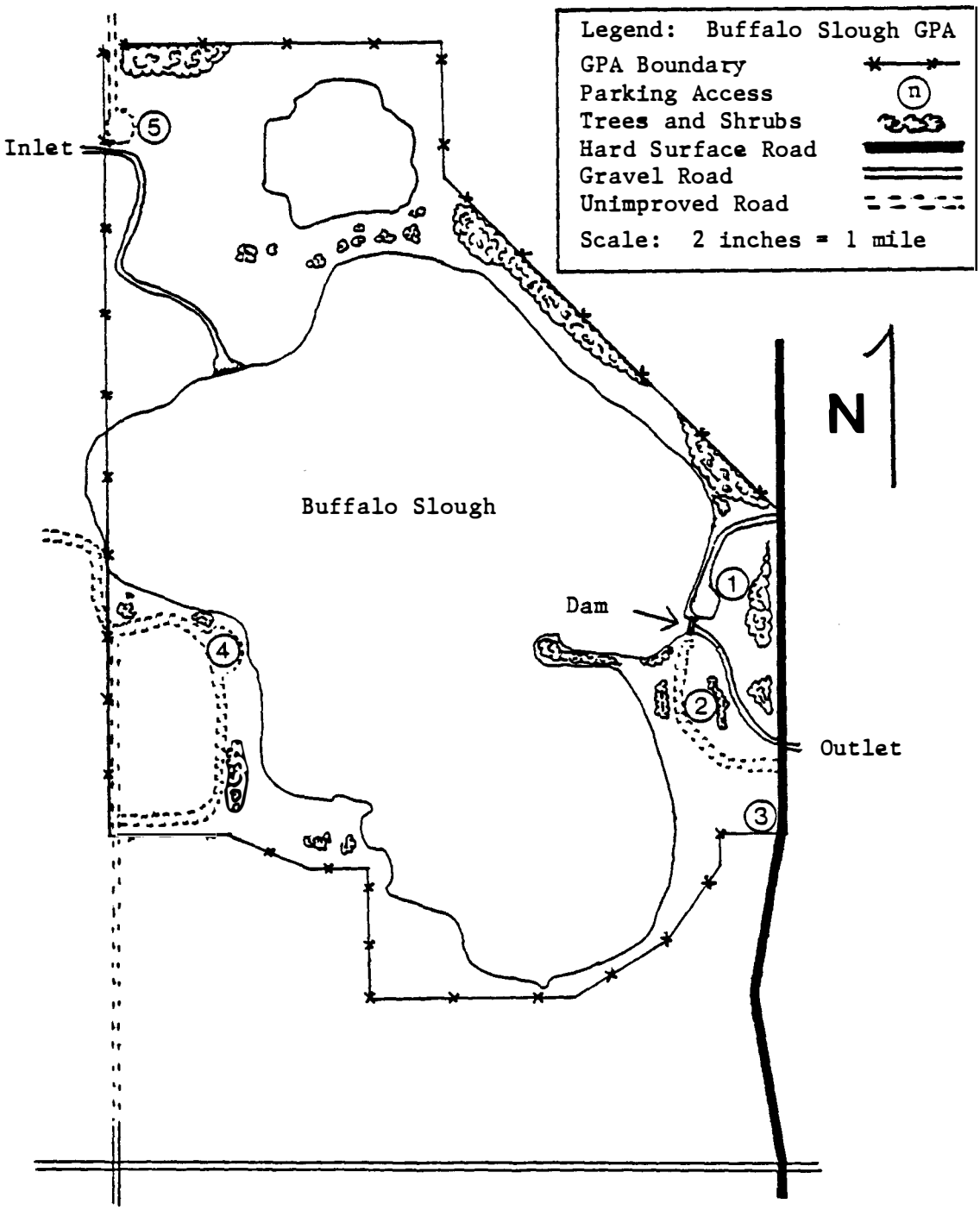


Figure 3. Location of parking accesses for Buffalo Slough GPA, South Dakota, sampled during a wetland recreation survey, August 9, 1981 through August 8, 1982.

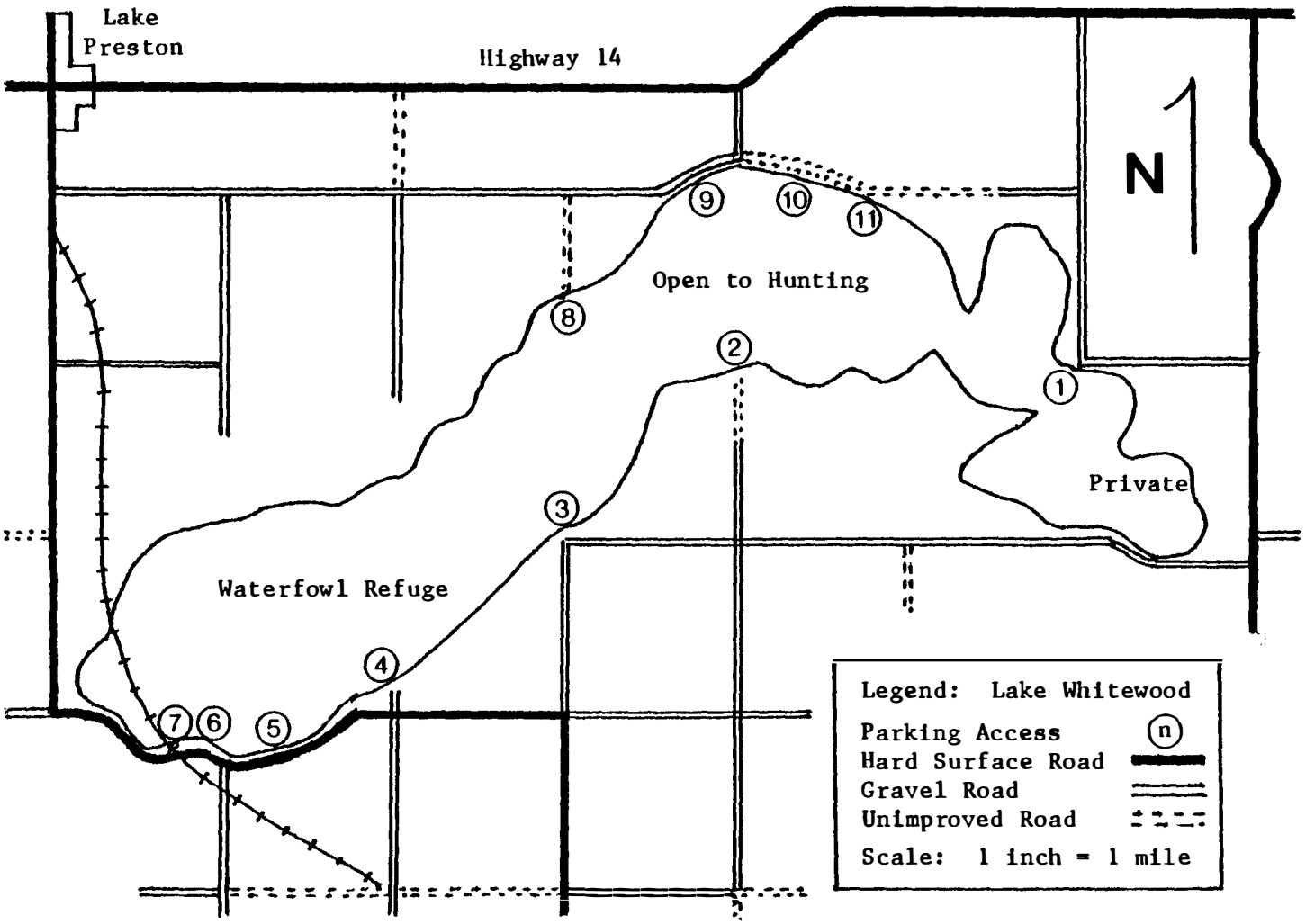


Figure 4. Location of parking accesses for Lake Whitewood, South Dakota, sampled during a wetland recreation survey, August 9, 1981 through August 8, 1982.

with vegetation; and some fringe areas of Class III wetlands. The total area is 253 hectares (625 acres) with approximately 58% wetlands. There are a few small groups of trees scattered along the wetland edges and one shelterbelt on an old farmstead. Some upland and a dry Class IV wetland located in the southeast corner of the Brush Lake WPA were not considered as part of the area. No use was observed in those areas during this study.

The Henrikson WPA is in T110N, R52W, sections 32 and 33 of Brookings County. This area has 1 Class IV wetland of approximately 32 hectares (100 acres) divided by a gravel road. Except for ditches along the road, most of this area was dry during the study. The total area is approximately 55 hectares (135 acres) with 75% wetlands.

The Holm WPA is located in T109N, R52W, section 6 of Brookings County adjacent to Highway 81. The area totals approximately 32 hectares (78 acres) with 17 hectares (42 acres) of it being a Class IV marsh. A mature shelterbelt runs the east-west distance of the area. The Holm WPA was dry during most of the study.

Larson WPA is located in T110N, R52W, section 31 of Brookings County adjacent to Highway 81. It is approximately 93 hectares (230 acres) with a 69 hectare (170 acre) Class IV marsh. It was dry during most of the study.

All of these WPAs are managed by the U.S. Fish and Wildlife Service for waterfowl production. They are shallow and were in the dry phase of their cycle. All are open to hunting and public use.

Buffalo Slough GPA is located in T105N, R51W, sections 22 and 27 of Lake County adjacent to a county blacktop road. It is a diverse area totaling 267 hectares (660 acres). Approximately 162 hectares (400 acres) of it are a large Class IV marsh. About half of this marsh had open water since there is a small dam across its outlet. Accessibility by boat or canoe was, thus, relatively easy. A small Class IV wetland of approximately 9 hectares (22 acres) lies north of this larger marsh. This small wetland is not easily accessible unless permission is received to cross private land.

A quarter-mile creek supplies water to the marsh. This creek is bordered by willow thickets and serves as habitat for wood ducks and beavers. Buffalo Slough also has 4 thick shelterbelts which provide excellent cover for white-tailed deer, rabbits, squirrels, and doves. One of these shelterbelts is approximately 1 kilometer (0.5 miles) long. There are also numerous brushy shrubs and trees scattered around the marsh edges. The area contains 1 large food plot and a reseeded native grass area.

The ratio of wetland to upland in Buffalo Slough is approximately 3 to 2. South Dakota Department of Game, Fish, and Parks (GFP) owns and manages the area for public hunting.

Lake Whitewood is located in T110N, R53W, sections 2, 3, 9 through 13, 15 through 21, 29, and 30 of Kingsbury County. It is a large meandered lake (Class IV wetland) totalling 1700 hectares (4200 acres) and extending 11 kilometers (7 miles). Meandered lakes are owned by the state and managed by GFP. State ownership extends to the high

water level; thus, all of Lake Whitewood is wetland except for 2 hectares (5 acres) of upland purchased by GFP. There are a few scattered trees and shrubs along the edges.

During the study, a large portion of Lake Whitewood was dry with about 121 hectares (300 acres) of open water for waterfowl hunting. Other small openings suitable for duck hunting could be found in thick vegetation. Access to much of Lake Whitewood was difficult. Approximately 405 hectares (1,000 acres) of open water located in the western 1/3 of the lake was a waterfowl refuge with hunting allowed withina 91 meter (100 yard) perimeter. The refuge provided a resting place for numerous ducks and geese.

METHODS

Five methods of data collection were used: a postcard survey, vehicle license plate numbers, personal interviews, traffic counters, and personal observations. Some methods complimented one another; others were analyzed separately and served as checks.

Sampling Framework

The year time period was divided into 4 sampling strata based on expected use. These are referred to as fall, winter, spring, and summer. Sampling probabilities were assigned to days of the week with the assumption that Saturdays and Sundays would have twice the usage of weekdays (Appendix B). Since there were no data for weighting sampling probabilities of the days of the week for prairie wetland usage in South Dakota, this choice was subjective based on sampling probabilities of other recreation studies. Holidays were assigned to have the same weight as weekend days. Hunting season opening days for archery deer, waterfowl, pheasant, and rifle deer, and opening day for trapping were weighted more heavily than other days.

Sampling was conducted between sunrise and sunset during randomly chosen 3-hour time periods. Typical periods for summer were 0500-0800, 0800-1100, 1100-1400, 1400-1700, 1700-2000, and 2000-2300. Since one objective was to detect the high use periods, all periods were weighted equally.

Summer, winter, and spring were treated equally. For prairie wetlands, there is no reason to assume increased usage during any one of these seasons over another. In spring there is waterfowl observation. In the summer wetlands can be used for canoeing. Snowmobiling is a potential winter activity for wetlands.

I assumed fall was a high use season because the main recreational activities on marshes are waterfowl hunting and furbearer trapping. Other types of hunting may also be significant uses of wetland areas. Although, hunting of upland game and deer is not widely documented in wetlands of the prairie pothole region, Schitoskey and Linder (1978) stated that use of wetlands by white-tailed deer and upland game is common.

The survey extended from August 9, 1981 to August 8, 1982 with sampling according to the seasonal tabulations (Table 1). A more intensive sampling schedule was followed in the fall to chart peaks of hunting use. Severe blizzards prevented sampling on 4 days (8 periods) during the winter.

Sampling periods were chosen by week and without replacement according to probabilities based on earlier stated assumptions. Sampling without replacement eliminated the need for more personnel and vehicles, and thus reduced travel costs. Sampling without replacement should have no biasing effect since all daily time periods are assumed equal in amount of use. Stratified random sampling of areas was used so that all areas were sampled the same number of times. Sampling periods were assigned at random until a certain number was reached for each area

Table 1. Time frame and sampling effort (3-hour periods) used during a recreational use survey of Brush Lake, Henrikson, Holm, and Larsen WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota.

Season	Date	Number of 7 day weeks	Sampling periods per week	Number of sampling periods per season
Summer	June 1 - September 26	16.9	6	101
Fall	September 27 - December 6	10.1	12	121
Winter	December 7 - March 31	16.4	6	98 [a]
Spring	April 1 - May 31	8.7	6	54
Total				374

a Blizzards on 4 days prevented sampling 8 periods.

for each week. An additional stipulation was that at least 1 visit per area was drawn on a weekday and 1 on a weekend for each week of the fall survey.

Sampling Techniques

Weather conditions at each wetland were recorded at the beginning of sampling periods. A stamped postcard questionnaire with a letter explaining the study was placed on the windshields of most vehicles in the area (Appendix C). It was not possible to place a questionnaire and letter on all cars since some were being driven and others were parked outside the area. If precipitation was likely, the questionnaire and letter were placed in a plastic bag.

Each postcard questionnaire was numbered. When a questionnaire was placed on a windshield, its number and the vehicle license plate number were recorded. If the same vehicle was encountered twice in 1 day, the license number was recorded but a second postcard survey was not distributed.

A card for hunters and trappers was used in the fall. A different card was used for winter, spring, and summer. General questions on both cards were directed toward activity for that day, number of people with the vehicle, length of stay, number of miles traveled to the site, and average number of visits to South Dakota public marshes in the last 12 months. In the fall, the questionnaire also asked which game species were hunted or trapped. A pretest of survey questions was conducted before the actual field study began.

Personal interviews were used as both a check and a replacement for individual questionnaires. The interviews were conducted during 10% of the random sampling periods at access 1 of Buffalo Slough and access 2 of Lake Whitewood. Those parking accesses were chosen because in a preliminary study they were the most used access of their respective areas.

On interview days one person recorded vehicle license numbers and distributed survey cards and another person conducted the interviews. During those 3-hour periods, the vehicle driver from each group completing their hunt and returning to the parking lot was interviewed. Questions were asked as they appeared on the survey questionnaire. No postcards were left with these persons.

Traffic counters were used on an experimental basis. The counters were placed as outlined by James and Ripley (1963) and McCurdy (1970). On August 9, 1981 one counter each was placed at Buffalo Slough and Lake Whitewood on the roads to access 1 and access 2 respectively (Fig. 3 and Fig. 4). Readings were taken whenever a sampling period occurred at that site. The counters were removed on November 19, 1981 after a blizzard. Counters were returned in spring 1982 at the same sites and readings were taken until August 6, 1982. An additional counter was placed at access 1 at Brush Lake (Fig. 2) during spring and summer of 1982.

Personal observation was used to check for errors by noting the number of people per vehicle and their activities, including any illegal activities that might not be reported on the questionnaires.

Observation added some users to the study who would not have been identified -- because they were not parked (e.g. sight-seers) or because they did not come in a motor vehicle (e.g. bicyclists).

Analysis of Data

Thirty-two subhypotheses were formulated from the three main hypotheses and were tested. Statistical tests were chi-square (X^2), goodness of fit, paired t-tests, and least significant difference (LSD) according to Steel and Torrie (1980). Other tests were analysis of variance (AOV), general linear model (GLM), discriminant analysis, and simple linear correlations. Frequencies, means, and percentages were also used to describe the amounts of wetland usage for various sampling time frames, different wetland sites, weather conditions, and activities.

Estimates of use in terms of trips or visits were based on expansion of vehicle counts. The formula used was modelled after similar equations of McCurdy (1970) and Schmidt (1975). Estimates for total recreational use and associated standard error were calculated individually in each season, area, week, type of day, and activity stratum as follows:

$$T = \frac{\sum t_i}{n} \times N$$

$$s_E = \sqrt{\frac{1}{n\,(n-1)} \times \left(\sum t_i^2 - \frac{(\sum t_i)^2}{n} \right) \times N^2}$$

where:

T = total number of expanded trips during that stratum,

t_i = number of vehicles counted during individual sampling periods for the stratum,

n = number of periods sampled during the stratum

N = number of total sampling periods possible during the stratum, and

s_E = standard error of the estimate.

The total year estimate was obtained by summing the season totals.

Estimates for total people participating in various strata were obtained by multiplying the mean number of people per party of that particular stratum by the total number of sampling periods possible as follows:

$$T = \frac{\sum t_i}{n} \times N\bar{P}$$

$$s_E = \sqrt{\frac{1}{n\,(n-1)} \times \left(\sum t_i^2 - \frac{(\sum t_i)^2}{n} \right) \times (N\bar{P})^2}$$

where:

$\bar{P}$ = mean number of people per party in the stratum.

All other symbols are the same as in the previous equations.

Estimates for total man-hours of recreational use in various strata were likewise found by multiplying the mean number of hours per visit by the NP in the above equations.

Confidence limits were placed around the estimated recreational use expressed by trips, people, and man-hours. These confidence limits were calculated as described by Ostle (1963).

$$CL = X \pm (t_p)\ (s_E)$$

where:

CL = the upper and lower confidence limits at the stated probability level of t,

X = the total estimate (either trips, people, or man-hours),

t_p = t value taken from a t-table at a selected probability level of either 95% or 66% commonly used in reporting recreation data, and

s_E = the standard error of the estimate.

RESULTS AND DISCUSSION

Response Rate

Between August 9, 1981 and August 8, 1982, 458 questionnaires were distributed to wetland users at the study sites. Two hundred and thirty-five were returned voluntarily for a response rate of 51.3%. More than 96% of the questionnaires were distributed during the fall, which yielded a 50.5% return rate. Winter, spring, and summer combined yielded a 75.0% return of the 4% distribution.

Total Recreational Use

The 6 wetland sites provided an estimated 63,093 hours of recreational use during the survey period. Approximately 10,020 people made 4,778 trips to these wetlands (Table 2).

The fall accounted for 92.9% of all trips, 95.0% of all people, and 98.9% of all man-hours spent at these wetlands. No significant difference in recreational use was found among winter, spring, and summer for trips ($X^2 = 0.015$, $P = 0.993$), people ($X^2 = 0.050$, $P = 0.975$), or man-hours ($X^2 = 2.537$, $P = 0.292$).

Twenty-six different activities were reported (Table 3). Almost half of all visits was multiple use trips. Hunting accounted for 87.0% of all trips, 93.4% of all people, and 97.7% of all man-hours spent at these wetlands. The major hunting uses were for ducks, geese, and pheasants, comprising 74.6%, 44.1%, and 20.5% of all trips, respectively. The most frequent nonconsumptive use was birdwatching

Table 2. Estimated recreational use by season for Brush Lake, Henrikson, Holm, and Larsen WPAs; Buffalo Slough GPA; and Lake Whitewood; South Dakota, from August 9, 1981 through August 8, 1982.

Season	Season Length (weeks)	Trips	People	Man-hours
Fall	10.1	4,255	9,232	62,014
Winter	16.4	184	276	587
Spring	8.7	114	152	177
Summer	16.9	225	360	315
Total	52.1	4,778	10,020	63,093
Standard Error		503	1,075	7,111

Table 3. Estimated recreational use by activity for Brush Lake, Henrikson, Holm, and Larsen WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, from August 9, 1981 through August 8, 1982.

Activity	Trips		People		Man-hours	
	No.	%	No.	%	No.	%
Consumptive Uses						
Duck Hunting	3,566	74.6	7,987	79.7	57,506	91.1
Goose Hunting	2,106	44.1	4,823	48.1	44,082	69.9
Coot Hunting	77	1.6	153	1.5	421	< 1
Rifle Deer Hunting	38	< 1	115	1.1	3,325	5.3
Archery Deer Hunting	177	3.7	276	2.8	707	1.1
Pheasant Hunting	979	20.5	2,222	22.2	26,020	41.2
Rabbit Hunting	136	2.8	291	2.9	643	1.0
Partridge Hunting	38	< 1	58	< 1	247	< 1
Squirrel Hunting	19	< 1	38	< 1	38	< 1
Predator Hunting	39	< 1	78	< 1	312	< 1
Trapping Aquatic Furbearers	98	2.1	98	1.0	206	< 1
Trapping Terrestrial Furbearers	38	< 1	39	< 1	29	< 1
Fishing	39	< 1	78	< 1	78	< 1
Nonconsumptive Uses						
Canoeing	19	< 1	38	< 1	156	< 1
Picnicking	19	< 1	115	< 1	345	< 1
Hiking	39	< 1	39	< 1	351	< 1
Enjoying Nature/ Sightseeing	96	2.0	153	1.5	275	< 1
Birdwatching	215	4.5	391	3.9	3,589	5.7
Camping	62	1.3	99	1.0	4,505	7.1
Loafing	39	< 1	39	< 1	20	< 1
Photography	57	1.2	57	< 1	133	< 1
Scientific Research	39	< 1	39	< 1	20	< 1
Target Practice	19	< 1	58	< 1	232	< 1
Arrowhead Hunting	39	< 1	39	< 1	a	a
Hunting/ Trapping Preparation	96	2.0	153	1.5	352	< 1
Miscellaneous	39	< 1	117	1.2	78	< 1

a No man-hours were available to estimate a total.

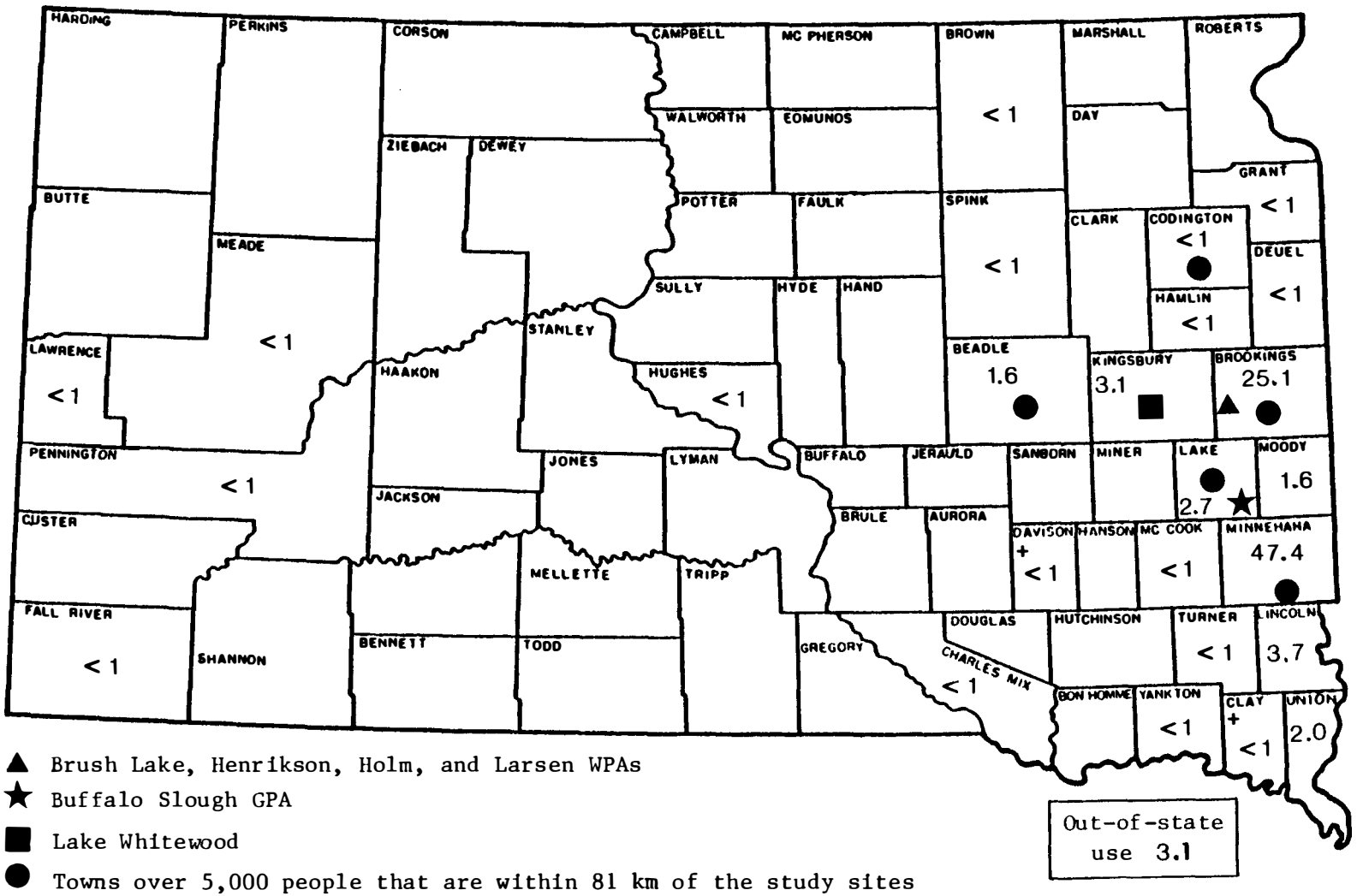
Numbers and percentages are not additive because of multiple use trips.

which accounted for 4.5% of all trips. Camping comprised only 1.3% of all trips, but because of its nature, accounted for 7.1% of all man-hours spent. Other activities not reported on surveys and thus, not quantifiable, yet observed, were bicycling, cross-country skiing, cutting firewood, sledding, and snowmobiling.

The average trip was made by slightly more than 2 people; these people spent approximately 6.5 hours at the study sites. There was no significant difference among seasons for party size ($X^2 = 0.241$, $P = 0.970$). However, the fall was significantly different from the other 3 strata for hours spent ($X^2 = 8.139$, $P = 0.045$). There was no difference in the hours spent among spring, summer, and winter ($X^2 = 1.010$, $P = 0.617$) with the average time spent being less than 1.5 hours per trip.

The average distance traveled one-way was slightly less then 80 kilometers (50 miles). Fall travel was significantly greater than the other 3 seasons ($X^2 = 27.785$, $P < 0.005$), averaging 82 kilometers (52 miles). There was no difference in distance traveled for spring, summer, and winter ($X^2 = 0.440$, $P = 0.986$) with an average one-way distance of 31 kilometers (19.3 miles). One-way distances traveled ranged from 1.5-780 kilometers (1-485 miles).

Recreationists identified by this study came from 25 different counties in South Dakota (Fig. 5). Out-of-state users accounted for 3.1% of the total trips. Minnehaha County accounted for the greatest number of users with 47.4%, followed by Brookings (25.1%), Lincoln (3.7%), Kingsbury (3.1%), and Lake (2.7%) counties. Residents from other counties comprised less than 2.5% each for the remaining 14.9%.



▲ Brush Lake, Henrikson, Holm, and Larsen WPAs

★ Buffalo Slough GPA

■ Lake Whitewood

● Towns over 5,000 people that are within 81 km of the study sites

\+ Indicated from survey responses

Figure 5. Percentage of use by residents of 25 South Dakota counties based on vehicle counts at all 3 wetland sites during fall, September 27 through December 6, 1981.

Based on survey returns indicating activities pursued, consumptive use was significantly greater than nonconsumptive use (for trips, $X^2 = 82.71$, $P < 0.005$; for people, $X^2 = 165.86$, $P < 0.005$; and for man-hours, $X^2 = 413.43$, $P < 0.005$). Consumptive use accounted for 92.3% of all trips, 94.6% of all people, and 98.1% of all time spent.

Consumptive and nonconsumptive use was also estimated from responses to the following survey question: "Estimate the number of times that you visited South Dakota public marshes during the last 12 months for: nonhunting _____ (and) hunting/trapping _____". There was a significant difference between the results obtained from this question and the results obtained by examining activities actually pursued ($X^2 = 7.974$, $P < 0.005$).

The survey question indicated that 17.5% of all trips to South Dakota marshes were for nonconsumptive uses. This compared to a 7.7% nonconsumptive use calculated from actual activities. Apparently other public marshes are used more extensively for nonconsumptive activities than the wetland sites used in this study. According to the survey data, the average wetland user makes 19.4 trips for consumptive activities and 4.1 trips for nonconsumptive activities during a 1-year period to South Dakota public marshes.

Fall Usage

Fall use consisted of 62,014 man-hours, or 98.9% of total use. There were 4,255 trips made by 9,232 people to the 3 wetland study sites. Hunting and trapping accounted for 93.6% of all the indicated

use, and nonconsumptive use (most associated with hunting trips) accounted for 6.4%.

Twenty different activities were reported (Table 4). The single most common activity was duck hunting, which accounted for 83.8% of all trips, 86.5% of all people, and 92.7% of all time spent. Other frequently listed activities were goose hunting (49.5%) and pheasant hunting (23.0%). All other individual activities were mentioned less than 5% of the time. Birdwatching (3.2%) was the most often mentioned nonhunting activity, although camping accounted for 7.3% of all time spent.

Pheasant hunting accounted for 23.0% of the total trips and 42.0% of the total man-hours spent. Almost 75% of all pheasant hunting was associated with at least 1 other activity on that trip (usually duck hunting). Gates and Hale (1974) found that wetlands (which comprised 10% of their landscape) held 75-90% of the pheasants at the end of the hunting season in Wisconsin. My data indicated that South Dakota pheasant hunters also realize the attraction wetlands have to this upland game bird. All other upland game species were hunted during pheasant hunting trips.

Deer hunting was expected to be a major use of eastern South Dakota wetlands since deer usage of marshes has been considered high (Cook 1945, Sparrowe and Springer 1970). Deer hunting (both archery and rifle) only amounted to 3.2% of the total trips, although it accounted for 6.2% of the total hours spent.

Table 4. Estimated recreational use by activity for Brush Lake, Henrikson, Holm, and Larsen WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

Activity	Trips		People		Man-hours	
	No.	%	No.	%	No.	%
Consumptive Uses						
All Hunting	4,085	96.0	9,027	97.8	61,654	99.4
Waterfowl Hunting	3,681	86.5	8,209	88.9	58,941	95.0
Ducks	3,566	83.8	7,987	86.5	57,506	92.7
Geese	2,106	49.5	4,823	52.2	44,082	71.1
Coots	77	1.8	153	1.7	421	< 1
Deer Hunting	136	3.2	272	2.9	3,827	6.2
Archery	98	2.3	157	1.7	502	< 1
Rifle	38	< 1	115	1.2	3,325	5.4
Upland Game Hunting	979	23.0	2,222	24.1	26,020	42.0
Pheasants	979	23.0	2,222	24.1	26,020	42.0
Rabbits	136	3.2	291	3.2	643	1.0
Partridge	38	< 1	58	< 1	247	< 1
Squirrels	19	< 1	38	< 1	38	< 1
All Furbearer Trapping	115	2.7	115	1.2	210	< 1
Aquatic	98	2.3	98	1.1	206	< 1
Terrestrial	38	< 1	38	< 1	29	< 1
Nonconsumptive Uses						
Hunting/ Trapping Preparation	60	1.4	119	1.3	337	< 1
Canoeing	19	< 1	39	< 1	156	< 1
Picnicking	19	< 1	115	1.2	345	< 1
Hiking	38	< 1	39	< 1	342	< 1
Enjoying Nature/ Sightseeing	19	< 1	38	< 1	228	< 1
Birdwatching	136	3.2	272	2.9	3,846	6.2
Camping	60	1.4	99	1.1	4,505	7.3
Photography	19	< 1	19	< 1	95	< 1
Target Practice	19	< 1	58	< 1	232	< 1

Numbers and percentages are not additive because of multiple use trips.

Rifle deer season accounted for 0.9% of the trips, but accounted for 5.4% of the total man-hours. However, the season was only open 9 days out of the 71-day fall sampling stratum.

The 1981 archery deer season lasted 92 days and extended through December, into the winter stratum. The archery deer season accounted for 3.7% of the total trips during the year. The abundance of habitat in Brookings, Kingsbury, and Lake Counties probably spreads archery deer hunters over a wide area.

Although these wetlands did not have a large number of deer hunters, they still provided necessary winter cover for deer. Sparrowe and Springer (1970) indicated that white-tailed deer usage of wetlands in South Dakota is most common between December and April.

Trappers were also expected to make frequent use of wetlands, but accounted for just 2.7% of the trips, and less than 1% of the people and man-hours (Table 4). This may be because a trapper uses a large area and other trappers stay off that area.

Weekly Usage Patterns. Weekly usage of the study sites was calculated and graphed based on vehicle counts (Fig. 6). These data were combined with data obtained from responses to the questionnaires to calculate the number of people using the wetlands per week and the total man-hours spent per week (Table 5).

An analysis of variance (AOV) test indicated a highly significant difference in usage among weeks ($F = 3.81$, $P = 0.002$). A least significant difference (LSD) test at the 0.05 level indicated that trip usage during week 2 (October 3-9) was significantly greater than

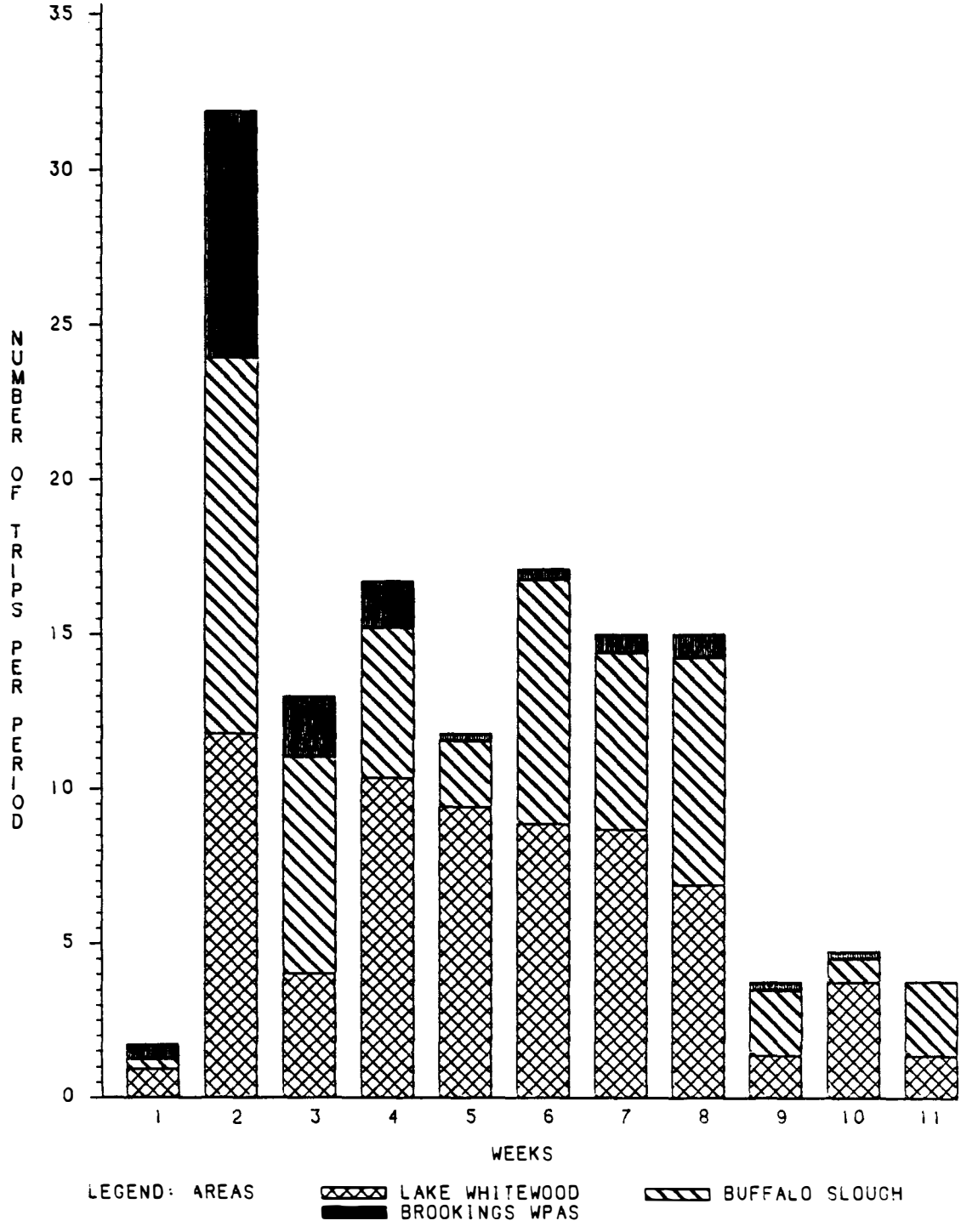


Figure 6. Estimated intensity of recreational use for a 3-hour sampling period by week by area in South Dakota during fall, September 27 through December 6, 1981.

Table 5. Estimated recreational use by week for Brush Lake, Henrikson, Holm, and Larsen WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

Week	Date	Number of trips	Number of people	Number of man-hours
1	09/27 - 10/02	52	129	321
2*	10/03 - 10/09	1,116	2,556	10,759
3	10/10 - 10/16	455	1,165	4,531
4	10/17 - 10/23	585	1,217	16,073
5	10/24 - 10/30	341	700	4,212
6	10/31 - 11/06	479	843	8,216
7	11/07 - 11/13	420	869	4,695
8	11/14 - 11/20	420	840	5,292
9	11/21 - 11/27	105	210	840
10	11/28 - 12/04	133	333	3,684
11	12/05 - 12/06	30	a	a

* This week was significantly different from all other weeks based on the LSD comparison; AOV test indicated $F = 3.81$, $P = 0.002$.

a No survey returns were available for week 11 to estimate people or man-hours.

during all other individual weeks. Week 6 (October 31-November 6) and week 4 (October 17-23) had significantly greater usage than weeks 1, 9, and 11, with week 6 use also greater than week 10. These tests were based on intensity of trip use per period (Fig. 6).

Intensity per period differs from overall use. As fall progressed, the shortening of daylight hours and the change back to central standard time caused the number of time periods to decrease from 5 to 4. Thus, estimated usage from September 27 through October 24 reflects these longer daylight hours. Intensity of use is a better measurement of hunting pressure; overall use is a better measurement for describing total use.

The questionnaires provided a way to explain usage by week. Since survey response rate varied by week through the season (Fig. 7), it must be remembered that weekly projections for activities (Fig. 8) are based on the number of surveys returned.

Duck hunting was the purpose of approximately 75% or more of all trips from its season opening in week 2 through the freeze up of the marshes in week 8 (Fig. 8). The greatest amount of duck hunting occurred during the opening week of the season.

Goose hunting was closely tied to duck hunting. Both were often checked on the questionnaire as is indicated by the waterfowl hunter category (Fig. 8). Only 5.5% of all goose hunters took to the field specifically for that activity.

Multiple users were the highest during week 4 (Fig. 8). Over 73% of all pheasant hunting trips were combined with duck hunting and

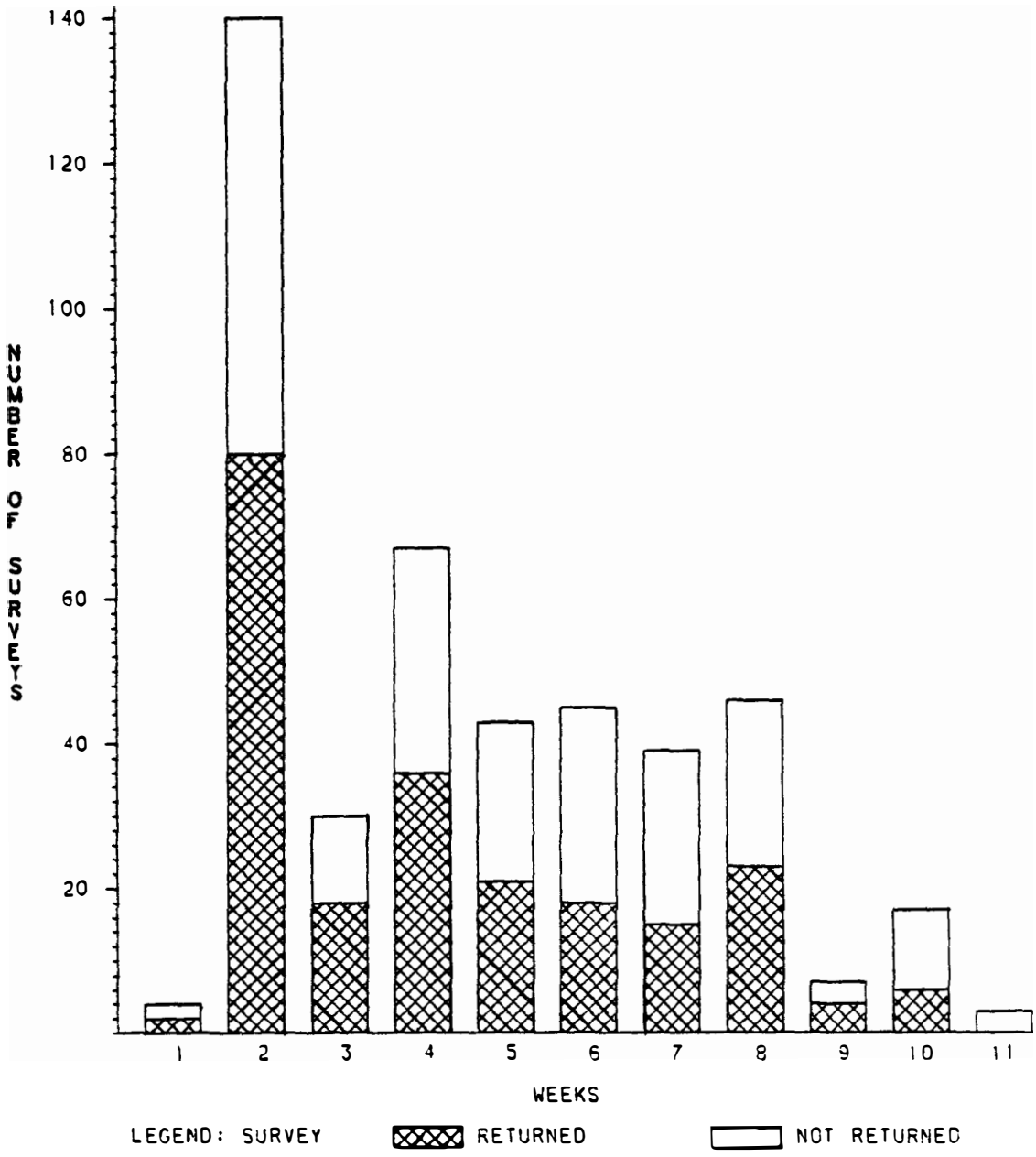


Figure 7. The number of surveys distributed and the number returned by week for the Brookings WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

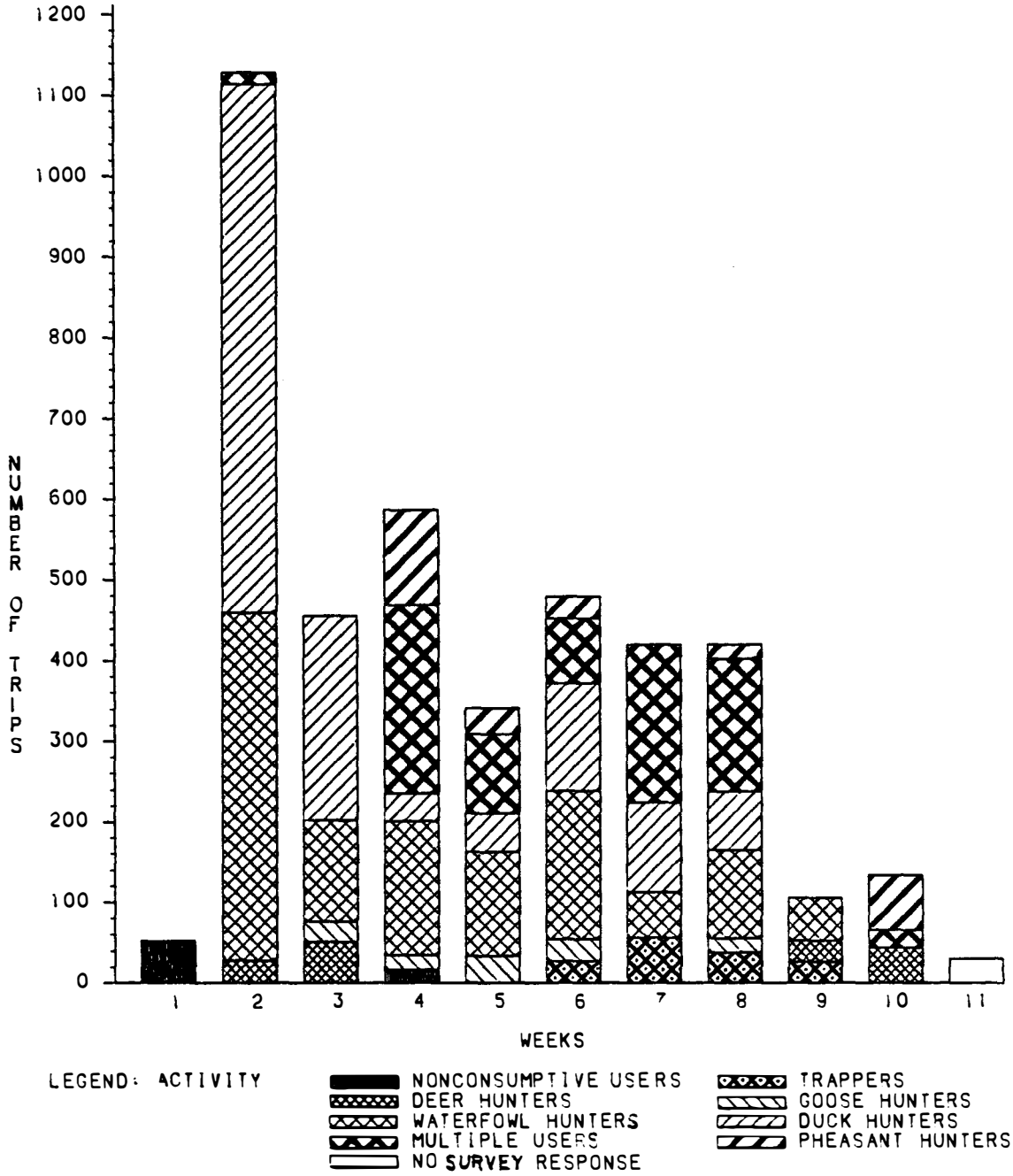


Figure 8. Estimated recreational use by week broken down by activity for the Brookings WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981. Waterfowl hunters include those hunting both ducks and geese on the same trip. Multiple users include those hunting both ducks and pheasants, and others who were combining waterfowl hunting with nonconsumptive activities on the same trip.

are included in this category. It appeared likely that the afternoon marsh pheasant hunters were often the same morning waterfowl hunters using the same wetlands.

An AOV indicated that pheasant hunting use (Fig. 8) did not change significantly on my study sites as the season progressed ($F = 0.74$, $P = 0.628$). Trautman (1982) indicated that pheasant hunting pressure on all land types declined sharply after the first 2 weeks of the season in South Dakota. Gates and Hale (1974) stated that marshes sustained a disproportionally high amount of the late season pheasant hunting pressure in Wisconsin.

It was speculated that weekly use of wetlands would be dependent upon the following variables: season openings, holidays, weather conditions, high goose concentrations, the extension of goose hunting hours (Kingsbury County had a noon closing time until November 1, after which closing was at sunset), and the extension of pheasant hunting hours (most of South Dakota had a noon opening time until November 1, after which opening time was 10 a.m.).

Over 38% of the fall trips were taken during week 2 (October 3-9). Duck hunters accounted for 97.5% of the trips that week, indicating the opening of waterfowl season had the greatest impact on peak wetland usage at the 3 study sites (Table 6). Week 1 before duck season was open and weeks 9, 10 and 11 after ice covered the marshes received the lowest recreational use because of the absence of duck hunters.

Table 6. Estimated recreational use by week ranked from highest to lowest usage with the corresponding variables and the percentage of use by activities for the Brookings WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

Week	Date	Percentage of use during fall	Variables	Activity by percentage of use: Duck hunting	Goose hunting	Pheasant hunting	Deer hunting	Trapping	Non-consumptive uses
2**	10/03 - 10/09	38.5	Duck and goose season opened 1st week for archery deer season	97.5	38.8	a	2.5	a	1.3
6*	10/31 - 11/06	12.7	Trapping season opened Extended hours for goose and pheasant hunting High goose concentration	83.3	55.6	16.7	0	5.6	11.1
4*	10/17 - 10/23	12.4	Pheasant season opened Rainy, cold, and windy weather	74.3	62.9	60.0	0	a	14.3
7	11/07 - 11/13	11.4	High goose concentration Veteran Holiday	86.7	53.3	46.7	0	13.3	13.3
8	11/14 - 11/20	11.4	High goose concentration Blizzard; marshes frozen	82.6	65.2	34.8	0	8.7	8.7
3	10/10 - 10/16	9.7	Columbus Holiday	83.3	33.3	a	11.1	a	0
5	10/24 - 10/30	8.8	High goose concentration	81.0	71.4	38.1	0	a	4.8
10	11/28 - 12/04	3.5	Rifle deer season opened	16.7	16.7	66.7	33.3	0	0
9	11/21 - 11/27	2.8	Thanksgiving Holiday	50.0	50.0	0	25.0	25.0	0
11	12/05 - 12/06	2.8		a	b	b	b	b	b
1	9/27 - 10/02	1.3	Archery deer season opened	a	a	a	0	a	100.0

a Season closed during this week.
b No surveys were returned for week 11.
Percentages for activities are not additive because of multiple use trips.

** Significant at the 0.01 probability level.
* Significant at the 0.05 probability level.

Wetland usage for the first 2 weeks of goose season totaled 38.8% and 33.3%, respectively (weeks 2 and 3 in Table 6). High goose concentrations appeared to affect hunter numbers, especially when geese first started concentrating at Lake Whitewood during week 5 (October 24-30). Goose hunters comprised their highest percentage (71.45%) that week. As with duck hunting, goose hunting dropped off after the marshes froze during week 8. Goose hunters often followed geese when flocks left Lake Whitewood during daily feeding flights. Field hunting of geese is popular and Lake Whitewood provides a large number of geese for this sport in Kingsbury County.

Total waterfowl hunting included all trips for duck and/or goose hunting. A paired t-test indicated that total waterfowl hunting trips were significantly greater than total nonwaterfowl hunting trips ($t = 2.260$, $P = 0.050$). Thus, it would be reasonable to assume that factors (variables) favorable to waterfowl hunting would increase marsh usage during those weeks. The season opening, extension of goose hunting hours, goose concentrations, and holidays (excluding Thanksgiving when the marshes were frozen) were important in explaining wetland usage.

The opening of pheasant season was an important nonwaterfowl-related variable. Week 4 rated third highest for intensity of use (Fig. 6), second highest for overall use (Fig. 8), and highest for total man-hours (Table 5). Numbers of pheasant hunters were quite high, although the weather on the opening weekend was cloudy, rainy, and cold.

Weekly Usage Patterns Among Wetland Sites. The number of surveys distributed and returned varied by week among the 3 study sites. At the Brookings WPAs 88% of all surveys were distributed and 90% of the total response occurred during weeks 2, 3, and 4 (Fig. 9). The response rate for Buffalo Slough was consistently around 50% (Fig. 10). The average response rate for Lake Whitewood dropped from 55% during the first 5 weeks to 36% during the last 6 weeks (Fig. 11).

Duck hunters accounted for 74% of the trips to the Brookings WPAs; over 90% of these trips occurred the first 2 weeks of the waterfowl season (Fig. 12). Little usage occurred after the first week of pheasant hunting season (week 4).

Fall usage at Buffalo Slough was 3 times greater than usage at the Brookings WPAs. Duck hunting accounted for 88% of all trips to Buffalo Slough from the season opening (week 2) through the next 8 weeks (Fig. 13). Trapping was the highest in week 7 (November 7-13) and then decreased through week 9 (November 21-27).

Lake Whitewood had the highest use of all 3 study sites (Table 7). The number of trips remained high in all weeks except weeks 1, 9, and 11 (Fig. 14). Sixty-seven percent of all trips included goose hunting. Fifty percent of all visits after week 3 (October 10-16) were multiple use trips. Lake Whitewood was the only study site where respondents indicated they were deer hunting during the rifle season.

Weekend Versus Weekday Usage. Two factors were considered to contribute to the amount of free-time people have to pursue marshland activities. One was the holidays discussed earlier; the other was weekends.

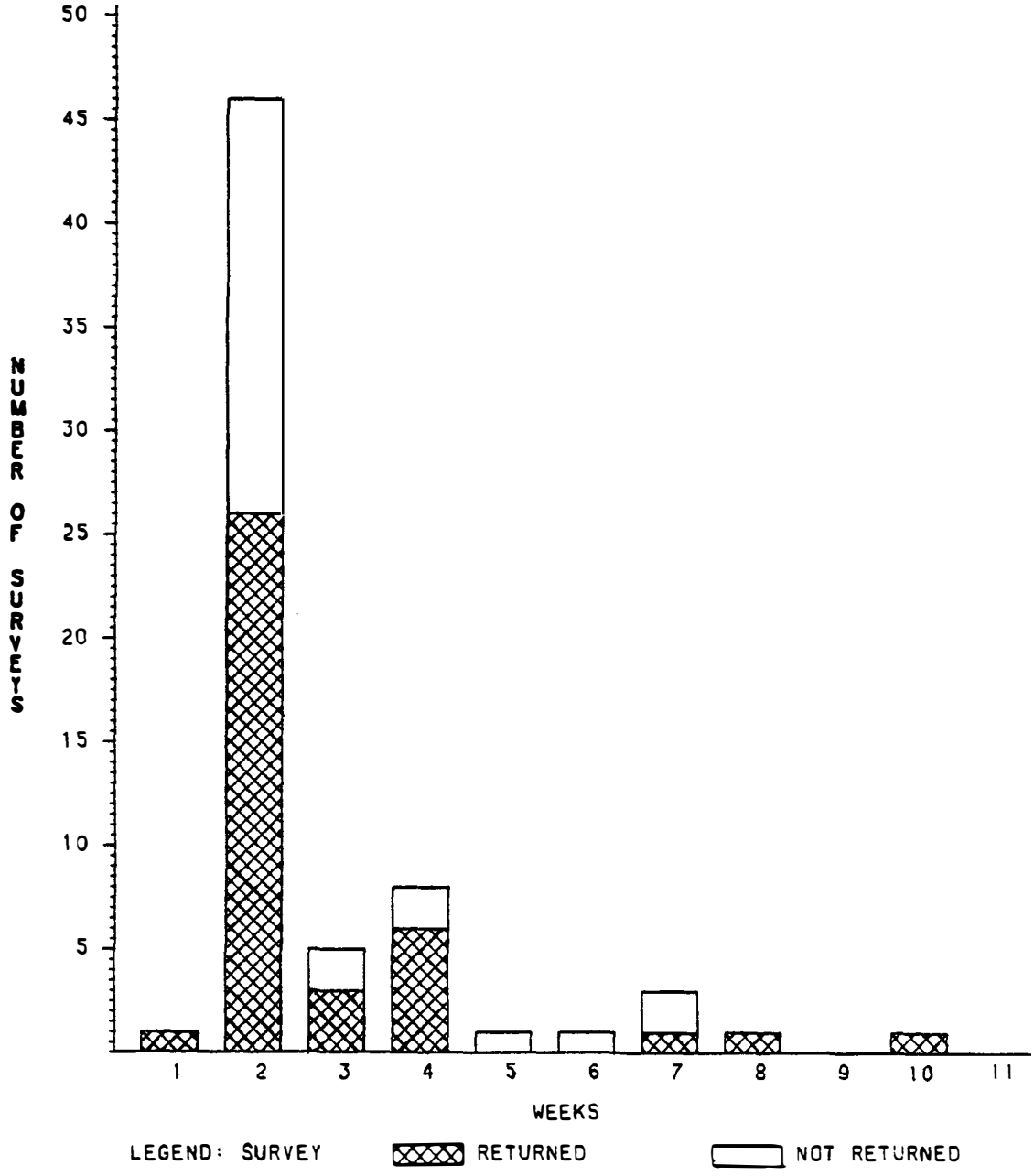


Figure 9. Number of surveys distributed and number returned by week for the Brookings WPAs, South Dakota, during fall, September 27 through December 6, 1981.

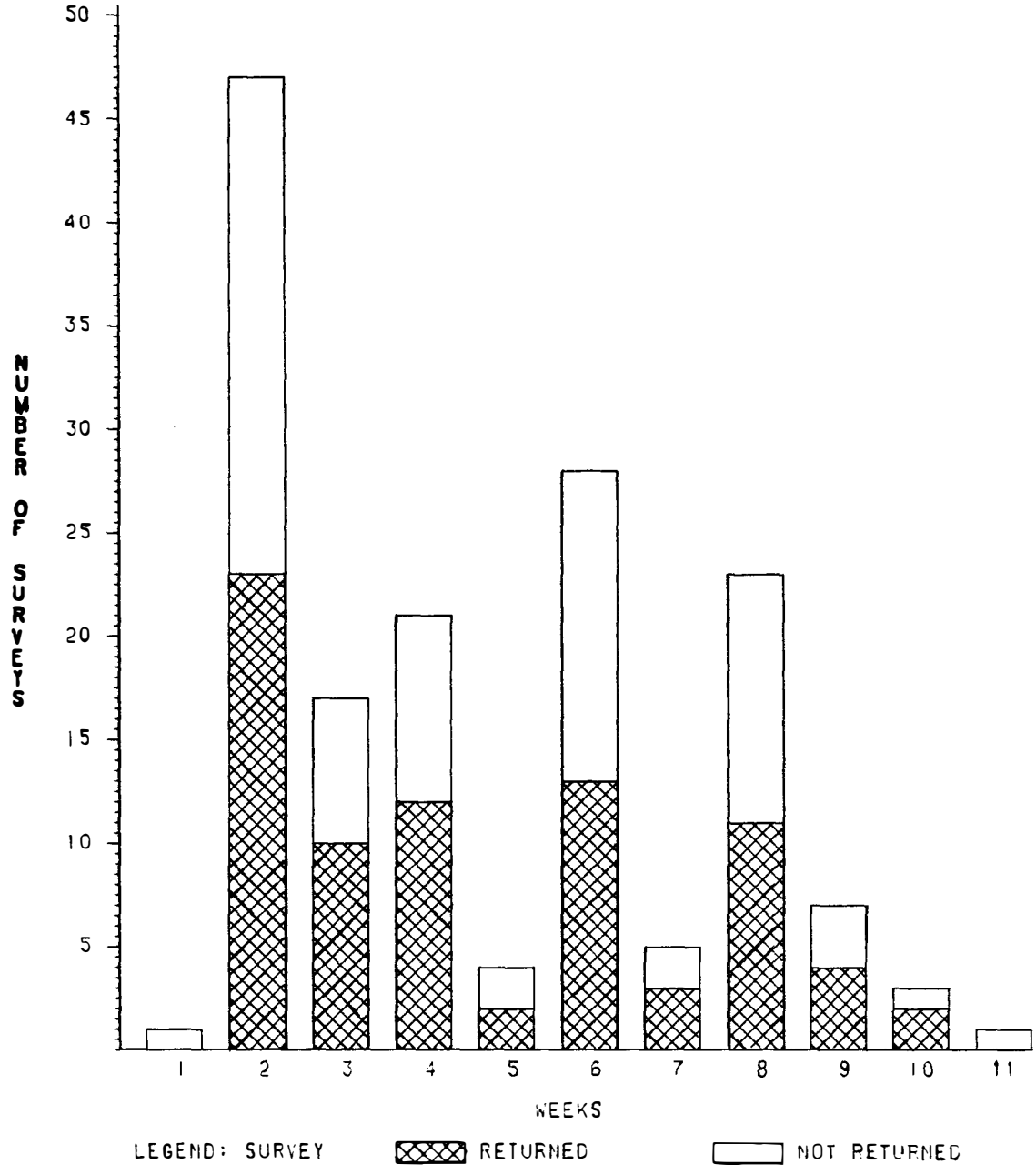


Figure 10. Number of surveys distributed and number returned by week for Buffalo Slough GPA, South Dakota, during fall, September 27 through December 6, 1981.

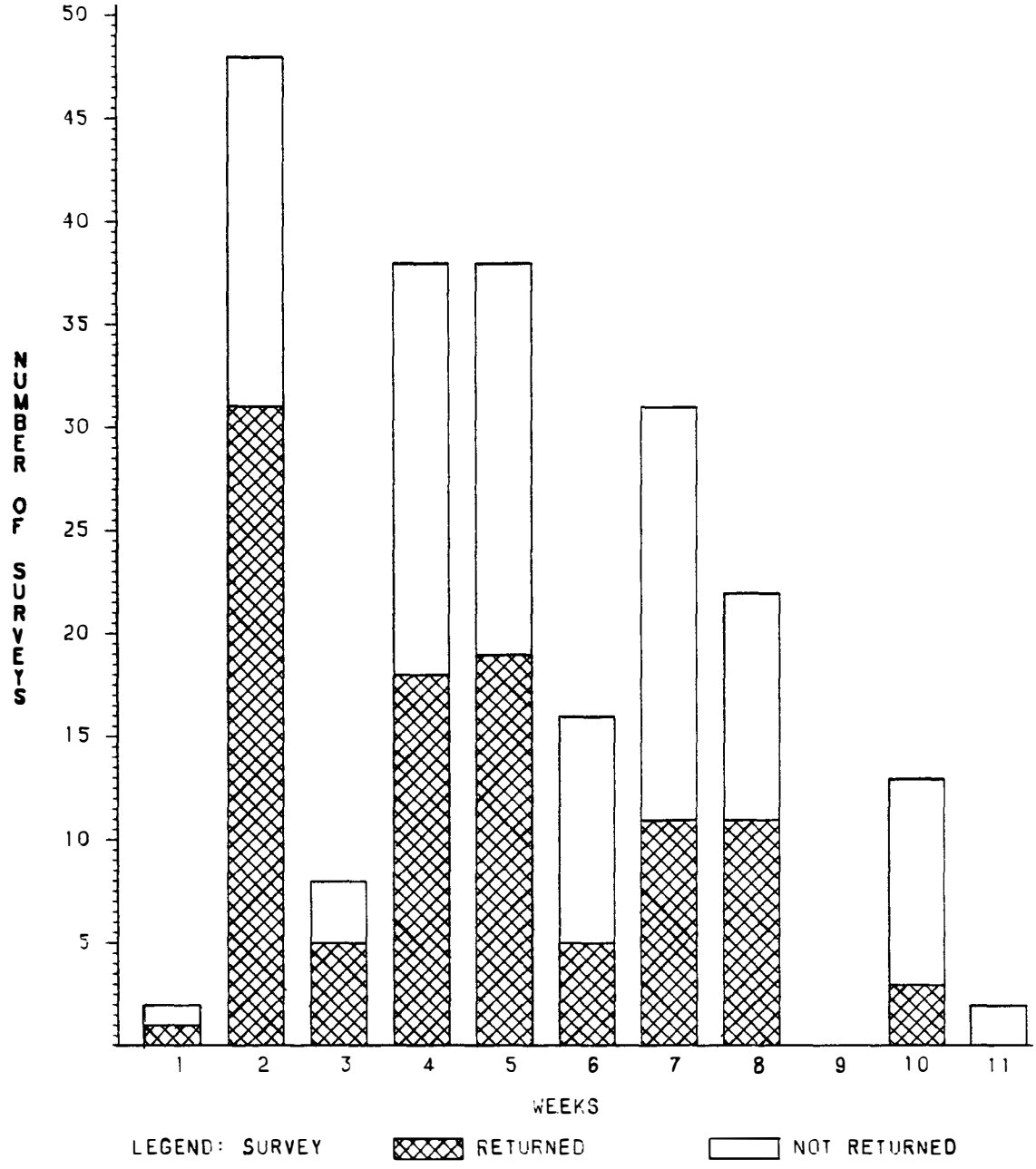


Figure 11. Number of surveys distributed and number returned by week for Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

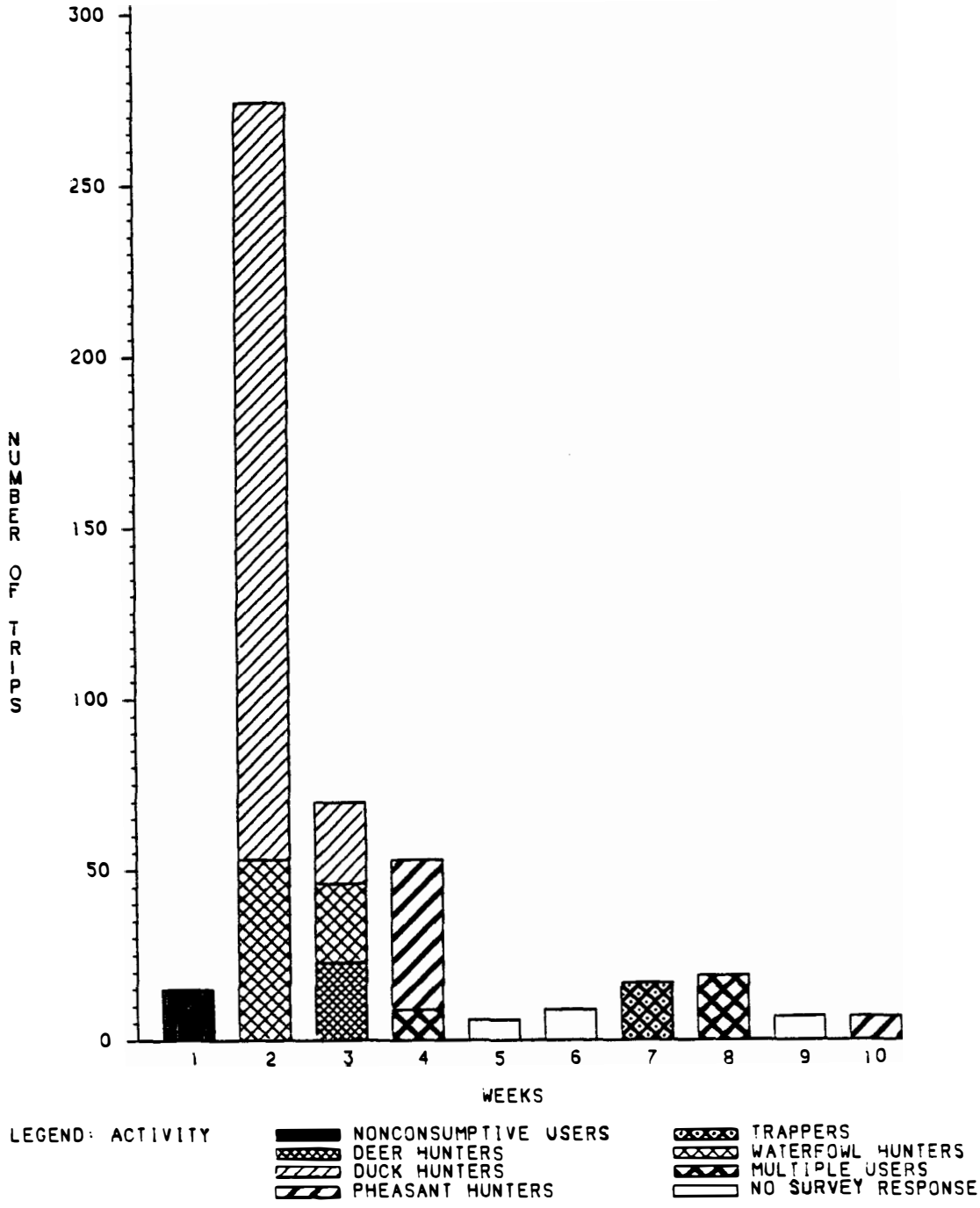


Figure 12. Estimated recreational use by week broken down by activity for the Brookings WPAs, South Dakota, during fall, September 27 through December 6, 1981. Waterfowl hunters include those hunting both ducks and geese on the same trip. Multiple users include those hunting both ducks and pheasants, and others who were combining waterfowl hunting with nonconsumptive activites on the same trip.

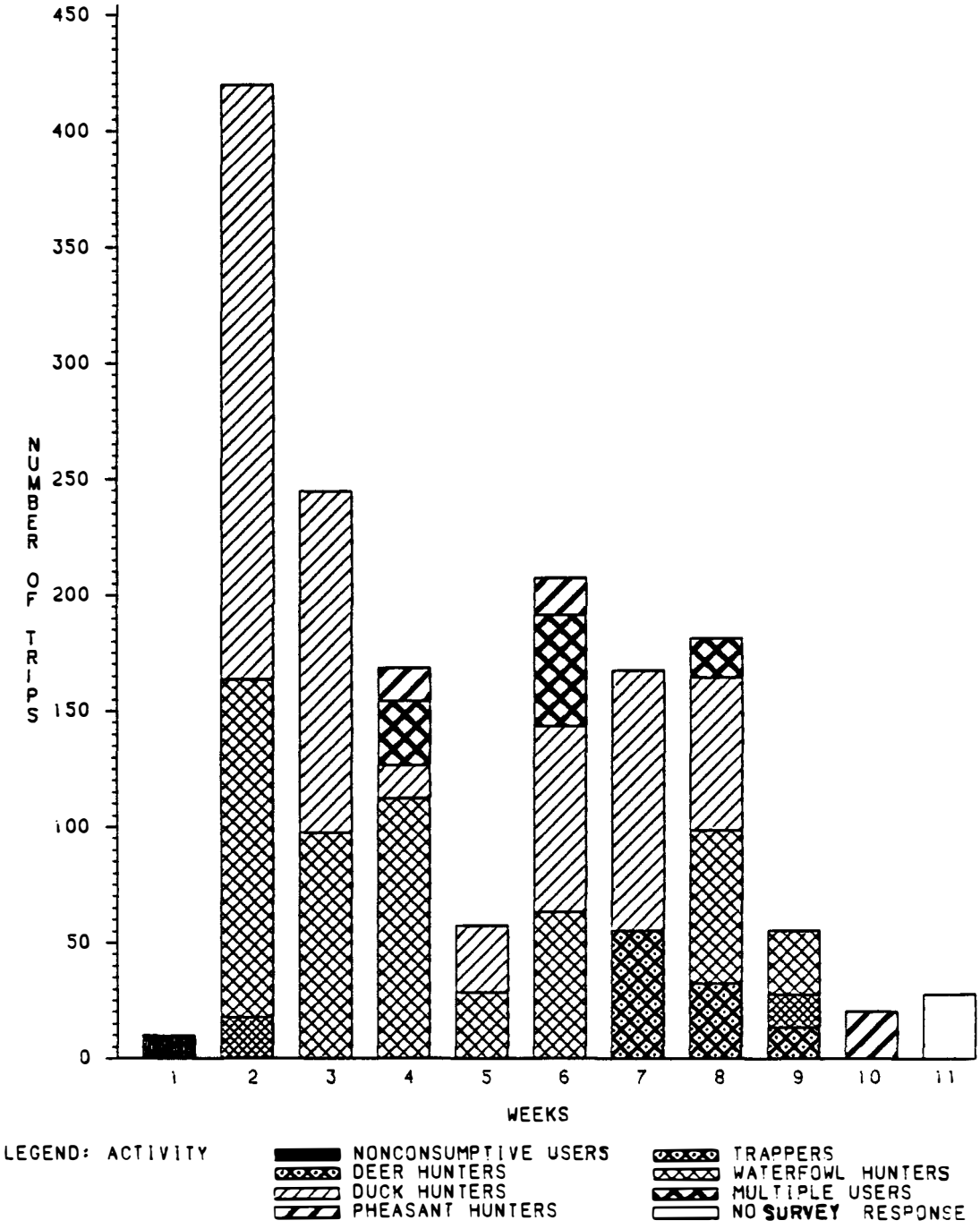


Figure 13. Estimated recreational use by week broken down by activity for Buffalo Slough GPA, South Dakota, during fall, September 27 through December 6, 1981. Waterfowl hunters include those hunting both ducks and geese on the same trip. Multiple users include those hunting both ducks and pheasants, and others who were combining waterfowl hunting with nonconsumptive activites on the same trip.

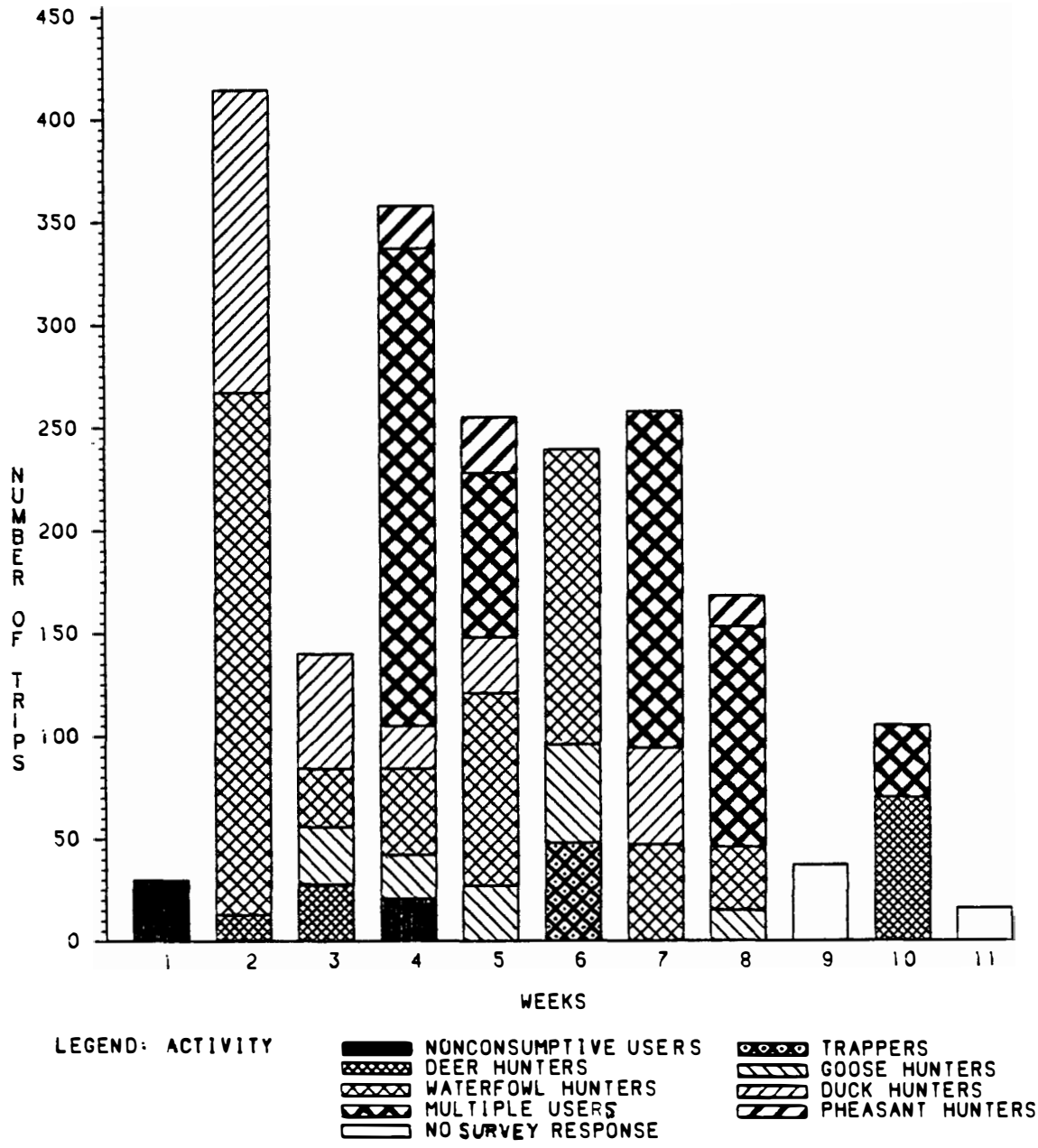


Figure 14. Estimated recreational use by week broken down by activity for Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981. Waterfowl hunters include those hunting both ducks and geese on the same trip. Multiple users include those hunting both ducks and pheasants, and others who were combining waterfowl hunting with nonconsumptive activites on the same trip.

Table 7. Estimated recreational use by week by each study site in South Dakota during fall, September 27 through December 6, 1981.

Week	Date	Trips		
		Brookings WPAs	Buffalo Slough	Lake Whitewood
1	09/27 - 10/02	15	10	30
2	10/03 - 10/09	274	420	414
3	10/10 - 10/16	70	245	140
4	10/17 - 10/23	53	169	359
5	10/24 - 10/30	6	58	255
6	10/31 - 11/06	9	207	238
7	11/07 - 11/13	17	168	258
8	11/14 - 11/20	19	182	168
9	11/21 - 11/27	7	56	37
10	11/28 - 12/04	7	21	105
11	12/05 - 12/06	0	28	16

A paired t-test for all hunters showed that weekend usage was significantly greater than weekday usage ($t = 3.193$, $P = 0.016$). Thus, we rejected the null hypothesis that there is no difference in hunter usage on weekends or weekdays.

I assumed that most family outings (nonconsumptive use) occurred on weekends. A paired t-test indicated that nonconsumptive use was significantly greater on weekends ($t = 2.443$, $P = 0.047$). These findings support the concept that weekends are used more than weekdays for recreation on wetlands.

Usage Patterns During the Day. Daily time periods were randomly sampled so that daily usage patterns could be detected. Null hypotheses stated that there is no difference among daily time period usage by duck hunters, goose hunters, pheasant hunters, and for all activities. The AOVs showed significant differences for all activities and for duck hunters, but not goose and pheasant hunters (see Appendix A for hypotheses and F values).

A LSD at the 0.05 probability level indicated that use during the sunrise period was significantly greater than use during each afternoon period for all activities (Fig. 15). More than 55% of all activities occurred in the morning. Percentages for all activities were based totally on vehicle counts.

Percentages for duck, goose, and pheasant hunting were obtained from survey returns. A bias arose when 2 or more periods were sampled at the same site on the same day and vehicles were present for more then 1 period.

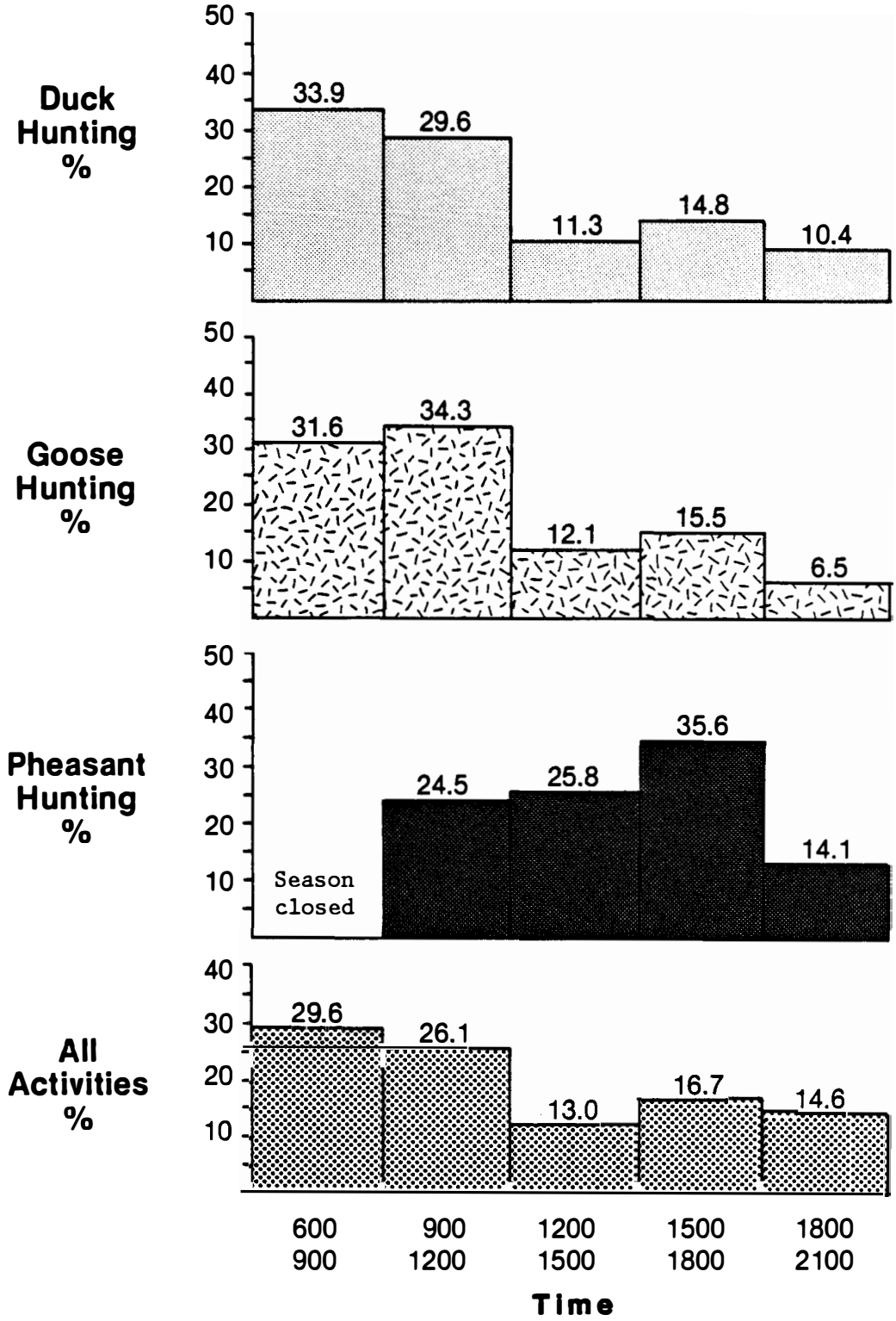


Figure 15. Percentage of recreational use by daily time periods for all activities and for major hunting uses for the Brookings WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

To overcome this bias the total vehicle count for each time period was multiplied by the percentage of total use an activity had for its respective time period. These new totals were converted to the same magnitude as the original numbers generated in the AOV and used for time period estimates.

A LSD at the 0.05 probability level for duck hunting showed that use during the sunrise period was significantly greater than use during the 1200-1500 and 1800-2100 time periods. Most duck hunting occurred in the morning (55.5%). Although sunset is often thought to be a popular duck hunting time, the sunset period had the lowest percentage of use (10.4%) (Fig.15).

Period 2 (0900-1200) was the most heavily used for goose hunting (34.3%); a LSD at the 0.05 level showed it was significantly different from the sunset period (Fig. 15). It was hypothesized that period 2 would receive most of the goose hunting pressure since geese at Lake Whitewood tended to sit in the refuge for some time after sunrise and then leave in flocks for grain fields throughout the rest of the morning.

Since study sites were selected because of differences, it is not surprising that those differences are reflected in daily usage patterns among areas. These differences show how various areas are favored for particular activities (Fig. 16, 17, and 18).

Chi-square showed a significant difference among the study areas for duck hunting use ($X^2 = 35.238$, $P < 0.005$). A comparison of the chi-square table indicated Lake Whitewood was different from the

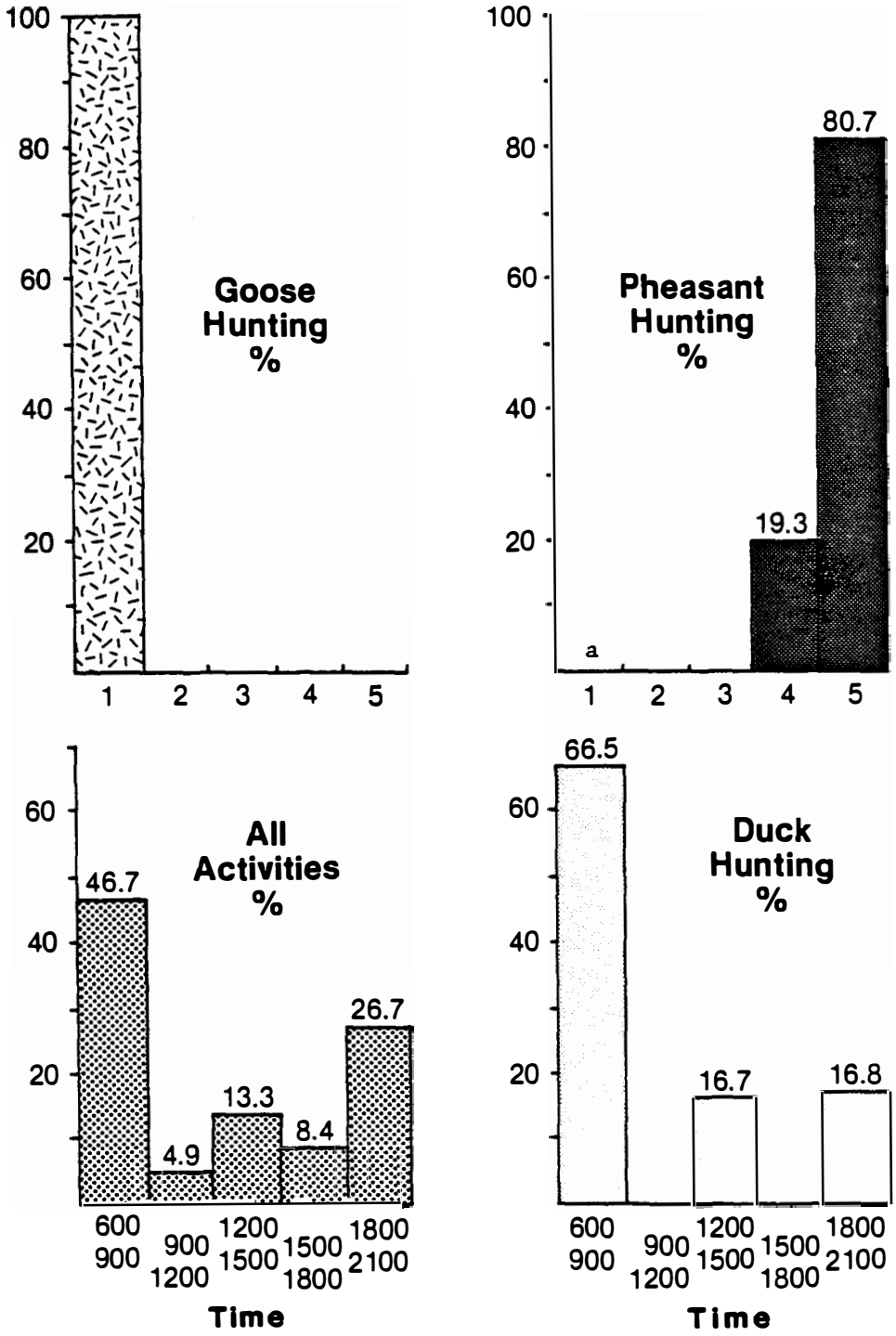


Figure 16. Percentage of recreational use by daily time periods for all activities and for major hunting uses for Brush Lake, Henrikson, Holm, and Larsen WPAs, South Dakota, during fall, September 27 through December 6, 1981. Pheasant hunting was not allowed during period 1.

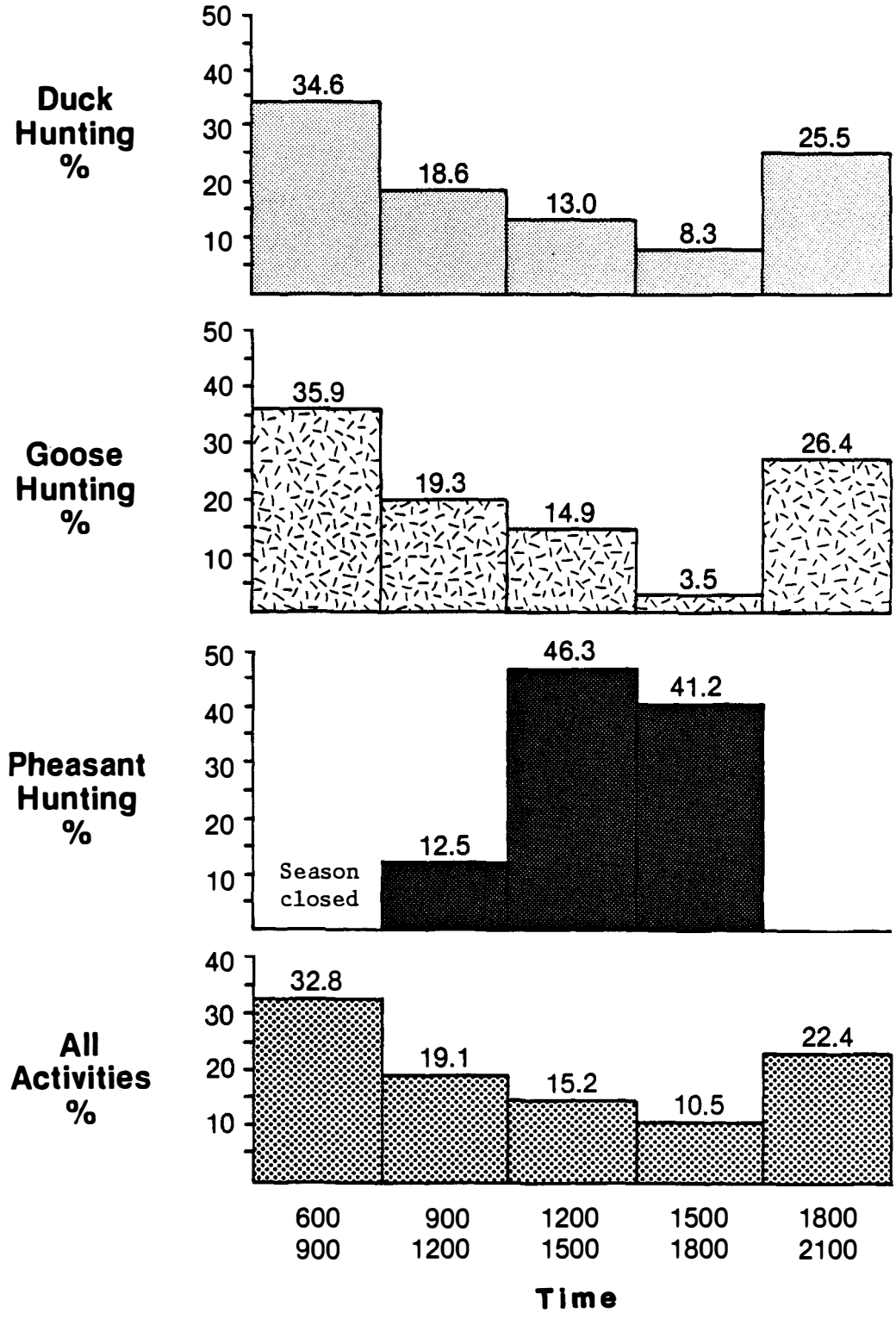


Figure 17. Percentage of recreational use by daily time periods for all activities and for major hunting uses for Buffalo Slough GPA, South Dakota, during fall, September 27 through December 6, 1981.

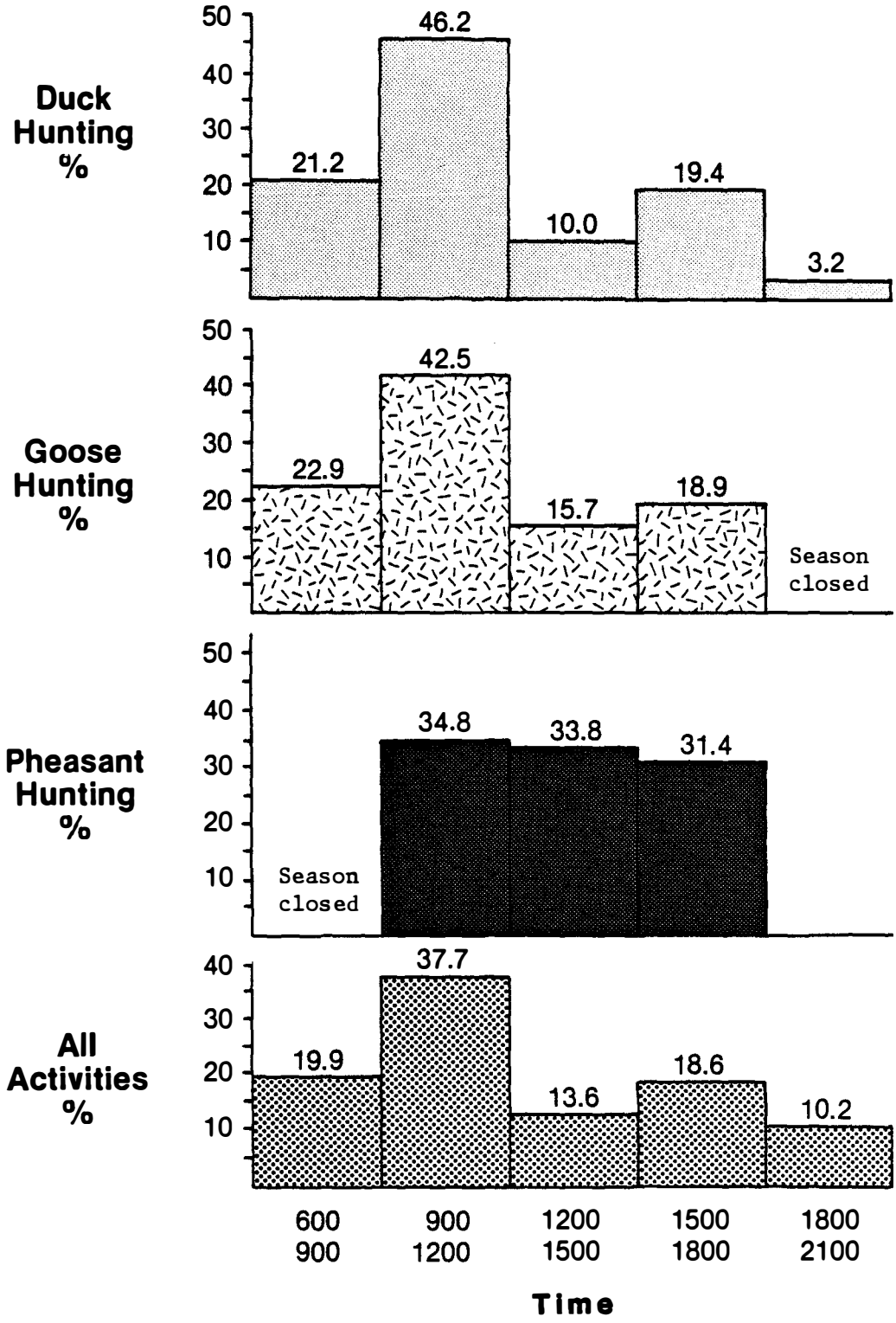


Figure 18. Percentage of recreational use by daily time periods for all activities and for major hunting uses for Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

other 2 study sites for duck hunting use by time period. Chi-square showed no significant difference between the Brookings WPAs and Buffalo Slough for duck hunting use ($X^2 = 1.178$, $P = 0.291$).

At Lake Whitewood 81% of the duck hunters were also goose hunting, compared to 49% at Buffalo Slough and 20% at the Brookings WPAs. This large percentage of goose hunters at Lake Whitewood may account for its lack of fit to the time period usage pattern by duck hunters at the other study sites.

More than 65% of the duck hunting occurred in the sunrise (44.8%) and sunset (20.7%) periods at the Brookings WPAs and Buffalo Slough. But a general linear model test (GLM) did not find differences among time periods to be significant ($F = 2.72$, $P = 0.055$).

Goose hunting at Lake Whitewood contributed to the high percentage of use during period 2 (34.3%) for all areas combined (Fig. 15). Forty-two and one-half percent of the goose hunting was in period 2 at Lake Whitewood (Fig. 18). Since Lake Whitewood was the only site to draw people exclusively for goose hunting I tested that area separately. A GLM indicated that goose hunting by daily time periods was not significantly different ($F = 0.28$, $P = 0.841$).

It was also hypothesized that goose hunters would focus some of their effort on period 4 (1500-1800) when afternoon hunting became legal on November 1 since afternoon feeding flights occurred during that time. There was a significant difference in goose hunting pressure between period 2 and periods 1, 3, and 4 before and after November 1 ($X^2 = 11.470$, $P < 0.005$). A second chi-squre, pooling 2 and 4 against 1 and 3

was not significant (X^2 = 0.548, P = 0.449), indicating that goose hunting pressure shifted from period 2 to period 4. Thus, 62.5% of the goose hunting was in periods 2 and 4 when goose feeding flights usually occurred.

There was no significant difference among time periods used by pheasant hunters on all the wetland sites. But individual study sites indicated hunter preference. Most notable is the very high evening use that the Brookings WPAs (specifically Henrikson, Holm, and Larsen WPAs) experienced. These small WPAs are close to human population and small and easy to hunt.

Weather Effects on Usage. I hypothesized that duck hunters selected times to hunt based on weather. Conditions thought to positively influence duck hunting were: a cloud cover of 50% or more or fog; temperatures of 10°C (50°F) or less; and wind speeds of 24 km/hr (15 mph) or greater. Less than 8% of the duck hunters chose to hunt under these "optimum" conditions which occurred during 19% of the sampling periods.

Duck hunters appeared to prefer cloudier skies, cooler temperatures, no or little snow, and a greater amount of precipitation than did other wetland users (based on discriminant analysis). Wind speed had no effect on duck hunters or nonduck hunters; the average for both groups was 16.6 km/hr (10.3 mph).

I also hypothesized that pheasant hunters would choose to hunt when weather conditions consisted of less than 50% cloud cover, temperatures of 5°C (41°F) or more, and wind speeds of 16.1 km/hr (10

mph) or less. Thirty percent of the pheasant hunters chose to hunt under those conditions which occurred during 16% of the sampling periods.

Pheasant hunters appeared to prefer sunnier skies, a light wind, and some snow on the ground compared to other wetland users (based on discriminant analysis). Neither temperature nor precipitation were important for differentiating between the 2 groups.

Discriminant analysis correctly placed 57.3% of the duck hunters and correctly classified 63.0% of all fall users by weather conditions. (Data from the opening weekend of duck season was deleted since high use would be expected no matter what the weather conditions were.) Discriminant analysis correctly placed 67.5% of the pheasant hunters and correctly classified 76.9% of all fall users by weather conditions. (Data from the opening weekend of pheasant season was deleted since high use would be expected no matter what the weather conditions were.) More years of data would be needed to correctly classify marsh users by weather. During this study I believed other variables were more important in determining marsh use than were weather conditions.

Distance Traveled. The average distance traveled by users in the fall was 82.4 kilometers (51.2 miles) one way. The distance traveled was significantly different by area (AOV: $F = 12.12$, $P < 0.005$). The average distance traveled to each site was 45.4 kilometers (28.2 miles) for the Brookings WPAs, 50.9 kilometers (31.6 miles) for Buffalo Slough, and 110.0 kilometers (68.3 miles) for Lake Whitewood.

Since there was a difference among areas, a GLM was used to test significant differences for distance traveled among activities. Four exclusive activities (camping, multiple use, pheasant hunting, and waterfowl hunting) showed no significant differences ($F = 0.30$, $P = 0.829$). Average distances were 102.7 kilometers (63.8 miles) for camping, 62.8 kilometers (39.0 miles) for multiple use, 84.9 kilometers (52.7 miles) for pheasant hunting, and 70.0 kilometers (43.5 miles) for waterfowl hunting.

The farther people traveled, the longer they hunted. Correlations were highly significant when distance traveled was compared with time spent hunting for total fall use ($r = 0.479$, $P < 0.005$), weekend trips ($r = 0.484$, $P < 0.005$), and weekday trips ($r = 0.598$, $P < 0.005$).

It was hypothesized that recreationists would travel farther on weekends and also spend more time than on weekdays. Weekend recreationists traveled an average of 19.0 kilometers (11.8 miles) farther ($F = 4.62$, $P = 0.033$) but there was no significant difference between time spent ($F = 1.18$, $P = 0.278$), although weekend recreationists averaged approximately 2 hours longer at the marshes than weekday users.

Residency. Recreationists came from 25 counties in South Dakota to hunt. Out-of-state hunters comprised 3.1% of the total. Minnehaha County comprised 47.4% of the total use and Brookings County 25.1% (Table 8).

Table 8. Estimated recreational use by county residents (based on vehicle tallies) for Brush Lake, Henrikson, Holm, and Larsen WPAS, Buffalo Slough GPA, and Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

County	Total number of trips	Percentage of total trips
Beadle	70	1.6
Brookings	1,044	25.1
Brown	31	0.7
Charles Mix	39	0.9
Clay	15	0.4
Codington	19	0.4
Davidson	19	0.4
Deuel	15	0.4
Fall River	8	0.2
Grant	8	0.2
Hamlin	31	0.7
Hughes	15	0.4
Kingsbury	132	3.1
Lake	116	2.7
Lawrence	15	0.4
Lincoln	147	3.7
McCook	15	0.4
Meade	8	0.2
Minnehaha	1,988	47.4
Moody	70	1.6
Pennington	23	0.5
Spinks	15	0.4
Turner	8	0.2
Union	85	2.0
Yankton	15	0.4
S.D. Commercial	70	1.6
S.D. National Guard	39	0.9
New Registration	8	0.2
Out-of-State	132	3.1

Eight counties were represented at Buffalo Slough (Figure 19). Minnehaha County comprised 77.7% of the total visitors. The Brookings WPAs and Lake Whitewood were represented by 17 and 20 counties respectively (Figures 20 and 21). Brookings County comprised 54.3% of the total visits to the Brookings WPAs and 35.5% of the total visits at Lake Whitewood. Lake Whitewood also received 34.8% of its visitors from Minnehaha County and the highest out-of-state use (4.4%).

It was hypothesized that most recreationists came from high population centers and that all people within about an hour drive, would not be discouraged from driving that distance to a wetland. Towns within these radii and with populations greater than 5,000 were Brookings, Huron, Madison, Sioux Falls, and Watertown. A goodness of fit test indicated that usage was not randomly distributed ($X^2 = 213.55$, $P < 0.005$), nor was usage from these urban areas more excessive. It was estimated that these 5 towns made up 62.0% of the population within the 80 kilometer radii of the 3 wetland sites (Riley and Baer 1981). These 5 towns comprised only 65.3% of my sample.

A goodness of fit test was run on use by county for all counties which made up at least 1% of the total use (see Table 8) based upon usage being proportional to the county's population. Chi-square indicated that usage by county was significantly different than what would be expected from random use based on population size ($X^2 = 80.546$, $P < 0.005$). Hunting tradition, management of the wetland, water levels, and other factors are undoubtedly more important than the mere close proximity of a wetland.

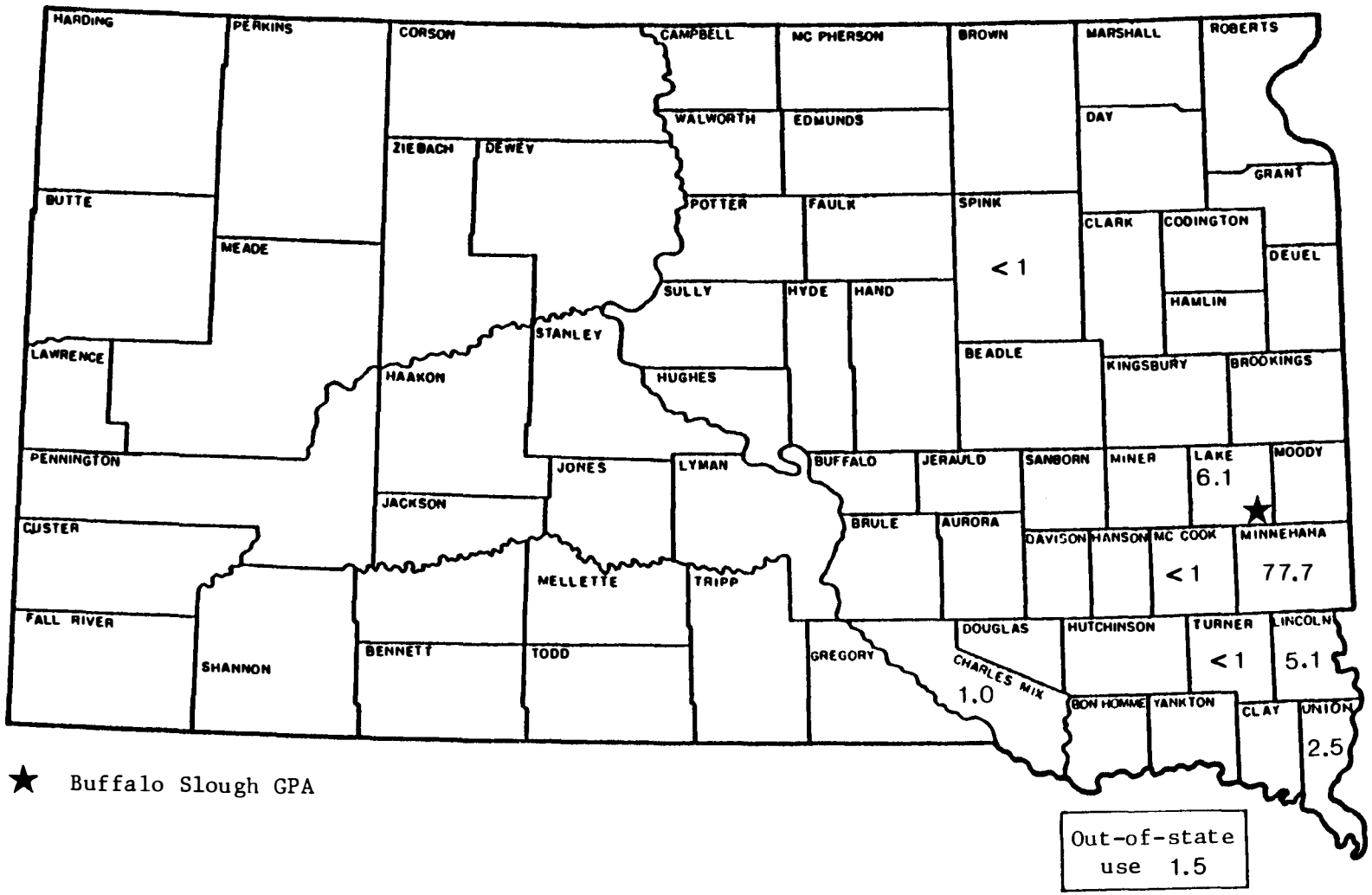


Figure 19. Percentage of use by residents of 8 South Dakota counties based on vehicle counts at Buffalo Slough GPA during fall, September 27 through December 6, 1981.

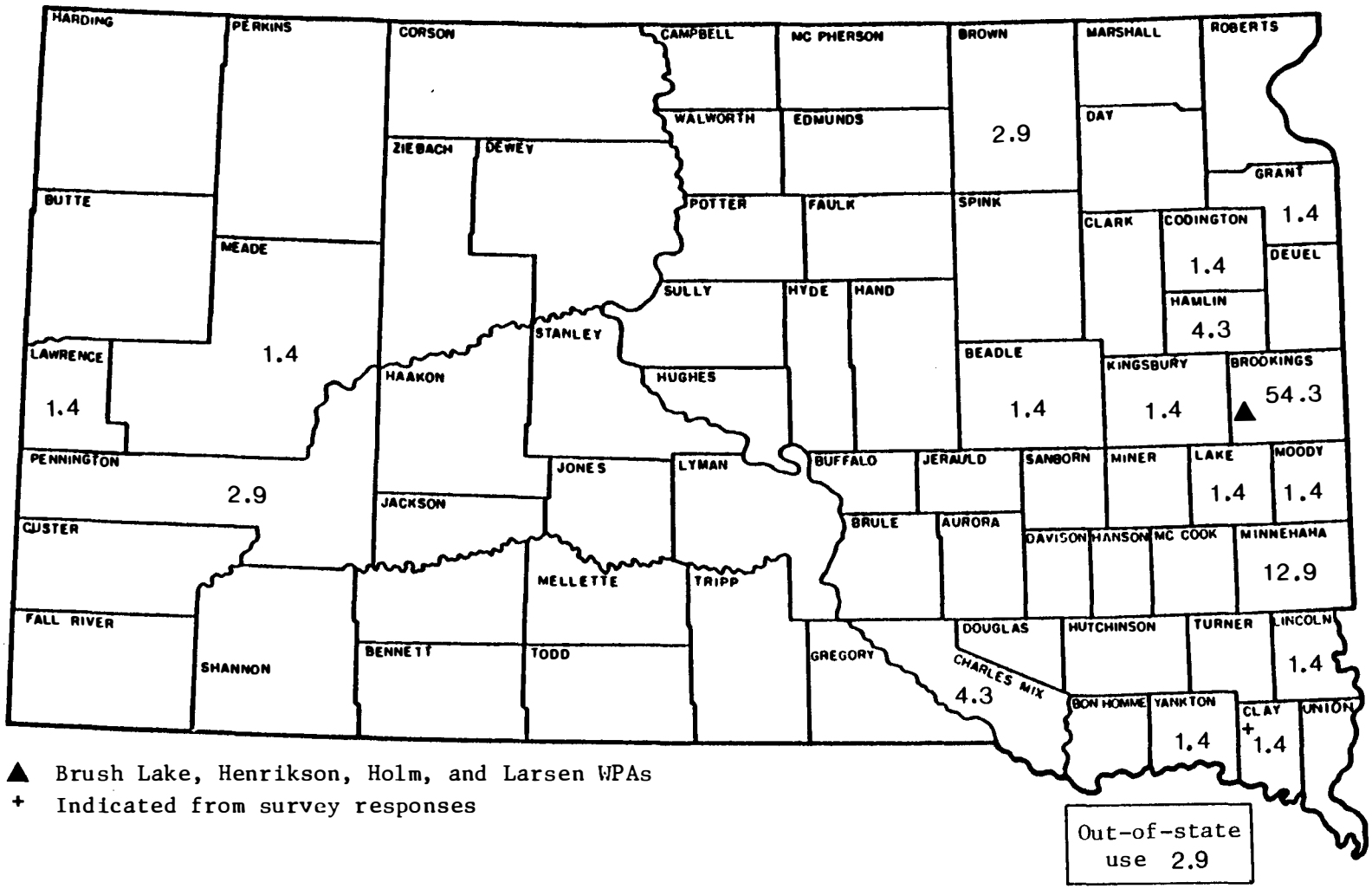


Figure 20. Percentage of use by residents of 17 South Dakota counties based on vehicle counts at the Brookings WPAs during fall, September 27 through December 6, 1981.

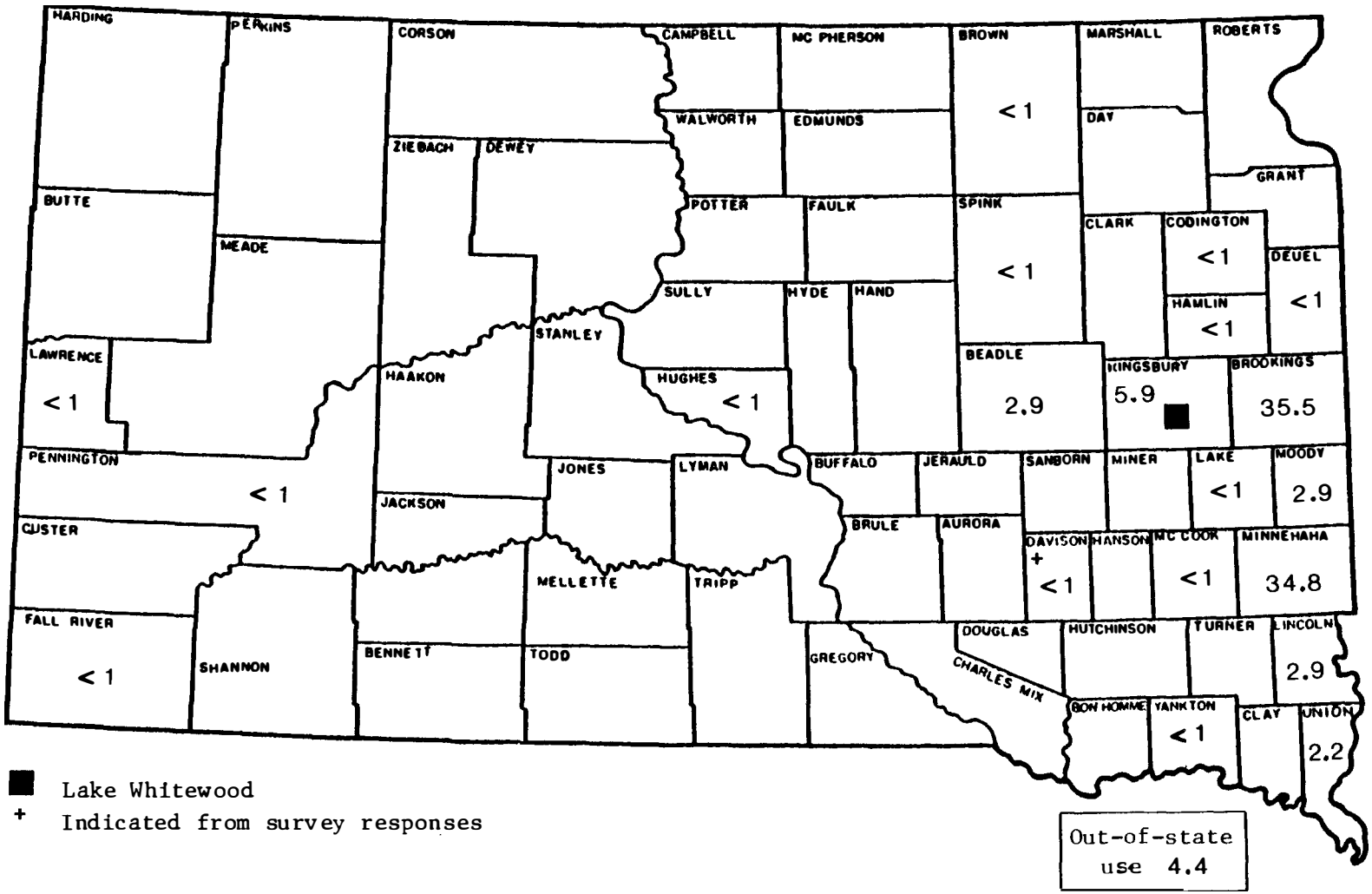


Figure 21. Percentage of use by residents of 20 South Dakota counties based on vehicle counts at Lake Whitewood during fall, September 27 through December 6, 1981.

A goodness of fit test found no significant difference between the license plate county and actual county of residency (X^2 = 20.24, P = 0.623). In 1981 new license plates were issued; this may have contributed to the good fit. Almost half of vehicle owners with differing license plates claimed Brookings as their county of residence. This probably reflected a large number of students with non-Brookings plates who attended South Dakota State University. It was generally found that if a county was represented by at least 6 vehicles, that county would be represented in the survey responses.

Personal Interviews

Personal interviews were conducted during 10% of all fall sampling periods at access 1 of Buffalo Slough (Fig. 3) and access 2 of Lake Whitewood (Fig. 4). In all, 24 hours were spent at these 2 accesses waiting to conduct interviews. Nine parties were interviewed (Table 9).

The tallying of vehicles and distribution of questionnaires for the whole study at Buffalo Slough and Lake Whitewood took approximately 240 hours and yielded information from 82 parties for these 2 accesses. The vehicle count and survey method also provided information on 14 additional access points.

Response rate for the questionnaire method was much higher than for the personal interview method, despite the fact that all parties interviewed answered the questions. That was because not all parties came back to their vehicles during a 3-hour interview period and other

Table 9. Comparison of results obtained from personal interviews and results obtained from questionnaires for access 1 at Buffalo Slough GPA and access 2 at Lake Whitewood, South Dakota, during fall, September 27 through December 6, 1981.

	Buffalo Slough		Lake Whitewood	
	Personal interviews	Questionnaires	Personal interviews	Questionnaires
Sampling periods	4	41	4	40
Hours spent sampling	12	124	12	120
Interviews conducted or surveys returned	3	59	6	23
Total number of vehicles encountered	9	129(100[a])	18	48(43[a])
Number of vehicles which were driven in but did not stop	3	0	9	0
Response rate	33.3%	59.0%	33.3%	53.5%
Expanded trips	702	982	1,404	374
Percentage of use for:				
Duck hunting	100%	88%	100%	100%
Goose hunting		51%	67%	39%
Coot hunting				4%
Pheasant hunting		3%		17%
Rabbit hunting				4%
Trapping		7%		
Birdwatching		2%		4%
Canoeing		2%		
Target practice		2%		

[a] This was the number of vehicles used to calculate the response rate; multiple sampling periods caused some vehicles to be counted twice in 1 day.

parties merely drove into the area and then drove out. Of all the vehicles sighted during interview periods, only 33.3% of their parties were interviewed.

The limited number of personal interviews held revealed just duck and goose hunting usage. The questionnaires left on vehicles at the accesses indicated 5 different hunting uses, trapping, and 3 nonconsumptive uses. Many short sampling days in the fall revealed more uses than those found by prolonged sampling on a few days.

The total expanded trips for both methods was quite close for Buffalo Slough. But the expanded trips at Lake Whitewood showed totals based on personal interviews almost 4 times greater than those based on vehicle counts (Table 9). This large discrepancy was probably due to 1 personal interview period held on the opening Saturday of waterfowl season. This greatly inflated the expanded trips value since only 4 interview periods were the basis of the calculations.

If all or most of area use is channeled into 1 access point and if use is both high and evenly distributed through time, personal interviews may be effective. As many sampling periods as possible should be scheduled. When sampling an area some distance away, this would be more cost effective than the vehicle count and questionnaire method since fewer trips would be taken but an equal number of hours could be spent.

Traffic Counters

The most frequently used parking lot of each study site was access 1 of the Brookings WPAs, access 1 of Buffalo Slough, and access 2 of Lake Whitewood. Traffic counters were placed on the roads to these parking areas.

Usage at these accesses was so low for April through September that monthly estimates of total use could not be calculated from the vehicle count method. Therefore, correlations could not be run with monthly estimates from the traffic counters. The traffic counters indicated that a minimum of usage occurred during each of these months (Table 10). This usage fit within the range of the total estimated trips for spring and summer, based on vehicle tallies.

The vehicle tallies for October and November were high enough to provide estimates of trips by week. Total weekly estimated trips and weekly traffic counter data were found to be significantly correlated for both Buffalo Slough ($r = 0.806$, $P < 0.05$) and Lake Whitewood ($r = 0.937$, $P < 0.01$). Total weekly man-hours were significantly correlated with traffic counter data for Buffalo Slough ($r = 0.855$, $P < 0.01$) but not for Lake Whitewood ($r = 0.465$, $P > 0.05$). The variance for weekly totals could not be calculated since the counters were not read every day. Thus, no confidence intervals could be calculated for the estimates.

Traffic counter usage and vehicle tally usage did vary. Vehicle tallies had higher total use estimates when a large proportion of weekend sampling occurred. Traffic counters had higher total use

Table 10. The number of estimated trips per month from traffic counter readings for access 1 of the Brookings WPAs, access 1 of Buffalo Slough, and access 2 of Lake Whitewood, South Dakota, from April through November.

Month	Brookings WPAs access 1	Buffalo Slough access 1	Lake Whitewood access 2	Total
April a	5	24	8	37
May	11	44	18	73
June	10	29	14	53
July	11	19	22	52
August	24	26	28	78
September	b	127	141	268 d
October	b	277	397	674 d
November c	b	223	208	431 d

a Counts were taken only for the last week of April.
b No traffic counter was placed at that access at that time.
c Counts were only taken for the first 19 days of November.
d Totals are only for Buffalo Slough and Lake Whitewood.

estimates when trips were very short. This occurred quite frequently at access 2 of Lake Whitewood. Some duck hunters commented that they expected to find water up to the parking lot but only found cattails; thus, they left to find a more suitable access or another wetland.

Even more variance occurred when comparing man-hours of use to the traffic counter data. If certain activities such as camping or rifle deer hunting occurred, man-hour estimates were greatly increased. Trips of short duration, as mentioned above, were infrequently reported on the questionnaires, and thus, added to the bias.

Traffic counters did perform well on the gravel and dirt roads found at South Dakota wetlands during a dry year. Traffic counters were placed at least 50 meters (164 feet) from the main parking areas and had little vandalism.

Traffic counters are generally used in recreation studies to predict future usage. Intensive site sampling must accompany their use so that specific cause and effect relationships can be derived. For example, a model might be developed to predict total man-hours of duck hunting use at a specific site for each month. Thereafter, a predicting equation might be used with the counter readings to estimate man-hours of duck hunting. See James and Ripley (1963) for a model for developed recreation areas.

Traffic counters are most efficient on intensively used sites where usage is fairly evenly distributed over the entire sampling stratum. If use is low, too much manpower and money would need to be spent to determine uses and man-hours for individual activities. If

usage is not uniform over time, estimates will not be within narrow confidence intervals. Therefore, individual sampling strata must be identified and usage during each established to keep variance at a minimum.

If traffic counters are to be used at low usage wetlands, only data for the number of vehicles entering the area should be expected. No attempt should be made to explain uses or man-hours. Counters should be placed at all parking accesses of interest at that wetland.

AN ECONOMIC VIEW

Decisions on wetland allocations are commonly based on an economic analysis. Calculation of all positive economic wetland values would greatly support their preservation. Site-specific costs for hunting were derived by combining total use of each site with dollar values taken from the 1980 National Survey of Fishing, Hunting, and Wildlife-associated Recreation for South Dakota (U.S. Department of the Interior, Fish and Wildlife Service, and U.S.Department of Commerce, Bureau of Census 1982). This national survey, based on detailed personal interviews with 680 sportsmen in South Dakota, gives dollar values for both travel-related and equipment expenditures.

Estimated expenditures per day in South Dakota were $12.66 for waterfowl hunters, $10.56 for upland game hunters, $3.63 for predator hunters, and $25.90 for deer hunters. Using these figures, total expenditures for all 3 study sites combined were $123,279 for the 1981 hunting season. Waterfowl hunters contributed $95,081, followed by upland game hunters with $17,249, deer hunters with $10,748, and predator hunters with $201 (Table 11). The annual monetary benefit (expenditure) for hunting recreation in 1981 generated by a hectare of each wetland site was $27.92 ($11.30 per acre) for the Brookings WPAs, $163.81 ($66.29 per acre) for Buffalo Slough GPA, and $39.51 ($15.99 per acre) for Lake Whitewood.

Thibodeau and Ostro (1981) did an economic analysis of the Charles River Basin, a 3,454 hectare (8,535 acre) marsh and wooded swamp

Table 11. Economic values of hunting uses for the Brookings WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, derived for the period September 27 through December 31, 1981.

Game hunted	Brookings WPAs	Buffalo Slough	Lake Whitewood	Total
Waterfowl	$ 9,806	$ 37,678	$ 47,597	$ 95,081
Upland game	1,727	2,896	12,626	17,249
Predators	---	201	---	201
Deer	834	2,978	6,936	10,748
Total	$ 12,367	$ 43,753	$ 67,159	$ 123,279

near Boston, Massachusetts. They estimated the annual value (expenditure) for waterfowl hunting to be $78.75 per hectare ($31.87 per acre). The annual value (expenditure) for waterfowl hunting was $22.68 per hectare ($9.18 per acre) for the Brookings WPAs, $28.00 per hectare ($11.33 per acre) for Lake Whitewood, and $141.07 per hectare ($57.09 per acre) for Buffalo Slough GPA.

Randall (1981) stated that the maximum net present value criteria is the preferred method for determining the worth of public investments. This method uses the differences between the costs and benefits of an investment and discounts those differences over time. With gross expenditures, only the costs are calculated and these are equated with benefits. Realistically, benefits are much greater than costs because a hunter's maximum willingness to pay for that activity would be the total benefit (Bart et al. 1979). Thus, monetary costs projected in my study do not provide the true (total) wetland benefit for hunting recreation but only a minor proportion --- the money actually spent which ends up in the local economy.

The social discount rate used is 7.875%. This percentage is the discount rate used by the U.S. Army Corps of Engineers in fiscal year 1983 for calculating cost/benefit analysis. The procedure for determining this rate was set by congress. Applying this discount rate to the hunting value per hectare for all 3 study sites ($51.40; $20.80 per acre), the net present wetland value is $653 per hectare ($264 per acre) for hunting alone.

The discounted hunting value per hectare was quite different for the 3 wetland sites. The Brookings WPAs were valued at $355 per hectare ($143 per acre), Lake Whitewood $502 per hectare ($203 per acre), and Buffalo Slough $2,080 per hectare ($842 per acre). Buffalo Slough was approximately 4-6 times as valuable per hectare as the other 2 sites. I would attribute this greater use, and thus, benefit, to Buffalo Slough's proximity to Sioux Falls (a high population center) and to the slough's manmade improvements. The dam across the outlet of Buffalo Slough guaranteed that there would be water in the marsh to attract waterfowl even in drought years. The dam also facilitated the installation of a boat ramp to allow easy access to the marsh. (Forty-five percent of all recreationists used boats or canoes at Buffalo Slough compared to only 6% at the Brookings WPAs and 14% at Lake Whitewood.) This allowed hunters with boats to utilize many parts of the marsh that otherwise might receive little or no hunting use.

Clawson and Knetsch (1966) stated that investments for access development and other improvements generally have a substantial effect upon the volume of use and sometimes upon the quality of experiences in natural areas. It is important that wetlands be attractive to game species and also provide cover or refuge to hold them during high hunting pressure. If access is provided for the hunters and other recreationists, then usage will be enhanced.

Wetlands provide other recreational benefits that can not be recorded through on-site studies. For instance, geese which rest in the refuge area of Lake Whitewood provide recreation to those hunters who

hunt geese in grain fields. Dispersal of ducks from Lake Whitewood's refuge may also improve duck hunting at surrounding wetlands. Wetlands certainly overwinter pheasants and deer that provide some of the surplus game hunted on private property in the fall. Nonconsumptive users benefit as they drive by on the highways to watch flocks of ducks and geese rise off these wetlands.

Management for waterfowl hunting is more complex than just providing wetlands for hunting. Many more breeding and brood-rearing marshes are needed to produce the harvestable surplus of ducks (Crissey 1969). Gooch (1969) determined 6 ducks per season was the minimum acceptable bag for American hunters. If this number of surplus ducks is not produced, the number of duck hunters will decline and less money will be spent for wetland acquisition since wetland preservation has been financed primarily by duck hunters. Thus, the recreational benefit of small wetlands may not necessarily be seen in the number of actual duck hunters at that marsh site.

CONCLUSIONS

The average user of the study sites made 19.4 trips for consumptive activities and 4.1 trips for nonconsumptive activities to South Dakota public marshes during a year. Over 89% of all trips to the 6 public wetland sites were for hunting. Fall received the heaviest use accounting for 96.3% of man-hours, 89.1% of trips, and 92.1% of people. Duck, goose, and pheasant hunting accounted for 83.8%, 49.5%, and 23.0% of all fall trips, respectively.

Eleven other consumptive actitivies and 17 nonconsumptive activities occurred during the 1 year sample. Less than 8% of all trips were for nonconsumptive pursuits; birdwatching accounted for the most trips (4.5%) and camping for the most man-hours (7.1%).

Each study site received an average of 53 visits per day during the opening week of waterfowl season. After this peak, usage remained high (22 visits per day per study site) for 6 weeks until the marshes froze. Peak usage occurred on openings of the waterfowl, pheasant, and trapping seasons. High goose concentrations also increased usage. Both holidays and weekends received more use than weekdays.

Morning received the greatest amount of use with duck hunters preferring the sunrise to 0900 period and goose hunters the 0900 to noon period. Over all sites, pheasant hunters showed no preference in hunting between 1000 to sunset, but they did hunt the smaller wetland study sites during the sunset period more than other times of the day. Enforcement personnel could increase their hunter contacts by working in these periods.

Lake Whitewood and Buffalo Slough with open water and cover received high waterfowl hunting use throughout fall. Most of the Brookings WPAs were small and dry; the other marshes in these WPAs were mostly open water. The Brookings WPAs received high use from duck hunters the first 2 weeks, then they were mainly used by pheasant hunters. It appears that larger hemi-marshes (marhses with 50% open water and 50% cover) receive the most hunting pressure but small wetlands and open water marshes relieve the peak usage of season openings.

Seventy-two percent of trips to the wetland study sites were by South Dakotans within an hour drive. Although 25 counties were represented, most users came from Minnehaha County (47.4%) and Brookings County (25.1%). (Minnehaha County has the largest population in South Dakota and Brookings County is fourth.) It appears that public wetlands located close to high populations receive greater use than similar wetlands some distance away from populations.

Increasing the recreational use of a wetland increases the dollar value per hectare of that marsh (for recreation). Wetlands in this study were valued at $653 per hectare ($264 per acre) for hunting alone. Buffalo Slough GPA was valued at $2,080 per hectare ($842 per acre). It appears that marshes with about 50% open water and 50% cover and within an hour drive of high population centers are ideal choices for public ownership and management. Water control structures can also increase hunting use by creating hemi-marsh conditions.

If increased marsh usage is a goal, then roads, parking lots, and boat launch areas should be better developed and maintained. Nonconsumptive use could be encouraged during winter, spring, and summer. There is potential to increase birdwatching, hiking, canoeing, photography, nature study, cross country skiing, and other activities on South Dakota public wetlands.

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Appendix A. Listing of 32 null hypotheses and their statistical values analyzed for the wetland study of Brush Lake, Henrikson, Holm, and Larsen WPAs, Buffalo Slough GPA, and Lake Whitewood, South Dakota, from August 9, 1981 through August 8, 1982.

1. There is no significant difference in the amount of recreational use among various wetland activities for the number of trips, people and man-hours.

Reject: Differences were so obvious that no statistical tests were run.

2. There is no significant difference in the amount of recreational use among fall, winter, spring, and summer strata.

Reject: Differences between fall and the other 3 strata were so obvious that no statistical tests were run.

3. There is no significant difference in the amount of recreational use among winter, spring and summer strata.

Fail to reject: Trips	$X^2 = 0.015$	d.f. = 2	P = 0.993
People	$X^2 = 0.050$	d.f. = 2	P = 0.975
Man-hours	$X^2 = 2.537$	d.f. = 2	P = 0.292

4. There is no significant difference in group size per vehicle among fall, winter, spring, and summer users.

Fail to reject:	$X^2 = 0.241$	d.f. = 3	P = 0.970

5. There is no significant difference in the average amount of time spent per wetland user among fall, winter, spring, and summer recreationists.

Reject:	$X^2 = 8.140$	d.f. = 3	P = 0.045

6. There is no significant difference in the average amount of time spent per wetland user among winter, spring and summer recreationists.

Fail to reject:	$X^2 = 1.010$	d.f. = 2	P = 0.617

7. There is no significant difference in the average distance traveled by wetland users during fall, winter, spring, and summer strata.

Reject:	$X^2 = 27.785$	d.f. = 3	P < 0.005

8. There is no significant difference in the average distance traveled by wetland users during winter, spring and summer strata.

Fail to reject: $X^2 = 0.440$ d.f. = 2 P = 0.986

9. There is no significant difference in the amount of use between consumptive users and nonconsumptive users.

Reject: Trips	$X^2 = 82.71$	d.f. = 3	$P < 0.005$
People	$X^2 = 165.86$	d.f. = 3	$P < 0.005$
Man-hours	$X^2 = 413.43$	d.f. = 3	$P < 0.005$

10. There is no significant difference in the 1-year ratio of nonhunting to hunting visits recorded compared to the ratio of nonhunting to hunting visits estimated for an 1-year period on the questionnaire.

Reject: $X^2 = 7.974$ d.f. = 1 $P < 0.005$

11. There is no significant difference between the number of hunting and trapping trips and the number of nonconsumptive trips in fall.

Reject: t = 2.872 d.f. = 9 P = 0.019

12. The amount of trapping use is not significantly different from the amount of use by other fall activities.

Reject: Differences between trapping and other fall activities were so obvious that no statistical tests were run.

13. The amount of waterfowl hunting, pheasant hunting, or deer hunting is not significantly different from the amount of use for other fall activities.

Reject: Differences were so obvious that no statistical tests were run.

14. There is no significant difference in weekly usage throughout fall.

Reject: F = 3.81 d.f. = 10 P = 0.002

15. Weekly usage by waterfowl hunters is not significantly different from weekly usage by other fall recreationists.

Reject: t = 2.260 d.f. = 9 P = 0.050

16. There is no significant difference between the amount of weekly usage by the group of hunters listing no nonconsumptive activities and the group of hunters and nonconsumptive users listing nonhunting activities during fall.

Reject: $t = 2.634$ d.f. = 9 $P = 0.030$

17. There is no significant difference in the amount of hunting use pursued on weekends versus weekdays during fall.

Reject: $t = 3.193$ d.f. = 7 $P = 0.016$

18. There is no significant difference in the amount of nonconsumptive use pursued on weekends versus weekdays during fall.

Reject: $t = 2.429$ d.f. = 7 $P = 0.047$

19. There is no significant difference in the amount of use among sampling periods within a day during fall.

Reject: $F = 2.87$ d.f. = 4 $P = 0.039$

20. There is no significant difference in the amount of duck hunting use among sampling periods within a day during fall.

Reject: $F = 3.67$ d.f. = 4 $P = 0.019$

21. There is no significant difference in the amount of goose hunting use among sampling periods within a day during fall.

$F = 2.42$ d.f. = 4 $P = 0.079$
But a LSD revealed a significant difference between periods 2 and 5.

22. There is no significant difference in the amount of pheasant hunting use among sampling periods within a day during fall.

Fail to reject: $F = 0.28$ d.f. = 4 $P = 0.885$

23. The number of duck hunters is not significantly different on days that are windy (greater than or equal to 15 mph), cool (less than or equal to 10 ^{0} C), and overcast (greater than or equal to 75% cloud cover) than on days with different weather conditions.

Reject: $X^2 = 9.57$ d.f. = 1 $P < 0.005$

24. The number of pheasant hunters is not significantly different on days that are calm (less than or equal to 10 mph), warm (greater than or equal to 5^{0} C), and sunny (less than or equal to 50% overcast) than on days with different weather conditions.

Reject: $X^2 = 5.83$ d.f. = 1 P = 0.017

25. There is no significant difference among the distance traveled by waterfowl hunters, pheasant hunters, multi-purpose hunters, and those camping during fall.

Fail to reject: F = 0.030 d.f. = 3 P = 0.829

26. The distance traveled is not related to the length of time spent at a wetland.

Reject:	Fall use	r = 0.484	d.f. = 218	P < 0.005
	Weekends	r = 0.479	d.f. = 158	P < 0.005
	Weekdays	r = 0.592	d.f. = 55	P < 0.005

27. There is no significant difference between weekend and weekday users for distance traveled or for the amount of time spent at a wetland.

Reject: Distance traveled	F = 4.62	d.f. = 1	P = 0.033
Fail to reject: Time spent	F = 1.18	d.f. = 1	P = 0.278

28. The number of users from large towns within a 80 kilometer radii of the study sites (Brookings, Huron, Madison, Sioux Falls, and Watertown) is not significantly different than the number of users expected randomly within these radii.

Reject: $X^2 = 213.55$ d.f. = 11 P < 0.005

29. The number of recreationists from a county using a particular wetland site is not significantly different than the number of users expected at random based on that county population.

Reject: $X^2 = 80.55$ d.f. = 7 P < 0.005

30. There is no significant difference in the car license plate record (of residency) and the actual residency response on the questionnaire.

Fail to reject: $X^2 = 20.24$ d.f. = 23 P = 0.623

31. There is no significant correlation between the number of trips recorded by traffic counters and the expanded trips calculated by the vehicle count method for weekly and monthly totals.

Monthly: Expanded trips could not be calculated by the vehicle count method for spring and summer.
Weekly (fall): Fail to reject:

Buffalo Slough	$r = 0.806$	$d.f. = 6$	$P < 0.05$
Lake Whitewood	$r = 0.937$	$d.f. = 6$	$P < 0.01$

32. There is no significant correlation between traffic counter readings and expanded man-hours from survey responses on a weekly and monthly basis.

Monthly: Expanded man-hours could not be calculated from the surveys for spring and summer.
Weekly (fall): Fail to reject:

Buffalo Slough	$r = 0.855$	$d.f. = 5$	$P < 0.05$

Reject:

Lake Whitewood	$r = 0.465$	$d.f. = 5$	$P > 0.05$

Appendix B. Table 1. Day of the week probabilities of use for selecting random samples for each site by week during the wetlands recreation survey in South Dakota, August 9, 1981 through August 8, 1982.

Day of week	Normal week	Week with holiday	Weeks for waterfowl season opening		Weeks for pheasant season opening		Week for trapping season opening	Weeks for rifle deer season opening	
Sunday	.22	.20	.16	.42b	.18	.30b	.36c	.20	.30b
Monday	.11	.10	.08	.08	.18a	.10	.09	.10	.10
Tuesday	.11	.10	.08	.08	.09	.10	.09	.10	.10
Wednesday	.11	.20a	.08	.08	.09	.10	.09	.10	.10
Thursday	.11	.10	.08	.08	.09	.10	.09	.10	.10
Friday	.11	.10	.08	.08	.09	.10	.09	.10	.10
Saturday	.22	.20	.42b	.16	.27b	.20	.18	.30b	.20

a Holiday probabilities equal weekend day probabilities.
b The Saturday and Sunday of the respective season opening weekend.
c Trapping season opened on a Sunday.

Appendix C. Figure 1. Letter explaining the wetland survey being conducted which was placed on vehicle windshields at study sites.

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South Dakota Cooperative Wildlife Research Unit

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Brookings, South Dakota 57006
(605)688-6121

Cooperating Agencies:

South Dakota Department Of Game, Fish and Parks
South Dakota State University
Wildlife Management Institute
U.S. Fish and Wildlife Service

Dear Outdoorsman:

WE NEED YOUR HELP!

This letter and a stamped, addressed postcard have been left on your vehicle by a field representative of the South Dakota Cooperative Wildlife Research Unit. We would like you to fill out the postcard and drop it in a mailbox at your earliest convenience.

We are attempting to determine the amount and types of recreation occurring on South Dakota's marshes and sloughs. We wish to maintain public areas and public accesses for your recreational and hunting use. This survey information will help determine the importance of wetlands for both recreation and economic benefits for the state. Survey results will also be useful for evaluating management practices and for planning future acquisition and preservation programs.

For this survey to be successful we need your help. We are interested in non-hunting as well as hunting activities. Please fill in and mail the enclosed postcard even if you received one on a previous day. It is important that we have a response from you every time you receive a card. All individual responses will remain confidential.

Thank you very much for your help!

Sincerely yours,

Timothy A. Thompson

Timothy A. Thompson
Research Wildlife Biologist

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Enclosure

Appendix C. Figure 2. Pre-addressed and stamped postcard questionnaires distributed on parked vehicles during fall hunting season and winter, spring, and summer strata.

How many people came in this car or truck? _____

Where do you live: Town _____

County _____

State _____

How long were you at this public area? _____
(to the nearest ½ hour)

How were you using this area: Hunting/trapping _____

Non-hunting activity _____

If hunting or trapping, what game did you pursue?

Ducks _____ Coots _____ Pheasants _____

Geese _____ Deer _____ Rabbits _____

Other (write in) _____

If non-hunting, indicate use: _____
(such as hiking, canoeing, target shooting, bird-watching)

Estimate the number of times that you visited South Dakota public marshes during the last 12 months for: Hunting ___ Non-hunting ____

How many people came in this car or truck? _____

Where do you live: Town _____

County _____

State _____

How long were you at this public area? _____
(to the nearest ½ hour)

How were you using this area? _____

_____
(such as hiking, canoeing, bird-watching, target shooting, etc.)

Estimate the number of times that you visited South Dakota public marshes during the last 12 months for:

Non-hunting _____ Hunting/trapping _____