Management-oriented study of bald eagle concentrations in Glacier National Park

David S. Shea

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A MANAGEMENT-ORIENTED STUDY OF BALD EAGLE
CONCENTRATIONS IN GLACIER NATIONAL PARK

by

David S. Shea
B. S., University of Montana, 1970

Presented in partial fulfillment of the requirements
for the degree of Master of Science

University OF MONTANA
1973

Approved by:

[Signatures]
Chairman, Board of Examiners
Dean, Graduate School
Date
June 26, 1973
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A MANAGEMENT-ORIENTED STUDY OF BALD EAGLE CONCENTRATIONS IN GLACIER NATIONAL PARK

CHAPTER I

INTRODUCTION

History

Annual runs of spawning kokanee salmon (*Oncorhynchus nerka kennerlyi*) and concentration of migrating Bald Eagles (*Haliaeetus leucocephalus alascanus*) in Glacier National Park are relatively recent developments. Kokanee salmon were first introduced into the Flathead drainage in 1916 from Washington, and were first reported in Lake McDonald in 1934. Plants made in Lake McDonald in 1922 and 1923 probably included some kokanee (Glacier National Park files).

Bald Eagles gradually began to migrate into the Park during the salmon runs to feed on the spawning fish. Records of eagle numbers before 1939 are scanty. In the fall of that year, 37 eagles were noted along McDonald Creek by rangers. From 1939 until about 1960, eagle numbers gradually increased annually. From about 1962 to the present, numbers have been more stable, averaging approximately 240 birds each fall at the peak count (Figure 1).

Objectives

The objectives of this study were:

1. To observe the eagle-salmon relationships;

2. To include a history of the eagle concentrations and related
Annual High Counts of Bald Eagles - 1939 to 1972

Numbers of Bald Eagles

Years

3. To observe both interspecific and intraspecific interactions of the eagles;

4. To study the feeding habits and general behavioral patterns of mature and immature Bald Eagles;

5. To gain insight into the status of Bald Eagle populations and movements by determining mature-immature ratios and total numbers through censusing;

6. To determine what influence man has upon the birds during their stay in Glacier;

7. To discuss the management implications involved;

8. To make recommendations for insuring the protection of the Bald Eagle and of the entire study area while allowing for viewing by visitors.
KOKANEE SALMON AND BALD EAGLES, GENERAL

Kokanee Salmon

Kokanee salmon (also known as sockeye, blueback, red, and silver salmon) are a dwarfed, land-locked form of the anadromous Pacific coast species. Sockeye salmon in British Columbia and Alaska commonly reach 2 feet in length and a weight of 8 pounds (Eddy, 1967). Salmon spawning in McDonald Creek usually average about 12.5 inches total length in the male, and 12 inches total length in the female, with an average spawned-out weight of about one-half pound. These measurements vary slightly from year to year, as shown in Figure 2.

Occasionally, salmon of a smaller average size are seen. It is thought that these smaller fish are permanent residents of Lake McDonald, but utilize the same spawning area as the migrants from Flathead Lake (Domrose, 1968).

Salmon in the Flathead drainage spend most of their lives in Flathead Lake, feeding almost exclusively on zooplankton filtered through their gill rakers, and occasionally on aquatic worms or insects. Usually when the fish are 4 years old, they begin their spawning runs up the Flathead River. The age for spawning may vary somewhat, but the fourth year is the most common (Hanzel, 1964). The fish cease feeding and develop reddish-colored bodies and greenish heads. This is in sharp contrast to their dark gray dorsal areas and silver sides when living in the Lake where they are known to local
Average Total Lengths of Salmon in McDonald Creek

- Males
- Females

Figure 2
fishermen as silver salmon. The males develop pronounced humped backs and the large hooked jaws common in migrating salmon. The fish form large schools and proceed upstream, their movements being somewhat influenced by water velocity and temperature (Wasem, 1967a).

They usually arrive at the mouth of McDonald Creek around the end of September. In 1971, the first salmon was observed on 16 September, and in 1972, on 24 September. This involves a river distance of about 60 miles from Flathead Lake. Migrating schools have also been seen as far up the Middle Fork as Schafer Meadows (125 miles above Flathead Lake), and well up the North Fork. Bowman and Kintla Lakes in the North Fork have no records of plantings but both have large populations of salmon. In September of 1972, kokanee were caught in Harrison Lake, a Middle Fork tributary where they were not previously known.

The first arrivals at McDonald Creek are predominantly males. Pre-spawning behavior includes the formation of schools at the mouth of the Creek, as well as in deep holes and slow moving water upstream. The females begin to arrive shortly and the spawning activities begin.

Optimum spawning conditions in McDonald Creek include a good gravel bottom, and cold, clean, rapidly moving water with a depth ranging from 6 to 18 inches. Preferred temperatures range from 42 to 55 degrees Fahrenheit (Hanzel, 1965).

The female digs a depression in the gravel with her tail to form a nest, or "redd", and the actual pairing off and spawning begins. In 1972, paired fish and spawning were observed frequently from 20 October to 15 November. The female lies on her side and quivers for
1 to 3 seconds, releasing the eggs into the gravel. The male is usually positioned to the side and slightly to the rear of the female as she spawns. After extrusion of the milt by the male, the female covers the eggs with gravel, often to a depth of 8 inches. New nests may be dug upstream, and gravel covers the eggs downstream. Egg fatalities are high due to predation and to gravel abrasion. An average female in McDonald Creek will lay about 650 eggs (Brunson, 1952).

All of the salmon die 2 to 3 weeks after spawning (Figure 4). A complete physiological breakdown occurs in which the stomach, spleen, gonads, thymus, kidneys, liver, thyroids, pituitary, and cardiovascular system atrophy. This may result from hyperactivity of the adrenal gland due to the stresses of spawning (Robertson, 1960). Fins, especially the caudal fin of the female, are worm and tattered, and large white spots appear on the body, often starting at the caudal peduncle. Fungus growths, of Saprolegnia spp., (Montana State Fish and Game Dept.) appear on bruised areas and may eventually cover the entire body after death. In 1971, the spawning period was essentially over by 10 November. In 1972, it lasted a short time longer, until about 20 November.

A second run or concentration of salmon appears in the Flathead River some distance above the Lake in early November (Hanzel, 1964) but these usually do not reach McDonald Creek.

After the spawning period, fish carcasses litter the shores and bottom of the Creek, and may nearly cover the bottom in deeper pools and quiet water. The carcasses do not last long, as they rapidly decompose. When I visited the Creek on 8 January, 1973, not
a trace of a dead fish could be found.

The salmon eggs deposited in the gravel continue to develop over the winter. The eggs hatch in late March and early April, and the fry work their way out of the gravel to start their downstream migration. These movements back to Flathead Lake are generally ahead of heavy spring runoff (Figure 3), and travel is primarily during the evening hours (Hanzel, 1964).

The Montana State Fish and Game Dept. estimates that between 75,000 and 125,000 salmon congregate annually in McDonald Creek. Some spawning activity also takes place in Lake McDonald, and, in previous years, spawning fish have been seen in Lake tributaries, including upper McDonald Creek (Wasem, 1967b). In 1971 and 1972, 11 trips to the upper Creek and the area of the Lake inlet failed to show any sign whatsoever of spawning salmon. Two searches of other major Lake McDonald tributaries (Sprague and Fish Creeks) during the same period showed similar results. Lower water temperatures in these streams may inhibit spawning.

**Bald Eagles**

The southern Bald Eagle (*Haliaeetus leucocephalus leucocephalus*) is considered an endangered species (USDI, 1968a). The northern subspecies which visits Glacier is not considered endangered. It is estimated that as many as 3,000 eagles annually gather along the Chilkat River in Alaska during November and December (Robards, 1967). The northern form is slightly larger in size, although the two subspecies probably intergrade (Bent, 1937).
Water Depths of McDonald Creek from the Apgar Bridge-1972
The average wingspan of Alaskan eagles is about 85 inches, and the average weight about 12.5 pounds (Robards, 1967). One immature bird captured during the Glacier study had a wingspan of 86.5 inches.

Female eagles are slightly larger than males, and immatures are slightly larger than matures in length measurements, though they weigh less (Imler and Kalmbach, 1955). It is very difficult to differentiate the sexes in the field; however, slight size differences are often apparent among groups of perching birds.

The eagles which gather in Glacier for the salmon runs are almost exclusively Bald Eagles. Single Golden Eagles (see Appendix A for scientific names) have been reported in years past (McClelland, 1973) but this is rather unusual. In 1972, I observed an immature golden on five occasions, and it was in the area during most of the salmon run. Immature balds may resemble Golden Eagles to some degree, but the mottled plumage, lighter colors, incompletely feathered tarsi, and lack of golden head feathers help to identify the young balds.

During the summer, there are perhaps 4 or 5 pairs of Bald Eagles in Glacier Park, mostly in the North Fork area. Possible nesting sites include Kintla, Quartz, Logging, and Trout lakes. On only one occasion, have I seen immature birds outside of the migrating season; on 15 June 1971, a single young eagle was observed along Logging Creek.

Bald Eagles usually lay their eggs in latitudes corresponding to that of Glacier in early April. There are usually 1 to 3 eggs
which hatch after about 34 or 35 days, and the young remain on the nest for another 12 weeks or so. Eagles are quite long-lived; two balds in captivity lived at least 15 years (Stott, 1948), and they probably live to twice that age.

There are several annual plumage patterns for immature birds which makes it possible to age them to some degree. The annual plumage change probably occurs during the summer months (Crandall, 1941). There is much disagreement as to when the birds acquire the adult plumage. One captive bird (Wilson, 1922) retained its juvenal plumage through its 3rd year, but the feathers of both head and tail were pure white a year later. Another captive acquired the white head and nearly white tail in the 6th year, and a completely white tail in its 11th year (Crandall, 1941). Southern (1967) describes 6 different juvenal plumages and concludes that the adult plumage is possibly acquired in the 7th year.

I found that plumages corresponding to those described for years 1, 2, 3, 5, and 6 were often quite distinct. All birds up to and including the 6th plumage (the 6th plumage still has substantial amounts of brown on the head and tail) were considered immatures during the study. Because of variations in the young birds, classification was confined to the two categories of mature and immature (Figure 5).
Figure 4. Spawned-out kokanee salmon. Note the white fungal growths on the male (top), and the worn caudal fin on the female (bottom).

Figure 5. Mature Bald Eagle (left) and the typical mottled dark plumage of the immature birds (right).
CHAPTER III

STUDY AREA

Approximately 1,000 square miles of fine mountain wilderness are found within the boundaries of Glacier National Park in northwestern Montana (Figures 6 and 7). The study area is located near and along the western boundary of the Park and includes the Lake McDonald area, lower McDonald Creek, and a portion of the Middle Fork of the Flathead River (Figure 8).

Lake McDonald

Lake McDonald is about 10 miles long, averages about 1 mile wide, and is situated in a U-shaped glacier-carved valley at an elevation of 3,144 feet. It is the largest lake in the Park with a surface area of 6,760 acres, 22 miles of shoreline, and a depth of 400+ feet (USDI, 1968b).

As is the case in most of the Park, the underlying rocks are a part of the Belt Series, formed from sediments laid down more than half a million years ago. Limestones and argillite, a metamorphosed shale, predominate (Ross and Rezak, 1959).

Dominant lakeshore vegetation consists of a climax western redcedar (Thuja plicata)-western hemlock (Tsuga heterophylla) Pacific coast type forest. A rather complex pattern of seral and climax species is present, mainly due to fires (Habeck, 1970). Common seral species include Douglas-fir (Pseudostuga menziesii), western larch
Figure 6. State of Montana, showing the location of Glacier National Park.

Figure 7. Glacier National Park, showing the location of the study area.
Figure 8. Study area.
(Larix occidentalis), and lodgepole pine (Pinus contorta).

**McDonald Creek**

Lower McDonald Creek (Figure 9) forms the outlet of Lake McDonald, and work during this study was concentrated along this stream. It has a winding 2.4 mile course through a wide (1 mile), flat valley, and flows in a generally southern direction to the Middle Fork of the Flathead River. The average width of McDonald Creek in the fall is about 75 feet. Most of the stream bed is composed of argillite gravel, and interspersed fast riffles and deep pools are common. Gravel bars are also common throughout the length of the Creek, and at several points along the western stream edge, large argillite outcroppings form small cliffs.

Most common streamside vegetation consists of Engelmann spruce (Picea engelmannii), black cottonwood (Populus trichocarpa), lodgepole pine, Douglas-fir, western larch, and a few western redcedar. Most common riparian trees and shrubs include willows (Salix spp.), red-osier dogwood (Cornus stolonifera), serviceberry (Amelanchier alnifolia), black hawthorn (Crataegus douglasii), and thinleaf alder (Alnus incana).

The big bend area (Figure 8) was the scene of the most concentrated efforts of the study. This 0.4 mile section of McDonald Creek provided riffles for spawning fish, quiet water where floating fish could be easily picked up by the eagles, and good perches, all of which made it attractive to the eagles. As a consequence, two blinds were set up, and much time was spent here.
Figure 9. McDonald Creek

Figure 10. Middle Fork of the Flathead River
Middle Fork

At the junction of McDonald Creek and the Middle Fork is a large deep hole where arriving salmon often congregate before moving up McDonald Creek. The Middle Fork (Figure 10) is a much larger and swifter stream than the Creek; deep holes, picturesque argillite bluffs, and canyons are common as it flows in a generally southwesterly direction for about 4.4 miles to the junction of the North Fork of the Flathead (Figure 8). Water temperatures of the Middle Fork are lower than McDonald Creek (Figure 11) because of the warming effects of Lake McDonald on the Creek.

Vegetation along the Middle Fork includes Douglas-fir, western larch, and many lodgepole pines and large black cottonwoods. Bear-grass (Xerophyllum tenax) and huckleberries (Vaccinium membranaceum) are common understory plants.

Climate

The general climate of the area is greatly affected by Pacific weather systems, with cool, moist, cloudy weather predominating. Average annual precipitation is about 30 inches, most of it in the form of snow. Though snowfall is heavy, winters are quite mild. Mean daily temperatures in October are 43.1 degrees Fahrenheit; in November 30.9 degrees; and in December 25.7 degrees (Dightman, 1961). Table 1 gives an idea of air temperatures and weather conditions during the study in 1972.
Creek and River Water Temperatures - 1972

McDonald Creek
Middle Fork

Figure 11
Degrees Fahrenheit
TABLE 1

AIR TEMPERATURES AND WEATHER CONDITIONS ON CENSUS DAYS, 1972

<table>
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<th>Date</th>
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<tr>
<td>24 September</td>
<td>40 degrees</td>
<td>1400</td>
<td>overcast</td>
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<tr>
<td>2 October</td>
<td>55 degrees</td>
<td>1800</td>
<td>partly cloudy</td>
</tr>
<tr>
<td>8 October</td>
<td>68 degrees</td>
<td>1600</td>
<td>clear</td>
</tr>
<tr>
<td>13 October</td>
<td>34 degrees</td>
<td>1000</td>
<td>overcast</td>
</tr>
<tr>
<td>19 October</td>
<td>34 degrees</td>
<td>1000</td>
<td>overcast</td>
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<tr>
<td>27 October</td>
<td>28 degrees</td>
<td>1000</td>
<td>low overcast</td>
</tr>
<tr>
<td>2 November</td>
<td>34 degrees</td>
<td>1000</td>
<td>overcast, light rain</td>
</tr>
<tr>
<td>9 November</td>
<td>34 degrees</td>
<td>1000</td>
<td>partly cloudy</td>
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<tr>
<td>17 November</td>
<td>33 degrees</td>
<td>1000</td>
<td>overcast</td>
</tr>
<tr>
<td>22 November</td>
<td>36 degrees</td>
<td>0900</td>
<td>overcast</td>
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<tr>
<td>30 November</td>
<td>38 degrees</td>
<td>0900</td>
<td>partly cloudy, strong southwest wind</td>
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<tr>
<td>13 December</td>
<td>10 degrees</td>
<td>1000</td>
<td>overcast</td>
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Fire History

During the 1920's, forest fires burned large sections of the study area (Glacier National Park files). These burns, adjacent to the southwest shore of Lake McDonald, have isolated large western larches which the eagles often utilize as night-time roosts. Much of the forest cover over the entire study area consists of dense stands of lodgepole pine, again due to fires.
Data were gathered for this study during the falls of 1971 and 1972 in Glacier National Park. Research was conducted from the beginning of September to mid-December during the times of greatest eagle and salmon activity.

Prior to the annual arrival of eagles (usually about mid-October), general observations were made throughout the study area. These activities included determining vegetation types, creek and river conditions, taking habitat photographs, observing the first salmon arrivals, noting other animals present, and setting up the observational blinds. After the eagles started arriving, care was taken not to be obtrusive as the birds were wary and easily disturbed.

Blinds

With the cooperation of the National Park Service, I erected three blinds for the purposes of observation and photography during the study. These were all on the east bank of lower McDonald Creek (Figure 8). Two sizes of blinds were used. One type was square, 3 feet on a side, and 7 feet tall. The other was 4 feet wide, 12 feet long, and 7 feet tall. They were constructed of heavy white canvas over a frame of metal pipes, the bases of these pipes set into the ground for a foot or more. The white canvas coverings blended in well with the snow, but were rather obtrusive at times when snow cover was
This did not have any major noticeable effects on the eagles, however. All of the blinds were equipped with zippered flaps to be raised and lowered as windows, and a large zippered flap in the back for entering and leaving. Small, padded folding-chairs and safety pins to hold up the window flaps completed the setup.

For convenience in keeping records, I numbered the blinds. Blind 1 was furthest upstream and was one of the small types. It had one 5 square-inch window flap on each of two adjoining sides, and thus, when placed with a corner of the blind toward the Creek, afforded a good view both up and downstream. This blind was situated about 2 feet back from the edge of an 8-foot high bank overlooking the Creek.

Blind 2 was the large one and was set up on the east side of the big bend about 2 feet back from the edge of a 20-foot high bank overlooking the Creek. Six 5 square-inch window flaps were located across the front, affording an opportunity for more than one observer in the blind.

Blind 3 was of the small type, located on the southeast edge of the big bend, and again set about 2 feet back from the edge of the 20-foot high creek bank. This blind had two 5 square-inch window flaps, one above the other on the same wall. This provided for easy viewing while either standing or seated.

The bulk of the information concerning eagle behavior and daily activities was obtained while using these blinds. Equipment used included 7X26 Bushnell binoculars, a 15 to 60 variable power Bausch and Lomb spotting scope, a Nikon F 35mm camera fitted with a
300mm Nikkor-3 lens or a 500mm Century Tele-Athenar lens, a tripod, light meter, small tape recorder for eagle calls, pad and pencil, watch with second hand, and a small butane stove for warmth.

A total of 45 hours was spent in blind number one, 45 hours in number two, and 27.5 hours in number three, for a total of 117.5 blind hours.

Censusing

A system of censusing eagles by canoe has been regularly carried out each fall since 1965 (McClelland, 1973). These counts were continued during this study. A canoe was launched near the outlet of Lake McDonald (refer to Figure 8), usually with two persons, the one in the bow would do the counting. If with three, the counting was done by the person in the middle. Observations were aided by the use of 7X binoculars.

Eagles visible around the lakeshore were counted after the canoe was launched, and we then proceeded down McDonald Creek. Any birds which we drifted past or that flew behind the canoe (upstream) were counted. Any birds which flew downstream ahead of the canoe were counted by an observer stationed at the Quarter-Circle Bridge (Figure 8). Birds were classed as either matures or immatures. The canoe was beached at the Bridge and the counts of the canoe observer and of the Bridge observer were added together for the total. The canoe was again launched and we proceeded down the Middle Fork River to the Blankenship Bridge, slightly downstream from the junction of the Middle and North Forks of the Flathead River. Since most of the
eagles disturbed by the passage of the canoe on McDonald Creek usually flew down the Middle Fork before realighting, they were counted again from the Quarter-Circle Bridge to Blankenship Bridge. If this count was higher than the total counted by the observer stationed at the Quarter-Circle Bridge, it was considered to be more accurate. Usually the river count was lower than the bridge count. The entire count took about 105 minutes.

Thus, the census route was composed of the 7 mile stretch of creek and river from Lake McDonald to Blankenship Bridge. On one occasion, we continued on down the Flathead River for an additional 14 miles to see how many birds were along this stretch, but very few were seen.

I feel that the counts were quite accurate, though if any error was involved, it would probably be a slight underestimation of actual numbers. A sample of the Eagle Census form is found on the following page. Other wildlife observed on the censuses were also noted on this form. On some counts, particularly toward the end of the salmon spawning, some eagles could not be classified as matures or immatures and were listed as "unknowns". This is because when their food supply is low, they are more prone to leave the Creek when disturbed and will soar at great heights.

Twelve counts were made in both 1971 and 1972 (Tables 2 and 3). Actual numbers counted will be discussed later, and are graphically represented in Figures 12, 13, 14, and 15.
# EAGLE CENSUS FORM

Date ___________________________ Time ___________________________

Observers __________________________________________________________

Methods ___________________________________________________________

McDonald Creek temperature at Apgar Bridge ____________________________

Middle Fork temperature midway down River ____________________________

Weather conditions _________________________________________________

Eagles counted:

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<th>Immature</th>
<th>Unknown</th>
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<td></td>
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<tr>
<td>1/4-0 Bridge to Blankenship Bridge</td>
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</tbody>
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Total Matures ________________

Total Immatures ______________

Total Unknowns ________________

Total Eagles Counted _____________

Fish Observations:

Other Comments:
Snaring Operations

Original plans for this study included the trapping and color marking of a small number of eagles to trace their daily and possibly seasonal activities. During the period 16 to 21 November, 1971, a number of snares were set out along lower McDonald Creek under the direction of U. S. Bureau of Sport Fisheries and Wildlife personnel. On 20 November, an immature bird was captured on the south side of the big bend and released in the same area after being banded on the left leg with U. S. Fish and Wildlife Service band number 599-10501. Snaring operations ceased on 21 November because the methods were deemed impractical, and the trapping activities unduly disturbed the birds.
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<th>Unknowns</th>
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<th>% Immature</th>
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<td>% Immature</td>
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</table>
Total Numbers of Bald Eagles - 1971

Numbers of Bald Eagles

September  October  November  December
Total Numbers of Bald Eagles - 1972

Numbers of Bald Eagles

September  | October  | November | December
1         | 10       | 20       | 30
20        | 30       | 20       | 10
30        | 10       | 20       | 30
50        | 10       | 20       | 30
70        | 10       | 20       | 30
90        | 10       | 20       | 30
110       | 10       | 20       | 30
130       | 10       | 20       | 30
150       | 10       | 20       | 30
170       | 10       | 20       | 30
190       | 10       | 20       | 30
210       | 10       | 20       | 30
230       | 10       | 20       | 30
250       | 10       | 20       | 30
270       | 10       | 20       | 30
290       | 10       | 20       | 30
300       | 10       | 20       | 30
Mature and Immature Bald Eagle Numbers - 1972

Matures

Immatures

September          October          November          December
CHAPTER V

RESULTS

Bald Eagle Behavior

Seasonal Movements

Tables 2 and 3 show the dates of first arrivals in the study area.

For the first three counts in 1971, more birds were counted along the Middle Fork than on McDonald Creek; this was also true for the first five counts in 1972. This would seem to indicate that the birds arrive on the River before moving up into the Creek. This is natural because the eagles would follow the salmon as they moved upstream from Flathead Lake. By the middle of October, there are fair numbers of eagles throughout the study area.

As noted in the past few years, the immature birds tend to arrive earlier than do the mature birds (McClelland, 1973). Southern (1964) observed the same pattern of arrival in northeastern Illinois. Sprunt and Ligas (1966) also noted that immature eagles move south earlier in the fall, go farther south, and move northward later in the spring. For most of the counts made in 1971, young birds outnumbered the adults (Figure 14), but in 1972, the opposite was true (Figure 15).

The arrival of eagles in the Park correlates with the arrival of the spawning salmon. On 22 September 1971, a small school of salmon was seen in the Creek and by 6 October, there were thousands.
The same pattern was observed in 1972 with large numbers of salmon in the Creek by the first week in October.

The greatest buildup of numbers of eagles migrating into the study area took place during the last part of October and the first two weeks of November (Figures 12 and 13). The high count in 1971 was on 10 November when 267 eagles were counted (Table 2). The high count in 1972 was on 9 November when 261 birds were seen (Table 3). The average date of high counts since 1965 is 16 November (McClelland, 1973). An unusually high ratio of immatures (54.3 per cent) was present during the peak count in 1971. Only 33.3 per cent of the total count in 1972 were immatures. Since 1965 (with the exception of 1967), there has been an average of 38 per cent immatures present during the peak counts.

After the peak count was reached, numbers tended to drop off rather sharply. This occurred around the third and fourth weeks in November during the study, and is closely related to the disappearance of the salmon in the Creek. As mentioned earlier, in 1971, the spawning run was about over by 10 November, and in 1972, by about 20 November. The earlier exodus of eagles in 1971 was caused by the earlier disappearance of the fish. Weather conditions also play a role in the departures of the birds. If a severe storm occurs near the end of the season when the fish are scarce, the eagles are more prone to leave.

After the fish die off, more birds are counted on the River than along the Creek as they leave the area. General movement appears
to be south toward Flathead Lake. Fair numbers can be seen at the point where the South Fork joins the Flathead during late November and early December. This junction is about 14 miles below the outlet of McDonald Creek. Table 4 shows the results of the Annual Midwinter Waterfowl and Eagle Surveys - Pacific Flyway (Fish and Game Dept. files, Kalispell), made by the Montana State Fish and Game Department since 1960. These surveys seem to indicate a rather wide dispersal of the eagles in the area south of the Park.

A summary of the movements of the eagles to and from the Park shows that first arrivals may be expected around the last week in September. Most rapid buildup in numbers takes place during the last week of October and the first 2 weeks of November, with the peak count occurring on 16 November as an average. Numbers drop off sharply after the peak. Departure of the birds is closely correlated to the availability of salmon and to weather conditions to a lesser degree. By the middle of December, nearly all eagles have left the study area and are dispersed down the Flathead River.

**Daily Movements**

During the time of eagle concentration, daily activities on McDonald Creek fell into a definite pattern. The first birds arrived on the feeding sites from the roosting areas about 30 minutes before actual sunrise. As soon as light allowed, the birds began to fish and feed quite intensively. This flurry of feeding usually lasted about 2 hours, and was accompanied by much vocalizing and flying about. Figure 16 shows the areas of greatest concentrations of eagles during
<table>
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<th>Date</th>
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<td>Flathead Lake, Flathead River to Plains; Swan River</td>
</tr>
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<td>16</td>
<td>Flathead Lake and River</td>
</tr>
<tr>
<td>3, 4 January 1962</td>
<td>29</td>
<td>Flathead River to Plains; Swan River</td>
</tr>
<tr>
<td>3 January 1963</td>
<td>103</td>
<td>Flathead Lake, Flathead River to Plains; Swan Lake</td>
</tr>
<tr>
<td>8 January 1964</td>
<td>93</td>
<td>Flathead Lake, Flathead River to Plains</td>
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<tr>
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<td>30</td>
<td>Flathead Lake, Flathead River to Coram</td>
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<td>38</td>
<td>Flathead Lake and River; Swan and Blaine Lakes</td>
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<td>42</td>
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</tr>
<tr>
<td>2 January 1968</td>
<td>54</td>
<td>Flathead Lake, Flathead River to Columbia Falls; Swan River</td>
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<tr>
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<td>17</td>
<td>Flathead Lake; Swan River</td>
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<tr>
<td>5 January 1970</td>
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<td>Flathead Lake, Flathead River; Swan Lake, Swan River</td>
</tr>
<tr>
<td>4 January 1971</td>
<td>33</td>
<td>Flathead Lake, Flathead River to Badrock Canyon and Plains</td>
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<td>3 January 1972</td>
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<td>Flathead Lake, Flathead River to Badrock Canyon</td>
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<tr>
<td>8 January 1973</td>
<td>16</td>
<td>Flathead Lake, Flathead River to Badrock Canyon</td>
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(Counts are made by the Montana State Fish and Game Department. The primary purpose of these aerial counts is to observe waterfowl. Eagles are counted rather incidentally, and no specific effort is made to count them all).
Activities during the rest of the day included long periods of perching interspersed with capturing of prey, occasional short flights along the Creek, and bathing and preening activities. At about 30 minutes before actual sunset, the birds began to fly off to their roosting areas when they stayed all night. Each of these aspects of daily activities will be discussed in more detail in this chapter.

**Roosting**

Definite areas were preferred by the birds for nighttime roosting areas (Figure 17). The most conspicuous and important one was adjacent to the southwest shore of Lake McDonald, about 2 air miles from the feeding areas. Another important roost was on the west bank of the Middle Fork about 0.7 miles south of the outlet of McDonald Creek. Very few birds were seen on the River at night below this point. Scattered birds were observed at night at various points along the west side of the Creek, especially across from the big bend, and a few on the east side. The largest number of birds were found in the Lake McDonald roost; possibly some spend the night further up the east side of Apgar Mountain, as well as in other areas. More work is needed to identify all of these roosting sites.

Large black cottonwoods, as well as western larches which escaped past fires, provide the favorite perches in the Lake McDonald roost. These are nearly all live trees. The cottonwoods are right along the lakeshore while the larches are up to 0.5 mile or more from the shore. The birds often perch in groups in one tree, or at least
Figure 16. Areas of greatest eagle concentrations during the day.
Figure 17. Known roosting areas.
close to one another. They are usually quite high in the tree, and
often close to the main trunk. Western larches are the most frequently
used trees along McDonald Creek, again these large trees being isolated
above the lower lodgepole pines due to past fires. An extensive stand
of large black cottonwoods provides the roosting area along the Middle
Fork. Proximity to water does not seem to be a major requirement, as
many birds spend the night quite a distance from it. Swisher (1964)
noted that eagles in northern Utah flew 15.5 miles from their feeding
areas to their roosting areas.

During the Glacier Park study, I found the first birds arrived
on the feeding areas an average of about 30 minutes (range of 24 to
39 minutes) before actual sunrise. This varied somewhat with the
weather; on overcast mornings, they arrived an average of 8 minutes
later than on clear mornings, due to the variation in light which they
require to commence feeding. First arrivals were closely followed by
many more birds, and active feeding commenced almost immediately.
Near the north end of McDonald Creek, it was noted that nearly all the
birds arrived from the north, and flew down the Creek. Observations
at the Quarter-Circle Bridge at dawn showed nearly all the birds flying
upstream, arriving from the south. On one morning, a total of 40
birds were counted from the Bridge flying north; most of the birds
flew over between 30 and 15 minutes before actual sunrise.

Departure from feeding areas to the roosts in the evening
again began about 30 minutes before actual sunset. Most of these
observations were made from just west of the Apgar Bridge in the
flight path of the eagles at dusk. All of these birds were flying north, toward the Fish Creek area. The largest number counted in one evening was 82 birds on 12 November 1971. On 2 November 1972, 76 birds were counted; this represented about 37 per cent of the total number counted on the same day during the weekly census. A count made on the south end of McDonald Creek at the Quarter-Circle Bridge on 10 November 1972 showed a total of 30 birds, all of them flying south. Departure times again varied with the weather. On clear evenings, the roosting flights would begin later, with the largest number of birds flying over after actual sunset. The latest that an eagle was observed flying was 15 minutes after sunset.

The flight of the birds going to or from roosts was distinctive in that it was of the direct, straight-line, flapping type. A visual estimate of about 2 wing-beats per second (125 to 130 per minute) was observed for this kind of flight. One mature bird was disturbed from its roost and was clocked by car for about 0.2 mile at about 20 miles per hour.

**Daytime Perches**

Certain trees along the Creek and River were preferred as daytime perches by the eagles. These included black cottonwood, western larch, Douglas-fir, Engelmann spruce, and western redcedar (Figure 18). They were mostly large, live trees near the edge of the streams. A large Engelmann spruce and nearby western redcedar on an island in the big bend, and curve-topped western larch and nearby stand of black cottonwoods along the Middle Fork were all particular favorites. It
was not unusual to see 10 or 15 birds in a single tree. The birds would perch on the side branches or occasionally on the very top, and would use these perches as resting and feeding sites, as well as vantage points for spotting fish. Three slanted dead logs in the big bend were heavily used as resting and feeding sites and provided fine opportunities for observations and photography (Figure 19). Rock outcrops overlooking the water were also occasionally utilized as perches.

**Feeding Behavior**

Bald Eagles have acquired a reputation for stealing and scavenging, but this study showed they are very adept at capturing live salmon. On 27 October 1972 at approximately 1500, Mr. Riley McClelland and I were on the south end of Lake McDonald watching waterfowl which had gathered as a result of a recent storm. We noticed a mature Bald Eagle flying back and forth over and diving upon a tightly bunched flock of American Coots (*Fulica americana*) about 500 yards from shore. The eagle finally dove into the middle of the flock, captured a Coot with its talons, and easily flew with it 0.4 mile west to the lake-shore. Another adult flew out from shore and attempted to steal the Coot from the first bird but was unsuccessful. The eagle landed in a cottonwood tree on shore and proceeded to eat his catch. Munro (1938) describes a similar encounter in British Columbia, and the Coot is not an uncommon part of their diet (Bender, 1960; Brooks, 1922; Kenyon, 1940; et al). This was the only occasion during the entire study that a Bald Eagle was seen to capture any live prey other than
Figure 18

Ten eagles perching in a western larch.

Figure 19. Seven eagles on favorite perches in the big bend area of McDonald Creek. Note the individual distances maintained between the birds.
salmon. Though their diet was almost exclusively fish while in Glacier Park, Bald Eagles have a wide variety of food items (Bendell, 1959; Brooks, 1922; Edwards, 1969; Gerow, 1939; Giddings, 1915; Hancock, 1964; Hawbecker, 1958; Imler, 1937; Munro, 1923, 1938; Murie, 1940; Noell, 1948; Pearse, 1937; Retfalvi, 1970; Smith, 1936; Yeager, 1950; et al).

The fishing and feeding activities of mature eagles differ somewhat from those of immature birds.

The mature birds locate the fish while on short flights along the Creek, or more frequently by observing from a high perch. The eagles dive down from these perches, swing their legs and feet forward, and pluck the fish from the water (Figure 20). This is all done while in flight, and usually only the feet get wet. This method of fishing has been described by a number of authors (McClelland, 1973; Pearse, 1937; Reimann, 1938; Southern, 1963; et al). By observing 312 of these dives during which success or failure could be easily determined, I found that mature birds were successful in capturing salmon on 83.9 per cent of their attempts. On a couple of occasions, mature birds were seen to pick up dead salmon stranded on gravel bars in the same manner.

After capture of the prey, the eagle would usually fly to a nearby perch while carrying the fish in its talons. Arrival on the perch was often accompanied by a short period of loud vocalizations, followed by the commencement of feeding (Figure 21). The bird would usually grip the perch with one foot and stand on the fish with the
Figure 20. Adult eagle plucking a salmon from the water.

Figure 21. Adult eagle on perch about to consume a freshly caught salmon.
other, and begin to tear off strips of flesh with the beak. Feeding often began right behind the head of the fish, and it appeared that the gills and the viscera were often consumed first. On many occasions, the heads were removed and dropped to the ground, where they were commonly found under favorite feeding perches. Consumption of the heads would probably depend on the hunger of the birds, and on the state of decomposition of the fish. Large pieces of muscle tissue were stripped off the body with the beaks and swallowed whole.

After feeding, the eagle would often clean its bill of blood and bits of flesh by swishing it back and forth in the water, if available, or by rubbing it on the perch on which the bird stood.

A mature, undisturbed eagle would usually consume a fish in 3 to 6 minutes.

The fishing and feeding activities of immature birds differed from the adults in a couple of aspects. The young birds did not attempt to capture prey by swooping on it as often as the adults (about one-third as often), and when they did attempt it, they were not as successful. Of 99 observed attempts, only 63.6 per cent were successful.

Young birds often attempted to steal fish, either from other immatures or from adults, by chasing them in flight or by flying directly at a perched bird in an attempt to make it drop the fish. They were often quite successful at this. These aspects will be further discussed under intraspecific behavior.

Immature birds were more prone to secure fish along the stream edges, either by landing and picking up fish which had been
washed ashore, or by wading into shallow water and picking up dead fish off the bottom with their talons (Figure 22). The prey would often be consumed right on the ground, rather than on a perch. Actual eating of the fish was done in the same manner as the matures, except that it often took longer. One young bird took 19 minutes to ingest a fish.

Because of the difficulty in recognizing individual eagles, it was hard to arrive at an average number of fish eaten per eagle per day. On one occasion, an adult bird near the blind was observed to eat 3 salmon in a period of 45 minutes. This was early in the morning, just after the birds arrived on the feeding areas from the roosts. I believe an average of 6 salmon per eagle per day would be a fair estimate during the peak of greatest food abundance. If this is a true figure, then during the periods of peak eagle numbers, about 1,550 salmon were eaten each day along the 7 miles of Creek and River. This represents a biomass of around 600 to 700 pounds.

An average of 6 salmon consumed a day again points out the fact that very much of the daylight time is spent in non-feeding activities, such as merely perching and resting. Bald Eagles can go for several days without feeding (Stewart, 1970) when food is scarce.

Weather conditions affected the rate of feeding activity, with a reduction of feeding on windy days and on days of heavy precipitation.

Birds of prey characteristically form pellets which are regurgitated sometime after feeding. At no time were any pellets found during this study. I believe that fish bones are readily
Figure 22. Immature eagle consuming a salmon picked up in a riffle in McDonald Creek. A Ring-billed Gull and Black-billed Magpie stand by for scraps.

Figure 23. Adult eagle floating in deep water after being knocked off its perch by an immature bird while feeding.
digested by the eagles, and that fur or feathers must be ingested to form the pellets. Similar results are reported by Grewe (1966) and Stewart (1970).

The possibility that the eagles used one foot more than the other for catching and holding prey was suggested, however, it was found that there was no tendency to favor one over the other.

Vocalizations

The period of vocalization following the capture of prey by an eagle has already been described. Another characteristic vocal period occurred just prior to dawn, when the birds were arriving on the feeding areas. The birds became involved in disputes at that time over favored perching sites. If an individual was on a perch and another approached too closely, the first bird would often call, especially if it had a fish. Eagles feeding on the ground appeared to be nervous and would often vocalize when others flew too closely overhead. Vocalizing while on the wing was less frequent, though it sometimes occurred during aerial chases.

One of the most common and distinctive calls of the adults is a descending "keeeeeeer", given 2 or 3 times with the head held in a horizontal position, followed closely by 3 to 5 sharp higher notes with the head in a vertical position. The mouth is held widely open when the bird is calling. Immature birds rarely use the call described above, but commonly use a series of sharp, high notes when disturbed. Both matures and immatures show a good deal of variation in their vocalizations.
Intraspecific Behavior

Due to the large concentration of birds, many interesting aspects of intraspecific behavior could be studied.

Aerial chases have already been briefly described. Often a bird that had captured prey and was flying to a perch to eat it would be chased by other eagles making an attempt to steal the catch. Chases were especially common near the end of the salmon spawning when fish were scarce. Great aerial agility was often shown during these chases. On a number of occasions, mature birds were observed stealing fish by flying under another bird from the rear, flipping over to an upside-down position, and plucking the fish from the other's talons. A more frequent tactic was to keep diving on the successful bird until it dropped the fish. It was more common to see immatures chasing matures or other immatures, than it was to see matures chasing immatures or other matures.

Another type of aerial behavior was occasionally observed; 2 or 3 birds would soar together and make diving passes at each other, often calling loudly at each pass. If a bird was approached from the side, or from slightly above or below, it would half-fold its wings above its back and veer away in the other direction. None of the birds appeared to be carrying food during these sparring matches, and the reason for this behavior is not known.

Occasionally, when a bird was sitting on a perch eating a fish, another bird, again often a young one, would dive on it with outstretched talons to make the first one drop the fish. On a few
occasions, the feeding bird would literally be knocked off its perch and into the water, and the fish would be lost to both as it sank to the bottom (Figure 23). On several occasions, birds which were feeding were driven from the perch with the fish still in their mouths, and would then nimbly reach up and transfer it to their talons while in flight.

If a perched feeding bird was approached too closely by another, it might vocalize, slash out with its talons, strike out with its beak, beat its wings, or any combination of these actions. Generally, an individual distance of 2 to 3 feet was kept between the birds lined up on a horizontal perch (Figure 19).

Flights to and from roosts could not be termed social in nature, as each bird acted as an individual and nothing like a flock was ever formed. Birds roosting close together were probably positioned that way because certain trees were favored over others.

Bathing by the eagles appeared to be one of their more social activities (Figure 24). When one bird initiated his bath, others often gathered around and joined in. It was not unusual to see 4 or 5 birds together. This activity was never seen early in the morning, but rather after the sun was high and continuing on through the afternoon. Bathing birds usually walked from the shore into water at least a foot deep. The body was tilted parallel to the surface of the water, flipping spray over the rest of the body. The wings were held slightly open and were flapped, creating a large amount of spray. Body feathers were fluffed out and the birds appeared to be quite
Figure 24. Four eagles bathing together in McDonald Creek.

Figure 25. White-tailed deer eating salmon. The doe (on the far right) is chewing on an entire salmon, and the fawn at far left is picking up another.
soaked. Between periods of flapping and throwing up spray, the birds remained quite motionless in the water, with their feet on the bottom. They often remained in the water for 30 minutes or longer. After the bathing was over, they waded to shore to dry out by shaking and by flapping nearly fully extended wings. This behavior was often followed by a period of standing about with the wings slightly drooping. There was also often some preening done during the drying-out process, mostly a rearranging of the feathers with the bill. Rather than standing on the ground, wet birds often flapped onto a log or a stump or, if not too wet, they flew to a tree. Then they would sit for a long period of time with the wings drooping. They were found to be reluctant to fly if disturbed in this position.

At no time during the study did eagles show any aversion to water. If knocked into deep water, they appeared very buoyant, and could easily take flight by springing from the surface of the water, if done before the feathers became saturated. On several occasions after long immersions, they appeared unable to fly because of saturated feathers, and had to swim to shore to dry. They were seen to swim in deep water by stroking with their feet, and by paddling with strong wingbeats. This sort of behavior is not uncommon (Baird, 1931; Blum, 1965; Campbell, 1969; Danielson, 1967; McClelland, 1973; Pearse, 1937; et al).

**Interspecific Behavior**

The tremendous food supply afforded by the migrating salmon drew many other animals into the area besides eagles, and provided
fine opportunities for observing interspecific behavior.

I observed a total of 9 other species of birds or prey on the study area during the eagle-salmon concentrations (Appendix A). Of these birds of prey, only the Bald and Golden Eagles were ever observed eating fish, though it is probable that some of the others did.

As mentioned earlier, a Golden Eagle was seen on five different occasions along McDonald Creek during the fall of 1972. It was an immature bird and its distinctive markings and aggressive behavior made it easy to distinguish from the young balds. The first time I observed this bird, it flew into the big bend area and landed in the large Engelmann spruce, a favorite Bald Eagle perch. As the golden approached, the large number of balds in the tree took flight and left the area, obviously disturbed by his presence. The golden later dived on a flock of ducks without success, and was seen eating salmon stolen from an immature bald. As the season progressed, the Bald Eagles were not as disturbed at its presence, and the young birds would approach it quite closely.

In September, 1971, a single Osprey was sighted along the Creek but it disappeared when the eagles arrived. The Sharp-shinned Hawk, Goshawk, and Marsh Hawk were observed chasing songbirds, but never eating salmon.

I observed sixty other bird species on the study area from September through December. Many of these, such as the Loon, Great Blue Heron, Common Merganser, and Gulls, were seen to capture and eat
whole salmon. The Mallards, Black-billed Magpies, and Ravens often scavenged along the Creek banks.

Early in the season, Ravens would sometimes chase the eagles in the air, or harass them sufficiently to drive them from a perch. LeDuc (1970) reports a Red-tailed Hawk in Minnesota striking a Bald Eagle on the back while flying, probably as a territorial defense. The Black-billed Magpies searching for scraps of food were the boldest of all, often walking about or perching within inches of the eagles. There were never any aggressive acts observed, though on one occasion, a magpie actually grasped an eagle by the tail feather and gave it a pull.

Bald Eagles were observed to steal fish from gulls and Common Mergansers. This was done by diving on the birds as they surfaced with a fish, chasing them away before they had a chance to swallow their catch. Erskine (1968) and Grubb (1971) reported similar incidents.

With the exception of the capture of the Coot described earlier, no serious conflicts between Bald Eagles and waterfowl were observed. Mallards and Widgeons were the ducks most frequently seen, followed by Common and Barrow's Goldeneyes and Common Mergansers. Occasionally, a dead salmon was brought to the surface by a duck, and large numbers of Mallards would gather to pick pieces of flesh from the carcass. This would often attract the attention of an eagle which would then swoop into the midst of the ducks and pick up the salmon. Ducks frequently swam within a very few feet of perching
eagles and were never seen to be bothered, although they would sometimes scatter if an eagle flew closely overhead.

On one morning, I observed a dead female Goldeneye floating past the upstream blind. This dead bird had floated for at least 0.25 mile in plain view past many perched eagles without being picked up. Remains of dead ducks which had obviously been fed on by eagles were found on a couple of occasions, but it was not known whether the eagles actually killed them.

I observed a total of 19 species of mammals on the study area from September through December (Appendix B). Only three of these, the grizzly bear, river otter, and white-tailed deer, were actually seen to eat salmon, though more undoubtedly did. Coyotes and striped skunks were frequent visitors to the Creek banks, and many muskrats and a few beaver lived in the Creek. A large, active beaver lodge was situated in the big bend area, and muskrats were especially common in this stretch of water. At no time during the study was any direct conflict observed between the eagles and any mammal. From 3 to 5 grizzly bears were present during both seasons of the study. The bears were almost strictly nocturnal, feeding on fish during the night and staying in the dense forest during the day. While looking for roosting birds at night or when entering the blind early in the morning, I observed the bears on several occasions. A curious grizzly tore a hole in the side of one of the unoccupied blinds during one night. No black bears were observed during the study.

On 11 November 1972 at about 1000, a white-tailed doe and her 2 fawns came to the Creek edge in the big bend and began to eat dead
salmon which were lying on the grassy bank (Figure 25). The doe picked up an entire salmon, chewed on it for 2 or 3 minutes, and then swallowed it headfirst. In all, she was seen to eat two, and the fawns, one.

Probably the tremendous food source provided by the spawning kokanee eliminated serious competition between eagles and other animals on the study area. The only things the eagles seemed to fear were the Golden Eagle and the presence of man. They have virtually no serious enemies, and at no time during the study was a dead eagle found. Coon (1970) found that biggest losses occurred through gunshots and diseases.
CHAPTER VI

DISCUSSION

In 1960, the National Audubon Society began a 5 year cooperative research program named the Continental Bald Eagle Project (Buchheister, 1961). The main goals of this project were to inventory eagle numbers and to investigate factors affecting their survival. During the winter, there are more Bald Eagles in the contiguous United States than at any other time of the year, being found principally in Florida, the middle Atlantic states, the Mississippi and Missouri River Valleys, and the Northwest. Intensive counts in these areas in January of 1961, 1962, and 1963 showed an average of about 3,700 Bald Eagles (Sprunt and Ligas, 1966). The high count made during the Glacier Park study was 267. This number represents slightly over 7 per cent of the estimated total number of Bald Eagles present in the contiguous United States at that time.

It is hoped that a close watch on the mature-immature ratios of the birds in Glacier will provide an index of the health of the overall population. In 1971, immature birds made up 54.3 per cent of the total during the peak count; this was quite unusual. In 1972, 33.3 per cent of the total counted during the peak were immatures. Both of these figures are much higher than those computed by Sprunt and Ligas (1966). These figures are far from significant but provide a basis for future comparisons.

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During peak counts in the study area, an average density of about 38 eagles per linear mile was recorded along the 7-mile census route. In 1972 during the peak count, an average of about 108 birds per linear mile was present along the 2.4 miles of McDonald Creek. No eagles are present along this same stretch of water during the summer.

Information regarding regional eagle movements and migrations is very scanty. At this point, it is safe to say only that the birds observed in Glacier Park arrive from the north and disperse to the south after the kokanee run is over. The possibility that the large numbers of eagles observed in west-central Utah (Platt, in lit.), at Lakes Coeur d'Alene and Pend Oreille in Idaho, and along the Yellowstone River in Montana, have been through Glacier can only be speculated upon. The fact that the birds disappear down the Flathead River toward Flathead Lake shows a general southward movement, as do the Annual Midwinter Waterfowl and Eagle Surveys made by the Montana State Fish and Game Department every January (Table 4).

The immature bird banded in Glacier in 1971 was not seen again. However, a different banded immature bird was seen during the study in 1972. Correspondence with the Fish and Wildlife Service Migratory Bird Populations Station revealed that the only two recently recovered banded birds (1959 and 1968) in Montana were both marked near northern Saskatchewan. A system of color-marking the eagles while in Glacier would be very informative.

The fact that the immature birds tended to arrive before the
matures was another interesting aspect of their migrations. It is not known why this pattern fluctuated somewhat from year to year, as occurred in 1972. Both matures and immatures tended to drift out of the study area at about the same time, however.

Since the salmon spawning runs are relatively recent developments, it is interesting to speculate on how the great gathering of eagles came to be. Probably through random wandering, individual birds discovered the great source of food and continued to return every year.

Various factors affected the migration of the eagles while in Glacier Park. The birds tended to arrive at about the same time every season, but their time of departure varied. The most important of these factors was the nature of the salmon runs. Lengths of the runs varied somewhat from year to year, and when the spawned-out fish became too few, the eagles would leave to search for fresher fish closer to Flathead Lake.

At the time of low salmon availability late in the season, weather played a large part in the departure of the eagles. A severe winter storm would cause many of the birds to leave en masse during a short period.

There is a good possibility that undue disturbance by humans when salmon were scarce would cause some of the birds to leave. If frightened from McDonald Creek down the Middle Fork, the birds were prone to remain on the River, since there was little food along the Creek. Humans exerted a heavy influence on the eagles in Glacier.
The birds were for the most part very wary, and were prone to fly if approached to within a couple of hundred yards. If large numbers were disturbed, especially on windy days or near the end of the season, the birds would soar together in large groups, sometimes riding the updrafts to great heights. As many as 75 eagles were seen soaring in one large group. When the eagles were thus disturbed, it usually took between 1 and 2 hours for them to return to the ground to the area from which they were frightened. From this, it can be seen that a very few disturbances to the birds could disrupt the greater part of their day and feeding activities.

On several occasions, it was noticed that immature birds were easier to approach and were less prone to fly than were the adult birds. This trait of young birds was also noted by Edwards (1969) in western Utah. Probably the recognition of danger is something to be learned as they grow older.

The harmful influence of man on eagles in the form of pesticides (DDT, chlordane, endrin, dieldrin, etc.) has been recognized in various parts of the United States (Hickey and Anderson, 1968; Stickel, et al, 1966). In 1968, 14 kokanee salmon and 1 pygmy whitefish from Glacier were analyzed for residues of pesticides (Tourangeau and Gaufin, 1968). Concentrations ranged from trace amounts to 0.068 ppm. At present then, there appears to be no immediate danger, though the situation should be continually monitored.

The three greatest reasons for decline in eagles are loss of nesting habitat, shooting, and general human disturbance (Sprunt and Ligas, 1966). The first two factors are of little consequence in
Glacier. At present, the greatest danger to the eagles during their stay in the Park stems from disruptions caused by large number of interested sightseers and photographers. Various aspects of these disruptions shall be discussed later in this chapter.

Management Implications

One of the primary goals of park management in natural areas is to insure that "the biotic associations within each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white men" (USDI, 1970). In line with this goal is the policy that non-native species of plants and animals should be eliminated to preserve wilderness qualities.

This poses a definite management problem in Glacier since the kokanee salmon are exotic. How do the salmon runs and concentrations of eagles affect other components of the ecosystem?

Effects on other Fish

There are 15 species of fish found in the study area (Appendix C), most of which are native (Wasem, 1970). Kokanee salmon live in Lake McDonald year round and are commonly caught by deep-water trolling during the summer. The large numbers of salmon in the Lake must certainly provide a source of food for the predatory Dolly Varden and Lake trout. How much the kokanee compete with the other fish for food is not known. Early in the fall before the salmon runs, cutthroat trout and large suckers are commonly seen in McDonald
Creek. After the salmon arrive from downstream, it is unusual to see any fish other than kokanee. This, of course, does not necessarily mean that they have forced the others out.

The large amounts of organic matter released from the decaying carcasses must also have some effect on aquatic life.

**Effects on Mammals**

The large numbers of salmon provide a good source of food for many mammals. Probably the mammal most affected was the grizzly bear. The bears were almost strictly nocturnal in their habits, and were seen on several occasions late in the evening or early in the morning. There is a strong possibility that the good source of food retarded their entering hibernation. During both falls, I observed fresh grizzly sign as late as 20 November. The Apgar Mountains provide good grizzly habitat, and it is rather surprising that larger concentrations have not occurred annually along McDonald Creek to feed on the salmon. There is a large open garbage dump just outside the Park near the study area. Grizzlies are shot there nearly every fall, and this has possibly prevented any annual buildup. From 1967 through 1972, 7 grizzlies were killed, 1 wounded, and 1 removed from the dump area (Glacier National Park files).

As stated earlier, there was never any direct conflict observed between the eagles and any mammal. Occasionally beavers and muskrats would dive as an eagle passed overhead, but no attempt at capture was ever seen.
Effects on other Birds

Again the large numbers of salmon provided food for many birds, most notably the Gulls, Black-billed Magpies, Common Mergansers, and Great Blue Herons. Very little direct conflict was observed between the Bald Eagles and other birds, and the majority of the other species observed paid little attention either to the eagles or the salmon.

Recommendation for Management

1. Because the salmon are non-native, the annual gathering of Bald Eagles in Glacier is an unusual, unique, exotic situation. However, the fact that one subspecies of the Bald Eagle is endangered and the other, which profits from the food source in Glacier is not as numerous as it once was, would certainly seem to justify not disrupting the salmon runs.

2. The weekly eagle censuses by canoe should be continued, at least during the month of November. This is an important management tool for detecting any changes in total numbers of birds, as well as trends in the mature-immature ratios. Since the numbers of eagles present in Glacier represent a relatively large percentage of total numbers in the contiguous United States, these counts might be used as an indication of the health of a large segment of the national eagle population.

3. The Bald Eagle-pesticides relationships should be monitored more closely. Samples of salmon from McDonald Creek could be analyzed on an annual basis to detect potentially dangerous levels.
4. The eagle roosting areas should be protected from human disturbances, particularly at Fish Creek and along the Middle Fork below the outlet of McDonald Creek. Approximately 142 acres, including about 1 mile of River frontage, are privately owned on this section of the Middle Fork and could be developed or subdivided by the owner. An effort should be made by the Park Service to acquire this land, as it is a favorite spot of the eagles during both day and night.

5. Bald Eagles nesting sites in the Park should be located and afforded better protection if necessary.

6. An eagle marking program should be established to determine where they come from and where they go. Since the Bald Eagle is an endangered species, knowledge of their regional movements may prove to be vital in long-range management plans. The disturbances caused by a short-term, well planned marking program would be compensated by the long-range knowledge gained. The ideal situation would ultimately involve a national or continental system of marking and observing.

7. The no salmon-snagging policy should be continued. Snagging is inconsistent with natural area policy and disruption of the eagles and other wildlife results.

8. The salmon egg-taking in McDonald Creek by the Montana State Fish and Game Department should be discontinued. The eagles are easily disturbed during the process, visitor viewing is disrupted, and there are many other places where the Department can gather eggs outside of the Park.

9. Snowmobiling should not be allowed along the bicycle trail near
McDonald Creek. Eagles are easily disturbed by foreign moving objects and by loud noises.

10. There is a good possibility that sometime in the near future someone will conduct commercially guided raft trips down the Middle Fork in the fall to view the eagles. Even though the Middle Fork is technically not in the Park, this possibility should be realized and guarded against.

11. Except for eagle censusing, the policy of no canoeing or rafting down McDonald Creek from 15 October to 15 December should be continued.

12. The large open dump near West Glacier should be closed, or else the cooperation of the Fish and Game Department should be sought to eliminate the killing of bears there. Grizzlies that wander to the dump from the McDonald Creek area are very apt to be shot.

13. A sprayfield for the effluents of secondarily treated sewage has been proposed for an area along McDonald Creek, between an eagle viewing area and the Creek. This would spray within a couple hundred feet of the stream. The aesthetic intrusion and possible nutrient pollution effects of this sprayfield suggests that it be placed at an alternate site, far from the Creek.

14. There is a need for a better public eagle-viewing program. Improvements might include the erection of more Area Closed signs and barricades; a better system of reservations for use of the photographing blind; a naturalist at both ends of McDonald Creek on weekends for control and interpretation; and more public information explaining the reasons for and the importance of following the rules.
If the situation does not improve, the possibility of removing the blind should be considered.

At present, the primary public viewing and interpretive areas are located at both ends of McDonald Creek. Disruptions along other sections of the Creek by persons wandering randomly about often ruin viewing opportunities for the majority of interested visitors. The primary management objectives should include the encouragement of public interest and education, with the all-important end result of protection and better understanding of the Bald Eagle. A long-range program with national or continental implications is desirable to attain these objectives.
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APPENDIX A

Birds Observed on the Study Area During Eagle and Salmon Concentrations
(September to mid-December, 1971 and 1972)

Common Loon
Horned Grebe
Eared Grebe
Western Grebe
Great Blue Heron
Whistling Swan
Canada Goose
Mallard
Green-winged Teal
Blue-winged Teal
American Wigeon
Wood Duck
Lesser Scaup
Common Goldeneye
Barrow’s Goldeneye
Bufflehead
Harlequin Duck
Hooded Merganser
Common Merganser
Goshawk
Sharp-shinned Hawk
Red-tailed Hawk
Golden Eagle
Bald Eagle
Marsh Hawk
Osprey
American Kestrel
Spruce Grouse
Ruffed Grouse
American Coot
Killdeer
Common Snipe
Herring Gull
California Gull
Ring-billed Gull
Great Horned Owl
Pygmy Owl
Belted Kingfisher
Red-shafted Flicker
Hairy Woodpecker

Gavia immer
Podiceps auritus
Podiceps nigricollis
Aechmophorus occidentalis
Ardea Herodias
Olor columbianus
Branta canadensis
Anas platyrhynchos
Anas crecca
Anas discors
Anas americana
Aix sponsa
Aythya affinis
Bucephala clangula
Bucephala islandica
Bucephala albeola
Histrionicus histrionicus
Lophodytes cucullatus
Mergus merganser
Accipiter gentilis
Accipiter striatus
Buteo jamaicensis
Aquila chrysaetos
Haliaeetus leucocephalus
Circus cyaneus
Pandion haliaetus
Falco sparverius
Canachites canadensis
Bonasa umbellus
Fulica americana
Charadrius vociferus
Capella gallinage
Larus argentatus
Larus californicus
Larus delawarensis
Bubo virginianus
Glaucidium gnoma
Megaceryle alcyon
Colaptes atratus
Dendrocoptes villosus
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APPENDIX B

Mammals Observed on the Study Area During Eagle and Salmon Concentrations (September to mid-December, 1971 and 1972)

Shrew: Sorex spp.
Lynx: Lynx canadensis
Grizzly Bear: Ursus arctos
Coyote: Canis latrans
Striped Skunk: Mephitis mephitis
River otter: Lutra canadensis
Weasel: Mustela spp.
Mink: Mustela vison
Marten: Martes americana
Snowshoe hare: Lepus americanus
Beaver: Castor canadensis
Chipmunk: Eutamias spp.
Red Squirrel: Tamiasciurus hudsonicus
Deer mouse: Peromyscus maniculatus
Muskrat: Ondatra zibethicus
Vole: Microtus spp.
White-tailed deer: Odocoileus virginianus
Mule deer: Odocoileus hemionus
American elk: Cervus canadensis
APPENDIX C

Fishes of the Study Area (from Wasem, 1970)

Family Salmonidae

Lake whitefish
Pygmy whitefish
Mountain whitefish
Kokanee salmon
Cutthroat trout
Brook trout
Dolly Varden
Lake trout

Family Cyprinidae

Longnose dace
Redside shiner
Northern squawfish
Pyeamouth

Family Catostomidae

Largescale sucker
Longnose sucker

Family Cottidae

Mottled sculpin

(* = native to study area)

Coregonus clupeaformis
Prosopium coulteri*
Prosopium williamsoni*
Oncorhynchus nerka
Salmo clarki*
Salvelinus fontinalis
Salvelinus malma*
Salvelinus naymuncush
Rhinichthys cataractae*
Richardsonius balteatus*
Ptychocheilus oregonensis*
Mylocheilus caurinus*
Catostomus macrocheilus*
Catostomus catostomus*
Cottus bairdi*