Bald Eagle Recovery Efforts at Corps of Engineers Projects

INTRODUCTION: The bald eagle (*Haliaeetus leucocephalus*) is one of the largest birds of prey on the North American continent. Two subspecies were historically recognized, the northern (*Haliaeetus l. alascensis*) and southern (*Haliaeetus l. leucocephalus*) bald eagle (American Ornithologists' Union 1983, Johnsgard 1990). However, recent evidence suggests that there is only one species of bald eagle, with a marked decline in size from north (i.e. those in Canada and Alaska) to south (i.e., those in the southern states).

Figure 1. The Corps of Engineers has taken a proactive approach in assisting the recovery of bald eagles

In late 1999, the U.S. Fish and Wildlife Service (USFWS) proposed removing the bald eagle from the Endangered Species List. Recovery of the bald eagle represents one of the greatest accomplishments under the Endangered Species Act (ESA). Also in 1999, the USFWS approached the Department of Defense and requested "success stories" to illustrate the effectiveness of the ESA and to celebrate the delisting of the bald eagle. The purpose of this report is to highlight efforts conducted by the U.S. Army Corps of Engineers in support of bald eagle recovery. Except for background information on current status of the species in North America, information for this report was provided primarily by natural resource managers at Corps project and District offices in response to an informal email survey. This information is not intended to be an exhaustive description and assessment of Corps-wide efforts.

This technical note is a product of the EMRRP work unit entitled, "Reservoir Operations -Impacts on Habitats of Target Species." Refer to Technical Note EMRRP-SI-11 (Mitchell et al. 2000) for additional information on bald eagles and other riparian raptors occurring on Corps lands.

POPULATION STATUS: From the late 1700s to the mid-1980s, the number of bald eagles in the lower 48 states decreased by at least 60 percent (USFWS 1983, World Wildlife Fund 1992). Significant declines were first noted in the early 1900s, and attributed to a decrease in the number of prey species, direct killing (i.e., shooting, trapping), and habitat loss. After World War II, the widespread use of the pesticide DDT became popular in coastal and wetland areas to control mosquitos, resulting in a decline in reproductive success of bald eagles and several other fish-eating raptors. Bioaccumulation of DDT in aquatic-based food chains resulted in dangerous accumulations of DDE, a persistent metabolite of DDT, in the fatty tissue of fish and waterfowl (Green 1985). DDE inhibits calcium metabolism, especially in flesh-eating birds, and causes a reduction in egg shell thickness (USFWS 1983). Affected birds regularly laid eggs that were too thin for successful incubation. Eggs that did not break during incubation often contained dead embryos, and mortality

rates for hatchlings were high (Green 1985). The result was mass reproductive failure and a further plummet in the number of breeding pairs. In the late 1960s, the detrimental effects of DDT and its metabolites were documented; the Environmental Protection Agency (EPA) banned the use of DDT on 31 December 1972. Reproductive success subsequently increased dramatically with the nationwide ban on DDT, but only 791 bald eagle nesting pairs were documented two years after the ban. The low number of eagle breeding pairs prompted the Secretary of the Interior to list the species under the ESA in the lower 48 states[1] in March 1978. The USFWS developed a recovery plan in the mid-1970s to provide guidelines for increasing the bald eagle throughout the lower 48 states.

Dramatic increases in bald eagle populations have resulted from successful hacking programs, restrictions on disturbances to breeding and nesting eagles, habitat conservation, and ban of DDT. Hacking involves placing fledglings in cages atop hacking towers, which contain simulated natural nests. When young birds are released, they still return to the tower to roost and receive some food until they have fully developed hunting skills. Hacking orients the young birds to the area, and biologists believe that most individuals will return to breed in the same general area upon maturity. By 1998, the number of breeding pairs increased to 5,748 (Figures 2 and 3). This increase in breeding pairs resulted in a 1995 USFWS decision to reclassify the bald eagle from endangered to threatened throughout the 48 conterminous states (Federal Register, 12 July 1995 [effective 11 August 1995]). There is currently a movement to completely remove the bald eagle from protection under the ESA. However, it still would remain protected under other federal legislation, including the Bald Eagle Protection Act, the Migratory Bird Treaty Act, and the Lacey Act.

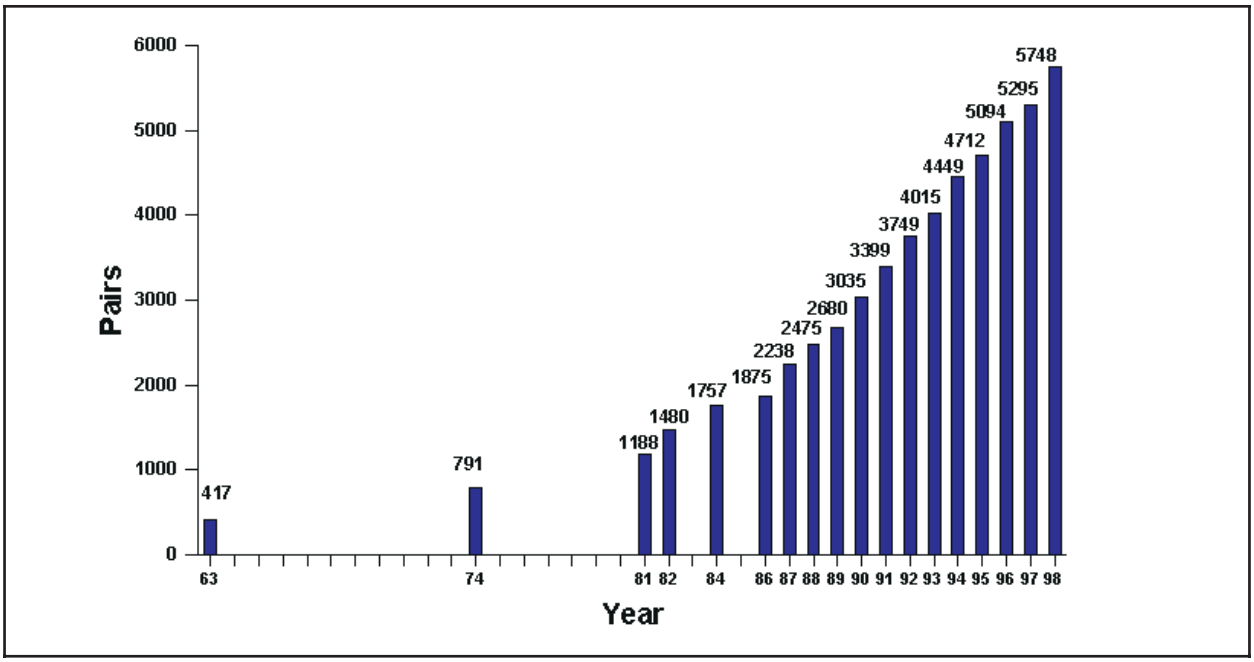

Figure 2. Number of breeding bald eagle pairs documented in the lower 48 United States from 1963 to 1998 (USFWS 1999)

1 Listed as endangered except in Minnesota, Michigan, Wisconsin, Washington, and Oregon, where it was listed as threatened. Bald eagles in Alaska are relatively abundant and are not Federally listed.

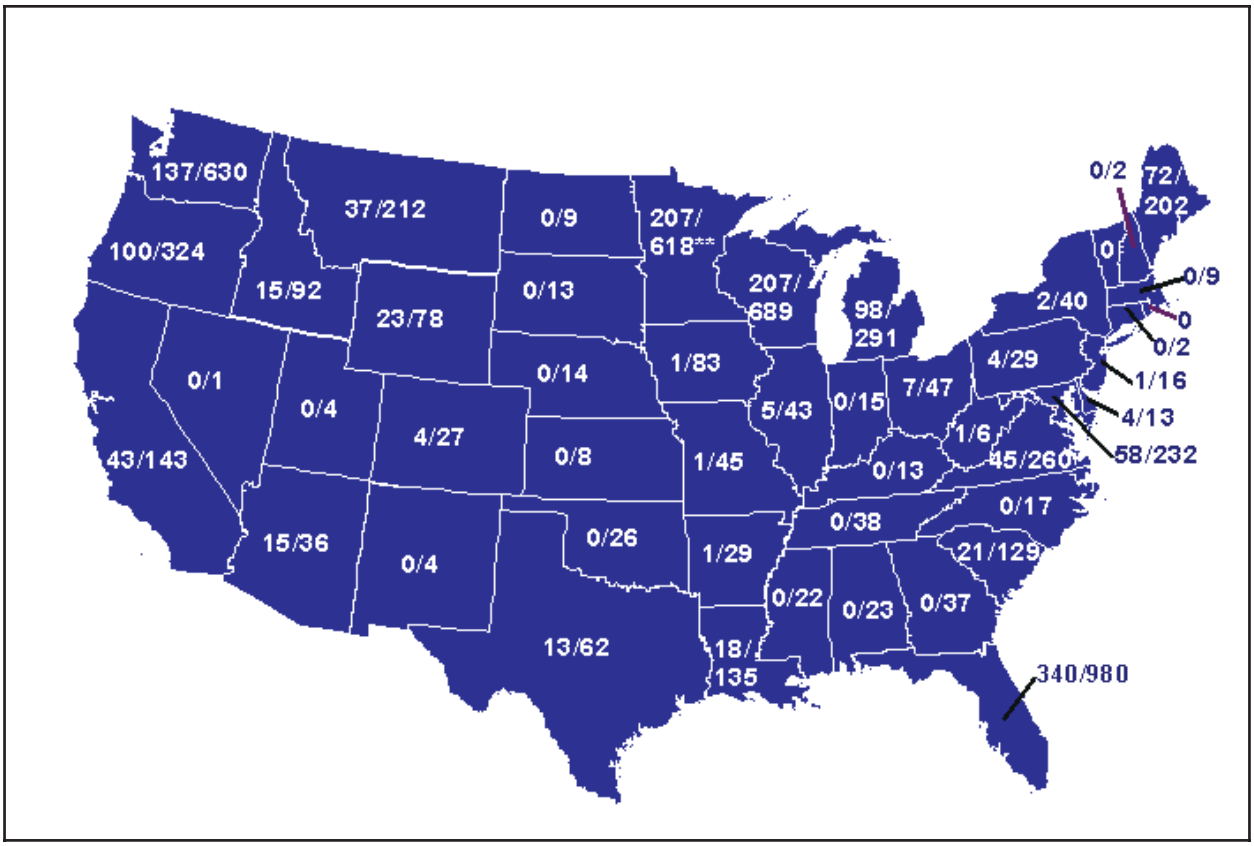

Figure 3. Number of bald eagle pairs by state, 1982 versus 1998 (USFWS 1999)

HABITAT REQUIREMENTS:[1] The bald eagle is primarily associated with riparian habitats near coastal areas, rivers, creeks, and lakes. Previous studies have indicated that nearly 100 percent of successful eagle nests in the United States are within 2 miles (3.2 km) of some type of open water and most are less than 0.5 mile (0.8 km) from a river, lake, coastal area, or open bay (fresh and marine) (Green 1985). The close association of bald eagles with water is primarily related to their dependence on fish, waterfowl, and seabirds as food.

Wintering bald eagles most often are associated with riparian and open-water areas that provide an ample food supply and have adequate nocturnal roost sites (USFWS 1983). Bald eagles have also been reported to spend a substantial portion of winter in more terrestrial, inland habitats hunting small prey and scavenging dead livestock and wildlife (USFWS 1983). During winter, eagles congregate around communal roost sites at night. Communal roosts are focal points of winter activity and are used repeatedly year after year (Steenhof 1978). Up to 100 birds have been observed at communal roosts but the number is usually much lower (Green 1985). Selection of roost trees appears to be based more on structural characteristics and is not necessarily dependent on species. Roost trees are usually larger trees with open branching and strong horizontal limbs, and usually

1 General information on the habitat requirements of bald eagles is provided here. Refer to Guilfoyle et al. (2000) and Mitchell et al. (2000) for additional information on bald eagle distribution, habitat, behavior, reproduction, food habits, impacts, and management.

are located in areas protected by topography and vegetation. Communal roosting in protected areas facilitates successful foraging in addition to providing thermoregulatory benefits (USFWS 1983).

Diurnal perches are extremely important winter habitat components. Trees, logs, driftwood, ice, powerline poles, fenceposts, and pilings are commonly used as perches. Dead trees are preferred for perching, but live trees will be used if snags are not available (Steenhof 1978). Trees used as perch sites are generally the taller, larger diameter trees, and tree species preference is dependent on region and availability (Steenhof 1978). Perch selection is based primarily on availability and proximity of a food source (Steenhof 1978, Stalmaster 1987), but locations near water that have an unobstructed view of the surrounding area are also important (Steenhof 1978).

RECOVERY EFFORTS BY THE CORPS: The Corps has played a significant role in recovery efforts of the bald eagle. Bald eagles breed, nest, migrate through, and winter on numerous Corps lakes and reservoirs throughout the United States. In cooperation with the USFWS, other federal and state agencies, and nongovernmental organizations, the Corps has been involved in a variety of activities in support of eagle conservation, including breeding season and mid-winter eagle surveys, management of breeding and wintering habitat, and education and outreach.

Breeding and Nesting Eagles. The increase in number of breeding and nesting bald eagles has been highly noticeable throughout the Southeast. Active restoration efforts and habitat management at numerous Corps projects has made a significant contribution to bald eagle population increases in the southeastern United States. The Corps has played a key role in the restoration of bald eagles in other parts of the country as well.

Mobile District. Population restoration efforts for the bald eagle in the southeastern United States are probably best exemplified by work conducted in the Mobile District. The District joined the USFWS, the Alabama Department of Conservation and Natural Resources, the Mississippi Department of Wildlife, Fisheries and Parks, and the Sutton Avian Research Center, Oklahoma, in the Southeastern Bald Eagle Recovery Project. The project is a joint effort among state and federal agencies and private groups to reestablish a solid nesting and breeding population of bald eagles in their historic range in the Southeast.

In 1990, USFWS officials indicated they wanted to bolster breeding populations of eagles in Alabama and Mississippi. The Mobile District offered to support the program with Corps-managed Federal lands at its lakes and share the cost between project O&M funds and Tennessee-Tombigbee Wildlife Mitigation Project funding. A hacking program was implemented with the guidance of the George M. Sutton Avian Research Center and significant assistance from the Nashville District, Weyerhauser, the National Wild Turkey Federation, and Corps resource managers at various projects. During 1991-92, Sutton biologists collected eggs from eagle nests in Florida, hatched them in incubators, and raised them to 8 weeks of age. Approximately 100 immature eagles were placed at seven nesting sites on hacking towers, all on Corps lands in Alabama and Mississippi, in an attempt to imprint them on their surroundings before departing the nest. Within two months, cages were opened and birds were allowed to leave the hacking sites. Recent sightings indicate new nests of the banded eagles have been successfully established on Corps and nearby lands.

The first active nest at Okatibbee Lake, Mississippi, was discovered during the 1996 nesting season. This pair has nested successfully each year since, fledging a total of 5 eaglets (Figure 4). In March 1995, a pair of bald eagles, the first reported nesting bald eagles in northern Georgia, were seen building a nest at Carter's Lake. The pair nested but failed to hatch any eggs. However, this same pair nested successfully the next three years, fledging one young per year. This nesting pair, which now inhabits Carter's Lake year-round, has added five eagles to the population.

Figure 4. Active bald eagle nest at Okatibbee Lake, Mississippi (Photo by Van McWhorter, CESAM-OP-OL)

At another Corps project in Georgia, one active nesting site has been located at Lake Allatoona near the mouth of the Little River. Since its discovery in 1997, the Corps and the Georgia Department of Natural Resources, Wildlife Resources Division, have been monitoring the nest. The Corps placed a 1,476-ft (450-m) buffer zone around the nest that restricted all land activities within the buffer and all major activities within a 1-mile (1.6-km) radius during the nesting period. Buffer strips around eagle nest sites are often recommended as an effective management practice to protect eagles from disturbances (Gende et al. 1998). These buffer strips not only reduce disturbances by human activity, they preserve perches for resting and foraging, and alternative trees for nest sites, all critical components of bald eagle habitat (Chandler et al. 1995). Buffer strips between 1,300 and 2,600 ft (400 and 800 m) typically are recommended (Fraser et al. 1985, Anthony and Isaacs 1989, Grubb and King 1991).

Savannah District. In 1992, the first bald eagle nest was verified on J. Strom Thurmond Lake. By 1999, seven active eagle nests were located on J. Strom Thurmond and one nest was found on the Richard B. Russell project. About half of the nesting pairs have successfully fledged young each year. The success of the bald eagles on the Thurmond and Richard B. Russell Projects can be attributed to several factors. Much of the 105,000 acres (42,490 ha) of project lands is relatively undeveloped with many large peninsulas extending out into the lakes. The majority of the adjoining private land is either pasture or timberland. The lakes have excellent water quality, which supports large fish and wintering/migrating waterfowl populations, all staples in eagle diets. Finally, forest management practices on Corps lands tend to provide the large, dominant trees that provide excellent nesting habitat, and perches for resting and foraging.

Vicksburg District. Corps personnel are currently monitoring several eagle nests at lakes Arkabutla, Sardis, and Grenada in Mississippi, and at lakes DeGray, Greeson, and Ouachita in Arkansas. These nests have had varying levels of success, with some producing fledglings annually, others serving as "practice nest areas," and some damaged by severe storms. Buffers and restricted zones are used to manage nesting habitat. This management can be challenging when faced with nests located in popular recreation areas such as along a boardwalk nature trail. Nest monitoring results are shared with state game agencies and the USFWS.

Nashville District. In 1987, the Corps began a five-year eagle hacking program at Dale Hollow Lake, in an effort to restore this national symbol to the Upper Cumberland region of Tennessee and Kentucky. Because Dale Hollow Lake has long been a major wintering area for bald eagles, this project was initiated to establish a year-round seed population. Prior to this program, it had been 30 years since the last known eagle nest had been found in middle Tennessee. Each year during this program, immature eaglets were brought from Minnesota, Wisconsin, and Alaska to a remote hacking tower overlooking Dale Hollow Lake. After about six weeks in the tower, the birds were tagged and released. When the eagle hacking program ended in 1991, forty-four eagles had been successfully released at Dale Hollow Lake.

Wilmington District. Before 1985, most bald eagles in North Carolina were found at scattered locations along major rivers, sounds, and the Atlantic coastline, with only a few incidental sightings of eagles occurring inland. In 1982, Jordan Lake, a newly constructed reservoir in the middle of the state, was coming to full pool. The next year, Falls Lake, another new reservoir project approximately 40 miles north of Jordan Lake, was also coming to full pool. By the summer of 1985 fish populations in these reservoirs were becoming abundant and there were reports that eagles were regularly observed foraging at Jordan Lake. By the summer of 1986 the public had discovered pine stands near Jordan Lake that were being used as roost sites by congregations of 20 to 30 immature bald eagles. The New Hope Chapter of The Audubon Society organized local birders and agency volunteers into a network that began monthly observations on both reservoirs. Their observations indicated that summer populations of 50 to 60 eagles (primarily juveniles) were using Jordan Lake (the largest summer communal roost of eagles on the east coast at that time), and 10 to 15 eagles were using Falls Lake.

The USFWS became concerned that planned recreation facilities at Jordan Lake, which were still under construction, could adversely impact this summer population of eagles. The Corps immediately initiated a study with Virginia Tech University that ultimately identified characteristics of pine stands that eagles preferred for roosting and nesting. The Corps also initiated a cooperative management strategy and convened nine federal and state agencies, two special interest groups, the local university, utility company, and marina concessionaire that were stakeholders in the resources to be potentially affected by eagle management at the two reservoirs. The cooperative management strategy promoted thinning operations in mature stands of pines near the shorelines of both lakes that mimicked the timber stand characteristics identified in the Virginia Tech study as being preferred by the birds. In 1991 the first nest attempt was observed at Jordan Lake, and in 1994, a successful nest was discovered at Falls Lake. At the end of the 1999 nesting season, there were five active and three inactive nests on the two lakes. Since 1994 the two lake projects have fledged at least 39 eaglets.

Jordan Lake is now considered the best place in the state to observe bald eagles. In 1999, the Audubon Society identified Jordan Lake as one of three initial Important Bird Areas in North Carolina, primarily for its importance as habitat for eagles and its role in promoting their recovery in North Carolina. The success of eagle management on Jordan and Falls Lakes is due in large part to public support and collaboration among many agencies, institutions, and volunteer groups. Corps natural resource specialists are working to successfully balance multiple resource use and responsible stewardship.

St. Louis District. The Rivers Project Office, located in West Alton, Missouri, adjacent to the Melvin Price Locks and Dam, has been heavily involved in the recovery of bald eagles. The first eagle chicks hatched in the Rivers Project Area in 50 years were banded in 1992 as the result of successful breeding in the region. Coordinated by the Rivers Project Office, the three eagle chicks were banded in a cooperative effort with the World Bird Sanctuary in Eureka, Missouri; the Missouri Department of Conservation; and the USFWS. The Corps also posted signs and buoys marking off a large area around Slim Island near Chautauqua, Illinois, restricting public disturbance to eagles while they raised young.

The Rivers Project Office was also involved in releasing two juvenile bald eagles into the wild. The eagles were raised in captivity and released in cooperation with the World Bird Sanctuary. The birds were fitted with radio transmitters, and hacked from an artificial nest in cooperation with J.S. Alberici Construction Co. Inc., Union Electric, and Anheuser-Busch Co. The birds were closely monitored until they moved out of range from the radio transmission tower. There are also several existing and new nesting sites on Corps property along the Mississippi River that have fledged numerous eagles during the past few years.

At Mark Twain Lake in northeast Missouri, an active bald eagle management plan was enacted after a nest was discovered on Otter Creek branch in 1996. Seven eagles have successfully fledged from this site since 1997. Through cooperative efforts with the Missouri Department of Conservation, the Corps established a refuge around the nest site to eliminate potential harassment and reduce stress on the birds during critical nesting periods.

Louisville District. The Indiana Department of Natural Resources conducted a hacking program for the release of eagles at Monroe Lake (a Corps multi-purpose project), releasing 73 immature eagles over a several-year period. Their initial goal was to release 35 eaglets, but restoration efforts were accelerated as eggs became increasingly available. Several released birds returned to Indiana to nest, producing the first active bald eagle nests in the state in over 70 years. The state has monitored eagle success and documented active nests beginning with one in 1991 and reaching twenty in 1999. During that time period, 39 of the 106 eaglets fledged in Indiana have been produced at Corps lakes. There currently are seven nests at three of the Corps lakes.

Tulsa District. During the late 1970s, a pair of bald eagles was observed nesting and raising young on the south side of Robert S. Kerr Lake. A hacking program involving several Federal, state, and private entities was initiated in the late 1980s and early 1990s. This project required removing eggs from Florida nest sites, hatching them in a controlled environment at the George M. Sutton Avian Research Center, and hacking the juvenile birds into the wild at several sites, including a major hacking tower on Kerr Lake. The eagles continued to return to Kerr for the winter and early spring. After the young eagles matured, they appeared to show an interest in nesting along Kerr Lake and surrounding areas. A considerable number of the Oklahoma-hacked eagles are now raising their young on Kerr Lake and several surrounding Corps lakes.

Kansas City District. Corps lakes in the Kansas City District have played a critical role in the resurgence of the bald eagle in the Midwest. In addition to their traditional role of providing habitat for hundreds of wintering eagles, lakes in the District are now providing critical nesting habitat for a number of birds. The first successful nesting attempt and fledging of a juvenile bald eagle in

Kansas occurred at Clinton Lake in 1989. The adults have returned to the same nest each year and fledged 29 juveniles over the past 11 years. This is one of the most productive nests in the nation, producing a mean of 2.6 young annually, compared to the national average of 1.6. During the past 12 years, 130 eaglets have fledged from nesting territories located at 5 District lakes, including Hillsdale and Perry Lakes in Kansas, Rathbun Lake in Iowa, and Truman Lake in Missouri. Truman Lake is the most prolific in terms of eaglet production. During 10 nesting seasons, 68 eaglets have been fledged from nesting territories; 16 eaglets were fledged from 8 nest sites in 1999.

Pittsburgh District. In the Pittsburgh District, nine pairs of bald eagles nested on Corps project lands in 1998. Eight of the nests (78 percent) were successful, producing 11 young (a mean of 1.4 eaglets per successful nest). Three projects, including Kinzua Dam and Allegheny Reservoir, Mosquito Creek Lake, and Shenango River Lake, documented bald eagle nestings in 1998. All three nests at Allegheny Reservoir successfully hatched eagles.

Baltimore District. The first documented eaglet was hatched near the Raystown Lake project Dam in April 1999. It fledged on June 22 and continued to feed in the vicinity of the nest. The Corps played an active role in the protection of this nest through public relations, providing access restrictions, and monitoring eaglet progress and coordination with the Pennsylvania Game Commission. The Corps has worked according to the recovery plan by monitoring winter populations, surveying for nesting eagles, and always evaluating project actions to protect potential nesting habitat.

Figure 5. Juvenile bald eagle recovered after its natural nest was destroyed by a storm. The eagle was placed in an artificial nest and eventually fledged (photo by Mark Andreasen, CENWS-OD-LI)

Seattle District. In 1995 a snow storm in northwestern Montana knocked a natural nest and two eaglets out of a western larch (*Larix occidentalis*). This situation provided an opportunity for Corps and U.S. Forest Service (USFS) employees to construct an artificial nest with canvas, sticks, and larger branches, to replace the destroyed natural nest. The displaced eaglets were captured and placed into the new nest approximately two days later (Figure 5). In general, the artificial nest was well-received by both the adults and juvenile eagles, and both juvenile birds eventually fledged from the nest. The success of the project provided valuable information about nest construction, eagle adaptation, using artificial nesting structures to replace damaged natural nests, and the effects of human interaction on eagle activity.

Portland District. Ten of thirteen Willamette Valley Project (WVP) reservoirs support nesting bald eagles; all of the reservoirs provide foraging habitat for at least one breeding pair and numerous juveniles. From 1989 to 1999, the number of active nesting territories increased from 9 to 14, with

2 new territories established in 1999 at Lookout Point reservoir. In 1998, 6 of 10 of nests produced 10 young, for an average of 1.67 young per successful nest.

In cooperation with the Oregon Cooperative Wildlife Research Unit at Oregon State University, WVP conducts bald eagle nest surveys during the breeding season, and mid-winter surveys just after the first of the year. In cooperation with the Willamette National Forest, USFS, the Corps conducted foraging surveys to gather data to aid in the development of bald eagle management plans at Detroit and Blue River reservoirs and five additional reservoirs managed by the Corps within the Portland District. By carefully evaluating the impacts of permitted activities and development, WVP has been successful in preserving bald eagle foraging perches and protecting nesting areas at its reservoirs.

Sacramento District. Bald eagles have visited Eastman Lake during the winter since the lake's formation in the mid-1970s. In 1993, a pair of bald eagles built a nest and fledged three young. In each year since then, the now-resident pair of eagles have raised and fledged two young. Initially, the Eastman Lake birds were the southernmost nesting pair in the Sierra Nevada mountains and the only ones in the Central Sierra. However, another nesting pair was discovered in 1999 at Bass Lake, which is approximately 50 miles (80 km) away. One of the adults is suspected of being an Eastman Lake offspring.

The eagles may have initially been attracted to Eastman Lake because of a lack of boat traffic. In 1989 the lake was quarantined when hydrilla (*Hydrilla verticillata*) was discovered growing in the lake. No boating was allowed between 1989 and 1995, but daytime boating has been permitted on the lower two-thirds of the lake since 1995. The upper portion of the lake is marked with "Keep Out" buoys to restrict boats from the area where most of the hydrilla has been found. The buoy line also provides a buffer of nearly 2,624 ft (800 m) between the eagles and any boat traffic. The birds have responded well to this management approach, as evidenced by their seven seasons of successful breeding.

Wintering Eagles. Many bald eagles migrate south from Canada, Alaska, and the northern states to areas of open water that provide abundant food sources during winter. Because bald eagles congregate in winter near lakes, reservoirs, and rivers, many Corps projects around the country provide excellent opportunities to view wintering eagles. Concentrations of wintering eagles also provide an opportunity to inventory the abundance and distribution of eagles and estimate population trends. The U.S. Geological Survey, Biological Resources Division, coordinates annual midwinter bald eagle surveys. These surveys are conducted nationwide during early January to establish an index to the total wintering bald eagle population in the lower 48 states, to determine eagle distribution during a standardized survey period, and to identify previously unrecognized areas of important winter habitat (USGS 1998). Most surveys are conducted by state or Federal conservation agency personnel, but private volunteers also participate in the surveys.

Vicksburg District. Wintering (October through March) eagles have increased significantly on the District's reservoir and river projects in the states of Arkansas, Louisiana, and Mississippi. Populations have ranged from a total of 156 birds in January 1988 to 218 in January 2000, to include a District high of 337 birds in January 1998.

Savannah District. Bald eagles were infrequent winter visitors to the Savannah District before 1992, and detections of more than one eagle per year during mid-winter surveys were rare. In 1998, 11 eagles were detected at J. Strom Thurmond Lake, GA, during the midwinter eagle survey. Six additional eagles were observed wintering at adjacent Richard B. Russell Reservoir and Lake Hartwell.

St. Louis District. The Rivers Project Office in Missouri is heavily involved in monitoring wintering bald eagles. From December through March, several hundred eagles are counted every day around the Melvin Price Locks and Dam, the Winfield Lock and Dam, and the Clarksville Lock and Dam. Ellis Bay, a 2-mile- (3-km-) long navigation channel upstream from the Melvin Price Locks and Dam, is a 495-acre (200-ha) backwater bay of the Mississippi River adjacent to the Rivers Project Office. This bay has abundant shad and other fish that eagles rely on for food. Ellis Island, which is adjacent to Ellis Bay, serves as a heavily used day roost for the eagles that migrate to the area. As many as 200 eagles have been counted in the trees on Ellis Island.

Pittsburgh District. The Pittsburgh District participates extensively in the annual midwinter bald eagle survey. In coordination with the USFWS and National Park Service, the Corps provides survey data to state wildlife agency coordinators in New York, Ohio, Pennsylvania, and West Virginia. The Corps has documented a general increase in bald eagle winter populations in these states over the past 19 years. In 1999, Corps personnel conducted mid-winter surveys at 80 fixed points from 1 to 15 January at 23 Corps facilities in the District, including all 16 reservoirs and locks and dams 3-9 on the Allegheny River. Eleven bald eagles (six adults and five juveniles) were observed at six Corps facilities during the survey period. One or more bald eagles were reported in 1999 at Lock and Dam 8 - Allegheny River, Kinzua Dam, Mosquito Creek Lake, Shenango Lake, Tionesta Lake, and Union City Dam. The 1999 total was 31 percent lower than the all-time high of 16 recorded in 1997. However, winter observations of bald eagles increased from 3 in 1990 to 11 in 1999. During the same time period, the number of Pittsburgh District facilities documenting bald eagles increased from 1 in 1990 to 6 in 1999.

Baltimore District. Raystown Lake in southern Pennsylvania has always been a heavily used winter foraging site for bald eagles. Since 1989, the Corps has assisted the Pennsylvania Game Commission with annual midwinter surveys. As many as eight different bald eagles winter at Raystown.

Education and Outreach. Public education and awareness of the saga of the bald eagle has been instrumental in recovery efforts for the species. Numerous Corps projects have either initiated or strongly participated in educational outreach programs directed at the general public, focusing on the factors leading to the decline of eagle populations, their sensitivity to disturbance during the breeding and nesting season, and opportunities to view eagles during the winter.

Vicksburg District. Eagle awareness programs within the District are very popular with the public and include cooperative education efforts and eagle viewing barge tours with the Arkansas Game and Fish Commission and Arkansas State Parks. At Lake Ouachita, the Corps and the Arkansas Department of Parks and Tourism - Lake Ouachita State Park saw a need for educating the public about bald eagles. Prior to 1990, Arkansas had a notorious record of bald eagle deaths attributed to shooting by humans. As many as 11 eagles were killed in a single year, with perhaps many more

killings going unreported. Eagle Extravaganza Weekend was initiated and originally offered tours on the lake to view eagles in their natural habitat. Events included presentations about eagles and other raptors and demonstrations of live birds of prey. Eagle Extravaganza and similar events around the state have raised public consciousness about protecting bald eagles and have contributed to the drastic decline in the number of eagles shot each year. In recent years, very few, if any, eagles have been shot in Arkansas.

The Vicksburg District has also played a leading role in assisting with investigations of a recently discovered disease that is killing bald eagles and other avian species. This disease, which causes a signature lesion in the brain and spinal cord of affected birds, is referred to as "Avian Vacuolar Myelinopathy" (AVM), formerly known as "Coot and Eagle Brain Lesion Syndrome" (CEBLS) or "Avian Brain Lesion Syndrome" (ABLES) (U.S. Army Corps of Engineers 2000). The disease was discovered at DeGray Lake in southwestern Arkansas in 1994 and has been responsible for the deaths of at least 60 bald eagles and hundreds of American coots (*Fulica americana*). This disease is caused by a neurotoxin of unknown origin and causes lesions in the white matter of the brain and in the spinal cord of affected birds. Recent research suggests that it may have first occurred in North Carolina in 1990. The disease is also known to affect other species including the mallard (*Anas platyrhynchos*), bufflehead (*Bucephala albeola*), American widgeon (*Anas americana*), and the ring-necked duck (*Aythya collaris*). Affected birds reportedly have difficulty flying, swimming, or walking and may even exhibit a partial paralysis on one side of the body. Live birds diagnosed with the disease usually do not live for more than a few days; there is no known effective treatment for this disease. Cooperative efforts are in effect with the Corps, USFWS, the U.S. Geological Survey, and numerous other state agencies and universities. Current efforts include clinical toxicology studies on numerous bird species, water quality analyses, bald eagle and American coot foraging ecology studies, toxicology of affected avian tissues, aquatic and terrestrial plant inventories, and collection of disease distribution data in a Geographical Information System database. The Corps has also been instrumental in informing the public on the nature and status of this disease. They provide an information page on the World Wide Web at: *http://www.mvk.usace.army.mil/od/odm/avm/index.htm*.

St. Louis District. For the past eight years, the Rivers Project Office of the Corps has hosted several special events focusing on the bald eagle. The Riverlands Office in Clarksville, Missouri, hosts "Eagle Days" with the Missouri Department of Conservation, and "Masters of the Sky" with the World Bird Sanctuary and the Illinois Department of Natural Resources. These events draw between 2,000 and 5,000 people who get a close look at bald eagles and other birds of prey. The Rivers Project also coordinates with the Greater Alton Convention and Visitors Bureau for seasonal bus tours to view eagles along the Mississippi and Illinois Rivers. The tours bring about 125 to 200 people per weekend to view wintering eagles. During the winter, more than 150,000 people visit the projects and most see bald eagles; Corps rangers conduct between 200 and 300 programs per season, not including special events.

Nashville District. Elementary and middle-school students attending one of several Environmental Awareness Days programs at Cheatham Lake, Tennessee, had the opportunity to view two bald eagle chicks in a nest through a spotting scope. The program was organized to teach environmental stewardship and responsibility to young people by offering them exposure to natural resources

professionals. Similar events were held at other Corps projects, including J. Percy Priest Lake and Old Hickory Lake, Tennessee.

Wilmington District. Each year, personnel from the Wilmington District educate the public about eagle management efforts on Corps lands by assisting with development of local newspaper articles, presenting programs to school groups, and sponsoring programs in conjunction with state parks in recreation areas. Brochures are distributed at reservoir management centers, state park offices and other high traffic sites around the lakes that highlight eagle management on the reservoirs, identify the best places and times to view eagles, and provide identification keys for adult and juvenile eagles.

A bald eagle observation platform was constructed at Jordan Lake in 1987 through a cooperative effort involving the Corps, the New Hope Chapter of The Audubon Society, and the North Carolina Wildlife Resources Commission. The site is included in the North Carolina Watchable Wildlife Guide, and in the first two years, more than 300 visitors per month visited the platform. These visitors came from 49 North Carolina counties, 37 states, and 18 countries.

Kansas City District. Many of the Corps lakes in the Kansas City District are involved in water-related recreational activities. The proximity of these activities to bald eagle nest sites could adversely impact the nesting eagles. To minimize potential conflicts between nesting eagles and the general public, the District worked with the USFWS to establish protective buffer zones around the nest trees. The nest perimeters are marked with "BOATS KEEP OUT" buoys and " KEEP OUT - Eagle Nesting Area" signs. The Corps developed interpretive displays, gave press releases, and conducted TV and radio interviews about bald eagles to educate the general public. In addition, seven Lake Project Offices conduct annual "Bald Eagle Days" activities. In 1999, more than 3,000 people attended these activities, which included live eagle presentations, guided eagle viewing tours, slide shows, movies, eagle arts and crafts, and Native American dancers.

SUMMARY: The bald eagle appears to be recovering at a remarkable rate, following a long history of declining populations attributed to a variety of factors. The Corps has been instrumental in recovery efforts by managing breeding, nesting, and wintering eagle populations, as well as conducting public education and outreach activities. The USFWS has recently considered removing the bald eagle from protection of the Endangered Species Act because of the dramatic increase in the number of breeding pairs of eagles. However, the species will continue to be federally protected from harmful activities by such legislation as the Bald Eagle Protection Act, Migratory Bird Treaty Act, Lacey Act, and other state and Federal legislation. Likewise, conservation measures that have been implemented to recover the bald eagle will continue, and bald eagle population status will be periodically reviewed through surveys and banding efforts (USFWS 1999). The direct role the Corps has played in contributing to the recovery of the bald eagle should provide an incentive to continue to participate in the recovery of other Federal and state-listed, or otherwise sensitive, species.

ACKNOWLEDGMENTS: Thanks go to the following Corps personnel for providing input to this technical note: Mr. Mark Andreasen, U.S. Army Engineer (USAE) District, Seattle; Ms. Julie Marcy and Messrs. Rick A. Dwyer and Johnny C. Cantrell, USAE District, Vicksburg; Ms. Carol Banaitis and Messrs. Steve Brown and Michael Hosey, USAE District, Wilmington; Messrs. Brian Peck, Paul Jastram, and Van McWhorter, USAE District, Mobile; Mr. Robert VanHoff, USAE

District, Louisville; Mr. Franklin Massa, USAE District, Nashville; Mr. Kirk Piehler, USAE District, Pittsburgh; Mr. Jerry Strother, USAE District, Nashville; Ms. Hope Pollmann and Mr. Allen Mehrer, USAE District, St. Louis; Mr. Loyd Isley, USAE District, Tulsa; Mr. Jeff Krause, USAE District Baltimore; Mr. Michael Watkins, USAE District, Kansas City; Mr. David Brady, USAE District, Savannah; Ms. Kat Beal, USAE District, Portland; and Mr. Jerry Magnuson, USAE District, Sacramento. Report review was provided by Drs. Wilma Mitchell and Michael F. Passmore, and Messrs. Chester O. Martin and Michael P. Guilfoyle, ERDC-WES.

POINTS OF CONTACT: For additional information, contact the author (Dr. Richard A. Fischer, 601-634-3983, *fischer@wes.army.mil*), the work unit coordinator (Mr. Chester O. Martin, 601-634-3958, *martinc@wes.army.mil*), or the manager of the Ecosystem Management Restoration and Research Program, Dr. Russell F. Theriot, 601-634-2733, *therior@wes.army.mil*). This technical note should be cited as follows:

> Fischer, R. A. (2000). "Bald eagle recovery efforts at Corps of Engineers Projects," *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SI-16), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

REFERENCES:

American Ornithologists' Union. (1983). *Check-list of North American Birds*. Sixth edition. American Ornithologists' Union, Washington, DC.

Anthony, R. G., and Isaacs, F. B. (1989). "Characteristics of bald eagle nest sites in Oregon," *Journal of Wildlife Management* 53, 148-159.

Chandler, S. R., Fraser, J. D., Buehler, D. A., and Seegar, J. K. (1995). "Perch trees and shoreline development as predictors of bald eagle distribution on Chesapeake Bay," *Journal of Wildlife Management* 59, 325-332.

Fraser, J. D., Frenzel, L. D., and Mathiesen, J. E. (1985). "The impact of human activities on breeding bald eagles in north-central Minnesota," *Journal of Wildlife Management* 49, 585-592.

Gende, S. M., Willson, M. F., Marston, B. H., Jacobson, M., and Smith, W. P. (1998). "Bald eagle nesting density and success in relation to distance from clearcut logging in southeast Alaska," *Biological Conservation* 83, 121-126.

Green, N. (1985). "The bald eagle." *1985 Audubon Wildlife Report.* R. L. DiSilvestro, ed., National Audubon Society, New York, 509-531.

Grubb, T. G., and King, R. M. (1991). "Assessing human disturbance to breeding bald eagles with classification tree models," *Journal of Wildlife Management* 55, 501-512.

Guilfoyle, M. P., and Wolters, M. S. (2000). "Riparian raptors on USACE projects: Red-shouldered hawk (*Buteo lineatus*)," *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SI-15), U. S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

Guilfoyle, M. P., Evans, D. E., Fischer, R. A., and Martin, C. O. (2000). "Riparian raptors on USACE projects: Bald eagle (*Haliaeetus leucocephalus*)," *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SI-12), U. S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

Johnsgard, P. A. (1990). *Hawks, eagles and falcons of North America*. Smithsonian Institution Press, Washington, DC.

Mitchell, W. A., and Wolters, M. S. (2000). "Riparian raptors on USACE projects: Osprey (*Pandion haliaetus*)," *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SI-13), U. S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

Mitchell, W. A., Evans, D. E., and Fischer, R. A. (2000). "Riparian raptors on USACE projects: Peregrine falcon (*Falco peregrinus*)," *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SI-14), U. S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

Mitchell, W. A., Guilfoyle, M. P., Wolters, M. S., and Martin, C. O. (2000). "Riparian raptor potentially impacted by USACE reservoir operations," *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SI-11), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

Stalmaster, M. V. (1987). *The bald eagle.* Universe Books, New York.

Steenhof, K. (1978). "Management of wintering bald eagles," U.S. Fish and Wildl. Serv. FWS/OBS-78/79.

Thomas, N. J., Meteyer, C. U., and Sileo, L. (1998). "Epizootic vacuolar myelinopathy of the central nervous system of bald eagles (*Haliaeetus leucocephalus*) and American coots (*Fulica americana*)," *Veterinary Pathology* 35, 479-487.

U.S. Army Corps of Engineers. (2000). "Avian vacuolar myelinopathy," Vicksburg District. *http://www.mvk.usace.army.mil/od/odm/avm/index.htm*

U.S. Fish and Wildlife Service. (1983). "Northern states bald eagle recovery plan," U.S. Fish and Wildlife Service, Washington, DC.

U.S. Fish and Wildlife Service. (1999). "Bald eagle species account." *http://endangered.fws.gov/i/b/msab0h.html*

U.S. Geological Survey. (1998). "Mid-winter eagle surveys." *http://eagle.idbsu.edu/mwc.html*

World Wildlife Fund. (1992). "Bald eagle." *The official world wildlife fund guide to endangered species of North America*. Beachum Publishing, Washington, DC, 624-627.