MONTANA STATE UNIVERSITY

Habitat requirements of molting Canada geese at Lima Reservoir, Montana

by Bernard Dewey Hildebrand

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Range Science
Montana State University
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Abstract:
Habitat relations of molting Canada geese Branta canadensis moffitti were studied at Lima Reservoir in southwestern Montana during 1977-78. Molters started arriving in mid-May and reached peak numbers by mid-June. The majority of these geese were flightless seven to ten days after arrival. Habitats selected while molting were large water areas and uplands. Following molt completion a shift to the exposed mud flats occurred. No competition between geese and livestock was detected. This population breeds primarily in Idaho and Utah and winters in California. These geese maintain small groups with strong cohesion. The groups had a high fidelity for their particular small area of the reservoir. Droppings were highly negatively correlated to the distance from the high water line and 20% of the transects had heavy use. Geese carrying capacity of Lima Reservoir was computed and will be reached when the flock numbers 15,000. Unrestricted vision is a requirement for feeding sites. Goose hunters spent more time and got fewer birds than duck hunters. Most hunters were aware of land ownership and the majority of these were hunting on BLM land.

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GEESE AT LIMA RESERVOIR, MONTANA

by

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of the requirements for the degree

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Habitat relations of molting Canada geese Branta canadensis moffitti were studied at Lima Reservoir in southwestern Montana during 1977-78. Molters started arriving in mid-May and reached peak numbers by mid-June. The majority of these geese were flightless seven to ten days after arrival. Habitats selected while molting were large water areas and uplands. Following molt completion a shift to the exposed mud flats occurred. No competition between geese and livestock was detected. This population breeds primarily in Idaho and Utah and winters in California. These geese maintain small groups with strong cohesion. The groups had a high fidelity for their particular small area of the reservoir. Droppings were highly negatively correlated to the distance from the high water line and 20% of the transects had heavy use. Geese carrying capacity of Lima Reservoir was computed and will be reached when the flock numbers 15,000. Unrestricted vision is a requirement for feeding sites. Goose hunters spent more time and got fewer birds than duck hunters. Most hunters were aware of land ownership and the majority of these were hunting on BLM land.

INTRODUCTION

The Intermountain population of Canada geese "occupies the marshes and streams channels interspersed among the mountain ranges and basins of the far west" (Bellrose 1976). This population is made up primarily of the race referred to as the Great Basin Canada goose *Branta canadensis moffitti* (Hanson 1965).

Numerous studies have been conducted on various aspects of the bird's life history; including renesting (Atwater 1959), breeding age (Craighead and Stockstad 1964), hunting pressure (Craighead and Stockstad 1956, Tautin and Low 1975), nesting and production (Childress 1971, Geis 1956, Hook 1973, and Steel et al. 1957) and management (Dimmick 1968, and Krohn 1977). However, little information has been published relative to the molt migration or molting areas utilized by this bird.

This study was conducted to investigate a population segment of non-breeding Great Basin Canada geese during the summer molt. The study was conducted on Lima Reservoir, Montana. It was designed to relate the number of geese and their chronology to habitat utilization and determine responses to other land uses.

LITERATURE REVIEW

"The process of natural feather loss (shedding) and replacement is called molting" (Palmer 1972). In this process old feathers are forced out of the follicles by the growth of the new feathers (Payne 1972).

All birds molt at least once, many species twice and a few three times a year. Molts are not necessarily complete each time. Most birds molt their remiges (wing flight feathers) once a year. Depending on the species of birds involved, flight feathers will be molted on one of two ways. They may be molted serially, where corresponding feathers on opposing wings are lost singly so that the bird never loses flight, or all the remiges may be molted simultaneously, as is found in the family Anatidae (ducks, geese and swans). Several other unrelated groups have one common characteristic that of utilizing an aquatic habitat which provides security during this flightless period (Van Tyne and Berger 1976).

MOLT MIGRATION

Several species of ducks, geese and swans have been reported to participate in molt migration, a post-breeding movement to a site which is often used exclusively by molting birds (Oring 1964, Mathiasson 1973, Ogilvie 1978). Oring (1964) suggested a southward molt migration for ducks while Ogilvie (1978) stated that nine of 14 goose species have a northward migration. Sterling and Dzubin (1967) recorded a northward molt migration for Canada geese.

TYPE OF MOLT MIGRATION

Two types of migration have been reported for geese. The most common involves the birds first returning to the breeding areas, from which a segment of the population later migrates to the molting areas. The second type involves immature geese migrating directly from the wintering area to the molting area (Ogilvie 1978).

BASIS FOR MOLT MIGRATION

Hardy (1966), Sterling and Dzubin (1967) Salomonsen (1968) and Ogilvie (1978) all have suggested that the molt migration is an adaptation to reduce competition between non-breeders and the adults with young for the available food on the breeding ground. Ogilvie (1978) suggested that geese utilizing molting areas to the far north use habitat and food resources that, because of the latitude and resulting short season, were less suitable for the activities of breeding birds. He also believed that requirements of a molting area were more likely to be found in the far north. These basic requirements include large areas of suitable water which provides safety and little disturbance (Salmonsen, 1968).

MOLT MIGRATION TIMING

Timing of the molt migration from the breeding grounds appears to vary among locations. Dimmick (1968), reported geese leaving Jackson Hole, Wyoming in June. Krohn (1977) in discussing the Rocky Mountain Canada goose population, stated that geese left the breeding areas on molt migration in late May to early June. Surrendi (1970) reported that geese departed for molting areas from southeastern Alberta by late May. Derksen et al. (1979), working north of the Brooks Mountain Range in Alaska, noted that Black Brant, *Branta nigricans*, migrated to molting areas in late June and early July. Sterling and Dzubin (1967) recorded Canada geese arriving on molting areas along the Thelon River in the Northwest Territories in mid-June.

MOLTING FLOCK COMPOSITION

As implied by Derksen et al. (1979), molting populations are made up of "small flocks that probably are family units or multiples thereof." Thus, each of these groups "may be a distinct segment of a flyway or sub-flyway population" (Sterling 1963).

AGE STRUCTURE OF MOLTERS

Only unsuccessful breeders and non-breeders or subadults participate in the molt migration (Sterling 1963, Sterling and Dzubin 1967, Dimmick 1968, Salomonsen 1968). Sterling (1963) defined non-breeding geese as yearlings and some two-year-olds. Krohn (1977) reported that molting flocks were comprised of 65 percent yearlings, 20 percent two-year-olds and 15 percent three-year-olds and older geese. He also stated that a portion of the three-year-olds and older birds were successful breeders that had lost their broods to more dominant pairs.

SEX RATIO OF MOLTERS

Sterling and Dzubin (1967) reported a male:female ratio of 111:100. King and Hodges (1979) reported that over a four-year period, males averaged 54.1% of a molting flock of White-fronted geese, *Anser albifrons*, and over a seven year period, 52.6% for Black Brant. However, these percentages varied greatly among years. Conversely, Arenson (1970), in Utah reported that females outnumbered males by 6%.

With respect to timing, Mathiasson (1973) indicated there was a distinct tendency in Mute swans, *Cygnus olor*, for females to start molting later than males. Salomonsen (1968) reported that in geese, the female initiated the molt approximately one week earlier than the male.

LENGTH OF FLIGHTLESS PERIOD

Hansen et al. (1971) noted that loss of flight in Trumpeter swans, *Olor buccinator*, occured following the molt of a few secondaries and the alula. Length of the flightless period for these swans was the same for both breeders and non-breeders: about 30 days after the loss of the primaries. Sterling and Dzubin (1967) believed the flightless period of the Canada geese in the Thelon drainage was about 25, but no more than 30, days. The length of time required to complete the molt varies with individuals; an entire population may require five or six weeks (Williams 1967, Dimmick 1968). MacInnes (1966) speculated that the smaller forms of Canada geese may complete the molt in a shorter period than the larger forms.

HABITAT REQUIREMENTS

During the molt, flightless geese are very wary (Hardy 1966), and some authors believe areas with sufficient food and large expanses of open water, which provide protection from predation and harassment, are prime requirements for molting (Krohn and Bizeau 1979, Dersen et al. 1979, Salomonsen 1968). Bergman (1973) found similar requirements for redhead, *Aythya americana*, and canvasback, *Aythya valisineria*, molting areas, and indicated that use of molting areas by redheads was related to the degree of isolation from human activity. Arneson (1970), from studies at Neponset Reservoir, Utah and Woodruff Narrows Reservoir, Wyoming, concluded that isolation did not appear to be an important factor in selection of a molting area by geese. Neponset was built first, and is more isolated and less frequented by man than Woodruff Narrows. With the construction of Woodruff there was a shift of molting geese from Neponset to Woodruff. This shift was attributed to a "greater area of open water and more suitable vegetation." Krohn (1977) presented a possible alternative explanation: that the geese were forced from Neponset, because of consecutive years of banding, to Woodruff where human use was greater but actual harassment was less. Sterling and Dzubin (1967) found that Canada geese have a strong fidelity to molting areas in subsequent years but a change can be induced by continual harassment. In the summer of 1963, 600 of 2,000 molters were captured and banded at the Thelon Island site. The following year only 1,000 molters remained and 300 refused to be driven near the traps. In 1965, the third consecutive year only 275 birds were at the site and all refused to be driven. Coinciding with this reduction of numbers in this area was an equivalent increase at another area 20 miles away. So, as Krohn (1977) has stated, "the degree of harassment, and not isolation as such, is probably one of the most critical factors influencing geese in the selection of their molting areas."

LIVESTOCK INTERFERENCE

Many farmers in England believe that sheep and cattle will avoid fields which have large amounts of goose droppings (Ogilvie 1978). However, Rochard and Kear (1970) found that sheep only avoid goose droppings that are fresh (less than 24 hours old). The avoidance by sheep of fresh goose droppings is beleived to be related to the amount of uric acid in the droppings. Once the uric acid has evaporated the livestock become indifferent to the droppings. In some areas stock have been known to eat droppings, probably to fill the need for some trace elements (Ogilvie 1978). Arneson (1970) found that there was little competition for grass between cattle and geese. He did find that areas where cattle watered were avoided by geese because of hoof marks. However, the amount of shoreline that was utilized by cattle in this manner was insignificant.

MORTALITY

Mortality of birds on the molting grounds is believed to be slight. In Mathiasson's (1973) study with Mute swans no evidence of mortality was observed. Dimmick (1968), in Wyoming, noted only one incidence of mortality in molting Canada geese: one was caught by a coyote, Canis latrans, while attempting to hide from the observer.

Ogilvie (1978) suggested that the molting population of Canada geese at Yorkshire, England suffers a higher mortality than birds of equal age that remain on the breeding grounds. He implied that molters making a double journey would entail more risk than those staying at the breeding grounds. The difference in mortality rates was significant: 23% for molt migrators compared to ten percent for non-migratory geese. These mortality rates are contrary to Krohn and Bizeau's (1979) findings that the Rocky Mountain Canada goose population experiences a higher mortality rate on breeding grounds (34%) than on molting areas (30%).

For whatever reason, the molt migration must have a selective advantage or it would have been eliminated by natural selection (Krohn 1977).

DESCRIPTION OF STUDY AREA

Lima Reservoir is located in the west portion of the Centennial Valley, 22 Km (14 mi) east of Lima in Beaverhead County, Montana (Figure 1).

The Centennial Valley lies in a broad east-west trough, bounded by faults. The north face of the Centennial mountain range to the south is a continuous series of echelon faults, while on the north, a series of faults lies along the front of the Gravelly mountain range (Banko 1960). Along the front and to the east of Lima Reservoir, there is evidence of a much dryer period in recent geologic time with the presence of many square kilometers of barchan sand dunes that are now stabilized by vegetational cover (Banko 1960). This valley is drained by the Red Rock river which has a very moderate gradient.

Brower (1896) noted that the first attempt at building Lima Dam on the Red Rock River was unsuccessful. A later attempt resulted in the dam being completed in 1902 (United States Geological Survey 1977). Around 1934 this dam was washed out and was reconstructed with an additional ten feet added to the crest.[1] The present dam is earth filled with a concrete spillway. The usable capacity of Lima Reservoir is $103.4h^3$ (84,050 acre-feet). The elevation

[1]Per. comm. Mrs. Leonard Starks

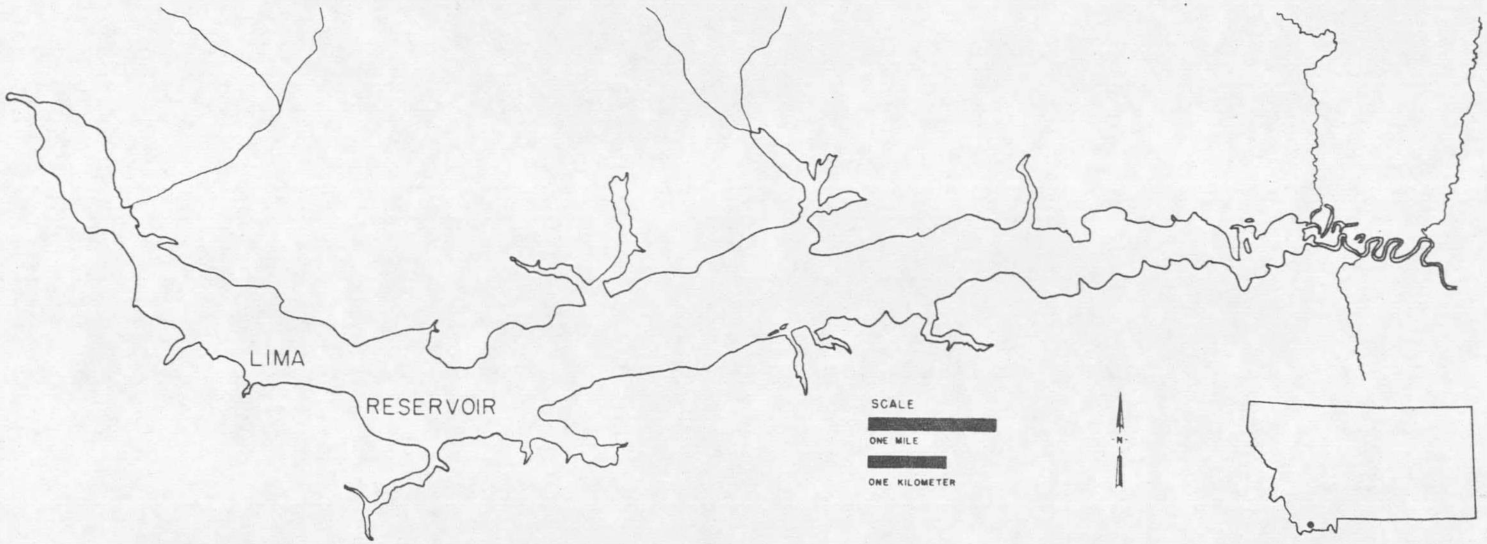

Figure 1. Study Area

at the spillway is 2,006.4m (6,582.7 ft) and at the tunnel bottom 1,992.6m (6,537.3 ft). Water level data are presented in Figure 2. The 15-year monthly averages from 1958 to 1972 show the extreme low water levels occurring in October ($32.4h^3$; 26,240 acre-feet) and the high in May ($74.2h^3$; 60,150 acre-feet). The reservoir is long (18.5km; 11.5 mi) and narrow (1.5km). Nine major bays contribute to a shoreline length of 82.7km (51.7 mi).

Climatological data for Lima, Montana show that from a 30 year average, June is the month of heaviest precipitation, and 68.3% of the yearly total occurs from April 1 to August 31 (Table 1). The monthly mean temperature is highest in July with 16.7°C (62.1°F) and lowest in January with -8.6°C (16.5°F).

A soil survey of the area surrounding Lima Reservoir was conducted for the Bureau of Land Management in 1977. Soils of the reservoir area were found to be Aridic Argiborolls-Cumulic Cryaquolls (BLM unpub. data).

Vegetational characteristics of the study area can be divided into two general zones: shrub-grasslands and riparian, with several community types. Some common shrubs and half-shrubs found on the study area are low sagebrush, *Artemsia arbuscula*, rubber rabbitbrush, *Chrysothamnus*

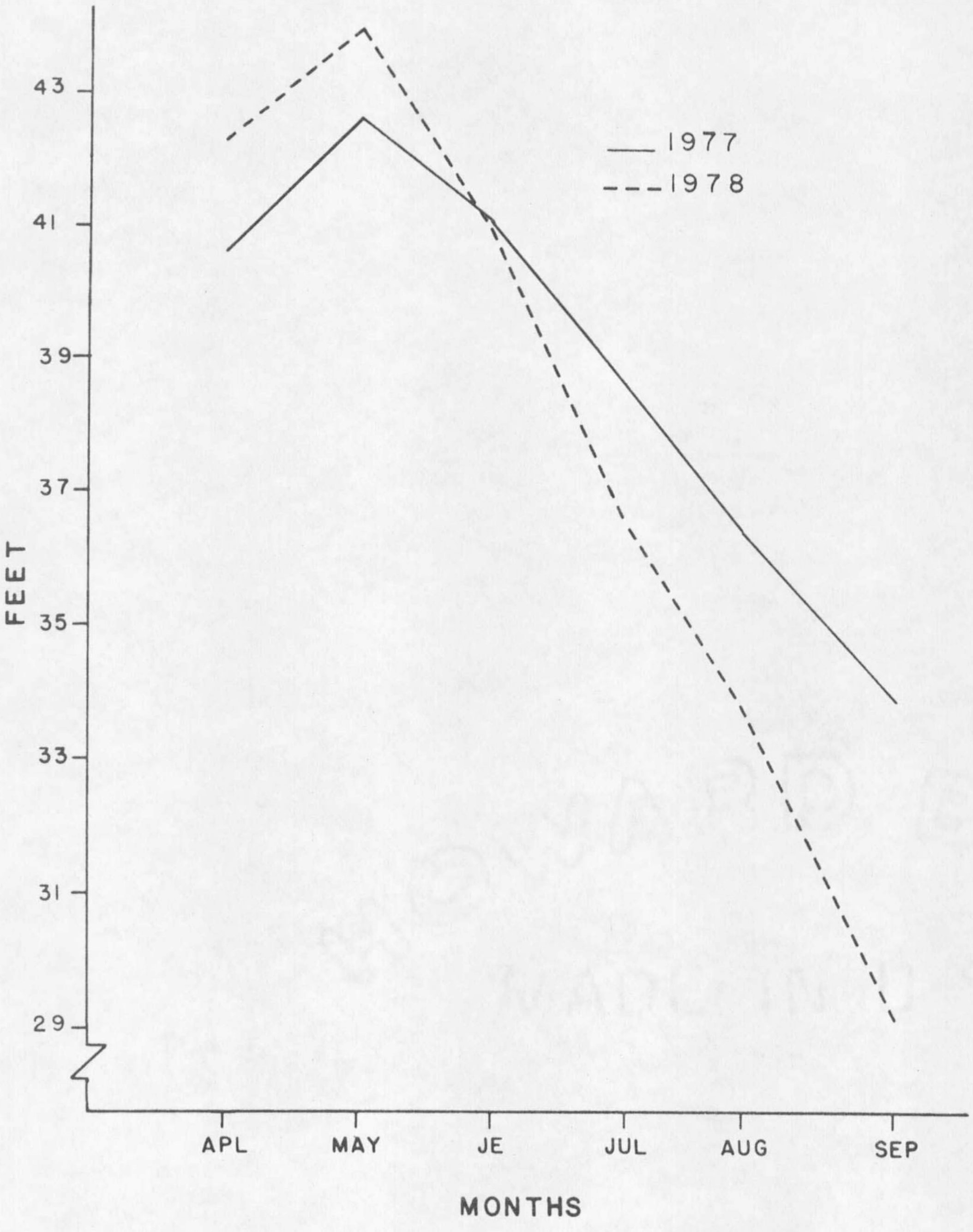

Figure 2. Water levels of Lima Reservoir for 1977 and 1978.

	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
Average Temperature (Degrees C)													
1977	-9.9	-3.3	-3.4	5.9	6.9	14.9	16.6	15.3	11.2	6.3	-2.0	-5.3	4.4
1978	-6.8	-6.1	0.1	4.5	7.0	12.9	16.2	14.9	11.1	7.1	-6.2	-13.1	3.5
Mean[1]	-8.6	-6.4	-3.4	3.2	8.1	12.0	16.7	15.9	11.2	5.8	-1.8	-6.9	3.8
Average Precipitation (Centimeters)													
1977	2.29	T	1.50	.30	9.75	4.83	7.57	3.96	5.31	.84	.18	1.73	38.26
1978	1.02	3.89	.23	4.47	7.54	3.28	3.73	.61	5.92	.51	1.37	2.31	34.80
Mean	.69	.66	1.27	2.29	4.78	6.02	2.79	1.68	2.69	1.68	.91	.84	27.57

[1]Based on the period 1941-1970

Table 1. Climatological Data – Lima, Montana – U.S. Department of Commerce, 1977 – 1978.

nauseous, winterfat, Ceratoides lanata, Nuttall's saltbush, Atriplex nutallii, and greasewood, Sarcobatus vermiculatus. Grasses and sedges common to the area are thickspike wheatgrass, Agropyron dasystachyum, Sandberg's bluegrass, Poa sandbergii, basin wildrye, Elymus cinereus, alkali saltgrass, Distichlis stricta, western needlegrass, Stipa occidentalis, foxtail barley, Hordeum jubatum, meadow barley, Hordeum brachyantherum, stream foxtail, Alopercurus aequalis, quackgrass, Agropyron repens, common spike-rush, Eleocharis palustris, and needle spike-rush, Eleocharis acicularis. Dominant forbs are silverweed cinquefoil, Potentilla anserina, biennial sagewort, Artemisia biennis, and rose pussytoes, Antennaria microphylla.

METHODS

Field work was conducted on a part-time basis from April 14, to June 14, 1977 and full-time from June 15 to September 23, 1977 and April 3, to October 13, 1978.

CENSUSES

All aerial censuses were conducted from a Piper Super Cub, except one which employed a Hughes 500 helicopter. Total counts and locations of ducks, geese and swans were obtained on these flights. In addition, observations of nesting birds, waterfowl broods, and other wildlife (white pelicans, *Pelecanus erythrorhynches*, sandhill cranes, *Grus canadensis*, and bald eagles, *Haliaeetus leucephalus*) were recorded.

With the aid of binolulars and a spotting scope, neck collars of geese banded elsewhere were identified. Ground counts were made to detect habitat use and activities of geese. Livestock (cattle, horses and sheep) locations and activities were also noted.

DROPPING COUNTS

Goose dropping counts were conducted for an index of use on sample areas and to determine the distance flightless geese fed from water. Counts were made by pacing a line perpendicular to the shore, beginning at the high water line. Each pace was considered 0.9m (35 in) in length. The width within which all droppings were counted was one meter (39 in). These data obtained were converted to droppings per square meter. Each line was extended until 15 consecutive paces did not reveal a dropping.

BANDING

A portion of this population was drive-trapped (Cooch 1953) for banding on June 20, 1978. Segments of this population had been banded in 1961 and 1962 by personnel of the Montana State Fish and Game Department and U.S. Fish and Wildlife Service. The records of these earlier banding activities were obtained from the U.S. Fish and Wildlife Service for analysis of recaptures, and direct and indirect recoveries.

VEGETATION

The vegetation of the study area was delineated into community types using color infrared aerial photography. Color transparancies were used for the small scale (1:31,680) photography while a color print mosaic was used for the medium scale (1:11,520) pictures. After community types were classified from the photographs, the areas were verified on the ground by canopy coverage analysis (Daubenmire 1959).

A cluster analysis was computed from these data (Sokal and Sneath 1963).

Twenty-three photograph plots were selected and permanently marked with steel fence posts in June 1977. Photographs were taken before cattle grazing in early summer and after a period of grazing in early fall of 1977 and 1978.

Clipping-plot exclosures were used to determine utilization during the grazing season of 1978. These exclosures were pyramidal in shape with a one meter square base, and were constructed of a 3/8 reinforcing frame, covered with one-inch mesh chicken wire. Three exclosures were located at each of four different plot areas. Three of these areas were selected because of heavy use by geese while the other acted as a control. Two of the areas heavily used by geese and the control were located in the sage-brush-grassland vegetation type, the most common upland community on the area. The other was located in a quackgrass type, an area that was unique to the reservoir. All vegetation was clipped at ground level and separated by species. Early clippings (July) were made after the geese had changed feeding sites from the upland to the exposed mud flats. The area inside each exclosure and a representative area that had been grazed were clipped concurrently. Exclosures were then placed in a previously grazed area with this procedure repeated in the fall (Sept.) to compare how much regrowth had occurred. Seedheads of Sandberg's bluegrass were counted for areas clipped to provide a relative index of vigor. All clippings samples were air dried in the field and then oven dried at 51°C (150°F) for 48 hours and weighed to the nearest hundredth of a gram. Topographic features and height measurements of low sagebrush were noted from areas receiving heavy use by geese.

Grasses, forbs, half-shrubs and shrubs of the study area were collected while in anthesis. Samples of this collection can be found at the Montana State University herbarium, the Bureau of Land Management herbarium in Dillon, Montana, and the Red Rock Lakes National Wildlife Refuge herbarium.

RECREATIONAL USE AND MISCELLANEOUS

Recreational activities pertaining to hunting and hunter harvest were evaluated from September 30 to October 7, 1978. Hunter check stations were operated on the two major access areas for the opening weekend of the waterfowl hunting season. Hunters were contacted in the field during the remainder of the week. Questions asked of hunters dealt with their awareness of land ownership, hours hunted, number of hunters in the party, bag, and their county of residency.

Two islands were constructed in the late fall of 1977 for goose nesting and were evaluated in 1978.

A bird species list was kept for 1977 and 1978.

RESULTS AND DISCUSSION

Lima Reservoir was not used by Canada geese as a molting area prior to 1934, when the addition of ten feet to the dam crest increased the surface area which may have attracted the molter.[2] Hall (1941) first recorded the use of Lima Reservoir as a waterfowl molting area. At present ducks, geese and swans utilize this area for molting.

AERIAL CENSUS

The first known census of molting Canada geese on Lima Reservoir was conducted by personnel of the United States Fish and Wildlife Service in Mid-July 1960 when over 5,000 geese were counted(Markly 1960). With approximately the same number present in 1962, personnel from the Montana Fish and Game Department and the U.S. Fish and Wildlife Service captured and banded 1259 Canada geese. By 1966 the population increased to 6500 (Vivion 1966). He later reported (Vivion 1968) a census figure of 8000 geese in 1967 while only 4000 were noted in 1968. No explanation for this reduction was given; however, as is shown in Table 2, timing of census could be very critical in obtaining valid trend counts. The population increased to 5000 the following year (Stroops 1969) and remained relatively stable through 1973, when 4500 were reported

[2] Per Comm. Mr. Blake Bean

Date	Ducks			Swans			Geese		
1977	River	Reservoir	Total	River	Reservoir	Total	River	Reservoir	Total
4/16	798	22,096	22,894	43	262	305	73	120	193
4/30	752	9,453	10,205	8	104	112	43	27	90
5/22	687	894	1,581	20	38	58	46	1,594	2,040
6/4	381	2,332	2,713	27	70	97	19(15)	9,211	9,245
7/11	445	8,191	8,636	34	71	105	239(11)	5,383	5,633
8/9	1,792	33,922	35,714	57(12)[b]	70	139	501[c]	1,966	2,467
9/10	1,253	35,072	36,325	43(16)	127(3)	189	23	300	323
1978									
4/24	704	11,570	12,274	20	75	75	23	67	90
5/21	286	753	1,039	51	44	95	47	1,409	1,456
6/16	399	2,482	2,881	35	96	131	9(14)	9,532(23)	9,578
7/18	1,093	15,196	16,289	14(12)	119(2)	147	429	3,933	4,362
8/24	2,713	12,499	15,211	46(9)	82	137	1	1,201	1,202
9/28	1,322	4,339	5,661	127(9)	32	168	77	433	510
10/5	746	5,025	5,771	131(9)	5	145	96	858	954

[a] Red Rock River surveyed from Red Rock Lakes National Wildlife Refuge boundary to Lima Reservoir

[b] Numbers in parenthesis represents juveniles

[c] 396 geese from areas not normally surveyed

Table 2. Aerial Census Data for Lima Reservoir and Red Rock River[a] for 1977-78.

(Stroops 1973). Census data for ducks, geese and swans for 1977-78 are presented in Table 2.

<u>Geese</u>

In 1977, the mid-April census probably included some migrant geese, while those in late April of both 1977-78 are believed to represent a segment of the Centennial Valley breeding geese (Figure 3). Peak numbers of molting Canada geese during both years occurred between early and mid-June. In mid-July of both years, increased use of Red Rock River was observed, presumably by geese that had completed the molt. Hardy (1966) attributed this apparent random flying to exercising the wing for the purpose of building up the wing muscles after the inactive period of the molt. Coincidental with the completion of molt was the initiation of a gradual decline of geese until September. This gradual reduction in numbers was also observed by Mathiasson (1973) working with molting Mute swans. The twofold increase in geese between late September (just prior to the start of waterfowl hunting season) and early October (just following the start of waterfowl hunting season) in 1978 is believed to be a response to hunting perssure at other areas. I observed an influx of Canada geese to the valley during the opening weekend of hunting season three different years.

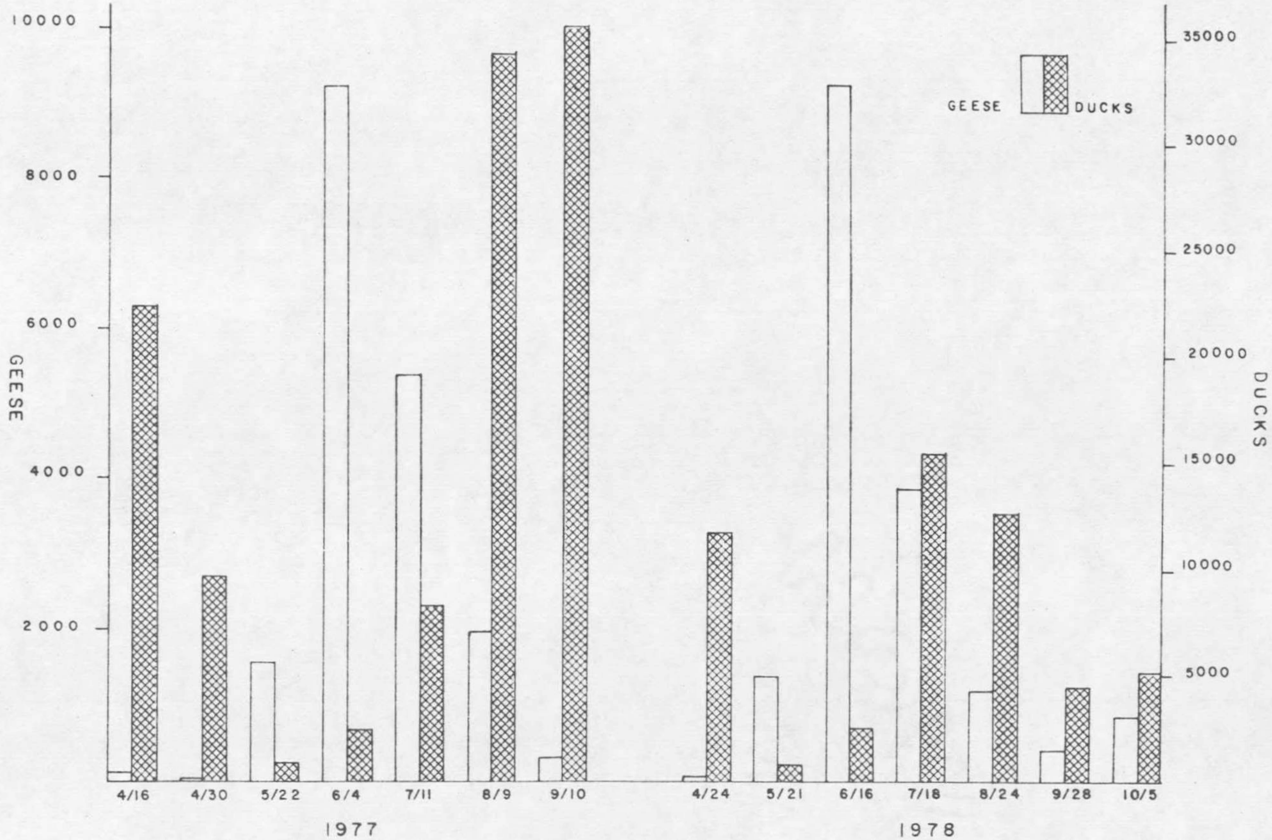

Figure 3. Ducks and geese census data from Lima Reservoir, 1977-78.

Swans

The high numbers of swans (Figure 4) recorded during the mid-April census of 1977, can be attributed to the presence of migrating whistling swans, Olor columbianus, Census data for May and June indicate a relatively stable number of trumpeter swans on the river, while an increase was observed on the reservoir with the arrival of the pre-molting birds. Only two pairs of swans with juveniles used the reservoir. One pair presumably moved down the river to the reservoir with two unfledged cygnets. A second pair was observed later with three fledged cygnets. Upon completion of the molt there was an increased number of swans in 1977 and a gradual decrease in 1978. The late September and early October censuses of 1978 revealed a definite trend, suggesting that swans moved from the reservoir to the river. The majority were found in Blake slough and adjacent river areas (Figure 5) where 78 and 92 percent were found on September 28 and October 5, respectively. This area seems to be an important staging area for swans prior to the shift to the spring fed ponds on Red Rock Lakes National Wildlife Refuge where these birds winter.

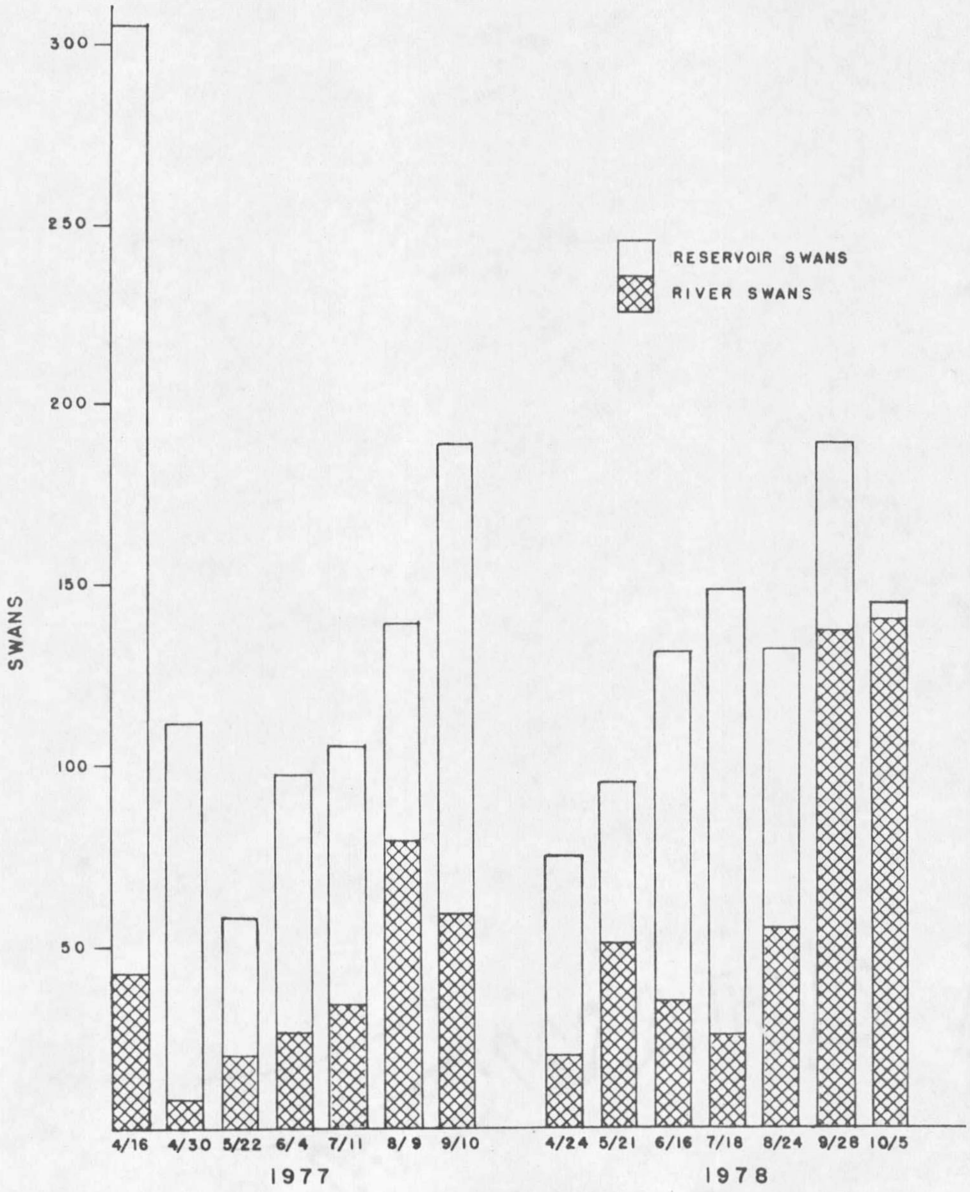

Figure 4. Trumpeter and Whistling swan census data from Red Rock River and Lima Reservoir, 1977-78.

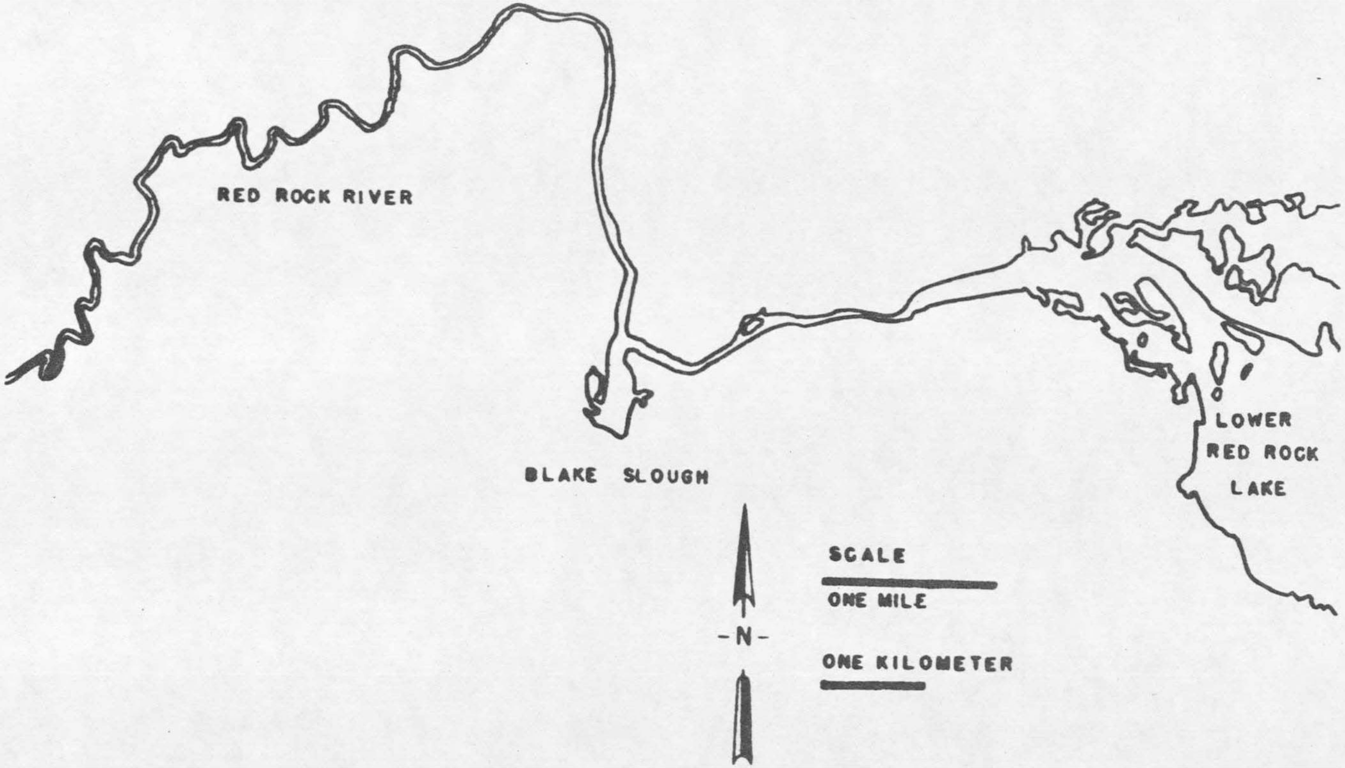

Figure 5. Map of Blake Slough and surrounding river area.

Ducks

Although peak numbers of ducks were considerably higher in 1977 than in 1978 (Figure 3), similar seasonal trends were observed in both years. High numbers in April represent large numbers of spring migrants. The low May counts probably included a few late migrants, some breeding birds, and the first molting birds, comprised of unsuccessful breeders, post-breeding drakes and non-breeding yearlings. Bellrose (1976) reported on the lack of breeding efforts by many yearling canvasbacks and lesser scaup, *Aythya affinis*.

The increase toward seasonal high numbers occurred from June into September of 1977 and through August in 1978. At least until early August, these birds were mostly molters. Numbers remained high into September 1977 but dropped in September of 1978. Ducks present in September of both years probably were birds staging for fall migration. The large number of birds and the maintenance of high numbers into September of 1977, as compared to 1978, is probably a reflection of higher water level in 1977 (Figure 2). This resulted in a greater abundance and availability of aquatic food.

GROUND CENSUSES

Geese

Ground censuses were initiated at the start of the 1977 field season and in 1978, shortly after the arrival of the first molting geese. In 1978, the first molters arrived on May 16 and their numbers peaked about June 16. This arrival date was similar to those mentioned by Krohn (1977), while Dimmick (1968) stated that geese leave the breeding area at Jackson Hole, Wyoming for molting areas in June. Surrendi (1970) reported that yearling geese had left his study area, in southeastern Alberta for molting areas by May 31. Canada geese began arriving along the Thelon River, in the Northwest Territories to molt in mid-June (Sterling and Dzubin 1967). Working north of the Brooks Mountain Range, in Alaska, Derksen et al. (1979) found that Black Brant arrived in late June and early July. These data, with the exception of Dimmick's (1968), show a progressively later migration for geese breeding or molting in higher latitudes. The late departure dates reported by Dimmick (1968) in Jackson Hole, probably result from the high elevation of the breeding and molting areas he studied.

Table 3 shows the habitats used and flight activity of molting geese in 1977 and 1978. A more complete record

1977	Water	Upland	Mud Flats	Flying	Other[a]
6/15-6/24	80.3	15.1	4.6		
6/25-7/4	84.8	11.2	4.0		
7/5-7/14		3.5	78.2	18.3	
7/15-7/24			100.0		
7/25-8/3	13.3		66.7	20.0	
8/4-8/13			81.5	18.5	
8/14-8/23			100.0		
8/24-9/2			74.6	25.4	
9/3-9/12			68.9	31.1	
9/13-9/22			100.0		
1978					
5/26-6/4	51.7	41.5	0.3	1.4	5.1
6/5-6/14	94.1	2.9	2.8		0.2
6/15-6/24	98.3	0.2	1.5		
6/25-7/4	98.4		1.5	0.1	
7/5-7/14	77.4	7.3	10.7	4.6	
7/15-7/24	3.6		96.4		
7/25-8/3	3.4		96.6		
8/4-8/13			100.0		
8/14-8/23	0.6		99.4		

[a] geese utilizing flooded uplands

Table 3. Percentage of Canada Geese using various habitats on Lima Reservoir by ten day periods - 1977 and 1978.

of the flightless birds is available in the 1978 data. A small number of birds was still flying by June 4, but most had initiated the flightless period. This suggests that some geese started molting seven to ten days after their arrival. Heavy dependence on water for safety was observed from this time until the period July 5 through 14. Observations for both years during this period indicate heavier use of the water in 1978 than 1977. This may have been a result of the observer's presence, to which geese responded by moving into the water and to the opposite side of the reservoir. Kuyt (1962) also noted this behavior in molting geese. By July 5 through 14, a greater shift from water to the exposed mud flat was observed in 1977 than in 1978. These data suggest that either the initiation date of molting in 1977 was earlier than 1978 or the length of the molting period for the entire population was shorter. Following the completion of the molt, the mud flats were the preferred habitat until departure.

Ducks

Pre-molting ducks started to arrive from late June through mid-July and initiated molt shortly after arrival. While in the process of molting, ducks restricted their use to mud flat shorelines and areas of high productivity where aquatic vegetation was abundant. Patternson (1976) reported that adult and fledged ducks showed a strong preference for more productive ponds in late summer.

Livestock

Horses, sheep and cattle graze the areas surrounding Lima Reservoir. Grazing by horses, because of low numbers and limited distribution was considered to have little if any effect on the molting goose population. Sheep grazed in the rolling hills to the west and southwest of the reservoir, and consequently were found to have no direct interactions with molting geese.

Cattle observations were primarily on the Matador, Moss and Munday allotments adjacent to the areas where the majority of the molters were found (Figure 6). Cattle were observed both years on the Moss and Munday allotments. Observations of cattle were not conducted on the Matador allotment in 1978 because of the late turn-in date (August 23). Data for the Matador allotment in 1977 are presented in Figure 7. The higher use by cattle appeared to be influenced by the time of day and weather (cloud cover, precipitation, and temperature).

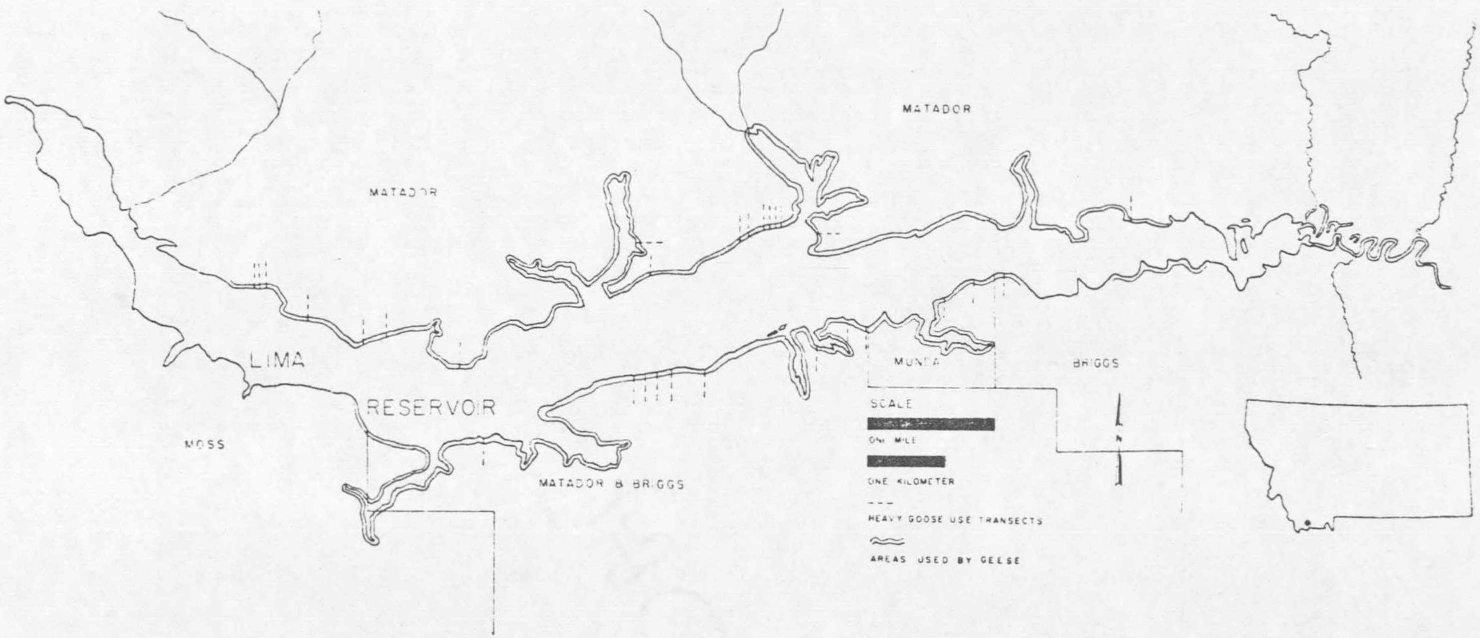

Figure 6. Map of heavy use transects, shoreline use by geese and grazing allotments for Lima Reservoir.

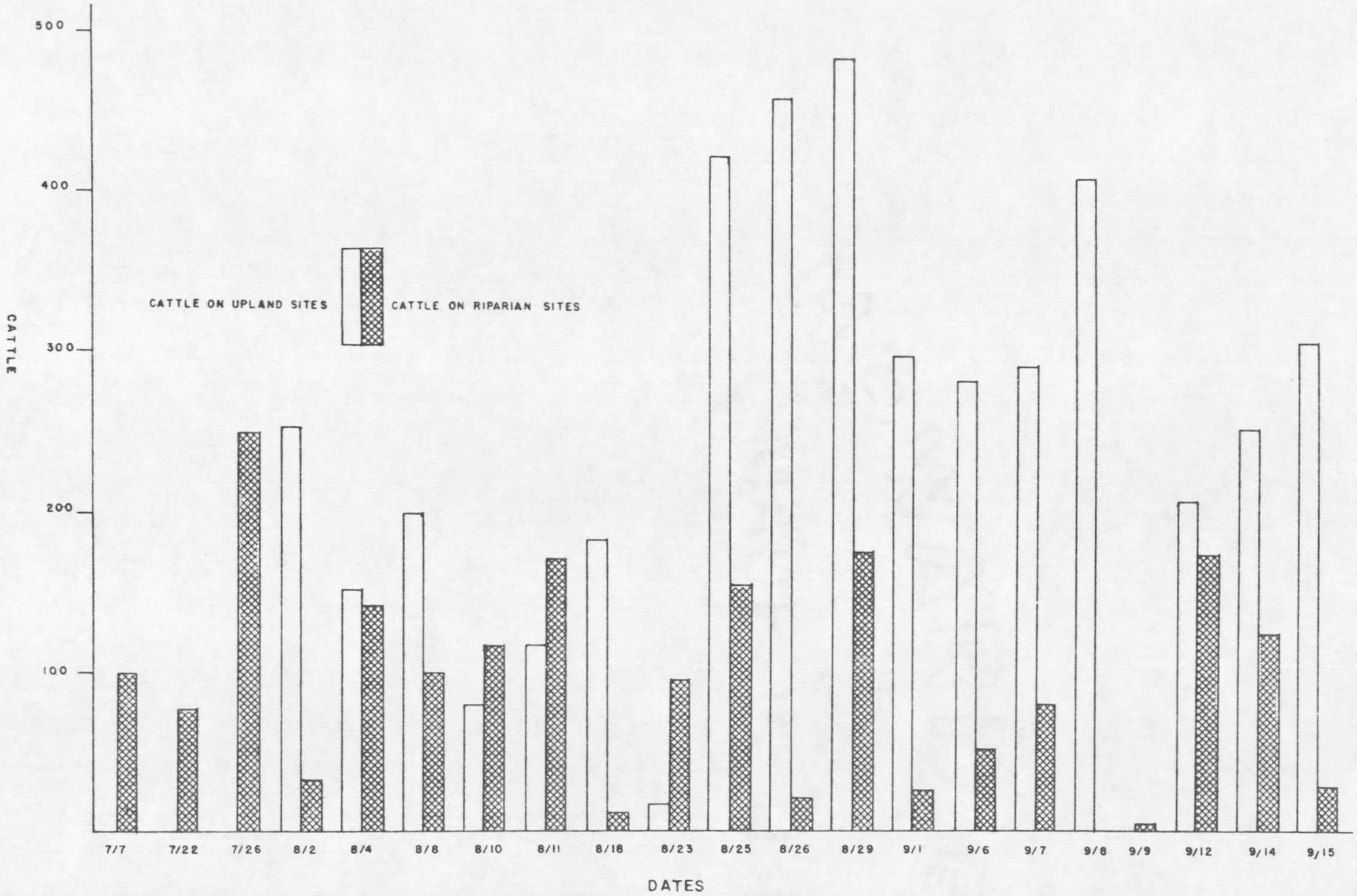

Figure 7. Distribution of cattle on the Matador allotment on Upland and Riparian zones - 1977.

No direct interactions between cattle and molting geese were observed. However, geese were never seen on land in the presence of cattle. After geese had regained flight they were never seen within 100m of cattle. Competition for upland grasses between cattle and geese was not observed. Arneson (1970), also working on irrigation reservoirs, found that there was little competition for grass between geese and cattle. At Lima Reservoir a large amount of shoreline and adjacent upland was available, providing plentiful areas for grazing by both geese and cattle independent of one another. Under such conditions, avoidance reactions would have been subtle and difficult to detect. Arneson (1970) reported an avoidance by geese of mud flats that had been heavily hoof-marked by cattle. Hoof-marked areas were also apparent on the mud flats of Lima Reservoir, but avoidance by geese was not observed.

Mathiasson (1973) reported no mortality while Dimmick (1968) had a mortality of one goose. During the two years at Lima Reservoir, only one goose and three swans were found dead during the molting period.

BANDING

In 1961 and 1962, 487 and 1259 Canada geese, respectively, were banded at Lima Reservoir. Only age was determined, and this to a single classification, that of "after hatching year" or birds older than juveniles. The distribution of band returns over the years for these two bandings is presented in Table 4.

Direct recoveries indicated southerly and southwesterly movements, primarily to Idaho, Utah and California (Figure 8). Indirect recoveries revealed more widespread movements, although breeding and wintering areas of this population are believed to be represented by the concentrated recoveries (Figure 9). This belief is further supported by June recaptures that indicate Utah and Idaho are the major breeding areas for this population, with Montana, Nevada, Wyoming, Kansas, and Colorado contributing lesser numbers (Figure 10). This point is also substantiated by multiple recaptures of several geese in different years in the same breeding areas. The lower number of recaptures compared to the relatively high number of direct and indirect recoveries for California, and the fact that all but two recoveries were made in December and January, indicate that a large portion of this population utilizes this state for wintering.

YEAR KILLED	1961	1962	TOTAL
1961	47[a]	---	47
1962	30	111[a]	141[b]
1963	25	114	139
1964	28	69	97
1965	15	34	49
1966	8	33	41
1967	2	19	21
1968	3	7	10
1969	1	5	6
1970	2	5	7
1971	1	6	7
1972	1	4	5
1973	1	-	1
1974	1	-	1
1975	-	2	2
TOTAL	165	409	574

[a]direct recoveries

[b]both direct and indirect recoveries

Table 4. Distribution of band returns (hunter harvest) of 487 and 1261 geese banded at Lima Reservoir in 1961 and 1962 respectively.

Figure 8. Direct returns of hunter harvested geese banded at Lima Reservoir, 1961 and 1962.

Figure 9. Indirect returns of hunter harvested geese banded at Lima Reservoir, 1961 and 1962.

Figure 10. Recapture returns of geese banded at Lima Reservoir, 1961 and 1962.

On June 20, 1978, 290 geese were banded by personnel of the Montana Fish and Game Department, Montana State University, U.S. Fish and Wildlife Service and Bureau of Land Management. Sex only was determined from these birds. The male:female ratio was 100:128. This female dominance is contrary to what was reported by Sterling and Dzubin (1967) working with molting Canada geese and King and Hodges (1979) studying Whitefronted geese and Black Brant. However, Arenson (1970) reported that the females outnumbered males by 6%. Solomonsen (1968) found that, in geese, females initiated the molt approximately one week earlier than males. Because of this, sex ratio obtained from the same population at different times will probably vary. For this reason sex ratios should be taken at a comparable chronological stage of the molt each year.

Sixteen collared geese were identified on Lima Reservoir during 1977 and 1978: twelve from Montana and four from Utah (Table 10). The age structure of these geese was 10 (62.5%) yearlings, 4 (25.0%) two year-olds, and 2 (12.5%) three year-olds and older. This is very similar to Krohn's (1977) estimated age structure of molting geese. The observations of these 16 collared geese, an albino and a domestic hybrid were used to determine group and pair cohesion, and

TABLE 5 . Date of sighting of individually marked Canada geese observed on Lima Reservoir, 1977 and 1978.

DATE	COLLAR	COLLAR COLOR/LETTER COLOR	AGE
7/12/77	MP69	Green/White	1
6/20/78	MZ51	" "	2
6/29/78	MT23	" "	1
6/29/78	MZ99	" "	1
6/29/78	EA80	Red/White	1
6/30/78	EA57	" "	1
6/30/78	EA46	" "	1
6/30/78	MK15	Green/White	3
6/30/78	MT31	" "	1
6/30/78	MT37	" "	3+
6/30/78	MT58	" "	1
6/30/78	MZ65	" "	1
6/30/78	MZ73	" "	1
6/30/78	313	Red/White	2
7/8/78	MP12	Green/White	2
7/8/78	MP39	" "	2

habitat selection and utilization. Two pairs of collared geese were observed at Canyon Ferry Reservoir, Montana.[3] One of these pairs was observed in the spring of 1978 prior to being sighted at Lima Reservoir. This suggests that geese migrate first to the breeding areas before continuing to molting areas, as stated by Ogilvie (1978). Three collared geese from Utah, banded on the same date and location, were recorded in close association with each other at Lima Reservoir. This tendency for geese to maintain small groups was also evident during aerial censuses. These small flocks could be family units or multiples thereof (Derksen et al. 1979). Family units are probably siblings and/or associated geese from the same breeding areas. These groups could also be distinct segments of sub-flyway or flyway populations (Sterling 1963). They probably remain intact in the migration to and from the molting area.

Repeated observations of recognizable geese suggest that group cohesion is strong. These small groups segregate themselves from others and maintain both their group integrity and a high fidelity to a small area on the reservoir. Kuyt (1966) reported the recapture of a Canada goose on the Thelon River molting area one year after it

[3]Per. Comm. Mr. Donald Childress

was banded on Lima Reservoir. Personnel of the Utah Division of Wildlife Resources trapped and transplanted a goose from Neponset Reservoir, one of the reservoirs Arneson (1970) studied. The following year this bird was observed molting at Lima Reservoir. These two examples seem to agree with Sterling and Dzubin's (1967) statement that molters have a high fidelity for a molting area but this may be broken by continued harassment.

DROPPING COUNTS

One hundred and forty-two dropping transects were measured during 1977 and 1978. Data were converted to number of droppings per square meter for 20 pace (18 square meter) intervals. Multiple regression analysis of these data (Figure 11) indicated that 98% of the variation in dropping per square meter was due to the distance from the high water line. This relationship was highly significant ($P > 0.01$).

Sixty percent use of a plant species by geese was considered heavy use. This was found at one clipping site (to be discussed later) on which dropping transects were measured. The number of droppings on this 20 pace section was 52, or 2.89 droppings/square meter for the interval. All lines that had segments equal to or exceeding this

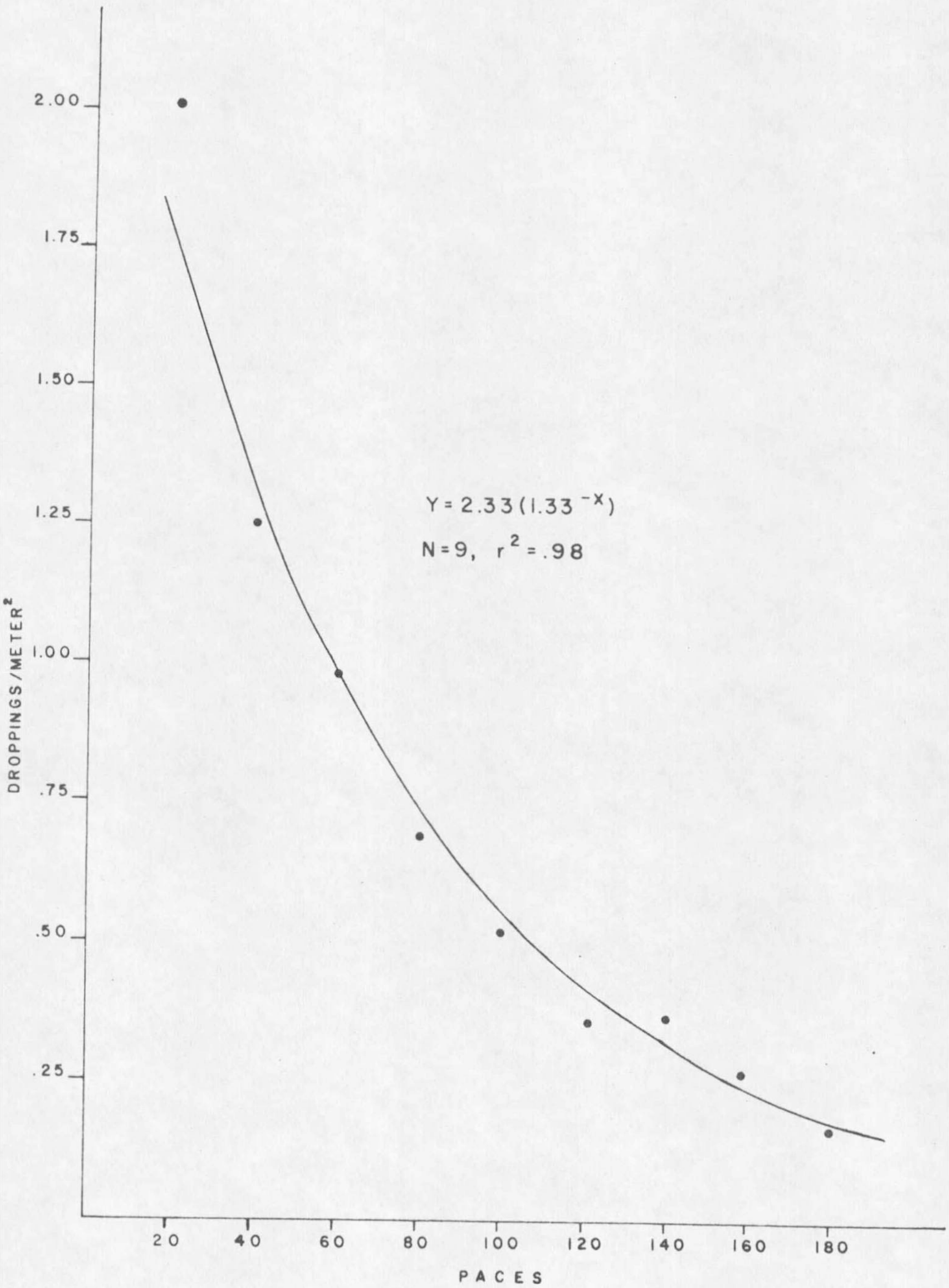

Figure 11. Relationship of distance from high water line to dropping per square meter.

value were designated heavy use areas. These are illustrated in Figure 6. Heavy use was found on 28 (20.4%) of the transects measured, although in no instance was the entire transect heavily used. Of these 28 transects, 14 (50.0%) had an 20 pace interval with heavy use, eight (28.5%) had two, four (14.2%) had three, and two (7.3%) had five. The inverse relationship of decreased dropping numbers as the distance from the high water line increased was also indicated by the total number of droppings observed. Eighty-six percent of the droppings were observed within 80 paces of the high water line.

Ogilvie (1978) stated that in England many farmers believed that livestock avoided fields which had large amounts of goose droppings. Rochard and Kear (1970) found that sheep only avoided fresh droppings. No avoidance of goose droppings by cattle was detected at Lima Reservoir.

VEGETATION

Daubenmire transects were measured on 15 community types identified from aerial photographs and ground observations. Cluster analysis by the linkage method (Sokal and Sneath 1963), were computed using plant cover and percent composition data. Percent similarity refers to levels at which stands group together. The cover cluster identified 12 community types, while percent composition identified 11. A dendrogram was constructed using canopy coverage, but the stands did not show similarity levels as high as in the percent composition dendrogram (Figure 12). Five transects did not cluster above the 75% level of similarity. For two of these, only one transect was measured, which precluded clustering. The other three were found similar to the three community types that had only two transects clustering together; however, the similarity levels were below the 75% level. Of eight community types that had three transects, four had all transects measured the same date, and all of these had at least 90% similarity. The remainng four types had some of the transects measured on different dates. The difference between two of these was due to transect selection, while the difference in the other two was caused by date of measurement and/or transect location.

Oblique photographs were taken at 23 sites before and after grazing both years. The only appreciable differences that could be observed occurred in the willow (Salix sp.) and rush (Juncus sp.) plots. The rush plots did not seem to be preferred by cattle; rather their use probably reflected the amount of time cattle spent in that particular area.

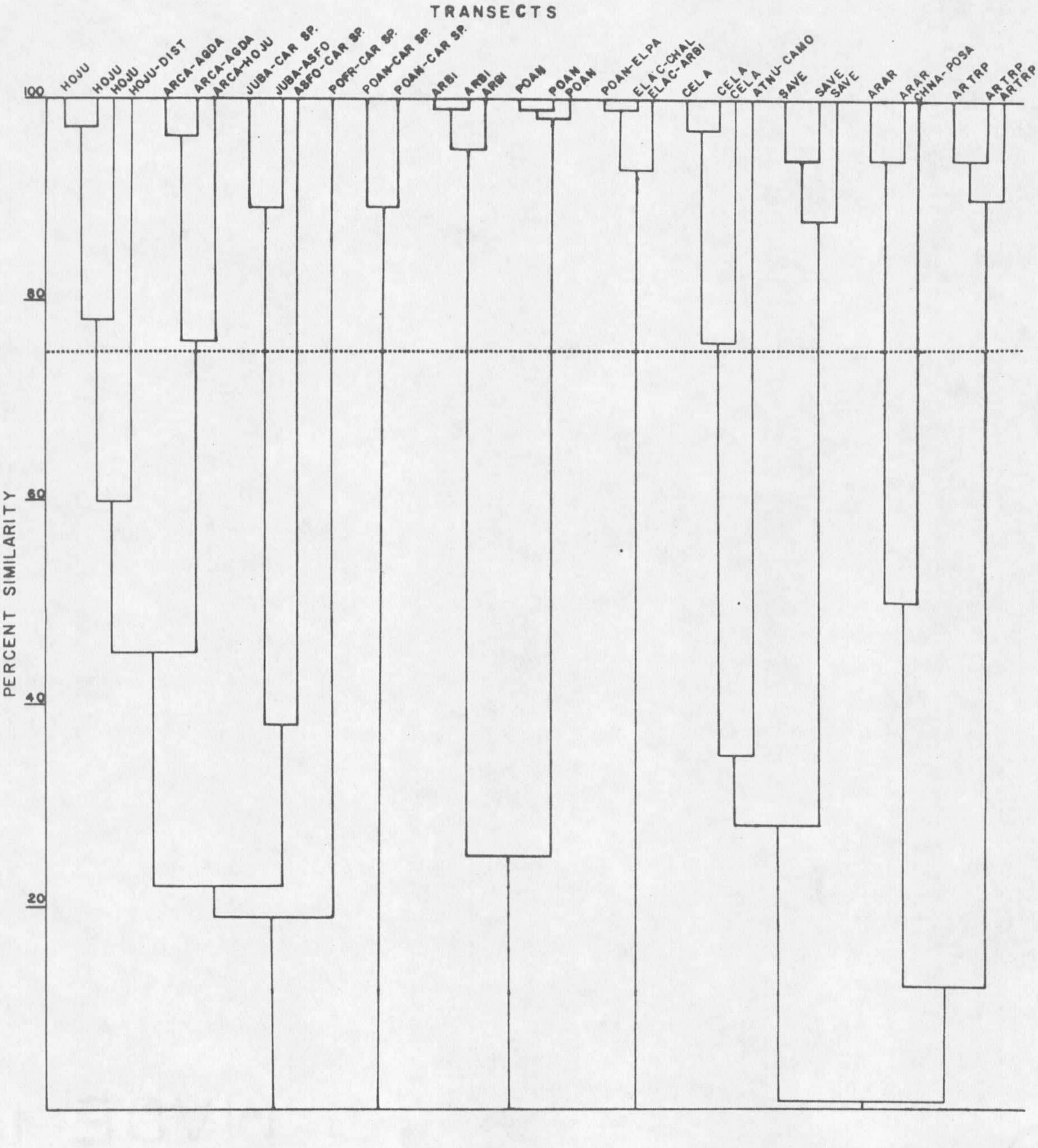

Figure 12. Cluster analysis of percent composition for 35 transects, four-letter symbols in Appendix, Table 12.

Willow did seem to be preferred but utilization did not appear heavy.

Clipping plot data for species consumed by geese are presented in Table 5. Percent utilization, averaged for the three plots in each of these four sites, is also given. Heavy utilization, 60% or more, was found at two sites, one each in the sagebrush-grassland and quackgrass types. Comparison of the means of early clippings outside the exclosure to late clippings within, revealed little regrowth for Sandberg's bluegrass, but substantial regrowth for quackgrass. Utilization of regrowth by cattle was higher than of Sandberg's bluegrass.

Ogilvie (1978) stated that White-fronted geese consumed 130-160 grams (dry weight) of food per day. If 160 grams per day were used by a Canada goose, then one goose would consume 4.8 Kg/month. Using these figures 85 geese would be equivalent to one animal unit. One animal unit is equivalent to 13.6 Kg/day. The largest number of geese recorded on Lima Reservoir during this study was 9,555, which thus represents 112.4 AU's. The amount of shoreline that received some use by geese was 50 Km (31 miles) and is illustrated in Figure 6. Using 80 paces (73.6 meters as the approximate distance geese fed away from the high water line, the amount

Poa sandbergii	Site 1		Site 2		Site 3		Site 4	
early	in	out	in	out	in	out	in	out
Plot 1	205	68	8	9	–[a]	76[b]		
Plot 2	230	178	150	118	140	25		
Plot 3	183	91	48	42	167	112		
x̄	206	113	69	56	154	59		
x̄ % use[c]	45.1%		18.8%		61.7%			
Poa sandbergii late								
Plot 1	101	132	1	19	71	69		
Plot 2	179	139	32	27	64	106		
Plot 3	108	65	101	65	77	91		
x̄	129	112	44	37	71	88		
x̄ %	13.2%		15.7%		-23.9%			
Agropyron repens early								
Plot 1							1761	252
Plot 2							1334	250
Plot 3							1050	98
x̄							1382	200
x̄ %							85.5%	
Agropyron repens late								
Plot 1							486	287
Plot 2							1226	350
Plot 3							364	341
x̄							692	326
x̄ %							38.3%	

[a]sample lost during accident
[b]sample omitted for mean
[c]percent utilization

Table 6. Production summary, in kilograms/hectare, and percent utilization for clipping plots from Lima Reservoir, 1978.

of area available to geese was 365 hectares (902 acres). The upland grasses are utilized for about one month before the geese start utilizing the mud flats. If 2 hectares (5 acres) were allowed for each AUM, the carrying capacity for geese would be about 15,000.

Ogilvie (1978) reported that both White-fronted and Barnacle goose (Branta leucopsis) defacation rates were one dropping every 3.5 minutes. Using this base in conjunction with the dropping counts on Lima Reservoir, the time required to utilize a hectare to 60% would be 825.7 goose days if 10 hour/day is used for the amount of time spent feeding.

Sandberg's bluegrass seedheads were counted from all of the plots at three sites. An analysis of variance (Table 7) showed highly significant difference between dates of clippings and a significant difference between sites. Differences between plots and treatments were not significant at the $P > 0.05$ level. Possible reasons why treatments were not significant are (1) one sample was lost in an accident, and (2) four of the regrowth plots had greater values outside than inside the exclosure. The exclosures may have affected the vegetation within, or the plots selected may not have been homogeneous.

Community types heavily utilized by geese for upland

Analysis of Variance Summary

Source of Variation	Degree of freedom	Mean square	Significance
Dates	1	57,280.44	**
Treatments	1	23,205.44	NS
Plots	2	21,823.00	NS
Sites	2	34,800.00	*
Error	29	7,266.27	---
Total	35	-------	---

** significant at P 0.01
 * significant at P 0.05
NS not significant

Table 7. Analysis of variance summary for clipping plots from Lima Reservoir.

feeding were sagebrush-grassland and quackgrass. The quackgrass type is located in a low area that is annually flooded by high water. Access to this area by geese was from a very gentle sloping beach. The surrounding area was level with no obstructions to impede the vision of the geese. This seemed to be a requirement for molting geese because no feeding areas were used that did not have an unrestricted field of vision. In the sagebrush-grassland type, sagebrush plants were measured from clipping plots to determine if they could reduce the vision of the geese. No impediment of their vision was believed to have occurred. One hundred and forty-seven plants were measured and averaged 7.7 cm (3 in). Access to some of these areas was the same as to the quackgrass type, but for most, coulees or small gulleys were used. After going up these coulees the geese would spread out in a "V" from the mouth of the coulee. These coulees were very gently sloped. With the apporach of danger geese jumped off the high banks, some as high as two meters, on each side of the coulee and moved toward water.

A plant species list of common names, scientific names and four letters symbols is found in Table 12 in the appendix.

RECREATIONAL USE & MISCELLANEOUS

Waterfowl hunting was the primary recreational use of the Lima Reservoir area. Waterfowl hunters were interviewed during the first eight days of the hunting season in 1978. Data for goose and duck hunters were segregated (Table 8). Goose hunters spent more hours per hunter for fewer birds than duck hunters. Waterfowl harvested, by species, during this time is listed in Table 9. Most hunters (73.7%) knew the ownership of the land they hunted upon. Of those that were aware of ownership, 92.9% were hunting on BLM land.

In the fall of 1977 two islands were built on Lima Reservoir for goose nesting. On May 8, 1978 log structures with straw between the logs were placed on these islands. A pair of geese was recorded on each island four days later, although neither initiated nests. Ring-billed gulls, *Larus delawarensis*, initiated nests just prior to May 8, 1978 while Double-crested Cormorants, *Phalacrocorax auritus*, started utilizing these island for nesting in early June (Table 10).

It is possible that the late ice-out (mid to late April) on Lima Reservoir, precludes a high nesting population of Canada geese even in the presence of suitable nesting sites. Current activity in the valley appears to be associated with

	Number of vehicles checked	Number of People	People/ Vehicle	Total Hours	Hours/ Hunter	Total Bag	Birds/ Hunter	Birds Hour
Duck Hunters	19	36	1.89	163	4.53	68	1.89	.42
Goose Hunters	19	38	2.00	213	5.61	35	.92	.16
Total	38	74	1.95	376	5.08	103	1.39	.27

Table 8. Summary of hunter harvest on Lima Reservoir, Sept. 30 - Oct.7, 1978

Canada goose	35
Gadwall	16
Mallard	14
Green-winged Teal	14
American Widgeon	8
Northern Shoveler	5
Bufflehead	4
Pintail	3
Blue-winged Teal	2
Canvasback	1
Ruddy Duck	1

Table 9. Numbers and species of waterfowl recorded harvested during hunter interviews, September 30 - October 7, 1978.

Date	Island	Number of Nests	Number of Eggs	Number of Young	Number of Dead
5/8	East	6	1		
	West	21	7		
6/1	East	38	89		
	West	32	88		
6/8	East		67	12	1
	West		61	19	1
6/15	East	(2)[a]	38(1)	32	
	West	(1)	20(1)	46	
6/29	East	(3)	7(6)	29	2
	West	(2)	(3)	36	3
7/10	East	(3)	(0)[b]	24	1
	West	(2)	(3)	32	2

[a]( ) Double-crested Cormorant (Phalacrocorax auritus)

[b]nests were predated

Table 10. Summary of nesting activity by ring-billed gulls and double-crested cormorants on the two constructed islands, Lima Reservoir, 1978.

rivers and streams which become free of ice at an earlier date.

A species list of all birds observed on the study ara during 1977 and 1978 is found in Appendix (Table 11). Three species of some concern were observed. These include four observations of Peregrine falcons, Falco peregrinus, one observation of a Burrowing Owl, Athene cunicularia, and numerous observations of adult and juvenile Bald Eagles, Haliaeetus leucocephalus.

SUMMARY AND CONCLUSIONS

A study of molting Canada geese was conducted at Lima Reservoir in southwestern Montana during 1977-78. The objectives were to determine goose habitat use and selection, their uses of vegetation, and competition with livestock. Data collected and observations made permit the following conclusions:

1. Geese first arrive at Lima Reservoir in mid-May. Peak numbers are reached by mid-June. Following arrival, geese begin to molt and are flightless within seven to ten days.

2. While molting, the primary habitat of geese is large water areas and upland. When flight is regained, habitat use shifts to exposed mud flats.

3. No competition between geese and cattle was detected.

4. The majority of the geese using Lima Reservoir breed in Idaho and Utah, and winter in California. Age structure of the molting population, 63% yearlings, 25% two-year-olds, and 12% three-year-olds and older, was similar to Krohn (1977).

5. Geese maintained small groups, the cohesion of which was strong. Each group showed a high fidelity for a specific area on the reservoir.

6. Distance from the high water line accounted for 98% of the variation in droppings per square meter. Sixty percent utilization of forage species was associated with an average of 2.89 droppings per square meter (for a 20 pace interval one meter wide). Heavy use was found on 20% of the transects.

7. Cluster analysis of the vegetation revealed 11 community types.

8. One Canada goose was estimated to consume 4.8 Kg/month which converts to 85 geese per AU. The amount of upland acceptable to geese is 365 hectares surrounding the reservoir. Estimated carrying capacity for this area will not be reached until the flock numbers 15,000.

9. Unrestricted field of vison was important for the selection of feeding sites.

10. Goose hunters spent more hours for fewer birds than duck hunters. Most hunters were aware of land ownership and the majority of these were hunting on BLM land.

MANAGEMENT RECOMMENDATIONS

1. Possibilities exist that Lima Reservoir could cease to be used as a molting area by geese because of harassment. Every precaution should be taken from disturbing this population. Banding should not be done on consecutive years.

2. Island construction for the purpose of creating a breeding flock is of questionable value. First, because of late ice-out, it is doubtful that large numbers of breeding geese would develop. Second, because of large fluctuations in water level, island construction is costly. Last, many major molting flocks seem to develop in the absence of breeding populations. Lima Reservoir is currently playing a significant role as a molting area for geese from a large area and should be managed as such.

3. If utilization of the uplands close to the high water line, by geese, becomes too great, then additional access to the uplands should be created. Such access areas should be very gently sloped so vision is not impeded.

4. Larger number of ducks could be retained in the months of September and October, if higher water levels were maintained to prevent the aquatic vegetation from being exposed on the mud flats.

APPENDIX

TABLE 11. Species list of birds observed at Lima Reservoir during 1977-78.

Common Loon	*Gavia immer*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
White Pelican	*Pelecans erythrorhynchos*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Blue Heron	*Arede hevodias*
Snowy Egret	*Egretta thula*
Black-crowned Night Heron	*Nycticorax nycticorax*
American Bittern	*Botaurus lentiginosus*
Whistling Swan	*Olor colombianus*
Trumpeter Swan	*Olor buccinator*
Canada Goose	*Branta canadensis*
Snow Goose	*Chen caerulescens*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
Pintail	*Anas acuta*
American Green-winged Teal	*Anas carolinensis*
Blue-winged Teal	*Anas discolor*
Cinnamon Teal	*Anas cyanoptera*
American Widgeon	*Anas americana*
Northern Shoveler	*Anas clypeata*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Canvasback	*Aythya valisineria*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Bufflehead	*Bucephala albeola*

Ruddy Duck	*Oxyura jamaicensis*
Red-breasted erganser	*Mergus serrator*
Sharp-shinned Hawk	*Accipiter striatus*
Red-tail Hawk	*Buteo jamaicensis*
Swainson's Hawk	*Buteo swainsoni*
Rough-legged Hawk	*Buteo lagopus*
Ferruginous Hawk	*Buteo regalis*
Golden Eagle	*Aquila chrysaetos*
Bald Eagle	*Haliaeetus leucocephalus*
Marsh Hawk	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Prairie Falcon	*Falco mexicanus*
Peregrine Falcon	*Falco peregrinus*
American Kestrel	*Falco sparverius*
Sage Grouse	*Centrocercus urophasianus*
Gray Partridge	*Perdix perdix*
Sandhill Crane	*Grus canadensis*
American Coot	*Fulica americana*
Killdeer	*Charadrius vociferus*
Common Snipe	*Capella gallinago*
Long-billed Curlew	*Numenius americanus*
Spotted Sandpiper	*Actitis macularia*
Willet	*Catoptrophorus semipalmatus*
Greater Yellowlegs	*Tringa melanoleusa*
Least Sandpiper	*Calidris ministilda*
American Avocet	*Recurvirostra americana*
Wilson's Phalarope	*Steganopus tricolor*
California Gull	*Larus californicus*
Ring-billed Gull	*Larus delawarensis*
Franklin's Gull	*Larus papixcan*

Common Tern	Sterna hirunda
Black Tern	Chlidonias niger
Rock Dove	Columba livia
Morning Dove	Zenaida macroura
Great Horned Owl	Budo virginianus
Burrowing Owl	Athene cunicularia
Short-earred Owl	Asio flammeus
Belted Kingfisher	Megoceryle alcyon
Common Flicker	Colaptes auratus
Eastern Kingbird	Tyrannus tyrannus
Horned Lark	Eremophila alpestris
Tree Swallow	Iridoproche bicolor
Bank Swallow	Riparia riparia
Barn Swallow	Hirundo rustica
Cliff Swallow	Petrochelidon pyrrhonota
Black-billed Magpie	Pica pica
Common Raven	Corvus corax
Common Crow	Corvus brachyrhynchos
House Wren	Troglodytes aedon
American Robin	Turdus migratorius
Mountain Bluebird	Sialia Currucoides
Starling	Sturnus vulgaris
Yellow Warbler	Dendroica petechia
Yellow-rumped Warbler	Dendroica coronata
Wilson's Warbler	Wilsonia pusilla
Western Meadowlark	Sturnella neglecta
Yellow-headed Blackbird	Xanthocephalus xanthocephalus
Red-winged Blackbird	Agelaius phoeniceus
Brewer's Blackbird	Euphagus cyanocephalus
Brown-headed Cowbird	Molothrus ater
Western Tanager	Piranga lucoviciana

Lazuli Bunting	*Passerina amoena*
Lark Bunting	*Calamaspiza melanocarys*
Vesper Sparrow	*Pooecetes gramineus*
White-crowned Sparrow	*Zonotrichia leucopyrys*

TABLE 12. Plant species list of plants collected at Lima Reservoir during 1977-78.

Asteraceae		
Achillea millefolium	Western yarrow	
Agoseris glauca	Pale agoseris	
Antennaria micrphylla	Rose pussytoes	
Artemisia arbuscula	Low sagebrush	(Arar)
Artemisia biennis	Biennial sagewort	(Arbi)
Artemisia cana	Silver sagebrush	(Arca)
Artemisia dracunculus	False-tarragon sagewort	
Artemisia tridentata	Big sagebrush	
Artemisia tripartita	Threetip sagebrush	(Artrp)
Aster foliaceus	Leafybract aster	(Asfo)
Aster scopulorum	Crag aster	
Balsamorhiza sagittata	Arrowleaf balsamroot	
Centaurea maculosa	Spotted knapweed	
Chrysothamnus nauseous	Rubber rabbitbrush	(Chna)
Chrysothamnus viscidiflorus	Green rabbitbrush	
Cirsium arvense	Canada thistle	
Erigeron compositus	Fernleaf fleabane	
Erigeron pumilus	Shaggy fleabane	
Grindelia squarrosa	Curlcup gumweed	
Haplopappus acaulis	Stemless goldenweed	
Haplopappus lanceolatus	Lance goldenweed	
Helianthella quinquenervis	Fivevein helianthella	
Senecio canus	Woolly groundsel	
Senecio hydrophilus	Water groundsel	
Solidago missouriensis	Missouri goldenrod	
Sonchus asper	Prickly sowthistle	

Taraxacum officinale	Common dandelion	
Tetradymia canescens	Gray horsebrush	
Tragopogon dubius	Common salsify	
Brassicaceae		
Draba oligosperma	Glacier draba	
Erysimum asperum	Plains wallflower	
Boraginaceae		
Hackelia patens	Spreading stickseed	
Lithospermum incisum	Narrow leaf gromwell	
Myosotis sylvatica	Alpine forget-me-not	
Plagiobothrys scouleri	Scouler's plagiobothrys	
Caprifoliaceae		
Symphoricarpos occidentalis	Western snowberry	
Ceratophyllaceae		
Ceratophyllum derersum	Coontail	
Chenopodiaceae		
Atriplex nuttallii	Nuttall saltbrush	(Atnu)
Ceratoides lanata	Winterfat	(Cela)
Chenopodium album[a]	White goosefoot	(Chal)
Monolepsis nuttalliana	Nuttall monolepsis	
Salicornia rubra	Red glasswort	
Sarcobatus vermiculatus	Greasewood	(Save)
Crassulaceae		
Sedum lanceolatum	Lance-leaf stonecrop	

Cyperaceae	Carex species	(Car sp.)
Carex athrostachya	Slenderbeaked sedge	
Carex douglasii	Douglas' sedge	
Carex nebrascensis	Nebraska sedge	
Carex praegracilis	Clustered field sedge	
Carex siccata	Silvertip sedge	
Carex stenophylla	Narrow-leaved sedge	
Eleocharis acicularis	Needle spike-rush	(Elac)
Eleocharis palustris	Common spike-rush	(Elpa)
Fabaceae		
Astragalus purshii	Pursh loco	
Astragalus striatus	Prairie milkvetch	
Lupinus argenteus	Silvery lupine	
Lupinus sericeus	Silky lupine	
Melilotus officinalis	Yellow sweetclover	
Oxytropis sericea	White pointloco	
Thermopsis montana	Mountain thermopsis	
Trifolium longipes	Longstalk clover	
Trifolium repens	White clover	
Furmariaceae		
Corydalis aurea	Golden corydalis	
Gentianaceae		
Gentiana affinis	Rocky Mountain pleated gentian	
Geraniaceae		
Geranium viscosissimum	Sticky geranium	

<u>Grossulariaceae</u>	
<u>Ribes</u> <u>aureum</u>	Golden currant
<u>Haloragaceae</u>	
<u>Myriophyllum</u> <u>spicatum</u>	Spiked water-milfoil
<u>Hydrocharitaceae</u>	
<u>Elodea</u> <u>canadensis</u>	Canada waterweed
<u>Hydrophyllaceae</u>	
<u>Phacelia</u> <u>hastata</u>	Silverleaf phacelia
<u>Iridaceae</u>	
<u>Iris</u> <u>missouriensis</u>	Rocky Mountain iris
<u>Juncaceae</u>	
<u>Juncus</u> <u>balticus</u>	Baltic rush (Juba)
<u>Liliaceae</u>	
<u>Allium</u> <u>cernuum</u>	Nodding onion
<u>Zigadenus</u> <u>venenosus</u>	Meadow death-camas
<u>Labiatae</u>	
<u>Mentha</u> <u>arvensis</u>	Field mint
<u>Linaceae</u>	
<u>Linum</u> <u>perenne</u>	Blue flax
<u>Loasaceae</u>	
<u>Mentzelia</u> <u>laevicaulis</u>	Fivepetal blazingstar

Malvaceae		
Sphaeralcea munroana	Munroe globemallow	
Onagraceae		
Oenothera breviflora	Shortleaf evening primrose	
Oenothera caespitosa	Tufted evening primrose	
Oenothera flava	Yellow evening primrose	
Oenothera serrulata	Shrubby evening primrose	
Plantaginaceae		
Plantago patagonica	Woolly plantain	
Poaceae		
Agropyron caninum	Bearded wheatgrass	
Agropyron cristatum	Crested wheatgrass	
Agropyron dasystachyum	Thick-spike wheatgrass (Agda)	
Agropyron smithii	Western wheatgrass	
Agropyron spicatum	Bluebunch wheatgrass	
Alopecurus aequalis	Little meadow-foxtail	
Beckmannia syzigachne	Sloughgrass	
Bromus inermis	Smooth brome	
Bromus tectorum	Downy chess	
Calamagrostis montanensis	Plains reedgrass	(Camo)
Distichlis stricta	Alkali saltgrass	(Dist)
Elymus cinereus	Basin wildrye	
Festuca idahoensis	Idaho fescue	
Hordeum brachyantherum	Meadow barley	
Hordeum jubatum	Foxtail barley	(Hoju)
Koeleria macrantha	Prairie junegrass	
Oryzopsis hymenoides	Indian ricegrass	

Phleum pratense	Common timothy
Poa arida	Dryland bluegrass
Poa cusickii	Cusick bluegrass
Poa pratense	Kentucky bluegrass
Poa sandbergii	Sandberg's bluegrass
Poa trivialis	Roughstalk bluegrass
Puccinellia nuttalliana	Nuttall's alkaligrass
Stipa comata	Needle-and-thread
Stipa viridula	Green needlegrass
Polemoniaceae	
Phlox hoodii	Hood's plox
Phlox longifolia	Longleaf phlox
Polygonaceae	
Eriogonum umbellatum	Sulfur eriogonum
Polygonum amphibium	Water smartweed
Polygonum aviculare	Prastrate knotweed
Potamogetonaceae	
Potamogeton filiformis	Slender-leaf pondweed
Potamogeton pectinatus	Fennel-leaf pondweed
Potamogeton richardsonii	Richardson's pondweed
Primulaceae	
Dodecatheon conjugens	Shootingstar

Ranunculaceae	
Anemone multifida	Ball anemone
Anemone nuttalliana	Pasque flower
Delphinium bicolor	Low larkspur
Delphinium occidentale	Tall larkspur
Ranunculus aquatilis	Aquatic buttercup
Ranunculus glaberrims	Sagebrush buttercup
Rosaceae	
Amelanchier alnifolia	Western serviceberry
Potentilla anserina	Silverweed cinquefoil (Poan)
Potentilla fruticosa	Shrubby cinquefoil (Pofr)
Potentilla gracilis	Northwest cinquefoil
Purshia tridentata	Antelope bitterbrush
Rosa woodsii	Woods rose
Scrophulariaceae	
Besseya wyomingensis	Kitten-tail
Castilleja flava	Yellow Indian paintbrush
Penstomon aridus	Stiffleaf penstemon
Penstemon cyaneus	Dark-blue penstemon
Penstemon eriantherus	Fuzzytongue penstemon
Solanaceae	
Hyoscyamus niger	Henbane
Violaceae	
Viola nuttallii	Nuttall violet

[a]species identified but not collected.

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