



Ecology of the bald eagle and osprey in Yellowstone National Park, Jon Eugene Swenson  
by Jon Eugene Swenson

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

The ecology of the bald eagle (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*) in Yellowstone National Park was studied during the summers of 1972, 1973 and 1974. From historical records, it appeared as though the bald eagle population had remained stable while the osprey population had declined in numbers and distribution. Bald eagles, apparently those which nest in the park, winter along • major rivers, primarily on ungulate wintering areas. Eagle and osprey nest sites were described and compared. Bald eagle territories seemed to be limited by open water at the time of nest initiation. Both species nested later in the park than elsewhere at the same latitude. Ospreys nested later on the lakes (after ice-out) than streams. Bald eagle nest success, 23.3 percent, and productivity per occupied nest, 0.23 percent, were significantly less than in 1960-61. Osprey reproduction has also declined, but nests on Yellowstone Lake had significantly lower nest success and productivity per occupied nest, 28.3 percent and 0.45, respectively, than stream nests, 63.4 percent and 0.95, respectively. This difference appeared to be related to human presence near nests. The corresponding parameters for the entire osprey population were 41.1 percent and 0.64, respectively. In 1972 and 1973, success of osprey nests on Yellowstone Lake was significantly higher for those over 1 km from a backcountry campsite. Bald eagle reproduction was apparently not affected by human presence.

Late ice-out was believed to be the cause of delayed nesting and reduced success of ospreys nesting on Yellowstone Lake in 1974. Pesticide residues were detected in osprey eggs from the park. The diet of bald eagles consisted of 57.1 percent birds, 36 percent water-fowl, 25.0 percent fish and 17.9 percent mammals; the diet of ospreys on Yellowstone Lake consisted of about 93 percent cutthroat trout of an average size of 27.6 cm. Osprey foraging parameters from Yellowstone Lake were reported. They seemed to forage over deep water in response to the distribution of the favored size of the major prey species. A hypothesis of population regulation in the bald eagles, based on increased subadult survival in response to reduced competition through lowered natality and adult territorial aggression, is presented to explain the stable numbers despite reduced reproduction. Management recommendations were presented.

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YELLOWSTONE NATIONAL PARK

by

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A thesis submitted in partial fulfillment  
of the requirements for the degree

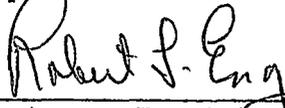
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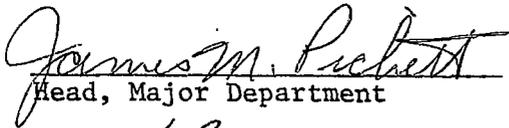
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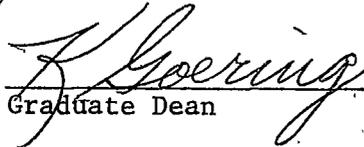
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## ABSTRACT

The ecology of the bald eagle (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*) in Yellowstone National Park was studied during the summers of 1972, 1973 and 1974. From historical records, it appeared as though the bald eagle population had remained stable while the osprey population had declined in numbers and distribution. Bald eagles, apparently those which nest in the park, winter along major rivers, primarily on ungulate wintering areas. Eagle and osprey nest sites were described and compared. Bald eagle territories seemed to be limited by open water at the time of nest initiation. Both species nested later in the park than elsewhere at the same latitude. Ospreys nested later on the lakes (after ice-out) than streams. Bald eagle nest success, 23.3 percent, and productivity per occupied nest, 0.23 percent, were significantly less than in 1960-61. Osprey reproduction has also declined, but nests on Yellowstone Lake had significantly lower nest success and productivity per occupied nest, 28.3 percent and 0.45, respectively, than stream nests, 63.4 percent and 0.95, respectively. This difference appeared to be related to human presence near nests. The corresponding parameters for the entire osprey population were 41.1 percent and 0.64, respectively. In 1972 and 1973, success of osprey nests on Yellowstone Lake was significantly higher for those over 1 km from a backcountry campsite. Bald eagle reproduction was apparently not affected by human presence. Late ice-out was believed to be the cause of delayed nesting and reduced success of ospreys nesting on Yellowstone Lake in 1974. Pesticide residues were detected in osprey eggs from the park. The diet of bald eagles consisted of 57.1 percent birds, 36 percent waterfowl, 25.0 percent fish and 17.9 percent mammals; the diet of ospreys on Yellowstone Lake consisted of about 93 percent cutthroat trout of an average size of 27.6 cm. Osprey foraging parameters from Yellowstone Lake were reported. They seemed to forage over deep water in response to the distribution of the favored size of the major prey species. A hypothesis of population regulation in the bald eagles, based on increased subadult survival in response to reduced competition through lowered natality and adult territorial aggression, is presented to explain the stable numbers despite reduced reproduction. Management recommendations were presented.

## INTRODUCTION

Declines have been reported by Sprunt (1969) in bald eagle (*Haliaeetus leucocephalus*) and by Henny and Ogden (1970) in osprey (*Pandion haliaetus*) populations in many areas of the United States. Consequently, the National Park Service funded this study during the summers of 1972, 1973 and 1974 to determine the population status and important ecological relationships for these two species in Yellowstone National Park, Wyoming. This study was to provide basic reference information for administrative, management, interpretive and scientific uses.

There have been few studies of these birds in Yellowstone Park. Murphy reported on bald eagle reproduction and population size (Murphy 1960, 1961) and on nest site selection (Murphy 1965). He compiled less intensive observations of nesting in 1962, 1963, 1965 and 1968 (Yellowstone National Park files). Skinner (1917) published observations on the life history, numbers and distribution of the osprey in the park and Turner (1968) included the park in a survey of osprey reproduction in northwestern Wyoming.

## DESCRIPTION OF AREA

Yellowstone National Park occupies 8995 km<sup>2</sup> in the northwestern corner of Wyoming and adjacent Montana and Idaho (Figure 1). It was established in 1872 and has received relatively little development by man. The geology of the park has been described by Keefer (1972), the climate by Lowery (1959) and the vegetation zones by Despain (1973).

### Physiography

Elevations in the park range from about 1525 to over 3370 m, but much of the park is a series of plateaus between 2140 and 2440 m. The plateaus are rolling and were chiefly formed by the Quaternary lava flows in and around the 2590 km<sup>2</sup> Yellowstone caldera. Widespread thermal areas are a remnant of the formerly extensive vulcanism which was important in forming Yellowstone's landforms. The landscape was further modified by at least three glacial periods, the last one ending about 8500 years ago (Keefer 1972). North, east and south of the central plateaus are high, extensive mountain ranges.

The park is divided from west to southeast by the Continental Divide. The Pacific side is drained by tributaries of the Snake River and the much larger Atlantic side is drained by the Yellowstone and Madison Rivers and their tributaries. Yellowstone Lake, the largest in the park, is drained by the Yellowstone River. It lies at an

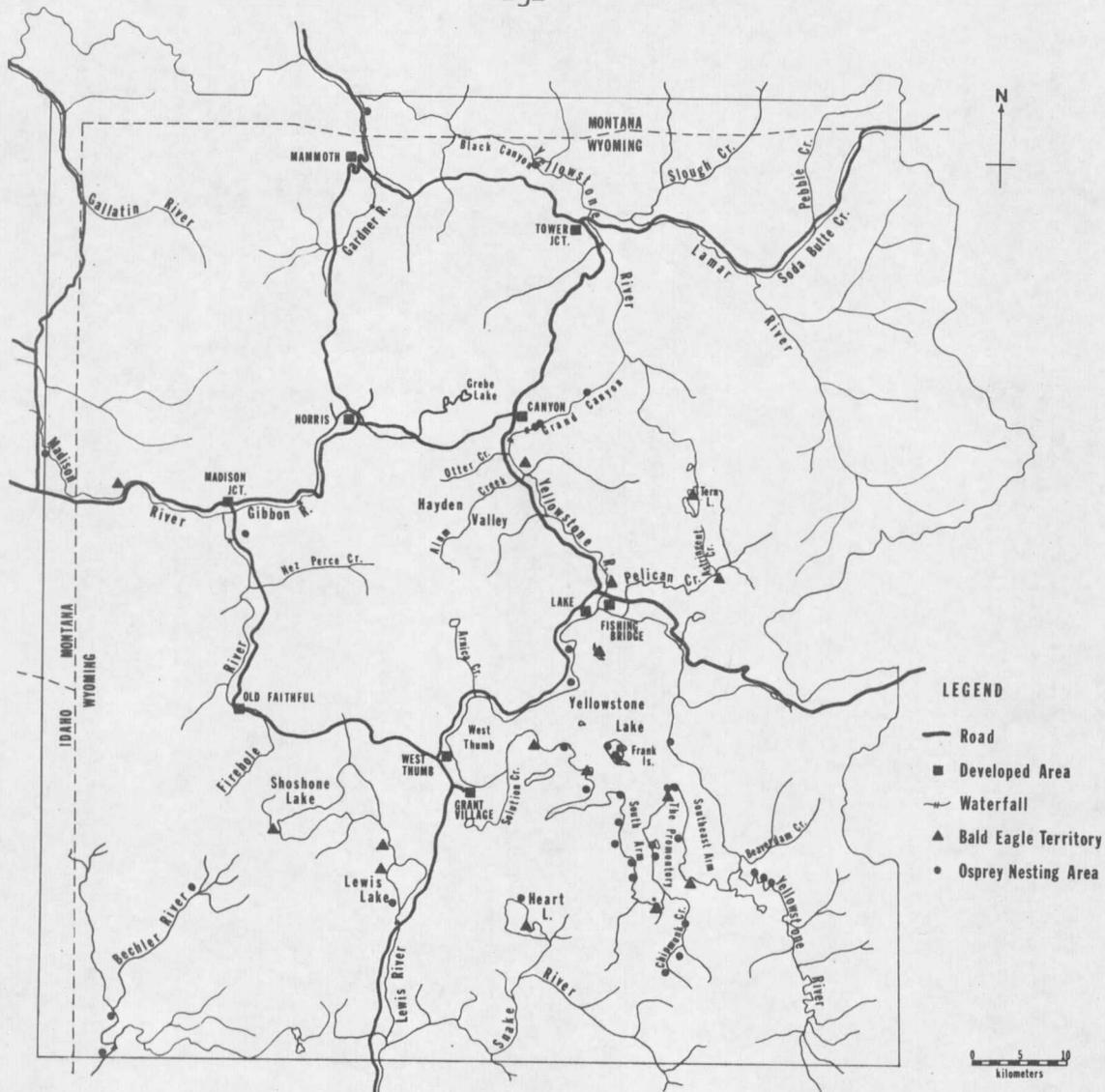


Figure 1. Map of Yellowstone National Park showing bald eagle territories and osprey nesting areas.

elevation of 2357 m, has a surface area of 355 km<sup>2</sup> and a shoreline of 177 km. Three large lakes are found in the Pacific drainage: Shoshone, Lewis and Heart Lakes. Shoshone Lake, about 30 km<sup>2</sup> in surface area, and Lewis Lake, 11 km<sup>2</sup>, are connected by a channel of the Lewis River. Heart Lake occupies 8.7 km<sup>2</sup>. There are many smaller lakes in the park.

Several V-shaped canyons are found in the park. The largest and most spectacular of these is the Grand Canyon of the Yellowstone which is 300-450 m deep and 32 km long. The upper 8 km is very colorful and contains many pinnacles, which are used as nest sites by ospreys.

#### Climate

The park has long, cold winters and short, cool summers. Winter extends from mid-November to mid-May on the plateaus. Ice-out on Yellowstone Lake is generally at the end of May or first of June. Summer begins around the first of July and autumn begins about the first of September (Meagher 1973).

In Mammoth, the coldest and warmest months are January and July with mean temperatures of -7.8 and 17.1 C, respectively. In general, the maximum summer temperatures are in the low twenties (C) and the minima are near freezing. Mammoth is about 3 C warmer than most other areas of the park.

The average annual precipitation is 395.2 mm at Mammoth (482.6 mm at Lake). June is the wettest month, receiving 50 to 75 mm, while

July, August and September receive between 25 and 50 mm per month. Most of the summer showers are light to moderate and of short duration. For most of the park, annual snowfall averages nearly 380 cm (Lowery 1959).

#### Vegetation

The park can be divided into three major and two smaller vegetation zones (Despain 1973). The primary study area is located almost entirely within the large spruce-fir and lodgepole pine zones.

The spruce-fir zone occurs above 2560 m and is the largest zone. The dominant trees are Engelmann spruce (*Picea engelmanni*) and sub-alpine fir (*Abies lasiocarpa*). The average tree density ranges from 133 to 178 trees per ha for spruce and from 173 to 207 trees per ha for fir (Despain 1973). Whitebark pine (*Pinus albicaulis*) or Douglas-fir (*Pseudotsuga menziesii*) may be major components near the timberline in some areas. In this zone, lodgepole pine (*Pinus contorta*) is a seral plant and depends on fire or other disturbance to maintain its presence.

The lodgepole pine zone has little or no spruce or fir in the understory. The lodgepole is probably maintained as the climax species by relatively low precipitation and the nutritionally poor rhyolite-derived soils in these areas (Despain 1973). Density of trees with a diameter at breast height (dbh) greater than 10 cm is about 800 trees per ha. This zone is located in the west-central and central portion

of the park and southeast of Yellowstone Lake.

Two large open meadows, Hayden and Pelican Valleys, and many smaller meadows occur on the primary study area. Idaho fescue (*Festuca idahoensis*) bluebunch wheatgrass (*Agropyron spicatum*), needle and thread (*Stipa* spp.) and big sagebrush (*Artemisia tridentata*) are common in these meadows (Don Despain 1974 pers. comm.).

#### Primary Study Area

The most intensive field work was carried out in the Yellowstone-Shoshone-Lewis Lake area and on the Yellowstone River from the lake to the Grand Canyon of the Yellowstone. Most of the bald eagles and ospreys were found to occur in this area. All of these lakes are cold and oligotrophic. Shoshone and Lewis Lakes were barren until lake trout (*Salvelinus namaycush*) and brown trout (*Salmo trutta*) were planted in 1890 (Smith and Kendall 1921). Brook trout (*Salvelinus fontinalis*) and rainbow trout (*Salmo gairdneri*) were also planted in the drainage, but the latter did not become established. Dean (1972) reported Utah chubs (*Gila atraria*), brown trout, lake trout, redbreast shiners (*Richardsonius balteatus*) and brook trout from Lewis Lake in 1971.

Cutthroat trout (*Salmo clarki*) and longnose dace (*Rhinichthys cataractae*) are the only fish native to Yellowstone Lake. Exotics include longnose suckers (*Catostomus catostomus*), which first appeared in 1931-33, lake chubs (*Couesius plumbeus*) and redbreast shiners (Dean

1972). The exotics were probably introduced by fishermen using them as bait. Longnose suckers are most abundant in the northern portions of Yellowstone Lake and near the delta of the Yellowstone River in the Southeast Arm (Dean and Varley 1973).

Common waterfowl in this area include: Barrow's goldeneye (*Bucephala islandica*), bufflehead (*B. albeola*), common merganser (*Mergus merganser*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), gadwall (*A. strepera*), green-winged teal (*A. crecca*), blue-winged teal (*A. discors*), American widgeon (*A. americana*), lesser scaup (*Aythya affinis*) and American coot (*Fulica americana*).

## METHODS

### Literature Search

I conducted a search of park files, Yellowstone Nature Notes, superintendents' monthly and annual reports and journals of early explorers. The results of this search provided the basis for determining the historical status of these birds in the park.

### Nest Surveys

Aerial surveys with a 150-hp Super Cub were conducted on 28 May, 7 and 29 June, 18 July and 11 August 1972; 12 and 29 May, 20 June, 7 and 24 July and 7 August 1973; and 25 April, 11 May, 9 June, 7 and 22 July and 11 August 1974. Data on population size and distribution, nest location and reproduction were collected during these flights. This method was the only practical way to determine reproductive parameters. Efforts were made to keep disturbance at a minimum. Nests were checked during the first pass of the airplane. A second pass was made only if the adult stood up, left the nest or if the pilot and I disagreed on the number of eggs or young in the nest. Osprey nests in the Grand Canyon were checked periodically with a 15-60 X spotting scope.

### Classification of Immatures

Immature bald eagles were classified according to plumage classes described by Southern (1967). I observed plumages A, B, C, E and F,

which may correspond to ages young-of-the-year, yearling, two-, four- and five-year-old, respectively. In this thesis, "immature" refers to eagles not in adult plumage and "subadult" refers to immatures beyond the first summer of life.

Subadults were counted using plumage differences and spatial-temporal separation. This method would result in a minimum estimate, since two subadults seen in the same area would be counted as one bird unless observed simultaneously. Immatures are also harder to observe than adults, especially from an airplane (Hancock 1964). Molting could affect this estimate, since it probably occurs during the summer (Bent 1937, Southern 1967), but eliminating subadult sightings from the late summer would only reduce the estimate by one in 1972, the year the subadult estimate was lowest.

Young-of-the-year ospreys were recognized by mottled backs and heavily streaked crowns (Bent 1937).

#### Nest Site Measurements

Nest locations were mapped and the following characteristics were measured or described: height of nest, using a Stratex Stratolevel; height, dbh, condition and species of the nest tree; distance to water; relationship of the nest tree to surrounding trees; general habitat and tree density. Tree density was estimated using a modification of the point-centered quarter method (Cottam and Curtis 1956). The nest

tree was used as the center and the distance to the nearest tree over 10 cm dbh in each quadrant was measured. This was considered only as an index to compare densities at bald eagle and osprey nest sites.

#### Reproductive Terminology

The following definitions were slightly modified for this study from Postupalsky's (1974) proposed terminology for describing raptor nest status:

**Breeding territory:** an area containing one or more nests within the range of one mated pair of birds.

**Occupied nest:** any nest at which one of the following activity patterns was observed during a given breeding season:

- a. Young were raised;
- b. Eggs were laid;
- c. One adult was observed sitting low in the nest, presumably incubating;
- d. Two adults were present on or near the nest, provided there was no reason to suspect the pair had already been counted elsewhere;
- e. A recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top.

**Active nest:** a nest in which eggs have been laid, activity patterns (a), (b) and (c) above being diagnostic.

Productive or successful nest: an active nest from which at least one young fledged or was raised to an advanced stage of development.

Alternate nest: one of several unoccupied nests within the breeding territory of one pair of birds.

Frustration nest: an alternate nest built, repaired or frequented by a pair of birds subsequent to a nesting failure at another nest during the same breeding season.

Nest success: the proportion of occupied or active breeding territories which produce at least one young to an advanced stage of development. Nest success and productivity were calculated on the basis of both occupied and active nests because of disagreements among researchers concerning the proper parameters to use (Henny and Van Velzen 1972, Postupalsky 1974).

Brood size: the number of advanced young per productive nest.

Productivity: the number of young raised to an advanced stage of development per occupied or active nest.

#### Effects of Human Presence

Efforts were made to evaluate the effects of human presence on osprey nest success on Yellowstone Lake. Comparisons were made between the success of active nests and their respective distances from backcountry campsites. Since 1972, backcountry campers have been required

to obtain a permit to use designated campsites. The campsites on the shores of Yellowstone Lake are regularly patrolled by rangers and few campers attempt to use areas other than the designated sites (Pat Ozmunt 1974 pers. comm.). The success of active nests was also related to "human use categories", which were measures of human use in the immediate vicinity of the nest. The nest areas were categorized independently by Elwood Jones and Dale Nuss, Park Rangers with considerable experience as boat rangers on Yellowstone Lake. The categories are:

- I. People often present on the bank adjacent to the nest.
- II. People expected to be fishing from boats near but not from the shore in the area.
- III. People not expected to be fishing from the shore nor boats near the shore in the area.

The reactions of nesting ospreys to boats were observed during early and late incubation in 1974. Observations were made from a 25-foot Bertram boat traveling at various speeds and distances from the nests.

#### Egg and Eggshell Analyses

Nest trees were climbed only after the incubation period of unhatched eggs was positively exceeded or the young were fledged. Five osprey eggs were collected and the contents of four were analyzed for

common pesticide residues by personnel of the Wisconsin Alumni Research Foundation using methods described in the 1970 Pesticide Analytical Manual, sections 211 and 310. The length and breadth at the equator of each egg was measured to the nearest 0.1 mm with a venier caliper and the eggshells, with membranes, were weighed to the nearest 0.1 mg with a Mettler Type H16 balance after being dried for several months at room temperature. From these data, an eggshell index was calculated using the formula, 
$$\frac{\text{eggshell weight (mg)}}{\text{length (mm)} \times \text{breadth (mm)}}$$
 (Ratcliffe 1967).

#### Food Items and Foraging Behavior

Food items were collected from in and under nests and under perches. The bones of cutthroat trout and longnose suckers were identified by comparing them with reference skeletons from Yellowstone Lake. Bird and mammal remains were identified to species by comparing them with specimens in the Montana State University Zoological Museum. For bald eagle items, the minimum recognizable number of individuals of each species was counted. With the osprey items, all bones were counted and the proportion of bones from a species was considered to be the proportion of that species taken by ospreys.

Osprey foraging behavior was observed in the southern portions of Yellowstone Lake in 1973 and 1974 and on the Yellowstone River in 1973. The time first seen, time and success of each dive, time last seen and











































































































































































































































































