DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2288
MOBILE, AL 36628-0001

REPLY TO
ATTENTION OF

July 11, 2008

Inland Environment Team
Planning and Environmental Division

Ms. Gail Carmody
Field Supervisor
U.S. Fish and Wildlife Service
1601 Balboa Avenue
Panama City, Florida 32405

Dear Ms. Carmody:

Reference is made to the Biological Opinion on the U.S. Army Corps of Engineers, Mobile District, Revised Interim Operating Plan for Jim Woodruff Dam and the Associated Releases to the Apalachicola River, issued by the U.S. Fish and Wildlife Service on June 1, 2008. In accordance with Reasonable and Prudent Measure Number 2008-5, and Terms and Conditions 7.4.5.b, 7.4.5.c, and 7.4.5.d we are hereby submitting updated study plans for estimating mussel take, estimating the depth distribution of listed mussel species, and a plan of study which will focus on the life history, movement and habitat for the listed mussels on the Apalachicola River, Chipola Cutoff, and lower reaches of the Chipola River (The Action Area).

The enclosed plans were developed in coordination with your staff and the U.S. Army Corps of Engineers, Engineering Research Development Center, Environmental Laboratory staff. However, the plans are considered provisional pending approval of your agency. We will continue to work closely with your staff to make any necessary refinements to the enclosed plans, and will implement elements of the enclosed plans as soon as practicable, depending upon available resources and flow conditions. As noted in the study plan for Term and Condition 7.4.5.d, portions of the proposed data collection would be collected in conjunction with the mussel depth distribution study - Term and Condition 7.4.5.c.

If you have any questions or suggestions for further refinements to the enclosed plans of study, please contact Mr. Brian Zettle at (251)-690-2115 or email at brian.a.zettle@usace.army.mil

Sincerely,

Curtis M. Flakes
Chief, Planning and Environmental
Division

Enclosures

RPM 2008-5, Condition b, Listed Mussels
Incidental Take Monitoring
Methodology

Sample Site Selection Protocol

The USFWS provided recent listed mussels observation data (1990-present) that included approximately 370 records. Records included multiple transect-base observations within sites visited on a single date as well as multiple visits to a site on different dates. In addition, the USFWS and Corps have completed efforts to map all potentially suitable fat threeridge habitat on the mainstem Apalachicola River and the USFWS is currently completing efforts to map all potentially suitable fat threeridge and Chipola slabshell habitat in the Chipola Cut and Chipola River downstream of the Cut. A total of 116 fat threeridge habitat sites were identified in the mainstem river and preliminary data suggests that an additional 50-60 sites suitable for fat threeridge and Chipola slabshell may exist in the Chipola Cut and Chipola River downstream of the Cut. Due to the large number of sites supporting listed mussels, only a portion of these sites will be monitored for incidental take and an estimate of the total amount of incidental take will be calculated using the relationship between the monitoring data and the density and the area and locations of listed mussels habitats. The site selection protocol is described below.

GIS Map Analysis: The USFWS has provided satellite imagery and shape layers for the known and potentially suitable habitat sites of fat threeridge and purple bankclimber in mainstem Apalachicola River. This data includes 116 fat threeridge sites and 14 purple bankclimber sites. In the near future, the USFWS will be providing additional satellite imagery and shape layers for known and potentially suitable listed mussel species habitat sites in the Chipola Cut and Chipola River downstream of the Cut.

It should be noted that several of the fat threeridge sites also include purple bankclimber or Chipola slabshell observations. These sites will be included among monitoring sites selected for each species. However, for the purposes of counting known or potentially suitable sites for each species, this overlap was ignored.

Fat Threeridge: Due to the high number of known fat threeridge sites (116 in the mainstem and potentially another 50-60 in the Chipola Cut/River), a stratified random sampling technique will be employed to survey a representative sample of these sites. Based on discussions with USFWS and ERDC, it was determined that a minimum of 15% of the fat threeridge sites should be monitored in order to provide a representative sample. Furthermore, because the largest fraction of the fat threeridge sites occur in the RM40-50 reach (including the Chipola Cut/River), it was determined that at least 40% of this effort would be allocated to the RM 40-50 reach; with the remaining sites being split between the reaches above RM50 and below RM40.

In order to provide a more robust data set for estimating take, we propose a selection of 20-25% of the total fat threeridge sites for incidental take monitoring. Specific sites will be selected by a random number generator in Microsoft Excel software based on the

unique site numbers provided by USFWS. As described above, 40% of the fat threeridge monitoring effort will be conducted in the RM 40-50 reach (including the Chipola Cut/River); with the remaining sites being split between the reaches above RM50 and below RM40. It is likely that several of the fat threeridge sites selected will also include purple bankclimber and/or Chipola slabshell sites. These sites will be included among the selected monitoring sites for those species.

Purple Bankclimber: The rock shoals near RM105.5 represent a particularly interesting purple bankclimber site in the Apalachicola River not only due to the relatively large numbers that can be found there, but also because it represents one of the only known purple bankclimber sites in the upper river where these mussels are observed at depths less than 3 feet deep when river flows are approximately 5,000 cfs. Therefore, this site is particular important for incidental take monitoring and thus will constitute the majority of the purple bankclimber incidental take monitoring. Additional sites will include those that occur at sites randomly selected for fat threeridge incidental take monitoring.

Chipola Slabshell: A portion of the Chipola slabshell sites identified within the action area will be monitored. The portion of sites selected will depend in part on the total number of sites identified by the UFWS known to support this species. However, at least 15% of these sites will be selected. It is likely that some of the Chipola slabshell sites will be included in sites randomly selected for fat threeridge incidental take monitoring.

Mussel Survey Protocol

We propose the following standard survey protocol for use at each of the sites. The incidental take monitoring protocol consists of a Catch Per Unit Effort (CPUE) technique, with effort determined by site length along the shore rather than a timed effort. The length of each site has been determined in previous efforts and represents the distance from the upstream GPS coordinate to the downstream GPS coordinate. This approach was based on discussions with USFWS and ERDC that determined sampling a portion of the known habitat as measured by length of shore (and area of recently exposed river bottom) was most appropriate for estimating the numbers of mussels exposed by a flow reduction.

The width of the search area among sites even within a limited river reach typically varies due to bank slope topography (i.e., steeper sloping topography results in a smaller band of exposure due to a reduction in discharge). At a larger spatial scale, the reduction from 5,000 to 4,5000 cfs flow affects water surface elevation differently in the upper, middle, and lower reaches. In the narrower upper reach, greater drop in water surface elevation will be observed. In the wider middle and lower river reaches, this drop in water surface elevation will be smaller.

A GPS unit will be used to locate the upstream and downstream limits of each mapped site and a measuring tape will be used to measure the width of the wetted area just prior

to the reduction in flow. Generally, algae and trash lines clearly mark the previous shoreline at each site and the width is measured from this demarcation to the current shoreline once the reduction in stage has occurred. The entire survey area will be searched for exposed listed mussel species and the number and condition (live, fresh dead, predation) of the observed listed mussels was recorded. Notes will also be taken regarding the presence of other native and non-native mussel species in the survey area and observations of mussels in the inundated habitat immediately offshore of the survey area.

Take Estimation

The initial estimate of numbers of mussels exposed by the reduction in flow will be calculated using the relationship between CPUE and density and the area and locations of listed mussels habitats.

RPM 2008-5, Condition c, Listed Mussels
Depth Distribution Survey Design

Introduction

Paragraph 7.4.5, Monitoring (RPM 2008-5), of the June 1, 2008 Biological Opinion on the Revised Interim Operations Plan (RIOP) for Jim Woodruff Dam and the associated releases to the Apalachicola River includes the following requirement under Condition "c":

"*By July 15, 2008, the Corps shall update its previous study plans for estimating the number of listed mussels present in the action area at 0.1-ft elevation intervals between the stage that is equivalent to a release of 5,130 cfs from Woodruff Dam and an elevation that is 3 ft lower than that stage. The Corps will implement this study plan as soon as practicable thereafter when flow levels permit an effective sampling of this range of stages.*"

In general, there are only minor revisions to the previous plan. Based on new habitat site data and discussions with USFWS, the following depth distribution survey is proposed.

Since most of our knowledge about mussel habitat preferences and suitability is limited to one species, the endangered fat threeridge mussel (*Amblema neislerri*), the depth distribution survey will focus on fat threeridge habitat and impacts to this species. However, several specific surveys and incidental data on Chipola slabshell (*Elliptio chipolaensis*) and purple bankclimber (*Elliptoideus sloatianus*) will be recorded and inferences can be made as appropriate regarding these species.

In December 2007 the USFWS and Corps completed efforts to identify and map fat threeridge habitat on the Apalachicola River. In July 2008 the USFWS completed fat threeridge habitat mapping in the Chipola Cut and Chipola River downstream of the Cut. Habitat identification was based on the observation of several habitat characteristics that appear to be strongly correlated to fat threeridge mussel presence. These characteristics include moderately depositional areas associated with eddies; stable banks with a gentle slope (<15°); and a firm silty-sand mixture substrate. In general, these sites also tended to support willow trees of various ages along the banks and occurred immediately up or downriver of point bars. A total of 116 sites were identified as potentially suitable to support fat threeridge between RM 24 and RM 105 on the Apalachicola River. At each site an upstream and downstream terminus was recorded with a GPS unit, and the presence of fat threeridge was confirmed at most sites. The USFWS has not completed the habitat mapping effort to identify potentially suitable fat threeridge habitat in the Chipola Cut and Chipola River downstream of the Cut. However, this effort will be completed soon and initial mapping suggests that an additional 50 to 60 sites may be present in this reach.

In October 2007, the USFWS conducted a detailed depth distribution study at 11 randomly selected sites known to support fat threeridge between RM40 and RM50 to assess the effects of water level declines on the fat threeridge population. The methodology for this study serves as the basis for the design of the new depth distribution study described below.

Site Selection

Due to the large number of fat threeridge sites, only a portion of the 116 sites in the Apalachicola River and a portion of the sites in the Chipola Cut and Chipola River downstream of the Cut will be surveyed in order to estimate the density of fat threeridge mussels at depth. Generally, a random sampling of approximately 15-20% of the available habitat is adequate to estimate trends regarding habitat use. Therefore, approximately 20% of the available sites in the Action Area will be randomly selected for the study. In order to ensure that 40% of the sites surveyed occur in the RM40-50 reach and Chipola Cut/River, a stratified random sampling technique will be used. 30% of the total number of sites will be selected from the reach above RM50, 40% will be selected from the sites occurring between RM40-50 (including sites within the Chipola Cut and Chipola River downstream of the Cut), and the remaining 30% will be selected from sites below RM40. Approximately 26 sites have been identified as supporting fat threeridge between RM40 and 50 on the Applachicola River. The USFWS has not completed the habitat mapping effort to identify potentially suitable fat threeridge habitat in the Chipola Cut and Chipola River downstream of the Cut. However, this effort will be completed soon and initial mapping suggests that an additional 50 to 60 sites may be present in this reach. Sites randomly selected for study in the RM40-50 reach will consist of sites that were not sampled in the USFWS October 2007 survey effort. This allows for an adequate number of sites to survey in this reach without revisiting sites where mussel distribution was altered by previous sampling activity. Avoidance of these previously sampled sites should also facilitate an unbiased interpretation of net movements of mussels in this reach. All of the sites will be randomly selected using random number generator software.

In addition to a sub-set of the potential fat threeridge habitat sites, the rock shoals near RM105.5 will be surveyed to collect data on purple bankclimber habitat and depth distribution at this site. This site is particularly interesting as it represents one of the only known purple bankclimber sites in the upper river where mussels are observed at depths less than 3 feet deep when river flows are approximately 5,000 cfs. However, we believe that the majority of the purple bankclimber population at this site occurs at depths greater than 3 feet deep when river flows are approximately 5,000 cfs. Therefore, divers will be used to survey the rock shoals site to estimate the number of purple bankclimbers at this site and their depth distribution. The details of this sampling methodology are still being coordinated with USFWS and ERDC personnel. Although the final methodology has not been developed yet, the use of divers will be limited to three days.

Like the fat threeridge sampling methods, standard sampling techniques will be used at the rock shoals site, with the exception of using search by feel techniques rather than excavation techniques due to the substrate material.

The Chipola slabshell mussels occur in habitats identical to those supporting fat threeridge and the species cohabit at several locations in the Chipola Cut and Chipola River. The five sites in the action area known to support Chipola slabshell will also be surveyed to collect data on this species habitat and depth distribution. USFWS recently indicated that additional Chipola slabshell sites have been identified in the Action Area. Therefore, a portion of the known Chipola slabshell sites will be selected for study either as part of the sites selected for the fat threeridge effort or specific Chipola slabshell sites. The sampling techniques at these sites will be identical to that at the fat threeridge sites. Information collected during these supplemental surveys will improve our knowledge about potential habitat preferences and depth distribution for these two species.

Data Collection

At each site, transect lines will be marked and recorded with a GPS unit. Each site will have varying numbers of transects based on site length. However, transects will extend over the full length of each site. Transect placement will be standardized to one transect every 40 feet of site length. The first transect will be randomly located within the first 40 feet of the upstream end of the site and subsequent transects will be placed accordingly. The 40-foot spacing is based on discussions with USFWS and ERDC personnel and review of the site length and transect placement for the October 2007 USFWS sampling effort. During the October 2007 USFWS sampling effort, standard mussel sampling techniques for wading surveys were utilized. However, in an effort to improve efficiency and ensure that all mussel specimens in a quadrat are collected, the Service has approved the use of a small dredge to excavate quadrats rather than the traditional hand excavation technique. The Service recently purchased a dredge for this type of activity and has agreed to provide it for this effort. The dredge will be used to collect all mussels within a 0.25 m^2 quadrat that is moved continuously along each transect beginning at the water surface and working perpendicular to shore until a depth of three feet relative to a Wewahitchka gage (located immediately upstream of the Chipola Cutoff at RM 41.8) height of 11.03 ft (approximately 5,130 cfs flow measured at the Chattahoochee, Fl gage). All material within the quadrat will be excavated with the dredge in order to insure that all age classes within the quadrat are collected. Because the slope of these sites will vary, the total number of quadrats taken at each site will also vary. Due to the gradual depth changes and the large number of quadrats that occur on each transect in sites with flat slopes, it may be appropriate to sample only every other quadrat at these sites. The methodology for flat slope sites will be coordinated with USFWS prior to beginning the study. The depth at the center of each quadrat will be measured and recorded. The number and species of mussels as well as the total length of all listed species will also be recorded for each quadrat.

In addition to the quantitative mussel sampling, channel bathymetry between the water surface and a depth of 3 to 4 feet will be quantified at each of the fat threeridge and Chipola slabshell sites using standard survey equipment. Bathymetry data will be collected along the same transects sampled for mussels at each site. An additional transect will be placed at each end of the site in order to bracket the site. This measurement technique will involve measuring bed elevations relative to water surface elevation along multiple transects from the bank towards the thalweg. A "total station" and computer software will be used to compute how much area at the site would be exposed at 0.1-foot reductions from the surveyed water surface elevation between the shore and the maximum depth surveyed. A similar channel bathymetry survey will be conducted at the purple bankclimber site (rock shoals) between the water surface and a depth approximate to the deepest point surveyed for listed mussels.

The data from the habitat surveys and the listed mussel density estimates from the quantitative surveys will be used to develop a relationship between the numbers of listed mussels by depth.

Additional Studies

It is anticipated that replication of this study or a similar study on some regular basis (annual or semi-annual) will also provide additional data relative to several of the life history questions outlined in condition "d" of RPM 2008-5. Please reference the RPM 2008-5-d Plan of Study for a more detailed description of this effort.

Furthermore, to the extent feasible, additional data will be collected at each of the sites. This data may include additional age structure data on non-listed native species (*Glebula*) or marking of fat threeridge individuals (either all or a proportion). The details of this additional data collection will be further refined in close coordination with USFWS once resource limitations and other constraints have been identified.

RPM 2008-5, Condition d, Listed Mussels
Life History, Movement and Habitat Studies

PLAN OF STUDY

Term and Condition 7.4.5, Monitoring (RPM 2008-5), of the June 1, 2008 Biological Opinion on the Revised Interim Operations Plan (RIOP) for Jim Woodruff Dam and the associated releases to the Apalachicola River includes the following requirement under Condition "d":

"By July 15, 2008, the Corps shall update its previous study plans for: 1) identifying listed mussels age structure at various depths; 2) determining mussel movements in response to changes in flow using mark-recapture methods; 3) estimating age-specific survival rates; 4) estimating age-specific-fecundity rates; 5) identifying other anthropogenic factors that may affect mussel habitat; and 6) characterizing the habitat of the purple bankclimber and Chipola slabshell in the Action Area. The Corps will implement these study plans as soon as practicable thereafter".

The following sections describe general approaches to three major areas of study that include methods addressing each of the six topics presented by U.S. Fish and Wildlife Service (USFWS) in RPM 2008-5-d. To the extent practicable, the data collection described below will be collected in conjunction with the mussel depth distribution study submitted by the Corps in accordance with RPM 2008-5-c. The depth distribution study is scheduled to occur in August or September 2008 when Apalachicola River flows are approximately 5,000 cfs in order to assess mussel movement response to the temporary period of flows less than 5,000 cfs in November 2007. However, the specific time for initiating these additional efforts will be closely coordinated with USFWS.

I. Life-history/population monitoring *(RPM 2008-5-d-1,3,4,6)*

Annual or semi-annual population monitoring for threatened and endangered species will involve quantitative sampling along transects randomly distributed among sites previously determined to contain suitable habitat for each species. Several habitat factors will be measured or noted at each site: site length, substratum composition, bank angle, water depth (mean, median, variance, profile), geomorphological features, riparian condition, and prominent landuse; these data will be used to characterize macrohabitat features associated with each of the endangered species.

Individual quantitative samples will be collected by excavating substratum from within standard-sized quadrats along each transect. For each sample, water depth and elevation will be measured near the center of the quadrat prior to excavation of substratum. Substratum removed from the quadrat will be washed through a series of nested sieves to aid with collection of mussels.

Each Federally listed mussel collected will be identified, measured, and etched with an identifying mark. An additional mark will be etched at the margin of the right valve to denote the extent of growth at time of capture. Shells from deceased individuals will be collected, measured, and sectioned in the laboratory to estimate age. Data collected from these shells will be used to establish the relationship between age and shell length for Apalachicola River species.

Life-history studies of non-listed species often involve sacrificing numerous individuals to obtain estimates of total fecundity, reproductive condition, percentage of viable gametes and glochidia, etc. However, this option will be precluded or limited due to the endangered or threatened status of the species of interest in the Apalachicola River. Valves of each Federally listed individual will be gently pried open to visually determine sex and gravidity prior to being returned to the location where collected. General fecundity (number of viable glochidia) will be estimated through non-lethal means. SCUBA or snorkeling techniques will be used to search along the substratum for displaying gravid females. Gravid females will be carefully collected, placed in separate plastic bags, and transported to the laboratory. Each female will be held in aerated containers until all larvae have been ejected. The size of each female along with the number and condition of ejected larvae will then be recorded to develop a size (age)-dependent estimate of fecundity.

Data collected using the above methods will provide estimates of the following:

a) **Sex ratio** – visual examination of gonads. Estimates for "overall" as well as "age/size-dependent" (e.g., <75 mm and ≥75 mm) should be calculated.
b) **Size-at-sexual maturity** – size at which 50% or 100% of females are gravid.
c) **Age-at-sexual maturity** can be estimated once sufficient data exist to reliably regress age and size.
d) **Gravidity** – sexual maturity is assumed if a female is either partially or fully gravid at time of capture. Sampling must be conducted during the time of reproductive activity for each species. Data describing gravidity of females is used to determine reproductive timing, size-at-sexual maturity, and size-specific proportion of reproductively active females within the population.
e) **Growth** – etching the terminal boundary of a mussel's valve will allow confirmation of annual growth rings and growth patterns during subsequent recapture events. Growth between capture events can be directly estimated by measuring differences in shell length after recapture. However, annual growth rings, if confirmed, allow size-dependent estimates of age and also can be individually measured to estimate annual growth when recaptures occur at two- or more-year intervals.
f) **Population size/density** – quantitative data will be used to estimate density and variance of sampled populations. Size-specific (age-specific) analyses will be used to estimate overall recruitment, age-structure, and age-specific mortality for each population across all sites and at different depths.

g) **Associated habitat characteristics** – macrohabitat data collected at each site will be analyzed to elucidate whether consistent habitat associations exist among listed species of the Apalachicola River. Subsequent analyses of these data may indicate other river reaches that contain suitable habitat but have not been included in previous surveys (i.e., development and verification of a landscape scale habitat model).

II. Behavioral response to stranding *(RPM 2008-5-d-2)*

Many variables can affect the behavioral response and subsequent fate of mussels that become stranded as water levels fall. Substratum type, bank angle, rate of water level decrease, humidity, temperature, etc. probably all influence the response and mortality rates of stranded mussels. Designing a study to estimate how mussels respond to declining water levels will be challenging.

Experiments designed to separately evaluate effects of potentially confounding variables can be carried out using laboratory flumes, streamside channels, or artificial ponds. Although "rate of water level decrease" and "temperature" are probably most relevant to the Apalachicola populations, responses of mussels placed on both "sand" and "shoal" (stable) substrata will also be investigated. Experiments will elucidate whether behavioral responses of stranded mussels (burying, directional movement, no response) are random or predictable (e.g., *Amblema neislerri* stranded in sand at a bank angle typical of RM40-50 sites moves in a non-random manner toward the channel when water level recedes very slowly…or buries/moves in a random direction when water level recedes rapidly).

Field studies based on repeated observations of "normal" and "low-flow" movement of marked mussels could provide useful data. However, the resources required to repeatedly observe individual mussels in the field combined with the unpredictable variability of confounding treatment factors would make field studies logistically difficult.

III. Other anthropogenic factors *(RPM 2008-5-d-5)*

1. Effects of hydrology, hydraulic factors, and geomorphology

Population viability of freshwater mussels ultimately depends on stability, quality, and quantity of suitable habitat. Therefore the most important question concerning the future viability of endangered freshwater mussels in the Apalachicola River is: "How will management-related changes in hydraulic conditions affect the quantity and quality of mussel habitat in the future?"

Hydrologic modeling will be used to improve our understanding of how flow conditions within the Apalachicola River respond to spatially and temporally variable trends in precipitation (e.g., can spatially explicit precipitation estimates be used to predict hydraulic responses within the river?). Hydraulic modeling will be used in combination with population modeling techniques to ascertain how changes in water levels and flow rates might affect overall distribution and quality of mussel habitat.

Attempts will be made to identify hydraulic thresholds (e.g., shear stress and current velocity) based on empirical data describing past distribution and abundance of mussels. Hydrological and hydraulic models will also be used to examine potential longterm changes in geomorphology and any anticipated impacts on habitat suitability and population viability of listed species.

2. Pollution and toxicity

Soil, water, and tissue-toxicity tests will indicate concentrations of heavy-metals and other contaminants in freshwater mussels and their environment. Samples will be collected during annual or semi-annual population monitoring. Standard protocols will be followed for sample collection and processing. Tissue samples will be collected from several non-listed species (surrogates) to infer levels of contamination in listed species.

3. Historical hydraulic conditions and landuse patterns

Attempts will be made to determine historical trends in hydraulic flow, geomorphology, and landuse conditions in an effort to better understand how habitat factors have changed over time. Understanding historical (i.e., more natural) tendencies in hydraulic and geomorphological variability will allow a more informed evaluation of relative habitat change attributed to regulated flow management.

These study proposals are submitted in accordance with condition 7.4.5.d. of RPM 2008-5 and are considered provisional pending USFWS approval and permitting. All listed mussel studies will be further refined and conducted in close coordination with USFWS. Resource limitations and other constraints may influence the timing and scope of the proposed studies. However, consistent with RPM 2008-5 condition 7.4.5.d., the studies shall be implemented as soon as is practicable.