1980

Performance Report: Bald Eagle

M. A. Byrd
The Center for Conservation Biology

PERFORMANCE REPORT

STATE:	Virginia	PROJECT NO.:	E-4
PROJECT TYPE:	Research and/or Survey	STUDY NO.:	VI
PROJECT TITLE:	Endangered Species Investigations	JOB NO.:	VI-E1, VI-E2, VI-E3 VI-E4, VI-E5
PERIOD COVERED:	July 1, 1979 - June 30, 1980		

JOB VI-E1 OBJECTIVE: To obtain a winter inventory of Bald Eagle numbers and determine range of these birds in Virginia.

JOB VI-E2 OBJECTIVE: To determine hatching and rearing success of Bald Eagles in Virginia.

JOB VI-E3 OBJECTIVE: To develop and utilize techniques to introduce Bald Eagles into formerly occupied habitat through hacking techniques and to introduce captivity reared bald eagle young into foster parent nests.

JOB VI-E4 OBJECTIVE: To determine post nesting dispersal and other movements of young eagles through the use of radio-telemetry equipment.

JOB VI-E5 OBJECTIVE: To monitor activities at two active eagle nest sites from egg laying through fledging of young through the use of video equipment. In addition, all aspects of incubation and post incubation behavior will be observed from blinds at two additional sites.

SUMMARY:

Aerial surveys resulted in the location of 35 active bald eagle nests in which 35 fledglings were produced for an average production of 1.00 young per active nest and 1.52 young per productive nest. A mid-winter eagle survey was again conducted within the state, resulting in the observation of 166 birds.

Studies were completed on both nest site selection and foraging methods and success.

Thirty-one young eagles of the thirty-five produced were banded and also marked with coded orange vinyl leg band tags.

Radio-transmitters were successfully placed on six pre-fledgling eagles in order to monitor post-fledging movements and dispersal. Video camera systems were installed at two nests and activities taped during the nesting season.

SURVEYS:

(a) Breeding surveys - Aerial surveys were conducted during March, April, May, and June to locate active nests and to monitor the fate of each located nest.

As in 1979, aerial surveys were not conducted of any of the inland lakes as there had been no additional evidence to suggest nesting birds in these areas.

Surveys in the Tidewater Area resulted in the location of 35 active nests. Location by county and the fate of each nest are indicated in Table 1. All nest locations were plotted on 7 1/2minute topographic sheets. Fate of each active nest is shown in Table 1.

TABLE 1: LOCATION AND PRODUCTIVITY OF ACTIVE BALD EAGLE NESTS IN VIRGINIA 1979? & 1980?

County	Nest Number	Reproductive Success	No. of Young Fledged
Accomac	80-01	Productive	2
Essex	78-01	Productive	1
Fairfax	80-01	Unproductive	0
King George	75-02	Unproductive	0
King George	78-04	Unproductive	0
King George	79-04	Productive	1
King George	80-01	Productive	2
King George	80-04	Productive	1
King George	80-05	Unproductive	0
King William	79-02	Unproductive	0
King William	80-01	Unproductive	0
Lancaster	75-01	Productive	2
Middlesex	77-01	Productive	1
Middlesex	77-03	Unproductive	0
Middlesex	80-01	Productive	1
New Kent	77-01	Productive	1
New Kent	79-04	Productive	1
New Kent	80-01	Unproductive	0
Northumberland	70-01	Productive	1
Northumberland	79-01	Productive	1
Prince George	61-01	Productive	2
Richmond	71-01	Productive	2
Richmond	74-01	Productive	1

Table 1. (continued)

Richmond	78-01	Productive	2
Richmond	79-02	Productive	2
Richmond	80-01	Productive	2
Stafford	75-01	Productive	2
Westmoreland	71-04	Unproductive	0
Westmoreland	78-01	Unproductive	0
Westmoreland	79-01	Productive	2
Westmoreland	78-05	Unproductive	0
Westmoreland	77-04	Productive	2
Westmoreland	79-04	Productive	1
Westmoreland	79-05	Productive	2
Westmoreland	80-01	Unproductive	0

Of the 35 active nests, 23 were productive and 12 were unproductive for a success rate of 65.7 percent. Total production (fledglings) was 35 of an average of 1.00 young per active nest and 1.52 young per productive nest.

These figures compare with a 39 percent success rate in 1977, a 38 percent success rate in 1978, and a 45 percent success rate in 1979. Average production of 1.0 young per active nest in 1980 compares respectively with 0.54, 0.49, and 0.61 in 1977, 1978, and 1979. The production of 1.52 young per productive nest compares with 1.38, 1.29, and 1.33 in 1977, 1978, and 1979.

Productivity remained relatively stable in each of the three years of 1977, 1978, and 1979, although total nest numbers and locations have fluctuated somewhat from year to year. Productivity was substantially higher in 1980 and was, perhaps, the best since the state eagle population was first monitored in 1957. Much of this increase may be attributed to the large increase in nests with two fledglings, from 5 in 1979 to 12 in 1980. Another factor of significance was the very high success rate on the Rappahannock River where 10 of 11 active nests contained fledglings.

Observation was made of a number of adult eagles during the breeding season where active nests were not known to occur. Despite extensive aerial searches in these areas, active nests were not located. It is believed that the Virginia nesting population of bald eagles may total at least 7 or 8 additional pairs beyond the number located.

A new active nest was reported in 1979 for the upper James River, an area once supporting a relatively large and viable population. This nest, representing the first known successful breeding activity on the river in 20 years, was again active and successful in 1980. Two young fledged from this nest. In addition, adults were observed during the breeding season at 3 other sites on the James

River system although no additional nests were located. Osprey nests also were successful in both 1979 and 1980, indicating that this river after a long period of contamination may again be suitable for reoccupancy by these species.

(b) Winter Survey - Personnel on the project, in conjunction with cooperators, participated in the mid-winter bald eagle survey sponsored by the Raptor Information Center, National Wildlife Federation. All of the state was covered by aerial survey with the exception of the inland impoundments. Many areas were also covered by co-operating ground and boat parties. Results of the survey are presented in Table 2.

TABLE 2. MID-WINTER BALD EAGLE SURVEY - VIRGINIA - 1980

Area	Adult B.E.	Imm. B.E.	Total B.E.
James River, Chickahominy River, Diascund Resevoir	21	19	40
Rappahannock, Great Wicomico Rivers	32	15	47
York, Pamunkey, Mattaponi, Piankatank Rivers	5	2	7
Potomac River	39	29	68
Inland Impoundments	3	0	3
Eastern Shore, Back Bay, Seashore Park, Norfolk	1	0	1
TOTALS	101	65	166

Of particular interest was the relatively high ratio of juveniles to adults as well as the fact that all subadult age groups were represented in the immature group.

Banding and Marking Program:

In collaboration with the Raptor Information Center, National Wildlife Federation, banding and color marking activities were conducted. Of 35 active nests, 33 were visited as part of the banding activities. Permission was denied to visit two nests.

A total of 31 young from a known production of 35 young was banded with regular Fish and Wildlife Service bands. Two young of the unbanded 4 were found to be too old for banding and 2 young were not banded because of denial of landowner permission.

In addition, all 31 young eagles were marked with double vinyl orange leg bands. Area of origin was designated by a series of symbols mounted in cut out areas on the band tags. Each symbol designated a specific estuary within the state. Subsequent observation of three of these color-banded young indicate that these particular band tags delaminate and are not likely to be highly durable. (Banding activities are reported on more completely in a special report.)

Contaminant Analyses

Two eggs collected in 1979 were examined for mercury levels. These two eggs, one each from the Pamunkey and Potomac Rivers, contained 0.17 and 0.09 p.p.m., levels not considered sufficiently high to have an impact on reproductive success.

Three eggs were collected in 1980 as well as shell fragments from seven others. Contaminant analyses have not been completed for these eggs. Eggshell thickness measurements from one egg and one set of fragments indicated a shell thickness respectively of 0.57mm (8% below the pre-DDT norm) and 0.53 (14% below the pre-DDT norm).

Necropsy Analyses

An adult bald eagle was found dead in King George County on March 5, 1980, apparently in good condition. The specimen was sent to the National Wildlife Health Laboratory for necropsy. No pathological condition was determined for the specimen. Death was thought to be attributable to severe emaciation, possible secondary to trap injury.

Nest site selection

Forty bald eagle nest sites in the Virginia portion of the Chesapeake Bay were studied. Although major plant species within the nest site area were recorded for most of these sites, detailed measurements of vegetation other than the nest tree itself, in the sense of Juenemann (1973), were not attempted because, although these data are informative, such a degree of detail has not proven vital to an understanding of bald eagle nest site selection. In addition, it was considered critical to be able to complete all measurements quickly, not only in order to limit disturbance of nesting eagles, but because it frequently took many hours, or many visits, to finally locate nests from the ground.

Nest site visitation was completed during the late summer of 1979. Nests were classified as inactive if there had been no known nesting attempt during that nesting season. Unsuccessful nests were those at which nesting attempts failed to produce fledged young. A nest was considered successful if the adults succeeded in fledging one or more eaglets.

Nest tree species was recorded for each nest. Measurements of nest tree height, canopy height, and nest height were obtained using a Toko model triangulator. Canopy distance, the location of the nest in relation to the overall canopy, was determined by subtracting canopy height from nest height. Diameter of the nest tree at breast height (DBH) was measured with a Chrome Clad tree tape at a standard breast height of approximately 1.4 meters (4 feet, 6 inches). Both the triangulator and the tree tape were calibrated according to the English system. Readings were converted later to the metric system.

The percent of light blocked by the foliage of the canopy and understory (foliage density) was determined using an ocular tube adapted from James and Shugart (1970) for an area of 0.04 hectare (0.1 acre) around the nest tree. All vegetation between the observer and the canopy was viewed through the tube, which was divided into ten sections with crossed threads. For most nests readings were taken along four transects - north, south, east, and west - around the nest tree as described in James and Shugart (1970). In addition, the density of the undergrowth around the base of the nest tree was determined qualitatively to be thin, with easy access to the trunk, or thick, with trunk access difficult, in order to determine the accessibility of the nest tree to such potential nest predators as raccons.

The distance of open water from nest sites was determined using topographic maps of the U.S. Geological Survey on which nest sites had been marked. Visibility of open water from the nest was determined for 1979 nests, only, by the climbers of the Chesapeake Bay Bald Eagle Banding Team.

The extent of human activity in the vicinity of nest sites was determined in two ways. First, the distance of nest sites from the nearest road was calculated using U.S. Geological Survey topographic maps on which nest sites had been marked. Secondly, a qualitative assessment was made of each nest site studied. If there was little indication of human activity near the nest site, or if such activity was regular, such as farming, then activity was categorized as light. The term moderate was used to describe nests where the possibility of nonregular, highly disruptive human activity, such as military maneuvers, existed. The presence of housing developments, marinas, construction, timbering, or heavily used major highways was considered heavy human activity.

Kruskal-Wallis tests or Wilcoxon 2-sample tests (Sokal and Rohlf 1969) were used to analyze differences between samples of habitat variables for variables such as tree species, undergrowth, water visibility, and human activity which are not measurements, but describe attributes. Differences between samples of habitat variables which are measurements, such as tree height, nest height, canopy height, canopy distance, DBH, water distance, and road distance were analyzed using analysis of variance (ANOVA) for normally distributed samples. Samples were tested for normality using the Shapiro-Wilk W-test (Shapiro and Wilk, 1965) as programmed in the Statistical Analysis System (Helwig and Council, 1979). Kruskal-Wallis or Wilcoxon 2-sample tests were used for non-normal samples. Foliage density percents were normalized using the arc-sine transformation, tested for normality using the Shapiro-Wilk W-statistic, and analyzed with ANOVA. The significance level for all tests was $p = .05$.

The present study was undertaken in order to provide basic information concerning bald eagle nesting habitat in the Virginia portion of the Chesapeake Bay. Another objective was to determine what influence, if any, factors such as proximity to water, nest site habitat characteristics, and human disturbance have on nest site selection and nesting success in Virginia. A third objective was to determine if differences exist between nesting habitat of three major river systems in Virginia - the Potomac, the Rappahannock, and the York - and, if so, to determine if nesting success is related to these differences.

As a result of the nest site selection study, a nest site description was provided for each of the 40 sites as a basis for management recommendations. Complete data on the nest site selection study may be found in (Jaffee, N.B., 1980. Nest Site Selection and Foraging Behavior of the Bald Eagle (Haliaeetus leucocephalus in Virginia. M. A. Thesis, College of William and Mary, Williamsburg, Virginia).

Foraging Behavior

Analyses of the factors influencing the foraging behavior of bald eagles have rarely been undertaken. Many reports provide information about prey species without describing the methods used by this raptor to capture prey (Brewster 1925, Bent 1937, Munro 1938, Wright 1953, Grewe 1966, Juenemann 1973, Ogden 1975, Ofelt 1976, Weseloh and Weseloh 1976). Edwards (1969) described a short, coursing flight over vegetation cover for wintering bald eagles in Utah, but did not discuss the effects of weather on foraging behavior. Hehnke (1973) reported two primary foraging patterns: (1) fishing and (2) searching beaches for carrion; but he did not associate these general methods with environmental conditions. Sherrod et al., (1976) identified three foraging methods: (1) still hunting from a perch, (2) hunting from an aerial height, and(3) hunting in direct flight; but they observed actual prey capture only in relation to the perched method. The authors did, however, give an account of an adult bald eagle returning to the nest, through dense fog, with prey, indicating that the bird could successfully forage under adverse conditions.

There is reason to believe that environmental conditions may influence the foraging success of bald eagles because the dependence of foraging success on weather has already been established in some other fish-eating birds (Dunn 1973, Grubb 1977, Stinson 1978, Bovino and Burtt 1979). Fishing success is directly related to wind speed and water surface conditions in sandwich terns (Sterna sandvicensis) and common terns (Sterna hirundo), while cloud cover does not affect fishing success (Dunn 1973). Overcast days, calm winds, and unrippled water are associated with fishing success in great blue herons (Ardea herodius) (Bovino and Burtt 1979). Cloudy skies and rippled water surface are associated with low success rates in ospreys (Pandion haliaetus) (Grubb 1977), and gusty winds affect the ability of these birds to fly (Stinson 1978).

One would expect that the foraging behavior of bald eagles would be affected in much the same way as in other fish-eating birds. The objectives of this study were as follows: (1) to examine the relationship between various environmental factors and the foraging methods employed, foraging frequency, and foraging success of bald eagles; and (2) to see if, indeed, bald eagles respond to environmental conditions in a manner similar to other piscivorous birds. Abiotic environmental factors which had been examined earlier (Dunn 1973, Grubb 1977, Stinson 1978, Bovino and Burtt 1979) were also examined in this study. These include cloud cover, water surface conditions, wind speed, relative humidity, air temperature, time of day, and day of the year.

Certain biotic factors may also influence foraging behavior. Ospreys use different hunting methods to forage for fish at different depths. They may either submerge after diving into the water to catch deep fish, or "pancake" on the surface with only their feet submerged to catch surface fish (Lambert 1943). Lambert (1943) also reported that overall foraging efficiency in ospreys is reduced later in the season. He attributed part of this reduction to higher water temperatures to which fish respond by staying deeper in the water, thus reducing the availabiltiy of surface fish, and part to the increased number of observations of recently fledged, inexperienced juveniles later in the season.

There is evidence to suggest that bald eagles also use specific hunting methods for specific prey types (Sherrod et al. 1976), and that the use of different methods and the relative success of these methods may vary with the age of the bird (Sherrod et al. 1976). In addition, it is not unreasonable to suspect that abiotic conditions such as wind speed, water surface conditions and cloud cover may also influence the method used to approach a prey item. In order to explore these possibilities, foraging methods are identified here, and the relationships between these methods, foraging success, age class, and weather conditions are analyzed.

In June and continuing through July, 1979, foraging bald eagles were observed from a 15 meter cliff along the south shore of the Potomac River in King George County, Virginia. This site is adjacent to a marsh in Caledon State Park. One hundred eighty three hours of observation were completed. Empire 7x35 binoculars and a Bausch and Lomb 15x20x35 spotting scope were used to observe foraging bald eagles.

Measurement of Environment Variables

Cloud cover, water surface conditions, wind speed, temperature, and relative humidity were recorded every 1/4 hour while observations were being conducted. Cloud cover was categorized as clear (sunny with no clouds), partly cloudy (sunny with clouds), hazy (limited visibility due to haze), overcast, or foggy. Water surface conditions were classified as calm, ripples only, waves only, or waves with ripples (including the presence of whitecaps). Wind speed in kilometers per hour was estimated by observing the disturbance produced by the wind in trees near the edge of the cliff, using Table 12-1 of Donn (1972). Dry bulb/wet bulb temperatures were determined using a sling psychrometer, and these readings were used to determine both air temperature and relative humidity.

Age Classes

Bald eagles were separated into two age classes, adults and subadults, the latter lacking the white head and tail of the adults. Age determination of subadult bald eagles in flight by plumage characteristics is inaccurate at best, though attempts have been made to characterize these differences (Bent 1937, Southern 1964, Sherrod et al. 1976). No attempt was made in the present study to distinguish between age groups of subadults.

Foraging Success and Hunting Methods

A bald eagle was considered to be foraging if it was flying over the river or shoreline, frequently moving its head from side to side, with its gaze directed at the water. A foraging event not resulting in an actual attempt to capture prey was termed a search as opposed to a hunt.

It was usually difficult or impossible to see clearly the prey items in the talons of the raptors. Preliminary observations appeared to indicate that a successful hunt by a foraging eagle was followed by an initially low, rhythmic flight directly back in to shore. Ueoka (1974) and Byrd (pers. data) observed a similar pattern in ospreys. Foraging success was determined in the present study by observing the post-hunt flight of hunting eagles. A low, direct approach to shore was accepted as evidence of a successful hunt.

Low flights ranged from 0-6 meters above the water surface. Flights ranging from 6 meters to approximately 30 meters (cliff height + tree level) were considered moderate. Any flight above this level was described as high.

The duration of the foraging event, timed with a stopwatch, was defined as the interval between the time the bird was first seen and the time it flew out of view.

Statistical Analysis

Tests of goodness of fit, using the G-statistic (Sokal and Rohlf 1969) were used to determine the influence of wind speed, cloud cover, water surface conditions, and time of day on foraging frequency. Adjusted G values were obtained for samples in which N is less than 200. In order to reduce sampling error, the observed frequencies were adjusted for the proportion of total observation time during which each condition was recorded.

The influence of age class, cloud cover, water surface conditions, wind speed, and hunting method on foraging success was analyzed with contingency tests for independence, using the G-statistic. Wilcoxon 2-sample tests were used to analyze the influence of day of the year, time of day, temperature, relative humidity, and foray duration on success for all age classes.

The influence of age class, hunting success, cloud cover, water surface conditions, and wind speed on the hunting method used was analyzed with contingency tests for independence, using the G-statistic.

Pearson's product-moment correlation coefficient was used to determine the relationship between temperature and day of the year. The significance level for all tests was $p = .05$.

Complete analysis and discussion of the foraging study may be found in (Jaffee, N. B. 1980. Nest Site Selection and Foraging Behavior in the Bald Eagle (Haliaeetus leucocephalus) in Virginia. M.A. Thesis, College of William and Mary, Williamsburg, Virginia).

Food Habits and Behavioral Studies

Data concerning the food habits of Bald Eagles are difficult to obtain, yet these data are necessary to gain a fuller understanding of the vectors by which environmental contaminents are being assimilated by Bald Eagles. Traditional techniques for obtaining these data are based on the collection and analysis of pellets and prey remains. With this technique, however, small prey items and prey items which are entirely, or almost entirely, consumed, such as fishes, are likely to be under-represented in the final results and there is often difficulty in establishing the number of individuals of each prey species present. We have utilized a closed circuit television system to monitor prey items brought back to Bald Eagle nests in Virginia. The procedure involved the placement of a video camera in or near the nest tree. Appropriate monitoring and recording equipment was housed in an observation blind located several hundred meters from the nest. A system was set up at one nest site in 1979 and two such installations were set up during the 1980 breeding season. During 1979 and 1980 Bald Eagle nests were observed for over 350 hours, using this system. In addition to the data concerning prey species, the effects of weather conditions on the delivery rate of food to the nests have been examined.

Previous work, carried out at the College of William and Mary, has suggested that Bald Eagles may be hunting in different habitats under different weather conditions. The current study is testing this hypothesis by noting whether prey items typically found in a particular habitat are brought to the nest only under a certain set of weather conditions while prey items typically found in other habitats are brought to the nest under different weather conditions. It may be most important for adult Bald Eagles to shift their foraging activities from one habitat to another during the breeding season when they are feeding young, a time when it is most important for the adults to maximize their foraging efficiency. If this is indeed the case, then one of the factors which may determine the suitability of an area for nesting Bald Eagles may be the presence of a high diversity of undisturbed habitat types. Similarly, historically active Bald Eagle nesting areas may become inactive as human development decreases habitat diversity and results in a decrease in the foraging efficiency of the adult birds below the level which is sufficient to provide for their young.

Preliminary observations have also suggested that sibling aggression may have an impact on productivity under certain conditions. Particularly during the earlier stages of the nestling period, the oldest of two eaglets in one observed nest was clearly dominant over the younger bird and a large number of agonistic interactions took place. This dominance was most clearly demonstrated when neither eaglet had eaten for some time and an adult made a delivery of food to the nest. Under these circumstances the older eaglet would almost invariably take possission of the food item and feed exclusively until the food item was completely consumed or until the eaglet was satiated. The smaller eaglet could eat unchallenged only after the dominant eaglet was satiated. Similar types of sibling aggression have been reported previously for Bald Eagles and several other species of eagles. In some species of eagles, sibling aggression invariably results in the death of the younger eaglet either by starvation or as a direct result of an attack by the older eaglet. This sort of sibling aggression has been referred to as "Cainism" by many authors. Cainism has rarely been reported for Bald Eagles. Although the aggression we observed did not result in any significant difference in the amount of food consumed by each eaglet, our preliminary observations seem to suggest that Cainism might be expected in Bald Eagles if the delivery rate of food to the nest, for whatever reasons, was not adequate to feed both eaglets. In this case, Cainism would result in the production of one healthy eaglet rather than two underfed young which would probably be much less likely to survive.

Telemetry Studies

Very few data are available concerning the movement and activity patterns of juvenile Bald Eagles after fledging. Banding programs and the use of patagial markers have provided limited, yet very valuable, data and the use of radio telemetry equipment in a few studies of other Bald Eagle populations has provided much more detailed data. No data of the latter type has been available for the Chesapeake Bay Bald Eagle population. In early 1979, seven nestling Bald Eagles from five different nest sites throughout Virginia were fitted with miniature back-pack mounted radio transmitters. Using this equipment over 350 hours of observation of fledgling eagles was obtained between 19 June and 16 October 1979.

The data indicate a suprisingly long period of juvenile dependence on the adults during which the young remained quite close to the nest. For approximately eight weeks after fledging, the young seldom ranged more than two miles from the nest and spent most of their time perched along isolated stretches of rivershore or on isolated ponds adjacent to the river. The largest percentage of their time was spent perched along one specific stretch of pond or river shoreline, often only 100-200 meters long, where the young would wait for the adults to return with food. Prior to this study, we had felt that the juveniles spent very little, if any, time near the nest after fledging and therefore human activity around the nest during this period should have very little impact on the birds. These results, however, indicate that human activity near the nest at this time may interfere with the delivery of food to the juvenile birds by the adults.

In early September, the juveniles begin to range farther and farther from the nest and it is probably at about this time that they become independent and begin to forage for themselves. Beginning in late September the juveniles begin to wander nomadically and it became much more difficult to maintain contact with them. The data during this period indicate more or less random movements around the region. By mid-October we had lost contact with all seven birds but it is not entirely clear whether this indicates a departure from the area or equipment failure. During the current breeding season we have radio-tagged six young eagles from three nest sites. The young have only been flying for a few weeks and this year with more careful observation and the use of aircraft for tracking, a more complete picture of the movements of these birds during dispersion should be obtained.

Literature Cited

Bent, A.C., 1937. Life histories of North American birds of prey. U.S. Nat. Museum Bull., 167. 409 pp.

Bovino, R.R. and E.H. Burtt, 1979. Weather-dependent foraging of great blue herons (Ardea herodius). Auk, 96:628-630.

Brewster, W., 1925. The birds of the Lake Umbagog region of Maine. Bull. Museum Comp. Zool., 66(2):211-402.

Donn, W.L., 1972. The earth: our physical environment. Wiley, New York, 621 pp.

Dunn, E.K., 1973. Changes in the fishing ability of terns associated with windspeed and sea surface conditions. Nature, 244:520-521.

Edwards, C.C., 1969. Winter behavior and population dynamics of American eagles in western Utah. Ph.D. dissertation. Brigham Young University, Salt Lake City, Utah. 142 pp.

Grewe, A., 1966. Some aspects of the natural history of the bald eagle, Haliaeetus leucocephalus, in Minnesota and South Dakota. Ph.D. dissertation. University of South Dakota, Vermillion. 71 pp.

Grubb, T.G., Jr., 1977. Weather-dependent foraging in ospreys. Auk, 94:146-149

Hehnke, M.F., 1973. Nesting ecology and feeding behavior of bald eagles on the Alaska Peninsula. M.S. thesis. California State University, Humboldt. 56 pp.

Helwig, J.T. and K.A. Council (eds.), 1979. SAS user's guide: 1979 edition. SAS Institute Inc., Raleigh, North Carolina. 494 pp.

James, F.C. and H.H. Shugart, Jr., 1970. A quantitative method of habitat description. Audubon Field Notes, 24(6):727-736.

Juenemann, B.G., 1973. Habitat evaluation of selected bald eagle nest sites on the Chippewa National Forest. M.S. thesis. University of Minnesota, St. Paul. 170 pp.

Lambert, G., 1943. Predation efficiency of the osprey. Canad. Field-Nat., 57:87-88.

Munro, J.A., 1938. The northern bald eagle in British Columbia. Wilson Bull., 50:28-35.

Ofelt, C.H., 1976. Unusual feeding behavior of bald eagles in British Columbia. Wilson Bull., 57(3):70.

Ogden, J.C., 1975. Effects of bald eagle territoriality on nesting ospreys. Wilson Bull., 87(4):496-505.

Shapiro, S.S., and M.B. Wilk, 1965. An analysis of variance test for normality (complete samples). Biometrika, 52:591-611.

Sherrod, S.K., C.M. White, and F.S.L. Williamson, 1976. Biology of the bald eagle on Amchitka Island, Alaska. Living Bird, 1976:143-182.

Sokal, R.R. and F.J. Rohlf, 1969. Biometry: the principles and practice of statistics in biological research. W.H. Freeman and Co., San Francisco. 776 pp.

__________, 1964. Additional observations on winter bald eagle populations: including remarks on biotelemetry techniques and immature plumages. Wilson Bull., 76(2):121-137.

Stinson, C.H., 1978. The influence of environmental conditions on aspects of the time budgets of breeding ospreys. Oecologia (Berl.), 36:127-139.

Ueoka, M.L., 1974. Feeding behavior of ospreys at Humboldt Bay, California. M.S. thesis. Humboldt State University, Humboldt, California. 76 pp.

Weseloh, D.V. and L.M. Weseloh, 1976. Bald eagle feeding on Richardson's ground squirrel. Calgary Field-Nat., 7(7):195-197.

Wright, B.S., 1953. The relation of bald eagles to breeding ducks in New Brunswick. J. Wildl. Manage., 17(1):55-62.

TARGET DATE FOR COMPLETION: June 30, 1983

STATUS OF PROGRESS: On Schedule

SIGNIFICANT DEVIATIONS IN PROGRESS: None

RECOMMENDATIONS: Continue with Remaining Projects Plans

COST THIS SEGMENT: FEDERAL: $13,035.75: STATE: $4,345.25: TOTAL: $17,381.00

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APPROVED BY: J. W. Raybourne
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DATE: August 6, 1980

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