Exhibit SNC 000051

"Analysis of Impacts of Navigation Channel Maintenance for Barge Delivery of Materials for Construction of Vogtle Units 3 and 4 on the Ecology of the Savannah River."

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Introduction

The FEIS for an Early Site Permit at the Vogtle Electric Generating Plant (VEGP) site anticipates that some maintenance of the Federal navigation channel in the Savannah River downstream of the VEGP site may be necessary in order to deliver construction materials by barge (NRC 2008). The U.S. Army Corps of Engineers ("Corps") has the responsibility for maintaining the Federal navigation channel in the Savannah River. Maintenance would entail selective dredging and snag removal. This maintenance activity would have the potential for adverse impacts on aquatic organisms (FEIS at 20). The Federal navigation channel between RM 21.3 (Savannah Harbor) and RM 204.4 near Augusta has not been maintained since 1979 because of disuse (SNSA 2008).

The FEIS acknowledges that a detailed assessment of dredging needs and related impacts has not been done, largely because "the dredging project is incompletely defined, the amount of material to be removed is unknown, and the locations of the dredged material disposal areas have not been identified." (FEIS at 7-20). It further states "impacts could include temporary loss of benthic habitat, disruption of spawning migrations, resuspension of sediments that may be contaminated, and would also require the disposal of dredged materials." The FEIS anticipated that the Corps would elaborate upon this partial evaluation when it assesses impacts to fulfill its NEPA requirements related to the Federal navigation channel.

Subsequent to development of the ER and FEIS, the river between the VEGP site and the Savannah harbor has now been surveyed, which further defines the scope of any dredging needs (Savannah River Survey, Southeastern Marine 2008; EC 6.0 Testimony of Mr. David Scott). This river survey by Mr. Scott of Southeastern Marine (2008) provides detailed depth and width information for the river reaches between Augusta and the Savannah River harbor and identification of likely dredge sites and snag removal requirements. This new information allows further analysis of the scope of impacts of dredging, and this report provides an evaluation of the environmental impacts of the dredging project.

Scope of the Dredging Project

The need for dredging and snag removal in the Savannah River from the upper Savannah Harbor (RM 36) to the VEGP site (RM 149.4) has now been evaluated (Savannah River Survey; Southeastern Marine 2008; EC 6.0 Testimony of Mr. David Scott). Snag removal (removing trees and branches) from the navigation channel would be required to some degree over nearly the entire length of the channel. A total of 180 trees and 277 snags were located for removal and identified by tenth of river mile. In its 1976 EIS for dredging the Savannah River navigation channel, the Corps explained that trees and branches normally would be physically lifted from the water and replaced in shallow river areas outside the navigation channel (Corps 1976). The Corps stated its intent at that time to place such materials underwater in places such as the mouths of oxbows not used for navigation (Corps 1976 at 23). This standard practice would likely be used for this project, although the specific plans are not clear at this time.

Dredging, in contrast, was identified as needed at only eight locations. For these locations, the river survey estimated the depth, width, and length of excavation and the approximate cubic yards of dredged materials (Table 1) (Savannah River Survey, Southeastern Marine 2008; Testimony of Mr. David Scott). Over the entire 110 miles of river surveyed, only slightly more than one mile is estimated would need to be dredged in total. Thus, dredging would occur in less than one percent of the surveyed river. This estimate, even if refined somewhat at a later time, is quite different from the Intervenors' assertion of "… dredging of over 100 miles of the Savannah River…" (Intervenors' Motion to Admit New Contention, at 3), or their witness Dr. Hayes' estimation that 116 miles of river channel would need to be dredged, 140 acres of benthic habitat disturbed and about 2 million cubic yards of sediment would be removed per foot of deepening (Hayes Declaration, ¶9). Rather, the extent of dredging would be minimal. Also, contrary to Dr. Hayes' assertion, the survey indicates that only approximately 36,000 cubic yards of dredged material would have to be removed. Although this is only an estimate, and could change during any actual dredging, it represents the best information available, and makes clear that the actual magnitude of the project is clearly significantly smaller than the "sizable project" envisioned by Intervenors. (Hayes Declaration, ¶9). The 1976 Corps EIS notes that dredging operations would be done in summer or fall at lower flow periods, presumably still the approach (Corps 1976 at 21).

Table 1. Estimated Dredging Needed for Barge Access to VEGP

River Mile	Depth (ft)	Width (ft)	Length (ft)	Cubic Yards
51.3	2	90	800	5,333
66.2	2	80	700	4,148
89.7-89.8	2	120	800	7,111
97.7-97.8	2	60	900	3,111
111.4-111.6	2	120	600	5,333
121.6	2	90	500	3,333
128	2	50	400	1,481
140.7	2	90	1,000	6,667
			5,500	35,519

Review of the results of a detailed river survey conducted in 2008 shows the types of river habitat that would most likely be affected by the dredging at each river location (Savannah River Survey, Southeastern Marine 2008; Testimony of Mr. David Scott). It is notable that nearly all identified dredge sites are at the inside of river bends where sand bars form. These bars typically build up on the insides of bends as the outsides of bends are eroded (Rosgen 1996). The balanced erosion (outside of bend) and deposition (inside of bend) is the cause of meandering that is typical of freely flowing and un-diked rivers over time spans of decades to centuries. The dredging would likely remove some of the build-up of sand where these bars encroach on the channel. As noted in the 1976 EIS, some dredging would also likely remove mid-channel sand shoals at these locations (Corps 1976 at C-4).

This report assumes that the dredged material would be simply loaded on barges and transported downriver to either existing permitted disposal sites near the Savannah Harbor already operated by the Corps, or used by the Corps for fill where needed (such as beach replenishment) (EC 6.0 Testimony of Mr. Tom Moorer). This alternative is considered feasible because of the relatively small amount of material involved. If this option is chosen, there would be essentially no environmental impacts of material disposal in the project reach. In general, individual organisms removed with dredged sediment would be lost. However, avoiding depositing dredged material within bank would alleviate impacts to organisms located in existing, near-shore habitats.

Risk Factors

Several risk factors are pertinent to evaluating impacts of the dredging operation. The NRC FEIS states, generally, “impacts could include temporary loss of benthic habitat, disruption of spawning migrations, resuspension of sediments that may be contaminated, and would also require the disposal of dredged materials.” (FEIS at 7-20) None of these could have been evaluated in detail because the scope of the effort was not then known. Intervenors have raised possible related impacts on ecological “web dynamics, spawning success and population size of freshwater mussels, shortnose sturgeon (an endangered species), Atlantic sturgeon, striped bass, robust redhorse and other catostomids, catfish species and benthic organisms” (Joint Intervenors’ Motion to Admit New Contention at 6; Young Declaration, ¶11, ¶12). Also, benthic habitat destruction and water quality impairment are potential impacts (Hayes Declaration ¶7). According to Dr. Young, “previous dredging activities have been cited as a cause for the decline of numerous Savannah River fish” (Young Declaration, ¶12). Freshwater mussels are cited as especially vulnerable to dredging (Young Declaration, ¶12, ¶13). A risk not mentioned specifically by either NRC staff or the Intervenors is possible reduction of riparian flooding and related ecosystem effects due to channel deepening (Duncan and EuDaly 2003). As aptly stated by Intervenor expert, Dr. Hayes, the “extent of impacts depends partially on the size and duration of the operations and the areas of benthic habitat that will be disturbed” (Hayes Declaration, ¶8). Each of these risk factors can now be evaluated in the context of the likely dredging and clearing operations, as actually defined in Table 1. They are evaluated in the order raised by the NRC staff and the Intervenors.

Loss of Benthic Habitat

There are two forms of benthic habitat that would be temporarily disturbed by the proposed maintenance of the navigation channel. These are (1) bottom sediments such as sand and mud that would be removed, and (2) solid substrates in the form of logs and branches (woody debris) that form the “trees and snags” that would be removed from the navigation channel and placed in other areas. Freshwater mussels and other surficial or buried invertebrates that occupy the dredged substrate or disposal zones could be directly killed, as has been documented in other dredged waters. Habitat for inhabitants of woody debris could be lost or simply displaced, depending on where the debris is placed. Any extensive loss of either form of habitat could have repercussions through the fish community that depends on benthic organisms for food. The important questions for this risk factor are the specific habitats to be dredged or removed, the amount of each habitat that would be affected, where the materials would be relocated and how long the disturbance would last.

Bottom sediments

The bottom sediments to be removed by dredging appear to be in sand bars and shoals that are typically sparsely populated by benthic organisms. The detailed survey of the river reach proposed for maintenance (Table 1) and the sites identified for dredging (Savannah River Survey, Southeastern Marine 2008; Testimony of Mr. David Scott) indicates that the specific locations are mostly in deposition zones at the insides of bends. Despite the flood control imparted by multiple dams in the Piedmont province, natural and man-made flood surges, mainly in spring, keep these depositional bars and shoals active. It has long been understood that these depositional habitats in rivers contain less varied inhabitants than the erosional habitats with more stable substrates (Hynes 1963 at 36). The shifting substrate itself limits animal colonization. Depositing silt, mud, and sand are unsuitable substrata for algae, and the main foodstuff available is the silt itself, dead leaves, and other decaying organic matter. Slower current and organic deposition often causes deficient dissolved oxygen within these sediments and along the sediment-water interface.

The macroinvertebrate composition of depositional areas in the Savannah River subjected to maintenance dredging has been described in one study, which may be indicative of biota and impacts here. A survey of the macroinvertebrate community in the Savannah River downstream of Richard B. Russell Lake, Georgia and South Carolina, was conducted in October 1989 (Miller and Bingham 1991). The purpose was to collect data on benthic organisms prior to maintenance dredging in depositional areas of the river immediately below the dam. The macroinvertebrate fauna in this habitat of the Savannah River was dominated by oligochaete worms (64.8 percent) with lesser numbers of chironomid (midge) larvae (10.7 percent), the phantom midge *Chaoborus* sp. (8.1 percent), and bivalve molluscs (9.0 percent). Macroinvertebrates other than these groups were uncommon (3.8 percent) and consisted mainly of Trichopterans (caddisfly larvae *Crynellus fraternus* and *Oecetis* sp.), the Megalopteran *Sialis rotunda* and the burrowing mayfly, *Hexagenia* sp. Total macroinvertebrate density at six stations ranged from 237.3 to 2,480.0 individuals/sq m. Sixteen species of Chironomidae were identified; species diversity (2.05) and evenness (0.74) were moderate for this group. Fourteen species of oligochaetes were identified; species diversity (1.48) and evenness (0.56) were substantially less than for Chironomidae. The fauna of the depositional areas of the river downstream of the Vogtle site, both in zones to be dredged and zones for disposal, are likely similar.

Thus, the impacts on the sediment-dwelling community of the river are likely to be slight except for the immediate areas of dredging where some organisms will be removed along with the sediment (estimated at slightly more than one mile of river length in a reach 110 miles long). The riverine habitat consisting of sandy substrate will remain. Dredging on this scale and in this type of location will produce only local impacts that should not have any system-wide effects on benthic communities. Individual organisms withdrawn by dredging, including freshwater mussels of special concern to Intervenors (Young Declaration, ¶12, ¶13)(discussed further below) would likely result in loss of the organisms transported to downstream disposal locations. However, bottom areas in the navigation channel that are newly devoid of bottom organisms will likely be re-colonized rapidly by continual bottom transport of benthic sediments and by invertebrate drift (Williams 1980).

Woody Debris (snags)

In coastal plain rivers with limited amount of hard substrate, the majority of macroinvertebrates tend to occupy the solid surfaces of woody debris (Benke et al. 1984, 1985). For example, the Satilla River in southeastern Georgia studied by Benke and colleagues is a low gradient coastal plain stream with large quantities of woody debris (snags) along its banks. It appears to be similar to the Savannah River between VEGP and Savannah Harbor proposed for maintenance. The relative importance of the snag habitat as a site of invertebrate production was compared to benthic habitats. This was accomplished from quantitative sampling of invertebrate habitats, analysis of drifting organisms, and gut analyses of the major fish species. Invertebrate diversity, biomass, and production were higher on snag surfaces than in either sandy or muddy benthic substrates. Although snags represented a relatively small habitat surface (4% of total habitat surfaces), snags supported 60% of total invertebrate biomass and 16% of the production for a stretch of river. Drift densities from night samples collected throughout the year were relatively high, and approximately 78% of drifting invertebrate biomass originated from the snags. Four of the eight major fish species obtained at least 60% of their prey biomass from snags, although all species utilized snags to some extent. The authors concluded that management practices involving permanent wood removal (snagging) from rivers such as the Satilla could be harmful to the invertebrate community and consequently to the several fish species, particularly sunfishes, that depend upon them. They opined that return of woody material to previously snagged streams may help restore their natural levels of animal productivity, however.

There is an extensive scientific literature of a similar nature that corroborates the importance of woody debris as a substrate for invertebrate production in coastal plain streams, e.g., Dudley and Anderson (1982). Smock et al. (1985), Benke and Meyer (1988), Sites and Benke (1989), and Benke (1993).

If the Corps follows prior accepted practice and simply moves snags to locations outside the navigation channel (Testimony of Mr. Tom Moorer), there would be little or no permanent loss of woody debris. Some organisms would likely wash off branches in the process of moving, and enter the normal invertebrate drift. Others could remain attached. The temporary displacement of invertebrates attached to woody debris would be rapidly replenished by normal stream processes. Authors cited above have demonstrated that woody debris and other solid substrates are colonized rapidly by invertebrates. This is accomplished largely by invertebrate drift, the general phenomenon whereby invertebrates disperse by leaving the substrate, drifting in the currents, and reattaching to a suitable substrate downstream (e.g., Williams and Hynes 1976, Williams 1980, Stites and Benke 1989). The usual method for evaluating macroinvertebrate population status in the Savannah River has been to use artificial solid substrates (usually Hester-Dendy multiple-plate samplers) on which invertebrates that colonize them are assayed after several weeks of submersion (e.g., Specht et al. 1983; O'Hop et al. 1986). The overall conclusion of these monitoring studies is that a highly diverse community of macroinvertebrates lives in the Savannah River on submerged hard substrates.

Critical information for evaluating the impact of the proposed navigation channel maintenance on invertebrate production of woody debris includes the percentage of the existing woody debris that would be removed, where it would be placed, and how long the snags would be gone. The proposed navigation-channel clearing likely will involve only a small percentage of the existing woody debris in the 110 miles of river, assuming that only snags in the navigation channel would be affected (Corps 1976 at 37). Although some attached invertebrates would likely be washed off the snags during removal, the snags would generally be moved to in-river locations where they would still be submerged and productive of invertebrates (Corps 1976 at 23). New woody debris would soon be recruited and rapidly be recolonized by drifting invertebrates.

Thus, the impact to benthic communities on woody debris and the high contribution of this substrate to aquatic productivity of the Savannah River is expected to be slight and temporary. These communities would not be significantly affected by moving snags and trees outside the navigation channel on the scale suggested in the dredging survey, which represents only a portion of the total of such material in the river.

Disruption of Spawning Migrations

There should be little or no impact on fish spawning migrations. Spawning migrations of anadromous fish (shortnose sturgeon, blueback herring, American shad, skipjack herring) occur in spring when river flows are high. In contrast, the Corps' procedures for dredging and snag removal are generally timed for summer and fall when river flows are lowest and fish spawning is least frequent. (Corps 1976 at 21).

Disturbance and Transport of Contaminated Sediments

Dredging will inevitably stir some bottom sediments into suspension. This increases turbidity locally and, where sediments contain contaminants, increases the liklihood that the contaminants could re-enter the water.

Increased Turbidity

The most common feature of dredging and snag removal is a temporary increase in turbidity in the water (Johnson and Pachure 1999). The stirring of bottom materials by dredge booms collecting sediment or grappling hooks raising snags will inevitably cause silt and organic matter to be suspended. Some material, including some attached organisms, will wash off woody debris as it is moved.

There is general consensus and scientific study results (Biggs 1967, as cited in Corps 1976 at 22; Johnson and Pachure 1999) that this increase in turbidity is temporary while suspended materials quickly settle. Furthermore, the Savannah River is typically moderately turbid (Paller and Saul 1996; ANSP 2001) so the change would not be significant. Additionally, the relatively small scope of the dredging project confirms that impacts of temporary increases in turbidity would not be significant.

Contaminated Sediments

The Intervenors cite a reasonable example study (Bellas et al. 2007), which demonstrated the spread of contaminants from a dredged site in Sweden. Other examples could be cited from the U.S. The important question for this risk factor in the Savannah River is whether the sediments to be dredged are contaminated.

Recent studies suggest that they are not contaminated. The Savannah River at Risk Study (SNSA 2008) sampled and analyzed representative sediments from three areas between the VEGP and Savannah Harbor: RM 148 just downstream of VEGP, RM 119 just upstream of the Hwy 301 bridge, and RM 61 just upstream of Hwy 119 bridge. Samples were analyzed for a suite of 74 metals, mercury, herbicides, pesticides, and PCBs. Their Table 2-5 (page 12) provides a full list of materials analyzed and methods used, while their Table 3-4 provides results for materials that exceeded state/federal clean water limits. At the stations downstream of Vogtle, mercury (all 3 stations) and zinc (RM 61) were the only detectable contaminants. The mercury exceedences were due to the low Georgia chronic exposure limit of 0.012 µg/L (the South Carolina limit of 0.91 µg/L was not exceeded). Zinc at RM exceeded the South Carolina chronic and acute limit of 37 µg/L by 3 µg/L but not the Georgia limits of 65 µg/L. Thus, the level of contamination of these representative sites in the river reach in question is very slight, and limited mainly to very low levels of mercury, which is increasingly ubiquitous. The disagreement between South Carolina and Georgia over justifiable limits exemplifies the uncertainty regarding hazards of mercury and zinc at low levels. The low levels of contaminants if sediments downstream of the Vogtle site were substantiated by studies there of levels in fish, which were similar to, or lower than, those for the United States generally, with no threat to consumers (Burger et al. 2002).

It would be incorrect to assume that levels of sediment contamination previously identified in the vicinity of the Savannah Harbor also occur in the upriver areas to be dredged for this project. The low levels of contaminants found in the sediments at the three mid-basin sites by SNSA (2008) are very different from levels in the lower river and its distributaries near Savannah. The Corps currently maintains the lower reaches for navigation with dredging and dredge-disposal areas. Twenty-six sites within Savannah Harbor and Back River were found to have sediments toxic to aquatic life (Winger and Lasier 1995). These results were confirmed in an expanded study of Front River, Back River, an unnamed tidal creek on Back River, and Middle River of the distributary system of the lower Savannah River, including disposal sites (Winger et al. 2000). This information might be extrapolated inappropriately to the upriver Savannah River reaches proposed for selective dredging to accommodate navigation for Vogtle Units 3 & 4 construction.

On the basis of the highly intensive but not spatially extensive chemical analyses downstream of Vogtle and upstream of the Savannah harbor region, it is reasonable to conclude that the spread of contaminated materials in Savannah River sediments from the proposed dredging is a very low risk. The main uncertainty lies in whether the sites studied by the SNSA are truly representative of the actual sites to be dredged. There is little reason to believe that they are not representative. Additionally, the relatively small scope of the dredging project further mitigates the impact of this risk.

Ecological Web Dynamics

The limited spatial extent of anticipated dredging and the relocation of channel-blocking woody debris into non-channel portions of the river ensure that aquatic ecosystem effects are minimal on a river reach scale from Savannah Harbor to the VEGP site. Activity on the order of magnitude suggested by the river survey at locations where sand bars or shoals would be dredged would not be enough to influence ecologically important overbank flooding, as discussed by Duncan and EuDaly (2003 at 15). Local areas of mostly loose sand to be dredged (a few hundred feet in each location) will lose bottom-dwelling inhabitants. If sediments are barged downstream, then inhabitants would be lost, but recolonization of dredged bottom areas is expected to be rapid, based on general scientific knowledge of recolonization rates in streams (Williams 1980). Snags with many of their macroinvertebrate inhabitants in the navigation channel will be relocated to other nearby sites where they will still be available for fish feeding. Snags will not be removed outside the navigation channel, thus preserving the vast majority of the woody debris habitat in the river. Invertebrates washed off snags as they are moved will enter the invertebrate drift (a natural phenomenon) and become available for feeding by fish. Turbidity may temporarily limit the feeding ability of sight feeding fish, but experience has shown that fish tend to be attracted to turbid plumes in search of entrained invertebrate food. Thus, although there may be some temporary (hours to a few days) effect on food web and other ecological dynamics, the impact should be local and slight.

Spawning Success and Population Size of Aquatic Life

The Intervenors listed several species for which they believed spawning success and population size could be affected by the proposed channel maintenance (Joint Intervenors' Motion to Admit New Contention at 6; Young Declaration, ¶11, ¶12). These included "freshwater mussels, shortnose sturgeon (an endangered species), Atlantic sturgeon, striped bass, robust redhorse and other catostomids, catfish species and benthic organisms."

Freshwater Mussels

Freshwater mussels are a common but declining component of the aquatic fauna in the Savannah River near the Savannah River Site (ANSP 2001) and presumably in the entire reach of fresh water from the VEGP to Savannah Harbor. As a group, they are found in all habitats and substrates to some degree, with different species prominent in different areas. Tabulated species lists from 1951 to 2000 indicate 16 species in early years but only 8 in the latest survey. The ANSP used primarily hand collecting in shallow water, and thus found most mussels in backwater areas, especially in deeper troughs. Other bivalve species included the Asian clam *Corbicula*, and several species of fingernail clams and pea clams. Heavy competition by *Corbicula* was identified as a likely cause of mussel decline, along with extended periods of low river flows. The taxonomically oriented survey provided incomplete information on specific habitats used.

The occurrence and habitat associations of freshwater mussels were studied recently in the nearby Pee Dee River basin (Savidge 2006). The introduced Asian clam, *Corbicula fluminea*, was found at all survey sites and was the most common bivalve found (too numerous to count). In the floodplain reach, mussels (mostly *Elliptio* species) were abundant in deep (10-20 ft), sandy runs and troughs typical of the main channel or cuts. These are not characteristics of the habitats proposed for dredging in the Savannah River. Mussels were generally scarce in slack water (6 ft) adjacent to the main channel that contained much woody debris (probably similar to the possible disposal areas). Sandy, deep troughs at the bases of banks (often at the outside of bends) contained numerous mussels. Mud-bottomed runs contained few mussels. In shallow sites (to 5 ft) with sandy bottoms, mussels were present but not abundant. In sites at river bends, where the inside of the bend side slopes gradually to a deep trough at the outside of the bend, mussels were found throughout, but mostly in the deep trough. Shifting sand bars along or in the channel were not well colonized by mussels. There was considerable habitat partitioning by species at all sites sampled.

Based on this detailed study, which exceeds those found for the similar floodplain reach of the Savannah River, the proposed dredging and snag removal is unlikely to have any major impact on population size of freshwater mussels. Localized losses of some mussels can be expected. A small percentage of the river is to be dredged. The specific sites to be dredged contain some mussels but are not those habitats where mussels are particularly abundant. The habitats used by a variety of species will continue to occur in most of the river reach.

Fish

Spring spawning migrations of anadromous fishes (shortnose sturgeon, Atlantic sturgeon, striped bass) would not be disrupted by the channel maintenance activities that are conducted in summer and fall (as discussed above).

Shortnose sturgeon spawn in rocky reaches of shoals near Augusta ("Augusta Shoals"), upstream of the VEGP site where the spawning would not be affected by dredging in the lower river (Hall et al. 1991). Atlantic sturgeon have similar requirements for rocky substrate and swift current and would likely use only the same rocky shoal habitat (Smith and Clugston 1997). Young sturgeon migrate rapidly through the areas to be dredged and cleared on their way to occupy a nursery area near the coast. Local turbidity increases would not cause any reduction in food supply or ability to feed. There may be some temporary loss of feeding on bottom organisms in the local areas dredged, although dredge sites would not be in the existing channel bottom where sturgeon feed (rather sand bars and sandy shoals). The temporary loss may be balanced by the dislodging of bottom organisms which would become temporarily more available for the bottom-feeding scavengers. Thus, there should be no population-level impacts to shortnose sturgeon.

Striped bass spawning and early life stages would not be at risk. Spawning occurs primarily in the lower river and tributaries (e.g., Little Back River) somewhat upstream from the salt-water interface and downstream of the lowermost proposed dredging site (Dudley et al 1977; Van Den Avyle and Maynard 1994). Early life stages (eggs and larvae) drift in the lower river and distributaries. After spawning, adults disperse in the river, spending most of their lives in the fresh water river, and could be in the area of dredging in summer and fall. The highly predaceous striped bass adults and juveniles would likely consume some of the small fish or large invertebrates (except mussels) displaced temporarily by the short-term dredging and snag relocation.

The robust redhorse is of interest because of its conservation status (Nichols 2003). It has not been identified from the reach of the Savannah River where the dredging is proposed, although spawning aggregations have been studied at the Augusta shoals upstream between RM 174 and 180 (Grabowski and Isely 2006, 2008). The sandy river substrate conditions in the reach proposed for dredging do not meet the criteria recognized for suitable spawning habitat (Freeman and Freeman 2001). Despite the fairly large numbers of the species that congregate for spawning in the gravel shoals, the population in the lower Savannah River is believed to be small with a low abundance of adults (Grabowski and Isely 2008). Spawning success at the Augusta shoals would not be affected by the down-river dredging. It is likely that some of the spawning population at the Augusta Shoals disperse in the lower river where, as bottom dwellers, they might be affected to a small degree by some of the temporary and localized dredging activities.

Other catostomids (suckers) are also shallow bottom dwellers in large river environments. They include the carpsuckers (*Catostomus* species), spotted sucker (*Minytrema melanops*), and Northern hogsucker (*Hypentelium nigrans*) (Grabowski and Isely 2007).

All appear to be present in the vicinity of VEGP (Paller and Saul 1986; ANSP 2001; Marcy 2005). They occur primarily in backwater habitats (Paller and Saul 1986; ANSP 2001), which would not be subject to dredging or snag removal. Displaced fish would likely quickly return.

Suckers generally require hard surface, gravel substrates for spawning, which are not common in the river between VEGP and Savannah Harbor. Probably for this reason several species of catostomids spawn in the Augusta shoals downstream of Augusta, Georgia (Grabowski and Isely 2007). The suckers partition their spawning in space and time to avoid disrupting each other's spawning. Because this occurs well upstream of the reach to be dredged, there should be no impact on reproduction. The young fish then must disperse throughout the lower river.

Other fishes of backwater habitats include a variety of sunfishes, minnows, and silversides, which comprised 74% of fish collected at Savannah River stations near the Savannah River Site as well as gizzard shad (ANSP 2001). Paller and Saul (1986) found the most abundant species (excluding minnows) in backwater and shore areas of the Savannah River near the SRS to be redbreast sunfish (41.6%), spotted sucker (8.8%), spotted sunfish (8.2%), largemouth bass (5.75), bluegill (5.6%), and American eel (5.4%). With abundant backwater habitat available outside the navigation channel, reproduction and populations should not be affected except locally and temporarily.

Catfish species include the widespread small catfishes in woody debris of channel margins and backwaters (speckled madtom, white catfish, flat bullhead) and channel catfish found in the river channel (Paller and Saul 1986; ANSP 2001). Removal of snags and other woody debris from the channel and relocation to channel margins and backwaters would likely entail displacement of the catfish fauna that inhabit them, with little loss of individuals or effects on the populations. Snags in the channel that are slated for removal are less likely than backwater debris to have such a fauna initially. Channel catfish also reproduce in backwater areas and not in the channel areas to be dredged, and should see no widespread or lasting effects on reproduction or population size.

Boat electrofishing in and along the channel indicated the presence of other species not generally seen in the backwater areas. These included American shad, blueback herring, threadfin shad, bowfin, Florida gar, bannerfin shiner, striped mullet and yellow perch (ANSP 2001). Species found only in the channel (where they would be vulnerable to the channel dredging) were channel catfish, dusky shiner, yellowfin shiner, tailgate shiner, and blackbanded shiner. These highly developed swimmers could avoid the dredge and return when dredging is completed. The sandy dredged sites are not likely to be sites of reproduction. Populations are unlikely to be reduced by the temporary displacement.

Conclusions

With dredging limited to a few discrete areas of the Savannah River in the 110-mile reach between VEGP and Savannah Harbor, impacts of these activities on aquatic life will be localized and temporary. Sandy bottom sediments with generally low abundance of organisms would be directly affected.   Instead of relocating these spoils to backwater areas where they would cover existing sediments dredged sediments may be barged downriver to permitted disposal sites or other areas needing fill, so impacts would be insignificant. Sediments in the project reach of river are not expected to be contaminated, so substrate disturbance will not spread contamination to water and other bottom areas. Short-lived turbidity plumes from dredging and possible material disposal will rapidly settle with no lasting effects on the normally turbid river. Snag removal will be more pervasive than dredging, but will still affect only a portion of the overall woody-debris habitat. In any event. this woody debris likely will be relocated to non-channel, underwater locations nearby, thus preserving most of the ecological benefit of this important substrate for aquatic insects and fish food (Testimony of Mr. Tom Moorer). Invertebrates will rapidly re-colonize any depopulated areas. Mussels that are abundant in deep channel locations will not be dredged. Operations would be undertaken in summer and fall when river flow is low after completion of spring fish migrations to zones upstream of VEGP. Fish will have the ability to move away from the disturbances of dredging and material disposal and are likely to rapidly re-colonize affected areas.

Overall, the impacts of dredging and snag removal operations on the scale suggested in the survey are expected to be localized and not biologically significant on a broad scale of geography or animal populations of the 110 miles of the Savannah River, and should be considered small on the scale of impacts used by the NRC.

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