



The influence of habitat features in waterfowl productivity on stock reservoirs in south Valley County, Montana
by Mark Gerard Miller

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Fish and Wildlife Management
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Abstract:

Waterfowl use and productivity was studied in relation to physical and vegetational features on 35 stock reservoirs in south Valley County, Montana and compared to similar data gathered in adjacent Phillips County. South Valley County was not glaciated during the most recent glacial period, so it lacks the natural potholes characteristic of glaciated areas, such as Phillips County. The percentage of bare ground in upland vegetative cover in this study was 2.3 times greater than that measured in Phillips County. Pond size was important in determining the number of breeding pairs of ducks utilizing a pond. However, the length of shoreline seemed to have the greatest influence on the number of breeding pairs per pond in this study.

During the same time period and similar water conditions, breeding pairs per ha were 44% and breeding pairs per 100 m of shoreline were 42% of comparable data gathered in Phillips County. Pond size, shoreline length, shoreline development, water turbidity, submerged vegetation and distance to the nearest reservoir were habitat features which influenced duck brood production in south Valley County. Duck broods per ha were only 16% and broods per 100 m of shoreline 22% of comparable numbers in Phillips County. Species representation between Phillips and south Valley Counties was comparable. However, differences in the numerical importance of each species were apparent. Canada geese in south Valley County are attracted to larger detention reservoirs in the spring with minimal outward movement to smaller reservoirs. Selection of reservoirs by geese for nesting and brood production was significantly greater on reservoirs with nesting islands. Significant siltation is occurring on the larger reservoirs and thus will render them unavailable to Canada geese for nesting in the near future. Management recommendations are discussed.

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For Vicki:

To the spirit that did embrace my spirit.

To the heart that did pour out its secrets into my heart.

To the hand that did kindle the flame of my love.

THE INFLUENCE OF HABITAT FEATURES ON WATERFOWL PRODUCTIVITY
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MARK GERARD MILLER

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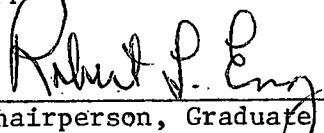
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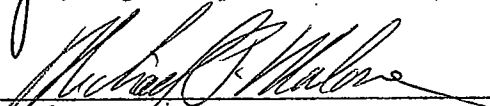
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ABSTRACT

Waterfowl use and productivity was studied in relation to physical and vegetational features on 35 stock reservoirs in south Valley County, Montana and compared to similar data gathered in adjacent Phillips County. South Valley County was not glaciated during the most recent glacial period, so it lacks the natural potholes characteristic of glaciated areas, such as Phillips County. The percentage of bare ground in upland vegetative cover in this study was 2.3 times greater than that measured in Phillips County. Pond size was important in determining the number of breeding pairs of ducks utilizing a pond. However, the length of shoreline seemed to have the greatest influence on the number of breeding pairs per pond in this study. During the same time period and similar water conditions, breeding pairs per ha were 44% and breeding pairs per 100 m of shoreline were 42% of comparable data gathered in Phillips County. Pond size, shoreline length, shoreline development, water turbidity, submerged vegetation and distance to the nearest reservoir were habitat features which influenced duck brood production in south Valley County. Duck broods per ha were only 16% and broods per 100 m of shoreline 22% of comparable numbers in Phillips County. Species representation between Phillips and south Valley Counties was comparable. However, differences in the numerical importance of each species were apparent. Canada geese in south Valley County are attracted to larger detention reservoirs in the spring with minimal outward movement to smaller reservoirs. Selection of reservoirs by geese for nesting and brood production was significantly greater on reservoirs with nesting islands. Significant siltation is occurring on the larger reservoirs and thus will render them unavailable to Canada geese for nesting in the near future. Management recommendations are discussed.

INTRODUCTION

Valley County is located in northeastern Montana adjacent to the southern edge of the Canadian prairie provinces, long noted for their contribution to the continental waterfowl production. Stock retention reservoirs have been constructed throughout the county to provide water for livestock and better grazing distribution. Also, several large detention reservoirs and spreader dikes have been constructed on major drainages in the area as run-off control structures. These water areas created habitat for waterfowl production. Although breeding pairs of Canada geese (*Branta canadensis* sp.) have been recorded on the area since 1964 (R. Trueblood, pers. comm.), productivity has been low compared to adjacent Phillips County. Little information was available concerning the breeding population and success of ducks utilizing the reservoirs of the area.

The purpose of this study was to evaluate Canada goose and duck production compared to similar data gathered in Phillips County. Specific factors evaluated were vegetational cover, livestock grazing, nesting islands, fencing, water turbidity, pond area, shoreline length, and water level fluctuations. Based on the findings, recommendations concerning habitat manipulations for the benefit of the waterfowl were to be proposed. Field work was conducted from June 15 to September 14, 1978 and from March 24 to September 13, 1979.

DESCRIPTION OF STUDY AREA

The study area was located in south Valley County, approximately 48 km southwest of Glasgow, Montana. South Valley County could be described as rolling plains interspersed with deeply eroded coulees. The elevation of the area is approximately 700 m.

The geologic history of the area is unique. The study area lies in a geographical area termed the Eastern Sedimentary Plains, which is about 30 km south of the Eastern Glaciated Plains (Ross and Hunter 1976). Since the area was not glaciated in the most recent glacial period, it lacks the natural potholes characteristic of glaciated areas, such as north Valley County and Phillips County (Allen 1932, Fenneman 1931). Prior to the construction of stock reservoirs, the area was essentially unsuitable for waterfowl.

The climate of south Valley County is cool semi-arid with cold dry winters and warm summers. Average annual temperature is 5.3°C and average annual precipitation is 27.6 cm, with over 50% of the precipitation occurring during April through July (U.S. Weather Bureau). Average date of the first fall freeze is September 22 and the average date of the last freeze is May 20, giving an average frost-free season of 125 days (Caprio 1965).

The drainage of Lone Tree Creek above Triple Crossing Reservoir was selected as the major study area. This included the reservoirs within the North, Middle and South Forks of Lone Tree Creek

(Figure 1). Certain reservoirs outside of this drainage, which showed Canada goose activity, were also studied. The major study area covered approximately 64 km², while the reservoirs outside the drainage ranged from 6.1 to 16 km from the major study area (Figure 2).

The entire study area included 35 reservoirs of two types: retention and detention. Most ponds were permanent and retained water throughout the season. However, a few were temporary, one becoming dry by June 12 in 1979. All of the reservoirs by type and location are listed in Appendix Table 20.

Vegetation of the area is of three generalized types: grassland, sagebrush, and greasewood, with the sagebrush type encompassing the majority of the study area. The important species in grassland include western wheatgrass (*Agropyron smithii*), blue gramma (*Bouteloua gracilis*), needle and thread (*Stipa comata*), June grass (*Koeleria cristata*), Sandberg bluegrass (*Poa secunda*), prairie sandreed (*Calamovilfa longifolia*), plains muhly (*Muhlenbergia cuspidata*), bottlebrush squirreltail (*Sitanion hystrix*), little bluestem (*Andropogon scoparius*), thread leaf sedge (*Carex filifolia*), prickly pear cactus (*Opuntia polycantha*), Hoods phlox (*Phlox hoodii*), fringed sagewort (*Artemisia frigida*), scarlet globemallow (*Sphaeralcea coccinea*), Kochia (*Kochia scoparia*), greasewood (*Sarcobatus vermiculatus*), big sagebrush (*Artemisia tridentata*), and Nuttall's salthush (*Atriplex nuttallii*).

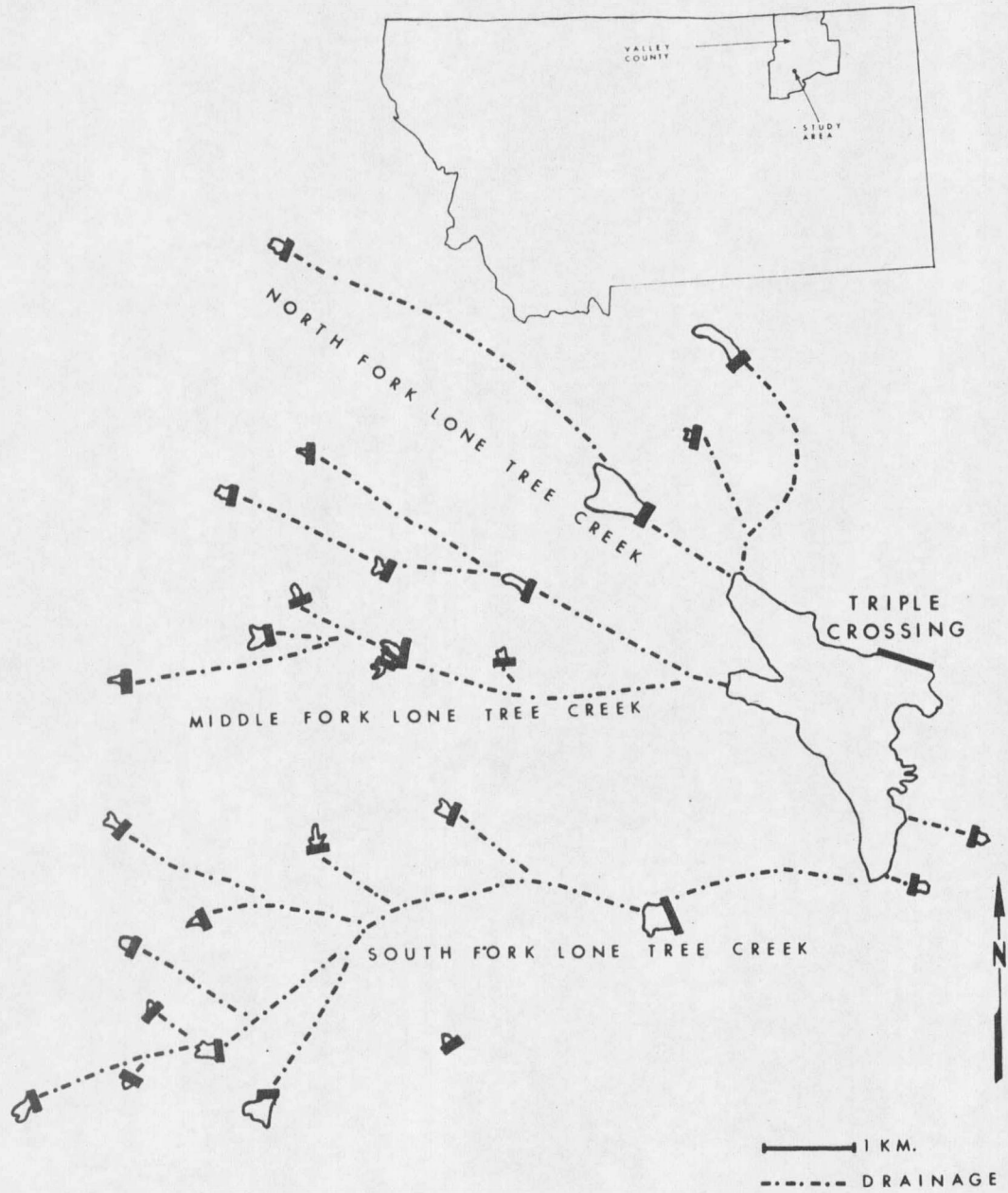


Figure 1. Map of major study area showing location of study ponds.

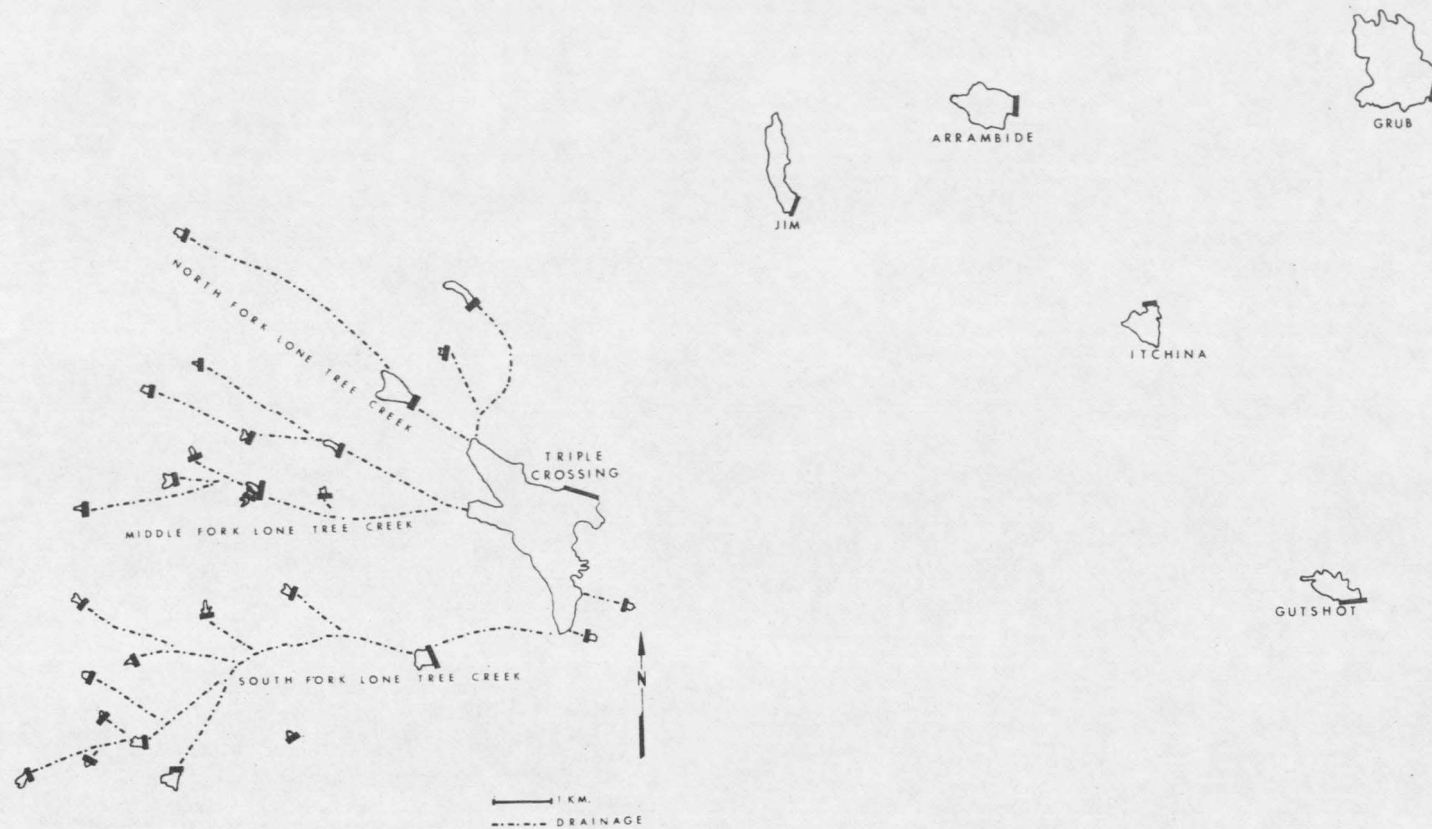


Figure 2. Map of entire study area showing location of all study reservoirs.

In the sagebrush type, the dominant species are big sagebrush and western wheatgrass. Other important species are silver sagebrush (*Artemisia cana*), fringed sagewort, blue gramma, and Sandberg bluegrass.

Dominant species in the greasewood type include greasewood, rabbitbrush (*Chrysothamnus* spp.), bottlebrush squirreltail, western wheatgrass, and Nuttall's saltbush (U. S. Dept. of Interior 1969).

Vegetation in and around each reservoir occurred in three zones: submerged, emerged, and riparian. Pondweeds (*Potamogeton* spp.) were the dominant aquatic plants in the submerged zone. Other submerged plants were crowfoot (*Ranunculus aquatilis*) and water milfoil (*Myriophyllum exalbescens*).

Common cattail (*Typha latifolia*), American great bulrush (*Scirpus validus*), and longspike spikerush (*Eleocharis macrostachya*) were the dominant species in the emerged zone. Other species in this zone were arrowhead (*Sagittaria* spp.) and smartweed (*Polygonum* spp.).

Foxtail barley (*Hordeum jubatum*), dock (*Rumex* spp.), and goosefoot (*Chenopodium* spp.) dominated in the riparian zone around the reservoirs. As water levels receded during the season, needle-spikerush (*Eleocharis acicularis*) occurred on exposed areas.

Vertebrates, other than waterfowl, which were common to the area are listed in Appendix Table 21.

METHODS

Selection of and initial familiarity with the study area was accomplished in 1978 with the aid of aerial reconnaissance and U. S. Bureau of Land Management maps of south Valley County. All viable reservoirs within the Lone Tree Creek drainage including its North, Middle, and South Forks plus 5 larger nearby reservoirs which showed signs of use by Canada geese were selected for study.

A physical description was made of each reservoir during initial visits. Shoreline slope was assigned by percentage into 1 of 4 categories: 0-10°, 11-30°, 31-45°, and >45° (McCarthy 1973). Also noted was the presence of islands, nesting platforms, or fences and dike condition. The construction date and type of reservoir was obtained from records in the Glasgow office of the Bureau of Land Management.

In August of both years, 35 mm color infra-red aerial photographs were taken of study reservoirs (Meyer et al. 1974). A scale map of each reservoir was constructed by tracing projections of the photographs. A Leitz zero-setting compensating planimeter was used to determine the surface area of each pond.

Graduated metal posts were placed in selected ponds in 1979 for monitoring water level fluctuations. Changes in water level were noted during each pond visit.

A Secchi disc was used to determine water turbidity of each pond. Turbidity measurements on the reservoirs were grouped into 3

classes: <50 cm, <50 cm and visible on the pond bottom, and >50 cm. The second class infers that, although water turbidity may be high, the relative shallowness of the pond enables light to penetrate to the bottom and is thus conducive to the growth of aquatic vegetation.

Vegetational data were gathered from two upland sites near each pond. One site was located perpendicular to the pond shoreline and the other in the drainageway immediately above. Percent canopy-coverage was determined through a modification of the method described by Daubenmire (1959). A 10 dm² plot (20x50 cm) was placed every 10 m along the transect. The percent canopy-coverage of grasses, forbs, shrubs and bare ground was estimated visually by class as follows: 0-5%, 5-25%, 25-50%, 50-75%, 75-95%, and 95-100%. The mean height (cm) of the vegetation in each plot was recorded. The mid-point in each class was used in data calculation. Two transects were systematically placed in the drainage 200 m above each pond to determine the percent canopy-coverage.

The extent of the aquatic vegetation present in each pond was determined from projections of the aerial photographs taken in 1978 and 1979. Species composition was obtained from ground examinations. All plants were classified through the use of Hitchcock and Cronquist (1973).

Waterfowl breeding pair counts were obtained only in 1979. All pairs, males, and females were counted. The sum of pairs and lone

males were used for breeding pair totals for dabbling ducks and redheads. The total number of pairs plus lone females was used for breeding pair totals for other diving ducks (Hammond 1959). The total number of breeding pairs plus females on nests was used for Canada geese (Rundquist 1973).

Brood counts were obtained in 1978 and 1979. Ponds were cautiously approached by vehicle and on foot to minimize disturbance. Species, brood size and relative age were recorded for any broods observed (Gollop and Marshall 1954).

No formal nest searches were conducted but any nests found were recorded as to location, species, clutch size and subsequent success or failure.

Relative cattle use on the study area was determined from Bureau of Land Management records and personal observations. Throughout the 1978 and 1979 field seasons, non-waterfowl observations were recorded.

Methods used in statistical analysis of the data were acquired from Mendenhall (1971) and Sokal and Rohlf (1969).

RESULTS

Pond Characteristics

Stockponds had a maximum amount of water in early spring and decreased as the season progressed, since snow cover and the subsequent spring melt provided the major source of water. Eisenlohr and Sloan (1968) reported that snow cover of any depth was effective in supplying potholes with water if melt occurred rapidly while the ground was frozen. Rainfall seemed to function primarily in maintaining the water levels throughout the season. Occasionally large amounts of precipitation in short periods of time increased water levels: e.g., heavy precipitation in early May 1979 caused water levels to rise in reservoirs and flooded one goose nest. Below average precipitation in May, June, and July 1979 caused 6 reservoirs to dry up, compared to only one in 1978 when rainfall was near normal (Figure 3).

Water turbidity in the study ponds varied between drainages and within drainages. Linear regression analysis showed little correlation between water turbidity and percent canopy-coverage around ponds. Likewise, there was no apparent correlation between water turbidity and the position of the reservoir in the drainage. Differences in water turbidity among ponds could reflect variations in soil conditions.

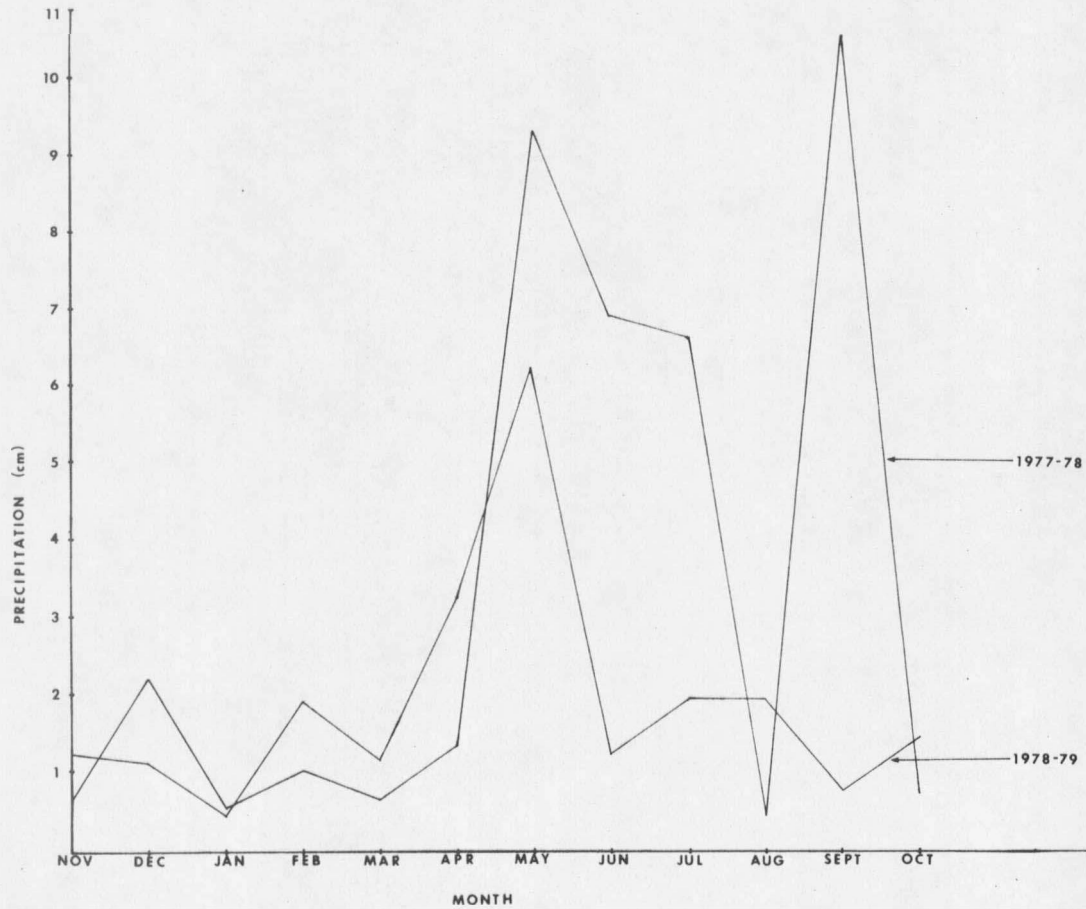


Figure 3. Average monthly precipitation recorded at Glasgow WSO AP, November-October, 1977-78 and November-October, 1978-79.

Fences, around sections of the pond shoreline, were present on 7 of the reservoirs. Due to the condition of fences, none were effective in keeping cattle out of the enclosed areas.

Breeding Pairs - Ducks

Surface feeding ducks made up the majority of waterfowl breeding pairs on the study area (Table 1). Included were mallards (*Anas platyrhynchos*), pintails (*A. acuta*), American wigeons (*Mareca americana*), gadwalls (*A. strepera*), shovelers (*Spatula clypeata*), blue-winged teal (*A. discors*), and green-winged teal (*A. carolinensis*). Four species of diving ducks were observed as breeders on the area: lesser scaup (*Aythya affinis*), ruddy duck (*Oxyura jamaicensis*), redhead (*Aythya americana*), and canvasback (*Aythya valisineria*). Buffleheads (*Bucephala albeola*) and common goldeneyes (*B. clangula*) were observed as migrants during the field season. Wigeons, mallards and blue-winged teal, in that order, were the three most abundant breeding species. Among diving ducks, lesser scaup represented almost 10% of the total breeding pairs, with other species making up less than 4% of the total.

The average number of breeding pairs per pond is presented in Table 2. Although the number of pairs increased as pond area increased, these differences were not significant ($P > .05$). The number

Table 1. Species composition of breeding pairs of waterfowl in south Valley County, Montana, 1979.

Species	No. of Breeding Pairs	Percent Composition
wigeon	107	30.1
mallard	57	16.0
blue-winged teal	46	13.0
lesser scaup	35	9.8
shoveler	30	8.4
pintail	24	6.7
gadwall	22	6.1
green-winged teal	22	6.1
ruddy duck	6	1.6
redhead	4	1.1
canvasback	2	.5

Table 2. Average number of breeding pairs per pond, hectare, and 100 m of shoreline for six size classes of ponds.

Pond Size Class ha	Average no. pairs/pond	Average no. pairs/ha	Average no. pairs/100 m
0.1-1.0 (6)	5.8	9.3	1.3
1.1-1.5 (7)	8.9	7.1	1.3
1.6-2.5 (5)	9.4	4.8	1.2
2.6-4.0 (5)	11.8	3.0	1.1
4.1-5.0 (5)	14.6	3.2	1.1
5.0+ (5)	14.0	.72	.56

() sample size

of breeding pairs was greatest in ponds 4.1-5.0 ha in area and smallest in ponds 0.1-1.0 ha. However, an increase in pond size did not bring about a proportional increase in breeding pairs. Breeding pair density was greatest on smaller ponds and smallest on larger ponds. There was no significant difference ($P > .05$) in breeding pairs per 100 m of shoreline between the different size classes of reservoirs.

The relationship between water turbidity and the occurrence of breeding pairs is presented in Table 3. Water turbidity had no significant effect on the number of breeding pairs per pond ($P > .05$).

Table 3. Average number of breeding pairs per pond and 100 m of shoreline for three classes of water turbidity.

Secchi disc reading (cm)	Average no. pairs/pond	Average no. pairs/100 m
<50 cm (10)	10.9	1.0
<50 cm and visible on the pond bottom (8)	10.0	1.1
>50 cm (15)	10.4	1.2

() sample size

The length of shoreline of a pond significantly influenced ($P < .05$) the number of breeding pairs per pond. As the length of shoreline increased, the number of pairs utilizing a reservoir also increased (Table 4).

Table 4. Average number of breeding pairs per pond and 100 m of shoreline for three classes of shoreline length.

Shoreline length (m)	Average no. pairs/pond	Average no. pairs/100 m
0-700 (10)	7.1	1.4
701-1200 (12)	9.9	1.1
1200+ (11)	14.1	.8

() sample size

Shoreline development, which relates the length of shoreline to the surface area of a body of water, showed no significant relation ($P > .05$) to the number of breeding pairs per pond (Table 5).

Table 5. Average number of breeding pairs per pond and 100 m of shoreline for three classes of shoreline development.

Shoreline development	Average no. pairs/pond	Average no. pairs/100 m
1.1-1.5 (7)	11.4	1.2
1.6-2.0 (18)	9.6	1.1
2.0+ (8)	11.6	1.0

() sample size

The percentage of submerged and emerged vegetation refers to the percentage of the surface area of a pond occupied by vegetation type as determined from aerial photographs. Percent of submerged vegetation

per pond had no significant influence ($P > .05$) on the number of breeding pairs utilizing a reservoir (Table 6). The same was true of percent emerged vegetation (Table 7).

Table 6. Average number of breeding pairs per pond and 100 m of shoreline for three classes of percentage of submerged vegetation.

% submerged vegetation		Average no. pairs/pond	Average no. pairs/100 m
0-10%	(14)	9.9	.9
11-30%	(10)	10.3	1.0
30%+	(9)	11.5	1.5

() sample size

Table 7. Average number of breeding pairs per pond and 100 m of shoreline for two classes of percentage of emerged vegetation.

% emerged vegetation		Average no. pairs/pond	Average no. pairs/100 m
0-14%	(16)	10.6	1.0
15%+	(17)	10.4	1.2

() sample size

The effects of pond proximity was evaluated. More pairs were present on ponds which were less than 1 km from another, than on ponds which were more than 1 km apart (Table 8). However, the differences in numbers of pairs per pond were not statistically significant ($P > .05$).

Table 8. Average number of breeding pairs per pond and 100 m of shoreline related to different distances to the nearest pond.

Distance to the nearest pond	Average no. pairs/pond	Average no. pairs/100 m
0-1.0 km (21)	10.1	1.2
1 km+ (8)	8.1	1.0

() sample size

The number of breeding pairs of ducks per 100 m of shoreline is presented in Tables 2 through 8 in relation to pond area, turbidity, shoreline length, shoreline development, percentage of submerged vegetation, percentage of emerged vegetation, and distance to the nearest reservoir. These parameters showed no significant relation ($P > .05$) to the number of breeding pairs per 100 m of shoreline utilizing a pond. This suggests that the number of breeding pairs of ducks using a pond is highly dependent on the amount of shoreline.

Brood Production - Ducks

A large part of the 1978 field season was spent locating and gathering physical data on all of the study ponds. The infrequent visits to each pond did not permit separation of transient from resident broods. Consequently, only brood data obtained in 1979 (Table 9) were used in comparing the various parameters between ponds. The 1978 brood data are presented in Appendix Table 22.

Table 9. Species composition of waterfowl broods in south Valley County, Montana, 1979.

Species	No. of broods	Percent Composition
wigeon	52	61
mallard	2	2
blue-winged teal	3	3.5
pintail	4	4
gadwall	6	7
green-winged teal	6	7
shoveler	1	1
lesser scaup	2	2
ruddy duck	3	3.5
redhead	2	2
canvasback	3	3.5

The number of broods per pond increased as pond area increased. The greatest number of broods occurred on ponds in the 4.1-5.0 ha size class with .1-1.0 ha ponds having the smallest number (Table 10).

Table 10. Average number of broods per pond, hectare and 100 m of shoreline for six size classes of ponds.

Pond size class	(ha)	Average no. broods/pond	Average no. broods/ha	Average no. broods/100 m
0.1-1.0	(6)	1.3	1.7	.25
1.1-1.5	(7)	1.9	1.5	.27
1.6-2.5	(5)	3.4	1.7	.40
2.6-4.0	(5)	3.8	1.1	.34
4.1-5.0	(5)	4.2	1.0	.33
5.0+	(4)	1.5	.1	.08

() sample size

A similar trend was seen between brood production and the length of shoreline (Table 11). As the length of shoreline increased, the number of broods present increased. Ponds with greater than 1200 m of shoreline had the highest production of duck broods. However, these differences in brood production related to the total length of shoreline did not vary significantly ($P > .05$).

Similar results are seen when relating brood production to shoreline development (Table 12). The highest brood production was seen on ponds with the greatest shoreline development, although the differences were not significant ($P > .05$).

Table 11. Average number of broods per pond and 100 m of shoreline for three classes of shoreline length.

Shoreline length m		Average no. broods/pond	Average no. broods/100 m
0-700	(10)	1.8	.31
701-1200	(12)	2.6	.29
1200+	(11)	3.4	.25

() sample size

Table 12. Average number of broods per pond and 100 m of shoreline for three classes of shoreline development.

Shoreline development		Average no. broods/pond	Average no. broods/100 m
1.1-1.5	(7)	1.6	.14
1.6-2.0	(18)	2.8	.33
2.0+	(7)	3.3	.30

() sample size

The number of broods was highest on ponds with the least turbidity (Table 13). This suggests that brood production may be related to submerged or emerged vegetation. The differences in broods produced on 3 classes of ponds with different percentages of submerged vegetation were significant ($P < .05$) (Table 14). The highest brood production was observed on ponds with submerged vegetation found in greater than

Table 13. Average number of broods per pond and 100 m of shoreline for three classes of water turbidity.

Secchi disc reading cm	Average no. broods/pond	Average no. broods/100 m
<50 cm (9)	1.6	.14
<50 cm and visible on the pond bottom	2.3	.21
>50 cm (15)	3.5	.40

() sample size

Table 14. Average number of broods per pond and 100 m of shoreline for three classes of percentage of submerged vegetation.

% submerged vegetation	Average no. broods/pond	Average no. broods/100 m
0-10% (13)	1.4	.12
11-30% (10)	3.4	.34
30+ (9)	3.6	.45

(sample size)

11% of the pond. Differences in brood production related to the percentage of emerged vegetation were not significant ($P > .05$) (Table 15).

More broods were produced on reservoirs which were less than 1 km from another, than on reservoirs which were more than 1 km apart (Table 16). However, the differences in broods between pond density classes were not statistically significant ($P > .05$).

Table 15. Average number of broods per pond and 100 m of shoreline for two classes of percentage of emerged vegetation.

% emerged vegetation		Average no. broods/pond	Average no. broods/100 m
0-14%	(15)	2.9	.30
15%+	(17)	2.4	.26

() sample size

Table 16. Average number of broods per pond and 100 m of shoreline related to different distances to the nearest pond.

Distance to the nearest pond		Average no. broods/pond	Average no. broods/100 m
0-1.0 km	(21)	3.0	.33
1 km+	(8)	2.0	.21

() sample size

The number of broods per 100 m of shoreline was presented in Tables 10 through 16, in relation to various parameters. Pond area, length of shoreline, shoreline development, and percent emerged vegetation did not have significant influence ($P > .05$) on the number of broods per 100 m of shoreline.

Water turbidity did affect the number of broods per 100 m of shoreline. Reservoirs with the lowest turbidity had significantly

more broods per 100 m of shoreline ($P < .05$) than on reservoirs with more turbid water.

As the amount of submerged vegetation in a pond increased, the number of broods per 100 m of shoreline increased. The differences in broods per 100 m of shoreline were significant ($P < .01$).

The number of broods per 100 m of shoreline was greater on ponds which were less than 1 km from another, than on ponds which were more than 1 km apart. This difference was statistically significant ($P < .01$).

The percent canopy-coverage of upland vegetation on all the stockponds averaged 52.1% (range 36.9-70.8%) and 52.1% (range 39.9-70.4%) for percent canopy-coverage in the drainage above each pond. The mean height of the vegetation averaged 15.5 cm and 16.1 cm, respectively. No apparent correlation was found between percent canopy-coverage and the number of breeding pairs or between percent canopy-coverage and brood production.

Correlation between percentage of shoreline slope greater than 30° and breeding pairs or brood production was not apparent.

Canada geese

With the construction of stock reservoirs in the 1960's, south Valley County became potential habitat for waterfowl. Detention reservoirs produced relatively large water areas, which seem especially attractive to Canada geese. Personnel of the Montana

Department of Fish, Wildlife, and Parks began flying aerial surveys in 1966, approximately 2 years after the construction of the reservoirs (R. Trueblood, pers. comm.). The purpose of the flights was to determine the number of breeding pairs of Canada geese utilizing the area and the number of young geese produced. Since these flights were initiated, the trend has been toward an increasing number of breeding pairs (Table 17). However, goose production on the area has been very erratic. There also was no apparent correlation between the number of geese produced and precipitation or deviation from normal precipitation.

Table 17. Production history for Canada geese in south Valley County, Montana.

Year	Breeding pairs	Young produced	Precipitation Nov.-April (mm)	Deviation from the normal (mm)
1966	4	10	40.1	-45.7
1967	9	6	84.6	-1.3
1968	9	35	42.4	-43.4
1969	16	15	101.6	15.7
1970	12	3	68.1	-17.8
1971	13	2	67.1	-18.8
1972	16	30	70.6	-15.2
1973	14	7	56.6	-29.2
1974	15	24	78.5	9.7
1975	19	0	70.1	6.9
1976	17	23	52.8	-10.4
1977	27	19	34.5	-28.7
1978	27	36	62.2	-1.0

Bowdoin National Wildlife Refuge is located in Phillips County, approximately 72 km northwest of the study area, in south Valley County. Breeding pair and production data for Canada geese from Bowdoin are presented in Table 18. The number of breeding pairs recorded on Bowdoin since 1965 has averaged about 247 with a range from 200 to 359. These data suggest a saturated breeding population, where all available nesting areas are utilized, depending on the water conditions on the area for a given year. Production from this base population has fluctuated considerably from year to year, probably reflecting yearly breeding habitat conditions. This apparent saturation of breeding habitat provides a condition whereby pioneering into unoccupied habitat may occur. Evidence of exchange between Bowdoin and surrounding reservoirs was presented by Atwater (1959).

When Canada geese first arrived in south Valley County in late March 1979, distribution was on open water on larger reservoirs. Although some geese later dispersed to smaller reservoirs, the majority remained on the larger.

Damage to the dike on Itchina Reservoir in 1978 produced less than ideal water conditions for waterfowl. Repair of the dike in August 1978 restored the water level for the 1979 breeding season. Severe erosion of the dike on Gutshot Reservoir in August 1978 caused it to be dry and unavailable to waterfowl in 1979. Triple Crossing Reservoir was drained by the BLM for maintenance in early 1979 and was

Table 18. Production history for Canada geese on Bowdoin National Wildlife Refuge, Phillips County, Montana.

Year	Breeding pairs	Young produced
1965	268	740
1966	359	706
1967	201	640
1968	250	725
1969	267	750
1970	276	506
1971	219	500
1972	310	425
1973	--	500
1974	200	600
1975	229	618
1976	200	700
1977	200	224
1978	247	576

also unavailable to waterfowl that year. This large detention reservoir, at the junction of the North, Middle, and South Forks of Lone Tree Creek, is the major water body nearest to the study area.

Physical and production data on reservoirs exhibiting Canada goose activity are presented in Table 19. Detention reservoirs collect large amounts of water during the spring run-off and release the water slowly, reducing the amount of soil erosion. The function of retention reservoirs is to collect water in the spring and keep it available for as long as possible during the season.

Table 19. Physical and production data on reservoirs exhibiting Canada goose activity in south Valley County, Montana.

Reservoir	Type	Age (years)	Area (ha)	Shoreline length (m)	Shoreline development	Secchi disc reading (cm)
Grub	det	14	68.6	7687	2.61	15
Arrambide	det	22	23.8	2400	1.38	20
Jim	det	14	23.9	3012	1.73	12
Itchina	ret	22	13.2	1897	1.47	12
Nod	ret	12	3.4	1428	2.18	57
Gutshot	det	13	10.0	2812	2.50	--
Horny	det	12	3.2	990	1.56	46
Whitetail	det	13	4.9	1299	1.64	40
Hard Rock	det	13	4.3	1218	1.66	28
Triple Crossing	det	17	--	--	--	--

Reservoir	% shoreline slope >30°	Islands	% submerged vegetation	% emerged vegetation	Pairs 1979	Broods 1978 1979	Total geese produced 1978 1979
Grub	30	9	0	4	5	6 5	26 20
Arrambide	30	4	2	7	2	2 0	9 0
Jim	50	0	0	7	0	2 0	6 0
Itchina	40	4	0	26	1	0 1	0 5
Nod	30	0	61	8	1	0 1	0 3
Gutshot	20	0	0	15	1	0 0	0 0
Horny	50	0	20	15	1	0 0	0 0
Whitetail	35	0	20	16	1	0 0	0 0
Hard Rock	20	0	0	32	1	0 0	0 0
Triple Crossing	35	8	--	--	0	2 0	7 0

Reservoirs showing goose activity were all less than 22 years old, with 70% of the reservoirs 14 years old or less. These reservoirs ranged from 3.2 ha to 68.6 ha with an average area of 17.2 ha. Nesting islands were present on 40% of the reservoirs. Water turbidity was high on the larger reservoirs and was related to the rapid siltation of their basins. The high water turbidity was also reflected by the low percentages of submerged vegetation.

In 1978, all of the geese produced occurred on reservoirs greater than 23 ha in area and 87% of the geese produced occurred on reservoirs with islands. Broods produced and reservoir size show strong correlation.

Of the breeding pairs utilizing reservoirs in 1979, 69% selected reservoirs 10 ha or greater in area with pond perimeters over 1800 m. Significant correlation is seen between breeding pairs and pond area and perimeter. Reservoirs with islands were utilized by 62% of the pairs. Reservoirs greater than 13 ha in area with islands present contained 89% of the broods produced. Correlation between breeding pairs and other physical and vegetational characteristics were not apparent. One goose brood was produced on Nod Reservoir, which is 3.4 ha and has no islands. The clutch was located on a narrow peninsula and in late June 1979 produced 3 goslings with 3 eggs unhatched. This late hatching date suggested a renesting attempt by the pair.

Five Canada goose nests were located in 1979. Two of the nests were located on islands and three were located on peninsulas. Four of the five nests were successful with one island nest being flooded.

DISCUSSION AND RECOMMENDATIONS

South Valley County is in the Eastern Sedimentary Plains geographical area and, as such, lacks the "natural" potholes of glaciated south Phillips County, immediately to the west. Thus, the water bodies in Valley County are restricted almost entirely to man-made basins.

Differences in vegetative coverage between the two areas are also evident. The percentages of bare ground in upland vegetative cover in south Valley County were 1.5 and 2.3 times greater, respectively, than Rundquist (1973) and Hudson (1980) reported in Phillips County.

Notable differences in waterfowl densities also exist between these counties. Habitat features, which influence the number of breeding pairs utilizing a pond in south Valley County, were similar to other waterfowl studies. The importance of pond size on the number of breeding pairs per pond has been presented by Lokemoen (1973), Evans and Black (1956), and Hudson (1980) and is evident in this study. However, the total length of shoreling seemed to have the greatest influence on the number of breeding pairs per pond. Behavioral spacing mechanisms disperse the pairs almost uniformly over all available habitat (McKinney 1965, Dzubin 1969, and Patterson 1976). This is supported in south Valley County by the insignificant differences in breeding pairs per 100 m of shoreline. Regardless of any other

habitat feature, the number of breeding pairs per 100 m of shoreline remained essentially the same.

Although many of the same habitat features influence duck populations, significant differences are apparent between breeding pair densities in south Valley and Phillips counties. In this study breeding pairs per ha of water were 66% and breeding pairs/100 m of shoreline 69% of similar data gathered on a sagebrush-grassland unit in Phillips County (Rundquist 1973). During the same time period and similar water conditions, breeding pairs per ha were 44% and breeding pairs/100 m of shoreline 42% of densities reported in Phillips County (Hudson 1980).

Habitat characteristics influencing brood use on stockponds were similar to those found in other studies. Pond size, shoreline length, shoreline development, turbidity, submerged vegetation and distance to the nearest pond are habitat features which influenced brood production in south Valley County. Brood production per pond was highest on larger ponds. Hudson (1980) found that larger ponds offered more brood security than smaller ponds. Shoreline length and shoreline development also influenced brood production. As shoreline length and shoreline development increased, the number of broods produced increased. Patterson (1976) reported a similar relationship of shoreline length to brood numbers and indicated that it was related to the behavioral requirements of broods for escape cover. Hudson (1980)

found that ponds with high shoreline development ratios supported high brood densities, possibly in response to the availability of escape cover.

Brood numbers were highest on ponds with the least water turbidity in south Valley County. Lokemoen (1973) also found broods to be less numerous on turbid ponds. Brood densities were also higher on ponds with greater percentages of submerged vegetation. The relationship between brood densities and the availability of food in a reservoir are well documented (Patterson 1976, Gjersing 1971, Hudson 1980). Brood densities increased as the distance between ponds decreased on the study area. Lokemoen (1973) reported a similar relationship between brood use and the distance between ponds.

A comparison between brood densities in south Valley and Phillips counties shows a trend similar to breeding pair densities. Broods per ha in this study were 28% and 16% of data reported by Rundquist (1973) and Hudson (1980), respectively. In Phillips County, broods per 100 m of shoreline were 22% of those found by Hudson (1980).

Even though breeding pair and brood densities are lower in Valley than in Phillips County, species representation between the two areas is comparable. The eleven species of ducks found producing broods on my study area were the same as those reported from a sagebrush-grassland habitat in Phillips County (Rundquist 1973, Mundinger, 1976). Also, habitat features influencing breeding pair and brood densities

are similar between the two areas. However, the differences in breeding pair densities and brood production reflect the inferior habitat conditions for waterfowl in south Valley compared to Phillips County. Even though the similarity in species representation between the two areas suggests a common habitat diversity relative to the parameters measured on the more permanent stockponds, the comparative absence of natural potholes in Valley County compared to Phillips may have contributed to a lesser overall habitat diversity and waterfowl productivity in Valley County. Therefore, if limited funds are available for waterfowl habitat improvements, these funds may be better spent in areas with higher potential for production than south Valley County.

Most of the duck species breeding in the prairie pothole region now occur as breeders on stockpond habitat in northern Montana. In this study and other recent studies on stockpond habitat (Mundinger 1976, Hudson 1980) 10 to 12 species have been observed to produce young. Early studies in this habitat type listed 6 and 7 species (Bue et al. 1952, Smith 1953), all of which were of the more adaptable dabbling group (Hochbaum 1959). In this study, diver broods were represented by lesser scaup, redheads, canvasbacks, and ruddy ducks.

In addition to an increase in species representation in stockpond habitat, a change in numerical importance of some species appears to be occurring. The American wigeon, which was not included by

Smith (1953) in the three major brood producing species, produced 60% of the broods on my study area and 42% on Rundquist's (1973) sagebrush-grassland area. Gjersing (1971) in Phillips County observed lesser scaup as the sole diving duck representative among the breeding pairs in 1969 and a brood of that species was first recorded that year. Lesser scaup made up 10% of the breeding pairs in my study and broods of divers comprised 11% of the total.

Canada geese in south Valley County are attracted to the larger detention reservoirs in the spring. Some outward movement from these to smaller reservoirs occurs but utilization of these smaller reservoirs is currently minimal. Significant siltation is occurring on the larger reservoirs and thus will render them unavailable to Canada geese for nesting in the near future.

Selection of reservoirs by geese for nesting and brood production was significantly greater on reservoirs with nesting islands. The importance of islands for breeding Canada geese was reported by McCarthy (1973), Hook (1973), Hamilton (1978), Lorang (1979), and Eng et al. (1979). Efforts should be made to draw Canada geese away from the large detention reservoirs to more permanent smaller reservoirs. Nesting platforms and islands strategically placed in smaller reservoirs could increase and stabilize goose production before the larger detention reservoirs disappear through siltation.

Even though waterfowl breeding pair and brood densities in south Valley County are relatively low, species representation is comparable to other areas. Maintenance of habitat conditions already present in south Valley County should be of major concern. Grazing on this study area did not follow a rest-rotation system. A three pasture plan was considered but was not in effect at the time of this study. Proper implementation of a rest-rotation grazing system would help preserve and possibly improve vegetative characteristics in the area. This in turn would enhance waterfowl production (Gjersing 1971, Munding 1976).

Maintenance of dikes on reservoirs will assure more consistent water areas and permit maturing to improved waterfowl habitat (Hudson 1980). Fencing portions of a reservoir is expensive and in this study, in the absence of persistent maintenance, was ineffective in excluding cattle and developing shoreline vegetation for nesting cover. Even if cattle are excluded, a small plot of nesting cover may be attractive to nesting ducks and predators alike with no overall increase in waterfowl production (Keith 1961). Funds for this effort may better be expended in the construction of additional water areas, mammal free islands or the upkeep of existing reservoirs.

APPENDIX

Table 20. Type, location description, age, area, and 1978 and 1979 duck broods for each study reservoir in south Valley County, Montana.

Reservoirs	Type	Location	Age (years)	Area (ha)	Broods* 1978	Broods@ 1979
Odin	ret	T25N, R35E, Sec. 8, NW $\frac{1}{4}$, SW $\frac{1}{4}$	14	2.1	5	4
ULT	det	T25N, R35E, Sec. 1, SW $\frac{1}{4}$, NE $\frac{1}{4}$	12	7.5	2	0
Summer	ret	T26N, R35E, Sec. 26, SE $\frac{1}{4}$, NW $\frac{1}{4}$	14	1.4	0	0
Clover	det	T26N, R35E, Sec. 9, SW $\frac{1}{4}$, NE $\frac{1}{4}$	12	2.1	4	5
Dividend	ret	T26N, R36E, Sec. 32, NE $\frac{1}{4}$, SE $\frac{1}{4}$	14	1.9	0	5
Horny	det	T26N, R35E, Sec. 27, SW $\frac{1}{4}$, NE $\frac{1}{4}$	12	3.2	3	5
Blinkum-Horny	ret	T26N, R35E, Sec. 27, SW $\frac{1}{4}$, NE $\frac{1}{4}$	12	.9	4	5
Blinkum	ret	T26N, R35E, Sec. 27, SW $\frac{1}{4}$, NE $\frac{1}{4}$	14	1.8	2	3
Finale	det	T25N, R35E, Sec. 9, NE $\frac{1}{4}$, SE $\frac{1}{4}$	15	4.1	7	4
Fawn	ret	T26N, R35E, Sec. 15, SW $\frac{1}{4}$, SW $\frac{1}{4}$	15	1.5	2	0
Back	ret	T26N, R35E, Sec. 21, NW $\frac{1}{4}$, NE $\frac{1}{4}$	14	1.5	2	3
Arrambide	det	T26N, R36E, Sec. 1, NE $\frac{1}{4}$, NE $\frac{1}{4}$	22	23.8	1	4
Nod Drop	det	T26N, R35E, Sec. 22, SW $\frac{1}{4}$, SE $\frac{1}{4}$	--	2.2	0	0
Nod	ret	T26N, R35E, Sec. 27, NW $\frac{1}{4}$, NW $\frac{1}{4}$	12	3.4	1	5
S.O.B.	det	T26N, R35E, Sec. 28, NE $\frac{1}{4}$, NE $\frac{1}{4}$	12	3.2	0	2
Itchina	ret	T26N, R37E, Sec. 17, SE $\frac{1}{4}$, NW $\frac{1}{4}$	22	13.2	0	2
Ruins	det	T25N, R35E, Sec. 9, NE $\frac{1}{4}$, NW $\frac{1}{4}$	13	1.3	3	2
Top Rail	ret	T26N, R35E, Sec. 35, NW $\frac{1}{4}$, SW $\frac{1}{4}$	14	5.0	0	1
Hard Rock	det	T26N, R35E, Sec. 24, SE $\frac{1}{4}$, NW $\frac{1}{4}$	13	4.3	5	7
Whitetail	det	T25N, R36E, Sec. 5, NE $\frac{1}{4}$, NW $\frac{1}{4}$	13	4.9	6	3
Hook	ret	T25N, R35E, Sec. 11, NW $\frac{1}{4}$, NW $\frac{1}{4}$	14	.3	0	0
Grub	det	T26N, R37E, Sec. 2, NW $\frac{1}{4}$, NE $\frac{1}{4}$	14	68.6	0	--
W.B.	ret	T26N, R35E, Sec. 34, SW $\frac{1}{4}$, SW $\frac{1}{4}$	24	1.1	1	2
Hawk	ret	T25N, R35E, Sec. 8, SE $\frac{1}{4}$, NE $\frac{1}{4}$	14	.4	2	1
Deer	ret	T25N, R35E, Sec. 5, SE $\frac{1}{4}$, SE $\frac{1}{4}$	14	.9	0	0
Tom	ret	T25N, R35E, Sec. 4, NE $\frac{1}{4}$, NW $\frac{1}{4}$	14	.8	1	2
Shag	ret	T25N, R35E, Sec. 5, SE $\frac{1}{4}$, NE $\frac{1}{4}$	14	1.2	0	1
Firebrand	ret	T26N, R35E, Sec. 32, NW $\frac{1}{4}$, SE $\frac{1}{4}$	14	.2	0	0
Winkum	ret	T26N, R35E, Sec. 29, NE $\frac{1}{4}$, SE $\frac{1}{4}$	14	3.7	4	4
Bend	det	T26N, R36E, Sec. 18, SW $\frac{1}{4}$, NW $\frac{1}{4}$	12	4.3	5	6
Nine Mile	ret	T26N, R35E, Sec. 13, SE $\frac{1}{4}$, SE $\frac{1}{4}$	--	1.2	1	5
Foul Weather	det	T26N, R35E, Sec. 23, SW $\frac{1}{4}$, SE $\frac{1}{4}$	12	3.1	1	0
Jim	det	T26N, R36E, Sec. 10, NE $\frac{1}{4}$, NE $\frac{1}{4}$	14	23.9	0	0
Triple Crossing	det	T26N, R36E, Sec. 29, SE $\frac{1}{4}$, NW $\frac{1}{4}$	17	--	3	0
Gutshot	det	T26N, R37E, Sec. 34, SW $\frac{1}{4}$, SE $\frac{1}{4}$	13	--	3	0

* resident + transient broods

@ resident broods

Table 21. Vertebrates other than waterfowl commonly observed on the study area in south Valley County.

leopard frog (<i>Rana pipiens</i>)
bull snake (<i>Pituophis catenifer</i>)
plains garter snake (<i>Thamnophis radix</i>)
prairie rattlesnake (<i>Crotalus viridis</i>)
western grebe (<i>Aechmophorus occidentalis</i>)
horned grebe (<i>Podiceps auritus</i>)
eared grebe (<i>Podiceps caspicus</i>)
pieb-billed grebe (<i>Podilymbus podiceps</i>)
white pelican (<i>Pelecanus erythrorhynchos</i>)
marsh hawk (<i>Circus cyaneus</i>)
Swainson's hawk (<i>Buteo swainsoni</i>)
golden eagle (<i>Aquila chrysaetos</i>)
sparrow hawk (<i>Falco sparverius</i>)
sharp-tailed grouse (<i>Pedioecetes phasianellus</i>)
sage grouse (<i>Centrocercus urophasianus</i>)
great blue heron (<i>Ardea herodias</i>)
American bittern (<i>Botaurus lentiginosus</i>)
American coot (<i>Fulica americana</i>)
American avocet (<i>Recurvirostra americana</i>)
killdeer (<i>Charadrius vociferus</i>)
spotted sandpiper (<i>Actitis macularia</i>)
willet (<i>Catoptrophorus semipalmatus</i>)
ring-billed gull (<i>Larus delawarensis</i>)
mourning dove (<i>Zenaidura macroura</i>)
short-eared owl (<i>Asio flammeus</i>)
common nighthawk (<i>Chordeiles minor</i>)
western meadowlark (<i>Sturnella neglecta</i>)
yellow-headed blackbird (<i>Xanthocephalus xanthocephalus</i>)
red-winged blackbird (<i>Agelaius phoeniceus</i>)
vesper sparrow (<i>Poocetes gramineus</i>)
lark bunting (<i>Calamospiza melanocorys</i>)
muskrat (<i>Ondatra zibethica</i>)
whitetail jackrabbit (<i>Lepus townsendi</i>)
pronghorn antelope (<i>Antilocapra americana</i>)
mule deer (<i>Odocoileus hemionus</i>)

Table 22. Species composition of waterfowl broods in south Valley County, Montana, 1978.

Species	No. of broods*
wigeon	32
mallard	8
blue-winged teal	1
pintail	7
gadwall	2
green-winged teal	1
shoveler	0
lesser scaup	8
ruddy duck	3
redhead	0
canvasback	1

* resident + transient broods

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