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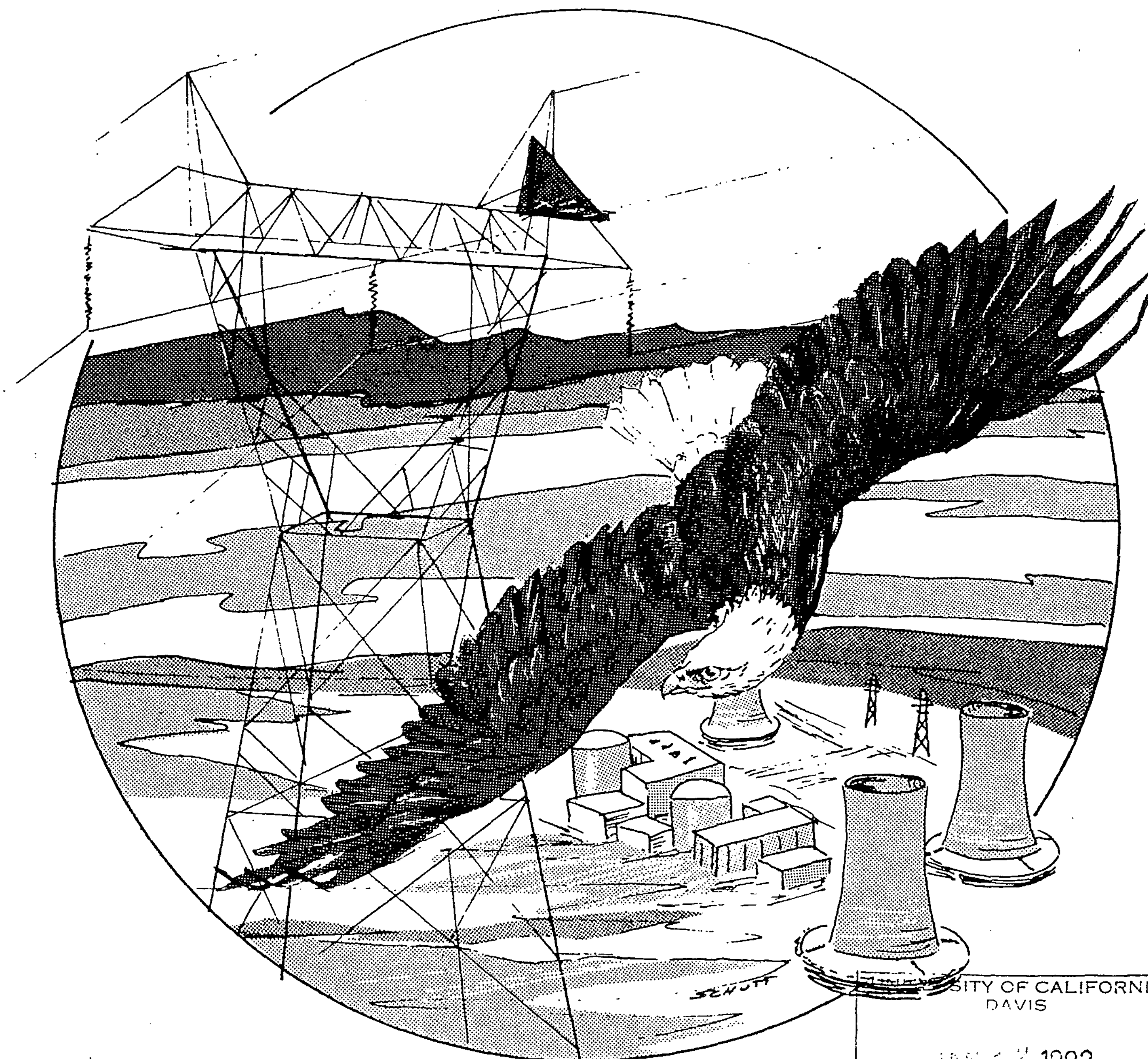
A Workshop on Raptors and Energy Development

Howard, R.P



Presented by THE IDAHO CHAPTER OF THE WILDLIFE SOCIETY, U.S. FISH AND WILDLIFE SERVICE, BONNEVILLE POWER ADMINISTRATION AND THE IDAHO POWER COMPANY.

January 25-26 1980

WORKSHOP ON RAPTORS AND ENERGY DEVELOPMENTS

Richard P. Howard and James F. Gore
Editors

Proceedings of a workshop held
in Boise, Idaho
January 25-26, 1980

Published through the assistance of Bonneville Power Administration, U. S. Fish and Wildlife Service, Idaho Power Company, and the Idaho Chapter of the Wildlife Society.

Cover furnished by Chris Shutt, 1416 Rossi, Boise, ID (208) 345-8079

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INTRODUCTION

Through a fortuitous circumstance, man has provided raptors with perching and nesting structures in the last one hundred years that have proven to be both beneficial and lethal. This massive powergrid found throughout the world runs our society of manufactures and consumers. It is a pandoras box for raptors; depending upon the activity of a particular species. It is expressed by the American kestrel using the powerlines of a rural area for hunting perches. One may see it when the prairie falcon lands on an H pole crossarm during mid-summer, seeks the shade adjacent to the vertical pole, and become concealed from all but the astute observer. It is reflected in the shadow of a golden eagle circling its nest which is located in the latice structure of a 500 kV transmission tower.

In 1972, a group of western utilities, in concert with the Edison Electric Institute, and various State and Federal agencies held a workshop on electrocution problems and raptors. The product of this effort was a cookbook for correcting lethal designs and was titled "Suggested Practices for Raptor Protection on Powerlines".

Since the early '70's, our vision of the positive and negative impacts of a powergrid imposed upon an ecosystem has broadened considerably. We have come to consider the siting of powerplants and utility corridors, including gas and oil, and to develop techniques for integrating these projects with a respect for wildlife.

The following papers, presented at the 1980 meeting of the Idaho Chapter of The Wildlife Society, represent a compendium of information on raptors and energy developments. It is not a definite statement on the subject since many studies are not yet completed. Rather this symposium serves as a midstream review of where we are and what directions we want to explore.

Through the cooperative contributions and services of The Idaho Power Company, the Bonneville Power Administration, and the Idaho Chapter of The Wildlife Society the papers are published under one cover. We wish to thank these organizations for their contributions. Additional copies are available upon request through the U.S. Fish and Wildlife Service, 4620 Overland Road, Boise, Idaho 83705.

Richard P. Howard and James F. Gore
April 1980

POWERLINE ELECTROCUTION OF RAPTORS

By Eric Peacock, U.S. Fish and Wildlife Service,
Boise, Idaho

ABSTACT--Raptor electrocutions probably have been occurring since the existence of powerlines. In 1972 the Division of Wildlife Services was assigned the responsibility within the Fish and Wildlife Service to identify raptor electrocution problems. From this information and the reports received from the public, we initiated field investigations to encourage corrective action by the utility.

Raptor electrocutions probably have been occurring since the existence of powerlines. In recent years some power companieshave implemented corrective action but it was not until May of 1971 when the bald and golden eagles were discovered poisoned in Wyoming that the role of powerlines in causing eagle mortality gained national attention. Significant numbers of birds, mostly golden eagles, were found electro-cuted in Wyoming, Colorado, Idaho and Utah during that time, and subsequent reports indicated that similar problems were occurring throughout most western states.

Following this, representatives of several Interior agencies, the Rural Electrification Administration and the Forest Service met to discuss ways to alleviate raptor electrocution problems. It was agreed that existing powerlines in serious problem areas should be modified to reduce further losses, and that specifications for future line construction should include safeguards against accidental electrocutions.

In 1972 the Division of Wildlife Services was assigned the responsibility within the Fish and Wildlife Service to identify and correlate raptor electrocution problems.

An intensive effort was begun to locate powerlines which were responsible for electrocuting raptors. Assistance was requested from power companies, State and Federal agencies and individuals in the identification of hazardous lines and submission of Raptor Mortality Reprots (See Tables I and II).

From this information and the reports received we initiated and continued field investigation and encouraged corrective action when necessary. All Raptor Mortality forms received by us are recorded and a photocopy sent to the power company involved for corrective action. We try whenever possible to follow up with ground checks or by inquiry as to what modifications, if any, have been made. We have had an excellent cooperation from power companies in general and especially with Idaho Power since they service much of this state and we maintain close contact with them.

There are still many miles of potentially dangerous powerlines in Idaho which have seldom, if ever, been checked for raptor electrocutions. Some segments of these lines span rugged terrain which is difficult and exceedingly time consuming to survey with ground transportation. We have checked lines on foot, on horse back, motor bikes, ATV's, pickups and, when funds permit, with aircraft.

Despite all these efforts we can still only cover a relatively small portion of the state. Most of the progress that has been made in locating hazardous conditions have only been accomplished with the excellent cooperation from many people throughout the state, some of whom are here today. We appreciate this and would like to encourage everyone that is in a position to check lines to keep us or the power companies informed so that necessary modifications can be made in this continuing effort to reduce raptor electrocutions.

TABLE I

REPORTED EAGLE MORTALITY IN IDAHO
1972-1979

Electrocutions	115	
Shot	27	
Other	32	(Excludes Road Kills)
Total Reported	174	
Golden Eagles	123	
Electrocutions	84	
Shot	17	
Other	22	
Bald Eagles	6	
Electrocutions	3	
Shot	1	
Other	2	
Unknown Eagles	4	
Other	4	

Total Eagle Mortality	133
Total Eagle Elec	87
Total Eagles Shot	18

TABLE II

OTHER RAPTOR MORTALITIES REPORTED IN
ASSOCIATION WITH POWERLINES IN IDAHO
1972-1979

Source of Mortality:	Electrocution	Shot	Other	Total
SPECIES				
Red-tailed Hawk	4	2	1	7
Rough-legged Hawk	16	2	1	19
Ferruginous Hawk	1	0	0	1
Swainson Hawk	0	1	0	1
Marsh Hawk	0	1	0	1
Unknown Hawk	3	0	2	5
Osprey	2	0	0	2
Great Horned Owl	2	1	0	3
Turkey Vulture	0	2	0	2
Total	28	9	4	41

HISTORIC OVERVIEW OF RAPTOR-POWERLINE PROBLEMS AND RAPTOR MANAGEMENT PRIORITIES

by Morlan Nelson, Raptor Consultant, Boise, ID

Forty years ago everyon said the major problem was with the golden and bald eagle. The real problem is with the peregrine falcon. In spite of all the shooting, electrocution, and other sources of mortality there are probably more golden eagles today than there were 30 years ago, and bald eagle numbers seem to be returning to former levels in the northwest.

The golden eagle is certainly one of the most successful of raptors in its adaptation to humanity and in its ability to reporduce and make a living under various conditions. The reproductive capacity of the bald eagle and the golden eagle right now is looking better every year. For example, we can now observe pairs of nesting bald eagles on Cascade Reservoir in Idaho and golden eagles nesting in nearly all counties of Idaho. This does not take away from the fact that cooperative work is the end to what we all should be doing.

Idaho Power Company and other utilities in the west have asked for help with electroctuion problems as it relates to raptors. Other companies such as Utah Power and Light, Pacific Power and Light and Bonneville Power Administration have identified similar problems. It is not necessary to discuss all the measures that we have devised to prevent electorcutions. They have been presented here at this meeting as well as overseas. However, the concern and efforts these companies have shown along with Federal and State agencies, and conservation organizations is truly great. We should also compliment the Edison Electric Institute, a united association of public power companies, for their participation and support. Presently, we are in the process of making a ½ hour film supported by Idaho Power, Pacific Power and Light, Utah Power and Light and the Instituite that shows many of the techniques for correcting powerlines electocution problems and the success of nesting platforms.

With respect to nesting platforms on powerpoles, Idaho Power, Pacific Power and Light and the Bonneville Power Administration have been leaders in using this technique for extending the use of habitat by nesting raptors. Some concern has been raised about the effects of radiaiton produced by electrical fields on raptors. In the past 20 years, I have observed raptors nesting on 120,000 to 720,000 volt lines. There exists a pool of data that humanity ought to consider in understanding the affects of radiation. We know of nesting raptors that live right between the wires of a 500,000 volt lines. The birds reproduction and behavior seem normal. In checking with University researchers about chromosome count and the possible effects of radiaiton, they have voiced some concern. We couldn't find a single affect on raptors living in these nests. The need for more definitive study is still there. The Edison Electric Institute is conducting more research on radiation tc determine if there is a difference between birds living in a high radiation environment and those that are not.

When one reads the population studies and looks at raptor densities keep in mind that there is an economic limit that humanity will put on saving birds. For example, Utah Power has 500,000 poles, and 2% of that is 10,000 poles that would need to be corrected. We cannot spend a million dollars to save 10 golden eagles or even 10 bald eagles. Humanity would turn against it. But by identifying real problem areas and correcting them, one can balance out the effects. The concern of humanity has grown so great in recent times for eagles however, that we have over reacted in the protection of the bald and golden eagles. The rate humanity breeds itself out of house and home represents a far bigger problem than what we're talking about here. I don't care what phase of wildlife one talks about, the numbers of people around the workd are the greatest singel factor against wildlife survival in this world. Only by using intelligence knowledge and creating a balanced measure of concern are we going to be able to allow these birds to live with us.

Birds of prey are adaptable to many human activities. Twenty years ago we found a few golden eagles nesting 60 yards above highways and railroads. Incooperative works in the film industry, I observed and trained eagles for falconry. Many lived very close to human activity. For example one lived about 70 yards above the highway; one was 200 yards from a railroad track. They were living close to the activities of people. In the work of the future, in putting up pole lines from coal fired power plants and other energy sources, we are not going to beable to say in every case that one can't do anything within a mile or ¼ mile from every eagle nest. We have all kinds of birds living within 100-150 yards of thes activities. One has to make a separation of individual intelligence and behavior of these birds. Some will live closely with man if left undisturbed. This is why I feel that the nesting platforms on the high power poles are a significant extension of the nesting possibilities for birds of prey in general. We are in the process of placing 40 nesting platforms on Pacific Power and Light Company poles which are made of steel. This line originates at Midpoint, Idaho and terminataes at Medford, Oregon. This will be a valid test of what platforms can do for raptors. We expect to see a variety of raptors use these structures but they are designed primarily for golden eagles.

The problem that I see however does not fit our discussion at all. I think that the talent and the ability that is represented in this room guarantees that the golden eagle and bald eagle will survive. The species that is really in trouble is the peregrine falcon. We can't find a single pair of nesting peregrine falcons in Wyoming, Montana, and Idaho. From two years of work in Oregon with Dr. Clearles Henny, U.S. Fish and Wildlife Service. Research Biologist, we found one active pair out of 41 I knew of 30 years ago. Where is the problem , with the golden or bald eagles, or with the peregrine falcon? Every coastal aerie in Oregon was checked and we could not find a single pair. Northern California does have several active pairs of birds. The idea that I belie that this group could implement is the introduction of peregrine falcons on power poles using nest platforms. There needs to be a whole realignment of our thinking to save these birds.

If humanity is concerned with birds of prey, there should be a maintenance item in the budget of public and private projects that funds the peregrine falcon recovery as well as other endangered species problems. In Oregon and Washington there are about 300 pairs of nesting bald eagles ... is that a threatened species? We can solve the problems of the golden and bald eagle, but we haven't began to solve the problems of the peregrine falcon and many other raptorial species. I propose to this group that the peregrine falcon is spectacular enough to bring about a national concern for reintroductions and the protection not only of birds, but also of mammals, reptiles and plants. I do not have any fear for the future for the big birds of prey, but I have a fear in my heart for the survival of the peregrine falcon.

IMPACTS OF A NUCLEAR ENERGY FACILITY ON RAPTORIAL BIRDS

R. E. Fitzner

February 1980

Prepared for
the U.S. Department of Energy
under Contract EY-76-C-06-1830

Pacific Northwest Laboratory
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IMPACTS OF A NUCLEAR ENERGY FACILITY ON RAPTORIAL BIRDS

INTRODUCTION

This report presents some of the results of a 5-year research study on the nesting ecology of birds of prey and the common raven on the Department of Energy's Hanford Site and discusses the impacts of man's activities and facilities on these birds.

The Hanford Site was established by the U.S. Atomic Energy Commission as a defense materials production facility in 1943. At that time, its 570 square miles were closed to unauthorized human trespass. By 1969, the last of nine production reactors (Figure 1) was retired and the onsite work force was also

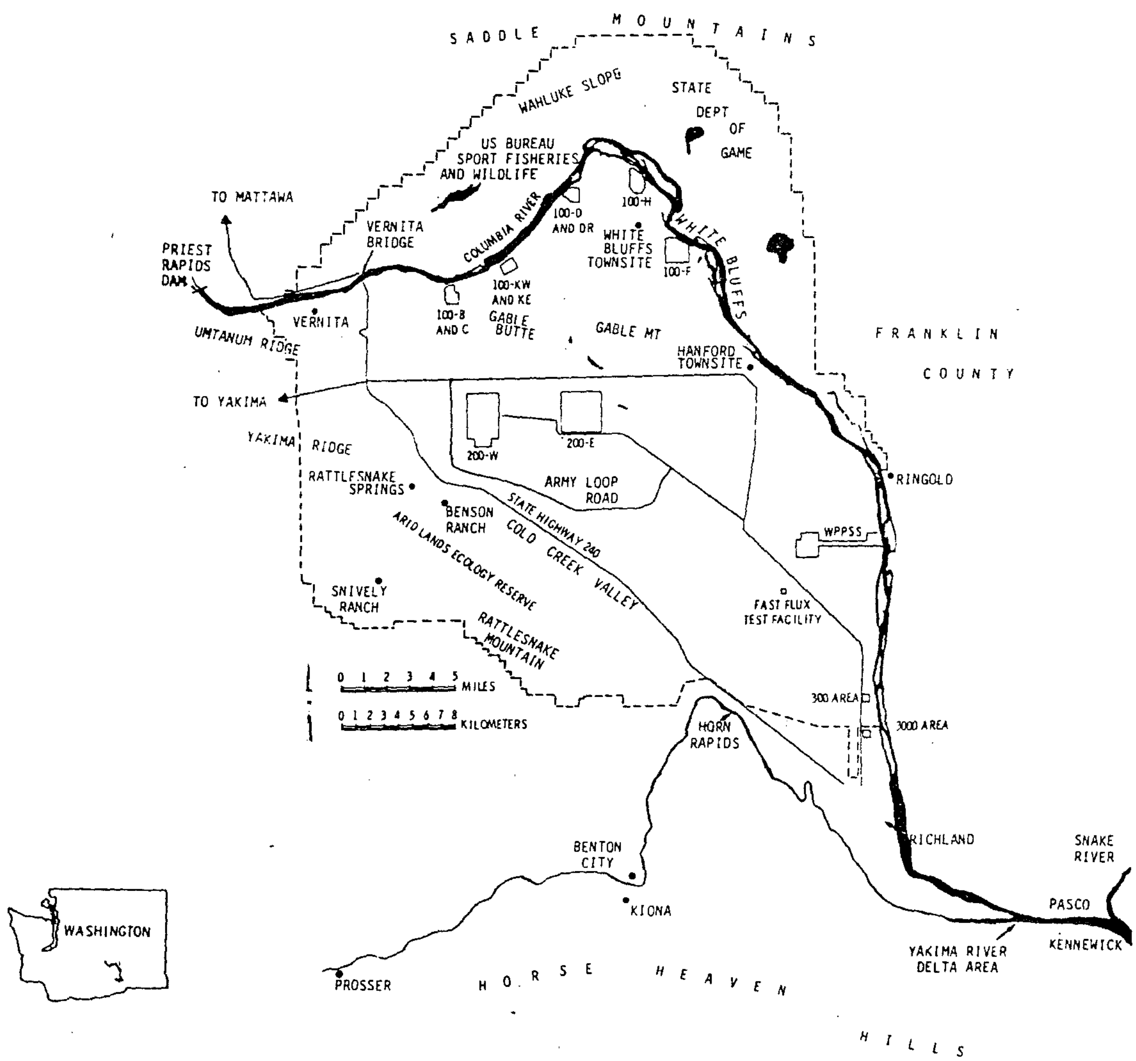

FIGURE 1. The Hanford Site in Southeastern Washington

reduced. The decreased level of human disturbance no doubt benefited wildlife species that were sensitive to man's activities.

In 1974, the Washington Public Power and Supply System began the construction of a nuclear-powered electricity generating plant on the Hanford Site (Figure 1). Construction of two other plants has since begun and the Fast Flux Test Facility for testing nuclear fuels will be completed in the 1980's. These new facilities have associated transmission corridors radiating outward across the landscape which may impact raptorial birds in the future.

We examined the types of raptorial and semi-raptorial birds that use the Hanford environs and discussed the impacts of past operations on their populations. My findings add insight into the population dynamics of the birds of prey community at the Hanford Site and the expected impacts of nuclear energy facilities now under construction. These findings may have implications toward other nuclear and non-nuclear energy facilities, particularly in the grasslands of the western United States.

STUDY AREA

Studies were conducted on the U.S. Department of Energy's Hanford Site from 1973 through 1977.

The Hanford Site lies at the southeastern end of the lower Columbia Basin and consists of approximately 1476 km^2 (147,715 ha) in Benton and Franklin Counties (Figure 1). It is bordered by the Columbia River on the east and the Yakima River to the south. This site was established in 1943 as a national security area and was closed to agriculture, grazing and unofficial travel. In 1968, the Atomic Energy Commission (now DOE) set aside a portion (311 km^2) of the site south of Highway 240 as an ecological study area called the Arid Lands Ecology (ALE) Reserve. During the early 1970's, 12,950 ha north of the Columbia River were leased to the U.S. Fish and Wildlife Service to be known as the Saddle Mountain Refuge. The Washington Department of Game was also given a lease on 21,853 ha to be used for outdoor recreation. In 1977, the Hanford Site was set aside as a National Environmental Research Park by the U.S. Energy Research and Development Administration (now DOE).

The most prominent topographic feature of the site is Rattlesnake Mountain, on the western boundary, which rises to 1100 m above mean sea level. For 5 km, the uniform crest of the mountain is 1100 m high, dropping on its southeastern end to 125 m at the water gap of the Yakima River. Northwest of this large crest, a jumbled topography, much less than 1000 m in elevation, merges with the northwest continuation of the Rattlesnake Hills (Brown 1968). The north slope of the mountain drops steeply (about 25 degrees) onto the ALE Reserve to about 650 m elevation, then eases to 7 degrees down to about 350 m, and finally slopes more gently to Cold Creek Valley at 150 m. North of Cold Creek Valley (150 to 200 m), the land surface rolls gently while rising to about 225 m on the crest of a broad ridge (Rickard et al. 1974). The Saddle Mountains rise in elevation to 925 m to the north. The Rattlesnake Hills and Saddle Mountai are separated by the Columbia River and an expanse of monotonous topograp interrupted by an alignment of basaltic ridges (Gable Mountain and Gable Butt which run east-west near the middle section of the Hanford Site. A series of steep-walled cliffs along the north and east shores of the Columbia, upstream from the old Hanford townsite, form another striking interruption to the site. Unstabilized sand dunes occur as scattered islands of various sizes ranging from 1 ha to several thousand ha. The most extensive dune complex lies along the east bank of the Columbia River opposite Ringold.

The climate of the Hanford Site is strongly influenced by the Cascade Mountain Range to the west, which forms a barrier to moisture-laden winter storms moving eastward from the Pacific Ocean. The resultant moisture-depleted air is warmed and further dried as it descends the eastern slopes of the Cascade Mountains (Thorp and Hinds 1977).

Annual precipitation at the Hanford Meteorological Station averages 16.5 cm, ranging from 7 to 30 cm over the past 30 years (Stone et al. 1972). On the average, 60% of the precipitation occurs between October and February. Precipitation decreases after January but increases again to a secondary maximum in June. The climate of the Hanford Site can thus be described as consisting of hot, dry summers and moderately cold winters. July is the hottest and driest month while January is the wettest and coldest (Thorp and Hinds 1977).

The vegetation of the Hanford Site is mapped in Figure 2. The three major types are the sagebrush (Artemisia tridentata)-bitterbrush (Purshia tridentata)/Cheatgrass type (Bromus tectorum), the sagebrush/bluebunch wheatgrass (Agropyron spicatum) type and the sagebrush/cheatgrass vegetation type (Cline et al. 1977).

The natural vegetation mosaic has been scarred by numerous fires and by past agricultural practices. Abandoned agricultural fields now dominated by cheatgrass and annual mustards are particularly noticeable. Trees appear erratically along both banks of the Columbia River from near shoreline to a few kilometers inland. Most of these trees were planted for shade or orchards by early settlers and were abandoned over 30 years ago with the creation of the Hanford Site. Trees also occur in other isolated spots around the site where they were planted as shade for industrial facilities and military installations, now decommissioned. The Black Locust (Robinia pseudacacia), Cottonwood (Populus sp.), Apricot (Prunus sp.) and Apple (Malus sp.) trees provide for much of the nesting of raptors.

Engineered features: transmission towers, water towers, meterological towers and buildings (pumps houses, reactor buildings, deserted farm houses) are scattered throughout the site.

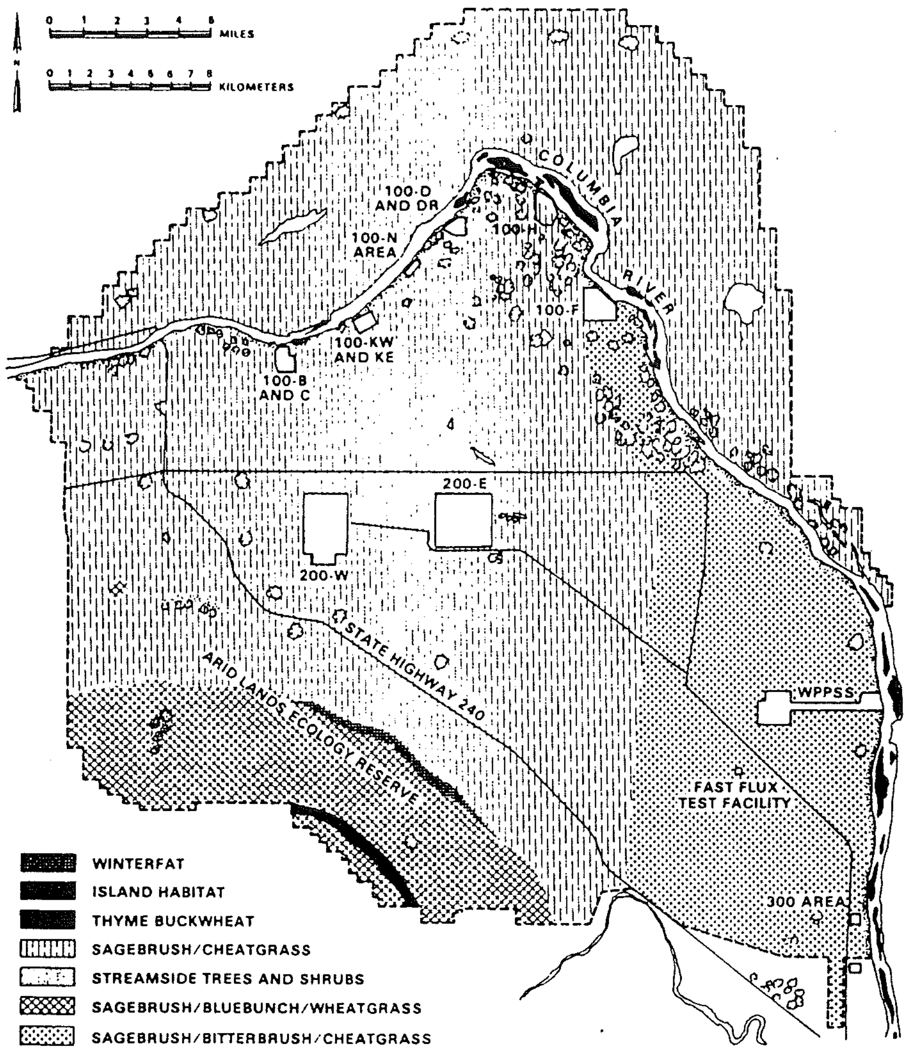

FIGURE 2. Vegetation Types of the Hanford Site

METHODS

This report summarizes data collected from 1973 through 1978. In 1973 and 1974 the entire Hanford Site was carefully surveyed for raptor nesting spots. These two years provided the background information vital to the comprehensive population study of the nesting birds of prey that live and interact together on the Hanford Site. Each year of the study an attempt was made to locate nests of all the raptors and ravens which used the Hanford Site during the breeding season. Considerable effort was also spent in determining the status of nonbreeding pairs and individuals. Certain raptors, notably the marsh hawk, short-eared owl and burrowing owl, presented problems in productivity determinations, as their ground nests were difficult to locate. American kestrels often nested on high inaccessible cliffs or in dead trees and p[illegible] tion data were also not always obtainable. Population density estimates [illegible] these species probably represents the minimum.

During this study an effort was made to cause no unnecessary disturbanc to the birds. The intent of the study was to examine a population under nat ural conditions so as to gain accurate data on behavior and population produ tivity. Once nests were found their locations were mapped and visits were m to nest sites once during each of the following periods: nest building, egg laying and incubation, brood rearing, and post fledging periods. In this wa precise data was gathered on behavior, clutch sizes, hatching success, and fledging success. Some raptor nests could not be reached and hence only dat on fledging success was obtained.

RESULTS

During the four years of intensive field investigation (1975-1978), five owl (strigiformes) species (great horned, long-eared, short-eared, barn, burrowing), five hawk (falconiformes) species (marsh, red-tailed, Swainson's, prairie falcon, American kestrel) and the common raven nested on the Hanford Site. All of these species nested during each four study years.

A total of 12 great horned owl nesting sites were found. No more than 7 pairs of birds were observed during any one year. Fourteen different nest sites were used by long-eared owls with no more than 8 pairs being observed in a given year. Only two pairs of short-eared owls were observed nesting dur[illegible] each year of the study. Four nest sites were observed but never more than two pairs were found nesting. Burrowing owls were the most abundant owl nesting on the site. No fewer than 20 pairs were found nesting during each year of the study. The burrow nest sites of this small raptor were difficult to find and estimates of their breeding density are minimum values. Productivity data are given in Table 1 and yearly summaries of nesting success are presented in Tables 2 through 5.

TABLE 1. Productivity of Owls 1975-1978

	Number Complete Clutches Observed	Average Clutch Size	Range of Clutch Size	Number Young Hatched	Average Number Young Fledged
Great Horned Owl	6	3.0 ± 0.56	2 - 4	2.67 ± 1.09	2.67 ± 1.09
Long-eared Owl	6	4.33 ± 0.21	4 - 5	3.83 ± 0.17	3.33 ± 0.33
Short-eared Owl	0	--	--	--	4 (1 nest)
Barn Owl	0	--	--	--	3.5 (2 nests)
Burrowing Owl	0	--	--	--	5.6 ± 1.0 (5 nests)

TABLE 2. Nesting Population Summary for Owls - 1975

	Number Pairs	Number Nesting Pairs	Number Single Birds	Number Successful Nests
Great Horned Owl	7	5	2	4
Long-eared Owl	4	3	5	3
Short-eared Owl	2	2	0	2
Barn Owl	3	2	2	1
Burrowing Owl	26	26	0	23

TABLE 3. Nesting Population Summary for Owls - 1976

	Number Pairs	Number Nesting Pairs	Number Single Birds	Number Successful Nests
Great Horned Owl	7	5	5	5
Long-eared Owl	8	8	2	8
Short-eared Owl	2	1	1	1
Barn Owl	4	2	1	2
Burrowing Owl	20	20	0	16

TABLE 4. Nesting Population Summary for Owls - 1977

	Number Pairs	Number Nesting Pairs	Number Single Birds	Number Successful Nests
Great Horned Owl	5	5	5	4
Long-eared Owl	8	8	1	8
Short-eared Owl	2	2	0	2
Barn Owl	2	2	1	1
Burrowing Owl	25	25	0	22

TABLE 5. Nesting Population Summary for Owls - 1978

	Number Pairs	Number Nesting Pairs	Number Single Birds	Number Successful Nests
Great Horned Owl	4	3	3	2
Long-eared Owl	8	7	2	6
Short-eared Owl	2	2	0	2
Barn Owl	2	2	0	2
Burrowing Owl	21	20	2	19

Diurnal raptors formed the bulk of the nesting raptor population on the Hanford Site. The two buteo species, red-tailed hawk and Swainson's hawk, dominated the scene. In 1975, 9 pairs of red-tailed hawks displayed a dramatic increase to 16 pairs in 1976 reaching a peak of 25 pairs in 1977. Swainson's hawks remained at nearly the same level, decreasing only slightly to 15 pairs in 1977. No more than 3 pairs of prairie falcons were ever recorded on the Hanford Site. Densities of marsh hawks and American kestrels were only estimated since nests of these species were difficult to find. These estimates, therefore, probably reflect the minimum yearly population levels. Productivity data for the diurnal raptors are provided in Table 6 and yearly summaries of nesting success are given in Tables 7 through 10.

TABLE 6. Productivity of Hawks and the Common Raven 1975-1978

	Number Complete Clutches Observed	Average Clutch Size	Range of Clutch Size	Number Young Hatched	Average Number Young Fledged
Marsh Hawk	2	4	4	4.0	4.0
Red-tailed Hawk	19	2.31 ± 0.205 n = 13	1 - 4	2.07 ± 0.203	1.85 ± 0.231
Swainson's Hawk	39	2.18 ± 0.137	104	1.92 ± 0.153	1.85 ± 0.154
Prairie Falcon	3	4.33 ± 0.333	4 - 5	3.67 ± 0.882	3.00 ± 1.528
American Kestrel	0	---		---	4.0 ± 0.41 n = 4
Raven	9	5.11 ± 0.310	3 - 6	4.89 ± 0.310	4.22 ± 0.430

TABLE 7. Nesting Population Summary for Hawks and the Common Raven - 1975

	Number Pairs	Number Nesting Pairs	Number Single Birds	Number Successful Nests
Marsh Hawk	5	5	-	5
Red-tailed Hawk	9	8	1	8
Swainson's Hawk	17	16	1	13
Prairie Falcon	2	2	0	2
American Kestrel	10	10	-	10
Raven	9	9	-	9

TABLE 8. Nesting Population Summary for Hawks and the Common Raven - 19

	Number Pairs	Number Nesting Pairs	Number Single Birds	Number Successful Nests
Marsh Hawk	5	5	-	5
Red-tailed Hawk	17	15	1	13
Swainson's Hawk	16	14	0	13
Prairie Falcon	2	2	0	1
American Kestrel	10	10	-	10
Raven	10	10	-	10

TABLE 9. Nesting Population Summary for Hawks and the Common Raven - 1977

	Number Pairs	Number Nesting Pairs	Number Single Birds	Number Successful Nests
Marsh Hawk	5	5	-	5
Red-tailed Hawk	25	22	0	19
Swainson's Hawk	15	9	0	9
Prairie Falcon	2	2	0	2
American Kestrel	10	10	-	10
Raven	9	9	-	9

TABLE 10. Nesting Population Summary for Hawks and the Common Raven - 1978

	Number Pairs	Number Nesting Pairs	Number Single Birds	Number Successful Nests
Marsh Hawk	5	5	-	5
Red-tailed Hawk	22	20	1	17
Swainson's Hawk	18	17	1	12
Prairie Falcon	3	3	0	2
American Kestrel	10	10	-	10
Raven	11	11	-	11

Red-tailed hawks displayed the greatest increase in population size over the four-year period, beginning with 19 recorded individuals (9 pair and 1 single bird) in 1975 peaking at 50 in 1977 and slightly dropping to 45 in 1978 (Table 11). This increase was induced by elimination of disturbances from humans during the nesting season. During the early 1970's local power companies removed nests from utility poles and towers on the Hanford Site, believing them to be fire hazards. In 1974 when this policy was discovered by researchers studying Hanford raptors, power company officials were requested to stop the practice, which they did. The result of this decision was a near 3-fold increase in the population of red-tailed hawks within three nesting seasons.

The common raven was recorded nesting on the Hanford Site during all years of the study, with a breeding population low of 9 pairs recorded in 1975 and 1977 and 10 and 11 breeding pairs being recorded in 1976 and 1978 respectively. Non-nesting pairs and single birds were difficult to locate, since these birds did not seem to hold territories as such and freely moved about on and off the Hanford Site. More studies need to be conducted on this species in order to understand its association with the raptorial bird community.

The minimum and maximum sizes of the total raptor breeding population, excluding ravens, varied from a low of 181 individuals in 1975 to a maximum of 205 in 1977 (Table 11). The number of individuals recorded each year were

TABLE 11. Number of Individual Adult Raptors Living on the Hanford Site During the 1975 through 1978 Nesting Seasons

Species	1975	1976	1977	1978
Great Horned Owl	16	19	15	11
Long-eared Owl	13	18	17	18
Short-eared Owl	4	5	4	4
Barn Owl	8	9	5	4
Burrowing Owl	52	40	50	44
Marsh Hawk	10	10	10	10
Red-tailed Hawk	19	35	50	45
Swainson's Hawk	35	32	30	37
Prairie Falcon	4	4	4	6
American Kestrel	20	20	20	20
Total Raptors	181	192	205	199
Total Estimated Biomass in kilograms	107.39	127.38	135.32	130.90
Biomass (kg/km^2)	0.073	0.086	0.092	0.089
Population Densities Individuals/km^2	0.120	0.130	0.140	0.135

fairly constant for most species, however. Great horned and barn owl populations decreased as red-tailed hawk numbers increased. Population data for burrowing owls, marsh hawks and American kestrels should be taken to represent the minimum population sizes for these species because their nests are inherently difficult to find. The population estimates for burrowing owls would indicate then that this species is certainly the most abundant nesting raptor to use the Hanford Site. Three species, great horned owl, red-tailed and Swainson's hawks comprised over 40% of the average yearly raptor population. Of these, the Swainson's hawk faithfully contributed over 15% to the annual breeding population. Red-tailed hawks constituted about 10% of the total population in 1975 but increased to 24% of the population in 1977.

The short-eared and barn owls and prairie falcon were the least abundant of all nesting raptors. Short-eared owls were found nesting only around Benson Ranch (Figure 1) using a habitat dominated by Jim-Hill Mustard (*Sisymbrium altissium*) and cheatgrass. The deep sandy-loam soils in this area received underground percolation of water from Rattlesnake Springs and supported a dense-tall growth of plants. The mustards in this area often exceeded 1 m in height while cheatgrass often approached 0.5 m.

Barn owls nested either in manmade structures (buildings, reactor outflows) or in old magpie nests situated in small groves of trees.

Prairie falcons, occurred only around cliffs, requiring natural cavities nesting. Gable Butte and Umtanum ridge were the only areas used for nesting.

The densities of adult nesting raptors from year to year averaged 0.13 birds per km^2, ranging from a low of 0.12 in 1975 to 0.14 in 1978 (Table 11). When expressed as biomass (kg/km^2) a low of 0.073 kg of adult raptors were present in the nesting season of 1975 and 0.092 kg in 1977 with an average of 0.085 kg. Weights used for calculating biomass of raptors are given in Table 12.

TABLE 12. Body Weights of Raptors Nesting on the Hanford Site

Species	Average Body Weight[a] (g)	Species	Average Body Weight[a] (g)
Great Horned Owl	1505	Marsh Hawk	521
Long-eared Owl	295	Red-tailed Hawk	1126
Short-eared Owl	346	Swainson's Hawk	988
Barn Owl	466	Prairie Falcon	709
Burrowing Owl	170	American Kestrel	114

[a]Weights represent the average for males and females combined (Johnson 1970)

PRODUCTIVITY

Production of young raptors and biomass are presented in Table 13. For the purpose of this report, fledged young weights are assumed to be nearly equal to adult weights. Johnson (1978) states that in some species, fledged young weigh less than adults (short-eared owls) in others they weight more (male red-tailed hawks and perhaps falcons) while in others weight of fledglings can be similar to adults (great horned owls). Since all raptor species are pooled in order to present a picture of total biomass on the Hanford Site, then these estimates of biomass production are likely to be relatively close if fledglings are assumed to be similar in weight to adults.

The combined biomass of fledged young and breeding and non-breeding adults present on the Hanford Site each breeding season from 1975 through 1978 are presented in Table 14. Biomass varied from a low of 145 g/km^2 in 1975 to a high of 177 g/km^2 in 1977. This represents a 10% increase in total biomass. The biomass of young produced in relation to biomass of adults present dropped by 2%, however, over the same time period and dropped by 4% in 1978. The decrease in biomass of young produced per biomass of adults present is a sensitive indication of reproductive performance.

TABLE 13. Number of Young Raptors Produced Each Year (1975 through 1978) on the Hanford Site

Species	Average Adult Weight	1975	1976	1977	1978
Great Horned Owl	1505	11	13	11	5
Long-eared Owl	295	10	27	27	20
Short-eared Owl	346	8	4	8	8
Barn Owl	466	4	7	4	7
Burrowing Owl	170	129	90	123	106
Marsh Hawk	521	20	20	20	20
Red-tailed Hawk	1126	15	24	35	31
Swainson's Hawk	988	24	24	17	22
Prairie Falcon	709	6	3	6	6
American Kestrel	114	40	40	40	40
Total Young Raptors Produced		267	252	291	265
Total Biomass[a] of Young Produced		(105903)	(115319)	(125502)	(113351)
Biomass (kg/km^2)		0.072	0.078	0.085	0.077

[a] Biomass of fledged raptors was calculated by using average adult weights.

TABLE 14. Productivity of Raptorial Birds on the Hanford Site--1975 through 1978.

Year	Biomass of young after fledging (kg/km^2)	Biomass of adults (kg/km^2)	Biomass of adult and young after fledging (kg/km^2)
1975	72	73	145
1976	78	86	164
1977	85	92	177
1978	77	89	166

Olendorff (1973a) studied the ecology of nesting birds of prey in Colorado in 1972, and provides data on productivity of large birds of prey. He found that 252.8 g of adults and fledged young were present per kilometer of his 2,598 km^2 study area. The presence of ferruginous hawks and golden eagles in Olendorff's area may explain the differences in biomass between the Colora[do] and Hanford study sites.

In viewing energy flow in an ecosystem, the total biomass of adults and young is a measure of carrying capacity and trophic level importance of raptors. The low of 145 g/km^2 in 1975 represents a low end of the raptor-carrying capacity while 177 g/km^2 represents a high. This high point resulted from a dramatic increase in red-tailed hawks due to an exploitation of habitats previously unavailable. In this situation, as noted earlier, utility pole nesting had been restricted by a utility company and when the restriction was lifted, red-tailed hawks moved in to use the utility poles as nest sites. Nest sites were clearly a limiting factor for red-tailed hawks. Olendorff (1973b) felt this to be the case on much of the Hanford Site and indicated that by providing nest sites in areas devoid of them, one could substantially increase the total raptor population on the Hanford Site. Even though prey were available for raptors throughout the Hanford environs, raptors were not using the resource because nest sites were not available. Only ground-nesting raptors were able to exploit the prey organisms. The restriction of red-tailed hawks from nesting on utility poles limited their population in that area. This suggests that indeed prey is not the total limiting factor for a predator population. In the case of red-tailed hawks, availability of nest sites appears to be of major importance.

HABITAT SELECTION

The Hanford Site consists of the major shrub-steppe vegetation types sh[own] in Figure 2. These are the sagebrush-bitterbrush/cheatgrass community, the sagebrush/bluebunch wheatgrass community and the sagebrush/cheatgrass community (Cline et al. 1977). Other minor plant associations with limited distribution on the Hanford Site include the winterfat (Ceratoides lanata) community, thyme buckwheat (Eriogonum thymoides), containing a variety of low growing plants characterized by Poa sandbergii, Eriogonum thymoides, and Balsamorhiza rosea; streamside communities containing willows (Salix sp.), Prunus, Amelanchier, Philadelphis, Rhus, and Rosa; and island communities consisting of Lupinus sp., Eriogonum compositum, Achillea millifolium, Artemisia absynthium, and perennial grasses.

A few exotic trees planted for shade about farmsteads and military buildings are still alive and these trees are mostly Chinese elm (Ulmus sibericus), black locust (Robinia pseudacacia), lombary poplar (Populus sp.) and white poplar (Populus albus). Abandoned orchards are scattered throughout the area between old Hanford Townsite and 100D area along the banks of the Columbia River.

Geological and engineered features occur throughout the Hanford Site. Cliff faces occur in Gable Mountain, White Bluffs, Rattlesnake Hills, and Umtanum ridge. Transmission towers, water towers, meterological towers and buildings (pump houses, reactor buildings, deserted farmhouses) are scattered throughout the Site.

Major vegetation types and exotic trees and orchards are shown in Figure 2. The location of the geological features of the Hanford Site are shown in Figure 1. In grouping all raptors and ravens, a 78% utilization of the sagebrush/cheatgrass plant association is noticed (Table 15). The

TABLE 15. Differential Utilization of Plant Associations by Ravens and Nesting Birds of Prey on the Hanford Site - 1978. (percent utilization)

	Sagebrush-Bitterbrush/ Cheatgrass	Sagebrush/bluebunch Wheatgrass	Sagebrush/ Cheatgrass	Native Riparian
Great Horned Owl			71%(5)	29%(2)
Long-eared Owl	14%(1)		43%(3)	43%(3)
Short-eared Owl			100%(2)	
Barn Owl			100%(2)	
Burrowing Owl	24%(5)	10%(2)	66%(14)	
Marsh Hawk		17%(2)	58%(7)	25%(3)
Red-tailed Hawk	5%(1)		95%(21)	
Swainson's Hawk	26%(5)	5%(1)	69%(13)	
Prairie Falcon			100%(3)	
American Kestrel		7%(2)	93%(28)	
Raven	27%(3)	18%(2)	55%(6)	
Total Use	10%	6%	78%	6%

sagebrush-bitterbrush/cheatgrass received the next highest use (10%) while sagebrush/bluebunch wheatgrass and native riparian received six percent utilization. Table 15 provides a breakdown by species and plant associations. At first glance, one would believe that some species clearly have a preference for certain habitats. The long-eared owl, burrowing owl, marsh hawk and Swainson's hawk seem more adaptable than the other breeding raptor species in their use of three plant associations while the barn owl, short-eared owl and prairie falcon seem to be the least adaptable in their use of one plant association. However, examination of the plant assciation use is quite misleading and any assumptions based on it are probably going to be inaccurate. Raptors and the raven, in general, occur where they do, not so much as a result of the species composition of a plant community but because of prey species abundance and presence of adequate nest sites. Table 16 shows the kinds of structures used for nesting as preferred by species. The occurrence of these structures are shown in Figures 3 through 6. If we examine several species of raptors only on the basis of nest structure used, we will notice that they nest in the plant associations which contain suitable nest sites. Great horned owls nest

TABLE 16. Differential Utilization of Nesting Structure by Ravens and of Prey on the Hanford Site--1978. (percent utilization)

	Native Trees	Exotic Trees	Cliffs	Transmission Towers	Buildings	Ground	Water Towers	Crane Derrick
Great Horned Owl	29%(2)	29%(3)	14%(1)	14%(1)	14%(1)			
Long-eared Owl	30%(3)	70%(7)						
Short-eared Owl						100%(2)		
Barn Owl		50%(1)			50%(1)			
Burrowing Owl						100%(21)		
Marsh Hawk						100%(12)		
Red-tailed Hawk		13%(3)	35%(8)	52%(12)				
Swainson's Hawk	6%(1)	94%(17)						
Prairie Falcon			100%(3)					
American Kestrel	7%(2)	56%(15)	33%(9)		4%(1)			
Raven		18%(2)	18%(2)	37%(4)			18%(2)	9%(1)

only in trees, on cliffs or where buildings occur. Long-eared owls nest only in trees, short-eared owls nest on the ground, barn owls nest in trees and buildings, and burrowing owls nest on the ground. Red-tailed hawks often nested in transmission towers, on cliffs and in trees. Their distribution likely was controlled by nesting structure not plant associates. Prairie falcons appear quite limited in their selection of plant associations used for nesting simply because they only nest on cliffs and cliffs only occurred in sagebrush/cheatgrass habitat. During the course of field work, we did notice a close association of several species with particular plant associations, however, and this was probably a result of the availability of suitable nesting structures or substrate. Long-eared and great horned owls, for instance, often nested in riparian areas. These areas contained trees of short stature, unsuitable for supporting the large bulky nest of a buteo, but were able to support magpie nests which served as nest sites for long-eared and great horned owls. Short-eared owls only nested in areas with dense cheatgrass vegetation. Cold Creek Valley near Benson Ranch on the ALE Reserve provided the proper vegetation structure for them. Marsh hawks also nested where dense ground vegetation occurred but utilized a wider range of densities in ground cover.

It would appear that the availability of suitable nesting substrates is of major importance in the distribution of raptors throughout the Hanford Site. Well-planned construction and placement of nest structures in areas where they are presently lacking, would further our understanding of the role of these structures in raptor nest distribution.

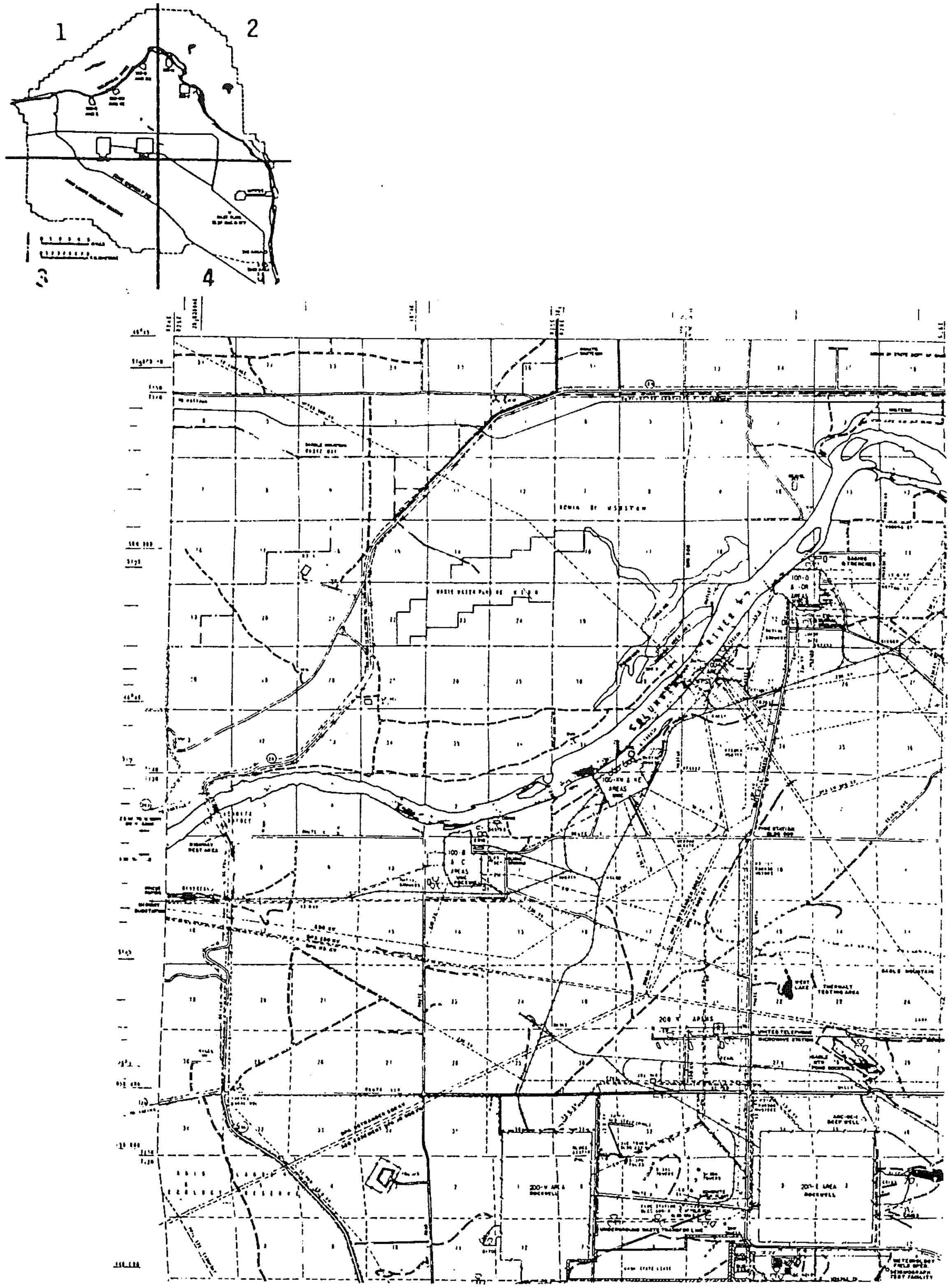

FIGURE 3. Location of Roads and Engineered Features on the Hanford Site, Part 1

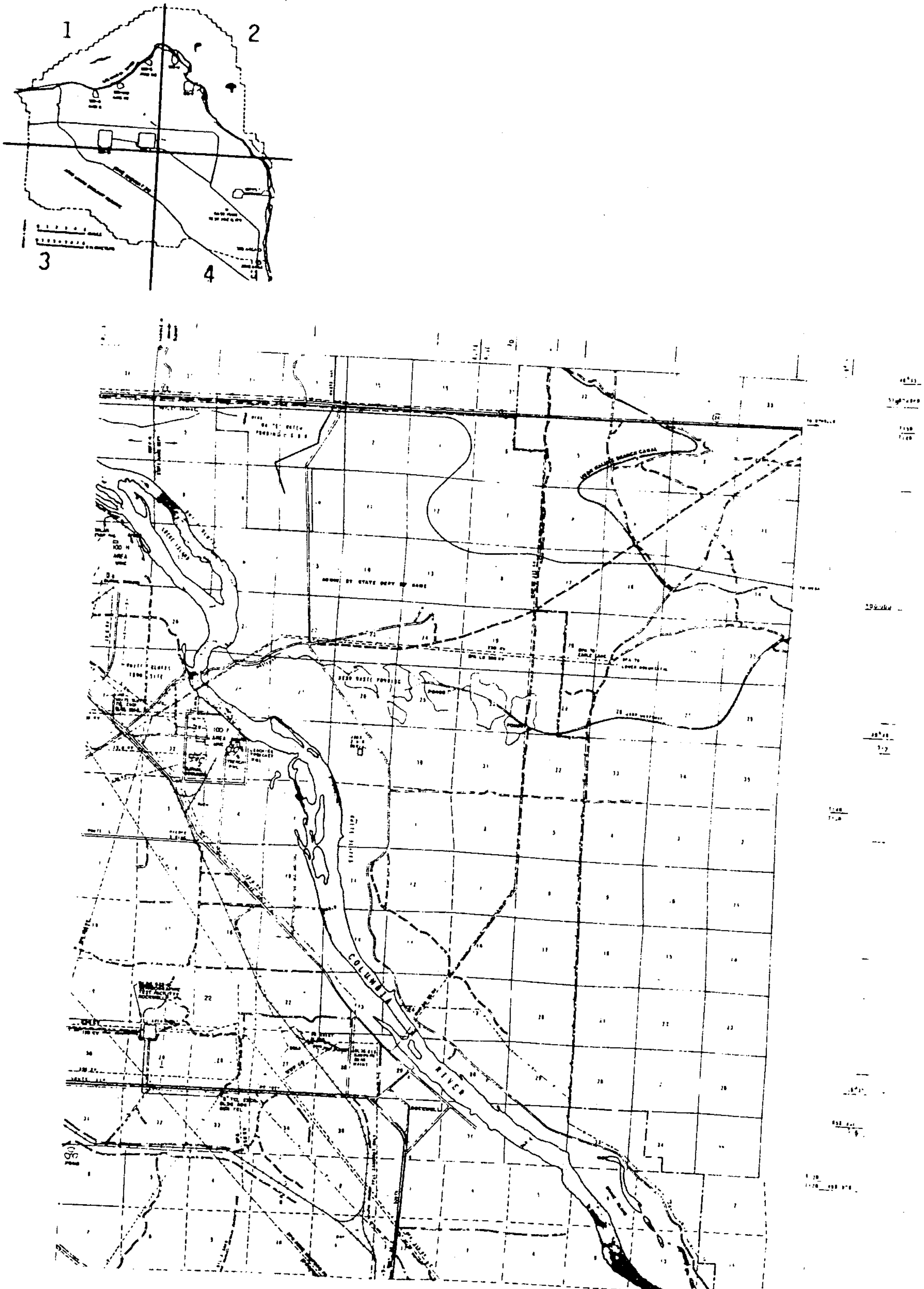

FIGURE 4. Location of Roads and Engineered Features on the Hanford Site, Part 2

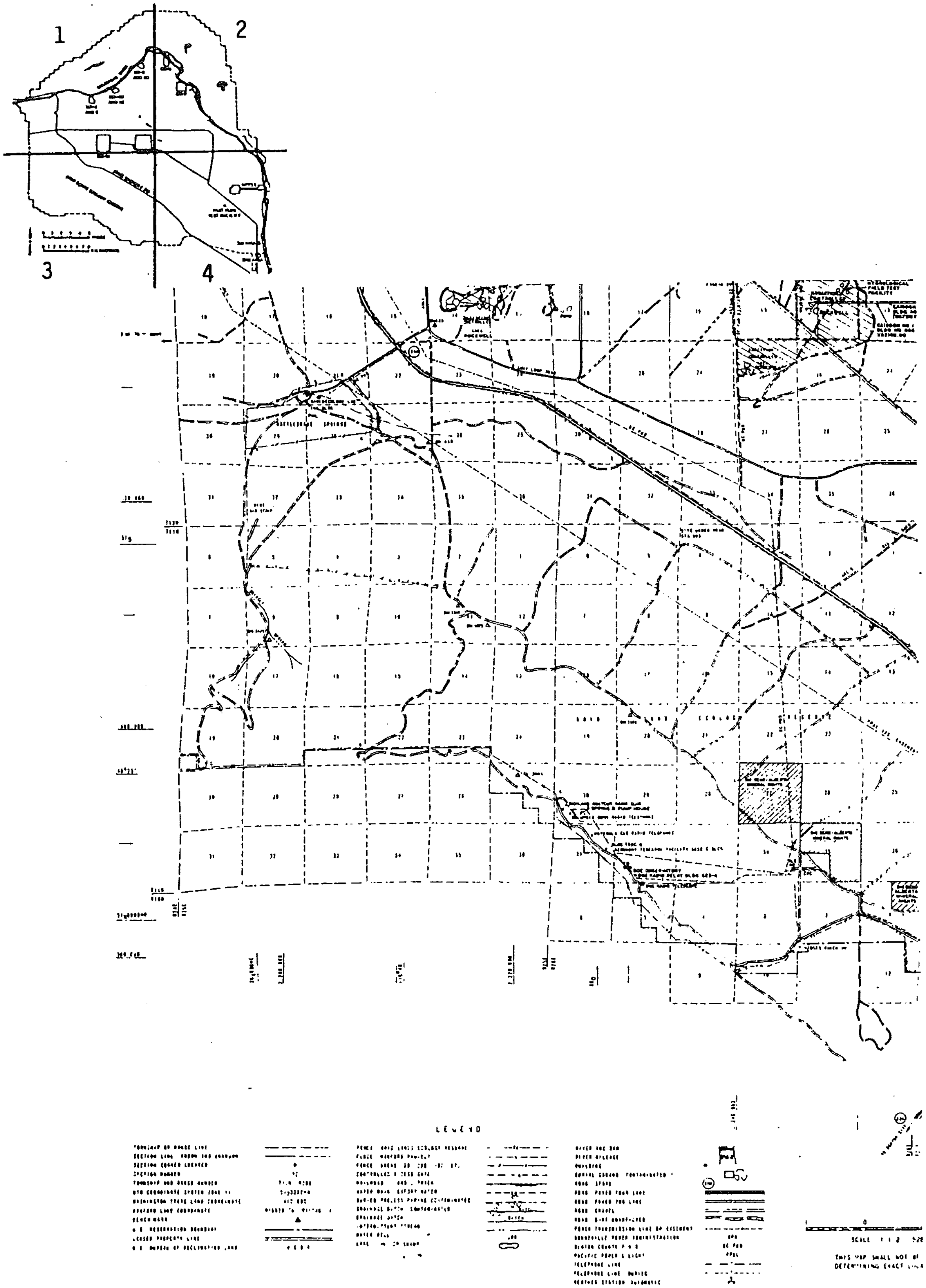

FIGURE 5. Location of Roads and Engineered Features on the Hanford Site, Part 3

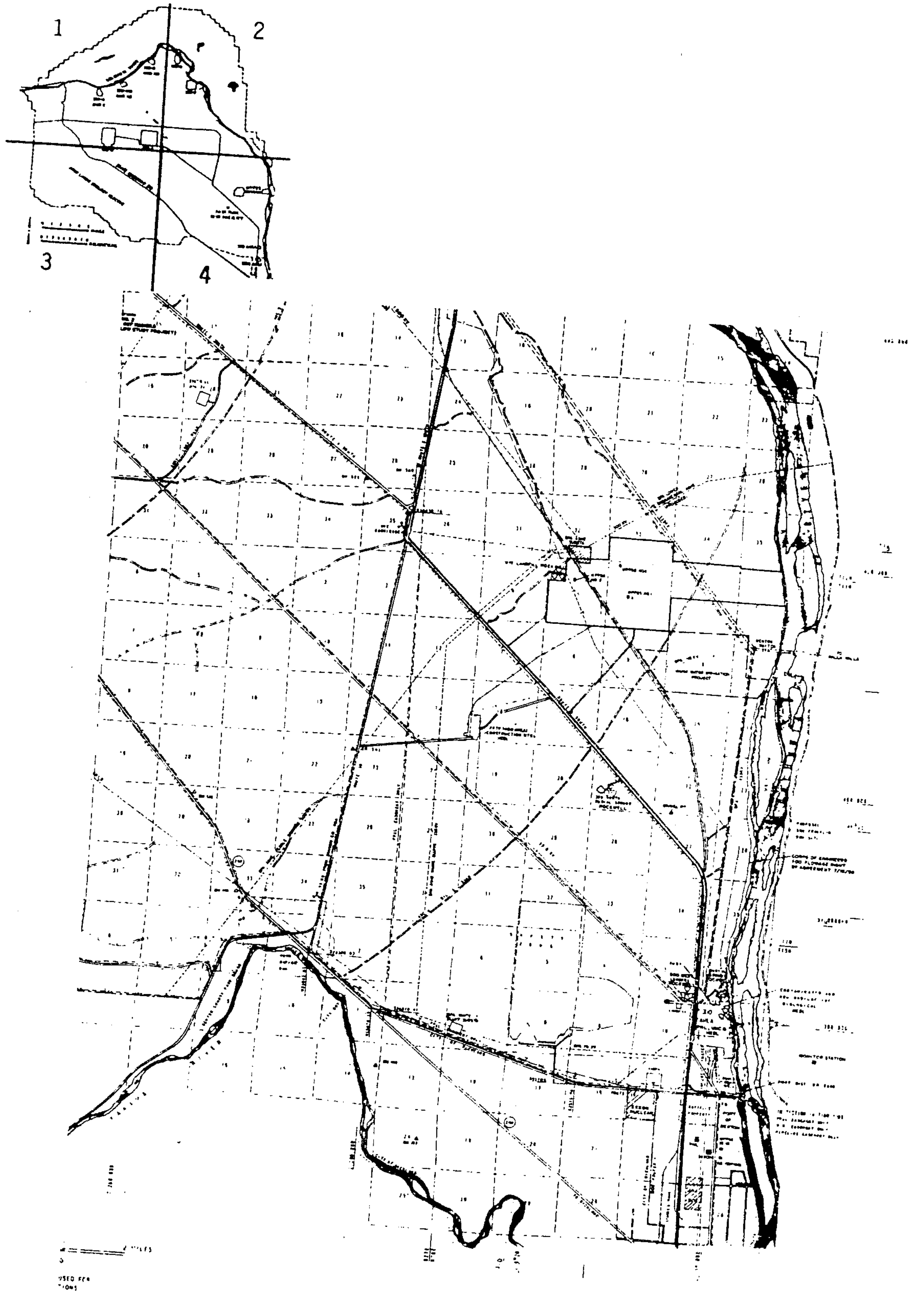

FIGURE 6. Location of Roads and Engineered Features on the Hanford Site, Part 4

DISCUSSION AND CONCLUSIONS

The Hanford Site's past history as a defense materials test facility essentially condoned a refuge status to much of the 1476 km^2 area. The reactor areas (100) and research and processing areas (200) certainly removed some lands from biological productivity but the remainder of the Hanford Site served as a buffer and wildlife sanctuary. Raptorial birds and ravens nested in the buffer zone and flourished in man's near absence. The buffer zones required today around nuclear energy facilities will probably also provide a positive impact on raptorial birds and other wildlife and can be viewed as a side benefit from man's activities. Other land uses (agriculture, urban sprawl) would undoubtedly be more detrimental to raptorial bird nesting.

In order to understand how the raptor population at Hanford is faring, one must have some basis for comparison to other areas of similar size. Howard et al. (1976) summarizes nesting densities in four areas removed from the Hanford Site. They are the Birds of Prey Natural Area (BPNA) in southern Idaho, Bureau of Land Management planning units not associated with the BPNA in southern Idaho, the Pawneee Grasslands in Colorado, and Cedar Valley in Utah. Table 17 summarizes nesting densities in these areas and on the Hanford Site. The BPNA and Cedar Valley are both extremely high density nesting areas which provide near optimum conditions for birds of prey. Both of these areas appear to be dominated by single species, the BPNA by prairie falcons and Cedar Valley by ferruginous hawks. Hence, neither of these areas present an accurate repre-

TABLE 17. Comparative Density of Raptor Nests per 100 km^2 Within the Western United States

Location	Size km^2	Number of Raptor Nests	Number of nests/ 100 km^2
Birds of Prey Natural Area Southern Idaho	252	456	181.0
BLM Lands Southern Idaho	12,437	464	3.7
Pawnee Grasslands, Colorado	2,590	159	6.1
Cedar Valley, Utah	207	35	16.9
Hanford Site, Washington 1975-1978	1,476	85	5.8

sentation of what one would expect a diverse group of raptors to be doing over a large land area of varied topography and habitats. The nesting density found in southern Idaho, the Pawnee Grasslands and at Hanford can be more realistically compared, however, since large land areas with diverse topography and habitats are considered. The Pawnee Grasslands and Hanford Site are particularly suited for comparison since both contain a number of deserted farmsteads and man created nest sites and also provide suitable nesting areas for many of the same raptor species. The Pawnee Grassland is lacking the energy development and work force of people present at Hanford, however, and is probably more representative of the response a nesting raptor population would give in relatively undisturbed western grassland habitats.

The raptor data for the Pawnee Grasslands and southern Idaho provide a crude base for rating the overall health of other large land areas in western grasslands. The BPNA and Cedar Valley are probably more representative of densities we could expect in small, isolated islands of near optimum nesting habitat. Since the Hanford Site is a large land area with heterogenous habitats and topography, one would expect raptor nesting densities to be somewhat similar to the Pawnee Grasslands and southern Idaho. Quite clearly, this is the case. Nesting densities from 1975-1978 averaged 5.8 nests/100 km^2, varying from a low of 5.4 nests/100 km^2 in 1975, 5.6 in 1976, 6.1 in 1977 and 6.0 in 1978. The small degree of variability in nesting density is certainly reflective of a relatively stable raptor population (not homogeneity of species) and when compared to the Pawnee Grasslands and southern Idaho, reveals that the Hanford Site supports a nesting raptor population which is as dense or denser than other large grassland areas in the West which do not support nuclear energy facilities. Long-term monitoring of raptor nesting densities on the Hanford Site and other areas in the West is needed in order to determine future land use impacts on raptors.

Besides preserving native habitat for wildlife, the nuclear energy facility at Hanford has provided artificial nest sites for several birds of prey species. Transmission towers, buildings, water towers and even a crane derrick have been used as nest sites by raptors and ravens. Table 16 reveals that red-tailed hawks, American kestrels, great horned owls, barn owls, and ravens nested in manmade structures associated with the nuclear energy facility. Sixteen of the twenty-two observed nestings by raptors and ravens were in transmission towers. Twelve of these were by red-tailed hawks and the remainder by ravens. Buildings accounted for three nestings, water towers two and a crane derrick for one. Nineteen of the nestings were by red-tailed hawks and ravens combined. Clearly, these two species were most adaptable to artificial nest sites.

The transmission towers utilized by the red-tailed hawks and ravens were of three general configurations (Figure 7). Wooden towers supporting 230 kV lines are about 60 feet high with the cross members intersecting at about 40 feet above ground. Raptors and ravens always nested at the intersection of the cross member.

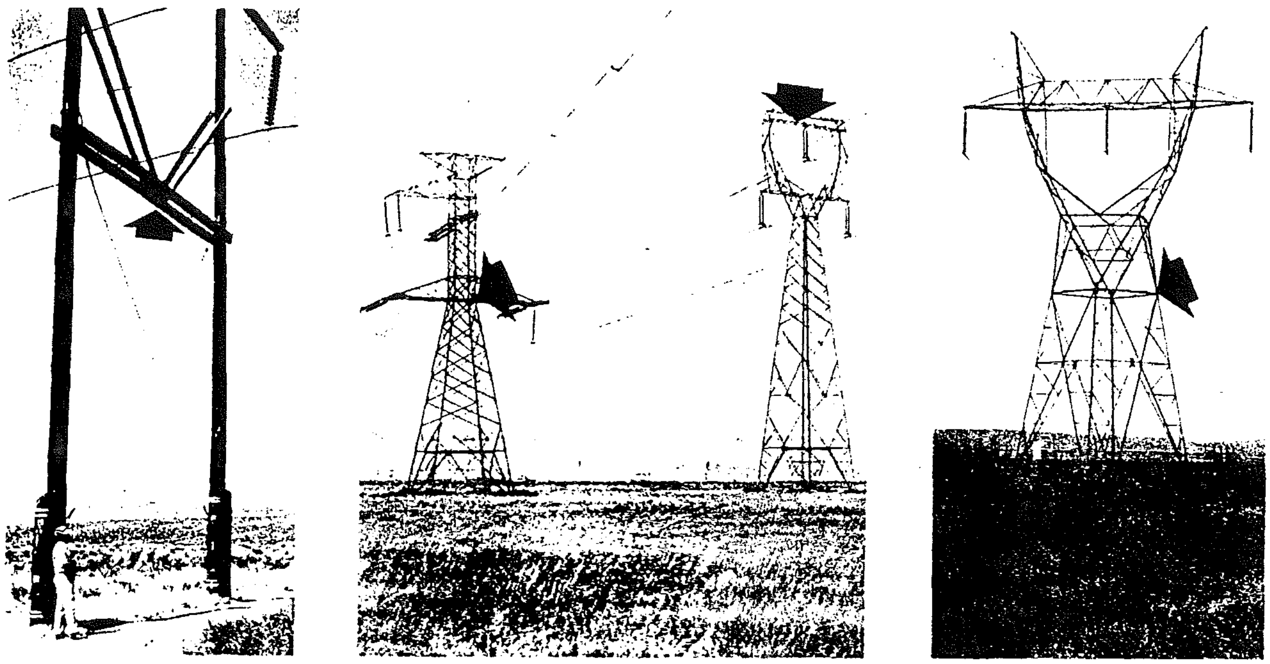

FIGURE 7. Types of Transmission Towers Used for Nesting by Red-Tailed Hawks and Ravens (left to right; 230 kV wooden towers, two 230 kV metal towers, 500 kV metal tower). Arrows indicate usual nest sites.

The other two types are of metal construction. One is a 230 kV line, while the other is 500 kV. Red-tailed hawks and great horned owls were the only species observed to nest in the 230 kV towers with nests generally being situated at corners at 2nd supports, over 30 feet above ground. Ravens and red-tailed hawks were found nesting in the 500 kV towers. Nests were situated in two different locations in these structures (center, Figure 7).

One raven nest was also associated with a substation and was built on the ledge of a support tower. Two ravens were observed nesting in water towers (left, Figure 8) and one raven even nested in the derrick of a moveable crane. This particular nest was subjected to frequent disturbance, as the crane was used daily for digging sanitary landfill trenches. The crane was moved finally, late in the incubation period, and the pair of nesting ravens flew along side of the crane and stayed with it until it stopped some 12 miles away. The nest was eventually destroyed by humans and the birds left.

One pair of barn owls were known to faithfully nest in the 100 H area pumphouse on the shore of the Columbia River while a pair of great horned owls nested on the reactor building in the 100 D area. Both of these nest sites were hidden from human view. A pair of American kestrels nested in a roof drain spout in the abandoned schoolhouse at Hanford Townsite.

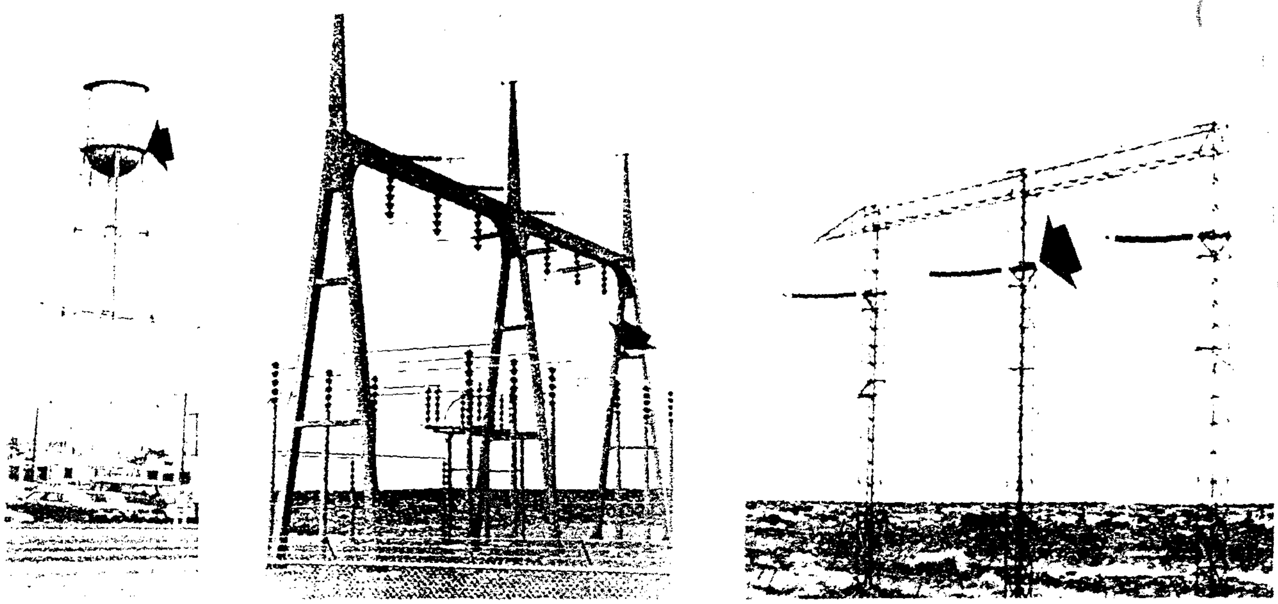

FIGURE 8. Man-made structures used for nest sites (left to right, water tower, substation tower, 230 kV transmission tower). Arrows indicate usual nest sites.

In the utilization of manmade structures as nest sites, the raven appeared to be the least selective. They nested in the wooden 230 kV and metal 500 kV towers, a substation tower (center, Figure 8), water towers and a crane derrick. These different nest sites ranged in their degrees of exposure to the elements. The transmission towers provided little protection, while water towers provided complete overhead protection. Great horned owls nested in a transmission tower nest previously built by a red-tailed hawk (right, Figure 8) and on a building with protection overhead and on one side. Barn owls nested in a near cave like situation and the kestrel nested in a cavity. The red-tailed hawks only nested on transmission towers but were able to nest in three types of towers. There was an apparent disassociation of red-tails with any enclosed or semi-enclosed nest sites. All red-tail nest sites had a commanding view of the surrounding landscape. Red-tailed hawk nests in towers were built at a height of over 30 feet above ground.

Raptors on the Hanford Site in 1978 that did not use manmade structures for nest sites were the marsh hawk, prairie falcon, Swainson's hawk, long-eared owl, short-eared owl, and burrowing owl. A pair of Swainson's hawks had been recorded nesting in the wooden 230 kV transmission tower (Fitzner 1978) but tree nests were the general rule.

Elsewhere, other researchers have recorded ospreys, golden and bald eagles, and ferruginous hawks (Call 1979) nesting on transmission towers.

Considerations

What does all of this mean? First: clearly, there are a number of raptorial and semi-raptorial birds that do use transmission towers and other manmade structures associated with energy facilities for nest sites. On the other hand, several species very rarely nest in manmade structures. Artificial nesting structures at the Hanford Nuclear facility may have benefited some species, particularly the red-tailed hawk but may not have had any significant effect on other nesting raptor species. By favoring certain species, artificial nests may even have had a negative impact on some raptors. Consider, for instance, the possible impact of placing a transmission tower within an area with known nesting tenacity for a pair of Swainson's hawks. Red-tailed hawks being earlier nesters than Swainson's could build a nest in the tower and effectively exclude the Swainson's. Likewise, a building with daylight protection for great horned owls would certainly have a negative impact on many other raptorial birds nesting nearby. A Swainson's hawk nest observed by Fitzner (1978) near the 100 D area had two fledgling birds preyed on by a pair of great horned owls nesting on a building at the 100 D area.

In considering the forementioned aspects of nest site segregation resulting from manmade nest sites, I suggest that we try to create a variety of different nesting options which would provide an equal opportunity for nesting of those raptors which typically nest within the impact area of any planned energy facility. Striking a balance of different species which manifest differing behavioral and physiological needs should be a goal of a raptor management program. Endangered and rare species certainly deserve consideration but only in regards to their overall relationship to the total raptor community and to how they might have historically fit into the raptorial bird community of the area.

The management considerations which follow, are intended primarily for the raptors of the Western Grasslands of the United States. Several of the nesting structures outlined could be used in other parts of the United States but consideration for a differing set of raptor species would be in order.

First, there are principally four major natural nesting situations in Western Grasslands: 1) ground or underground nests, 2) cavity nests, 3) cliff faces, 4) trees.

Ground nesting species include marsh hawks, burrowing owls and short-eared owls. These birds could best be managed by preserving natural vegetative cover at energy facilities. Known nesting areas should be bypassed during construction and operation practices. Artificial nesting structures for other raptor species should be used with discretion in areas already being used by ground nesters. Species such as barn owls and American kestrels may be compatible nesters with ground nesting species and management practices (nest boxes) could be utilized to promote nesting in areas being used by ground nesters.

One ground nesting species, the burrowing owl, could be managed at energy facilities by creating artificial burrows. Collins and Landry (1977) describe a wooden tunnel and nest box which when buried provides a suitable nest site for burrowing owls.

Cavity nesters, barn owls and American kestrels, could be inticed to ne on transmission towers and on buildings or other manmade structures through the use of nest boxes. Hamerstrom et al. (1973) discuss the successful use c nest boxes for kestrels and I have observed wood duck nest boxes being used b barn owls.

Cliff nesting species, prairie falcons, red-tailed hawks, ferruginous hawks, great horned owls and ravens may nest on buildings, but human disturbances at active energy facilities would probably negate any chances for nesting on buildings. Transmission towers could be equipped with artificial nesting structures which simulate a cliff nest site. Imprinting of some young birds to these structures may be necessary in order to establish some species, particularly prairie and peregrin falcons, as regular nesters in a given area.

Many of the raptor species and raven which often nest in trees have adapted well to nesting in transmission towers. Red-tailed hawks, ferruginous hawks, ospreys, golden eagles, great horned owls, and ravens have been recorded nesting in transmission towers of one type or another (Gilmer and Wiehe 1977, Call 1979). The placement of artificial nests in towers has already been tried and there is an apparent preference to nest in towers equipped with artificial nests over those not so equipped (Call 1979). Tree-nesting raptors seldom recorded nesting in transmission towers in Western U.S. are the Swainson's hawk (Fitzner 1978) and long-eared owl (Call 1979).

In examining parameters influencing nest site selection by these specie we may be able to increase their use of artificial nests in transmission towers. For instance, research conducted by Fitzner (1978) reveals that most Swainson's hawks nest close to the ground in small trees that customarily are not used by red-tails. Perhaps by placing manmade nests at lower elevations in towers, we may be able to encourage Swainson's hawks to regularly nest in transmission towers.

In summary, the long-term ecological studies of the birds of prey at the Hanford Site reveal that: 1) A wide variety of raptorial birds and the raven nests on the site primarily due to the no-trespass policies and buffer zone requirements at a nuclear energy facility. 2) Several raptor species and ravens have adapted to nesting on or in manmade structures, particularly transmission towers. 3) Artificial nest sites appear to be preferred by only a select group of birds and thus may be causing an increase in these few species, having no impact on some, and negatively impacting others. The negative impacts could result when species preferring artificial structures move into an area already being used for nesting by those species not preferring artificial structures. 4) Management of raptors and ravens at energy facilities should consider the overall natural species makeup of the raptor community in the impact area and manmade structures should be equipped with a variety of artificial nests suitable as nest sites for these raptors. Care must be taken not to disturb or alter naturally existing raptor nest sites.

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A STUDY OF LARGE RAPTOR ELECTROCUTION AND POWERPOLE UTILIZATION IN SIX WESTERN STATES

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ABSTRACT.--In an attempt to determine the ecological factors influencing the majority of raptor electrocution mortalities in the West, data from 24 five mile sections of powerline were collected. Soil and vegetation types, topographic relief, weather patterns and prey base were all considered to isolate the ecological types where the problem most often occurred. Human disturbance both active and passive were considered, attempting to eliminate bias due to shooting. Age was determined, when possible, to assess the impacts upon breeding and subadult populations. Construction and power output of the poles were measured to determine the safest types avialable for use. These data will hopefully be used by power companies and state and federal management agencies to determine modification needs and the most practical solutions to eliminate raptor electrocutions.

"In early 1972 a group of Western utilities with the assistance of the Edison Electric Institute, coordinated a workshop with various federal and state agencies and other interested groups to study the problems associated with raptor electrocution occurring on powerlines. It was determined that grounding practices on distribution and transmission lines from 4kV through 69kV along the certain configurations of transformer banks, fused cutouts, lightning arresters and conductor phase spacings could be a substantial cause of raptor deaths. Subsequent studies have proved that the solution to the problem lies more with engineering expertise than with a biological approach." (Miller, *et al.*, 1975).

Although the solution to raptor electrocution does greatly involve engineering aspects, certain biological criteria must be utilized to pinpoint specific types of habitat and environmental factors which are conducive to either potential danger or beneficial use by raptors in a given area. Much of the information collected to date concerning the effects of powerlines on raptor populations is extremely limited and most has little statistical data to give a complete and accurate analysis of the problem. This study was designed to accumulate and analyze data on the beneficial and detrimental effects of electrical power structures, particularly distribution lines in areas of raptor use.

The objectives of this study were 1) determine the significance of various environmental factors on powerpole utilization and electrocutions (i.e. soil types, vegetative types, prey base, wind direction, etc.) i an attempt to establish criteria for necessary changes in powerpole design, 2) analyze significance of high nesting density to electrocution mortality rates, 3) analyze hunting and wintering territorial effects on electrocution mortality rates, 4) gather data on the use of powerpoles by raptors for hunting perches and nesting structures, 5) provide data on the apparent impact on breeding populations with a reduced recruitment potential, 6) provide data and suggest impact on migrant populations.

There is a baseline of data on raptors in the areas designated. This includes data from: 1) The Birds of Prey Natural Area, Snake River, Idaho; 2) Bald Eagle wintering area, west central Utah; 3) B.L.M. Raptor Nesting Survey, northern and central Utah; 4) inventory of Golden Eagle nests in Elko County, Nevada. Data are available on existing transmission and distribution powerlines in most of the study area allowing for easy determination of possible areas of raptor contact. That a raptor electrocution problem does exist has been determined by observations and work conducted by Idaho Power Company with the assistance of Morlan W. Nelson, Boise, Idaho. Utah Power and Light has reported Golden Eagle electrocutions in several areas serviced by the company. Two such areas are a distribution line between Tooele, Utah and Vernon, Utah and a 46kV transmission line in the Milford-Beaver, Utah area. This researcher in June of 1974 discovered 37 Golden Eagles and a Short-eared Owl dead under a distribution line located southwest of Delta, Utah. The distance in which these birds were discovered represents approximately 12 miles of line. Beyond the 12 mile distance a definate change in topography and soils occurred as well as a disappearance of raptor mortalities. A variety of ecotypes occur throughout the study area allowing for a comparison and analysis of many biological factors significant to the utilization of powerpoles by raptors.

"In 1973 over 300 incidents of eagle electrocution were reported in the United States." (Nelson, 1974). Although these numbers are high and may be significantly higher it appears that the majority of these mortalities occur on a very small minority of the power structures therefore eliminating the need to modify all poles. Nelson stated the count of electrocuted birds indicated that approximately 98% are subadult. This problem would add to the already high mortality rate which young raptors appear to experience. Because of the relatively large populations of raptors in the Western states and a large number of potentially dangerous powerlines present in these areas the electroction problem is a significant factor in raptor mortality particularly of Golden Eagles. Since various pole configurations are used for different voltage lines only those lines of less than 69kV present a significant electrocution problem. Some of these lines represent smaller transmission lines but the majority represent distribution lines.

This study attempted to locate and isolate the significant problem areas. Though only a small percentage of distribution lines are involved in the electrocution problem, 100% of the unmodified poles should be considered potentially dangerous due to configuration. Factors including altitude, soil and vegetative types, prey base density and prevailing winds can be used to elimiate most of the poles and establish a relative danger factor to the birds in a specific area.

During the entire year of 1978, the first two months of 1979 and the summers of 1977 and 1979, data were collected from 24 distribution powerlines in Idaho, Oregon, Wyoming, Utah, Nevada and New Mexico. Data were classified in the following catagories; vegetation, prey base, raptor density, raptor mortality, age class of electrocuted birds, season birds were electrocuted, topography, altitude, prevailing winds, nearest roads, powerline configuration and power output.

TOTAL RAPTOR MORTALITIES

SPECIES	NUMBER	PERCENTAGE
GOLDEN EAGLE *Aquila chrysaetos*	336	81.16
RAVEN *Corvus corax*	14	3.38
RED-TAILED HAWK *Buteo jamaicensis*	9	2.17
ROUGH-LEGGED HAWK *Buteo lagopus*	8	1.93
FERRUGINOUS HAWK *Buteo regalis*	4	.97
SWAINSON'S HAWK *Buteo swainsoni*	2	.48
UNKNOWN BUTEO	32	7.73
BUTEO TOTAL	55	13.28
PRAIRIE FALCON *Falco mexicanus*	3	.72
GREAT HORNED OWL *Bubo bubo*	2	.48
MARSH HAWK *Circus cyaneus*	1	.24
GREAT BLUE HERON *Ardea herodias*	3	.72
TOTAL [illegible]	[illegible]	100.00

TOTAL		414	100.00

RAPTOR MORTALITIES BY STATE AND LINE

STATE	LINE	NUMBER	PERCENTAGE
IDAHO	HAMER	67	16.18
	KIMAMA	18	4.35
	HOLBROOK	13	3.14
	ROGERSON	4	.97
	SALMON FALLS	1	.24
		TOTAL 103	TOTAL 24.88
NEVADA-OREGON	JORDON VALLEY	24	5.80
	PARADISE VALLEY	8	1.93
	DENIO	5	1.21
		TOTAL 37	TOTAL 8.94
NEW MEXICO	MAGDALENA I	20	4.83
	GIST	8	1.93
	MAGDALENA II	2	.48
		TOTAL 30	TOTAL 7.25
UTAH	VERNON	51	12.32
	SEVIER	19	4.59
	BERYL	15	3.62
	CRICKET	14	3.38
	DUGWAY	9	2.17
		TOTAL 108	26.09
WYOMING	NEIBER DOME	42	10.14
	BLACK MOUNTAIN	25	6.04
	COTTONWOOD	21	5.07
	SEEDSKADEE	16	3.86
	GREEN RIVER	13	3.14
	VOLLMAN-REYNALDS	9	2.17
	VOLLMAN-SOUTH	7	1.69
	LA BARGE	3	.72
		TOTAL 136	TOTAL 32.85

OBSERVED LIVING GOLDEN EAGLES SEPARATED BY AGE

N=183

ADULT	SUBADULT/IMMATURE
32%	68%
(59)	(124)

GOLDEN EAGLE MORTALITIES SEPARATED BY AGE

N=60

ADULT	SUBADULT/IMMATURE
5%	95%
(3)	(57)

RAPTOR MORTALITIES SEPARATED BY TIME PERIODS

GOLDEN EAGLES
N=23

DECEMBER-FEBRUARY	MARCH-MAY	JUNE-AUGUST	SEPTEMBER-NOVEMBER
65.22% (15)	17.39% (4)	4.35% (1)	13.04% (3)

OTHER RAPTORS
N=16

DECEMBER-FEBRUARY	MARCH-MAY	JUNE-AUGUST	SEPTEMBER-NOVEMBER
25.00% (4)	62.50% (10)	12.50% (2)	0.0% (0)

RAPTORS AND THE BPA TRANSMISSION SYSTEM

by Jack M. Lee, Jr., Bonneville Power Administration, Portland, Oregon

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ABSTRACT.--The use of powerline structures by raptors is one of the more visible effects of these lines on wildlife. Because of this visibility and because birds may affect the reliable operation of the lines, the raptor/powerline association has been studied for many years.

INTRODUCTION

Much of the early study was by power company personnel who were interested primarily in reducing power outages caused by birds. Some of these early efforts were recounted by Dickinson (1957) and Benton (1954). Considerable work has also been done on the subject of raptor electrocutions (Miller et al. 1975).

Raptors have received attention from Bonneville Power Administration (BPA) personnel for a number of years. BPA is the agency within the U.S. Department of Energy responsible for marketing power generated by Federal hydroelectric dams in the Pacific Northwest. BPA began building transmission lines in 1938 and today the agency operates approximately 20,000 km of transmission lines. This includes 5520 km and 115-kV lines, 5430 km of 230 kV, 4648 km of 500 kV, and 425 km of ±400 kV d-c line. BPA operates a few 34.5 kV and 69 kV lines but problems with bird electrocutions have not developed.

In this paper I will briefly discuss BPA maintenance policy regarding birds and powerlines, and present some preliminary results from our raptor nesting study.

MAINTENANCE CONSIDERATIONS

Until the last few years, BPA had no overall maintenance policy dealing with the handling of large bird nests in transmission structures. It was left primarily to individual maintenance crews to determine whether such nests should be removed. Through the years many nests were probably destroyed when they were thought to pose a hazard to operation of the transmission line.

Some maintenance personnel, however, noticed that simply removing the nests did not always solve the problem. Birds were observed to repeatedly attempt to renest after the original nest was removed. Not only was it costly to have linemen keep removing nests, but additional problems were posed by the nesting material continually being brought in by the birds. Long sticks, string, or wire that hang or fall near conductors can cause power outages. Studies done in BPA's high voltage laboratory also indicate that a stream of excrement from a large bird may also cause such outages (West et al. 1971).

In an attempt to reduce problems caused by raptors, in the late 1960's BPA lineman Earle Hoaglin began experimenting with moving problem nests rather than tearing them down. In most cases this consisted of moving nests located over insulators and conductors to another location on the transmission tower. In many cases birds returned to use the relocated nests.

Another attempt at reducing "unexplained" power outages was the installation of "bird guards" beginning in 1971. The guards were actually short pieces of large diameter stranded wire, unravelled so the many stiff wire strands stuck out. These "metal porcupines" were placed over insulators on about 248 km of 500-kV lines having a history of outages to discourage raptors from perching or nesting. The guards were not effective in reducing outages and their use was discontinued in 1978. Some raptors have built nests on the bird guards. BPA engineers now believe most unexplained momentary outages are not caused by birds (Ed Johnson, personal communication). More likely they are caused by light, moist contamination on insulators coupled with certain atmospheric and line loading conditions.

In 1977 a BPA Transmission Maintenance Standard on bird nests was adopted. The standard directed that nests on transmission structures over insulators be moved to another location on the structure. The nests were not to be removed or destroyed.

RAPTOR NESTING STUDY

Helicopter Patrol Surveys

In addition to our studies of how raptors affect transmission lines, we are also interested in how these lines affect raptors and other birds. In 1976 we began systematically recording the locations of all nests observed on BPA transmission structures. Much data in the survey were obtained during routine helicopter line patrols. In addition to noting such things as broken insulators, the helicopter observers note the locations of nests each year during spring and summer patrols. The observers were given assistance in raptor identification and forms were developed for recording nest information.

Table 1 shows the results of the first year of the raptor nesting survey. Figure 1 shows the BPA transmission system covered in the survey. Most nests were observed on 500-kV lines in range or cropland. Highest nesting concentrations were on lines in central Washington and northcentral Oregon. Most nests were 2 or more kilometers apart. In one location in central Washington, however, there were three active red-tailed hawk nests within a 1.5 km section of 500-kV line. Only five nests were reported for lines in the forested areas of western Oregon and Washington. Almost all osprey nests were on lines in northern Idaho and western Montana. In contrast to lines in other areas of the west, we have documented only one active golden eagle nest (Aquila chrysaetos), on BPA lines during the survey. This nest is located on the ±400-kV Celilo-Sylmar line in south central Oregon.

One of the most interesting nesting occurrences identified during the survey involved a Canada goose (Branta canadenis) and an osprey (Pandion haliaetus) nesting in the same 230-kV transmission tower (Fig. 2). This particular tower is located in the Clark Fork River in Montana. In 1977 the two nests were occupied by ospreys. In 1978 a Canada goose nested in the top nest (38 m above the river) and osprey were in the lower nest. In 1979 a goose was on the lower nest (with six eggs) and osprey were in the upper nest. Unfortunately we were not able to obtain information on the outcome of these nestings.

Special Helicopter Surveys

We have flown some special nesting surveys to obtain data on productivity of nests located on transmission towers. To conduct the survey we fly a Bell Jet Ranger helicopter approximately 15 m above the line at about 90-130 km/hour. When a nest is observed, we circle the tower and attempt to determine if there are young birds or eggs in the nest.

This method, of course, is not as accurate as climbing the towers but it is much faster. In recent years we have used a 35 mm camera with motor drive, 300 mm telephoto lens, automatic exposure, and ASA 400 film, to photograph each nest. Examination of the 35 mm color slides aids greatly in identifying nest contents. Data from the slides indicate observations with the unaided eye or even with binoculars from the helicopter, often results in an underestimate of the number of birds or eggs in a nest.

Table 2 gives results of two special nesting surveys flown in central Washington in 1978 and 1979. Most young red-tailed hawks (Buteo jamaicensis) observed appeared to be between 1-3 weeks of age. As shown in Table 2, average young per active hawk nest ranged between 1.86 to 2.57. Luttich et al. (1971) reported that for tree-nesting red-tailed hawks in Alberta, "minimum hatch" averaged 1.9/nest and for 3-4 week old birds, the average was 1.7/nest. Cliff-nesting red-tailed hawks along the Snake River in Idaho had a mean brood size at hatching of 2.86 young/nest (BLM 1979). To date, we have not obtained information on average number of birds fledged per nest.

Most birds observed on towers during the surveys appeared very tolerant of the helicopter. As an example, in one of our surveys of lines in central Oregon, of the 41 birds seen perched or nesting on towers, 76 percent of them remained on the tower as the helicopter passed by. Almost all raptors seen on nests with young or eggs remained on the nest even when the helicopter circles. On a few occasions, however, red-tailed hawks have attempted to attack the helicopter as it approached.

Raptor Nest Platforms

Another part of our raptor study involves the installation of artificial nesting platforms for raptors. We have installed five platforms to date. They are of the design developed by Morlan Nelson and the Idaho Power Company (Nelson and Nelson 1976) (Fig. 3). Morlan was a consultant to BPA on this project. The platforms were constructed of plywood and covered wth fiberglass. The two high sides on the platforms act as a sun and wind shade.

The first four platforms were installed in the spring of 1977. The fifth was installed in March 1978. Table 3 summarizes location and use information for the five platforms. The platforms on the 115-kV line near Kalispell, Montana is the only one that has been used every year since it was installed. A large osprey nest had occupied the structure near Kalispell for a number of years prior to the platform being installed. The old nest was approximately 1.8 m in diameter, weighed around 200 kg and was located over the center insulator string. A portion of the nest was placed in the platform and the platform was moved from directly over the insulators. It is hoped this arrangement will allow the osprey to continue nesting on the structure without adversely affecting operation of the line.

We had planned to install up to five additional nesting platforms during 1979. We experienced delays in getting the platforms built and they were not available prior to the nesting season. These latest platforms are constructed almost entirely out of fiberglass. We want to evaluate cost, installation, and durability aspects of these platforms compared to the plywood/fiberglass type used previously. The plywood/fiberglass platforms cost approximately $265 each to construct. Costs to design the methods for attaching the platforms to the tower ranged up to over $1,000. This upper cost involved replacing tower parts on a steel tower 500-kV line. In contrast, installation consisted of simply bolting the platform to the crossarm of an "H frame" wood pole structure. Installation of the platforms required a minimum crew of 3-4 linemen and took from 2 to 4 hours to complete.

Electric Field and Audible Noise Studies

Another reason for our raptor study is that we wanted to obtain data on birds living in relatively close proximity to energized conductors. Considerable interest has developed in recent years about the biologic effects of electric and magnetic fields (BSTT 1978). Birds nesting or perching in towers are exposed to much higher fields compared to fields occurring near ground level. In addition, audible noise due to corona is greater in the tower at conductor height. We have discussed various aspects of these subjects in previous papers (Lee and Griffith 1978, Lee 1978, and Lee et al., 1979).

Most research done on electric field effects has been in laboratory settings where field strength can be controlled. Studies have included effects of electric fields on adult birds (Graves et al. 1977) and young (Krueger et al. 1972, Giarola and Krueger 1974). Some of the studies have conflicting results. Based on a recent review of the literature on this subject (CBEELFR 1977), it appears unlikely that electric and magnetic fields of the strength as found at most locations in transmission line towers pose any biological hazard to birds. It should be pointed out, however, that relating laboratory studies to conditions in a transmission tower is difficult. This is because determining field strengths within towers can be complicated. Tower parts distort the electric field and most field strength meters are designed primarily to measure in a uniform field, i.e., on the ground beneath the line. The tower parts can also greatly shield the electric field from a bird nesting or perched on a tower.

A bird would be exposed to the maximum field in situations where there is no tower parts between the birds and the conductor. For BPA towers a "worst case" situation occurs in 500-kV single circuit delta towers, directly beneath the center phase (Fig. 4). This is sometimes called the "tower throat". We have measured electric field levels of around 40 kV/m at such locations. At most other locations on such a tower, however, the field was approximately 5 kV/m or less. In comparison the maximum electric field near the ground beneath the line would be 8-9 kV/m. The magnetic field in a tower is generally less than 0.5 Gauss. This is the approximate magnitude of the earth's d-c magnetic field.

To date, we have found only a few birds nesting in the maximum field area of BPA 500-kV lines. Whether this is due to the fields or to other factors is not clear. Figure 4 shows the locations of nests observed in 500-kV towers during a nesting survey. Most nests were in the tower bridge, directly under the overhead groundwire support structure (position A). Ellis et al. (1978) reported most raven and red-tailed hawks they found on a 230-kV line in Sonora, Mexico were also located in this same position. Martial eagles (Polemaetus bellicosus) in South Africa also most commonly nested near the groundwire support structure on steel transmission towers (Dean 1975). Dean (1975) pointed out that few eagle nests were located in the tower throat area (position D in Fig. 4). That position, however, most closely corresponded to typical tree nesting sites for the eagle. Note that in Figure 4 only one nest was observed in the tower throat area. This was a red-tailed hawk nest with three young estimated to be approximately 2 weeks old.

Twenty-one days after the above mentioned survey, Morlan Nelson a I returned to observe the nest that was in the high electric field. O plan was to remove one of the young for study and to mark the other tw When we returned, however, there was only one young bird in the nest. The fate of its nestmates is not known. Although both adults were stil in the immediate vicinity, there were no prey remains in the nest. In Morlan's judgment, the young bird remaining in the nest was suffering from malnutrition possibly due to a low prey base in the immediate area

We decided that Morlan should take the one remaining bird and care for it in an effort to identify any effects that may have been related to exposure to the electric field. The measured field at the nest location was 15 kV/m and the calculated field was 16 kV/m.

The young hawk grew well in captivity and appeared outwardly healthy. Morlan observed only one thing that could be considered abnorma in the young bird. This consisted of slight misalignment of feathers in the first and second primaries of both wings. This did not appear to cause any problems in flying, however.

During 1979 no nesting occurred on the tower where the young hawk was removed the previous year. Red-tailed hawks did nest on the next tower west of the tower that had the nest in 1978. The new nest was not located in the tower throat area.

DISCUSSION

Although raptors can create problems to the reliable operation of transmission lines, such problems can be minimized by preventing nesting directly over insulators. In most cases this can be accomplished by simply moving the nests a short distance. With problems minimized, transmission towers can provide good perching and nesting sites for raptors. As would be expected, the most noticeable use of transmission towers by raptors occurs in areas devoid of natural perching or nesting sites. However, use of lines in such areas by raptors is spotty.

In addition to habitat type, raptor use of transmission towers probably depends on raptor distribution, prey base, and tower type. This latter factor can be especially important. For example, a wood pole "H frame" structure that has two square wooden crossarms makes a fine nest base. The same kind of structure with a single round crossarm provides a very poor base and few, if any, nests are observed on these structures.

One of the original goals in our study was to estimate the total annual raptor production occurring in nests on BPA transmission towers. This has proven to be a difficult estimate to make. One problem is that during regular helicopter line patrols, it is not possible to get complete data on each nest. Some nests are also missed because attention of the observers may be directed at inspecting a defective tower part.

Data collected during helicopter line patrol surveys is valuable in assessing general distribution of raptor nesting concentrations. Unusual nesting situations can also be identified by these surveys. Special surveys can then be flown of areas of particular interest to obtain specific information.

I believe another benefit of the raptor surveys and the raptor studies in general is the involvement that occurs by the personnel connected with the studies. In our program, helicopter crews patrolling areas where nesting on the lines occur, show a high degree of interest in collecting data for the study. Likewise, other personnel involved in various aspects of our raptor program probably develop a greater sense of environmental awareness. For many, working with "the birds" adds variety to their job. As a biologist, I have also gained a better understanding of the jobs performed by fellow utility workers and a better appreciation of the problems they must deal with. Biologists from other agencies have also participated in our nesting surveys.

The studies at BPA, Idaho Power Company, and elsewhere do show that a variety of raptor species will use artificial nest platforms placed on transmission line structures. Some such platforms can be costly to construct and install. However, benefits in terms of reduced line maintenance costs and use by raptors will accrue over many years.

I doubt if nest platforms are necessary on most steel tower lines. Steel lattice towers inherently provide an abundance of nesting sites. Problems with wind blowing the nests down can be lessened by tying the nests to the tower. We have used timelapse movie cameras to document that nesting birds take advantage of shade from steel tower parts as they do in nest platforms. Platforms are probably most useful on wood pole structures that provide less suitable nesting bases. A variety of platform types are possible from simple wood frames, to the "deluxe" model developed by Morlan Nelson and Idaho Power. Compatibility of the platform with the mechanical and electrical aspects of the transmission tower should be a major consideration. Platforms should also be located at the proper height to be attractive to raptors (Stahlecker 1979).

Although I have concentrated primarily on positive effects in this paper, powerlines can of course have a number of adverse effects on raptors. These include electrocutions from distribution lines, collisions with wires and the shooting of raptors perched or nesting on powerline structures. To date, however, researchers conducting studies of effects of BPA transmission lines on wildlife have reported few instances of raptor mortality from these lines. Jim Meyer addresses the subject of raptor collisions with transmission lines in his paper presented at this workshop.

An assessment of the net effect of a particular transmission line would require an evaluation of conditions existing prior to construction of the line. For example, it is possible that the nesting and perching habitat provided by transmission towers may extend and/or increase raptor populations in a certain area. Raptor mortality (from collisions or shooting) due to the transmission line should be considered along with the possibility that some of the birds killed may have been raised in nests on the same line.

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Table 1. Results of the 1977 raptor nesting survey conducted as part of routine helicopter patrols of BPA transmission lines.

Line Voltage (kV)	Total Structure (km)	Nest Type					
		Hawks	Raven	Osprey	Golden eagle	Unknown a/	Total
±400 d.c.	425	10	1	0	1	1	13
500	4,290	61	55	0	0	63	179
345	766	1	0	0	0	0	1
287	365	0	0	0	0	1	1
230	5,557	26	25	6	0	26	83
115	681	3	2	3	0	0	8
TOTAL	12,084	101	83	9	1	91	285

a/ Nests in the unknown category includes both active and inactive nests.

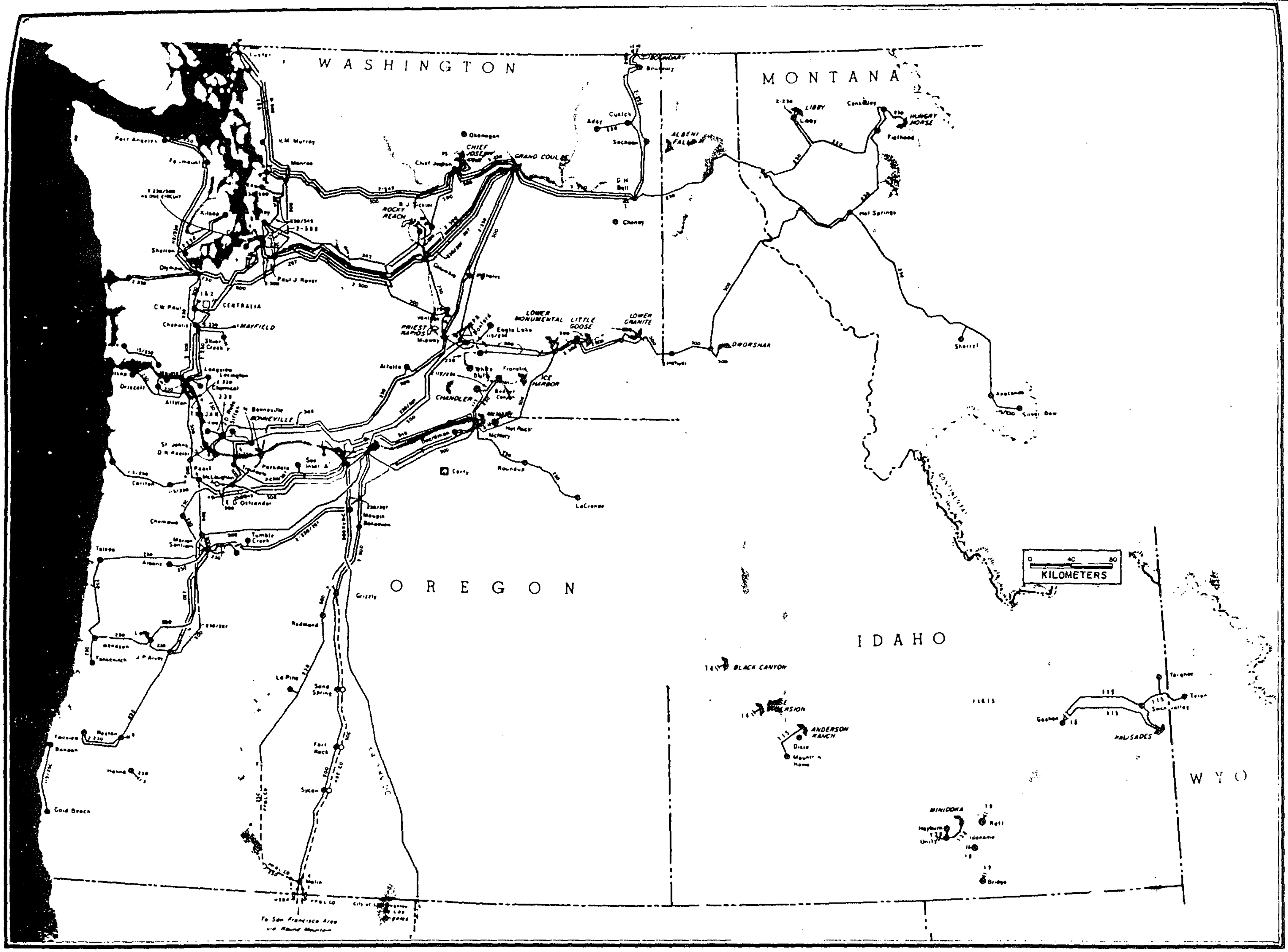


Figure 1. BPA transmission system as of 1977 - The first year of the raptor nesting survey. Not shown are all 115 KV lines or lines of lower voltages. Distribution of raptor nests on transmissiom structures is described in the text.

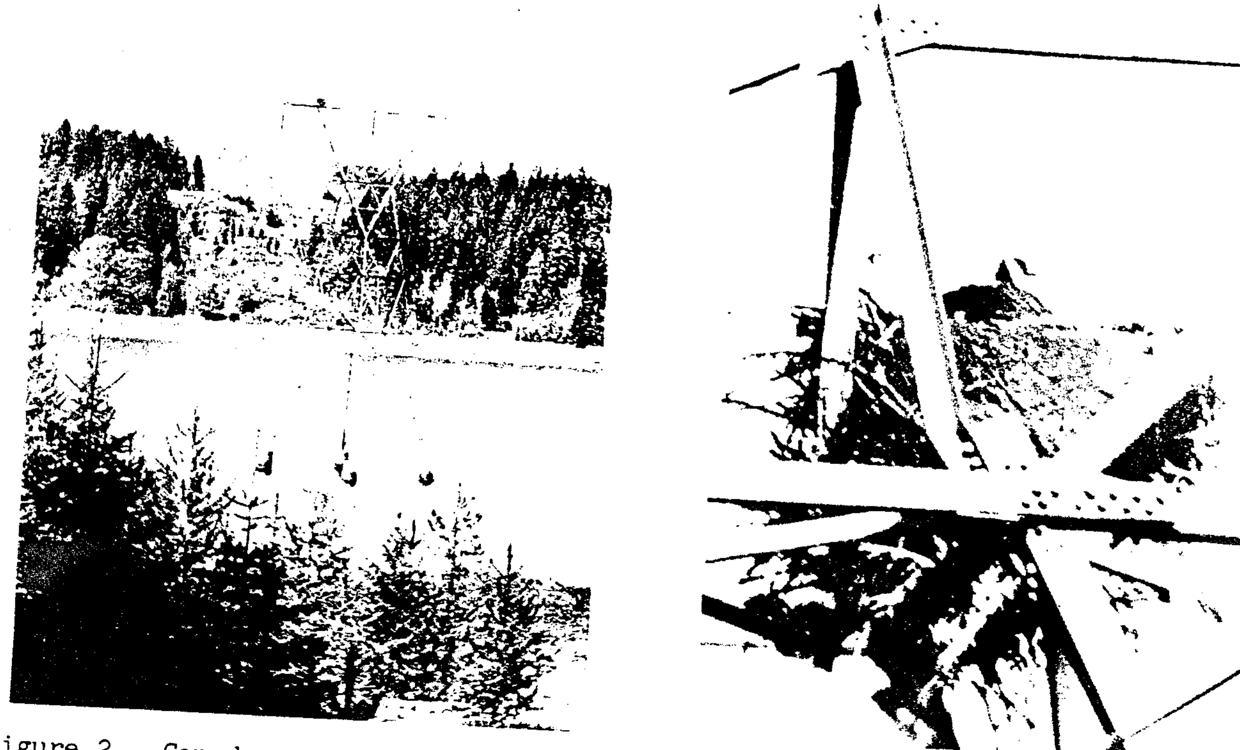


Figure 2. Canada goose (upper nest) and osprey nesting (lower) on a BPA 230-kV transmission line tower in the Clark Fork River, Montana.

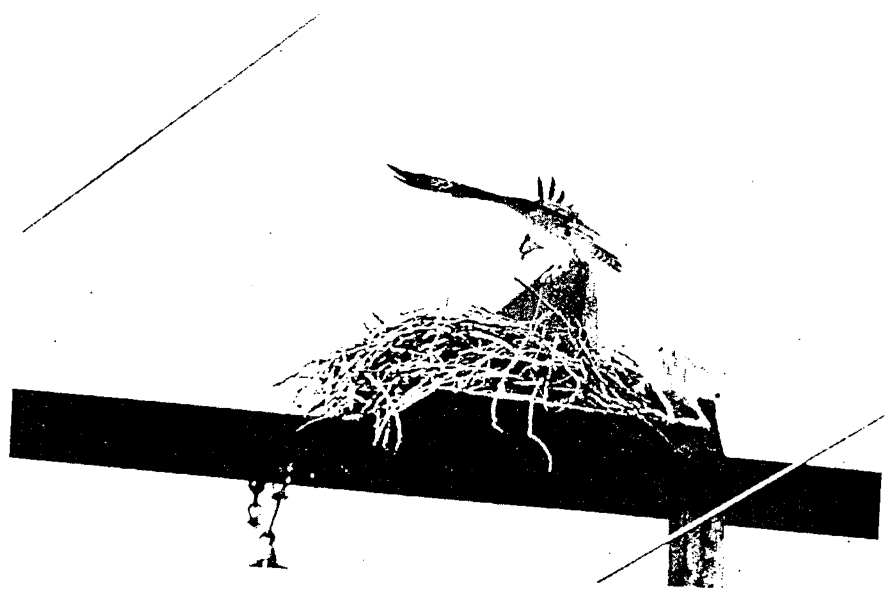
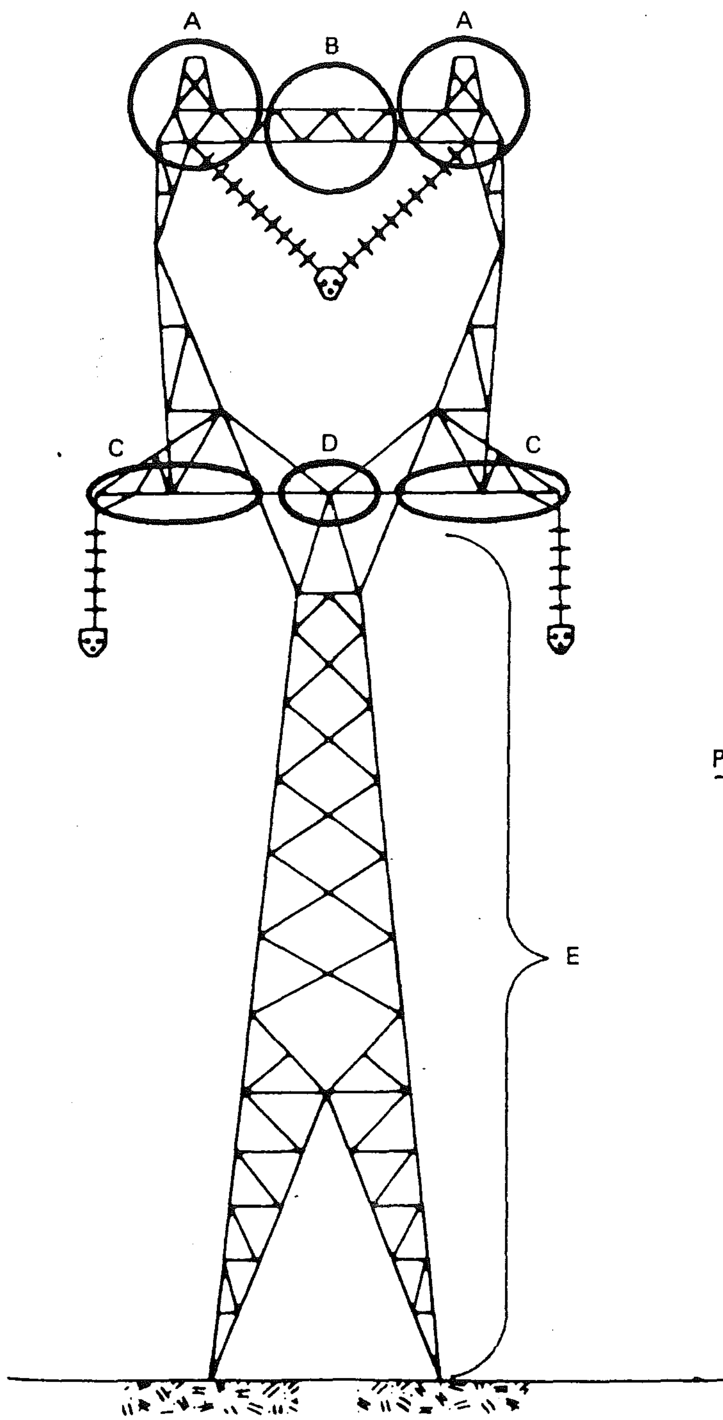


Figure 3. Osprey nesting on a platform installed on a BPA 115-kV transmission line near Kalispell, Montana.



POSITION	NO. NESTS	%
A	51	74
B	5	7
C	3	4
D	1	1
E	9	13
	69	

Figure 4. Locations of red-tailed hawk, raven, and empty nests observed in 500 KV single circuit delta configuration transmission towers during two special helicopter surveys in central Washington in 1978 and 1979. Average tower height is 38 m.

RAPTOR PROTECTION ACTIVITIES OF THE IDAHO POWER COMPANY

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ABSTRACT.--A brief history of the electrocution of birds-of-prey within the Idaho Power Company service area is given, including a brief discussion of the ecological interrelationships which culminate in the electrocution of large raptoral birds. Ongoing raptor protection activities and associated costs are summarized. A useful appendix is attached illustrating recommended modification techniques of "hazard poles" and a form to be used by interested individuals to notify the company of suspected electrocutions.

Since 1972, the Idaho Power Company, in cooperation with Morlan Nelson, other power companies, and several state and federal agencies and private organizations has been investigating raptor electrocutions on transmission and distribution structures. This pioneering work has led to industry-wide standards and practices which have gained worldwide acceptance and recognition for the prevention of the inadvertent electrocution of birds-of-prey.

Early on, it was recognized that hazardous structures were confined to distribution systems, and that these could be classified into several categories:

1. Those which are a definite hazard to "birds-of-prey".
2. Structures which are possible hazards.
3. "Safe" structures.
4. Structures which because of location are not preferred by the birds, and are therefore safe.

These studies, utilizing slow motion photography and trained eagles, seemed to demonstrate conclusively that electrocutions would occur if an eagle, or other bird, with a wide wing span could make contact with any two phase conductors or one phase and a ground wire while attempting to land or take off.

To correct this, several practical solutions to modify existing structures and various redesigned structures to be utilized with new facilities were developed.

In many areas, having no cliffs or trees, birds-of-prey will often choose specific power poles for hunting sites and feeding perches. This is a common situation throughout Idaho and the West. The preferred pol is one on which the cross arm is crosswise with the prevailing winds an in a commanding topographic position.

In flat, featureless terrain with a relatively uniform distribution of the prey base the "preferred pole" concept may not apply. This is probably because one pole does not offer an appreciable advantage over another. Therefore, with all else being equal, a bird is likely to use any pole rather than a particular one.

Ongoing research has demonstrated that many factors other than the simple contact of a raptor's wing tips with conductor are necessary for an electrocution to occur. An electrocution is presently believed to be the end result of several environmental criteria interacting simultaneously with one another.

Work conducted by Mr. Morlan Nelson of Boise, Idaho and Mr. Patrick Benson, of Brigham Young University and raptor mortality reports maintained by the power industry and U.S. Fish and Wildlife Service has provided several clues to the sequential events which result in the electrocution of a bird.

Records maintained by the Idaho Power Company for a period of seven years, (1972-1979), indicate that approximately 79% of all reported mortalities are Golden Eagles. These records do not distinguish clearly between electrically related mortality and mortality caused by other factors. Table I is a breakdown of Idaho Power Company's recorded mortalities by species.

Table I - Raptor Mortality Summary
(1972-1979*)

Species	% of Total
Golden Eagle	78.7
Great Horned Owl	3.5
Red Tailed Hawk	2.6
Rough Legged Hawk	1.7
Kestral	1.7
Bald Eagle	1.7
Raven	1.7
Osprey	0.8
Unknown	7.0

*113 reported mortalities; Idaho Power Company, U.S. Fish and Wildlife Service

The first criteria that must be evaluated in determining the actual cause of death of a suspected electrocution is the physical size of the bird in question and the physical opportunity provided by the electrical facility for an electrocution to occur. If the size of the bird is insufficient to make electrical contact and complete a circuit, electrocution is physically impossible. A cause of death other than electrocution must be considered.

Another criteria that becomes evident in examining past mortalities of birds is the age of the individuals concerned. Nelson and Benson report that their observations indicate that the vast majority are immature, and generally are migrants which have not yet become established as part of a defined population.

A third factor which has recently come to light is the insulation quality of a bird's feathers. A dry feather has insulation qualities surpassing what was previously assummed. Research conducted for Pacific Power and Light and Idaho Power Company graphically demonstrates these qualities. Tests were conducted on live eagles and on feathers which had been molted from live birds or collected from dead birds.

On similar tests, conducted on wet feathers, the insulation quality quickly broke down and the feather acted as a poor insulator.

The significance of the natural protection provided by a bird's feather becomes obvious when the number of bonafide electrocution mortalities are compared with the number of opportunities for electrocution to occur. Several thousands of potentially deadly distribution poles are distributed across southern Idaho, few of these are involved with raptor mortality. Understanding of this information provides more insight into why relatively few birds are found dead.

Weather patterns in southern Idaho are typically characterized by hot, dry summers and mild winters. In a recently completed study conducted by the Bureau of Land Management on the Birds-of-Prey study area the highest average monthly precipitation recorded in the five-year study period occurred in April. Other months of relatively high precipitation are January, February and March. The summer and fall months are typically periods of low precipitation.

A fourth factor which must be considered is the type of habitat in which a line is located. The habitat will largely determine the availability of prey, or in some other way establish a reason for the presence of a bird-of-prey.

As previously implied, weather conditions may also play a hand in a mortality by electrocution. An electrocution is believed to be more likely to occur during periods of heavy rain, when the insulating quality of the feathers is greatly reduced.

The physical characteristics of the suspected facilities must be examined. Cross-arm type distribution structures are usually more likely to be involved with an electrocution than any other type. Because of the wider spacing between power lines with electrical ratings over 69,000 volts, larger transmission lines do not present a hazard to birds-of-prey.

As a result of the investigations conducted to date, Idaho Power Company, along with many other utilities, has instituted an extensive and ongoing raptor protection program.

Once the problem had been identified and viable solutions developed, the company, in cooperation with state and federal agencies and other interested individuals conducted surveys of existing distribution lines to identify hazard poles that needed to be modified. This work has continued and has been incorporated into routine distribution pole maintenance activities. Linemen and other area encouraged to report mortalities so that corrective actions can be taken. Additionally, the Fish and Wildlife Service routinely patrols several potential hazard lines to monitor mortalities.

After a hazard pole has been identified, it is normally a relatively inexpensive operation to modify the pole, providing that no unusual problems are associated with the pole in question. I want to emphasize that in some cases modification of a structure can involve many thousands of dollars, depending on the circumstances. Table II shows the cost comparison of the various modification alternatives that are presently available to the company. These costs are developed from past activities and assume that the modification is conducted as a part of the routine line maintenance program. They do not reflect cost in the event that special problems exist.

Table II - Cost comparison to modify existing cross arm distribution poles to incorporate birds-of-prey protection into the structure.

Modification	Cost
Perches	"L" shaped $ 74.00 "T" shaped $103.00
Pole top extension	$68.00
PVC insultation	$40.00

Beginning in 1974, it has been the Idaho Power Company's policy to utilize only "armless" distribution configurations in areas of heavy raptor use. Although these structures are quite beneficial in preventing electrocution of birds of prey they do pose some problems to the utility and create extra hazard to maintenance crews working on the modified lines. Because the phases, or conductors, are closer together when the armless configuration is used, it is necessary to place the poles nearer to one another than it is with standard cross arm configurations. This means that more structures are needed per mile of distribution line. On the average, an armless structure cost about the same as structures utilizing cross arms, however approximately three to four more poles are required per mile of line. This results in an additional cost of about $1000-1200 per mile of construction.

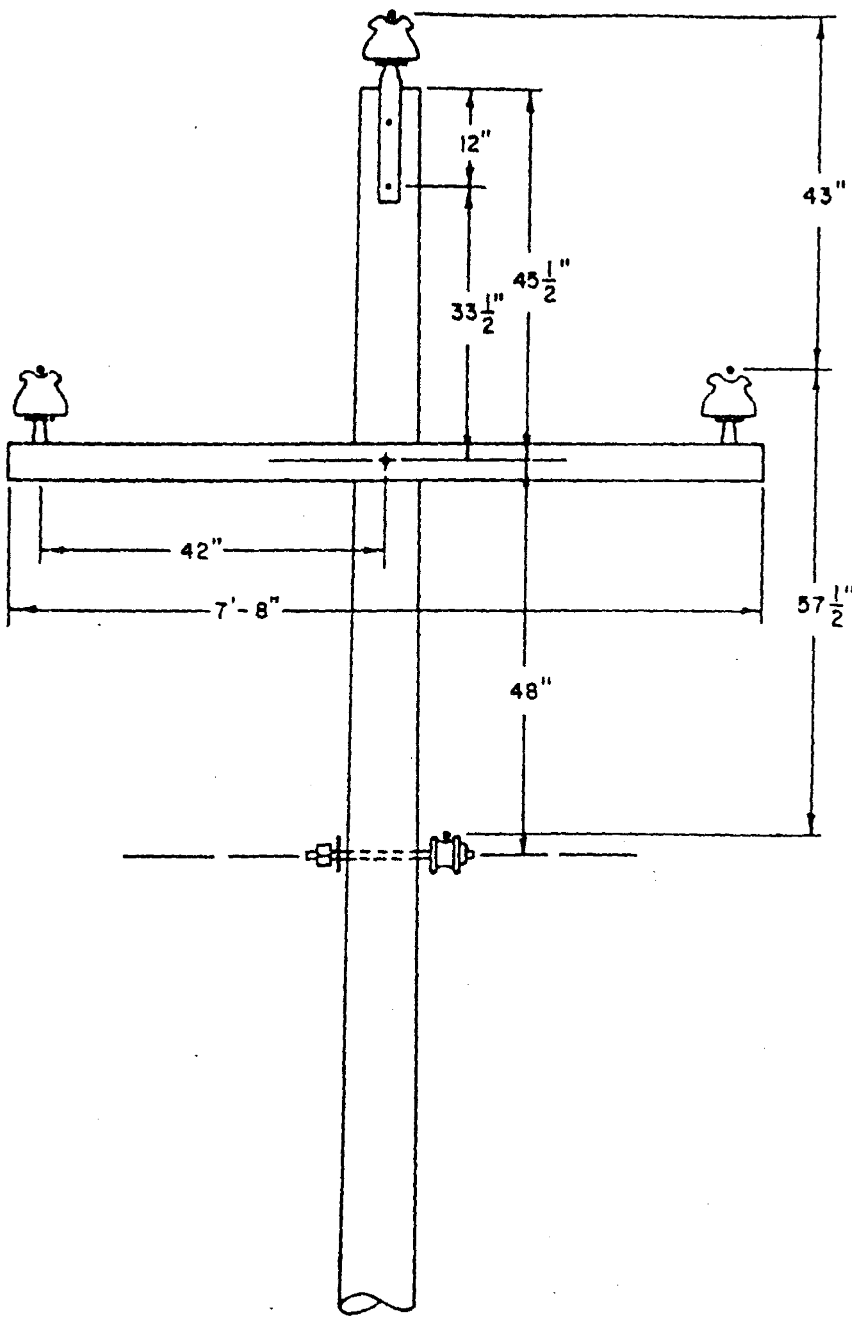
Table III is a summary of the distribution pole activities of the Idaho Power Company since 1974.

Table III - Summary of distribution pole construction activities, 1974-1979. Idaho Power Company.

Year	Miles of Construction
1974	311.21
1975	206.15
1976	208.74
1977	181.42
1978	201.6
1979	177.02
Total	1287.04
Total miles IPCo system distribution	16,549.27

To date, over 225 miles of three phase distribution line have been built in Idaho, incorporating the design modifications resulting from the investigations of raptor electrocutions. In addition to the new construction, several scores of existing hazard poles have been identified and modified to protect these magnificant birds as a part of the company's ongoing raptor protection program.

In the event that you, as an individual, should come across a dead bird beneath a distribution line which you suspect has died as a result of an electrocution you should make every effort to inform the company of your find. The best method to coordinate this type of information is by utilizing the form marked "Appendix B" and forwarding to Wendell E. Smith, Environmental Director, Idaho Power Company, P.O. Box 70, Boise, Idaho 83707. A copy of your report should be forwarded to the U.S. Fish and Wildlife Service and the local fish and game office. A word of caution; the carcass of a bird of prey should not be moved from the location unless the finder is in possession of the proper state and federal permits. If a bird is collected, it should be deposited with the local state fish and game office or with the U.S. Fish and Wildlife Service. The Idaho Power Company does not have the facilities to handle dead birds.



Crossarm Distribution
Triangular Construction

Approved for corrections on preferred poles in existing lines

APPENDIX
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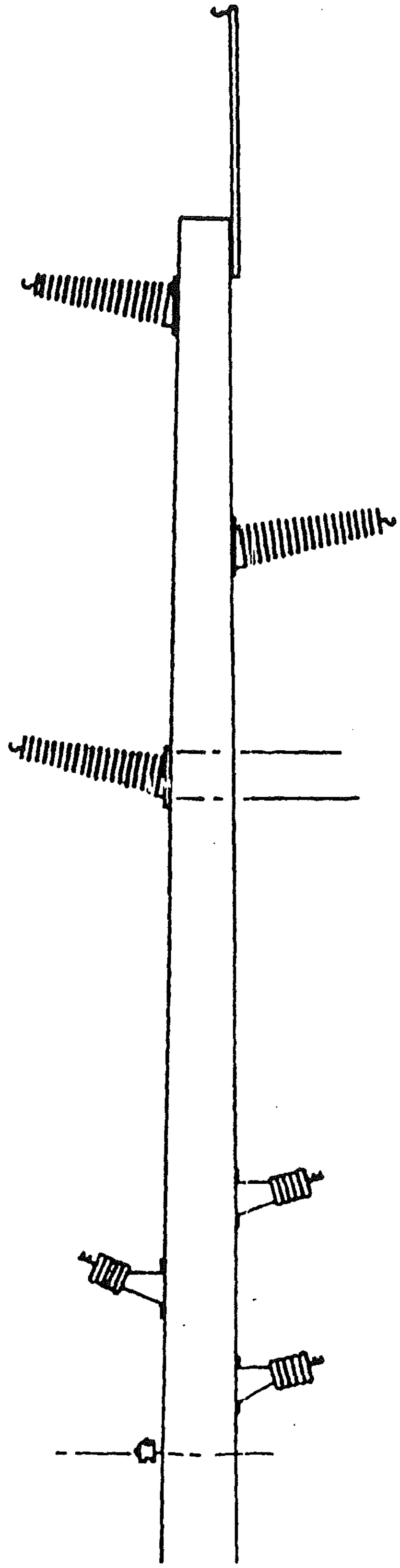
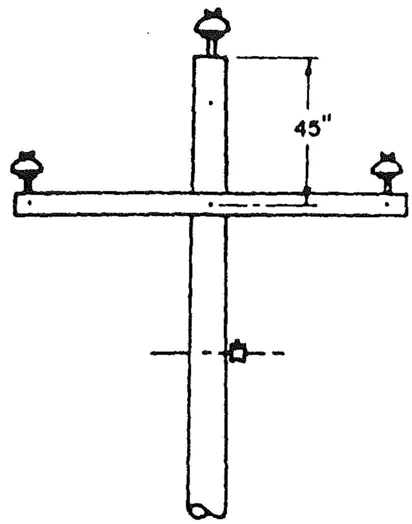
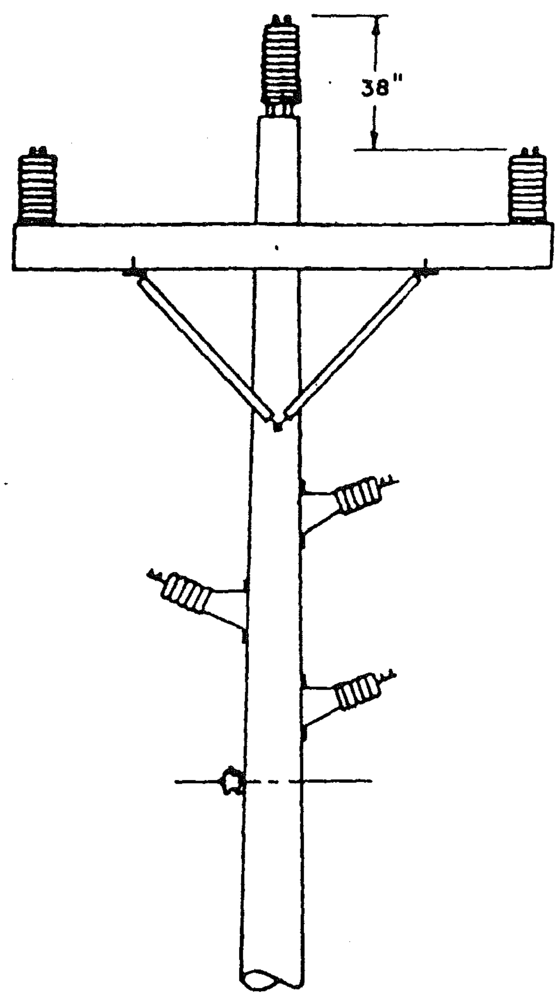
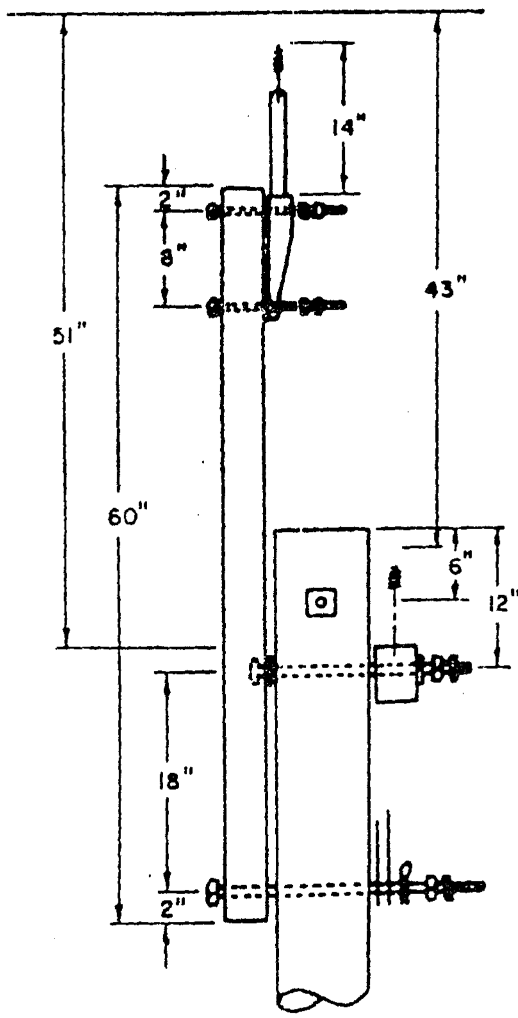


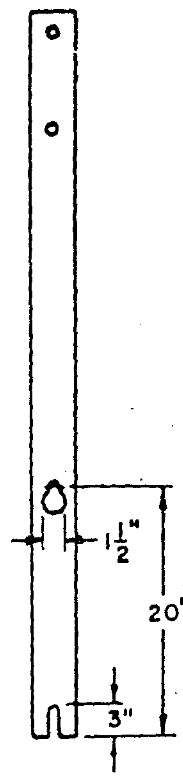




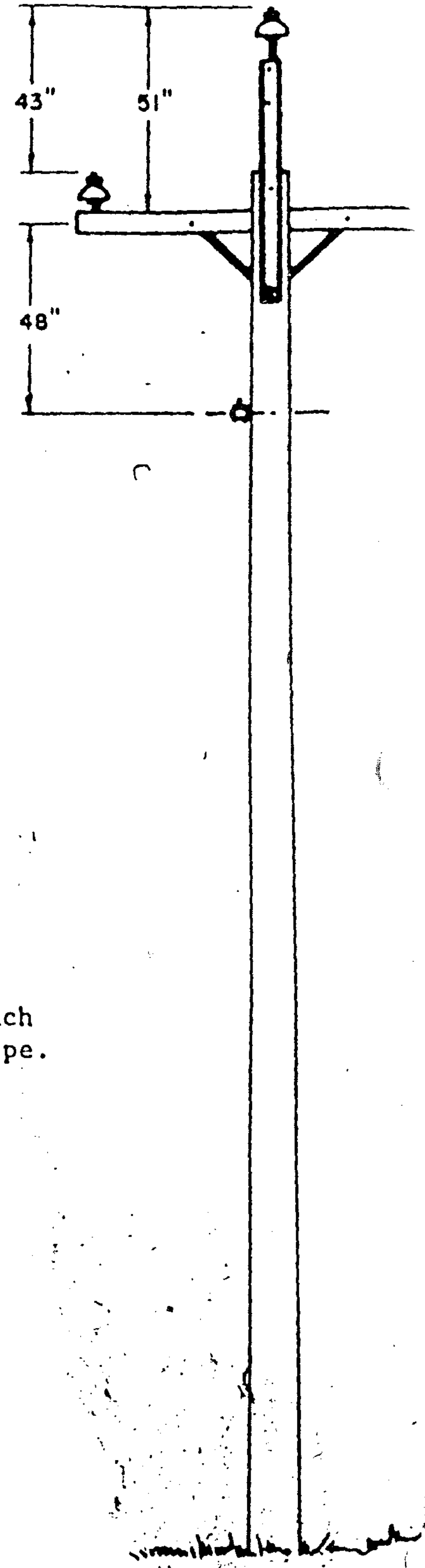
Approved type structure
to be installed in a
"Birds of Prey" area



Assembly Detail



Fabricate from 3-inch galvanized steel pipe.



Center Phase Riser

Approved for corrections on preferred poles in existing lines

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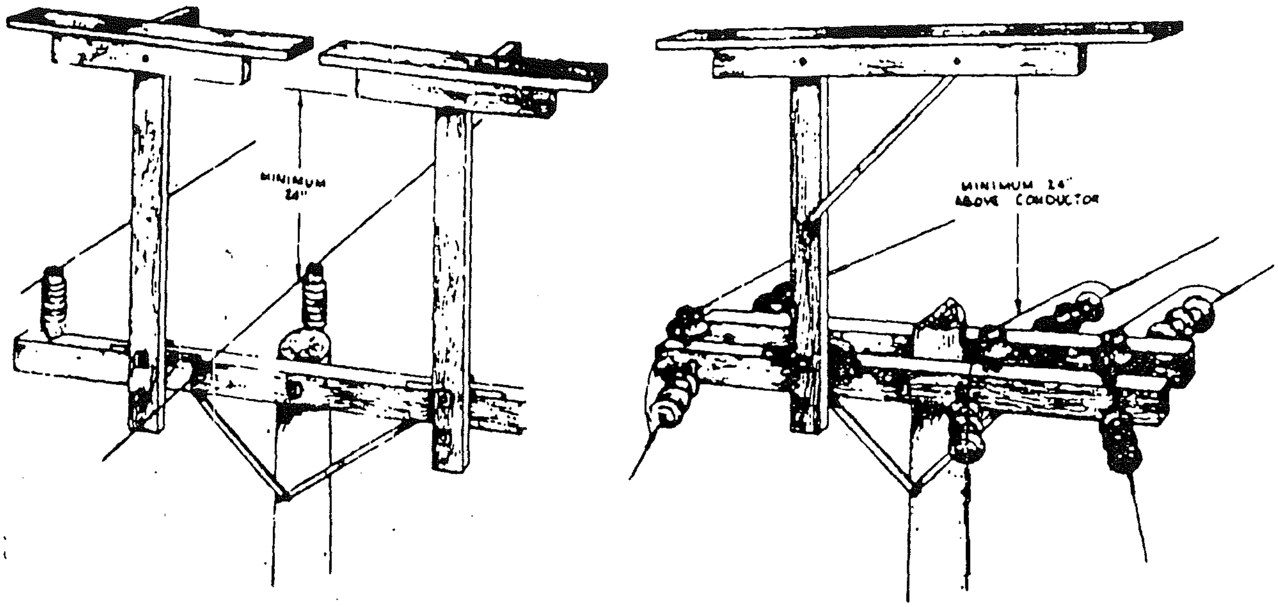
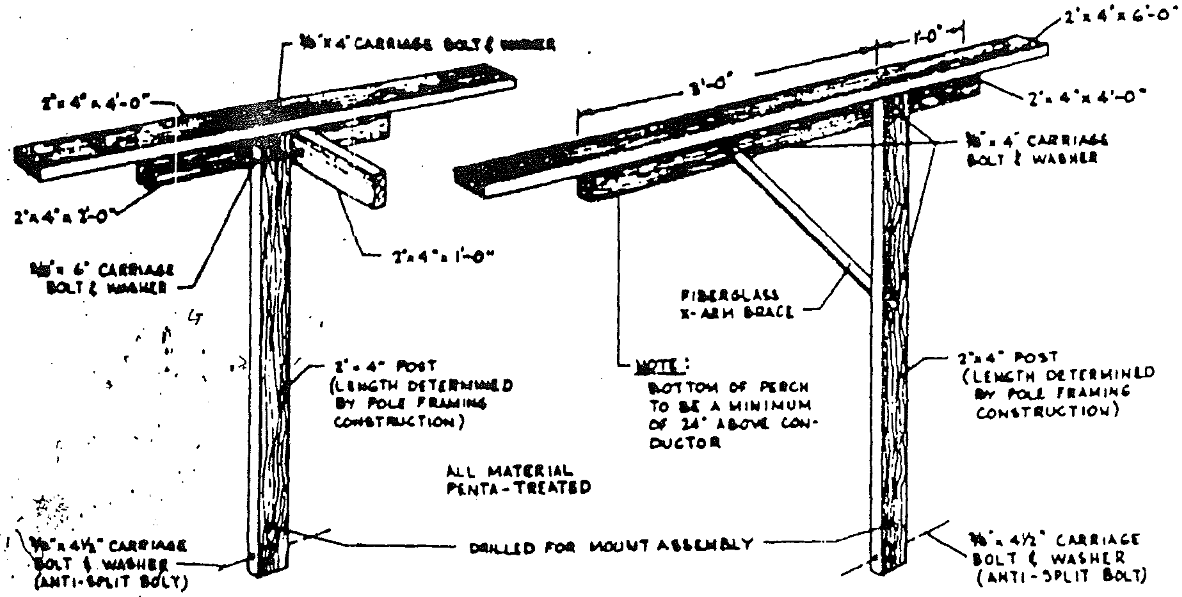
"T" Perch | Straight Perch



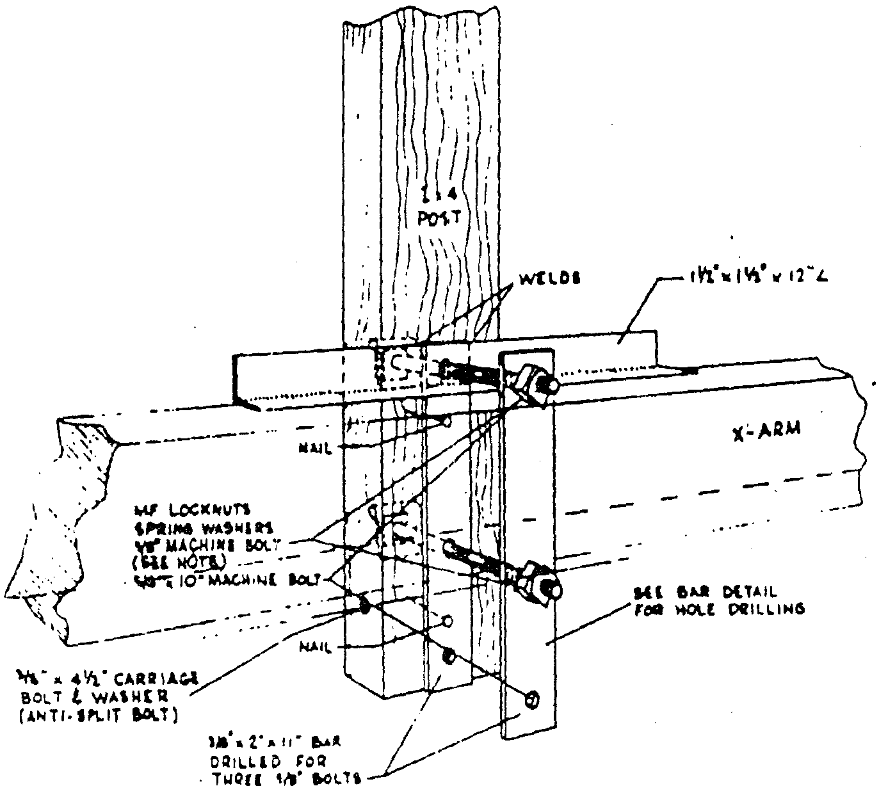
Typical Perch Applications

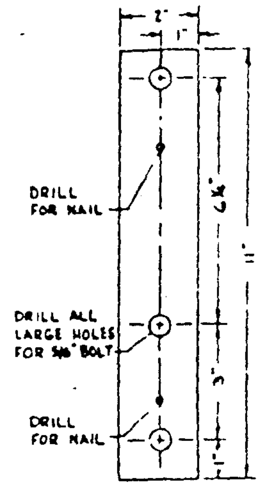


Perch Assembly Details

Approved for corrections on preferred poles in existing lines

Birds-of-Prey Consultant



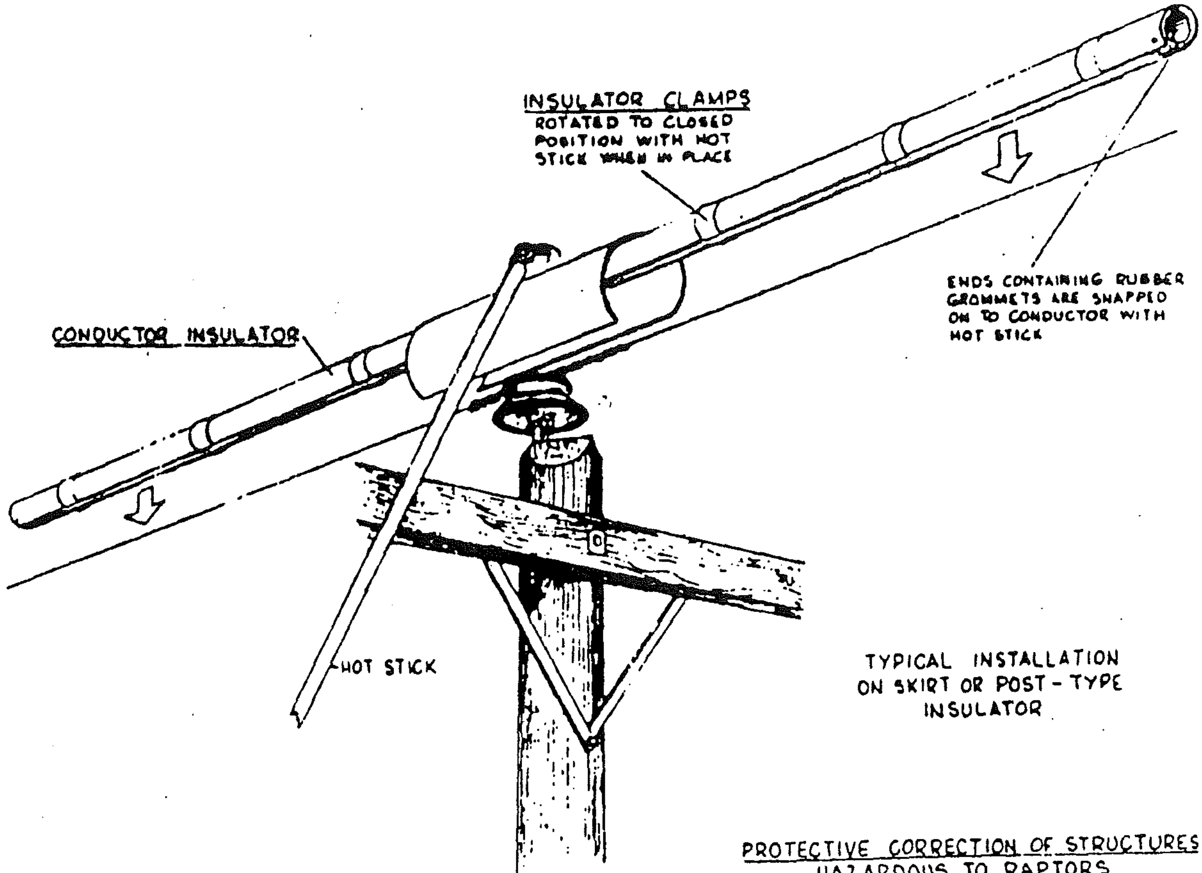


MOUNT BAR DETAIL

NOTE:
FOR LIGHT-DUTY X-ARM:
USE UPPER SET OF MOUNTING HOLES
USE 5/8" x 8" MACHINE BOLTS
FOR HEAVY-DUTY X-ARM:
USE LOWER SET OF MOUNTING HOLES
USE 5/8" x 10" MACHINE BOLTS

MOUNT ASSEMBLY FOR TYPES ① & ② PERCHES
(SHOWN MOUNTED ON LIGHT-DUTY X-ARM)

Approved for corrections
on preferred poles in
existing lines

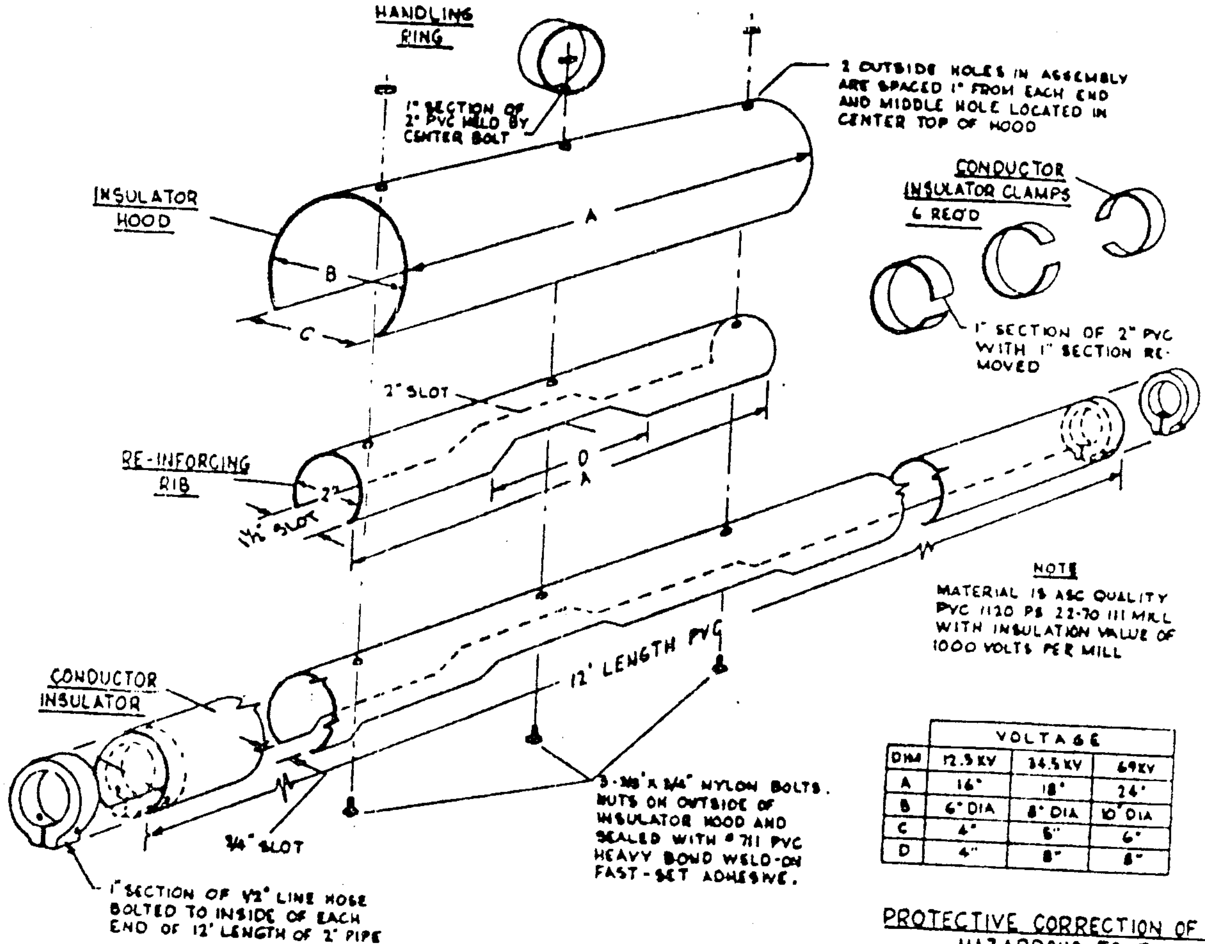


TYPICAL INSTALLATION ON SKIRT OR POST-TYPE INSULATOR

PROTECTIVE CORRECTION OF STRUCTURES HAZARDOUS TO RAPTORS
CONDUCTOR INSULATOR
IDAHO POWER COMPANY
SEPTEMBER 1972

Approved for corrections on preferred poles in existing lines

Morlan W. Nelson



	VOLTAGE		
DIM	12.5 KV	34.5 KV	69 KV
A	16"	18"	24"
B	6" DIA	8" DIA	10" DIA
C	4"	6"	6"
D	4"	8"	8"

PROTECTIVE CORRECTION OF STRUCTURES HAZARDOUS TO RAPTORS
CONDUCTOR INSULATOR DETAILS
IDAHO POWER COMPANY
SEPTEMBER 1972

Approved for corrections
on preferred poles in
existing lines

Morlan W. Nelson
Birds-of-Prey Consultant

APPENDIX B

STATE: ____________________

RAPTOR MORTALITY REPORT

1. Date of discovery

2. Approximate date when mortality occurred

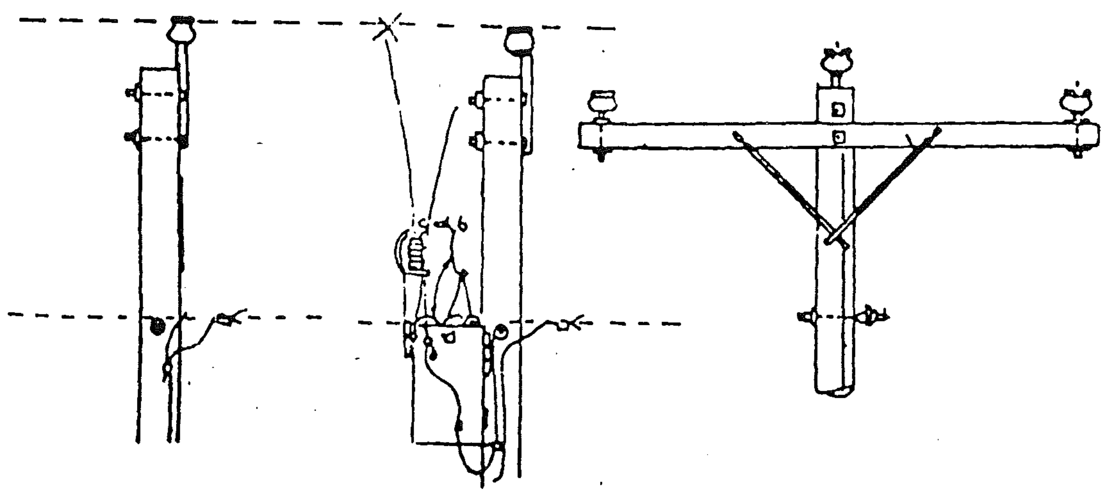
3. Location (county, nearest post office, township, name of electric utility and pole number)

4. Species, age, sex (if known) of each bird found

5. Probable cause of mortality (electrocution, gunshot, etc.)

6. Vegetation (forest, grassland, etc.) and terrain (hilly, flat, etc.)

7. Check pole type from those below



____No crossarm ____No crossarm, but transformer present ____Crossarm(s) ____Other (describe on back)

8. Name, address, phone number, and agency of person making report

Please send to: Wendell E. Smith
Environmental Director
General Office

GOLDEN EAGLE REPRODUCTION AND POPULATION CHANGES IN RELATION TO JACKRABBIT CYCLES: IMPLICATIONS TO EAGLE ELECTROCUTIONS

by Michael N. Kochert, Snake River Birds of Prey Research, Boise, Idaho

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ABSTRACT.--Golden eagle (*Aquila chrysaetos*) reproductive performance and relative black-tailed jackrabbit (*Lepus californicus*) densities were assessed in the Snake River Birds of Prey Area from 1970-1978. Golden eagle mid-winter densities were enumerated from 1973-1979. The proportion of eagles breeding, young eagles fledged per pair and per breeding attempt and eagle breeding success all declined in response to lower jackrabbit numbers. Mid-winter golden eagle densities were related to jackrabbit densities. The incidence of eagle electrocutions was correlated with the mid-winter eagle density. A possible relationship among golden eagle winter density and reproductive performance, the incidence of golden eagle electrocutions and jackrabbit density is established. The incidence of golden eagle electrocutions may be cyclic with jackrabbit fluctuations.

INTRODUCTION

Concern about raptors and powerlines became significant in the early 1970's when large numbers of raptors, especially golden eagles, were found electrocuted under distribution powerlines. This concern prompted many large-scale programs of assessment, research and management intended to mitigate this problem. Work ranged from assessment of problem powerline configurations to analyzing those environmental factors which influence raptor electrocutions.

In this paper, I present possible relationships among jackrabbit population levels, golden eagle reproductive performance, golden eagle wintering densities, and the incidence of golden eagle electrocutions.

Appreciation is extended to the Idaho State Office of the Division of Animal Damage Control, U.S. Fish and Wildlife Service (FWS) for providing the annual tally of electrocution reports; Region I, FWS for assisting with some of the aerial surveys; the Idaho Cooperative Wildlife Research Unit, University of Idaho for providing the 1970-1971 golden eagle reproductive data (Kochert 1972); and Region III of the Idaho Fish and Game Department for providing laboratory space to autopsy birds. K. Steenhof, A. Bammann, T. Kucera, and G. Smith critically reviewed the manuscript.

Most data presented in this paper are a part of the continuing effort of the Bureau of Land Management's Snake River Birds of Prey Research Project. Jackrabbit and golden eagle reproduction results were taken from the Snake River Birds of Prey Special Research Report to the Secretary of the Interior (USDI 1979).

STUDY AREA

Golden eagle reproductive and jackrabbit data were collected within the 340,000 ha Birds of Prey Study Area located south of Boise, Idaho (Fig. 1). Golden eagle reproductive data were also collected in the comparison study area that extended along the Snake River Canyon 35 miles upstream and 20 miles downstream from the east and west BPSA boundaries (Fig. 1). The area lies in an Upper Sonoran Life Zone. Detailed descriptions of the climate, vegetation and physiographic characteristics of the BPSA are presented in USDI (1979). Golden eagle mid-winter densities were assessed in an 18,000 km study area which encompassed the BPSA and extended for Meridian to Rupert, Idaho (Fig. 2).

METHODS

Jackrabbit Abundance

Yearly jackrabbit trends were assessed from flushing transects and counts of jackrabbits seen during regular activities of the raptor survey crews.

From 1972 through 1979, 26 to 60 flushing transects (Gross et al. 1974) were walked in October. Transects were 1.6 km in length and were evenly distributed throughout the BPSA. To supplement yearly trends derived from the BPSA walking transects, data from northern Utah for 1970 and 1971 (Stoddart, unpublished data) were incorporated in the analysis. This incorporation is appropriate because both the BPSA and northern Utah have similar cover types, and jackrabbit index values for the two areas were nearly the same from 1972 through 1977 (Stoddart, unpublished data). Gates density indices (Gross et al. 1974) were tabulated from the walking transect data.

To supplement the data on yearly trends for 1971, 1973, and 1975-79, the average number of jackrabbits seen each day by a 2-person raptor survey crew was tabulated from field notes. These data were summarized for a period from late March through July.

Eagle Nesting Density and Reproductive Performance

Golden eagle populations in both the BPSA and Comparison Area were surveyed each breeding season from 1971 to 1978. Most surveys were conducted on foot and by boat, but fixed-wing and rotary-wing aircraft were used occasionally. All potential nesting cliffs within the survey area were checked for occupancy. Occupied sites were located on the basis of territorial activity, courtship, brood-rearing activity, or the presence of young, eggs, or conspicuous field sign (fresh white wash or new nesting material).

Selected nest sites were entered and examined for eggs, eggshell fragments, or other signs of reproductive activity. Pairs that occupied sites but showed no evidence of egg laying after repeated observations were categorized as "non-breeding". A nesting attempt was confirmed if an occupied site contained an incubating adult, eggs, young or any field sign that indicated eggs were present.

Clutch and brood sizes and the number of fledging young were enumerated for selected nesting attempts. The total number of young fledged in the study area was calculated by multiplying the number of occupied sites by the number of young fledged per pair. Criteria, definitions, and methods used for assessing eagle reproductive performance are described in detail in the Birds of Prey Special Research Report (USDI 1979).

Eagle Population Density

Golden eagle aerial transects were flown each year in January or February. The area was sampled from a fixed-wing aircraft via 20 random north-south (80 km) transects following the procedure of Boeker and Bolen (1972). Golden eagles within 0.4 km of either side of the transect route were recorded and aged.

Eagle Electrocutions

The incidence of eagle electrocutions was determined from the annual tally of U.S. Fish and Wildlife Service electrocution reports from 1972 to 1979, and from the number of electrocuted eagles found annually in or near the BPSA by the raptor field crews. The cause of death of those birds found in the BPSA was confirmed by autopsy.

RESULTS

Jackrabbit Densities

Gates Transect indices, and the number of jackrabbits seen per research crew day, both showed the same general trend from 1970 to 1978 (Fig. 3). Rabbit numbers were assumed to have peaked in 1970 or early 1971, based on the observed population changes in nearby Curlew Valley, Utah. The population declined in 1972, reached a low from 1973 to 1975 and slowly recovered from 1976 to 1978.

Eagle Reproductive Performance and Jackrabbit Relationships

Eagle reproductive performance declined as jackrabbit numbers decreased (Fig. 4). Among eagle pairs occupying traditional sites, the proportion of eagles breeding declined from 100% in 1971, a good jack-rabbit year, to an average of 65% in poor jackrabbit years. Only 56% of the pairs bred in 1973, one of the poorest jackrabbit years.

Average clutch size showed no definite trend, but no 3-egg clutches were observed in poor jackrabbit years. Nestling survival declined markedly from good to poor jackrabbit years, and there was similar decreases in the percent of pairs that bred successfully, number of young fledged per successful attempt, and number of young eagles fledged per pair (Fig. 4). Yearly jackrabbit densities were correlated with both total numbers of eagles fledged ($r = 0.74$; $p < 0.03$; 6 df) and number fledged per pair ($r = 0.66$; $p < 0.05$; 6 df).

All traditional eagle sites were occupied from 1971 until 1974 (2 years after the jackrabbit crash). Occupancy decreased to about 95%, from 1975 to 1978.

Golden Eagle Populations

The mid-winter golden eagle population was highest in February of 1973. It decreased by 50% between 1973 and 1974 and has gradually decreased further over the last five years (Fig. 5).

The mid-winter eagle density for each survey was compared to the total number of young eagles fledged during the previous nesting season. Changes in the mid-winter eagle densities resembled changes in eagle productivity until 1976 (Fig. 6). However, the relationship was not strongly correlated ($r = 0.79$; $p > 0.1$; 3 df). Eagle mid-winter density did not respond to the increased eagle reproduction after 1976.

The estimated eagle winter density was more closely related to relative jackrabbit abundance (rabbits seen per crew-day) than eagle productivity (Fig. 7). Eagle winter density and jackrabbit abundance were strongly correlated ($r = 0.92$; $p < 0.002$; 6 df).

Eagle Electrocutions

I compared the number of FWS eagle electrocution reports for Idaho with mid-winter eagle population levels in southwestern Idaho. Often the time of death of the electrocuted birds in the FWS reports for a particular year is unknown. To reduce the problem caused by the birds dying in one year and not being reported until the next year, I pooled the electrocution data into your groups that represented major changes in the mid-winter eagle density. The 1973 eagle density was compared with the mean number of electrocution reports for calendar years 1972 and 1973 combined since the 1973 survey represents the eagle population for the winter of 1972-1973. This comparison is valid since most golden eagle electrocutions occur during the winter (Benson In press). Eagle densities and the number of electrocution reports for 1974-1976 and 1977-1979 were pooled and their means compared. The pooled mean number of eagle electrocution reports decreased in relation to the decrease in eagle winter density (Fig. 8) and their pooled means were correlated ($r = 0.92$; $p < 0.13$; 2 df).

I then compared the mid-winter density in the aerial survey area which includes the BPSA with the number of electrocuted eagles found in or near the BPSA 6 months prior to and 6 months after each aerial survey. The number of electrocuted eagles found in or near the BPSA followed the same general pattern as the mid-winter eagle density (Fig. 9). The relationship was strongly correlated ($r = 0.90$; $p < 0.003$; 6 df). The greatest number of electrocuted eagles were found in the BPSA between Fall 1972 and Spring 1973; the time of the greatest eagle density. The number of electrocuted eagles discovered in the BPSA decreased as winter eagle density decreased.

DISCUSSION

Golden eagle reproduction, especially young fledged per pair and the total number of young fledged in the BPSA, appears to be correlated with jackrabbit numbers. Evidence indicates that this phenomenon exists elsewhere (Murphy 1975), and the numeric response of other raptor species to changes in their major prey has been documented (MacInville and Keith 1974).

Golden eagle mid-winter population densities were not strongly related to golden eagle productivity. The low estimated eagle wintering density during 1977-1978 could be the result of abnormal weather patterns (Fig. 6). A serious drought occurred over the winter of 1976-1977 while the winter of 1977-1978 was unusually warm. Both conditions resulted in little snow cover at the higher elevations. These mild conditions may not have forced birds to the Snake River Plain which happens during normal winters. During 1977 and 1978 eagle productivity increased, and the eagle winter density has remained static or decreased slightly. Juvenile mortality, weather patterns, and eagle emigration and immigration could be influencing the eagle winter density during the last few years.

The incidence of eagle electrocutions, especially in the BPSA, appeared to be a function of the mid-winter eagle density in south-western Idaho, and the mid-winter eagle density was strongly related to the density of jackrabbits in the BPSA. Therefore the incidence of golden eagle electrocutions must be related to jackrabbit density. The mid-winter eagle density, did not directly reflect golden eagle productivity. However, both parameters were related to the density of jackrabbits.

In 1972 Idaho Power Company began modifying problem distribution power poles which caused eagle electrocutions. By 1979 this resulted in modification of 1.3% of all distribution power poles (Smith and Ancell in press). This modification program, however, cannot account for the abrupt decline in eagle electrocutions related to the golden eagle winter density in 1974. The modification program, could have biased the relationship between eagle winter density and electrocutions during the later years of the study but it had little effect on the relationship over the entire study period.

The information presented in this paper presents some possible relationships that should be investigated further. Evidence in the literature reveals that the genus Lepus (especially jackrabbits) is predictively cyclic with jackrabbits reaching population peaks approximately every decade (Gross et. al 1974). The relationships I present in this paper suggest that eagle reproduction, eagle wintering densities and the incidence of golden eagle electrocutions are related to jackrabbit numbers and could be cyclic as well.

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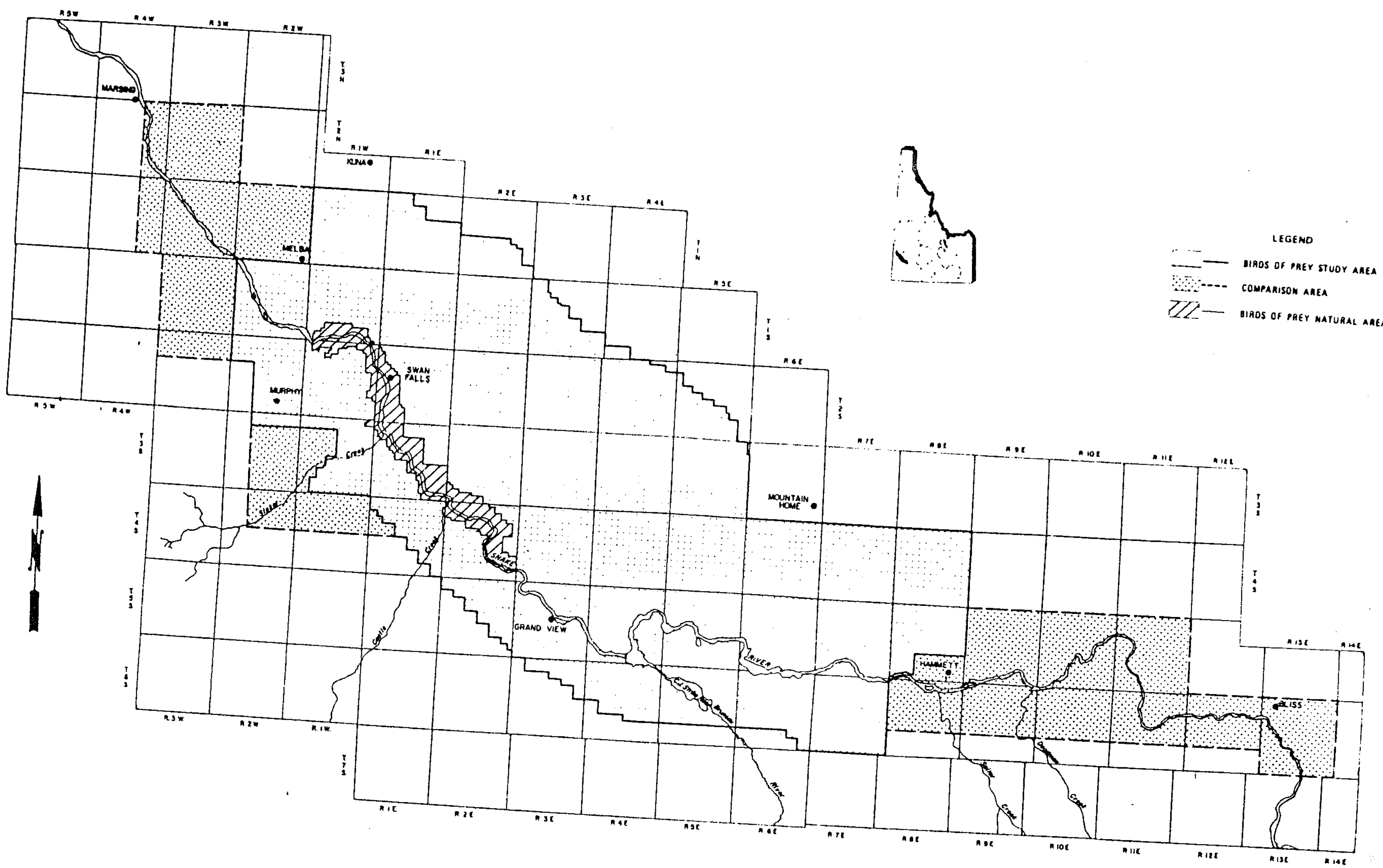

Figure 1. Location of birds of prey study area and Co rison Study Area.

Figure 1. Location of birds of prey study area and Compar , Study Area.

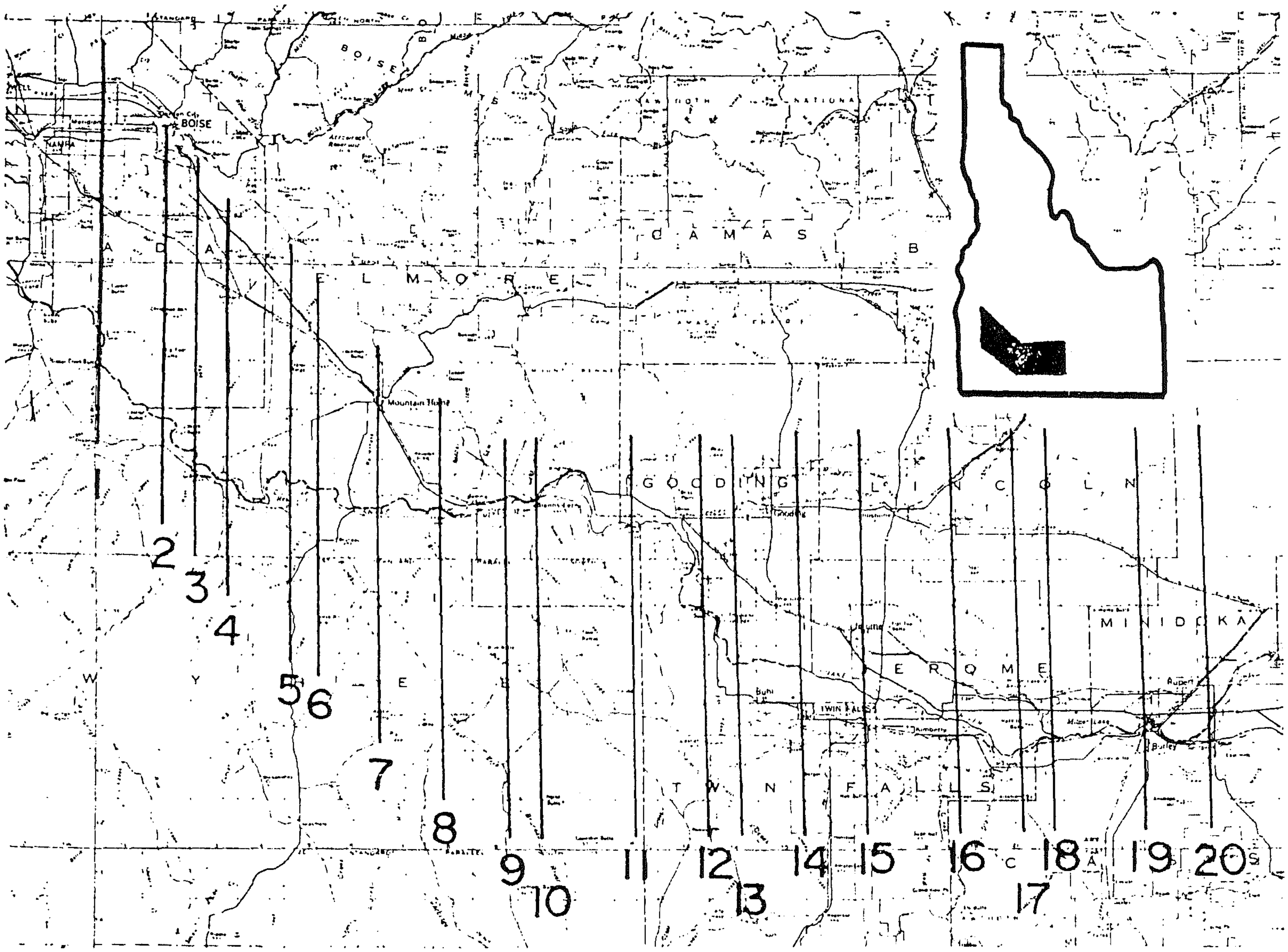

Figure 2. Location of golden eagle aerial survey area with numbered transects.

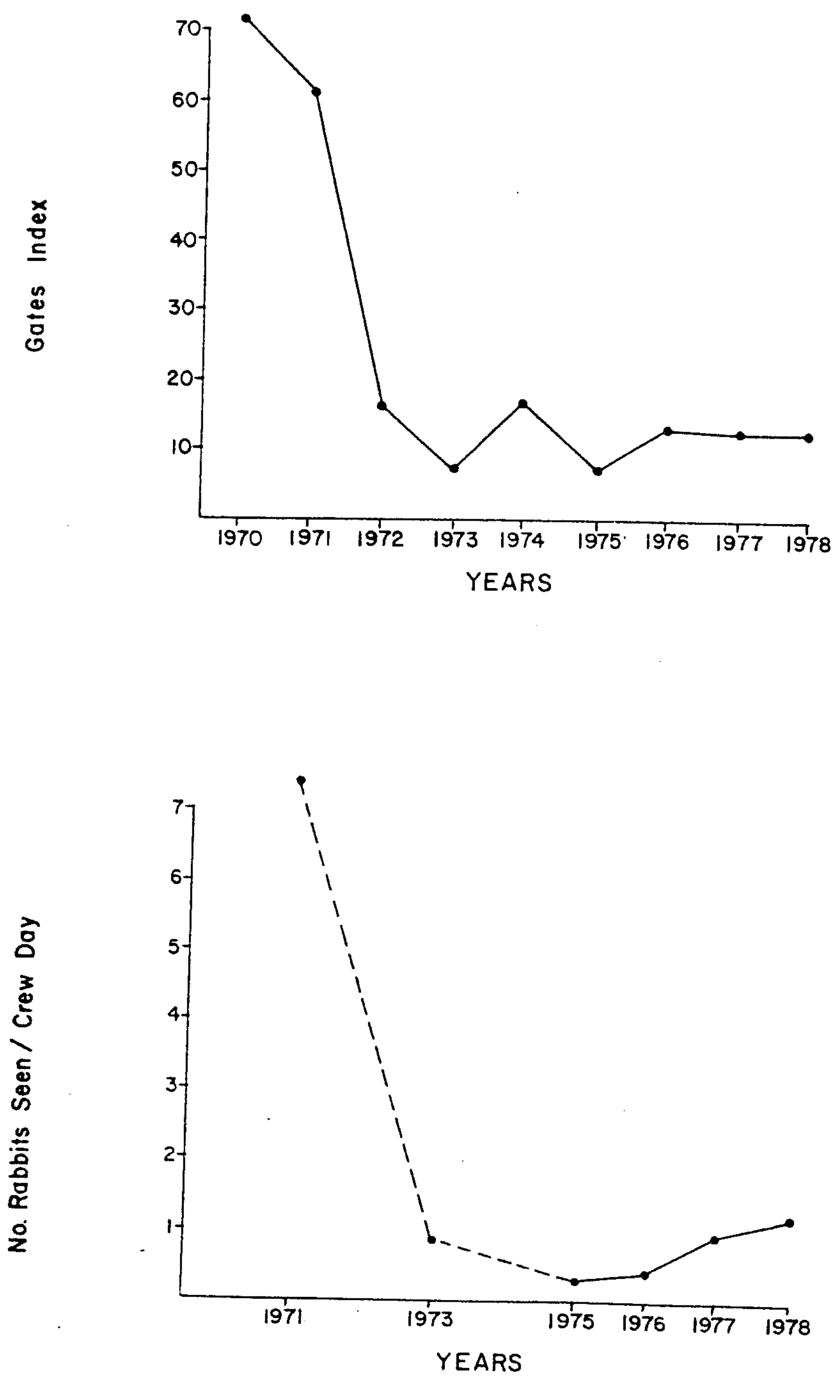

Figure 3. Black-tailed jackrabbit population trends in the BPSA, 1970-1978.

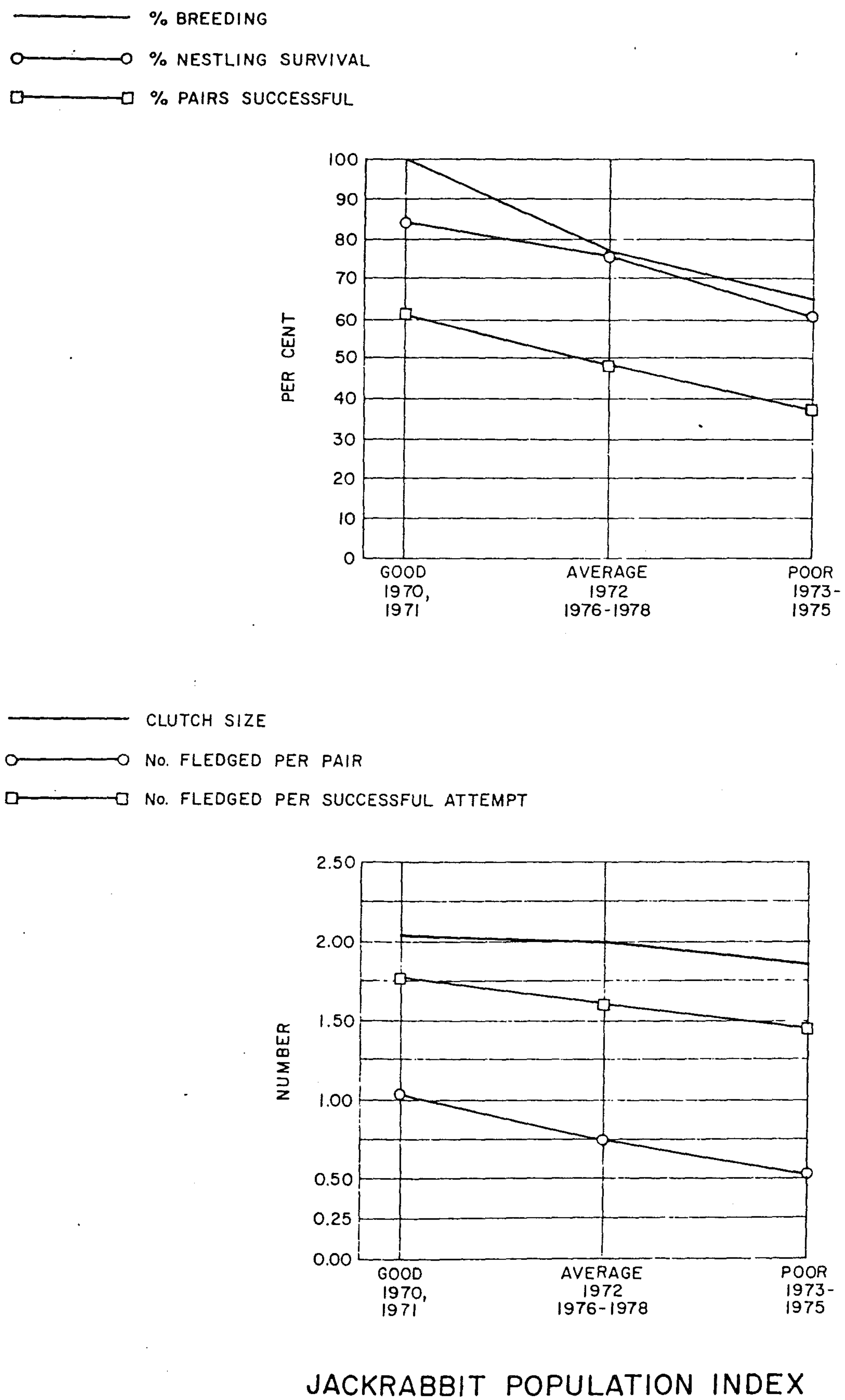

Figure 4. Golden eagle reproductive parameters as functions of the jackrabbit population index in the BPSA and Comparison Study Area, 1970-1971.

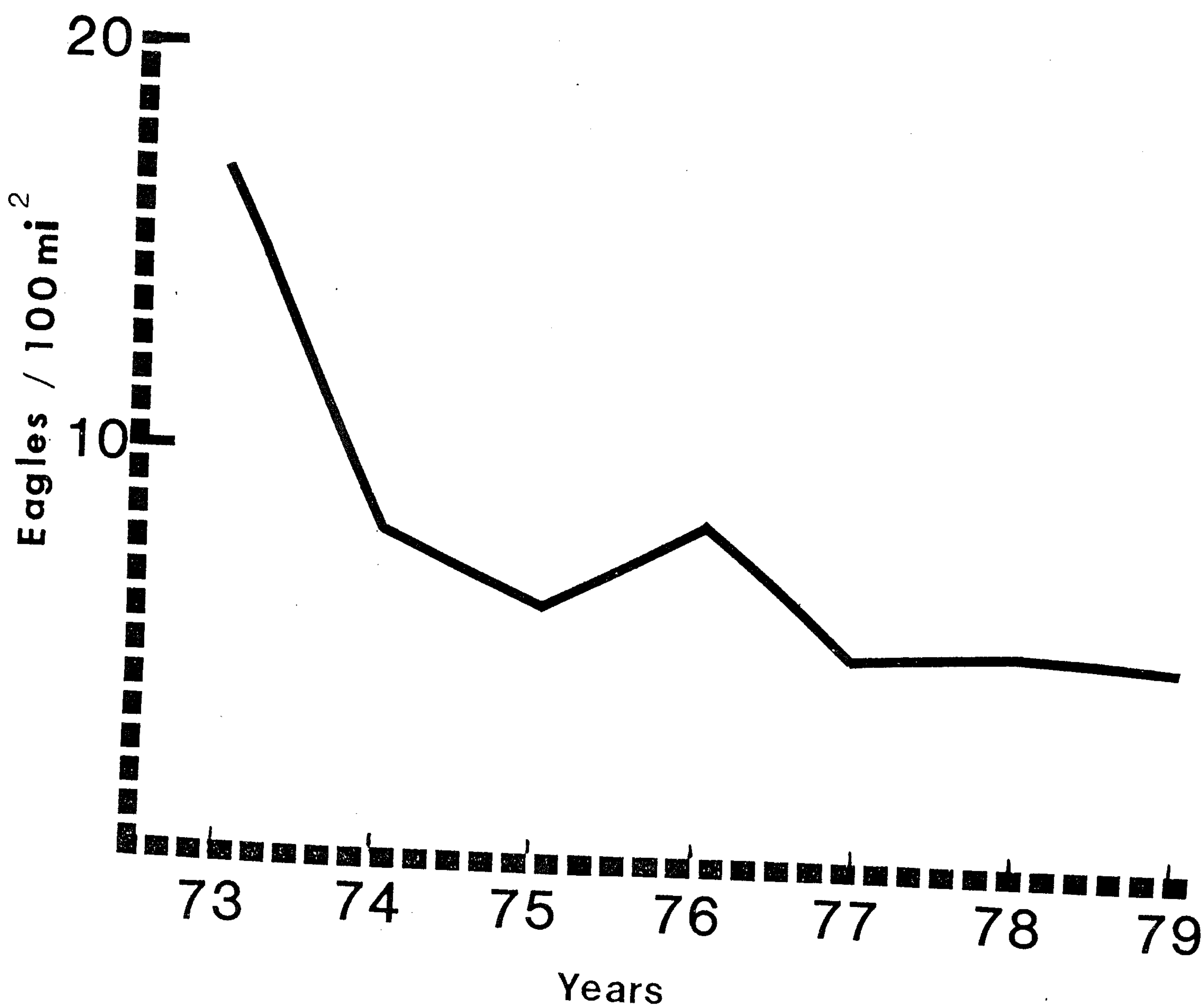

Figure 5. Mid-winter golden eagle population trends in southwestern *Idaho*, 1973-1979.

Figure 5. Mid-winter golden eagle popula[...] trends in southwestern Idaho, 1973-1979.

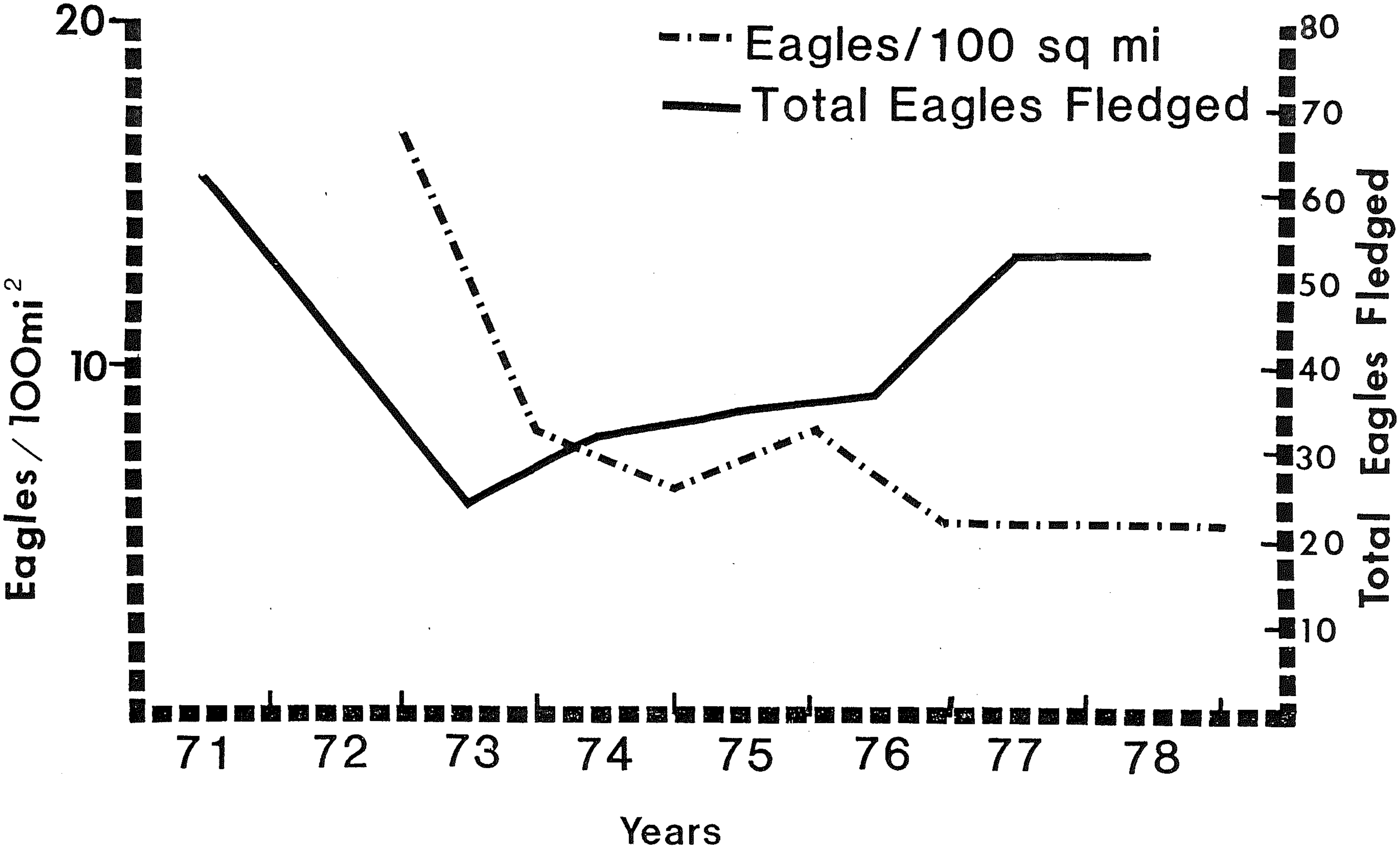

Figure 6. Comparison of mid-winter golden eagle population densities in southwestern Idaho with golden eagle productivity in the BPSA and Comparison Study Area, 1971-1979.

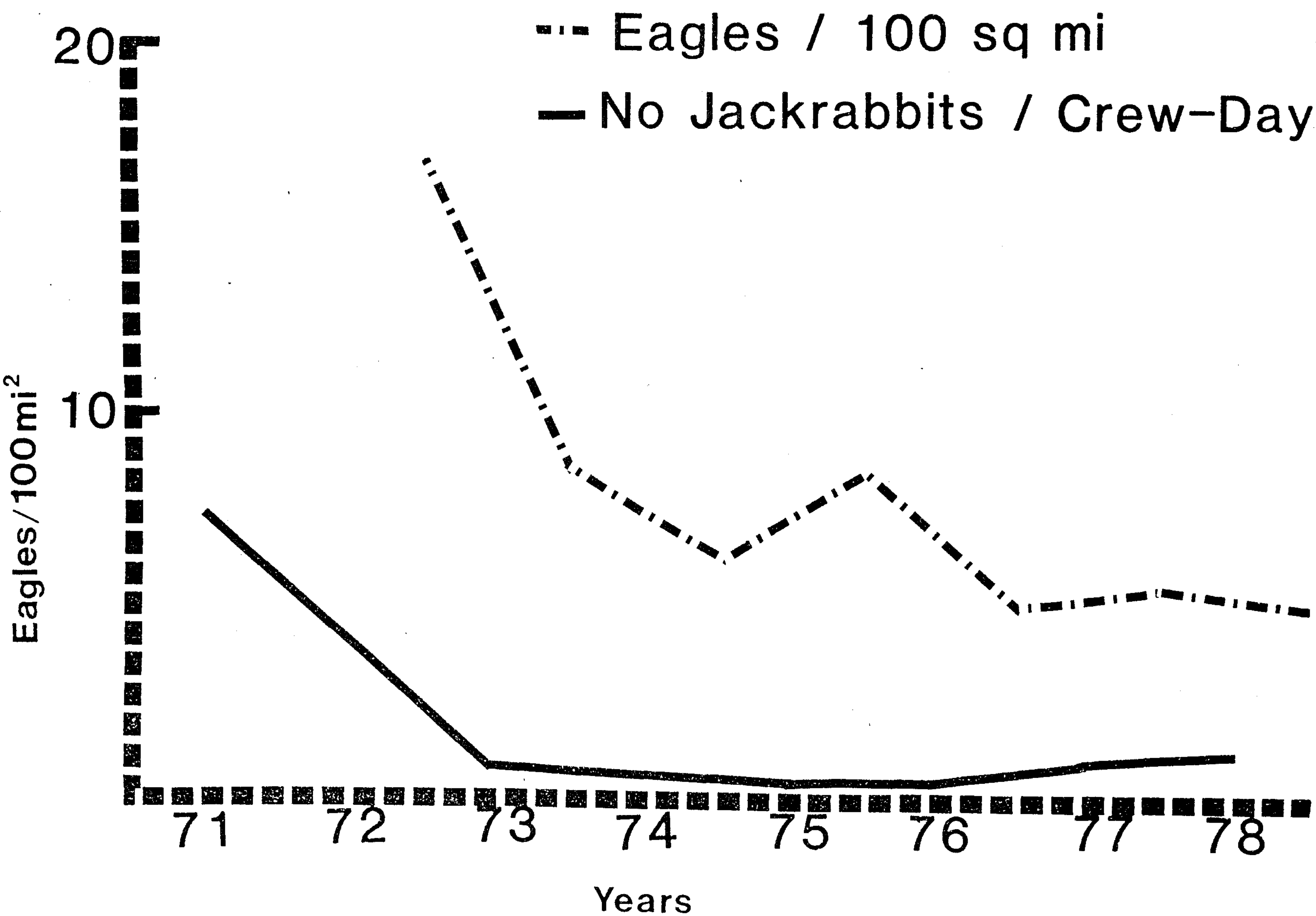

Figure 7. Comparison of mid winter golden eagle population densities in southwestern Idaho with the jackrabbit population index in the BPSA 1971-1979.

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Figure 7. Comparison of mid-winter golden eagle population densities in southwestern Idaho with the jackrabbit population index in the BPSA, 1971-1979.

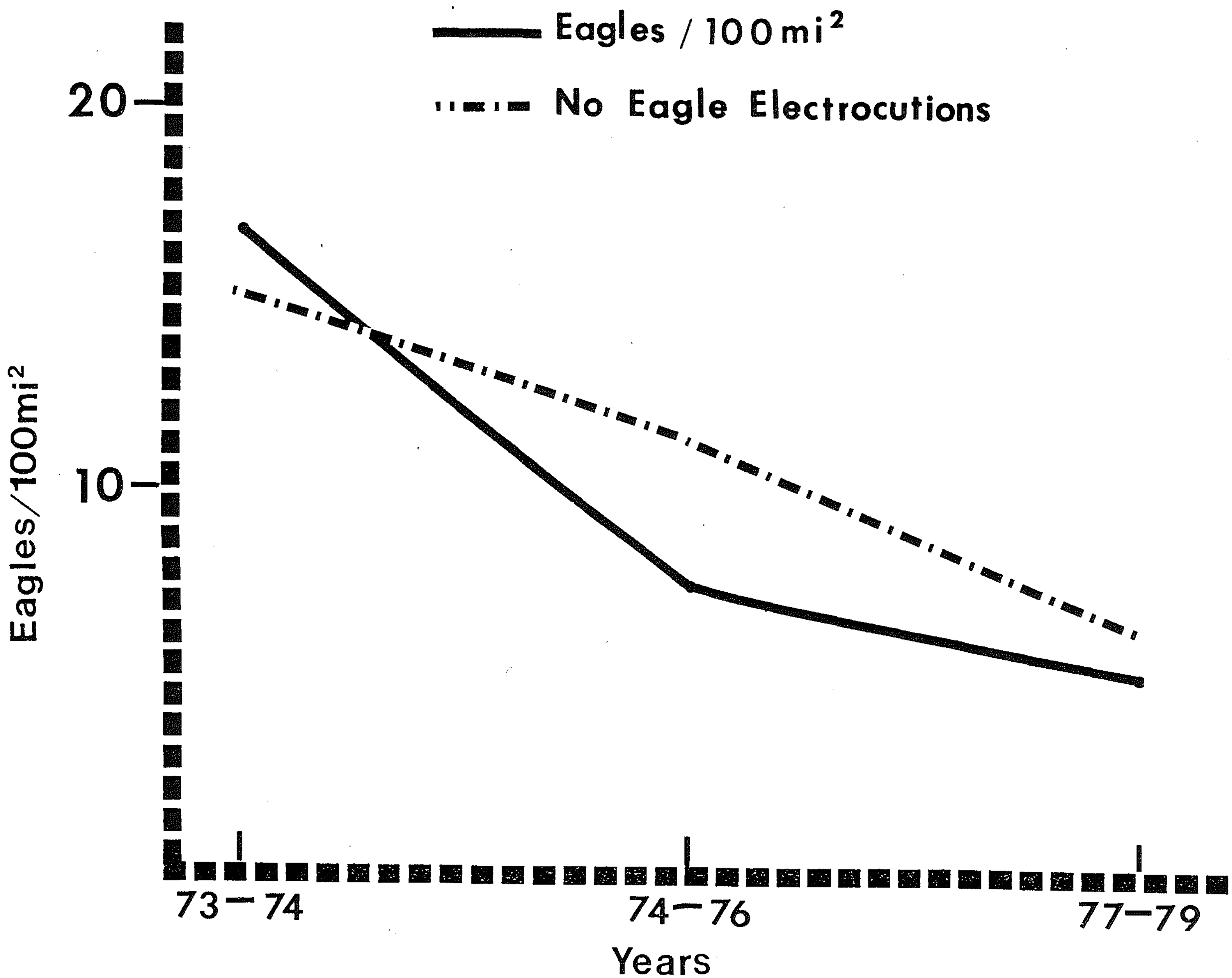

Figure 8. Comparison of mid-winter golden eagle population densities in southwestern Idaho with the annual number of eagle electrocutions reported in Idaho to the U.S. Fish and Wildlife Service, 1972-1979.

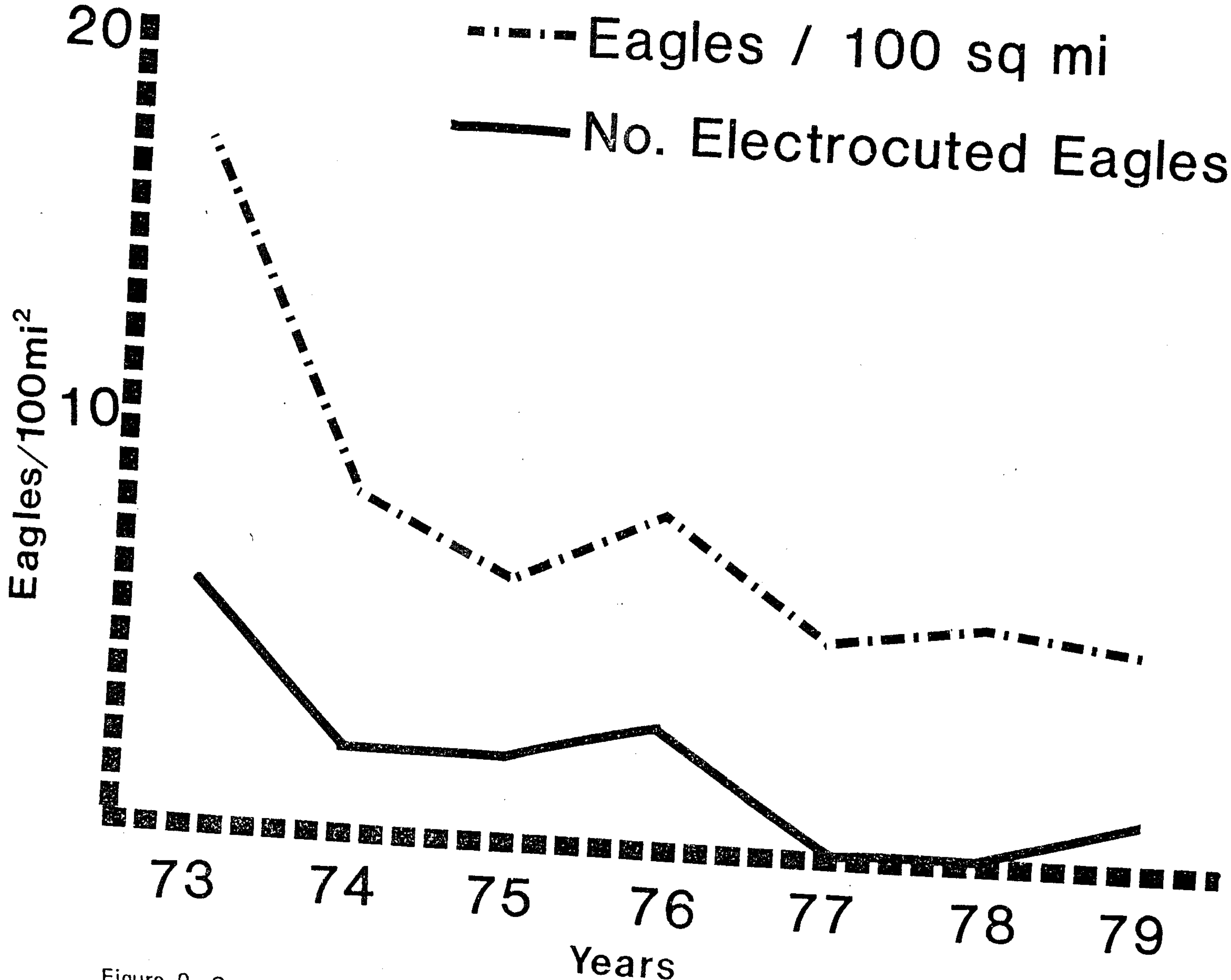

Figure 9. Comparison of mid-winter golden eagle densities in southwestern Idaho with the annual number of electrocuted golden eagles found in the BPSA, 1973-1979.

A STUDY OF WINTERING BALD EAGLES TO ASSESS POTENTIAL IMPACTS FROM A PROPOSED 230-kV TRANSMISSION LINE

by James R. Meyer, Wildlife Biologist

ABSTRACT.--A biological study of the Northern bald eagle (*Haliaeetus leucocephalus alascanus*) was conducted from November 1978 through April 1979 to assess the potential impacts from Bonneville Power Administration's proposed 230-kV transmission line project in Northwestern Montana and Northern Idaho. Bald eagles' use of wintering habitat was investigated on the Pend Oreille and Kootenai Rivers. The overall impact of the proposed project was considered to be minor and not likely to jeopardize the continued existence of the bald eagle.

INTRODUCTION

Bonneville Power Administration (BPA) has proposed construction of a 230-kV transmission line in Northwestern Montana and Northern Idaho. This proposed line would cross two areas, the Pend Oreille and Kootenai Rivers, which are used by Northern bald eagles (*Haliaeetus leucocephalus alascanus*) as wintering grounds. Because of the endangered species status of the bald eagle in Montana and Idaho (U.S. Dept. Interior, 1978), BPA was required to enter into formal consultation with the U.S. Fish and Wildlife Service (FWS). Formal consultation is required by Section 7 of the "Endangered Species Act" of 1973. Due to the lack of information on the bald eagle in these areas, BPA conducted a study (November 1978-April 1979) to aid the FWS in preparing its biological opinion on the impacts of the proposed project on the eagle (Meyer, 1979). The information presented in this paper is derived largely from that study.

STUDY AREAS

The Pend Oreille River study area consisted of that portion of the river between Sandpoint, Idaho and Albeni Falls Dam, a river distance of approximately 45 km (Fig. 1). Numerous wetlands occur along the river and the slopes are largely vegetated with Douglas fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) habitat types. The proposed route for the 230-kV line on this portion of the project will replace an existing 115-kV transmission line on the north side of the river. In most areas this portion of the line will be 0.3 to 0.8 km from the river. The proposed line will also cross the Pend Oreille River and head south of Rathdrum, Idaho on a new corridor. Four alternative route locations have been identified (A, B, C, D--Fig. 1). but the proposed route has not been chosen.

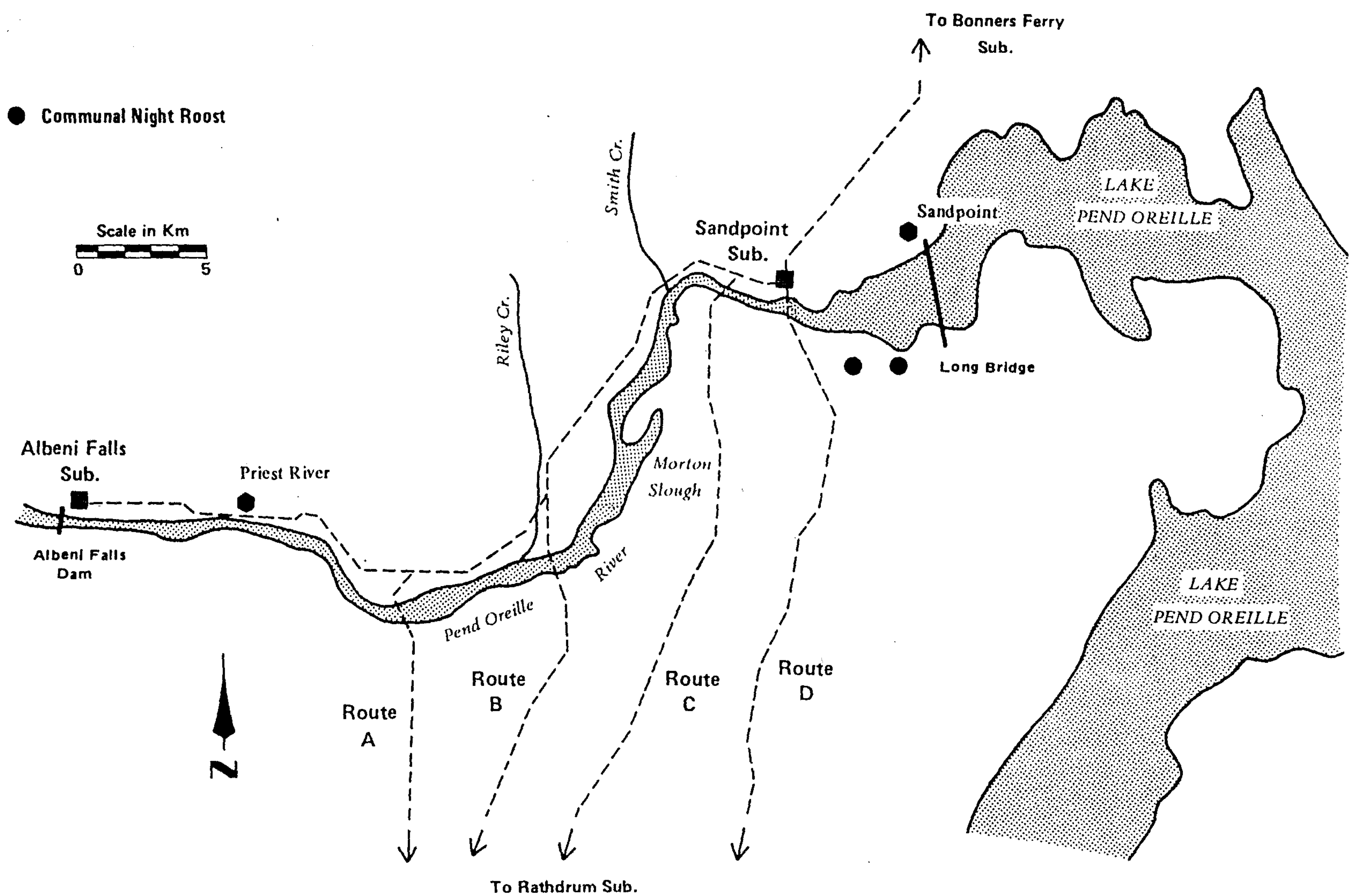

Fig. 1. Pend Oreille River study area.

The proposed 230-kV line between Sandpoint substation and the crossing of the Pend Oreille River will be double-circuit and require a right-of-way width of 30 m. Tower heights for the double-circuit line will be approximately 43 m. A single-circuit 230-kV line will be constructed from and include the river crossing west of Sandpoint, and run south of Rathdrum. The line will also be single-circuit between the river crossing and Albeni Falls Dam. Tower heights for the single-circuit line will be approximately 30 m and require a right-of-way width of 38 m.

The Kootenai River study area was that portion of the river between Bonners Ferry, Idaho and Libby, Montana; a river distance of approximately 112 km (Fig. 2). The terrain along the river is largely mountainous and covered with Douglas fir and ponderosa pine habitat types.

The proposed 230-kV line will be double-circuit and largely replace an existing 115-kV line (same characteristics as described for the double-circuit line on the Pend Oreille River). In most areas the proposed line will be approximately 0.8 km or more from the river. The exception is the portion between Kootenai Falls and Quartz Creek. Here the line will be adjacent to the river, usually between 30 and 183 m. Also along this portion of the project the existing right-of-way will be expanded to bring it to the required 30 m width. The proposed line will cross the Kootenai River at 4 locations.

Craighead and Craighead (1979) studied bald eagles on the Kootenai River between Libby Dam and Libby, Montana (LAURD area) for the Army Corps of Engineers, so this area was not included in BPA's study.

Overhead groundwires for both the single-circuit and double-circuit 230-kV lines will be used within 1.6 km of the substations. This will require groundwires on proposed crossing B and D of the Kootenai River. Proposed crossing D is located in the area studied by Craighead and Craighead (1979). Construction is scheduled to begin in early spring of 1981 and will be done in phases over the project area. Final energization is planned for the fall of 1983.

METHODS

Data collection consisted of two main activities, bald eagle censuses and behavioral observations. Bald eagle censuses were conducted using aerial and ground surveys. Aerial census was done monthly with a Bell Jet Ranger helicopter and ground census was conducted weekly by car. A standardized driving route was followed with strategic stops to look for eagles. Ground censuses were usually begun about one hour after daylight and aerial censuses somewhat later, usually in late morning. The portion of the Kootenai River between Bonners Ferry and the Yaak River was censused only from the air due to poor accessibility by road.

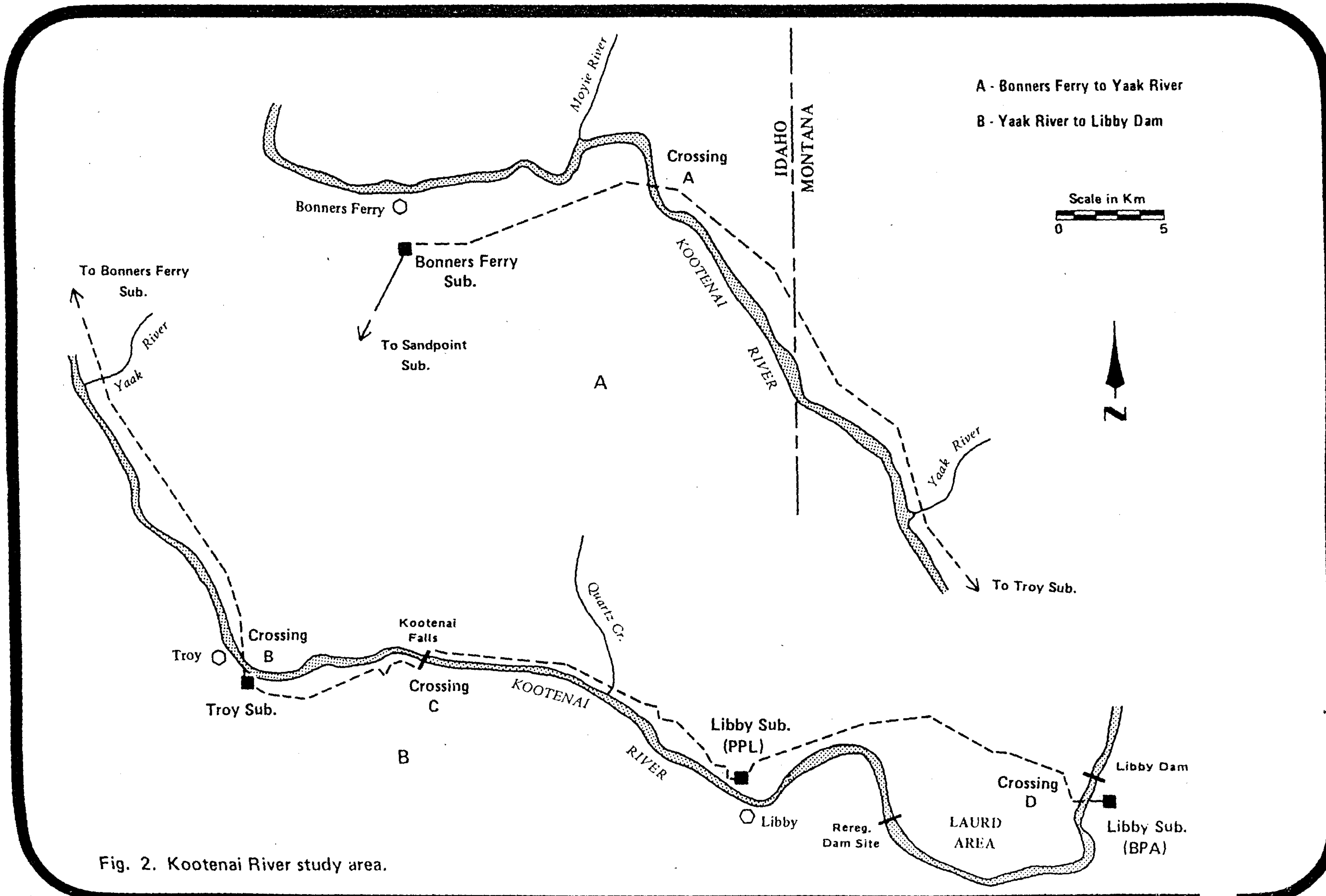

Fig. 2. Kootenai River study area.

Observations of eagle behavior were conducted to determine locations of feeding, perching, and roosting areas. When eagles were observed they were recorded as immature or adult based on the presence of a white head and tail for the latter. Information was also recorded on type of perch, perch tree distance from the river, and approximate height of eagle flights. Daylong observations (daylight to dark) were conducted at alternative crossings A and D of the Pend Oreille River and proposed crossing C of the Kootenai River to obtain information on eagle movement at these locations.

Distribution of eagles for the study areas is based on the total eagles observed during census counts. Results of perch type, perch distance from the river, and flight heights are based on the total eagles observed perched or flying. These include eagles observed during behavioral observations and census counts.

RESULTS AND DISCUSSION

Bald Eagle Population, Habitat Use, and Behavior

The first survey of the study areas for bald eagles was on 6 and 7 November 1978. It is likely eagles were using the Pend Oreille and Kootenai Rivers earlier (early October) as the first bald eagle in the LAURD area of the Kootenai was observed on 27 September 1978 (Craighead and Craighead, 1979).

Pend Oreille River

Counts of bald eagles during November and December indicate there was a small number of eagles using the Pend Oreille River (Table 1). During this time eagles were scattered along the river and were usually observed as singles or in pairs. In January there was a large increase in the number of eagles, which appeared to coincide with the on set of cold temperatures which froze many of the waterways in the area. The peak number of eagles was observed on 19 January with 29 adults and 7 immatures counted.

The majority of eagles observed were concentrated between Sandpoint and Smith Creek. This area contained 66 percent of the eagles observed during census counts. The primary reason for bald eagles concentrating on this portion of the river was the large number of wintering American coots (*Fulica americana*), which were the eagles major food source. The remaining eagle distribution was 21 percent for Smith Creek to Riley Creek and 13 percent for Riley Creek to Albeni Falls Dam.

The primary area used by bald eagles for perching and feeding was riparian habitat along the river. Surrounding hillsides were used primarily for roosting and to a lesser extent for day perching. Perches were used extensively throughout the day with certain perches being preferred over others. Five species of trees were used. Use of these

TABLE 1. Bald eagle census counts of the Pend Oreille River (Sandpoint to Albeni Falls Dam)

Date	Number of Bald Eagles		
	Adult	Immature	Total
7 November 1978[a]	12	1	13
15 November 1978	6	2	8
20 November 1978	3	2	5
27 November 1978	4	2	6
4 December 1978	9	1	10
11 December 1978	7	2	9
13 December 1978[a]	12	1	13
18 December 1978	5	1	6
4 January 1979	16	3	19
8 January 1979	17	4	21
15 January 1979	18	7	25
19 January 1979[a]	29	7	36
23 January 1979	14	4	18
30 January 1979	14	2	16
2 February 1979[a]	25	6	31
7 February 1979	12	2	14
10 February 1979	11	4	15
13 February 1979	11	2	13
21 February 1979	9	2	11
26 February 1979[a]	10	3	13
27 February 1979	7	2	9
7 March 1979	5	2	7
12 March 1979	6	2	8
19 March 1979[a]	11	1	12
22 March 1979	8	1	9
27 March 1979	1	0	1
29 March 1979	1	0	1
4 April 1979	0	0	0
19 April 1979[a]	0	0	0
TOTAL	283	66	349

[a]Aerial census.

perches was as follows (based on a total of 397 eagles): Douglas fir 37.3 percent; cottonwood (Populus trichocarpa) 23.7 percent; ponderosa pine 12.1 percent; western larch (Larix occidentalis) 11.8 percent; and quaking aspen (Populus tremuloides) 0.8 percent. Snags, usually dead ponderosa pine were also used (14.1 percent) and on one occasion an immature bald eagle was observed perched on a wood structure of the 115-kV line (0.2 percent). Seventy-three percent of the eagles used perches within 30 m of the river. The remainder were distributed from the river as follows: 14 percent were 30 to 76 m; 5 percent were 76 to 152 m; and 8 percent were further than 152 m. Steenhof (1976) found that proximity of perch trees to the river and to a food source was one of the more important factors in habitat selection.

During November and December when the number of eagles was low, no night roost sites were located. It appeared eagles were roosting individually or in pairs on the hillsides along the river. When the number of eagles increased in January two communal night roosts were located. Other studies (Hansen, 1977; Johnson, 1961; Wood, 1975) have found that eagles roost singly upon arrival at the wintering grounds and later communally as more eagles arrive.

Both night roosts were located on privately owned land on the south side of the river south of Sandpoint. The first night roost consisted of a group of cottonwoods situated in a small flat approximately 245 m from the river. The roost is protected from the river by a stand of Douglas fir and western larch. An interesting feature is that a well-traveled road passes within 15 m of the roosting trees. The roost is approximately 3 km from the nearest transmission line route (alternative route D). During its peak use (mid-January) 18 eagles were counted at the roost. The other night roost consisted of two snags in a stand of western larch. This roost was smaller, being used by only 3 to 5 eagles. It was in a small basin on the hillside approximately 0.6 km from the river. The closest alternative transmission line route (route D) is approximately 1.1 km southwest of the roost. These roosts did not account for all the eagles using the river near Sandpoint, so I believe additional roosting sites existed in this general area.

The majority of eagles arrived at the roost just before sunset, with immatures having a tendency to arrive earlier than adults. Eagles started departing the roost at dawn; the majority left shortly after dawn. However, arrival and departure times are known to be influenced by weather conditions (Ingram, 1965; Shea, 1973). Eagles usually arrived and departed the roosts as singles. Most eagles leaving the roosts flew directly to feeding areas along the Pend Oreille River (Sandpoint area). Flight heights were usually just above the tree tops or approximately 30 to 60 m above the ground. In early spring (March) eagles resumed roosting singly and in pairs.

Bald eagle feeding habits appeared to shift during the course of the winter. Early in the winter when eagles were few and scattered along the river, they were observed capturing free-swimming fish and feeding on waterfowl. As the waterways in the area froze and eagles were concentrated near Sandpoint, American coots appeared to make up a large part of their diet. With the onset of spring when sloughs in the area started to thaw, eagles returned to a fish diet which consisted of winter-killed catfish and perch. Peak feeding times were in early morning and late afternoon.

Eagles movement occurred throughout the day as birds changed perching locations or went about feeding activites. The greatest amount of movement occurred near sunset and sunrise when eagles were moving to and from roosting areas. I estimated that 30 percent of observed eagle flights (223 total flights) were less than 30 m above the river, 58 percent were between 30 and 60 m, and 12 percent were above 60 m. Soaring occurred infrequently, usually on warm winter and spring afternoons.

Observations of eagle flight intensity were conducted at alternative river crossings A and D to determine eagle movement along the river. River crossing A is the route farthest to the west and farthest from the major eagle concentration area. This area received very little use by bald eagles. During 5 days of observation (45 hours) a total of 4 eagles were observed. Alternative river crossing D is the route farthest to the east and closest to the major eagle concentration area. Flight intensity was higher, with 29 eagles observed during 6 days of observation (53 hours).

Kootenai River

The Kootenai River supports a smaller wintering bald eagle population than the Pend Oreille River, due primarily to the difference in food availability. Craighead and Craighead (1979) found that the LAURD area of the Kootenai River was more important as a stop over for migrating eagles than as a wintering area. They estimated 350 eagles passed through this area on their southward migration. For the Kootenai River (Libby Dam to Porthill-Canadian border) they estimated the wintering bald eagle population at approximately 40. This appears to be a reasonable estimate based on data collected during my study.

Table 2 gives the counts of bald eagles for the Kootenai River. Approximately 10 eagles, mostly adults, wintered on the portion between Bonners Ferry and the Yaak River. The major concentration centered near the mouth of the Moyie River. For the portion of the Kootenai between the Yaak River and the Libby, censuses indicated the peak number of bald eagles occurred in early December, with a high count of 14 (Table 2).

TABLE 2. Bald eagle census counts of the Kootenai River (Bonners Ferry to Libby)

Area/Date	Number of Bald Eagles: Adult	Immature	Total
Bonners Ferry to Yaak River			
6 November 1978[a]	5	0	5
13 December 1978[a]	9	1	10
19 January 1979[a]	8	0	8
2 February 1979[a]	8	0	8
26 February 1979[a]	10	0	10
19 March 1979[a]	1	0	1
19 April 1979[a]	0	0	0
TOTAL	41	1	42
Yaak River to Libby			
6 November 1978[a]	5	0	5
14 November 1978	4	1	5
21 November 1978	7	2	9
30 November 1978	6	4	10
5 December 1978	5	5	10
13 December 1978[a]	8	6	14
14 December 1978	8	4	12
18 December 1978	7	3	10
5 January 1979	4	0	4
12 January 1979	4	0	4
18 January 1979	5	1	6
19 January 1979[a]	6	0	6
25 January 1979	5	1	6
31 January 1979	4	0	4
2 February 1979[a]	6	0	6
8 February 1979	6	1	7
15 February 1979	5	0	5
22 February 1979	5	0	5
26 February 1979[a]	6	0	6
28 February 1979	4	1	5
8 March 1979	4	0	4
13 March 1979	2	0	2
16 March 1979	3	0	3
19 March 1979[a]	2	0	2
23 March 1979	1	0	1
30 March 1979	0	1	1
5 April 1979	2	0	2
19 April 1979[a]	0	0	0
TOTAL	124	30	154

[a]Aerial census.

After the peak date, approximately 7 eagles (6 adults and 1 immature) wintered here. The area of the heaviest eagle concentration was between Kootenai Falls and Quartz Creek, which contained 40 percent of the bald eagles observed during census counts. For the remainder of this portion of the Kootenai, eagle counts were distributed as follows: 24 percent for Kootenai Falls to Troy; 21 percent for Troy to the Yaak River; and 15 percent for Quartz Creek to Libby.

As on the Pend Oreille River, a large portion of bald eagle activity was devoted to perching. Six species of trees were used as perches. Eagles perched in cottonwoods 43.2 percent of the time (based on a total of 243 eagles), Douglas fir 24.3 percent, ponderosa pine 14.4 percent, western larch 7.4 percent, western redcedar (Thuja plicata) 1.2 percent, and paper birch (Betula papyrifera) 0.4 percent. Snags were also used as perches (9.1 percent). The greater use of cottonwood and Douglas fir was possibly due to the predominance and river bank location of these two species. The majority of perch trees were within 30 m of the river. This area accounted for 81 percent of the perched eagles counted. Fourteen percent of the eagles used perches 30 to 76 m from the river, 3 percent were 76 to 152 m. and 2 percent were further than 152 m. However, eagles' use of hillsides along the river (greater than 152 m from the river) is probably underestimated, as observations of eagles in these areas were difficult.

Approximately 68 percent of the eagles observed between Kootenai Falls and Quartz Creek were on the north side of the river. This side contains the existing 115-kV line and is opposite the railroad and highway. Stalmaster (1976) found bald eagles avoid disturbance by perching in areas relatively low in human activity. This could be an explanation for the greater use of the north side of the river by eagles.

No communal night roosts were located along the Kootenai River during this study or by Craighead and Craighead (1979). Eagles appeared to roost as singles on the hillsides. Several roosting areas were located on the south side of the river (side away from the proposed transmission line route) between Kootenai Falls and Quartz Creek. Arrival and departure times of bald eagles at roosting areas were similar to those on the Pend Oreille River.

Food availability appeared to be the factor limiting the number of wintering eagles on the Kootenai River. No concentrated food souce was available at any time to attract and hold a large number of eagles. Feeding activity appeared to be highest in the morning, but eagles were observed feeding throughout the day. Fish was the major food item observed used by eagles. Craighead and Craighead (1979) observed heavy utilization of carrion on the LAURD area. Little carrion was found on the Kootenai River below Libby during my study. Waterfowl did not appear to be an important food item for eagles. No observations of eagles using waterfowl were made and Craigheads observed only two instances of eagles feeding on waterfowl.

Eagles usually arrived on the Kootenai River just after dawn where they would take up perches. Eagles would commonly move up and down the river as they changed from one perch to another. In late morning and early afternoon eagles tended to leave the river. I believe they moved to areas away from the river in search of food or took up perches on the hillsides. However, throughout the day eagle movement was observed between the river and adjacent hillsides. Eagles usually left the river for roosting areas between sunset and darkness.

Heights of bald eagle flights over the river were usually just above tree top height. Approximately 40 percent of observed flights (153 total flights) were less than 30 m above the river, 52 percent were 30 to 61 m, and 8 percent were greater than 61 m.

Observations of eagle movement across proposed river crossing C gave a total of 27 eagles during 6 days (54 hours). This river crossing likely had the highest eagle flight intensity as any on the Kootenai River as it was nearest the area to be affected by weather. No reactions of eagles with the existing 115-kV line were observed as eagle flights were usually above the conductors.

Potential Impacts

Four potential impacts of the proposed project concerning bald eagles need to be addressed. These are habitat loss, disturbance, electrocution, and collision mortality.

Habitat Loss

On the Pend Oreille and Kootenai Rivers, shoreline vegetation within the first 30 m of these rivers can be classified as essential perching habitat for the bald eagle. Within this zone particular trees were used as perches, but essentially all trees in this zone can be viewed as potential perches. Removal of a large number of trees in this area could be detrimental to the eagle.

For the proposed project removal of wintering eagle habitat will be minimal. The line will usually be located away from primary wintering areas and will largely follow existing right-of-way through them. Perching habitat may be removed at alternative crossing D of the Pend Oreille River and along the portion of the Kootenai River between Kootenai Falls and Quartz Creek. Roosting areas will not be affected as they are located away from the proposed and alternative routes.

Disturbance

Steenhof (1978) provided a literature review of human disturbance to bald eagles. Stalmaster (1976) and Stalmaster and Newman (1978) quantified disturbance factors for wintering bald eagles. These reports indicate human activity can cause eagles to abandon favorable use areas.

Stalmaster determined that 98 percent of wintering bald eagles tolerated human activities 300 m from them. However, only 50 percent of eagles tolerated disturbance at 150 m.

Disturbance will likely be a factor affecting wintering bald eagles between Kootenai Falls and Quartz Creek if construction occurs during October through March. In this area much of the construction activity will occur within 245 m of the river. This is within the activity restriction zone (300 m) suggested by Stalmaster (1976) to reduce disturbance to wintering eagles.

Much of the bald eagle wintering area is already traversed by roads. Limited construction of new access roads will occur in key wintering areas so disturbance to eagles should be minor in the long term.

Electrocution and Collisions

Electrocution of eagles can be a problem on distribution lines where the wing can contact two conductors or a conductor and a groundwire (Raptor Research Foundation, 1975; Nelson and Nelson, 1975). It is not a problem on high voltage transmission lines with more widely spaced conductors. Conductor spacing for the proposed tower types will be 5.2 m at the minimum. Average wingspread for bald eagles measured at Glacier National Park was 2 m (McClelland and Shea, 1978).

Bald eagles like any bird are susceptible to collisions with transmission lines. However, there have been no field studies to determine the extent of such mortality for bald eagles. Dead bald eagles sent to the U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center by federal, state, and private cooperators for autopsy, provides some information on the causes of bald eagle mortality. Because these data are not a random sample, the causes of death may not be representative for the population (Coon et. al., 1969). Mortality data for 1960 through 1974 indicate about 4 percent of eagle deaths were attributed to electrocution and 9.4 percent were due to impacts (Coon et al., 1970; Mulhern et al., 1970; Belisle et al., 1972; Cromartie et al., 1975; Prouty et al., 1977). A large portion of the impact mortality was attributed to collisions with power lines, usually distribution lines. However, much of this "collision" mortality might have been due to electrocution (Kroodsma, 1978).

A report prepared for Northern States Power Company (Pinkowski, 1977) concluded there was no apparent evidence power lines pose a collision hazard to bald eagles. The report was based on literature review and personal interviews. Kroodsma (1978) felt eagle collisions with power lines should not be a major problem, because the species has keen sight, flies relatively slowly, and manuvers well. Steenhof (1978) indicated collision potential would be greatest near roost sites. She believed transmission lines should not be constructed within 1.6 km of communal roosts because eagles use these areas during strong winds and poor light conditions, when the potential for accidents is high.

Data on mortality of other bird species (primarily waterfowl) from collision with transmission lines indicate collision mortality is relatively small (Meyer, 1978). Results from that study indicate transmission lines with stacked configuration and overhead groundwires cause greater collision mortality than flat type configurations. Approximately 86 percent of all observed collision mortality occurred with overhead groundwires.

The single-circuit 230-kV line that is proposed to cross the Pend Oreille River has the least potential for eagle collisions than other designs. This is due to the flat configuration and no overhead groundwires. Collision potential would be greatest at alternative crossing D. This crossing is closest to the major eagle concentration area and had the greatest amount of eagle movement near it. Collision potential decreases for the alternative routes to the west, with the least potential at alternative crossing A. At the Kootenai River crossings there is a greater potential for eagle collisions, as the proposed facility will be a double-circuit 230-kV line.

In my opinion, bald eagles are not immune to collisions with transmission lines. However, the amount of mortality from collisions that might occur on the study area should be small. Immatures would be more vulnerable to collisions than adults due to their lower flying ability.

Conservation and Recommendations

Route selection is the key to minimizing potential impacts to wintering bald eagles on the Pend Oreille River. The most westerly alternative route (route A) would have the least overall impact, while the most easterly alternative route (route D) has the greatest potential to impact the eagle. I would recommend either alternative route A or B as the proposed route, as they are away from the primary eagle wintering area. However, none of the alternative routes would threaten the existence of the bald eagle.

Conservation measures can reduce potential impacts to wintering bald eagles for the portion of the Kootenai River between Kootenai Falls and Quartz Creek. The two main concerns are disturbance and habitat loss. The first impact, disturbance, can be alleviated by timing of construction activities. No construction should occur on this portion of the Kootenai from October through March. Some habitat loss could occur within the primary perching area (first 30 m of the shoreline) with expansion of the existing right-of-way. When the proposed corridor is within this primary perching zone, the following recommendations are made: 1) widen the existing right-of-way on the side away from the river where possible; 2) remove only those trees that threaten operation of the line (i.e. danger trees); 3) leave all cottonwood trees if possible, trim if necessary or replant away from the line if they must be removed.

To reduce collision potential of the Kootenai River crossings the following recommendations should be considered: 1) construct two single-circuit 230-kV lines with flat configuration; 2) parallel the existing line crossings below Libby Dam (crossing D, LAURD area).

CONCLUSIONS

1) The Pend Oreille River supports a larger concentration of wintering eagles than the Kootenai River, apparently due to the difference in food availability.

2) The peak number of eagles on the Kootenai River (Bonners Ferry to Libby, Montana; 112 km) occurred on 13 December 1978 with a count of 24 eagles. On the Pend Oreille River (Sandpoint to Albeni Falls Dam; 45 km) the peak occurred on 19 January 1979 with a count of 36.

3) The Kootenai River is more important as a stop over for eagles during their southward migration than as a wintering area.

4) The major eagle concentration area on the Pend Oreille River was between Smith Creek and Sandpoint. On the Kootenai River concentration areas were near the mouth of the Moyie River and between Kootenai Falls and Quartz Creek.

5) The first 20 m of the Pend Oreille and Kootenai River is essential perching habitat for the bald eagle.

6) Potential impacts of the proposed transmission project include; increased collision potential; disturbance during construction; and some loss of perching habitat. However, these potential impacts should not be of enough significance for any of the routes to jeopardize the continued existence of the bald eagle.

7) Impacts can be reduced or alleviated by conservation measures. These include route selection, construction timing and transmission design considerations.

LITERATURE CITED

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OSPREY AND POWER POLES IN IDAHO

by Lawrence J. Van Daele, Department of Biological Science, University of Idaho, Moscow, ID

ABSTRACT.--Throughout their range, ospreys (*Pandion haliaetus*) frequently nest on power poles. This habit is advantageous because it provides the birds with good nest sites, increases public exposure to a large raptor, and facilitates scientific research. Disadvantages of these sites are an increased susceptibility of the osprey to human disturbance, more chances for osprey electrocutions, and power interruptions caused by hanging nest material. Management practices which can be used to minimize the adverse effects of power pole nests include the construction of artificial nesting platforms and/or nesting discouragement devices. All management activities should be coupled with a public education program for a better understanding of the osprey and the managing agency's activities.

INTRODUCTION

Ospreys are among the most obvious and widely distributed of the world's raptors. They can be quickly identified by their dark brown and white color pattern, long crooked wings and characteristic whistling chirp. Although they are seldom numerous, osprey populations can be found on most continents in areas with relatively clean water and an abundant supply of fish.

Ospreys are a terminal link in the aquatic food chain and are very susceptible to pesticides. During the middle of this century, some populations experienced drastic declines because of pesticide contamination and resultant egg-shell thinning (Ames 1966, Wiemeyer et al. 1975). Since the ban on the use of several pesticides in the early 1970s, the depressed osprey populations have shown an increase in productivity (Spitzer et al. 1978), to the point that they are no longer listed by the U.S. Fish and Wildlife Service under the Endangered Species Act of 1973 (U.S. Dept. of Interior 1979).

Idaho has one of the largest populations of breeding ospreys in the western United States. Ospreys occur in the summer months on all major rivers, lakes and reservoirs in the state. The largest concentration is in the Coeur d'Alene-Pend Oreille vicinity of northern Idaho, where over 180 pair nest every year (Melquist 1974). Another large concentration of osprey (57 pair) nest around Long Valley in the west-central portion of the state.

Research is currently being conducted by the U.S. Water and Power Resources Service (WPRS) (formerly U.S. Bureau or Reclamation) on the osprey nesting in Long Valley. The primary objective of this research is to develop a management plan to protect this osprey population in the face of increasing pressure from human development.

When ospreys arrive in Idaho in April, they begin courtship and nest building activities. Although ospreys probably mate for life, pair bonds are reinforced each spring by courtship displays (Brown & Amadon 1969). These displays usually consist of a series of undulating flight patterns by the male, along with a series of rapid whistles. Nests are constructed atop snags, live trees, power poles, or any other site which provides an unobstructed view and is within 2 km (1.25 miles) of water. The same nesting area is used annually by the same pair, although the actual nest site may change from one year to the next. As many as three nests may occur within a 100 m (328 ft) area, all having been built by the same pair in different years. Winter storms frequently destroy nests, but this presents no threat to the osprey, because they are such prodigious nest builders.

A typical nest is 1.5 to 2 m (5-6.5 ft) in diameter and is constructed of sticks 10 to 200 cm (4-79 in) in length. Nest bowls are lined with grass, bark, and mud. Prior to egg laying, both sexes share in the building responsibility. When building a new nest, an average of 30 sticks and 10 pieces of lining are brought in each day. At this rate, the nest is ready for eggs in three weeks. Little nest maintenance occurs throughout the five week incubation period (Fig. 1). Most incubation is done by the female (ca. 65%) while the male provides her with fish and the few pieces of nest material needed. Soon after the eggs hatch, in mid-June, large amounts of nesting material are again brought to the nest. Amounts of nesting materials brought to the nest continue to increase until the young are three weeks old. At this point, the nest is still maintained, though, a decreasing amount of material is collected until the young osprey leave the nest in August.

If an osprey pair is unsuccessful in raising a brood, they will often abandon their old nest site and build a 'frustration' nest nearby. Even though it is often well built, no eggs are laid in the frustration nest and the osprey will leave it as soon as it is completed. Reasons for these nests are not well understood.

OSPREYS ON POWER POLES

In several areas power poles provide osprey with an ideal nesting site. Poles are often near fishing areas, provide a stable base for a nest, and offer a commanding view of the surrounding area. Ospreys have their choice of sites along a power line and the male is assured of a nearby perching site, or 'pilot tree', from which he can observe the nest.

Nine percent of the osprey nests in Long Valley are on power poles and, 4 percent of the northern Idaho osprey nests were on power poles in

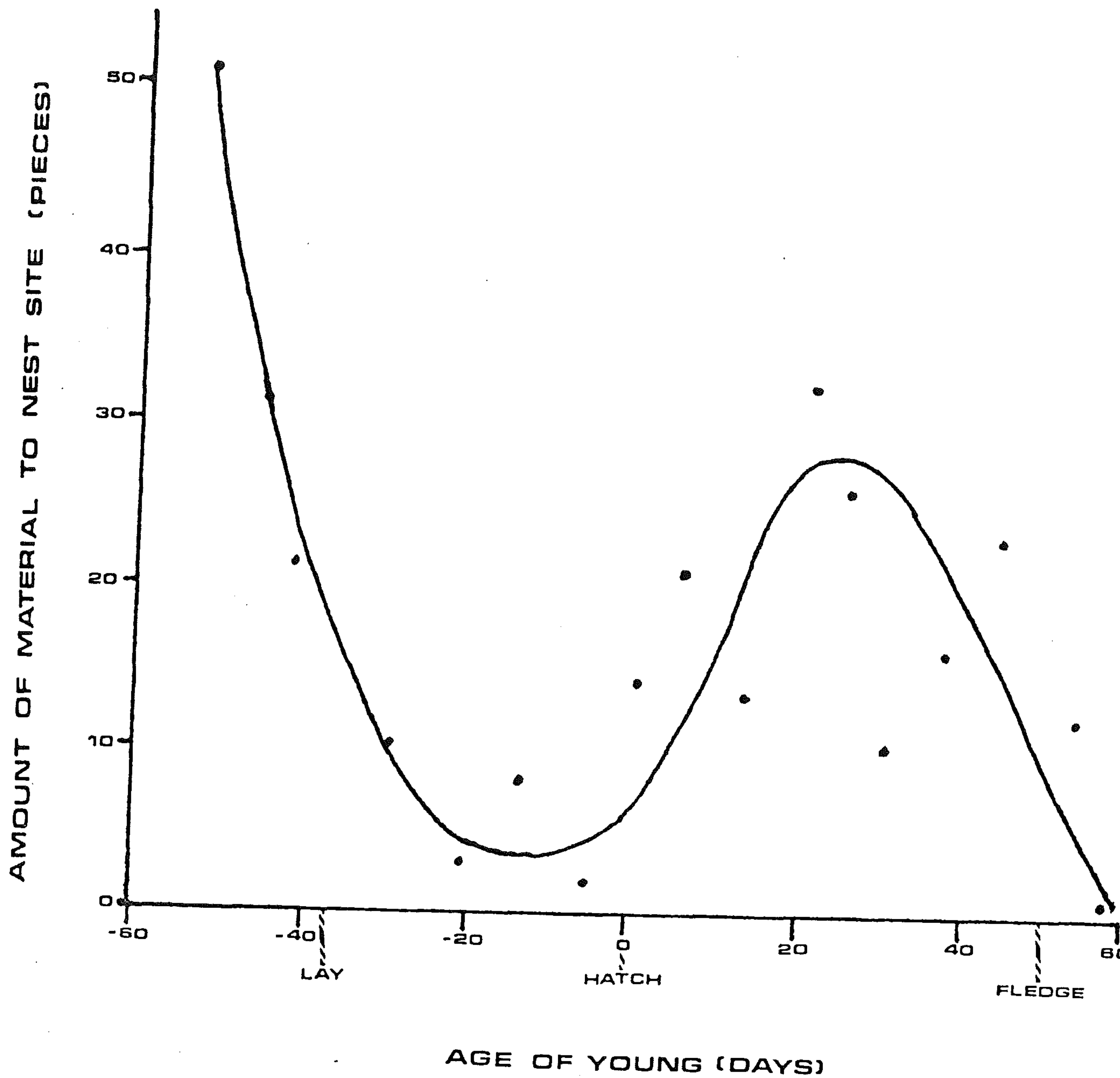

Figure 1. Timing of nest material deliveries by an osprey pair to build a new nest, Cascade Reservoir, Valley County, Idaho, 1979 (curve is an ocular estimate of the trend).

1972-73 (Melquist 1974). Since power poles nest sites are often superior to natural sites, this occurrence of nests on power poles probably does not indicate that natural sites are unavailable, as has been previously suggested (MacCarter & MacCarter 1979). Osprey nesting success and productivity on power pole nest sites have been higher than on natural sites in Long Valley. However in nothern Idaho, they have been lower than on natural sites (Melquist 1974). In both areas, the sample size of power pole nests was too small to demonstrate statistically significant differences. Overall, osprey productivity and success is probably not affected by the type of nest support structure.

In many cases, new power pole nests (i.e. those which are not built near a previous nest) are probably the work of sub-adult osprey. At about two years of age, ospreys return to their natal areas to establish pair bonds, build nests, and go through the motions of incubation, but do not lay any eggs. Soon after eggs are hatching on other nests, these sub-adults abandon their empty nests. The pair will usually return for the next nesting season to raise a brood from the same nest area (Henry & Van Velzen 1972). When observing power pole nest success, or osprey nest success in general, it is important to realize that not all ospreys that build nests will lay eggs.

OSPREYS AND MAN

Power poles provide ospreys with excellent nesting sites, however, since humans are inevitably associated with power poles, problems often arise. All ospreys will defend their nest sites if they are threatened, but most will tolerate human activity if their nests are high enough from the ground. Timing and duration of human activities are also important. Though ospreys will seldom abandon nests because of human disturbance, less tolerant individuals may be kept from their nests while attending eggs or young. If this occurs, embryos or offspring may become chilled and die.

Accessibility to power poles and the tolerant nature of ospreys nesting on these poles, offer a unique opportunity for raptor observation. The public can develop an appreciation for the birds through these observations. Research activities, including detailed behavior observations and banding, are also facilitated by these accessible nest sites. Power companies in both northern and west-central Idaho have cooperated with researchers in banding young ospreys at power pole nests.

Another disadvantage of power pole nests to osprey is the danger of electrocution. An osprey's wing span is similar to that of the golden eagle (*Aquila chrysaetos*), and eagle electrocutions (especially young of the year) are well documented (Miller et al. 1975). In the past couple of years only two electrocuted ospreys have been found in Idaho. Newly fledged ospreys have been observed attempting to land on power lines and making clumsy landings on poles, indicating that they are potentially susceptible to electrocution. As populations continue to increase, and more osprey utilize power poles, this potential for electrocutions will also increase.

Although ospreys are an important ecological and aesthetic resource, few people are sympathetic when electrical power is interrupted because of an osprey nest. Since ospreys are such prolific nest builders, these interruptions may occur frequently from wires brought in as nest material or from wet hanging sticks shorting the lines. This is the most important disadvantage, from the human standpoint, of osprey nests on power poles.

OSPREY NEST MANAGEMENT

To minimize adverse aspects of osprey nesting on power poles, some management practices must be implemented. Idaho Power Company is currently placing artificial nesting platforms on poles where osprey nests have presented a problem. These platforms are large enough to support a nest, yet they are raised above the pole itself to lessen chances of lines being shorted by nesting material.

Artificial nesting platforms are also being used in the WPRS study of the Long Valley osprey population. These platforms are similar to those used by Idaho Power, except they are on poles (not power poles) in selected WPRS wildlife areas around Cascade Reservoir (Fig. 2) (Rhodes 1977). WPRS nesting platforms are being used to investigate factors which influence osprey nest site selection, and also to provide a good setting for studies on behavior and diet. Osprey have had no problem in accepting these and other nesting platforms (Postupalsky 1978), three osprey pairs successfully nested on WPRS platforms in 1979, although it may take a couple of years before they are recongnized as nest sites.

Artificial nesting platforms are not always the solution to osprey nesting problems. Before any nesting platforms are constructed, the land manager must ask: 1) is there a lack of adequate nesting sites in the locality, 2) are the platforms needed for research, 3) are the platforms needed to protect a particular osprey pair which has traditionally nested on a pole and caused problems, or, 4) are the platforms to be used as a public relations tool? All of these factors are legitimate reasons for erecting osprey nesting platforms. However some caution should still be exercised, especially in public relations situations. Platforms should not be placed in areas of intense human activity since some nesting pairs are sensitive to disturbance. Platforms should not be placed near fish hatcheries or private fishing ponds as depredation problems will undoubtedly result. Finally, platforms should be high enough from the power lines (at least 2 m) to prevent nest material from contacting with conductors. Poorly placed or constructed nesting platforms will cause more harm than good.

In locations where osprey nests and nesting platforms are deemed disadvantageous, measures should be taken to discourage nesting. Following fall migration in October, the problem nest should be removed and replaced with a device on which the ospreys cannot place sticks in the future, such as a PVC plastic pipe section above the crossarms of the pole (Fig. 3). This discouragement will not harm the ospreys, as they will find another site, and will alleviate further problems. Discouragement devices should also be placed on poles adjacent to other osprey nests and nesting platforms to dissuade ospreys from using these structures for supplemental or frustration nest sites. Providing a

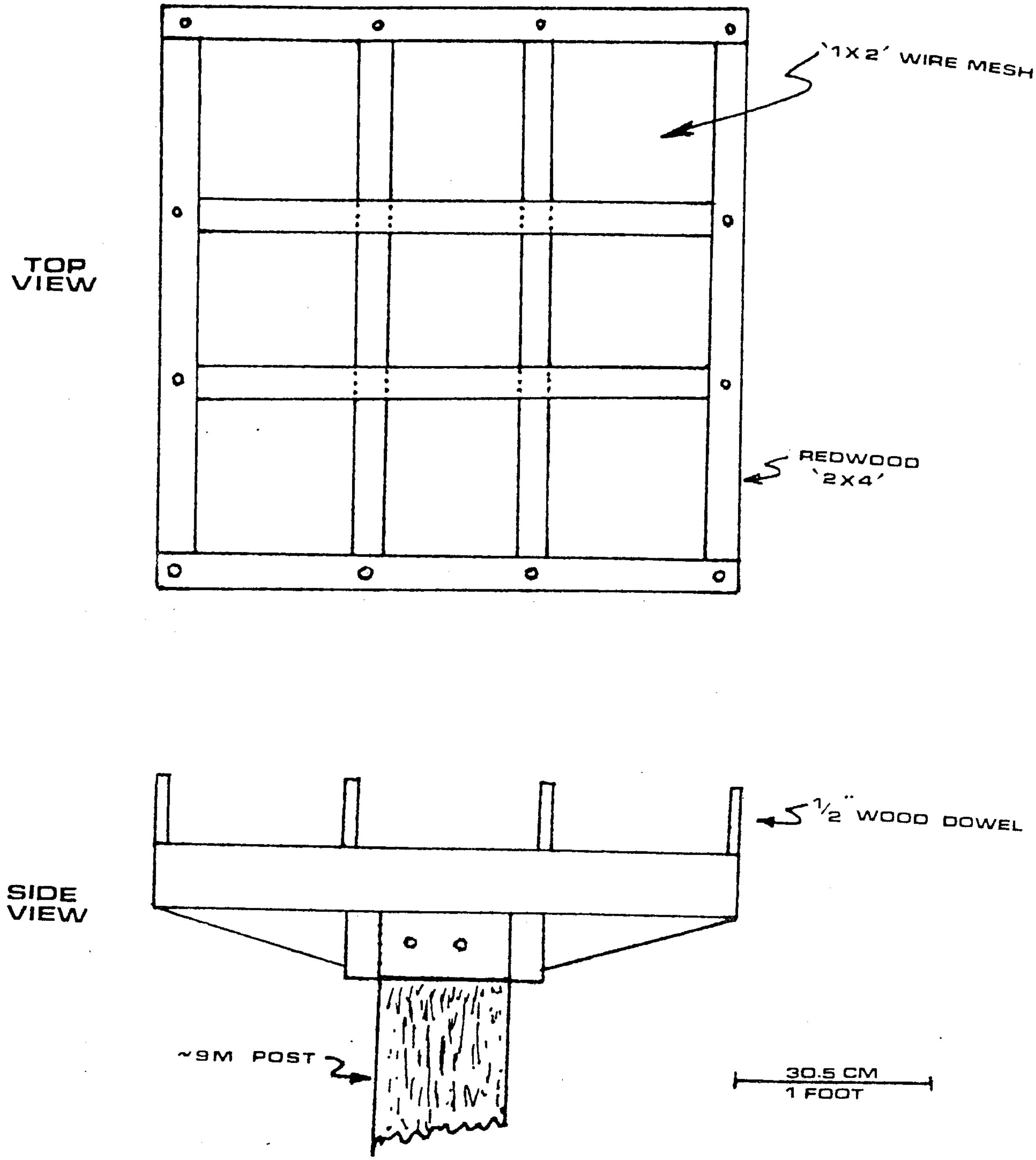

Figure 2. Artificial nesting platform used by the U.S. Water and Power Resources Ser[vice] for ospreys at Duck Creek Wildlife Area, Cascade Reservoir, Valley County, Idaho. Detailed plans for this platform are available from: Bob Adair, Environmental Specialist, U.S. Water and Power Resources Service, Box 043, 550 W. Fort Street, Boise, Idaho, 83724.

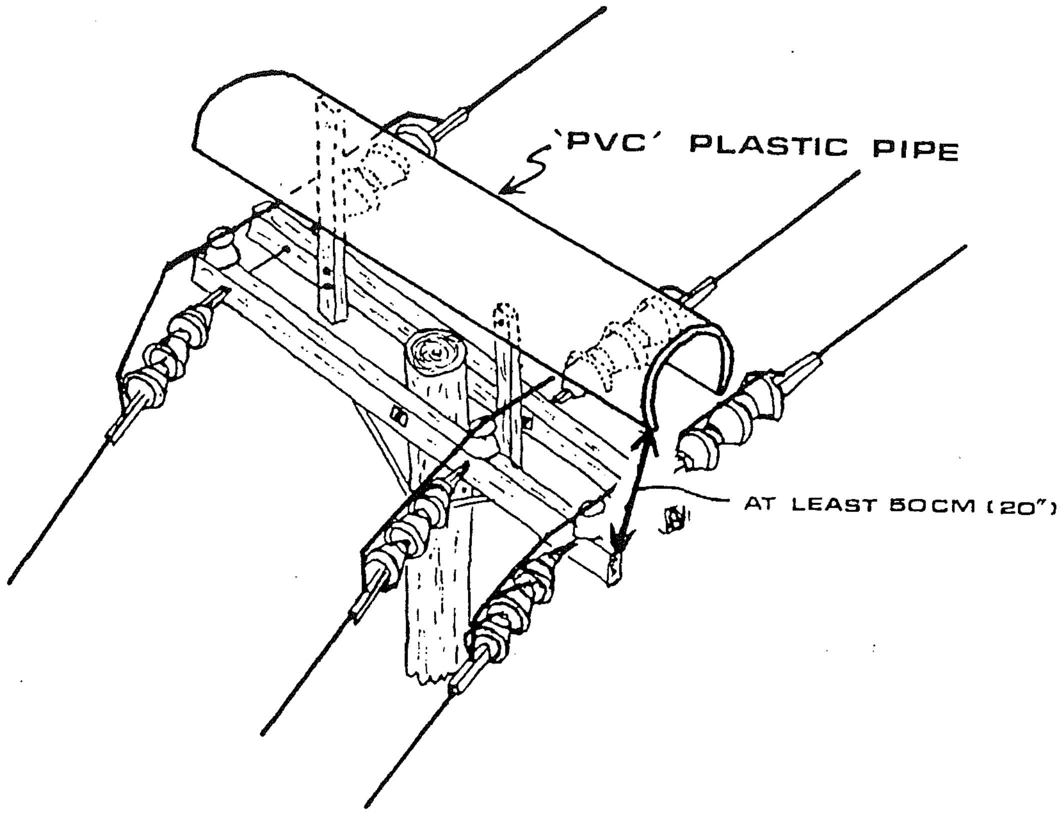

Figure 3. Example of an osprey nesting discouragement device for a double crossarm power pole (note: this design has not been field tested).

safe substitute nest site might also be used to prevent a pair from attempting to nest in another, unfavorable, location.

Areas supporting osprey populations should be treated similarly to those areas with golden eagle populations. Power pole construction and alteration should reflect the guidelines presented by Morlan W. Nelson (Miller et al. 1975) to reduce golden eagle electrocutions.

Ultimately, all osprey management decisions should be coupled with some degree of public education. Factors leading to the management decision and probable results of the action should be explained. Articles in local newspapers and/or signs near the area where management action is being taken are sufficient for notifying the public. A better understanding and respect for the birds and the managing agency will result from a public education program.

SUMMARY

Ospreys are common summer residents of Idaho's waterways. Their nest building activities on man-made structures such as power poles have both advantages and disadvantages for ospreys and man. With proper management practices we can continue to live in harmony with the osprey, as competition for land and the demand for electrical power around these areas continues to increase.

ACKNOWLEDGMENTS

I thank the U.S. Water and Power Resources Service for initiating and providing the funding for the Long Valley, Idaho osprey project on which I am working, and from which much of this information is taken. I also thank D.R. Johnson, H.A. VanDaele, W.B. Kessler, E.O. Garton, E.J. Larrison, P.L. Kennedy and K.R. Moore for their critical review and comments on this paper.

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RAPTOR NESTING PLATFORMS AND THE NEED FOR FURTHER STUDIES

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ABSTRACT.--Artificial nesting structures have been placed in 400 kV d.c. transmission towers in central North Dakota to provide additional nesting habitat for raptor species in that area. Three different types of nesting platforms were regularly spaced over approximately 80 miles of the line. One type is wooden and follows the designs suggested by Morlan Nelson for Idaho Power and Light. The other two are experimental designs developed by Commonwealth Associates in conjunction with United Power Association. The latter two designs are somewhat less expensive to construct and should realize a greater longevity. Additional studies are recommended which might enhance the few positive aspects of transmission line - raptor interactions.

The use of electrical transmission and distribution poles or towers by raptors for perching and nesting has been well documented (Gilmer and Wiehe, 1977; Stahlecker and Griese, 1979 and many others). This adaptation appears particularly common in the Great Plains area, although it is not clear if this apparent regional phenomena is the result of habitat limitations or the increased visibility of such behavior in the nearly treeless short and midgrass prairie regions.

In March, 1977, the North Dakota Public Service Commission (NDPSC) issued a permit, as a result of case No. 9370, to Cooperative Power Association (CPA) and United Power Association (UPA) to construct a ± 400 kV d.c. transmission line across the eastern half of the state. Because of public interest in birds of prey, the loss of their nesting habitat and resulting decline in their populations in central North Dakota, one of the conditions of the permit was "CPA-UPA shall build and attach up to 20 raptor nesting platforms on towers in Stutsman and Kidder Counties..."

To comply with the conditions set forth by the NDPSC, CPA and UPA and Commonwealth Associates, Inc. (CAI) developed nesting platforms to be placed in 20 towers in the Missouri Coteau region of Kidder and Stutsman Counties. Platforms were selectively placed on towers to facilitate any potential future research studies that may be conducted. The location of the diaphram on the towers where the platforms were attached (Figure 1) varied in height from ground level from 15 feet to 90 feet, depending on the leg extensions necessary. Table 1 demonstrates the randomness of design versus platform height above ground, as well as the distribution of the artificial nesting structures along the transmission line.

The platform designs referred to above include the eagle nesting platform developed by M. W. Nelson for Idaho Power and Light, which cost CPA/UPA $125 to construct, and two designs similar to the platform described by Richard Fyfe, Canadian Wildlife Service (personal communication), which cost $113 to construct. Figure 2 shows the design of the platforms developed by the authors. The only difference between the platforms detailed in Figure 2 is the mesh of the nesting surface. The nesting substrate in one was 1/2 inch mesh hardware cloth, while the other was made of cyclone fence material with a mesh opening of approximately two inches. By using the metal mesh, an increased longevity is expected. It is not known at this time if the difference in mesh size will affect nesting success; however, as previously mentioned, the platforms have been arranged to facilitate possible future studies.

The permit conditions issued by the NDPSC did not specify the birds of prey for which the platforms were to be designed. Therefore, based on studies undertaken during the transmission line routing process, the platforms were designed to provide nesting habitat for hawks of the genus Buteo.

However, with minor modifications, the platforms can be adapted for use by many species. For example, osprey nesting on distribution poles in southern Florida are causing flashovers and power outages. By providing a nesting place away from conductors, and yet near enough to its desired location so the bird will not be forced to rebuild the nest and cause the same problems, the mesh type platform should reduce impact to the bird as well as to the transmission of electricity.

Additionally, these platforms are being recommended to surface mining companies in the central and Great Plains states for use during and after reclamation. If the platforms are placed in areas being reclaimed, they will provide nesting habitat for birds of prey. If the platforms are used by raptors, the presence of those species should help control rodent populations, which are severely limiting the success of some reclamation plans, by eating seeds and vegetation used to reclaim the mined land.

One aspect of the platforms that has not yet been fully investigated is the potential for nesting success or failure. Gilmer and Wiehe (1977) reported the percentage of nesting success of ferruginous hawks was lower in HVTL towers than nests in any other substrate they studied. They partially attributed the low success rate to high winds. The design of the platforms Commonwealth has placed in towers in central North Dakota would reduce the probability of nest loss due to high winds. Additionally, a lack of use of platforms in wooden H-frame structures was noted by Stahlecker and Griese (1979) in east-central Colorado. The nonuse of platforms in Colorado was tentatively attributed to improper height above ground level. The variable height placement of the platforms in North Dakota should allow a comparison of raptor use to platform height, if future studies are undertaken.

The need for studies of the platforms in the d.c. towers in North Dakota has been demonstrated above. These studies should include correlation studies of nesting success versus platform design versus platform height. Also it has become apparent, after five years of noting raptor use of transmission lines in nearly every region of the country, that some assessment of that behavior should be scientifically studied. These studies should be developed with at least the following objectives in mind:

1) To document the extent of raptors nesting in HVTL towers, the ecological regions of heavy use, and the locations of the nests in the towers.

2) The nesting success (or lack of it) of different raptor species compared to different tower designs.

3) Recommendations of tower design which will facilitate nesting and enhance success, particularly in regions where raptor populations are declining, while insuring line reliability.

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ARTIFICIAL NEST STRUCTURES AND GRASSLAND RAPTORS

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ABSTRACT.--During a four year study at the Birds of Prey National Conservation Area in Idaho, nest structures were placed in three different habitat types. Two species of birds, the ferruginous hawk (*Buteo regalis*) and the raven (*Corvus corax*), successfully nested on these structures. Ferruginous hawks utilized sites where no raptor nests had previously been found. Component factors are discussed that may affect the selection of artificial nests by raptors. Applications are presented where artificial nest structures may serve to mitigate loss of natural nest sites and associated habitat.

INTRODUCTION

Interest in the role of artificial nest platforms as an enhancement technique has encouraged many investigators to place them in a variety of habitats. Studies by Postupalsky (1974), and Reese (1970) have demonstrated the effectiveness of these strucutres of Osprey (*Pandion haliaetus*). Dunstan and Borth (1970) found that a pair of Bald Eagles (*Haliaeetus leucocephalus*) would accept a reconstructed nest. Fyfe and Armbruster (1977) pioneered the improvement of potholes for Prairie Falcons (*Falco mexicanus*) and the use of basket structures for grassland raptors. Bohm (1977) erected a number of nest platforms in Minnesota to encourage nesting of Great Horned Owls (*Bubo virginianus*) and Red-tailed Hawks (*Bueto jamaicensis*). Anderson and Follett (1978) reversed a downward trend of available nest sites and productive ferruginous hawk (*Buteo regalis*) pairs on the Pawnee National Grassland by providing new supporting structures.

The impetus for the present project was suggested by Olendorff and Stoddart (1974) and was motivated by projected habitat loss due to agricultural conversion and energy development on rangelands in the west.

METHODS

In 1975, a survey was conducted to determine the presence or absence of nesting raptors in three selected habitat types within and near the proposed Birds of Prey National Conservation Area (BPNCA). An assessment was made of the available prey base in these habitat types utilizing data being generated by studies at BPNCA. By 1976, a plan was implemented whereby nesting structures designed to attract ferruginous hawks were built in and adjacent to the BPNCA in western Idaho (See Figures I and II). The plan called for placement of a total of 24 nesting structures in these three habitat types. Two structures in close proximity (150 meters), one with a shade cover and one without, were placed at each of the 12 selected sites.

The experiment was designed to test the hypothesis that: (1) ferruginous hawks can be attracted to nest on artificial platforms; (2) platforms will attract breeding pairs to nest in an area where none were previously known; (3) higher productivity will result from structures that are shaded versus those that are unshaded.

The three habitat types selected for the nest sites are typical of western Idaho Great Basin vegetation. They include native Shadscale/Winterfat (Atriplex confertifolia/Cerratoides lanata), Sagebrush/Bluegrass (Artemisia tridentata/Poa sandbergii), and Forbs/grass (Pure forbs or 1-20% blue grass or cheat grass (Bromus tectorum). Four nest sites, a total of 8 nest structures were placed in each habitat type.

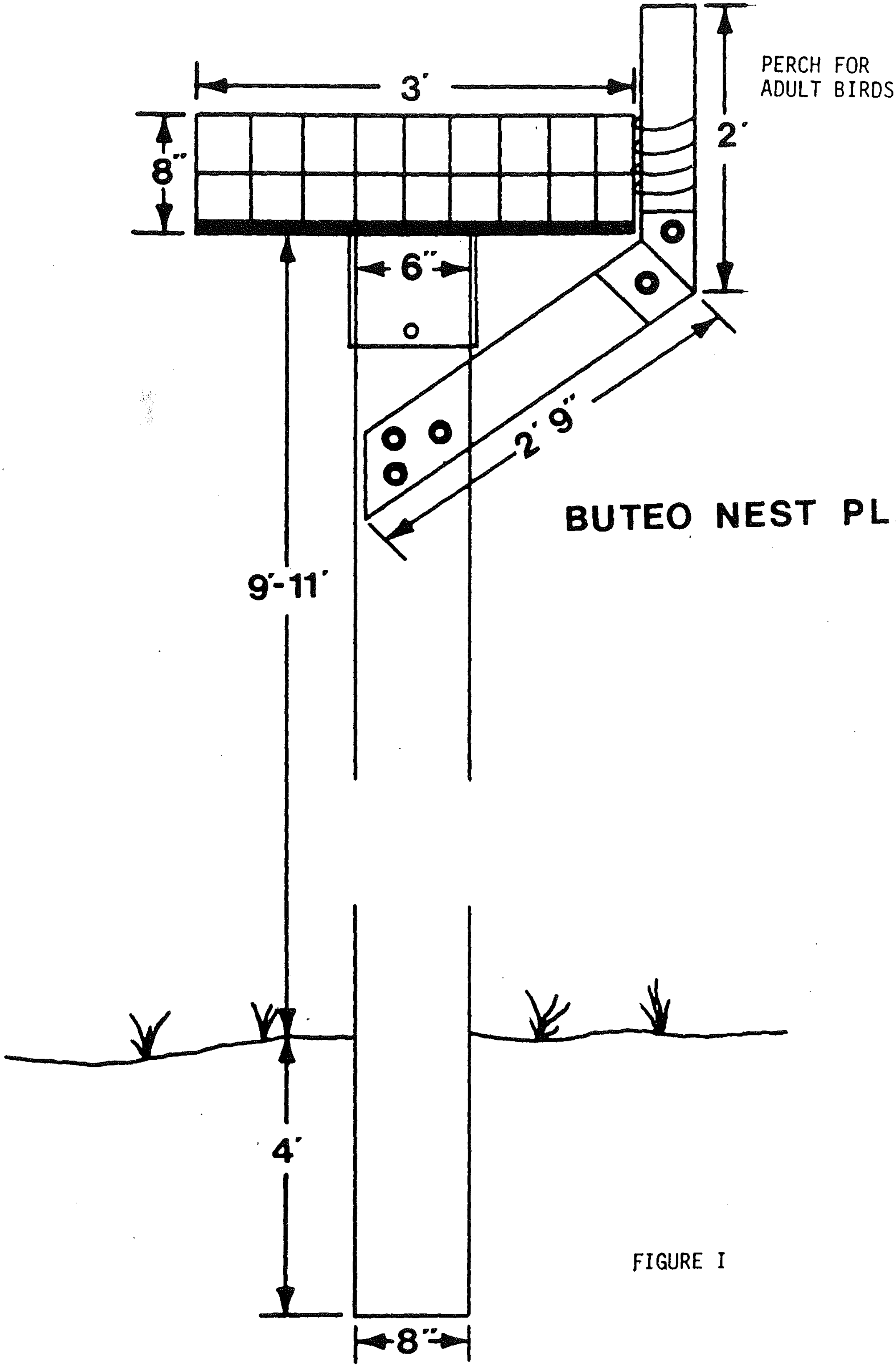
The structures were surveyed twice each spring -- once in March to check for occupation and to repair any damage sustained during the winter, and again in June to count and band young.

RESULTS

Our results show that raptor nest platforms provide a feasible technique for increasing the local nesting population within certain limits. Our first hypothesis, i.e. ferruginous hawks can be attracted to nest on artificial platforms, was demonstrated one year after placement of the structures (See Table I).

TABLE I. FERRUGINOUS HAWK NESTING SUCCESS, 1976-1979

YEAR	NO. OF OCCUPIED NESTS	NO. OF SUCCESSFUL NESTS	NO. OF YOUNG FLEDGED	$\bar{X}$. NO. OF YOUNG FLEDGED/OCCUPIED NESTS
1976	0	0	0	0
1977	1	1	2	2
1978	3	2	5	1.6
1979	3	2	5	1.6
TOTAL	7	5	12	1.7



BUTEO NEST PLATFORM

FIGURE I

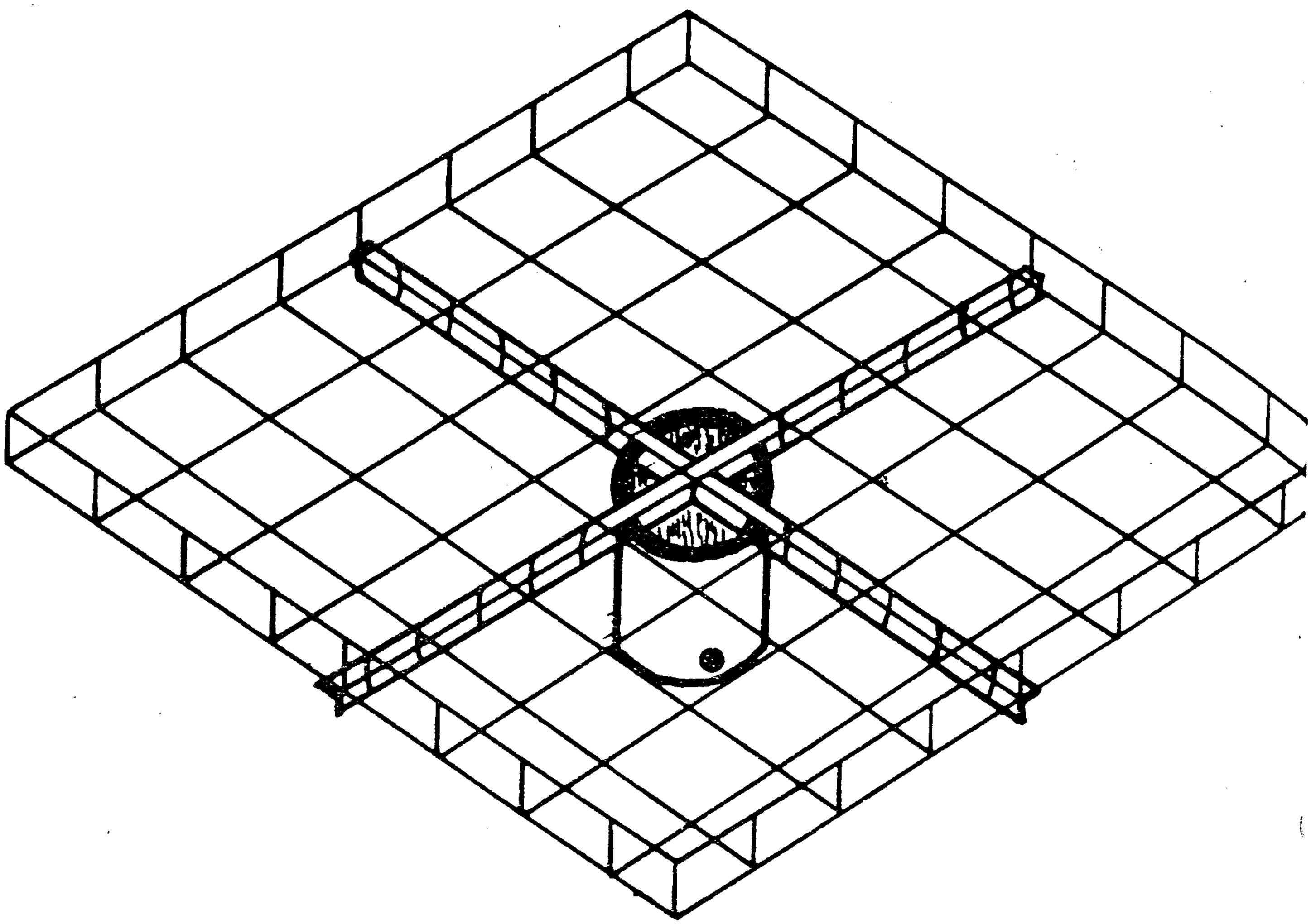


FIGURE II

MATERIALS

STEEL PIPE 6" INSIDE DIAMETER x 9" LONG
ANGLE IRON 1¼" X 1¼" X 36" LONG
LAG SCREW 3/8" X 4", FIVE LAG BOLTS WITH WASHERS AND NUTS
WELDED WIRE BASKET, MESH SIZE 4" X 4", BASKET SIZE 36" X 36"
1-4' BOARD 2" X 6" FOR PERCH
1-UTILITY POLE 13'-15' LONG
NOTE: WIRE INTO BASKET ABOUT TWO DOZEN SAGE BRUSH STICKS. STICKS SHOULD BE DEAD-WITHOUT LEAFY BRANCHES AND 15"-25" LONG.

The pair that nested in 1977 also confirmed our second hypothesis, i.e. platforms will attract breeding pairs to nest in the area where none were previously known. The Forbs/grass habitat type was the area where all pairs except one nested. This habitat type supports a substantial population of rodents (138/hectare) and Townsend Ground Squirrels (Spermophilus townsendi) (14/hectare) (DOI Report, 1979). The third hypothesis was not confirmed, i.e. higher productivity will result from structures that are shaded versus those that are unshaded. No pairs of Ferruginous Hawks nested on shaded structures. In 1979, we moved a shading device to the nearby unshaded nest platform. This latter platform had been occupied by a successful pair for two years. When the birds returned in 1979, they utilized the other platform from which the shading device had been moved.

Ravens were very successful in pioneering the use of the platforms in 1976 but declined thereafter (Table II). They nested within the Shadscale/Winterfat and Sagebrush/Bluegrass habitat types but did not nest on the Forbs/grass type where the Ferruginous hawks nested.

TABLE 2. RAVEN NESTING SUCCESS, 1976-1979

YEAR	NO. OF OCCUPIED NESTS	NO. OF SUCCESSFUL NESTS	NO. OF YOUNG FLEDGED	$\bar{X}$ NO. OF YOUNG FLEDGED/OCCUPIED NESTS
1976	4	4	13	3.2
1977	2	1	4	2
1978	3	2	9	3
1979	1	1	3	3
TOTAL	10	8	29	2.8

Somewhat to our suprise, ravens used the shaded structures quite readily. They fledged 29 young during the four-year study, of which 23 were from nest structures with shade covers. One can only conclude that we now have a dynamite technique for raven management.

DISCUSSION

As more human demands are placed on areas where Ferruginous hawks and other raptors exist, it may become crucial to find other areas where they might exist but can't, due to a missing requirement. We have demonstrated the application of nest structures as a technique to expand the breeding population of a species within a local area. Utility companies are beginning to cooperate in accepting the use of similar platforms on steel towers (Nelson, 1977).

The requirements to implement a basic raptor management program of this type are few. The following information should first be secured: (a) determine population history of target species and its competitors; (b) evaluate for feasibility and methods; (c) determine habitat and nesting requirements of the species; (d) determine if the prey base will support additional populations of raptors; and (e) determine that the introduction of nest structures will not displace or effect threatened and endangered species.

ACKNOWLEDGEMENTS

We thank Douglas Smithey, former BPNCA manager, and Pat Benson for helping us to initiate this study.

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A Study of Wintering Bald Eagles to Assess Potential Impacts from a Proposed 230-kV Transmission Line