28 March 2008

RPM5, Condition 7.4.5.h.
Life History, Movement and Habitat Studies

PLAN OF STUDY

Term and Condition 7.4.5, Monitoring (RPM5), of the November 15, 2007 Amended Biological Opinion and Conference Report on the Exceptional Drought Operations (EDO) for the Interim Operations Plan (IOP) for Jim Woodruff Dam and the associated releases to the Apalachicola River includes the following requirement under Condition "h":

"The Corps shall develop information on the life history of the listed mussels to better inform future decisions about how to minimize the impact of anticipated take, especially take that results from reductions in minimum flows. Special studies to be funded by the Corps: 1) identifying 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 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 RPM5-h. 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 RPM5-f. The depth distribution study is scheduled to occur as soon as Apalachicola River flows return to 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 will be closely coordinated with USFWS.

I. Life-history/population monitoring *(RPM5-h-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 *(RPM5-h-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 *(RPM5-h-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.h. of RPM5 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 RPM5 condition 7.4.5.j., the studies shall be implemented as soon as is practicable.