United States Department of the Interior

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August 9, 2017

Mr. Michael T. McFadden
Department of the Army
Kansas City District, Corps of Engineers
221 Bolivar Street, Suite 103
Jefferson City, Missouri 65101

Dear Mr. McFadden:

Pursuant to section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*), the enclosed document transmits the U.S. Fish and Wildlife Service's (Service) final biological opinion (BO) for the U.S. Army Corps of Engineers' proposed renewal of application No. NWK-2003-02428 for Capital Sand, Inc. to remove up to 150,000 tons of sand and gravel per year from the Osage River between river. Your request for formal consultation was received on February 3, 2017.

The enclosed Biological Opinion addresses effects of the project that are likely to result in adverse effects to the federally endangered Pink Mucket Pearlymussel (*Lampsilis abrupta*), Scaleshell Mussel (*Leptodea leptodon*), and Spectaclecase Mussel (*Cumberlandia monodonta*). It includes an incidental take statement with nondiscretionary reasonable and prudent measures and terms and conditions that are necessary and appropriate to minimize incidental take associated with this project. We have also included a brief list of discretionary conservation recommendations that could contribute to the recovery of the species. As discussed in the BO, the Service concludes that the proposed action will not jeopardize the continued existence of the above listed species and no critical habitat will be affected.

The enclosed Biological Opinion is based on information provided in the May 26, 2016 Biological Assessment, meetings, field investigations, available literature, personal communications with species experts, and other sources of information regarding the status of the species. A complete administrative record of this consultation is on file in our office.

We appreciate your cooperation in working to protect federally listed species. If you have any questions or concerns regarding this consultation and biological opinion, please contact Andy Roberts at 573/234-2132, extension 110.

Sincerely,

Karen Herrington
Field Supervisor

Enclosure

BIOLOGICAL OPINION

for the

Effects of the Capital Sand, Inc. Instream Gravel Dredging Operation on the Federally Endangered Pink Mucket Pearlymussel (*Lampsilis abrupta*), Scaleshell Mussel (*Leptodea leptodon*), and Spectaclecase Mussel (*Cumberlandia monodonta*) in Cole County, Missouri.

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services
Missouri Field Office

August 9, 2017

INTRODUCTION

This document is the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) based on our review of the U.S. Army Corps of Engineers' (USACE) proposed renewal of a Section 404, Clean Water Act/Section 10, Rivers and Harbors Act of 1899 permit application No. NWK-2003-02428 from Capital Sand, Inc. for an instream sand and gravel mining operation on the Osage River in Cole County, Missouri. This BO evaluates the effects of project activities on the Pink Mucket Pearlymussel (*Lampsilis abrupta*), Scaleshell mussel (*Leptodea leptodon*), and Spectaclecase mussel (*Cumberlandia monodonta*) in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). No other federally listed, proposed, or candidate species or designated or proposed critical habitat are expected to be affected by project activities.

As stated in the Biological Assessment (BA), the purpose of the project is to harvest 150,000 tons per year of gravel and sand from the main channel of the Osage River between river mile (RM) 22.0 and 23.0. Formal consultation was initiated on February 3, 2017 via an email from the USACE to the Service's Missouri Ecological Services Field Office. Section 7(a)(2) of Act requires that Federal agencies shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any threatened or endangered species, or result in the destruction or adverse modification of critical habitat.

This BO is based on information provided in the January 2017 BA, available literature, personal communications with species experts, Capital Sand, Inc., Ecological Specialists, Inc., Cardno, and other sources of information.

CONSULTATION HISTORY

September 27, 2014 – Email correspondence from the Service to the USACE providing comments on public notices NWK 2003-2428 and NWK 2003-2429 (published in August 27, 2014) for renewal of a 5-year permit to operate instream gravel dredging at two sites in the lower Osage River. The submitted comments included a non-concurrence with the USACE's "May affect, but not likely to adversely affect" determination on the federally listed Pallid Sturgeon, Pink Mucket, Scaleshell, and Spectaclecase.

December 23, 2014 – letter from USACE to the Service proposing a one-year permit extension of instream gravel mining on the lower Osage River for Capital Sand Inc. and requesting concurrence with a "May affect, but not likely to adversely affect" determination on the federally listed Pallid Sturgeon, Pink Mucket, Scaleshell, and Spectaclecase.

February 20, 2015 – email and attached letter from the Service to the USACE requesting a BA and providing non-concurrence with their December 23, 2014, determination.

April 14, 2015 – Meeting between the Service, USACE, and Capital Sand, Inc. to discuss potential project impacts and the need for a mussel survey for the proposed permit extension.

June 12, 2015 – Mussel survey completed and final report provided by Ecological Specialists, Inc. of the proposed gravel mining area included in the permit extension.

June 25, 2015 – Letter from USACE to the Service requesting informal consultation and concurrence with a "May affect, but not likely to adversely affect" determination on the federally listed Pallid Sturgeon, Pink Mucket, Scaleshell, and Spectaclecase for a permit extension for Capital Sand, Inc.

July 16, 2015 – Letter from the Service to the USACE concurring with their June 25, 2015, request and outlining conditions of the extension.

March 2, 2016 – Conference call between the Service and Cardno to discuss requirements for a Biological Assessment for Capital Sand Inc.

July 26, 2016 – Email and attached letter from USACE to the Service providing a Biological Assessment and requesting concurrence with a "may affect, but not likely to adversely affect" determination.

August 29, 2016 – Email from the Service to the USACE denying concurrence with their July 26, 2016 concurrence request and requesting a mussel survey of the complete project area.

November 2016 – Mussel survey conducted of the proposed dredging area.

February 3, 2017 – Email with attached letter from the USACE to the Service requesting formal consultation and providing an updated Biological Assessment and November 2016 mussel survey report.

March 3, 2017 – Email with attached letter from the Service to the USACE acknowledging that information with the submitted Biological Assessment is complete.

June 14, 2017 – Meeting between the Service; Capital Sand, Inc.; and USACE to discuss draft biological opinion and options to reduce effects to mussel species.

June 15, 2017 – Email from the Service to the USACE requesting a 45-day extension to the formal consultation period.

June 16, 2017 – Letter from USACE to Service granting a 45-day extension to the formal consultation process.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The USACE has proposed to renew a permit (NWK-2003-02428) under section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 to Capital Sand Inc. for the proposed removal of up to 150,000 tons of sand and gravel per year for five years from the lower Osage River in central Missouri (Figure 1). During the five-year permit period, the dredge may advance up to one linear mile from RM 22.0 to 23.0. However, there are many factors affecting the rate at which the operation progresses upstream, and more than one permit period may be required to harvest the material within this river reach. Capital Sand's Osage River mining operation is located on the left descending bank at the confluence of Gum Creek and Osage River at approximate geographic coordinates 38.441991° latitude and -92.160986° longitude in Cole County, Missouri. Capital Sand uses a chain ladder with a hydraulic suction dredge to excavate and remove sand and gravel deposits from the river bed. During harvesting the dredge barge is positioned at the upstream dredge face, which is a steep-sloped wall of the sediment under the river bed.

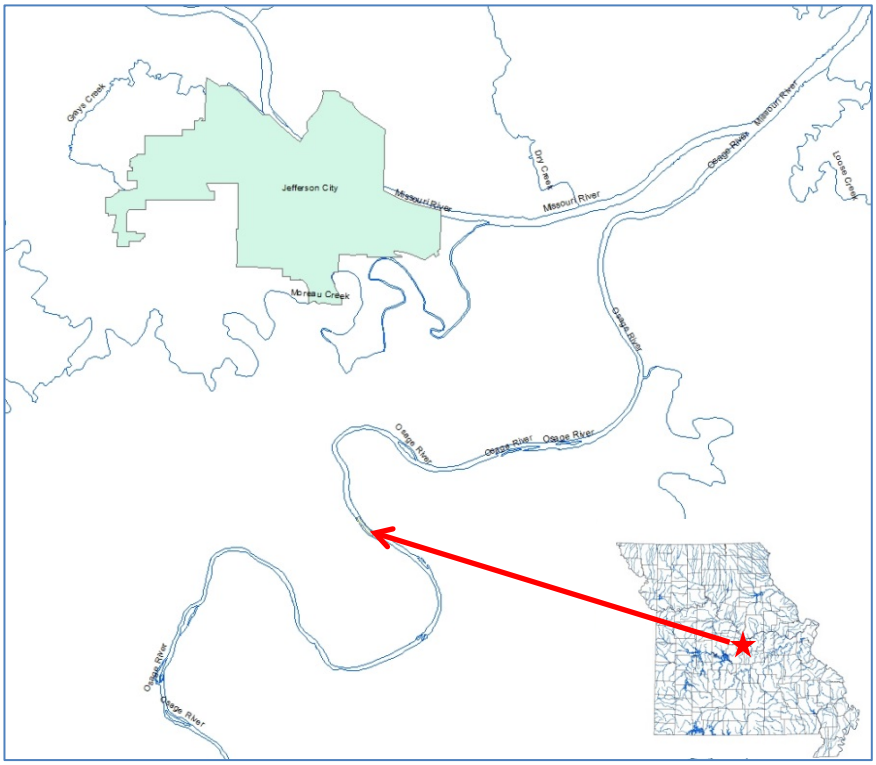

Figure 1. Location of proposed gravel mining project by Capital Sand, Inc.

The dredge face is generally arc-shaped, resulting from the semicircular pivoting action of the arm of the dredging equipment (Cardno 2017). The slope of the face currently range between 20°-25° with excavation depth tending to average approximately 30-ft below the historical river bottom. The operational limit of the equipment is at approximately 40-ft depth. Sand and

gravel excavated from the dredge face is brought to the surface and deposited on a transfer barge. The material is partially dewatered as it is pumped on to the transfer barge. This discharge is authorized under Nationwide Permit 16 and through the issuance of Missouri Clean Water Act 401 Water Quality Certification (Permit No. PN03-2428/CEK001309). Sand and gravel is then barged to an on-shore facility, offloaded, washed and sorted, and stockpiled for sale and delivery by trucks. All sand and gravel equipment at the on-shore facility lies outside of the high bank of the river. Wash water from the screening process is passed through settling basins prior to being discharged into Gum Spring Creek and the Osage River. This discharge is permitted by the Missouri Department of Natural Resources (MO-G500010).

Conservation Measures

Conservation measures are actions that benefit or promote the recovery of a listed species that a Federal agency includes as an integral part of its proposed action and that are intended to avoid, minimize or compensate for potential adverse effects of the action on the listed species. As such, these measures are mandatory. In addition to the two conservation measures listed below, Capital Sand withdrew their permit application to continue mining gravel and sand from their downstream location on the Osage River between RM 0.5 and 5.5. This was done to avoid adverse effects to the federally endangered Pallid Sturgeon (*Scaphirhynchus albus*) and minimize impacts to listed freshwater mussels. Additionally, the proposed mining area for the upstream location (subject of this BO) was reduced from RM 21.0-25.0 to a one mile segment between RM 22.0 and 23.0 to avoid known mussel beds.

Capital Sand has proposed to implement the following additional conservation measures[1] in order to minimize potential impacts to the Pink Mucket, Scaleshell, and Spectaclecase and contribute their recovery:

1) Maintain the following depth to distance criteria between the proposed dredging area and the left and right descending banks:

Depth Below Normal Water Surface (feet)	Minimum Distance to Riverbank (feet)
< 15	50
15 - 25	75
> 25	100

2) To help offset the loss of habitat and mussels from the dredge area, Capital Sand contributed $35,000 to ongoing mussel habitat restoration efforts on the lower Osage River. These funds were transferred to the Missouri Conservation Heritage Foundation (MoCHF) at 230 Commerce Drive Ste. 301, Jefferson City, Missouri 65109 by Capital Sand, Inc..

[1] These conservation measures were developed during a June 14, 2017, meeting between the Service, Capital Sand Inc., and the USACE and differ from the proposed conservation measures in the USACE's BA.

Action Area

Service regulations define "Action Area" as all areas affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR §402.02). Because there may be indirect effects from the Federal actions included in the consultation that occur outside of the geographic area of the proposed action as described by the action agency, the Action Area of the biological opinion may not be the same as the actual geographic area of the proposed action.

The action area for the proposed gravel mining includes the length of channel included in the proposed dredging reach, from RM 22.0 to RM 23.0, and the channel extending two miles upstream and downstream from this reach. This delineation recognizes that some indirect impacts could possibly extend some distance upstream and/or downstream from the dredging operation.

STATUS OF THE SPECIES

This section presents the biological or ecological information relevant to formulating this BO. Appropriate information for the Pink Mucket, Scaleshell, and Spectaclecase mussels, including life history, habitat and distribution, and other data on factors necessary to their survival are either included or referenced to provide background for analysis in later sections. This analysis documents the effects of past human and natural activities or events that have led to the current range-wide status of the species.

Species Description

The Pink Mucket is a freshwater mussel that was listed as federally endangered in 1976 (USFWS 1976). At the time of listing, it was officially called *Lampsilis orbiculata*, but that name has been changed recently to *L. abrupta* (Turgeon *et al.* 1998). Adult Pink Muckets grow to lengths of approximately 4 inches, and are characterized by thick, inflated, and unsculptured shells. The species is sexually dimorphic with the shell of male specimens being curved anteriorly and somewhat pointed posteriorly. Females have a rounded anterior margin, but the posterior area of the shell is expanded and somewhat truncated. The periostracum is yellow or yellowish (sometimes greenish) brown; the shells of young specimens exhibit wide greenish rays. Nacre color varies from pink or salmon to iridescent, silvery white (Service 1985).

The Scaleshell mussel was listed as endangered on October 9, 2001 (USFWS 2001). The following species description is summarized from Buchanan (1980), Cummings and Mayer (1992), Oesch (1995), Watters (1995), Parmalee and Bogan (1998), and Barnhart (2001). The Scaleshell reaches a length of approximately 10 centimeters (4 inches), although old individuals may reach 12 centimeters (4 ¾ inches). The periostracum is smooth, yellowish green or brown, with numerous faint green rays. The shells are elongate, very thin, compressed, and rhomboidal. The anterior end is rounded. The dorsal margin is straight, and the ventral margin is gently rounded. Beaks are small and low, and nearly even with the hinge line. The beak sculpture, which may not be visible in older individuals, is inconspicuously compressed and consists of four or five double-looped ridges. The pseudocardinal teeth are reduced to a small, thickened ridge. The lateral teeth are moderately long with two indistinct teeth occurring in the left valve

and one fine tooth in the right valve. The beak cavity is very shallow. The nacre is pinkish white or light purple and highly iridescent.

The Scaleshell exhibits marked sexual dimorphism. The most notable difference is the morphology of the posterior end. In males, the posterior end is bluntly pointed. In females, the periostracum forms a broad, ruffled extension of the posterior end of the shell (Buchanan 1980). Males and females also differ in overall size and shape. Females are usually smaller and less tall than males of similar age. Lastly, the beak of the female is located further anterior than that of the male (Barnhart 2001).

The following description of the Spectaclecase is generally summarized from Oesch (1995), Parmalee and Bogan (1998), and Baird (2000). The Spectaclecase is a large mussel that reaches at least 9.25 inches in length. The shape of the shell is greatly elongated, sometimes arcuate, and moderately inflated, with the valves being solid and moderately thick. Both anterior and posterior ends of the shell are rounded with a shallow depression near the center of the valve. The anterior end is higher than the posterior end. The posterior ridge is low and broadly rounded. Year one specimens have heavy ridges running parallel with the growth rests. The periostracum (external shell surface) is somewhat smooth, rayless, and light yellow, greenish-tan, to brown in young specimens becoming rough and dark brown to black in old shells. The shell will commonly crack posteriorly when dried.

Internally, the single pseudocardinal tooth is simple and peg-like in the right valve, fitting into a depression in the left. The lateral teeth are straight and single in the right valve, double in the left valve, but with age become fused and represented by an indistinct raised hingeline. The color of the nacre (mother-of-pearl) is white, occasionally granular and pitted, mostly iridescent in young specimens, but becoming iridescent posteriorly in older shells. There is no sexual dimorphism in the shells of this species. The soft anatomy was described by Oesch (1995). Key characters useful for distinguishing the Spectaclecase from other mussels is its large size, elongate shape, arcuate ventral margin, dark coloration, roughened surface, poorly developed teeth, and white nacre. No other North American mussel species has this suite of characters.

Life History

Relatively little is known of the specific life history of the Pink Mucket, Scaleshell, and Spectaclecase. Their general biology is believed to be similar to other bivalve mollusks belonging to the family Unionidae. Adults are suspension feeders, using their gills to remove suspended particles in the water column. While the diet of unionids is a subject of debate, it is believed to include phytoplankton, zooplankton, diatoms, bacteria, and fine organic detritus (Fuller 1974, Haag 2012). The extent of selectivity exhibited by mussels feeding on each of these food groups and species within these food groups is poorly understood and is likely to vary by species. Recent evidence suggests that detritus and bacteria may be an important food source (Silverman *et al.* 1997, Nichols and Garling 2000). Even less is known of the feeding behaviors of juvenile mussels. Juvenile mussels are believed to employ foot (pedal) feeding to some degree for the first several months of their lives, feeding on depositional materials in interstitial water, including bacteria, algae, and detritus (Yeager *et al.* 1994). Pedal feeding in juveniles is accomplished by movements of microscopic cilia lining the foot that carry food particles into the

mantle cavity and into the mouth. Juveniles also use the foot in a sweeping motion to draw particles toward the mantle cavity (Reid *et al.* 1992).

Adult unionids spend their entire lives partially or completely buried in the stream bottom (Murray and Leonard 1962). The depth to which they bury themselves may depend on the species, season, and environmental conditions (Parmalee and Bogan 1998). The posterior margin of the shell is usually partially spread, and the siphons extended to facilitate feeding and respiration. During periods of activity, movement is accomplished by extending and contracting a single muscular foot between the valves. Extension of the foot also enables the mussel to wedge itself into the river bottom.

Unionids have an unusual and complex mode of reproduction, which includes a brief, obligatory parasitic stage on fish. Most species typically have separate sexes, and spawning occurs in the spring, summer, or early fall (depending on the species). First, females lay eggs and brood them in specialized chambers in the gills (marsupia). Then males release sperm into the water column that are drawn into the female's incurrent siphon. Fertilization takes place internally within the marsupium. Within the marsupium, fertilized eggs develop into microscopic larvae (glochidia), which only have embryonic stages of a mouth, intestines, heart, and foot. The female may brood glochidia until the following year (long-term brooders) or release glochidia the same year it is fertilized (short-term brooder). Once glochidia are expelled by the female, they must quickly attach to the gills or the fins of an appropriate fish host to complete development. Glochidia that fail to attach to a suitable host will die. Host fish specificity varies among unionids. While some mussel species appear to require a single host species, other species can transform their glochidia into juvenile mussels on several fish species. The glochidia parasitize a fish host for a variable length of time, likely depending upon water temperature, fish species and other factors. Following proper host infestation, glochidia transform into juveniles, excyst from the host (drop off), and must settle into suitable habitat to survive.

The successful transfer of mature glochidia to a suitable host constitutes one of the critical events in the life cycle of freshwater mussels, and various adaptations to facilitate this process have evolved. The method of host infection greatly varies among species. While some species simply release glochidia into the water where they must haphazardly come into contact with the appropriate host, the process is more intricate and direct in other species. For example, females in the genus *Lampsilis* (including *L. abrupta*) have an extension of the mantle tissue that strikingly resembles a small fish. This structure is displayed outside the shell from between the valves and is twitched repetitively to attract its predaceous fish host. The host is infested by the female mussel when the fish attempts to eat the lure (Kraemer 1970, Barnhart and Roberts 1997). Other unionid species release conglutinates (small structures made up of gelatinous material that enclose large numbers of glochidia) freely into the water. These structures resemble prey items of the mussel's host fish; the host fish are infested when they attempt to eat them (Chamberlain 1934, Barnhart and Roberts 1997). How a Scaleshell infests its host and the intricacy of this relationship is unknown. One interesting hypothesis is that the Scaleshell infests drum via host predation of females (Barnhart 2001). The small size, sexual dimorphism, apparent rarity of females (see sex ratio section below), and the fact that freshwater drum are molluscivores support this hypothesis. Furthermore, the Scaleshell produce glochidia at a small size and young age, which may be another adaptation for consumption by drum (Barnhart 1998).

The Pink Mucket is a long-term brooder, becoming gravid in August and the females infect fish hosts the following spring (Ortman 1912 & 1919). Based on laboratory host fish infections, potential fish hosts include the Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*M. dolomieui*), Spotted Bass (*M. punctulatus*), and Walleye (*Stizostedion vitreum*) (Barnhart *et al.* 1997). As discusses above, female Pink Muckets have a well-developed mantle that is modified to a flap that holds glochidia and is presumed to be used as a lure to attract fish. This "lure" of glochidia increases the probability that a fish will come in contact with the mantle flap and release the glochidia when it approaches or attacks the lure.

The Scaleshell is also a long-term brooder, with spawning occurring in the fall and host infection in spring Baker (1928). Based on recent field observations, the Scaleshell spawns and begins brooding in early August, and glochidia are released the following June in Missouri (Gordon 1991, Barnhart 1998, Barnhart 2001, data from Roberts and Bruenderman 2000). The Scaleshell appears to utilize the Freshwater Drum (*Aplodinotus grunniens*) exclusively as a host for its larvae (Barnhart 1998. Other species in the genus *Leptodea* and a closely related genus *Potamilus* are also known to use Freshwater Drum exclusively as a host (Watters 1994, Barnhart and Roberts 1997, Roe *et al.* 1997, Barnhart 1998).

Once attached to its host fish, the developing glochidia will disperse with the fish for a period of weeks while they must successfully transform. This phase is another major bottleneck in the life cycle of unionids as not all glochidia that attach to a suitable host successfully transform into juveniles. Transformation period for Pink Mucket glochidia on suitable host fish was reported in the laboratory to be 12 to 14 days at 25° C (77° F) (Barnhart *et al.* 1997). Transformation period for Scaleshell glochidia was slightly longer, 16 to 20 days on freshwater drum in water 25.5° C (77.9 °F) (Barnhart 2003). Transformation success on suitable host fish can vary widely and may be affected by the genetics and age of host fish as well as acquired immunity from previous parasitic infestations.

The Spectaclecase mussel appears to be bradytictic; producing gametes and releasing glochidia mainly in the spring (Baird 2000). Despite considerable research efforts, the host has not yet been identified (Watters 1994, Hove *et al*. 1998, Knudsen and Hove 1997, Lee and Hove 1997, Baird 2000). This species releases white conglutinates (cohesive aggregations of eggs or glochidia), which are branched and have a feathery shape (Baird 2000). However, it is unknown whether or not these structures are involved in host attraction like many other unionid species that release conglutinates.

Growth and Longevity

Many freshwater mussel species are long-lived. Individuals of many species live more than 10 years, and some have been reported to live over 100 years (Cummings and Mayer 1992). Freshwater mussels exhibit distinct lines on the surface of their shells that are hypothesized to form annually. External annuli counts from Missouri collections from the Meramec, Osage, Sac, and Black rivers indicate that the Pink Mucket can live over 20 years (Roberts and Bruenderman 2000, ESI 2003, Hutson and Barnhart 2004). Recent collections of the Scaleshell from Missouri indicate that it is relatively short-lived, with a life expectancy of less than 10 years (Roberts and

Bruenderman 2000, Barnhart 2001). The Spectaclecase mussel has a longer life expectancy. Baird (2000) aged 278 specimens of the Spectaclecase in the Missouri by sectioning the hinge ligament. The maximum age he determined was 56 years, but surmised that some large individuals may have been older. A very large specimen (9.25 inches) from the St. Croix River, Minnesota and Wisconsin, was estimated (qualitatively based on external growth rings counts) to be aged at ~70 years (Havlik 1994).

Habitat

The Pink Mucket and Scaleshell occupy similar habitat. Both species occur in medium to large rivers (20 meters or 65 ft wide or greater) from riffles and runs (USFWS 1985, 2010). They are typically found in stable stream channels where a diversity of other mussel species are concentrated (i.e. mussel bed). These areas of suitable habitat naturally occur in relatively small patches separated by longer reaches of unsuitable habitat (Vaughn and Pyron 1995). Roberts and Bruenderman (2000) collected the Pink Mucket and Scaleshell primarily from mussel beds with stable, gravel substrates in the Meramec River. Likewise, ESI collected these species from mussel beds in the Osage River (ESI 2003). The Pink Mucket appears to also use habitats where other mussel species are less concentrated and diverse in the Osage River (Roberts *et al*. 2014, Roberts *et al*. 2016*a*).

Both the Pink Mucket and Scaleshell can be found in a range of substrates and substrate mixtures including gravel, cobble, boulder, and occasionally mud or sand (Call 1900; Goodrich and Van der Schalie 1944; Cummings and Mayer 1992; Oesch 1995; Buchanan 1979, 1980, and 1994; Gordon 1991). However, they are most commonly reported from a stable gravel/sand mixture with various levels of cobble and silt (Buchanan 1980, Roberts and Bruenderman 2000, ESI 2003). While both species require flowing water and are considered typical riffle species, they can occupy a wide range of currents and water depths (Hickman 1937, Yokley 1972, Buchanan 1980, Clarke 1982; Oesch 1995; Roberts and Bruenderman 2000).

The Spectaclecase are known from medium to large rivers, but are more specialized in their habitat use than most other mussel species. They are often reported from deeper pools and runs adjacent to steep bluffs with moderate or swift current and substrates dominated by large cobbles and boulders (Buchanan 1979, Roberts 2000, Baird 2000). They can be found in large numbers crowded into a small space between or under rocks with few or no other mussel species present. It has been collected in the lower Osage River from similar areas (Grace and Buchanan 1981, ESI 2016), but also along the toe of training structures in swift water (Roberts *et al*. 2014).

Distribution and Population Status

The Pink Mucket was historically widespread in the lower half of the Mississippi River basin, occurring in 48 streams (USFWS data). It was known mainly from the Tennessee, Cumberland, and Ohio river drainages with occasional records from elsewhere within the Mississippi River Drainage. While the species was widespread, it never was known to occur in large numbers from any one site, and, therefore, it has usually been considered rare (Service 1985). It is estimated that the Pink Mucket has been extirpated over 80% of its historical range (USFWS data). At the present time, extant populations are known from 29 including the Tennessee River

(Alabama, Tennessee, and Kentucky); Cumberland River (Tennessee); Holsten River (Tennessee); French Broad River (Tennessee); Clinch River (Tennessee); Ohio River (Ohio, Kentucky, West Virginia, Illinois); Kanawha River (West Virginia); Elk River (West Virginia); Licking River (Kentucky); Green River (Kentucky); Barren River (Kentucky); Paint Rock River (Alabama); and Bear Creek (Alabama). The extant localities west of the Mississippi River include the White, Spring, Current, Black, Little Black, Eleven Point, Little Missouri, Saline, and Ouachita rivers (Arkansas); the Meramec, Gasconade, Bourbeuse, Big, Black, Sac, St. Francis, Spring, and Osage rivers (Missouri); and Bayou Bartholomew (Arkansas and Louisiana). Most extant populations are small and sporadically distributed with little evidence of recruitment (USFWS data). The largest and most significant populations are currently known to occur in the Tennessee, Cumberland, Osage, and Meramec rivers. The Tennessee and Cumberland river populations appear to be stable, but the Osage and Meramec populations are thought to be declining (USFWS data). However, artificial propagation efforts on the lower Osage River have been successful in augmenting this population (Roberts *et al*. 2016*a*).

The Scaleshell historically occurred in 56 rivers in 13 states within the Mississippi River Drainage including the states of Alabama, Arkansas, Illinois, Indiana, Iowa, Kentucky, Missouri, Ohio, Oklahoma, South Dakota, Tennessee, Minnesota, and Wisconsin (USFWS 2010). Like the Pink Mucket, the Scaleshell had a broad distribution historically, but is not believed to have ever been common locally (Call 1900, Baker 1928, Stansbery 1970, Oesch 1995, Clarke 1996). The Scaleshell is thought to be extirpated from all states within its historical range except Missouri, Arkansas, Oklahoma, and South Dakota. The Scaleshell is believed to be extirpated from Minnesota, Iowa, Wisconsin, and all states east of the Mississippi River. Most of this decline occurred before 1950 (USFWS 2010). Since 1950 the species has become increasingly rare and its range further restricted. Currently, the Scaleshell can only be consistently found, although very rare, in three Missouri streams including the Meramec, Bourbeuse, and Gasconade rivers. These populations are extremely small and restricted to isolated patches of suitable habitat. It has been reported from 12 additional streams in the last 25 years, but only has been represented by a small number or a single specimen (live or dead) collected during one or more extensive mussel surveys of these rivers. These streams include the Big, Osage, and Missouri rivers (Missouri); Missouri River (South Dakota); Myatt Creek, White, Spring, Strawberry, South Fourche LaFave, and the Little Missouri rivers (Arkansas); Kiamichi River (Oklahoma); and Illinois River (Illinois).

The Spectaclecase occurred historically in at least 44 streams in the Mississippi, Ohio, and Missouri River basins (USFWS 2012). Its distribution comprised portions of 14 states including Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Minnesota, Missouri, Ohio, Tennessee, Virginia, West Virginia, and Wisconsin. Currently, it is only known from 20 of the 44 historical streams extant populations occur in the Tennessee River (Alabama); Mulberry and Ouachita rivers (Arkansas); Mississippi and Ohio rivers (Illinois), Mississippi River (Iowa); Ohio, Green, and Cumberland rivers (Kentucky); Mississippi and St. Croix rivers (Minnesota), Mississippi, Meramec, Bourbeuse, Big, Gasconade, Sac, Osage, and Big Piney rivers and Osage Fork (Missouri); Tennessee, Clinch, Nolichucky, and Duck rivers (Tennessee); Clinch River (Virginia); Kanawha River (West Virginia); and Mississippi and St. Croix rivers (Wisconsin). Of the 20 extant populations, six are represented by only one or two recent specimens each and are likely declining and some may be extirpated. Populations in Mississippi and Clinch Rivers

have recently experienced significant population declines. Most surviving populations face significant threats and with few exceptions are highly fragmented and restricted to short stream reaches. The only relatively strong populations remaining are in the Meramec and Gasconade Rivers in Missouri and in the St. Croix River in Minnesota and Wisconsin (USFWS 2012).

Threats to the Species

In general, the decline of the Pink Mucket, Scaleshell, and Spectaclecase parallels the decline and elimination of freshwater mussels from many big river systems in the United States. These species were listed as endangered for similar reasons largely because of their extirpation from many river systems and significant reduction in range (USFWS 1976, USFWS 1985, USFWS 2001, USFWS 2012, USFWS data,). Habitat destruction and degradation as a result of physical, chemical, and biological alterations, has and continues to threaten populations throughout their current ranges. The major causes of such alterations are impoundments, water pollution, sedimentation, river alterations (channelization and dredging), sand and gravel mining, and invasive species. Presented below is a brief description of the threats; additional information, including a description of all potential threats, may be found in the final listing rules for these species (USFWS 1976, USFWS 2001, and USFWS 2012).

Impoundments

Impoundments negatively affect mussels both upstream and downstream by inducing bank and channel scouring, altering water temperature regimes, and altering habitat, food, and fish host availability (Neves *et al*. 1997, Watters 2000). Impoundments permanently flood stream channels and eliminate flowing water that is essential habitat for most unionids (Fuller 1974, Oesch 1995). Scouring is a major cause of mussel mortality below dams (Layzer *et al.* 1993). Most detrimental, however, is the disruption of reproductive processes. Impoundments interfere with movement of host fishes, alter fish host assemblages, and isolate mussel beds from each other and from host fishes (Stansbery 1973, Fuller 1974, Vaughn 1993, Williams *et al.* 1993). The result is diminished recruitment (Layzer *et al.* 1993).

Water Quality Degradation

Mussel biologists generally agree that contaminants are partially responsible for the decline of mussels (Havlik and Marking 1987, Bogan 1993, Williams *et al.* 1993, Neves et al. 1997, The National Native Mussel Conservation Committee 1998). Mussels are sedentary filter feeders and are vulnerable to contaminants that are dissolved in water, associated with suspended particles, or deposited in bottom sediments (Naimo *et al.* 1992). Mussels appear to be among the most sensitive organisms to heavy metals (e.g. cadmium, chromium, copper, mercury, zinc) some of which are lethal even at low levels (Havlik and Marking 1987, Keller and Zam 1991, Wang *et al*. 2007*a*, Wang *et al*. 2007*b*, Wang *et al*. 2010). Mussels are also sensitive to ammonia (Augspurger *et al*. 2003, Wang *et al*. 2007*a*, Wang *et al*. 2007*b*, Wang *et al.* 2010), which is a common pollutant in streams associated with animal feedlots, nitrogenous fertilizers, and the effluents of municipal wastewater treatment plants (Goudreau *et al*. 1993). Contaminants enter streams from point and nonpoint sources. Point source pollution is the entry of material from a discrete, identifiable source such as industrial effluents, sewage treatment plants, solid waste disposal sites, and accidental chemical spills. Industrial and municipal effluents often contain

heavy metals, ammonia, chlorine, phosphorus, and numerous organic compounds. Direct freshwater mussel mortality from toxic spills and polluted water is well documented (Ortmann 1909, Baker 1928, Cairns *et al.* 1971, Goudreau *et al.* 1988). Decline and elimination of populations may be due to acute and chronic toxic effects that result in direct mortality, reduced reproductive success, or compromised health of the animal or host fish.

Nonpoint source pollution is the entry of material into the environment from a diffuse source such as runoff from urban areas, cultivated fields, pastures, private wastewater effluents, agricultural feed lots and poultry houses, active and abandoned mines, construction, and highway and road drainage. Stream discharge from these sources may accelerate eutrophication (i.e., organic enrichment), decrease oxygen concentration, increase acidity and conductivity, and cause other changes in water chemistry that are detrimental to the survival of unionids and may impact host fishes (Fuller 1974, Dance 1981, Goudreau *et al.* 1988). Eutrophication generally occurs when nutrients are added in concentrations that cannot be assimilated as a result of runoff of organic wastewater contaminants from livestock farms and fertilizers used on row crops. Excessive growths of filamentous algae alter the surface of the stream bottom and may cause shifts in algal communities, disrupting food supplies for mussels. Juvenile mussels, utilizing interstitial habitats, are particularly affected by excessive levels of oxygen-consuming algae during nocturnal respiration (Sparks and Strayer 1998). Pesticides from row crops are a major source of agricultural contaminants, and are known to have direct affect on mussels (Havlik and Marking 1987).

Sedimentation

Sediment is material that is suspended in the water, and is being transported, or has been moved, as the result of erosion [U.S. Soil and Conservation Service (USSCS) 1988]. Although sedimentation is a natural process, intensive agricultural practices, channelization, impoundments, timber harvesting within riparian zones, heavy recreational use, urbanization, and other land use activities can accelerate erosion (Chesters and Schierow 1985, Myers *et al.* 1985, Waters 1995, Watters 2000). The water quality impacts caused by sedimentation are numerous. Generally, it affects aquatic biota by altering the substratum and by altering the chemical and physical composition of the water (Ellis 1936, Myers *et al.* 1985, USSCS 1988). Heavy sediment loads can directly affect freshwater mussel survival by interfering with respiration and feeding. Due to their difficulty in escaping smothering conditions (Imlay 1972, Aldridge *et al.* 1987), either sudden or gradual blanketing of the stream bottom with sediment can suffocate freshwater mussels (Ellis 1936). Sediment particles may carry contaminants toxic to mussels (Naimo *et al.* 1992). Increased sediment levels may also reduce feeding efficiency (Ellis 1936), which can lead to decreased growth and survival (Bayne *et al.* 1981). Additionally, fine sediment fills interstitial spaces in the substrate in which young juveniles feed (Yeager *et al.* 1994). Sedimentation can also affect mussels indirectly by disrupting the life cycle. Impacts to host fish populations, such as reduced food availability and the elimination of spawning beds and habitat critical to young fish, will affect dependent mussel populations.

River alterations and gravel mining

Channelization, sand and gravel mining, and dredging operations physically remove mussels from the water and may also bury or crush mussels (Watters 2000). More lasting effects of these

activities involve the alteration or destruction of important unionid habitat that can extend upstream and downstream of the excavated area. Headcutting, the upstream progression of stream bed destabilization and accelerated bank erosion, can affect an area much larger than the dredging site (Hartfield 1993). In severe cases, this erosional process can extend for several miles upstream. As relatively immobile bottom-dwelling invertebrates, mussels are particularly vulnerable to channel degradation (Hartfield 1993). Accelerated erosion also releases sediment and pollutants, and in some instances, diminishes mussel diversity and habitat as documented in the Yellow and Kankakee Rivers in Indiana, the Big Vermillion River in Illinois, and the Ohio River (Fuller 1974).

Invasive species

The introduction of non-native freshwater bivalves into the United States has contributed to the decline of the native mussel fauna. The recent invasion of the exotic Zebra and Quagga mussels (*Dreissena polymorpha* and *D. bugensis*) pose a substantial threat to native unionids (Herbert *et al.* 1989). The introduction of *Dreissena* into North America probably resulted from an ocean-crossing vessel that discharged freshwater ballast from Europe containing free-swimming larvae (Griffiths *et al.* 1991). Since the introduction of these species, the zebra mussel has proved to be more widespread and abundant. Since the discovery of Zebra mussels in North America in Lake St. Clair of the Laurentain Great Lakes in 1988, this prolific species has spread throughout the Mississippi River and many of its tributaries including the Illinois and Ohio basins and the Arkansas (into Oklahoma and Kansas) and Tennessee rivers.

Zebra and Quagga mussels have effective dispersal mechanisms, which has facilitated their spread in the United States. Because Zebra mussels attach themselves to hard surfaces, they can spread by attaching and living on commercial and recreational vessels. The free swimming, microscopic larva spread naturally downstream of reproducing populations. The larva are also transported from infected waters via bait buckets and live wells of recreational boats and introduced into new areas. Zebra mussels starve and suffocate native mussels by attaching to their shells and the surrounding habitat in large numbers. The spread of this prolific species has caused severe declines of native freshwater mussel species in many areas (Tucker *et al.* 1993). Populations in navigable rivers and downstream from reservoirs are particularly vulnerable due to commercial and recreational vessels that utilize these water bodies, which will hasten the invasion.

The Asian clam (*Corbicula fluminea*) is another freshwater bivalve that has been introduced into North America. It was first discovered in the United States in the late 1930's (Oesch 1995). Its prolific reproductive capability has allowed it to quickly spread its range across the continent, and the species is now almost ubiquitous throughout the range of the Scaleshell. The Asian clam can become the dominant benthic species as densities of several hundred to 10,000/m^2 have been reported in some rivers (Neves 1986, Sickel 1986). The species is believed to compete with native mussels for resources such as food, nutrients, and space (Kraemer 1979). High densities of Asian clams have been found to negatively affect the survival and growth of juvenile native mussels by disturbance and displacement of young juveniles and possibly through incidental ingestion of newly metamorphosed individuals (Yeager *et al*. 2000). Further, *Corbicula* populations can grow rapidly and are prone to rapid die-offs (McMahon and Williams 1986),

which can affect native mussels by depleting the oxygen supply and by producing high levels of ammonia (Strayer 1997).

Critical Habitat

No critical habitat has been designated, or proposed, for these species, therefore, none will be affected.

ENVIRONMENTAL BASELINE

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the Action Area, i.e., the species status given the effects from all past, current and ongoing factors within the Action Area. The environmental baseline is a "snapshot" of a species' health at a specified point in time. It does not include the effects of the action under review in the consultation.

Status of the Species within the Action Area

As noted under "DESCRIPTION OF THE PROPOSED ACTION", the action area is located between RM 20.0 and 25.0 on the lower Osage River (LOR). The LOR refers to the Osage River from RM 81.7 at Bagnell Dam to its confluence with the Missouri river. It is a low gradient moderately clear stream that transitions between the upper Ozarks and Missouri River physiographic regions of Missouri. Habitat is dominated by pool and slow run/glide habitat, with riffle with swift run habitat lacking in many segments. Much of the diversity in habitat (riffle, run, back channel, and backwater) occurs around island and tributary mouths. An important natural feature of the LOR is the occurrence of diverse mussel beds, where multiple mussel species are concentrated in a localized area. To date, 18 significant mussel beds have been identified from Bagnell Dam at RM 81.7 to the mouth of the Missouri River confluence (Grace and Buchanan 1981, ESI 2003, Roberts et. al. 2014). Long-term mussel monitoring stations sites have been established at these 18 sites. One of these monitored mussel beds is located on the upstream end of the project area at approximately RM 23.5 (ESI 2003, Roberts *et al.* 2014).

The lower Osage River is among the most important mussel streams in the state of Missouri with thirty nine species including the federally endangered Pink Mucket, Spectaclecase, and Scaleshell. It is the most important stream in the Osage Basin for mussel conservation because of its potential to be restored and the fact that it is the largest and longest remaining segment of flowing habitat in the basin. The lower Osage River supports the largest population of Pink Mucket west of the Mississippi and one of the most significant remaining populations throughout its range. Significant progress has been made to improve aquatic habitat conditions in the Lower Osage River through the implementation of a new license order for Bagnell Dam, a hydropower facility located at RM 81.7. Major operational changes were made to improve water quality, flows, and reduce erosion. Additionally, actions are currently underway to augment mussel populations and improve mussel habitat in the lower Osage River. With the impacts of the Bagnell Dam operation minimized and other impacts, the lower Osage River could support stable populations in the future and provide many miles of suitable habitat for the Pink Mucket, Spectaclecase, and Scaleshell. Thus the lower Osage River is essential to the recovery of these

mussel species.

The Pink Mucket was reported live in the LOR at nine of 25 sites surveyed by Grace and Buchanan (1981) and at eight of 25 sites during a survey conducted by ESI (2003). The species was rare in both of these surveys representing less than 0.5% of all living mussels collected. The youngest individuals were estimated to be 8 and 9 yrs old over the two studies, respectively (Grace and Buchanan 1981, ESI 2003), despite some quantitative sampling during the latter study. These data indicated that recruitment has remained limited over the 20-year period (ESI 2003). Two of the known LOR Pink Mucket sites are located within the proposed action area including RM 21.5, where four living specimens were found by Grace and Buchanan (1981), and five specimens were found at RM 23.5 by ESI (2003). ESI resurveyed RM 21.5 in 2001 and did not collect any living Pink Mucket specimens. More recently, two site-specific mussel surveys were conducted within the action area by ESI (ESI 2015 and 2016). During these surveys, mussels were found throughout the proposed dredging area, but two distinct areas of suitable habitat occupied by multiple mussel species were delineated as two narrow bands along the left descending bank with an estimated area of 15,490 m^2. Three living Pink Muckets were found within these two small mussel beds (two specimens were found in the downstream bed). A more detailed distribution of the Pink Mucket distribution within the project area is provided by Cardno (2017).

The Scaleshell has only recently been discovered in the LOR. One live male, approximately three years old, was found near RM 17 during a 2001 survey (ESI 2003). This individual was collected from an open shallow run where 17 other species were present. A dead specimen was collected in 2013 from RM 27 (Roberts *et al*. 2014). No other evidence of the Scaleshell has been found in the Osage River. The Scaleshell has not been previously reported from the Osage Basin and may indicate that the species is extremely rare in this river. This river population represents one of the 15 populations that are considered extant range-wide (USFWS 2011).

Grace and Buchanan (1981) reported the Spectaclecase at eight sites within the LOR with a relative abundance of 0.2%, including one live individual at RM 22.2 within the action area. ESI (2003) did not report any living specimens in 2001, but reported dead shells from four sites. More recently, the USFWS has collected the species live from RM 13.5, 26.5, and 51. Dead shells were observed at RM 33 and 65 (Roberts *et al.* 2014, Roberts *et al.* 2017). It was observed living in clusters around boulders along the base of L-shaped training structures in deep water, where these structures form deep, swift chutes in the river. This species is not as common in the LOR as it is in the Meramec and Gasconade rivers and represents one of the 20 currently extant river populations (USFWS 2012).

Factors Affecting the Species within the Action Area

The Pink Mucket, Scaleshell, and Spectaclecase are subject to several ongoing threats within the LOR, which also affect the aquatic community as a whole. The most apparent impact to mussel populations in the LOR is the operation of Bagnell Dam, a hydropower facility located approximately 57 miles upstream from the action area. Many effects of the dam extend downstream through the action area but have been minimized through operational changes and environmental measures achieved after the relicensing of this facility in 2007. These environmental achievements were written into a BO that was transmitted to the Federal

Energy Regulatory Commission to reduce adverse effects of Bagnell Dam to the Pink Mucket and Scaleshell mussels (USFWS 2006). The operational changes included substantial technological improvements to increase dissolved oxygen levels in the LOR and minimize supersaturation in the tailrace. The facility now meets or exceeds the state water quality standards for the LOR of 5 mg/L while minimizing supersaturation. A new flow regime and increased minimum flow provided spawning flows, seasonal variability in flows, and flows that will increase and create more persistent aquatic habitat that benefits downstream aquatic resources including endangered species. Additionally, a program was put into place to restore and enhance aquatic habitat and augment populations of federally listed mussel species in the LOR. To date Pink Mucket populations have been successfully augmented through artificial propagation at two sites in the LOR, one of which is located approximately two river miles from the upstream end of the action area.

Because Bagnell Dam will continue to operate as a peaking facility, the effects of peaking and hypolimnetic (e.g., water released from the hypolimnion layer of the lake that is typically cold and stagnant with lower oxygen) flows continue throughout the entire LOR to some extent. These effects also attenuate with increasing distance from the dam. Peaking flows will continue to limit suitable mussel habitat and recruitment, disrupt the mussel life cycles, and cause stranding in shallow habitats to some degree. Hypolimnetic releases will continue to slightly alter water temperature and alter/reduce food sources for mussels. The impacts are in the form of a linear impact gradient where recruitment, overall abundance, species richness, diversity, and growth rates of mussels have been observed to increase with distance from the dam (ESI 2003).

Mussels in the action area can be exposed to various contaminants throughout the year. The Lake of the Ozarks (LOZ) is source of pollution and eutrophication to the LOR because if its intensive development and land use within its watershed. Pollutants also enter the LOR via its own watershed or by atmospheric deposition and are transported downstream through the action area. Significant forms of point and non-point source pollution enter streams of the LOR watershed including industrial and municipal effluents, runoff from urban areas, cultivated fields, pastures, private wastewater effluents, agricultural feed lots and poultry houses, construction, and highway and road drainage. Despite all these containment sources, the LOR is not currently listed under the 303(d) list (Missouri Department of Natural Resources 2016). Additionally, data from the U.S. Geological Survey (USGS) ambient water-quality monitoring network station near St. Thomas, Missouri, reflect water of good quality for the LOR (e.g. dissolved oxygen, ammonia, aluminum, arsenic, cadmium, copper, lead, mercury) (2005 data, https://pubs.usgs.gov/wdr/2005/wdr-mo-05/). The USGS also has records on selected metals monitored from 1996 to 2000 (aluminum, barium, cadmium, cobalt, copper, lead, mercury, nickel, selenium, silver, and zinc). All concentrations were well below applicable state standards and most were below detection limits. River samples were analyzed for pesticides in November 1992, including atrazine, cyanazine, simazine, and alachlor. All analysis showed pesticide levels were below laboratory detection limits (USGS 2001).

In 2006, an established Zebra mussel population was discovered in the LOZ. In subsequent years they have been observed attached to docks and monitoring devices in large numbers. This species is now present in the LOR and been observed attached to the substrate and living native mussels. However, Zebra mussels have not been observed in large numbers during annual

mussel monitoring at several sites in the LOR (Roberts *et al*. 2014, 2015, 2016*b*, 2017). In the future, Zebra mussels could become abundant enough to become a threat to mussels in the action area as they have in other streams and rivers in the U.S.

Sand and gravel mining has occurred with the action area (in the vicinity of RM 22) for several decades leading up to the present time. Capital Sand, Inc. began dredging at this location in 1974 as Roweth Sand and Gravel Inc., but other instream mining has occurred here since 1945. These activities most likely impacted mussel species within this river reach. Grace and Buchanan (1981) reported a mussel bed adjacent to and 600 meters (about 2,000 ft) downstream of the Roweth Sand and Gravel Inc. dredging operation. Grace and Buchanan reported 22 species, including four living Pink Mucket at this location. In 2001, ESI reported only 15 species after intensive efforts to sample the same location (ESI 2003). The Pink Mucket was one of the previously reported species that was not observed living at this site. Considering that the dredge operation was in close proximity to the mussel bed in 1981, impacts from the activities could have affected this habitat from long-term exposure to the increased turbidity and sedimentation. Additionally, the mussel habitat may have changed over time for a portion of the mussel bed that became part of the deep pool created by the dredge.

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the proposed action on the species and critical habitat and its interrelated and interdependent activities.

Factors Considered

Our analysis considers the following factors:

Proximity of the action: The proposed action will directly affect occupied habitat of all thee mussel species.

Distribution: The Action Area includes a relatively small fraction of the range of all three species.

Timing: In general, mining typically occurs approximately 2.5 hours one day and 5.5 hours the next day from March through November. This schedule alternates between 2.5 and 5.5 hours per day during the work week. The dredge cannot operate during periods of higher flows (14-15' elevation at the St. Thomas USGS gauge).

Nature of the effect: Direct and indirect effects are described below.

Duration: The duration of the effects will be relatively short-term over the five year period, although long-term and permanent effects are anticipated as well because the habitat will be permanently altered.

Disturbance frequency: Dredging activities will result in a prolonged disturbance to habitat for as much as nine months during the year that will affect all life stages of the three species and

their fish hosts.

Disturbance intensity and severity: The intensity and severity of the disturbance are described below.

Impact of the Proposed Action

Direct Effects

Direct effects are defined as the direct or immediate effects of the action on the species or its critical habitat. The primary direct effect of instream gravel excavation is the removal or destruction of mussels and their habitat from the stream within the excavated area. As discussed above, the majority of the project area includes marginally suitable habitat in the center of the channel (where a very low density of mussels was found) and two narrow strips of more suitable mussel habitat along the left descending bank (where a moderately dense mussel population was found) (Figure 2). Up to approximately 146,294 m^2 (36 acres) of the marginal mussel habitat will be destroyed during the permit period. Within this area, the mussels and their habitat will be permanently removed from the water as gravel is harvested and the stream channel deepened, which will result in death. Mussels may also die as a result of being buried or crushed on the stream bottom by the harvesting techniques (Watters 2000). The marginal habitat supports several species of living mussels (ESI 2016), and given its larger size, it is

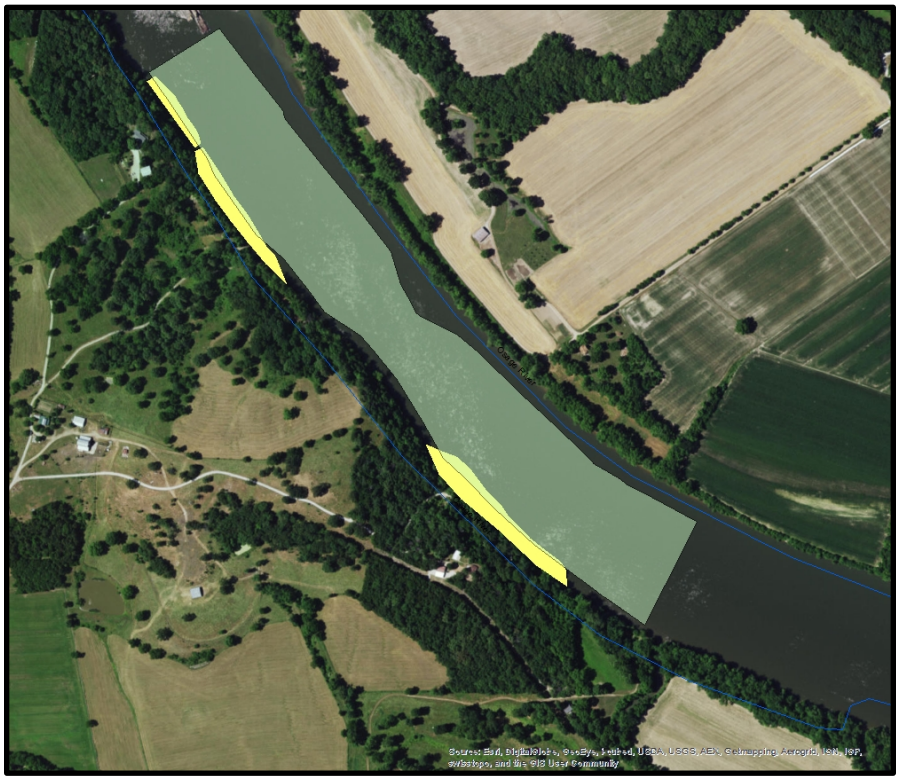

Figure 2. The proposed dredging area (green) by Capital Sand, Inc. and areas of suitable mussel habitat (yellow). The proposed dredged area is shown 50 feet away from the river banks (the minimum distance required by depth to distance ratios).

likely to contain a small number of Pink Muckets and possibly Scaleshell. The presence of Spectaclecase is highly unlikely outside of the delineated mussel beds because they are associated with boulders, which are absent in the main channel. The majority of animals residing within this portion of the dredged area are likely to be killed. Based on the results of ESI's surveys and recent surveys the USFWS, we anticipate that up to 40 Pink Muckets and one Scaleshell will be killed during sand and gravel harvesting activities.

Capital Sand, Inc. has agreed to avoid dredging along the left and right descending banks as described above in the **Description of the Proposed Action.** This depth to distance criteria (or buffer) will exclude most of the two areas of suitable habitat from the dredging area. The extent of which the dredged area will overlap with the mussel beds will depend upon the actual width of the mussel habitat, water depth, and if suitable harvest material is present. The two mussel beds tend to be tapered on the upstream and downstream ends, but at their widest point extend laterally 88 feet from the left bank (Figure 2). According to the proposed buffer, dredging can only occur up to 50 feet from the left bank. If any of the mussel bed areas are dredged, mussels in this area are likely to be removed with the dredged material. Mussels and suitable habitat left behind by the dredge will be subject to direct and indirect effects as described below.

Other potential direct effects of Capital's proposed dredging include increased turbidity and sedimentation downstream of the hydraulic suction dredge, loading barge, and onshore sorting facility during time periods when those operations are active. Based on recent studies at the site, increased turbidity and sedimentation during active operation will be localized and is not likely to exceed the range of ambient turbidities in the Osage River for the most proximal mussel habitat located downstream at RM 21.5 (JD-Mc Engineering 2016). At RM 21.5, the effects are anticipated to be minimal and not cause harm or habitat modification that significantly disrupts normal mussel behavior patterns such as breeding, feeding, or sheltering. However, remaining areas of the two mussel beds within the excavated reach are likely to experience periods of higher turbidity compared to ambient levels once the operation advances upstream of them. Even though these areas are located along the left descending bank, they may be exposed to the plume of sediments from the dredge and loading barge as they disperse laterally downstream. Increased turbidity would only occur while the dredge is in operation, which, as described above is for several hours per day weekdays from March through November. The increased turbidity may result in a reduction in feeding and/or reproductive success.

Indirect Effects

Indirect effects are those effects that are caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur [50 CFR §402.02]. Habitat conditions within the avoided mussel beds may degrade over time as a result of the operation. As the operation advances upstream, these areas will be left perched along the deepened river channel, and the habitat will change from a deep run to a deep pool. Because the Pink Mucket, Scaleshell, and Spectaclecase mussels require flowing habitat, they may not be able to persist under these conditions. Further, the decreased water velocity in the pool may allow sedimentation and an increase in silt composition of the substrate to the point that it becomes unsuitable habitat. These habitat changes are expected to be long lasting, as it will take a long

period of time for the mining pit to fill with river sediment. Ultimately, both mussel beds are likely to become unsuitable habitat after dredging occurs, and this effect cannot be reduced or avoided. Given the estimated overall mussel density and percent total area of the mussel beds (15,490 m^2) up to 736 Pink Muckets, four Scaleshell, and 186 Spectaclecase mussels may be killed as a result of declining habitat conditions after dredging.

Removing large quantities of gravel from the stream channel can cause instability and physical changes to the stream bed that can spread both upstream and downstream over time. Headcutting can occur if the channel becomes incised or the pool-riffle ration is altered. Headcutting is the upstream progression of substrate destabilization and accelerated bank erosion (Hartfield 1993). In severe cases, this erosional process can extend for several miles upstream destroying habitat for mussels and other species. As relatively immobile benthic invertebrates that require stable substrates (Haag 2012), mussels are particularly vulnerable to channel degradation (Hartfield 1993) and may take many years to recover (Grace and Buchanan 1981). The deep pit created by the dredging can also intercept the natural sediment transport and interrupt the supply of sediment to downstream areas. If the bedload is significantly reduced, it can cause bed lowering downstream, especially immediately downstream from the mining pit. Longitudinal and cross-sectional profiles have been completed for the project area in 1995, 1998, 2003, 2008, 2014 and 2016 to examine the streambed elevation as reported in the Biological Assessment. The USACE concluded from these studies that there has not been a marked decrease in stream bed elevation upstream or downstream of the current dredging activity since 1995 that would indicate a channel incision. The reason that the upstream dredge face has not propagated upstream (i.e. headcut) is unknown, but the Osage Lock and Dam #1 could potentially be serving as a gradient stabilization. However, as the dredge face progresses upstream and the resulting deep pool enlarges, it remains uncertain whether headcutting or downcutting may occur sometime in the future, particularly because of the hydropower operation. The Service is not reasonably certain that indirect effects from upstream headcutting or downstream bed lowering will occur; therefore, we assume that habitat degradation will not result in impacts to these three species in the known mussel beds outside of the immediate dredging area. However, if monitoring indicates that headcutting or bed degradation is occurring outside of the dredging area, this may constitute adverse effects not considered in this BO.

Interrelated and Interdependent Actions

Interrelated activities are those that are part of a larger action and depend on the larger action for their justification; interdependent actions have no independent utility apart from the proposed action; and indirect effects are those caused by or result from the agency action, are later in time, and are reasonably certain to occur. There are no interrelated or interdependent activities anticipated related to the proposed dredging project.

Summary of Effects of the Action

As described above, the Service estimates that as many as 40 Pink Muckets and 1 Scaleshell could be killed by dredging activities within the marginally suitable habitat located outside of the two mussel beds. Within the two mussel beds, we anticipate that up to 736 Pink Muckets, four Scaleshell, and 186 Spectaclecase may be either killed during dredging or will not persist

in the declining habitat conditions of the deep pool left behind by the dredge. Because we anticipate impacts to individuals, we must evaluate the aggregated consequences of the effects to individuals and habitat on the fitness of the population to which those individuals belong. Currently, there are 17 substantial mussel beds known from the lower 80 miles of the Osage River that provide suitable habitat for the Pink Mucket and Scaleshell mussels (Roberts et al. 2014). Additional habitat is likely present in some areas that have not been surveyed. The distribution of the Spectaclecase mussel in the lower Osage River has not been adequately studied, but incidentally it has been found living at four sites (Roberts et al. 2014 and 2017). This species has been found at the base of bluff lines and man-made training structures in the Lower Osage River, and more sites that support this species are likely present. We do not think that the death of Pink Muckets, Scaleshell, and Spectaclecase mussels from the two beds within the dredge area will affect the long-term persistence of the population in the LOR.

CONCLUSION

After reviewing the current status of the Pink Mucket, Scaleshell, and Spectaclecase mussels, environmental baseline for the action area, the effects of the proposed instream gravel mining operation, and cumulative effects, it is the Service's biological opinion that the completion of the project, as proposed, is not likely to jeopardize the continued existence of these species. No critical habitat has been designated, or proposed, for these species, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to Section 4 (d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering [50 CFR §17.3].

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7 (o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

The measures described below are non-discretionary, and the USACE must ensure that they become binding conditions of permitting issued to Capital Sand Inc. as the applicant, as appropriate, for the exemption in Section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by ITS. If the USACE: 1) fails to assume and implement the terms and conditions or 2) fails to require Capital Sand Inc. to adhere to the terms and conditions

through enforceable terms that are added to the permitting documents, the protective coverage of Section 7 (o)(2) may lapse. In order to monitor the impact of incidental take, the USACE or the permit applicant must report the progress of the action and its impact on the species to the Service as specified in the ITS, pursuant to 50 CFR §402.14(i)(3).

Amount or Extent of Take Anticipated

As described within the accompanying Biological Opinion (BO), adverse effects to the Pink Mucket, Scaleshell, and Spectaclecase mussels will occur as a result of the proposed gravel mining operation. During the five-year permit period (and during subsequent permit periods), the dredge may advance up to one linear mile from RM 22.0 to 23.0. Considering the exclusion of the proposed buffers, up to approximately 72,033 m^2 (17.8 acres) of marginal mussel habitat will be destroyed. Within this area, the Service expects that up to 40 Pink Muckets and one Scaleshell will be taken (killed) during the sand and gravel harvest. While the two mussel beds will be mostly avoided by the dredge, the Pink Mucket, Spectaclecase, and Scaleshell individuals within these areas are likely to be harmed by increased turbidity once the dredge advances upstream of their location during periods of active dredging for the duration of the proposed five-year permit. Ultimately, we anticipate that declining habitat conditions will result in the lethal take of 736 Pink Muckets, four scaleshell, and 186 Spectaclecase mussels. The take provided is set based on the results of the two mussel surveys conducted in the action area and Service mussel monitoring data from other portions of the Osage River.

Effect of Take

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to jeopardize the continued existence of the Pink Mucket, Scaleshell, or Spectaclecase mussels. No critical habitat has been designated for these species; therefore, none will be affected.

Reasonable and Prudent Measures

The Service believes the following RPMs are necessary and appropriate to minimize impacts of incidental take of the Pink Mucket, Scaleshell, and Spectaclecase mussels:

1. The USACE will ensure that the conservation measures outlined under the **DESCRIPTION OF THE PROPOSED ACTION** are implemented.

2. The USACE will require Capital Sand to monitor to ensure that the take is minimize and not exceeded and that the Service is notified of any violations or unforeseen circumstances.

Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the Act, the USACE must ensure compliance with the following terms and conditions, which implement the RPMs described above. The terms and conditions are mandatory and should be incorporated into the terms and conditions of the permit issued by the USACE to Capital Sand, Inc.

RPM 1

1.1 No dredging will occur at the previously mined area at the downstream location between RM 0.5 and 5.5.
1.2 No dredging will occur upstream from river mile 23.0.

1.3 Maintain the following depth to distance criteria between the proposed dredging area and the river banks:

Depth Below Normal Water Surface (feet)	Minimum Distance to Riverbank (feet)
<15	50
15-25	75
>25	100

1.4 A contribution of $35,000 will be transferred to the MoCHF by August 25, 2017.

RPM 2

3.1 Conduct hydrographic monitoring to confirm that no headcutting or downstream channel degradation occurs with the following requirements:

a. Establish a baseline cross channel profile upstream of the proposed dredging area (in the vicinity of RM 23.2) by the end of 2017. This profile will be monitored and the results provided to the Service annually.
b. At the end of the five-year permit period the longitudinal section and cross sections 1-4 (of the original hydrological survey) and the upstream baseline cross section will be measured and the results provided to the Service.

3.2 The USACE will ensure that the Service is notified of project initiation and completion dates. The USACE will also notify the Service when the dredging operations reach RM 22.5. The USACE will provide the Service a copy of the annual report from Capital Sand that documents compliance with the USACE permit.

3.3 The USACE will ensure that the Service is notified of any violations of the U.S. Army Corps of Engineers Nationwide 16 or the General Permit and Water Quality Certification issued by the Missouri Department of Natural Resources by including the Service on any non-compliance correspondence.

3.4 If any of the above monitoring requirements cannot be implemented or require modification, contact Service biologist Andy Roberts at 573-234-2132 x 110 for further discussion.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that the action will result in the mortality of no more than 776 Pink

Muckets and five Scaleshell, and 186 Spectaclecase.

If, during the course of the action, these numbers are exceeded, such incidental take represents new information requiring the reinitiation of consultation and review of the reasonable and prudent measures provided. The USACE must immediately provide an explanation of the causes of the taking, and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7 (a)(1) of the Act, directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation Recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery programs, or to develop information.

The following recommendations are provided for your consideration, to provide additional conservation benefits for the Pink Mucket, Spectaclecase, and Scaleshell mussels within their known ranges.

1. Provide a wider buffer from the left descending bank along the two mussel beds within the dredging area than required by the USACE permit when practicable.
2. Continue to monitor the established hydrographic channel profiles after the five year dredging period measured during this project to provide information on future channel recovery.
3. Continue to monitor mussel populations and habitat conditions within the two mussel beds after the five year dredging period to provide information on the changing habitat conditions of these areas.
4. Contribute funds for mussel propagation to further the recovery of the Pink Mucket, Scaleshell, and Spectaclecase mussels in the lower Osage River.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the BO. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information shows that the action may affect listed species in a manner or to an extent not considered in this BO; (3) the action is subsequently modified in a manner that causes an effect to the listed species not considered in this BO; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. The effects analysis and ITS of this BO take into account that more than one permit period may be required to harvest the available material

between RM 22.0 and 23.0. Therefore, the ITS may still apply for subsequent Corps permits within RM 22.0 and 23.0 provided that the project description is the same and no new information becomes available that invalidates the affects analysis.

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