BEHAVIORAL PATTERNS OF BALD EAGLES UTILIZED IN AN EXPERIMENTAL HACKING PROJECT

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Abstract: A bald eagle *(Haliaeetus leucocephalus)* hacking program was initiated at the Tennessee Valley Authority's (TVA) Land Between The Lakes during the summer of 1980. This program was a cooperative effort between TVA and the Tennessee Wildlife Resources Agency to reintroduce the bald eagle as a breeding species in Tennessee. Two eaglets, obtained from wild nests in Wisconsin, were placed in a manmade nest atop a 12.7 m (40-foot) tower on June 28. They were fed and monitored from a nearby observation tower until released on August 10. Observations of the behavior patterns of the eaglets were made. These included documentation of feeding activity, inter- and intraspecific interactions, exercising, and other behavior patterns. Each bird was fitted with 2 transmitters for monitoring post-release movements.

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Land Between The Lakes (LBL) is a wintering ground for approximately 30 bald eagles. Bald eagles once nested in western Tennessee (Alsop 1979) with the last documented nests at LBL being in the 1940's (Peterson 1973). Reelfoot Lake, located in northwest Tennessee, had a similar decline of breeding efforts and supported Tennessee's last successful nesting in 1961 (Crews, pers. commun. Reelfoot Natl. Wildl. Refuge, 1981).

Factors theorized as responsible for the decline of eagles in Tennessee include human harassment, indiscriminate shooting, habitat encroachment, and, perhaps the most serious factor, chemical contaminants. Effects of organo-chlorine pesticides such as DDT, dieldrin, and industrial contaminants like polychlorinated biphenyls (PCB's) on bald eagles have been discussed by Stickel et al. (1966), Chura et al. (1967), Reichel et al. (1969), Mulhern et al. (1970), and Wiemeyer et al. (1972, 1975). Records of pesticide residue levels in western Tennessee bald eagle carcasses and/or eggs do not exist, but previous widespread use of pesticides in the study area no doubt significantly impacted the area's eagle population.

Improved habitat conditions in Tennessee now appear to provide a suitable environment for the return of breeding eagles. Reservoir constructions along the Tennessee and Cumberland River systems have substantially increased suitable breeding habitat. Federal restrictions placed on use of contaminants such as DDT and strict enforcement of laws protecting the bird result in void habitats capable of supporting a viable breeding population of bald eagles. As populations nationwide rebound, it is hoped that historical breeding grounds like western Tennessee can be naturally repopulated.

In an effort to foster the natural reestablishment of breeding eagles in Tennessee, TVA is cooperating with the Tennessee Wildlife Resources Agency (TWRA) using a restoration technique known as "hacking." A review of this technique as a means of reestablishing bald eagles in the mid-south has been presented by Hammer et al. (1981*a*).

The purpose of this paper is to describe the behavioral patterns of the 2 eaglets utilized in this experimental hacking project. Data were not collected in a manner that allowed for quantitative analysis, so results and discussions are presented in a descriptive format. However, as literature on this technique is limited, it is hoped this document will provide a reference of behavioral information for future hacking experiments.

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METHODS

Land Between The Lakes is located in Lyon and Trigg Counties, Kentucky, and Stewart County, Tennessee. The area is managed as a national demonstration of outdoor recreation, environmental/energy education, and natural resources management. The 68,800-ha (170,000-acre) peninsula is formed between TVA's Kentucky Lake on the Tennessee River and the Corps of Engineers' Lake Barkley on the Cumberland River. A navigational canal connects the 2 lakes near their respective dams. Potential bald eagle nesting habitat exists along most of the 480 km of relatively undeveloped shoreline. See Wright (1975) for a description of soils, vegetation, and climate.

Hacking is a falconer's term referring to the release of a captively held raptor into the wild to sharpen its hunting skills after which it is recaptured for the falconer's use. However, New York's Department of Environmental Conservation applied the term to the technique of establishing eaglets (taken from donor nests) in semi-natural environments remote from where they hatched. Eaglets are fed and monitored without direct human contact until capable of flying when they are released into the wild. New York pioneered bald eagle hacking in 1976, based on the successful peregrine falcon *(Falco peregrinus)* release program developed by Cornell University (Sherrod and Cade 1978). The basis for the reintroduction technique is the belief that the birds, when sexually mature, will return to the general region whre they fledged to raise their young (Milburn 1979). The 1980 successful rearing of 2 young eaglets by a pair of eagles that was hacked by New York in 1976 (Nye 1980) demonstrated that the technique is a viable means of reestablishing breeding eagles in the birds' historic range.

The U.S. Fish and Widlife Service (FWS), TWRA, and TVA decided to obtain eaglets from the Great Lakes region. This selection was made because 7 wing-marked and/or leg-banded wintering eagles seen in the LBL vicinity were from the Great Lakes region, and local false nesting attempts coincided with breeding-nesting time periods in northern latitudes. The Wisconsin Department of Natural Resources made a pair of wild eaglets available for the hacking effort.

The eaglets were taken from separate nests in the north-central portion of Wisconsin. One was obtained from a nest of 3 young and the other from a nest of

2. The eaglets were tentatively identified as male and female on the basis of body and foot size (Brown and Amadon 1968), with the larger bird assumed to be the female. Based on Wisconsin nesting area survey records and feather growth and development, the birds were determined to be 8 to 9 weeks old at the time of their removal from the nests.

Two towers were constructed — a hacking (nesting) tower and an observation tower. The hacking tower, 12.7 m tall, was situated approximately 200 m from the Prior Bay shoreline of Lake Barkley. The eaglets were confined on the hacking platform by a conduit pipe and plywood enclosure. This enclosure, which measured approximately 3 m by 3 m by 2 m high, protected the young birds from possible predation and prevented premature attempts at flight. One-third of the top was covered by plywood to offer partial protection from the sun and inclement weather. One side panel was held in position with easily removed wing nuts to allow quick removal for release of the birds. A simulated eagle nest was constructed within the hacking tower enclosure. The hacking and observation towers were constructed approximately 23 m apart, separated by a line of trees which restricted the eaglets view of approaching researchers. The observation tower was mounted 0.5 m higher than the hacking platform to provide a better viewing angle. It was approximately 3 m by 3 m by 2½ m high, had a plywood front which faced the hacking tower, and a roof and partial sides. The front had several small holes cut for visual observation and for monitoring equipment. (For a detailed description of tower construction see Hammer et al. 1981.*b*)

The eaglets were provided food items in a sheet metal tray via a trolley system that connected the 2 towers. This tray was moved along on a cable from the observation tower to the hacking tower by a continuous rope and pulley system.

It was critical that there be only minimal direct exposure to humans in order to prevent the eaglets from becoming accustomed to human activities. To minimize the possibility of the birds associating humans with their food, extreme caution was exercised to ensure that the eaglets could not see the researchers supplying it via the food tray.

A diet of fish supplemented with an occasional mammal (or parts of same) was fed to the eaglets. The major types of fish offered to the eagles included: shad *(Alosa sapiolissma),* carp *(Cyprinus carpio),* catfish *(Ictalurus melas),* and crappie *(Poxomis annularis).* In addition, the eaglets were fed parts of the following mammals: fox squirrels *(Sciurus niger),* gray squirrels *(Sciurus carolinensis),* white-tailed deer *(Odocoileus virginianus),* and woodchucks *(Marmota monax).*

Food was made available to the eaglets several times each day to ensure the birds had ample food and as much moisture as possible. To increase the moisture content, the body cavities of the smaller fish were injected with water. All food items were weighed by means of a spring scale before being placed in the food delivery tray.

The monitoring of the eaglets was achieved through (1) direct visual observation, (2) an 8-mm camera, (3) several 35-mm cameras, (4) a remote video camera, and (5) radio telemetry equipment.

The birds were visually observed from dawn until dusk either through a variable 15× to 60× spotting scope, 7× binoculars, or with the naked eye.

An 8-mm time-lapse camera and automatic timer in the observation tower exposed 1 frame every 60 seconds during daylight hours. However, during the

birds' last 3 days on the tower, exposure frequency was increased to 1 frame every 30 seconds to provide more intensive monitoring. Several 35-mm still cameras were also used to document bird behavior.

A closed-circuit video camera on the observation tower relayed images of the eaglets to a monitor screen located in a trailer where the researchers lived. It was designed to provide remote observation capability during bad weather or at meal time and taped records for future review. Design of the voltage and phase converter portion of the system proved unsatisfactory and only limited information was obtained.

Radio-telemetry equipment became the predominant means of monitoring after release. Prior to the eaglets' release, a solar-powered harness-mount transmitter and a battery-powered tail-mount transmitter were attached to each bird using procedures outlined by Dunstan (1972, 1973).

Following release, the birds were monitored during daylight hours on an hourly basis for the 1st week; twice a day for the 2nd and 3rd weeks; and on a gradually decreasing basis after that. Aerial searches were also conducted on a periodic basis in conjunction with other projects.

RESULTS AND DISCUSSION

Arrival and First Day Reactions

The 2 eaglets arrived at the hacking site on 28 June 1980. When approached by the handlers, the birds situated themselves in the corners of the carrying crates and made a hissing sound, appearing very defensive. Ellis (1979) reported similar behavior with young wild golden eagles *(Aqila chrysaetos).*

When placed in the hacking enclosure, the birds moved very little, remaining on the platform for 3 hours before moving onto the nest. Neither ventured off the nest onto the platform during the remainder of the 1st day. Activity consisted of preening and inspecting their new surroundings with no feeding occurring.

Pre-fledging Feeding Patterns

The birds required an adjustment period before establishing a routine feeding pattern. Neither bird ate for the 1st 2 days, nor did they leave the nest for any other purpose. On the 3rd day, biologists concealed themselves behind the wooden doorway of the hacking enclosure and tossed small fish onto the nest and platform. The female eagerly ate 4 of these fish, ingesting them whole, but the male still did not eat. Direct feeding was repeated on the 4th day and both eaglets ate small quantities. By the 5th day both birds were feeding on the fish scraps on the nest and platform. The male was observed to eat fish directly from the food tray on day 7 and the female on day 8.

Because both birds had been force-fed prior to being transferred to the LBL hack site, failure to eat for the 1st few days on the tower did not appear to jeopardize their health. The trauma associated with being taken from the natural nest and placed in the artificial environment no doubt affected feeding behavior. The placement of fish directly on the nest encouraged both birds to eat suggesting the failure to eat reflected unfamiliarity with the food in the feeding tray or

possibly an unwillingness to leave the nest to obtain food. The placement of food items on the nest or possibly situating the food tray to bump against the nest sticks could reduce feeding adjustment time periods. For the remainder of the project, the continuous rope-pulley mechanism to transport the tray proved very beneficial as it prevented any association of food with project personnel, provided a means of removing most of the uneaten food, and aided with estimation of amounts of food consumed.

During the 1st week, only small shad (<15 cm) were provided. During the 2nd week, the eaglets were provided larger, fleshier fish such as carp and catfish, and seemed to prefer these to the smaller fish. A preference for mammals was also noted but the birds readily ate all food types.

To encourage feeding, the larger fish and mammals were cut open to expose the flesh and internal organs. The intestines and other viscrea were commonly consumed 1st and the fleshy portions later. Heads of large fish were often not eaten and were strewn about the hacking platform and the nest as were mammal skins and bones.

At 10 weeks of age, the male displayed a behavior described by Ellis (1979) as a foot stab. This involves a forward thrusting and clutching motion of the foot and talons at a food item. Prior to this development, the birds would stand on the food item using body weight to secure it in position. According to Ellis, the foot-stab behavior is a developmental step of raptorial birds learning to strike, capture, and subdue prey. By 11 weeks of age, both eaglets were foot-stabbing most food items as well as nest branches, and occasionally making stabbing motions toward each other. Portions of food were commonly foot-stabbed and carried about the nest and platform in the bill or talons. By 12 weeks of age, the pair was carrying most food items onto the nest, rarely eating directly out of the tray or on the platform.

On 3 occasions, food stealing threats elicited a food shielding or mantling behavior by the threatened eaglet. This concealing posture increases the likelihood the eagle can ward off the other bird and will be able to consume the food item (Ellis 1979).

Major feeding sessions (15 to 30 min) usually occurred 2 or 3 times a day, although small amounts of food were consumed throughout the day. Fresh food was provided throughout the day yet feeding generally occurred immediately after sunrise, at mid-morning, and occasionally in the late afternoon hours.

After feeding, the eaglets would stroke the sides and tips of their bills against the nest material, the bars of the enclosure, or the feeding tray in a bill-wiping fashion. This behavior is considered a mechanism to remove food fragments or water from the bill (Ellis 1979).

Total daily food consumption averaged 570 g (1¼ pounds) but varied from approximately 230 g to 1360 g (½ pound to 3 pounds) per bird. Feeding activity decreased on hot, still days and increased on cooler or windy days. On hotter days, both birds continued to go to the food tray (apparently in response to the hunger stimulus) but would not feed. Although there was a decrease in feeding and activity on hot days, both birds were alert and defecated regularly.

Intraspecific and Interspecific Interactions

Little interactions between the eaglets were noted during the 1st week on the tower. They sat side by side on the nest generally gazing at their new surroundings

throughout each day. A social billing behavior involving the eaglets gently biting at each other's bill was observed. At sunset, the birds would move close together and would be in the same positions when first observed the following morning.

Although nonaggressive interactions were predominant, aggression between the 2 eaglets did occur. This was first observed in association with feeding. For the 1st 2 weeks the male was dominant as he usually fed first chasing the female from the tray until he had eaten. Occasionally the male chased the female about the platform until she relinquished a food item.

At 10 weeks of age, there was an abrupt reversal of feeding dominance as the female began to wing-slap at the male — driving him away from the food. After a week of such harassment, the male would make only 1 attempt to secure food and after receiving the usual aggressive response, the male assumed a submissive posture similar to that described for golden eagles by Ellis (1979). This posture involved lowering of the head and turning his back toward the female. When aggression continued for several minutes, the male retreated to the farthest corner of the enclosure away from the food. While in the corner, the male would partially spread his tail and lower the head which appeared to halt the female's attack. Despite this dominance, the male was able to feed in comparable amounts by waiting until the female had finished eating before approaching the food tray.

The female continued to initiate most aggressive interactions until 14 weeks of age, when the male began returning the female's wing-slaps and remained crouched over food items instead of retreating. During the 3 days prior to the birds' release, the male did not relinquish any food to the female.

Other instances of agression were usually initiated by 1 bird apparently accidentally bumping against the other while wing-flapping or moving about the nest. The eaglets would react by a thrusting of the bill toward its nestmate and/or with a slapping action with the wings. Often, after this exchange, a short period of mock fighting would ensue in which both birds would move about wing-flapping and bill stabbing with little contact actually occurring. Mock fighting among hacking nestmates has also been reported by Milburn (1979) and generally results in no physical harm to the birds.

In general, aggressive behavior represented a small portion of the total time on the tower. Other interactions, such as tossing or carrying sticks, mutual preening, and tug-of-war with remains of food items (skins of mammals) occurred with increasing frequency as the release date approached. Similar behavior of hacked eagles was observed by Milburn (1979).

Because of the closure of the hacking area to the public, interactions with humans were minimal. However, there were 4 occasions when humans were partially or fully in view of the eaglets. They were: to toss fish directly onto the nest, to place wire mesh around the enclosure, to attach the radio transmitters, and to remove a side panel to release the birds. On each occasion, the eaglets' reaction was an attempt to escape from the approaching person by moving to the most distant corner of the enclosure. In wild eyries, this same behavior has been observed and often results in the eaglet jumping out of the nest to a nearby limb and/or gliding to the ground (Grier 1969). As individuals entered the enclosure, the birds would jump into the bars trying to escape. Other reactions noted were raising of head feathers (hackles), slight arching of the wings, bill opening, and a clucking vocalization.

Interspecific interactions with other animals in the hacking tower area were also noted. The birds' attention was often directed toward white-tailed deer and woodchucks which were especially numerous in the area. Other birds, however, seemed to receive the most visual attention. Both eaglets would stare intently at larger birds flying and/or feeding in the area.

Preening

Preening was a common activity of both birds throughout the project. During the 1st 2 weeks on the tower, the birds concentrated preening efforts on their developing feathers. Small bits of down were pulled from the plumage throughout the day. After a rain, the eaglets would spend as much as 4 hours constantly preening themselves. Associated with this was a vigorous shaking of the entire body.

Reactions to Summer Heat

The summer of 1980 was one of the hottest on record in Tennessee. During the birds' 44-day stay in the hacking enclosure, LBL weather station data revealed there were 9 days with temperatures that reached or exceeded 37.7 C (100 F). The mean daily high temperature for the same period was 35 C (95 F). Temperatures ranged from a high of 39.4 C (103 F) to a low of 16.6 C(62 F).

Various responses were noted in association with the intense heat. The birds commonly utilized the shade provided by the partial plywood roof. Beaks were often widely opened with the tongues partially elevated from the base of the mouth. Periods of heavy panting and wing drooping were also noted.

On days of extreme heat and humidity, both birds would lie on the wooden floor of the platform. This occurred very close to the edge of the platform and frequently the eaglets would rest their heads on the wooden base frame of a side panel. On several occasions the birds would hang their head between the bars, extending it over the side of the enclosure. It was doubtful that this behavior was induced by the enclosure as the conduit bars allowed for near maximum ventilation.

In addition to the above specific responses, a general lethargy was shown by the eaglets during the hot summer days. Other activities such as feeding and wing flapping decreased as compared to the cooler days and early morning hours.

Wing-Flapping Exercises

Various wing-flapping exercises were observed. Wing-flapping in association with walking, hopping, and jumping were used primarily in movement about the nest and the platform. Two exercises were closely associated with flight. A stationary exercise involved the grasping of nest sticks while vigorously flapping with fully extended wings. Free wing-flapping differed as no objects were grasped and as a result the birds would rise into the air. Short periods (5 to 25 seconds) of hovering above the nest were observed. The birds occasionally bumped their heads on the roof of the enclosure while free wing-flapping.

Wind is an important factor in stimulating flapping exercises (Kussman 1977). The birds would orient directly into a breeze, taking advantage of the added lift.

During periods of no wind, the eaglets did not orient in any particular direction when wing-flapping. The length of time for the exercises varied from a few seconds to extended sessions of over a half-hour. During the longer sessions, 1 or more of the different types of wing exercises were generally observed. The frequency and intensity of exercise gradually increased throughout the birds' stay on the hacking tower. This has also been observed in wild eaglets by Kussman (1977), and in hacked eagles by Milburn (1979).

Behavior at the Approach of Release

Movements within the enclosure, wing-flapping, and attempts to escape gradually increased during the last 3 weeks of captivity. Escape attempts involved jumping at the enclosure bars while wing-flapping, followed by a brief period of pacing. The birds would also walk directly into the bars, extending the head and 1 or both legs through the bars. In combination with these activities both birds exhibited "restless" behavior characterized by an almost continual movement about the enclosure. During the period, it was common for the birds to gaze intently in the direction of the nearby embayment.

Post-release Movements and Behavior

Monitoring of the birds' movements and behavior was conducted on a decreasing basis following release, therefore, detailed discussions of post-release behavior and movements are not presented. However, as eagle hacking is a relatively new restoration technique, the information presented has value for future reference.

The eaglets were released from the hacking tower enclosure at 6:30 a.m. (CST) on 10 August 1980. At this date the birds were 15 weeks old, which is about 3 weeks later than eaglets normally leave a natural (wild) nest (Harper 1974, Pramstaller 1977). This intentional delay of release was to allow the tail feathers to fully develop in order to attach the transmitters and to allow for additional development of flight muscles and coordination.

The initial flight of both birds was basically a long glide, which is a common 1st flight for eagles (Kussman 1977). The male was first to leave the hacking enclosure but remained perched for 1 hour and 15 minutes on large limbs attached to the platform. The female took the 1st flight (directly from the tower) and traveled a distance of approximately 175 m, alternating her glide with wing-flapping. The flight ended when she landed on the ground out of view of observers. The male's initial flight covered a slightly greater distance than the female's. He was able to gain some altitude as he approached the desired perch tree but missed the apparent target limb and fell about 5 m before gaining his balance on a lower limb. Such awkward and uncoordinated landings, as was observed, is normal for newly fledged bald eagles (Retfalvi 1965). By late afternoon the female had managed to fly to a nearby low-level tree perch. The male had changed perches several times by short (<20 m) flights to nearby trees. Both birds remained within 400 m of the hacking encloser for the remainder of the day.

The 2nd day following release showed an increase in attempts at flight. All flights were low (<30 m) and short in duration (<30 sec). One exception was a 2-min flight of the male which circled the embayment.

Very deep wing beats in flight with uncoordinated landings were common throughout the 2nd day, with both birds remaining within 1 km of the tower. Neither bird returned to feed upon fish left on the tower, but did locate and feed upon fish previously placed along the shoreline.

By the end of the 1st week, flight had grown progressively stronger and landings on perch limbs were accomplished with little difficulty. Flights continued to be short in distance (<400 m) and remained low (<50 m). Both birds made circling flights around the bay which involved a good deal of wing-flapping, gliding, and banking in wide arcs. Flights were often very low to the water, sometimes striking the surface of the water with the wing tips.

Food was placed on the hacking embayment shoreline on 3 occasions, once prior to release and twice afterwards. Observations revealed that the birds utilized the fish but the extent was not determined. During the 2nd week following the release, fish was scattered in the shallow water areas of the embayment to encourage the birds to associate fish with water. The carcass of a white-tailed deer fawn was also placed along the shoreline and was fed upon during the following week. All food placement was done after sunset to avoid any association of food with humans.

Two weeks following release, an apparent attempt to catch live prey was observed. While flying very close to the water, the female struck at but failed to capture a live fish swimming in the shallow water area of the bay.

Three weeks after release, flight distances and duration began to increase and the birds moved onto the main portion of Lake Barkley (Fig. 1). More experienced at flight, both spent more time in the air and performed various aerial displays. Strong, graceful flights that included soaring, gliding, banking, and a display described by Ellis (1979) for golden eagles as "parachuting" was observed. Harper (1974) documented similar displays at this same age (18 weeks) for wild bald eagles.

By the end of the 3rd week, return trips to the immediate vicinity of the hacking site were rare. The strong flight and the alert condition of the birds indicated that the birds were successful in foraging for themselves.

During the 4th and 5th weeks, the eagles ventured farther northward to the Fords Bay/Donaldson Creek area of Lake Barkley. This area is approximately 8 km north of the hacking site (Fig. 1). Movement from this area was less than 2 km for the following 6 weeks. Flight during this period appeared easy for the birds as spot checks found the eagles soaring for continuous periods of several minutes.

On 3 other occasions, the eagles were observed eating food items while perched on snags just above the waterline. It could not be determined if these food items were the result of a live catch or from scavenging because only feeding was observed.

The female could not be located during the 1st week of November 1980 (11 weeks post release). The male remained in the Fords Bay area for 2 additional weeks but daily movements were ranging farther than previously documented. While searches for the female were being conducted, other migrating bald eagles were observed at LBL. It is thought that the female encountered these migrant eagles, possibly resulting in the separation of the hacked eagles. By the 2nd week of November, searches failed to locate either bird. Periodic water and aerial

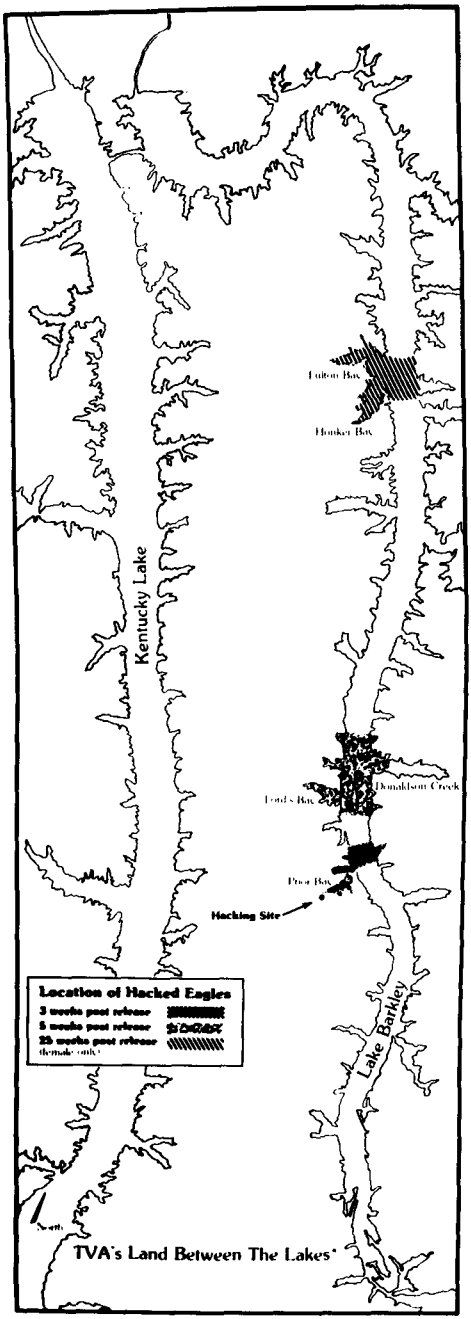

Fig. 1. Location of Land Between The Lakes Eagle Hacking Tower and Areas Utilized by the Eagles 3, 5, and 25 Weeks Post-Release.

searches of the LBL perimeter continued during November and December but neither bird could be located.

An early February aerial search of the western Kentucky-Tennessee region was successful in locating both hacked eagles. The male was at the junction of the Duck and Tennessee Rivers on the Tennessee National Wildlife Refuge some 80 km south of the hacking site. The male appeared to be in good condition and was observed soaring with 2 other immature bald eagles. The female was located on the Lake Barkley shoreline of LBL some 28 km north of the hacking site (Fig. 1). Two additional immature bald eagles were seen with the female. The female also appeared in good condition as flight was very strong and graceful.

Additional aerial searches were successful in located the hacked eagles during the month of March. Both were found within 5 km of their February location. On each instance the birds were seen with other wintering bald eagles.

Monitoring efforts during April through June 1981 were unsuccessful in locating either hacked bird. However, personnel at the Tennessee National Wildlife Refuge (Rhodes pers. commun., 1981) revealed that a leg-banded immature bald eagle had been sighted on several occasions during the months of March through June on the refuge. The location was the same as that of the male in March. At the writing of this paper (Jun 1981) monitoring efforts continue to be made in conjunction with the collection of other data.

The movements of the hacked birds to local environs at about 13 weeks after initial flight corresponds with the general time frame typical of both hacked eagles (Milburn 1979) and wild eagles (Kussman 1977). The presence of migrant eagles could have caused this sudden movement but this is speculation.

This joint TVA and TWRA hacking project proved successful in accomplishing the primary objective of rearing and releasing 2 immature bald eagles. Of course the ultimate success in meeting the goal of reestablishing a breeding population of bald eagles will not be known until the birds reach sexual maturity and hopefully return to raise young. However, hacking does appear to be a viable means for the achieving this goal as the results of New York's project have shown. This information and the positive results to date of this project are encouraging enough that both TVA and TWRA are planning additional hacking projects. The more birds that are hacked, the greater the possibility of establishing a breeding population of bald eagles in the region.

LITERATURE CITED

Alsop, E. J. 1979. Population status and management considerations for Tennessee's threatened and endangered bird species. Tenn. Wildl. Resour. Agency Publ. Proj. no. E-2-1. 200pp.

Brown, L. H. and D. Amadon. 1968. Eagles, hawks and falcons of the world, Volume I. McGraw-Hill Book Company, New York. 414pp.

Chura, N. J. and P. A. Stewart. 1967. Care, food consumption, and behavior of bald eagles used in DDT tests. The Wilson Bull. 79(4):441-448.

Dunstan, T. C. 1972. A harness for radio-tagging raptorial birds. Inland Bird Banding News 44:4-8.

_____. 1973. A tail feather package for radio-tagging raptorial birds. Inland Bird Banding News 45:3-6.

Ellis, D. H. 1979. Development of behavior in the golden eagle. Wildl. Monogr. 70. 94pp.

Grier, J. W. 1969. Bald eagle behavior and productivity responses to climbing and nests, J. Wildl. Manage. 33:961-966.

Hammer, D. A., J. L. Mechler, and R. M. Hatcher. 1981*a*. Restoration of bald eagles in the mid-south. Proc. of Raptor Research Foundation Symp. — bald eagle and osprey management. Montreal Quebec, Canada.

_____, R. L. Lowe, R. M. Hatcher. 1981*a*. Bald eagle restoration project - 1980, Interoffice Rep. TVA, Office of Nat. Resour., Norris, Tenn. 30pp.

Harper, J. F. 1974. Activities of fledging bald eagles in north-central Minnesota, M.S. Thesis. Western Ill. Univ., Macomb. 68pp.

Kussman, J. V. 1977. Post-fledging behavior of the Northern Bald Eagle, *Haliaeetus leucocephalus alascanus* Townsend, on the Chippewa National Forest, Minnesota. Ph.D. Thesis. Univ. of Minn., St. Paul. 434pp.

Milburn, E. H. 1979. An evaluation of the hacking technique for establishing bald eagles *(Haliaeetus leucocephalus)*. M.S. Thesis. Cornell Univ., Ithica, N.Y. 184pp.

Mulhern, B. M., W. L. Reichel, L. N. Locke, T. G. Lamont, A. A. Belisle, E. Cromartie, G. E. Bagley, and R. M. Prouty. 1970. Organochlorine residues and autopsy data from bald eagles, 1966 - 1968. Prestic. Monit. J. 4:141-144.

Nye, P. E. 1980. Successful establishment of nesting bald eagles by hacking. Proc: Raptor Res. Found. Ann. Meeting. Duluth, Minn.

Peterson, C. T. 1973. Bald eagles in Land Between The Lakes. Publ. by Tennessee Valley Authority, Land Between The Lakes, Golden Pond, Ky. 5pp.

Pramstaller, M. E. 1977. Nocturnal, pre-roosting and post-roosting behavior of breeding adult and young of the year Bald Eagles *(Haliaeetus leucocephalus)* of the Chippewa National Forest, Minnesota. M.S. Thesis, Univ. of Minn. St. Paul. 97pp.

Reichel, W. L., E. Cromartie, T. G. Lamont, B. M. Mulhern, and R. M. Prouty. 1969. Pesticide residues in eagles. Pestic. Monit. J. 3:142-144.

Retfalvi, L. I. 1965. Breeding behavior and feeding habits of the Bald Eagle *(Halieaeetus leucocephalus)* on San Juan Island, Washington. M.S. Thesis. Univ. of British Columbia, Vancouver. 193pp.

Sherrod, B. K. and T. J. Cade. 1978. Release of peregrine falcons by hacking. Pages 121-136 *in* T. G. Geer, ed. Birds of prey management techniques. British Falconers' Club.

Stickel, L. F., N. J. Chura, P. A. Stewart, C. M. Menzie, R. M. Prouty, and W. L. Reichel. 1966. Bald eagle pesticide relations. Trans. N. Am. Wildl. and Nat. Resour. Conf. 31:190-200.

Wiemeyer, S. N., B. M. Mulhern, F. J. Ligas, R. J. Hensel, J. E. Mathisen, F. C. Robards, and S. Postupalsky. 1972. Residues of organochlorine pesticides, polychlorinated biphenyls, and mercury in bald eagle eggs and changes in eggshell thickness — 1969 and 1970. Pestic. Monit. J. 6:50-55.

_____, P. R. Spitzer, W. C. Krantz, T. G. Lamont, and E. Cromartie. 1975. Effects of environmental pollutants on Connecticut and Maryland osprey. J. Wildl. Manage. 39:124-139.

Wright, G. A. 1975. Compatibility of the eastern wild turkey with recreational and land management activities at Land Between The Lakes, Kentucky. M.S. Thesis. Auburn Univ., Auburn, Ala. 74pp.