Effects of monitoring effort and recreation patterns on temporal and spatial activities of breeding bald eagles

by Janine Marie Stangl

A thesis submitted in partial fulfillment of the requirements for the degree Master of Science in Biological Sciences
Montana State University

Abstract:
To conserve bald eagle (Haliaeetus leucocephalus) populations on Hebgen and Earthquake Lakes, Montana, the U.S. Forest Service, Hebgen Lake Ranger District, initiated research in 1990 to gather data for the development of management guidelines for breeding bald eagles. Visual monitoring was conducted on 3 breeding bald eagle areas during nesting seasons from 1990 to 1992 to identify home range. Home range was determined from 20 June to 29 July, 1992, for an adult bald eagle of the Canyon pair using radio telemetry, and visual monitoring and results were compared. Spatial and temporal responses to recreation activities were evaluated for the Moonlight and Canyon bald eagle areas. Monitoring effort required to identify 50% of home range size was determined for all breeding bald eagle areas. Average home range size of 3 bald eagle breeding areas was 9.1 km^2. Bald eagles selected perch sites in close proximity to good quality habitat which was reflected in perch to nest distances at the cumulative 50 percent level. There was no difference in home range size identified using radio telemetry or visually during the late nesting season. Canyon bald eagles were spatially separated from angler activities during all observation hours and from stationary and slow moving watercraft and float-tube activities during mid-day. Bald eagles of the Moonlight pair foraged early in the morning and late in the evening and were temporally separated from watercraft activity. A minimum of 74 hours of observation with eagle(s) in view was required to determine 50% of home range size of breeding bald eagles. Although bald eagles may have avoided recreation activities either spatially or temporally, productivity was high and relatively stable.

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Janine Marie Stangl

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Cochairperson, Graduate Committee

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Graduate Dean

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Date May 25, 1994

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TABLE OF CONTENTS

TABLE OF CONTENTS -- Continued

LIST OF TABLES

LIST OF TABLES -- continued

LIST OF TABLES -- continued

LIST OF FIGURES

LIST OF FIGURES -- Continued

LIST OF FIGURES -- Continued

ABSTRACT

To conserve bald eagle (*Haliaeetus leucocephalus*) populations on Hebgen and Earthquake Lakes, Montana, the U.S. Forest Service, Hebgen Lake Ranger District, initiated research in 1990 to gather data for the development of management guidelines for breeding bald eagles. Visual monitoring was conducted on 3 breeding bald eagle areas during nesting seasons from 1990 to 1992 to identify home range. Home range was determined from 20 June to 29 July, 1992, for an adult bald eagle of the Canyon pair using radio telemetry and visual monitoring and results were compared. Spatial and temporal responses to recreation activities were evaluated for the Moonlight and Canyon bald eagle areas. Monitoring effort required to identify 50% of home range size was determined for all breeding bald eagle areas. Average home range size of 3 bald eagle breeding areas was 9.1 km^2. Bald eagles selected perch sites in close proximity to good quality habitat which was reflected in perch to nest distances at the cumulative 50 percent level. There was no difference in home range size identified using radio telemetry or visually during the late nesting season. Canyon bald eagles were spatially separated from angler activities during all observation hours and from stationary and slow moving watercraft and float-tube activities during mid-day. Bald eagles of the Moonlight pair foraged early in the morning and late in the evening and were temporally separated from watercraft activity. A minimum of 74 hours of observation with eagle(s) in view was required to determine 50% of home range size of breeding bald eagles. Although bald eagles may have avoided recreation activities either spatially or temporally, productivity was high and relatively stable.

INTRODUCTION

Human activities have been shown to affect wildlife populations in a variety of ways. Bald eagles have been directly affected by pesticides, poisoning, electrocution, and shooting and indirectly affected by various types of human activities that influence the environment (Mathisen 1968, Knight and Knight 1984, Stalmaster 1987, Buehler et al. 1991, McGarigal et al. 1991, Harmata and Oakleaf 1992). Management concerns have initially focused on permanent alterations (e.g., cutting down of nest trees) of bald eagle habitat. However, recent studies have demonstrated the importance of protecting eagle habitat from temporary human activities such as recreation (Stalmaster and Newman 1978, Knight and Knight 1984, Knight et al. 1991, McGarigal et al. 1991, Harmata and Oakleaf 1992). Temporary human activities have influenced behavior of wintering (Stalmaster and Newman 1978, Knight and Knight 1984) and summering bald eagles (Mathisen 1968, Fraser et al. 1985, McGarigal et al. 1991, Harmata and Oakleaf 1992) and have overlapped both spatially and temporally with bald eagle activities in breeding areas (McGarigal et al. 1991, Harmata and Oakleaf 1992).

Plans developed that identify threats and provide management direction and recommendations for population recovery of bald eagles include the *Recovery Plan for the Pacific Bald Eagle* (U. S. Fish and Wildlife Service (USFWS) 1986), A *Bald Eagle Management Plan for the Greater Yellowstone Ecosystem* (Greater Yellowstone

Bald Eagle Working Team (GYEBEWT) 1983), and the *Montana Bald Eagle Management Plan* (Montana Bald Eagle Working Group (MTBEWG) 1986). These plans recommend the monitoring of bald eagle nesting areas to determine productivity and that management plans for nesting areas be developed. Bald eagle use of nesting habitat and responses to human activities vary among populations (Fraser et al. 1985), and management of bald eagle breeding areas should be based on data from each managed population (GYEBEWT 1983, Fraser et al. 1985, MTBEWG 1986). The USFS, Hebgen Lake Ranger District, Gallatin National Forest, initiated research to identify nesting and foraging habitat of individual bald eagle pairs within their jurisdiction to determine affects of recreation activities on breeding bald eagles and to develop management guidelines for the protection of bald eagle nesting habitat.

Bald eagle nest sites have been monitored in the Hebgen Lake area since 1977 by Montana Department of Fish, Wildlife and Parks (MDFWP), USFWS and U. S. Forest Service (USFS) to determine bald eagle productivity, to identify bald eagle nesting and feeding habitat and to identify new bald eagle nest sites. My research began in 1990 and continued through 1992. Study objectives were to:

1. record levels and types of human recreation activities and determine if these activities influence bald eagles' spatial and temporal use patterns;
2. estimate the amount of monitoring effort required to identify a portion of breeding bald eagle pair's home range size;
3. evaluate the use of observation and telemetry monitoring methods in determining summer home range size.

STUDY AREA

The study area was located in southwestern Montana and encompassed Hebgen and Earthquake Lakes and a portion of the Madison River (Figure 1). The Madison Mountain Range lies to the north and south of the lake systems. Topographic relief in this portion of Montana ranges from 1920 m to 3444 m. Annual precipitation between 1982 and 1992 averaged 51 cm and annual snowfall averaged 364 cm. Daily temperatures in the West Yellowstone area between 1982 and 1992 ranged from a mean minimum of 7.6 C to a mean maximum of 10.5 C (U. S. Dept. of Commerce, Weather Bureau). Both lake surfaces are generally frozen from December to May.

Hebgen Dam, an impoundment of the Madison River that created Hebgen Lake, was completed in 1915 to store water for power generation. Hebgen Lake is approximately 27.4 km long and up to 4.8 km wide. It is an oligotrophic reservoir with a surface area of 5261 ha at full pool. Reservoir water levels fluctuate approximately 6 m annually with the lowest levels occurring in the first 2 weeks of May (Montana Power Company 1992). Principle fish species include brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykis*), Utah chub (*Gila atraria*), and mountain whitefish (*Prosopium williamsoni*). Prior to 1979, hatchery rainbow trout were stocked annually in Hebgen Lake (N. Hetrick pers. comm.).

Earthquake Lake was formed on 17 August 1959 after an earthquake created a landslide that blocked the Madison River. Approximately 7 km long, this lake has an

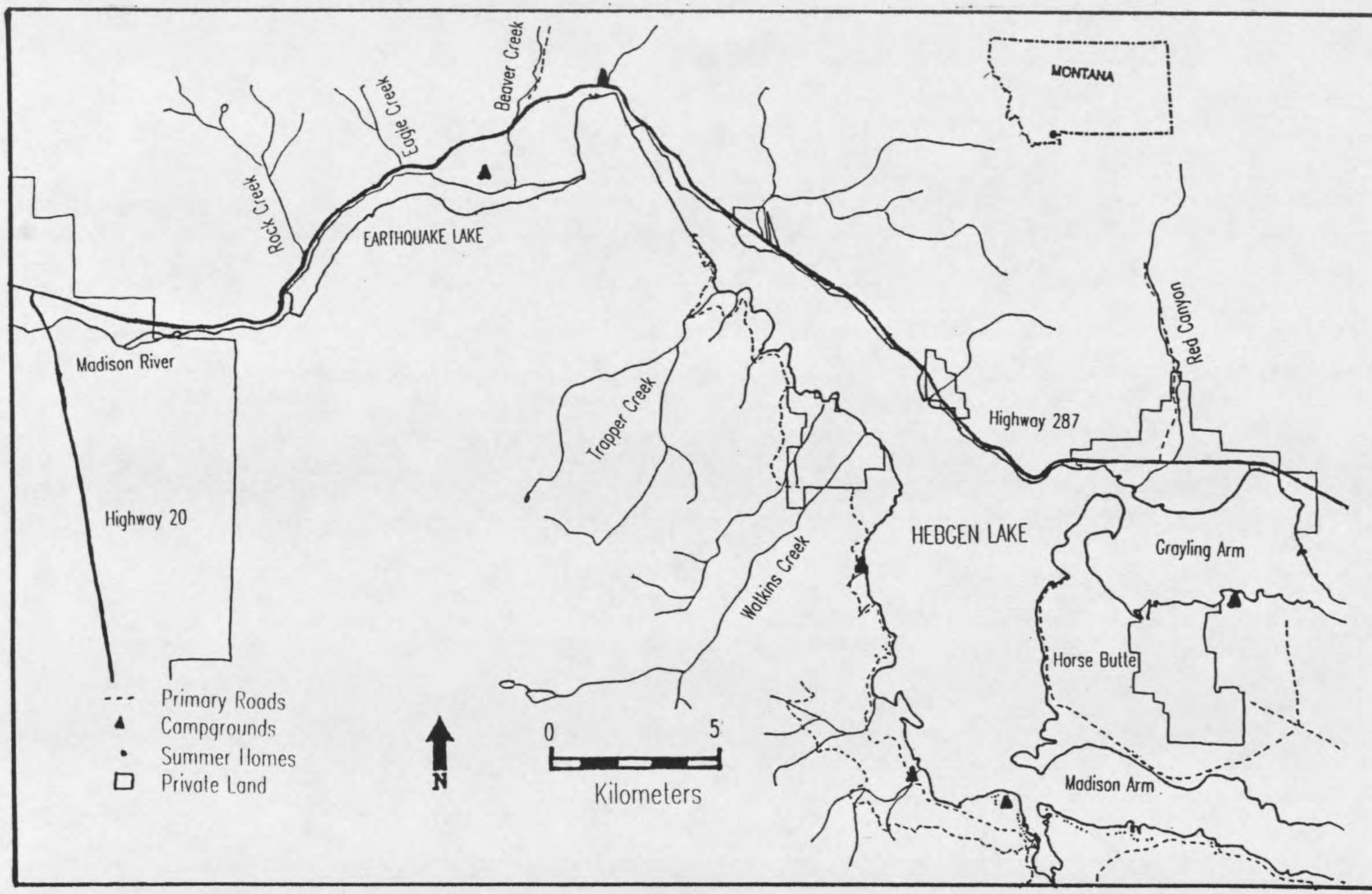

Figure 1. Study area including Hebgen Lake and Earthquake Lake, Gallatin County, Montana.

average width of 0.5 km and is 405 ha in size (Martin and Arneson 1978). Maximum depth is approximately 60 m at the slide. A channel was constructed through the top of the slide resulting in a surface discharge from the lake to the Madison River. Discharge rates are controlled primarily by water release from Hebgen Dam (Martin et al. 1978). MDFWP classifies the Madison River between Hebgen Dam and Three Forks, Montana as a Class I, high quality fishery resource. Principle fish species are brown trout, rainbow trout, mountain whitefish, and mountain sucker (*Catostomus platyrhynchus*).

Vegetation on the study area consists primarily of Douglas fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*) occurring at higher elevations on northern or eastern exposures, spruce (*Picea spp.*), and lodgepole pine (*Pinus contorta*) at lower elevations on southern or western exposures. Valley bottoms consist primarily of grasses and big sagebrush (*Artemesia tridentata*). Quaking aspen (*Populus tremuloides*) occur in mesic sites (Pfister et al. 1977). The study area is characterized by plains and benches rising to steep slopes.

U.S. Highway 287 parallels Hebgen and Earthquake Lakes. Earthquake Lake is partially screened from the highway by topographic relief. However, bald eagle nests are visible from the highway. Vehicle stopping areas, information and viewing areas, picnic areas and parking areas are provided for public use.

Bald eagle nests were located on public lands administered by the USFS, Hebgen Lake Ranger District on the Gallatin National Forest. A multitude of forest roads, private developments and public and private recreation facilities surround

Hebgen Lake. Developments around Earthquake Lake include a small private recreation resort, 2 public campgrounds, a public boat ramp, and 2 access roads. Private homes and a recreation facility border the Madison River. These areas receive peak use in the summer and fall by boaters and fisherman and in winter by snowmobilers. Other recreation activities include water skiing, hiking, camping, hunting, berry picking, cross-country skiing, trapping and horn hunting. Public activities also include logging and cattle grazing along the southwest slopes of Hebgen Lake.

The study area is located in the Greater Yellowstone Ecosystem (GYE) which encompasses southwestern Montana, northwestern Wyoming, and eastern Idaho (Figure 2). The bald eagle population in the GYE is one of the most significant in the Rocky Mountains due to past and present reproductive performance (Swenson et al. 1986, Harmata and Oakleaf 1992). Population trends, production, and densities of breeding bald eagle pairs all indicate a secure population (Harmata and Oakleaf 1992). Three population units have been delineated within the GYE (Alt 1980, Swenson et al. 1986). Nesting bald eagles within the study area lie in the Continental Unit of the GYE (Figure 2).

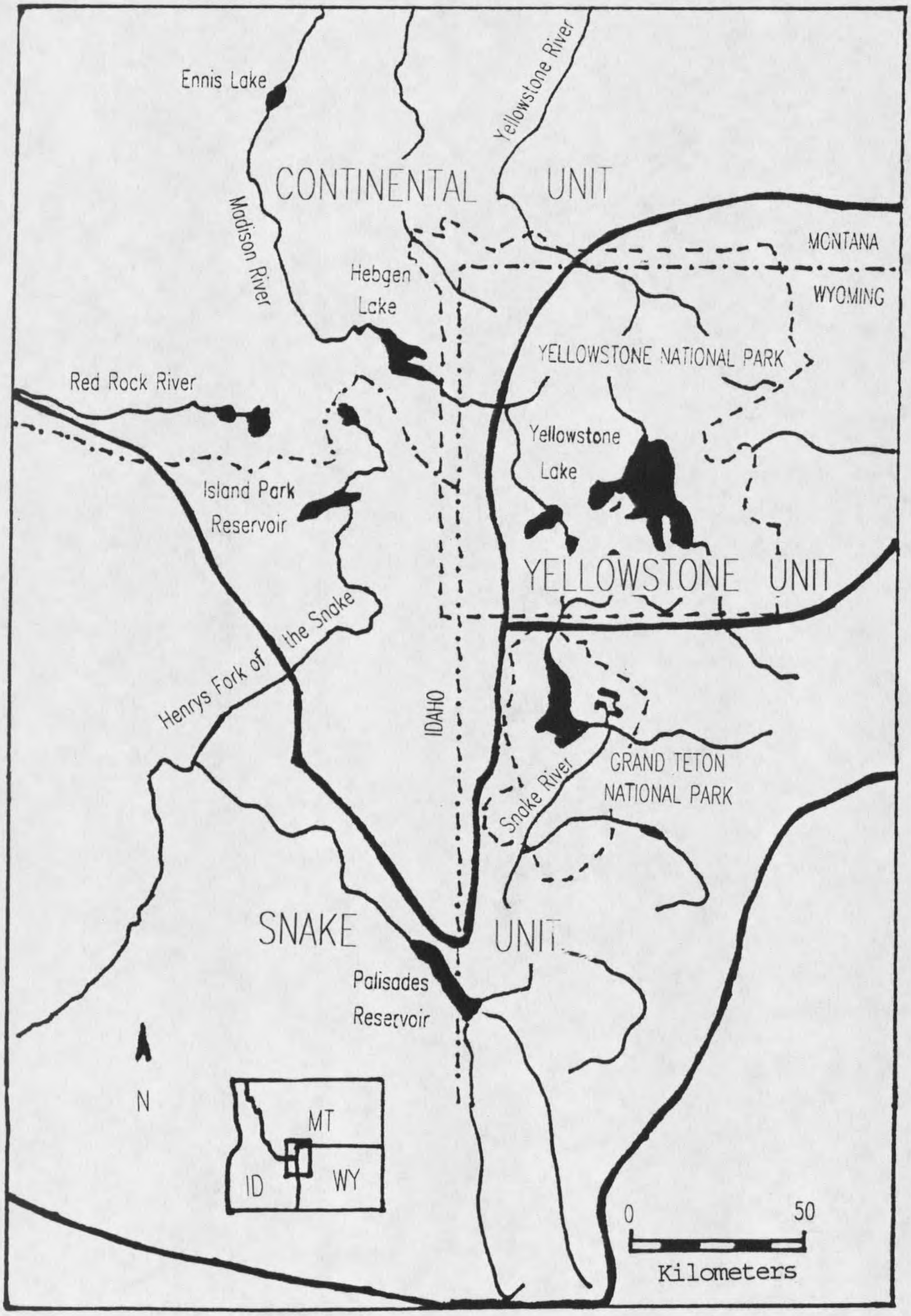

Figure 2. Bald eagle population units within the Greater Yellowstone Ecosystem.

METHODS

Visual Monitoring

USFS employees, volunteers and I observed bald eagle nesting areas from late February to September 1990-1992. Eagles were located using 10x50 and 7x35 binoculars and 15-60x and 20-40x spotting scopes. Monitoring locations were selected to provide maximum visibility of eagle nest activities while avoiding encroachment into Zone I. Zone I is defined as a 400-m radius around a nest site where human activity may cause stress to nesting adults or inattentiveness to eggs or young (GYEBEWT 1983). Data were collected by 1 or 2 observers from observation sites located 500 m to 1.5 km from the nest on upland slopes, from a vehicle positioned on U.S. Highway 287, or from a vehicle along secondary roads. Initial monitoring (1990) was generally by 1 observer and later monitoring (1991-1992) was mostly by 2 observers. When 2 observers were present, 1 person remained stationary while observing the nest area and the other tried to follow eagles in flight. When an adult left the nest area, both adults were visually tracked when possible but priority was given to the adult away from the nest site. Observers used hand held radios to relay information on bald eagle locations.

Visual monitoring of bald eagle pairs was often difficult to complete due to excessive distance, weather conditions and obstructive topography. Eagles would often fly from view and could not be located until returning to the nest area. Therefore, some observations were biased toward the nest area and are so noted in results.

Bald eagle nest attendance, forage attempts, prey deliveries, flight paths, begin and end time of activity, activity location, and description of activity were recorded in narrative style. Foraging attempts were classified as any activity where an eagle obtained (successful foraging) or attempted to obtain (unsuccessful foraging) food and included kleptoparasitism. Because monitoring effort varied for each hour of observation, foraging attempts were standardized on an hourly basis. Foraging attempts were weighted by the formula: $FI = (F_H / M_H) \times 60$ minutes where; FI = forage index, F_H = total number of foraging attempts observed within an hour block ($_H$) and M_H = minutes of monitoring effort within an hour block.

Eagle locations were categorized as nest, perch and preforage locations. A perch was any location, other than the nest, where a bald eagle stood. A preforage location was any bald eagle location occupied immediately prior to a foraging attempt (Harmata and Oakleaf 1992). Perch locations were mapped on 7.5-minute topographic maps and assigned a consecutive letter and number designation. When individual perches could not consistently be identified, a distinguishable area (rock outcrop, tree group, isolated meadow) surrounding the perch was classified as a perch area and given a designation. A nest area location included perches within 50 m of the nest.

Observation periods ranged from 1/2 hour prior to sunrise to 1/2 hour post sunset. Schedules for monitoring were composed by dividing the day into 4 to 6 hour monitoring periods depending on seasonal day length (Harmata and Oakleaf 1992). Observation periods were classified as 0500-1000, 1000-1400, 1400-1800 and 1800-2200 hours. One or 2 monitoring periods were selected for each observation day. Monitoring periods were selected to obtain a representative, even distribution of periods throughout the study (Harmata and Oakleaf 1992). Seasons of observations were defined based on nesting phenology in the GYE: Early nesting =1 March-31 May; Late nesting =1 June-31 July; Post-fledging =1 August-30 September; and Fall =1 October-15 November (Swenson et al. 1986, Harmata and Oakleaf 1992).

Monitoring effort was determined by summing the total time (monitoring time) an observer was engaged in monitoring a site. The time an individual eagle or eagle pair was observed represented actual hours of eagle in view. For example, if 4 hours of monitoring time were accrued, and observers monitored the female bald eagle of a pair for 2 hours and the male for the entire 4 hours, then actual hours of eagle in view would be 6 hours. Potential hours of eagle in view was the total time 2 eagles could have been observed (2 x monitoring time) and is equivalent to 8 hours in the above example. Actual hours of eagle in view were divided by potential hours of eagle in view to calculate the percentage of time that eagle(s) were in view.

Home ranges for adult bald eagle pairs were estimated using the minimum convex polygon method (Mohr 1947) and the computer program TELDAY (Lonner and Burkhalter 1992).

Reproductive performance was determined from nesting activity data between 1983 and 1989 from MDFWP and USFS files. Nest success from 1990 to 1992 was determined during observations for this study. Reproductive terminology follows that proposed by Postupalsky (1974). However, the term breeding area is used instead of the traditional definition of territory (Flath et al. 1991).

Capture

The adult female of the Canyon bald eagle pair was captured on 18 June 1992 using a floating, noosed fish (Jackman et al. 1993, Cain and Hodges 1989). The area actively used by this eagle pair was pre-baited with carrion from April to June, 1992. Scavenging by the Canyon bald eagle pair on bait was not included in foraging results. Sex of the eagle captured was determined from behavior at the nest, relative size and morphological measurements described by Bortolotti (1984) and Garcelon et al. (1985). The bald eagle was banded with a USFWS band and a Telonics 49 gm battery-powered, 148 mHz, tail-mount transmitter was attached to the central retrices (Harmata 1984). Secondary feathers were notched to aid in visual identification.

I located the Canyon female bald eagle by telemetry using a 3-element Yagi directional antenna. Bearings were secured at the initiation of a tracking bout from a vehicle or from a stationary location. Visual monitoring of both adults were included whenever possible. Visual monitoring completed by 2 other observers were compared to radio telemetry observations made by 1 observer. Different monitoring methods occurred on separate days to prevent the location of the radio telemetry observer from influencing visual trackers searching.

Response to Human Activity

Spatial and temporal responses of bald eagles to human activities were recorded for 2 bald eagle breeding areas in 1992. Locations of recreation activities and bald eagles were simultaneously mapped on a copy of a USGS 7.5-minute map by 1 observer from a stationary, designated location, every 10 minutes. Observations were restricted to the observers' field of view and included the nest area. Human activities were divided into 3 categories: watercraft, anglers and float-tubes. Watercraft included motor boats, sail boats, row boats, canoes and kayaks. Anglers were any persons not operating a watercraft and included pedestrians and wading anglers.

Because monitoring effort varied for each hour of observation, recreation activities were standardized on an hourly basis using the formula: $RI = (R_H / P_H) \times 6$ where; RI = recreation index, R_H = total number of recreation activities within an hour block, P_H = number of 10-minute periods that observations were made within an hour block, and 6 represents the total number of 10-minute observation periods within an hour block.

In an effort to determine if eagle perch locations were influenced by locations of recreation activities, distances of use points (perches of eagles) and non-use points (randomly distributed locations) from recreation activities were measured and compared for each observation period and each recreation type. A stratified random sampling method which excluded the nest was used to select points. Use points were randomly selected from each observation period that a recreation activity was present and an eagle was observed perched. To select non-use points randomly, suitable bald eagle perching habitat was subjectively identified based on habitat characteristics that excluded housing and recreation developments along lake shoreline. Shoreline was partitioned into 100-m segments. I calculated the 95% confidence interval of all known perch distances from shore within the specific nesting area to delineate the maximum distance of random points from the water. Thirty use and non-use points were selected within each observation period and within each recreation type. Distances of use and non-use points to the nearest recreation activity that occurred during the same 10-minute interval were measured in 50-m increments.

The relationship between temporal distribution of recreation activities and foraging attempts by bald eagles was assessed by comparing type of coincidental recreation activities and number of foraging attempts per hour period within observation periods.

Data Analysis

Level of rejection for all significance tests was $P \geq 0.05$. Chi-square analyses were used to compare monitoring time and home range sizes to actual hours of eagle