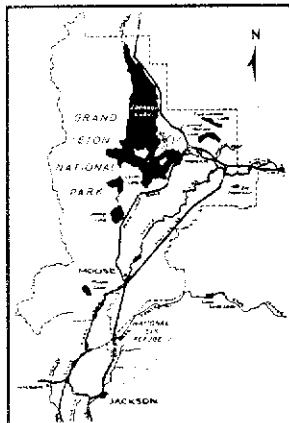
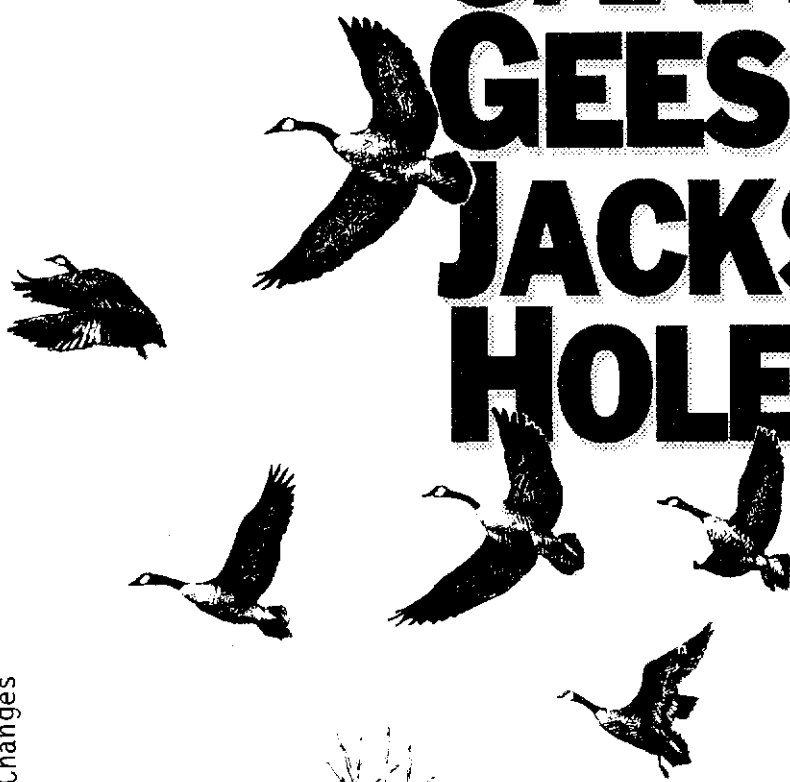


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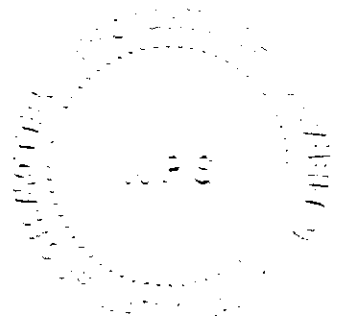
Canada Geese of Jackson Hole
Some Aspects of Population and Habitat Changes

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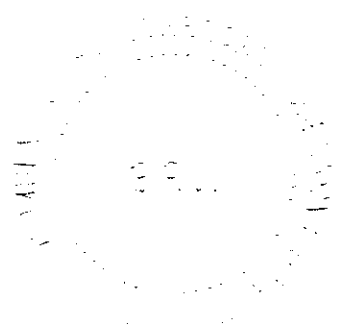
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Abstract

This study addresses the population dynamics, factors influencing goose habitat and population productivity, as well as the maintenance of optimal levels of Canada geese in Jackson Hole, Wyoming during the period 1965-1989. Mean breeding pairs increased 54% from 117 pairs in 1965-76 to 180 pairs in 1977-1989. Mean clutch size in 1979-80 was 5.0 compared to 5.2 for 1962-64 with mean brood sizes being 4.0 and 4.7, respectively. Thus it appears the Jackson Hole goose breeding areas had not yet reached their maximum capacity for Canada goose production. Analysis of band recoveries indicated that the adjusted average annual mortality rate for geese banded in 1961-72 decreased by slightly more than 8% in comparison to those banded in 1956-60. Also, 1961-72 survival rates were higher in the 3rd year following banding and continued to be higher well beyond the 6th or 7th year than the survival rates of the 1956-1960 birds. Based on the 1977-89 data, the Canada goose breeding flock size in Jackson Hole was estimated to be 496 birds with a growth rate of 5-8%/year. Ninety to 97% of hunter recoveries of banded geese are concentrated within Wyoming, Idaho, Utah, Arizona and California. Hunter harvests have not depressed the rate of population growth. Primary wintering areas for the geese are chiefly in southern California and Arizona. A 130% increase of private river float trips during the 10 years prior to 1989 presents a serious threat to the protective isolation historically provided the geese within Grand Teton National Park. A ceiling of 5000 commercial and 5000 private float trips per year with trip permits required for all floaters would best serve all interests. A lottery drawing system for the allocation of private permits may be required. Snake River floater traffic is recommended to be lightest on the Flagg Ranch to Berry Creek sector, moderate on the Pacific Creek to Dead Man's Bar and heaviest on the Dead Man's Bar to Moose sector. Vegetated riverine island habitat provides some of the most desirable goose nesting and loafing habitat. Between 1949 and 1979, 19% (293 ha) of the vegetated island habitat of the Snake River in Jackson Hole was lost. The largest proportionate decrease (79.2 ha) was associated with the area of sectional flood control diking along the river below Wilson. At the same time there was a 37% (65.6 ha) increase in bare sand and gravel areas in the continuous flood control dike region. The prime Canada goose habitat in Jackson Hole extends laterally downstream from the Dime Creek-Upper Snake River junction to Jackson Lake, as well as along the western lake shore to the Berry Creek meadows. This habitat is particularly in need of management regulations which preserve their seasonal isolation from human activities. Long term aerial censusing of the goose breeding population should be continued on an annual basis with consistent procedures and experienced observers. Reliable flock composition and monitoring of population changes and the nature of the hunter harvest can only be determined through continued and consistent banding and color marking of geese in all seasons.

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Introduction

Between 1955 and 1974 the U.S. population of Canada geese (Branta canadensis), the Pacific Flyway excluded, nearly doubled in size. In the same period, the Pacific Flyway Canada goose population of all races appeared to have declined by 10 percent (Bellrose, 1976). The complex western Canada goose subspecies composition of the flyway and the diverse habitat and goose population distribution made it difficult to determine if this decline was a general phenomena or a condition associated with one or more specific populations. In his 1962-64 studies of a population of one of the western Canada goose races B. C. moffitti, Wyoming's Jackson Hole Canada goose population, Dimmick concluded that that goose population was stabilized around a mean of 280 birds. As a result of the study of Krohn and Bizeau (1980), the Jackson Hole Canada goose population is part of the B. C. moffitti Rocky Mountain Population.

Consequently, an update of Dimmick's (1968) study was appropriate. This update addresses the following topics:

1. An inventory of Canada geese within the Snake River drainage in Jackson Hole;
2. A further identification and evaluation of factors in Jackson Hole influencing goose habitat and productivity; and
3. Suggestions for maintenance of optimal population levels of the Jackson Hole Canada geese.

Procedures

This study began in July of 1978 with field investigations being terminated in late August of 1980. Censusing of geese on the Snake River, marshes, ponds and other habitat was comparable in design to Dimmick's (1968) censuses. Wintering and breeding population counts were made by the Wyoming Game and Fish Department. Normally, these aerial censuses are made from a Piper Super-Cub or a comparable airplane flying at an altitude of 300-500 ft. when flight conditions allowed. When concentrations of geese are encountered or where terrain and habitat make counting difficult, the area is circled until the count is completed. Where flight conditions permit the pilot may assist with location and counting of geese. Flight transects follow rivers, lakes, reservoirs, marshes and ponds of Jackson Hole.

Searches for nests were conducted by walking in and around areas where single or paired geese appeared to have an established attachment to a specific location and/or defended it against other geese. Also, suitable nesting habitat areas on islands, in marshes and along shoreline areas of rivers, lakes and ponds were searched. Where necessary, a rubber raft and a canoe were used for access along the foregoing water areas.

Censuses of late summer and fall concentrations of geese on large lakes and marshes were made using a spotting scope from vantage points overlooking those areas.

Comparative analyses of Snake River islands and their habitat was done from aerial photographs VV 16 PS-5M706 taken on June 1, 2, 8-22 & 28, 1945 and B/R17 taken on June 11, 12, 14 & 15, 1979. Island habitat was mapped on transparencies in 1 of 4 categories: (1) bare sand or gravel; (2) sedge, forb or grass cover; (3) woody shrub cover; and (4) deciduous-conifer tree cover. Area of each habitat category and island size were determined in the University of Wyoming Remote Sensing Laboratory.

Banding of molting geese on June 29, 1979 in the Southeast Arm of Yellowstone Lake was conducted jointly with personnel of the Wyoming Game and Fish Department. A portable wire mesh and twine net drive trap was erected on the east shoreline of the large grassy meadow in the southwestern portion of the Southeast Arm. Outboard motor boats were used to roundup the molting geese into a large concentration and then herd that concentration into the land situated drive trap. From erection of the trap to completion of the banding, the entire process required about 4 1/2 hrs.

The complexities introduced by: (1) the poorly defined parameters of the non-breeding component of the Jackson Hole Canada goose population; (2) the poorly defined parameters of the non-breeding molting geese of Yellowstone and Turbid Lakes; (3) the sole use of the molting Yellowstone geese for banding; and (4) the intermittent and irregular periods of banding; limit the nature of any analysis of the banding information collected. Consequently, two contrasting analytical procedures were used: (1) the simplified format developed by Bellrose and Chase (1950) to estimate survival and mortality; and (2) the more intricate statistical formats used by Brownie et al. (1985) to estimate survival. The Bellrose and Chase (1950) format is self explanatory.

In a more complex analytical procedure, four models described by Brownie et al. (1985) for birds banded as adults were judged to be the most applicable to the Yellowstone banded goose population and the subsequent banded bird recoveries. Regarding the assumptions involved in these models Brownie et al. (1985) state:

1. All of the models entail an age-independence assumption;
2. For Model 1 "In addition to the assumption of age-independence referred to above, it is assumed that survival, hunting, and reporting rates are year-specific but independent of the year of banding."
3. "The assumptions of Model 2 are more restrictive than those of Model 1, in that survival rate is assumed to be constant from year to year. Band reporting rates and harvest rates H (and hence recovery rates f) are assumed to be year-specific."

4. "Model 3 is the simplest possible age-independent model for band recoveries. It is based on the assumption that recovery rates (and therefore harvest rates H and band reporting rates) and survival rates are constant from year to year and independent of the age of the bird or its capture history."
5. "Models 2 and 3 were introduced as restrictions on Model 1. We now present a model that is a generalization of Model 1. Model 0 allows year-specific recovery and survival rates as does Model 1. The generalization involves the assumption that the recovery rates the first year after banding are different from recovery rates of previously banded birds."

Finally, the program ESTIMATE (Brownie et al. 1985) was used to determine the goodness of fit of the individual models with each of the two sets of banding data, 1956-58 and 1961-72.

Unfortunately, unforeseen events required the use of three different field researchers between July 1, 1978 and September 1980. As a consequence, problems of continuity, and comparability were inevitable. Field research was carried out by Samuel I. Zeveloff, Gary Radke and David Krementz. Island habitat analyses were conducted by Joseph Meyer and Amber Travsky. Statistical assistance was provided by Lyman McDonald, while the Brownie et al. (1985) model analyses were conducted by George Petrakos. A variety of additional information for the period 1981 to 1987 has been included to supplement those 1978-80 data. Special technical assistance and information were provided by Edna Good and Peter Hayden, Grand Teton National Park; Tim Britt, Garvis Roby, Leonard Serdiuk, and George Wrakestraw, Wyoming Game and Fish Department; and David Love, U.S. Geological Survey. Reviews of the draft report were provided by Stanley Anderson, Wyoming Cooperative Fisheries and Wildlife Research Unit; Mark Boyce, University of Wyoming; Edna Good and Peter Hayden, Grand Teton National Park; and Harold Harju, Leonard Serdiuk and Tim Britt, Wyoming Game and Fish Department. Karen Noland, University of Wyoming provided invaluable secretarial assistance in the manuscript production. The services, assistance and encouragement of the foregoing were invaluable in completion of this project. Funding for the study was provided by the U.W.-N.P.S. Research Center, with secondary financial assistance provided by the Wyoming Game and Fish Department and the University of Wyoming.

RESULTS AND DISCUSSION

Flooding of the Snake River

Throughout Jackson Hole the bank full capacity of the mainstream of the Snake River is approximately 169,920 l/sec (6,000 c.f.s.). Historically, the mainstream flow has exceeded that amount in 5 out of 6 years (U.S. Dept. of Agr. 1979). The mean annual flood flow is 368,160 l/sec (13,000 c.f.s.) with the flood flow usually lasting 30 days (U.S. Environ. Prot. Agency 1977). Flood peaks equaling or exceeding 438,960 l/sec (15,500 c.f.s.) have occurred in 1894, 1904, 1918, 1927, 1943, and 1964 (U.S.

Dept. of Agr. 1979). The Jackson Lake Dam was constructed to provide irrigation water storage and serve as a flood control structure. Historically, when irrigation water needs were urgent, large volumes of water were quickly released from the dam. As a result, those regulated water discharges from Jackson Lake all too often combined with the unregulated flows of the downstream tributaries of the Snake River creating flooding conditions 2 or 3 times a year (Kiefling 1978).

Between 1947 and 1955 the maximum 5-day mean l/sec flow during the months of May thru July reached 198,240 l/sec (7,000 c.f.s.) 26% of the time, 169,920 l/sec to 198,240 l/sec (6,000 to 7,000 c.f.s.) 19% of the time and 141,600 to 169,920 l/sec (5,000 to 6,000 c.f.s.) 7% of the time. By comparison, between 1956 and 1974 169,920 l/sec - 198,240 l/sec (6,000-7,000 c.f.s.) flows were reached only 7% of the time and 141,600 l/sec - 169,920 l/sec (5,000-6,000 c.f.s.) flows were reached 21% of the time. The reasons for this dramatic change were two fold: (1) completion of the Palisades Reservoir provided greater reservoir storage stability; and (2) a concerted effort by the U.S. Bureau of Reclamation to reduce the magnitude of the seasonal oscillations of the volumes of water released from Jackson Lake (Grand Teton Natl. Park, Unpublished File data). Between 1976 and 1989 the level of Jackson Lake was held well below the full reservoir storage capacity due to concerns about the structural safety of the dam. During that time, regulated flows in the Snake River were erratic and generally low. Following rebuilding of the dam in 1989, improved water management technology should lead to a pattern of water releases from Jackson Lake which will further reduce the historic oscillations of the seasonal water releases.

The degree of flooding and the type and amount of flooding damage are dependent on: (1) time of flooding initiation; (2) duration of flooding; (3) total volume of flood flow; (4) the volume and duration of the peak flow; (5) the character and capacity of the river channels; and (6) the gradient of the river. Shortly after 1950, because of the damage caused by flooding in Jackson Hole, the U.S. Army Corps of Engineers initiated levee construction which would ultimately extend along 25 km of the Snake River (U.S. Environ. Prot. Agency 1977; and Kiefling 1978).

Upstream from the Wilson Bridge, the levees extend 14.4 km along the west bank and 9.6 km along the east bank. Downstream from the same bridge the levees extend 5.6 km along the west bank and 6.9 km along the east bank (U.S. Environ. Prot. Agency 1977; and Kiefling 1978). Unfortunately, the levees do not follow the bank line of the river. Consequently, they form a straighter and narrower channel constriction than that of the natural river banks. The result of the more concentrated water flow has been an erosion of islands and vegetated areas between the levees discussed later. Also, this flow pattern has created two river channels, one on each side of the river, flowing immediately adjacent to the levees (U.S. Environ. Prot. Agency 1977). As a consequence, more water born sedimentary material has been carried out and downstream from the levee area than has been carried in from upstream. These sedimentary materials are deposited in downstream channels, filling them in and thereby introducing the potential for greater flooding downstream from the levees (Karaki et al

1964; and Kiefling 1978).

Wintering and Breeding Populations

The size of the over-wintering Canada goose population in Jackson Hole is determined by the severity of winter weather. The population composition is thought to include transient migrants, as well as resident breeders. Limited warm spring flows and seeps provide open water and submerged aquatic plants to feed upon (Table 1). Most of the large open water resting areas are provided by the Snake River. Also, limited feeding takes place on a few domestic livestock winter feeding sites. Winter populations fluctuate substantially as evidenced in the irregularly conducted January aerial population censuses (Table 2). Breeding population censuses of the Jackson Hole Canada goose population for the period 1952-1989 were more stable (Table 3).

Activities and Habitats Used

Feeding

The Canada goose has a long neck and a long, narrow, multi-purpose bill particularly well adapted to grazing, seed stripping and some limited grubbing in aquatic substrates. The long neck and bill lamellae particularly facilitate grazing on submerged aquatic vegetation. Also, the longer bill permits ingestion of more food per bite (Owen, 1980). Feeding sites for the Jackson Hole Canada geese are primarily limited to upland meadows providing short, green forage and to submerged and emergent vegetation of lakes, reservoirs, ponds and warm spring waters. Birds migrating in and out of Jackson Hole are likely to be transient feeders on dry farm and irrigated cereal croplands of the Afton area and the Idaho farmlands west of the Tetons and the Salt River Range.

Geese wintering within Jackson Hole are primarily restricted to feeding on submerged aquatic vegetation with some limited feeding on and around areas where livestock are being fed, i.e. the warm spring waters along the Snake River west of the airport and the South Park elk feed grounds and the livestock feed grounds in South Park, respectively. Goose use of the concentrated livestock feed grounds can be life threatening for geese because they are likely to inhale lethal Aspergillosis spores released from moldy soil, grains, silage and even hay (Thorne et al 1982).

Owen (1980) points out that as a predominantly grazing species, Canada geese need considerable time to acquire their daily food ration. Consequently, morning feeding flights are particularly critical for them. Usually, morning flights can be expected to occur 30-60min before sunrise. However, they may be later on overcast and/or cold days. When ambient temperatures drop to 15° F or lower, these morning feeding flights may cease entirely. Late day inbound or early evening outbound flight times usually take place 30-60min after sunset. Nighttime feeding occurs mostly when the regular daytime feeding routine has been disrupted by some type

Table 1. The range of some winter concentrations of Canada geese observed at various times of day in Jackson Hole, Jan-Feb., 1980.

Location	Numbers Observed
Nowline Creek Ponds, Nat'l Elk Refuge	18-55
South Park Gravel Pit	11-67
Spring Creek, Rafter J. Subdivision	4-28
Jackson Hole Hereford Ranch*	13-30
Huckleberry Hot Springs	16+

*Feeding along cattle hay feed line.

Table 2. Periodic Wyoming Game and Fish Department January aerial counts of Canada geese in Jackson Hole, 1968-89.

Year	No.	$\bar{X}$	SD
1968	149		
1969	383		
1972	189		
1973	301		
1976	358		
		276	103
1977	260		
1978	529		
1982	612		
1983	338		
1984	272		
1986	379		
1987	282		
1988	313		
1989	370		
		373	121

Table 3. Wyoming Game and Fish Department aerial censuses of the Jackson Hole Canada goose breeding population, 1965-89.*

Date		Total Pairs Counted	Total Geese Counted	Observer
	1965	125	295	WAKESTRAW
4/29	1966	143	313	"
4/24	1967	74	257	"
4/18	1968	89	334	"
4/22	1969	107	265	SERDIUK
5/1	1970	105	390	"
4/27	1971	110	376	"
4/22	1972	76	317	"
4/18	1973	151	408	"
4/15	1974	174	524	"
4/21	1975	158	473	"
4/20	1976	96	419	"
			$\bar{X}$ -117 SD-33	$\bar{X}$ -364 SD-83
4/20	1977	127	540	SERDIUK
4/25	1978	158	478	"
4/21	1979	121	405	"
5/6	1980	133	284	"
4/23	1981	193	425	"
4/25	1982	157	667	LOCKMAN
4/20	1983	193	622	"
5/2	1985**	253	503	"
5/1	1986	165	354	"
4/29	1987	160	415	"
4/26	1988	229	441	"
5/6	1989	267	379	ROBY
	12-yr.		$\bar{X}$ -180 SD-48	$\bar{X}$ -459 SD 114
	24-yr.		$\bar{X}$ -149 SD-52	$\bar{X}$ -412 SD 107

*Censuses considered 80% accurate (Serdiuk, personal communication 9/4/87).

**1984 data lost when tape recorder malfunctioned.

of disturbance or when the daylight period is seasonably shortened (Owen, 1980).

Owen (1980) goes on to say, as with roosting sites, the lower the level of disturbance, the more favorable a feeding site becomes. Despite food abundance and easy availability, if disturbance levels reach a point where the geese are spending more time being vigilant or are frequently put to flight, then the costs of feeding exceed the benefits and they cannot afford to continue feeding at such a site.

Bossermaier and Marshall (1958) state time spent feeding is also a function of the quality, quantity and availability of food. Where cereal grains are readily available, feeding time may be as short as 2-4h with an evening outbound flight occurring 3h before sunset. When the quality of the food resources decline and/or distances to feeding resources from primary roost sites increase, only one round trip flight may occur. This is particularly relevant in winter when low ambient temperatures and light intensities delay initiation of feeding flights (Raveling et al 1972). Under such circumstances, secondary roosting sites near to or even at the feeding site may be utilized, thereby lessening energy expenditures and maximizing the time spent feeding (Reed et al 1976; Owen 1980). This type of movement is seen over the town of Jackson when the migrant and wintering geese leave the Flat Creek area of the Elk Refuge in the morning flying to South Park and returning just at dark.

Besides the foregoing constraints influencing when and where Canada geese feed within Jackson Hole, the quality of the upland green feed grazed is of major importance. Year after year geese are observed intensively grazing the same areas, i.e. the Grand Teton National Park Elk Ranch livestock pastures, the Triangle X and Moosehead horse pastures and a variety of livestock pasture in and around South Park. Also, the Canada geese intensively graze the large meadow at the southwesterly end of the Southeast Arm of Yellowstone Lake.

In addition to upland areas, geese feed extensively on submergent aquatic plants in shallow areas of Jackson Lake, i.e. the Snake River delta at the northern end of Jackson Lake, the shallows between the mouth of Third Creek and the Jackson Lake dam and around Arizona Creek and Lizard Creek outlets. Besides having abundant submerged aquatic vegetation, the shallow nature of these areas severely limits disturbance from boaters. The same situation is true for Yellowstone Lake along the shallows of the delta of Yellowstone River and shallows in the southwest portion of the Southeast Arm, as well as the shallows of the southeast portion of the South Arm.

An important seasonal feeding site develops between these shallows and the adjacent upland areas as the lakewater levels recede in late summer and early fall. Eleocharis accicularis stands dominate these transitional exposed shorelines following seasonal water recession. It is at that time that the geese concentrate on those drying mud flats and feed intensively on those newly emerging Eleocharis shoots.

The explanation of this traditional grazing pattern appears to involve the forces of grazing itself and the response of the plants being grazed. Westoby (1989) reports that lesser snow goose, Anser c. caerulescens grazing stimulated the growth of grazed plants compared to protected, ungrazed plants. Specifically, Westoby found that the net above ground primary productivity of the grazed stoloniferous grass Puccinellia phryganodes, was 30-106% greater than the ungrazed grass. In addition, while 40% of the above-ground standing crop was removed by grazing, the grazed areas produced a standing crop 30-50% greater than the controls 36-48 days later. Furthermore, intensely grazed grass genotypes had a 200% greater leaf production than the same genotypes which were protected and ungrazed. While Westoby's study was on the grazing of snow geese, grazing by any herbivore could likely be expected to produce much the same plant response. Within limits grazing can stimulate plant growth rate compared to a lowered growth rate among ungrazed plants. The Jackson Hole Canada geese seek out the grazed pastures, i.e. the Triangle X and Elk Ranch pastures, where there is little or no accumulated biomass and the green vegetation is short. Repeated grazing by the geese further accentuates the patchwork pattern of intensively grazed areas amongst light or non-grazed vegetation.

The attraction to these greener and shorter grazed areas likely involves more than vegetation height and abundance of the biomass. The availability of green vegetation prior to egg laying has been shown to be a major factor for increasing the reproductive effort of forest grouse (Siivonen, 1957) and for the weaver finch (Disney and Marshall 1956). It has been shown that a compound 6-methoxybenzoxazolinone (6-MBOA) stimulates the breeding activity in small rodents (Berger et al. 1981 and 1987) and in bobwhite quail (Epstein et al. 1986). A detailed discussion of this compound in green plants is presented by Epstein et al. (1986). The important points here are that 6-MBOA is concentrated in the first centimeter of grasses, the meristematic tissue. Also, 6-MBOA is more concentrated under colder temperatures and shorter photoperiods characteristic of early spring. Under intensive grazing the grasses remain in a vegetative state never flowering or fruiting. Furthermore, rhizome growth is stimulated, resulting in a continuum of new shoot development (Negus et al. 1977). Grazing organisms attracted chemically to these new vegetative shoots return time after time to the same clusters of previously grazed plants resulting in the patchy pattern of grazing.

The correlation between increased breeding activity in birds and the presence of new green vegetation reported for grouse by Siivonen (1957) and for quail by Berger et al (1986) reflects an enhanced physical condition of the birds. Enhanced physical condition permits greater reproductive effort resulting in the laying of a larger number of eggs and/or an increased size of eggs laid (Welty and Baptista 1988). Chemically, 6-MBOA in the new grass shoots has been described as an important compound which can trigger neuroendocrine activity in quail and various small mammal herbivores inhabiting highly unpredictable environments. Also, other green plant chemical stimulants may be important additional factors serving to enhance the physical condition of herbivorous species like the Canada goose (Berger et al. 1987).

Roosting

Usually geese roost on a variety of shorelines associated with sheltered waters having a suitable combination of resting, drinking and bathing areas. One exception is winter roosting which may take place on ice or on open water of lakes, reservoirs, rivers and warm water areas. Within Jackson Hole the abundance of lakes, ponds, reservoirs and several moderate meandering river systems would seem to provide adequate roosting areas. Roosting sites may be large enough to accommodate hundreds of birds as on the Second Creek-Third Creek and Upper Snake River delta areas of Jackson Lake. Also, they may be small in size accommodating only members of a pair of geese, as in the nesting period.

Preservation and protective isolation of roosting and feeding sites is extended to the Jackson Hole geese in varying ways and degrees by Grand Teton National Park, Yellowstone National Park, the U.S. Bureau of Reclamation, the National Elk Refuge and the Wyoming Game and Fish Department. Despite these efforts, with increasing human activity associated with land development along riparian and wetland areas and recreational rafting on the Snake River, the safety factor of isolation of some historic roosting and feeding sites can be expected to diminish significantly. The increased goose use of the isolated Evans gravel pits for late fall, winter and early spring roosting emphasizes the value of isolation for the geese.

Nesting and Island and River Dynamics

The average number of nests found per year were similar, 48 per year in the 1962-64 period and 42 in the 1979-80 period (Table 4). Despite the relatively small sample size in each area, reproductive effort and nest distribution appear to have remained fairly stable in these two periods. Even so, goose nests remained irregularly distributed in Jackson Hole. While small nesting sites are scattered throughout, the major observed nesting concentrations (60-65% in 1979-80) remain along the Snake River and in particular in those riparian areas from Wilson south to Cabin Creek. Two factors are likely responsible for this skewed distribution. First, riparian areas provide more potential nest sites offering protective isolation, as well as close by feeding and roosting sites in close proximity to a suitable body of water. Second, the more southerly portions of Jackson Hole are lower in elevation, plus they are further removed from the ambient temperature modifying influence of the high snow covered Teton peaks. Consequently, ice and snow melt earlier to produce bare ground which provides a warmer substrate which fosters earlier greening of upland vegetation. All of these factors combine to produce an enhanced body condition which in turn generates increased net energy resources resulting in an earlier and increased qualitative and quantitative reproductive effort (Marshall 1960-61; Siivonen 1959; Welty and Baptista 1988).

Types of nest sites remained relatively unchanged from those observed by Dimmick (1968) (Table 5). The slight shifts in nesting data likely

Table 4. Comparative distribution of Canada goose nests in Jackson Hole, Wyoming, 1962-64 and 1979-80.

Location	Total No.		No./Yr.		%/Yr.	
	'62-'64	'79-'80	'62-'64	'79-'80	'62-'64	'79-'80
Snake River						
Flagg Ranch to Jackson Lake	4		1.3		2.8	
Jackson Lake Dam to Moose	15	7	5.0	3.5	10.3	8.3
Moose to Wilson	10	7	3.3	3.5	6.9	8.3
Wilson to Hoback River	15	18	5.0	9.0	10.3	21.4
Hoback River to Cabin Creek	42	27	14.0	13.5	29.0	32.2
National Elk Refuge						
Flat Creek Marsh	13	11	4.3	5.5	9.0	13.1
Gros Ventre River Bottoms	7	2	2.3	1.0	4.8	2.4
Buffalo River	20	9	6.6	4.5	13.8	10.7
Miscellaneous	19	3	6.3	1.5	13.1	3.6
TOTAL	145	84	48.0	42.0	100.0	100.0

Table 5. Nest sites utilized by Canada geese in Jackson Hole, 1962-64 and 1979-80.

Nest Site	No.		%	
	'62-'64	'79-'80	'62-'64	'79-'80
Islands	104	52	72	68
Marsh Pond or Stream	19	7	13	9
Beaver Pond	8	2	6	3
Artificial Pond	5	4	4	5
Riverbank	7	1	5	1
Pothole	1	2	2	3
Haystack	1	5	1	7
Tree		3		4
	145	76	100	100

reflect natural annual variations and/or variations in field searches conducted by different personnel. The importance of river island sites and their protective isolation continues to be emphasized. Also, the use of haystacks as nesting platforms further points out the potential adaptability of geese to use properly placed artificial structures for nesting, where suitable land substrates may be limited or absent.

In 1980, 29% of the nests located on islands were placed on ephemeral gravel and sand islands in the Snake River. At such a location they are highly vulnerable to loss by flooding. In Dimmick's (1968) study and this study, nests were found over 100m from water, however, the majority of nests were less than 100m from sources of water. Overall, the average placement of 54 nests with respect to water in 1979-80 was 5m (10.3m vs 5.3m) closer than that recorded in 1962-64. No single explanation is likely for this disparity since yearly variations in available cover, representative composition of the sample, and water conditions are important influences. The mean height of the nearest bank in 1962-64 was 1m for 130 nests and in 1979-80 it was 0.7m for 58 nests.

The causes for the apparent decrease of 1962-64 and 1979-80 goose nesting along the Snake River from Pacific Creek south to Moose compared to that reported by Craighead and Craighead (1948) are unclear. The elimination of domestic livestock grazing along many riparian sectors in Grand Teton National Park has allowed the vegetation in those areas to proceed to rank climax stages. As a result, suitable feeding sites adjacent to or near to historic nesting and brooding sites have likely been reduced in number. Regarding the 1948 flooding caused nest losses reported by Craighead and Craighead (1949) high water volumes of 212,400 l/sec (7,500 c.f.s.) were released in June and July of that year. That volume of water has not been released since and 184,080 l/sec (6,500 c.f.s.) has only been released once in June 1963 and once in May 1971 in the period of 1956 through 1974. Flooding losses are still possible, however, recent marked reductions in volume and the asynchronous timing of releases with regard to tributary seasonal peak flood flows suggest that historic flooding nest losses (prior to 1955) are not likely factors for causing the disparity of nest numbers from 1948-1980. In addition, natural flooding from Pacific Creek, the Buffalo River and Spread Creek plus controlled releases from Jackson Lake likely contribute to diminishing nest sites. Lastly, the spectacular increase of river floating on this portion may play a more important adverse role as discussed under the section on broods. While river floating is not a major factor during the nesting period, the adverse impact on young goslings may have resulted in geese abandoning much of this river section in favor of production areas having much less disturbance.

Despite the importance of riverine islands for Canada goose nesting, little information exists concerning stability of island numbers over time, as well as, the nature of island structural and habitat changes. The Snake River islands in Jackson Hole are no exception. Comparative data for these islands, for the periods 1945-79 are summarized in Table 6 and 7. Note that from 1945 to 1979 there was a 25% increase in the number of islands over the length of the Snake River from the Flagg Ranch to the

Table 6. Comparative summary of some Jackson Hole Snake River island characteristics, 1945 and 1979.*

River Segment	Year	Dominant Cover Type in Hectares					Total Hectares Cat 2-4	Total Hectares	No. of Vegetated Islands
		Bare Sand and Gravel (1)	Grass Sedge and Forbs (2)	Woody Shrubs (3)	Conifer Trees (4)	Deciduous and (4)			
Flagg Ranch Jackson Lake	1945	26.24	11.29	38.68	0.00	0.00	49.97	76.21	15
	1979	40.03	13.49	42.96	2.34	2.34	58.79	98.82	22
	Diff	13.79	2.20	4.28	2.34	2.34	8.82	-22.61	7
Jackson Lake Dam Pacific Creek	1945	2.05	0.88	1.17	0.00	0.00	3.22	5.28	2
	1979	2.05	0.88	0.44	1.10	1.10	2.40	4.47	5
	Diff	0.00	0.00	-0.73	1.10	1.10	-0.82	-0.81	3
Pacific Creek Moose Bridge	1945	103.57	137.78	248.74	99.12	99.12	485.64	589.21	80
	1979	69.63	67.53	184.10	181.39	181.39	433.02	502.66	113
	Diff	-33.94	-70.25	-64.64	82.27	82.27	-52.62	-86.55	33
Moose Bridge Wilson Bridge	1945	144.57	79.91	335.04	105.17	105.17	520.12	664.69	115
	1979	164.21	39.30	196.48	137.68	137.68	373.46	537.46	144
	Diff	19.64	-40.61	-138.56	32.51	32.51	-146.66	-127.03	29
Wilson Bridge S. Park Bridge	1945	127.12	64.02	307.80	83.85	83.85	455.67	582.78	72
	1979	177.86	100.00	161.14	92.67	92.67	353.80	531.66	131
	Diff	50.74	35.98	-146.66	8.82	8.82	-101.87	-51.12	59
Total	1945	403.55	293.88	932.60	288.14	288.14	1514.62	1918.21	480
	1979	453.78	221.20	585.11	415.18	415.18	1221.49	1674.27	737
	Diff	50.23	-72.68	-347.49	127.04	127.04	-293.20	-242.94	257

Table 6. Con't

River Segment	Year	Dominant Cover Type in Hectares					Total Hectares Cat 2-4	Total Hectares	No. of Vegetated Islands
		Bare Sand and Gravel (1)	Grass Sedge and Forbs (2)	Woody Shrubs (3)	Conifer Trees (4)	Deciduous and			
Continuous Dikes	1945	176.87	63.19	253.66	76.14		393.00	596.86	136
	1979	<u>242.36</u>	<u>66.14</u>	<u>197.65</u>	<u>155.86</u>		<u>419.65</u>	<u>662.01</u>	<u>149</u>
	Diff	65.49	2.95	-56.01	79.72		26.65	92.15	13
Sectional Dikes	1945	60.40	32.35	174.37	55.26		261.98	322.38	24
	1979	<u>61.88</u>	<u>50.58</u>	<u>93.34</u>	<u>38.56</u>		<u>182.69</u>	<u>244.57</u>	<u>63</u>
	Diff	1.48	18.23	-80.83	-16.70		-79.29	-77.81	39

*Lack of historic aerial photos for Astoria-Cabin Creek sector precluded that sectors inclusion in this table.

Table 7. Summary of Table 6 with respect to % of change from 1945 to 1979.

River Area	Dominant Cover Type				Total Vegetated Acreage	Total Acreage	No. Vegetated Islands
	Bare Sand and Gravel	Grass Sedge and Forbs	Woody Shrubs	Deciduous and Conifer Trees			
Pacific Creek Moose	-33	-51	-26	+83	-11	-15	+41
Moose Wilson Bridge	+14	-51	-41	+31	-38	-19	+25
Wilson Bridge South Park Bridge	+40	+56	-48	+11	-22	- 9	+81
Continuous Dikes	+37	+ 5	-22	+105	+ 7	+16	+10
Sectional Dikes	+ 2	+56	-46	-30	-30	-24	+162

Snake River Bridge just south of the South Park elk feedground. This increase is likely due to both a carving off of new islands from the river shoreline, in addition to the cutting up of existing islands into smaller islands. As a braided river, the Snake river in Jackson Hole is a dynamic water system which is subject to considerable natural, uncontrolled flooding and hydraulic forces from the Buffalo River, Gros Ventre River and the Hoback River. The cumulative erosional forces in the river bed are quite evident when one adds to these effects the manipulated outflow from the Jackson Lake dam and the westward tilting of the river bed in southern Jackson Hole. The ephemeral sand and gravel islands were not included in the island count because one is not quite sure where to begin identification of an island and leave off what would be covered in higher water. On vegetated islands, discrete island parameters appear to be self evident. Even so, it is still difficult to determine the exact island parameters where bare sand and gravel serve as the outer island limits. Those bare outer sand and gravel areas will vary with the variable river water depths within, as well as between years. Some of these gravel and sand outer limits of vegetated islands and their accumulated drift wood debris were at times utilized by geese for nesting. Nests on these island gravel and sand borders were usually less vulnerable to flooding than those nest sites on completely bare gravel and sand bars.

More useful than changes in the number of islands is the area of change within each dominant cover type on islands of the Snake River. Over the 34 years between 1945 and 1979 natural succession would be expected to produce shifts in hectares between the various cover types. Nevertheless, the impact of flooding intensities would likely be greater on those islands with shorter, less durable vegetative cover. Depending on the year and variations in the gradient of the river bed, flooding could wash away island structures in one part of the river and deposit those sedimentary materials in another portion of the river. Indeed, with the exception of the sectional dikes, hectares of coniferous and deciduous island cover increased. This is likely the result of splitting larger islands into smaller islands and/or carving out island chunks from the river banks. The greatest area losses involved the woody shrub vegetative cover. This is not unexpected since this stage is an intermediate succession stage requiring longer times for transition from grass to the shrub stage. Also, the shrub stage lacks the cohesive root structure and trunk resistance to flooding inherent in the coniferous and deciduous successional stage. The mixed picture for sedge grass and forbes likely reflects vulnerability to flooding, as well as successful abilities to rapidly reestablish colonies of invading plants on recently formed and relatively stable sand and gravel islands.

Considering the rather short length of the Snake River in Jackson Hole, the loss of 293ha (19%) of the vegetated island habitat over 34 years (8.8ha/yr) is cause for concern. More importantly, in 1945 64% (976ha) of the total vegetated island habitat was on that portion of the Snake River between the Moose Bridge and the South Park Bridge. By 1979 that habitat had decreased by 248.8ha (25%). The largest proportionate vegetated decrease (79.2ha, 32%) was associated with the area of sectional diking along the river below the Wilson Bridge and just below the section of

continuous river dikes. Also, note the 37% (65.6ha) increase in the bare sand and gravel area in the continuous dike region. The dikes appear to have acted just like a hydraulic sluice which eroded away the vegetated island habitat. That feature has also prevented any revegetation of the sand or gravel bars in the continuous dike region. It should be pointed out that the marked losses or changes of riparian land forms and associated vegetation upstream from the levees were more likely the result of the irregular and frequent water releases from Jackson Lake that equalled or exceeded 198,920 l/sec (7,000 c.f.s.) between 1945 and 1955.

The low water levels in Jackson Lake and the Snake River precluded any evaluation of the influence of flooding on goose nesting in 1979-80. Dimmick (1968) states that while he observed little nest loss to flooding, natural unregulated flooding from the Buffalo River, Gros Ventre and the Hoback River combined with simultaneously significantly large controlled releases of Jackson Lake water could adversely impact goose nests along the Snake River. As just discussed, one could expect such losses would likely be amplified in the levied sections of the river. Not only does the levee constriction of the river flow result in increased flow velocity, it also causes the normally meandering river channel to split into two straight channels which follow the levee structures on each side of the river (Kiefling, 1978). The result is an unstable and highly eroded river bed between the levees. Dr. John C. Peters, U.S. Bureau of Reclamation, estimated that the degree of that instability and erosion is five times greater than in an area where there are no levees (Kiefling 1978). Unfortunately, the area from immediately below the levees all the way to the Highway 187 bridge just south of the South Park Elk Feed Grounds is also being negatively impacted by the deposition of the materials being eroded from between the levees (Kiefling 1978).

Even though the foregoing loss of island habitat is a matter of great concern, changes in the river channel between Astoria and the Elbow Campground, the prime goose nesting area in Jackson Hole, are potentially of equal or greater concern. The low river channel gradient in that area appears to be serving as sedimentary catchment for erosion materials originating in the upper Snake River drainage from what appears to be accelerated island and channel erosion. If this sedimentary accumulation continues filling deeper portions of that river section, the result will be a system of shallow braided river channels leading to increased flooding. Also, such change will allow easier mammalian predator access to the islands, adversely impacting the historic protective isolation of the islands. In addition, there will likely be a marked loss of aquatic feeding and nesting sites vital to goose nesting and brooding activities. Collectively these changes would be expected to produce a significant decline in goose numbers on what has historically been one of the most productive subunits of the Jackson Hole Canada goose population. Unfortunately, the lack of historic aerial photos for the Astoria-Elbow Campground river section makes it impossible at this time to determine the historic rate of sediment accumulation and the exact pattern of sediment distribution. Nevertheless, that does not change the fact that the Astoria-Elbow Campground river channels appear to be experiencing extensive sedimentary accumulations which can only adversely impact the

Jackson Hole Canada goose nesting.

Where flooding and nesting habitat destruction persist to the detriment of Canada goose production, the use of artificial nesting structures may be particularly appropriate. Such structures should not only have a proven record of goose nesting success, they should also be inexpensive to construct, easy to install, require little long term maintenance and as much as possible be relatively inconspicuous. The elevated tree nest structure developed by Mackey et al (1988) meets all of the foregoing criteria. Such a structure is especially useful in riparian habitat where security from ground predators, flooding and nesting habitat loss are or may significantly depress goose production. While some may say that such elevated tree nest use by geese will only increase predation by ravens, one can equally argue that where ravens are significant predators, raven predation of elevated nests should be no greater than it had been for ground nests. In fact, the elimination of ground predator losses and flooding losses should more than offset any predation by ravens. Krohn and Bizeau (1980) point out that artificial nesting platforms increase goose production thru slightly larger clutches and significantly higher nesting success. While inappropriate in Grand Teton Park, the Mackey structure could be utilized on other public and private lands.

Egg Laying and Broods

In 1979, one fresh egg sample was collected from each of 14 randomly selected clutches. The collected egg contents were quick frozen and were later analyzed for lead, PCB's and chlorinated hydrocarbons by the Wyoming State Chemical and Bacteriological Laboratory, Laramie. All of the egg samples contained less than 0.7 ppm of lead. No PCB's were detected in any of the egg samples. With respect to the chlorinated hydrocarbons, 1 egg had 0.04 ppm and 2 eggs had 0.02 ppm DDE. The remaining 11 eggs contained no detectable amount of chlorinated hydrocarbons. Despite the limited sample, the results suggest the eggs of the Jackson Hole Canada geese have negligible contamination from these pollutants.

Comparison of clutch and brood sizes between 1962-64 and 1979-80 (Table 8) suggests overall productivity in '79-'80 was similar to that of the mid 1960's. Unfortunately, this conclusion, or any other, on just 2 years of census data are rather frail. Consider that varying levels of nesting failures and brood losses undetected in any one or several of the intervening years could significantly improve or diminish the overall long-term productivity trend. Nevertheless, a mean clutch size of 5.0 with a S.D. of 1.6 is very consistent with the 3-9 range given for B. C. mofitti (Bellrose, 1976). The nature of the Jackson Hole goose habitat makes representative brood counts difficult. The use of class Ia thru IIa broods (Gallop and Marshall, 1954) strengthens this effort since these young goslings are less mobile and their parents hover more closely over those broods. As goslings mature they become more mobile and much less tolerant of disturbances, usually scattering quickly thus making complete counts difficult or impossible. Also, parents and older young join other family units drifting down rivers or gathering on larger ponds, lakes and

Table 8. Clutch size and brood size of Canada geese in Jackson Hole, WY, 1962-64 and 1979-80.

Year	<u>$\bar{X}$ Clutch Size</u>				<u>$\bar{X}$ Brood Size</u>			
	n	$\bar{X}$	SD	Range	n	$\bar{X}$	SD	Range
1962-64	114	5.2		2-11	61	4.7		
1979-80	61	5.0	1.6	1-8	47	4.0	2.0	1-11

isolated river backwaters. Geese and their young from the Lower Snake tend to drift through the Canyon to join large groups of adults and young on Palisades Reservoir. Other geese from the Upper Snake River drift down to large aggregations on the river delta on Jackson Lake. In any event, it is difficult to collect data on young goslings once family units merge into larger aggregations regardless of location. In Appendix A the census routes described were used for a base count of total young per brood.

In years of severe flooding along riverine areas, the survival of young goslings may decline markedly. On a number of occasions we observed small goslings being swept downstream by strong flood currents into a maze of braided water channels of the Snake River. Under such circumstances, the young goslings quickly become lost as they are rapidly separated by long distances from their parents and other brood members. It is difficult, if not impossible for such goslings to rejoin their family group. Also, under such circumstances, these single goslings become very vulnerable to predation. On two occasions we observed ravens swoop down and pick up early Class II goslings and carry them off.

A key element in goose habitat and ultimately a goose population's productivity is that of brood feeding sites. These feeding sites do not necessarily have to be closely associated with a nest site as long as there are available travel lanes affording protective cover and isolation from outside disturbance by predators and/or human activities. These brood feeding sites are important for both the goslings and the adult female. During incubation and the following molt, the adult female's net energy reserves are heavily and in some cases severely depleted. Naturally the energy demands for the rapidly growing goslings are also very high. Eberhardt (1989) points out that the adult females and young Canada goose goslings spend 50% of their prefledging daylight hours (7 to 8 h/day) feeding. The actual amount of feeding time will vary according to food site patchiness and distance between patches, as well as the quality, quantity and phenology of the food resources. Once the goslings fledge and the adult female completes her molt, they all spend more time resting and preening with a concomittant decrease in foraging and feeding travel.

Daytime recreational river floaters discussed later under human disturbance, can cause the same problem as described for flooding and/or amplify the impact of flooding. As a consequence, gosling survival along the Pacific Creek to Moose sector of the Snake River could be expected to be lower than for other river sectors. In the long term, this loss of goslings could be a factor contributing to the marked historic decrease in nesting geese along the Pacific Creek to Moose sector.

Molting

Canada goose populations can be divided into five groups: (1) immature, non-breeders; (2) continent non-breeding adults; (3) unsuccessful breeding adults; (4) successful breeders; and (5) maturing juveniles. Continent non-breeding adults may include those individual adults who (1) represent

surplus birds unable to find a suitable nesting site or mate; (2) periodically cycle in and out of a breeding goose population; and (3) are members of an adult component which has not, nor will ever breed. Unsuccessful breeders represent those adults who successfully nested but subsequently lost their nest, eggs or even their young goslings. Collectively, all of these groups constitute varying proportions of the entire goose population.

The periodic loss and replacement of feathers by these groups occurs at different times and usually in separate places. Immature non-breeders and continent non-breeding adults can be expected to molt 2-4 weeks before successful breeders molt (Stirling and Dzubin, 1967). This means they could begin their molt as early as the first of May or as late as the last of June or early July (Dimmick, 1968). Successful breeders usually begin their molt when their goslings are 3-4 weeks of age (Owen, 1980) with the molt initiation usually peaking between late June or early July (Dimmick, 1968). Generally, this molt of the successful breeders will last $\pm$ 30-35 days (Owen, 1980) coinciding nicely with the peak time of fledging, which in Jackson Hole would be early to-mid August. Clear identification of molting geese is difficult after mid-July since at that time mixed groups of molting adults and large juveniles are common.

Dimmick (1968) describes the Turbid Lake and Yellowstone Lake areas used by molting immature and continent non-breeders and unsuccessful breeding Canada geese. Censuses of the molting geese for the period 1980-1989 are presented in Table 9. While there have been wide fluctuations in numbers, generally, the sizes of the molting flocks remain large and they appear to have been increasing from 1980 to 1989.

All of the molting sites have in common favorable feeding and protective isolation security traits. The optimal areas possess extensive shallow water areas with rich sediment bottoms capable of supporting highly productive aquatic plant beds for feeding, while being deep enough to provide security from terrestrial mammalian predators. Most of these areas interface with open beach and meadow areas which provide excellent upland grazing areas and open vistas permitting early detection of intruders and predators. Furthermore, their physical location, and the extensive associated shallows serve as excellent barriers to human activities, thus enhancing the degree of isolation for the birds in this vulnerable flightless period. Typical of these optimal molting areas are the delta areas of the Upper Yellowstone River in the Southeast Arm and the Chipmunk and Grouse Creeks in the South Arm of Yellowstone Lake; the Snake River, Berry Creek and Lizard Creek deltas entering Jackson Lake; and the deltas from Second and Third Creeks in Jackson Lake.

Human Disturbance Effects

The human population of Teton county has grown from 5918 in 1970 to 7300 in 1975 (a 23% increase) (Livingston and Assoc. 1976) to an estimated 14,000 in 1990 (an increase of 92% since 1975) (Personal communication Teresa DeGrogh, Teton County Planner, 1990). Even though the Jackson Hole

Table 9. Locations and numbers of molting Canada geese in southern Yellowstone National Park and in Jackson Hole, late June and early July, 1980-89.

Location	Year												SD
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	$\bar{X}$		
*Yellowstone Lake, YNP													
South and Southeast Arms	3500	3000	7275	7470	7685	7298	2810	6860	6900	5035	5783	1993	
*Turbid Lake, YNP	650	650	1050	850	1350	1200	700	1100	1000	950	950	238	
*Jackson Lake					780	300	900	750	1500	1380	935	443	
Jackson Hole													
Upper Snake River	101												
Dam to Third Creek	212												
Emma Matilda Lake	5												
Buffalo River	49												
Elk Ranch Reservoir	1												
Lower Snake River													
Jackson Lake Dam to Buffalo R.	8												
Buffalo River to Moose	66												
Wilson Br. to S. Park	54												
Astoria to Elbow Camp	23												
Gros Ventre River													
Upper Slide Lake to Snake R.	52												
Elk Refuge	24												

* Wyoming Game and Fish aerial censuses.

Canada goose population appears to have been stable or has even increased during this period, there is now need for concern about the impact of continuing human population growth and associated developments. Three of the 4 most productive goose habitat areas are on private lands and 2 of these areas are adjacent to the rapidly growing South Park urban sprawl and the proposed Buffalo River Valley real estate and oil and gas developments. There is an increasingly significant potential that the foregoing human activities will displace the geese from their historically important wintering, feeding, roosting, nesting and molting sites.

Diminished use and/or loss of these sites will adversely impact the Jackson Hole Canada goose population and its productivity. Increasing fisherman use of the Wyoming Game and Fish Department South Park Elk Feed Grounds is a serious potential threat to the nesting, brooding and molting sites on the second most productive goose area in Jackson Hole during the months of late May, June and the first two weeks of July. As with the elk use of the feed ground, human encroachment makes protection of that goose habitat and maintenance of its protective isolation vital for the long term well being of the Jackson Hole Canada goose population.

Between 1964 and 1971, recreational rafting and boating on the Snake River increased markedly. Except for a peak in 1978, the overall commercial floating appears to have increased only slightly (Grand Teton Natl. Park, Unpublished File Data). A summary of the specific commercial launchings made in 1979 and in 1989 is presented in Table 10. Note that the June, July and August launches were essentially unchanged between 1979 & 1989. Overall, the 1989 commercial float trips only increased 6% above that of 1979.

By contrast the numbers of private float trips have increased steadily since 1974. In 1979 it was estimated there were 3,000 private float trips on the Snake River. By 1989 the private float trips were estimated to be 6,900 (an increase of 130%) (Grand Teton Natl. Park, Unpublished File Data). Numbers of private rafts and boats are not limited on the Snake River within Jackson Hole. Furthermore, private floaters are constrained by fewer regulations than commercial floaters. Except for posted eagle nesting areas, they can make periodic stops anywhere along the river. As a consequence, private floaters have a much higher potential for impacting goose habitat, goose behavior and diminishing any protective isolation normally provided by riparian physiographic features.

Canada geese are susceptible to disturbances generated by raft and boating traffic during nesting, brood rearing and molting. Nesting disturbances are least likely because of the lower levels of floater traffic in May and very early June. As previously discussed, this disturbance would likely be most serious for newly hatched goslings and/or goslings as old as 2 weeks of age in the period of mid-June to mid-July. While not life threatening for molting geese, heavy floater traffic from mid-June to early August is a potential cause for a chronic low level movement of molters to areas with less human disturbance.

Craighead and Craighead (1948) reported finding more nesting geese along

Table 10. Commercial rafts and/or boats launched from Snake River sites, 1979 and 1989.

Site	May		June		July		August		Sept	
	1979	1989	1979	1989	1979	1989	1979	1981	1979	1989
Flagg Ranch-Lizard Pt.	3		11		17					
Pacific Creek	18	5	252	153	405	328	381	330	56	65
Triangle X	3	2	21	6	16	6	11	20		
Dead Man's Bar	79	167	667	793	1037	1412	1010	1234	242	580
Lower Schwabaker	27		182	52	365	56	227	71	11	10
Moose			4		16	32	14	40	25	6
Total	130	174	1125	1019	1842	1851	1643	1695	334	661
%	3	3	22	19	36	34	32	32	7	12

the Pacific Creek-Moose sector than has been found since. In 1979-80, twice as many goose nests were found upstream from Dead Man's Bar as were found downstream from it. Differentials in floater traffic may have been a factor. In 1979, 3 times the number of commercial float trips were launched from Dead Man's Bar compared to launches at Pacific Creek. In 1989 the number of commercial float trips launched at Dead Man's Bar were 5 times that of launches made at Pacific Creek.

Heavy river floater traffic may generate abandonment by adults of important goose nesting habitat. This in turn could produce a gradual and collective decline in the numbers of young geese who would normally be expected to serve as replacements for repopulating their traditional home areas.

River floater traffic on the Snake River between Flagg Ranch and Lizard Point is limited by the river's low water levels late in the season, as well as by the long stretch of open water of Jackson Lake from the delta of the Snake to Lizard Point. Importantly, the sector from the mouth of Dime Creek to Berry creek remains as the most unique and productive goose habitat, as well as for other wildlife, in Jackson Hole and it deserves every effort to limit the intrusions of human activities. Even though the floater traffic is currently low on this river sector, now is the time, before commercial and private floaters develop proprietary rights, to establish limits and regulations of the numbers of float trips to assure protection of the wildlife values of this special river and delta sector. From the mouth of Dime Creek down to the western half of the river delta and the shallows and upland wetlands of the western shore of Jackson Lake down to the Berry Creek meadows are particularly in need of management regulations which preserve their seasonal isolation from human activities.

Habitat Characteristics and Evaluation

Within Jackson Hole goose habitat is highly variable in the amount, quality and degree of utilization. Table 11 represents an attempt to identify, characterize and evaluate those habitat areas. The criteria used to evaluate the different habitat areas are presented in Appendix B. A summary of the habitat ranking is presented in Table 12.

Population Dynamics

General Breeding Population Trends

Analyses of population data for long lived birds requires continuous and comparable long term collection of the pertinent population information. Even then, the accuracy of those data may be biased by such things as changes in census takers, pilots and aircraft, weather, time of the census, area censused, etc. Fortunately, since 1965 the Wyoming Game and Fish Department has attempted to minimize those biases in their aerial waterfowl breeding population censuses conducted in Jackson Hole (Table

Table 11. Summary of Jackson Hole Canada goose habitat locations and characteristics.*

Area	Habitat Characteristics	Total Points**
Elbow Campground To Astoria ± 9.6 km Gradient ± 1.3 m/km	This relatively low gradients section of the river has deep runs and pools with a few highly stable islands and little channel braiding. In terms of nests found, this area is the most important goose nesting area in Jackson Hole. As many as 7 nests per island have been recorded. Nest concentrations are likely due to: (1) the warmest and driest riverine area in Jackson Hole; (2) well vegetated, stable island structures protected by low oscillation of river water flows; (3) deep water channels provide protective isolation from ground predators; (4) dense vegetation screens nests both from other nesting geese, as well as from aerial predators; and (5) nesting, feeding and roost sites are closely associated. Broods and molting geese appear to drift down the Snake River Canyon to Palisades Reservoir. Increasing deposition of upstream sediments in the river channels is a serious potential threat to the protective isolation from ground predators, as well as being a serious potential flooding threat to the island's stability and integrity. Also, any real estate development on the R-D ranch would be a serious potential threat to the protective isolation of the feeding and roosting sites on the ranch lands of that private holding.	21
South Park Bridge to Wilson Bridge ± 16 km Gradient ± 3.9 m/km	Several important elements comprise this area: (1) the main Snake River with 5.6 km of levees along the upper west bank and 9.6 km along the upper east bank; (2) Evans gravel pit property along the lower south and west bank; (3) sections of the small streams (Spring Creek and Flat Creek) plus some spring flowage all of which are closely associated with the Wyoming Game and Fish Department South Park Elk Feedground. Increased water velocities between the levees have reduced the previously vegetated islands to ephemeral and constantly shifting sand and gravel bars. Of 18 nests located in 1980, only 2 were found on gravel bars. The gravel pit property includes ± 0.5 km of grazed meadow.	24

Table 11. (Con't)

Area	Habitat Characteristics	Total Points**
Wilson Bridge To Moose ± 23.2 km Gradient ± 3.7 m/km	Vegetation there is kept short but remains dense. Numerous springs and slow water flowages on both sides of the river provide good submergent and emergent aquatic feed. The limited gravel pit meadow land is used as a brooding area until mid-July. About that time, goslings regularly cross the river to the pastures of the elk feed ground. By the 2nd week of August the geese can fly and they leave the area for other feeding and roosting areas. In winter this lower section is an important feeding and roosting area. Increasing South Park real estate development is a serious potential threat to goose habitat on the private riparian lands. Fisherman vehicular and foot traffic within the elk feed ground and on the Evans gravel pit area strongly diminishes the protective isolation for the geese, particularly during late spring thru June. Flood control levees extend 14.4 km along the west bank and 9.6 km along the east bank of the lower portions of this sector. The extensive levees have destabilized the river channel, particularly during flood water flows. The steeper stream gradient aggravates this problem. Furthermore, the levees isolate many potential nest sites from the river. The flowage from the Three Channel Spring Creek traditionally provided considerable protective isolation for feeding and roosting sites. However, adjacent real estate developments are potential threats to that goose habitat, particularly in the summer and early fall periods. Feeding sites are generally limited, because of extensive levee induced destruction of riparian goose habitat and increased water velocity between the levees. This river sector contains the second lowest goose productivity on the Snake River in Jackson Hole.	17
Moose to	This moderately braided sector of the Snake River lies wholly	

Table 11. (Con't)

Area	Habitat Characteristics	Total Points**
Pacific Creek ± 32 km Gradient ± 2.7 m/km	within Grand Teton National Park. Controlled water releases from Jackson Lake combined with uncontrolled flood waters from Pacific Creek, the Buffalo River, Spread Creek, Ditch Creek and Cottonwood Creek can severely impact the geese and their riparian habitat in this sector. Recreational floating on this river sector is extremely heavy reaching an estimated 12,000 trips in 1989. Historically, this sector is reported to have had 3-8 times more geese nesting there than in 1979-80 (Craighead and Craighead, 1949). This change may be the result of one or more of the following: (1) reduction in live-stock grazing limited feeding sites for geese; (2) high population levels of beaver, moose, and elk have played a role in altering riparian vegetation patterns; (3) intensive recreational river floater traffic has markedly reduced any protective isolation for the geese; and (4) flood waters may have diminished gosling survival. Limited brooding areas occur along the Spread Creek junction and below Deadman's Bar at the bald eagle closure site and along Spruce Ditch. In August, post molting geese roost along the banks of the river from the Moosehead Ranch to the Triangle X Ranch picnic area.	12
Pacific Creek to Jackson Lake Dam ± 6.9 km Gradient ± 0.4 m/km	There is no braiding in this sector whose flow is totally linked to the controlled discharges from Jackson Lake. The goose habitat is primarily confined to the Oxbow area. Even there, the seasonal discharges from Jackson Lake make for a very unstable river environment. River floating traffic through the Oxbow is light to moderate. Also, foot traffic of visitors is increasing around the margins of the Oxbow. Consequently, easy accessibility and the limited nature of the Oxbow habitat provide little protective isolation for either brooding, feeding or roosting.	
Jackson Lake Dam to	This is an extensive, shallow lakeshore bounded by gentle sloping mud beaches and wet meadows. All of this is protectively isolated	25

Table 11. (Con't)

Area	Habitat Characteristics	Total Points**
3rd Creek ± 3.2 km	by an even more extensive stand of tall, dense willows. The shallow waters contain dense mats of <u>Elodea canadensis</u> , <u>Chara</u> sp., <u>Myriophyllum exalbescentis</u> , <u>Potamogeton richardsonii</u> and <u>Ranunculus aquatilis</u> (Brewer 1986). As the lake water level recedes, extensive stands of the emergent <u>Eleocharis acicularis</u> flourish. The shallow waters and the dense willow stands provide excellent protective isolation from human disturbance. The aquatic vegetation and the wet meadows comprise a feeding area second only to the Upper Snake River Delta. A few family broods from the 3rd Creek-Swan Lake area mix with the largest aggregation of molters within Jackson Hole. It also serves as a very important staging area for post molters.	21
Arizona Creek Flats, Arizona Island and Lizard Creek Flats ± 4.8 km	This involves a combination of extensive shallow water along the east shore of Jackson Lake from Arizona Creek and Arizona Island to the shallows just south of Lizard Point and the narrow belt of wet meadowlands. This area provides very good feeding and roosting sites along with protective isolation for large numbers of molting geese. Excellent extensive stands of <u>Eleocharis</u> develop in the Lizard Creek flats in late summer as lake levels recede. These and the aquatic sub-mergents listed for the Dam-3rd Creek area are largely used by concentrations of post molting geese. The long distance from nesting sites appears to preempt brood usage of the area.	27
Berry Creek to Flagg Ranch	This river and lake sector consists of three district segments: (1) an upper moderately braided riverbed extending from the Flagg Ranch south to the mouth of Dime Creek; (2) a less braided and lower river gradient but more meandering riverbed from Dime Creek to the Grand Teton National Park boundary; and (3) the river delta of the Upper Snake River. The first segment has considerable human activity associated with its shorelines from the Flagg Ranch	
Flagg Ranch to Dime Creek ± 5.2 km		

Table 11. (Con't)

Area	Habitat Characteristics	Total Points**
Dime Creek to JDR Mem. Boundary ± 4 km	facilities, the Snake River Campground and a number of Rockefeller Parkway campgrounds between the Grassy Lake road and the Snake River. The Dime Creek-GTNP boundary sector involves an extensive wetland area of ponds, marshes and streams away from the main Snake River channel, i.e. Dime Creek, Glade Creek, Glade Creek Ponds, etc. These wetland areas are heavily utilized by adults in late spring and early summer. Despite the low number of observed nests in this area of feeder stream and ponds it is difficult to successfully locate nests even though it has an inherently high reproductive potential for geese.	
JDR Mem. Boundary to Berry Creek ± 6 km	The latter segment consists of old shallow-channels and a number of islands situated in shallow waters plus the shallow waters of the western shore of the delta-lake interface which extends to Berry Creek and its wet shore-line meadows. Also, this lower segment is dynamic goose habitat which, depending on lake water levels, provides virtually every need for all goose age classes. Numerous islands have excellent visibility, escape cover and food production. While the lower area has shallow waters which limit boat travel, the soft substrate and escape cover also limits ground predator effectiveness. Like the Lizard Creek Flat-Arizona Creek area, the shallow waters have extensive mats of submergents and the mud flats produce dense stands of the emergent <i>Eleocharis</i>. Overall, this is the most important single portion of goose habitat in Jackson Hole. It has consistently had: (1) the highest number of broods; (2) the second highest number of molting geese; (3) large aggregations of post molting geese from late July till mid-August; and (4) the most extensive and varied feeding grounds in Jackson Hole. Float trip use, while comparatively low, poses a serious potential threat if it increases beyond the current level and extends in time beyond the June and July periods. Any float trips down the western	

Table 11. (Con't)

Area	Habitat Characteristics	Total Points**
Turpin Meadow to Pinto Ranch ± 19.2 km	portion of the river delta to Berry Creek are especially serious human disturbances of this vital goose habitat. This meandering sector of the Buffalo River is a moderately braided channel bordered by numerous hayfields and grazed pastureland. The importance of this sector as a rich segment of goose habitat is supported by the high number of broods observed there. Equally important is the high number of goose nests that are located on hay stacks. The low number of river islands and extensive riparian grazing by livestock and big game have promoted use of these artificial nesting structures. Also, the hayfields and pasture land are heavily utilized by post molting geese in late July and early August. Human disturbance is currently minimal with respect to raft or boat traffic on the river. This is largely due to numerous obstructions in the river and a pattern of private land-ownership. Proposed real estate developments and oil and gas leasing present a serious threat to the future maintenance of this valuable riparian goose habitat.	22
Elk Ranch Pastures and Reservoir	These grazed pasture lands are used in early June by pre-molters before the vegetation grows much beyond the height of breastline and back for the geese. Post molters use these areas in mid to late August where domestic livestock and buffalo have grazed down patches of the vegetation. The small reservoir's primary value appears to be that of a roosting site next to the feeding sites.	14
Moosehead Ranch and Triangle X Ranch Pastures	As with the Elk Ranch pastures, the grazed pasture land is used by pre-molting adults in June. However, by July 1, goose use has declined markedly. Use of these feeding sites resumes in August by post molters who roost in isolated areas of the nearby Snake River.	17

Table 11. (Con't)

Area	Habitat Characteristics	Total Points**
Upper Slide Lake to Snake River ± 46.4 km	A series of marginal islands at the upper end of Upper Slide Lake are the main nesting areas with some possible nest sites along the Gros Ventre River between the two lakes. While broods have been seen on both lakes, Lower Slide Lake appears to be the better brooding area of the two. Foraging for all classes of geese on the D. Taylor Ranch pastures, adjacent to Lower Slide Lake, can be heavy in early June and late August. Some movement of broods down the Gros Ventre River to the Jackson Hole Golf course occurs in early June.	20
U.S. National Elk Refuge	Nesting geese tend to concentrate in two areas: (1) around the refuge's artificial ponds; and (2) in the riparian woodlands adjacent to the Gros Ventre River. Feeding sites are a mixture of patches of grazed upland vegetation and submergent vegetation in the ponds and in Flat Creek. Being located within the boundaries of the National Elk Refuge provides very good protective isolation for nesting adults and brood rearing family units. Artificial nest structures like the Mackey elevated tree nest structures would likely do much to offset any predation and flooding losses along the Gros Ventre River.	19
Skyline Ranch Pond	Historically an important breeding and feeding area. Use has dwindled following drainage of the meadows to accommodate housing development. The breeding territory requirements of geese precludes anything but minimal use of that habitat. In August, some post molting geese do feed on the surrounding pastures and they do some loafing and feeding on the pond.	13

*Physical mensurations of the Snake River are taken from Kiefling (1978).

**Derivation of the Total Points is presented in Appendix B.

Table 12. Ranking of Canada goose habitats in Jackson Hole.

Ranking	Habitat Area
Outstanding	Berry Creek - Dime Creek
Very good	South Park to Wilson Bridge Turpin Meadows to Pinto Ranch Elbow Campground to Astoria
Moderate	Moose to Pacific Creek Upper Slide Lake to Snake River National Elk Refuge
Fair	Wilson Bridge to Moose
Marginal to poor	Skyline Ranch ponds Pacific Creek to Jackson Lake dam
Special Use	Jackson Lake dam to 3rd Creek Arizona Island-Arizona Creek Flats and Lizard Creek Flats Moosehead to Triangle X pastures Elk Ranch pastures

3).

Separating the 24-year period 1965-1989 into two 12-year time intervals (no data for 1984), a distinct increasing trend in the mean breeding flock size emerges: (1) a X of 364 for 1964-76; and (2) a X of 459 for 1977-89 (a 26% increase over 1965-76) (Table 3). Furthermore, the mean breeding pairs for the period 1977-89 sharply increased 54% over the mean breeding pairs for the 1965-76 period. The breeding population increases graphically depicted in Figure 1 suggest that the Canada goose breeding habitat within Jackson Hole had not reached a saturation point as of 1989. This is in agreement with Krohn's (1980) general sense that the availability of habitats was not limiting population sizes in the Rocky Mountain Canada goose population. No single factor is likely responsible for this apparent population increase. It may be that better integration of flyway hunt management has achieved better hunt management of specific goose populations within the flyway and that in turn has reduced radical oscillations of the annual hunter harvests.

Banding, Color Marking and Band Recoveries

There are no very large post breeding aggregations of the breeding population of Canada geese in Jackson Hole. However, large concentrations of unsuccessful breeding Canada geese and successful breeding geese gather on Yellowstone Lake and bodies of water immediately adjacent to that lake within Yellowstone National Park.

Between 1956-58 and 1960 through 1972, the Wyoming Game and Fish Department obtained permission from Yellowstone National Park to trap geese molting on Turbid Lake. This isolated lake was particularly suited to trapping, as well as having a sizeable aggregation of molting birds. In 1963, the Department color marked 127 yearlings and 71 Canada geese 2-years or older (Dimmick, 1968). In 1964, 11 color marked yearlings were observed in Jackson Hole, but none was believed to have nested. More importantly, 6 pairs of geese successfully nesting in Jackson Hole had one or more of the color marked adults in each pair. Other reports indicated 1 color marked 2-year-old female nested on the Bear River in Utah and 1 male adult was observed on the Madison River within Yellowstone Park and 1 color marked adult was the member of a pair which successfully hatched a brood east of the Park in Sunlight Basin (Dimmick, 1968). With the bulk of the observations of these color marked birds being made in Jackson Hole, it was assumed that any banding information from these molting birds may serve to reflect the population dynamics of the Jackson Hole breeding Canada goose population. In 1979, permission was granted to extend trapping to the larger molting aggregation in the southern portion of the Southeast Arm of Yellowstone Lake. Permission to trap and band molting geese was rescinded in 1973 for Turbid Lake and in 1980 for the Southeast Arm of Yellowstone Lake. Periodic efforts by the Wyoming Game and Fish Department to reinstitute that banding program within Yellowstone Park have been unsuccessful.

A variety of observations of color-marked geese (Dimmick, 1968) have

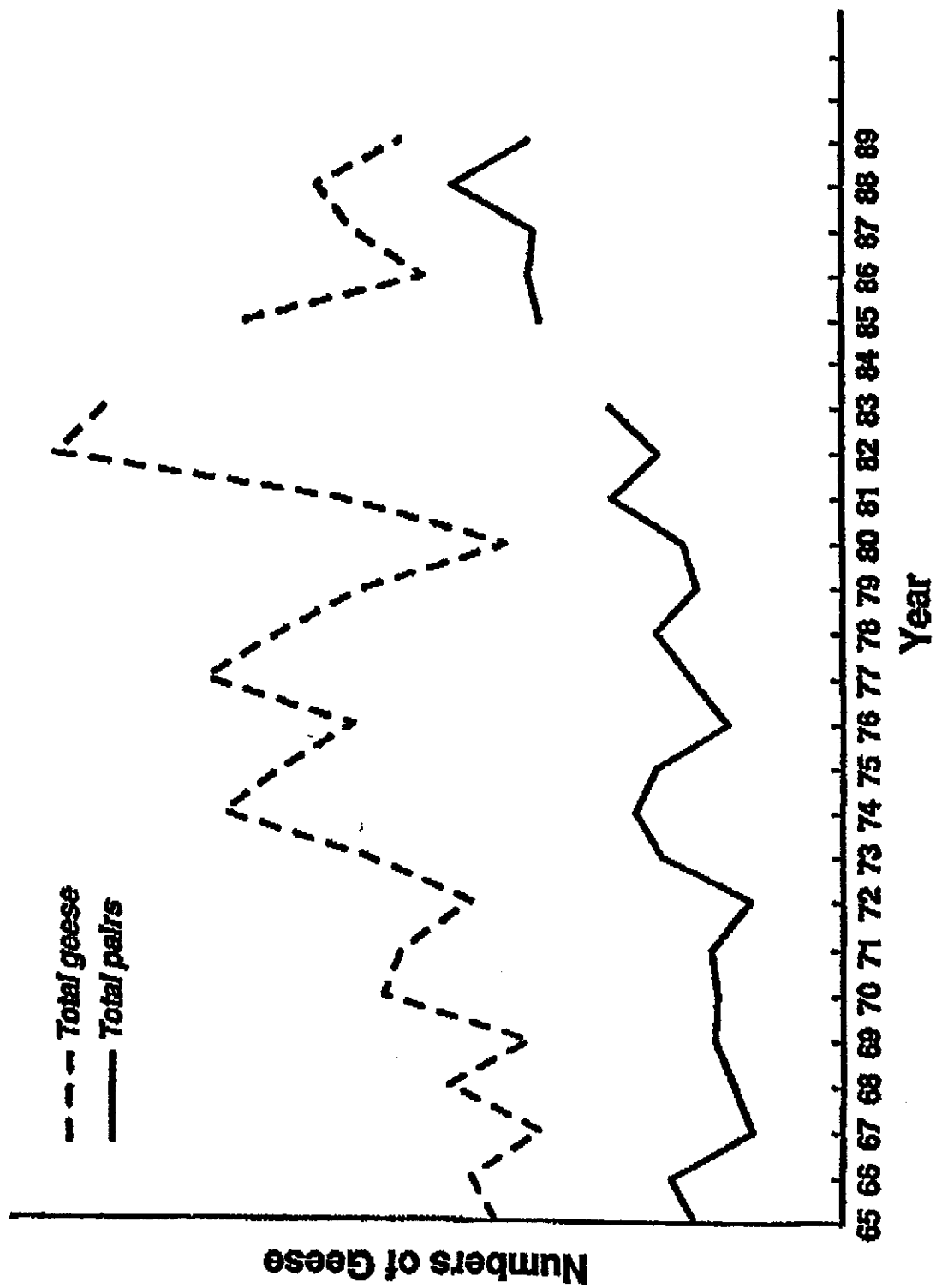


Figure 1. Aerial censuses of Jackson Hole Canada goose breeding population, 1965-89 (See Table 3).

historically been used to link the survival and mortality of molting Canada geese on Turbid Lake and Yellowstone Lake with the breeding population of Canada geese in Jackson Hole. Unfortunately, as discussed earlier in the Procedures section of this paper, the poorly defined parameters of these two goose aggregations and the irregular and restricted nature of the banding efforts place constraints on any analysis of those data. In response to some of those concerns, two contrasting methods for calculating survival and mortality have been employed. The simplified analytical format developed by Bellrose and Chase (1950) was used in calculating the survival and mortality data presented in Tables 13, 14 and 15. All of the mortality rate calculations were extended to that time when less than 3% of the population remained alive. It was at that point that the population was assumed to have "turned over" (Leopold et al. 1943). Also, those data included all recoveries from hunting and other causes of death (4.3% for 1956-60 and 0.5% for 1961-72).

Using the same basic banding data, comparisons between the four analytical models for banded adult birds developed in Brownie et al. (1950) were made using their program ESTIMATE. Some restrictions on the scope of the data analyzed were required because of the nature of the models being used. Only the continuous data of 1956-58 were used and the single year of data for 1979 was insufficient for any of the four models. The program ESTIMATE identified that the best fit with the 1956-58 data was produced by Model 0. The null hypothesis was rejected when:

Chi-squared value (Sample) =	16.04
Theoretical chi-square value	
at the 5% level =	16.90
Degrees of freedom =	9
Probability of a chi-square	
value larger than 16.04 =	0.066

With respect to the 1961-72 data, the best fit existed with Model 2. The null hypothesis was rejected on the basis of:

Chi-square value (Sample) =	87.84
Theoretical chi-square value	
at the 5% level =	112.02
Degrees of freedom =	89
Probability of a chi-square	
larger than 87.84 =	0.515

For the 1956-58 banding data, Model 0 calculations were as follows:

Mean survival rate (%) =	55.48
Standard error of the	
survival rate =	1.24
95% confidence interval for	
the mean survival rate =	42.74-68.22
and Mean life span =	1.70
Standard error of the mean	

Table 13. Mortality and survival of Canada geese banded as adults at Turbid Lake, Yellowstone National Park, Wyoming, 1956, 1957, 1958 and 1960. Data are based upon bands recovered up to May 1, 1964, from birds shot or found dead.

Year Banded	Total Banded	Recoveries in Years Following Banding (July 1-June 30)									Total
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8		
1956	560	44	24	17	13	11	8	3	2	122	
1957	319	13	9	26	15	8	5	6		82	
1958	246	22	36	17	5	2	2			84	
1960	341	22	14	13	8					57	
Total	1,350	101 of 1,350 banded	83 of 1,350 banded	73 of 1,350 banded	41 of 1,350 banded	21 of 1,350 banded	15 of 1,009 banded	9 of 763 banded	2 of 444 banded	345	
Percent of bands recovered		7.48	6.15	5.41	3.04	1.56	1.48	1.18	0.45	26.75	
Mortality series, or percent of total number of bands recovered in each year-class		29.27	24.05	21.16	11.88	6.08	4.35	2.61	0.58	100.00	
Cumulative percent of bands recovered		29.27	53.32	74.48	86.36	92.44	96.79	99.40	100.00		
Survival series, or percent of total number of banded geese in each year-class alive at end of year		70.73	46.68	25.52	13.64	7.56	3.21	0.6	0.00		
Mortality rate, or percent of banded geese in each year-class alive at beginning of year lost during year*		29.27	34.02	42.69	41.84	36.84	41.67	33.33			

*Average annual mortality rate was 37.09 percent. Adj. Mort. rate 41.28 (1st year birds double 29.27).

Table 14. Mortality and survival of Canada geese banded as adults at Turbid Lake, Yellowstone National Park, Wyoming, 1961-72. Data are based on bands recovered up to May 1, 1982, from birds shot or found dead.

Year Banded	Total Banded	Recoveries in Years Following Banding (July 1-June 30)									
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	
1961	275	23	10	16	13	7	6	5	2	3	
1962	256	17	16	18	9	10	6	3	1		
1963	285	32	27	9	7	7	3	4	3	3	
1964	156	13	10	5	3	4	3	1	4	1	
1965	18		1	2		1					
1966	240	28	20	9	5	4	6	2		1	
1967	198	32	14	7	8	5	2		3	3	
1968	157	24	12	9	8	4	3	2			
1969	119	10	6	7	3	2					
1970	274	36	13	13	3	2	3	2	2	1	
1971	248	27	14	9	6	8	4	3	4	3	
1972	223	15	9	8	9	4	4	4	3	1	
2,449		257	152	112	74	58	40	26	22	16	
Percent of bands recovered		10.49	6.20	4.57	3.02	2.36	1.63	1.06	0.89	0.65	
Mortality series or percent of total number of bands recovered in each year-class		32.49	19.22	14.15	9.36	7.33	5.05	3.29	2.78	2.02	
Cumulative percent of bands recovered		32.49	51.71	65.86	75.22	82.55	87.60	90.89	93.67	95.69	
Survival series, or percent of total number of banded geese in each year-class alive at end of year		67.51	48.29	34.14	24.78	17.45	12.40	9.11	6.33	4.31	
Mortality rate, or percent of banded geese in each year-class alive at beginning of year lost during year*		32.49	28.46	29.32	27.40	29.59	28.99	26.53	30.56	32.00	
*Ave. Mort. Rate 28.35. Adj. mort. rate 31.31 (1st year birds double 32.49).											

Table 14. (Con't)

Year Banded	Total Banded	Recoveries in Years Following Banding (July 1-June 30)										Total
		9-10	10-11	11-12	12-13	13-14	14-15	15-16	19-20	20-21		
1961	275			1	1						87	
1962	256			1	1			1		1	84	
1963	285	2			1						98	
1964	156	1	2			2		1			50	
1965	18								1		5	
1966	240	4	1	1				1			82	
1967	198		1	1			1				77	
1968	157										62	
1969	119										28	
1970	274		1				1				77	
1971	248		1	1			1				81	
1972	223	1		2							60	
2,449		8	6	5	5	2	3	3	1	1	791	
Percent of bands recovered		0.32	0.24	0.20	0.22 of 2226	0.10 of 1978	0.18 of 1704	0.18 of 1585	0.10 of 990	0.10 of 972	32.51	
Mortality series, or percent of total number of bands recovered in each year-class		1.01	0.75	0.63	.63	0.25	0.38	0.38	0.13	0.13	100.0	
Cumulative percent of bands recovered		96.7	97.45	98.08	98.71	98.96	99.34	99.72	99.85	100.00		
Survival series, or percent of total number of banded geese in each year-class alive at end of year												
Mortality rate, or percent of banded geese in each year-class alive at beginning of year lost during year		3.30	2.55	1.92	1.32	1.05	0.60	0.13	0.00			
		23.53	23.08									

Table 15. Mortality and survival of Canada geese banded as adults in the Southeast Arm, Yellowstone Lake, Wyoming, 1979. Data are based upon bands recovered up to May 1, 1989 from birds found shot or dead.

Year Banded	Recoveries in Years Following Banding (July 1-June 30)										
	Total Banded	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	Total
1979	560	28	25	9	19	17	6	6	5	5	120
Percent of bands recovered		5.00	4.46	1.61	3.39	3.04	1.07	1.07	0.89	0.89	21.42
Mortality series, or percent of total number of bands recovered in each year-class		23.33	20.83	7.50	15.83	14.17	5.00	5.00	4.17	4.17	100.0
Cumulative percent of bands recovered		23.33	44.16	51.66	67.49	81.66	86.66	91.66	95.83	100.0	
Survival series, or percent of total number of banded geese in each year-class alive at end of year		76.67	55.84	48.34	32.51	18.34	13.34	8.34	4.17	00.0	
Mortality rate, or percent of banded geese in each year-class alive at beginning of year lost during year*		23.33	27.17	13.43	32.76	43.59	27.27	37.50	50.00		
*Average annual mortality rate was 31.88 percent. The average annual mortality rate adjusted to incorporate estimated juvenile first year mortality was 34.79 percent.											

*Average annual mortality rate was 31.88 percent. The average annual mortality rate adjusted to incorporate estimated juvenile first year mortality was 34.79 percent.

life span = 1.18-2.62

For the 1961-72 banding data, Model 2 calculations were as follows:

Constant survival rate (%) =	70.99
Standard error of constant survival rate =	1.24
95% confidence interval for the constant survival rate =	68.57-73.41
and Mean life span =	2.92
Standard error of the mean life span =	0.15
95% confidence interval of life span =	2.65-3.24

Comparisons of survival series between those of Tables 13 and 14 and the Model 0 and Model 2 are presented in Table 16. While there is a striking disparity of survival rates generated by the two analyses for the 1956-60 period, the two analyses are in closer agreement than those figures indicate. The mean adjusted mortality rate of 41.28 (a survival rate of 58.72) from Table 13 indicates a lower than expected survival rate and is in agreement with the low mean life span indicated by Model 0.

By contrast, the survival series for the longer 1961-72 period are very similar in both the Bellrose and Chase (1950) and the Brownie et al. (1985) Model 2 projections (Table 16). These data reinforce Dimmick's (1968) statement that the Jackson Hole Canada goose population survival patterns appear equal to or greatly exceed those of other goose flocks. These survival rates could also serve to explain the significant increases in the size of the Jackson Hole Canada goose breeding population. Most importantly, all of these data serve to amplify the need for a long-term, continuous, regularly scheduled program of banding of Canada geese known to breed in Jackson Hole to accurately describe and characterize the nature of that population.

Distribution patterns of banding recoveries of hunter killed birds banded at Turbid Lake and the Southeast Arm of Yellowstone Lake are presented in Tables 17, 18, 19, 20 and 21. These recoveries suggest that those geese continue to winter chiefly in southern California and Arizona as described earlier by Dimmick (1968). During migration, it appears the geese follow the two forks of the Snake River, as well as moving up the Salt River and down the Bear River to Utah and thence to Arizona and California. Note that 91-97% of the hunter band recoveries are concentrated within five states: Wyoming, Idaho, Utah, Arizona and California. Compared to the years of 1956-60, the 1961-72 and 1979 hunter band recoveries of Canada geese suggest hunter harvests have markedly shifted from Wyoming and to a lesser extent from Arizona to Idaho and Utah. In California, the goose harvest appears to be stabilized while Arizona's harvest seems to be narrowly oscillating around the 1961-72 level. Within Wyoming, the greatest number of hunter harvests occur along the lower Snake River from the vicinity of Wilson to the Elbow Campground and from Palisades Reser-

Table 16. A comparative summary of survival series of Canada geese from data analyzed after Bellrose and Chase (1950) and Brownie et al. (1985) as per Tables 13 and 14 and Model 0 and Model 2, respectively.

% Survival in Years Following Banding										
Years	Source	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
1956-60	Table 13 Survival Series	70.73	46.68	25.52	13.64	7.56	3.21	0.6	0.00	
1956-58	Model 0 Mean Survival Series	55.48	30.78	17.08	9.47	5.26	2.92	1.62	0.89	
1961-72	Table 14 Survival Series	67.51	48.29	34.14	24.78	17.45	12.40	9.11	6.33	4.31
1961-72	Model 2	70.60	49.84	35.19	24.84	17.54	12.38	8.74	6.17	4.36

Table 16. (Con't)

		% Survival in Years Following Banding									
Years	Source	9-10	10-11	11-12	12-13	13-14	14-15	15-16	19-20	20-21	
1956-60	Table 13 Survival Series										
1956-58	Model 0 Mean Survival Series										
1961-72	Table 14 Survival Series	3.3	2.55	1.92	1.32	1.05	0.60	0.13	0.00	0.00	
1961-72	Model 2 Constant Survival Series	3.08	2.17	1.53	1.08	0.76	0.54	0.38	0.27	0.19	

Table 17. Number and percent of Canada geese harvested each year by state or region from the Turbid Lake molting concentrations. Data are based upon bands applied from 1955-60 and recovered prior to May 1, 1961 (Modified from Dimmick, 1968).

State or Region	1956				1957				Year Recovered				1959				1960				Total Recoveries	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Wyoming	15	48.4	28	75.7	23	48.9	63	86.3	29	47.5	158	63.4										
Idaho	3	9.7	4	10.8	8	17.0	2	2.7	13	21.3	30	12.1										
California	1	3.2			3	6.4	1	1.4			5	2.0										
Utah	1	3.2			2	4.3	2	2.7	4	6.6	9	3.6										
Arizona	10	32.3	4	10.8	9	19.1	4	5.5	14	23.0	41	16.5										
Nevada	1	3.2									1	0.4										
Montana			1	2.7	2	4.3					3	1.2										
Canada							1	1.4			1	0.4										
Mexico															1	1.6						
	31	12.4	37	14.9	47	18.9	73	29.3	61	24.5	249	100.0										

Table 18. Number and percent of Canada geese harvested each year by state or region from the Turbid Lake molting concentrations. Data are based upon bands applied from 1961-72 and recovered prior to May 1, 1986.

State or Region	Year Recovered													
	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	
	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	
Wyoming	9 39.1	13 48.2	19 29.7	20 28.2	15 44.1	9 15.5	23 30.7	14 25.4	13 28.9	8 11.9	12 16.0	8 13.8	1 3.4	
Idaho	1 4.4	4 14.8	17 26.6	9 12.7	6 17.7	10 17.2	11 14.7	8 14.5	11 24.4	10 14.9	21 28.0	11 18.2	10 34.5	
California	5 21.7	3 11.1	15 23.4	15 21.1	5 14.7	12 20.7	17 22.7	21 38.2	7 15.6	26 38.8	19 25.3	27 46.6	6 20.7	
Utah	4 17.4	3 11.1	6 9.3	11 15.5	6 17.7	10 17.2	8 10.7	5 9.1	7 15.6	11 16.4	11 14.7	7 12.1	1 3.4	
Arizona	4 17.4	3 11.1	3 4.7	13 18.3	2 5.8	12 20.7	9 12.0	4 7.3	5 11.1	5 7.5	8 10.7	3 5.2	2 6.9	
Nevada			3 4.7	1 1.4		4 6.9	1 1.3	3 5.5					3 10.4	
Montana		1 3.7	1 1.6	2 2.8			4 5.3		2 4.4	2 3.0	3 4.0	2 3.4	1 3.4	
Colorado						1 1.8	1 1.3			2 3.0			2 6.9	
Illinois							1 1.3							
Wisconsin										1 1.5				
New Mexico										1 1.5				
Saskatchewan													1 3.4	
Mexico											1 1.3			
Alberta													1 6.9	
N. Dakota														
Total	23 2.9	27 3.4	64 8.1	71 9.0	34 4.3	58 7.3	75 9.5	55 7.0	45 5.7	67 8.5	75 9.5	58 7.3	29 3.7	

Table 18. (Con't)

State or Region	Year Recovered													Total Recoveries No. %
	1974 No. %	1975 No. %	1976 No. %	1977 No. %	1978 No. %	1979 No. %	1980 No. %	1981 No. %	1982 No. %	1984 No. %	1985 No. %			
Wyoming	1 4.0	6 24.0	1 7.1		1 9.1	5 71.4		1 33.3		1 33.3	1 50.0	181 22.9		
Idaho	4 16.0	7 28.0	2 14.3	4 26.7	1 9.1		2 100.0	1 33.3				150 19.0		
California	6 24.0	8 32.0	3 21.4	2 13.3	1 9.1			1 33.3	1 33.3	1 33.3		201 25.4		
Utah	8 32.0	1 4.0	2 14.3	1 6.7	5 45.4	1 14.3					1 50.0	109 13.8		
Arizona	5 20.0	1 4.0		2 13.3								81 10.2		
Nevada			2 14.3	1 6.7								18 2.2		
Montana	1 4.0	1 4.0	4 28.6	4 26.7	2 18.2	1 14.3			1 33.3			32 4.1		
Colorado												6 0.7		
Illinois												1 0.1		
Wisconsin												1 0.1		
New Mexico		1 4.0		1 6.7								3 0.4		
Saskatchewan												2 0.3		
Mexico									1 33.3			2 0.3		
Alberta					1 9.1							3 0.4		
N. Dakota											1 33.3	1 0.1		
Total	25 3.2	25 3.2	14 1.7	15 1.9	11 1.4	7 0.8	2 0.3	3 0.4	3 0.4	3 0.4	2 0.3	791 100.0		

Table 19. Number and percent of Canada geese harvested each year by state or region from the Southeast Arm, Yellowstone Lake molting concentration. Data are based on bands applied in 1979 and recovered prior to May 1, 1988.

State or Region	Year Recovered												Total Recoveries	
	1979	1980	1981	1982	1983	1984	1985	1986	1987				No.	%
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
Wyoming	4	14.2	2	22.2	2	10.5	2	11.8	2	40	1	20	13	10.8
Idaho	14	50.0	6	24.0	8	42.1	10	58.8	4	66.6	2	33.3	1	20
California	5	17.9	7	28.0	1	11.1	3	15.8	3	17.6	1	16.7	48	40.0
Utah	1	3.6	6	24.0	4	44.5	3	15.8	1	5.9	4	66.7	20	16.6
Arizona	3	10.7	3	12.0	1	11.1	3	15.8	1	5.9	2	40	23	19.2
Nevada													11	9.2
Montana	1	3.6											1	0.8
Alberta			1	11.1									2	1.8
Saskatchewan													1	0.8
													1	0.8
	28	23.3	25	20.8	9	7.5	19	15.8	17	14.2	6	5.0	5	4.2
													120	100.0

Table 20. Percent of direct recoveries by major recovery areas from Canada geese banded at Turbid Lake and Yellowstone Lake, Wyoming, 1961-72 and 1979, respectively.

Major Recovery Areas State	% Recoveries: Area x State and Total Recoveries ()		Total Band Recoveries Per State	
	1961-72	1979	1961-72	1979
Wyoming			181	13
Snake River Wilson- Cabin Creek	47(11)	46(5)		
Palisades Reservoir- Smoot	18(64)	46(5)		
Idaho			150	48
Ashton-Victor	13(2)	21(8)		
Palisades Reservoir- Gray's Lake	18(3)	34(14)		
Blackfoot Reservoir	18(3)	27(10)		
American Falls-Rupert				
Utah			109	23
Bear River Refuge-Locomotive Springs	28(4)	26(5)		
Utah Lake	10(1)	17(3)		
Salina-Piute Reservoir	13(2)	17(3)		
Arizona			81	11
Roosevelt Lake	38(4)	27(3)		
California			201	21
Salton Sea	57(14)	30(3)		
Total Bands Recovered			791	120

Table 21. Summary by state of mean recoveries/year class of geese banded in years of 1955-60, 1961-72 and 1979.

State	$\bar{X}$ Recoveries/ Year Class Banded 1955-60	$\bar{X}$ Recoveries/ Year Class Banded 1961-72	1979 Recoveries
Wyoming	31.6	15.1	13
Idaho	6.0	12.5	48
California	1.0	16.8	20
Utah	1.8	9.1	23
Arizona	8.2	6.8	11

voir to Smoot. Care must be taken in interpretation of any analysis of these data since the change of one band recovery in these low-band recovery areas can easily distort the interpretation of any recovery changes. Nevertheless, one is tempted to speculate whether the 55% decrease in hunter harvest recoveries in the Wilson to Cabin Creek area marks a loss of hunter access to privately owned riparian lands (Table 20). This circumstance emphasizes the importance for Wyoming to support long term banding studies of the Jackson Hole geese. Meaningful surveillance will require efforts to initiate banding of geese known to be members of the breeding population within Jackson Hole. Banding should include the larger aggregations of geese on Jackson Lake, however, they should also concentrate on the smaller but representative family aggregations of geese.

Concurrent banding of molting geese on Yellowstone Lake would be desirable. If that is not possible, the lack of such molting information should not deter efforts to successfully acquire sufficient numbers of banded geese from the Jackson Hole breeding population. Also, it will be important in such a banding effort to maintain continuity and comparability of information acquired from one year to the next. The importance of acquiring this banding information is discussed in the conclusion section.

Estimated Annual Population Cycle

As previously stated the Jackson Hole Canada goose population consists of two well defined components: (1) the successful breeding component; and (2) the unsuccessful breeding and the non-breeding component. Unfortunately, we do not know whether all breeding individuals are at some time in their life cycle a member of the non-breeder segment or if only certain individuals are periodically non-productive or entirely non-productive. Additionally, if an individual is periodically non-productive, the interval between being a breeder and a non-breeder, as well as the length of the periods as a breeder or as a non-breeder remains unknown. Even so, constructing a minimum estimated annual life cycle for the breeding segment of the population is useful (Table 22). The contents of Table 22 suggest that the Jackson Hole Canada goose annual breeding component is at worst stable and at best is slightly increasing. Carrying those calculations one step further, based on the observations of color marked individuals reported by Dimmick (1968), one might estimate conservatively that 20-25% of the birds banded in Yellowstone were actually members of the Jackson Hole Canada goose population. If this assumption is correct, then the flock size in the succeeding breeding season would range from 520-540 or 595-620 individuals, respectively.

Conclusions and Recommendations

As in other Canada goose studies (Owen, 1980; Krohn and Bizeau, 1980) hunter harvest remains the major source of mortality for the Jackson Hole Canada goose population.

Table 22. Computed annual cycle for the Jackson Hole Canada goose population based on data collected from 1964 thru mid-1989.

	$\bar{X}$ 1964	24_yr $\bar{X}$ 1965-89	12_yr $\bar{X}$ 1977-89
Flock size during breeding season			
Breeding adults	287	412	459
Successful nests	124	149	180
Brood size	38	54	65
Goslings produced per year	4.7	4.0	4.0
Goslings per breeding adult	1.4	1.5	1.4
Autumn flock size	466	628	719
Annual mortality rate (%)	39.7	31	31
Autumn to spring decrease	185	195	223
Flock size in succeeding breeding season	281	433	496
Change from preceeding breeding season (%)	-2.1	+5	+8

While there have been fluctuations in hunter harvests and changes in the areas of harvest as reflected by banded bird recoveries, long-term hunting pressure appears to have been a rather constant mortality factor. The continued maintenance of a population recruitment surplus beyond the annual mortality level from 1965 to 1989 seems well supported by the increases in breeding pair numbers and the total breeding population as seen in Table 3. Also, this situation suggests that the Jackson Hole breeding areas have not yet reached their maximum capacity for Canada goose production (Chapman et al. 1969; Grieb 1970; Raveling and Lumsden 1977; and Krohn and Bizeau 1980).

Despite this favorable circumstance, the Jackson Hole Canada goose population remains as a frustrating management dilemma. Except for the long-term aerial censusing of the breeding population within Jackson Hole, other monitoring efforts have been at best irregular and/or at worst curtailed and/or lacked consistent procedures and observers to permit year to year comparisons of census data. Banding and color marking efforts have been sporadic and conducted outside of Jackson Hole, primarily at Turbid Lake and the Southeast Arm of Yellowstone Lake in Yellowstone National Park. Consequently, there is still no clear definition of the proportion of the population, if any, that resides year long within Jackson Hole, as opposed to those geese that breed there but winter elsewhere, as opposed to those that winter there but breed elsewhere, as opposed to those migrant geese that represent solely transient visitors in Jackson Hole.

Furthermore, an undetermined number of the Jackson Hole geese intermingle with the Canada goose populations on and around Yellowstone Lake. It is not known how many Jackson Hole Canada geese molt on Yellowstone Lake as: (1) breeding adults whose nests or very young goslings were destroyed or lost; (2) breeding adults sitting out a particular breeding season; (3) adult geese who have never or never will breed; or (4) immature geese.

A reliable composition of the Jackson Hole Canada goose population can only be determined through banding and low profile color marking of individuals during all seasons. Initially, molting adults, immatures and young geese congregating on Jackson Lake on the delta of the Upper Snake River and along the shoreline between the Dam and 3rd Creek of Jackson Lake should be primary banding and marking targets. Secondary targets should include the molters and young on the South Park elk feed ground and the associated Spring Creek-Flat Creek area, plus the smaller aggregations on the Buffalo River. Winter time cannon trapping on baited areas around the Evans gravel pits in South Park and possibly around the Nowlin Creek Ponds on the National Elk Refuge would be important for a reliable composition of the wintering flocks. While important for flock composition and distribution, banding would also provide a needed index of annual hunter harvest levels. Unfortunately, the physical constraints of the various Jackson Hole goose habitats, as well as the widely dispersed distribution of the geese within those habitats will require sufficient commitment of funds and manpower to acquire a sample realistically representative of the different components of the Jackson Hole Canada goose population.

Censuses of Class Ia-IIa broods should be initiated as a measure of any changes in the success of the annual nesting effort of these geese. Also, there is a further need to monitor the impact of the heavy recreational river rafting traffic on the movement and survival of Classes I and II goslings. These birds are particularly at risk because of potential separation from their parents and their parental custody. This is a difficult but not impossible task. Such monitoring would best be initiated on the Pacific Creek to Moose sector of the Snake River.

The adverse impact of riverine flooding on geese and their habitat can be decreased if sudden controlled, large water releases from Jackson Lake do not coincide with the peak flood flows from Pacific Creek, Buffalo River, Spread Creek, Gros Ventre and Hoback Rivers. The time period of greatest vulnerability of nests and young goslings ranges from early April through early July. Also, inauguration of the foregoing water discharge control would help to offset the adverse impacts of the destruction of riparian goose habitat caused by the flood control levee structures on the Snake River.

Sedimentary materials being transported to and deposited in the low gradient river channels between Astoria and the Elbow Campground on the Snake River represent a serious threat to that area which historically has supported the greatest goose nest density in Jackson Hole. With river transported sediments filling those channels, a shallow, braided stream will result which then provides land base predators easier access to islands here-to-fore protectively isolated by deep water. Also, increased flooding and flooding damage can be expected in this area as a consequence of such sediment deposition. Both will eventually lead to increased losses of goose nests and goslings.

Where nest flooding and ground predation losses are known to occur outside of Grand Teton National Park, artificial nest structures may successfully mitigate such losses. It would seem particularly advantageous to construct and install elevated artificial nest structures like those designed and successfully tested by Mackey and Matthews (1988). Specifically, such installations may be appropriate in the riparian goose habitat areas of (1) the Buffalo River upstream from the Pinto Ranch; (2) the South Park to Wilson sector, especially the wooded riparian areas of the South Park Elk Feed Ground; (3) the Gros Ventre River from Lower Slide Lake to Upper Slide Lake; (4) the wooded riparian areas between Astoria and the Elbow Campground; and (5) the wooded riparian sections of the National Elk Refuge.

Safe and adequate roosting, feeding and nesting sites are basic prerequisites for optimal goose habitats. Importantly, the selection of these sites is primarily dependent on the degree of isolation of the site from all forms of daytime and nighttime disturbances caused by predators and human activity. The size of a goose population may be effectively restricted in size if the number, size or quality of roosting sites or feeding sites are limited. For example, the encroachment of land development and associated human activities represent disturbances capable of placing the riparian habitat of South Park and the Buffalo River Valley

in serious jeopardy as productive goose habitat.

Any significant increase or decrease of cattle or horse grazing on Jackson Hole upland meadows can be expected to influence the quality and quantity of feeding sites for geese. Initially, grazing by cattle and horses opens up densely vegetated upland meadow feeding sites for utilization by geese. If livestock stocking rates are sufficiently intense, such livestock grazing can delay or even prevent maturation of the vegetation which in turn greatly enhances the value of those sites for goose feeding sites.

Basic goose habitat is generally well preserved in Grand Teton National Park and the John D. Rockefeller Parkway. However, riverine recreational activities present a very serious threat to the inherent natural protective isolation historically provided the geese, as well as other wildlife by that habitat. In 1989 there were ±12,000 commercial and private river float trips on the Snake River, primarily between Pacific Creek and Moose. What is most startling is the 130% increase of private float trips during the 10 years prior to 1989 when commercial float trips remained relatively unchanged. Also, the location of twice as many goose nests upstream from Dead Man's Bar as found downstream from the Bar suggests the intensity of floater traffic is a factor for this disparity. Between 1979 and 1989 the commercial launching traffic at Dead Man's Bar changed from 3 to 5 times that at Pacific Creek, respectively.

Under these circumstances it seems apparent additional changes in management of the river floater traffic is necessary. The level of floating traffic on the Pacific Creek to Moose section of the Snake River would best serve all interests if a ceiling of 5,000 commercial and 5,000 private float trips was established. Furthermore, to lessen the negative impact on the protective isolation for the geese 75%-80% of all launches should continue to be at Dead Man's Bar or points downstream from Dead Man's Bar. For those launches from Pacific Creek they would best be limited to launching between 8 am and 5 pm in June through July. Curtailing early and late daytime float trips would provide the opportunity for geese and their young goslings to move about and feed more naturally without disruption from float trips.

Equitable implementation of these changes will likely require trip permits for all floaters, private as well as commercial. Also, it may require use of a lottery drawing system in the allocation of the private permits. In addition, as much as possible, launching from the Pacific Creek site during May to mid-June should be curtailed or at the very least sharply reduced. If river use is to expand, it would be best to do so during the month of September. Allocation of commercial trip permits would likely best be done within the framework of established Park concessioner policy. In addition, one important regulation change for private floaters is imperative. Private floaters should no longer be allowed to stop anywhere along the river. To minimize disturbance to geese, as well as other wildlife, private floaters, like the commercial operators should not be allowed to land anywhere except at designated rest stops or launching/landing sites.

The Flagg Ranch-Berry Creek sector, particularly the Dime Creek-Berry Creek portion, has the most outstanding goose habitat and some of the most important general wildlife riparian habitat in Jackson Hole. Float trip usage on the river is limited by two factors (1) seasonally declining river water levels essentially limit floating to June and July; and (2) extensive open water travel on Jackson Lake, generally into the wind, to the nearest landing on Lizard Point. Since goose nesting is usually later at this higher elevation of Jackson Hole, floater disturbance of geese and their goslings can be potentially greater in June and July than for other river sectors. Consequently, it seems appropriate to limit float trip use to no more than 2-3 morning launched trips per day from mid-June into early August. The rationale being that afternoon launches are impractical considering the difficulties of negotiating into the afternoon winds on 4.8 km of open water on Jackson Lake with rubber rafts and boats. Also, this would be compatible with the 1989 level of concessioner operations while for the private floater usage would require a permit issued on a lottery or first come first served basis. Because of the nature of the river and adjacent cover plus considerations of the open water crossing, float trips could be initiated as early as 8 am. The critical importance of this riparian wildlife habitat, the natural limitations of the depth of the river water flow and the low commercial and private float trip usage make implementation of limitations less controversial. Considering the heavy recreational activities on every other major riverine system in Jackson Hole, it seems appropriate to provide one small, important resource sector of the Snake River with an adequate level of protective isolation.

Lastly, with the extremely rapidly changing human developments within Jackson Hole, it seems prudent to monitor, evaluate and update management strategies no less frequently than every 2-3 years to cope with and/or mitigate natural and man-caused losses of critical goose habitat. This is most important in the South Park area and Buffalo River Valley.

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APPENDIX A

Gosling and Molting Goose Census Route*

Start at Elbow Campground

1. Count to Cabin Creek Campground
2. Count from next small turnout on right where lower R-D pasture can be observed.
3. Count from next turnout where central R-D pasture can be seen
4. Census Evans gravel pit.
5. Conduct foot census along South Park Elk Feed Ground levee.
6. Census north along South Park Road.
7. Census Skyline Ranch Pond.
8. Census south from Wilson Bridge on West levee.
9. Return to Spring Creek Road between Gros Ventre Buttes and census along road to Gros Ventre River and upstream from Gros Ventre Bridge.
10. Circle back to Jackson and make census stop at north Flat Creek fisherman parking area.
11. Continue census at south Flat Creek fisherman parking area.
12. Continue count from parking area at Flat Creek turnout just north of Visitor Information Center.
13. Census Nowlin Ponds after getting permission from Elk Refuge manager.
14. Travel up Gros Ventre River and census Lower Slide Lake and the D. Taylor pastures.
15. Census Upper Slide Lake on foot.
16. Return to Blacktail Butte and census Blacktail Pond on foot.
17. Travel north to Triangle X Ranch and census horse pastures.
18. Travel north to Cunningham Cabin and census Moosehead Ranch pastures.
19. Proceed north to the Elk Ranch Reservoir and conduct census on foot.

20. Proceed up Buffalo River to wide meander just below Turpin Meadow Ranch and census visible portion of river.
21. Retrace road west to census Tracy Lake.
22. Proceed west to point where large "Oxbow" of Buffalo River can be seen for censusing.
23. Proceed to Heart 6 Ranch and census river section south of the Buffalo Valley road.
24. Proceed south to census the Pinto Ranch "Oxbow".
25. Travel to Jackson Lake Dam and conduct census of Dam-3rd Creek area on foot.
26. Proceed north to census mouth of Arizona Creek, including Arizona Island on foot.
27. Travel north to census lake area north of Arizona Island to Lizard Creek Flat.
28. Proceed northward to Southwest face of Steamboat Mountain to conduct census on foot of visible portions of Snake River and upper river delta.
29. Complete last census of Snake River from Campground #3 on the Grassy Lake Road.

This census route can be completed in 2-5 days.

APPENDIX B

Summary of Jackson Hole Canada goose habitat evaluation criteria.

Area	Evaluation & Criteria											Total Points
	No of Nests	Nest Site Potential	Brooding Ground Visibility	Brooding Ground Use	Feeding Ground Use and Feed Used			Molting Site Use	1980 Human Impact	Potential Human Impact		
					June	July	August					
Elbow Campground to Astoria ± 9.6 km Gradient ± 1.3 m/km	3	3	1	2	2	2	1 Ter	2	3	2	21	
South Park Bridge to Wilson Bridge ± 16 km Gradient ± 3.9 m/km	3	3	2	3	2 Ter Sub	2 Ter Sub	2 Ter Sub Emer	2	3	2	24	
Wilson Bridge to Moose ± 23.2 km Gradient	2	1	2	1	2 Ter	2 Ter	1 Ter Emer	2	2	2	17	
Moose to Pacific Creek ± 32 km Gradient ± 2.7 m/km	2	2	2	3	2 Ter	2 Ter	1 Ter Emer	2	2	2	20	
Pacific Creek to Jackson Lake Dam ± 6.9 km Gradient ± 0.4 m/km	2	1	1	1	1 Ter	1 Ter Sub	1 Ter Sub Emer	1	2	1	12	

Appendix B (Cont)

Area	Evaluation & Criteria												Total Points
	No of Nests	Nest Site Potential	Brooding Ground Visibility	Brooding Ground Use	Feeding Ground Use and Feed Used			Molting Site Use	1980 Human Impact	Potential Human Impact			
					June	July	August						
Jackson Lake Dam to 3rd Creek ± 3.2 km	2	1	2	2	3 Ter	3 Ter Sub	3 Ter Sub Emer	3	3	3	25		
Arizona Creek Flats, Arizona Island and Lizard Creek Flats	1	1	3	1	2 Ter Sub	1 Ter Sub	3 Ter Sub Emer	3	3	3	21		
Berry Creek to Flagy Ranch ± 14.2 km	2	2	3	3	3 Ter	3 Ter Sub	3 Ter Sub	3	2	3	27		
Turpin Meadow to Pinto Ranch ± 19.2 km	2	2	2	2	2 Ter	2 Ter	3 Emer Ter	2	3	2	22		
Elk Ranch Pastures and Reservoir	1	1	1	1	1 Ter	1 Ter	1 Ter Emer	1	3	3	14		
Moosehead Ranch and Triangle X Ranch Pastures	1	1	1	1	2 Ter	1 Ter	3 Ter	1	3	3	17		

Appendix B (Con't)

Area	No of Nests	Nest Site Potential	Brooding Ground Visibility	Brooding Ground Use	Feeding Ground and Criteria							Molting Site Use	1980 Human Impact	Potential Human Impact	Total Points
					Feeding Ground Use			and Feed Used							
					June	July	August	June	July	August	September				
Upper Slide Lake to Snake River ± 46.4 km	2	2	2	2	2	2	2	2	2	2	2	2	2	2	20
U.S. National Elk Refuge	2	2	2	2	1	1	1	1	1	2	3	3	3	3	19
Skyline Ranch Pond	1	1	1	1	1	1	1	1	1	2	2	2	2	2	13

*Evaluation Points and Number of Nests

1. Less than 3 nests found or thought to exist
2. At least 3 nests and fewer than 10 found or thought to exist
3. Ten or more nests found or thought to exist

Nest Site Potential

1. Use of artificial nest sites and/or ground nest sites will produce less than 10 nests
2. Use of artificial nest sites and/or ground nest sites will produce at least 10 and fewer than 20 nests
3. Use of artificial nest sites and/or ground nest sites will produce 20 or more nests

Brooding Ground Visibility

1. Unobstructed vision for 150 meters in less than 33% of all directions
2. Unobstructed vision for 150 meters for at least 33% and less than 66% of all directions
3. Unobstructed vision for 150 meters in 66% or more of all directions

Brooding Ground Use

1. Less than 3 broods observed at only one time
2. At least 3 and fewer than 10 broods observed at any one time
3. Ten or more broods observed at any one time

Feeding Ground Use

1. Fewer than 20 geese regularly seen foraging
 2. At least 20 and fewer than 70 geese regularly seen foraging
 3. Seventy or more geese regularly seen foraging
- Ter: Terrestrial plant foods
 Sub: Submergent aquatic plant foods
 Emer: Emergent aquatic plant foods

Molting Site Use

1. Fewer than 20 molting geese regularly seen
2. At least 20 and fewer than 70 molting geese regularly seen
3. Seventy or more molting geese regularly seen

1980 Human Impact

1. Humans and/or human activities disturbed geese 66% or more of times observed
2. Humans and/or human activities disturbed geese 33% to 66% of the times observed
3. Humans and/or human activities disturbed geese less than 33% of the time observed

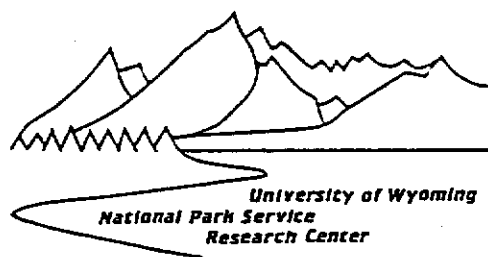
Potential Future Human Impact

1. Humans and/or human activities will likely disturb geese 66% or more of the time
2. Humans and/or human activities will likely disturb geese 33% to 66% of the time
3. Humans and/or human activities will likely disturb geese less than 33% of the time









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