CESAM-PD-EI 27 August 2007

MEMORANDUM FOR RECORD

SUBJECT: Jim Woodruff Interim Operations Plan Biological Opinion – RPM 4 and 5 Workshop

1. Representatives of the US Army Corps of Engineers, Mobile District (CESAM) met with Jerry Ziewitz of the US Fish and Wildlife Service (USFWS), Panama City Field Office, and specialists in the fields of fluvial geomorphology, riverine hydraulics, and malacology on 14-15 August 2007, to participate in a two-day sediment dynamics and channel morphology workshop. This workshop was a follow-up to a previous two day field reconnaissance inspection by the river specialist and malacologist to the Apalachicola River on 19-20 June 2007, to familiarize the participants with the river process and mussel habitat features. The purpose of the workshop was for the various experts to present the findings of their individual analyses of river sediment and geomorphological trends with respect to mussel habitat requirements; discuss the individual findings with the attendees of the workshop; and present their recommendations regarding the issues identified in Reasonable and Prudent Measures (RPM)4 and RPM5 of the Biological Opinion (BO), issued by USFWS on 5 September 2006. The following representatives participated in the workshop.

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Dr. Andrew Miller, Ecological Applications	850-878-7653
Dr. David Biedenharn, Biedenharn Group	601-636-3492
Dr. Michael Harvey, Mussetter Engineering, Inc.	970-224-4612, Ext. 103

2. The participants provided a brief introduction of themselves and then Mr. Zettle discussed the workshop agenda and provided a review of the workshop goals, the Jim Woodruff Dam Interim Operations Plan Section 7 consultation, and the requirements of the RPM's. The following summarizes the RPM4 and RPM5 issues addressed during the workshop:

RPM4. Sediment dynamics and channel morphology evaluation. Improve our understanding of the channel morphology and the dynamic nature of the Apalachicola River.

Rationale. The dynamic conditions of the Apalachicola need to be evaluated to monitor the zone at which take may occur and to identify alternatives to minimize effects to listed mussels in vulnerable locations. Both sediment transport and channel morphology need to be considered to provide a basis for predicting changes in morphology that may affect the relative vulnerability of mussels to take due to the IOP. The amount of mussel habitat and thus IOP-related take depends on channel morphology. This evaluation will inform alternatives that may be considered under RPM1 and RPM3.

a. In coordination with the Service, and other experts jointly identified, the Corps shall evaluate before March 30, 2007, (**extended to August 30, 2007**) the current status of sediment transport and channel stability in the Apalachicola River as it relates to the distribution of listed mussels and their vulnerability to low-flow conditions. The goals of the evaluation are to identify: 1) feasible water and/or habitat management actions that would minimize listed mussel mortality; 2) current patterns and trends in morphological changes; and 3) additional information needed, if any, to predict morphological changes that may affect the listed mussels. This evaluation shall be based on available information and tools and best professional judgment.

RPM5. Monitoring. Monitor the level of take associated with the IOP and evaluate ways to minimize take by studying the distribution and abundance of the listed mussels in the action area.

Rationale. Take needs to be monitored monthly to insure that the level of take identified in the biological opinion is not exceeded. As natural conditions change, the populations of the species need to be assessed and the amount of take evaluated relative to any new information. Since this is an interim plan and there will be additional consultations on the overall operations of the ACF project for flood control, water supply contracts, hydropower, and navigation, the monitoring information is needed to prepare the biological assessments for these future consultations.

b. In coordination with the Service, the Corps shall develop on or before March 30, 2007, (**extended to August 30, 2007**) a feasible plan to monitor listed mussels in the action area. The goals are to: 1) periodically estimate total abundance of listed mussels in the action area; and 2) determine the fraction of the population that is located in habitats that are vulnerable to low-flow impacts.

3. Dr. Biedenharn (riverine hydraulic engineer) provided a presentation outlining his observations and recommendations regarding a) current patterns and trends in morphological changes; b) possibly feasible water and/or habitat management actions that might minimize listed mussel mortality; and c) additional information needed, if any, to identify trends and/or predict future morphological changes that may affect listed mussels. Dr. Biedenharn's evaluation was based on the reconnaissance field trip conducted on the river in June and his review of the existing data provided by the Corps. Dr. Biedenharn's evaluation is provided in the Summary of Findings report he drafted (see enclosure). However, a brief summary of his observations and resultant discussions is provided below. For the purpose of discussion, the river was divided into three reaches similar to those adopted by USGS in their reports regarding river level decline and floodplain connectivity: Reach 1 (Upper reach) extends from the dam at RM 106 down to RM 78; Reach 2 (Middle reach) extends from RM 78 to RM 35; Reach 3 (Lower reach) extends from RM 35 to the mouth of the Apalachicola River.

- The flow regime has not changed significantly since the upstream dams were constructed. This is somewhat atypical since reservoirs generally reduce downstream flood flows and increase low flows. If the dam does not alter the flow regime significantly, then the effects of bed material retention may be more pronounced (i.e., bed degradation and channel widening).
- It appears that the primary impact of the construction of the upstream dams is trapping bed material sized sediments. However, it is unknown how much sediment is moving through the dam. The upper reach of the river provides evidence that a sediment deficit is occurring, but we don't know how large the deficit is. Bed degradation of 4-5 ft has occurred throughout the reach, but appears to have stabilized now. This reach is relatively straight with little sediment storage and appears to be locally controlled both vertically and laterally by limestone outcrops (natural toe protection). A sediment budget could be calculated for the river in order to assess the magnitude of the sediment deficit.
- It's interesting to note that the river slope remains fairly constant between the three reaches. The middle reach is a much more active meandering channel with a high sinuosity. Coincidentally, this reach has the largest erosion rates of the three. However, based on visual observations and cursory data review, this erosion appears to be part of the natural down-valley meander migration which is common to most meandering streams, and does not appear to be the result of some post dam system-wide adjustments such as degradation, aggradation, or channel widening.
- The middle reach has also degraded approximately 1-2 feet, but there is considerable sediment storage in this reach as evidenced by the large point bars. It appears that most of the dam induced channel degradation is limited to Reach 1.
- The processes responsible for the apparent increase in the percent of flow (25% to 34%) diverted at the Chipola Cutoff warrants further study. Dr. Harvey noted that a paper written by Odom in 1966 stated that approximately 35% of the flow was diverted down the Chipola Cutoff at that time. This flow of relatively "clean" water down the Chipola River may be contributing to sediment aggradation and past dredging efforts in the Apalachicola River between the cutoff and RM 35.
- Comparison of the USGS calculated 1941 and 2004 channel widths (based on treeline) indicate that channel widening is occurring throughout the river down to RM 20, and is especially prevalent in portions of the middle reach. Further analysis is needed to determine if these width increases are real, and if so, what the factors responsible for them are. It was also noted by Mrs. Brandt that some of the areas demonstrating the greatest increase in width appear to be associated with anthropomorphic impacts such as meander cutoffs or other navigation activities. Dr. Harvey noted that the relatively low erosion rates observed on the river do not support the theory of rapid widening. Perhaps some of the widening is a long-term result of snagging and removal of woody debris dams that were prevalent in the past.
- The lower reach is less sinuous and has been less impacted by bed degradation. Bed degradation in this reach is likely attributable to local meander cutoffs.
- It appears there is a correlation between good mussel habitat and the highly sinuous reach in the middle river. However, we must recognize that scale (macro, meso, micro, temporal, spatial) plays an important role in interpreting the impacts of river processes on mussels and their habitat. Mr. Farr noted that mussels represent a dynamic population in

a dynamic system and we must manage for the whole population and not just individuals. Isolated areas of mortality can and does occur, but may not be adverse to the population as a whole.

- Preferred mussel habitat appears to occur in the lower energy environments associated with the flow separation zones (eddies) in the transition between meander bends. However, the size and location of the eddy zones change with flow and through time as the meanders migrate though the floodplain. Eddies, and consequently mussel habitat, are constantly being destroyed and created through the natural process of meander migration. Based on the erosion rates and the movement of the bank lines, it appears that there is no net change in the amount of suitable mussel habitat over time.
- The mussel mortality sites at RM 44.3 and RM 43.6 appear to be the result of the natural migration of the channel and not some systematic channel changes. A discussion of whether or not the rate of change in the spatial extent of these habitats has been altered by water management decisions followed. The similarities in the pre- and post-dam construction period flow regimes suggest that this is not likely the case, but additional studies need to be conducted to verify.
- The mussel stranding in Swift Slough appears to be the result of deposition of sands from the river. It appears that a sand bar has moved to the entrance of Swift Slough and may be the source of the sediment. However, a more detailed analysis of this area is needed to establish the exact processes responsible for this situation.
- Dr. Biedenharn made the following recommendations regarding additional study efforts:
    - Perform eco-geomorphic assessment of the system to fully develop how the system has responded in the past and where it is today with emphasis on the connection between the morphology and mussel habitat;
    - Build a relatively simple 1D sediment continuity model (possibly SIAM) of the river. This would provide the big picture assessment of the entire river system below Jim Woodruff dam with respect to sediment continuity, channel stability, impacts of flow diversions, etc.; and
    - Build a 2D hydrodynamic model for selected reaches. This model could be used to link detailed hydrodynamic processes to the mussel assemblages.

4. Dr. Harvey (Geomorphologist) followed Dr. Biedenharn with a presentation sharing many of the same conclusions. A brief summary of further explanations or differences in opinion is provided below. A detailed description of Dr. Harvey's evaluation is available in the Summary of Findings report he drafted (see enclosure). Dr. Harvey utilized slightly different reach delineation as Dr. Biedenharn. Reach 1 (Upper reach) extends from the dam down to RM 78; Reach 2 (Middle reach) extends from RM 78 to RM 42; Reach 3 (Non-tidal Lower reach) extends from RM 42 to RM 20.

- In the upper reach, the bed has degraded about by about 5 feet near the dam and by about 2 feet at Blountstown and the bed material has coarsened, both of which are river responses that are consistent with upstream dam construction.
- It is unclear, based on field observations and the uncertainty associated with measuring treeline width of the main channel, if river widening reported by USGS has actually occurred in this reach (and others) or to the extent which has been reported. Analysis of the comparative bank lines does not indicate much lateral adjustment of the channel in

this reach. This is likely due to the presence of numerous limestone outcrops throughout the upper reach.

- Very little sediment storage occurs within this reach, except between RM 77.2 and RM 78.8 where annual dredging occurred in the past. The observed bed degradation and the limited amount of sediment stored in the numerous dike fields in the reach indicate that the reach was supply limited following construction of the dam.
- The middle reach of the river is very sinuous and the banks are composed of a mixture of cohesive and non-cohesive sediments that exhibit widespread erosion on the outside of bends. The very high sinuosity of the river in the middle reach appears to be the result of the river responding to active tectonics. The axis of the northeast –southwest trending Gulf Trough geologic structure crosses the Apalachicola River near the confluence with the Chipola River at about RM 27. The steeper valley floor (0.00018) on the down-dip side of the trough between about RM 78 and RM 35 requires the river sinuosity to be higher (1.92) to balance the river slope (0.000094) and thus the sediment continuity.
- The bed has degraded approximately 1 to 2 feet within the reach, but there is no evidence that the bed material has coarsened.
- The degree of channel widening reported by USGS for this reach was also questioned. Field observations indicate that bank erosion is limited to the outside of bends as expected for sand bed rivers. Comparative bank lines (1941, 1963, 1993, 1999, 2002) clearly indicate that the bends within the middle reach are migrating laterally and down-valley as a result of cutbank erosion and point bar deposition. The USACE previously reported that erosion rates were highest where the radii of curvature of the bends were smaller, and accordingly, the highest erosion rates were located in the most sinuous portion of the river (between RM 40 and RM 60). The findings of the USACE study are totally consistent with the literature on erosion rates on meandering rivers. Further analysis including the addition of the channel widths to the USACE radii of curvature and erosion rate data for the studied bends permits the Apalachicola River data to be compared with data from other rivers. The maximum erosion rates are associated with radius of curvature to channel width ratios (R/W) of between 1.5 and 2.5, which is consistent with the literature. Dr. Harvey noted that these maximum erosion rates (about 10 ft/yr) are consistent with those calculated for the Alabama River, but are very low in comparison with those reported for other large alluvial rivers. Erosion rates in this range do not suggest that bank erosion on the middle reaches of the Apalachicola River is in response to an upstream sediment deficit. Bank erosion appears to be consistent with what is to be expected for sand bed meandering rivers.
- The upper portion of the lower reach (RM 42 – RM35) is very sinuous and the banks exhibit widespread erosion on the outside bends leading to active channel migration. As stated previously this appears to be the result of the river responding to active tectonics. This high sinuosity could also be due to the diversion of about 35% of the flow (and very little of the bed material load) into the Chipola Cutoff (RM 41.5). This diversion effectively increases the sediment supply to the upper portion of the lower reach which in turn accelerates the meander processes. Below RM 35 the sinuosity is much lower and there is little evidence of channel migration.
- Stage data at the Sumatra gauge do not indicate that the bed of the river has degraded or the channel has widened in the post-dam period and there is no evidence that the bed material has coarsened.

- There is concern regarding the USGS reports that significant widening has occurred in throughout the Apalachicola River. Given the uncertainty associated with these measurements (Smith and Vincent, 2004) and the extensive presence of dredge material disposal sites, especially within the reach between RM 35 and RM 42 that limit vegetation recovery, it is unclear whether the river has actually widened in this reach in the post-dam period. Field observations do not indicate that both channel banks are eroding along the reach, rather the bank erosion is limited to the outside of bends, which is to be expected.
- Fat threeridge mussel habitat appears to be associated with eddy deposits (downstream end of bends, backwater bars, dike fields). Qualitative sampling data for the fat threeridge mussel in the Apalachicola River appear to support the hypothesis that the fat threeridge habitat is formed and maintained by meander processes. These types of habitat are ephemeral and change with time and space. Rates of change are a function of the frequency and magnitude of flood events. Distributary channels (e.g. Swift Slough) which can support mussels are also ephemeral features and are expected to become disconnected or fill in with sediment as the channel migrates through the floodplain. However, these active meander processes are likely to create new channels as the older distributary channels are eliminated. Dr. Harvey noted that based on the qualitative sampling data from the dike field at RM 47.4, it appears that suitable habitat can be created if amount of habitat available is deemed a limiting factor.
- The mortality occurring at sites located along the mainstem of the river and Swift Slough in 2006 appear to be related to deposition of sandy bed material and can be explained by the dynamics of the river.
- Dr. Harvey noted that the erosion rates within the highly sinuous reach are low in comparison to other alluvial rivers and are unlikely to increase over time under the current operations of the system. Bends with low radii of curvature (RM 62, RM 50, RM 43, RM 40, and RM 38) could cutoff in the not too distant future (dependent on hydrology). This would result in reduced sinuosity and increased hydraulic slope.
- Available data do not indicate that the river is continuing to degrade, and in fact the uniformity of the average channel slopes in all three reaches (0.000093 – 0.000095) suggests that the river may have attained a measure of equilibrium. This hypothesis should be further tested by development of a sediment budget for the river.
- Additional studies are needed to speculate on future trends in channel width as there is some uncertainty in the comparative channel width measurements utilized to date. If the channel is indeed widening, then the river processes or anthropomorphic means responsible need to be determined.
- Dr. Harvey made the following recommendations regarding additional study efforts:
    - Conduct an in-depth quantitative geomorphic assessment of the river between the dam and RM 20;
    - Develop a one-dimensional sediment continuity analysis using the SIAM computer code;
    - Develop two-dimensional hydrodynamic models of selected listed mussel habitat sites located: 1) downstream of a bend, 2) in association with a backwater-induced bar complex, and 3) in the upper reach of a distributary channel; and
    - In conjunction with the mussel experts use the results of the above to develop a biological process-physical response model that can be used to predict the

impacts of water management operations at Jim Woodruff Dam on fat threeridge mussel habitat.

5. Dr. Miller concluded the first day of the workshop with a presentation on the sampling efforts he conducted this summer and a recommendations for long-term studies.

- Dr. Miller provided a brief review of fresh water mussels and the fat threeridge in particular. He followed this with a discussion on the methodology and results of this summer's sampling.
- Based on the May 2007 reconnaissance field trip conducted by representatives of the Mobile District, USFWS, and FWCC, personnel of the USFWS identified 25 study areas between RM 40 and 50 along the Apalachicola River which either supported, or appeared likely to support *A. neislerii*. Detailed field studies were conducted at the 10 randomly selected sites and partial (qualitative) studies were conducted at most remaining sites (23 total). In addition, one new site (DS01) was added at a disposal area of interest at the downstream extent of the reach. The 25 sites chosen by USFWS had one or more of the following characteristics: 1) stable, gently sloping banks primarily vegetated with newly established black willow, 2) dense and species-rich mussel assemblages, 3) firm substratum consisting of silty sand, or 4) signs of recent mussel mortality from low water in 2006 and 2007. Virtually every one of these areas was along a moderately depositional reach that was immediately downriver of a point bar.
- *A. neislerii* was found at 23 of the 25 areas between NM 40 and 50. This species comprised nearly 37% of the mussel fauna and at least one individual was present in approximately 30% of the 180 quadrats sampled. Dr. Miller noted that it is unusual to have an endangered species dominate the mussel assemblage.
- Total mean density of *A. neislerii* ranged from 0.2 to 12.7/m^2. The maximum number of *A. neislerii* in a single quadrat at site DM14 was 13 individuals, corresponding to a density of 52/m^2. At the 10 sites surveyed, total mean density (all species) ranged from 2.4 to 28.9 individuals/m^2. Compared with other medium-sized to large rivers, total mussel density in the Apalachicola River is moderate to low.
- Qualitative and quantitative data were used to predict density of *A. neislerii* from CPUE ($Y = 0.28X – 0.77$; $R^2 = 0.59$) for sites where only CPUE data were obtained. If only a 1-m strip (to a water depth of approximately 50 cm) of live *A. neislerii* existed along the shore at each location surveyed between NM 40 and 50, then the total population size at all 25 sites would be estimated at 19,000 individuals. It is likely that this strip is wider than 1 meter and extends into deeper water. Therefore, the total population of *A. neislerii* at these 25 locations probably exceeds 19,000 individuals. In addition, this figure does not include other sites both in and outside the study reach that also support *A. neislerii*.
- There was evidence of strong recent *A. neislerii* recruitment at the sample sites. *Amblema neislerii* is most abundant close to shore and becomes less common moving offshore.
- Dr. Miller agreed that the 2006 mortalities observed during low water conditions appear to be the product of natural river processes. He also noted that Swift Slough supported substantial mussel populations prior to 2006. It is unclear exactly how many *A. neislerii* were in Swift Slough prior to the low water. Regardless, it is difficult to imagine that a 1-mile segment of ephemeral off channel habitat contributed substantially to *A. neislerii* populations in the river (since this species is more prolific in main stem large river

channels). This species is abundant and shows good evidence of recent recruitment at many sites, regardless of the recent low water. There is no reason to believe that a 3,000 m slough could be of much value for a species that is remarkably abundant in moderately depositional habitats that are common in the main stem of the river.

- In the Apalachicola River, like all rivers, mussel distribution is influenced by fish behavior, flow pattern, and velocity. If currents are too erosional, juvenile mussels cannot settle, and if they do, survival is poor. If immature mussels are dropped in reaches with excessive sedimentation, they can be buried and killed. Juveniles almost certainly are more susceptible than adults to sediment accretion and scour. Mussel collections and observations tend to be made mostly in summer and fall at low water. Yet recruitment, which affects adult distribution, usually occurs in periods of higher flow in the spring. The physical effects of water velocity, when integrated over many years, define water depth, sediment characteristics, bank slope and the nature of the riparian community. Regardless, unionid abundance and distribution in rivers is dependent upon flow characteristics at large and small scales. Long-term monitoring should be conducted, including sediment and velocity modeling, in order to provide a better understanding of the distribution and abundance of *A. neislerii* in the Apalachicola River.
- Dr. Miller recommended the following types of long-term study:
    - Knowledge of riverine geomorphic processes is needed to understand effects of reduced flow on the density and distribution of important mussel resources. Three sites that support dense and species rich mussel assemblages would be selected for intensive long-term study and sediment and hydrodynamic models could be used to identify site specific habitat conditions relative to the mussel distribution. The models could also be used to demonstrate how biologically important parameters change in response to various flows and river processes.
    - Conduct stratified random sampling across the various types of mussel habitat in the river in order to estimate mussel population distribution and abundance.

6. The second day (half day) of the workshop consisted of open discussion of the previous day presentations. Specific discussions included:

- Large sample sizes are sometimes required to reach acceptable confidence margins for population estimates.
- Current data suggests that *Amblema* population in Apalachicola River is relatively robust.
- A stratified random design is appropriate for estimating mussel abundance in the river.
- The stratified random design could be accomplished by 1) mapping potential mussel habitat areas (eddies etc.); 2) sorting the habitat by specific type; 3) randomly sampling subgroups from each habitat type; and 4) apply density estimates from samples to amount of habitat available for each type.
- Additional studies could include looking at habitat change over time and mussel response, as well as, using 2D models that measure velocity, vector, and bed sheer stress to understand site specific mussel “hot spots”.
- Mark Antwine mentioned that recent satellite imagery could be purchased and utilized to determine the amount of vulnerable habitat compared to relatively stable habitat. This would help verify the theory that the 2006 mortality sites represent only a small portion of the suitable mussel habitat.

- Jerry Ziewitz suggested that we should coordinate our mussel sampling strategy with Florida’s plan in order to avoid duplication of effort and perhaps be able to produce more refined population estimates. He will facilitate these discussions.
- Dr. Harvey and Dr. Biedenharn agreed to edit their Summary of Findings reports and provide final copies the following week.
- Dr. Miller agreed to edit and incorporate the sediment sampling data and new study recommendations into his long-term monitoring proposal and provide a draft copy the following week.

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Encl
Agenda
Presentations
Reports