

March 26, 1991

IN REPLY REFER TO:

4-C-90-304

Colonel James P. King
District Engineer
U.S. Army Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202-1070

Dear Colonel King:

A. Introduction

This letter presents the biological opinion of the U.S. Fish and Wildlife Service (Service) regarding impacts to Federally listed endangered and threatened species from construction of a new navigation lock at Kentucky Lock and Dam in Livingston and Marshall Counties, Kentucky. It responds to your letter of December 28, 1990, transmitting a biological assessment and requesting formal Section 7 consultation. This letter only addresses the requirements of Section 7(a)(2) and Section 7(b)(4) of the Endangered Species Act of 1973, as amended (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), and does not include requirements of other environmental statutes such as the Fish and Wildlife Coordination Act or National Environmental Policy Act. The Nashville District, U.S. Army Corps of Engineers (Corps), has determined that the proposed project may affect the following five listed species:

1. Indiana bat - Myotis sodalis (E)
2. Orange-footed pearly mussel - Plethobasus cooperianus (E)
3. Pink mucket pearly mussel - Lampsilis orbiculata (E)
4. Ring pink - Obovaria retusa (E)
5. Fanshell - Cyprogenia stegaria (E)

The Nashville District also considered impacts to eight other endangered and threatened species and a number of State-listed and Federal candidate species, and made "no effect" determinations for them based on the species' ability to avoid the construction area, or on the absence from collection of individuals in the project area for over 15 years.

Section 2(b) of the Endangered Species Act describes the purposes for which the Act was passed, one of which is to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." Recent rediscoveries of populations of endangered

species in areas from which they were thought to have been extirpated (e.g., collection of snail darters in the lower Holston River; collection of tan riffleshell in the Duck River), and discoveries of populations of listed species where they were not previously thought to occur at all (e.g., discovery of maternity colonies of Virginia big-eared bats along sandstone cliffines in Kentucky), leads the Service to believe that even extremely rare endangered or threatened species that have not been found for long periods, or those that may be considered extinct, could potentially occur in any area within the species' historic range, provided that suitable habitat capable of sustaining populations still exists. In addition, based upon the above-stated purpose of the Act, we believe that impacts to the species' habitat constitute impacts to the species. Therefore, since the Tennessee River below Kentucky Dam still provides excellent habitat for a diverse, abundant, and reproducing mussel community, this document will include the Service's biological opinion on whether or not the proposed action is likely to jeopardize the continued existence of the following four additional endangered species:

1. Rough pigtoe pearly mussel - Pleurobema plenum (E)
2. White wartyback pearly mussel - Plethobasus cicatricosus (E)
3. Fat pocketbook pearly mussel - Potamilus capax (E)
4. Tubercled-blossom pearly mussel- Epioblasma torulosa torulosa (E)

B. Project Description

Construction of the Barkley Canal in 1967 created the Kentucky-Barkley navigation system, an important link in the inland waterway transportation system. The system consists of both the Kentucky Lock and Dam, Barkley Lock and Dam, Barkley Canal, the lower 30.6 miles of the Cumberland River, the lower 22.4 miles of the Tennessee River, and the Ohio River from Smithland to Paducah. Lock and dam facilities on the Cumberland River provide navigation from the river's mouth at Smithland, Kentucky, upriver to Celina, Tennessee, a distance of approximately 381 miles. Nine facilities on the Tennessee River provide navigation for a length of 652 miles to Knoxville, and for up to 60 miles further up three of its major headwater tributaries, the Clinch River, Hiwassee River, and Little Tennessee River. Between 1967 and 1986, the tonnage of goods shipped on the Kentucky-Barkley system increased significantly from 13 million tons to 34 million tons. Commodities presently transported consist primarily of coal, aggregates, and grains, but significant amounts of steel, chemicals, and ores are also shipped. In 1989, approximately 40,400 barges in 4,700 tows moved through Kentucky and Barkley Locks. Ninety percent of the barges measured 195 feet long by 35 feet wide. Average tow size over the past four years was thirteen to fifteen barges. The Corps of Engineers projects that by the year 2050 traffic demand on the Kentucky-Barkley system will more than double to 89 million tons. This increase in traffic, coupled with operational procedures, could potentially cause significant traffic problems on the waterway. Closure of Kentucky Lock in 1986 for maintenance resulted in a 76% delay rate increase through the system. Projected increases in barge traffic will likely result in serious and more lengthy delays in the future, particularly when locks are closed for periodic and major maintenance.

In order to prevent undue delays in water traffic, the Corps of Engineers has investigated the feasibility of implementing improvements to the Cumberland/Tennessee navigation system. Initially, modification of sharp bendways on the Cumberland River was evaluated. However, other considerations, namely significant fluctuations in water levels with concomitant increases in current velocities due to discharge resulting from hydropower generation, rendered this alternative infeasible. These water level fluctuations and strong current velocities make travel on the lower Cumberland difficult and dangerous. However, completion of the Barkley Canal allowed tows to avoid use of Barkley Lock despite increases in travel time. At present, the majority of traffic utilizing Barkley Lock consists of empty barges moving downriver. The currently proposed project (addition of a lock at Kentucky Dam) was considered during the initial planning stages of the project, but was dismissed from consideration for a time.

Construction of an additional navigation lock at Kentucky Dam is the preferred alternative to resolve navigation problems on the lower Cumberland and Tennessee Rivers. Several lock sizes have been evaluated, and the selected plan calls for the construction of a 110-foot X 1200-foot lock landward of the existing lock. The proposed lock would be a concrete gravity structure with steel miter gates. An emergency gate would be constructed upstream of the upper miter gate and stoplogs would be provided downstream. Slots and seals would be included for dewatering of the lock chamber for maintenance. Guidewalls would also be concrete gravity type structures. The downstream wall would be 1200 feet long and the upstream wall would extend for 700 feet upstream of the existing approach wall. Four new mooring cells would be constructed, two in the reservoir and two near the I-24 bridge on the right descending side of the navigation channel downstream from the existing cells. Construction of the lock chamber and downstream guidewall would occur in the dry behind cofferdams at both upstream and downstream ends. Placement of the new lock will necessitate relocation of a railroad line across the river. The present line crosses the river on the dam. However, trains would be unable to negotiate the grade of a raised track in the same location. A new railroad bridge will be constructed downstream from the dam at river mile 22.1. The bridge will span the new lock to a small peninsula, cross the remainder of the river on piers, and will be atop an earth embankment on the left side of the river. The Corps of Engineers is also considering construction of a training dike downstream from the peninsula to moderate river currents in the new navigation channel. Although no definite plans have been made for this structure, the dike could be up to 3,200 feet long.

Approximately 1,700,000 cubic yards of material will be excavated from dry land on the right bank during construction of the lock proper, and 527,000 cubic yards will be removed from the lower approaches. If a bottom longitudinal filling/emptying system is selected an additional 62,000 cubic yards of excavation will be required upstream of Kentucky Dam. Excavation requirements for the highway and railroad relocations are 148,500 and 153,000 cubic yards, respectively. The proposed project would also require approximately 980,000 cubic yards of borrow for these two portions of the project, most of which would be placed on the left descending side. The source of borrow and the site for disposal of excavated material are proposed for an open pasture area adjacent to river mile 21.2 on the right descending side. To obtain an adequate depth and width in the proposed navigation channel upstream of I-24, approximately 73,400 cubic yards of sand and gravel will be dredged from the river bottom and right bank. Of this amount, 59,400 cubic yards will be disposed of in the river downstream from the project. The remainder will be placed in an upland disposal site. Construction and operation of a new navigation lock at Kentucky Dam, and actions associated with the construction (railroad relocation, riverbank and channel excavation, etc.), could have significant adverse impacts on all of the listed species mentioned above for which the Corps has made "may

affect" determinations. Excavation required for lock construction and channel dredging will significantly affect the aquatic habitats and will result in loss of a portion of a substantial mussel bed along the right descending bank. In addition, construction of a training dike, depending on the length, will impact the mussel bed and other aquatic resources on the right side by altering present river flows and sediment deposition over the area. Construction activities could also result in spills of pollutants or toxicants, or runoff of these materials into the river. Adult and juvenile mussels could suffer direct mortality from being excavated with river substrate. Since excavated material is proposed for disposal on an upland site, mussels removed would not survive. Even if the material were disposed of in the river, it is likely that the stress of being dislodged or physical damage to the shells would result in high mortality. Direct mortality could also result from spills or runoff of pollutants or toxicants. Excessive and/or prolonged sediment loads resulting from construction activities settling out over the bed could also smother mussels of all ages and cause potential fish hosts to abandon the area.

Barges navigating within the proposed navigation channel will have to maneuver close to the right descending bank to achieve proper alignment into the lock, to safely pass between the I-24 bridge piers, or to tie up to two proposed mooring cells. Silt raised by propellers and waves generated by tow wakes will likely settle on the mussel bed adjacent to the channel. Although the number of tows may not increase as a result of the new lock, the average size of tow is likely to increase. This could result in a significant increase in the amount of silt that settles out on the mussel bed in and adjacent to the navigation channel. In addition, Russell Creek may serve as a source of sand that provides substrate suitable for growth and survival of juvenile mussels. Placement of fill and a culvert across the stream may impede flow of sand onto the mussel bed, which may result in a decline in reproduction and recruitment. Also, the projected doubling of tonnage shipped on the lower Tennessee River could potentially make the area more attractive to commercial or industrial developers for construction and operation of loading and/or fleeting facilities. These developments could result in additional adverse impacts to aquatic and terrestrial communities.

Construction of a training dike would likely modify river flows in downriver reaches, the degree of modification dependent on the length of the dike. With significantly reduced flow along the right descending bank, barge-related siltation of the mussel bed on the right bank would increase and could result in significant reductions in reproduction, recruitment, and survival of mussels. In time, the mussels now existing in this bed would probably be eliminated. Although no specific plans have been proposed for construction of this dike, the Corps of Engineers is considering addition of this structure to the project plans.

Construction of access roads, equipment staging areas and construction platforms will result in the removal of several acres of forested habitat. Removal of riparian and bottomland forest from the river banks, the banks of adjacent Russell Creek, or upland forest areas could result in loss of potential maternity sites for breeding bats, or loss of important canopy cover that provides sheltered travel corridors between the maternity trees and foraging areas. Both impacts would likely result in reproductive failure and a subsequent decline in numbers of bats. Fill and installation of a culvert across Russell Creek could result in ponding of the stream, significant mortality to riparian trees, and siltation of the stream. This could destroy potential bat maternity and foraging habitat.

The Nashville District will implement measures to avoid or minimize adverse impacts to the mussel resources and potential bat habitat below Kentucky Dam. Prior to construction, cofferdams will be built so that excavation and construction of the navigation lock and lower guidewall can be

accomplished in the dry. Excavation of the right bank downstream of the guidewall and dredging the proposed navigation channel could result in excessive siltation of downstream areas. However, the Corps will implement measures to keep sediment loads to a minimum. Whenever possible, dredging will be timed to correspond with high flows or hydro releases that will disperse silt and help prevent it from settling onto the mussel bed. Other silt control and/or containment measures will be employed to the extent possible. The original site for the railroad bridge relocation has been changed to avoid impacts to a cypress slough. Also, project activities (construction, spoil disposal, etc.) will avoid a bottomland hardwood forest and riparian area along Russell Creek. An equipment staging area has been relocated from its original proposed location to avoid adverse impacts to portions of a mature upland forest. The Corps will place rock riprap and establish riparian vegetation to stabilize the badly eroded right descending bank. A culvert on Russell Creek that will be placed under an access road to the area to be used for borrow/disposal will be designed so as not to impede streamflow during low water conditions, and will allow complete passage of water and sand during high flows. The Corps will also investigate the feasibility of grading the borrow/disposal area to create wetland acreage that eventually could, through succession, provide additional bottomland hardwood habitat.

Prior to dredging, the Corps will remove as many mussels as possible from the river bottom to be impacted. Mussels removed will immediately be relocated downriver to areas within the same mussel bed, or to another area containing suitable habitat. Dredged material is anticipated to consist primarily of sand and gravel. This material will be transported downriver and disposed of in an area presently supporting sparse populations of mussels in an attempt to create additional mussel habitat within the designated mussel sanctuary. Because the area adjacent to the proposed disposal site contains a moderately dense mussel community, the Corps will have divers survey the disposal site thoroughly, before disposal occurs, to determine if endangered mussels are present. The proposed right channel margin will be heavily bouyed to alert tow operators, and tows will not be allowed to maneuver to the landward side of the proposed mooring cells. Lock operators will monitor traffic to the extent possible to ensure compliance with all measures implemented to protect the mussels and habitat above I-24.

If and when plans for the training dike are finalized, the Corps will conduct hydrologic studies to determine the level of river flow modification over the mussel bed and the degree of impact to the mussels from reduced flow and silt deposition. Results of these studies will be submitted to the Service, along with a determination of potential effects to endangered mussels. If "may affect" determinations are made for one or more listed species, the Corps will reinitiate consultation and the Service will issue a new biological opinion or a supplement to this biological opinion with appropriate alternatives presented for any "jeopardy" findings, and modification of the "Incidental Take" section, if necessary.

C. Consultation History

The Nashville District, Corps of Engineers, initiated Section 7 consultation for proposed bendway improvements on the Cumberland River by letter of November 20, 1984, addressed to Mr. Warren Parker of the Service's Asheville, North Carolina, Field Office. The Service's response, dated January 22, 1985 (delay of the Service's response was apparently due to loss of the Corps' letter), indicated that six listed species (two bats, one bird, three mussels) might occur in the project impact area. The Corps concluded that the proposed action would not affect two of the mussels (based on

a 1982 survey of the Cumberland River), the bald eagle, and two listed bat species. A biological assessment was submitted to the Cookeville Office on May 2, 1988, with a finding of "no effect" to the third mussel species. The assessment reported that two candidate snail species did occur in areas proposed for rock ledge removal, and the Corps proposed to transplant individuals to other areas in the river containing suitable habitat. The Service concurred with the Corps' finding by letter of May 16, 1988.

In June, 1990, the Corps released a Draft Interim Feasibility Study for the project. The scope of the project had changed dramatically; the only alternative under consideration was construction of a new lock at Kentucky Dam. The Service informed the Corps that reinitiation of consultation would be necessary, and that a new biological assessment would be needed. Consultation was reinitiated on June 22, 1990. The Service response, dated July 18, 1990, presented a list of twelve endangered and threatened species that might occur in the project area. The Nashville District submitted a biological assessment on January 2, 1991, with "may affect" findings for five species: the Indiana bat and four mussels. "No effect" determinations were made for one bat, two birds, four mussels, and one plant. The assessment was accompanied by a request for formal consultation.

A copy of this consultation is on file and available for review during normal business hours at the Fish and Wildlife Enhancement Office, U.S. Fish and Wildlife Service, 9 East Broad Street, Cookeville, Tennessee 38501; telephone 615/528-6481.

D. Biological Opinion

Although construction of Kentucky Lock and Dam, U.S. 62 and I-24, the I.C.G. Railroad, and other agricultural, commercial, and residential development has significantly affected the terrestrial and aquatic habitats, the project area still contains areas of bottomland and upland forest and aquatic habitat that support a diversity of fish and wildlife resources, including species which are presently listed as endangered or threatened. Upon review of the biological assessment, the Fish and Wildlife Service believes that the assessments for the gray bat (Myotis grisescens), bald eagle (Haliaeetus leucocephalus), arctic peregrine falcon (Falco peregrinus tundrius), and Price's potato bean (Apios priceana) are adequate and support the determinations of "no effect", with which we concur. Therefore, requirements of Section 7 of the Endangered Species Act have been fulfilled and no further consultation is needed for these species at this time. Since Section 7 requirements do not apply to status review species, no consultation is needed for the seven candidate species for which "may affect" findings were made. However, we commend the Nashville District for including these species in the biological assessment, and we request that you include protective measures for them during the planning stages of the project.

Indiana bat

The Indiana bat, Myotis sodalis, is a medium-sized member of the genus, closely resembling the little brown bat. However, the Indiana bat differs in having a keeled calcar, smaller feet, and a sagittal crest on the skull. It is a monotypic species that historically occupied a large range in the eastern half of the United States. Large populations and individual records are known from Indiana, Virginia, Missouri, Kentucky, Arkansas, Connecticut, Florida, Georgia, Illinois, West Virginia, Iowa, Maryland, Oklahoma, Michigan, New Jersey, New York, Massachusetts, Alabama, North Carolina, Ohio, Pennsylvania, Tennessee, Vermont, Mississippi, and Wisconsin. The species is known

primarily from information gathered at hibernacula. The Indiana bat is selective about its hibernacula as evidenced by the fact that two caves and an abandoned mine provide winter habitat for approximately 90% of the total known population. Information on summer habitat and distribution of M. sodalis is largely unknown.

Indiana bats migrate between winter and summer habitats. Swarming activity and mating occur in the autumn, prior to hibernation. Females enter hibernacula directly after mating, some by October. Males remain active for a longer period, but all are hibernating by early December. The bats hibernate in tight clusters of several thousand in areas of the cave with average temperatures of 3-6 degrees Celsius and relative humidities of 66-95 percent. Depending on climatic conditions, hibernation lasts from October through April. Upon emergence, males migrate to summer caves and females establish small maternity colonies (50 to 100 individuals) in cracks or under loose bark of mature trees in riparian or upland forest. Females exhibit strong site fidelity to maternity trees, returning year after year. Young are born in June or July and are capable of flight within 30 days.

Optimum foraging habitat consists of streams with approximately 70 to 90 percent mature riparian forest canopy cover, and adjacent upland forest. The bats feed at heights of 2 to 30 meters in the riparian or floodplain forest, or over upland fields. Aquatic insects and Lepidoptera comprise the primary prey of M. sodalis. Roost trees are not necessarily within the foraging area, and individuals have been reported to fly up to 3.5 kilometers to feeding areas. Home ranges of 54 hectares for pregnant females, 94 for lactating females, 212 for post-lactating females, 28 to 37 hectares for juveniles, and 57 for adult male Indiana bats have been reported (Gene Gardner, Illinois Natural History Survey, personal communication).

The Indiana bat population is presently estimated to consist of approximately 550,000 individuals. Some areas within the species' range have exhibited stable or increasing population trends, particularly in the eastern and northeastern portions of the range, due to the discovery of new colonies. However, many known Indiana bat colonies have undergone significant declines in numbers within the past fifteen years, despite the fact that most large hibernacula have been identified and protected, and intensive cave management programs have been initiated in some areas. The population in Missouri's third largest hibernaculum has declined from 72,000 in 1960 to 33,000 in 1980. Population censuses indicate that Kentucky's population has declined almost 75% since 1960.

Human disturbance is likely the leading factor in the decline of Myotis sodalis throughout its range. Bats enter hibernation with only enough stored fat reserves to last until spring. Human entry into hibernacula results in arousal of the bats, causing depletion of stored reserves. A single arousal may result in loss of up to 30 days of fat supply. Frequent arousal likely causes the bats to leave the cave before insect prey is available, resulting in starvation.

Vandalism is also a leading cause of mortality. In 1960, several individuals entered a hibernaculum in Kentucky and trampled or stoned an estimated 10,000 Indiana bats. Many other examples of this type of activity have been reported in other parts of the species' range.

Natural hazards are also a potential threat to the species, and have caused high mortalities in some colonies. In a cave in Mammoth Cave National Park, flooding of the Green River apparently resulted in the drowning of 300,000 bats. Ceiling collapse is another hazard. Subsidence of an abandoned mine in Missouri threatens the largest known Indiana bat hibernaculum. Severe winter

weather may also cause high mortality in hibernating colonies of M. sodalis because the species tends to hibernate in cool portions of caves near the entrance.

Deforestation and stream channelization may also be contributory factors in the decline of the Indiana bat in many portions of the species' range. Destruction of riparian and associated upland forest, and channelization of streams significantly alter the habitat. The species prefers to forage over streams with good canopy cover. Deforestation eliminates riparian vegetation that helps maintain good water quality and results in declines in aquatic and terrestrial insect populations. Also, deforestation would remove trees that do, or potentially could, serve as roost sites for maternity colonies. Destruction of maternity sites would likely result in elimination of the colony, given the species' strong site fidelity.

Other factors thought to contribute to the species' status and threaten its continued existence are pesticide use, indiscriminate handling by biologists and researchers, commercialization of hibernacula, alteration of cave microclimate, and inundation of caves by reservoirs. Indiana bat numbers in the two largest hibernacula in Kentucky declined significantly because gates designed to protect the bats were poorly conceived and installed, resulting in alteration of the microclimate of the caves.

A cave near Smithland in Livingston County, Kentucky, supports a hibernating colony of approximately 160 M. sodalis, approximately ten miles from Kentucky Dam. Construction activities and operation of a new navigation lock are not likely to have any significant adverse effects on this colony. However, there are areas within the project impact area that could potentially support summer maternity colonies. Although there are no confirmed records of Indiana bats in the project area, the riparian and bottomland forest along Russell Creek and associated upland forest adjacent to the right descending bank, as well as a cypress slough near the boat ramp on the left descending side of the river, appear to contain suitable summer roosting and foraging habitat. Since the site of the proposed railroad relocation has been moved upriver, the Service does not anticipate any adverse impacts to the cypress slough habitat. However, construction of an access road near the mouth Russell Creek, including placement of fill and installation of a culvert, would affect the forest along that stream. In addition, the new railroad right-of-way will result in bisection of a mature upland forest associated with the bottomland and riparian forest along Russell Creek.

The Nashville District has stated that the railroad relocation through the left bank cypress slough has been dropped from consideration. Also, they have agreed not to conduct any activities that would adversely affect the riparian and bottomland forest along Russell Creek, and that the culvert under the proposed access road will be designed to allow free flow of Russell Creek at all times. Therefore, although the project will result in the loss of a portion of, and will bisect, a tract of mature upland forest, it is the biological opinion of the Service that the proposed construction and operation of a navigation lock, relocation of a railroad bridge, construction of an access road, and (possible) construction of a training dike along the proposed navigation channel on the Tennessee River are not likely to jeopardize the continued existence of the endangered Indiana bat.

Freshwater mussels

Because of its age and the fact that it did not undergo glaciation, the Tennessee River Basin has long been known as a primary center of freshwater mussel speciation. Over 100 species historically

occurred and evolved in the Tennessee River and its tributaries. Since 1800, however, populations of many species have undergone significant declines, some to extinction and others reduced to remnants restricted to isolated portions of their former ranges. Several species in the genus Epioblasma have not been recorded from any stream in the entire Tennessee or Cumberland River drainages for over 50 years and are presently believed to be extinct. At present, however, over 60 species may still inhabit streams and rivers in the basin, 26 of which are officially listed or proposed as endangered species. Within the Tennessee River Basin, mussels are found in the main stem of the river, as well as in large tributaries and medium-sized and small headwater streams. Some species are more tolerant than others, occurring in mud-bottomed pool habitats. However, most are found in riffle or shoal habitat with relatively swift current over substrate consisting of mixed sand, gravel, and cobble. Swift currents maintain high levels of dissolved oxygen and sweep the bottom clean of silt and other settleable materials. Being filter feeders, mussels consume algae, zooplankton, diatoms, detritus, and other matter suspended in the water column.

Reproduction among mussels is unique. Sperm are released into the water column by males and are siphoned from the water by females during normal respiration and feeding activity. Fertilized eggs are stored in specially modified gills (marsupia) that act as brood pouches for the developing larvae (glochidia). Fully developed glochidia are released into the water and drift with stream currents. Within three or four days, they must attach to a suitable fish host, encysting on gill filaments, opercles, or fins. Those glochidia not successfully attaching to a host fish probably settle to the bottom eventually and perish or serve as prey for fish or invertebrate predators. During the period of encystment, which lasts up to several weeks depending on water temperatures and other factors, the glochidia metamorphose. When metamorphosis is complete, the glochidia detach from their host and, again drifting with the current, settle to the bottom as fully developed, free-living juvenile mussels. It is thought that there are two stages in this complex life cycle that are critical: attachment to the host and settling to the bottom after detachment. Significant mortality likely occurs at both stages as a result of glochidia attaching to unsuitable hosts (some species are extremely host-specific) or not successfully attaching, and from settling onto unsuitable habitat.

A number of factors have been identified as causes in the decline of freshwater mussel populations in the Tennessee River Basin. Construction of impoundments altered miles of riverine habitat and eliminated significant populations of riffle-dwelling mussel species in portions of the Tennessee River. Prolonged or excessive siltation causes mussels to cease siphoning, inducing significant stress as a result of reduced feeding and respiration. Pollutants such as pesticides and heavy metals cause mortality directly, or accumulate in body tissues and result in stress-related mortality. Over-harvest of mussels for shells used in cultured pearl production has resulted in significant population declines. In addition, recently reported die-offs of unknown cause have significantly reduced remaining populations. Many endangered mussel species now exist only in river reaches below dams, and in unimpounded streams and rivers in the headwater areas. Although species of mussels that are tolerant of lentic conditions still exist or have recolonized habitats in the upper reaches of some reservoirs, these communities are neither as abundant nor diverse as those existing prior to impoundment.

The Tennessee River from river mile 17.8 to 22.4, including the entire project area, has been designated by the State of Kentucky as a mussel sanctuary. Although this reach of river supports diverse and abundant mussel populations, no commercial harvest of mussels is allowed. Habitat immediately below the dam is marginal for mussels, due to swift currents that sweep the bottom clean of silt, sand, and gravel. As current velocities moderate downriver, mussels increase in

numbers. Since the project area consists of a portion of the last free-flowing riverine habitat in the main stem of the Tennessee River, it supports one of the best remaining preimpoundment mussel communities in the Tennessee River Basin. Various surveys conducted between 1931 and 1978 revealed that 38 species of mussels once inhabited the lower Tennessee River, and reported the presence of up to 27 species in this reach. However, a survey done in 1985 by Dr. James Sickel recorded the presence of 36 species, including two endangered species. The lower end of the project area contains a portion of one of the most extensive mussel beds in this reach of river; twenty-four species were found in this bed and good recruitment was reported. Mean mussel density in the bed was calculated to be 10 mussels per square meter, with a range of 1 to 66 per square meter. Dr. Sickel hypothesized that sand washed from Russell Creek provides and perpetuates excellent habitat for mussels, particularly the juveniles.

Mussels in the sanctuary area (TRM 17.8 to 22.4) exhibit excellent reproduction and recruitment because they are protected from commercial harvest. The beds within the sanctuary likely serve as sources of juveniles that contribute to the replenishment of depleted, commercially harvested beds downriver. Also, the area serves as a refuge for rare and endangered species.

o Tuberculed-blossom pearly mussel

The tuberculed-blossom pearly mussel, Epioblasma torulosa torulosa, is an Ohioan (Interior Basin) species. It was historically widespread in the Tennessee, Cumberland, Ohio, and St. Lawrence river drainages. Epioblasma t. torulosa once occurred in the Tennessee, Elk, Duck, Paint Rock, Nolichucky, Cumberland, Ohio, Kentucky, Kanawha, and Scioto Rivers. The species was reported to be relatively common in the Tennessee River, but extremely rare in the Cumberland. It has also been reported from the St. Marys River in Indiana; Grand, Black, Clinton, Detroit, Huron, and Raisin Rivers in Michigan; and the Sydenham River in southern Ontario. The tuberculed-blossom pearly mussel is thought to be the inflated, large-river form that intergrades into the subspecific headwater forms: the green-blossom, E. t. gubernaculum (Clinch River), and northern riffleshell, E. t. rangiana (Ohio River). It occurs in shoal and riffle reaches with swift current and sand and gravel substrate, but unlike the other large-river mussels described, it inhabits relatively shallow water in depths up to six feet. Studies done on other Epioblasma species reveal that the tuberculed-blossom may be a long-term breeder, breeding in early August and releasing glochidia by September. Fish hosts for the species are unknown. The lower Tennessee River lies within the species' range, but six surveys conducted from 1931 to 1985 failed to collect the tuberculed-blossom from the project area. Although suitable habitat still exists in parts of the species range, E. t. torulosa has not been collected in over fifteen years and is believed by some malacologists to be extinct.

o White wartyback pearly mussel

The white wartyback pearly mussel, Plethobasus cicatricosus, is another Ohioan species occurring in the Ohio, Cumberland, and Tennessee River systems. Historical records indicate that the species occurred in the Tennessee River, Cumberland River, Ohio River, Holston River, Wabash River, and Kanawha River. It has always been uncommon throughout its range, and the only recent collections of this species have been from the mainstem of the Tennessee River. However, surveys conducted by Ellis (1931), Williams (1969), Isom (1969), Bates (1975), Miller (1990), and Sickel (1985) did not report P. cicatricosus from the project area. Since no young specimens have been found in recent

years, the species may be facing imminent extinction. The white wartyback is a big-river species, inhabiting shoal and riffle areas with sand and gravel substrate. Its life history is unknown, but it may be a short-term breeder as is its congener, P. cyphus. Fish hosts for the species are also not known.

o Orange-footed pearly mussel

The orange-footed pearly mussel, Plethobasus cooperianus, is also an Ohioan species, but it is more widely distributed than P. cicatricosus. Historically, the orange-footed mussel occurred in the Ohio, Kanawha, Wabash, Rough, Tennessee, Duck, French Broad, Holston, Clinch, and Cumberland Rivers. It was reported to be an abundant species in the Ohio, Wabash, and Cumberland Rivers; however, it was rare in the Tennessee River and its tributaries above Knoxville. Presently, P. cooperianus is known to occur in the Tennessee River for an undetermined number of miles below Pickwick Dam; the Cumberland River at Bartlett's Bar and Rome Landing; and the lower Ohio River near Metropolis and Olmstead, Illinois, and McCracken County, Kentucky. Of these three populations, only the one in the Tennessee River is known to be reproducing. The orange-footed mussel is also a large-river, shoal-inhabiting species. It is found in gravel and sand substrate in water from 15 to 29 feet in depth. The species' life history is unknown, but gravid females have been collected during the summer, indicating that the species is a short-term breeder. The glochidia are undescribed and the fish hosts are unknown.

o Rough pigtoe pearly mussel

The rough pigtoe pearly mussel, Pleurobema plenum, is an Ohioan species that was historically widespread in the Ohio River, Cumberland River, and Tennessee River systems, and it was reported to occur in large rivers in Arkansas and southwest Kansas. The rough pigtoe presently occurs only in the Tennessee River, Cumberland River, Clinch River, Green River, and Barren River. In the Tennessee River, the species is thought to occur for an undetermined number of miles below Pickwick, Wilson, and Guntersville Dams, and is believed to be reproducing below Pickwick. It is also thought to be reproducing in the Green River and upper Clinch River. Pleurobema plenum is considered to be a rare species in the Cumberland River. Sampling by TVA in 1976 failed to find any live specimens in the Cumberland. Surveys done in the Green and Barren Rivers indicate that the rough pigtoe occurs in the Green River from lock and dam 5 (Glenmore, Kentucky) to lock and dam 4 (Woodbury, Kentucky), and in the Barren River from the mouth to lock and dam 1 (BRM 15.0). Since this population is considered to be abundant, reproduction and recruitment are likely occurring. Although the project area lies within the species' range, it has not been found in the river below Kentucky Dam since before 1931. The species' life history is not known, but studies done on other Pleurobema species indicate that P. plenum is a short-term breeder. Fish hosts are unknown.

o Pink mucket pearly mussel

The pink mucket pearly mussel, Lampsilis orbiculata (= Lampsilis abrupta), like the other species addressed, is an Ohioan species with a relatively wide range. Historical records include large rivers in Tennessee, Alabama, Kentucky, Ohio, Pennsylvania, West Virginia, Indiana, Illinois, Virginia, Iowa, Arkansas, and Missouri. Presently, known populations occur only in the Ohio River,

Tennessee River, Cumberland River, Kanawha River, Osage River, Meramec River, Paint Rock River, Clinch River, Green River, Big River, Black River, Little Black River, Current River, and Gasconade River. Only four populations have shown recent evidence of reproduction: the Tennessee, Paint Rock, Meramec, and Cumberland Rivers. However, some taxonomists have recently postulated that the reproducing populations west of the Mississippi River are not Lampsilis orbiculata, but rather are subspecies of another endangered species, Lampsilis higginsii. If this is true, then only three known reproducing populations of L. orbiculata are extant. Although it has a relatively wide distribution and is apparently more tolerant than other listed mussel species, the pink mucket is reported to be rare where it occurs. It is a large-river mussel, inhabiting primarily shoal areas with swift current at depths of 0.5 to 8.0 meters. Nonetheless, L. orbiculata appears to have adapted to lentic conditions in the upper reaches of some impoundments. Life history aspects of this species are presently unknown, although it may be a long-term breeder, as are other Lampsilis species. Glochidia are undescribed and fish hosts are unknown.

o Fat pocketbook pearly mussel

The fat pocketbook pearly mussel, Potamilus capax, like the pink mucket, has a relatively wide distribution, but is extremely rare where it occurs. Although there are only a few published records for the distribution of the fat pocketbook, available information indicates that the species once occurred in the Mississippi River from Minnesota to Missouri. It was also found in the Des Moines River in Missouri; Wabash River and Ohio River, Indiana; Niagara River, New York; and the Illinois River, Illinois. Until 1987, the only verified extant population of P. capax occurred in the St. Francis River, Arkansas. Since 1987, however, Ron Cicerello from the Kentucky Nature Preserves Commission has found fresh dead and live specimens in the Ohio River at the mouth of the Wabash River and in the lower Ohio River between lock and dam 53 and the Mississippi River. James Sickel from Murray State University collected live specimens in the lower Cumberland River (CRM 0.6) in Livingston County, Kentucky, during a survey in 1987. The fat pocketbook may, therefore, inhabit the Ohio River from the mouth of the Wabash River to the Mississippi River. Populations may also exist in the Wabash River and White River in Indiana. Unverified collection records of fat pocketbook pearly mussels exist from the Green River, Kentucky; Neosho River, Kansas; and Verdigris River, Oklahoma. These are likely misidentified specimens since all three are based on single records that have not been verified, and no subsequent collections of the species have been made from any of these rivers. The species has recently been found in the lower Ohio River and lower Cumberland River, but it has not been collected in the Tennessee River below Kentucky Dam in recent years.

Potamilus capax is a large-river mussel that requires flowing water in areas ranging from a few inches to eight feet in depth, and having mud, sand, or fine gravel substrate. Many aspects of the species' life history are unknown, but it is thought to be a long-term breeder. Gravid females have been collected in June, July, August, and October. Although fish hosts for P. capax are unknown, studies conducted on other species of Potamilus reveal that the fish host for P. alata, P. purpurata, and P. laevisissima is the freshwater drum; the white crappie also serves as a host for glochidia of P. laevisissima.

o Ring pink

The ring pink (formerly known as the golf stick pearly mussel), Obovaria retusa, is also an Ohioan species. Historically, it was a wide-ranging species, occurring in the Ohio, Cumberland, and Tennessee River systems in Pennsylvania, West Virginia, Ohio, Illinois, Indiana, Kentucky, Tennessee, and Alabama. It is presently found in only four river reaches: the Tennessee River in Livingston, Marshall, and McCracken Counties, Kentucky; the Tennessee River in Hardin County, Tennessee; the Cumberland River in Wilson, Trousdale, and Smith Counties, Tennessee; and the Green River in Edmonson and Hart Counties, Kentucky. Also, in December 1990, an eight-year-old specimen was collected in the upper Kanawha River. However, no evidence of reproduction or recruitment has been reported for any of the populations in recent years, and the continued existence of the species is questionable. Obovaria retusa was collected in the lower Tennessee River in 1985, but it was not found in the project area. The ring pink is a shoal species inhabiting riffle areas in large rivers with mixed sand and gravel substrate. The species' life history and fish hosts are unknown.

o Fanshell

The fanshell, Cyprogenia stegaria, is another Ohioan species that was described as a medium-to-large-river mussel. Historically, it had a wide distribution in the Ohio, Wabash, Cumberland, and Tennessee River drainages in Pennsylvania, Ohio, West Virginia, Illinois, Indiana, Kentucky, Tennessee, Alabama, and Virginia. Over the past ninety years, however, the species has undergone significant population declines throughout its range. Presently, reproducing populations are thought to occur only in the Clinch River, Hancock County, Tennessee, and Scott County, Virginia; the Green River, Hart and Edmonson Counties, Kentucky; and the Licking River, Kenton, Campbell, and Pendleton Counties, Kentucky. Remnant, non-reproducing populations still exist in Tygarts Creek, Greenup and Carter Counties, Kentucky; Cumberland River, Smith County, Tennessee; and Tennessee River, Rhea, Meigs, and Hardin Counties, Tennessee; as well as the Muskingum River in Ohio, Wabash River in Illinois and Indiana, East Fork White and Tippecanoe Rivers in Indiana, and the Kanawha River in West Virginia. Like most other mussel species, the fanshell is an inhabitant of riffles and shoals in the mainstem of large rivers and their larger tributaries and, like the other species addressed in this opinion, most aspects of its life history are unknown.

The Corps conducted a freshwater mussel survey in the project area in September of 1990. Qualitative and quantitative samples taken from the proposed dredge area revealed the presence of mussels, but no individuals of any of the eight endangered species were collected from this area. Also, no specimens of six of the species included in this opinion have been reported from the lower Tennessee in recent years, despite the fact that the area has been surveyed several times since 1985. The only recent reports of endangered mussels from this mussel bed were the collection of a gravid female L. orbiculata in 1987 in the vicinity of the I-24 bridge and collection of three specimens of P. cooperianus in 1985 at river mile 20.6. The Service believes that construction activities will result in the loss of a portion of the habitat in the mussel bed, and dredging may directly result in the loss of individual mussels. However, until evidence of the presence of O. retusa, P. cicatricosus, P. plenum, C. stegaria, P. capax, and E. torulosa torulosa in the area is confirmed, and because the bed provides excellent habitat for other mussel species, we must conclude that the area is unsuitable or extremely marginal as habitat for these six species and that if they do occur in the area, they occur in densities well below that which would be needed to sustain viable populations. Therefore, upon

review of available information, it is the biological opinion of the Fish and Wildlife Service that construction and operation of a new navigation lock at Kentucky Dam, and associated construction activities, are not likely to jeopardize the continued existence of the ring pink, white wartyback, rough pigtoe, fanshell, fat pocketbook, and tubercled-blossom pearly mussels.

Individuals of the pink mucket and orange-footed pearly mussels have been collected in the project impact area within the past five years. Information from past surveys indicates that the mussel bed below Russell Creek provides excellent habitat for mussels, including these two endangered species. The bed contains a diverse mussel community, and reproduction and recruitment are reported to be excellent. Furthermore, the lower Tennessee River may be one of only a few areas where both of these species are still reproducing. Loss of the population in the lower Tennessee could threaten the survival of both species. However, based on measures to be implemented by the Corps to protect the mussel bed in the project area, and upon review of available information, it is the biological opinion of the Fish and Wildlife Service that construction and operation of a navigation lock, relocation of a railroad bridge, and construction of an access road--as presented by the Nashville District and described in Section B above--are not likely to jeopardize the continued existence of the pink mucket or the orange-footed pearly mussels, provided that all protective measures presented in Section B of this opinion are implemented and stringently enforced. However, construction of a training dike would likely have significant impacts on all of the listed mussel species that occur, or possibly occur, in the area.

E. Incidental Take

This section of the biological opinion addresses incidental take of Myotis sodalis, Plethobasus cooperianus, Lampsilis orbiculata, Obovaria retusa, Cyrogenia stegaria, Pleurobema plenum, Plethobasus cicatricosus, Potamilus capax, and Epioblasma torulosa torulosa resulting from project activities and presents the Service's estimate of the allowable level of take. In meeting the provisions of Section 7(b)(4) of the Endangered Species Act, we have reviewed the biological information and other available information relative to this action. Based on the nature of the proposed project and proposed protective measures to be implemented, it is anticipated that incidental take of the Indiana bat should not occur. However, if the Nashville District anticipates that incidental take may occur in the future as a result of the discovery of new information, consultation should be reinitiated for the reassessment of these impacts and the development of an incidental take statement pursuant to provisions of Section 7(b)(4) of the Act.

The Corps of Engineers has agreed to remove as many mussels as possible from the impact areas prior to dredging. We believe that it is not reasonable to expect every individual mussel to be removed from dredging sites, so there is a potential for incidental mortality to endangered mussels.

In order to provide a navigation channel of suitable depth and width, dredging near the right descending bank will be necessary. A total of 59,388 cubic yards (45,432 cubic meters), or roughly an area of 17,733 square meters will be dredged. The biological assessment included results of six quantitative samples taken from within the proposed dredge cut that revealed mussel densities of 9.2 to 128 mussels per square meter, or an average of 63 per square meter. However, the Corps estimates that approximately 33 percent of the proposed dredge area consists of well-scoured substrate unsuitable for mussels. Therefore, approximately 11,900 square meters contain suitable mussel habitat. Also, the mussels in this area are nonrandomly distributed; patches of substrate

containing high mussel density are interspersed with areas of low density. Assuming that the average density estimate adequately accounts for the patchy distribution reported in the biological assessment, an estimated 749,700 mussels occur in the proposed dredge cut. The survey did not report collection of individuals of any of the 8 endangered mussel species that may occur in the lower Tennessee River in the project area. However, the assessment did state that, if any of the endangered species were present, they would occur in densities of less than 0.02 percent of the total mussel community. The lowest species abundance reported in the assessment for the proposed dredge cut was 0.001 percent (yellow sand shell, Lampsilis teres). Since no listed species were found during the survey, it is reasonable to assume that the eight endangered species occur in densities as low as or even lower than the lowest reported. Therefore, assuming that all eight endangered species occur in the proposed dredge cut at individual densities of 0.001 percent (1 in 100,000 individuals), there would be a total of 60 individual endangered species present.

Since the river bottom in the area consists of sand and gravel, it should be relatively easy to remove a large number of the total mussel community. The Service believes, and the Corps agrees, that 70 percent of the mussels (524,800 individuals) can be removed prior to dredging. Therefore, the anticipated level of incidental take is 18 mussels inclusive of all eight species, or no more than 2 individuals per species.

Reasonable and Prudent Measures - As reasonable and prudent measures to minimize incidental take of the endangered mussels addressed in this biological opinion, the Nashville District should provide this office with proposed plans for removal of mussels, including methods of collection, handling, and relocation. The plan should also provide information as to where the mussels will be placed and details of monitoring that will be conducted. In addition, qualified malacologists should be directly involved with the removal and relocation of mussels. Numbers and identification, including size measurements and age estimates, of all endangered species should be recorded, and all mussels should be placed back into the river within 24 hours after removal. The Service recommends that all mussels be relocated to suitable habitat within the existing mussel bed in the vicinity of the I-24 bridge. Any endangered species collected should be placed in close proximity to each other to increase the potential for successful fertilization. If the Corps wishes to place the mussels into areas other than the existing bed, we recommend that this office be contacted prior to the relocation.

Disposal of dredged material at the proposed downriver site could possibly result in incidental take of listed mussels. However, since no quantitative samples were taken in that area, it is not possible to specify the level or extent of take anticipated. Nevertheless, as a final reasonable and prudent measure to minimize take, the Corps should survey the disposal area thoroughly before the material is deposited. Any endangered species found should be immediately relocated to the nearest suitable habitat. Conspecifics should be placed in close proximity to each other.

Any dead endangered mussels should be reported to this office immediately, and to the Special Agent, U.S. Fish and Wildlife Service, P.O. Box 849, Louisville, Kentucky 40201, telephone 502/582-5989. Instructions for handling and disposal will be provided by this office.

F. Conservation Recommendations

Because the river reach below Kentucky Dam has been designated by the State of Kentucky as a sanctuary to protect one of the last remaining areas in the Tennessee River Basin containing

reproducing populations of the pre-impoundment mussel fauna, the Fish and Wildlife Service believes that this area warrants an extremely high level of protection from any adverse impacts. Although (1) the proposed project will result in destruction of only a small portion of the mussel bed along the right descending bank, (2) no endangered species were collected in the project impact area, and (3) the Corps of Engineers has agreed to remove mussels and create mussel habitat downriver, there is no guarantee of successful relocation of mussels or colonization of the newly created habitat. Also, the Corps is considering the construction of a training dike that could have significant adverse impacts on the bed. Furthermore, potential Indiana bat summer habitat will be impacted by project activities. Therefore, in accordance with Section 7(a)(1) of the Endangered Species Act, we recommend that the following measures be implemented to promote the conservation of the Indiana bat and the eight endangered mussels considered in this biological opinion.

The Corps should determine if the riparian/bottomland forest and associated mature upland forest are used as summer habitat by Indiana bats. Mist netting should be conducted between June 1 and August 1 along Russell Creek. If the species is present and if the proposed disposal area is used to create a wetland, the Corps should monitor the area to determine if and to what degree the bats utilize the artificially-created wetland.

To date, there is a general lack of information regarding the success of mussel transplants and relocations, particularly concerning whether or not transplanted mussels survive and reproduce. Several transplant studies conducted by TVA and Virginia Polytechnic Institute have reported positive results, but both also reported relatively high levels of mortality at some transplant sites, and neither provided conclusive evidence that mussel transplants do not adversely affect the individuals or the populations. In addition, only limited information regarding colonization of newly created mussel habitat is available. To determine success of transplants and of creating suitable mussel habitat apparently requires long-term monitoring, which most agencies are unable or unwilling to do. If relocated mussels exhibit low survival and inadequate recruitment, or if mussels do not colonize artificially created habitat, then both activities may actually result in adverse impacts to endangered species, not the intended avoidance of adverse impacts.

If the mussels removed from the proposed dredge cut will be moved only a short distance downriver to a different part of the same mussel bed within a short time of their removal, we believe that, if proper methods of removal and transport are employed, there is little potential for stress or other adverse impacts. Unless they were placed in an area that was not inhabited by other mussels, it would not be possible to identify relocated mussels in the bed for any length of time, and monitoring of relocated mussels would not be possible. However, there is an opportunity to gain valuable information with regard to relocation if the mussels were placed in a suitable area outside of the existing bed. Information could also be gained concerning colonization of artificially created mussel habitat. The Service therefore recommends that, if the Corps decides to move the mussels to an area away from the existing bed, they implement a long-term monitoring program to determine if suitable mussel habitat can be successfully created and if successful relocation of portions of an existing mussel community is possible. The dredge disposal area at river mile 19.7, and the relocation site (if appropriate), should be monitored to determine if mussels colonize the area, and if they do, the densities achieved, species composition, survival rates, and evidence of reproduction and/or recruitment. Results should be made available to the Service and other agencies/universities in the form of informal reports or published articles. In order to make the above determinations, both the relocation site and the created habitat should be monitored for a period of not less than ten years.

In addition to the proposed lock construction project, the Corps of Engineers conducts and issues permits for many activities that have significant impacts on aquatic communities and habitats. Cumulatively, these actions, along with actions conducted and permitted by other agencies, have contributed to the present endangered status of a number of species. However, we believe that the Corps has the means to play a leading role in the protection and recovery of endangered aquatic species. The Service recommends that the Corps conduct, or cooperate in, long-term studies to determine the effects of transplants and relocations on mussels, and to determine the success of artificially creating mussel habitat.

Seven of the species addressed in this biological opinion are extremely rare, and no evidence of recent reproduction has been reported for two others throughout their ranges. The eighth species may already be extinct. None of these endangered species are likely to recover naturally in the foreseeable future, if at all. The only potential for recovery of these and other endangered mussel species may lie in the development of technology to artificially propagate juveniles and introduce them into suitable habitats within their historic ranges. Several attempts at artificial propagation have been made, with limited success. Since the Corps has existing research facilities (e.g., Waterways Experiment Station), the Fish and Wildlife Service recommends that the Corps actively pursue, or cooperate with other resource agencies in, development of technology for the artificial propagation of freshwater mussels, introduction of propagated individuals into suitable habitats, and monitoring of introduced individuals. Non-endangered mussels should be used until successful propagation and introduction techniques are developed. Information gained from monitoring created habitat and artificial propagation efforts would significantly promote the recovery of the species addressed in this opinion and other endangered mussel species, and may contribute to recovery of candidate species, eliminating the need to protect them through listing under the Endangered Species Act.

This concludes formal Section 7 consultation for the proposed Kentucky Navigation Lock Project. Reinitiation of consultation will be required if (1) the amount or extent of incidental take specified in this biological opinion is exceeded, (2) new information reveals that the proposed project may affect listed species in a manner not previously considered, (3) the identified action is subsequently modified in a manner or to an extent that was not considered during this consultation, or (4) new species are listed or critical habitat designated that may be affected by the project. In addition, consultation should be reinitiated if and when final plans for the training dike and/or results of a new assessment addressing impacts to listed species are available. The Fish and Wildlife Service will review the additional information and, if necessary, issue either a separate biological opinion or a supplement to this opinion.

Thank you for the opportunity to comment on this project. Your concern for the protection of endangered, threatened, and candidate species is greatly appreciated.

Sincerely,

Lee A. Barclay, Ph.D.
Field Supervisor

xc: Director, FWS, Washington, D.C.
Assistant Regional Director, FWE, FWS, Atlanta, GA (Attn: Augie Valido)