Impacts of Water Levels on Breeding Canada Geese and the Methodology for Mitigation and Enhancement in the Flathead Drainage

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IMPACTS OF WATER LEVELS ON BREEDING CANADA GEESE AND THE METHODOLOGY FOR MITIGATION AND ENHANCEMENT IN THE FLATHEAD DRAIMAGE

ANNUAL REPORT 1984

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ABSTRACT

The lower Flathead System Canada Goose Study was initiated to determine population trends and the effects of water level fluctuations on nest and brood habitat on the southern half of Flathead Lake and the lower Flathead River as a result of the operations of Kerr Dam. This report presents data collected during the 1984 field season (1 October 1983 through 30 September 1984) as part of an ongoing project.

Eighty geese were captured and 44 adult geese were radio-collared. Geese used Pablo, Kicking Horse, and Rinepipe Reservoirs heavily during late summer and fall. Use cf the river by geese was high during the winter, when the reservoirs were frozen, and during the breeding period. Most breeding geese left the river after broods fledged. Goose territorial pair surveys on the river indicated no significant difference between boat and aerial or morning and afternoon surveys. The indicated pairs/nest ratio on the river ranged from 1.3 to 1.4 depending on survey method. Three island groups on Flathead Lake were used to assess the effectiveness of aerial vs. boat census methods for breeding geese. No significant differences were found between methods, but the indicated pairs/nest ratios ranged from 0.49 to 0.71, well below similar ratios on the river.

Thirteen percent (7 of 52) of the artificial tree nest, structures on the river were used by nesting geese. Mean loss of bark nest material after one year was 17% and no loss of shale nest material occurred. Rock pillar nest structures appear to be unfeasible for use on the river because of winter ice conditions. Goose nest. initiation on the river peaked the last week in March through the first week in April, and hatching peaked the first week in May. Fifty-six goose nests were located on the river and 74% of these nests hatched successfully. Predation was the most significant cause of nest loss on the river, and nest loss by flooding was not observed. Seventy-one percent of the goose nests on the river were island ground nests. Use of artificial nest. structures on the river increased from 9% in 1983 to 19% in 1984. A total of 164 nests was found on the islands in Flathead Lake, and an overall success rate of 72% was re

corded. Avian predation was the single largest factor contributing to nest loss on the lake. Nest initiation on the lake peaked the last week of March and the peak hatch was the last week of April.

On the river, ground nests were exclusively on islands and most were in shrub habitat. Nest sites were commonly less than 5 m inland and within 1 m above or below the HWM. Overhead cover at nest sites was sparse, and vertical cover near nests was dense at levels close to the ground, but sparse above 2 m height. Thirty-seven percent of all nests, and 52% of island ground nests on the river were at or below the high water mark (HWM).

Three radio-collared adults successfully nested and raised broods on the lake. Geese nesting on the Bird Islands appeared to prefer mixed deciduous and coniferous forest habitat, however they frequently nested in the abundant coniferous forest habitat. All were ground nests, and most were within 5 m inland and 2 m above the HWM. A preference was shown for dense overhead and vertical cover at and near nest sites. No nests were found at or below the HWM on the lake.

Habitat use was studied in 4 brood areas on the river and 8 brood areas on the lake, and available habitat was assessed for 2 portions of both the lake and the river. Brood habitat use was significantly different from the available habitat in all areas studied. On the lower river, broods used wheat fields, gravel bars, and shrub habitats. On the upper river, coniferous forest and shrub habitats were preferred. On the West Bay of the lake, brood areas consisted primarily of lawns and tall herbaceous habitat, while on the South Bay, marshes dominated the brood areas studied. Water levels on the river and lake affect both accessibility of these areas to brooding geese, and the ecology of the habitats preferred by geese.

Young goslings on the river spent significantly less time resting and more time locomoting than older goslings. Adults on the river spent less time resting and more time locomoting when their goslings were young. Adults on the river spent 50% of their time alert; goslings spent twice as much time feeding and locomoting, and four times as much time resting as adults. On the lake, goslings spent over half of their time feeding (55%) compared to locomoting (28%) and resting (17%). Adults with goslings on the lake spent more time alert and less time locomoting when their goslings were less than 25 days old. Proportions of adult activity during morning were different than during afternoon. During morning, adults spent less than one quarter of their time feeding and only 9% of their time resting.

INTRODUCTION

Western Canada goose (Branta *canadensis moffitti*) nesting populations on the lower Flathead River from 1980 through 1982 were lower than those documented during the 1950's while current numbers on Flathead Lake have remained relatively stable (Ball 1983). Recruitment rates on the river appear to depend primarily on the availability of secure nest sites, while brood habitat may be a more important limiting factor on the lake. Fluctuating water levels resulting from the operation of Kerr Dam can impact goose reproductive output in several ways. When water levels are extremely low, nest islands on the river may be attached to the mainland, promoting nest destruction by mammalian predators and possibly discouraging nesting by some goose pairs. In addition, riparian areas important to brooding geese on the lake may be inaccessible due to separation from the water by extensive mudflats. Nest flooding occurs on the river during periods of high water levels since many geese nest below the high water mark (HWM). During the past 20 years, providing secure artificial nest sites at Ninepipe Reservoir resulted in major increases in the nesting Canada goose population (Ball 1981), and there is every reason to expect similar results on the Flathead River if nest site limitations can be remedied.

The brood rearing period is poorly understood, primarily because geese are exceptionally wary and secretive during. this phase of the reproductive cycle. As with other waterfowl, the early brood period likely consists of extensive use of shallow shoreline areas where invertebrates and succulent young plants are available to goslings. The shallow water zone on the Flathead River and Lake provides potential habitat for invertebrate production which is directly affected by water fluctuations. We have documented use of these areas by broods and will continue to relate effects of water level fluctuations on the use, availability and ecology of these habitats.

Specific project objectives from 1 October 1983 through 30 September 1984, included the following:

Nest Studies:

1. Document goose production on lower Flathead Lake and River.
2. Determine population impacts of providing additional secure nest sites for geese along the river.
3. Compare effectiveness of tree nest structures, stone pillar nest structures and natural sites with respect to:
   a. acceptance and nest success rates
   b. vulnerability to human disturbance
   c. vulnerability and effect of water level fluctuations
   d. cost (initial, maintenance, projected life).

4. Develop techniques and guidelines that maximize effectiveness of nest structure management programs, while minimizing costs.
   a. experiment with nest materials to minimize deterioration and loss
      Target: ≥ 5 year intervals between maintenance visits.

5. Analyze physical and vegetation characteristics of nest sites.

Brood Studies:

1. Describe habitat selection by goose broods and relate it to water fluctuations on the study area.

2. Document the location of key goose brood rearing areas.

3. Describe the physical and vegetation characteristics of brood rearing areas.

4. Identify potential brooding areas that could be managed to maintain and improve brood habitat.

5. Record river water levels at key brood rearing areas when broods are present and relate these levels to releases from Kerr Dam.

6. Formulate any management recommendations necessary to protect and enhance brood habitat.

7. Document historical trends in availability of brood habitats.

STUDY AREA

The lower Flathead drainage encompasses an area of about 3900 km^2 in northwestern Montana, forming one of the state's largest rivers. The Flathead River is formed by three main tributaries originating along the west slope of the continental divide in British Columbia, Canada, and south of Glacier National Park, Montana. These three forks join and flow for approximately 74 km before entering Flathead Lake. After leaving the lake, the river flows south and then west to its confluence with the Clark Fork of the Columbia River.

Kerr Dam is a power-peaking hydroelectric facility which controls the water level of Flathead Lake between the elevations of 879 m (2983 ft) and 882 m (2993 ft) and affects the river discharge, resulting in flows that vary from 1500 cfs to over 50,000 cfs. Hungry Horse Dam, upstream from the lake, also affects lake elevations and the results of operations of Kerr Dam.

The entire study area (Fig. 1) includes two parts: the southern portion of Flathead Lake, and the lower Flathead River from Kerr Dam to the confluence with the Clark Fork River at Paradise, Montana. The majority of the study area lies within the boundaries of the Flathead Indian Reservation, with the exception of five islands near the west shore of Flathead Lake north of the reservation boundary, and

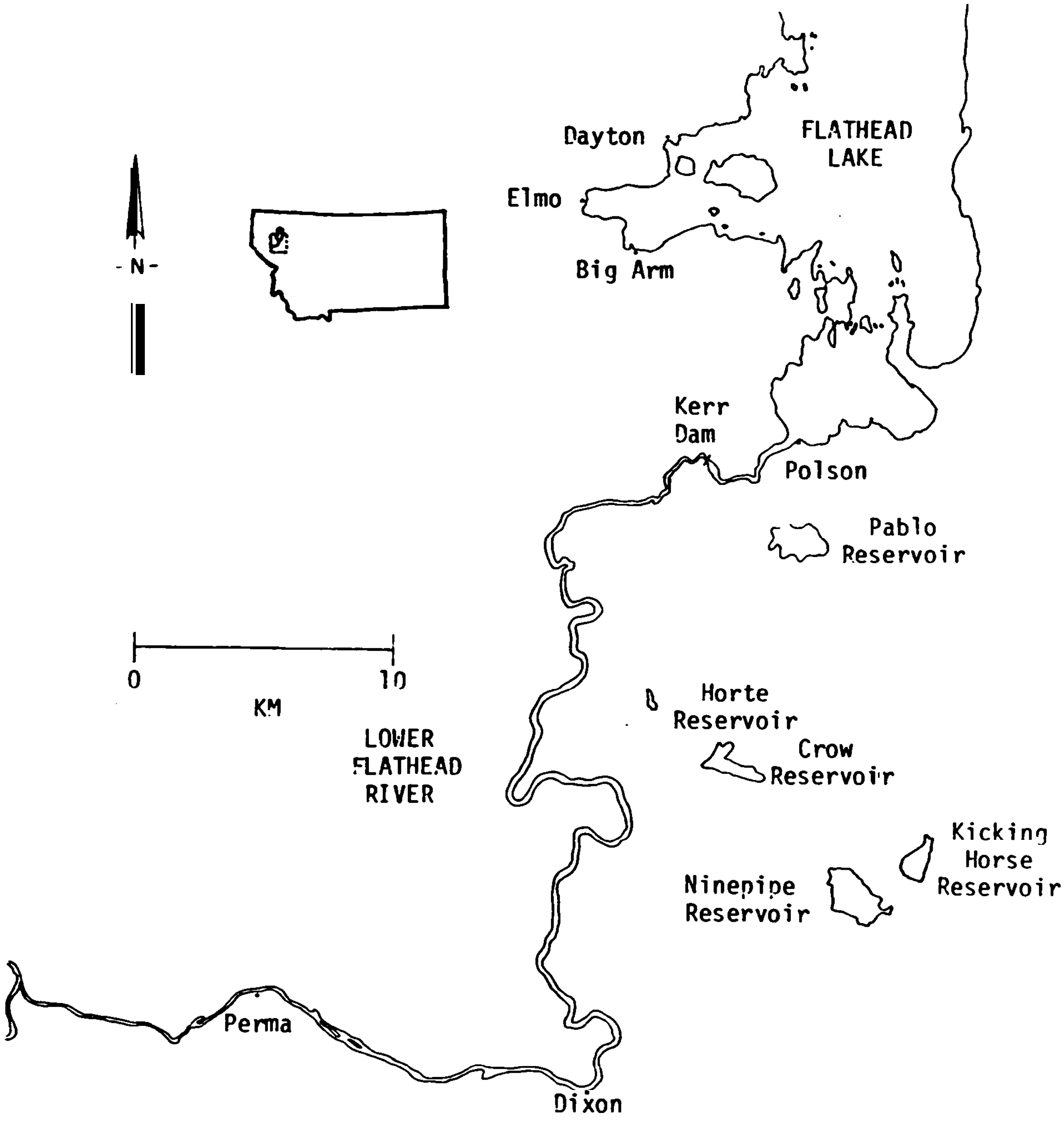

Fig. 1. Map of the study area, Lower Flathead River and Lake, Montana.

the last 8 km of the river. The study area encompasses 116 km of river in addition to over 120 km of lake shoreline and 15 major islands in the lake.

Flathead Lake, with a full-pool surface area of 50,992 ha (126,000 ac), is the largest natural freshwater lake in the western United States. Average rainfall in the area is about 40 cm/year (Polson weather station). Air temperatures vary from a monthly mean of 20 C in July (maximum 37 C), to a mean of -4.5 C for the month of January (minimum -34 C) (Zackheim et al. 1983).

A history of glaciation shapes the landscape of the Flathead Basin. At least four major glacial advances reached the area, the most extensive pushing southward to St. Ignatius. During the last of the ice advances, approximately 25,000 years ago, a continuous ice sheet covered the Rocky Mountain Trench to the site of Flathead Lake. Subsequently, for more than 10,000 years, the lower Flathead lay under the waters of the enormous glacial Lake Missoula. About 12,000 years ago the ice dam gave way, draining the entire lake in a few days. The lower stretches of the lower Flathead River exhibit scoured canyon walls as evidence of the torrential flow. Surrounding hillsides of the middle stretches of the lower river show bend and ripple marks from lakeshore effects. In the initial 6.5 km below Kerr Dam, the river cuts through a terminal morraine resulting from the glacier which formed the Flathead Lake Basin (Zackheim et al. 1983).

This initial stretch of river below the dam is characterized by a steep rocky canyon, with extensive whitewater in the steepest gradient (3 m/km) of the lower Flathead River. The next 64 km downstream have a lesser gradient of 0.64 m/km, producing a blend of riffle and pool areas in a comparatively smooth flowing river moving about 6.5 m/km. Fine-grained lactustrine sediments (clays) characterize the river banks as the channel flows south. Coniferous forests and rangeland dominate the riparian vegetation of this section. Near Dixon, Montana, the river takes a sharp bend to the west, and slows to about 5 km/hr for the remaining 45 km. The average drop of only 0.28 m/km has allowed for the establishment of many islands, backwaters, and gravel bars. Riparian vegetation in this lower section is dominated by dense shrubs, agricultural lands, deciduous and coniferous forests, and marsh areas. In contrast to the river, most of the lakeshore is developed with homesites or recreational facilities; most of the remaining undeveloped shoreline is forest or marsh.

METHODS

Water Levels

Oblique and vertical aerial photographs were taken of nesting islands and brood areas on the river to document the extent of habitat inundation and desiccation created by varying discharge rates. Vertical photographs were taken from a Cessna 206 aircraft at 850 m above the ground. Vertical photographs were taken on 25 May, 15 June, and 17 July as examples of low, high, and medium discharge rates. Oblique photographs were taken from a Piper Super Cub aircraft at approximately 120 m above the ground. Oblique photographs were taken during most census and radio-tracking flights so a wide variety of discharge rates could be recorded. Maximum, mean, and minimum discharge rate data were obtained from the USDI-Geological Survey, lower Flathead River gage station located below Kerr Dam.

Oblique and vertical photographs were taken of all bays and the important goose nesting islands on Flathead Lake from a Cessna 206 aircraft flying between 600 and 1000 m above the lake. Three series of slides were taken to show the effects of different water levels on shoreline areas. Winter drawdown, mid-level, and full pool level aerial photographs were made on 24 April, 31 May and 17 July. The pool elevation data were obtained from personnel at Kerr Dam.

Trapping, Censuses and Movements

Seasonal movement and activity data were obtained from radio-marked geese. Geese were trapped using rocket nets and night-lighting, and captured by hand during the flightless period. Selected adult geese were fitted with solar transmitters (Model no. RS50-2TM-6X, Telemetry Systems, Inc., Mequon, WI) mounted on numbered plastic Canada goose neck collars (Craven 1979). The completed packages weighed approximately 80 g each. Locations were obtained using ground triangulation (Cochran 1980:517), aerial radiolocations (Gilmer *et* al. 1981), or visual observations.

We attempted to locate radio-marked geese, and census all geese on the study area, on weekly aerial surveys. Surveys were flown in a Piper Super Cub aircraft from 30 to 90 m above ground level and at an airspeed of approximately 105 km/hr.

Adult geese with broods were censused twice weekly on the lake by plane and boat and on the river by plane. We attempted to run both censuses on the lake concurrently to minimize the effects of extraneous variables on brood observability. The locations of adults with goslings were plotted on maps or aerial photographs and the numbers of geese, cover type, landform, and activity were recorded.

Radio-collared adults with broods were periodically located and their movements were plotted over the entire brooding period. The numbers of associated geese, cover type, landform, and activity were recorded in all instances.

Territarial Pair Surveys

Pair surveys were conducted by boat and plane weekly from mid-March through April. The entire river was surveyed by boat between 0730 and 1800 hours. Boat surveys were performed on the southern half of the river during a morning (0730 to 1200 hours) and an afternoon (1200 to 1800 hours) each week. Aerial surveys on the river were conducted during the morning (0900 to 1030 hours) and afternoon (1330 to 1500 hours) of the same day. Flights were conducted using Cessna 206 or 185 aircraft flown at heights of less than 30 m and a mean airspeed of 120 km/hr. All surveys were conducted from the northern to southern ends of the river.

Three island groups in the lake were surveyed weekly by boat and plane to compare the effectiveness of aerial versus boat census methods. All surveys were conducted in the morning between 0800 and 1200 hours. Bird Islands, Northern Islands (Cedar, Shelter, Rock, Douglas and Goose) and Melita Island were chosen for these surveys because they are known to be important nesting areas, are widely spaced within the study area, and are removed from areas of dense human population.

Data recorded at each goose observation were time, location, number of geese, and goose behavior. Geese were classified as indicated territorial pairs or non-breeding birds using methods similar to Hanson and Eberhardt (1971) and Allen *et al.* (1978). Pairs of geese were counted as indicated territorial pairs if they were at least 10 m from any other geese when observed. Single geese so spaced were considered to represent the male of a nesting pair, and hence were also counted as an indicated territorial pair. Flocked geese (> 2 birds) were considered non-breeding birds.

For comparisons of pair survey data on the river, within and between boat and aerial surveys, only data from the lower portion of the river (river mile O-32.5) were used because: 1) morning and afternoon data were available in this section of the study area for both survey methods; and 2) most nesting geese are located in this area (Gregory *et al.* 1984). River miles (RM) were obtained from the Army Corps of Engineers maps (Hydrology and Hydraulics Committee 1976). Data used for comparisons of pair surveys on the river began the last week in March to correspond with the dates of peak nest initiation (see Goose Production Estimates). Paired t-tests (Soka) and Rohlf 1981:359) were used to test the hypothesis that there was no difference in the number of indicated pairs observed on morning and afternoon aerial surveys. Tests of equal variance (Soka) and Rohlf 1981:190) were used on all data comparing boat and aerial surveys and morning and afternoon boat surveys. If variances were not significantly different, t-tests (Soka) and Rohlf 1981:228) were used to test the hypothesis of no difference in the mean number of indicated pairs. Tests were considered significant at $P<0.05$.

Artificial Nest Structures

Two artificial tree nest structures were located within a systematically selected 0.6 km segment of the river, and spaced approximately every 2.0 km. All nest structures were located in trees specifically selected to maximize structure life and visibility of structures to geese. Trees selected for structure placement were: 1) ponderosa pine >30 cm in diameter at breast height (DBH); 2) "healthy" appearing trees lacking dead tops, within 15 m of the HWM, and relatively isolated from other trees; 3) trees with roots that were not severely undercut by erosion; 4) positioned at least 100 m from other artificial goose nest structures, great blue heron (*Ardea herodias*) and osprey (*Pandion haliaetus*) nests, and previous years goose nests; and 5) situated away from human access points. Structures were placed from 6-13 m above the ground and facing the river. One of 2 nest materials (expanded shale or ponderosa pine-cedar bark mixture) was randomly assigned to each structure of the pair.

Rock pillar nest structures similar to those described by Fielder (1979) were placed along the river. Pillar structures were composed of wire cylinders (0.9 m in diameter and 2.3 m tall) filled with rock with a cone placed on top containing the same nest materials used in tree structures. Pillar structures were placed on gravel bars which were: 1) $\geq$ 50 m from the mainland; 2) surrounded by river channels with water depths of at least 40 cm; 3) $\geq$ 100 m from other artificial nest structures, heron and osprey nests, and previous years goose nests; 4) away from human access points; and 5) in areas with relatively slow moving water to reduce ice damage.

Goose Production Estimates

Previous studies (Geis 1956, Ball 1981) indicated most nesting by Canada geese on the study area occurred on islands; therefore, mainland areas and very large islands such as Cromwell and Wildhorse were not searched unless observations of geese indicated a nest may have been present. Production estimates were therefore obtained from intensive ground searches for nests during late April and early May, on all islands of the study area except Cromwell and Wildhorse. On larger islands in the lake, a complete nest search was accomplished by 20 volunteers spaced approximately 10 m apart who completely searched the entire land area. Smaller islands were walked by 2 observers until the island had been completely surveyed.

Data recorded at each nest were: 1) location, 2) number of eggs laid, 3) number of eggs hatched, 4) stage of egg development, 5) nest type, and 6) nest fate. Stage of egg development was classified by recording the position of eggs when immersed in water (Westerskov 1950). Nest fate was determined by classifying egg shell fragments as hatched or depredated using methods described by Rearden (1951). A nest was considered abandoned if all the eggs were cold and unbroken in the nest. Nests destroyed by flooding were recorded. We attempted to visit all nests at least twice, before and after hatching. Nest success was calculated as the percent of total nests of known fate that hatched at least one egg (Geis 1956). Nest initiation was calculated by backdating from the date the nest was found, using the stage of egg development and allowing 7 days for egg laying (Hanson and Frowning 1959). Hatching dates were calculated using an incubation period of 28 days (Hanson and Eberhardt 1971, Bellrose 1978:160). Nests that had already hatched when found were used to determine the nest initiation and hatching peaks, but were separated from those nests dated by the stage of egg development.

Nest Site Analysis

An investigation of characteristics in the immediate vicinity of ground nest sites was conducted in the higher density nesting areas. On both the lake and the river, characteristics at nest sites were compared to the available nesting area. Availability was determined by mapping the habitats of the entire area, and sampling characteristics at a number of random sites equal to the number of ground nest sites sampled in that area.

At each nest and random site the following data were recorded: the distance to and above the HWM and the current water level (to the nearest 0.5 m), dominant plant species present, canopy cover of vegetation by life form within 5 m of the plot center, vertical (visual) cover within 5 m of the plot center, and overhead cover at plot center. Habitats and landforms were defined and mapped for both study areas, and these were also recorded at each site.

Canopy cover was estimated using the line-intercept method (Canfield 1941), extending a line 5 m from the plot center in each of the four cardinal directions. Cover of trees, shrubs, herbaceous plants and subshrubs were recorded to the nearest 0.1 m along each line. Low growing shrubs (< 20 cm) were considered subshrubs.

Vertical cover was measured using a (0.5 x 3.0 m) density board (DeVos and Mosby 1969:142, Noon 1981) gridded to dm^2 and divided into four height intervals (0.0-0.3 m, 0.3-1.0 m, 1.0-2.0 m and 2.0-3.0 m). The first 2 height intervals were read from a crouching position and the latter two from standing at the nest or the plot center. The density board was held 5 m from the nest in the 4 cardinal directions. These 4 readings were averaged for each height level.

Overhead cover was estimated using a densiometer (Lemmon 1956) held at 0.5 m height over the nest bowl or plot center, and averaging readings from each of the 4 cardinal directions. Four categories of cover were used to describe relative values of percent cover: dense (75-100%), moderate (50-74%), sparse (25-49%) and open (<25%).

Differences in means were tested using t-tests when variances were similar. To insure the homogeneity of variances, F-tests were performed prior to t-tests (Snedecor and Cochran 1980). Chi-square (X^2) analyses were performed to detect differences in distributions. Simultaneous confidence intervals were calculated around the proportions of use as in Neu et al. (1974).

Random sites on the lake study area were located by pacing 30 m between points along lines running NW and NE, crisscrossing each island. On the river all islands normally surrounded by water during the early nesting period (March) were considered available. The edge of each island was marked parallel to the 0.1 RM mark, and each mark was numbered. Random points were selected among these marks and a random distance was paced inland from the water's edge to the center of each random sample site. Habitat types were mapped on aerial photos at a scale of 1:10,050 and measured using a grid with 55.6 squares per hectare (ha).

Brood Habitat Use and Availability

Areas of brood use on the lake were determined from locations obtained during aerial and boat brood censuses, and from radiolocations of adults with broods. Miscellaneous visual observations of unmarked adults with broods were also recorded and plotted on maps. All visual locations were combined to delineate important brood areas on the lake.

Intensively used brood areas on the river were determined by using brood observations from aerial surveys and brood activity budgets. Areas with at least 10 observations were delineated using the modified minimum area method of home range delineation (Harvey and Barbour 1965).

The riparian zone was delineated on aerial photos of both the lake and river. On the lake, a line was drawn 100 m inland from the full pool level, while on the river, a more variable width demanded a different definition. The limits of the riparian zone on the river were defined by either a distinct change in vegetation, a 12 m (40’) increase in elevation (transcribed from topographic maps), or by the presence of a paved road. In addition, the adjacent upland vegetation was mapped 100 m to the side of the river’s riparian zone.

Habitat types were defined based on major differences in existing (not potential) vegetation cover. These types were revised from cover types used in 1983 (Gregory *et al.* 1984) and definitions are given in Table 1. Habitat types were mapped on aerial photos at a scale of approximately 1:10,050, and field checked. A random dot overlay with 1,030 randomly located points on a 36 x 60 cm mylar sheet was used to estimate the proportion of different habitat types available (Marcum and Loftsgaarden 1980) within the riparian zone. Amount of area occupied by each habitat type within brood areas was estimated using a grid with 55.6 squares/ha.

The study area was divided into segments, based on physiographic characteristics, to enable a stratified random sample of appropriate characteristics for each habitat type. Lines created by the UTM grid were used for selection of sampling sites on the lake, while lines created by 0.1 RM were used on the river. Agricultural lands and homesites were excluded from the sampling.

At each sampling point, the following data were collected: canopy cover of all plant species, plant litter, rock or bare ground; dominant heights of herbaceous and shrub layers; tree density and dbh; total overstory coverage; vertical vegetation density; physiographic and topographic features of the site; landform, and location.

Canopy cover of herbaceous vegetation was recorded by species within 10 1 m^2 quadrats, placed at 5 m intervals, on either side of a 25 m transect which ran parallel to the shoreline. Surface area of litter, rock and bare ground were

Table 1. Habitat categories used in description of Canada goose brood areas and the riparian zone of the lower Flathead System, Montana, 1984.

Major Type	Distinction	Sub-type	Distinction
Forest	At least 10% tree canopy cover	Coniferous	Dominated by coniferous trees (80%)
		Deciduous	Dominated by deciduous trees (80%)
		Combination	Mixed deciduous and coniferous trees with at least 30% of one or the other
Gravel bars (vegetated)	Intertidal habitat with at least 10% but less than 50% vegetation cover	Shrub	Cover dominated by shrubs
		Herbaceous	Cover dominated by herbaceous plants
Shrub	At least 10% shrub cover, except if Intertidal, at least 50% shrub cover	Dense	At least 20% shrub cover
		Sparse	10-20% shrub cover
Herbaceous (Grass/Forb)	At least 10% herbaceous cover, except if intertidal, at least 50% herbaceous cover	Tall	Dominant layer at least 0.5 m tall
		Medium	Dominant layer less than 0.5 m tall but taller than 10 cm
		Short	Dominant layer less than 10 cm tall
Marsh	Intertidal, dominated by emergent species requiring standing water for the majority of the growing season		
Aquatic (vegetated)	At least 10% cover by aquatic (submerged) plants		
Cultivated land	Land use practices obscure natural vegetation	Pasture	
		Alfalfa	
		Grainfield	
		Orchard	
		Lawn	
		Other	

also recorded within these quadrats. Canopy cover of tree and shrub species was recorded within 2 circles (10 m diameter) located at either end of the line. Tree densities within DBH size classes were also recorded in these circles. All the above coverages were estimated within 6 cover classes (Daubenmire 1959).

Total overstory cover was measured by averaging 4 directional readings on a densiometer held at chest height 5 m from either end of the line. Vertical (visual) cover was estimated at distances of 5, 10 and 15 m at 4 height levels using the same density board described in the nest site analysis. Landform classes were recorded, as well as adjacent habitat types, and U.S.F.W.S. wetland types (Cowardin et al. 1979). Additional measures included the slope, aspect, transect bearing, elevation, and distance to and above the HWM. Each transect line was run parallel to the river or lake shoreline, and was permanently marked when possible. Plants difficult to identify in the field were collected, cataloged and pressed for later reference. Plant names follow Hitchcock and Cronquist (1973) or (if non-vascular) Fassett (1957).

Aquatic vegetation was mapped on the river in 5 sections, 4 miles in length, each representing different stream gradients and substrates. Amount of area occupied by aquatic plants was calculated using aerial photos and a planimeter. Major aquatic plant species were identified within these sections, and structural cover types were defined. Collections of aquatic plants on the lake enabled a preliminary species list to be developed. Brood habitat use and availability were compared using chi-square contingency table tests, and were considered significantly different at $\underline{P}<0.05$.

Brood Activity Budgets

Brood activity budgets were performed from 9 May through 9 July using the instantaneous sampling technique (Altmann 1974). Broods were located during aerial and boat surveys or by incidental observations, and sampling was performed by an observer on the ground. Observations were made using a 15-60x spotting scope and binoculars.

One observation was made every 5 minutes within a 2-hour sampling period. If several broods were together in a gang brood, one brood was randomly selected for sampling. We defined a gang brood following Warhurst _et al_. (1983). The activities and locations of one brood were monitored throughout the entire sampling period when possible. However, if the brood left the area or became mixed with other broods, we selected another brood for sampling. An attempt was made to divide sampling among 3 time periods to obtain a representative sample of the entire diurnal period.

For each observation, the activity and habitat type

(Table 2) of one systematically selected gosling and adult within the brood was recorded. Gosling age classes were recorded using the plumage characteristics method of Yocom and Harris (1965). To simplify data recording, we numbered ages classes 1 through 8 from youngest to oldest to correspond with the 8 plumage classes described by these authors.

Specific brood activities (Table 2) were grouped into the general overall category for preliminary analyses (i.e. activities such as walking and swimming were combined into locomotion, etc.). Other categories with few or no observations were eliminated from the analysis because of the exaggerated effect a small sample size has on chi-square contingency table expected values. Activities analyzed for adults and goslings were feeding, resting, and locomotion, and for adults we also included alert. All activities for both groups were also analyzed by morning and afternoon time periods and young and old gosling age classes.

A chi-square contingency table (Steel and Torrie 1980:495) was used to test the hypothesis that activities of goslings and adults were 1) independent between morning (sunrise to 1300 hours) and afternoon (1300 hours to sunset) time periods and 2) independent between gosling age classes. Chi-square contingency table tests were considered significant at $p<0.05$. If activities of goslings and/or adults were

Table 2. Activity and habitat categories used for Canada goose brood activity budgets, lower Flathead River and Lake, Montana, 1984.

ACTIVITY	HABITAT TYPES
FEEDING	FOREST
Grazing	Coniferous
Hawking	Deciduous
Tipping	Combination
Gleaning	
Pecking	SHRUB
	Dense shrub
RESTING	Sparse shrub
LOCOMOTION	GRASW/FORB
Walking	Tall herbaceous
Swimming	Short herbaceous
	Medium herbaceous
COMFORT MOVEMENTS	CULTIVATED
	Pasture
SOCIAL INTERACTIONS	Grainfield
	Alfalfa
BROODING	Orchard
	Lawn
ALERT	Other
DISTURBED	MARSH
by observer	
by other people	AQUATIC
by dogs	
by wild mammals	UNVEGETATED
by wild birds	
other	
OUT OF SIGHT	

independent between morning and afternoon, data were pooled to test for differences in activities with respect to gosling age classes. For cases when activities were significantly different between morning and afternoon, data relating activities to gosling age classes were analyzed separately for morning and afternoon. If chi-square contingency table tests indicated activities were significantly different between gosling age classes, methods of Marcum and Loftsgaarden (1980) were used to determine which activities were significantly different with respect to gosling age classes. Tests using methods of Marcum and Loftsgaarden (1980) were considered significant at $\underline{P}<0.10$.

RESULTS AND DISCUSSION

Water Levels

RIVER

Minimum daily discharge rates during March and April varied from approximately 1400 to 7600 cfs, and maximum discharge rates ranged from approximately 8500 to 14,000 cfs (Fig. 2). Minimum discharge rates during the first half of May varied from approximately 2500 to 9500 cfs. Minimum discharges dropped to approximately 1500 cfs for the last half of May (Fig. 2). Maximum daily discharge rates remained relatively constant at approximately 13,000 cfs for the first half of May. Maximum discharge dropped dramatically to approximately 1700 cfs on 25 May and remained low through 30 May. Mean discharge from 25 through 30 May was approximately 1600 cfs. Daily discharge rates increased during June to a maximum of approximately 40,000 cfs on 28 June. June discharge fluctuations were extreme both within and among days.

LAKE

The yearly cycle generally consists of a gradual draw down beginning in September and continuing until March or April (Fig. 3). Between late March and early April, filling of the lake begins. The full pool elevation of 882 m (2893 ft) above mean sea level is scheduled to be accomplished by 1 July, and maintained until the 1 September every year.

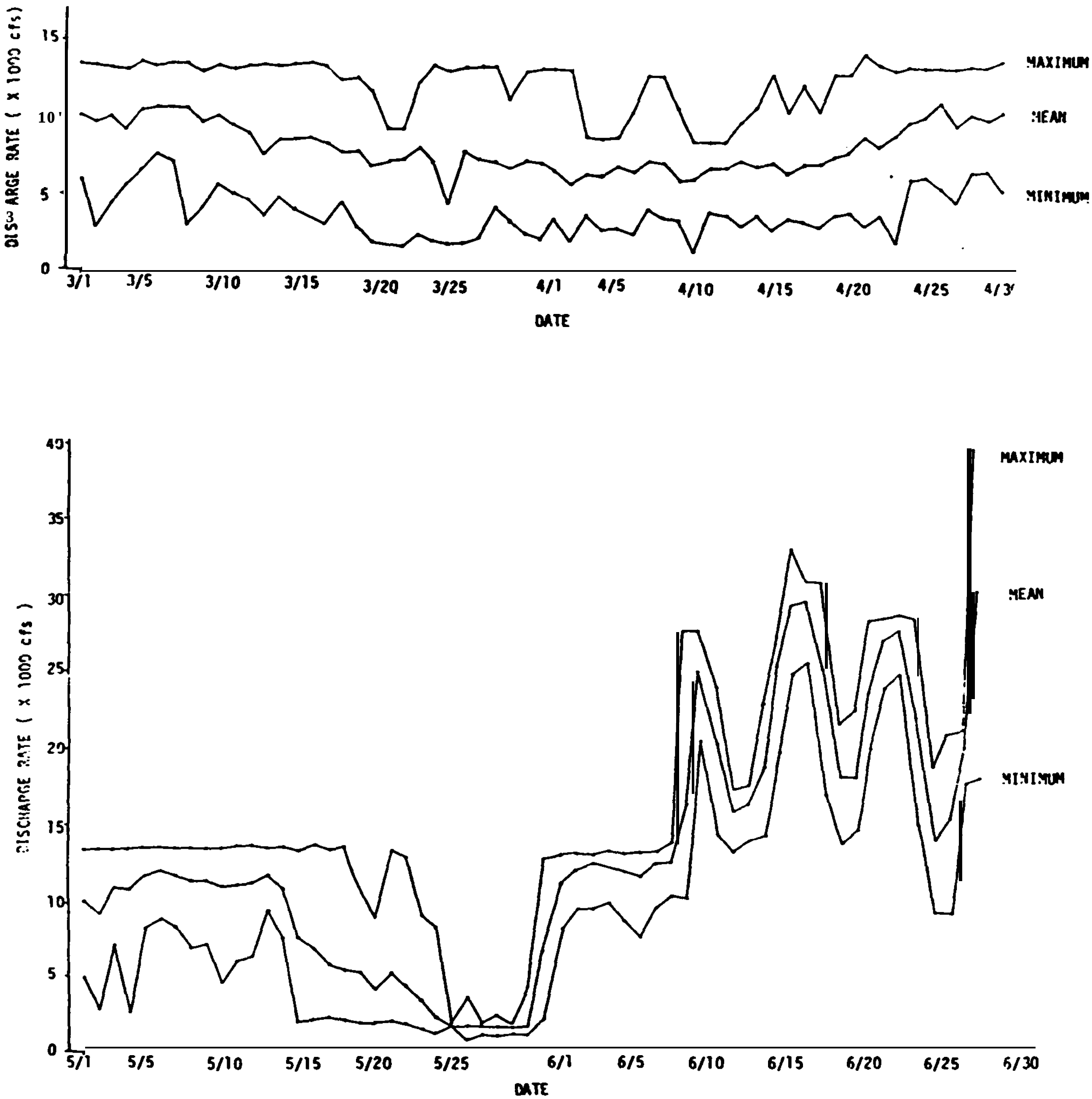

Fig. 2. Maximum, mean, and minimum discharge rates from Kerr Dan. lower Flathead River, Montana, 1984 (unpublished USDI - Geological Survey data from the lower Flathead River gage station no. 12372000 located below Kerr Dam).

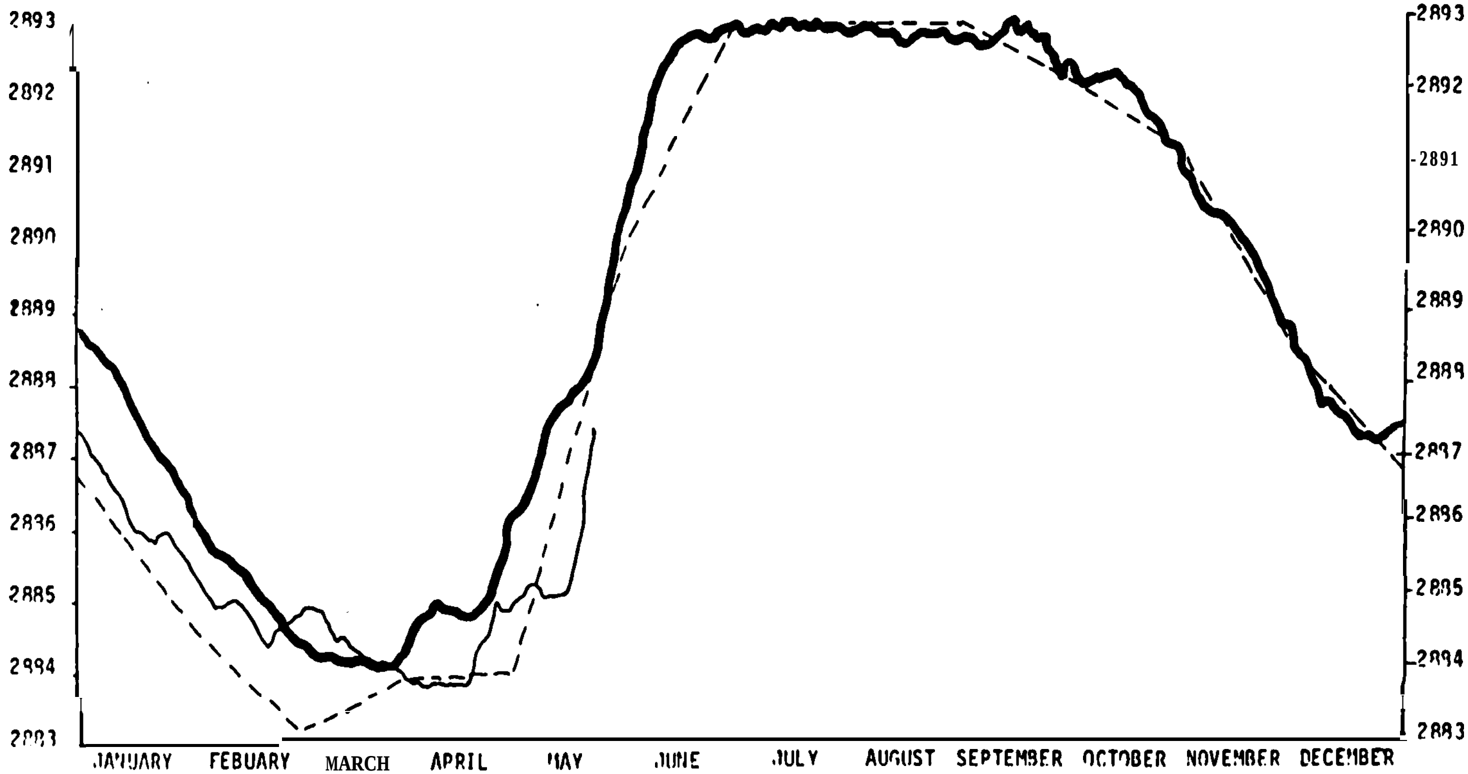

Fig. 3. Flathead Lake elevation above mean sea level, 1983(▬▬), 1984(-), and 1984 projected draw down and fill(- - - -).

During the period of late March through late June, the most dramatic change in water levels takes place. It is during this time period that the effects of water level fluctuations on nesting and brooding geese are most important.

Trapping, Censuses, and Movements

TRAPPING

Eighty geese were trapped between January and June during the 1984 field season. Rocket nets were used to capture 70 geese and 8 were chased down during the annual molting period. Two incubating females were captured on the nest at night with the aid of light and sound. We selected 44 adult geese for radio-collaring over the entire trapping season (Appendix A). Only 1 transmitter is known to have failed.

CENSUSES

Aerial census data from 1983 and 1984 indicate that from late summer through fall, most geese are located on Pablo, Kicking Horse, and Ninepipe Reservoirs (Table 3). Few geese were observed on the river during this time period. Craighead and Stockstad (1956) also observed most of the Flathead Valley Canada goose population concentrating on Pablo and Ninepipe Reservoirs from August through the hunting season.

During 1984, most geese used the reservoirs until the

Table 3. Numbers of Canada geese observed on aerial censuses, Flathead Valley, Montana, 1983 - 1984.

Date	Time Period	Lower Flathead River	Pablo Reservoir	Kicking Horse Reservoir	Ninepipe Reservoir	Horte Reservoir	Crow Reservoir	Total
03/22/83	A[a]	25	300	120	460	-[c]	-	905
03/29/83	M[b]	60	375	0	260	-	-	695
11/08/83	M	50	180	170	230	-	-	630
11/17/83	A	150	360	120	420	-	-	1050
11/22/83	M	412	340	170	420	-	-	1342
11/29/83	A	385	250	0	540	-	-	1175
12/11/83	A	920	0	20	400	-	-	1340
12/19/83	M	1825	80	0	5	-	-	1910
01/05/84	M	0	0	0	0	-	-	0
01/17/84	A	330	0	0	0	-	-	330
02/01/84	M	509	0	0	0	-	-	509
02/10/84	A	150	2	0	120	-	-	272
02/15/84	A	50	3	0	90	-	60	203
02/22/84	A	65	2	5	140	50	2	264
03/02/84	M	94	21	60	-	50	15	240
03/12/84	M	73	89	56	89	47	4	358
03/21/84	M	132	-	-	-	-	-	132

Table 3. Continued

Date	Time Period	Lower Flathead River	Pablo Reservoir	Kicking Horse Reservoir	Ninepipe Reservoir	Horte Reservoir	Crow Reservoir	Total
03/28/84	M	166	-	-	-	-	-	166
04/03/84	M	153	-	-	-	-	-	153
04/12/84	M	151	-	-	-	-	-	151
04/17/84	M	109	-	-	-	-	-	109
04/24/84	M	141	-	-	-	-	-	141
05/15/84	M	144	-	-	-	-	-	144
05/17/84	M	197	-	-	-	-	-	197
05/21/84	M	152	-	-	-	-	-	152
05/24/84	M	146	65	45	-	-	-	256
05/30/84	M	-	90	0	-	50	0	140
06/01/84	M	168	288	0	-	92	0	548
06/04/84	M	134	441	0	-	75	0	650
06/07/84	M	179	366	0	-	35	26	606
06/11/84	M	81	-	-	-	-	-	81
06/13/84	M	156	404	0	-	81	18	659
06/18/84	M	88	-	-	-	-	-	88
06/27/84	M	52	410	0	-	55	16	533
06/29/84	M	62	265	0	-	70	30	427

Table 3. Continued

Date	Time Period	Lower Flathead River	Pablo Reservoir	Kicking Horse Reservoir	Ninepipe Reservoir	Horte Reservoir	Crow Reservoir	Total
07/02/84	M	29	312	0	-	100	10	451
07/09/84	M	52	410	1	-	90	1	554
07/18/84	M	65	340	5	-	30	20	460
07/25/84	M	55	397	5	610	45	45	1157
08/01/84	M	37	316	0	408	0	160	921
08/08/84	M	35	461	20	870	0	345	1731
08/14/84	M	-	-	-	620	-	330	950
08/15/84	M	14	580	0	780	0	330	1704
08/22/84	M	90	1015	290	468	21	475	2359
08/29/84	M	0	715	247	215	0	455	1632
09/05/84	M	35	50	5	0	0	0	91
09/13/84	M	80	797	249	477	150	0	1753
09/21/84	M	2	385	325	272	0	0	984

[a] A = Survey conducted between 1300 and 1700 hours.

[b] M = Survey conducted between 0700 and 1200 hours.

[c] - = No survey performed

end of November when cold weather began freezing the reservoirs. Goose use of the river began to increase at this time, and by 19 December virtually all geese had moved to the river (Table 3) apparently because the reservoirs froze. Extremely cold weather during the last week in December caused the lower section of the river to freeze, and most of the geese left the valley. One radio-marked goose located on the river on 19 December was shot 28 December near Darby, Montana, approximately 145 km south of the study area. Craighead and Stockstad (1956) reported most Canada geese left the Flathead Valley in 1955 as the result of a severe cold period.

Most breeding geese did not return to the river until the last week in March (Table 3). Numbers of geese on the river remained relatively stable during the nesting and brooding period. By mid-July, after broods had fledged, numbers of geese using the river were low, apparently a result of geese moving to the reservoirs. In 1983, radio-marked adults with broods began using reservoirs more than the river after goslings had fledged (Gregory <u>et al.</u> 1984).

The numbers of adults and goslings observed in brood groups on the lake and river were highly variable (Table 4; Fig. 4 and 5). The decreasing counts after mid-June are likely a result of broods fledging and leaving the lake or river. Counts were highest and less variable during the

Table 4. **Numbers of Canada** geese in brood groups observed on aerial censuses [a], lower Flathead River, Montana, **1984.**

Date	No. Adults	No. Goslings	Total
5/15	22	46	68
5/17	32	67	99
5/21	20	42	62
5/24	43	82	125
6/01	55	113	168
6/04	48	86	134
6/07	53	126	179
6/11	29	52	81
6/13	56	100	156
6/18	26	62	88
6/27	16	36	52
6/29	22	40	62
7/02	13	16	29
$\bar{X}$ - SD	32-17	67-33	100-48

[a] All censuses were conducted between 0700 and 1000 hours.

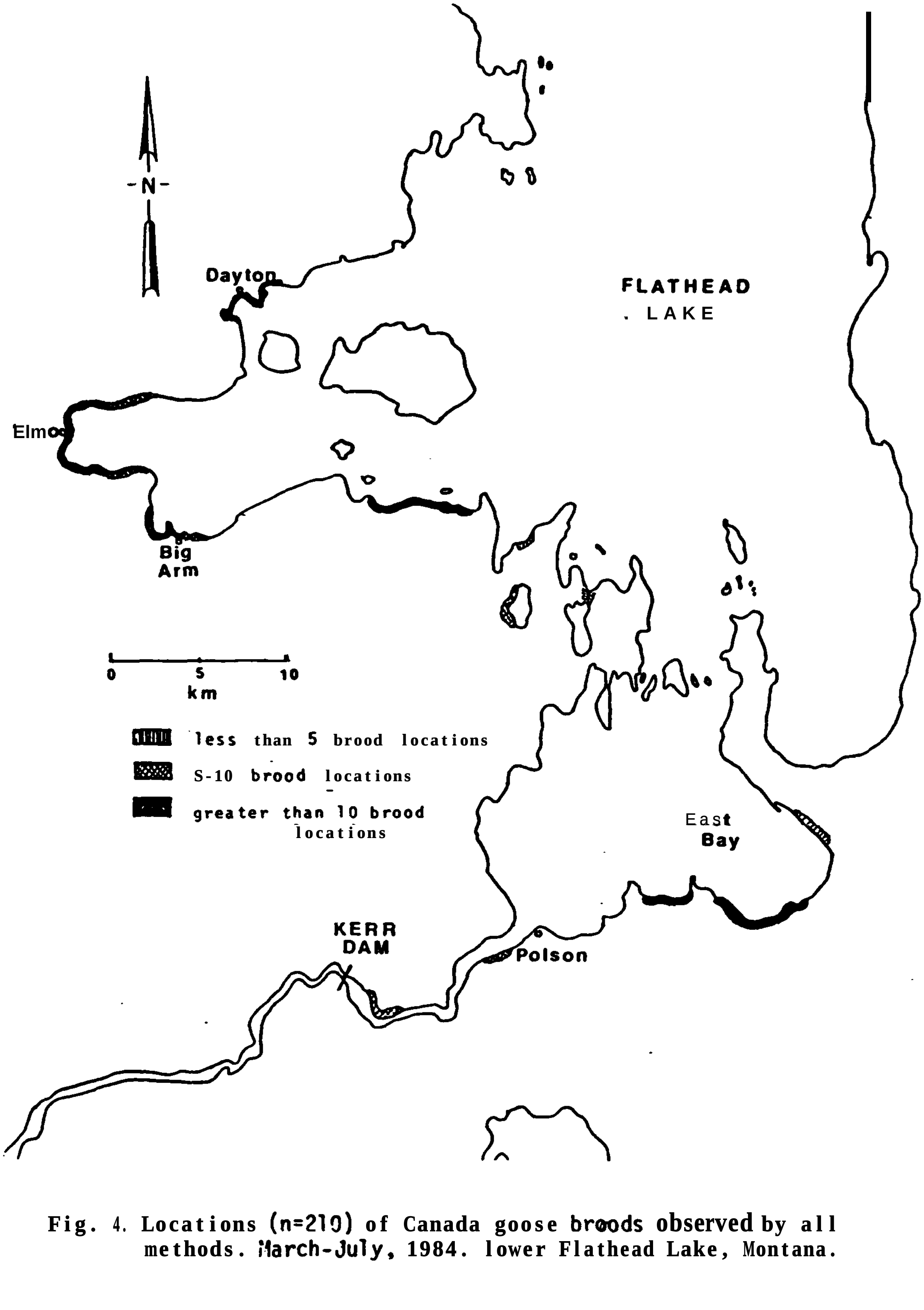

Fig. 4. Locations (n=210) of Canada goose broods observed by all methods. March-July, 1984. lower Flathead Lake, Montana.

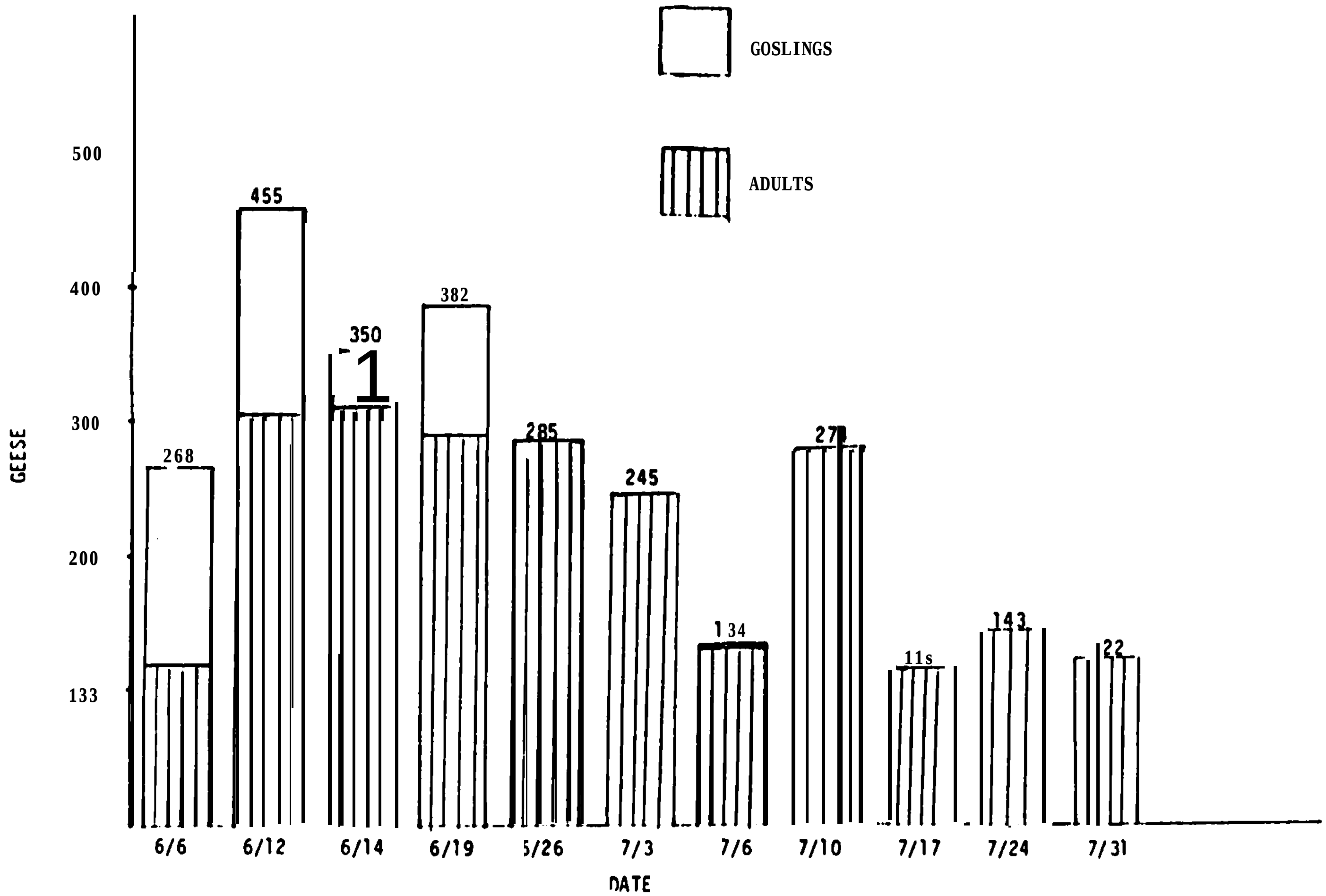

Fig. 5. Number of adult and gosling Canada geese observed in brood groups from aircraft, lower Flathead Lake, Montana, 1984.

first 2 weeks of June on the river and highest during this time on the lake. These data indicate that if aerial surveys are to be performed to census the brooding goose population on the river or lake they should be performed during the first half of June.

MOVEMENTS

During the nesting period there were 10 radio-marked adult geese on the river, however, they either did not nest or were unsuccessful at nesting. All 10 geese left the river between 15 and 30 Hay, and 8 moved to reservoirs. By June, we were unable to obtain signals from 9 of the geese, apparently because they had left the Flathead Valley. One goose moved from the river to Pablo Reservoir, and remained on the reservoir throughout the molting period. On 21 August, 2 of the geese which had apparently left the valley were located on Ninepipe Reservoir. These radio-marked geese were likely on a northward molt migration. Molt migration of Western Canada geese has been discussed by others (Krohn and Bizeau 1979, Ball _et al_. 1981).

Only 3 of the geese radio-collared on the lake are known to have successfully produced goslings. All of these were from nests on Melita Island. Two radio-collared geese were observed in the Bird Islands vicinity and one goose was located between Cedar and Shelter Islands during the nesting period. Four additional radio-collared geese were periodically located on or near Melita Island during the nesting period, but none of these successfully produced goslings.

Two of the successful nesters were females and 1 radio collared male was paired with a successfully nesting female. All 3 of these radio-collared adults, with their mates and broods, were monitored extensively during the brooding period.

The radio-collared male, (No. 60), was first observed with mate and 5 goslings, on the south shore of Elmo Bay on 10 May (Fig. 6). This family group spent the remainder of the brooding period in Elmo Bay, as part of a larger gang brood. One of the radio-collared females, (No. 29), mate and brood, were also included in this gang brood. The first observation of this bird with a brood was also on 10 May and also on the south shore of Elmo Bay (Fig. 7). However, this first location was separate from that of the previous bird (No. 60). The presence of both of these radio-collared adults in the same gang brood explains to a large extent the similarity of the locations plotted for each during the brooding period.

The remaining radio-collared female (No. 26) was also first observed with brood on 10 May in Big Arm Bay, where the family group spent the majority of the brooding period (Fig. 8). Although this bird was also a part of a larger gang brood located in Elmo Bay on several occasions, no mixing of

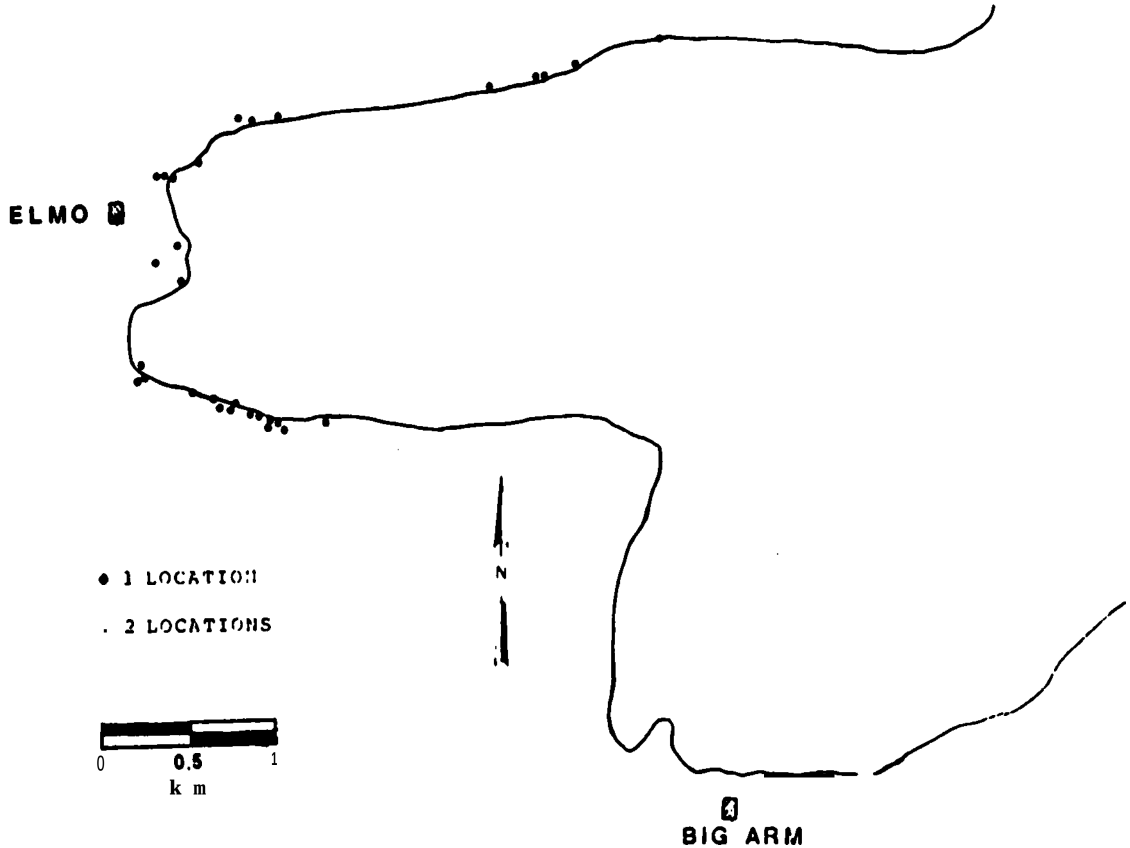

Fig. 6. **Thirty-five locations of radio-collared adult** male Canada goose (#60) and brood, March-July **1984**, Flathead **Lake**, Montana.

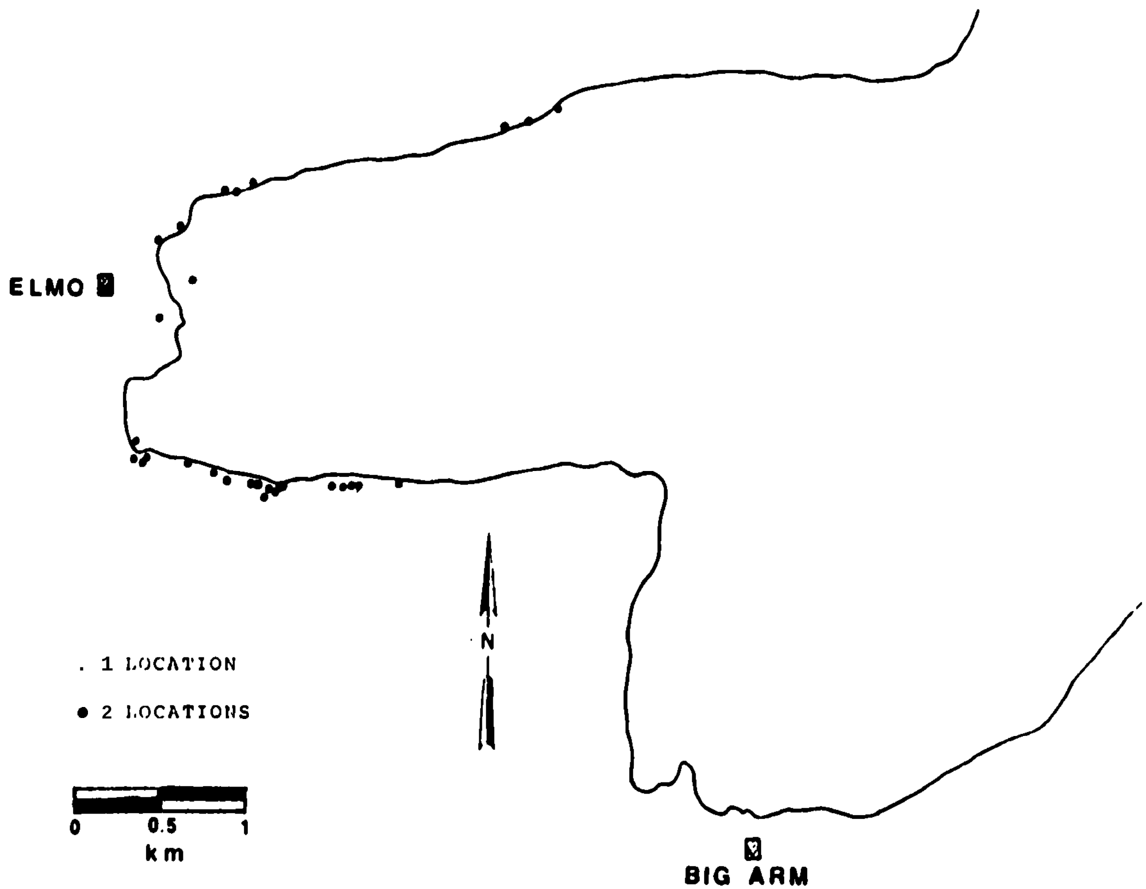

Fig. 7. Thirty-three locations of radio-collared adult female Canada goose (#29) and brood, March-July 1984, Flathead Lake, Montana.

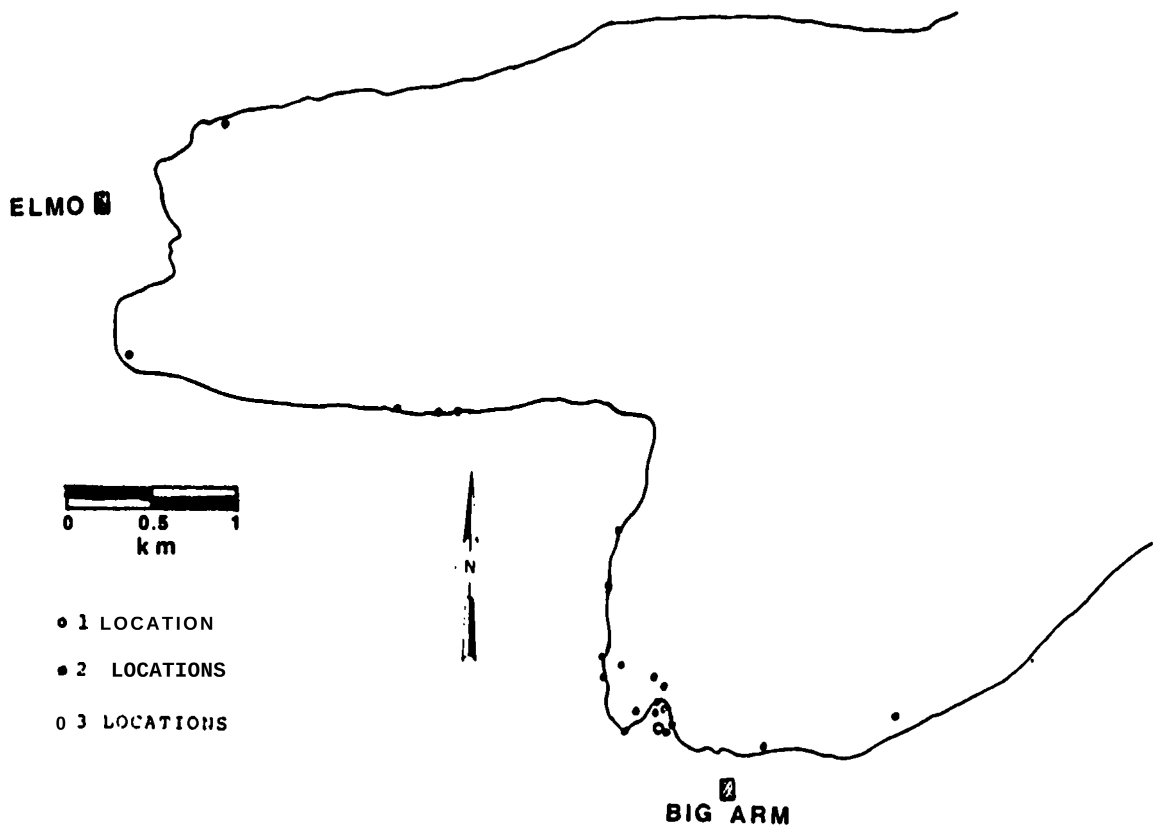

Fig. 8. Twenty-nine locations of radio-collared adult female Canada goose (#26) and brood, March-July 1984, Flathead Lake, Montana.

the 2 gang broods was observed.

After the goslings had fledged and the adults molted, bird 60 and 29 were located once on Crow Reservoir and thereafter on Pablo Reservoir until mid-September. The post-fledging movements of bird 26 were similar, with the first location away from Big Arm Bay in a field approximately 6 km north of Horte Reservoir. The remaining locations of this bird were on Pablo Reservoir.

Most non-breeding geese left Flathead Lake during the last week in May or the first week in June. Most radio-collared geese were not located on the study area thereafter until late August and early September. While the locations of these birds are unknown, the possibility of a large molt migration coupled with the increased recreational use of Flathead Lake during this time, may explain the large scale disappearance of the non-breeding segment of the population.

Territorial Pair Surveys

RIVER

The mean number of indicated pairs observed on the entire river in 1984 was 66 (SD=20) for boat surveys and 78 (SD=13) for morning aerial surveys (Tables 5 and 6). Estimates from both survey methods were more variable in 1984 than 1983. Indicated pair data for the entire river in 1984 convert to 1.2 pairs/nest for boat surveys, 1.4 pairs/nest for morning aerial surveys. These ratios are similar to the

Table 5, Counts from Canada goose pair surveys conducted by boat, lower Flathead River, Montana, 1984.

Date	Singles	Pairs	Indicated Pairs[a]	Non-breeders	Total
3/13	1	35	36	44	115
3/19	4	47	51	11	109
3/26	8	53	61	84	198
4/02	23	70	93	22	185
4/09	26	49	75	26	150
4/16	29	57	86	44	187
4/23	24	37	61	30	128
$\bar{X}$ - SD	16-12	50-12	66-20	37-24	153-37

[a]Indicated Pairs = Singles + Pairs

Table 6. Counts from Canada goose pair surveys conducted by plane, lower Flathead River, Montana, 984.

Date	Singles		Pairs		Indicated Pairs[a]		Nonbreeders		Total	
	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
3/23	[illegible]	–	4[illegible]	–	58	–	26	–	32	–
3/28	7	5	67	42	84	57	5	35	66	34
4/03	33	4	55	61	88	75	10	20	53	56
4/12	43	33	46	52	89	85	16	9	151	146
4/17	31	24	35	38	66	62	8	22	109	122
4/24	37	20	44	31	81	51	16	17	141	99
- SD	28- 2	21-8	49-1	45-12	78-13	66-14	15-6	21-9	42-20	3[illegible]-22

[a]Indicated Pairs = Singles + Pairs

1.3 pairs/nest observed for both survey methods in 1983 (Gregory *et al.* 1984).

In 1984, there were no significant differences in the number of indicated pairs observed on: morning and afternoon aerial surveys ($t=1.7$, $P>0.05$), morning boat and aerial surveys ($t=-0.43$, $P>0.05$), afternoon boat and aerial surveys ($t=0.12$, $P>0.05$), or morning and afternoon boat surveys ($t=1.88$, $P>0.05$). The indicated pairs/nest ratio was 1.4 for both morning boat and aerial surveys (Tables 7 and 8). The number of indicated pairs and the -indicated pairs/nest ratios observed on morning boat and morning aerial surveys were less variable than estimates from afternoon surveys (Tables 7 and 8).

In 1984, as in 1983, no significant differences in the number of indicated pairs observed were found between boat and aerial surveys. However, in 1984 there was also no significant difference between morning and afternoon surveys as there was in 1983 (Gregory *et al.* 1984). Considering the significant decrease in indicated pairs observed between morning and afternoon aerial surveys in 1983, and the greater variation in afternoon than morning boat and aerial counts in 1984, morning boat or aerial surveys appear to give the most precise estimate of indicated pairs on the river. Other studies have found aerial surveys to be unsuitable in estimating Canada goose breeding populations (Geis 1956, Hanson

Table 7. Counts from Canada goose pair surveys conducted by boat on the southern half of the lower Flathead River, Montana, 1984.

Date	Singles		Pairs		Indicated Pairs[a]				Nonbreeders		Total	
	Morning	Afternoon	Morning	Afternoon	Morning	Pairs/Nest	Afternoon	Pairs/Nest	Morning	Afternoon	Morning	Afternoon
3/26		5		45	-	-	50	1.0		64		159
3/30	18	-	58	-	76	1.5			24		158	-
4/2		16		58		-	74	1.5		18		150
4/6	21	-	47	-	68	1.4			15		130	-
4/9		16		37	-	-	53	1.1		26		116
4/13	31	-	38	-	69	1.4			38		145	-
4/16		22		43	-	-	65	1.3		37		145
4/21	28	-	36	-	64	1.3			18		118	-
4/23	-	15		25			40	0.8		18		83
$\bar{X}$ - SD	24-6	15-6	45-10	42-12	69-5	1.4-0.1	56-13	1.1-0.3	24-10	33-19	138-17	131-31

[a] Indicated Pairs = Singles + Pairs

Table 8. Counts from Canada goose pair surveys conducted by plane on the southern half of the lower Flathead River, Montana, 1984.

Date	Singles		Pairs		Indicated Pairs[a]				Nonbreeders		Total	
	Morning	Afternoon	Morning	Afternoon	Morning	Pairs/Nest	Afternoon	Pairs/Nest	Morning	Afternoon	Morning	Afternoon
3/28	17	13	55	37	72	1.5	50	1.0	15	32	142	119
4/3	28	12	44	55	72	1.5	67	1.4	3	17	119	139
4/12	34	28	37	46	71	1.4	74	1.5	16	9	124	129
4/17	25	19	29	35	54	1.1	54	1.1	8	16	91	105
4/24	27	16	39	26	66	1.3	42	0.9	9	17	114	85
$\bar{X}$ - SD	26–6	18–6	41–10	40–11	67–8	1.4–0.2	57–13	1.2–0.3	10–5	18–8	118–18	115–21

[a]Indicated Pairs = Singles + Pairs

and Eberhardt 1971, Tacha and Linder 1978).

LAKE

The comparison of plane versus boat pair survey methods revealed no significant difference ($P>0.05$) on any of the 3 island groups. The mean number of indicated pairs observed on the Northern Islands group was 27.5 by plane, and 26.2 by boat ($t=0.28$ $P>0.05$) (Table 9). Similar data for the Bird Islands group were 30.8 and 38.8 ($t=1.39$ $P>0.05$)(Table 10), and for Melita Island the mean number of pairs observed by the 2 methods was 22.8 and 19.0 ($t=0.66$ $P>0.05$)(Table 11). The ratio of indicated pairs/nest is also given for each island by each of the 2 survey methods. The means of these ratios range from 0.49 to 0.71, generally less than half of similar ratios observed on the river. The use of aerial or boat methods of censusing the breeding segment of the population on the lake consistently underestimates the actual number of breeders present. However, knowing the relative ratio of counted birds to actual breeders will improve future estimates on the goose nesting islands in Flathead Lake. Continuation of pair counts through another nesting season will allow a more precise calibration between pair counts and actual nesting populations.

Artificial Nest Structures

Thirteen percent (7 of 52) artificial tree nest struc-

Table 9. Counts from Canada goose pair surveys, Northern Islands group[a] Flathead Lake, Montana, 1984.

	AERIAL SURVEY				BOAT SURVEY			
Date	Singles	Pairs	Indicated Pairs[b]	Indicated Pairs/Nest	Singles	Pairs	Indicated Pairs[b]	Indicated Pairs/Nest
16 March					2	19	21	0.54
22 March					4	18	22	0.56
23 March	4	11	15	0.38	-	-	-	-
28 March	14	24	38	0.97		-		-
30 March					4	29	33[c]	0.85
3 April	9	11	20	0.51		-	-	-
6 April					18	13	31	0.79
12 April	11	27	38	0.97	..	-	-	-
13 April					16	15	31	0.79
17 April	11	14	25	0.64		-	-	-
20 April					13	6	19	-
24 April	18	11	29	0.74	-	-	-	0.49
	$\bar{X}$ = 11.2	16.3	27.5	0.71	9.5	16.7	26.2	0.67
	SD = 4.7	6.6	9.4	0.24	7.0	7.6	6.1	0.16

[a]The Northern Islands group includes Cedar, Shelter, Rock, Goose, Douglas and Mary B Islands.

[b]Indicated Pairs = Singles + Pairs

[c]Incomplete survey

Table 10. Counts from Canada goose pair surveys, Bird Islands, Flathead Lake, Montana, 1984.

Date	AERIAL SURVEY				BOAT SURVEY			
	Singles	Pairs	Indicated Pairs[a]	Indicated Pairs/Nest	Singles	Pairs	Indicated Pairs[a]	Indicated Pairs/Nest
19 March					4	22	26	0.41
23 March	1	17	18	0.29				
26 March	-	-	-	-	6	21	27	0.43
28 March	12	23	35	0.55				
2 April	-	-	-	-	18	26	44	0.70
3 April	15	15	30	0.48				
9 April	-	-	-	-	16	30	46	0.73
12 April	12	24	36	0.57				
16 April	-	-	-	-	17	20	37	0.59
17 April	21	14	35	0.55				
24 April					23	30	53	0.84
	$\bar{X}$ = 12.2	18.6	30.8	0.49	14.0	24.8	38.8	0.62
	SD = 7.3	4.6	7.5	0.12	7.4	4.5	10.8	0.17

[a]Indicated Pairs = Singles + Pairs

Table 11. Counts from Canada goose pair surveys, Melita Island, Flathead Lake, Montana, 1984.

Date	AERIAL SURVEY Singles	Pairs	Indicated Pairs[a]	Indicated Pairs/Nest	BOAT SURVEY Singles	Pairs	Indicated Pairs[a]	Indicated Pairs/Nest
28 March	4	23	27	0.73	-	-	-	-
30 March					7	15	22	0.60
3 April	10	21	31	0.84	-	-	-	-
12 April	4	13	17	0.46	-	-	-	-
13 April					12	13	25	0.68
17 April	12	8	20	0.54				
20 April	-	-	-	-	6	4	10	0.27
24 April	12	7	19	0.51				
$\bar{X}$ =	8.4	14.4	22.8	0.62	8.3	10.7	19.0	0.51
SD =	4.1	7.3	5.9	0.16	3.2	5.9	7.9	0.21

[a]Indicated Pairs = Singles + Pairs

tures located on the river were used by nesting geese. Five of the occupied structures contained bark and 2 contained shale. Nesting success of geese using structures was 100% on bark and 50% on shale. Two of the 3 nest structures used in 1983 were used again in 1984. Eight percent (4 out of 52) of the tree structures were used by nesting great horned owls (Bubo virginianus).

Nineteen percent (5 of 26) of the tree structures in the northern half of the river were used compared to 8% (2 of 26) in the southern half. Very few islands occur in the northern half of the river, therefore, secure natural ground nest sites are scarce in this area. The greater use of structures in the northern half of the river may be a result of structures providing secure artificial nest sites in an area where natural ground nest sites are limited. Most geese on the lower Flathead River nest in the southern half where most of the islands occur (Gregory et al. 1984).

Mean loss of bark nest material over one year was 17% (range = 4%-36%). Most bark loss was a result of wind. We expect loss of bark to decrease through time when exposed bark becomes more sheltered by the nest structure sides as the amount of bark in the structure decreases. No loss of shale nest material had occurred after one year.

Five rock pillar nest structures were constructed along the river. All 5 pillar structures were destroyed by ice during December and January. Severe ice conditions appear to occur often enough on the lower Flathead River to make the use of rock pillar structures unfeasible.

Goose Production Estimates

RIVER

In 1984, nest initiation on the river began the second week in March and peaked between the last week in March and first week in April (Figure 9). Hatching peaked the first week in May (Figure 10). These dates are similar to those observed on the study area in 1983 (Gregory et al. 1984).

Nest numbers on the river in 1984 were slightly higher than those observed in 1983 (Table 12), and substantially higher than those observed from 1980 to 1982. Nesting success on the river was 74% in 1984 (Table 12). The success rate in 1984 was comparable to rates observed in 1981 and 1983, but substantially higher than rates observed in 1980 and 1982. The average nesting success rate reported by most studies of Canada geese is approximately 70% (Bellrose 1978:161).

Goose nest fate data indicate predation as the most significant cause of nest loss on the river (Table 13). Predation accounted for the loss of 14% and 17% of the nests in 1983 and 1984, respectively. Our data indicate that when predators are present on goose nesting islands, significant

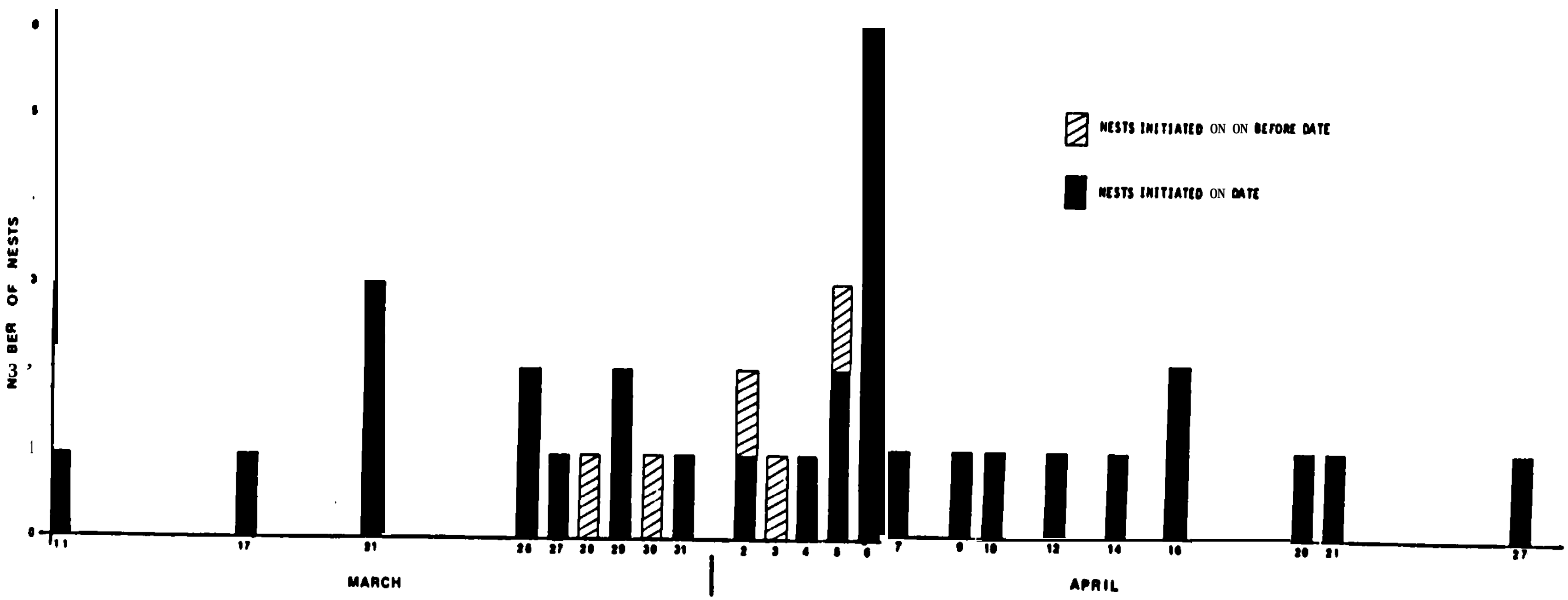

Fig. 9. Frequency distribution of nest initiation by Canada geese, lower Flathead River, Montana, 1984.

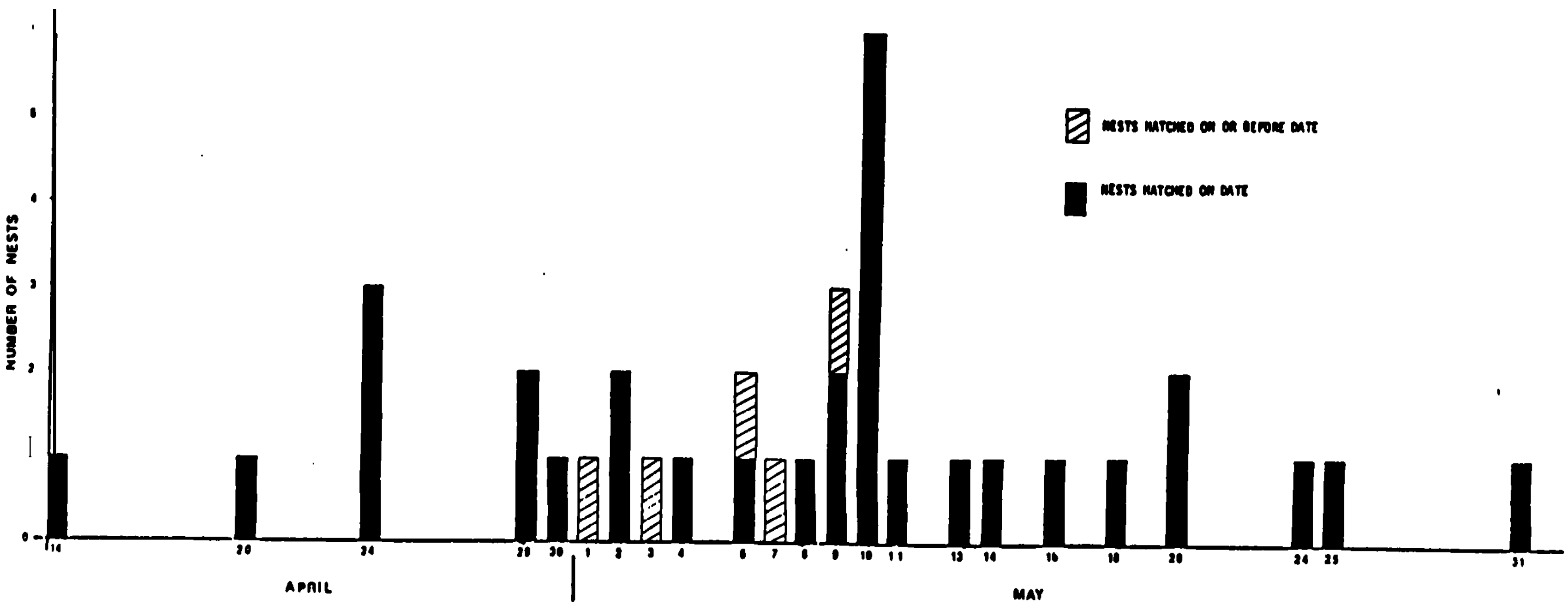

Fig. 10. Frequency distribution of Canada goose hatching dates, lower Flathead River, Montana, 1984.

Table 12. Number of nests and nesting success of Canada geese, lower Flathead River, Montana, 1953-1960 and 1980-1984.

Year	No. Nests	Nesting Success (%)
1953-1960 mean[a]	46	65
1980[a]	24	53
1981[a]	32	74
1982[a]	36	43
1983	53	68
1984	56	74

[a]Data from Ball (1983).

Table 13. Fate of Canada goose nests on the lower Flathead River, Montana, 1983 and 1984.

Nest Fate	1983 No. Nests	1983 Percent of Known Fate Nests	1984 No. Nests	1984 Percent of Known Fate Nests
Hatch	32	68	39	74
Mammal Predation	1	2	3	6
Bird Predation	2	4	1	2
Unclassified Predation	4	8	5	9
Flooded	2	4	0	0
Abandoned	6	13	5	9
Unknown	6		3	
Total	53	99	56	100

levels of predation and/or discouragement of nesting occur. On the river, we observed coyote (*Canis latrans*), raccoon (*Procyon lotor*), or black bear (*Ursus americanus*) tracks on 12 goose nesting islands during the nesting period. Nesting was adversely affected by predators on 8 (67%) of these islands. All goose nests on 4 (33%) of the 12 islands were destroyed, and no geese nested on 2 (17%) islands, both of which supported nesting geese in 1983. Partial predation of nests was observed on 2 (17%) islands. Discharge rates less than 6000 cfs may expose some goose nesting islands to access by mammalian predators (Gregory *et al.* 1984). Minimum discharge rates during March and April were typically well below 6000 cfs (Fig. 2), which is similar to minimum discharge patterns observed in 1983 (Gregory *et al.* 1984). Low water levels during the nesting period can result in serious predation rates and/or discouragement of nesting by allowing predators access to nesting islands (Sherwood 1968, Vermeer 1970, Ball *et al.* 1981).

Nest loss by flooding accounted for 2 nests (4%) in 1983 and 0 nests in 1984 (Table 13). Both nests flooded in 1983 were used again in 1984 and both hatched successfully. The maximum daily discharge rate was approximately 24,000 cfs during the 1983 nesting period Gregory *et al.* 1984, and 14,000 cfs during the 1984 nesting period (Fig. 2). Maximum discharge rates less than approximately 14,000 cfs would have resulted in no nest flooding during 1983 or 1984. River water levels reach the HWM as a result of discharge rates between 25,000 and 35,000 cfs. Maximum discharge rates did not reach 25,000 cfs until the second week of June; all nests on the river had hatched by this time. Fifty-two percent of island ground nests and 37% of all nests on the river were at or below the HWM. This is considerably greater than proportions observed in 1983 (Gregory et al. 1984), and illustrates the potential for significant nest loss should water levels reach the HUM prior to the end of hatching.

Seventy-one percent of the goose nests on the river were island ground nests (Table 14), which is comparable to the 74% island ground nests observed in 1983. Use of artificial nest structures increased from 9% in 1983 (Gregory et al. 1984) to 19% in 1984. The increased use of artificial nest structures is likely a result of increased availability of tree structures provided by our study.

LAKE

During the 1984 nesting season, the estimated peak of nest initiation on Flathead Lake occurred during the last week in March (Fig. 11) based on backdating of 119 nests. Seventy-one (60%) of these nests had already hatched when found in late April-early May, and this therefore represented the estimated peak of hatching (Fig. 12).

Table 14. Canada goose nest types, lower Flathead River, Montana, 1984.

Nest Type	No. Nests	Percent of Total Nests
Island Grcund Nests	40	71
Osprey, Heron, and Owl nests	5	9
Artificial Tree Structures	8	14
Other Artificial Structures	3	5
Total	56	99

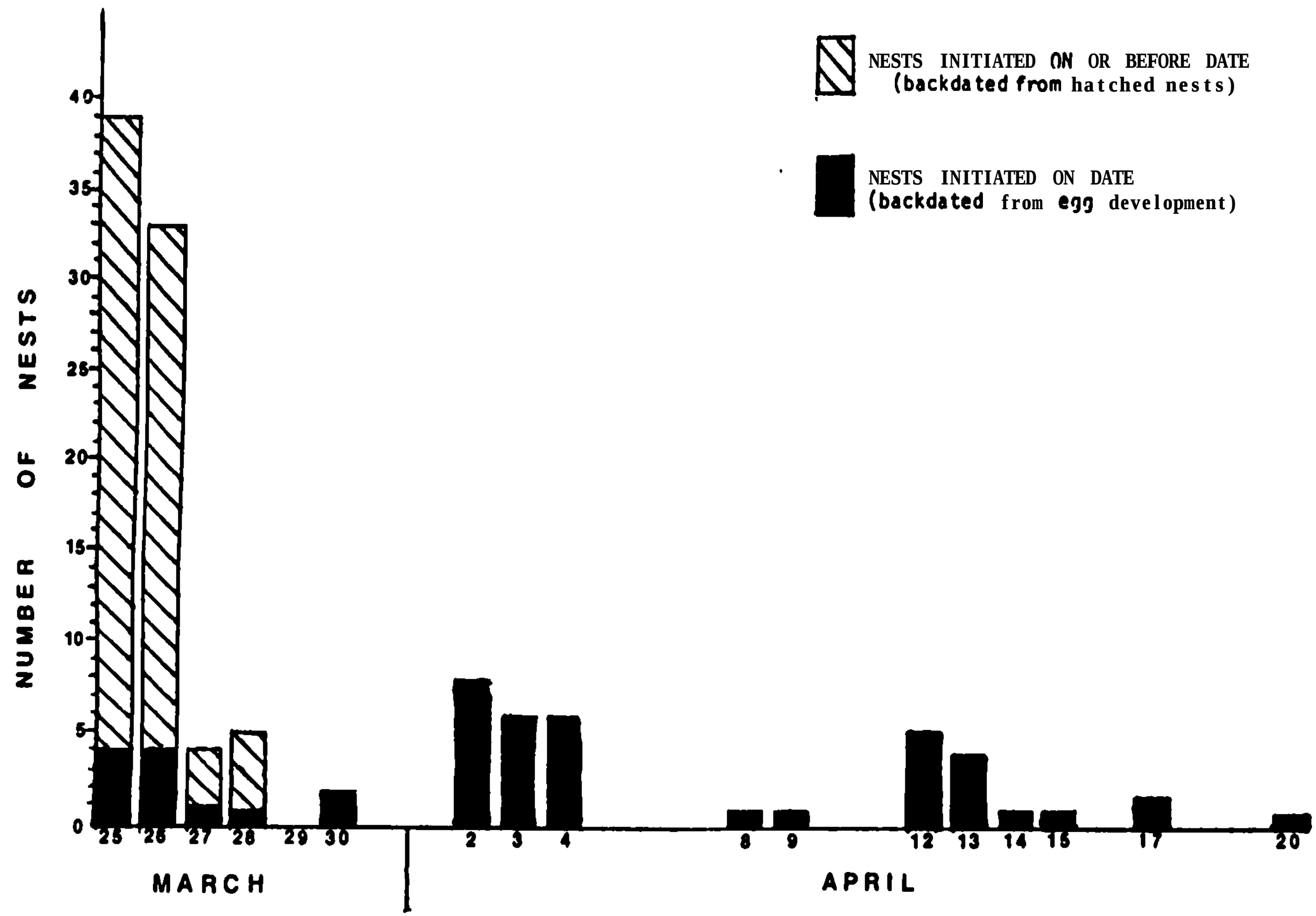

Fig. 11. Estimated dates of Canada goose nest initiation determined from backdating from hatched nests or stage of egg development, lower Flathead Lake, Montana, 1984. (The entire bar represents the total number of nests initiated on or before each date.)

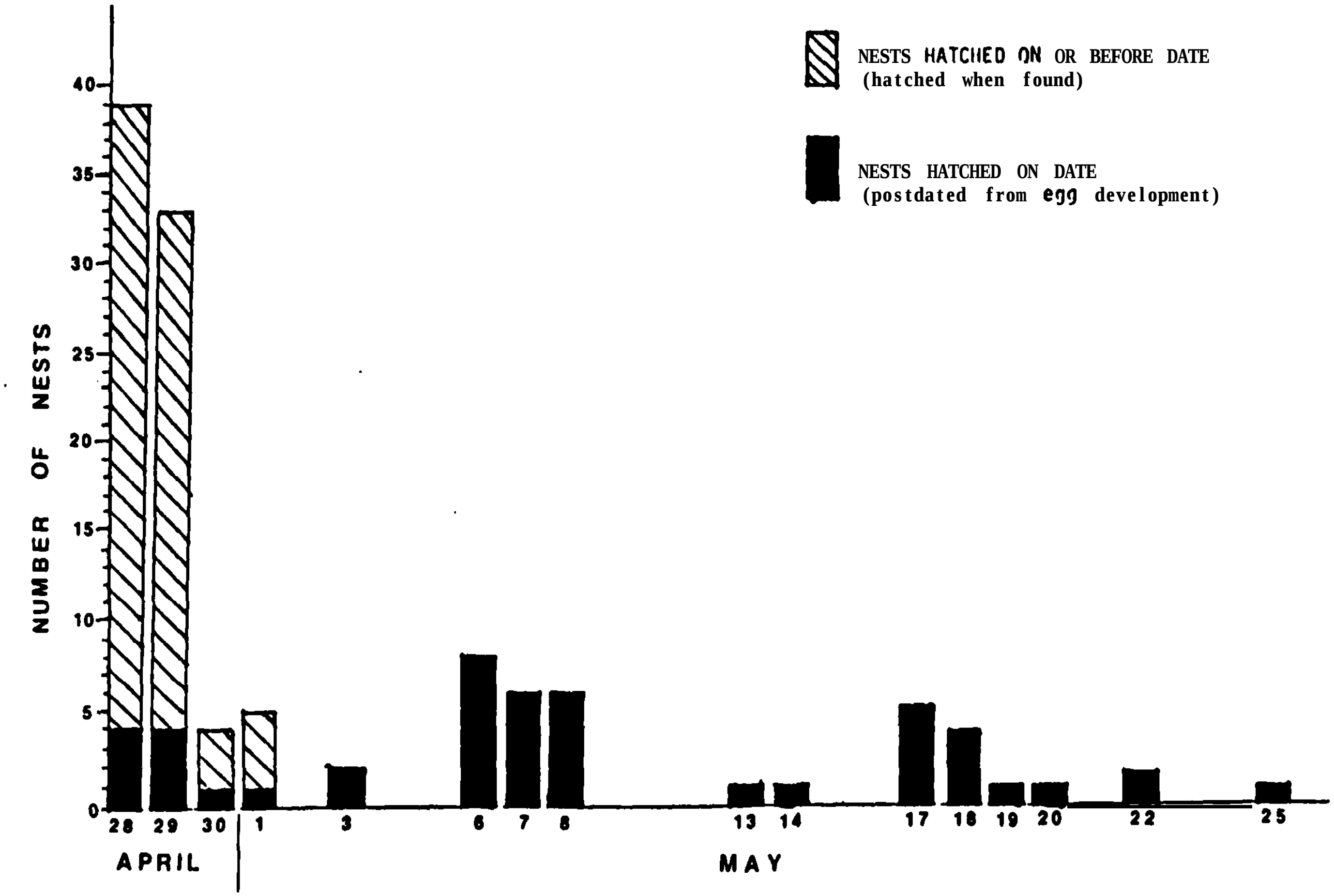

Fig. 12. Estimated dates of Canada goose hatch, determined by postdating from stage of egg development, lower Flathead Lake, Montana, 1984. (The entire bar represents the total number of nests hatched on or before each date.)

During 1984, 164 nests were found on the lake portion of the study area (Table 15). This number compared favorably to numbers found during previous years (Ball 1983) (Table 16). Nests were found on 19 of the 21 islands searched (Fig. 13 and 14) while 122 nests (74%) were found on Cedar, Melita and the Bird Islands (Table 14). Nest success averaged 72% for the entire lake (Table 15 and Fig. 15) with 99 hatched nests, and this compared favorably to other reports of Canada goose nest success of approximately 70% (Bellrose 1978:161), However, nest success was down slightly from the same area last year (Table 16). Nest success by island ranged from 0-100%. Melita Island had the highest success of the larger islands (97%) but the 3 Bird Islands hatched more nests (37) than any other island or island group.

Predation of nests on the lake was primarily avian and only 2 nests were classified as being destroyed by a mammal. Nest predation on the larger islands was highest (33%) on the Bird Islands collectively and on Shelter Island (Fig. 14). U-shaped Bird Island had the highest single rate of predation (52%), of the larger islands. The smaller islands generally either had very high or very low rates of success/predation. Douglas, Goose, Drift and Dream Islands collectively had an 80% rate of success with Goose and Dream hatching all nests. Conversely, none of the 15 nests found on the 9 islands in the Narrows, Cat Bay, Indian Bay, and Kings Point Harsh were

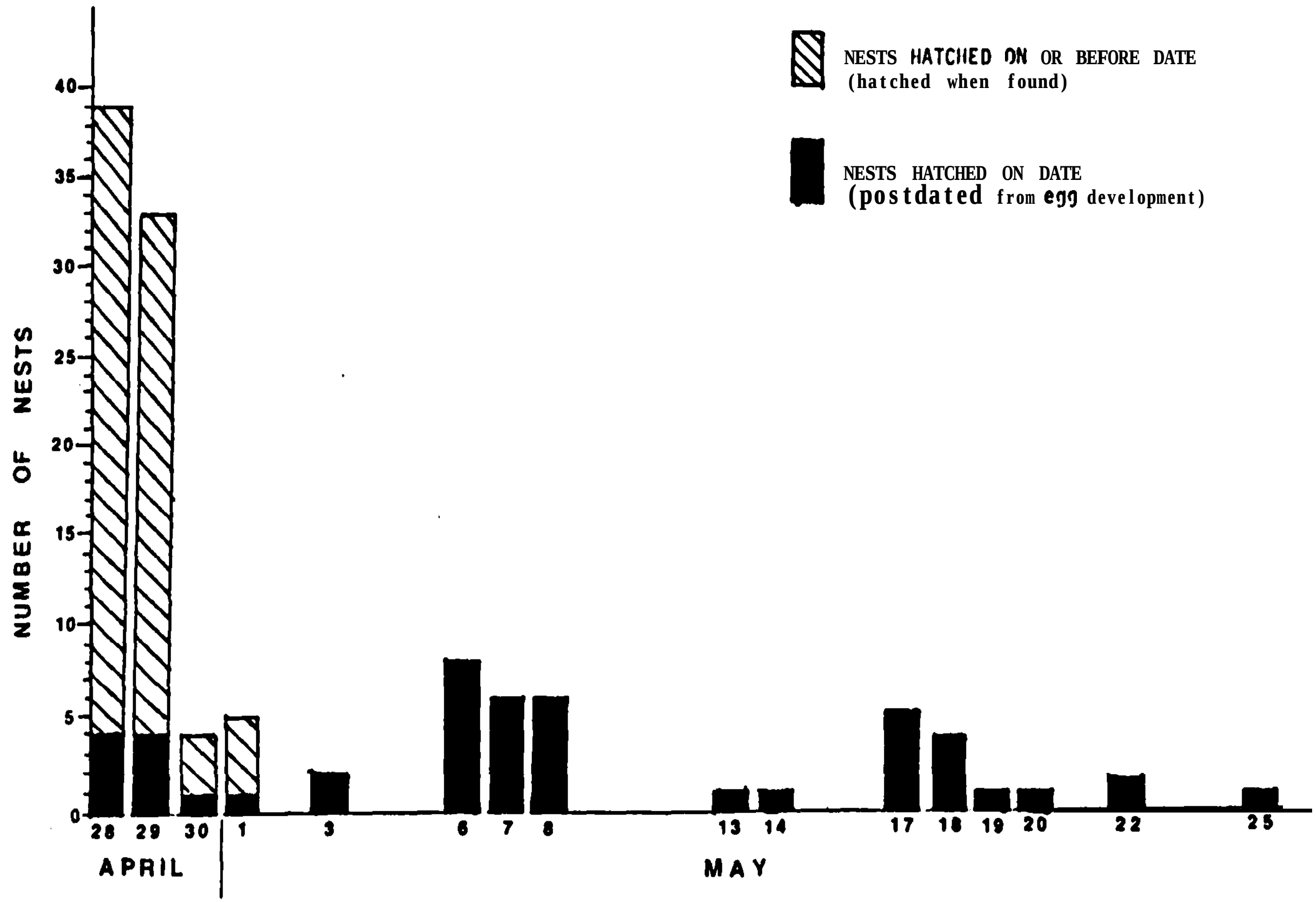

Fig. 12. Estimated dates of Canada goose hatch,' determined by postdating from stage of egg development, lower Flathead Lake, Montana, 1984. (The entire bar represents the total number of nests hatched on or before each date.)

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Table 15. Canada Goose nest distribution and fate, lower Flathead Lake, Montana, 1984.

Island	Number of Nests	Number Hatched	Percent Success	Number Predated	Number of Unknown Fate
Melita	37	29	97	1	7
Big Bird	27	17	77	5	5
U-Shaped Bird	24	11	48	12	1
Long Birds	12	9	90	1	2
Cedar	22	14	83	3	5
Shelter	5	2	67	1	2
Douglas	7	4	57	3	0
Goose	4	4	100	0	0
Drift	6	5	83	1	0
Dream	3	3	100	0	0
Ginger	4	0	0	4	0
Kings Point Marsh	4	0	0	1	3
Rock	1	1	100	0	0
Narrows East	2	0	0	2	0
Narrows West	2	0	0	2	0
Baby Bull	1	0	0	1	0
Little Bull	0			—	
Big Bull	1	0	0	1	0
Cat Bay East	1	0	0	1	0
Cat Bay West	0	—	—		
Upper River	1	0	0	0	1
Totals	164	99		39	26
Nests of Known Fate	138	72%		28%	

Table 16. Number of Canada goose nests and percent success, Iower Flathead Lake, Montana, 1953-1960, and 1980-1984.

Year	Number of Nests	Percent Success
1953-1960 mean[a]	132	64.5
1980[b]	135	80.0
1981[b]	159	81.4
1982[b]	170	64.6
1983[b]	158	84.4
1984	164	72.0
5 year average	$\bar{x}$ = 157.2	$\bar{x}$ = 76.3

[a]All percent success figures except 1984, include nests at the north end of Flathead Lake; remaining figures do not.

[b]Ball (1983)

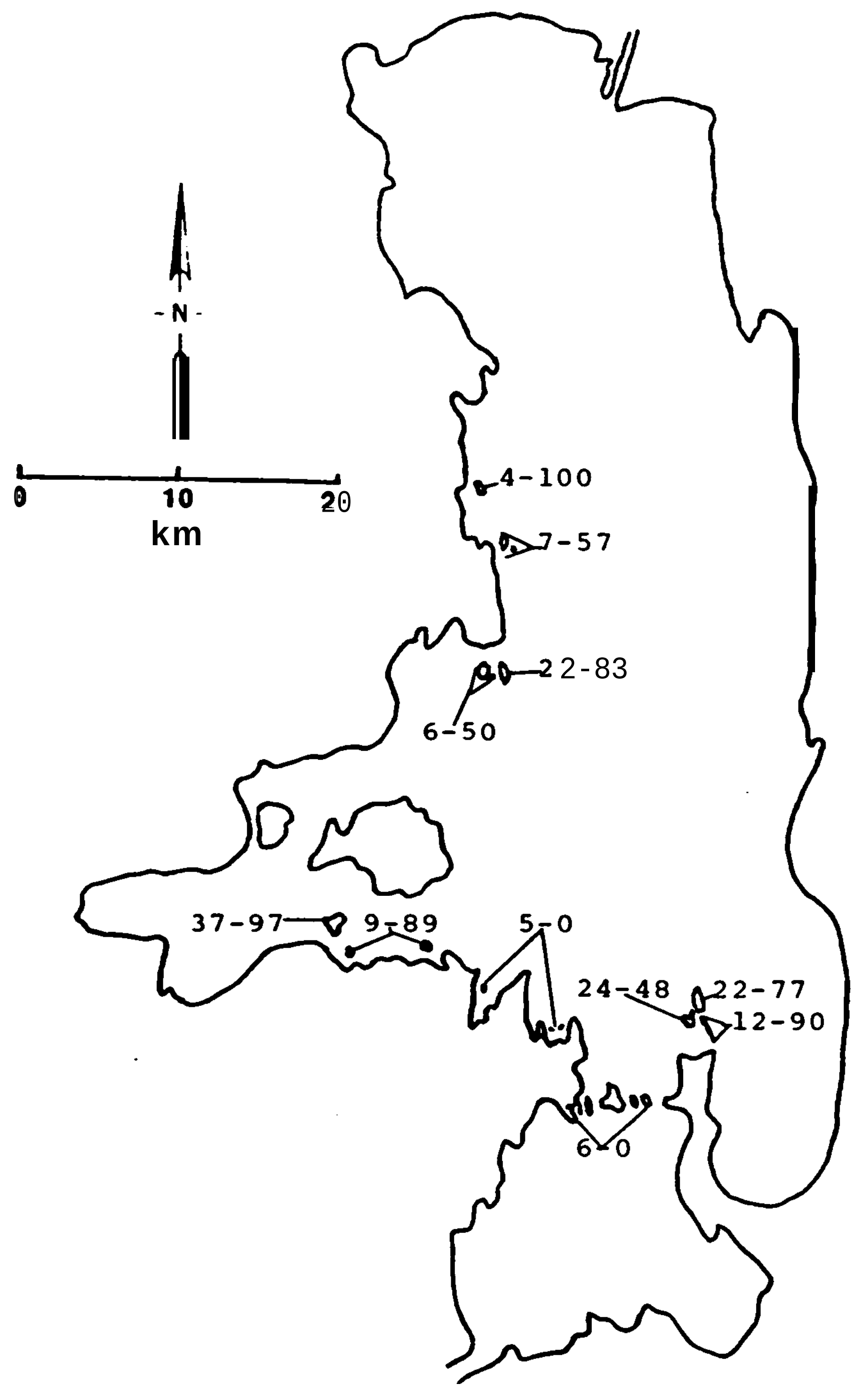

Fig. 13. Canada goose nest distribution and success, lower Flathead Lake, Montana, 1984. Figures are number of nests(left), and percent success(right).

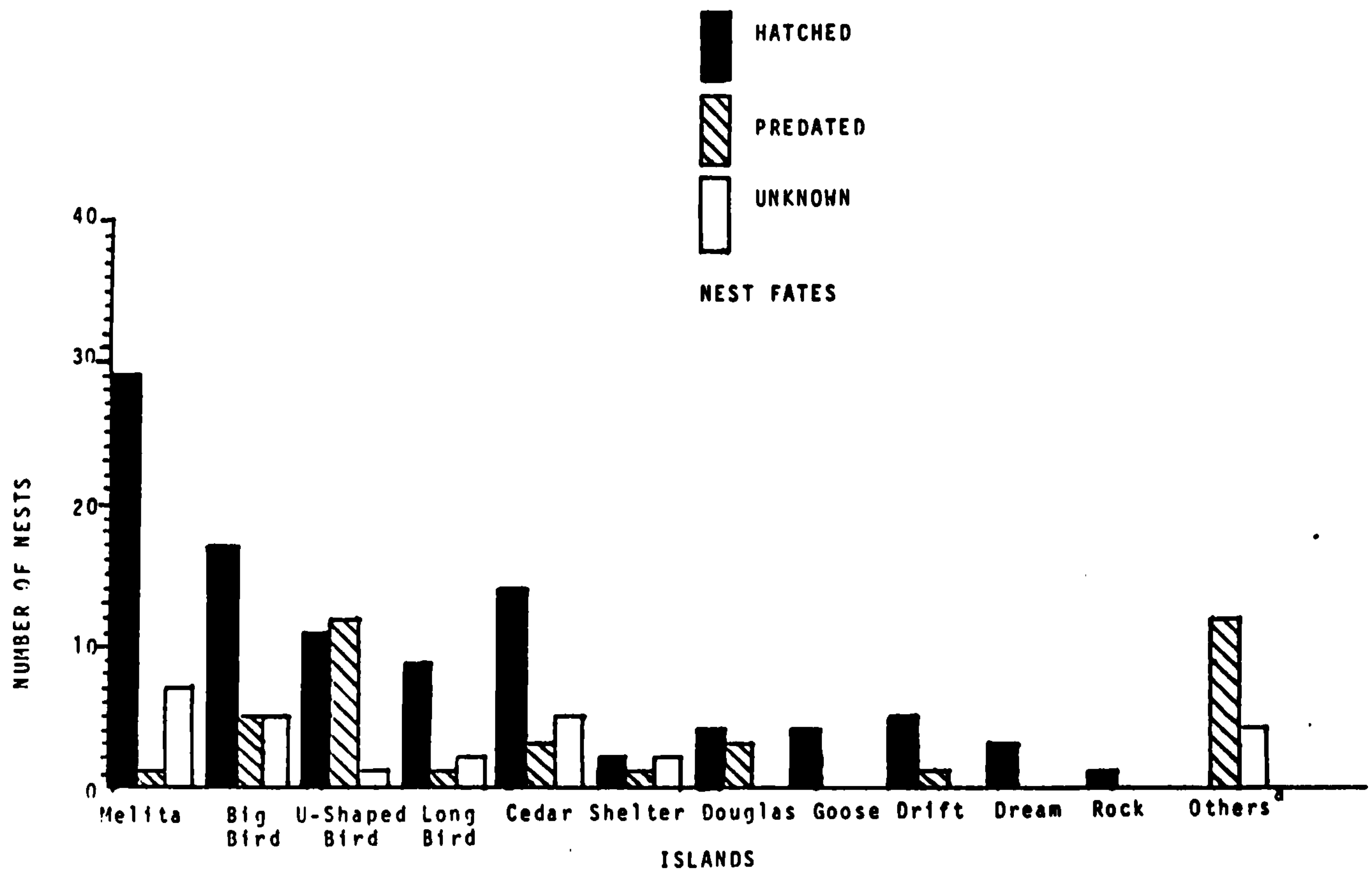

Fig. 14 . Number of Canada goose nests and fate by island, lower Flathead Lake, Montana, 1984.

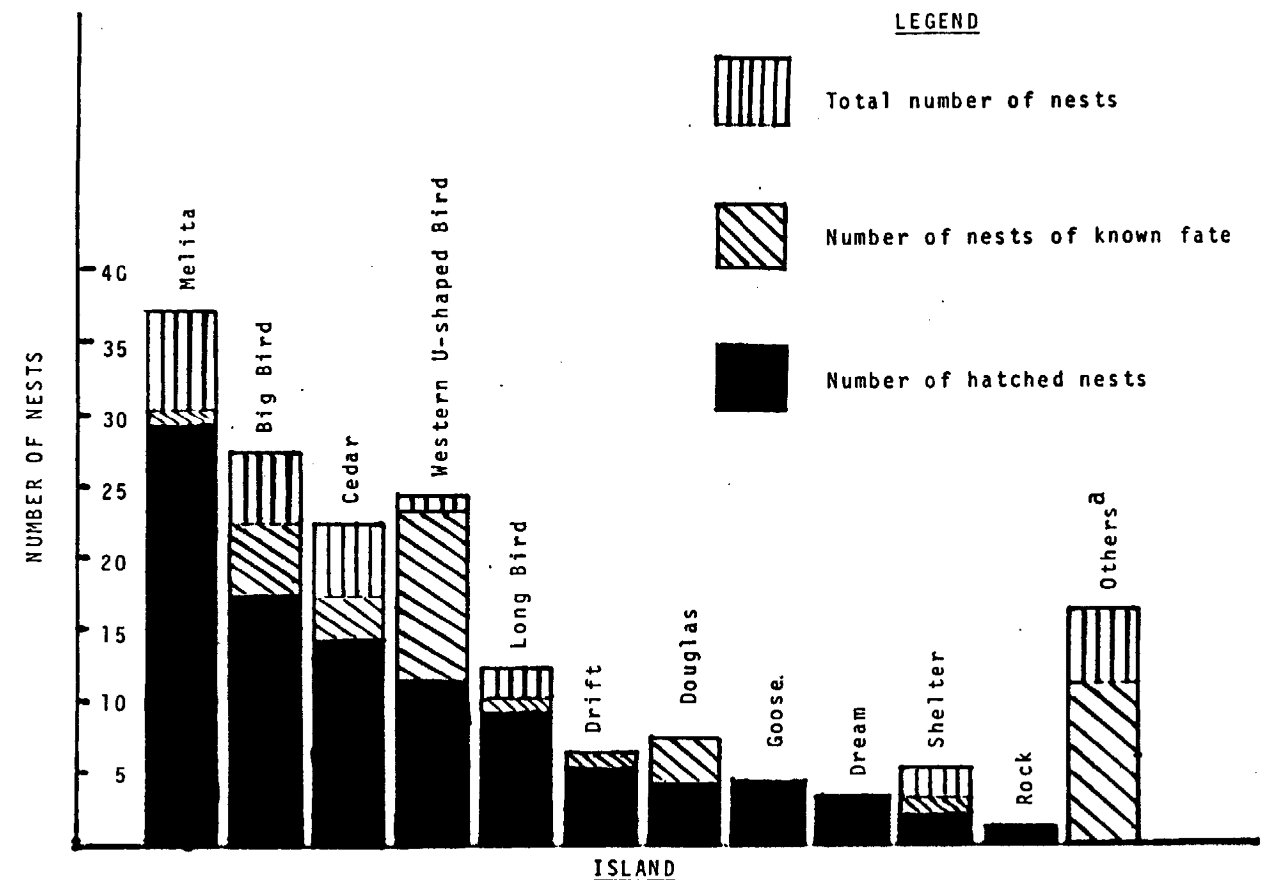

Fig. 15. Total number of Canada goose nests, number of nests of known fate, and number of hatched nests, by island, lower Flathead Lake, Montana, 1984. (The entire bar represents the total number of nests on each island.)

[a] Includes all islands in the Narrows, Cat Bay, Indian Bay, Kings Point Marsh, and the Flathead River above Kerr Dam.

successful. The numbers of nests in each category are presented in Fig. 14.

All nests on the lake were natural island ground nest types. Two observations were made of a goose in an osprey nest on Long Bird Island during late March, but an osprey pair soon began using this structure and a goose was no longer seen there. One goose was seen in a tree structure on the northeastern side of Wildhorse Island, accompanied by another goose in the water, but further investigations into nesting in that and other similar structures revealed no evidence of use during 1984.

All nest sites on the lake islands were above the high water mark and therefore none of the nests were potentially affected by flooding.

N e s t - -

RIVER

Ground nests on the river were found exclusively on islands. Ninety-five percent (38) of these nests were on the lower portion of the river, between RM 4 and RM 33, where more than 30 islands were surrounded by water during most spring flows. Total island area measured approximately 140 ha, of which approximately 1/3 is forested, 1/3 is dominated by shrubs, and the remaining 1/3 is predominantly herbaceous cover. Thirty-eight nest sites and 40 random sites were sampled in this area (Appendix B).

More specifically, habitat composition of the island area is: 10.2% coniferous forest, usually ponderosa pine (Pinus ponderosa) and Rocky Hountain juniper (Juniperus scopulorum); 5.4% deciduous forest, commonly black cottonwood (Populus trichocarpa) or aspen (Populus tremuloides); and 20.5% mixed deciduous and coniferous forest. To simplify the analysis, the deciduous and mixed forest types were combined. Shrub cover occupies 29.8% of the island area, and is commonly dominated by sandbar willow (Salix exigua), red-osier dogwood (Cornus stolonifera) or chokecherry (Prunus virginiana). Herbaceous cover dominates 34.1% of the area with dominant species including reed canarygrass (Phalaris arundinaceae), Columbia River mugwort (Artemisia lindleyana), and compressed bluegrass (Poa compressa).

Ground nests on the lower river were found in significantly different habitat proportions than the available habitats ($X^2 = 24.9$, 3 df, $P < 0.005$). Shrub habitats were used significantly more (65.8%) than available (25.9%), while mixed forest and herbaceous habitats were used significantly less than available (Table 17). Coniferous forests were used in proportion to their availability. These data suggest nesting geese on the river prefer shrub habitats, and show some avoidance of herbaceous habitats and mixed-deciduous forests in comparison to their availability.

The 40 random sites sampled on the river were not satis-

Table 17. Statistical comparisons of habitat use and availability by ground nesting geese on the lower Flathead River, Montana, 1984.

Habitat Type	Nest sites (%) (n=38)	Available sites (%)	95% Simultaneous confidence interval on proportions of use
Coniferous Forest	$P_1 = 10.5$	10.2	$22.9 > P_1 > 0$
Mixed-deciduous Forest	$P_2 = 10.5$	25.9[a]	$22.9 > P_2 > 0$
Shrub Habitat	$P_3 = 65.8$	29.8[b]	$85.0 > P_3 > 46.6$
Herbaceous Habitat	$P_4 = 13.2$	34.1[a]	$26.9 > P_4 > 0$

[a] Use was significantly less than availability.

[b] Use was significantly greater than availability.

factory to adequately describe the availability of characteristics studied. For example, only 5% (2) of the random sites were in forested habitats, whereas these habitats occupied 30% of the available land. Nest site availability data on the river was therefore limited to information from habitat maps.

Most ground nests on the river were in riparian areas that were either flat (66%) or gently sloping (16%). Some (18%) were classified as intertidal, on either gravel bars or rocky banks.

Twenty nests (53%) on the lower river were situated at or below the HWM, of which 2 nests were more than 0.5 m below the HWM (Table 18). As previously discussed in this report, 1984 water levels were not sufficient to flood any nests. All ground nests on the river were within 1.5 m above or below the HWM, and 92% were less than 5 m inland from the HWM. This suggests a preference for edge since several islands considered were as much as 500 m wide.

Average overhead cover at nest sites on the river was relatively sparse ($\bar{X}$ = 29.9%, SD = 27.1) compared to nest sites on the lake. This is related to the high proportion of nests in shrub dominated areas where less overhead cover is available. When nest site overhead cover is compared between habitats, the mixed forest habitat exhibited the most cover

Table 18. Height above or below high water mark (HWM) of ground nests on the lower portion of the lower Flathead River, Montana, 1984.

Height	# of Nests	% of Nests
0.5-1.0 m below HWM	2	5.2
0.0-0.4 m below HWM	18	47.4
0.1-0.5 m above HWM	8	21.1
0.6-1.0 m above HWM	4	10.5
1.1-1.5 m above HWM	6	15.8
TOTAL	38	100

($\bar{X}$ = 62.81, SD = 11.3) and herbaceous sites had the least overhead cover ($\bar{X}$ = 1.81, SD = 2.0), while nest in shrub habitats averaged 27.2% overhead cover (SD = 24.6).

Canopy cover was highly variable at nest sites on the river due to the wide range of habitat use (Fig. 16). Between the two forest types, there was more herbaceous cover at coniferous forest sites, and more shrub cover at mixed forest and shrub dominated sites. Total cover was greatest at nest sites in the mixed forest, least at those in the herbaceous habitat, and moderate at nests in shrub-dominated areas and coniferous forests.

Vertical cover at nest sites on the river was sparse at higher levels and successively more dense at lower levels (Fig. 17). A few nests were found with relatively sparse cover at the level closest to the ground (0.0-0.3 m), but most sites (68%) had dense cover (75%) in this lowest level. The next 2 levels showed a transition to the highest level (2-3 m) in which most nest sites (53%) had sparse cover, but some (29%) had moderate to dense (50-100%) cover.

In general, ground nesting geese on the lower river show a preference for shrub-dominated areas. Sites selected for nesting were commonly less than 5 m inland and within 1 m above or below the HWM. Sparse overhead cover was observed at nest sites on the river. Vertical cover was dense below 1 m and progressively less dense at higher levels. At 2-3 m

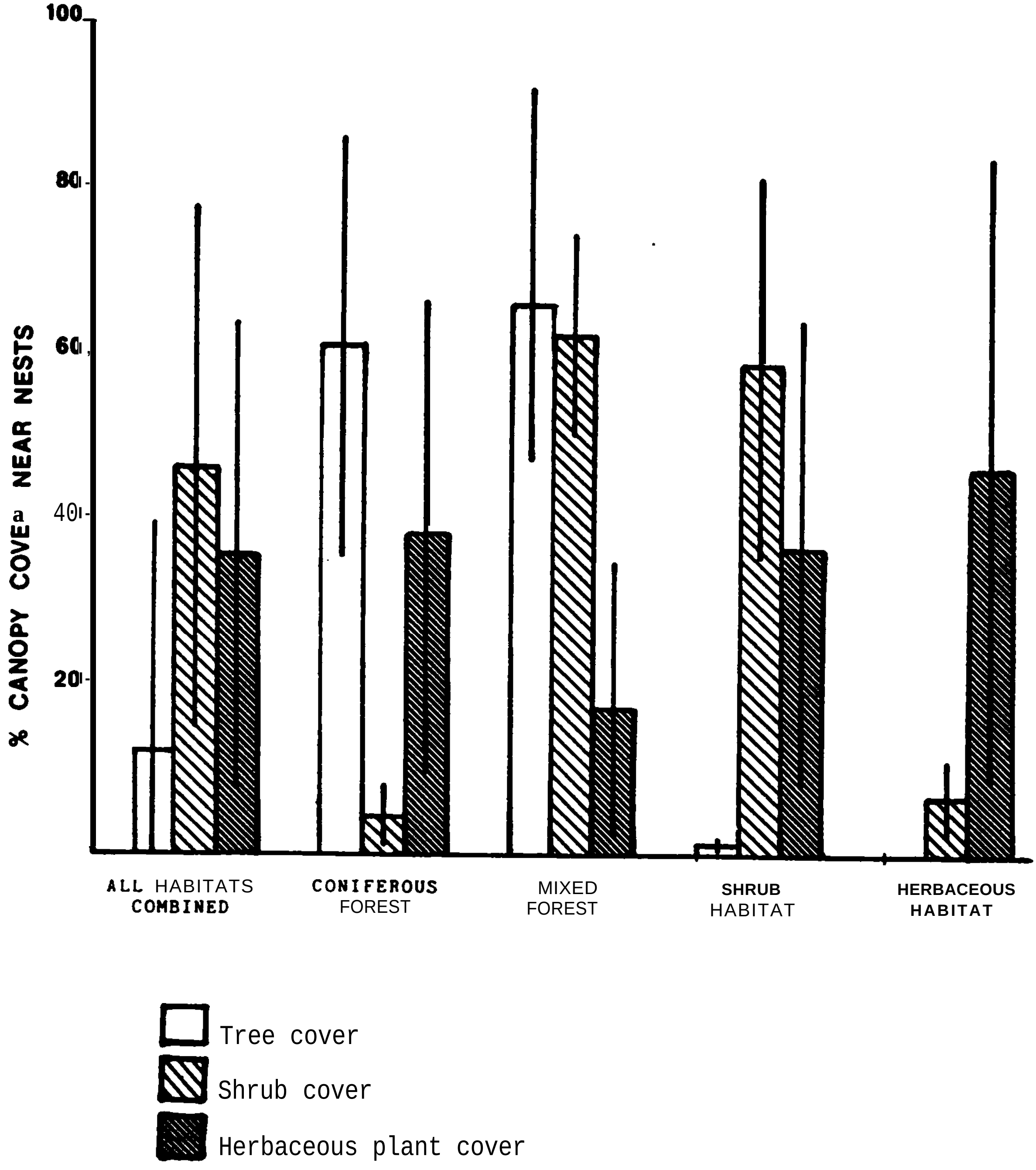

Fig. 16. Canopy cover ($\bar{X}$ and standard deviation) at nest sites found in different habitats on the lower Flathead River, Montana, 1984.

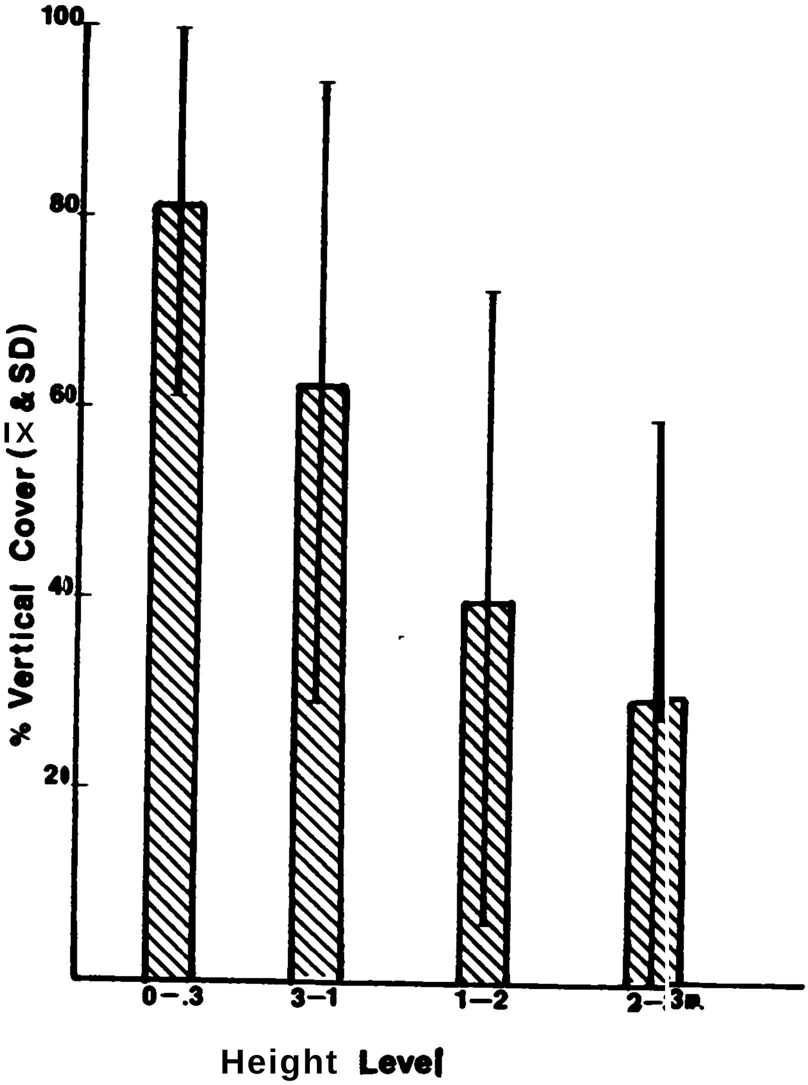

Fig. 17. Percent vertical cover (X̄ and standard deviation) at 4 height levels near ground nests on the lower Flathead River, Montana, 1984.

height, vertical cover near nest sites was sparse.

LAKE

The Bird Islands group on the east side of the lake was chosen for a study of nest site characteristics due to the high concentration of nests in a small area. In 1984, 38% of all nests in the lake study area were found on this island group. Forty ground nests and 36 random sites were sampled on the two largest islands: Big Bird Island and U-shaped Island. Big Bird Island contains 12.9 ha of mostly coniferous forest (96% of the island area) with a narrow band of mixed deciduous and coniferous trees (4%) along portions of the edge of its oval shape. U-shaped Island is much smaller (2.4 ha), with two lobes connected by a narrow strip of land. It is composed of coniferous forest (63%), mixed deciduous and coniferous forest (21%) and shrub habitat (16%).

Combining habitat data from both islands, 97.5% of the land surface (above HWM) is forested, with 90.7% coniferous forest, dominated by Douglas fir (Pseudotsuga menziesii), ponderosa pine and Rocky Mountain juniper. Common shrub understory species include ocean-spray (Holodiscus discolor), ninebark (Physocarpus malvaceus), and serviceberry (Amelanchier alnifolia). A low cover of sub-shrubs frequently includes kinnikinnick (Arctostaphylos uva-ursi) and Oregon grape (Berberis repens). The mixed deciduous and coniferous forest occupies 6.8% of the land area above HWM and is dominated by black cottonwood along with many of the above mentioned tree and shrub species. Shrub dominated areas occupy the remaining 2.5% of the land, with many of the understory species mentioned above as well as Wood's rose (*Rosa woodsii*), common snowberry (*Symphoricarpos albus*), squaw currant (*Ribes cereum*), and buffalo berry (*Sherpherdia canadensis*).

Nests on both islands were found in significantly different proportions to the available habitats (X^2 = 32.1, 2 df, *P* <0.005). Most preference was shown in the disproportionately high use of the mixed forest areas: 27.53 of nests found in habitat comprising 6.8% of the area. This is significantly greater than the 95% confidence interval on proportion of use (Table 19). Although most of the nests were found in coniferous forest (65%), this was significantly less than expected from habitat availability, while shrub habitat use was in proportion to its availability. This suggests a preference for mixed-deciduous forest habitat by geese nesting on these islands.

On U-shaped Bird Island alone, 39% of nests were found in mixed-deciduous forest which involved only 21% of the available area, and created a density of approximately 18 nests/ha in this habitat compared to approximately 7.5 nests/ha in the other habitats. In general, U-shaped Island

Table 19. Statistical comparisons of habitat use and availability by nesting geese on Bird Islands, Flathead Lake, Montana, 1984.

Habitat Type	Nest sites (%)	Available sites (%)	95% Simultaneous confidence interval on proportions of use
Coniferous Forest	$P_1 = 65.0$	90.7[a]	$83.1 > P_1 > 46.9$
Mixed-deciduous Forest	$P_2 = 27.5$	6.8[b]	$44.4 > P_2 > 10.6$
Shrub Habitat	$P_3 = 7.5$	2.5	$17.5 > P_3 > 0.0$

[a] Use was significantly less than availability.

[b] Use was significantly greater than availability.

had a much higher nest density than Big Bird Island, but also had the lowest percent success of the larger islands on the entire study area. The distribution of successful nests in different habitats suggests that success was not dependent on habitat type (Table 20).

Three types of landforms were used for the description of nest sites: *intertidal* (between low and high water marks); *riparian* (near the water's edge, usually with vegetation influenced by the proximity of water); and upland (distant from the water's edge, or not showing marked influence of shoreline). A comparison of random and nest sites on Bird Islands revealed a significantly different proportion of use of these landforms in relation to their availability (χ^2 = 44.23, 2 df, $P < 0.005$). Since full pool water level was not reached until early June, the intertidal zone was exposed during the entire nest season; however, its use by nesting geese is negligible (2.5%). On Bird Islands, this area is a rocky shore, devoid of vegetation, which occupies approximately 11% of the land area exposed during nesting. The preferred landform appears to be the riparian zone, which was used in much higher proportion (50%) than its availability (14%). Although nearly half (47%) of the nests were classified as upland sites, possible avoidance of this type was expressed when compared with the high proportion (75%) of upland areas available.

Table 20. Nest density and distribution of successful and unsuccessful nests in different habitats on U-shaped Bird Island, Flathead Lake, Montana, 1984.

Habitat Type	Area (ha)	Nest Density (#/ha)	Number of Nests: Successful	Unsuccessful	Unknown
Coniferous Forest	1.5	7.3	4	6	1
Mixed Forest	0.5	18.0	5	4	
Shrub Habitat	0.4	7.5	2	1	
Total	2.4	9.6	11	11	1

This concept was further defined with measures of the height of nest sites above the HWM, and the distance inland from the HWM. The proportion of use in areas near the water was significantly greater than the proportion of land available (χ^2 = 22.88, 3 df, P <0.005). Although nest sites were found in relatively equal proportions in 4 categories above the HWM, availability was far less and a possible preference was shown between 1 and 4 m (Fig. 18). Meanwhile 52% of the land was categorized as more than 4 m above the HWM, and only 25% of the nests were found in this area.

These data also indicate a possible preference for nest sites within 5 m inland from the HWM, as 35% of the nests and only 19% of the random sites were located in this zone. However, the proportion of nest sites more than 20 m inland (33%) was similar to availability (44%) suggesting at least an acceptance of areas relatively distant from the HWM, especially when not far above the HWM.

Average overhead cover was significantly greater at nest sites than at random sites (t = 2.931, P <0.01). The distribution of sites with dense to open overhead cover was also significantly different between random and nest sites (χ^2 = 21.3, 3 df, P <0.005). Twenty-five percent of the random sites had open cover, while none of the nests were in that category (Fig. 19). Most nest sites (73%) had more than 60% overhead cover.

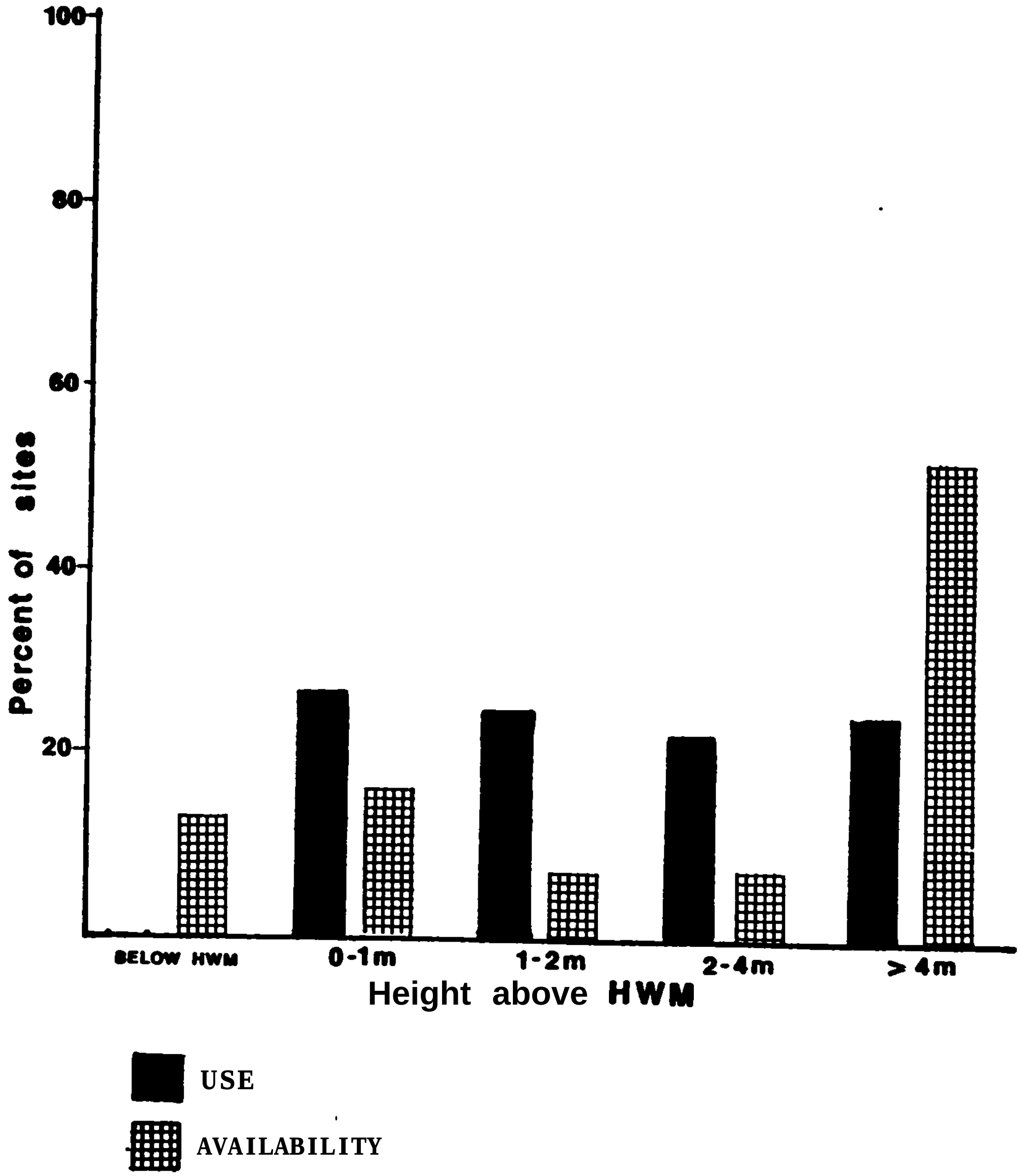

Fig. 18. Proportion of nest and random sites at various heights above and below high water mark (HUM) on Bird Islands, Flathead Lake, Montana, 1984.

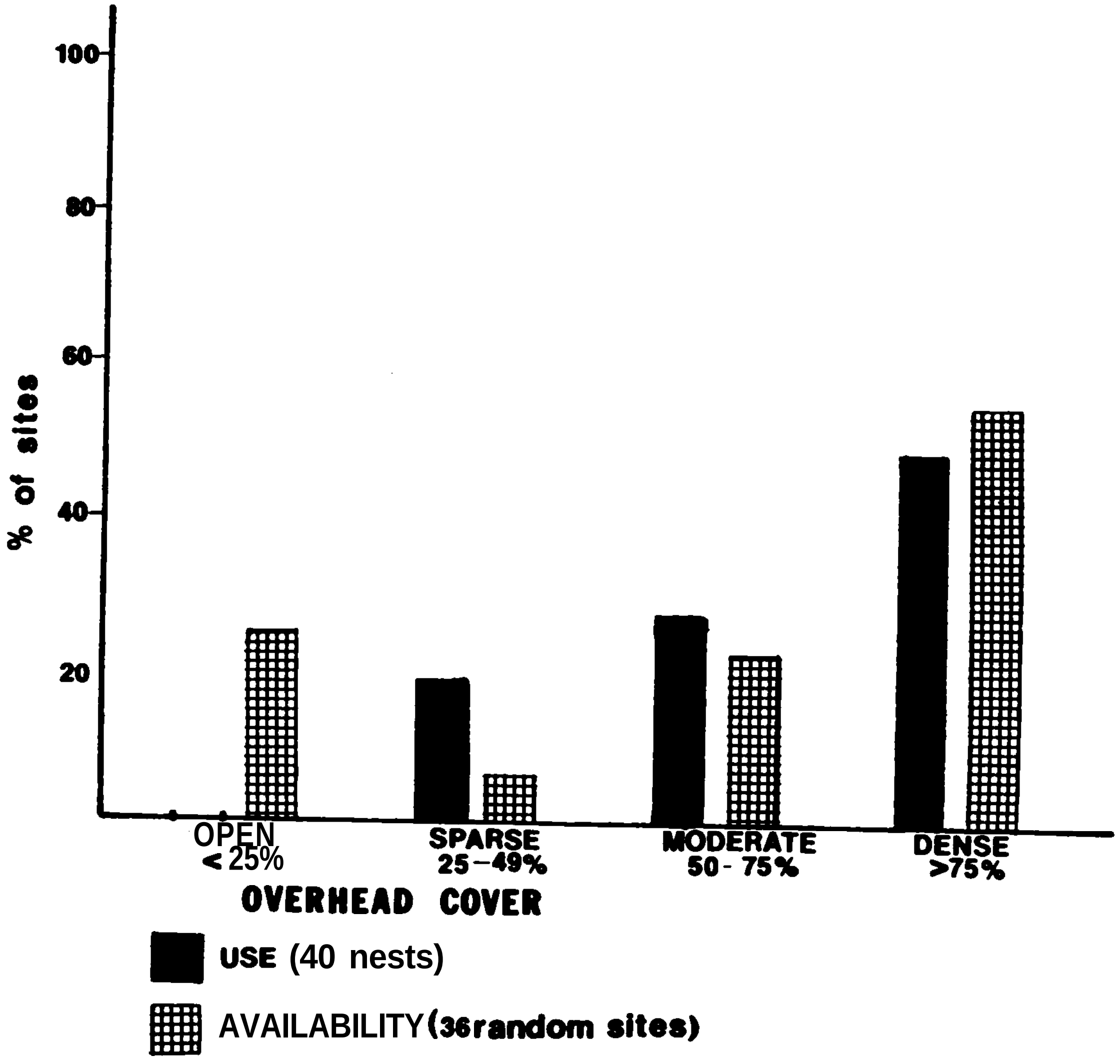

Fig. 19. Density of overhead cover at nest and random sites on Bird Islands, Flathead Lake, Montana, 1984.

Canopy cover of trees, shrubs, subshrubs and herbaceous plants was compared both between and within habitats. Overall averages showed nest sites were in areas with significantly more shrub cover ($t = 2.299$, $P < 0.05$), and significantly less herbaceous cover ($t = 2.635$, $P < 0.025$) than random sites. Although cover was greater in most categories, within habitat comparisons of means were limited due to variation between samples. In the mixed forest, significantly more tree cover was found at nest sites than at random sites ($t = 3.060$, $P < 0.005$). The average cover composition for all nest sites was 64% tree, 38% shrub, 16% subshrub and 12% herbaceous cover.

Vertical cover was significantly greater at nest sites than at random sites at each height level considered (Table 21). Densest cover was provided closest to the ground with successively less cover at higher levels (Fig. 20). When cover at each level was categorized as open to dense, the distribution of nest sites was significantly different from random sites at both the 1-2 m level ($\chi^2 = 12.99$, 3 df, $P < 0.01$) and the 2-3 m level ($\chi^2 = 14.48$, 3 df, $P < 0.005$). However, distributions in the 2 lower levels (below 1 m) were not significantly different.

In summary, nesting geese on the lake show a preference for nest sites within 5 m inland and 2 m above the HWM, in the riparian zone. In addition, a preference was shown for

Table 21. Percent vertical cover at 4 height levels within 5 m of nest and random sites (and statistical differences between these) on Bird Islands, Flathead Lake, Montana, 1984.

Height Level	% vertical cover at nests sites (n = 40)	% vertical cover at random sites (n = 36)	t-value
0.0-0.3 m	78.3%	72.1%	2.048 ($P<0.05$)
0.3-1.0 m	63.1%	52.4%	2.791 ($P<0.01$)
1.0-2.0 m	56.4%	44.5%	3.029 ($P<0.005$)
2.0-3.0 m	52.0%	42.6%	2.632 ($P<0.025$)

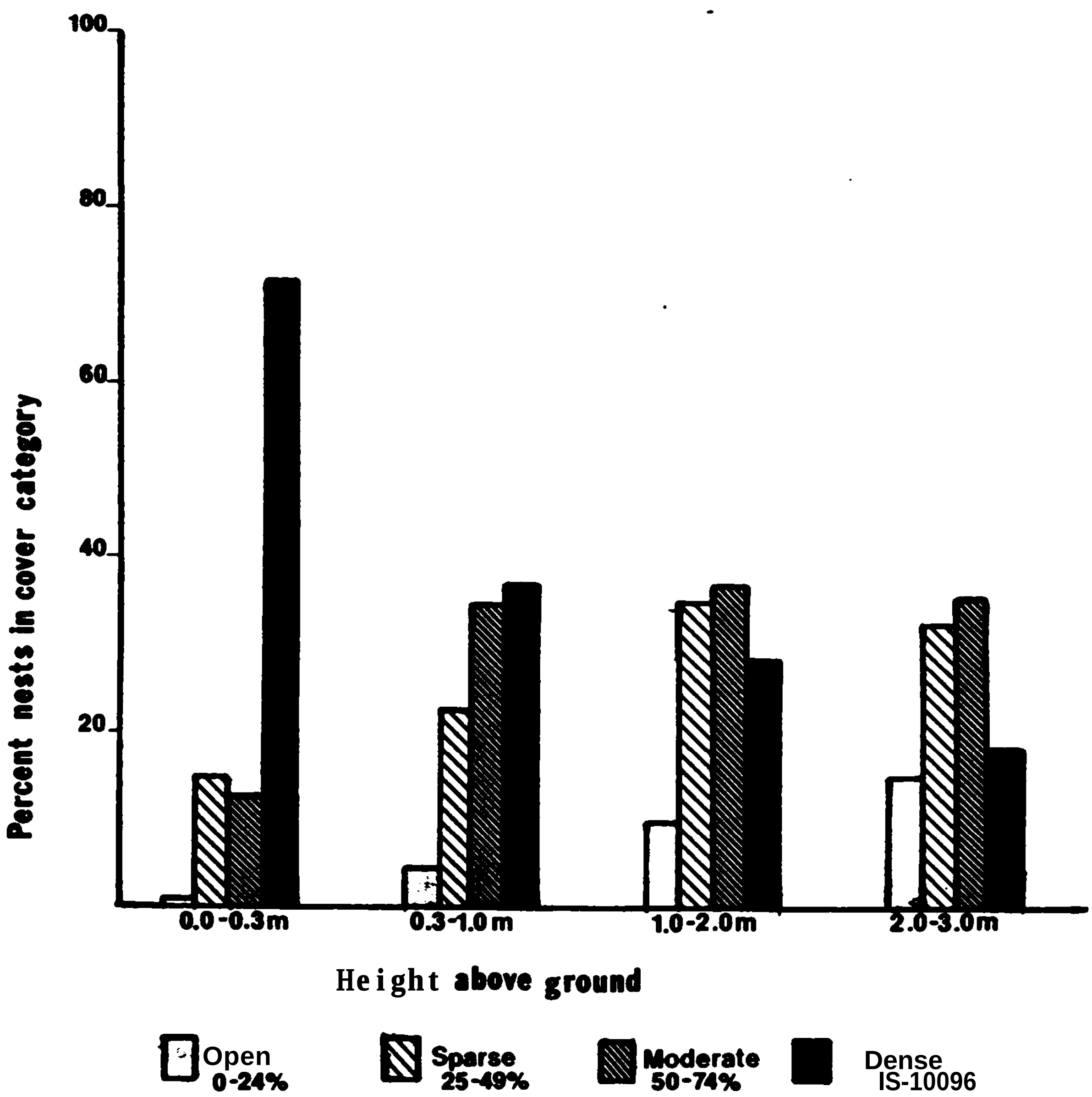

Fig. 20. Density of vertical cover at 4 height levels near ground nests on Bird Islands, Flathead Lake, Montana, 1984.

more overhead cover, more tree and shrub canopy cover, and more dense vertical cover than the average available site. Most differences in nest site selection on the lake and the river can be explained through differences in habitat availability.

Brood Habitat Use and Availability

RIVER

Four areas of intensive brood use were located on the river in 1984. Three of these areas were on the lower half of the river, between RM 13 and RM 33, and the other was on the upper half at RM 64 (Fig. 21). Incidental locations of broods outside these specific areas also indicated more brood use of the lower half than the upper half of the river. This coincides with use of the river by nesting geese documented in 1983 (Gregory et al. 1984) and 1984.

On the upper river, the Buffalo Bridge Brood Area had more scattered use than the lower river brood areas. The delineated area of the Buffalo Bridge Brood Area encompassed 50 ha, of which 45% was river surface, leaving 28 ha land area. The 3 areas on the lower river collectively measured 77 ha, averaging 56% water surface, and resulting in a collective land area of 34 ha. Individually, the Goose Islands Brood Area at RM 13 (Fig. 21) was the largest of the 3, encompassing 38 ha (61% water). The Mission Creek Brood

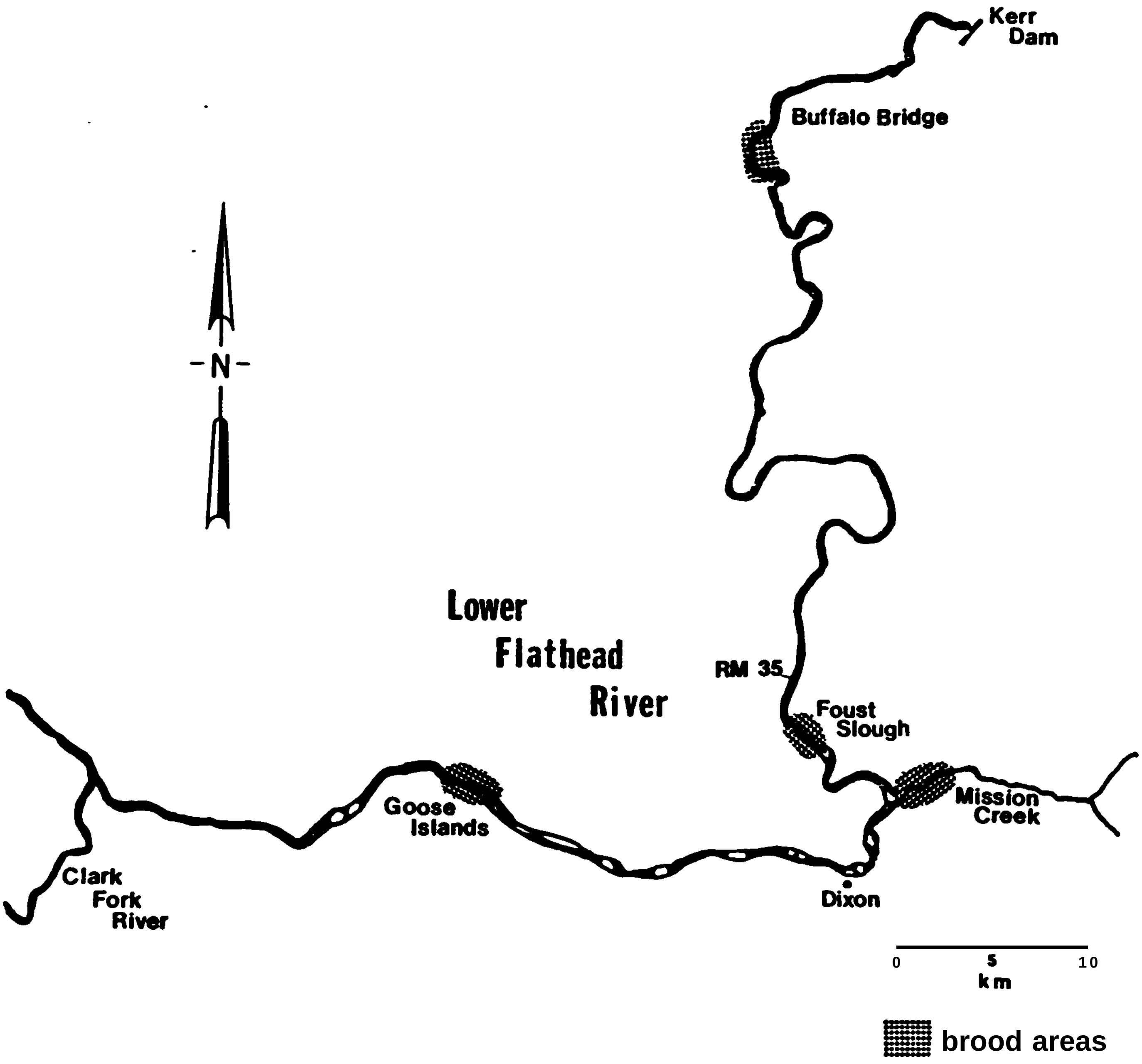

Fig. 21. Locations of 4 Canada goose brood areas on the upper and lower portions of the lower Flathead River, Montana, 1984.

Area was located near the mouth of Mission Creek, a major tributary entering the river at RM 28.1. This was the smallest brood area on the river, encompassing 5 ha, of which 26% was water surface. Slightly upriver, at RM 32, the Foust Slough Brood Area encompassed 32 ha, including 55% water surface.

Some habitat categories were combined during analysis to elucidate major differences in use and availability. The short herbaceous type was combined with pastures and alfalfa fields, deciduous forest and combination forests were considered as a unit, and unvegetated gravel bars were combined with vegetated (shrub and herbaceous) gravel bars. No sparse shrub areas were recorded.

Habitat use and availability were determined from aerial photos taken 6 and 7 August 1981, during flows of approximately 4,000 cfs. Broods were recorded using these areas during May, June and early July 1984 when mean daily flows fluctuated between approximately 1,000 and 40,000 cfs. Water surface area may therefore be slightly underestimated (exposed riverbanks and gravel bars slightly overestimated) in the discussion of habitat composition. This was not considered significant enough to affect major relationships exposed in these preliminary data. Data collected on characteristics of habitat types have not yet been analyzed; however, dominant plant species from each habitat type used in the analysis are listed in Table 22.

Table 22. Dominant plant species found in riparian habitats of the lower Flathead River, Montana, 1984.

HABITAT TYPE	DOMINANT SPECIES	
Coniferous forest	ponderosa pine	*Pinus ponderosa*
	Rocky Mountain juniper	*Juniperus scopulorum*
Deciduous forest (with combination forest)	black cottonwood	*Populus trichocarpa*
	aspen	*Populus tremuloides*
Dense shrub	red-osier dogwood	*Cornus stolonifera*
	sandbar willow	*Salix exigua*
	big sagebrush	*Artemisia tridentata*
	black hawthorn	*Crataegus douglasii*
Tall herbaceous	reed canarygrass	*Phalaris arundinaceae*
	spotted knapweed	*Centaurea maculata*
	dogbane	*Apocynum cannabinum*
	redtop	*Agrostis alba*
Short herbaceous (including pastures and alfalfa fields)	compressed bluegrass	*Poa compressa*
	white clover	*Trifolium repens*
	alfalfa	*Medicago sativa*
Gravel bars (vegetated)	Columbia River mugwort	*Artemisia lindleyana*
	blanket flower	*Gaillardia aristata*
	nodding onion	*Allium cernuum*
	short-style onion	*Allium brevistylum*
	black cottonwood	*Populus trichocarpa*
	sandbar willow	*Salix exigua*
Grainfield	wheat	*Triticum aestivum*
Marsh	hardstem bulrush	*Scirpus acutus*
	common cat-tail	*Typha latifolia*
	horsetail	*Equisetum spp.*
	spike-rush	*Eleocharis spp.*
Aquatic vegetation	Canadian waterweed	*Elodea canadensis*
	curled pondweed	*Potamogeton crispus*
	slenderleaved pondweed	*Potamogeton filiformis*
	water crowfoot	*Ranunculus aquatilis*
	spiked water-milfoil	*Myriophyllum spicatum*
	chara	*Chara vulgaris*

Habitat availability was determined within the riparian zone of both the upper half of the river (RM 35-72) and the lower half of the river (RM 0-35) (Appendix C). The riparian zone on the lower river is wider than that of the upper river, due to local topography and river gradient. Therefore, although less than half the river's length is included in the lower river, 70% of the river's riparian habitat is in that portion. The proportions of habitat types found on the upper and lower river were significantly different ($\chi^2 = 498.32$, 7 df, $P<0.005$). The upper river is dominated by coniferous forest, shrubs and short herbaceous habitats (rangeland); while the lower river has more diversity, with considerable areas of deciduous forest and short herbaceous habitats (pastures), as well as nearly all the grainfields on the river (Table 23). The majority of the upper river brood area was either coniferous forest or shrubland. On the lower river, brood areas were predominantly grain fields, short herbaceous habitat, dense shrubs and gravel bars (Table 23). Due to these differences, brood habitat preferences were evaluated in each half of the river separately.

On the upper river, brood areas differed significantly from the riparian zone in that shrub and coniferous forest cover were more prominent in brood areas than expected, and short herbaceous cover as well as gravel bars were more prevalent in the riparian (available) zone. The large

Table 23. Proportions of habitats used and available to brooding Canada geese on the lower Flathead River, Montana, 1984.

HABITAT TYPES	UPPER RIVER USE[a] %	UPPER RIVER AVAILABILITY[b] %	LOWER RIVER USE %	LOWER RIVER AVAILABILITY %
Coniferous forest	50	35	6	8
Deciduous forest	0	1	6	11
Dense shrub	42	21	19	16
Tall herbaceous	0	<1	1	3
Short hebaceous	<1	32	34	40
Gravel bars	7	11	22	7
Grainfields	0	0	12	12
Marsh	0	<1	<1	3
Sample points		626		1446

[a] Determined from area estimates of delineated brood areas.

[b] Determined from random points sampled within the riparian zone of the designated portion of river.

difference in use and availability of short herbaceous cover is due in part to the relative location of the small brood area examined. Our data suggest that coniferous forests were also used more than expected. In general, brooding geese on the upper river used habitats providing more abundant cover. Future analysis of habitat characteristics will augment interpretations of these data.

The lower river brood areas also exhibited a significantly different distribution of habitat use than was available (χ^2 = 502.78, 7 df, $P<0.005$). In contrast to the upper river, forests (both coniferous and deciduous) were present in smaller proportions in brood areas (12%) than in the riparian zone (19%) of the lower river. Grainfields were used in equal proportion to their availability. Slightly more shrub, and less herbaceous cover was used than was available. The most dramatic difference was in the relatively large proportion of gravel bars used (22%) compared to the small proportion available (8%). The wider riparian zone may have exagerated the lower proportion of gravel bar area available; however, the magnitude of the difference still suggests that brooding geese exhibit a preference for these areas.

This is of particular interest in our study since these gravel bar areas are some of the most affected by daily and seasonal water level fluctuations on the river. Effects of water level changes on plant growth, availability to geese, and plant succession will be monitored and analyzed in subsequent years of this study.

LAKE .

During 1984 the lowest water level on the lake occurred during the first 2 weeks in April, with pool elevation readings below 879.3 m. (2884 ft) (Fig. 22). After the early April low period, the lake pool elevation was increased, until the full pool elevation of 881.8 m (2893 ft), was tentatively reached on 1 July. The most drastic change in water levels on Flathead Lake corresponded to the early May through early July period of gosling growth and development. It was during this period that the lake elevation was increased from approximately 879.4 m (2885 ft) to the full pool elevation of 881.8 m (2893 ft), a change of 2.4 m (8 ft). This increase gradually inundated the mudflats exposed in most bays during winter drawdown, and eventually provided access via water to areas of marsh vegetation which occurred at the higher edges of the mudflats.

The relationship of water level fluctuations on Flathead Lake to the chronology of gosling development from a projected 1 Hay hatching date (see Fig. 12) is shown in Fig. 23. The mid-point of each stage development (Yocom and Harris 1965) is plotted on a graph of lake water levels during the spring of 1984. The midpoint of stage 1 and 2 occurred

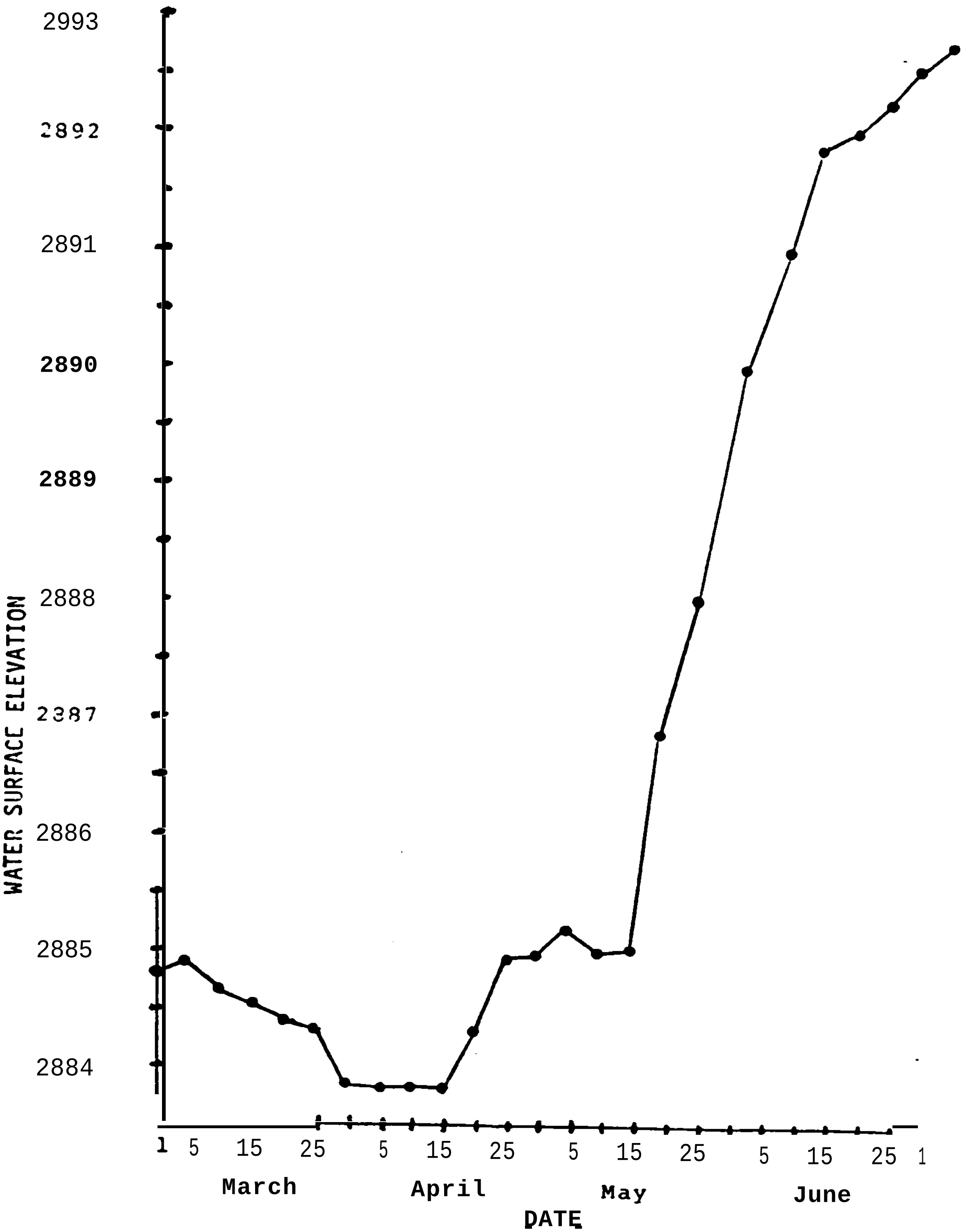

Fig.. 22. Approximate water **surface** elevation in feet above mean sea level, 1 March-l July 1984, **Flathead** Lake, Montana.

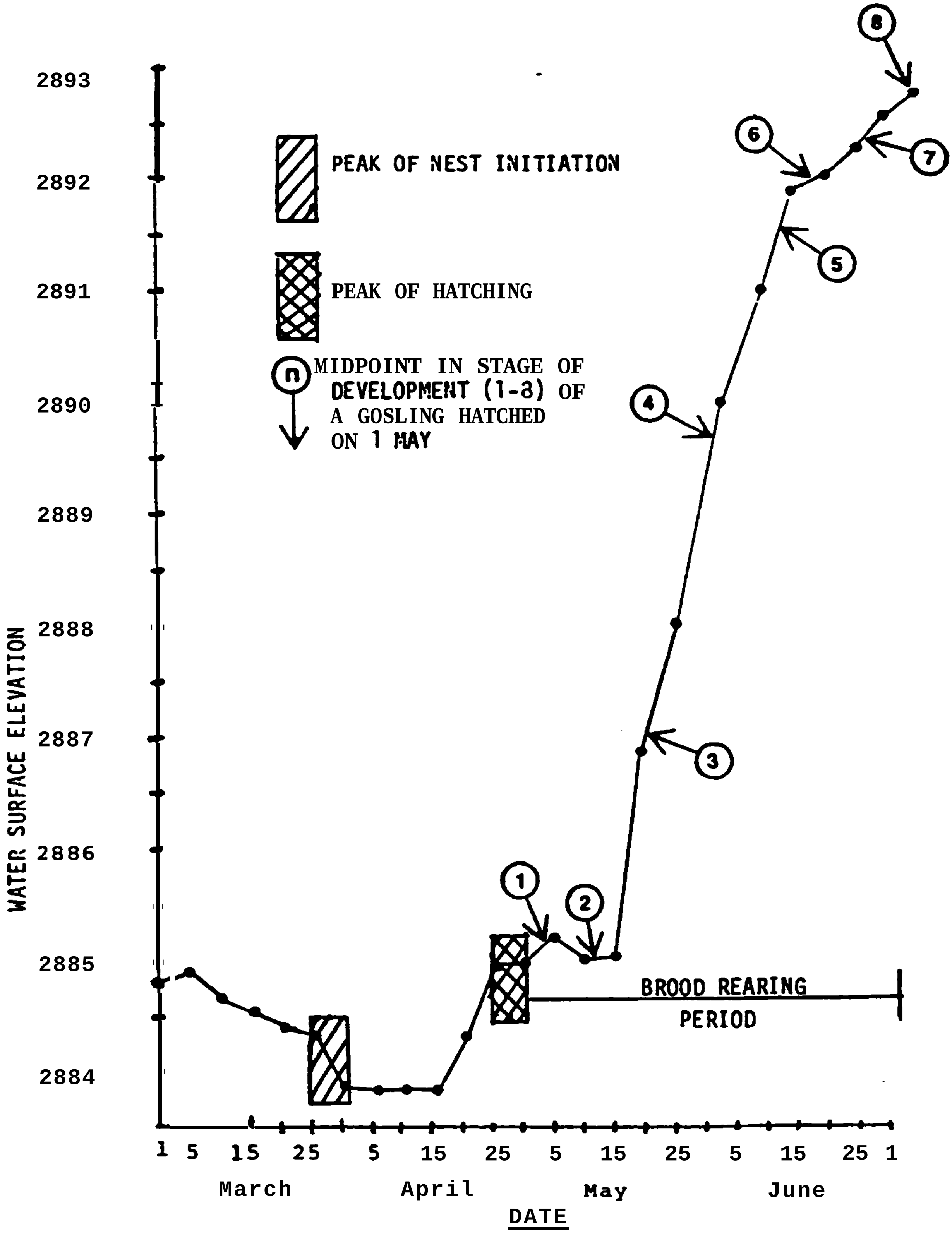

Fig. 23. Approximate water surface elevation in feet above mean sea level, 1 March-1 July 1984, Flathead Lake, Montana, showing the brood rearing period of a gosling hatched on 1 May.

before the pool elevation reached 879.5 m (2885.5 ft). At this point, most mudflats are largely exposed and the distance between the waters edge and the cover of marsh vegetation is near the maximum. In addition, it is difficult for goslings to travel over land during these stages, making this period one in which goslings are potentially susceptible to predators when they cross expansive mudflats. As goslings become more adept at terrestial locomotion, the distance across mudflats is likewise reduced due to the increase in water levels.

Eight areas of brood use were studied on the lake in 1984. Three of these were in the South Bay, here defined as the area south from the Narrows to the gates of Kerr Dam. The other five areas were in the West Bay, here defined as the area west of Black Point and including the shoreline and islands north to the Reservation boundary (Fig. 24). No brood use was observed on the eastern portion (Skidoo Bay north to Yellow Bay) of the study area.

The three areas in the South Bay area included approximately 25 ha of marsh and terrestrial habitat, and approximately 2 ha of aquatic vegetation. Individually, the area on the east side of the bay was the largest, encompassing approximately 22 ha; however, habitats represented were similar to those at the southern end of the study area. Therefore the three areas were combined to simplify the

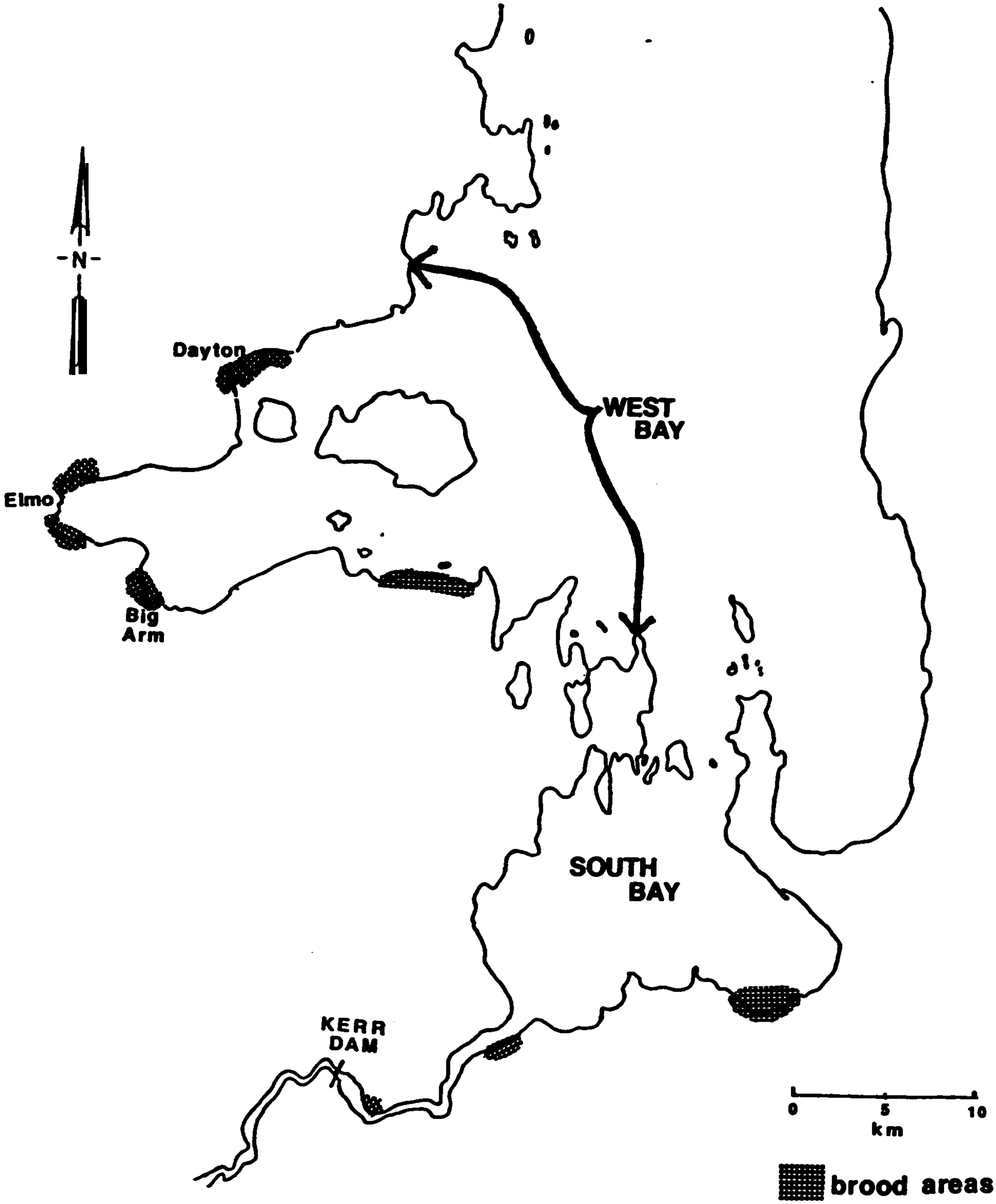

Fig. 24. Locations of 18 Canada goose brood areas in the South and West Bays of Flathead Lake, Montana, 1984.

comparison of habitat use and availability.

The five areas in West Bay collectively contained approximately 29 ha of marsh and terrestrial habitat, with an additional 0.5 ha of aquatic vegetation. The individual brood area north of Elmo measured approximately 14 ha, while the other 4 areas varied from approximately 3 to 5 ha each. The location of these brood areas coincides with general observations from previous work in the area (Geis 1956, Ball 1981).

These areas were mapped on color aerial photos and compared with habitat type maps; however, the photos were taken in August, 1980 when the lake was at full pool while brood were using these areas at least a month before full pool level on the lake was reached. This has resulted in an underestimate of the use of exposed mudflats and gravelbanks, since the lake level was between 1 and 2 m below full pool elevation for approximately half the brood period. Regardless, major relationships between habitat use and availability as mapped on these photos elucidate habitat preferences which we consider important to broods on the lake.

As on the river, some habitat types recorded were combined to simplify the analysis of habitat preferences. The short herbaceous habitat was combined with pastures, orchards, lawns, and homesites with lawns. Homesites with forest cover on their surrounding grounds were kept separate, and deciduous and combination forests were considered as a unit. Dominant species in each type used in the analysis are listed in Table 24.

Habitat composition in the South Bay brood areas was dominated by marsh habitat (81%), with small amounts of herbaceous, shrub and forest types also represented (Table 25). In contrast, the West Bay brood areas were more than half herbaceous habitat; however, marshes still comprised 17% of the brood areas. Nearly all of the forested homesites referred to here had lawns beneath the forest canopy.

The proportions of different habitats available within 100 m of the shoreline of each bay were significantly different between the West and South Bays ($\chi^2 = 82.72$, 6 df, $P<0.005$). The West Bay had more coniferous forest, less short herbaceous habitat, and less marsh habitat than the South Bay (Table 25). Slightly more area (30%) was included in the South Bay.

Brood habitat use and availability was significantly different in both the South Bay ($\chi^2 = 3009.26$, 4 df, $P<0.005$) and the West Bay ($\chi^2 = 1580.37$, 6 df, $P<0.005$). In the South Bay, a distinct preference for marsh habitat was exhibited in that the brood areas contained 81% marsh, but the bay as a whole averaged 9% marsh habitat. Thirty one percent of this bay was occupied by homesites with forested grounds, while no use of these grounds was documented. An additional 30% of

Table 24. Dominant plant species found in riparian habitats of the southern half of Flathead Lake, Montana, 1984.

HABITAT TYPE	DOMINANT SPECIES	
Coniferous forest	Douglas-fir	*Pseudotsuga menziesii*
	ponderosa pine	*Pinus ponderosa*
Deciduous and combination forest	black cottonwood	*Populus trichocarpa*
	paper birch	*Betula papyrifera*
	mountain alder	*Alnus incana*
Dense shrub	Wood's rose	*Rosa woodsii*
	serviceberry	*Amelanchier alnifolia*
	western snowberry	*Symphoricarpos occidentalis*
Tall herbaceous	red top	*Agrostis alba*
	Idaho fescue	*Festuca idahoensis*
	quackgrass	*Agropyron repens*
Short herbaceous (including lawns pastures and orchards)	compressed bluegrass	*Poa compressa*
	Kentucky bluegrass	*Poa pratensis*
	sweet clover	*melilotus spp.*
Marsh	common cat-tail	*Typha latifolia*
	hardstem bulrush	*Scirpus acutus*
	sedges	*Carex spp.*
	horsetails	*Equisetum spp.*
	mare's tails	*Hippuris montanus*

Table 25. Proportions of habitats used and available to brooding Canada geese on Flathead Lake, Montana, 1984.

Habitat Types	South Bay		West Bay	
	Use[a] %	Availability[b] %	Use %	Availability %
Coniferous forest	1	30	5	43
Deciduous and combination forest	6	8	4	2
Shrubs	2	3	3	>1
Tall herbaceous	4	2	54	8
Short herbaceous	6	17	8	6
Homesites (with forest cover)	0	31	8	36
Marshes	81	9	17	4
Sample points		496		378

[a] Determined from area estimate of delineated brood areas.

[b] Determined from random points sampled within the riparian zone of the selected bay area.

the shoreline was coniferous forest, of which very little was used (1%).

In West Bay, only 8% of the available habitat was classified as tall herbaceous, compared to 54% of the brood areas (much of which was in the largest area near Elmo). Heanwhile, minor brood use (5%) was documented in the coniferous forest which comprised 43% of the shoreline of this Bay. While marshes were not as important here as in the South Bay brood areas, use (17%) was still far in excess of availability (4%).

The use of marsh areas on the lake by brooding geese was previously documented by Geis (1956), and agrees with brood habitat use elsewhere (Zicus 1981, Raveling 1977). Food habit studies have also noted the importance of emergent (marsh) plant species in the spring diet of Canada geese (Craven 1984, Seddinger and Raveling 1984). Nearly all our observations of brooding geese on the lake were in areas near or containing marshes, and frequently were near aquatic vegetation. These high use areas were near or at the mouth of creeks entering the lake which coincides with various topographical and biological factors. Extensive data of water level changes will be documented in these areas in an attempt to determine consequences of the timing of lake fill to these areas and the geese. We hypothesize that. both the availability of these areas to young and flightless adult geese, plant composition and succession, as well as invertebrate populations are severely affected by the timing of lake fill.

We recorded 57 observations of goose broods in East Bay between 19 April and 17 July. Only 2 observations (3%) were made before 23 May, while 10 (18%) were made during the last week in Hay. The remaining 45 (79%) observations were made during June and early July when the lake level was within 2 feet of full pool, and the distance between waters edge and marsh vegetative cover was at a minimum.

Brood Activity Budgets

RIVER

Observations of goslings totaled 636 and observations of adults totaled 741 over the entire study period. Most observations were recorded at the 4 intensively used brood areas on the river (Fig. 21). Eighty-seven percent of the observations were of single broods within gang broods, and 13% were of solitary single broods. Gosling activities were significantly different (χ^2 = 8.13, $P<0.05$) between morning and afternoon; therefore, morning and afternoon data were analyzed separately for comparisons of activities and gosling age classes. Adult activities were not significantly different (χ^2 = 3.76, $P>0.05$) between morning and afternoon, and data were pooled for comparisons of adult activity with respect to their goslings age.

During mornings and afternoon, young broods (age classes l-2; 1-15 days old) spent significantly less time resting and more time locomoting ($P<0.10$) than older broods (age classes 3-8; 16-65 days old) (Tables 26 and 27). Young broods spent 14% of their time resting compared to 29% for older broods (Table 26). Young broods spent 52% of their time locomoting versus 30% for older broods. There was no significant difference ($P>0.10$) in the amount of time spent feeding between young and older broods.

Adult activity patterns were similar to those of goslings. Adults spent significantly less time resting when their goslings were young (2% vs. 9%) ($P<0.10$), and more time locomoting when their goslings were young (26% vs. 17%) ($P<0.10$) (Table 28). There was no significant difference ($P>0.10$) in the amount of time spent feeding or alert by adults with respect to their goslings age.

Adults spent approximately 50% of their time alert (Table 28). Goslings spent approximately twice as much time feeding and locomoting, and four times as much time resting as adults (Tables 26 and 28).

Young broods spent more time locomoting than older broods. This may be a result of broods covering a larger area when they are young to satisfy nutritional requirements. Broods using the Buffalo Bridge Brood Area traveled over a larger area than most broods in the lower river, however, our

Table 26. Horning activities of Canada goose goslings observed on the lower Flathead River, Montana, 1984.

GOSLING ACTIVITY	GOSLING AGE CLASSES					
	1 - 2			3 - 8		
	Obs.	Exp.	% of Time	Obs.	Exp.	% of Time
Feeding	56	52	45	140	144	41
Resting[a]	17	31	14	100	86	29
Locomotion[a]	52	42	42	104	114	30
Total Obs.	125			344		

[a] Activity significantly different between gosling age classes ($P < 0.10$).

Table 27. Afternoon activities of Canada goose goslings observed on the lower Flathead River, Montana, 1984.

GOSLING ACTIVITY	GOSLING AGE CLASSES					
	1 - 2			3 - 8		
	Obs.	Exp.	% of Time	Obs.	Exp.	% of Time
Feeding	13	15	48	78	76	56
Resting[a]	1	5	4	30	26	21
Locomotion[a]	13	7	48	32	38	23
Total Obs.	27			140		

[a] Activity significantly different between gosling age classes ($P<0.10$).

Table 28. Diurnal activities of adult Canada geese observed with goslings on the lower Flathead River, Montana, 1984.

ADULT ACTIVITY	GOSLING AGE CLASSES 1 - 2 Obs.	Exp.	% of Time	3 - 8 Obs.	Exp.	% of Time
Feeding	29	35	17	125	119	22
Resting[a]	3	12	2	52	43	9
Locomotion[a]	43	32	26	99	110	17
Alert	92	88	55	298	302	52
Total Obs.	167			574		

[a] Activity significantly different between gosling age classes ($\underline{P}<0.10$).

data are insufficient to make inferences regarding relationships of movements to gosling age in this area.

LAKE

Analysis of the activities of all brood age class groups revealed no significant difference between morning versus afternoon time periods ($n = 419$, $\chi^2 = 2.93$, 2 df, $P>0.05$). Gosling activity data were then pooled for all time periods and analysis of young (2-3) and older (4-8) brood age class groups was performed. Again, no significant differences were found ($\chi^2 = 2.58$, 2 df, $P>0.05$); therefore, all age class and time period observations of gosling activity were pooled to determine percentages of time spent engaged in various activities (Table 29). Goslings spent over half of their time feeding (55%), (Table 29) compared to locomotion (28%) and resting (17%).

Analysis of adult activity revealed a significant difference between morning and afternoon time periods ($n = 439$, $\chi^2 = 11.72$, 3 df, $P<0.01$). We therefore analyzed morning ($n = 277$) and afternoon ($n = 162$) adult activity seperately by the age class group of the associated goslings. The activity of adults with goslings in the age class group 2-3 was significantly different from their activity with age class group 4-8, during the morning period ($\chi^2 = 9.50$, 3 df, $P<0.05$). Analysis of afternoon activity of adults with each age class

Table 29. Diurnal activities of Canada goose goslings observed on Flathead Lake, Montana, 1984.

GOSLING ACTIVITY	2 - 3 Obs.	2 - 3 Exp.	2 - 3 % of Time	4 - 8 Obs.	4 - 8 Exp.	4 - 8 % of Time	All Ages Obs.	All Ages % of Time
Feeding	131	130	56	102	103	55	233	55
Resting	44	39	19	26	31	14	70	17
Locomotion	59	65	25	57	51	31	116	28
Total Obs.	234			185			419	

group of goslings revealed no significant difference (χ^2 = 6.26, 3 df, P>0.05). Major adult activities were similar to gosling activity with the addition of the "ALERT" category.

During the morning period, adults spent less than one quarter of their time feeding (Table 30) and only 9% of their time resting while with goslings of both age groups. The time spent by adults locomoting and alert was significantly different between the 2 age groups during morning. Adults with young goslings spent 15% less time locomoting and 15% more time alert than with goslings of older age classes (Table 30).

Afternoon activities of adults were not significantly different between the 2 gosling age groups (n = 162, χ^2 = 6.26, 3 df, P<0.05). Adults spent more of their time feeding (30%) and less time resting (3%) during afternoon than morning. The amount of time spent locomoting and alert was similar during both time periods (Table 31).

Future analyses will relate brood activities to specific habitat types to determine how habitats are being utilized by broods. These data will be used to determine how water levels may influence brood activity and habitat use.

Table 30. Horning activities of adult Canada geese observed with goslings, Flathead Lake, Montana, 1984

ADULT ACTIVITY	GOSLING AGE CLASSES 2 - 3 Obs.	Exp.	% of Time	4 - 8 Obs.	Exp.	% of Time
Feeding	39	39	22	21	21	21
Resting	16	16	9	9	9	9
Locomotion[a]	35	45	20	35	25	35
Alert[a]	88	78	49	34	44	34
Total Obs.	178			99		

[a] Activity significantly different between gosling age classes ($P<0.10$).

Table 31. Afternoon activities of adult Canada geese observed with goslings, Flathead Lake, Montana, 1984.

	GOSLING AGE CLASSES							
	2 - 3			4 - 8			All Ages	
ADULT ACTIVITY	Obs.	Exp.	% of Time	Obs.	Exp.	% of Time	Obs.	% of Time
Feeding	16	20	25	33	29	34	49	30
Resting	0	2	0	5	3	5	5	3
Locomotion	25	20	38	26	30	27	51	32
Alert	24	23	37	33	34	34	57	35
Total Obs.	65			97			162	

SUMMARY AND CONCLUSIONS

RIVER

Boat and aerial pair surveys show promise for providing a valid index of the paired component of the goose population on the river. Pair surveys should continue for another nesting season to determine the extent of yearly variation in the indicated pairs/nest ratio. Use of artificial tree nest structures on the river increased in 1984 and we expect use to increase in the future. Tree nest structures on the river provide geese with nest sites which are free from mammalian predators, high and fluctuating water levels, and human disturbance. Rock pillar nest structures placed in river channels are unfeasible for use because of relatively frequent and severe ice conditions. Numbers of nests and nesting success on the river in 1984 and 1983 were similar. Nest predation (primarily mammalian) was the factor accounting for most nest loss. Discharge rates less than 6000 cfs likely facilitate access to goose nesting islands by mammalian predators. Nest flooding during 1983 and 1984 was low, however, 37% of all goose nests on the river were below the HWM and are vulnerable to flooding should water levels reach the HWM before mid-May. Goose use of the river is high during the breeding season and during winter when the reservoirs are frozen. During late summer and early fall goose use of the river is low, apparently a result of most geese being concentrated on reservoirs.

Ground nesting geese on the lower river show a preference for shrub-dominated areas. Nest sites on islands were commonly less than 5 m inland and within 1 m above or below the HWM. Overhead cover at nest sites on the river was relatively sparse (30%). Vertical cover within 5 m of the nest sites was dense below 1 m (70%) and progressively less dense at higher levels. At 2-3 m height, vertical cover averaged 35%.

Four areas of intensive brood use were located on the river during 1984. The proportions of brood habitat use and availability were significantly different on both the upper and lower halves of the river. On the upper river, coniferous forest and shrub habitats were used in significantly greater proportions than available; however, only minor brood use of this portion of the river was documented. On the lower river, gravel bars and dense shrub habitats were used more, grainfields were used in equal proportion, and forested habitats were used less than available. Water level fluctuations have an obvious effect on gravel bars in terms of plant succession, plant growth, and the accessibility of these areas to brooding geese. These effects, as well as less visible effects on shrub, herbaceous and forest habitats are being evaluated and will be discussed in future reports.

Observations of nesting and brooding geese indicate that burning an island in the lower river and planting a brood pasture along the upper river are warranted as experimental management techniques. Decoy Island is 4.5 ha in size and located adjacent to the most heavily used nesting area on the river. The island appears to be secure from mammalian predators and human disturbance; however, geese did not use this island for nesting in 1983 or 1984. Dense shrubs cover 70% of the island and may be so dense that geese are discouraged from nesting. Burning the island should reduce shrub density, at least temporarily, and may create a more desirable island to nesting geese. In addition, burning should create succulent regrowth which may be attractive to goose broods. Greater movements of broods in the upper river than lower river may be a result of fewer pastures available to broods in the upper river. Planting a pasture in the upper river would create the opportunity to determine if brood movements become localized around pastures.

LAKE

Pair surveys of 3 goose nesting islands on Flathead Lake considerably underestimated the actual number of breeding geese present. The ratios of pairs observed to actual number of nests found ranged from 0.49 to 0.71. Although these numbers are lower than those observed on the river, the relative ratios and trends of these estimates are important. Pair surveys of the 3 goose nesting islands on the lake should continue for at least 1 additional year to provide a broader base of data on the reliability of pair counts.

Goose production on Flathead Lake remained relatively stable during 1984 as compared to previous years. Cedar and the Bird Islands remain secure for goose nesting, but the future status of Melita Island is uncertain. Other islands such as Shelter, Wildhorse and some islands in the Narrows have very little if any goose nesting activity, and could possibly be improved as nesting areas. Host nest loss on the lake is the result of avian predation.

Nesting geese on Bird Islands show a preference for nest sites within 5 m inland and 2 m above the HWM, in the riparian zone. While most nests were in coniferous forest habitat, availability of this habitat was significantly greater than its use. Meanwhile, the mixed deciduous and coniferous forest habitat was used significantly more than available (on Bird Islands) suggesting a preference for this habitat by nesting geese. In addition, a preference was shown for more overhead cover, more tree and shrub canopy cover, and more dense vertical cover at nest sites compared to random sites on Bird Islands.

Goose use of the lake is high during winter and spring.

During late Hay through early June almost all non-breeding geese leave the lake and move to nearby reservoirs, or leave the study area entirely. Some of these non-breeders reappear on the study area during late September. The breeding geese begin leaving the lake as soon as the goslings have fledged and the adult molt is complete. Movement of this segment of the lake population is to local reservoirs, notably Pablo, where they remain until late September. High levels of recreational activity on the lake during the full pool stage may account for the complete disappearance of geese from Flathead Lake during this time.

Eight areas of brood use were studied on the lake, 3 in South Bay and 5 in West Bay. In both areas, habitat use was significantly different from availability. In South Bay, marshes occupied over 80% of brood areas, and only 9% of the available area. Water levels on the lake have a dramatic impact on both accessibility and ecology of marsh areas. Next year's investigations will attempt to document these affects as they impact brooding geese. Residential lawns and tall herbaceous habitat were used exclusively in West Bay. Conditioning of geese to lawns in several areas has been accomplished by feeding during winter and protection during the brood period. This precedent could be potentially detrimental to gosling recruitment if landowner tolerance or attitude changes rapidly occur.

Non-residential brood areas on the lake need to be protected and even enhanced to augment gosling recruitment on Flathead Lake. **Marsh** areas are limited, yet are the least desirable for homesites, and it may therefore be feasible to protect some of these areas as key brood areas.

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Appendix A. Adult Canada geese trapped and equipped with transmitters during the 1984 field season lower Flathead River and Lake, Montana.

USFWS Band #		Collar #	Sex	Date Trapped	Where Trapped
728					
	7 ill	MHo3	F	01-25i-84	Elmo Bay
	12	MH06			
	16	MH09			
	17	MH12			
	18	MH24			
	19	MH16			
	27	MH19		02-13-84	Upper River
	28	MH15			
	29	MH20	M		
	36	MH21	F	02-24-84	Elmo Bay
	42	MH22			
	43	MH26			
	45	MH23			
	48	MH25			
	49	MH27			
	50	MH29			
	56	MH30		02-25-84	Ninepipe
	57	MH41			
	58	MH44			
	59	MH58	M		
	60	MH59			
	63	MH47	F		
	65	MH56			
	66	MH55	I		
	68	MH60	M	02-28b-84	Elmo Bay
	69	MH61			
	71	MH44	F		
	73	MH49	M	03-21-84	Lower River
	74	MH52		03-28-84	
	75	MH66		04-03-84	
	76	MH65		04-11-84	
	77	MH81	F	04-26-84	
	78	MH62	M	04-29-84	
	79	MH73			
	80	MH87	F	I	
	81	MB88		05-09-84	
	82	MH79		05-11-84	
	9 !02	MH11	M	06-08-84	East Bay
	03	MH96			
	04	MH13			
	05	MH48	F		
	06	MH28	M		
528					
I	44951	MH08	F	01-25-84	Elmo Bay
678					
I	02784	MH85	M	06-08-84	East Bay
		MH82		04-29-84	Lower River

Appendix B. Summary of nest site data, 1984.

		River		Lake	
		Nest	Random	Nest	Random
Cover Type					
	11	4	0	27	29
	12/13	4	2	10	2
	21	25	15	3	2
	31	2	4	0	0
	32/33	3	16	0	0
Line Intercept					
	Tree	13		64	55
($\bar{X}$ % cover)	Shrub	47		38	30
	Herb	36		12	17
	Subshrub	0		16	12
Landform					
	Intertidal	7	20	1	4
	Riparian	32	17	20	5
	Upland	0	1	19	27
Overhead Cover					
	0-25%	19	30	1	9
	26-50	8	4	6	2
	51-75	9	2	11	8
	76-100	2	2	22	17
Vertical Cover					
Level 1:	0-25%	2	15	0	3
	26-50	4	1	6	2
	51-75	9	5	7	10
	76-100	23	16	27	21
Level 2:	0-25%	8	20	3	5
	26-50	3	6	8	12
	51-75	13	6	15	10
	76-100	14	6	14	9
Level 3:	0-25%	14	28	14	11
	26-50	10	4	8	8
	51-75	7	1	7	12
	76-100	7	5	11	15
Level 4:	0-25%	20	31	0	5
	26-50	7	2	12	7
	51-75	10	3	13	14
	76-100	1	2	7	3

Appendix B. (Continued)

	River		Lake	
	Nest	Random	Nest	Random
HWM Vertical Distance (classes)				
0-2	15	32	0	5
3-4	17	6	11	6
5-8	6	2	19	6
9	0	0	10	19
Horizontal Distance				
< 0 m	20	-	0	5
0-5 m	15	-	14	2
5-10 m	2	-	4	5
10-20 m	1	-	9	8
20-30 m	0	-	7	8
30+ m	0	-	7	8

Code	Vertical distance
0	1-1.5 m below HWM
1	0.5-1.0 m " "
2	0-0.5 m " "
3	0-0.5 m above HWM
4	0.5-1.0 m " "
5	1.0-1.5 m " "
6	1.5-2.0 m " "
7	2.0-3.0 m " "
8	3.0-4.0 m " "
9	> 4.0 m " "

Cover Types

- 10 Forest
  - 11 Coniferous forest
  - 12 Deciduous forest
  - 13 Combination
- 20 Shrub
  - 21 Dense shrub
  - 22 Sparse shrub
- 30 Grass/Forb
  - 31 Tall herbaceous
  - 32 Short herbaceous
  - 33 Med Herbaceous
- 40 Cultivated land
  - 41 Pasture
  - 42 Grainfield
  - 43 Alfalfa
  - 44 Orchard/Tree farm
  - 45 Lawn
  - 46 Other
  - 47 Homesite
- 50 Marsh
- 60 Aquatic
- 70 Unvegetated

Appendix C. Number of sample points in each cover type, segregated by study area **segment** .

	River							Lake		
	Seg 1	**Seg 2**	**Seg 3**	**Seg 4**	**Seg 5**	**Upper Mission**	Entire River	South **Bay**	**West Bay**	**Study Area**
River Mile	68-71	44-67	35-43	11-34	G-10		0-71			
Cover Type:										
11	28	139	50	96	26		339	100	163	155
12				62	5	2	67	22		24
13		5	3	63	13	10	84	17	6	52
21	3	114	12	171	50	8	350	16	2	17
21G		13	8	24			45			
31		2	2	25	14	3	43	10	32	31
32/33		85	100	224	45	4	454	49	15	62
33G	3	32	13	98	11		133			
41		2	4	141	9	2	156	13	2	17
42				115	23	25	138	6		
43		7		142	2		151			
47/11								56	69	
47/12								9		
47/13								89	66	
4-				7	7		14	16	6	22
50			1	24	16	3	41	44	17	46
60		7		39	13		59			
80	41	262	106	358	135	2	902			
Total	75	668	299	1565	369	59	2982			
Ron **Aquatic**	34	339	193	1168	221	57	2080			796

APPENDIX D

THE LOWER FLATHEAD CANADA GOOSE STUDY PROJECT 83-2
CONFEDERATED SALISH AND KOOTENAI TRIBES

PROJECT OVERVIEW

The project goal is to evaluate the effects of hydroelectric operations and the ensuing water level fluctuations on nesting and brooding Canada geese in the lower Flathead system, and formulate a series of management recommendations necessary to protect, mitigate and/or enhance Canada geese in the lower Flathead drainage. To meet this project goal, certain objectives have been identified. Specific tasks being conducted to accomplish these objectives are explained below.

Periodically taking aerial photographs during the yearly cycle of water level fluctuations is the most accurate method of identifying the extent of goose habitat affected. These photos are especially important during nesting and brooding periods because it is during these times that changes in water levels are most drastic and have the highest potential for detrimental affects.

Nest searches are essential to provide an accurate census of nesting geese so that increasing or decreasing population levels can be detected on a year to year basis. Since this task is very labor intensive, we have initiated territorial goose pair surveys , conducted during the nesting season, to determine the ratio of territorial pairs to actual nests. Once these ratios have been determined, a single yearly survey can be conducted that will provide a precise index to the current years breeding population. An accurate knowledge of trends coupled with a detailed record of water levels, will enable us to determine what effects different flows have on the breeding segment of the Flathead Canada goose population.

Canada geese are known to select specific areas as preferred nesting sites. On the lower Flathead River about 1/3 of the nest sites are at or beneath the high water mark and others are in adjacent habitats affected by fluctuating water levels. At each ground nest we are measuring various habitat characteristics including horizontal and vertical distance to the high water mark, habitat type, and plant species composition. These measures will enable us to determine numbers of nests flooded at different water levels (flows) and, when paired with habitat characteristics mapped on the entire study area, will allow us to evaluate affects of water levels on the availability of preferred nesting habitats.

Canada geese will readily use artifically provided nest sites. Conventional artificial nesting structures are often unaesthetic, temporary, or require intensive maintenance. Artificial nest structures, free from the effects of fluctuating water levels, have been placed in trees on the study area. We are monitoring use of these structures to determine if they result in an increase of the goose nesting population. The major problem with Canada goose artificial nest structure programs is the need for frequent (<5 year intervals) replacement of nest material. We are experimenting with 3 types of nest materials to determine which are most preferred by geese and will last at least 5 years. The goal of our artificial nest structure studies is to develop a nest structure/nest material combination which is economically feasible to produce, and benefits geese by providing nest sites which are free from water level fluctuations created by Kerr Dam. Nesting structures may be important tools in mitigating for nest loss from fluctuating water levels, but improvement in methods are needed.

Trapping and radio-marking geese and subsequently monitoring their movements is necessary so that we can secure a random sample of locations and activities at various water levels, times, and biological stages of their life cycle. By classifying and mapping habitat we will determine the availability of various habitat types. Goose use of these habitats in relation to availability provides a measure of habitat preference (habitat importance). The accessibility of habitats to goslings is more critical than to adults, since goslings cannot fly. Fluctuating water levels change habitat accessibility, so we are assessing activity and habitat use by goose broods through "time-budget" analysis. What broods are doing in a particular habitat type provides information on what characteristics of that type (cover, security, food, etc.) are important and may be affected by changes in water levels.

Effectiveness of potential mitigation techniques vary in a site specific manner. Therefore, development of an effective mitigation plan will depend on specific knowledge about the effectiveness of mitigation alternatives on our study area. Small scale trials of techniques will prevent the waste of large amounts of mitigation funds on measures that do not work. For example, we plan to burn a portion (1-2 acres) of an island in the lower river to remove dense brush and produce low grass cover for brood pasture. The fire prescription and burning of the site will be accomplished by experienced Tribal and Bureau of Indian Affairs employees. In addition, we will seed selected gravel bars and mudflats (5 acres) to evaluate the feasibility of providing additional forage for geese in the spring and early summer in areas essentally devoid of vegetation due to water fluctuations.

Results from these intensive studies will be utilized to design mitigation and management recommendations necessary to protect and enhance Canada geese in conjunction with operation of Kerr Dam. These recommendations will be reviewed before the Northwest Power Council in 1987 and specify the relationships among Canada geese, water releases from Kerr Dam and Flathead Lake levels. Consideration will be given to all operational aspects of the Dam such as hydropower production, flood control, and recreation as we develop our recommendations for Canada geese.